35IHSSF10,625

35IHSSF10,625

Site Name (Subject):	STEWART-WARNER CORP/BASSICK-SACK
Site ID (Document ID):	NCD024895864
Document Name (DocType):	Other (O)
Report Segment:	
Date of Document:	9/30/1992
Date Received:	
Box: *Enter SF and # with no spaces*	SF10,625
Access Level:	PUBLIC
Division:	WASTE MANAGEMENT
Section:	SUPERFUND
Program (Document Group):	IHS (IHS)
Document Category:	FACILITY

Print Report for Record | Go to New Blank Record | Go to New Record - (default to last record values) | Delete Record

ILCO-UNICAN CORPORATION

Chronology and Background
to Soil Contaminants

September 30, 1992

STATE FILE

CHRONOLOGY AND BACKGROUND TO SOIL CONTAMINANTS

1/19/88 Ilco contracts to purchase site from Stewart-Warner ("SW").

- SW discloses two spill sites which occurred in 1987, agrees to remediate those two sites after the Transfer Day to approval of "final authority."

- SW warrants that, to the knowledge of its officers and management, rest of property is free of "hazardous waste chemical contaminants" at levels which require reporting under any applicable environmental law.

2/4/88 Transfer Day.

2/88 SW notifies Ilco that an employee has disclosed that an unknown number of drums were buried on the property during the 1950's, and agrees to take whatever remedial action required.

2/88-11/88 Stewart-Warner's contractor remediating two disclosed spill sites and drum pits. (Parties now dispute whether disclosed sites cleaned to approval of final authority.)

5/88-11/88 Through internal audits, Ilco begins to discover wastes in other areas besides the two spill sites and drum pits disclosed by SW before the sale, including:

foundry wastes in baghouses and soils around baghouses,

buffing waste on the roof and soils,

electroplating waste below electroplating lines,

plating wastes along adjacent railroad tracks outside scope of spill which occurred after Ilco took over, and

plating and other wastes described by former SW employees as (two) former waste piles, undisclosed by SW.

11/88- present Ilco voluntarily undertakes to remediate wastes described above discovered after sale which were not disclosed by SW. Ilco has spent approximately $197,600.00 to date in remediation.

To date, Ilco has cleaned up:

- electroplating waste under electroplating lines,

- buffing waste on the roof, and

- foundry waste in baghouses.

Ilco has also: removed undiked tanks, blocked pipe leading outside from waste treatment system, a source of previous spills, discontinued use of tetrachloroethane, built new diking around electroplating lines, discontinued use of underground pipes from electroplating to waste treatment, installing new piping in the ceiling, installed a new DMP waste treatment system and sludgedryer.

<u>What remains to be addressed are areas of soil contamination outside two spill sites disclosed by SW</u>, specifically:

(i) two former waste piles,

(ii) foundry waste around baghouses, and

(iii) runoff of buffing waste from the roof.

1/91 After protracted negotiations, Ilco files cost recovery lawsuit against SW.

4/91 SSI completed by Greenhorne & O'Mara for DEHNR, recommending further investigation in next phase of pre-remedial process.

11/91 After old employee discloses existence of a well underneath heavy equipment on-site, Ilco samples water in the well, detecting small amounts of tetrachloroethane and trichloroethene.

5/92 Ilco has monitoring well installed near former drum pit areas. Results show same contaminants in pits also in groundwater in that area, including tetrachloroethane and trichloroethene.

7/92 Ilco has Engineering Evaluation/Cost Analysis ("EECA") (evaluation of non-time critical removal actions) completed for contaminated soil areas. **See Exhibit A.**

9/92 Ilco has sampling completed in contaminated soil areas. **See Exhibit B.**

late 1992 Site scheduled for ESI by DEHNR, Superfund Branch.

mj1660/081
state.930

A

ENGINEERING EVALUATION/COST ANALYSIS (EE/CA) OF REMOVAL ACTION ALTERNATIVES FOR THE ILCO-UNICAN FACILITY

July 1992

ENGINEERING EVALUATION/COST ANALYSIS (EE/CA) OF REMOVAL ACTION ALTERNATIVES FOR THE ILCO-UNICAN FACILITY

July 1992

Prepared for

ILCO-UNICAN
Winston-Salem, North Carolina

Prepared by

Geraghty & Miller, Inc.
180 Admiral Cochrane Drive
Suite 300
Annapolis, Maryland 21401
(410) 224-8777

CONTENTS

Page

1.0 INTRODUCTION 1-1
1.1 OVERVIEW 1-1
1.2 SITE DESCRIPTION 1-2
1.3 SUMMARY OF PREVIOUS INVESTIGATIONS 1-3
1.3.1 Background History 1-3
1.3.2 Research and Analytical Laboratories, Inc. Investigations 1-4
1.3.3 Weston Environmental Consultants Investigation 1-6
1.3.4 Ground-water Technology Investigation 1-6
1.3.5 Geraghty & Miller, Inc. Investigation 1-8
1.4 SITE CONDITIONS 1-8

2.0 REMOVAL ACTION OBJECTIVES 2-1
2.1 REMOVAL SCOPE AND SCHEDULE 2-1
2.1.1 Areas Under Consideration 2-1
2.1.2 Preliminary Soil Remedial Goals 2-1
2.1.3 Quantities of Affected Media 2-2
2.1.4 Removal Schedule 2-2
2.2 IDENTIFICATION OF APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARAR) 2-2
2.2.1 Chemical-Specific ARARs 2-3
2.2.2 Action-Specific ARARs 2-4
2.2.3 Location-Specific ARARs 2-4
2.2.4 To-Be-Considered Information and Criteria 2-4

3.0 DEVELOPMENT OF REMOVAL ACTION ALTERNATIVES 3-1
3.1 IDENTIFICATION OF POTENTIAL REMOVAL ACTION TECHNOLOGIES 3-1
3.1.1 Excavation 3-1
3.1.2 Off-Site Disposal 3-1
3.1.3 On-Site Landfill Disposal 3-2
3.1.4 Capping 3-3
3.1.5 In-situ Treatment 3-3
3.1.5.1 Stabilization 3-4
3.1.5.2 Vitrification 3-5
3.1.5.3 Soil Flushing 3-6
3.1.6 Ex-situ Treatment 3-6
3.1.6.1 Stabilization 3-7
3.1.6.2 Soil Washing (Solvent Extraction) 3-7
3.2 ASSEMBLY OF REMOVAL ACTION ALTERNATIVES 3-8

CONTENTS (Continued)

4.0 ANALYSIS OF REMOVAL ACTION ALTERNATIVES 4-1
4.1 EVALUATION CRITERIA 4-1
4.1.1 Effectiveness 4-1
4.1.2 Implementability 4-2
4.1.2.1 Technical Feasibility 4-3
4.1.2.2 Availability 4-3
4.1.2.3 Administrative Feasibility 4-4
4.1.3 Cost 4-4
4.2 REMOVAL ACTION ALTERNATIVE 1 - CAPPING 4-4
4.2.1 Effectiveness 4-5
4.2.2 Implementability 4-6
4.2.2.1 Technical Feasibility 4-6
4.2.2.2 Availability 4-6
4.2.2.3 Administrative Feasibility 4-6
4.2.3 Cost 4-7
4.3 REMOVAL ACTION ALTERNATIVE 2 - CAPPING AND IN-SITU STABILIZATION 4-7
4.3.1 Effectiveness 4-8
4.3.2 Implementability 4-8
4.3.2.1 Technical Implementability 4-8
4.3.2.2 Availability 4-9
4.3.2.3 Administrative Feasibility 4-9
4.3.3 Cost 4-9
4.4 REMOVAL ACTION ALTERNATIVE 3 - FULL EXCAVATION AND OFF-SITE LANDFILL DISPOSAL 4-10
4.4.1 Effectiveness 4-10
4.4.2 Implementability 4-11
4.4.2.1 Technical Implementability 4-11
4.4.2.2 Availability 4-12
4.4.2.3 Administrative Feasibility 4-12
4.4.3 Cost 4-13
4.5 REMOVAL ACTION ALTERNATIVE 4 - EXCAVATION WITH SOIL WASHING AND LANDFILL DISPOSAL 4-13
4.5.1 Effectiveness 4-13
4.5.2 Implementability 4-15
4.5.2.1 Technical Implementability 4-15
4.5.2.2 Availability 4-16
4.5.2.3 Administrative Feasibility 4-16
4.5.3 Cost 4-16

CONTENTS (Continued)

4.6 REMOVAL ACTION ALTERNATIVE 5 - EXCAVATION WITH STABILIZATION AND OFF-SITE LANDFILL DISPOSAL 4-17
4.6.1 Effectiveness 4-17
4.6.2 Implementability 4-18
4.6.2.1 Technical Implementability 4-18
4.6.2.2 Availability 4-19
4.6.2.3 Administrative Feasibility 4-19
4.6.3 Cost 4-19
4.7 REMOVAL ACTION ALTERNATIVE 6 -EXCAVATION/ STABILIZATION/LANDFILL DISPOSAL WITH SINGLE BARRIER CAPPING 4-19
4.7.1 Effectiveness 4-20
4.7.2 Implementability 4-21
4.7.2.1 Technical Implementability 4-21
4.7.2.2 Availability 4-22
4.7.2.3 Administrative Feasibility 4-22
4.7.3 Cost 4-23
4.8 REMOVAL ACTION ALTERNATIVE 7 -EXCAVATION/ STABILIZATION/LANDFILL DISPOSAL WITH IN-SITU STABILIZATION AND SINGLE BARRIER CAPPING 4-23
4.8.1 Effectiveness 4-24
4.8.2 Implementability 4-25
4.8.2.1 Technical Implementability 4-25
4.8.2.2 Availability 4-26
4.8.2.3 Administrative Feasibility 4-26
4.8.3 Cost 4-26

5.0 COMPARISON OF REMOVAL ALTERNATIVES 5-1
5.1 EFFECTIVENESS 5-1
5.2 IMPLEMENTABILITY 5-2
5.2.1 Technical Implementability 5-2
5.2.2 Availability 5-2
5.2.3 Administrative Implementability 5-3
5.3 COST 5-3

6.0 PROPOSED REMOVAL ACTION 6-1

7.0 REFERENCES 7-1

1.0 INTRODUCTION

1.1 OVERVIEW

This Engineering Evaluation/Cost Analysis (EE/CA) has been prepared to document the evaluation and selection of a removal action alternative for the ILCO-UNICAN facility in Winston-Salem, North Carolina. Previous studies performed at the facility have indicated that the soils in various locations throughout the facility have been impacted by inorganic constituents associated with the operational and waste management practices of the previous owner and operator. The areas which have been affected include the soils around the two baghouses, the sludge piles in the southeastern portion of the property, and the soils around the areas subject to roof run-off. The constituents of concern include zinc, copper, lead, chromium, cyanide, and nickel. As discussed in the Removal Action Evaluation presented in Appendix A, a removal action has been judged to be appropriate for the site because the affected soils pose potential risks to human health and the environment.

This EE/CA has been prepared in accordance with the procedures described in guidance issued by the U.S. Environmental Protection Agency (USEPA) entitled, "Draft Engineering Evaluation/Cost Analysis Guidance For Non-time-critical Removal Actions" (USEPA 1988). The EE/CA for the ILCO-UNICAN facility is also consistent with the requirements of the National Oil and Hazardous Substances Contingency Plan (NCP [Title 40 Code of Federal Regulations, Part 300]). According to the NCP, an EE/CA is required only for non-time-critical removal actions wherein the release or threatened release does not require initiation of on-site activity within 6 months after a removal action is deemed to be appropriate. The site conditions and risks posed by the affected soils at the ILCO-UNICAN facility necessitate that action be taken in a timely, but not immediate, manner. For this reason, the removal action contemplated for the ILCO-UNICAN facility constitutes a non-time-critical removal action.

The EE/CA for the ILCO-UNICAN facility has been organized according to the format suggested in USEPA guidance. A description of the site and a summary of the

previous investigations conducted at the facility are provided in the remainder of Section 1.0. The objectives for the removal action including the scope, schedule, and regulatory requirements are identified in Section 2.0. Section 3.0 describes the identification of potentially applicable removal action technologies and the development of removal action alternatives. Each prospective removal action alternative is evaluated individually in terms of its effectiveness, implementability, and cost in Section 4.0 and compared against the other alternatives in Section 5.0 The removal action alternative selected for implementation and the rationale for that selection are presented in Section 6.0.

1.2 SITE DESCRIPTION

The ILCO-UNICAN facility is located in Winston-Salem, North Carolina. The facility had been in operation under Stewart Warner from 1945 to 1988 finishing furniture hardware. Operations performed at the site included foundry work, vibratory finishing, electroplating, oxidizing, buffing, lacquering, painting, and degreasing. As a result of these operations, waste generated included electroplating sludges, baghouse wastes, spent halogenated solvents, and ignitable wastes. In 1988, ILCO-UNICAN purchased the property and modified the facility for lock manufacturing.

Winston-Salem, North Carolina is located near the western edge of the Piedmont Physiographic Province. The topography in the region is characterized by rolling hills which resulted from the partial dissection of streams during regional uplift of the pre-existing peneplane. Subsurface geology consists generally of bedrock composed of biotite, gneiss, schists, and other metamorphic rock types. A mantle of fine-grained soils consisting of fine sands, silts, and clays overlay the bedrock. This mantle was derived from the weathering of underlying bedrock material. Its thickness ranges to over 60 feet.

Ground water is encountered within the weathered soils under water table conditions, and has been discovered at approximately 41 feet below land surface. The businesses and

residences in the immediate vicinity of the site are reportedly served by the public water supply system.

1.3 SUMMARY OF PREVIOUS INVESTIGATIONS

1.3.1 Background History

The following sections summarize prior investigations conducted at the ILCO-UNICAN site. Laboratory data and information referenced in various reports have not been validated by Geraghty & Miller, Inc., but will be considered accurate and valid.

In May of 1982, an emergency hazardous waste permit was issued to Stewart-Warner in response to a cyanide plating solution spill that occurred on May 5, 1982. The permit allowed chemical treatment of soils containing cyanide to below 6 parts per million (ppm) for total cyanide. This clean-up criterion was later revised to 10 parts per billion (ppb) for cyanide gas emissions and 5 ppb for cyanide in the surface-water run-off. In November of the same year, the North Carolina Department of Environment, Health and Natural Resources (NCDEHNR) determined that the clean-up criteria for cyanide had been achieved, and that no additional soil treatment was necessary.

Two additional spill incidents involving cyanide plating solution occurred in April, 1986 and February, 1987. Over 250 gallons of cyanide plating solution were spilled during both incidents. In response to the 1987 spill, a Notice of Violation was issued by the SHWMB which required the development of a comprehensive sampling and analysis plan to characterize the extent of soil contamination and provide plans for remedial action.

1.3.2 Research and Analytical Laboratories, Inc. Investigations

Research & Analytical Laboratories, Inc. (RAL) was retained by Stewart-Warner to develop the sampling and analysis plan (RAL 1987a) to address spill sites 1 and 2. The

sampling and analysis plan set forth a grid pattern for the collection of soil samples. Soil samples were collected at various depth intervals up to one foot below ground surface. The collection program resulted in one sample per depth-interval per quadrant. The Solid and Hazardous Waste Management Branch (SHWMB) approved the sampling and analysis plan and mandated a clean-up criteria. The SHWMB also set heavy metal clean-up limits for the site based on drinking water standards and use of the EP Toxicity leaching procedure (EP Tox). The soil clean-up limits set by the SHWMB were as follows:

- chromium - 0.05 ppm;
- nickel - 0.35 ppm; and,
- cyanide - 0.2 ppm.

As required by the SHWMB, the presence of these substances was determined using an extraction technique prior to analysis (i.e., the EP Tox). In addition to the above, the SHWMB also provided a working concentration of 40 ppm for total cyanide. The SHWMB indicated that Steward-Warner could be subject to enforcement by the Division of Environmental Management.

RAL concluded from this investigation that zinc, copper, and cyanide extended the full length of the sampling depth which ranged from 9 to 12 inches. The maximum allowable leachate concentration of chromium was not exceeded. Leachate concentrations of nickel ranged from 0.42 to 6.0 ppm. Based upon the analytical data, RAL determined that remediation of affected soil would consist of excavation and backfilling with clean fill. RAL further determined that the soil would be excavated to a depth of 1.5 feet below ground surface and backfilled with confirmation sampling and additional excavation if necessary. The SHWMB reaffirmed the clean-up limits identified above.

RAL conducted an additional assessment of soil contamination outside of spill areas 1 and 2 which covered the southeastern portion of the facility. The investigation included the collection of soil samples within various quadrants and 3-inch intervals down to one foot below ground surface. Analytical data for this sampling event were compared with pre-existing clean-up criteria specified by the SHWMB for chromium, nickel, lead, zinc, copper, and cyanide. Cadmium was not addressed. RAL concluded that concentrations of constituents of concern for 17 of the quadrants investigated during this investigation exceeded the clean-up levels identified above. RAL also concluded that spill sites 1 and 2 and the unpaved land surrounding these areas exhibited the presence of constituents of concern traceable to Bassick-Sack industrial processes. RAL further determined that the sources of constituents in the southeastern quadrants were the following:

- inadequate air exhaust and ventilation systems as evidenced by chemical waste dust accumulation and sampling;

- failure to adequately implement a hazardous waste management and spill prevention program; and,

- the practice of dumping chemical waste in past years.

RAL prepared a report in March, 1988, which summarized the investigation conducted which included the collection of soil samples in various sections of the excavated spill sites. Samples were analyzed for the presence of zinc, copper, lead, chromium, nickel and cyanide. The samples collected during this investigation were split with the SHWMB. Analytical results indicated that concentrations of nickel exceeded the clean-up criteria set by the SHWMB. Cadmium was not addressed in RAL's 1988 analytical program.

In July, 1988, three pits, identified as A, B and C, were excavated by GSX Environmental Services. A summary of the procedures employed during closure of these pits was presented in RAL's 1988 report. Drums, metal debris, crucibles, and contaminated

soils were excavated during this work. Excavation and sample collection reportedly continued until soils no longer exhibited visual indications of discoloration. After excavation was completed, the pits were backfilled with clean soil and compacted. The excavated soils were reportedly disposed of by landfilling at an off-site facility.

1.3.3 Weston Environmental Consultants Investigation

ILCO-UNICAN purchased the facility from Stewart-Warner in 1988. After a review of RAL's reports and considering observations made during several site visits, ILCO-UNICAN performed preliminary sampling and analysis of the roof dust and, collected soil samples from the areas surrounding the baghouses. One sample was collected at the ground surface, and the other sample was collected at a depth of 12 inches below ground surface.

In October, 1990, Weston Environmental Consultants (Weston) was retained by Stewart-Warner to complete soil borings in Pits A, B, and C. Two soil borings were advanced in each pit area. Volatile organic compounds (VOCs) were not detected in samples collected from pits A and B. However, the analytical data for pit C indicated the presence of tetrachloroethene ranging in concentrations from 6 to 1,500 ppb. Trichloroethene was also detected in Pit C at concentrations ranging from 5 to 680 ppb. Both of these chlorinated VOCs were detected at depths of up to 22 feet below the ground surface.

1.3.4 Ground-water Technology Investigation

During 1991 confirmation sampling was conducted by Ground-water Technology, Inc. (GTI) in the vicinity of spill sites 1 and 2 to evaluate the presence or absence of metals, cyanide, and VOCs. During this confirmatory investigation, GTI obtained soil samples from 42 locations. Confirmation soil samples were collected at depth intervals of 0 to 0.5 feet and 1.5 to 2.0 feet below ground surface. Soil samples collected from the baghouses and areas susceptible to roof run-off were collected at two depth intervals. Soil samples were

submitted to IEA Laboratories for analyses relative to the following parameters: Toxicity Characteristic Leaching Procedures (TCLP) for copper, lead, zinc, nickel, chromium, and cadmium and total cyanide. Two soil samples were screened for VOCs using in-the-field headspace methodologies. The samples with the greatest concentrations were submitted for VOC analysis by USEPA Method 8240.

The GTI results show that leachable levels of lead, copper, nickel and zinc were present in soils from the roof run-off areas, baghouse areas, and former plating sludge waste pile areas. Nearly all soil samples showed lead leachate levels to exceed the MCLs, the State of North Carolina's clean closure standard. GTI's TCLP results for nickel concentrations in soil leachate and total cyanide were above the state's 1987 clean up levels at selected locations.

1.3.5 Geraghty & Miller, Inc. Investigation

Geraghty & Miller, Inc. was retained by ILCO-UNICAN to perform additional field work to obtain information necessary for a quantitative evaluation of the potential risks to human health and the environment associated with the site. Under this investigation, additional soil samples were collected from selected locations previously sampled by GTI. The samples were analyzed for total metals (modified hazardous substance list) and total cyanide.

ILCO-UNICAN also authorized Geraghty & Miller, Inc. to install a water-table monitor well downgradient of pit C. The monitor well was sampled and analyzed for VOCs and metals according to a modified hazardous substance list. Analytical data for ground-water collected from the pit C monitor well indicated the presence of several chlorinated VOCs.

1.4 SITE CONDITIONS

Studies and investigations previously conducted at the ILCO-UNICAN site indicate that soils found at various locations throughout the facility have been impacted by operational and waste management practices of the previous owner/operator, Steward-Warner. Several factors, discussed in the Removal Evaluation presented in Appendix A, pursuant to Section 53(2) of CERCLA are applicable to the ILCO-UNICAN site in justifying the necessity of a removal action compliant with the NCP. The factors are as follows:

- actual or potential exposure to nearby human populations, animals, or the food chains from hazardous substances, pollutants or contaminants;

- high levels of hazardous substances or pollutants or contaminants in soils largely at or near the surface that may migrate; and,

- weather conditions that may cause hazardous substances or pollutants or contaminants to migrate or be released.

2.0 REMOVAL ACTION OBJECTIVES

The objectives for the removal action that will be performed at the ILCO-UNICAN site are identified in this section. Additionally, the chemical- and location-specific Applicable or Relevant and Appropriate Requirements (ARARs) that were identified for the site constituents and location are presented and evaluated in this section. Action-specific ARARs pertinent to each removal action alternative will be identified once those alternatives are formulated (Section 4.0).

2.1 REMOVAL SCOPE AND SCHEDULE

2.1.1 Areas Under Consideration

The scope of the potential removal action contemplated for the ILCO-UNICAN site encompasses soil which has been impacted by the constituents of concern (i.e., zinc, copper, lead, chromium, cyanide, and nickel) throughout the facility. Specifically, the affected soils proximate to the two baghouses, areas subject to run-off from the roof, and the former plating sludge waste piles in the southeastern portion of the property will be addressed under this removal action. The locations of these areas are depicted in Figure 1.

Soil samples representative of the areas under consideration contained total metals above the preliminary soil remediation goals (PSRGs). Baghouse soils contained excessive (i.e. above PSRGs) copper and lead to a depth of 6 inches. Roof run-off soils contained excessive arsenic and elevated levels (less than the PSRG) of copper, lead and zinc. Plating sludge waste pile soils contained excessive levels of arsenic, chromium, copper, lead and zinc.

2.1.2 Preliminary Soil Remedial Goals

Preliminary soil remediation goals (PSRGs) were calculated for the ILCO-UNICAN facility in accordance with the procedures described in USEPA guidance (USEPA 1991).

PSRGs were calculated for both industrial and hypothetical residential exposure scenarios. Additionally, PSRGs were calculated separately for both carcinogens and non-carcinogens. Of the 15 constituents detected at the site, arsenic, beryllium, cadmium, chromium (hexavalent form only), and nickel are regulated as carcinogens. Cadmium, chromium, and nickel are only considered carcinogenic from inhalation exposure. PSRGs for carcinogens were calculated for both cancer and non-cancer effects. The lower value should be selected as the PSRG. If the lowest health-based PSRG was lower than background, the appropriate PSRG was set at two times the background concentration. This method is consistent with USEPA Region IV policy. For example, the residential PSRG for arsenic of 0.37 milligrams per kilogram (mg/kg) was below background.

The arsenic PSRG for industrial land use was 3 mg/kg and was also below the average concentration in the background samples; therefore, the PSRG for arsenic is 10 mg/kg (twice the average background). Beryllium was not detected in background samples; however, the average concentration reported for the eastern U.S. was 0.87 mg/kg (Shacklette and Boerngen, 1984). The PSRG for beryllium is 1.8 mg/kg. The results of the PSRG calculations are provided in Appendix B.

For purposes of this EE/CA and the pursuant removal action, the PSRGs calculated for the hypothetical residential exposure scenario have been selected as the removal goals for the ILCO-UNICAN facility. Although the facility is utilized solely for industrial purposes and there is no intention of developing housing on this property in the foreseeable future, this conservative selection was made because of the proximity of the facility to residences and public schools.

2.1.3 Quantities of Affected Media

Based upon available soil quality data from previous studies and the PSRGs presented in Table 1, it has been estimated that a total of approximately 385 cubic yards (CY) of soils will be addressed under the selected removal action. This estimate includes

approximately 100 CY of soil around the baghouses, 225 CY in the former plating sludge waste piles, and 60 CY around the roof drain near sample location RR-3. While the exact quantities are not known, the accuracy of these estimates is sufficient to support the evaluation and selection of removal action alternatives. A more accurate determination of the quantity of affected soils in each area will be required prior to initiating implementation of the selected removal-action alternative.

2.1.4 Removal Schedule

Since the removal action contemplated for the site is a non-time critical action, the schedule for the removal action is flexible. The goal for this removal action is to complete implementation within approximately 12 months.

2.2 IDENTIFICATION OF APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARAR)

The 1985 version of the NCP established a provision that remedial actions at CERCLA sites must attain clean-up standards (requirements) that are considered to be applicable, or relevant and appropriate for that site. Applicable requirements are, "...those cleanup standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under Federal or State law that specifically address a hazardous substance, pollutant, contaminant, remedial action, location or other circumstances at the CERCLA site." [NCP as revised in 55 FR 8665, March 8, 1990]. Relevant and appropriate requirements are those standards that, "...address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well suited to the particular site." [NCP as revised in 55 FR 8665, March 8, 1990]. Section 121(d) of Superfund Amendments and Reauthorization Act (SARA) adopted and expanded this provision to require attainment of Federal ARARs, and of State ARARs in State environmental or facility siting laws, when the promulgated State requirements are more

stringent than Federal Laws. According to the NCP, removal actions should attain ARARs to the extent practicable.

Potential ARARs for the removal action at the ILCO-UNICAN facility were identified and evaluated to determine their status in accordance with the procedures described in USEPA guidance (USEPA 1988b). Federal and North Carolina regulations pertaining to air, land use, ground water and drinking water were reviewed to determine which regulations were potentially appropriate, relevant, and/or applicable for the ILCO-UNICAN site. ARARs pertaining to removal actions at the ILCO-UNICAN site are identified in this section and presented in Tables 2 and 3.

2.2.1 Chemical-Specific ARARs

Chemical-specific ARARs are risk- or health-based numerical values or methodologies that establish acceptable quantities or concentrations of a hazardous substance or pollutant that may be found in, or discharged to, the environment. Since the media to be addressed consists of soil and the state has not promulgated clean-up limits for soils, there are no chemical-specific ARARs that pertain directly to soil.

There are several potential chemical-specific ARARs that relate to the removal action contemplated in this EE/CA. For example, regulations governing particulate emissions would pertain to the earthmoving and material handling activities that may be elements of the selected removal action. The "ancillary" chemical-specific ARARs that have been identified for the ILCO-UNICAN site are presented in Table 2.

2.2.2 Action-Specific ARARs

Action-specific ARARs are technology- or activity-based requirements, limitations, and constraints imposed on the specific removal actions under consideration. These requirements may relate to an entire removal alternative, or to component technologies of

that alternative. General action-specific ARARs identified for the ILCO-UNICAN site are summarized in Table 3. Additional action-specific ARARs relating to specific removal alternatives are presented in Section 4.0 of this EE/CA.

2.2.3 Location-Specific ARARs

Location-specific ARARs are those regulations that place restrictions on the concentrations of hazardous substances or performance of activities because they occur in a specific location, such as a wetland, floodplain, seismic zone, historic place or sensitive ecosystem. No location-specific ARARs have been identified for the ILCO-UNICAN site because the site is not situated in any of the aforementioned areas.

2.2.4 To-Be-Considered Information and Criteria

Other information and criteria to be considered during the EE/CA consist of non-promulgated advisories or guidance. As discussed in Section 1.3.2, the SHWMB previously established clean-up levels for the site. The clean-up limits established by the SHWMB will be considered in this EE/CA. The risk-based PSRGs discussed in Section 2.1.2 will be relied upon to gauge the protectiveness that can be achieved by the removal action alternatives under consideration. The PSRGs were selected for this purpose because they have been derived according to procedures outlined in USEPA guidance and are therefore based upon site-specific exposure scenarios.

3.0 DEVELOPMENT OF REMOVAL ACTION ALTERNATIVES

3.1 IDENTIFICATION OF POTENTIAL REMOVAL ACTION TECHNOLOGIES

The identification of potential removal action technologies for the ILCO-UNICAN facility utilized several sources of information. The first source was the master list of potential technologies contained in USEPA guidance entitled, "Guidance For Conducting Remedial Investigations and Feasibility Studies Under CERCLA." In addition, potential removal technologies were identified using the USEPA's Risk Reduction Engineering Laboratory (RREL) Treatability database (version 4.0). The removal technologies which are potentially applicable to the soils at the ILCO-UNICAN facility are discussed in the following sections. The principle of the technology is presented along with an evaluation of the potential application to the site and a conclusion as to whether the technology has been retained for further consideration. Technologies that are retained for further consideration will be assembled into removal action alternatives in Section 3.2.

3.1.1 Excavation

Excavation is the physical removal and relocation of affected media using heavy equipment to engineered facilities with treatment or disposal capabilities. Excavation is an established source control measure and applicable for implementation at the ILCO-UNICAN site. Affected soils in and around the sludge piles, the baghouses, and roof drains could be physically removed from the site for disposal and/or treatment. Excavation can also be employed for these soils as a means of consolidating these soils within a single, common area for containment. Excavation has been retained for further evaluation.

3.1.2 Off-Site Disposal

Landfilling at a controlled off-site location is an established technology for the disposal of affected media. Affected media requires excavation with heavy equipment and transportation to the pre-engineered, designated location. Transportation of the excavated

media can be achieved by a variety of means, including, railcar, barge, or truck. After excavation and transportation, the affected soils would be placed into the landfill.

Landfilling can be a reliable technology; however, this reliability is largely dependent on the geology, hydrogeology, and design of the subject site. This removal-action technology can lead to long-term liability and costs for releases at the off-site facility. Future liability and response costs for off-site landfilling can be addressed by performing a due diligence audit of the selected disposal facility.

Off-site landfilling may be suitable for addressing the affected soils from the ILCO-UNICAN site. This removal technology would necessitate physical removal of the affected soil. Engineering controls would typically be instituted to minimize potential environmental impacts due to erosion and airborne transport. The volumes of affected soil estimated in Section 2.1 could be landfilled.

Disposal by off-site landfilling is an established and reliable technology and could be applicable for affected soils at the ILCO-UNICAN site. Potential environmental impacts through the creation of additional transport pathways resulting from physical removal of the affected soils could be managed by instituting engineering controls. Transportation requirements and disposal capacity is a significant consideration under this technology. Off-site disposal (landfilling) have been retained for further evaluation.

3.1.3 On-Site Landfill Disposal

As described in Section 3.1.2, landfilling in a pre-engineered and permitted cell is an established technology for the disposal of affected media. Excavated affected media would remain at the site for on-site disposal.

On-site landfilling is dependent upon the facility's ability to properly dispose of affected media (i.e. applicable permits, adequate land capacity, etc.). On-site disposal is not

applicable for implementation as a removal action at the ILCO-UNICAN site. The ILCO-UNICAN facility is not a permitted treatment, storage, and disposal facility and it is unlikely that a permit for an on-site landfill could be obtained in the timeframe allotted for this removal action. This removal action technology will not be considered further.

3.1.4 Capping

Capping is a common remedial technology which can be used to achieve containment of soils. Capping involves constructing a relatively impermeable barrier over the affected media to minimize or prevent the infiltration of precipitation by ensuring positive drainage and surface water run-off, thereby reducing leachate generation. Cap configurations can be single barrier or multi-layer barrier. A typical single barrier cap may consist simply of compacted soil, asphalt, synthetic membrane, soil/bentonite admixtures, or concrete. A multi-layer cap may be constructed of a synthetic membrane in conjunction with single barrier media.

The implementability of the capping technology is largely dictated by site location and conditions. Capping is generally not installed in areas which are heavily travelled or congested. Open areas with restricted access are best suited for cap installation. Capping technology provides a reliable technology, and obviates off-site disposal and transportation requirements. Capping can effectively isolate affected media from human or environmental exposure and prevent the infiltration of precipitation reducing the potential for the off-site migration of contamination. This removal-action technology would necessitate limiting future property utilization to surficial activities to ensure that the integrity and effectiveness of the cap is maintained. Capping has been retained for further consideration.

3.1.5 In-situ Treatment

The in-situ treatment technology group involves options for treating the affected soil in place without excavation. Technologies within the in-situ treatment group which are

potentially applicable to the constituents of concern at the ILCO-UNICAN facility include stabilization, vitrification, and soil flushing. Other in-situ treatment technologies such as soil vapor extraction, RF heating, and bioremediation are most suitable for volatile and semi-volatile organic constituents. As discussed in Section 2.0, this removal action is intended to address soils exhibiting the presence of the predominant constituents of concern (i.e., inorganics). Therefore, the in-situ treatment technologies applicable for VOCs identified above would be ineffective in addressing the predominant site constituents. For this reason, in-situ soil flushing, RF heating, and bioremediation will not be retained for further consideration.

3.1.5.1 Stabilization

Stabilization is a physical treatment technology which serves to reduce the solubility and mobility of chemical constituents by creating bonds between the constituents and the matrix and/or the stabilizing agents. A wide range of reagents including portland cement, lime, reactive flyash, clay, or cement kiln dust can be added to soil by means of various mixing systems. Vertical auger and injection systems are most often used for in-situ application of the stabilization technology. This technology can also be applied as an ex-situ technology and is considered as such in Section 3.1.6.1.

In-situ stabilization could be effective in reducing the mobility and solubility of the constituents of concern at the ILCO-UNICAN facility. Data obtained from the USEPA RREL treatability database indicates that all of the metals present in the soil at the facility are effectively immobilized using various stabilization reagents (Appendix C). Published data also indicates that cyanide can also be effectively immobilized using Portland cement with various additives such as activated $Al(OH)_3$, anion exchange resin, calcium polysulfide, or CaO and iron salt. These methods are reportedly capable of reducing leachable concentrations of cyanide to the 0.02 to 1.0 mg/L range (Conner 1990). The effectiveness of this technology over the long-term would necessitate coupling in-situ stabilization with a containment technology (e.g., capping) to ensure that the integrity of the stabilized matrix

does not degrade due to exposure to the elements. Site conditions do not appear to limit the potential implementability of the in-situ stabilization technology.

In-situ stabilization of the affected soil will be retained for further consideration due to its potential effectiveness.

3.1.5.2 Vitrification

Vitrification is a thermal treatment process whereby soils containing a wide variety of organic and inorganic constituents can be converted in chemically inert and stable glass-like material. Implementation of in-situ vitrification is accomplished by inserting large electrodes vertically into the soil. Glass frit is placed between the electrodes to form a conductive path. Electric current is passed through the electrodes thereby melting the glass frit by resistance heating. The underlying and surrounding soil is gradually incorporated into the melt. This process continues until the heat losses approach the energy input. After treatment, the current is stopped and the melt solidifies into a vitreous (amorphous) material. Inorganics present in the soil are incorporated into the vitrified mass while organics combust at the surface and are collected in an off-gas hood.

The in-situ vitrification process is potentially applicable to the constituents of concern at the ILCO-UNICAN facility. However, this technology is not implementable for two reasons. First, the technology is not currently available commercially. Commercial application of the technology was terminated by the sole licensee of the technology due to equipment malfunctions necessitating redesign. The licensee of the technology has not yet reintroduced in-situ vitrification to the market.

A second reason in-situ vitrification is not implementable at the facility is due to the presence of plant facilities in close proximity to the areas to be treated. Vendor literature indicates that this technology should not be applied where the melt would be closer than 15 feet to underground structures and utilities that could be damaged by temperatures in excess

of 100 degrees Celsius. Application of this technology at the ILCO-UNICAN facility could result in damage to the foundation of the facility buildings and the propane storage tanks adjacent to the sludge piles.

In-situ vitrification will not be retained for further consideration due to its limited availability and implementation difficulties.

3.1.5.3 Soil Flushing

In-situ soil flushing is a physical treatment technology that involves the elutriation of organic and inorganic constituents from soil for subsequent recovery or treatment. This technology is implemented by applying a suitable solvent (e.g., water or dilute solution of detergents, chelating agents, or acids) to the surface of the affected soils. The solvent is allowed to infiltrate through the soils solubilizing the constituents of concern in the process. The elutriate is collected in a series of shallow well points or subsurface drains for subsequent treatment and reapplication to the site.

In-situ soil flushing is likely to be of limited effectiveness for treating the affected soils at the ILCO-UNICAN facility. The primary reasons for the limited effectiveness are: 1) the technology is subject to channeling wherein the solvent flows along preferential pathways and does not contact all of the soil, and 2) the hydrogeology of the site is not well understood at this time and good hydrogeologic control must be maintained over the site to ensure complete and efficient recovery of the elutriate.

In-situ soil flushing has been eliminated from further consideration for the ILCO-UNICAN facility due to the limited effectiveness that may be achieved.

3.1.6 Ex-situ Treatment

Treatment of the affected soils could also be accomplished by utilizing various ex-situ treatment processes. The two ex-situ treatment technologies most pertinent to the soil constituents are stabilization and soil washing. These technologies would necessitate excavation of the affected soils as a precursor to the treatment process.

3.1.6.1 Stabilization

Ex-situ stabilization is similar to the in-situ application described in Section 3.1.5.1 with the exception that contacting between the soil and the stabilization agents occurs in an above ground vessel. In this application, the soil is excavated and mixed with the stabilizing agents in a pugmill. The mixing can be conducted either on-site or at an appropriately permitted off-site facility. After treatment, the stabilized soil is stockpiled pending its ultimate disposition.

The potential effectiveness and implementability of ex-situ stabilization of the affected soil at the ILCO-UNICAN facility is similar to in-situ stabilization. Due to the potential effectiveness and implementability of this technology, it will be retained for further consideration.

3.1.6.2 Soil Washing (Solvent Extraction)

Soil washing is similar to the in-situ soil flushing technology described in Section 3.1.5.3. In this application, the soils are contacted with the solvent in an above ground system. The solvent is then separated from the treated soil prior to stockpiling the soil pending final disposition.

The effectiveness limitations associated with in-situ soil flushing do not arise for ex-situ soil washing. Data obtained form the USEPA RREL database indicate that the removal efficiency of soil washing is moderate for the constituents of concern, but generally

removal efficiency of soil washing is moderate for the constituents of concern, but generally less than that achievable using other treatment technologies such as stabilization. There are no significant limitations on the implementability of ex-situ soil washing.

Soil washing will be retained for further consideration due to its potential effectiveness and implementability.

3.2 ASSEMBLY OF REMOVAL ACTION ALTERNATIVES

Site-wide removal action alternatives have been developed by combining potential removal action technologies previously identified. The removal action technologies that are pertinent to each of the areas under consideration in this EE/CA are identified in Table 4. A summary of the removal action alternatives identified for the ILCO-UNICAN site is presented in Table 5. Descriptions of each removal action alternative is presented in Section 4.0. The details provided herein are intended to facilitate the evaluation and comparative analysis performed in Section 5.0. These details are also intended to facilitate the selection of a removal action alternative in Section 6.0. Actual dimensions, quantities, and equipment types will be identified and selected during the removal action.

4.0 ANALYSIS OF REMOVAL ACTION ALTERNATIVES

The removal action alternatives developed in Section 3.2 will be subjected to a detailed analysis according to the criteria specified in USEPA guidance. The criteria that will be employed in this evaluation and the analysis of the removal action alternatives are presented in this Section.

4.1 EVALUATION CRITERIA

Each of the potential removal action alternatives developed for the ILCO-UNICAN Site is evaluated on its own individual merit in this Section. As required by USEPA guidance, the analysis of potential removal action alternatives for the Site utilized three primary evaluation criteria: effectiveness, implementability, and cost. These criteria are identical with those utilized for screening technologies and process options during a CERCLA Feasibility Study (FS). The factors considered under each of these primary criteria correspond with the nine evaluation criteria utilized for detailed analysis of remedial alternatives during an FS. The evaluation criteria that will be utilized in this EE/CA are described below.

4.1.1 Effectiveness

The alternatives considered in this EE/CA have been evaluated in terms of their effectiveness in terms of protecting human health and the environment. The protectiveness evaluation considers the following factors:

- protection of the community during the removal action (i.e., identification of potential threats that may result from implementation of the removal action and corrective or preventive measures that can be taken to address those threats);

- protection of workers involved in on-site implementation of the removal action;
- reduction of potential risks or mitigation of health threats identified in Section 2.1;
- time until protection is achieved for the principal threats at the site in comparison to the removal action schedule;
- compliance with the chemical- and location-specific ARARs identified for the Site in Section 2.2;
- identification of any potential environmental impacts that could result from implementation and any preventive or corrective measures that can be taken;
- an assessment of the potential for future exposure to residuals remaining on-site after completion of the removal action; and,
- an assessment of the long-term reliability of the engineered components and the potential for failure of the removal alternative and the need for replacement.

Additionally, the effectiveness of each removal alternative has been evaluated with respect to the degree to which the alternative utilizes alternatives to land disposal such as treatment or recycling.

4.1.2 Implementability

The implementability of each removal action alternative was evaluated in terms of three factors; technical feasibility, availability, and administrative implementability.

4.1.2.1 Technical Feasibility

Technical feasibility considers the ability to construct and operate the technologies in the removal action alternatives. The technical implementability also assesses the developmental status of the technology and the ability of the alternative to meet processing efficiencies. Environmental conditions such as terrain and climate will be evaluated in terms of their potential impacts on the operability or reliability of the alternative. Action-specific ARARs which pertain to the removal action alternative will be identified and evaluated as part of the technical implementability evaluation. The ARAR evaluation will consider whether the alternative attains or exceeds attainment of the action-specific ARARs or whether a waiver is appropriate.

According to USEPA guidance for conducting an EE/CA, the evaluation of technical implementability should consider whether removal action alternatives will satisfy the requirement set forth in SARA that the removal action should contribute to the efficient performance of any long-term remedial action to the extent practical. This criterion will be fully satisfied by each of the removal action alternatives considered in this EE/CA for the ILCO-UNICAN Site because the need for long-term remedial action for soil will be averted through implementation of the selected removal action alternative.

4.1.2.2 Availability

The second implementability consideration is the availability of the necessary equipment, materials, and personnel. The availability of adequate off-site services (i.e, for treatment, storage, or disposal) and capacity will also be evaluated. The availability (or scarcity) of these resources will be compared to the removal action schedule.

According to USEPA guidance on conducting an EE/CA, this evaluation criterion includes consideration of the availability of other parties to assume the responsibility for any post-removal site controls that may be necessary at the completion of the removal action.

Since the removal action contemplated in this EE/CA is a voluntary action, any post-removal site controls would be maintained by ILCO-UNICAN. Consequently, this factor will not be considered in this EE/CA.

4.1.2.3 Administrative Feasibility

The administrative implementability of each removal action alternative includes the ability to obtain any approvals or permits required for implementation of the removal action. The need for institutional controls such as access restrictions or deed notifications and the compatibility of those restrictions with future property utilization will also be considered in the evaluation of administrative implementability. Since the removal action at the ILCO-UNICAN Site is a voluntary action, there will be no need to coordinate with other agencies. The likelihood that the removal action alternatives evaluated in this EE/CA will be acceptable to the public, including state and local community, is not known. Public notice of the selected removal action alternative will be provided by ILCO-UNICAN to gauge public interest in the removal action.

4.1.3 Cost

The cost of each removal action alternative will be estimated in accordance with the procedures described in USEPA guidance (USEPA 1987b). The cost of each alternative will be expressed as the total present worth of the alternative. The total present worth will be calculated as the summation of the total (direct and indirect) capital cost and the present worth of the operation and maintenance (O&M) costs. The present worth of the O&M costs will be calculated as the product of the annual O&M cost and a present worth factor. As suggested by USEPA guidance, the present worth factor will be based on a discount rate (i.e., before taxes and after inflation) of 10 percent.

4.2 REMOVAL ACTION ALTERNATIVE 1 - CAPPING

As presented in Table 5, this removal action alternative involves the capping of affected soils which exhibit concentrations of constituents of concern above the PSRGs. Since the affected soils occur in three distinct areas and occupy limited surface areas, this alternative would be most suitable if the soils from the roof runoff and baghouse areas were consolidated with those from the former plating sludge waste pile. In accordance with NCAC, Title 15A, Chapter 13B, Section .0505, the cap would be composed of two feet of suitable compacted earth and stabilized with native grasses.

4.2.1 Effectiveness

This removal action alternative provides for the protection of human health and the environment by the application of a barrier over the affected area. Potential threats to the community are minimal because the consolidation activities would only disturb limited areas. The on-site workers involved in the consolidation activities and construction of the cap would be protected from exposure through development and implementation of a site-specific health and safety plan prepared in accordance with Occupational Safety and Health Administration (OSHA) regulations contained in 29 CFR 1910.120. This removal action alternative would be effective in reducing existing human health risks posed by the affected soils at the ILCO-UNICAN site. The potential for future exposure to the affected soils would exist but this potential would be minimized by routine, scheduled maintenance of the cap integrity and erosion controls.

This removal action alternative could be implemented in the short-term (i.e., 3 - 6 months) and the protection afforded could be immediately realized. Removal Action Alternative 1 does not employ alternatives to land disposal, as it allows for the affected soils to remain in-place.

4.2.2 Implementability

4.2.2.1 Technical Feasibility

Removal Action Alternative 1 utilizes conventional, fully-developed earth moving equipment and techniques and is constructable within site conditions. Capping is an established source control technology and has been proven effective in providing a barrier between affected media and the environment.

The action-specific ARARs which pertain to this removal action alternative include NCAC, Title 15A, Chapter 13B, Section .0505 which specify the cover system configuration for a solid waste landfill. These relevant and appropriate requirements would be attained by the cap layers that would be constructed under this alternative as described in Section 4.2.

4.2.2.2 Availability

Equipment for cap installation is not specialized and is readily available. Materials and skilled personnel are not required for the implementation of this removal action alternative. Post-removal site control activities to include cap maintenance and erosion control would be required to preserve cap integrity. Off-site treatment and disposal services would not be needed for implementation of this alternative.

4.2.2.3 Administrative Feasibility

Approval would be required from the state officials to allow the affected soils to remain in place. The ability to obtain this approval within the timeframe allotted for the removal action is likely to be limited. Additionally, institution controls including placement of a notice in the property deed would be required for implementation of Removal Action Alternative 1.

4.2.3 Cost

The estimated capital cost for the implementation of Removal Action Alternative 1 is $75,130 (Table 6). There will be limited O&M activities following implementation of this alternative for periodic inspection, maintenance, and repair of the cap. The annual O&M cost for these activities is estimated to be $27,014 with a present worth of $254,662 over a period of 30 years (Table 7). The total present worth of Removal Action Alternative 1 is $329,792.

The capital cost estimate provided above is based on a cap which meets the configuration described in state regulations. Other more durable materials (e.g. asphalt or concrete) of construction can be selected to reduce the long-term O&M savings. To evaluate this tradeoff, a sensitivity analysis was performed for the situation where the cap is configured as an 8-inch thick, reinforced concrete slab. The capital cost for this scenario would increase to approximately $148,837 (see Table 8) while the annual O&M would decrease to approximately $15,674 (see Table 9). The present worth of the O&M over a 30-year period would be $147,761, resulting in a total present worth for the alternative of $296,598. This analysis indicates that the present worth of Alternative 1 (and all subsequent alternatives involving capping) can be reduced by approximately $33,194 by utilizing a durable cap versus the soil cap specified in the state regulations.

4.3 REMOVAL ACTION ALTERNATIVE 2 - CAPPING AND IN-SITU STABILIZATION

This removal action alternative combines stabilization of the affected soils with the application of a cap. Under this removal action alternative, affected soils from the roof run-off area and around the baghouses would be consolidated with the former plating sludge waste pile area. The consolidated soils would be stabilized in situ with Portland cement or a similar pozzolanic process to bind the metal constituents. The affected soils would then be covered with a cap composed of two feet of suitable compacted earth and stabilized with native grasses.

4.3.1 Effectiveness

Removal Action Alternative 2 would be protective of both human health and the environment. According to the RREL treatability database, stabilization is a proven method for reducing the mobility of the metals present at the ILCO-UNICAN facility (Appendix C). Capping serves as a barrier to protect human health and the environment from the affected soils. Potential threats to the community during the implementation of this removal action alternative include particulate-borne transport of the constituents of concerns during the stabilization process. This risk can be readily controlled using standard construction techniques for dust suppression to include applying water or anhydrous calcium chloride. The on-site workers involved in the implementation of this removal action alternative would be protected from exposure through development and implementation of a site-specific health and safety plan per OSHA regulations contained in 29 CFR 1910.120. Removal Action Alternative 2 would be effective in reducing existing human health risks posed by the affected soils at the site. The potential for future exposure exists but is minimized by the stabilization of the metals and the formation of a physical barrier. The PSRGs would be achieved in the roof run-off and baghouse areas and the constituents of concern would be rendered immobile reducing the potential for migration from the capped area.

Removal Action Alternative 2 could be implemented in the short-term (i.e., 3 - 6 months) and the protection afforded could be immediately realized. This removal action alternative does not employ alternatives to land disposal, as it allows for the affected soils to remain in-place.

4.3.2 Implementability

4.3.2.1 Technical Implementability

This removal action alternative utilizes conventional, fully-developed earthmoving equipment for stabilization and cap construction and is constructable within site conditions.

Adequate space is necessary and available for the implementation of this removal action alternative.

The action-specific ARARs which pertain to this removal action alternative include NCAC, Title 15A, Chapter 13B, Section .0505 which specify the cover system configuration for a solid waste landfill. These relevant and appropriate requirements would be attained by the cap layers that would be constructed under this alternative as described in Section 4.2.

4.3.2.2 Availability

Removal Action Alternative 2 would not require specialized materials or equipment. Vendors of these services are commercially available. Specialized labor would not be necessary. Off-site treatment and disposal services would not be required for implementation of Removal Action Alternative 2.

4.3.2.3 Administrative Feasibility

Approval would be required from the NCDEHNR to allow the affected soils to remain on site. The ability to obtain this approval from the NCDEHNR within the timeframe allotted for the removal action is not known. Additionally, institution controls such as placement of a notice in the property deed would be required for implementation to ensure the long-term protectiveness afforded by the cap.

4.3.3 Cost

The estimated capital cost for the implementation of Removal Action Alternative 2 is $151,382 (Table 10). There will be limited O&M activities following implementation of this alternative for periodic inspection, maintenance, and repair of the cap. The annual O&M cost for these activities is estimated to be $27,014 with a present worth of $254,662

over a period of 30 years (Table 9). The total present worth of Removal Action Alternative 2 is $406,044.

4.4 REMOVAL ACTION ALTERNATIVE 3 - FULL EXCAVATION AND OFF-SITE LANDFILL DISPOSAL

Removal Action Alternative 3 is comprised of complete excavation of affected soils which exhibit concentrations of the constituents of concern above the PSRGs. The excavated soils would be transported to an off-site location for landfill disposal. For the purposes of this EE/CA, it has been assumed that the soils in the former plating sludge waste pile areas will be managed as hazardous wastes. This assumption was based on the fact that plating sludges formerly placed in these areas would be listed hazardous wastes under current RCRA regulations and the soils contain constituents attributable to those former waste piles. Soil excavated from the roof-run-off area and around the baghouses would be managed as solid waste provided they do not exhibit hazardous characteristics. The excavated areas would be backfilled with common borrow fill, compacted, and revegetated, or otherwise restored to pre-excavation condition.

4.4.1 Effectiveness

This removal action alternative is protective of human health and the environment. Potential threats to the community are associated with the excavation portion of this removal action alternative. The constituents of concerns can become airborne during the excavation and handling. This risk can be readily controlled using standard construction techniques for dust suppression such an the application of water or anhydrous calcium chloride. On-site workers responsible for the implementation of this removal action alternative would be protected from exposure through the development and implementation of a site-specific health and safety plan in compliance with OSHA regulations contained in 29 CFR 1910.120. Human health risks posed by the affected soils would be effectively reduced after the source is removed. The potential risks associated with the residuals are

also limited since excavation would continue until all affected media is removed, and the PSRGs are attained.

This alternative could be implemented in the short-term (i.e. 3 - 6 months) and the protection afforded by this alternative would be realized in the same period. There are no engineered components under this alternative and consequently, there would be no reliability issues arising after implementation. Removal Action Alternative 3 does not employ alternatives to land disposal.

4.4.2 Implementability

4.4.2.1 Technical Implementability

Removal Action Alternative 3 utilizes conventional, fully-developed earthmoving equipment and techniques. Therefore, this action can be accomplished within the site conditions.

The action-specific ARARs which pertain to this alternative include the following:

- hazardous waste generator and transporter standards contained in 40 CFR 261 and 292, respectively (applicable to soils from the former plating sludge waste pile area);

- hazardous waste generator and transporter standards contained in NCAC, Title 15A, Subchapter 13A sections .0007 and .0008; and,

- land disposal restrictions (LDRs) contained in 40 CFR 268 and NCAC, Title 15A, Subchapter 13A, Section .0012 which require treatment of hazardous waste prior to land disposal.

4.4.2.2 Availability

Transportation and off-site disposal services are required for the implementation of this removal action alternative. These services and adequate capacity are commercially available. Specialized equipment and skilled personnel would not be needed for implementation of this alternative.

4.4.2.3 Administrative Feasibility

Approval would be needed from the off-site landfill facility regarding the acceptability of the excavated soils. Additionally, the necessity of pretreating the soils from the former plating sludge waste pile area would need to be assessed. As discussed in Section 3.0, the off-site disposal component of this removal-action alternative could lead to future liability for response costs due to releases at the off-site landfill facility. This can be addressed by performing a due diligence compliance audit of the selected facility. This approval is obtainable within the timeframe allotted for the removal action at the ILCO-UNICAN facility. No other approvals would be required for implementation of this alternative.

4.4.3 Cost

The estimated capital cost for implementing this removal action alternative is $127,858 (Table 11). There would be no O&M costs incurred following implementation of this alternative.

4.5 REMOVAL ACTION ALTERNATIVE 4 - EXCAVATION WITH SOIL WASHING AND LANDFILL DISPOSAL -

Removal Action Alternative 4 consists of excavating all of the affected soil which exceeds the PSRGs. Soils from the former plating sludge waste pile area or which exhibit the presence of the constituents of concern at concentrations that exceed the hazardous waste characterization thresholds would be treated by ex-situ soil washing prior to land disposal. The residuals from the soil washing process would be containerized and managed at an off-site hazardous waste landfill. The actual means of managing these materials would be determined during implementation and would be based upon testing of the residuals. The excavated areas would be backfilled with common borrow and revegetated or otherwise returned to their pre-removal condition.

4.5.1 Effectiveness

Removal Alternative 4 would be protective of human health and the environment. Information available for soil washing (referred to in the RREL database output contained in Appendix C as solvent extraction) indicates that this technology results in less efficient removal of most of the constituents of concern versus other treatment technologies such as stabilization. Therefore, implementation of this removal action alternative would be of limited effectiveness when compared to other alternatives.

Potential threats to the community during implementation include particulate-borne transport of the constituents of concern during excavation and material handling. This risk

can be readily controlled using standard construction techniques for dust suppression such as application of water or anhydrous calcium chloride.

The on-site workers involved in implementation of Removal Alternative 4 would be at risk to exposure to the soils, treatment reagents, and residuals during treatment. These workers would be protected from exposure through development and implementation of a site-specific health and safety plan per OSHA regulations contained in 29 CFR 1910.120. This removal alternative would be effective in reducing existing human health risks posed by the affected soils at the ILCO-UNICAN facility. The potential for future exposure to the treatment residuals would be minimal since they would be removed from the site for further treatment or disposal. Additionally, the soils would be removed until the PSRGs have been achieved.

The timeframe for implementing this alternative could be quite long. This is because the soil washing technology would likely require a treatability study prior to full-scale implementation and because, in general, the technology has not yet been accepted as a demonstrated technology by regulatory authorities. A significant amount of additional time would be required for obtaining the permits required for on-site treatment of soil which contains constituents associated with listed hazardous waste or which exhibits the toxicity characteristic for hazardous waste (Section 4.5.2.1). For these reasons, the protection afforded by this alternative would probably not be achievable within the timeframe established for this removal action.

The engineered components that would be utilized under this alternative would be present on-site only during the implementation phase, and consequently, there would be no reliability issues arising after implementation. Removal Action Alternative 4 does not employ alternatives to land disposal but does utilize treatment as a component of the removal action.

4.5.2 Implementability

4.5.2.1 Technical Implementability

Removal Action Alternative 4 utilizes conventional, fully developed earthmoving equipment and techniques. Therefore, it is constructable within site conditions. As previously discussed, the soil washing technology has not yet been accepted as a demonstrated technology by most regulatory authorities.

The action-specific ARARs which pertain to this alternative include the following:

- hazardous waste generator and treatment facility standards contained in 40 CFR 261 and 264 respectively and NCAC, Title 15A, Subchapter 13A, Sections .0007 and .0010 (applicable to soils which contain lead at concentration sufficient to be classified as a characteristic hazardous waste); and,

- land disposal restrictions contained in 40 CFR 268 and NCAC, Title 15A, Subchapter 13A, Section .0012 which require treatment of hazardous wastes prior to land disposal.

Removal Alternative 4 would attain the hazardous waste generator requirements by following the manifesting provisions for soils which contain hazardous waste constituents. On-site treatment of soil which contains hazardous waste constituents or which is characteristically hazardous waste would necessitate permitting of the soil washing treatment system. Licensed transporters will be used for the off-site transportation of excavated soils and treated residuals.

4.5.2.2 Availability

Off-site treatment and disposal services would be necessary for implementation of Removal Action Alternative 4. These services and adequate capacity are commercially available. The future liability consideration associated with the off-site landfill facility can be addressed under this alternative in a similar manner as described in Section 4.4.2.2. Specialized equipment and skilled personnel would be needed for implementation of the soil washing component of this alternative. These services are commercially available.

4.5.2.3 Administrative Feasibility

Approvals would be needed from the off-site landfill facility utilized for the stabilized soils. These approvals are obtainable provided that the requisite documentation is provided to the facility. As previously discussed, a permit would be needed for implementation of the soil washing component of this alternative. Based on experience with obtaining hazardous waste facility permits for other facilities, the permit application and review process is likely to be lengthy (i.e., on the order of two or more years). For this reason, Removal Action Alternative 4 is not readily implementable in terms of administrative considerations.

4.5.3 Cost

The estimated capital cost for implementing Removal Action Alternative 4 is $269,722 (Table 12). There will be no O&M costs incurred following implementation of this alternative.

4.6 REMOVAL ACTION ALTERNATIVE 5 - EXCAVATION WITH STABILIZATION AND OFF-SITE LANDFILL DISPOSAL

As discussed in Section 3, this removal alternative consists of excavating affected soils which exhibit concentrations of the constituents of concern above the PSRGs (Table 1). The excavated soil would be transported to an off-site hazardous waste landfill where it would be treated by stabilization using Portland cement or a similar pozzolanic process prior to placement in the landfill. The excavated areas would be backfilled with common borrow and revegetated or otherwise restored to their pre-removal condition.

4.6.1 Effectiveness

Removal Alternative 5 would be protective of human health and the environment. The stabilization process would effectively reduce the mobility of the constituents of concern at the ILCO-UNICAN facility (Appendix C).

Potential threats to the community during implementation include particulate-borne transport of the constituents of concern during excavation and material handling. This risk can be readily controlled using standard construction techniques for dust suppression such as application of water or anhydrous calcium chloride. The on-site workers involved in implementation of Removal Alternative 5 would be protected from exposure through development and implementation of a site-specific health and safety plan per OSHA regulations contained in 29 CFR 1910.120. This removal alternative would be effective in reducing potential human health risks posed by the affected soils at the ILCO-UNICAN facility. The potential for future exposure to the treatment residuals would be minimal since soils would be removed until the PSRGs have been achieved.

This alternative could be implemented in the short-term (i.e., 3 - 6 months) and the protection afforded by this alternative would be achieved in the same timeframe. There are no engineered components under this alternative and consequently, there would be no

reliability issues arising after implementation. Removal Alternative 5 does not employ alternatives to land disposal, but does utilize treatment as a principal component of the action.

4.6.2 Implementability

4.6.2.1 Technical Implementability

Removal Action Alternative 5 utilizes conventional, fully developed earthmoving equipment and techniques. Therefore, it is constructable within site conditions.

The action-specific ARARs which pertain to this alternative include the following:

- hazardous waste generator and transporter standards contained in 40 CFR 261 and 262, respectively and NCAC, Title 15A, Subchapter 13A, Sections .0007 and .0010 (applicable to soils from the former plating sludge waste pile area); and

- land disposal restrictions contained in 40 CFR 268 and NCAC, Title 15A, Subchapter 13A, Section .0012 which require treatment of hazardous wastes prior to land disposal.

Removal Alternative 5 would attain these requirements by following the manifesting provisions for soils which are characteristic hazardous wastes or which contain listed hazardous waste constituents. Licensed transporters will be used for the off-site transportation.

4.6.2.2 Availability

Off-site treatment and disposal services would be necessary for implementation of Removal Action Alternative 5. These services and adequate capacity are commercially available. The future liability considerations associated with the off-site landfill facility can be addressed in a similar manner as described in Section 4.4.2.3. Specialized equipment and skilled personnel would not be needed for implementation of this alternative.

4.6.2.3 Administrative Feasibility

Approvals would be needed from the off-site landfill facility utilized for the stabilized soils. These approvals are obtainable provided that the requisite documentation is provided to the facility. No other approvals would be needed for implementation of this alternative.

4.6.3 Cost

The estimated capital cost for implementing Removal Action Alternative 5 is $214,508 (Table 13). There will be no O&M costs incurred through implementation of this alternative.

4.7 REMOVAL ACTION ALTERNATIVE 6 - EXCAVATION/STABILIZATION/LANDFILL DISPOSAL WITH SINGLE BARRIER CAPPING

Removal Alternative 6 consists of excavating affected soils which exhibit concentrations of the constituents of concern above the concentrations that would characterize them as hazardous wastes according to 40 CFR 261. According to the analytical data from previous investigations at the facility, only limited occurrences and quantities of soils which exceed the hazardous waste thresholds are present in the areas of concern. Only these soils would be excavated under this alternative. The excavated soil

(assumed to be on the order of approximately 225 CY or less) would be transported to an off-site hazardous waste landfill where it would be treated by stabilization using Portland cement or similar pozzolanic process prior to placement in the landfill.

Affected soils exhibiting the presence of the constituents of concern above the PSRGs but less than the concentrations that would characterize the soils as hazardous waste would be contained on site by capping. The excavated areas would be backfilled with common borrow. All areas with affected soil would be covered with a single barrier cap. The cap would consist of the layers described in Section 4.2.

4.7.1 Effectiveness

Removal Alternative 6 would be protective of human health and the environment. The ex-situ stabilization component of this removal action alternative would effectively reduce the mobility of the constituents of concern in the soils removed from the ILCO-UNICAN facility.

Potential threats to the community during implementation include particulate-borne transport of the constituents of concern during excavation and other material handling activities. This risk can be controlled during excavation and material handling using standard construction techniques for dust suppression such as application of water or anhydrous calcium chloride. The on-site workers involved in implementation of Removal Alternative 6 would be protected from exposure through development and implementation of a site-specific health and safety plan per OSHA regulations contained in 29 CFR 1910.120.

This removal alternative would be effective in reducing potential human health risks posed by the affected soils at the ILCO-UNICAN facility. All potential human health exposure pathways would be effectively blocked by the physical barriers created by the cap system. These barriers would also block potential exposure of exposed environmental

receptors. The reduced infiltration afforded by the cap system would effectively protect ground-water resources. A potential for future exposure to the constituents of concern would exist since soils exceeding the PSRGs would remain on-site. The potential for future exposure would be low due to the thickness and durability of the materials of construction that would be utilized in the cap.

This alternative could be implemented in the mid-term (i.e., 9 - 12 months) and the protection afforded by this alternative would be achieved in the same timeframe.

The engineered components under this alternative consist of the cap system. Single barrier caps have been proven to be reliable over the long-term, particularly in areas where severe freeze/thaw cycles are not common. Since this is the case for Winston-Salem, the cap would be expected to be reliable. Removal Alternative 6 does not employ alternatives to land disposal, but does utilize treatment by stabilization as a principal component of the action.

4.7.2 Implementability

4.7.2.1 Technical Implementability

Removal Action Alternative 6 utilizes conventional, fully developed earthmoving equipment and techniques and is constructable within site conditions. Adequate space is necessary and available for implementation of this removal action alternative.

The action-specific ARARs which pertain to this alternative include the following:

- hazardous waste generator and transporter standards contained in 40 CFR 261 and 262, respectively and NCAC, Title 15A, Subchapter 13A, Sections .0007 and .0010 (applicable to soils which contain lead at concentration sufficient to be classified as a characteristic hazardous waste);

- land disposal restrictions contained in 40 CFR 268 and NCAC, Title 15A, Subchapter 13A, Section .0012 which require treatment of hazardous wastes prior to land disposal; and

- North Carolina's solid waste landfill cover system requirements.

Removal Alternative 6 would attain these requirements by following the manifesting provisions for soils which are characteristically hazardous waste. Stabilization of the excavated soil which is characteristic hazardous waste would attain the LDRs. Licensed transporters would be used for the off-site transportation. The cap system that would be installed at the facility would attain the configuration requirements specified by the state.

4.7.2.2 Availability

Off-site treatment and disposal services would be necessary for implementation of Removal Action Alternative 6. These services and adequate capacity are commercially available. Specialized equipment and skilled personnel would not be needed for implementation of this alternative.

4.7.2.3 Administrative Feasibility

Approvals would be needed from the off-site landfill facility utilized for the stabilized soils. These approvals are obtainable provided that the requisite documentation is provided to the facility. Approval would also be needed from the NCDEHNR for implementation of the capping component of Removal Action Alternative 6. The ability to obtain the NCDEHNR's approval within the timeframe allotted for the removal action is not known.

4.7.3 Cost

The estimated capital cost for implementing Removal Action Alternative 6 is $198,306 (Table 14). There will be limited O&M costs incurred under this alternative. These costs will be for periodic inspection, maintenance and repair of the cap system. The annual O&M cost for these activities has been estimated at $27,014 (Table 9) with a present worth of $254,662 over a period of 30 years. The total present worth of this alternative is $452,968.

4.8 REMOVAL ACTION ALTERNATIVE 7 - EXCAVATION/STABILIZATION/LANDFILL DISPOSAL WITH IN-SITU STABILIZATION AND SINGLE BARRIER CAPPING

Removal Alternative 7 consists of excavating affected soils which exhibit concentrations of the constituents of concern above the concentrations that would characterize them as hazardous wastes according to 40 CFR 261. According to the analytical data from previous investigations at the facility, only limited quantities of soils in the areas of concern exceed the hazardous waste characterization threshold and would be excavated under this alternative. The excavated soil (assumed to be on the order of approximately 40 CY or less) would be transported to an off-site hazardous waste landfill where it would be treated by stabilization using Portland cement or similar pozzolanic process prior to placement in the landfill.

Affected soils exhibiting the presence of the constituents of concern above the PSRGs but less than the concentrations that would characterize the soils as hazardous waste would be treated by in-situ stabilization. This would be accomplished using a Portland cement or similar pozzolanic process where the treatment agents would be introduced and contacted with the soils using vertical augers or comparable equipment.

4.8.1 Effectiveness

Removal Alternative 7 would be protective of human health and the environment. The in-situ stabilization component of this removal action alternative would effectively reduce the mobility of the constituents of concern in the soils remaining at the ILCO-UNICAN facility.

Potential threats to the community during implementation include particulate-borne transport of the constituents of concern during excavation, stabilization, and other material handling activities. This risk can be controlled during excavation and material handling using standard construction techniques for dust suppression such as application of water or anhydrous calcium chloride. However, particulate control during in-situ stabilization may be more difficult. The on-site workers involved in implementation of Removal Alternative 7 would be protected from exposure through development and implementation of a site-specific health and safety plan per OSHA regulations contained in 29 CFR 1910.120.

This removal alternative would be effective in reducing potential human health risks posed by the affected soils at the ILCO-UNICAN facility. All potential human health exposure pathways would be effectively blocked by the physical barriers created by the cap system. These barriers would also block potential exposure of exposed environmental receptors. The reduction in constituent mobility that would be achieved through in-situ stabilization coupled with the reduced infiltration afforded by the cap system would effectively protect ground-water resources. A potential for future exposure to the constituents of concern would exist since soils exceeding the PSRGs would remain on-site. The potential for future exposure would be low due to the thickness and durability of the materials of construction that would be utilized in the cap.

This alternative could be implemented in the mid-term (i.e., 9 - 12 months) and the protection afforded by this alternative would be achieved in the same timeframe. The

timeframe takes into account the need for performing a treatability study to identify the appropriate treatment reagents and the optimum mix.

The engineered components under this alternative consist of the cap system. Single barrier caps have been proven to be reliable over the long-term, particularly in areas where severe freeze/thaw cycles are not common. Since this is the case for Winston-Salem, the cap would be expected to be reliable. Removal Alternative 7 does not employ alternatives to land disposal, but does utilize treatment by stabilization as a principal component of the action.

4.8.2 Implementability

4.8.2.1 Technical Implementability

Removal Action Alternative 7 utilizes conventional, fully developed earthmoving equipment and techniques and is constructable within site conditions. Adequate space is necessary and available for implementation of this removal action alternative.

The action-specific ARARs which pertain to this alternative include the following:

- hazardous waste generator and transporter standards contained in 40 CFR 261 and 262, respectively and NCAC, Title 15A, Subchapter 13A, Sections .0007 and .0010 (applicable to soils which contain lead at concentration sufficient to be classified as a characteristic hazardous waste);

- land disposal restrictions contained in 40 CFR 268 and NCAC, Title 15A, Subchapter 13A, Section .0012 which require treatment of hazardous wastes prior to land disposal; and

- North Carolina's solid waste landfill cover system requirements.

Removal Alternative 7 would attain these requirements by following the manifesting provisions for soils which are characteristically hazardous waste. Treatment of excavated soil which is characteristic hazardous waste would attain the LDRs. Licensed transporters will be used for the off-site transportation. The cap system that would be installed at the facility would attain the configuration requirements specified by the state.

4.8.2.2 Availability

Off-site treatment and disposal services would be necessary for implementation of Removal Action Alternative 7. These services and adequate capacity are commercially available. Specialized equipment and skilled personnel would be needed for implementation of the in-situ stabilization component of this alternative. The personnel and equipment are commercially available.

4.8.2.3 Administrative Feasibility

Approvals would be needed from the off-site landfill facility utilized for the stabilized soils. These approvals are obtainable provided that the requisite documentation is provided to the facility. The future liability considerations associated with the off-site landfill facility can be addressed in a similar manner as described in Section 4.4.2.2. Approval would also be needed from the NCDEHNR for implementation of the capping component of Removal Action Alternative 7. The ability to obtain the NCDEHNR's approval within the timeframe allotted for the removal action is not known.

4.8.3 Cost

The estimated capital cost for implementing Removal Action Alternative 7 is $164,890 (Table 15). There will be limited O&M costs incurred under this alternative. These costs will be for periodic inspection, maintenance and repair of the cap system. The annual O&M cost for these activities has been estimated at $27,014 (Table 9) with a

present worth of $254,662 over a period of 30 years. The total present worth of this alternative is $419,552.

5.0 COMPARISON OF REMOVAL ALTERNATIVES

Each of the removal action alternatives for the ILCO-UNICAN facility was evaluated on an individual basis in Section 4.0. This section constitutes a comparative analysis wherein the relative performance of each alternative will be evaluated with respect to each of the evaluation criteria. The purpose of this comparative analysis is to identify the advantages and disadvantages of each alternative relative to one another. In general, the alternative(s) that perform best in each evaluation criterion are discussed first, with other alternatives discussed in order of decreasing relative performance. Certain aspects of the comparison will be presented qualitatively whereas other aspects will be quantitative. Quantitative information will include cost estimates and time until protection is achieved.

5.1 EFFECTIVENESS

All seven of the removal action alternative evaluated in this EE/CA would be protective of human health and the environment. Alternatives 2 and 5 would employ stabilization as a means of effectively reducing the mobility of the constituents of concern prior to land disposal. Although Removal Action Alternative 4 also employs treatment prior to disposal, the effectiveness of this alternative would be less due to the lower removal efficiency achievable for soil washing versus stabilization. All seven of the alternatives would be protective of the community during implementation. The potential threats to the community result from the potential for airborne particulate release during excavation and materials handling. These risks can be effectively controlled under all alternative by using conventional dust suppression techniques. Dust control may be more difficult during in-situ stabilization activities under alternatives 2 and 7.

Alternatives 1, 2, 3, and 5 could be implemented in the short term with the protectiveness achievable in 3 to 6 months. Removal Action Alternatives 6 and 7 would be implementable within 6 to 12 months. Alternative 4 would is not implementable within the

timeframe allotted for the removal action due to the need to obtain a permit for on-site treatment of any characteristically hazardous waste that would be excavated.

None of the seven alternatives employ alternatives to land disposal such as recycling or treatment. However, alternatives 2, 4, 5, 6, and 7 include treatment by stabilization or soil washing a principal element of the alternative. This treatment would effectively reduce the mobility or toxicity of the constituents of concern.

5.2 IMPLEMENTABILITY

5.2.1 Technical Implementability

All of the seven removal action alternative would utilize conventional and fully developed earthmoving techniques and equipment. All of the alternatives would attain the ARARs which pertain to the site and the actions under evaluation. However, the alternatives differ in their constructability and the developmental status of the treatment technologies that would be employed. Alternatives 3, 4, and 5 would be constructable within site conditions. Alternatives 1, 2, 6, and 7 would be constructable within site conditions provided that the cap is installed in the former plating sludge waste pile area. Alternative 4 would utilize a treatment technology which is still considered to be developmental; this could lead to schedule delays as acceptance of this technology is sought.

5.2.2 Availability

Alternative 1 would not require any specialized equipment, skilled personnel, or off-site services for implementation. Alternatives 3, 4, 5, and 6 would require off-site disposal services; these services and adequate capacity are commercially available. Skilled workers and specialized equipment would be needed for implementation of Removal Action Alternative 4; these resources are commercially available.

5.2.3 Administrative Implementability

Approvals would be needed for implementation of all seven alternative. Under alternatives 3, 4, 5, 6, and 7 approvals would be needed from the selected disposal facility. These approvals are obtainable within the timeframe allotted for the removal action. Approval would also be needed from SHWMB for alternatives 1, 2, 6, and 7 which involve capping. This ability to obtain this approval within the timeframe allotted for the removal action is not known. Additionally, alternative 4 would require a permit for treating any characteristically hazardous soil which is excavated. This permit is probably not obtainable within the available time.

5.3 COST

The removal action alternatives rank, in order of increasing total present worth, is 3, 5, 4, 1, 2, 7, and 6. Alternative 3 is significantly less costly than the other alternatives. This is largely attributable to the fact that alternative 3 would not incur any long-term O&M costs. The costs that would be incurred under alternatives 1, 2, 6, and 7 involve long-term expenditures for O&M activities relating to periodic maintenance and repair of the cap system.

6.0 PROPOSED REMOVAL ACTION

Based on the individual and comparative analyses of the potential removal action alternatives for the ILCO-UNICAN facility, Removal Action Alternative 3 has been selected for implementation. This selection was made because this alternative would provide a high level of protectiveness to human health and the environment while not posing any significant implementability issues. These results would be achievable at a mid-range cost when compared to the other alternatives.

7.0 REFERENCES

Connor, Jesse, R., 1990. Chemical Fixation and Solidification of Hazardous Waste, Van Nostrand Reinhold, New York.

Ground Water Technology, Inc. 1991. Soil Contamination Assessment Report, Sections 1,3,4, and Appendices, ILCO UNICAN Facility, Winston-Salem, North Carolina, July.

Research & Analytical Laboratories, Inc. 1987a. Comprehensive Sampling Analysis Plan to Determine the Extent of Chemical Contamination at Spill Site(s) Located At Bassick-Sack Division, Winston-Salem, NC.

Research & Analytical Laboratories, Inc. 1987b. Comprehensive Site Report for the Assessment of Chemical Contamination at Spill Sites Land 2, Bassick-Sack Division, Winston-Salem, NC, July.

Research & Analytical Laboratories, Inc. 1987c. Final Report Concerning the Continued Assessment of Chemical Contamination Outside Spill Sites 1 and 2, September.

Research & Analytical Laboratories, Inc. 1988a. Remedial Sampling and Analyses at Chemical Spill Site 1 and 2, March.

Research & Analytical Laboratories, Inc. 1988b. Final Report Concerning Chemical Spill Sites 1, 2 and Areas A, B, C, August.

U.S. Environmental Protection Agency 1987a. Draft Engineering Evaluation/Cost Analysis Guidance for Non-Time-Critical Removal Actions, June.

U.S. Environmental Protection Agency 1987b. Remedial Action Costing Procedures Manual, Document No. EPA/600/8-87/049, October.

U.S. Environmental Protection Agency 1988a. Memorandum from Timothy Fields, Jr., Director Emergency Response Division to Superfund Branch Chiefs, Regions I - X, Regarding Outline of EE/CA Guidance, March.

U.S. Environmental Protection Agency 1988b. CERCLA Compliance With Other Laws Manual: Interim Final, Document No. EPA/540/G-89/006, August.

U.S. Environmental Protection Agency 1991. Human Health Evaluation Manual, Part B: "Development of Risk-based Preliminary Remediation Goals." Office of Solid Waste and Emergency Response, Washington, DC.

Table 1
PSRGs Established for the
ILCO–UNICAN Facility

Constituent	Concentration (mg/kg)	MCL (mg/L)
Chromium	1,350	0.1
Cyanide	5,400	0.2
Nickel	5,400	0.1
Lead	500	none
Copper	9,990	1.3
Zinc	54,000	none
Cadmium	270	0.005

TBL1.WK1/ILCO–UNICAN

Table 2
Evaluation of Chemical Specific ARARs

Regulatory Citation/Pertinent Paragraph	Title/Subject of Regulation	Description of Regulation	Application of Regulation	Status	Rationale
NCAC, Title 15A, Chapter 2, Supchapter 21 Section.0202	Water Quality Standards	Water quality standards for ground waters of the state.	Maximum allowable concentrations resulting from any discharge of contaminants to the land or waters of the state.	Relevant and applicable.	Operational and waste management practices of previous owner and operator resulted in discharges of hazardous substances to the ground waters of the state. Thereby, increasing concentrations of concern in the land (soil).
NCAC, Title 15A, Chapter 2 Subchapter 20 Section.0400	Ambient Air Quality Standards	Establishes ambient air quality standards, certain maximum limits, on parameters of air quality considered desirable for the preservation and enhancement of the quality of the air's resources.	Pertains to sources of air pollution.	Relevant and appropriate.	Excavation actions could potentially result in releases of particulate matter.
NCAC, Title 15A, Chapter 2 Subchapter 2D Section.0500	Emission Control Standards	Regulation assures orderly compliance with emission control standards.	Pertains to all air pollution sources, both combustible and non-combustible.	Relevant and applicable.	Excavation actions could potentially result in releases of particulate matter.
—	State Mandated Clean-Up Criteria	Established clean-up criteria for the spill sites remedial action (1.0 ppm for cyanide, drinking water standards for heavy metals).	Clean-up criteria for soil remediation.	To be considered.	The state mandated this clean-up criteria after approval of a remedial action for the spill sites.

NCAC - North Carolina Administrative Code

CHEMICAL.TBL/UNICAN6/92JEC

GERAGHTY & MILLER, INC.

Table 3
Evaluation of Action Specific ARARs

Regulatory Citation/Pertinent Paragraph	Title/Subject of Regulation	Description of Regulation	Application of Regulation	Status	Rationale
NCAC, Title 15A Chapter 2, Subchapter 2L Section.0106	Corrective Action	Goal of actions taken to restore ground-water quality.	Pertains to any person conducting an activity which results in the discharge of waste or hazardous substance or oil to the ground waters of the State.	Relevant and applicable.	Operational and waste management practices of previous owner and operator resulted in discharges of hazardous substances to the ground waters of the State.
NCAC, Title 15A Chapter 2, Subchapter 2D Section.0201	Classification of Air Pollution Standards	System for classifying air pollution sources.	Pertains to sources of air pollution.	Relevant and applicable.	Excavation activities could potentially result in releases of particulate matter.
NCAC, Title 15A Chapter 2, Subchapter 2D Section.0202	Registration of Air Pollution Sources	Registration procedures for air pollution sources.	Pertains to any source of air pollution.	Relevant and applicable.	
NCAC,Title 15A Chapter 13B Section.0505	Operational Requirements For Sanitary Landfills	Requirements for landfill operation and/or closure.	Minimum requirements for capping of landfill.	Relevant and applicable.	Removal Actions alternatives that include capping must adhere to capping requirements specified in the regulation.

NCAC - North Carolina Administrative Code

ACTION.TBL/UNICAN6/91.JEC

GERAGHTY & MILLER, INC.

Table 4
Removal Action Technologies
For Areas Under Consideration

Removal Action Technology	Baghouses	Roof Drains	Former Plating Sludge Waste Pile
Excavation (Partial)	X	X	X
Excavation (Complete)	X	X	X
Off–Site Landfill Disposal	X	X	X
In–Situ Stabilization			X
Ex–Situ Stabilization	X	X	X
Soil Washing			X
Capping			X

TABLE4.WK1/UNICAN6/92JEC

Table 5
Removal Action Alternatives

	Removal Action Alternatives						
Removal Technology	1	2	3	4	5	6	7
Excavation (Partial)						X	X
Excavation (Complete)			X	X	X		
Off–Site Landfill Disposal			X	X	X	X	
In–Situ Stabilization		X					X
Ex–Situ Stabilization					X	X	X
Soil Washing				X			
Capping	X	X				X	X

TABLE5.WK1/UNICAN6/92JEC

Table 6
Capital Cost Estimate for Removal Action Alternative 1

Cost Element	Estimated Quantity	Unit	Unit Cost	Estimated Cost
Access Restrictions				
Chain Link Fence	1700	LF	$18.37	$31,229
Removal of Soil (1)				
Excavation	160	CY	$5.65	$904
Common Borrow	200	CY	$12.76	$2,552
Compaction	200	CY	$5.03	$1,006
Revegetation	240	SY	$0.37	$89
			SUBTOTAL	$4,551
Single Barrier Cap				
Grading	675	SY	$12.44	$8,397
Common Borrow	563	CY	$12.76	$7,184
Compaction	563	CY	$5.03	$2,832
Revegetation	675	SY	$0.37	$250
			SUBTOTAL	$18,663
	Construction Cost Subtotal:			$54,442
	Contingency @ 20%:			$10,888
	Capital Cost Subtotal:			$65,331
	Design @ 10%:			$6,533
	Construction Management @ 5%:			$3,267
TOTAL OPINION OF PROBABLE CAPITAL CONSTRUCTION COSTS:				$75,130

(1) For consolidation of soils around the baghouses and the roof drains with the soil in the former plating sludge waste pile.

ALTN1.WK1/ILCO-UNICAN.COST

Table 7
Operations & Maintenance Cost Estimate for Removal Action Alternative 1

Cost Element	Estimated Quantity	Unit	Unit Cost	Estimated Cost
Site Inspection	2	EA	$1,120.00	$2,240
Site Maintenance	4	cutting	$1,300.00	$5,200
Cover Restoration	2	EA	$2,000.00	$4,000
Report Preparation	2	EA	$5,000.00	$10,000
	Annual O&M Subtotal:			$21,440
	Contingency @ 20%:			$4,288
	Annual O&M Total:			$25,728
	Administrative @ 5%:			$1,286
TOTAL OPINION OF PROBABLE ANNUAL O&M COSTS:				$27,014
TOTAL 30-YEAR PRESENT WORTH OF ANNUAL O&M COSTS (1):				$254,662

(1) The present worth factor of 10% (i=10%) was used to calculate the 30-year Annual O&M Cost.

ALTN1.WK1/ILCO-UNICAN.COST

Table 8
Capital Cost Estimate for Removal Action Alternative 1 With Modified Cap

Cost Element	Estimated Quantity	Unit	Unit Cost	Estimated Cost
Access Restrictions				
Chain Link Fence	1700	LF	$18.37	$31,229
Removal of Soil (1)				
Excavation	160	CY	$5.65	$904
Common Borrow	200	CY	$12.76	$2,552
Compaction	200	CY	$5.03	$1,006
Revegetation	240	SY	$0.37	$89
			SUBTOTAL	$4,551
Concrete Cap				
Common Borrow	563	CY	$12.76	$7,184
Compaction	563	CY	$5.03	$2,832
Gravel	112	CY	$18.37	$2,057
Concrete	150	CY	$400.00	$60,000
			SUBTOTAL	$72,073
	Construction Cost Subtotal:			$107,853
	Contingency @ 20%:			$21,571
	Capital Cost Subtotal:			$129,424
	Design @ 10%:			$12,942
	Construction Management @ 5%:			$6,471
TOTAL OPINION OF PROBABLE CAPITAL CONSTRUCTION COSTS:				$148,837

(1) For consolidation of soils around the baghouses and the roof drains with the soil in the former plating sludge waste pile.

MOD1.WK1/ILCO-UNICAN.COST

Table 9
Operations & Maintenance Cost Estimate for Removal Action Alternative 1
With Modified Cap

Cost Element	Estimated Quantity	Unit	Unit Cost	Estimated Cost
Site Inspection	2	EA	$1,120.00	$2,240
Site Maintenance (1)	4	EA	$1,300.00	$5,200
Report Preparation	2	EA	$2,500.00	$5,000
	Annual O&M Subtotal:			$12,440
	Contingency @ 20%:			$2,488
	Annual O&M Total:			$14,928
	Administrative @ 5%:			$746
TOTAL OPINION OF PROBABLE ANNUAL O&M COSTS:				$15,674
TOTAL 30-YEAR PRESENT WORTH OF ANNUAL O&M COSTS (2):				$147,761

(1) Site maintenance includes repair of cracks in the concrete cap.
(2) The present worth factor of 10% (i=10%) was used to calculate the 30-year Annual O&M Cost.

MOD1.WK1/ILCO-UNICAN.COST

Table 10
Capital Cost Estimate for Removal Action Alternative 2

Cost Element	Estimated Quantity	Unit	Unit Cost	Estimated Cost
Access Restriction				
Chain Link Fence	1700	LF	$18.37	$31,229
Removal of Soil (1)				
Excavation	160	CY	$5.65	$904
Common Borrow	200	CY	$12.76	$2,552
Compaction	200	CY	$5.03	$1,006
Revegetation	240	SY	$0.37	$89
			SUBTOTAL	$4,551
Single Barrier Cap				
Grading	675	SY	$12.44	$8,397
Common Borrow	563	CY	$12.76	$7,184
Compaction	563	CY	$5.03	$2,832
Revegetation	675	SY	$0.37	$250
			SUBTOTAL	$18,663
In–Situ Stabilization (2)	257	TON	$215.00	$55,255
	Construction Cost Subtotal:			$109,697
	Contingency @ 20%:			$21,939
	Capital Cost Subtotal:			$131,637
	Design @ 10%:			$13,164
	Construction Management @ 5%:			$6,582
TOTAL OPINION OF PROBABLE CAPITAL CONSTRUCTION COSTS:				$151,382

(1) For consolidation of soil around the baghouses and the roof drains with the soil in the former plating sludge waste pile.
(2) USEPA 1990. International Waste Technologies/Geo–Con In Situ Stabilization/ Solidification, Applications Analysis Report, August.

ALTN2.WK1/ILCO–UNICAN.COST

Table 11
Capital Cost Estimate for Removal Action Alternative 3

Cost Element	Estimated Quantity	Unit	Unit Cost	Estimated Cost
Removal of Soil				
Excavation	385	CY	$5.65	$2,175
Transportation (1)	13	load	$740.00	$9,620
Disposal	257	TON	$280.00	$71,960
			SUBTOTAL	$83,755
Site Restoration				
Common Borrow	481	CY	$12.76	$6,138
Compaction	481	CY	$5.03	$2,419
Revegetation	915	SY	$0.37	$339
			SUBTOTAL	$8,896
	Construction Cost Subtotal:			$92,651
	Contigency @ 20%:			$18,530
	Capital Cost Subtotal:			$111,181
	Design @ 10%:			$11,118
	Construction Management @ 5%:			$5,559
TOTAL OPINION OF PROBABLE CAPITAL CONSTRUCTION COSTS:				$127,858

(1) One (1) load = Twenty (20) Tons.

ALTN3&4.WK1/ILCO-UNICAN.COST

Table 12
Capital Cost Estimate for Removal Action Alternative 4

Cost Element	Estimated Quantity	Unit	Unit Cost	Estimated Cost
Ex–Situ Soil Washing				
Soil Washing	257	TON	$400.00	$102,800
Excavation	385	CY	$5.65	$2,175
Transportation (1)	13	load	$740.00	$9,620
Disposal	257	TON	$280.00	$71,960
			SUBTOTAL	$186,555
Site Restoration				
Common Borrow	481	CY	$12.76	$6,138
Compaction	481	CY	$5.03	$2,419
Revegatation	915	SY	$0.37	$339
			SUBTOTAL	$8,896
	Construction Cost Subtotal:			$195,451
	Contigency @ 20%:			$39,090
	Capital Cost Subtotal:			$234,541
	Design @ 10%:			$23,454
	Construction Mangement @ 5%:			$11,727
TOTAL OPINION OF PROBABLE CAPITAL CONSTRUCTION COSTS:				$269,722

(1) One (1) load = Twenty (20) Tons.

ALTN3&4.WK1/ILCO–UNICAN.COST

Table 13
Capital Cost Estimate for Removal Action Alternative 5

Cost Element	Estimated Quantity	Unit	Unit Cost	Estimated Cost
Ex–Situ Stabilization				
Excavation	385	CY	$5.65	$2,175
Transportation (1)	13	load	$740.00	$9,620
Stabilization	385	CY	$70.00	$26,950
Disposal	385	TON	$280.00	$107,800
			SUBTOTAL	$146,545
Site Restoration				
Common Borrow	481	CY	$12.76	$6,138
Compaction	481	CY	$5.03	$2,419
Revegetation	915	SY	$0.37	$339
			SUBTOTAL	$8,896
	Construction Cost Subtotal:			$155,441
	Contigency @ 20%:			$31,088
	Capital Cost Subtotal:			$186,529
	Design @ 10%:			$18,653
	Construction Management @ 5%:			$9,326
TOTAL OPINION OF PROBABLE CAPITAL CONSTRUCTION COSTS:				$214,508

(1) One (1) load = Twenty (20) Tons.

ALT5&6&7.WK1/ILCO–UNICAN.COST

Table 14
Capital Cost Estimate for Removal Action Alternative 6

Cost Element	Estimated Quantity	Unit	Unit Cost	Estimated Cost
Access Restriction				
Chain Link Fence	1700	LF	$18.37	$31,229
Ex-Situ Stabilization (1)				
Excavation	225	CY	$5.65	$1,271
Transportation (2)	12	load	$740.00	$8,880
Stabilization	225	CY	$70.00	$15,750
Disposal	225	TON	$280.00	$63,000
			SUBTOTAL	$88,901
Removal of Soil (3)				
Excavation	160	CY	$5.65	$904
Common Borrow	220	CY	$12.76	$2,807
Compaction	220	CY	$5.03	$1,107
Revegetation	240	SY	$0.37	$89
			SUBTOTAL	$4,907
Single Barrier Cap				
Grading	675	SY	$12.44	$8,397
Common Borrow	563	CY	$12.76	$7,184
Compaction	563	CY	$5.03	$2,832
Revegetation	675	SY	$0.37	$250
			SUBTOTAL	$18,663
	Construction Cost Subtotal:			$143,699
	Contigency @ 20%:			$28,740
	Capital Cost Subtotal:			$172,439
	Design @ 10%:			$17,244
	Construction Management @ 5%:			$8,622
TOTAL OPINION OF PROBABLE CAPITAL CONSTRUCTION COSTS:				$198,305

(1) For soils which exhibit concentrations of the concerned constituents above the concentrations that would characterize them as hazardous waste (40 CFR 261).
(2) One (1) load = Twenty (20) Tons.
(3) For consolidation of soils around the baghouses and the roof drains with the soil in the former plating sludge waste pile.

ALT5&6R7.WK1/TLCO-UNICAN.COST

Table 15
Capital Cost Estimate for Removal Action Alternative 7

Cost Element	Estimated Quantity	Unit	Unit Cost	Estimated Cost
Access Restriction				
Chain Link Fence	1700	LF	$18.37	$31,229
Ex–Situ Stabilization (1)				
Excavation	40	CY	$5.65	$226
Transportation (2)	2	load	$740.00	$1,480
Stabilization	40	CY	$70.00	$2,800
Disposal	40	TON	$280.00	$11,200
			SUBTOTAL	$15,706
Removal of Soil (3)				
Excavation	140	CY	$5.65	$791
Common Borrow	200	CY	$12.76	$2,552
Compaction	200	CY	$5.03	$1,006
Revegetation	240	SY	$0.37	$89
			SUBTOTAL	$4,438
In–Situ Stabilization (4)	230	TON	$215.00	$49,450
Single Barrier Cap				
Grading	675	SY	$12.44	$8,397
Common Borrow	563	CY	$12.76	$7,184
Compaction	563	CY	$5.03	$2,832
Revegetation	675	SY	$0.37	$250
			SUBTOTAL	$18,663
	Construction Cost Subtotal:			$119,485
	Contigency @ 20%:			$23,897
	Capital Cost Subtotal:			$143,382
	Design @ 10%:			$14,338
	Construction Management @ 5%:			$7,169
TOTAL OPINION OF PROBABLE CAPITAL CONSTRUCTION COSTS:				$164,890

(1) For soils which exhibit concentrations of the concerned constituents above the concentrations that would characterize them as hazardous waste (40 CFR 261).
(2) One (1) load = Twenty (20) Tons.
(3) For consolidation of soils around the baghouses and the roof drains with the soil in the former plating sludge waste pile.
(4) USEPA 1990. International Waste Technologies/Geo–Con In Situ Stabilization/ Solidification, Applications Analysis Report, August.

ALT5&6&7.WK1/ILCO–UNICAN.COST

Preliminary Soil Remediation Goals, Ilco Unican, Winston-Salem, North Carolina.

Constituent	References Dose (mg/kg/day)		Slope Factor (kg-day/mg)		PSRG (mg/kg)	
	Oral	Inhalation	Oral	Inhalation	Residential	Industrial
Antimony	4.0E-04	NA			108	816
Arsenic	1.0E-03	NA			270	2,040
Arsenic (cancer)			1.75	15	0.37 *	3 *
Barium	7.0E-02	1.0E-04			18,900	134,692
Beryllium	5.0E-03	NA			1,350	10,200
Beryllium (cancer)			4.3	8.4	0.15 *	1
Cadmium	1.0E-03	NA			270	2,040
Cadmium (cancer)			NC	6.1	-	11,056
Chromium III	1.0E+00	5.7E-07			270,000	13,432
Chromium VI	5.0E-03	5.7E-07			1,350	5,814
Chromium (cancer)			NC	41	-	1,645
Copper	3.7E-02	NA			9,990	75,480
Cyanide	2.0E-02	NA			5,400	40,800
Lead	NA	NA			500	1,000
Mercury	3.0E-04	8.6E-05			81	612
Nickel	2.0E-02	NA			5,400	40,800
Nickel (cancer)			NC	0.84	-	80,288
Selenium	5.0E-03	NA			1,350	10,200
Silver	3.0E-03	NA			810	6,120
Vanadium	7.0E-03	NA			1,890	14,280
Zinc	2.0E-01	NA			54,000	408,000

mg/kg Milligrams per kilogram.
NC Constituent is not considered a carcinogen from oral exposure.
PSRG Preliminary soil remediation goal.
* Value is less than the background concentration.

APPENDIX C

RREL Treatability Database Output For The Constituents Of Concern

ZINC

CAS NO.: 7440-66-6

COMPOUND TYPE: INORGANIC,ELEMENT

FORMULA: ZN

CHEMICAL AND PHYSICAL PROPERTIES	REF.
MOLECULAR WEIGHT: 65.38	333A
MELTING POINT (C): 419.58	333A
BOILING POINT (C): 907	333A
VAPOR PRESSURE @ T(C), TORR: 1 @ 487	333A
SOLUBILITY IN WATER @ T(C), MG/L: INSOLUBLE	333A
LOG OCTANOL/WATER PARTITION COEFFICIENT:	NA
HENRY'S LAW CONSTANT, ATM x M3 MOLE-1:	NA

ENVIRONMENTAL DATA	REF.
CHRONIC NONCARCINOGENIC SYSTEMIC TOXICITY	NA
RISK ESTIMATES FOR CARCINOGENS	NA
DRINKING WATER HEALTH ADVISORIES/STANDARDS	NA
WATER QUALITY CRITERIA	345B
AQUATIC TOXICITY DATABASE	5B

FREUNDLICH ISOTHERM DATA

FREUNDLICH ISOTHERM DATA NOT AVAILABLE AT THIS TIME :

ZINC

CONCENTRATION Before	After	Removal %	Scale	Ref.	Anal. Meth.	Comments
SLUDGE						
SOLVENT EXTRACTION						
1.9 gm/kg	5.6 (1) mg/kg	99.70	B1(B)	2010A-	TCA	pH 1.5 (H2SO4), 4Hr
1.9 gm/kg	1.4 (1) gm/kg	26	B10(B)	2010A-	TCA	EDTA,0.5 X Sto.,4Hr
1.9 gm/kg	1.4 (1) gm/kg	26	B11(B)	2010A-	TCA	EDTA, 1 X Sto., 4Hr
1.9 gm/kg	1.4 (1) gm/kg	26	B12(B)	2010A-	TCA	EDTA, 2 X Sto., 4Hr
6.5 gm/kg	5.4 (1) gm/kg	17	B13(B)	2010A-	TCA	EDTA,0.5 X Sto.,4Hr
6.5 gm/kg	5.3 (1) gm/kg	18	B14(B)	2010A-	TCA	EDTA, 1 X Sto., 4Hr
6.5 gm/kg	5.0 (1) gm/kg	23	B15(B)	2010A-	TCA	EDTA, 2 X Sto., 4Hr
34 gm/kg	10 (1) gm/kg	71	B16(B)	2010A-	TCA	EDTA,1 X Sto., 4Hr
42 gm/kg	10 (1) gm/kg	76	B17(B)	2010A-	TCA	EDTA, 1 X Sto., 4Hr
1.9 gm/kg	1.6 (1) gm/kg	16	B18(B)	2010A-	TCA	NTA,0.5 X Sto., 4Hr
1.9 gm/kg	1.6 (1) gm/kg	16	B19(B)	2010A-	TCA	NTA, 1 X Sto., 4Hr
1.9 gm/kg	120 (1) mg/kg	93.7	B2(B)	2010A-	TCA	pH 2 (H2SO4), 4Hr
1.9 gm/kg	1.6 (1) gm/kg	16	B20(B)	2010A-	TCA	NTA, 2 X Sto., 4Hr
6.5 gm/kg	5.0 (1) gm/kg	23	B21(B)	2010A-	TCA	NTA,0.5 X Sto., 4Hr
6.5 gm/kg	3.8 (1) gm/kg	42	B22(B)	2010A-	TCA	NTA, 1 X Sto., 4Hr
6.5 gm/kg	3.3 (1) gm/kg	49	B23(B)	2010A-	TCA	NTA, 2 X Sto., 4Hr
34 gm/kg	7.0 (1) gm/kg	79	B24(B)	2010A-	TCA	NTA, 1 X Sto., 4Hr
42 gm/kg	15 (1) gm/kg	64	B25(B)	2010A-	TCA	NTA, 1 X Sto., 4Hr
34 gm/kg	8.5 (1) gm/kg	75	B26(B)	2010A-	TCA	pH 1.5,3-STAGE, 3Hr
34 gm/kg	6.2 (1) gm/kg	82	B27(B)	2010A-	TCA	EDTA(1X)3-STAGE,3Hr
34 gm/kg	5.9 (1) gm/kg	83	B28(B)	2010A-	TCA	NTA(1X) 3-STAGE,3Hr
1.9 gm/kg	1.1 (1) gm/kg	42	B3(B)	2010A-	TCA	pH 3 (H2SO4), 4Hr
1.9 gm/kg	1.5 (1) gm/kg	21	B4(B)	2010A-	TCA	pH 4 (H2SO4), 4Hr
6.5 gm/kg	3.3 (1) gm/kg	49	B5(B)	2010A-	TCA	pH 1.5 (H2SO4),4Hr
6.5 gm/kg	5.4 (1) gm/kg	17	B6(B)	2010A-	TCA	pH 2 (H2SO4), 4Hr
6.5 mg/kg	6.5 (1) gm/kg	0	B7(B)	2010A-	TCA	pH 3 (H2SO4), 4Hr
34 gm/kg	8.4 (1) gm/kg	75	B8(B)	2010A-	TCA	pH 1.5 (H2SO4),4Hr
42 gm/kg	1.9 (1) gm/kg	95.5	B9(B)	2010A-	TCA	pH 1.5 (H2SO4),4Hr

ZINC

CONCENTRATION Before	After	Removal %	Scale	Ref.	Anal. Meth.	Comments
SOIL						
LOW TEMPERATURE DESORPTION						
12 mg/L	14 (3) mg/L	0	B1(B)	2000E-	TCLP	550 F for 30 min
12 mg/L	24 (2) mg/L	0	B2(B)	2000E-	TCLP	342 F for 30 min
12 mg/L	27 (1) mg/L	0	B3(B)	2000E-	TCLP	161 F for 30 min
14 mg/L	27 (3) mg/L	0	B7(B)	2000E-	TCLP	551 F for 30 min
14 mg/L	36 (2) mg/L	0	B8(B)	2000E-	TCLP	150 F for 30 min
14 mg/L	27 (1) mg/L	0	B9(B)	2000E-	TCLP	350 F for 30 min
SOLVENT EXTRACTION						
480 mg/kg	460 (1) mg/kg	4	B1(B)	2018B$	TCA	H2O2, 15 min.
9.2 mg/L	7.3 (1) mg/L	21	B1(B)	2018B$	TCLP	H2O2, 15 min.
27 gm/kg	16 (1) gm/kg	41	B10(B)	2018B$	TCA	0.5% Tide, 30 min.
400 mg/L	290 (1) mg/L	28	B10(B)	2018B$	TCLP	0.5% Tide, 30 min.
480 mg/kg	410 (1) mg/kg	14	B2(B)	2018B$	TCA	0.5% Tide, 30 min.
9.2 mg/L	9.6 (1) mg/L	0	B2(B)	2018B$	TCLP	0.5% Tide, 30 min.
640 mg/kg	830 (1) mg/kg	0	B3(B)	2018B$	TCA	H2O2, 15 min.
15 mg/L	16 (1) mg/L	0	B3(B)	2018B$	TCLP	H2O2, 15 min.
640 mg/kg	340 (1) mg/kg	47	B4(B)	2018B$	TCA	5.4% EDTA, 15 min.
15 mg/L	7.0 (1) mg/L	53	B4(B)	2018B$	TCLP	5.4% EDTA, 15 min.
640 mg/kg	560 (1) mg/kg	12	B5(B)	2018B$	TCA	0.5% Tide, 30 min.
15 mg/L	23 (1) mg/L	0	B5(B)	2018B$	TCLP	0.5% Tide, 30 min.
32 gm/kg	28 (1) gm/kg	12	B6(B)	2018B$	TCA	H2O2, 15 min.
360 mg/L	210 (1) mg/L	42	B6(B)	2018B$	TCLP	H2O2, 15 min.
32 gm/kg	4.1 (1) gm/kg	87	B7(B)	2018B$	TCA	5.4% EDTA, 15 min.
360 mg/L	140 (1) mg/L	61	B7(B)	2018B$	TCLP	5.4% EDTA, 15 min.
27 gm/kg	22 (1) gm/kg	18	B8(B)	2018B$	TCA	H2O2, 15 min.
400 mg/L	250 (1) mg/L	38	B8(B)	2018B$	TCLP	H2O2, 15 min.
27 gm/kg	4.4 (1) gm/kg	84	B9(B)	2018B$	TCA	5.4% EDTA, 15 min.
400 mg/L	140 (1) mg/L	65	B9(B)	2018B$	TCLP	5.4% EDA, 15 min.
SOLIDIFICATION						
9.2 mg/L	490 (1) ug/L	94.7	B1(B)	2021B-	TCLP	CEMENT, 28 DAY
390 mg/kg	320 (1) mg/kg	18	B1(B)	2021B-	TCA	CEMENT, 28 DAY
15 mg/L	20 (1) ug/L	99.87	B10(B)	2021B-	TCLP	LIME/FLYASH, 28d
540 mg/kg	280 (1) mg/kg	48	B10(B)	2021B-	TCA	LIME/FLYASH, 28d
360 mg/L	4.0 (1) mg/L	98.9	B11(B)	2021B-	TCLP	LIME/FLYASH, 28d
53 gm/kg	4.8 (1) gm/kg	90.9	B11(B)	2021B-	TCA	LIME/FLYASH, 28d
400 mg/L	3.6 (1) mg/L	99.10	B12(B)	2021B-	TCLP	LIME/FLYASH, 28d
29 gm/kg	7.0 (1) gm/kg	76	B12(B)	2021B-	TCA	LIME/FLYASH, 28d
15 mg/L	540 (1) ug/L	96.4	B2(B)	2021B-	TCLP	CEMENT, 28 DAY
540 mg/kg	480 (1) mg/kg	11	B2(B)	2021B-	TCA	CEMENT, 28 DAY
360 mg/L	690 (1) ug/L	99.81	B3(B)	2021B-	TCLP	CEMENT, 28 DAY
53 gm/kg	22 (1) gm/kg	58	B3(B)	2021B-	TCA	CEMENT, 28 DAY
400 mg/L	740 (1) ug/L	99.82	B4(B)	2021B-	TCLP	CEMENT, 28 DAY
29 gm/kg	21 (1) gm/kg	28	B4(B)	2021B-	TCA	CEMENT, 28 DAY
9.2 mg/L	620 (1) ug/L	93.3	B5(B)	2021B-	TCLP	KILN DUST, 28 DAY
390 mg/kg	230 (1) mg/kg	41	B5(B)	2021B-	TCA	KILN DUST, 28 DAY
15 mg/L	780 (1) ug/L	94.8	B6(B)	2021B-	TCLP	KILN DUST, 28 DAY
540 mg/kg	400 (1) mg/kg	26	B6(B)	2021B-	TCA	KILN DUST, 28 DAY
360 mg/L	4.1 (1) mg/L	98.9	B7(B)	2021B-	TCLP	KILN DUST, 28 DAY
53 gm/kg	7.7 (1) gm/kg	85	B7(B)	2021B-	TCA	KILN DUST, 28 DAY
400 mg/L	3.8 (1) mg/L	99.05	B8(B)	2021B-	TCLP	KILN DUST, 28 DAY
29 gm/kg	12 (1) gm/kg	59	B8(B)	2021B-	TCA	KILN DUST, 28 DAY
9.2 mg/L	10 (1) ug/L	99.89	B9(B)	2021B-	TCLP	LIME/FLYASH, 28d

ZINC

CONCENTRATION Before	After	Removal %	Scale	Ref.	Anal. Meth.	Comments
SOIL						
SOLIDIFICATION						
390 mg/kg	150 (1) mg/kg	62	B9(B)	2021B-	TCA	LIME/FLYASH, 28d

COPPER

CAS NO.: 7440-50-8

COMPOUND TYPE: INORGANIC,ELEMENT

FORMULA: CU

CHEMICAL AND PHYSICAL PROPERTIES	REF.
MOLECULAR WEIGHT: 63.55	333A
MELTING POINT (C): 1083	333A
BOILING POINT (C): 2567	333A
VAPOR PRESSURE @ T(C), TORR: 1 @ 1628	333A
SOLUBILITY IN WATER @ T(C), MG/L: INSOLUBLE	333A
LOG OCTANOL/WATER PARTITION COEFFICIENT:	NA
HENRY'S LAW CONSTANT, ATM x M3 MOLE-1:	NA

ENVIRONMENTAL DATA	REF.
CHRONIC NONCARCINOGENIC SYSTEMIC TOXICITY	NA
RISK ESTIMATES FOR CARCINOGENS	NA
DRINKING WATER HEALTH ADVISORIES/STANDARDS	NA
WATER QUALITY CRITERIA	345B
AQUATIC TOXICITY DATABASE	5B

FREUNDLICH ISOTHERM DATA

FREUNDLICH ISOTHERM DATA NOT AVAILABLE AT THIS TIME !

COPPER

CONCENTRATION Before	After	Removal %	Scale	Ref.	Anal. Meth.	Comments
SLUDGE						
SOLVENT EXTRACTION						
240 mg/kg	220 (1) mg/kg	8	B1(B)	2010A-	TCA	pH 1.5 (H2SO4), 4 HR.
240 mg/kg	220 (1) mg/kg	8	B10(B)	2010A-	TCA	EDTA, 0.5 X Sto., 4 HR.
240 mg/kg	210 (1) mg/kg	13	B11(B)	2010A-	TCA	EDTA, 1 X Sto., 4 HR.
240 mg/kg	200 (1) mg/kg	17	B12(B)	2010A-	TCA	EDTA, 2 X Sto., 4 HR.
1.5 gm/kg	1.5 (1) gm/kg	0	B13(B)	2010A-	TCA	EDTA, 0.5 X Sto., 4 HR.
1.5 gm/kg	1.5 (1) gm/kg	0	B14(B)	2010A-	TCA	EDTA, 1 X Sto., 4 HR.
1.5 gm/kg	1.5 (1) gm/kg	0	B15(B)	2010A-	TCA	EDTA, 2 X Sto., 4 HR.
21 gm/kg	5.1 (1) gm/kg	76	B16(B)	2010A-	TCA	EDTA, 1 X Sto., 4 HR.
27 gm/kg	0.98 (1) gm/kg	96.4	B17(B)	2010A-	TCA	EDTA, 1 X Sto., 4 HR.
240 mg/kg	240 (1) mg/kg	0	B18(B)	2010A-	TCA	NTA, 0.5 X Sto., 4 HR.
240 mg/kg	220 (1) mg/kg	8	B2(B)	2010A-	TCA	pH 2 (H2SO4), 4 HR.
240 mg/kg	230 (1) mg/kg	4	B20(B)	2010A-	TCA	NTA, 2 X Sto., 4 HR.
1.5 gm/kg	1.4 (1) gm/kg	7	B21(B)	2010A-	TCA	NTA, 0.5 X Sto., 4 HR.
1.5 gm/kg	1.2 (1) gm/kg	20	B22(B)	2010A-	TCA	NTA, 1 X Sto., 4 HR.
1.5 gm/kg	1.0 (1) gm/kg	33	B23(B)	2010A-	TCA	NTA, 2 X Sto., 4 HR.
21 gm/kg	3.3 (1) gm/kg	84	B24(B)	2010A-	TCA	NTA, 1 X Sto., 4 HR.
27 gm/kg	0.11 (1) gm/kg	99.59	B25(B)	2010A-	TCA	NTA, 1 X Sto., 4 HR.
21 gm/kg	0.38 (1) gm/kg	98.2	B26(B)	2010A-	TCA	pH 1.5, 3-STAGE, 3 HR.
21 gm/kg	1.7 (1) gm/kg	91.9	B27(B)	2010A-	TCA	EDTA (1X) 3-STAGE, 3 HR
21 gm/kg	2.2 (1) gm/kg	89.5	B28(B)	2010A-	TCA	NTA (1X) 3-STAGE, 3 HR.
240 mg/kg	220 (1) mg/kg	8	B3(B)	2010A-	TCA	pH 3 (H2SO4), 4 HR.
240 mg/kg	220 (1) mg/kg	8	B4(B)	2010A-	TCA	pH 4 (H2SO4), 4 HR.
1.5 gm/kg	1.4 (1) gm/kg	7	B5(B)	2010A-	TCA	pH 1.5 (H2SO4), 4 HR.
1.5 gm/kg	1.4 (1) gm/kg	7	B6(B)	2010A-	TCA	pH 2 (H2SO4), 4 HR.
1.5 gm/kg	1.4 (1) gm/kg	7	B7(B)	2010A-	TCA	pH 3 (H2SO4), 4 HR.
21 gm/kg	0.27 (1) gm/kg	98.7	B8(B)	2010A-	TCA	pH 1.5 (H2SO4), 4 HR.
27 gm/kg	0.11 (1) gm/kg	99.59	B9(B)	2010A-	TCA	pH 1.5 (H2SO4), 4 HR.

COPPER

CONCENTRATION Before	After	Removal %	Scale	Ref.	Anal. Meth.	Comments
SOIL						
LOW TEMPERATURE DESORPTION						
3.5 mg/L	400 (3) ug/L	88	B1(B)	2000E-	TCLP	550 F for 30 min
3.5 mg/L	5.1 (2) mg/L	0	B2(B)	2000E-	TCLP	342 F for 30 min
3.5 mg/L	6.8 (1) mg/L	0	B3(B)	2000E-	TCLP	161 F for 30 min
2.5 mg/L	2.2 (3) mg/L	12	B7(B)	2000E-	TCLP	551 F for 30 min
2.5 mg/L	7.3 (2) mg/L	0	B8(B)	2000E-	TCLP	150 F for 30 min
2.5 mg/L	3.2 (1) mg/L	0	B9(B)	2000E-	TCLP	350 F for 30 min
SOLVENT EXTRACTION						
1.7 mg/gm	2.2 (2) mg/gm	0	B1(B)	2004E-	TCA	30 min with H2O
230 mg/kg	230 (1) mg/kg	0	B1(B)	2018B$	TCA	H2O2, 15 min.
610 ug/L	1.2 (1) mg/L	0	B1(B)	2018B$	TCLP	H2O2, 15 min.
11 gm/kg	6.6 (1) gm/kg	40	B10(B)	2018B$	TCA	0.5% Tide, 30 min.
160 mg/L	120 (1) mg/L	25	B10(B)	2018B$	TCLP	0.5% Tide, 30 min.
1.7 mg/gm	1.8 (2) mg/gm	0	B2(B)	2004E-	TCA	H2O+0.053 mol EDTA
230 mg/kg	230 (1) mg/kg	0	B2(B)	2018B$	TCA	0.5% Tide, 30 min.
610 ug/L	2.1 (1) mg/L	0	B2(B)	2018B$	TCLP	0.5% Tide, 30 min.
1.7 mg/gm	2.6 (2) mg/gm	0	B3(B)	2004E-	TCA	H2O+0.074 mol EDTA
260 mg/kg	390 (1) mg/kg	0	B3(B)	2018B$	TCA	H2O2, 15 min.
890 ug/L	2.7 (1) mg/L	0	B3(B)	2018B$	TCLP	H2O2, 15 min.
1.7 mg/gm	2.5 (2) mg/gm	0	B4(B)	2004E-	TCA	H2O+0.105 mol EDTA
260 mg/kg	140 (1) mg/kg	46	B4(B)	2018B$	TCA	5.4% EDTA, 15 min.
890 ug/L	2.4 (1) mg/L	0	B4(B)	2018B$	TCLP	5.4% EDTA, 15 min.
1.7 mg/gm	2.4 (2) mg/gm	0	B5(B)	2004E-	TCA	H2O+0.105 mol EDTA
260 mg/kg	290 (1) mg/kg	0	B5(B)	2018B$	TCA	0.5% Tide, 30 min.
890 ug/L	4.2 (1) mg/L	0	B5(B)	2018B$	TCLP	0.5% Tide, 30 min.
9.1 gm/kg	12.0 (1) gm/kg	0	B6(B)	2018B$	TCA	H2O2, 15 min.
81 mg/L	86 (1) mg/L	0	B6(B)	2018B$	TCLP	H2O2, 15 min.
9.1 gm/kg	1.3 (1) gm/kg	86	B7(B)	2018B$	TCA	5.4% EDTA, 15 min.
81 mg/L	31 (1) mg/L	62	B7(B)	2018B$	TCLP	5.4% EDTA, 15 min.
11 gm/kg	11 (1) gm/kg	0	B8(B)	2018B$	TCA	H2O2, 15 min.
160 mg/L	130 (1) mg/L	19	B8(B)	2018B$	TCLP	H2O2, 15 min.
11 gm/kg	1.3 (1) gm/kg	88	B9(B)	2018B$	TCA	5.4% EDTA, 15 min.
160 mg/L	72 (1) mg/L	55	B9(B)	2018B$	TCLP	5.4% EDTA, 15 min.
SOLIDIFICATION						
610 ug/L	60 (1) ug/L	90.2	B1(B)	2021B-	TCLP	CEMENT, 28 DAY
190 mg/kg	160 (1) mg/kg	16	B1(B)	2021B-	TCA	CEMENT, 28 DAY
890 ug/L	30 (1) ug/L	96.6	B10(B)	2021B-	TCLP	LIME/FLYASH, 28d
260 mg/kg	110 (1) mg/kg	58	B10(B)	2021B-	TCA	LIME/FLYASH, 28d
81 mg/L	2.6 (1) mg/L	96.8	B11(B)	2021B-	TCLP	LIME/FLYASH, 28d
9.6 gm/kg	1.7 (1) gm/kg	82	B11(B)	2021B-	TCA	LIME/FLYASH, 28d
160 mg/L	2.2 (1) mg/L	98.6	B12(B)	2021B-	TCLP	LIME/FLYASH, 28d
13 gm/kg	3.4 (1) gm/kg	74	B12(B)	2021B-	TCA	LIME/FLYASH, 28d
890 ug/L	60 (1) ug/L	93.2	B2(B)	2021B-	TCLP	CEMENT, 28 DAY
260 mg/kg	220 (1) mg/kg	15	B2(B)	2021B-	TCA	CEMENT, 28 DAY
81 mg/L	90 (1) ug/L	99.89	B3(B)	2021B-	TCLP	CEMENT, 28 DAY
9.6 gm/kg	8.0 (1) gm/kg	17	B3(B)	2021B-	TCA	CEMENT, 28 DAY
160 mg/L	170 (1) ug/L	99.89	B4(B)	2021B-	TCLP	CEMENT, 28 DAY
13 gm/kg	10 (1) gm/kg	23	B4(B)	2021B-	TCA	CEMENT, 28 DAY
610 ug/L	30 (1) ug/L	95.1	B5(B)	2021B-	TCLP	KILN DUST, 28 DAY
190 mg/kg	100 (1) mg/kg	47	B5(B)	2021B-	TCA	KILN DUST, 28 DAY
890 ug/L	90 (1) ug/L	89.9	B6(B)	2021B-	TCLP	KILN DUST, 28 DAY
260 mg/kg	150 (1) mg/kg	42	B6(B)	2021B-	TCA	KILN DUST, 28 DAY

COPPER

CONCENTRATION Before	After	Removal %	Scale	Ref.	Anal. Meth.	Comments
SOIL						
SOLIDIFICATION						
81 mg/L	850 (1) ug/L	99.00	B7(B)	2021B-	TCLP	KILN DUST, 28 DAY
9.6 gm/kg	2.7 (1) gm/kg	72	B7(B)	2021B-	TCA	KILN DUST, 28 DAY
160 mg/L	1.7 (1) mg/L	98.9	B8(B)	2021B-	TCLP	KILN DUST, 28 DAY
13 gm/kg	4.9 (1) gm/kg	62	B8(B)	2021B-	TCA	KILN DUST, 28 DAY
610 ug/L	30 (1) ug/L	95.1	B9(B)	2021B-	TCLP	LIME/FLYASH, 28d
190 mg/kg	62 (1) mg/kg	67	B9(B)	2021B-	TCA	LIME/FLYASH, 28d

LEAD

CAS NO.: 7439-92-1

COMPOUND TYPE: INORGANIC,ELEMENT

FORMULA: PB

CHEMICAL AND PHYSICAL PROPERTIES	REF.
MOLECULAR WEIGHT: 207.20	333A
MELTING POINT (C): 327	333A
BOILING POINT (C): 1740	333A
VAPOR PRESSURE @ T(C), TORR: 1 @ 970	333A
SOLUBILITY IN WATER @ T(C), MG/L: INSOLUBLE	333A
LOG OCTANOL/WATER PARTITION COEFFICIENT:	NA
HENRY'S LAW CONSTANT, ATM x M3 MOLE-1:	NA

ENVIRONMENTAL DATA	REF.
CHRONIC NONCARCINOGENIC SYSTEMIC TOXICITY	NA
RISK ESTIMATES FOR CARCINOGENS	NA
DRINKING WATER HEALTH ADVISORIES/STANDARDS	NA
WATER QUALITY CRITERIA	345B
AQUATIC TOXICITY DATABASE	5B

FREUNDLICH ISOTHERM DATA

FREUNDLICH ISOTHERM DATA NOT AVAILABLE AT THIS TIME !

LEAD

CONCENTRATION Before	After	Removal %	Scale	Ref.	Anal. Meth.	Comments
DEBRIS						
SOLVENT EXTRACTION						
20 gm/kg	290 (1) mg/kg	98.6	B10(B)	2007B$	TCA	CARBONATION + NITRIC ACID
20 gm/kg	230 (1) mg/kg	98.8	B11(B)	2007B$	TCA	CARBONATION + NITRIC ACID

NICKEL

CONCENTRATION Before	After	Removal %	Scale	Ref.	Anal. Meth.	Comments
SLUDGE						
SOLVENT EXTRACTION						
62 mg/kg	18 (1) mg/kg	71	B1(B)	2010A-	TCA	pH 1.5 (H2SO4), 4 HR.
62 mg/kg	53 (1) mg/kg	15	B10(B)	2010A-	TCA	EDTA, 0.5 X Sto., 4 HR.
62 mg/kg	53 (1) mg/kg	15	B11(B)	2010A-	TCA	EDTA, 1 X Sto., 4 HR.
62 mg/kg	51 (1) mg/kg	18	B12(B)	2010A-	TCA	EDTA, 2 X Sto., 4 HR.
450 mg/kg	130 (1) mg/kg	71	B13(B)	2010A-	TCA	EDTA, 0.5 X Sto., 4 HR.
450 mg/kg	100 (1) mg/kg	78	B14(B)	2010A-	TCA	EDTA, 1 X Sto., 4 HR.
450 mg/kg	89 (1) mg/kg	80	B15(B)	2010A-	TCA	EDTA, 2 X Sto., 4 HR.
15 gm/kg	9.7 (1) gm/kg	35	B16(B)	2010A-	TCA	EDTA, 1 X Sto., 4 HR.
19 gm/kg	9.0 (1) gm/kg	53	B17(B)	2010A-	TCA	EDTA, 1 X Sto., 4 HR.
62 mg/kg	4.4 (1) mg/kg	92.9	B18(B)	2010A-	TCA	NTA, 0.5 X Sto., 4 HR.
62 mg/kg	4.1 (1) mg/kg	93.4	B19(B)	2010A-	TCA	NTA, 1 X Sto., 4 HR.
62 mg/kg	25 (1) mg/kg	60	B2(B)	2010A-	TCA	pH 2 (H2SO4), 4 HR.
62 mg/kg	3.0 (1) mg/kg	95.2	B20(B)	2010A-	TCA	NTA, 2 X Sto., 4 HR.
450 mg/kg	82 (1) mg/kg	82	B21(B)	2010A-	TCA	NTA, 0.5 X Sto., 4 HR.
450 mg/kg	66 (1) mg/kg	85	B22(B)	2010A-	TCA	NTA, 1 X Sto., 4 HR.
450 mg/kg	58 (1) mg/kg	87	B23(B)	2010A-	TCA	NTA, 2 X Sto., 4 HR.
15 gm/kg	8.1 (1) gm/kg	46	B24(B)	2010A-	TCA	NTA, 1 X Sto., 4 HR.
19 gm/kg	9.6 (1) gm/kg	49	B25(B)	2010A-	TCA	NTA, 1 X Sto., 4 HR.
15 gm/kg	2.1 (1) gm/kg	86	B26(B)	2010A-	TCA	pH 1.5, 3-STAGE, 3 HR.
15 gm/kg	8.0 (1) gm/kg	47	B27(B)	2010A-	TCA	EDTA (1X) 3-STAGE, 3 HR.
15 gm/kg	8.5 (1) gm/kg	43	B28(B)	2010A-	TCA	NTA (1X) 3-STAGE, 3 HR.
62 mg/kg	38 (1) mg/kg	39	B3(B)	2010A-	TCA	pH 3 (H2SO4), 4 HR.
62 mg/kg	44 (1) mg/kg	29	B4(B)	2010A-	TCA	pH 4 (H2SO4), 4 HR.
450 mg/kg	4.9 (1) mg/kg	98.9	B5(B)	2010A-	TCA	pH 1.5 (H2SO4), 4 HR.
450 mg/kg	36 (1) mg/kg	92.0	B6(B)	2010A-	TCA	pH 2 (H2SO4), 4 HR.
450 mg/kg	150 (1) mg/kg	67	B7(B)	2010A-	TCA	pH 3 (H2SO4), 4 HR.
15 gm/kg	2.3 (1) gm/kg	85	B8(B)	2010A-	TCA	pH 1.5 (H2SO4), 4 HR.
19 gm/kg	3.8 (1) gm/kg	80	B9(B)	2010A-	TCA	pH 1.5 (H2SO4), 4 HR.

NICKEL

CAS NO.: 7440-02-0

COMPOUND TYPE: INORGANIC,ELEMENT

FORMULA: NI

CHEMICAL AND PHYSICAL PROPERTIES	REF.
MOLECULAR WEIGHT: 58.69	333A
MELTING POINT (C): 1455	333A
BOILING POINT (C): 2730	333A
VAPOR PRESSURE @ T(C), TORR: 1 @ 1800	333A
SOLUBILITY IN WATER @ T(C), MG/L: INSOLUBLE	333A
LOG OCTANOL/WATER PARTITION COEFFICIENT:	NA
HENRY'S LAW CONSTANT, ATM x M3 MOLE-1:	NA

ENVIRONMENTAL DATA	REF.
CHRONIC NONCARCINOGENIC SYSTEMIC TOXICITY	NA
RISK ESTIMATES FOR CARCINOGENS	NA
DRINKING WATER HEALTH ADVISORIES/STANDARDS	349B
WATER QUALITY CRITERIA	345B
AQUATIC TOXICITY DATABASE	5B

FREUNDLICH ISOTHERM DATA

FREUNDLICH ISOTHERM DATA NOT AVAILABLE AT THIS TIME !

CHROMIUM

CONCENTRATION Before	After	Removal %	Scale	Ref.	Anal. Meth.	Comments
SOIL						
LOW TEMPERATURE DESORPTION						
60 ug/L	40 (3) ug/L	33	B1(B)	2000E-	TCLP	550 F for 30 min
60 ug/L	130 (2) ug/L	0	B2(B)	2000E-	TCLP	342 F for 30 min
60 ug/L	100 (1) ug/L	0	B3(B)	2000E-	TCLP	161 F for 30 min
40 ug/L	100 (3) ug/L	0	B7(B)	2000E-	TCLP	551 F for 30 min
40 ug/L	100 (2) ug/L	0	B8(B)	2000E-	TCLP	150 F for 30 min
40 ug/L	60 (1) ug/L	0	B9(B)	2000E-	TCLP	350 F for 30 min
SOLVENT EXTRACTION						
24 mg/kg	26 (1) mg/kg	0	B1(B)	2018B$	TCA	H2O2, 15 min.
10 ug/L	10 (1) ug/L	0	B1(B)	2018B$	TCLP	H2O2, 15 min.
60 ug/L	1.3 (1) mg/L	0	B10(B)	2018B$	TCLP	0.5% Tide, 30 min.
1.3 gm/kg	880 (1) mg/kg	32	B10(B)	2018B$	TCA	0.5% Tide, 30 min.
24 mg/kg	28 (1) mg/kg	0	B2(B)	2018B$	TCA	0.5% Tide, 30 min.
10 ug/L	10 (1) ug/L	0	B2(B)	2018B$	TCLP	0.5% Tide, 30 min.
28 mg/kg	54 (1) mg/kg	0	B3(B)	2018B$	TCA	H2O2, 15 min.
10 ug/L	10 (1) ug/L	0	B3(B)	2018B$	TCLP	H2O2, 15 min.
28 mg/kg	42 (1) mg/kg	0	B4(B)	2018B$	TCA	5.4% EDTA, 15 min.
10 ug/L	310 (1) ug/L	0	B4(B)	2018B$	TCLP	5.4% EDTA, 15 min.
28 mg/kg	34 (1) mg/kg	0	B5(B)	2018B$	TCA	0.5% Tide, 30 min.
10 ug/L	470 (1) ug/L	0	B5(B)	2018B$	TCLP	0.5% Tide, 30 min.
1.2 gm/kg	1.5 (1) gm/kg	0	B6(B)	2018B$	TCA	H2O2, 15 min.
10 ug/L	30 (1) ug/L	0	B6(B)	2018B$	TCLP	H2O2, 15 min.
1.2 gm/kg	1.1 (1) gm/kg	8	B7(B)	2018B$	TCA	5.4% EDTA, 15 min.
10 ug/L	680 (1) ug/L	0	B7(B)	2018B$	TCLP	5.4% EDTA, 15 min.
1.3 gm/kg	1.3 (1) gm/kg	0	B8(B)	2018B$	TCA	H2O2, 15 min.
60 ug/L	42 (1) ug/L	30	B8(B)	2018B$	TCLP	H2O2, 15 min.
1.3 gm/kg	870 (1) mg/kg	33	B9(B)	2018B$	TCA	5.4% EDTA, 15 min.
60 ug/L	380 (1) ug/L	0	B9(B)	2018B$	TCLP	5.4% EDTA, 15 min.
SOLIDIFICATION						
27 mg/kg	56 (1) mg/kg	0	B1(B)	2021B-	TCA	CEMENT, 28 DAY
37 mg/kg	19 (1) mg/kg	49	B10(B)	2021B-	TCA	LIME/FLYASH, 28d
1.2 gm/kg	280 (1) mg/kg	77	B11(B)	2021B-	TCA	LIME/FLYASH, 28d
60 ug/L	70 (1) ug/L	0	B12(B)	2021B-	TCLP	LIME/FLYASH, 28d
1.6 gm/kg	390 (1) mg/kg	76	B12(B)	2021B-	TCA	LIME/FLYASH, 28d
37 mg/kg	45 (1) mg/kg	0	B2(B)	2021B-	TCA	CEMENT, 28 DAY
1.2 gm/kg	1.1 (1) gm/kg	8	B3(B)	2021B-	TCA	CEMENT, 28 DAY
60 ug/L	60 (1) ug/L	0	B4(B)	2021B-	TCLP	CEMENT, 28 DAY
1.6 gm/kg	1.0 (1) gm/kg	38	B4(B)	2021B-	TCA	CEMENT, 28 DAY
27 mg/kg	22 (1) mg/kg	18	B5(B)	2021B-	TCA	KILN DUST, 28 DAY
37 mg/kg	27 (1) mg/kg	27	B6(B)	2021B-	TCA	KILN DUST, 28 DAY
1.2 gm/kg	430 (1) mg/kg	64	B7(B)	2021B-	TCA	KILN DUST, 28 DAY
60 ug/L	120 (1) ug/L	0	B8(B)	2021B-	TCLP	KILN DUST, 28 DAY
1.6 gm/kg	520 (1) mg/kg	68	B8(B)	2021B-	TCA	KILN DUST, 28 DAY
27 mg/kg	19 (1) mg/kg	30	B9(B)	2021B-	TCA	LIME/FLYASH, 28d
THERMAL DESTRUCTION						
270 ug/L	380 (1) ug/L	0	B1(B)	2002E-	EPT	UNKNOWN
24 ug/L	400 (1) ug/L	0	B2(B)	2002E-	EPT	UNKNOWN

CHROMIUM

CONCENTRATION Before	After	Removal %	Scale	Ref.	Anal. Meth.	Comments
SLUDGE						
SOLVENT EXTRACTION						
69 mg/kg	21 (1) mg/kg	70	B1(B)	2010A-	TCA	pH 1.5 (H2SO4), 4 HR.
69 mg/kg	67 (1) mg/kg	3	B10(B)	2010A-	TCA	EDTA, 0.5 X Sto., 4 HR.
69 mg/kg	66 (1) mg/kg	4	B11(B)	2010A-	TCA	EDTA, 1 X Sto., 4 HR.
69 mg/kg	65 (1) mg/kg	6	B12(B)	2010A-	TCA	EDTA, 2 X Sto., 4 HR.
360 mg/kg	320 (1) mg/kg	11	B13(B)	2010A-	TCA	EDTA, 0.5 X Stoc., 4 HR.
360 mg/kg	260 (1) mg/kg	28	B14(B)	2010A-	TCA	EDTA, 1 X Sto., 4 HR.
360 mg/kg	250 (1) mg/kg	31	B15(B)	2010A-	TCA	EDTA, 2 X Sto., 4 HR.
7.0 gm/kg	6.5 (1) gm/kg	7	B16(B)	2010A-	TCA	EDTA, 1 X Sto., 4 HR.
11 gm/kg	9.8 (1) gm/kg	11	B17(B)	2010A-	TCA	EDTA, 1 X Sto., 4 HR.
69 mg/kg	67 (1) mg/kg	3	B18(B)	2010A-	TCA	NTA, 0.5 X Sto., 4 HR.
69 mg/kg	67 (1) mg/kg	3	B19(B)	2010A-	TCA	NTA, 1 X Sto., 4 HR.
69 mg/kg	34 (1) mg/kg	51	B2(B)	2010A-	TCA	pH 2 (H2SO4), 4 HR.
69 mg/kg	64 (1) mg/kg	7	B20(B)	2010A-	TCA	NTA, 2 X Sto., 4 HR.
360 mg/kg	290 (1) mg/kg	19	B21(B)	2010A-	TCA	NTA, 0.5 X Sto., 4 HR.
360 mg/kg	260 (1) mg/kg	28	B22(B)	2010A-	TCA	NTA, 1 X Sto., 4 HR
360 mg/kg	250 (1) mg/kg	31	B23(B)	2010A-	TCA	NTA, 2 X Sto., 4 HR.
7.0 gm/kg	6.4 (1) gm/kg	9	B24(B)	2010A-	TCA	NTA, 1 X Sto., 4 HR.
11 gm/kg	10 (1) gm/kg	9	B25(B)	2010A-	TCA	NTA, 1 X Sto., 4 HR.
7.0 gm/kg	3.4 (1) gm/kg	51	B26(B)	2010A-	TCA	pH 1.5, 3-STAGE, 3 HR.
7.0 gm/kg	6.5 (1) gm/kg	7	B27(B)	2010A-	TCA	EDTA (1X) 3-STAGE, 3 HR.
7.0 gm/kg	6.3 (1) gm/kg	10	B28(B)	2010A-	TCA	NTA (1X) 3-STAGE, 3 HR.
69 mg/kg	45 (1) mg/kg	35	B3(B)	2010A-	TCA	pH 3 (H2SO4), 4 HR.
69 mg/kg	49 (1) mg/kg	29	B4(B)	2010A-	TCA	pH 4 (H2SO4), 4 HR.
360 mg/kg	9.7 (1) mg/kg	97.3	B5(B)	2010A-	TCA	pH 1.5 (H2SO4), 4 HR.
360 mg/kg	44 (1) mg/kg	88	B6(B)	2010A-	TCA	pH 2 (H2SO4), 4 HR.
360 mg/kg	330 (1) mg/kg	8	B7(B)	2010A-	TCA	pH 3 (H2SO4), 4 HR.
7.0 gm/kg	2.9 (1) gm/kg	59	B8(B)	2010A-	TCA	pH 1.5 (H2SO4), 4 HR.
11 gm/kg	6.4 (1) gm/kg	42	B9(B)	2010A-	TCA	pH 1.5 (H2SO4), 4 HR.

CHROMIUM

CAS NO.: 7440-47-3

COMPOUND TYPE: INORGANIC,ELEMENT

FORMULA: CR

CHEMICAL AND PHYSICAL PROPERTIES	REF.
MOLECULAR WEIGHT: 52.00	333A
MELTING POINT (C): 1857	333A
BOILING POINT (C): 2672	333A
VAPOR PRESSURE @ T(C), TORR: 1 @ 1616	333A
SOLUBILITY IN WATER @ T(C), MG/L: INSOLUBLE	333A
LOG OCTANOL/WATER PARTITION COEFFICIENT:	NA
HENRY'S LAW CONSTANT, ATM x M3 MOLE-1:	NA

ENVIRONMENTAL DATA	REF.
CHRONIC NONCARCINOGENIC SYSTEMIC TOXICITY	4B
RISK ESTIMATES FOR CARCINOGENS	4B
DRINKING WATER HEALTH ADVISORIES/STANDARDS	NA
WATER QUALITY CRITERIA	345B
AQUATIC TOXICITY DATABASE	5B

FREUNDLICH ISOTHERM DATA

FREUNDLICH ISOTHERM DATA NOT AVAILABLE AT THIS TIME !

LEAD

CONCENTRATION Before	After	Removal %	Scale	Ref.	Anal. Meth.	Comments
SOIL						
SOLIDIFICATION						
240 mg/kg	290 (1) mg/kg	0	B2(B)	2021B-	TCA	CEMENT, 28 DAY
20 mg/L	<150 (1) ug/L	>99.25	B3(B)	2021B-	TCLP	CEMENT, 28 DAY
15 gm/kg	12 (1) gm/kg	20	B3(B)	2021B-	TCA	CEMENT, 28 DAY
70 mg/L	370 (1) ug/L	99.47	B4(B)	2021B-	TCLP	CEMENT, 28 DAY
17 gm/kg	8.7 (1) gm/kg	49	B4(B)	2021B-	TCA	CEMENT, 28 DAY
490 ug/L	<150 (1) ug/L	>69	B5(B)	2021B-	TCLP	KILN DUST, 28 DAY
190 mg/kg	120 (1) mg/kg	37	B5(B)	2021B-	TCA	KILN DUST, 28 DAY
700 ug/L	370 ug/L	47	B6(B)	2021B-	TCLP	KILN DUST, 28 DAY
240 mg/kg	190 (1) mg/kg	21	B6(B)	2021B-	TCA	KILN DUST, 28 DAY
20 mg/L	18 (1) mg/L	10	B7(B)	2021B-	TCLP	KILN DUST, 28 DAY
15 gm/kg	4.4 (1) gm/kg	71	B7(B)	2021B-	TCA	KILN DUST, 28 DAY
70 mg/L	21 (1) mg/L	70	B8(B)	2021B-	TCLP	KILN DUST, 28 DAY
17 gm/kg	5.2 (1) gm/kg	69	B8(B)	2021B-	TCA	KILN DUST, 28 DAY
490 ug/L	<150 (1) ug/L	>69	B9(B)	2021B-	TCLP	LIME/FLYASH, 28d
190 mg/kg	110 (1) mg/kg	42	B9(B)	2021B-	TCA	LIME/FLYASH, 28d
THERMAL DESTRUCTION						
830 ug/L	230 (1) ug/L	72	B1(B)	2002E-	EPT	UNKNOWN

LEAD

CONCENTRATION Before	After	Removal %	Scale	Ref.	Anal. Meth.	Comments
SOIL						
LOW TEMPERATURE DESORPTION						
1.6 mg/L	200 (3) ug/L	88	B1(B)	2000E-	TCLP	550 F for 30 min
1.6 mg/L	2.3 (2) mg/L	0	B2(B)	2000E-	TCLP	342 F for 30 min
1.6 mg/L	2.8 (1) mg/L	0	B3(B)	2000E-	TCLP	161 F for 30 min
1.2 mg/L	1.6 (3) mg/L	0	B7(B)	2000E-	TCLP	551 F for 30 min
1.2 mg/L	7.3 (2) mg/L	0	B8(B)	2000E-	TCLP	150 F for 30 min
1.2 mg/L	2.1 (1) mg/L	0	B9(B)	2000E-	TCLP	350 F for 30 min
SOLVENT EXTRACTION						
210 ug/gm	160 (2) ug/gm	24	B1(B)	2004E-	TCA	30 min with H2O
540 mg/kg	450 (1) mg/kg	17	B1(B)	2007BS	TCA	CARBONATION + NITRIC ACI
240 mg/kg	240 (1) mg/kg	0	B1(B)	2018BS	TCA	H2O2, 15 min.
490 ug/L	690 (1) ug/L	0	B1(B)	2018BS	TCLP	H2O2, 15 min.
15 gm/kg	8.9 (1) gm/kg	41	B10(B)	2018BS	TCA	0.5% Tide, 30 min.
70 mg/L	16 (1) mg/L	77	B10(B)	2018BS	TCLP	0.5% Tide, 30 min.
210 ug/gm	140 (2) ug/gm	33	B2(B)	2004E-	TCA	H2O+0.053 mol EDTA
540 mg/kg	99 (1) mg/kg	82	B2(B)	2007BS	TCA	CARBONATION + NITRIC ACI
240 mg/kg	260 (1) mg/kg	0	B2(B)	2018BS	TCA	0.5% Tide, 30 min.
490 ug/L	680 (1) ug/L	0	B2(B)	2018BS	TCLP	0.5% Tide, 30 min.
210 ug/gm	160 (2) ug/gm	24	B3(B)	2004E-	TCA	H2O+0.074 mol EDTA
540 mg/kg	110 (1) mg/kg	80	B3(B)	2007BS	TCA	CARBONATION + NITRIC ACI
300 mg/kg	430 (1) mg/kg	0	B3(B)	2018BS	TCA	H2O2, 15 min.
700 ug/L	2.2 (1) mg/L	0	B3(B)	2018BS	TCLP	H2O2, 15 min.
210 ug/gm	170 (2) ug/gm	19	B4(B)	2004E-	TCA	H2O+0.105 mol EDTA
1500 mg/kg	180 (1) mg/kg	88	B4(B)	2007BS	TCA	CARBONATION + NITRIC ACI
300 mg/kg	68 (1) mg/kg	77	B4(B)	2018BS	TCA	5.4% EDTA, 15 min.
700 ug/L	1.4 (1) mg/L	0	B4(B)	2018BS	TCLP	5.4% EDTA, 15 min.
210 ug/gm	140 (2) ug/gm	33	B5(B)	2004E-	TCA	H2O+0.105 mol EDTA
1500 mg/kg	180 (1) mg/kg	88	B5(B)	2007BS	TCA	CARBONATION + NITRIC ACI
300 mg/kg	310 (1) mg/kg	0	B5(B)	2018BS	TCA	0.5% Tide, 30 min.
700 ug/L	2.7 (1) mg/L	0	B5(B)	2018BS	TCLP	0.5% Tide, 30 min.
22 gm/kg	410 (1) mg/kg	98.1	B6(B)	2007BS	TCA	CARBONATION + NITRIC ACI
14 gm/kg	18 (1) gm/kg	0	B6(B)	2018BS	TCA	H2O2, 15 min.
20 mg/L	16 (1) mg/L	20	B6(B)	2018BS	TCLP	H2O2, 15 min.
22 gm/kg	860 (1) mg/kg	96.1	B7(B)	2007BS	TCA	CARBONATION + NITRIC ACI
14 gm/kg	910 (1) mg/kg	93.5	B7(B)	2018BS	TCA	5.4% EDTA, 15 min.
20 mg/L	39 (1) mg/L	0	B7(B)	2018BS	TCLP	5.4% EDTA, 15 min.
22 gm/kg	520 (1) mg/kg	97.6	B8(B)	2007BS	TCA	CARBONATION + NITRIC ACI
15 gm/kg	14 (1) gm/kg	7	B8(B)	2018BS	TCA	H2O2, 15 min.
70 mg/L	40 (1) mg/L	43	B8(B)	2018BS	TCLP	H2O2, 15 min.
50 gm/kg	190 (1) mg/kg	99.62	B9(B)	2007BS	TCA	CARBONATION + NITRIC ACI
15 gm/kg	880 (1) mg/kg	94.1	B9(B)	2018BS	TCA	5.4% EDTA, 15 min.
70 mg/L	89 (1) mg/L	0	B9(B)	2018BS	TCLP	5.4% EDTA, 15 min.
SOLIDIFICATION						
490 ug/L	150 (1) ug/L	69	B1(B)	2021B-	TCLP	CEMENT, 28 DAY
190 mg/kg	190 (1) mg/kg	0	B1(B)	2021B-	TCA	CEMENT, 28 DAY
700 ug/L	<150 (1) ug/L	>78	B10(B)	2021B-	TCLP	LIME/FLYASH, 28d
240 mg/kg	130 (1) mg/kg	46	B10(B)	2021B-	TCA	LIME/FLYASH, 28d
20 mg/L	51 (1) mg/L	0	B11(B)	2021B-	TCLP	LIME/FLYASH, 28d
15 gm/kg	2.8 (1) gm/kg	81	B11(B)	2021B-	TCA	LIME/FLYASH, 28d
70 mg/L	65 (1) mg/L	7	B12(B)	2021B-	TCLP	LIME/FLYASH, 28d
17 gm/kg	4.6 (1) gm/kg	73	B12(B)	2021B-	TCA	LIME/FLYASH, 28d
700 ug/L	150 (1) ug/L	78	B2(B)	2021B-	TCLP	CEMENT, 28 DAY

LEAD

CONCENTRATION Before	After	Removal %	Scale	Ref.	Anal. Meth.	Comments
SLUDGE						
SOLVENT EXTRACTION						
130 mg/kg	46 (1) mg/kg	65	B1(B)	2010A-	TCA	pH 1.5 (H2SO4), 4 HR.
130 mg/kg	38 (1) mg/kg	71	B10(B)	2010A-	TCA	EDTA, 0.5 X Sto., 4 HR.
130 mg/kg	30 (1) mg/kg	77	B11(B)	2010A-	TCA	EDTA, 1 X Sto., 4 HR.
130 mg/kg	29 (1) mg/kg	78	B12(B)	2010A-	TCA	EDTA, 2 X Sto., 4 HR.
160 mg/kg	69 (1) mg/kg	57	B13(B)	2010A-	TCA	EDTA, 0.5 X Sto., 4 HR.
160 mg/kg	68 (1) mg/kg	58	B14(B)	2010A-	TCA	EDTA, 1 X Sto., 4 HR.
160 mg/kg	63 (1) mg/kg	61	B15(B)	2010A-	TCA	EDTA, 2 X Sto., 4 HR.
29 gm/kg	9.2 (1) gm/kg	68	B16(B)	2010A-	TCA	EDTA, 1 X Sto., 4 HR.
36 gm/kg	7.7 (1) gm/kg	79	B17(B)	2010A-	TCA	EDTA 1 X Sto., 4 HR.
130 mg/kg	100 (1) mg/kg	23	B18(B)	2010A-	TCA	NTA, 0.5 X Sto., 4 HR.
130 mg/kg	100 (1) mg/kg	23	B19(B)	2010A-	TCA	NTA, 1 X Sto., 4 HR.
130 mg/kg	61 (1) mg/kg	53	B2(B)	2010A-	TCA	pH 2 (H2SO4), 4 HR.
130 mg/kg	100 (1) mg/kg	23	B20(B)	2010A-	TCA	NTA, 2 X Sto., 4 HR.
160 mg/kg	95 (1) mg/kg	41	B21(B)	2010A-	TCA	NTA, 0.5 X Sto., 4 HR.
160 mg/kg	93 (1) mg/kg	42	B22(B)	2010A-	TCA	NTA, 1 X Sto., 4 HR.
160 mg/kg	90 (1) mg/kg	44	B23(B)	2010A-	TCA	NTA, 2 X Sto., 4 HR.
29 gm/kg	5.3 (1) gm/kg	82	B24(B)	2010A-	TCA	NTA, 1 X Sto., 4 HR.
36 gm/kg	6.9 (1) gm/kg	81	B25(B)	2010A-	TCA	NTA, 1 X Sto., 4 HR.
29 gm/kg	5.4 (1) gm/kg	81	B26(B)	2010A-	TCA	pH 1.5, 3-STAGE, 3 HR.
29 gm/kg	4.7 (1) gm/kg	84	B27(B)	2010A-	TCA	EDTA (1X) 3-STAGE, 3 HR.
29 gm/kg	4.7 (1) gm/kg	84	B28(B)	2010A-	TCA	NTA (1X) 3-STAGE, 3 HR.
130 mg/kg	63 (1) mg/kg	52	B3(B)	2010A-	TCA	pH 3 (H2SO4), 4 HR.
130 mg/kg	83 (1) mg/kg	36	B4(B)	2010A-	TCA	pH 4 (H2SO4), 4 HR.
160 mg/kg	100 (1) mg/kg	38	B5(B)	2010A-	TCA	pH 1.5 (H2SO4), 4 HR.
160 mg/kg	100 (1) mg/kg	38	B6(B)	2010A-	TCA	pH 2 (H2SO4), 4 HR.
160 mg/kg	110 (1) mg/kg	31	B7(B)	2010A-	TCA	pH 3 (H2SO4), 4 HR.
29 gm/kg	9.4 (1) gm/kg	68	B8(B)	2010A-	TCA	pH 1.5 (H2SO4), 4 HR.
36 gm/kg	10 (1) gm/kg	72	B9(B)	2010A-	TCA	pH 1.5 (H2SO4), 4 HR.

NICKEL

CONCENTRATION Before	After	Removal %	Scale	Ref.	Anal. Meth.	Comments
SOIL						
LOW TEMPERATURE DESORPTION						
550 ug/L	600 (3) ug/L	0	B1(B)	2000E-	TCLP	550 F for 30 min
550 ug/L	1.1 (2) mg/L	0	B2(B)	2000E-	TCLP	342 F for 30 min
550 ug/L	1.4 (1) mg/L	0	B3(B)	2000E-	TCLP	161 F for 30 min
530 ug/L	940 (3) ug/L	0	B7(B)	2000E-	TCLP	551 F for 30 min
530 mg/L	1.5 (2) mg/L	0	B8(B)	2000E-	TCLP	150 F for 30 min
530 ug/L	900 (1) ug/L	0	B9(B)	2000E-	TCLP	350 F for 30 min
SOLVENT EXTRACTION						
2.1 mg/gm	2.3 (2) mg/gm	0	B1(B)	2004E-	TCA	30 min with H2O
32 mg/kg	23 (1) mg/kg	28	B1(B)	2018BS	TCA	H2O2, 15 min.
270 ug/L	260 (1) ug/L	4	B1(B)	2018BS	TCLP	H2O2, 15 min.
1.5 gm/kg	380 (1) mg/kg	75	B10(B)	2018BS	TCA	0.5% Tide, 30 min.
27 mg/L	14 (1) mg/L	48	B10(B)	2018BS	TCLP	0.5% Tide, 30 min.
2.1 mg/gm	2.6 (2) mg/gm	0	B2(B)	2004E-	TCA	H2O+0.053 mol EDTA
32 mg/kg	21 (1) mg/kg	34	B2(B)	2018BS	TCA	0.5% Tide, 30 min.
270 ug/L	440 (1) ug/L	0	B2(B)	2018BS	TCLP	0.5% Tide, 30 min.
2.1 mg/gm	3.8 (2) mg/gm	0	B3(B)	2004E-	TCA	H2O+0.074 mol EDTA
38 mg/kg	42 (1) mg/kg	0	B3(B)	2018BS	TCA	H2O2, 15 min.
400 ug/L	570 (1) ug/L	0	B3(B)	2018BS	TCLP	H2O2, 15 min.
2.1 mg/gm	2.5 (2) mg/gm	0	B4(B)	2004E-	TCA	H2O+0.105 mol EDTA
38 mg/kg	27 (1) mg/kg	29	B4(B)	2018BS	TCA	5.4% EDTA, 15 min.
400 ug/L	460 (1) ug/L	0	B4(B)	2018BS	TCLP	5.4% EDTA, 15 min.
2.1 mg/gm	3.1 (2) mg/gm	0	B5(B)	2004E-	TCA	H2O+0.105 mol EDTA
38 mg/kg	27 (1) mg/kg	29	B5(B)	2018BS	TCA	0.5% Tide, 30 min.
400 ug/L	580 (1) ug/L	0	B5(B)	2018BS	TCLP	0.5% Tide, 30 min.
1.5 gm/kg	930 (1) mg/kg	38	B6(B)	2018BS	TCA	H2O2, 15 min.
18 mg/L	11 (1) mg/L	39	B6(B)	2018BS	TCLP	H2O2, 15 min.
1.5 gm/kg	280 (1) mg/kg	81	B7(B)	2018BS	TCA	5.4% EDTA, 15 min.
18 mg/L	5.4 (1) mg/L	70	B7(B)	2018BS	TCLP	5.4% EDTA, 15 min.
1.5 gm/kg	740 (1) mg/kg	51	B8(B)	2018BS	TCA	H2O2, 15 min.
27 mg/L	12 (1) mg/L	56	B8(B)	2018BS	TCLP	H2O2, 15 min.
1.5 gm/kg	190 (1) mg/kg	87	B9(B)	2018BS	TCA	5.4% EDTA, 15 min.
27 mg/L	7.9 (1) mg/L	71	B9(B)	2018BS	TCLP	5.4% EDTA, 15 min.
SOLIDIFICATION						
270 ug/L	40 (1) ug/L	85	B1(B)	2021B-	TCLP	CEMENT, 28 DAY
27 mg/kg	32 (1) mg/kg	0	B1(B)	2021B-	TCA	CEMENT, 28 DAY
400 ug/L	<40 (1) ug/L	>90.0	B10(B)	2021B-	TCLP	LIME/FLYASH, 28d
32 mg/kg	20 (1) mg/kg	38	B10(B)	2021B-	TCA	LIME/FLYASH, 28d
18 mg/L	50 (1) ug/L	99.72	B11(B)	2021B-	TCLP	LIME/FLYASH, 28d
1.1 gm/kg	170 (1) mg/kg	84	B11(B)	2021B-	TCA	LIME/FLYASH, 28d
27 mg/L	50 (1) ug/L	99.81	B12(B)	2021B-	TCLP	LIME/FLYASH, 28d
1.4 gm/kg	260 (1) mg/kg	81	B12(B)	2021B-	TCA	LIME/FLYASH, 28d
400 ug/L	40 (1) ug/L	90.0	B2(B)	2021B-	TCLP	CEMENT, 28 DAY
32 mg/kg	39 (1) mg/kg	0	B2(B)	2021B-	TCA	CEMENT, 28 DAY
18 mg/L	<40 (1) ug/L	>99.78	B3(B)	2021B-	TCLP	CEMENT, 28 DAY
1.1 mg/kg	720 (1) mg/kg	34	B3(B)	2021B-	TCA	CEMENT, 28 DAY
27 mg/L	40 (1) ug/L	99.85	B4(B)	2021B-	TCLP	CEMENT, 28 DAY
1.4 gm/kg	750 (1) mg/kg	46	B4(B)	2021B-	TCA	CEMENT, 28 DAY
270 ug/L	40 (1) ug/L	85	B5(B)	2021B-	TCLP	KILN DUST, 28 DAY
27 mg/kg	69 (1) mg/kg	0	B5(B)	2021B-	TCA	KILN DUST, 28 DAY
400 ug/L	40 (1) ug/L	90.0	B6(B)	2021B-	TCLP	KILN DUST, 28 DAY
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	TCA	KILN DUST, 28 DAY

NICKEL

CONCENTRATION Before	After	Removal %	Scale	Ref.	Anal. Meth.	Comments
SOIL						
SOLIDIFICATION						
18 mg/L	<40 (1) ug/L	>99.78	B7(B)	2021B-	TCLP	KILN DUST, 28 DAY
1.1 gm/kg	310 (1) mg/kg	72	B7(B)	2021B-	TCA	KILN DUST, 28 DAY
27 mg/L	<40 (1) ug/L	>99.85	B8(B)	2021B-	TCLP	KILN DUST, 28 DAY
1.4 gm/kg	450 (1) mg/kg	68	B8(B)	2021B-	TCA	KILN DUST, 28 DAY
270 ug/L	40 (1) ug/L	85	B9(B)	2021B-	TCLP	LIME/FLYASH, 28d
27 mg/kg	16 (1) mg/kg	41	B9(B)	2021B-	TCA	LIME/FLYASH, 28d

CYANIDE

CAS NO.: 57-12-5

COMPOUND TYPE: INORGANIC,ION

FORMULA: C N (-1)

CHEMICAL AND PHYSICAL PROPERTIES	REF.
MOLECULAR WEIGHT: 26.018	333A
MELTING POINT (C):	NA
BOILING POINT (C):	NA
VAPOR PRESSURE @ T(C), TORR:	NA
SOLUBILITY IN WATER @ T(C), MG/L:	NA
LOG OCTANOL/WATER PARTITION COEFFICIENT:	NA
HENRY'S LAW CONSTANT, ATM x M3 MOLE-1:	NA

ENVIRONMENTAL DATA	REF.
CHRONIC NONCARCINOGENIC SYSTEMIC TOXICITY	4B
RISK ESTIMATES FOR CARCINOGENS	NA
DRINKING WATER HEALTH ADVISORIES/STANDARDS	349B
WATER QUALITY CRITERIA	4B
AQUATIC TOXICITY DATABASE	5B

FREUNDLICH ISOTHERM DATA

FREUNDLICH ISOTHERM DATA NOT AVAILABLE AT THIS TIME !

SOLIDS DATA FILE

(Includes Thermal Destruction of Liquids)

Matrix

Combination (two or more of the following)
Debris
Liquid (both aqueous and organic liquids)
Sediment
Sludge
Soil
Groundwater

Technologies (Those with data)

Treatment systems are non-in situ unless labelled "(in situ)" after the name of the technology.

LTD - Low Temperature Desorption
SE - Solvent Extraction
TD - Thermal Destruction
Comp - Composting
Sol - Solidification
Bio - Biological Treatment
CD - Chemical Destruction
BD,asp - Biological Destruction, aerobic, solid phase
Fil - Filtration
UV - UV Rad.\Light\Solar
Land - Landfarming
Elec - Electro-Kinetics
Ozon - Ozonation
TD RK - Thermal Destruction (Rotary Kiln)
VE(in) - Vacuum Extraction (in-situ)

Concentration

Number in "()" following "After" is number of tests/runs used to calculate average concentrations and "% Improvement".

Improvement,%

Change in % based upon "Analytical Method".

$$\text{DRE} = \frac{\text{Conc. in} - \text{Exhaust gas Conc.}}{\text{Conc. in}}$$

$$\text{TCA, etc.} = \frac{\text{Conc. in soil at start} - \text{Conc. in soil at end}}{\text{Conc. in soil at start}}$$

$$\text{EPT, TCLP, etc.} = \frac{\text{Conc. of Infl. leachate} - \text{Conc. of Effl. leachate}}{\text{Conc. of Infl. leachate}}$$

Scale

B - Bench Top, P - Pilot Plant, F - Full Scale

Number after letter refers to the test/run number or plant number in the specific reference. The test/run is a continuous flow process unless there is a "(B)" after scale, then it is a batch process (ex. P1 (B) - is first pilot test under batch conditions).

Reference

Quality codes same as for "Aqueous" data file. One extra field notes if cost data are available in reference.

Analytical Method

Lists anayltical test used to generated both the "Before" and "After" concentrations except for "(DRE)" which is the destruction/removal efficiency based upon feed mass per unit time and air emission mass per unit time.

(DRE) - Destruction and removal efficiency
EPT - Extraction procedure toxicity test
TCA - Total contaminant analysis
TCLP - Toxicity characteristic leaching procedure test

Operating Parameters

Key operational parameters during test run.

END

B

SOIL SAMPLING INVESTIGATION AND ANALYSIS FOR THE ILCO-UNICAN SITE, WINSTON-SALEM, NORTH CAROLINA

Prepared for:

Mr. Brian E. Wells
Corporate Environmental Manager
Ilco-Unican Corporation
P.O. Box 2627
Rocky Mount, North Carolina 27802-2627

Prepared and Submitted by:

ESE Biosciences, Inc.
Raleigh, North Carolina

J. Blair Davis
Project Manager/Hydrogeologist

James A. Bennett, P.G. #1002
Senior Hydrogeologist/Manager, Site Assessments

NORTH CAROLINA LICENSED SEAL 1002 GEOLOGIST JAMES A. BENNETT

September 1992
Project No. J362

Confidentiality Statement

The data, design, methods, products, equipment, and processes described in this report are confidential and may not be reproduced, distributed or used for profit or company gain without written consent from ESE Biosciences, Inc.

Table 1. Total Metals Concentration Ranges for Collected Soil Samples from Waste Pile No. 1 (WP #1)

Parameter	6" bls (2)[a]		12" bls (2)		18" bls (3)		24" bls (9)	
	Low	High	Low	High	Low	High	Low	High
Cyanide	1.49[b]	2.57	0.905	5	0.322	3.55	0.287	9.33
Arsenic	2.4	5.5	2.4	6.0	1.3	3.4	1.0	8.4
Chromium	3.2	52	23	51	16	58	23	136
Copper	405	1737	260	1964	169.7	3094	386	6038
Lead	60	172	54	240	123	232	71	995
Nickel	103	273	102	532	44.7	471	33	870
Zinc	1233	3528	1200	5407	416	8206	724.3	5840

[a]Number of collected soil samples from indicated depth
[b]Concentration ranges listed in parts per million (ppm)

Table 2. Total Metals Concentration Ranges for Collected Soil Samples from Waste Pile No. 2 (WP #2)

Parameter	6" bls (2)[a]		12" bls (2)		18" bls (0)		24" bls (0)	
	Low	High	Low	High	Low	High	Low	High
Cyanide	<0.059[b]	0.730	<0.064	8.15	NA	NA	NA	NA
Arsenic	2.2	47	2.5	21.5	"	"	"	"
Chromium	5.0	36	8.3	104	"	"	"	"
Copper	34	544	20	1846	"	"	"	"
Lead	18	357	17	127	"	"	"	"
Nickel	26	128	19	321	"	"	"	"
Zinc	190	981	182	994	"	"	"	"

[a]Number of collected soil samples from indicated depth
[b]Concentration ranges listed in parts per million (ppm)
NA = samples collected but not analyzed at representative depths

Table 3. Total Metals Concentration Ranges for Collected Soil Samples from the Foundry Building (FB) Area

Parameter	6" bls (3)[a]		12" bls (3)		6" comp. (2)		12" comp. (2)	
	Low	High	Low	High	Low	High	Low	High
Arsenic	0.7[b]	3.0	0.7	2.0	2.8	3.1	1.7	2.7
Chromium	16	188	8	263	13.3	21	6	9
Copper	3822	7191	196	5414	13940	35720	4162	5140
Lead	529	1365	137	857	931	1079	347	353
Zinc	7720	44880	2913	6744	19170	22300	4027	4659

[a]Number of collected soil samples from indicated depth
[b]Concentration ranges listed in parts per million (ppm)

Table 4. Total Metals Concentration Ranges for Collected Soil Samples from the Roof Runoff (RR) Area

Parameter	6" bls ([illegible])		12" bls (0)		6" comp. (6)		12" comp. (6)	
	Low	High	Low	High	Low	High	Low	High
Arsenic	NA	NA	NA	NA	0.38[b]	9.5	0.61	3.4
Chromium	"	"	"	"	2.4	144	1.1	56
Copper	"	"	"	"	246	9108	74	6108
Lead	"	"	"	"	17	498	25	382
Zinc	"	"	"	"	255	226600	292	35760

[a]Number of collected soil samples from indicated depth
[b]Concentration ranges listed in parts per million (ppm)
NA = samples collected but not analyzed at representative depths

Table 5. Total Metals Concentration Ranges for Collected Soil Samples from the Other Baghouse (OB) Area

Parameter	6" bls (0)[a]		12" bls (0)		6" comp. (2)		12" comp. (2)	
	Low	High	Low	High	Low	High	Low	High
Arsenic	NA	NA	NA	NA	1[b]	2.8	0.15	7
Chromium	"	"	"	"	10	32	9	10
Copper	"	"	"	"	770	1472	56	280
Lead	"	"	"	"	53	77	7	7
Zinc	"	"	"	"	1125	1999	261	502

[a]Number of collected soil samples from indicated depth
[b]Concentration ranges listed in parts per million (ppm)
NA = samples collected but not analyzed at representative depths

FIGURES

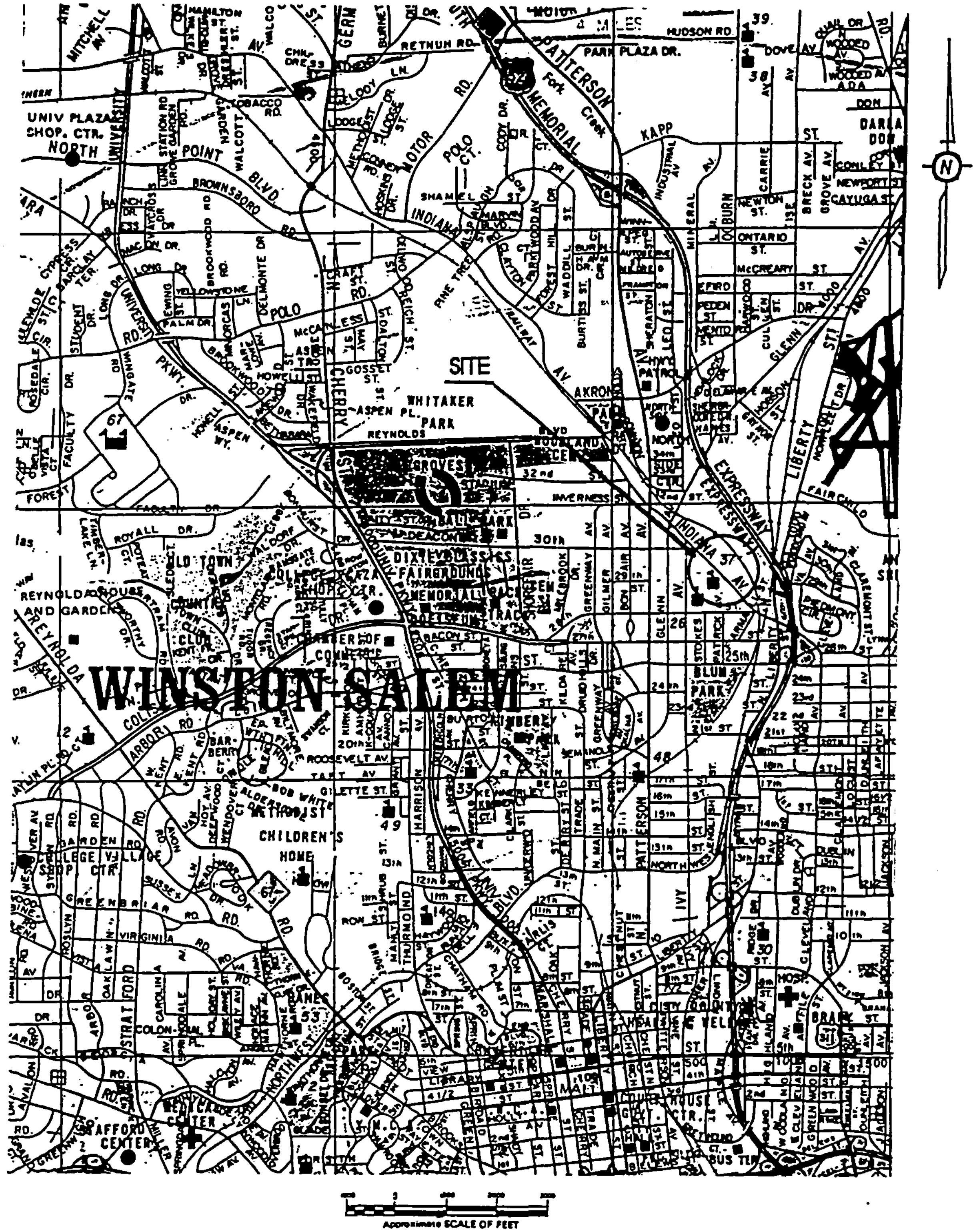


FIGURE I GENERAL LOCATION MAP FOR THE I LCO-UNICAN FACILITY. WINSTON SALEM. NC SOURCE: ESE BIOSCIENCES. INC., 1992	ESE BIOSCIENCES. INC. RALEIGH. NC	DRAWN BY: JBD CHECKED BY: JAB PROJ. MGR.: JBD PROJ. NO.: J362 SCALE: 1" - 3000 FEET DATE: 9/11/92

RINSATE BLK (021)

CN	<0.005
As	<0.005
Cr	<0.05
Cu	<0.01
Pb	<0.05
Ni	<0.04
Zn	0.042

FIELD BLK (022)

CN	<0.005
As	<0.005
Cr	<0.05
Cu	<0.01
Pb	<0.05
Ni	<0.04
Zn	<0.005

RINSATE BLK (043)

CN	<0.005
As	<0.005
Cr	<0.05
Cu	<0.01
Pb	<0.05
Ni	<0.04
Zn	0.074

FIELD BLK (044)

CN	<0.005
As	<0.005
Cr	<0.05
Cu	<0.01
Pb	<0.05
Ni	<0.04
Zn	<0.005

FIELD BLK (065)

CN	<0.005
As	<0.005
Cr	<0.05
Cu	<0.01
Pb	<0.05
Ni	<0.04
Zn	<0.005

RINSATE BLK (066)

CN	<0.005
As	<0.005
Cr	<0.05
Cu	<0.01
Pb	<0.05
Ni	<0.04
Zn	<0.005

FIELD BLK (087)

CN	<0.005
As	<0.005
Cr	<0.05
Cu	<0.01
Pb	<0.05
Ni	<0.04
Zn	<0.005

RINSATE BLK (088)

CN	<0.005
As	<0.005
Cr	<0.05
Cu	<0.01
Pb	<0.05
Ni	<0.04
Zn	0.006

FIELD BLK (109)

CN	<0.005
As	<0.005
Cr	<0.05
Cu	<0.01
Pb	<0.05
Ni	<0.04
Zn	<0.005

RINSATE BLK (110)

CN	<0.005
As	<0.005
Cr	<0.05
Cu	<0.01
Pb	<0.05
Ni	<0.04
Zn	<0.005

FIELD BLK (131)

CN	<0.005
As	<0.005
Cr	<0.05
Cu	<0.01
Pb	<0.05
Ni	<0.04
Zn	<0.005

RINSATE BLK (132)

CN	<0.005
As	<0.005
Cr	<0.05
Cu	<0.01
Pb	<0.05
Ni	<0.04
Zn	0.006

RINSATE BLK (151)

CN	<0.005
As	<0.005
Cr	<0.05
Cu	<0.01
Pb	<0.05
Ni	<0.04
Zn	0.038

FIELD BLK (152)

CN	<0.005
As	<0.005
Cr	<0.05
Cu	<0.01
Pb	<0.05
Ni	<0.04
Zn	<0.005

LEGEND

CN Cyanide
Ar Arsenic
Cr Chromium
Cu Copper
Pb Lead
Ni Nickel
Zn Zinc
(070) Sample Number
All concentrations in mg/Kg (ppm)

FIGURE 2 WATER RINSATE AND FIELD BLANK RESULTS CONDUCTED DURING SOIL SAMPLING AT THE ILCO-UNICAN FACILITY. WINSTON SALEM, NC

SOURCE: ESE BIOSCIENCES, INC., 1992

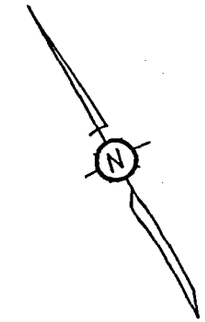
ESE BIOSCIENCES, INC. RALEIGH, NC

DRAWN BY:	JBD
CHECKED BY:	JAB
PROJ. MGR.:	JBD
PROJ. NO.:	J362
SCALE:	NTS
DATE:	9/11/92

WASTE PILE #1

WPI-1A - 6" (001)	WPI-2D - 24" (008)	WPI-3D - 24" (012)	WPI-4D - 24" (016)
CN 2.57	CN 11.1	CN 9.33	CN 3.69
As 5.5	As 10	As 6.0	As 8.4
Cr 52	Cr 23	Cr 135	Cr 132
Cu 1,767	Cu 734	Cu 5,054	Cu 1,950
Pb 172	Pb 80	Pb 318	Pb 86
Ni 273	Ni 158	Ni 512	Ni 452
Zn 3,528	Zn 1,672	Zn 724.3	Zn 2,894
WPI-8B - 12" (032)	**WPI-7C - 18" (029)**	**WPI-6D - 24" (025)**	**WPI-5D - 24" (020)**
CN 5.0	CN 3.55	CN 2.84	CN 0.892
As 6.0	As 3.4	As 3.6	As 4.0
Cr 51	Cr 58	Cr 77	Cr 60
Cu 1,964	Cu 3,094	Cu 6,038	Cu 1,021
Pb 240	Pb 232	Pb 337	Pb 368
Ni 532	Ni 471	Ni 418	Ni 313
Zn 5,407	Zn 8,206	Zn 5,840	Zn 1,716
WPI-9C - 18" (037)	**WPI-10B - 12" (040)**	**WPI-11D - 24" (048)**	**WPI-12D - 24" (052)**
CN 0.322	CN 0.905	CN 1	CN 3.17
As 1.3	As 2.4	As 2.7	As 5
Cr 16	Cr 23	Cr 31	Cr 136
Cu 169.7	Cu 260	Cu 386	Cu 2,744
Pb 140	Pb 54	Pb 94	Pb 995
Ni 44.7	Ni 102	Ni 80	Ni 870
Zn 416	Zn 1,200	Zn 1,116	Zn 5,321
WPI-16D - 24" (070)	**WPI-15D - 24" (064)**	**WPI-14A - 6" (057)**	**WPI-13C - 18" (055)**
CN 5.38	CN 0.287	CN 1.49	CN 0.490
As 3.7	As 2.4	As 2.4	As 2
Cr 32	Cr 32	Cr 3.2	Cr 32
Cu 1,833	Cu 423	Cu 405	Cu 1,024
Pb 156	Pb 71	Pb 60	Pb 123
Ni 150	Ni 33	Ni 103	Ni 108
Zn 3,322	Zn 1,885	Zn 1,233	Zn 2,341

WASTE PILE #2



WP2-13A - 6" (119)	WP2-14A - 6" (123)	WP2-15A - 6" (127)	WP2-16A - 6" (133)
CN 0.207	CN 0.537	CN 0.569	CN 0.730
As 9.2	As 5.2	As 47	As 2.2
Cr 13	Cr 8	Cr 22	Cr 21
Cu 122	Cu 316	Cu 544	Cu 499
Pb 47	Pb 72	Pb 357	Pb 43
Ni 76	Ni 47	Ni 71	Ni 44
Zn 190	Zn 292	Zn 981	Zn 483

WP2-12B - 12" (118)	WP2-11A - 6" (111)	WP2-10A - 6" (105)	WP2-9B - 12" (102)	WP2-8B - 12" (098)	WP2-7B - 12" (094)
CN 3.98	CN 1	CN 0.19	CN 8.15	CN 0.176	CN 0.168
As 6.6	As 19.2	As 7.5	As 5.8	As 4.7	As 6
Cr 62	Cr 36	Cr 8	Cr 104	Cr 9.4	Cr 20
Cu 708	Cu 281	Cu 113	Cu 1,846	Cu 88	Cu 236
Pb 72	Pb 29	Pb 29	Pb 24	Pb 31	Pb 50
Ni 321	Ni 128	Ni 47	Ni 255	Ni 19	Ni 40
Zn 789	Zn 356	Zn 206	Zn 994	Zn 182	Zn 359

WP2-1A - 6" (071)	WP2-2B - 12" (075)	WP2-3A - 6" (078)	WP2-4B - 12" (081)	WP2-5B - 12" (084)	WP2-6A - 6" (089)
CN <0.059	CN 2.04	CN 0.366	CN <0.064	CN 0.119	CN 1.91
As 2.5	As 21.5	As 3.2	As 3.5	As 5.8	As 7.2
Cr 5.2	Cr 11	Cr 5.0	Cr 8.3	Cr 20	Cr 35
Cu 34	Cu 117	Cu 51.	Cu 20	Cu 140.6	Cu 511
Pb 127	Pb 44	Pb 18	Pb 17	Pb 34	Pb 168
Ni 26	Ni 146	Ni 64	Ni 24	Ni 52	Ni 119
Zn 263	Zn 440	Zn 206	Zn 247	Zn 260	Zn 404

LEGEND

CN Cyanide
Ar Arsenic
Cr Chromium
Cu Copper
Pb Lead
Ni Nickel
Zn Zinc

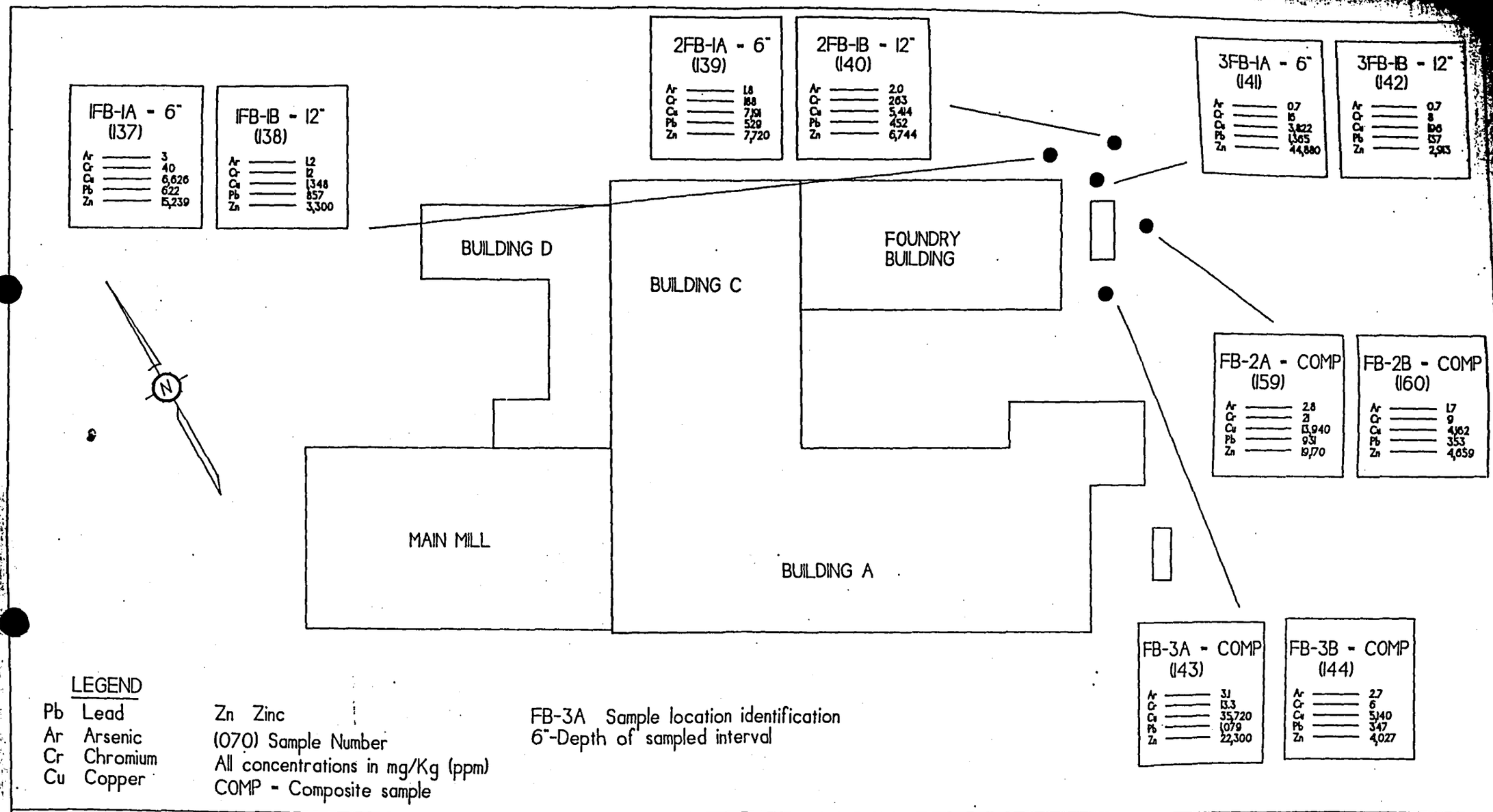
(070) Sample Number
All concentrations in mg/Kg (ppm)
WPI-1A Sample location identification
6"-Depth of sampled interval

FIGURE 3. SOIL CONCENTRATIONS AT INDICATED DEPTHS FOR WASTE PILE #1 AND WASTE PILE #2 AT THE ILCO-UNICAN FACILITY, WINSTON SALEM, NC

SOURCE: ESE BIOSCIENCES, INC., 1992

ESE BIOSCIENCES, INC.
RALEIGH, NC

DRAWN BY: JBD
CHECKED BY: JBB
PROJ. MGR.: JBD
PROJ. NO.: J362
SCALE: NTS
DATE: 9/10/92



LEGEND

Pb Lead
Ar Arsenic
Cr Chromium
Cu Copper
Zn Zinc
(070) Sample Number
All concentrations in mg/Kg (ppm)
COMP - Composite sample

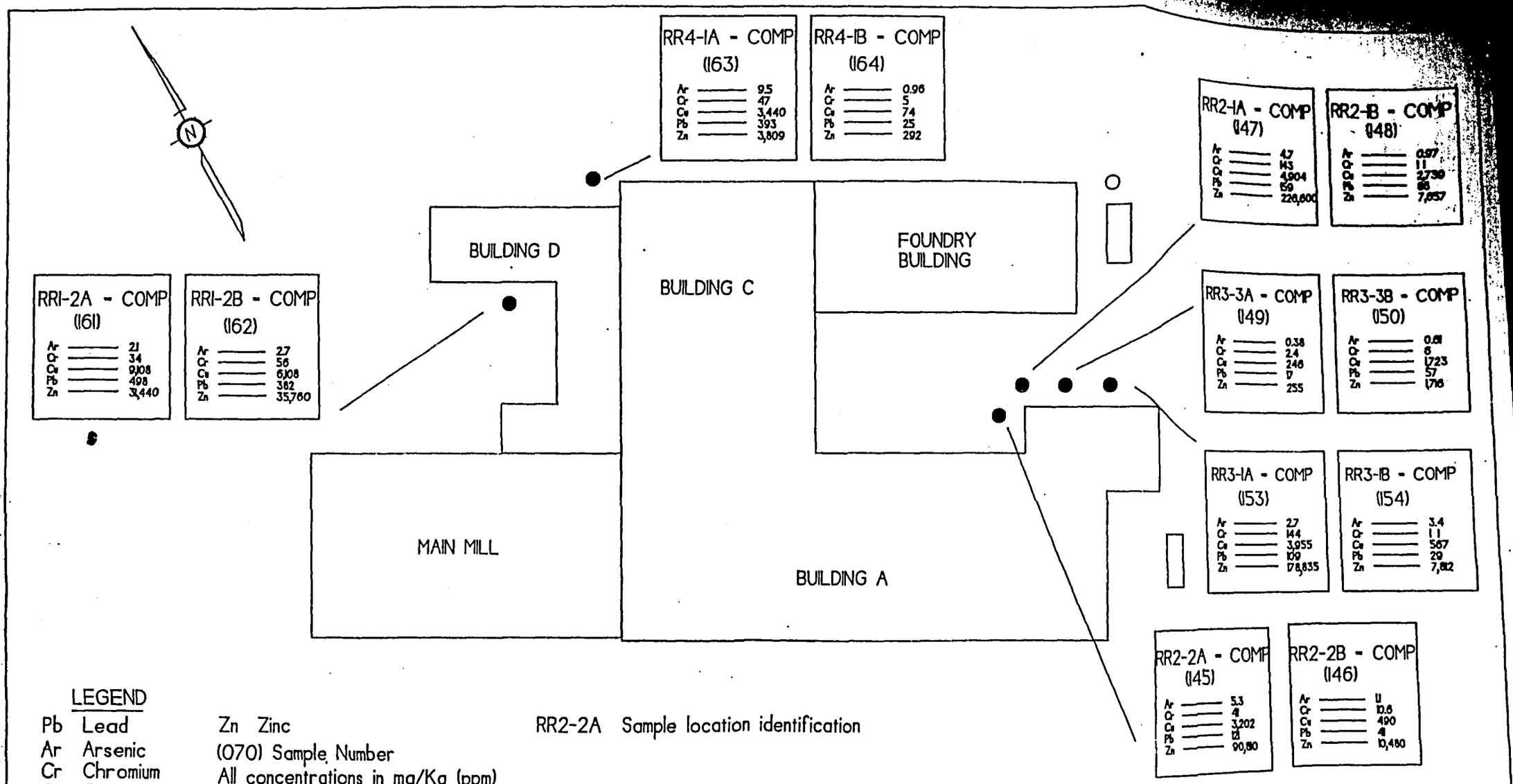
FB-3A Sample location identification
6"-Depth of sampled interval

FIGURE 4. SOIL CONCENTRATIONS AT INDICATED DEPTHS AROUND FOUNDRY BUILDING AT THE ILCO-UNICAN FACILITY, WINSTON SALEM, NC

SOURCE: ESE BIOSCIENCES, INC., 1992

ESE BIOSCIENCES, INC.
RALEIGH, NC

DRAWN BY: JBD
CHECKED BY: JAB
PROJ. MGR.: JBD
PROJ. NO.: J362
SCALE: NTS
DATE: 9/10/92



LEGEND

Pb Lead
Ar Arsenic
Cr Chromium
Cu Copper
Zn Zinc
(070) Sample Number
All concentrations in mg/Kg (ppm)
COMP - Composite sample

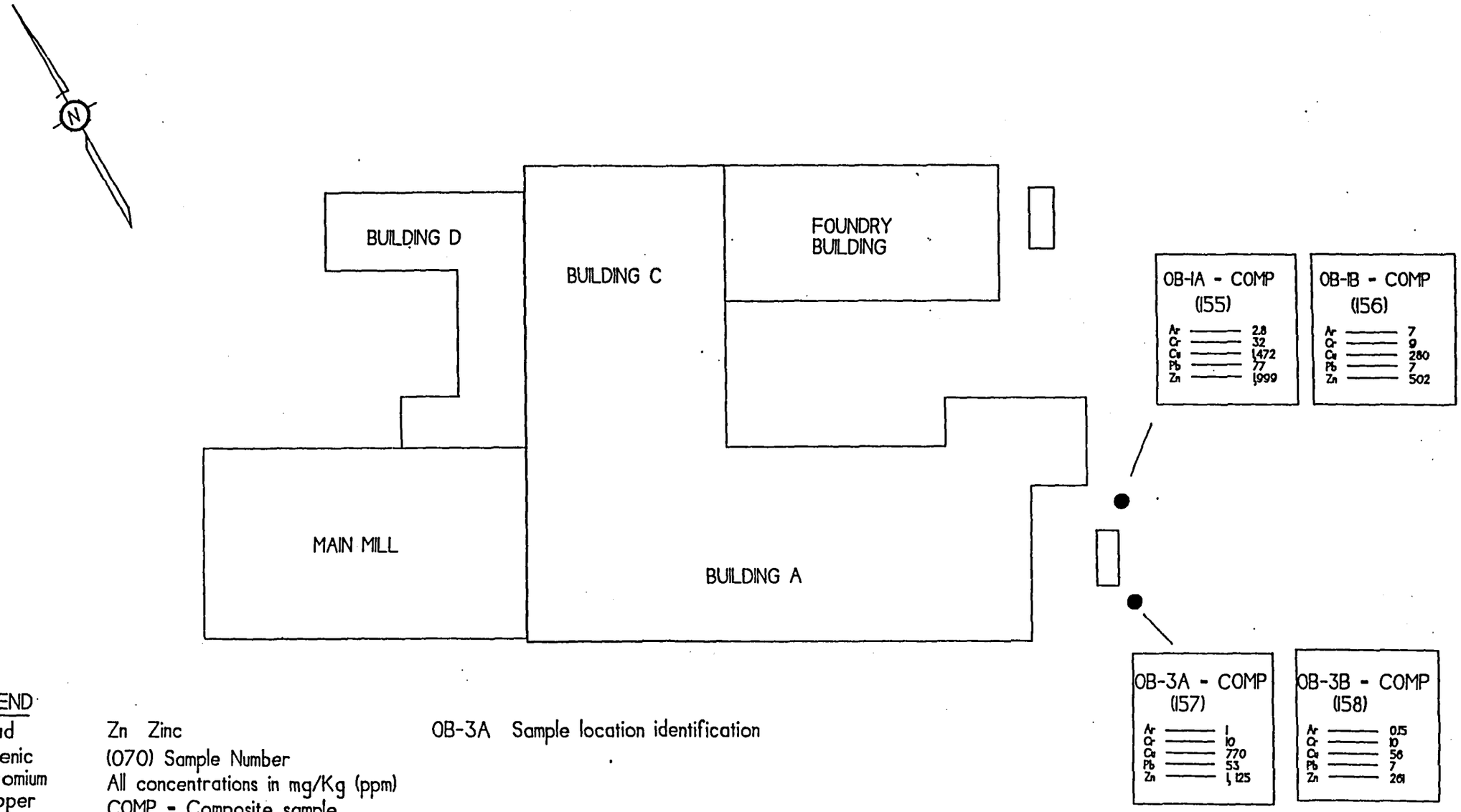
RR2-2A Sample location identification

FIGURE 5. SOIL CONCENTRATIONS AT INDICATED DEPTHS FROM ROOF RUNOFF AT THE ILCO-UNICAN FACILITY, WINSTON SALEM, NC

SOURCE: ESE BIOSCIENCES, INC., 1992

ESE BIOSCIENCES, INC.
RALEIGH, NC

DRAWN BY: JBD
CHECKED BY: JAB
PROJ. MGR.: JBD
PROJ. NO.: J362
SCALE: NTS
DATE: 9/10/92



LEGEND

Pb Lead
Ar Arsenic
Cr Chromium
Cu Copper
Zn Zinc

(070) Sample Number
All concentrations in mg/Kg (ppm)
COMP - Composite sample

OB-3A Sample location identification

FIGURE 6. SOIL CONCENTRATIONS AT INDICATED DEPTHS AROUND OTHER BAGHOUSE AT THE ILCO-UNICAN FACILITY. WINSTON SALEM, NC

SOURCE: ESE BIOSCIENCES, INC., 1992

ESE BIOSCIENCES, INC.
RALEIGH, NC

DRAWN BY: JBD
CHECKED BY: JAB
PROJ. MGR.: JBD
PROJ. NO.: J362
SCALE: NTS
DATE: 9/10/92