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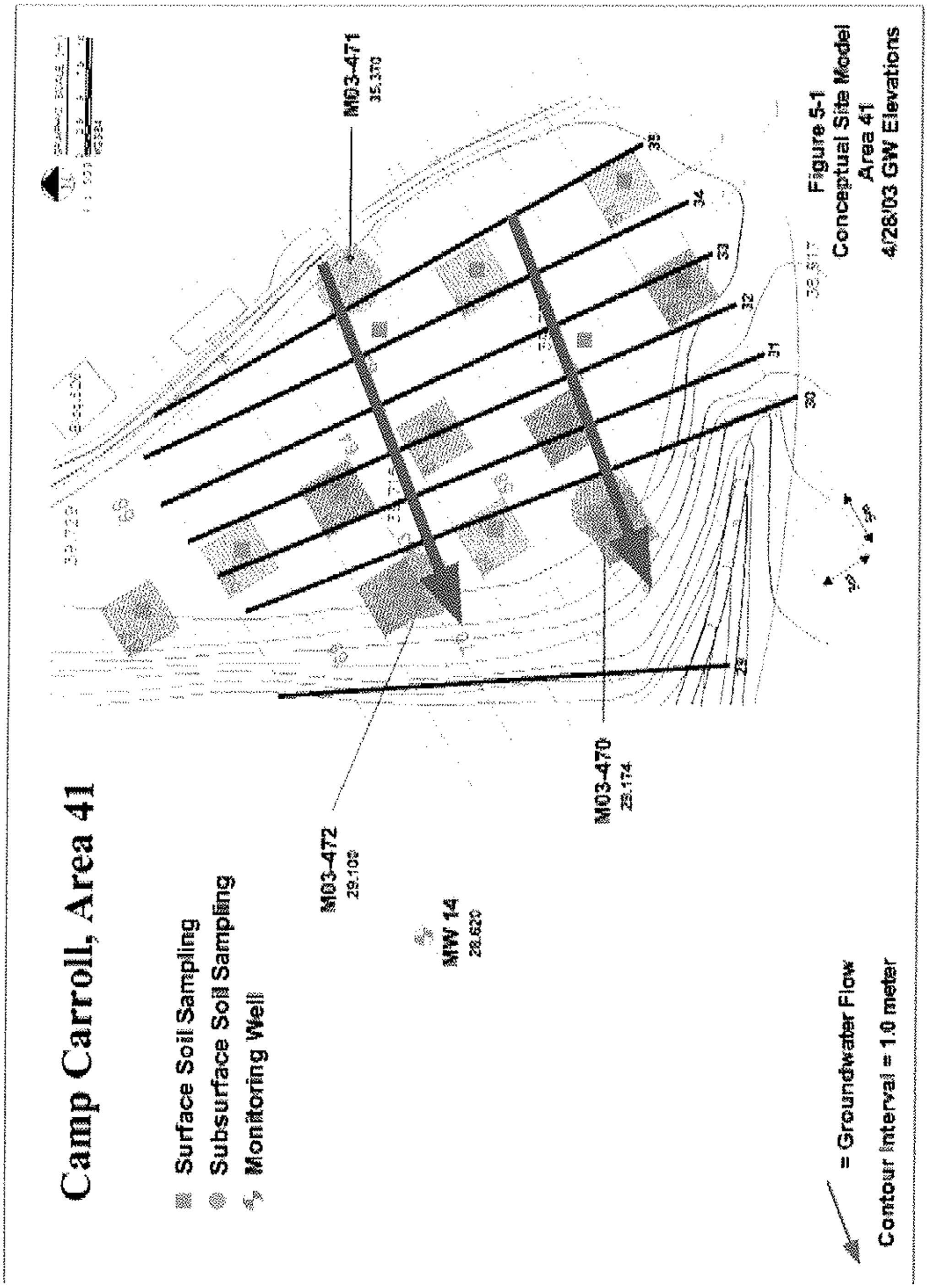


Figure 5-1
Conceptual Site Model
Area 41
4/26/03 GW Elevations



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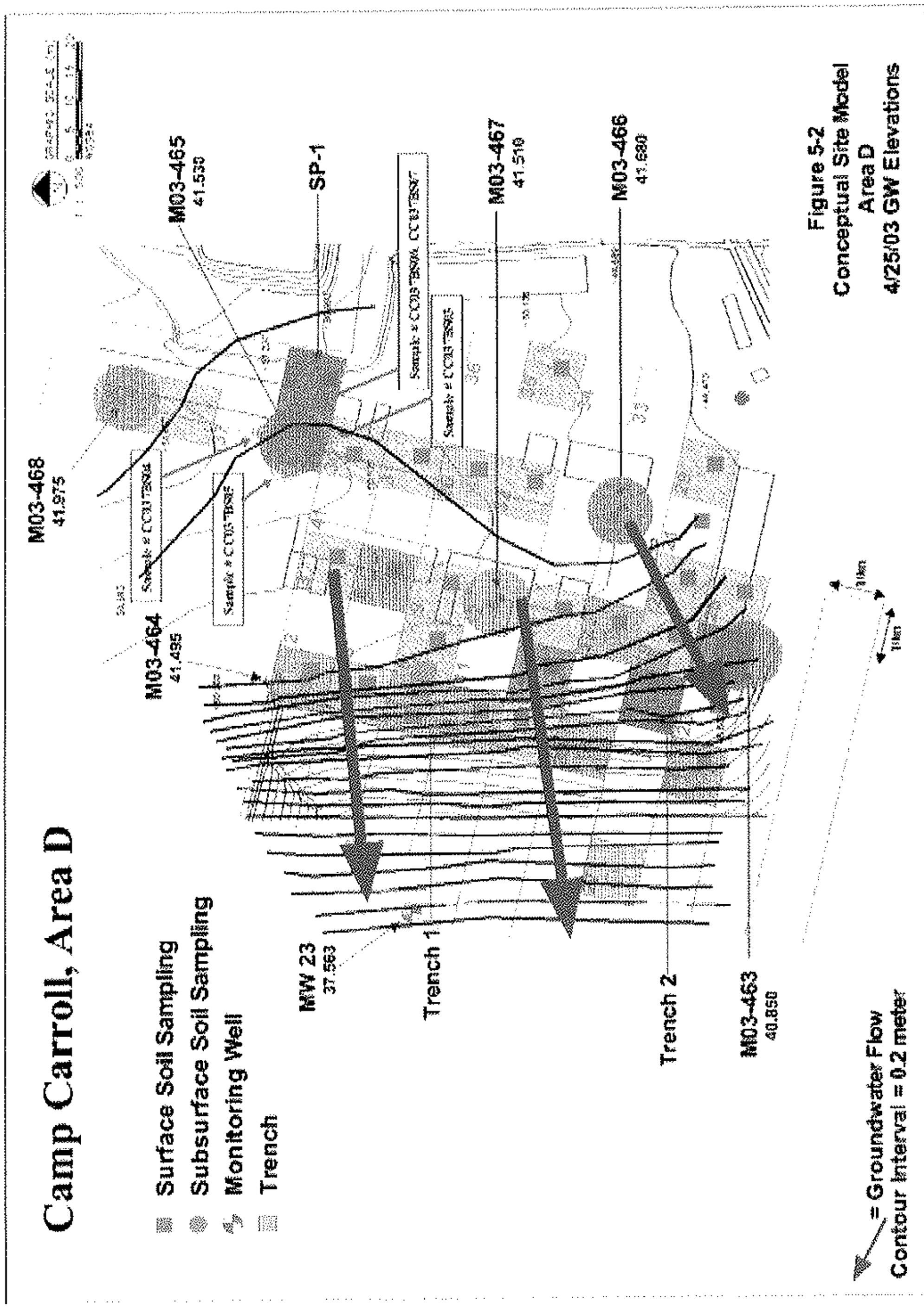


Figure 5-2
Conceptual Site Model
Area D
4/25/03 GW Elevations



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higher fluid elevations to lower fluid elevations); however, this flow may be disrupted by any non-homogeneous nature of the rock media. During drilling activities, no major fractures or faulting was observed in the soil cores. Thus it is anticipated that groundwater flow beneath the site will be in the general direction of the observed hydraulic gradient.

Groundwater depths have been observed to vary over time at the site, however, the hydraulic gradient and direction of groundwater flow has remained relatively constant over the approximately four month period monitored during the field activities for this project. The observed variations in water table elevation are presumed to result from large quantities of infiltrated rainwater during storm events and seasonal periods of higher precipitation. The reasonably low storage capacity typical of igneous rock aquifers allows rapid increases in water level with increased rates of recharge.

In general, groundwater level contour maps prepared for each of the sites depict the groundwater gradient and presumed direction of groundwater flow directed towards the west. For illustration purposes, water table maps prepared for April 28, 2003 (Area 41) and April 25, 2003 (Area D) are depicted on the CSMs. These maps represents general ground-water gradient conditions at the Site and show that for each of the two sites, contaminants dissolved in groundwater will travel predominantly to the west. If additional groundwater level information becomes available from other locations within or in the vicinity of the Site, the interpreted groundwater flow patterns may require modification.

The conceptualized movement of groundwater and dissolved contaminants are depicted with directional arrows on the CSMs. It is anticipated that soil-bound contaminants are leaching vertically downward to the groundwater table with infiltrated rainwater. When reaching the groundwater, the dissolved chemicals are migrating laterally with the ground-water at the site. At the location of the observed soil and groundwater contaminant plumes, the groundwater gradient is directed to the west, and dissolved contaminants will travel preferentially in this direction when rock permeability is available with this orientation.

In summary, the identified groundwater gradient at each of the two sites investigated is directed toward the west. It appears that aqueous phase contaminants originating in shallow soils may have migrated downward through the vadose zone to the groundwater table, and then laterally to the west with groundwater flow. The observed presence of similar contaminants in groundwater wells located to the west of Area 41 (Monitoring Well MW-14) and Area D (Monitoring Well MW-23) are consistent with this scenario.

## 5.2 Preliminary Screening Evaluation

This section documents the results of a Human Health Preliminary Risk Evaluation (PRE) of potential human exposure associated with chemical compounds present at the Camp Carroll Area 41 and Area D sites. The purpose of the PRE is to identify sites that do not warrant further consideration in the site evaluation process and sites that require immediate remedial actions or further studies to address concerns related to elevated concentrations of chemicals in environmental media.

### Approach

The approach for this human health PRE is based on the *USEPA Risk Assessment Guidance for Superfund* (RAGS): *Volume 1 - Human Health Evaluation Manual (Parts A and B)* (USEPA 1989, 1991). The Risk Assessment process is conducted in two phases. The first phase is the initial conservative screening PRE conducted using USEPA Region 9 PRGs (USEPA 2000). This phase is followed, when necessary, by a site-specific Baseline Risk Assessment. A brief overview of the risk assessment process is presented below.

The initial screening PRE is performed when the complete or potentially complete exposure pathways of concern and pathway-specific exposure parameters are the same as those used in the development of the standards in which they are compared. For this preliminary assessment, the preliminary screening criteria are the United States Forces Korea Environmental Governing Standards (USFK EGS) and the USEPA Region 9 Preliminary Remediation Goals (PRGs) (USEPA 2000). USFK EGS drinking water MCLs are applicable to sites in which groundwater is used as a drinking water source. PRGs are health-based remediation goals developed by USEPA Region 9 for soil, groundwater, and ambient air. USEPA Region 9 has developed soil PRGs for both residential and industrial land use scenarios. If pathways not addressed in the PRGs or USFK EGS are complete or potentially complete at the Site, or if site-specific exposure factors differ from those used in the development of the PRGs or USFK EGS, a site-specific baseline risk assessment may be performed. Additionally, if the conservative screening PRE results indicate potentially significant health risks, a site-specific baseline risk assessment is performed to derive more realistic risk estimates.

As stated above, the use of screening values for estimating human health risks requires that the exposure pathways and exposure assumptions used in the development of PRGs or USFK EGS are consistent with the exposure pathways and exposure assumptions for the Site. In using PRGs or USFK EGSs to estimate potential health risks, the screening PRE essentially adopts the exposure pathways and exposure parameter values used to develop the standards. Therefore, the screening PRE does not use any site-specific information, other than media chemical concentration data. The underlying assumptions used in the development of PRGs or USFK EGSs relevant to the Camp Carroll Site are summarized below:

PRG Exposure Pathways – Industrial Land Use Soil Media

- Incidental ingestion
- Inhalation of particulates
- Inhalation of volatile compounds
- Dermal absorption

Exposure Pathways – Industrial Land Use Groundwater Media

- Incidental ingestion

The exposure parameters used to develop Region 9 Industrial Soil PRGs are presented below.

PRG Exposure Parameter Values – Industrial Land Use – Soil

| | |
|---|---|
| • Target cancer risk | 1E-06 (unitless) |
| • Target hazard quotient | 1 (unitless) |
| • Adult worker body weight | 70 kg |
| • Exposed adult skin surface area | 3,300 $cm^2$/day |
| • Adult worker soil adherence factor | 0.2 $mg/cm^2$ |
| • Dermal absorption factor in soil (svocs) | 0.10 (unitless) |
| • Adult worker respiration (inhalation) rate | 20 $m^3$/day |
| • Adult worker soil ingestion rate | 100 mg/day |
| • Exposure frequency | 250 days/year |
| • Exposure duration adult | 25 years |
| • Lifetime | 70 years |
| • Volatilization factor for soil | Chemical-specific |
| • Particulate emission factor | 1.3E+09 (unitless) |

**Methodology**

The steps involved in performing a screening PRE are as follows:

- identification of relevant data sets and chemicals of potential concern
- exposure pathways analysis and development of a conceptual evaluation model (CEM)
- estimation of exposure point concentrations (EPCs)
- calculation of screening cumulative health risks
- evaluation of health effects posed by lead, if necessary
- evaluation of the screening PRE results

Identification of Relevant Data Sets and Chemicals of Potential Concern

Before performing a screening PRE, a review of the analytical data is performed to identify the appropriate impacted area(s) of concern and to develop an understanding of three-dimensional contaminant distributions. If environmental samples are analyzed for a chemical using more than one analytical method, the most reliable results (as indicated by data validation qualifiers or laboratory data qualifiers) that provide representative environmental concentrations are selected. To conservatively protect human health, the screening PRE focuses on data from the impacted area(s) within the study Site. Chemicals not included in the screening PRE are compounds that are not regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and contaminants that do not have available USFK EGS or USEPA Region 9 PRGs.

Exposure Pathways Analysis and Development of a CEM

In accordance with USEPA (1989), human health PREs are intended to address only contaminants for which there is a complete or potentially complete exposure pathway under current and future land use conditions. The first step in the exposure pathway analysis is the identification of possible human receptors. The identification of possible human receptors considers both current and future land uses of the Site and may include adult and child residents, workers, recreators, trespassers, and other receptors as appropriate. Relevant exposure pathways are then evaluated to determine their completeness based on receptor characteristics, fate and transport considerations, the types of chemicals detected in site media, and other site-specific factors.

An exposure pathway consists of four distinct elements: (1) a source and mechanism of release, (2) a retention medium or transport mechanism, (3) a point of potential contact with a receptor, and (4) an exposure route (USEPA 1989). Each of these four elements must be present for a given exposure pathway in order for the pathway to be complete. In the absence of a complete exposure pathway, there is no exposure and consequently no risk to human health. The purpose of the exposure pathways analysis is to evaluate whether a possible exposure pathway is complete, potentially complete, incomplete, or insignificant. A potentially complete exposure pathway is one that either could be complete in the future if certain conditions are met, or could be complete under current conditions if certain conditions are present but for which data are inadequate for making a definitive determination. Potentially complete exposure pathways are addressed in the PRE in the same manner as complete exposure pathways. An exposure pathway may be complete, but insignificant, if the degree of exposure is found to be insignificant as compared to other exposure pathways. Risks are generally not estimated for insignificant exposure pathways.

Estimation of Exposure Point Concentrations

Exposure point concentrations are defined by USEPA as the chemical concentrations a receptor may contact at a location over the exposure period (USEPA 1989). Exposure point concentrations may be estimated using direct measurement data (i.e., soil concentrations from the sampling and analytical programs) or a combination of direct measurement data as well as fate and transport modeling results. Direct measurement data are appropriately used when there is human contact with the media sampled, such as ingestion of or dermal contact with soil or groundwater. For these direct contact pathways, site-specific measured chemical concentrations are used to estimate exposure point concentrations. For pathways where exposure points are spatially separate from the media sampled, or where contact media are not sampled, fate and transport modeling is used in conjunction with site-specific direct measurement data to estimate exposure point concentrations. Examples of this method include estimating onsite (or offsite) chemical concentrations in air or groundwater from onsite soil data.

Calculation of Screening Cumulative Health Risks for Soil

Potential health risks are calculated using reasonable maximum exposure (RME) point concentrations, chemical-specific cancer and noncancer PRGs, and the cancer and noncancer target risk values. Since the USEPA Region 9 PRGs are defined as the concentrations of chemicals in environmental media that correspond to an excess cancer risk of one-in-one-million (1E-06) or a noncancer hazard index (HI) of 1, the cancer and noncancer target risk values are 1E-06 and 1, respectively. As illustrated in the following equations, potential excess cancer risks and noncancer HIs for each chemical detected in each media at the Site are estimated using the ratio of the exposure point concentration and the carcinogenic or noncarcinogenic PRG, respectively.

For noncancer risk, the hazard index is calculated as:

$$HI = \frac{EPC}{PRGnc}$$

Where,

HI = Hazard Index (unitless)

EPC = Exposure Point Concentration (mg/kg)

PRGnc = Preliminary Remediation Goal based on noncancer effects

The estimated excess cancer risk is calculated as:

$$Risk = TR\left(\frac{EPC}{PRGc}\right)$$

Where,

Risk = Excess Cancer Risk (unitless)

TR = Target Risk Level upon which the PRG is based ($1 \times 10^{-6}$)

EPC = Exposure Point Concentration (mg/kg)

PRGc = Preliminary Remediation Goal based on cancer (mg/kg)

Assuming that the effects posed by different contaminants are additive (i.e., that no synergistic or antagonistic interactions occur) and that chemical concentrations and other exposure parameters remain constant throughout the exposure period (USEPA 1989), cumulative excess cancer risks and HIs are estimated by adding the contributions from each chemical. Thus, the cumulative excess cancer risk for the Site is the sum of the estimated excess cancer risks for each chemical, and the cumulative HI for the Site is the sum of the estimated HIs for each chemical.

Evaluation of Health Effects Posed by Lead in Soil

Because there is no discernible, safe threshold for lead exposure, an HI for lead cannot be determined by employing the approach used for other chemicals. Thus, the cumulative HI reported in the screening PRE does not include a quantitative HI estimate for lead. Lead is evaluated separately in the screening PRE by direct comparison to USEPA Region 9 PRGs. USEPA Region 9 currently proposes an industrial PRG for lead of 750 mg/kg in soil.

Evaluation of the Screening PRE Results

The human health PRE decision tree for all chemicals except lead is described below.

1. If the site has been adequately characterized:

- No further action is recommended when the cumulative excess cancer risk based on the maximum detected concentration is less than or equal to 1E-06 and the HI is less than or equal to 1, and if there are no adverse ecological impacts.

- A site-specific baseline risk assessment is performed when the screening cumulative excess cancer risk based on the maximum detected concentration is greater than 1E-06 and/or the HI is greater than 1.

- For lead, a site-specific risk assessment may be performed if maximum and/or RME lead concentrations are greater than USEPA Region 9 PRGs.

In other cases, it may be determined that additional data are needed in order to better evaluate the site.

### 5.2.1 Screening Human Health PRE for the Camp Carroll Site

This screening human health PRE was performed to assess potential human health risks if remedial actions are not taken at the Camp Carroll Site.

**Development of a Conceptual Evaluation Model (CEM)**

A CEM describes the interrelationships between all potential receptors, exposure points, transport pathways and contaminant sources at a site. Development of a site-specific CEM and determination of relevant potential exposure pathways evaluated in the PRE must consider historical and current site use as well as potential future land use conditions.

Historical and Current Land Use Conditions

A detailed description of past and current operations at Camp Carroll is provided in Section 1.

Future Land Use Conditions

Use of both the Area 41 and Area D sites are proposed to remain industrial in the future. The water table aquifer will continue to be a nonpotable water supply.

CEM Development and Exposure Pathways Analysis

Based on sources of contaminants at the Camp Carroll Site, possible complete or potentially complete exposure pathways associated with soils include incidental ingestion of and dermal contact; incidental ingestion, dermal contact, and inhalation of soil-derived fugitive dusts; inhalation of volatile compounds in soils. The complete and potentially complete exposure pathways identified in this analysis for soil are consistent with those used by USEPA to develop PRGs. Therefore, use of PRGs for estimating soil exposure risks is appropriate.

Potentially complete exposure pathways between groundwater and human receptors exist via the ingestion or dermal contact with groundwater during industrial activities and through the inhalation of chemicals that may volatilize to air. Only the drinking water pathway has been evaluated in this PRE. Other pathways may be evaluated in site-specific baseline risk assessment if deemed appropriate.

Other potential exposure pathways not included in this PRE are the consumption of fish, beef or other livestock that may have been impacted by the site, ingestion of fruits or vegetables grown on the site, migration of contaminants to an underlying potable aquifer, inhalation of volatiles that may have migrated into building and ecological pathways. Based on the results of the screening PRE, these potential pathways may be recommended for evaluation in a comprehensive baseline risk assessment or ecological risk assessment.

**Identification of Relevant Datasets**

This study is focused on the nature and extent of target COPCs for the impacted soil and groundwater at the Site. Soil and groundwater at the Site were analyzed for VOCs, SVOCs, metals, dioxins and furans (dioxins), chlorinated pesticides and total petroleum hydrocarbons (TPH). The complete list of chemicals analyzed is provided in Table 5-1. All surface soil samples, subsurface soil samples and groundwater samples were collected from within the geographic boundaries of the Site. Soil samples were limited to "open" areas within the study boundary. "Open" areas within the study boundary are defined as any area, paved or unpaved, that were readily accessible to field personnel and sampling equipment. Groundwater was sampled from monitoring wells within the study boundary. All analytical data collected during the Site assessment were evaluated for inclusion in the PRE. TPH and petroleum hydrocarbon fractions were not evaluated using Region 9 PRGs because PRGs have not been published for these chemical groups. However, available TPH data, was compared to Hawaii State TOALs. TOALs are not risk-based values, but are remediation level goals endorsed by the State of Hawaii. It is important to note that TOALs are not *de facto* cleanup standards and do not have to applied as such. TOALs are helpful in providing long-term targets to use during the analysis of different remedial activities. If TPH values onsite exceed State of Hawaii TOALs, a site-specific risk analysis may be conducted to determine potential health risks.

Because Area 41 and Area D were historically used for different purposes and the levels of chemicals in soil and groundwater may differ, the Screening PRE has evaluated the two sites separately. Comparison of analytical soil data with USEPA Region 9 PRGs for Area 41 and Area D sites are provided in Tables 5-2 and 5-3. Groundwater comparison with USFK EGS for Area 41 and Area D sites are provided in Tables 5-4 and 5-5.

**Methodology for Determining EPCs**

For the Camp Carroll PRE, the maximum detected concentration was deemed appropriate for use as the RME concentration. The RME is a conservative estimate of exposure and when used to calculate potential health risks, are protective of the high end of the population distribution (USEPA 1989, USEPA 1992a).

### 5.2.2 Screening PRE Results

**Soil Results**

In the screening PRE, cumulative risks were estimated using the RME point concentration (maximum concentration detected) and USEPA Region 9 PRGs. Results are shown in Tables 5-2 and 5-3. PRGs are not directly applicable to subsurface soil data, however, for the purposes of the screening PRE, surface and subsurface soil data were conservatively evaluated as a single dataset. In this discussion, the term "risk drivers" is used to refer to chemicals with concentrations exceeding their respective industrial soil PRGs and contribute approximately 10 percent or more of the cumulative excess cancer risk or HI. Since there are no differences in the screening PRE approaches for current and future industrial workers, the scenario evaluated is referred to as "current and future industrial land use."

Current and Future Industrial land Use

For soil, the cumulative excess cancer risk and HI based on the RME exposure point concentration for Area 41 are 2E-05 and 4.2E-02, respectively, as shown in Table 5-2.

Cumulative excess cancer risk and HI for Area D are 2E-05 and 5.7E-01, respectively, as shown in Table 5-3. The excess cancer risks for both areas are greater than the point-of-departure risk of 1E-06, but within the USEPA upper bound acceptable cancer risk level of 1E-04. The HIs are less than the target value of 1.

Carcinogenic risk drivers for Area 41 are arsenic, Dieldrin, 4,4'-DDD, 4,4'-DDT, gamma-Chlordane, and Benzo(a)pyrene. Carcinogenic risk drivers for Area D are arsenic, 4,4'-DDT, and Trichloroethene. The above screening PRE results do not include the health risk due to lead exposure. The RME lead concentration detected in soil at Area 41 and Area D are 38 and 48.3 mg/kg, respectively. Lead concentrations detected in surface and subsurface soils are less than the USEPA Region IX industrial soil PRG of 750 mg/kg.

**Table 5-1**
**Analyte List**
**Camp Carroll Area 41 and Area D**

| Compound | Soil | Groundwater |
|---|---|---|
| ***METALS*** | | |
| Arsenic | X | X |
| Barium | X | X |
| Cadmium | X | |
| Chromium | X | X |
| Lead | X | X |
| Mercury | X | X |
| Selenium | X | X |
| Silver | X | X |
| ***CHLORINATED PESTICIDES*** | | |
| alpha-BHC | X | X |
| beta-BHC | X | X |
| delta-BHC | X | X |
| gamma-BHC (Lindane) | X | X |
| Hepatochlor | X | X |
| Aldrin | X | |
| Hepatochlor epoxide | X | |
| Endosulfan I | X | |
| Dieldrin | X | X |
| 4,4'-DDE | X | |
| Endrin | X | |
| Endosulfan II | X | |
| 4,4'-DDD | X | |
| Endosulfan sulfate | X | |
| 4,4'-DDT | X | |
| Methoxychlor | X | |
| Endrin Ketone | X | |
| Endrin Aldehyde | X | |
| alpha-Chlordane | | X |
| gamma-Chlordane | X | |
| ***VOCS/SVOCs*** | | |
| 1,2,3-Trichlorobenzene | X | |
| 2-Chlorotoluene | X | X |
| 4-Chlorotoluene | X | X |
| Chlorobenzene | X | X |
| cis-1,2-Dichloroethene | X | X |
| trans-1,2-Dichloroethene | | X |
| Tetrachloroethene | X | X |
| Toluene | X | X |
| Trichloroethene | X | X |
| 2-Methynaphthalene | X | X |
| 2-Methylphenol (o-Cresol) | X | X |

| Compound | Soil | Groundwater |
|---|---|---|
| 3&4-Methylphenol (p&m-Cresol) | X | X |
| Benzo(a)anthracene | X | |
| Benzo(a)pyrene | X | |
| Benzo(b)fluoranthene | X | |
| Benzo(g,h,i)perylene | X | |
| bis(2-Ethylhexyl)phthalate | X | |
| Chrysene | X | |
| Fluoranthene | X | X |
| Indeno(1,2,3-cd)pyrene | X | |
| Phenanthrene | X | |
| Pyrene | X | |
| 1,1,1,2-Tetrachloroethane | | X |
| 1,1,2,2-Tetrachloroethane | | X |
| 1,1,2-Trichloroethane | | X |
| 1,1-Dichloroethane | | X |
| 1,1-Dichloroethene | | X |
| 1,2,4-Trimethylbenzene | | X |
| 1,3,5-Trimethylbenzene | | X |
| 1,4-Dichlorobenzene | | X |
| Acetone | | X |
| Benzene | | X |
| Carbon disulfide | | X |
| Chloroethane | | X |
| Chloroform | | X |
| Ethylbenzene | | X |
| Isopropylbenzene (Cumene) | | X |
| Methylene chloride | | X |
| Naphthalene | | X |
| n-Propylbenzene | | X |
| o-Xylene | | X |
| P & M -Xylene | | X |
| Vinyl chloride | | X |
| 1,4-Dichlorobenzene | | X |
| Acenaphthene | | X |
| Benzyl alcohol | | X |
| Butylbenzylphthalate | | X |
| Diethylphthalate | | X |
| Napthalene | | X |
| Phenol | | X |
| ***DIOXINS/FURANS*** | | |
| Total TEQ | X | X |
| ***TOTAL PETROLEUM HYDROCARBONS*** | | |
| Gasoline Range | X | X |
| Diesel Range | X | X |
| Oil Range | X | |

## Table 5-2
## PRG Screening and COPC Selection
## Current Industrial - Surface Soil Exposure Pathway
## Camp Carroll Area 41

| Compound | $PRG_{ca}$ | $PRG_{nc}$ | RME Concentration (mg/kg) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | (mg/kg) | (mg/kg) | EPC | > $PRG_{ca}$? | > $PRG_{nc}$? | ECR | % | HI | % |
| ***METALS*** | | | | | | | | | |
| Arsenic | 1.6E+00 | 2.6E+02 | 8.24E+00 | **YES** | No | 5 E-06 | 21 | 3.2E-02 | 75 |
| Barium | - | 6.7E+04 | 2.35E+02 | No | No | | | 3.5E-03 | 8 |
| Cadmium | - | 4.5E+02 | 5.86E-01 | No | No | | | 1.3E-03 | 3 |
| Chromium | 4.5E+02 | - | 7.99E+01 | No | No | 2 E-07 | <1 | | |
| Lead | - | 7.5E+02 | 3.80E+01 | No | No | | | | |
| Mercury | - | 6.2E+01 | 1.28E-02 | No | No | | | 2.1E-04 | <1 |
| Selenium | - | 5.1E+03 | 4.44E-01 | No | No | | | 8.7E-05 | <1 |
| Silver | - | 5.1E+03 | 5.60E-02 | No | No | | | 1.1E-05 | <1 |
| ***CHLORINATED PESTICIDES*** | | | | | | | | | |
| alpha-BHC | 3.6E-01 | - | 8.04E-04 | No | No | 2 E-09 | <1 | | |
| beta-BHC | 1.3E+00 | - | 4.79E-03 | No | No | 4 E-09 | <1 | | |
| delta-BHC | - | - | 8.56E-04 | No | No | | | | |
| gamma-BHC (Lindane) | 1.7E+00 | - | 3.90E-03 | No | No | 2 E-09 | <1 | | |
| Hepatochlor | 3.8E-01 | - | 3.48E-03 | No | No | 9 E-09 | <1 | | |
| Aldrin | 1.0E-01 | - | 1.54E-02 | No | No | 2 E-07 | <1 | | |
| Hepatochlor epoxide | 1.9E-01 | - | 1.05E-02 | No | No | 6 E-08 | <1 | | |
| Endosulfan I | - | 3.7E+03 | 8.44E-02 | No | No | | | 2.3E-05 | <1 |
| Dieldrin | 1.1E-01 | - | 5.01E-01 | **YES** | No | 5 E-06 | 19 | | |
| 4,4'-DDE | 7.0E+00 | - | 2.65E+00 | No | No | 4 E-07 | 2 | | |
| Endrin | - | 1.8E+02 | 3.69E-02 | No | No | | | 2.1E-04 | <1 |
| Endosulfan II | - | 3.7E+03 | 2.07E-03 | No | No | | | 5.6E-07 | <1 |
| 4,4'-DDD | 1.0E+01 | - | 2.17E+01 | **YES** | No | 2 E-06 | 9 | | |
| Endosulfan sulfate | - | 3.7E+03 | 1.46E-01 | No | No | | | 3.9E-05 | |
| 4,4'-DDT | 7.0E+00 | - | 4.30E+01 | **YES** | No | 6 E-06 | 25 | | |
| Methoxychlor | - | 3.1E+03 | 6.63E-03 | No | No | | | 2.1E-06 | <1 |
| Endrin Ketone | - | 1.8E+02 | 1.21E-01 | No | No | | | 6.7E-04 | 2 |
| Endrin Aldehyde | - | 1.8E+02 | 2.88E-03 | No | No | | | 1.6E-05 | <1 |
| gamma-Chlordane | 6.5E+00 | - | 8.50E+00 | **YES** | No | 1 E-06 | 5 | | |
| ***VOCS/SVOCs*** | | | | | | | | | |
| 1,2,3-Trichlorobenzene | - | 3.0E+03 | 1.93E-02 | No | No | | | 6.4E-06 | <1 |
| 2-Chlorotoluene | - | 5.6E+02 | 1.93E-02 | No | No | | | 3.4E-05 | <1 |
| 4-Chlorotoluene | - | 5.6E+02 | 1.93E-02 | No | No | | | 3.4E-05 | <1 |
| Chlorobenzene | - | 5.3E+02 | 1.93E-02 | No | No | | | 3.6E-05 | <1 |
| cis-1,2-Dichloroethene | - | 1.5E+02 | 1.93E-02 | No | No | | | 1.3E-04 | <1 |
| Tetrachloroethene | 3.4E+00 | - | 5.02E-01 | No | No | 1 E-07 | <1 | | |
| Toluene | - | 5.2E+02 | 8.75E-02 | No | No | | | 1.7E-04 | <1 |
| Trichloroethene | 1.1E-01 | - | 1.54E-02 | No | No | 1 E-07 | <1 | | |



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Results Table 5-3

**Table 5-3**
**PRG Screening and COPC Selection**
**Current Industrial - Surface Soil Exposure Pathway**
**Camp Carol Area D**

| Compound | $PRG_{ca}$ (mg/kg) | $PRG_{nc}$ (mg/kg) | RME Concentration (mg/kg) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | EPC | > $PRG_{ca}$? | > $PRG_{nc}$? | ECR | % | HI | % |
| ***METALS*** | | | | | | | | | |
| Arsenic | 1.6E+00 | 2.6E+02 | 2.07E+01 | **YES** | No | 1 E-05 | 61 | 8.0E-02 | 14 |
| Barium | - | 6.7E+04 | 2.11E+02 | No | No | | | 3.1E-03 | <1 |
| Cadmium | - | 4.5E+02 | 2.87E+00 | No | No | | | 6.4E-03 | 1 |
| Chromium | 4.5E+02 | - | 1.56E+01 | No | No | 3 E-08 | <1 | | |
| Lead | - | 7.5E+02 | 4.83E+01 | No | No | | | | |
| Mercury | - | 6.2E+01 | 1.46E-02 | No | No | | | 2.4E-04 | <1 |
| Selenium | - | 5.1E+03 | 3.85E-01 | No | No | | | 7.5E-05 | <1 |
| Silver | - | 5.1E+03 | 4.72E-01 | No | No | | | 9.3E-05 | <1 |
| ***CHLORINATED PESTICIDES*** | | | | | | | | | |
| alpha-BHC | 3.6E-01 | - | 1.65E-03 | No | No | 5 E-09 | <1 | | |
| beta-BHC | 1.3E+00 | - | 2.52E-03 | No | No | 2 E-09 | <1 | | |
| delta-BHC | - | - | 1.93E-03 | No | No | | | | |
| gamma-BHC (Lindane) | 1.7E+00 | - | 3.91E-02 | No | No | 2 E-08 | <1 | | |
| Hepatochlor | 3.8E-01 | - | 1.10E-01 | No | No | 3 E-07 | 1 | | |
| Aldrin | 1.0E-01 | - | 8.82E-04 | No | No | 9 E-09 | <1 | | |
| Hepatochlor epoxide | 1.9E-01 | - | 1.10E-01 | No | No | 6 E-07 | 3 | | |
| Endosulfan I | - | 3.7E+03 | 8.00E-02 | No | No | | | 2.2E-05 | <1 |
| Dieldrin | 1.1E-01 | - | 5.11E-03 | No | No | 5 E-08 | <1 | | |
| 4,4' DDE | 7.0E+00 | | 4.82E 02 | No | No | 7 E 00 | <1 | | |
| Endrin | - | 1.8E+02 | 1.10E-01 | No | No | | | 6.1E-04 | <1 |
| Endosulfan II | - | 3.7E+03 | 1.46E-03 | No | No | | | 3.9E-07 | <1 |
| 4,4'-DDD | 1.0E+01 | - | 5.16E-01 | No | No | 5 E-08 | <1 | | |
| Endosulfan sulfate | - | 3.7E+03 | 1.10E-01 | No | No | | | 3.0E-05 | <1 |
| 4,4'-DDT | 7.0E+00 | - | 2.93E+01 | **YES** | No | 4 E-06 | 20 | | |
| Methoxychlor | - | 3.1E+03 | 1.10E-01 | No | No | | | 3.5E-05 | <1 |
| Endrin Ketone | - | 1.8E+02 | 1.10E-01 | No | No | | | 6.1E-04 | <1 |
| Endrin Aldehyde | - | 1.8E+02 | 1.10E-01 | No | No | | | 6.1E-04 | <1 |
| gamma-Chlordane | 6.5E+00 | - | 3.33E-03 | No | No | 5 E-10 | <1 | | |
| ***VOCS/SVOCs*** | | | | | | | | | |
| 1,2,3-Trichlorobenzene | - | 3.0E+03 | 3.47E-02 | No | No | | | 1.2E-05 | <1 |
| 2-Chlorotoluene | - | 5.6E+02 | 5.28E-01 | No | No | | | 9.4E-04 | <1 |
| 4-Chlorotoluene | - | 5.6E+02 | 1.93E+00 | No | No | | | 3.4E-03 | <1 |
| Chlorobenzene | - | 5.3E+02 | 6.10E-02 | No | No | | | 1.2E-04 | <1 |
| cis-1,2-Dichloroethene | - | 1.5E+02 | 2.04E-01 | No | No | | | 1.4E-03 | <1 |
| Tetrachloroethene | 3.4E+00 | - | 2.00E+00 | No | No | 6 E-07 | 3 | | |



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**Groundwater Results**

The following table summarizes the results for Area 41 groundwater samples that exceeded EGS screening criteria. USFK EGS values are analogous to United States MCLs. Exceedances in the EGS require remedial actions if groundwater is to be used as a drinking water source.

**Table 5-4**
**Summary of EGS Exceedances**
**Area 41 Groundwater Samples**

| Sample ID | Analyte | Conc. (mg/L) | EGS (mg/L) |
|---|---|---|---|
| CC053WS01 | tetrachloroethene | 0.192 | 0.005 |
| CC054WS01 | tetrachloroethene | 11.1 | 0.005 |
| CC066WS01 | tetrachloroethene | 0.504 | 0.005 |
| CCM14WS01 | tetrachloroethene | 0.0926 | 0.005 |
| CC053WS01 | trichloroethene | 0.0237 | 0.005 |
| CC054WS01 | trichloroethene | 0.171 | 0.005 |
| CC066WS01 | trichloroethene | 0.325 | 0.005 |
| CCM14WS01 | trichloroethene | 0.0126 | 0.005 |
| CC054WS01 | 1,2-dichloroethene | 0.0305 | 0.005 |

Notes:
EGS = USFK Environmental Governing Standards
mg/L= milligrams per liter

The following table summarizes the results for Area D groundwater samples that exceeded EGS screening criteria.

| Table 5-5<br>Summary of EGS Exceedances<br>Area D Groundwater Samples | | | |
|---|---|---|---|
| Sample ID | Analyte | Conc. (mg/L) | EGS (mg/L) |
| CC001WS01 | tetrachloroethene | 0.00888 | 0.005 |
| CC024WS01 | tetrachloroethene | 0.423 | 0.005 |
| CC037WS01 | tetrachloroethene | 0.35 | 0.005 |
| CC038WS01 | tetrachloroethene | 0.0247 | 0.005 |
| CC039WS01 | tetrachloroethene | 0.203 | 0.005 |
| CC137WS01 | tetrachloroethene | 0.343 | 0.005 |
| CC237WS01 | tetrachloroethene | 0.427 | 0.005 |
| CC024WS01 | trichloroethene | 0.361 | 0.005 |
| CC037WS01 | trichloroethene | 0.949 | 0.005 |
| CC039WS01 | trichloroethene | 0.0754 | 0.005 |
| CC137WS01 | trichloroethene | 0.941 | 0.005 |
| CC237WS01 | trichloroethene | 1.4 | 0.005 |
| CC012WS01 | cis-1,2-dichloroethene | 0.00966 | 0.005 |
| CC024WS01 | cis-1,2-dichloroethene | 0.386 | 0.005 |
| CC037WS01 | cis-1,2-dichloroethene | 1.32 | 0.005 |
| CC039WS01 | cis-1,2-dichloroethene | 0.122 | 0.005 |
| CC137WS01 | cis-1,2-dichloroethene | 1.21 | 0.005 |
| CC237WS01 | cis-1,2-dichloroethene | 1.67 | 0.005 |
| CCM23WS01 | cis-1,2-dichloroethene | 0.0105 | 0.005 |
| CC137WS01 | trans-1,2-dichloroethene | 0.0398 | 0.005 |
| CC237WS01 | trans-1,2-dichloroethene | 0.0376 | 0.005 |
| CC037WS01 | benzene | 0.00691 | 0.005 |
| CC039WS01 | benzene | 0.014 | 0.005 |
| CC137WS01 | benzene | 0.00692 | 0.005 |
| CC237WS01 | benzene | 0.00693 | 0.005 |
| CC012WS01 | Lindane | 0.114 | 0.002 |
| CC024WS01 | Lindane | 8.76 | 0.002 |
| CC039WS01 | Lindane | 0.362 | 0.002 |
| CC024WS01 | alpha-Chlordane | 0.05 | 0.002 |

Notes:
EGS = USFK Environmental Governing Standards
mg/L= milligrams per liter

A review of the above tables indicates detected compound concentrations that exceeded EGS values for groundwater are limited to VOCs and pesticides. A baseline groundwater investigation conducted by Woodward Clyde Consultants (WWC 1992b) reported relatively widespread contamination of the aquifer throughout the base. The most common contaminants identified were the chlorinated solvents trichloroethylene, tetrachloroethylene, and 1,2-dichloroethylene. These contaminants were detected in 15 of 18 groundwater monitoring wells sampled and in 8 of 10 water supply wells sampled during the survey in April 1992. Subsequent detections of chlorinated solvents at the subject sites may reflect the widespread aquifer contamination rather than location-specific impacts. In addition, the widespread surface application of pesticides may result in increased background levels of these compounds.

Monitoring well M03-471 (grid cell 53) is located on the eastern side of Area 41 and was intended to provide background chemical information for this site. The detection of VOCs and dioxins in this well may indicate elevated background concentrations of these compounds in the area.

Monitoring well M03-468 (grid cell 38) is located on the north and eastern side of Area D and was intended to provide background chemical information for this site. The detection of TPH and VOCs in this well may indicate elevated background concentrations of these compounds in the area.

Despite potential elevated background VOC levels, several groundwater samples contained relatively high concentrations of chlorinated solvents that suggest a local source. In particular, sample CC054WS01 obtained from monitoring well M03-470 in Area 41 contained a reported tetrachloroethene concentration of 11.1 mg/L and sample CC237WS01 obtained in monitoring well M03-465 in Area D contained a reported trichloroethene concentration of 1.4 mg/L. Cis-1,2-dichloroethene concentrations were also greater than 1.2 mg/L in monitoring well M03-465 (samples CC037WS01, CC137WS01, and CC237WS01). In addition, sample CC024WS01 in Area D contained the pesticide Lindane with a concentration of 8.76 mg/L.

**Uncertainty Analysis**

Uncertainties in the risk estimates are related primarily to the methodologies and parameter values used in estimating exposure and toxicity in humans. They are also the product of many factors affecting each component of the risk assessment process, namely data collection/evaluation and selection of COPCs, exposure assessment, and toxicity assessment. These factors generally include, at a minimum, measurement errors, conservative exposure and modeling assumptions, and uncertainty and variability of the values used in the assessment. The compounding effects can be at least two orders of magnitude or more. This section presents a qualitative discussion of the uncertainties, assumptions, and limitations as well as the scientific basis and rationale for the PRE.

Uncertainties associated with the exposure assessment in this PRE involve, at a minimum, those associated with the estimation of exposure point concentrations, identification of complete or potentially complete pathways, and use of upper-bound exposure parameters.

Another source of uncertainty in estimating exposures is the assumption that individuals within a particular receptor population (or subpopulation) will receive the same intake doses. Variability in parameters such as absorption rates, ingestion rates, dermal contact rate, skin surface area, frequency and duration of exposure, body weight, and activity pattern will exist even in a narrowly defined age group or identified sensitive subpopulation. To account for such variability in the development of PRGs, which implicitly incorporate all exposure assumptions, the USEPA uses upper-bound parameter values. The effect of incorporating multiple upper-bound values into the PRG calculation results in a substantial overestimation of the reasonable maximum exposure. On the basis of the information discussed above, the net overall uncertainty associated with assessing exposure is moderate to high with a bias toward overestimation of risk.

Uncertainties in this PRE are also related to the use of USEPA-derived toxicity values. For chemical risk drivers, animal data served as the principal basis of the toxicity values used to develop PRGs. Extrapolation from animals exposed to high doses to humans potentially exposed to much lower doses is a major source of uncertainty influencing chemical toxicity and, consequently, the evaluation of risks. Furthermore, the use of uncertainty factors, typically ranging from 100 to 1,000, in the derivation of USEPA reference doses introduces additional uncertainty, biased toward overstating the actual toxic potential. Similarly, the use of the UCL 95 on the slope of the linear dose-response curve for carcinogens introduces additional uncertainty, biased toward overstating the actual toxic potential. On the basis of the information discussed above, the net overall uncertainty associated with the toxicity values is moderate to high with a bias toward overestimation of risk.

The summation of RME risks across pathways is also conservative. According to the USEPA (1989), multiple-pathway RME risks could be best presented by a combination of a single-pathway RME and other average risks. As a result of compounding conservatism, the actual risks, if any, are likely to be less than the RME estimates presented in this PRE (USEPA 1989).

Based on this evaluation of uncertainty, it can be concluded that the overall uncertainty associated with the risk estimates presented in this PRE are moderate to high with a bias toward overstating actual risks.

### 5.2.3 PRE Conclusions and Recommendations

Exceedances in USEPA Region 9 Industrial Soil PRGs were observed for several chemicals found at the Area 41 and Area D sites. Although exceeding industrial screening risk criteria, under industrial use scenarios, screening RME carcinogenic risks for both Area 41 and Area D site soils were within USEPA regulatory levels of concern (1E-04 to 1E-06). Carcinogenic risk drivers for Area 41 were Dieldrin, 4,4'-DDD, 4,4'-DDT, gamma-Chlordane, and Benzo(a)pyrene. Carcinogenic risk drivers for Area D were arsenic, 4,4'-DDT, and Trichloroethene. Dioxin concentrations found at the site were below regulatory risk criteria. The maximum dioxin/furan TEQ concentrations detected in Area 41 and Area D were 2.34 parts per trillion (ppt) and 1.05 ppt, respectively. The industrial soil PRG for 2,3,7,8 TCDD is 16 ppt. The USEPA OSWER directive cleanup level goal for dioxin and related compounds is 5-20 ppb TEQ.

Screening RME noncarcinogenic risks for site soils do not exceed USEPA's upper bound risk level of 1.0. The maximum concentration of lead in surface and subsurface soils was also below the screening risk values. Noncancer health effects are not expected to occur from exposures assumed in this preliminary risk assessment.

Groundwater at the Area 41 and Area D sites are not drinking water sources. Consequently, a comparison of groundwater concentrations to USFK EGS drinking water standards is not appropriate. The drinking water exposure pathway is incomplete. This

PRE makes such a comparison only to confirm that groundwater at the site not be used for drinking water. The data indicates that exceedances in groundwater were limited to VOCs and pesticides. As reported above, previous groundwater investigations report relatively widespread contamination of the aquifer throughout the base.

Based on the results of this PRE, the following conclusions can be made:

- Estimated potential carcinogenic risks associated with current and future industrial exposures to site soils are within USEPA's target risk range (1E-6 to 1E-4).
- Under current and future industrial site use scenarios, hazard indices associated with receptor exposure to site soils are below 1, indicating that there is little potential for noncarcinogenic health effects to occur given current site conditions.
- Although exceedances in EGS drinking water standards were observed, comparison of these standards to the data collected at the site is inappropriate. Groundwater at the Area 41 and Area D sites are not drinking water aquifers. The ingestion pathway is incomplete. Furthermore, previous groundwater investigations report relatively widespread contamination of the aquifer throughout the base. Background chemical contributions are probable.
- No remedial actions are recommended at this time.

# SECTION 6
# REMEDIAL ALTERNATIVES EVALUATION

The sections above show that the material disposed of in Area D has impacted both soils and groundwater to some extent. The soils contain several compounds that were detected at concentrations less than the health risk guidelines evaluated in the PRE. Groundwater in the vicinity of Area D contains dioxins, VOCs, and other compounds. Some groundwater contaminant concentrations exceed the respective EGS values, however, because the water table aquifer is not used for drinking water purposes, the EGS values are overly conservative and not applicable as cleanup standards under anticipated site usage. On the basis of the PRE results, no remedial actions are currently recommended at the site. However, recommended additional site characterization may reveal contaminant concentrations that exceed risk guidelines. This section evaluates potential remedial alternative actions that may be applicable in the future.

Groundwater contamination is understood to be a site-wide issue. The evaluation of remedial alternatives to treat groundwater directly is beyond the scope of this report. Rather, the remedial alternatives selected for evaluation were reviewed for their ability to reduce potential human health risk caused by exposure to contaminated soil, and for their ability to reduce continuing impacts to groundwater from the contaminated soil.

Four remedial alternatives were evaluated. The four alternatives include:

1) no remedial action;

2) capping with a geosynthetic liner;

3) capping without a geosynthetic liner; and,

4) removal of contaminated material.

These actions are discussed in more detail below.

It should be noted that the full extent of contaminants in the soil in Area D is not known. In particular, clean samples were not obtained to the north-west and south-west; and the area to the north-east is also not fully defined. We have made reasonable assumptions on the extent of impacts beyond the samples taken; but additional delineation is recommended.

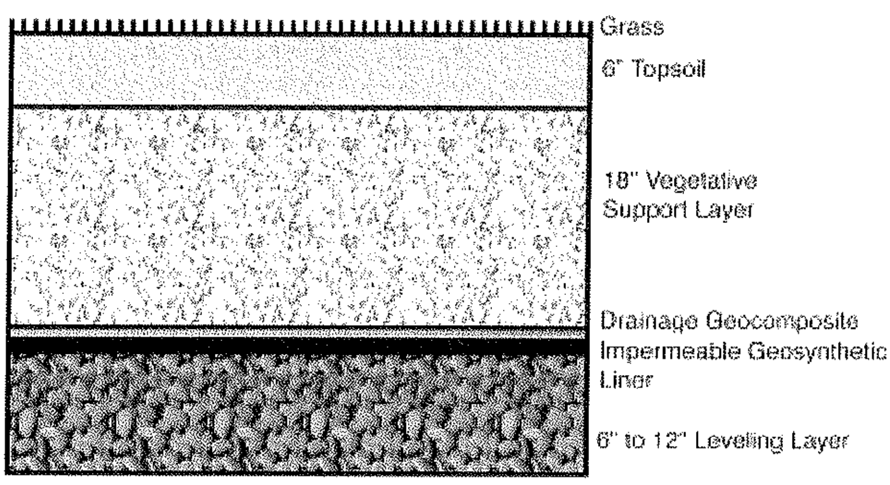
## 6.1 NO REMEDIAL ACTION

For this action, nothing is done to the site. There is no capital cost and no operations and maintenance cost. Precipitation will continue to leach contaminants from the soil into the underlying groundwater. Unprotected site workers will continue to be exposed to impacted soils. To prevent exposure to site contaminants, site access would need to restricted to workers wearing appropriate personal protective equipment (PPE).

## 6.2 CAP WITH A GEOSYNTHETIC LINER

For this option, the site will be contoured to direct run-off away from the impacted area by adding clean fill material. A geosynthetic cap, meeting RCRA Title 35 Subtitle C criteria, will be constructed over the impacted site. This cap will likely consist of a 6 to 12 inch thick leveling and bedding layer; an impermeable geosynthetic liner, a drainage geocomposite, an 18" thick vegetative support layer and a 6" layer of topsoil. Grass will be established in the topsoil layer.

**Cap with Geosynthetic Liner**



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Operations and maintenance (O&M) will consist of mowing the grass, preventing intrusive work in the area, and occasional repairs to the topsoil layer to maintain surface contours. Groundwater monitoring should also be performed regularly.

This option will provide a boundary to prevent human contact with the contaminated soils. No precipitation infiltration will occur; therefore, there will be no leaching of contaminants to groundwater.

Construction is relatively straightforward, and poses little additional risk to workers. Capital costs are estimated at $179,000, and O&M costs are estimated at $2,650 per year.

## 6.3 CAP WITH A CLAY LINER

This option is similar to Option 2 above, except that a clay liner is substituted for the geosynthetic liner, and the cap is not designed to meet RCRA Title 35 Subtitle C criteria. The site will be contoured to direct run-off away from the impacted area by adding clean fill material. A clay cap will be constructed over the impacted site. This cap is assumed to consist of a 24" thick low-permeability clay layer, a 6" thick vegetative support layer, and a 6" layer of topsoil. Grass will be established in the topsoil layer.

Operations and maintenance will consist of mowing the grass, preventing intrusive work in the area, and occasional repairs to the topsoil layer to maintain surface contours. Groundwater monitoring should also be performed regularly.



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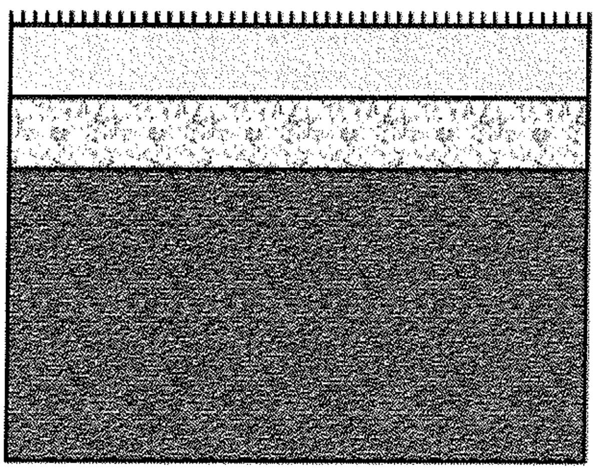
**Cap with Clay Liner**




This option will provide a boundary to minimize human contact with the contaminated soils. Precipitation infiltration will be greatly reduced (but not completely stopped); therefore, there will be only minimal leaching of contaminants to groundwater.

Construction is relatively straightforward, and poses little additional risk to workers. Capital costs are estimated at $105,000, and O&M costs are estimated at $2,900 per year.

### 6.4 REMOVAL OF CONTAMINATED SOILS

For this option, the dioxin-impacted soils in Area D will be excavated and hauled off site for treatment and/or disposal. It is estimated that approximately 57,950 cubic yards will be excavated for offsite disposal and treatment (see Figure 6-1). It is assumed that excavated materials will be disposed of by shipment to the United States followed by thermal treatment (due to the presence of dioxins). Following excavation, clean fill will be placed back into the excavation and contoured. Once the excavation is complete, no O&M is required.

This option will eliminate the potential for human contact with the contaminated soils. There will be no leaching of contamination to groundwater, since all soil contamination will be removed.



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The execution of the remedial action is relatively complicated, with significant handling of contaminated materials. There is an increased risk of exposure to workers during excavation and trucking. Capital costs are estimated at $93,800,000, and no O&M costs are anticipated.

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# SECTION 7
# CONCLUSIONS AND RECOMMENDATIONS

Conclusions and recommendations for the SI conducted at Area 41 and Area D of Camp Carroll are presented in the following sections.

## 7.1 CONCLUSIONS

This SI was initiated to investigate possible soil and groundwater contamination associated with a former hazardous waste drum storage area (Area 41) and a temporary landfill (Area D). The SI was designed to evaluate the nature and extent of existing contamination, to determine groundwater flow patterns and potential contaminant migration pathways, and to evaluate several potential remedial alternatives.

The SI included the following field activities: Site reconnaissance; geophysical survey, exploratory trenching, exploratory drilling; installation monitoring wells; soil and ground-water sampling; water level monitoring in wells; and aquifer testing. Soil and groundwater samples were analyzed at offsite analytical laboratories.

The following conclusions concerning the site have been developed based on the data acquired during the SI:

Geology and Hydrology

- The site is underlain by granitic bedrock which is covered by varying thicknesses of weathered granitic bedrock material (saprolite) and fill soils derived from a similar source rock. Fractures and faulting were not observed in soil cores during the drilling activities.
- The measured groundwater level within the monitoring wells at Area 41 is approximately 13 feet to 33 feet (4 to 10 meters) bgs, at elevations of approximately 95 feet to 115 feet (29 to 35 meters) msl. The measured groundwater level within the monitoring wells at Area D is approximately 23 feet to 33 feet (7 to 10 meters) bgs, at elevations of approximately 131 feet to 141 feet (40 to 43 meters) msl. The groundwater gradient at each of

the two areas investigated is directed to the west. If additional groundwater level information becomes available from other locations within or in the vicinity of the site, the interpreted groundwater flow patterns may require modification.

- On the basis of the available site data, groundwater and aqueous phase contaminants will tend to flow toward the west with the groundwater gradient when the subsurface lithology is permeabile in that direction. On the basis of groundwater contaminants measured in existing monitoring wells located to the west of Area 41 and Area D, a preferred westward migration pathway is consistent with the observed data at each Site.

Assessment of Soil and Groundwater Impacts

- On the basis of a geophysical survey and exploratory trenching conducted at Area D, it is considered likely that buried drums containing hazardous materials at the site have previously been excavated and removed.

- Soil samples obtained from Area 41 contained concentrations of numerous contaminants including TPH-G, TPH-D, TPH-O, VOCs, SVOCs, pesticides, RCRA metals, and dioxins. Several soil contaminant concentrations exceeded PRG screening criteria, however, contaminant concentrations are less than the risk criteria evaluated in the PRE. Groundwater samples obtained from Area 41 monitoring wells contained concentrations of TPH-G and TPH-D, VOCs, RCRA Metals, and dioxins. Detected concentrations that exceeded EGS values for groundwater are limited to VOCs. EGS values are not considered appropriate cleanup criteria for the site because the water table aquifer is not used for drinking water purposes in the area.

- Soil samples obtained from Area D contained concentrations of numerous contaminants including TPH-G, TPH-D, TPH-O, VOCs, SVOCs, pesticides, RCRA metals, and dioxins. Several soil contaminant concentrations exceeded PRG screening criteria, however, contaminant concentrations are less than the risk criteria evaluated in the PRE. Groundwater samples obtained from Area D monitoring wells contained concentrations of TPH-G and TPH-D, VOCs, SVOCs, pesticides, RCRA Metals, and dioxins. Detected concentrations that exceeded EGS values for groundwater are limited to VOCs and pesticides. EGS values are not considered appropriate cleanup criteria for the site because the water table aquifer is not used for drinking water purposes in the area.

- Contaminants identified in existing groundwater monitoring wells located to the west of Area 41 and Area D are consistent with a westward direction of groundwater flow and migration of aqueous contaminants at each of these areas. However, a baseline groundwater investigation conducted by Woodward Clyde Consultants (WWC 1992b) reported relatively widespread chlorinated solvent contamination of the aquifer throughout the base. The detection of VOCs in wells located hydraulically upgradient of each site investigated may indicate elevated background concentrations of these compounds in the area.

- Despite potential elevated background VOC levels, several groundwater samples contained relatively high concentrations of chlorinated solvents that suggest a local source. In particular, sample CC054WS01 obtained from monitoring well M03-470 in Area 41 contained a reported tetrachloroethene concentration of 11.1 mg/L and sample CC237WS01 obtained in monitoring well M03-465 in Area D contained a reported trichloroethene concentration of 1.4 mg/L. Cis-1,2-dichloroethene concentrations were greater than 1.2 mg/L in monitoring well M03-465 (samples CC037WS01, CC137WS01, and CC237WS01). In addition, sample CC024WS01 contained the pesticide Lindane with a concentration of 8.76 mg/L.

Conceptual Site Model

- The subsurface environment appears to be comprised of weathered granitic bedrock and fill materials derived from similar source rock. No preferred fracture orientations were observed during drilling activities. The direction of groundwater flow and migration of aqueous contaminants are presumed to be consistent with the hydraulic gradient.

- The identified groundwater gradient at each of the two sites investigated is directed toward the west. It appears that aqueous phase contaminants originating in shallow soils may have migrated downward through the vadose zone to the groundwater table, and then laterally towards the west with groundwater flow. The observed presence of similar contaminants in groundwater wells located to the west of Area 41 (Monitoring Well MW-14) and Area D (Monitoring Well MW-23) are consistent with this scenario.

## 7.2 RECOMMENDATIONS

On the basis of the information and analytical data obtained during the site investigations performed in Area 41 and Area D, the recommendations to address COPCs at Camp Carroll include:

- Additional groundwater investigation is recommended at both Area 41 and Area D to further evaluate the observed concentrations of chlorinated solvents. A 1992 baseline groundwater investigation of the Site (WWC 1992b) reported relatively widespread contamination of the aquifer throughout the base.
- Additional soil investigation is recommended at Area D to further define the limits of impacted soil and the boundaries of the former landfill.
- No remedial actions are recommended at this time. In the event that additional site characterization indicates that contaminant concentrations exceed risk criteria in Area D, it is anticipated that capping of the landfill area using a clay cap will be the preferred method to provide a barrier to human contact with impacted soils and to limit infiltration through the impacted soils.

## SECTION 8
## REFERENCES

OEES. 1999. Standard Operating Procedures Manual.

Samsung, 2002a. *Sampling and Analysis Plan for Camp Carroll Area D and Area 41 Site Investigations, Camp Carroll, Korea.*

Samsung, 2002b. *Quality Assurance Project Plan for Camp Carroll Area D and Area 41 Site Investigations, Camp Carroll, Korea.*

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Woodward-Clyde Consultants (WWC), 1992a. *Historical Land Use and Background Survey Report, Camp Carroll, Korea. June 1992.*

Woodward-Clyde Consultants (WWC), 1992b. *Camp Carroll Baseline Groundwater Investigation, Korea, July 13, 1992.*

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## Appendix A

Geophysical Survey Results

Final Report

# Geophysical assessment to a landfill site in Camp Carroll, Waegwan, Korea

May 2003

**Submitted to:**

Samsung Corporation
Engineering & construction Group
263 Seohyeon-Dong, Pundang-Gu
Sungnam 463-721, Korea

**Submitted by:**

Geomax Co., Ltd.
#402 Hyang-Jeong Plaza
185-7, Gumi-Dong, Pundang-Gu
Sungnam 463-810, Korea

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# Geophysical assessment to a landfill site in Camp Carroll, Waegwan, Korea

## Signature Sheet

**Prepared By:**______________________

b6
[redacted] Ph.D
Project Manager
Geomax Co., Ltd.
#402 Hyang-Jeong Plaza
185-7, Gumi-Dong, Pundang-Gu
Sungnam 463-810, Korea

**Concurrence:** ______________________

b6
[redacted] Ph.D
Representative
Geomax Co., Ltd.
#402 Hyang-Jeong Plaza
185-7, Gumi-Dong, Pundang-Gu
Sungnam 463-810, Korea

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## 1. Introduction

Area D (Figure 1) in Camp Carroll has been identified as a former hazardous waste landfill. Numerous hazardous materials were disposed in this landfill between the years of 1977 and 1982. Personnel interviews indicated that many drummed hazardous materials were transported from Area 41. The landfill dimensions were approximately 500 feet by 250 feet in area; and 20 to 30 feet deep (Figure 2). Reportedly, much of the filled materials and surrounding soil was excavated between 1982 and 1983 and placed into 55-gallon drums. Despite the removal activity, residual amounts of contaminated material may have remained.

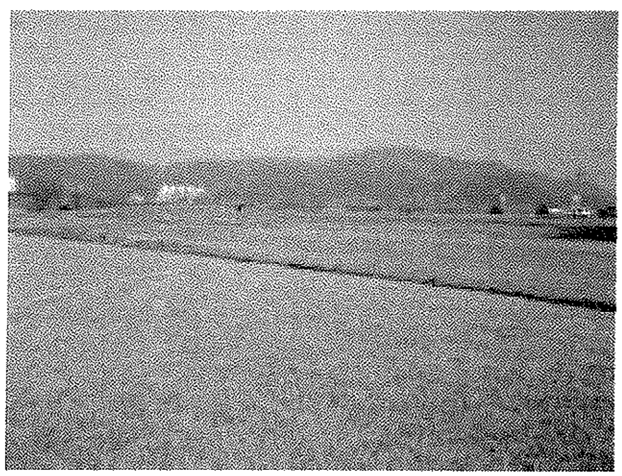


Figure 1. An overview of Area D in Camp Carroll

In this project, two different geophysical approaches have been made to characterize the landfill site. The objectives of geophysical survey can be summarized by following two; 1) defining the thickness of the landfill or the depth to the bedrock, and 2) locating the buried metallic objects such as drums, if they still remains. Two different approaches have been made for each objective; DC resistivity method for the former, and horizontal loop electromagnetic (HLEM) method for the latter.

Electrical properties of a medium are mainly dependent on the ion contents of pore fluid as well as clay contents of the soil (Keller, 1988). Typical waste disposal site shows three-layered structure; the landfill on top, residual soil on the middle, and the bedrock on the bottom. Usually the resistivity of the landfill and the residual soil is smaller to the bedrock. Residual soil shows lowest resistivity among them. Residual soils commonly contain much of clay rather than sand. The landfill, however, commonly contains plenty of sand other than clay, which makes its resistivity larger than that of the residual soils underneath the landfill. DC resistivity method shows very strong features to map the layered earth model (Dobrin, 1976).

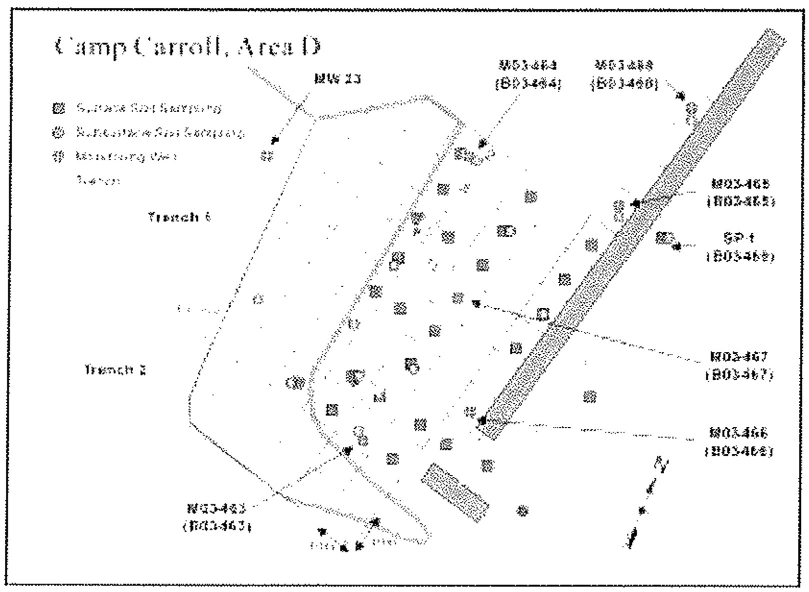



Figure 2. Site map of Camp Carroll landfill area

Electromagnetic (EM) survey, horizontal loop EM (HLEM), can give us an useful information about the location of the metallic objects, if they are within the landfill. The depth of investigation of HLEM ranges up to 20 m depending on the frequency it uses and the conductivity of the medium (Song et al., 2001).

By integrating the two methods in this project, geo-electrical structures for the landfill site as well as the position of potential buried metallic objects (e.g., drums or other containers) can be identified.

## 2. Theories & Methods

### 2.1 Horizontal Loop Electro-Magnetic method (HLEM)

HLEM transmits HF band (kHz ~ tens of kHz) electromagnetic waves. The transmitted primary electromagnetic (EM) fields induce the eddy currents in the metallic (conductive) objects beneath the earth. The eddy currents, in turn, make secondary EM fields as shown in figure 3. Measuring the secondary field with small loops on the surface, one can figure out the location of the anomalous body as well as the conductivity of the ground.

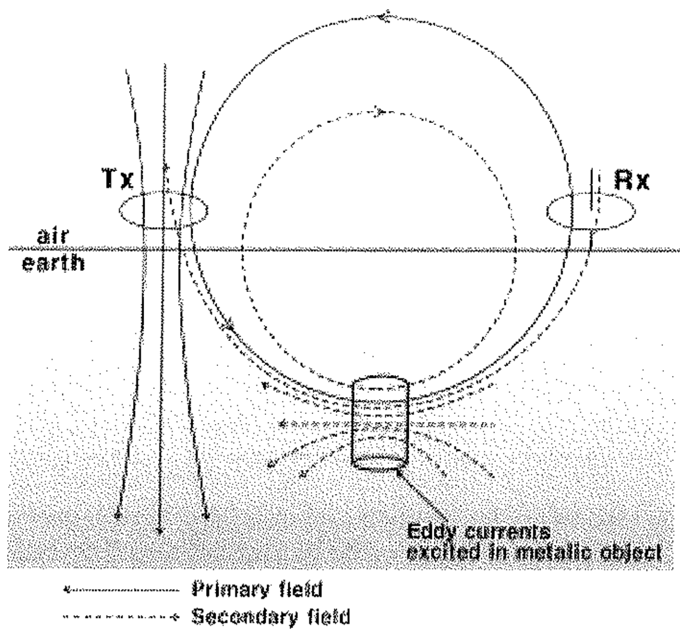



Figure 3. Theory of horizontal loop electromagnetic (HLEM) method.

Figure 4 and Figure 5 shows typical HLEM survey procedure and typical responses of buried metallic sphere, respectively. EM31 provides two types of measurements; i.e., horizontal coplanar (HCP) and vertical coplanar (VCP) arrays. Apparent conductivity can be calculated from both modes but HCP configuration is a little more sensitive to the buried targets than VCP configuration (Frischknecht et al., 1991). Note that the minimum or maximum peaks at the right position of the buried objects.

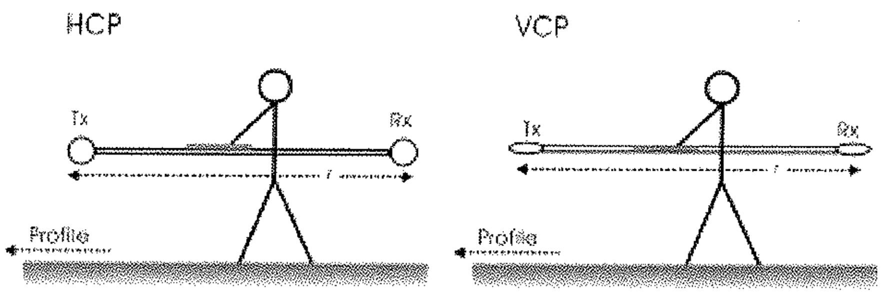



Figure 4. Schematic diagram for typical HLEM survey. The survey can be either the horizontal co-planar (HCP) or the vertical co-planar (VCP) configuration.

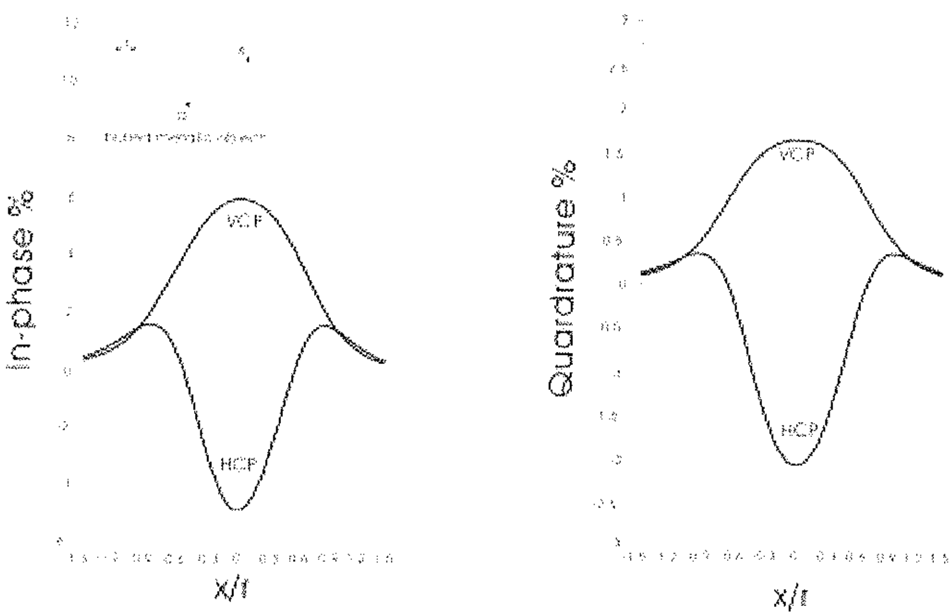



Figure 5. Schematic diagram for typical HLEM survey. The survey can be either the horizontal coplanar (HCP) or the vertical coplanar (VCP) configuration.

Apparent resistivity ( $\rho_a$ ) can be calculated from both configurations by

$$\frac{1}{\rho_a} \approx \frac{4}{\mu_0 \omega r^2} \times (Quardrature\ reading) \qquad (1)$$

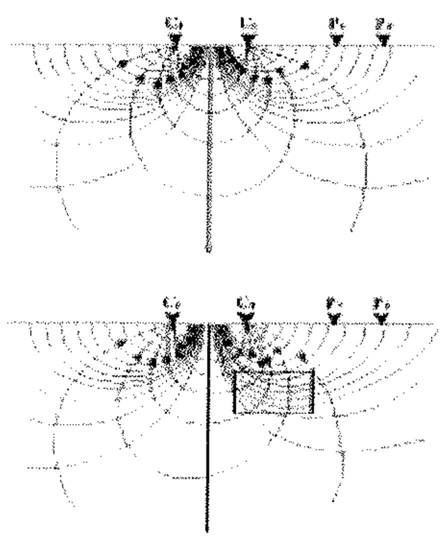
where, $\omega$ is angular frequency, $\mu_0$ is magnetic permeability in free space, and r is the distance between the transmitter and the receiver.

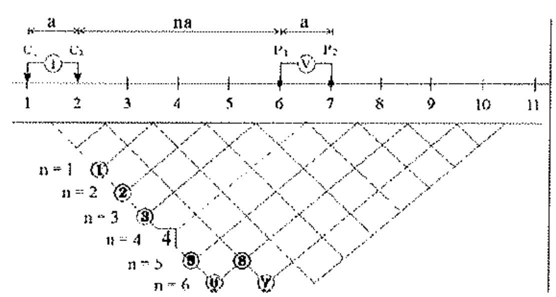
## 2.2 DC resistivity (dipole-dipole) survey

Dipole-dipole survey needs two current electrodes and two potential electrodes. The potential induced by transmitted current is disturbed by underground inhomogeneities (Figure 6). Dipole-dipole survey measures the potential distribution on the surface with fixed current/potential electrode spacing. The bigger the separation between the current electrodes and the potential electrodes is, the deeper information the data carries. With moving the potential electrodes with fixed separation, normalized potential with applied current ($\Delta V / I$) is measured (Figure 7). The measured data is converted to apparent resistivity by multiplying the geometric factor (G):

$$\rho_a = G\frac{\Delta V}{I} \qquad (2)$$
$$G = -2\pi(n-1)n(n+1)a$$

The geometric factor is dependant on the electrode spacing ($a$) and the spread number ($n$) illustrated in Figure 7. Two-dimensional resistivity image can be gathered by inversion process using the apparent resistivity. A commercial software Dipro4Win was used for inversion of the data.





Stacking will improve signal to noise (S/N) ratio. Maximizing transmitting power (current) is another good way of improving S/N ratio. ABEM Terrameter (model SAS300C) provides 2mA to 500mA transmitting currents selectable depending on the resistivity of the earth. In most of cases, 20mA of currents were transmitted in this survey.

## 3. Geophysical survey design

Twelve HLEM survey lines were set up to from two-dimensional grid on the surface as shown in Figure 8. The main purpose of the HLEM survey is to detect any metallic objects (drums) beneath the earth. When plotting 2-dimensional contours of the resistivity measured, closed contours will be concentrated on the right place where a metallic objects is buried.

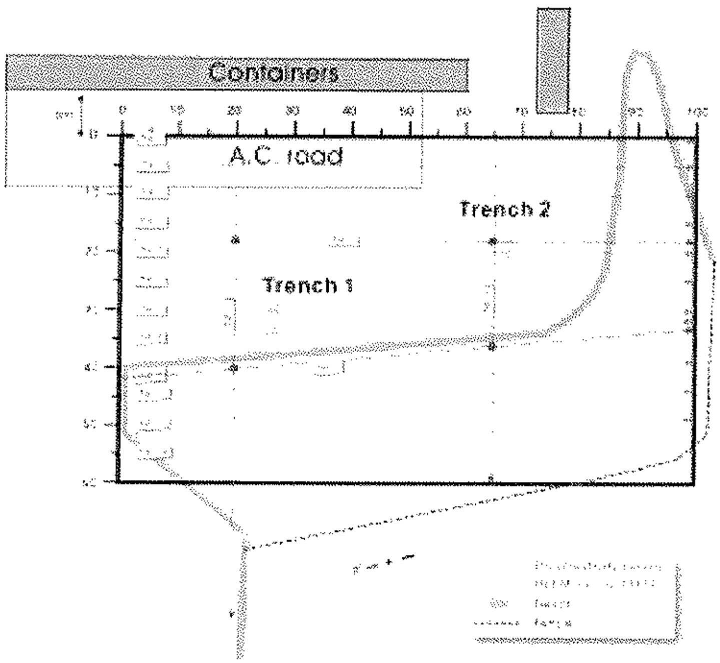



Figure 8. Survey lines for HLEM (blue) and DC resistivity method (red)

At every survey line, the HLEM data have been collected at every 2m for both vertical co-planer (VCP) and horizontal co-planer (HCP) configuration of the source and receiver coils. Though, in-line configuration of the coils (the TX coil and RX coils are in-line with the survey lines) was used to minimize the interferences by the containers and by the fences around the survey area, they will inevitably affect the data near to them.

Four DC resistivity survey lines are set up to find out the depth to the residual soils and/or bedrock; two of them are in N-S directions and the other two are perpendicular to them (red lines in Figure 8). The dipole spacing for Line-1 and Line-2 are set to 5m, and for Line-3 and Line 4 to 3m, of which maximum penetration depth is 25m and 15m, respectively.

## 4. Results and Interpretations

### 4.1 DC resistivity (dipole-dipole) survey

Figure 9 shows the inversion results of the four DC resistivity surveys. Generally speaking, the resistivity sections show the characteristics of the two-layered earth. The top layer shows high resistivity and the bottom shows relatively low resistivity for all the four sections. The top layer with high resistivity (ranged from 100 ~500 ohm-m) can be the landfill material over the groundwater level, while the bottom layer with lower resistivity (below 100 ohm-m) can be the residual soil below the groundwater level. They say that the area used to be an agricultural field before the landfill. The residual soil in agricultural fields shows the characteristics of fine-grained, low permeability, high water contents, and thus low resistivity. Estimated boundary between the landfill materials and the residual soils are overlain in each resistivity sections. The boundary shows almost flat except for Line-3 and the thickness of the landfill ranges 3 to 7 m.

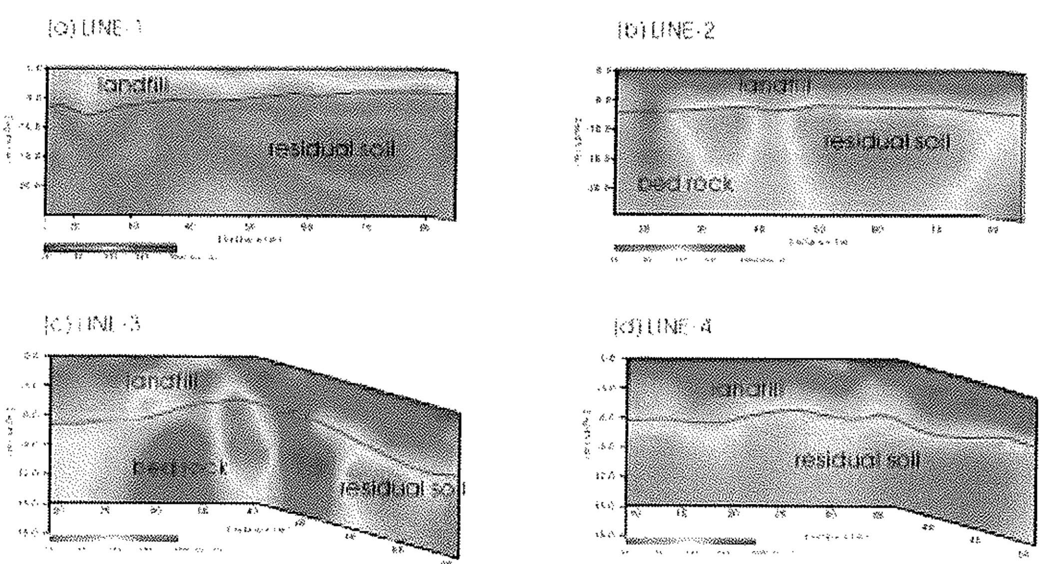



Figure 9. Resistivity sections from DC resistivity survey for the four lines shown in figure 8.

High resistivity below 10m (a few hundred ohm-m) can be the bedrock underneath the residual soils. Note that it appears only at the left side in Line-2 and at the center of Line-3. One cannot find such layer from Line-1 and Line-4. The bedrock can lie deeper than 20 m in Line-1 and Line-4.

The resistivity of groundwater normally shows from about 50 ohm-m to a few hundreds ohm-m depending on its mineral contents. The more the groundwater contains the metallic mineral, the smaller the resistivity of the groundwater. From the extra-ordinarily low resistivity of the second layer (especially at around 70m in Line-1), which shows 30 ~80 ohm-m, we have a doubt that the groundwater may contains various kind of metallic mineral or be contaminated.

Figure 10 shows a 3-D view of the DC resistivity results. Note that high resistivity zone of 3rd layer is concentrated to the NW part of the site. We assumed that this high resistivity zone indicates the bedrock. The bedrock is seated deeper than 20 m in SE part, while at around 10m in NW part of the survey area (marked A in the figure).

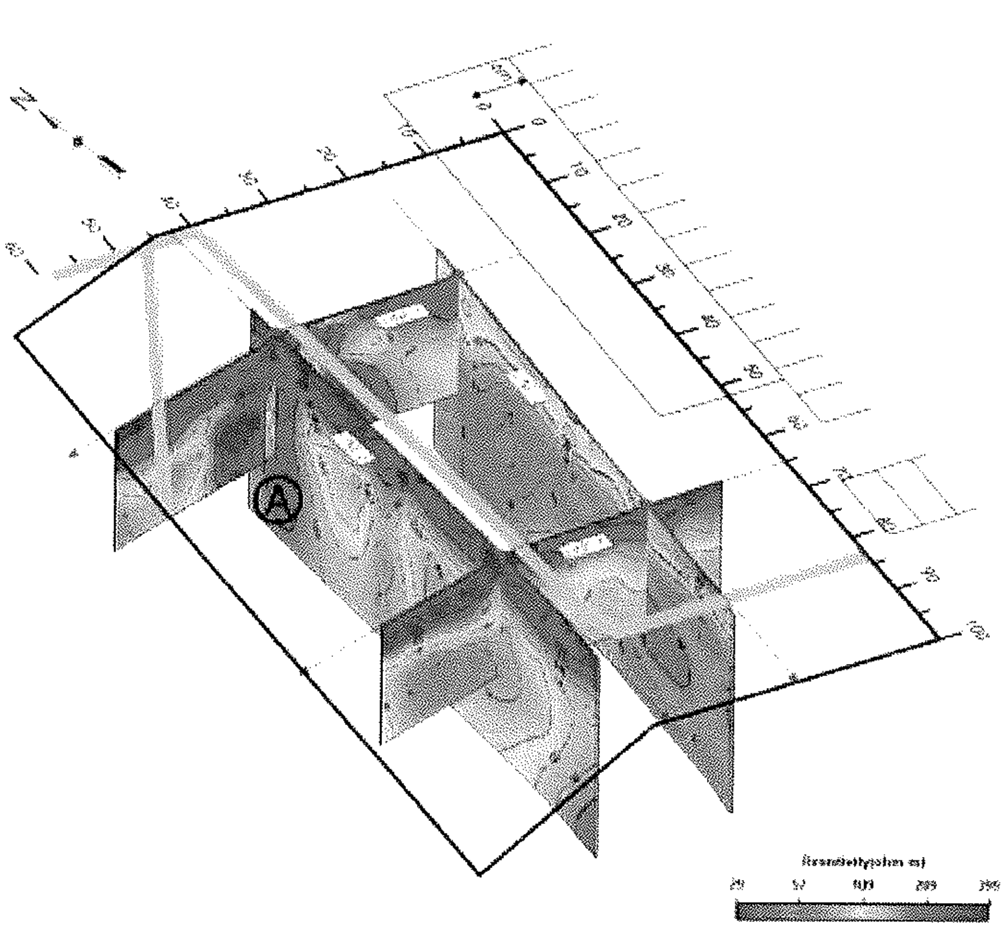


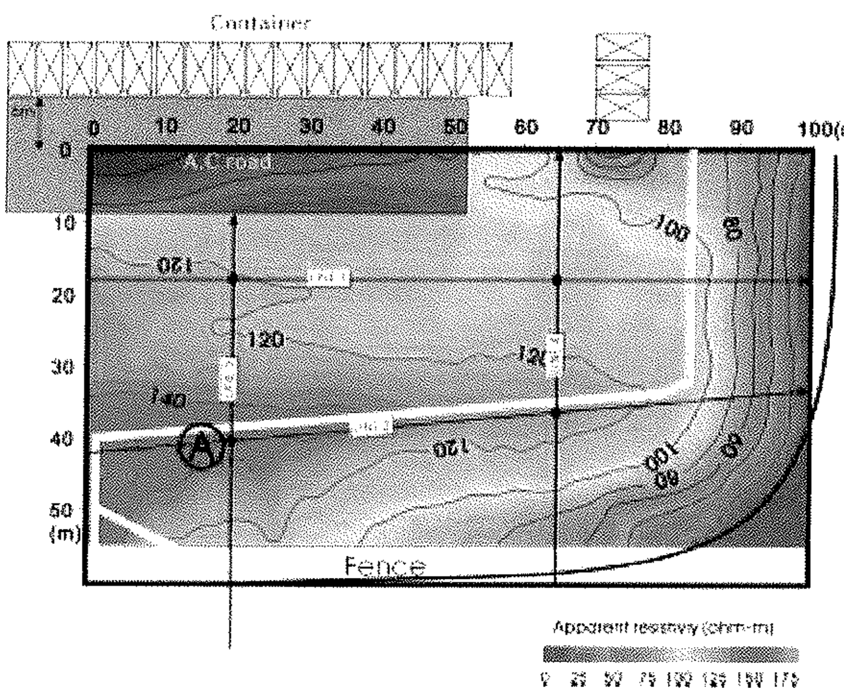

Figure 10. 3-D view of electrical resistivity distribution from DC resistivity survey

### 4.2 HLEM survey

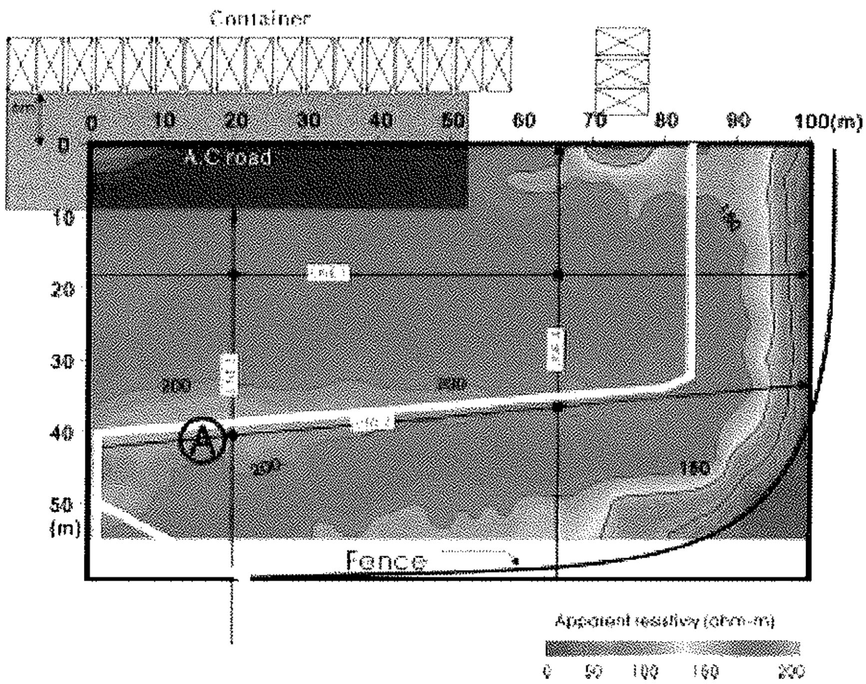
Figure 11 shows the apparent resistivity contours from the HLEM survey. Apparent resistivity contours from VCP and HCP shows very similar results, except for the resistivity values. VCP shows slightly high apparent resistivity values than HCP.

The HLEM methods are very sensitive to the nearby metallic objects. Note that the fences and the containers affect the HLEM data and appear as low resistivity anomalies (below 100 ohm-m) surrounding the survey area. Excluding them, any conductive anomaly couldn't be found within the region. This, in turn, implies us that no more metallic drums are exists within the survey area. Overall apparent resistivity of the ground lies at around 100 ohm-m.

Note the high resistivity anomaly at the marking point (A). This high resistivity anomaly is consistent with the high resistivity zone in DC resistivity survey above. As mentioned in DC resistivity section, the bedrock seems to lie in shallow depth (about 10 m) at the marking point A. Shallow bedrock will affect the HLEM data and appears as high resistivity anomaly.




(a) HCP




(b) VCP

Figure 11. Apparent resistivity contours from HLEM survey

### 4.3 Integrated interpretations

Backhoe excavation has been carried out on two spots indicated in Figure 2. Figure 12 shows the resistivity sections from two different geophysical methods, HLEM and DC resistivity, with the pictures after the excavation. As expected in Trench 1, the residual soil came out at the depth of about 4~ 4.5 m from the surface, which is right depth where it shows low resistivity anomaly in resistivity section of Line-3 as indicated in the figure. The upper part of the residual soil (the landfill) showed almost homogeneous sand layer, which forms the high resistivity top layers in resistivity sections. Residual soils, however, has not been found in Trench 2 through about 5m from the surface. As can be seen from the resistivity section from Line-4, the boundary to the residual soil layer lies in around 6m in depth, which is somewhat deeper than at Trench 1.

Any drums or metallic objects could not been found, which, in turn, shows us why any conductive anomaly did not appear in HLEM data.

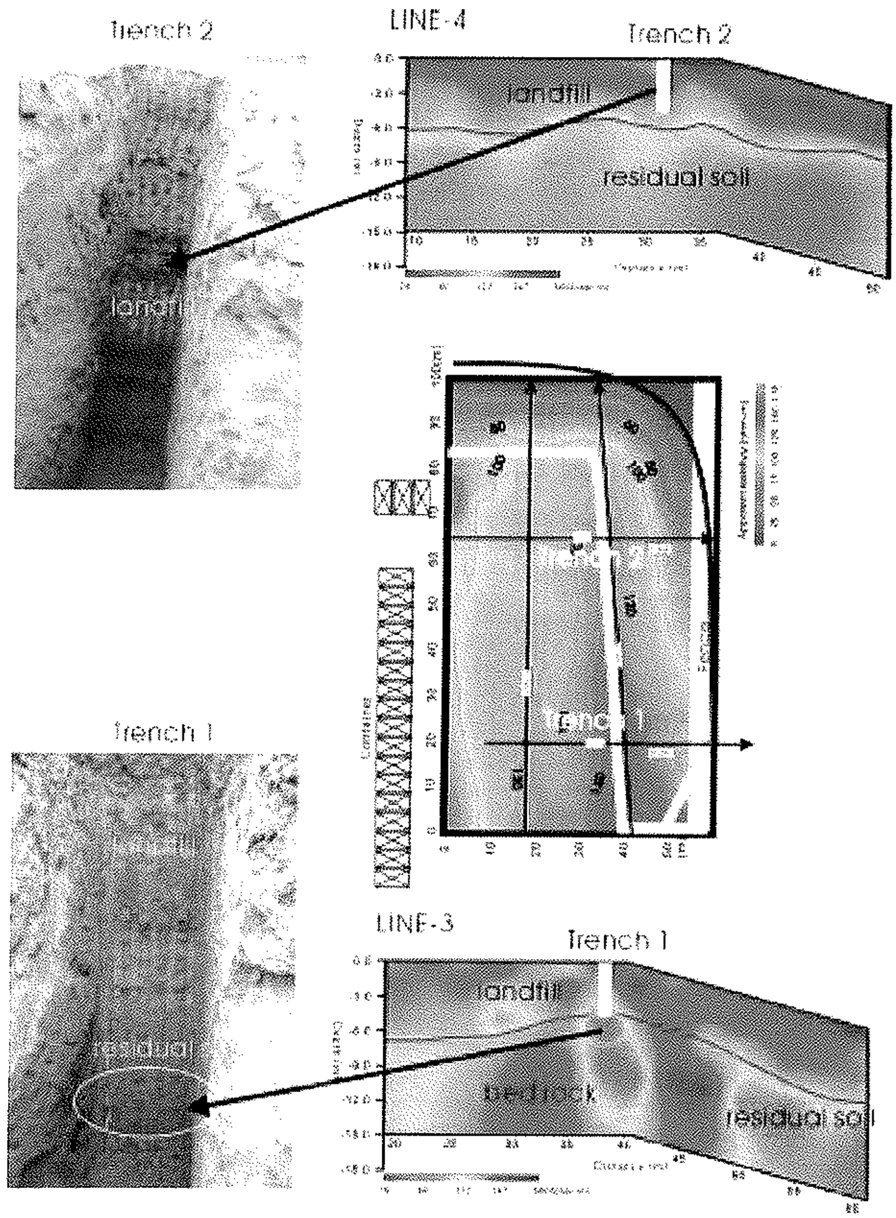



Figure 12. Integrated interpretation of geophysical methods (HLEM and DC resistivity) with backhoe excavation.

## 5. Conclusions and remarks

Horizontal loop electromagnetic method (HLEM) and DC resistivity survey has been carried out to characterize the landfill and potential buried drums or metallic objects. Both of the geophysical data showed very consistent results with each other. The resistivity of the landfill ranges from 100 ~ 250 ohm-m, while that of residual soils is a few tens of ohm-m. The bedrock in this area seems to reach deeper than 20m in most parts of the area. An exception is NW part, where the bedrock depth seems to be within 10 m.

Two-dimensional resistivity section clearly showed the boundary between the landfill and the residual soils. The boundary lies between 3 to 6 m in depth. Backhoe excavation also confirmed it. No conductive anomaly by any buried metallic objects was found in 2-dimensional apparent resistivity contour map from HLEM survey. Ground resistivity showed homogeneous feature all through the area.

Though we couldn't find any proof that metallic drums are still remains within the landfill, careful attention should be paid to the extra-ordinal low resistivity anomaly (below 50 ohm-m) in the resistivity section from DC resistivity survey, see 70m from left in Line-2 section in Figure 9. This can be either some kind of conductive objects including metallic drums or the groundwater contaminated by various ionic solutions as well as heavy metallic ions. The latter is more consistent with *a-priori* information of the site as well as geophysical interpretation in following two reasons;

1) The anomaly doesn't appear within the landfill layer, but in depth over 15m below the residual soils. There is no reason that metallic drums are buried within the residual soil layer.
2) The anomaly only appears in DC resistivity. The HLEM method, which is more sensitive to the concentrated metallic objects than DC resistivity, couldn't show the anomaly. In HLEM data, the resistivity in that part shows slightly lower than other parts instead. This suggests us that the anomaly is not any concentrated body but spread widely.

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Keller, G. V., 1988, Rock and Mineral Properties, in Nabighian, M. N., ed., *Electromagnetic methods in applied geophysics – Theory*, Soc. Expl. Geophys.

Song, Y., Park, S. G., Seol, S. J., Cho, S. J., and Chung, S. H, 2001, A geophysical survey result over a hydrocarbon contaminated site, *Application of Geophysical Techniquest to the Evaluation of Contaminated Site, Abstract from the 3rd Special symposium of KSEG*, Korean Society of Exploration Geophysicists, p.122-140.

## Appendix B

Field Logbook and Notes

## MEASUREMENT CONVERSIONS

| IF YOU KNOW | MULTIPLY BY | TO FIND |
|---|---|---|
| **LENGTH** | | |
| inches | 2.540 | centimeters |
| feet | 30.480 | centimeters |
| yards | 0.914 | meters |
| miles | 1.609 | kilometers |
| millimeters | 0.039 | inches |
| centimeters | 0.393 | inches |
| meters | 3.280 | feet |
| meters | 1.093 | yards |
| kilometers | 0.621 | miles |
| **WEIGHT** | | |
| ounces | 28.350 | grams |
| pounds | 0.453 | kilograms |
| grams | 0.035 | ounces |
| kilograms | 2.204 | pounds |
| **VOLUME** | | |
| fluid ounces | 29.573 | milliliters |
| pints | 0.473 | liters |
| quarts | 0.946 | liters |
| gallons (U.S.) | 3.785 | liters |
| milliliters | 0.033 | fluid ounces |
| liters | 1.056 | quarts |
| liters | 0.264 | gallons (U.S.) |

**TEMPERATURE**

°C = (°F - 32) x .555
°F = (°C x 1.8) + 32

| Inches | Decimals of foot | Millimeters |
|---|---|---|
| 1/16 | .0052 | 1.5875 |
| 1/8 | .0104 | 3.1750 |
| 3/16 | .0156 | 4.7625 |
| 1/4 | .0208 | 6.3500 |
| 5/16 | .0260 | 7.9350 |
| 3/8 | .0313 | 9.5250 |
| 1/2 | .0417 | 12.700 |
| 5/8 | .0521 | 15.875 |
| 3/4 | .0625 | 19.050 |
| 7/8 | .0729 | 22.225 |
| 1" | .0833 | 25.400 |
| 2" | .1667 | 50.800 |
| 3" | .2500 | 76.200 |
| 4" | .3333 | 101.60 |
| 5" | .4167 | 127.00 |
| 6" | .5000 | 152.40 |
| 7" | .5833 | 177.80 |
| 8" | .6667 | 203.20 |
| 9" | .7500 | 228.60 |
| 10" | .8333 | 254.00 |
| 11" | .9167 | 279.40 |
| 1 foot | 1.0000 | 304.80 |

IN / CM

860

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Camp Carroll, Korea
4/0/03
Onsite 8:00 AM : Area D
ARCC = [redacted] (PS)
Samsung : Principal Investigator = Dr. Lee
Field Mgr = Yun, Jun Ki
Myoung hee Noh = QA/QC
+ Samsung's field technicians + drillers
BEC (Beautiful Environmental) = drillers
for soil borings. (FED for wells)
Preparing for surface soil sampling
Selected grid locations to sample -
will collect 27 surface samples
on regular grid with 10-meter
centers. Some locations limited
by site conditions (drainage
ditch, asphalt paving.) Surface
soil samples will actually be
collected beneath cover soils
to landfill, if this can be
discerned using a backhoe.
0915 Exclusion zone marked
off. Each soil sampling grid
node has been assigned a location
number: 001 → 027. The

198

② 4/1/03

Same grid location number will be used for both surface soil samples and subsurface soil samples.

Sample numbers will be assigned as follows:

CC001 SS 01
aa bbb cc dd

where aa = CC for Camp Carroll
bbb = 001 → 027 for sample location ID
cc = SS for surface soil or BS for boring
dd = 01, 02, etc. for sample number (consecutive)

862

Subsurface soil borings & sampling will be conducted at 6 of these locations: tentatively at 006, 010, 017, 022, ~~~~ 026, and 027.

Exploratory trenching will be conducted starting tomorrow to investigate geophysical anomalies and observe subsurface conditions.

0920 Begin subsurface boring location 010 - direct push, split spoon sample.

Cores 1 = 0.3 - 0.9 m

4/1/03 ③

Boring 1 - location 010

0.3 - 0.9 m: moist, strong brown 7.5YR 5/6, silty fine to coarse sand (SM), (100% recovery)
PID = 0.0 ppm, medium dense
10:10 AM, some cobbles at 0.8 m

10:20: 0.9 m - 2.0 m: 80% Recovery
Same as 0.3 - 0.9 m w/ trace clay & more cobbles (decomposing granite & quartzite, ~~some~~ & gneiss)
some fine gravels [5% G / 80% S / 15% F] & dense
collected surface sample at 1.0 - 2.0 m
CC010SS01 (beneath fill cover)

Note: surface soil sampling using backhoe began at 10:30

10:50: 2.0 m - 3.2 m, 80% Recovery
2.0 - 2.6 m = same as above w/ ↑ clay.
2.6 - 3.2 m = moist fine to medium sandy clay, 7.5YR 5/6 strong brown with white 10YR 8/1 inclusions, firm, low to medium plasticity (CL)
some cobbles, increased moisture
(some manganese oxide on faces at 2.1 m)
(5% G / 35% S / 60% F)
[white inclusions = silty to fine sandy clay (CL)]

(4)

4/1/03

11:03 = 3.2m - 4.5m, 80% Recovery

3.2m - 4.0m = moist, clayey to silty fine to medium SAND (SC - SM) 7.5YR 5/6 strong brown (65% S / 35% F), dense

4.0 - 4.5m = moist, firm to medium sandy clay, medium plasticity (CL) (40% S / 60% F) 7.5YR 5/6 strong brown, firm

entire section appears to be saprolite - decomposed granite w/ quartz & feldspar, no cobbles.

11:30 = 4.7m - 5.8m, 95% Recovery

4.7 - 5.2m = moist, clayey f-m SAND (65% S / 35% F) (SC) dense 7.5YR 5/6 strong brown

5.2 - 5.5 = moist, AS 4.7 - 5.2m but olive gray 5Y 4/2

5.5 - 5.8 = SAME but 7.5YR 7/8 strong brown, with some coarse sands.

entire section appears to be saprolite.

collected soil sample (CC0108S01)

863

(5)

4/1/03

12:00 = 5.8m - 7.3m, 100% Recovery

5.8 - 6.3m moist 10YR 5/4 yellowish brown, clayey fine to med. sand, dense. (some metal shavings, could be slough)

6.3 - 6.8m = moist, variegated, (65% S / 35% F) clayey f-m sand (saprolite) (SC) color varies in bands & patches from red 2.5YR 4/6 to olive brown 2.5Y 4/4

- quartz & feldspar clasts, angular

6.8m - 7.3m = moist to wet f-m sandy clay (CL) medium plasticity, micaceous (35% S / 65% F), dark yellowish brown 10YR 4/4

12:24 - 7.3m - 8.6m, 100% Recovery

collect sample (CC0108S02)

moist to wet saprolite = clayey f-m sand (SC) to f-m sandy clay (CL) low to medium plasticity, approx (50% S 50% F)

12:30 Lunch break

(6)

4/1/03

1420 Begin drilling Boring 2 at Location 06 :

14:29 : 1.0m – 2.5m 80% recovery
moist, strong brown 7.5YR 5/6, clayey, f-m SAND (SC) with some coarse sd. & fine gravels.
[5% G / 70% S / 25% F] medium-dense,
some cobbles at 2.3 m. PID=0.0ppm

14:40 : 2.5m – 4.0m, 90% recovery.
moist, strong brown 7.5YR 5/6 silty to clayey f-m sand. (SM–SC). Appears to be weathered granite (saprolite)
angular quartz & feldspar, mica.
PID = 0.0 ppm

864

1500 : 4.0m – 5.5m, 80% recovery
4.0–5.0 m = Same as 2.5–4.0m
5.0–5.2m = moist, clayey f-m sd. (SC), red 2.5YR 4/6
(65% S / 35% F)
5.2–5.3 m = silty f-m sd (SM) w/ ~~some~~ trace clay, yellowish brown 10YR 5/4
5.3–5.5 m = clayey f-m sd (SC)

(7)

4/1/03

[60% S / 40% F]
yellowish red 5YR 4/6
collect sample CC006BS01

1518 : 5.5m – 7.0m, 100% recovery
moist, clayey f-m sd. (SC)
some large quartz grains sub-rounded to sub angular. strong brown 7.5YR 5/6, dense
PID = 0.0 ppm [60% S / 40% F]

~~1545 7.0m – 8.5m~~

Collect sample CC006BS02

15:45 – 7.0m – 8.5m, 65% recovery
7.0m – 7.1m – same as 5.5–7.0m
at 7.1m : moist to wet clayey f-m SAND (SC), dark grayish brown 2.5Y 4/2 (saprolite)
at 8.3 m = wet, f-m sandy clay (CL) medium plasticity, dark grayish brown 2.5Y 4/2.
PID = 0.0 ppm

1600 : Begin Boring #3 at location 026.

1615 : 1.0m – 2.5m.
moist, clayey f-c sand (SC), strong brown 7.5YR 5/6,

(8)

4/1/03

with some gravels. [5% G/65% S/30% F]
collected sample CC02CSS01

1630: 2.5m - 4.0m ; 100% Recovery
2.5 - 3.5m = moist, clayey fine to
coarse sand with some gravel (SC)
10% G/ 60% S/ 30% F
strong brown 7.5YR 4/6
PID = 0.0 ppm

865 3.5m - 4.0m = same but olive
gray 5Y 4/2. // sample CC02CBS01

1700 attempted sample at 4.0 - 5.5m -
no recovery due to lg. gravel
clast in shoe. will attempt again.
No Recovery

1714: 5.5m - 7.0m, 90% Recovery
5.5-6.0: moist, saprolite - clayey fine
sand (SC), [60% S / 40% F]
mottled color, dark greenish
gray 5GY 4/1 and yellowish
brown 10YR 5/4.
granitic gravel at 6.0
6.0-6.5 = same but dark greenish gray
5G 4.5/1 with some coarse
sand.

4/1/03 (9)

6.5 - 7.0 : moist, firm sandy
clay (CL), (15% S/85% F)
medium plasticity - dark
grayish brown (2.5Y 3.5/2
collected sample CC02CBS02

17:33 = 7.0 - 8.5m, 100% Recovery
wet, high plasticity clay
with some fine to med sand (5%)
(CH) - dark brown 10YR 3/3
less sand at 7.5m
becomes 10YR 3.5/3 at 8.0m
(dark brown)

All borings filled with bentonite chips.

Trench soils general description:
moist, strong brown 7.5YR 5/6,
silty to clayey fine to coarse
sand (SM) with approx 20%
gravels and cobbles to 6" diam.
(trench depths ~ 2 meters.)
medium dense. (Fill materials)

1800 Packing samples for
shipment.

1900 Site secured. Leaving site.

[redacted]

(10) 4/2/03

0800 On site Area D.
Note: All trenches excavated yesterday were backfilled prior to leaving site.
0820 Setting up on boring #4 (at Location 017.
0835 Begin drilling. Using direct-push (Geoprobe) rig on Tread mounting. 2" diameter sampler fitted with acrylic tube liner.
0845: Core 1.0m-2.5m. Moist clayey f-c sand with some fine gravels (SC) [10% G, 70% S, 20% F], strong brown 7.5YR 5/6, Recovery 70%, gravel angular, Fill soils. PID 0.0 ppm. Collect sample CC017SS01.
0855 Core 2.5m - 4.0m, Recovery 80%.
2.5-3.0 m: Same as above but yellowish brown 10YR 5/6
3.0-3.5 m = moist f-c sandy clay (CL) with angular f-m gravels. Strong brown 7.5YR 5/8. Low-mod. plasticity.

866

4/2/03 (11)

3.5-4.0 m = moist, f-c sandy clay (CL) with f-m angular gravels. Yellowish Red 5YR 5/8. Fill soils. (quartzite gravels)
09:15: Core 4.0m - 5.5m. Recovery = 80%.
4.0m-5.1m = moist, clayey f-c sand (SC) with some fine gravels. [5% G, 60% S, 35% F] sands = quartz & feldspar sub-angular to sub rounded. Looks much like saprolite but gravel inclusions indicate fill soils.
5.1m-5.5m = moist, ~~[illegible]~~ clayey f-c sand. [55% S/45% F] clay = low-mod. plasticity. Strong brown 7.5YR 5/6. Fill soils
09:35 Core 5.5m-7.0m, Recovery 70%.
5.5m-6.6m = same as 5.1m - 5.5m
6.6m-6.7m = gneissic f-m gravels & silty sands (GM) Dark brown 10YR 3/3 (angular gravels)
6.7-7.0 m = f-c clayey sands (SC) with f-m quartzite gravels. Strong brown 7.5YR 5/6 (fill)
Collected sample CC017BS01.

(12) 4/2/03

09:55 : core 7.0 – 8.5 m., Recovery 60%. Moist, clayey f-c SAND (SC) with trace fine gravels. Strong brown 7.5YR 5/6. (Fill soils)

At 8.4 m = dark greenish gray 5G 4/1 fine & medium sandy clay (CL), low plasticity, increased moisture content.

1025 : core 8.5m – 10.0 m, Recovery = 90%.

8.5-9.0 m = wet, f-m sandy clay, high plasticity (CH) - Yellowish Red 5YR 5/8 [30% S / 70% F] (soft)

9.0 - 9.8 m = becomes olive brown 2.5Y 3.5/2

9.8 - 10.0 = becomes dark brown 10YR 3.5/3 less sands [20% S / 80% F] medium stiff. manganese nodules.

~~Sam~~ Collected Sample CC017BS02.

1040 Move to Boring #5 : location 018.

1045 Begin drilling.

1055 0.0 - 1.0 m : moist, strong brown 7.5 YR 4/6, fine to coarse clayey sands (SC) with some fine gravels. (Fill soils) medium dense to dense. [10% G, 60% S, 30% F]

867

4/2/03 (13)

11:10 core 1.0 m - 2.5 m, Recovery 70%. Same as 0.0 – 1.0 m with increased f-m gravels. [sample CC018SS01] [20% G, 55% S, 25% F] very dense.

11:30 core 2.5m – 4.0 m → no recovery. drilling difficult, appear to be pushing coarse gravels or cobble before sampler. Will try breaking with hammer.

11:45 Lunch break

12:45 Resume drilling.

13:25 core 4.5m – 6.0 m, Recovery = 80%, moist, medium dense, clayey f-c SANDS (SC) with some fine gravels [5% G, 50% S, 45% F], strong brown, 7.5 YR 4.5/6. clasts: quartz & feldspar, minor mafics. Possibly saprolite with granite parent but some angular clasts could indicate fill materials. [Sample CC018BS01]

1345 Core 6.0 – 7.5 m, Recovery 55%. increased gravels (quartzite) At 7.0 m becomes f-c sandy clay (CL) with increased water content (Fill soils).

(14) 4/2/03

1400 Core 7.5m – 9.0 m, Recovery = 60 %
SAME AS 4.5m – 6.0m → appears to be Fill.
Collect Sample CC018BS02

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1410 Begin drilling Boring 6: Location 022
1420 Core 0.0m – 1.0m: moist, strong brown 7.5 YR, medium dense, clayey f-c SANDS (SC) [60% S/40% F] (Fill Soils.)
14:30 Core 1.0m – 2.5m, Recovery = 80 %
SAME AS 0.0m – 1.0m. [Sample CC022SS01]
14:40 Core 2.5m – 4.0m, Recov. 65%
SAME AS 1.0 – 2.5m
1500 Core 4.0m – 5.5m Recov. = 80%
SAME AS 2.5m – 4.0m but more consolidated. Could be saprolite or may be fill. [Sample CC022BS01]
1510 Core 5.5m – 6.2m, Recovery 30%
SAME AS 5.5m – 6.2m. with very small plant roots at 6.1m → indicates = fill material.
(Core short because encountered cobble.)
1545 Core 6.5 – 8.0m, Recov. 80 %

868

4/2/03 (15)

~~SAME AS 5.5–6.2m.~~
Moist f-c SANDY clay (CL), Low plasticity [45% S/55% F] strong brown 7.5YR 5/8 (Fill)
Becomes wet clayey SAND (SC) at 7.5m. [75% S/25% F]
[Sample SS022BS02]
1605 Core 8.0m – 9.5m, Recov. = 65%
moist to wet f-c Sandy clay (CL) Low-med plasticity [40% S/60% F] Strong brown 7.5YR 5/8

---

1615 Begin drilling Boring 7: Location 028
1620 Core 0.0m – 1.0m, Recov. = 100%
moist, strong brown 7.5YR, dense, clayey f-c SANDS (SC) [60% S/40% F] Fill Soils. (trace fine gravels)
16:30 Core 1.0 – 2.5m, Recov. = 80%
SAME AS 0.0–1.0m with 15% f-m gravels. [15% G/55% S/30% F] (SC) (Fill)
1640 Core 2.5m – 4.0m, Recov. = 90 %
SAME AS 0.0 – 1.0m with trace fine gravels. (FILL)
At 3.5m becomes f-c sandy clay (CL) [20% S/80% F]

4/2/03

Low plasticity, strong brown
7.5 YR 4.5/6 (F, CL)

16:55 core 4.0m - 5.5m, 90% Recov.
4.0m - 4.3m = Same as 3.5 - 4.0 m
4.3m - 5.5m = moist, clayey f-c
sand (SC) [65% S/35% F]
strong brown 7.5 YR 5/6 (Fill)
dense. [Sample CC028BS01]

1804: core 5.5m - 7.0m, 40% Recov.
moist, clayey f-c sand (SC) (Fill)
[55% S/45% F] strong brown
7.5YR 4.5/6

At 6.6 - 6.9 m = Root inclusions
color changes to dark greenish
gray 5GY 4/1 + fine angular
quartzite gravel.

1825 core 7.0m - 8.5m, 65% Recov.
moist f-c sandy clay (CL)
[45% S/55% F] strong brown
7.5YR 4.5/6 with some
dark greenish gray 5GY 4/1
at 7.0 - 7.2 m
[Sample CC028BS02]

1830 Leaving Site

[redacted]

869

66

4/3/03 

Onsite 0745 - Area D.
Begin drilling Boring 8 - location 027

0750: core 0.0 - 1.0m. 100% Recovery.
moist, clayey f-c sands (SC)
with some fine - medium gravels.
[5% G, 75% S, 20% F], dark yellowish
brown 10 YR 4.5/6. (Fill soils)

0755 core 1.0 - 2.5 m, Recov. = 40 %
moist, f-c sandy clay (CL),
low plasticity [45% S/55% F]
yellowish red 5YR 5/8

0811 core 2.5m - 4.0m, Recov. = 60 %
2.5-3.5 moist, f-c sandy clay (CL)
low-mod. plasticity [40% S/60% F]
strong brown 7.5YR 4.5/6

3.5-4.0 [Sample CC027BS01]
3.5-4.0 = contact, moist f-c sandy
clay (CL) mod-plasticity [40% S/60% F]
dark greenish gray 5GY 4/1
high mica content (biotite + muscovite)
grading to fine sandy clay (CL)
[20% S/80% F], mod - high
plasticity (CL) (micaceous)

0820 core 4.0 - 4.5m, 20% Recov.

(18)

4/3/03

(encountered cobble (quartzite)
moist, + sandy clay (CL)
medium plasticity - ~~V~~
~~(... with ...)~~ - firm
variegated greenish gray 5G 6/1
and olive 5Y 4.5/4,

08:47 core 5.0 - 6.5m, Recov: 55%
moist f-m sandy clay (CL)
med plasticity. micaceous
(biotite - muscovite).
variegated olive 5Y 4/3,
reddish brown 5YR 5/6, and
yellowish brown 10YR 5/8.
[Sample CC0278502]

09:05 core 6.5m - 7.0m, Recov. 50%
saprolite - ~~clear~~ angular quartz,
highly weathered feldspar → clay.
low mica, some mang. nex.
moist, f-m sandy clay (CL)
Low plasticity variegated
7.5 YR 6/8 to 10YR 6/8
reddish yellow to brownish
yellow.

0130 Packing up site to move to Area 41.

870

(19)

4/3/03

0945 Leaving Area D
0955 Onsite Area 41
locating sample areas
10:41: Water level BW14 = 6.472m TOC
→ well located in adjacent yard near
hazardous materials storage area.
Area 3 meters lower than site
ground surface.
1105 Boring & well locations marked.
1130 Lunch Break
1215 On site - waiting for
utility clearance.
1330 Begin drilling 1st Boring
at Area 41. - - Location = 05E
1340 Core 0.0m - 1.0m Recovery = 70%
material in core looks like
decomposed granite - saprolite -
can see grain structure of
weathering quartz & feldspar with
biotite mica and other mafics.
when crushed feldspars disintegrate
to clays - and material becomes:
moist, clayey f-c sands.
[60% S / 40% F] = strong brown

4/3/03

1350 2.5 YR ~~4.5~~/6 , dense
~~1400~~: Core 1.0 – 2.5 m , Recov = 70%,
same as 0.0 – 1.0 m but more
friable. color = 7.5 YR 5/6.
[Sample at 0.2 – 1.5 m = CC052SS01]

1400 Core 2.5 – 3.0 m , recovery = 90 %
difficult drilling / Refusal at 3.0 m
same as 1.0 – 2.5 m.

---

1410 Begin 2nd Boring at location 061.
1420 core 0.0 – 1.00 m, recov = 60 %
0.0 m – 0.5 m = Fill materials,
moist, Red 2.5 YR 4/6, f-c
sandy clay (CL) and yellowish red
5YR 4/6 ~~sandy~~ clayey f-c
sands (SC) – material appears to
be decomposed granitic source, some
manganese!

0.5 m – 1.0 m : contact at 0.5 m
with Saprolite : same as Boring
052 – granitic structure visible

1430 : core 1.0 – 2.0 m , recov = 90 %.
same as 0.5 – 1.0 m , but more
friable. [Sample (CAIR) CC061SS01]

1440 : changed to percussion bit to

871



4/3/03

advance boring. Sample collected
from cuttings at 4.0 – 5.0 m :
CC061BS01 : Saprolite.

1505 Boring 3rd : Location 062
0.0 – 1.0 m core.
0.0 – 0.1 = fill soil as before.
0.1 – 1.0 = Saprolite (granitic)
mottled 10YR 8/4 pale brown
to 10YR 5/4 yellowish brown
Sample CC062SS01

1510 Boring 4th . Location 065
core 0.0 – 0.7 m –
0.0 – 0.3 = Fill : some dark staining (0.1–0.3)
Sample CC065SS01
0.3 – 0.7 = Saprolite : strong brown
7.5YR 5/6 , dense.

1520 core 0.7 m – 1.5 m = Saprolite
as 0.3 – 0.7 m.
Sample combined 0.3 m – 1.5 m
CC065BS01

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Boring 5 → Location 060
1530 Core 0.1 m – 0.8 m = fill soil →
f-c materials with gravels at 0.7 – 0.8
(SC)

(22)

4/3/03

Strong brown 7.5YR 5/6.

1540: Core - 0.8 - 1.5 m.

0.8 - 0.9 = same as above. (SC)

0.9 - 1.2 = fill = Red 2.5YR 4/6

~~1.2 - 1.5~~ fine - med sandy clay (CL)

1.2 - 1.5 m = Native soil = Silt (ML) Brownish yellow 10YR 6/5. Fine stockwork silt with manganese carbon.

1545: core 1.5 m - 2.2 m - silt (ML) same as above.

Combined cores for 2 samples:

0.1 - 1.2 = CC0608SS01

1.2 - 2.2 = CC0608BS01

1608: core 2.5 m - 4.0 m, Recov = 100% = silt (ML) - same as above.

1425 Area secured - Leaving Area 41

1530 Leaving area Drilling sampling

bb [redacted]

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(23)

4/4/03

08:30 Onsite Area 41

09:00 continue drilling 0[illegible]

core 4.0 m - 4.7 m -

Same as above but gradually

some clay - low plasticity (ML)

09:10 Moved to Boring 6, Location 063

Core 0.1 - 0.8 m [Sample CC063SS01]

0.1 - 0.6 = Fill materials - DG (SC)

0.6 - 0.8 - Fill materials - clayey gravels. (GC)

09:18: core 0.8 - 2.3 m Recovery = 70% Saprolite (DG), when weathered = moist, clayey f-c sand with some clayey gravels (SC) [52% G / 95 %S / 20 % F] [Sample]

Strong brown 7.5YR 4.5/6

09:25 Moved to Boring 7, Location 058

core 0.1 - 0.8 m: Fill material

moist, f-m sandy clay (CL)

Low plasticity, Red 2.5YR 4/6

09:35 = Core 0.8 - 2.4 m, Recov = 85%

0.8 - 1.1 m = same as above

1.1 - 2.4 m = highly weathered argillic rock (Saprolite), yellowish brown

Sample 0.8 - 1.4 m - CC058SS01

Sample 1.4 - 2.4 m - CC058BS01

4/4/03

10YR 5/6, crushes to clayey f-c SAND (SC) [55%/45% F]

0945 Move to Boring #8, Location 056

0950 Core 0.1-0.8m = weathered quartz - AS Boring 58 1.2m.
Sample CC056SS01

Core 0.8-2.3m = highly weathered granite (saprolite)
Strong brown 7.5YR 4.5/6

1000 Move to Boring #9, Location 55
Core 0.1-0.8m = fill
Core 0.8-2.3m = Recov. = 60%
saprolite as in #56

1010 Move to Boring #10, Location 051
Core 0.1-1.0m = fill soil
0.1-0.6m = weathered quartz fill,
0.6-1.0m = Fill - clay (CL/CH)
med. high plasticity + dark brown 10YR 4/3 [SAMPLE CC051SS01]
organic material at 1.0m: wood

10:25 Core 1.0-2.3: saprolite at 1.3m

1030 Move to Boring #11, Location 057
Core 0.1-0.8m = saprolite

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4/4/03

Strong brown 7.5YR 5/6
[Sample CC057SS01 at 0.1-1.3m]
Core 0.8-2.0m = same as above

10:45 Move to Boring #12, Location 064
Core 0.1-0.8m, saprolite
(weathered granite rock)
quartz veining at 0.1-0.4m
strong brown 7.5YR 5/6
(no samples)

Move to Boring #13, Location 059

10:50 Core 0.1-0.8m = Fill soils
(brown weathered granite rock)
7.5YR 5/6

1100 Core 0.8-2.4m = saprolite (granite)
Sample 0.1-1.6m [CC059SS01]

1200 Lunch Break.

1300 Set up on Boring #14, Location 067

1305 Core 0.1-0.8m → fill soil
moist f-c sandy clay (CL)
strong brown 7.5YR 4/6 [Sampled]

1315 Core 0.8m-2.2m, recovery 70%
0.8-2.0m = fill (CL)
2.0m-2.2m = saprolite

(26)
4/4/03
13:27 core 2.2m – 4.0m = saprolite
very weathered

Move to boring #15, location 068
13:40 core 0.1m – 0.8m =
0.1 – 0.3m = fill (CL)
0.3 – 0.8m = saprolite
13:48 core 0.8m – 2.2m = saprolite

Move to boring #16, location 069
1400 core 0.1m – 0.8m = fill [Sampled]
1408 core 0.8 – 2.2m = saprolite
~~Sample~~
Move to boring #17, location 070
14:16 core 0.1 – 0.8m = fill
1428 core 0.8 – 2.2m
0.8 – 1.5m = fill [Sampled]
1.5m – 2.2m = saprolite
note: upper 30 cm of ~~core~~ 0.1 → 0.8 core color = dark greenish gray 5GY 4/1

(27)
4/8/03
Onsite Area D 08:00

START DRILLING @ LOCATION 24.
WILL UTILIZE HSA & AIR ROTARY AS NEEDED FED
DRILLING USING CME DRILL RIG
4 WORKER + SUPERVISOR, SAM SUNG 4 WORKERS

1050 BORING INSTALLED TO 45'
CONTINUOUS CORE TO 14'
@ 15 → 40' 2' SAMPLE EVERY 5'. LET WELL SET TIL AFTER LUNCH WL @ 37'

1215 WL @ 27' INSTALL WELL. USE 20' [illegible] CASING

1445 BENTONITE SEAL INSTALLED MOBILIZE TO LOCATION # [illegible] & START DRILLING

1600 STOPPED DRILLING [illegible] @ 10'

AREA 41 SET UP ON LOCATION #54
COLLECT SURFACE SOIL SAMPLE @ LOC.

1600 LOC #54 @ 35', ENCOUNTERING
REFUSAL WITH AUGER. FED
MAY SWITCH TO ROCK CORING.
AREA 41 IS SECURED @ 1630, WORK
MUST STOP @ 1600.
FED HAS MUCH PROB WITH RIG
(CLUTCH) MAY NOT BE ABLE TO AUGER
FURTHER. WILL LET SITE SIT &
CHECK WL TOMORROW.

878

1630 OFF SITE.

COLLECTED SAMPLES

CC-001 BS-002
CC-~~08~~ 054 ~~BS~~-001
CC-054 BS-002

LAST ENTRY [redacted] 4/10/03



4/10/03

AREA D MW 1, 8.14 M @ 0830 (TOC)
MW 24, 8.39 M @ 0835 (TOC)

0730 ONSITE PREP. EQUIP
0800 FED CHECKS WL, NO WATER
BUT AUGER BIT IS MOIST-WET
OPTIONS A: SWITCH TO CORING
B: SWITCH TO SMALLER DIA AUGER.
~~OPTION~~ OPT. TO TRY SMALLER AUGERS
BORING @ 35'.
0900 FED REMOVED AUGERS, WORKING
ON RIG
0930 SMOKE BREAK.
0945 START DRILLING. FED ESTIMATED
WL @ 38' NOW USING 6" AUGERS
1045 @ 45' WL @ 44'. ~~SEEMS~~ ESTIMATE
WL WILL REBOUND TO ~36'
DUE TO INTRUSIVE ACTIVITY & FRICTION
WL @ 40' AFTER 5 MIN. WILL
WAIT FOR WL TO STABILIZE THEN
REAM OUT BORING WITH 8" AUGER
& INSTALL WELL

WL @ 37' @ 1100, FED WILL REMOVE AUGERS & PREP FOR REAMING.

1145 LUNCH

1300 RESUME WORK. FED START REAMING OUT BOREHOLE TO 8" DIA. WL @ 36' @ 1300

1630 MW INSTALLED BORING COMPLETED TO 145' WILL GROUT TOMORROW 4/11/03. FED SETS UP ON LOC #66. NOTED THAT SELECTED LOC WAS WITHIN 10-15' OF OVERHEAD UTILITIES INSTRUCTED FED TO MOVE 15' STREETSIDE OF OVERHEAD LINES BECAUSE OF SAFETY CONCERNS.

~~ANALYTICAL~~ NO SAMPLES COLLECTED TODAY.

LAST ENTRY [redacted] 66 4/10/03

876



4/11/03 CAMP CARROLL AREA 41

0730 ONSITE PRIOR TO START BORING #66. NOTE CONDITIONS ARE COLD & RAINY

0800 MR PAK OF FED, INDICATES THAT THE DRILLERS WILL START THIS BORING USING 6" HSA. IF SITE CONDITIONS ALLOW THE WELL WILL BE INSTALLED IN THE OPEN 6" BORING. IF HOLE COLLAPSES TO LESS THAN REQ D. BORING WILL BE REAMED WITH 8" HSA.

1130 MINIMAL SAMPLE RECOVERY DUE TO SPLITSPOON REFUSAL. PRE BORE TO 45' & CHECK WL / COLLECT SPLITSPOON SAMPLE.

1230 LUNCH

1330 RESUME WORK.

1355 SAMPLER REFUSAL @ 45'. NO WATER ENCOUNTERED. FED DECIDES TO DRILL TO 50' & RECHECK WL.

(34)

1440 @ 50' SAMPLER REFUSAL
WL @50' @ 1440, @ 45' ℓ/RSJ

1445 BORING/WELL #66 COMPLETE
DECIDED TO USE 25' SCREEN DUE
TO SLOW RECOVERY OF BORING
EXPECT [illegible] WL TO RISE TO LOC
54 WL ~35', SO EXTRA SCREEN
SHOULD COVER WELL REQ.

COLLECTED SAMPLES:
CC-066 SS-01
CC-066 SB-02
CC-066 SB-03.

NOTE: FED CREW WILL DRUM 800
FOR WEEKEND. MR KIM WILL BE
THE PRIMARY POC. WILL DRILL
AREA D BECAUSE AREA 41 WILL BE
SECURED OVER THE WEEKEND.

LA[illegible] 4/11/03 [redacted] b6

(35)

4/12/03 CAMP CARROLL AREA D

0730 ONSITE, SUNNY, CLEAR,
SET UP ON LOCATION #37
@ AREA D.

0812 START DRILLING

0940 NOTED CHEMICAL ODOR @ ~20'-30'

1045 BORING #37 COMPLETE, WELL INST.
TO FOLLOW (2 ANALYTICAL SAMP. COLLECTED)

1145 WELL INSTALLED (FILTER PACK & BENT.
SEAL

1200 LUNCH BREAK

1300 RESUME WORK SETUP ON LOC #39
GROUT MW # 37

1605 BORING #39 COMPLETE TO 41'
INSTALL WELL 4/13/03.
NOTE LOC# 36 NO ACCESS THIS
WEEKEND INSTALL ON MON/TUES
ON 4/13 WORK: INSTALL #39, DRILL/
INSTALL #12.

(36)

COLLECTED ANALYTICAL SAMPLES:

CC-03768-01
CC-03788-02

TODAY. NO SOIL COLLECTED FROM #39.

1605 SECURE SITE.

LAST ENTRY 4/2/09 [redacted] 6b

878

(37)

4/13/09 CAMP CARROLL AREA "D" R1

0730 ONSITE W/ CREW IN #39
BEGIN WELL INSTALLATION.

0915 INSTALLATION COMPLETE
SET UP ON LOC #2

1105 BORING COMPLETE TO 41'

1130 LUNCH BREAK,

1200 RESUME WORK

1403 WELL #2 INSTALLED. (FILTER PACK & SEAL) INSTALLING GROUT. NOTED THAT 10W CUTTINGS ARE BEING BAGGED IN PREP. FOR TRANSPORT TO LANDFARM FACILITY NEAR AREA D (ADJACENT TO SMALL ARMS RANGE.) CUTTINGS FROM AREA D WELL #1, 2, 4 WERE "DISPOSED OF" ~~BURIED~~ BACKFILLED DURING TRENCHING INVESTIGATION NEAR #1 @ AREA D.

1500 SAMPLES IN AREA D WILL BE COLLECTED FROM AREAS WITH

NOTED ODOR OBSERVABLE IMPACT.
NO ANALYTICAL SAMPLES COLLECTED
TODAY. WORK WILL RESUME @
AREA D #38 OR AREA #41 #53

~~ERROR ENTRY~~ 4/15/03 [redacted] 66

668



4/14/03 CAMP CARROLL AREA D & 41 R1

0730 ONSITE AREA D SAM JUNG RELOCATED LOCATION #38 FROM THE BOTTOM OF THE HILL TO ~~AN~~ A NEW LOCATION 30M NORTH OF #37. THIS CHANGE IS DUE TO SUSPECTED CONTAMINATION IN LOCATION #37. I NOTED ~~THE~~ TO SAM JUNG THAT THE CHANGE WILL LEAVE NO ~~BORING~~ GW INFO B AT ELEV. BELOW AREA D HOWEVER THE CONCERN ~~TO~~ IS IF CONT IS ENCOUNTERED IN #37, THE CONT / REA MAY EXTEND OUTSIDE OF AREA D. DR. LEE ~~REQUEST~~ MADE THIS DECISION TO RELOCATE #38.

0805 START BORING #38, AREA D.

0900 NATIVE MATERIAL ENCOUNTERED @ [illegible] BECOMES INCREASINGLY DENSE WITH DEPTH, FED SWITCH TO 6" AUGERS.

1100 @ 31' LITHOLOGY IS VERY DENSE. FED DRILLER MR. JUNG, INDICATES THAT HE CANNOT PROGRESS WITH 6" HSA. FED WILL USE CORING TO COMPLETE THE BORING. SET UP CORING EQUIP.

1130 LUNCH BREAK

1232 RESUME WORK. NOTE: FED IS USING WATER AS A CIRCULATION FLUID. THIS WILL SKEW GW LEVELS IN THE LOCAL VIC. GW MEASUREMENT SHOULD BE TAKEN AFTER GW LEVELS HAVE STABILIZED.

1500 WELL INSTALLED, MOBILIZE TO AREA 41. IF BORING IS COMPLETED SATURDAY, WILL RETURN TO COLLECT A SAMPLE AFTER BORING/WELL # 37

1522 ONSITE AREA 41, SB ~~#~~ #53

1632 #53 COMPLETE TO W/

LAST ENTRY 4/16/03 [redacted] 66

4/15/03 CAMP CARROLL AREA D + AREA 41

0930 ONSITE AREA 41, LOCATION # 53
WL IN LOC # 53 @ 15' DEPTH
WL DATA FROM WL 54 + 66 INDICATE WL SHOULD BE ABOUT 30' DEPTH.
NOTED THE PROXIMITY OF A OPEN ~~[illegible]~~ DRAINAGE TRENCH, ~~AND~~ AND THE SIZE OF THE PARKING LOT THAT IT DRAINS. THE HIGHER WL MAY BE A PERCHED ZONE, OR A LARGE POOL OF WATER MAY BE INFLUENCING TO THE 30' WL, OR A CONFINED LAYER. INSTRUCTED FED TO SET WELL @ 40' BUT SCREEN TO 10' (30' SCREEN SECTION) TO CAPTURE ALL POSSIBILITIES

0945 LOCATION # 53 COMPLETE. MOBILIZE BACK TO AREA "D" TO COLLECT SUBSURFACE SOIL SAMPLE.

1030 ON SITE AREA "D" SET UP ON LOC# 40

1200 LUNCH BREAK @ 17' IN LOC #40

1300 RESUME WORK

1330 NATIVE MATERIAL ENCOUNTERED

COLLECTED 2 ANALYTICAL SAMPLES
TODAY

CC-04C BS-01

CC-04 BS-02

1345 ~~HAD~~ COMPLETE NO WELL INSTALLED
BORING. BACK FILLED WITH BENTONITE
& SAND.

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# Appendix C

Boring Logs, Well Completion Diagrams, Well Development Logs,

and Groundwater Sampling Logs

## Soil Sampling PID Checking AREA D

| Point NO./ Soil NO. | | Date | Time(1st sampling) Collected Time | Measured Time | Depth | PID (ppm) | REMARK | Date | Time(2nd sampling) Collected Time | Measured Time | Depth | PID (ppm) | REMARK |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CC001 | SS01 | 2003.04.01 | 11:03 | - | 1m | - | ascon at 9ft | 2003.5.27 | 11:05 | - | 1m | - | |
| | BS01 | 2003.04.09 | 8:25 | 8:45 | 20~22ft | 57.6 | | 2003.5.27 | 12:15 | - | 6.6m | - | |
| | | | 8:35 | 8:50 | 25~27ft | 465 | | | | | | | |
| | | | 8:55 | 9:20 | 35~37ft | 16.1 | | | | | | | |
| | | | 9:20 | 9:45 | 40~42ft | N.D | | | | | | | |
| CC003 | SS01 | 2003.04.01 | 14:40 | 14:58 | 2m | N.D | | 2003.6.2 | 10:31 | 10:50 | 1~2.2m | 0 | |
| CC004 | SS01 | 2003.04.01 | 10:53 | - | 1m | - | | 2003.5.27 | 13:55 | - | 1m | - | |
| CC006 | SS01 | 2003.04.01 | 14:29 | - | 1~2.5m | - | | 2003.5.28 | 15:10 | - | 2~3m | - | |
| | BS01 | | 15:00 | - | 4~5.5m | - | | | 15:28 | - | 3.5~4.5m | - | |
| | BS02 | | 15:15 | - | 5.5~7m | - | | | 15:52 | - | 5~6m | - | |
| CC007 | SS01 | 2003.04.01 | 11:15 | 11:27 | 2m | 0.1 | | 2003.6.2 | 10:59 | 11:15 | 1~2.2m | 5.1 | |
| CC008 | SS01 | 2003.04.01 | 11:30 | 11:45 | 2m | 0.1 | BG=0 mg/l | 2003.5.28 | 14:12 | 14:35 | 2~3m | 0 | |
| CC009 | SS01 | 2003.04.01 | 11:45 | 12:00 | 2.1m | 0.2 | | 2003.5.28 | 14:40 | - | 2~3m | - | |
| CC010 | SS01 | 2003.04.01 | 10:28 | 11:02 | 1m | 0.2 | | 2003.5.27 | 14:20 | - | 1~2m | - | |
| | BS01 | | 11:40 | - | 4.7~5.8m | - | | | 15:30 | - | 4.7~5.8m | - | |
| | BS02 | | 12:20 | - | 7.3~8.6m | - | grab | | 15:56 | - | 7.3~8.6m | - | |
| CC012 | | 2003.04.13 | 9:35 | 10:00 | 0~2ft | N.D | | | | | | | |
| | | | 9:45 | 10:00 | 2~4ft | N.D | | | | | | | |
| | | | 9:50 | 10:10 | 4~6ft | 2.6 | | | | | | | |
| | | | 10:00 | 10:20 | 6~7.5ft | 2.3 | | | | | | | |
| | | | 10:05 | 10:40 | 8~10ft | 40.6 | | | | | | | |
| | | | 10:10 | 10:40 | 10~12ft | 7.4 | | | | | | | |
| | | | 10:15 | 10:45 | 12~14ft | 453 | | | | | | | |
| | | | 10:20 | 10:45 | 15~17ft | 40.7 | | | | | | | |
| | | | 10:25 | 10:50 | 20~22ft | 236 | | | | | | | |
| | | | 10:50 | 11:20 | 25~27ft | 8.1 | | | | | | | |
| | | | 11:05 | 11:25 | 30~32ft | 284 | | | | | | | |
| | | | 11:25 | 12:15 | 35~37ft | 5.5 | | | | | | | |
| | | | 11:45 | 12:15 | 40~42ft | 6.6 | | | | | | | |
| CC013 | SS01 | 2003.04.01 | 12:00 | 12:15 | 2m | 0.5 | | 2003.5.27 | 14:48 | - | 2~3m | - | |
| CC014 | SS01 | 2003.04.02 | 14:00 | - | 1.9m | - | | 2003.6.2 | 11:22 | 11:35 | 1~2.2m | 0 | |
| CC015 | SS01 | 2003.04.01 | 14:20 | 14:55 | 2m | N.D | T.P: 68.1, lots of ascon | 2003.5.28 | 12:25 | 12:40 | 2~3m | 0 | |
| CC017 | SS01 | 2003.04.02 | 8:43 | 9:13 | 1~2.5 | N.D | | 2003.6.2 | 13:05 | 13:30 | 1~2.2m | 2.5 | |
| | BS01 | | 8:55 | 9:15 | 2.5~4m | 0.1 | | | 15:16 | 15:40 | 4~5.2m | 2.6 | |
| | BS02 | | 9:35 | 10:40 | 5.5~7m | 0.8 | | | 16:15 | 16:40 | 5.5~6.7m | 1.2 | |
| | BS03 | | 9:55 | 10:47 | 7~8.5m | 0.7 | | | 16:15 | 16:50 | 7.0~8.2m | 2.7 | |
| CC018 | SS01 | 2003.04.02 | 11:10 | - | 1~1.25m | - | | 2003.6.2 | 16:58 | 17:20 | 1~2.2m | 2.9 | |
| | BS01 | | 13:20 | 13:40 | 4.5~6.0m | 1.3 | CH4 ConC: 89.3mg/kg | | 17:13 | 17:40 | 4.5~5.7m | 3.4 | |
| | BS02 | | 14:00 | 14:18 | 7.5~9m | 0.2 | CH4 ConC: 152.2mg/kg | | 17:46 | 18:10 | 7.5~8.7m | 5.1 | |
| CC019 | SS01 | 2003.04.01 | 15:15 | 15:39 | 1.2m | 0.1 | | 2001.5.27 | 17.57 | - | 1.2~2.2m | - | |
| CC020 | SS01 | 2003.04.01 | 16:20 | 16:35 | 2m | N.D | | 2003.5.29 | 15:56 | 16:15 | 1.5~2.5m | 5.3 | |
| CC021 | SS01 | 2003.04.01 | 16:58 | 17:15 | 1.9m | N.D | | 2003.5.29 | 15:36 | 15:50 | 1.5~2.5m | 4.1 | |
| CC022 | SS01 | 2003.04.02 | 14:30 | - | 1~2.5m | - | | 2003.6.3 | 9:10 | 9:40 | 1.0~2.2m | 3.4 | |
| | BS01 | | 15:45 | 16:05 | 6.5~8m | 0.1 | | | 10:20 | 10.36 | 6.5~7.7m | 0.7 | |
| CC023 | SS01 | 2003.04.01 | 17:15 | 17:23 | 2m | N.D | | 2003.5.27 | 17:02 | - | 2~3m | - | |
| CC024 | BS01 | 2003.04.08 | 9:50 | 10:05 | 20~22ft | 83.8 | | 2003.6.2 | 18:20 | 18:40 | 5.5~6.7m | 2 | |
| | BS02 | | 10.30 | 10.52 | 30~32ft | 1605 | | | 18:40 | 19:30 | 8.5~9.7m | 3.5 | |
| | BS03 | | 10:40 | 11:10 | 35~37ft | 325 | BG : 2.1 | | 19:20 | 19:50 | 9.7~10.8m | 0 | |

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| Point NO./ Soil NO. | | Date | Time | | Depth | PID (ppm) | REMARK | Date | Time | | Depth | PID (ppm) | REMARK |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Collected Time | Measured Time | | | | | Collected Time | Measured Time | | | |
| CC039 | | 2003.04.12 | 14:05 | 14:25 | 8~10ft | N.D | | | | | | | |
| | | | 14:10 | 14:30 | 10~12ft | N.D | | | | | | | |
| | | | 14:15 | 14:40 | 15~17ft | N.D | | | | | | | |
| | | | 14:27 | 15:00 | 20~22ft | N.D | | | | | | | |
| | | | 14:45 | 15:10 | 25~27ft | N.D | | | | | | | |
| | | | 15:25 | 16:00 | 30~32ft | N.D | | | | | | | |
| | | | 15:35 | 16:00 | 35~37ft | N.D | | | | | | | |
| CC040 | | 2003.04.15 | 10:30 | 10:55 | 0~2ft | 42 | | 2003.5.29 | | | | | |
| | | | 10:35 | 10:55 | 2~4ft | 22 | | | | | | | |
| | SS01 | | 10:45 | 11:05 | 4~6ft | 14.7 | | | 11:48 | 12:10 | 1.2~2.2m | 4.8 | |
| | | | 11:05 | 11:35 | 6~7.5ft | 3.2 | | | | | | | |
| | | | 11:15 | 11:35 | 8~10ft | 8.8 | | | | | | | |
| | | | 11:20 | 11:35 | 10~12ft | 106 | | | | | | | |
| | | | 11:25 | 11:40 | 12~14ft | 190 | | | | | | | |
| | | | 11:30 | 11:40 | 15~17ft | 72.1 | | | | | | | |
| | BS01 | | 13:15 | 13:30 | 20~22ft | 94.7 | | | 13:22 | 13:33 | 6~6.7m | 4.3 | |
| | | | 13:20 | 13:35 | 25~27ft | 26.5 | | | | | | | |
| | | | 13:40 | 13:50 | 30~32ft | 5.4 | | | | | | | |
| CC080 | BS01 | 2003.04.09 | 10:40 | - | 4.5m | - | | 2003.6.3 | 11:45 | 12:00 | 4.5~5.7m | 1.4 | |

885

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| Point NO./ Soil NO. | | Date | Time(1st sampling) | | Depth | PID (ppm) | REMARK | Date | Time(2nd sampling) | | Depth | PID (ppm) | REMARK |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Collected Time | Measured Time | | | | | Collected Time | Measured Time | | | |
| CC066 | SS01 | | 8:30 | 8:53 | 0~2ft | 113 | | | 10:05 | 10:20 | 0.5~1.7m | 6 | |
| | | | 8:30 | 9:05 | 2~4ft | 53.6 | | | | | | | |
| | | | 8:40 | 9:10 | 6~7.5ft | 44.6 | | | | | | | |
| | | | 8:45 | 9:20 | 8~10ft | 15.2 | | | | | | | |
| | BS01 | | 8:50 | 9:20 | 10~12ft | 2 | | | 10:35 | 10:48 | 3~4.2m | 4.1 | |
| | | 2003.4.11 | 9:05 | 9:30 | 12~14ft | 1.8 | | 2003.6.4 | | | | | |
| | | | 9:45 | 10:15 | 15~17ft | 9.5 | | | | | | | |
| | | | 10:05 | 10:40 | 20~21.5ft | 25.3 | | | | | | | |
| | | | 10:30 | 10:50 | 25~27ft | 30.2 | | | | | | | |
| | BS02 | | 11:05 | 11:30 | 30~32ft | 6 | | | | | | | |
| | | | 11:35 | 12:05 | 35~35ft" | 5.9 | | | 11:25 | 11:50 | 9~10.0m | 0.5 | |
| CC067 | SS01 | 2003.04.04 | 13:05 | 13:35 | 0.1~0.8m | 0.8 | | 2003.6.4 | 12:15 | 12:40 | 0.5~1.7m | 1.4 | |
| CC069 | SS01 | 2003.04.04 | 14:00 | 14:35 | 0.1~0.8m | 0.2 | T.P: 23.3 CO2: 1831 | | | | | | |
| CC070 | SS01 | 2003.04.04 | 14:16 | 14:38 | 0.1~0.8m | 0.1 | T.P:70.2 CO2 :5300.2 | | | | | | |

# LOG OF WELL AREA 41 #53

BOREHOLE / WELL LOCATION SKETCH MAP

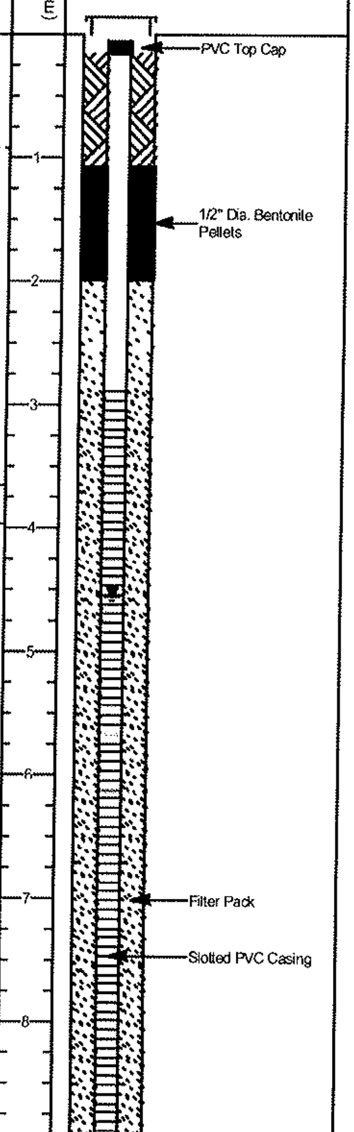
N

| | |
|---|---|
| PROJECT NO. | PROJECT NAME: Camp Carroll Area D and Area 41 RI |
| LOCATION: Camp Carroll, Taegu, Republic of Korea | DATE & TIME STARTED: 4/14/03 15:22 |
| LOGGED BY: [redacted] bb / REVIEWED BY: | DATE & TIME FINISHED: 4/15/03 09:00 |
| DRILLING CONTRACTOR / DRILLER: FED / [redacted] bb | DRILLING METHOD: Hollow-Stem Auger |
| COORDINATES: | |
| SAMPLING METHOD: Split-Spoon Sampler / SAMPLE HAMMER TYPE: Hydraulic Hammer | SIZE / TYPE OF BIT: 6" |
| SURFACE ELEVATION: | DATUM: mean sea level |
| WELL INSTALLED? YES ■ NO / CASING MATERIAL / DIAMETER: Sch 40 PVC / 2" | SCREEN: Type: Slotted Material: PVC Length: 6.1 m Diameter: 2" Slot Size: |
| ELEVATION OF (msl): WELL COVER / TOP OF WELL CASING / TOP & BOTTOM OF SCREEN: m / m | PRODUCT SURFACE / GROUNDWATER SURFACE / DATE: 4/15/2003 |

SURFACE CONDITION:

| DEPTH (meters bgs) | PID (ppmv) | BLOWS / DRIVE | DRIVE / RECOVERY (meters / %) | LAB SAMPLE ID | EXTENT | SAMPLE TYPE | DEPTH (meters bgs) | USCS | GRAPHIC LOG | LITHOLOGIC DESCRIPTION |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 4/4/6/7 | 0.6098 / 83 | | | | | SC | | CLAYEY SAND (SC): reddish yellow(7.5YR 6/6), ~70% medium to coarse sand, ~30% fines, moist; medium dense. |
| 1 | | 5/9/10/12 | 0.6098 / 88 | | | | 1 | SM | | SILTY, CLAYEY SAND (SM): reddish yellow(7.5YR 6/6) 30% grades to light brown (7.5YR 6/3), ~70% sand, ~30% fines, dense. |
| | | 2/12/16/22 | 0.6098 / 100 | | | | | | | |
| 2 | | 18/23/25 | 0.6098 / 67 | | | | 2 | | | |
| | | 9/26/37/50 | 0.6098 / 52 | | | | | | | |
| 3 | | 5/40/41/50 | 0.6098 / 87 | | | | 3 | | | |
| | | | | | | | | CL | | SILTY, CLAYEY SAND (CL): light yellowish brown (10YR 6/4), ~20% very fine to fine sand, ~80% fines, moist. |
| 4 | | 6/40/45/50 | 0.6098 / 91 | | | | 4 | SM | | SILTY SAND (SM): reddish yellow(7.5YR 6/6) 40% grades to reddish yellow(7.5YR 6/8), ~70% medium to coarse sand, ~30% fines, wet; very dense; increased sand at 9.1 meters bgs (80% sand, 20% fines) |
| | | 31/50 | 0.6098 / 100 | | | | | | | |
| 5 | | | | | | | 5 | | | |
| 6 | | | | | | | 6 | | | |
| 7 | | | | | | | 7 | | | |
| | | 50 | 0.1524 / 100 | | | | | | | |
| 8 | | | | | | | 8 | | | |

DEPTH (meters bgs) — WELL CONSTRUCTION DETAILS




This log is part of the report prepared for the named project and should be read together with that report for complete information. This summary applies only at the location of this boring / well and at the time of drilling. Subsurface conditions may differ at other locations and may change at this location with the passage of time. The data presented is a simplification of actual conditions encountered.

BORING LOG METRIC UNITS CAMP CARROLL AREA D AND AREA 41.GPJ ACE_1836.GDT 16/9/03

888

# LOG OF WELL AREA 41 #53

| PROJECT NO. | PROJECT NAME: Camp Carroll Area D and Area 41 RI | |
|---|---|---|
| LOCATION: Camp Carroll, Taegu, Republic of Korea | | DATE & TIME STARTED: 4/14/03 15:22 |
| LOGGED BY: [redacted] | REVIEWED BY | DATE & TIME FINISHED: 4/15/03 09:00 |

BOREHOLE / WELL LOCATION SKETCH MAP

N

SURFACE CONDITION:

| DEPTH (meters bgs) | PID (ppmv) | BLOWS / DRIVE | DRIVE / RECOVERY (meters / %) | LAB SAMPLE ID | EXTENT | SAMPLE TYPE | DEPTH (meters bgs) | USCS | GRAPHIC LOG | LITHOLOGIC DESCRIPTION | DEPTH (meters bgs) | WELL CONSTRUCTION DETAILS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 47 | 0.1524 | | | | | | | | | |
| 10 | | | | | | | 10 | | | | 10 | |
| 11 | | | | | | | 11 | | | | 11 | |
| 12 | | | | | | | 12 | | | End of Borehole at 12.2 m. | 12 | Threaded PVC End Cap |
| 13 | | | | | | | 13 | | | | 13 | |
| 14 | | | | | | | 14 | | | | 14 | |
| 15 | | | | | | | 15 | | | | 15 | |
| 16 | | | | | | | 16 | | | | 16 | |
| 17 | | | | | | | 17 | | | | 17 | |
| 18 | | | | | | | 18 | | | | 18 | |
| 19 | | | | | | | 19 | | | | 19 | |

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BORING LOG METRIC UNITS CAMP CARROLL AREA D AND AREA 41.GPJ ACE_1836.GDT 16/9/03

# LOG OF WELL AREA 41 #54

BOREHOLE / WELL LOCATION SKETCH MAP

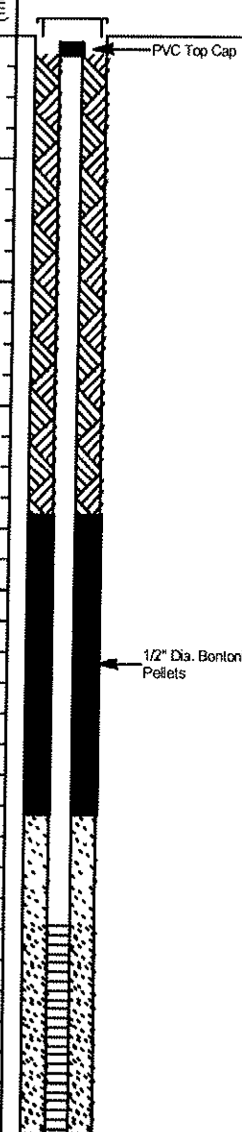
N

| Field | Value |
|---|---|
| PROJECT NO. | |
| PROJECT NAME | Camp Carroll Area D and Area 41 RI |
| LOCATION | Camp Carroll, Taegu, Republic of Korea |
| DATE & TIME STARTED | 4/9/03 13:40 |
| LOGGED BY | [redacted] |
| REVIEWED BY | |
| DATE & TIME FINISHED | 4/10/03 14:05 |
| DRILLING CONTRACTOR / DRILLER | FED / [redacted] |
| DRILLING METHOD | Hollow-Stem Auger |
| COORDINATES | |
| SAMPLING METHOD | Split-Spoon Sampler |
| SAMPLE HAMMER TYPE | Hydraulic Hammer |
| SIZE / TYPE OF BIT | 8" |
| SURFACE ELEVATION | |
| DATUM | mean sea level |
| WELL INSTALLED? | YES ■ NO |
| CASING MATERIAL / DIAMETER | Sch 40 PVC / 2" |
| SCREEN | Type: Slotted; Material: PVC; Length: 6.1 m; Diameter: 2"; Slot Size: |
| ELEVATION OF (msl) — WELL COVER | |
| TOP OF WELL CASING | |
| TOP & BOTTOM OF SCREEN | m / m |
| PRODUCT SURFACE | |
| GROUNDWATER SURFACE | |
| DATE | 4/10/2003 |

SURFACE CONDITION:

| DEPTH (meters bgs) | PID (ppmv) | BLOWS / DRIVE | DRIVE / RECOVERY (meters / %) | LAB SAMPLE ID | SAMPLE TYPE | USCS | LITHOLOGIC DESCRIPTION |
|---|---|---|---|---|---|---|---|
| 0 | | 1/3/5/4 | 0.6098 / 70 | CC-054SB-0 | SS | SC | SANDY LEAN CLAY (SC): greenish gray (GLEY1 5/5GY), ~10% gravel, ~30% sand, ~60% fines, loose. |
| 1 | | 2/3/6/10 | 0.6098 / 80 | | | SC | CLAYEY SAND (SC): strong brown (7.5YR 4/6) 50% grades to reddish yellow(7.5YR 6/6), ~50% medium to coarse sand, ~50% fines, loose. |
| | | 7/9/11/15 | 0.6098 / 90 | | | | |
| 2 | | 8/11/14 | 0.4573 | | | SC | CLAYEY SAND (SC): strong brown (7.5YR 5/8), ~60% coarse sand, ~40% fines, loose. |
| | | 10/15/15/1 | 0.6098 / 70 | | | | |
| 3 | | 4/12/15/20 | 1.2195 / 80 | | | SC | CLAYEY SAND (SC): light reddish brown(5YR 6/4) 40% grades to brown (7.5YR 5/4), 60% coarse to medium sand, ~40% fines, moist; medium dense. |
| 5 | | 14/24/29/3 | 0.6098 / 70 | | | SM | SILTY SAND (SM): pink (7.5YR 7/3), ~70% coarse to medium sand, ~30% fines, dense. |
| 6 | | 8/20/49/50 | 0.6098 / 100 | | | SM | SILTY SAND (SM): reddish brown(5YR 5/3) 50% grades to reddish brown(5YR 5/4), ~70% coarse to medium sand, ~30% fines, dry; very dense; increased clay content at 7.6 meters bgs (60% sand, 40% fines). |
| 8 | | 25/50 | 0.3049 / 100 | | | | |

WELL CONSTRUCTION DETAILS

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BOREHOLE / WELL LOCATION SKETCH MAP

N

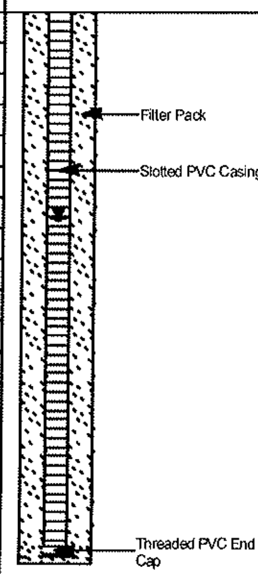
# LOG OF WELL AREA 41 #54

| PROJECT NO. | PROJECT NAME: Camp Carroll Area D and Area 41 RI |
|---|---|
| LOCATION: Camp Carroll, Taegu, Republic of Korea | DATE & TIME STARTED: 4/9/03 13:40 |
| LOGGED BY: [redacted] bc / REVIEWED BY: | DATE & TIME FINISHED: 4/10/03 14:05 |

SURFACE CONDITION:

| DEPTH (meters bgs) | PID (ppmv) | BLOWS / DRIVE | DRIVE / RECOVERY (meters / %) | LAB SAMPLE ID | EXTENT | SAMPLE TYPE | DEPTH (meters bgs) | USCS | GRAPHIC LOG | LITHOLOGIC DESCRIPTION | DEPTH (meters bgs) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 16/43/50 | 0.4573 / 100 | CC-054SB-02 | X | SS | | SM | | SILTY SAND (SM): reddish brown(5YR 5/3), ~60% coarse to medium sand, ~40% fines, very dense. | |
| 10 | | | | | | | 10 | | | | 10 |
| | | 40/50 | 0.3049 / 0 | | | | | | | | |
| 11 | | | | | | | 11 | | | Preprobe. No recovery. | 11 |
| 12 | | | | | | | 12 | | | | 12 |
| 13 | | | | | | | 13 | | | | 13 |
| | | 50 | 0.1524 / 100 | | | | | SM | | SILTY, CLAYEY SAND (SM): yellowish brown (10YR 5/4), ~60% coarse to medium sand, ~40% fines, no odor; wet; very dense. | |
| | | | | | | | | | | End of Borehole at 13.7 m. | |
| 14 | | | | | | | 14 | | | | 14 |
| 15 | | | | | | | 15 | | | | 15 |
| 16 | | | | | | | 16 | | | | 16 |
| 17 | | | | | | | 17 | | | | 17 |
| 18 | | | | | | | 18 | | | | 18 |
| 19 | | | | | | | 19 | | | | 19 |

WELL CONSTRUCTION DETAILS




This log is part of the report prepared for the named project and should be read together with that report for complete information. This summary applies only at the location of this boring / well and at the time of drilling. Subsurface conditions may differ at other locations and may change at this location with the passage of time. The data presented is a simplification of actual conditions encountered.

BORING LOG METRIC UNITS CAMP CARROLL AREA D AND AREA 41.GPJ ACE_1836.GDT 16/9/03

# LOG OF WELL AREA 41 #66

| Field | Value |
|---|---|
| PROJECT NO. | |
| PROJECT NAME | Camp Carroll Area D and Area 41 RI |
| LOCATION | Camp Carroll, Taegu, Republic of Korea |
| DATE & TIME STARTED | 4/11/03 08:15 |
| LOGGED BY | [redacted] 66 |
| REVIEWED BY | |
| DATE & TIME FINISHED | 4/11/03 16:30 |
| DRILLING CONTRACTOR / DRILLER | FED / [redacted] 66 |
| DRILLING METHOD | Hollow-Stem Auger |
| COORDINATES | |
| SAMPLING METHOD | Split-Spoon Sampler |
| SAMPLE HAMMER TYPE | Hydraulic Hammer |
| SIZE / TYPE OF BIT | 6" |
| SURFACE ELEVATION | |
| DATUM | mean sea level |
| WELL INSTALLED? | YES ■ NO |
| CASING MATERIAL / DIAMETER | Sch 40 PVC / 2" |
| SCREEN | Type: Slotted; Material: PVC; Length: 6.1 m; Diameter: 2"; Slot Size: |
| ELEVATION OF (msl) | |
| WELL COVER | |
| TOP OF WELL CASING | |
| TOP & BOTTOM OF SCREEN | m / m |
| PRODUCT SURFACE | |
| GROUNDWATER SURFACE | |
| DATE | 4/11/2003 |

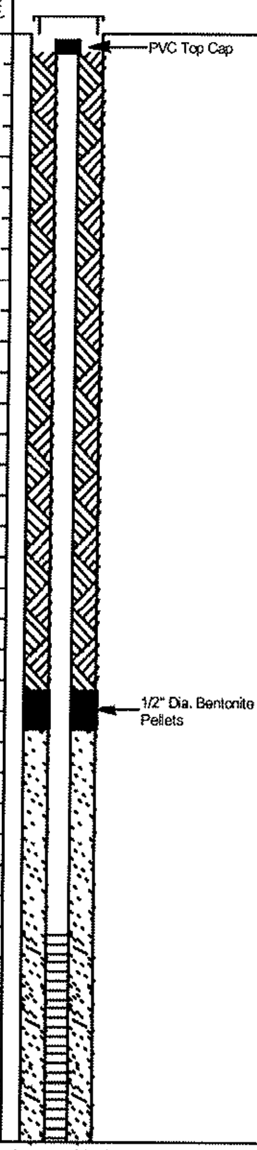
BOREHOLE / WELL LOCATION SKETCH MAP

N

SURFACE CONDITION:

| DEPTH (meters bgs) | PID (ppmv) | BLOWS / DRIVE | DRIVE / RECOVERY (meters / %) | LAB SAMPLE ID | SAMPLE TYPE | USCS | LITHOLOGIC DESCRIPTION |
|---|---|---|---|---|---|---|---|
| 0 | | | | | SS | SC | SANDY LEAN CLAY (SC): strong brown (7.5YR 4/6) 20% grades to reddish yellow(7.5YR 6/6) and 50% grades to strong brown (7.5YR 5/6), ~40% medium to coarse sand, ~60% fines, petroleum odor; odor noted at 0.9 meters bgs. |
| | | 2/4/4/4 | 0.6098 / 80 | CC-066SS-01 | | | |
| | | 1/3/3/3 | 0.6098 / 50 | | | | |
| | | 2/4/4/5 | 0.6098 / 80 | | | | |
| ~1.8 | | | | | | CL | CLAYEY SILT (CL): light yellowish brown (2.5Y 6/4) 60% grades to light olive brown (2.5Y 5/4), ~100% fines, petroleum odor; stiff to very stiff; odor noted at 1.8 meters bgs. |
| | | 2/4/7 | 0.4573 | | | | |
| | | 4/6/11/15 | 0.6098 / 100 | | | | |
| | | 2/6/9/12 | 0.3049 / 0 | | SS | | |
| | | 4/7/11/12 | 0.9146 | CC-066SB-02 | | | |
| ~4.9 | | 6/18/22/27 | 0.6098 / 90 | | | SC | CLAYEY SAND (SC): dark reddish brown(5YR 3/2), ~70% coarse to medium sand, ~30% fines, no odor; moist; medium dense. |
| ~6.1 | | | | | | SC | CLAYEY SAND (SC): reddish yellow(5YR 7/8), ~60% coarse to medium sand, ~40% fines, no odor; moist; very dense. |
| | | 26/31/50 | 0.4573 / 100 | | | | |
| ~7.6 | | | | | | SC | CLAYEY SAND (SC): light brown(7.5YR 6/4), ~70% coarse to medium sand, ~30% fines, moist. |
| | | 5/20/38/50 | 0.6098 | | | | |

WELL CONSTRUCTION DETAILS




This log is part of the report prepared for the named project and should be read together with that report for complete information. This summary applies only at the location of this boring / well and at the time of drilling. Subsurface conditions may differ at other locations and may change at this location with the passage of time. The data presented is a simplification of actual conditions encountered.

BORING LOG METRIC UNITS CAMP CARROLL AREA D AND AREA 41.GPJ ACE_1836.GDT 16/9/03

# LOG OF WELL AREA 41 #66

| PROJECT NO. | PROJECT NAME | |
|---|---|---|
| | Camp Carroll Area D and Area 41 RI | |
| LOCATION | | DATE & TIME STARTED |
| Camp Carroll, Taegu, Republic of Korea | | 4/11/03 08:15 |
| LOGGED BY | REVIEWED BY | DATE & TIME FINISHED |
| [redacted] 66 | | 4/11/03 16:30 |

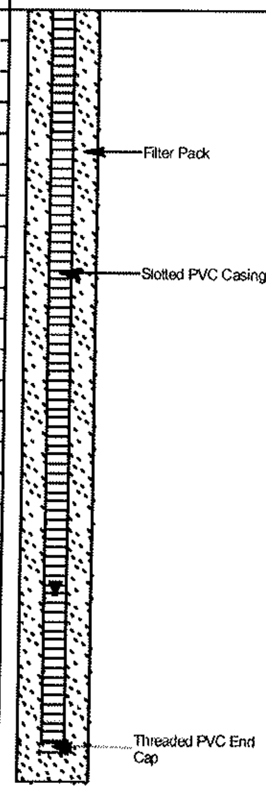
BOREHOLE / WELL LOCATION SKETCH MAP

N

SURFACE CONDITION:

| DEPTH (meters bgs) | PID (ppmv) | BLOWS / DRIVE | DRIVE / RECOVERY (meters / %) | LAB SAMPLE ID | EXTENT | SAMPLE TYPE | DEPTH (meters bgs) | USCS | LITHOLOGIC DESCRIPTION | DEPTH (meters bgs) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | SS | | | | |
| | | 36/44/29/40 | 0.9146 | CC-066SB-03 | | | | CL | SANDY LEAN CLAY (CL): light brown(7.5YR 6/4), ~40% coarse to medium sand, ~60% fines. | |
| 10 | | | | | | | 10 | | | 10 |
| | | 50 | 0.1524 | | | SS | | SM | SILTY SAND (SM): brown (7.5YR 5/4), ~70% coarse to medium sand, ~30% fines, very dense. | |
| 11 | | | | | | | 11 | | | 11 |
| 12 | | | | | | | 12 | | Preprobe. No recovery. | 12 |
| 13 | | | | | | | 13 | | | 13 |
| | | 50 | 0.1524 | | | | | | | |
| 14 | | | | | | | 14 | | | 14 |
| 15 | | | | | | | 15 | SM | SILTY SAND (SM): brown (7.5YR 5/3), ~70% coarse to medium sand, ~30% fines, no odor. | 15 |
| | | 100 | 0.1524 / 100 | | | | | | End of Borehole at 15.2 m. | |
| 16 | | | | | | | 16 | | | 16 |
| 17 | | | | | | | 17 | | | 17 |
| 18 | | | | | | | 18 | | | 18 |
| 19 | | | | | | | 19 | | | 19 |

WELL CONSTRUCTION DETAILS

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BORING LOG METRIC UNITS CAMP CARROLL AREA D AND AREA 41.GPJ ACE_1836.GDT 16/9/03

# LOG OF BORING AREA 41 B-051

BOREHOLE / WELL LOCATION SKETCH MAP

N

| Field | Value |
|---|---|
| PROJECT NO. | |
| PROJECT NAME | Camp Carroll Area D and Area 41 RI |
| LOCATION | Camp Carroll, Taegu, Republic of Korea |
| DATE & TIME STARTED | 4/4/03 10:10 |
| LOGGED BY | [redacted] 66 |
| REVIEWED BY | |
| DATE & TIME FINISHED | 4/4/03 10:27 |
| DRILLING CONTRACTOR / DRILLER | Beautiful Environmental Corp |
| DRILLING METHOD | Direct-Push |
| COORDINATES | |
| SAMPLING METHOD | Geoprobe Sampler |
| SAMPLE HAMMER TYPE | |
| SIZE / TYPE OF BIT | |
| SURFACE ELEVATION | |
| DATUM | mean sea level |
| WELL INSTALLED? | YES / NO ■ |
| CASING MATERIAL / DIAMETER | |
| SCREEN | Type: Material: Length: Diameter: Slot Size: |
| ELEVATION OF (msl) | WELL COVER / TOP OF WELL CASING / TOP & BOTTOM OF SCREEN / PRODUCT SURFACE / GROUNDWATER SURFACE / DATE |

SURFACE CONDITION:

WELL CONSTRUCTION DETAILS: NO WELL INSTALLED

| DEPTH (meters bgs) | PID (ppmv) | BLOWS / DRIVE | DRIVE / RECOVERY (meters / %) | LAB SAMPLE ID | EXTENT | SAMPLE TYPE | USCS | LITHOLOGIC DESCRIPTION |
|---|---|---|---|---|---|---|---|---|
| 0 – ~0.5 | | | 0.9 / 80 | SS051SS01 | X | SS | SC | CLAYEY SAND (SC): strong brown (7.5YR 5/6), ~5% gravel, ~55% fine to coarse sand, ~40% fines, moist; dense; fill soil. |
| ~0.5 – ~1.3 | | | 0.4 | | | | CL | LEAN CLAY (CL): dark grayish brown (10YR 4/3), ~100% fines, medium to high, moist; stiff. |
| ~1.3 – 2.3 | | | 1.3 / 80 | | | | SC | CLAYEY SAND (SC): yellowish brown (10YR 5/6), ~55% fine to medium sand, ~45% fines, moist; dense. |

End of Borehole at 2.3 m.

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BORING LOG METRIC UNITS CAMP CARROLL AREA D AND AREA 41.GPJ ACE_1836.GDT 16/9/03

# LOG OF BORING AREA 41 B-052

| | |
|---|---|
| PROJECT NO. | PROJECT NAME: Camp Carroll Area D and Area 41 RI |
| LOCATION: Camp Carroll, Taegu, Republic of Korea | DATE & TIME STARTED: 4/3/03 13:30 |
| LOGGED BY: [redacted] bk — REVIEWED BY: | DATE & TIME FINISHED: 4/3/03 14:05 |
| DRILLING CONTRACTOR / DRILLER: Beautiful Environmental Corp | DRILLING METHOD: Direct-Push |
| SAMPLING METHOD: Geoprobe Sampler — SAMPLE HAMMER TYPE: | SIZE / TYPE OF BIT: |
| WELL INSTALLED? YES NO ■ — CASING MATERIAL / DIAMETER: | SCREEN Type: Material: Length: Diameter: Slot Size: |

BOREHOLE / WELL LOCATION SKETCH MAP

N

COORDINATES:

SURFACE ELEVATION: — DATUM: mean sea level

ELEVATION OF (msl): WELL COVER — TOP OF WELL CASING — TOP & BOTTOM OF SCREEN — PRODUCT SURFACE — GROUNDWATER SURFACE — DATE

SURFACE CONDITION:

WELL CONSTRUCTION DETAILS: NO WELL INSTALLED

| DEPTH (meters bgs) | PID (ppmv) | BLOWS / DRIVE | DRIVE / RECOVERY (meters / %) | LAB SAMPLE ID | EXTENT | SAMPLE TYPE | DEPTH (meters bgs) | USCS | GRAPHIC LOG | LITHOLOGIC DESCRIPTION |
|---|---|---|---|---|---|---|---|---|---|---|
| 0–1 | | | 1 / 70<br>1.3 | CC052SS01 | X | SS | | SC | | CLAYEY SAND (SC): (7.5YR 4.5/6), ~60% fine to coarse sand, ~40% fines, moist; dense. |
| 1–3 | | | 1.5 / 70<br>0.5 / 90 | | | | 1 | SC | | CLAYEY SAND (SC): strong brown (7.5YR 5/6), ~60% fine to coarse sand, ~40% fines, moist; more friable |
| 3 | | | | | | | 3 | | | Refusal.<br>End of Borehole at 3.0 m. |

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BORING LOG METRIC UNITS CAMP CARROLL AREA D AND AREA 41.GPJ ACE_1836.GDT 16/9/03

895

# LOG OF BORING AREA 41 B-055

BOREHOLE / WELL LOCATION SKETCH MAP

N

| | |
|---|---|
| PROJECT NO. | PROJECT NAME: Camp Carroll Area D and Area 41 RI |
| LOCATION: Camp Carroll, Taegu, Republic of Korea | DATE & TIME STARTED: 4/4/03 10:00 |
| LOGGED BY: [redacted] | REVIEWED BY |
| DATE & TIME FINISHED: 4/4/03 10:09 | |
| DRILLING CONTRACTOR / DRILLER: Beautiful Environmental Corp | DRILLING METHOD: Direct-Push |
| COORDINATES | |
| SAMPLING METHOD: Geoprobe Sampler | SAMPLE HAMMER TYPE |
| SIZE / TYPE OF BIT | SURFACE ELEVATION / DATUM: mean sea level |
| WELL INSTALLED? YES / NO ■ | CASING MATERIAL / DIAMETER |
| SCREEN Type: Material: Length: Diameter: Slot Size: | |
| ELEVATION OF (msl) | WELL COVER / TOP OF WELL CASING / TOP & BOTTOM OF SCREEN / PRODUCT SURFACE / GROUNDWATER SURFACE / DATE |

SURFACE CONDITION:

WELL CONSTRUCTION DETAILS: NO WELL INSTALLED

| DEPTH (meters bgs) | PID (ppmv) | BLOWS / DRIVE | DRIVE / RECOVERY (meters / %) | LAB SAMPLE ID | EXTENT | SAMPLE TYPE | DEPTH (meters bgs) | USCS | GRAPHIC LOG | LITHOLOGIC DESCRIPTION |
|---|---|---|---|---|---|---|---|---|---|---|
| 0–0.7 | | | 0.7 / 80 | | | | | CL | | SANDY LEAN CLAY (CL): red (2.5YR 4/6), ~30% fine to medium sand, ~70% fines, low, moist; firm; fill soil. |
| 0.7–2.3 | | | 1.5 / 60 | | | | | SC | | CLAYEY SAND (SC): yellowish brown (10YR 5/6), ~55% fine to medium sand, ~45% fines, moist; dense. |
| 2.3 | | | | | | | | | | End of Borehole at 2.3 m. |

Depth scale: 1, 2, 3, 4, 5, 6, 7, 8

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BORING LOG METRIC UNITS CAMP CARROLL AREA D AND AREA 41.GPJ ACE_1836.GDT 16/9/03

# LOG OF BORING AREA 41 B-056

BOREHOLE / WELL LOCATION SKETCH MAP

N

| | | | |
|---|---|---|---|
| PROJECT NO. | PROJECT NAME: Camp Carroll Area D and Area 41 RI | | |
| LOCATION: Camp Carroll, Taegu, Republic of Korea | | DATE & TIME STARTED: 4/4/03 09:45 | |
| LOGGED BY: [redacted] b6 | REVIEWED BY | DATE & TIME FINISHED: 4/4/03 09:57 | |
| DRILLING CONTRACTOR / DRILLER: Beautiful Environmental Corp | | DRILLING METHOD: Direct-Push | COORDINATES |
| SAMPLING METHOD: Geoprobe Sampler | SAMPLE HAMMER TYPE | SIZE / TYPE OF BIT | SURFACE ELEVATION / DATUM: mean sea level |
| WELL INSTALLED? YES NO ■ | CASING MATERIAL / DIAMETER | SCREEN Type: Material: Length: Diameter: Slot Size: | |
| ELEVATION OF (msl) | WELL COVER / TOP OF WELL CASING | TOP & BOTTOM OF SCREEN / PRODUCT SURFACE | GROUNDWATER SURFACE / DATE |

SURFACE CONDITION:

| DEPTH (meters bgs) | PID (ppmv) | BLOWS / DRIVE | DRIVE / RECOVERY (meters / %) | LAB SAMPLE ID | EXTENT | SAMPLE TYPE | DEPTH (meters bgs) | USCS | GRAPHIC LOG | LITHOLOGIC DESCRIPTION | DEPTH (meters bgs) | WELL CONSTRUCTION DETAILS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0–0.7 | | | 0.7 / 80 | CC056SS01 | X | SS | | SC | | CLAYEY SAND (SC): yellowish brown (10YR 5/6), ~55% fine to medium sand, ~45% fines, moist; dense. | | NO WELL INSTALLED |
| 0.7–2.3 | | | 1.5 / 80 | | | | | SC | | CLAYEY SAND (SC): strong brown(7.5YR 4.5/6), ~55% fine to medium sand, ~45% fines, moist; dense. | | |
| 2.3 | | | | | | | | | | End of Borehole at 2.3 m. | | |

Depth scale: 1, 2, 3, 4, 5, 6, 7, 8

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BORING LOG METRIC UNITS CAMP CARROLL AREA D AND AREA 41.GPJ ACE_1833.GET 16/9/03

897

# LOG OF BORING AREA 41 B-057

BOREHOLE / WELL LOCATION SKETCH MAP

N

| | |
|---|---|
| PROJECT NO. | PROJECT NAME: Camp Carroll Area D and Area 41 RI |
| LOCATION: Camp Carroll, Taegu, Republic of Korea | DATE & TIME STARTED: 4/4/03 10:30 |
| LOGGED BY: [redacted] b6 / REVIEWED BY: | DATE & TIME FINISHED: 4/4/03 10:40 |
| DRILLING CONTRACTOR / DRILLER: Beautiful Environmental Corp | DRILLING METHOD: Direct-Push |
| SAMPLING METHOD: Geoprobe Sampler / SAMPLE HAMMER TYPE: | SIZE / TYPE OF BIT: |
| COORDINATES: | SURFACE ELEVATION: / DATUM: mean sea level |
| WELL INSTALLED? YES / NO ■ | CASING MATERIAL / DIAMETER: |
| SCREEN: Type: Material: Length: Diameter: Slot Size: | |
| ELEVATION OF (msl): WELL COVER / TOP OF WELL CASING / TOP & BOTTOM OF SCREEN / PRODUCT SURFACE / GROUNDWATER SURFACE / DATE | |

SURFACE CONDITION:

WELL CONSTRUCTION DETAILS: NO WELL INSTALLED

| DEPTH (meters bgs) | PID (ppmv) | BLOWS / DRIVE | DRIVE / RECOVERY (meters / %) | LAB SAMPLE ID | EXTENT | SAMPLE TYPE | DEPTH (meters bgs) | USCS | GRAPHIC LOG | LITHOLOGIC DESCRIPTION | DEPTH (meters bgs) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0–2.0 | | | 0.7 / 80<br>1.2<br>1.1 / 80 | CC057SS01 | | SS | | SC | | CLAYEY SAND (SC): strong brown (7.5YR 5/6), ~55% fine to medium sand, ~45% fines, moist; dense. | |
| 2.0 | | | | | | | | | | End of Borehole at 2.0 m. | |

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BORING LOG METRIC UNITS CAMP CARROLL AREA D AND AREA 41.GPJ ACE_1836.GLT 16/9/03

# LOG OF BORING AREA 41 B-058

| | | |
|---|---|---|
| PROJECT NO. | PROJECT NAME: Camp Carroll Area D and Area 41 RI | |
| LOCATION: Camp Carroll, Taegu, Republic of Korea | DATE & TIME STARTED: 4/4/03 09:25 | |
| LOGGED BY: [redacted] 66 | REVIEWED BY: | DATE & TIME FINISHED: 4/4/03 09:40 |
| DRILLING CONTRACTOR / DRILLER: Beautiful Environmental Corp | DRILLING METHOD: Direct-Push | COORDINATES: |
| SAMPLING METHOD: Geoprobe Sampler | SAMPLE HAMMER TYPE: | SIZE / TYPE OF BIT: |
| SURFACE ELEVATION: | DATUM: mean sea level | |
| WELL INSTALLED? YES / NO ■ | CASING MATERIAL / DIAMETER: | SCREEN Type: Material: Length: Diameter: Slot Size: |
| ELEVATION OF (msl): WELL COVER / TOP OF WELL CASING / TOP & BOTTOM OF SCREEN / PRODUCT SURFACE / GROUNDWATER SURFACE / DATE | | |

BOREHOLE / WELL LOCATION SKETCH MAP

N

SURFACE CONDITION:

WELL CONSTRUCTION DETAILS: NO WELL INSTALLED

| DEPTH (meters bgs) | PID (ppmv) | BLOWS / DRIVE | DRIVE / RECOVERY (meters / %) | LAB SAMPLE ID | EXTENT | SAMPLE TYPE | DEPTH (meters bgs) | USCS | GRAPHIC LOG | LITHOLOGIC DESCRIPTION |
|---|---|---|---|---|---|---|---|---|---|---|
| 0–1.0 | | | 0.7 / 80 | CC058SS01 | X | SS | | CL | | SANDY LEAN CLAY (CL): red (2.5YR 4/6), ~30% fine to medium sand, ~70% fines, low, moist; firm; fill soil. |
| 1.0–2.4 | | | 0.6<br>1.4 / 80<br>1 | CC058BS01 | X | SS | | SC | | CLAYEY SAND (SC): yellowish brown (10YR 5/6), ~55% fine to medium sand, ~45% fines, moist; dense. |
| 2.4 | | | | | | | | | | End of Borehole at 2.4 m. |

Depth scale: 1, 2, 3, 4, 5, 6, 7, 8 (meters bgs)

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BORING LOG METRIC UNITS CAMP CARROLL AREA D AND AREA 41.GPJ ACE_1836.GDT 16/9/03

PAGE 1 OF 1

# LOG OF BORING AREA 41 B-059

BOREHOLE / WELL LOCATION SKETCH MAP

N

| | | | |
|---|---|---|---|
| PROJECT NO. | PROJECT NAME: Camp Carroll Area D and Area 41 RI | | |
| LOCATION: Camp Carroll, Taegu, Republic of Korea | | DATE & TIME STARTED: 4/4/03 10:50 | |
| LOGGED BY: [redacted] bb | REVIEWED BY | DATE & TIME FINISHED: 4/4/03 11:05 | |
| DRILLING CONTRACTOR / DRILLER: Beautiful Environmental Corp | | DRILLING METHOD: Direct-Push | COORDINATES |
| SAMPLING METHOD: Geoprobe Sampler | SAMPLE HAMMER TYPE | SIZE / TYPE OF BIT | SURFACE ELEVATION; DATUM: mean sea level |
| WELL INSTALLED? YES / NO ■ | CASING MATERIAL / DIAMETER | SCREEN Type: Material: Length: Diameter: Slot Size: | |

ELEVATION OF (msl) | WELL COVER | TOP OF WELL CASING | TOP & BOTTOM OF SCREEN | PRODUCT SURFACE | GROUNDWATER SURFACE | DATE

SURFACE CONDITION:

WELL CONSTRUCTION DETAILS: NO WELL INSTALLED

| DEPTH (meters bgs) | PID (ppmv) | BLOWS / DRIVE | DRIVE / RECOVERY (meters / %) | LAB SAMPLE ID | EXTENT | SAMPLE TYPE | DEPTH (meters bgs) | USCS | GRAPHIC LOG | LITHOLOGIC DESCRIPTION |
|---|---|---|---|---|---|---|---|---|---|---|
| 0–0.8 | | | 0.7 / 80 | | | SS | | SC | | CLAYEY SAND (SC): strong brown (7.5YR 5/6), ~60% fine to coarse sand, ~40% fines, moist; dense; fill soil. |
| 0.8–2.4 | | | 1.5 | CC059SS01 | | | | SC | | CLAYEY SAND (SC): strong brown (7.5YR 5/6), ~55% fine to medium sand, ~45% fines, moist; dense. |
| | | | 1.6 / 80 | | | | | | | |
| 2.4 | | | | | | | | | | End of Borehole at 2.4 m. |

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BORING LOG METRIC UNITS CAMP CARROLL AREA D AND AREA 41.GPJ ACE_1838.GLT 16/9/03