FINAL DESIGN ANALYSIS

NL INDUSTRIES/TARACORP SUPERFUND SITE

GRANITE CITY, Illinois

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US Army Corps
of Engineers
Omaha District

OMAHA DISTRICT

FINAL DESIGN ANALYSIS

FOR

N.L. INDUSTRIES/TARACORP SUPERFUND SITE GRANITE CITY, ILLINOIS

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PART 1 - GENERAL DESCRIPTION

1. **INTRODUCTION.** This document contains the 100% Design Analysis (DA) prepared by the United States Army Corps of Engineers (USACE) - Omaha District for the N.L. Industries/Taracorp Superfund Remedial Action. The N.L. Industries/Taracorp Superfund Site is located in and near the cities of Granite City, Madison, and Venice in Madison County, Illinois, an area of approximately 40,000 people located across the Mississippi River from St. Louis, MO. This submittal will accomplish the following items:

* Present design assumptions and calculations.
* Identify Right-of-Way (ROW) requirements.
* Provide a list of specifications to be used.
* Verify throughout the text that the functional intent of the Record of Decision (ROD) is being accomplished with the remedial action.

2. **PURPOSE.** The purpose of this project is to perform remedial action on the N.L. Industries Superfund site, Granite City, Illinois in accordance with the Record of Decision (ROD) and the Decision Document/Explanation of Significant Differences (DD/ESD) in accordance with the ROD and the DD/ESD for capping the Taracorp Pile at the NL Industries Superfund Site in Granite City, Illinois.

3. **AUTHORIZATION.**

3.1. **AUTHORITY.** This project was authorized by the United States Environmental Protection Agency (USEPA) Interagency Agreement No. DW96947548-0 dated February 26, 1991.

3.2. **RECORD OF DECISION (ROD) AND DECISION DOCUMENT/EXPLANATION OF SIGNIFICANT (DD/ESD).** The ROD and the DD/ESD is provided as Appendix A of this document. If the Design Plan in any way conflicts with the 1990 Record of Decision (ROD) or the 1995 Decision Document/Explanation of Significant Differences (DD/ESD), the ROD and DD/ESD shall govern.

4. **GENERAL CRITERIA.** The general criteria to be used in the remedial design of the N.L. Industries/Taracorp Superfund Site includes the ROD; the requirements of the Illinois Environmental Protection Agency (IEPA); the USEPA's Technical Guidance Document titled: Minimum Technology Guidance for Final Covers on Hazardous Waste Landfills and Surface Impoundments, (EPA/530-SW-89-047) dated July 1989; the USEPA's Seminar Publication titled: Requirements for Hazardous Waste Landfill Design, Construction and Closure, (EPA/625/4-89/022) dated August 1989; the USEPA's Technical Guidance Document titled Lining of Waste Containment and Other Impoundment Facilities, (EPA/600/2-88/052) dated September 1988; and the USACE Technical Letter titled Engineering and Design Checklist for Hazardous Waste Landfill Cover Design, (ETL 1110-1-162) dated July 1995. Additional criteria is included in Part 2 - Design Requirements and Provisions.

5. **PROJECT BACKGROUND.**

5.1. **SITE NAME, LOCATION, AND DESCRIPTION.** The N.L. Industries/Taracorp Superfund Site is located within a heavily industrialized section of Granite City, Illinois, a community of approximately 40,000 people located across the Mississippi River from St. Louis, Missouri (See Sheet No. 2 of the drawings). Although the site is located within the Mississippi River Valley, it is protected by a Mississippi River Levee system, and it is not within the 100-year flood plain of any surface water.

The N.L. Industries/Taracorp Superfund Site is the location of a former secondary lead smelting facility. Metal refining, fabricating, and associated activities have been conducted at the site since before the turn of the century. Prior to 1903, the facilities at the site included a shot tower, machine shop, factory for the manufacture of blackbird targets, sealing wax, manufacture of mixed metals, refining of dross, and the rolling of sheet lead. From 1903 to 1983 secondary lead smelting occurred on-site. Secondary smelting facilities included a blast furnace, a rotary furnace, several lead smelting kettles, a battery breaking operation, a natural gas-fired boiler, several baghouses, cyclones and an afterburner. Secondary lead smelting operations were discontinued during 1983 and equipment dismantled.

5.1.1. **Taracorp Pile.** Located on the N.L. Industries/Taracorp Superfund Site is the Taracorp pile which is composed primarily of blast furnace slag and battery case material. The volume of the pile is approximately 85,000 cubic yards. In addition, several smaller piles immediately adjacent to the southern end of the Taracorp pile, total approximately 2450 cubic yards. Tests conducted on the materials in the Taracorp pile demonstrate lead concentrations in the range of 1-28%. EP toxicity test results demonstrate that the waste pile materials are a characteristic hazardous waste under 40 CFR Part 261. In addition, on the surface of the Taracorp pile are 25-35 drums and containers holding solid wastes from the smelting operations which were to have been recycled. These containers remained after the smelting operations ceased in 1983.

5.1.2. **Area 1 Battery Case Material and Soils.** Area 1 consists of property owned by Trust 454, Rich Oil, and BV&G Transport (See Sheet No. 5 and 11 of the drawings). These properties abut the N.L. Industries/Taracorp Superfund Site.

5.1.2.1. The Trust 454 property contains a pile of battery case materials, the St. Louis Lead Recyclers (SLLR) pile. The SLLR pile contains approximately 4,050 cubic yards of material. The lead concentration range in this pile was 10-30%. EP toxicity analyses of the pile indicate that this material has characteristics similar to those of the Taracorp pile and should be managed as hazardous waste. Analyses of the unpaved areas indicate lead concentrations at the surface up to 345,000 mg/kg.

5.1.2.2. The BV&G Transport property includes a large unpaved area which is used to park and service trucks. Analyses of soils from areas around this property indicate lead concentrations ranging to 91,500 mg/kg.

5.1.3. **Groundwater.** Based on data from the Remedial Investigation Report, background water quality at the site is characterized by elevated concentrations of dissolved solids, sulfates, and manganese. Groundwater

monitoring data from wells adjacent to the site and collected subsequent to the Remedial Investigation have shown elevated concentrations (as compared to background) of sulfates, dissolved solids, arsenic, cadmium, manganese, nickel, zinc, and lead. The possibility of a strong downward hydraulic gradient was identified during the RI. Groundwater contamination resulting from activities at the site will be treated as a separate operable unit and be remediated during a subsequent phase.

5.1.4. **Surface Water and Air.**

5.1.4.1. No surface water is present at the site; any runoff away from the area of the Taracorp pile would be limited to the property of BV&G Transport, Trust 454, and Taracorp.

5.1.4.2. Results of air monitoring for lead conducted by IEPA have indicated that emissions from the site are within the National Ambient Air Quality Standard for lead since Taracorp ceased smelting operations in 1983.

5.2. **SITE HISTORY AND ENFORCEMENT ACTIVITIES.**

5.2.1. In July of 1981, St. Louis Lead Recyclers, Inc. (SLLR) began using equipment on adjacent property owned by Trust 454 to separate components of the Taracorp waste pile. The objective was to recycle lead-bearing materials to the furnaces at Taracorp and send hard rubber and plastic off-site for recycling. SLLR continued operations until March 1983. Residuals from the operation remain on Trust 454 property as does some equipment.

5.2.2. A State Implementation Plan for Granite City was published in September 1983 by the IEPA. The IEPA's Report indicated that the lead nonattainment problem for air emissions in Granite City was in large part attributable to emissions associated with the operation of the secondary lead smelter operated by Taracorp and lead reclamation activities conducted by SLLR. The IEPA procured Administrative Orders by Consent with Taracorp during March 1984. The Orders required the implementation of remedial activities relative to the air quality.

5.2.3. N.L. Industries, as former owner of the site, voluntarily entered into an Agreement and Administrative Order by Consent with the USEPA and IEPA in May 1985 to implement a Remedial Investigation and Feasibility Study (RI/FS) for the site and other potentially affected areas. Taracorp, then site-owner, was not a party to the agreement due to the fact that it filed for bankruptcy. The USEPA determined that the site was a CERCLA facility and it was placed on the National Priorities List on June 10, 1986.

5.3. **GEOLOGIC CHARACTERISTICS.** The N.L. Industries/Taracorp Superfund Site is located in the Southwestern portion of Madison County, Illinois within the Mississippi River Valley. The site is approximately eight to ten miles south of the confluence of the Mississippi and Missouri Rivers. The site is underlain by recent alluvium and glaciofluvial and glaciolacustrine deposits. Bedrock beneath the alluvium is Carboniferous age rocks consisting of limestone, sandstone, and shale. The alluvial and glacial deposits which fill the valley range in thickness from less than one foot adjacent to the bluff boundary and

the Chain of Rocks reach of the Mississippi River to greater than 170 feet near the City of Wood River. The estimated thickness of the valley deposits become progressively coarser with depth. Generally, groundwater in the Granite City area occurs within the unconsolidated valley deposits under unconfined and leaky confined conditions. Recharge of groundwater within the area is from the Mississippi River and smaller surface water bodies in the area.

PART 2 - DESIGN REQUIREMENTS AND PROVISIONS

1. DESIGN GUIDELINES AND OBJECTIVES - 100% SUBMITTAL.

1.1. **INTRODUCTION.** Based on the Record of Decision, and discussions between USACE, USEPA, and the IEPA the following are the guidelines and objectives used in this design submittal.

- Following the review of the 90% design submittal, USACE was directed by USEPA to proceed to 100% design, with Alternative "B". Alternative B was selected since it was determined to be feasible, as protective as Alternative A, and more cost efficient than Alternative A.

  Alternative "B" consists of constructing one continuous RCRA-compliant cap over the Taracorp pile and other consolidated contaminated materials adjacent to the Taracorp pile on the BV&G Transport property. The other consolidated contaminated materials will consist of contaminated soils from the industrial properties and the SLLR pile which will be consolidated and placed on a bottom liner. This cap will toe out to the existing ground surface in all areas around the site, except for the northern portion of the site. In this area a concrete wall will be incorporated so as to not impact the Tarcorp and BV&G Transport office buildings, railroad tracks, or local roadways. The layout for Alternative "B" is depicted in the General Site Plan.

- Some regrading of the Taracorp waste pile is acceptable; however, stringent dust control measures will be implemented.

- For aesthetics, and in accordance with public concern, the final height of the cap will not exceed the maximum height of the current waste pile (El. 447).

- For aesthetics, and in accordance with public concern, the cap will utilize synthetic materials to reduce the amount of borrow required, thus reducing impacts on the local infrastructure during construction, lower the height of the cap, lessen the lateral extent of the cap, and provide better long term performance of the cover system.

- Per requirements established for a RCRA cap, the cap cross section will consist of 6" topsoil, 18" select fill, geotextile, geonet, geomembrane, geosynthetic clay liner (GCL), and 12" minimum of random fill.

- All unpaved areas within the industrial area will be excavated to 1000 ppm lead or three feet, whichever occur first, to reach the desired cleanup criteria, and placed under a RCRA cover on-site. Determination of 1000 ppm lead, where applicable, should be done using an XRF for screening, and then followed up with lab results. XRF Screening will be conducted to guide depths of excavation. All excavated areas will then be backfilled with clean borrow material and surfaced.

- The bottom liner and a leachate collection system will be constructed to meet the intent of State of Illinois regulations 35 IAC Part 724, Subpart N,

Landfills, on the expanded portion of the landfill on-site in accordance with the selected alternative.

- All unpaved areas within the industrial area will be excavated to 1000 ppm lead or three feet, whichever occurs first. There will be no treatability/ stabilization requirements for the contaminated soil to be excavated in the industrial area, or the waste pile located on Trust 454 property.

- An upgraded security fence or concrete wall will be around all capped areas to control all unauthorized access.

- All drums will be removed from the site and disposed of at a secondary lead smelter, if available. The existing battery casing crusher, large drums, and other large debris currently on top of, or adjacent to the waste pile which cannot be effectively capped, will be removed and disposed of offsite.

1.2. **PREDESIGN.** Predesign field activities for the N.L. Industries/Taracorp Superfund site were conducted as part of Woodward Clyde-Consultants, indefinite delivery contract with USACE, Omaha District (Contract No. DACW45-90-0008). The objective of the predesign effort was to obtain information required for the remedial design. The results of the predesign field activities were presented in "Final Report-NL/Taracorp Superfund Site Predesign Field Investigation", dated March 1993.

1.2.1. **Additional Required Predesign.** An A-E scope of services was prepared by USACE, Omaha District in 1996 to obtain the following information for the final design.

1.2.1.1. **Boundary Surveys and Property Searches.** Boundary surveys for the industrial areas have been obtained; however, the A-E has encountered difficulties in converting the surveys to the appropriate coordinate system. Therefore, the boundary surveys shown in this design package are approximate. More accurate boundary information will be available for the final design package.

1.2.1.2. **Utilities Search.** Additional survey information which has been obtained for the final design includes the location, invert, type and size of pipes entering all storm and sanitary sewer manholes, catch basins, and curb inlets in the vicinity of the industrial properties.

1.2.1.3. **Geotechnical Information.** Geotechnical information which is required for the design of the concrete walls has been obtained for the final design and is shown in Appendix B.

2. GEOLOGIC SUBSURFACE INVESTIGATIONS.

2.1. **GENERAL.** The most extensive geotechnical/groundwater investigations of the Granite City area were performed by the Illinois State Geological Survey (Bergstrom and Walker, 1956), the Illinois State Water Survey (Schicht and Jones, 1962, Schicht, 1965, Kohlhase, 1987), and the U.S. Corps of Engineers (Smith and Smith, 1984, American Bottoms Feasibility Report, 1987). The most recent and

comprehensive groundwater quality assessments were performed by the Illinois State Water Survey (Rehfeldt, 1992). Site specific geotechnical and groundwater investigations were performed as part of the 1988 Remedial Investigation, and during a supplemental groundwater investigation in 1992 and on a quarterly basis since 1992. The following is a summary of these investigations.

2.2. **GEOLOGY.** The geologic stratification of the site has been formed by repeated cycles of vertical incision, aggradation, and lateral migration of the Mississippi River. The uppermost deposits at the site are principally point bar deposits formed on the inside river bank of meander loops during the lateral migration of the river channel. There are two main types of deposits within the point bar: silty and sandy elongate ridges deposited during high river stages, and silty and clayey arcuate fills deposited in depressions during falling river stages. At the site, these point bar deposits average 20 to 40 feet thick.

The meander point bar deposits are underlain by glacial meltwater streams during the Pleistocene epoch. The major soil types found in the glacial deposits beneath the site are poorly graded, medium to coarse grained sands. These deposits extend approximately an additional 60 to 80 feet to Mississippian age limestone bedrock beneath the site.

3. GEOTECHNICAL.

3.1. CONTAMINATED EXCAVATIONS.

3.1.1 **Industrial Area.** Soil in the main industrial area will be excavated to 1000 ppm lead or to a depth of three feet, whichever occurs first. This material will be consolidated with the existing Taracorp pile. A liner system will be constructed under all newly created portions of the expanded Taracorp pile. The resultant expanded Taracorp pile will be graded and a RCRA-compliant cap placed over it.

3.2. CAP DESIGN.

3.2.1. **General.** The multi-layer RCRA compliant cap, with a surface area of approximately 6.5 acres, has been designed to meet the requirements of 40 CFR Part 264. The USEPA's technical guidance document dated July 1989 titled Minimum Technology Guidance for Final Covers on Hazardous Waste Landfills and Surface Impoundments, (EPA/530-SW-89-047), was also followed where applicable. The cap consists of a 6-inch top soil layer underlain by an 18-inch select fill layer, a geocomposite drainage layer, (geotextile filter/geonet/geotextile filter), a geomembrane barrier layer, a geosynthetic clay liner (GCL), and a random fill layer. In addition, portions of the landfill surface will be regraded to minimize the quantity of borrow materials needed. Each of the layer components is described in detail below.

3.2.2. **Cap Components.**

3.2.2.1. **Vegetative Cover.** The vegetative cover shall consist of low maintenance grasses including native species/praries plant. This plan shall be developed in accordance with the document "Revegetation of

Superfund Sites with Native Plants: A Primer for Superfund Personnel, December 1996 (or most recent), and Beneficial Landscape Practice Guidance published in the Federal Register on August 10, 1995. Grass types shall consist of varieties which will germinate quickly and grow to a relatively low height for less frequent mowing. All seeded areas on slopes of 1 (Vertical):4 (Horizonal) or steeper will receive a premanufactured straw mulch fabric to be used as a mulch and soil erosion control blanket. This has proven very effective in erosion control and grass establishment. The flat areas of the cap at the top of the slope will also have an erosion control fence. This fence will slow the sheet erosion off of the flat portion of the cap prior to the break of the slope, thus preventing gullying and erosion at the break of grade between the flat portion of the cap and the 4:1 slope. Erosion control fencing will also be used at various locations on the site during the grading process to prevent water borne silt from leaving the construction limits. A separate vegetative cover implementation plan shall be required to be submitted to U.S. EPA for approval at least two months prior to completion of the cap.

3.2.2.2. **Topsoil.** Topsoil shall be placed at a minimum thickness of 6 inches to promote a vegetative stand that is relatively maintenance free, that readily grows in the climatic environment of the area, and which will not be easily eroded. The topsoil will be required to be uniformly distributed and evenly spread to a thickness of 6 inches with no density requirements. The topsoil will promote the generation of the vegetative cover that will reduce erosion of topsoil and select fill. The pH of the topsoil shall be within the 6.0 to 7.5 range, and have an organic content between 5 to 20 percent as determined by the organic carbon 6A chemical analysis. The spreading of topsoil shall be performed in such a manner that planting can proceed with little additional soil preparation or tillage and thus reducing the overall cost of the spreading and/or seeding operation. The topsoil will be placed such that there is no damage to the underlying geosynthetics, and must be able to support both construction and maintenance equipment.

3.2.2.3. **Select Fill.**

3.2.2.3.1. **Purpose and Function.** Below the six-inch thick top soil layer and directly above the geocomposite drainage layer will be a layer of soil called the select fill. The select fill will be designed and installed to perform the following functions: The select fill should be capable of supporting the root systems of vegetative growth, protect the underlying geosynthetics from the elements, such as ultraviolet radiation, and allow rainfall infiltration to the underlying drainage layer. The select fill must also be resistant to soil erosion and be stable during the most adverse rainfall conditions. The select fill must be compatible with the underlying geotextile fabric such that there is no migration of soil particles into the geonet drainage layer. The select fill will be placed such that there is no damage to the underlying geosynthetics, and must be able to support both construction and maintenance equipment.

3.2.2.3.2. **Thickness Criteria.** The minimum thickness for the select fill will be 18 inches. The initial layer of select fill must be placed with a minimum thickness of 12-15 inches to avoid damaging the underlying geosynthetics.

3.2.2.3.3. Material Type. The select fill will consist of a cohesionless or low plasticity soil type classified as either silty sands (SM), clayey sands (SC), or lean clays (CL) according to the Unified Soil Classification System. Highly plastic soils are avoided as select fill because they may grab or adhere to the underlying geotextile fabric causing it to stretch or rip during placement, and when dried, form vertical tension cracks. The effects of desiccation cracking of plastic soils and the corresponding transfer in load to the geosynthetics is avoided by using a cohesionless or low plasticity select fill material. Use of a cohesionless or low plasticity material reduces the potential for vertical tension cracks. Tension cracks in the select fill can allow a direct path for surface runoff to infiltrate the soil in sufficient quantities where hydrostatic pressures build up leading to instability of the soil cover. In addition, highly plastic soil types are difficult to spread and compact in large lift thicknesses (12-15") especially with low ground pressure placement equipment. The maximum particle size will be specified not to exceed 3/4-inch to avoid puncture or damage to the underlying geosynthetics. The select material shall be free of chemical contamination. Fill material shall be tested for the Priority Pollutant List of constituents as required.

3.2.2.3.4. Placement Requirements. The Contractor will be required to place the select fill without damaging the underlying materials. The Contractor will be required to install the select fill material starting at the toe of the slope working up the slope and parallel to the toe. The first layer of the select fill will be placed at a minimum thickness of 12-15" to avoid damaging the underlying geotextile. Equipment will not be allowed to be driven or pulled on any of the underlying geosynthetics. Equipment will be allowed on the geotextile only after the first layer of select fill has been placed. The select fill will not be dropped and/or dumped onto the geosynthetics from a height greater than 36 inches and will not be stockpiled on the geosynthetics and pushed across the underlying geotextile. A low ground pressure (LGP) tracked front end loader will be specified to transport and place the select fill material. A LGP tracked dozer shall be used to spread the material to conform to thicknesses on drawings and specifications. The ground pressure from loaded transport and placement equipment will be limited to 10.5 pounds per square inch. To protect the geosynthetics, achieve a stable structure, and to enhance the ability of the soil to support vegetative growth, the select fill will be compacted with a minimal effort using only the tracks of the placement equipment. The Contractor will be required to cover the geosynthetics as quickly as possible to reduce the potential for damage from ultraviolet radiation, wind, temperature extremes, and on-going construction activity.

3.2.2.3.5. Compaction Requirements. In order to protect the underlying geosynthetics, the select fill shall be compacted with only minimum effort using the traffic compaction of the placement equipment. The moisture content of the select fill at the time of placement will be plus or minus 3 percent of optimum. Traffic compaction of the select fill by the low ground pressure tracks of the placement equipment should achieve a minimum compaction which will still facilitate root development and allow sufficient infiltration to maintain vegetative cover through drier periods; refer to page 12 of the Minimum Technology Guidance Document For Final Covers on Hazardous

Waste Landfills and Surface Impoundments, (EPA/530-SW-89-047). The select fill will not be subject to any specific density requirements.

3.2.2.3.6. **Material Availability**. The volume of select fill material required to construct the final cover for the Taracorp pile and the contaminated soil/SLLR pile for Alternative "B" is approximately 15,500 cubic yards. Suitable offsite select fill material sources were identified in "Final Report" for predesign activities by Woodward-Clyde Consultants.

3.2.2.4. **Geogrid Tensile Reinforcement**. A geogrid will be placed on top of the geosynthetics, prior to the placement of the select fill, to provide stability against slidig of the cover soils. A geogrid is necessary to achieve the State of Illinois regulations requiring a minimum factor of safety of 1.5. The design of the geogrid is discussed in paragraph 3.5 of this document. To assure that proper anchorage takes place at corners, and in other areas where overlap of pannels will take place, the contractor in coordination with the geogrid manufacturer, will submit the pattern to be used when placing the pannels. To anchor the georid, 18 inches of select fill shall be placed over the geogrid runout on the 5% slope. The select fill shall then be placed on the sideslopes starting at the bottom of the slope, working up.

3.2.2.5. **Geotextile Filter Layer**. A filter layer shall be used to separate the upper zone fill from the underlying geonet drainage layer as part of the geocomposite drainage layer. The filter layer will ensure consistent drainage by preventing migration of fine graded soil particles encompassing the upper zone fill into the void spaces of the drainage layer below.

Since the design of the filter fabric is dependant upon the gradation of the overlying material, the geotextile filter will be specified as a contractor submittal once the borrow sources are identified. This will allow for the accurate determination of the apparent opening size (AOS) of the geotextile based on the gradation of the borrow material. Calculations of the AOS will be based on the procedures outlined in "Designing With Geosynthetics", 3rd Edition, by Robert M. Koerner.

The following are the various design criteria considered while determining the appropriate geotextile: 1) the fabric must retain the soil (retention criteria); 2) the fabric must allow surface infiltration to permeate through the fabric into the drainage layer (permeability criteria); and 3) the fabric must not clog over time (clogging criteria). In addition, 4) the fabric must survive the installation process, placement of select fill upon it, and long-term loading from the select fill surcharge (survivability criteria), and 5) the fabric must be compatible with surface water (compatibility criteria). The fabric is also designed to withstand a tensile force (tensile criteria). The geotextile filter fabric design will be based on the following:

3.2.2.5.1. **Retention Criteria**. To prevent the migration of soil particles from the select fill into the drainage layer, the voids in the geotextile filter must be small enough to retain the soil on the top side of the fabric. It is the coarser soil fraction that must be initially retained. The coarser soil fraction eventually blocks the finer sized particles. Koerner presents several approaches to determine the AOS of the fabric based upon

the particle size distribution of the soil to be retained. The most conservative method presented by Koerner was developed by Giroud. Giroud predicts the apparent opening size of the geotextile based upon the following soil characteristics: relative density; coefficient of uniformity and the soil particle size corresponding to 50% finer.

3.2.2.5.2. Permeability Criteria. The geotextile filter must have an apparent opening size fine enough to retain the select fill but yet open or permeable enough to allow surface water infiltration to pass through the filter into the underlying drainage layer. Therefore, it is necessary to compare the cross-plane permeability (k) of the fabric with that of the select fill. The permittivity value of the fabric is the permeability divided by the fabric thickness. The permittivity value is designated in the specifications at 1.0 (1/sec). The minimum expected fabric thickness is approximately 1 mm. The corresponding cross-plane permeability of the fabric is approximately 0.1 cm/sec. The permeability of the select fill is controlled by the D10 particle size. The permeability of the fabric should far exceeds that of the select fill. A factor of safety of 10 is normally used for cover design to accommodate for factors that could reduce the permeability of the fabric such as soil clogging, creep reduction, intrusion, chemical clogging, and biological clogging.

3.2.2.5.3. Clogging Criteria. The hydraulic compatibility of the soil-fabric system needs to be assessed to assure silt-size soil particles are not forced into the fabric under a pressure head thus clogging the fabric. Experiments by Haliburton and Wood using the Gradient Ratio Test indicate that clogging can be critical under test conditions which have high hydraulic gradients coupled with soils that were cohesionless, being gap-graded and having a high silt content. It should be noted that the select fill material is specified as a cohesionless material. Therefore, it is important to control the other parameters that can contribute to clogging. There should be no hydraulic head build up in the select fill since the geonet will be designed to accommodate infiltration. In addition, the silt content will be limited to 35% and the particle size distribution controlled, in part, by specifying a range for the value of the Coefficient of Uniformity. Based upon these controls, it is not considered necessary to require the specified select fill material and geotextile filter be tested together using a Gradient Ratio Test.

3.2.2.5.4. Survivability Criteria. Fabric survivability refers to the ability of the fabric to undergo the construction/installation process. The survivability is related to the construction equipment used, construction technique, subgrade materials, subgrade condition, backfill material, backfill size and backfill shape. The first layer of select fill will be placed at a minimum thickness of 12" - 15" to avoid damaging the underlying geotextile. Constructibility concerns such as burst strength, tensile strength and impact energies, as specified, are conservative with the 12" -15" initial lift.

3.2.2.5.5. Compatibility Criteria. The compatibility between surface water infiltration and the geotextile filter is not critical. The select fill will be tested to assure the material is not contaminated.

3.2.2.5.6. **Tensile Criteria**. As specified, the geotextile filter fabric will not be in tension. In order for the geotextile filter to be stable on a 4H:1V slope without mobilizing tensile forces, the interface friction angle between the various underlying material interfaces must be greater than 14 degrees. To assist in obtaining the required friction angles, double sided textured geomembrane liners and geocomposite drainage layers will be utilized. A geogrid is also incorporated into the cover system to carry the tensile forces within the select fill layer.

3.2.2.6. **Drainage Layer**. The purpose of the drainage layer is to drain away any precipitation which infiltrates the topsoil and select fill layers of the cover system. By providing adequate drainage, little or no head will develop on the geomembrane; thus, limiting the potential of infiltration of surface water into the waste.

3.2.2.6.1. **HELP Model Description**. The Hydrologic Evaluation of Landfill Performance (HELP) Model was utilized to evaluate the overall performance of the cover system and its individual components. The HELP program models the hydrologic processes occurring in the landfill system, including surface runoff, infiltration, percolation, evapotranspiration, soil moisture storage, and lateral drainage. The HELP model requires three general types of input data: climatological, geometric, and soil characteristics.

3.2.2.6.1.1. **Climatological Data**. The climatological data to be used in the model was obtained from "Climates of the States", published by the National Oceanic and Atmospheric Administration. The input data that was used is the 20-year monthly mean temperatures and rainfalls recorded at the St. Louis, MO weather station, between 1954 and 1973. St. Louis is located approximately 10 miles south-west of N.L. Industries/Taracorp Superfund and is the closest weather station to the site. The HELP model then synthetically generated daily precipitation and temperature values, for a 30 year period, for this geographic area based on the monthly mean precipitation and temperature input data.

3.2.2.6.1.1. **Geometric Parameters**. The geometric parameters will be derived from design considerations and the layout of the site. The required geometric input data includes the number of cover system components, layer thickness, layer type, the drainage layer slope and maximum drainage length, and the landfill area.

3.2.2.6.1.2. **Soil Parameters**. The soil parameters required as input into the HELP model for each layer of the cover system are: initial water content, porosity, field capacity, wilting point, and hydraulic conductivity. These parameters are further discussed in Section 3.2.2.5.2.

3.2.2.6.2. **Input Data for the Cover and Landfill Cross-Section**. There were seven layers used to model a profile through the existing pile while nine layers were necessary for the expanded area. Layer 1 is the topsoil, Layer 2 is the select fill, Layer 3 is the geonet, Layer 4 is

the geomembrane, Layer 5 is GCL, and Layer 6 is the random fill. The program recognizes three general types of layers: vertical percolation layers, lateral drainage layers, and barrier layers. At a profile through the existing pile, Layers 1, 2, and 6 are classified as vertical percolation layers, Layer 3 as a lateral drainage layer, and Layers 4 and 5 are barrier layers. The soil characteristics can be assigned to each layer by using either the default or the manual option of the program. The soil characteristics which need to be input for each layer, along with a brief description are listed below.

* Water Content - The ratio of the volume of water in the soil to the total volume.
* Porosity - The water content at saturation.
* Field Capacity - The water content after a long time period of gravity drainage.
* Wilting Point - The water content at which plants wilt and fail to recover.
* Hydraulic Conductivity - The rate at which water drains through a saturated soil.

3.2.2.6.3. Cover System Interior Drainage Design.

3.2.2.6.3.1. Geonet Drainage Layer Flow Capacity Specification Requirements. The required flow rate of the geonet was determined by the HELP Model. Using previously discussed input data, the peak flow rate from the geonet was obtained from the HELP model. The factors of safety (FS) applied to the flow rate were determined from "Designing With Geosynthetics", by Robert M. Koerner. The factors of safety included: FS for intrusion of adjacent geosynthetics into the geonet core space, FS for creep deformation of the geonet, FS for chemical clogging, and FS for biological clogging.

The geonet specifications require a minimum transmissivity of 2.3 gallons/minute/foot with a gradient of 10%, and under a normal pressure of 1.65 psi. The transmissivity value shall be obtained based upon testing in accordance with ASTM D4716. The geonet shall have a minimum thickness of 0.20 inches.

HELP model runs and geonet design calculations are shown in Appendix B-2.

3.2.2.6.3.2. Subdrain Collector Pipe. A subdrain system will be installed behind the concrete wall portions of the cap to collect and convey all flow from the geonet from these areas. The subdrain will consist of a slotted PVC pipe installed in a gravel packed trench. The flow will then be exited through the wall, into a perimeter drainage ditch. The maximum flow which this system will be required to carry was obtained from the lateral drainage layer peak daily flow, from the HELP model. Since the Collector pipe will be a non-pressurized pipe, Mannings equation for open channel flow was used for sizing the pipe. An 8 inch diameter pipe is typically the minimum sized pipe utilized for this type of drainage system. This pipe size greatly exceeded the flow requirements, and will be used. The additional capacity will also be required to handle any surface runoff from the downslope side of the surface water diversion berm. Calculations for sizing this collector pipe are shown in Appendix B-3. The geomembrane liner will extend under and on the sides of the subdrain to prevent any infiltration along the wall. A geotextile will be

wrapped around the trench to prevent the migration of fine materials into the trench.

3.2.2.7. **Geomembrane Layer**. A low permeability layer has been designed to provide long-term minimization of precipitation infiltration through the cover system. A 40 mil thick double sided textured geomembrane has been specified for the low permeability layer. The Corps of Engineers Missouri River Division (CEMRD) recommends the geomembrane be a minimum of 40 mils thick to avoid burn-outs during the seaming process and for survivability during construction. The geomembrane will be designed so that no tension will develop in the geomembrane over the steeper portions of the cover system.

3.2.2.8. **Geosynthetic Clay Liner (GCL)**. A GCL will be used directly underneath the geomembrane in the cover system and in the bottom liner section. In both applications the GCL will replace a compacted clay layer. There are several advantages in using a GCL in lieu of compacted clay. Freeze-thaw cycles will not affect the performance of a GCL; whereas, a clay layer will crack and the hydraulic conductivity of the clay layer will be greatly affected due to freeze-thaw conditions. Instead of an as-constructed hydraulic conductivity of $1x10^{-7}$ cm/sec for a compacted clay, values in the range of $1x10^{-6}$ to $1x10^{-5}$ cm/sec is all that could be anticipated over the long term. This phenomenon is described by Chamberlain, E. J., Iskandar, I., and Hunsucker, S. E. (1990), "Effect of Freeze-Thaw Cycles on the Permeability and Macrostructure of Soils". Their work evaluated the effects of freeze-thaw cycles on the hydraulic conductivity of four soil types. In each case the hydraulic conductivity increased by one to two orders of magnitude after just five freeze-thaw cycles, and from 1.5 to 2.5 orders of magnitude after 15 cycles. In the St. Louis area, frost depth is at 38 inches. To utilize a clay layer at N.L. Industries/Taracorp Superfund, an additional 14 inches of select fill material would be required for the cover. This additional soil, in addition to the 24 inches of clay, would raise the height of the cover system 38 inches. This would also greatly increase the truck traffic on city streets. The use of a GCL in the bottom liner system will reduce that cross section by 36 inches. GCL's are also superior when differential settlement is a concern. Other advantages are that GCL's perform better under situations of differential settlement than do compacted clay, there is better quality control, and ease of construction. Precautions will be followed during the placement of the GCL so that it will not be damaged during installation. The GCL will immediately be covered by a geomembrane liner during both the bottom liner and cover construction to prevent hydration.

3.2.2.9. **Random Fill**. After required grading of waste and proof rolling, random fill will be placed to achieve the grades required for the final cap. Random fill will be suitable material, either cohesive or cohesionless, obtained from an off-site borrow area. Contaminated excavated on-site borrow will also be allowed to be used as random fill within the cover system, with the exception that only clean off-site material can be used in the top 12 inches of the random fill layer. The random fill is not subject to specific density requirements; however, all lifts of the random fill shall receive a minimum of 5 passes with approved compaction equipment. The moisture requirements of the fill before compaction will be required to be within 3% of optimum moisture content for cohesive materials and saturated for cohesionless

materials. The intent of utilizing either cohesive or cohesionless materials is to allow the Contractor to use the least costly suitable material available to establish the design slopes placed at a moisture content which will allow compaction.

3.2.3. **Grading Requirements.** Per Minimum Technology Guidance For Final Covers on Hazardous Waste Landfills and Surface Impoundments, (EPA/530-SW-89-047), specifications for the select fill include final top slope, after allowance for settling and subsidence, of at least 3 percent, but no greater than 5 percent, to facilitate runoff while minimizing erosion...". The slope utilized over the landfill top is 5 percent allowing 1-2 percent for any consolidation of landfill materials. Around the landfill perimeter, 4H:1V sideslopes are used. One of the primary design considerations in developing the final cover grading plans and other project features was to minimize adverse impacts to adjoining properties. To accomplish this, some reshaping of the waste pile material was required. Stringent dust control measures will be implemented during all regrading of the existing waste pile materials.

3.3. **SETTLEMENT.** Based on the type of waste materials at this Site, the only potential settlement scenario would be due to mechanical consolidation or void ratio reduction, due to crushing or material reorientation.

3.4. **LINER.** A bottom liner and leachate collection system will be installed under all expanded portions of the landfill. These areas will receive contaminated excavated soil and the waste material from the SLLR pile. The bottom liner will consist of 12 inches of granular material, a geocomposite drainage layer, a 60 mil geomembrane, a GCL, and 12 inches of random fill. The bottom lined area will be sloped to drain to a gravel packed leachate collection sump pit. A PVC pipe, which will be slotted within the sump pit, will extend through the cap surface to allow for pumping of leachate out of the sump pit. The primary purpose of the granular material is to provide protection for the underlying geosynthetics as waste materials are being placed. This layer will also provide flow carrying potential for the leachate. The geocomposite drainage layer will serve as the primary drainage layer. The geotextile attached to the geonet will prevent movement of the overlying granular material into the geonet. The geomembrane and GCL will serve as the composite barrier layer. The random fill will provide a smooth surface for the placement of the geosynthetics.

3.5. **STABILITY ANALYSIS.** Slope stability of the cover system at N.L. Industries/Taracorp Superfund was evaluated by the method described in Stability and Tension Considerations Regarding Cover Soils on Geomembrane Lined Slopes, by Robert M. Koerner and Bao-Lin Hwu, Geosynthetic Research Institute, Drexel University, Philadelphia, PA. Stability of the cover soils was designed to have a factor of safety of 1.5, in accordance with the State of Illinois regulations. To achieve this factor of safety, a geogrid reinforcement layer was incorporated to carry the tensile forces in the cover soils. The analysis for the Taracorp pile (Alternative B) is shown in Appendix B-2.

3.6. **INSTRUMENTATION/MONITORING.**

3.6.1. **Monitoring Wells.** The need for additional monitoring wells at the site will be evaluated during a later phase which will address groundwater remediation.

3.6.2. **Settlement Monuments.** To determine if any consolidation of the waste piles is taking place, both during construction and after closure, settlement monuments will be installed at this site. Settlement monuments will be placed at the locations shown on the drawings. To avoid penetration of the geosynthetics, the plate at the bottom of the settlement monuments will be located on top of the geosynthetics. The contractor will be directed to establish elevations of the settlement monuments prior to placement of the select fill and after placement of the topsoil.

3.6.3. **Vegetative Cover.** The vegetative cover shall be monitored visually for effectiveness in covering the topsoil, thickness, height, and in preventing soil erosion on an annual basis. Vegetative cover shall be fertilized during the establishment period. Areas where the grass has not become established shall be reseeded and mulched as specified.

4. **CIVIL.**

4.1. **DESIGN REFERENCES.** The following references were used in preparing the grading, paving, drainage, and fencing design:

4.1.1. **Department of the Army and Air Force Technical Manuals.**

TM 5-820-1 88-5, Chap 1	Surface Drainage Facilities for Airfields and Heliports (Aug 87)
TM 5-820-2 88-5, Chap 2	Drainage and Erosion Control, Subsurface Drainage Facilities for Airfield Pavements (Mar 79)
TM 5-820-4 88-5, Chap 4	Drainage for Areas Other Than Airfields (Oct 83)
TM 5-822-2 88-7, Chap 5	General Provisions and Geometric Design for Roads, Streets, Walks, and Open Storage Areas (July 87)
TM 5-822-5 88-7, Chap 1	Pavement Design for Roads, Streets, Walks, and Open Storage Areas (June 92)

4.1.2. **Department of the Army Technical Manuals (TM).**

5-822-12	Design of Aggregate Surfaced Roads and Airfields (Sept 90)

4.2. PAVEMENT DESIGN.

4.2.1. **TARACORP ACCESS ROAD.** The Taracorp access road to be removed and replaced has flexible pavement.

4.2.1.1. **Traffic.** Traffic consists of the following vehicles:

85% Passenger cars, panel trucks, and pickup trucks

14% Two-axle trucks

1% Three-, four-, and five- axle trucks

4.2.1.2. **Strength Method.** (Non-Frost Design)

Class - E
Category - III
Design Index - 3
CBR (Compacted Subgrade) - 7
Total Design Thickness - 11.5 inches
Compacted Subgrade Thickness - 6 inches

4.2.1.3. **Reduced Subgrade Strength Method.** (Frost Design)

Design Index - 3
Soil Group - F3
Soil Support Index - 3.5
Total Design Thickness - 18 inches

4.2.1.4. **Recommended Pavement Section.**

2-inches Bituminous Surface Course
Bituminous Tack Coat
2-inches Bituminous Intermediate Course
6-inches Crushed Aggregate Base Course
8-inches Subbase Course
6-inches Compacted Subgrade (95% maximum density)

4.2.2. **ACCESS ROAD "A".**

4.2.2.1. **Traffic.** Traffic consists of the following vehicles:

85% Passenger cars, panel trucks, and pickup trucks

14% Two-axle trucks

1% Three-, four-, and five- axle trucks

4.2.2.2. **Aggregate Surfacing.**

4.2.2.3. **Strength Method.** (Non-Frost Design)

Class = F
Category = III
Design Index = 2
CBR (Compacted Subgrade) = 7
Total Design Thickness = 5 inches

4.2.2.4. **Reduced Subgrade Strength Method.**
(Frost Design)

Design Index = 2
Soil Group = F3
Soil Support Index = 3.5
Total Design Thickness = 8 inches

4.2.2.5. **Recommended Pavement Section.**

8-inches Crushed Rock Surfacing
6-inches Compacted Subgrade
(95% maximum density)

4.2.2.6. **Rigid Pavement.**

4.2.2.7. **Strength Method.** (Non-Frost Design)

Class = F
Category = III
Design Index = 2
Modulus of Soil Reaction, k=125 pci
Concrete 28-Day Flexural
Strength = 500 psi
Base Course Thickness = 4 inches
Effective k at Surface of
Base Course = 160 pci
Pavement Thickness = 5.9 inches

4.2.2.8. **Reduced Subgrade Strength Method.**
(Frost Design)

Design Index = 2
Concrete 28-Day Flexural
Strength = 500 psi
Soil Group = F-3

A trial and error solution using assumed base course thicknesses was used. The following thicknesses were produced:

ASSUMED BASE COURSE THICKNESS	FROST-AREA INDEX OF REACTION	PAVEMENT THICKNESS
6"	37	6.5

Pavement Thickness = 6.5 inches
Total Base Course
Thickness = 6 inches

4.2.2.9. **Recommended Pavement Section.** The recommended pavement section is as follows:

6.5-inches P.C. Concrete Pavement
6-inches Subbase Course
6-inches Compacted Subgrade
(95% maximum density)

4.2.3. **ACCESS ROAD "B".** Access road "B" has crushed aggregate surfacing.

4.2.3.1. **Traffic.** Traffic consists of the following vehicles:

99% Passenger cars, panel trucks, and pickup trucks

1% Two-axle trucks

4.2.3.2. **Strength Method.** (Non-Frost Design)

Class = F
Category = I
Design Index = 1
CBR (Compacted Subgrade) = 7
Total Design Thickness = 4.2 inches
Compacted Subgrade Thickness = 6 inches

4.2.3.3. **Reduced Subgrade Strength Method.** (Frost Design)

Design Index = 1
Soil Group = F3
Soil Support Index = 3.5
Total Design Thickness = 6.8 inches

4.2.3.4. **Recommended Pavement Section.**

8-inches Crushed Aggregate Surfacing
6-inches Compacted Subgrade (95% maximum density)

4.3. DRAINAGE.

4.3.1. **Criteria.** Site drainage facilities were designed to accommodate a 25-year frequency, 24-hour duration storm. Section 5-10 Storm Water Runoff of the Granite City Zoning Ordinance states that downstream property owners, watercourses, channel or conduits shall not receive storm water runoff from proposed upstream developments at a higher peak flow rate than would have resulted from the same storm event occurring over the site of the proposed development with the land in its natural, undeveloped conditions, nor shall storm water runoff exceed the capacity of the natural drainage system. Section 5-10 also states that storm water detention facilities shall have sufficient capacity to store flows up to the 25-year, 24-hour rainstorm and that for purposes of designing adequate on-site detention facilities, the Illinois State Water Survey rainfall data for this region shall be used.

4.3.1.1. **Methodology.** Storm water peak flow rates and detention facilities capacity were determined using the Corps of Engineers Hydrologic Engineering Center's HEC-1 model. Kinematic wave modeling was used to transform the precipitation excess to runoff. Muskingum-Cunge routing was used to route flows through channels.

4.3.1.2. **Precipitation Depth-Duration.** In accordance with Section 5-10 Storm Water Runoff of the Granite City Zoning Ordinance, the Illinois State Water Survey rainfall data for this region was used. In 1989 the Illinois State Water Survey published Bulletin 70, entitled "Frequency Distribution and Hydroclimatic Characteristics of Heavy Rainstorms in Illinois", by Floyd A. Huff and James R. Angel. The ISWS study contains data and techniques for estimating rainfall amounts and time distributions. In 1990 it was followed by two more ISWS publication. Circular 172 is a numerical abstract of Bulletin 70 which contains rainfall frequency distributions for 10 distinct sections of Illinois. Circular 173 includes time-distribution relationships. Together, the three volumes represent a research study utilizing 83 years of gaging data taken from 61 stations around the state. Bulletin 70 provides total rainfall (inches) for a storm of given duration and frequency by dividing Illinois into 10 zones of "homogeneous precipitation climate". Bulletin 70 identifies an anomaly around the St. Louis urban area which affects rainfall amounts downwind of the city. Consequently, Madison County rainfall is 12-25% higher than typical Southwest section values for certain storm durations. The following precipitation depth-duration values for a 25-year frequency storm event from Illinois State Water Survey (ISWS) Bulletin-70 were used in the analysis.

Table 4-1

Duration	Depth (Inches)
5 min	0.72
15 min	1.63
60 min	2.92
2 hrs	3.60
3 hrs	3.88
6 hrs	4.58
12 hrs	5.25
24 hrs	6.02

4.3.1.3. **Rainfall Time Distribution.** Storm water peak flow rates and detention facilities capacity were determined using the rainfall time distributions from both the HEC-1 Model and I.S.W.S. Bulletin-70. Circular 173 categorizes storm as 1st, 2nd, 3rd, or 4th quartile according to whether the largest percentages of total rainfall occurs in the first, second, third, or fourth quarter of the storm duration. For 1, 2, and 3-hour design storm durations, the 1st quartile type storm was used. For a 24-hour design storm duration, the 3rd quartile type storm was used. Once the quartile type has been determined, the correct time distribution is based on the drainage area. Table 1 in Appendix C shows the rainfall time distribution for a 25-year, 24-hour storm determined using I.S.W.S. Bulletin-70.

4.3.1.4. **HEC-1 Model Parameters.** The following parameters were used for analysis with the HEC-1 model.

4.3.1.4.1. **Infiltration Rates.** The existing soils outside the slag piles consist of relatively porous fill material overlaying clay. New turfed areas will be topsoiled. The following infiltration rates were used:

Existing Turfed and Gravel Areas:
Initial Rainfall Loss = 0.3 inch
Uniform Rainfall Loss = 0.6 in/hr

New Cap Turfed Areas:
Initial Rainfall Loss = 0.1 inch
Uniform Rainfall Loss = 0.05 in/hr

New Gravel Areas:
Initial Rainfall Loss = 0.3 inch
Uniform Rainfall Loss = 0.6 in/hr

New Turfed Areas:
Initial Rainfall Loss = 0.2 inch
Uniform Rainfall Loss = 0.3 in/hr

4.3.1.4.2. **Roughness Coefficients.** The following roughness coefficients were used:

Overland Flow:

Turf	n = 0.40
Gravel	n = 0.20
Pavement	n = 0.10

Channel Flow:

Turf	n = 0.035
Concrete	n = 0.015

4.3.2. **Existing Drainage System.** The existing drainage patterns were evaluated to determine the peak flows into the existing storm drain system. The existing groundwater depth at the project site is approximately 14 feet.

4.3.2.1. **Rainfall Runoff.** The existing project site was divided into drainage subbasins as shown on sheet D-1 of Appendix C-1. The following peak discharges and runoff volumes from the 25-year, 1, 2, 3, and 24-hour storms were determined for each area using the rainfall time distributions from the HEC-1 Model and the I.S.W.S Bulletin-70:

Table 4-2

Drainage Subbasin	Drainage Area
Area 3	6.85 Acres
Area 5	1.21 Acres
Area 1	4.24 Acres
Area 2	1.28 Acres

Table 4-3 PEAK DISCHARGES (CFS)

Drainage Subbasin	HEC-1 Balanced Storm				ISWS Bulletin-70 Storm			
	1-Hr	2-Hr	3-Hr	24-Hr	1-Hr	2-Hr	3-Hr	24-Hr
Area 3	50	51	52	52	41	31	31	2
Area 5	8	8	8	8	6	5	4	<1
Area 1	27	28	28	28	21	15	12	<1
Area 2	8	8	9	8	6	5	3	<1

Table 4-4 RUNOFF VOLUMES (ACRE-FT)

Drainage Subbasin	HEC-1 Balanced Storm				ISWS Bulletin-70 Storm			
	1-Hr	2-Hr	3-Hr	24-Hr	1-Hr	2-Hr	3-Hr	24-Hr
Area 3	1.41	1.64	1.71	2.20	1.36	1.58	1.57	1.41
Area 5	0.26	0.30	0.32	0.42	0.25	0.29	0.30	0.31
Area 1	0.78	0.86	0.88	0.92	0.74	0.80	0.73	0.14
Area 2	0.24	0.27	0.27	0.29	0.23	0.25	0.23	0.07

The area within the existing TARACORP pile was assumed to have no storm runoff.

4.3.2.2. **Storm Drain System.** Runoff from the project site drains into three (3) combined sewer systems. Two (2) of the sewer lines are 24-inches in diameter and the third is 96-inches in diameter. One of the 24-inch combined sewers is located in the TARACORP Industries/Taracorp Superfund area north of the project site and the other is located within the project site. The 24-inch sewer through the project site does not appear to be connected to any sanitary sewers.

4.3.2.2.1. **Drainage Areas 6, 7, 8, and 9.** The peak flow into existing area inlets in Area 6, Area 7, Area 8, and Area 9 was determined using the Corps of Engineers modified rational method.

Table 4-5

Drainage Subbasin	Drainage Area	Peak Discharge
Area 6	0.80 Acres	6.6 cfs
Area 7	0.42 Acres	3.4 cfs
Area 8	1.31 Acres	10.7 cfs
Area 9	0.78 Acres	5.2 cfs

The existing area inlets within Area 6, Area 7, Area 8, and Area 9 drain into one of the 24-inch sewer lines.

4.3.2.2.2. **Drainage Area 3.** Runoff from drainage area 3 flows into an existing area inlet north of the existing asphalt pad. The peak flow into the area inlet from the 25-year, 24-hour duration storm using the HEC-1 rainfall time distribution was 50 cfs. The peak flow into the area inlet from the 25-year, 24-hour duration storm using the I.S.W.S. Bulletin-70 rainfall time distribution was 2 cfs. The maximum capacity of the 8-inch outfall pipe from the area inlet to MH 149 in the 96-inch sewer line was assumed to be approximately 1.7 cfs.

4.3.2.2.3. **Drainage Areas 1, 2, and 5.** Runoff from drainage areas 1, 2, and 5 flow into an existing curb inlet and area inlet along State Street to the southwest of the Rich Oil Company. The peak flow into the existing curb inlet and area inlet from the 25-year, 24-hour duration storm using the HEC-1 rainfall time distribution was 45 cfs. The peak flow into the existing curb inlet and area inlet from the 25-year, 24-hour duration storm using the I.S.W.S. Bulletin-70 rainfall time distribution was 1 cfs. The existing area inlet has a waterway opening of 0.57 sf. The grate elevation is at approximately 413.70 ft msl. The existing curb inlet opening is approximately 7-inches high and 35-inches wide. The gutter elevation of the existing curb inlet is approximately 413.68 ft msl. The existing curb height along State Street is 4-inches. At a ponded depth of 0.33-feet, the area inlet has a capacity of 1.6 cfs and the curb inlet has a capacity of 5.7 cfs. The combined capacity of the two (2) inlets is 7.3 cfs. The existing 24" sewer line between MH 150 and MH 198 has a slope of 0.23% and a capacity of 7.0 cfs. The existing 24" sewer line between MH 198 and MH 199-A has a slope of 0.06% and a capacity of 3.1 cfs.

4.3.2.2.4. **Drainage Area** 4. Runoff from drainage area 4 flows into an existing area inlet. The storm drain pipe from the inlet flows to the south.

4.3.3. **New Drainage System.** The new drainage patterns were evaluated to determine the peak flows into the existing storm drain system.

4.3.3.1. **Rainfall Runoff.** The project site was divided into drainage subbasins as shown on sheet D-2 of Appendix C-3. The following peak discharges and runoff volumes from the 25-year, 1, 2, 3, and 24-hour storms were determined for each area using the rainfall time distributions from the HEC-1 Model and the I.S.W.S Bulletin-70:

Table 4-6

Drainage Subbasin	Drainage Area
Area 1	1.51 Acres
Area 2	0.75 Acres
Area 3	0.74 Acres
Area 4	4.02 Acres
Area 5	0.45 Acres
Area 6	0.84 Acres
Area 7	0.63 Acres
Area 8	0.35 Acres
Area 9	1.38 Acres
Area 10	1.15 Acres
Area 11	0.86 Acres
Area 12	0.65 Acres
Area 13	0.45 Acres
Area 14	0.33 Acres
Area 15	0.49 Acres
Area 16	3.20 Acres
Area 17	0.44 Acres

Table 4-7 PEAK DISCHARGES (CFS)								
Drainage Subbasin	HEC-1 Balanced Storm				ISWS Bulletin-70 Storm			
	1-Hr	2-Hr	3-Hr	24-Hr	1-Hr	2-Hr	3-Hr	24-Hr
Area 1	12	11	11	11	8	7	5	1
Area 2	4	4	4	4	3	2	2	<1
Area 3	5	5	5	5	5	3	3	<1
Area 4	22	22	22	22	18	15	12	3
Area 5	3	3	3	3	2	2	2	<1
Area 6	6	6	6	5	5	6	4	1
Area 7	4	4	5	4	3	3	2	<1
Area 8	3	3	3	3	3	2	2	<1
Area 9	8	8	9	9	7	4	3	1
Area 10	8	8	8	9	5	5	3	<1
Area 11	7	7	7	7	5	4	4	<1
Area 12	4	4	4	4	3	3	2	<1
Area 13	3	3	3	3	2	2	1	<1
Area 14	1	1	1	1	1	1	1	<1
Area 15	4	4	4	4	3	2	2	<1
Area 16	16	17	17	17	13	10	8	1
Area 17	3	3	3	3	3	2	2	<1

Table 4-8 RUNOFF VOLUMES (ACRE-FT)								
Drainage Subbasin	HEC-1 Balanced Storm				ISWS Bulletin-70 Storm			
	1-Hr	2-Hr	3-Hr	24-Hr	1-Hr	2-Hr	3-Hr	24-Hr
Area 1	0.33	0.39	0.41	0.47	0.33	0.39	0.40	0.31
Area 2	0.15	0.18	0.19	0.20	0.15	0.18	0.18	0.09
Area 3	0.17	0.20	0.21	0.30	0.16	0.20	0.20	0.26
Area 4	0.97	1.20	1.29	1.97	0.97	1.19	1.28	1.94
Area 5	0.10	0.13	0.14	0.18	0.10	0.13	0.14	0.18
Area 6	0.19	0.24	0.26	0.34	0.19	0.24	0.25	0.34
Area 7	0.15	0.18	0.19	0.25	0.15	0.18	0.19	0.25
Area 8	0.08	0.10	0.11	0.14	0.08	0.10	0.11	0.14
Area 9	0.26	0.30	0.30	0.34	0.25	0.28	0.26	0.12
Area 10	0.25	0.30	0.31	0.36	0.25	0.29	0.30	0.23
Area 11	0.17	0.20	0.21	0.21	0.17	0.20	0.20	0.07
Area 12	0.15	0.18	0.20	0.26	0.15	0.18	0.20	0.26
Area 13	0.10	0.13	0.14	0.18	0.10	0.13	0.14	0.18
Area 14	0.07	0.08	0.08	0.09	0.07	0.08	0.08	0.04
Area 15	0.11	0.14	0.15	0.20	0.11	0.14	0.15	0.20
Area 16	0.66	0.78	0.80	0.81	0.65	0.76	0.77	0.32
Area 17	0.10	0.13	0.13	0.18	0.10	0.12	0.13	0.18

4.3.3.2. **Storm Drain System.** Runoff from the project site drains into three (3) combined sewer systems. Two (2) of the sewer lines are 24-inches in diameter and the third is 96-inches in diameter.

4.3.3.2.1. **Drainage Areas 18, 19, 20, and 21.** The peak flow into existing area inlets in Area 18, Area 19, Area 20, and Area 21 was determined using the Corps of Engineers modified rational method.

Area Inlet	Peak Discharge
Area 18	4.7 cfs
Area 19	8.1 cfs
Area 20	8.8 cfs
Area 21	4.3 cfs

The existing total peak flow from Areas 6, 7, 8, and 9 before construction was 25.9 cfs. The total peak flow from Areas 18, 19, 20, and 21 after construction was also 25.9 cfs.

4.3.3.2.2. **Drainage Areas 5, 6, 7, 8, 9, 10 and 11.** Runoff from drainage areas 5, 6, 7, 8, 9, 10, and 11 flows into Area Inlet C-1. The peak flow into Area Inlet C-1 from the 25-year, 24-hour duration storm using the HEC-1 rainfall time distribution was 40 cfs. The peak flow into Area Inlet C-1 from the 25-year, 24-hour duration storm using the I.S.W.S. Bulletin-70 rainfall time distribution was 2 cfs. Area Inlet C-1 was designed to reduce the peak flow into the inlet from 40 cfs to approximately 1.5 to 2 cfs. A 12-inch by 3-inch rectangular orifice was used to limit inflow into the structure. The weir or orifice equation was used to determine the capacity of the rectangular orifice at varying depths. Two areas between the new TARACORP cap and access road were excavated to permit temporary ponding of storm runoff water during the design storm. See Appendix C-3 for elevation, volume, discharge data used to route the design storm through the inlet structure. The maximum ponding elevation using the HEC-1 rainfall time distribution was 414.7 with a peak discharge of approximately 2.0 cfs. The maximum ponding elevation using the I.S.W.S. Bulletin-70 rainfall time distribution was 413.2 with a peak discharge of approximately 1.4 cfs. The inlet elevation of the drainage structure was located 0.1 feet above the maximum ponding elevation of 414.7 to allow for reduction in ponding volume due to sedimentation. The sediment storage capacity is approximately 100 cy. The new 12-inch diameter storm drain pipe from Area Inlet C-1 to MH B-2 has a maximum capacity flowing full of 2.52 cfs at a velocity of 3.21 fps.

4.3.3.2.3. **Drainage Areas 12, 13, 14, 15, 16 and 17.** Runoff from drainage areas 12, 13, 14, 15, 16 and 17 flows into Area Inlet A-2. The peak flow into Area Inlet A-2 from the 25-year, 24-hour duration storm using the HEC-1 rainfall time distribution was 31 cfs. The peak flow into Area Inlet A-2 from the 25-year, 24-hour duration storm using the I.S.W.S. Bulletin-70 rainfall time distribution was 3 cfs. Area Inlet A-2 was designed to reduce the peak flow into the inlet from 31 cfs to approximately 1.5 to 2 cfs. A 12-inch by 3-inch rectangular orifice was used to limit inflow into the structure. The weir or orifice equation was used to determine the capacity of

the rectangular orifice at varying depths. An area between the new TARACORP cap and the State Street was excavated to permit temporary ponding of storm runoff water during the design storm. See Appendix C-3 for elevation, volume, discharge data used to route the design storm through the inlet structure. The maximum ponding elevation using the HEC-1 rainfall time distribution was 415.4 with a peak discharge of approximately 1.9 cfs. The maximum ponding elevation using the I.S.W.S. Bulletin-70 rainfall time distribution was 414.2 with a peak discharge of approximately 1.3 cfs. The inlet elevation of the drainage structure was located 0.1 feet above the maximum ponding elevation of 415.4 to allow for reduction in ponding volume due to sedimentation. The sediment storage capacity is approximately 150 cy. The new 12-inch diameter storm drain pipe from Area Inlet A-2 to MH AA-3 on the existing 24-inch combined sewer line has a maximum capacity flowing full of 2.52 cfs at a velocity of 3.21 fps.

4.3.3.2.4. **Drainage Area 4.** Runoff from drainage area 4 flows into Area Inlet B-3. The peak flow into Area Inlet B-3 from the 25-year, 24-hour duration storm using the HEC-1 rainfall time distribution was 22 cfs. The peak flow into Area Inlet B-3 from the 25-year, 24-hour duration storm using the I.S.W.S. Bulletin-70 rainfall time distribution was 3 cfs. Area Inlet B-3 was designed to reduce the peak flow into the inlet from 22 cfs to approximately 1.5 to 2 cfs. A 12-inch by 4-inch rectangular orifice was used to limit inflow into the structure. The weir or orifice equation was used to determine the capacity of the rectangular orifice at varying depths. An area between the new access road and existing fence was excavated to permit temporary ponding of storm runoff water during the design storm. See Appendix C-3 for elevation, volume, discharge data used to route the design storm through the inlet structure. The maximum ponding elevation using the HEC-1 rainfall time distribution was 414.1 with a peak discharge of approximately 1.6 cfs. The maximum ponding elevation using the I.S.W.S. Bulletin-70 rainfall time distribution was 413.4 with a peak discharge of approximately 1.4 cfs. The inlet elevation of the drainage structure was located 0.1 feet above the maximum ponding elevation of 414.1 to allow for reduction in ponding volume due to sedimentation. The sediment storage capacity was approximately 200 cy. The new 12-inch diameter storm drain pipe from Area Inlet B-3 to existing MH B-1 on the existing 96-inch combined sewer line has a maximum capacity flowing full of 4.06 cfs at a velocity of 5.17 fps.

4.3.3.2.5. **Drainage Areas 1, 2 and 3.** Runoff from drainage areas 1, 2, and 3 flows into an existing curb inlet and area inlet along State Street to the southwest of the Rich Oil Company. The peak flow into the existing curb inlet and area inlet from the 25-year, 24-hour duration storm using the HEC-1 rainfall time distribution was 19 cfs. The peak flow into the existing curb inlet and area inlet from the 25-year, 24-hour duration storm using the I.S.W.S. Bulletin-70 rainfall time distribution was 1 cfs.

4.3.3.3. **Summary.**

4.3.3.3.1. **HEC-1 Rainfall Time Distribution.** The peak discharge into the existing 96-inch diameter combined sewer will increase from approximately 1.7 cfs before construction to approximately 3.6 cfs after construction of the new facilities. The peak discharge into the existing 24-inch diameter combined sewer will increase from approximately 7.3 cfs before construction to approximately 9.2 cfs after construction of the new facilities.

The peak discharge into the existing 24-inch diameter combined sewer through the TARACORP Industries/Taracorp Superfund area will not increase after construction of the new facilities.

4.3.3.3.2. **ISWS Rainfall Time Distribution.** The peak discharge into the existing 96-inch diameter combined sewer will increase from approximately 1.7 cfs before construction to approximately 2.8 cfs after construction of the new facilities. The peak discharge into the existing 24-inch diameter combined sewer will increase from approximately 1 cfs before construction to approximately 2.3 cfs after construction of the new facilities. The peak discharge into the existing 24-inch diameter combined sewer through the TARACORP Industries/Taracorp Superfund area will not increase after construction of the new facilities.

4.3.4. **Landfill Cap Terraces.** The peak discharge into landfill cap terraces was approximately 3 cfs. The longitudinal slope along terraces was 1 percent. Using a roughness coefficient of 0.035 and a 1 percent slope, the depth of flow during peak discharge will be 0.71 feet and the velocity will be 2.05 fps. The flow will be subcritical with a Froude number of 0.61.

4.4. **EROSION AND SEDIMENTATION CONTROL.** Erosion and sedimentation controls are being provided to reduce migration of contaminated and uncontaminated soils during and after construction to the extent possible. The total area disturbed by construction is approximately 17 acres. Because the project is a Superfund Site, an NPDES permit for stormwater discharges from construction sites was not required. However, the Contractor is required to comply with the requirements of the permit.

4.4.1. **Permanent Erosion and Sediment Controls.** Permanent erosion and sediment controls include the following:

4.4.1.1. **Seeding.** All areas disturbed by construction and not otherwise surfaced were seeded. Seeding of grass provides stabilization to the soil by holding the soil particles in place.

4.4.2. **Temporary Erosion and Sediment Controls.** Temporary erosion and sediment controls such as silt fences, erosion control matting, and mulching were used to reduce erosion and contain sediment until establishment of a permanent grass cover.

4.5. **FENCING.** A new FE6 chain-link security fence is being installed around the capped areas to limit access to the site. The fence has a standard single outrigger with three strands of barbed-wire on the outrigger. The fence fabric is 6-feet high with top rail and bottom tension wire. A new FE5 chain-link security fence is being installed between the Rich Oil fuel storage tanks and office building.

5. **STRUCTURAL.**

5.1. **RETAINING WALL DESCRIPTION.** In order to limit the excavation required for a conventional L shaped retaining wall system a cantilever retaining wall system was selected. Due to the high water table and sandy soils a cantilever

sheet pile system was selected over drilled piers where casing would be required for drilled pier placement. The sheet pile is encased above grade with concrete for appearance and to provide a watertight barrier for the cap. The concrete encasement extends below grade to frost depth. Expansion joints with waterstops are located at change in alignment of the wall.

5.2. **SOIL PROPERTIES**. The following are soil properties used for design of the cantilever sheet pile retaining wall:

5.2.1. **RETAINED CAP**

Moist Unit Weight = 110 pcf
Angle of Internal Friction = 16 degrees

5.2.2. **RETAINED PILE**.

Unit Weight = 250 pcf
Angle of Internal Friction = 34 degrees

5.2.3. **FOUNDATION**.

Moist Unit Weight = 115 pcf
Saturated Unit Weight = 115 pcf
Angle of Internal Friction = 32 degrees
Cohesion = 500 psf
Water Table = 10 feet below grade

6. ENVIRONMENTAL.

6.1. **DISPOSAL OF DECONTAMINATION WATER**. This section covers the disposal of contaminated water resulting from equipment and personnel protective equipment wash down activities at the decontamination pad. The Contractor has several options available for the disposal of the decontamination water.

One option is to discharge to the local Publicly Owned Treatment Plant (POTW), Granite City Wastewater Treatment Plant. According to the POTW superintendent, Terry Kellahan, the Contractor would be required to obtain a permit, and the wastewater would have to be tested for specific pollutants prior to discharging to the existing sanitary sewer system. Mr. Kellahan said that the testing would have to be performed by the POTW and not the Contractor. Another option would be to discharge to the Chain of Rocks Canal or the Mississippi River. Testing for specific pollutants would be the responsibility of the Contractor. Prior to discharging the Contractor is required to obtain a NPDES permit.

The contractor will also have the option of utilizing a Treatment, Storage, Disposal Facility (TSDF) for the treatment and disposal of the contaminated water. The contractor will be required to submit for approval the TSDF they plan on using prior to removing any wastes from the site.

7. **ELECTRICAL.**

7.1. **PROJECT POWER REQUIREMENTS.** Illinois Power & Gas Co. will provide site power for staging areas, contractor's trailers, area lighting, and equipment.

7.2. **ELECTRICAL UTILITIES.**

7.2.1. **Description and Location of Existing Electrical Utilities.** The site has a 34.5 kV service drop that runs from 15th & State Street to the northwest side of Taracorps powerhouse. This service drop runs along the south and west side of the lead pile. This pole line also has a metering structure at the south end of the lead pile. The entire line is owned by Taracorp with the point of service one span beyond the metering structure. There are numerous poles and service drops in the adjacent properties of BV&G Transport and Rich Oil.

7.2.2. **Transmission Line.** There is a 69 kV transmission line that runs through the Trust 454 property. This transmission line is a substation to substation line that is part of the electrical grid for southeast Illinois, and Granite City.

7.2.3. **Utility Relocation Requirements.** The proposed work area will require the relocation of some power lines and the permanent removal of other lines. The existing telephone lines also will be addressed.

8. **HEALTH AND SAFETY.** The specifications for the remedial action will present requirements to ensure that the Contractor performs the work in compliance with applicable regulations, especially 29 CFR 1910.120, "Hazardous Waste Operations and Emergency Response". The specifications will require the Contractor to maintain a Safety and Health Program and to prepare a Site Safety and Health Plan (SSHP) covering all work to be performed under the construction contract. The paragraphs below describe background information and decision logic involved in determining specific requirements that will be included in the specifications.

8.1. **SITE DESCRIPTION AND CONTAMINATION CHARACTERIZATION.**

8.1.1. **Site Description (General).** The NL Industries/Taracorp site is located in Madison County, Illinois, at 16th Street and Cleveland Boulevard in Granite City which is approximately two miles east of downtown St. Louis, Missouri. The area surrounding the site is primarily utilized by heavy industry. This industrial property consists of approximately 30 acres that is the location of a former secondary lead smelting facility (NL Industries/Taracorp), a former battery recycling operation (formerly St. Louis Lead Recyclers (SLLR), now Trust 454), a trucking company (BV&G Transport), and a fuel oil distributor (Rich Oil). Two separate waste piles, the Taracorp pile and the SLLR pile, cover portions of the site. These waste piles have a combined estimated volume of approximately 91,000 cubic yards. Approximately 80 percent of the waste pile material is blast furnace slag, with the remainder being a mixture of broken battery casing material, lead oxide dust, and drummed smelter drosses.

8.1.2. Contamination Characterization. In general, lead contamination was primarily found in the on-site waste piles as well as soils and groundwater around the area. The groundwater in and around the pile and the site is contaminated with excessive levels of arsenic, nickel, lead, and cadmium, but the contamination resulting from activities at the site will be treated as a separate operable unit and will be remediated during a subsequent phase.

The material contained in both the Taracorp and SLLR piles is characterized as hazardous waste based on results of EP Tox analyses for lead. For unpaved areas of the Trust 454 and Rich Oil properties, soil lead concentrations range from 6.0 mg/kg to 345,000 mg/kg. For the BV&G Transport property, soil lead concentrations range from less than 6.5 mg/kg to 91,500 mg/kg (Woodward-Clyde, 1993). Soil lead concentrations above the action level specified in the Record of Decision (ROD) of 1000 mg/kg extend to an average depth of approximately 2 feet in all contaminated soils.

Personal air monitoring results for total lead from previous excavation activities at the site have indicated the OSHA eight hour weighted average standard for worker exposure of 0.050 mg/m^3 was slightly exceeded (Woodward-Clyde, 1995). Based upon this information, remediation and construction activities must meet the OSHA construction standard for worker exposure to lead as specified in 29 CFR 1926.62. If lead particulate levels exceed 30 $\mu g/m^3$, all the requirements of 29 CFR 1926.62 are applicable. This includes pre- and post-blood leads, on-going monitoring (regardless of the level of respiratory protection in use), and documentation of all air sampling results.

8.2. HAZARD ASSESSMENT AND RISK ANALYSIS. The final remedy includes excavating the contaminated soils into one of the existing waste piles and providing the waste pile or piles with a RCRA-compliant, multimedia cap. Excavation, handling, and regrading the contaminated waste piles and soil will cause the potential for exposure to lead and lead oxide dust at the NL Industries/Taracorp site. At the levels detected from previous investigations, inhalation and incidental ingestion as well as dermal and eye contact are all exposure pathways of concern.

8.3. PERSONAL PROTECTIVE EQUIPMENT (PPE). Because of the nature of this work, it is possible that engineering controls and work practices will not be able to provide complete control of the hazards at NL Industries/Taracorp Superfund, therefore the contractor will be required to provide personal protective equipment to all affected employees. This PPE shall provide dermal and respiratory protection specific to the site hazards. The requirement for use of chemical resistant outer clothing is not so much for mitigation of dermal exposure as it is a method of ensuring adequate decontamination of workers prior to exiting the work area. Removal of outer protective clothing during decontamination will ensure that contaminated soils will not be inadvertently carried away from the site. Selection of appropriate PPE will be based on task specific hazards and air monitoring results. The Contractor shall be required to establish a written personal protective equipment program in compliance with 29 CFR 1910.120(g)(5) and a respiratory protection program in accordance with 29 CFR 1910.134 (b),(d),(e) and (f).

8.3.1. **INITIAL LEVELS OF PROTECTION FOR EACH TASK.**

Mobilization/Site Preparation	Modified Level D/ Level C
Excavation and Backfill	Level C
Construction of Cap/Retaining Wall	Level C
Surface Drum Removal (smelter drosses)	Level C
Final Grading/Drainage Improvements	Modified Level D
Reconstruction of Road and Fences	Modified Level D
Monitoring Well Sampling	Modified Level D
Equipment Decontamination	Level C
Removal of bulky debris	Modified Level D
Demobilization	Level D

8.3 **SPECIFICATION REQUIREMENTS.**

The specification will detail requirements for the following topics:

Personal Protective Equipment
Air Monitoring
Stress Monitoring
Medical Surveillance
Training
Staff Organization, Qualifications, and Responsibility
Safety Procedures, Engineering Controls and Work Practices

8.4. **REFERENCES.**

NL/Taracorp Pre-Design Feasibility Investigation Final Report, Woodward-Clyde, 1993.

NL/Taracorp Waste Pile Investigation, Woodward-Clyde, February 1995.

9. **PERIMETER AIR MONITORING.** Ambient air monitoring results from a NL/Taracorp waste pile investigation performed by Woodward-Clyde (1995) indicated that on each day that excavation activities were conducted, at least one of the four ambient air monitoring stations (around the pile) measured total lead levels above the 1.5 $\mu g/m^3$ National Primary and Secondary (NAAQS) ambient air quality standard for lead.

Based on the waste pile investigation, it is likely that the excavation, hauling and stockpiling of contaminated soils and waste piles found on this site will release contaminants into the ambient air. Since these waste piles and soils have lead concentrations above Illinois standards, it is possible that excavation will create dust emissions great enough to exceed State of Illinois standards for lead and particulate matter. Good work practices and engineering controls shall be used to minimize emissions as described in Section \-01310-\ DUST CONTROL.

9.1. **TARGET COMPOUNDS FOR AIR MONITORING.** Perimeter monitoring/sampling shall be performed to ensure and document compliance with applicable State of

Illinois standards for lead and particulate matter (PM_{10}), and requirements for prevention of release of visible "fugitive" dust.

9.2. **MONITORING STRATEGY.** The chemical and physical characteristics of the contaminants at the NL Industry/Taracorp site require that time integrated sampling and analysis be performed.

9.3. **SAMPLING LOCATIONS AND FREQUENCY.** The excavation, handling, stockpiling and landfilling of the material on the NL Industries/Taracorp site will be taking place in three areas: The Taracorp Pile, the Saint Louis Lead Recycler's (SLLR) pile, and soils surrounding each pile. The phasing of the project is such that at some phases construction activities will be taking place in one or the other areas, at other times construction will be taking place in all areas.

9.3.1. **Sampling frequency for time integrated monitoring.**

9.3.1.1. Compound-specific sampling shall be performed every day of each work phase, from mobilization through demobilization.

9.3.1.2. The contractor will be required to have verbal results of the analysis from each of the air samples no more than 1 day after each sample is taken.

9.3.2. **Monitoring Locations.** There shall be a minimum of four air monitoring stations set up during construction. Station location will be based on wind direction. Monitors will be placed in the prevalent upwind direction, 180 degrees (downwind) of the upwind location and 90 degrees from upwind on both sides (crosswind). Each station shall be equipped to monitor for PM_{10}, and lead. The actual station locations shall be made based on discussions with the Contracting Officer, EPA, and the Illinois Environmental Protection Agency (IEPA). Upon approval from IEPA, use of the Granite City air monitoring network for PM_{10} and lead (located at 15th and Madison) will also be possible.

9.4. **AIR MONITORING EQUIPMENT.** The contractor will supply the equipment/instrumentation and all analysis.

9.4.1. **Time Integrated Sampling.** The contractor will provide all the equipment and analytical services for time integrated sampling at each of the monitoring stations.

9.4.1.1. **Lead.** The contractor will provide the equipment to collect samples of the atmosphere according to 40 CFR 50 App G.

9.4.1.2. **PM_{10}.** The contractor will provide the equipment to collect samples of the atmosphere according one of the following methods: (1) Method 201, 40 CFR 51, Appendix M, (2) Method 210A, 40 CFR 51, Appendix M, or (3) Method 5, 40 CFR 60, Appendix A, provided that all particulate matter measured by Method 5 shall be considered to be PM_{10}.

9.5. **METEOROLOGICAL MONITORING.** The contractor will required to collect enough meteorological data to determine the source and destination of airborne contamination.

9.5.1. The contractor will be responsible for recording wind speed and wind direction data and correlating it to the detection of contaminants at the perimeter of the site.

9.6. **CONTAMINANT CONTROL TECHNOLOGY.** The contractor will be responsible for applying water to the excavation, dumping, transport, and grading operations. The contractor will assure that the water or other possible dust control operations provide efficient control of dust for these operations.

9.7. **REFERENCES.**

NL/Taracorp Waste Pile Investigation, Woodward-Clyde, February 1995.

10. CHEMISTRY DESIGN.

10.1. **BACKGROUND.** This section sets forth the Contractor's responsibility for sample collection, handling, and analysis requirements to ensure compliance with environmental regulations during the excavation and consolidation of the Taracorp pile and construction of the cap over the pile. The Contractor is tasked to collect and analyze samples from the existing sixteen monitoring wells surrounding the site. The data will be used to evaluate the current ground water quality.

10.2. **APPLICABLE PUBLICATIONS.**

10.2.1. United States Army Corps of Engineers (USACE), Engineering Regulation 1110-1-263, Appendix E, March 1, 1996.

10.2.2. Environmental Protection Agency (EPA), Test Methods for Evaluating Solid Waste Physical/Chemical Methods (SW-846), 3rd Edition, Updates I, II, and IIA, September 1994.

10.2.3. Woodward-Clyde Consultants (WCC), Final Report, NL/Taracorp Superfund Site, Granite City, Illinois, March 1993.

10.2.4. Woodward-Clyde Consultants (WCC), Second Quarter 1994 Groundwater Sampling Event, NL/Taracorp Superfund Site, Granite City, Illinois, December 1994.

10.3. **GENERAL REQUIREMENTS**

10.3.1. **Chemical Quality Management.** The Contractor shall be responsible for preparing the contractual details of the Quality Assurance Project Plan (QAPP). The QAPP shall summarize chemical data required for remediation of the contamination. The QAPP shall be developed to assure that the chemical data collected during this project are scientifically and legally defensible. This plan also assures the Government that the Contractor

understands the chemical quality management details of this specification and allows Government approval of the Contractor's implementation procedures.

10.3.2. **Contract Lab Requirements**. The laboratory to be used by the Contractor shall be reviewed and approved by the Contracting Officer Representative (COR) prior to beginning any of the project analyses. Laboratories must also be competent for each specific analytical method to be employed during the remediation. The Contractor shall notify the COR identifying the analytical laboratory, the point of contact, and the address, as soon as possible. If the Contractor selects a laboratory not currently validated by USACE, the COR may elect to use the laboratory without additional certification if the laboratory is currently certified with the USEPA and the State of Illinois. The option to have the contract laboratory validated by the USACE has been given to the COR to decide. The amount of data to be collected to support the project does not warrant the cost of laboratory validation. The majority of the samples are in support of disposal and will be analyzed by the disposal facility, and not the contractor's laboratory.

10.3.3. **Sample Collection and Analysis Requirements**

10.3.3.1. **Verification/Confirmation**. X-Ray Flourescence (XRF) screening will be used to guide excavation depths. XRF screening samples will be collected on 50' x50' grids. Excavation of soil will be conducted in 1 foot lifts for those grids with lead greater than 1000 ppm. Confirmation of the XRF technology will be achieved by sending a percentage of the screening samples to an off-site laboratory. Soil samples will also be collected after excavation to verify clean-up criteria for lead has been met. Excavation will continue at 1 foot lifts to a maximum of 3 feet or 1000 ppm lead, which ever occurs first.

10.3.3.2. **Monitoring well samples**. The sixteen monitoring wells currently installed will be sampled to determine a more current status of the groundwater quality at the site. The results can also be used to determine the effectiveness of the cap by serving as a baseline before the construction of the cap.

10.3.3.3. **Disposal Sampling (Drums)**. The sampling results will be used to determine disposal options. The planned disposal is for recycling of the lead containing material in the drums.

10.3.3.4. **Decontamination waste water sampling**. The sample results will be used to determine whether the decontamination water will require treatment prior to discharge to the local POTW.

10.3.4. **Analytical Methods and Procedures**. X- Ray Flourescence and Standard SW-846 methods are to be used to support this work.

10.3.5. **Data Analysis and Reporting**. The Contractor will be required to submit a Quality Control Summary Report that summarizes the quality of the data.

11. **CONSTRUCTION PHASING REQUIREMENTS**. Construction will be phased to allow continued operation of BV&G Transport, Trust 454, Rich Oil, and Taracorp during excavation and backfilling of contaminated soils and construction of the new cover system. Construction phasing requirements will be presented in the final design package. In addition, Construction Contractor shall be required to submit an implementation schedule plan to the USEPA Region V for approval.

12. **OPERATION AND MAINTENANCE REQUIREMENTS**. The contractor will be required to perform site maintenance on the project on a quarterly basis for a period of one year after completion of the project. The purpose of the inspections shall be to identify and perform required maintenance activities and to maintain the integrity of the final grades, and erosion control system. This shall include at a minimum, the maintenance of the final grade, access roads, drainage ditches, stone protection, culverts, and prevention of storm water runoff from eroding or otherwise damaging the final grades, ditches or berms. Operation and Maintenance requirements have been included in the specs section titled: Site Maintenance.

13. **PHOTOGRAPHIC REQUIREMENTS**. The contractor will be required to provide project photographs to fully document critical construction activities. These requirements have proven to be invaluable in aiding contract administration and quality assurance efforts. The photograph requirements have been included in specification section titled: Photographic Documentation.

14. **REAL ESTATE**. As currently designed, the required real estate easements includes portions of the Taracorp, Trust 454, Rich Oil, and BV&G properties.

15. **SPECIFICATIONS FOR CONSTRUCTION**. The following is a list of specifications which will be prepared for the final design package.

DIVISION 1	GENERAL REQUIREMENTS
01010	SUMMARY OF WORK
01040	AS-BUILT DRAWINGS
01110	SAFETY, HEALTH, AND EMERGENCY RESPONSE (HTRW/UST)
01200	WARRANTY OF CONSTRUCTION
01300	SUBMITTAL PROCEDURES
01310	DUST CONTROL
01420	VEHICLE AND BULKY DEBRIS DECONTAMINATION
01432	PERIMETER AIR MONITORING
01440	CONTRACTOR QUALITY CONTROL
01450	CHEMICAL QUALITY MANAGEMENT
01460	SECURITY
01500	MEASUREMENT AND PAYMENT
01510	SURVEYS FOR RECORD DRAWINGS
01520	PHOTOGRAPHIC DOCUMENTATION
01565	NPDES PERMIT REQUIREMENTS FOR STORM WATER DISCHARGES FROM CONSTRUCTION SITES
01600	PROJECT RECORD DOCUMENTS
01740	DEMOBILIZATION AND PROJECT COMPLETION
01745	HAZARDOUS WASTE TRANSPORTATION AND DISPOSAL
01750	REGULATORY REQUIREMENTS
01800	SITE MAINTENANCE

DIVISION 2 SITE WORK

02050	DEMOLITION
02110	CLEARING AND GRUBBING
02210	EXCAVATION AND BACKFILLING FOR AREAS OTHER THAN LANDFILL COVER SYSTEM
02211	INITIAL GRADING AND RANDOM FILL FOR LANDFILL COVER SYSTEMS
02221	EXCAVATION, FILLING AND BACKFILLING FOR RETAINING WALLS
02222	EXCAVATION, TRENCHING, AND BACKFILLING FOR UTILITIES SYSTEMS
02223	SELECT FILL AND TOPSOIL FOR LANDFILL COVER
02245	STONE PROTECTION
02249	SUBDRAINAGE SYSTEM FOR LANDFILL COVER SYSTEMS
02260	GEOGRID SOIL REINFORCEMENT
02271	GEOMEMBRANE
02272	GEOTEXTILE
02273	GEONET
02411	METAL SHEET PILING
02442	GEOSYNTHETIC CLAY LINER (GCL)
02485	SOIL EROSION AND SEDIMENTATION CONTROL
02513	CONCRETE DECONTAMINATION PAD
02526	PRECAST CONCRETE WHEEL STOPS
02552	BITUMINOUS PAVEMENT, PORTLAND CEMENT CONCRETE AND BASE COURSES
02580	PAVEMENT MARKINGS
02685	GAS DISTRIBUTION SYSTEM
02710	LEACHATE COLLECTION SYSTEM
02720	STORM-DRAINAGE SYSTEM
02730	COMBINED SEWERS
02831	CHAIN LINK FENCE
02935	TURF

DIVISION 3 CONCRETE

03100	STRUCTURAL CONCRETE FORMWORK
03200	CONCRETE REINFORCEMENT
03250	EXPANSION JOINTS, CONTRACTION JOINTS, AND WATERSTOPS
03300	CAST-IN-PLACE STRUCTURAL CONCRETE

DIVISION 4 MASONRY THRU **DIVISION 15 MECHANICAL**

NOT USED

DIVISION 16 ELECTRICAL

16370	ELECTRICAL DISTRIBUTION SYSTEM, AERIAL
16742	TELEPHONE SYSTEM, OUTSIDE PLANT

APPENDIX A

RECORD OF DECISION
AND
DECISION DOCUMENT/EXPLANATION OF SIGNIFICANT DIFFERENCES

DECLARATION FOR THE RECORD OF DECISION

SITE NAME AND LOCATION

NL Industries/Taracorp
Granite City, Illinois

STATEMENT OF BASIS AND PURPOSE

This decision document represents the selected remedial action for the NL Industries/Taracorp (NL) site developed in accordance with the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA), and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP).

This decision is based upon the contents of the administrative record for the NL site. The attached index identifies the items which comprise the administrative record upon which the selection of a remedial action is based.

The State of Illinois has concurred on the selected remedy. The letter of concurrence is attached.

ASSESSMENT OF THE SITE

Actual or threatened releases of hazardous substances from this site, if not addressed by implementing the response action selected in this ROD, may present an imminent and substantial endangerment to public health, welfare, or the environment.

DESCRIPTION OF THE REMEDY

This final remedy includes treatment of the principal threats posed by the site by (1) removing crushed hard rubber battery casings and lead contaminated soil from residential areas, 2) consolidating the soils, crushed casings and lead-contaminated materials from an adjacent waste pile into the existing Taracorp slag pile and 3) providing the expanded Taracorp pile with a RCRA-compliant, multimedia cap.

The major components of the selected remedy include:

- Installation of an upgraded security fence around the expanded Taracorp pile.
- Deed Restrictions and other institutional controls to ensure protection of the Taracorp pile.
- Performance of soil-lead sampling to determine which areas must be excavated and the extent of the excavation.
- Inspection of alleys and driveways and areas containing surficial battery case material in Venice, Eagle Park Acres, Granite City, Madison and any other nearby communities to determine whether additional areas not identified in the Feasibility Study must be remediated as described below.

- Performance of blood lead sampling to provide the community with current data on potential acute health effects associated with site contamination.

- Installation of a minimum of one upgradient and three downgradient deep wells, monitoring of groundwater and air, and inspection and maintenance of the cap.

- Removal and recovery of all drums on the Taracorp pile at a secondary lead smelter.

- Consolidation of waste contained in an adjacent St. Louis Lead Recyclers piles with the Taracorp pile.

- Excavation and consolidation with the Taracorp pile or off-site disposal of battery case material from all applicable alleys and driveways in Venice, Illinois, Eagle Park Acres, and any other nearby communities.

- Excavation and consolidation with the Taracorp pile of all unpaved portions of adjacent Area 1 (see Figure) with lead concentrations greater than 1000 ppm.

- Excavation and consolidation with Taracorp pile or off-site disposal of all residential soils and battery case materials around the site and in Venice, Eagle Park Acres, and any other nearby communities with lead concentrations greater than 500 ppm.

- Inspection of the interiors of homes on property to be excavated to identify possible additional sources of lead exposure and recommend appropriate actions to minimize exposure.

- Implementation of dust control measures during all remedial construction activities.

- Construction of a RCRA-compliant, multi-media cap over the expanded Taracorp pile and a clay liner under all newly-created portions of the expanded Taracorp pile.

- Development of contingency plans to provide remedial action in the event that the concentration of contaminants in groundwater or lead or PM_{10} (particulate matter greater than 10 microns) in air exceed applicable standards or established action levels, or that waste materials or soils have become releasable to the air in the future.

- Development of contingency measures to provide for sampling and removal of any soils within the zone of contamination described by the soil lead sampling to be implemented above with lead concentrations above 500 ppm which are presently capped by asphalt or other barriers but become exposed in the future due to land use changes or deterioration of the existing use.

DECLARATION

The selected remedy is protective of human health and the environment, attains Federal and State requirements that are applicable or relevant and appropriate, and is cost-effective. This remedy satisfies the statutory preference for remedies that employ treatment that reduces toxicity, mobility, or volume as a principal element and utilizes permanent solutions and alternative treatment technologies to the maximum extent practicable for this site.

However, because this remedy will result in hazardous substances remaining on-site above health-based levels, a review will be conducted every five years after commencement of remedial action to ensure that the remedy continues to provide adequate protection of human health and the environment.

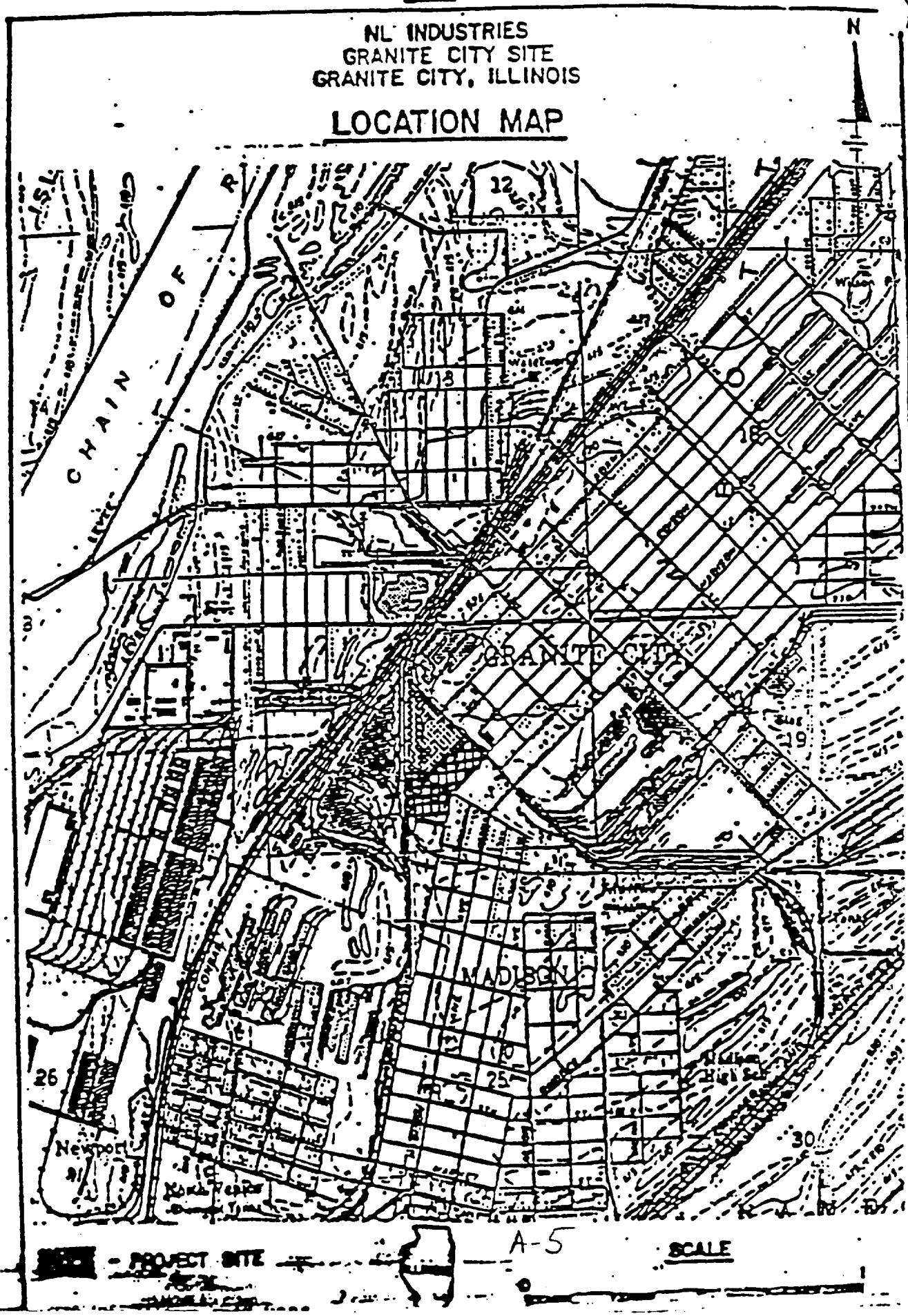
3/30/90
Date

for Frank M. Covington
Valdas V. Adamkus
Regional Administrator
Region V

AREA 1

NL INDUSTRIES
GRANITE CITY SITE
GRANITE CITY, ILLINOIS

LOCATION MAP



A-5

RECORD OF DECISION SUMMARY
NL INDUSTRIES/TARACORP SITE
GRANITE CITY, ILLINOIS

I. SITE BACKGROUND

The NL Industries/Taracorp Site ("the NL Site" or "the Site") is located within a heavily industrialized section of Granite City, Illinois, a community of approximately 40,000 people located across the Mississippi River from St. Louis, Missouri. Although the site is located within the Mississippi River Valley, it is not within the 100-year flood plain of any surface water. The location of the site is shown on Figure 1. Figure 2 presents the site plan, and Figure 3 shows the 100-year flood plain in the vicinity of the site.

II. SITE HISTORY AND ENFORCEMENT ACTIVITIES

The NL Site is the location of a former secondary lead smelting facility. Metal refining, fabricating, and associated activities have been conducted at the site since before the turn of the century. Prior to 1903, the facilities at the site included a shot tower, machine shop, factory for the manufacture of blackbird targets, sealing wax, manufacture of mixed metals, refining of drosses, and the rolling of sheet lead. From 1903 to 1983 secondary lead smelting occurred on-site. Secondary smelting facilities included a blast furnace, a rotary furnace, several lead melting kettles, a battery breaking operation, a natural gas-fired boiler, several baghouses, cyclones and an afterburner. Secondary lead smelting operations were discontinued during 1983 and equipment dismantled.

In July of 1981, St. Louis Lead Recyclers, Inc. (SLLR) began using equipment on adjacent property owned by Trust 454 to separate components of the Taracorp waste pile. The objective was to recycle lead bearing materials to the furnaces at Taracorp and send hard rubber and plastic off-site for recycling. SLLR continued operations until March 1983 when it shut down its equipment. Residuals from the operation remain on Trust 454 property as does some equipment.

A State Implementation Plan for Granite City was published in September 1983 by the Illinois Environmental Protection Agency (IEPA). The IEPA's Report indicated that the lead nonattainment problem for air emissions in Granite City was in large part attributable to emissions associated with the operation of the secondary lead smelter operated by Taracorp and lead reclamation activities conducted by SLLR. The IEPA procured Administrative Orders by Consent with Taracorp, St. Louis Lead Recyclers Inc., Stackorp, Inc., Tri-City Truck Plaza, Inc., and Trust 454 during March 1984. The Orders required the implementation of remedial activities relative to the air quality.

NL Industries (NL), as former owner of the site, voluntarily entered into an Agreement and Administrative Order by Consent with the U.S. Environmental Protection Agency (U.S. EPA) and IEPA in May 1985 to implement a Remedial Investigation and Feasibility Study (RI/FS)

for the site and other potentially affected areas. Taracorp was not a party to the agreement due to the fact that it filed for bankruptcy. The U.S. EPA determined that the site was a CERCLA facility and it was placed on the National Priorities List on June 10, 1986.

III. COMMUNITY RELATIONS HISTORY

U.S. EPA published the Proposed Plan in accordance with CERCLA Section 117. This document and the draft Feasibility Study (FS) Report and associated FS Addendum were made available to the public on January 10, 1990, at the beginning of a 45 day public comment period. The comment period was extended an additional 15 days to March 12, 1990, due to extensive community interest and response to the proposed remedy for the site. Availability sessions were held on January 23-25, 1990, and March 5, 1990, and a public meeting was held on February 8, 1990. Approximately 240 people attended the public meeting and expressed their concerns. Comments received during the public comment period and the responses to those comments are contained in the Responsiveness Summary (Appendix A).

IV. SCOPE AND ROLE OF THE RESPONSE ACTION

NL Industries, a Potentially Responsible Party (PRP) and former site owner/operator, under the direction of U.S. EPA and IEPA, initiated a RI/FS at this site. Activities performed under the May 1985, RI/FS Administrative Order by Consent included determining the nature and extent of contamination at the site and evaluating the feasibility of various remedial alternatives to clean up the site.

This Record of Decision (ROD) addresses contaminated soil and waste materials on the site, in adjacent residential areas, and in nearby alleys, driveways and residential areas. These areas were determined to be a principal threat at the site due to the potential risk from direct contact, ingestion, and inhalation of contaminated soils, dust, and waste materials. The surface water and air exposure pathways did not present an unacceptable risk to human health and the environment, and groundwater was not contaminated immediately downgradient (200-300 feet) from the site; however, the deeper portion of the upper aquifer was not sampled. This is the first and only planned response action at the site.

V. SITE CHARACTERISTICS

The RI was conducted by NL under the direction of U.S. EPA and IEPA to determine the nature and extent of contamination at the NL Site. Field activities were conducted from December 1986 through November 1987. Field aspects of the investigation included excavating test pits in the Taracorp pile, constructing monitoring wells, collecting representative samples of waste materials, soils, surface water, sediment, groundwater, and air, and conducting aquifer tests.

The NL Site is located in the Southwestern portion of Madison County, Illinois within the Mississippi River Valley. The site is approximately eight to ten miles south of the confluence of the Mississippi and Missouri Rivers. The site is underlain by recent alluvium and glaciofluvial and glaciolacustrine deposits. Bedrock beneath the alluvium is Carboniferous age rocks consisting of limestone, sandstone and shale. The alluvial and glacial deposits which fill the valley range in thickness from less than one foot adjacent to the bluff boundary and the Chain of Rocks reach of the Mississippi River to greater than 170 feet near the City of Wood River. The fill thickness across the entire area averages approximately 120 feet. The estimated thickness of the valley deposits beneath the site is approximately 100 to 120 feet. Investigations conducted by the Illinois State Water Survey have revealed the valley deposits become progressively coarser with depth. Generally, groundwater in the Granite City area occurs within the unconsolidated valley deposits under unconfined and leaky confined conditions. Recharge of groundwater within the area is from precipitation and inducted infiltration of surface water from the Mississippi River and smaller surface water bodies in the area.

A search of available hydrogeologic data, door-to-door surveys in areas immediately downgradient of the site, and hydrogeologic field investigations conducted during the RI indicated the following:

- residents of Granite City drink water provided by the city which is obtained from the Mississippi River.

- only one well in the downgradient vicinity of the site was in use; it was used for lawn watering.

- the water table was encountered at an average depth of 24 feet below ground surface.

- the horizontal hydraulic conductivity of the site ranged from 5.3×10^{-4} cm/sec to 2.0×10^{-2} cm/sec within the shallow portion (approximately 20 feet deep) of the aquifer and 4.3×10^{-4} cm/sec to 6.1×10^{-2} cm/sec in the "deeper" zone (approximately 35 feet deep).

- groundwater flow is in a south-southwesterly direction across the site, toward the Mississippi River.

- the linear groundwater flow velocity has been calculated as ranging from 3×10^{-3} ft/day to 0.5 ft/day in the shallow portion of the aquifer and 2×10^{-3} ft/day to 0.5 ft/day in the "deeper" zone.

- a downward verticle gradient was identified in some of the well nests at the site.

Results of the RI, which was finalized on February 1, 1989, with Addendum dated January 10, 1989, are summarized below:

Areas of contamination (Refer to Figure 4):

Taracorp Pile

Located on the site is a pile composed primarily of blast furnace slag and battery case material. The volume of the pile is approximately 85,000 cubic yards. In addition, smaller piles immediately adjacent to the Taracorp pile, which were associated with the adjacent SLLR recycling operation, comprise approximately 2450 cubic yards. Tests conducted on the materials in the Taracorp pile and small SLLR piles demonstrate lead concentrations in the range of 1-28%. EP toxicity test results demonstrate that the waste pile materials are a characteristic hazardous waste under 40 CFR Part 261. In addition, on the surface of the pile are 25-35 drums and containers holding solid wastes from the smelting operations which normally would be recycled. These containers remained after the smelting operations ceased in 1983.

Area 1 Battery Case Material and Soils

Area 1 consists of property owned by Trust 454 and Tri-City Trucking. These properties abut the NL Site and were the subject of previous regulatory action. The limits of Area 1 are shown on Figure 4.

Trust 454 property contains a pile of battery case materials (the St. Louis Lead Recyclers or SLLR pile) as well as unpaved areas. The SLLR pile contains approximately 4000 cubic yards in two general areas. The lead concentration range in this pile was 10-30%. EP toxicity analyses of the pile materials indicate that this material has characteristics similar to those of the Taracorp pile and should be managed as hazardous waste. Analyses of the unpaved area indicate a lead concentration at the surface of 9250 mg/kg.

Tri-City Trucking property includes a large unpaved area which is used to park and service trucks. Analyses of soils from areas around this property suggest that the soils contain lead concentrations in the range of 12,000 to 75,000 mg/kg.

Surface Soils

Surface soil samples were collected from 50 locations not including Taracorp or Trust 454 properties. Generally samples were collected at depths of 0-3 and 3-6 inches below grade. With the exception of one anomalous value approximately 3200 feet from the site boundary, the results indicate that the lead concentration in surface soils (0-3 inches) within 1/4 mile of the site boundary were higher (514-4150 mg/kg) than those further from the site (139-983 mg/kg). Samples collected from the surface (0-3 inches) generally contained more lead (average 1160 mg/kg) than the deeper (3-6 inch) samples which averaged 560 mg/kg. Refer to Figure 5 for the estimated areas of lead contamination above 500 ppm.

Eagle Park Acres

Eagle Park Acres includes some vacant land to which battery case material was previously hauled. The battery case material was used to fill a ditch on the property and a portion has been uncovered during subsequent excavation. The approximate volume of material and surrounding soil at Eagle Park Acres is 2700 cubic yards. Testing of the soil in this area indicated surface lead concentrations ranging from 63 mg/kg to 3280 mg/kg. Refer to Figure 6 for the estimated areas of contamination in Eagle Park Acres.

Venice Township Alleys

According to residents in the area, Venice Township hauled hard rubber case material to unpaved alleys in Venice Township. Tests conducted on these alleys resulted in a wide range of lead concentrations. Surface lead concentrations ranged from 200 mg/kg to 126,000 mg/kg. The estimated volume of battery case material and associated soil in these alleys is 670 cubic yards. Refer to Figure 7 for estimated areas of contamination in Venice.

Groundwater

Background water quality at the site is characterized by elevated concentrations of dissolved solids, sulfates, and manganese. Collectively, a shallow and adjacent deep well located on the site demonstrated elevated concentrations (as compared to background) of sulfates, dissolved solids, arsenic, cadmium, manganese, nickel, and zinc. However, data from the shallow and deep wells located hydraulically downgradient demonstrated water quality similar to that in the background monitoring well. The possibility of a strong downward hydraulic gradient was identified during the RI.

Surface Water and Air

No surface water is present at the site; runoff away from the area of the Taracorp pile is limited to the property of Tri-City Trucking, Trust 454, and Taracorp.

Results of air monitoring for lead conducted by IEPA have indicated that emissions from the site are well within the National Ambient Air Quality Standard for lead since Taracorp ceased smelting operations in 1983.

Post RI Information and Inspections

An inspection conducted with residents of Eagle Park Acres indicated that battery case material was used for fill much more extensively than indicated in the draft FS Report. Many former driveways and parking lots throughout the area contain battery case material at the surface; others have been covered with an undetermined depth of fill material. The estimated volume of contaminated material in the draft FS Report is low.

During the public comment period, many residents indicated areas in Granite City which contained battery case material as fill. These area are currently being investigated. It should be noted that Figures 5, 6 and 7 were generated based on information available at the time of the Feasibility Study, and therefore, represent only estimated areas of contamination/remediation.

VI. SUMMARY OF SITE RISKS

The Risk Assessment included in the RI Report identified two complete exposure pathways that exist at the site: direct contact with contaminated waste materials and soils, and inhalation of contaminated airborne dust. Lead was identified as the primary contaminant of concern at the site, and all remedial activities included in alternatives in the FS are based on lead contamination levels.

Based on the above information, it was determined that remedial alternatives considered should address the Taracorp pile, Area 1 battery case materials and soils, nearby residential surface soils, battery case materials at Eagle Park Acres and in Venice Township Alleys, and the potential data gap presented by the possible strong downward hydraulic gradient near the site.

U.S. EPA and IEPA did not agree with the portions of the Risk Assessment conducted by NL Industries which selected soil cleanup levels for lead. This dispute led to the drafting of an FS Addendum by U.S. EPA and IEPA which added an eighth alternative, Alternative H, to the list of alternatives to be evaluated for the site. Among other things, Alternative H utilized a 500 ppm soil lead cleanup level for residential areas around the site. Documentation for the selection of this cleanup level is included in Appendix B.

VII. DESCRIPTION OF ALTERNATIVES

The alternatives that underwent detailed analysis are briefly described below.

Alternative A - No Action

Monitoring:	Air Quality Monitoring; Ground Water Monitoring, Additional Deep Wells.
Institutional Controls:	Site Access Restrictions; Land Use Restrictions; Deed Restrictions; Sale Restrictions.

Estimated Total Remedial Costs: $475,110 Present Worth
Estimated Months to Implement: 6-12

The no action alternative (A) includes a group of activities that can be used to monitor contaminant transport. The sources considered potentially viable include air, surface soils, and groundwater. It includes institutional controls on the Taracorp property and other properties where residual concentrations do not meet Remedial Objectives. In addition, a minimum of one upgradient and three downgradient deep wells would be installed to monitor water quality in the lower portion of the aquifer; well nests or clusters would be employed wherever possible.

Alternative B

Taracorp Pile:	Multimedia Cap, Institutional Controls.
Taracorp Drums:	Off-Site Recovery at Secondary Lead Smelter.
SLLR Piles:	Excavate and Consolidate with Taracorp Pile.
Venice Alleys:	Asphalt or Sod Cover Based on Usage.
Eagle Park Acres:	Vegetated Clay Cap, Institutional Controls.
Area 1 Unpaved Surfaces:	Asphalt or Sod Cover Based on Usage.
Area 2 Unpaved Surfaces:	Asphalt or Sod Cover Based on Usage.
Area 3 Unpaved Surfaces:	Asphalt or Sod Cover Based on Usage.
Monitoring:	Air and Groundwater Monitoring, Additional Deep Wells, Contingency Plans.

Estimated Total Remedial Cost: $5,685,020 Present Worth
Estimated Months to Implement: 12-24

To implement Alternative B, drums containing lead drosses and other production by-products would be removed to an off-site secondary lead smelter for lead recovery. Wastes contained in the SLLR piles would be consolidated into the Taracorp pile; the consolidated pile would be graded and capped with a multimedia cap. Institutional controls such as site access restrictions, restrictive covenants, deed restrictions, and property transfer restrictions would also be implemented.

Eagle Park Acres would be purchased and a vegetated clay cap in compliance with ARARs would be installed over the battery case material (refer to Figure 6). Institutional controls such as site access restrictions, restrictive covenants, deed restrictions, and property transfer restrictions would also be implemented.

Venice Alleys would be covered in accordance with present usage (refer to Figure 7). Asphalt would be applied to the portions subject to vehicular or pedestrian use; the remaining areas would be covered with 3 inches of topsoil followed by sod.

Unpaved portions of Areas 1, 2, and 3 (refer to Figure 4) would be covered in accordance with present usage. Asphalt would be applied to unpaved driveways and alleys; grassed or open areas would be covered with three inches of topsoil followed by sod. Removal of existing soils would be limited to driveway subgrade preparation; therefore, surface elevations would change somewhat depending on surface treatment. Any soil excavated would be transported to the Taracorp pile for use in grading prior to cap installation.

The air and groundwater monitoring included in the no action alternative would also be implemented as part of Alternative B.

Alternative C

Alternative C in the FS Report is nearly identical to Alternative D; therefore, Alternative C has been excluded from further consideration.

Alternative D

Taracorp Pile:	Multimedia Cap, Institutional Controls.
Taracorp Drums:	Off-Site Recovery at Secondary Lead Smelter.
SLLR Piles:	Excavate and Consolidate with Taracorp Pile.
Venice Alleys:	Excavate Case Material and Consolidate with Taracorp Pile. Restore Surfaces.
Eagle Park Acres:	Excavate Case Material and Consolidate with Taracorp Pile. Restore Surfaces.
Area 1 Unpaved Surfaces:	Excavate Soil and Consolidate with Taracorp Pile. Restore Surfaces.
Area 2 Unpaved Surfaces:	Excavate Soil and Consolidate with Taracorp Pile. Restore Surfaces.
Area 3 Unpaved Surfaces:	Excavate Soil and Consolidate with Taracorp Pile. Restore Surfaces.
Monitoring:	Air and Groundwater Monitoring, Additional Deep Wells, Contingency Plans.

Estimated Total Remedial Cost: $6,835,450 Present Worth
Estimated Months to Implement: 12-24

To implement Alternative D, drums containing lead drosses and other production by-products would be removed to an off-site secondary lead smelter for lead recovery. Wastes contained in the SLLR piles would be consolidated into the Taracorp pile; the consolidated pile would be graded and capped with a multimedia cap. Institutional controls such as site access restrictions, restrictive covenants, deed restrictions, and property transfer restrictions would be implemented.

Battery case material would be excavated from both Venice Alleys and Eagle Park Acres and transferred to the Taracorp pile. After preliminary sampling is conducted, any portion of the case material that is EP Toxic for lead will be removed to an off-site, RCRA compliant landfill or treated prior to placement in the Taracorp pile. These areas would be restored with either asphalt or sod, in accordance with current usage.

Unpaved portions of Areas 1, 2, and 3 would be excavated to a depth of three inches and restored with either asphalt or sod, in accordance with present usage. Excavated soil would be transported to the Taracorp pile for use in grading prior to cap installation.

The air and groundwater monitoring included in the no action alternative would also be implemented as part of Alternative D.

Alternative E

Taracorp Pile:	Multimedia Cap, Supplemental Liner, Institutional Controls.
Taracorp Drums:	Off-Site Recovery at Secondary Lead Smelter.
SLLR Piles:	Excavate and Consolidate with Taracorp Pile.
Venice Alleys:	Excavate Case Material and Consolidate with Taracorp Pile. Restore Surfaces.
Eagle Park Acres:	Excavate Case Material and Consolidate with Taracorp Pile. Restore Surfaces.
Area 1 Unpaved Surfaces:	Excavate Soil and Consolidate with Taracorp Pile. Restore Surfaces.
Area 2 through 8 Residential Surfaces:	Excavate Soil and Consolidate with Taracorp Pile
Taracorp Pile.	Restore Surfaces.
Monitoring:	Air and Groundwater Monitoring, Additional Deep Wells, Contingency Plans.

Estimated Total Remedial Cost: $31,000,000 Present Worth
Estimated Months to Implement: 42-54

To implement Alternative E, drums containing lead drosses and other production by-products would be removed to an off-site secondary lead smelter for lead recovery. An impermeable liner would then be installed on a section of Area 1 adjacent to the Taracorp pile. All soils in Area 1 with lead concentrations greater than 1000 ppm would be excavated prior to liner installation, with the excavated soil staged with the Taracorp pile. The liner would consist of 2 feet of clay, 1 foot of sand (secondary drainage layer), a 60 mil synthetic membrane, and 1 foot of sand (primary drainage layer). A primary and secondary leachate collection system (perforated PVC piping) would also be provided. Excavated soils from Areas 1 through 8 would be placed over the primary drainage layer as a base to protect the liner from damage. Following liner construction, waste materials from the Taracorp pile, SLLR pile, Eagle Park Acres, and Venice Alleys would be excavated, transported to, and placed on the liner. These wastes would be covered and graded with soils excavated from the base of the former Taracorp pile. A multimedia cap would then be installed over the consolidated pile. All construction activities in Area 1 mentioned above would comply with any applicable flood plain construction permit

requirements. Institutional controls such as site access restrictions, restrictive covenants, deed restrictions, and property transfer restrictions would also be implemented.

As discussed above, battery case material would be excavated from both Venice Alleys and Eagle Park Acres and transferred to the newly constructed liner. These areas would be restored with either asphalt or sod, in accordance with current usage.

Residential soils in Areas 2 through 8 (see Figure 5) with lead concentrations greater than 500 ppm would be excavated and restored with either asphalt or sod, in accordance with present usage. As stated above, excavated soil would be transported to the newly constructed liner and placed directly over the primary drainage layer, to protect the synthetic membrane from damage from heavy slag and debris.

Air and groundwater monitoring included in the no action alternative would be implemented as part of Alternative E.

Alternative F

Taracorp Pile:	Multimedia Cap, Supplemental Liner Recovery of Plastic Battery Case Materials and Lead, Institutional Controls.
Taracorp Drums:	Off-Site Recovery at Secondary Lead Smelter.
ELLR Piles:	Excavate and Consolidate with Taracorp Pile.
Venice Alleys:	Excavate Case Material and Consolidate with Taracorp Pile. Restore Surfaces.
Eagle Park Acres:	Excavate Case Material and Consolidate with Taracorp Pile. Restore Surfaces.
Area 1 Unpaved Surfaces:	Excavate Soil and Consolidate with Taracorp Pile. Restore Surfaces.
Area 2 through 8 Residential Surfaces:	Excavate Soil and Consolidate with Taracorp Pile. Restore Surfaces.
Monitoring:	Air and Groundwater Monitoring, Additional Deep Wells, Contingency Plans.

Estimated Total Remedial Cost: $45,000,000 Present Worth
Estimated Months to Implement: 66-78

Alternative F is identical to Alternative E, with the exception of recycling a portion of the waste materials as described below.

Prior to transport to the newly constructed liner, waste materials in the Taracorp pile would be processed to recover plastic battery case material and smeltable lead. During the initial excavation, waste material would be visually segregated: excavations containing primarily slag would be transported directly to the adjacent liner; those containing significant amounts of plastic battery case material and smeltable lead would be transported to an on-site

segregation unit. The commercially available unit would utilize flotation as a recovery mechanism. Recovered plastic would be shipped off-site for use as a raw material. Recovered lead and lead oxide would be shipped to a secondary smelter after drying. Residuals, including slag and rubber case material, would be transported to the liner.

Alternative G

Taracorp Pile:	Recovery of Plastic Battery Case Material and Lead, Disposal of Residuals in RCRA Landfill.
Taracorp Drums:	Off-Site Recovery at a Secondary Lead Smelter.
SLIR Piles:	Disposal in RCRA Landfill.
Venice Alleys:	Excavate Case Material, Disposal in RCRA Landfill. Restore Surfaces.
Eagle Park Acres:	Excavate Case Material, Disposal in RCRA Landfill. Restore Surfaces.
Area 1 Unpaved Surfaces:	Excavate and Restore. Disposal in RCRA Landfill.
Area 2 through 8 Residential Surfaces:	Excavate and Restore. Disposal in RCRA or Non-RCRA Landfill.
Monitoring:	Groundwater Monitoring, Additional Deep Wells, Contingency Plan.

Estimated Total Remedial Cost: $67,000,000 Present Worth
Estimated Months to Implement: 66-78

To implement Alternative G, drums containing lead drosses and other production by-products would be removed to an off-site secondary lead smelter for lead recovery. The remaining waste materials in the Taracorp pile would be excavated, processed to recover recyclable plastic, and disposed of in a RCRA landfill.

Processing would consist of visual segregation during initial excavations to separate non-plastic bearing wastes from wastes containing plastics. Non-plastic bearing waste would be transported directly to the RCRA landfill; those containing significant amounts of plastic battery case material and smeltable lead would be transported to an on-site segregation unit. The commercially available unit would utilize flotation as a recovery mechanism. Recovered plastic would be shipped off-site for use as a raw material. Recovered lead and lead oxide would be shipped to a secondary smelter after drying. Residuals, including slag and rubber case material, would be transported to the RCRA landfill.

Battery case material would be excavated from both Venice Alleys and Eagle Park Acres and transported directly to the RCRA landfill. It is thought that these casings are primarily rubber and, therefore, not likely suitable for recycling. If significant amounts of plastic casings were excavated, however, they would be processed in the same fashion as the Taracorp pile casings. Venice Alleys

and Eagle Park Acres surface areas would be restored with either asphalt or sod, in accordance with current usage.

Unpaved portions of Areas 1 through 8 would be excavated and restored with either asphalt or sod, in accordance with present usage. Excavated soil from Area 1 would be transported to a RCRA landfill; excavated soil from Areas 2 through 8 would be transported to a RCRA or non-RCRA landfill, based on the results of preliminary EP Toxicity tests for lead.

The groundwater monitoring included in the no action alternative would also be implemented as part of Alternative G. Long term air monitoring would not be required.

Alternative H

Taracorp Pile:	Multimedia Cap, Institutional Controls.
Taracorp Drums:	Off-Site Recovery at a Secondary Lead Smelter.
SLLR Piles:	Excavate and Consolidate with Taracorp Pile.
Venice Alleys:	Excavate Case Material and Consolidate with Taracorp Pile. Restore Surfaces.
Eagle Park Acres:	Excavate Case Material and Consolidate with Taracorp Pile. Restore Surfaces.
Area 1 Unpaved Surfaces:	Excavate Soil and Consolidate with Taracorp Pile. Restore Surfaces.
Areas 2 through 8 Residential Surfaces:	Excavate Soil and Consolidate with Taracorp Pile. Restore Surfaces.
Monitoring:	Air and Groundwater Monitoring, Additional Deep Wells, Contingency Plans.

Estimated Total Remedial Cost: $25,000,000 Present Worth
Estimated Months to Implement: 18-30 (construction)

Alternative H, which was added by U.S. EPA and IEPA in an addendum to the draft FS Report, is identical to Alternative D, with the exception that the scope of off-site soil and waste materials excavation is increased significantly as described below. NL Industries has indicated to U.S. EPA its objections to the increased scope of soil excavation in this alternative.

All soils in Area 1 with lead concentrations greater than 1000 ppm and residential soils in Areas 2 through 8 with lead concentrations greater than 500 ppm would be excavated and consolidated with the Taracorp pile. Surfaces would be restored with either asphalt or sod, in accordance with present usage.

VIII. SUMMARY OF COMPARATIVE ANALYSIS OF ALTERNATIVES

The nine criteria used for evaluating the remedial alternatives listed above include: overall protection of human health and the environment; compliance with ARARs; long-term effectiveness; reduction of toxicity, mobility, or

acceptance; volume; short-term effectiveness; implementability; cost; State of Illinois acceptance and communities of Granite City, Madison, and Venice, Illinois acceptance. Based on these nine criteria, the U.S. EPA and IEPA have selected Alternative H, as modified with five additional elements added due to public comments received, as the preferred alternative for remedial action at the NL site. The preferred alternative includes: Blood Lead Sampling in the Neighboring Communities/Removal and Recovery of Taracorp Drums/Consolidation of SLLR Piles Into Taracorp Pile/Excavation and Restoration Of Unpaved Portions Of Area 1 With Lead Concentration Greater than 1000 ppm and Residential Areas Around The Site and in Venice, Eagle Park Acres, and Other Nearby Communities with Lead Concentration Greater Than 500 ppm, and Consolidation of These Soils and Battery Case Materials with the Taracorp Pile or Off-Site Disposal/ Excavation, Restoration and Consolidation With Taracorp Pile or Off-Site Disposal of Battery Case Material in Alleys and Driveways in Venice, Eagle Park Acres, and Other Nearby Communities/Construction of a RCRA-Compliance Cap Over the Expanded Taracorp pile and a Clay Liner Under All Newly-Created Portion of the Expanded Taracorp Pile/Construction of a RCRA-Compliant Cap Over the Expanded Taracorp Pile/Inspection of Home Interiors/Establishment of Contingency Measures To Properly Dispose of Contaminated Soil Generated Through Changes In Land Use/Installation of Deep Monitoring Wells/Cap, Air and Groundwater Monitoring And Contingency Plans/Fencing and Institutional Controls. Refer to Figure 8 for a diagram of the RCRA-compliant, multimedia cap to be placed over the Taracorp pile, after consolidation. This section discusses the performance of the preferred alternative against the nine criteria, noting how it compares to the other options under consideration.

It must be noted that the comparisons made below are for the alternatives as discussed in the Proposed Plan. Due to comments received during the public comment period, five elements were added to Alternative H, namely blood lead sampling in the surrounding community, home interior inspections on properties to be excavated, provisions to remediate additional areas in Eagle Park Acres, Venice, Granite City, Madison and other nearby communities where battery case materials are located at or near the surface and which were not identified in the draft FS Report, construction of a clay liner under the new newly-created portions of the expanded Taracorp pile, and establishment of contingency measures to provide for proper disposal of contaminated soil due to land use changes within the zone of contamination. The selected remedy, or preferred alternative, is Alternative H as modified by the addition of these five elements. These elements are not discussed in the analysis below since, with the exception of Alternative A and Alternative B and G, for which a liner would not be required, they would be included in each of the alternatives. Additionally, cost estimates have not been provided for these elements; however, it is expected that, excluding the contingency measures, these activities will not cost more than 15% of the cost estimates for the alternatives provided in this ROD. It is difficult to provide a cost estimate for the contingency measures; however, it is expected that the cost of these measures would be the same for each alternative which remediates residential soils. Finally, it must be noted that Figures 5, 6, and 7 represent only estimated areas of remediation and that the extensive soil sampling and inspections provided as part of the preferred alternative will result in the accurate delineation of areas of remediation during the upcoming Remedial Design phase of the Superfund process.

ANALYSIS

Overall Protection - With the exception of the no action alternative, the treatment of Areas 4 through 8 in Alternative B, and the treatment of Areas 1 through 8 in Alternative D, all of the alternatives, as amended by the addendum to the Feasibility Study, would provide adequate protection of human health and the environment. Each of the alternatives found adequately protective of human health and the environment includes a residential soil lead cleanup standard of 500 ppm and a soil lead cleanup standard of 1000 ppm in Area 1. Levels of protectiveness are based on interim guidance and site specific analysis of Granite City and the surrounding communities (see Appendix B). The preferred alternative includes the elimination of direct contact with and inhalation of soils and waste materials contaminated with lead at concentrations above levels which may present a risk to public health by: removal of Taracorp drums and off-site recovery at a secondary lead smelter; excavation, restoration, and consolidation with the Taracorp pile of the SLLR piles, soils and battery case materials with lead concentrations greater than 500 ppm in residential areas in Areas 2 through 8, and battery case material in Venice Alleys and Eagle Park Acres; excavation, restoration, and consolidation of soils and waste materials in Area 1 with lead concentrations greater than 1000 ppm; and providing a multimedia cap over the Taracorp pile and providing institutional controls. The preferred alternative also includes installation of additional deep wells, air and groundwater monitoring plans, and contingency plans to be developed and implemented in the event that site-related contaminant levels in the air or groundwater exceed applicable standards or that materials in the expanded Taracorp pile become exposed or releasable to the air in the future.

Compliance with ARARs - Alternatives B through H would meet all Applicable or Relevant and Appropriate Requirements (ARARs) of Federal and State Environmental Laws except for State of Illinois General Use Water Quality Standards (35 IAC 302.208). These standards are applicable to groundwater beneath the site and are exceeded for sulfates, total dissolved solids, iron, manganese and zinc. The standards for these parameters were developed to ensure the aesthetic quality of water and concentrations in excess of the General Use standards for these parameters would not present a health concern. Cadmium was also present above the General Use standard during three rounds of sampling but not during the most recent sampling. The groundwater monitoring and additional deep well installation included in all alternatives will verify cadmium concentrations and monitor concentrations of all other parameters of concern. Care would have to be exercised with Alternatives E, F, and G to ensure that Taracorp pile excavation activities do not create exceedances of air ARARs.

Additionally, the consolidation of excavated contaminated soils from the residential areas around the site is included in Alternatives D and H due to the fact that these areas are within a zone of continuous contamination created by the airborne deposition of lead from the smelter stack throughout its years of operation. Lead contamination is highest next to the smelter stack (on-site) and gradually decreases with increasing radial distance from the stack; and the nearest residential areas to be excavated are physically separated from the site boundary by one roadway, 16th Avenue.

Long-Term Effectiveness - Alternatives E, F, and G would provide good long-term effectiveness against direct contact with and inhalation of soils and waste materials containing lead concentrations above levels which may present a risk to public health, as well as an additional barrier against leaching of lead and other metals into the groundwater. The preferred alternative (i.e., Alternative H) would provide similar long-term effectiveness but would not provide the additional barrier (bottom clay liner) against leaching metals under the present Taracorp pile; however, the groundwater does not represent a complete risk pathway at this site. With the exception of Areas 4 through 8, for which no remediation is provided, Alternative B would eliminate the risk of human exposure in off-site areas upon completion of remediation but would not provide long-term effectiveness in these areas due to maintenance requirements and the potential for uncontrolled excavation. With the exception of Areas 4 through 8, for which no remediation is provided, Alternative D would provide good long-term effectiveness with respect to materials consolidated with the Taracorp pile; however, at Areas 1, 2, and 3, lead concentrations at 3 inches beneath the ground surface would remain at levels which may present a risk to public health. The no action alternative allows waste materials to remain in place and, thus, has poor long-term effectiveness.

Reduction of Toxicity, Mobility, or Volume - With the exception of the no action alternative, all alternatives provide a reduction of mobility of contaminants; the degree of mobility reduction provided, from least to greatest, is Alternative B, D, H, E, F, then G. The no action alternative does not provide any reduction of toxicity or volume, Alternatives B, D, H, and E provide a slight reduction of toxicity and volume by removal and recovery of Taracorp drums, and Alternatives F and G provide a slightly greater reduction of toxicity and volume by recycling some waste materials. The reduction of volume effected by Alternatives F and G has been calculated to be less than 10%, based on the quantity, nature and physical condition of recyclable materials in the Taracorp pile. A recycling effort on the Taracorp pile was conducted in the early 1980's by St. Louis Lead Recyclers. The effort was unsuccessful in that anticipated volume reductions were not achieved and the material remaining after recycling was more contaminated than that which entered the process. The nature of the materials in the Taracorp pile is not conducive to a successful recycling effort, and will potentially create a greater adverse health impact to workers and the public than would exist if the materials remain in place. Treatment/stabilization has been applied to contaminated soils at other sites, but has not been successfully applied to waste materials such as exist in the Taracorp pile. Additionally, Alternatives F and G would produce a contaminated sludge as a result of precipitation of rinse waters used for recycling.

Short-Term Effectiveness - Implementation of Alternatives A and B would produce minimal short-term impacts to the community, workers, or the environment, as contaminated material would be left in place. Implementation of Alternatives D, E, F, G, and H could generate dust in residential and commercial areas, which would require monitoring and control. Alternative D would be of shorter duration and would involve the movement of less materials than Alternative H, which would in turn involve less materials movement than Alternatives E, F, and G. Alternatives E, F, and G include significant excavation at the Taracorp pile; the generated dust could impact the

community, workers, and the environment. Control measures would be required. Alternatives F and G also include extensive manual handling of waste materials at the Taracorp pile; worker health and safety could be jeopardized through ingestion of and direct contact with lead containing materials.

The following periods of time are required to implement the remedial construction activities for each alternative:

Alternative	Time
A	6-12 Months
B, D	1-2 Years
H	Approximately 2 1/2 Years
E	3 1/2 - 4 1/2 Years
F, G	5 1/2 - 6 1/2 Years

Implementability - Alternatives A, B, D, and H would utilize standard monitoring and construction techniques which would be readily implementable. The excavation of the Taracorp pile and other soils and waste materials incorporated in Alternatives D, E, F, G, and H would require dust control measures. The segregation and recovery utilized by Alternatives F and G, however, would utilize equipment designed to handle batteries, not the slag and waste materials present at the Taracorp pile. In addition, the recovered products may not be suitable for recycling: the recovered plastic may not pass the TCLP test for lead, and the lead content of the recovered slag/dirt/lead mixture may not be high enough to be acceptable to a secondary smelter.

Cost - The costs of each alternative are presented below. It must be noted that these are estimated costs. More detailed cost estimates will be prepared during the Remedial Design phase of the project.

Alternative	Capital Cost	O&M	Present Worth
A	$143,840	$21,550	$475,110
B	$5,142,390	$35,300	$5,685,020
D	$6,292,820	$35,300	$6,835,450
E	$30,500,000	$35,300	$31,000,000
F	$44,500,000	$35,300	$45,000,000
G	$66,500,000	$5,300	$67,000,000
H	$24,500,000	$35,300	$25,000,000

State Acceptance - The State of Illinois supports the preferred alternative.

Community Acceptance - Community acceptance of the preferred alternative has been evaluated and it has been determined that the following five elements should be added to the preferred alternative: 1) blood lead sampling in the surrounding community, 2) home interior inspections on properties to be excavated, 3) provisions to remediate additional areas in Eagle Park Acres, Venice, Granite City, Madison, and other nearby communities where battery case materials are located at or near the surface and which were not identified in the draft FS Report, 4) construction of a clay liner under the newly-created portions of the expanded Taracorp pile and 5) establishment of contingency

measures to provide for proper disposal of contaminated soil due to land use changes within the zone of contamination. The Responsiveness Summary is included in Appendix A of this Record of Decision and addresses all comments received during the 60 day public comment period.

IX. THE SELECTED REMEDY

The preferred alternative (selected remedy) for cleaning up the NL Site is Alternative H, as amended by the addition of the five elements listed above: Blood Lead Sampling In the Neighboring Communities/Removal and Recovery of Taracorp Drums/Consolidation of SLLR Piles Into Taracorp Pile/Excavation and Restoration Of Unpaved Portions Of Area 1 With Lead Concentration Greater than 1000 ppm and Residential Areas Around The Site and in Venice, Eagle Park Acres, and Other Nearby Communities With Lead Concentration Greater than 500 ppm, and Consolidation of These Soils and Battery Case Materials with the Taracorp Pile/Excavation, Restoration and Consolidation With Taracorp Pile, or Off-site Disposal, of Battery Case Material in Alleys and Driveways in Eagle Park Acres, Venice, and Other Nearby Communities/Construction of a RCRA-Compliant Cap Over the Expanded Taracorp Pile and Clay Liner under all Newly-Created Portions of the Expanded Taracorp Pile/Inspection of Home Interiors/Establishment of Contingency Measures To Properly Dispose of Contaminated Soil Generated Through Changes In Land Use/Installation of Deep Monitoring Wells/Cap, Air and Groundwater Monitoring and Contingency Plans/Fencing and Institutional Controls. Based on current information, this alternative provides the best balance of trade-offs among the alternatives with respect to U.S. EPA's nine evaluation criteria.

Soil Sampling/Inspection

Soil lead sampling shall be conducted in Area 1 and all residential portions of Areas 2-8 (Figure 5) and immediately adjacent properties to determine the depth to which each individual residential yard must be excavated to achieve a 500 ppm soil lead cleanup level and the depth to which Area 1 must be excavated to achieve a 1000 ppm cleanup level.

Inspections of alleys and driveways and areas containing surficial battery case materials in Eagle Park Acres, Venice, Granite City, Madison, and other nearby communities shall be conducted to determine which specific areas not already identified in Figures 5, 6 and 7 need remediation. EP toxicity sampling for lead shall be conducted for all identified areas, and lead sampling of all identified areas which are not alleys or driveways shall be conducted to determine the depth to which such areas must be excavated to achieve a 500 ppm cleanup level.

Blood Lead Study

A comprehensive blood lead study shall be conducted on a representative number and distribution of residents nearby the site. Results shall be provided to the community as soon as possible. The study will be coordinated with and/or conducted by the Agency for Toxic Substances and Disease Registry and/or Illinois Department of Public Health and shall be conducted during optimum exposure time (i.e. summer 1990).

Taracorp Drums

All drums on the Taracorp pile shall be removed and transported to an off-site secondary lead smelter for lead recovery.

SLLR Pile

All wastes contained in the SLLR pile shall be consolidated into the Taracorp pile.

Alleys and Driveways in Venice and Eagle Park Acres

Based upon the FS and the inspections outlined above, battery case material shall be excavated from all alleys and driveways in Venice, Eagle Park Acres, and other nearby communities in which it has come to be located at or near the surface. Sampling for EP toxicity for lead shall be conducted in all affected areas prior to removal of the case material. All excavated material which is not EP toxic for lead shall be transported to the Taracorp pile for consolidation. All excavated material which is EP toxic for lead shall be transported to an off-site RCRA-compliant landfill or treated prior to placement in the Taracorp pile. Excavated areas shall be backfilled, if necessary, and paved.

Area 1

Based on the sampling outlined in the Soil Sampling/Inspection paragraph above, all unpaved portions of Area 1, including the material which is beneath the SLLR pile, with lead concentrations greater than 1000 ppm shall be excavated and consolidated with the Taracorp pile. The surfaces shall be restored with asphalt or sod, in accordance with present usage.

Residential Areas

Based on the sampling outlined in the Soil Sampling/Inspection paragraph above, an accurate mapping of all residential areas around the site and in Eagle Park Acres, Venice, and other nearby communities with a lead concentration greater than 500 ppm shall be provided. All soils and battery case materials with lead concentrations greater than 500 ppm in the residential areas indicated on the map shall be excavated and consolidated with the Taracorp pile, with the exception of soils and battery case materials in Eagle Park Acres, Venice, and other nearby communities which are EP toxic for lead, which shall be transported to an off-site RCRA-compliant landfill or treated prior to placement in the Taracorp pile. The surfaces shall be restored in accordance with present usage. Every effort shall be made to remediate sensitive areas (school yards, playgrounds, areas with highest lead concentrations, etc) first, and no trees or structures or large vegetation shall be removed.

Home Interior Inspection

During the excavation of each residential yard, an inspection of the interior of each home shall be conducted to identify possible sources of lead exposure.

The results and recommendations of each inspection shall be provided to the appropriate residents.

Dust Control Measures

During all excavation, transportation, and consolidation activities conducted as part of the remedy, dust control measures shall be implemented as necessary to prevent the generation of visible emissions during these activities.

RCRA-Compliant Multimedia Cap

After all materials have been transported to and consolidated with the Taracorp pile, the consolidated pile shall be graded and capped with a RCRA-compliant, multimedia cap. The cap shall be constructed as indicated in Figure 8 and shall meet or exceed the requirements of RCRA Subtitle C, and Illinois State law. The proposed construction does not lie within any floodway in the area.

Bottom Liner

With the exception of the existing Taracorp pile, a clay bottom liner shall be constructed on all areas upon which consolidated materials are to be placed as part of this remedy. Portions of this liner on Area 1 shall be constructed after Area 1 has been excavated to a 1000 ppm lead cleanup level.

Institutional Controls/Fencing

Institutional controls, such as site access restrictions, restrictive covenants, deed restrictions, and property transfer restrictions, shall be implemented for the properties which contain the expanded Taracorp pile to prohibit future development of the site and any activities that would in any way reduce the effectiveness of the cap in achieving remedial action goals.

The facility shall be fenced in a manner sufficient to prevent access to the expanded Taracorp pile. Warning signs shall be posed at 200-foot intervals along the fence advising that the area is hazardous due to chemicals in the waste materials and soils beneath the cap which may pose a risk to public health.

Groundwater Monitoring

A minimum of one upgradient and three downgradient deep wells shall be installed to monitor water quality in the lower portion of the upper aquifer. Monitoring of these wells and the 14 existing site wells shall be conducted semi-annually for a minimum of 30 years and analyses shall be performed for the full scan Hazardous Substance List organics and inorganics. After four sampling events, consideration shall be given to deleting parameters from the list which are below detection limits for all four events.

Air Monitoring

Air monitoring for lead and PM_{10} (particulate matter less than 10 microns) shall be performed annually at a minimum of two locations adjacent to the site for a minimum of 30 years.

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Cap Monitoring

For a minimum of 30 years, annual inspections of the cap shall be conducted to identify areas requiring repair. Appropriate maintenance shall be conducted immediately following the inspections.

Contingency Plans

Contingency Plans for air, groundwater and the cap/soil cover shall be developed to provide remedial action in the event that concentrations of contaminants in groundwater or lead or PM_{10} in air exceed applicable standards or established action levels or that waste materials have migrated to the surface or become releasable to the air in the future.

Other Contingency Measures

Contingency measures shall be established to provide for sampling and removal of any soils located within the zone of contamination established pursuant to the Soils Sampling/Inspection paragraph above with lead concentrations above 500 ppm which are presently capped by asphalt or other barriers but become exposed in the future due to land use changes or deterioration of the existing cap.

X. STATUTORY DETERMINATIONS

Based on the information available at this time, U.S. EPA and IEPA believe this alternative will satisfy statutory requirements to: protect human health and the environment, attain ARARs, be cost-effective, utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable.

Protectiveness

The selected remedy will be adequately protective of human health and the environment. Removal of soils and battery case materials in residential areas above 500 ppm lead, soils and waste materials in Area 1 above 1000 ppm, and battery case materials in alleys and driveways, and restoration through applications of sod, paving, etc. will eliminate direct contact with and inhalation of dust and lead contaminated soils and waste materials which may create a risk to human health and the environment. Inspection of the interiors of homes and providing residents with recommendations to minimize exposure to potential indoor contamination will add an additional measure of reduction of direct contact and inhalation of dust and contaminated soils. Consolidation of the SLLR pile and soils and waste materials removed from the excavations described above with the Taracorp pile and capping of the resulting, expanded Taracorp pile, or off-site disposal of the above mentioned soils and waste materials, will bring all contaminated materials to a central location and provide a barrier against direct contact and dust generation from the waste materials. The cap, along with the bottom liner to be constructed under all newly-created portions of the expanded Taracorp pile, will also provide a barrier against leaching of contaminants from the expanded Taracorp pile. Transporting EP toxic soils and battery case material from Venice, Eagle Park

Acres, and other nearby communities to a RCRA-compliant landfill or treating these soils prior to placement in the Taracorp pile will also provide proper management of these materials to provide a barrier against direct contact and dust generation and leaching of contaminants into the groundwater. Additional measures to prevent exposure to contaminated waste materials and soil included in the selected remedy are: site fencing and institutional controls; groundwater, air, and cap monitoring and associated contingency plans; and establishment of contingency measures to provide for appropriate disposal of soils within the zone of contamination with lead concentrations above 500 ppm. Removal of drums on the Taracorp pile will allow these waste materials to be recycled in a secondary lead smelter. Finally, a blood lead study will provide current, useful information to residents in the vicinity of the site with respect to any acute health effects that may be present due to exposure to the contaminated soils and waste materials at and around the site.

Attainment of Applicable or Relevant and Appropriate Requirements

The Superfund Amendments and Reauthorization Act (SARA) requires that remedial actions meet legally applicable or relevant and appropriate requirements of other environmental laws. These laws may include: the Toxic Substances Control Act, the Safe Drinking Water Act, the Clean Air Act, the Clean Water Act, the Resource Conservation and Recovery Act (RCRA), and any state law which has stricter requirements than the corresponding federal law.

A "legally applicable" requirement is one which would legally apply to the response action if that action were not taken pursuant to Section 104 or Section 106 of CERCLA. A "relevant and appropriate" requirement is one that, while not "applicable", is designed to apply to problems sufficiently similar that its application is appropriate.

In addition to ARARs, many Federal and state environmental and public health programs also develop criteria, policies, guidance, and proposed standards that are not legally applicable, but that may provide useful information or recommended procedures (referred to as "To Be Considered" criteria (TBC)). These guidance or policy documents may be considered and used as appropriate, where necessary to ensure protectiveness. If no ARARs address a particular situation, TBC policies, criteria or guidelines should be used to set cleanup targets.

ARARs and TBC criteria have been identified for the NL Site. Discussed below are the primary ARARs and TBC criteria and how the selected remedy complies with them.

- RCRA Subtitle C Cap

The State of Illinois has jurisdiction for RCRA Subtitle C, hazardous waste landfill operation and closure laws. This is covered by 35 IAC Part 724, standards for owners and operators of Hazardous Waste Treatment, Storage and Disposal Facilities. This regulation applies to owners or operators of waste piles that are closed with wastes left in place. The regulation seeks to minimize infiltration by specifying clay type and to promote drainage by

specifying sloping and topsoil requirements. Closure of the expanded Taracorp pile shall be conducted in accordance with 35 IAC Part 724, subpart N; Landfills. These requirements are ARARs for the capping of the expanded Taracorp pile.

- Lead, PM_{10}, and Fugitive Dust Emissions During and After Construction and Post-Construction Monitoring/Contingency Plan

The State of Illinois has jurisdiction for Ambient Air Quality Standards and Measurement Methods for Lead and PM_{10} and requirements for fugitive particulate matter. This is covered by 35 IAC Part 212, Subpart B for lead and PM_{10} and 35 IAC Part 212, subpart K for fugitive particulate matter. Construction activities and post-construction monitoring shall be conducted in a manner that will achieve compliance with these requirements, which are ARARs for these activities.

- Groundwater Contingency Plan Action Levels

The State Of Illinois General Use Water Quality Standards which are covered by 35 IAC Part 302, Subpart B, also apply to the groundwater at the NL site. Action levels for the Groundwater Contingency Plan shall be adopted from the Maximum Contaminant Levels (MCLs) and the General Use Water Quality Standards. Groundwater contingency plans will be triggered if concentrations of contaminants in the groundwater exceed action levels at the points of compliance.

- Soil Lead Cleanup Level

Due to the fact that there is no promulgated soil lead cleanup standard and that a complete quantitative risk assessment cannot be performed at this time (see Appendix B for detailed explanation), the September 7, 1989 "Interim Guidance on Establishing Soil Lead Cleanup Levels at Superfund Sites" is a TBC criteria for this site. This guidance basically recommends a residential soil total lead cleanup level at 500 to 1000 ppm. The selected remedy, which utilizes a 500 ppm residential soil cleanup level, complies with this guidance.

Cost Effectiveness

The selected remedy is implementable and provides the elimination of direct contact with and inhalation of soils and waste materials contaminated with lead at concentrations above levels which may present a risk to public health in a comparable or smaller time frame and cost than other alternatives which achieve this goal.

Utilization of Permanent Solutions and Alternative Treatment Technologies to the Maximum Extent Practicable

The selected remedy utilizes permanent solutions and alternative treatment technologies to the maximum extent practicable, in that it would remove contaminated soils and waste materials from areas where maximum human exposure would occur and provide recycling of the Taracorp drums. Due to the nature of contaminated waste materials in the Taracorp pile and SLLR piles, the

relatively low concentrations of lead in the contaminated soils, and the lack of downgradient groundwater contamination at the site, this remedy represents the maximum extent to which permanent solutions and treatment can be practicably utilized.

Preference for Treatment as a Principle Element

The selected remedy satisfies the statutory preference for remedies that employ treatment that achieves substantial risk reduction through recycling of the Taracorp drums and by providing safe management of waste materials and soils that will be consolidated and remain at the site.

No treatment is provided for the Taracorp pile and SLIR piles because, although treatment has been provided for lead contaminated soils and certain lead waste materials at other Superfund sites, the quantity, nature, and physical condition of waste materials in the Taracorp pile create a situation where very little volume reduction can be achieved, stabilization is not feasible, and treatment will create a significant potential risk to workers and the community during implementation but will not achieve an appreciable volume reduction or reduction in mobility. The soils and battery case materials from residential areas and alleys and driveways to be consolidated with the Taracorp pile will not be EP toxic for lead. This, in conjunction with the fact that no downgradient groundwater contamination has been detected at the site, make treatment of these materials unnecessary and impractical. Soils and battery case materials which are EP toxic for lead will be treated prior to consolidation with the Taracorp pile or will be disposed off-site. However, because this remedy will result in hazardous substances remaining on-site above health-based levels (the expanded Taracorp pile), a review will be conducted every five years after commencement of remedial action to ensure that the remedy continues to provide adequate protection of human health and the environment. The monitoring and contingency plans provided in the remedy will help to achieve this goal.

FIGURE 1

NL INDUSTRIES
GRANITE CITY SITE
GRANITE CITY, ILLINOIS

LOCATION MAP

■ - PROJECT SITE

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SCALE

Figure 8
Multimedia Cap Detail

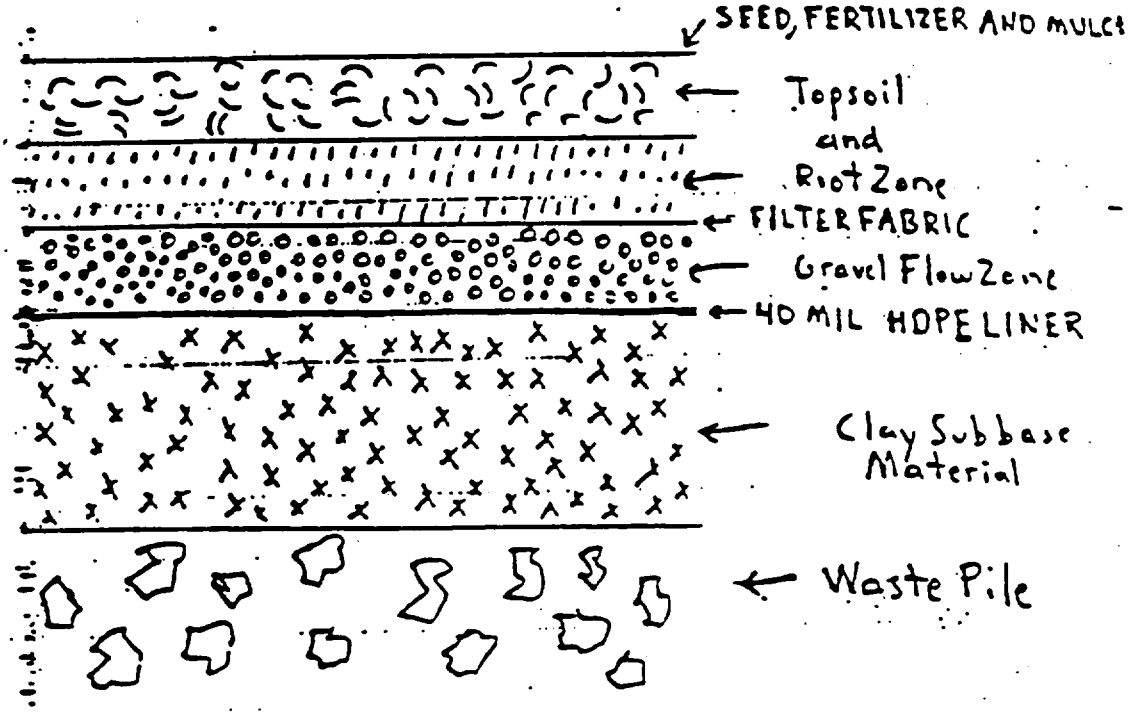
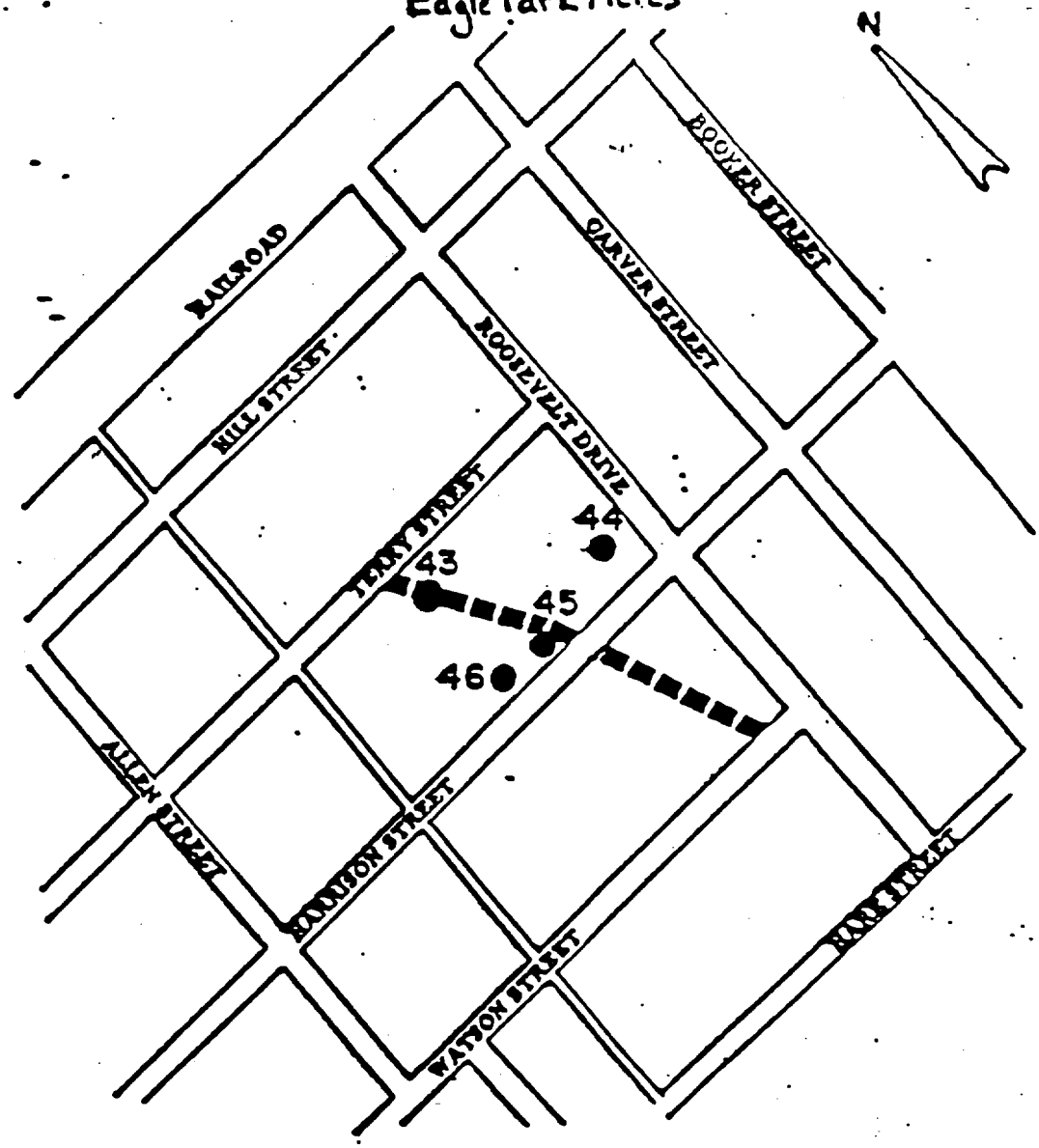


Figure 6
Estimated Areas of Contamination
Eagle Park Acres



REMOTE FILL AREA

EAGLE PARK ACRES

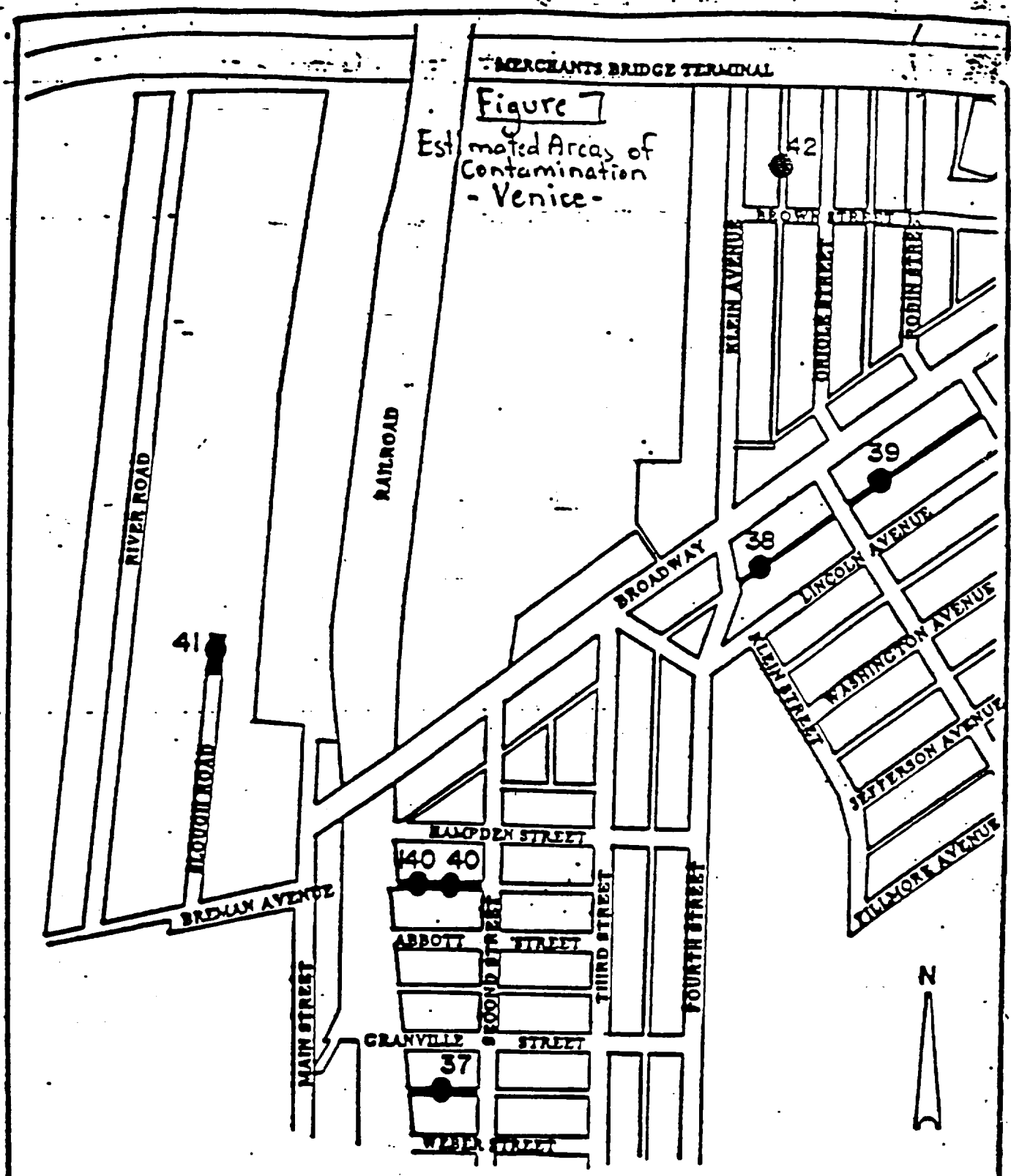
LEGEND

● SOIL SAMPLE LOCATION

■■■ APPROXIMATE LOCATION OF DITCH

SCALE

A-31



REMOTE FILL AREA

VENICE

LEGEND

● SOIL SAMPLE LOCATION

PROPOSED REMEDIATION SITES

SCALE

A-32

Site Plan - Waste Pile

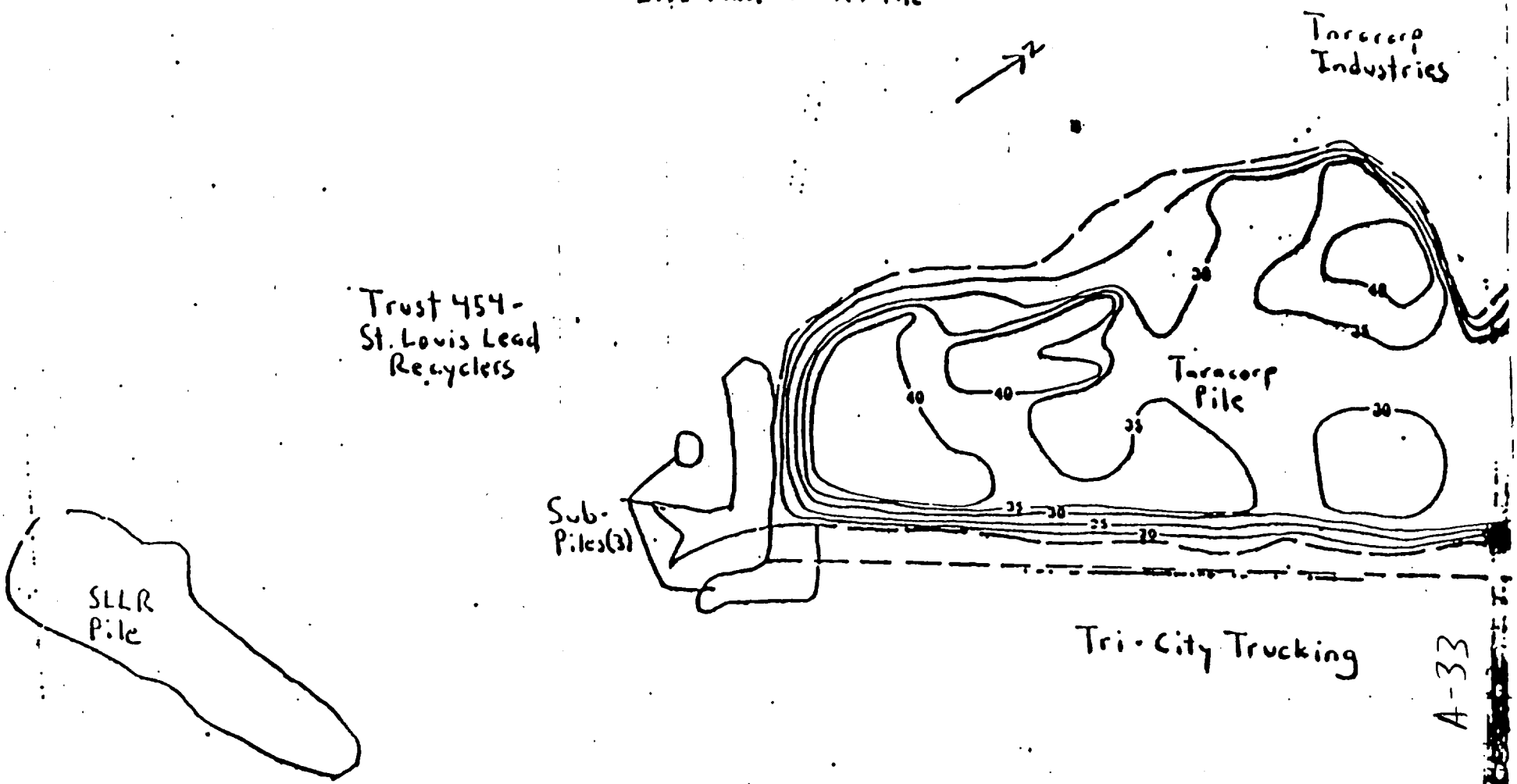
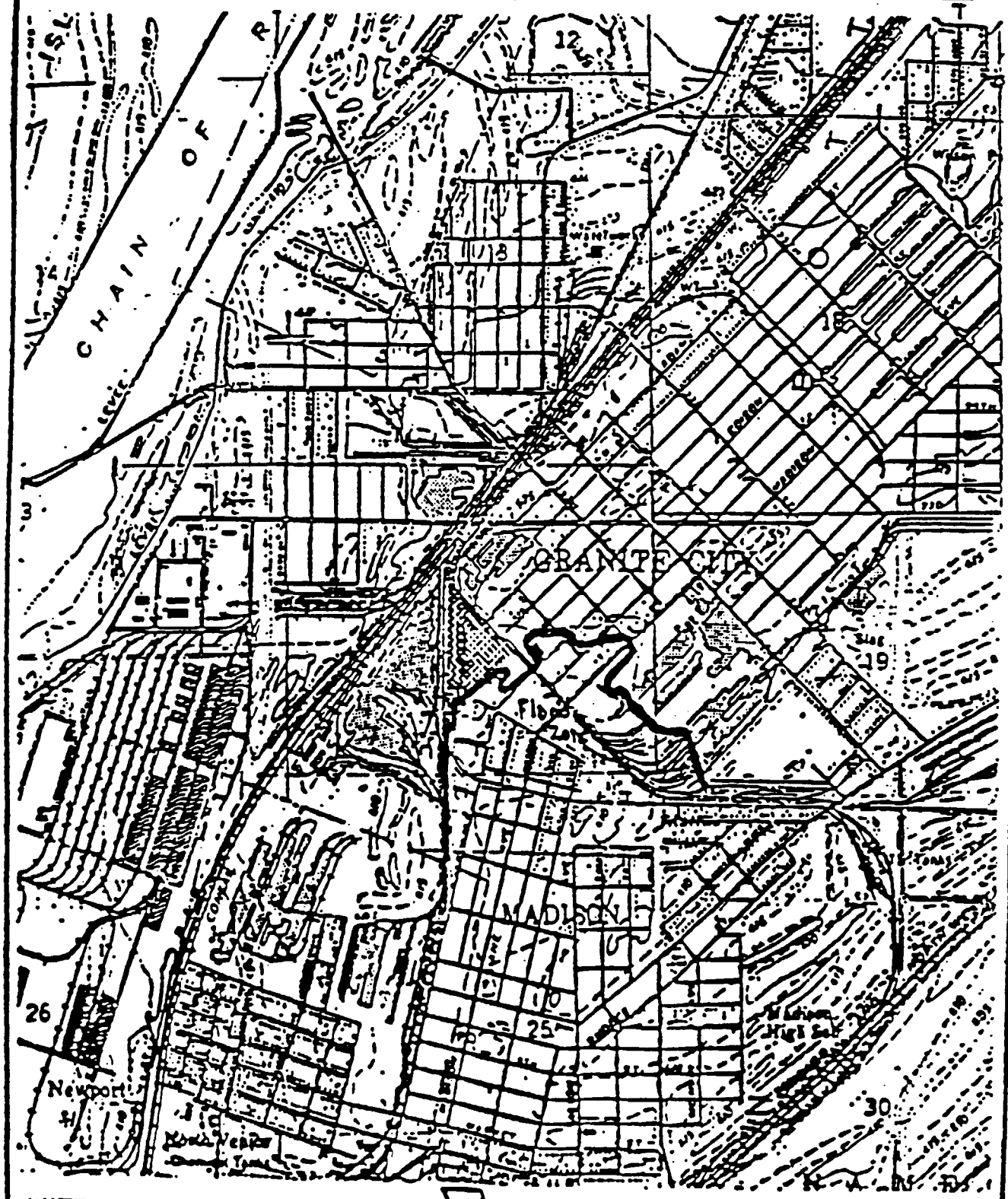


Figure 3

NL INDUSTRIES
GRANITE CITY SITE
GRANITE CITY, ILLINOIS
Flood Plain in the
Vicinity of the Site



- PROJECT SITE
- FLOOD PLAIN BOUNDARY

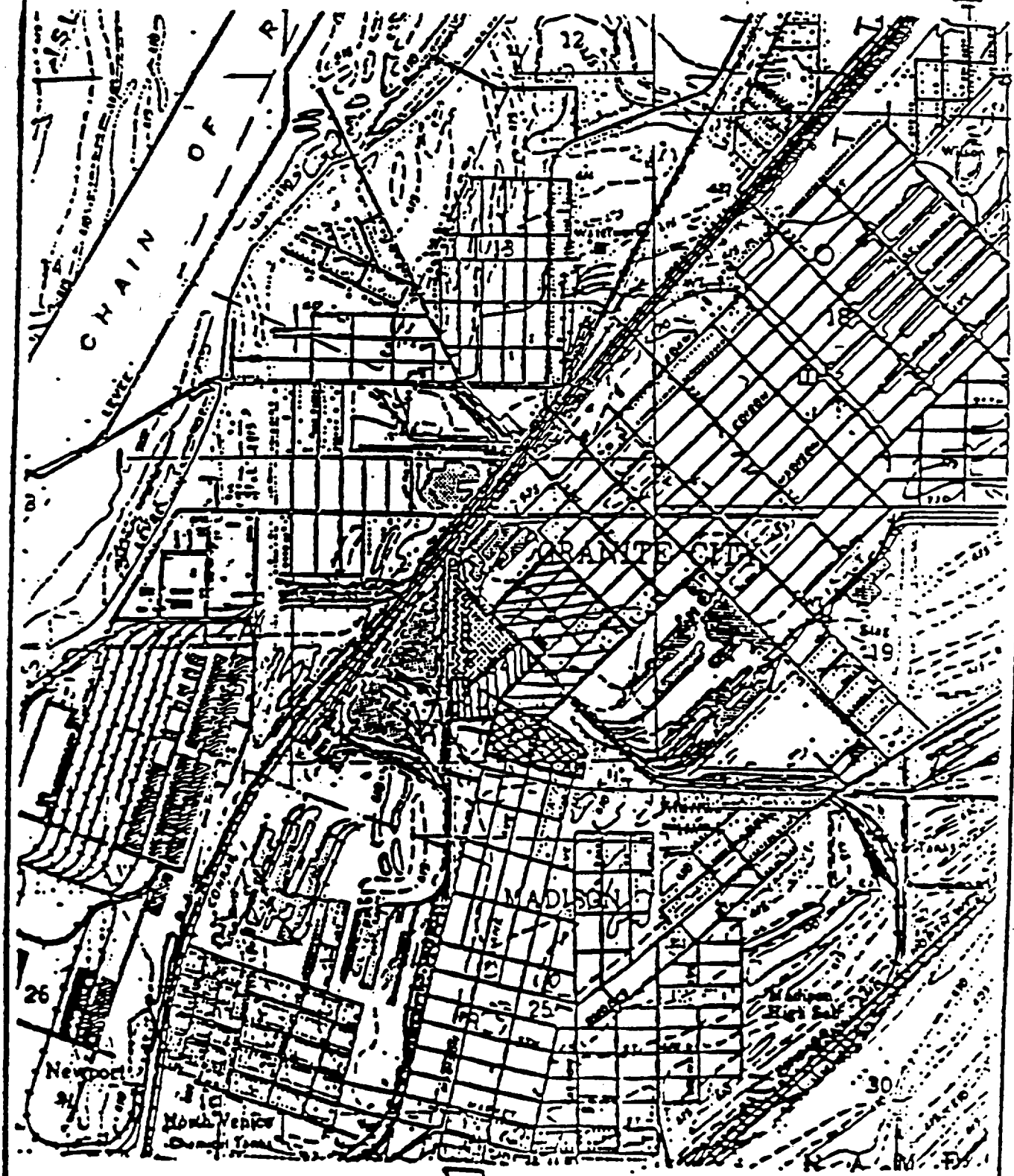
A-34

SCALE

Figure 4

GRANITE CITY SITE
GRANITE CITY, ILLINOIS

Areas 1, 2, and 3



- PROJECT SITE -Area 2

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SCALE

Figure 5

NL INDUSTRIES
GRANITE CITY SITE
GRANITE CITY, ILLINOIS
Estimated Areas of Lead Contamination
Above 500 ppm

MEMORANDUM

SUBJECT: Request for Concurrence on the Decision Document/Explanation of Significant Differences for the NL Industries/Taracorp Site in Granite City, Illinois

FROM: William Muno, Director
Waste Management Division

Gail Ginsberg, Regional Counsel
Office of Regional Counsel

TO: Valdas V. Adamkus
Regional Administrator

By this memorandum we are recommending that you authorize the retention of the 500 parts per million cleanup level for lead in residential soils and capping of the Taracorp pile, and the changes in the remedial action with respect to the ground water and the remote fill areas at the NL Industries/Taracorp site by executing the attached Decision Document(DD)/Explanation of Significant Differences (ESD).

This DD/ESD was prepared in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act, 42 U.S.C. 9601 et seq., the National Contingency Plan (40 CFR Part 300), and Agency Policy. We have reviewed the attached documents and have concluded that the DD/ESD is both legally and technically sufficient. As such, we believe that the implementation of the remedial measures is a proper exercise of your delegated authority.

Please feel free to contact either one of us should you have any questions.

Concur

Valdas V. Adamkus
Regional Administrator

9/29/96
Date

Not Concur

Valdas V. Adamkus
Regional Administrator

Date

INTRODUCTION

The purpose of this document is to provide a brief background for the NL Industries Site (NL Site or the Site), and explain which remedial activities will remain the same and which will differ from the Remedial Action (RA) selected by the United States Environmental Protection Agency (U.S. EPA) in the Record of Decision (ROD) signed on March 30, 1990.

The U.S. EPA is issuing this Decision Document to reaffirm its decision regarding the residential soil cleanup level and capping of the Taracorp pile. Because U.S. EPA has determined that there will be no change to the residential soil cleanup level and capping of the Taracorp pile in the March 1990 ROD, the U.S. EPA is not issuing a ROD amendment or an ESD for these portions of the remedy as described in the March 1990 ROD.

The U.S. EPA is issuing an ESD, in accordance with Section 117(c) of the Comprehensive Environmental Response, Compensation, and Liability Act, as amended (CERCLA), and consistent with Section 300.435(c)(2)(i) of the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), because the changes to the ground water and remote fill portions of remedy as described in the March 1990 ROD constitute a significant change to the remedy.

This presents U.S. EPA's Decision Document (DD)/Explanation of Significant Difference (ESD) for the Remedial Action at the NL Site. This document combines the results of U.S. EPA's re-analysis of the 500 parts per million residential soil lead cleanup level conducted pursuant to an in court agreed public comment period which occurred from October 14, 1994 through January 13, 1995, with U.S. EPA's re-analysis of the remedy for the Taracorp pile and associated ground water contamination and additional remote fill areas pursuant to a second public comment period which occurred from February 17, 1995 through April 19, 1995.

This DD/ESD and corresponding documents will become part of the NL Site's administrative record file and are available for public review. The administrative record is available at the following locations:

Granite City Public Library
2001 Delmar Avenue
Granite City, Illinois 62040

U.S. Environmental Protection Agency
Region V Records Center
77 W. Jackson Blvd. (7HJ)
Chicago, Illinois 60604

phone: (312) 886-0900

The administrative record index for this DD/ESD is included as Attachment 1.

SUMMARY OF SITE HISTORY, CONTAMINATION, AND SELECTED REMEDY

The NL Site, located in Granite City, Madison (including Eagle Park Acres), and Venice, Illinois, is the location of a former secondary lead smelting facility. Metal refining, fabricating, and associated activities have been conducted at the Site since the turn of the century. From 1903 to 1983, secondary lead smelting occurred on-site. Secondary lead smelting operations were discontinued during 1983 and the equipment dismantled. Taracorp Industries, the current owner of the main industrial site, purchased the property from NL Industries, Inc., in 1979.

In July of 1981, St. Louis Lead Recyclers, Inc. (SLLR) began using equipment on adjacent property owned by Trust 454 to separate components of the Taracorp pile. SLLR attempted to recycle lead-bearing materials to the furnaces at Taracorp and send hard rubber and plastic off-site for recycling. SLLR continued operations until March 1983 when it shut down its equipment. Residual lead-bearing waste materials from the operation remain on Trust 454 property, as does some equipment.

A State Implementation Plan for Granite City was published in September 1983 by the Illinois Environmental Protection Agency (IEPA). The IEPA's Report indicated that the nonattainment status for lead air emissions in Granite City was in large part attributable to emissions associated with the operation of the secondary lead smelter operated by Taracorp and lead reclamation activities conducted by SLLR. The IEPA negotiated Administrative Orders by Consent with Taracorp, St. Louis Lead Recyclers Inc., Stackorp, Inc., Tri-City Truck Plaza, Inc., and Trust 454 during March 1984. The Orders required the implementation of remedial activities relative to the air quality. Taracorp subsequently closed its smelting operations.

The NL Site was listed on the National Priorities List, 40 C.F.R. Part 300 (NPL), on June 10, 1986. NL, as former owner of the Site, voluntarily entered into an Agreement and Administrative Order by Consent with the U.S. EPA and IEPA in May 1985 to implement a Remedial Investigation and Feasibility Study (RI/FS). The RI/FS was completed in January 1990.

The RI for the NL Site indicated the need to prevent direct contact with and inhalation of lead-contaminated soils and waste materials in the Taracorp pile, the SLLR piles, and the main industrial site; residential soils contaminated by lead fallout from the smelter stack; and battery case material used as fill material for alleys, driveways, and other areas. Additionally,

the RI indicated a need for further ground water monitoring in the deeper zone of the upper aquifer and a mechanism for remediation of any contaminants in the ground water that are detected in concentrations that would present an endangerment to public health and the environment.

Different alternatives to address Site contamination were evaluated in the NL Feasibility Study and Addendum, and after detailed analysis of the alternatives, a Proposed Plan was issued. After taking into consideration all public comments, the Regional Administrator signed a Record of Decision ("ROD") on March 30, 1990. The cleanup decision is embodied in the ROD. The remedy specified therein consisted of the following components:

- Installation of an upgraded security fence around the expanded Taracorp pile.
- Deed Restrictions and other institutional controls to prevent access to the Taracorp pile.
- Performance of soil lead sampling to determine which areas must be excavated and the extent of the excavation.
- Inspection of alleys and driveways and areas containing surficial battery case material in Venice, Eagle Park Acres, Granite City, Madison and any other nearby communities to determine whether additional areas not identified in the Feasibility Study must be remediated as described below.
- Performance of blood lead sampling to provide the community with current data on potential acute health effects associated with Site contamination.
- Installation of a minimum of one upgradient and three downgradient deep wells, monitoring of ground water and air, and inspection and maintenance of the cap.
- Removal and recovery of all drums on the Taracorp pile at a secondary lead smelter.
- Consolidation of waste contained in adjacent St. Louis Lead Recyclers piles with the Taracorp pile.
- Excavation and consolidation with the Taracorp pile or off-Site disposal of battery case material from all applicable alleys and driveways in Granite City, Madison, and Venice, Illinois, and any other nearby communities.

- Excavation and consolidation with the Taracorp pile of all unpaved portions of the adjacent Trust 454, Rich Oil, and BV&G Transport properties with lead concentrations greater than 1000 ppm.

- Excavation and consolidation with the Taracorp pile or off-Site disposal of all residential soils and battery case materials in Granite City, Madison, and Venice, Illinois, and any other nearby communities with lead concentrations greater than 500 ppm.

- Inspection of the interiors of homes on property to be excavated to identify possible additional sources of lead exposure and recommend appropriate actions to minimize exposure.

- Implementation of dust control measures during all remedial construction activities.

- Construction of a RCRA-compliant, multi-media cap over the expanded Taracorp pile and a clay liner under all newly-created portions of the expanded Taracorp pile.

- Development of contingency plans to provide remedial action in the event that the concentration of contaminants in ground water or air (lead or PM_{10} (particulate matter greater than 10 microns)) exceed applicable standards or established action levels, or that waste materials or soils have become releasable to the air in the future.

- Development of contingency measures to provide for sampling and removal of any soils within the zone of contamination described by the soil lead sampling to be implemented above with lead concentrations above 500 ppm which are presently capped by asphalt or other barriers but become exposed in the future due to land use changes or deterioration of the existing use.

Following unsuccessful efforts to negotiate a settlement with the Potentially Responsible Parties (PRPs) for remedy implementation, U.S. EPA, on November 27, 1990, issued an administrative order, pursuant to Section 106 of CERCLA, 42 U.S.C. § 9606, directing certain PRPs to undertake the response actions identified in the ROD. In issuing this Order, U.S. EPA made a number of findings based on the administrative record for the Order before it, including a finding that the release and threat of release of hazardous substances from the facilities at the NL Site is or may be presenting an imminent and substantial endangerment to the public health or welfare or the environment.

None of the recipients of the Order notified U.S. EPA of its intention to comply fully with the Order. In view of the failure or refusal of PRPs to comply with the November 27, 1990, Administrative Order, U.S. EPA decided to use Superfund money to proceed with implementation of the remedy selected in the ROD.

The U.S. EPA has brought an action in Federal Court to compel certain PRPs to perform the Site remedy and to collect penalties for their failure to comply with the 1990 Administrative Order.

U.S. EPA has commenced the Remedial Design (RD) for the NL Site and has conducted early actions to remediate the contaminated residential soil, beginning with the areas of greatest contamination first, and the highly lead-contaminated battery case material that was used as fill material.

Two revised decision documents termed "Explanation of Significant Differences" (ESDs) have preceded this Decision Document and Explanation of Significant Differences (DD/ESD). The first ESD, signed on May 7, 1993, allowed for battery case material that was contaminated with greater than 500 ppm lead but was not hazardous per the Toxic Characteristic Leaching Procedure (TCLP) test found at 40 CFR 261 Appendix II-Method 1311, to be disposed of at an off-site landfill rather than consolidated with the Taracorp pile, as originally specified in the 1990 ROD. The second ESD, signed on January 27, 1994, allowed for disposal of residential soils contaminated with greater than 500 ppm lead and that are not hazardous per the TCLP test at an off-site landfill rather than consolidated with the Taracorp pile, as originally specified in the 1990 ROD.

As a result of an action brought by certain PRPs and the City of Granite City to enjoin U.S. EPA from conducting the remedy, U.S. EPA agreed to reopen the public comment period for the residential soil cleanup level to allow for U.S. EPA's evaluation of all information that has become available subsequent to the March 30, 1990 ROD. Accordingly, U.S. EPA released a Proposed Plan and reopened the public comment period for the residential soil lead cleanup level on October 14, 1994. The proposed plan reaffirmed the 500 ppm residential lead soil cleanup level. Public meetings were held on this matter on October 25 and 26, 1994. The Responsiveness Summary addressing comments received during this comment period comprises Attachment 2 to this DD/ESD. Additional provisions contained in the Proposed Plan that were not in the 1990 ROD were to make a High Efficiency Particulate Arrester (HEPA) vacuum available to residents in the cleanup zone for interior house dust cleaning, and to remediate a truck lot at 1420 State Street to prevent possible lead recontamination of nearby residential properties.

During U.S. EPA's remediation of battery case material, which commenced in the spring of 1993, numerous additional battery case

locations were discovered. It is currently estimated that over 100 such locations exist with lead concentrations exceeding 500 ppm. Given this tremendous increase (1990 ROD cost estimates were based on 18 locations) in volume of battery case material to be remediated, U.S. EPA decided to reevaluate the excavation and disposal remedy for the battery case material contained in the 1990 ROD and the subsequent 1993 ESD. The Proposed Plan for the battery case material was combined with that for the Taracorp pile and associated ground water contamination, which is discussed below.

Starting in mid-1992, U.S. EPA changed its sampling protocols for groundwater collection from the monitoring wells on the main industrial area based upon current sampling protocols. The new protocols better characterize ground water contamination.

The results of this sampling and subsequent sampling indicate that ground water downgradient from the waste pile contains among other things, lead levels that greatly exceeded the federal and state drinking water standards.

As a result, U.S. EPA reevaluated the remedy for the Taracorp pile, selected in the 1990 ROD. U.S. EPA also evaluated alternatives for remediation of the contaminated ground water. After conducting some additional studies in late 1994 regarding the treatability of the Taracorp pile and the likely success of some dust suppression techniques during excavation/grading of the pile, U.S. EPA released a Proposed Plan for the Taracorp pile, the ground water, and the additional remote fill areas on February 17, 1995. A public meeting on this matter was held on March 6, 1995. The Responsiveness Summary addressing comments received during this comment period comprises Attachment 3 to this DD/ESD.

In the February 17, 1995 Proposed Plan, the following 5 alternatives were evaluated for addressing the Taracorp pile and contaminated solid materials at the Main Industrial Area:

1) Alternative M-A: Capping of the Taracorp Pile per the 1990 ROD;
2) Alternative M-B: Source Removal to On-Site Landfill and On-Site Treatment of Material Characterized as Hazardous Waste;
3) Alternative M-C1: Source Removal to Off-Site Landfill and Off-Site Treatment of Hazardous Waste;
4) Alternative M-C2: Source Removal to Off-Site Landfill and On-Site Treatment of Hazardous Waste; and
5) Alternative M-D: Source Removal with On-Site Sorting and Treatment, Off-Site Recycling, and On- or Off-Site Disposal.

U.S. EPA has chosen to retain the capping remedy (Alternative M-A) outlined in the 1990 ROD. The bases for this decision are

outlined below.

In the February 17, 1995 Proposed Plan, the following 2 alternatives were evaluated for addressing the remaining Remote Fill Areas:

1) Alternative RF-A: Removing Remote Fill from Residential Areas, Treating Remote Fill Characterized as Hazardous, and Capping Remote Fill in Alleys and Driveways; and
2) Alternative RF-B: Removing Remote Fill from All Remote Fill Areas to On- or Off-Site Landfill and Treating Remote Fill Characterized as Hazardous per the 1990 ROD.

U.S. EPA has chosen to remediate the remaining remote fill areas with lead concentrations greater than 500 ppm and with paving uses (alleys, driveways, parking lots) by paving over these areas instead of excavation and off-site disposal, as originally specified in the 1990 ROD and the 1993 ESD. The bases for this decision are outlined below.

In the February 17, 1995 Proposed Plan, the following 3 alternatives were evaluated for addressing the ground water contamination:

1) Alternative G-A: Monitoring/Natural Attenuation;
2) Alternative G-B: Ground Water Containment by Pumping and Disposing into the Local Publicly-Owned Treatment Works (POTW), and Monitoring and Natural Attenuation in the Remote Fill Areas; and
3) Alternative G-C: Ground Water Containment Through a Combination of Installing a Slurry wall and Pumping and Disposing into the Local POTW, and Monitoring and Natural Attenuation in the Remote Fill Areas.

U.S. EPA has chosen to contain the ground water contamination at the Site through pumping, treatment, and discharge to the local Publicly Owned Treatment Works. The bases for this decision are outlined below.

STATEMENT OF BASES FOR RETENTION OF THE 500 PPM RESIDENTIAL SOIL CLEANUP LEVEL AND THE CAPPING REMEDY FOR THE TARACORP PILE

A. Residential Soil Cleanup Level

The March 1990 ROD specified a 500 ppm cleanup level for lead in residential soil, based on the information in the administrative record at the time. Based on all of the information in the administrative record, including new information received after March 1990, U.S. EPA retains the 500 ppm cleanup level for lead in residential soil. EPA made its decision to retain the 500 ppm

cleanup level by using the nine criteria as required by CERCLA and the NCP, by evaluating the cleanup options based on all the available information and studies, guidance, and by studying the risks at the Site by using a computer model. The computer model is known as the Integrated Exposure Uptake Biokinetic (IEUBK) Model for lead in children, version .99d, designed to predict risks from lead. This was used in conjunction with the data available from the 1991 Illinois Department of Public Health (IDPH) blood study. The 1991 IDPH blood study supports retaining the 500 ppm residential soil lead cleanup level.

The bases for this decision are provided in Attachment 4 to this DD/ESD and are summarized below:

1. Consistent with the July 14, 1994 "Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities" ("July 1994 Guidance"), U.S. EPA has taken and will continue to take a "global" or multi-media approach to addressing the lead contamination at the NL Site. The primary sources of lead at the Site are interior dust and soil. The dust and the soil are the primary exposure pathways of lead to the children in the vicinity of the Site. In addition, soil lead is the primary contributor to interior dust lead in the vicinity of the NL/Taracorp smelter. U.S. EPA's cleanup goal is to limit exposure to lead such that a typical pregnant woman or child or group of similarly exposed children would have an estimated risk of no greater than 5% probability of exceeding a blood lead level of 10 ug/dl. 10 ug/dl is a level of concern for increased potential of health risks. The level of concern is for a population's blood lead levels and not meant to imply that it is a threshold for an individual's lead-induced effects. The level of concern is a scientific judgement that may have important public health implications, but not meant to imply the biological effects do not occur at lower level of exposure. In conjunction with evaluating studies and reports in the Administrative Record, U.S. EPA used the IEUBK Model to determine the appropriate soil lead cleanup level. The IEUBK Model is designed to predict blood lead concentrations for children given various concentrations of lead in the environment. Running the IEUBK Model using both site specific data as well as data compiled from comparable smelter sites (known as "default" values in the IEUBK Model) yielded a range of protective residential soil lead cleanup levels from 340 ppm to 480 ppm.

2. Using the nine criteria as required by CERCLA and the NCP, U.S. EPA selected a soil lead cleanup level for the Site of 500 ppm. Although this cleanup level is

slightly higher than the range determined from use of the IEUBK Model, this cleanup level is fully protective. First, 500 ppm is a rounded value which represents the high end of the protective soil lead values predicted from the model using site-specific values instead of default values. Second, the IDPH blood study, even with its inherent limitations, indicates that soil lead levels in excess of 500 ppm can be associated with unacceptably high blood lead concentrations in the community. Third, based upon rough cost estimates, lowering the residential soil cleanup level from 500 to 400 ppm will cost approximately 45 to 55% more, and, hence, may be considered less cost effective.

3. Additional measures will be taken beyond soil remediation to 500 ppm lead to assure that the selected remedy is protective. These additional measures are:

a. Continue to work with IDPH and other agencies to address interior and exterior lead-based paint at residences where soil remediation is required. In all instances, every effort will be made to address deteriorating exterior lead-based paint prior to soil remediation in order to prevent recontamination of the soil and thus protect the remedy. These concerns were expressed in comments received during the public comment period, and this procedure was followed by U.S. EPA during previous remediations of residential soils at the NL Site;

b. Encourage the local community to work with local health providers to implement an ongoing lead exposure reduction program;

c. Provide a HEPA vacuum and proper training in its operation to residents whose yards are remediated in order to clean up interior house dust; and

d. Remediate the truck lot at 1420 State Street to prevent possible lead recontamination of nearby residential properties. Additionally, U.S. EPA will inspect other areas in the immediate vicinity of the main industrial area to identify and remediate, if necessary, any additional significant sources of lead dust.

Consistent with the consensus of the experts for the City of Granite City, the PRPs, and U.S. EPA, residential soil remediation will have long-term benefits (years) for the community, including future residents, and may have short-

term benefits (months) for the current residents.

B. Capping the Taracorp Pile

The discovery of ground water contamination exceeding federal and state drinking water standards associated with the Taracorp pile prompted a re-examination of the capping remedy for the Taracorp pile that was selected in the 1990 ROD. After conducting a supplemental Feasibility Study and several additional studies regarding the treatability of the Taracorp pile and likelihood of success of conventional dust suppression methods during excavation of the Taracorp pile, U.S. EPA has chosen to retain the capping remedy outlined in the 1990 ROD.

The bases for this decision are as follows:

1. The cost differential between capping and the least expensive pile removal alternative is approximately $30 million;

2. Conventional dust suppression methods did not control lead dust to acceptable levels during test trenching in the Taracorp pile; therefore, a more sophisticated system of dust suppression will likely be needed to achieve the National Ambient Quality Standard for lead during pile remediation. Given this factor, capping is the preferred alternative, involving the least potential for dust generation;

3. Once implemented, capping of the pile will be essentially equal to removal in terms of prevention of direct contact with and inhalation of contaminants from the Taracorp pile;

4. Although removal of the Taracorp pile will provide superior protection to capping in terms of reduction of ground water contamination, capping of the pile will greatly reduce infiltration and leaching of contaminants from the pile; and

5. There are no known drinking water users of ground water downgradient from the Taracorp pile/main industrial area of the Site. Illinois EPA and U.S. EPA conducted extensive surveys to verify this fact. Drinking water in the area of the Site is obtained from the Mississippi River.

   At this site, the additional $30 million for removal of the Taracorp pile will only increase the potential for generation of dust during its implementation, and thus possible recontamination of remediated residential

yards near the pile. Second, the cap will greatly reduce groundwater contaminimation due to significant reduction of infiltration and leaching through the pile. Hence, little additional benefit would be realized from removal of the Taracorp pile as opposed to capping of the pile.

The liner, without a leachate collection system, under the newly expanded portions of the Taracorp pile will be retained from the 1990 ROD. The liner will retard contamination from entering the ground water, and the cap will retard infiltration through the waste material. Since the Taracorp pile extends up to ten feet below grade, the cap alone may not serve as a full containment system. Accordingly, the ground water collection system will serve the purpose of a leachate collection system. Additionally, in response to public comments regarding the effectiveness of the ground water containment system, a contingency plan is being added to the ground water remedy to require a reevaluation of the ground water remedy and further remedial action, if necessary, in the event that the cap is not effective in allowing the ground water standards to be attained via attenuation in a reasonable period of time.

SUMMARY OF ANALYSIS OF NINE EVALUATION CRITERIA

The following evaluation of the nine criteria conducted pursuant to the NCP supports U.S. EPA's determination that the 500 ppm residential soil lead cleanup and the capping of the Taracorp pile are appropriate remedial actions.

1) Overall Protection of Human Health and the Environment

Levels of protectiveness for the residential soils were selected by using the IEUBK model and evaluation of the nine criteria in accordance with the NCP and CERCLA and are based on a site-specific analysis of the data for Granite City and surrounding communities, including consideration of the results of a blood study conducted in the site area by the Illinois Department of Public Health. The 500 parts per million cleanup level for lead in residential soil will eliminate inhalation and ingestion of lead in soil at concentrations above levels which may present a risk to public health.

Regarding the Taracorp pile, capping will effectively eliminate inhalation and ingestion of lead from waste materials in the pile. Once implemented, capping will also eliminate the generation of lead dust from the pile. Further, capping will significantly reduce the amount of water infiltration into the pile and, thus, the amount of leachate generated from the pile. The liner under the newly generated portions of the capped pile, or cell, will also greatly reduce the impact of the contaminants from the pile to site ground water.

2) Compliance with State and Federal Regulations (ARARS)

There are no specific Applicable or Relevant and Appropriate Regulations (ARARs) for lead in residential soil (CERCLA Section 121, 42 USC 9621, and the NCP). The 500 ppm lead cleanup level for residential soil, and provisions to provide a HEPA vacuum to residents and to address paint contamination within the site area, were selected by using site-specific factors, the IEUBK model and evaluation of the nine criteria in accordance with the NCP and CERCLA.

The cap for the Taracorp pile will comply with all applicable Resource Conservation and Recovery Act requirements, and dust control measures will be implemented during remedial activities to within the National Ambient Air Quality Standards and to prevent recontamination.

The SLLR pile and the associated contaminated soils from the industrial area will be consolidated with the Taracorp pile. Because the SLLR pile and the contaminated soils comprise continuous zone of contamination created by site operations, the newly created portion of the Taracorp pile is not a new unit subject to full RCRA regulation pursuant to 40 CFR Subpart L for Waste Piles or Subpart N for Landfills.

Both the Taracorp pile and the cell will utilize a RCRA-compliant Subtitle C cap to reduce the direct contact/ingestion threat, air emissions and infiltration of water through the waste material to protect the groundwater, and the newly created portions will be provided with a liner for additional protection against leaching and as a barrier to further protect the groundwater.
Proper long-term operation and maintenance of the pile will be instituted.

The ground water extraction system to be placed near the pile will serve as a "leachate collection system", to collect contaminated leachate emanating from the pile, and newly created portions of the pile. Groundwater monitoring in the area will serve to evaluate the remedial action and verify the effectiveness of the collection system. A contingency plan will provide for reevaluation and, if necessary, further remedial action for the ground water in the event that the cap is ineffective in reducing the quantity of leachate to levels that will allow the ground water cleanup standards to be achieved within a reasonable period of time.

Institutional controls such as site access restrictions, restrictive covenants, deed restrictions and property transfer restrictions will be implemented for the industrial area to assure that the remedy is effective.

It is impracticable to retrofit the more highly contaminated

existing pile with either a liner or leachate collection system, and the newly expanded portions will add very little to the existing potential for leachate generation since U.S. EPA is planning on putting waste material with much lower average lead concentration in a cell next to the existing Taracorp pile which has a much higher lead concentration. As stated above, there will be a liner under the cell. However, there will be no liner under the Taracorp pile because the pile is large, very dense and some of the waste is below grade; hence, it would be impossible to place a liner and leachate collection system under the existing Taracorp pile without physically moving it. As described below, it would not be cost effective to move the pile. Movement of the pile would also increase the potential to generate dust and recontaminate nearby residential properties.

3) Reduction of Toxicity, Mobility, or Volume Through Treatment

The selected remedy does not call for treatment of the residential soils or the waste materials in the Taracorp pile. However, cleaning up residential soils to 500 ppm lead will eliminate the toxicity, mobility and volume of lead-contaminated soils which pose an unacceptable health risk to children in the site area. Likewise, the cap on the Taracorp pile will reduce the mobility of the lead in the Taracorp pile by providing a barrier to both infiltration into and release of lead dust from the pile.

4) Short-Term Effectiveness

Residential soil remediation will have short-term benefits (i.e., months) for the current residents. The removal of the most highly lead contaminated soils first will eliminate the exposure of children to lead in residential soil at the site at concentrations that pose the highest health risk to children. U.S. EPA presence in the community has had a positive impact with respect to making residents aware of the dangers of lead.

Implementation of the residential soil cleanup will create the potential for releases of lead dust to the air on the very short term. This potential will be eliminated by the use of effective dust control measures. These measures have already been effective during the remediation of approximately 50 residences which have been completed thus far. Air monitoring results during these cleanups have indicated that lead air emissions were well within the applicable standards on every occasion.

Residential soil cleanup will also slightly increase truck traffic and therefore create the potential for increased traffic related accidents on the very short term. This potential increase is not significant given that Granite City has considerable truck traffic in the site vicinity due to many currently operating industries, including a large steel mill. In

addition, procedures in place during the cleanup of approximately 50 residences completed to date have resulted in zero traffic-related accidents. These procedures will continue to be implemented during remaining residential soil cleanup activities.

Placing of the cap on the Taracorp pile along with pre-capping grading activities will create the potential for dust generation and runoff from the pile. Runoff will not be a significant problem since site runoff pools in low spots and does not leave the site.

Dust generation is of great importance to U.S. EPA, and dust control measures will be implemented to control dust emissions to acceptable levels, both for attainment of ARARs and to prevent recontamination of nearby residences which have already been cleaned up to 500 ppm lead. If initial dust control measures, such as wetting with water, are not effective, work will be halted and more sophisticated measures will be taken. It should be noted that the potential for dust generation is much less for capping the pile than for the pile removal/recycling options researched in the Second Addendum to the Feasibility Study.

5) Long-Term Effectiveness

The residential soil and pile remediation will have long-term benefits (i.e., years) for the community, including future residents. Both the residential soil cleanup and capping of the Taracorp pile will be effective in the long-term because removing soil in excess of 500 ppm will permanently address the exposure of children to lead in residential soil at the site at concentrations that pose a health risk and capping the pile, along with the required operation and maintenance of the cap, will prevent the generation of airborne lead from the pile and ingestion of lead in the pile and will significantly reduce the infiltration into, and thus the leaching of lead from, the pile. This, in conjunction with the ground water remedy described below, will provide an effective long-term remedy for site ground water contamination.

6) Implementability

The residential soil cleanup and capping remedies both utilize proven technologies that are readily implementable.

7) Cost

The cost of cleaning up to 500 ppm amounts to remediating approximately 1300 residences. The cost estimates range from $15,000,000 to $42,000,000. The higher cost estimate is based upon actual costs incurred to date during the period where the U.S. EPA was subject to a court proceeding for a Temporary Restraining Order (TRO) brought by the City of Granite City. The

$42,000,000 cost estimate was prorated for all work and is not considered to be representative of normal operations due to excessive mobilization and demobilization costs and startup and shutdown periods brought about by the TRO proceedings.

The cost of cleaning up to 500 ppm is greater than that for a higher cleanup level. This additional cost is justified since allowing higher lead levels to remain at site residences will simply not provide adequate protection of human health. The bases for the selection of the 500 ppm cleanup level are outlined in Attachment 4 and the preceding section of this DD/ESD.

The cost of capping the Taracorp pile (approximately $4.8 million) is significantly less than that for the cheapest pile removal scenario (approximately $34.6 million). Given the fact that capping provides overall protection of human health and the environment, cost was a strong factor in selecting capping for the Taracorp pile.

8) State Acceptance

As was the case with the March 1990 ROD, the Illinois Environmental Protection Agency fully supports the 500 ppm residential soil cleanup level, as well as U.S. EPA's decision to cap the Taracorp pile.

9) Community Acceptance

After personal visits by U.S. EPA employees with at least 400 of the residents in the cleanup area (approximately 1300 residences will require cleanup using a 500 ppm lead level), it is clear that the majority of these residents support the 500 ppm soil cleanup level. The support is overwhelming in the areas immediately adjacent to the Taracorp property. This support is evident in the transcript of the public meetings for the residential soil cleanup level, the petitions signed by residents opposing the Granite City government's (City's) attempts to halt cleanup activities in the residential areas, and the fact that a significant number of residents travelled to Benton, Illinois (two hours away) to attend a court hearing and register their opposition regarding the City's efforts to halt the residential cleanups. The City of Madison, Illinois signed an access agreement to allow U.S. EPA to clean up the city easement area of properties to which the resident granted access to U.S. EPA to clean up the residential soil. The City of Venice, Illinois has been fully cooperative in granting U.S. EPA access for residential cleanup activities. By contrast, the City of Granite City alone has strongly opposed U.S. EPA's efforts to clean up residential soil.

Regarding the Taracorp pile, the community is not clearly for or against capping the pile. In the past (1990), based on public

comments received, the majority of people in the area wanted the pile removed from the area; however, interest in the pile issue has fallen off dramatically, as evidenced by the low attendance at the public meeting for the proposed remedy for the pile and the submission of only five public comments on the matter. Given the low level of input on the pile remedy during the public comment period, it is difficult to gage the public opinion on capping. Individual conversations with residents have revealed that many of them would still like the pile removed, but many have also changed their mind to support capping when they became aware of the $30 million cost differential between capping and pile removal.

DESCRIPTION OF THE SIGNIFICANT DIFFERENCES AND THE BASES FOR THE DIFFERENCES

In accordance with Section 117(c) of the Comprehensive Environmental Response, Compensation, and Liability Act, as amended (CERCLA), and consistent with Section 300.435(c)(2)(i) of the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), U.S. EPA has determined that the changes to the remedy constitute a significant change to the remedy required in the March 30, 1990 ROD. The changes, however, are not a fundamental reconsideration of the basic remedy selection on which comment was taken. This ESD pertains to the changes discussed below.

A. Remote Fill Areas

After review of the February 1995 Second Feasibility Study Addendum, the Proposed Plan, and comments received during the public comment period, U.S. EPA has chosen to remediate the remaining remote fill areas with lead concentrations greater than 500 ppm and with paving uses (alleys, driveways, parking lots) by paving over these areas instead of excavation and off-site disposal, as originally specified in the 1990 ROD and the 1993 ESD. All other remaining remote fill areas with lead concentrations exceeding 500 ppm (i.e., residential lots) will still be excavated, subject to the current practice of limiting excavation depth to three feet, and disposed of off-site. The bases for this difference are as follows:

1. U.S. EPA has already remediated or is currently remediating all of the most highly contaminated remote fill areas that have been identified to date, with only one exception in Venice on Slough Road,

2. The number of remote fill areas to be excavated has escalated from the 1990 ROD estimate of 18 to the current estimate of over 100, and

3. Given this nearly fivefold increase in the number of locations to be remediated, it is not cost effective to continue excavation and off-site disposal of the remaining remote fill areas with paving uses. Paving and maintaining this surface cover will provide adequate protection from ingestion of battery case materials and surrounding soils in these alleys, driveways, and parking lots with scattered contamination and lead concentrations that do not greatly exceed the 500 ppm lead cleanup level.

Any remote fill areas with paving uses that are newly identified after signature of this DD/ESD and with a lead concentration greater than 500 ppm will be reviewed on a case-by-case basis to determine whether paving or excavation is appropriate. Such areas may include areas that are uncovered by intrusive activities (e.g. utility excavations) in the future.

B. Ground Water

After review of the February 1995 Second Feasibility Study Addendum (Second FS Addendum), Proposed Plan, and comments received during the public comment period, U.S. EPA has chosen to contain the ground water contamination at the Site through pumping, treatment, and discharge to the local Publicly Owned Treatment Works. The bases for this difference are:

1. The ground water remedy is linked to the capping remedy for the Taracorp pile and basically will serve as a leachate collection system, ensuring that the capping remedy is effective in the long term.

2. Natural attenuation alone is unacceptable because it does not meet ARARs and will not be acceptable to the Illinois EPA; and

3. Given that there are no downgradient users of drinking water in the site area, the additional cost of implementing a more elaborate remedy cannot be justified.

As part of the selected ground water remedy, further downgradient ground water monitoring will be needed to determine the extent of the ground water contamination plume, and the cost estimate in the Second FS Addendum will be adjusted accordingly if more than four pumping wells will be necessary to contain the plume. Additionally, provisions for shutting off the containment system will be developed (e.g., if ARARs are achieved at the point(s) of compliance).

SUMMARY OF ANALYSIS OF NINE EVALUATION CRITERIA

1) Overall Protection of Human Health and the Environment

Paving of remote fill areas that exceed 500 ppm and have current paving uses (i.e. driveways, alleys, and parking lots), along with operation and maintenance of the paving surface, will provide overall protection of human health by providing an effective barrier between the battery chips and the receptor (children).

Containment of the contaminant plume, in conjunction with the fact that downgradient users are all drinking city water obtained from the Mississippi River, also provides overall protection of human health and the environment.

2) Compliance with State and Federal Regulations (ARARs)

There are no ARARs for remediation of lead contaminated soil and battery chips; however, the battery chip remediation program is consistent with all applicable U.S. EPA guidance.

Containment of the contaminated ground water will meet all ARARs.

3) Reduction of Toxicity, Mobility, or Volume Through Treatment

The selected remedy does call for treatment for some of the remote fill areas and will reduce the mobility of lead from the fill which pose an unacceptable health risk to children in the site area.

For those areas which will be paved, instead of off-site disposal, paving will reduce the mobility of lead.

Likewise, containment of the ground water plume will halt the migration of the plume and reduce the volume of contaminated ground water, and the extracted ground water will be treated, as necessary, prior to discharge to the POTW.

4) Short-Term Effectiveness

Paving of remote fill areas with current paving uses will present less potential for producing lead dust than removal. Even so, dust control measures, which have been very effective during battery chip removal actions, will be used to control lead dust emissions to within applicable standards.

Ground water is currently being monitored and there are no known users of the ground water for drinking purposes. The monitoring system will evaluate the plume characteristics on the short term. Ground water containment presents minimal potential for short-term impacts.

5) Long-Term Effectiveness

This remedy utilizes permanent solutions to the maximum extent practicable for the Site. The long term exposure will be eliminated for the remote fill areas.

Ground water will be contained to eliminate migration of lead. U.S. EPA and IEPA believe that the remedy remains protective of human health and the environment and is enhanced by addressing ground water contamination that was not previously discovered.

6) Implementability

Both paving of remote fill areas with current paving uses and ground water containment are proven technologies that are readily implementable.

7) Cost

Paving of a portion of the remote fill areas as opposed to excavation will be more cost effective. The current cost estimate for completing remediation of all remote fill areas is $18,000,000. The increase in cost for remediation of remote fill areas is due to the increase in the number of these areas that must be remediated as compared to the estimates in the 1990 ROD.

Ground water containment and monitoring will cost approximately $3 million. This remedy is cheaper than the other remedies considered in the proposed plan and is more cost effective.

8) State Acceptance

As was the case with the March 1990 ROD, the Illinois Environmental Protection Agency (IEPA) fully supports the remedies for the remote fill areas. IEPA also supports the remedy for the contaminated ground water at the site.

9) Community Acceptance

No comments were received regarding paving of remote fill areas, so it is hard to gage community acceptance of this minor change in the remedy. Few comments were received regarding containment of the ground water plume. The comments that were received indicated a split opinion on containment versus attenuation only. Concerns were also raised regarding the cost estimates for ground water containment in the Second Feasibility Study. These comments are addressed in the Responsiveness Summary Regarding the Taracorp Pile, Remote Fill Areas, and Ground Water, which comprises Attachment 3 to this DD/ESD.

APPENDIX B

GEOTECHNICAL CALCULATIONS

APPENDIX B-1

SLOPE STABILITY ANALYSIS

OMAHA DISTRICT	COMPUTATION SHEET	CORPS OF ENGINEERS	
PROJECT N.L. INDUSTRIES		SHEET NO. 1	OF
ITEM SLOPE STABILITY ANALYSIS		BY	DATE
		CHKD. BY	DATE

MIN. RECOMMENDED F.S. AGAINST SLIDING = 1.50 PER STATE OF ILLINOIS REGS.

ALTERNATIVE B

TAKING INTO CONSIDERATION BUTTRESSING EFFECTS WILL IMPROVE THE FACTOR OF SAFETY. THE SIDE SLOPE STABILITY IS EVALUATED USING THE METHOD DESCRIBED IN "STABILITY AND TENSION CONSIDERATIONS REGARDING COVER SOILS ON GEOMEMBRANE LINED SLOPES," BY ROBERT M. KOERNER AND BAO-LIN HUWU, GEOSYNTHETIC RESEARCH INSTITUTE, DREXEL UNIVERSITY.

ω = SLOPE = 1V ON 4H = 14°

L = SLOPE LENGTH = 90'

H = HEIGHT OF FILL ON COVER = 2 FEET

γ = 120 PCF

C = COHESION OF SOIL TO SOIL = 0

C_a = ADHESION OF SOIL TO GEOSYNTHETIC = 0

ϕ = FRICTION ANGLE OF THE SOIL = 18°

δ = MIN. INTERFACE FRICTION ANGLE = 14°

OMAHA DISTRICT	COMPUTATION SHEET	CORPS OF ENGINEERS	
PROJECT N.L. INDUSTRIES		SHEET NO. 2	OF
ITEM SLOPE STABILITY ANALYSIS		BY	DATE
		CHKD. BY	DATE

STABILITY OF COVER SOIL:

$a = (.5)(120)(90')(2')\sin^2(2)(14°) = 2380$ #/FT

$b = -[(120)(90)(2)\cos^2(14°)\tan(14°)(\sin(2)(14°))$
$+0+(120)(90)(2)(\sin^2 14°)(\tan 18°)(\sin(2)(14))$
$+0+(120)(2)^2(\tan 18°)]$

$b = -[2380+0+193+0+156] = -2729$ #/FT

$c = [(120)(90)(2)(\cos 14°)(\tan 14°)+0][(\tan 18°)$
$(\sin 14°)(\sin(2)(14))] = 193$ #/FT

$$FS = \frac{-b \pm \sqrt{b^2-4ac}}{2a}$$

$$FS = \frac{2729 + \sqrt{(-2729)^2-(4)(2380)(193)}}{2(2380)}$$

FS = 1.07 AGAINST SLIDING OF THE 2' SOIL COVER ON TOP OF THE GEOCOMPOSITE. THIS IS LESS THAN THE 1.50 FS REQUIRED BY THE STATE OF IL; THEREFORE, A GEOGRID REINFORCEMENT LAYER IS REQUIRED.

THE TENSILE STRENGTH OF MOST GEOGRIDS ON THE MARKET RANGE BETWEEN 1560 #/FT AND 17000 #/FT. ASSUME A GEOGRID OF 5000 #/FT. THIS GEOGRID WILL MOBILIZE FRICTION FORCES WITHIN THE COVER SOILS AND CARRY THE TENSILE FORCES.

THE ALLOWABLE TENSILE FORCES IN THE GEOGRID MUST BE FACTORED DOWN DUE TO POTENTIAL OF INSTALLATION DAMAGE, CREEP, CHEMICAL AND BIOLOGICAL DEGREDATION. FROM "DESIGNING WITH GEOSYNTHETICS", ROBERT M. KOERNER:

F.S.	RANGE	USE
$FS_{INSTALLATION}$	1.1-1.4	1.2
FS_{CREEP}	2.0-3.5	2.7
$FS_{BIOLOGICAL}$	1.0-1.3	1.1
$FS_{CHEMICAL}$	1.0-1.4	1.0

$$F.S._{TOTAL} = (1.2)(2.7)(1.1)(1.0) = 3.56$$

$$T_{ALLOWABLE} = \frac{5000\ \#/FT}{3.56} = 1400\ \#/FT$$

BY INCLUDING T_{ALLOW} TO THE EQ., $\Sigma_A = \Sigma_P + T$, WHERE Σ_A IS THE ACTIVE FORCES DOWNSLOPE, AND Σ_P IS THE RESISTING PASSIVE AND GEOGRID FORCES. THIS RESULTS

OMAHA DISTRICT	COMPUTATION SHEET	CORPS OF ENGINEERS	
PROJECT		SHEET NO. 4	OF
ITEM		BY	DATE
		CHKD. BY	DATE

IN CHANGING THE "C" TERM OF THE QUADRATIC EQ. TO:

$$C = 193 - T_{ALLOW} = -1207$$

RECOMPUTING THE QUADRATIC EQ.

$$FS = \frac{2729 + \sqrt{(-2729)^2 - 4(2380)(-1207)}}{2(2380)}$$

$$FS = 1.48 < 1.50$$

TRY A 5500 #/FT TENSILE STRENGTH GEOGRID

$$T_{ALLOW} = \frac{5500}{3.56} = 1545 \ \#/FT$$

$$C = 193 - T_{ALLOW} = -1352$$

$$FS = \frac{2729 + \sqrt{(-2729)^2 - 4(2380)(-1352)}}{2(2380)}$$

$$FS = 1.52 \text{ O.K.}$$

RUNOUT OF GEOGRID:

$$T = \frac{H \gamma L \tan 14^\circ}{2 \cos 14^\circ - \sin 14^\circ \tan 14^\circ}$$

$$1545 = \frac{(2)(120) L \tan 14^\circ}{2 \cos 14^\circ - \sin 14^\circ \tan 14^\circ}$$

$L = 48$ FT $\Rightarrow$ USE 50 FT

Model #1: Stability of Cover Soil Above a Geomembrane

Consider a cover soil (usually a permeable soil like gravel, sand or silt) placed directly on a geomembrane at a slope angle of "ω". Two discrete zones can be visualized as seen in Figure 3. Here one sees a small passive wedge resisting a long, thin active wedge extending the length of the slope. It is assumed that the cover soil is a uniform thickness and constant unit weight. At the top of the slope, or at an intermediate berm, a tension crack in the cover soil is considered to occur thereby breaking communication with additional cover soil at higher elevations.

Resisting the tendency for the cover soil to slide is the adhesion and/or interface friction of the cover soil to the specific type of underlying geomembrane. The values of "c_a" and "δ" must be obtained from a simulated laboratory direct shear test as described earlier. Note that the passive wedge is assumed to move on the underlying cover soil so that the shear parameters "c" and "φ", which come from soil-to-soil friction tests, will also be required.

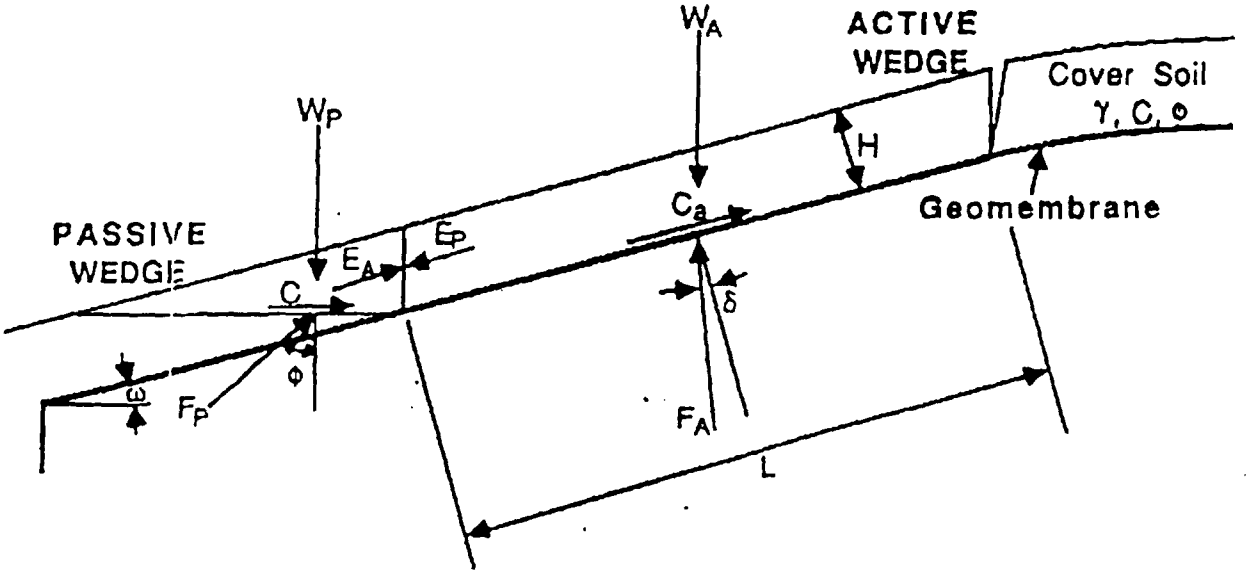


Figure 3 - Cross Section of Cover Soil on a Geomembrane Illustrating the Various Forces Involved on the Active and Passive Wedges

By taking free bodies of the passive and active wedges with the appropriate forces being applied, the following formulation for the stability factor-of-safety results, see Equation 3. Note that the equation is not an explicit solution for the factor-of-safety (FS), and must be solved indirectly. The complete development of the equation is given in Appendix "A".

$$(FS)^2 [0.5 \gamma LH \sin^2(2\omega)] - (FS) [\gamma LH \cos^2\omega \tan\delta \sin(2\omega) + c_a L \cos\omega \sin(2\omega)$$
$$+ \gamma LH \sin^2\omega \tan\phi \sin(2\omega) + 2cH\cos\omega + \gamma H^2 \tan\phi]$$
$$+ [(\gamma LH \cos\omega \tan\delta + c_a L)(\tan\phi \sin\omega \sin(2\omega))] = 0 \qquad (3)$$

Using $ax^2 + bx + c = 0$, where

$$a = 0.5 \gamma LH \sin^2 2\omega$$
$$b = -[\gamma LH \cos^2\omega \tan\delta \sin(2\omega) + c_a L \cos\omega \sin(2\omega)$$
$$+ \gamma' LH \sin^2\omega \tan\phi \sin(2\omega) + 2cH\cos\omega + \gamma H^2 \tan\phi]$$
$$c = (\gamma LH \cos\omega \tan\delta + c_a L)(\tan\phi \sin\omega \sin(2\omega))$$

the resulting factor-of-safety is as follows:

$$FS = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a} \qquad (4)$$

When the calculated factor-of-safety value falls below 1.0, a stability failure of the cover soil sliding on the geomembrane is to be anticipated. However, it should be recognized that seepage forces, seismic forces and construction placement forces have not been considered in this analysis and all of these phenomena tend to lower the factor-of-safety. Thus a value of greater than 1.0 should be targeted as being the minimum acceptable factor-of-safety. An example problem illustrating the use of the above equations follows:

Example Problem: Given a soil cover soil slope of $\omega = 18.4°$ (i.e., 3 to 1), $L = 300$ ft., $H = 3.0$ ft, $\gamma = 120$ lb/ft^3, $c = 300$ lb/ft^2, $c_a = 0$, $\phi = 32°$, $\delta = 14°$, determine the resulting factor-of-safety

Solution:

$$a = 0.5 (120)(300)(3) \sin^2(36.8°)$$
$$= 19.400 \text{ lb/ft}$$
$$b = -[(120)(300)(3)\cos^2(18.4°) \tan(14°) \sin(36.8°)$$
$$+ 0 + (120)(300)(3) \sin^2(18.4°) \tan(32°) \sin(36.8°)$$
$$+ 2(300)(3) \cos(18.4°) + 120(9) \tan(32°)]$$

$= -[14523 + 0 + 4028 + 1708 + 675]$

$= -20{,}934$ lb/ft

$c = [(120)(300)(3)\cos(18.4°)\tan(14°) + 0]$

$[\tan(32°)\sin(18.4°)\sin(36.8°)]$

$= [25500][0.118]$

$= 3019$ lb/ft

$$FS = \frac{20{,}934 + \sqrt{(-20934)^2 - 4(19400)(3019)}}{38{,}800}$$

FS = 0.91, which signifies that a stability failure will occur

Model #2: Reinforcement of Cover Soil on a Geomembrane

Once the cover soil factor-of-safety becomes unacceptably low for the site specific conditions (as illustrated in the previous problem), a possible solution to the situation is to add a layer of geogrid or geotextile reinforcement as shown in Figure 4. In the case of landfill covers, the tensile stresses that are mobilized in the reinforcement are carried over the crown to (generally) an equal and opposite reaction on the opposing slope. Alternatively, these stresses can be carried in friction via an anchorage mode of resistance as would occur in an intermediate berm situation. For a landfill liner, the stresses in the reinforcement are generally carried to an individual anchor trench extending behind the geomembrane anchor trench. If the reinforcement is a geogrid it is placed within the cover soil so that soil can strike-through the apertures and the maximum amount of anchorage against the transverse ribs can be mobilized. When using geotextiles, they can be placed directly on the geomembrane, or embedded within the cover soil so as to mobilize friction in both surfaces.

The tensile stress of the reinforcement layer per unit width is calculated by setting "E_A" equal to "E_p" in Figure 3 and solving for the unbalanced force "T" in Figure 4 which is required for a factor-of-safety equal to one. This value of T becomes T_{reqd} which is given in Equation 5. The complete development is available in Appendix "B".

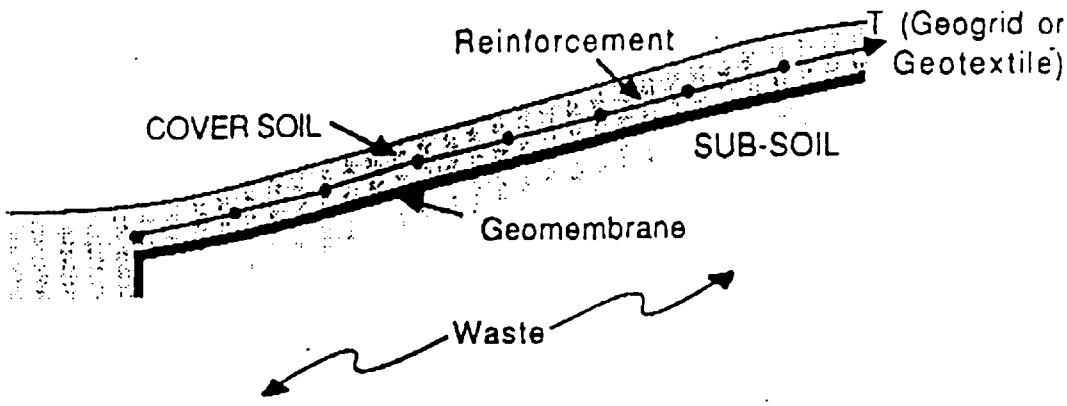
$$T_{reqd} = \frac{\gamma LH \sin(\omega-\delta)}{\cos\delta} - c_a L - \frac{\cos\phi\left[\dfrac{cH}{\sin\omega} + \dfrac{\gamma H^2}{\sin 2\omega}\tan\phi\right]}{\cos(\phi+\omega)} \tag{5}$$

This value is now compared to the allowable wide width tensile strength of the particular geogrid or geotextile under consideration, i.e.,

$$FS = T_{allow}/T_{reqd} \tag{6}$$

Note that the value of "T_{allow}" must include such considerations as installation damage, creep and long-term degradation from chemical or biological interactions. If the value is obtained from a test such as ASTM D-4595, the wide width strip tensile test, the use of partial factors-of-safety is recommended to accommodate the above items.[7] An example problem using Equations 5 and 6 follows:

> Example Problem: Continue the previous problem of cover soil instability where a geogrid with allowable wide width tensile strength of 4000 lb/ft is being considered (i.e., the value includes the above mentioned partial factors-of-safety). What is the resulting overall factor-of-safety? The parameters are $\omega = 18.4°$, $L = 300$ ft., $H = 3.0$ ft.,



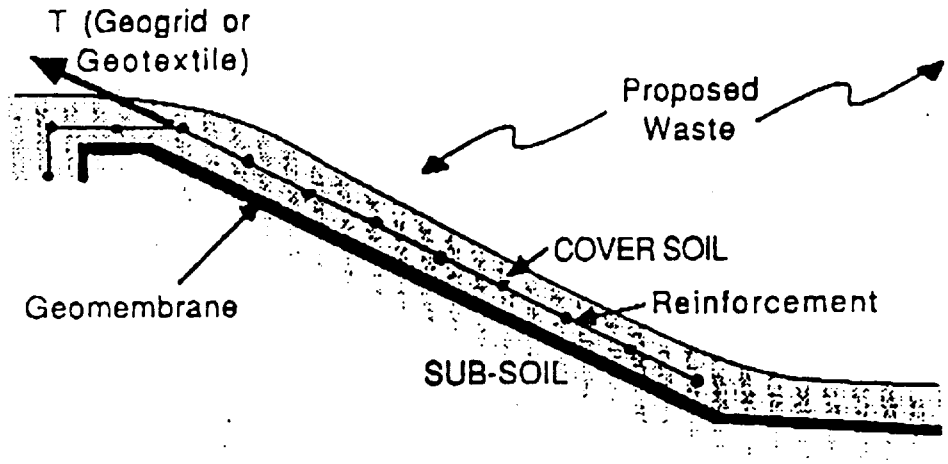


Figure 4 - Geogrid or Geotextile Reinforcement of a Cover Soil Above Waste and of a Cover Soil on a Geomembrane Beneath Waste

$\gamma = 120\ lb/ft^3$, $c = 300\ lb/ft^2$, $c_a = 0$, $\phi = 32°$, $\delta = 14°$.

Solution:

$$T_{reqd} = \frac{(120)(300)(3)\sin(4.4°)}{\cos(14°)} - 0 - \frac{\cos(32°)\left[\frac{(300)(3)}{\sin(18.4°)} + \frac{(120)(9)}{\sin(36.8°)}\tan(32°)\right]}{\cos(50.4°)}$$

$$= 8539 - 0 - 5292$$

$$T_{reqd} = 3247\ lb/ft$$

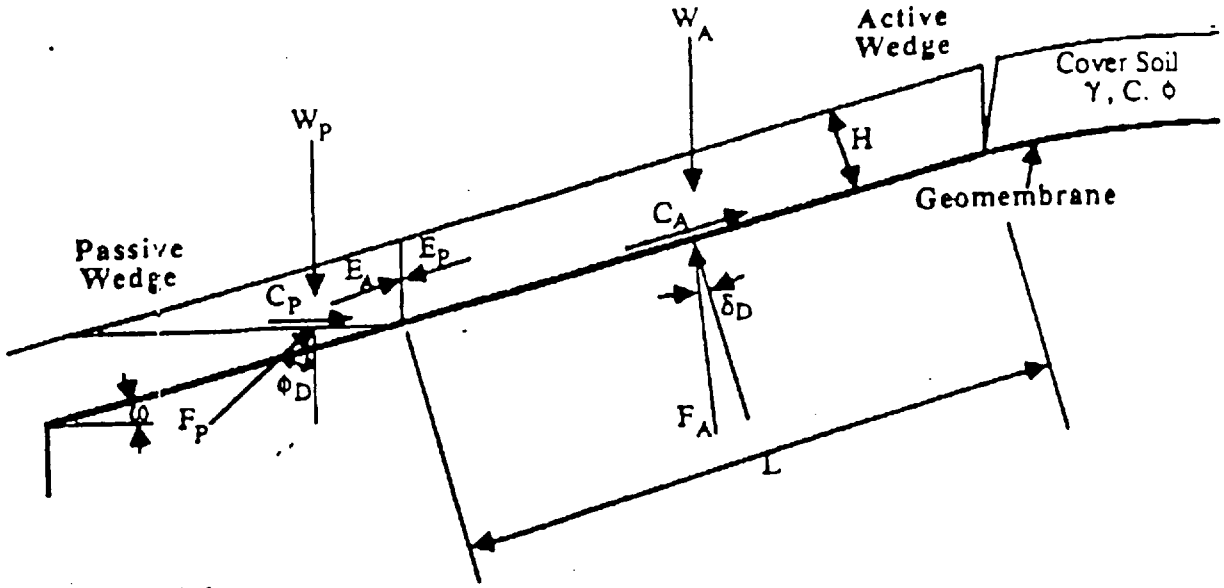
$$FS = T_{allow}/T_{reqd}$$

$$= \frac{4000}{3247}$$

FS = 1.23, which is marginally acceptable and a stronger reinforcement or a double layer should be considered.

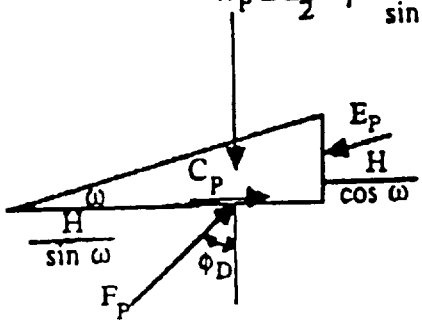
Note: Using the formulation developed by Giroud and Beech[5] with the soil cohesion equal to zero results in a $T_{reqd} = 6890\ lb/ft$, while the above formulation adjusted for a zero cohesion results in $T_{reqd} = 7040\ lb/ft$. Thus the methods appear to be comparable to one another.

Appendix "A"
Derivation of FS for Cover Soil Stability on a Geomembrane

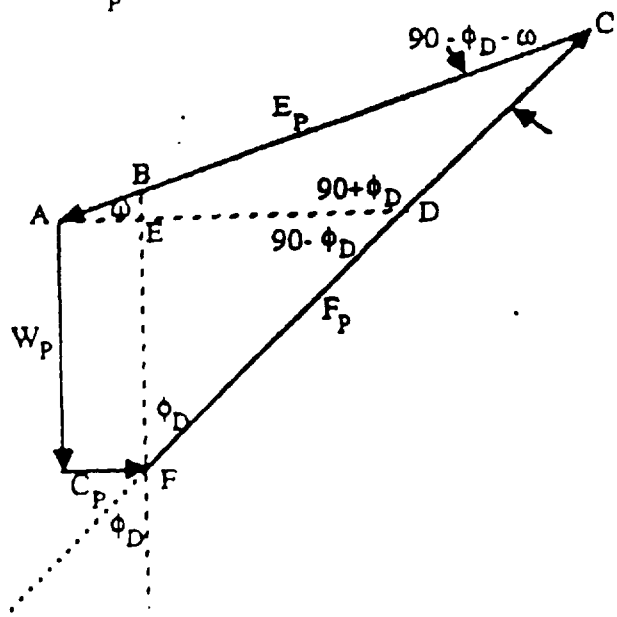


Passive Wedge

$$W_P = \frac{1}{2}\gamma \frac{H^2}{\sin\omega \cos\omega} = \frac{\gamma H^2}{\sin 2\omega}$$



$$C_P = \frac{C}{FS}\frac{H}{\sin\omega}$$



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Passive Wedge

$$\overline{EF} = W_P$$

$$\frac{\overline{DE}}{\sin \varphi_D} = \frac{\overline{EF}}{\sin (90^\circ - \phi_D)} = \frac{W_P}{\cos \phi_D}$$

$$\overline{DE} = W_P \cdot \tan \phi_D$$

$$\frac{E_P}{\sin (90^\circ + \phi_D)} = \frac{\overline{AD}}{\sin (90^\circ - \varphi_D - \varpi)}$$

$$\frac{E_P}{\cos \phi_D} = \frac{C_P + W_P \cdot \tan \phi_D}{\cos (\phi_D + \varpi)}$$

$$E_P = \frac{\cos \phi_D \cdot [C_P + W_P \cdot \tan \phi_D]}{\cos (\phi_D + \varpi)}$$

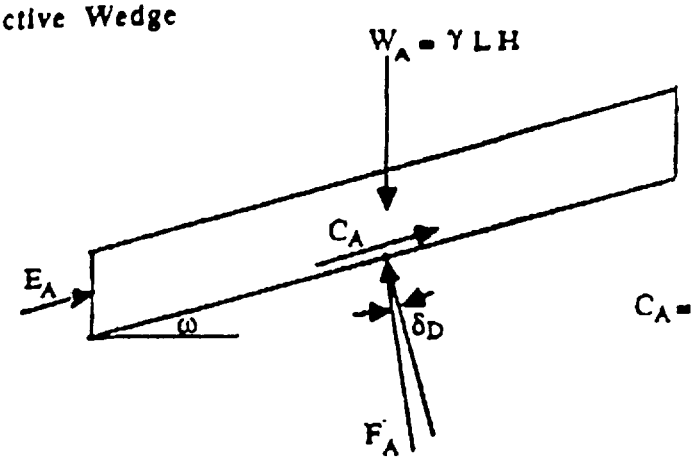
$$= \frac{\cos \phi_D \cdot \left[\frac{C}{FS} \cdot \frac{H}{\sin \varpi} + \frac{\gamma \cdot H^2}{\sin 2\varpi} \cdot \tan \phi_D \right]}{\cos (\phi_D + \varpi)}$$

$$= \frac{\cos \phi_D}{(\cos \varphi_D \cos \varpi - \sin \phi_D \sin \varpi)} \left[\frac{C \cdot H}{FS \cdot \sin \varpi} + \frac{\gamma \cdot H^2}{2 \sin \varpi \cos \varpi} \cdot \frac{\tan \phi}{FS} \right]$$

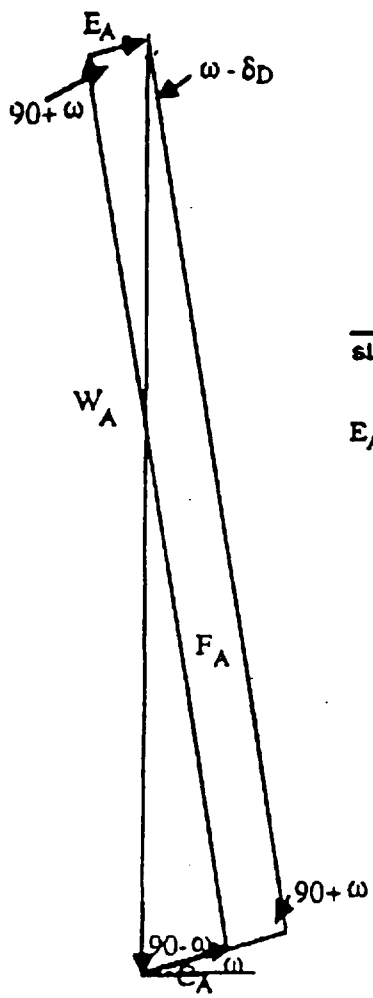
$$= \frac{1}{(\cos \varpi - \tan \phi_D \sin \varpi)} \left[\frac{2 \cdot C \cdot H \cdot \cos \varpi + \gamma \cdot H^2 \cdot \tan \phi}{2 \cdot \sin \varpi \cdot \cos \varpi \cdot FS} \right]$$

$$= \frac{FS}{(FS \cdot \cos \varpi - \tan \phi \cdot \sin \varpi)} \left[\frac{2 \cdot C \cdot H \cdot \cos \varpi + \gamma \cdot H^2 \cdot \tan \phi}{2 \cdot \sin \varpi \cdot \cos \varpi \cdot FS} \right]$$

Active Wedge



$$C_A = \frac{C_a L}{FS}$$



$$\frac{E_A + C_A}{\sin(\omega - \delta_D)} = \frac{W_A}{\sin(90° + \delta_D)} = \frac{W_A}{\cos \delta_D}$$

$$E_A = \frac{W_A \sin(\omega - \delta_D)}{\cos \delta_D} - C_A$$

$$= \frac{W_A\left[\sin \omega \cos \delta_D - \cos \omega \sin \delta_D\right]}{\cos \delta_D} - C_A$$

$$= \gamma \cdot L \cdot H (\sin \omega - \cos \omega \tan \delta_D) - \frac{C_a \cdot L}{FS}$$

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$E_A = E_P$

$$\gamma \cdot L \cdot H \cdot (\sin \varpi - \cos \varpi \cdot \tan \delta_D) - \frac{C_a \cdot L}{FS} = \frac{(2 \cdot C \cdot H \cdot \cos \varpi + \gamma \cdot H^2 \cdot \tan \phi)}{(FS \cdot \cos \varpi - \tan \phi \cdot \sin \varpi) \cdot (\sin 2\varpi)}$$

$$\gamma \cdot L \cdot H \cdot \left(\sin \varpi - \frac{\cos \varpi \cdot \tan \delta}{FS}\right) - \frac{C_a \cdot L}{FS} = \frac{(2 \cdot C \cdot H \cdot \cos \varpi + \gamma \cdot H^2 \cdot \tan \phi)}{(FS \cdot \cos \varpi - \tan \phi \cdot \sin \varpi) \cdot (\sin 2\varpi)}$$

$$\frac{\gamma \cdot L \cdot H \cdot (\sin \varpi \cdot FS - \cos \varpi \cdot \tan \delta) - C_a \cdot L}{FS} = \frac{(2 \cdot C \cdot H \cdot \cos \varpi + \gamma \cdot H^2 \cdot \tan \phi)}{(FS \cdot \cos \varpi \cdot \sin 2\varpi - \tan \phi \cdot \sin \varpi \cdot \sin 2\varpi)}$$

$$\frac{\gamma \cdot L \cdot H \cdot \sin \varpi \cdot FS - \gamma \cdot L \cdot H \cdot \cos \varpi \cdot \tan \delta - C_a \cdot L}{FS} = \frac{(2 \cdot C \cdot H \cdot \cos \varpi + \gamma \cdot H^2 \cdot \tan \phi)}{(FS \cdot \cos \varpi \cdot \sin 2\varpi - \tan \phi \cdot \sin \varpi \cdot \sin 2\varpi)}$$

$$FS^2 \cdot (\gamma \cdot L \cdot H \cdot \sin \varpi \cdot \cos \varpi \cdot \sin 2\varpi) - FS \cdot (\gamma \cdot L \cdot H \cdot \cos^2 \varpi \cdot \tan \delta \cdot \sin 2\varpi)$$

$$- FS \cdot (C_a \cdot L \cdot \cos \varpi \cdot \sin 2\varpi) - FS \cdot (\gamma \cdot L \cdot H \cdot \sin^2 \varpi \cdot \tan \phi \cdot \sin 2\varpi)$$

$$+ (\gamma \cdot L \cdot H \cdot \cos \varpi \cdot \tan \delta + C_a \cdot L) \cdot (\tan \phi \cdot \sin \varpi \cdot \sin 2\varpi) = FS \cdot (2 \cdot C \cdot H \cdot \cos \varpi + \gamma \cdot H^2 \cdot \tan \phi)$$

$$FS^2 \cdot \left(\frac{1}{2} \cdot \gamma \cdot L \cdot H \cdot \sin^2 2\varpi\right) - FS \cdot (\gamma \cdot L \cdot H \cdot \cos^2 \varpi \cdot \tan \delta \cdot \sin 2\varpi + C_a \cdot L \cdot \cos \varpi \cdot \sin 2\varpi$$

$$+ \gamma \cdot L \cdot H \cdot \sin^2 \varpi \cdot \tan \phi \cdot \sin 2\varpi + 2 \cdot C \cdot H \cdot \cos \varpi + \gamma \cdot H^2 \cdot \tan \phi)$$

$$+ (\gamma \cdot L \cdot H \cdot \cos \varpi \cdot \tan \delta + C_a \cdot L) \cdot (\tan \phi \cdot \sin \varpi \cdot \sin 2\varpi) = 0$$

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APPENDIX B-2

GEONET DESIGN

OMAHA DISTRICT	COMPUTATION SHEET	CORPS OF ENGINEERS
PROJECT N.L. INDUSTRIES	SHEET NO. 1	OF
ITEM GEONET DESIGN - ALTERNATIE "B"	BY	DATE
	CHKD. BY	DATE

A PRELIMINARY HELP MODEL RUN WAS PERFORMED UTILIZING A GEONET WITH VERY HIGH FLOW CARRYING PROPERTIES. THIS WAS DONE TO DETERMINE THE MAXIMUM AMOUNT OF FLOW REQUIRED FROM THE GEONET. THESE RUSULTS INDICATE THAT THE PEAK DAILY QUANTITY OF FLOW TO BE CARRIED BY THE DRAINAGE LAYER IS 14.1 $FT^3/DAY/FT$.

FACTORS OF SAFETY

	RANGE	USE
$F.S._{INTRUSION}$	1.3-1.5	1.4
$F.S._{CREEP}$	1.2-1.4	1.3
$F.S._{CHEM\ CLOGGING}$	1.0-1.2	1.2
$F.S._{BIO\ CLOGGING}$	1.2-1.5	1.4

$$F.S._{TOTAL} = (1.4)(1.3)(1.2)(1.4) = 3.06$$

$$Q_{REQ} = (14.1\ FT^3/DAY/FT)\left(\frac{1\ DAY}{24\ HR}\right)\left(\frac{1\ HR}{60\ MIN}\right)\left(\frac{1\ MIN}{60\ SEC}\right) = .00016\ FT^3/SEC$$

$$Q_{DES} = (.00016)(3.06) = .0005\ FT^3/SEC$$

USING DARCY'S EQ.:

$$Q = KiA$$

$$Q = Kiwt$$

$$\frac{Q}{iw} = Kt = \Theta$$

Θ = TRANSMISSIVITY

OMAHA DISTRICT	COMPUTATION SHEET	CORPS OF ENGINEERS	
PROJECT N.L. INDUSTRIES		SHEET NO. 2	OF
ITEM GEONET DESIGN – ALTERNATIVE 'B'		BY	DATE
		CHKD. BY	DATE

$$\frac{Q}{iw} = \frac{(.0005\ FT^3/SEC)}{.05\ (1FT)} = Kt$$

$Kt = .01\ FT^2/SEC$

IF $t = .20''$

THEN $K = .60\ FT/SEC$

$= 18.3\ cm/SEC$

$$\theta = Kt = (.01\ FT^2/SEC)\left(\frac{7.49\ GAL}{FT^3}\right)\left(\frac{60\ SEC}{1\ MIN}\right)$$

$= 4.5$ GAL/MIN/FT AT A 5% GRADIENT

HOWEVER, MOST GEONET MATERIALS ARE SPECIFIED ACCORDING TO TRANSMISSIVITY VALUES DETERMINED BY LAB TESTING AT A 10% GRADIENT.

CALCULATING AN EQUIVELANT GEONET AT A 10% GRADIENT:

$$\frac{Q}{iw} = \frac{(.0005\ FT^3/SEC)}{(.10)\ (1FT)} = Kt$$

$Kt = .005\ FT^2/SEC$

IF $t = .20''$

THEN $K = .30\ FT/SEC$

$9.2\ cm/SEC$

$$\theta = Kt = (.005\ FT^2/SEC)\left(\frac{7.49\ GAL}{FT^3}\right)\left(\frac{60\ SEC}{1\ MIN}\right)$$

$= 2.3$ GAL/MIN/FT AT A 10% GRADIENT

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**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                 HELP MODEL VERSION 3.05  (30 MARCH 1996)                 **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
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PRECIPITATION DATA FILE:      C:\HELP3\NL.D4
TEMPERATURE DATA FILE:        C:\HELP3\NL.D7
SOLAR RADIATION DATA FILE:    C:\HELP3\NL.D13
EVAPOTRANSPIRATION DATA:      C:\HELP3\NL.D11
SOIL AND DESIGN DATA FILE:    C:\HELP3\NLB.D10
OUTPUT DATA FILE:             C:\HELP3\NLALTB.OUT


TIME:  15:12      DATE:   7/29/1996


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     TITLE:  N.L. INDUSTRIES - ALTERNATIVE "B"

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     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
              COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.


                                  LAYER  1
                                  --------

                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER   4
          THICKNESS                  =      6.00   INCHES
          POROSITY                   =      0.4370 VOL/VOL
          FIELD CAPACITY             =      0.1050 VOL/VOL
          WILTING POINT              =      0.0470 VOL/VOL
          INITIAL SOIL WATER CONTENT =      0.1630 VOL/VOL
          EFFECTIVE SAT. HYD. COND.  =  0.170000002000E-02 CM/SEC
       NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  3.00
                FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.
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LAYER 2

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 7

THICKNESS	=	18.00	INCHES
POROSITY	=	0.4730	VOL/VOL
FIELD CAPACITY	=	0.2220	VOL/VOL
WILTING POINT	=	0.1040	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.2649	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.520000001000E-03	CM/SEC

LAYER 3

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 0

THICKNESS	=	0.20	INCHES
POROSITY	=	0.8500	VOL/VOL
FIELD CAPACITY	=	0.0100	VOL/VOL
WILTING POINT	=	0.0050	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0100	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	20.0000000000	CM/SEC
SLOPE	=	5.00	PERCENT
DRAINAGE LENGTH	=	240.0	FEET

LAYER 4

TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURE NUMBER 35

THICKNESS	=	0.04	INCHES
POROSITY	=	0.0000	VOL/VOL
FIELD CAPACITY	=	0.0000	VOL/VOL
WILTING POINT	=	0.0000	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0000	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.199999996000E-12	CM/SEC
FML PINHOLE DENSITY	=	1.00	HOLES/ACRE
FML INSTALLATION DEFECTS	=	8.00	HOLES/ACRE
FML PLACEMENT QUALITY	=	4 - POOR	

LAYER 5

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 17

THICKNESS	=	0.24	INCHES
POROSITY	=	0.7500	VOL/VOL
FIELD CAPACITY	=	0.7470	VOL/VOL
WILTING POINT	=	0.4000	VOL/VOL

INITIAL SOIL WATER CONTENT	=	0.7500	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.300000003000E-08	CM/SEC

LAYER 6

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 7

THICKNESS	=	12.00	INCHES
POROSITY	=	0.4730	VOL/VOL
FIELD CAPACITY	=	0.2220	VOL/VOL
WILTING POINT	=	0.1040	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.2001	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.520000001000E-03	CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM A USER-SPECIFIED CURVE NUMBER OF 72.0, A SURFACE SLOPE OF 5.% AND A SLOPE LENGTH OF 240. FEET.

SCS RUNOFF CURVE NUMBER	=	73.40	
FRACTION OF AREA ALLOWING RUNOFF	=	100.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	0.005	ACRES
EVAPORATIVE ZONE DEPTH	=	20.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	4.859	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	9.244	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	1.738	INCHES
INITIAL SNOW WATER	=	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	8.330	INCHES
TOTAL INITIAL WATER	=	8.330	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
ST. LOUIS MISSOURI

STATION LATITUDE	=	38.45	DEGREES
MAXIMUM LEAF AREA INDEX	=	2.00	
START OF GROWING SEASON (JULIAN DATE)	=	98	
END OF GROWING SEASON (JULIAN DATE)	=	300	
EVAPORATIVE ZONE DEPTH	=	20.0	INCHES
AVERAGE ANNUAL WIND SPEED	=	10.40	MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	73.00	%
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	67.00	%
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	71.00	%
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	74.00	%

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR ST. LOUIS MISSOURI

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
1.72	2.14	3.28	3.55	3.54	3.73
3.63	2.55	2.70	2.32	2.53	2.22

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR ST. LOUIS MISSOURI

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
28.60	33.80	43.20	56.10	65.60	74.80
78.90	77.00	69.70	57.90	44.60	34.20

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR ST. LOUIS MISSOURI
AND STATION LATITUDE = 38.45 DEGREES

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 30

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	1.59	2.12	3.09	3.37	3.44	4.42
	3.38	2.66	2.75	2.18	2.16	2.06
STD. DEVIATIONS	0.96	1.10	0.92	1.36	1.56	2.04
	1.87	1.38	1.45	1.28	1.38	1.14
RUNOFF						
TOTALS	0.169	0.452	0.256	0.012	0.002	0.023
	0.006	0.001	0.001	0.000	0.002	0.008
STD. DEVIATIONS	0.313	0.582	0.451	0.063	0.010	0.074
	0.023	0.005	0.003	0.002	0.005	0.021
EVAPOTRANSPIRATION						

TOTALS	0.533	0.672	2.121	3.114	3.557	5.017
	3.526	2.373	2.368	2.100	0.989	0.728
STD. DEVIATIONS	0.300	0.400	0.498	0.734	0.860	1.493
	1.478	0.988	1.050	0.776	0.308	0.205

LATERAL DRAINAGE COLLECTED FROM LAYER 3

TOTALS	0.3028	0.6413	1.6763	0.8892	0.5036	0.2807
	0.0671	0.0207	0.0672	0.0444	0.1652	0.5352
STD. DEVIATIONS	0.4179	0.9245	0.9654	0.7702	0.6452	0.5888
	0.1631	0.1054	0.2702	0.0986	0.4706	0.9345

PERCOLATION/LEAKAGE THROUGH LAYER 5

TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

PERCOLATION/LEAKAGE THROUGH LAYER 6

TOTALS	0.0026	0.0021	0.0032	0.0032	0.0022	0.0015
	0.0010	0.0007	0.0005	0.0007	0.0009	0.0012
STD. DEVIATIONS	0.0061	0.0053	0.0050	0.0047	0.0029	0.0024
	0.0016	0.0011	0.0005	0.0009	0.0020	0.0021

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 4

AVERAGES	0.0004	0.0010	0.0024	0.0013	0.0007	0.0004
	0.0001	0.0000	0.0001	0.0001	0.0002	0.0007
STD. DEVIATIONS	0.0006	0.0014	0.0016	0.0011	0.0009	0.0008
	0.0002	0.0001	0.0004	0.0001	0.0007	0.0013

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 30

	INCHES		CU. FEET	PERCENT
PRECIPITATION	33.21	(4.731)	663.1	100.00
RUNOFF	0.933	(0.9070)	18.63	2.809
EVAPOTRANSPIRATION	27.100	(3.1719)	541.05	81.595

LATERAL DRAINAGE COLLECTED FROM LAYER 3	5.19360 (2.09565)	103.690	15.63742
PERCOLATION/LEAKAGE THROUGH LAYER 5	0.00000 (0.00000)	0.000	0.00001
AVERAGE HEAD ON TOP OF LAYER 4	0.001 (0.000)		
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.01981 (0.02917)	0.396	0.05965
CHANGE IN WATER STORAGE	-0.042 (1.0222)	-0.85	-0.128

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 30

	(INCHES)	(CU. FT.)
PRECIPITATION	3.44	68.680
RUNOFF	2.123	42.3894
DRAINAGE COLLECTED FROM LAYER 3	0.99139	19.79312
PERCOLATION/LEAKAGE THROUGH LAYER 5	0.000000	0.00001
AVERAGE HEAD ON TOP OF LAYER 4	0.132	
MAXIMUM HEAD ON TOP OF LAYER 4	0.085	
LOCATION OF MAXIMUM HEAD IN LAYER 3 (DISTANCE FROM DRAIN)	0.0 FEET	
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.001281	0.02558
SNOW WATER	2.43	48.5185

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.3568
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.0869

*** Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner
by Bruce M. McEnroe, University of Kansas
ASCE Journal of Environmental Engineering
Vol. 119, No. 2, March 1993, pp. 262-270.

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FINAL WATER STORAGE AT END OF YEAR 30

LAYER	(INCHES)	(VOL/VOL)
1	1.1412	0.1902
2	3.9263	0.2181
3	0.0020	0.0100
4	0.0000	0.0000
5	0.1800	0.7500
6	1.8069	0.1506
SNOW WATER	0.000	

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**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                 HELP MODEL VERSION 3.05  (30 MARCH 1996)                 **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
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PRECIPITATION DATA FILE:      C:\HELP3\NL.D4
TEMPERATURE DATA FILE:        C:\HELP3\NL.D7
SOLAR RADIATION DATA FILE:    C:\HELP3\NL.D13
EVAPOTRANSPIRATION DATA:      C:\HELP3\NL.D11
SOIL AND DESIGN DATA FILE:    C:\HELP3\NLB.D10
OUTPUT DATA FILE:             C:\HELP3\NLALTB.OUT


TIME:  14:33      DATE:    7/29/1996


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     TITLE:  N.L. INDUSTRIES - ALTERNATIVE "B"

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     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
              COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.


                                  LAYER  1
                                  --------

                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER   4
          THICKNESS                  =      6.00   INCHES
          POROSITY                   =      0.4370 VOL/VOL
          FIELD CAPACITY             =      0.1050 VOL/VOL
          WILTING POINT              =      0.0470 VOL/VOL
          INITIAL SOIL WATER CONTENT =      0.1003 VOL/VOL
          EFFECTIVE SAT. HYD. COND.  =  0.170000002000E-02 CM/SEC
       NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  3.00
                FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.
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LAYER 2

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 7

THICKNESS	=	18.00	INCHES
POROSITY	=	0.4730	VOL/VOL
FIELD CAPACITY	=	0.2220	VOL/VOL
WILTING POINT	=	0.1040	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.2811	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.520000001000E-03	CM/SEC

LAYER 3

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 0

THICKNESS	=	0.20	INCHES
POROSITY	=	0.8500	VOL/VOL
FIELD CAPACITY	=	0.0100	VOL/VOL
WILTING POINT	=	0.0050	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0100	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	50.0000000000	CM/SEC
SLOPE	=	5.00	PERCENT
DRAINAGE LENGTH	=	240.0	FEET

LAYER 4

TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURE NUMBER 35

THICKNESS	=	0.04	INCHES
POROSITY	=	0.0000	VOL/VOL
FIELD CAPACITY	=	0.0000	VOL/VOL
WILTING POINT	=	0.0000	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0000	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.199999996000E-12	CM/SEC
FML PINHOLE DENSITY	=	1.00	HOLES/ACRE
FML INSTALLATION DEFECTS	=	8.00	HOLES/ACRE
FML PLACEMENT QUALITY	=	4 - POOR	

LAYER 5

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 17

THICKNESS	=	0.24	INCHES
POROSITY	=	0.7500	VOL/VOL
FIELD CAPACITY	=	0.7470	VOL/VOL
WILTING POINT	=	0.4000	VOL/VOL

INITIAL SOIL WATER CONTENT	=	0.7500	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.300000003000E-08	CM/SEC

LAYER 6

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 7

THICKNESS	=	12.00	INCHES
POROSITY	=	0.4730	VOL/VOL
FIELD CAPACITY	=	0.2220	VOL/VOL
WILTING POINT	=	0.1040	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.1920	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.520000001000E-03	CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM A USER-SPECIFIED CURVE NUMBER OF 72.0, A SURFACE SLOPE OF 5.% AND A SLOPE LENGTH OF 240. FEET.

SCS RUNOFF CURVE NUMBER	=	73.40	
FRACTION OF AREA ALLOWING RUNOFF	=	100.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	0.005	ACRES
EVAPORATIVE ZONE DEPTH	=	20.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	4.588	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	9.244	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	1.738	INCHES
INITIAL SNOW WATER	=	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	8.148	INCHES
TOTAL INITIAL WATER	=	8.148	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
ST. LOUIS MISSOURI

STATION LATITUDE	=	38.45	DEGREES
MAXIMUM LEAF AREA INDEX	=	2.00	
START OF GROWING SEASON (JULIAN DATE)	=	98	
END OF GROWING SEASON (JULIAN DATE)	=	300	
EVAPORATIVE ZONE DEPTH	=	20.0	INCHES
AVERAGE ANNUAL WIND SPEED	=	10.40	MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	73.00	%
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	67.00	%
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	71.00	%
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	74.00	%

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR ST. LOUIS MISSOURI

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
1.72	2.14	3.28	3.55	3.54	3.73
3.63	2.55	2.70	2.32	2.53	2.22

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR ST. LOUIS MISSOURI

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
28.60	33.80	43.20	56.10	65.60	74.80
78.90	77.00	69.70	57.90	44.60	34.20

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR ST. LOUIS MISSOURI
AND STATION LATITUDE = 38.45 DEGREES

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 30

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	1.59	2.12	3.09	3.37	3.44	4.42
	3.38	2.66	2.75	2.18	2.16	2.06
STD. DEVIATIONS	0.96	1.10	0.92	1.36	1.56	2.04
	1.87	1.38	1.45	1.28	1.38	1.14
RUNOFF						
TOTALS	0.161	0.423	0.239	0.012	0.002	0.020
	0.006	0.001	0.000	0.000	0.001	0.006
STD. DEVIATIONS	0.299	0.558	0.416	0.063	0.009	0.064
	0.021	0.005	0.001	0.000	0.002	0.018
EVAPOTRANSPIRATION						

TOTALS	0.548	0.680	2.214	3.137	3.503	4.835
	3.341	2.263	2.320	1.975	1.041	0.753
STD. DEVIATIONS	0.303	0.415	0.513	0.793	0.893	1.580
	1.488	0.995	1.084	0.813	0.363	0.204

LATERAL DRAINAGE COLLECTED FROM LAYER 3

TOTALS	0.2864	0.5887	1.6183	0.9548	0.5034	0.3842
	0.1792	0.1792	0.1485	0.1768	0.2213	0.5130
STD. DEVIATIONS	0.3979	0.8879	0.9039	0.7615	0.6366	0.6084
	0.1241	0.1188	0.2160	0.1540	0.4238	0.8088

PERCOLATION/LEAKAGE THROUGH LAYER 5

TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

PERCOLATION/LEAKAGE THROUGH LAYER 6

TOTALS	0.0015	0.0013	0.0019	0.0022	0.0015	0.0017
	0.0018	0.0017	0.0012	0.0015	0.0012	0.0012
STD. DEVIATIONS	0.0039	0.0034	0.0025	0.0032	0.0017	0.0022
	0.0025	0.0025	0.0014	0.0020	0.0021	0.0018

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 4

AVERAGES	0.0002	0.0004	0.0009	0.0005	0.0003	0.0002
	0.0001	0.0001	0.0001	0.0001	0.0001	0.0003
STD. DEVIATIONS	0.0002	0.0005	0.0005	0.0004	0.0003	0.0003
	0.0001	0.0001	0.0001	0.0001	0.0002	0.0004

****

****

AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 30

	INCHES		CU. FEET	PERCENT
PRECIPITATION	33.21	(4.731)	663.1	100.00
RUNOFF	0.871	(0.8545)	17.40	2.623
EVAPOTRANSPIRATION	26.611	(3.1518)	531.28	80.122

LATERAL DRAINAGE COLLECTED FROM LAYER 3	5.75389	(2.17441)	114.877	17.32440
PERCOLATION/LEAKAGE THROUGH LAYER 5	0.00000	(0.00000)	0.000	0.00001
AVERAGE HEAD ON TOP OF LAYER 4	0.000	(0.000)		
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.01871	(0.02713)	0.374	0.05633
CHANGE IN WATER STORAGE	-0.051	(1.2067)	-1.01	-0.153

****

****

PEAK DAILY VALUES FOR YEARS 1 THROUGH 30

	(INCHES)	(CU. FT.)
PRECIPITATION	3.44	68.680
RUNOFF	2.055	41.0332
DRAINAGE COLLECTED FROM LAYER 3	0.70356	14.04650
PERCOLATION/LEAKAGE THROUGH LAYER 5	0.000000	0.00000
AVERAGE HEAD ON TOP OF LAYER 4	0.012	
MAXIMUM HEAD ON TOP OF LAYER 4	0.024	
LOCATION OF MAXIMUM HEAD IN LAYER 3 (DISTANCE FROM DRAIN)	1.0 FEET	
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.000751	0.01499
SNOW WATER	2.43	48.5185

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.3480
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.0869

*** Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner
by Bruce M. McEnroe, University of Kansas
ASCE Journal of Environmental Engineering
Vol. 119, No. 2, March 1993, pp. 262-270.

****

****

FINAL WATER STORAGE AT END OF YEAR 30

LAYER	(INCHES)	(VOL/VOL)
1	1.1443	0.1907
2	3.5554	0.1975
3	0.0021	0.0105
4	0.0000	0.0000
5	0.1800	0.7500
6	1.7426	0.1452
SNOW WATER	0.000	

****
****

APPENDIX B-3

GEONET SUBDRAIN PIPE

OMAHA DISTRICT	COMPUTATION SHEET	CORPS OF ENGINEERS
PROJECT N L INDUSTRIES	SHEET NO. 1	OF 2
ITEM DESIGN OF GEONET SUBDRAIN PIPE	BY / CHKD. BY	DATE / DATE

DRAINAGE FROM THE GEONET BASED ON PEAK DAILY VALUES FROM THE HELP MODEL:

ALT. "A": .9664 INCHES/DAY

MAX DRAINAGE LENGTH = 175 FT.

ALT. "B": .7036 INCHES/DAY

MAX DRAINAGE LENGTH = 240 FT.

USING A 1 FOOT WIDTH:

$$Q_{ALT\,"A"} = \frac{.9664\ ''/DAY}{12\ ''/FT}(175')(1') = 14\ FT^3/DAY/FT$$

$$Q_{ALT\,"B"} = \frac{.7036\ ''/DAY}{12\ ''/FT}(240')(1') = 14\ FT^3/DAY/FT$$

SINCE THE COLLECTOR PIPE WILL BE NON-PRESSURIZED SLOTTED PIPE, MANNING'S EQ. FOR OPEN CHANNEL FLOW WILL BE USED.

$$Q = aKR^{\frac{2}{3}}S^{\frac{1}{2}}$$

WHERE: Q = FLOW THROUGH THE PIPE

a = CROSS SECTIONAL AREA OF THE PIPE

K = PIPE ROUGHNESS COEFFICIENT – CONSERVATIVELY ASSUME A VALUE OF 100

R = HYDRAULIC RADIUS WHICH EQUALS $\frac{d}{4}$ FOR A CLOSED PIPE

OMAHA DISTRICT	COMPUTATION SHEET	CORPS OF ENGINEERS
PROJECT NL INDUSTRIES	SHEET NO. 2	OF 2
ITEM DESIGN OF GEONET SUBDRAIN PIPE	BY / CHKD. BY	DATE / DATE

S = SLOPE OF PIPE = .5% MIN.

ASSUME THE USE OF AN 8 INCH MINIMUM DIAMETER PIPE:

$$Q = \frac{\pi\left(\frac{8''}{12}\right)^2}{4}(100)\left(\frac{\frac{8''}{12}}{4}\right)^{\frac{2}{3}}(.005)^{\frac{1}{2}}$$

$$Q = .75 \text{ FT}^3/\text{SEC}$$

$$Q_{REQUIRED} = 14 \text{ FT}^3/\text{DAY}/\text{FT} = .0002 \text{ FT}^3/\text{SEC}/\text{FT}$$

THE 8" DIA PIPE WILL BE USED. THIS IS MUCH LARGER THAN THAT REQUIRED FOR FLOW; HOWEVER, THIS IS CONSIDERED NECESSARY FOR MAINTENANCE PURPOSES.

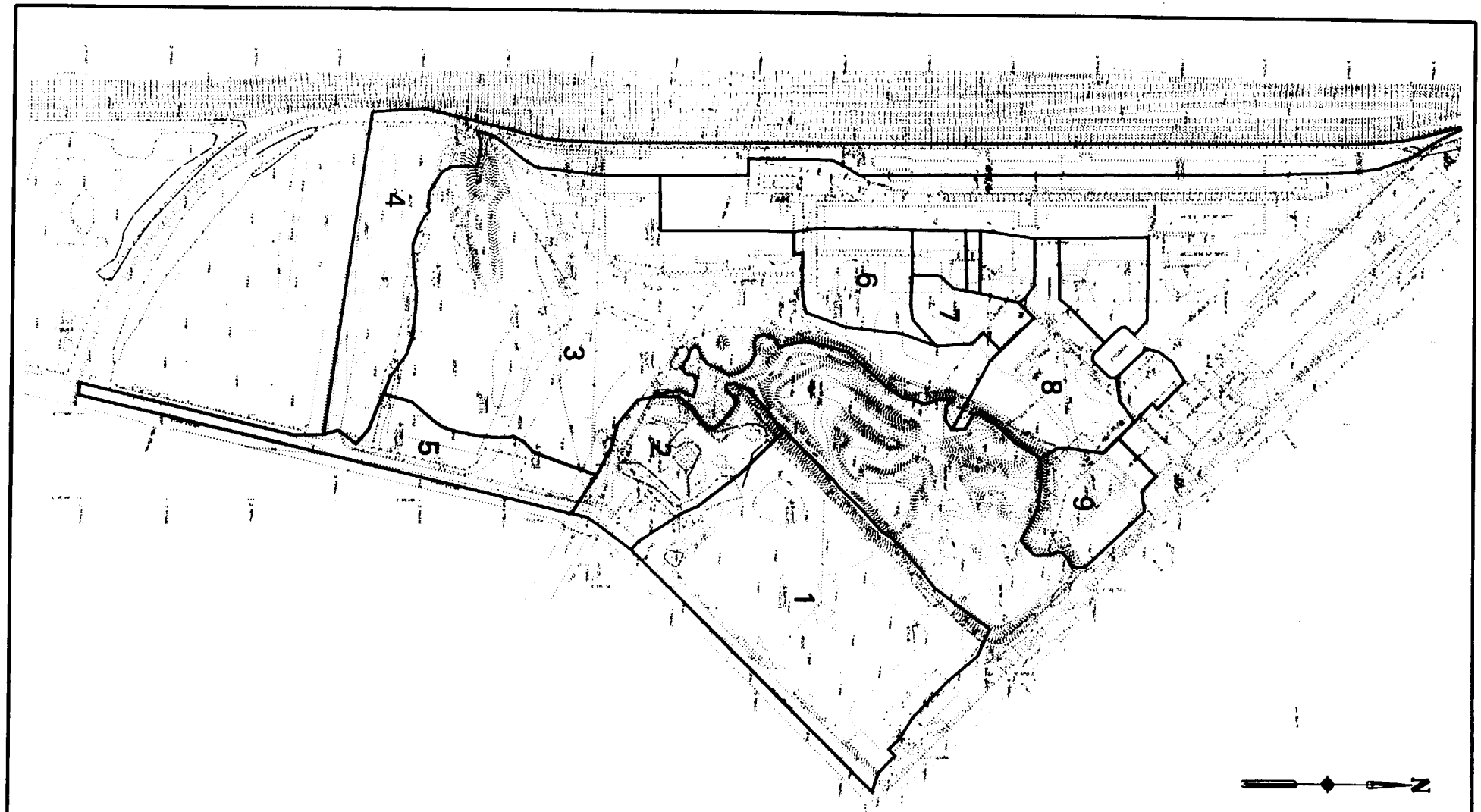
THE ALLOWABLE LENGTH OF PIPE BETWEEN OUTFALLS $= \frac{.75 \text{ FT}^3/\text{SEC}}{.0002 \text{ FT}^3/\text{SEC}/\text{FT}} = 3700 \text{ FT}$

APPENDIX C

DRAINAGE CALCULATIONS

APPENDIX C-1

EXISTING DRAINAGE



Sheet No. D-2	Computer File: DRAIN.DGN	Spec. No. DACX	U S ARMY ENGINEER DISTRICT CORPS OF ENGINEERS OMAHA, NEBRASKA	GRANITE CITY, ILLINOIS **N.L. INDUSTRIES/TARACORP** **EXISTING DRAINAGE SUBBASINS**	Submitted by: Chief Civil Engineering Section	Designed by: D.J.K.	Checked by: J.D.C.
	Date: X	Contract No. DACX				Reviewed by: J.A.V.H.	Drawn by: D.J.K.
	Drawing Code:						

C-1-2

HEC-1 INPUT

1. **Drainage Subbasin No. 1**

Initial Rainfall Loss = 0.3 inches
Uniform Rainfall Loss = 0.6 in/hr
Percentage of Drainage Area that is impervious = 5%
Drainage Area = 4.24 acres = 0.0066 sq mi
Overland Flow Length = 60 ft.
Representative Slope = 0.004 ft/ft
Roughness Coefficient = 0.2
Percentage of Subbasin this Element Represents = 100%
Collector Channel
    Channel Length = 355 ft.
    Channel Slope = 0.004 ft/ft
    Channel Roughness = 0.2
    Contributing Area = 0.0015 sq mi
    Channel Shape = TRAP
    Channel Bottom Width = 10 ft.
    Side Slopes = 200 Horizontal
    Route Upstream Hydrograph NO
Main Channel
    Left Overbank Manning's n = 0.10
    Channel Manning's n = 0.012
    Right Overbank Manning's n 0.2
    Reach Length = 520 ft.
    Energy Grade line Slope = 0.003 ft/ft
Route Upstream Hydrograph NO

2. **Drainage Subbasin No. 2**

Initial Rainfall Loss = 0.3 inches
Uniform Rainfall Loss = 0.6 in/hr
Percentage of Drainage Area that is impervious = 9%
Drainage Area = 1.28 acres = 0.0020 sq mi
Overland Flow Length = 60 ft.
Representative Slope = 0.009 ft/ft
Roughness Coefficient = 0.35
Percentage of Subbasin this Element Represents = 100%
Collector Channel
    Channel Length = 300 ft.
    Channel Slope = 0.009 ft/ft
    Channel Roughness = 0.035
    Contributing Area = 0.0013 sq mi
    Channel Shape = TRAP
    Channel Bottom Width = 10 ft.
    Side Slopes = 100 Horizontal
    Route Upstream Hydrograph NO
Main Channel
    Channel Length = 60 ft.
    Channel Slope = 0.009 ft/ft

Channel Roughness = 0.035
Contributing Area = 0.0020 sq mi
Channel Shape = TRAP
Channel Bottom Width = 10 ft.
Side Slopes = 100 Horizontal
Route Upstream Hydrograph NO

3. **Drainage Subbasin No. 3**

Initial Rainfall Loss = 0.3 inches
Uniform Rainfall Loss = 0.6 in/hr
Percentage of Drainage Area that is impervious = 40%
Drainage Area = 6.85 acres = 0.0107 sq mi
Overland Flow Length = 110 ft.
Representative Slope = 0.02 ft/ft
Roughness Coefficient = 0.05
Percentage of Subbasin this Element Represents = 100%
Collector Channel
Channel Length = 240 ft.
Channel Slope = 0.012 ft/ft
Channel Roughness = 0.012
Contributing Area = 0.59 acres = 0.0009 sq mi
Channel Shape = TRAP
Channel Bottom Width = 10 ft.
Side Slopes = 50 Horizontal
Route Upstream Hydrograph NO
Main Channel
Channel Length = 440 ft.
Channel Slope = 0.012 ft/ft
Channel Roughness = 0.035
Contributing Area = 6.26 acres = 0.0098 sq mi
Channel Shape = TRAP
Channel Bottom Width = 10 ft.
Side Slopes = 20 Horizontal
Route Upstream Hydrograph NO

Ponded Area No. 1
Maximum Area of Ponding = Approx. 51,111 SF
Approximate maximum ponding elev. = 414.7
Low Point elev. = 413.6
Approximate Ponded Volume = 19,000 cf

Existing catch basin
18" Diameter Inlet
Waterway Opening Approx. 1.3 sf
8" Diameter Outlet Pipe @ approximately 2.8% slope
Pipe Capacity = 1.5 cfs
Pipe capacity of 1.5 cfs controls drainage to 96" combined sewer

Outlet from pond in Area 3

Elev.	Ponded Area	Volume	Outflow (CFS)
413.6	50 sf	0 ac-ft	1.5
414.0	8,500 sf	0.04 ac-ft	1.5
414.7	78,598 sf	0.74 ac-ft	1.5
415.2	153,760 sf	2.07 ac-ft	21

Outlet modeled as a spillway 30-feet wide with 2% sideslopes

4. Drainage Subbasin No. 4

Initial Rainfall Loss = 0.3 inches
Uniform Rainfall Loss = 0.6 in/hr
Percentage of Drainage Area that is impervious = 39%
Drainage Area = 3.64 acres = 0.0057 sq mi
Overland Flow Length = 40 ft.
Representative Slope = 0.02 ft/ft
Roughness Coefficient = 0.20
Percentage of Subbasin this Element Represents = 100%
Collector Channel
Channel Length = 1800 ft.
Channel Slope = 0.003 ft/ft
Channel Roughness = 0.025
Contributing Area = 1.94 acres = 0.0030 sq mi
Channel Shape = TRAP
Channel Bottom Width = 8 ft.
Side Slopes = 2 Horizontal
Route Upstream Hydrograph NO
Main Channel
Channel Length = 300 ft.
Channel Slope = 0.009 ft/ft
Channel Roughness = 0.05
Contributing Area = 3.64 acres = 0.0057 sq mi
Channel Shape = TRAP
Channel Bottom Width = 10 ft.
Side Slopes = 50 Horizontal
Route Upstream Hydrograph NO

5. Drainage Subbasin No. 5

Initial Rainfall Loss = 0.3 inches
Uniform Rainfall Loss = 0.6 in/hr
Percentage of Drainage Area that is impervious = 50%
Drainage Area = 1.21 acres = 0.0019 sq mi
Overland Flow Length = 50 ft.
Representative Slope = 0.02 ft/ft
Roughness Coefficient = 0.05
Percentage of Subbasin this Element Represents = 100%
Left Overbank Manning's n = 0.10
Channel Manning's n = 0.015
Right Overbank Manning's n = 0.4

Reach Length = 885 ft.
Energy Grade line Slope = 0.0013 ft/ft
Route Upstream Hydrograph NO

```
ID NL INDUSTRIES/TARACORP SUPERFUND SITE
ID GRANITE CITY, IL
ID EXISTING DRAINAGE
ID DANNY KLIMA
ID US ARMY CORPS OF ENGINEERS
ID 15 NOV 96
ID 25-YEAR, 1-HOUR RAINSTORM, HEC-1 RAINFALL TIME DISTRIBUTION
* *DIAGRAM
*
IT    5 20SEP96   0005     20
IO    1
*
KK    A4
KM DRAINAGE AREA 4
PH              0.72   1.63   2.92
LU  0.3    0.6     60
BA .0057
UK   40    .02    .20    100
RD  1800   .003   .025  .0030   TRAP     8     2    NO
RD   300   .009    .05  .0057   TRAP    10    50    NO
ZW A=DRAINAGE AREA 4 C=FLOW
*
KK    A3
KM DRAINAGE AREA 3
LU  0.3    0.6     40
BA .0107
UK   60    .02    .10    100
RD   200   .012   .015  .0009   TRAP    10    50    NO
RD   700   .012   .035  .0107   TRAP    10    20    NO
ZW A=DRAINAGE AREA 3 C=FLOW
*
KK   DAM
KM DEPRESSION ACTING AS A RESERVOIR
RS    1   STOR
SV    0    .04   0.74   2.07
SQ  1.7    1.7    1.7     21
SE 413.6  414.0  414.7  415.2
ZW A=DEPRESSION C=STORAGE
ZW A=DEPRESSION C=STAGE
ZW A=DEPRESSION C=FLOW
*
KK    A5
KM DRAINAGE AREA 5
LU  0.3    0.6     50
BA .0019
UK   50    .02    .10    100
RD   885                                NO
RC  .10   .015    0.4    885  .0013
RX  100    120    140    146    165  165.5  265.5  365.5
RY 11.5   10.9   10.5  10.38     10   10.5   10.9   11.5
ZW A=DRAINAGE AREA 5 C=FLOW
*
KK    A1
KM DRAINAGE AREA 1
```

```
LU  0.3    0.6     5
BA .0066
UK   60  0.004    0.2    100
RD  355  0.004   .035  .0015   TRAP    10    200     NO
RD  520                                NO
RC 0.10   .012    0.2    520   .003
RX  100    120    140    146    165  165.5  265.5  365.5
RY 11.3   10.9   10.5  10.38     10   10.5   10.9   11.3
ZW A=DRAINAGE AREA 1 C=FLOW
*
KK   A2
KM DRAINAGE AREA 2
BA .0020
LU  0.3    0.6     9
UK   60  0.009   0.35    100
RD  300  0.009   .035  .0013   TRAP    10    100     NO
RD   60  0.009   .035  .0020   TRAP    10    100     NO
ZW A=DRAINAGE AREA 2 C=FLOW
*
KK  PTB
KM COMBINE RUNOFF FROM 3 DRAINAGE AREAS
HC    3
ZW A=EXISTING COMBO C=FLOW
*
ZZ
```

```
ID NL INDUSTRIES/TARACORP SUPERFUND SITE
ID GRANITE CITY, IL
ID EXISTING DRAINAGE
ID DANNY KLIMA
ID US ARMY CORPS OF ENGINEERS
ID 15 NOV 96
ID 25-YEAR, 2-HOUR RAINSTORM, HEC-1 RAINFALL TIME DISTRIBUTION
* *DIAGRAM
*
IT    5 20SEP96   0005     30
IO    1
*
KK    A4
KM DRAINAGE AREA 4
PH              0.72   1.63   2.92   3.60
LU  0.3    0.6     60
BA .0057
UK   40    .02    .20    100
RD  1800   .003   .025  .0030   TRAP     8     2    NO
RD   300   .009    .05  .0057   TRAP    10    50    NO
ZW A=DRAINAGE AREA 4 C=FLOW
*
KK    A3
KM DRAINAGE AREA 3
LU  0.3    0.6     40
BA .0107
UK   60    .02    .10    100
RD   200   .012   .015  .0009   TRAP    10    50    NO
RD   700   .012   .035  .0107   TRAP    10    20    NO
ZW A=DRAINAGE AREA 3 C=FLOW
*
KK   DAM
KM DEPRESSION ACTING AS A RESERVOIR
RS    1   STOR
SV    0    .04   0.74   2.07
SQ  1.7    1.7    1.7     21
SE 413.6  414.0  414.7  415.2
ZW A=DEPRESSION C=STORAGE
ZW A=DEPRESSION C=STAGE
ZW A=DEPRESSION C=FLOW
*
KK    A5
KM DRAINAGE AREA 5
LU  0.3    0.6     50
BA .0019
UK   50    .02    .10    100
RD   885                                NO
RC   .10   .015    0.4    885   .0013
RX   100    120    140    146    165   165.5   265.5   365.5
RY  11.5   10.9   10.5  10.38     10    10.5    10.9    11.5
ZW A=DRAINAGE AREA 5 C=FLOW
*
KK    A1
KM DRAINAGE AREA 1
```

```
LU  0.3    0.6     5
BA .0066
UK   60  0.004    0.2    100
RD  355  0.004   .035  .0015   TRAP     10    200     NO
RD  520                                  NO
RC 0.10   .012    0.2    520   .003
RX  100    120    140    146    165  165.5  265.5  365.5
RY 11.3   10.9   10.5  10.38     10   10.5   10.9   11.3
ZW A=DRAINAGE AREA 1 C=FLOW
*
KK   A2
KM DRAINAGE AREA 2
BA .0020
LU  0.3    0.6     9
UK   60  0.009   0.35    100
RD  300  0.009   .035  .0013   TRAP     10    100     NO
RD   60  0.009   .035  .0020   TRAP     10    100     NO
ZW A=DRAINAGE AREA 2 C=FLOW
*
KK  PTB
KM COMBINE RUNOFF FROM 3 DRAINAGE AREAS
HC    3
ZW A=EXISTING COMBO C=FLOW
*
ZZ
```

```
ID NL INDUSTRIES/TARACORP SUPERFUND SITE
ID GRANITE CITY, IL
ID EXISTING DRAINAGE
ID DANNY KLIMA
ID US ARMY CORPS OF ENGINEERS
ID 15 NOV 96
ID 25-YEAR, 3-HOUR RAINSTORM, HEC-1 RAINFALL TIME DISTRIBUTION
* *DIAGRAM
*
IT    5 20SEP96   0005     45
IO    1
*
KK    A4
KM DRAINAGE AREA 4
PH              0.72   1.63   2.92   3.60   3.88
LU  0.3    0.6     60
BA .0057
UK   40    .02    .20    100
RD  1800   .003   .025  .0030   TRAP     8     2    NO
RD   300   .009    .05  .0057   TRAP    10    50    NO
ZW A=DRAINAGE AREA 4 C=FLOW
*
KK    A3
KM DRAINAGE AREA 3
LU  0.3    0.6     40
BA .0107
UK   60    .02    .10    100
RD   200   .012   .015  .0009   TRAP    10    50    NO
RD   700   .012   .035  .0107   TRAP    10    20    NO
ZW A=DRAINAGE AREA 3 C=FLOW
*
KK   DAM
KM DEPRESSION ACTING AS A RESERVOIR
RS    1   STOR
SV    0    .04   0.74   2.07
SQ  1.7    1.7    1.7     21
SE 413.6  414.0  414.7  415.2
ZW A=DEPRESSION C=STORAGE
ZW A=DEPRESSION C=STAGE
ZW A=DEPRESSION C=FLOW
*
KK    A5
KM DRAINAGE AREA 5
LU  0.3    0.6     50
BA .0019
UK   50    .02    .10    100
RD   885                                   NO
RC  .10   .015    0.4    885  .0013
RX  100    120    140    146    165  165.5  265.5  365.5
RY 11.5   10.9   10.5  10.38     10   10.5   10.9   11.5
ZW A=DRAINAGE AREA 5 C=FLOW
*
KK    A1
KM DRAINAGE AREA 1
```

```
LU  0.3    0.6     5
BA .0066
UK   60  0.004    0.2    100
RD  355  0.004   .035  .0015   TRAP    10    200     NO
RD  520                                NO
RC 0.10   .012    0.2    520   .003
RX  100    120    140    146    165  165.5  265.5  365.5
RY 11.3   10.9   10.5  10.38     10   10.5   10.9   11.3
ZW A=DRAINAGE AREA 1 C=FLOW
*
KK   A2
KM DRAINAGE AREA 2
BA .0020
LU  0.3    0.6     9
UK   60  0.009   0.35    100
RD  300  0.009   .035  .0013   TRAP    10    100     NO
RD   60  0.009   .035  .0020   TRAP    10    100     NO
ZW A=DRAINAGE AREA 2 C=FLOW
*
KK  PTB
KM COMBINE RUNOFF FROM 3 DRAINAGE AREAS
HC    3
ZW A=EXISTING COMBO C=FLOW
*
ZZ
```

```
ID NL INDUSTRIES/TARACORP SUPERFUND SITE
ID GRANITE CITY, IL
ID EXISTING DRAINAGE
ID DANNY KLIMA
ID US ARMY CORPS OF ENGINEERS
ID 15 NOV 96
ID 25-YEAR, 24-HOUR RAINSTORM, HEC-1 RAINFALL TIME DISTRIBUTION
* *DIAGRAM
*
IT    5 20SEP96   0005    288
IO    1
*
KK    A4
KM DRAINAGE AREA 4
PH              0.72   1.63   2.92   3.60   3.88   4.58   5.25   6.02
LU  0.3    0.6     60
BA .0057
UK   40    .02    .20    100
RD  1800   .003   .025  .0030   TRAP     8     2    NO
RD   300   .009    .05  .0057   TRAP    10    50    NO
ZW A=DRAINAGE AREA 4 C=FLOW
*
KK    A3
KM DRAINAGE AREA 3
LU  0.3    0.6     40
BA .0107
UK   60    .02    .10    100
RD   200   .012   .015  .0009   TRAP    10    50    NO
RD   700   .012   .035  .0107   TRAP    10    20    NO
ZW A=DRAINAGE AREA 3 C=FLOW
*
KK   DAM
KM DEPRESSION ACTING AS A RESERVOIR
RS    1   STOR
SV    0    .04   0.74   2.07
SQ  1.7    1.7    1.7     21
SE 413.6  414.0  414.7  415.2
ZW A=DEPRESSION C=STORAGE
ZW A=DEPRESSION C=STAGE
ZW A=DEPRESSION C=FLOW
*
KK    A5
KM DRAINAGE AREA 5
LU  0.3    0.6     50
BA .0019
UK   50    .02    .10    100
RD   885                                NO
RC   .10   .015    0.4    885   .0013
RX   100    120    140    146    165  165.5  265.5  365.5
RY  11.5   10.9   10.5  10.38     10   10.5   10.9   11.5
ZW A=DRAINAGE AREA 5 C=FLOW
*
KK    A1
KM DRAINAGE AREA 1
```

```
LU  0.3    0.6     5
BA .0066
UK   60  0.004    0.2    100
RD  355  0.004   .035  .0015   TRAP    10    200    NO
RD  520                                NO
RC 0.10   .012    0.2    520   .003
RX  100    120    140    146    165  165.5  265.5  365.5
RY 11.3   10.9   10.5  10.38     10   10.5   10.9   11.3
ZW A=DRAINAGE AREA 1 C=FLOW
*
KK   A2
KM DRAINAGE AREA 2
BA .0020
LU  0.3    0.6     9
UK   60  0.009   0.35    100
RD  300  0.009   .035  .0013   TRAP    10    100    NO
RD   60  0.009   .035  .0020   TRAP    10    100    NO
ZW A=DRAINAGE AREA 2 C=FLOW
*
KK  PTB
KM COMBINE RUNOFF FROM 3 DRAINAGE AREAS
HC    3
ZW A=EXISTING COMBO C=FLOW
*
ZZ
```

```
ID NL INDUSTRIES/TARACORP SUPERFUND SITE
ID GRANITE CITY, IL
ID EXISTING DRAINAGE
ID DANNY KLIMA
ID US ARMY CORPS OF ENGINEERS
ID 15 NOV 96
ID 25-YEAR, 1-HOUR RAINSTORM, ISWS BULLETIN-70 RAINFALL DISTRIBUTION
* *DIAGRAM
*
IT    5 20SEP96   0005     20
IO    1
*
KK    A4
KM DRAINAGE AREA 4
IN    3 20SEP96   0005
PB  2.92
PC  .16    .33    .43    .52    .60    .66    .71    .75    .79    .82
PC  .84    .86    .88    .90    .92    .94    .96    .97    .98    1.0
LU  0.3    0.6    60
BA .0057
UK   40    .02    .20    100
RD  1800   .003   .025  .0030   TRAP    8     2     NO
RD  300    .009   .05   .0057   TRAP   10    50     NO
ZW A=DRAINAGE AREA 4 C=FLOW
*
KK    A3
KM DRAINAGE AREA 3
LU  0.3    0.6    40
BA .0107
UK   60    .02    .10    100
RD  200    .012   .015  .0009   TRAP   10    50     NO
RD  700    .012   .035  .0107   TRAP   10    20     NO
ZW A=DRAINAGE AREA 3 C=FLOW
*
KK   DAM
KM DEPRESSION ACTING AS A RESERVOIR
RS    1   STOR
SV    0    .04   0.74   2.07
SQ  1.7    1.7    1.7    21
SE 413.6  414.0  414.7  415.2
ZW A=DEPRESSION C=STORAGE
ZW A=DEPRESSION C=STAGE
ZW A=DEPRESSION C=FLOW
*
KK    A5
KM DRAINAGE AREA 5
LU  0.3    0.6    50
BA .0019
UK   50    .02    .10    100
RD  885                              NO
RC  .10   .015    0.4    885  .0013
RX  100    120    140    146    165  165.5  265.5  365.5
RY  11.5   10.9   10.5  10.38    10   10.5   10.9   11.5
ZW A=DRAINAGE AREA 5 C=FLOW
```

```
*
KK   A1
KM DRAINAGE AREA 1
LU  0.3    0.6     5
BA .0066
UK   60  0.004    0.2    100
RD  355  0.004   .035  .0015   TRAP    10    200    NO
RD  520                                NO
RC 0.10   .012    0.2    520   .003
RX  100    120    140    146    165  165.5  265.5  365.5
RY 11.3   10.9   10.5  10.38     10   10.5   10.9   11.3
ZW A=DRAINAGE AREA 1 C=FLOW
*
KK   A2
KM DRAINAGE AREA 2
BA .0020
LU  0.3    0.6     9
UK   60  0.009   0.35    100
RD  300  0.009   .035  .0013   TRAP    10    100    NO
RD   60  0.009   .035  .0020   TRAP    10    100    NO
ZW A=DRAINAGE AREA 2 C=FLOW
*
KK  PTB
KM COMBINE RUNOFF FROM 3 DRAINAGE AREAS
HC    3
ZW A=EXISTING COMBO C=FLOW
*
ZZ
```

```
ID NL INDUSTRIES/TARACORP SUPERFUND SITE
ID GRANITE CITY, IL
ID EXISTING DRAINAGE
ID DANNY KLIMA
ID US ARMY CORPS OF ENGINEERS
ID 15 NOV 96
ID 25-YEAR, 2-HOUR RAINSTORM, ISWS BULLETIN-70 RAINFALL DISTRIBUTION
* *DIAGRAM
*
IT    5 20SEP96   0005     30
IO    1
*
KK    A4
KM DRAINAGE AREA 4
IN    6 20SEP96   0005
PB  3.60
PC  .16    .33    .43    .52    .60    .66    .71    .75    .79    .82
PC  .84    .86    .88    .90    .92    .94    .96    .97    .98    1.0
LU  0.3    0.6    60
BA .0057
UK   40    .02    .20    100
RD  1800   .003   .025  .0030   TRAP     8     2    NO
RD   300   .009    .05  .0057   TRAP     1    50    NO
ZW A=DRAINAGE AREA 4 C=FLOW
*
KK    A3
KM DRAINAGE AREA 3
LU  0.3    0.6    40
BA .0107
UK   60    .02    .10    100
RD   200   .012   .015  .0009   TRAP    10    50    NO
RD   700   .012   .035  .0107   TRAP    10    20    NO
ZW A=DRAINAGE AREA 3 C=FLOW
*
KK   DAM
KM DEPRESSION ACTING AS A RESERVOIR
RS    1   STOR
SV    0    .04   0.74   2.07
SQ  1.7    1.7    1.7    21
SE 413.6  414.0  414.7  415.2
ZW A=DEPRESSION C=STORAGE
ZW A=DEPRESSION C=STAGE
ZW A=DEPRESSION C=FLOW
*
KK    A5
KM DRAINAGE AREA 5
LU  0.3    0.6    50
BA .0019
UK   50    .02    .10    100
RD  885                          NO
RC  .10   .015    0.4    885  .0013
RX  100    120    140    146    165  165.5  265.5  365.5
RY 11.5   10.9   10.5  10.38     10   10.5   10.9   11.5
ZW A=DRAINAGE AREA 5 C=FLOW
```

```
*
KK   A1
KM DRAINAGE AREA 1
LU  0.3    0.6     5
BA .0066
UK   60  0.004    0.2    100
RD  355  0.004   .035  .0015   TRAP    10    200    NO
RD  520                                NO
RC 0.10   .012    0.2    520   .003
RX  100    120    140    146    165  165.5  265.5  365.5
RY 11.3   10.9   10.5  10.38     10   10.5   10.9   11.3
ZW A=DRAINAGE AREA 1 C=FLOW
*
KK   A2
KM DRAINAGE AREA 2
BA .0020
LU  0.3    0.6     9
UK   60  0.009   0.35    100
RD  300  0.009   .035  .0013   TRAP    10    100    NO
RD   60  0.009   .035  .0020   TRAP    10    100    NO
ZW A=DRAINAGE AREA 2 C=FLOW
*
KK  PTB
KM COMBINE RUNOFF FROM 3 DRAINAGE AREAS
HC    3
ZW A=EXISTING COMBO C=FLOW
*
ZZ
```

```
ID NL INDUSTRIES/TARACORP SUPERFUND SITE
ID GRANITE CITY, IL
ID EXISTING DRAINAGE
ID DANNY KLIMA
ID US ARMY CORPS OF ENGINEERS
ID 15 NOV 96
ID 25-YEAR, 3-HOUR RAINSTORM, ISWS BULLETIN-70 RAINFALL TIME DISTRIBUTION
* *DIAGRAM
*
IT    5 20SEP96   0005     45
IO    1
*
KK    A4
KM DRAINAGE AREA 4
IN    9 20SEP96   0005
PB  3.88
PC  .16   .33   .43   .52   .60   .66   .71   .75   .79   .82
PC  .84   .86   .88   .90   .92   .94   .96   .97   .98   1.0
LU  0.3   0.6   60
BA .0057
UK   40   .02   .20   100
RD  1800   .003   .025  .0030   TRAP    8    2    NO
RD  300   .009   .05  .0057   TRAP    10   50   NO
ZW A=DRAINAGE AREA 4 C=FLOW
*
KK    A3
KM DRAINAGE AREA 3
LU  0.3   0.6   40
BA .0107
UK   60   .02   .10   100
RD  200   .012   .015  .0009   TRAP    10   50   NO
RD  700   .012   .035  .0107   TRAP    10   20   NO
ZW A=DRAINAGE AREA 3 C=FLOW
*
KK   DAM
KM DEPRESSION ACTING AS A RESERVOIR
RS    1   STOR
SV    0   .04   0.74   2.07
SQ  1.7   1.7   1.7   21
SE 413.6  414.0  414.7  415.2
ZW A=DEPRESSION C=STORAGE
ZW A=DEPRESSION C=STAGE
ZW A=DEPRESSION C=FLOW
*
KK    A5
KM DRAINAGE AREA 5
LU  0.3   0.6   50
BA .0019
UK   50   .02   .10   100
RD  885                          NO
RC  .10   .015   0.4   885  .0013
RX  100   120   140   146   165  165.5  265.5  365.5
RY  11.5   10.9   10.5  10.38   10   10.5   10.9   11.5
ZW A=DRAINAGE AREA 5 C=FLOW
```

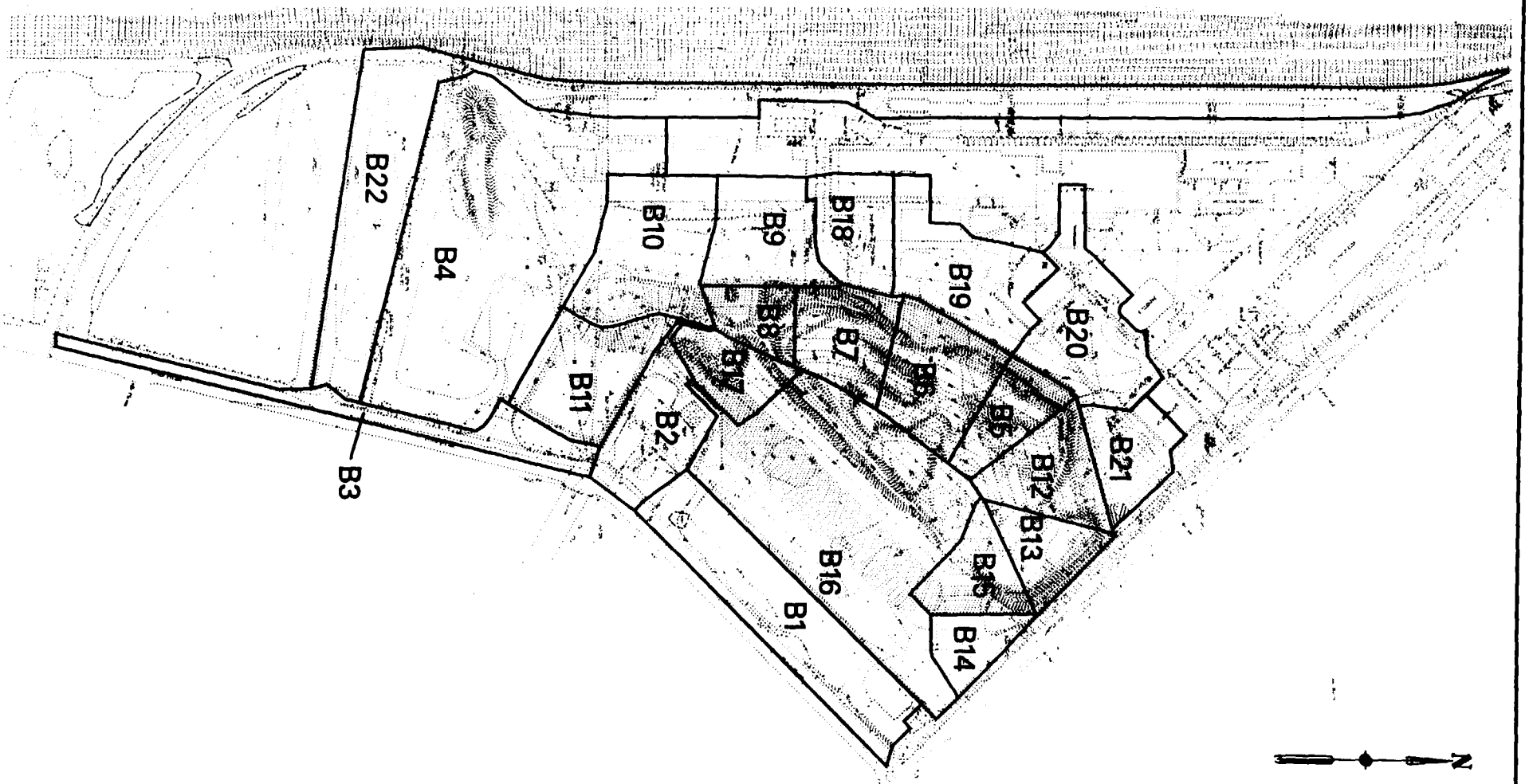
```
*
KK   A1
KM DRAINAGE AREA 1
LU  0.3    0.6     5
BA .0066
UK   60  0.004    0.2    100
RD  355  0.004   .035  .0015   TRAP    10    200    NO
RD  520                                NO
RC 0.10   .012    0.2    520   .003
RX  100    120    140    146    165  165.5  265.5  365.5
RY 11.3   10.9   10.5  10.38     10   10.5   10.9   11.3
ZW A=DRAINAGE AREA 1 C=FLOW
*
KK   A2
KM DRAINAGE AREA 2
BA .0020
LU  0.3    0.6     9
UK   60  0.009   0.35    100
RD  300  0.009   .035  .0013   TRAP    10    100    NO
RD   60  0.009   .035  .0020   TRAP    10    100    NO
ZW A=DRAINAGE AREA 2 C=FLOW
*
KK   PTB
KM COMBINE RUNOFF FROM 3 DRAINAGE AREAS
HC    3
ZW A=EXISTING COMBO C=FLOW
*
ZZ
```

```
ID NL INDUSTRIES/TARACORP SUPERFUND SITE
ID GRANITE CITY, IL
ID EXISTING DRAINAGE
ID DANNY KLIMA
ID US ARMY CORPS OF ENGINEERS
ID 15 NOV 96
ID 25-YEAR, 24-HOUR RAINSTORM, ISWS BULLETIN-70 RAINFALL TIME DISTRIBUTION
* *DIAGRAM
*
IT    5 20SEP96   0005    288
IO    1
*
KK    A4
KM DRAINAGE AREA 4
IN   72 20SEP96   0005
PB  6.02
PC  .03    .06    .09    .12    .15    .19    .23    .27    .32    .38
PC  .45    .57    .70    .79    .85    .89    .92    .95    .97    1.0
LU  0.3    0.6    60
BA .0057
UK   40    .02    .20    100
RD  1800   .003   .025  .0030   TRAP     8     2    NO
RD  300    .009   .05   .0057   TRAP    10    50    NO
ZW A=DRAINAGE AREA 4 C=FLOW
*
KK    A3
KM DRAINAGE AREA 3
LU  0.3    0.6    40
BA .0107
UK   60    .02    .10    100
RD  200    .012   .015  .0009   TRAP    10    50    NO
RD  700    .012   .035  .0107   TRAP    10    20    NO
ZW A=DRAINAGE AREA 3 C=FLOW
*
KK   DAM
KM DEPRESSION ACTING AS A RESERVOIR
RS    1   STOR
SV    0    .04   0.74   2.07
SQ  1.7    1.7    1.7    21
SE 413.6  414.0  414.7  415.2
ZW A=DEPRESSION C=STORAGE
ZW A=DEPRESSION C=STAGE
ZW A=DEPRESSION C=FLOW
*
KK    A5
KM DRAINAGE AREA 5
LU  0.3    0.6    50
BA .0019
UK   50    .02    .10    100
RD  885                              NO
RC  .10   .015    0.4    885  .0013
RX  100    120    140    146    165  165.5  265.5  365.5
RY 11.5   10.9   10.5  10.38     10   10.5   10.9   11.5
ZW A=DRAINAGE AREA 5 C=FLOW
```

```
*
KK   A1
KM DRAINAGE AREA 1
LU  0.3    0.6     5
BA .0066
UK   60  0.004    0.2    100
RD  355  0.004   .035  .0015   TRAP     10    200     NO
RD  520                                  NO
RC 0.10   .012    0.2    520   .003
RX  100    120    140    146    165  165.5  265.5  365.5
RY 11.3   10.9   10.5  10.38     10   10.5   10.9   11.3
ZW A=DRAINAGE AREA 1 C=FLOW
*
KK   A2
KM DRAINAGE AREA 2
BA .0020
LU  0.3    0.6     9
UK   60  0.009   0.35    100
RD  300  0.009   .035  .0013   TRAP     10    100     NO
RD   60  0.009   .035  .0020   TRAP     10    100     NO
ZW A=DRAINAGE AREA 2 C=FLOW
*
KK   PTB
KM COMBINE RUNOFF FROM 3 DRAINAGE AREAS
HC    3
ZW A=EXISTING COMBO C=FLOW
*
ZZ
```

APPENDIX C-2

NEW DRAINAGE



Sheet No. D-2	Computer File: DRAIN3.DGN	Spec. No. DACX	U S ARMY ENGINEER DISTRICT CORPS OF ENGINEERS OMAHA, NEBRASKA	GRANITE CITY, ILLINOIS **N.L. INDUSTRIES/TARACORP** DRAINAGE SUBBASINS	Submitted by: Chief Civil Engineering Section	Designed by: D.J.K. / Checked by: J.D.C.
	Date: X	Contract No. DACX				Reviewed by: J.A.V.H. / Drawn by: D.J.K.
	Drawing Code:					

C-2-2

HEC-1 INPUT

1. **Drainage Subbasin No. B12**

Initial Rainfall Loss = 0.1 inches
Uniform Rainfall Loss = 0.05 in/hr
Percentage of Drainage Area that is impervious = 0%
Drainage Area = 0.65 acres = .0010 sq mi
Overland Flow Length = 170 ft.
Representative Slope = 0.05 ft/ft
Roughness Coefficient = 0.4
Percentage of Subbasin this Element Represents = 100%
Main Channel
Channel Length = 145 ft.
Channel Slope = 0.01 ft/ft
Channel Roughness = .035
Contributing Area = 0.65 acres = .0010 sq mi
Channel Shape = TRAP
Channel Bottom Width = 0 ft.
Side Slopes = 3 Horizontal
Route Upstream Hydrograph NO

2. **Drainage Subbasin No. B13**

Initial Rainfall Loss = 0.1 inches
Uniform Rainfall Loss = 0.05 in/hr
Percentage of Drainage Area that is impervious = 0%
Drainage Area = 0.45 acres = .0007 sq mi
Overland Flow Length = 160 ft.
Representative Slope = 0.05 ft/ft
Roughness Coefficient = 0.4
Percentage of Subbasin this Element Represents = 100%
Main Channel
Channel Length = 70 ft.
Channel Slope = .01 ft/ft
Channel Roughness = .035
Contributing Area = 0.45 acres = .0007 sq mi
Channel Bottom Width = 0 ft.
Side Slopes = 3 Horizontal
Route Upstream Hydrograph NO

3. **Drainage Subbasin No. B14**

Initial Rainfall Loss = 0.2 inches
Uniform Rainfall Loss = 0.3 in/hr
Percentage of Drainage Area that is impervious = 5%
Drainage Area = 0.33 acres = .0005 sq mi
Overland Flow Length = 15 ft.
Representative Slope = 0.04 ft/ft
Roughness Coefficient = 0.4
Percentage of Subbasin this Element Represents = 100%

Collector Channel
Channel Length = 60 ft.
Channel Slope = 0.019 ft/ft
Channel Roughness = 0.012
Contributing Area = 0.032 acres = 0.0001 sq mi
Channel Shape = TRAP
Channel Bottom Width = 3 ft.
Side Slopes = 0.1 Horizontal
Route Upstream Hydrograph YES

Main Channel
Channel Length = 130 ft.
Channel Slope = 0.01 ft/ft
Channel Roughness = 0.10
Contributing Area = 0.33 acres = 0.0005 sq mi
Channel Shape = TRAP
Channel Bottom Width = 6 ft.
Side Slopes = 25 Horizontal
Route Upstream Hydrograph YES

4. Drainage Subbasin No. B15

Initial Rainfall Loss = 0.1 inches
Uniform Rainfall Loss = 0.05 in/hr
Percentage of Drainage Area that is impervious = 0%
Drainage Area = 0.49 acres = .0008 sq mi
Overland Flow Length = 160 ft.
Representative Slope = 0.05 ft/ft
Roughness Coefficient = 0.4
Percentage of Subbasin this Element Represents = 100%
Main Channel
Channel Length = 65 ft.
Channel Slope = 0.01 ft/ft
Channel Roughness = .035
Contributing Area = 0.49 acres = .0008 sq mi
Channel Shape = TRAP
Channel Bottom Width = 0 ft.
Side Slopes = 3 Horizontal
Route Upstream Hydrograph NO

5. Drainage Subbasin No. B16

Initial Rainfall Loss = 0.19 inches
Uniform Rainfall Loss = 0.29 in/hr
Percentage of Drainage Area that is impervious = 0%
Drainage Area = 3.20 acres = .0050 sq mi
Overland Flow Length = 240 ft.
Representative Slope = 0.12 ft/ft
Roughness Coefficient = 0.4
Percentage of Subbasin this Element Represents = 100%
Main Channel
Channel Length = 380 ft.

Channel Slope = 0.005 ft/ft
Channel Roughness = 0.10
Contributing Area = 3.20 acres = 0.0050 sq mi
Channel Shape = TRAP
Channel Bottom Width = 6 ft.
Side Slopes = 25 Horizontal
Route Upstream Hydrograph YES

6. **Drainage Subbasin No. B17**

Initial Rainfall Loss = 0.1 inches
Uniform Rainfall Loss = 0.05 in/hr
Percentage of Drainage Area that is impervious = 0%
Drainage Area = 0.44 acres = .0007 sq mi
Overland Flow Length = 105 ft.
Representative Slope = 0.05 ft/ft
Roughness Coefficient = 0.4
Percentage of Subbasin this Element Represents = 100%
Main Channel
Channel Length = 90 ft.
Channel Slope = 0.01 ft/ft
Channel Roughness = 0.035
Contributing Area = 0.44 acres = 0.0007 sq mi
Channel Shape = TRAP
Channel Bottom Width = 0 ft.
Side Slopes = 3 Horizontal
Route Upstream Hydrograph NO

7. **Drainage Subbasin No. B5**

Initial Rainfall Loss = 0.1 inches
Uniform Rainfall Loss = 0.05 in/hr
Percentage of Drainage Area that is impervious = 2%
Drainage Area = 0.45 acres = .0007 sq mi
Overland Flow Length = 215 ft.
Representative Slope = 0.11 ft/ft
Roughness Coefficient = 0.4
Percentage of Subbasin this Element Represents = 100%
Main Channel
Channel Length = 50 ft.
Channel Slope = 0.005 ft/ft
Channel Roughness = 0.012
Contributing Area = 0.45 acres = 0.0007 sq mi
Channel Shape = TRAP
Channel Bottom Width = 3 ft.
Side Slopes = 0.1 Horizontal
Route Upstream Hydrograph NO

8. **Drainage Subbasin No. B6**

Initial Rainfall Loss = 0.1 inches
Uniform Rainfall Loss = 0.05 in/hr

Percentage of Drainage Area that is impervious = 2%
Drainage Area = 0.84 acres = .0013 sq mi
Overland Flow Length = 210 ft.
Representative Slope = 0.11 ft/ft
Roughness Coefficient = 0.4
Percentage of Subbasin this Element Represents = 100%
Main Channel
Channel Length = 210 ft.
Channel Slope = .0066 ft/ft
Channel Roughness = 0.012
Contributing Area = 0.84 acres = .0013 sq mi
Channel Shape = TRAP
Channel Bottom Width = 3 ft.
Side Slopes = 0.1 Horizontal
Route Upstream Hydrograph YES

9. Drainage Subbasin No. B7

Initial Rainfall Loss = 0.1 inches
Uniform Rainfall Loss = 0.05 in/hr
Percentage of Drainage Area that is impervious = 2%
Drainage Area = 0.63 acres = .0010 sq mi
Overland Flow Length = 145 ft.
Representative Slope = 0.05 ft/ft
Roughness Coefficient = 0.40
Percentage of Subbasin this Element Represents = 100%
Main Channel
Channel Length = 165 ft.
Channel Slope = 0.01 ft/ft
Channel Roughness = .035
Contributing Area = 0.63 acres = .0010 sq mi
Channel Shape = TRAP
Channel Bottom Width = 0 ft.
Side Slopes = 3 Horizontal
Route Upstream Hydrograph NO

10. Drainage Subbasin No. B8

Initial Rainfall Loss = 0.1 inches
Uniform Rainfall Loss = 0.05 in/hr
Percentage of Drainage Area that is impervious = 0%
Drainage Area = 0.35 acres = .0006 sq mi
Overland Flow Length = 38 ft.
Representative Slope = 0.05 ft/ft
Roughness Coefficient = 0.40
Percentage of Subbasin this Element Represents = 100%
Main Channel
Channel Length = 130 ft.
Channel Slope = 0.01 ft/ft
Channel Roughness = .035
Contributing Area = 0.35 acres = .0006 sq mi
Channel Shape = TRAP

Channel Bottom Width = 0 ft.
Side Slopes = 3 Horizontal
Route Upstream Hydrograph NO

11. Drainage Subbasin No. B9

Initial Rainfall Loss = 0.3 inches
Uniform Rainfall Loss = 0.6 in/hr
Percentage of Drainage Area that is impervious = 16%
Drainage Area = 1.38 acres = 0.0022 sq mi
Overland Flow Length = 140 ft.
Representative Slope = 0.01 ft/ft
Roughness Coefficient = 0.20
Percentage of Subbasin this Element Represents = 100%
Main Channel
Channel Length = 160 ft.
Channel Slope = 0.015 ft/ft
Channel Roughness = .012
Contributing Area = 1.38 acres = 0.0022 sq mi
Channel Shape = TRAP
Channel Bottom Width = 5 ft.
Side Slopes = 0.1 Horizontal
Route Upstream Hydrograph YES

12. Drainage Subbasin No. B10

Initial Rainfall Loss = 0.17 inches
Uniform Rainfall Loss = 0.29 in/hr
Percentage of Drainage Area that is impervious = 24%
Drainage Area = 1.15 acres = 0.0018 sq mi
Overland Flow Length = 110 ft.
Representative Slope = 0.02 ft/ft
Roughness Coefficient = 0.15
Percentage of Subbasin this Element Represents = 100%
Main Channel
Channel Length = 105 ft.
Channel Slope = 0.008 ft/ft
Channel Roughness = 0.012
Contributing Area = 1.15 acres = 0.0018 sq mi
Channel Shape = TRAP
Channel Bottom Width = 5 ft.
Side Slopes = 0.1 Horizontal
Route Upstream Hydrograph YES

13. Drainage Subbasin No. B11

Initial Rainfall Loss = 0.21 inches
Uniform Rainfall Loss = 0.33 in/hr
Percentage of Drainage Area that is impervious = 0%
Drainage Area = 0.86 acres = .0013 sq mi
Overland Flow Length = 80 ft.
Representative Slope = 0.25 ft/ft

Roughness Coefficient = 0.4
Percentage of Subbasin this Element Represents = 100%
Main Channel
Channel Length = 20 ft.
Channel Slope = 0.02 ft/ft
Channel Roughness = 0.035
Contributing Area = 0.86 acres = .0013 sq mi
Channel Shape = TRAP
Channel Bottom Width = 6 ft.
Side Slopes = 50 Horizontal
Route Upstream Hydrograph NO

14. Drainage Subbasin No. B4

Initial Rainfall Loss = 0.2 inches
Uniform Rainfall Loss = 0.32 in/hr
Percentage of Drainage Area that is impervious = 8%
Drainage Area = 4.02 acres = .0063 sq mi
Overland Flow Length = 115 ft.
Representative Slope = 0.005 ft/ft
Roughness Coefficient = 0.2
Percentage of Subbasin this Element Represents = 5%
Overland Flow Length = 250 ft.
Representative Slope = 0.02 ft/ft
Roughness Coefficient = 0.4
Percentage of Subbasin this Element Represents = 95%
Main Channel
Channel Length = 30 ft.
Channel Slope = 0.005 ft/ft
Channel Roughness = 0.035
Contributing Area = 4.02 acres = .0063 sq mi
Channel Shape = TRAP
Channel Bottom Width = 10 ft.
Side Slopes = 50 Horizontal
Route Upstream Hydrograph NO

15. Drainage Subbasin No. B1

Initial Rainfall Loss = 0.17 inches
Uniform Rainfall Loss = 0.26 in/hr
Percentage of Drainage Area that is impervious = 22%
Drainage Area = 1.51 acres = 0.0024 sq mi
Overland Flow Length = 80 ft.
Representative Slope = 0.008 ft/ft
Roughness Coefficient = 0.2
Percentage of Subbasin this Element Represents = 100%
Left Overbank Manning's n = 0.05
Channel Manning's n = 0.012
Right Overbank Manning's n = 0.2
Reach Length = 595 ft.
Energy Grade line Slope = 0.003 ft/ft
Route Upstream Hydrograph NO

16. Drainage Subbasin No. B2

Initial Rainfall Loss = 0.21 inches
Uniform Rainfall Loss = 0.36 in/hr
Percentage of Drainage Area that is impervious = 11%
Drainage Area = 0.75 acres = 0.0012 sq mi
Overland Flow Length = 75 ft.
Representative Slope = 0.25 ft/ft
Roughness Coefficient = 0.40
Percentage of Subbasin this Element Represents = 100%
Main Channel
Channel Length = 200 ft.
Channel Slope = 0.007 ft/ft
Channel Roughness = 0.35
Contributing Area = 0.75 acres = 0.0012 sq mi
Channel Shape = TRAP
Channel Bottom Width = 20 ft.
Side Slopes = 100 Horizontal
Route Upstream Hydrograph NO

17. Drainage Subbasin No. B3

Initial Rainfall Loss = 0.3 inches
Uniform Rainfall Loss = 0.6 in/hr
Percentage of Drainage Area that is impervious = 70%
Drainage Area = 0.74 acres = 0.0012 sq mi
Overland Flow Length = 50 ft.
Representative Slope = 0.02 ft/ft
Roughness Coefficient = 0.10
Percentage of Subbasin this Element Represents = 100%
Left Overbank Manning's n = 0.05
Channel Manning's n = 0.012
Right Overbank Manning's n = 0.4
Reach Length = 885 ft.
Energy Grade line Slope = 0.0013 ft/ft
Route Upstream Hydrograph NO

Detention Basin A-2

Elev.	Ponded Area	Volume	Outflow (CFS)
412.50	16 sf	0 ac-ft	0 cfs
413.00	5017 sf	0.0288 ac-ft	0.27 cfs
414.00	18,185 sf	0.2951 ac-ft	1.21 cfs
415.00	34,462 sf	0.8994 ac-ft	1.71 cfs
415.80	43,120 sf	1.6118 ac-ft	2.02 cfs

Detention Basin B-3

Elev.	Ponded Area	Volume	Outflow (CFS)
412.00	16 sf	0 ac-ft	0 cfs
413.00	13,760 sf	0.1581 ac-ft	1.00 cfs
414.00	54,130 sf	0.9374 ac-ft	1.97 cfs
414.50	76,540 sf	1.6873 ac-ft	2.28 cfs

Detention Basin C-1

Elev.	Ponded Area	Volume	Outflow
411.5	16 sf	0 ac-ft	0 cfs
412.0	3,580 sf	0.0206 ac-ft	0.27 cfs
413.0	21,810 sf	0.3121 ac-ft	1.21 cfs
414.0	24,935 sf	0.8486 ac-ft	1.71 cfs
415.0	28,830 sf	1.4658 ac-ft	2.09 cfs

```
ID NL INDUSTRIES/TARACORP SUPERFUND SITE
ID GRANITE CITY, IL
ID ALTERNATIVE B
ID DANNY KLIMA
ID US ARMY CORPS OF ENGINEERS
ID 05 MARCH 96
ID 25-YEAR, 1-HOUR RAINSTORM, HEC-1 RAINFALL TIME DISTRIBUTION
* *DIAGRAM
*
IT    5 20SEP96   0005    288
IO    1
*
KK  B1
KM DRAINAGE AREA 1
PH              0.72   1.63   2.92
LU 0.17   0.26    22
BA .0024
UK   80  0.008    0.2    100
RD  595
RC 0.05   .012    0.2    595   .003
RX  100    120    140    146    165  165.5  265.5  365.5
RY 11.3   10.9   10.5  10.38     10   10.5   10.9   11.3
ZW A=DRAINAGE AREA 1 C=FLOW
*
KK  B2
KM DRAINAGE AREA 2
BA .0012
LU 0.21   0.36    11
UK   75   0.25   0.40    100
RD  200  0.007   0.35  .0012   TRAP    20    100    NO
ZW A=DRAINAGE AREA 2 C=FLOW
*
KK  B3
KM DRAINAGE AREA 3
LU  0.3    0.6    70
BA .0012
UK   50   0.02    0.1    100
RD  885
RC 0.05   .012    0.4    885  .0013
RX  100    120    140    146    165  165.5  265.5  365.5
RY 11.3   10.9   10.5  10.38     10   10.5   10.9   11.3
ZW A=DRAINAGE AREA 3 C=FLOW
*
KK  PTB
KM COMBINE RUNOFF FROM 3 DRAINAGE AREAS
HC    3
ZW A=EXISTING COMBO C=FLOW
*
KK  B4
KM DRAINAGE AREA 4
LU  0.2   0.32     8
BA .0063
UK  115  0.005    0.2     5
UK  250   0.02    0.4    95
```

```
RD   30  0.005  0.035  .0063   TRAP    10    50    NO
ZW A=DRAINAGE AREA 4 C=FLOW
*
KK  DAM
KM DETENTION BASIN B-3
RS    1   STOR
SV    0  .1580  .9373  1.6873
SQ    0   1.00   1.97   2.28
SE 412.0  413.0  414.0  414.5
ZW A=DETENTION BASIN B-3 C=STORAGE
ZW A=DETENTION BASIN B-3 C=STAGE
ZW A=DETENTION BASIN B-3 C=FLOW
*
KK   B5
KM DRAINAGE AREA 5
LU  0.1   0.05     2
BA .0007
UK  215   0.11    0.4    100
RD   50  0.005   .012  .0007   TRAP    3    0.1    NO
ZW A=DRAINAGE AREA 5 C=FLOW
*
KK   B6
KM DRAINAGE AREA 6
LU  0.1   0.05     2
BA .0013
UK  210   0.11    0.4    100
RD  210  .0066   .012  .0013   TRAP    3    0.1    YES
ZW A=DRAINAGE AREA 6 C=FLOW
*
KK  PTC
KM ROUTE THROUGH CHANNEL
RD  185   .017   .012          TRAP    5    0.1
*
KK   B7
KM DRAINAGE AREA 7
LU  0.1   0.05     2
BA .0010
UK  145   0.05    0.4    100
RD  165   0.01   .035  .0010   TRAP    0     3    NO
ZW A=DRAINAGE AREA 7 C=FLOW
*
KK  PTB
KM COMBINE RUNOFF FROM 2 DRAINAGE AREAS
HC    2
ZW A=COMBO C=FLOW
*
KK   B8
KM DRAINAGE AREA 8
LU  0.1   0.05     0
BA .0006
UK   38    .05    0.4    100
RD  130   0.01   .035  .0006   TRAP    0     3    NO
ZW A=DRAINAGE AREA 8 C=FLOW
*
```

```
KK  PTB
KM COMBINE RUNOFF FROM 2 DRAINAGE AREAS
HC   2
ZW A=COMBO C=FLOW
*
KK  B9
KM DRAINAGE AREA 9
LU  0.3    0.6     16
BA .0022
UK  140   0.01    0.2    100
RD  160  0.015   .012  .0022   TRAP     5    0.1    YES
ZW A=DRAINAGE AREA 9 C=FLOW
*
KK  B10
KM DRAINAGE AREA 10
LU 0.17   0.29     24
BA .0018
UK  110   0.02   0.15    100
RD  105   .008  0.012  .0018   TRAP     5    0.1    YES
ZW A=DRAINAGE AREA 10 C=FLOW
*
KK  B11
KM DRAINAGE AREA 11
LU  .21    .33      0
BA .0013
UK   80   0.25    0.4    100
RD   20    .02   .035  .0013   TRAP     6     50     NO
ZW A=DRAINAGE AREA 11 C=FLOW
*
KK  PTB
KM COMBINE RUNOFF FROM 2 DRAINAGE AREAS
HC   2
ZW A=COMBO C=FLOW
*
KK  DAM
KM DETENTION BASIN C-1
RS    1   STOR
SV    0  .0206  .3121  .8486  1.4658
SQ    0   0.27   1.21   1.71   2.09
SE 411.5  412.0  413.0  414.0  415.0
ZW A=DETENTION BASIN C-1 C=STORAGE
ZW A=DETENTION BASIN C-1 C=STAGE
ZW A=DETENTION BASIN C-1 C=FLOW
*
KK  B12
KM DRAINAGE AREA 12
LU  0.1   0.05      0
BA .0010
UK  170   0.05    0.4    100
RD  145    .01   .035  .0010   TRAP     0      3     NO
ZW A=DRAINAGE AREA 12 C=FLOW
*
KK  PTC
KM ROUTE THROUGH CHANNEL
```

```
RD  135   .009   .012        TRAP     3    0.1
*
KK  B13
KM DRAINAGE AREA 13
LU  0.1   0.05     0
BA .0007
UK  160   0.05    0.4    100
RD   70   0.01   .035  .0007   TRAP     0     3    NO
ZW A=DRAINAGE AREA 2 C=FLOW
*
KK  PTB
KM COMBINE RUNOFF FROM 2 DRAINAGE AREAS
HC    2
ZW A=COMB0 C=FLOW
*
KK  B14
KM DRAINAGE AREA 14
LU  0.2    0.3     5
BA .0005
UK   15   0.04    0.4    100
RD   60   .019   .012  .0001   TRAP     3    0.1    YES
RD  130    .01    .10  .0005   TRAP     6     25    YES
ZW A=DRAINAGE AREA 14 C=FLOW
*
KK  B15
KM DRAINAGE AREA 15
LU  0.1   0.05     0
BA .0008
UK  160   0.05    0.4    100
RD   65   0.01  0.035  .0008   TRAP     0     3    NO
ZW A=DRAINAGE AREA 15 C=FLOW
*
KK  PTB
KM COMBINE RUNOFF FROM 2 DRAINAGE AREAS
HC    2
ZW A=COMBO C=FLOW
*
KK  B16
KM DRAINAGE AREA 16
LU 0.19   0.29     0
BA .0050
UK  240   0.12    0.4    100
RD  380   .005   0.10  .0050   TRAP     6     25    YES
ZW A=DRAINAGE AREA 16 C=FLOW
*
KK  B17
KM DRAINAGE AREA 17
LU  0.1   0.05     0
BA .0007
UK  105   0.05    0.4    100
RD   90   0.01  0.035  .0007   TRAP     0     3    NO
ZW A=DRAINAGE AREA 17 C=FLOW
*
KK  PTB
```

```
KM COMBINE RUNOFF FROM 2 DRAINAGE AREAS
HC    2
ZW A=COMBO C=FLOW
*
KK   DAM
KM DETENTION BASIN A-2
RS    1   STOR
SV    0  .0288  .2951  .8994  1.6118
SQ    0   0.27   1.21   1.71   2.02
SE 412.5  413.0  414.0  415.0  415.8
ZW A=DETENTION BASIN A-2 C=STORAGE
ZW A=DETENTION BASIN A-2 C=STAGE
ZW A=DETENTION BASIN A-2 C=FLOW
*
ZZ
```

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ID NL INDUSTRIES/TARACORP SUPERFUND SITE
ID GRANITE CITY, IL
ID ALTERNATIVE B
ID DANNY KLIMA
ID US ARMY CORPS OF ENGINEERS
ID 05 MARCH 96
ID 25-YEAR, 2-HOUR RAINSTORM, HEC-1 RAINFALL TIME DISTRIBUTION
* *DIAGRAM
*
IT    5 20SEP96   0005    288
IO    1
*
KK  B1
KM DRAINAGE AREA 1
PH              0.72   1.63   2.92   3.60
LU 0.17   0.26    22
BA .0024
UK   80  0.008    0.2    100
RD  595
RC 0.05   .012    0.2    595   .003
RX  100    120    140    146    165  165.5  265.5  365.5
RY 11.3   10.9   10.5  10.38     10   10.5   10.9   11.3
ZW A=DRAINAGE AREA 1 C=FLOW
*
KK  B2
KM DRAINAGE AREA 2
BA .0012
LU 0.21   0.36    11
UK   75   0.25   0.40    100
RD  200  0.007   0.35  .0012   TRAP    20    100    NO
ZW A=DRAINAGE AREA 2 C=FLOW
*
KK  B3
KM DRAINAGE AREA 3
LU  0.3    0.6    70
BA .0012
UK   50   0.02    0.1    100
RD  885
RC 0.05   .012    0.4    885  .0013
RX  100    120    140    146    165  165.5  265.5  365.5
RY 11.3   10.9   10.5  10.38     10   10.5   10.9   11.3
ZW A=DRAINAGE AREA 3 C=FLOW
*
KK  PTB
KM COMBINE RUNOFF FROM 3 DRAINAGE AREAS
HC    3
ZW A=EXISTING COMBO C=FLOW
*
KK  B4
KM DRAINAGE AREA 4
LU  0.2   0.32     8
BA .0063
UK  115  0.005    0.2     5
UK  250   0.02    0.4    95
```

```
RD   30  0.005  0.035  .0063   TRAP    10    50    NO
ZW A=DRAINAGE AREA 4 C=FLOW
*
KK  DAM
KM DETENTION BASIN B-3
RS    1   STOR
SV    0  .1580  .9373  1.6873
SQ    0   1.00   1.97   2.28
SE 412.0  413.0  414.0  414.5
ZW A=DETENTION BASIN B-3 C=STORAGE
ZW A=DETENTION BASIN B-3 C=STAGE
ZW A=DETENTION BASIN B-3 C=FLOW
*
KK   B5
KM DRAINAGE AREA 5
LU  0.1   0.05     2
BA .0007
UK  215   0.11    0.4    100
RD   50  0.005   .012  .0007   TRAP    3    0.1    NO
ZW A=DRAINAGE AREA 5 C=FLOW
*
KK   B6
KM DRAINAGE AREA 6
LU  0.1   0.05     2
BA .0013
UK  210   0.11    0.4    100
RD  210  .0066   .012  .0013   TRAP    3    0.1    YES
ZW A=DRAINAGE AREA 6 C=FLOW
*
KK  PTC
KM ROUTE THROUGH CHANNEL
RD  185   .017   .012         TRAP    5    0.1
*
KK   B7
KM DRAINAGE AREA 7
LU  0.1   0.05     2
BA .0010
UK  145   0.05    0.4    100
RD  165   0.01   .035  .0010   TRAP    0     3    NO
ZW A=DRAINAGE AREA 7 C=FLOW
*
KK  PTB
KM COMBINE RUNOFF FROM 2 DRAINAGE AREAS
HC    2
ZW A=COMBO C=FLOW
*
KK   B8
KM DRAINAGE AREA 8
LU  0.1   0.05     0
BA .0006
UK   38    .05    0.4    100
RD  130   0.01   .035  .0006   TRAP    0     3    NO
ZW A=DRAINAGE AREA 8 C=FLOW
*
```

```
KK  PTB
KM COMBINE RUNOFF FROM 2 DRAINAGE AREAS
HC   2
ZW A=COMBO C=FLOW
*
KK  B9
KM DRAINAGE AREA 9
LU  0.3    0.6     16
BA .0022
UK  140   0.01    0.2    100
RD  160  0.015   .012  .0022   TRAP     5    0.1    YES
ZW A=DRAINAGE AREA 9 C=FLOW
*
KK  B10
KM DRAINAGE AREA 10
LU 0.17   0.29     24
BA .0018
UK  110   0.02   0.15    100
RD  105   .008  0.012  .0018   TRAP     5    0.1    YES
ZW A=DRAINAGE AREA 10 C=FLOW
*
KK  B11
KM DRAINAGE AREA 11
LU  .21    .33      0
BA .0013
UK   80   0.25    0.4    100
RD   20    .02   .035  .0013   TRAP     6     50     NO
ZW A=DRAINAGE AREA 11 C=FLOW
*
KK  PTB
KM COMBINE RUNOFF FROM 2 DRAINAGE AREAS
HC   2
ZW A=COMBO C=FLOW
*
KK  DAM
KM DETENTION BASIN C-1
RS    1   STOR
SV    0  .0206  .3121  .8486  1.4658
SQ    0   0.27   1.21   1.71   2.09
SE 411.5  412.0  413.0  414.0  415.0
ZW A=DETENTION BASIN C-1 C=STORAGE
ZW A=DETENTION BASIN C-1 C=STAGE
ZW A=DETENTION BASIN C-1 C=FLOW
*
KK  B12
KM DRAINAGE AREA 12
LU  0.1   0.05      0
BA .0010
UK  170   0.05    0.4    100
RD  145    .01   .035  .0010   TRAP     0      3     NO
ZW A=DRAINAGE AREA 12 C=FLOW
*
KK  PTC
KM ROUTE THROUGH CHANNEL
```

```
RD  135   .009   .012        TRAP     3    0.1
*
KK  B13
KM DRAINAGE AREA 13
LU  0.1   0.05     0
BA .0007
UK  160   0.05    0.4    100
RD   70   0.01   .035  .0007   TRAP     0     3    NO
ZW A=DRAINAGE AREA 2 C=FLOW
*
KK  PTB
KM COMBINE RUNOFF FROM 2 DRAINAGE AREAS
HC    2
ZW A=COMB0 C=FLOW
*
KK  B14
KM DRAINAGE AREA 14
LU  0.2    0.3     5
BA .0005
UK   15   0.04    0.4    100
RD   60   .019   .012  .0001   TRAP     3    0.1    YES
RD  130    .01    .10  .0005   TRAP     6     25    YES
ZW A=DRAINAGE AREA 14 C=FLOW
*
KK  B15
KM DRAINAGE AREA 15
LU  0.1   0.05     0
BA .0008
UK  160   0.05    0.4    100
RD   65   0.01  0.035  .0008   TRAP     0     3    NO
ZW A=DRAINAGE AREA 15 C=FLOW
*
KK  PTB
KM COMBINE RUNOFF FROM 2 DRAINAGE AREAS
HC    2
ZW A=COMBO C=FLOW
*
KK  B16
KM DRAINAGE AREA 16
LU 0.19   0.29     0
BA .0050
UK  240   0.12    0.4    100
RD  380   .005   0.10  .0050   TRAP     6     25    YES
ZW A=DRAINAGE AREA 16 C=FLOW
*
KK  B17
KM DRAINAGE AREA 17
LU  0.1   0.05     0
BA .0007
UK  105   0.05    0.4    100
RD   90   0.01  0.035  .0007   TRAP     0     3    NO
ZW A=DRAINAGE AREA 17 C=FLOW
*
KK  PTB
```

```
KM COMBINE RUNOFF FROM 2 DRAINAGE AREAS
HC    2
ZW A=COMBO C=FLOW
*
KK   DAM
KM DETENTION BASIN A-2
RS    1   STOR
SV    0   .0288   .2951   .8994  1.6118
SQ    0   0.27    1.21    1.71    2.02
SE 412.5  413.0  414.0  415.0  415.8
ZW A=DETENTION BASIN A-2 C=STORAGE
ZW A=DETENTION BASIN A-2 C=STAGE
ZW A=DETENTION BASIN A-2 C=FLOW
*
ZZ
```

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ID NL INDUSTRIES/TARACORP SUPERFUND SITE
ID GRANITE CITY, IL
ID ALTERNATIVE B
ID DANNY KLIMA
ID US ARMY CORPS OF ENGINEERS
ID 05 MARCH 96
ID 25-YEAR, 3-HOUR RAINSTORM, HEC-1 RAINFALL TIME DISTRIBUTION
* *DIAGRAM
*
IT    5 20SEP96    0005    288
IO    1
*
KK  B1
KM DRAINAGE AREA 1
PH              0.72   1.63   2.92   3.60   3.88
LU 0.17   0.26    22
BA .0024
UK   80  0.008    0.2    100
RD  595
RC 0.05   .012    0.2    595   .003
RX  100    120    140    146    165  165.5  265.5  365.5
RY 11.3   10.9   10.5  10.38     10   10.5   10.9   11.3
ZW A=DRAINAGE AREA 1 C=FLOW
*
KK  B2
KM DRAINAGE AREA 2
BA .0012
LU 0.21   0.36    11
UK   75   0.25   0.40    100
RD  200  0.007   0.35  .0012   TRAP    20    100    NO
ZW A=DRAINAGE AREA 2 C=FLOW
*
KK  B3
KM DRAINAGE AREA 3
LU  0.3    0.6    70
BA .0012
UK   50   0.02    0.1    100
RD  885
RC 0.05   .012    0.4    885  .0013
RX  100    120    140    146    165  165.5  265.5  365.5
RY 11.3   10.9   10.5  10.38     10   10.5   10.9   11.3
ZW A=DRAINAGE AREA 3 C=FLOW
*
KK  PTB
KM COMBINE RUNOFF FROM 3 DRAINAGE AREAS
HC    3
ZW A=EXISTING COMBO C=FLOW
*
KK  B4
KM DRAINAGE AREA 4
LU  0.2   0.32     8
BA .0063
UK  115  0.005    0.2     5
UK  250   0.02    0.4    95
```

```
RD   30  0.005  0.035  .0063   TRAP    10    50    NO
ZW A=DRAINAGE AREA 4 C=FLOW
*
KK  DAM
KM DETENTION BASIN B-3
RS    1   STOR
SV    0  .1580  .9373  1.6873
SQ    0   1.00   1.97   2.28
SE 412.0  413.0  414.0  414.5
ZW A=DETENTION BASIN B-3 C=STORAGE
ZW A=DETENTION BASIN B-3 C=STAGE
ZW A=DETENTION BASIN B-3 C=FLOW
*
KK   B5
KM DRAINAGE AREA 5
LU  0.1   0.05     2
BA .0007
UK  215   0.11    0.4    100
RD   50  0.005   .012  .0007   TRAP    3    0.1    NO
ZW A=DRAINAGE AREA 5 C=FLOW
*
KK   B6
KM DRAINAGE AREA 6
LU  0.1   0.05     2
BA .0013
UK  210   0.11    0.4    100
RD  210  .0066   .012  .0013   TRAP    3    0.1    YES
ZW A=DRAINAGE AREA 6 C=FLOW
*
KK  PTC
KM ROUTE THROUGH CHANNEL
RD  185   .017   .012         TRAP    5    0.1
*
KK   B7
KM DRAINAGE AREA 7
LU  0.1   0.05     2
BA .0010
UK  145   0.05    0.4    100
RD  165   0.01   .035  .0010   TRAP    0    3    NO
ZW A=DRAINAGE AREA 7 C=FLOW
*
KK  PTB
KM COMBINE RUNOFF FROM 2 DRAINAGE AREAS
HC    2
ZW A=COMBO C=FLOW
*
KK   B8
KM DRAINAGE AREA 8
LU  0.1   0.05     0
BA .0006
UK   38    .05    0.4    100
RD  130   0.01   .035  .0006   TRAP    0    3    NO
ZW A=DRAINAGE AREA 8 C=FLOW
*
```

```
KK  PTB
KM COMBINE RUNOFF FROM 2 DRAINAGE AREAS
HC   2
ZW A=COMBO C=FLOW
*
KK  B9
KM DRAINAGE AREA 9
LU  0.3    0.6     16
BA .0022
UK  140   0.01    0.2    100
RD  160  0.015   .012  .0022   TRAP     5    0.1    YES
ZW A=DRAINAGE AREA 9 C=FLOW
*
KK  B10
KM DRAINAGE AREA 10
LU 0.17   0.29     24
BA .0018
UK  110   0.02   0.15    100
RD  105   .008  0.012  .0018   TRAP     5    0.1    YES
ZW A=DRAINAGE AREA 10 C=FLOW
*
KK  B11
KM DRAINAGE AREA 11
LU  .21    .33      0
BA .0013
UK   80   0.25    0.4    100
RD   20    .02   .035  .0013   TRAP     6     50     NO
ZW A=DRAINAGE AREA 11 C=FLOW
*
KK  PTB
KM COMBINE RUNOFF FROM 2 DRAINAGE AREAS
HC   2
ZW A=COMBO C=FLOW
*
KK  DAM
KM DETENTION BASIN C-1
RS    1   STOR
SV    0  .0206  .3121  .8486  1.4658
SQ    0   0.27   1.21   1.71   2.09
SE 411.5  412.0  413.0  414.0  415.0
ZW A=DETENTION BASIN C-1 C=STORAGE
ZW A=DETENTION BASIN C-1 C=STAGE
ZW A=DETENTION BASIN C-1 C=FLOW
*
KK  B12
KM DRAINAGE AREA 12
LU  0.1   0.05      0
BA .0010
UK  170   0.05    0.4    100
RD  145    .01   .035  .0010   TRAP     0      3     NO
ZW A=DRAINAGE AREA 12 C=FLOW
*
KK  PTC
KM ROUTE THROUGH CHANNEL
```

```
RD  135   .009   .012        TRAP     3    0.1
*
KK  B13
KM DRAINAGE AREA 13
LU  0.1   0.05     0
BA .0007
UK  160   0.05    0.4    100
RD   70   0.01   .035  .0007   TRAP     0     3    NO
ZW A=DRAINAGE AREA 2 C=FLOW
*
KK  PTB
KM COMBINE RUNOFF FROM 2 DRAINAGE AREAS
HC    2
ZW A=COMB0 C=FLOW
*
KK  B14
KM DRAINAGE AREA 14
LU  0.2    0.3     5
BA .0005
UK   15   0.04    0.4    100
RD   60   .019   .012  .0001   TRAP     3    0.1    YES
RD  130    .01    .10  .0005   TRAP     6     25    YES
ZW A=DRAINAGE AREA 14 C=FLOW
*
KK  B15
KM DRAINAGE AREA 15
LU  0.1   0.05     0
BA .0008
UK  160   0.05    0.4    100
RD   65   0.01  0.035  .0008   TRAP     0     3    NO
ZW A=DRAINAGE AREA 15 C=FLOW
*
KK  PTB
KM COMBINE RUNOFF FROM 2 DRAINAGE AREAS
HC    2
ZW A=COMBO C=FLOW
*
KK  B16
KM DRAINAGE AREA 16
LU 0.19   0.29     0
BA .0050
UK  240   0.12    0.4    100
RD  380   .005   0.10  .0050   TRAP     6     25    YES
ZW A=DRAINAGE AREA 16 C=FLOW
*
KK  B17
KM DRAINAGE AREA 17
LU  0.1   0.05     0
BA .0007
UK  105   0.05    0.4    100
RD   90   0.01  0.035  .0007   TRAP     0     3    NO
ZW A=DRAINAGE AREA 17 C=FLOW
*
KK  PTB
```

```
KM COMBINE RUNOFF FROM 2 DRAINAGE AREAS
HC    2
ZW A=COMBO C=FLOW
*
KK   DAM
KM DETENTION BASIN A-2
RS    1   STOR
SV    0  .0288  .2951  .8994  1.6118
SQ    0   0.27   1.21   1.71   2.02
SE 412.5  413.0  414.0  415.0  415.8
ZW A=DETENTION BASIN A-2 C=STORAGE
ZW A=DETENTION BASIN A-2 C=STAGE
ZW A=DETENTION BASIN A-2 C=FLOW
*
ZZ
```

```
ID NL INDUSTRIES/TARACORP SUPERFUND SITE
ID GRANITE CITY, IL
ID ALTERNATIVE B
ID DANNY KLIMA
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ID 05 MARCH 96
ID 25-YEAR, 24-HOUR RAINSTORM, HEC-1 RAINFALL TIME DISTRIBUTION
* *DIAGRAM
*
IT    5 20SEP96   0005    288
IO    1
*
KK  B1
KM DRAINAGE AREA 1
PH            0.72   1.63   2.92   3.60   3.88   4.58   5.25   6.02
LU 0.17   0.26    22
BA .0024
UK   80  0.008    0.2    100
RD  595
RC 0.05   .012    0.2    595   .003
RX  100    120    140    146    165  165.5  265.5  365.5
RY 11.3   10.9   10.5  10.38     10   10.5   10.9   11.3
ZW A=DRAINAGE AREA 1 C=FLOW
*
KK  B2
KM DRAINAGE AREA 2
BA .0012
LU 0.21   0.36    11
UK   75   0.25   0.40    100
RD  200  0.007   0.35  .0012   TRAP    20    100    NO
ZW A=DRAINAGE AREA 2 C=FLOW
*
KK  B3
KM DRAINAGE AREA 3
LU  0.3    0.6    70
BA .0012
UK   50   0.02    0.1    100
RD  885
RC 0.05   .012    0.4    885  .0013
RX  100    120    140    146    165  165.5  265.5  365.5
RY 11.3   10.9   10.5  10.38     10   10.5   10.9   11.3
ZW A=DRAINAGE AREA 3 C=FLOW
*
KK  PTB
KM COMBINE RUNOFF FROM 3 DRAINAGE AREAS
HC    3
ZW A=EXISTING COMBO C=FLOW
*
KK  B4
KM DRAINAGE AREA 4
LU  0.2   0.32     8
BA .0063
UK  115  0.005    0.2     5
UK  250   0.02    0.4    95
```

```
RD   30  0.005  0.035  .0063   TRAP    10    50    NO
ZW A=DRAINAGE AREA 4 C=FLOW
*
KK  DAM
KM DETENTION BASIN B-3
RS   1   STOR
SV   0  .1580  .9373  1.6873
SQ   0   1.00   1.97   2.28
SE 412.0  413.0  414.0  414.5
ZW A=DETENTION BASIN B-3 C=STORAGE
ZW A=DETENTION BASIN B-3 C=STAGE
ZW A=DETENTION BASIN B-3 C=FLOW
*
KK   B5
KM DRAINAGE AREA 5
LU  0.1   0.05     2
BA .0007
UK  215   0.11    0.4    100
RD   50  0.005   .012  .0007   TRAP    3    0.1    NO
ZW A=DRAINAGE AREA 5 C=FLOW
*
KK   B6
KM DRAINAGE AREA 6
LU  0.1   0.05     2
BA .0013
UK  210   0.11    0.4    100
RD  210  .0066   .012  .0013   TRAP    3    0.1    YES
ZW A=DRAINAGE AREA 6 C=FLOW
*
KK  PTC
KM ROUTE THROUGH CHANNEL
RD  185   .017   .012         TRAP    5    0.1
*
KK   B7
KM DRAINAGE AREA 7
LU  0.1   0.05     2
BA .0010
UK  145   0.05    0.4    100
RD  165   0.01   .035  .0010   TRAP    0    3    NO
ZW A=DRAINAGE AREA 7 C=FLOW
*
KK  PTB
KM COMBINE RUNOFF FROM 2 DRAINAGE AREAS
HC   2
ZW A=COMBO C=FLOW
*
KK   B8
KM DRAINAGE AREA 8
LU  0.1   0.05     0
BA .0006
UK   38   .05    0.4    100
RD  130   0.01   .035  .0006   TRAP    0    3    NO
ZW A=DRAINAGE AREA 8 C=FLOW
*
```

```
KK  PTB
KM COMBINE RUNOFF FROM 2 DRAINAGE AREAS
HC   2
ZW A=COMBO C=FLOW
*
KK  B9
KM DRAINAGE AREA 9
LU  0.3    0.6     16
BA .0022
UK  140   0.01    0.2    100
RD  160  0.015   .012  .0022   TRAP     5    0.1    YES
ZW A=DRAINAGE AREA 9 C=FLOW
*
KK  B10
KM DRAINAGE AREA 10
LU 0.17   0.29     24
BA .0018
UK  110   0.02   0.15    100
RD  105   .008  0.012  .0018   TRAP     5    0.1    YES
ZW A=DRAINAGE AREA 10 C=FLOW
*
KK  B11
KM DRAINAGE AREA 11
LU  .21    .33      0
BA .0013
UK   80   0.25    0.4    100
RD   20    .02   .035  .0013   TRAP     6     50     NO
ZW A=DRAINAGE AREA 11 C=FLOW
*
KK  PTB
KM COMBINE RUNOFF FROM 2 DRAINAGE AREAS
HC   2
ZW A=COMBO C=FLOW
*
KK  DAM
KM DETENTION BASIN C-1
RS    1   STOR
SV    0  .0206  .3121  .8486  1.4658
SQ    0   0.27   1.21   1.71   2.09
SE 411.5  412.0  413.0  414.0  415.0
ZW A=DETENTION BASIN C-1 C=STORAGE
ZW A=DETENTION BASIN C-1 C=STAGE
ZW A=DETENTION BASIN C-1 C=FLOW
*
KK  B12
KM DRAINAGE AREA 12
LU  0.1   0.05      0
BA .0010
UK  170   0.05    0.4    100
RD  145    .01   .035  .0010   TRAP     0      3     NO
ZW A=DRAINAGE AREA 12 C=FLOW
*
KK  PTC
KM ROUTE THROUGH CHANNEL
```

```
RD  135   .009   .012        TRAP     3    0.1
*
KK  B13
KM DRAINAGE AREA 13
LU  0.1   0.05     0
BA .0007
UK  160   0.05    0.4    100
RD   70   0.01   .035  .0007   TRAP     0     3    NO
ZW A=DRAINAGE AREA 2 C=FLOW
*
KK  PTB
KM COMBINE RUNOFF FROM 2 DRAINAGE AREAS
HC    2
ZW A=COMB0 C=FLOW
*
KK  B14
KM DRAINAGE AREA 14
LU  0.2    0.3     5
BA .0005
UK   15   0.04    0.4    100
RD   60   .019   .012  .0001   TRAP     3    0.1    YES
RD  130    .01    .10  .0005   TRAP     6     25    YES
ZW A=DRAINAGE AREA 14 C=FLOW
*
KK  B15
KM DRAINAGE AREA 15
LU  0.1   0.05     0
BA .0008
UK  160   0.05    0.4    100
RD   65   0.01  0.035  .0008   TRAP     0     3    NO
ZW A=DRAINAGE AREA 15 C=FLOW
*
KK  PTB
KM COMBINE RUNOFF FROM 2 DRAINAGE AREAS
HC    2
ZW A=COMBO C=FLOW
*
KK  B16
KM DRAINAGE AREA 16
LU 0.19   0.29     0
BA .0050
UK  240   0.12    0.4    100
RD  380   .005   0.10  .0050   TRAP     6     25    YES
ZW A=DRAINAGE AREA 16 C=FLOW
*
KK  B17
KM DRAINAGE AREA 17
LU  0.1   0.05     0
BA .0007
UK  105   0.05    0.4    100
RD   90   0.01  0.035  .0007   TRAP     0     3    NO
ZW A=DRAINAGE AREA 17 C=FLOW
*
KK  PTB
```

```
KM COMBINE RUNOFF FROM 2 DRAINAGE AREAS
HC    2
ZW A=COMBO C=FLOW
*
KK   DAM
KM DETENTION BASIN A-2
RS    1   STOR
SV    0  .0288  .2951  .8994  1.6118
SQ    0   0.27   1.21   1.71   2.02
SE 412.5  413.0  414.0  415.0  415.8
ZW A=DETENTION BASIN A-2 C=STORAGE
ZW A=DETENTION BASIN A-2 C=STAGE
ZW A=DETENTION BASIN A-2 C=FLOW
*
ZZ
```

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ID NL INDUSTRIES/TARACORP SUPERFUND SITE
ID GRANITE CITY, IL
ID ALTERNATIVE B
ID DANNY KLIMA
ID US ARMY CORPS OF ENGINEERS
ID 05 MARCH 96
ID 25-YEAR, 1-HOUR RAINSTORM, ISWS BULLETIN-70 RAINFALL DISTRIBUTION
* *DIAGRAM
*
IT   5 20SEP96   0005    20
IO   1
*
KK  B1
KM DRAINAGE AREA 1
IN   3 20SEP96   0005
PB  2.92
PC  .16   .33   .47   .52   .60   .66   .71   .75   .79   .82
PC  .84   .86   .88   .90   .92   .94   .96   .97   .98   1.0
LU  0.17   0.26    22
BA .0024
UK   80  0.008   0.2   100
RD  595
RC  0.05   .012   0.2   595   .003
RX  100   120   140   146   165  165.5  265.5  365.5
RY  11.3   10.9   10.5  10.38   10   10.5   10.9   11.3
ZW A=DRAINAGE AREA 1 C=FLOW
*
KK  B2
KM DRAINAGE AREA 2
BA .0012
LU  0.21   0.36    11
UK   75   0.25   0.40   100
RD  200  0.007   0.35  .0012  TRAP    20    100    NO
ZW A=DRAINAGE AREA 2 C=FLOW
*
KK  B3
KM DRAINAGE AREA 3
LU  0.3    0.6    70
BA .0012
UK   50   0.02   0.1   100
RD  885
RC  0.05   .012   0.4   885  .0013
RX  100   120   140   146   165  165.5  265.5  365.5
RY  11.3   10.9   10.5  10.38   10   10.5   10.9   11.3
ZW A=DRAINAGE AREA 3 C=FLOW
*
KK  PTB
KM COMBINE RUNOFF FROM 3 DRAINAGE AREAS
HC   3
ZW A=EXISTING COMBO C=FLOW
*
KK  B4
KM DRAINAGE AREA 4
LU  0.2   0.32    8
```

```
BA .0063
UK  115  0.005   0.2    5
UK  250   0.02   0.4   95
RD   30  0.005  0.035  .0063  TRAP   10   50   NO
ZW A=DRAINAGE AREA 4 C=FLOW
*
KK  DAM
KM DETENTION BASIN B-3
RS   1  STOR
SV   0  .1580  .9373  1.6873
SQ   0  1.00   1.97   2.28
SE 412.0  413.0  414.0  414.5
ZW A=DETENTION BASIN B-3 C=STORAGE
ZW A=DETENTION BASIN B-3 C=STAGE
ZW A=DETENTION BASIN B-3 C=FLOW
*
KK  B5
KM DRAINAGE AREA 5
LU  0.1   0.05    2
BA .0007
UK  215   0.11   0.4   100
RD   50  0.005  .012  .0007  TRAP   3   0.1   NO
ZW A=DRAINAGE AREA 5 C=FLOW
*
KK  B6
KM DRAINAGE AREA 6
LU  0.1   0.05    2
BA .0013
UK  210   0.11   0.4   100
RD  210  .0066  .012  .0013  TRAP   3   0.1   YES
ZW A=DRAINAGE AREA 6 C=FLOW
*
KK  PTC
KM ROUTE THROUGH CHANNEL
RD  185  .017  .012        TRAP   5   0.1
*
KK  B7
KM DRAINAGE AREA 7
LU  0.1   0.05    2
BA .0010
UK  145   0.05   0.4   100
RD  165   0.01  .035  .0010  TRAP   0   3   NO
ZW A=DRAINAGE AREA 7 C=FLOW
*
KK  PTB
KM COMBINE RUNOFF FROM 2 DRAINAGE AREAS
HC   2
ZW A=COMBO C=FLOW
*
KK  B8
KM DRAINAGE AREA 8
LU  0.1   0.05    0
BA .0006
UK   38   .05   0.4   100
```

```
RD  130   0.01   .035  .0006   TRAP     0     3    NO
ZW A=DRAINAGE AREA 8 C=FLOW
*
KK  PTB
KM COMBINE RUNOFF FROM 2 DRAINAGE AREAS
HC    2
ZW A=COMBO C=FLOW
*
KK  B9
KM DRAINAGE AREA 9
LU  0.3    0.6     16
BA .0022
UK  140   0.01    0.2    100
RD  160  0.015   .012  .0022   TRAP     5    0.1    YES
ZW A=DRAINAGE AREA 9 C=FLOW
*
KK  B10
KM DRAINAGE AREA 10
LU 0.17   0.29     24
BA .0018
UK  110   0.02   0.15    100
RD  105   .008  0.012  .0018   TRAP     5    0.1    YES
ZW A=DRAINAGE AREA 10 C=FLOW
*
KK  B11
KM DRAINAGE AREA 11
LU  .21    .33      0
BA .0013
UK   80   0.25    0.4    100
RD   20    .02   .035  .0013   TRAP     6     50    NO
ZW A=DRAINAGE AREA 11 C=FLOW
*
KK  PTB
KM COMBINE RUNOFF FROM 2 DRAINAGE AREAS
HC    2
ZW A=COMBO C=FLOW
*
KK  DAM
KM DETENTION BASIN C-1
RS    1   STOR
SV    0  .0206  .3121  .8486  1.4658
SQ    0   0.27   1.21   1.71   2.09
SE 411.5  412.0  413.0  414.0  415.0
ZW A=DETENTION BASIN C-1 C=STORAGE
ZW A=DETENTION BASIN C-1 C=STAGE
ZW A=DETENTION BASIN C-1 C=FLOW
*
KK  B12
KM DRAINAGE AREA 12
LU  0.1   0.05      0
BA .0010
UK  170   0.05    0.4    100
RD  145    .01   .035  .0010   TRAP     0     3    NO
ZW A=DRAINAGE AREA 12 C=FLOW
```

```
*
KK  PTC
KM ROUTE THROUGH CHANNEL
RD  135   .009   .012        TRAP     3    0.1
*
KK  B13
KM DRAINAGE AREA 13
LU  0.1   0.05     0
BA .0007
UK  160   0.05    0.4    100
RD   70   0.01   .035  .0007   TRAP     0     3    NO
ZW A=DRAINAGE AREA 2 C=FLOW
*
KK  PTB
KM COMBINE RUNOFF FROM 2 DRAINAGE AREAS
HC    2
ZW A=COMB0 C=FLOW
*
KK  B14
KM DRAINAGE AREA 14
LU  0.2    0.3     5
BA .0005
UK   15   0.04    0.4    100
RD   60   .019   .012  .0001   TRAP     3    0.1    YES
RD  130    .01    .10  .0005   TRAP     6     25    YES
ZW A=DRAINAGE AREA 14 C=FLOW
*
KK  B15
KM DRAINAGE AREA 15
LU  0.1   0.05     0
BA .0008
UK  160   0.05    0.4    100
RD   65   0.01  0.035  .0008   TRAP     0     3    NO
ZW A=DRAINAGE AREA 15 C=FLOW
*
KK  PTB
KM COMBINE RUNOFF FROM 2 DRAINAGE AREAS
HC    2
ZW A=COMBO C=FLOW
*
KK  B16
KM DRAINAGE AREA 16
LU 0.19   0.29     0
BA .0050
UK  240   0.12    0.4    100
RD  380   .005   0.10  .0050   TRAP     6     25    YES
ZW A=DRAINAGE AREA 16 C=FLOW
*
KK  B17
KM DRAINAGE AREA 17
LU  0.1   0.05     0
BA .0007
UK  105   0.05    0.4    100
RD   90   0.01  0.035  .0007   TRAP     0     3    NO
```

```
ZW A=DRAINAGE AREA 17 C=FLOW
*
KK   PTB
KM COMBINE RUNOFF FROM 2 DRAINAGE AREAS
HC    2
ZW A=COMBO C=FLOW
*
KK   DAM
KM DETENTION BASIN A-2
RS    1   STOR
SV    0   .0288   .2951   .8994  1.6118
SQ    0   0.27    1.21    1.71    2.02
SE 412.5   413.0   414.0   415.0   415.8
ZW A=DETENTION BASIN A-2 C=STORAGE
ZW A=DETENTION BASIN A-2 C=STAGE
ZW A=DETENTION BASIN A-2 C=FLOW
*
ZZ
```

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ID NL INDUSTRIES/TARACORP SUPERFUND SITE
ID GRANITE CITY, IL
ID ALTERNATIVE B
ID DANNY KLIMA
ID US ARMY CORPS OF ENGINEERS
ID 05 MARCH 96
ID 25-YEAR, 2-HOUR RAINSTORM, ISWS BULLETIN-70 RAINFALL DISTRIBUTION
* *DIAGRAM
*
IT   5 20SEP96   0005    30
IO   1
*
KK  B1
KM DRAINAGE AREA 1
IN   6 20SEP96   0005
PB 3.60
PC  .16   .33   .43   .52   .60   .66   .71   .75   .79   .82
PC  .84   .86   .88   .90   .92   .94   .96   .97   .98   1.0
LU 0.17   0.26    22
BA .0024
UK   80  0.008   0.2   100
RD  595
RC 0.05   .012   0.2   595   .003
RX  100   120   140   146   165  165.5  265.5  365.5
RY 11.3   10.9   10.5  10.38   10   10.5   10.9   11.3
ZW A=DRAINAGE AREA 1 C=FLOW
*
KK  B2
KM DRAINAGE AREA 2
BA .0012
LU 0.21   0.36    11
UK   75   0.25   0.40   100
RD  200  0.007   0.35  .0012  TRAP    20    100    NO
ZW A=DRAINAGE AREA 2 C=FLOW
*
KK  B3
KM DRAINAGE AREA 3
LU  0.3    0.6    70
BA .0012
UK   50   0.02    0.1   100
RD  885
RC 0.05   .012   0.4   885  .0013
RX  100   120   140   146   165  165.5  265.5  365.5
RY 11.3   10.9   10.5  10.38   10   10.5   10.9   11.3
ZW A=DRAINAGE AREA 3 C=FLOW
*
KK  PTB
KM COMBINE RUNOFF FROM 3 DRAINAGE AREAS
HC   3
ZW A=EXISTING COMBO C=FLOW
*
KK  B4
KM DRAINAGE AREA 4
LU  0.2   0.32    8
```

```
BA .0063
UK  115  0.005   0.2    5
UK  250   0.02   0.4   95
RD   30  0.005  0.035  .0063  TRAP   10   50   NO
ZW A=DRAINAGE AREA 4 C=FLOW
*
KK  DAM
KM DETENTION BASIN B-3
RS   1  STOR
SV   0  .1580  .9373  1.6873
SQ   0  1.00   1.97   2.28
SE 412.0  413.0  414.0  414.5
ZW A=DETENTION BASIN B-3 C=STORAGE
ZW A=DETENTION BASIN B-3 C=STAGE
ZW A=DETENTION BASIN B-3 C=FLOW
*
KK  B5
KM DRAINAGE AREA 5
LU  0.1   0.05    2
BA .0007
UK  215   0.11   0.4   100
RD   50  0.005  .012  .0007  TRAP   3   0.1   NO
ZW A=DRAINAGE AREA 5 C=FLOW
*
KK  B6
KM DRAINAGE AREA 6
LU  0.1   0.05    2
BA .0013
UK  210   0.11   0.4   100
RD  210  .0066  .012  .0013  TRAP   3   0.1   YES
ZW A=DRAINAGE AREA 6 C=FLOW
*
KK  PTC
KM ROUTE THROUGH CHANNEL
RD  185  .017  .012        TRAP   5   0.1
*
KK  B7
KM DRAINAGE AREA 7
LU  0.1   0.05    2
BA .0010
UK  145   0.05   0.4   100
RD  165   0.01  .035  .0010  TRAP   0   3   NO
ZW A=DRAINAGE AREA 7 C=FLOW
*
KK  PTB
KM COMBINE RUNOFF FROM 2 DRAINAGE AREAS
HC   2
ZW A=COMBO C=FLOW
*
KK  B8
KM DRAINAGE AREA 8
LU  0.1   0.05    0
BA .0006
UK   38   .05   0.4   100
```

```
RD  130   0.01   .035  .0006   TRAP     0     3     NO
ZW A=DRAINAGE AREA 8 C=FLOW
*
KK  PTB
KM COMBINE RUNOFF FROM 2 DRAINAGE AREAS
HC    2
ZW A=COMBO C=FLOW
*
KK  B9
KM DRAINAGE AREA 9
LU  0.3    0.6     16
BA .0022
UK  140   0.01    0.2    100
RD  160  0.015   .012  .0022   TRAP     5    0.1    YES
ZW A=DRAINAGE AREA 9 C=FLOW
*
KK  B10
KM DRAINAGE AREA 10
LU 0.17   0.29     24
BA .0018
UK  110   0.02   0.15    100
RD  105   .008  0.012  .0018   TRAP     5    0.1    YES
ZW A=DRAINAGE AREA 10 C=FLOW
*
KK  B11
KM DRAINAGE AREA 11
LU  .21    .33      0
BA .0013
UK   80   0.25    0.4    100
RD   20    .02   .035  .0013   TRAP     6     50     NO
ZW A=DRAINAGE AREA 11 C=FLOW
*
KK  PTB
KM COMBINE RUNOFF FROM 2 DRAINAGE AREAS
HC    2
ZW A=COMBO C=FLOW
*
KK  DAM
KM DETENTION BASIN C-1
RS    1   STOR
SV    0  .0206  .3121  .8486  1.4658
SQ    0   0.27   1.21   1.71   2.09
SE 411.5  412.0  413.0  414.0  415.0
ZW A=DETENTION BASIN C-1 C=STORAGE
ZW A=DETENTION BASIN C-1 C=STAGE
ZW A=DETENTION BASIN C-1 C=FLOW
*
KK  B12
KM DRAINAGE AREA 12
LU  0.1   0.05      0
BA .0010
UK  170   0.05    0.4    100
RD  145    .01   .035  .0010   TRAP     0     3     NO
ZW A=DRAINAGE AREA 12 C=FLOW
```

```
*
KK  PTC
KM ROUTE THROUGH CHANNEL
RD  135   .009   .012        TRAP     3    0.1
*
KK  B13
KM DRAINAGE AREA 13
LU  0.1   0.05     0
BA .0007
UK  160   0.05    0.4    100
RD   70   0.01   .035  .0007   TRAP     0     3    NO
ZW A=DRAINAGE AREA 2 C=FLOW
*
KK  PTB
KM COMBINE RUNOFF FROM 2 DRAINAGE AREAS
HC    2
ZW A=COMB0 C=FLOW
*
KK  B14
KM DRAINAGE AREA 14
LU  0.2    0.3     5
BA .0005
UK   15   0.04    0.4    100
RD   60   .019   .012  .0001   TRAP     3    0.1    YES
RD  130    .01    .10  .0005   TRAP     6     25    YES
ZW A=DRAINAGE AREA 14 C=FLOW
*
KK  B15
KM DRAINAGE AREA 15
LU  0.1   0.05     0
BA .0008
UK  160   0.05    0.4    100
RD   65   0.01  0.035  .0008   TRAP     0     3    NO
ZW A=DRAINAGE AREA 15 C=FLOW
*
KK  PTB
KM COMBINE RUNOFF FROM 2 DRAINAGE AREAS
HC    2
ZW A=COMBO C=FLOW
*
KK  B16
KM DRAINAGE AREA 16
LU 0.19   0.29     0
BA .0050
UK  240   0.12    0.4    100
RD  380    .005   0.10  .0050   TRAP     6     25    YES
ZW A=DRAINAGE AREA 16 C=FLOW
*
KK  B17
KM DRAINAGE AREA 17
LU  0.1   0.05     0
BA .0007
UK  105   0.05    0.4    100
RD   90   0.01  0.035  .0007   TRAP     0     3    NO
```

```
ZW A=DRAINAGE AREA 17 C=FLOW
*
KK   PTB
KM COMBINE RUNOFF FROM 2 DRAINAGE AREAS
HC    2
ZW A=COMBO C=FLOW
*
KK   DAM
KM DETENTION BASIN A-2
RS    1   STOR
SV    0  .0288  .2951  .8994  1.6118
SQ    0   0.27   1.21   1.71   2.02
SE 412.5  413.0  414.0  415.0  415.8
ZW A=DETENTION BASIN A-2 C=STORAGE
ZW A=DETENTION BASIN A-2 C=STAGE
ZW A=DETENTION BASIN A-2 C=FLOW
*
ZZ
```

```
ID NL INDUSTRIES/TARACORP SUPERFUND SITE
ID GRANITE CITY, IL
ID ALTERNATIVE B
ID DANNY KLIMA
ID US ARMY CORPS OF ENGINEERS
ID 05 MARCH 96
ID 25-YEAR, 3-HOUR RAINSTORM, ISWS BULLETIN-70 RAINFALL DISTRIBUTION
* *DIAGRAM
*
IT    5 20SEP96   0005     45
IO    1
*
KK  B1
KM DRAINAGE AREA 1
IN    9 20SEP96   0005
PB  3.88
PC  .16    .33    .43    .52    .60    .66    .71    .75    .79    .82
PC  .84    .86    .88    .90    .92    .94    .96    .97    .98    1.0
LU  0.17   0.26     22
BA .0024
UK   80  0.008    0.2    100
RD  595
RC  0.05   .012    0.2    595   .003
RX  100    120    140    146    165  165.5  265.5  365.5
RY  11.3   10.9   10.5  10.38    10   10.5   10.9   11.3
ZW A=DRAINAGE AREA 1 C=FLOW
*
KK  B2
KM DRAINAGE AREA 2
BA .0012
LU  0.21   0.36     11
UK   75   0.25   0.40    100
RD  200  0.007   0.35  .0012   TRAP    20    100    NO
ZW A=DRAINAGE AREA 2 C=FLOW
*
KK  B3
KM DRAINAGE AREA 3
LU  0.3    0.6     70
BA .0012
UK   50   0.02    0.1    100
RD  885
RC  0.05   .012    0.4    885  .0013
RX  100    120    140    146    165  165.5  265.5  365.5
RY  11.3   10.9   10.5  10.38    10   10.5   10.9   11.3
ZW A=DRAINAGE AREA 3 C=FLOW
*
KK  PTB
KM COMBINE RUNOFF FROM 3 DRAINAGE AREAS
HC    3
ZW A=EXISTING COMBO C=FLOW
*
KK  B4
KM DRAINAGE AREA 4
LU  0.2    0.32     8
```

```
BA .0063
UK  115  0.005   0.2    5
UK  250   0.02   0.4   95
RD   30  0.005  0.035  .0063  TRAP   10   50   NO
ZW A=DRAINAGE AREA 4 C=FLOW
*
KK  DAM
KM DETENTION BASIN B-3
RS   1  STOR
SV   0  .1580  .9373  1.6873
SQ   0  1.00   1.97   2.28
SE 412.0  413.0  414.0  414.5
ZW A=DETENTION BASIN B-3 C=STORAGE
ZW A=DETENTION BASIN B-3 C=STAGE
ZW A=DETENTION BASIN B-3 C=FLOW
*
KK  B5
KM DRAINAGE AREA 5
LU  0.1   0.05    2
BA .0007
UK  215   0.11   0.4   100
RD   50  0.005  .012  .0007  TRAP   3   0.1   NO
ZW A=DRAINAGE AREA 5 C=FLOW
*
KK  B6
KM DRAINAGE AREA 6
LU  0.1   0.05    2
BA .0013
UK  210   0.11   0.4   100
RD  210  .0066  .012  .0013  TRAP   3   0.1   YES
ZW A=DRAINAGE AREA 6 C=FLOW
*
KK  PTC
KM ROUTE THROUGH CHANNEL
RD  185  .017  .012        TRAP   5   0.1
*
KK  B7
KM DRAINAGE AREA 7
LU  0.1   0.05    2
BA .0010
UK  145   0.05   0.4   100
RD  165   0.01  .035  .0010  TRAP   0   3   NO
ZW A=DRAINAGE AREA 7 C=FLOW
*
KK  PTB
KM COMBINE RUNOFF FROM 2 DRAINAGE AREAS
HC   2
ZW A=COMBO C=FLOW
*
KK  B8
KM DRAINAGE AREA 8
LU  0.1   0.05    0
BA .0006
UK   38   .05   0.4   100
```

```
RD  130   0.01   .035  .0006   TRAP     0     3    NO
ZW A=DRAINAGE AREA 8 C=FLOW
*
KK  PTB
KM COMBINE RUNOFF FROM 2 DRAINAGE AREAS
HC    2
ZW A=COMBO C=FLOW
*
KK  B9
KM DRAINAGE AREA 9
LU  0.3    0.6     16
BA .0022
UK  140   0.01    0.2    100
RD  160  0.015   .012  .0022   TRAP     5    0.1    YES
ZW A=DRAINAGE AREA 9 C=FLOW
*
KK  B10
KM DRAINAGE AREA 10
LU 0.17   0.29     24
BA .0018
UK  110   0.02   0.15    100
RD  105   .008  0.012  .0018   TRAP     5    0.1    YES
ZW A=DRAINAGE AREA 10 C=FLOW
*
KK  B11
KM DRAINAGE AREA 11
LU  .21    .33      0
BA .0013
UK   80   0.25    0.4    100
RD   20    .02   .035  .0013   TRAP     6     50    NO
ZW A=DRAINAGE AREA 11 C=FLOW
*
KK  PTB
KM COMBINE RUNOFF FROM 2 DRAINAGE AREAS
HC    2
ZW A=COMBO C=FLOW
*
KK  DAM
KM DETENTION BASIN C-1
RS    1   STOR
SV    0  .0206  .3121  .8486  1.4658
SQ    0   0.27   1.21   1.71   2.09
SE 411.5  412.0  413.0  414.0  415.0
ZW A=DETENTION BASIN C-1 C=STORAGE
ZW A=DETENTION BASIN C-1 C=STAGE
ZW A=DETENTION BASIN C-1 C=FLOW
*
KK  B12
KM DRAINAGE AREA 12
LU  0.1   0.05      0
BA .0010
UK  170   0.05    0.4    100
RD  145    .01   .035  .0010   TRAP     0     3    NO
ZW A=DRAINAGE AREA 12 C=FLOW
```

```
*
KK  PTC
KM ROUTE THROUGH CHANNEL
RD  135   .009   .012        TRAP     3    0.1
*
KK  B13
KM DRAINAGE AREA 13
LU  0.1   0.05     0
BA .0007
UK  160   0.05    0.4    100
RD   70   0.01   .035  .0007   TRAP     0     3    NO
ZW A=DRAINAGE AREA 2 C=FLOW
*
KK  PTB
KM COMBINE RUNOFF FROM 2 DRAINAGE AREAS
HC    2
ZW A=COMB0 C=FLOW
*
KK  B14
KM DRAINAGE AREA 14
LU  0.2    0.3     5
BA .0005
UK   15   0.04    0.4    100
RD   60   .019   .012  .0001   TRAP     3    0.1    YES
RD  130    .01    .10  .0005   TRAP     6     25    YES
ZW A=DRAINAGE AREA 14 C=FLOW
*
KK  B15
KM DRAINAGE AREA 15
LU  0.1   0.05     0
BA .0008
UK  160   0.05    0.4    100
RD   65   0.01  0.035  .0008   TRAP     0     3    NO
ZW A=DRAINAGE AREA 15 C=FLOW
*
KK  PTB
KM COMBINE RUNOFF FROM 2 DRAINAGE AREAS
HC    2
ZW A=COMBO C=FLOW
*
KK  B16
KM DRAINAGE AREA 16
LU 0.19   0.29     0
BA .0050
UK  240   0.12    0.4    100
RD  380   .005   0.10  .0050   TRAP     6     25    YES
ZW A=DRAINAGE AREA 16 C=FLOW
*
KK  B17
KM DRAINAGE AREA 17
LU  0.1   0.05     0
BA .0007
UK  105   0.05    0.4    100
RD   90   0.01  0.035  .0007   TRAP     0     3    NO
```

```
ZW A=DRAINAGE AREA 17 C=FLOW
*
KK  PTB
KM COMBINE RUNOFF FROM 2 DRAINAGE AREAS
HC   2
ZW A=COMBO C=FLOW
*
KK  DAM
KM DETENTION BASIN A-2
RS   1   STOR
SV   0  .0288  .2951  .8994  1.6118
SQ   0   0.27   1.21   1.71   2.02
SE 412.5  413.0  414.0  415.0  415.8
ZW A=DETENTION BASIN A-2 C=STORAGE
ZW A=DETENTION BASIN A-2 C=STAGE
ZW A=DETENTION BASIN A-2 C=FLOW
*
ZZ
```

```
ID NL INDUSTRIES/TARACORP SUPERFUND SITE
ID GRANITE CITY, IL
ID ALTERNATIVE B
ID DANNY KLIMA
ID US ARMY CORPS OF ENGINEERS
ID 05 MARCH 96
ID 25-YEAR, 24-HOUR RAINSTORM, ISWS BULLETIN-70 RAINFALL DISTRIBUTION
* *DIAGRAM
*
IT   5 20SEP96   0005   288
IO   1
*
KK  B1
KM DRAINAGE AREA 1
IN   72 20SEP96   0005
PB  6.02
PC  .03   .06   .09   .12   .15   .19   .23   .27   .32   .38
PC  .45   .57   .70   .79   .85   .89   .92   .95   .97   1.0
LU  0.17   0.26   22
BA .0024
UK   80  0.008   0.2   100
RD  595
RC  0.05   .012   0.2   595   .003
RX  100   120   140   146   165  165.5  265.5  365.5
RY  11.3   10.9   10.5  10.38   10   10.5   10.9   11.3
ZW A=DRAINAGE AREA 1 C=FLOW
*
KK  B2
KM DRAINAGE AREA 2
BA .0012
LU  0.21   0.36   11
UK   75   0.25   0.40   100
RD  200  0.007   0.35  .0012  TRAP   20   100   NO
ZW A=DRAINAGE AREA 2 C=FLOW
*
KK  B3
KM DRAINAGE AREA 3
LU  0.3   0.6   70
BA .0012
UK   50   0.02   0.1   100
RD  885
RC  0.05   .012   0.4   885  .0013
RX  100   120   140   146   165  165.5  265.5  365.5
RY  11.3   10.9   10.5  10.38   10   10.5   10.9   11.3
ZW A=DRAINAGE AREA 3 C=FLOW
*
KK  PTB
KM COMBINE RUNOFF FROM 3 DRAINAGE AREAS
HC   3
ZW A=EXISTING COMBO C=FLOW
*
KK  B4
KM DRAINAGE AREA 4
LU  0.2   0.32   8
```

```
BA .0063
UK  115  0.005   0.2    5
UK  250   0.02   0.4   95
RD   30  0.005  0.035  .0063  TRAP   10   50   NO
ZW A=DRAINAGE AREA 4 C=FLOW
*
KK  DAM
KM DETENTION BASIN B-3
RS   1  STOR
SV   0  .1580  .9373  1.6873
SQ   0  1.00   1.97   2.28
SE 412.0  413.0  414.0  414.5
ZW A=DETENTION BASIN B-3 C=STORAGE
ZW A=DETENTION BASIN B-3 C=STAGE
ZW A=DETENTION BASIN B-3 C=FLOW
*
KK  B5
KM DRAINAGE AREA 5
LU  0.1   0.05    2
BA .0007
UK  215   0.11   0.4   100
RD   50  0.005  .012  .0007  TRAP   3   0.1   NO
ZW A=DRAINAGE AREA 5 C=FLOW
*
KK  B6
KM DRAINAGE AREA 6
LU  0.1   0.05    2
BA .0013
UK  210   0.11   0.4   100
RD  210  .0066  .012  .0013  TRAP   3   0.1   YES
ZW A=DRAINAGE AREA 6 C=FLOW
*
KK  PTC
KM ROUTE THROUGH CHANNEL
RD  185   .017   .012        TRAP   5   0.1
*
KK  B7
KM DRAINAGE AREA 7
LU  0.1   0.05    2
BA .0010
UK  145   0.05   0.4   100
RD  165   0.01   .035  .0010  TRAP   0   3   NO
ZW A=DRAINAGE AREA 7 C=FLOW
*
KK  PTB
KM COMBINE RUNOFF FROM 2 DRAINAGE AREAS
HC   2
ZW A=COMBO C=FLOW
*
KK  B8
KM DRAINAGE AREA 8
LU  0.1   0.05    0
BA .0006
UK   38   .05   0.4   100
```

```
RD  130   0.01   .035  .0006   TRAP     0     3    NO
ZW A=DRAINAGE AREA 8 C=FLOW
*
KK  PTB
KM COMBINE RUNOFF FROM 2 DRAINAGE AREAS
HC    2
ZW A=COMBO C=FLOW
*
KK  B9
KM DRAINAGE AREA 9
LU  0.3    0.6     16
BA .0022
UK  140   0.01    0.2    100
RD  160  0.015   .012  .0022   TRAP     5    0.1    YES
ZW A=DRAINAGE AREA 9 C=FLOW
*
KK  B10
KM DRAINAGE AREA 10
LU 0.17   0.29     24
BA .0018
UK  110   0.02   0.15    100
RD  105   .008  0.012  .0018   TRAP     5    0.1    YES
ZW A=DRAINAGE AREA 10 C=FLOW
*
KK  B11
KM DRAINAGE AREA 11
LU  .21    .33      0
BA .0013
UK   80   0.25    0.4    100
RD   20    .02   .035  .0013   TRAP     6     50    NO
ZW A=DRAINAGE AREA 11 C=FLOW
*
KK  PTB
KM COMBINE RUNOFF FROM 2 DRAINAGE AREAS
HC    2
ZW A=COMBO C=FLOW
*
KK  DAM
KM DETENTION BASIN C-1
RS    1   STOR
SV    0  .0206  .3121  .8486  1.4658
SQ    0   0.27   1.21   1.71   2.09
SE 411.5  412.0  413.0  414.0  415.0
ZW A=DETENTION BASIN C-1 C=STORAGE
ZW A=DETENTION BASIN C-1 C=STAGE
ZW A=DETENTION BASIN C-1 C=FLOW
*
KK  B12
KM DRAINAGE AREA 12
LU  0.1   0.05      0
BA .0010
UK  170   0.05    0.4    100
RD  145    .01   .035  .0010   TRAP     0     3    NO
ZW A=DRAINAGE AREA 12 C=FLOW
```

```
*
KK  PTC
KM ROUTE THROUGH CHANNEL
RD  135   .009   .012        TRAP     3    0.1
*
KK  B13
KM DRAINAGE AREA 13
LU  0.1   0.05     0
BA .0007
UK  160   0.05    0.4    100
RD   70   0.01   .035  .0007   TRAP     0     3    NO
ZW A=DRAINAGE AREA 2 C=FLOW
*
KK  PTB
KM COMBINE RUNOFF FROM 2 DRAINAGE AREAS
HC    2
ZW A=COMB0 C=FLOW
*
KK  B14
KM DRAINAGE AREA 14
LU  0.2    0.3     5
BA .0005
UK   15   0.04    0.4    100
RD   60   .019   .012  .0001   TRAP     3    0.1    YES
RD  130    .01    .10  .0005   TRAP     6     25    YES
ZW A=DRAINAGE AREA 14 C=FLOW
*
KK  B15
KM DRAINAGE AREA 15
LU  0.1   0.05     0
BA .0008
UK  160   0.05    0.4    100
RD   65   0.01  0.035  .0008   TRAP     0     3    NO
ZW A=DRAINAGE AREA 15 C=FLOW
*
KK  PTB
KM COMBINE RUNOFF FROM 2 DRAINAGE AREAS
HC    2
ZW A=COMBO C=FLOW
*
KK  B16
KM DRAINAGE AREA 16
LU 0.19   0.29     0
BA .0050
UK  240   0.12    0.4    100
RD  380   .005   0.10  .0050   TRAP     6     25    YES
ZW A=DRAINAGE AREA 16 C=FLOW
*
KK  B17
KM DRAINAGE AREA 17
LU  0.1   0.05     0
BA .0007
UK  105   0.05    0.4    100
RD   90   0.01  0.035  .0007   TRAP     0     3    NO
```

```
ZW A=DRAINAGE AREA 17 C=FLOW
*
KK   PTB
KM COMBINE RUNOFF FROM 2 DRAINAGE AREAS
HC    2
ZW A=COMBO C=FLOW
*
KK   DAM
KM DETENTION BASIN A-2
RS    1    STOR
SV    0   .0288   .2951   .8994  1.6118
SQ    0   0.27    1.21    1.71    2.02
SE 412.5   413.0   414.0   415.0   415.8
ZW A=DETENTION BASIN A-2 C=STORAGE
ZW A=DETENTION BASIN A-2 C=STAGE
ZW A=DETENTION BASIN A-2 C=FLOW
*
ZZ
```

APPENDIX D

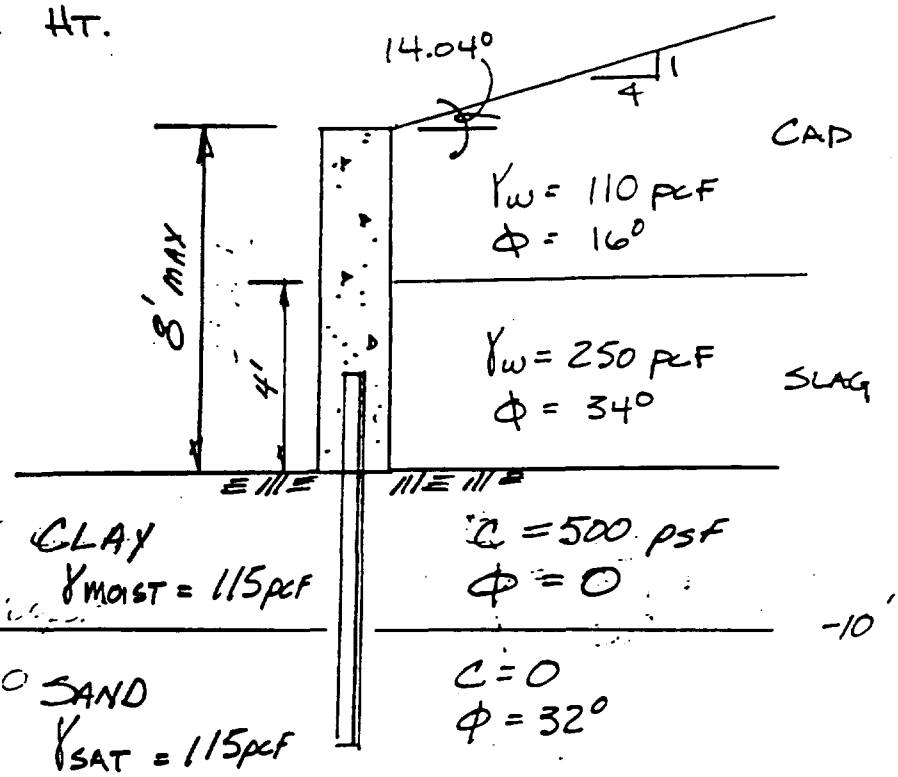
STRUCTURAL CALCULATIONS

OMAHA DISTRICT	COMPUTATION SHEET	CORPS OF ENGINEERS
PROJECT NL INDUSTRIES	SHEET NO. 1	OF
ITEM RETAINING WALL.	BY DFM	DATE Aug 96
	CHKD. BY	DATE

8' MAX WALL HT.

2' MIN WALL HT.

WATER TABLE @ -10'



APPROXIMATE γ_w OF LEAD SLAG

RE: AISC MAN OF STL. CONST PG 6-8

WROUGHT IRON = 485 pcf

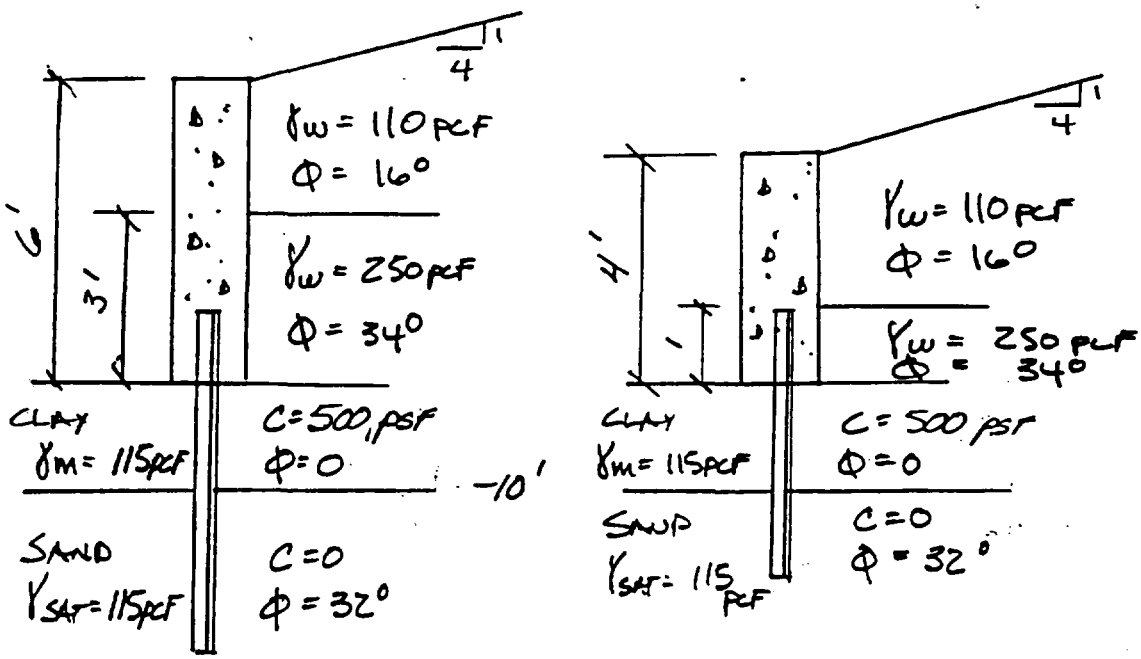
IRON SLAG = 172 pcf

LEAD = 710 pcf

$$\text{APPROX WT SLAG} = 172\text{pcf} \times \frac{710\text{ pcf}}{485\text{pcf}} \approx \underline{\underline{250\text{ pcf}}}$$

SLOPING BACKFILL $\beta = \tan^{-1} 1/4 = 14.04°$

OMAHA DISTRICT	COMPUTATION SHEET	CORPS OF ENGINEERS
PROJECT N.L. INDUSTRIES.	SHEET NO. 2	OF
ITEM RETAINING WALLS.	BY DFM	DATE SEP 96
	CHKD. BY	DATE



OUTPUT RESULTS FROM CWALSHT COMPUTER PROGRAM:

FOR 8' HIGH WALL depth = 15.27' USE 16'

M_{MAX} = 17.035 KI

FOR 6' HIGH WALL depth = 6.26' USE 7'

M_{MAX} = 33.14 KI

FOR 4' HIG WALL depth = 2.33'

USE FROST depth = 4'

M_{MAX} = 0.742 KI

OMAHA DISTRICT	COMPUTATION SHEET	CORPS OF ENGINEERS	
PROJECT NL IND.		SHEET NO. 3	OF
ITEM SHEETPILE DESIGN		BY DFM	DATE SEP 96
		CHKD. BY	DATE

8' High wall $\quad Mom_{MAX} = 17.1^{KI}$

EM 1110-2-2504
Pg. 6-1

$f_b = 0.5 F_y$

BETHLEM SHT
PIL. MANUAL
P 35

$F_y = 38{,}500$ psi FOR GRADE A328

$S_{MIN} = M/F_b$

$$S_{MIN} = \frac{17.1^{KI} \times 12}{.5(38.5)_{psi}} = 10.66 \text{ IN}^3$$

PZ22 $\quad S_x = 18.1 \text{ IN}^3 > 10.66 \text{ IN}^3$ ok

USE PZ-22
A328 SHT-PILE.

CHECK Δ

PZ22 $\quad I_{SHEET} = 154.7 \text{ IN}^4$
SHT WIDTH = 22"

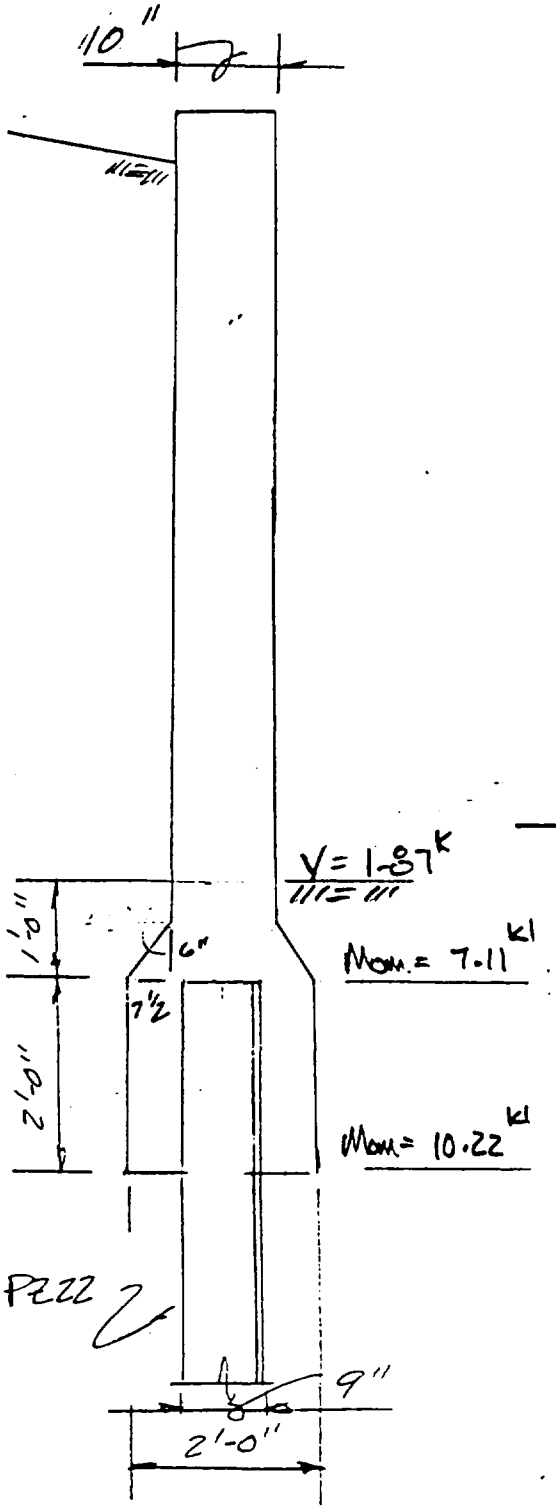
$$I_{FOOT\ OF\ WALL} = \frac{154.7 \times 12''}{22''} = 84.4 \text{ IN}^3$$

SCALED Δ FROM PROGRAM = 2.4085×10^8

$$\Delta = \frac{2.4085 \times 10^8}{29 \times 10^6 \text{ psi} \times 84.4} = 0.10''$$ ok

OMAHA DISTRICT	COMPUTATION SHEET	CORPS OF ENGINEERS
PROJECT N.L. INDUSTRIES	SHEET NO. 4	OF
ITEM WALL REINF.	BY DFM	DATE OCT 96
	CHKD. BY	DATE

8' HIGH WALL



MOMENT TOP OF SHT-PILE
∴ POINT OF TRANSFER = $7.11^{k'}$

COVER = 2" d = 10"
−2.5"
7.5"

$$A_{s\,REQ} = \frac{M_u}{4d}$$

$$= \frac{7.11 \times 1.7}{4(7.5")} = 0.40 \ \square''/'$$

USE #5 @ 9"

$A_s = 0.41 \ \square''/'$

CHECK SHEAR @ GROUND LEVEL:

$V = 1.87^K$

$V_u = 1.87 \times 1.7 = 3.2^{k'}$

$\phi V_c = 0.85(2)\sqrt{f'c}\, b_w d$

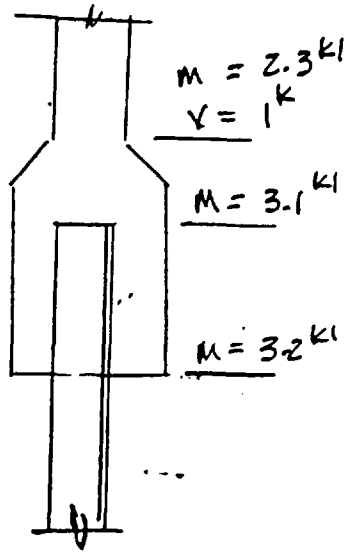
$= 0.85(2)\sqrt{4000}(12)(7.5)$

$\phi V_c = 9.7^K > 3.2^K$

∴ 10" WALL OK

OMAHA DISTRICT	COMPUTATION SHEET	CORPS OF ENGINEERS	
PROJECT N.L. IND		SHEET NO. 5	OF
ITEM		BY DFM	DATE OCT 96
		CHKD. BY	DATE

6' HIGH WALL



$M_{MAX} = 3.2^{kl}$

$A_{S\,REQ} = \frac{3.2(1.7)}{(4)(7.5")} = 0.18\ IN^2/1$

$A_{S\,MIN} = \rho_{MIN} = \frac{200}{F_y}$

$= \frac{200}{60{,}000} = 0.0033$

$A_{S\,MIN} = 0.0033(7.5")(12") = 0.30\ \frac{\square''}{1}$

$\longrightarrow \frac{4}{3} A_{S\,REQ} = \frac{4}{3}(0.18) = 0.24\ \frac{\square''}{1}$

ACI 14.3.2 FOR WALLS

$A_{S\,VERT\,MIN} = 0.0015\ A_g$

$= 0.0015(10")(12") = 0.18\ \frac{\square''}{1}$

USE $\frac{4}{3} A_S = 0.24\ \square''/1$

USE #4 @ 10"

$A_S = 0.24\ \square''/1$

BY INSPECTION $\frac{4}{3} A_{S\,REQ}$ WILL CONTROL FOR ALL WALL HTS < 6'

USE #4 @ 10"

OMAHA DISTRICT	COMPUTATION SHEET	CORPS OF ENGINEERS
PROJECT NL IND	SHEET NO. 6	OF
ITEM REINF	BY DFM	DATE OCT 96
	CHKD. BY	DATE

REF CRSI
RETAINING WALLS
Pg 14-10
FIG 14-6

FIG 14-6
CONTROL JOINTS @ 60'
USE 0.005

HORZ A_{ST} = 0.005(12")(10") = 0.60 IN²/FT

PUT ON BOTH FACES HORZ A_S = 0.60/2 = 0.30 □"/1

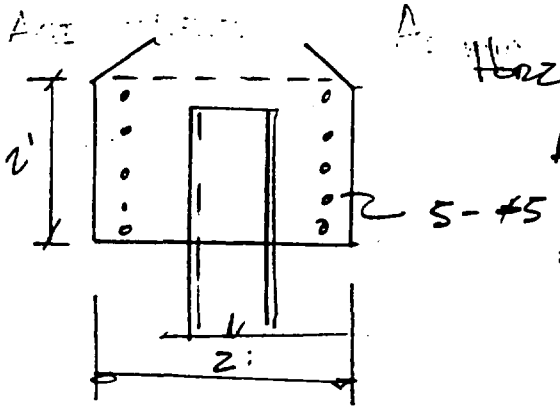
USE #5 @ 12"
A_S = 0.31 □"/1

ACI 14.3.2 VERT MIN A_S = 0.0015 A_G

A_S VERT = 0.0015(10")(12") = 0.18 □"/1

ACI 14.3.4 A_S VERT ≮ ½ = 0.18/2 = 0.09 □"/1

USE #4 @ 18"
A_S = 0.13 □"/1



HORZ STEEL FOR BASE

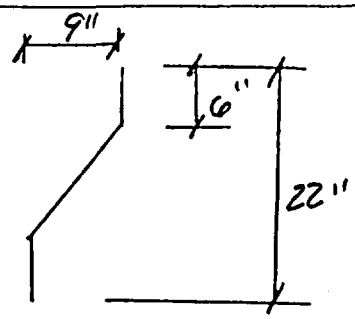
A_{ST} = 0.005(24")(24") = 2.88 IN²

#5 A_S = 0.31

2.88/.31 = 9.3 BARS

USE 10 BARS — 5 E-F
#5

OMAHA DISTRICT	COMPUTATION SHEET	CORPS OF ENGINEERS
PROJECT NL IND	SHEET NO.	OF
ITEM SHEAR STUDS	BY DFM	DATE OCT 96
	CHKD. BY	DATE



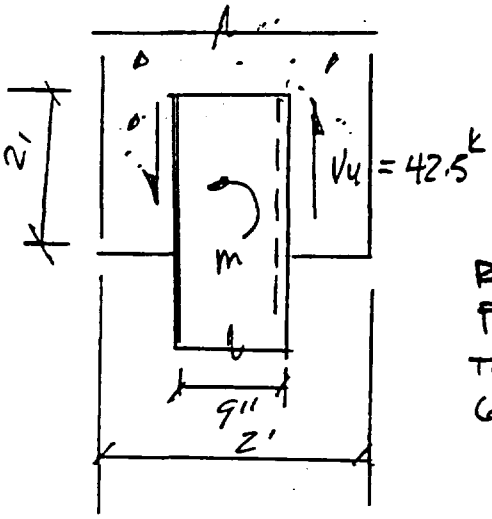
PZ 22

FOR 8' HIGH WALL MOMENT @ BOTTOM OF SHT PILE = $10.22^{k'}$

$M_{SHEET} = 10.22^{k'} \times \frac{22''}{12} = 18.7^{k'}/SHT$

$V = (18.7^{k'} \times 12'')/9'' = 25^{k}$

$V_u = 25^{k} \times 1.7 = 42.5^{k}$



$f'_c = 4000$ PSI TRY 5/8" STUDS

RE: PCI TABLE 6.20.7 | STUD STRENGTH BASED ON CONC. FAILURE

5/8" ϕ $E_d > 9''$

$\phi V_c = 13.2^{k}/STUD$

$\#/STUDS = 42.5^{k}/13.2 = 3.2$ STUDS

TRY 4 STUDS CHECK STRENGTH OF STUDS

PCI TABLE 6.20.7 | 5/8" ϕ $V_s = 13.8^{k} > \phi V_c = 13.2^{k}$ OK

PROGRAM CWALSHT-DESIGN/ANALYSIS OF ANCHORED OR CANTILEVER SHEET PILE WALL
BY CLASSICAL METHODS

DATE: 01-OCT-1996 TIME: 8.12.3

INPUT DATA

I.--HEADING:
'NL INDUSTRIES
'8 FEET CANTILEVER SHEET PILE WALL
'NORMAL CONDITION

II.--CONTROL
CANTILEVER WALL DESIGN

LEVEL 1 FACTOR OF SAFETY FOR ACTIVE PRESSURES = 1.00
LEVEL 1 FACTOR OF SAFETY FOR PASSIVE PRESSURES = 1.50

III.--WALL DATA
ELEVATION AT TOP OF WALL = 8.00 (FT)

IV.--SURFACE POINT DATA

IV.A--RIGHTSIDE

DIST. FROM WALL (FT)	ELEVATION (FT)
.00	8.00
4.00	9.00

IV.B-- LEFTSIDE

DIST. FROM WALL (FT)	ELEVATION (FT)
.00	.00

V.--SOIL LAYER DATA

V.A.--RIGHTSIDE LAYER DATA
LEVEL 2 FACTOR OF SAFETY FOR ACTIVE PRESSURES = DEFAULT
LEVEL 2 FACTOR OF SAFETY FOR PASSIVE PRESSURES = DEFAULT

SAT. WGHT. (PCF)	MOIST WGHT. (PCF)	ANGLE OF INTERNAL FRICTION (DEG)	COH-ESION (PSF)	ANGLE OF WALL FRICTION (DEG)	ADH-ESION (PSF)	<--BOTTOM--> ELEV. (FT)	SLOPE (FT/FT)	<-SAFETY <-FACTOR ACT.	PAS
110.00	110.00	16.00	.0	.00	.0	4.00	.00	DEF	DE
250.00	250.00	34.00	.0	.00	.0	.00	.00	DEF	DE
115.00	115.00	.00	500.0	.00	.0	-10.00	.00	DEF	DE
115.00	115.00	32.00	.0	.00	.0			DEF	DE

V.B.-- LEFTSIDE LAYER DATA

LEVEL 2 FACTOR OF SAFETY FOR ACTIVE PRESSURES = DEFAULT
LEVEL 2 FACTOR OF SAFETY FOR PASSIVE PRESSURES = DEFAULT

SAT. WGHT. (PCF)	MOIST WGHT. (PCF)	ANGLE OF INTERNAL FRICTION (DEG)	COH-ESION (PSF)	ANGLE OF WALL FRICTION (DEG)	ADH-ESION (PSF)	<--BOTTOM--> ELEV. (FT)	SLOPE (FT/FT)	<-SAFETY-<-FACTOR- ACT.	PASS
115.00	115.00	.00	500.0	.00	.0	-10.00	.00	DEF	DEF
115.00	115.00	32.00	.0	.00	.0			DEF	DEF

VI.--WATER DATA

UNIT WEIGHT = 62.40 (PCF)
RIGHTSIDE ELEVATION = -12.00 (FT)
LEFTSIDE ELEVATION = -12.00 (FT)
NO SEEPAGE

VII.--SURFACE LOADS
NONE

VIII.--HORIZONTAL LOADS
NONE

PROGRAM CWALSHT-DESIGN/ANALYSIS OF ANCHORED OR CANTILEVER SHEET PILE WALI
BY CLASSICAL METHODS

DATE: 01-OCT-1996 TIME: 8.12.3

SOIL PRESSURES FOR CANTILEVER WALL DESIGN

I.--HEADING

'NL INDUSTRIES
'8 FEET CANTILEVER SHEET PILE WALL
'NORMAL CONDITION

II.--SOIL PRESSURES

RIGHTSIDE SOIL PRESSURES DETERMINED BY FIXED SURFACE WEDGE METHOD.

LEFTSIDE SOIL PRESSURES DETERMINED BY COULOMB COEFFICIENTS AND THEORY OF ELASTICITY EQUATIONS FOR SURCHARGE LOADS.

ELEV. (FT)	<-LEFTSIDE PRESSURES-> PASSIVE (PSF)	ACTIVE (PSF)	<---NET PRESSURES----> (SOIL PLUS WATER) ACTIVE (PSF)	PASSIVE (PSF)	<RIGHTSIDE PRESSURES- ACTIVE (PSF)	PASSIVE (PSF)
8.00	.00	.00	.000	.000	.00	.00
7.00	.00	.00	76.961	231.745	76.96	231.75
6.00	.00	.00	156.153	443.144	156.15	443.14
5.00	.00	.00	217.646	683.079	217.65	683.08
4.00	.00	.00	235.705	1149.909	235.71	1149.93
3.00	.00	.00	250.317	1835.054	250.32	1835.05
2.00	.00	.00	303.020	2525.246	303.02	2525.25
1.00	.00	.00	381.483	2971.523	381.48	2971.52
.00+	.00	.00	490.681	2863.093	490.68	2863.09
.00-	666.67	.00	-175.986	2863.093	490.68	2863.09
-.50	724.17	.00	-166.014	2686.871	558.15	2686.87
-1.00	781.67	.00	-156.042	2510.649	625.62	2510.65
-2.00	896.67	.00	-140.340	2456.268	756.33	2456.27
-3.00	1011.67	.00	-129.605	2576.685	882.06	2576.69
-4.00	1126.67	.00	-120.000	2680.539	1006.67	2680.54
-5.00	1241.67	.00	-116.667	2791.667	1125.00	2791.67
-6.00	1356.67	.00	-116.616	2906.608	1240.05	2906.61
-7.00	1471.67	.00	-116.667	3021.667	1355.00	3021.67
-8.00	1586.67	.00	-103.165	3094.971	1483.50	3094.97
-8.70	1666.67	.00	-167.551	3375.165	1499.12	3375.16
-9.00	1701.67	35.00	-195.719	3462.749	1505.95	3497.75
-10.00+	1816.67	150.00	-944.923	4473.006	1256.95	4724.68
-10.00-	2587.08	353.35	-944.923	4473.006	1256.95	4724.68
-11.00	2845.79	388.68	-1878.397	5646.754	967.39	6035.4
-12.00	3104.50	424.02	-2202.382	6149.546	902.12	6573.5
-13.00	3222.83	440.18	-2290.525	6265.805	932.31	6705.9
-14.00	3341.16	456.34	-2396.385	6372.847	944.78	6829.1
-15.00	3459.49	472.50	-2502.400	6473.944	957.09	6946.4
-16.00	3577.82	488.66	-2608.384	6576.100	969.44	7064.7
-17.00	3696.16	504.83	-2713.652	6678.269	982.50	7183.0
-18.00	3814.49	520.99	-2817.150	6780.438	997.34	7301.4
-19.00	3932.82	537.15	-2919.448	6882.607	1013.37	7419.7
-20.00	4051.15	553.31	-3021.587	6984.777	1029.56	7538.0
-21.00	4169.48	569.47	-3123.756	7086.946	1045.72	7656.4
-22.00	4287.81	585.63	-3225.925	7189.115	1061.89	7774.7
-23.00	4406.14	601.80	-3328.094	7291.284	1078.05	7893.0
-24.00	4524.47	617.96	-3430.263	7393.453	1094.21	8011.4
-25.00	4642.80	634.12	-3532.433	7495.622	1110.37	8129.7
-26.00	4761.13	650.28	-3634.602	7597.792	1126.53	8248.0
-27.00	4879.47	666.44	-3736.771	7699.961	1142.69	8366.4
-28.00	4997.80	682.61	-3838.940	7802.130	1158.86	8484.7
-29.00	5116.13	698.77	-3941.109	7904.299	1175.02	8603.0
-30.00	5234.46	714.93	-4043.278	8006.468	1191.18	8721.4
-31.00	5352.79	731.09	-4145.448	8108.638	1207.34	8839.7

PROGRAM CWALSHT-DESIGN/ANALYSIS OF ANCHORED OR CANTILEVER SHEET PILE WAL
BY CLASSICAL METHODS

DATE: 01-OCT-1996 TIME: 8.12.

SUMMARY OF RESULTS FOR
CANTILEVER WALL DESIGN

I.--HEADING

'NL INDUSTRIES
'8 FEET CANTILEVER SHEET PILE WALL
'NORMAL CONDITION

II.--SUMMARY

RIGHTSIDE SOIL PRESSURES DETERMINED BY FIXED SURFACE WEDGE METHOD.

LEFTSIDE SOIL PRESSURES DETERMINED BY COULOMB COEFFICIENTS AND THEORY OF ELASTICITY EQUATIONS FOR SURCHARGE LOADS.

WALL BOTTOM ELEV. (FT)	:	-15.27
PENETRATION (FT)	:	15.27
MAX. BEND. MOMENT (LB-FT)	:	17035.
AT ELEVATION (FT)	:	-10.11
MAX. SCALED DEFL. (LB-IN3)	:	4.8759E+09
AT ELEVATION (FT)	:	8.00

(NOTE: DIVIDE SCALED DEFLECTION BY MODULUS OF ELASTICITY IN PSI TIMES PILE MOMENT OF INERTIA IN IN**4 TO OBTAIN DEFLECTION IN INCHES.)

PROGRAM CWALSHT-DESIGN/ANALYSIS OF ANCHORED OR CANTILEVER SHEET PILE WAL
BY CLASSICAL METHODS

DATE: 01-OCT-1996 TIME: 8.12.

COMPLETE RESULTS FOR
CANTILEVER WALL DESIGN

I.--HEADING

'NL INDUSTRIES
'8 FEET CANTILEVER SHEET PILE WALL
'NORMAL CONDITION

II.--RESULTS

ELEVATION (FT)	BENDING MOMENT (LB-FT)	SHEAR (LB)	SCALED DEFLECTION (LB-IN3)	NET PRESSURE (PSF)
8.00	0.	0.	4.8759E+09	.00
7.00	13.	38.	4.5516E+09	76.96
6.00	103.	155.	4.2273E+09	156.15
5.00	346.	342.	3.9033E+09	217.65
4.00	800.	569.	3.5798E+09	235.71
3.00	1489.	812.	3.2578E+09	250.32
2.00	2435.	1088.	2.9384E+09	303.02
1.00	3687.	1431.	2.6232E+09	381.48
FIN GRADE .00	5327.	1867.	2.3145E+09	490.68
.00	5327.	1867.	2.3145E+09	-175.99
-.50	6239.	1781.	2.1634E+09	-166.01
T.O. SAT. -1.00	7109.	1701.	2.0150E+09	-156.04
PILE -2.00	8734.	1552.	1.7277E+09	-140.34
BOTTOM OF CONC. -3.00	10218.	1417.	1.4556E+09	-129.60
-4.00	11572.	1293.	1.2010E+09	-120.00
-5.00	12806.	1174.	9.6647E+08	-116.67
-6.00	13922.	1058.	7.5403E+08	-116.62
-7.00	14921.	941.	5.6562E+08	-116.67
-8.00	15806.	831.	4.0298E+08	-103.17
-8.70	16354.	737.	3.0586E+08	-167.55
-9.00	16570.	682.	2.6764E+08	-195.72
-10.00	17029.	111.	1.6090E+08	-944.92
-11.00	16512.	-1300.	8.3437E+07	-1878.40
-12.00	14219.	-3341.	3.4250E+07	-2202.38
-12.82	10729.	-5177.	1.2304E+07	-2274.69
-13.00	9766.	-5528.	9.3184E+06	-1630.92
-14.00	4019.	-5367.	1.0470E+06	1951.80
-15.00	225.	-1624.	2.4102E+03	5534.53
-15.27	0.	0.	0.0000E+00	6501.52

(NOTE: DIVIDE SCALED DEFLECTION BY MODULUS OF ELASTICITY IN PSI TIMES PILE MOMENT OF INERTIA IN IN**4 TO OBTAIN DEFLECTION IN INCHES.)

III.--SOIL PRESSURES

ELEVATION (FT)	< LEFTSIDE PRESSURE (PSF) > PASSIVE	ACTIVE	<RIGHTSIDE PRESSURE (PSF) > ACTIVE	PASSIVE
8.00	0.	0.	0.	0.
7.00	0.	0.	77.	232.
6.00	0.	0.	156.	443.
5.00	0.	0.	218.	683.
4.00	0.	0.	236.	1150.
3.00	0.	0.	250.	1835.
2.00	0.	0.	303.	2525.
1.00	0.	0.	381.	2972.
.00+	0.	0.	491.	2863.
.00-	667.	0.	491.	2863.
-.50	724.	0.	558.	2687.
-1.00	782.	0.	626.	2511.
-2.00	897.	0.	756.	2456.
-3.00	1012.	0.	882.	2577.
-4.00	1127.	0.	1007.	2681.
-5.00	1242.	0.	1125.	2792.

-6.00	1357.	0.	1240.	2907.
-7.00	1472.	0.	1355.	3022.
-8.00	1587.	0.	1484.	3095.
-8.70	1667.	0.	1499.	3375.
-9.00	1702.	35.	1506.	3498.
-10.00+	1817.	150.	1257.	4725.
-10.00-	2587.	353.	1257.	4725.
-11.00	2846.	389.	967.	6035.
-12.00	3105.	424.	902.	6574.
-12.82	3202.	437.	927.	6682.
-13.00	3223.	440.	932.	6706.
-14.00	3341.	456.	945.	6829.
-15.00	3459.	473.	957.	6946.
-15.27	3578.	489.	969.	7065.
-17.00	3696.	505.	983.	7183.

PROGRAM CWALSHT-DESIGN/ANALYSIS OF ANCHORED OR CANTILEVER SHEET PILE WALL
BY CLASSICAL METHODS

DATE: 23-SEP-1996 TIME: 10.29.2

INPUT DATA

I.--HEADING:
'NL INDUSTRIES
'7 FEET CANTILEVER SHEET PILE WALL
'NORMAL CONDITION

II.--CONTROL
CANTILEVER WALL DESIGN

LEVEL 1 FACTOR OF SAFETY FOR ACTIVE PRESSURES = 1.00
LEVEL 1 FACTOR OF SAFETY FOR PASSIVE PRESSURES = 1.50

III.--WALL DATA
ELEVATION AT TOP OF WALL = 7.00 (FT)

IV.--SURFACE POINT DATA

IV.A--RIGHTSIDE

DIST. FROM WALL (FT)	ELEVATION (FT)
.00	7.00
4.00	8.00

IV.B-- LEFTSIDE

DIST. FROM WALL (FT)	ELEVATION (FT)
.00	.00

V.--SOIL LAYER DATA

V.A.--RIGHTSIDE LAYER DATA
LEVEL 2 FACTOR OF SAFETY FOR ACTIVE PRESSURES = DEFAULT
LEVEL 2 FACTOR OF SAFETY FOR PASSIVE PRESSURES = DEFAULT

SAT. WGHT. (PCF)	MOIST WGHT. (PCF)	ANGLE OF INTERNAL FRICTION (DEG)	COH-ESION (PSF)	ANGLE OF WALL FRICTION (DEG)	ADH-ESION (PSF)	<--BOTTOM--> ELEV. (FT)	SLOPE (FT/FT)	<-SAFETY <-FACTOR ACT.	PAS
110.00	110.00	16.00	.0	.00	.0	3.50	.00	DEF	DE
250.00	250.00	34.00	.0	.00	.0	.00	.00	DEF	DE
115.00	115.00	.00	500.0	.00	.0	-10.00	.00	DEF	DE
115.00	115.00	32.00	.0	.00	.0			DEF	DE

V.B.-- LEFTSIDE LAYER DATA
LEVEL 2 FACTOR OF SAFETY FOR ACTIVE PRESSURES = DEFAULT
LEVEL 2 FACTOR OF SAFETY FOR PASSIVE PRESSURES = DEFAULT

SAT. WGHT. (PCF)	MOIST WGHT. (PCF)	ANGLE OF INTERNAL FRICTION (DEG)	COH-ESION (PSF)	ANGLE OF WALL FRICTION (DEG)	ADH-ESION (PSF)	<--BOTTOM--> ELEV. (FT)	SLOPE (FT/FT)	<-SAFETY-> <-FACTOR-> ACT.	PASS.
115.00	115.00	.00	500.0	.00	.0	-10.00	.00	DEF	DEF
115.00	115.00	32.00	.0	.00	.0			DEF	DEF

VI.--WATER DATA

UNIT WEIGHT = 62.40 (PCF)
RIGHTSIDE ELEVATION = -12.00 (FT)
LEFTSIDE ELEVATION = -12.00 (FT)
NO SEEPAGE

VII.--SURFACE LOADS
NONE

VIII.--HORIZONTAL LOADS
NONE

PROGRAM CWALSHT-DESIGN/ANALYSIS OF ANCHORED OR CANTILEVER SHEET PILE WALLS
BY CLASSICAL METHODS

DATE: 23-SEP-1996 TIME: 10.29.49

SUMMARY OF RESULTS FOR
CANTILEVER WALL DESIGN

I.--HEADING

'NL INDUSTRIES
'7 FEET CANTILEVER SHEET PILE WALL
'NORMAL CONDITION

II.--SUMMARY

RIGHTSIDE SOIL PRESSURES DETERMINED BY FIXED SURFACE WEDGE METHOD.

LEFTSIDE SOIL PRESSURES DETERMINED BY COULOMB COEFFICIENTS
AND THEORY OF ELASTICITY EQUATIONS FOR SURCHARGE LOADS.

WALL BOTTOM ELEV. (FT) : -11.23
PENETRATION (FT) : 11.23

MAX. BEND. MOMENT (LB-FT) : 6758.
AT ELEVATION (FT) : -4.53

MAX. SCALED DEFL. (LB-IN3): 1.2112E+09
AT ELEVATION (FT) : 7.00

(NOTE: DIVIDE SCALED DEFLECTION BY MODULUS OF ELASTICITY IN PSI TIMES PILE MOMENT OF INERTIA IN IN**4 TO OBTAIN DEFLECTION IN INCHES.)

PROGRAM CWALSHT-DESIGN/ANALYSIS OF ANCHORED OR CANTILEVER SHEET PILE WAL
BY CLASSICAL METHODS

DATE: 23-SEP-1996 TIME: 10.29.

COMPLETE RESULTS FOR
CANTILEVER WALL DESIGN

I.--HEADING

'NL INDUSTRIES
'7 FEET CANTILEVER SHEET PILE WALL
'NORMAL CONDITION

II.--RESULTS

ELEVATION (FT)	BENDING MOMENT (LB-FT)	SHEAR (LB)	SCALED DEFLECTION (LB-IN3)	NET PRESSURE (PSF)
7.00	0.	0.	1.2112E+09	.00
6.00	13.	38.	1.1033E+09	76.96
5.00	103.	155.	9.9532E+08	155.48
4.00	345.	338.	8.8758E+08	211.14
3.50	540.	443.	8.3391E+08	207.00
3.00	787.	545.	7.8047E+08	202.35
2.00	1442.	773.	6.7474E+08	254.76
1.00	2353.	1061.	5.7155E+08	319.54
.00	3583.	1409.	4.7246E+08	376.51
.00	3583.	1409.	4.7246E+08	-290.16
-.50	4250.	1259.	4.2510E+08	-306.35
-1.00	4841.	1102.	3.7957E+08	-322.54
-2.00	5782.	780.	2.9501E+08	-321.53
-3.00	6404.	465.	2.2038E+08	-309.45
-4.00	6715.	160.	1.5678E+08	-300.03
-5.00	6726.	-138.	1.0474E+08	-296.67

-6.00	6439.	-435.	6.4279E+07	-296.62
-7.00	5856.	-732.	3.4903E+07	-296.67
-8.00	4978.	-1023.	1.5603E+07	-285.11
-8.70	4193.	-1240.	7.3361E+06	-340.01
-9.00	3800.	-1347.	4.8621E+06	-364.03
-10.00	2154.	-2060.	6.2619E+05	-1062.58
-10.15	1824.	-2234.	3.8365E+05	-1198.48
-11.00	124.	-1053.	9.0390E+02	3990.18
-11.23	-1.	0.	0.0000E+00	5370.54

(NOTE: DIVIDE SCALED DEFLECTION BY MODULUS OF ELASTICITY IN PSI TIMES PILE MOMENT OF INERTIA IN IN**4 TO OBTAIN DEFLECTION IN INCHES.)

III.--SOIL PRESSURES

ELEVATION (FT)	< LEFTSIDE PRESSURE (PSF) > PASSIVE	ACTIVE	<RIGHTSIDE PRESSURE (PSF) > ACTIVE	PASSIVE
7.00	0.	0.	0.	0.
6.00	0.	0.	77.	232.
5.00	0.	0.	155.	447.
4.00	0.	0.	211.	708.
3.50	0.	0.	207.	986.
3.00	0.	0.	202.	1374.
2.00	0.	0.	255.	2080.
1.00	0.	0.	320.	2560.
.00+	0.	0.	377.	2557.
.00-	667.	0.	377.	2557.
-.50	724.	0.	418.	2432.
-1.00	782.	0.	459.	2307.
-2.00	897.	0.	575.	2280.
-3.00	1012.	0.	702.	2397.
-4.00	1127.	0.	827.	2501.
-5.00	1242.	0.	945.	2612.
-6.00	1357.	0.	1060.	2727.
-7.00	1472.	0.	1175.	2842.
-8.00	1587.	0.	1302.	2918.
-8.70	1667.	0.	1327.	3182.
-9.00	1702.	35.	1338.	3297.
-10.00+	1817.	150.	1139.	4432.
-10.00-	2587.	353.	1139.	4432.
-10.15	2627.	359.	1103.	4620.
-11.00	2846.	389.	900.	5652.
-11.23	3105.	424.	849.	6165.
-13.00	3223.	440.	877.	6301.

CET 86

PROGRAM CWALSHT-DESIGN/ANALYSIS OF ANCHORED OR CANTILEVER SHEET PILE WAL
BY CLASSICAL METHODS

DATE: 18-SEP-1996 TIME: 8.27.

INPUT DATA

I.--HEADING:
'NL INDUSTRIES
'6 FEET CANTILEVER SHEET PILE WALL
'NORMAL CONDITION

II.--CONTROL
CANTILEVER WALL DESIGN

LEVEL 1 FACTOR OF SAFETY FOR ACTIVE PRESSURES = 1.00
LEVEL 1 FACTOR OF SAFETY FOR PASSIVE PRESSURES = 1.50

III.--WALL DATA
ELEVATION AT TOP OF WALL = 6.00 (FT)

IV.--SURFACE POINT DATA

IV.A--RIGHTSIDE

DIST. FROM WALL (FT)	ELEVATION (FT)
.00	6.00
4.00	7.00

IV.B-- LEFTSIDE

DIST. FROM WALL (FT)	ELEVATION (FT)
.00	.00

V.--SOIL LAYER DATA

V.A.--RIGHTSIDE LAYER DATA
LEVEL 2 FACTOR OF SAFETY FOR ACTIVE PRESSURES = DEFAULT
LEVEL 2 FACTOR OF SAFETY FOR PASSIVE PRESSURES = DEFAULT

SAT. WGHT. (PCF)	MOIST WGHT. (PCF)	ANGLE OF INTERNAL FRICTION (DEG)	COH-ESION (PSF)	ANGLE OF WALL FRICTION (DEG)	ADH-ESION (PSF)	<--BOTTOM--> ELEV. (FT)	SLOPE (FT/FT)	<-SAFETY <-FACTOR ACT.	PAS
110.00	110.00	16.00	.0	.00	.0	3.00	.00	DEF	DI
250.00	250.00	34.00	.0	.00	.0	.00	.00	DEF	DI
115.00	115.00	.00	500.0	.00	.0	-10.00	.00	DEF	DI
115.00	115.00	32.00	.0	.00	.0			DEF	DI

V.B.-- LEFTSIDE LAYER DATA
LEVEL 2 FACTOR OF SAFETY FOR ACTIVE PRESSURES = DEFAULT
LEVEL 2 FACTOR OF SAFETY FOR PASSIVE PRESSURES = DEFAULT

SAT. WGHT. (PCF)	MOIST WGHT. (PCF)	ANGLE OF INTERNAL FRICTION (DEG)	COH-ESION (PSF)	ANGLE OF WALL FRICTION (DEG)	ADH-ESION (PSF)	<--BOTTOM--> ELEV. (FT)	SLOPE (FT/FT)	<-SAFETY- <-FACTOR- ACT.	PASS
115.00	115.00	.00	500.0	.00	.0	-10.00	.00	DEF	DEF
115.00	115.00	32.00	.0	.00	.0			DEF	DEF

VI.--WATER DATA

UNIT WEIGHT = 62.40 (PCF)
RIGHTSIDE ELEVATION = -12.00 (FT)
LEFTSIDE ELEVATION = -12.00 (FT)
NO SEEPAGE

VII.--SURFACE LOADS
NONE

VIII.--HORIZONTAL LOADS
NONE

PROGRAM CWALSHT-DESIGN/ANALYSIS OF ANCHORED OR CANTILEVER SHEET PILE WALLS
BY CLASSICAL METHODS
DATE: 18-SEP-1996 TIME: 8.28.06

SUMMARY OF RESULTS FOR CANTILEVER WALL DESIGN

I.--HEADING

'NL INDUSTRIES
'6 FEET CANTILEVER SHEET PILE WALL
'NORMAL CONDITION

II.--SUMMARY

RIGHTSIDE SOIL PRESSURES DETERMINED BY FIXED SURFACE WEDGE METHOD.

LEFTSIDE SOIL PRESSURES DETERMINED BY COULOMB COEFFICIENTS AND THEORY OF ELASTICITY EQUATIONS FOR SURCHARGE LOADS.

WALL BOTTOM ELEV. (FT) : -6.26
PENETRATION (FT) : 6.26

MAX. BEND. MOMENT (LB-FT) : 3314.
AT ELEVATION (FT) : -2.11

MAX. SCALED DEFL. (LB-IN3): 2.4085E+08
AT ELEVATION (FT) : 6.00

(NOTE: DIVIDE SCALED DEFLECTION BY MODULUS OF ELASTICITY IN PSI TIMES PILE MOMENT OF INERTIA IN IN**4 TO OBTAIN DEFLECTION IN INCHES.)

PROGRAM CWALSHT-DESIGN/ANALYSIS OF ANCHORED OR CANTILEVER SHEET PILE WALL BY CLASSICAL METHODS

DATE: 18-SEP-1996 TIME: 8.28.0

COMPLETE RESULTS FOR CANTILEVER WALL DESIGN

I.--HEADING

'NL INDUSTRIES
'6 FEET CANTILEVER SHEET PILE WALL
'NORMAL CONDITION

II.--RESULTS

	ELEVATION (FT)	BENDING MOMENT (LB-FT)	SHEAR (LB)	SCALED DEFLECTION (LB-IN3)	NET PRESSURE (PSF)
	6.00	0.	0.	2.4085E+08	.00
	5.00	13.	39.	2.0975E+08	78.63
	4.00	103.	151.	1.7868E+08	143.90
	3.00	331.	311.	1.4780E+08	177.28
	2.00	736.	506.	1.1752E+08	212.84
	1.00	1356.	740.	8.8548E+07	254.32
E/N GRADE	.00	2224.	998.	6.1953E+07	262.39
	.00	2224.	998.	6.1953E+07	-404.27
	-.50	2671.	785.	4.9997E+07	-446.59
T.O. PILE	-1.00	3006.	552.	3.9190E+07	-488.91
	-2.00	3311.	56.	2.1552E+07	-502.48
B.O. CONC.	-3.00	3118.	-440.	9.5645E+06	-489.19
	-4.00	2435.	-925.	2.8941E+06	-480.06
	-4.95	1343.	-1378.	4.2033E+05	-476.84
	-5.00	1271.	-1400.	3.6213E+05	-356.21
	-6.00	81.	-593.	8.1853E+02	1969.85

-6.26	0.	0.	0.0000E+00	2576.62

(NOTE: DIVIDE SCALED DEFLECTION BY MODULUS OF ELASTICITY IN PSI TIMES PILE MOMENT OF INERTIA IN IN**4 TO OBTAIN DEFLECTION IN INCHES.)

III.--SOIL PRESSURES

ELEVATION (FT)	< LEFTSIDE PRESSURE (PSF) > PASSIVE	ACTIVE	<RIGHTSIDE PRESSURE (PSF) > ACTIVE	PASSIVE
6.00	0.	0.	0.	0.
5.00	0.	0.	79.	224.
4.00	0.	0.	144.	485.
3.00	0.	0.	177.	934.
2.00	0.	0.	213.	1599.
1.00	0.	0.	254.	2149.
.00+	0.	0.	262.	2250.
.00-	667.	0.	262.	2250.
-.50	724.	0.	278.	2177.
-1.00	782.	0.	293.	2104.
-2.00	897.	0.	394.	2104.
-3.00	1012.	0.	522.	2217.
-4.00	1127.	0.	647.	2321.
-4.95	1236.	0.	759.	2426.
-5.00	1242.	0.	765.	2432.
-6.00	1357.	0.	880.	2547.
-6.26	1472.	0.	995.	2662.
-8.00	1587.	0.	1120.	2742.

APPENDIX E

COST ESTIMATE

N.L. INDUSTRIES/TARACORP SF SITE
MADISON COUNTY, ILLINOIS

Designed By: OMAHA DISTRICT - LARRY BOARDMAN
Estimated By: OMAAH DISTRICT - JAMES DUNN

Prepared By: JAMES DUNN

Preparation Date: 10/31/96
Effective Date of Pricing: 10/31/96
Est Construction Time: 270 Days

Sales Tax: 6.25%

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Release 5.30A

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** PROJECT OWNER SUMMARY - LEVEL 3 (Rounded to 1000's) **

	QUANTITY UOM	CONTRACT	COST GWT	CONTINGN	E&D	SIOH	QA\QC	TOTAL COST	UNIT COST
33 HTRW REMEDIAL ACTION									
33.00 SSHP 01110-1	1.00 EA	331,000	5,000	17,000	0	21,000	0	374,000	373562.40
TOTAL SSHP 01110-1	1.00 EA	331,000	5,000	17,000	0	21,000	0	374,000	373562.40
33.02 MONITORING,									
33.02.01 AIR MONITOR & SAMPL		203,000	3,000	10,000	0	13,000	0	230,000	
33.02.05 CHEMICAL QUALITY CO /	1.00 EA	24,000	0	1,000	0	2,000	0	27,000	27252.77
33.02.08 SITE MAINTENANCE AN	1.00 EA	29,000	0	1,000	0	2,000	0	33,000	32722.72
TOTAL MONITORING,	1.00 EA	256,000	4,000	13,000	0	16,000	0	290,000	289699.87
33.03 SITE WORK									
33.03.01 DEMOLITION		136,000	2,000	7,000	0	9,000	0	154,000	
33.03.04 CAP EARTHWORK AND G		2,262,000	35,000	115,000	0	145,000	0	2,557,000	
33.03.05 PERIMITER FENCING.	3450.00 LF	74,000	1,000	4,000	0	5,000	0	83,000	24.20
33.03.06 ELECTRICAL DISTRB R		90,000	1,000	5,000	0	6,000	0	101,000	
33.03.08 GAS LINE RELOCATION	850.00 LF	16,000	0	1,000	0	1,000	0	18,000	21.74
33.03.14 RETAINING WALLS		1,049,000	16,000	53,000	0	67,000	0	1,186,000	
TOTAL SITE WORK	1.00 EA	3,628,000	56,000	184,000	0	232,000	0	4,100,000	4100085
33.04 PHOTOGRAPHY	1.00 EA	4,000	0	0	0	0	0	5,000	4539.09
33.10 DRUMS TANKS STRUCT MIS									
33.10.01 DRUM REMOVAL	69.00 EA	9,000	0	0	0	1,000	0	10,000	145.01
33.10.03 STRUCTURE REMOVAL		12,000	0	1,000	0	1,000	0	13,000	
TOTAL DRUMS TANKS STRUCT	1.00 EA	21,000	0	1,000	0	1,000	0	23,000	23203.39
33.19 DISPOSAL (COMMERCIAL)									
33.19.02 TRANSPORT DRUMS /DI	69.00 BRL	9,000	0	0	0	1,000	0	11,000	154.10
33.19.03 DISPOSAL FEES & TAX	30.00 BRL	4,000	0	0	0	0	0	4,000	145.03
33.19.99 DECON WATER	5000.00 GAL	5,000	0	0	0	0	0	6,000	1.16
TOTAL DISPOSAL (COMMERCIA	1.00 EA	18,000	0	1,000	0	1,000	0	21,000	20784.82
33.20 SITE RESTORATION									
33.20.02 SETTLEMENT MONITORS	7.00 EA	4,000	0	0	0	0	0	5,000	725.16
33.20.04 REVEGETATION & PLAN		133,000	2,000	7,000	0	9,000	0	151,000	

** PROJECT OWNER SUMMARY - LEVEL 3 (Rounded to 1000's) **

		QUANTITY	UOM	CONTRACT	COST GWT	CONTINGN	E&D	SIOH	QA\QC	TOTAL COST	UNIT COST
33.20.06	POST-CONTRUCTION MA	6.20	AC	8,000	0	0	0	1,000	0	9,000	1450.31
33.20.22	28" SELECT FILL-PRI	51728.00	CY	898,000	14,000	46,000	0	57,000	0	1,015,000	19.63
33.20.23	8" CRUSHED ROCK SU	1800.00	CY	55,000	1,000	3,000	0	4,000	0	62,000	34.35
33.20.24	8" CONCRETE PAVING	400.00	SY	22,000	0	1,000	0	1,000	0	25,000	61.64
33.20.25	4" ASPHALT PAVING	3800.00	SY	134,000	2,000	7,000	0	9,000	0	151,000	39.73
33.20.32	CULVERTS	60.00	LF	5,000	0	0	0	0	0	6,000	95.09
33.20.33	STORM DRAINS.	685.00	LF	53,000	1,000	3,000	0	3,000	0	60,000	87.87
33.20.34	SANITARY SEWER.	224.00	LF	34,000	1,000	2,000	0	2,000	0	38,000	171.72
	TOTAL SITE RESTORATION	1.00	EA	1,346,000	21,000	68,000	0	86,000	0	1,522,000	1521726
33.21	DEMOBILIZATION										
33.21.01	REMOVAL TEMP FACILI			4,000	0	0	0	0	0	4,000	
33.21.02	REMOVAL TEMP UTILIT			1,000	0	0	0	0	0	1,000	
33.21.03	FINAL DECONTAMINATI			4,000	0	0	0	0	0	4,000	
33.21.04	DEMOB CONST EQUIP &			3,000	0	0	0	0	0	4,000	
33.21.05	DEMOB OF PERSONNEL	1.00	EA	1,000	0	0	0	0	0	1,000	1450.31
33.21.06	POST-CONSTRUCTION S			6,000	0	0	0	0	0	7,000	
	TOTAL DEMOBILIZATION	1.00	EA	20,000	0	1,000	0	1,000	0	22,000	22479.88
	TOTAL HTRW REMEDIAL ACTIO	1.00	EA	5,624,000	87,000	286,000	0	360,000	0	6,356,000	6356081
	TOTAL N.L. INDUSTRIES/TAR	1.00	EA	5,624,000	87,000	286,000	0	360,000	0	6,356,000	6356081

** PROJECT INDIRECT SUMMARY - LEVEL 3 (Rounded to 1000's) **

	QUANTITY UOM	DIRECT	OVERHEAD	HOME OFC	PROFIT	BOND	TOTAL COST	UNIT COST
33 HTRW REMEDIAL ACTION								
33.00 SSHP 01110-1	1.00 EA	258,000	25,000	17,000	25,000	6,000	331,000	330527.72
TOTAL SSHP 01110-1	1.00 EA	258,000	25,000	17,000	25,000	6,000	331,000	330527.72
33.02 MONITORING,								
33.02.01 AIR MONITOR & SAMPLING		158,000	15,000	10,000	15,000	4,000	203,000	
33.02.05 CHEMICAL QUALITY CONTROL	1.00 EA	19,000	2,000	1,000	2,000	0	24,000	24113.23
33.02.08 SITE MAINTENANCE AND O&M MANU	1.00 EA	23,000	2,000	1,000	2,000	1,000	29,000	28953.04
TOTAL MONITORING,	1.00 EA	200,000	19,000	13,000	19,000	5,000	256,000	256326.23
33.03 SITE WORK								
33.03.01 DEMOLITION		106,000	10,000	7,000	10,000	3,000	136,000	
33.03.04 CAP EARTHWORK AND GEO-MEMBRAN		1,763,000	171,000	116,000	168,000	44,000	2,262,000	
33.03.05 PERIMITER FENCING.	3450.00 LF	58,000	6,000	4,000	5,000	1,000	74,000	21.41
33.03.06 ELECTRICAL DISTRB RELOCATION.		70,000	7,000	5,000	7,000	2,000	90,000	
33.03.08 GAS LINE RELOCATION 2"	850.00 LF	13,000	1,000	1,000	1,000	0	16,000	19.24
33.03.14 RETAINING WALLS ALTERNATE		818,000	79,000	54,000	78,000	21,000	1,049,000	
TOTAL SITE WORK	1.00 EA	2,827,000	274,000	186,000	270,000	71,000	3,628,000	3627752
33.04 PHOTOGRAPHY	1.00 EA	3,000	0	0	0	0	4,000	4016.18
33.10 DRUMS TANKS STRUCT MISC DEMO/REM								
33.10.01 DRUM REMOVAL	69.00 EA	7,000	1,000	0	1,000	0	9,000	128.30
33.10.03 STRUCTURE REMOVAL		9,000	1,000	1,000	1,000	0	12,000	
TOTAL DRUMS TANKS STRUCT MISC DEMO/	1.00 EA	16,000	2,000	1,000	2,000	0	21,000	20530.34
33.19 DISPOSAL (COMMERCIAL)								
33.19.02 TRANSPORT DRUMS /DISPOSE	69.00 BRL	7,000	1,000	0	1,000	0	9,000	136.34
33.19.03 DISPOSAL FEES & TAXES	30.00 BRL	3,000	0	0	0	0	4,000	128.32
33.19.99 DECON WATER	5000.00 GAL	4,000	0	0	0	0	5,000	1.03
TOTAL DISPOSAL (COMMERCIAL)	1.00 EA	14,000	1,000	1,000	1,000	0	18,000	18390.39
33.20 SITE RESTORATION								
33.20.02 SETTLEMENT MONITORS.	7.00 EA	4,000	0	0	0	0	4,000	641.62
33.20.04 REVEGETATION & PLANTING.		104,000	10,000	7,000	10,000	3,000	133,000	

** PROJECT INDIRECT SUMMARY - LEVEL 3 (Rounded to 1000's) **

		QUANTITY	UOM	DIRECT	OVERHEAD	HOME OFC	PROFIT	BOND	TOTAL COST	UNIT COST
33.20.06	POST-CONTRUCTION MAINTENANCE	6.20	AC	6,000	1,000	0	1,000	0	8,000	1283.24
33.20.22	28" SELECT FILL-PRIVATE LOTS-	51728.00	CY	700,000	68,000	46,000	67,000	18,000	898,000	17.37
33.20.23	8" CRUSHED ROCK SURFACING	1800.00	CY	43,000	4,000	3,000	4,000	1,000	55,000	30.40
33.20.24	8" CONCRETE PAVING	400.00	SY	17,000	2,000	1,000	2,000	0	22,000	54.54
33.20.25	4" ASPHALT PAVING	3800.00	SY	104,000	10,000	7,000	10,000	3,000	134,000	35.15
33.20.32	CULVERTS	60.00	LF	4,000	0	0	0	0	5,000	84.14
33.20.33	STORM DRAINS.	685.00	LF	41,000	4,000	3,000	4,000	1,000	53,000	77.74
33.20.34	SANITARY SEWER.	224.00	LF	27,000	3,000	2,000	3,000	1,000	34,000	151.93
	TOTAL SITE RESTORATION	1.00	EA	1,049,000	102,000	69,000	100,000	26,000	1,346,000	1346422
33.21	DEMOBILIZATION									
33.21.01	REMOVAL TEMP FACILITIES			3,000	0	0	0	0	4,000	
33.21.02	REMOVAL TEMP UTILITIES			1,000	0	0	0	0	1,000	
33.21.03	FINAL DECONTAMINATION			3,000	0	0	0	0	4,000	
33.21.04	DEMOB CONST EQUIP & FAC			3,000	0	0	0	0	3,000	
33.21.05	DEMOB OF PERSONNEL	1.00	EA	1,000	0	0	0	0	1,000	1283.24
33.21.06	POST-CONSTRUCTION SUBMITS			5,000	0	0	0	0	6,000	
	TOTAL DEMOBILIZATION	1.00	EA	16,000	2,000	1,000	1,000	0	20,000	19890.18
	TOTAL HTRW REMEDIAL ACTION	1.00	EA	4,383,000	425,000	288,000	418,000	110,000	5,624,000	5623856
	TOTAL N.L. INDUSTRIES/TARACORP SF S	1.00	EA	4,383,000	425,000	288,000	418,000	110,000	5,624,000	5623856

COST GROWTH		87,000
SUBTOTAL		5,711,000
CONTINGENCY	5.00%	286,000
SUBTOTAL		5,996,000
SIOH	6.00%	360,000
TOTAL INCL OWNER COSTS		6,356,000

** SYSTEM INDIRECT SUMMARY (Rounded to 1000's) **

	DIRECT	OVERHEAD	HOME OFC	PROFIT	BOND	TOTAL COST
<<< No System ID >>>	2,551,000	247,000	168,000	243,000	64,000	3,273,000
2A Off-Site Borrow	844,000	82,000	56,000	80,000	21,000	1,082,000
2B Contaminated Soil	584,000	57,000	38,000	56,000	15,000	749,000
3A Select Fill	229,000	22,000	15,000	22,000	6,000	294,000
4A Geogrid	129,000	13,000	9,000	12,000	3,000	166,000
5A SLLR Pile Material	46,000	4,000	3,000	4,000	1,000	60,000
	4,383,000	425,000	288,000	418,000	110,000	5,624,000

2A Contam Soil
2B Off-Site Backfill
4A Geogrid
5A SLLR Pile

** SYSTEM OWNER SUMMARY (Rounded to 1000's) **

	CONTRACT	COST GWT	CONTINGN	E&D	SIOH	QA\QC	TOTAL COST
<<< No System ID >>>	3,273,000	51,000	166,000		209,000		3,700,000
2A Off-Site Borrow	1,082,000	17,000	55,000		69,000		1,223,000
2B Contaminated Soil	749,000	12,000	38,000		48,000		846,000
3A Select Fill	294,000	5,000	15,000		19,000		332,000
4A Geogrid	166,000	3,000	8,000		11,000		187,000
5A SLLR Pile Material	60,000	1,000	3,000		4,000		67,000
	5,624,000	87,000	286,000	0	360,000	0	6,356,000

PRIME CONTRACTOR	QUANTY	UOM	MANHOUR	LABOR	EQUIPMNT	MATERIAL	TOTAL COST	UNIT COST
PRIME CONTRACTOR								
Overhead Items - AA								
Supervisor			227.27	7954.53	0.00	0.00	7954.53	
	9.00	MO	2,045	71,591	0	0	71,591	7954.53
Supervisor: Assistant			238.09	5952.27	0.00	0.00	5952.27	
	9.00	MO	2,143	53,570	0	0	53,570	5952.27
Administrator			200.00	3999.92	0.00	0.00	3999.92	
	9.00	MO	1,800	35,999	0	0	35,999	3999.92
Quality Control Supervisor			212.77	4468.08	0.00	0.00	4468.08	
	9.00	MO	1,915	40,213	0	0	40,213	4468.08
Chemical Control Supervisor			212.77	4468.08	0.00	0.00	4468.08	
	5.00	MO	1,064	22,340	0	0	22,340	4468.08
Security Manager			188.68	3773.51	0.00	0.00	3773.51	
	9.00	MO	1,698	33,962	0	0	33,962	3773.51
Trailer: Contractor			0.00	0.00	411.05	0.00	411.05	
	9.00	MO	0	0	3,699	0	3,699	411.05
Trailer: Security			0.00	0.00	411.05	0.00	411.05	
	9.00	MO	0	0	3,699	0	3,699	411.05
Trailer: Government			0.00	0.00	411.05	0.00	411.05	
	9.00	MO	0	0	3,699	0	3,699	411.05
Trailer: Supplies			0.00	0.00	219.23	0.00	219.23	
	9.00	MO	0	0	1,973	0	1,973	219.23
Small Tools			0.00	0.00	288.46	0.00	288.46	
	9.00	MO	0	0	2,596	0	2,596	288.46
Pickup Truck: 4x2, F250, 3/4T			0.00	0.00	1088.35	0.00	1088.35	
	9.00	MO	0	0	9,795	0	9,795	1088.35
Pkup Trk: 4x2, Compact 3500 GVW			0.00	0.00	832.48	0.00	832.48	
	9.00	MO	0	0	7,492	0	7,492	832.48
Utility Hookup: Electrical			0.00	0.00	0.00	318.75	318.75	
	3.00	EA	0	0	0	956	956	318.75
Utility Hookup: Water			0.00	0.00	0.00	318.75	318.75	
INCL CAP EARTH WORK	6.00	EA	0	0	0	1,913	1,913	318.75

PRIME CONTRACTOR	QUANTY UOM	MANHOUR	LABOR	EQUIPMNT	MATERIAL	TOTAL COST	UNIT COST
Utility Hookup: Telephone		0.00	0.00	0.00	318.75	318.75	
	3.00 EA	0	0	0	956	956	318.75
Electricity		0.00	0.00	0.00	478.13	478.13	
	9.00 MO	0	0	0	4,303	4,303	478.13
Water		0.00	0.00	0.00	2125.00	2125.00	
INCLUDES CAP EARTHWORK	9.00 MO	0	0	0	19,125	19,125	2125.00
Telephone 3ea		0.00	0.00	0.00	318.75	318.75	
	9.00 MO	0	0	0	2,869	2,869	318.75
3 EA: Temporary Sanitary Fac		0.00	0.00	216.34	0.00	216.34	
	9.00 MO	0	0	1,947	0	1,947	216.34
Project Sign		0.00	0.00	0.00	318.75	318.75	
	2.00 EA	0	0	0	638	638	318.75
Jobsite Fencing: Temporary		0.00	0.00	0.00	5312.50	5312.50	
	1.00 EA	0	0	0	5,313	5,313	5312.50
Survey\Layout		32.00	592.00	0.00	0.00	592.00	
	30.00 DAY	960	17,760	0	0	17,760	592.00
Care of Water\Erosion Control		0.00	0.00	0.00	53.13	53.13	
	180.00 DAY	0	0	0	9,563	9,563	53.13
C.P.M. Scheduling		0.00	0.00	0.00	10625.00	10625.00	
	1.00 EA	0	0	0	10,625	10,625	10625.00
Quality Control TESTING		0.00	0.00	0.00	5312.50	5312.50	
	1.00 EA	0	0	0	5,313	5,313	5312.50
pre cons meetings		0.00	5000.00	0.00	0.00	5000.00	
	1.00 EA	0	5,000	0	0	5,000	5000.00
site operational plans		0.00	1500.00	0.00	0.00	1500.00	
pg 01010-2 par 5.3	15.00 EA	0	22,500	0	0	22,500	1500.00
as built drawings		0.00	1500.00	0.00	531.25	2031.25	
	2.00 SET	0	3,000	0	1,063	4,063	2031.25
WARRANTY		0.00	0.00	0.00	4250.00	4250.00	
	1.00 EA	0	0	0	4,250	4,250	4250.00
QC TRAINING		0.00	0.00	0.00	2836.88	2836.88	
PG 01440-6	1.00 EA	0	0	0	2,837	2,837	2836.88

LABOR,PIER DIEM,TRAVEL, COURSE
COST OF $170

PRIME CONTRACTOR	QUANTY	UOM	MANHOUR	LABOR	EQUIPMNT	MATERIAL	TOTAL COST	UNIT COST
COMPUTER/SOFTWARE			0.00	0.00	5000.00	0.00	5000.00	
	2.00	EA	0	0	10,000	0	10,000	5000.00
COPIER			0.00	0.00	400.00	0.00	400.00	
	9.00	MO	0	0	3,600	0	3,600	400.00
FAX			0.00	0.00	65.00	0.00	65.00	
	9.00	MO	0	0	585	0	585	65.00
TOTAL Overhead Items - AA			11,625	305,935	49,087	69,721	424,743	

SSHP 01110-1	QUANTY	UOM	MANHOUR	LABOR	EQUIPMNT	MATERIAL	TOTAL COST	UNIT COST
HTRW REMEDIAL ACTION								
SSHP 01110-1								
Industrial Hygienist Technician			166.67	6666.65	0.00	0.00	6666.65	
SSHO	9.00	MO	1,500	60,000	0	0	60,000	6666.65
Pkup Trk: 4x2, Compact 3500 GVW			0.00	0.00	832.48	0.00	832.48	-
	9.00	MO	0	0	7,492	0	7,492	832.48
Industrial Hygienist			166.67	10833.31	0.00	0.00	10833.31	
FOR SSHP AND MONITORING SITE	3.00	MO	500	32,500	0	0	32,500	10833.31
Emergency Body Shower And Eye			5.00	209.74	2.14	583.97	795.84	
Wash Stations	2.00	EA	10	419	4	1,168	1,592	795.84
Assumes Std Hook-Up. No Addition								
al Copper Piping Etc.								
Portable Eye Wash Station			0.00	0.00	0.00	228.60	228.60	
(6Gal/10#)	2.00	EA	0	0	0	457	457	228.60
Dry Chemical Extinguisher (10#)			0.00	0.00	0.00	60.19	60.19	
	5.00	EA	0	0	0	301	301	60.19
36 Ingredients			0.00	0.00	0.00	136.05	136.05	
	2.00	EA	0	0	0	272	272	136.05
Heat Stress Monitor			0.00	0.00	0.00	504.69	504.69	
(Monthly Rental)	1.00	EA	0	0	0	505	505	504.69
8' x 24', 4 Showers, HVAC,			0.00	0.00	0.00	2018.75	2018.75	
2 Sinks (Monthly Rental)	9.00	EA	0	0	0	18,169	18,169	2018.75
Transportation Of Rental Units			0.00	0.00	0.00	1.59	1.59	
	100.00	MI	0	0	0	159	159	1.59
Disposal Fees			0.00	0.00	0.00	10625.00	10625.00	
PPE, WATER, DECON PAD, ECT.	1.00	LS	0	0	0	10,625	10,625	10625.00
Decontamination Hand Soap			0.00	0.00	0.00	37.51	37.51	
(1 Gallon)	5.00	EA	0	0	0	188	188	37.51
4 Hour Site Specific TRAINING			0.00	0.00	0.00	159.38	159.38	
Training (Cost Per Student)	15.00	EA	0	0	0	2,391	2,391	159.38
ESTIMATE ASSUMES WORKERS								
ALREADY HAVE 40 HOUR HAZ WASTE								
TRAINING AND ANNUAL 8 HR								
REFRESHER CURRENT. MEDICAL								
EXAMS ARE ALSO CONSIDERED TO BE								
UP TO DATE. COSTS FOR THESE								
ARE ASORBED IN THE HOME OFFICE								

SSHP 01110-1	QUANTY	UOM	MANHOUR	LABOR	EQUIPMNT	MATERIAL	TOTAL COST	UNIT COST
EXPENSE MARKUP.								
Utility Hookup: Electrical			0.00	0.00	0.00	318.75	318.75	
	1.00	EA	0	0	0	319	319	318.75
Utility Hookup: Water			0.00	0.00	0.00	318.75	318.75	
	1.00	EA	0	0	0	319	319	318.75
Jobsite Fencing: Temporary			0.00	0.00	0.00	2125.00	2125.00	
FOR CWRZ, HWZ FENCES MARKING TAPES ECT.	1.00	EA	0	0	0	2,125	2,125	2125.00
CONCRETE DECON PAD W/PUMP, SUMP			0.00	2000.00	1000.00	5312.50	8312.50	
ECT.	1.00	LS	0	2,000	1,000	5,313	8,313	8312.50
Truck Drivers, Heavy			1.00	31.22	0.00	0.00	31.22	
DUST CONTROL CREW, IN ADDITION TO COMPACTION WATER CREWS.	800.00	HR	800	24,978	0	0	24,978	31.22
50 HRS X 16 WEEKS = 800 HRS								
Equip. Operators, Light			1.00	34.48	0.00	0.00	34.48	
	800.00	HR	800	27,585	0	0	27,585	34.48
PUMP,SUBM, 6"D,1950GPM/40'HD, EL			0.00	0.00	7.85	0.00	7.85	
	800.00	HR	0	0	6,278	0	6,278	7.85
TRK,WTR,OF-HY, 6000GAL,W/CAT621E			0.00	0.00	57.76	0.00	57.76	
	800.00	HR	0	0	46,208	0	46,208	57.76
PPE			0.00	0.00	0.00	4.25	4.25	
	1600.00	HR	0	0	0	6,800	6,800	4.25
TOTAL SSHP 01110-1	1.00	EA	3,610	147,482	60,983	49,109	257,573	257573.37

MONITORING,

AIR MONITOR & SAMPLING
SEE QUOTE FROM ENVIROMENTAL OPERATIONS INC 314-436-0370 DONN HAINES
ST LOUIS MO 10/21/96

AIR MONITORING PLAN			0.00	3080.00	0.00	0.00	3080.00	
	1.00	EA	0	3,080	0	0	3,080	3080.00
REVISIONS TO PLAN			0.00	770.00	0.00	0.00	770.00	
	1.00	EA	0	770	0	0	770	770.00
ON SITE LABOR			0.00	13860.00	0.00	0.00	13860.00	
	4.00	MO	0	55,440	0	0	55,440	13860.00

MONITORING,	QUANTY	UOM	MANHOUR	LABOR	EQUIPMNT	MATERIAL	TOTAL COST	UNIT COST
SAMPLE ANALYSIS			0.00	0.00	0.00	19576.56	19576.56	
	4.00	MO	0	0	0	78,306	78,306	19576.56
AIR MONITORING EQUIP FIRST			0.00	0.00	5200.00	0.00	5200.00	
	4.00	MO	0	0	20,800	0	20,800	5200.00
TOTAL AIR MONITOR & SAMPLING		MO	0	59,290	20,800	78,306	158,396	
CHEMICAL QUALITY CONTROL								
DECON WATER								
SAMPLING MATERIALS								
PG 01402-2 PAR 2.2								
TOTAL SAMPLING MATERIALS	1.00	EA	0	0	0	2,000	2,000	2000.00
CHEMICAL ANALYSIS								
CONFIRMATION SAMPLES								
Lead EPA 3050			0.00	0.00	0.00	26.56	26.56	
spec says 1 per acre, 30 acre site. 30 + 10% QA/QC = 33EA	33.00	EA	0	0	0	877	877	26.56
TOTAL CONFIRMATION SAMPLES	1.00	EA	0	0	0	877	877	876.56
SELECT FILL SAMPLING								
PG 01402-4 PAR 3.1.1.2								
3 SOURCES + 10% QA/QC = 4								
Volatile Organics (8260)			0.00	0.00	0.00	239.06	239.06	
	4.00	EA	0	0	0	956	956	239.06
Semi-Volatile Organics (8270)			0.00	0.00	0.00	371.88	371.88	
	4.00	EA	0	0	0	1,488	1,488	371.88
Pesticides/PCBs (8080)			0.00	0.00	0.00	223.13	223.13	
	4.00	EA	0	0	0	893	893	223.13
Metals Screen, 25 Listed in SW3005/SW6010			0.00	0.00	0.00	456.88	456.88	
	4.00	EA	0	0	0	1,828	1,828	456.88
TOTAL SELECT FILL SAMPLING	1.00	EA	0	0	0	5,164	5,164	5163.75

MONITORING,	QUANTY UOM	MANHOUR	LABOR	EQUIPMNT	MATERIAL	TOTAL COST	UNIT COST
DEWATERING SAMPLING							
CONTRACTOR TO DETERMINE TESTING REQUIREMENTS							
TOTAL DEWATERING SAMPLING	1.00 EA	0	0	0	2,000	2,000	2000.00
DECON WATER SAMPLING							
CONTRACTOR TO DETERMINE TESTING REQUIREMENTS							
TOTAL DECON WATER SAMPLING	1.00 EA	0	0	0	3,000	3,000	3000.00
LEACHATE WATER SAMPLING							
CONTRACTOR TO DETERMINE TESTING REQUIREMENTS							
TOTAL LEACHATE WATER SAMPLING	1.00 EA	0	0	0	2,000	2,000	2000.00
MONITORING WELL SAMPLING							
1 ROUND X 16 WELLS + NO QA/QC = 16							
TAL Metals (6010/7000s)		0.00	0.00	0.00	217.81	217.81	
	16.00 EA	0	0	0	3,485	3,485	217.81
TOTAL MONITORING WELL SAMPLING	1.00 EA	0	0	0	3,485	3,485	3485.00
DRUM SAMPLING							
Lead EPA 3050		0.00	0.00	0.00	26.56	26.56	
QUANTITY UNKKNOWN	10.00 EA	0	0	0	266	266	26.56
TOTAL DRUM SAMPLING	1.00 EA	0	0	0	266	266	265.63
TOTAL CHEMICAL ANALYSIS	1.00 EA	0	0	0	16,791	16,791	16790.94
TOTAL CHEMICAL QUALITY CONTROL	1.00 EA	0	0	0	18,791	18,791	18790.94
SITE MAINTENANCE AND O&M MANUAL							
QUARTERLY MAINT & MONITORING		0.00	2000.00	1000.00	2125.00	5125.00	
	4.00 EA	0	8,000	4,000	8,500	20,500	5125.00
O&M MANUAL		0.00	1000.00	0.00	1062.50	2062.50	
	1.00 EA	0	1,000	0	1,063	2,063	2062.50
TOTAL SITE MAINTENANCE AND O&M MANUAL	1.00 EA	0	9,000	4,000	9,563	22,563	22562.50
TOTAL MONITORING,	1.00 EA	0	68,290	24,800	106,660	199,750	199749.69

SITE WORK	QUANTY UOM	MANHOUR	LABOR	EQUIPMNT	MATERIAL	TOTAL COST	UNIT COST
SITE WORK							
DEMOLITION							
Remove & Reuse Chain Link Fence		0.06	2.03	0.01	0.00	2.04	
	3330.00 LF	215	6,762	36	0	6,798	2.04
Clear and Grub Med Trees to 10"D		80.00	2589.15	1138.10	0.00	3727.25	
(25cm) Dia, Cut and Chip	2.00 ACR	160	5,178	2,276	0	7,454	3727.25
Chipping - Hvy. Brush		38.41	1243.19	546.46	0.00	1789.65	
	2.00 ACR	77	2,486	1,093	0	3,579	1789.65
Machine Load Spoils, Haul		0.11	3.65	1.40	0.00	5.05	
(3.2Km) Haul to Dump	1000.00 CY	111	3,647	1,401	0	5,048	5.05
Demo Bituminous Roads		0.01	0.22	0.03	0.00	0.25	
Remove Paving and Base Course	96550 SF	637	20,971	3,283	0	24,253	0.25
Demo Mesh Reinforced Conc To 8"		0.04	1.24	0.18	0.00	1.42	
w/Air	6310.00 SF	244	7,852	1,119	0	8,970	1.42
Saw Cut Bituminous Paving		0.02	0.72	0.03	0.00	0.75	
Per Linear Inch of Depth	643.00 LF	15	465	18	0	484	0.75
Saw Cut Mesh Reinf Concrete Slab		0.08	2.46	0.10	0.00	2.56	
8" Inch of Depth	370.00 LF	29	910	36	0	946	2.56
Demo Railroad Track and Ties		0.15	4.74	0.78	0.00	5.51	
	1300.00 LF	190	6,157	1,012	0	7,169	5.51
Remove Railroad Track Ballast		0.10	3.11	0.28	0.00	3.39	
	2600.00 CY	250	8,078	723	0	8,802	3.39
Remove Railroad Track Turnouts		48.00	1553.49	139.08	0.00	1692.57	
Re-Install w/New Bolts & Spikes	3.00 EA	144	4,660	417	0	5,078	1692.57
Demo and Load Plain Conc Curbing		0.09	2.87	0.45	0.00	3.32	
	233.00 LF	20	668	105	0	773	3.32
Saw Cut Mesh Reinf Concrete Slab		0.08	2.46	0.10	0.00	2.56	
8" Inch of Depth	237.00 LF	19	583	23	0	606	2.56
Exc & Ld,2-1/2CY Wh Ldr, Lt Matl		0.02	0.59	0.70	0.00	1.28	
90 CY/Hr (69M3)	1500.00 CY	25	884	1,044	0	1,927	1.28
8 LCY Truckload, 20 MPH		0.04	1.20	1.64	0.00	2.84	
2.6 Cycles/Hr	1500.00 CY	58	1,801	2,457	0	4,258	2.84
Remove 4"(10cm) Pavement Stripe		0.04	1.39	0.01	0.63	2.03	
	1550.00 LF	65	2,155	22	972	3,149	2.03

SITE WORK	QUANTY	UOM	MANHOUR	LABOR	EQUIPMNT	MATERIAL	TOTAL COST	UNIT COST
Demo BILLBOARD			13.00	430.14	67.34	0.00	497.48	
5' Deep x 5' Wide x 12' Long	1.00	EA	13	430	67	0	497	497.48
Demo SIGN			3.25	107.54	16.84	0.00	124.37	
5' Deep x 5' Wide x 12' Long	1.00	EA	3	108	17	0	124	124.37
Demo Catch Basin or Manhole			3.71	122.90	19.24	0.00	142.14	
Masonry or Concrete, Abandon	1.00	EA	4	123	19	0	142	142.14
Demo Conc Catch Basin or Manhole			6.50	215.07	33.67	0.00	248.74	
5'(1.5M) Deep by 4'(1.2M) Dia	2.00	EA	13	430	67	0	497	248.74
Demo Concrete Vault			16.25	537.68	84.18	0.00	621.85	
5' Deep x 5' Wide x 12' Long	1.00	EA	16	538	84	0	622	621.85
Demo Concrete Pipe to 12" Dia			0.15	5.09	0.87	0.00	5.96	
Water/Sewer Pipe, No Excavation	350.00	LF	51	1,783	304	0	2,087	5.96
Demo Conc Pipe 21" to 24" Dia			0.22	7.64	1.30	0.00	8.94	
Sewer/Water Pipe, No Excavation	222.00	LF	49	1,696	289	0	1,985	8.94
Trench, 1 CY Hyd Excav, Hvy Soil			0.02	0.66	0.56	0.00	1.21	
4' to 6' Deep,104 CY/Hr	600.00	CY	12	393	333	0	726	1.21
Backfill Trench w/60 HP Tr Dozer			0.03	1.00	0.32	0.00	1.32	
Without Compaction	600.00	CY	17	597	194	0	791	1.32
Compaction, 6" Layers, Vib Plate			0.07	2.34	0.06	0.00	2.40	
(15cm) Layers	600.00	CY	44	1,402	36	0	1,438	2.40
REMOVE BATTERY CRUSHER			8.00	264.87	41.47	0.00	306.33	
5' Deep x 5' Wide x 12' Long	1.00	EA	8	265	41	0	306	306.33
REMOVE TRAILER			8.00	264.87	41.47	0.00	306.33	
5' Deep x 5' Wide x 12' Long	1.00	EA	8	265	41	0	306	306.33
REMOVE BUILDING BV&G TRUCKING			40.02	1324.33	207.33	1593.75	3125.41	
5' Deep x 5' Wide x 12' Long	1.00	EA	40	1,324	207	1,594	3,125	3125.41
Demo Service Drop Wire			0.05	1.98	0.31	0.00	2.29	
100' Drop, Roll Up and Disposal	1900.00	LF	95	3,762	591	0	4,352	2.29
TOTAL DEMOLITION			2,631	86,373	17,355	2,565	106,293	

SITE WORK	QUANTY UOM	MANHOUR	LABOR	EQUIPMNT	MATERIAL	TOTAL COST	UNIT COST
CAP EARTHWORK AND GEO-MEMBRANES							
CONTAMINATED SOIL REMOVAL							
3' EXCAV OF CONTAMINATED SOIL ON SITE.							
EXCAVATE (COFWK)				** OVERTIME **	** ADJUSTED **		
Equip. Operators, Medium		1.82	76.86	0.00	0.00	76.86	
	336.93 HR	613	25,895	0	0	25,895	76.86
LDR,FE, CRWLR, 3.75 CY		0.00	0.00	136.25	0.00	136.25	
	336.93 HR	0	0	45,906	0	45,906	136.25
Truck Drivers, Heavy		1.82	64.65	0.00	0.00	64.65	
	336.93 HR	613	21,782	0	0	21,782	64.65
Equip. Operators, Light		1.82	70.83	0.00	0.00	70.83	
	336.93 HR	613	23,864	0	0	23,864	70.83
PUMP,SUBM, 6"D,1950GPM/40'HD, EL		0.00	0.00	14.04	0.00	14.04	
	336.93 HR	0	0	4,731	0	4,731	14.04
TRK,WTR,OF-HY, 6000GAL,W/CAT621E		0.00	0.00	100.25	0.00	100.25	
	336.93 HR	0	0	33,778	0	33,778	100.25
PPE		0.00	0.00	0.00	4.25	4.25	
	1347.71 HR	0	0	0	5,728	5,728	4.25
TOTAL EXCAVATE	50539 CY	1,840	71,541	84,415	5,728	161,683	3.20
HAUL (COETH)				** OVERTIME **	** ADJUSTED **		
51,728 X 1.25 SWELL = 64,700CY							
Truck Drivers, Heavy		1.82	64.65	0.00	0.00	64.65	
	862.67 HR	1,570	55,770	0	0	55,770	64.65
TRK,OFF-HWY,R-DUMP, 14-19CY, 25T		0.00	0.00	77.50	0.00	77.50	
	862.67 HR	0	0	66,854	0	66,854	77.50
PPE		0.00	0.00	0.00	4.25	4.25	
	862.67 HR	0	0	0	3,666	3,666	4.25
TOTAL HAUL	64700 CY	1,570	55,770	66,854	3,666	126,290	1.95

SITE WORK	QUANTY UOM	MANHOUR	LABOR	EQUIPMNT	MATERIAL	TOTAL COST	UNIT COST
PLACE (COFWK)				** OVERTIME **	** ADJUSTED **		
Equip. Operators, Medium		1.82	75.80	0.00	0.00	75.80	
	862.67 HR	1,570	65,387	0	0	65,387	75.80
ROLLER,VIB,DO,S/P,11.1T, 66"W		0.00	0.00	60.26	0.00	60.26	
	431.33 HR	0	0	25,991	0	25,991	60.26
BLADE, ANGLE, HYDR (FOR D6		0.00	0.00	6.95	0.00	6.95	
	431.33 HR	0	0	2,998	0	2,998	6.95
DOZER,CWLR, D-6H,PS (ADD BLADE)		0.00	0.00	70.76	0.00	70.76	
	431.33 HR	0	0	30,523	0	30,523	70.76
Equip. Operators, Medium		1.82	75.80	0.00	0.00	75.80	
	431.33 HR	785	32,693	0	0	32,693	75.80
GRADER,MOTOR, ARTIC, CAT 12-G		0.00	0.00	53.15	0.00	53.15	
	431.33 HR	0	0	22,926	0	22,926	53.15
Equip. Operators, Light		1.82	71.89	0.00	0.00	71.89	
	431.33 HR	785	31,008	0	0	31,008	71.89
Truck Drivers, Heavy		1.82	64.65	0.00	0.00	64.65	
	431.33 HR	785	27,885	0	0	27,885	64.65
PUMP,SUBM, 6"D,1950GPM/40'HD, EL		0.00	0.00	14.04	0.00	14.04	
	431.33 HR	0	0	6,057	0	6,057	14.04
TRK,WTR,OF-HY, 6000GAL,W/CAT621E		0.00	0.00	100.25	0.00	100.25	
	431.33 HR	0	0	43,242	0	43,242	100.25
TOTAL PLACE	64700 CY	3,925	156,973	131,738	0	288,711	4.46
TOTAL 3' EXCAV OF CONTAMINATED SOIL ON	51728 CY	7,335	284,284	283,007	9,394	576,685	11.15
EXCAV OF EXIST SLLR WASTE PILE							
EXCAVATE (COFWK)				** OVERTIME **	** ADJUSTED **		
Equip. Operators, Medium		1.82	76.86	0.00	0.00	76.86	
	27.00 HR	49	2,075	0	0	2,075	76.86
LDR,FE, CRWLR, 3.75 CY		0.00	0.00	136.25	0.00	136.25	
	27.00 HR	0	0	3,679	0	3,679	136.25
Truck Drivers, Heavy		1.82	64.65	0.00	0.00	64.65	
	27.00 HR	49	1,745	0	0	1,745	64.65

SITE WORK	QUANTY UOM	MANHOUR	LABOR	EQUIPMNT	MATERIAL	TOTAL COST	UNIT COST
Equip. Operators, Light		1.82	70.83	0.00	0.00	70.83	
	27.00 HR	49	1,912	0	0	1,912	70.83
PUMP,SUBM, 6"D,1950GPM/40'HD, EL		0.00	0.00	14.04	0.00	14.04	
	27.00 HR	0	0	379	0	379	14.04
TRK,WTR,OF-HY, 6000GAL,W/CAT621E		0.00	0.00	100.25	0.00	100.25	
	27.00 HR	0	0	2,707	0	2,707	100.25
PPE		0.00	0.00	0.00	4.25	4.25	
	108.00 HR	0	0	0	459	459	4.25
TOTAL EXCAVATE	4050.00 CY	147	5,733	6,765	459	12,957	3.20
HAUL (COETH)			** OVERTIME **		** ADJUSTED **		
4,050 X 1.25 SWELL = 5,100CY							
Truck Drivers, Heavy		1.82	64.65	0.00	0.00	64.65	
	68.00 HR	124	4,396	0	0	4,396	64.65
TRK,OFF-HWY,R-DUMP, 14-19CY, 25T		0.00	0.00	77.50	0.00	77.50	
	68.00 HR	0	0	5,270	0	5,270	77.50
PPE		0.00	0.00	0.00	4.25	4.25	
	68.00 HR	0	0	0	289	289	4.25
TOTAL HAUL	5100.00 CY	124	4,396	5,270	289	9,955	1.95
PLACE (COFWK)			** OVERTIME **		** ADJUSTED **		
Equip. Operators, Medium		1.82	75.80	0.00	0.00	75.80	
	68.00 HR	124	5,154	0	0	5,154	75.80
ROLLER,VIB,DD,S/P,11.1T, 66"W		0.00	0.00	60.26	0.00	60.26	
	34.00 HR	0	0	2,049	0	2,049	60.26
BLADE, ANGLE, HYDR (FOR D6		0.00	0.00	6.95	0.00	6.95	
	34.00 HR	0	0	236	0	236	6.95
DOZER,CWLR, D-6H,PS (ADD BLADE)		0.00	0.00	70.76	0.00	70.76	
	34.00 HR	0	0	2,406	0	2,406	70.76
Equip. Operators, Medium		1.82	75.80	0.00	0.00	75.80	
	34.00 HR	62	2,577	0	0	2,577	75.80
GRADER,MOTOR, ARTIC, CAT 12-G		0.00	0.00	53.15	0.00	53.15	
	34.00 HR	0	0	1,807	0	1,807	53.15

SITE WORK	QUANTY UOM	MANHOUR	LABOR	EQUIPMNT	MATERIAL	TOTAL COST	UNIT COST
Equip. Operators, Light		1.82	71.89	0.00	0.00	71.89	
	34.00 HR	62	2,444	0	0	2,444	71.89
Truck Drivers, Heavy		1.82	64.65	0.00	0.00	64.65	
	34.00 HR	62	2,198	0	0	2,198	64.65
PUMP,SUBM, 6"D,1950GPM/40'HD, EL		0.00	0.00	14.04	0.00	14.04	
	34.00 HR	0	0	477	0	477	14.04
TRK,WTR,OF-HY, 6000GAL,W/CAT621E		0.00	0.00	100.25	0.00	100.25	
	34.00 HR	0	0	3,409	0	3,409	100.25
PPE		0.00	0.00	0.00	4.25	4.25	
	170.00 HR	0	0	0	723	723	4.25
TOTAL PLACE	5100.00 CY	309	12,373	10,384	723	23,480	4.60
TOTAL EXCAV OF EXIST SLLR WASTE PILE	4050.00 CY	581	22,503	22,419	1,471	46,392	11.45

EXCAV FOR NEW LINER

CLEAN SOIL BELOW 3' LEVEL. TO BE PLACED IN LINER AS RANDOM FILL.

EXCAVATE (COFWK)				** OVERTIME **	** ADJUSTED **		
Equip. Operators, Medium		1.82	76.86	0.00	0.00	76.86	
	9.11 HR	17	700	0	0	700	76.86
LDR,FE, CRWLR, 3.75 CY		0.00	0.00	136.25	0.00	136.25	
	9.11 HR	0	0	1,241	0	1,241	136.25
Truck Drivers, Heavy		1.82	64.65	0.00	0.00	64.65	
	9.11 HR	17	589	0	0	589	64.65
Equip. Operators, Light		1.82	70.83	0.00	0.00	70.83	
	9.11 HR	17	645	0	0	645	70.83
PUMP,SUBM, 6"D,1950GPM/40'HD, EL		0.00	0.00	14.04	0.00	14.04	
	9.11 HR	0	0	128	0	128	14.04
TRK,WTR,OF-HY, 6000GAL,W/CAT621E		0.00	0.00	100.25	0.00	100.25	
	9.11 HR	0	0	913	0	913	100.25
PPE		0.00	0.00	0.00	4.25	4.25	
	36.43 HR	0	0	0	155	155	4.25
TOTAL EXCAVATE	1366.00 CY	50	1,934	2,282	155	4,370	3.20

SITE WORK	QUANTY	UOM	MANHOUR	LABOR	EQUIPMNT	MATERIAL	TOTAL COST	UNIT COST
HAUL (COETH)					** OVERTIME **	** ADJUSTED **		
1366 X 1.25 SWELL = 1,700CY								
Truck Drivers, Heavy			1.82	64.65	0.00	0.00	64.65	
	22.67	HR	41	1,465	0	0	1,465	64.65
TRK,OFF-HWY,R-DUMP, 14-19CY, 25T			0.00	0.00	77.50	0.00	77.50	
	22.67	HR	0	0	1,757	0	1,757	77.50
PPE			0.00	0.00	0.00	4.25	4.25	
	22.67	HR	0	0	0	96	96	4.25
TOTAL HAUL	1700.00	CY	41	1,465	1,757	96	3,318	1.95
PLACE (COFWK)					** OVERTIME **	** ADJUSTED **		
Equip. Operators, Medium			1.82	75.80	0.00	0.00	75.80	
	22.67	HR	41	1,718	0	0	1,718	75.80
ROLLER,VIB,DD,S/P,11.1T, 66"W			0.00	0.00	60.26	0.00	60.26	
	11.33	HR	0	0	683	0	683	60.26
BLADE, ANGLE, HYDR (FOR D6			0.00	0.00	6.95	0.00	6.95	
	11.33	HR	0	0	79	0	79	6.95
DOZER,CWLR, D-6H,PS (ADD BLADE)			0.00	0.00	70.76	0.00	70.76	
	11.33	HR	0	0	802	0	802	70.76
Equip. Operators, Medium			1.82	75.80	0.00	0.00	75.80	
	11.33	HR	21	859	0	0	859	75.80
GRADER,MOTOR, ARTIC, CAT 12-G			0.00	0.00	53.15	0.00	53.15	
	11.33	HR	0	0	602	0	602	53.15
Equip. Operators, Light			1.82	71.89	0.00	0.00	71.89	
	11.33	HR	21	815	0	0	815	71.89
Truck Drivers, Heavy			1.82	64.65	0.00	0.00	64.65	
	11.33	HR	21	733	0	0	733	64.65
PUMP,SUBM, 6"D,1950GPM/40'HD, EL			0.00	0.00	14.04	0.00	14.04	
	11.33	HR	0	0	159	0	159	14.04
TRK,WTR,OF-HY, 6000GAL,W/CAT621E			0.00	0.00	100.25	0.00	100.25	
	11.33	HR	0	0	1,136	0	1,136	100.25
PPE			0.00	0.00	0.00	4.25	4.25	
	56.67	HR	0	0	0	241	241	4.25

SITE WORK	QUANTY	UOM	MANHOUR	LABOR	EQUIPMNT	MATERIAL	TOTAL COST	UNIT COST
TOTAL PLACE	1700.00	CY	103	4,124	3,461	241	7,827	4.60
TOTAL EXCAV FOR NEW LINER	1366.00	CY	194	7,523	7,500	492	15,515	11.36
TOTAL CONTAMINATED SOIL REMOVAL			8,109	314,310	312,925	11,357	638,591	

LINER

RANDOM FILL. (OMASHEE102) ** OVERTIME ** ** ADJUSTED **
LEVEL "C" PROTECTION REQUIRED FOR 1ST LIFT ONLY. USE .82 FACTOR DIVIDED BY ASSUMED 3 LIFTS = .27

QUOTE: BRUCE TRUCKING AND EXCAVATING 10/15/96
BRUCE MORE 618-931-3757

RANDOM FILL $6.25 DELIVERED TO SITE 25% ADDED FOR SWELL

QUANTITY IS 1,917 LESS 1,366 FROM EXCAVATION FOR NEW LINER = 551 NET
ASSUME CONVERSION FACTOR OF 1:1

Outside Equip. Op. Heavy		1.27	50.44	0.00	0.00	50.44	
	7.35 HR	9	448	0	0	448	61.03
DOZER,CWLR,CAT D-8N, (ADD BLADE)		0.00	0.00	82.77	0.00	82.77	
POWERSHIFT, (ADD BLADE)	7.35 HR	0	0	736	0	736	100.15
RIPPER,MULTISHANK BEAM, HYD, D-9		0.00	0.00	14.63	0.00	14.63	
RIPPER,MULTI-SHANK;W/HYD-CONTROL	7.35 HR	0	0	130	0	130	17.70
GRADER,MOTOR,CAT12-G, ARTIC		0.00	0.00	37.94	0.00	37.94	
ARTICULATED FRAME, POWERSHIFT	3.67 HR	0	0	169	0	169	45.90
Outside Equip. Op. Heavy		1.27	50.44	0.00	0.00	50.44	
	3.67 HR	5	224	0	0	224	61.03
Self-prop Sheepsfoot Roller 815		0.00	0.00	50.80	0.00	50.80	
	7.35 HR	0	0	452	0	452	61.47
Outside Equip. Op. Heavy		1.27	50.44	0.00	0.00	50.44	
	7.35 HR	9	448	0	0	448	61.03
RANDOM FILL		0.00	0.00	0.00	6.64	6.64	
	551.00 TON	0	0	0	4,427	4,427	8.04
PPE		0.00	0.00	0.00	4.25	4.25	
	18.37 HR	0	0	0	94	94	5.14

SITE WORK	QUANTY	UOM	MANHOUR	LABOR	EQUIPMNT	MATERIAL	TOTAL COST	UNIT COST
TOTAL RANDOM FILL.	551.00	TON	23	1,121	1,486	4,522	7,129	12.94
GCL.				** OVERTIME **				
QUOTE: GSE 10/01/96								
ROGER CRABLE IL REP 800-435-2008								
1/4" Geosyn clay liner-bentonite			0.03	1.02	0.42	3.05	4.49	
Installed On Soil Or Agg. Base	5754.00	SY	166	7,132	2,891	21,231	31,253	5.43
TOTAL GCL.	5754.00	SY	166	7,132	2,891	21,231	31,253	5.43
GEOMEMBRANE.				** OVERTIME **				
QUOTE: GSE 10/01/96								
ROGER CRABLE IL REP @ 800-435-2008 INSTALLED PRICE								
60 Mil HDPE			0.04	1.38	0.07	3.67	5.12	
	5754.00	SY	230	9,609	517	25,521	35,647	6.20
TOTAL GEOMEMBRANE.	5754.00	SY	230	9,609	517	25,521	35,647	6.20
GEOCOMPOSITE.				** OVERTIME **				
QUOTE: GSE 10/01/96 INSTALLED PRICE								
ROGER CRABLE IL REP @ 800-435-2008								
GeoComposite			0.04	1.37	0.04	3.32	4.72	
	5754.00	SY	230	9,520	274	23,080	32,874	5.71
TOTAL GEOCOMPOSITE.	5754.00	SY	230	9,520	274	23,080	32,874	5.71
12" GRADED GRANULAR FILTER MTL. (XSABD)				** OVERTIME **				
QUOTE: METRO EAST SAND 10/02/96								
JERY BOHNENSTIEHL 618-398-3838								
GRANULAR FILTER MATERIAL $7.00/TON DELIVERED 25% ADDED FOR SWELL								
HIS FA-2 WHICH MEETS OUR SPEC. TRUCKING AT $3.00/TON.								
HIS FA-6 IF ACCEPTABLE $5.80/TON								
CONVERSION FACTOR AT 1.5 TON/CY = $7.00 X 1.5 = $10.50/CY								
LDR,FE,CRWLR, 1.5 CY, 943			0.00	0.00	28.53	0.00	28.53	
1.5 CY	38.34	HR	0	0	1,324	0	1,324	34.52
ROLLER,SM-DR,SELF,12T,3WHL,3"OVL			0.00	0.00	13.44	0.00	13.44	
12 TON, 3 WHEEL, 3" OVERLAP	38.34	HR	0	0	624	0	624	16.26

SITE WORK	QUANTY UOM	MANHOUR	LABOR	EQUIPMNT	MATERIAL	TOTAL COST	UNIT COST
BLADE, ANGLE, HYDR, FOR D6		0.00	0.00	3.90	0.00	3.90	
BLADE, ANGLE, HYDRAULIC, FOR D6	38.34 HR	0	0	181	0	181	4.72
DOZER,CWLR,D-6H,PS,(ADD BLADE)		0.00	0.00	39.46	0.00	39.46	
POWERSHIFT, (ADD BLADE)	38.34 HR	0	0	1,831	0	1,831	47.75
Outside Equip. Op. Medium		1.00	39.72	0.00	0.00	39.72	
	115.02 HR	115	5,527	0	0	5,527	48.06
Outside Oiler		1.00	32.71	0.00	0.00	32.71	
	38.34 HR	38	1,517	0	0	1,517	39.58
GRANULAR FILL DELIVERED		0.00	0.00	0.00	11.16	11.16	
	2396.25 CY	0	0	0	26,733	26,733	11.16
TOTAL 12" GRADED GRANULAR FILTER MTL.	1917.00 CY	153	7,045	3,959	26,733	37,737	19.69
TOTAL LINER		803	34,426	9,126	101,087	144,640	
MAIN CAP							
PILE REGRADING cut. (OMADOZE402)			** OVERTIME **		** ADJUSTED **		
Outside Equip. Op. Heavy		1.82	72.28	0.00	0.00	72.28	
	31.28 HR	57	2,736	0	0	2,736	87.46
DOZER,CWLR,CAT D-8N, (ADD BLADE)		0.00	0.00	118.61	0.00	118.61	
POWERSHIFT, (ADD BLADE)	31.28 HR	0	0	4,490	0	4,490	143.52
RIPPER,MULTISHANK BEAM, HYD, D-9		0.00	0.00	20.96	0.00	20.96	
RIPPER,MULTI-SHANK;W/HYD-CONTROL	31.28 HR	0	0	793	0	793	25.36
Equip. Operators, Light		1.82	67.60	0.00	0.00	67.60	
	31.28 HR	57	2,559	0	0	2,559	81.79
PUMP,SUBM, 6"D,1950GPM/40'HD, EL		0.00	0.00	14.14	0.00	14.14	
	31.28 HR	0	0	535	0	535	17.11
TRK,WTR,OF-HY, 6000GAL,W/CAT621E		0.00	0.00	102.20	0.00	102.20	
	31.28 HR	0	0	3,869	0	3,869	123.66
PPE		0.00	0.00	0.00	4.25	4.25	
	62.57 HR	0	0	0	322	322	5.14
TOTAL PILE REGRADING cut.	1877.00 CY	114	5,295	9,687	322	15,304	8.15

SITE WORK	QUANTY	UOM	MANHOUR	LABOR	EQUIPMNT	MATERIAL	TOTAL COST	UNIT COST
RANDOM FILL. (OMASHEE102)					** OVERTIME **	** ADJUSTED **		
LEVEL "C" PROTECTION REQUIRED FOR 1ST LIFT ONLY. USE .82 FACTOR DIVIDED BY ASSUMED 3 LIFTS = .27								
QUOTE: BRUCE TRUCKING AND EXCAVATING 10/15/96								
BRUCE MORE 618-931-3757								
RANDOM FILL $6.25 DELIVERED TO SITE 25% ADDED FOR SWELL								
Outside Equip. Op. Heavy			1.27	50.44	0.00	0.00	50.44	
	137.72	HR	175	8,405	0	0	8,405	61.03
DOZER,CWLR,CAT D-8N, (ADD BLADE)			0.00	0.00	82.77	0.00	82.77	
POWERSHIFT, (ADD BLADE)	137.72	HR	0	0	13,793	0	13,793	100.15
RIPPER,MULTISHANK BEAM, HYD, D-9			0.00	0.00	14.63	0.00	14.63	
RIPPER,MULTI-SHANK;W/HYD-CONTROL	137.72	HR	0	0	2,437	0	2,437	17.70
GRADER,MOTOR,CAT12-G, ARTIC			0.00	0.00	37.94	0.00	37.94	
ARTICULATED FRAME, POWERSHIFT	68.86	HR	0	0	3,161	0	3,161	45.90
Outside Equip. Op. Heavy			1.27	50.44	0.00	0.00	50.44	
	68.86	HR	87	4,203	0	0	4,203	61.03
Self-prop Sheepsfoot Roller 815			0.00	0.00	50.80	0.00	50.80	
	137.72	HR	0	0	8,465	0	8,465	61.47
Outside Equip. Op. Heavy			1.27	50.44	0.00	0.00	50.44	
	137.72	HR	175	8,405	0	0	8,405	61.03
RANDOM FILL			0.00	0.00	0.00	6.64	6.64	
	12911	CY	0	0	0	85,739	85,739	6.64
PPE			0.00	0.00	0.00	4.25	4.25	
	344.30	HR	0	0	0	1,771	1,771	5.14
TOTAL RANDOM FILL.	10329	CY	437	21,013	27,856	87,509	136,379	13.20
GEOMEMBRANE.					** OVERTIME **			
QUOTE: GSE 10/01/96								
ROGER CRABLE IL REP @ 800-435-2008								
40 Mil HDPE TEXTURED TWO SIDES			0.02	0.69	0.04	3.46	4.19	
	30986	SY	620	25,874	1,391	129,867	157,132	5.07
TOTAL GEOMEMBRANE.	30986	SY	620	25,874	1,391	129,867	157,132	5.07

SITE WORK	QUANTY UOM	MANHOUR	LABOR	EQUIPMNT	MATERIAL	TOTAL COST	UNIT COST
GEOCOMPOSITE.			** OVERTIME **				
QUOTE: GSE		10/01/96	INSTALLED PRICE				
ROGER CRABLE	IL REP @ 800-435-2008						
GeoComposite		0.04	1.37	0.04	3.32	4.72	
	30986 SY	1,239	51,264	1,477	124,289	177,031	5.71
TOTAL GEOCOMPOSITE.	30986 SY	1,239	51,264	1,477	124,289	177,031	5.71
GEOGRID.			** OVERTIME **				
QUOTE: GSE		10/01/96	INSTALLED PRICE				
ROGER CRABLE	IL REP @ 800-435-2008						
Geogrid		0.02	0.68	0.02	3.63	4.34	
	24624 SY	492	20,371	587	108,268	129,226	5.25
TOTAL GEOGRID.	24624 SY	492	20,371	587	108,268	129,226	5.25
18" SELECT FILL. (XSABD)			** OVERTIME **				
QUOTE: BRUCE TRUCKING AND EXCAVATING		10/15/96					
BRUCE MORE	618-931-3757						
SELECT FILL	$6.80/CY	DELIVERED	25% ADDED FOR SWELL				
LDR,FE,CRWLR, 1.5 CY, 943		0.00	0.00	28.53	0.00	28.53	
1.5 CY	309.86 HR	0	0	10,698	0	10,698	34.52
ROLLER,SM-DR,SELF,12T,3WHL,3"OVL		0.00	0.00	13.44	0.00	13.44	
12 TON, 3 WHEEL, 3" OVERLAP	309.86 HR	0	0	5,039	0	5,039	16.26
BLADE, ANGLE, HYDR, FOR D6		0.00	0.00	3.90	0.00	3.90	
BLADE, ANGLE, HYDRAULIC, FOR D6	309.86 HR	0	0	1,461	0	1,461	4.72
DOZER,CWLR,D-6H,PS,(ADD BLADE)		0.00	0.00	39.46	0.00	39.46	
POWERSHIFT, (ADD BLADE)	309.86 HR	0	0	14,795	0	14,795	47.75
Outside Equip. Op. Medium		1.00	39.72	0.00	0.00	39.72	
	929.58 HR	930	44,672	0	0	44,672	48.06
Outside Oiler		1.00	32.71	0.00	0.00	32.71	
,	309.86 HR	310	12,264	0	0	12,264	39.58
SELECT FILL DELIVERED		0.00	0.00	0.00	7.23	7.23	
	19366 CY	0	0	0	139,921	139,921	7.23
TOTAL 18" SELECT FILL.	15493 CY	1,239	56,936	31,994	139,921	228,851	14.77

SITE WORK	QUANTY UOM	MANHOUR	LABOR	EQUIPMNT	MATERIAL	TOTAL COST	UNIT COST
6" TOPSOIL. (XSABD)			** OVERTIME **				
QUOTE: BRUCE TRUCKING AND EXCAVATING 10/15/96							
BRUCE MORE 618-931-3757							
TOPSOIL DELIVERED TO SITE $8.50/CY ADDED SWELL FACTOR 25%							
LDR,FE,CRWLR, 1.5 CY, 943		0.00	0.00	28.53	0.00	28.53	
1.5 CY	103.28 HR	0	0	3,566	0	3,566	34.52
ROLLER,SM-DR,SELF,12T,3WHL,3"OVL		0.00	0.00	13.44	0.00	13.44	
12 TON, 3 WHEEL, 3" OVERLAP	103.28 HR	0	0	1,680	0	1,680	16.26
BLADE, ANGLE, HYDR, FOR D6		0.00	0.00	3.90	0.00	3.90	
BLADE, ANGLE, HYDRAULIC, FOR D6	103.28 HR	0	0	487	0	487	4.72
DOZER,CWLR,D-6H,PS,(ADD BLADE)		0.00	0.00	39.46	0.00	39.46	
POWERSHIFT, (ADD BLADE)	103.28 HR	0	0	4,931	0	4,931	47.75
Outside Equip. Op. Medium		1.00	39.72	0.00	0.00	39.72	
	309.84 HR	310	14,890	0	0	14,890	48.06
Outside Oiler		1.00	32.71	0.00	0.00	32.71	
	103.28 HR	103	4,088	0	0	4,088	39.58
TOPSOIL DELIVERED		0.00	0.00	0.00	9.03	9.03	
	6455.00 CY	0	0	0	58,297	58,297	9.03
TOTAL 6" TOPSOIL.	5164.00 CY	413	18,977	10,664	58,297	87,938	17.03
TOTAL OBSERVATION RISER.	8.00 EA	32	968	0	1,452	2,420	302.50
TOE DRAIN PIPE AND ROCK. (CODFA)			** OVERTIME **				
QUOTE: CASPER STONE 618-337-3343 9/30/96							
JOHN CAMER							
STONE OUR ASTM C 33 #57 COMPERABLE TO ILL CA 11							
STONE $5.00 TRUCKING $ 4.00 = $9.00/TON DELIVERED.							
CONVERSION FACTOR OF 1.5 TONS/CY.							
3/4" STONE FOR ROAD SURFACING USE SAME PRICE							
AT THIS TIME SCOTT RUNWAY JOB IS USING ALL LOCAL PRODUCTION, PROBABLY WON'T BE A PROBLEM LATE NEXT YEAR.							
Laborers, (Semi-Skilled)		1.00	34.00	0.00	0.00	34.00	
	37.17 HR	37	1,529	0	0	1,529	41.14
Equip. Operators, Medium		1.00	39.72	0.00	0.00	39.72	
	37.17 HR	37	1,786	0	0	1,786	48.06

SITE WORK	QUANTY UOM	MANHOUR	LABOR	EQUIPMNT	MATERIAL	TOTAL COST	UNIT COST
LDR,BH,WH, 1.38CY FE BKT, 30"DIP		0.00	0.00	16.20	0.00	16.20	
	37.17 HR	0	0	728	0	728	19.60
ROCK DELIVERED		0.00	0.00	0.00	9.56	9.56	
	669.00 TON	0	0	0	7,741	7,741	11.57
6" Dia Perf PVC Pipe, Underdrain		0.13	4.55	1.45	2.60	8.61	
(21cm) Diameter	1178.00 LF	152	6,484	2,071	3,710	12,265	10.41
Plastic Filter Fabric		1.24	42.41	11.21	5.80	59.42	
Underground Drain Lines	80.20 CSF	100	4,115	1,088	563	5,766	71.90
1604' X 5 = 8020 / 100 = 80.2							
4'Dia x 6'Deep CIP Manhole		17.29	618.91	87.22	386.50	1092.62	
8"(20cm)Tk, (1.2M)Dia x (1.8M)Dp.	5.00 EA	86	3,744	528	2,338	6,610	1322.07
Cast Iron 24" X 24"		3.25	116.35	16.40	106.25	239.00	
	5.00 SF	16	704	99	643	1,446	289.19
OBSV RISER		2.00	71.60	10.09	106.25	187.94	
	10.00 SF	20	866	122	1,286	2,274	227.41
SUBDRAIN OUTLET		2.00	71.60	10.09	78.63	160.32	
	10.00 EA	20	866	122	951	1,940	193.98
TOTAL TOE DRAIN PIPE AND ROCK.	446.00 CY	469	20,096	4,759	17,232	42,086	94.36

SCOUR HOLE STONE (CODFA) ** OVERTIME **

QUOTE: CASPER STONE 618-337-3343 9/30/96
JOHN CAMER

STONE OUR ASTM C 33 #57 COMPERABLE TO ILL CA 11

STONE $5.00 TRUCKING $ 4.00 = $9.00/TON DELIVERED.
CONVERSION FACTOR OF 1.5 TONS/CY.

3/4" STONE FOR ROAD SURFACING USE SAME PRICE

AT THIS TIME SCOTT RUNWAY JOB IS USING ALL LOCAL PRODUCTION, PROBABLY WON'T BE A PROBLEM LATE NEXT YEAR.

Laborers, (Semi-Skilled)		1.00	34.00	0.00	0.00	34.00	
	2.08 HR	2	86	0	0	86	41.14
Equip. Operators, Medium		1.00	39.72	0.00	0.00	39.72	
	2.08 HR	2	100	0	0	100	48.06

SITE WORK	QUANTY UOM	MANHOUR	LABOR	EQUIPMNT	MATERIAL	TOTAL COST	UNIT COST
LDR,BH,WH, 1.38CY FE BKT, 30"DIP		0.00	0.00	16.20	0.00	16.20	
	2.08 HR	0	0	41	0	41	19.60
ROCK DELIVERED		0.00	0.00	0.00	9.56	9.56	
	37.50 TON	0	0	0	434	434	11.57
TOTAL SCOUR HOLE STONE	25.00 CY	4	186	41	434	661	26.42
TOTAL LEACHATE COLLECTION RISER	1.00 EA	0	1,000	0	1,500	2,500	2500.00
TOTAL MAIN CAP		5,060	221,980	88,455	669,091	979,526	
TOTAL CAP EARTHWORK AND GEO-MEMBRANES		13,972	570,716	410,507	781,535	1,762,758	
PERIMITER FENCING.							
6'(1.8M)H Fabric Security Fence		0.06	1.76	0.01	11.33	13.10	
Standard FE-6	3450.00 LF	193	7,351	42	47,312	54,705	15.86
10'x 6' Double Galv Steel Gate		4.32	139.57	47.67	401.83	589.07	
For 10'(3M) High Fence	4.00 EA	17	676	231	1,945	2,851	712.77
TOTAL PERIMITER FENCING.	3450.00 LF	210	8,026	272	49,257	57,556	16.68
ELECTRICAL DISTRB RELOCATION.							
ELECTRICAL DISTRB 34KV Line							
Quote from illinova	10/15/96	$62,000					
800-750-6830							
TOTAL ELECTRICAL DISTRB 34KV Line		0	0	0	62,000	62,000	
DIRECT BURIED TELEPHONE							
Direct Burial		0.07	2.66	2.13	0.27	5.06	
	630.00 LF	47	2,030	1,624	202	3,857	6.12
JACK AND BORE		0.40	13.22	10.28	9.56	33.06	
	40.00 LF	16	669	520	484	1,673	41.82
50 Pr #22AWG Phone,Direct Burial		32.70	1287.53	4.96	1456.45	2748.94	
	0.65 MLF	21	1,013	4	1,146	2,162	3326.22
TERMINATION/SPLICE		1.67	70.47	0.24	9.63	80.33	
	2.00 EA	3	171	1	23	194	97.20
TOTAL DIRECT BURIED TELEPHONE	950.00 LF	88	3,882	2,149	1,855	7,886	8.30

SITE WORK	QUANTY	UOM	MANHOUR	LABOR	EQUIPMNT	MATERIAL	TOTAL COST	UNIT COST
TOTAL ELECTRICAL DISTRB RELOCATION.			88	3,882	2,149	63,855	69,886	
GAS LINE RELOCATION 2"								
Trench, Chain Trencher, 6" Wide			0.04	1.49	0.39	0.00	1.89	
X 36" Deep	1700.00	LF	71	3,211	848	0	4,059	2.39
2" Gas Dist Line			0.08	3.01	0.21	2.86	6.08	
Polyethylene, 60 PSI, Coils	850.00	LF	72	3,238	228	3,071	6,537	7.69
2" Gas Pressure Regulator			3.33	125.86	1.40	542.54	669.80	
Flanged End	1.00	EA	3	159	2	686	847	847.30
DEMO GAS LINE			0.03	1.13	0.08	0.00	1.21	
Polyethylene, 60 PSI, Coils	850.00	LF	27	1,214	86	0	1,300	1.53
TOTAL GAS LINE RELOCATION 2"	850.00	LF	173	7,822	1,164	3,757	12,743	14.99
RETAINING WALLS ALTERNATE B								
SHEET PILE (CPIDV)				** OVERTIME **		** ADJUSTED **		
15,774 SF								
Equip. Operators, Crane/Shovel			1.82	72.28	0.00	0.00	72.28	
	489.48	HR	891	42,811	0	0	42,811	87.46
Equip. Operators, Oilers			1.82	59.53	0.00	0.00	59.53	
	244.74	HR	445	17,629	0	0	17,629	72.03
Pile Drivers			1.82	72.64	0.00	0.00	72.64	
	244.74	HR	445	21,510	0	0	21,510	87.89
Pile Drivers			1.82	59.07	0.00	0.00	59.07	
	489.48	HR	891	34,985	0	0	34,985	71.48
Pile Drivers			1.82	71.64	0.00	0.00	71.64	
	489.48	HR	891	42,427	0	0	42,427	86.68
CR,ME,CWLR,LIFTING, 85T/160'BOOM			0.00	0.00	159.55	0.00	159.55	
	244.74	HR	0	0	47,250	0	47,250	193.06
Small Tools			0.00	0.00	2.78	0.00	2.78	
	330.40	HR	0	0	1,110	0	1,110	3.36
PILE HAMMER,VIB,116T FORCE DRIVE			0.00	0.00	126.28	0.00	126.28	
	244.74	HR	0	0	37,396	0	37,396	152.80
Shoring for 15'(5M) Exc, 22 PSF			0.00	0.00	0.00	1015.27	1015.27	
Steel Sheeting, Pull and Salvage	173.52	TON	0	0	0	161,734	213,166	1228.48

SITE WORK	QUANTY UOM	MANHOUR	LABOR	EQUIPMNT	MATERIAL	TOTAL COST	UNIT COST
Mod For Std. Sheeting Left In Place					51,431		
PPE		0.00	0.00	0.00	4.25	4.25	
	1957.91 HR	0	0	0	10,069	10,069	5.14
TOTAL SHEET PILE	173.52 TON	3,563	159,363	85,756	223,234	468,354	2699.13
CONCRETE RETAINING WALL			** OVERTIME **		** ADJUSTED **		
Trench,1-1/4 CY Hyd Exc,Hvy Soil		0.03	1.74	1.35	0.00	3.09	
6' to 10' Dp, 76 CY/HR	834.00 CY	22	1,451	1,125	0	2,575	3.09
Backfill Trench w/60 HP Tr Dozer		0.03	1.96	0.57	0.00	2.53	
Without Compaction	638.00 CY	18	1,249	366	0	1,615	2.53
Compaction, 6" Layers w/Air Tamp		0.10	6.21	0.16	0.00	6.37	
By Hand, (15cm) Layers	638.00 CY	64	3,961	103	0	4,064	6.37
Exc & Ld,1-1/2CY Wh Ldr,Med Matl		0.03	2.08	1.01	0.00	3.10	
50 CY/Hr (38M3)	196.00 CY	6	409	199	0	607	3.10
Hauling 12 LCY 1 Mile		0.02	1.03	0.99	0.00	2.02	
	196.00 CY	3	201	194	0	395	2.02
Int Wall Form,Plywd 8-16',3 Uses		0.11	7.49	0.13	0.98	8.59	
(2.4 M to 4.8 M) High	22345 SF	2,483	167,267	2,896	21,890	192,052	8.59
Gr 60 Resteel,Bm,Clmn,Wall,#3-#6		12.78	898.54	6.03	547.20	1451.78	
	25.76 TON	329	23,146	155	14,096	37,398	1451.78
Conc Curing, Sprayed Membrane		0.21	13.07	0.06	4.41	17.54	
Curing Compound	223.45 CSF	47	2,920	14	985	3,920	17.54
Pour Conc Walls,12"Tk, Conc Pump		0.34	21.74	5.88	69.06	96.67	
(31cm) 4000 PSI Conc	448.00 CY	151	9,738	2,632	30,940	43,310	96.67
Wall Finishes,Break Ties & Patch		0.02	1.33	0.00	0.11	1.44	
	22345 SF	413	29,740	110	2,374	32,224	1.44
6'(1.8M)H Fabric Security Fence		0.06	3.47	0.02	11.34	14.83	
Standard FE-6	240.00 LF	13	1,009	5	3,292	4,306	17.94
Premolded Asph Expan Jnt,.5"X 9"		0.03	2.39	0.02	0.80	3.21	
Premolded in Slabs	237.00 LF	8	568	5	189	762	3.21
Wtrstop,Ctr Bulb PVC,3/8"T x 9"W		0.08	5.53	0.05	4.44	10.02	
	112.00 LF	9	619	6	497	1,122	10.02
Polyurethane Cmpd,1/2"x3/4"Joint		8.17	460.52	3.63	70.66	534.81	
	4.74 CLF	39	2,183	17	335	2,535	534.81

SITE WORK	QUANTY UOM	MANHOUR	LABOR	EQUIPMNT	MATERIAL	TOTAL COST	UNIT COST
PVC Chamfer Strips, 3/4" Wide		2.00	143.67	1.47	49.10	194.24	
	35.69 CLF	71	5,128	52	1,752	6,932	194.24
PPE		0.00	0.00	0.00	4.25	4.25	
	3676.00 HR	0	0	0	15,623	15,623	4.25
TOTAL CONCRETE RETAINING WALL	1.00 EA	3,676	249,588	7,880	91,974	349,442	349441.69
TOTAL RETAINING WALLS ALTERNATE B		7,239	408,951	93,636	315,208	817,795	
TOTAL SITE WORK	1.00 EA	24,314	1,085,770	525,083	1,216,178	2,827,032	2827032

PHOTOGRAPHY

PG 01520-1

ASSUMED 2 TIMES MONTHLY FOR 6 MO = 12 ROUNDS. 10 PER ROUND. DELIVER TWO 5 X 7 PRINTS AND TWO SLIDES.

12 X 10 X 2 =240 WITH ADDITIONAL VIEWS USE 300 TOTAL.

5" x 7", Color, 24 Ct., Made		0.00	0.00	0.00	99.62	99.62	
from Slide Film	12.50 EA	0	0	0	1,245	1,245	99.62
300/24 = 12.5							
35 mm Slides, Ectachrome, 24 Ct.		0.00	0.00	0.00	10.51	10.51	
Includes Film	12.50 EA	0	0	0	131	131	10.51
300/24 = 12.5							
Potographer		0.00	0.00	0.00	3506.25	3506.25	
	0.50 MON	0	0	0	1,753	1,753	3506.25
TOTAL PHOTOGRAPHY	1.00 EA	0	0	0	3,130	3,130	3129.73

DRUMS TANKS STRUCT MISC DEMO/REM

DRUM REMOVAL (HLABP) ** ADJUSTED **

LEVEL "C" PROTECTION

83 Gal, 26" Dia x 36" High		0.00	0.00	0.00	72.09	72.09	
	30.00 EA	0	0	0	2,163	2,163	72.09
FORK LIFT 8000#@24"LC PNEUM TIRE		0.00	0.00	23.27	0.00	23.27	
8000# @ 24" LOAD CENTER	17.25 HR	0	0	401	0	401	23.27
TRK TRLR,BOTTOM DUMP, 20CY,30T		0.00	0.00	13.32	0.00	13.32	
20 CY, 30 TON	17.25 HR	0	0	230	0	230	13.32

DRUMS TANKS STRUCT MISC DEMO/REM	QUANTY	UOM	MANHOUR	LABOR	EQUIPMNT	MATERIAL	TOTAL COST	UNIT COST
TRK, HWY,F600,21,000 GVW, 2 AXLE			0.00	0.00	29.16	0.00	29.16	
21,000 GVW, 2 AXLE	17.25	HR	0	0	503	0	503	29.16
Small Tools			0.00	0.00	2.86	0.00	2.86	
	17.25	HR	0	0	49	0	49	2.86
Eq Oper, Light			1.82	62.76	0.00	0.00	62.76	
	17.25	HR	31	1,083	0	0	1,083	62.[illegible]
Laborer (Semi-Skilled)			1.82	58.01	0.00	0.00	58.01	
	8.63	HR	16	500	0	0	500	58.0[illegible]
Laborer (Semi-Skilled)			1.82	57.10	0.00	0.00	57.10	
	34.50	HR	63	1,970	0	0	1,970	57.10
TOTAL DRUM REMOVAL	69.00	EA	110	3,553	1,183	2,163	6,899	99.98
STRUCTURE REMOVAL					** ADJUSTED **			
LEVEL "C" PROTECTION								
TOTAL STRUCTURE REMOVAL			0	4,550	4,550	0	9,100	
TOTAL DRUMS TANKS STRUCT MISC DEMO/REM	1.00	EA	110	8,103	5,733	2,163	15,999	15998.86
DISPOSAL (COMMERCIAL)								
TRANSPORT DRUMS /DISPOSE								
Transport & DISPOSE OF DRUMS			0.00	0.00	0.00	106.25	106.25	
Solid Hazardous Waste	69.00	EA	0	0	0	7,331	7,331	106.25
TOTAL TRANSPORT DRUMS /DISPOSE	69.00	BRL	0	0	0	7,331	7,331	106.25
TOTAL DISPOSAL FEES & TAXES	30.00	BRL	0	0	0	3,000	3,000	100.0[illegible]
TOTAL DECON WATER	5000.00	GAL	0	0	0	4,000	4,000	0.80
TOTAL DISPOSAL (COMMERCIAL)	1.00	EA	0	0	0	14,331	14,331	14331.25
SITE RESTORATION								
TOTAL SETTLEMENT MONITORS.	7.00	EA	0	2,100	0	1,400	3,500	500.00

SITE RESTORATION	QUANTY UOM	MANHOUR	LABOR	EQUIPMNT	MATERIAL	TOTAL COST	UNIT COST
REVEGETATION & PLANTING.							
Mechanical Seeding, 172#/ACRE		0.65	20.30	0.80	15.94	37.04	
NO WATERING REQUIRED.	706.00 CSY	455	14,332	564	11,252	26,148	37.04
200Lb/ACRE Fertilizer,		0.04	1.43	1.64	2.28	5.35	
Spread by Machine	706.00 CSY	31	1,010	1,158	1,613	3,780	5.35
Erosion Control,Webbed Reveg Mat		0.02	0.48	0.00	0.80	1.28	
TYPE I	24700 SY	380	11,960	64	19,683	31,707	1.28
Erosion Control,18 Mil Vinyl Mat		0.05	1.65	0.06	5.23	6.93	
3 Dimensional, Nylon Geomatrix	900.00 SY	47	1,481	54	4,705	6,240	6.93
TYPE II							
Mulch, Pine Straw		0.01	0.22	0.00	0.27	0.49	
	45000 SY	315	9,905	59	11,953	21,916	0.49
Silt Fences, Vinyl, 3' High		0.05	1.68	0.01	0.29	1.97	
With 7.5' Posts	7100.00 LF	378	11,918	64	2,037	14,019	1.97
TOTAL REVEGETATION & PLANTING.		1,607	50,605	1,963	51,242	103,810	
TOTAL POST-CONTRUCTION MAINTENANCE	6.20 AC	0	3,100	0	3,100	6,200	1000.00
28" SELECT FILL-PRIVATE LOTS- (XSABD)		** OVERTIME **					
LDR,FE,CRWLR, 1.5 CY, 943		0.00	0.00	28.53	0.00	28.53	
1.5 CY	517.28 HR	0	0	17,859	0	17,859	34.52
ROLLER,SM-DR,SELF,12T,3WHL,3"OVL		0.00	0.00	13.44	0.00	13.44	
12 TON, 3 WHEEL, 3" OVERLAP	517.28 HR	0	0	8,412	0	8,412	16.26
BLADE, ANGLE, HYDR, FOR D6		0.00	0.00	3.90	0.00	3.90	
BLADE, ANGLE, HYDRAULIC, FOR D6	517.28 HR	0	0	2,440	0	2,440	4.72
DOZER,CWLR,D-6H,PS,(ADD BLADE)		0.00	0.00	39.46	0.00	39.46	
POWERSHIFT, (ADD BLADE)	517.28 HR	0	0	24,699	0	24,699	47.75
Outside Equip. Op. Medium		1.00	39.72	0.00	0.00	39.72	
	1551.84 HR	1,552	74,576	0	0	74,576	48.06
Outside Oiler		1.00	32.71	0.00	0.00	32.71	
	517.28 HR	517	20,473	0	0	20,473	39.58
SELECT FILL DELIVERED		0.00	0.00	0.00	7.23	7.23	
	64660 CY	0	0	0	467,169	467,169	7.23
Truck Drivers, Heavy		1.00	33.80	0.00	0.00	33.80	
	517.28 HR	517	21,156	0	0	21,156	40.90

SITE RESTORATION	QUANTY	UOM	MANHOUR	LABOR	EQUIPMNT	MATERIAL	TOTAL COST	UNIT COST
Equip. Operators, Light			1.00	37.14	0.00	0.00	37.14	
	517.28	HR	517	23,248	0	0	23,248	44.94
PUMP,SUBM, 6"D,1950GPM/40'HD, EL			0.00	0.00	7.77	0.00	7.77	
	517.28	HR	0	0	4,862	0	4,862	9.40
TRK,WTR,OF-HY, 6000GAL,W/CAT621E			0.00	0.00	56.15	0.00	56.15	
	517.28	HR	0	0	35,147	0	35,147	67.9
TOTAL 28" SELECT FILL-PRIVATE LOTS-	51728	CY	3,104	139,453	93,420	467,169	700,041	13.53
8" CRUSHED ROCK SURFACING (XSABD)								
LDR,FE,CRWLR, 1.5 CY, 943			0.00	0.00	29.13	0.00	29.13	
1.5 CY	36.00	HR	0	0	1,049	0	1,049	29.13
ROLLER,SM-DR,SELF,12T,3WHL,3"OVL			0.00	0.00	13.74	0.00	13.74	
12 TON, 3 WHEEL, 3" OVERLAP	36.00	HR	0	0	495	0	495	13.74
BLADE, ANGLE, HYDR, FOR D6			0.00	0.00	4.02	0.00	4.02	
BLADE, ANGLE, HYDRAULIC, FOR D6	36.00	HR	0	0	145	0	145	4.02
DOZER,CWLR,D-6H,PS,(ADD BLADE)			0.00	0.00	40.33	0.00	40.33	
POWERSHIFT, (ADD BLADE)	36.00	HR	0	0	1,452	0	1,452	40.33
Outside Equip. Op. Medium			1.00	36.82	0.00	0.00	36.82	
	108.00	HR	108	3,977	0	0	3,977	36.82
Outside Oiler			1.00	30.45	0.00	0.00	30.45	
	36.00	HR	36	1,096	0	0	1,096	30.45
CRUSHED ROCK SURFACING			0.00	0.00	0.00	19.13	19.13	
	1800.00	CY	0	0	0	34,425	34,425	19.13
TOTAL 8" CRUSHED ROCK SURFACING	1800.00	CY	144	5,073	3,140	34,425	42,638	23.69
8" CONCRETE PAVING								
Crushed Stone Paving, Small Area			0.03	1.08	0.44	0.45	1.97	
Prepare and Roll Subbase	400.00	SY	13	523	213	216	952	2.38
Graded Crushed Agg Rdwy Base Crs			0.26	8.45	7.13	12.91	28.49	
	70.00	CY	18	716	604	1,093	2,413	34.47
8"(20cm) Concrete Pavement			0.08	2.54	0.40	16.91	19.85	
4,500 PSI Concrete at Spreader	400.00	SY	31	1,229	193	8,187	9,608	24.02

SITE RESTORATION	QUANTY UOM	MANHOUR	LABOR	EQUIPMNT	MATERIAL	TOTAL COST	UNIT COST
Broom Finish Concrete Pavement		0.15	5.32	0.02	0.00	5.34	
	400.00 SY	59	2,574	11	0	2,586	6.46
Concrete Pavement Curing		0.03	1.05	0.01	0.21	1.26	
	400.00 SY	13	508	3	101	612	1.53
Concrete Curb, 8" X 8"		0.00	0.00	0.00	4.15	4.15	
	165.00 LF	0	0	0	829	829	5.03
TOTAL 8" CONCRETE PAVING	400.00 SY	134	5,550	1,023	10,427	17,000	42.50
4" ASPHALT PAVING							
Crushed Stone Paving, Small Area		0.03	1.08	0.44	0.45	1.97	
Prepare and Roll Subbase	3800.00 SY	122	4,971	2,021	2,052	9,044	2.38
SUBBASE COURSE		0.26	8.45	7.13	10.78	26.36	
	633.00 CY	162	6,473	5,461	8,260	20,193	31.90
Graded Crushed Agg Rdwy Base Crs		0.26	8.45	7.13	12.91	28.49	
	633.00 CY	162	6,473	5,461	9,888	21,821	34.47
Bituminous Hot Mix Intrm Course		0.48	15.67	5.08	18.78	39.53	
3954#/CY (2349Kg/M3),Ctrl Plant	430.00 TON	206	8,154	2,641	9,772	20,567	47.83
Bituminous Hot Mix Surf Course		0.48	15.67	5.08	24.42	45.16	
3774#/CY (2242Kg/M3),Ctrl Plant	430.00 TON	206	8,154	2,641	12,704	23,498	54.65
Surface Prime Coat, .28 Gal/SY		0.01	0.36	0.18	3.98	4.52	
(1.25 L/M2)	342.00 CSF	4	150	73	1,649	1,871	5.47
Tack Coat, .1 Gal/SY (.5L/M2)		0.03	1.01	0.49	1.35	2.86	
	342.00 CSF	11	419	204	558	1,182	3.45
Pavement Marking, Paint Curbing		0.02	0.51	0.01	0.50	1.01	
	2000.00 LF	31	1,230	12	1,213	2,455	1.23
6"x 10"x 6' Prcst Conc Wh Stop		0.33	10.49	0.08	39.66	50.23	
Including Dowels	57.00 EA	19	724	5	2,736	3,465	60.78
TOTAL 4" ASPHALT PAVING	3800.00 SY	923	36,746	18,518	48,831	104,095	27.39
CULVERTS							
Precast Conc Headwall, 30" Pipe		6.00	194.19	17.38	251.27	462.84	
	2.00 EA	12	388	35	503	926	462.84

SITE RESTORATION	QUANTY UOM	MANHOUR	LABOR	EQUIPMNT	MATERIAL	TOTAL COST	UNIT COST
30"Dia Reinf Cl III Conc Culvert		0.72	23.19	3.81	23.14	50.14	
(76cm) Diameter	60.00 LF	43	1,391	229	1,388	3,008	50.14
TOTAL CULVERTS	60.00 LF	55	1,780	263	1,891	3,934	65.57
STORM DRAINS.							
Trench, 3/4 CY Hyd Exc, Hvy Soil		0.04	1.22	0.61	0.00	1.83	
4' to 6' Deep, 55 CY/Hr	770.00 CY	28	941	472	0	1,413	1.83
Backfill Trench w/Sm FEnd Loader		0.02	0.76	0.42	0.00	1.17	
Without Compaction	650.00 CY	14	492	271	0	763	1.17
Compaction, 6" Layers w/Air Tamp		0.10	3.15	0.09	0.00	3.24	
By Hand, (15cm) Layers	650.00 CY	65	2,046	59	0	2,104	3.24
Exc & Ld,2-1/2CY Wh Ldr, Lt Matl		0.02	0.59	0.70	0.00	1.28	
90 CY/Hr (69M3)	120.00 CY	2	71	83	0	154	1.28
HAUL, 8 LCY Truckload, 20 MPH		0.04	1.20	1.64	0.00	2.84	
2.6 Cycles/Hr	120.00 CY	5	144	197	0	341	2.84
12"(31cm) Dia Cl III Conc Pipe		0.23	7.40	0.66	6.90	14.96	
Reinforced without Gaskets	685.00 LF	157	5,067	454	4,723	10,244	14.96
4'x 4'x 8' Deep CIP Grate Inlet		38.39	1297.65	23.94	1626.42	2948.01	
8" Thick Wall, Storm Drainage	8.00 EA	307	10,381	191	13,011	23,584	2948.01
24"Dia CI Catch Basin Fr & Cover		2.60	86.03	13.47	262.61	362.10	
NEENAH R2504C	8.00 EA	21	688	108	2,101	2,897	362.10
TOTAL STORM DRAINS.	685.00 LF	598	19,831	1,834	19,836	41,500	60.58
SANITARY SEWER.							
Trench, 3/4 CY Hyd Exc, Hvy Soil		0.04	1.22	0.61	0.00	1.83	
4' to 6' Deep, 55 CY/Hr	800.00 CY	29	978	490	0	1,468	1.83
Backfill Trench w/Sm FEnd Loader		0.02	0.76	0.42	0.00	1.17	
Without Compaction	680.00 CY	15	515	283	0	798	1.17
Compaction, 6" Layers w/Air Tamp		0.10	3.15	0.09	0.00	3.24	
By Hand, (15cm) Layers	680.00 CY	68	2,140	61	0	2,201	3.24
Exc & Ld,2-1/2CY Wh Ldr, Lt Matl		0.02	0.59	0.70	0.00	1.28	
90 CY/Hr (69M3)	120.00 CY	2	71	83	0	154	1.28

SITE RESTORATION	QUANTY	UOM	MANHOUR	LABOR	EQUIPMNT	MATERIAL	TOTAL COST	UNIT COST
HAUL, 8 LCY Truckload, 20 MPH			0.04	1.20	1.64	0.00	2.84	
2.6 Cycles/Hr	120.00	CY	5	144	197	0	341	2.84
24"(61cm) Dia Cl III Conc Pipe			0.48	15.53	1.39	15.41	32.33	
Reinforced without Gaskets	224.00	LF	108	3,480	312	3,451	7,242	32.33
4'x 4'x 12' Deep CIP Grate Inlet			50.00	1690.19	31.18	2688.92	4410.29	
8" Thick Wall, Storm Drainage	3.00	EA	150	5,071	94	8,067	13,231	4410.29
24"Dia CI Catch Basin Fr & Cover			2.60	86.03	13.47	262.61	362.10	
NEENAH R2504C	3.00	EA	8	258	40	788	1,086	362.10
TOTAL SANITARY SEWER.	224.00	LF	384	12,656	1,560	12,306	26,521	118.40
TOTAL SITE RESTORATION	1.00	EA	6,949	276,893	121,720	650,626	1,049,239	1049239
DEMOBILIZATION								
TOTAL REMOVAL TEMP FACILITIES			0	2,000	1,000	0	3,000	
TOTAL REMOVAL TEMP UTILITIES			0	500	500	0	1,000	
TOTAL FINAL DECONTAMINATION			0	1,000	1,000	1,000	3,000	
TOTAL DEMOB CONST EQUIP & FAC			0	2,000	500	0	2,500	
TOTAL DEMOB OF PERSONNEL	1.00	EA	0	1,000	0	0	1,000	1000.00
TOTAL POST-CONSTRUCTION SUBMITS			0	4,000	0	1,000	5,000	
TOTAL DEMOBILIZATION	1.00	EA	0	10,500	3,000	2,000	15,500	15500.00
TOTAL HTRW REMEDIAL ACTION	1.00	EA	34,983	1,597,038	741,319	2,044,196	4,382,553	4382553
TOTAL N.L. INDUSTRIES/TARACORP SF SITE	1.00	EA	34,983	1,597,038	741,319	2,044,196	4,382,553	4382553

APPENDIX F

SUBSURFACE INVESTIGATION

REPORT

MODIFICATION NO. 003, DELIVERY ORDER 0029, CONTRACT NO. DACW45-93-D-0005

NL/TARACORP SUPERFUND SITE GRANITE CITY, ILLINOIS

Prepared for
U.S. Department of the Army
Corps of Engineers, Omaha District
Omaha, Nebraska
October 1996

Woodward-Clyde

101 South 108 Avenue
Omaha, Nebraska 68154

WCC Project No. C3M11Q1

F-2

Woodward-Clyde

October 9, 1996
C3M11Q1 - Mod 003

U.S. Department of the Army
Corps of Engineers, Omaha District
CEMRO-CT-H
215 North 17th Street
Omaha, Nebraska 68102-4978

Attn: Mr. Eugene Liu
Technical Manager
Engineering Division

Gentlemen:

This letter presents the subsurface and laboratory data obtained as part of USACE Contract No. DACW45-93-D-0005, Delivery Order No. 0029, Modification 003. This modification was for geotechnical services at the NL/Taracorp site in Granite City, Illinois, and was authorized by acceptance of our revised proposal dated July 29, 1996. This investigation was made to identify the general subsurface conditions underlying the site, to collect laboratory test data to help define engineering properties of existing soils, and to evaluate existing groundwater conditions. Data interpretation, engineering analyses, and conclusions and recommendations for foundation design were not included in our scope of work.

Site Conditions

This study was made at the Main Industrial Properties of the NL/Taracorp site (Figure 1), located at the southern end of Granite City and at the northern border of Madison. The area is underlain by a sequence of Quaternary-age alluvial, glaciofluvial, and glaciolacustrine deposits associated with the Mississippi River Valley. These deposits generally extend to depths of about 100 feet and tend to become coarser with depth. The site area is a typical river floodplain, tending to be flat and poorly drained.

The Main Industrial Properties consist of approximately 30 acres and are the location of a former secondary lead smelting facility and battery cracking operation (NL/Taracorp), a former battery recycling operation (formerly St. Louis Lead Recyclers [SLLR], now Trust 454), a trucking company (BV&G Transport), and a fuel oil distributor (Rich Oil). Discrete separate waste piles, the Taracorp pile and the SLLR piles, cover portions of the site. The borings drilled as part of

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402-334-8181 • Fax 402-334-1984

this modification were drilled around the base of the larger Taracorp pile on the Taracorp and BV&G properties.

Subsurface Investigation

The subsurface investigation for this study consisted of 6 borings drilled between July 30 and August 2, 1996 at the boring locations shown on Figure 1. The borings were 40.5 feet deep. The boring locations were selected by USACE and were located in the field by taping from existing site features. The ground surface elevations at the boring locations were not determined. Following drilling of the six, 40.5-foot borings, additional holes were drilled adjacent to the initial borings to collect additional undisturbed samples for laboratory testing, as directed by USACE.

The borings were drilled with a truck-mounted drilling rig using 4-inch-diameter continuous flight augers and 3.25-inch ID hollow stem augers. Samples of soil were obtained at selected depths by hydraulically pushing or by driving a 2-inch OD split-barrel sampler into undisturbed soils, and by hydraulically pushing 3-inch OD thin-walled tube samplers into undisturbed soils. Disturbed samples were examined throughout the drilling operation. The sample containers were sealed to preserve the water content and integrity of the soil samples and transported to our Totowa, New Jersey laboratory. The borings were grouted using tremie methods upon completion, except for DH-5 and DH-6, which were left open for 24 hours before grouting to measure delayed water levels.

The boring logs were prepared by our field geologist based on visual inspection of disturbed and undisturbed samples and on observation of the drilling characteristics of the subsurface strata. At USACE's request, the field logs have not been modified; we note that some variations exist between the field logs that are based on visual classifications and the laboratory test results. The lines between materials shown on the boring logs represent approximate boundaries between material types. The material changes may actually be gradual. Water level readings shown on the logs were made at the time and under the conditions indicated. Fluctuations in the water levels may occur with time. The boring logs are included as Appendix A.

Laboratory Investigation

The laboratory investigation for this study was made to provide information to assist in classifying the various soil types and in evaluating the engineering properties of the soils. The laboratory testing program was approved by USACE before tests were completed. Selected soil tests included visual description, dry unit weight, average natural water content, sieve analysis, hydrometer, and Atterberg limit tests. The shear strengths of cohesive samples were evaluated using torvane, hand penetrometer, and unconfined compression tests. The compressibility of selected samples was evaluated with one-dimensional consolidation tests. The laboratory test results obtained in this study are summarized in Appendix B.

Subsurface Conditions

The general subsurface conditions indicated by the borings consisted of site fill underlain by a zone of low to highly plastic silts and clays and by clean and silty sands. The site fill was encountered in all of the borings and generally consisted of loose to medium dense, dry to wet, black to grayish brown, sandy gravel and sandy, gravelly slag. Layers of low plastic, silty and sandy clay fill (CL and CL w/SP) were encountered at the base of the fill in Borings DH-2 and DH-6. The fill thickness varied from about 1 to 7.5 feet.

A zone of alluvial silt, sand, and clay was encountered below the fill in all of the borings. In Borings DH-1, DH-5, and DH-6, this zone generally consisted of medium dense, moist to wet, dark gray, fine-grained, silty and clayey sand (SC) and medium stiff to stiff, gray and brown, low plastic, silty clay (CL). In Borings DH-2 through DH-4, this zone generally consisted of very soft to stiff, brown and dark gray to grayish-green, highly plastic clay (CH). This alluvial layer varied in thickness from about 3.5 to 8 feet.

Alluvial clean and silty sands were encountered below the silt, sand, and clay layer described above to the final depths of the borings. These materials generally consisted of very loose to medium dense, reddish-brown and brown to gray, fine-grained, poorly-graded, sand (SP) and silty sand (SM). A 10.5-foot-thick layer of well-graded, fine- to medium-grained sand (SW) was logged in Boring DH-4.

Free subsurface water entered the borings during drilling between depths of about 12 to 18 feet. Subsurface water levels are expected to fluctuate seasonally.

If you have any questions concerning this letter, please call.

Very truly yours,

John S. Nealon, P.E.

Kenneth H. Nass, P.E.
Senior Principal

JSN:KHN:cee 3M11\Q1\3M11Q1SL.LTR

cc: USACE, Omaha District
Attention: Mr. Mark Huckle

APPENDIX A
SUBSURFACE INVESTIGATION

BORING LOG
LEGEND AND NOMENCLATURE

Items shown on boring logs refer to the following:

1. Depth - Depth below ground surface.

2. Sample - Types designated by letter:

   D - Disturbed sample, obtained from auger cuttings.

   S - Split spoon sample, obtained by driving a 2-inch split spoon unless otherwise noted.

   C - California liner sample, obtained using a thick-walled sampler containing 2-inch-diameter liner tubes.

   U - Undisturbed sample, obtained using a thin-walled tube, 3-inch-diameter, or as noted, and open sampling head.

   Recovery - Recovery is expressed as a ratio of the length recovered to the total length pushed, driven or cored (in inches) e.g., 8/12.

   Resistance - Resistance is designated as follows:
   - P - Sample pushed in one continuous movement by hydraulic rig action.
   - 3, 6, 9 - Numbers indicate blows per 6 inches of penetration of split spoon sampler driven by a 140-pound hammer falling 30 inches. The Standard Penetration Resistance is the number of blows for the last 12 inches of penetration of the split spoon sampler, e.g., 15.
   - 50/4" - Number of blows to drive sampler distance shown.

3. Description - Description of material according to the Unified Soil Classification: word description giving soil constituents, consistency or density, and other appropriate classification characteristics. Geologic name or type of deposit, where appropriate, is shown under Field Notes. A solid line indicates an approximate location of stratigraphic change; a dashed line indicates the change is slight, gradual, or of uncertain depth.

4. Field Notes - Pertinent observations including type of boring, water seepage, fluid loss, boring termination depth, etc.

5. Legend -

AD	After drilling	ND	Not detectable due to drilling method
ATD	At time of drilling	NR	Not recorded
CFA	Continuous flight auger	RWB	Rotary wash boring
DWL	Drill water loss	RQD	Rock quality designation
DWR	Drill water return	▽	Water entry depth at time of drilling
NA	Not Applicable	▼	Water level in boring at time indicated after drilling

↓ - Dynamic Cone Penetration Test. 2-inch O.D., 60-degree conical tip attached to AW drill rods and driven by 140-pound hammer falling 30 inches. Numbers denote the number of blows to advance the cone each 12 inches.

6. Limitations

The lines between materials shown on the boring logs represent approximate boundaries between material types and the changes may be gradual. Water level readings shown on the logs were made at the time and under the conditions indicated. Fluctuations in the water levels may occur with time. The boring logs in this report are subject to the limitations, explanations and conclusions of this report.

APPENDIX B
LABORATORY INVESTIGATION

Project No.: C3M11Q1 File: INDX1.XLS

TABLE _____

LABORATORY TESTING ASSIGNMENT AND DATA SUMMARY

BORING NO.	SPECIME NO.	DEPTH (ft)	IDENTIFICATION TESTS: WATER CONTENT (%)	LIQUID LIMIT	PLASTIC LIMIT	PLAS. IND.	USCS SYMB. (1)	SIEVE MINUS NO. 200 (%)	HYDROMETER % MINUS 2 µm (%)	TOTAL UNIT WEIGHT (pcf)	STRENGTH: TORVANE Su (tsf)	POCKET PENETR q u (tsf)	Type Test	PEAK COMP. STRESS (psi)	AXIAL STRAIN @ PEAK STRESS (%)	REMARKS
DH-1-2		6.5-8.5	24.2				CL	93.5	11							
DH-1-3		9-11	27.5				CL	94.0	13							
DH-1-5		14-15.5					CL	60.2	12							
DH-2-2		4-5.5	29.1	50	23	27	CL									
DH-2-3		6.5-8	27.5	58	21	37	CH									
DH-2-4		9-10.5	41.4													
DH-2-5		14-15.5	27.1				SP-SM	5.5								
DH-3-1		1.5-3	24.1													
DH-3-2		4-5.5	24.9	38	19	19	CL									
DH-3-3		6.5-8	39.3													
DH-3-4		9-10.5	19.8				SM	31.6								
DH-3-5		14-14.5	36.6				SM	36.6								
DH-4-1		1.5-3	27.2													
DH-4-2		4-5.5	42.8	94	32	62	CH									
DH-4-4		9-9.5					CL	96.7	53							
DH-5-4		8.5-10	43.6	85	30	55	CH									
DH-5-5		13-14					CL	69.7	20							
DH-6-2		6.5-8	30.6													
DH-6-3		6.5-8	24.5	40	20	20	CL	92.9	17							jar broken
DH-6-4		9-10.5					SM	47.2	21							
DH-1		9-11								118.0						
DH-1		9.15	18.2								1.4	3.8				
DH-1		9.7	25.5								0.8	1.8				
DH-1		10.2	22.7								1.2	1.8				

Prepared by: EK Reviewed by: ___ Date: 9/3/96

Project No.: C3M11Q1 File: INDX1.XLS

TABLE _____

LABORATORY TESTING ASSIGNMENT AND DATA SUMMARY

BORING NO.	SPECIME NO.	DEPTH (ft)	IDENTIFICATION TESTS								STRENGTH					REMARKS
			WATER CONTENT (%)	LIQUID LIMIT	PLASTIC LIMIT	PLAS. IND.	USCS SYMB. (1)	SIEVE MINUS NO. 200 (%)	HYDROMETER % MINUS 2 µm (%)	TOTAL UNIT WEIGHT (pcf)	TORVANE Su (tsf)	POCKET PENETR q u (tsf)	Type Test	PEAK COMP. STRESS (psi)	AXIAL STRAIN @ PEAK STRESS (%)	
DH-2		11.5-13								115.4						
DH-2		11.65	39.6								0.8	1.8				
DH-2	A	11.9	28.7							114.2			UC	10.6	2.7	
DH-2		12.15	37.1								0.8	1.6				
DH-2	B	12.45	38.8	74	28	46	CH			112.4						consol
DH-2		12.75	24.8								0.3	1.4				
DH-3		7.5-9.5								116.3						
DH-3		7.6	41.9								0.7	1.3				
DH-3	A	7.9	35.9	85	31	54	CH			114.4						consol
DH-3		8.15	27.1								0.8	2.0				
DH-3	B	8.4	28.0							117.5			UC	9.2	2.7	
DH-4		7.5-9.5								115.2						
DH-4		7.6	39.1								0.8	1.4				
DH-4	A	7.85	33.9							115.7			UC	10.2	3.2	
DH-4	B	8.3	29.9	68	24	44	CH			114.6						consol
DH-6		7.5-9								116.5						
DH-6	A	7.95	28.7							116.6			UC	6.4	4.3	
DH-6	B	8.4	27.5	53	23	30	CH			117.0						consol

Note: (1) Plasticity of fines for USCS symbol based on visual observation unless Atterberg limits reported.

Prepared by: EK Reviewed by: CMT Date: 8/29/96

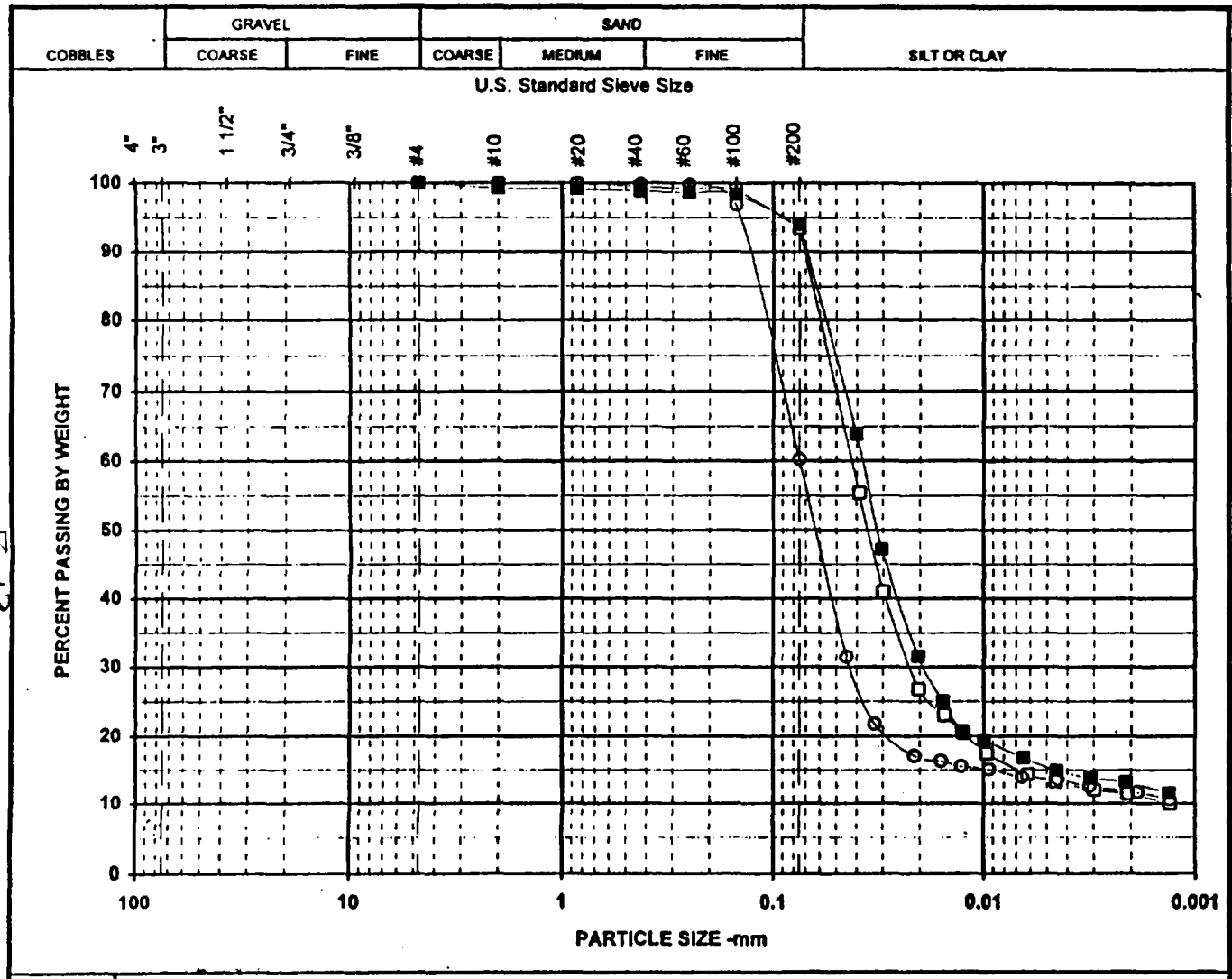
Project No.: C3M11Q1 File: VISUAL1.XLS

TABLE _____
VISUAL CLASSIFICATION

BORING NO.	SAMPLE NO.	DEPTH (ft)	VISUAL DESCRIPTION	WATER CONTENT (%)	LIQUID LIMIT	PLASTIC LIMIT
DH-1-2		6.5-8.5	CL, dark brown-gray medium plastic silty CLAY, trace f. sand.	24.2		
DH-1-3		9-11	CL, dark brown-gray medium plastic silty CLAY, trace f. sand.	27.5		
DH-2-2		4-5.5	CL, dark gray plastic sandy silty CLAY.	29.1	50	23
DH-2-3		6.5-8	CH, dark gray plastic CLAY, trace f. sand.	27.5	58	21
DH-2-4		9-10.5	CH, grayish brown plastic silty CLAY.	41.4		
DH-3-1		1.5-3	CH, dark gray plastic silty CLAY, trace f. sand.	24.1		
DH-3-2		4-5.5	CL, dark gray medium plastic silty CLAY, trace f. sand.	24.9	38	19
DH-3-3		6.5-8	CH, grayish brown medium plastic to plastic silty CLAY.	39.3		
DH-4-1		1.5-3	CL, grayish brown medium plastic silty CLAY, trace f. sand.	27.2		
DH-4-2		4-5.5	CH, grayish brown very plastic CLAY.	42.8	94	32
DH-5-4		8.5-10	CH, grayish brown very plastic CLAY, trace fine sand.	43.6	85	30
DH-6-2		4-5.5	SM, black and brown c-f SAND, some silt, trace f. gravel.	30.6		
DH-6-3		6.5-8	CL, dark brown plastic silty CLAY, trace f. sand.	24.5	40	20
DH-1-1		1.5-2.5	SP, dark brown gravelly c-f SAND, trace silt (fill).			
DH-2-1		1.5-3	SP-SM, dark brown c-f SAND, some gravel, trace silt (fill).			
DH-5-1		1.5-3	SP, red-brown c-f SAND, trace gravel, silt (fill).			
DH-5-2		3.5-5	SP, reddish brown c-f SAND, some gravel, trace silt (fill).			
DH-6-1		1.5-3	SM, black and yellow gravelly c-f SAND, some silt (fill).			

Prepared by: CMJ Reviewed by: CMJ Date: 8/28/96

F-12



Symbol	□	■	○
Boring	DH-1-2	DH-1-3	DH-1-5
Sample			
Spec			
Depth	6.5-8.5	9-11	14-15.5
% +3"			
% Gravel			
% SAND	6.5	6.0	39.8
% FINES	93.5	94.0	60.2
% -2μ	11	13	12
Cc			
Cu			
LL			
PL			
PI			
USCS	CL	CL	CL
w (%)			

Particle Size (Sieve #)	PERCENT FINER □	■	○
4"			
3"			
1 1/2"			
3/4"			
3/8"			
4	100.0	100.0	
10	99.9	99.4	100.0
20	99.8	99.2	100.0
40	99.5	98.9	100.0
60	99.3	98.7	99.9
100	99.0	98.4	96.9
200	93.5	94.0	60.2

SYMBOL	DESCRIPTION AND REMARKS
□	Dark brown-gray medium plastic silty CLAY, trace f. sand.
■	Dark brown-gray medium plastic silty CLAY, trace f. sand.
○	Brown medium plastic f. sandy silty CLAY.

PARTICLE SIZE DISTRIBUTION
NL TARACORP

Project No.		Figure
C3M11Q1	August 1996	

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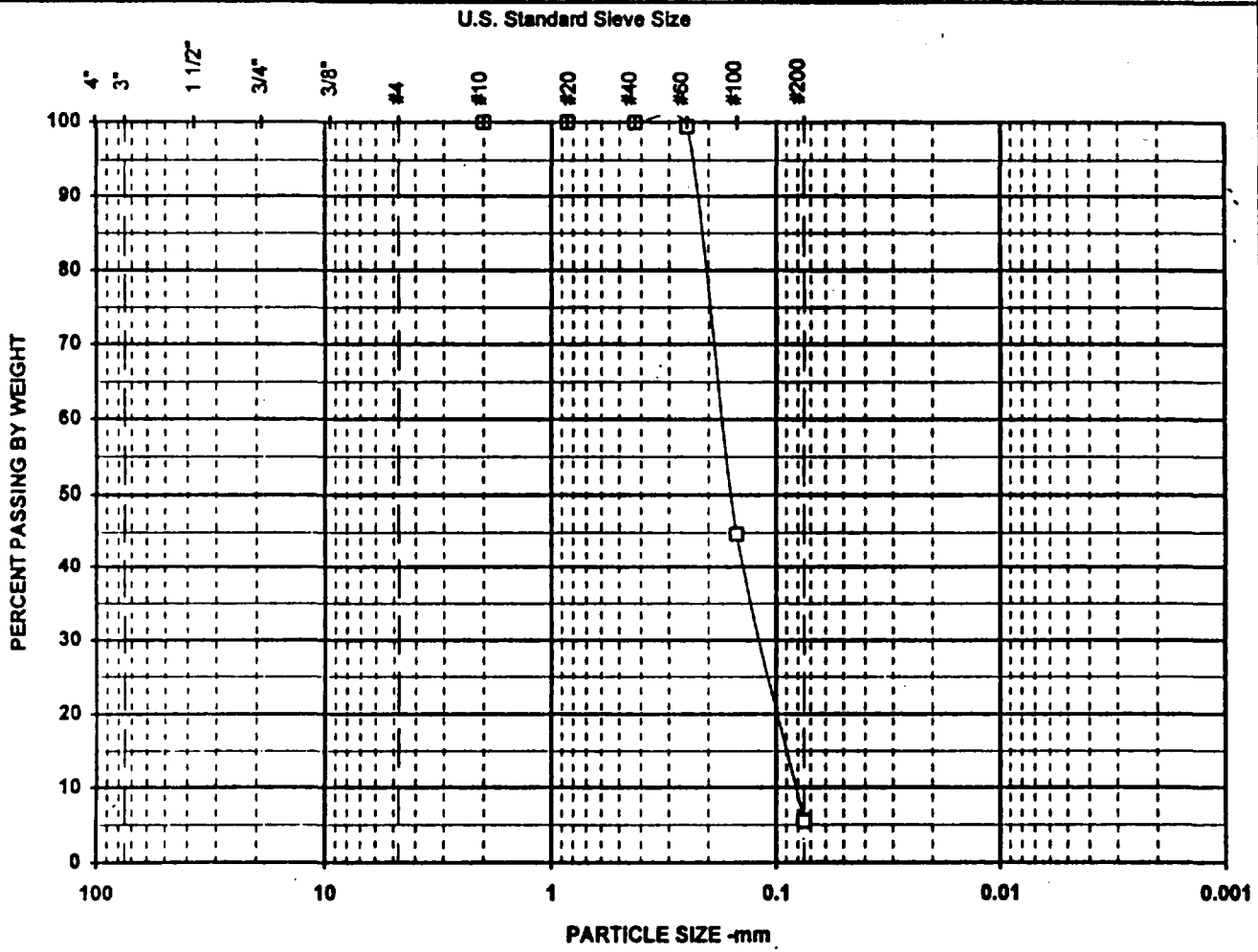
SIEV1A.XLS 8/28/96

F-13

COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	



Symbol	□	■	○
Boring	DH-2-5		
Sample			
Spec			
Depth	14-15.5		
% +3"			
% Gravel			
% SAND	94.5		
% FINES	5.5		
% -2μ			
Cc	1.0		
Cu	2.1		
LL			
PL			
PI			
USCS	SP-SM		
w (%)	27.1		

Particle Size	PERCENT FINER		
(Sieve #)	□	■	○
4"			
3"			
1 1/2"			
3/4"			
3/8"			
4			
10	100.0		
20	100.0		
40	100.0		
60	99.4		
100	44.8		
200	5.5		

SYMBOL	DESCRIPTION AND REMARKS
□	Yellowish-brown f. SAND, trace silt.
■	
○	

PARTICLE SIZE DISTRIBUTION
NL TARACORP

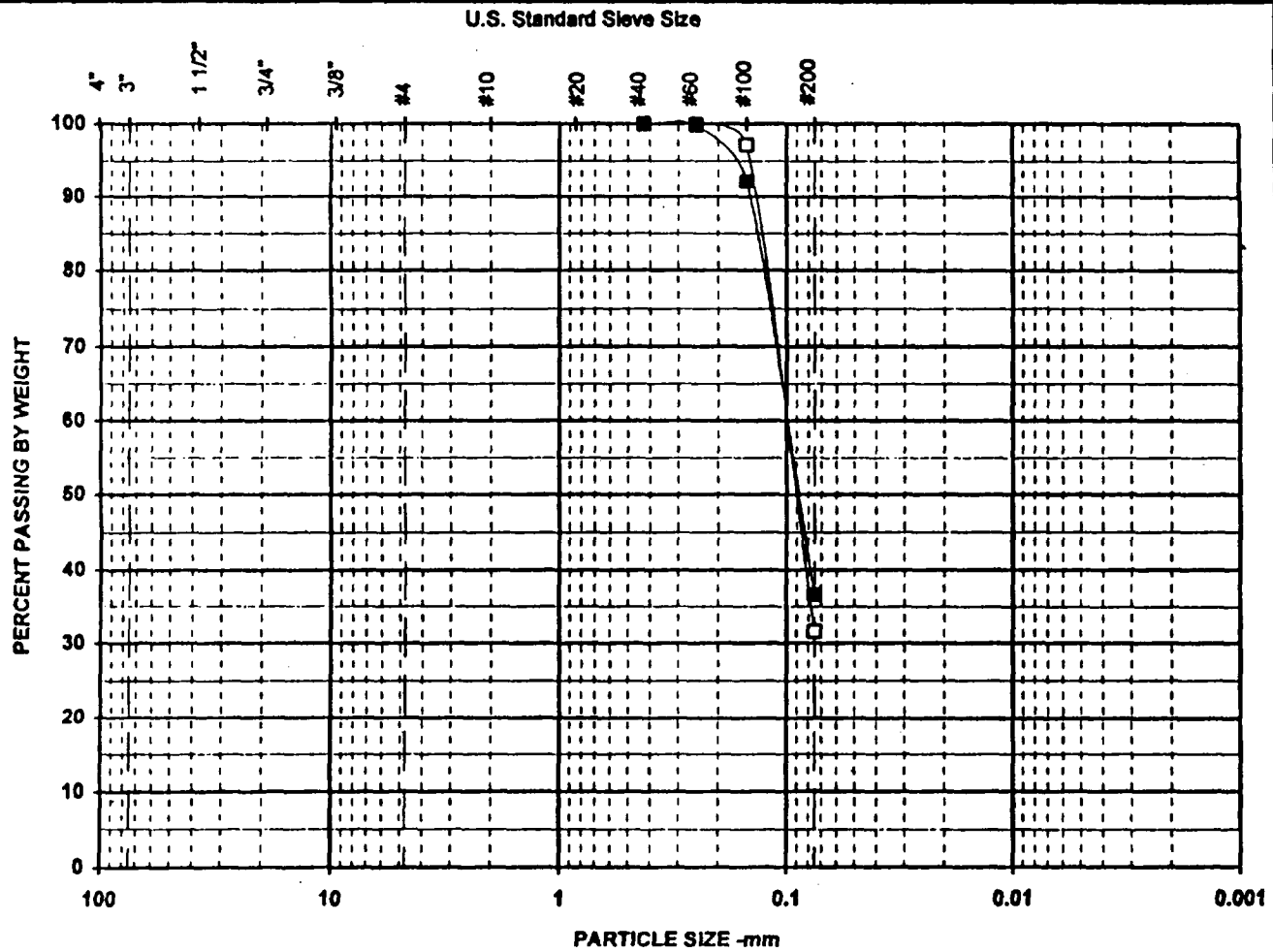
Project No.		
C3M11Q1	August 1996	Figure

Woodward-Clyde

SIEV1G.XLS 8/21/96

F-14

COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	



Symbol	□	■	○
Boring	DH-3-4	DH-3-5	
Sample			
Spec			
Depth	9-10.5	14-14.5	
% +3"			
% Gravel			
% SAND	68.4	63.4	
% FINES	31.6	36.6	
% -2μ			
Cc			
Cu			
LL			
PL			
PI			
USCS	SM	SM	
w (%)	19.8	26.6	

Particle Size	PERCENT FINER		
(Sieve #)	□	■	○
4"			
3"			
1 1/2"			
3/4"			
3/8"			
4			
10			
20			
40	100.0	100.0	
60	99.9	99.8	
100	97.1	92.2	
200	31.6	36.6	

SYMBOL	DESCRIPTION AND REMARKS
□	Grayish-brown silty f. SAND.
■	Grayish-brown silty f. SAND.
○	

PARTICLE SIZE DISTRIBUTION
NL TARACORP

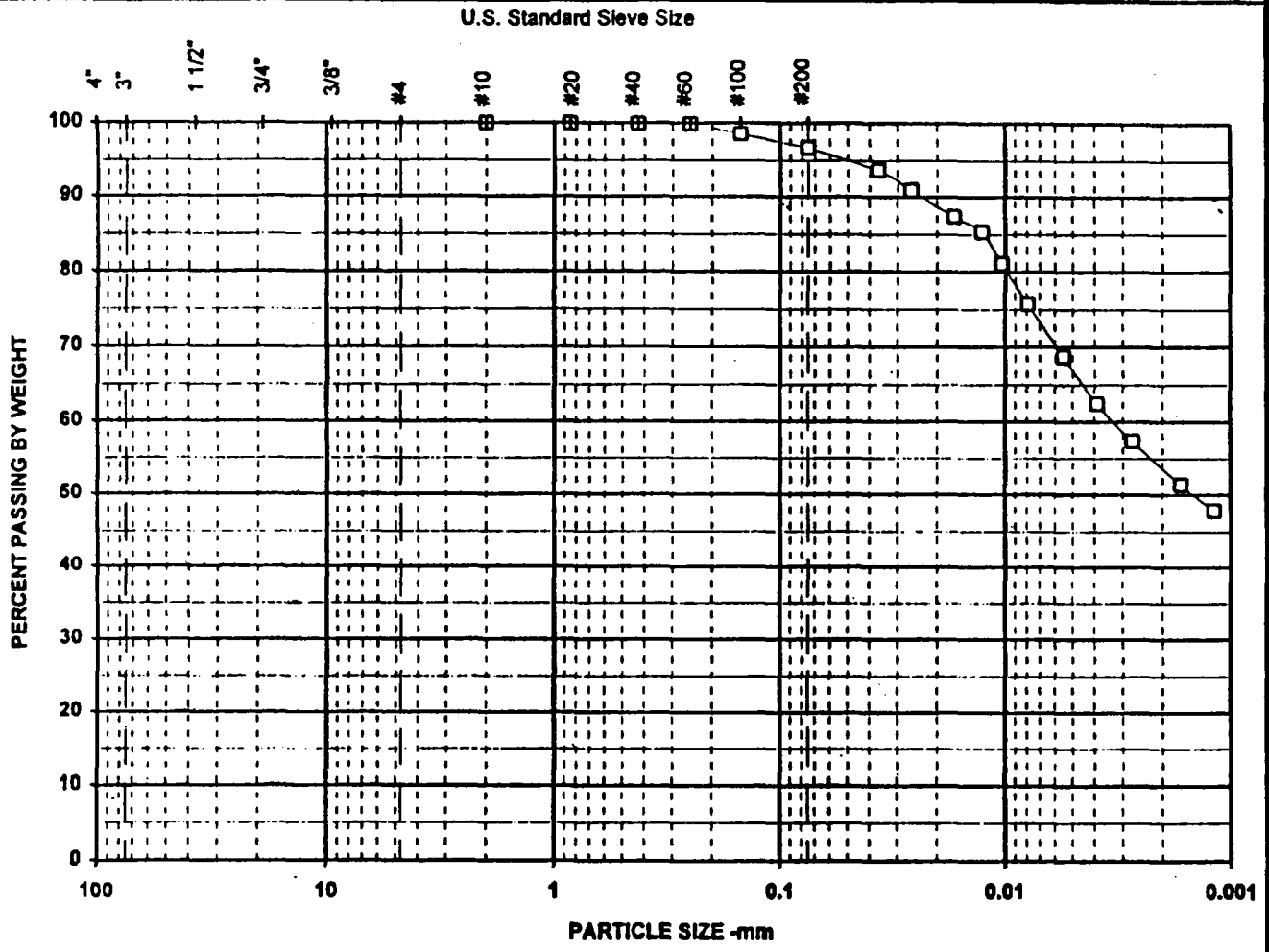
Project No.		Figure
C3M11Q1	August 1996	

Woodward-Clyde

SIEV1H.XLS 8/19/96

F-15

COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	



Symbol	□	■	○
Boring	DH-4-4		
Sample			
Spec			
Depth	9-9.5		
% +3"			
% Gravel			
% SAND	3.3		
% FINES	96.7		
% -2μ	53		
Cc			
Cu			
LL			
PL			
PI			
USCS	CL		
w (%)			

Particle Size	PERCENT FINER		
(Sieve #)	□	■	○
4"			
3"			
1 1/2"			
3/4"			
3/8"			
4			
10	100.0		
20	100.0		
40	99.9		
60	99.9		
100	98.6		
200	96.7		

SYMBOL	DESCRIPTION AND REMARKS
□	Dark brown plastic silty CLAY, trace f. sand.
■	
○	

PARTICLE SIZE DISTRIBUTION
NL TARACORP

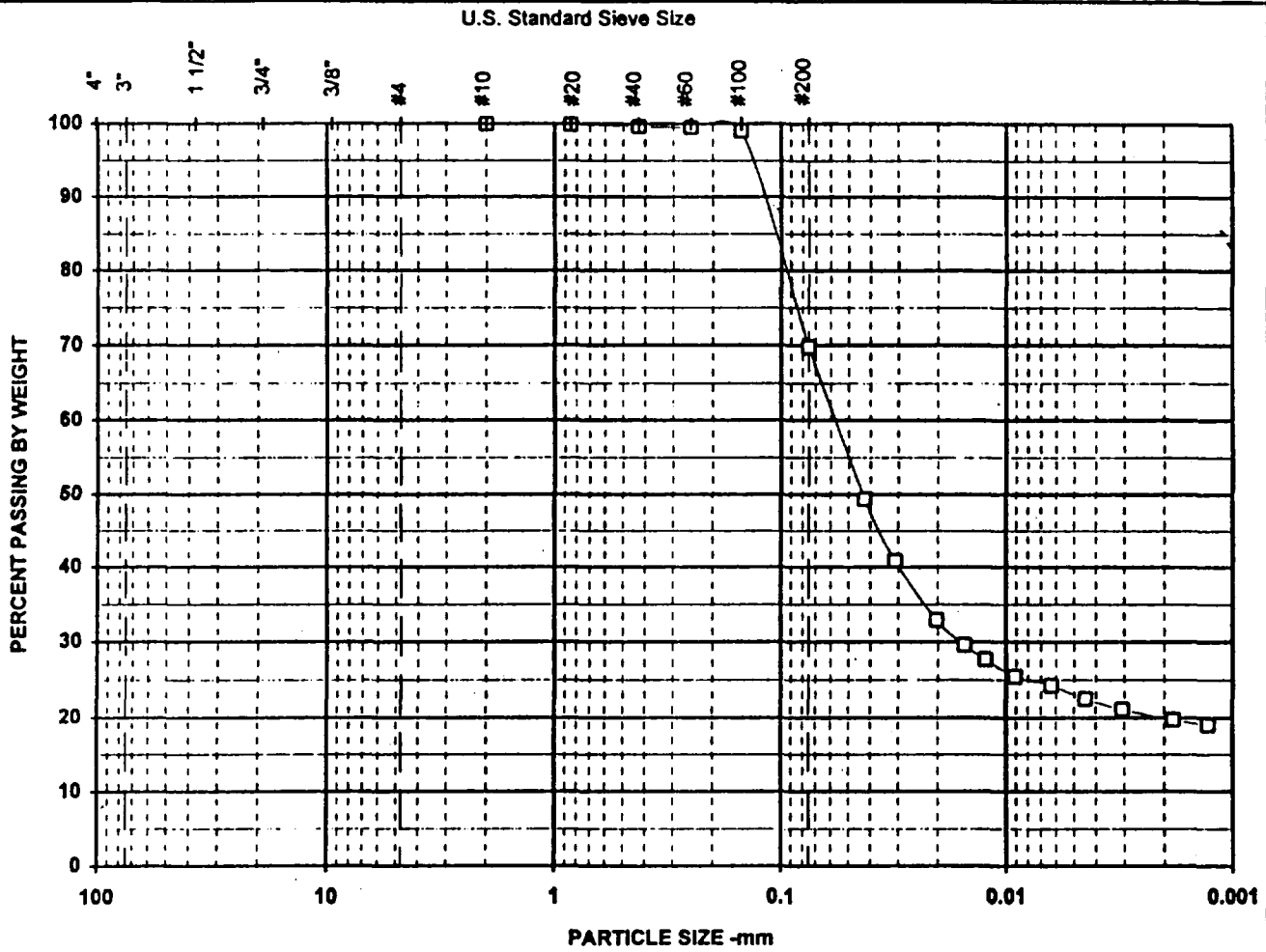
Project No.		Figure
C3M11Q1	August 1996	

Woodward-Clyde

SIEV1D.XLS 8/28/96

F-16

COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	



Symbol	□	■	○
Boring	DH-5-5		
Sample			
Spec			
Depth	13-14		
% +3"			
% Gravel			
% SAND	30.3		
% FINES	69.7		
% -2μ	20		
Cc			
Cu			
LL			
PL			
PI			
USCS	CL		
w (%)			

Particle Size (Sieve #)	PERCENT FINER □	■	○
4"			
3"			
1 1/2"			
3/4"			
3/8"			
4			
10	100.0		
20	99.9		
40	99.6		
60	99.5		
100	99.0		
200	69.7		

SYMBOL	DESCRIPTION AND REMARKS
□	Dark brown medium plastic silty CLAY, some f. sand.
■	
○	

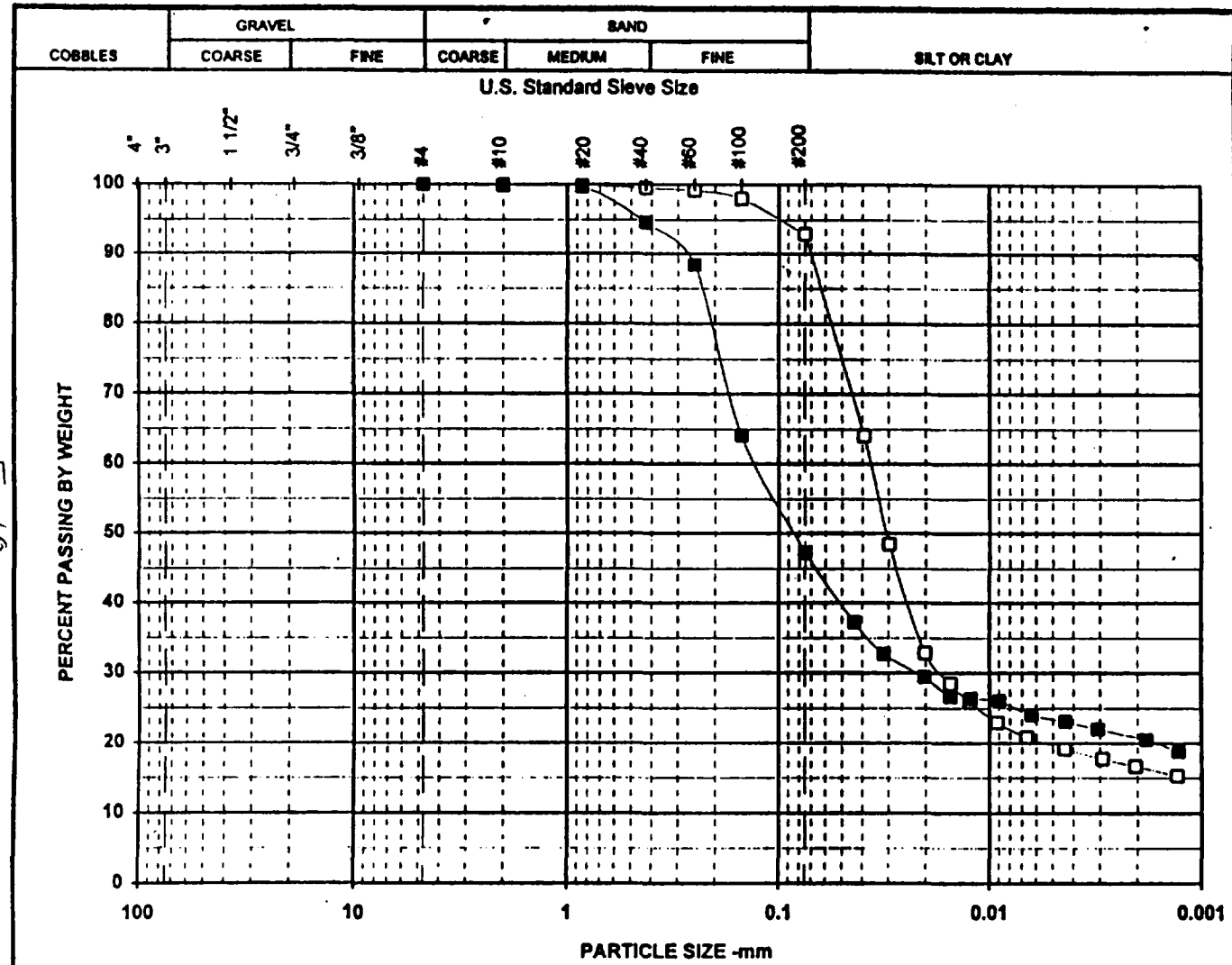
PARTICLE SIZE DISTRIBUTION
NL TARACORP

Project No.		Figure
C3M11Q1	August 1996	

Woodward-Clyde

F-17

SIEV1E.XLS 8/28/96



Symbol	□	■	○
Boring	DH-6-3	DH-6-4	
Sample			
Spec			
Depth	6.5-8	9-10.5	
% +3"			
% Gravel			
% SAND	7.1	52.8	
% FINES	92.9	47.2	
% -2μ	17	21	
Cc			
Cu			
LL	40		
PL	20		
PI	20		
USCS	CL	SC	
w (%)			

Particle Size	PERCENT FINER		
(Sieve #)	□	■	○
4"			
3"			
1 1/2"			
3/4"			
3/8"			
4		100.0	
10	100.0	99.8	
20	99.8	99.7	
40	99.5	94.6	
60	99.2	88.4	
100	98.0	64.1	
200	92.9	47.2	

SYMBOL	DESCRIPTION AND REMARKS
□	Dark brown plastic silty CLAY, trace f. sand.
■	Dark brown silty clayey f. SAND, trace c-m sand.
○	

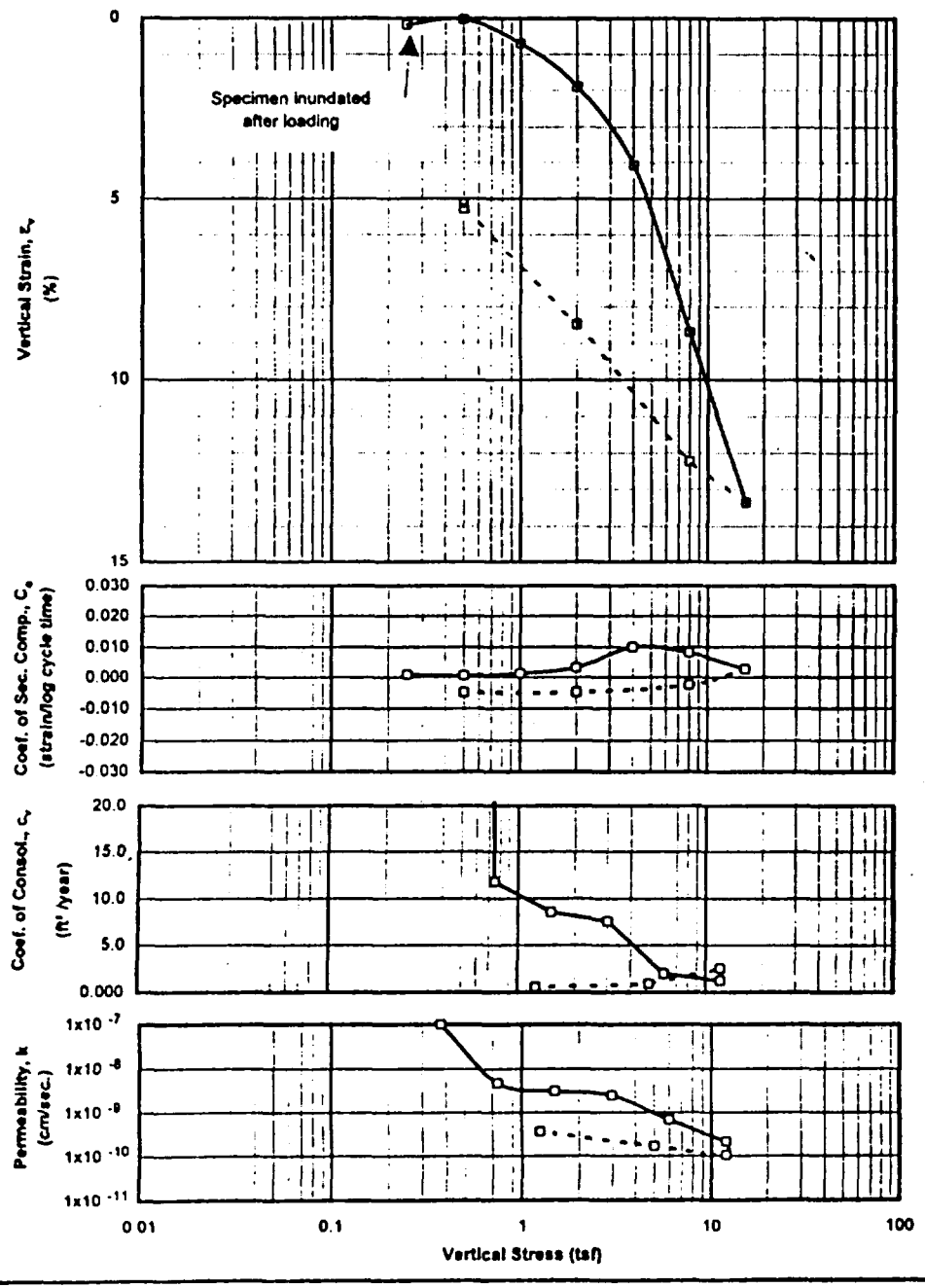
PARTICLE SIZE DISTRIBUTION
NL TARACORP

Project No.		Figure
C3M11Q1	August 1996	

Woodward-Clyde

SIEV1F.XLS 8/28/96

F-18



SAMPLE INFORMATION

Boring:	DH-2
Sample:	SPEC B
Depth:	12.5 feet
Elevation:	
Type:	3-inch thin wall tube
	CH, gray very plastic silty CLAY.

LL = 74, PL = 28, PI = 46

SPECIMEN INFORMATION

(NOTE: Initial and final states refer to beginning and end of test)

Initial height:	0.62	inch
Diameter:	2.50	inch

Initial water content:	38.8	%
Initial total unit weight:	112.4	pcf
Initial dry unit weight:	81.0	pcf
Initial void ratio:	1.159	
Initial degree of saturation:	94	%
Final water content:	45.4	%
Final total unit weight:	111.4	pcf
Final dry unit weight:	76.6	pcf
Final void ratio:	1.282	
Final degree of saturation:	99	% (assumed specific gravity = 2.80)

TEST SUMMARY

Construction Method:	Casagrande (Log)
Estimated preconsolidation stress (tsf):	3.3 (Range: 3.1 to 3.5)
Estimated in situ effective overburden stress (tsf):	
Compression Ratio (strain per log cycle stress):	0.154
Compression Index (void ratio per log cycle stress):	0.332
Swell Ratio (strain per log cycle stress):	0.062
Swell Index (void ratio per log cycle stress):	0.134
Recompression Ratio (strain per log cycle stress):	0.031
Recompression Index (void ratio per log cycle stress):	0.067
Remarks:	

LEGEND: ⊓ End of primary ○ End of Stage ——— Loading - - - - - - Unloading

Test Date: 8/12/96 Tested By: CMJ Checked By:

	NL/ TARACORP	ONE DIMENSIONAL CONSOLIDATION TEST Boring: DH-2 Depth: 12.5 feet
Woodward-Clyde	Project No. C3M11Q1	August 1996 Fig.

C96035.XLS 8/29/96

F-19

PROJECT:	NL/ TARACORP				
PROJECT NO.:	C3M11Q1	Initial height:	0.623 inch	Final height:	0.658 inch
BORING:	DH-2	Initial water content:	38.8 %	Final water content:	45.4 %
SAMPLE:	SPEC B	Initial dry density:	81.0 pcf	Final dry density:	76.6 pcf
TEST:	C96035	Initial total density:	112.4 pcf	Final total density:	111.4 pcf
DEPTH, feet:	12.45	Initial saturation:	94 %	Final saturation:	99 %
BY:	CMJ	Initial void ratio:	1.159	Final void ratio:	1.282
TEST DATE:	8/12/96			Final strain:	-5.5 %

EQUIPMENT:

Load Frame No.: 5

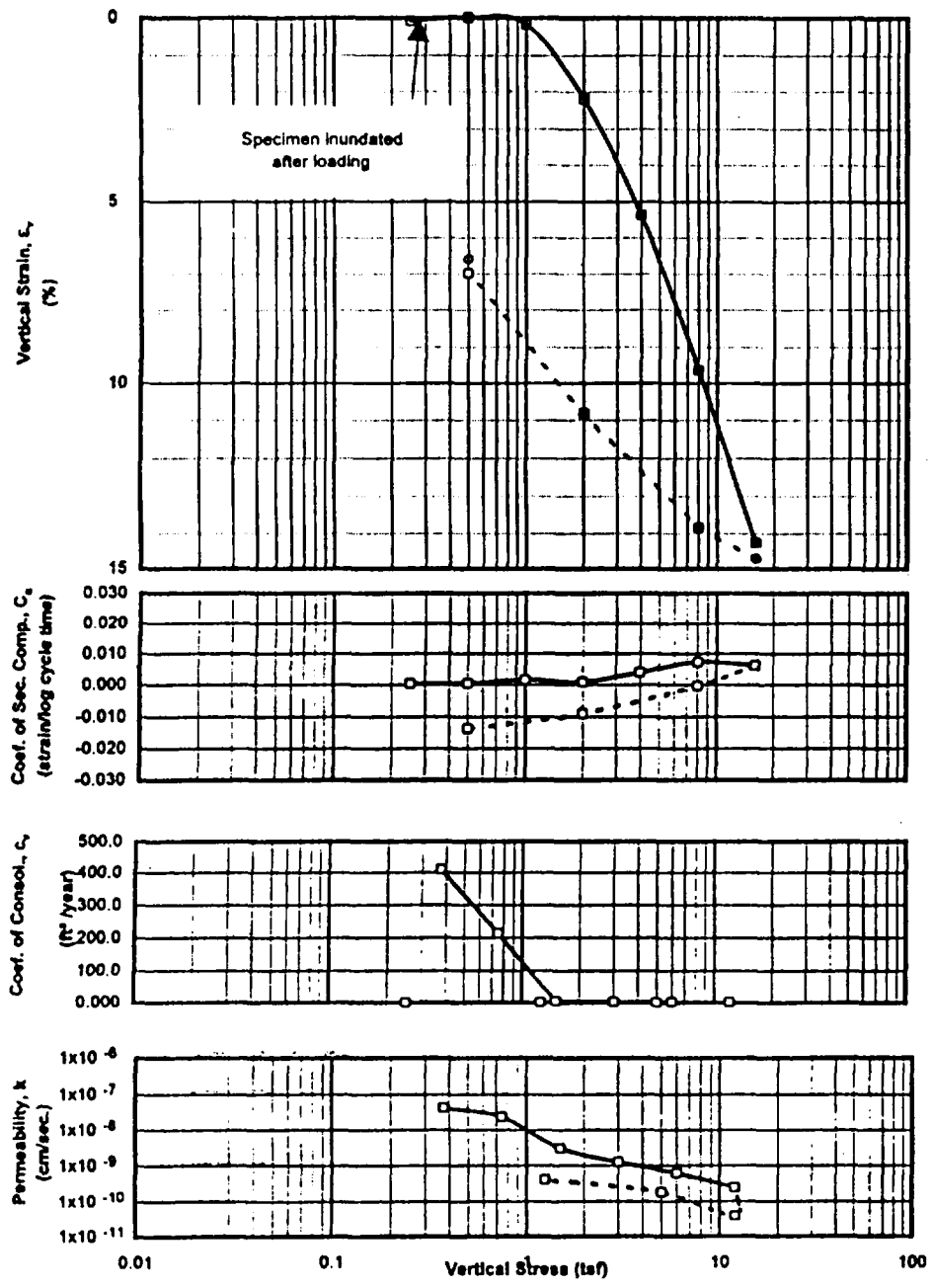
Ring Diameter: 2.5 inch

SPECIMEN DESCRIPTION: CH, gray very plastic silty CLAY.

G	LL	PL	PI
2.8	74	28	46

Load No.	Load (tsf)	d_{100} (inch)	t_{100} Strain (%)	t_{100} Void Ratio (-)	Final Strain (%)	Final Void Ratio (-)	c_v (ft^2/year)	C_α (strain/logt)	Constrained Modulus (tsf)	Permeability (cm/sec)
1	0.250	0.0011	0.177	1.155	0.112	1.156	580.87	0.0009	141.64	1.24E-07
2	0.500	0.0001	0.021	1.158	0.364	1.151	536.03	0.0006	161.16	1.00E-07
3	1.00	0.0043	0.686	1.144	0.747	1.143	11.81	0.0013	75.28	4.73E-09
4	2.00	0.0118	1.895	1.118	1.965	1.116	8.53	0.0033	82.68	3.11E-09
5	4.00	0.0254	4.075	1.071	4.289	1.066	7.57	0.0100	91.74	2.49E-09
6	8.00	0.0542	8.699	0.971	8.880	0.967	1.94	0.0081	86.51	6.76E-10
7	16.0	0.0832	13.343	0.871	13.352	0.871	1.23	0.0027	172.28	2.15E-10
8	8.00	0.0762	12.234	0.895	12.349	0.892	2.53	-0.0024	721.49	1.06E-10
9	2.00	0.0529	8.482	0.976	8.309	0.979	0.89791	-0.0047	159.93	1.69E-10
10	0.500	0.0329	5.276	1.045	5.119	1.048	0.57004	-0.0048	46.78	3.68E-10

F-20



SAMPLE INFORMATION

Boring:	DH-3
Sample:	SPEC A
Depth:	7.9 feet
Elevation:	
Type:	3-inch thin wall tube
	CH, gray very plastic CLAY.

LL = 85, PL = 31, PI = 54

SPECIMEN INFORMATION

(NOTE: Initial and final states refer to beginning and end of test)

Initial height:	0.61	inch
Diameter:	2.50	inch

Initial water content:	35.9	%
Initial total unit weight:	114.4	pcf
Initial dry unit weight:	84.2	pcf
Initial void ratio:	1.076	
Initial degree of saturation:	93	%
Final water content:	44.1	%
Final total unit weight:	111.8	pcf
Final dry unit weight:	77.6	pcf
Final void ratio:	1.252	
Final degree of saturation:	99	% (assumed specific gravity = 2.80)

TEST SUMMARY

Construction Method:	Casagrande (Log)
Estimated preconsolidation stress (tsf):	1.9 (Range: 1.3 to 3.5)
Estimated in situ effective overburden stress (tsf):	
Compression Ratio (strain per log cycle stress):	0.148
Compression Index (void ratio per log cycle stress):	0.307
Swell Ratio (strain per log cycle stress):	0.050
Swell Index (void ratio per log cycle stress):	0.104
Recompression Ratio (strain per log cycle stress):	0.036
Recompression Index (void ratio per log cycle stress):	0.075
Remarks:	

LEGEND: □ End of primary ○ End of Stage ——— Loading - - - - - - Unloading

Test Date: 8/13/96 Tested By: CMJ Checked By:

	NL TARACORP	ONE DIMENSIONAL CONSOLIDATION TEST Boring: DH-3 Depth: 7.9 feet
Woodward-Clyde	Project No. C3M11Q1	August 1996 Fig.

C96037.XLS 9/3/96

F-21

PROJECT:	NL TARACORP				
PROJECT NO.:	C3M11Q1	Initial height:	0.615 inch	Final height:	0.664 inch
BORING:	DH-3	Initial water content:	35.9 %	Final water content:	44.1 %
SAMPLE:	SPEC A	Initial dry density:	84.2 pcf	Final dry density:	77.6 pcf
TEST:	C96037	Initial total density:	114.4 pcf	Final total density:	111.8 pcf
DEPTH, feet:	7.9	Initial saturation:	93 %	Final saturation:	99 %
BY:	CMJ	Initial void ratio:	1.076	Final void ratio:	1.252
TEST DATE:	8/13/96			Final strain:	-8.0 %

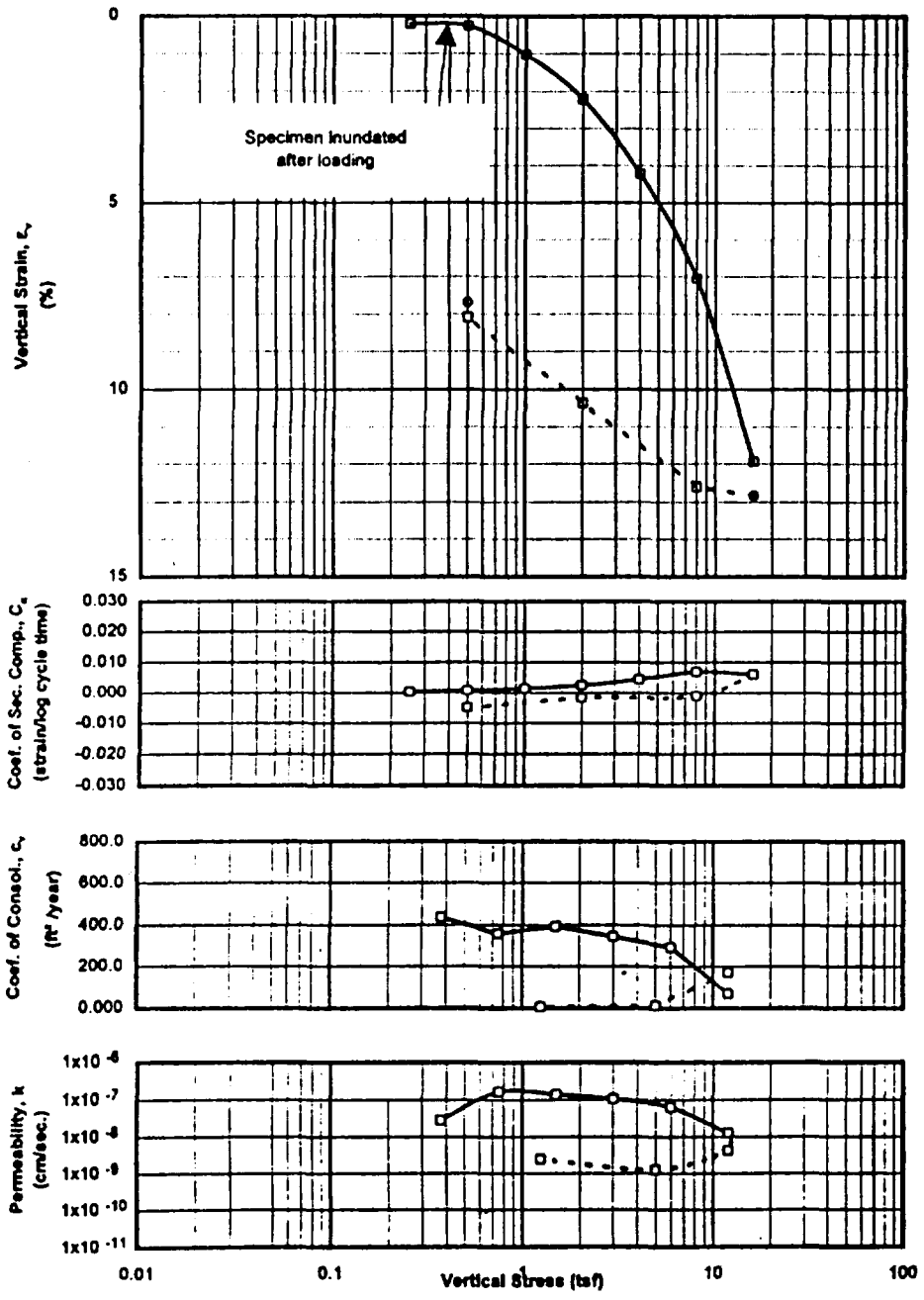
EQUIPMENT:
Load Frame No.: 4
Ring Diameter: 2.5 inch

SPECIMEN DESCRIPTION: CH, gray very plastic CLAY.

G	LL	PL	PI
2.8	85	31	54

Load No.	Load (tsf)	d_{100} (inch)	t_{100} Strain (%)	t_{100} Void Ratio (-)	Final Strain (%)	Final Void Ratio (-)	c_v (ft²/year)	C_α (strain/logt)	Constrained Modulus (tsf)	Permeability (cm/sec)
1	0.250	0.0005	0.078	1.075	0.068	1.075	833.52	0.0004	320.10	7.86E-08
2	0.500	-0.0001	-0.009	1.077	0.084	1.075	411.34	0.0005	287.69	4.31E-08
3	1.00	0.0011	0.173	1.073	0.391	1.068	214.19	0.0016	274.50	2.35E-08
4	2.00	0.0134	2.186	1.031	2.260	1.030	5.03	0.0009	49.70	3.06E-09
5	4.00	0.0330	5.370	0.965	5.707	0.958	2.60	0.0040	62.81	1.25E-09
6	8.00	0.0592	9.640	0.876	10.131	0.866	1.89	0.0073	93.67	6.10E-10
7	16.0	0.0877	14.262	0.780	14.718	0.771	1.38	0.0062	173.07	2.41E-10
8	8.00	0.0851	13.842	0.789	13.826	0.789	2.38	-0.0003	1903	3.78E-11
9	2.00	0.0665	10.816	0.852	10.414	0.860	1.20	-0.0090	198.28	1.82E-10
10	0.500	0.0429	6.979	0.932	6.575	0.940	0.53426	-0.0137	39.09	4.12E-10

F22



SAMPLE INFORMATION

Boring: DH-4
Sample: SPEC B
Depth: 8.3 feet
Elevation:
Type: 3-inch thin wall tube
CH, gray very plastic CLAY.

LL = 68, PL = 24, PI = 44

SPECIMEN INFORMATION

(NOTE: Initial and final states refer to beginning and end of test)

Initial height:	0.63	inch
Diameter:	2.50	inch
Initial water content:	29.9	%
Initial total unit weight:	114.6	pcf
Initial dry unit weight:	88.2	pcf
Initial void ratio:	0.875	
Initial degree of saturation:	90	%
Final water content:	35.1	%
Final total unit weight:	114.8	pcf
Final dry unit weight:	85.0	pcf
Final void ratio:	0.947	
Final degree of saturation:	98	% (assumed specific gravity = 2.65)

TEST SUMMARY

Construction Method:	Casagrande (Log)
Estimated preconsolidation stress (tsf):	5.1 (Range: 4.8 to 6.6)
Estimated in situ effective overburden stress (tsf):	
Compression Ratio (strain per log cycle stress):	0.162
Compression Index (void ratio per log cycle stress):	0.304
Swell Ratio (strain per log cycle stress):	0.037
Swell Index (void ratio per log cycle stress):	0.069
Recompression Ratio (strain per log cycle stress):	0.025
Recompression Index (void ratio per log cycle stress):	0.047
Remarks:	

LEGEND: ☐ End of primary ○ End of Stage ——— Loading - - - - - - Unloading

Test Date: 8/12/96 Tested By: CMJ Checked By:

	NL/ TARACORP	ONE DIMENSIONAL CONSOLIDATION TEST Boring: DH-4 Depth: 8.3 feet
Woodward-Clyde	Project No. C3M11Q1	August 1996 Fig.

C96036.XLS 9/3/96

F-23

PROJECT:	NL/ TARACORP				
PROJECT NO.:	C3M11Q1	Initial height:	0.629 inch	Final height:	0.651 inch
BORING:	DH-4	Initial water content:	29.9 %	Final water content:	35.1 %
SAMPLE:	SPEC B	Initial dry density:	88.2 pcf	Final dry density:	85.0 pcf
TEST:	C96036	Initial total density:	114.6 pcf	Final total density:	114.8 pcf
DEPTH, feet:	8.3	Initial saturation:	90 %	Final saturation:	98 %
BY:	CMJ	Initial void ratio:	0.875	Final void ratio:	0.947
TEST DATE:	8/12/96			Final strain:	-3.5 %

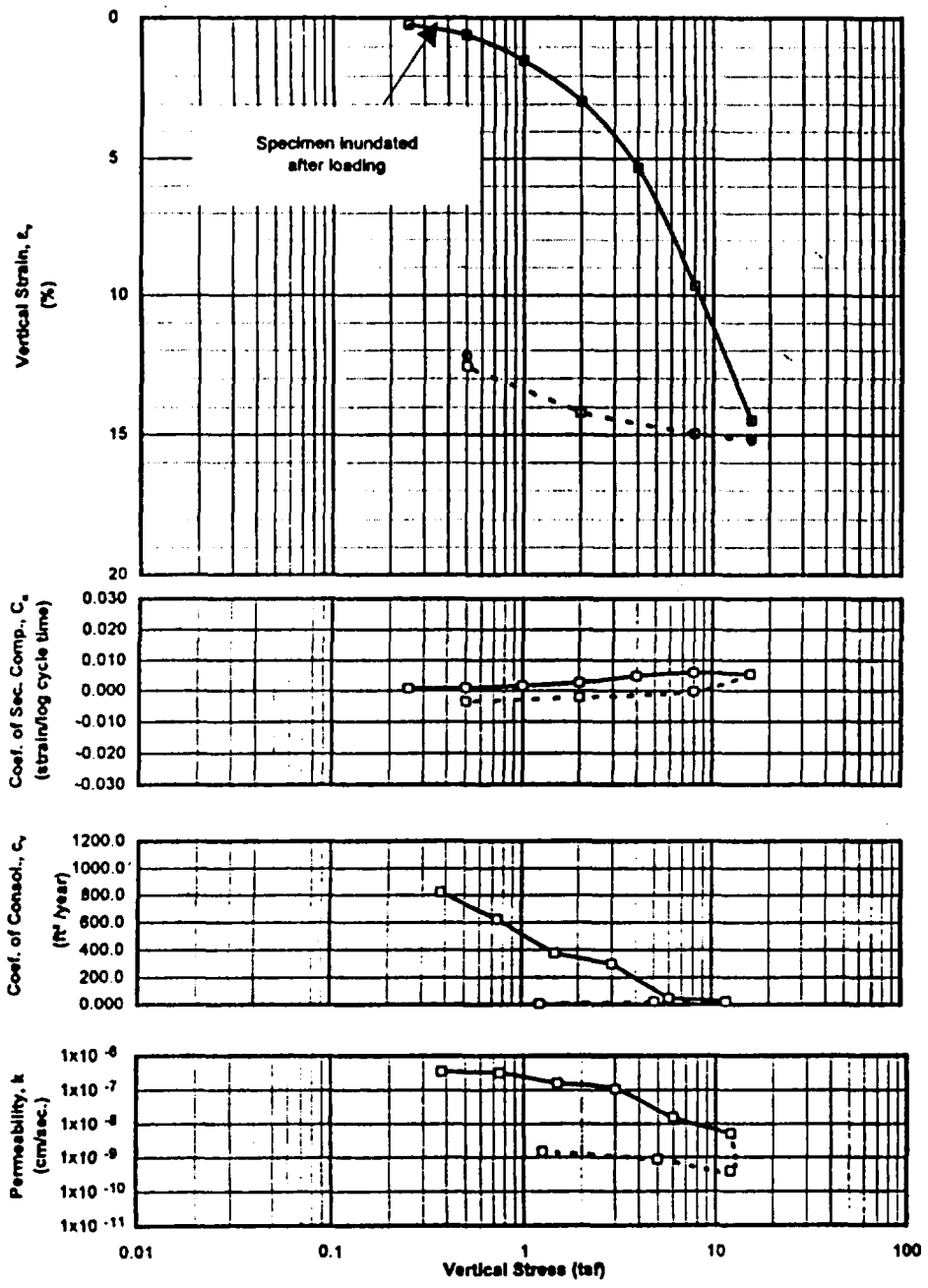
EQUIPMENT:
Load Frame No.: 6
Ring Diameter: 2.5 inch

SPECIMEN DESCRIPTION: CH, gray very plastic CLAY.

G	LL	PL	PI
2.65	68	24	44

Load No.	Load (tsf)	d_{100} (inch)	t_{100} Strain (%)	t_{100} Void Ratio (-)	Final Strain (%)	Final Void Ratio (-)	c_v (ft^2/year)	C_α (strain/logt)	Constrained Modulus (tsf)	Permeability (cm/sec)
1	0.250	0.0013	0.214	0.871	0.164	0.872	603.74	0.0004	116.65	1.56E-07
2	0.500	0.0017	0.268	0.870	0.542	0.865	435.13	0.0008	468.99	2.80E-08
3	1.00	0.0064	1.024	0.855	1.291	0.850	358.84	0.0015	66.09	1.64E-07
4	2.00	0.0139	2.212	0.833	2.665	0.825	392.57	0.0025	84.19	1.41E-07
5	4.00	0.0266	4.233	0.795	5.007	0.781	344.90	0.0045	98.96	1.05E-07
6	8.00	0.0444	7.058	0.742	8.296	0.719	293.18	0.0070	141.58	6.25E-08
7	16.0	0.0750	11.929	0.651	12.825	0.634	68.48	0.0061	164.26	1.26E-08
8	8.00	0.0792	12.596	0.639	12.399	0.642	169.11	-0.0010	1198	4.26E-09
9	2.00	0.0652	10.358	0.680	10.182	0.684	11.49	-0.0016	268.10	1.29E-09
10	0.500	0.0509	8.094	0.723	7.699	0.730	5.42	-0.0049	66.24	2.47E-09

F-24



SAMPLE INFORMATION

Boring:	DH-6
Sample:	SPEC B
Depth:	8.4 feet
Elevation:	
Type:	3-inch thin wall tube
	CH, gray plastic CLAY, some f. sand.

LL = 53, PL = 23, PI = 30

SPECIMEN INFORMATION

(NOTE: Initial and final states refer to beginning and end of test)

Initial height:	0.63	inch
Diameter:	2.50	inch

Initial water content:	27.5	%
Initial total unit weight:	117.0	pcf
Initial dry unit weight:	91.8	pcf
Initial void ratio:	0.802	
Initial degree of saturation:	91	%
Final water content:	24.7	%
Final total unit weight:	124.5	pcf
Final dry unit weight:	99.9	pcf
Final void ratio:	0.656	
Final degree of saturation:	100	% (assumed specific gravity = 2.65)

TEST SUMMARY

Construction Method:	Casagrande (Log)
Estimated preconsolidation stress (tsf):	3.1 (Range: 2.6 to 3.2)
Estimated in situ effective overburden stress (tsf):	
Compression Ratio (strain per log cycle stress):	0.152
Compression Index (void ratio per log cycle stress):	0.274
Swell Ratio (strain per log cycle stress):	0.013
Swell Index (void ratio per log cycle stress):	0.023
Recompression Ratio (strain per log cycle stress):	0.028
Recompression Index (void ratio per log cycle stress):	0.050
Remarks:	

LEGEND: □ End of primary ○ End of Stage ——— Loading - - - - - - Unloading

Test Date: 8/13/96 Tested By: CMJ Checked By:

	NL / TARACORP	ONE DIMENSIONAL CONSOLIDATION TEST Boring: DH-6 Depth: 8.4 feet
Woodward-Clyde	Project No. C3M11Q	August 1996 Fig.

C96038 XLS 9/3/96

PROJECT:	NL / TARACORP				
PROJECT NO.:	C3M11Q	Initial height:	0.625 inch	Final height:	0.574 inch
BORING:	DH-6	Initial water content:	27.5 %	Final water content:	24.7 %
SAMPLE:	SPEC B	Initial dry density:	91.8 pcf	Final dry density:	99.9 pcf
TEST:	C96038	Initial total density:	117.0 pcf	Final total density:	124.5 pcf
DEPTH, feet:	8.4	Initial saturation:	91 %	Final saturation:	100 %
BY:	CMJ	Initial void ratio:	0.802	Final void ratio:	0.656
TEST DATE:	8/13/96			Final strain:	8.1 %

EQUIPMENT:

Load Frame No.: 8

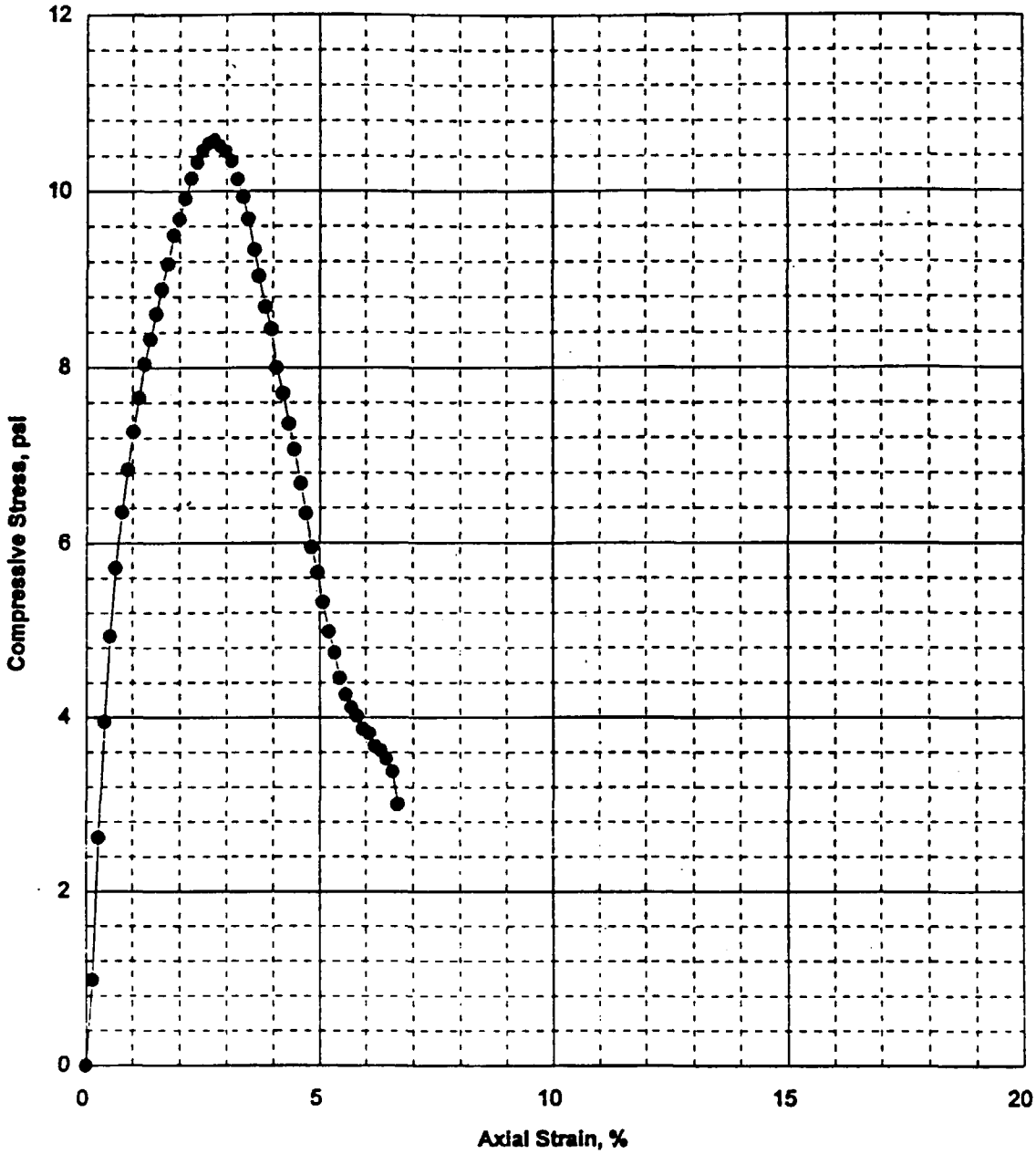
Ring Diameter: 2.5 inch

SPECIMEN DESCRIPTION: CH, gray plastic CLAY, some f. sand.

G	LL	PL	PI
2.65	53	23	30

Load No.	Load (tsf)	d_{100} (inch)	t_{100} Strain (%)	t_{100} Void Ratio (-)	Final Strain (%)	Final Void Ratio (-)	c_v (ft^2/year)	C_α (strain/logt)	Constrained Modulus (tsf)	Permeability (cm/sec)
1	0.250	0.0016	0.251	0.798	0.557	0.792	1173.68	0.0008	99.41	3.56E-07
2	0.500	0.0038	0.611	0.791	0.860	0.787	821.87	0.0010	69.63	3.56E-07
3	1.00	0.0092	1.467	0.776	1.839	0.769	621.49	0.0017	58.36	3.21E-07
4	2.00	0.0181	2.898	0.750	3.607	0.737	375.81	0.0027	69.90	1.62E-07
5	4.00	0.0334	5.346	0.706	6.660	0.682	297.45	0.0049	81.71	1.10E-07
6	8.00	0.0605	9.669	0.628	10.390	0.615	48.13	0.0060	92.52	1.57E-08
7	16.0	0.0905	14.471	0.542	15.161	0.529	28.38	0.0055	166.58	5.14E-09
8	8.00	0.0936	14.966	0.533	14.934	0.533	21.50	-0.0002	1619	4.01E-10
9	2.00	0.0887	14.184	0.547	13.967	0.551	22.07	-0.0021	767.36	8.68E-10
10	0.500	0.0784	12.542	0.576	12.176	0.583	4.46	-0.0035	91.38	1.47E-09

F-26



Specimen Information

Water Content (%)	Wet Unit Weight (pcf)	Dry Unit Weight (pcf)	LL	PI	Length (in)	Diameter (in)
28.7	114.2	88.8			6.002	2.866

Description and/or Classification: CL, brown m.p. silty CLAY, trace f. sand.

Test Summary

q_u (psi)	Strain to Peak (%	Strain Rate (%/min)
10.58	2.74	0.73

Tested by: DT
Test Date: Aug-12-96
Reviewed by:

FAILURE SKETCH

Project No. C3M11Q1	NL TARACORP	UNCONFINED COMPRESSION TEST Boring: DH-2	
Woodward-Clyde		Sample: Spec A Depth (ft):11.9	August 1996

Standard Test Method for Unconfined Compression

ASTM D 2166-91

Project Number: C3M11Q1
Project Name: NL TARACORP
Client:
Test by: DT

Task Number:
Assignment No.:
Test Number:
Test Date: Aug-12-96

Boring: DH-2
Sample: Spec A
Depth (ft): 11.9
Report Date: 8/15/96

Specimen Description and/or Classification:

SPECIMEN INFORMATION

Specimen Condition :

Intact: X
Remold:
Comp. Ref. Effort:
Max. DUW (pcf):
OPT. WC (%)
% Comp.
points Wet/ Dry of Opt.:

Cell Pressure (psi): 0.0 (ksf): 0.00

Height / Diameter, (h/d): 2.1

		Set Up	Final
Mass of wet soil (gm):		1160.90	1159.00
Height (in):	6.004	6.000	6.004
	6.001	6.003	
Average Height (in):		6.002	XXXXX
Diameter (in):	2.869	2.863	
	2.869	2.861	
	2.868	2.865	
Average Diameter (in):		2.866	

Change in height during consolidation (in): 0

Pre-test Height (in): 6.0024

	Set Up	Pre-test
Diameter (in):		2.866
Area (in^2):	6.450	6.450
Volume (cm^3):	634.48	634.48

WATER CONTENT	Trimmings	After Test
Container No.:		P-101
Mass of wet soil + cont. (g):		1242.5
Mass of dry soil + cont. (g):		994.9
Mass of cont. (g):		130.7
Water content (%):		28.65
Selected Water Content (%):	28.65	
Wet unit weight (pcf):	114.2	114.2
Dry unit weight (pcf):	88.8	88.8

No. of Membranes: 0 @ Thickness: 0.012

Membrane correction 0.0000

Piston: Diameter(in) 0.375 Area (ft^2) 0.00077

Weight of Top Cap (g) 555.58 Pc(lb) -1.2248

Strain Rate Used (%/min) : 0.73

Stress Data Corrected for membr. Yes ☐ No ☒

Readings			Data Reduction		
Elapsed Time (min)	CH. # Dial Reading (in)	CH. # Load Cell (lb)	Axial Strain (%)	Corr. Area (in^2)	Compressive Stress (psi)
0.00	0.140	0.000	0.00	6.450	0.00
0.17	0.149	5.130	0.14	6.460	0.98
0.33	0.156	15.709	0.27	6.468	2.62
0.50	0.164	24.365	0.40	6.476	3.95
0.67	0.171	30.777	0.52	6.484	4.94
0.83	0.179	35.907	0.65	6.492	5.72
1.00	0.187	40.075	0.77	6.501	6.35
1.17	0.194	43.281	0.90	6.509	6.84
1.33	0.201	46.166	1.02	6.517	7.27
1.50	0.209	48.731	1.14	6.525	7.66
1.67	0.216	51.295	1.26	6.533	8.04
1.83	0.223	53.219	1.39	6.541	8.32
2.00	0.231	55.143	1.51	6.549	8.61
2.17	0.238	57.066	1.63	6.557	8.89
2.33	0.245	58.990	1.75	6.566	9.17
2.50	0.253	61.234	1.88	6.574	9.50
2.67	0.260	62.516	1.99	6.582	9.68
2.83	0.267	64.119	2.12	6.590	9.92
3.00	0.275	65.722	2.24	6.598	10.15
3.17	0.282	67.005	2.36	6.607	10.33
3.33	0.289	67.967	2.49	6.615	10.46
3.50	0.297	68.608	2.61	6.624	10.54
3.67	0.305	68.928	2.74	6.632	10.58
3.83	0.312	68.608	2.86	6.641	10.52
4.00	0.319	68.287	2.99	6.649	10.45
4.17	0.327	67.646	3.11	6.657	10.34
4.33	0.334	66.364	3.23	6.666	10.14
4.50	0.342	65.081	3.36	6.675	9.93
4.67	0.348	63.478	3.47	6.682	9.68
4.83	0.356	61.234	3.60	6.691	9.33
5.00	0.363	59.310	3.71	6.699	9.04
5.17	0.371	57.066	3.85	6.709	8.69
5.33	0.378	55.463	3.97	6.717	8.44
5.50	0.385	52.578	4.08	6.725	8.00
5.67	0.393	50.654	4.22	6.734	7.70

Standard Test Method for Unconfined Compression

ASTM D 2166-91

Project Number: C3M11Q1
Project Name: NL TARACORP
Client:
Test by: DT

Task Number:
Assignment No.:
Test Number:
Test Date: Aug-12-96

Boring: DH-2
Sample: Spec A
Depth (ft): 11.9
Report Date: 8/15/96

Specimen Description and/or Classification:

SPECIMEN INFORMATION

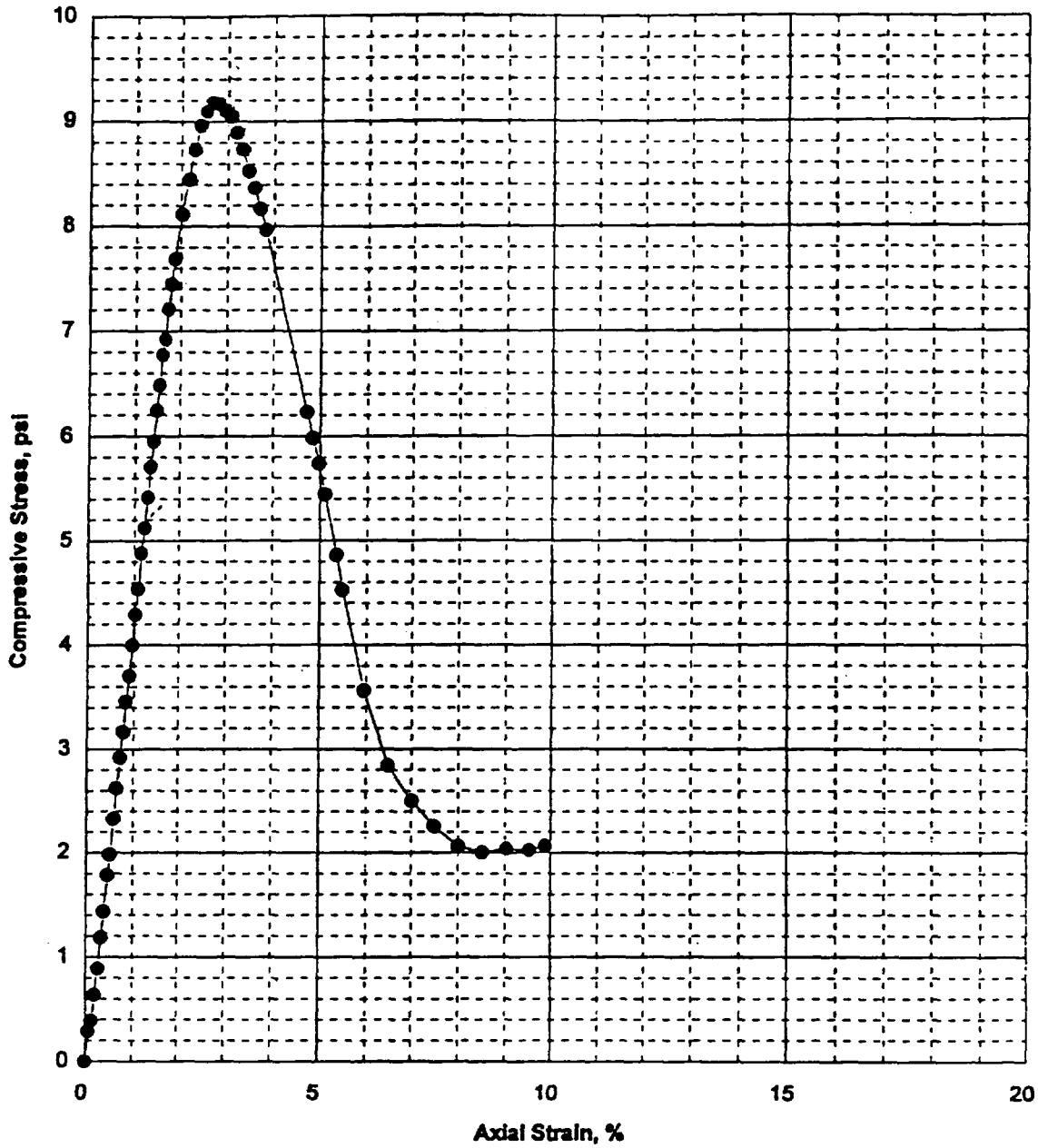
Specimen Condition :

Intact: X
Remold:
Comp. Ref. Effort:
Max. DUW (pcf):
OPT. WC (%)
% Comp.
points Wet/ Dry of Opt.:

Cell Pressure (psi): 0.0 (ksf): 0.00
Height / Diameter, (h/d): 2.1

Strain Rate Used (%/min) : 0.73
Stress Data Corrected for membr. Yes ☐ No ☒

Readings			Data Reduction		
Elapsed Time (min)	CH. # Dial Reading (in)	CH. # Load Cell (lb)	Axial Strain (%)	Corr. Area (in^2)	Compressive Stress (psi)
0.00	0.140	0.000	0.00	6.450	0.00
5.83	0.401	48.410	4.34	6.743	7.36
6.00	0.408	46.487	4.46	6.751	7.07
6.17	0.416	43.922	4.59	6.761	6.68
6.33	0.422	41.678	4.70	6.769	6.34
6.50	0.430	39.113	4.83	6.778	5.95
6.67	0.438	37.189	4.96	6.787	5.66
6.83	0.445	34.945	5.07	6.795	5.32
7.00	0.453	32.701	5.21	6.805	4.99
7.17	0.460	31.098	5.33	6.814	4.74
7.33	0.467	29.174	5.44	6.822	4.46
7.50	0.475	27.892	5.57	6.831	4.26
7.67	0.482	26.930	5.70	6.840	4.12
7.83	0.489	26.289	5.82	6.849	4.02
8.00	0.497	25.327	5.94	6.858	3.87
8.17	0.504	25.007	6.07	6.867	3.82
8.33	0.512	24.045	6.19	6.876	3.67
8.50	0.519	23.724	6.32	6.886	3.62
8.67	0.527	23.083	6.44	6.895	3.53
8.85	0.535	22.121	6.58	6.905	3.38
9.12	0.542	19.556	6.69	6.913	3.01



Specimen Information

Water Content (%)	Wet Unit Weight (pcf)	Dry Unit Weight (pcf)	LL	PI	Length (in)	Diameter (in)
28.0	117.5	91.8			5.756	2.858

Description and/or Classification: CL, dark brown f. sandy silty CLAY

Test Summary

q_u (psi)	Strain to Peak (%	Strain Rate (%/min)
9.18	2.68	0.83

Tested by: DT
Test Date: Aug-13-96
Reviewed by:

FAILURE SKETCH

Project No. C3M11Q1	NL TARACORP	UNCONFINED COMPRESSION TEST Boring: DH-3	
Woodward-Clyde		Sample: Spec B Depth (ft):8.4	August 1996

Standard Test Method for Unconfined Compression

ASTM D 2166-91

Project Number: C3M11Q1
Project Name: NL TARACORP
Client:
Test by: DT

Task Number:
Assignment No.:
Test Number:
Test Date: Aug-13-96

Boring: DH-3
Sample: Spec B
Depth (ft): 8.4
Report Date: 8/15/96

Specimen Description and/or Classification:

SPECIMEN INFORMATION

Specimen Condition :

Intact: X
Remold:
Comp. Ref. Effort:
Max. DUW (pcf):
OPT. WC (%)
% Comp.
points Wet/ Dry of Opt.:

Cell Pressure (psi): 0.0 (ksf): 0.00

Height / Diameter, (h/d): 2.0

	Set Up	Final
Mass of wet soil (gm):	1139.90	1139.90
Height (in): 5.750	5.762	5.755
5.757	5.757	
Average Height (in):	5.756	XXXXX
Diameter (in): 2.853	2.849	
2.867	2.847	
2.872	2.862	
Average Diameter (in):	2.858	

Change in height during consolidation (in): 0

Pre-test Height (in): 5.7562

	Set Up	Pre-test
Diameter (in):		2.858
Area (in^2):	6.417	6.417
Volume (cm^3):	605.27	605.27

WATER CONTENT	Trimmings	After Test
Container No.:		P-34
Mass of wet soil + cont. (g):		1259.2
Mass of dry soil + cont. (g):		1011.4
Mass of cont. (g):		126.83
Water content (%):		28.01
Selected Water Content (%):	28.01	
Wet unit weight (pcf):	117.5	117.5
Dry unit weight (pcf):	91.8	91.8

No. of Membranes: 0 @ Thickness: 0.012
Membrane correction 0.0000
Piston: Diameter(in) 0.375 Area (ft^2) 0.00077
Weight of Top Cap (g) 555.58 Pc(lb) -0.9042

Strain Rate Used (%/min) : 0.83

Stress Data Corrected for membr. Yes ☐ No ☒

Readings			Data Reduction		
Elapsed Time (min)	CH. # Dial Reading (in)	CH. # Load Cell (lb)	Axial Strain (%)	Corr. Area (in^2)	Compressive Stress (psi)
0.00	0.019	0.321	0.00	6.417	0.00
0.08	0.022	0.962	0.07	6.421	0.29
0.17	0.026	1.603	0.13	6.425	0.39
0.25	0.030	3.206	0.20	6.429	0.64
0.33	0.034	4.809	0.27	6.434	0.89
0.42	0.038	6.733	0.34	6.438	1.19
0.48	0.041	8.336	0.38	6.441	1.43
0.58	0.045	10.580	0.46	6.447	1.78
0.65	0.048	11.862	0.51	6.450	1.98
0.75	0.053	14.106	0.59	6.455	2.33
0.83	0.056	16.030	0.65	6.459	2.62
0.92	0.060	17.953	0.72	6.463	2.92
1.00	0.064	19.556	0.78	6.467	3.16
1.08	0.067	21.480	0.84	6.471	3.46
1.17	0.071	23.083	0.91	6.476	3.70
1.25	0.075	25.007	0.97	6.480	4.00
1.33	0.078	26.930	1.03	6.484	4.29
1.42	0.082	28.533	1.10	6.488	4.54
1.50	0.086	30.777	1.16	6.492	4.88
1.58	0.089	32.380	1.23	6.497	5.12
1.67	0.093	34.304	1.29	6.501	5.42
1.75	0.097	36.227	1.35	6.505	5.71
1.83	0.100	37.830	1.42	6.509	5.95
1.92	0.104	39.754	1.48	6.513	6.24
2.00	0.107	41.357	1.54	6.517	6.48
2.08	0.111	43.281	1.61	6.522	6.77
2.15	0.114	44.242	1.66	6.525	6.92
2.25	0.119	46.166	1.74	6.530	7.21
2.33	0.122	47.769	1.80	6.534	7.45
2.42	0.126	49.372	1.87	6.539	7.69
2.62	0.135	52.257	2.02	6.549	8.12
2.80	0.143	54.501	2.16	6.558	8.45
2.97	0.150	56.425	2.29	6.567	8.73
3.13	0.158	58.028	2.42	6.576	8.96
3.30	0.165	58.990	2.55	6.585	9.10

Standard Test Method for Unconfined Compression
ASTM D 2166-91

Project Number: C3M11Q1
Project Name: NL TARACORP
Client:
Test by: DT

Task Number:
Assignment No.:
Test Number:
Test Date: Aug-13-96

Boring: DH-3
Sample: Spec B
Depth (ft): 8.4
Report Date: 8/15/96

Specimen Description and/or Classification:

SPECIMEN INFORMATION

Specimen Condition :

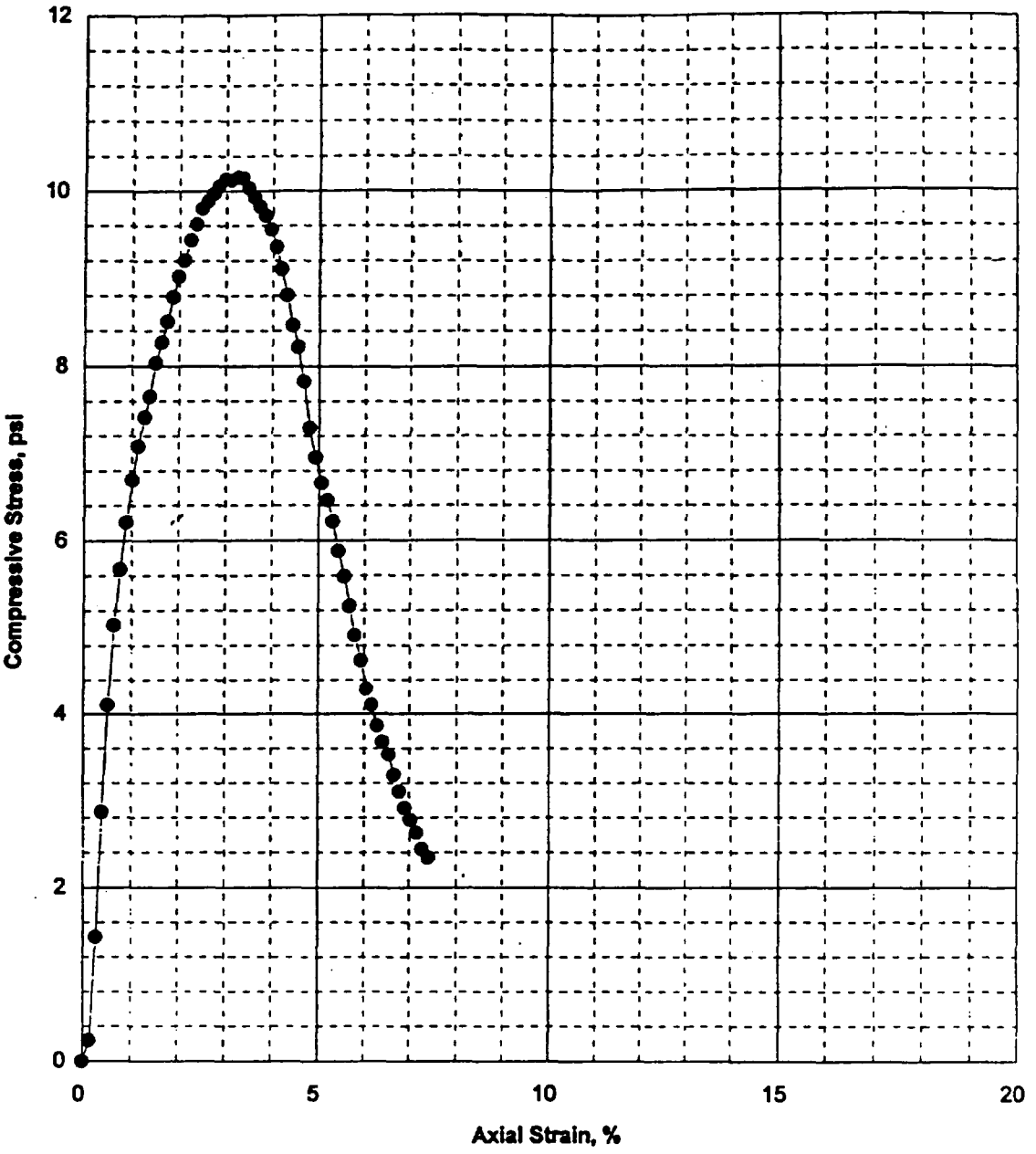
Intact: X
Remold:
Comp. Ref. Effort:
Max. DUW (pcf):
OPT. WC (%)
% Comp.
points Wet/ Dry of Opt.:

Cell Pressure (psi): 0.0
(ksf): 0.00
Height / Diameter, (h/d): 2.0

Strain Rate Used (%/min) : 0.83

Stress Data Corrected for membr. Yes [ ] No [X]

	Readings			Data Reduction		
	Elapsed Time (min)	CH. # Dial Reading (in)	CH. # Load Cell (lb)	Axial Strain (%)	Corr. Area (in^2)	Compressive Stress (psi)
	0.00	0.019	0.321	0.00	6.417	0.00
1	3.47	0.173	59.631	2.68	6.594	9.18
	3.63	0.180	59.631	2.81	6.602	9.17
	3.80	0.188	59.310	2.94	6.611	9.11
	3.97	0.195	58.990	3.07	6.620	9.05
	4.13	0.202	58.028	3.19	6.628	8.89
	4.30	0.210	57.066	3.32	6.637	8.73
	4.47	0.217	55.784	3.45	6.646	8.53
	4.63	0.225	54.822	3.58	6.655	8.37
	4.80	0.232	53.540	3.71	6.664	8.17
	4.97	0.239	52.257	3.83	6.672	7.97
	5.13	0.291	41.036	4.73	6.735	6.23
	5.30	0.298	39.433	4.86	6.744	5.98
	5.47	0.306	37.830	4.99	6.754	5.74
	5.63	0.313	35.907	5.11	6.763	5.44
	5.97	0.328	32.060	5.37	6.781	4.86
	6.13	0.335	29.816	5.49	6.790	4.52
	6.73	0.361	23.404	5.95	6.823	3.56
	7.42	0.392	18.595	6.48	6.861	2.84
	8.10	0.422	16.350	7.02	6.901	2.50
	8.73	0.450	14.747	7.50	6.937	2.26
	9.40	0.480	13.465	8.01	6.976	2.06
	10.07	0.509	13.144	8.52	7.014	2.00
	10.73	0.539	13.465	9.04	7.055	2.04
	11.40	0.568	13.465	9.54	7.094	2.03
	11.83	0.587	13.786	9.88	7.120	2.06



Specimen Information

Water Content (%)	Wet Unit Weight (pcf)	Dry Unit Weight (pcf)	LL	PI	Length (in)	Diameter (in)
33.9	115.7	86.5			6.001	2.863

Description and/or Classification: CL, gray plastic CLAY

Test Summary

q_u (psi)	Strain to Peak (%	Strain Rate (%/min)
10.16	3.23	0.74

Tested by: DT
Test Date: Aug-12-96
Reviewed by:

FAILURE SKETCH

Project No. C3M11Q1	NL TARACORP	UNCONFINED COMPRESSION TEST Boring: DH-4	
Woodward-Clyde		Sample: Spec A Depth (ft):7.85	August 1996

Standard Test Method for Unconfined Compression
ASTM D 2166-91

Project Number: C3M11Q1
Project Name: NL TARACORP
Client:
Test by: DT

Task Number:
Assignment No.:
Test Number:
Test Date: Aug-12-96

Boring: DH-4
Sample: Spec A
Depth (ft): 7.85
Report Date: 8/15/96

Specimen Description and/or Classification:

SPECIMEN INFORMATION

Specimen Condition :

Intact: X
Remold:
Comp. Ref. Effort:
Max. DUW (pcf):
OPT. WC (%)
% Comp.
points Wet/ Dry of Opt.:

Cell Pressure (psi): 0.0 (ksf): 0.00
Height / Diameter, (h/d): 2.1

		Set Up	Final
Mass of wet soil (gm):		1173.50	1172.00
Height (in):	6.004	6.000	5.994
	6.004	6.001	
Average Height (in):		6.001	XXXXX
Diameter (in):	2.866	2.851	
	2.868	2.856	
	2.873	2.863	
Average Diameter (in):		2.863	

Change in height during consolidation (in): 0
Pre-test Height (in): 6.0006

	Set Up	Pre-test
Diameter (in):		2.863
Area (in^2):	6.437	6.437
Volume (cm^3):	632.96	632.96

WATER CONTENT	Trimmings	After Test
Container No.:		P-52
Mass of wet soil + cont. (g):		1718.7
Mass of dry soil + cont. (g):		1422.3
Mass of cont. (g):		546.8
Water content (%):		33.85
Selected Water Content (%):	33.85	
Wet unit weight (pcf):	115.7	115.7
Dry unit weight (pcf):	86.5	86.5

No. of Membranes: 0 @ Thickness: 0.012
Membrane correction 0.0000
Piston: Diameter(in) 0.375 Area (ft^2) 0.00077
Weight of Top Cap (g) 555.58 Pc(lb) -1.2248

Strain Rate Used (%/min) : 0.74
Stress Data Corrected for membr. Yes [ ] No [X]

Readings			Data Reduction		
Elapsed Time (min)	CH. # Dial Reading (in)	CH. # Load Cell (lb)	Axial Strain (%)	Corr. Area (in^2)	Compressive Stress (psi)
0.00	0.022	0.000	0.00	6.437	0.00
0.17	0.031	0.321	0.15	6.446	0.24
0.33	0.038	8.015	0.27	6.455	1.43
0.50	0.046	17.312	0.40	6.463	2.87
0.67	0.053	25.327	0.52	6.471	4.10
0.83	0.061	31.418	0.65	6.479	5.04
1.00	0.068	35.586	0.77	6.487	5.67
1.17	0.076	39.113	0.89	6.495	6.21
1.33	0.083	42.319	1.02	6.503	6.70
1.50	0.090	44.884	1.14	6.511	7.08
1.67	0.098	47.128	1.26	6.519	7.42
1.82	0.104	48.731	1.37	6.527	7.65
2.00	0.112	51.295	1.51	6.535	8.04
2.17	0.120	52.898	1.63	6.544	8.27
2.33	0.127	54.501	1.75	6.552	8.51
2.50	0.134	56.425	1.87	6.560	8.79
2.67	0.142	58.028	1.99	6.568	9.02
2.83	0.149	59.310	2.11	6.576	9.21
3.00	0.156	60.913	2.24	6.584	9.44
3.17	0.164	62.196	2.36	6.593	9.62
3.33	0.171	63.478	2.49	6.601	9.80
3.50	0.179	64.119	2.61	6.610	9.89
3.67	0.186	64.761	2.74	6.618	9.97
3.82	0.193	65.402	2.85	6.626	10.06
4.00	0.201	66.043	2.99	6.635	10.14
4.17	0.209	66.043	3.11	6.644	10.13
4.33	0.216	66.364	3.23	6.652	10.16
4.50	0.223	66.364	3.36	6.661	10.15
4.67	0.231	65.722	3.48	6.669	10.04
4.83	0.238	65.081	3.60	6.677	9.93
5.00	0.245	64.440	3.72	6.686	9.82
5.17	0.253	63.799	3.84	6.694	9.71
5.33	0.260	62.837	3.96	6.703	9.56
5.50	0.267	61.555	4.08	6.711	9.35
5.67	0.274	59.952	4.20	6.719	9.10

Standard Test Method for Unconfined Compression
ASTM D 2166-91

Project Number: C3M11Q1
Project Name: NL TARACORP
Client:
Test by: DT

Task Number:
Assignment No.:
Test Number:
Test Date: Aug-12-96

Boring: DH-4
Sample: Spec A
Depth (ft): 7.85
Report Date: 8/15/96

Specimen Description and/or Classification:

SPECIMEN INFORMATION

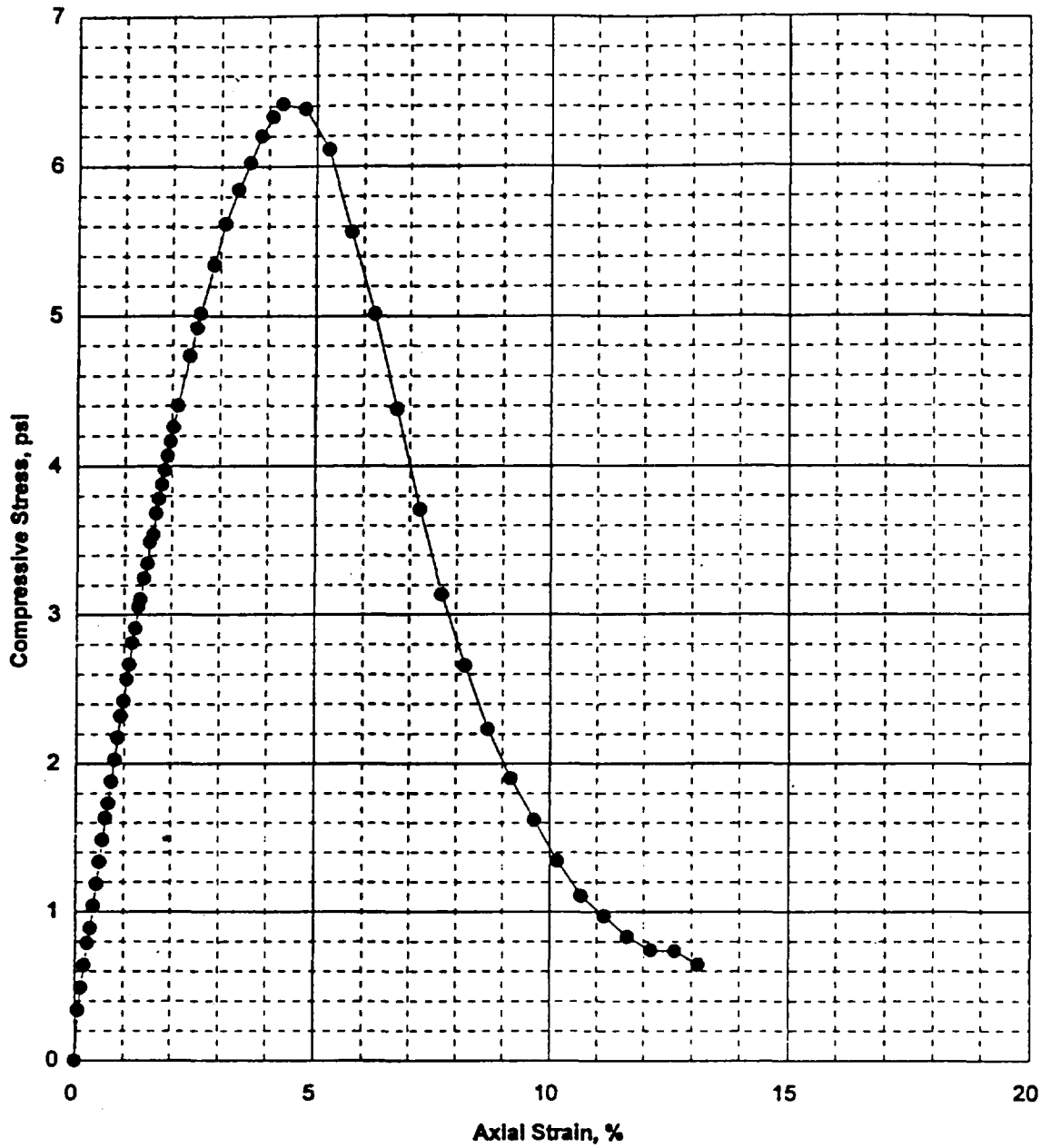
Specimen Condition :

Intact: X
Remold:
Comp. Ref. Effort:
Max. DUW (pcf):
OPT. WC (%)
% Comp.
points Wet/ Dry of Opt.:

Cell Pressure (psi): 0.0 (ksf): 0.00
Height / Diameter, (h/d): 2.1

Strain Rate Used (%/min) : 0.74
Stress Data Corrected for membr. Yes ☐ No ☒

Readings			Data Reduction		
Elapsed Time (min)	CH. # Dial Reading (in)	CH. # Load Cell (lb)	Axial Strain (%)	Corr. Area (in^2)	Compressive Stress (psi)
0.00	0.022	0.000	0.00	6.437	0.00
5.82	0.281	58.028	4.31	6.727	8.81
6.00	0.288	55.784	4.44	6.736	8.46
6.17	0.296	54.181	4.56	6.744	8.21
6.33	0.303	51.616	4.68	6.753	7.82
6.50	0.310	48.090	4.81	6.762	7.29
6.67	0.319	45.845	4.94	6.772	6.95
6.83	0.326	43.922	5.07	6.780	6.66
7.00	0.333	42.639	5.19	6.789	6.46
7.17	0.341	41.036	5.31	6.798	6.22
7.33	0.348	38.792	5.44	6.807	5.88
7.50	0.356	36.869	5.56	6.816	5.59
7.67	0.363	34.624	5.68	6.825	5.25
7.82	0.369	32.380	5.79	6.833	4.92
8.00	0.378	30.457	5.92	6.842	4.63
8.17	0.385	28.213	6.05	6.851	4.30
8.33	0.392	26.930	6.17	6.860	4.10
8.50	0.400	25.327	6.29	6.869	3.87
8.67	0.407	24.045	6.42	6.878	3.67
8.83	0.415	23.083	6.54	6.888	3.53
9.00	0.422	21.480	6.67	6.897	3.29
9.17	0.429	20.198	6.79	6.906	3.10
9.33	0.437	18.915	6.91	6.915	2.91
9.50	0.444	17.953	7.04	6.924	2.77
9.67	0.452	16.992	7.16	6.933	2.63
9.82	0.458	15.709	7.27	6.942	2.44
10.00	0.467	15.068	7.41	6.952	2.34



Specimen Information

Water Content (%)	Wet Unit Weight (pcf)	Dry Unit Weight (pcf)	LL	PI	Length (in)	Diameter (in)
28.7	116.6	90.7			6.016	2.855

Description and/or Classification: CL-ML, dark brown - gray s.p. clayey SILT, trace sand.
SM at top

Test Summary

q_u (psi)	Strain to Peak (%	Strain Rate (%/min)
6.41	4.29	0.74

Tested by: DT
Test Date: Aug-13-96
Reviewed by:

FAILURE SKETCH

Project No. C3M11Q1	NL TARACORP	UNCONFINED COMPRESSION TEST Boring: DH-6	
Woodward-Clyde		Sample: Spec A Depth (ft):7.95	August 1996

Standard Test Method for Unconfined Compression

ASTM D 2166-91

Project Number: C3M11Q1
Project Name: NL TARACORP
Client:
Test by: DT

Task Number:
Assignment No.:
Test Number:
Test Date: Aug-13-96

Boring: DH-6
Sample: Spec A
Depth (ft): 7.95
Report Date: 8/15/96

Specimen Description and/or Classification:

SPECIMEN INFORMATION

Specimen Condition :

Intact: X
Remold:
Comp. Ref. Effort:
Max. DUW (pcf):
OPT. WC (%)
% Comp.
points Wet/ Dry of Opt.:

Cell Pressure (psi): 0.0 (ksf): 0.00

Height / Diameter, (h/d): 2.1

	Set Up	Final
Mass of wet soil (gm):	1179.60	1179.60
Height (in): 6.015	6.012	6.022
6.021	6.012	
Average Height (in):	6.016	XXXXX
Diameter (in): 2.852	2.868	
2.846	2.852	
2.861	2.851	
Average Diameter (in):	2.855	

Change in height during consolidation (in): 0

Pre-test Height (in): 6.0164

	Set Up	Pre-test
Diameter (in):		2.855
Area (in^2):	6.402	6.402
Volume (cm^3):	631.16	631.16

WATER CONTENT	Trimmings	After Test
Container No.:		P-39
Mass of wet soil + cont. (g):		1242.5
Mass of dry soil + cont. (g):		994.9
Mass of cont. (g):		130.7
Water content (%):		28.65
Selected Water Content (%):	28.65	
Wet unit weight (pcf):	116.6	116.6
Dry unit weight (pcf):	90.7	90.7

No. of Membranes: 0 @ Thickness: 0.012

Membrane correction 0.0000

Piston: Diameter(in) 0.375 Area (ft^2) 0.00077

Weight of Top Cap (g) 555.58 Pc(lb) -1.2248

Strain Rate Used (%/min) : 0.74

Stress Data Corrected for membr. Yes ☐ No ☒

Readings			Data Reduction		
Elapsed Time (min)	CH. # Dial Reading (in)	CH. # Load Cell (lb)	Axial Strain (%)	Corr. Area (in^2)	Compressive Stress (psi)
0.00	0.027	0.000	0.00	6.402	0.00
0.08	0.031	0.962	0.07	6.406	0.34
0.17	0.035	1.924	0.13	6.410	0.49
0.25	0.038	2.885	0.19	6.414	0.64
0.33	0.042	3.847	0.26	6.418	0.79
0.42	0.046	4.488	0.32	6.422	0.89
0.50	0.050	5.450	0.38	6.426	1.04
0.58	0.053	6.412	0.44	6.430	1.19
0.67	0.057	7.374	0.50	6.434	1.34
0.75	0.061	8.336	0.57	6.438	1.48
0.83	0.065	9.297	0.63	6.442	1.63
0.92	0.068	9.939	0.69	6.446	1.73
1.00	0.072	10.900	0.75	6.450	1.88
1.08	0.076	11.862	0.81	6.454	2.03
1.17	0.079	12.824	0.87	6.458	2.18
1.25	0.083	13.786	0.93	6.462	2.32
1.33	0.087	14.427	1.00	6.466	2.42
1.42	0.090	15.389	1.06	6.470	2.57
1.50	0.094	16.030	1.12	6.474	2.67
1.58	0.098	16.992	1.18	6.478	2.81
1.67	0.101	17.633	1.24	6.482	2.91
1.75	0.105	18.595	1.30	6.486	3.06
1.82	0.108	18.915	1.35	6.489	3.10
1.92	0.113	19.877	1.43	6.494	3.25
2.00	0.116	20.518	1.49	6.498	3.35
2.08	0.119	21.480	1.54	6.502	3.49
2.17	0.123	21.801	1.61	6.506	3.54
2.25	0.127	22.762	1.67	6.511	3.68
2.33	0.131	23.404	1.73	6.515	3.78
2.42	0.135	24.045	1.79	6.519	3.88
2.50	0.138	24.686	1.85	6.523	3.97
2.58	0.142	25.327	1.92	6.527	4.07
2.67	0.146	25.968	1.98	6.531	4.16
2.75	0.149	26.610	2.04	6.535	4.26
2.88	0.155	27.571	2.14	6.541	4.40

Standard Test Method for Unconfined Compression
ASTM D 2166-91

Project Number: C3M11Q1
Project Name: NL TARACORP
Client:
Test by: DT

Task Number:
Assignment No.:
Test Number:
Test Date: Aug-13-96

Boring: DH-6
Sample: Spec A
Depth (ft): 7.95
Report Date: 8/15/96

Specimen Description and/or Classification:

SPECIMEN INFORMATION

Specimen Condition :
Intact: X
Remold:
Comp. Ref. Effort:
Max. DUW (pcf):
OPT. WC (%)
% Comp.
points Wet/ Dry of Opt.:

Cell Pressure (psi): 0.0 (ksf): 0.00
Height / Diameter, (h/d): 2.1

Strain Rate Used (%/min) : 0.74
Stress Data Corrected for membr. Yes ☐ No ☒

	Readings			Data Reduction		
	Elapsed Time (min)	CH. # Dial Reading (in)	CH. # Load Cell (lb)	Axial Strain (%)	Corr. Area (in^2)	Compressive Stress (psi)
	0.00	0.027	0.000	0.00	6.402	0.00
	3.20	0.169	29.816	2.36	6.557	4.73
	3.38	0.178	31.098	2.51	6.567	4.92
	3.50	0.182	31.739	2.58	6.572	5.02
	3.88	0.200	33.983	2.87	6.591	5.34
	4.20	0.213	35.907	3.10	6.607	5.62
	4.55	0.229	37.510	3.37	6.625	5.85
	4.88	0.244	38.792	3.61	6.641	6.03
	5.22	0.258	40.075	3.85	6.658	6.20
	5.55	0.273	41.036	4.09	6.675	6.33
1	5.83	0.285	41.678	4.29	6.689	6.41
	6.48	0.313	41.678	4.77	6.722	6.38
	7.15	0.343	40.075	5.25	6.757	6.11
	7.82	0.372	36.548	5.74	6.792	5.56
	8.48	0.402	33.021	6.23	6.827	5.02
	9.15	0.432	28.854	6.73	6.864	4.38
	9.82	0.461	24.365	7.22	6.900	3.71
	10.48	0.490	20.518	7.70	6.936	3.13
	11.15	0.520	17.312	8.19	6.973	2.66
	11.82	0.549	14.427	8.69	7.011	2.23
	12.48	0.579	12.183	9.18	7.049	1.90
	13.15	0.609	10.259	9.67	7.087	1.62
	13.82	0.638	8.336	10.17	7.126	1.34
	14.48	0.668	6.733	10.66	7.166	1.11
	15.15	0.698	5.771	11.16	7.206	0.97
	15.82	0.728	4.809	11.65	7.246	0.83
	16.48	0.758	4.168	12.15	7.287	0.74
	17.15	0.788	4.168	12.65	7.329	0.74
	17.82	0.818	3.527	13.15	7.371	0.64

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(6/75)

LABORATORY LOG OF TUBE SAMPLE

Proj No. C3M11Q1 Proj Eng. _____ Date Opened 8/23/98 By BJ

Boring No. D14-1 Sample No. _____ Depth 9 To 11

Tag No. _____

Tube Seals	Wax	Mech	Good	Fair	Loose	Leaking Water	Leaking Soil
Top							
Bottom							

Cutting Edge	Sharp	Dull	Nicked <Mod>	Dented	Neck Down <OK>

Remarks _____

Tube Scale Ft	Jar No.	Sample Use	Depth in Ground, ft	DESCRIPTION OF SOIL AND REMARKS
0.0				
0.2				0.82' VOID
0.4				
0.6				
0.8				0.05' discard
	LA	120.9 (Sum)		Dry TV=1.25, 1.0 x 0.25 PP=3.5, 4.0
1.0				CL, dk brown stiff m-plastic silty CLAY
1.2	A		9.45'	trace f. sand
1.4				
	LC		9.7	TV=2.0, 3.0 x 0.25 PP=1.5, 2.0
1.6				CL, brown m-plastic silty CLAY trace f.
1.8	B		9.95'	sand, becoming more sandy towards
				bottom
2.0	LA		10.2	TV=1.75, 5.0 x 0.1 PP=1.25, 1.75
2.2	C		10.45'	
2.4				0.05 VOID

Measured length of tube = 2.50 ft Recovery 1.63 ft

Type Tube _____ O.D. Brass / Steel Shelby _____ I.D. { Cutting edge(D_e) 2.831 in. / Tube(D_i) 2.892 in.

Inside Clearence Ratio = $\frac{D_i - D_e}{D_e} \times 100 =$ ____ %

Total Unit Weight of Soil				
Wgt. soil + tube 6222.0 gm	Total Unit Weight by			
Wgt. tube 2327.9 gm		CUTTING EDGE (D_e)	TUBE (D_i)	AVE
Wgt. wet soil _____ gm	γ_t	120.49	115.46	117.98 lb/ft^3
Calculated by _____	Reviewed by		MS	

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(6/75)

LABORATORY LOG OF TUBE SAMPLE

Proj No. C3M11Q1 Proj Eng. _____ Date Opened 8/12/96 By [illegible]

Boring No. DH-2- Sample No. _____ Depth 11.5 To 13.0

Tag No. _____

Tube Seals	Wax	Mech	Good	Fair	Loose	Leaking Water	Leaki Soi
Top							
Bottom							

Cutting Edge	Sharp	Dull	Nicked <Mod.>	Dented	Neck Down <OK>

Remarks _____

Tube Scale Ft	Jar No.	Sample Use	Depth in Ground, ft	DESCRIPTION OF SOIL AND REMARKS
0.0				
0.2				
0.4				[illegible]
0.6				
0.8				
1.0	LA-08		11.05	[illegible]
1.2	A	UC <PZ	11.9	[illegible]
1.4				
1.6	LC-4		12.15	[illegible]
1.8	B	Consol	[illegible]	[illegible]
2.0				
2.2	LA-09		11.75	[illegible]
2.4	C		12.9	[illegible]

Measured length of tube = [illegible] ft Recovery 1.67 ft

Type Tube _____ O.D. Brass Steel Shelby _____ I.D. { Cutting edge(D_e) [illegible] in. Tube(D_i) [illegible] in.

Inside Clearence Ratio $\frac{D_i - D_e}{D_e} \times 100 =$ _____ %

Total Unit Weight of Soil					
Wgt. soil + tube	[illegible] gm	Total Unit Weight by			
Wgt. tube	[illegible] gm	CUTTING EDGE (D_e)	TUBE (D_i)	AVE	
Wgt. wet soil	3841.4 gm	γ_t 117.5	113.36	115.43	lb/ft
Calculated by	_____	Reviewed by	MT		

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(6/75)

LABORATORY LOG OF TUBE SAMPLE

Proj No. C3M1101 Proj Eng. _____ Date Opened 8/13/86 By [illegible]

Boring No. DH-3 Sample No. _____ Depth 7.5 To 9.5

Tag No. _____

Tube Seals	Wax	Mech	Good	Fair	Loose	Leaking Water	Leaking Soil
Top							✓
Bottom							

Cutting Edge	Sharp	Dull	Nicked <Mod.>	Dented	Neck Down <OK>

Remarks no seal, bot. cap broken

Tube Scale Ft	Jar No.	Sample Use	Depth in Ground, ft	DESCRIPTION OF SOIL AND REMARKS
0.0				
0.2				0.53' void
0.4				
0.6				a.1 discarded
	LA 1.0		7.6	TV-6.5, 7.0 x0.1 ppc 1.25, 1.75
0.8		Cond	7.2	CL, dk brown stiff plastic silty clay, c.c
1.0	A	UC	7.9	x 0.1
1.2	LA 2.15		8.15	TV-8.0, 8.5 x0.1 ppc 2.0, 2.0
1.4				sandy
	B	UC	8.4	
1.6				
1.8				
2.0				0.86' void
2.2				
2.4				

Measured length of tube = 2.50 ft Recovery 1.11 ft

Type Tube _____ O.D. Brass / Steel Shelby _____ I.D. { Cutting edge(D_e) 2.831 in. / Tube(D_i) 2.870 in.

Inside Clearence Ratio = $\frac{D_i - D_e}{D_e} \times 100 =$ ____ %

Total Unit Weight of Soil				
Wgt. soil + tube	4844.6 gm	Total Unit Weight by		
Wgt. tube	2243.8 gm	CUTTING EDGE (D_e)	TUBE (D_i)	AVE
Wgt. wet soil	2600.8 gm	γ_t 117.84	114.67	116.25 lb/ft^3
Calculated by	_____	Reviewed by	[illegible]	

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L-107
(6/75)

LABORATORY LOG OF TUBE SAMPLE

Proj No. C3M 11Q1 Proj Eng. _____ Date Opened 8/13/96 By [illegible]

Boring No. DH-4 Sample No. _____ Depth 7½ To 9½

Tag No. _____

Tube Seals	Wax	Mech	Good	Fair	Loose	Leaking Water	Leaking Soil
Top		X					
Bottom		X					

Cutting Edge	Sharp	Dull	Nicked <Mod.>	Dented	Neck Down <OK>

Remarks _____

Tube Scale Ft	Jar No.	Sample Use	Depth in Ground, ft	DESCRIPTION OF SOIL AND REMARKS
0.0				
0.2				
0.4				0.7' VOID
0.6				
0.8	1A.32		7.6	7.6, 8.35 x0.05 disturb pp = 1.x 1.0
1.0	A	UC	7.85	
1.2				
1.4	B	coal	8.3	
1.6		PC		
1.8				
2.0				0.8' VOID
2.2				
2.4				

Measured length of tube = 2.10 ft Recovery 0.99 ft

Type Tube _____ O.D. Brass Steel Shelby _____ I.D. { Cutting edge(D_e) 2.835 in. Tube(D_i) 2.861 in.

Inside Clearence Ratio = $\frac{D_i - D_e}{D_e} \times 100 =$ ____ %

Total Unit Weight of Soil					
Wgt. soil + tube	[illegible] qm	Total Unit Weight by			
Wgt. tube	2203.0 qm		CUTTING EDGE (D_e)	TUBE (D_i)	AVE
Wgt. wet soil	2287.4 qm	γ_t	116.20	114.10	115.15 lb/ft³
Calculated by	_____	Reviewed by	F-42		MT

L-107
(6/75)

LABORATORY LOG OF TUBE SAMPLE

Proj No. C3M 11Q1 Proj Eng. _____ Date Opened 8/13/86 By [illegible]

Boring No. DH-6 Sample No. _____ Depth 7.5 To 9.0

Tag No. _____

Tube Seals	Wax	Mech	Good	Fair	Loose	Leaking Water	Leaking Soil
Top							Y
Bottom							

Cutting Edge	Sharp	Dull	Nicked <Mod.>	Dented	Neck Down <OK>

Remarks No Seal.

Tube Scale Ft	Jar No.	Sample Use	Depth in Ground, ft	DESCRIPTION OF SOIL AND REMARKS
0.0				
0.2				
0.4				
0.6				1.37' Void
0.8				
1.0				
1.2				
1.4				0.13' discard, Loose silty matl
1.6				top 1" silt
1.8	A	UC	7.85	change to CL-ML, olive brown - gray s- plastic clayey silt [illegible]
2.0				
2.2	B	consl	8.4	CL-ML gray plastic highly silty
2.4		PL		[illegible] 1.0 void

Measured length of tube = [illegible] ft Recovery 1.13 ft

Type Tube _____ O.D. Brass Steel Shelby _____ I.D. { Cutting edge(D_e) [illegible] in. Tube(D_i) [illegible] in.

Inside Clearence Ratio = $\frac{D_i - D_e}{D_e} \times 100 =$ ____ %

Total Unit Weight of Soil					
Wgt. soil + tube	[illegible] gm	Total Unit Weight by			
Wgt. tube	2070.6 gm	CUTTING EDGE (D_e)	TUBE (D_i)	AVE	
Wgt. wet soil	2661.4 gm	γ_t 119.89	113.05	116.47	lb/ft^3
Calculated by	_____	Reviewed by	CMT		

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APPENDIX G

PROJECT TEAM

PROJECT TEAM

U.S. ARMY CORPS OF ENGINEERS PERSONNEL

OMAHA DISTRICT

NAME	OFFICE SYMBOL	ROLE	PHONE NUMBER
Larry Boardman	CEMRO-ED-GB	Project Engineer	(402)221-4706
Janis Pfingsten	CEMRO-ED-GB	Geotechnical	(402)221-4357
Mark Huckle	CEMRO-ED-GA	Geotechnical	(402)221-3977
Danny Klima	CEMRO-ED-DJ	Civil	(402)221-4429
Rick Kerzman	CEMRO-ED-DK	Environmental	(402)221-3827
Don Miller	CEMRO-ED-DF	Structural	(402)221-4431
Jeff Sobczyk	CEMRO-ED-DC	Electrical	(402)221-4448
Judy Strawhecker	CEMRO-ED-EH	Health/Safety	(402)221-7693
Susan George	CEMRO-ED-EG	Chemistry	(402)221-7746
Jim Dunn	CEMRO-ED-CM	Estimating	(402)221-4496
Doug Larsen	CEMRO-ED-DI	Specifications	(402)221-4547
Gene Liu	CEMRO-ED-ED	Technical Manager	(402)221-7169
John Cataldo	CEMRO-MD-HB	Project Manager	(402)221-7716
Mike Jerina	CEMRO-ED-DN	Site Planning	(402)221-4832

U.S. ENVIRONMENTAL PROTECTION AGENCY (USEPA) PERSONNEL

NAME	OFFICE SYMBOL	ROLE	PHONE NUMBER
Brad Bradley	Region 5	Remedial P.M.	(314)886-4742