prepared for:

Delaware Solid Waste Authority
1128 S. Bradford Street
Dover, Delaware 19903

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Cherry Island Landfill Expansion Project Wilmington, Delaware

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WASTE CHARACTERIZATION REPORT

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1. INTRODUCTION

This waste characterization report (report) presents an evaluation and interpretation of data and site information relating to the physical properties and characteristics of in-place waste at the Delaware Solid Waste Authority's (DSWA's) Cherry Island Landfill (CIL) located near Wilmington, Delaware. This report presents: (i) a review of previously reported data and site information; (ii) an evaluation of existing data; (iii) assumed physical properties of waste used in previous reports and expansion designs for the CIL; (iv) the procedures and results of field investigations of the physical properties and characteristics of waste performed at the CIL by GeoSyntec Consultants (GeoSyntec) or sub-consultants to GeoSyntec; (v) the procedures and results of waste characterization studies and laboratory analyses performed by sub-consultants or sub-contractors to GeoSyntec and/or DSWA; and (vi) a summary of findings from all of the above, and final conclusions and recommendations.

This report was prepared for the DSWA by Dr. Jeremy W.F. Morris and Ms. Carrie H. Pendleton, and reviewed by Dr. R. David Espinoza, Dr. Carlos A. Lazarte, and Dr. Robert C. Bachus, all of GeoSyntec, in accordance with the internal review policy of the firm. In addition, it was reviewed by two members of GeoSyntec's expert review panel: Dr. James K. Mitchell and Dr. J. Michael Duncan, both of the Department of Civil Engineering at the Virginia Polytechnic Institute and State University in Blacksburg, Virginia. This report, which was prepared in partial fulfillment of the requirements of *Task 1.3.4 "Phase I Field Work"* outlined in the scope of services presented in GeoSyntec's proposal for the CIL Expansion Design Project (the expansion project), comprises Appendix O of the Geotechnical Characterization Report (GCR) prepared as part of the expansion project documentation.

2. OBJECTIVES

The information presented in this report will be used in support of design activities for the expansion project. To analyze the stability and deformability of the CIL, unit weight, shear strength, and compressibility parameters for waste are needed. Because of the soft foundation conditions at the CIL site, a key driver in the landfill stability evaluation is the unit weight of waste. For this reason, this parameter was thoroughly investigated under the conditions and layout of the CIL using several different methods. Evaluation of the findings from these investigations, and application of these evaluations to provide recommendations for future design conditions, is the primary focus of this

report. Values and trends published in literature are used to complement findings from field investigations, and to provide supplementary information for waste unit weight variations with depth. For the remaining design parameters related to waste (i.e., shear strength and compressibility), values published in the literature will typically be used. Where possible, these values will be supplemented and/or supported using site-specific laboratory and/or field data.

The field investigations performed for physical characterization of the waste at the CIL were conducted by, or under the supervision of, GeoSyntec in March and April of 2002. The field investigations consisted of the following six distinct activities: (i) eleven Spectral Analysis of Surface Waves (SASW) surveys of the waste mass and landfill perimeter material; (ii) nine large diameter bucket auger test borings within the waste mass; (iii) collection of bulk waste samples for characterization studies and laboratory testing; (iv) nine small diameter rotary auger test borings within the waste mass and underlying dredge material; (v) nine cone penetrometer test (CPT) soundings with pore pressure dissipation tests performed at selected depths within the waste mass and underlying dredge material; and (vi) extensive dipping of existing gas wells at the CIL to determine standing liquid levels.

The primary aim of this report is to further the GeoSyntec design team's understanding of the geotechnical properties of the waste mass in the CIL. The above field activities were performed and coordinated with each other to fulfill the following main objectives:

- evaluate the structure and physical properties of the landfilled waste mass;
- characterize the spatial variability of waste materials within the landfill;
- investigate standing liquid elevations within the waste mass, and evaluate the nature of any liquid levels encountered with regard to whether they are connected or unconnected (i.e., perched);
- collect representative samples of waste for laboratory testing;
- identify and close existing data gaps so as to facilitate design activities and address concerns raised by DSWA, the GeoSyntec design team, and the expert review panel regarding characterization of the CIL site; and
- provide recommendations for waste unit weight and strength characteristics for use in design of the future expansion of the CIL.

The primary objective of the SASW investigation was to evaluate, in a non-invasive manner, the potential spatial variability of mechanical properties of the waste mass using shear wave velocity as an index for the waste mass mechanical properties. The shear wave velocity profiles obtained from the SASW survey can also provide direct input for seismic response analyses of the waste mass. The primary objectives of the test boring programs were: (i) to determine the in-situ bulk unit weight of the in-place waste (i.e., municipal solid waste (MSW) as well as soil and other cover materials); and (ii) to establish the spatial variability of standing liquid elevations within the waste mass. Secondary objectives of the test-boring programs were to visually classify the waste and recover representative samples of waste for an on-site waste classification study and laboratory testing. In the context of this report, the primary objective of the CPT soundings and dissipation tests was to establish the nature of standing liquid within the waste mass by determining whether liquid levels encountered during the test boring programs were connected or unconnected. In addition, CPT soundings were attempted in the leachate collection system (i.e., sand or pea gravel layer) to provide an indirect indication of the hydraulic conductivity of that system. The program of dipping existing gas wells was performed to complement the data collected from other test programs and provided standing liquid elevations in areas of the CIL not covered by other test programs.

3. ORGANIZATION OF THIS REPORT

The remainder of this report is organized as follows.

- Section 4, Literature Review, summarizes the waste unit weight values assumed in previous reports and expansion designs for the CIL as well as results of previous field investigations of waste unit weight carried out by GeoSyntec at other landfill sites. An extensive literature review of waste strength and compressibility characteristics is also presented.
- Section 5, Evaluation of Existing Data, presents an evaluation of historical variations in waste settlement, waste unit weight, and settlement of the dredge spoil foundation. This evaluation is based on analysis of data from instruments located within the CIL. This section also presents an evaluation of whole-site waste unit weights based on analysis of waste receipt records and topographic maps from the site.

- Section 6, Spectral Analysis of Surface Waves (SASW) Survey, summarizes the procedures and main results from the SASW investigation.
- Section 7, Large Diameter Test Boring Program, describes the procedures used to advance the test borings and calculate the in-situ unit weight of waste from each boring. This section also includes the rationale for waste sampling, summarizes results from on-site characterization activities performed during the boring program and results from subsequent laboratory testing of collected waste samples, and presents findings related to the elevations of standing liquid in the waste.
- Section 8, Small Diameter Test Boring Program, describes the procedures used to advance the test borings and calculate the in-situ unit weight of waste samples collected from borings. This section also includes findings related to the elevations of standing liquid in the waste.
- Section 9, Cone Penetrometer Tests (CPTs), summarizes the procedures and main results from the CPT soundings and dissipation tests.
- Section 10, Gas Well Dipping Program, summarizes the results of extensive dipping of existing gas wells across the plan area of the CIL. Since this dipping program involved gas wells, any available information on gas well installation and structure, including gas well installation logs provided to GeoSyntec by DSWA, are included in this section.
- Section 11, Summary and Discussion, presents a summary overview and discussion of the main findings in this report, and draws broad conclusions regarding waste unit weight, waste strength characteristics, and the nature and elevation of standing liquid in the CIL.
- Section 12, Recommendations, presents recommendations regarding values for waste parameters and the condition of the waste body that should be assumed during design of the CIL expansion project.

4. LITERATURE REVIEW

4.1 Waste Unit Weight

4.1.1 Previous Assumptions of Waste Unit Weight at the CIL

A number of investigations and calculations presented in previous reports and expansion design documents for the CIL have provided measured or assumed values for waste unit weight at the site. Assumed values were based on literature review findings or on estimates of waste density based on waste receipts and actual or projected landfill phase volumes. A summary of the waste unit waste values used in previous documents, and the assumptions on which these values were based, is provided as Table 1.

4.1.2 Field Investigations of Waste Unit Weight at Other Landfill Sites

4.1.2.1 Introduction

Values for waste unit weight and trends of unit weight with depth published in literature were used to complement findings from field investigations, and to provide supplementary information for waste unit weight variations with depth. Methodologies employed during previous investigations were also review for possible direct use and/or adaptation for field investigations at the CIL. The literature review focused on the two most widely used methods of waste unit weight determination: (i) SASW surveys (see Section 4.1.2.2); and (ii) large diameter test boring programs (see Section 4.1.2.3). Findings from two published studies that employed both these techniques [Kavazanjian et al., 1995; Zornberg et al., 1999] are used to make final recommendations for the relationship between waste unit weight and landfill depth in Section 12.2.2.

4.1.2.2 Spectral Analysis of Surface Waves (SASW) Surveys

The main objective of a SASW investigation is to evaluate, in a non-intrusive manner, the potential spatial variability of the mechanical properties of the waste mass, using shear wave velocity as an index of the waste mass mechanical properties. The technique has enjoyed considerable success and use: Zornberg, et al. [1999] present results from six SASW surveys performed at a landfill site in southern California, Kavazanjian, et al. [1996] report performing SASW surveys at six landfill sites in the greater Los Angeles metropolitan area, and GeoSyntec has previously performed

SASW surveys at two landfills in California [GeoSyntec & Todd, 1995; GeoSyntec, 1996]. The results from these SASW survey programs were encouraging and demonstrated the value of this technique in characterizing the spatial distribution of shear wave velocities within the landfill, and the use of these shear wave velocities to infer other mechanical properties of the waste mass (e.g., stiffness and unit weight). SASW survey data generally requires calibration with unit weight data obtained via other means, usually test boring programs, before SASW profiles of waste unit weight versus depth can be developed. This was the case with the aforementioned studies by Kavazanjian, et al. [1995] and Zornberg, et al. [1999], which both used two borings to calibrate data from six or more SASW survey locations.

4.1.2.3 Test Boring Programs

Test boring programs are one of the most common means of determining waste unit weight at landfills sites. GeoSyntec has previously performed test boring programs at a number of sites in the United States. The methodologies, assumptions, and results of these investigations, as well as the problems encountered and how they were overcome, are summarized in Table 2. Table 2 also includes calculated in-place waste unit weight values for Area A/B at DSWA's Central Solid Waste Management Site in Sandtown, Delaware. The methodologies developed for, and the experience gained from, the field investigations listed in the table were used as the basis for developing the test boring, unit weight evaluation, and waste logging procedures used in the field investigation conducted at the CIL.

A slight departure from previous methodologies which was used in the field investigation at the CIL involved calculating borehole volumes using gravel backfill. GeoSyntec's experience from field investigations at landfills in southern California [GeoSyntec, 1995] indicates that bucket auger drilling through waste generally results in over-excavation of the borehole, or "overbore," of between 15 and 20 percent. During the investigation at the Operating Industries, Inc. (OII) Landfill in Monterey Park, California [GeoSyntec, 1996], borehole volumes were measured for the same depth intervals from which solid waste samples were collected. The unit weight versus depth of borehole relationship for the gravel backfill was determined at the OII Landfill by tremying the gravel backfill down the borehole into a 10-ft long calibration pipe. The calibration pipe was then removed from the borehole and the weight of gravel was measured. This process was performed at selected borehole depths so that the resultant unit weight of the gravel backfill could be measured for various drop-heights. A

calibration curve was developed to illustrate the trend between the unit weight of gravel and the drop height to the tremy. Initial calculations of the profile of waste unit weight versus depth within the borings using this calibration curve resulted in suspect values for the unit weight of waste in a few borings. Borehole diameters back-calculated from the borehole volume calculated using this calibration curve sometimes indicated a smaller borehole diameter than the diameter of the bucket auger itself. It was assumed that gravel must fracture upon impact when dropped from height into the steel calibration pipe but not when dropped into the more cushioned waste hole, and that this was the cause of any apparent "underbore".

Based on the experience gained at OII, it was decided to change the method of borehole volume calculation for the field investigation at the CIL. The gravel unit weight versus drop-height relationship was established at the gravel quarry prior to the field investigations in order to avoid the problematic and inaccurate use of the calibration pipe described above. The procedures developed to determine gravel unit weight, volumes of borehole intervals, and waste unit weight in each borehole interval, are presented and discussed in Section 7.5.

4.2 Waste Strength and Compressibility

An extensive literature review of waste properties was performed by Kavazanjian et al. [1995]. From back-analysis of several stable slopes, as well as laboratory and in-situ testing, waste drained strength parameters (S_w) can be represented by a bi-linear strength Mohr-Coulomb envelope with a slope of $\phi'=33^{\circ}$ and a minimum strength of 500 psf, that is:

$$S_w = \min(\sigma' \tan 33^{\circ}, 500\,\text{psf})$$

The bi-linear strength envelope represents an approximate lower-bound of the measured/calculated drained strength of municipal solid waste. During the site characterization of the dredge/alluvium at the CIL site, a total of 18 CPT soundings were pushed through the waste into the underlying dredge/alluvium material. Negligible dynamic pore pressures were recorded during the CPT testing when pushed through waste, thus indicating that the CIL waste is essentially a free draining material. The results of CPTs in the waste together with laboratory shear strength tests on remolded samples will be used to further evaluate shear strength parameters.

Sowers [1973] related compression coefficient index (C_c) of MSW to the initial void ratio (e_o) and organic content and indicated that C_c falls within the range of $0.15e_o$ (for MSW with low organic content) and $0.55e_o$ (for MSW with high organic content). An evaluation of the void ratio of waste was performed based on calculations of specific gravity using bulk unit weight, waste composition, and moisture content data. Void ratio can be estimated from the on-site study of waste composition performed by SCS Engineers of Reston, Virginia, at selected locations during the large diameter test boring program described above. As part of that study, SCS Engineers also collected samples of waste for laboratory determination of moisture content and biochemical methane potential (BMP). BMP is a good indicator of the biodegradable (i.e., organic) content of the waste. The methodology and results of the void ratio calculation are presented and discussed in Section 7.7.

Any additional settlement of waste is due to secondary compression (i.e., creep). The modified secondary compression index ($C_{\alpha\varepsilon}$) for waste for typical municipal landfills is estimated to be 0.01 to 0.03 [Fasset et al., 1994]. Waste settlement is discussed in Section 5.1 below, while data from the settlement plates is presented as Appendix Q of the GCR.

5. EVALUATION OF EXISTING DATA AT THE CIL

5.1 Landfill Settlement

Measurements of the degree of settlement occurring at the top of the dredge spoil foundation layer and within the waste were calculated periodically by conversion of readings from a series of settlement plates installed at a number of locations through the entire waste at the site. Settlement plates were installed during development of all five phases at the CIL between December 1992 (in Phase I) and October 1997 (in Phase V). The locations of each of the settlement plates installed at the CIL are shown in Figure 1. The initial base plate elevation (i.e., the elevation of the top of the dredge spoil foundation layer) at each location was known from construction drawings of the landfill subgrade and leachate collection layers in each phase. The total length of each rod was known, and the rod stick-up above the surface elevation of the waste has been recorded at regular intervals over the last ten years. Calculation of the elevation of the top of the dredge spoil layer and the surface of the waste from measurement of the top-of-rod elevation and rod stick-up is therefore elementary.

Settlement measurement data are included in the Geographic Information System (GIS) developed for DSWA by Pennoni and Schnabel Engineering [2001]. The settlement measurement data is reproduced along with plots showing temporal variations in dredge spoil and waste placement and settlement in Appendix Q of the GCR. A summary of the main assumptions and uncertainties involved in calculation of settlement in each phase of the CIL is also presented in Appendix Q. The procedure used to calculate waste and dredge spoil settlement is relevant to the calculation of waste unit weight discussed in the next sub-section, and is therefore shown in the calculation package presented as Appendix O-1 to this report. Table 3 summarizes the initial and most recent dredge spoil and waste settlement data at each settlement plate location.

As shown in Table 3, the extent of dredge settlement (i.e., settlement at the base of the landfill) was found to depend directly on the depth of landfilled waste (i.e., surcharge load). In the older, thicker Phases I and II at the CIL, dredge settlement appeared to vary from approximately 5 ft. under 45 ft. of waste to over 20 ft. under 85 ft. of waste. Values in the latter range are questionable considering that the total depth of compressible material (i.e., dredge spoils plus alluvial deposits) underlying the waste in these two phases was only 40 ft. It is considered that these higher settlement readings were recorded incorrectly, and they are not used in any further analysis. Although the dredge deposits were thicker below the newer Phases III through V, dredge settlement there ranged from only 2 ft. to 5 ft. under 15 ft. to 35 ft. of waste. This is because the loads in Phases III through V are smaller and have been in place for a shorter time. As a result, settlement under the imposed loads in these three phases has not been fully completed.

5.2 Waste Unit Weight

5.2.1 Waste Unit Weight Evaluation Based on Instrumentation Data

The bulk unit weight of waste in a select number of locations in the CIL was calculated from evaluation of data from proximal settlement plates (SPs) and total pressure cells (TPCs). The required data for unit weight determination are included in the GIS. The calculation procedure is shown in Appendix O-1. Although it should be noted that calculation of waste unit weight using TPC data is considered to yield inaccurate results because of the fragility of TPCs in the aggressive conditions encountered within a landfill, and that GeoSyntec would not generally recommend

installation of TPCs for this purpose, it was decided to include evaluation of the data in this report rather than exclude any existing source of unit weight data. Once evaluated, the worth of the data was critically assessed.

As described in the calculation procedure, two alternative scenarios were evaluated:

- *Scenario 1*: waste depth includes only 1 ft of cover soil per 10 ft lift of waste (i.e., minimum bulk unit weight conditions); and

- *Scenario 2*: cover soil is assumed to comprise 25 percent of the landfilled depth (i.e., maximum bulk unit weight conditions).

The calculation procedure, which is included as Attachment 1 to Appendix O-1, is based on that developed by Weston [1998]. The cover soil content in Scenario 1 the same as that used by Weston [1998]. The soil content in Scenario 2 is an upper-bound value based on the site records discussed in Section 5.2.2. As such, Scenario 2 is considered to provide a more realistic estimate of the condition of the CIL, and it is results from Scenario 2 that are therefore quoted and/or used in subsequent tables and figures in this report. The procedure was modified to incorporate an improved method for conversion of TPC readings to actual pressures (see Attachment 2 to Appendix O-1). This method, which was supplied to GeoSyntec by Schnabel, is the same as that applied by Schnabel before inclusion of pressure values in the GIS.

This procedure for determining waste unit weight requires the use of simultaneous data from proximal settlement plates and TPCs (referred to as total stress cells, TSCs, in the GIS data tables). These locations are shown in Figure 1. A summary of waste unit weight at placement and after settlement at each of the seven SP locations with a TPC nearby is presented in Table 3. Plots showing temporal variations in waste unit weight calculated under Scenario 2 for the seven locations (one in Phase IV and six in Phase V) are presented in Attachment 3 to Appendix O-1. Average waste unit weight values relating to average depths of waste (i.e., surface elevations) were estimated from these plots as shown in the attachment.

In the four-year period between mid-1997 and October 2001 for which TPC data were available, the calculated unit weight of waste generally appeared to decrease, often to approximately half of its initial value. For example, at position P5_SP_10, TPC data indicates that the unit weight of waste decreased from 114.5 pcf in July 1997 to 45 pcf

in October 2001. The depth of waste increased from 7 ft. to 28 ft. during this period. Similarly, at position P4_SP_2, the unit weight of waste appears to decrease from 77 pcf in April 1997 to 58 pcf in August 2001. The depth of waste increased from 12 ft. to 30 ft. during this period. Although some decrease in the average unit weight of waste through the entire depth of waste in Phases IV and V may be due to the use of highly compressible, low-density compost mulch as daily cover in recent years, it seems unlikely that this could cause a decrease in unit weight of such magnitude. Conventional experience suggests that waste unit weight generally increases over time due to waste degradation and settlement. It is therefore suspected that all or much of data output from the TPCs is erroneous and this method is assigned a very low overall confidence rank in the summary of methods in Section 11.2.1.

5.2.2 Whole-Site Waste Unit Weight Evaluation

An evaluation of the bulk unit weight of the waste and cover soil materials at the CIL was made, based on analysis of waste receipt records and topographic maps from the site. The amount of waste and cover soil used at the CIL was obtained from operating records. The volume used at CIL was obtained from a series of aerial surveys of the site. Using this information, the bulk unit weight of the waste and cover soil was calculated on a cumulative basis for five time periods at the CIL. The bulk unit weight was calculated for the following time periods:

- Time period 1 - January 1985 to December 1997;
- Time period 2 - January 1985 to April 1999;
- Time period 3 - January 1985 to September 2000;
- Time period 4 - January 1985 to April 2001; and
- Time period 5 - January 1985 to April 2002.

The volume between cumulative surveys was calculated from differences in ground surface elevations, which account for increasing landfill volumes resulting from waste placement. Settlement of the dredge spoils underlying the waste results in some additional, "unseen" waste volume gain, and this was estimated from appropriate settlement plate data. Assumptions were made regarding the rate of waste placement between January 1985 and December 1997 as detailed monthly site operational records were not available for this period. Thereafter, site operations reports were reviewed to obtain the quantity of waste material and cover soils placed in the landfill between January 1998 and April 2002. Bulk unit weights were then calculated separately for

Phases I and II and Phases III through V for the different time periods. Separating the phases into two groups in this way reflected that they essentially represent different distinct landfill 'mounds'. The effects of waste degradation, which would have caused the mass of waste in place to decline over time due to the consumption of organic matter by microbial populations, were not considered. The calculation procedure is provided in Appendix O-2 and the results are presented in Table 4.

The bulk unit weight was calculated cumulatively from January 1985 in each case because the actual volume of waste placed between each aerial survey event could not be determined on a year-by-year basis. This is due to the fact that the extent of waste settlement in lower landfill lifts as a result of surcharge loading from new upper lifts of waste was "unseen" and could not be accounted for. Table 4 presents a summary of the cumulative unit weight calculations. The table shows that the unit weight of waste in Phases I and II remains approximately constant at approximately 77 pcf. During the same time period, the unit weight of waste in Phases III through V increased from 47 pcf to 59 pcf. It is interesting that the unit weight in the older, thicker Phases I and II seems to be decreasing slightly while it is increasing in the newer, shallower Phases III through V (the latter case being as expected due to waste degradation and settlement). The slight decrease in unit weight in Phases I/II may be due to the fact that recent waste deposition in Phases I and II has tended to comprise only special wastes such as asbestos, which has a low unit weight. In addition, the asbestos waste arrives in flat, pre-packaged units which are laid out and immediately covered with low-density, compost-rich soil without being compacted.

6. SPECTRAL ANALYSIS OF SURFACE WAVES (SASW) SURVEY

6.1 Introduction

The SASW testing program was conducted under the supervision of Dr. Kenneth H. Stokoe, II, Ph.D., P.E., Professor of Civil Engineering at the University of Texas, Austin, acting as an independent consultant to GeoSyntec, on 7 and 8 Marcb 2002. Dr. Stokoe has performed similar SASW surveys for GeoSyntec on two previous occasions at landfills in California [GeoSyntec & Todd, 1995; GeoSyntec, 1996]. He was also involved in the six site study in the greater Los Angeles metropolitan area undertaken by Kavazanjian, et al. [1996]. The main objective of the SASW investigation was to evaluate, in a non-intrusive manner, the potential spatial variability

of the mechanical properties of the waste mass, using shear wave velocity as an index of the mechanical properties of the waste (primarily unit weight).

6.2 SASW Technique, Testing Program, and Results

The SASW technique utilizes the dispersive nature of Rayleigh-type surface waves propagating through a layered material to determine the shear wave velocity profile in the materials. Dispersion in the shear wave velocity arises from changing stiffness properties of the subsurface material with depth. SASW testing was selected for field investigation of waste physical characteristics at the CIL because of the technique's ability to non-invasively provide a measure of the spatial distribution of shear wave velocity within a waste mass. Previous SASW testing results [Stokoe et al., 1994] have demonstrated the value of this technique in characterizing the spatial distribution of shear wave velocity, and then, by inference, of other mechanical properties of the waste mass in the landfill (e.g., stiffness and unit weight).

The SASW survey technique and testing program are described in full in a separate report provided to GeoSyntec by Dr. Stokoe. The SASW report is presented as Appendix P of the GCR and its contents are therefore not reproduced or discussed in detail in this report. The SASW report provides site-specific data on the distribution and variability of shear wave velocity within the waste mass and foundation soil at the CIL. Specifically, the results of the SASW testing were used to evaluate:

- the distribution and variability of shear wave velocities within the waste mass to provide a qualitative indication of the heterogeneity in waste composition and the relative variability in waste density;
- the shear wave velocity of the landfill foundation;
- the thickness of the waste mass and dredge deposit; and
- the shear wave velocity profile of the waste and dredge for use in the seismic response analysis.

The SASW survey locations are presented on Figure 2. The survey locations were selected to: (i) provide broad characterization of the homogeneity (or lack thereof) of the waste mass in each phase of the landfill; (ii) provide characterization of the waste along specific cross sections that would subsequently be used in numerical analysis of the landfill; (iii) provide subsurface characterization data at specific points where

instrumentation (i.e., settlement plates or piezometers) data are available; and (iv) provide characterization of foundation material beneath and adjacent to the landfill. SASW testing was conducted at nine locations on the top surface of the landfill (one location in Phases I and II, two locations in Phases III and IV, and three locations in Phase V) and at two locations adjacent to the landfill. The latter two locations were selected to allow more direct evaluation of the shear wave velocity of the foundation material at the landfill. Where large diameter test borings and SASW locations coincided (see Figure 2), unit weight values obtained from the test borings were used to calibrate the inference of waste unit weight from the SASW shear wave velocity results. SASW surveys were conducted at locations and/or depths where test boring were not possible due to the presence of standing liquid or hazardous materials (asbestos), enabling estimations of waste bulk unit weight at these locations and/or depths to be made.

SASW surveys were conducted according to the requirements of the Health and Safety Plan (HASP) for the field investigation activities at the CIL. The HASP is presented as Appendix O-3.

The results from the SASW survey are contained in the SASW report (see Appendix P of the GCR) and so are not reproduced in this report, although inferred waste unit weight profile values at survey locations SASW01 through SASW09 are included in the overall summary Table 10 and discussed and ranked in Section 11.2. It should be noted that the SASW profiles are tentative, especially for SASW01 where no data from the large diameter test boring were available to calibrate the SASW soundings. According to Dr. Stokoe's report, this was because the waste at the CIL contains high quantities of paper combined with significant water. Increasing water content will tend to increase the unit weight of the waste but decrease the shear wave velocity, resulting in the lack of a simple correlation between increasing unit weight and shear velocity.

7. LARGE DIAMETER TEST BORING PROGRAM

7.1 Introduction

The large diameter (LD) test boring program consisted of nine large diameter (36-in.) bucket auger borings, which were advanced to depths between 22 ft. and 31 ft. The

LD test boring program, which was conducted by GeoSyntec from 11 to 15 March 2002, had the following specific objectives:

- to obtain measurements of the in-situ unit weight of waste at selected locations in each of the five phases of the CIL;
- to visually characterize the waste mass, particularly with regard to composition and moisture content, from observation of the drill cuttings from the boreholes; and
- to obtain representative waste samples from specified depth intervals in selected borings for: (i) on-site compositional classification; and (ii) laboratory testing.

To achieve the above objectives, the LD test boring program included: (i) in-situ evaluation of total unit weight using a procedure modeled on the sand cone density test; (ii) visual logging of the recovered samples; (iii) on-site classification of recovered borehole cuttings; and (iv) retention of bulk samples for use in laboratory testing.

Figure 2 shows the locations of the nine LD borings on the top surface of the landfill. Each LD boring was located near a survey location from the SASW investigation. LD boring locations were selected in each phase of the CIL to encompass the range of conditions expected to be encountered at the landfill with respect to the moisture content and age of the waste. However, drilling at the selected location in Phase I (i.e., P1_02_SASW01) was not conducted due to concerns about the presence of asbestos throughout this phase. As an alternative, a second drilling location was selected in Phase II (i.e., P2_02_UW02A) as shown in Figure 2.

The procedures used for test boring and waste sampling, logging, laboratory testing, and unit weight determination, are discussed in the remainder of this section. Results of the waste sampling, logging, laboratory testing, and unit weight determination and are also presented and discussed.

7.2 Test Boring Procedure

Each LD boring was drilled vertically from the upper surface of the landfill and was advanced approximately 20 ft. to 30 ft. into the waste mass. The intended depth of each boring was the top of the leachate collection system (LCS), which, according to

the design drawings, consists of 1 ft. of coarse sand or pea gravel in Phases III through V, and 1 ft. of Backfill Type F for Phase II. No LCS was reported to be present in Phase I. A 36-inch diameter bucket auger on a truck-mounted drill rig was used to advance the borings. The final augered depth was dictated by the elevation of standing liquid encountered at each boring location as the extremely wet and cohesionless waste below the standing liquid level could not be effectively removed from a borehole using the bucket auger. In addition, a representative mass of wet waste could not be transferred into or stored in a roll-off container because the liquid contained in the waste spilled from the bucket during transfer or seeped from the container after the waste was placed into it.

The bucket auger consisted of a hollow cylinder supported on a rigid drill stem. The cylinder, or bucket, has teeth on one end that cut through the waste as the drill stem rotates the bucket. The bucket auger is well suited for the heterogeneous conditions and large size of waste constituents expected in a solid waste landfill. For this reason, bucket augers are typically used to install landfill gas wells. They have also been effectively used to conduct exploration activities in waste at a number of landfills. The large diameter of the borehole produced by the bucket auger rig facilitates the collection of relatively large waste samples containing reasonably intact waste constituents.

The LD test boring activities were carried out by Kellett's Well Boring, Inc. of Simpsonville, South Carolina, under GeoSyntec's supervision. LD test borings activities were conducted according to the Standard Operating Procedure SOP-1 presented in Appendix O-4.1 and followed the requirements of the HASP for the field investigation activities.

DSWA requested that each LD borehole be completed as a gas well using a 20 ft. section of perforated HDPE pipe surrounded with gravel. Each borehole was backfilled with gravel to within 2 to 5 ft of the landfill surface. The procedure for gravel backfilling is described in Section 7.5. After backfilling, a bentonite seal was placed at the top of the gravel by site representatives of Cereza, Inc., the gas well field installation and gas system operations contractor for DSWA at the CIL. The two boreholes in Phase II were not completed as gas wells due to the age of the waste and the height of standing liquid encountered. These boreholes were backfilled with gravel to a depth of 4 ft. from the landfill surface and then sealed with tamped clayey soil.

7.3 Procedures for Waste Collection, Weighing, Sampling, Logging, and Classification

7.3.1 Waste Collection, Weighing, and Sampling

Each LD test boring was advanced in intervals of approximately 10 ft. Retrieved waste from each interval was placed directly into a roll-off container and the net weight of each interval of waste was measured using the procedure outlined in Standard Operating Procedure SOP-2, Section 5.3 (see Appendix O-4.2).

Solid waste samples were collected for the following activities:

1. on-site compositional classification;
2. laboratory testing of moisture content and biochemical methane potential (BMP); and
3. laboratory testing of internal direct shear strength.

The boreholes and depth intervals from which samples were collected are indicated in the table below.

Borehole	On-Site Waste Classification	Laboratory Testing	
		Moisture Content and Biochemical Methane Potential (BMP)	Shear Strength
	Activity (1)	Activity (2)	Activity (3)
P2_02_UW02	All depth intervals	All depth intervals	
P2_02_UW02A	All depth intervals	All depth intervals	
P2_02_UW03			Collected from depth of 27 to 28 ft
P3_02_UW04	All depth intervals	All depth intervals	
P4_02_UWO5	All depth intervals	All depth intervals	
P5_02_UW08	All depth intervals	All depth intervals	
P5_02_UW09	All depth intervals	All depth intervals	

Summary of Large Diameter Test Boring Locations with Sample Collection for Field Classification or Laboratory Testing

With reference to the table, waste sampling for Activities (1) and (2) was carried out by personnel from SCS Engineers of Reston, Virginia, under a separate scope of

services to DSWA. Collection of samples for these activities was conducted after an entire depth interval had been drilled and the waste-filled roll-off container dragged away from the drill rig. For Activity (1), a 130 to 170 lbs. bulk sample of waste was taken from the entire waste mass within the container. After completion of this activity, an SCS Engineers field engineer selected representative samples of waste that were removed and stored for Activity (2). Waste that was not retained for laboratory analysis was returned to the roll-off container.

Collection of a sample for Activity (3) was conducted by a GeoSyntec field engineer. Sample collection was conducted after drilling an entire depth interval had been completed and the full roll-off container dragged away from the drill rig. A 40 to 100 lb. sample of waste was collected from the final two bucket loads deposited in the container. In this way, the sampled depth interval could be established to within approximately 2 ft.

The locations of the sampled boreholes are shown on Figure 2. All sampling activities were carried out in accordance with Standard Operating Procedure SOP-2 Section 5.1 (see Appendix O-4.2) and followed the requirements of the HASP (see Appendix O-3).

7.3.2 Borehole Logging

Each bucket auger load was emptied into a metal roll-off container and visually classified by a GeoSyntec engineer on site. Borehole logging including recording of visual observations of waste composition (i.e., household, paper and plastics, putrescible organics, soil, glass, etc.), compaction of the waste (i.e., slight, moderate, or heavy), degradation of the waste (i.e., none, slight, moderate, or high), moisture in the waste (i.e., dry, moist, or saturated), and structure of the waste (i.e., layered, encapsulated, fibrous, interlocked, or indistinguishable). Sampling intervals, locations of zones of wet or saturated waste or "dripping" liquid, depths to standing liquid, and areas where waste of similar composition were observed by the field engineer were also documented on the boring logs along with any other data considered pertinent by the field engineer.

Borehole logging was conducted in accordance with Standard Operating Procedure SOP-2 Section 5.4 (see Appendix O-4.2) and followed the requirements of the HASP. Site-specific Procedural Record and Visual Classification Forms (PRVCFs) were

developed for borehole logging at the CIL. An example of the PRVCF used is shown in SOP-2 Attachment 1 (see Appendix O-4.2).

Designations of "Slight," "Moderate," and "Heavy," used to describe waste compaction, were employed to describe the apparent in situ density of the waste based upon the difficulty encountered in removing the waste from the bucket auger. "Slight" compaction indicates that the waste easily fell out of the bucket auger. "Moderate" compaction indicates that the waste fell out of the bucket auger only after impact. "Heavy" compaction indicates that the waste fell out of the bucket auger only after the bucket auger was struck several times with a hammer.

Designations of "None," "Slight," "Moderate," and "High," were used to describe waste degradation based upon the legibility of newspaper and the discoloration of the waste. "None" indicates that the newspapers were very legible and that the waste was not discolored. "Slight" indicates some of the newspapers were legible and the waste was somewhat discolored. "Moderate" indicates that the newspapers were only partly legible and the waste was highly discolored. "High" indicates that the newspapers were highly faded gray to black.

Designations of "Layered," "Encapsulated," "Fibrous," "Interlocked," and "Indistinguishable" were used to describe waste structure based upon the aggregation of waste after it was removed from the bucket auger. "Layered" indicates that waste constituents were oriented with the long axis in a preferred direction. "Encapsulated" indicates that waste constituents were encapsulated in a soil matrix. "Fibrous" indicates that waste constituents were intertwined. "Interlocked" indicates that waste constituents had a granular structure. "Indistinguishable" indicates that no clear structure could be discerned.

Completed PRVCFs are reproduced in Appendix O-8.1. Findings are summarized and discussed in Section 7.6.2.

7.3.3 Waste Classification

The procedures for, and results of, the waste classification study were provided in a 10 January 2003 letter report from SCS Engineers to DSWA. A copy of the letter report is included in full as Appendix O-5 to this report. Results are summarized in Section 7.6.3.1.

7.4 Procedures for Laboratory Testing of Waste

7.4.1 Waste Moisture Content and Biochemical Methane Potential (BMP)

The procedures for laboratory determination of waste sample moisture content and BMP were provided in the aforementioned 10 January 2003 letter report from SCS Engineers to DSWA (see Appendix O-5). Results are summarized in Sections 7.6.3.2 and 7.6.3.3, respectively.

7.4.2 Shear Strength of Waste

Waste shear strength testing was conducted by SGI Testing, Inc. (SGI) of Atlanta, Georgia, under the supervision of Mr. Robert H. Swan, Jr. The procedures used for determining internal direct shear were stated in a letter report from SGI to GeoSyntec dated June 15, 2002. A copy of this letter report is included in full as Appendix O-6 to this report. Results are summarized in Section 7.6.3.4.

7.5 Determination of In-Situ Waste Unit Weight

7.5.1 General Procedures

The in-situ unit weight of waste was determined for each depth interval in each of the nine LD borings to evaluate profiles of waste unit weight versus depth. The procedure used for measuring the unit weight was adapted by GeoSyntec from the American Society for Testing and Materials (ASTM) Standard Test Method for Evaluating the Density of Soil in Place by the Sand-Cone Method (ASTM D 1556). The procedure consisted of weighing the waste removed from each depth interval of the borehole until the borehole had been advanced to that interval's maximum depth. The procedures for determination of waste weight are given in Section 5.2 of SOP-2 in Appendix O-4.2. The tolerance on the landfill weighbridge was 200 lbs. The volume of each depth interval in the LD borings was estimated using the three alternative methods described in Sections 7.5.2 through 7.5.4 next. Results from the volume calculations are presented and discussed in Section 7.6.4. Waste unit weight calculations are presented and discussed in Section 7.6.5.

7.5.2 Backfilling With Gravel of Known Density

The relationship between unit weight and drop height for Delaware No. 57 gravel, the gravel selected for backfilling the boreholes, was established prior to the test boring program (see Appendix O-7.1). A known weight of this gravel was then backfilled into the borehole in two or three known depth intervals. A perforated HDPE pipe was placed into each borehole with a tip depth of 18 to 14 ft b.g.l. during gravel backfilling to allow each borehole to be finished as gas wells. Gravel delivered to the site in concrete trucks and was backfilled directly into each borehole using the truck's positioning chutes. Gravel delivery in this way was provided by Bear Materials, LLC of New Castle, Delaware. Based upon a calibration curve developed for the weight of the gravel backfill versus the depth interval over which it was placed, the volume of each depth interval from which waste had been removed and weighed could be calculated. This calculation took into account the volume occupied by the gas pipe. The in-situ unit weight of waste in each interval could then be determined. The procedures for determination of borehole volume, and hence waste unit weight, using the gravel backfill method are provided in Appendix O-7.2.

Because the unit weight of the backfill gravel (i.e., Delaware No. 57 gravel), and the relationship between the unit weight of the gravel and borehole depth (i.e., drop depth), were key elements in evaluating the in-situ unit weight of waste, these were determined independently of the field investigation. Typical gravel properties reported by the quarry and reliable literature resources were obtained (see Appendix O-7.1). In addition, the following two tests were carried out in order to investigate the drop height versus gravel unit weight relationship. Both tests were carried out at the Greggo & Ferrara, Inc. quarry located in New Castle, Delaware, which was the source of gravel used for borehole backfilling.

A. The procedure for the first test, in which gravel was dropped from a known height into a known volume (i.e., 55 gallon drums) and then weighed, is presented in Appendix O-7.1. Over a drop height of up to 20 ft, it was found that the drop height had no influence over gravel density, which was calculated to be approximately 102 to 116 pounds per cubic foot (pcf). The large range is the result of the 200 lb. tolerance on the truck scale at the quarry.

B. The procedure for the second test, in which gravel was compacted at two different compactions into 2 gallon buckets and then weighed, is also presented

in Appendix O-7.1. The density of gravel was calculated to range from 114 – 122 pcf depending on compaction.

As shown in Appendix O-7.1, a gravel density of 115 pcf, which was independent of drop height, was selected. This value was selected based on engineering judgment and the intercept between data from the following sources: (i) the range in Method A (i.e., 102 – 116 pcf); (ii) the range in Method B (i.e., 114 – 122 pcf); (iii) a value of 95 pcf supplied by the quarry; and (iv) a review of published values for gravel density. It was considered unwise to simply rely on the value provided by the quarry because it was so low.

Calculation of borehole volume using the gravel backfill method often resulted in a net "underbore" for the boring (i.e., the volume calculated indicated that the diameter of the boring was less than the diameter of the bucket auger). This reduction in resultant borehole diameter, which is likely a result of radial deformation of the waste around the open borehole during the time between boring and backfilling, yields an erroneously large waste unit weight value. For this reason, it was decided that this method did not yield usable results for the purpose intended. Two simple alternative methods for estimating upper- and lower-bound values for borehole volumes were therefore sought as described next.

7.5.3 Assuming Diameter of Borings is Equal to Bucket Auger Diameter

It is reasoned that the mass of waste attributed to each borehole depth interval could not have been recovered from a boring with a diameter less than that of the bucket auger. This method of estimating borehole volume, the calculation procedure for which is trivial, therefore provides a reasonable lower-bound value for borehole volume, and hence an upper-bound value for waste unit weight.

7.5.4 Assuming Diameter of Borings is Larger Than Bucket Auger Diameter

A 16 percent overbore value was used in the analysis. This is based on an upper-bound average value reported from previous field investigations carried out by GeoSyntec at landfill sites in California (see Table 1). This method of estimating borehole volume, the calculation procedure for which is also trivial, is therefore

considered to provide reasonable upper-bound values for borehole volume, and hence lower-bound values for waste unit weight.

7.6 Results of the Large Diameter Test Boring Program

7.6.1 Waste Moisture Content and Limit of Saturated Waste

As discussed in Section 7.2, the final augered depth of eight of the nine LD boreholes was dictated by the depth at which significant free liquid (which at the time was assumed to be the top surface of connected standing liquid in the CIL) was encountered in the borehole. Only Borehole P4_02_UW06 remained dry through the entire depth of waste above the leachate collection system (LCS), although many of the other eight were bored to within a few feet of the LCS. The depth to this apparent free liquid in each borehole (which, for ease of communication, is referred to as standing liquid for the remainder of this section), both when first encountered and after a few hours, were recorded on Procedural Record and Visual Classification Forms (PRVCFs). The PRVCFs are presented in Appendix O-8.1. It was found that the standing liquid level remained stable in all boreholes except P5_02_UW07 where it rose by about 4 ft. The final observed depths to standing liquid are shown in Table 5 and Figure 3. A visual classification of the moisture content of the waste as it was brought to the surface is presented in Table 6. This classification is a qualitative measure of the moisture content of the waste. Quantitative measurement of the moisture content of collected waste samples was conducted during the laboratory testing program conducted by SCS Engineers. Results are provided in Section 7.6.3.2.

The moisture content of waste in the CIL varied considerably depending upon the location and depth of waste within the landfill. Moisture content either remained constant or increased with depth, becoming saturated below standing liquid levels. During the LD test boring program, intermittent pockets of high moisture content waste underlain by relatively dry waste material were not generally observed, although subsequent CPT soundings and small diameter test borings indicated that the liquid encountered in each boreholes did not always extend all the way down to the LCS (i.e., perched liquid levels are present within the landfill). This is discussed further in Section 11.1.

The moisture content of excavated waste was the most significant factor with regard to other observed physical properties. The influence of moisture content on

waste structure, compaction, degradation, and composition, as well as on waste unit weight, is discussed during the remainder of this section.

7.6.2 Borehole Logging

7.6.2.1 Cover Conditions

The cover conditions in Phase I could not be determined precisely, although a walk-over survey suggested that it was generally comprised well compacted, clayey material. From observation of drill cuttings and walk-over surveys, cover conditions over the other four phases can generally be grouped into the following three broad classifications:

1. 1 to 2 ft of loosely compacted soil in Phase II;
2. 1 to 3 ft of soil, grit, and stabilized sludge and ash in Phase III; and
3. 1 to 3 ft of soil and wood chip mulch in Phases IV and V.

The relatively large quantities of highly compressible, low density non-soil components in cover at Phases III through V helps explain the low overall unit weight of landfilled material generally recovered in the top 10 ft lift in the LD drilling program, as well as the low value obtained in the whole-site estimate of unit weight in these phases (as previously discussed in Section 5.2.2).

7.6.2.2 Waste Compaction

Table 6 presents the observed waste compaction in each depth interval. Waste compaction throughout the site was generally low, especially in Phases IV and V where mulch material was used as cover. Compaction in Phase II was highest where significant quantities of soil were noted. The compaction of waste was generally constant with depth and was observed to increase slightly with depth in only one borehole: P2_02_UW02A. The observed compaction of waste thus appears generally to vary mostly with age and soil content, and vary less significantly with moisture. Assessment of the compaction of waste removed from below the standing liquid level was not possible.

7.6.2.3 Waste Degradation

Table 6 presents waste degradation in each depth interval. The degradation of the waste was generally observed to increase with depth, although depth was, in effect, a measure of moisture content. With the exception of Borehole P5_02_UW08, waste from close to or below the standing liquid level was highly degraded. Waste in dryer boreholes (e.g., P4_02_UW06) or drier intervals (e.g., 0 to 10 ft in Borehole P5_02_UW07) was generally less degraded than in wetter boreholes (e.g., P2_02_UW03). The degradation of the waste was also somewhat dependent upon waste composition.

7.6.2.4 Waste Structure and Composition

The structure of waste was extremely difficult to classify visually as it was deposited in the roll-off container. It is likely that the bucket augering process disrupts the waste structure even before the waste is brought to the surface. In most cases, any structure in the waste that may have been retained in the bucket was probably destroyed as the waste was removed from the bucket auger. However, it was observed (see Table 6) that fresher, drier, less degraded waste was generally more fibrous than older, wetter, or more degraded waste.

7.6.2.5 Summary

Observations made during the test boring program indicate that the composition of the waste present in the CIL is generally heterogeneous, as was expected. The most useful observation from the borehole logging activity was probably that no unusual or oversized waste materials were observed.

7.6.3 Waste Classification Study and Laboratory Testing

7.6.3.1 Waste Classification

The results from the waste classification study and moisture content determination were provided in the 10 January 2003 letter report from SCS Engineers to DSWA (see Appendix O-5). Waste compositional data obtained from the waste sort and comments

in the letter report regarding the recognizable waste materials are summarized as follows:

1. Waste was separated into the following six categories: (i) paper; (ii) plastic; (iii) glass; (iv) metals; (v) organics; and (vi) fines and inert materials. Results are summarized in the table below.

2. The waste material, for the most part, was in poor condition, fairly degraded, and problematic to sort. Much of the waste was black in color and very wet, making it visually indistinguishable (the photograph of sample collected from P2_02_UW03, which is reproduced in Appendix O-8.1, shows a similar waste sample). To sort the waste, the field crew had to rely on the texture, density, and consistency of waste materials.

3. Some general characteristics of the waste were: (i) paper was usually wet and therefore rather heavy; (ii) glass was always in small fragments; and (iii) organics generally consisted of wood, compost material, and leaves; (iv) most inert material consisted of wet fines, primarily soil, rock fragments, or grit.

4. In general, waste in Phases I, II, and III was more degraded than waste in Phases Iv and V. Waste recovered from greater depths was also more difficult to recognize and classify.

Component	Proportion by wet mass (%)	
	Minimum	Maximum
Paper	4.6	33.9
Plastic	1.9	18.9
Glass	0.1	1.0
Metals	1.2	11.1
Organics	1.8	29.3
Inert Materials and Fines	32.5	87.1

Summary of results from waste classification study

7.6.3.2 Moisture Content

The results from the laboratory analysis of waste sample moisture content were provided in the 10 January 2003 letter report from SCS Engineers to DSWA (see Appendix O-5). Results from the moisture content analysis, which are summarized in the table below, show an increasing trend of moisture content with depth in most boreholes.

Borehole	Moisture Content (%)		
	Depth Interval (ft)		
	0 – 10	10 – 20	> 20
P2_02_UW02	32.9	49.6	53.5
P2_02_UW02A	48.6	42.4	36.5
P3_02_UW04	29.4	29.1	-
P4_02_UW05	21.1	24.1	34.1
P5_02_UW08	20.3	24.5	35.2
P5_02_UW09	19.7	23.2	-

Summary of results from waste moisture content analysis

7.6.3.3 Biochemical Methane Potential (BMP)

Results from the BMP evaluation were provided in the 10 January 2003 letter report from SCS Engineers to DSWA (see Appendix O-5). BMP analyses were conducted on waste samples collected from the top and bottom depth intervals in four boreholes: (i) P2_02_UW02; (ii) P3_02_UW04; (iii) P4_02_UW05; and (iv) P5_02_UW08. BMP values were reported along with organic solid fractions. With the exception of P2_02_UW02, BMP and organic solids values were significantly higher in samples collected from the top borehole interval, indicating (as expected) that the waste at the bottom of the borehole was more degraded with a lower volatile solid (VS) content. BMP and organic solids values were also higher in the boreholes in Phases IV and V than in those in Phases II and III, reflecting that waste in the former phases was generally placed more recently.

7.6.3.4 Waste Shear Strength and Compressibility

Laboratory results for five consolidation tests and five direct shear tests performed on a waste sample collected from a depth of 27 to 28 ft below ground surface (i.e., Elevation 49.8 ft-msl) in P2_02_UW03 were provided by SGI (see Appendix O-6). The waste sample was collected from approximately one foot below the observed standing liquid level (i.e., the sample was fully saturated in the field). The dimensions of the consolidation (shear) box were 12 in. long, 12 in. wide, and 5 in. high. The samples were reconstituted and consolidated at two different confining stresses (i.e., 800 and 2,000 psf). The waste compressibility (C_{cc}) was estimated to be 0.28.

The shear displacement rates used during the tests were 0.3 in./min, 0.04 in./min, and 0.006 in/min. A summary of the test conditions is presented in the table below. A copy of the SGI letter report dated June 15 2002 containing the results of the laboratory testing is included as Appendix O-6. A photograph of the saturated waste sample collected from P2_02_UW03 is included in the boring records in Appendix O-8.1.

Test ID	Confining Stress (psf)	Shear Rate (in/min)	Avg. Friction Angle (°)
1A 1B	800 2,000	0.3	36.0
2A 2B	800 2,000	0.04	34.0
3B	2,000	0.006	37.4

Summary of Waste Shear Strength

The average friction angle of Test 2 was calculated disregarding a friction angle of 29° measured at 0.75 in of displacement. A review of the laboratory data shows that this value appears to be significantly lower than the remaining values of friction angle.

7.6.3.5 Further Evaluations of Waste Properties Based on Waste Classification and Moisture Content Studies

Results from the waste classification and moisture content studies were used in the following analyses:

1. Correlation of waste composition and/or moisture content to intervals of high, low, or average shear wave velocity (see SASW Testing Report in Appendix P of the GCR). These correlations were used as an aid to inferring of waste unit weight profiles from SASW soundings.

2. Calculation of the void ratio (e) of waste. This is used in alternative calculations of the saturated unit weight (γ_{sat}) of waste and to obtain a site-specific value for waste porosity (n) for potential use in HELP analyses of the hydraulic performance of the landfill.

The evaluation procedures for (1) are detailed in the SASW report in Appendix P of the GCR. Procedures for (2) are detailed in Section 7.7.

7.6.4 Volume of Borings

The volume of each LD boring was determined using the three alternative volume calculation procedures (i.e., "gravel backfill method", "no overbore assumption", and "16 percent overbore assumption") described in Section 7.5. Calculated values are presented in Table 7. As previously discussed, values derived from the "no overbore assumption" and "16 percent overbore assumption" were considered to yield best-ease upper- and lower-bound waste bulk unit weight estimates for each depth interval. Values from the "gravel backfill method" are considered to be too high due to the reduction in borehole volume (noticed as a net "underbore" on the diameter of the boring) due to waste radial deformation.

7.6.5 Bulk Unit Weight of Waste

The bulk unit weight of waste was evaluated for the same depth intervals from which solid waste samples were collected. The forms presented in Appendix O-8.1 were used to record the weight of waste removed from each depth interval, and the weight of gravel used to backfill the boreholes. Calculated bulk unit weight values based on each of the above estimates of borehole volume are presented in Table 7. As discussed previously, values derived from the "no overbore assumption" are considered to represent maximum in-situ waste bulk unit weights. Values derived from the "16 percent overbore assumption" are considered to represent minimum bulk unit weights.

The tolerance of 100 lbs on the landfill truck scale was accounted for as appropriate when calculating maximum and minimum values. Maximum and minimum bulk unit weight profiles for waste in each LD boring in Phases II through V are presented in Figures 4-1 through 4-4.

When maximum and minimum values are averaged over the whole site, the bulk unit weight values derived from the LD borings ranged from 31 – 108 pcf with the whole-site average bulk unit weight of the waste being 60.7 pcf. As can be seen from Figures 4-1 through 4-4, a general trend of increasing unit weight with depth was evident in most borings. A summary of the waste unit weight in each approximate 10 ft depth increment is presented in the table below. It should be noted that the maximum value in the 10 – 20 ft depth range is from P4_02_UW05 which is considered to be suspect. Doubt has been cast over the accuracy of the depth increment records below 10 ft for this borehole, meaning that the mass of recovered waste attributed to the 10 – 20 ft and 20 – 28 ft depth increments may be incorrect.

Interval	Minimum	Maximum	Average
0 to 10 ft	31 pcf	64 pcf	49.7 pcf
10 to 20 ft	44 pcf	108 pcf	64.6 pcf
> 20 ft	48 pcf	97 pcf	71.4 pcf

Summary of Waste Unit Weight Values Determined from Large Diameter Test Boring Program (Averaged over the Whole Site)

7.7 Calculation of Specific Gravity, Void Ratio, and Saturated Unit Weight of Waste

The composition (in terms of wet mass) and the initial gravimetric moisture content, w, of the waste in each sampled increment were known from the on-site waste classification and laboratory studies performed by SCS Engineers (see Appendix O-5). Using previously published data on the proportion of moisture held by different waste fractions [Morris, 2001], the proportional dry mass of each waste component (m_{dwc}) could be determined as shown in the Microsoft Excel© spreadsheet printouts provided in Appendix O-7.3. The specific gravity (G_s) of waste in each sampled borehole depth interval was then calculated from the equation below:

$$G_s = \Sigma \frac{m_{dwc} \times \rho_c}{100}$$

where:

m_{dwc} = dry mass of waste component (percent of total dry mass)
ρ_c = solids density of waste component (relative)

Previously published values for the solids density of each different major waste component (ρ_c) were known from Morris [2001]. Results from the above calculation are shown in Table 8.

Once a specific gravity value for each representative waste sample is known, the void ratio (e) of the entire mass of waste in place in each increment can be determined from standard soil mechanics formulae such as can be found in Taylor [1956]. Calculated values are given in Table 8 along with resultant values for porosity (n), degree of saturation (S), dry unit weight (γ_d), and saturated unit weight (γ_{sat}). Calculation of the latter four terms is trivial and also based on standard soil mechanics formulae. Average saturated unit weight profiles for waste in each sampled LD boring interval in Phases II through V are presented in Figures 4-1 through 4-4. Maximum and minimum values for e, n, and S were found to vary significantly due to their direct dependence on bulk unit weight. Dry and saturated unit weight values were generally less variable, especially when the two suspect results from borehole P2_02_UW05 were omitted. Due to the similarity between the average bulk unit weight of the waste (i.e., 60.7 pcf) and the unit weight of water, it is reasonable that the saturated unit weight should be relatively independent of depth. For this reason, maximum saturated unit weight values, averaged over the entire depth of each sampled LD boring, are included in the unit weight summary table presented as Table 10.

8. SMALL DIAMETER TEST BORING PROGRAM

8.1 Introduction

The small diameter (SD) test boring program consisted of nine small diameter (8-in.) rotary auger borings, which were advanced to depths of 14 – 60 ft. The SD test

boring program, which was conducted by GeoSyntec from 10 to 12 April 2002, had the following specific objectives:

- to visually characterize and pictorially record the waste mass, particularly with regard to moisture content and the elevation of standing liquid in the CIL, so as to clarify the findings from the previous large diameter boring program; and
- to visually characterize, pictorially record, and obtain undisturbed samples of the waste-LCS-dredge material interfaces at selected locations in the landfill to assess the extent of, or potential for, clogging in the LCS.

A secondary objective was to recover intact Shelby tube waste samples from selected depths and locations in the landfill from which estimations of in-situ bulk unit weight could be made. Figure 3 shows the locations of the nine SD borings on the top surface of the landfill (two borings were duplicates drilled after refusal at shallow depth on the initial attempt at that location). SD boring locations were selected in Phases II through V of the CIL to encompass the range of conditions expected to be encountered at the landfill with respect to the moisture content and age of the waste. No drilling was conducted in Phase I and portions of Phase II due to concerns about the presence of asbestos.

The procedures used for test boring, waste sampling, and unit weight determination, followed by the results from these activities, are presented and discussed in the remainder of this section.

8.2 Test Boring and Waste Sampling Procedure

Each SD boring was drilled vertically from the upper surface of the landfill. The intended depth of each boring was 1 – 2 ft. below the leachate collection system (LCS), which was thought to consist of 1 – 2 ft. of coarse sand or pea gravel (except in Phase II where the LCS drainage layer consists of backfill material type F). An 8-inch diameter rotary auger on a truck-mounted drill rig (i.e., a standard SPT rig) was used to advance the borings. Once the boring had been advanced below the level of saturated waste (estimated from observation of drill cuttings) and/or was close to the estimated depth of the LCS, an attempt to recover a 2 ft. split-spoon or Shelby tube sample was made. This was repeated a number of times in each boring. Recovered split-spoons were opened and then sampled and/or photographed if their contents thought to be of interest. Recovered Shelby tubes were opened if it was obvious that little sample recovery had

occurred, otherwise they were taped and sealed. On completion of drilling, each borehole was backfilled with drill cuttings.

Attempts were made during drilling to dip the SD borings (both with the auger in place and after it had been withdrawn) to determine the elevation of standing liquid at that location. Results from these dipping events were inconclusive due either to caving in of the walls in open holes or elevated readings in the hollow stem of the auger the boring (i.e., readings significantly about the depth from which saturated drill cuttings were first recovered). Although shown on the boring logs in Appendix O-8.2, neither of these two elevations can be regarded as being truly representative of site conditions.

The SD test boring activities were carried out by Summit Site Services, Inc. of Baltimore, Maryland, under GeoSyntec's supervision. SD test borings activities followed the requirements of the HASP for the field investigation activities as specified in Appendix O-3.

8.3 Procedure for Calculation of Waste Unit Weight

The procedure for calculation of waste unit weight from Shelby tube samples is straightforward and is shown, along with the calculation, in Appendix O-7.4. The calculation also shows a procedure for calculating the unit weight of samples recovered from split spoons, but these are not considered to be representative of in-situ conditions and are therefore not discussed further. Care was taken when opening sample tubes to avoid disturbing the samples. The top and bottom of sample sections were trimmed to ensure that a cylindrical section was obtained. Split spoon samples were weighted on site. Shelby tube samples were weighed at GeoSyntec's Maryland office.

8.4 Results

8.4.1 Waste Unit Weight

Collection of a reasonably sized, relatively undisturbed waste sample in Shelby tubes was extremely difficult due to the stiffness of the waste material and the macro-sized particles (e.g., wood, metal cables and rods, plastic sheets, etc.) present in the landfill. As a result, only one useable Shelby tube sample was obtained. The unit weight value determined for this sample, which was collected at a depth of 34-34.5 ft in P3_02_SPT3W, was 76 pcf as shown in Tables 9 and 10.

8.4.2 Visual Characterization of Waste and Leachate Collection System

The boring logs and photographic records from the SD test boring program are presented in Appendix O-8.2. Boring information is summarized in Table 9. The high ratio of failed to successful attempts at precisely locating the waste-LCS-dredge interface and recovering Shelby tube and split-spoon samples from it is recorded in the boring logs and summarized in Table 9. Only four samples were successfully extracted from this interface:

1. *Split-spoon sample recovered from a depth of 24.5 ft. in P3_02_SPT5AW.* This sample showed that the LCS consisted of poorly graded soil and pebbles. The recovered LCS material was not saturated, appeared to be relatively clean, and earthen brown in color. The fact that the split-spoon pushed at a depth of 26 – 28 ft. in P3_02_SPT5W missed the LCS completely and the split-spoon pushed at 24 – 24.5 ft. in the duplicate P3_02_SPT5AW boring only just hit the LCS when data from the closest settlement plate, P3_SP8, indicated that the LCS should be at a depth of 25 – 26 ft. demonstrates the degree of uncertainty involved in this exercise and the small margin of error that could be tolerated.

2. *Split-spoon sample recovered from a depth of 38 – 40 ft. in P3_02_SPT3W.* Although recovery in this split-spoon was very low, some wet, dirty, rather odorous, gritty material, was recovered. A split spoon pushed from 40 ft recovered only dredge material.

3. *Split-spoon sample recovered from a depth of 40 – 42 ft. in P5_02_SPT1W.* This split-spoon hit the waste-LCS interface, recovering 18-in. of MSW and 6-in. of LCS material (course sand and pea gravel). The condition of the LCS material was that it was grey-black in color, very wet, highly odorous, and rather stiff, cemented, and crumbly in structure.

4. *Shelby tube sample pushed from 42 – 44 ft. in P5_02_SPT1W.* had not been extracted and inspected. However, based on observation of the material visible at both ends of the tube, it is doubtful whether the tube contains any of the LCS.

The condition and likely performance of the LCS is described and discussed further in Chapter 7 of the GCR. The depth to saturated waste was determined in all borings except two in Phase II, which were abandoned before saturated conditions were encountered. From the results shown in Table 9, it is apparent that there is significant

depth of saturated waste in Phase II. Saturated conditions were not encountered in the borings in the central section of Phase III, while there appears to be little saturated waste in Phase V. As previously discussed, the top elevation of saturated waste in P3_02_SPT3W near the Phase II/III boundary was high.

In summary of the SD boring effort, some useful, albeit limited, information regarding the nature of standing liquid, waste unit weight, and condition of the LCS was obtained. However, it proved to be extremely difficult to precisely locate the waste-LCS-dredge interface due to the fact that the LCS was only approximately 1-ft thick and the site records and surveys on which boring locations and depths for sample collection were based were only accurate to approximately 1 or 2 feet.

9. CONE PENETROMETER TESTS

9.1 Introduction

The procedures, methodologies, and results from the CPT soundings and dissipation tests performed in the waste at the CIL are presented in full along with all other CPT related data from the site in Appendix A of the GCR. These data are discussed in depth in the GCR. Consequently, only the results of the CPT dissipation tests, which are of relevance to determining the characteristics of standing liquid in the landfill (i.e., whether liquid encountered in the waste is present in one static, connected layer or present in several unconnected, perched layers), are presented and discussed in this report. No attempt was made to estimate the shear strength of waste based on CPT data.

Dissipation tests in the waste and underlying dredge material were performed at CPT soundings C060 through C068. These CPT soundings were pushed by ConeTec, Inc. of West Berlin, New Jersey under the supervision of Mr. Rick Pope and the direction of GeoSyntec between 10 and 16 April 2002. It was intended that soundings be pushed through the entire depth of waste in at least one location in each phase of the CIL, ending 20 – 30 ft. into the underlying dredge material. An attempt to perform a dissipation test within the LCS, to assess the free draining nature of the LCS at that location, was to be made at each sounding location. At least one dissipation test in the underlying dredge material at each location was to be attempted. The locations of C060 through C068 are shown in Figure 3. The method provided by ConeTec for derivation of the depth of standing liquid from dissipation test data is presented in Appendix O-9.

9.2 Results from CPT Dissipation Tests

Results from the CPT dissipation tests are summarized in Figures 5-1 and 5-2. As shown in the figures, 2 to 11 dissipation tests were performed at each CPT sounding. CPT soundings C061 (Phase V), C063 and C064 (Phase I), and C065 (Phase II) were abandoned before the LCS was encountered because the cone tip hit an obstruction. C066, which was pushed as a duplicate to C065 but which also hit an obstruction before encountering the LCS, is not included in Figure 5-2 because no dissipation tests were performed in this sounding. At most dissipation test depths, negative pore pressures were measured, indicating that standing liquid was either not present or only present below the test depth. Where positive pore pressures were measured in the waste, conditions indicative of static water levels were not encountered. This suggests that, while a great deal of liquid is present in the waste, it exists in unconnected, perched layers and is not truly static. As expected, the pore pressures measured in the underlying dredge spoil material were significantly higher than those measured in the waste.

10. GAS WELL DIPPING PROGRAM

10.1 Introduction

An extensive program of dipping existing gas wells at the CIL was performed by GeoSyntec on 10 and 11 April 2002. The dipped gas wells were selected in all Phases of the CIL to provide data on static liquid levels in areas where test bores were not advanced, and to confirm measured liquid levels at test boring locations in which static liquid levels were found to be high.

The locations of all dipped wells are shown on Figure 3. If wells were connected to the gas collection system at the site, well valves were closed before dipping. Where possible, wellheads were unscrewed, the well dipped, and then the wellhead reassembled and the valve re-opened. Where it was not possible to unscrew wellheads, the vertical wellhead pipe was cut, the well dipped, and then the wellhead pipe repaired using a glued flange before the valve was re-opened. Selection of wells for dipping and/or wellheads for cutting, as well as all cutting and repair activities, were carried out in close consultation with Cereza and DSWA.

10.2 Results

Three different types of gas wells were dipped as part of this program:

1. Existing gas wells (nomenclature "EGW" on Figure 3). These are generally long-standing gas vents built up as the height of the landfill increased from interlocking cylindrical 48-in. diameter concrete sections. The concrete sections contain a 4-in. diameter slotted PVC pipe surrounded by coarse aggregate. A typical cross-section through a gas vent is presented in Appendix O-10.1. These gas wells are predominant in Phases I and II.

2. Gas wells installed during March and April 2002 within large (36-in.) diameter bucket auger borings drilled by EMCON Organic Waste Technologies, Inc. (OWT) of Brecksville, Ohio (nomenclature "OWT" on Figure 3). These gas wells consist of a slotted 6-in. diameter PVC pipe surrounded by coarse aggregate. OWT's drilling and gas well completion logs, which were provided to GeoSyntec by DSWA, are presented in Appendix O-10.2.

3. Borings from the large diameter test boring program (see Section 7) finished as gas wells (nomenclature "UW" on Figure 3).

The coordinates and elevations of all "EGW", "OWT", "SPT", and "CPT" type locations were surveyed by GeoSyntec in April 2002. These are shown, along with a summary of results, in Figure 3. Standing liquid was encountered in almost all of the dipped wells. A table showing a comprehensive list of all borings and gas well dipping data and results, including all liquid level data from the other test programs featured in this report, is presented as Appendix O-10.3 of this report. Where the liquid level measured in a gas well was less than 2 ft. above the base of the well, it was assumed that the liquid was trapped gas condensate and not representative of the elevation of standing liquid or saturated conditions in the surrounding waste. The liquid levels measured in all other dipped wells are used in the subsequent overview summary and discussion of the limits of saturated waste in the CIL (see Section 11.1).

11. SUMMARY AND DISCUSSION

11.1 Limits of Saturated Waste

The locations of all test borings and dipped gas wells are presented on Figure 3. The figure includes tabulated summary data on surface elevations, depth of waste, and depth to standing liquid at each location. During the LD test boring program, intermittent pockets of high moisture content waste underlain by relatively dry waste material were not generally observed. However, the findings from the subsequent CPT soundings dissipation tests, small diameter test borings, and well dipping program indicated that the liquid encountered in the LD boreholes does not extend all the way down to the LCS (i.e., perched, unconnected liquid levels are commonly present within the landfill). As a result, all waste located below the depth at which significant free liquid or saturated conditions were observed is therefore considered to be saturated, but it is not assumed that this depth corresponds to the limit of connected free standing liquid in the landfill. This is consistent with the findings from other studies [e.g., Zornberg, et al., 1999]. The assumption that any free liquid with the landfill exists in unconnected perched layers rather than as connected standing liquid is supported by reports that, during waste drilling and installation of gas wells by OWT in March and April 2002 (see Section 10.2), intermittent layers of apparent free liquid and saturated waste were encountered below the level at which liquid was initially encountered.

Five cross-sections marked A-A through E-E are shown on Figure 3. These sections are drawn to pass completely through the landfill in a general north-south direction. Each test boring, CPT sounding, and dipped gas well featured in this report, as well as other relevant sources of data (e.g., various CPT soundings between C001 and C059, various settlement plates, piezometer PZ1_09C, and the two SASW surveys located outside the limits of waste), are linked to one of the five cross-sections. These extra data sources are included to provide additional information regarding the elevation of the dredge spoils, limit of saturated waste, or landfill surface. Cross sections A-A through E-E are presented in Figures 6-1 through 6-5. Notes relating to the cross sections are provided on Figure 6-1. The five cross sections demonstrate the following:

1. *Section A-A (Figure 6-1).* This cross section passes through Phase I only. The elevation of dredge spoils is approximately at datum with surface elevation ranging from 40 to 90 ft-msl. The elevation below which the waste is assumed to be saturated varies from approximately 30 ft-msl on the north side of Phase I to 40 to 50 ft-msl in the center and south side.

2. *Section B-B (Figure 6-2).* This cross section passes through Phase II only. The dredge spoils are at elevation 20 to 30 ft-msl, the surface ranges from approximately 20 to 90 ft-msl, and saturated waste generally exists below 45 to 50 ft-msl. Dissipation test data from CPT C065 indicates that the pressure head at different elevations is approximately constant (i.e., 2 – 3 ft.). This suggests that liquid in the central portion of Phase II is either perched or flowing downwards.

3. *Section C-C (Figure 6-3).* This cross section passes through Phases III, IV, and V. The elevation of dredge spoils is approximately at 40 ft-msl with the surface elevation ranging from 45 to 75 ft-msl. Saturated waste is shown to be present up to elevations of 60 to 65 ft-msl in Phases III and V and up to 55 ft-msl in Phase IV. Dissipation test results from CPT C061, C062, and C068 suggest that these are either perched layers or that downward flow of liquid is taking place.

4. *Section D-D (Figure 6-4).* This cross section also passes through Phases III, IV, and V. The elevation of dredge spoils is approximately at 40 to 45 ft-msl with the surface elevation ranging from 45 to 80 ft-msl. Saturated waste is shown to be present at a few confined locations up to elevations of 60 ft-msl and 50 ft-msl in Phases III and V, respectively. Dissipation test results from C060 in Phase V suggest that perched liquid or saturated waste layers are present.

5. *Section E-E (Figure 6-5).* This final cross section passes through Phases III, IV, and V. The elevation of dredge spoils is approximately at 40 to 45 ft-msl with the surface elevation ranging from 45 to 80 ft-msl. As with Section D-D, saturated waste is shown to be present at a few confined locations up to elevations of 50 ft-msl and 55 ft-msl in Phases III and V, respectively.

A surface contour plot showing the limit between dry/moist and saturated waste is shown in Figure 8. The surface was derived from borings and gas wells, supplemented by straight-line extrapolation of the limits of saturated waste shown in the cross sections provided in Figures 6-1 through 6-5. The limit of saturated waste at borings or gas wells in which the depth to standing liquid or saturated waste was below the base of the boring or gas well is estimated from the cross sections. CPT dissipation test data suggests that free liquid in the waste body is likely to be perched or flowing downwards

rather than static. From the point of view of determining waste unit weight, however, it is reasonable to consider all waste located below the surface elevation shown in Figure 8 to be saturated (see Section 11.2). It is important to recognize that the limits of saturated waste in the CIL are certain to be dynamic, especially with regard to seasonal fluctuations in precipitation, and that the contours shown in Figure 8 only represent existing conditions at the site in April 2002.

11.2 Waste Unit Weight

11.2.1 Ranking of Methods Used for Determination of Waste Unit Weight

11.2.1.1 Introduction and Overview

The unit weight of waste within the CIL has been estimated in this report using a variety of different methods. These methods are summarized below:

1. *Method A.* Value assumed from previous reports (see Section 4.1.1);

2. *Method B.* Calculated from settlement plate and total pressure cell data (see Section 5.2.1);

3. *Method C.* Estimated from whole-site waste placement records and topographic surveys (see Section 5.2.2);

4. *Method D.* Maximum values estimated from the large diameter test borings (see Section 7);

5. *Method E.* Calculated from Shelby tube samples recovered during the small diameter test boring program (see Section 8); and

6. *Method F.* Estimated from SASW survey data (see Appendix P of the GCR).

The six methods used for determination of waste unit weight were ranked in terms of their accuracy and representability. The ranking system is subjective, based solely on GeoSyntec's engineering judgment, and depends on the level of confidence that the GeoSyntec design team has in values derived using that method. Methods are ranked (relative to Method D) from 1 (lowest) to 5 (highest), where 5 corresponds to the degree of confidence in maximum values obtained from Method D (i.e., assuming no overbore

on the boreholes). It was considered that these values represented the best available data for in-situ waste unit weight available from all the field investigations carried out at the CIL. Method A, which simply involved reviewing previously suggested values for waste unit weight at the CIL, was not ranked. Method rankings are summarized in the table below.

Method	Description of Method	Rank
D	Large Diameter Test Borings	5
C	Whole site surveys and records	3.5
F	SASW Surveys	3
E	Shelby Tube Samples from Small Diameter Test Borings	2
B	Settlement plates and TPCs data	1
A	Assumed in previous reports	Not Ranked

Note: Ranking varies from 5 (highest) to 1 (lowest).

Ranking of Methods Used for Determination of Waste Unit Weight

11.2.1.2 Method A – Assumed values from Previous Reports

Values assumed in previous reports were generally based on review of 'typical' values for MSW landfills and are therefore not site-specific. Values derived or assumed under Method A (see Tables 1 and 10) are presented for completeness only, mainly to serve as a design reference point with regards to the values used in previous expansion design reports prepared for the CIL.

11.2.1.3 Method B – Settlement Plate and Total Pressure Cell Data

Method B is not considered to provide unit weight values in which much confidence can be placed and is thus given a very low ranking (i.e., Rank = 1). This is primarily explained by considering the following four observations.

- Calculation of waste unit weight using Method B relied on data from electronic total pressure cells (TPCs). The GeoSyntec project team's previous experience with the performance of electronic instruments buried in landfills is that they do not perform satisfactorily after a period of 6 to 12 months.
- TPC data was only available in Phases IV and V.
- In the four-year period between mid-1997 and October 2001 during which TPC data was available, the calculated unit weight of waste generally appeared to decrease, often to approximately half of its initial value. Conventional experience suggests that the opposite occurs: waste unit weight increases over time after placement due to waste degradation and settlement. Although some decrease in the average unit weight of waste through the entire depth of waste in Phases IV and V may be due to the use of highly compressible, low-density compost mulch as daily cover in recent years, it is extremely unlikely that this could cause a decrease in unit weight of such magnitude. It is suspected that data output from the TPCs is erroneous.
- Inspection of the plots of calculated unit weight versus time (see Appendix O-1) shows greater-than-reasonable variations in waste unit weight on a number of occasions at most positions with TPCs in the CIL.

11.2.1.4 Method C – Whole-Site Surveys and Waste Receipt Records

A number of small uncertainties are built into the use of Method C to determine waste unit weight at the landfill. These include:

- It is estimated that the elevations on the aerial surveys used to calculate landfill volumes could be out by ± 2-ft;
- Waste receipt records from the landfill were sometimes difficult to decipher;
- Assumptions had to be made as to the initial condition and elevation of the base of the landfill in Phases I and II;

- Settlement of the dredge under surcharge loading from the landfill could only be measured at discrete settlement plate locations, and an average value applied across the whole site; and
- The actual unit weight of cover soil used at the site, and the ratio of waste to soil in the landfill was not always precisely known.

Although these small uncertainties are inherent in most whole-site calculations of this nature, this method is widely used and accepted in the landfill industry for estimating historical trends in waste unit weight and airspace utilization. However, because the effects of these uncertainties are often cumulative, coupled with the fact that values obtained from this method are for waste placed over a 17-year period (i.e., for the entire depth of waste placed), the method is not assigned a high ranking. Despite this, it is still considered to provide good overall values, and is therefore assigned a good ranking (i.e., Rank = 3.5).

11.2.1.5 Method D – Large Diameter Borings

Method D is considered to provide the best estimates of unit weight for waste in the CIL and is given the highest ranking (i.e., Rank = 5). This is due to the following factors:

- Values obtained from direct field measurement;
- A high degree of engineering control was possible. The depth of drilling, waste removal and weighing, waste composition, and depth to saturated waste could be accurately measured and/or assessed under direct control of the GeoSyntec field engineer;
- A large representative volume (approximately 70 cu. ft.) and mass (up to 3.5 tons) of waste was obtained from each depth increment in the boring;
- The 100 lb tolerance on the landfill truck scale amounted to less than 1.5 percent of the mass of waste in each truckload; and
- A large number of discrete locations and depths were sampled.

Both maximum and minimum values for waste unit weight were estimated using Method D. Maximum values for unit weight were estimated assuming that the boring diameter was equal to the diameter of the bucket auger (i.e., no overbore was assumed,

yielding minimum borehole volume). Minimum unit weight values were estimated by assuming a 16 percent overbore on the borehole diameter. Because there are fewer assumptions associated with their calculation, therefore, a greater degree of confidence exists in maximum values than minimum values.

An additional advantage associated with the values from method D is that the complimentary study of waste moisture content and composition carried out by SCS Engineers enabled reasonably accurate estimates of additional waste properties (e.g., void ratio, porosity, and saturated unit weight) based on these bulk unit weight values to be made for use in design analyses.

11.2.1.6 Method E – Shelby Tube Samples from Small Diameter Borings

Use of Method E to determine waste unit weight incorporates a number of advantages and disadvantages in approximately equal measure. The method is therefore assigned a mid-low level ranking (i.e., Rank = 2). Factors in favor of the method include:

- The fact that it is a direct field technique and that a relatively high degree of engineering control and accuracy was possible during sampling and measurement; and
- There is good agreement between Method E and Method D values.

However, the following are all factors against the method:

- Small sample size (less than ½-lb.);
- Very small total number of samples (one only); and
- During sampling, Shelby tubes were forced into the waste by percussive hammering, and so collected samples do not truly represent undisturbed, in-situ conditions.

11.2.1.7 Method F – SASW Surveys

Waste unit weight values derived from the SASW surveys at the CIL were based on values from Method D. As described in Section 6.2, and detailed in the SASW

report in Appendix P of the GCR, the waste was found to have very high moisture content, especially below 30-ft depth of waste. Because of this, it proved difficult to develop good correlations between shear wave velocity and waste unit weight. Such correlations form the basis of this method and, as a result, the method is assigned a mid-level ranking only (i.e., Rank = 3).

11.2.2 Coordination and Summary of Waste Unit Weight Data

A summary table providing data derived using all of the above approaches is presented as Table 10. Settlement plates located close to the center of waste placement activities are used to position unit weight values derived from Methods B and C. Figures 7-1 through 7-5 depict waste unit weight values derived from each of these approaches at representative locations along the cross sections lines shown in Figure 3 and which were drawn with regard to the limit of saturated waste shown in Figures 6-1 through 6-5. The unit weight information presented on the figures allows each cross-section to be divided into regions and/or depths with different waste unit weight values. Relevant notes relating to the division of waste unit weight into these regions and/or depths are provided on the drawings.

Saturated unit weight values are also shown in the figures where possible. These values were calculated from bulk unit weights using Method D in combination with waste composition and moisture content data. Where no Method D data were available (e.g., in Phase I), saturated unit weight values were tentatively estimated from SASW survey profiles. It should be noted that the latter approach provides unreliable estimates of saturated unit weight. The elevations of saturated waste suggested by Figures 6-1 through 6-5 were used to set the boundary between regions of bulk unit weight and saturated unit weight.

A final coordinated summary of the unit weight of existing waste in all five phases of the CIL is presented in the table below. Average values and ranges in the table were generated from coordinated inspection of: (i) the data in Table 10; (ii) the distribution of waste unit weight values illustrated in the five cross sections presented as Figures 7-1 through 7-5; and (iii) application of the method ranking system described in Section 11.2. The overall level of confidence in values for each phase shown in the table are assigned using engineering judgment and based on what method(s) featured predominantly in that phase. Saturated unit weight values for existing waste are assumed to apply at elevations below the limits of saturated waste shown in Figure 8.

Existing Phase	Bulk Unit Weight of Waste (pcf)	Saturated Unit Weight of Waste (pcf)	Level of Confidence (1 – 5, 5 = highest)
I	30 (asbestos disposal areas) 70 – 120 (other areas)	95 (average)	2
II	40 – 75	75 – 90	2.5
III	45 – 75	75 – 95	3
IV	30 – 45 (top 10-ft lift) 45 – 75 (other depths)	75 – 95	3
V	45 – 75	75 – 95	4

Coordinated Summary of Unit Weight Values for Existing Waste in the CIL

12. RECOMMENDATIONS

12.1 Limits of Saturated Waste

The limits of saturated waste should be assumed from Figure 8 which was compiled from the best available data from a variety of sources at the site. It is reasonable to consider all waste located below the surface elevation shown in Figure 8 to be saturated. As discussed in Section 11.1, it is not considered that this represents the limit of connected standing liquid. It is important to recognize that the limits of saturated waste in the CIL are certain to be dynamic, especially with regard to seasonal fluctuations in precipitation, and that the contours shown in Figure 8 only represent existing conditions at the site in April 2002.

12.2 Waste Unit Weight

12.2.1 Existing Conditions

Final recommended ranges and average values for the bulk and saturated unit weight of waste in the existing landfill, and variations of unit weight with depth, are summarized in the table below. These values and ranges were developed using engineering judgment and are based on only findings from: (i) Method C (whole-site estimates); (ii) Method D (large diameter borings); (iii) Method E (Shelby tube

samples); and (iv) Method F (SASW surveys). The method ranking system described in Section 11.2.1 was used to 'weigh' values from each method. Other methods were considered to provide insufficiently accuracy estimates for inclusion in the final recommendation. Saturated unit weight values for existing waste are assumed to apply at elevations below the limits of saturated waste shown in Figure 8.

Depth of Waste	Bulk Unit Weight of Waste Maximum – Minimum (Average) pcf	Saturated Unit Weight of Waste Maximum – Minimum (Average) Pcf
0 – 10 ft. (i.e., top lift)	35 – 65 (50)	
10 – 20 ft. (i.e., previous lift)	45 – 100 (65)	
Below 20 ft., dry/moist waste	50 – 100 (75)	
Any depth below limit of saturated waste		75 – 110 (90)

Summary of Recommended Values and Variation of Waste Unit Weight with Depth for Existing Conditions at the CIL

The range of unit weight values obtained at various depths in the CIL using the above four methods are plotted in Figure 9-1. Horizontal error bars on the data points depict the range of unit weight values assigned to each point, while vertical error bars depict the depth increment to which each point is referring. Disregarding a very small number of outlying data points, most values fall within the shaded range shown in the figure. Although broad, this range shows that waste unit weight increases somewhat rapidly with depth in the first 20 ft of waste. From 20 ft down to about 55 ft (the lowest depth at which any data were available), unit weight continues to increase with depth, but at a slower rate. This is consistent with findings from previous studies by, for example, Fasset, et al. [1994] and Kavazanjian, et al. [1995].

An average trend of waste unit weight variation with depth is shown in the center of the shaded range on Figure 9-1. In addition, the recommended variation of bulk and saturated unit weights with depth from the above table is reproduced graphically on the

figure. For simplicity of design, the two values recommended for the top two 10 ft lifts of waste (i.e., 50 pcf and 65 pcf) are combined, 'weighed' in favor of the latter higher value to yield a final value of 60 pcf for the entire 20 ft increment.

12.2.2 Final Conditions

Recommendations for the variation of waste unit weight with depth in the CIL after final construction, when the total depth of waste will likely be 250 ft or more, could not be properly developed from existing field data because no data existed at depths of more than 50 ft. Because of this, trends of unit weight with depth published in literature were used to provide supplementary information and develop recommendations for waste unit weight variation with depth in the final CIL at depths greater than 50 ft.

Trends proposed by two studies, Kavazanjian, et al. [1995] and Zornberg, et al. [1999] are presented in Figure 9-2, along a range of 'typical' values from a review by Kavazanjian, et al. [1995] and the range of values obtained from the field investigations at CIL. The trends proposed by these two studies were developed as follows:

1. The lower trendline from Kavazanjian, et al. [1995] is an combination of trends proposed by previous studies [e.g., Fasset et al., 1994] coupled with findings from SASW surveys and test boring programs performed at the OII landfill in California by the authors. The upper trendline was not based on observation, but is proposed at a unit value higher than lower trendline to reflect that all the data used to develop the lower trendline originated in dry landfills.

2. Zornberg, et al. [1999] presented average results from six SASW surveys performed at a landfill in southern California. The SASW survey data were calibrated using data from two large diameter test borings in the landfill.

Finally, a final recommended trend to be used in future design activities at the CIL is also shown on Figure 9-2. The recommended values and trend are summarized in the table below. This recommended trend does not differentiate between saturated and unsaturated conditions: it is assumed that for saturated conditions the unit weight is 100 pcf.

Depth of Waste (ft)	Bulk Unit Weight of Waste (pcf)	Saturated Unit Weight of Waste (pcf)
0 – 20	60	
20 – 100	75	
100 – 150	80	
150 – 200	85	
> 200	90	
Any depth below limit of saturated waste		100

Summary of Recommended Values and Variation of Waste Unit Weight with Depth for Final Conditions at the CIL

12.3 Waste Strength and Compressibility

Final recommended values for the waste drained strength parameters is a friction angle of ϕ'=33°. The recommended waste primary and secondary compressibility, C_{cr}) and $C_{\alpha c}$ are 0.28 and 0.02, respectively.

13. REFERENCES

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TABLES

TABLE 1

ASSUMED VALUES FOR WASTE UNIT WEIGHT IN PREVIOUS REPORTS

Waste Characterization Report
Cherry Island Landfill Expansion Project
Delaware Solid Waste Authority

Report	Page	Phase	Assumed Unit Weight (pcf) Average (Range)		Assumptions
			MSW	MSW + Soil	
Terraqua Resources/Duffield January 1984	4-5	Assumed value for the permit, used for Phase I design	48	N/A	assumed 3:1 ratio MSW: Soil by volume weighted average in-place density derived from consideration of three types of waste assumed to be landfilled: 1. unprocessed mixed MSW (700 - 1,200 pcy, assume 1,000 pcy) 2. Residue (cinders) from Delaware Reclamation Project at Pigeon Pt (1,450 pcy) 3. Non processable fraction (C&D waste, wood, mattresses, etc.) (1,300 pcy)
Gannett Fleming December 1986	41	assumed value for Phase II	48	N/A	daily cover soil is 7% of total by volume aggregate in-place density derived from compacted densities of predicted deliveries to the landfill of: 1. Waste directly to landfill (1,150 pcy) 2. Delaware Reclamation Project residues (1,150 pcy) 3. Energy Generation Facility residue (2,000 pcy)
Gannett Fleming March 1990 (Revised August 1990)	5	value from literature, assumed for Phase III	43	N/A	value cited in literature (Dvinoffy and Munion, 1986, Oweiss and Khera, 1986)
Gannett Fleming August 1990 (Revised September 1990)	8 & Figures	assumed value for Phase IA	50	N/A	no discussion of assumptions
Weston August 1992	3-18 3-19	value from literature, assumed for Phase IV	43* 65**	70 70	*initial placement density (assumed - no justification); daily cover soil is assumed to be 10% by volume **in-place density (based on a review of 16 references)
Duffield 1996	4	All		60-90	Values cited in literature (Sharma and Lewis, 1994; Reynolds, 1991).
Gannett Fleming July 1998	4	Phase IV	84		This value is assumed, based on value for Phase III determined with elevation survey data obtained during the Phase III TPC installation.

TABLE 1

ASSUMED VALUES FOR WASTE UNIT WEIGHT IN PREVIOUS REPORTS
(continued)

Report	Page	Phase	Assumed Unit Weight (pcf) Average (Range)		Assumptions
			MSW	MSW + Soil	
Weston 1998		Phase V			Calculated in-situ density for January 1998 using settlement plate and pressure cell data. These values ignore two data sets with erroneously high calculated waste densities.
	Table 3		95.3(78.6 - 104.0)*		*Assuming 1 ft. of cover soil
	Table 3		92.1 (72.1 - 102.6)**		**Assuming cover soil is 25% of waste body.
	Figure 2		43***		***Assumed placement density (from previous report).
	Figure 2		65****	70	****Assumed density after some degradation and settlement (from previous report).

TABLE 2

MEASURED VALUES FOR WASTE UNIT WEIGHT IN PREVIOUS INVESTIGATIONS BY GEOSYNTEC AT OTHER LANDFILL SITES

Waste Characterization Report
Cherry Island Landfill Expansion Project
Delaware Solid Waste Authority

Report	Site	Bulk Unit Weight (pcf) Average (Range)	Method of Test/Test Details	Assumptions	Observations/Comments
GeoSyntec 1996	Operating Industries, Inc. Landfill (OII), California	102 (76 - 131)	Testbores Waste weighed in 10 ft. intervals. 3 borings to 150 ft.	Assumed 16 percent overbore (based on 15 - 20 percent overbore found at other sites in California).	No increase in density with depth noticed except in 1 borehole below 60 ft. depth. 16% overbore assumed because volume measured using gravel backfill method produced erroneous results.
		99.6	Test trench One trench: 20 ft. long, 6 ft. deep. Volume of trench measured by backfilling with gravel of known density		Volume measured with gravel equated to 6% over excavation.
		100		Assumed value used.	
GeoSyntec 1995	Azusa Land Reclamation Landfill, California	(90 - 113)* (63 - 93)** (97 - 108)***	Testbores; Waste weighed in 5 to 10 ft. intervals; 2 borings to 180 ft.; Volume from gravel backfill method		*Density at less than 30 ft. depth. **Density from 30 ft. - 160 ft. depth. ***Density at greater than 160 ft. depth.
GeoSyntec 2002	Area A/B Central Solid Waste Manag. Center, Delaware	56.5* 70**	Calculated from waste receipt Records and topographic maps		*Calculated for October 1988 **Calculated for August 2001 Landfill operational from 1982 - 1988

TABLE 2

MEASURED VALUES FOR WASTE UNIT WEIGHT IN PREVIOUS INVESTIGATIONS BY GEOSYNTEC AT OTHER LANDFILL SITES
(continued)

Report	Site	Bulk Unit Weight (pcf) Average (Range)	Method of Test/Test Details	Assumptions	Observations/Comments
GeoSyntec 2001a & GeoSyntec 2001b	Maplewood Landfill, Virginia	75 (71 - 78)* 75 (55 - 101)**	Testbores Waste weighed in 10 - 20 ft. intervals. 5 borings to 40 ft.	*Average from whole borehole. **Average from 10 ft. intervals. No overbore assumed. Volume estimated from borehole diameter.	No increase in density with depth noticed. Density varied with moisture content. Some cover soil was accidentally included in Measurement of waste mass.

TABLE 3

SUMMARY OF SETTLEMENT PLATE INFORMATION

Waste Characterization Report
Cherry Island Landfill Expansion Project
Delaware Solid Waste Authority

Settlement Plate	Dredge Spoils				Waste						
	Initial Elevation (ft.)	Date	Most Recent Elevation (ft.)	Date	Most Recent Elevation (ft.)	Most Recent Depth (ft.)	Date	Unit Weight at Placement (pcf)	Date	Most Recent Unit Weight (pcf)	Date
P1 SP 1AA	7.1	15-Dec-92	2.0	1-Oct-01	59.7	57.7	1-Oct-01	-	-	-	-
P1 SP 1BA	11.4	15-Dec-92	-4.3	1-Oct-01	71.5	75.8	1-Oct-01	-	-	-	-
P1 SP 3	15.6	15-Dec-92	14.0	1-Oct-01	26.9	12.9	1-Oct-01	-	-	-	-
P1 SP 4	17.3	15-Dec-92	16.1	1-Oct-01	22.5	6.4	1-Oct-01	-	-	-	-
P1 SP 5	21.3	15-Dec-92	15.1	1-Oct-01	58.1	43.0	1-Oct-01	-	-	-	-
P1 SP 6	25.6	15-Dec-92	7.4	1-Oct-01	91	83.6	1-Oct-01	-	-	-	-
P1 SP 7	24.8	15-Dec-92	6.6	1-Oct-01	90.3	83.7	1-Oct-01	-	-	-	-
P2 SP 1	34.5	14-Apr-94	29.6	1-Oct-01	74.9	45.3	1-Oct-01	-	-	-	-
P2 SP 2	35.4	14-Apr-94	31.3	1-Oct-01	77.1	45.8	1-Oct-01	-	-	-	-
P2 SP 4	33.7	14-Apr-94	22.8	1-Oct-01	78.8	56.0	1-Oct-01	-	-	-	-
P2 SP 5	33.2	14-Apr-94	21.3	1-Oct-01	92.4	71.1	1-Oct-01	-	-	-	-
P2 SP 7	33.6	14-Apr-94	14.6	1-Oct-01	88.2	73.6	1-Oct-01	-	-	-	-
P2 SP 8	33.0	14-Apr-94	24.6	1-Oct-01	93.5	68.9	1-Oct-01	-	-	-	-
P2 SP 10	35.2	14-Apr-94	30.0	1-Oct-01	80.8	50.8	1-Oct-01	-	-	-	-
P2 SP 13	36.2	14-Apr-94	28.7	1-Oct-01	84.2	55.5	1-Oct-01	-	-	-	-
P2 SP 14	36.7	14-Apr-94	33.2	1-Oct-01	77.1	43.9	1-Oct-01	-	-	-	-
P3 SP 1	44.9	1-Feb-94	40.1	1-Oct-01	78.8	38.7	1-Oct-01	-	-	-	-
P3 SP 2	46.4	1-Feb-94	41.1	1-Oct-01	76.8	35.7	1-Oct-01	-	-	-	-
P3 SP 4	45.5	1-Feb-94	41.4	24-Apr-01	70.2	28.8	24-Apr-01	-	-	-	-
P3 SP 5	45.4	1-Feb-94	40.4	1-Oct-01	78.1	37.7	1-Oct-01	-	-	-	-
P3 SP 8	43.6	1-Feb-94	39.7	1-Oct-01	63.3	23.6	1-Oct-01	-	-	-	-

TABLE 3

SUMMARY OF SETTLEMENT PLATE INFORMATION
(continued)

Settlement Plate	Dredge Spoils				Waste						
	Initial Elevation (ft.)	Date	Most Recent Elevation (ft.)	Date	Most Recent Elevation (ft.)	Most Recent Depth (ft.)	Date	Unit Weight at Placement (pcf)	Date	Most Recent Unit Weight (pcf)	Date
P3 SP 11	45.0	1-Feb-94	39.7	1-Oct-01	56.6	16.9	1-Oct-01	-	-	-	-
P3 SP 11A	44.7	15-Aug-94	41.49	21-Apr-98	62.5	21.0	2-Jan-98	-	-	-	-
P3 SP 12	44.7	1-Feb-94	40.6	1-Dec-01	61.1	20.5	1-Oct-01	-	-	-	-
P3 SP 13	43.6	1-Feb-94	39.5	1-Oct-01	57.8	18.3	1-Oct-01	-	-	-	-
P3 SP 14	43.6	1-Feb-94	41.2	1-Oct-01	59.8	18.6	1-Oct-01	-	-	-	-
P4 SP 1	46.65	4-Apr-97	42.05	1-Oct-01	78.8	36.8	1-Oct-01	-	-	-	-
P4 SP 2	47.9	4-Apr-97	45.1	8-Aug-01	75.1	30	8-Aug-01	77.2	4-Apr-97	57.8	8-Aug-01
P4 SP 5	45.9	4-Apr-97	43.5	1-Oct-01	61.5	18	1-Oct-01	-	-	-	-
P4 SP 6	48.9	4-Apr-97	46.3	1-Oct-01	76.6	30.3	1-Oct-01	-	-	-	-
P4 SP 7	47.15	4-Apr-97	43.85	1-Oct-01	60.2	16.35	1-Oct-01	-	-	-	-
P4 SP 8	47.4	4-Apr-97	43.1	1-Oct-01	62.8	19.7	1-Oct-01	-	-	-	-
P5 SP 1	48.13	31-Jul-97	42.03	1-Oct-01	79.6	37.57	1-Oct-01	86.5	31-Jul-97	54.8	1-Oct-01
P5 SP 2	48.12	4-Apr-97	43.52	1-Oct-01	72.8	29.28	1-Oct-01	146.0	4-Apr-97	60.7	1-Oct-01
P5 SP 3	48.88	31-Jul-97	45.88	1-Oct-01	67.8	21.92	1-Oct-01	163.1	31-Jul-97	62.4	1-Oct-01
P5 SP 4	49.09	4-Apr-97	46.69	1-Oct-01	72.2	25.51	1-Oct-01	-	-	-	-
P5 SP 5	48.28	31-Jul-97	41.48	1-Oct-01	70.9	29.42	1-Oct-01	-	-	-	-
P5 SP 6	48.28	17-Oct-97	45.58	1-Oct-01	75.9	30.32	1-Oct-01	70.6	17-Oct-97	70.9	1-Oct-01
P5 SP 7	48.07	17-Oct-97	44.47	1-Oct-01	69.9	25.43	1-Oct-01	-	-	-	-
P5 SP 8	47.84	31-Jul-97	44.94	1-Oct-01	73.4	28.46	1-Oct-01	-	-	-	-
P5 SP 9	48.21	31-Jul-97	43.41	1-Oct-01	71.5	28.09	1-Oct-01	114.5	31-Jul-97	44.9	1-Oct-01
P5 SP 10	48.22	17-Oct-97	45.0	1-Oct-01	74.2	29.18	1-Oct-01	73.2	17-Oct-97	34.9	1-Oct-01

Note: The unit weight values shown are bulk values assuming 25% cover soil (by depth). The soil is assumed to have a unit weight of 120 pcf.

TABLE 4

UNIT WEIGHT CALCULATIONS FROM AERIAL SURVEY AND OPERATING RECORDS

Waste Characterization Report
Cherry Island Landfill Expansion Project
Delaware Solid Waste Authority

Time Period	Mass Placed in Phase I/II (tons)	Volume Used in Phase I/II (cy)	Unit Weight in Phase I/II (lbs/ft^3)	Mass Placed in Phase III/IV/V (tons)	Volume Used in Phase III/IV/V (cy)	Unit Weight in Phase III/IV/V (lbs/ft^3)
January 1985* to December 1997	6,578,000	6,183,259	79	3,550,800	5,592,267	47
January 1985 to April 1999	6,599,500	6,313,077	77	4,263,800	6,577,758	48
January 1985 to September 2000	6,669,800	6,450,481	77	5,802,700	7,880,350	55
January 1985 to April 2001	6,719,100	6,552,640	76	6,377,600	8,402,261	56
January 1985 to April 2002	6,792,900	6,644,877	76	7,472,400	9,355,628	59

Ref: Calculated in Appendix O-2.

* For Phases III to V, waste placement began in 1952.

TABLE 5

SUMMARY OF LARGE DIAMETER TEST BORINGS

Waste Characterization Report
Cherry Island Landfill Expansion Project
Delaware Solid Waste Authority

Boring	Surface Elevation (ft.)	Depth to Liquid[1] (ft.)	Top of Liquid Elevation (ft.)	Top of LCS Elevation[2] (ft.)	Total Depth of Boring (ft.)	Total Thickness of Waste (ft.)
P2_02_UW02	76.8	21.5	55.3	30.3	26	46.5
P2_02_UW02A	87.2	28	59.2	30.3	28	57.0
P3_02_UW03	79.03	26	53.03	40.4	28	38.5
P3_02_UW04	63.12	20.5	42.62	40.6	22	22.5
P4_02_UW05	82.62	24.5	58.12	45.1	28	37.5
P4_02_UW06	74.8	-	-	43.1	31	31.5
P5_02_UW07	78.89	16.5	62.39	43.52	22	36.5
P5_02_UW08	83.8	29	54.8	45.58	30	38.0
P5_02_UW09	71.3	20	51.3	43.41	22	28.0

Notes:
1. Depth to liquid measured during boring. No liquid was found in UW06.
2. Elevation of top of Leachate Collection System (LCS) drainage layer is estimated from October 2001 data from closest settlement plate to boring. LCS in Phase II is a 12-in thick backfill material type F.

TABLE 6

VISUAL CLASSIFICATION SUMMARY FOR LARGE DIAMETER TEST BORINGS

Waste Characterization Report
Cherry Island Landfill Expansion Project
Delaware Solid Waste Authority

Boring	Cover	Depth Interval (ft.)	Waste Classification				
	Description and Depth		Structure	Moisture Content	Compaction	Degradation	Composition (see key)
P2_02_UW02	Soil, 2-ft.	0 - 10	layered / encapsulated	dry - damp	moderate	moderate - high	1, 2, 9, 13a
		10 - 21	indistinguishable	wet - very wet	moderate	high	1, 2, 9, 13a
		21 - 26	indistinguishable	standing water		high	11
P2_02_UW02A	Soil, less than 1-ft.	0 - 10	encapsulated	dry - damp	moderate	moderate - high	1, 2, 9
		10 - 20	fibrous	dry - damp	slight	none - slight	1, 2
		20 - 28	encapsulated	dry - damp	slight - moderate	moderate - high	1, 2, 9
		28		standing water		high	11
P3_02_UW03	Stabilized ash and grit, 1-ft. - 2-ft.	0 - 10		dry - damp		moderate	1, 2
		10 - 20					
		20 - 28	encapsulated - fibrous	wet - very wet	moderate	high	1, 2, 9
P3_02_UW04	Compacted clayey soil, 1-ft., over stabilized sludge / ash, 2-ft.	0 - 10		dry - damp		moderate	1, 2
		10 - 20					
		20 - 22		standing water		high	
P4_02_UW05	Soil / Mulch, less than 1-ft.	0 - 10	fibrous	dry - damp	slight	slight - moderate	1, 2
		10 - 20					
		20 - 28		wet - very wet		high	

TABLE 6

VISUAL CLASSIFICATION SUMMARY FOR LARGE DIAMETER TEST BORINGS
(continued)

Boring	Cover Description and Depth	Depth Interval (ft.)	Waste Classification				
			Structure	Moisture Content	Compaction	Degradation	Composition (see key)
P4_02_UW06	Soil / Mulch, less than 1-ft.	0 - 10	fibrous	dry - damp	slight	slight - moderate	1, 2, 13b
		10 - 20		dry - damp			
		20 - 31	fibrous	dry - damp	slight	slight - moderate	1, 2
P5_02_UW07	Soil / Mulch, 1-ft.	0 - 10	fibrous	dry - damp	slight	slight - moderate	1, 2, 9
		10 - 20	fibrous	dry - damp	slight	slight - moderate	1, 2, 9
		20 - 22		standing water		high	
P5_02_UW08	Soil / Mulch, 1-ft.	0 - 10					
		10 - 20					
		20 - 30	encapsulated	wet	slight	none - slight	1, 2
P5_02_UW09	Soil / Mulch, 3-ft.	0 - 10					
		10 - 20	encapsulated	wet	moderate	moderate	1, 2
		20 - 22		standing water			

Waste Composition Key:
1 = household, paper & plastics
2 = putrescible organics
9 = soil
11 = indistinguishable
13a = wood
13b = mulch

TABLE 7

WASTE UNIT WEIGHT CALCULATED FROM LARGE DIAMETER TEST BORINGS

Waste Characterization Report
Cherry Island Landfill Expansion Project
Delaware Solid Waste Authority

Borehole ID	Total Borehole Depth (ft.)	Depth Interval (ft.)	Waste Mass (lb)	Gravel Backfill Volume[1] (cf)	Gravel Backfill Diameter (ft.)	Resultant Borehole Under-Bore[2]	Volume of Borehole (cf)			Waste Unit Weight (pcf)		
							From Gravel Backfill Method	Assuming 36-in. Diameter	Assuming 16% Overbore[3]	Assuming Gravel Backfill Volume	Assuming 36-in. Diameter Volume	Assuming 16% Overbore Volume
UW_02	21	0 - 10	3,800	67.4	2.9	2%	157.4	148.4	199.7	56.4	53.8	40.0
		10 - 21	4,600	90.0	3.2	-8%				51.1	59.2	44.0
UW_02A	28	0 - 10	no data	57.4	2.7	10%	160	197.9	266.3	-	-	-
		10 - 20	4,540	57.4	2.7	10%				79.1	64.2	47.7
		20 - 28	4,300	45.2	2.7	11%				95.1	76.0	56.5
UW_03	28	0 - 10	4,200	61.1	2.8	7%	167.3	197.9	266.3	68.7	59.4	44.2
		10 - 20	4,980	61.4	2.8	7%				81.1	70.5	52.4
		20 - 28	5,180	44.9	2.7	11%				115.5	91.6	68.1
UW_04	22	0 - 10	4,240	61.1	2.8	7%	130.0	155.5	209.3	69.4	60.0	44.6
		10 - 22	6,720	68.9	2.7	10%				97.5	79.2	58.9
UW_05	28	0 - 10	2,900	74.1	3.1	-2%	182.2	197.9	266.3	39.4	41.3	30.7
		10 - 20	7,640	66.6	2.9	3%				114.7	108.1	80.3
		20 - 28	5,480	41.5	2.6	14%				132.1	96.9	72.0
UW_06	31	0 - 10	4,160	58.5	2.7	9%	181.7	219.1	294.9	71.1	58.9	43.7
		10 - 20	5,300	58.6	2.7	9%				90.5	75.0	55.7
		20 - 31	5,000	64.6	2.7	9%				77.4	64.3	47.8
UW_07	20	0 - 10	4,020	61.1	2.8	7%	119.4	141.4	190.2	65.8	56.9	42.3
		10 - 20	5,440	58.3	2.7	9%				93.4	77.0	57.2
UW_08	30	0 - 10	4,420	63.5	2.8	5%	189.0	212.1	285.3	69.6	62.5	46.5
		10 - 20	4,340	61.7	2.8	7%				70.3	61.4	45.6
		20 - 30	5,700	63.8	2.9	5%				89.3	80.6	59.9
UW_09	20	0 - 10	4,500	55.9	2.7	11%	114.1	141.4	190.2	80.5	63.7	47.3
		10 - 20	5,100	58.2	2.7	9%				87.7	72.2	53.6

Notes:

1. Volume calculated from backfilling borehole with gravel of known unit weight. See Appendices O-7.1 and O-7.2 for details.
2. Diameter calculated from gravel backfill volume, as percent of 36-in. diameter.
3. Assuming 16 percent overbore relative to original 36-in. diameter.

TABLE 8

CALCULATION OF VOID RATIO, POROSITY, AND SATURATED UNIT WEIGHT OF WASTE IN SAMPLED LARGE DIAMETER TEST BORING INCREMENTS

Waste Characterization Report
Cherry Island Landfill Expansion Project
Delaware Solid Waste Authority

Location	Boring	Depth (ft)	Waste G_s	Waste w	γ_b (pcf)		e		n		γ_d (pcf)		S		γ_{sat} (pcf)	
					A	B	A	B	A	B	A	B	A	B	A	B
P2	UW02	0-10	2.71	0.329	53.8	40.0	3.187	4.631	0.761	0.822	40.5	30.1	0.281	0.193	88.0	81.4
		10-21	2.39	0.496	59.2	44.0	2.769	4.071	0.735	0.803	39.6	29.4	0.429	0.291	85.4	79.5
P2	UW02A	0-10	2.59	0.486												
		10-20	2.00	0.424	64.2	47.7	1.768	2.726	0.639	0.732	45.1	33.5	0.480	0.311	84.9	79.1
		20-28	2.02	0.365	76.0	56.5	1.269	2.052	0.559	0.672	55.7	41.4	0.583	0.361	90.5	83.3
P3	UW04	0-10	2.63	0.294	60.0	44.6	2.547	3.772	0.718	0.790	46.3	34.5	0.305	0.206	91.2	83.8
		10-22	2.99	0.291	79.2	58.9	2.045	3.095	0.672	0.756	61.3	45.6	0.427	0.282	103.2	92.8
P4	UW05	0-10	2.11	0.211	41.3	30.7	2.868	4.203	0.741	0.808	34.1	25.3	0.156	0.106	80.4	75.7
		10-20	2.37	0.241	108.1	80.3	0.698	1.285	0.411	0.562	87.1	64.7	0.820	0.445	112.7	99.8
P5	UW08	0-10	2.48	0.203	62.5	46.5	1.975	2.998	0.664	0.750	51.9	38.6	0.255	0.168	93.4	85.4
		10-20	2.70	0.245	61.4	45.6	2.414	3.596	0.707	0.782	49.3	36.6	0.274	0.184	93.4	85.4
		20-30	2.38	0.352	80.6	59.9	1.493	2.355	0.599	0.702	59.6	44.3	0.562	0.357	97.0	88.1
P5	UW09	0-10	2.41	0.197	63.7	47.3	1.827	2.807	0.646	0.737	53.2	39.5	0.261	0.170	93.5	85.5
		10-20	2.32	0.232	72.2	53.6	1.472	2.329	0.595	0.700	58.6	43.5	0.367	0.232	95.7	87.1

Notes:

A = calculated assuming 36-in boring diameter (i.e., maximum bulk unit weight of waste)
B = calculated assuming 16% overbore on diameter (i.e., minimum bulk unit weight of waste)
w = moisture content (gravimetric)
G_s = specific gravity
γ_b = bulk density (pcf)

γ_w = 62.4 pcf (1000 kg/m^3)
γ_d = dry density (pcf)
γ_{sat} = saturated density (pcf)
e = voids ratio
n = porosity
S = degree of saturation

TABLE 9

SUMMARY OF SMALL DIAMETER TEST BORINGS

Waste Characterization Report
Cherry Island Landfill Expansion Project
Delaware Solid Waste Authority

Borehole ID	Surface Elevation (ft.)	Max Depth (ft.)	Depth to LCS (ft.)	Thickness of LCS (ft.)	Thickness of Waste (ft.)	Depth to wet waste (ft.)	Depth to saturated waste (ft.)	Samples collected[4]				Number of Photos Incl. in Borelogs
								Total	Sample at Interface[5]	Sample suitable for unit weight calc.		
										(depth - ft.)	(pcf)	
P2_02_SPT4W	93.5[1]	59.5	68.9[1]	1?[2]	69[1]	0 - 10	51	ST (1/1) S-S (6/4)				1
P2_02_SPT6W	88.2[1]	45[3]	73.6[1]	1?[2]	74[1]	-	-	-				-
P2_02_SPT7W	92.4[1]	13[3]	71.1[1]	1?[2]	71[1]	-	-	-				-
P2_02_SPT7AW	92.4[1]	43[3]	71.1[1]	1?[2]	71[1]	35	41	-				-
P3_02_SPT3W	77.2	42	38?	<2	38	10	10	ST (1/1) S-S (4/3)		34 - 34.5 (ST)	75.5	4
P3_02_SPT5W	63.3[1]	26	<26	<1	24.5	N/A	N/A	S-S (1/0)				1
P3_02_SPT5AW	63.3[1]	24.5	24.5	<1	24.5	N/A	N/A	S-S (2/1)	1 S-S			1
P5_02_SPT1W	83.8	44	42	<1	42	27	36.5	ST (3/1) S-S (3/2)	1 ST			2
P5_02_SPT2W	78.9	40	38?	<1	38	20	35	ST (1/0) S-S (3/1)				2

Notes:

1. Estimated from settlement plate data for October 2001 (see Table 3).
2. Design drawings show LCS in Phase II is 1-ft of backfill type F.
3. Refusal - hit obstruction.
4. ST = Shelby tube, S-S = split-spoon, (x/x) = (no. attempted/no. with recovery greater than 6-in.).
5. Interface = waste-LCS-dredge material interface.

TABLE 10

WASTE UNIT WEIGHT SUMMARY TABLE

Waste Characterization Report
Cherry Island Landfill Expansion Project
Delaware Solid Waste Authority

Data Source/ Instrument	Method	Date	Phase	Elevation Top (ft msl)	Elevation Bottom (ft msl)	Bulk Unit weight (pcf)	Sat. Unit weight (pcf)	Comments	Data Source
Weston Report	A	1995	IV		>LCS	70		Assumed value	Table 1
Duffield Report	A	1996	I - V		>LCS	60 - 90			
Weston Report	A	Jan-98	V	60	50	100 ave 85 - 105		Calculated from SPs and TPCs, assuming 25% soil at 110 pcf.	
SP4-2	B	4/97 - 1/98 1/98 - 4/00 4/00 - 8/01	IV	60 68 75		75 65 60		Calculated from SPs and TPCs, assuming 25% soil at 110 pcf. Density value is average for entire depth to LCS.	Table 3 App. O-1
SP5-1	B	7/97 - 7/99 7/99 - 7/00 7/00 - 1/01 1/01 - 10/01	V	55 60 70 80		80 100 80 60			
SP5-2	B	7/99 - 1/01 1/01 - 10/01	V	60 75		100 70			
SP5-3	B	7/99 - 4/01 4/01 - 10/01	V	60 70		100 60			
SP5-6	B	7/99 - 8/01	V	65		110			
SP5-9	B	7/99 - 8/01 8/01 - 10/01	V	60 70		90 50			
SP5-10	B	10/97 - 11/98 11/98 - 9/01 9/01 - 10/01	V	55 65 75		75 70 45			
SP1-1AA	C	1/85 - 4/01	I	60		69		Calculated from Waste Receipts and Aerial Surveys. Settlement plates indicated are closest to center of waste placement during period shown. Density value is average for entire depth to LCS. Value shown represents most recent (April 2001) for which settlement plate data is available.	Table 4 App. O-2
SP1-6	C	1/85 - 4/01	I/II	91		69			
SP3-4	C	1/85 - 4/01	III	70		50			
SP4-2	C	1/85 - 4/01	IV	75		50			
SP5-1	C	1/85 - 4/01	V	80		50			
SP5-5	C	1/85 - 4/01	V	71		50			
SP4-6	C	1/85 - 4/01	IV	77		50			
SP5-7	C	1/85 - 4/01	V	70		50			
SP3-13	C	1/85 - 4/01	III	58		50			
SP4-8	C	1/85 - 4/01	IV	63		50			
UW02	D	Mar-02	II	77 67	67 56	40-54 44-59	87 ave	From large diameter borings in waste. Saturated values Are calculated from waste composition and moisture content, and are shown as whole-phase averages.	Table 5 Table 7 Table 8
UW02A	D	Mar-02	II	77 67	67 59	48-64 57-76	87 ave		

TABLE 10

WASTE UNIT WEIGHT SUMMARY TABLE
(continued)

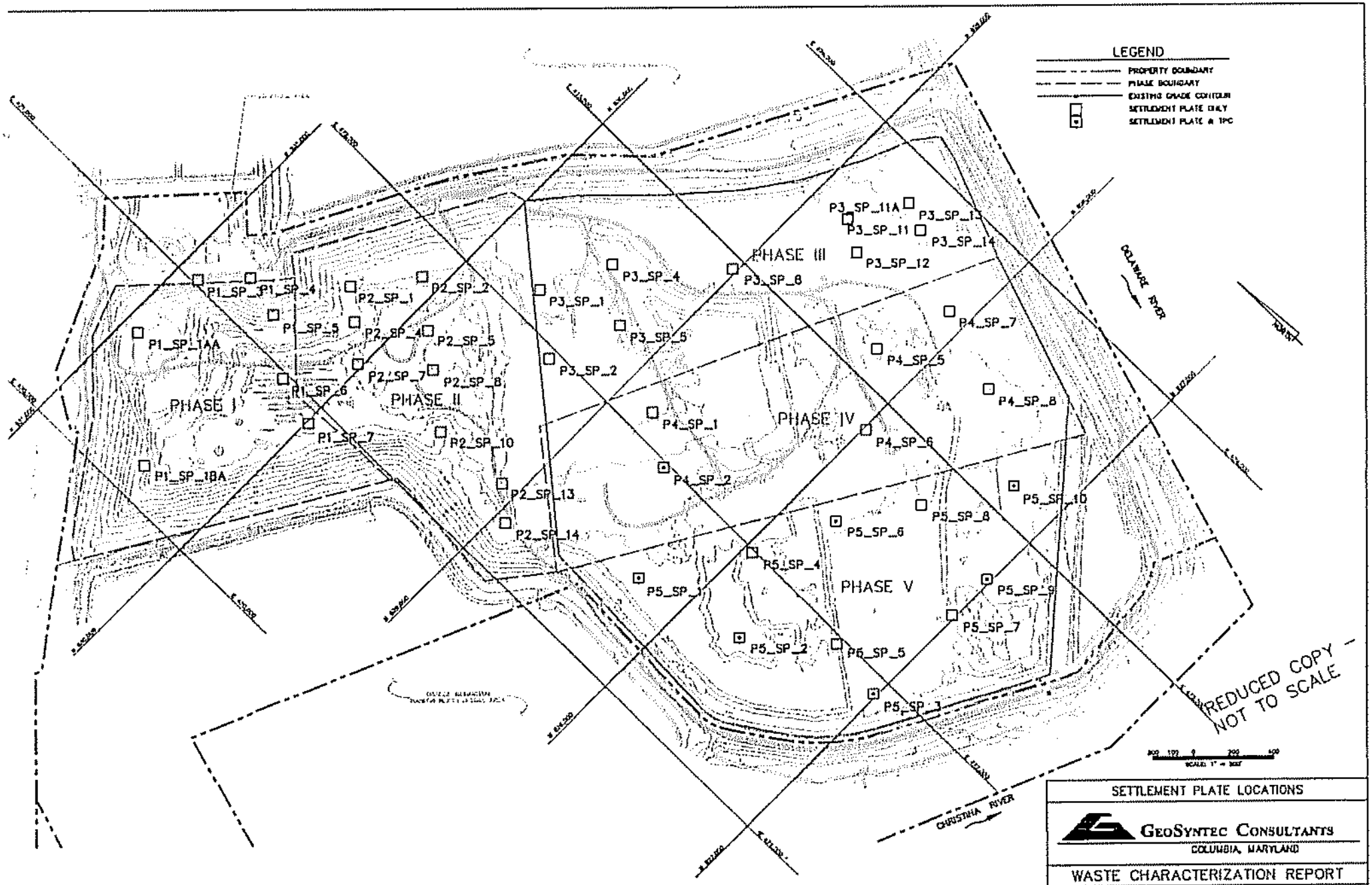
Data Source/ Instrument	Method	Date	Phase	Elevation Top (ft msl)	Elevation Bottom (ft msl)	Bulk Unit weight (pcf)	Sat. Unit weight (pcf)	Comments	Data Source
UW03	D	Mar-02	III	79	69	44-59		Range shown is minimum-maximum values. Saturated unit weight calculation is based on maximum UW values.	
				69	59	52-71			
				59	51	68-92			
UW04	D	Mar-02	III	63	53	45-60	95		
				53	41	59-79	ave		
UW05	D	Mar-02	IV	83	73	31-41	95		
				73	63	80-108	ave		
				63	55	72-97			
UW06	D	Mar-02	IV	75	65	44-59			
				65	55	56-75			
				55	44	48-64			
UW07	D	Mar-02	V	79	69	42-57			
				69	59	57-77			
UW08	D	Mar-02	V	84	74	47-63	95		
				74	64	46-61	ave		
				64	54	60-81			
UW09	D	Mar-02	V	71	61	47-64	95		
				61	51	54-72	ave		
SPT3W	E	Apr-02	III	43	43		76	Shelby tube sample rec. from below sat. waste level	Table 9 App. O-7.4
SASW01	F	Mar-02	I	88	86	120		Estimated from SASW surveys. First value is for cover material. Lower depths may reflect γ_{sat} rather than γ_{bulk} values.	App. P of the GHR
				86	73	160			
				73	53	85			
SASW02	F	Mar-02	II	79	77	N/A			
				77	69	46			
				69	61	54			
				61	58	65			
				58	53	75			
				53	43	65			
				43	30	82			
SASW03	F	Mar-02	III	79	77	N/A			
				77	69	52			
				69	59	62			
				59	53	80			
				53	51	75			
				51	41	82			
ASW04	F	Mar-02	III	63	60	N/A			
				60	53	52			
				53	42	69			
				42	39	85			

TABLE 10

WASTE UNIT WEIGHT SUMMARY TABLE
(continued)

Data Source/ Instrument	Method	Date	Phase	Elevation Top (ft msl)	Elevation Bottom (ft msl)	Bulk Unit weight (pcf)	Sat. Unit weight (pcf)	Comments	Data Source
SASW05	F	Mar-02	IV	83	81	N/A			
				81	73	36			
				73	68	80			
				68	63	60			
				63	45	70			
SASW06	F	Mar-02	IV	75	73	N/A			
				73	65	51			
				65	50	65			
				50	44	75			
SASW07	F	Mar-02	V	79	78	N/A			
				78	69	49			
				69	62	67			
				62	58	70			
				58	53	80			
				53	42	90			
SASW08	F	Mar-02	V	84	82	N/A			
				82	74	55			
				74	64	54			
				64	55	70			
				55	46	88			
SASW09	F	Mar-02	V	71	69	N/A			
				69	61	56			
				61	51	63			
				51	43	88			

FIGURES



SETTLEMENT PLATE LOCATIONS

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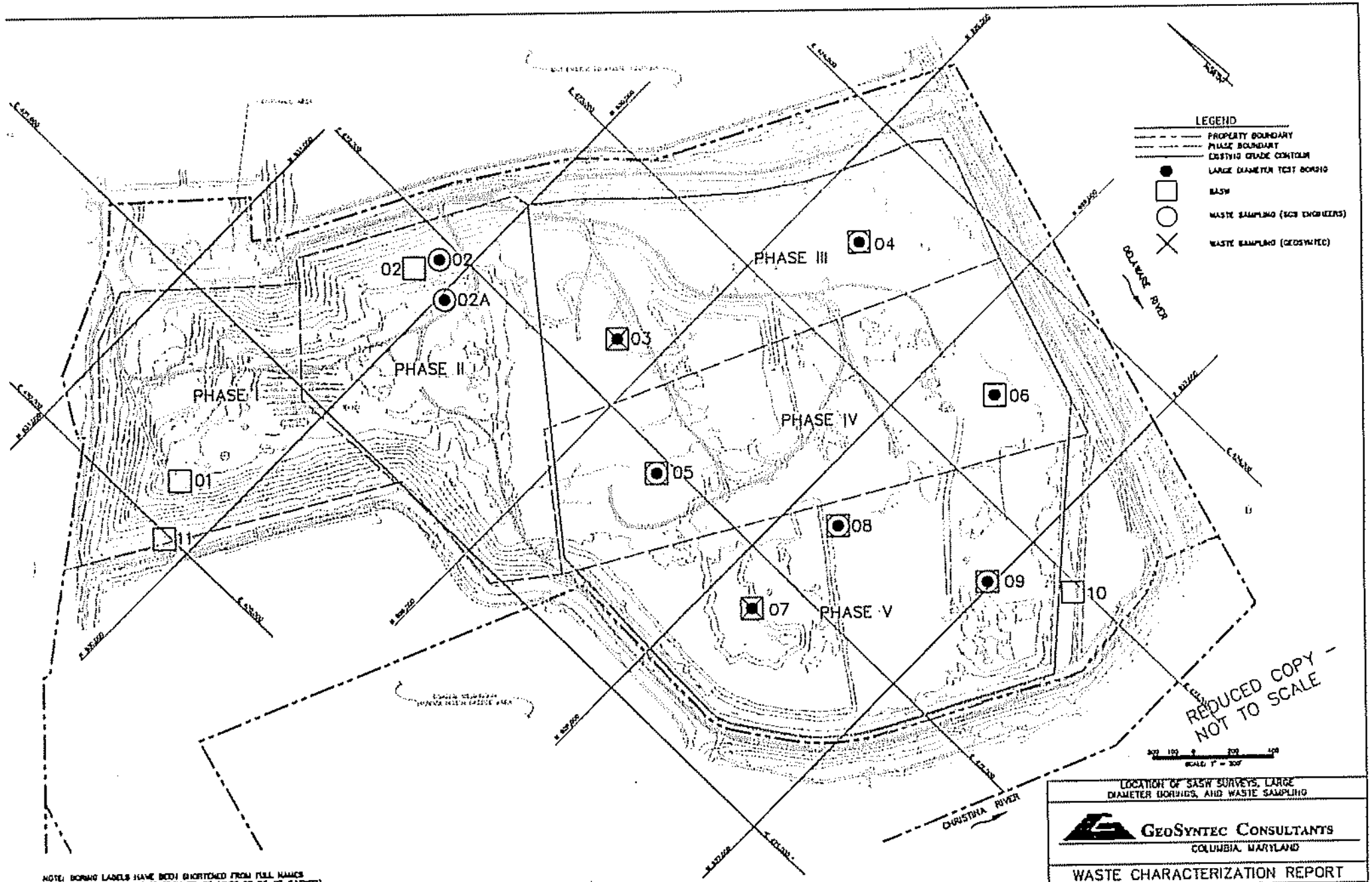
WASTE CHARACTERIZATION REPORT

PROJECT NO.	ME0250	FILE NO.	0250F001E
DOCUMENT NO.	MD02217	FIGURE NO.	1



NOTE: BORING LABELS HAVE BEEN SHORTENED FROM FULL NAMES (i.e. 01 IS SHORTENED FROM P2_01_LW02 OR P2_01_SASW02)

LOCATION OF SASW SURVEYS, LARGE DIAMETER BORINGS, AND WASTE SAMPLING

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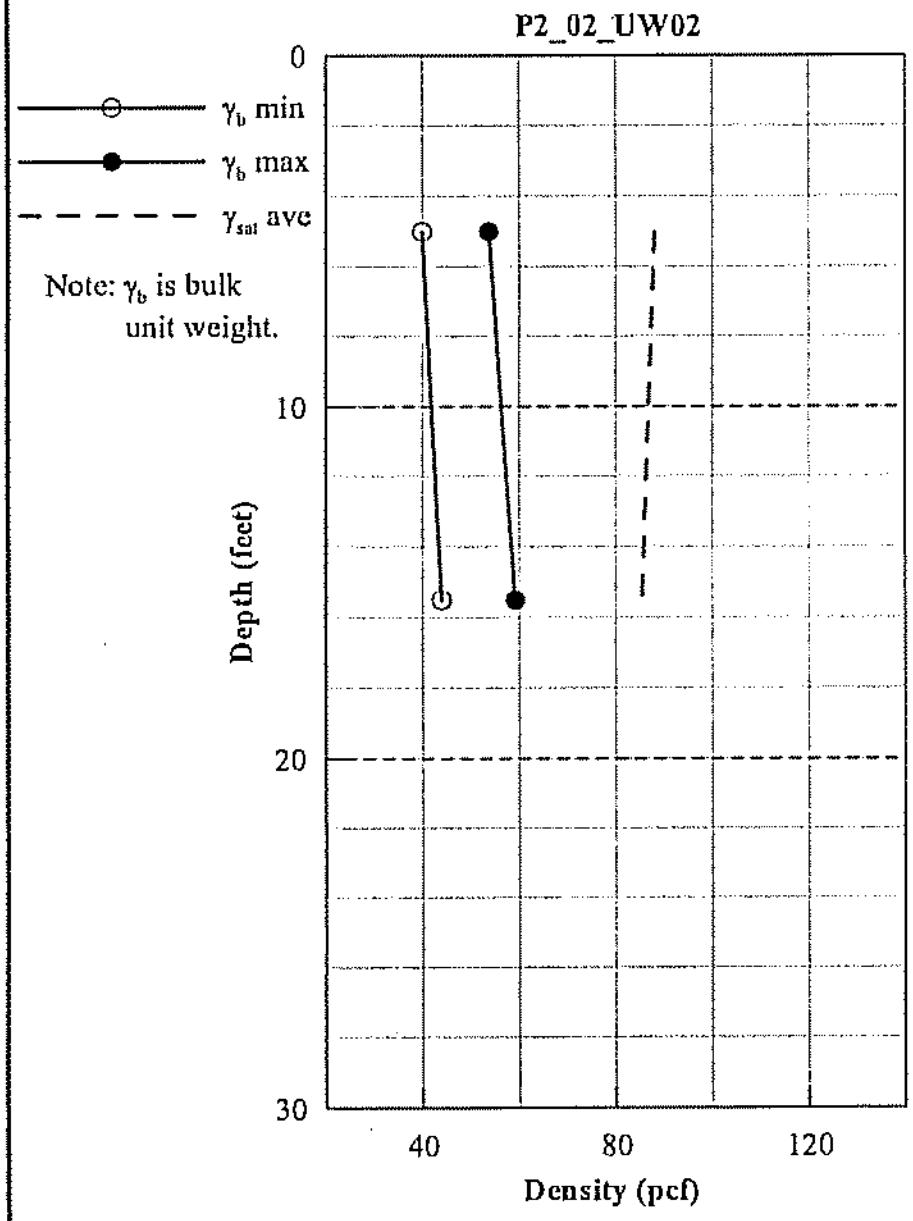
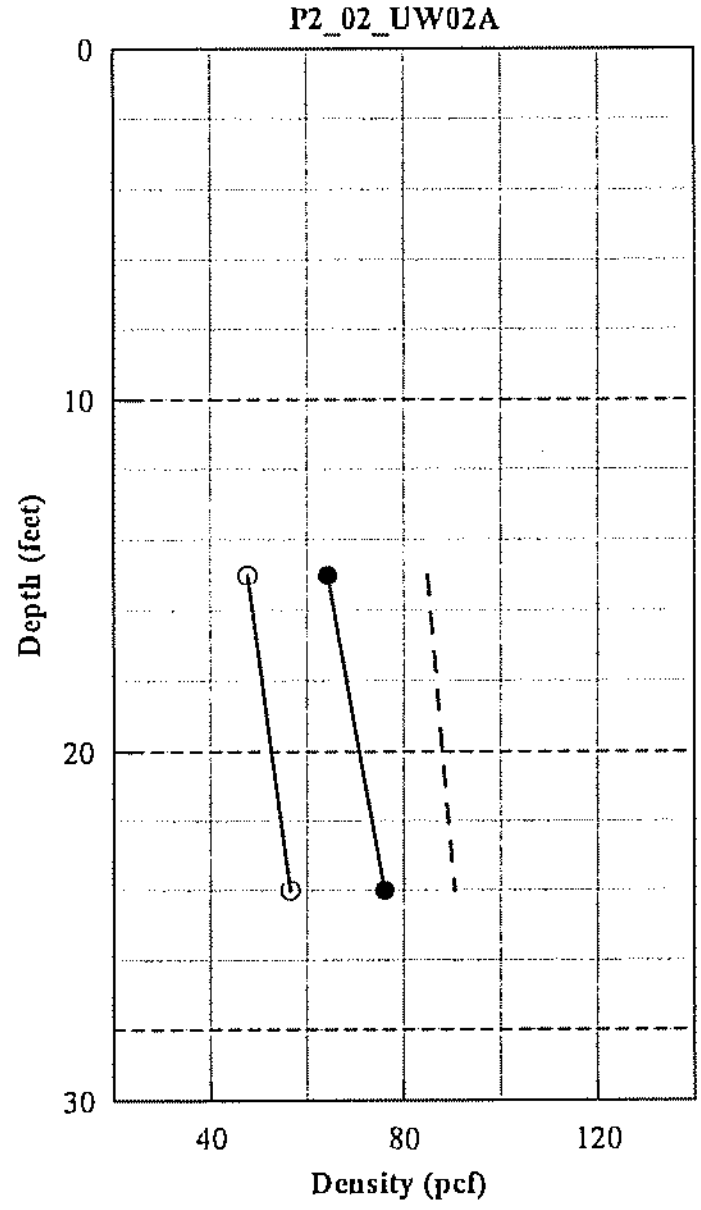
COLUMBIA, MARYLAND

WASTE CHARACTERIZATION REPORT

PROJECT NO.	ME0250	FILE NO.	0250F001D2
DOCUMENT NO.	MD02217	FIGURE NO.	2





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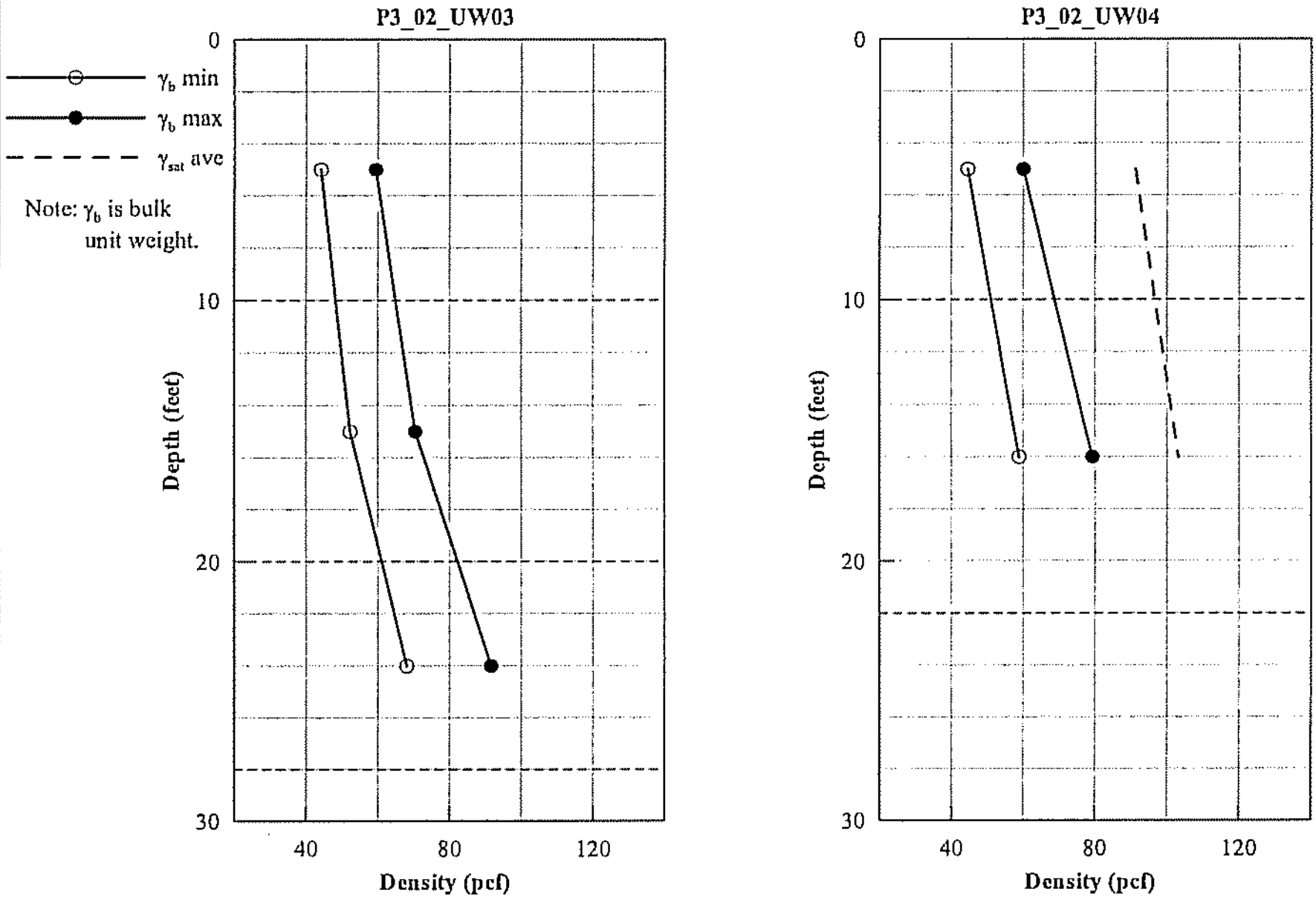
Calculated In-Situ Density of Waste From Large Diameter Borings Phase II

FIGURE 4-1

PROJECT: ME0250 Cherry Island Waste Characterization Report



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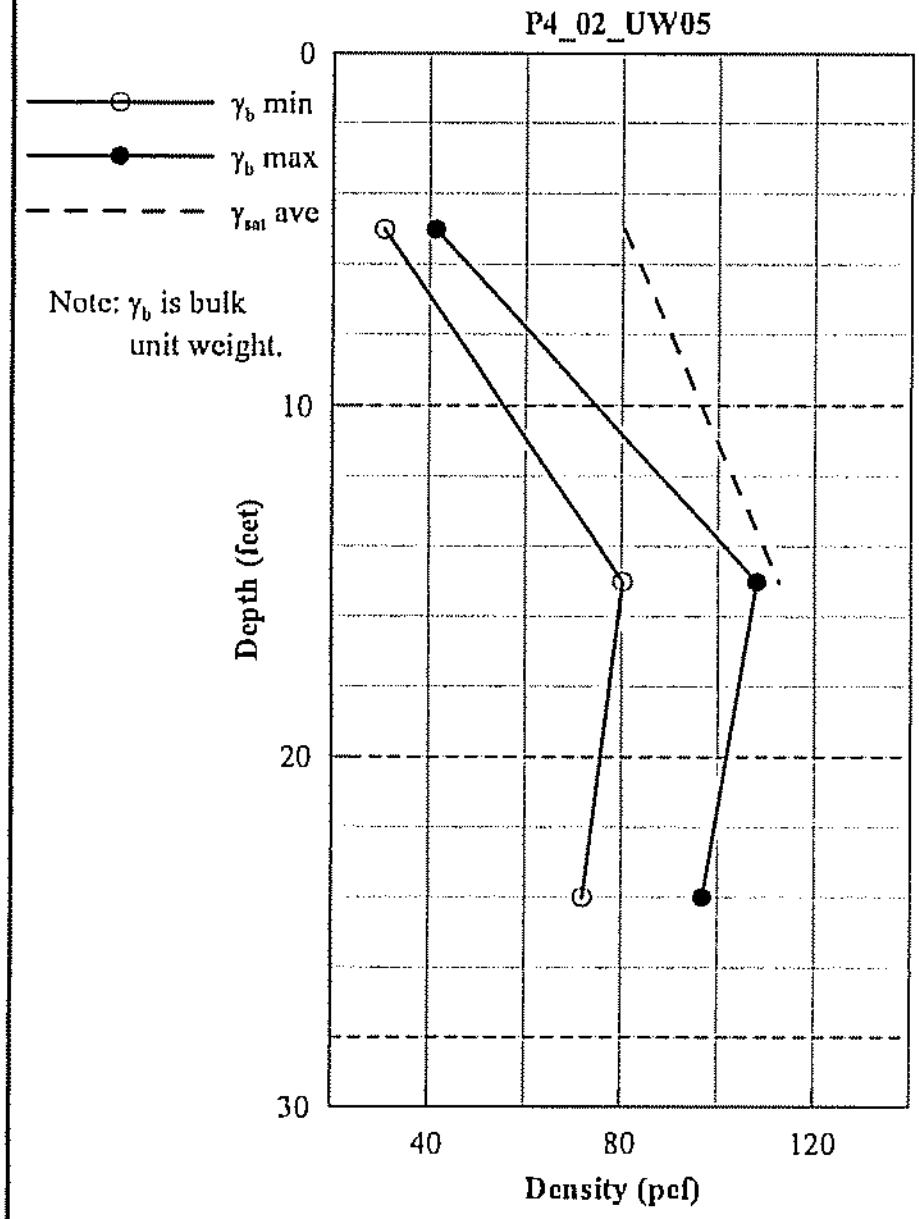
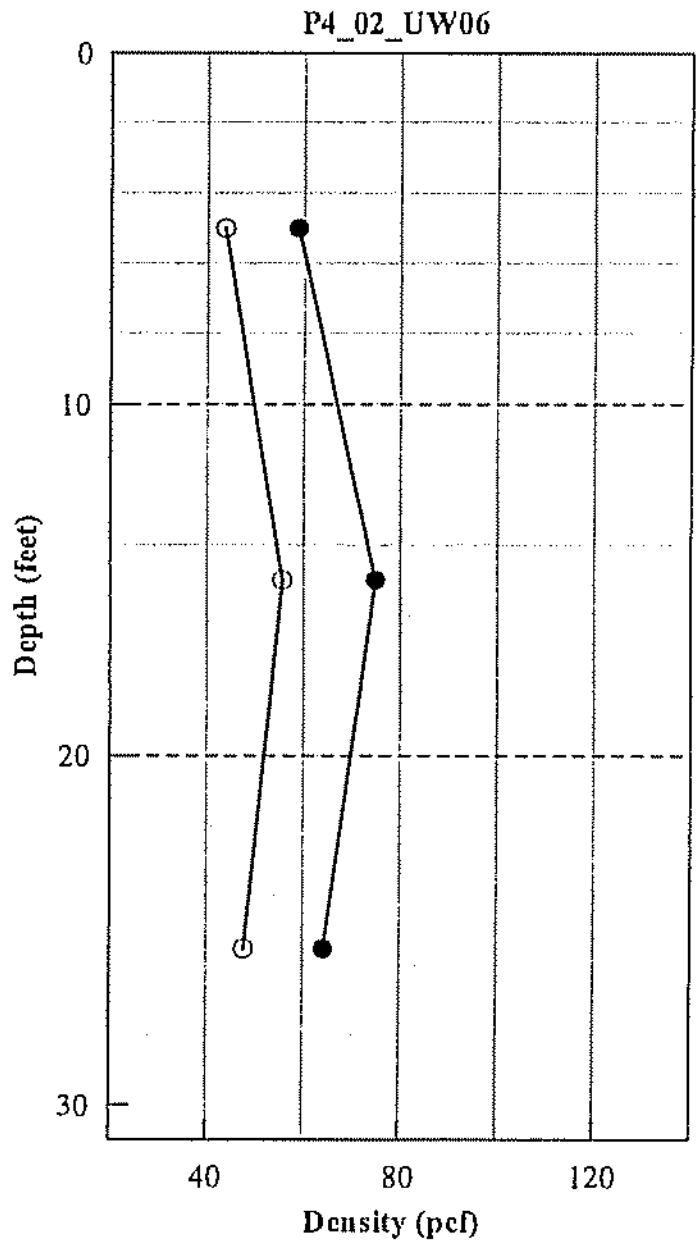
Calculated In-Situ Density of Waste From Large Diameter Borings Phase III

FIGURE 4-2

PROJECT: ME0250 Cherry Island Waste Characterization Report





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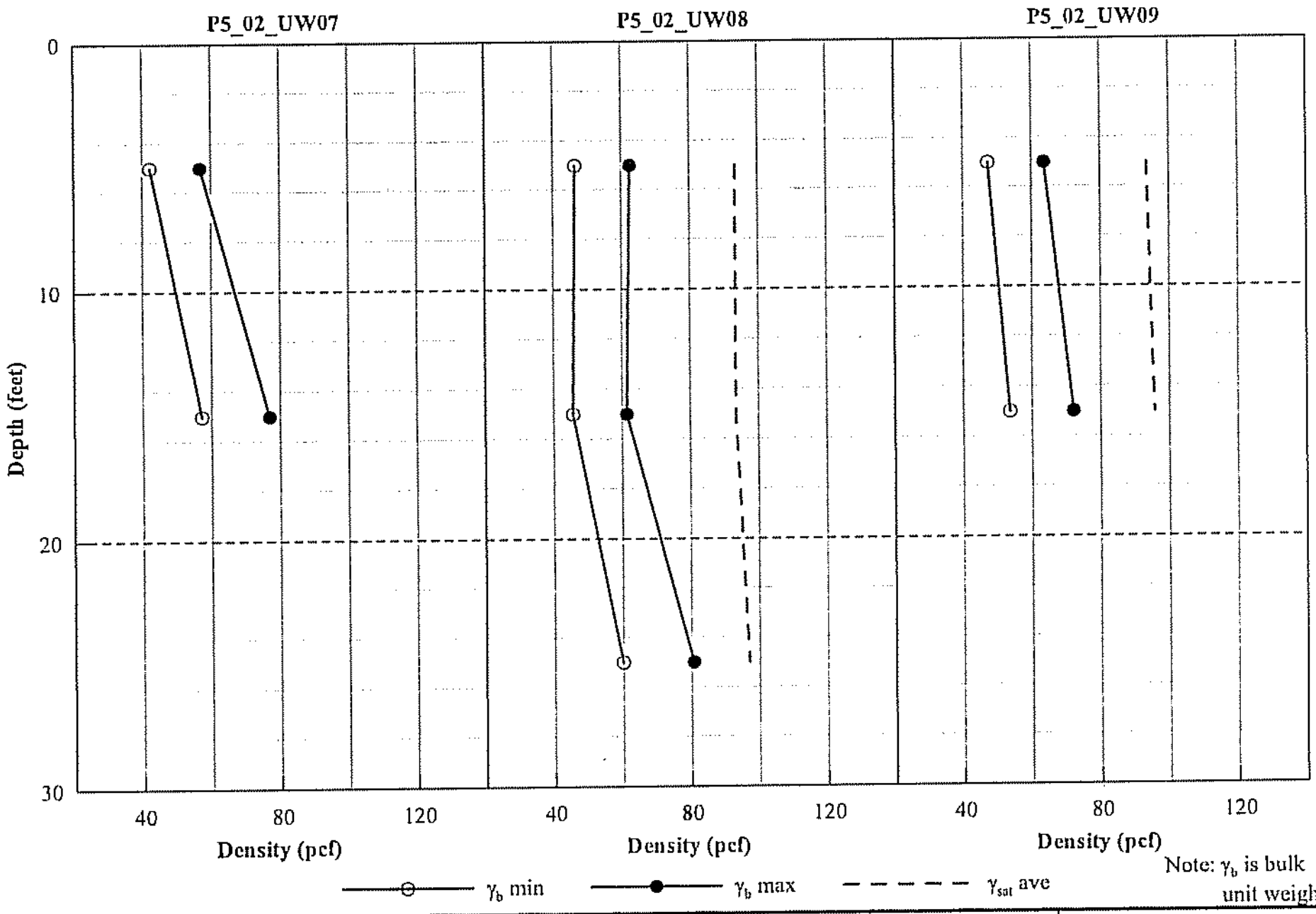
Calculated In-Situ Density of Waste From Large Diameter Borings Phase IV

FIGURE 4-3

PROJECT: ME0250 Cherry Island Waste Characterization Report



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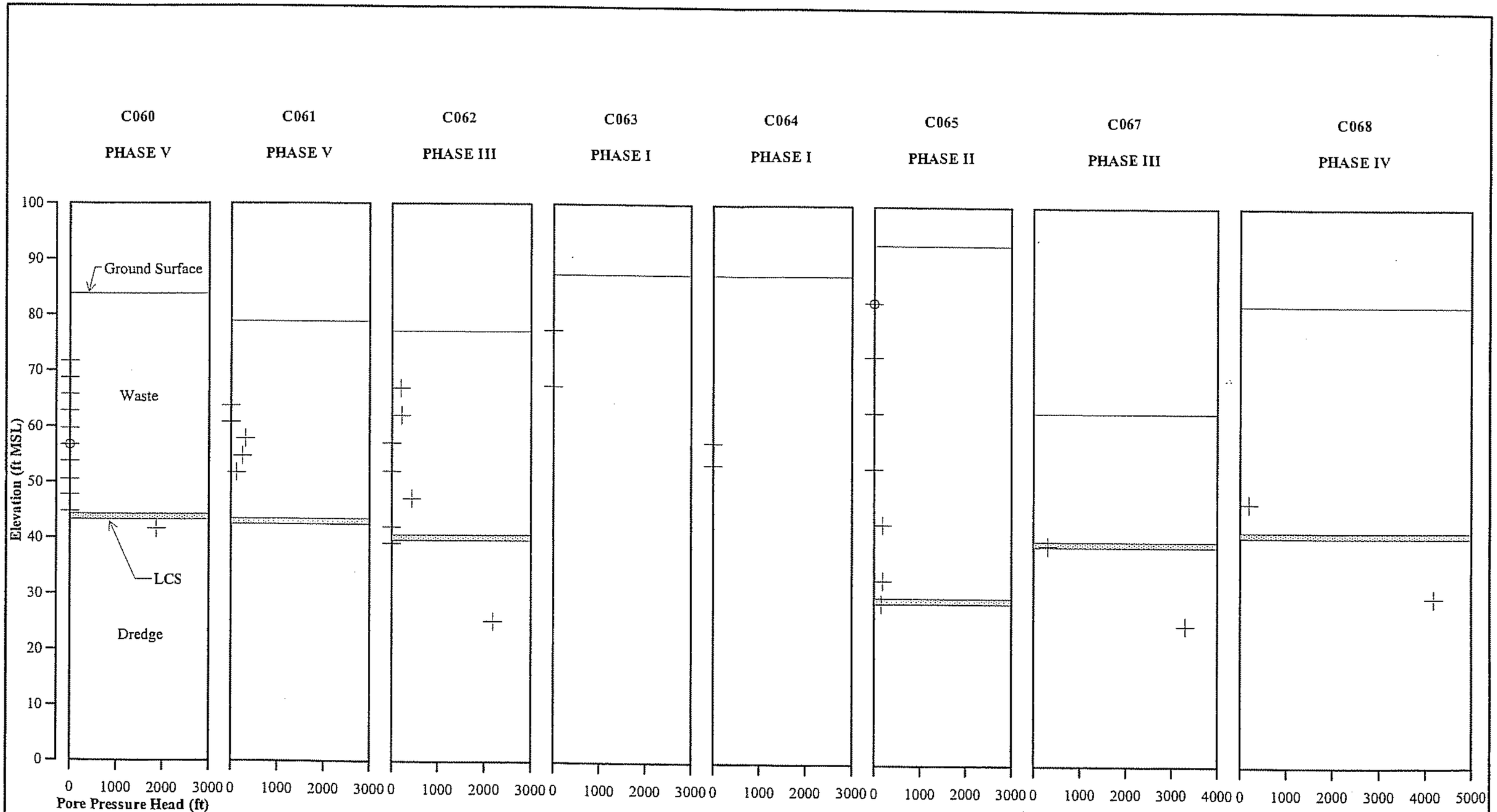
Calculated In-Situ Density of Waste From Large Diameter Borings Phase V

FIGURE 4-4

PROJECT: ME0250 Cherry Island Waste Characterization Report



Stabilized Pore Pressure from Dissipation Test

Measured Zero Pore Pressure

NOTE: Except as noted, dissipation tests at depths with reported pore pressure of zero actually recorded negative pore pressures.

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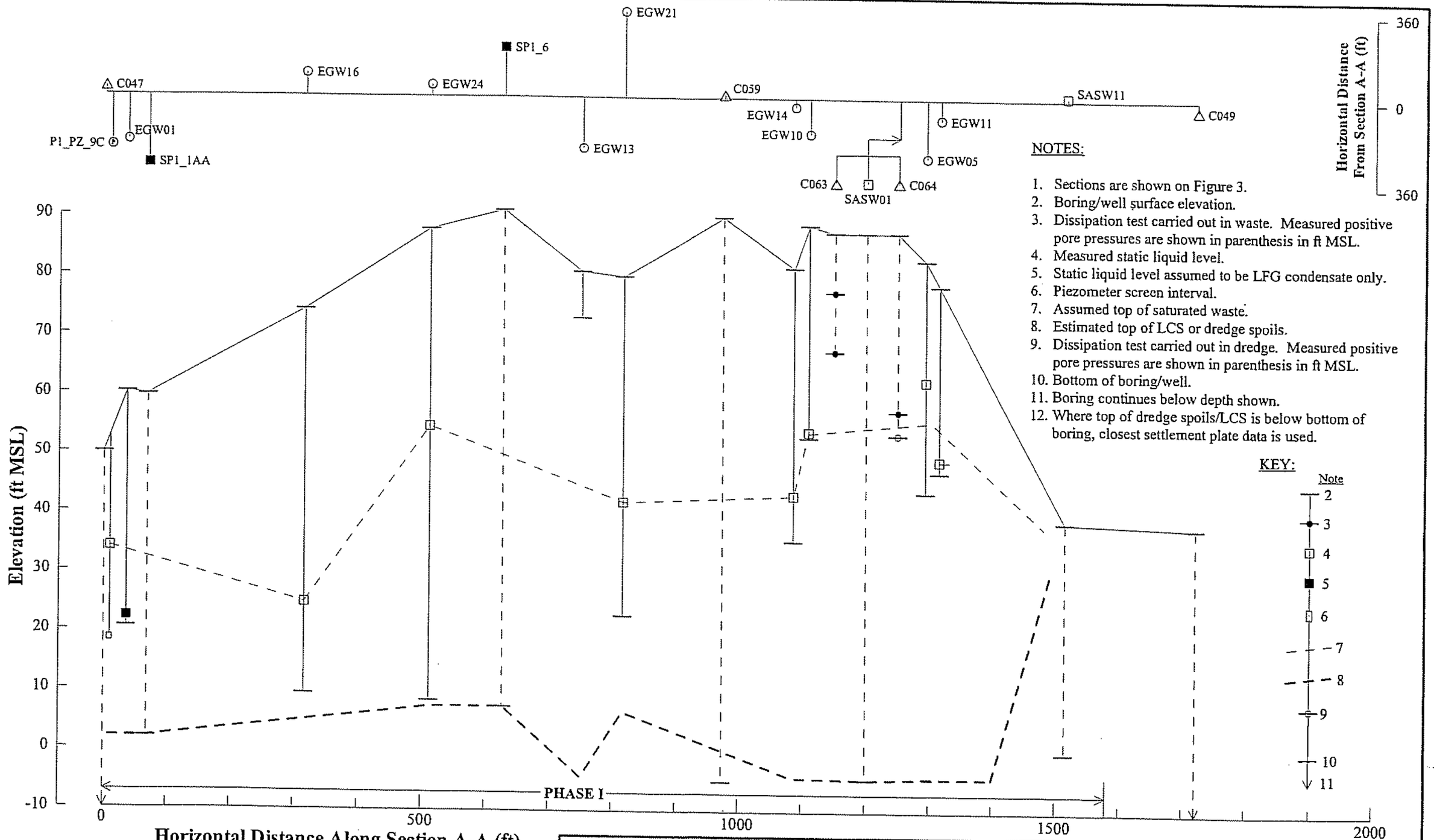
CPT DISSIPATION TEST RESULTS

FIGURE 5

PROJECT: ME0250 Cherry Island Waste Characterization Report

P:/Field Exploration II/CPT/CPT Dissipation.grf 9/11/02



NOTES:

1. Sections are shown on Figure 3.
2. Boring/well surface elevation.
3. Dissipation test carried out in waste. Measured positive pore pressures are shown in parenthesis in ft MSL.
4. Measured static liquid level.
5. Static liquid level assumed to be LFG condensate only.
6. Piezometer screen interval.
7. Assumed top of saturated waste.
8. Estimated top of LCS or dredge spoils.
9. Dissipation test carried out in dredge. Measured positive pore pressures are shown in parenthesis in ft MSL.
10. Bottom of boring/well.
11. Boring continues below depth shown.
12. Where top of dredge spoils/LCS is below bottom of boring, closest settlement plate data is used.

P:/.../Field Exploration I/Settlement_Density/Section AA Water.grf 9/13/02

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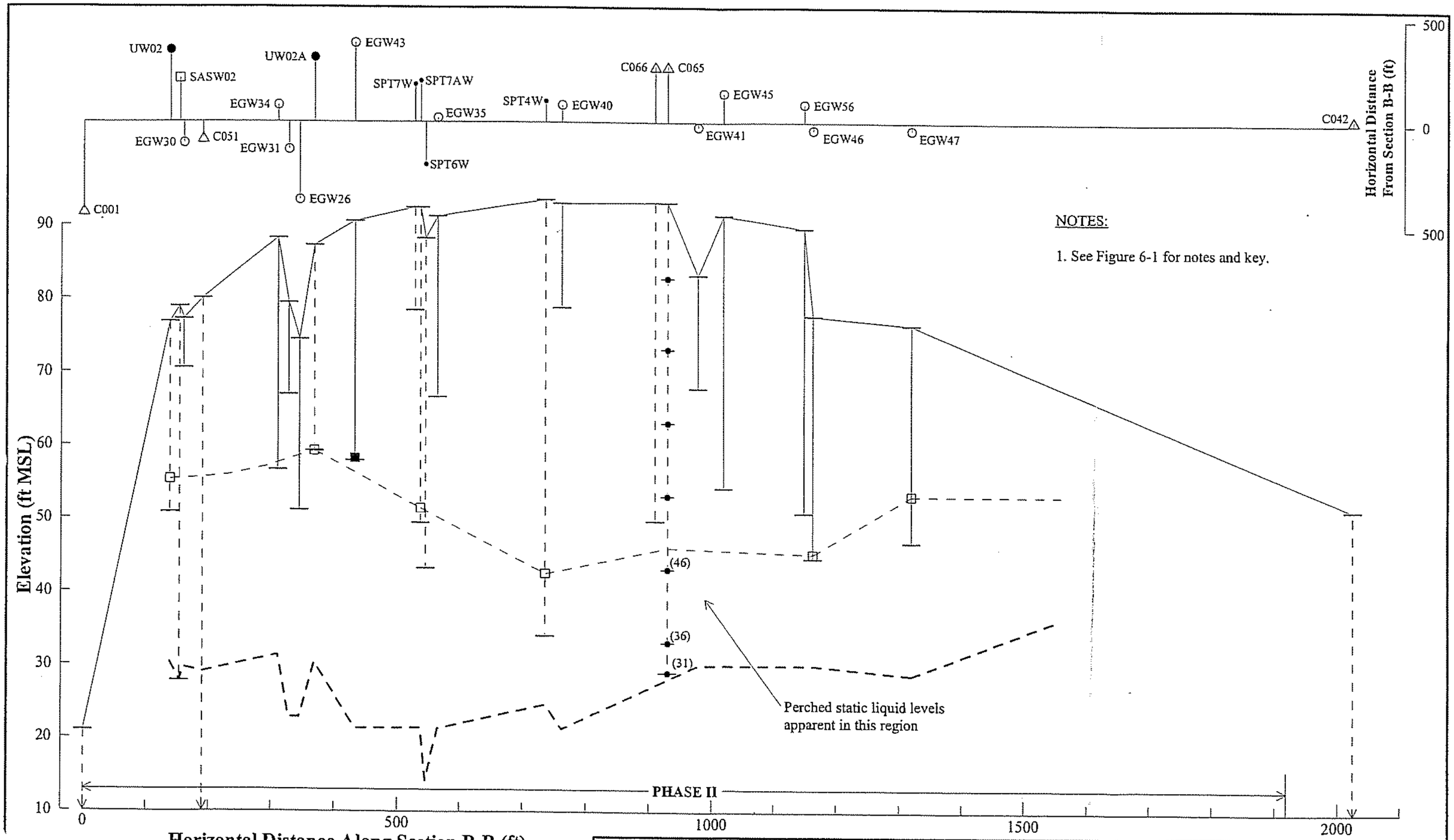
PROFILE OF SATURATED WASTE ELEVATIONS IN LANDFILL
Section A-A

FIGURE 6-1

PROJECT: ME0250 Cherry Island Waste Characterization Report



P:/.../Field Investigation I/Settlement_Density/Section BB Water.grf 9/16/02

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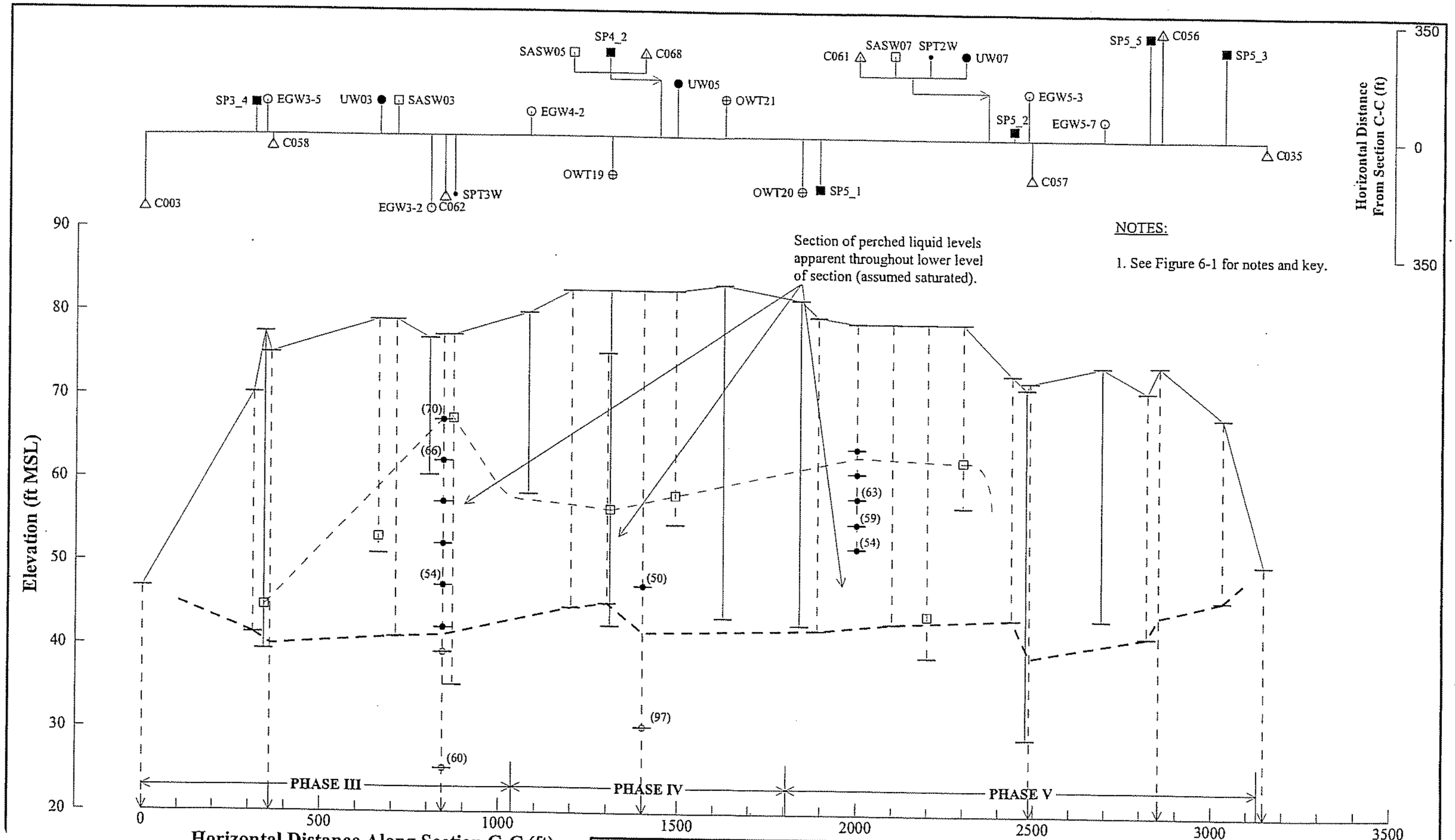
PROFILE OF SATURATED WASTE ELEVATIONS IN LANDFILL
Section B-B

FIGURE 6-2

PROJECT: ME0250 Cherry Island Waste Characterization Report



P:/.../Field Exploration I/Settlement_Density/Section CC Water.grf 9/13/02

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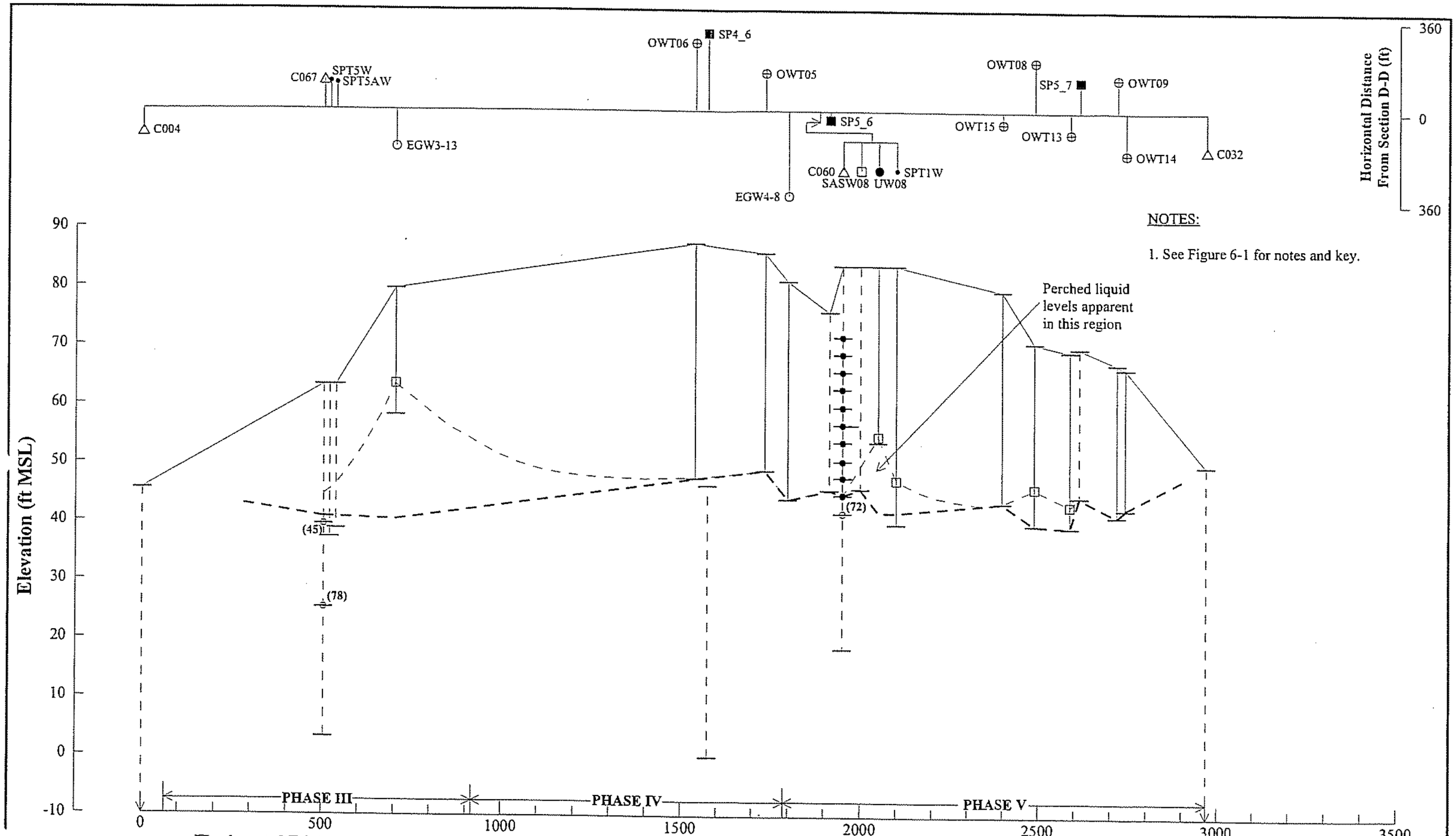
Columbia, Maryland 21046

PROFILE OF SATURATED WASTE ELEVATIONS IN LANDFILL
Section C-C

FIGURE 6-3

PROJECT: ME0250 Cherry Island Waste Characterization Report



P:/.../Field Exploration I/Settlement_Density/Section DD Water.grf 9/13/02

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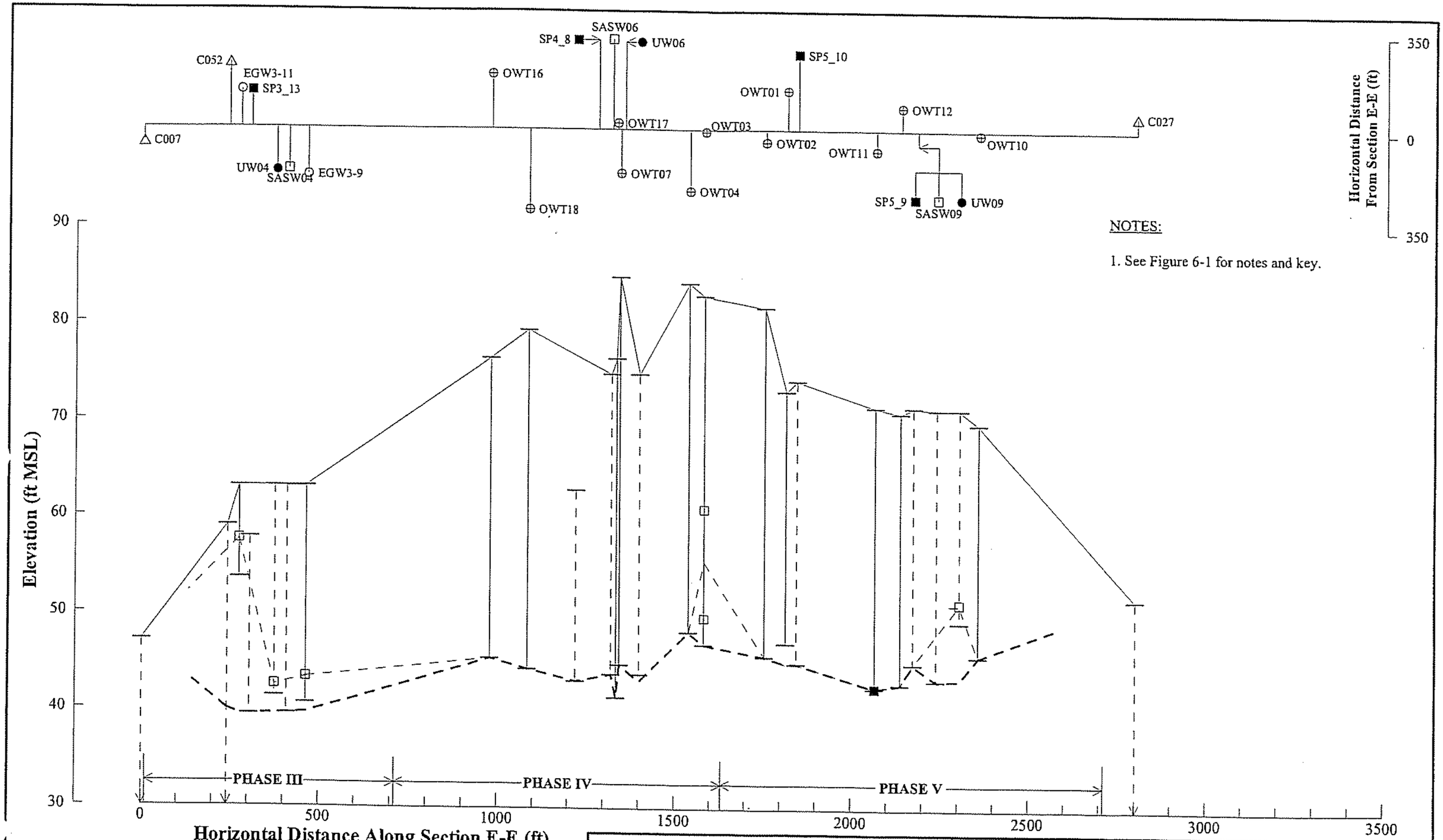
Columbia, Maryland 21046

PROFILE OF SATURATED WASTE ELEVATIONS IN LANDFILL
Section D-D

FIGURE 6-4

PROJECT: ME0250 Cherry Island Waste Characterization Report



NOTES:

1. See Figure 6-1 for notes and key.

P:/.../Field Exploration I/Settlement_Density/Section EE Water.grf 9/13/02

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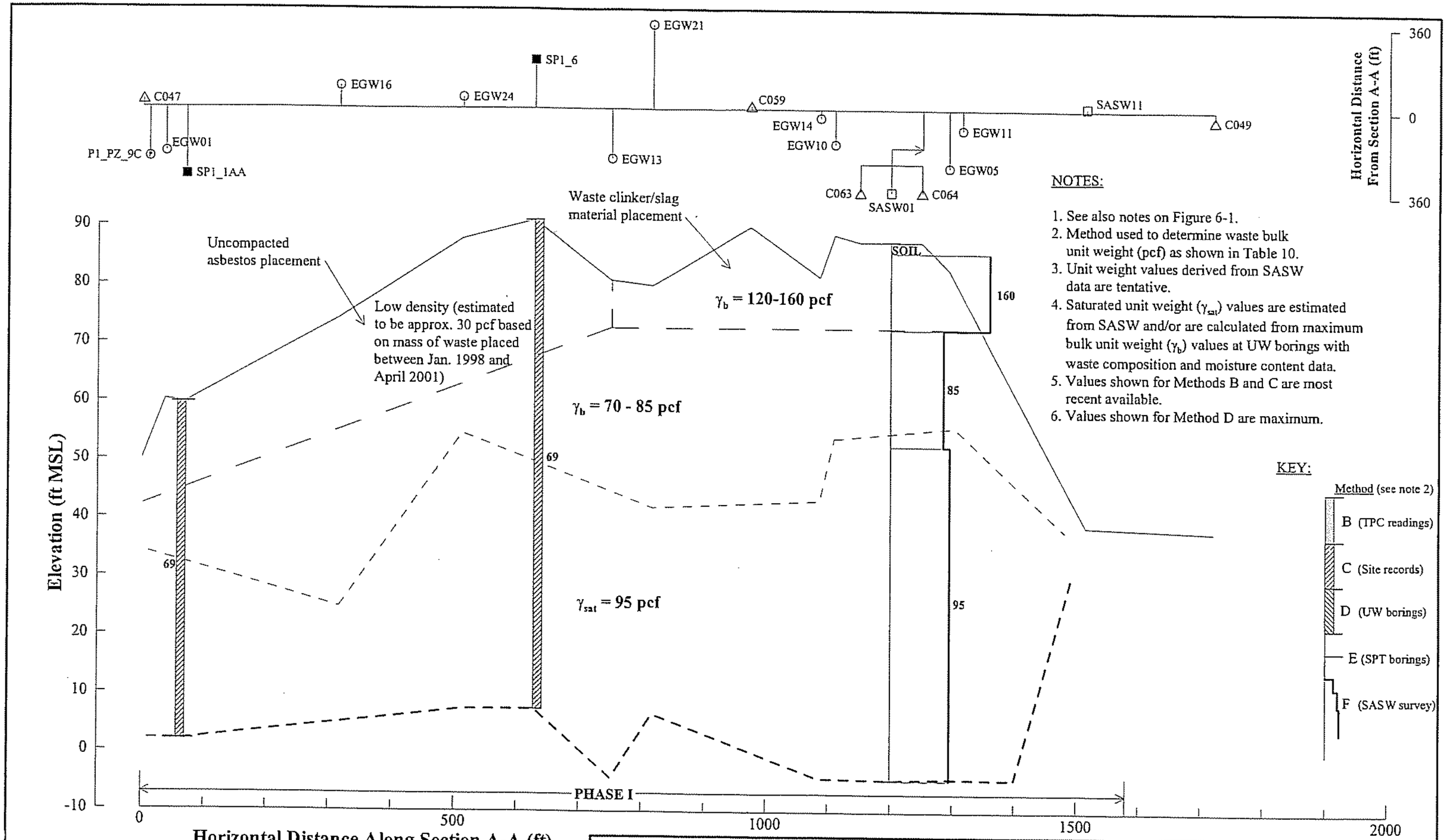
Columbia, Maryland 21046

PROFILE OF SATURATED WASTE ELEVATIONS IN LANDFILL
Section E-E

FIGURE 6-5

PROJECT: ME0250 Cherry Island Waste Characterization Report



P:/.../Field Exploration I/Settlement_Density/Section AA Unit Weight.grf 2/27/03

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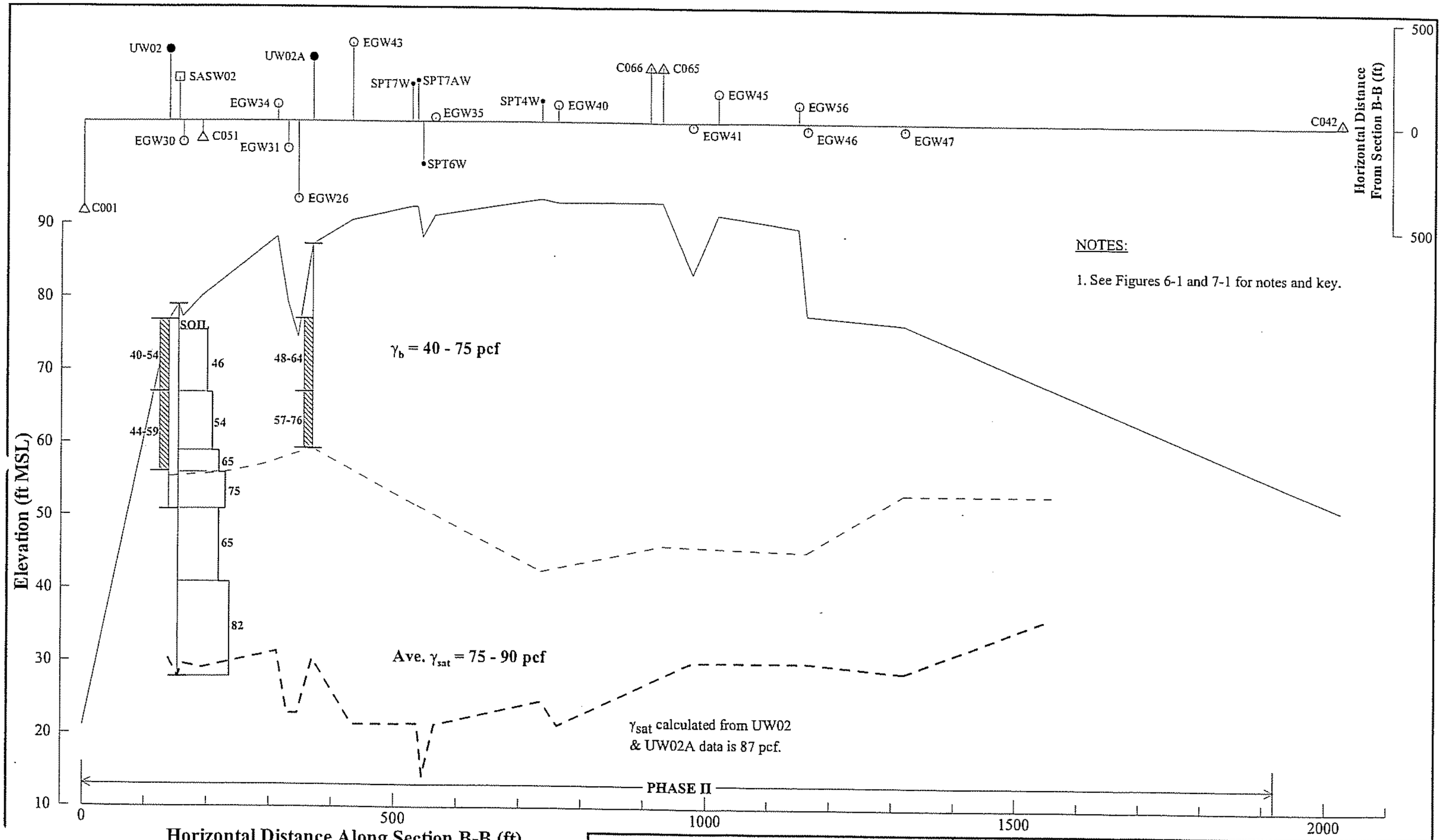
Columbia, Maryland 21046

WASTE UNIT WEIGHT PROFILE
Section A-A

FIGURE 7-1

PROJECT: ME0250 Cherry Island Waste Characterization Report



P:/.../Field Investigation I/Settlement_Density/Section 8B Unit Weight.grf 2/27/03

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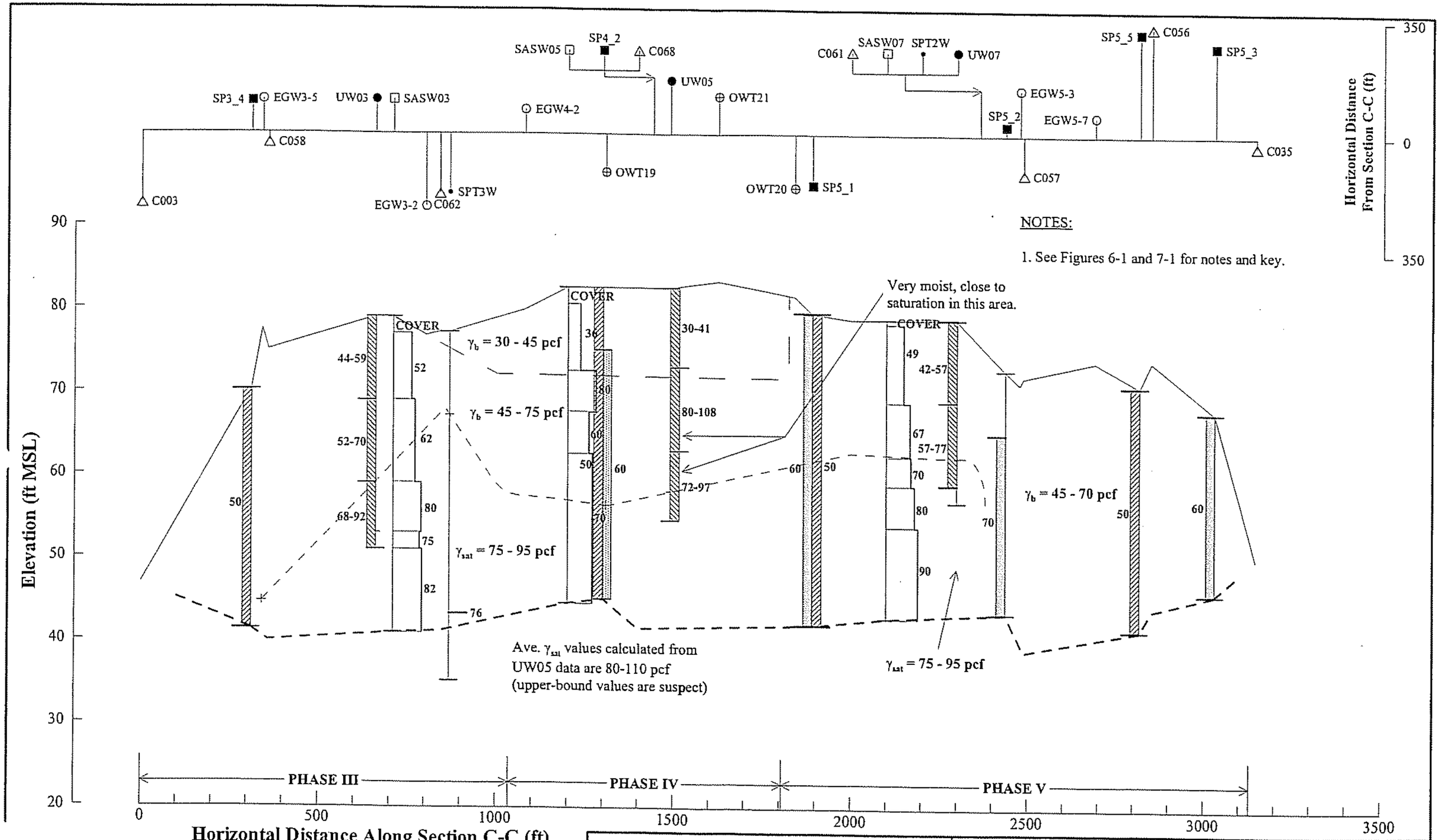
Columbia, Maryland 21046

WASTE UNIT WEIGHT PROFILE
Section B-B

FIGURE 7-2

PROJECT: ME0250 Cherry Island Waste Characterization Report



P:/.../Field Exploration I/Settlement_Density/Section CC Unit WeighLgrf 2/27/03

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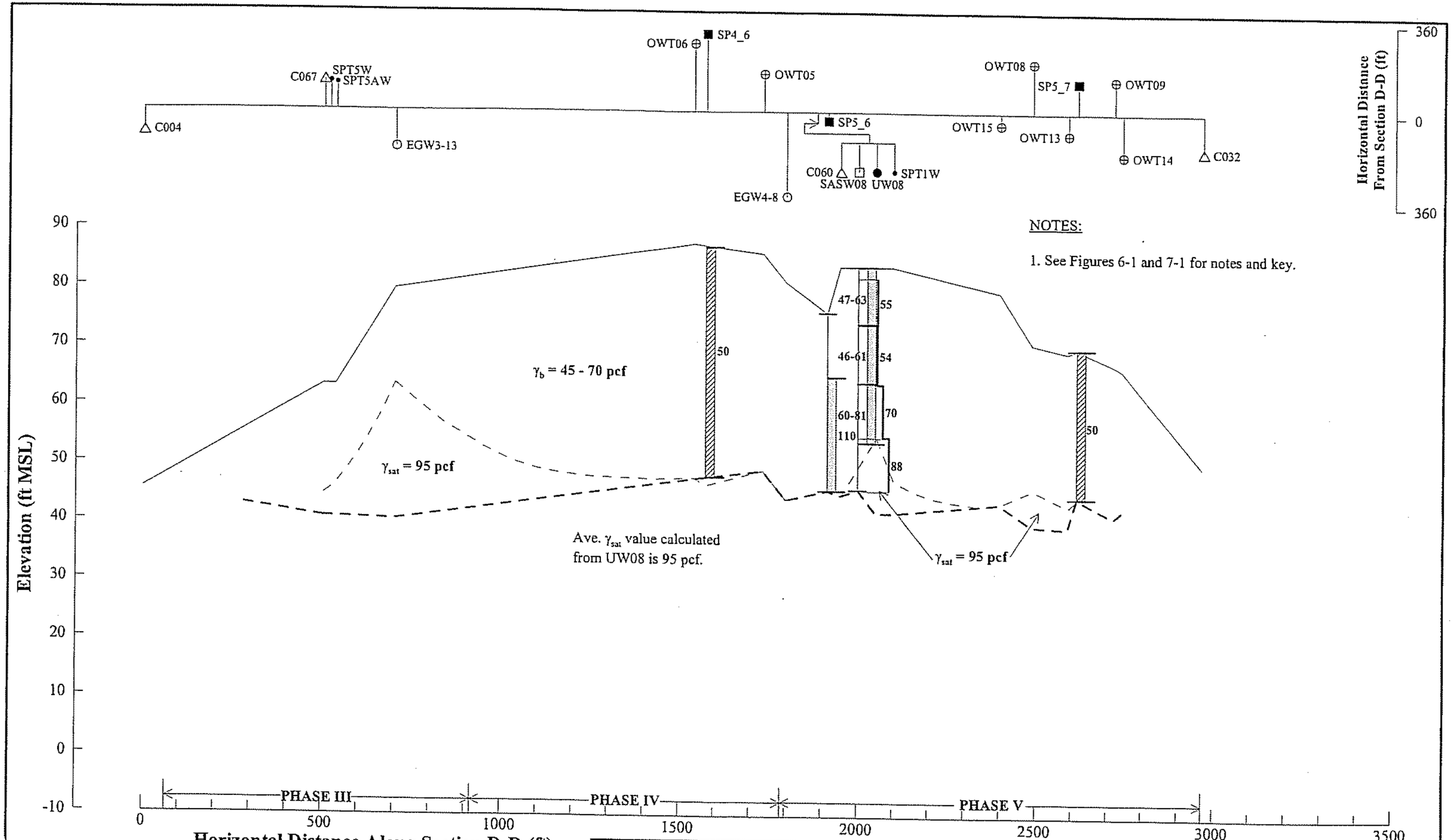
Columbia, Maryland 21046

WASTE UNIT WEIGHT PROFILE
Section C-C

FIGURE 7-3

PROJECT: ME0250 Cherry Island Waste Characterization Report



P:/.../Field Exploration I/Settlement_Density/Section DD Unit Weight.grf 2/27/03

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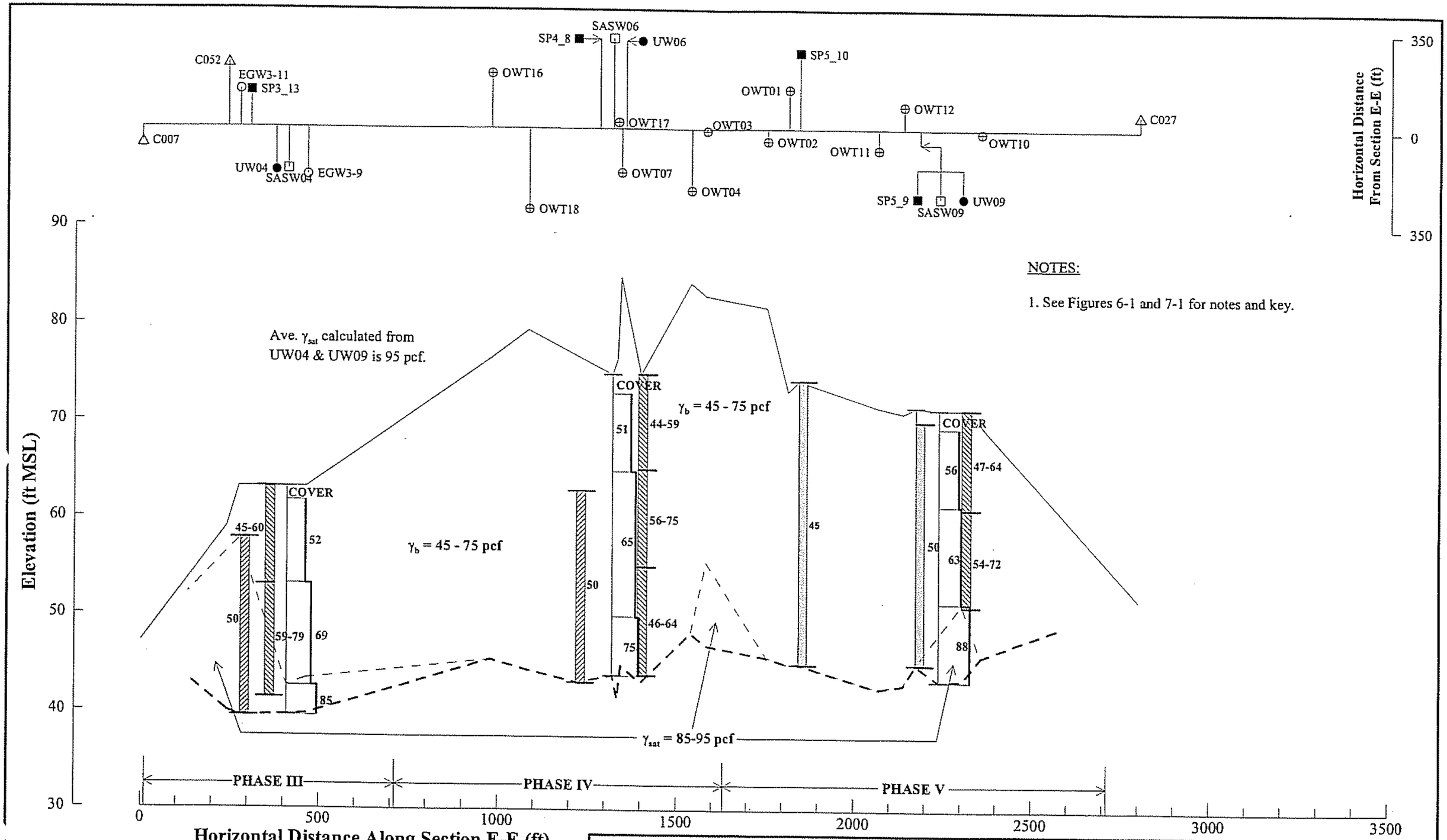
Columbia, Maryland 21046

WASTE UNIT WEIGHT PROFILE
Section D-D

FIGURE 7-4

PROJECT: ME0250 Cherry Island Waste Characterization Report



P:/.../Field Exploration I/Settlement_Density/Section EE Unit Weight.grf 9/11/02

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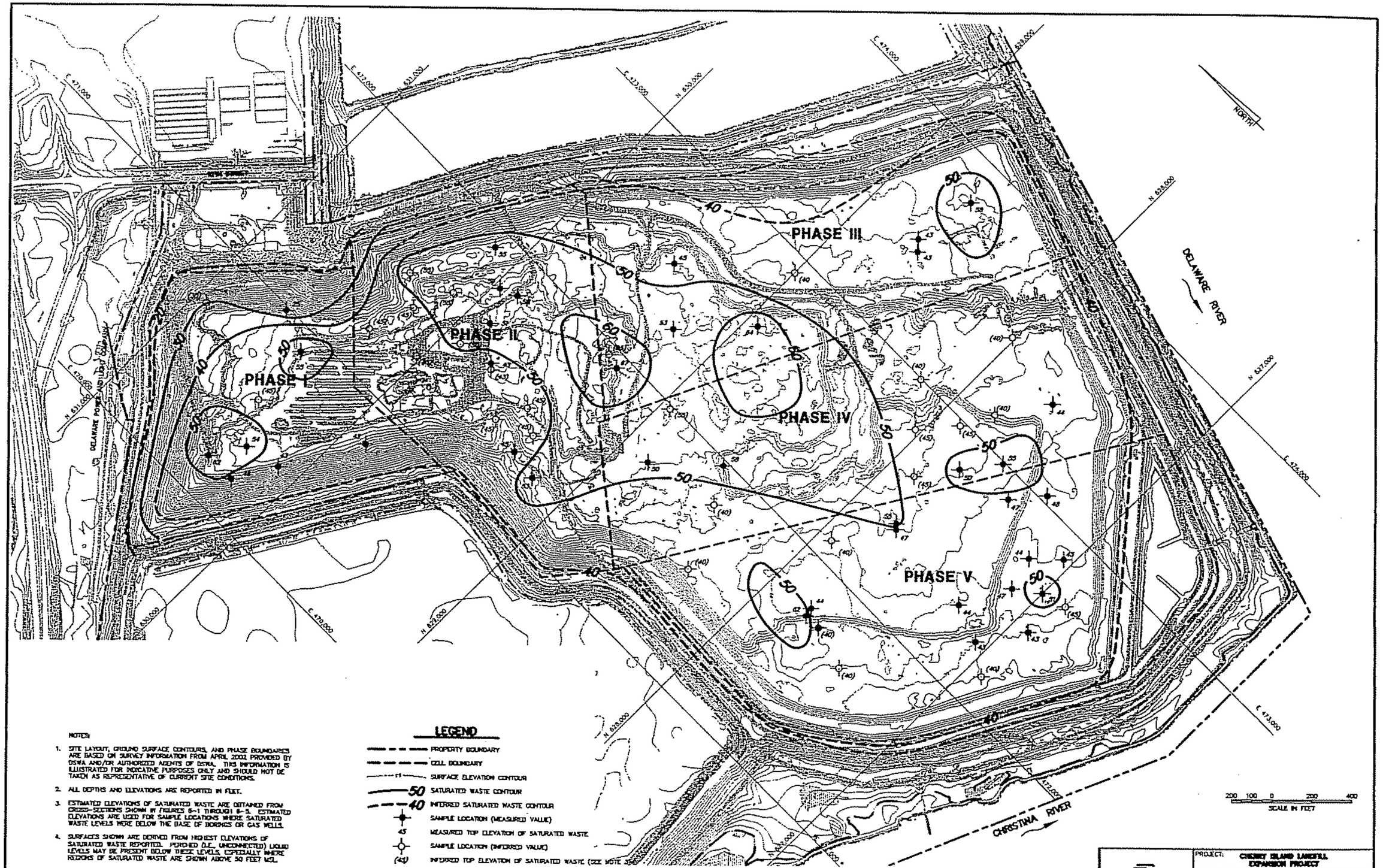
Columbia, Maryland 21046

WASTE UNIT WEIGHT PROFILE
Section E-E

FIGURE 7-5

PROJECT: ME0250 Cherry Island Waste Characterization Report

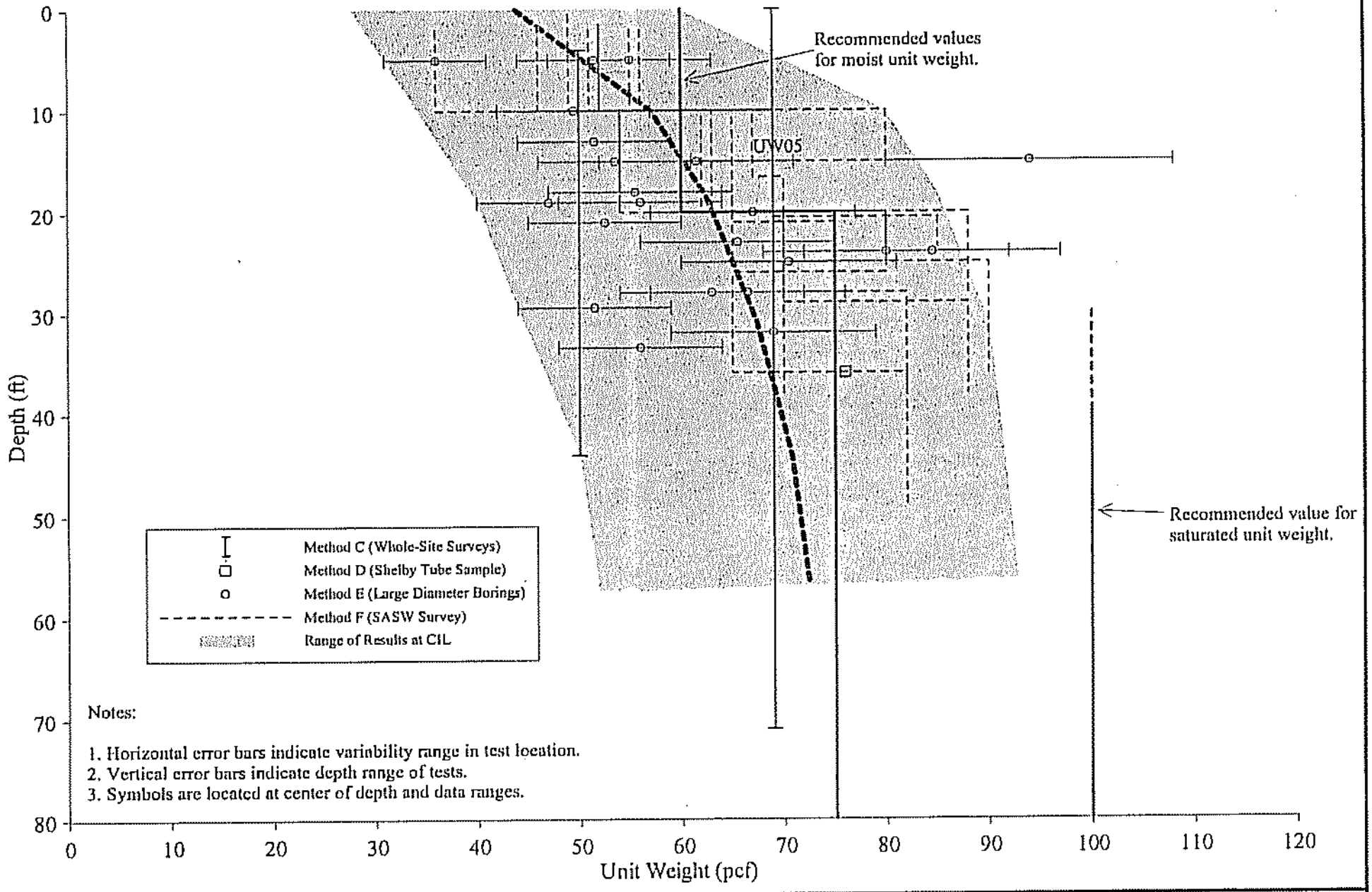


NOTES:

1. SITE LAYOUT, GROUND SURFACE CONTOURS, AND PHASE BOUNDARIES ARE BASED ON SURVEY INFORMATION FROM APRIL 2002 PROVIDED BY DSWA AND/OR AUTHORIZED AGENTS OF DSWA. THIS INFORMATION IS ILLUSTRATED FOR INDICATIVE PURPOSES ONLY AND SHOULD NOT BE TAKEN AS REPRESENTATIVE OF CURRENT SITE CONDITIONS.
2. ALL DEPTHS AND ELEVATIONS ARE REPORTED IN FEET.
3. ESTIMATED ELEVATIONS OF SATURATED WASTE ARE OBTAINED FROM CROSS-SECTIONS SHOWN IN FIGURES 8-1 THROUGH 8-5. ESTIMATED ELEVATIONS ARE USED FOR SAMPLE LOCATIONS WHERE SATURATED WASTE LEVELS WERE BELOW THE BASE OF BORINGS OR GAS WELLS.
4. SURFACES SHOWN ARE DERIVED FROM HIGHEST ELEVATIONS OF SATURATED WASTE REPORTED. PERCHED (I.E., UNCONNECTED) LIQUID LEVELS MAY BE PRESENT BELOW THESE LEVELS, ESPECIALLY WHERE REGIONS OF SATURATED WASTE ARE SHOWN ABOVE 50 FEET MSL.

GEOSYNTEC CONSULTANTS
COLUMBIA, MARYLAND

PROJECT:	CHERRY ISLAND LANDFILL EXPANSION PROJECT
TITLE:	ESTIMATED ELEVATIONS OF SATURATED WASTE IN THE EXISTING LANDFILL
SCALE:	1" = 200'
PROJ. NO.:	ME2220
DATE:	JUNE 2002
FILE NO.:	02SOF013
FIGURE NO.	8



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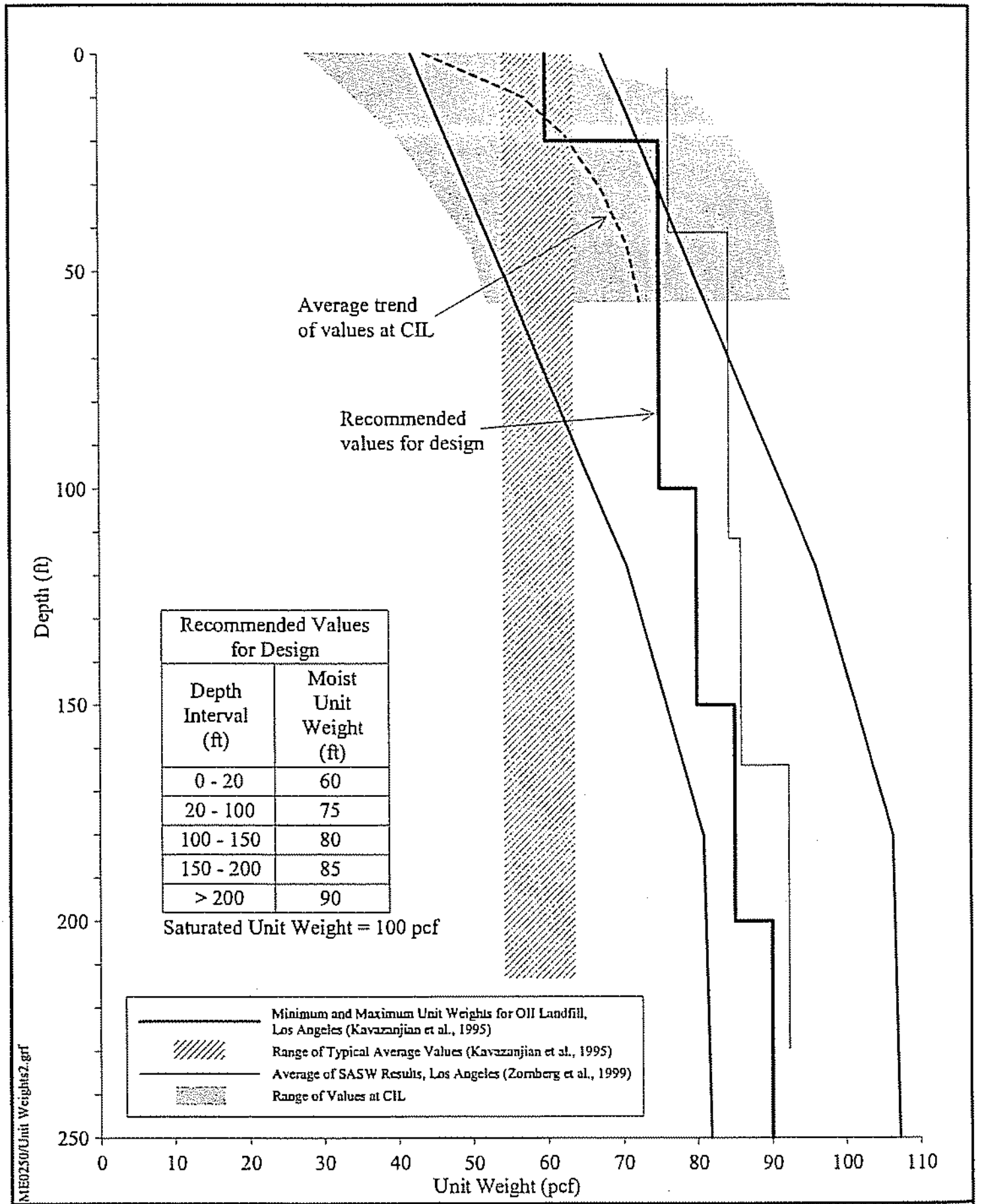
Columbia, Maryland 21046

Recommendations for Waste Unit Weight Variation with Depth - Existing Conditions

FIGURE 9-1

PROJECT: ME0250 Cherry Island Waste Characterization Report

ME0250/Unit Weights2.grf



Recommended Values for Design	
Depth Interval (ft)	Moist Unit Weight (ft)
0 - 20	60
20 - 100	75
100 - 150	80
150 - 200	85
> 200	90

Saturated Unit Weight = 100 pcf

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Recommended Waste Unit Weight Variation with Depth

FIGURE 9-2

PROJECT: ME0250
Cherry Island

APPENDICES

APPENDIX O-1

CALCULATION OF WASTE UNIT WEIGHT FROM SETTLEMENT PLATE AND TOTAL PRESSURE CELL DATA

GEOSYNTEC CONSULTANTS

COMPUTATION COVER SHEET

Client: DSWA **Project:** CIL **Project/Proposal #:** ME0250 **Task #:** 1.3.1

TITLE OF COMPUTATIONS CALCULATION OF IN-SITU UNIT WEIGHT OF MSW FROM SETTLEMENT PLATE AND TPC DATA – PHASE 5

COMPUTATIONS BY:
Signature
Printed Name and Title: Jeremy W.F. Morris, Senior Staff Engineer
DATE: 5/28/02

ASSUMPTIONS AND PROCEDURES CHECKED BY:
(Peer Reviewer)
Signature
Printed Name and Title: Douglas T. Mandeville, Senior Staff Engineer
DATE: 5/28/02

COMPUTATIONS CHECKED BY:
Signature
Printed Name and Title: Douglas T. Mandeville, Senior Staff Engineer
DATE: 5/28/02

COMPUTATIONS BACKCHECKED BY:
(Originator)
Signature
Printed Name and Title: Jeremy W.F. Morris, Senior Staff Engineer
DATE: 5/30/02

APPROVED BY:
(PM or Designate)
Signature
Printed Name and Title: R. David Espinoza, Senior Engineer
DATE: 5/30/02

APPROVAL NOTES:

REVISIONS (Number and initial all revisions)

NO.	SHEET	DATE	BY	CHECKED BY	APPROVAL

Written by: JWF MORRIS Date: 02/02/12 (YY/MM/DD) Reviewed by: Doug Mackenzie Date: 02/05/28 (YY/MM/DD)

Client: DSWA Project: CIL Project/Proposal No.: ME0250 Task No.: 1×3×1

1. Calculation of unit wt. of MSW (γ_{msw}) from settlement plate (SP) and total pressure cell (TPC) (or Total Stress Cell, TSC) data.

Assumptions

- Rework "Technical Evaluation" by WESTON (March, 1998)
  → Included as Attachment 1.
- Calculate γ_{msw} vs. Time for Phase IV and V, CIL.
- Require simultaneous SP and TPC readings.
- Methodology changes: (i) Discounting end-pt data used by WESTON for:
  TSCS-2A TSCS-3A TSCS-6A
  TSCS-2B TSCS-3B TSCS-6B
  – assumed to be erroneous

  (ii) Use method provided by Schnabel (see Attachment 2) for conversion of TPC field-measured values to actual pressures.

Locations: Only available at the following.

- Phase V SP5-1 SP5-3 SP5-9
  SP5-2 SP5-6 SP5-10
- Phase IV SP4-2

These locations are shown in Figure 1 of WCR.

Example Calculation: Settlement Plate S5-1 (ie SP5-1) on 7/31/97

- Sample TPC readings (psi) are given in Table 1.
- Sample SP readings (ft) are given in Table 2.

→ Closest TPC readings are 8/7/97. TPCS-1A = 6.1 psi

Written by: JWF Morris Date: 02/02/12 Reviewed by: D. Mondonic Date: [illegible]

Client: DSWA Project: CIL Project/Proposal No.: ME0250 Task No.: 1.3.1

Two cases are considered: (A) Soil Cover Thickness = 1-ft.

(B) Soil Cover Thickness = 25% of MSW lift.

Dimensions are shown in Figure 1.

Case (A) $(5.98' \times \gamma_{msw}\,pcf) + (1' \times 110\,pcf) + (1' \times 120\,pcf) + (1' \times 115\,pcf)$

$$= \left(\frac{6.1+5.7}{2}\right) psi \times 144\ in^2/ft^2$$

$$\longrightarrow \gamma_{msw} = 84.4\ pcf$$

Case (B) $(4.86' \times \gamma_{msw}\,pcf) + (2.12' \times 110\,pcf) + (1' \times 120\,pcf) + (1' \times 115\,pcf)$

$$= \left(\frac{6.1+5.7}{2}\right) psi \times 144\ in^2/ft^2$$

$$\longrightarrow \gamma_{msw} = 78.48\ pcf$$

Procedure repeated for all available SP and TPC data in GIS. It was assumed that the vertical profile of SP's in Phase V shown in Fig. 1 was also true for SP's in other phases (ie settlement plate is directly on top of LCS).

For in-place bulk density, γ_b:

Case (A) $\gamma_b = \left(\frac{5.98'}{1'+5.98'}\right) \times \gamma_{msw} + \left(\frac{1'}{1'+5.98'}\right) \times 110$

$$= 88.1\ pcf$$

Case (B) $\gamma_b = (\gamma_{msw} \times 0.75) + (110 \times 0.25)$

$$= 86.4\ pcf$$

DVM 5/28/02

3/24

INST_ID	ORTHIN	EASTING	Phase	DATE_READ	CALC_READING
P5_TPC_10A	627260	473162	P5	11-Apr-97	1.5
P5_TPC_10A	627260	473162	P5	10-Jul-97	1.6
P5_TPC_10A	627260	473162	P5	07-Aug-97	5
P5_TPC_10A	627260	473162	P5	06-Sep-97	5.5
P5_TPC_10A	627260	473162	P5	08-Oct-97	5.4
P5_TPC_10A	627260	473162	P5	09-Jan-98	5
P5_TPC_10B	627265	473165	P5	11-Apr-97	1.9
P5_TPC_10B	627265	473165	P5	10-Jul-97	2
P5_TPC_10B	627265	473165	P5	07-Aug-97	3.7
P5_TPC_10B	627265	473165	P5	06-Sep-97	4.3
P5_TPC_10B	627265	473165	P5	08-Oct-97	4.3
P5_TPC_10B	627265	473165	P5	09-Jan-98	4.3
P5_TPC_1A	628278	471499	P5	10-Jan-97	2.5
P5_TPC_1A	628278	471499	P5	12-Feb-97	5.8
P5_TPC_1A	628278	471499	P5	07-Mar-97	5.7
P5_TPC_1A	628278	471499	P5	08-Apr-97	6.1
P5_TPC_1A	628278	471499	P5	17-May-97	6.1
P5_TPC_1A	628278	471499	P5	09-Jun-97	5.9
P5_TPC_1A	628278	471499	P5	10-Jul-97	5.8
P5_TPC_1A	628278	471499	P5	07-Aug-97	6.1 ←
P5_TPC_1A	628278	471499	P5	06-Sep-97	6
P5_TPC_1A	628278	471499	P5	08-Oct-97	6
P5_TPC_1A	628278	471499	P5	09-Jan-98	6
P5_TPC_1B	628280	471495	P5	10-Jan-97	1.6
P5_TPC_1B	628280	471495	P5	12-Feb-97	5.6
P5_TPC_1B	628280	471495	P5	07-Mar-97	5.4
P5_TPC_1B	628280	471495	P5	08-Apr-97	5.8
P5_TPC_1B	628280	471495	P5	17-May-97	5.8
P5_TPC_1B	628280	471495	P5	09-Jun-97	5.2
P5_TPC_1B	628280	471495	P5	10-Jul-97	5
P5_TPC_1B	628280	471495	P5	07-Aug-97	5.7 ←
P5_TPC_1B	628280	471495	P5	06-Sep-97	5.1
P5_TPC_1B	628280	471495	P5	08-Oct-97	5.1
P5_TPC_1B	628280	471495	P5	09-Jan-98	5.1
P5_TPC_2A	627698	471646	P5	12-Feb-97	4.2
P5_TPC_2A	627698	471646	P5	07-Mar-97	5.5
P5_TPC_2A	627698	471646	P5	08-Apr-97	6.8
P5_TPC_2A	627698	471646	P5	17-May-97	6.7
P5_TPC_2A	627698	471646	P5	09-Jun-97	6.4
P5_TPC_2A	627698	471646	P5	10-Jul-97	6.4
P5_TPC_2A	627698	471646	P5	07-Aug-97	6.5
P5_TPC_2A	627698	471646	P5	06-Sep-97	6.2
P5_TPC_2A	627698	471646	P5	08-Oct-97	6
P5_TPC_2A	627698	471646	P5	09-Jan-98	10
P5_TPC_2B	627695	471640	P5	12-Feb-97	4.4
P5_TPC_2B	627695	471640	P5	07-Mar-97	3.9
P5_TPC_2B	627695	471640	P5	08-Apr-97	5.5
P5_TPC_2B	627695	471640	P5	17-May-97	5.5
P5_TPC_2B	627695	471640	P5	09-Jun-97	5.3
P5_TPC_2B	627695	471640	P5	10-Jul-97	5.4
P5_TPC_2B	627695	471640	P5	07-Aug-97	5.5

TABLE 1: TPC Readings, Phase 5 locations.
(Data from Schabel GIS)

AS-BUILT SUBGRADE ELEVATION

CONFIRMED WITH DUFFIELD THAT THIS IS ROD STICKUP, NOT GS ELEV.

NSWMC-2
PHASE V
SETTLEMENT OBSERVATION DATA TABLE

Data

Plate Number	Top of Rod Elevation / Total Settlement (feet) / Approximate Ground Surface Elevation[2]				
		04/04/97	07/31/97	10/17/97	01/02/98
S5-1	47.33	61.5 / 0	61.3 / 0.2 / 4.7	61.0 / 0.5 / 4.8	61.0 / 0.5 / 4.7
S5-2	47.12	61.4 / 0 / 7.2	61.2 / 0.2 / 7.5	61.0 / 0.4 / 7.4	60.9 / 0.5 / 7.4
S5-3	47.86		62.4 / 0 / 8.0	62.1 / 0.3 / 8.1	62.1 / 0.3 / 8.4
S5-4	48.09	62.1 / 0 / 4.7	62.0 / 0.1 / 4.1	61.7 / 0.4 / 4.4	61.7 / 0.4 / 4.4
S5-5	47.59	62.1 / 0 / 6.3	61.8 / 0.3 / 5.7	61.7 / 0.4 / 6.0	61.7 / 0.4 / 6.0
S5-6	47.28			62.0 / 0 / 4.4	62.1 / 0 / 4.6
S5-7	47.32		61.8 / 0 / 7.2	61.6 / 0.3 / 7.4	61.5 / 0.4 / 7.0
S5-8	46.84			61.0 / 0 / 4.3	61.1 / 0 / 4.6
S5-9	47.2		61.1 / 0 / 5.5	60.7 / 0.4 / 6.1	60.5 / 0.6 / 5.7
S5-10	47.22			65.2 / 0 / 9.4	65.2 / 0 / 9.8

TSC5-1A 1B

Notes:
1. See Settlement Plate location sketch for plate locations.
2. The approximate ground surface elevation has been calculated based on the top of settlement plate rod elevation and the amount of rod observed above the ground surface.

on as-built drawings

TABLE 2
(TABLE 1 of WESTON, 1998)

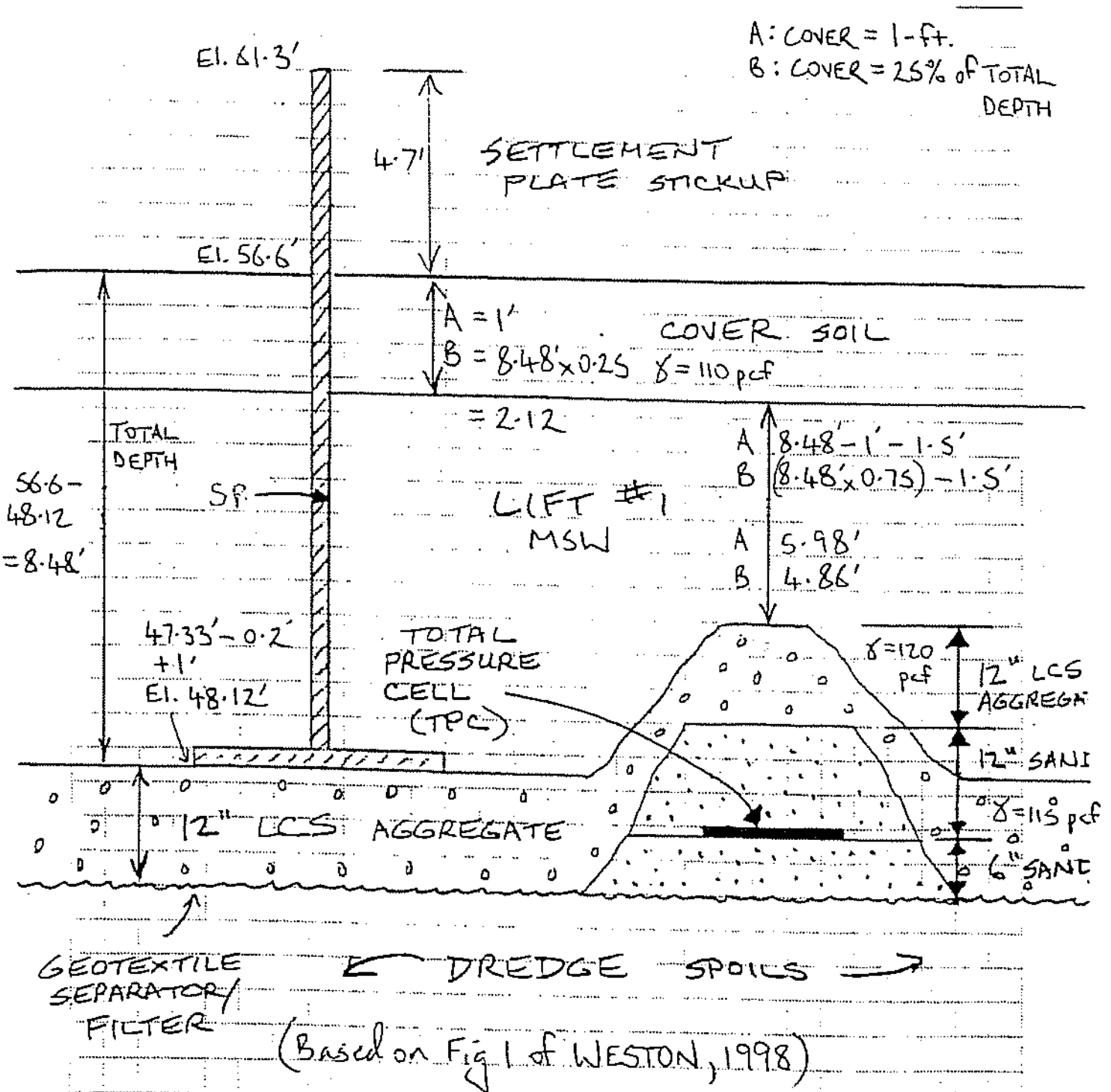
WO 630 GV
Duffield Associates, Inc
January 1998

EXCEL\NSWMC2\630GV05.XLS

4/24

DM 5/28/02

Figure 1: SS-1, data for 7/31/97 (see Table 2)



(Based on Fig 1 of WESTON, 1998)

Written by: JWF Morris Date: 02/02/18 (YY MM DD) Reviewed by: D. Mandeville Date: 02/05/18 (YY MM DD)

Client: DSWA Project: CIL Project/Proposal No.: ME0250 Task No.: 1.3.1

2. Calculation of: MSW depth
MSW surface elevation
Dredge spoil settlement
] vs. time for all Phases.

- MSW Surface elevation and settlement plate reading (ie dredge spoil settlement) given in GIS.
- SP initial base elevation from Construction Dwgs or Report.

At any time: Depth MSW = MSW surf. elev. − (SP initial base elev − SP reading
This depth includes any cover soil used.

3. Excel Spreadsheets used for calculations: P1_SP data
P2_SP data
P3_SP and TPC data
P4_SP and TPC data
P5_SP and TPC data.

In: MDENG/PROPOSALS/ME0250-CHERRY ISLAND/FIELD EXPL (2002)/SETTLE_DENSITY.

Spreadsheets list:
- location of SPs and TPCs
- Assumptions on SP/TPC elevation/position
- Source information
- SP base elevations
- All SP and TPC data in GIS to Oct 2001
- Plots of settlement, elevation, & γ_{MSW} vs. time

Note - P1_SP data includes SP data from 1986-90 from Gannett Fleming, Aug 1990 report,

Written by: JWF MORRIS Date: 02/02/13 (YY MM DD) Reviewed by: D. Mackenzie Date: 02/05/28 (YY MM DD)

Client: DSWA Project: CIL Project/Proposal No.: ME0250 Task No.: 1.3.1

- References

1. WESTON, INC. Technical evaluation of settlement plate/total stress cell (TSC) data, Phase IV and V Disposal Areas, Cherry Island Landfill W.O. No. 02477-007-001. Mar 24, 1998

2. SCHNABEL, INC. AND PENNONI. DSWA Cherry Island Landfill, Geotechnical Information System (GIS)

Written by: Jeremy Morris Date: 2/13/02 Reviewed by: [illegible] Date: 05/28/02

Client: DSWA Project: CIL Proj./Proposal No.: ME0250 Task No.: 1.3.1

ATTACHMENT 1

WESTON METHOD FOR CALCULATION
OF MSW UNIT WEIGHT

pM 5/28/02 9/24

WESTON

SHEET 1 of 4

CLIENT/SUBJECT _____ W.O. NO. _____

TASK DESCRIPTION _____ TASK NO. _____

PREPARED BY _____ DEPT _____ DATE _____

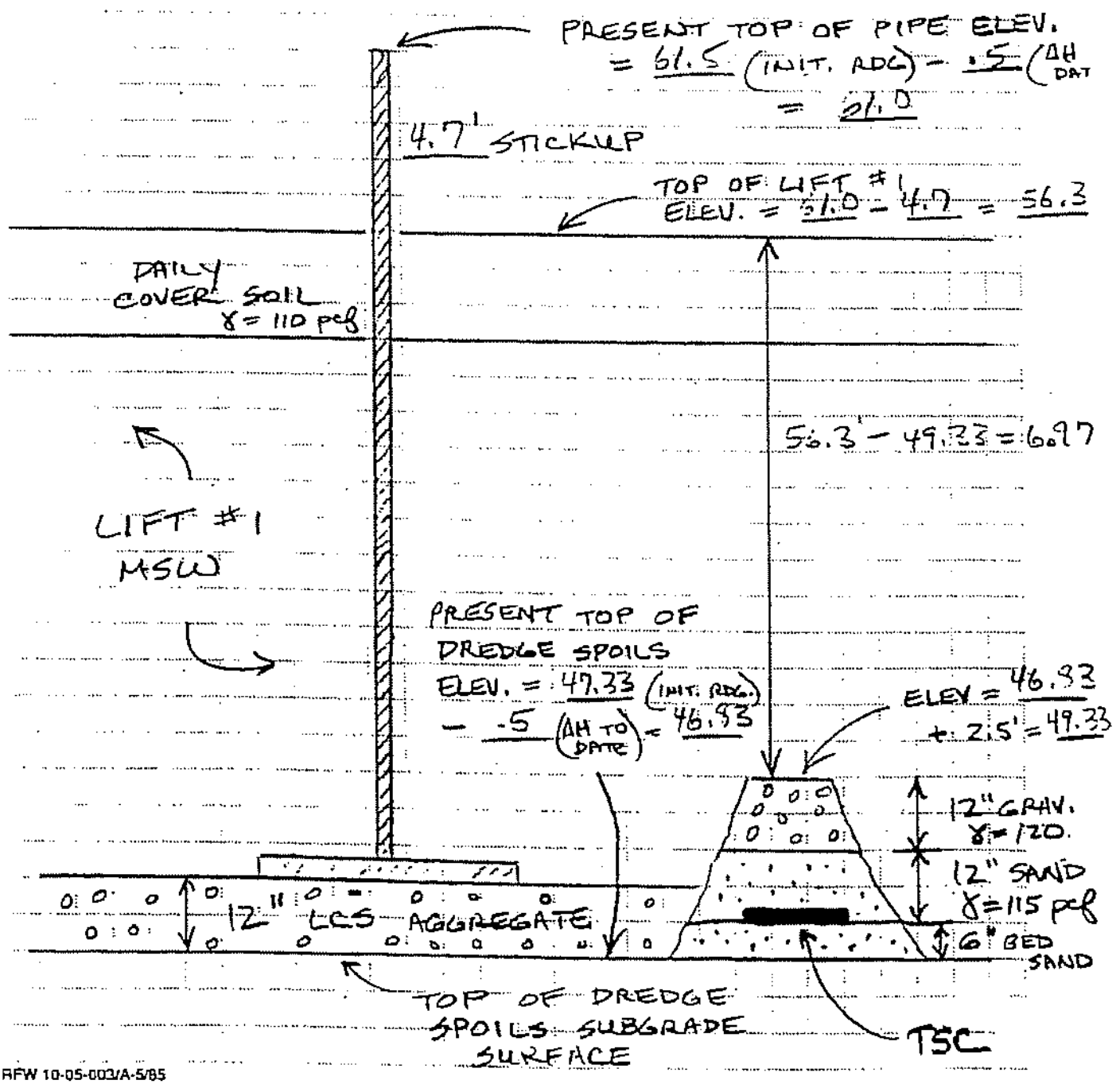
MATH CHECK BY _____ DEPT _____ DATE _____

METHOD REV. BY _____ DEPT _____ DATE _____

APPROVED BY _____ DEPT _____ DATE _____

ΔH PLATE SS-1 / TSCS-1A 1B

(BASED ON 1/2/98 DATA)



RFW 10-05-003/A-5/85
512-5543

D.M. 5/28/02 10/24

WESTON

SHEET 2 of 4

CLIENT/SUBJECT _____ W.O. NO. _____

TASK DESCRIPTION _____ TASK NO. _____

PREPARED BY _____ DEPT _____ DATE _____

MATH CHECK BY _____ DEPT _____ DATE _____

METHOD REV. BY _____ DEPT _____ DATE _____

APPROVED BY _____ DEPT _____ DATE _____

CALCULATION OF γ_{MSW}

I.) CASE 1: ASSUMES DAILY COVER SOIL THICKNESS = 12" = 1'

$$1'(110\,pcf) + (6.97 - 1')\gamma_{MSW} + 1'(120\,pcf) + 1'(115\,pcf) = 6.35\,psi \times 144\,in^2/ft^2$$

AVE OF TPSC 5-1A, B RDGS

$$\boxed{\gamma_{MSW} = 95.4\,pcf}$$

II.) CASE 2: ASSUMES DCS = 25% OF LIFT THICKNESS (LT)

$$LT = 56.3 - (46.83 + 1) = 8.47'$$

$$\therefore DCS = .25(8.47') = 2.12'$$

$$\therefore 2.12(110\,pcf) + (6.97' - 2.12')\gamma_{MSW} + 1'(120\,pcf) + 1'(115\,pcf) = 6.35 \times 144$$

$$\boxed{\gamma_{MSW} = 92.0\,pcf}$$

RFW 10-05-003/A-5/85
512-5543

NSWMC-2
PHASE V
TOTAL STRESS CELLS

Total Stress Cell No. [1]	Lab Zero Reading (psi) [2]	Pressure (psi) 01/03/97 [4]	01/10/97	02/12/97	03/07/97	04/08/97	04/11/97	05/17/97	06/09/97	07/10/97	08/07/97	09/06/97	10/08/97	01/09/98
Subcell V-4														
TSC5-1A	0.2	1.4	2.2	5.5	5.9	6.3	---	8.3	6.3	6.2	6.3	6.4	6.4	6.4
TSC5-1B	0.8	1.5	1.8	5.8	6.0	6.4	---	8.4	8.4	6.2	6.3	6.3	6.3	6.3
Subcell V-5														
TSC5-2A	0.4	1.6		3.5	5.2	6.6	—	6.5	6.5	6.5	6.2	6.3	6.1	10.4
TSC5-2B	0.2	1.6		4.3	4.1	5.8	---	5.8	5.8	5.8	5.7	5.7	5.6	10.1
Subcell V-6														
TSC5-3A	0.2	1.3			1.3	1.8	—	5.6	6.0	5.8	5.8	6.0	5.9	8.3
TSC5-3B	0.3	1.1			0.9	1.4	—	5.9	8.5	8.5	6.4	6.5	6.5	8.9
Subcell V-1														
TSC5-6A	0.8	2.4					3.0	—	—	2.6	2.7	2.7	5.6	7.3
TSC5-6B	0.6	1.7 [5]					2.0 [6]	—	—	2.1	1.9	2.2	6.4	7.2
Subcell V-3														
TSC5-9A	0.6	1.4					1.7	—	1.7	4.8	5.1	5.2	5.0	5.0
TSC5-9B	0.2	1.4					1.8	—	1.8	6.6	7.1	7.0	6.8	6.5
Subcell V-1														
TSC5-10A	0.1	1.1					1.5	—	—	1.7	5.2	5.9	5.8	5.4
TSC5-10B	0.1	1.5					1.9	—	—	2.0	3.7	4.5	4.5	4.5

NOTES:
1. Total Stress Cells are RST Instruments Total Earth Pressure Cell Model TP-101-P (12½-inch cell diameter) installed by Woodward-Clyde Consultants in October 1996 as part of the Phase V construction.
2. Lab zero readings reported in Woodward-Clyde's as-built data package.
3. Pressure = Field Pressure - Lab Zero Reading
4. Instruments monitored by Woodward-Clyde Consultants.
5. Reading collected by Woodward-Clyde on 12/27/96. Woodward-Clyde was unable to collect a reading on 1/3/97 from this instrument.
6. TSC5-6B was purged with nitrogen on 4/11/97 prior to monitoring. Purging was performed by Woodward-Clyde Consultants to attempt to remove moisture from the lines.

AS-BUILT SUBGRADE ELEVATION

CONFIRMED WITH DUFFIELD THAT THIS IS ROD STICKUP, NOT GS ELEV.

NSWMC-2
PHASE V
SETTLEMENT OBSERVATION DATA TABLE

Plate Number	Top of Rod Elevation / Total Settlement (feet) / Approximate Ground Surface Elevation[2]				
		04/04/97	07/31/97	10/17/97	01/02/98
S5-1	47.33	61.5 / 0	61.3 / 0.2 / 4.7	61.0 / 0.5 / 4.8	61.0 / 0.5 / 4.7
S5-2	47.12	61.4 / 0 / 7.2	61.2 / 0.2 / 7.5	61.0 / 0.4 / 7.4	60.9 / 0.5 / 7.4
S5-3	47.86		62.4 / 0 / 8.0	62.1 / 0.3 / 8.1	62.1 / 0.3 / 8.4
S5-4	48.04	62.1 / 0 / 4.7	62.0 / 0.1 / 4.1	61.7 / 0.4 / 4.4	61.7 / 0.4 / 4.4
S5-5	47.58	62.1 / 0 / 6.3	61.8 / 0.3 / 5.7	61.7 / 0.4 / 6.0	61.7 / 0.4 / 6.0
S5-6	47.28			62.0 / 0 / 4.4	62.1 / 0 / 4.6
S5-7	47.34		61.9 / 0 / 7.2	61.6 / 0.3 / 7.4	61.5 / 0.4 / 7.0
S5-8	46.84			61.0 / 0 / 4.3	61.1 / 0 / 4.6
S5-9	47.2		61.1 / 0 / 5.5	60.7 / 0.4 / 6.1	60.5 / 0.6 / 5.7
S5-10	47.22			65.2 / 0 / 9.4	65.2 / 0 / 9.8

TSC5-1A 1B

USE LATEST DATA IN ANALYSIS

Notes:
1. See Settlement Plate location sketch for plate locations.
2. The approximate ground surface elevation has been calculated based on the top of settlement plate rod elevation and the amount of rod observed above the ground surface.

on as-built drawings

12/24 4/4

W.O. 630.GV
Duffield Associates, Inc.
January 1998

EXCEL\NSWMC2\630GV05.XLS

ATTACHMENT 2

SCHNABEL METHOD FOR CORRECTION OF TPC READINGS

14/24

Schnabel

Schnabel Engineering Associates, Inc.

Schnabel Engineering Associates, Inc.
510 East Gay Street
West Chester, PA 19380
Phone: (610) 696-6066
Fax: (610) 696-7771

FACSIMILE TRANSMISSION COVER LETTER

FAX NO.:	410 381 4499	**DATE:**	2/6/02
PAGES	3 (including cover)	**JOB:**	CIL
COMPANY:	Geosyntec	**FROM:**	D Wilder
ATTN:	Jeremy Morris		

THESE ITEMS ARE TRANSMITTED AS CHECKED BELOW:

( ) For your action
( ) For approval
( ) As requested
( ) For review and comment
( ) For your use
( )

REMARKS:

Jeremy,
These are the conversion / calculations sheets that Gannett Fleming provided to us. I'll give you a call.

Darrell

HARD COPY BEING SENT VIA:
( ) First Class Mail ( ) Federal Express ( ) Messenger ( ) None

Connell Fleming
ENGINEERS AND PLANNERS

BY MLM DATE 7/98 CHKD. BY DATE

This is a revision to the equation established 1/98 DM 5/28/

2. Phases III & IV

$$L = \left(\frac{L_m + (T_m - T_c)0.005 - b}{m} \right) 0.93$$

where:

L_m = TPC reading (psi)

T_m = Temperature measured for thermistor adjacent to TPC (1) (°C)

T_c = Temperature used during TPC calibration (noted on TPC calibration sheets) (°C)

Note: use 19.4°C for TPC serial #'s: 21013, 21014, 21015, 21016

0.005 = TPC temperature calibration factor

b = y-intercept of "Indicated load vs. applied load" graph for each TPC

m = slope of "Indicated load vs. applied load" graph for each TPC

L = actual load (psi)

Calculated b and m are indicated on the attached page.

Note: (1) For center of cluster TPCs, use an average of thermistor readings for the 4 outer thermistors.

TPC Serial Number	TPC ID Number	Tc (Deg. C)	m	b
20997	TPC4-9	19.2	1.011	0.118
20998	TPC3-7	18.8	1.013	-0.091
20999	TPC3-1	19.2	1.005	0.138
21000	TPC3-5	19.2	1.012	-0.377
21001	TPC4-8	18.3	1.016	0.645
21002	TPC4-2	18.3	1.010	0.200
21003	TPC3-3	18.8	1.014	0.305
21004	TPC1-2	18.3	1.016	-0.569
21005	TPC3-6	18.8	1.013	-0.036
21006	TPC4-1	18.4	1.017	-0.429
21007	TPC3-8	18.8	1.014	0.109
21008	TPC4-3	18.4	1.007	0.332
21009	TPC3-10	18.8	1.012	0.214
21010	TPC4-4	19.7	1.008	-0.514
21011	TPC3-9	18.8	1.010	0.066
21012	TPC4-10	19.7	1.012	-0.214
21013	TPC3-4	19.4	1.017	0.073
21014	TPC4-5	19.4	1.015	-0.259
21015	TPC4-6	19.4	1.021	0.009
21016	TPC4-7	19.4	1.022	-0.123

Gannett Fleming
ENGINEERS AND PLANNERS

SUBJECT TPC Raw Data Correction
SHEET NO. 10 OF
JOB NO. 35158-102
BY MCH DATE 7/98 CHKD. BY DATE

3. Phase V

$$L = \left(\frac{L_m + (T_m - T_c)(0.005) - b}{m} \right) 0.93$$

TPC Serial Number	Tc (Deg. C)	m	b
TSC5-1A	17.3	1.016	-0.259
TSC5-1B	17.3	1.001	0.695
TSC5-2A	17.3	0.999	-0.409
TSC5-2B	17.3	0.996	-0.012
TSC5-3A	17.3	1.003	-0.214
TSC5-3B	17.3	0.999	-0.145
TSC5-6A	17.3	0.997	1.645
TSC5-6B	17.3	0.997	-0.738
TSC5-9A	17.3	1.002	-0.193
TSC5-9B	17.3	1.002	-0.522
TSC5-10A	17.3	1.002	-0.064
TSC5-10B	17.3	1.003	-0.166

T_m = measured temperature (°C)

L_m = uncorrected TPC reading (psi)

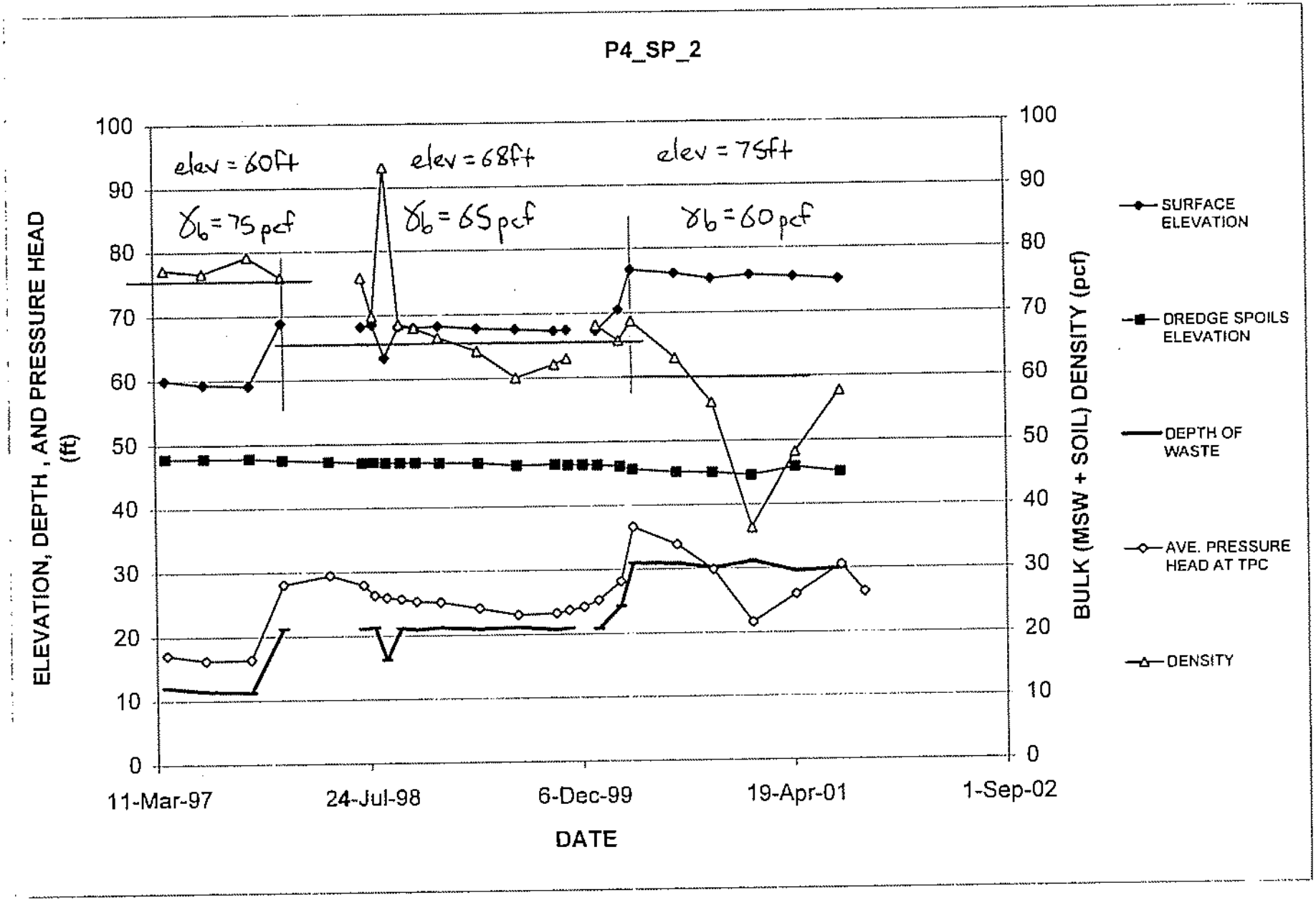
Written by: JWF Morris Date: 02/06/12 (YY/MM/DD) Reviewed by: C. Pendleton Date: 02/06/20 (YY/MM/DD)

Client: DSWA Project: CIL Project/Proposal No.: ME0250 Task No.: 1.3.4

ATTACHMENT 3

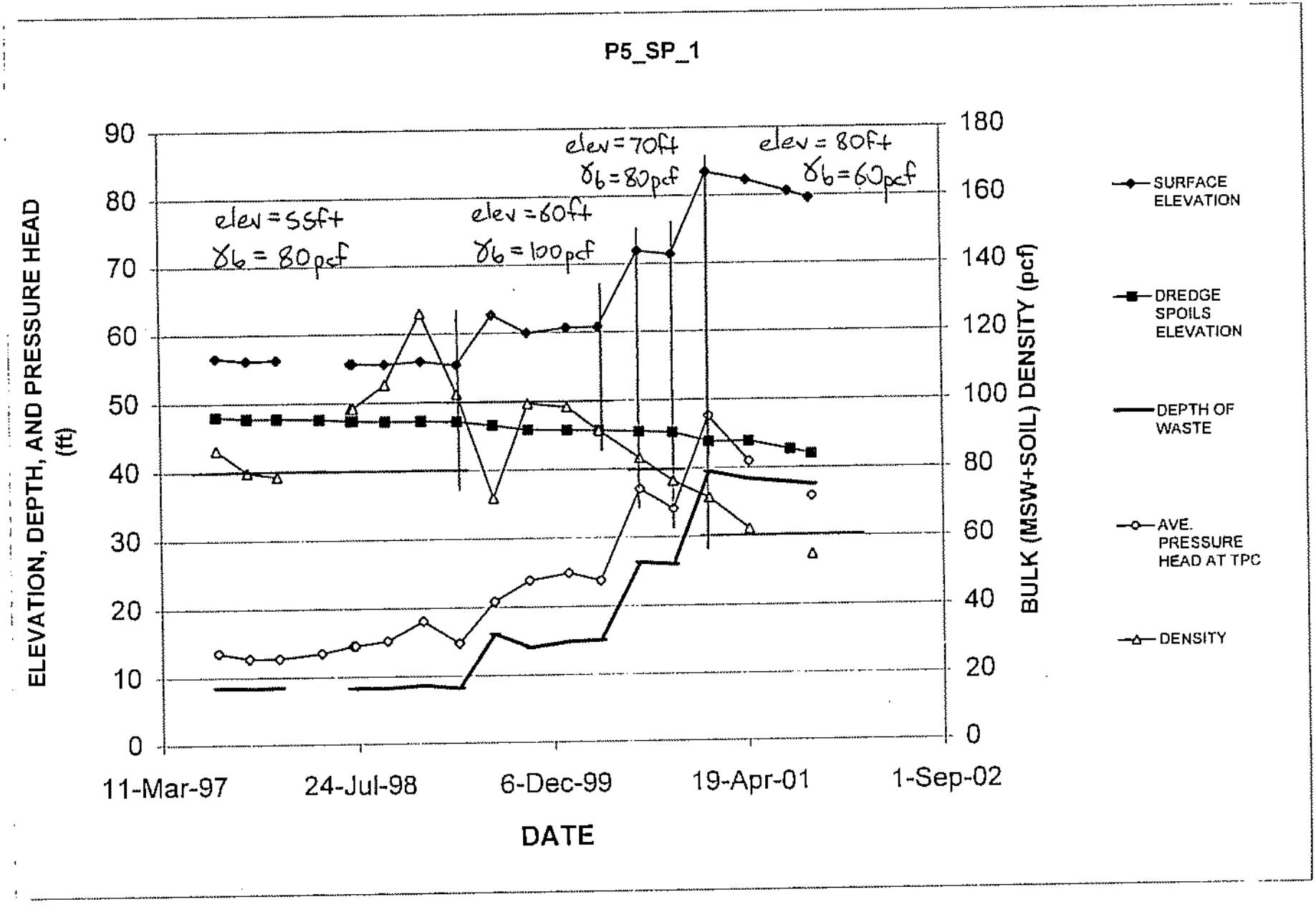
ESTIMATION OF WASTE SURFACE ELEVATION & UNIT WEIGHT

-TEMPORAL VARIATIONS


P4_SP_2
elev = 60ft
elev = 68ft
elev = 75ft
γ_b = 75 pcf
γ_b = 65 pcf
γ_b = 60 pcf
ELEVATION, DEPTH , AND PRESSURE HEAD (ft)
BULK (MSW + SOIL) DENSITY (pcf)
DATE
11-Mar-97
24-Jul-98
6-Dec-99
19-Apr-01
1-Sep-02
SURFACE ELEVATION
DREDGE SPOILS ELEVATION
DEPTH OF WASTE
AVE. PRESSURE HEAD AT TPC
DENSITY

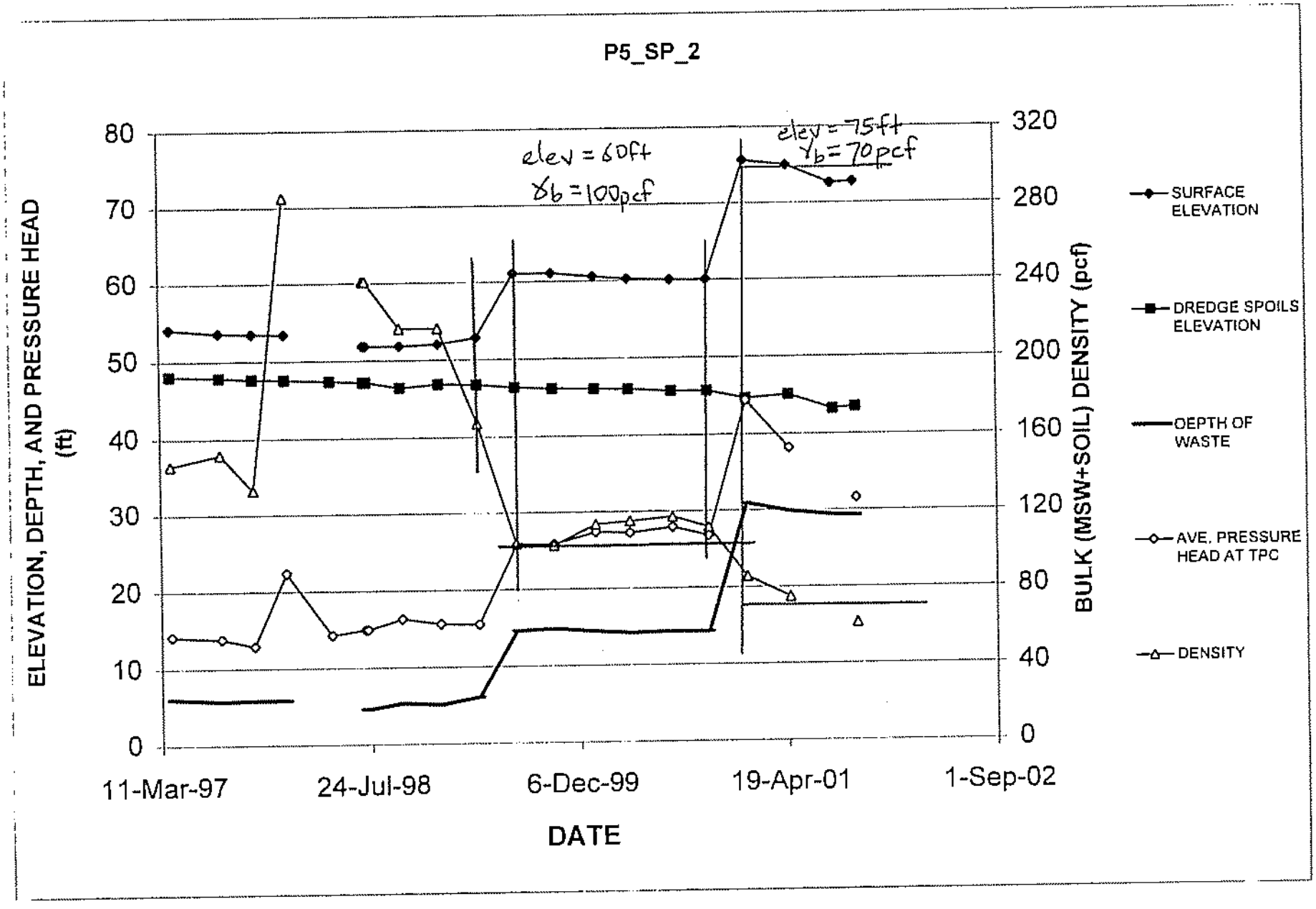
18/24

CHP

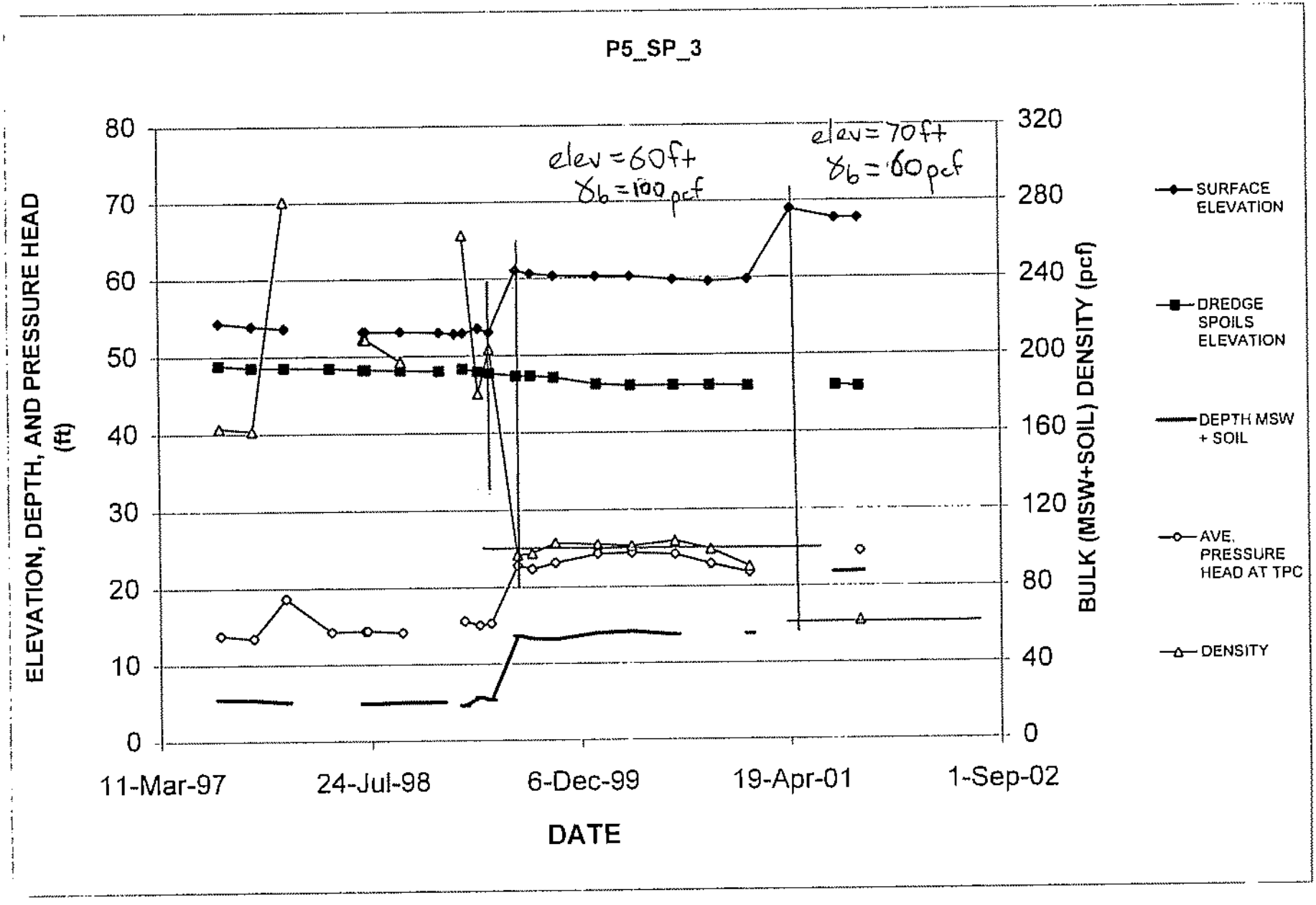

P5_SP_1
ELEVATION, DEPTH, AND PRESSURE HEAD (ft)
BULK (MSW+SOIL) DENSITY (pcf)
DATE
11-Mar-97
24-Jul-98
6-Dec-99
19-Apr-01
1-Sep-02
elev = 55ft
γb = 80pcf
elev = 60ft
γb = 100pcf
elev = 70ft
γb = 80pcf
elev = 80ft
γb = 60pcf
SURFACE ELEVATION
DREDGE SPOILS ELEVATION
DEPTH OF WASTE
AVE. PRESSURE HEAD AT TPC
DENSITY

19/24

cdp

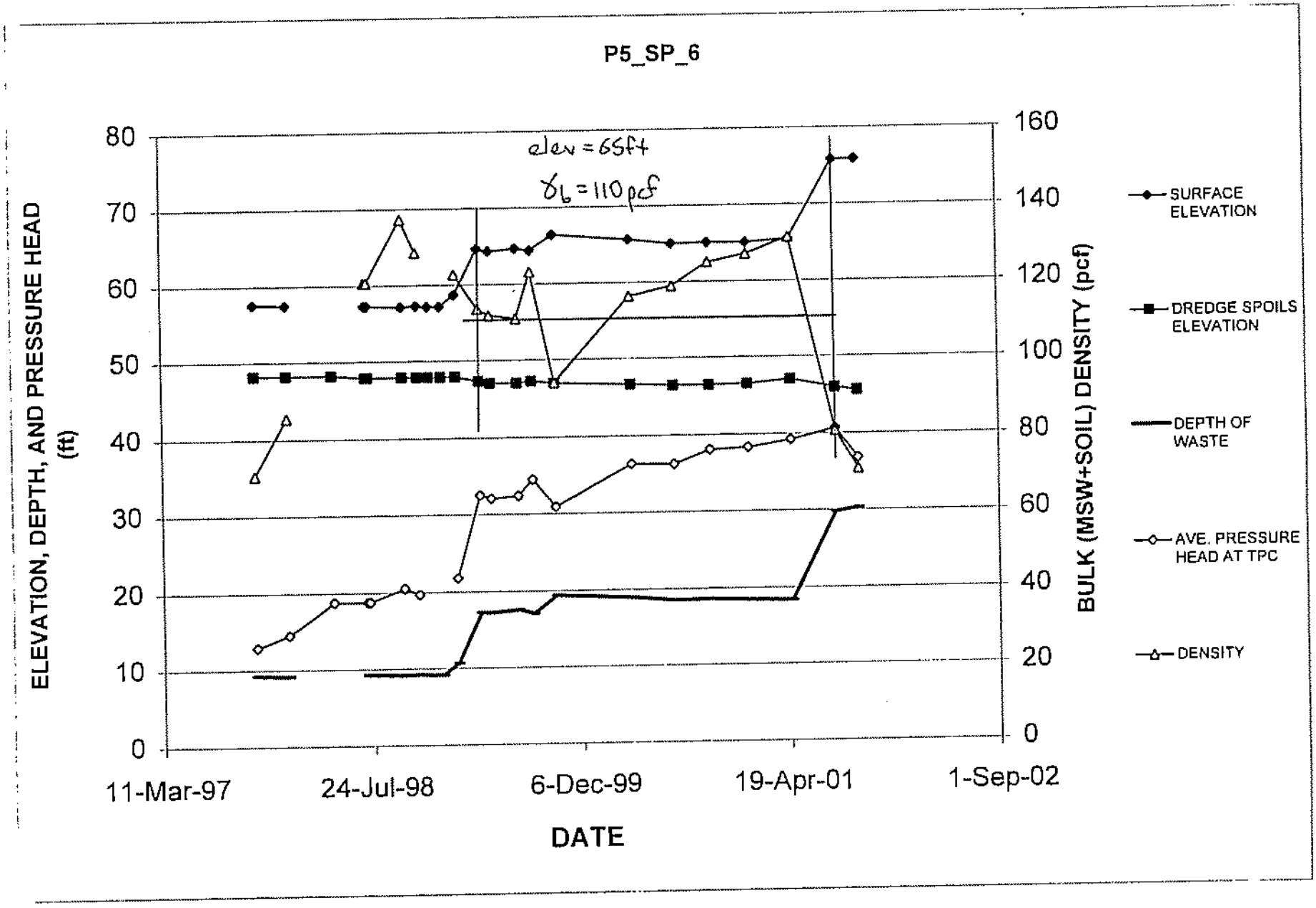

P5_SP_2
ELEVATION, DEPTH, AND PRESSURE HEAD (ft)
BULK (MSW+SOIL) DENSITY (pcf)
DATE
11-Mar-97
24-Jul-98
6-Dec-99
19-Apr-01
1-Sep-02
0
10
20
30
40
50
60
70
80
0
40
80
120
160
200
240
280
320
elev = 60ft
γb = 100pcf
elev = 75ft
γb = 70pcf
SURFACE ELEVATION
DREDGE SPOILS ELEVATION
DEPTH OF WASTE
AVE. PRESSURE HEAD AT TPC
DENSITY

20/24
CHP


P5_SP_3
ELEVATION, DEPTH, AND PRESSURE HEAD (ft)
BULK (MSW+SOIL) DENSITY (pcf)
DATE
11-Mar-97
24-Jul-98
6-Dec-99
19-Apr-01
1-Sep-02
0
10
20
30
40
50
60
70
80
0
40
80
120
160
200
240
280
320
elev = 60ft
γ_b = 100 pcf
elev = 70ft
γ_b = 60 pcf
SURFACE ELEVATION
DREDGE SPOILS ELEVATION
DEPTH MSW + SOIL
AVE. PRESSURE HEAD AT TPC
DENSITY

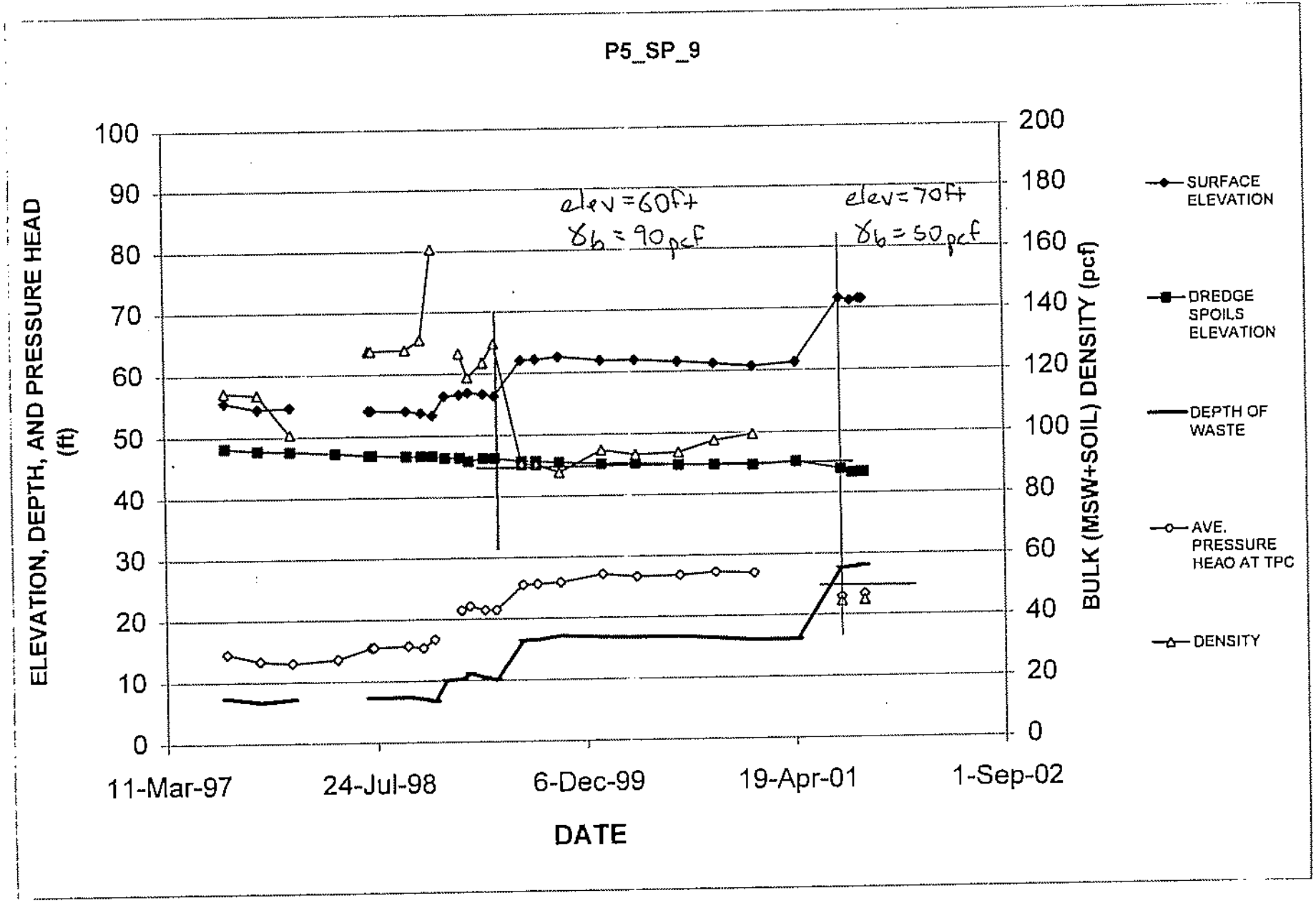
21/24

CHP


P5_SP_6
elev = 65ft
γ_b = 110 pcf
ELEVATION, DEPTH, AND PRESSURE HEAD (ft)
BULK (MSW+SOIL) DENSITY (pcf)
DATE
11-Mar-97
24-Jul-98
6-Dec-99
19-Apr-01
1-Sep-02
0
10
20
30
40
50
60
70
80
0
20
40
60
80
100
120
140
160
SURFACE ELEVATION
DREDGE SPOILS ELEVATION
DEPTH OF WASTE
AVE. PRESSURE HEAD AT TPC
DENSITY

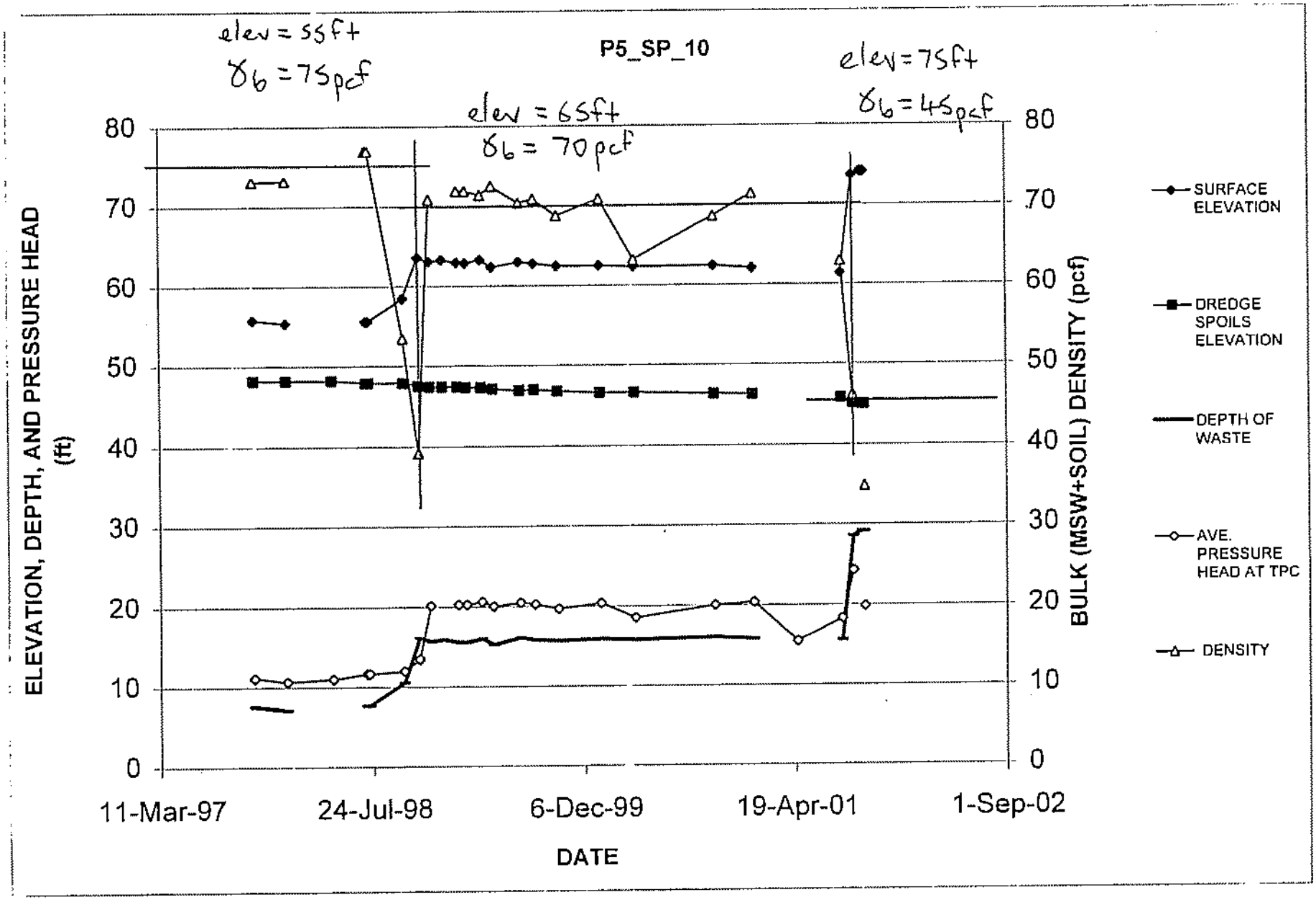
22/24

CHP


P5_SP_9
ELEVATION, DEPTH, AND PRESSURE HEAD (ft)
BULK (MSW+SOIL) DENSITY (pcf)
DATE
11-Mar-97
24-Jul-98
6-Dec-99
19-Apr-01
1-Sep-02
elev = 60ft
γ_b = 90pcf
elev = 70ft
γ_b = 50pcf
SURFACE ELEVATION
DREDGE SPOILS ELEVATION
DEPTH OF WASTE
AVE. PRESSURE HEAD AT TPC
DENSITY

23/24

CHP


P5_SP_10
elev = 55ft
γb = 75pcf
elev = 65ft
γb = 70pcf
elev = 75ft
γb = 45pcf
ELEVATION, DEPTH, AND PRESSURE HEAD (ft)
BULK (MSW+SOIL) DENSITY (pcf)
DATE
11-Mar-97
24-Jul-98
6-Dec-99
19-Apr-01
1-Sep-02
0
10
20
30
40
50
60
70
80
SURFACE ELEVATION
DREDGE SPOILS ELEVATION
DEPTH OF WASTE
AVE. PRESSURE HEAD AT TPC
DENSITY

24/24

dfp

APPENDIX O-2

CALCULATION OF WASTE UNIT WEIGHT FROM WASTE RECEIPT RECORDS AND AERIAL SURVEYS

GEOSYNTEC CONSULTANTS

COMPUTATION COVER SHEET

Client: DSWA **Project:** Cherry Island **Project/Task #:** ME0250 1.3.4

TITLE OF COMPUTATIONS UNIT WEIGHT CALCULATION FROM AERIAL SURVEY

COMPUTATIONS BY:
Signature Douglas T. Mandeville — 9/11/02 DATE
Printed Name and Title: Douglas T. Mandeville, Senior Staff Engineer

ASSUMPTIONS AND PROCEDURES CHECKED BY:
(Peer Reviewer)
Signature — 9/11/02 DATE
Printed Name and Title: Jeremy W.F. Morris, Engineer

COMPUTATIONS CHECKED BY:
Signature — 9/11/02 DATE
Printed Name and Title: Jeremy W.F. Morris, Engineer

COMPUTATIONS BACKCHECKED BY:
(Originator)
Signature Douglas T. Mandeville — 9/11/02 DATE
Printed Name and Title: Douglas T. Mandeville, Senior Staff Engineer

APPROVED BY:
(PM or Designate)
Signature — 9/11/02 DATE
Printed Name and Title: R. David Espinoza, Senior Engineer

APPROVAL NOTES:

REVISIONS (Number and initial all revisions)

NO.	SHEET	DATE	BY	CHECKED BY	APPROVAL

Written by: Doug Mandeville Date: 9/11/02 Reviewed by: Jeremy Morris Date: 9 / 11 / 02

Client: DSWA Project: Cherry Island Proj./Proposal No.: ME0250 Task No.: 1.3.4

UNIT WEIGHT CALCULATION FROM AERIAL SURVEY

PURPOSE

The purpose of this calculation is to evaluate the bulk unit weight of the waste and cover soil materials at the Cherry Island Landfill (CIL). The amount of waste and cover soil used in at CIL was obtained from operating records. The volume used at CIL was obtained from a series of aerial surveys of the site. Using this information, the bulk unit weight of the waste and cover soil was calculated on a cumulative basis for five time periods at the CIL. The bulk unit weight was calculated for the following time periods:

- Time period 1 - January 1985 to December 1997;
- Time period 2 - January 1985 to April 1999;
- Time period 3 - January 1985 to September 2000;
- Time period 4 - January 1985 to April 2001; and
- Time period 5 - January 1985 to April 2002.

METHOD OF ANALYSIS

Initial Filling to January 1998

The volume of airspace used was calculated using AutoCad computer software. AutoCad was used to create a 3-d surface of the 10 January 1998 ground contours and the assumed initial ground surface. For this calculation, it was assumed that the initial ground surface elevation (prior to waste filling) was approximately 22-ft MSL in Phase I/II and was approximately 40-ft MSL in Phase III/IV/V. The volume between these surveys was calculated using the grid method in AutoCad, a drawing sbowing the fill contours and the volume is included in Attachment I. Using the existing ground contours from aerial surveys only reflects the volume changes of the ground surface; settlement plate data was used to calculate the additional volume gained through settlement of the foundation soils. The average monthly settlement for Phase I/II and Phase III/IV/V was based on settlement plate data from March 1986 to January 1998 for Phase I/II and February 1994 to January 1998 for Phase III/IV/V. The average monthly settlement between for the selected time period was estimated to be 0.075 per month in Phase I/II and 0.04 ft per month in Phase III/IV/V. Details regarding the settlement rates can be found in Attachment II.

The amount of waste placed during this time period was obtained from Delaware Solid Waste Authority (DSWA) operating records. For this time period, the ratio of cover soil to waste was

estimated to be 1:1. This ratio was based on the operating records for the January 1998 to April 2002 time period. The cover soil was assumed to have a unit weight of 120 lbs/ft^3.

The bulk unit weight was calculated by dividing the total weight (obtained from operating records) by the total volume used (survey volume plus settlement volume). The weight, volume, and bulk unit weights were calculated separately for Phase I/II and Phase III/IV/V.

January 1998 to April 2002

For the January 1998 to April 2002 time period, the bulk unit weight of the waste and cover soils at the CIL was evaluated based on five aerial surveys between 1998 and 2002 and waste acceptance rates from Delaware Solid Waste Authority (DSWA) annual operating summaries between 1998 and 2002. AutoCad was used to create a 3-d surface of the ground contours for each survey listed below and the volume between successive surveys was calculated using the grid method in AutoCad. The aerial surveys used in this calculation were as follows:

- Jan 1998 (survey date 10 January 1998);
- April 1999 (survey date 24 April 1999);
- October 2000 (survey date 27 September 2000);
- April 2001 (survey date 3 April 2001); and
- April 2002 (survey date 3 April 2002).

Drawings showing the fill contours and the volumes between the consecutive surveys listed above are presented in Attachment I. Using the existing ground contours from aerial surveys only reflects the volume changes of the ground surface; settlement plate data was used to calculate the additional volume gained through settlement of the foundation soils. Settlement plate data from January 1998 to April 2001 was obtained from the existing GIS database for the CIL site. Figures 1 and 2, located in Attachment II, show a typical settlement curve in Phases II and IV, respectively. The settlement values all of the settlement plates in Phases I/II and III/IV/V were averaged and was found to equal 0.05 and 0.04 feet per month, respectively. The volume resulting from the settlement was added to the volume from the change in the ground surface. It should be noted that the Phase I/II and Phase III/IV/V volumes were calculated separately.

Operating records were reviewed to obtain the waste disposal rates and amount of daily and intermediate cover used during landfilling. The following operating reports, provided in Attachment III, were used in this calculation:

- 1998 Annual Operating Report, dated 1 March 1999;
- 1999 Annual Operating Report, dated 28 February 2000;
- 2000 Annual Operating Report, dated 18 January 2001; and
- 2001 Annual Operating Report, dated 7 February 2002.

The operating reports contained the monthly tonnages for the amount of waste and cover soils placed in Phase I/II and Phase III/IV/V. The following assumptions were made when calculating the amount of material placed in the landfill:

- Stabilized sludge had a unit weight of 110 lbs/ft^3;
- Cover soil had a unit weight of 120 lbs/ft^3;
- Intermediate cover was 12-inches thick;
- MSW and special wastes were added to Phase III/IV/V;
- Slag used for road building was included in the tonnages; and
- Daily cover was not re-used from one day to the next.

A detailed breakdown of the material placed in the landfill is provided in Table 1. It should be noted that the tonnages for Jan 2002 through April 2002 are based on the average waste and cover soil placement between May 2001 and December 2001. The information presented in this table summarizes the tonnages reported in the annual operating reports.

The total amount of material (i.e., both waste and cover soils) was divided by the total amount of volume used (i.e., the difference in the ground surface elevations and settlement of the foundation soils) to obtain an estimate for the in-place bulk unit weight. Based on the dates of the aerial surveys, unit weights for Phases I/II and Phases III/IV/V were calculated cumulatively for the following time periods presented earlier. As an example, time period 3 covers January 1985 to September 2000. The volume calculation associated with this time period includes the initial filling to January 1998 volume, the volume between the April 1999 and January 1999 survey, the volume between the October 2000 and April 1999 survey, the settlement of the landfill between January 1985 and September 2000, and the amount of waste and cover material placed in the landfill up to September 2000.

The bulk unit weight of waste was calculated on a cumulative basis because the actual volume of waste placed between each aerial survey event could not be determined. The calculated differences in landfill volume between each survey event could not take account of the settlement experienced in lower waste layers as a result of surcharge loading imposed by the placement of new waste layers above them. Whole-site settlement could, however, be calculated, and the localized reduction in landfill volume resulting from waste settlement appears as 'cut' in AutoCAD volume calculations. As would be expected,

the landfill areas experiencing most settlement are directly adjacent to areas of recent or active waste placement operations.

RESULTS AND CONCLUSIONS

Table 2 presents a summary of the unit weight calculations. The values presented in this table are cumulative. The unit weight in Phase I/II was found to decrease from 74 lbs/ft^3 for the period January 1985 to December 1997 to 66 lbs/ft^3 for the period January 1985 to April 2002. For the same time periods, the unit weight in Phase III/IV/V was found to increase from 43 lbs/ft^3 to 51 lbs/ft^3. Previous research indicates that the total unit weight of waste in a landfill can range from 22 lbs/ft^3 to 84 lbs/ft^3 and the dry unit weight can range from 12 lbs/ft^3 to 50 lbs/ft^3 [Fassett et al., 1994]. The values calculated in this analysis are therefore generally within ranges that have been previously measured.

REFERENCES

Delaware Solid Waste Authority, Cherry Island Landfill Operations Report for December 1998, dated March 1, 1999.

Delaware Solid Waste Authority, Cherry Island Landfill Operations Report for December 1999, dated February 28, 2000.

Delaware Solid Waste Authority, Cherry Island Landfill Operations Report for December 2000, dated January 18, 2001.

Delaware Solid Waste Authority, Cherry Island Landfill Operations Report for December 2001, dated February 7, 2002.

Fassett, J.B., Leonards, G.A., and Repetto, P.C., "Geotechnical Properties of Municipal Solid Wastes and Their Use in Landfill Design", Proceedings of Waste Tech 1994.

GeoSyntec drawing located in P:\cadd\0250\volumes\1998-eg.dwg, 1998 existing ground aerial survey, date of survey January 10, 1998.

GeoSyntec drawing located in P:\cadd\0250\volumes\1999-eg.dwg, 1999 existing ground aerial survey, date of survey April 24, 1999.

GeoSyntec drawing located in P:\cadd\0250\volumes\2000-eg.dwg, 2000 existing ground aerial survey, date of survey September 27, 2000.

GeoSyntec drawing located in P:\cadd\0250\volumes\2001-eg.dwg, 2001 existing ground aerial survey, date of survey 3 April 2001.

GeoSyntec drawing located in P:\cadd\0250\volumes\2002-eg.dwg, 2002 existing ground aerial survey, date of survey 3 April 2002.

the landfill areas experiencing most settlement are directly adjacent to areas of recent or active waste placement operations.

RESULTS AND CONCLUSIONS

Table 2 presents a summary of the unit weight calculations. The values presented in this table are cumulative. The unit weight in Phase I/II was found to decrease from 79 lbs/ft^3 for the period January 1985 to December 1997 to 76 lbs/ft^3 for the period January 1985 to April 2002. For the same time periods, the unit weight in Phase III/IV/V was found to increase from 47 lbs/ft^3 to 59 lbs/ft^3. Previous research indicates that the total unit weight of waste in a landfill can range from 22 lbs/ft^3 to 84 lbs/ft^3 and the dry unit weight can range from 12 lbs/ft^3 to 50 lbs/ft^3 [Fassett et al., 1994]. The values calculated in this analysis are therefore generally within ranges that have been previously measured.

Table 1
Detailed Placement Records and Unit Weight Calculations
DSWA - CIL Expansion Project

	Phase III/IV/V - Mass										Phase I/II - Mass							All Phases - Volume														All Phases - Unit Weight			
	MSW Tonnage into Phase III/IV/V	Daily Cover - Slope (tons)	Daily Cover - Top (tons)	Intermediate Cover (tons)	Total Cover (tons)	Slag into Phase III/IV/V	Monthly Total Material placed in Phase III/IV/V (tons) (MSW+Cover+slag)	Percent Waste (by weight) in Phase III/IV/V	Percent Non-waste (by weight) in Phase III/IV/V	Cumulative total of material placed in Phases III/IV/V (tons)	Waste into Phase I/II (tons)	Slag into Phase I/II (tons)	Total Cover (tons)	Monthly total material placed in Phase I/II (tons) (Waste+slag+cover)	Percent Waste (by weight)	Percent Non-waste (by weight)	Cumulative total of material placed in Phases I/II (tons)	Total Volume (cy)	Phase I/II Volume (cy)	Phase III/IV/V Volume (cy)	Average Monthly Settlement Phase I/II (ft)	Average Monthly Settlement Phase III/IV/V (ft)	Months	Phase I/II Area (sf)	Phase III/IV/V Area (sf)	Cumulative Volume due to settlement Phase I/II (cy)	Cumulative Volume due to settlement Phase III/IV/V (cy)	Total Volume in Phase I/II (cy)	Total Volume in Phase III/IV/V (cy)	Unit Weight in Phase I/II (tons/cy)	Unit Weight in Phase III/IV/V (tons/cy)	Unit Weight in Phase I/II (lbs/cf)	Unit Weight in Phase III/IV/V (lbs/cf)
Jan 85 to Dec 97	1775400	0	0	0	1775400	0	3550800	50.00	50.00	3,550,800	3289000	0	3289000	6578000	50	50	6,578,000	10,161,000	5,350,000	4,811,000	0.075	0.04	143	3,146,573	6,353,680	1,249,889	1,346,039	6,599,889	6,157,039	1.00	0.58	73.83	42.72
Jan-98	20,963	1,672	6,009	1,017	10,698	0	31,661	66.21	33.79	3,582,461	289	0	0	289	100	0	6,578,289																	
Feb-98	13,544	1,361	5,851	808	8,021	0	21,565	62.81	37.19	3,604,026	213	0	0	213	100	0	6,578,502																	
Mar-98	16,910	1,128	7,737	8,358	17,222	0	34,132	49.54	50.46	3,638,158	272	0	0	272	100	0	6,578,774																	
Apr-98	22,088	797	10,310	9,785	20,892	0	42,980	51.39	48.61	3,681,138	198	0	0	198	100	0	6,578,972																	
May-98	22,305	350	10,848	4,499	15,696	0	38,001	58.70	41.30	3,719,139	274	0	0	274	100	0	6,579,246																	
Jun-98	22,131	1,983	10,614	4,241	16,838	0	38,969	56.79	43.21	3,758,108	340	0	0	340	100	0	6,579,586																	
Jul-98	21,739	700	9,020	492	10,212	0	31,951	68.04	31.96	3,790,060	525	0	0	525	100	0	6,580,111																	
Aug-98	18,778	1,458	7,737	0	9,195	0	27,973	67.13	32.87	3,818,033	372	0	0	372	100	0	6,580,483																	
Sep-98	21,556	0	13,284	0	13,284	0	34,840	61.87	38.13	3,852,873	258	0	0	258	100	0	6,580,741																	
Oct-98	21,321	9,078	15,947	2,216	27,242	0	48,563	43.90	56.10	3,901,436	423	0	0	423	100	0	6,581,164																	
Nov-98	20,255	10,284	10,595	0	20,879	0	41,134	49.24	50.76	3,942,569	443	0	0	443	100	0	6,581,607																	
Dec-98	19,644	15,260	18,837	0	34,098	0	53,742	36.55	63.45	3,996,311	195	0	0	195	100	0	6,581,802																	
Jan-99	23,801	12,851	14,286	0	27,137	3,832	54,769	43.46	56.54	4,051,081	188	534	3,671	4,392	4.27	95.73	6,586,194																	
Feb-99	20,647	6,678	12,354	2,232	21,264	4,331	46,242	44.65	55.35	4,097,323	105	544	2,085	2,735	3.85	96.15	6,588,929																	
Mar-99	33,169	12,441	21,312	4,204	37,957	1,087	72,213	45.93	54.07	4,169,536	117	684	3,286	4,088	2.86	97.14	6,593,017																	
Apr-99	45,221	20,260	26,004	2,696	48,960	0	94,180	48.01	51.99	4,263,716	172	981	5,322	6,475	2.65	97.35	6,599,492	11,032,471	5,386,586	5,645,885	0.05	0.04	16	3,146,573	6,353,880	1,343,121	1,496,645	6,729,707	7,142,530	0.98	0.60	72.64	44.22
May-99	45,105	28,649	15,809	363	44,820	1,120	91,045	49.54	50.46	4,354,761	231	780	3,389	4,400	5.26	94.74	6,603,891																	
Jun-99	47,453	30,210	22,964	0	53,174	1,885	102,512	46.29	53.71	4,457,273	378	749	4,387	5,513	6.86	93.14	6,609,405																	
Jul-99	41,493	17,439	24,538	0	41,977	1,986	85,456	48.55	51.45	4,542,729	642	869	4,975	6,486	9.89	90.11	6,615,891																	
Aug-99	42,684	6,500	28,190	0	34,690	3,275	80,649	52.93	47.07	4,623,378	550	1,226	4,188	5,964	9.23	90.77	6,621,855																	
Sep-99	49,070	10,691	26,604	0	37,295	7,231	93,596	52.43	47.57	4,716,974	241	403	2,138	2,782	8.66	91.34	6,624,637																	
Oct-99	43,241	10,094	27,752	0	37,846	3,582	84,669	51.07	48.93	4,801,642	196	633	2,138	2,967	6.62	93.38	6,627,604																	
Nov-99	45,519	11,004	26,756	0	37,760	5,345	88,624	51.36	48.64	4,890,267	212	732	2,299	3,243	6.54	93.46	6,630,847																	
Dec-99	42,808	16,683	42,104	1,477	60,264	6,828	109,900	38.95	61.05	5,000,166	161	371	1,693	2,225	7.24	92.76	6,633,072																	
Jan-00	35,142	10,252	31,162	0	41,414	5,310	81,867	42.93	57.07	5,082,033	74	210	1,426	1,709	4.33	95.67	6,634,781																	
Feb-00	36,671	7,567	33,729	0	41,295	7,814	85,581	42.85	57.15	5,167,614	246	500	2,922	3,668	6.70	93.30	6,638,450																	
Mar-00	45,296	11,333	39,969	0	51,302	4,231	100,829	44.92	55.08	5,268,443	201	236	2,014	2,451	8.19	91.81	6,640,900																	
Apr-00	42,442	11,333	18,932	0	30,265	8,515	81,222	52.25	47.75	5,349,665	145	602	1,818	2,565	5.67	94.33	6,643,466																	
May-00	51,971	11,731	23,523	0	35,255	5,217	92,443	56.22	43.78	5,442,108	249	527	2,388	3,163	7.86	92.14	6,646,629																	
Jun-00	49,328	13,297	35,674	0	48,971	7,858	106,157	46.47	53.53	5,548,265	458	661	3,956	5,075	9.03	90.97	6,651,704																	
Jul-00	44,297	13,079	20,157	0	33,236	5,613	83,145	53.28	46.72	5,631,411	685	486	4,883	6,054	11.32	88.68	6,657,759																	
Aug-00	49,487	13,885	25,124	0	39,009	3,809	92,305	53.61	46.39	5,723,716	568	820	4,312	5,700	9.96	90.04	6,663,459																	
Sep-00	43,416	9,263	22,109	0	31,372	4,173	78,961	54.98	45.02	5,802,677	559	501	5,257	6,317	8.86	91.14	6,669,776	12,228,628	5,430,758	6,797,871	0.05	0.04	32	3,146,573	6,353,680	1,529,584	1,797,856	6,960,342	8,595,727	0.96	0.68	70.98	50.00
Oct-00	44,052	9,262	35,993	0	45,256	3,121	92,429	47.66	52.34	5,895,106	624	881	5,934	7,439	8.38	91.62	6,677,215																	
Nov-00	43,375	7,895	32,915	0	40,811	2,214	86,400	50.20	49.80	5,981,506	551	684	5,186	6,420	8.58	91.42	6,683,636																	
Dec-00	38,409	6,399	22,553	0	28,951	1,296	68,657	55.94	44.06	6,050,162	527	760	4,206	5,492	9.60	90.40	6,689,128																	
Jan-01	40,165	7,567	32,805	0	40,373	5,994	86,531	46.42	53.58	6,136,694	543	1,343	4,527	6,412	8.47	91.53	6,695,541																	
Feb-01	36,203	3,849	27,280	0	31,129	10,000	77,332	46.81	53.19	6,214,026	596	640	6,179	7,415	8.03	91.97	6,702,956																	
Mar-01	41,432	2,749	24,291	0	27,039	11,734	80,205	51.66	48.34	6,294,231	786	940	6,942	8,668	9.07	90.93	6,711,624																	
Apr-01	46,566	6,681	26,845	0	33,527	3,202	83,294	55.91	44.09	6,377,525	577	645	6,214	7,436	7.76	92.24	6,719,060	12,746,020	5,492,128	7,253,892	0.05	0.04	39	3,146,573	6,353,680	1,756,837	2,164,958	7,248,965	9,418,850	0.93	0.68	68.66	50.16
May-01	50,567	7,422	37,404	0	44,826	5,599	100,992	50.07	49.93	6,478,517	537	878	8,196	9,610	5.58	94.42	6,728,670																	
Jun-01	49,378	9,594	35,926	0	45,521	7,741	102,640	48.11	51.89	6,581,157	527	666	4,755	5,947	8.86	91.14	6,734,617																	
Jul-01	47,003	7,972	32,814	0	40,786	6,337	94,127	49.94	50.06	6,675,284	643	806	7,468	8,918	7.22	92.78	6,743,535																	
Aug-01	47,896	10,585	33,393	0	43,978	2,908	94,782	50.53	49.47	6,770,065	374	713	4,084	5,171	7.23	92.77	6,748,706																	
Sep-01	43,992	9,564	22,783	0	32,347	3,124	79,462	55.36	44.64	6,849,528	390	196	3,281	3,868	10.08	89.92	6,752,572																	
Oct-01	49,514	11,964	28,252	0	40,215	2,233	91,962	53.84	46.16	6,941,489	257	666	3,757	4,679	5.49	94.51	6,757,251																	
Nov-01	46,879	9,770	29,002	0	38,772	3,423	89,074	52.63	47.37	7,030,564	448	487	5,689	6,624	6.76	93.24	6,763,875																	
Dec-01	42,970	8,604	21,449	0	30,052	3,820	76,842	55.92	44.08	7,107,405	237	538	3,597	4,372	5.43	94.57	6,768,248																	
Jan-02 *	47,275	9,434	30,128	0	39,562	4,398	91,235	51.82	48.18	7,198,640	427	619	5,103	6,148	6.94	93.06	6,774,396																	
Feb-02 *	47,275	9,434	30,128	0	39,562	4,398	91,235	51.82	48.18	7,289,876	427	619	5,103	6,148	6.94	93.06	6,780,544																	
Mar-02 *	47,275	9,434	30,128	0	39,562	4,398	91,235	51.82	48.18	7,381,111	427	619	5,103	6,148	6.94	93.06	6,786,693																	
Apr-02 *	47,275	9,434	30,128	0	39,562	4,398	91,235	51.82	48.18	7,472,346	427	619	5,103	6,148	6.94	93.06	6,792,841	13,580,507	5,514,441	8,066,066	0.05	0.05	51	3,146,573	6,353,680	2,054,013	2,765,027	7,568,454	10,831,093	0.90	0.69	66.48	51.10

* - for these months, the waste placement was taken to be the average between May 01 and Dec 01

Table 2
Unit Weight Calculations from Aerial Survey and Operating Records
DSWA - CIL Expansion Project

Phase I/II

Time Period	Total Mass Placed in Phase I/II (lbs)	Settlement Volume (ft^3)	Survey Volume (ft^3)	Total Volume Used in Phase I/II (ft^3)	Unit Weight in Phase I/II (lbs/ft^3)
1. Jan 1985 to December 1997	13,156,000,000	22,497,999	144,450,000	166,947,999	79
2. Jan 1985 to April 1999	13,198,983,410	25,015,257	145,437,822	170,453,079	77
3. Jan 1985 to September 2000	13,339,552,270	27,532,516	146,630,466	174,162,982	77
4. Jan 1985 to April 2001	13,438,119,870	28,633,816	148,287,456	176,921,272	76
5. Jan 1985 to April 2002	13,585,682,580	30,521,760	148,889,907	179,411,667	76

Phase III/IV/V

Time Period	Total Mass Placed in Phase III/IV/V (lbs)	Settlement Volume (ft^3)	Survey Volume (ft^3)	Total Volume Used in Phase III/IV/V (ft^3)	Unit Weight in Phase III/IV/V (lbs/ft^3)
1. Jan 1992 to December 1997	7,101,600,000	21,094,218	129,897,000	150,991,218	47
2. Jan 1992 to April 1999	8,527,432,680	25,160,573	152,438,895	177,599,468	48
3. Jan 1992 to September 2000	11,605,354,140	29,226,929	183,542,517	212,769,446	55
4. Jan 1992 to April 2001	12,755,049,520	31,005,959	195,855,084	226,861,043	56
5. Jan 1992 to April 2002	14,944,691,380	34,818,167	217,783,782	252,601,949	59

ATTACHMENT I

☐ GEOSYNTEC CONSULTANTS

CADD Volume Calculation

CADD Operator: Doug M Date: 02, 02, 14 (YY MM DD) Reviewed by: _____ Date: / / (YY MM DD)

Client: DSWA Project: CIL Project No.: ME0250 Task No.: 221

Description of volume to be calculated:

~~Area~~ assumed existing ground before any filling occurred (Phase 1/2 at 22 ft msl, Phase 3,4,5 at 40 ft msl) and 1998 topo

Softdesk Project Name: 0250

Surface Generation:

Surface 1 (Surface existing first):

Source of Grading (Contours, Points, Faults)

Filename: 1998-eg

Surface Name: surf

Description: surface before filling

Surface 2 (Resulting from cut and fill on Surface 1):

Source of Grading (Contours, Points, Faults)

Filename: 1998-eg

Surface Name: sur-1

Description: 1998 existing ground

Contours generated from surfaces 1 and 2 checked by (initial): _____ Plots attached: yes no

Site Information:

Site Name: 0250v6

Confirm that site limits are appropriate for smallest surface (Initial): _____

Site Approximate Dimensions: Length = _____ Width = _____

Grid Size: 10x10

Results:

Cut-Fill Surface:

Stratum Name: vol6 Description: grid volume for vol 5

Volume Surface Name (typically same as Stratum Name): vol6

Cut and fill contours checked by (initial): _____ Plot attached: yes no

Volume:

Units: m^3 (yd^3)

Cut = ~~[illegible]~~ 4009	Fill = 1045338	Net = 1045329	Cut Fill

Notes:

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Site Volume Table: Unadjusted

Site	Stratum	Surf1	Surf2	Cut yards	Fill yards	Net yards	Method
0250v6	vol5	surfp	sur1	4009	10457338	10453329 (F)	Grid

Subsite Volume Table: Unadjusted

Subsite	Stratum	Surf1	Surf2	Cut yards	Fill yards	Net yards	
12	vol5	surfp	sur1	129	5350074	5349945 (F)	— Phases I & II
13	vol5	surfp	sur1	0	4811175	4811175 (F)	— Phases III, IV, & V

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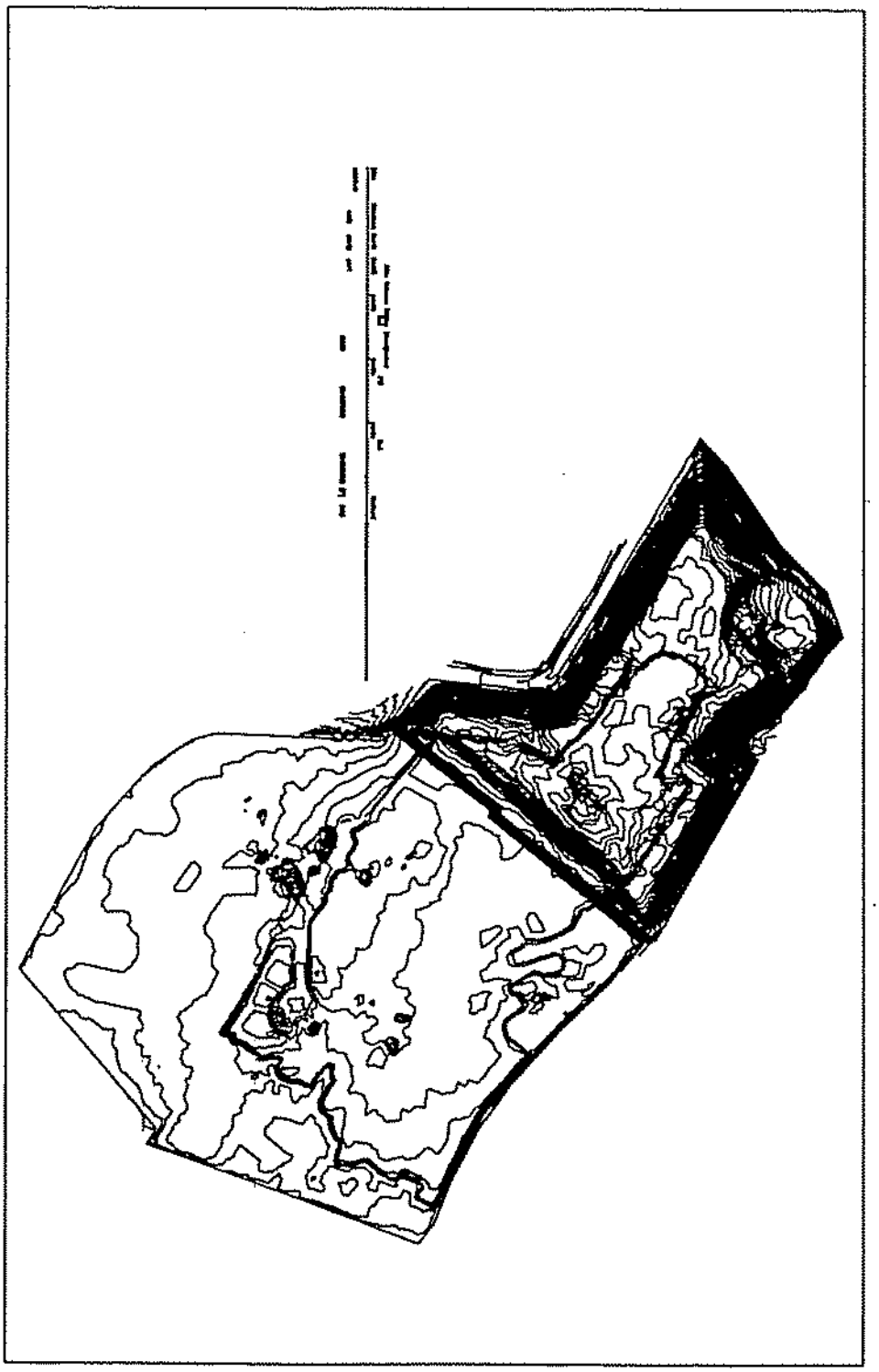

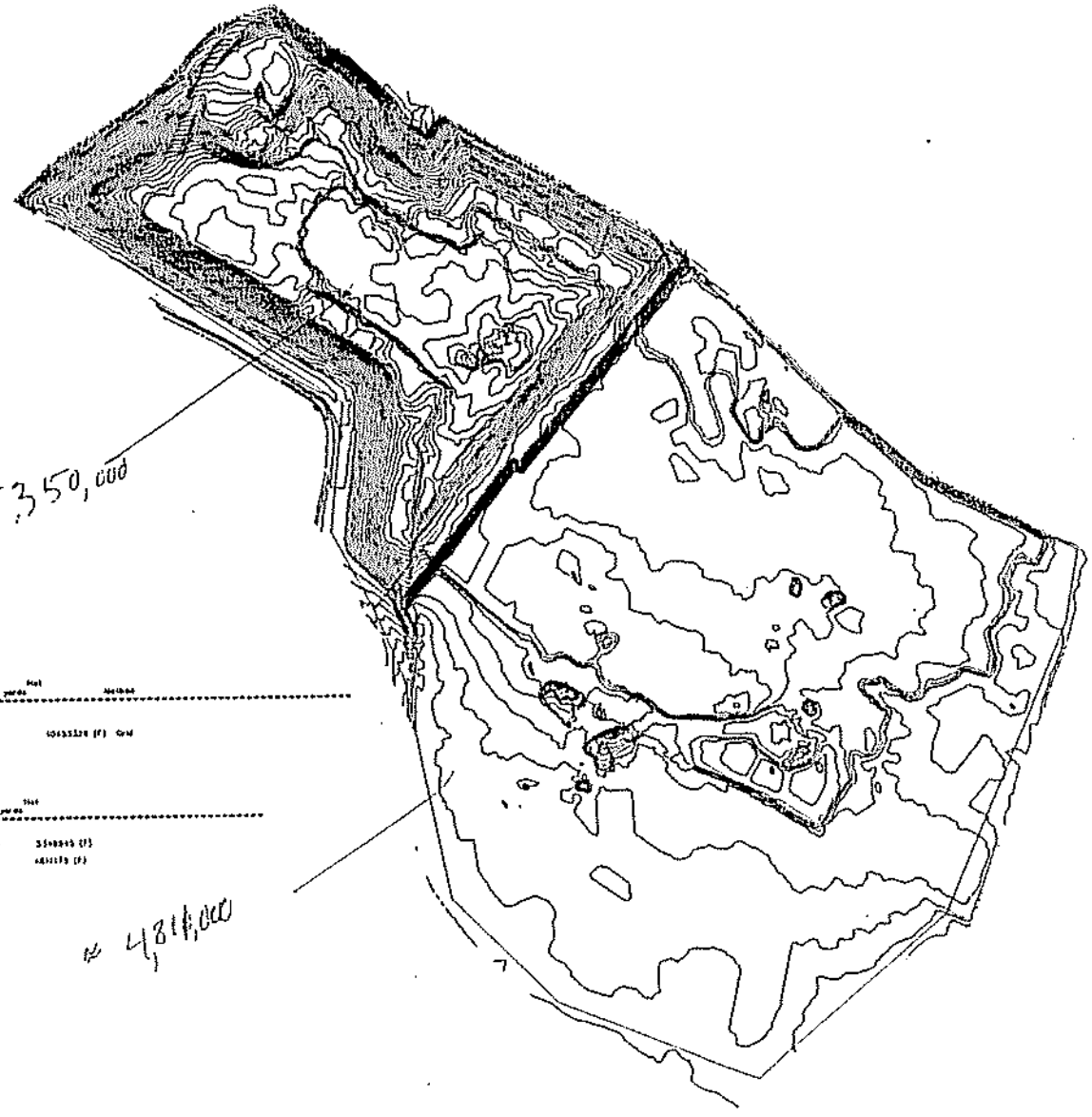

Site Volume Table: Unadjusted

Site	Stratum	Surf	Surf2	Cut yards	Fill yards	Net yards	Method
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible] (F)	Grid

Subsite Volume Table: Unadjusted

Subsite	Stratum	Surf	Surf2	Cut yards	Fill yards	Net yards
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible] (F)
[illegible]	[illegible]	[illegible]	[illegible]	0	[illegible]	[illegible] (F)

☐ GEOSYNTEC CONSULTANTS — CADD Volume Calculation

CADD Operator: Brent Date: 02/02/11 (YY MM DD) Reviewed by: _____ Date: / / (YY MM DD)

Client: _____ Project: Cherry Island Project No.: ME0250 Task No.: _____

Description of volume to be calculated:

topo 1998 existing ground to 1999 existing ground topo

Softdesk Project Name: 0250

Surface Generation:

Surface 1 (Surface existing first):

Source of Grading (Contours, Points, Faults)

Filename: 1998-eg

Surface Name: sur-1

Description: 1998 existing ground

Surface 2 (Resulting from cut and fill on Surface 1):

Source of Grading (Contours, Points, Faults)

Filename: 1999-eg

Surface Name: sur-2

Description: 1999 existing ground

Contours generated from surfaces 1 and 2 checked by (initial): _____ Plots attached: yes no

Site Information:

Site Name: 0250 v1

Confirm that site limits are appropriate for smallest surface (Initial): _____

Site Approximate Dimensions: Length = 5270 Width = 5580

Grid Size: 10×10

Results:

Cut-Fill Surface:

Stratum Name: Vol 1 Description: 1999 ex vol

Volume Surface Name (typically same as Stratum Name): Vol 1

Cut and fill contours checked by (initial): JKS Plot attached: (yes) no

Volume:

Units: m³ (yd³)

Cut = 55,122	Fill = 926,594	Net = 871,471	Cut (Fill)

Notes:

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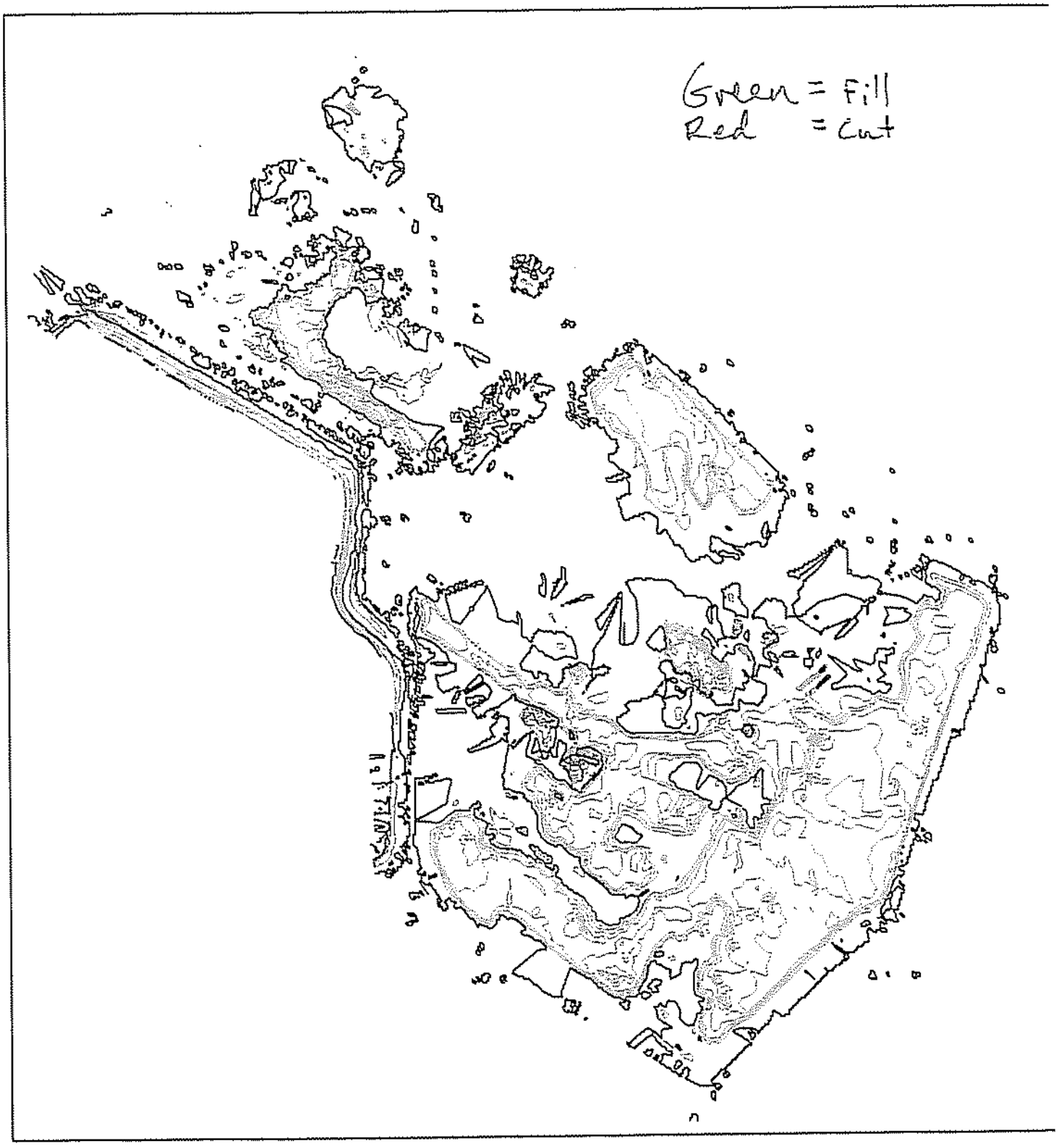
Site Volume Table: Unadjusted

Site	Stratum	Surf1	Surf2	Cut yards	Fill yards	Net yards	Method
0250v1	vol1	sur1	sur2	55122	926594	871471 (F)	Grid



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☐ GEOSYNTEC CONSULTANTS — CADD Volume Calculation

CADD Operator: Brown Date: 02/02/11 (YY MM DD) Reviewed by: _____ Date: / / (YY MM DD)

Client: _____ Project: Cherry Island Project No.: ME0250 Task No.: _____

Description of volume to be calculated:

topo 1999 existing ground to 2000 existing ground topo

Softdesk Project Name: 0250

Surface Generation:

Surface 1 (Surface existing first):

Source of Grading (Contours, Points, Faults)

Filename: 1999-eg

Surface Name: sur-2

Description: 1999 existing ground

Surface 2 (Resulting from cut and fill on Surface 1):

Source of Grading (Contours, Points, Faults)

Filename: 2000-eg

Surface Name: sur-3

Description: 2000 existing ground

Contours generated from surfaces 1 and 2 checked by (initial): _____ **Plots attached: yes no**

Site Information:

Site Name: 0250v2

Confirm that site limits are appropriate for smallest surface (Initial): _____

Site Approximate Dimensions: Length = 5230 Width = 5530

Grid Size: 10x10

Results:

Cut-Fill Surface:

Stratum Name: Vol2 Description: 2000 ex vol

Volume Surface Name (typically same as Stratum Name): Vol 2

Cut and fill contours checked by (initial): JB **Plot attached:** (yes) no

Volume:

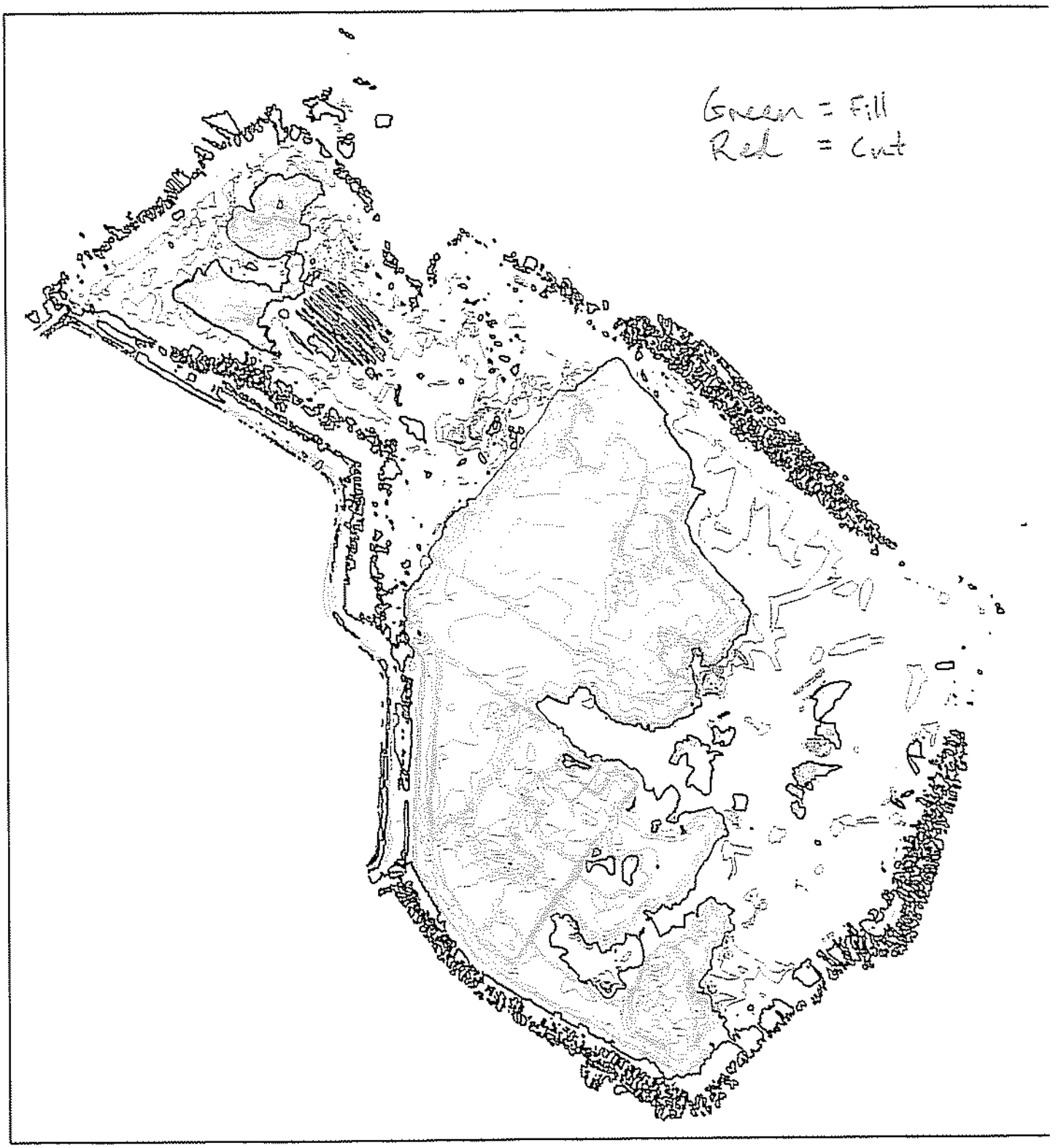
Units: m^3 (yd^3)

Cut = 236,145	Fill = 1,432,303	Net = 1,196,158	Cut (Fill)

Notes:

Site Volume Table: Unadjusted

Site	Stratum	Surf1	Surf2	Cut yards	Fill yards	Net yards	Method
0250v2	vol2	sur2	sur3	236145	1432303	1196158 (F)	Grid



cadd\0250\volumes\2000-eg.dwg Mon Feb 11 15:28:49 2002 GeoSyntec Consultants, MO (JAB)

☐ GEOSYNTEC CONSULTANTS — CADD Volume Calculation

CADD Operator: Brown Date: 02.02.11 (YY MM DD) Reviewed by: _____ Date: / / (YY MM DD)

Client: _____ Project: Cherry Island Project No.: ME0250 Task No.: _____

Description of volume to be calculated:

topo 2000 existing ground to 2001 existing ground topo

Softdesk Project Name: 0250

Surface Generation:

Surface 1 (Surface existing first):

Source of Grading (Contours, Points, Faults)

Filename: 2000-eg

Surface Name: SUR-3

Description: 2000 existing ground

Surface 2 (Resulting from cut and fill on Surface 1):

Source of Grading (Contours, Points, Faults)

Filename: 2001-eg

Surface Name: SUR-4

Description: 2001 existing ground

Contours generated from surfaces 1 and 2 checked by (initial): _____ Plots attached: yes no

Site Information:

Site Name: 0250 v3

Confirm that site limits are appropriate for smallest surface (Initial): _____

Site Approximate Dimensions: Length = 5220 Width = 5530

Grid Size: 10×10

Results:

Cut-Fill Surface:

Stratum Name: vol 3 Description: 2001 ex vol

Volume Surface Name (typically same as Stratum Name): vol 3

Cut and fill contours checked by (initial): JB Plot attached: (yes) no

Volume:

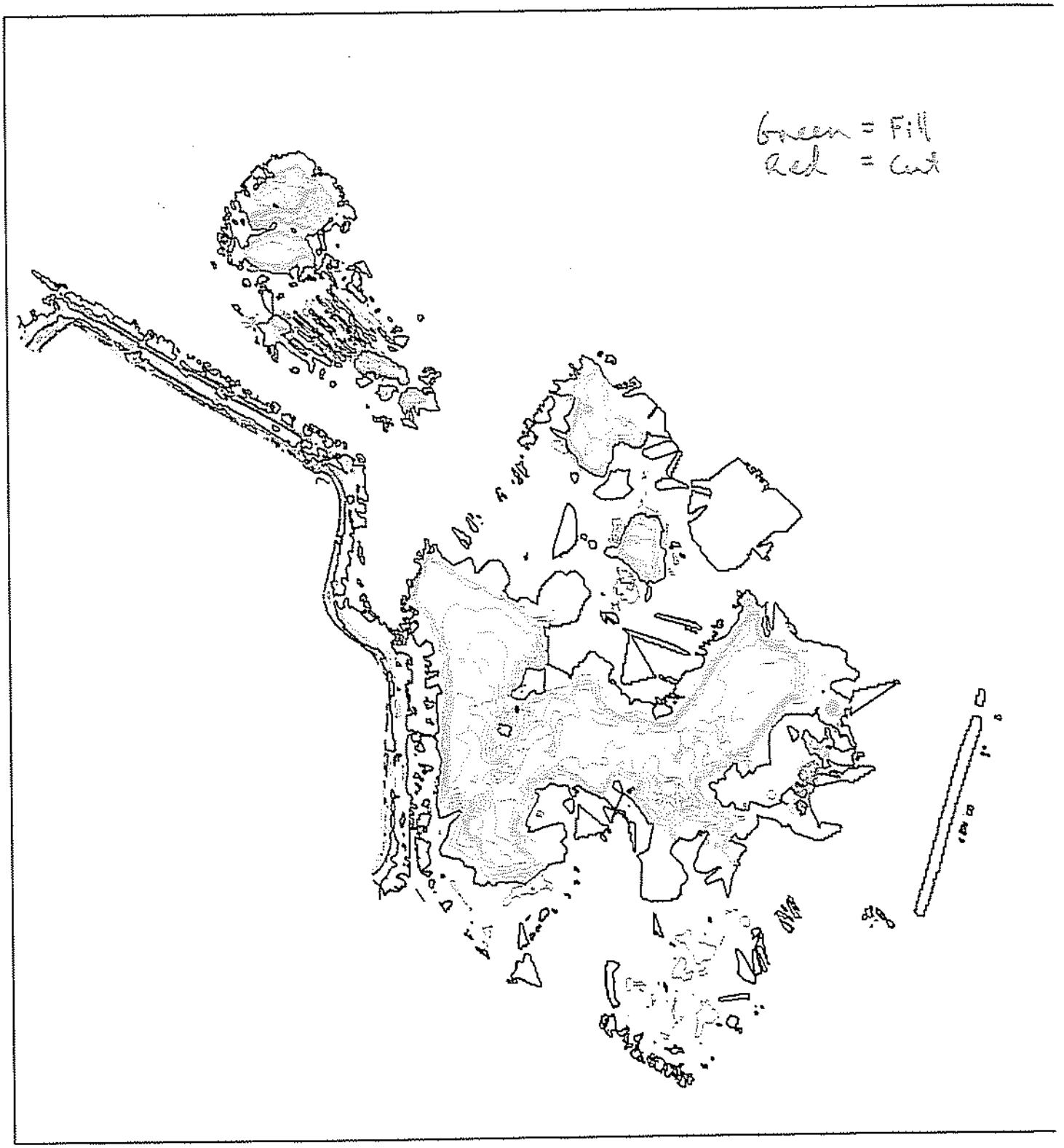
Units: m^3 (yd^3)

Cut = 66,957	Fill = 584,349	Net = 517,391	Cut (Fill)

Notes:

Site Volume Table: Unadjusted

Site	Stratum	Surf1	Surf2	Cut yards	Fill yards	Net yards	Method
0250v3	vol3	sur3	sur4	66957	584349	517391 (F)	Grid



.cadd\0250\volumes\2001-eg.dwg Mon Feb 11 15:25:14 2002 GeoSyntec Consultants, MO (JAB)

☐ GEOSYNTEC CONSULTANTS — CADD Volume Calculation

CADD Operator: D. Mandeville Date: 02/07/11 (YY MM DD) Reviewed by: _____ Date: / / (YY MM DD)

Client: DSWA Project: CIL Project No.: ME0250 Task No.: _____

Description of volume to be calculated:

April 2001 existing ground to April 2002 existing ground

Softdesk Project Name: 0250

Surface Generation:

Surface 1 (Surface existing first):

Source of Grading (Contours, Points, Faults)

Filename: 2001-eg

Surface Name: sur-4

Description: 2001 existing ground

Surface 2 (Resulting from cut and fill on Surface 1):

Source of Grading (Contours, Points, Faults)

Filename: 2002-eg

Surface Name: sur9

Description: 2002 existing ground

Contours generated from surfaces 1 and 2 checked by (initial): _____ Plots attached: yes no

Site Information:

Site Name: ~~0250 vol~~ 0250 vol7

Confirm that site limits are appropriate for smallest surface (Initial): _____

Site Approximate Dimensions: Length = 7870 Width = 5500

Grid Size: 10x10

Results:

Cut-Fill Surface:

Stratum Name: vol7 Description: volume between 2001 and 2002 existing ground

Volume Surface Name (typically same as Stratum Name): vol7

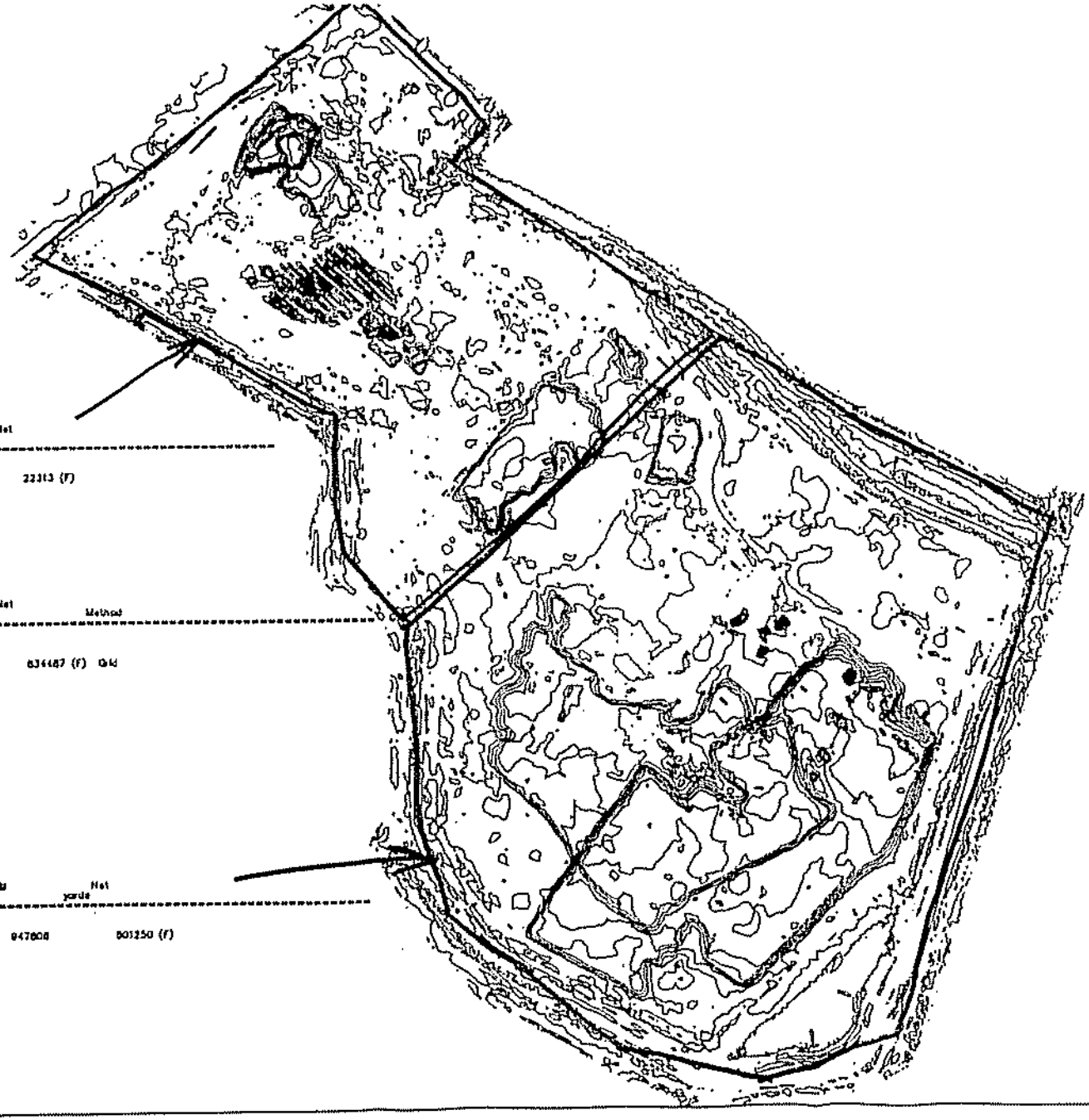
Cut and fill contours checked by (initial): _____ Plot attached: yes no

Volume:

Units: m^3 (yd^3)

Cut = 271,394	Fill = 1105882	Net = 834,487	Cut/Fill

Notes:



Subsite Volume Table: Unadjusted

Subsite	Stratum	Surf1	Surf2	Cut yards	Fill yards	Net yards
0	vol7	sur4	sur9	109077	131389	22313 (F)

Site Volume Table: Unadjusted

Site	Stratum	Surf1	Surf2	Cut yards	Fill yards	Net yards	Method
0250-vol7	vol7	sur4	sur9	271394	1105882	834487 (F)	Grid

Subsite Volume Table: Unadjusted

Subsite	Stratum	Surf1	Surf2	Cut yards	Fill yards	Net yards
0	vol7	sur4	sur9	146335	947608	801250 (F)

GEOSYNTEC CONSULTANTS

Page ___ of ___

Written by: Doug M Date: 02/02/13 (YY MM DD) Reviewed by: ___ Date: __/__/__ (YY MM DD)

Client: DSWA Project: Cherry Island Project/Proposal No.: ME0250 Task No.: 2.2.1

Volume summary for CIL

	Volume description	Total Volume	Phase I/II volume	sub site
1999-eg.dwg	98eg to 99eg	871,471 cy F	36,586 cy F	1,2
2000-eg.dwg	99eg to 2000eg	1,196,158 cy F	44,172 cy F	3,4
2001-eg.dwg	2000eg to 2001eg	517,391 cy F	61,370 cy F	5,6
2001-eg.dwg	1998eg to 2001eg	2,584,592 cy F	~~[illegible]~~ 142,141 cy F	5,6

from CAD volumes by Jeff Brown on 2/11/02

CAD volumes by Doug using Jeff's setup - with subsites defined 2/13/02 - stayed within Phase I/I boundary

overall volume comparing the 1998 eg survey to the elevations prior to filling

Phase 1/2 elevation 22

Phase 3/4/5 elevation 40

artificial surface	surf to 98eg	10,453,329	5,684,385

ATTACHMENT II

Written by: Doug Mandeville Date: 02/08/13 Reviewed by: Date: / /

Client: CMWA Project: CIL Project/Proposal No.: ME0250 Task No.: 1.4.4

settlement between Jan 1985 and December 1997 / Jan 1998

		settlement		
0.04 ft/month ✓ P3	SP-1	1.7		Feb 94 to Jan 98
	SP-2	2.9		same
	SP-4	2.5		same
	SP-5	1.9	2.1 ft	same
	SP-8	3.0		same
	SP-12	2.3		same
	SP-13	1.4		same
	SP-14	1.0		same

0.03 ft/month ✓ P4	SP-1	0.6		April 97 to Jan 98
	SP-2	0.4		same
	SP-5	0.1	0.3	same
	SP-6	0.2		same
	SP-7	0.2		same
	SP-8	0.3		same

0.05 ft/month P5	SP-1	0.5	July 97 to Jan 98
	SP-2	0.5	Apr 97 to Jan 98
	SP-3	0.3	July 97 to Jan 98
	SP-4	0.4	Apr 97 to Jan 98
	SP-5	0.4	July 97 to Jan 98
	SP-6	0.0	Oct 97 to Jan 98
	SP-7	0.4	Oct 97 to Jan 98
	SP-8	0.0	July 97 to Jan 98
	SP-9	0.6	July 97 to Jan 98
	SP-10	0.0	Oct 97 to Jan 98

will use an average monthly settlement of 0.04 ft/month ✓

will use this to cover the entire March 86 to Jan 98 time frame - 143 months

Written by: Doug Mandeville Date: 02/08/13 (YY/MM/DD) Reviewed by: ____ Date: __/__/__ (YY/MM/DD)

Client: DSWA Project: CIL Project/Proposal No.: ME0250 Task No.: 1.4.4

CIL unit weight calculations

Need to account for settlement between January 1985 and December 1997 / January 1998

for Phase I/II

2 settlement plates have data for this time frame

0.11'/month ✓ P1	SP-1AA	9.5'	settlement	March 86 to Jan 98
	SP-1BA	20.6'	settlement	Feb 86 to Jan 98
0.16'/month ✓ P1	SP-3	3.7'		Dec 1992 to Jan 98
	SP-4	2.0'		Dec 92 to Jan 98
	SP-5	7.7'		Dec 92 to Jan 98
	SP-6	15.8		Dec 92 to Jan 98
	SP-7	18.5		Dec 92 to Jan 98
0.135'/month ✓ P2	SP-1	3.6		Apr 94 to Jan 98
	SP-2	2.6		same
	SP-4	4.3		same
	SP-5	10.4		same
	SP-7	11.2		same
	SP-8	9.3		same
	SP-10	3.6		same
	SP-13	5.2		same
	SP-14	3.3		same

will use an average monthly settlement of 0.135 ft/month ✓

total months elapsed = 143

settlement in Phase I/II between March 86 to Jan 98 ✓

= 0.135 ft/month · 143 months = 19.31 ft Phase

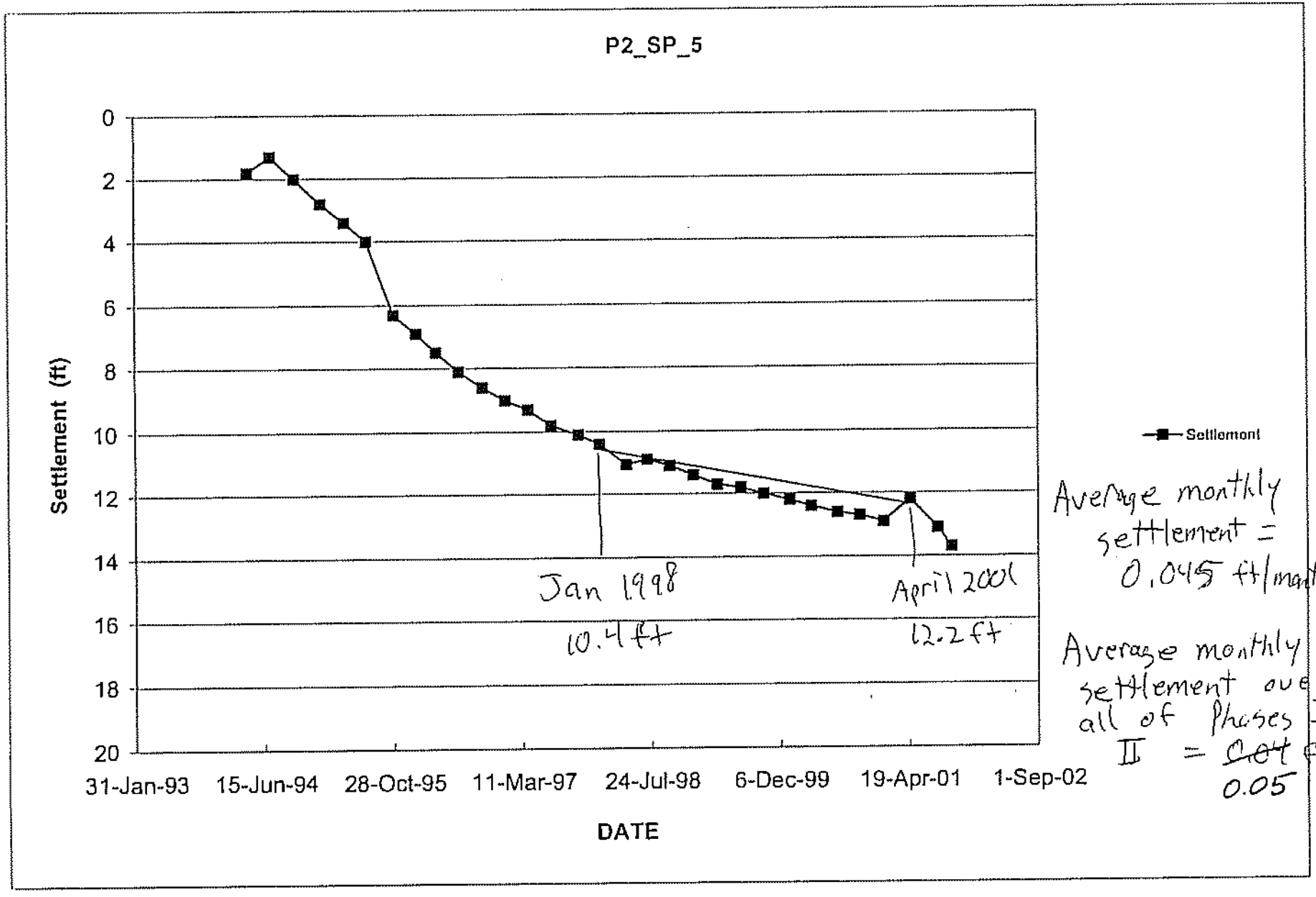

P2_SP_5
Settlement (ft)
0
2
4
6
8
10
12
14
16
18
20
31-Jan-93
15-Jun-94
28-Oct-95
11-Mar-97
24-Jul-98
6-Dec-99
19-Apr-01
1-Sep-02
DATE
Settlement
Jan 1998
10.4 ft
April 2001
12.2 ft
Average monthly settlement = 0.045 ft/month
Average monthly settlement over all of Phases I and II = ~~0.04~~ 0.05 ft/month

Figure 1

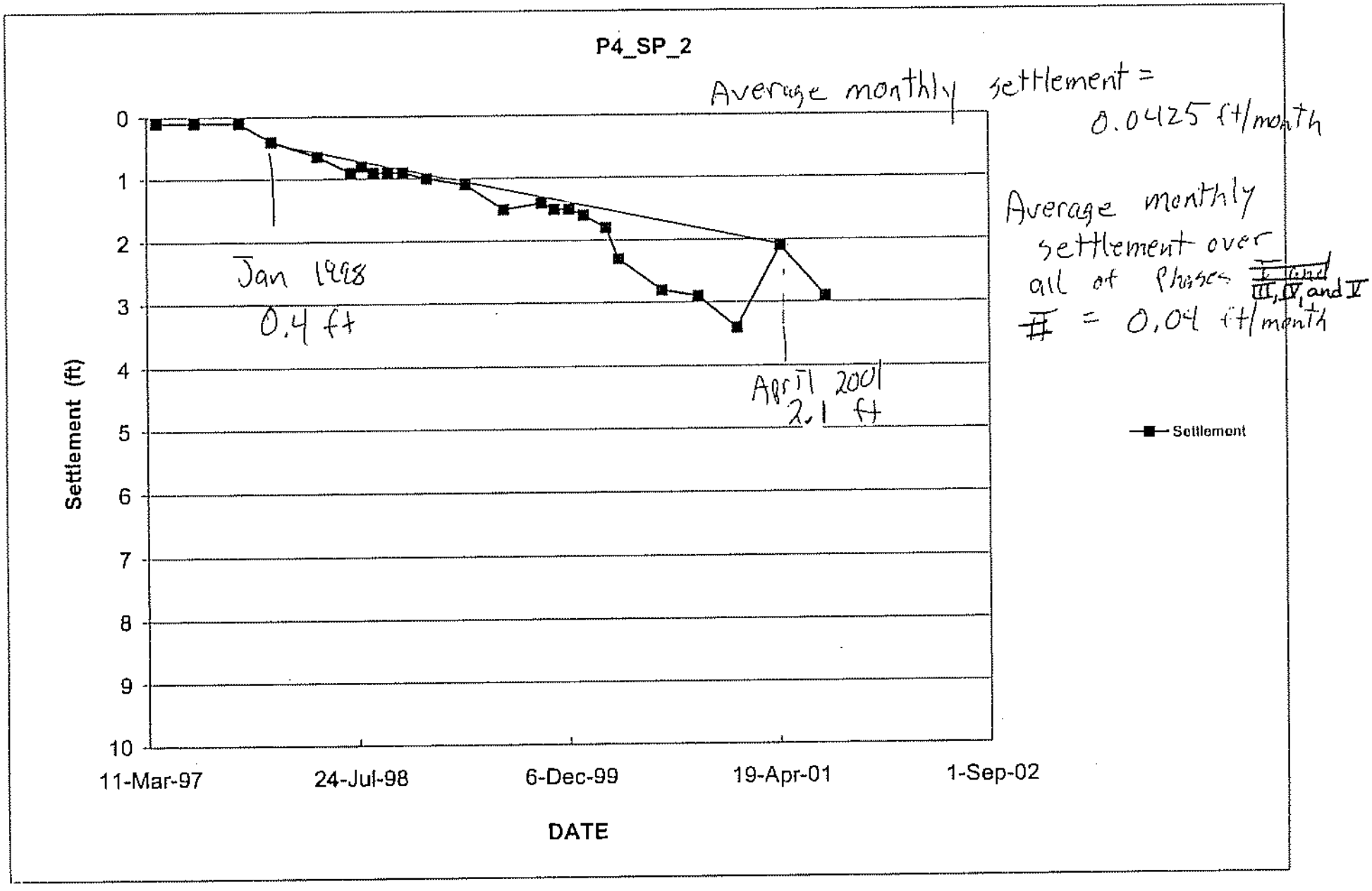

P4_SP_2
Average monthly settlement = 0.0425 ft/month
Average monthly settlement over all of Phases I and III, IV, and V = 0.04 ft/month
Jan 1998
0.4 ft
April 2001
2.1 ft
Settlement
Settlement (ft)
0
1
2
3
4
5
6
7
8
9
10
11-Mar-97
24-Jul-98
6-Dec-99
19-Apr-01
1-Sep-02
DATE

Figure 2

ATTACHMENT III

February 7, 2002

Ref.: CIL – 02.05

TO: Richard P. Watson, P.E., DEE
Chief Engineer

FROM: Drew R. Sammons, P.E.
Acting Facility Manager

SUBJECT: CHERRY ISLAND LANDFILL (CIL) OPERATIONS REPORT DECEMBER 2001

Operation Summary

- During the month of December, Greggo & Ferrara (G&F) landfilled solid waste from residential and commercial vehicles in Phase V as shown on the attached drawing.

- December 3 - Lou Pisapia (LJP) and Don Poore, Safety Consultant (DP) were onsite to conduct safety inspection of CIL.
  December 27 – A report from the Safety Committee was received.

- December 4 - Conectiv delivered 295.85 tons of ash. No further deliveries of ash were received in December.

- December 5 - Three (3) 24" x 5" x ¼" patches were placed on the deck of Scale 2 by Widgeon Enterprises, Inc. (Widgeon). Damage to structural members within the deck is not repairable. Current repairs are temporary until scale replacement.

- December 7 - A new spare pump #005556 for the Southeast pumpstation was delivered and placed in inventory.

- December 10 - City of Wilmington's (COW) environmental compliance officer, Mathew Miller (MM), inspected CIL's records and pump station relevant to Permit # W-88-02. MM indicated that ammonia levels exceeded pretreatment levels.
  December 11 - Rick Watson (RPW) and Jim Vescovi (JV) met with MM and Sid Sharma (SS) of COW concerning ammonia variance.
  December 12 - JV sent a letter to Mr. Kash Srinivasan, of COW requesting a copy of the waiver for excess ammonia, suspended solids and BOD delivered to COW
  December 27 - JV received COW Pretreatment Inspection Report for Permit #W-88-02. ??????????

- December 10 - Texnet's Annette Cline, along with JV inspected the litter fence. Ms. Cline will prepare cost estimate for repairs.

- December 11 - LRM, Inc (LRM) inspected and verified calibration of metering system for the main pump station (MPS). A report was submitted on January 7 and a copy forwarded to COW.

- December 12 - The Department of Agriculture tested and passed all fours scales at CIL.

- December 14 - COW and CIL tentatively agreed upon a proposal for Christmas tree recycling. VFL Technology, Inc. (VFL) agreed to utilize the shredded material in soil blending.

- December 19 - Additional deck cracks were found in the inbound scale of scalehouse #1.
  December 21 - JV and RPW examined the inbound scale at scalehouse #1. Quotes for installing a patch and replacing the deck were requested from Widgeon and Advance Scale.

- December 19 - VFL requested the use of CIL scales for the following two (2) days, December 20 and 21, due to maintenance of their scale. VFL however only used CIL scales on December 20 as VFL scales were operational on December 21.

- December 20 - MGK Industries, Inc. (MGK) commenced valve replacement to east pump station. This required the temporary idling of the pump station.
  December 21 - The valve replacement was completed and leachate collection for the affected areas was returned to service.

- December 21 - JV and RPW toured COW, Waste Water Treatment Plant's sludge production facilities. Short and long term plans for sludge production as well as sludge characteristics and quantities were discussed with US Filter's plant manager, Phil Panteleo.

- December 28 - MGK replaced the three-way valve at the MPS. Work was completed prior to the day's leachate delivery and no interruption of service occurred. The cause of the valve failure was not evident upon inspection but will be investigated.

Pumpstation Activity Report

PUMPSTATION	PUMP STATUS X operational ✓ repair/maintenance	COMMENTS
Main Pumpstation (MPS) Pump #1 SN: 980701937 Pump #2 SN: 980701665 Spare No Spare	 X X N/A	
North Central Pumpstation (NCPS) Pump #1 SN: 9610001 Pump #2 SN: 9610002 Spare SN: 9610003	 X X X	
East Pumpstation (EPS) Pump #1 SN: 9840083 Pump #2 SN: 9840082 Spare SN: 9850043	 X X X	
South East Pumpstation (SEPS) Pump #1 SN: 005309 Pump #2 SN: 95-2987C Spare 005556	 X X X	Spare pump #005556 was delivered on December 7 and placed in inventory.
South Pumpstation (SPS) Pump #1 SN: 9250009 Pump #2 SN: 9250008 Spare SN: 9250010	 X X X	
South Central Pumpstation (SCPS) Pump #1 SN: 95-2987C Pump #2 SN: 00A18 31-5248 Spare SN: 5327	 X X X	
Central Pumpstation (CPS) Pump #1 SN: 9350005 Pump #2 SN: 9350006 Spare SN: 9350007	 X X X	

Monthly Breakdown of Solid Waste Tonnage During Calendar Year 2001

MONTH	MSW	SPECIAL WASTE	ASBESTOS	TOTAL
Jan	39,843.82	320.89	543.18	40,707.89
Feb	35,859.53	342.98	595.54	36,798.05
Mar	40,187.21	1,244.84	785.95	42,218.00
Apr	46,268.66	297.07	567.25	47,132.98
May	50,004.47	562.40	536.68	51,103.55
Jun	49,281.30	97.03	526.67	49,905.00
Jul	46,863.00	140.36	643.45	47,646.81
Aug	47,617.61	278.20	362.02	48,257.83
Sep	43,646.67	344.97	389.64	44,381.28
Oct	48,599.84	913.95	251.14	49,764.93
Nov	46,624.45	254.22	442.32	47,320.99
Dec	42,780.15	189.48	237.40	43,207.03
TOTAL	537,576.71	4,986.39	5,881.24	548,444.34

Summary of 2001 Monthly Capacity Estimates For CIL

MONTH	SOLID WASTE TONNAGE	ESTIMATED REMAINING CAPACITY (TONS)	ESTIMATED REMAINING CAPACITY (MOS.)
Jan	40,707.89	3,063,441.10	69.53
Feb	36,798.05	3,026,643.05	68.69
Mar	42,218.00	2,984,425.05	67.73
Apr	47,132.98	2,937,292.07	66.66
May	51,103.55	2,886,188.52	65.50
Jun	49,905.00	2,836,283.52	64.37
Jul	47,646.81	2,788,636.71	63.29
Aug	48,257.83	2,740,378.88	62.19
Sep	44,381.28	2,695,997.60	61.19
Oct	49,764.93	2,646,232.67	60.06
Nov	47,320.99	2,598,911.68	58.98
Dec	43,207.86	2,555,703.82	58.00
TOTAL	548,445.17	N/A	N/A

Estimated Remaining Capacity of CIL

- Total estimated capacity for solid waste in CIL
  CIL----------12,755,000 tons
- Total tonnage landfilled in CIL as of 12/31/99----------5,489,208 tons
- Estimated capacity remaining for solid waste in CIL
  as of 12/31/99----------7,265,792 tons
- Revised estimated capacity remaining for solid waste in CIL as of
  12/31/99 based on Schnabel Engineering Composite
  Stability Analysis dated January 2000----------3,632,896 tons
- Estimated capacity remaining for solid waste in CIL
  as of 12/31/00----------3,104,149 tons

Note:
Sample Estimated Remaining Capacity Calculation: (estimated remaining capacity in tons) ÷ (average monthly tonnage from CIL). Average monthly tonnage for calendar year 2000 was 44,062 tons.

$$\text{Example: } \frac{3{,}063{,}441.1 \text{ tons}}{44{,}062 \text{ tons}} = 69.53 \text{ months}$$

Summary of Special Wastes Landfilled (tons)
Calendar Year 2001

MONTH	CITISTEEL USA	GA GULF/ KANEKA	UNIQEMA	VPI MIRREX	OTHER	TOTAL
Jan	20.07	85.72	52.95	9.97	152.18	320.89
Feb	26.44	69.04	30.41	5.90	211.19	342.98
Mar	26.36	47.05	37.03	5.67	1,128.73	1,244.84
Apr	16.64	60.22	15.06	6.27	198.88	297.07
May	40.53	46.41	14.46	11.65	449.35	562.40
Jun	17.03	35.38	19.36	0.00	25.26	97.03
Jul	13.89	53.24	43.23	12.23	17.77	140.36
Aug	20.59	94.26	41.41	5.34	116.60	278.20
Sep	16.42	77.11	25.80	6.18	219.46	344.97
Oct	22.39	87.67	23.29	21.25	759.35	913.95
Nov	10.49	51.98	45.49	0.00	146.26	254.22
Dec	9.36	53.14	23.65	0.00	103.33	189.48
TOTAL	240.21	761.22	372.14	84.46	3,528.36	4,986.39

December

CitiSteel USA – scarfing dust
Kaneka – biosolids
Uniqema - non-hazardous press cake.

The "other" category is comprised of the following companies:
Daimler Chrysler Corp. – sludge pit deposit (30.75 tons)
DuPont Experimental – selexsore HCL (4.24 tons)
DuPont White Pigment and Mineral Products
- chlorinator brick, mortar and gangue (6.51 tons)
- coke and ore dust (7.59 tons)
- excavated soil from the Waste Water Treatment Plant area (28.61 tons)
- excavated soil from construction activity (21.37 tons)
- fiberglass vessels and piping (2.65 tons)

Rath Performance Fibers, Inc. – ceramic fiber board scraps and dust (1.61 tons)

November

CitiSteel USA – scarfing dust
Kaneka – boisolids
Uniqema - non-hazardous press cake.

The "other" category is comprised of the following companies:
Chloramone Company – cellroom filter press sludge (6.94 tons)
DuPont White Pigment and Mineral Products
- chlorinator brick, mortar and gangue (98.09 tons)
- coke and ore dust (17.04 tons)
- fiberglass vessels and piping (7.57 tons)
- off-spec titanium (11.82 tons)
- pebble lime (2.41 tons)

SQM North America – soluble fertilizer (2.39 tons)

October

CitiSteel USA – scarfing dust
Kaneka – biosolids
Uniqema - non-hazardous press cake
VPI Mirrex – press cake sludge

The "other" category is comprised of the following companies:
Barr-None - sandblast grit (14.14 tons)
Chloramone Company – cellroom filter press Sludge (4.64 tons)
Conectiv – pressed tank sludge (429.79 tons)
Crawford & Company – Rolling Rock beer (18.75 tons)
DuPont White Pigment and Mineral Products
- chlorinator brick, mortar and gangue (166.07 tons)
- coke and ore dust (22.40 tons)
- excavated soil (47.87 tons)

DuPont Stine Haskell Research Center
- refactory brick (1.61 tons)

Hoober Inc. – rubber tracks (15.67 tons)
New Castle County Dept. of Special Services
- Army Creek groundwater treatment plant sludge (25.33 tons)

NVF Company - b-drum waste (13.08 tons)

September

CitiSteel USA – scarfing dust
Kaneka Delaware Corp. – biosolids
Uniqema - non-hazardous press cake
VPI Mirrex – press cake sludge

The "other" category is comprised of the following companies:
DuPont White Pigment and Mineral Products
- chlorinator brick, mortar and gangue (198.29 tons)
- coke and ore dust (8.15 tons)
- off-spec titanium dioxide pigment (6.97 tons)
- pebble lime (2.69 tons)
- sandblast grit (3.36 tons)

August

CitiSteel USA – scarfing dust
Kaneka Delaware Corp. – biosolids
Uniqema - non-hazardous press cake
VPI Mirrex – press cake sludge

The "other" category is comprised of the following companies:
DuPont White Pigment and Mineral Products
- coke and ore dust (15.80 tons)
- off-spec titanium dioxide pigment (17.70 tons)
- pebble lime (1.52 tons)
- sandblast grit (5.50 tons)

New Castle County Dept. of Special Services
- Army Creek groundwater treatment plant sludge (28.58 tons)

NVF Company - b-drum waste (23.99 tons)
Superior Nutrition Corp. – outdated power smoothie Zuice (23.51 tons)

July

CitiSteel USA – scarfing dust
Kaneka Delaware Corp. – biosolids
Uniqema - non-hazardous press cake
VPI Mirrex – press cake sludge

The "other" category is comprised of the following companies:
Chloramone Co. – cellroom filter press sludge (4.88 tons)
DuPont White Pigment and Mineral Products
- coke and ore dust (10.35 tons)
- pebble lime (0.97 tons)

NVF Company - b-drum waste (1.57 tons)

June

CitiSteel USA – scarfing dust
Kaneka Delaware Corp. – biosolids
Uniqema - non-hazardous press cake

The "other" category is comprised of the following companies:
DuPont White Pigment and Mineral products
- coke and ore dust (1.66 tons)
- off-spec titanium dioxide pigment (9.59 tons)
- pebble lime (1.79 tons)

New Castle County Dept. of Special Services
- Army Creek groundwater treatment plant Sludge (12.22 tons)

May

CitiSteel USA – scarfing dust
Kaneka Delaware Corp. – biosolids
Uniqema - non-hazardous press cake
VPI Mirrex Corp. – press cake sludge

The "other" category is comprised of the following companies:
DuPont White Pigment and Mineral Products
- chlorinator brick, mortar and gangue (310.11 tons)
- excavated soil (buried as waste) (106.78 tons)
- pebble lime (2.01 tons)
- railroad ties (14.05 tons)

New Castle County Dept. of Special Services
- Army Creek groundwater treatment sludge (16.40 tons)

April

CitiSteel – scarfing dust
Kaneka – biosolids
Uniqema - non-hazardous press cake
VPI Mirrex – press cake sludge from VPI Mirrex.

The "other" category is comprised of the following companies:
AET Specialty Nets – railroad ties (8.12 tons)
Chloramone Company – cellroom filter press sludge (7.69 tons)
New Castle County Dept. of Special Services
- Army Creek groundwater treatment plant sludge (28.16 tons)

Vlassic Foods – pickles (154.91 tons)

March

CitiSteel USA – scarfing dust
Kaneka – biosolids
Uniqema - non-hazardous press cake
VPI Mirrex – press cake sludge

The "other" category is comprised of the following companies:
Conectiv Energy – oil ash (141.69 tons)
DuPont White Pigment and Mineral Products
- excavated soil (buried as waste) (967.72 tons)
- off-spec titanium dioxide pigment (15.19 tons)
- pebble lime (4.13 tons)

February

CitiSteel USA – scarfing dust
Kaneka – biosolids
Uniqema - non-hazardous press cake
VPI Mirrex – press cake sludge

The "other" category is comprised of the following companies:
BFI Waste Systems – old gas pumps (10.99 tons)
DuPont Whit Pigment and Mineral Products
- excavated soil (buried as waste) (122.12 tons)
FMC Biopolymer – microcrystalline cellulose and cellulose derivative products (66.65 tons)
NVF Company - B-drum waste (11.43 tons)

January

CitiSteel USA – scarfing dust
Kaneka – biosolids
Uniqema - non-hazardous press cake, tween-60 and Absorbent
VPI Mirrex – press cake sludge.

The "other" category is comprised of the following companies:
DuPont White Pigment and Mineral Products
- excavated soil (buried as waste) (50.34 tons)
- fiberglass vessels (3.62 tons)
- off-spec titanium dioxide pigment (3.62 tons)
- pebble lime (2.62 tons)
FMC Biopolymer - microcrystalline cellulose and cellulose derivative products (80.55 tons)
NVF Company - B-drum waste (11.43 tons)

Summary of Activities in Phase IA
During Calendar Year 2001

MONTH	DELIVERED TO CIL				CSWMC ASBESTOS DELIVERED TO CIL (tons)	SSWMC ASBESTOS DELIVERED TO CIL (tons)	RECYCLED BATTERIES (tons)	TOTAL LANDFILLED (tons)
	FRIABLE ASBESTOS (tons)	NON FRIABLE ASBESTOS		CIL SUB-TOTAL (tons)				
		Cat. I (tons)	Cat. II (tons)					
Jan	450.99	58.74	33.45	543.18	0.00	0.00	0.00	543.18
Feb	553.21	18.29	15.01	586.51	0.00	9.03	0.00	595.54
Mar	714.40	22.05	32.09	768.54	8.64	8.77	0.00	785.95
Apr	512.67	21.21	33.37	567.25	0.00	0.00	9.95	577.20
May	409.38	74.52	52.78	536.68	0.00	0.00	0.00	536.68
Jun	350.38	137.44	38.85	526.67	0.00	0.00	0.00	526.67
Jul	514.70	40.96	58.37	614.03	8.29	21.13	0.00	643.45
Aug	243.71	59.22	59.09	362.02	0.00	0.00	12.06	374.08
Sep	248.05	117.55	24.04	389.64	0.00	0.00	0.00	389.64
Oct	174.18	41.78	35.18	251.14	0.00	0.00	5.85	256.99
Nov	337.74	55.43	49.15	442.32	0.00	0.00	5.48	447.80
Dec	185.40	35.61	16.39	237.40	0.00	0.00	0.00	237.40
TOTAL	4,694.81	682.80	447.77	5,825.38	16.93	38.93	33.34	5,914.58

Summary of Activities in Phase IA
During Calendar Year 2001 (Continued)

MONTH	STAB. SLUDGE USED IN PHASE IA (cy)	SLAG USED IN PHASE IA (tons)
Jan	3,408	1,342.56
Feb	4,320	640.41
Mar	4,947	939.92
Apr	4,206	645.32
May	5,688	877.93
Jun	3,322	665.62
Jul	4,920	806.13
Aug	2,724	712.93
Sep	2,124	195.62
Oct	2,196	665.99
Nov	3,840	487.02
Dec	5,124	537.66
TOTAL	46,819	8,517.11

Summary of State Asbestos Projects Landfilled in Phase IA
During Calendar Year 2001
(Figures are Estimated)

MONTH	FRIABLE (tons)	NON-FRIABLE Category I (tons)	NON-FRIABLE Category II (tons)	TOTAL ASBESTOS LANDFILLED From State Projects (tons)
Jan	37.78	4.97	0.00	42.75
Feb	5.38	1.83	0.00	7.21
Mar	10.50	0.00	1.52	12.02
Apr	30.99	0.00	0.52	31.51
May	49.48	4.55	0.00	54.03
Jun	40.14	9.98	121.83	171.95
Jul	221.34	40.96	24.18	286.48
Aug	106.58	53.63	12.01	172.22
Sep	54.33	4.93	2.80	62.06
Oct	12.30	0.00	0.00	12.30
Nov	58.71	15.69	0.00	74.40
Dec	28.30	28.78	0.00	57.08
TOTAL	655.83	165.32	162.86	984.01

Monthly Summary of Activities in Phases III/IV/V

MONTH	SOLID WASTE (tons)	DAILY COVER (Slope)		
		STAB SLUDGE (tons)	TARPS (sf)	OTHER (tons)
Jan	40,164.71	7,567.28	202,000	0.00
Feb	36,202.51	3,849.04	274,000	0.00
Mar	41,432.05	2,748.62	374,000	0.00
Apr	46,565.73	6,681.40	296,000	0.00
May	50,566.87	7,422.47	284,000	0.00
Jun	49,378.33	9,594.22	282,000	0.00
Jul	47,003.36	7,971.90	284,000	0.00
Aug	47,895.81	10,584.51	354,000	0.00
Sep	43,991.64	9,563.85	352,000	0.00
Oct	49,513.79	11,963.66	416,000	0.00
Nov	46,878.67	9,770.00	400,000	0.00
Dec	42,970.46	8,603.66	430,000	0.00
TOTAL	542,563.93	96,320.61	3,948,000	0.00

Note: 1. March 2001 stabilized sludge tonnage revised in April 2001.

Monthly Summary of Activities in Phases III/IV/V (Continued)

	DAILY COVER(Top)									
MONTH	BARRIER (tons)	CLEAN EARTH (tons)	RCLMD INT.CVR. (est. tons)	GLEN MILLS (tons)	REAGENT M (tons)	MATERIALS RECOVERY (tons)	SOIL/ REAGENT M (tons)	RECOVERY/AT (tons)	OTHER (tons)	TOTAL TONS
Jan	4,890.83	11,372.64	3,337.50	6,863.52	6,261.01	0.00	0.00	0.00	79.95	32,805.45
Feb	4,333.52	12,479.68	1,350.00	789.58	5,756.08	0.00	359.53	2,211.62	0.00	27,280.01
Mar	4,908.34	8,798.34	1,500.00	0.00	6,782.38	0.00	0.00	2,301.65	0.00	24,290.71
Apr	4,363.40	7,699.09	3,045.00	0.00	9,316.89	0.00	0.00	2,420.95	0.00	26,845.33
May	4,862.79	21,889.01	2,820.00	0.00	5,655.76	0.00	0.00	2,175.99	0.00	37,403.55
Jun	4,922.07	20,964.53	1,692.00	0.00	5,972.56	0.00	0.00	2,375.25	0.00	35,926.41
Jul	5,589.25	15,725.36	2,250.00	0.00	5,010.19	1,930.85	0.00	2,308.83	0.00	32,814.48
Aug	5,466.53	6,762.00	3,150.00	0.00	2,892.21	9,321.30	0.00	2,719.71	3,081.55	33,393.30
Sep	4,139.03	7,706.20	2,700.00	0.00	2,158.41	4,084.16	0.00	1,893.10	101.75	22,782.65
Oct	5,283.41	17,069.41	2,925.00	0.00	1,173.31	0.00	0.00	865.58	934.86	28,251.57
Nov	4,882.90	19,546.03	2,700.00	0.00	0.00	0.00	0.00	729.22	1,144.28	29,002.43
Dec	4,789.56	15,931.20	0.00	0.00	0.00	0.00	0.00	726.34	21.45	21,448.55
TOTAL	58,411.63	165,943.49	27,469.50	7,653.10	50,978.80	15,336.51	359.53	20,728.24	5,363.84	367

Notes:

1. Daily Cover (Slope) consists of six (6) inches of material or tarps.
2. Daily Cover (Top) consists of six (6) inches of daily cover material and six (6) of intermediate cover material.
3. January 2001 clean earth tonnage revised in April 2001.
4. The "other" category for slope and daily cover combined is comprised of the following:

December
DuPont Edgemoor (21.45 tons)
- excavated clean soil

November
DuPont Edgemoor (1,144.28 tons)
- excavated clean soil

October
DuPont Edgemoor (934.86 tons)
- excavated clean soil

September
DuPont Edgemoor (101.75 tons)
- excavated clean soil

August
DuPont Edgemoor (3,081.55 tons)
- excavated clean soil

July
None

June
None

May
None

April
None

February
None

March
None

January
Conectiv (79.95 tons) – excavated clean soil

Monthly Solid Waste : Cover Ratio

MONTH	ASBESTOS (tons)	ASBESTOS COVER (tons)	COVER RATIO (asb:cov)	SOLID WASTE (tons)	SOLID WASTE COVER (tons)	COVER RATIO (sw:cov)
Jan	543.18	4,526.71	1:8.3	40,164.71	40,372.73	1:1
Feb	595.54	6,179.26	1:10.4	36,202.51	31,129.05	1.2:1
Mar	785.95	6,942.14	1:8.8	41,432.05	27,039.33	1.5:1
Apr	567.25	6,213.62	1:11	46,565.73	33,526.73	1.4:1
May	536.68	8,195.82	1:15.3	50,566.87	44,826.02	1.1:1
Jun	526.67	4,754.82	1:9.03	49,378.33	45,520.63	1.1:1
Jul	643.45	7,468.01	1:11.6	47,003.36	40,786.38	1.2:1
Aug	362.02	4,083.82	1:11.3	47,895.81	43,977.81	1.1:1
Sep	389.64	3,280.68	1:8.42	43,991.64	32,346.50	1.4:1
Oct	251.14	3,756.51	1:14.96	49,513.79	40,215.23	1.2:1
Nov	442.32	5,688.95	1:12.86	46,878.67	38,772.43	1.2:1
Dec	237.40	3,597.35	1:15.15	42,970.46	30,052.21	1.4:1
TOTAL	5,881.24	64,687.69	1:10.6	542,563.93	448,565.05	1.2:1

Notes:

1. January 2001 solid waste tonnage revised in April 2001.
2. March asbestos cover tonnage and solid waste cover tonnage revised in April 2001.

Monthly Summary of Activities in Phases III/IV/V (Continued)

MONTH	ADDITIONAL COVER (cy)	SLAG USED FOR ROADS (tons)
Jan	0	5,994.00
Feb	4,312	10,000.16
Mar	0	11,733.68
Apr	0	3,201.67
May	0	5,599.02
Jun	0	7,740.87
Jul	0	6,337.38
Aug	0	2,907.96
Sep	0	3,124.34
Oct	0	2,232.55
Nov	0	3,423.37
Dec	0	3,819.82
TOTAL	4,312	66,114.82

Additional cover was used as follows to fill in low spots:

December
None

November
None

October
None

September
None

August
None

July
None

June
None

May
None

April
None

March
None

February
Barrier (2,856 cy)
Recovermat (1,456 cy)

January
None

Stabilized Sludge Delivered to CIL and PPLF by VFL

	ASBESTOS COVER		SLOPE COVER		TOPSOIL BLEND		PPLF		TOTAL	
MONTH	(loads)	(tons)	(loads)	(tons)	(loads)	(tons)	(loads)	(tons)	LOADS	TONS
Jan	282	4,526.71	416	7,567.28	41	841.04	784	14,212.54	1,523	27,147.57
Feb	347	6,179.26	183	3,849.04	159	3,231.82	198	4,129.53	887	17,389.65
Mar	389	6,942.14	123	2,748.62	0	0.00	317	6,965.78	829	16,656.54
Apr	348	6,213.62	306	6,681.40	0	0.00	0	0.00	654	12,895.02
May	435	8,195.82	330	7,422.47	0	0.00	0	0.00	765	15,618.29
Jun	271	4,754.82	469	9,594.22	0	0.00	360	7,748.46	1,100	22,097.50
Jul	410	7,468.01	391	7,971.90	0	0.00	136	2,833.14	937	18,273.05
Aug	227	4,083.82	518	10,584.51	0	0.00	801	17,449.13	1,546	32,117.46
Sep	177	3,280.68	461	9,563.85	0	0.00	311	6,862.77	949	19,707.30
Oct	214	3,756.51	586	11,963.66	0	0.00	0	0.00	800	15,720.17
Nov	320	5,688.95	458	9,770.00	0	0.00	1,107	24,241.10	1,885	39,700.05
Dec	211	3,597.35	409	8,603.66	0	0.00	0	0.00	620	12,201.01
TOTAL	3,631	64,687.69	4,650	96,320.61	200	4,072.86	4,014	84,142.45	12,495	249,523.61

Notes:

1. March 2001 asbestos cover, slope cover and total tonnage revised in April 2001.

Recovered Resources Delivered to CIL

	COMPANY (tons)							
MONTH	BARRIER	SLAG	CLEAN EARTH	VFL REAGENT M	MATERIALS RECOVERY	RECOVERMAT	OTHER	TOTAL (tons)
Jan	4,890.83	7,336.56	11,372.64	6,261.01	0.00	0.00	79.95	29,940.99
Feb	4,333.52	10,640.57	12,479.68	5,756.08	0.00	2,211.62	0.00	35,421.47
Mar	4,908.34	12,673.60	8,798.34	6,782.38	0.00	2,301.65	1,786.80	37,251.11
Apr	4,363.40	3,846.99	7,699.09	9,316.89	0.00	2,420.95	1,218.37	28,865.69
May	4,862.79	6,476.95	21,889.01	5,655.76	0.00	2,175.99	0.00	41,060.50
Jun	4,922.07	8,406.49	20,964.53	5,972.56	0.00	2,375.25	1,591.29	44,232.19
Jul	5,589.25	7,143.51	15,725.36	5,010.19	1,930.85	2,308.83	819.00	38,526.99
Aug	5,466.53	3,620.89	6,762.00	2,892.21	9,321.30	2,719.71	3,081.55	33,864.19
Sep	4,139.03	3,319.96	7,706.20	2,158.41	4,084.16	1,893.10	101.75	23,402.61
Oct	5,283.41	2,898.54	17,069.41	1,173.31	0.00	865.58	962.31	28,252.56
Nov	4,882.90	3,910.39	19,546.03	0.00	0.00	729.22	1,323.44	30,391.98
Dec	4,769.56	4,357.48	15,931.20	0.00	0.00	726.34	103.31	25,887.89
TOTAL	58,411.63	74,631.93	165,943.49	50,978.80	15,336.31	20,728.24	11,067.77	397,098.17

The "other" category is comprised of the following:

December
Excavated clean soil from DuPont Edgemoor (21.45 tons). $0/ton.
Leaves from VFL (81.86 tons). $0/ton.

November
Excavated clean soil from DuPont Edgemoor (1,144.28 tons). $0/ton.
Leaves from VFL (179.16 tons). $0/ton.

October
Excavated clean soil from DuPont Edgemoor (934.86 tons). $0/ton.
Leaves from VFL (27.45 tons). $0./ton.

September
Excavated clean soil from DuPont Edgemoor (101.75 tons). $0./ton.

August
Excavated clean soil from DuPont Edgemoor (3,081.55 tons). $0/ton.

July
Crushed asphalt stockpiled for future roads. (819.00 tons). Purchased from G&F for $6.80/ton.

June
Crushed asphalt stockpiled for future roads. (1,591.29 tons). Purchased from G&F for $6.80/ton.

May
None

April
Crushed asphalt used for wet weather areas (1,218.37 tons). Purchased from Diamond Materials for $6.80/ton.

March
Crushed asphalt used for wet weather areas (1,786.90 tons). Purchased from Diamond Materials for $6.80/ton.

February
None

January
Conectiv (79.95 tons), excavated clean soil.

Materials Recycled at CIL

MONTH	Yard Waste Received (tons)	Yard Waste Shred (tons)	Non-CFC White Goods Sent to Market (tons)	CFC White Goods Sent to Market (tons)	Tires Received (tons)	Tires Sent to Market (tons)	Recycled C&D Sent to Burns (tons)
Jan	17.03	809.38	46.69	18.99	42.00	0.00	80.28
Feb	43.90	0.00	23.04	14.11	48.90	181.36	83.27
Mar	40.73	0.00	44.21	20.91	57.52	0.00	139.41
Apr	106.62	0.00	61.21	18.36	54.73	18.66	0.00
May	180.99	0.00	38.05	36.64	47.04	0.00	98.42
Jun	116.39	1,404.00	20.04	43.62	100.17	79.77	225.15
Jul	71.48	0.00	37.09	24.16	58.89	98.88	274.21
Aug	91.51	0.00	44.58	45.93	124.07	107.98	213.33
Sep	74.57	131.57	51.04	21.40	58.87	243.93	216.17
Oct	96.14	154.86	66.09	52.72	86.48	215.28	232.67
Nov	66.97	473.13	61.12	30.44	105.64	75.84	182.81
Dec	77.76	0.00	64.70	32.93	50.29	81.44	168.48
TOTAL	984.09	2,972.94	557.86	360.21	834.60	1,103.14	1,914.20

Notes:

1. The "Yard Waste Received" tonnage represents "yard waste only" loads. This number includes PTCTS yard waste transferred to CIL.

2. The "Tires Received" tonnage represents "tire only" loads. This number includes PTCTS tires transferred to CIL.

3. 0 tons of C&D material was sent to Burns for recycling during the month of April. During that time, DSWA was waiting for DNREC approval to continue the C&D recycling efforts.

Leachate Quality and Quantity

During the month of December, SAIC sampled the North-central and Main pumpstations on December 4 and December 18, 2001. Both samples were 24-hour composites. The sample taken on December 4, 2001 was a mixture of CIL leachate and leachate from CSWMC and SSWMC. The sample taken on December 18, 2001 was of only CIL leachate.

Total Site Leachate Discharge for Calendar Year 2001

MONTH	CIL (gallons)	OFFSITE LEACHATE CSWMC (gallons)	OFFSITE LEACHATE SSWMC (gallons)	OFFSITE LEACHATE TOTAL (gallons)	TOTAL SITE DISCHARGE (gallons)	# DAYS	AVG CIL DISCHARGE PER DAY (gallons/day)	AVG CIL DISCHARGE PER/ACRE/DAY (gals/acre/day)	AVG TOTAL DISCHARGE PER DAY (gallons/day)
Jan	4,563,091	605,230	211,679	816,909	5,380,000	32	142,597	669	168,125
Feb	5,369,990	1,029,060	198,950	1,228,010	6,598,000	28	191,785	900	235,643
Mar	5,525,897	1,182,036	385,067	1,567,103	7,093,000	31	178,255	837	228,806
Apr	5,973,650	1,005,355	211,995	1,217,350	7,191,000	29	205,988	967	247,966
May	5,519,856	777,964	224,180	1,002,144	6,522,000	31	178,060	836	210,387
Jun	6,211,777	1,448,424	289,799	1,738,223	7,950,000	30	207,059	972	265,000
Jul	5,623,163	922,129	258,708	1,180,837	6,804,000	30	187,439	880	226,800
Aug	4,422,567	592,659	303,774	896,433	5,319,000	31	142,663	670	171,581
Sep	4,129,154	437,849	181,997	619,846	4,749,000	31	133,199	625	153,194
Oct	3,650,129	327,357	106,514	433,871	4,084,000	31	117,746	553	131,742
Nov	3,609,000	242,777	94,538	337,315	3,946,315	30	120,300	565	131,544
Dec	3,936,000	234,022	194,373	428,395	4,364,395	32	123,000	577	136,387
TOTAL	58,534,274	8,804,862	2,661,574	11,466,436	70,000,710	366	159,930	751	191,259

Note:

1. In accordance with CIL's wastewater discharge permit (W-88-02), the average daily discharge during a sixth month monitoring period (period 1= January – June and period 2 = July – December) cannot exceed 500,000 gpd.

2. Gallons per acre per day is based on a total Phases I-V in use acreage of 213 acres.

3. Total site discharge for July was corrected as of the August monthly report.

Summary By Offsite Origin for Calendar Year 2001

MONTH	CSWMC Area E Facility Tanks (gallons)	SSWMC Cell 1 (gallons)	SSWMC Cell 2 T2A/2B (gallons)	SSWMC Cell 2 T2C/2D (gallons)	SSWMC Cell 3 (gallons)	SSWMC TOTAL (gallons)	TOTAL OFFSITE GALLONS
Jan	605,230	31,197	25,180	31,110	124,192	211,679	816,909
Feb	1,029,060	37,456	12,398	37,465	111,631	198,950	1,228,010
Mar	1,182,036	31,436	37,602	24,283	291,746	385,067	1,567,103
Apr	1,005,355	37,468	12,549	43,942	118,036	211,995	1,217,350
May	777,964	25,213	18,436	37,679	142,851	224,179	1,002,143
Jun	1,448,424	56,319	43,444	37,010	153,026	289,799	1,738,223
Jul	922,129	31,281	18,523	35,420	173,484	258,708	1,180,837
Aug	592,659	56,014	18,566	59,096	170,098	303,774	896,433
Sep	437,849	25,062	25,002	31,501	100,432	181,997	619,846
Oct	327,357	25,209	18,950	22,221	40,134	106,514	433,871
Nov	242,777	18,847	6,319	31,518	37,854	94,538	337,315
Dec	234,022	31,525	18,755	25,062	119,031	194,373	428,395
TOTAL	8,804,862	407,027	255,724	416,307	1,582,515	2,661,573	11,466,435

Summary of Gas Monitoring Data For 2001

MONTH	TOTAL mSCF collected from CIL	TOTAL mSCF sent to Conectiv from CIL	mSCF Flared	TOTAL mSCF collected from COW and sent to Conectiv	TOTAL mSCF collected from CIL and COW	TOTAL mSCF sent to Conectiv	% cH4 (AVG)
Jan	48.903	48.903	0.000	10.159	59.062	59.062	51-53
Feb	41.394	41.394	0.000	7.872	49.266	49.266	51-53
Mar	50.673	50.673	0.000	12.714	63.387	63.387	51-53
Apr	54.753	52.305	2.448	14.177	68.930	66.482	51-53
May	52.222	46.744	5.478	12.183	64.405	58.927	51-53
Jun	58.253	57.843	0.410	14.123	72.376	71.966	51-53
Jul	56.189	55.928	0.261	15.880	72.069	71.808	51-53
Aug	50.467	49.185	1.282	16.289	66.756	65.474	51-53
Sep	54.441	54.441	0.000	11.778	66.219	66.219	51-53
Oct	60.967	59.104	1.863	14.089	75.056	73.193	51-53
Nov	65.709	65.709	0.000	15.184	80.893	80.893	51-53
Dec	67.573	67.573	0.000	12.310	79.883	79.883	51-53
TOTAL	661.544	649.802	11.742	156.758	818.302	806.560	

- The flare was not in operation during the month of December.

- The plant was down for a total of 6.0 hours;
  - 5.7 hours to install manual bypass valves on compressor oil lines;
  - 0.3 hours due to Conectiv gas line or automatic gas line valve freezing up.

- No. 1 Compressor was down for an additional 4 hours for maintenance and 17.7 hours due to Conectiv gas line or automatic gas line valve freezing up. The line froze because of very low temperatures.

- No. 2 Compressor was down for an additional 3.2 hours for maintenance.

- On December 4 and December 5, Surface Monitoring for the 4th quarter was conducted in Phases I, II, III and IV. All readings were satisfactory.

2f. Closure and Post Closure Care

- The detailed cost estimate for closure and post-closure care is included in the FY 00 Annual Report. DSWA and its auditors, Coles, Dietz, Mustaro and Thomas generate the information. On December 20, 2000, DSWA submitted the Financial Assurance Mechanism Certification to Ms. Nancy Marker at DNREC. The certification is for the Fiscal Year ending June 30, 2000.

2g. Deviations From Approved Operating Plan For Calendar Year 2001

- None to report.

2h. Summary of Construction or Corrective Work

- None to report.

ARS:ur
Attachments

c: Board of Directors
N. C. Vasuki, P. E., DEE
P. S. Canzano, P. E., DEE
T. E. Houska II, P.E.
R. J. Peters, Sr.

January 18, 2001

Ref.: CIL – 01.03

TO: Richard P. Watson, P.E., DEE
Chief Engineer

FROM: Robin M. Roddy, P.E.
Facility Manager

SUBJECT: CHERRY ISLAND LANDFILL (CIL) OPERATIONS REPORT FOR DECEMBER 2000

Operation Summary

- During the month of December, Greggo & Ferrara (G&F) landfilled solid waste from commercial vehicles in the 4th lift of the southwest portion of Phase IV. G&F landfilled solid waste from non-commercial vehicles in the 4th lift of the northwest portion of Phase III.

- During the month of December, landfilling of Asbestos Containing Materials (ACM) in Phase I continued outside of a 400' radius from the northwest corner of Phase I due to movement detected in IC-4 and IC-6 between April and July 2000. ACM landfilling will resume within the 400' radius in January with weekly monitoring of instruments in the area including:
  Inclinometers, P1-IC-4, P1-IC-6, P1-IC-9, P1-IC-10 and P1-IC-11
  Standpipe Piezometers, IC-2C and P1-PZ-09
  Vibrating Wire Piezometers, P4-23B

- On December 4, Lou Pisapia and Don Poore conducted a safety inspection at CIL. Mr. Poore issued a report dated January 8, 2001. The report contained only minor safety infractions that have been rectified.

- On December 4, CIL fire extinguishers were serviced.

- RMR met with RPW on December 6, to conduct a CIL site walk to discuss the CIL site improvement project.

- On December 8, five (5) proposals for Contract S00457NC, Construction Management Services for the CIL Improvement Project were received. Staff is reviewing the proposals and intends to shortlist and interview in January 2001.

- Gannett Fleming (GF) conducted the monthly geotechnical monitoring event on December 12th and 13th. Nothing abnormal was reported during that visit.

- On December 13, the Coast Guard illuminated the new lighthouse on the north side of the landfill and turned the power off to the old lighthouse. Landfilling operations at CIL can resume without restrictions in the lighthouse line of site area.

- On Thursday, December 14, Tony A. Casarino, (TAC) G&F's Site Supervisor, noted that the power serving the EPS, SEPS, SCPS and SPS was out. Superior Electric Services (SES) was contacted. SES contacted Conectiv. Conectiv determined that the problem was on DSWA's private line. Conectiv disconnected power to the line in question. SES arranged to have a private locator on site on Friday, December 15. SES and a private locator investigated the situation and determined that a splice was bad in an electrical manhole located on the northeast corner of Phase II. SES ordered a splice repair kit and rented a generator to power the pump stations until the repair could be made. SES worked on the repair on 12/18 and 12/19. The locator was back on site on 12/20 to test the repair. Conectiv was also on site on 12/20 to reconnect the power. Power was restored and the back-up generator was disconnected on 12/20.

- On December 15, Weights and Measures was onsite to test the scales at scalehouse #2. Both scales were approved.

- On December 20, five (5) proposals for Contract S00458NC, Geotechnical Monitoring Services for CIL were received. Staff is reviewing the proposals and intends to shortlist and interview in January 2001.

- On December 20, RMR attended interviews conducted at the Dover office, for Contract S00456NC, CIL Site Improvement Design and Engineering Services. Gannett Fleming, Malcolm Pirnie, Vollmer Associates, W. B. Satterthwaite and SCS were the design firms interviewed that day. Staff intends to make a recommendation to the Technical & Facilities Management Committee on January 11, 2001.

- On December 22, the current CIL operating permits SW-93/02 and SW-95/04 were extended by DNREC until January 22, 2000 in order to allow for resolution of global permit issues currently under appeal by DSWA. The current permits SW-93/02 and SW-95/04 should have expired on September 22, 2000 but were extended until November 22, 2000 and extended again until December 22, 2000.

- On Saturday, December 23, 2000 Jimmy Johnson (G&F) determined that power to the EPS, SEPS, SCPS and SPS was out again. SES arrived onsite on Monday, December 26, 2000 to investigate the problem. SES replaced two (2) additional splices in the same manhole that contained the bad splice earlier in the month. One replaced splice was bad; the other was replaced as a preventative measure. Power was restored that same day.

Pumpstation Activity Report

PUMPSTATION	PUMP STATUS X operational ✓ repair/ maintenance	COMMENTS
Main Pumpstation (MPS) Pump #1 SN: 980701937 Pump #2 SN: 980701665 Spare No Spare	 X X N/A	
North Central Pumpstation (NCPS) Pump #1 SN: 9610001 Pump #2 SN: 9610002 Spare SN: 9610003	 X X X	
East Pumpstation (EPS) Pump #1 SN: 9840083 Pump #2 SN: 9850043 Spare SN: 9840082	 X X X	Affected by power failure described in Operations Summary.
South East Pumpstation (SEPS) Pump #1 SN: 005309 Pump #2 SN: 95-2987F Spare SN: 95-2987C	 X X X	Affected by power failure described in Operations Summary.
South Pumpstation (SPS) Pump #1 SN: 9250008 Pump #2 SN: 9250010 Spare SN: 9250009	 X X X	Affected by power failure described in Operations Summary.
South Central Pumpstation (SPS) Pump #1 SN: 95-2987C Pump #2 SN: 95-2987A Spare SN: 004942	 X X X	Affected by power failure described in Operations Summary.

Pumpstation Activity Report Continued

PUMPSTATION	PUMP STATUS X operational ✓ repair/ maintenance	COMMENTS
Central Pumpstation (CPS) Pump #1 SN: 9350005 Pump #2 SN: 9350006 Spare SN: 9350007	 X X X	On December 4, Tony Casarino (TAC), G&F's Site Supervisor discovered that CPS pump #1 and #2 were intermittently turning on and off. TAC suspected a bad relay, Superior Electric Service (SES) was contacted. On December 5, SES replaced both float control relays at the Central Pump Station. Affected by power failure described in Operations Summary.

Monthly Breakdown of Solid Waste Tonnage During Calendar Year 2000

MONTH	MSW	SPECIAL WASTE	ASBESTOS	TOTAL
Jan	34,894.41	247.97	73.93	35,216.31
Feb	36,492.58	178.74	245.69	36,917.01
Mar	45,170.10	125.83	200.80	45,496.73
Apr	42,344.19	97.73	145.34	42,587.26
May	51,837.78	133.71	248.63	52,220.12
Jun	48,909.78	418.40	449.22	49,777.40
Jul	43,966.68	330.40	685.10	44,982.18
Aug	49,075.79	411.01	566.26	50,053.06
Sep	43,180.37	235.95	559.39	43,975.71
Oct	43,965.76	86.59	616.01	44,668.36
Nov	43,228.20	147.28	551.04	43,926.52
Dec	38,165.88	243.11	516.95	38,925.94
TOTAL	521,231.52	2,656.72	4,858.36	528,746.60

Summary of 2000 Monthly Capacity Estimates For CIL

MONTH	SOLID WASTE TONNAGE	ESTIMATED REMAINING CAPACITY (TONS)	ESTIMATED REMAINING CAPACITY (MOS.)
Jan	35,216.31	7,265,792	161.46
Feb	36,917.01	7,228,875	160.64
Mar	45,496.73	7,183,378	159.63
Apr	42,587.26	7,140,791	158.68
May	52,220.12	7,088,571	157.52
Jun	49,777.40	7,038,793	156.42
Jul	44,982.18	6,993,811	155.42
Aug	50,053.06	6,943,758	154.31
Sep	43,975.71	6,899,783	153.33
Oct	44,668.36	6,855,114	152.34
Nov	43,926.52	6,811,188	151.36
Dec	38,925.94	6,772,262	150.49
TOTAL	528,746.60	N/A	N/A

Estimated Remaining Capacity of CIL

- Total estimated capacity for solid waste in CIL
  CIL----------12,755,000 tons

- Total tonnage landfilled in CIL
  as of 12/31/99----------5,489,208 tons

- Estimated capacity remaining for solid waste
  in CIL as of 12/31/99----------7,265,792 tons

Note:
Sample Estimated Remaining Capacity Calculation: (estimated remaining capacity in tons) ÷ (average monthly tonnage from CIL). Average monthly tonnage for April 1999 – December 1999 was 45,000 tons. Use April 1999 – December 1999 since all waste was delivered to CIL during those months. This reflects current operations.

Example: $\frac{7,265,792 \text{ tons}}{45,000 \text{ tons}} = 161.46$ months

Summary of Special Wastes Landfilled (tons)
Calendar Year 2000

MONTH	GA GULF/ KANEKA	MEDAL L.P.	HMMT	OTHER	TOTAL
Jan	56.00	3.31	0.00	188.66	247.97
Feb	45.47	5.18	1.72	126.37	178.74
Mar	46.75	12.59	0.00	66.49	125.83
Apr	48.39	7.87	0.00	41.47	97.73
May	57.89	0.82	0.00	75.00	133.71
Jun	30.67	3.54	0.00	384.19	418.40
Jul	15.57	5.23	0.00	309.60	330.40
Aug	58.47	6.14	10.29	336.11	411.01
Sep	40.27	1.03	0.00	194.65	235.95
Oct	40.44	1.50	7.37	37.28	86.59
Nov	63.69	0.00	0.00	83.59	147.28
Dec	54.26	0.00	0.00	188.85	243.11
TOTAL	557.87	47.21	19.38	2,032.26	2,656.72

December

Kaneka – biosolids

The "other" category is comprised of the following companies:

CitiSteel USA – scarfing dust (17.89 tons)
BOC Gases – molecular sieve (33.34 tons)
FMC Biopolymer – microcrystalline cellulose and cellulose derivative products (72.92 tons)
New Castle County Dept. of Special Services – army creek groundwater treatment plant sludge (27.52 tons)
Uniqema - non-hazardous press cake (30.98 tons)
VPI Mirrex Corp. – press cake sludge (6.20 tons)

November

Kaneka – biosolids

The "other" category is comprised of the following companies:

The Chloramone Company – cellroom filter press sludge (5.41 tons)
CitiSteel USA – scarfing dust (16.78 tons)
Delaware Importers – rejected wine (15.58 tons)
DuPont White Pigment and Mineral Products – pebble lime (1.84 tons)

Hoober, Inc. – rubber tracks (9.80 tons)
Uniqema - non-hazardous press cake (23.61 tons)
VPI Mirrex Corp. – press cake sludge (10.57 tons)

October

Kaneka – biosolids
Medal, L. P. – polymer waste
HMMT – ADA filter press sludge

The "other" category is comprised of the following companies:

CitiSteel USA – scarfing dust (14.02 tons)
Uniqema - non-hazardous press cake (17.68 tons)
VPI Mirrex Corp. – press cake sludge (5.58 tons)

September

Kaneka – biosolids
Medal, L. P. – polymer waste

The "other" category is comprised of the following companies:

The Chloramone Company – cellroom filter press sludge (7.24 tons)
CitiSteel USA, Inc. – scarfing dust (20.12 tons)
DuPont White Pigment and Mineral Products – sandblast grit (6.42 tons)
– stabilized sludge (8.97 tons)
– chlorinator brick, mortar and gangue (65.10 tons)
– fiberglass vessels and piping (3.94 tons)
– ceramic liners (14.13 tons)
– pebble lime (8.98 tons)
New Castle County Dept. of Special Services – dewatered sludge (31.91 tons)
Uniqema - non-hazardous press cake (21.81 tons)
VPI Mirrex Corp. – press cake sludge (6.03 tons)

August

Kaneka – biosolids
Medal, L. P. – polymer waste
HMMT – ADA filter press sludge

The "other" category is comprised of the following companies:

CitiSteel USA, Inc. – scarfing dust (10.40 tons)
Dana Railcare – aerosil, hydrophobic amorphous fumed silica (6.12 tons)

DuPont Facility Services Experimental Station – excavated soil and concrete mixture (152.51 tons)
DuPont White Pigment and Mineral Products – chlorinator brick, mortar and gangue (74.21 tons)
– pebble lime (1.92 tons)
Eckerd Corporation – over the counter drugs (7.16 tons)
NVF Company - B-drum waste (11.81 tons)
Turner Underground – bentonite slurry (1.55 tons)
Uniqema - non-hazardous press cake (58.49 tons)
VPI Mirrex Corp. – press cake sludge (11.94 tons)

July

Kaneka – biosolids
Medal, L. P. – polymer waste

The "other" category is comprised of the following companies:

CitiSteel USA, Inc. – scarfing dust (9.10 tons)
DuPont White Pigment and Mineral Products – chlorinator brick, mortar and gangue (194.23 tons)
– pebble lime (2.90 tons)
– medial mill grit (15.97 tons)
LAX (DE) QRS 12-16, Inc. – silicon carbide, silicon nitride, betone, graphite, wallastonite and klucel J (24.68 tons)
Railworks Kennedy – railroad crossing panels and ties (23.20 tons)
Uniqema - non-hazardous press cake (33.68 tons)
VPI Mirrex Corp. – press cake sludge (5.84 tons)

June

Kaneka – biosolids
Medal, L. P. – polymer waste

The "other" category is comprised of waste from the following companies:

ALANX – calcium metascilicate (12.46 tons)
The Chloramone Company – sludge from the cellroom filter press (6.21 tons)
Conectiv – oil ash (236.38 tons)
DuPont White Pigment and Mineral Products – chlorinator brick, mortar and gangue (19.15 tons)
Enviroclean Services LLC - alcobolic beverages (48.56 tons)
Hercules Research Center – purolite ion exchange resin (2.81 tons)
Uniqema – non-hazardous press cake (58.62 tons)

May

Kaneka – biosolids
Medal, L. P. – polymer waste

The "other" category is comprised of waste from the following companies:

DuPont White Pigment and Mineral Products – chlorinator brick, mortar and gangue (15.73 tons)
- pebble lime (2.53 tons)
NVF Company – alum, copper sulfate and soda ash (9.29 tons)
Uniqema – non-hazardous presscake (47.45 tons)

April

Kaneka – biosludge
Medal, L. P. – polymer waste

The "other" category is comprised of waste from the following companies:

ALANX – calcium metasilicate (2.65 tons)
Delchem, Inc. – calcium carbonate and talc (7.44 tons)
Uniqema – non-hazardous presscake (31.38 tons)

March

Kaneka – biosludge
Medal, L. P. – polymer waste

The "other" category is comprised of waste from the following companies:

DuPont White Pigment Material Products – chlorinator brick, mortar and gangue (27.04 tons)
- media mill grit (0.85 tons)
Uniqema – non-hazardous presscake (38.60 tons)

February

Kaneka – biosludge
HMMT – ADA filter press sludge
Medal, L. P. – polymer waste

The "other" category is comprised of waste from the following companies:

The Chloramone Company – cellroom filter press (6.18 tons)
Delchem, Inc. – calcium carbonate and talc (12.28 tons)
E. I. DuPont De Nemours & Co. – dirt and rock (55.14 tons)
Roger Oswalt Produce, Inc. – cantaloupe (20.49 tons)
Uniqema – non-hazardous presscake (32.28)

January

Kaneka – biosludge
Medal, L. P. – polymer waste

The "other" category is comprised of waste from the following companies:

EA Engineering – timber piles (152.16 tons)
Uniqema – non-bazardous presscake (36.50 tons)

Summary of Activities in Phase IA
During Calendar Year 2000

MONTH	DELIVERED TO CIL				CSWMC ASBESTOS DELIVERED TO CIL (tons)	SSWMC ASBESTOS DELIVERED TO CIL (tons)	RECYCLED BATTERIES (tons)	TOTAL LANDFILLED (tons)
	FRIABLE ASBESTOS (tons)	NON FRIABLE ASBESTOS		CIL SUB-TOTAL (tons)				
		Cat. I (tons)	Cat. II (tons)					
Jan	61.26	4.02	8.65	73.93	0.00	0.00	0.00	73.93
Feb	88.02	133.34	24.33	245.69	0.00	0.00	0.00	245.6
Mar	44.35	99.05	45.18	188.58	0.00	12.22	0.00	200.
Apr	93.13	8.62	35.76	137.51	7.83	0.00	0.00	145.34
May	135.63	13.47	81.30	230.40	0.00	18.23	0.00	248.63
Jun	268.88	92.85	87.49	449.22	0.00	0.00	8.95	458.17
Jul	398.20	218.51	68.39	685.10	0.00	0.00	0.00	685.10
Aug	451.68	36.79	77.79	566.26	0.00	0.00	1.48	567.74
Sep	462.80	64.27	32.32	559.39	0.00	0.00	0.00	559.39
Oct	489.99	53.60	51.85	595.44	11.25	9.32	7.68	623.69
Nov	458.04	28.29	30.00	516.33	8.58	26.13	0.00	551.04
Dec	414.70	63.02	39.23	516.95	0.00	0.00	10.20	527.15
TOTAL	3,366.68	815.83	582.29	4,764.80	27.66	65.90	28.31	4,886.67

Summary of Activities in Phase IA

During Calendar Year 2000 (Continued)

MONTH	STAB. SLUDGE USED IN PHASE IA (cy)	SLAG USED IN PHASE IA (tons)
Jan	960	209.64
Feb	1,968	499.92
Mar	1,356	236.31
Apr	1,224	602.48
May	1,608	526.83
Jun	2,664	661.16
Jul	3,288	486.45
Aug	2,904	820.17
Sep	3,540	500.79
Oct	3,996	881.29
Nov	3,492	683.81
Dec	2,832	759.81
TOTAL	29,832	6,868.66

Summary of State Asbestos Projects Landfilled in Phase IA
During Calendar Year 2000
(Figures are Estimated)

MONTH	FRIABLE (tons)	NON-FRIABLE Category I (tons)	NON-FRIABLE Category II (tons)	TOTAL ASBESTOS LANDFILLED From State Projects (tons)
Jan	23.04	0.00	1.28	24.32
Feb	42.49	54.23	0.15	96.87
Mar	11.01	8.43	0.00	19.44
Apr	16.51	8.87	0.00	25.38
May	7.22	22.55	5.27	35.04
Jun	126.41	58.46	10.20	195.07
Jul	94.11	264.46	5.15	363.72
Aug	85.89	34.43	9.45	129.77
Sep	11.99	26.03	0.00	38.02
Oct	45.32	0.00	0.00	45.32
Nov	4.47	0.00	0.00	4.47
Dec	3.64	1.12	0.00	4.76
TOTAL	472.10	478.58	31.50	982.18

Monthly Summary of Activities in Phases III/IV/V

MONTH	SOLID WASTE (tons)	DAILY COVER (Slope) STAB SLUDGE (tons)	TARPS (sf)	OTHER (tons)
Jan	35,142.38	10,251.77	8,375	0.00
Feb	36,671.32	7,566.77	2,250	0.00
Mar	45,295.93	11,333.00	26,000	486.00
Apr	42,441.92	11,333.49	70,000	314.00
May	51,971.49	11,731.42	90,000	273.00
Jun	49,328.18	13,297.37	86,000	0.00
Jul	44,297.08	13,078.97	110,000	0.00
Aug	49,486.80	13,885.24	108,000	0.00
Sep	43,416.32	9,262.96	90,000	0.00
Oct	44,052.35	9,262.47	163,000	0.00
Nov	43,375.48	7,895.48	148,000	0.00
Dec	38,408.99	6,398.76	163,000	0.00
TOTAL	523,888.24	125,297.70	1,064,625	1,073.00

MONTH	DAILY COVER (Top) BARRIER (tons)	CLEAN EARTH (tons)	RCLMD INT.CVR. (cy)	GLEN MILLS (tons)	REAGENT M. (tons)	MLK (tons)	OTHER (tons)
Jan	3,986.60	14,166.76	0	0.00	0.00	214.40	12,794.53
Feb	3,033.42	8,563.76	0	10,560.53	0.00	414.33	11,156.53
Mar	3,765.03	9,280.17	0	7,178.11	0.00	2,662.77	17,122.86
Apr	3,637.78	0.00	0	3,457.93	0.00	1,370.01	10,466.22
May	3,424.97	15,149.21	0	186.08	0.00	539.27	4,223.64
Jun	3,747.44	29,921.43	0	0.00	0.00	70.12	1,934.92
Jul	4,028.52	13,084.48	0	2,253.79	0.00	798.99	0.00
Aug	5,014.33	18,453.64	0	92.04	191.77	1,372.39	0.00
Sep	4,660.68	7,835.80	0	2,917.30	5,526.72	239.17	929.77
Oct	5,159.70	21,420.37	0	2,175.54	6,806.55	431.02	0.00
Nov	5,392.02	15,896.02	2,957	4,212.02	7,094.63	320.38	0.00
Dec	4,512.24	12,727.62	3,360	50.24	5,152.53	109.88	0.00
TOTAL	50,362.73	166,499.26	6,317	33,083.58	24,772.20	8,542.73	58,628.47

The "other" category for slope and daily cover combined is comprised of the following:

December
None

November
None

October
None

September
VFL Soil Mix (929.77 tons)

August
None

July
None

June
Bellevue Corp. Center (1,934.92 tons)

May
Bellevue Corp. Center (3,595.85 tons)
Governor Printz (900.79 tons)

April
Bellevue Corp. Center (6,936.04 tons)
Governor Printz (3,844.18 tons)

March
Bellevue Corp. Center (9,165.21 tons)
DuPont Edgemoor (77.13 tons)
Governor Printz (6,943.19 tons)
Riverview Cemetery (937.33 tons)

February
Bellevue Corp. Center (9,131.99 tons)
DuPont Edgemoor (1,333.68 tons)
Governor Printz (380.62 tons)
Riverview Cemetery (290.99 tons)

January
Governor Printz (380.62 tons)
Maryland Material (12,104.30 tons)
Riverview Cemetery (309.61 tons)

Monthly Summary of Activities in Phases III/IV/V (Continued)

MONTH	INTERMEDIATE COVER (cy)	SLAG USED FOR ROADS (tons)
Jan	2,976	5,310.09
Feb	0	7,614.21
Mar	1,148	4,231.22
Apr	0	8,514.63
May	0	5,217.18
Jun	0	7,857.57
Jul	0	5,612.62
Aug	0	3,808.87
Sep	0	4,172.77
Oct	0	3,121.01
Nov	0	2,213.58
Dec	0	1,296.46
TOTAL	4,124	58,970.21

Intermediate cover was used as follows:

March
Maryland material - (1,148 cy – top cover and filled in various slope washouts)

January
Stabilized Sludge – (1,164 cy-slope cover)
Maryland Material – (1,812 cy- top cover)

Stabilized Sludge Delivered to CIL by VFL

	ASBESTOS COVER		SLOPE COVER		BIOBLEND		TOTAL	
MONTH	(loads)	(tons)	(loads)	(tons)	(loads)	(tons)	LOADS	TONS
Jan	86	1,807.08	519	10,251.77	0	0.00	605	12,058.85
Feb	106	1,914.36	350	7,566.77	0	0.00	456	9,481.13
Mar	144	2,587.38	545	11,333.00	0	0.00	689	13,920.38
Apr	82	1,863.05	562	11,333.49	0	0.00	644	13,196.54
May	121	2,170.51	558	11,731.42	0	0.00	679	13,901.93
Jun	218	4,026.25	662	13,297.37	0	0.00	880	17,323.62
Jul	264	4,362.29	732	13,078.97	0	0.00	996	17,441.26
Aug	242	3,965.86	767	13,885.24	0	0.00	1,009	17,851.10
Sep	296	4,534.68	512	9,262.96	0	0.00	808	13,797.64
Oct	314	4,896.64	499	9,262.47	0	0.00	813	14,159.11
Nov	271	4,609.24	402	7,895.48	0	0.00	673	12,504.72
Dec	211	3,360.21	338	6,398.76	0	0.00	549	9,758.97
TOTAL	2,355	40,097.55	6,446	125,297.70	0	0.00	8,801	165,395.25

Recovered Resources Delivered to CIL

MONTH	COMPANY (tons)					OTHER (tons)	TOTAL
	BARRIER	SLAG	CLEAN EARTH	VFL REAGENT M	MLK		
Jan	3,986.60	5,519.73	14,166.76	0.00	214.40	690.23	24,577.72
Feb	3,033.42	8,114.13	8,563.76	0.00	414.33	11,156.53	31,282.17
Mar	3,765.03	4,467.53	9,280.17	0.00	2,662.77	17,122.86	37,298.36
Apr	3,637.78	9,117.11	0.00	0.00	1,370.01	10,780.22	24,905.12
May	3,424.97	5,744.01	15,149.21	0.00	539.27	4,496.64	29,354.10
Jun	3,747.44	8,518.73	29,921.43	0.00	70.12	1,934.92	44,192.64
Jul	4,028.52	6,099.07	13,084.48	0.00	798.99	0.00	24,011.06
Aug	5,014.33	4,629.04	18,453.64	191.77	1,372.39	0.00	29,661.17
Sep	4,660.68	4,673.56	7,835.80	5,526.72	239.17	929.77	23,865.70
Oct	5,159.70	4,002.30	21,420.37	6,806.55	431.02	0.00	37,819.94
Nov	5,392.02	2,897.39	15,896.02	7,094.63	320.38	0.00	31,600.44
Dec	4,512.24	2,056.27	12,727.62	5,152.53	109.88	0.00	24,558.54
TOTAL	50,362.73	65,838.87	166,499.26	24,772.20	8,542.73	47,111.17	363,126.[illegible]

The "other" category is comprised of the following:

December
None

November
None

October
None

September
VFL Soil Mix (929.77 tons)

August
None

July
None

June
Bellevue Corp. Center (1,934.92 tons)
Governor Printz (900.79 tons)

May
Bellevue Corp. Center (3,595.85 tons)
Governor Printz (900.79 tons)

April
Bellevue Corp. Center (6,936.04 tons)
Governor Printz (3,844.18 tons)

March
Bellevue Corp. Center (9,165.21 tons)
DuPont Edgemoor (77.13 tons)
Governor Printz (6,943.19 tons)
Riverview Cemetery (937.33 tons)

February
Bellevue Corp. Center (9,131.99 tons)
DuPont Edgemoor (1,333.68 tons)
Governor Printz (399.87 tons)
Riverview Cemetery (290.99 tons)

January
Governor Printz (380.62 tons)
Riverview Cemetery (309.61 tons)

Materials Recycled at CIL

MONTH	Yard Waste Received (tons)	Yard Waste Shred (tons)	Non-CFC White Goods Sent to Market (tons)	CFC White Goods Sent to Market (tons)	Tires Received (tons)	Tires Sent To Market (tons)	Recycled C&D sent to Burns (tons)
Jan	16.63	452.08	18.04	23.31	19.05	0.00	13.73
Feb	3.98	0.00	17.50	19.67	23.42	78.50	83.64
Mar	20.61	0.00	32.12	7.84	41.77	76.66	58.68
Apr	33.07	0.00	31.51	31.63	28.77	30.13	65.84
May	50.77	379.64	39.39	29.41	68.28	47.16	108.17
Jun	79.63	0.00	26.82	13.92	132.00	60.52	245.31
Jul	81.27	0.00	25.41	10.07	44.81	68.40	241.06
Aug	79.90	344.12	14.97	13.71	62.01	92.19	439.14
Sep	44.91	257.10	25.45	19.73	72.02	33.26	210.31
Oct	88.55	0.00	33.47	21.14	77.10	129.71	242.87
Nov	45.01	0.00	16.01	13.97	38.44	44.17	155.80
Dec	15.15	0.00	30.58	22.31	30.88	0.00	98.85
TOTAL	559.48	1,432.94	311.27	226.71	638.55	660.70	1,963.40

Note: The "Yard Waste Received" tonnage represents "yard waste only" loads.

Leachate Quality and Quantity

During the month of December, SAIC sampled the Northcentral and Main pumpstations on December 5 and December 19, 2000. Both samples were 24-hour composites. The sample taken on December 5, 2000 was a mixture of CIL leachate and leachate from CSWMC and SSWMC. The sample taken on December 19, 2000 was of only CIL leachate.

Total Site Leachate Discharge for Calendar Year 2000

MONTH	CIL (gallons)	OFFSITE LEACHATE CSWMC (gallons)	OFFSITE LEACHATE SSWMC (gallons)	OFFSITE LEACHATE TOTAL (gallons)	TOTAL SITE DISCHARGE (gallons)	# DAYS	AVG. CIL DISCHARGE PER DAY (gallons/day)	AVG. CIL DISCHARGE PER/ACRE/DAY (gals/acre/day)	AVG. TOTAL DISCHARGE PER DAY (gallons/day)
Jan	5,550,000	695,017	161,146	856,163	6,406,163	31	179,032	841	206,650
Feb	5,165,693	1,072,871	285,437	1,358,308	6,524,001	29	178,127	836	224,966
Mar	6,440,211	933,329	194,460	1,127,789	7,568,000	31	207,749	975	244,129
Apr	6,147,350	1,317,556	233,094	1,550,650	7,698,000	29	211,978	995	265,448
May	5,582,703	878,588	248,710	1,127,298	6,710,001	32	174,459	819	209,688
Jun	4,289,098	662,089	179,813	841,902	5,131,000	30	142,970	671	171
Jul	5,197,825	638,010	198,166	836,176	6,034,001	31	167,672	787	19
Aug	5,104,032	811,153	174,815	985,968	6,090,000	31	164,646	773	196,452
Sep	5,200,892	813,264	154,844	968,108	6,169,000	30	173,363	814	205,633
Oct	5,423,739	658,043	176,218	834,261	6,258,000	31	174,959	821	201,871
Nov	4,886,962	517,177	136,861	654,038	5,541,000	30	162,899	765	184,700
Dec	3,963,933	728,448	199,619	928,067	4,892,000	30	132,131	620	163,067
TOTAL	62,952,438	9,725,545	2,343,183	12,068,728	75,021,166	365	172,472	810	205,537

Note:

1. In accordance with CIL's wastewater discharge permit (W-88-02), the average daily discharge during a sixth month monitoring period (period 1= January – June and period 2 = July – December) cannot exceed 500,000 gpd.

2. Gallons per acre per day is based on a total Phases I-V in use acreage of 213 acres.

Summary By Offsite Origin for Calendar Year 2000

MONTH	CSWMC Area E Facility Tanks (gallons)	SSWMC Cell 1 (gallons)	SSWMC Cell 2 T2A/2B (gallons)	SSWMC Cell 2 T2C/2D (gallons)	SSWMC Cell 3 (gallons)	SSWMC TOTAL (gallons)	TOTAL OFFSITE GALLONS
Jan	695,017	24,935	6,235	36,815	93,161	161,146	856,163
Feb	1,072,871	37,326	36,341	56,048	155,722	285,437	1,358,308
Mar	933,329	50,578	31,151	43,412	69,319	194,460	1,127,789
Apr	1,317,556	37,818	25,353	43,446	126,477	233,094	1,550,650
May	878,588	25,038	12,540	43,770	167,362	248,710	1,127,298
Jun	662,089	43,146	62,703	18,031	55,933	179,813	841,902
Jul	638,010	37,161	30,679	43,072	87,254	198,166	836,176
Aug	811,153	37,823	30,779	37,470	68,743	174,815	985,968
Sep	813,264	48,945	37,096	43,700	25,103	154,844	968,108
Oct	658,043	31,029	24,719	31,180	89,290	176,218	834,261
Nov	517,177	25,086	6,245	24,223	81,307	136,861	654,038
Dec	728,448	24,935	18,257	50,139	106,288	199,619	928,067
TOTAL	9,725,545	423,820	322,098	471,306	1,125,959	2,343,183	12,068,728

Summary of Gas Monitoring Data For 2000

MONTH	TOTAL mSCF collected from CIL	TOTAL mSCF collected from COW	TOTAL mSCF COLLECTED	mSCF sent to CONECTIV	mSCF Flared	% cH4 (AVG)
Jan	73.720	0	73.720	69.29	4.43	53-56
Feb	76.965	0	76.965	74.963	2.003	53-56
Mar	87.496	0	87.496	87.469	0.000	53-56
Apr	74.357	0	74.357	74.357	0.000	53-56
May	76.253	0	76.253	76.028	0.225	53-56
Jun	72.148	0	72.148	72.148	0.000	53-56
Jul	59.556	0	59.556	59.358	0.198	53-56
Aug	58.372	0	58.372	57.63	0.743	51-53
Sep	58.326	0	58.326	58.326	0.000	51-53
Oct	63.708	0	63.708	63.708	0.000	51-53
Nov	56.606	10.944	67.550	67.377	0.173	51-53
Dec	52.556	6.935	59.491	56.391	3.099	51-53
TOTAL	810.063	17.879	827.942	817.045	10.871	

- The flare was in operation for 94 hours during the month of December.
- The plant was down for a total of 105.5 hours:
  - 102.2 hours because of gas lines freezing up due to severe cold weather.
  - 3.3 hours due to Conectiv units 3&4 tripping and not able to accept landfill gas.
- No. 1 compressor was down for and additional 36.3 hours for maintenance.
- No. 2 compressor was down for an additional 76.2 hours for maintenance.
- Surface monitoring of the landfill for the 4th quarter was done during the month of December. All readings were below the permissible limit.

2f. Closure and Post Closure Care

- The detailed cost estimate for closure and post-closure care is included in the FY 99 Annual Report. DSWA and its auditors, Coles, Dietz, Mustaro and Thomas generate the information. On December 20, 2000, DSWA submitted the Financial Assurance Mechanism Certification to Ms. Nancy Marker at DNREC. The certification is for the Fiscal Year ending June 30, 2000.

2g. Deviations From Approved Operating Plan For Calendar Year 2000

None to report.

2h. Summary of Construction or Corrective Work

None to report.

RMR:ur
Attachments

c: Board of Directors
N. C. Vasuki, P. E., DEE
P. S. Canzano, P. E., DEE
T. E. Houska II, P.E.
R. J. Peters, Sr.

February 28, 2000

Ref.: CIL – 00.11

TO: Richard P. Watson, P.E., DEE
Chief Engineer

FROM: Ann Marie Andrzejewski, P.E.
Facility Manager

SUBJECT: CHERRY ISLAND LANDFILL (CIL) OPERATIONS REPORT FOR DECEMBER 1999

Operation Summary

- During the month of December, George & Lynch (G&L) landfilled on the western side of the 3rd lift of Phases III and IV (see the attached map).

- At approximately 10:30 p.m. on December 1, Jim Ricci, Cereza Energy (Cereza) was paged. Jim arrived at 11:00 p.m. at CIL and found No. 1 compressor down and No. 2 compressor on-line with a high discharge pressure (55 psi – normal is 30-40 psi). Jim called Conectiv. Jim discovered that Conectiv was having problems and that Conectiv could not accept gas from Cereza. Jim stopped No. 2 compressor at 11:30 p.m. and started the flare at 11:45 p.m.

- On December 2, Jim informed me that he bad to start the flare the previous night (December 1). The plant was running again by 9:30 a.m. on December 2.

- At approximately 9:00 a.m., Evelyn Renshaw and Janet Dick (weighmasters on duty) informed me of minor gas odors present at scalebouse 1. I explained to them that the flare had been running since 11:45 p.m. on December 1 and that gas odors may be more prevalent because the flare only pulls 300 cfm (at that time) and the gas plant pulls 2,000 cfm. Cereza modified the blower to the flare on December 7. The flare now operates between 700-900 cfm.

- Doug Martin, VFL Technologies (VFL) and Dick Green (VFL) were onsite on December 2 to inspect the blending experiment of Barrier and bottom ash. The blend was a 50/50 by volume mix - 304 tons of bottom ash was blended with 54.63 tons of Barrier.

- The user fee sign at entrance 2 was installed on new signposts on December 2.

- Tom Houska and I conducted a tour of CIL for an environmental group on December 6.

- The City of Wilmington (Sid Sharma and Martha Corrozi) conducted the Annual Industrial User Inspection of CIL on December 7. No deficiencies were noted during the inspection. Sid did note during the inspection and on the Industrial User Inspection Report that he revised DSWA's reporting requirements for the Self-Monitoring Report. DSWA is now only required to report the mixed sample (CIL leachate and offsite leachate) results.

- I met with VFL (Lou Ruggiano and Bob Jones) on December 8 regarding the topsoil bioblending trial to discuss the terms for finalizing the purchase order.

- MGK and EG Controls (EG) were onsite on December 17, attempting to finalize outstanding items for the SCADA system.

- On December 17, Gannett Fleming (GF) was onsite and raised the Phase III Western TPC and Phase IV Western TPC cluster. Pneumatic piezometers P3-103 D and E were flushed

- Cereza welded the new header pipe for wells 40 and 44 on December 22. A trench was dug and the header was placed in the trench in January.

- The gas plant was down from 9:00 to 12:30 on December 25. This occurred because the line to the sump froze. The line was heat traced later in the day.

- On December 26, the gas plant was down again from 6:15 a.m. to 7:30 a.m. due to a power surge (low line voltage). The plant was restarted at 7:30 a.m. However, from 12:30 p.m. to 1:30 p.m. the plant was down because Conectiv re-routed the power. Conectiv was working on a power surge problem from earlier in the day. The plant does not have an auto restart after a power loss. The plant was manually started again at 1:30 p.m.

- Superior Electric Service (SES) was onsite on December 30 and completed installation of the backup generator at scale #1.

- Throughout the month of December, H&H sent seven 30 cy rolloffs with yard waste collected at PTCTS to CIL. The yard waste collected at PTCTS was shred at CIL (due to limited space and operator availability at PTCTS – an operator is needed to assist MES with the shredding operation) in December.

- The following is a summary of maintenance related activities at each of the CIL pumpstations:

  Main Pumpstation (MPS):
  - No action to report.

North-central Pumpstation (NCPS)

- On December 20, MGK was onsite to conduct the following at the NCPS:
  1. Eye seals installed on the conduits;
  2. Lines were installed in the control panel to allow for remote start/stop of the pumps via the SCADA system.
  3. Two (2) new dry contacts were installed, which are normally closed.

- I called SES on December 22 because pump #1 was not running. The hour meters indicated that pump #1 had not run since Monday, December 20. I attempted to turn pump #1 on in manual, but it would not run. I left a message for SES (Al Shields) regarding the situation.

- On December 27, I left another message for Al Shields regarding pump #1. I had not yet received a response from my call on December 22.

- On December 29, SES was onsite and the dry contact that MGK installed was found "open" and therefore not feeding electric to pump #1. In order to get the pump to run Frank (SES) moved the wire from terminal 61 to terminal 62.

East Pumpstation (EPS)

- On December 10, SES installed pump #1 (SN 9850043). (Note this pump was ultimately returned to DSWA in February 1999 after repairs were made. Please also note that pump SN 9850043 was originally delivered, as a spare (had never been used by DSWA) in January 1999 with a power cable that was too short. SES installed the pump on January 22, 1999 and SES did not notice that the power cord was too short. This caused damage to the pump. The pump was removed on January 26, 1999. SES and Flygt split the cost of repairs).

- On December 29, SES was onsite and disconnected pump #1 (SN 9850043) because of moisture and over-temperature. G&L replaced the bearings on January 3, 2000.

Southeast Pumpstation (SEPS):

- No action to report.

South Pumpstation (SPS):

- No action to report.

South-central Pumpstation (SCPS):

- No action to report.

Central Pump Station (CPS)

- On December 8, G&L turned off pump #2 because of moisture (SN 9350005). Superior Electric Service (SES) disconnected the pump on December 10. The pump was sent to Flygt for repairs in January 2000 because G&L did not have time to repair the pump.

Monthly Breakdown of Solid Waste Tonnage During Calendar Year 1999

MONTH	MSW	SPECIAL WASTE	ASBESTOS	TOTAL
Jan	23,310.47	490.03	187.66	23,988.16
Feb	20,532.65	114.51	105.29	20,752.45
Mar	33,109.18	59.74	117.06	33,285.98
Apr	44,949.69	270.82	171.72	45,392.23
May	44,983.10	121.64	231.42	45,336.16
Jun	47,396.17	57.12	377.99	47,831.28
Jul	41,342.71	150.36	641.76	42,134.83
Aug	42,546.84	136.81	550.37	43,234.02
Sep	48,940.87	128.90	240.83	49,310.60
Oct	42,921.31	319.97	196.40	43,437.68
Nov	45,377.67	141.82	202.76	45,722.25
Dec	42,366.26	441.64	161.06	42,968.96
TOTAL	477,776.92	2,433.36	3,184.32	483,394.60

Estimated Remaining Capacity of Phases III, IV and V

- Total area of Phase III disposal area----------40 acres
- Total area of Phase IV disposal area----------50 acres
- Total area of Phase V disposal area----------60 acres
- Total estimated capacity for solid waste in Phases III, IV and V----------7,920,214 tons[1]
- Total tonnage landfilled in Phases III, IV, and V as of 12/31/98----------1,644,154 tons
- Estimated capacity remaining for solid waste in Phases III, IV and V as of 12/31/98----------6,276,806 tons

1. Capacity calculated from volumes taken from Phase III Top of Grading Plan, Phase IV Top of Final Cover System and the Phase V Design Criteria Report. Total volume for cover and solid waste is 19,284,000 cy. Assumed 2.5 to 1 solid waste to cover ratio and 1,150 lbs./cy average solid waste density.

Summary of 1999 Monthly Capacity Estimates For Phases III/IV/V

MONTH	SOLID WASTE TONNAGE	ESTIMATED REMAINING CAPACITY (TONS)	ESTIMATED REMAINING CAPACITY (MOS.)
Jan	23,800.50	6,253,005.50	146.28[2]
Feb	20,647.16	6,232,358.34	145.79
Mar	33,168.92	6,199,189.42	145.02
Apr	45,220.51	6,153,968.91	143.96
May	45,104.74	6,108,864.17	142.90
Jun	47,453.29	6,061,410.88	141.79
Jul	41,493.07	6,019,917.81	140.82
Aug	42,683.65	5,977,234.16	139.82
Sep	49,069.77	5,928,164.39	138.68
Oct	43,241.28	5,884,923.11	137.67
Nov	45,519.49	5,839,403.62	136.60
Dec	42,807.90	5,796,595.72	135.60
TOTAL	480,210.28	N/A	N/A

2. Calculated with Engineer's design data in Footnote 1 and average tonnage for 1998 (42,748). Calculation: (estimated remaining capacity in tons) ÷ (average monthly tonnage from CIL & PPTS during 1998). Since all waste is now delivered to CIL, total 1998 tonnage was CIL (241,524) + PPTS (271,448) = 512,972.
Example: $\frac{6,253,005 \text{ tons}}{42,748 \text{ tons}}$ = 146 months.

Summary of Special Wastes Landfilled (tons)
Calendar Year 1999

MONTH	GA GULF/ KANEKA	MEDAL L.P.	HMMT	OTHER	TOTAL
Jan	113.41	2.22	0.00	374.40	490.03
Feb	113.07	1.44	0.00	0.00	114.51
Mar	32.92	4.42	0.00	22.40	59.74
Apr	28.38	2.75	0.00	239.69	270.82
May	41.94	0.00	19.70	60.00	121.64
Jun	55.48	1.64	0.00	0.00	57.12
Jul	38.32	4.31	6.34	101.39	150.36
Aug	0.00	37.26	0.00	99.55	136.81
Sep	75.82	3.54	7.98	41.56	128.90
Oct	71.75	7.28	5.16	235.78	319.97
Nov	93.39	0.00	0.00	48.43	141.82
Dec	45.72	0.00	0.00	395.92	441.64
TOTAL	710.20	64.86	39.18	1,619.12	2,433.36

December

Kaneka – biosludge

The "other" category is comprised of waste from the following companies:

The Chloramone Company – solka floc sludge (7.24 tons)
DuPont White Pigment and Mineral Products – waste media mill grit (18.40 tons)
Hercules Research Center – sand filter media (13.92 tons)
ICI Americas Inc. – non-hazardous press cake (48.57 tons)
LaFarge Gypsum – gypsum material (307.79 tons)

November

Kaneka – biosludge

The "other" category is comprised of waste from the following companies:

DuPont White Pigment and Mineral Products – waste media mill grit (11.89 tons)
ICI Americas Inc. – non-hazardous press cake (32.73 tons)

Occidental Chemical Corp. – crushed RCRA empty steel drums (3.81 tons)

October

Kaneka – biosludge
Medal, L.P. – polymer waste
HMMT – ADA filter press sludge

The "other" category is comprised of waste from the following companies:

The Chloramone Company – sludge from the cellroom filter press (8.90 tons)
E. I. DuPont De Nemours & Co. – dirt and rock (34.38 tons)
NVF Company – cellulose rags (192.50 tons)

September

Kaneka – biosludge
Medal L.P. – polymer waste
HMMT – ADA filter press sludge

The "other" category is comprised of waste from:

DuPont White Pigments: waste media mill grit

August

Medal, L. P. – polymer waste

The "other" category is comprised of the following companies:

The Chloramone Company – sludge from the Cellroom Filter Press (8.75 tons)
DuPont White Pigment and Mineral Products – chlorinator brick, mortar and gangue (90.80 tons)

July

Kaneka – biosludge
Medal, L. P. – polymer waste
HMMT – ADA filter press sludge

The "other" category is comprised of the following:

EA Engineering – Timber piles (101.39 tons)

June

Kaneka – biosludge
Medal, L. P. – polymer waste.

May

Kaneka – biosludge
Hazardous Material Management Team – ADA filter press sludge

The "other" category is comprised of the following companies:

DuPont Co. Edgemoor Plant – hoses and pipe debris (40.08 tons)
ICI Americas Inc. – non-hazardous press cake (19.07 tons)
Port Contractors – food grade emulsion (0.85 tons)

April

Kaneka – biosludge
Medal, L. P. – polymer waste

The "other" category is comprised of the following companies:

DuPont Co. Edgemoor Plant – chlorinator brick, mortar and gangue (225.21 tons)
ICI Americas Inc. – non-hazardous press cake (14.48 tons)

March

Kaneka – biosludge
Medal, L. P. – polymer waste

The "other category is comprised of the following:

Environmental Industrial Services Corp. – kiln dust solid, faction and garbage (22.40 tons)

February

Kaneka – biosludge
Medal L. P. – polymer waste

January

Kaneka – biosludge
Medal, L. P. – polymer waste

The "other" category is comprised of the following companies:

Delmarva Power and Light – dewatered wastewater treatment plant sludge (36.86 tons)
DuPont Company Edgemoor Plant – chlorinator brick, mortar and gangue (335.46 tons)
WIK Associates – fiberglass tanks (2 .08 tons)

Summary of Activities in Phase IA
During Calendar Year 1999

MONTH	DELIVERED TO CIL				CSWMC ASBESTOS DELIVERED TO CIL (tons)	SSWMC ASBESTOS DELIVERED TO CIL (tons)	RECYCLED BATTERIES (tons)	TOTAL LANDFILLED (tons)[3]
	FRIABLE ASBESTOS (tons)	NON FRIABLE ASBESTOS		CIL SUB-TOTAL (tons)				
		Cat. I (tons)	Cat. II (tons)					
Jan	118.23	50.13	19.30	187.66	0.00	0.00	0.00	187.66
Feb	70.40	2.34	32.55	105.29	0.00	0.00	0.00	105.29
Mar	52.84	19.88	27.15	99.87	0.00	17.19	0.00	117.06
Apr	61.79	36.34	66.21	164.34	7.38	0.00	0.00	171.72
May	118.87	44.35	68.20	231.42	0.00	0.00	0.00	231.42
Jun	201.41	127.40	49.18	377.99	0.00	0.00	0.00	377.99
Jul	296.06	235.86	91.74	623.66	9.83	8.27	0.00	641.76
Aug	122.24	338.87	89.26	550.37	0.00	0.00	0.00	550.37
Sep	98.62	60.49	59.96	219.07	7.99	13.77	0.00	240.83
Oct	108.93	67.99	19.48	196.40	0.00	0.00	0.00	196.40
Nov	83.11	73.41	46.24	202.76	0.00	0.00	9.24	212.00
Dec	95.34	17.79	47.93	161.06	0.00	0.00	0.00	161.06
TOTAL	1,427.84	1,074.85	617.20	3,119.89	25.20	39.23	9.24	3,193.56

3. Includes State and Non-State Projects as well as recycled batteries.

Summary of Activities in Phase IA
During Calendar Year 1999 (Continued)

MONTH	STAB. SLUDGE USED IN PHASE IA (cy)	SLAG USED IN PHASE IA (tons)
Jan	2,472	533.79
Feb	1,404	544.39
Mar	2,213	684.19
Apr	3,584	981.20
May	2,282	779.54
Jun	2,954	748.73
Jul	3,350	869.20
Aug	2,820	1,226.15
Sep	1,440	402.94
Oct	1,440	632.66
Nov	1,548	731.81
Dec	1,140	371.32
TOTAL	26,647	8,505.92

Summary of State Asbestos Projects Landfilled in Phase IA During Calendar Year 1999 (Figures are Estimated)

MONTH	FRIABLE (tons)	NON-FRIABLE Category I (tons)	NON-FRIABLE Category II (tons)	TOTAL ASBESTOS LANDFILLED From State Projects (tons)
Jan	22.75	13.76	0.71	37.22
Feb	6.40	2.34	4.67	13.41
Mar	13.26	0.00	1.20	14.46
Apr	30.77	4.15	0.00	34.92
May	8.49	0.00	0.00	8.49
Jun	118.91	116.08	0.00	234.99
Jul	201.80	223.86	24.86	450.52
Aug	111.02	323.17	45.42	479.61
Sep	36.20	44.40	11.65	92.25
Oct	14.37	8.96	0.00	23.33
Nov	30.40	0.00	4.98	35.38
Dec	72.85	5.17	4.66	82.68
TOTAL	667.22	741.89	98.15	1,507.26

Monthly Summary of Activities in Phases III/IV/V

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MONTH	SOLID WASTE (tons)	DAILY COVER (Slope) STAB SLUDGE (cy)	TARPS (sf)	RECLAIMED INT. COVER (sf)	OTHER (cy)	DAILY COVER (Top) TOP[4] MIX (cy)	CLEAN EARTH (cy)	RECLAIMED INT. COVER (sf)	OTHER (cy)
Jan	23,800.50	7,356	0	32,125	0	8,640	0	24,260	0
Feb	20,647.16	1,620	0	71,200	0	3,168	1,824	78,244	0
Mar	33,168.92	7,847	0	13,130	0	0	12,400	2,020	681
Apr	45,220.51	13,249	0	9,750	0	0	15,507	0	545
May	45,104.74	19,292	0	0	0	0	6,110	65,350	1,228
Jun	47,453.29	17,286	0	75,675	0	0	14,175	0	0
Jul	41,493.07	9,845	0	46,980	0	0	14,552	0	595
Aug	42,683.65	3,038	77,000	33,150	0	0	6,212	0	11,189
Sep	49,069.77	550	40,875	164,575	0	0	11,662	0	4,760
Oct	43,241.28	0	49,575	168,225	0	0	7,952	0	9,179
Nov	45,519.49	0	62,875	183,400	0	0	6,912	0	9,604
Dec	42,807.90	1,337	79,925	148,625	3,568	0	9,590	0	16,400
TOTAL	480,210.28	81,420	310,250	946,835	3,568	11,808	106,896	169,874	54,181

120

The "other" category is comprised of the following:

December

Slope

Reclaimed soil (dredge spoil) from appliance area in Phase IA (3,568 cy)

Top

Barrier (6,300 cy)
Maryland Materials (6,821 cy)
Martin Luther King (409 cy)
DuPont Boiler Soil (647 cy)
Governor Printz Soil (1,041 cy)
VFL ADC (Bottom Ash and Reagent "M") (1182 cy)

November

Barrier (7,350 cy)
Governor Printz soil (1,708 cy)
Martin Luther King soil (378 cy)
DuPont boiler ash soil (168 cy)

4. Top Mix figure represents Stab Sludge + Bottom Ash. (Placed in approximately 18" lifts.) Assume Stab Sludge = 65% of mixture.

Leachate Quality and Quantity

R. E. Wright Laboratory Services sampled the Northcentral and Main pumpstation on December 7 and 16, 1999. Both samples were 24-hour composites. The sample taken on December 7, 1999 was a mixture of CIL leachate and leachate from CSWMC and SSWMC. The sample taken on December 16, 1999 was of only CIL leachate.

Total Site Leachate Discharge for Calendar Year 1999

MONTH	CIL (gallons)	OFFSITE LEACHATE			TOTAL SITE DISCHARGE (gallons)	# DAYS	AVG. CIL DISCHARGE PER DAY (gallons/day)	AVG. TOTAL DISCHARGE PER DAY (gallons/day)
		CSWMC (gallons)	SSWMC (gallons)	TOTAL (gallons)				
Jan	5,446,239	534,060	284,446	818,506	6,264,745	30	181,541	208,825
Feb	7,759,713	521,345	364,441	885,787	8,645,500	33	235,143	261,985
Mar	6,098,972	717,556	289,072	1,006,628	7,105,600	28	217,820	253,771
Apr	5,875,516	567,791	344,693	912,484	6,788,000	28	209,840	242,429
May	4,989,662	391,372	155,966	547,338	5,537,000	29	172,057	190,931
Jun	3,995,520	209,434	161,046	370,480	4,366,000	27	147,982	161,704
Jul	3,490,842	195,710	308,448	504,158	3,995,000	32	109,089	124,844
Aug	3,433,871	532,441	216,688	749,130	4,183,000	30	114,462	139,433
Sep	7,331,381	1,629,842	314,777	1,944,619	9,276,000	30	244,379	309,200
Oct	7,516,343	1,540,365	162,293	1,702,657	9,219,000	31	242,463	297,387
Nov	5,427,122	664,484	276,393	940,878	6,368,000	30	180,904	212,267
Dec	4,962,947	933,837	247,216	1,181,053	6,144,000	30	165,432	204,800
TOTAL	66,328,128	8,438,237	3,125,480	11,563,717	77,891,845	358	185,274	217,575

Note: In accordance with CIL's wastewater discharge permit (W-88-02), the average daily discharge during a sixth month monitoring period (period 1= January – June and period 2 = July – December) cannot exceed 500,000 gpd.

August
Rotomill

April
Cover from Greenville Texaco

January
Coal Slag Residue from Stolzfus

Materials Recycled at CIL

MONTH	Yard Waste Received (tons)	Yard Waste Shred (tons)	Non-CFC White Goods Sent to Market (tons)	CFC White Goods Sent to Market (tons)	Tires Rec'd and Placed in Phase IA (tons)	Tires Sent To Market (tons)	Recycled C&D sent to Burns (tons)
Jan	18.64	0.00	11.42	10.75	47.15	67.12	0.00
Feb	13.45	0.00	21.16	11.62	88.61	66.30	0.00
Mar	68.54	300.72	23.95	11.41	73.64	32.15	0
Apr	109.54	0.00	26.39	18.36	67.70	205.10	0.00
May	59.39	332.74	37.39	14.19	56.69	50.86	0.00
Jun	52.71	0.00	40.36	28.18	33.22	98.46	0.00
Jul	42.77	0.00	15.47	47.86	23.84	82.52	0.00
Aug	24.00	295.92	8.81	23.75	66.11	0.00	0.00
Sep	79.68	0.00	42.19	27.27	31.23	55.20	25.49
Oct	38.56	0.00	28.67	33.76	24.47	78.49	95.88
Nov	37.73	0.00	27.26	17.57	21.56	44.51	86.42
Dec	31.40	518.28	50.33	12.04	76.39	94.03	110.67
TOTAL	576.41	1,447.66	333.40	256.76	610.61	874.74	318.46

Note: The "Yard Waste Received" tonnage represents "yard waste only" loads.

Recovered Resources Delivered to CIL

MONTH	COMPANY (tons)					OTHER (tons)	TOTAL
	MUMFORD & MILLER	BARRIER	SLAG	CLEAN EARTH	RESOURCE RECOVERY STONE		
Jan	0.00	0.00	4,365.51	0.00	0.00	503.30	4,868.81
Feb	3,876.15	0.00	4,875.61	10,614.19	0.00	0.00	19,365.95
Mar	1,186.40	593.31	1,771.54	24,215.25	218.32	0.00	27,984.82
Apr	1,117.19	1,167.42	981.20	19,509.44	0.00	681.11	23,456.36
May	1,842.37	1,295.89	1,901.94	17,661.86	0.00	0.00	22,702.06
Jun	32.60	1,345.07	2,633.95	24,661.36	0.00	0.00	28,672.98
Jul	0.00	1,233.60	2,855.36	19,171.75	0.00	0.00	23,260.71
Aug	0.00	1,944.16	4,501.14	16,134.80	0.00	531.38	23,111.48
Sep	0.00	2,621.71	8,967.07	19,834.59	0.00	2,573.63	33,997.00
Oct	0.00	3,476.18	4,214.27	12,975.94	0.00	4,307.50	24,973.89
Nov	0.00	4,078.97	6,076.81	11,118.70	0.00	3,228.39	24,502.87
Dec	0.00	3,414.94	7,198.83	16,095.46	0.00	15,361.90	42,071.13
TOTAL	8,054.71	21,171.25	50,343.23	191,993.34	218.32	27,187.21	298,968.06

The "other" category is comprised of the following:

December

Maryland Material (10,393.60 tons)
Martin Luther King Soil (623.95 tons)
DuPont Boiler Ash Soil (985.26 tons)
Governor Printz Soil (1,586.16 tons)
VFL ADC (Bottom Ash and Reagent "M") (1, 772.93 tons)

November

Martin Luther King Soil (570.41 tons)
DuPont Boiler Ash Soil (272.68 tons)
Governor Printz Soil (2,385.30 tons)

October

Governor Printz Soil

September

Governor Printz Soil

Stabilized Sludge Delivered to CIL by VFL

	ASBESTOS COVER		SLOPE COVER		OUTER SLOPE		TOP MIX		BIOBLEND		TOTAL	
MONTH	(loads)	(tons)	(loads)	(tons)	(loads)	(tons)	(loads)	(tons)	(loads)	(tons)	LOADS	TONS
Jan	171	2,664.70	0	0.00	0	0.00	733	13,712.89	0	0.00	904	16,377.59
Feb	88	1,501.77	0	0.00	0	0.00	366	6,564.24	0	0.00	454	8,066.01
Mar	157	2,498.48	577	9,497.64	0	0.00	0	0.00	0	0.00	734	11,996.12
Apr	248	4,097.58	223	3,990.82	0	0.00	0	0.00	0	0.00	471	8,088.40
May	205	3,394.92	47	783.77	0	0.00	0	0.00	0	0.00	252	4,178.69
Jun	306	5,289.12	0	0.00	0	0.00	0	0.00	0	0.00	306	5,289.12
Jul	326	5,183.31	0	0.00	64	1,096.22	0	0.00	54	948.42	444	7,227.95
Aug	277	4,226.12	140	2,468.29	0	0.00	0	0.00	86	1,849.35	503	8,543.76
Sep	142	2,259.16	0	0.00	0	0.00	0	0.00	0	0.00	142	2,259.16
Oct	100	1,872.96	0	0.00	0	0.00	0	0.00	0	0.00	100	1,872.96
Nov	210	4,413.90	0	0.00	0	0.00	0	0.00	0	0.00	210	4,413.90
Dec	149	3,316.93	76	1,604.15	0	0.00	0	0.00	0	0.00	225	4,921.08
TOTAL	2,379	40,718.95	1,063	18,344.67	64	1,096.22	1,099	20,277.13	140	2,797.77	4,745	83,234.74

Monthly Summary of Activities in Phases III/IV/V (Continued)

MONTH	INTERMEDIATE COVER (cy)	SLAG USED FOR ROADS (tons)
Jan	0	3,831.72
Feb	1,378	4,331.22
Mar	2,595	1,087.35
Apr	1,664	0.00
May	224	1,119.90
Jun	0	1,885.22
Jul	0	1,986.16
Aug	0	3,274.99
Sep	0	7,230.91
Oct	0	3,581.61
Nov	0	5,345.00
Dec	912	6,827.51
TOTAL	6,773	40,501.59

October
Barrier (6,135 cy)
Governor Printz soil (3,044 cy)

September
Barrier

August
Barrier (3,801 cy)
Clean Earth on slopes (7,388 cy)

July
Barrier

May
Cover from Mumford & Miller – Naamans Road Project.

April
Cover from Mumford & Miller.

March
Cover from Greenville Texaco Station.

Summary By Offsite Origin for Calendar Year 1999

	CSWMC				SSWMC				
MONTH	Area A/B (gallons)	Area C (gallons)	Area D (gallons)	TOTAL (gallons)	Cell 1 (gallons)	Cell 2 - T2A/2B (gallons)	Cell 2 - T2C/2D (gallons)	Cell 3 (gallons)	TOTAL (gallons)
Jan	325,811	83,962	124,288	534,060	57,046	18,499	61,993	146,909	284,446
Feb	346,983	84,077	90,285	521,345	43,952	22,489	42,398	255,602	364,441
Mar	458,036	127,717	131,803	717,556	55,290	24,192	43,456	166,134	289,072
Apr	331,321	102,470	134,000	567,791	36,928	30,477	24,748	252,540	344,693
May	215,204	85,655	90,513	391,372	31,209	12,400	24,899	87,458	155,966
Jun	111,333	48,525	49,576	209,434	55,909	31,173	55,288	18,676	161,046
TOTAL	1,788,688	532,405	620,465	2,941,559	280,333	139,230	252,782	927,319	1,599,664
	CSWMC Area E Facility Tanks			TOTAL (gallons)					
Jul	195,710			195,710	55,971	25,019	42,703	184,755	308,448
Aug	532,441			532,441	43,374	37,400	43,638	92,276	216,688
Sep	1,629,842			1,629,842	60,005	55,065	55,914	143,794	314,777
Oct	1,540,365			1,540,365	37,619	24,830	37,271	62,573	162,293
Nov	664,484			664,484	31,309	18,971	56,518	169,595	276,393
Dec	933,837			933,837	43,528	25,072	50,084	128,532	247,216
TOTAL	5,496,679			8,438,237	552,139	325,588	538,909	1,708,844	3,125,480

Summary of Gas Monitoring Data For 1999

MONTH	mSCF sent to CONECTIV	mSCF Flared	TOTAL mSCF COLLECTED	% cH4 (AVG)
Jan	80.876	0.8586	81.735	54-56
Feb	80.042	0.036	80.078	54-56
Mar	91.688	0.072	91.78	54-56
Apr	86.117	0.000	86.117	54-56
May	89.339	0.126	89.465	53-56
Jun	74.772	0.575	75.289	53-56
Jul	79.373	1.297	80.671	53-56
Aug	79.499	1.388	80.838	53-56
Sep	66.496	2.158	68.654	53-56
Oct	90.392	0.085	90.477	53-56
Nov	77.827	0.345	78.172	53-56
Dec	72.085	0.28	72.365	53-56
TOTAL	968.506	7.2206	975.641	[illegible]

- The flare was in operation during the month for 12.5 hours.

- The plant was down:
  1. 11.8 hours because Conectiv Power was having problems with the landfill gas valve;
  2. 3.8 hours for emission tests on the flare;
  3. 3.5 hours due to low line voltage and
  4. 1.4 hours because the gas supply line to sump pump froze.

- No. 2 compressor was down for 414.3 hours because the motor cooling fan fell off the shaft and bearing failure problems.

- Wells No. 18, 20, 27, 40 and 44 had no vacuum on them because the suction lines were crushed. The lines to the wells were replaced in January 2000.

2f. Closure and Post Closure Care

- The detailed cost estimate for closure and post-closure care is included in the FY 98 Annual Report. DSWA and its auditors, Coles, Dietz, Mustaro and Thomas generate the information.

2g. Deviations From Approved Operating Plan For Calendar Year 1999

None to report.

2h. Summary of Construction or Corrective Work

None to report.

AMA:ur
Attachments

c: Board of Directors
N. C. Vasuki, P. E., DEE
P. S. Canzano, P. E., DEE
T. E. Houska II, P.E.
R. J. Peters, Sr.
R. F. Alexander, P.E.

March 1, 1999

Ref.: CIL – 99.36

TO: Richard P. Watson, P.E., DEE
Chief Engineer

FROM: Ann Marie Dykes, P.E.
Facility Manager

SUBJECT: CHERRY ISLAND LANDFILL (CIL) OPERATIONS REPORT FOR DECEMBER 1998

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1. Operation Summary

- I spoke with Sid Sharma (City of Wilmington – COW) on December 1 to request an extension for the construction of the main pumpstation (MPS) at Cherry Island Landfill (CIL). Sid requested that I send him a letter requesting a formal extension.

- I alerted Rodney Alexander on December 1 that a settlement plate and the piezometers in subcell V-1 needed to be raised.

- Site Equipment Corporation delivered the Bomag roller to CIL on December 7. The roller is being used to roll the stabilized sludge/bottom ash blend being used as daily top cover.

- I contacted Superior Electric on December 8 because pump 2 (S/N 95-2987-D) in the southcentral pumpstation (SCPS) was not turning off once the wetwell reached low level conditions.

- Gannett Fleming raised settlement plate, SP5-9 and piezometers, P5-15A, B and C on December 9. DSWA rented a high reach for Gannett Fleming.

- George & Lynch (G&L) informed me on December 9 that the rate to haul stabilized sludge from the stockpile to either the asbestos area or the slope would be $50/hr (including the truck and driver).

- I spoke with Indra Batra on December 9 regarding DSWA's request to renew the permit for asbestos disposal (SWA-93-012). Indra stated that the permit had been renewed and that the new permit is in the mail. The new permit was received on December 14. The new permit

number is SWA-98/14. SWA-98/14 expires on December 14, 2003. DSWA must request an extension no later than 90 days prior (September 14, 1998) to the expiration date.

- MGK paved the new road to the main pumpstation (MPS) on December 10.

- I checked the discharge of the east pumpstation (EPS) pumps on December 10 and found each to operate at approximately 70 gpm.

- Holt's delivery truck pulled down the electric line between the office trailer and the maintenance building on December 11. I contacted Conectiv. Conectiv stated that the line was dead, however I still requested that they resecure the overhead line.

- MES completed the shredding and demobilized on December 11.

- I received a call from Nick Recchi on December 14. Mr. Recchi called to inquire whether DSWA would accept approximately 130 tons of baled phragmites from Star. I directed Mr. Recchi to NC. NC spoke with Bob Hartman about using the phragmites as daily cover. I spoke with Bob and Indra Batra on December 15 and they gave DSWA approval to utilize the the phragmites for daily slope cover.

- Superior Electric removed pump 2 (S/N 95-2987-D) from the SCPS and installed the spare (S/N 95-2987-A) on December 22.

- Mark Mallamo visited CIL on December 22.

- A meeting was held with MGK on December 23.

- Gary Burris informed me on December 28 that the NCPS pumps were running while in low level conditions. I contacted C&D Instruments to see if they could determine the cause of the problem.

- Flygt picked up a faulty pump (S/N 9350006) from the central pumpstation (CPS) on December 29.

- I received a call from a customer on December 29 because he had been tipping G&L employees that had previously helped him unload waste at the working face. The customer said that every time he comes to CIL, the G&L employees help him unload his waste and seem to expect a tip. I informed the customer that G&L employees are not to accept tips from customers. I alerted Gary Burris who said he would put a stop to it.

- Superior Electric and G&L pulled a faulty pump (S/N 9610001) from the NCPS and installed the spare. The pump was sent to Saunder Pumps for service.

2a. Miscellaneous: Calendar Year 1998

MONTH	Stabilized Sludge Received (tons)	Yard Waste Received (tons)	Yard Waste Shred (tons)	Non-CFC White Goods Sent to Market (tons)	CFC White Goods Sent to Market (tons)	Tires Rec'd and Placed in Phase IA (tons)	Tires Sent To Market (tons)
Jan	14,145	14	0	0	14	9	58
Feb	13,027	22	0	15	8	8	0
Mar	14,980	56	0	10	18	35	0
Apr	12,537	89	0	0	7	41	0
May	5,101	84	502	17	6	13	18
Jun	21,356	142	0	15	14	27	0
Jul	26,637	147	0	18	6	243	0
Aug	20,211	62	431	13	7	103	54
Sep	10,555	78	0	18	16	129	0
Oct	21,355	45	0	16	17	295	684
Nov	22,055	50	42	26	34	64	148
Dec	20,923	43	745	6	20	37	49
TOTAL	202,882	832	1,720	154	167	1,004	1,011

Note: The stabilized sludge was either used for daily cover in the asbestos disposal area, active landfill area, or for replenishing the contractor's stockpile.

The "Yard Waste Received" tonnage represents "yard waste only" loads. Mixed yard waste loads were also sent to the yard waste stockpile, but were weighed in as solid waste (23.47 tons of yard waste received from CIL customers and 19.55 tons were delivered to CIL from PTCTS).

Summary of Solid Waste Landfilled in Phases III/IV/V
During Calendar Year 1998

MONTH	SOLID WASTE TONNAGE	DENSITY OF SOLID WASTE #/cy	EST. VOL. (CY) SOLID WASTE	EST. VOL. (CY) DAILY SLOPE COVER PLACED	EST. VOL. (CY) DAILY TOP COVER PLACED	VOL. (CY) OF INTER. COVER	TOTAL VOL. USED (CY)	% OF DAILY VOL. USED BY DAILY COVER
Jan	21,252	1310[1]	32,446	1,032	4,944	628	39,050	15.6
Feb	13,544	1310	20,678	840	3,612	499	25,629	17.7
Mar	16,910	1310	25,817	696	4,776	5,159	36,448	17.5
Apr	22,088	1300[2]	33,982	492	6,364	6,040	46,878	16.8
May	22,305	1300	34,315	216	6,696	2,777	44,004	16.8
Jun	22,132	1300	34,049	1,224	6,552	2,618	44,443	18.6
Jul	21,739	1300	33,445	432	5,568	304	39,749	15.2
Aug	18,778	1300	28,889	900	4,776	0	34,565	16.4
Sep	21,556	1300	33,163	0	8,200	0	41,363	19.8
Oct	21,321	1300	32,802	5,604	9,844	1,368	49,618	24.3
Nov	20,255	1300	31,162	6,348	6,540	0	44,050	29.3
Dec	19,644	1300	30,222	9,420	11,628	0	51,270	33.5
TOTAL	241,524	N/A	370,969	27,204	79,500	19,393	497,066	N/A

Note: 1. Solid Waste Tonnage and Volume of Intermediate Cover taken from CII monthly invoice.

2. % of Daily Vol. Used By Daily Cover = $\frac{\text{Est. Vol. Daily Slope Cover} + \text{Est. Vol Daily Top Cover}}{\text{Est. Vol. Daily Slope Cover} + \text{Est. Vol. Daily Top Cover} + \text{Est. Vol. Solid Waste}}$

3. Starting in October 1998, CIL began using a blend of Recovermat and stabilized sludge for daily top cover. This blend was placed in 12-18 inch lifts. As such, no intermediate will be needed in this fill area. The % of Daily Volume Used was calculated by assuming 50% of the daily top cover was used as actual daily cover.

1. Based on first quarter 1998 density test.
2. Based on second quarter 1998 density test.

Summary of Asbestos Landfilled in Phase IA
During Calendar Year 1998

MONTH	DELIVERED TO CIL				CSWMC DELIVERED TO CIL (tons)[3]	SSWMC DELIVERED TO CIL (tons)	TOTAL ASBESTOS LANDFILLED AT CIL (tons)
	FRIABLE (tons)	NON FRIABLE Category I (tons)	NON FRIABLE Category II (tons)	CIL SUBTOTAL (tons)			
Jan	181	58	50	289	0	0	289
Feb	173	4	25	202	11	0	213
Mar	183	59	30	272	0	0	272
Apr	83	67	40	190	0	8	198
May	85	127	44	256	9	9	274
Jun	188	96	56	340	0	0	340
Jul	160	302	54	516	0	9	525
Aug	197	113	62	372	0	0	372
Sep	102	93	63	258	0	0	258
Oct	99	250	64	413	10	0	423
Nov	110	263	70	443	0	0	443
Dec	116	25	46	187	0	8	195
TOTAL	1,677	1,457	604	3,738	30	34	3,802

3. Includes State and Non-State Projects.

Summary of State Asbestos Projects Landfilled in Phase IA
During Calendar Year 1998
(Figures are Estimated)

MONTH	FRIABLE (tons)	NON-FRIABLE Category I (tons)	NON-FRIABLE Category II (tons)	TOTAL ASBESTOS LANDFILLED From State Projects (tons)
Jan	34.36	22.72	6.25	63.33
Feb	35.59	0.00	0.00	35.59
Mar	10.18	3.06	2.12	15.36
Apr	0.81	17.08	3.94	21.83
May	2.01	8.39	0.00	10.40
Jun	89.00	74.74	0.72	164.46
Jul	83.56	148.54	0.00	232.10
Aug	115.71	57.42	0.20	173.33
Sep	40.98	26.29	9.03	76.30
Oct	6.28	53.61	0.00	59.89
Nov	20.73	17.6	10.55	48.88
Dec	5.59	8.78	0.45	14.82
TOTAL	444.8	438.23	33.26	916.29

Monthly Breakdown of Solid Waste Tonnage
During Calendar Year 1998

MONTH	MSW	ASBESTOS	SPECIAL WASTE	RDF	TOTAL
Jan	20,821	289	142	0	21,252
Feb	13,499	213	45	0	13,757
Mar	16,834	272	76	0	17,182
Apr	21,664	198	424	0	22,286
May	22,229	274	76	0	22,579
Jun	21,937	340	194	0	22,471
Jul	21,673	525	66	0	22,264
Aug	18,445	372	333	0	19,150
Sep	21,433	258	123	0	21,814
Oct	21,275	423	46	0	21,744
Nov	20,227	443	28	0	20,698
Dec	19,425	195	219	0	19,839
TOTAL	239,462	3,802	1,772	0	245,036

2b. Estimated Remaining Capacity of Phases III, IV and V

- Total area of Phase III disposal area----------40 acres
- Total area of Phase IV disposal area----------50 acres
- Total area of Phase V disposal area----------60 acres
- Total estimated capacity for solid waste in Phases III, IV and V----------7,920,214 tons[4]
- Total tonnage landfilled in Phases III, IV, and V as of 12/31/97----------1,402,630 tons
- Estimated capacity remaining for solid waste in Phases III, IV and V as of 12/31/97----------6,518,330 tons
- Estimated capacity remaining for solid waste and cover in Phases III, IV and V as of 12/31/97----15,832,572 cy

4. Capacity calculated from volumes taken from Phase III Top of Grading Plan, Phase IV Top of Final Cover System and the Phase V Design Criteria Report. Total volume for cover and solid waste is 19,284,000 cy. Assumed 2.5 to 1 solid waste to cover ratio and 1,150 lbs./cy average solid waste density.

Summary of 1998 Monthly Capacity Estimates
For Phases III/IV/V

MONTH	SOLID WASTE TONNAGE	ESTIMATED REMAINING CAPACITY (TONS)	TOTAL ESTIMATED CY CONSUMED	ESTIMATED REMAINING CAPACITY (CY)	ESTIMATED REMAINING CAPACITY (MOS.)	
Jan	21,252	6,497,078	39,050	15,793,522	239[5]	321[6]
Feb	13,544	6,483,534	25,629	15,767,893	238	313
Mar	16,910	6,466,624	36,448	15,731,445	238	313
Apr	22,088	6,444,536	46,878	15,684,567	237	311
May	22,305	6,422,231	44,004	15,640,563	236	312
Jun	22,132	6,400,099	44,443	15,596,120	235	304
Jul	21,739	6,378,360	39,749	15,556,371	235	315
Aug	18,778	6,359,582	34,565	15,521,806	234	310
Sep	21,556	6,338,026	41,363	15,480,443	233	297
Oct	21,321	6,316,705	49,618	15,430,825	232	280
Nov	20,255	6,296,450	41,350	15,389,475	232	281
Dec	19,644	6,276,806	51,270	15,338,205	231	244
TOTAL	241,524	N/A	494,367	N/A	N/A	N/A

5. Calculated with Engineer's design data in Footnote 1 and average tonnage for 1997 (27,188 tons/ mo). Calculation: (estimated remaining capacity in tons) ÷ (previous year's average monthly tonnage).
Example: $\frac{6,497,078 \text{ tons}}{27,188 \text{ tons/mo}}$ = 239 months.

6. Calculated with the original design volume listed in section 2B, estimated total volume consumed, estimated volume of daily cover, estimated volume solid waste to daily cover ratio and average tonnage for 1997. (figure does not account for intermediate cover volume) 15,793,593 cy remain for solid waste and cover as of January 31, 1998 using quarterly density test. Calculation: { [estimated remaining capacity in cy (SW : DC)] ÷ [SW : DC ÷ 1] } x density ÷ previous year's average monthly tonnage.
Example: $\frac{15,793,593 \text{ cy } (5.43)}{6.43} \times \frac{1.310 \text{ lb/cy}}{2000 \text{ lbs/ton}} \div 27,188 \text{ tons/mo} = 321 \text{ months}$

2c. Summary of Special Wastes Landfilled (tons)

Calendar Year 1998

MONTH	GA GULF/ KANEKA	MEDAL L.P.	OTHER	TOTAL
Jan	105	4	33	142
Feb	43	2	0	45
Mar	43	4	29	76
Apr	13	11	400	424
May	63	2	12	77
Jun	4	6	135	145
Jul	53	4	9	66
Aug	27	107	199	333
Sep	60	5	58	123
Oct	44	2	0	46
Nov	18	3	7	28
Dec	94	3	122	219
TOTAL	567	153	1,004	1,724

A. December

Kaneka – biodludge
Medal, L. P. – polymer waste

The "other" category is comprised of the following companies:

Delmarva Power and Light – dewatered wastewater treatment plant sludge (103 tons)
Forbes Steel and Wire Corp. - #2 soap and #1 scale wastes (9 tons)
Potts Welding & Boiler Repair Co. – sandblast residue (7 tons)
WIK Associates, Inc. – fiberglass tanks (3 tons)

November

Kaneka – biosludge
Medal, L. P. – polymer waste

The "other" category is comprised of the following companies:

The Chloromone Co. – dry sludge (6 tons)

Clean Earth – bag house filter bags, metal cages and dust (1 ton)

October

Kaneka – biosludge
Medal, L. P. – polymer waste

September

Kaneka – biosludge
Medal, L. P. – polymer waste

The "other" category is comprised of the following companies:

DuPont Company Edgemoor Plant – chlorinator brick, mortar and gangue (50 tons)
WIK Associates, Inc. – debris and carbon black (8 tons)

August

Kaneka – biosludge
Medal, L. P. – polymer waste

The "other" category is comprised of the following companies:

Delmarva Power & Light Company – oil ash from Edgemoor Unit #5 (199 tons)

July

Kaneka – biosludge
Medal, L. P. – polymer waste

The "other" category is comprised of the following companies:

Lanxide Armor Products, Inc. - machine shop composite (5 tons)
NVF Company – fly ash (4 tons)

June

Kaneka – biosludge
Medal, L. P. – polymer waste

The "other" category is comprised of the following companies:

DuPont Company Edgemoor Plant – chlorinator brick, mortar and gangue (127 tons)
ICI Americas, Inc. – presscake (8 tons)

May

Kaneka – biosludge
Medal L.P. – polymer waste
The "other" category is comprised of the following:

Hercules Research Center – Sand filter media (12 tons)

April

Kaneka – biosludge
Medal, L. P. – polymer waste

The "other" category is comprised of the following companies:

Delmarva Power & Light Company – Oil ash from Edgemoor unit # 5 (394 tons)
ICI Americas, Inc. – Non-hazardous presscake (6 tons)

March

Kaneka – biosludge
Medal, L. P. – polymer waste

The "other" category is comprised of the following companies:

Clean Earth of America, Inc. – bag house filters bags, metal cages and dust (20 tons)
Forbes Steel and Wire Corp. - #2 soap and #1 scale waste (9 tons)

February

Kaneka - biosludge
Medal, L. P. - polymer waste

January

Kaneka - biosludge
Medal, L. P. - polymer waste

The "other" category is comprised of the following companies:

ICI Americas, Inc. - presscake (33 tons)

2d. Leachate Quality and Quantity

R. E. Wright Laboratory Services sampled the Northcentral and Northwest Pump Stations on December 8 and 22, 1998. Both samples were 24-hour composites. The sample taken on December 8, 1998 was a mixture of CIL leachate and leachate from CSWMC and SSWMC. The sample taken on December 22, 1998 was of only CIL leachate.

Total Site Leachate Discharge for Calendar Year 1998

MONTH	CIL (gallons)	CSWMC (gallons)	SSWMC (gallons)	TOTAL SITE DISCHARGE (gallons)	# DAYS	AVG. TOTAL DISCHARGE PER DAY (gallons/day)
Jan	7,135,068	649,261	405,774	8,190,103	35	234,003
Feb	7,274,118	682,332	513,508	8,469,958	28	302,499
Mar	9,402,073	760,177	605,435	10,767,685	28	384,560
Apr	6,949,026	695,278	443,933	8,088,237	28	288,866
May	8,944,698	504,686	183,074	9,632,458	35	275,213
Jun	6,195,382	512,132	481,305	7,188,819	28	256,744
Jul	5,054,641	456,672	283,137	5,794,450	28	206,945
Aug	5,108,803	377,341	327,501	5,813,645	35	166,104
Sep	3,248,307	383,259	407,659	4,039,225	28	144,258
Oct	4,093,176	342,849	302,600	4,738,625	35	135,389
Nov	3,408,052	298,686	197,357	3,904,095	28	139,432
Dec	2,694,123	327,393	207,674	3,229,190	28	115,328
TOTAL	69,507,467	5,990,066	4,358,957	79,856,490	N/A	N/A

Note: Errors were found on data entered for January and August 1998. The data has been corrected in the table.

In accordance with CIL's wastewater discharge permit (W-88-02), the average daily discharge during a sixth month monitoring period (period 1 = January – June and period 2 = July – December) can not exceed 500,000 gpd. The average daily discharge for period 1 was 290,314 gpd. The average daily discharge for period 2 was 151,243 gpd.

The average CIL (250 acres) discharge was 385 gal/acre/day.

Summary By Offsite Origin for Calendar Year 1998

MONTH	CSWMC Area A/B (gallons)	CSWMC Area C (gallons)	CSWMC Area D (gallons)	CSWMC TOTAL (gallons)	SSWMC Cell 1 (gallons)	SSWMC Cell 2 T2A/2B (gallons)	SSWMC Cell 2 T2C/2D (gallons)	SSWMC Cell 3 (gallons)	SSWMC TOTAL (gallons)	TOTAL OFFSITE (gallons)
Jan	332,633	149,369	167,259	649,261	125,791	48,367	49,182	182,434	405,774	1,055,035
Feb	455,261	106,647	120,424	682,332	120,482	36,621	54,050	302,355	513,508	1,195,840
Mar	480,424	153,216	126,537	760,177	133,528	30,180	61,082	380,645	605,435	1,365,612
Apr	290,537	142,679	262,062	695,278	95,825	42,959	48,825	256,324	443,933	1,139,211
May	230,609	91,652	182,425	504,686	79,218	24,640	37,178	42,038	183,074	687,760
Jun	217,206	107,962	186,964	512,132	67,106	17,899	55,724	340,576	481,305	993,437
Jul	208,046	103,504	145,122	456,672	61,727	30,465	61,890	129,055	283,137	739,809
Aug	165,264	85,204	126,873	377,341	53,662	49,187	24,257	200,396	327,502	704,843
Sep	164,549	90,408	128,302	383,259	61,024	12,369	60,722	273,544	407,659	790,918
Oct	138,470	89,079	115,300	342,849	48,341	18,278	42,851	193,130	302,600	645,449
Nov	120,199	79,242	99,245	298,686	42,386	18,161	36,400	100,410	197,357	496,043
Dec	152,998	72,487	101,909	327,394	30,652	24,067	54,859	98,096	207,674	535,068
TOTAL	2,956,196	1,271,449	1,762,422	5,990,067	919,742	353,193	587,020	2,499,003	4,358,958	10,349,025

2e. Summary of Gas Monitoring Data For1998

MONTH	mSCF sent to DP&L	mSCF Flared	TOTAL mSCF COLLECTED	% cH4 (AVG)
Jan	56.16	5.88	62.04	54-56
Feb	25.81	12.1	37.91	54-56
Mar	80.26	1.69	81.95	54-56
Apr	73.34	2.45	75.79	54-56
May	84.425	0.306	84.731	54-56
Jun	85.36	0.173	85.532	53-56
Jul	87.541	0.173	87.714	53-56
Aug	74.877	4.797	79.674	53-56
Sep	87.015	0.245	87.26	53-56
Oct	88.276	0.14	88.416	53-56
Nov	86.519	0	86.519	53-56
Dec	79.565	1.074	80.639	53-56
TOTAL	909.148	29.028	938.175	

- The flare was in operation during December for 66.33 hours.
- The plant was down for 72.1 hours during the month due to DP&L shut downs (power surge in #3 Boiler transformer and blockage in gas line due to very low temperatures).

- No. 1 compressor was down for 7 hours for maintenance and 63.4 hours due to water contamination and freezing up of micromaster sensing lines. No. 2 compressor was down for 7.3 hours for maintenance and 41 hours due to micromaster sensing lines freezing up because of very low temperatures. Compressor kept tripping during the month.

- Wells 44, 50 and 51 are still out of service.

2f. Closure and Post Closure Care

The detailed cost estimate for closure and post-closure care is included in the Annual Operating Report submitted to DNREC.

2g. Deviations From Approved Operating Plan For Calendar Year 1998

None to report.

2h. Summary of Construction or Corrective Work

None to report.

AMD:ur
Attachment

c: Board of Directors
N. C. Vasuki, P. E., DEE
P. S. Canzano, P. E., DEE
T. E. Houska II, P.E.
R. J. Peters, Sr.

APPENDIX O-3

SITE HEALTH AND SAFETY PLAN FOR FIELD INVESTIGATIONS

Prepared for

Delaware Solid Waste Authority
1128 South Bradford Street
Dover, Delaware 19903-0455

PHASE I GEOTECHNICAL INVESTIGATION: WASTE UNIT WEIGHT EVALUATION

SITE HEALTH & SAFETY PLAN

Cherry Island Landfill
Wilmington, New Castle County
Delaware

Prepared by

GEOSYNTEC CONSULTANTS
10015 Old Columbia Road, Suite A-200
Columbia, Maryland 21046

Project Number ME0250

March 2002

Project Health and Safety Plan (HASP)

TEMPLATE B

Project Name: Cherry Island Landfill – Site Exploration
Project Number: ME0250

This HASP, which must be kept on site, addresses the safety hazards of each phase of site operation, including the requirements and procedures for worker protection. Only the Site Health and Safety Officer (SHSO) can change or amend this document in agreement with the Environmental Health and Safety Coordinator (EHSC), Project Manager and Principal-in-Charge. The SHSO must initial any change made to the HASP at the relevant section. Major amendments (e.g., changes in fall protection not provided for in this plan, addition of tasks, etc.) must be documented by indicating the amendment date shown on this page.

Prepared by: Jeremy Morris — 3/5/02
SHSO — Date

Reviewed by: Rick Jensen
EHSC — Date

Approved by: David Espinoza
Project Manager — Date

Copy Cover Sheet to: EHSC

Brief Description of Amendment	Amendment Date
No Smoking Anywhere on Site	3/5/02

All site workers must read this HASP. A pre-entry briefing conducted by the SHSO must be held prior to initiating this project. All sections of this HASP must be reviewed during this briefing. Any worker not in attendance at the initial meeting must be trained by the SHSO on the information covered in the pre-entry briefing meeting. ***Tailgate meetings must be held at the beginning of the work shift by the SHSO to discuss important safety issues concerning tasks performed on that day. A brief description of topics discussed in tailgate meetings must be documented in the Field Logbook.*** After reading the HASP and attending a pre-entry briefing, workers must sign the following acknowledgment statement.

I have read, understand, and agree with the information set forth in this HASP. I have also attended a pre-entry briefing. I agree to perform my work in accordance with this HASP.

Name	Date	Name	Date

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Appendix A: Hazard Mitigators Directory
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1. SITE/TASK DESCRIPTION

Brief description of site (including information as to current and previous site usage, location and approximate size of site, and a description of the tasks):

- Site Usage: MSW Landfill
- Site Location: 1706 E. 12th St., Wilmington, DE
- Size of Site: 210 acres
- Expected Field Dates: 7 – 8 March and 11 – 15 March, 2002
  (Beginning date - ending date)
- Tasks for this project include:

① SASW determination of waste unit weight

② Drilling nine boreholes (20 - 75-ft) vertically through landfill

③ Sampling waste, removing waste for weighing, return to working face

④ Backfilling boreholes with pipe and gravel

- Description of Surrounding Property/Population:

North	Urban – Commercial	East	Delaware River
South	Urban – Industrial	West	Urban – Industrial

2. KEY PERSONNEL AND SAFETY RESPONSIBILITIES

Table 1 lists project personnel and their responsibilities in regard to safety concerns on this project.

3. WORKER TRAINING

All on-site workers have met the appropriate CPR and First Aid training requirements according to the company Environmental, Health, and Safety (EH&S) Training Program. A pre-entry briefing and daily tailgate meetings are also conducted to facilitate onsite training.

4. SITE CONTROL

Site control procedures must be implemented **before** the start of site tasks to control worker exposures to safety hazards.

4.1 Site and Hospital Map

A site map is shown as Figure 1. The site map includes the route to the nearest hospital or medical facility.

4.2 Buddy System

APPLIES TO TASK ☒ ① ☒ ② ☒ ③ ☒ ④

The Buddy System is required in the task(s) indicated above. The buddy system includes maintaining regular contact (see Section 4.6) with onsite GeoSyntec personnel, clients and/or contractors.

In situations where task work does not require the buddy system, onsite personnel must have appropriate communication device(s) on his/her person(s) at all times, and shall maintain contact with office personnel, at a minimum, upon arriving at and departing from the site on a daily basis.

4.3. Work Zones

Two work zones must be established for each task. The Exclusion Zone is defined as the area on-site where tasks are to be performed. The Support Zone is defined as the command area and serves as a storage area for supplies. The exact location and extent of the work zones will be modified as necessary as site investigation information becomes available. The boundaries of the Exclusion Zone and Support Zone must be marked using the following methods:

- ☒ Warning tape
- ☒ Traffic cones
- ☒ Signs
- ☐ Fence
- ☐ Other_____

4.4. Site Access

Access to the site must be controlled using the following method:

- ☒ Sign in/Sign out log
- ☒ Guard
- ☐ Identification badges
- ☐ Other:_____

4.5. Visitors

Visitors to the site must be continually escorted in order to assure their safety since they may be unfamiliar with the site. Visitors must not be allowed past the Support Zone unless they read, understand, sign, and meet the requirements outlined in this HASP.

4.6. Communications

On-site communications must be conducted through the use of:

- ☒ Verbal
- ☐ Two-way radio
- ☐ Horn
- ☒ Cellular telephone
- ☐ Siren
- ☒ Hand signals
- ☐ Other:_____

Off-site communications must be conducted through the use of:

- ☒ Cellular telephone
- ☐ Pay phone: Location _____
- ☒ Other: Landfill office landline_____

4.7. Safe Work Practices

General Safe Work Practices that must be implemented during work activities at this site are included in Table 2.

5. HAZARD ANALYSIS AND MITIGATORS

Site specific hazards must be identified (through hazard analysis) to determine the appropriate safety hazard mitigators needed to protect workers from the identified hazards. Hazard analysis involves a complete review of physical and biological hazards.

5.1 Physical Hazards ☒ APPLICABLE ☐ NOT APPLICABLE

Physical hazards associated with tasks to be performed (e.g., electrocution due to drilling, etc.) and site location (e.g., slips, trip, or falls due to rocky terrain, etc.) have been analyzed in Table 3. If, based on the hazard analysis, physical hazards exist, hazard mitigators (Appendix A) must be implemented.

5.2 Biological Hazards ☒ APPLICABLE ☐ NOT APPLICABLE

If, based on the hazard analysis (Table 3), biological hazards exist associated with tasks to be performed and site location (e.g., allergic reactions to poisonous plants or insects indigenous to the area, etc.), hazard mitigators (Appendix A) must be implemented.

6. PERSONAL PROTECTIVE EQUIPMENT

☒ APPLICABLE ☐ NOT APPLICABLE

The following personal protection equipment is required for this project:

☐ Tyvek
☒ Hard Hat
☒ Safety Glasses
☒ Hard-toe boots
☒ Hearing Protector (ear plugs)
☒ Other: Nitrile and/or leather gloves, dustmasks, long sleeves_____

7. EMERGENCY PREPAREDNESS AND RESPONSE

A list of contacts and telephone numbers for the applicable local off-site emergency responders is provided in Table 4. The following emergency response equipment is required for this project:

☒ Fire Extinguisher: ☐ Type A ☐ Type B ☐ Type C ☒ Type ABC
☒ Eyewash (Note: 15 minutes of free-flowing fresh water)
☒ First Aid Kit
☐ Other:_____

The emergency response communication system for the site is:

☒ Verbal
☐ Two-way radio
☒ Hand signals:
Hands on top of head = "Need assistance"
Thumbs up = "OK; I am all right; I understand"
Thumbs down = "No; negative"
☐ Horn
☐ Siren
☐ Other_____

In the event that an on-site emergency develops, the procedures delineated in Table 5 are to be followed immediately.

8. CONFINED SPACE ENTRY ☐ APPLICABLE ☒ NOT APPLICABLE

The task(s) for this project involve confined-space entry. Workers must adhere to the company's Confined Space Entry Program [29 CFR §1910.120(j)].

9. HAZARD COMMUNICATION ☒ APPLICABLE ☐ NOT APPLICABLE

9.1 Chemicals

The following procedures must be followed for all chemicals brought on site (i.e., benonite, gasoline, etc.):

- Label containers.
- Containers with gasoline or diesel fuel, if any, must be equipped with flame arrestors.
- A Material Safety Data Sheet (MSDS) for each chemical is included in Appendix B.
- Workers have reviewed and understood the hazards and the safe handling procedures of these chemicals as described in the respective MSDS.

9.2 Landfill gases (e.g, methane and/or hydrogen sulfide)

☒ APPLICABLE ☐ NOT APPLICABLE

The following steps must be followed when performing non-intrusive work at a municipal landfill:

- MSDSs for these two contaminants are included in Appendix B
- Workers have reviewed and understood the hazards of these contaminants as described in each MSDS.
- Workers shall ask the client contact about the potential locations and concentrations of these gases before entering the Exclusion Zone.

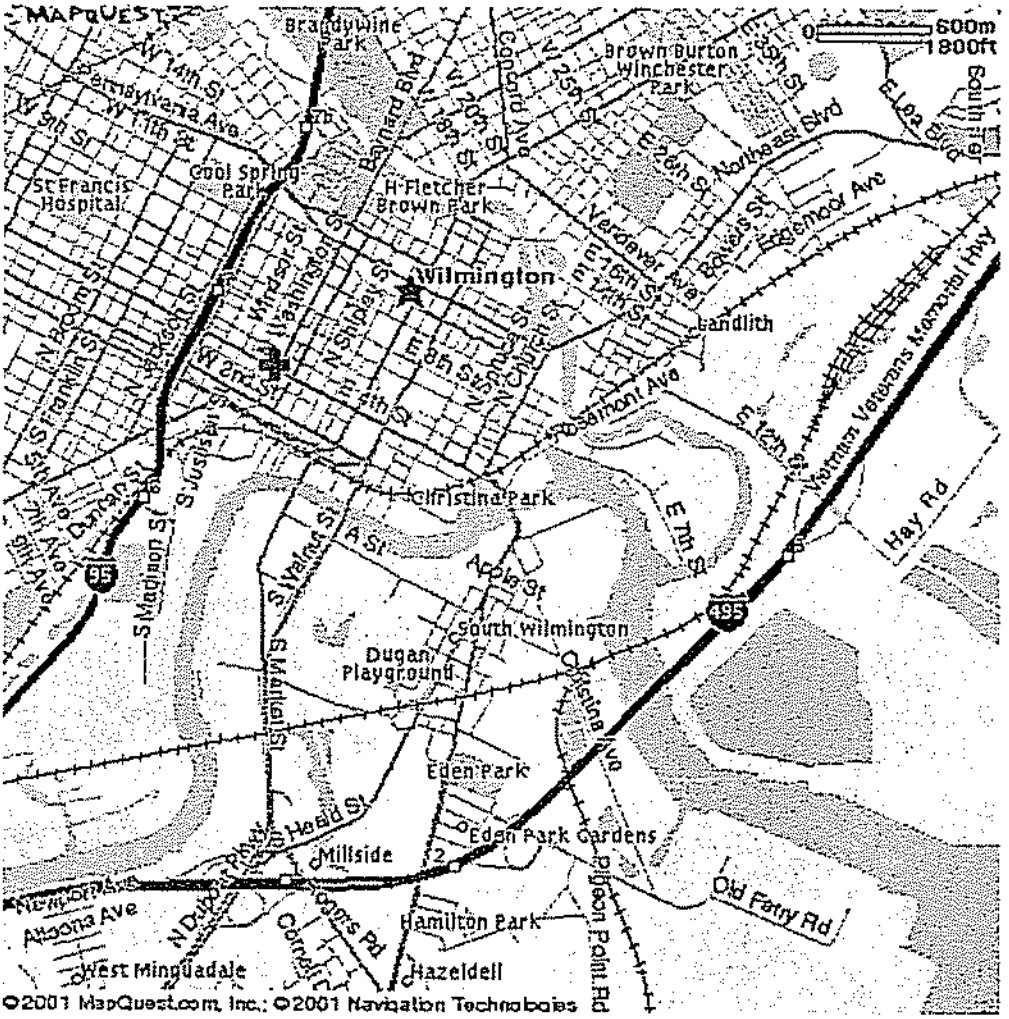
- Workers shall never enter into a workplace where the methane gas concentration exceeds 10% of the LEL registered on a calibrated explosimeter or where the hydrogen sulfide gas concentration exceeds 15 ppm registered on a calibrated hydrogen sulfide meter at any time.

- Air purifying respirators shall not be used for protection from methane and/or hydrogen sulfide gases. If measured air concentrations exceed the limited described in this section, workers must evacuate the workplace.

When chemicals are used or landfill gases are encountered on site, workers must adhere to the company's Hazard Communication Program (29 CFR §1910.1200).

Figure 1

Site and Hospital Map



WILMINGTON HOSPITAL
501 W 4TH ST
WILMINGTON, DE 19801 (US)
302-428-6436

Driving directions:

1: Start out going Southeast on E 12TH ST by turning right.	0.06 miles
2: Turn LEFT.	0.01 miles
3: Turn LEFT onto E 12TH ST.	1.06 miles
4: Turn LEFT onto NORTHEAST BLVD/US-13.	0.07 miles
5: NORTHEAST BLVD/US-13 becomes E 11TH ST/US-13.	0.01 miles
6: Turn RIGHT onto N SPRUCE ST/US-13 S.	0.16 miles
7: Turn RIGHT onto E 10TH ST.	0.39 miles
8: Turn LEFT onto N KING ST/US-13 BR S.	0.39 miles
9: Turn RIGHT onto E 4TH ST/DE-9.	0.30 miles

Total Estimated Time:
10 minutes

Total Distance:
2.45 miles

Table 1

Key Personnel and Health & Safety Responsibilities

Principal-in-Charge *Mike Houlihan*	*Project Manager (PM)* *David Espinoza*	*Site Health & Safety Officer (SHSO)* *Jeremy Morris*	*Project Personnel* *Doug Mandeville,* *Sub-consultants,* *Sub-contractors*	*Environmental, Health & Safety Coordinator (EHSC)* *Eric Jensen*
• Approve this HASP and amendments, if any. • Assure that all elements of this HASP are implemented.	• Approve this HASP and amendments, if any. • Monitor the Field Logbooks for safety work practices employed. • Coordinate with SHSO so that emergency response procedures are implemented. • Verify corrective actions are implemented. • See to it that personnel receive this plan, are aware of its provisions, are aware of the potential hazards associated with site operations, are instructed in safe work practices, are familiar with emergency response procedures, and that this is documented. • Provide for appropriate personal protective equipment.	• Prepare and implement project (HASP) and amendments, if any, and report to the Project Manager for action if any deviations from the anticipated conditions exist, and authorize the cessation of work if necessary. • Confirm that site personnel meet the training requirements. • Conduct pre-entry briefing and daily tailgate safety meetings. • Verify that all personal protective equipment is operating correctly and such equipment is utilized by on-site personnel. • Implement site emergency response procedures. • Notify the EHSC in the event an emergency occurs.	• Provide verification of required safety training prior to arriving at the site. • Notify the SHSO of any special medical conditions (e.g., back injuries). • Attend pre-entry briefings and daily tailgate safety meetings. • Immediately report any accidents and/or unsafe conditions to the SHSO. • Be familiar with and abide by the HASP. • Individuals are responsible for their own safety.	• Review and audit HASP and amendments • Maintain a copy of the cover sheet of each completed HASP. • Notify Corporate Human Resources Manager and/or Director of Environment, Health & Safety in the event an emergency occurs. • Assist with the implementation of the corporate safety program. • Consult on safety issues.

Table 2

General Safe Work Practices

- Smoking, eating, or drinking after entering the work zone must not be allowed. Use of illegal drugs and alcohol are prohibited. Workers taking prescribed medication that may cause drowsiness should not be operating heavy equipment.
- Practice good housekeeping. Keep everything orderly and out of potentially harmful situations.
- The following conditions must be observed when operating a motor vehicle.
  - Wearing of seat belts is mandatory
  - During periods of rain, fog, or other adverse weather conditions, the use of headlights is mandatory
  - A backup warning system or use of vehicle horn is mandatory when the vehicle is engaged in a backward motion
  - All posted traffic signs and directions from flagmen must be observed
  - Equipment and/or samples transported in vehicles must be secured from movement
  - The use of GeoSyntec acquired vehicles by non-GeoSyntec personnel is prohibited
- In an unknown situation, always assume the worst conditions.
- Be observant of your immediate surroundings and the surroundings of others. It is a team effort to notice and warn of impending dangerous situations. Withdrawal from a hazardous situation to reassess procedures is the preferred course of action.
- Conflicting situations may arise concerning safety requirements and working conditions and must be addressed and resolved rapidly by the SHSO and PM to relieve any motivations or pressures to circumvent established safety policies.
- Unauthorized breaches of specified safety protocol must not be allowed. Workers unwilling or unable to comply with the established procedures must be discharged.

Table 3

Hazard Analysis

Tasks	
① SASW determination of waste unit weight	
② Drilling nine boreholes (20 - 75-ft) vertically through landfill	
③ Sampling waste, removing waste for weighing, return to working face	
④ Backfilling boreholes with pipe and gravel	

	①	②	③	④					*Mitigator Document Number*
I. Physical Hazards									
Boating									WJ104701
Cold Stress	X	X	X	X					GA970106
Compressed Gas Cylinder									GA970107
Drilling		X							GA970108
Drum Handling		X	X	X					WJ104702
Electrocution									GA970111
Excavation/Trenching		X							GA970112
Eye Injury	X	X	X	X					GA970614
Hand/Foot Injury	X	X	X	X					GA970615
Heat Stress	X	X	X	X					GA970113
Heavy Equipment	X	X	X	X					GA970114
Lifting Heavy Loads	X	X	X	X					GA970116
Noise	X	X	X	X					GA970616
Portable Power/Hand Tool	X		X						GA970122
Radiation Exposure									GA970617
Slipping/Tripping/Falling	X	X	X	X					WJ104703
Other:									
II. Biological Hazards									
Allergic Reaction to Poisonous Plants	X	X	X	X					GA970119
Insect/Vermin/Snake Bites	X	X	X	X					GA970618
Medical Waste		X	X						GA970619
Other:									

Instructions: For each task, place an "X" in the blank corresponding to associated hazards.

Table 4

Emergency Response Contacts

Name	*Telephone Numbers*	
	Office	*Home*
Wilmington Fire Department	(302) 571-4594	-
Wilmington Hospital	(302) 428-6436	-
DSWA Landfill Facility Manager: Robin Roddy	(302) 764-5385	-
Branch Office Manager*: Lernette Patterson	(410) 381-4333	(301) 574-3150
Corporate Human Resources Manager**: Mary Masty	(561) 995-0900	(954) 802-7498
Project Manager*: David Espinoza	(410) 381-4333	(301) 765-0895
Principal-in-Charge*: Mike Houlihan	(410) 381-4333	(301) 657-1086
Environmental, Health & Safety Coordinator*: Rick Jensen	(410) 381-4333	(410) 552-3725
Director of Environment, Health & Safety**: Jack Peng	Mobile (404) 307-2689	-
Other: Emergency Services	911	-
Other: Site Health & Safety Officer*: Jeremy Morris	Mobile (410) 271-3094	-

* GeoSyntec Consultants, Columbia, Maryland
** GeoSyntec Consultants

Table 5

Emergency Response Procedures

- The SHSO (or alternate) should be immediately notified via the on-site communication system. The SHSO assumes control of the emergency response.
- The SHSO notifies the PM, Principal-in-Charge, and the EHSC of the emergency. The EHSC must then contact the Corporate Human Resources Manager and/or Director of Environment, Health & Safety. If a GeoSyntec employee is injured, the SHSO must contact the worker's Branch Office Manager immediately. If the Branch Office Manager can not be contacted, then the Corporate Human Resources Department must be notified.
- If applicable, the SHSO must notify off-site emergency responders (i.e., fire department, hospital, police department, etc.) and must inform the response team as to the nature and location of the emergency on site.
- If applicable, the SHSO evacuates the site.
- For small fires, flames should be extinguished using the fire extinguisher. Large fires should be handled by the local fire department.
- If a worker is injured, first aid will be administered by workers certified in first aid.
- After the response, the SHSO must complete accident investigation reports obtained from the Branch Office Manager.

Appendix A

Hazard Mitigators Directory

Included in HASP	*Hazards*	*Mitigators Document Number*
I. Physical Hazards		
☐	Boating	WJ104701
☒	Cold Stress	GA970106
☐	Compressed Gas Cylinder	GA970107
☒	Drilling	GA970108
☒	Drum Handling	WJ104702
☐	Electrocution	GA970111
☒	Excavation/Trenching	GA970112
☒	Eye Injury	GA970614
☒	Hand/Foot Injury	GA970615
☒	Heat Stress	GA970113
☒	Heavy Equipment	GA970114
☒	Lifting Heavy Loads	GA970116
☒	Noise	GA970616
☒	Portable Power/Hand Tool	GA970122
☐	Radiation Exposure	GA970617
☒	Slipping/Tripping/Falling	WJ104703
II. Biological Hazards		
☒	Allergic Reaction to Poisonous Plants	GA970119
☒	Insect/Vermin/Snake Bites	GA970618
☒	Medical Waste	GA970619

HAZARD MITIGATORS -*COLD STRESS*

Applies to Task: ☒ ① ☒ ② ☒ ③ ☒ ④

- Be aware of the symptoms of cold stress and appropriate first aid measures. Because of the considerable danger to personnel, outdoor work should be suspended if the ambient temperature drops below 0°F or if the wind chill factor drops below -29°F.
- Wear layers of loose fitting clothing, including insulated coveralls, head covering, and boots.
- Minimize wind chill effects by wearing a wind resistant outer shell (such as the required personal protective clothing).
- Minimize lengthy periods of outdoor activity. This may require additional shifts.
- Provide warm shelter.

HAZARD MITIGATORS - *DRILLING*

Applies to Task: ☐ ① ☒ ② ☐ ③ ☐ ④

- All members of the drilling crews shall be trained in the safety features and procedures to be utilized during operation, inspection, and maintenance of the equipment.
- Conduct a survey, prior to bringing drilling equipment to the job site, to identify overhead electrical hazards, potential subsurface hazards, and terrain hazard. Once on site, before drilling equipment is moved, the travel route shall again be visually surveyed for overhead and terrain hazards.
- Use only drilling equipment equipped with two easily-accessible emergency shutdown devices, one for the operator and one for the helper.
- Do not transport drilling equipment with the mast in the upward position.
- Set up equipment on stable ground. Cribbing (a system of timbers, arranged in a rectangular pattern, used to support and distribute the weight of the equipment) shall be used when necessary.
- Extend outriggers per the manufacturer's specifications.
- Monitor weather conditions. Operations shall cease during electrical storms or when electrical storms are imminent.
- Wearing of loose clothing or equipment is not permitted.
- Use auger guides on hard surfaces.
- Verbally alert employees and visually ensure employees are clear from dangerous parts of equipment prior to starting or engaging equipment.
- Channel the discharge of drilling fluids away from the work area to prevent the ponding of water.
- Use hoists only for their designed intent. Hoists shall not be loaded beyond their rated capacity. Steps shall be taken to prevent two-blocking of hoists (the condition when the lower load block or hook assembly comes in contact with the upper load block, or when the load block comes in contact with the boom tip).
- Follow the equipment manufacturer's procedures if ropes become caught in, or objects are pulled into a cathead.

- Do not run or rotate drill rods through rod slipping devices. No more than 1 foot of drill rod column shall be hoisted above the top of the drill mast. Drill rod tool joints shall not be made up, tightened, or loosened while the rod column is supported by a rod slipping device.
- Control dust using dust suppression techniques.
- Clean augers only when the rotating mechanism is in neutral and the auger is stopped. Tools such as long-handled shovels shall be used to remove cuttings from the auger.
- Cap and flag open boreholes; open excavations shall be barricaded.
- Keep all hand tool used during drilling operations clean and in good working condition.
- Wear hard hats and steeltoed boots at all times when performing drilling operations.
- Wear hearing protection when required.

Hazard Mitigators

Drum Handling

Applies to Task: ☐ ① ☒ ② ☒ ③ ☒ ④

- Use only drums and containers that meet the appropriate DOT, OSHA, and EPA regulations.
- Be aware of the potential hazards of the contents of drums or containers before handling. Only trained personnel should open drums containing unknown materials.
- Know that bulging drums or containers are an indication of pressure buildup. Open all drums or bungs extremely slowly to determine the presence of vapors or pressure inside the drum. If the possibility of fire or explosion exists, a protective shield should be used and/or remote opening devices.
- Consider any unlabeled drum or container as containing a hazardous substance and leave it alone until contents are properly identified and labeled. Do not assume that exterior labeling properly identifies the contents or potential hazards of drums and containers.
- Label and identify drums and containers when moved to the staging areas to safely identify and classify their contents. Segregate incompatible drums.
- Staging areas shall be provided with adequate ingress and egress routes. Use secondary containment at staging area for all moved drums.
- Inspect the integrity of the drum or container before moving. Any drum or container lacking integrity shall be overpacked.
- Organize site operations to minimize the amount of drum or container movement. Have a clear view of the available pathway when moving drums. If needed, an additional person should be available to provide guidance.
- Utilize drum/container handling equipment whenever possible. The equipment utilized should have a sufficiently rated load capacity, and should be able to operate smoothly on the available surface.

Hazard Mitigators
Drum Handling
(continued)

- Use proper lifting and moving techniques to prevent back injuries, if handling equipment is not available.
- Never stand on drums or containers.
- Use non-sparking tools.
- Cease all site operations immediately if site activities uncover buried drums or containers. The SHSO must be notified. The SHSO will evacuate the area. All unknown situations must be evaluated before site activities are resumed. The services of a specialized contractor trained in handling unknown contaminants may be needed. If, after evaluating the situation, only a portion of the site is affected, that area shall be barricaded and work may continue at other portions of the site.

HAZARD MITIGATORS - *EXCAVATION/TRENCHING*

Applies to Task: ☐ ① ☒ ② ☐ ③ ☐ ④

- Remove trees, boulders, etc., adjacent to the work area that could fall into the work area before excavating begins.
- Adequately slope or shore all sides of excavations 5 feet or more in depth before allowing anyone to enter them.
- Store and retain all excavated material (spoil) at least 2 feet or more from the edge of the excavation.
- Examine all excavation work areas and faces for unsafe conditions at least at the beginning of each shift and especially after blasting, a rain, a freeze or a thaw. If unsafe conditions are found, all work in that immediate area shall cease until the necessary precautions have been taken to eliminate the hazardous condition.
- Use diversion ditches or dikes to prevent surface water from entering an excavation, and to provide adequate drainage of the area adjacent to the excavation. Prevent water from accumulating in an excavation.
- Pile, shore, and/or brace sides of excavations if it is necessary to place or operate trucks, materials or other heavy objects on a level above and near the excavation to resist the extra pressure due to such superimposed loads.
- Install substantial stop logs or barricades when mobile equipment is utilized or allowed adjacent to excavations.
- Provide a walkway or bridge with standard guardrails where employees or equipment are required or permitted to cross over excavations.
- Implement the Confined Space Entry Program if employees are to enter excavations of 4 feet deep or deeper.
- Ladders must be located so as to require no more than 25 feet of lateral travel.
- Underpin all nearby existing structures to insure their stability before excavating below the level of the base of the footing of any foundation or retaining wall.

HAZARD MITIGATORS – *EYE INJURY*

Applies to Task: ☒ ① ☒ ② ☒ ③ ☒ ④

- Wear appropriate eye protection according to the task at hand (e.g., goggles if liquid splash could occur, welding lenses, etc.).
- Minimize the amount of vapor or particulate matter generated, if possible.
- Avoid touching the face and eyes.
- Flush eye with water for at least 15 minutes if chemicals do get into the eye.

HAZARD MITIGATORS - *HAND/FOOT INJURY*

Applies to Task: ☒ ① ☒ ② ☒ ③ ☒ ④

- Be aware of "pinch points" when working with tools and heavy equipment.
- Use proper lifting techniques to avoid dropping heavy loads on hands and feet.
- Be aware of moving machinery and heavy equipment in the work area.
- Wear protective gloves as required in the Health and Safety Plan.
- Wear steeltoed boots as required in the Health and Safety Plan.

HAZARD MITIGATORS – *HEAT STRESS*

Applies to Task: ☒ ① ☒ ② ☒ ③ ☒ ④

- Be able to recognize and treat heat stress, and to identify the signs and symptoms of heat stress (e.g., muscle spasms, dizziness, lack of perspiration).
- Maintain an optimal level of physical fitness. Fit individuals may acclimatize more readily to temperatures.
- Adjust work and rest schedules as needed. Establish a work regimen that will provide adequate rest periods for cooling down. This may require additional shifts of workers.
- Provide shelter or shaded areas (77^{N} F is best) to protect personnel during rest periods.
- Maintain worker's body fluids at normal levels to ensure that the cardiovascular system functions adequately. Daily fluid intake must equal the approximate amount of water lost in sweat. Workers are encouraged to drink more than the amount required to satisfy thirst, because thirst is not an adequate indicator of adequate salt and fluid replacement.
- Remove impermeable protective garments during rest periods.
- Do not assign other tasks to personnel during rest periods.
- Provide cooling devices, when necessary, to aid natural body heat exchange during prolonged work or severe heat exposure. Effect devices include field showers or hose-down areas; as well as cooling jackets, vests, or suits.

HAZARD MITIGATORS – *HEAVY EQUIPMENT*

Applies to Task: ☒ ① ☒ ② ☒ ③ ☒ ④

- Apply Hazard Mitigators for motor vehicles when utilizing heavy equipment (where applicable).
- Remember, heavy equipment has the right-of-way over regular vehicles and pedestrians. Yield to heavy equipment.
- Listen for warning signals on heavy equipment.
- Perform a visual inspection and walk around parked heavy equipment before moving to assure that equipment is in good condition and that there are no personnel on the ground that could be injured or objects that could be damaged by vehicle movement.
- Use hand rails and footholds when mounting and dismounting equipment,
- Follow appropriate equipment startup procedures. Brakes, steering, clutches and controls shall be tested.
- Pay attention to workers on the ground who may be in the path and provide warning prior to moving the equipment.
- Permit no one to ride on, or in, heavy equipment. This includes any portion of a backhoe, bulldozer, forklift or the back of a pickup truck, except in locations specifically designed for passenger use and approved by the SHSO.
- Locate and flag underground utilities and buried cables, whenever possible, prior to intrusive activities (such as excavation and drilling).
- Keep haulage vehicles under positive control at all times while operating. Vehicles shall be kept in gear when descending grades.
- Do not use heavy equipment on slopes with steepness exceeding 3H:1V unless operations are consistent with manufacturer's recommendations (if the Owner's Manual is not with the equipment or does not specify slope operating procedures, see the SHSO).
- Operate equipment with booms, blades, buckets, beds, etc., lowered or in a stable position while on slopes. Safety cables tethered to appropriate anchors shall be used for equipment working on steep slopes, where appropriate. The use of cables and anchors must be approved by the SHSO.

- Use rollover protection and seat belts.
- Lower hydraulic systems (e.g., blades, rippers, etc.) to the ground, set brakes, and shut down equipment if malfunction occurs which impairs the ability to control a piece of equipment.
- Suspend in slings or support by hoists or jacks heavy equipment in need of repair. The equipment must also be blocked or cribbed before workers are permitted to work underneath. Working under heavy equipment can pose a crushing hazard.
- Shut off motors, do not allow smoking, and use proper dispensing equipment when refueling gasoline-operated equipment to prevent fire hazards.
- Wear hearing protection if required.
- Maintain eye contact with the heavy equipment operator when working near equipment.
- Be aware of changes in sound of equipment which may indicate a change in direction or activity.

- *Arms and Elbows* - The load should be drawn close, and the arms and elbows should be tucked into the side of the body. When the arms are held away from the body, they lose much of their strength and power. Keeping the arms tucked in also helps keep body weight centered.
- *Palm* - The palm grip is one of the most important elements of lifting. The fingers and the hand are extended around the object to be lifted. Use the full palm; fingers alone have very little power.
- *Chin* - Tuck in the chin so the neck and head continue the straight back line. Keep the spine straight and firm.
- *Body Weight* - Position the body so its weight is centered over the feet. This provides a more powerful line of thrust and assures better balance. Start the lift with a thrust of the rear foot. Shift hand position so the object can be boosted after knees are bent. Straighten knees as object is lifted or shifted to the shoulders. To change direction, lift the object to a carrying position, and turn the entire body, including the feet. Do not twist your body. In repetitive work, both the person and the material should be positioned so that the worker will not have to twist his body when moving the material. If the object is too heavy to be handled by one person, get help.

HAZARD MITIGATORS – *LIFTING HEAVY LOADS*

Applies to Task: ☒ ① ☒ ② ☒ ③ ☒ ④

- Know and practice proper lifting techniques.
- Limit continuous lifting of weights to 50 pounds or less. Lifts of heavier weights are permitted on an interim basis. Help shall be obtained for lifting of loads greater than 50 pounds. Mechanical equipment should be used on heavy materials when possible. If mechanical assistance is not available, adequate manpower to maintain the 50-pound limit per employee will be required.
- Do not lift more weight than can be handled comfortably, regardless of load weight. If necessary, help should be requested to lift a load so that the lifting is comfortable.
- Use drum dollies when moving drums or barrels.
- Inspect objects for grease or slippery substances before they are lifted to ensure that the object will not slip.
- Do not carry long, bulky or heavy objects without first verifying that the way is clear and that vision is unobstructed. This ensures that other persons or objects will not be struck by the load.
- Do not carry loads that cannot be seen over or around.
- Make sure workers are physically suited for the job before assigning jobs requiring heavy and/or frequent lifting. A person's lifting ability is not necessarily indicated by his height or weight.
- Before lifting an object, consideration should be given to how the object will be set down without pinching or crushing hands or fingers. For example, to place an object on a bench or table, the object should be set on the edge and pushed far enough onto the support so it will not fall. The object can then be released gradually as it is set down, and pushed in place with the hands and body from in front of the object.
- When two or more persons are handling the same object, one should "call the signals". All the persons on the lift should know wbo this person is and should warn him if anyone in the crew is about to relax his grip.
- Proper lifting includes:
  - *Feet* - Feet should be parted, with one foot alongside the object being lifted and one behind. Feet should be comfortably spread to give greater stability. The rear foot should be in position for the upward thrust of the lift.
  - *Back* - Use the sit-down position and keep the back straight, but remember that "straight" does not mean "vertical". A straight back keeps the spine, back muscles, and organs of the body in correct alignment. It minimizes the compression of the abdomen that can cause a hernia.

HAZARD MITIGATORS - *NOISE*

Applies to Task: ☒ ① ☒ ② ☒ ③ ☒ ④

- Know the effects of noise, including:
  - Workers being startled, annoyed, or distracted.
  - Physical damage to the ear, pain, and temporary and/or permanent hearing loss.
  - Communication interference that may increase potential hazards due to the inability to warn of danger and proper safety precautions to be taken.
- Utilize feasible administrative or engineering controls if workers are subjected to noise exceeding an 8-hour, time-weighted average (TWA) sound level of 90 dBA (decibels on the A-weighted scale).
- Implement the company Hearing Conservation Program when noise exposures equal or exceed an 8-hour, TWA sound level of 85 dBA.
- Wear hearing protection where applicable.

HAZARD MITIGATORS - *PORTABLE POWER/HAND TOOLS*
Applies to Task: ☒ ① ☐ ② ☒ ③ ☐ ④

- Route cords, hoses, and cables supplying power to portable power tools to prevent tripping hazards or contact with equipment or machinery.
- Avoid abusing the power supply lines of portable equipment. Excessive scraping, kicking, stretching, and exposure tn grease and oils will damage lines or cause them to fail prematurely, and possibly injure the operator or fellow workers.
- Inspect cords, hoses, and cables for wear or deterioration. Defective power supply lines shall not be used.
- Do not use electrically powered tools near flammable materials or explosive atmosphere, unless they are of the explosion-proof type tueeting the National Electrical Code for explosive area. Employees operating the equipment should be aware of sparks and or metal fragments when using this equipment.
- Ground-check portable electric power tools with metal cases initially and quarterly. At no time will electrical power equipment be operated without proper grounding. All electrical cords and cables, including extension cords, shall include a third wire ground.
- Prohibit operatious of electric tools in wet or damp areas except in unusual emergency circumstances. When operation is required in wet or damp conditions, extreme care will be exercised to ensure effective grounding of equipment and proper use of protective gear.
- Size cords adequately for length and the electrical demand of the tool. Otherwise, they may cause a fire hazard.
- Limit use of tools to the purpose for which the tool is intended (e.g., wrenches will not be used as hammers). Defective tools (e.g., with mushroomed heads or split or defective handles) shall not be used.
- Protect tools from corrosion damage.
- Keep tools free of accumulated dirt and unnecessary oil or grease. Moving and adjustable parts shall be lubricated frequently to prevent wear and misalignment.
- Replace or repair damaged or worn tools promptly. Temporary or makeshift repairs are prohibited. At the discretion of the supervisor, discard all tools that cannot be repaired safely. Supervisors shall decide when to discard a tool.
- Store tools in suitable boxes or containers. Loose tools shall not be stored on ledges or where they might fall. Tools shall be picked up when a job is completed and not be allowed to accumulate in the work area. Store all tools in a safe place.
- Do not use conducting (i.e., metal) tools around electrical facilities. Insulated tools, approved for electrical work, shall be tested frequently for proper insulation.
- Select the correct size and type of wrench for each job. Wrench handles shall not be extended with a pipe nr cheater because the jaws will spread.
- Repair mushroomed punch, drift and chisel heads. Mushroomed heads represent crystallized metal that will break and fly off when struck.
- Wear eye protection at all times.

Hazard Mitigators

Slips, Trips and Falls

Applies to Task: ☒ ① ☒ ② ☒ ③ ☒ ④

- Wear the proper footwear for the task at hand.
- Pay attention to the environment and use caution when moving about onsite.
- Use caution when walking on sloped areas (especially geosynthetics), particularly when moisture is present. Use caution when walking on soft or uneven surfaces; e.g., marsh areas. Watch for icy conditions in cold weather.
- Follow the easiest and safest path to the destination.
- Follow good housekeeping procedures. Never assume that someone else will clean up a spill or put away an object.
- Remove objects that pose tripping hazards where practicable.
- Prevent water accumulation where practicable.
- Cables and/or wiring should be taped down, when possible.
- Mark or repair any opening or hole in the floor.
- Carry objects in a manner that allows you to see in the area you are moving in. Do not carry objects that are too large or bulky. Do not carry more weight than you can balance and keep stable. Understand that PPE can reduce or limit your field of vision and mobility.
- Use the proper ladder for the task at hand and do not exceed the recommended height. Do not use the top two rungs of a ladder. Utilize the buddy system to help secure the ladder. When working over 6 ft., utilize fall prevention measures. Obey height and weight guidelines and/or rules.

Hazard Mitigators

Slips, Trips and Falls (continued)

- Use the handrail when using stairs. Be aware of stairway blockages.
- If conditions even slightly resemble an unsafe environment, do not make any assumptions that the integrity of a workplace is intact.
- Never jump over or into a trench or excavation.
- Close filing cabinets and drawers.
- Avoid becoming fatigued.
- Slow down. Do not run.

HAZARD MITIGATORS – *ALLERGIC REACTION TO POISONOUS PLANTS*

Applies to Task: ☒ ① ☒ ② ☒ ③ ☒ ④

- Be able to recognize and identify poisonous plants indigenous to the site location.
- Removed or destroy poisonous plants where practicable.
- Wear appropriate protective clothing (e.g., gloves, long-sleeved shirts) as required.
- Provide soap and water for washing exposed parts.
- Make first aid remedies available for treatment of affected skin areas.

HAZARD MITIGATORS – *INSECT/VERMIN/SNAKE BITES*

Applies to Task: ☒ ① ☒ ② ☒ ③ ☒ ④

- Be able to recognize insects/vermin/snakes indigenous to the site location.
- Advise the SHSO if you have allergies to any insects prior to engaging in any field activities.
- Include the following controls:
  - Boots, hoods, netting, gloves, masks, or other personal protection.
  - Repellents.
  - Drainage or spraying of breeding areas.
  - Burning or destruction of nests.
  - Smudge pots and aerosols for protecting small areas.
  - Elimination of unsanitary conditions which propagate insects or vermin.
  - Extermination measures.
  - Inoculation.
- Report any bites or stings to the SHSO and seek first aid immediately.

HAZARD MITIGATORS – *MEDICAL WASTE*

Applies to Task: ☐ ① ☒ ② ☒ ③ ☐ ④

- Be aware of the possibility of bloodborne pathogens when dealing with medical waste.
- Use mechanical means to handle waste or collect samples whenever possible, to avoid contact with medical waste and "sharps."
- Notify the SHSO immediately if suspected medical waste is uncovered during sampling activities.
- Be trained in first aid activities for bloodborne pathogens.

Appendix B

Material Safety Data Sheets (MSDS) Directory

Included in HASP	*Chemical*
☒	Bentonite
☒	Diesel Fuel Oil No. 2-D
☒	Gasoline, Lead-free
☒	Hydrogen Sulfide
☒	Methane Gas
☐	Other: _____
☐	Other: _____
☐	Other: _____
☐	Other: _____
☐	Other: _____
☐	Other: _____

International Chemical Safety Cards

ICSC: 0384

BENTONITE

BENTONITE
Wilkinite

CAS # 1302-78-9
RTECS # CT9450000
ICSC # 0384

TYPES OF HAZARD/ EXPOSURE	ACUTE HAZARDS/ SYMPTOMS	PREVENTION	FIRST AID/ FIRE FIGHTING
FIRE	Not combustible.		In case of fire in the surroundings: all extinguishing agents allowed.
EXPLOSION			
EXPOSURE		PREVENT DISPERSION OF DUST!	
• INHALATION		Avoid inhalation of fine dust and mist.	
• SKIN		Protective gloves.	
• EYES		Safety spectacles.	
• INGESTION			

SPILLAGE DISPOSAL	STORAGE	PACKAGING & LABELLING
Sweep spilled substance into containers; if appropriate, moisten first to prevent dusting (extra personal protection: P1 filter respirator for inert particles).		

SEE IMPORTANT INFORMATION ON BACK

ICSC: 0384

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Genium Publishing Corp.
One Genium Plaza
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(518) 377-8854

Section 1 - Chemical Product and Company Identification

51

Product/Chemical Name: Diesel fuel oil no. 2-D
Chemical Formula: Unspecified or variable
CAS Number: 68334-30-5
Synonyms: automotive diesel oil; diesel fuel; diesel oil (medium); diesel oil no. 2; diesel oil (petroleum); diesel oils; diesel test fuel; fuels, diesel; no. 2 diesel oil; olej napeldowy III (Polish)
Derivation: Fuel oil may be a distilled fraction of petroleum, a residuum from refinery operations, a crude petroleum or a blend of two or more of these.
General Use: This medium viscosity residual fuel oil has both light and heavy grades, and is used in furnaces and boilers of utility and industrial power plants, ships, locomotives, and metallurgical operations.
Vendors: Consult the latest *Chemical Week Buyers' Guide.* (73)

Section 2 - Composition / Information on Ingredients

Diesel fuel oil no. 2-D, ca 100% vol; diesel fuels consist primarily of aliphatic (64% vol), aromatic (35% vol), and olefinic (1-2% vol) hydrocarbons.
Trace Impurities: May contain sulfur (< 0.5), benzene (<100 ppm), and additives such as sulfurized esters.

OSHA PEL
As petroleum distillates
8-hr TWA: 500 ppm (2000 mg/m^3)

ACGIH TLV
As diesel fuel
Notice of impending change (1997):
TWA: 100 mg/m^3, *Skin*

NIOSH REL
As petroleum distillates
10-hr TWA: 350 mg/m^3
Ceiling (15 min): 1800 mg/m^3

IDLH Level
As petroleum distillates
1,100 ppm

DFG (Germany) MAK
None established

Section 3 - Hazards Identification

ANSI Signal Word: Caution

☆☆☆☆☆ Emergency Overview ☆☆☆☆☆

Diesel fuel oil no. 2-D is a brown, slightly viscous liquid with a kerosene-like odor. It is irritating to the skin and respiratory tract. Inhalation of mist or vapor may result in headache, nausea, vomiting, diarrhea, central nervous system (CNS) depression, tachycardia (rapid heart beat), cyanosis (blue coloration of skin due to oxygen deficiency), pulmonary edema (fluid in the lungs), and liver or kidney injury. Diesel fuel oil no. 2-D is an environmental hazard when spilled. When exposed to heat or flame, this flammable liquid is a fire hazard. When heated to decomposition, diesel fuel oil no. 2-D will emit acrid smoke and irritating vapors.

Wilson Risk Scale	
R	1
I	2
S	2*
K	2

*Skin absorption

HMIS	
H	1*
F	2
R	0
PPE†	

*Chronic effects
†Sec. 8

Potential Health Effects

Primary Entry Routes: Inhalation, ingestion, skin contact/absorption
Target Organs: Skin, CNS, cardiovascular system (CVS), respiratory system, liver, kidneys
Acute Effects
Inhalation: Euphoria, respiratory irritation, cardiac dysrhythmia, increased respiration rates, cyanosis, pulmonary edema, hemoptysis (spitting up blood from the respiratory tract), respiratory arrest, renal (kidney) and liver injury, and CNS toxicity can result from inhalation of diesel fuel oil no. 2-D mist or vapor.
Eye: Contact may result in irritation.
Skin: Contact may cause irritation, systemic effects (see Inhalation), and block the sebaceous (oil) glands, resulting in a rash of acne-like pimples and spots, usually on the arms and legs.
Ingestion: Gastrointestinal irritation, vomiting, diarrhea, and in severe cases, CNS depression progressing to coma and death and other systemic effects (see Inhalation) can result. Aspiration can result in transient CNS depression or excitement, hypoxia, infection, pneumatocele (abnormal cavities in lungs) formation, and chronic lung dysfunction.
Carcinogenicity: IARC lists occupational exposure in petroleum refining as Group 2A (Probable human carcinogen) and distillate light (diesel) fuels as Group 3 (Not classifiable as to carcinogenicity to humans). ACGIH lists a notice of impending change for diesel fuels as TLV-A3 (Animal carcinogen). NTP and OSHA do not list diesel fuel oil no. 2-D as a carcinogen.

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International Chemical Safety Cards

ICSC: 0384

BENTONITE

I M P O R T A N T D A T A	PHYSICAL STATE; APPEARANCE: ODOURLESS GRANULES OR POWDER IN VARIABLE COLOUR. PHYSICAL DANGERS: CHEMICAL DANGERS: The substance is a weak base in suspension in water. OCCUPATIONAL EXPOSURE LIMITS (OELs): TLV not established.	ROUTES OF EXPOSURE: The substance can be absorbed into the body by inhalation of dust. INHALATION RISK: Evaporation at 20°C is negligible; a harmful concentration of airborne particles can, however, be reached quickly. EFFECTS OF SHORT-TERM EXPOSURE: EFFECTS OF LONG-TERM OR REPEATED EXPOSURE: The substance may have effects on the lungs, resulting in silicosis due to the presence of crystalline silica (see ICSC # 0808).
PHYSICAL PROPERTIES	Relative density (water = 1): 2.5	Solubility in water: none
ENVIRONMENTAL DATA		

NOTES

Bentonites are aluminate silicate and can contain crystalline silica. The content varies widely from less than 1% to about 24%.

ADDITIONAL INFORMATION

ICSC: 0384 BENTONITE

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Medical Conditions Aggravated by Long-Term Exposure: None reported.
Chronic Effects: Prolonged or repeated skin contact causes dermatitis and possible systemic toxicity. Prolonged or repeated inhalation can cause CNS and peripheral nervous system damage.

Section 4 - First Aid Measures

Inhalation: Remove exposed person to fresh air and support breathing as needed.
Eye Contact: *Do not* allow victim to rub or keep eyes tightly shut. Gently lift eyelids and flush immediately and continuously with flooding amounts of water for at least 15 minutes. Consult a physician or ophthalmologist if pain and/or irritation develops.
Skin Contact: Quickly remove contaminated clothing. Rinse with flooding amounts of water followed by washing the exposed area with soap and water. For reddened or blistered skin, consult a physician.
Ingestion: Never give anything by mouth to an unconscious or convulsing person. Have the *conscious and alert* person drink 1 to 2 glasses of water. Contact a poison control center. Because of aspiration risk, *do* not induce vomiting unless the poison control center advises otherwise.
After first aid, get appropriate in-plant, paramedic, or community medical support.
Note to Physicians: Gastric lavage is contraindicated due to aspiration risk. Instead, consider administration of charcoal or milk. If ingestion amount is large, gastric emptying in the alert patient can be accomplished through administration of Syrup of Ipecac. Treat overexposure symptomatically and supportively.

Section 5 - Fire-Fighting Measures

NFPA

Flash Point: 100.4 °F (38 °C)
Flash Point Method: CC
Autoignition Temperature: 351-624 °F (177-329 °C)
LEL: 1.3% v/v
UEL: 75% v/v
Flammability Classification: OSHA Class II Combustible Liquid
Extinguishing Media: Use dry chemical, carbon dioxide, foam, low velocity water fog or spray. Use a smothering technique to extinguish fire. Water may be ineffective in putting out a fire involving diesel fuel oil no. 2-D, and a solid water stream may spread the flames; however, a water spray may be used to cool fire-exposed containers, and flush spills away from ignition sources.
Unusual Fire or Explosion Hazards: Vapor or mist can form explosive mixtures in air. In still air, the heavier-than-air vapors of diesel fuel oil no. 2-D from a large source may travel along low-lying surfaces to distant sources of ignition and flash back to the material source. Containers may explode in heat of fire.
Hazardous Combustion Products: Heating diesel fuel oil no. 2-D to decomposition can produce acrid smoke and irritating vapors.
Fire-Fighting Instructions: *Do not* release runoff from fire control methods to sewers or waterways.
Fire-Fighting Equipment: Because fire may produce toxic thermal decomposition products, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode.

Section 6 - Accidental Release Measures

Spill /Leak Procedures: Eliminate all ignition sources (no smoking, flares, sparks or flames in immediate area). Ground all equipment used when handling this product. *Do not* touch or walk through spilled material. Stop leak if you can do it without risk. Prevent entry into waterways, sewers, basements or confined areas. A fire fighting foam may be used to suppress vapors. Absorb or cover with dry earth, sand or other non-combustible material and transfer to containers. Use clean non-sparking tools to collect absorbed material.
Small Spills: Absorb diesel fuel oil no. 2-D with vermiculite, earth, sand or similar material.
Large Spills
Containment: For large spills, consider downwind evacuation of at least 1000 ft (300 m). Dike far ahead of liquid spill for later disposal. *Do not* release into sewers or waterways.
Cleanup: Ground all equipment. Use non-sparking tools. Spills can be absorbed with materials such as peat, activated carbon, polyurethane foam, or straw. Sinking agents, gelling agents, dispersants, and mechanical systems can also be use to treat oil spills.
Regulatory Requirements: Follow applicable OSHA regulations (29 CFR 1910.120).

Section 7 - Handling and Storage

Handling Precautions: Avoid vapor or mist inhalation, and skin and eye contact. Use only with ventilation sufficient to reduce airborne concentrations to non-hazardous levels (see Sec. 2). Wear protective gloves (or use barrier cream), and clothing (see Sec. 8). Keep away from heat and ignition sources. Ground and bond all containers during transfers to prevent static sparks. Use non-sparking tools to open and close containers.

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Storage Requirements: Store in tightly closed container in cool, well-ventilated area, away from heat, ignition sources and incompatibles (see Sec. 10). Periodically inspect stored materials. Equip drums with self-closing valves, pressure vacuum bungs, and flame arrestors.

Regulatory Requirements: Follow applicable OSHA regulations (29 CFR 1910.106) for Class II Combustible Liquid.

Section 8 - Exposure Controls / Personal Protection

Engineering Controls: To prevent static sparks, electrically ground and bond all containers and equipment used in shipping, receiving, or transferring operations.

Ventilation: Provide general or local exhaust ventilation systems to maintain airborne concentrations as low as possible. Local exhaust ventilation is preferred because it prevents contaminant dispersion into the work area by controlling it at its source.

Administrative Controls: Enclose operations and/or provide local exhaust ventilation appropriately designed for flammable mist and vapor at the site of chemical release. Where possible, transfer diesel fuel oil no. 2-D from drums or other storage containers directly to process containers. Minimize sources of ignition in surrounding low-lying areas.

Respiratory Protection: Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a MSHA/NIOSH-approved respirator. Select respirator based on its suitability to provide adequate worker protection for given working conditions, level of airborne contamination, and presence of sufficient oxygen. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), use an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.* If respirators are used, OSHA requires a written respiratory protection program that includes at least: medical certification, training, fit-testing, periodic environmental monitoring, maintenance, inspection, cleaning, and convenient, sanitary storage areas.

Protective Clothing/Equipment: Wear chemically protective gloves, boots, aprons, and gauntlets. Wear protective eyeglasses, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Contact lenses are not eye protective devices. Appropriate eye protection must be worn instead of, or in conjunction with contact lenses.

Safety Stations: Make emergency eyewash stations, safety/quick-drench showers, and washing facilities available in work area.

Contaminated Equipment: Separate contaminated work clothes from street clothes. Launder before reuse. Remove this material from your shoes and clean personal protective equipment.

Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9 - Physical and Chemical Properties

Physical State: Liquid
Appearance and Odor: Brown, slightly viscous; kerosene-like odor
Odor Threshold: 0.7 ppm
Vapor Pressure: < 0.1 mm Hg at 68 °F (20 °C)
Vapor Density (Air=1): > 6
Formula Weight: N/A

Specific Gravity (H_2O=1, at 4 °C): < 0.86
Water Solubility: Insoluble
Boiling Point: 340-676 °F (171-358 °C)
Freezing Point: -29.2 °F (-34 °C)
Viscosity: 1.9-4.1 centistoke at 104 °F (40 °C)
Surface Tension: 23-32 dynes/cm at 68 °F (20 °C)

Section 10 - Stability and Reactivity

Stability: Diesel fuel oil no. 2-D is stable at room temperature in closed containers under normal storage and handling conditions.
Polymerization: Hazardous polymerization cannot occur.
Chemical Incompatibilities: Include strong oxidizing agents.
Conditions to Avoid: Exposure to heat and ignition sources.
Hazardous Decomposition Products: Thermal oxidative decomposition of diesel fuel oil no. 2-D can produce low molecular weight hydrocarbons, hydrocarbon derivatives, carbon oxides (CO_x), and sulfur oxides (SO_x).

Section 11- Toxicological Information

Acute Oral Effects:
Rat, oral, LD_{50}: 7500 mg/kg
Acute Dermal Effects:
Rabbit, skin, LD: > 5 mL/kg
Skin Effects:
Rabbit, skin, standard Draize test: 500 µL/24 hr, resulted in severe reaction.

Toxicity Data:*
Other Multiple Dose Toxicity Data:
Rat, inhalation: 2 g/m³/6 hr/3 weeks, intermittently, resulted in changes in blood erythrocyte (RBC) count, and focal fibrosis (pneumonoconiosis) and other changes in the lung, thorax or respiration.
Rat, inhalation: 400 µg/m³/16 hr/2.5 years, intermittently, caused other changes in the blood, and biochemical effects - transaminases.
Rabbit, skin: 80 mL/kg/12 days, continuously, resulted in other changes in the liver, kidney, ureter, and bladder, and death.

* See NIOSH, *RTECS* (HZ1800000), for additional toxicity data.

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Section 12 - Ecological Information

Ecotoxicity: Juvenile American shad, salt water TLm: 204 mg/L/24 hr; mallard duck, LD_{50}=20 mg/kg.

Environmental Fate: Diesel fuel oil no. 2-D will evaporate from water or soil. In surface water, it may partition from the water column to suspended sediments.

Environmental Degradation: Biodegradation may occur in soil and water.

Section 13 - Disposal Considerations

Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

Section 14 - Transport Information

DOT Transportation Data (49 CFR 172.101):

Shipping Name: Diesel fuel
Shipping Symbols: D
Hazard Class: 3
ID No.: NA1993
Packing Group: III
Label: None
Special Provisions (172.102): B1

Packaging Authorizations
a) **Exceptions:** 173.150
b) **Non-bulk Packaging:** 173.203
c) **Bulk Packaging:** 173.242

Quantity Limitations
a) **Passenger, Aircraft, or Railcar:** 60 L
b) **Cargo Aircraft Only:** 220 L

Vessel Stowage Requirements
a) **Vessel Stowage:** A
b) **Other:** –

Section 15 - Regulatory Information

EPA Regulations:
Classified as RCRA Hazardous Waste (40 CFR 261.21): Characteristic of Ignitability
RCRA Hazardous Waste Number: D001
Listed as a CERCLA Hazardous Substance (40 CFR 302.4), Unlisted Hazardous Waste, Characteristic of Ignitability per RCRA Sec. 3001
CERCLA Final Reportable Quantity (RQ): 100 lb (45.4 kg)
SARA Toxic Chemical (40 CFR 372.65): Not listed
SARA EHS (Extremely Hazardous Substance) (40 CFR 355): Not listed

OSHA Regulations:
Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1-A, as petroleum distillates)

Section 16 - Other Information

References: 73, 103, 136, 190, 209, 222, 230, 231

Prepared By..... HM Spliethoff, MS
Industrial Hygiene Review..... PA Roy, MPH, CIH
Medical Review..... T Thoburn, MD, MPH

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Material Safety Data Sheet Collection
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Issue Date: 2000-07

Unleaded Gasoline
MSDS 467
AUT5000

Section 1 - Chemical Product and Company Identification

CAS Number: 8006-61-9

Material Name: Unleaded Gasoline
Chemical Formula: Mixture of hydrocarbons
Synonyms: AUTOMOTIVE GASOLINE, LEAD-FREE; GASOLINE; MOTOR FUEL; MOTOR SPIRITS; NATURAL GASOLINE; PETROL; UNLEADED PETROL
General Use: Lead free motor fuel for internal combustion engines, 2-stroke and 4-stroke.

Section 2 - Composition / Information on Ingredients

Name	CAS	%
gasoline	8006-61-9	>90
benzene	71-43-2	5 max.

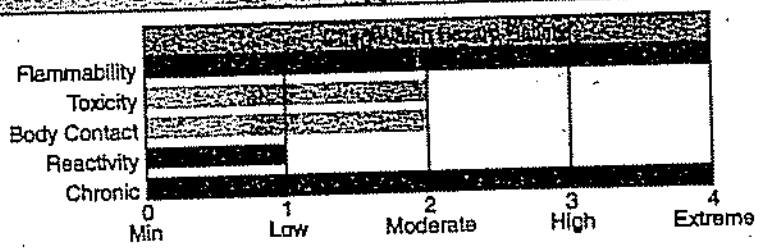
OSHA PEL
No data found.

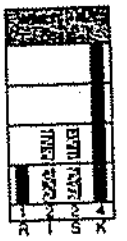
NIOSH REL
No data found.

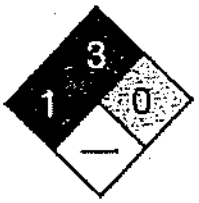
OSHA PEL Vacated 1989 Limits
TWA: 300 ppm; 900 mg/m^3;
STEL: 500 ppm; 1500 mg/m^3.

ACGIH TLV
TWA: 300 ppm; 890 mg/m^3;
STEL: 500 ppm; 1480 mg/m^3.

Section 3 - Hazards Identification







Fire Diamond

ANSI Signal Word
Danger!

Flammable

☆☆☆☆☆ Emergency Overview ☆☆☆☆☆

Clear liquid; distinctive odor. Irritating to eyes/skin/respiratory tract. Also causes: dizziness, drunkenness, unconsciousness. Absorbed through skin. Chronic: dermatitis. Possible cancer hazard. Flammable. Can form explosive mixtures in air.

Potential Health Effects

Primary Entry Routes: inhalation, ingestion, skin contact
Target Organs: skin, eye, respiratory system, central nervous system (CNS)

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Acute Effects

Inhalation: The vapor is discomforting to the upper respiratory tract and may be harmful if exposure is prolonged. Inhalation hazard is increased at higher temperatures. Acute effects from inhalation of high concentrations of vapor are pulmonary irritation, including coughing, with nausea; central nervous system depression - characterized by headache and dizziness, increased reaction time, fatigue and loss of coordination. If exposure to highly concentrated solvent atmosphere is prolonged this may lead to narcosis, unconsciousness, even coma and possible death. WARNING: Intentional misuse by concentrating/inhaling contents may be lethal. High inhaled concentrations of mixed hydrocarbons may produce narcosis characterized by nausea, vomiting and lightheadedness. Inhalation of aerosols may produce severe pulmonary edema, pneumonitis and pulmonary hemorrhage. Inhalation of petroleum hydrocarbons consisting substantially of low molecular weight species may produce irritation of mucous membranes, incoordination, giddiness, nausea, vertigo, confusion, headache, appetite loss, drowziness, tremors and anesthetic stupor. Massive exposures may produce central nervous system depression with sudden collapse and deep coma; fatalities have been recorded. Irritation of the brain and/or apneic anoxia may produce convulsions. Although recovery following overexposure is generally complete, cerebral micro- hemorrhage of focal post-inflammatory scarring may produce eleptiform seizures some months after the exposure. Pulmonary episodes may include chemical pneumonitis with edema and hemorrhage. The lighter hydrocarbons may produce kidney and neurotoxic effects. Liquid paraffins may produce anesthesia and depressant actions leading to weakness, dizziness, slow and shallow respiration, unconsciousness, convulsions and death. C_{5-7} paraffins may also produce polyneuropathy. Aromatic hydrocarbons accumulate in lipid-rich tissues (typically the brain, spinal cord and peripheral nerves) and may produce functional impairment manifested by nonspecific symptoms such as nausea, weakness, fatigue, vertigo; severe exposures may produce inebriation or unconsciousness. Many of the petroleum hydrocarbons are cardiac sensitizers and may cause ventricular fibrillations.

Eye: The liquid may produce eye discomfort and is capable of causing temporary impairment of vision and/or transient eye inflammation, ulceration. The vapor is discomforting to the eyes. Petroleum hydrocarbons may produce pain after direct contact with the eyes. Slight, but transient, disturbances of the corneal epithelium may also result. The aromatic fraction may produce irritation and lachrymation. The material may produce moderate eye irritation leading to inflammation. Repeated or prolonged exposure to irritants may produce conjunctivitis.

Skin: The material is moderately discomforting to the skin if exposure is prolonged. The material contains a component that may be absorbed through the skin and may cause drying of the skin, which may lead to dermatitis from repeated exposures over long periods. Toxic effects may result from skin absorption. Open cuts, abraded or irritated skin should not be exposed to this material. The material may accentuate any pre-existing dermatitis condition.

Ingestion: Considered an unlikely route of entry in commercial/industrial environments. The liquid may produce gastrointestinal discomfort and may be harmful if swallowed. Ingestion may result in nausea, pain and vomiting. Vomit entering the lungs by aspiration may cause potentially lethal chemical pneumonitis. Ingestion of petroleum hydrocarbons may produce irritation of the pharynx, esophagus, stomach and small intestine with edema and mucosal ulceration. Resulting symptoms include a burning sensation in the mouth and throat. Large amounts may produce narcosis with nausea and vomiting, weakness or dizziness, slow and shallow respiration, swelling of the abdomen, unconsciousness and convulsions. Myocardial injury may produce arrhythmias, ventricular fibrillation and electrocardiographic changes. Central nervous system depression may also occur. Light aromatic hydrocarbons produce a warm, sharp, tingling sensation on contact with taste buds and may anesthetize the tongue. Aspiration into the lungs may produce coughing, gagging, and a chemical pneumonitis with pulmonary edema and hemorrhage.

Carcinogenicity: NTP - Not listed; IARC - Group 2B, Possibly carcinogenic to humans; OSHA - Not listed; NIOSH - Listed as carcinogen; ACGIH - Class A3, Animal carcinogen; EPA - Not listed; MAK - Not listed.

Chronic Effects: Chronic solvent inhalation exposures may result in nervous system impairment and liver and blood changes. Prolonged or continuous skin contact with the liquid may cause defatting with drying, cracking, irritation and dermatitis following. Chronic poisoning may occur from vapor inhalation or skin absorption. The most significant toxic effect is insidious and irreversible injury to the blood-forming tissue by benzene. Leukemia may develop. Chronic exposure may cause headache, fatigue, loss of appetite and lassitude with incipient blood effects including anemia and blood changes. Gasoline "sniffing" has caused severe nerve damage. Repeated or prolonged exposure to mixed hydrocarbons may produce narcosis with dizziness, weakness, irritability, concentration and/or memory loss, tremor in the fingers and tongue, vertigo, olfactory disorders, constriction of visual field, paresthesias of the extremities, weight loss and anemia and degenerative changes in the liver and kidney. Chronic exposure by petroleum workers to the lighter hydrocarbons has been associated with visual disturbances, damage to the central nervous system, peripheral neuropathies (including numbness and paresthesias), psychological and neurophysiological deficits, bone marrow toxicities (including hypoplasia, possibly due to benzene) and hepatic and renal involvement. Chronic dermal exposure to petroleum hydrocarbons may result in defatting which produces localized dermatoses. Surface cracking and erosion may also increase susceptibility to infection by microorganisms.

Section 4 - First Aid Measures

Inhalation: Remove to fresh air. Lay patient down. Keep warm and rested.
If breathing is shallow or has stopped, ensure clear airway and apply resuscitation. Transport to hospital, or doctor.

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Eye Contact: Immediately hold the eyes open and wash continuously for at least 15 minutes with fresh running water. Ensure irrigation under eyelids by occasionally lifting the upper and lower lids. Transport to hospital or doctor without delay. Removal of contact lenses after an eye injury should only be undertaken by skilled personnel.

Skin Contact: Immediately remove all contaminated clothing, including footwear (after rinsing with water). Wash affected areas thoroughly with water (and soap if available). Seek medical attention in event of irritation.

Ingestion: Contact a Poison Control Center. If swallowed, do NOT induce vomiting. Give a glass of water.

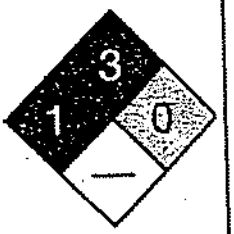
After first aid, get appropriate in-plant, paramedic, or community medical support.

Note to Physicians: For acute or short term repeated exposures to petroleum distillates or related hydrocarbons:

1. Primary threat to life from pure petroleum distillate ingestion and/or inhalation is respiratory failure.
2. Patients should be quickly evaluated for signs of respiratory distress (e.g. cyanosis, tachypnea, intercostal retraction, obtundation) and given oxygen. Patients with inadequate tidal volumes or poor arterial blood gases (pO_2 <50 mm Hg or pCO_2 >50 mm Hg) should be intubated.
3. Arrhythmias complicate some hydrocarbon ingestion and/or inhalation and electrocardiographic evidence of myocardial injury has been reported; intravenous lines and cardiac monitors should be established in obviously symptomatic patients. The lungs excrete inhaled solvents, so that hyperventilation improves clearance.
4. A chest x-ray should be taken immediately after stabilization of breathing and circulation to document aspiration and detect the presence of pneumothorax.
5. Epinephrine (adrenalin) is not recommended for treatment of bronchospasm because of potential myocardial sensitization to catecholamines.
   Inhaled cardioselective bronchodilators (e.g. Alupent, Salbutamol) are the preferred agents, with aminophylline a second choice.
6. Lavage is indicated in patients who require decontamination; ensure use of cuffed endotracheal tube in adult patients.

Section 5 - Fire-Fighting Measures

Flash Point: -43 °C
Autoignition Temperature: 280 °C
LEL: 1.4% v/v
UEL: 7.6% v/v



Fire Diamond

Extinguishing Media: Foam. Dry chemical powder. Bromochlorodifluoromethane (BCF) (where regulations permit). Carbon dioxide.

General Fire Hazards/Hazardous Combustion Products: Liquid and vapor are highly flammable. Severe fire hazard when exposed to heat, flame and/or oxidizers. Vapor forms an explosive mixture with air. Severe explosion hazard, in the form of vapor, when exposed to flame or spark. Vapor may travel a considerable distance to source of ignition. Heating may cause expansion/decomposition with violent rupture of containers. On combustion, may emit toxic fumes of carbon monoxide (CO).

Fire Incompatibility: Avoid contamination with oxidizing agents, i.e. nitrates, oxidizing acids, chlorine bleaches, pool chlorine etc., as ignition may result.

Fire-Fighting Instructions: Alert fire department and tell them location and nature of hazard. May be violently or explosively reactive. Wear breathing apparatus plus protective gloves. Prevent, by any means available, spillage from entering drains or water ways. If safe, switch off electrical equipment until vapour fire hazard removed.
Use water delivered as a fine spray to control fire and cool adjacent area. Avoid spraying water onto liquid pools. Do not approach containers suspected to be hot. Cool fire exposed containers with water spray from a protected location. If safe to do so, remove containers from path of fire.

Section 6 - Accidental Release Measures

Small Spills: Remove all ignition sources. Clean up all spills immediately. Avoid breathing vapors and contact with skin and eyes. Control personal contact by using protective equipment. Contain and absorb small quantities with vermiculite or other absorbent material. Wipe up. Collect residues in a flammable waste container.

Large Spills: Clear area of personnel and move upwind. Alert fire department and tell them location and nature of hazard. May be violently or explosively reactive. Wear breathing apparatus plus protective gloves. Prevent, by any means available, spillage from entering drains or water ways. No smoking, naked lights or ignition sources. Increase ventilation. Stop leak if safe to do so.
Water spray or fog may be used to disperse/absorb vapor. Contain spill with sand, earth or vermiculite. Use only spark-free shovels and explosion proof equipment. Collect recoverable product into labeled containers for recycling. Absorb remaining product with sand, earth or vermiculite. Collect solid residues and seal in labelled drums for disposal. Wash area and prevent runoff into drains.
If contamination of drains or waterways occurs, advise emergency services.

Regulatory Requirements: Follow applicable OSHA regulations (29 CFR 1910.120).

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Section 7 - Handling and Storage

Handling Precautions: Avoid generating and breathing mist. Avoid all personal contact, including inhalation. Wear protective clothing when risk of exposure occurs. Use in a well-ventilated area. Prevent concentration in hollows and sumps. DO NOT enter confined spaces until atmosphere has been checked. Avoid smoking, bare lights, heat or ignition sources. When handling, DO NOT eat, drink or smoke. Vapor may ignite on pumping or pouring due to static electricity. DO NOT use plastic buckets. Ground and secure metal containers when dispensing or pouring product. Use spark-free tools when handling. Avoid contact with incompatible materials. Keep containers securely sealed. Avoid physical damage to containers. Always wash hands with soap and water after handling. Work clothes should be laundered separately. Use good occupational work practices. Observe manufacturer's storing and handling recommendations. Atmosphere should be regularly checked against established exposure standards to ensure safe working conditions.

Recommended Storage Methods: Metal can, metal drum. Packing as recommended by manufacturer. Check all containers are clearly labeled and free from leaks.

Regulatory Requirements: Follow applicable OSHA regulations.

Section 8 - Exposure Controls / Personal Protection

Engineering Controls: CARE: Use of a quantity of this material in confined space or poorly ventilated area, where rapid build-up of concentrated atmosphere may occur, could require increased ventilation and/or protective gear. Use in a well-ventilated area. If inhalation risk of overexposure exists, wear a NIOSH approved organic-vapor respirator. Correct respirator fit is essential to obtain adequate protection. In confined spaces where there is inadequate ventilation, wear full-face air supplied breathing apparatus. Provide adequate ventilation in warehouse or closed storage areas.

Personal Protective Clothing/Equipment

Eyes: Safety glasses with side shields; or as required, chemical goggles.
Contact lenses pose a special hazard; soft lenses may absorb irritants and all lenses concentrate them.

Hands/Feet: Barrier cream with polyethylene gloves or PVC gloves. Safety footwear. Do NOT use this product to clean the skin.

Respiratory Protection:
Exposure Range >300 to 1000 ppm: Air Purifying, Negative Pressure, Half Mask
Exposure Range >1000 to 15,000 ppm: Air Purifying, Negative Pressure, Full Face
Exposure Range >15,000 to 300,000 ppm: Supplied Air, Constant Flow/Pressure Demand, Full Face
Exposure Range >300,000 to unlimited ppm: Self-contained Breathing Apparatus, Pressure Demand, Full Face
Cartridge Color: black

Other: Overalls. Ensure that there is ready access to eye wash unit. Ensure there is ready access to an emergency shower.

Section 9 - Physical and Chemical Properties

Appearance/General Info: Purple, highly flammable, volatile liquid with characteristic sharp odor. Floats on water. Consists of a complex mixture of hydrocarbons with small amounts of residual benzene from the refining operations.

Physical State: Liquid
Vapor Pressure (kPa): 53.33 at 20 °C
Vapor Density (Air=1): > 2
Formula Weight: Not applicable.
Specific Gravity (H_2O=1, at 4 °C): 0.72-0.735 at 15 °C
Water Solubility: Insoluble
Evaporation Rate: Fast

pH: Not applicable
pH (1% Solution): Not applicable.
Boiling Point Range: 38.89 °C (102 °F)
Freezing/Melting Point Range: Not available
Volatile Component (% Vol): 100
Decomposition Temperature (°C): Not available.

Section 10 - Stability and Reactivity

Stability/Polymerization: Presence of incompatible materials. Product is considered stable. Hazardous polymerization will not occur.

Storage Incompatibilities: Avoid storage with oxidizers.

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Section 11 - Toxicological Information

Unless otherwise specified, data extracted from RTECS - Registry of Toxic Effects of Chemical Substances

TOXICITY
Oral (rat) LD50: 18800 mg/kg

IRRITATION
Skin (rabbit): 500 mg/24h mild

Section 12 - Ecological Information

Environmental Fate: No data found.
Ecotoxicity: No data found.
Biochemical Oxygen Demand (BOD): 8%, 5 days

Section 13 - Disposal Considerations

Disposal: Consult manufacturer for recycling options and recycle where possible. Follow all applicable federal, state, and local laws. Incinerate residue at an approved site. Recycle containers where possible, or dispose of in an authorized landfill.
BEWARE: Empty solvent, paint, lacquer and flammable liquid drums present a severe explosion hazard if cut by flame torch or welded. Even when thoroughly cleaned or reconditioned, the drum seams may retain sufficient solvent to generate an explosive atmosphere in the drum.

Section 14 - Transport Information

DOT Transportation Data (49 CFR 172.101):

Shipping Name: MOTOR SPIRIT OR GASOLINE OR PETROL
Hazard Class: 3.1
ID No.: 1203
Packing Group: II
Label: Flammable Liquid[3]

Additional Shipping Information: PETROL

Section 15 - Regulatory Information

EPA Regulations:
RCRA 40 CFR: Not listed
CERCLA 40 CFR 302.4: Not listed
SARA 40 CFR 372.65: Not listed
SARA EHS 40 CFR 355: Not listed
TSCA: Listed

Section 16 - Other Information

Research Date: .....1999-11 **Review Date:** 2000-07

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CONTAMINANT FACT SHEET - METHANE

CAS Number: 0074-82-8
Synonyms: Fire damp; marsh gas; Methyl hydride

Molecular Weight: 16
Physical State: Gas

Color: Colorless
Odor: Odorless; Commercially, mercaptans added produce rotten egg odor

Ionization Potential (eV): 12.51
Henry's Constant: NA

Vapor Density (Air=1): 0.544 @ 32F
Vapor Pressure: NA (mmHg@20C)

Fire Hazard rating: 4 NFPA
HMIS rating: 4

Reactivity Hazard NFPA rating: 0
HMIS rating: 0

Health Hazard NFPA rating: 1
HMIS rating: 1

Flash Point(°F): -213
LEL(%): 5 UEL(%): 15

Fire Extinguishing Media: *See Note*
- ☐ Dry Chemical
- ☐ Foam
- ☐ Water Spray
- ☐ CO_2

Fire Extinguisher:
- ☐ Class A
- ☐ Class B
- ☐ Class C
- ☐ Class D
- ☐ Class A/B/C

DOT: ☒ Flammable Gas ☐ Combustible Liquid

Incompatibilities: Bromine pentafluoride; chlorine; chlorine dioxide; nitrogen trifluoride; liquid oxygen; oxygen difluoride

DOT: ☐ Oxidizer ☐ Water Reactive

Odor Threshold (ppm): NA

IDLH (ppm): NA

Source	TWA (ppm)	STEL (ppm)	C (ppm)
OSHA PELs	NA	NA	NA
ACGIH TLVs	NA	NA	NA

Signs/Symptoms of Acute Exposure: Simple asphyxiant; rapid respir.; air hunger; diminish. mental alert.; impair. muse. coord.; faulty judge.; rapid fatigue; emotion. instabil.; nausea; convul.; coma; death

DOT: ☐ Poison

Carcinogenic:
OSHA: ☐ Yes ☒ No
IARC: ☐ Group 1 ☐ Group 2A ☐ Group 2B ☐ Group 3 ☐ Group 4 ☒ No
NTP: ☐ Known ☐ Anticipated ☐ Process ☒ No
ACGIH: ☐ A1 ☐ A2 ☐ A3 ☐ A4 ☐ A5 ☒ No

Skin Absorbable: ☐ Yes ☒ No
Skin Corrosive: ☒ Yes ☐ No (as liquid)

DOT: ☐ Corrosive

Air Monitoring

Type	Brand/Model No.	Calibration Method/Media	Relative Resp. or Conv. Factor	Acceptable Meter Reading
☐ Explosimeter	GasTech	Methane	1	NA
☒ Multigas	Rae Systems - VRAE	Four gas mix	NA	NA
☐ PID	MiniRAE	Isobutylene		
☐ FID	Foxboro OVA	Methane	100%	NA
☐ Colorometric Tubes	Drager/	Check pump for leaks		
☐ Chemical Monitor ☐ Dust Monitor				
☐ Collection Medium/Sampling Pump	Gilian Pump/NIOSH#	Calibrate pump w/ media		

Protective Clothing

Glove Type/Brand (Breakthrough >2 hrs unless noted):
- ☐ Viton/North
- ☐ Viton/Best
- ☐ Silvershield/North
- ☐ 4H/Safety
- ☐ Neoprene/Mapa
- ☐ Neoprene/Ans.Ed.
- ☐ Neoprene/BestUltraflex
- ☐ Neoprene/BestNeo.(30min)
- ☐ PVC/Ans.Ed.
- ☐ PVC/BestHustler
- ☐ Nitrile/LabSafe.
- ☐ Nitrile/Ans.Ed.
- ☐ Butyl/North
- ☐ PVA/Ans.Ed.
- ☒ Other

Suit Type (Breakthrough >1hr unless noted): ☐ Tyvek ☐ Tyvek QC ☐ Tyvek/Saranex ☐ Tychem7500 ☐ Tychem 9400 ☐ Tychem 10,000 ☒ Other

Respiratory Protection

☐ Air Purifying ☒ Air Supplied Only | Maximum Use Concentration (ppm): Half mask: NA Full face: NA

Notes: To treat fire, shut off source.
Prepared by: Sherry Hall

Date: 23 June 1997

CONTAMINANT FACT SHEET - *HYDROGEN SULFIDE*

CAS Number:7783-06-4
Synonyms: Hydrosulfuric acid; Sewer gas; Sulfuretted hydrogen

Molecular Weight:34.1
Physical State: Gas

Color: Colorless
Odor: Strong odor of rotten eggs

Ionization Potential (eV): 10.46
Henry's Constant: NA ((atm x m³)/mol)

Vapor Density (Air=1):1.175
Vapor Pressure: 17.6 (atm)

Fire Hazard NFPA rating: 4 HMIS rating: 4

Reactivity Hazard NFPA rating: 0 HMIS rating: 0

Health Hazard NFPA rating: 3 HMIS rating: 3

Flash Point(°F): NA
LEL(%): NA UEL(%): NA

Fire Extinguishing Media:
- ☐ Dry Chemical
- ☒ Water Spray
- ☒ Foam
- ☐ CO_2

Fire Extinguisher:
- ☐ Class A
- ☐ Class C
- ☒ Class A/B/C
- ☐ Class B
- ☐ Class D

DOT: ☒ Flammable Gas ☐ Combustible Liquid

Incompatibilities: Strong oxidizers; strong nitric acid; metals

DOT: ☐ Oxidizer ☐ Water Reactive

Odor Threshold (ppm): 0.001-0.13*

IDLH (ppm): 100

Source	TWA (ppm)	STEL (ppm)	C (ppm)
OSHA PELs	NA	NA	20
ACGIH TLVs	10	15	NA

Signs/Symptoms of Acute Exposure: Irritation of eyes, respiratory system; apnea; coma; convulsions; conjunctivitis; eye pain; dizziness; headache; irritability

DOT: ☐ Poison

Carcinogenic:
OSHA: ☐ Yes ☒ No

IARC: ☐ Group 1 ☐ Group 2A ☐ Group 2B ☐ Group 3 ☐ Group 4 ☒ No

NTP: ☐ Known ☐ Anticipated ☐ Process ☒ No

ACGIH: ☐ A1 ☐ A2 ☐ A3 ☐ A4 ☐ A5 ☒ No

Skin Absorbable: ☐ Yes ☒ No
Skin Corrosive: ☐ Yes ☒ No

DOT: ☐ Corrosive

Air Monitoring

Type	Brand/Model No.	Calibration Method/Media	Relative Resp. or Conv. Factor	Acceptable Meter Reading
☐ Explosimeter	Gastech GX-82	Methane	NA	NA
☒ Multigas	Rae Systems – VRAE	Four gas mix	NA	NA
☐ PID	MiniRAE	Isobutylene	4.1(10.6eV); 0.9(11.7eV)	2 ppm(10.6eV); 10 ppm(11.7eV)
☐ FID	Foxboro OVA	Methane	NA	NA
☐ Colorimetric Tubes	Drager/8101831 (1-200 ppm)	Check pump for leaks	NA	NA
☐ Chemical Monitor ☐ Dust Monitor	Many available	See owner's manual	NA	NA
☐ Collection Medium/Sampling Pump	Gilian Pump/NIOSH#6013	Calibrate pump w/ media	NA	NA

Protective Clothing

Glove Type/Brand (Breakthrough >2 hrs unless noted):
- ☐ Viton/North
- ☐ Neoprene/Mapa
- ☐ PVC/Ans.Ed.
- ☐ Butyl/North
- ☐ Viton/Best
- ☐ Neoprene/Ans.Ed.
- ☐ PVC/BestHustler
- ☐ PVA/Ans.Ed.
- ☐ Silvershield/North
- ☐ Neoprene/BestUltraflex
- ☐ Nitrile/LabSafe.
- ☒ Other
- ☐ 4H/Safety
- ☐ Neoprene/BestNeo.(30min)
- ☐ Nitrile/Ans.Ed.

Suit Type (Breakthrough >1hr unless noted): ☐ Tyvek ☐ Tyvek QC ☐ Tyvek/Saranex ☒ Tychem7500 ☒ Tychem 9400 ☐ Tychem10,000 ☒ Other

Respiratory Protection

☐ Air Purifying ☒ Air Supplied Only | Maximum Use Concentration (ppm): Half mask: NA Full face: NA

Notes: Causes olfactory fatigue and can not be relied upon to warn of continuous hydrogen sulfide presence

Prepared by: Sherry Hall Date: 10 October 1997

APPENDIX O-4

STANDARD OPERATING PROCEDURES (LARGE DIAMETER BORINGS)

APPENDIX O-4.1

SOLID WASTE DRILLING

STANDARD OPERATING PROCEDURE
SOP-1

SOLID WASTE DRILLING
(LARGE DIAMETER BORINGS)

REVISION 0

Prepared for

DELAWARE SOLID WASTE AUTHORITY
Cherry Island Landfill
1706 E. 12th Street
Wilmington, Delaware 19809
(302) 784-5385

Prepared by:

GEOSYNTEC CONSULTANTS
10015 Old Columbia Road, Suite A-200
Columbia, Maryland 21046
(410) 381-4333

8 March 2002

Title: **SOLID WASTE DRILLING** **STANDARD OPERATING PROCEDURE (SOP)**	
Procedure No.: SOP-1 Revision No.: Revision 0	
Effective Date: 8 March 2002	Page i of i

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2. GENERAL 1
3. RESPONSIBILITIES 1
4. MATERIALS AND EQUIPMENT 2
5. PROCEDURES 2
6. REFERENCES 3

Title: SOLID WASTE DRILLING STANDARD OPERATING PROCEDURE (SOP)	
Procedure No.: SOP-1 Revision No.: Revision 0	
Effective Date: 8 March 2002	Page 1 of 3

1. PURPOSE

This standard operating procedure (SOP) establishes the guidelines for drilling through solid waste at the Cherry Island Landfill (CIL), which is owned and operated by the Delaware Solid Waste Authority (DSWA). During the solid waste drilling activities, the waste will be visually classified, samples of waste will be collected for on-site characterization and laboratory testing, and in-situ evaluations of waste unit weight will be conducted.

2. GENERAL

This SOP applies to personnel involved in waste drilling activities. Waste drilling will be performed to better characterize the type of materials within the landfill and to facilitate further evaluation of the physical (i.e., mechanical) properties of the waste.

3. RESPONSIBILITIES

Project Manager - Reviews and approves the locations to be drilled.

Project Engineer - Selects drilling location and monitors the field engineer's work to confirm that the field work is performed in accordance with this SOP.

Field Engineer - Monitors drilling contractor during waste drilling activities and documents field activities.

Drilling Contractor - Performs drilling activities for drilling through deposited waste.

4. MATERIALS AND EQUIPMENT

The following materials and equipment are needed to drill in waste.

A. Drilling rig, capable of advancing a 36-in. diameter bucket auger through deposited waste at 10 ft increments.

B. Roll-off containers and roll-off truck to transfer waste to CIL weigh bridge for weight determination and then to active disposal area.

C. Miscellaneous health and safety and sampling equipment (i.e., shovels, gloves, tyvek suits, steel-toed/steel shank boots, respirators, self contained breathing apparatuses, hard hats, etc.).

5. PROCEDURES

A. Drilling locations will be identified by the project or field engineer.

B. Drilling will be advanced in 10-ft increments (approximately). Actual increments to be identified by the field engineer.

C. Drilling activities will pause at selected increments to allow in-situ evaluations of waste unit weight to be conducted. The depth of the borehole will be verified at this time by the field engineer with a surveyors tape of known length, which is weighted at one end.

D. Following any waste sampling activities (see SOP-2), waste cuttings from each depth increment will be weighed before being transported to the active filling area for disposal.

E. Boreholes will be completed as gas wells after volume determination (see SOP-2).

F. Borehole will be capped from a depth of 3-ft to the surface with clayey soil stockpiled on site, bentonite, or other approved material as part of gas well completion (see SOP-2).

G. Completion and capping will be carried out under supervision of field engineer and responsible representative from Dominion Airtech, LLC of Taylor, Pennsylvania, or their appointed gas well installation contractor at the CIL site.

H. Drilling equipment that is exposed to contamination will be decontaminated with high-pressure steam or similar process prior to demobilizing all equipment off site.

I. Both the field engineer and drilling contractor will follow health and safety protocols as described in each firm's Health and Safety Plan (HASP) and as described in the HASP for the site.

6. REFERENCES

GeoSyntec Consultants, Site Health and Safety Plan for Phase I Geotechnical Investigation Waste Unit Weight Evaluation, Cherry Island Landfill (CIL), March 2002.

APPENDIX O-4.2

SOLID WASTE SAMPLING AND FIELD TESTING

STANDARD OPERATING PROCEDURE
SOP-2

SOLID WASTE SAMPLING AND FIELD TESTING

REVISION 1

Prepared for

DELAWARE SOLID WASTE AUTHORITY
Cherry Island Landfill
1706 E. 12th Street
Wilmington, Delaware 19809
(302) 784-5385

Prepared by:

GEOSYNTEC CONSULTANTS
10015 Old Columbia Road, Suite A-200
Columbia, Maryland 21046
(410) 381-4333

June 2002

Title: SOLID WASTE SAMPLING AND FIELD TESTING STANDARD OPERATING PROCEDURE (SOP)	
Procedure No.: SOP-2 Revision No.: Revision 1	
Effective Date: June 2002	Page i of i

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6. REFERENCES 8

Title: SOLID WASTE SAMPLING AND FIELD TESTING STANDARD OPERATING PROCEDURE (SOP)	
Procedure No.: SOP-2 Revision No.: Revision 1	
Effective Date: June 2002	Page 1 of 8

1. PURPOSE

This standard operating procedure (SOP) establishes standard guidelines for solid waste sampling and field testing at the Cherry Island Landfill (CIL), which is owned and operated by the Delaware Solid Waste Authority (DSWA). These activities include the recovery of bulk samples for laboratory testing of reconstituted solid waste, visual classification of CIL waste composition, and in-situ unit weight evaluation.

2. GENERAL

This SOP applies to personnel involved in waste sampling and field testing activities. Waste sampling will be performed to: better characterize the type and properties of waste materials within the landfill; and to obtain bulk samples for laboratory reconstitution and evaluation of the physical (i.e., mechanical) properties of the waste.

3. RESPONSIBILITIES

Project Manager - Reviews and approves the sampling program.

Project Engineer - Develops the sampling program and monitors the field engineer's work to confirm that the field work is performed in accordance with this SOP.

Field Engineer - Conducts and documents waste sampling and field testing activities.

4. MATERIALS AND EQUIPMENT

The following materials and equipment are needed to drill in waste, sample and test waste in the field, and, as requested by DSWA, backfill the boreholes as gas wells.

A. Drilling rig, capable of advancing a 36-in. diameter bucket auger through deposited waste to a target depth of up to 80 ft.

B. Perforated 6-in. diameter HDPE pipe sections for construction of gas wells.

C. Clean, washed Delaware No. 57 gravel, or other gravel with ½-in. to 1½-in. diameter and possessing the characteristic property of not requiring compaction following deposition in the borehole in order to maintain uniform bulk density. The bulk density of the backfill gravel should be determined prior to field operations as described in Section 5.3(H). Gravel is to be delivered in concrete trucks as required. The gravel backfill storage area at the concrete plant is covered in order to reduce large variations in the moisture content, which may affect the gravel's in-situ bulk density.

D. Concrete trucks with positioning chutes for transferring Delaware No. 57 gravel into 36-in. diameter boreholes.

E. Metal roll-off containers (10 cy capacity) and truck. The containers should be placed directly adjacent to the drill rig and used to collect cuttings from the bucket auger.

F. Certified landfill truck scale with a capacity of approximately 80,000 lbs accurate to within ± 20 lbs.

G. Surveyor's tape at least 80 ft in length and weighted at one end.

H. Clayey soil, bentonite, and/or other material approved by the field engineer for capping borehole upon completion of gravel backfilling operations (i.e., completion of borehole as gas well).

I. Portable gas analyzer for monitoring oxygen, methane, and hydrogen sulfide concentrations around open boreholes.

I. Miscellaneous health and safety and sampling equipment (e.g., shovels, gloves, steel-toed/steel shank boots, hard hats, etc.) as required in the Site Health and Safety Plan (HASP).

The following materials and equipment are needed to determine the bulk density of the backfill gravel.

A. Four watertight 55-gallon metal or heavy-duty plastic drums.

B. Front-end loader with front bucket-scoop capacity of up to 3500 lb. of gravel and with a bucket-scoop lift height of at least 20 ft.

C. Pick-up truck capable of carrying four 55-gallon drums filled with gravel (up to 3500 lb. total weight).

D. Certified truck scale with a capacity of approximately 10,000 lbs accurate to within ± 20 lbs.

E. Surveyor's tape at least 25 ft in length and weighted at one end.

F. Heavy-duty friction-hold lifting strapping.

5. PROCEDURES

5.1. Waste Sample Collection for Laboratory Testing

Sampling activities will be carried out by SCS Engineers of Reston, Virginia. As such, no waste sampling procedures are included in this SOP, except for the following.

A. Visual classification of waste will be conducted during deposition of waste cuttings in the roll-off containers from the bucket auger. After drilling of each depth increment has been completed, the roll-off container will be dragged away from the drill rig and replaced with an empty container. Bulk sample collection from the full container will then be conducted.

B. SCS Engineers personnel shall follow health and safety protocols as described in their Health and Safety Plan and as described in the Health and Safety Plan (HASP) for the site.

5.2 In-Situ Waste Unit Weight Evaluation – *Weight*

A. The unit weight is to be evaluated in the same intervals in which bulk samples of waste were recovered, (i.e., approximately every 10 ft of depth of drilling), using a procedure similar in concept to ASTM 5030-89.

B. From each designated sample interval, place all waste material excavated into a roll-off container of known tare weight, located adjacent to the drill rig. Carefully track each container to identify the sampling interval.

C. Upon completion of drilling each depth interval, weigh the full waste container from each of the sample intervals. Calculate the weight of the waste interval by subtracting the container tare weight from the container full weight. Each waste container will have a maximum volume of approximately 10 cubic yards.

D. If necessary, add weight of waste from each interval used in waste sampling activities (see Section 5.1(A)) to the weight of the waste in the waste container. This represents the total weight of the waste for the designated waste interval.

E. Measure the depth of the borehole at the beginning (shallow end) of the sampling interval and at the end (deep end) of the sampling interval and record the location of the sampling interval within the waste profile. The depth should be measured at the center and at least two points on the circumference of each interval's cross section.

F. Place safety grid over borehole until such time as backfilling of gravel and construction of gas well can be completed.

G. The field engineer, gas well contractor, driller contractor, and SCS Engineers personnel, shall follow health and safety protocols as described in each firm's Health and Safety Plan and as described in the Health and Safety Plan (HASP) for the site.

5.3 In-Situ Waste Unit Weight Evaluation – *Volume (Gravel Backfill Method)*

A. After advancing the borehole into the waste mass to the maximum depth, measure the depth of the borehole as in Section 5.2(E).

B. Upon entering the CIL site, the concrete trucks should pass over the landfill truck scale. The trucks should then be positioned such that their positioning chutes are directed at the borehole. The borehole should then be backfilled with gravel up to the designed depth for the bottom of the 6-in. diameter HDPE perforated gas well pipe. The concrete truck should then pass back over the landfill truck scale.

C. Place the 6-in. diameter perforated pipe in the borehole. Continue to backfill the remaining depth of the borehole with gravel in one to three intervals (depending on maximum depth) so that the top of the final interval is approximately 3 ft below the surface. The concrete truck should pass back over the landfill truck scale between each filling interval.

D. Completed gas wells will be capped from a depth of 3-ft to the surface with clayey soil, bentonite, or other approved material. Completion and capping will be carried out under supervision of field engineer and responsible representative from Dominion Airtech, LLC of Taylor, Pennsylvania, or their appointed gas well installation contractor at the CIL site.

E. During gravel backfilling, the field engineer, gas well contractor, and driller contractor shall follow health and safety protocols as described in each firm's Health and Safety Plan and as described in the Health and Safety Plan (HASP) for the site.

F. Determine the height of each backfilled interval in items (B) and (C) above by measuring the depth of the borehole after backfilling with gravel. Use the method described in Section 5.2(E). The borehole should be backfilled as evenly around the borehole and gas pipe circumference as possible.

G. Determine the weight of gravel backfilled into the borehole in each depth interval by calculating the weight of the concrete truck before and after each backfilling operation.

H. The density of Delaware No. 57 gravel, and the relationship between gravel density and drop height, was determined using a number of methods and literature sources as described in Appendix G-1 of the Waste Characterization Report (WCR).

I. Develop a relationship between weight of gravel backfill, borehole depth, and gravel density for the whole borehole. This will enable the volume of any depth interval within the borehole to be calculated (see Appendix G-2 of the WCR). The volume of the gas pipe should be taken into account where necessary.

J. Calculate the in-situ unit weight of the excavated waste by dividing the weight of waste material in each interval, obtained as described in Section 5.2, by the corresponding interval's volume, obtained from the calculation described in item (F) above.

5.4 Waste Logging

A. Document visual classification of the waste with depth, in accordance with the attached Procedural Record and Visual Classification Form (see Attachment 1). A more detailed classification of waste will be conducted on waste obtained for sampling purposes as specified in Section 5.1. Visual classification of waste will be conducted during deposition of waste cuttings in the roll-off containers from the bucket auger.

B. Document drilling and sampling activities and procedures. Note variations from this SOP, if any.

C. The field engineer, gas well contractor, driller contractor, and SCS Engineers personnel, shall follow health and safety protocols as described in each firm's Health and Safety Plan and as described in the Health and Safety Plan (HASP) for the site.

6. REFERENCES

GeoSyntec Consultants, SOP-1, *"Solid Waste Drilling"*, March 2002.

GeoSyntec Consultants, Site Health and Safety Plan for Phase I Geotechnical Investigation Waste Unit Weight Evaluation, Cherry Island Landfill (CIL), March 2002.

ASTM, 1991, Standard Test Method for Density of Soil and Rock in Place by the Water Replacement Method in a Test Pit.

Title: **SOLID WASTE DRILLING** **STANDARD OPERATING PROCEDURE (SOP)**	
Procedure No.: CIL-2 Revision No.: Revision 1	
Effective Date: June 2002	

ATTACHMENT 1

PRECEDURAL RECORD AND CLASSIFICATION FORM

GEOSYNTEC CONSULTANTS
(410) 381-4333

Procedural Record & Visual Classification Form (PRVCF)

BOREHOLE LOCATION NO.: _____ WEATHER: _____

CONTRACTOR: _____ DATE (MM.DD.YY): ____/____/____

FIELD ENGINEER: _____ Auger Dia. _____ (in) Gas Pipe Dia. _____ (in)

CIL: Test Boring and Sampling Project No. ME0250 Task No. 1.3.4

Time	Depth (ft.)	Structure	Moisture Content	Compaction	Degradation	Composition	Depth Int. (ft)	Waste Mass (tons)	Total Waste Mass (tons)	Depth Int. (ft)	Gravel Mass (Begin) (tons)	Gravel Mass (End) (tons)	Notes/Comments Visual Classification Legend on rear of form.

WASTE GRAVEL

Reviewed By: _____ Page No _____ of _____

REFUSE VISUAL CLASSIFICATION
LEGEND

GEOSYNTEC CONSULTANTS

MOISTURE CONTENT
1= DRY-DAMP MOISTURE LEVELS
2=WET MOISTURE LEVELS
3=STANDING WATER

COMPACTION
1= SLIGHT - REFUSE EASILY FALLS OUT OF BUCKET AUGER
2= MODERATE - REFUSE FALLS OUT OF BUCKET AUGER UPON IMPACT
3= HEAVY - REFUSE FALLS OUT OF BUCKET AUGER ONLY AFTER BEING STRUCK MULTIPLE TIMES

DEGRADATION
1=NONE - NEWSPAPERS VERY LEGIBLE, NO REFUSE DISCOLORATION
2=SLIGHT - SOME NEWSPAPERS STILL LEGIBLE, DISCOLORATION
3=MODERATE - NEWPAPER PARTLY LEGIBLE, HIGHLY DISCOLORED
4=HIGH - NEWSPAPER HIGHLY FADED GRAY TO BLACK

COMPOSITION
1=HOUSEHOLD- PAPER AND PLASTICS
2=PUTRESCIBLE ORGANICS
3=CONCRETE, BRICKS
4=WIRING
5=METAL
6=NON FERROUS METAL
7=TIRES
8=ASPHALT
9=SOIL
10=MEDICAL
11=INDISTINGUISHIBLE
12=GLASS
13=OTHER (SPECIFY)

STRUCTURE
1=LAYERED - WASTE CONSTITUENTS ORIENTED WITH LONG AXIS IN A PREFERRED DIRECTION (E.G., HORIZONTAL) (NOTE: DIRECTION IN DIFFERENT COLUMN)
2=ENCAPSULATED - WASTE CONSTITUENTS ENCAPSULATED IN A SOIL MATRIX
3=FIBROUS - WASTE CONSTITUENTS INTERTWINED
4=INTERLOCKED - WASTE CONSTITUENTS INTERLOCKED ("COMPACT, "GRANULAR" TYPE STRUCTURE)
5=INDISTINGUISHABLE

Reviewed By _____

APPENDIX O-5

WASTE CLASSIFICATION STUDY AND LABORATORY TESTING OF WASTE MOISTURE CONTENT

Environmental Consultants

11260 Roger Bacon Drive
Reston, VA 20190-5282

703 471-6150
FAX 703 471-6676
www.scsengineers.com

SCS ENGINEERS

RECEIVED
JAN 15 2003
DSWA

January 10, 2003
File No. 02201089.00

Ms. Anne Germain
Project Director
Delaware Solid Waste Authority
1128 South Bradford Street
Dover, Delaware 19903

Subject: Waste Characterization of Borehole Materials from Cherry Island Landfill

Dear Ms. Germain:

This letter report presents the results from the sampling event at the Cherry Island Landfill in Wilmington, Delaware on March 11 and 12, 2002. The purpose of the sampling event was to assess the degree of degradation of landfilled material for varying locations and depths at the site.

SCOPE OF WORK

GeoSyntec Consultants (GeoSyntec) planned to drill a total of nine borings at specific predetermined locations within the five Phases of the landfill. Of the nine, SCS Engineers (SCS) planned to sample one borehole in Phases 1, 2, and 4; and two boreholes in Phase 5. SCS planned to obtain grab samples at 10-foot depth increments within the depth range of each borehole. Boreholes should have ranged in depth from 20 to 70 feet; however, boreholes were not drilled beyond 30 feet in depth due to the presence of static water beyond these depths.

At each 10 foot depth interval, SCS conducted a manual waste sort of 50 to 60 kilograms (110 to 130 pounds) of waste, collected samples for laboratory analysis of moisture content and biochemical methane potential (BMP); and collected samples of the recognizable fraction (organic and non-organic) of the waste.

APPROACH

Geosyntec and their contracted driller arrived at the appropriate predetermined borehole location and began drilling operations. A hollow-stem auger was used for all of the samples collected from each borehole. 10-foot continuous intervals of waste were collected and placed into roll-off containers at each borehole. Samples were subsequently brought to the SCS field sorting crew. Approximately 110 to 130 pounds of waste from the roll-off dumpster was then shoveled into 30-gallon waste containers for subsequent sorting. A SCS representative obtained two samples for laboratory analysis from the roll-

off dumpster prior to the waste being sorted. Samples were double bagged, sealed, labeled, and sent overnight via Federal Express to Mort Barlaz with the Civil Engineering Department of North Carolina State University for laboratory analysis of moisture content and BMP. Next, the crew began sorting the waste manually. Waste was separated into the following categories:

- Paper,
- Plastic,
- Glass,
- Metals,
- Organics,
- Other Inerts (primarily rock and dirt), and
- Fines (predominantly rock and dirt).

Each category of waste was placed into separate 30-gallon container. Once the entire sample was sorted, the waste in each category was weighed and recorded on a data sheet. The waste was sorted in a table with the bottom lined with 0.25-inch mesh wiring for fines. The quantity of fines was calculated by subtracting the combined weight of the other materials from the total weight of the sample.

As the waste sample was sorted, SCS representatives searched for recognizable organic and non-organic items in the waste and placed them into labeled plastic sample bags. Samples were sealed and labeled and will be provided to DSWA along with this report. SCS tried to focus on obtaining the recognizable organic fraction of the waste, but also selected recognizable non-organic materials when recognizable organic waste could not be found. The sorted waste was placed back into the roll-off dumpster and then all drilled material was disposed of at the working face of the landfill. Geosyntec was responsible for placing a slotted pvc pipe into the borehole for a possible future gas well and sealing the remainder of the hole.

RESULTS

Waste composition data obtained from the waste sort; moisture content obtained from the laboratory analysis, and comments regarding the recognizable organic waste are presented in this section.

The waste material, for the most part, was in poor condition, fairly degraded, and problematic to sort. Most of the waste was black in color and very wet making it visually indistinguishable. To sort the waste, the field crew had to rely on the texture, density, and consistency of the waste.

Some general characteristics about the waste are as follows:

- Paper was generally wet and therefore rather heavy;
- Glass was always in small fragments due to compaction that had occurred;

- Organics generally consisted of wood, compost material, and leaves;
- Inert material consisted of either wet dirt or rock; and
- Most of the fines were inert material (dirt).

In general, waste in Phases 1, 2, and 3 were more degraded than waste in Phases 4 and 5. Waste from greater depths was also more difficult to recognize. Photographs of waste are provided as an Appendix. (not included in this letter report as reproduced for Ap-0-5 for the Waste Characterization Report)

Borehole P2-1sub

This borehole was drilled as a substitute for the Phase 1 borehole. The original borehole for Phase 1 was not drilled due to the presence of asbestos. As a substitute for the P1-02-1, Geosyntec chose to drill P2-1sub, which was close to Phase 1 but actually located in Phase 2. The original Phase 1 borehole was supposed to be drilled to a depth of 70 feet; however, due to the presence of standing water at P2-1sub drilling was stopped at 28 feet.

SCS obtained an organic fraction from each of the three samples. Organics found at each depth are described below:

- 10 feet – paper
- 20 feet – paper towels
- 30 feet – a boot and paper

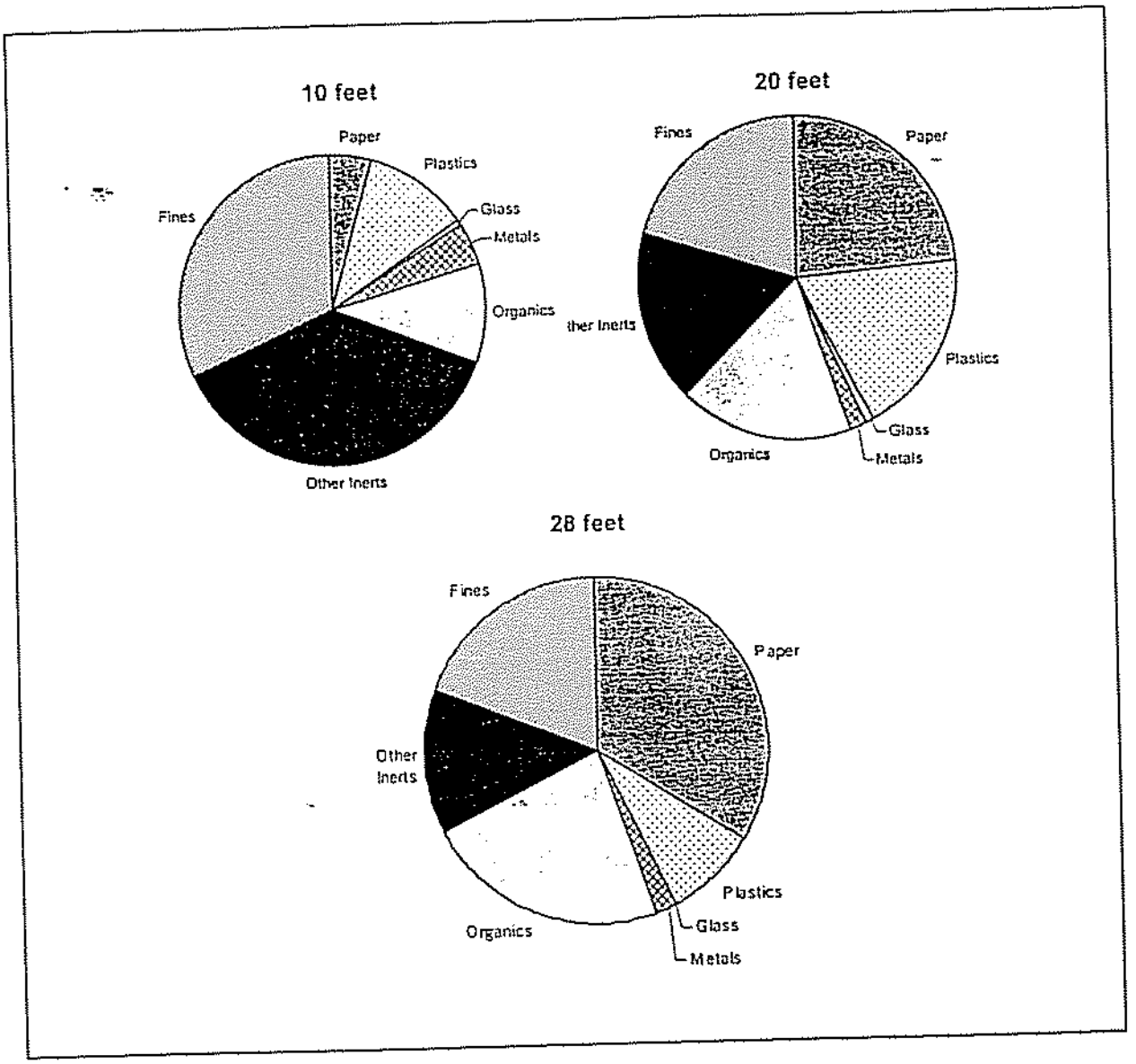
Waste composition data for borehole P2-1sub are presented in Exhibits 1 and 2.

Exhibit 1
P2-1sub Waste Composition and Moisture Content

Depth	10 feet		20 feet		28 feet	
Waste Component	Weight (lbs)	Percent (%)	Weight (lbs)	Percent (%)	Weight (lbs)	Percent (%)
Paper	7.3	4.6	35.7	23.5	43.9	33.9
Plastic	17.5	11.0	28.7	18.9	11.5	8.9
Glass	0.7	0.4	0.9	0.6	--	--
Metals	7.1	4.5	2.6	1.7	2.5	1.9
Organics	16.4	10.4	27.1	17.9	29.5	22.8
Other Inerts	59.6	37.5	26.0	17.1	17.4	13.5
Fines	50.2	31.6	31.0	20.4	24.6	19.0
Total Waste	158.9	100.0	151.9	100.1	129.4	100.0
Moisture content	--	48.6	--	42.4	--	36.5

Note: Waste component percentages may not sum to 100 percent due to rounding.

Exhibit 2
P2-1sub Waste Composition by Percentage



Borehole P2-02-02

This borehole was planned to be drilled to a depth of 40 feet; however, standing water was reached at 30 feet and drilling did not continue. SCS sorted the 10-foot and 20-foot samples, but did not sample the 30-foot sample due to the liquid nature of the waste; however, a sample was obtained from the 30-foot sample for laboratory analysis. SCS did not obtain an organic sample for DSWA because there was no recognizable organics, other than wood and wood chips, present in the waste.

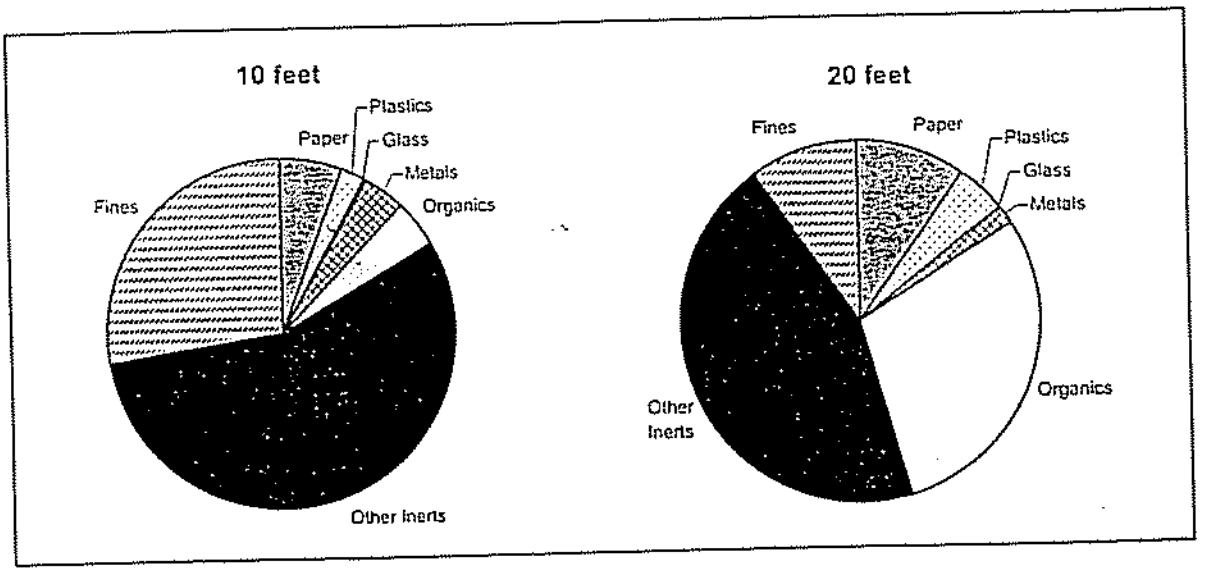
Waste composition data for borehole P2-02-02 are presented in Exhibit 3 and 4.

Exhibit 3
P2-02-02 Waste Composition and Moisture Content

Depth	10 feet		20 feet		25 feet*	
Waste Component	Weight (lbs)	Percent (%)	Weight (lbs)	Percent (%)	Weight (lbs)	Percent (%)
Paper	8.0	5.7	15.1	10.0	--	--
Plastic	3.3	2.4	6.7	4.4	--	--
Glass	0.2	0.1	--	--	--	--
Metals	5.6	4.1	2.7	1.8	--	--
Organics	6.3	4.5	44.4	29.3	--	--
Other Inerts	77.4	55.6	67.6	44.6	--	--
Fines	38.5	27.6	14.9	9.9	--	--
Total Waste	139.3	100.0	158.9	100.0	--	--
Moisture content	--	32.9	--	49.6	--	53.5

*Sort not performed due to liquid nature of waste.

Exhibit 4
P2-02-02 Waste Composition by Percentage



Borehole P3-02-04

This borehole was drilled to a depth of about 20 feet. SCS obtained an organic fraction from each of the three samples. Organics found at each depth are described below:

- 10 feet – paper
- 20 feet – paper

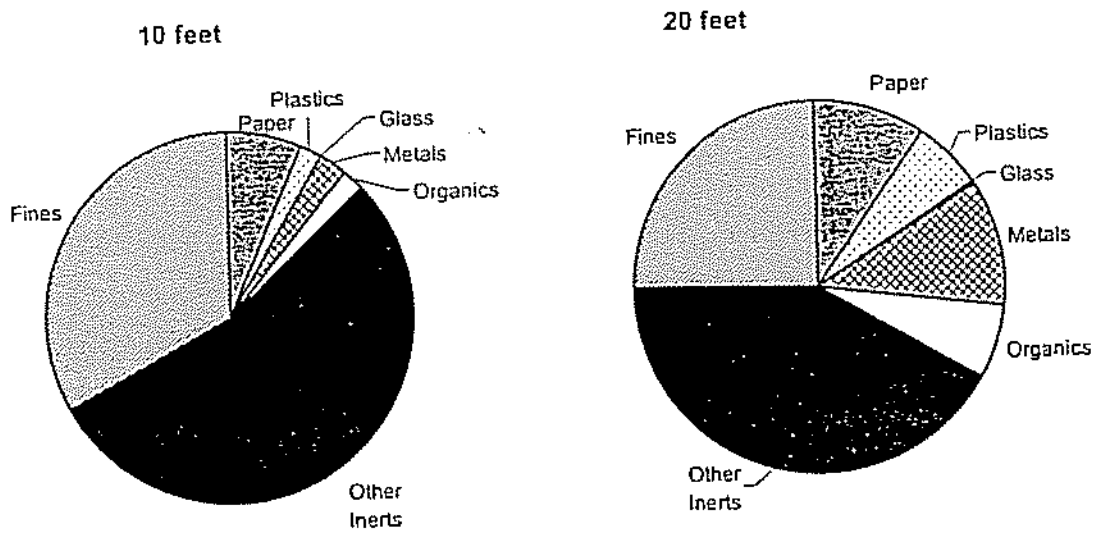
Waste composition data for borehole P3-02-04 are presented in Exhibits 5 and 6.

Exhibit 5
P3-02-04 Waste Composition and Moisture Content

Depth	10 feet		20 feet	
Waste Component	Weight (lbs)	Percent (%)	Weight (lbs)	Percent (%)
Paper	11.7	6.6	17.1	9.8
Plastic	3.3	1.9	10.3	5.9
Glass	0.1	0.1	0.5	0.3
Metals	4.7	2.7	19.3	11.1
Organics	3.1	1.8	11.1	6.4
Other Inerts	95.6	54.3	73.2	42.0
Fines	57.7	32.8	42.9	24.6
Total Waste	176.2	100.2	174.4	100.1
Moisture content	--	29.4	--	29.1

Note: Waste component percentages may not sum to 100 percent due to rounding.

Exhibit 6
P3-02-04 Waste Composition by Percentage



Borehole P4-02-05

This borehole was drilled to a depth of about 30 feet. The drilling contractors completed drilling to the desired 30-foot depth at 5:00 pm on Monday. SCS was required to be off-site before 5:30 pm and decided to sort the waste the next morning. SCS gathered

samples for moisture content and BMP to ensure they were not affected by sitting overnight. SCS had asked the disposal company not to remove the waste until they were notified, but when the disposal company arrived on-site they saw the SCS truck in the distance and assumed that a sample had been taken. The disposal company took the sample to the working face prior to SCS grabbing a sample for the sort.

SCS obtained an organic fraction from the first two samples. Organics found at each depth are described below:

- 10 feet – textiles and paper
- 20 feet – paper

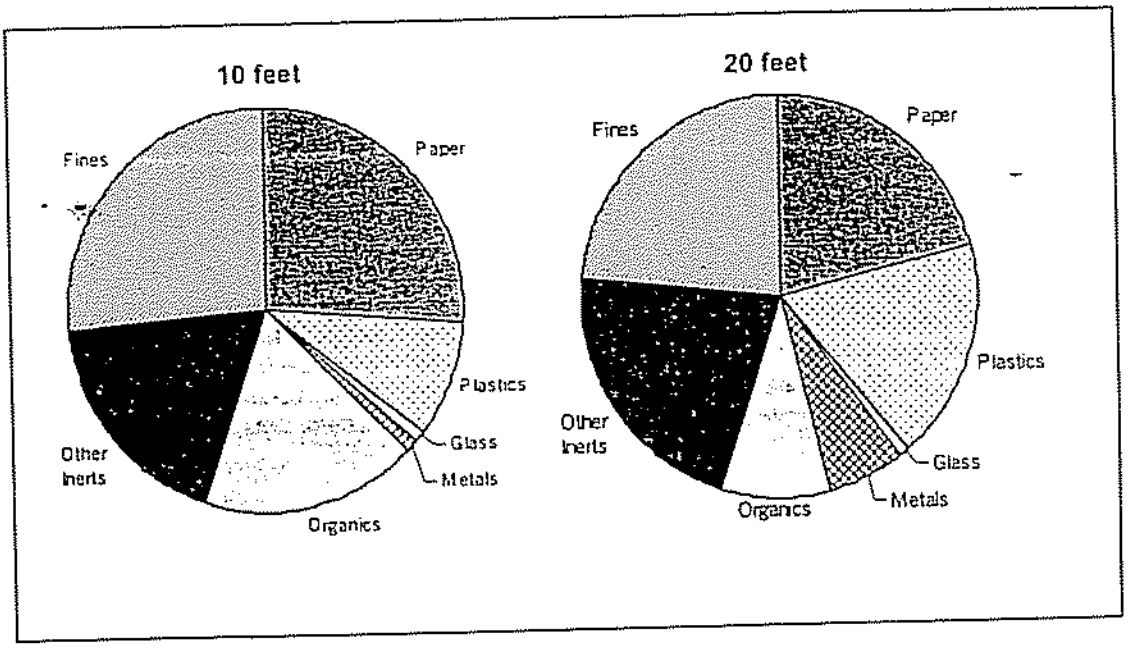
SCS also observed small pieces of orange peels and spare rib bones in the 10-feet sample, which are not included in the DSWA sample. Waste composition data for borehole P4-02-05 are presented in Exhibits 7 and 8.

Exhibit 7
P4-02-05 Waste Composition and Moisture Content

Depth	10 feet		20 feet		30 feet	
	Weight (lbs)	Percent (%)	Weight (lbs)	Percent (%)	Weight (lbs)	Percent (%)
Paper	34.5	26.3	30.7	21.2	--	--
Plastic	12.3	9.4	25.9	17.9	--	--
Glass	0.9	0.7	1.1	.8	--	--
Metals	1.7	1.3	9.3	6.4	--	--
Organics	23.1	17.6	12.7	8.8	--	--
Other Inerts	24.0	18.3	31.4	21.6	--	--
Fines	34.80	26.5	34.0	23.4	--	--
Total Waste	131.30	--	145.1	--	--	--
Moisture content	--	21.1	--	24.1	--	34.1

Note: Waste component percentages may not sum to 100 percent due to rounding.

Exhibit 8
P4-02-05 Waste Composition by Percentage



Borehole P5-02-08

This borehole was to be drilled to 30 feet. SCS sorted each of the three samples and obtained samples for laboratory analysis and DSWA. SCS was able to obtain an organic fraction from two of the three samples. Organics found at each depth are described below:

- 10 feet – no organics recognized
- 20 feet – paper
- 30 feet – paper

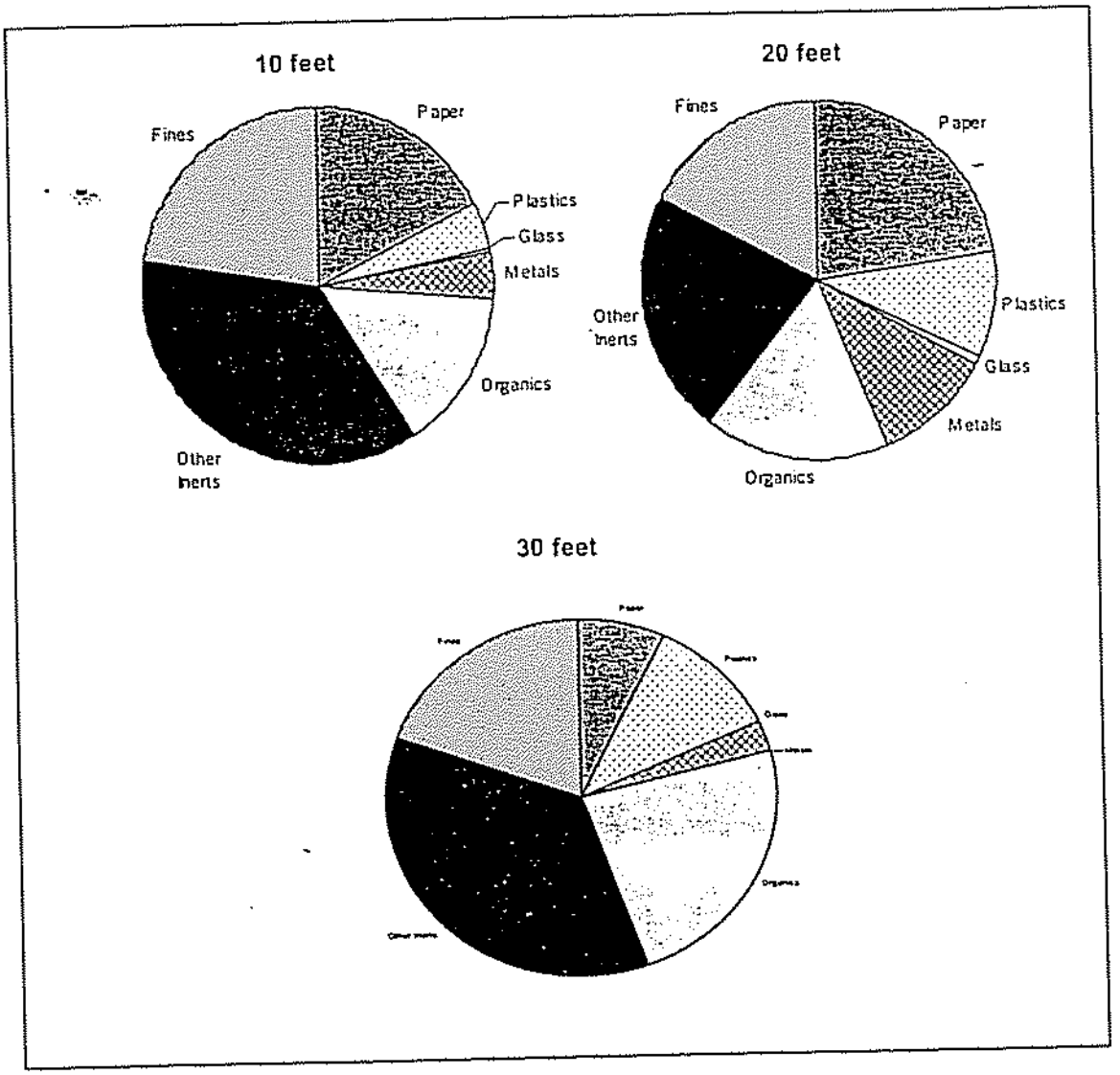
Waste composition data for borehole P5-02-08 are presented in Exhibits 9 and 10.

Exhibit 9
P5-02-08 Waste Composition and Moisture Content

Depth	10 feet		20 feet		30 feet	
Waste Component	Weight (lbs)	Percent (%)	Weight (lbs)	Percent (%)	Weight (lbs)	Percent (%)
Paper	27.3	17.8	29.7	22.7	9.3	7.2
Plastic	6.3	4.1	12.3	9.4	14.1	11.0
Glass	0.3	0.2	1.3	1.0	0.3	0.2
Metals	6.5	4.2	14.3	10.9	3.5	2.7
Organics	22.7	14.8	21.9	16.7	30.1	23.4
Other Inerts	55.6	36.3	28.8	22.0	46.4	36.1
Fines	34.6	22.6	22.6	17.3	24.7	19.2
Total Waste	153.3	100.0	130.9	100.0	128.4	99.8
Moisture content	--	20.3	--	24.5	--	35.2

Note: Waste component percentages may not sum to 100 percent due to rounding.

Exhibit 10
P5-02-08 Waste Composition by Percentage



Borehole P2-02-09

This borehole was planned to be drilled to a depth of 30 feet; however, standing water was reached at 20 feet and drilling did not continue. SCS sorted each of the two samples and obtained samples for laboratory analysis and DSWA. SCS obtained an organic fraction from each of the samples. Organics found at each depth are described below:

- 10 feet – food and paper
- 20 feet – paper

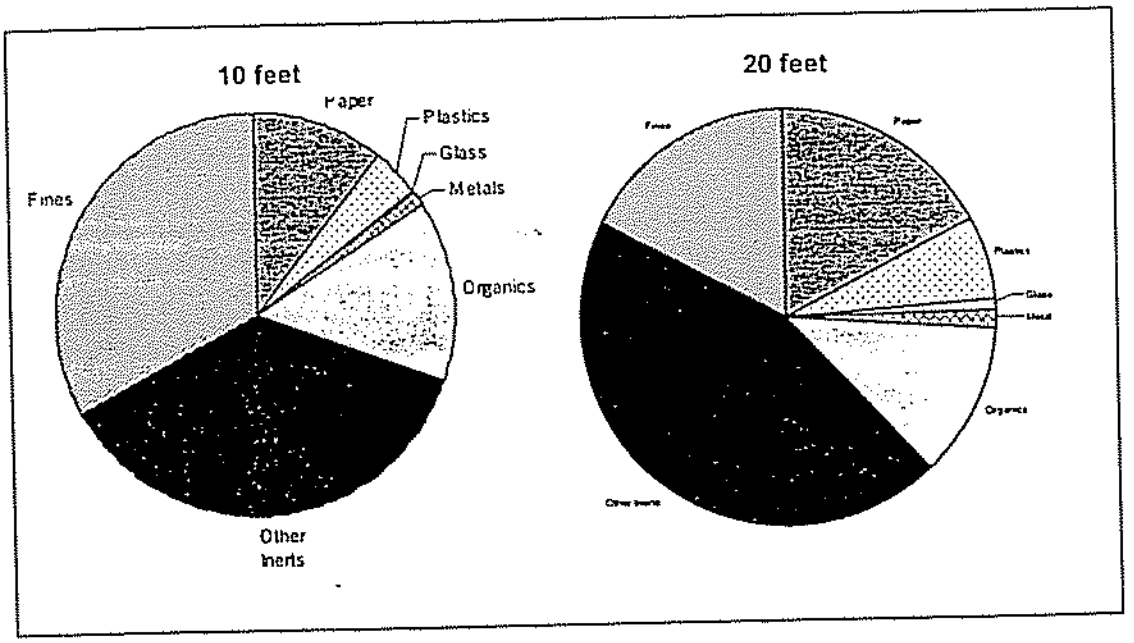
Waste composition data for borehole P2-02-09 are presented in Exhibits 11 and 12.

Exhibit 11
P5-02-09 sub Waste Composition and Moisture Content

Depth	10 feet		20 feet	
	Weight (lbs)	Percent (%)	Weight (lbs)	Percent (%)
Paper	17.3	10.9	27.5	6.6
Plastic	6.3	4.0	9.9	1.9
Glass	0.1	0.1	1.1	0.1
Metals	1.9	1.2	2.5	2.7
Organics	22.9	14.4	18.5	1.8
Other Inerts	58.6	36.8	70.0	54.3
Fines	52.2	32.8	26.7	32.8
Total Waste	159.3	--	156.2	--
Moisture content	--	19.7	--	23.2

Note: Waste component percentages may not sum to 100 percent due to rounding.

Exhibit 12
P5-02-09 Waste Composition by Percentage



Biochemical Methane Production

Biochemical Methane Production (BMP) coupled with the determination of major organic fraction of the landfill defines the biodegradability and methane yield of the landfill material for treatment or energy production. BMP measures the anaerobic biodegradability of a material by quantifying cumulative gas production, gas composition and organic matter reduction. Eight of the sixteen samples were selected and sent to Mort Barlaz at North Carolina State University to perform a BMP analysis. Shallow and deep

samples were selected from each of the four phases sampled (Phase 2-5). The results of the BMP analysis are below.

Exhibit 13
Biochemical Methane Production

	% Moisture	Organic Solids		BMP	
ID	Total	Avg.	RPD	Avg.	RPD
P2-02-10ft	32.9%	14.90	2.8%	1.64	1.94
P2-02-20ft	49.6%				
P2-02-25ft	53.5%	22.40	6.3%	4.22	30.83
PS-1sub-10ft	48.6%				
PS-1sub-20ft	42.4%				
PS-1sub-28ft	36.5%				
P4-02-05-10ft	21.1%	63.90	1.1%	33.19	5.70
P4-02-05-20ft	24.1%				
P4-02-05-30ft	34.1%	9.13	5.6%	4.15	21.56
P5-02-08-10ft	20.3%	35.45	6.6%	24.85	12.52
P5-02-08-20ft	24.5%				
P5-02-08-30ft	35.2%	21.90	3.2%	2.10	28.30
P5-02-09-10ft	19.7%				
P5-02-09-20ft	23.2%				
P3-02-04-10ft	29.4%	21.45	2.3%	0.00	0.00
P3-02-04-20ft	29.1%	38.35	0.9%	36.01	3.36

Note: RPD is equal to 100% x standard deviation/average

It has been our pleasure working with DAWA on this project. Should you have any questions, please do not hesitate to call either of the undersigned.

Sincerely,

Stacey T. Demers

Stacey T. Demers
Project Manager
SCS ENGINEERS

W. Gregory Vogt
Vice President
SCS ENGINEERS

APPENDIX O-6

LABORATORY TESTING OF WASTE SHEAR STRENGTH

SGI TESTING SERVICES, LLC

15 June 2002

Dr. Robert C. Bachus
GeoSyntec Consultants, Inc.
1100 Lake Hearn Drive N.E., Suite 200
Atlanta, Georgia 30342

Subject: Laboratory Test Results Transmittal
Internal Direct Shear Testing
DSWA Cherry Island MSW Testing

Dear Dr. Bachus,

SGI Testing Services, LLC (SGI®) is pleased to present the attached test results for the above-mentioned project. The note section below addresses sample preparation, sample disposal and a disclosure statement.

SGI® appreciates the opportunity to provide laboratory testing services for this project. Should you have any questions regarding the attached document(s), or if you require additional information, please do not hesitate to contact the undersigned.

Sincerely,

Robert H. Swan, Jr.
President and CEO

Attachment

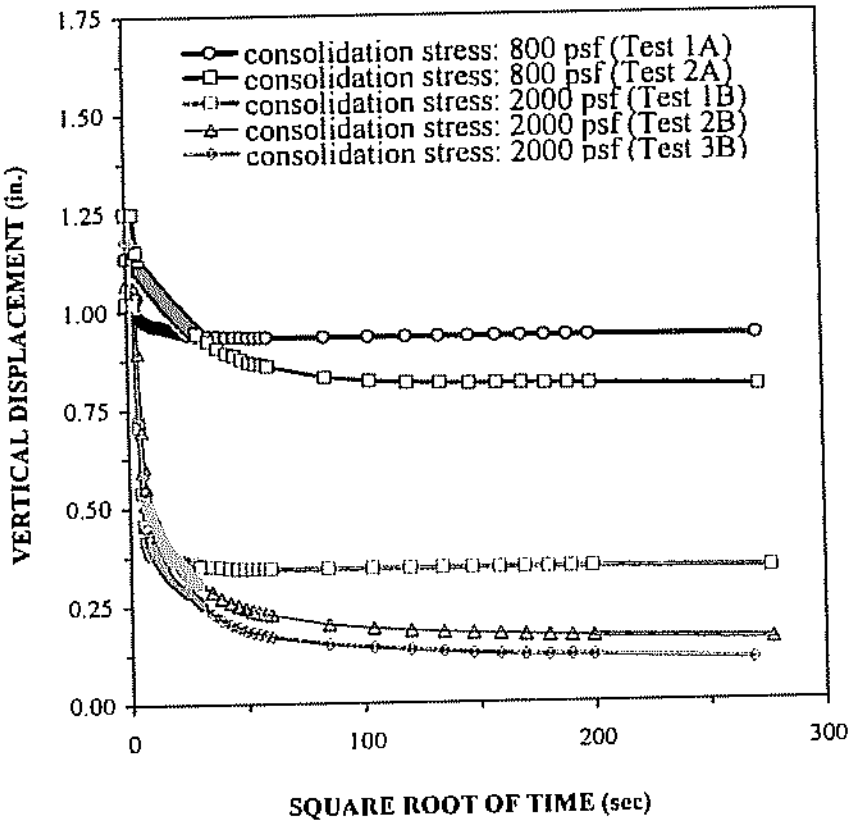
Notes:
(1) Unless otherwise noted in the test results the sample(s)/specimen(s) were prepared in accordance with the applicable test standards or generally accepted sampling procedures.
(2) Contaminated/chemical samples and all related laboratory generated waste (i.e., test liquids, PPE, absorbents, etc.) will be returned to the client or designated representative(s), at the client's cost, within 60 days following the completion of the testing program, unless special arrangements for proper disposal are made with SGI®.
(3) Materials that are not contaminated will be discarded after test specimens and archived specimens are obtained. Archived specimens will be discarded 60 days after the samples are received at the laboratory, unless long-term storage arrangements are specifically made with the laboratory.
(4) The reported results apply only to the materials and test conditions used in the laboratory testing program. The results do not necessarily apply to other materials or test conditions. The test results should not be used in engineering analysis unless the test conditions model the anticipated field conditions. The testing was performed in accordance with general engineering testing standards and requirements. The reported results are submitted for the exclusive use of the client to whom they are addressed.

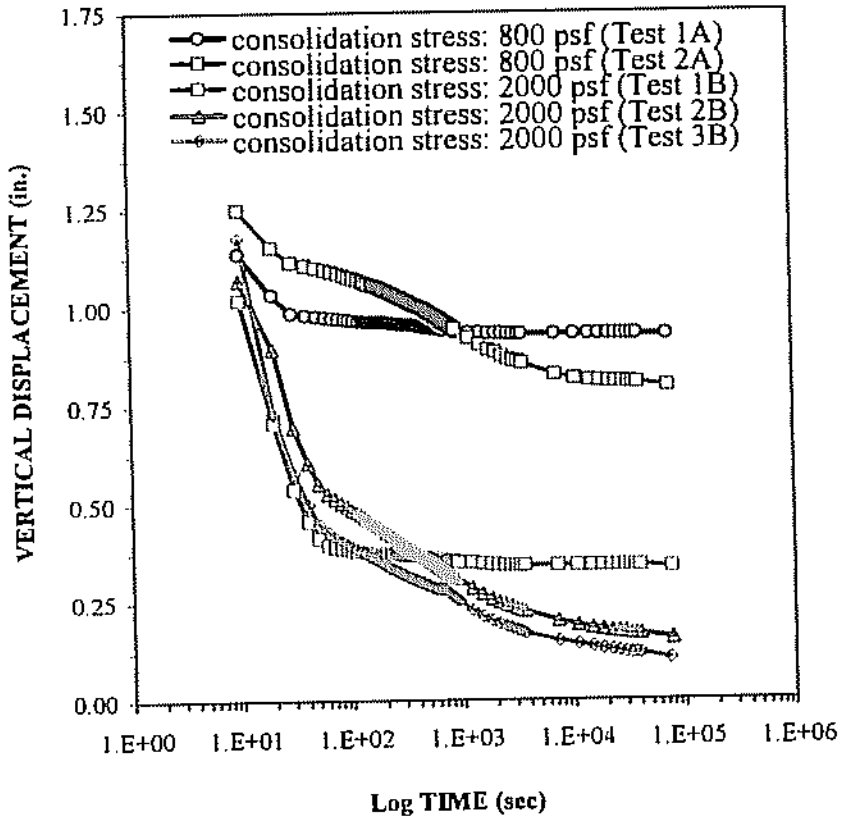
SGI2041/SGI02082

SGI® Testing Services, LLC
5775 PEACHTREE DUNWOODY ROAD
SUITE 11D
ATLANTA, GEORGIA 30342
PHONE : 404.256.9939 FAX: 404.705.9300
WEB SITE: WWW.INTERACTIONSPECIALISTS.COM

GEOSYNTEC CONSULTANTS, INC. - DSWA CHERRY ISLAND MSW TESTING
CONSOLIDATION TESTING

TEST NOS. 1 and 2: Cherry Island MSW waste (as-received moisture content)
INITIAL TEST SPECIMEN DIMENSIONS: 12 in. length by 12 width by 5 in. height
CONSOLIDATION STRESSES: 800 and 2000 psf





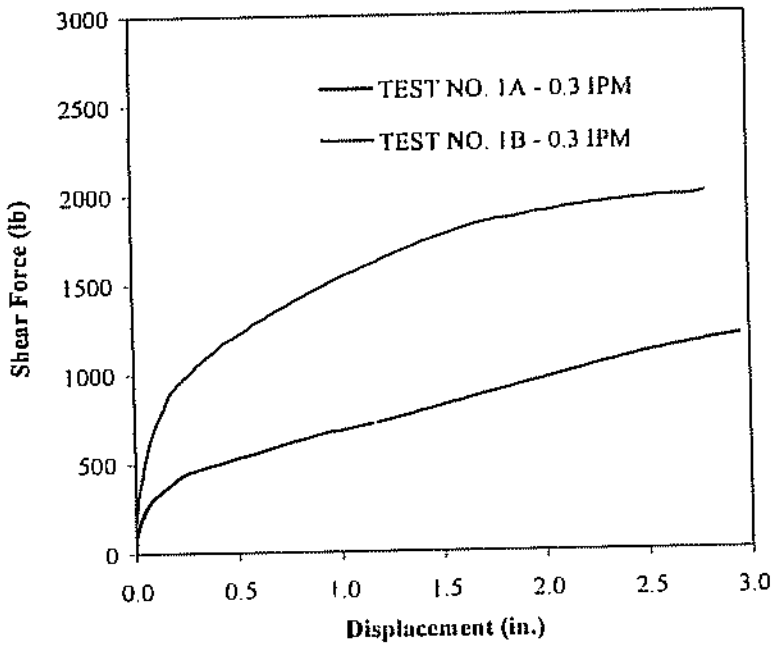
DATE TESTED: 24 April to 22 May 2002

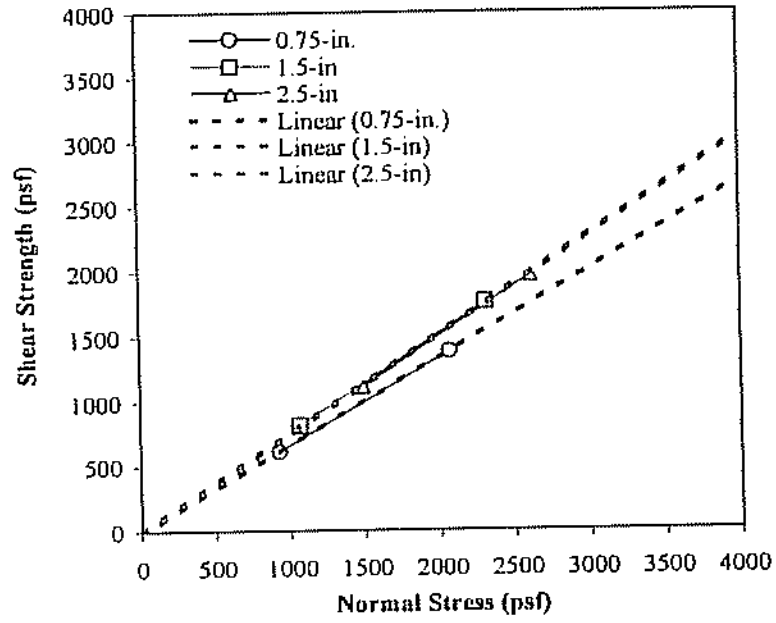
SGI TESTING SERVICES, LLC

FIGURE NO.	A-1
PROJECT NO.	SGI2041
DOCUMENT NO.	SGI02082
FILE NO.	C2041-1

GEOSYNTEC CONSULTANTS, INC. - DSWA CHERRY ISLAND MSW TESTING
DIRECT SHEAR TESTING

TEST SERIES NO. 1: Cherry Island MSW waste under consolidated conditions and shear displacement rate of 0.3 in./min





Test No.	Initial Total Unit Weight (pcf)	Initial Moisture Content (%)	Final Total Unit Weight (pcf)	Final Moisture Content (%)	Shear Displ = 0.75 in.		Shear Displ = 1.5 in.		Shear Displ = 2.5 in.		Shear Strength Equations
					σ (psf)	τ (psf)	σ (psf)	τ (psf)	σ (psf)	τ (psf)	
1A	76.8	100.0	80.7	50.0	931	612	1071	813	1495	1105	$\tau_{0.75\text{-in.}} = -15 + \sigma \tan(34^\circ)$
1B	75.0	100.0	87.5	41.9	2073	1383	2313	1759	2616	1962	$\tau_{1.5\text{-in}} = 0 + \sigma \tan(37^\circ)$
											$\tau_{2.5\text{-in}} = -10 + \sigma \tan(37^\circ)$

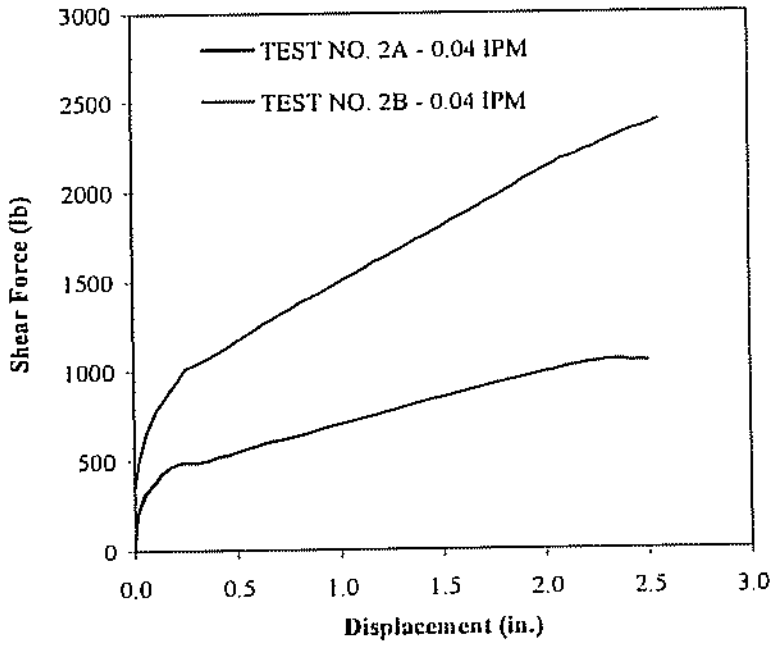
DATE TESTED: 24 April to 1 May 2002

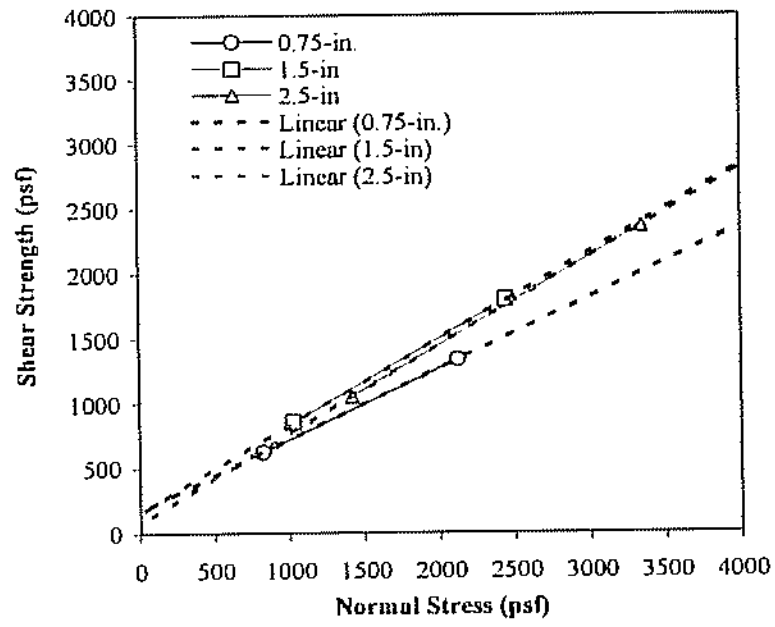
SGI TESTING SERVICES, LLC

FIGURE NO.	A-2
PROJECT NO.	SGI2041
DOCUMENT NO.	SGI02082
FILE NO.	S2041-1

GEOSYNTEC CONSULTANTS, INC. - DSWA CHERRY ISLAND MSW TESTING
DIRECT SHEAR TESTING

TEST SERIES NO. 2: Cherry Island MSW waste under consolidated conditions and shear displacement rate of 0.04 in./min





Test No.	Initial Total Unit Weight (pcf)	Initial Moisture Content (%)	Final Total Unit Weight (pcf)	Final Moisture Content (%)	Shear Displ = 0.75 in.		Shear Displ = 1.5 in.		Shear Displ = 2.5 in.		Shear Strength Equations
					σ (psf)	τ (psf)	σ (psf)	τ (psf)	σ (psf)	τ (psf)	
2A	80.4	100.0	89.0	46.9	826	619	1030	848	1424	1045	$\tau_{0.75\text{-in.}} = 165 + \sigma \tan(29°)$
2B	74.7	100.0	92.2	43.5	2129	1333	2448	1795	3350	2361	$\tau_{1.5\text{-in}} = 160 + \sigma \tan(34°)$
											$\tau_{2.5\text{-in}} = 70 + \sigma \tan(34°)$

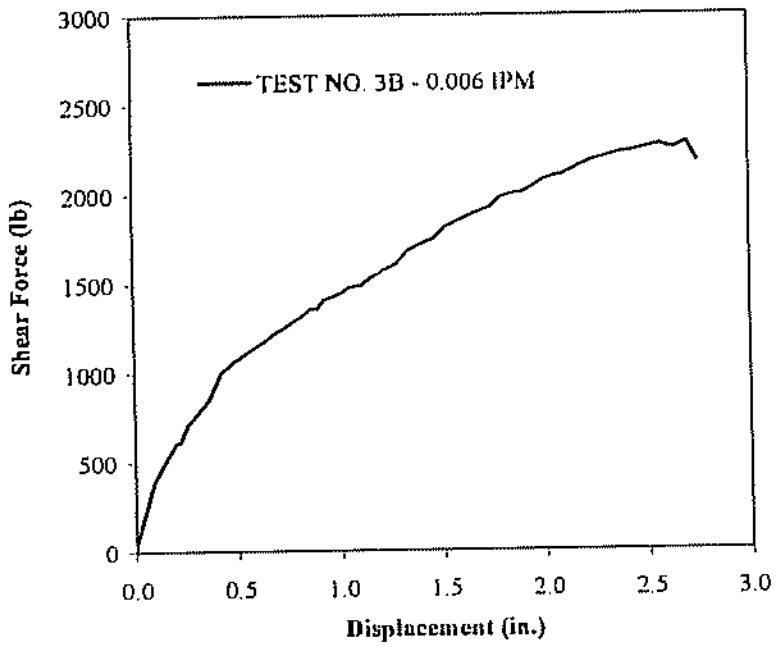
DATE TESTED: 24 April to 1 May 2002

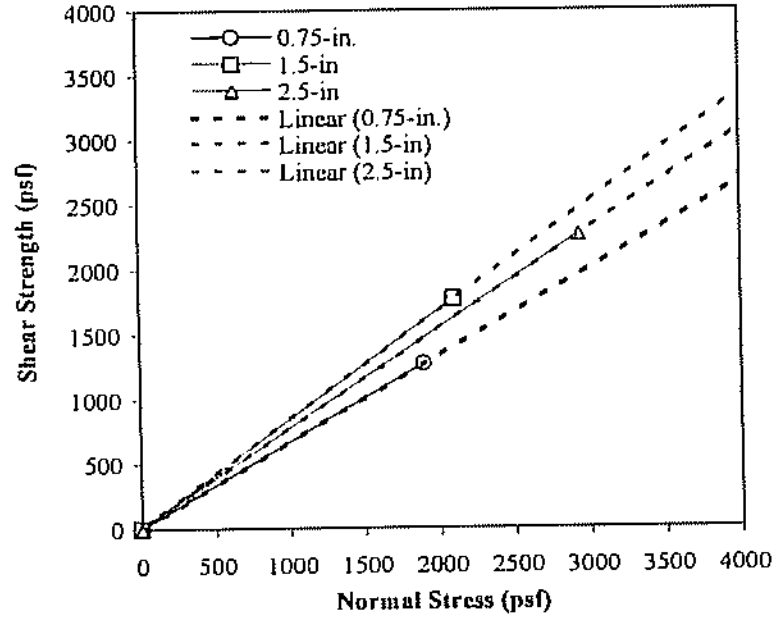
SGI TESTING SERVICES, LLC

FIGURE NO.	A-3
PROJECT NO.	SGI2041
DOCUMENT NO.	SGI02082
FILE NO.	S2041-2

GEOSYNTEC CONSULTANTS, INC. - DSWA CHERRY ISLAND MSW TESTING
DIRECT SHEAR TESTING

TEST SERIES NO. 3: Cherry Island MSW waste under consolidated conditions and shear displacement rate of 0.006 in./min





Test No.	Initial Total Unit Weight (pcf)	Initial Moisture Content (%)	Final Total Unit Weight (pcf)	Final Moisture Content (%)	Shear Displ = 0.75 in.		Shear Displ = 1.5 in.		Shear Displ = 2.5 in.		Shear Strength Equations
					σ (psf)	τ (psf)	σ (psf)	τ (psf)	σ (psf)	τ (psf)	
					0	0	0	0	0	0	$\tau_{0.75\text{-in.}} = 0 + \sigma \tan(34°)$
3B	70.8	100.0	90.9	44.4	1897	1266	2104	1762	2935	2255	$\tau_{1.5\text{-in}} = 0 + \sigma \tan(40°)$
											$\tau_{2.5\text{-in}} = 0 + \sigma \tan(38°)$

DATE TESTED: 24 April to 22 May 2002

SGI TESTING SERVICES, LLC

FIGURE NO.	A-4
PROJECT NO.	SGI2041
DOCUMENT NO.	SGI02082
FILE NO.	S2041-3

Table O.1 - Waste Compressibility Evaluation
Cherry Island Landfill
Wilmington, Delaware

Test	Initial Dial Reading* (in.)	Final Dial Reading* (in.)	Sample Compression (ΔH) (in.)	Final Sample Height, H_f (in.)	Applied Normal Pressure, σ_n (psf)
1A	1.12	0.97	0.15	4.85	800
2A	1.25	1.10	0.15	4.85	800
1B	1.00	0.38	0.62	4.38	2000
2B	1.06	0.34	0.72	4.28	2000
3B	1.17	0.38	0.80	4.21	2000

$$C_{c\varepsilon} = \frac{\Delta \varepsilon_v}{\log \frac{\sigma_2}{\sigma_1}}$$

1) Initial Height, H 5 in.

2) Average initial H at σ_n = 800 psf 4.85 in.

3) Average initial sample height at σ_n = 2,000 psf 4.29 in.

* values obtained from test results from SGI Testing Services (Figure A-1 in Appendix O-6)

$$C_{c\varepsilon} = \frac{\left(\frac{5-4.29}{5}\right)-\left(\frac{5-4.85}{5}\right)}{\log\left(\frac{2000}{800}\right)} = \frac{0.14-0.03}{0.398} = 0.276$$

APPENDIX O-7

WASTE UNIT WEIGHT

APPENDIX O-7.1

DETERMINATION OF GRAVEL DENSITY

Written by: JWF MORRIS Date: 02/03/18 (YY MM DD) Reviewed by: Dana Mandeville Date: 02/05/19 (YY MM DD)

Client: DSWA Project: CIL Project/Proposal No.: ME0250 Task No.: 1.3.4

– Relationship between Gravel Density & Drop Height: Procedure

1. Place 4 55-gal. drum in a row beside gravel stockpile.
2. Use front-end loader to scoop up 3500 lb (approx.) gravel. Position bucket-scoop, 10-ft above ground level directly above the drums. Drop gravel into drums until all are filled to overflowing.
3. Flatten off the gravel at the top of each drum so that it is flush with the brim.
4. Hoist each drum into the back of a pick-up truck using a friction-hold lifting strap.
5. Obtain weight of truck plus full drums. Subtract tare weight of truck with empty drums to obtain the weight of the gravel.
6. Repeat steps (1) – (5) but drop gravel from a height of 20-ft.

– Calculation:

M_F = weight full drums + truck (lb)
M_E = weight empty drums + truck (lb)
$\gamma_{GD=H}$ = density of gravel dropped from height H (pcf)

$$\gamma_{GD=H} = \frac{M_F - M_E}{(4 \times 55)} \times 7.48 \text{ pcf}$$

Scale tolerance = 200 lb

i) Drop height = 10-ft.

$$\gamma_{GD=10} = \frac{8220 - 5000}{220} \times 7.48 = 109.5 \text{ pcf}$$

min γ_D = 102.7 pcf max γ_D = 116.3 pcf

ii) Drop height = 20-ft.

$$\gamma_{GD=20} = \frac{8200 - 5000}{220} \times 7.48 = 108.8 \text{ pcf}$$

102.0 pcf 115.6 pcf

→ Gravel density is independent of drop height, $\gamma_{GD=10} = \gamma_{GD=20} = \gamma_{GAVE}$

γ_{GAVE} = 109 pcf (range = 102 – 116 pcf) Slope = 0 on fig (i)

2/5

– Test results from quarry (Pinewood Quarry, New Castle, DE) for Delaware No 57 gravel.

Specific Gravity	-	2.60
Absorption	-	2.0%
Unit Weight	-	94.9 lbs./cu.ft.
-200 Wash	-	0.8%

Sieve Size	Percent Passing	ASTM C33-95 Size No. 57 Percent Passing
2"	100.0	———
1 1/2"	100.0	100.0
1"	83.0	95 -100
3/4"	70.0	———
1/2"	29.5	25 - 60
3/8"	13.5	———
No. 4	4.0	0 - 10
No. 8	2.2	0 - 5

All results are the confidential property of clients, and information contained may not be published or reproduced, pending our written approval.

Written by: JWF Morris Date: 02/04/23 (YY/MM/DD) Reviewed by: C. Pendleton Date: 02/04/29 (YY/MM/DD)

Client: DSWA Project: CIL Project/Proposal No.: ME0250 Task No.: 1.3.6

- Calculation of γ_{Gave} for gravel based on small-scale test. Test carried out in the field @ Parkway Gravel Quarry, New Castle, DE on 4/12/02 by JWF Morris.

Gravel: Delaware No. 57 Gravel, from stockpile.

Mass of bucket: 0.825 lb.

Vol. of bucket: Vol. to brim measured by mass of bucket filled with water.

Mass of full bucket = 17.46 lb.

→ Mass of water = 17.46 − 0.825
= 16.635 lb.

→ Vol. of water = $\frac{16.635 \text{ lb}}{62.4 \text{ lb/cf}}$ = 0.2666 cf

→ check = 1.994 gal (ie 2-gal).

1. Mass and Unit Weight of gravel – no compaction.

Gravel was scooped up by hand & placed in bucket, top levelled without compacting.

	Mass Bucket + Gravel (lb)	Mass Bucket (lb)	Mass Gravel (lb)	Vol. Bucket (cf)	Density Gravel (lb/cf)	Average Density (lb/cf)
1.	31.15	0.825	30.325	0.267	~~113.4~~ 113.6	~~113.8~~ 113.9
2.	31.51		30.685		114.9	
3.	31.10		30.275		113.4	
4.	31.26		30.435		114.0	
5.	31.11		30.285		113.4	

Written by: JWF Morris Date: 02/04/23 (YY MM DD) Reviewed by: C. Pendleton Date: 02/04/29 (YY MM DD)

Client: DSWA Project: CIL Project/Proposal No.: ME0250 Task No.: 1.3.6

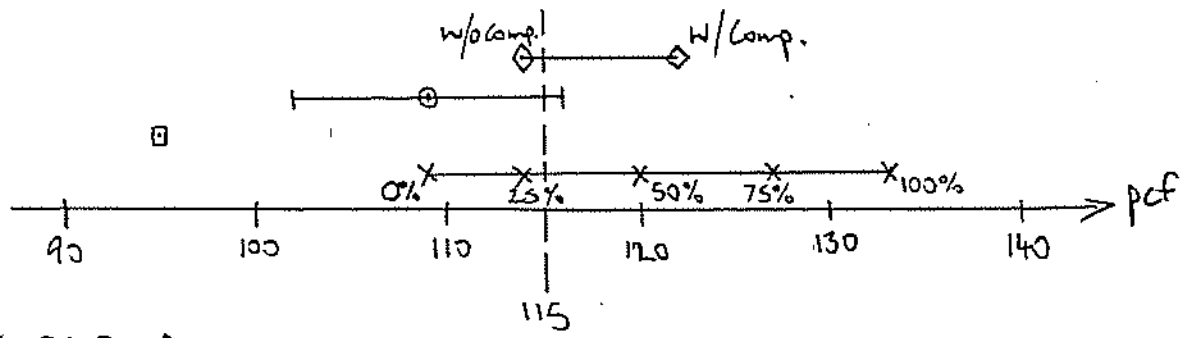
2. Mass and Unit Weight of Gravel – with compaction

Gravel compacted into bucket in 3 layers using end of rubber mallet.

	Mass Bucket + Gravel (lb)	Mass Bucket (lb)	Mass Gravel (lb)	Vol. Bucket (cf)	Density Gravel (lb/cf)	Average Density (lb/cf)
1.	33.60	0.825	32.775	0.267	122.8	121.9
2.	33.20		32.375		121.3	
3.	32.91		32.085		120.2	
4.	33.62		32.795		122.8	
5.	33.44		32.615		122.2	

3. Summary of Gravel Density Information:

Fig 1.



⊡ $\gamma = 94.9$ pcf (from Quarry data)

◇ $\gamma = 114$ (w/o comp.)

$\gamma = 122$ (w/ comp.)

from small-scale testing done by Geosyntec at quarry

⊙ $\gamma = 109$ pcf (range = 102 – 116)

from Drop-Height vs. density calibration done by GeoSyntec at quarry.

X dry unit wt, γ_D for USCS GP (% = relative density)

from NFEC (1982)

Written by: JWF Morris Date: 02/04/24 (YY MM DD) Reviewed by: C. Pendleton Date: 02/04/29 (YY MM DD)

Client: DSWA Project: CIL Project/Proposal No.: MED250 Task No.: 1.3.6

→ from Figure 1, a gravel $\gamma_D = 115$ pcf was selected.

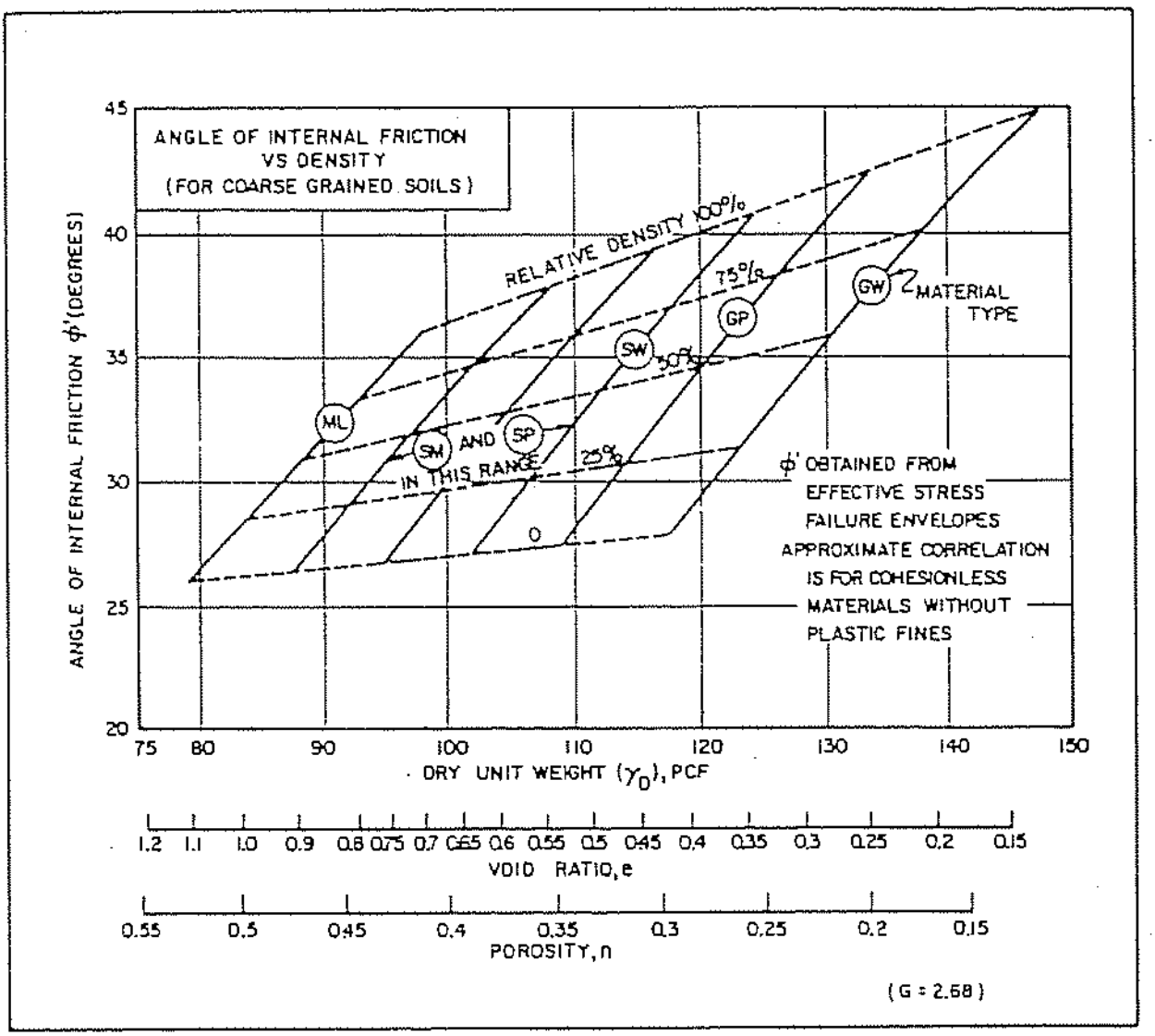


FIGURE 7
Correlations of Strength Characteristics for Granular Soils

Ref: Dept. of the Navy, Facilities Eng. Command (1982) "Soil Mechanics Design Manual 7.1", NAVFAC DM-7.1, NFEC, Alexandria, VA.

APPENDIX O-7.2

DERIVATION OF WASTE UNIT WEIGHT USING GRAVEL BACKFILL VOLUME

Written by: JWF Morris Date: 02/02/28 (YY MM DD) Reviewed by: Dan Mandeville Date: 02/05/[illegible] (YY MM DD)

Client: DSWA Project: CIL Project/Proposal No.: ME0250 Task No.: 1.3.4

- Derivation of Waste Unit Weight from Boreholes:

- establish relationship between gravel density and drop height. (see Attachment 1)

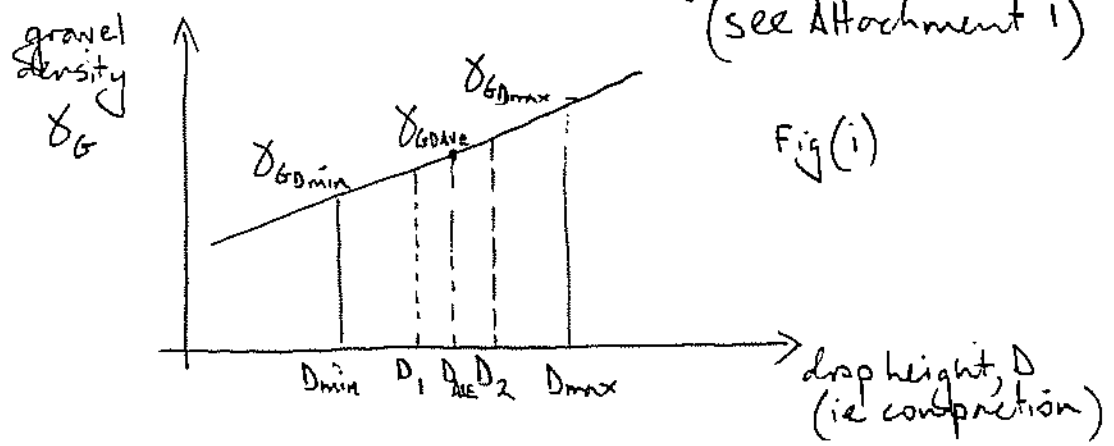


Fig (i)

- Drill each testbore to max. depth. Backfill completely with gravel in 2-3 increments: Develop figure below for each borehole.

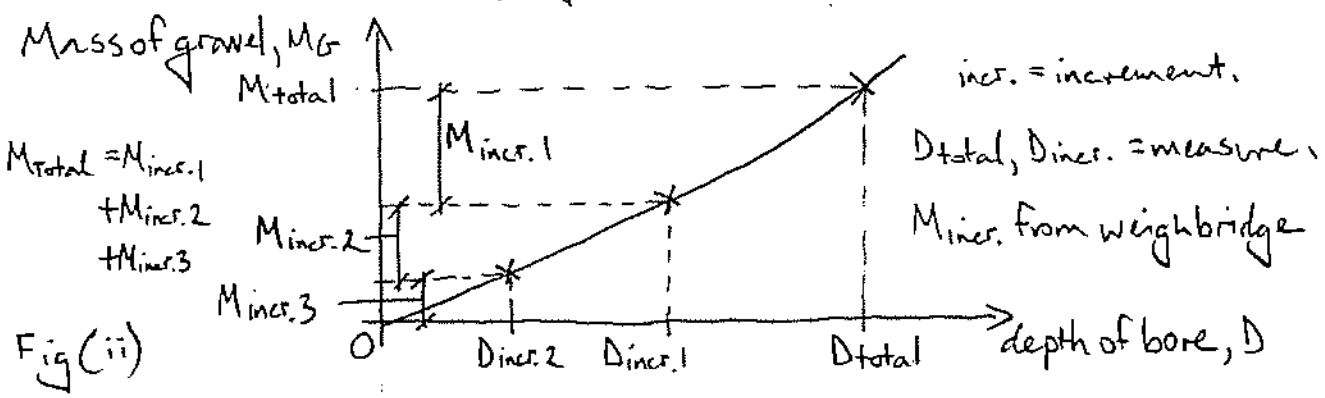


Fig (ii)

- This then becomes the calibration chart for vol. at each borehole.

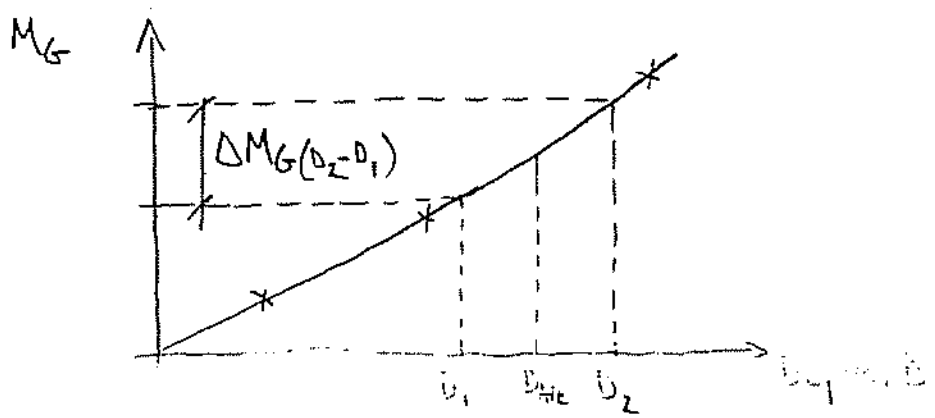


Fig (iii)

Written by: JWFMORRIS Date: 02/02/28 (YY MM DD) Reviewed by: Doug Mandeville Date: 02/05/29 (YY MM DD)

Client: DSWA Project: CIL Project/Proposal No.: ME0250 Task No.: 1·3·4

- Procedure:

1. Mass of MSW, $\Delta M_{MSW(D_2-D_1)}$, from depth $D_2 - D_1$ is known from weighbridge.

2. $D_{AVE} = D_1 + \left(\frac{D_2 - D_1}{2}\right)$ → Obtain $\gamma_{GD_{AVE}}$ from fig (i).

3. Read $\Delta M_{G(D_2-D_1)}$ from Fig (iii).

4. $\gamma_{GD_{AVE}} = \frac{\Delta M_{G(D_2-D_1)}}{\Delta V_{(D_2-D_1)}}$ → Obtain $\Delta V_{(D_2-D_1)}$

5. $\gamma_{MSW(D_2-D_1)} = \frac{\Delta M_{MSW(D_2-D_1)}}{\Delta V_{(D_2-D_1)}}$ → solve.

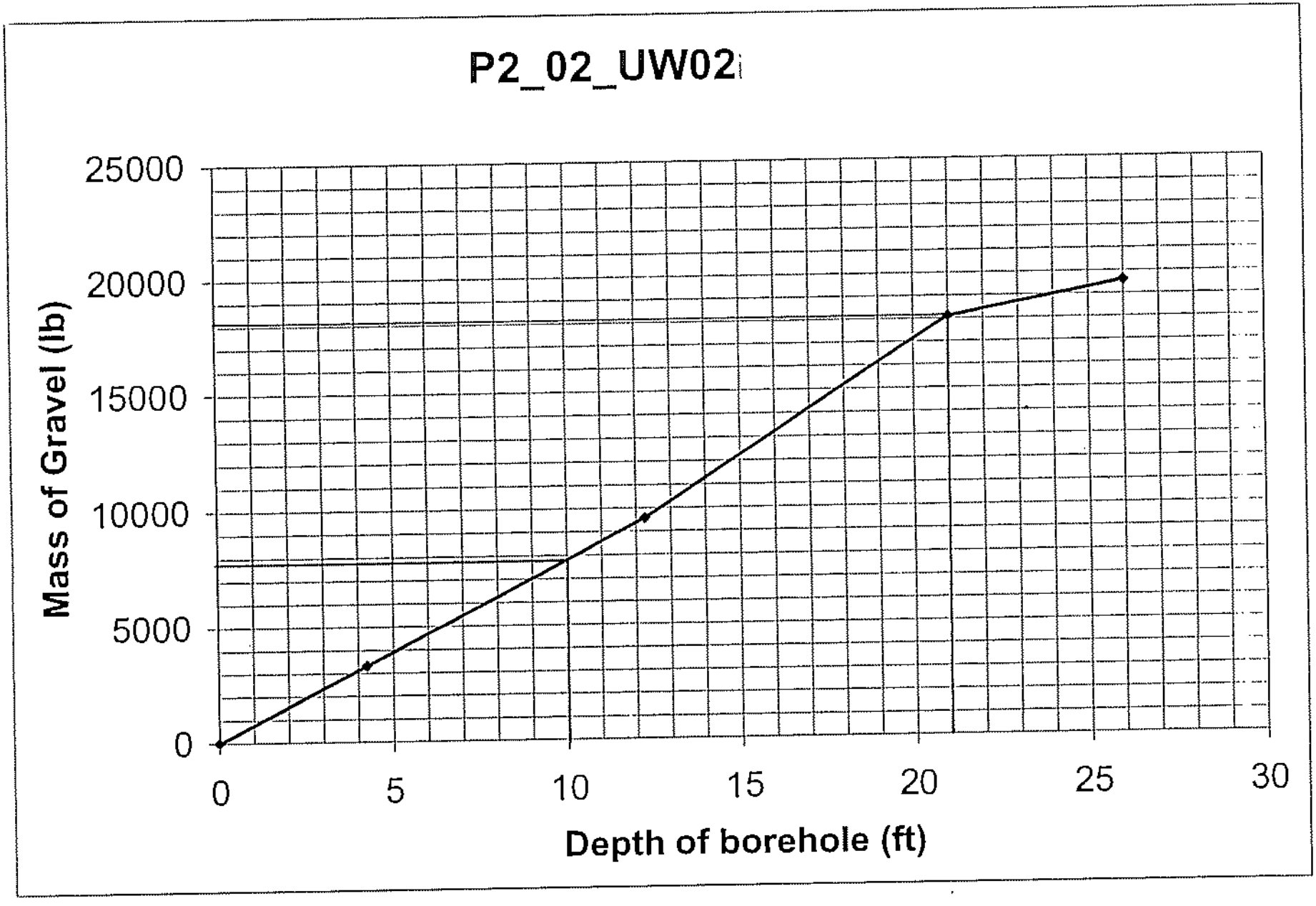
6. Repeat for each depth increment at each test bore.

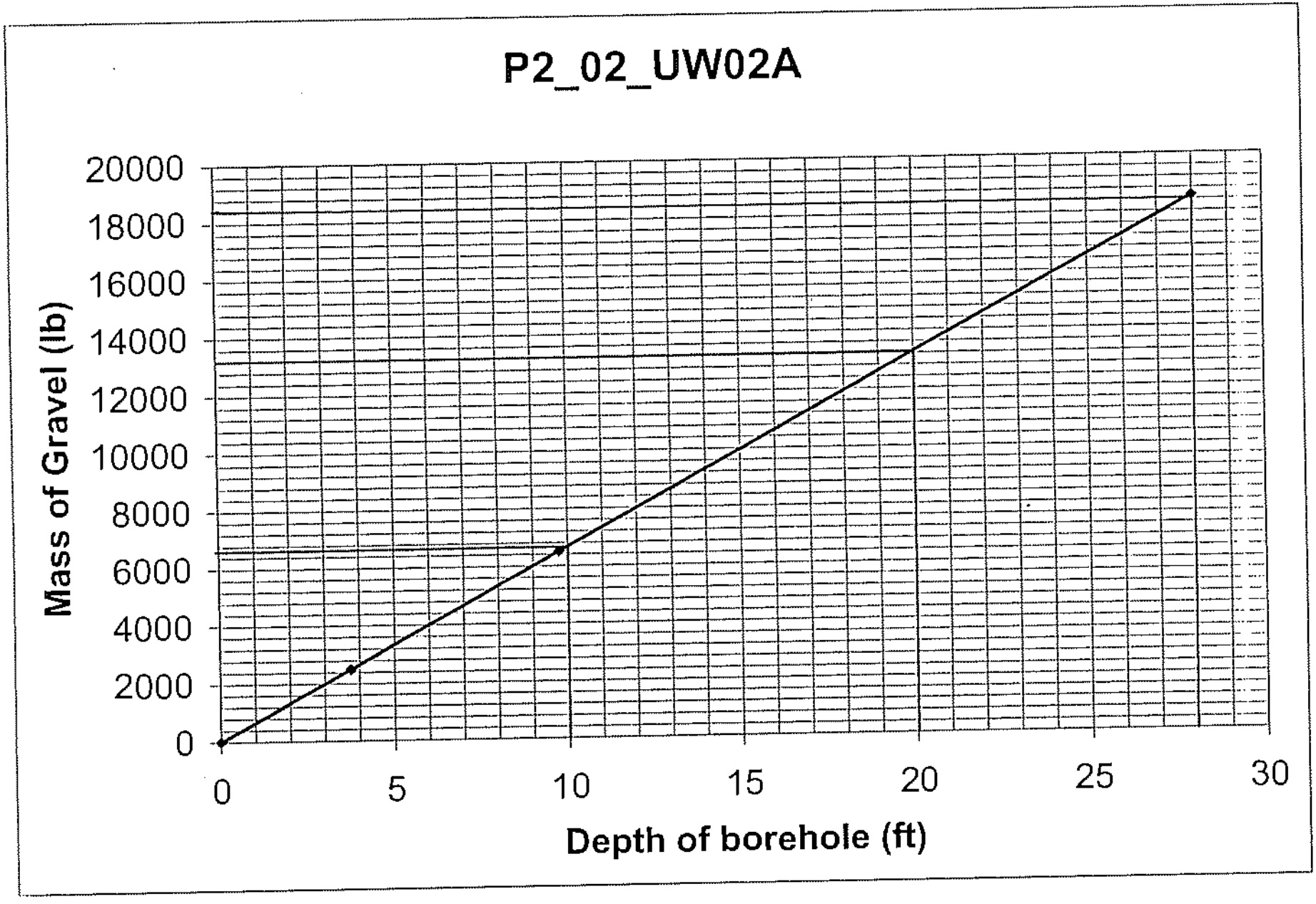
- Fig (iii) calibration charts for each borehole are shown in pages 3 –

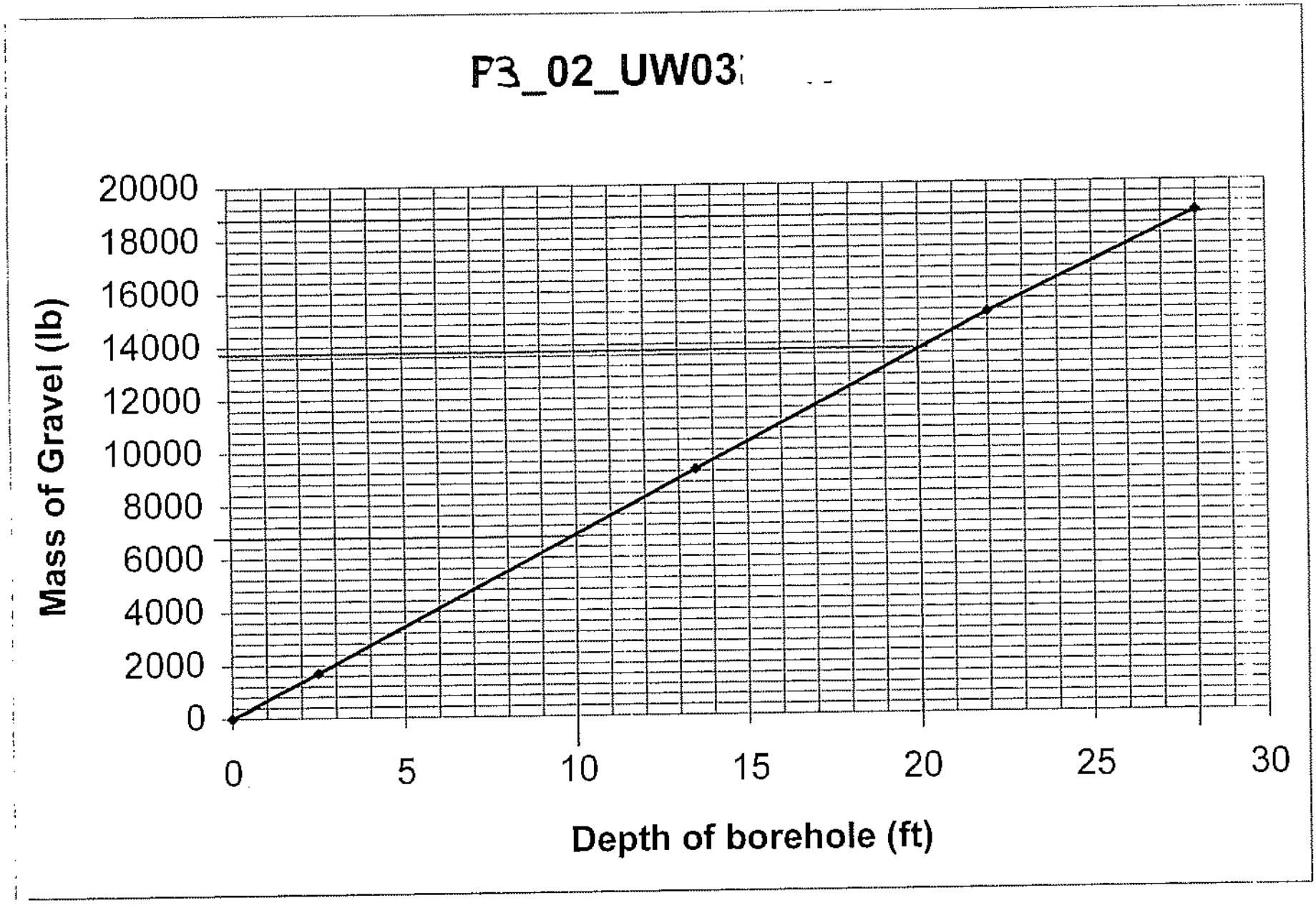
- Calibration charts are adjusted to pass through origin by assuming a straight line passes through origin, 1st depth interval, and 2nd depth interval.
  Boreholes could only be filled to within 2–5 feet of surface due to capping and sealing requirements for boreholes to be developed as gas wells.

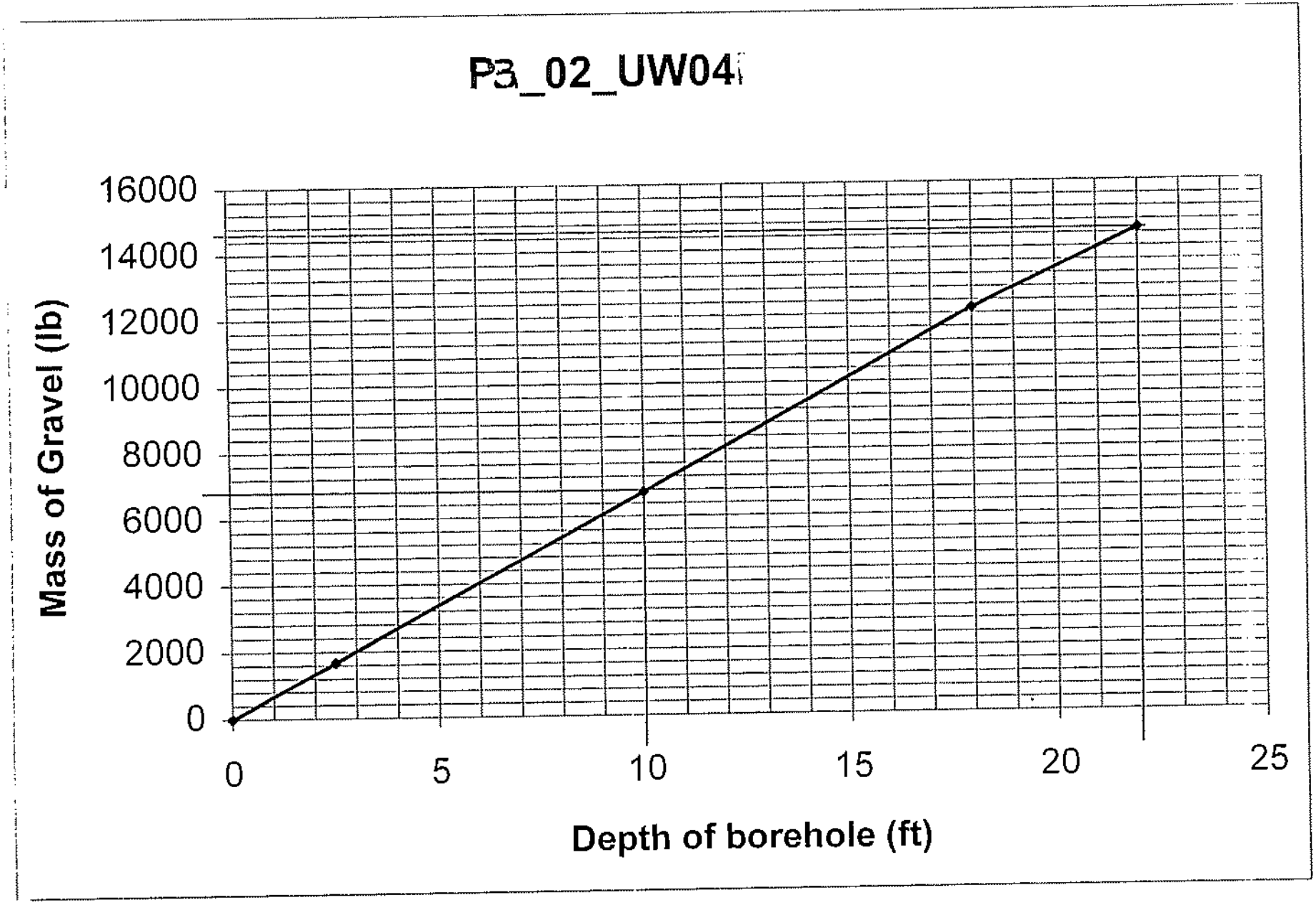
- Calibration charts and calculation of waste in-situ unit weight based on procedure steps (1) – (6) above can be found in Excel spreadsheet:

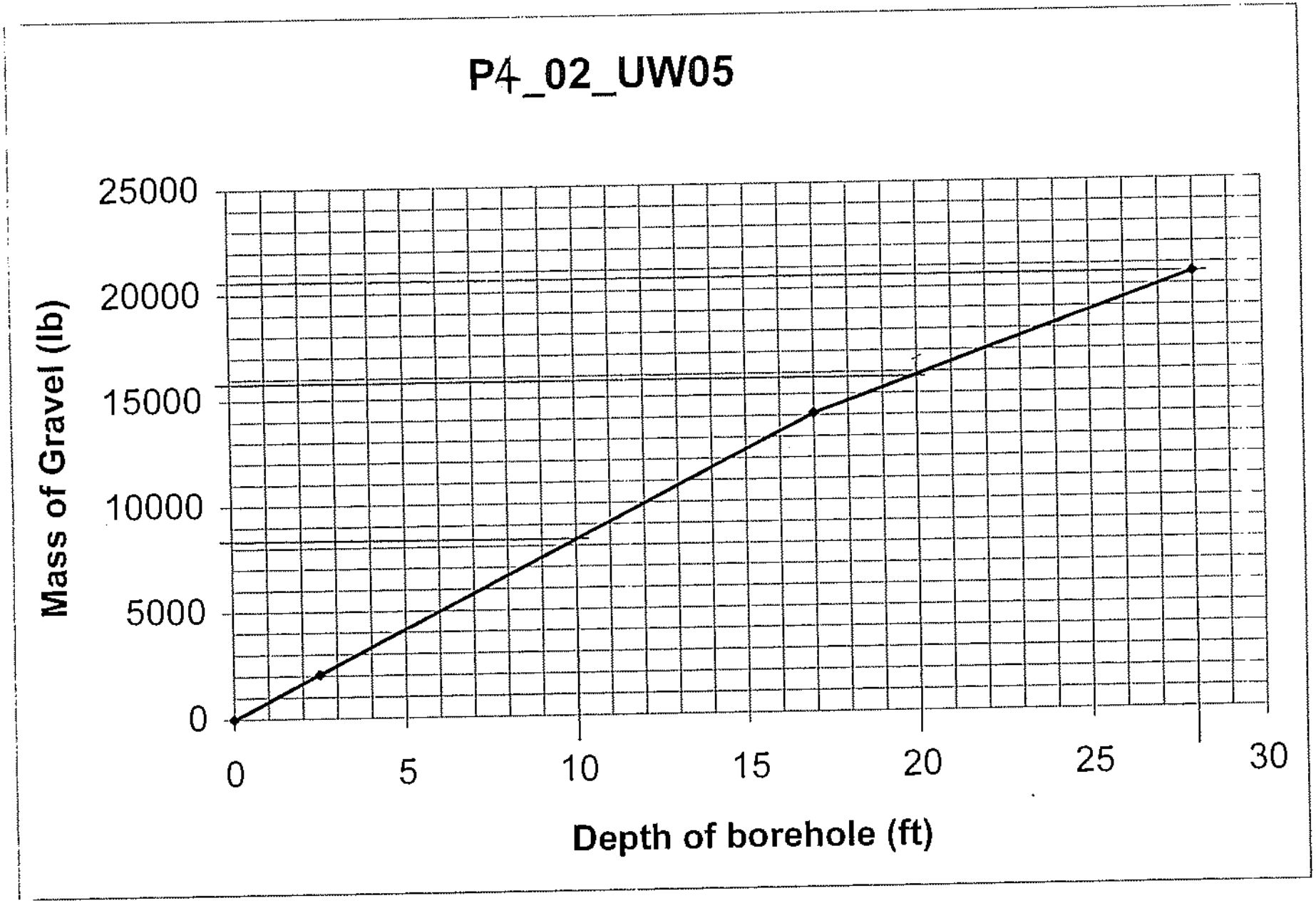
  me0250-cherry island/field exploration1(2002)/settlement_density/waste density.xls.

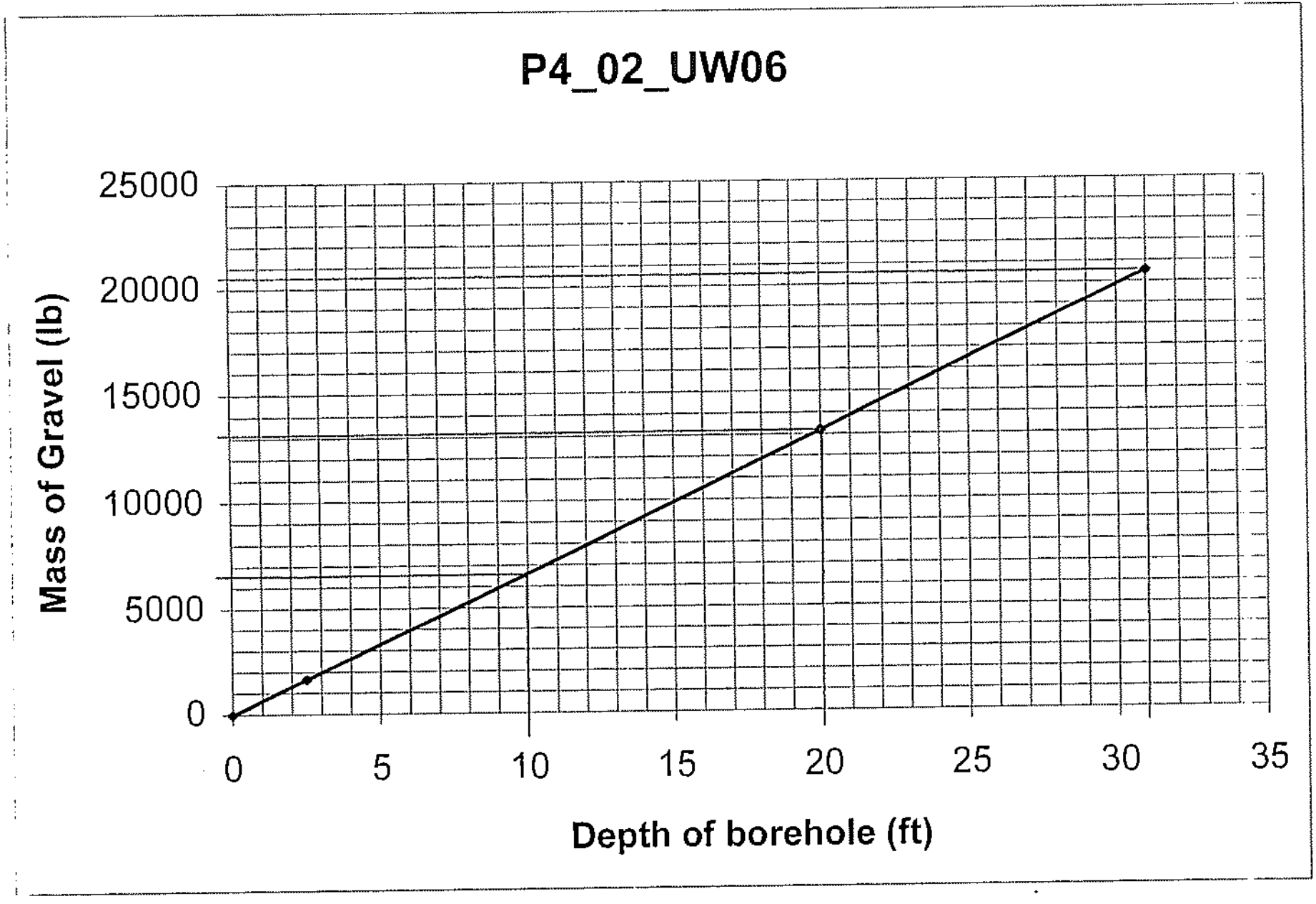

P2_02_UW02
Mass of Gravel (lb)
25000
20000
15000
10000
5000
0
0
5
10
15
20
25
30
Depth of borehole (ft)

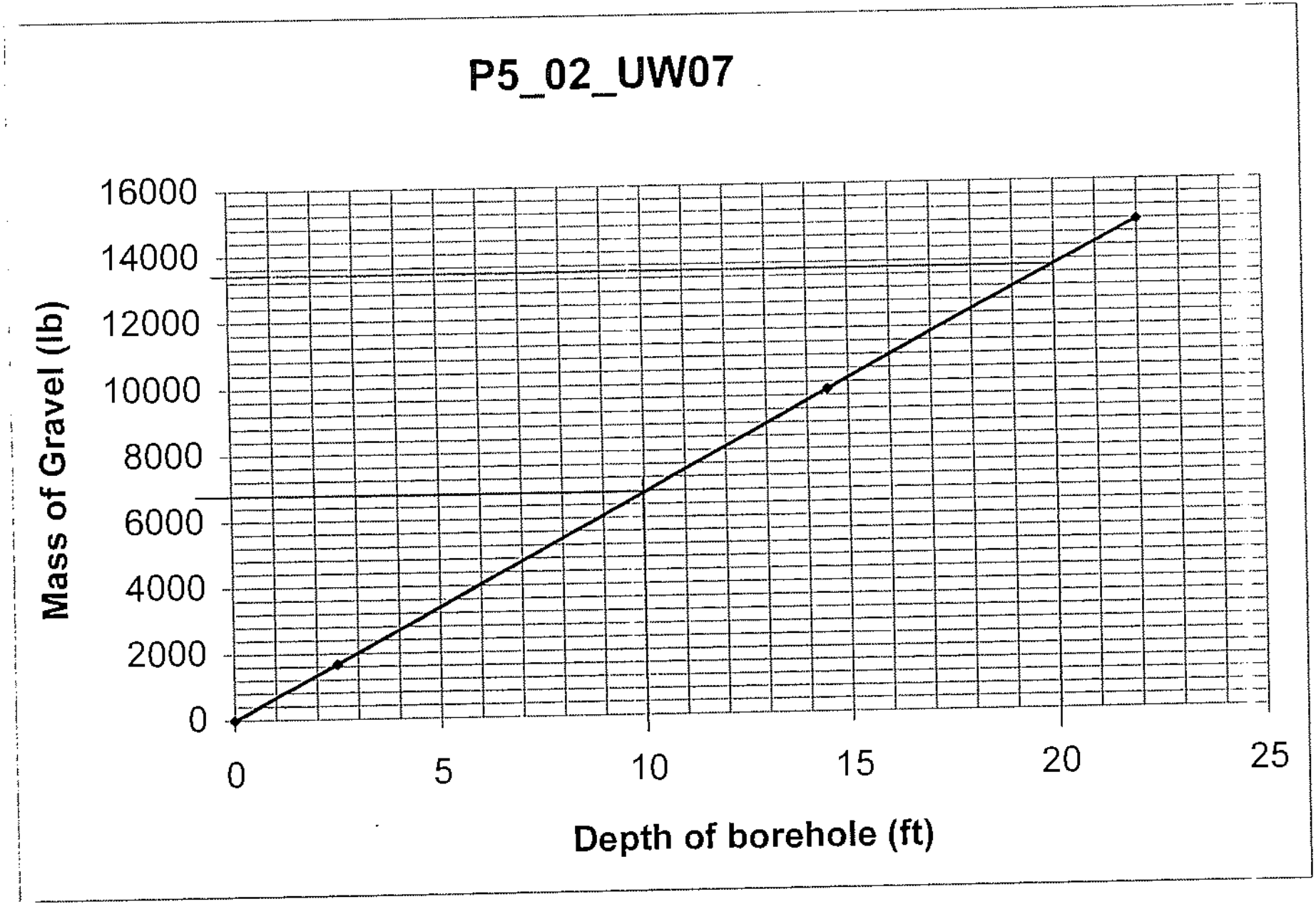

P2_02_UW02A
Mass of Gravel (lb)
20000
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
0
5
10
15
20
25
30
Depth of borehole (ft)

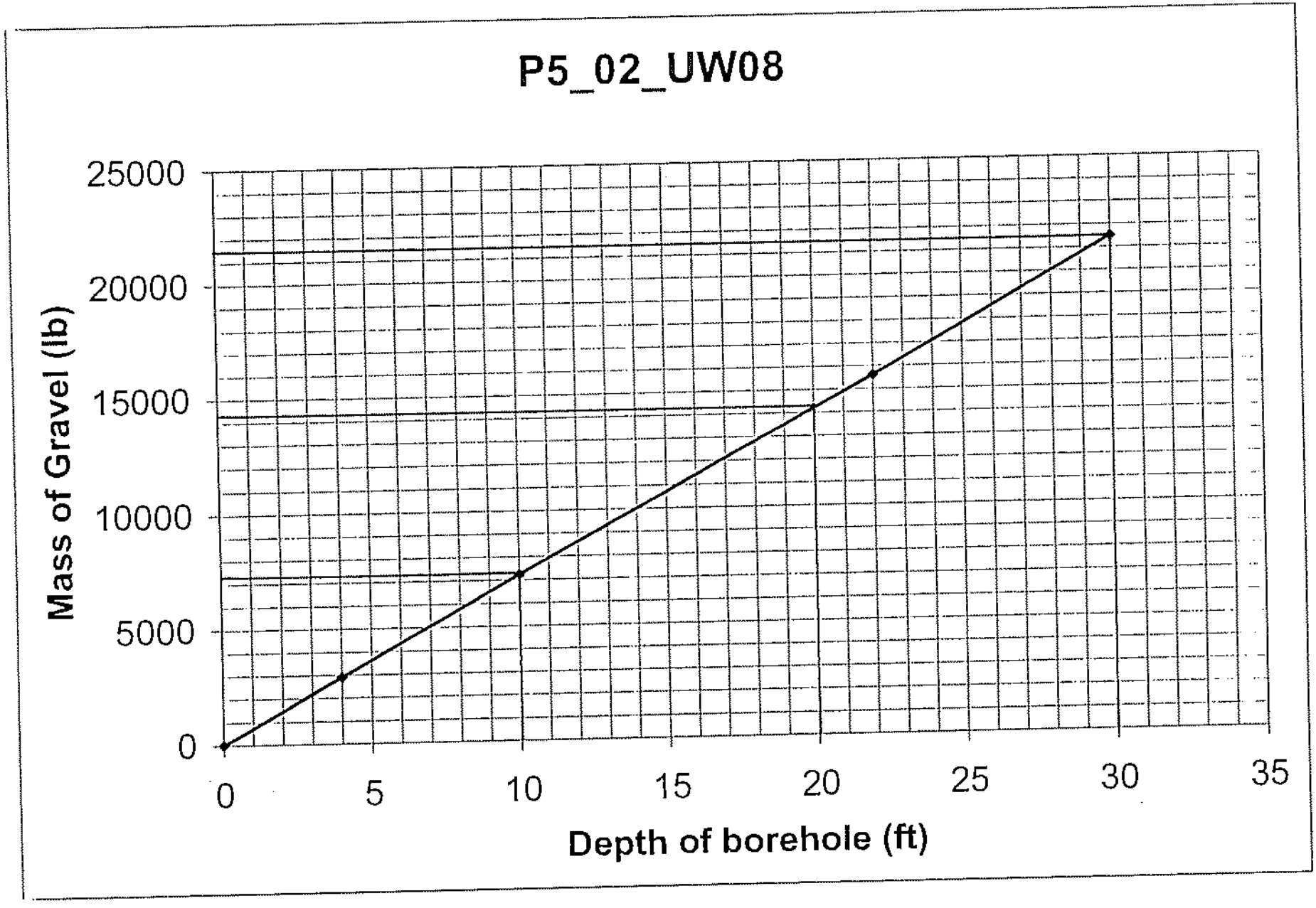

P3_02_UW03
Mass of Gravel (lb)
20000
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
0
5
10
15
20
25
30
Depth of borehole (ft)

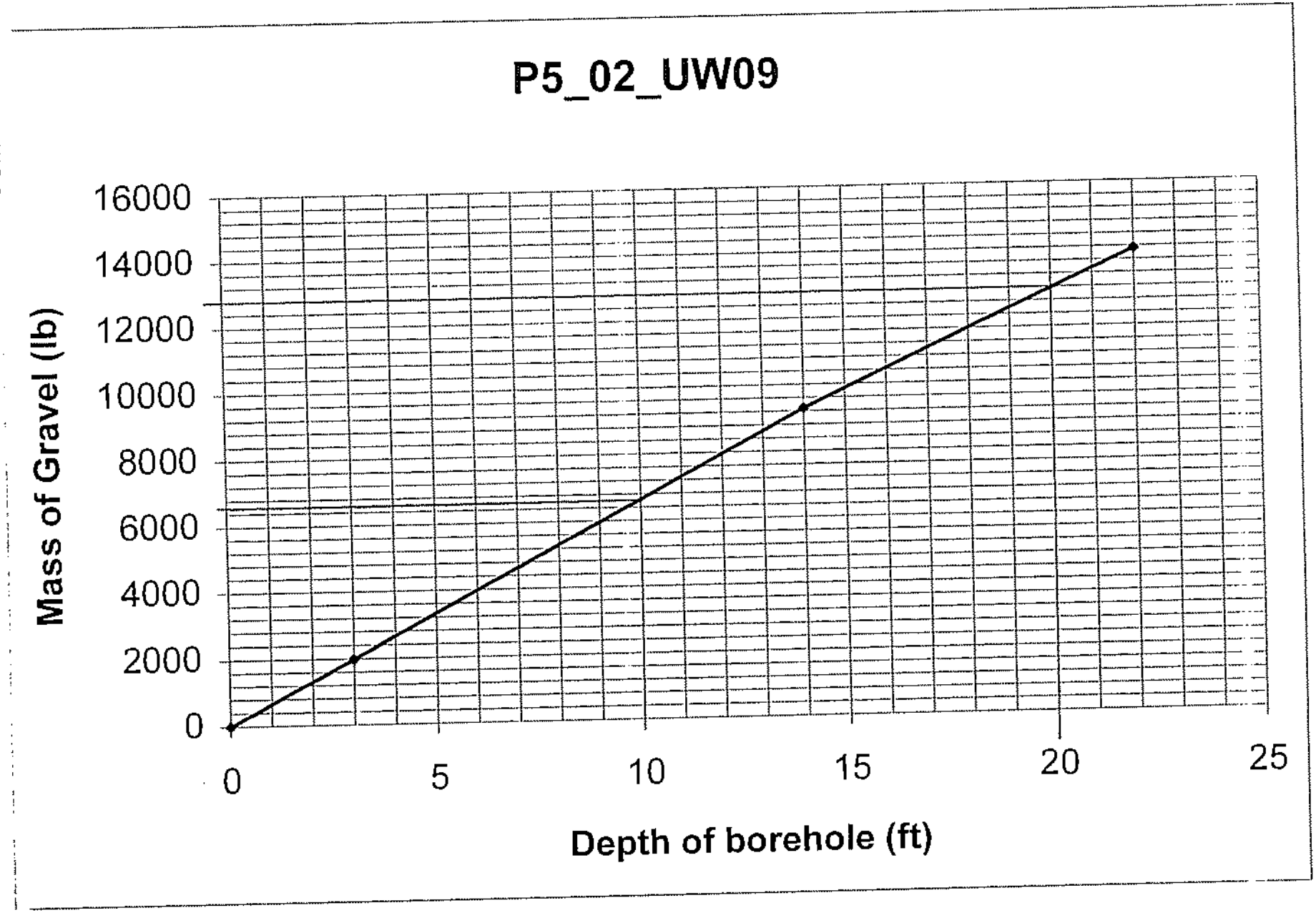

P3_02_UW04
Mass of Gravel (lb)
16000
14000
12000
10000
8000
6000
4000
2000
0
0
5
10
15
20
25
Depth of borehole (ft)


P4_02_UW05
Mass of Gravel (lb)
25000
20000
15000
10000
5000
0
0
5
10
15
20
25
30
Depth of borehole (ft)


P4_02_UW06
Mass of Gravel (lb)
25000
20000
15000
10000
5000
0
0
5
10
15
20
25
30
35
Depth of borehole (ft)


P5_02_UW07
Mass of Gravel (lb)
16000
14000
12000
10000
8000
6000
4000
2000
0
0
5
10
15
20
25
Depth of borehole (ft)


P5_02_UW08
Mass of Gravel (lb)
25000
20000
15000
10000
5000
0
0
5
10
15
20
25
30
35
Depth of borehole (ft)


P5_02_UW09
Mass of Gravel (lb)
16000
14000
12000
10000
8000
6000
4000
2000
0
0
5
10
15
20
25
Depth of borehole (ft)

APPENDIX O-7.3

CALCULATION OF SPECIFIC GRAVITY, VOID RATIO, AND SATURATED WASTE UNIT WEIGHT

Calc. Of Gs

P2_UW02
0 - 10 ft

X = SA data from Table B.1 (Morris, 2001)
Y = US data from Table 4-1 (Tchobanoglous, et al., 1993) = moisture content of as-collected materials, not of actual material structure.

Actual data from SCS Engineers study (2002)

Component	wet mass % total	X solids density kg / m3	X moisture content % gravim.	Y moisture content % gravim.
Textiles	0	1500	0	10
Plastics	2.4	1200	0	2
Glass	0.1	2700	0	2
Metals	4.1	7000	0	2
Paper	5.7	1500	3.7	6
Ash / Fines	27.6	2600	15	7
Organics	4.5	1800	224.4	70
Other Inerts	55.6	2600	15	7
Total	100			
Total (with MC)*	93.4			
measured	w	0.329		
	Mw	24.7555		
	Ms	75.2445	diff Mw	10.58708

* materials containing moisture according to data from X.

Using data from X
For a 100 kg sample

Msolids	Mw	prop. Extra Mw	New Mw	new Ms	%Ds	Gs
0	0	0	0	0	0	0
2.4	0	0	0	2.4	3.1896	0.03828
0.1	0	0	0	0.1	0.1329	0.00359
4.1	0	0	0	4.1	5.4489	0.38142
5.49662	0.20338	0.6461067	0.84948	4.85052	6.44634	0.0967
24	3.6	3.1285169	6.72852	20.8715	27.7382	0.72119
1.38718	3.11282	0.5100843	3.62291	0.87709	1.16566	0.02098
48.3478	7.25217	6.3023746	13.5545	42.0455	55.8784	1.45284
85.8316	14.1684	10.587083	24.7555	75.2445	100	2.715 = Gs for sample

For water content to be 32.9%, mass of water = 24.76 and mass of solids = 75.24.
Therefore: factor mass of water.

16.5072 req. (ie meas.) w 32.9
Ms + Mw 100

input
check
output

Calc. Of Gs

P2_UW02
10 - 21 ft

Component	wet mass % total	X solids density kg / m3	X moisture content % gravim.	Y moisture content % gravim.
Textiles	0	1500	0	10
Plastics	4.4	1200	0	2
Glass	0	2700	0	2
Metals	1.8	7000	0	2
Paper	10	1500	3.7	6
Ash / Fines	9.9	2600	15	7
Organics	29.3	1800	224.4	70
Other Inerts	44.6	2600	15	7
Total	100			
Total (with MC)	93.8			
measured	w	0.495		
	Mw	33.1551		
	Ms	66.8449	diff Mw	5.421645

Using data from X
For a 100 kg sample

Msolids	Mw	prop. Extra Mw	New Mw	new Ms	%Ds	Gs
0	0	0	0	0	0	0
4.4	0	0	0	4.4	6.5824	0.07899
0	0	0	0	0	0	0
1.8	0	0	0	1.8	2.6928	0.1885
9.6432	0.3568	0.5780006	0.9348	9.0652	13.5615	0.20342
8.6087	1.2913	0.5722206	1.86352	8.03648	12.0226	0.31259
9.03206	20.2679	1.6935417	21.9615	7.33852	10.9784	0.19761
38.7826	5.81739	2.5778825	8.39527	36.2047	54.1623	1.40822
72.2666	27.7334	5.4216453	33.1551	66.8449	100	2.38933 = Gs for sample

38.3766 49.6
100

input
check
output

6/18/02

Calc. Of Gs — X = SA data from Table B.1 (Morris, 2001) — Actual data from SCS Engineers study (2002)

Y = US data from Table 4-1 (Tchobanoglous, et al., 1993)

P2_UW02A
0 - 10 ft

Component	wet mass % total	X solids density kg / m3	X moisture content % gravim.	Y moisture content % gravim.	Using data from X For a 100 kg sample Msolids	Mw	prop. Extra Mw	New Mw	new Ms	%Ds	Gs
Textiles	0	1500	0	10	0	0	0	0	0	0	0
Plastics	11	1200	0	2	11	0	0	0	11	16.346	0.196152
Glass	0.4	2700	0	2	0.4	0	0	0	0.4	0.5944	0.016049
Metals	4.5	7000	0	2	4.5	0	0	0	4.5	6.687	0.46809
Paper	4.6	1500	3.7	6	4.435873	0.164127	0.89341719	1.057544	3.542456	5.264089	0.078951
Ash / Fines	31.6	2600	15	7	27.47826	4.121739	6.13738764	10.25913	21.34087	31.71254	0.824526
Organics	10.4	1800	224.4	70	3.205919	7.194081	2.01989973	9.213981	1.186019	1.762424	0.031724
Other Inerts	37.5	2600	15	7	32.6087	4.891304	7.28329229	12.1746	25.3254	37.63355	0.978472
Total	100				83.62875	16.37125	16.3339968	32.70525	67.29475	100	2.593974 = Gs for sample
Total (with MC)	84.1										
measured	w	0.486				19.57611			48.6		
	Mw	32.70525						100			
	Ms	67.29475	diff Mw	16.334							

input / check / output

Calc. Of Gs

P2_UW02A
10 - 20 ft

Component	wet mass % total	X solids density kg / m3	X moisture content % gravim.	Y moisture content % gravim.	Using data from X For a 100 kg sample Msolids	Mw	prop. Extra Mw	New Mw	new Ms	%Ds	Gs
Textiles	0	1500	0	10	0	0	0	0	0	0	0
Plastics	18.8	1200	0	2	18.8	0	0	0	18.8	26.7712	0.321254
Glass	0.6	2700	0	2	0.6	0	0	0	0.6	0.8544	0.023069
Metals	1.7	7000	0	2	1.7	0	0	0	1.7	2.4208	0.169456
Paper	23.5	1500	3.7	6	22.66152	0.838476	3.47388358	4.31236	19.18764	27.3232	0.409848
Ash / Fines	20.4	2600	15	7	17.73913	2.66087	3.0156266	5.676496	14.7235	20.96627	0.545123
Organics	17.9	1800	224.4	70	5.517879	12.38212	2.64606451	15.02819	2.871815	4.089464	0.07361
Other Inerts	17.1	2600	15	7	14.86957	2.230435	2.52780465	4.758239	12.34176	17.57467	0.456941
Total	100				81.8881	18.1119	11.6633793	29.77528	70.22472	100	1.999302 = Gs for sample
Total (with MC)	78.9										
measured	w	0.424				22.11787			42.4		
	Mw	29.77528						100			
	Ms	70.22472	diff Mw	11.66338							

input / check / output

Calc. Of Gs

P2_UW02A
20 - 28 ft

Component	wet mass % total	X solids density kg / m3	X moisture content % gravim.	Y moisture content % gravim.	Using data from X For a 100 kg sample Msolids	Mw	prop. Extra Mw	New Mw	new Ms	%Ds	Gs
Textiles	0	1500	0	10	0	0	0	0	0	0	0
Plastics	8.9	1200	0	2	8.9	0	0	0	8.9	12.1485	0.145782
Glass	0	2700	0	2	0	0	0	0	0	0	0
Metals	1.9	7000	0	2	1.9	0	0	0	1.9	2.5935	0.181545
Paper	33.9	1500	3.7	6	32.69045	1.209547	2.09769916	3.307246	30.59275	41.75911	0.626387
Ash / Fines	19	2600	15	7	16.52174	2.478261	1.17570159	3.653962	15.34604	20.94734	0.544631
Organics	22.6	1800	224.4	70	7.02836	15.77164	1.41084191	17.18248	5.617518	7.667912	0.138022
Other Inerts	13.5	2600	15	7	11.73913	1.76087	0.83536692	2.596236	10.90376	14.88364	0.386975
Total	100				78.77968	21.22032	5.51960958	26.73993	73.26007	100	2.023341 = Gs for sample
Total (with MC)	89.2										
measured	w	0.365				25.93628			36.5		
	Mw	26.73993						100			
	Ms	73.26007	diff Mw	5.51961							

input / check / output

Calc. Of Gs

X = SA data from Table B.1 (Morris, 2001) Actual data from SCS Engineers study (2002)

Y = US data from Table 4-1 (Tchobanoglous, et al., 1993)

P3_UW04
0 - 10 ft

Component	wet mass % total	X solids density kg / m3	X moisture content % gravim.	Y moisture content % gravim.
Textiles	0	1500	0	10
Plastics	1.9	1200	0	2
Glass	0.1	2700	0	2
Metals	2.7	7000	0	2
Paper	6.6	1500	3.7	6
Ash / Fines	32.7	2600	15	7
Organics	1.8	1800	224.4	70
Other Inerts	54.2	2600	15	7
Total	100			
Total (with MC)	95.3			
measured	w	0.294		
	Mw	22.7202		
	Ms	77.2798	diff Mw	9.904848

Using data from X
For a 100 kg sample

Msolids	Mw	prop. Extra Mw	New Mw	new Ms	%Ds	Gs
0	0	0	0	0	0	0
1.9	0	0	0	1.9	2.4586	0.0295
0.1	0	0	0	0.1	0.1294	0.00349
2.7	0	0	0	2.7	3.4938	0.24457
6.36451	0.23549	0.8859601	0.92145	5.67855	7.34805	0.11022
28.4348	4.26522	3.3986205	7.66384	25.0362	32.3968	0.84232
0.55487	1.24513	0.18708	1.43221	0.36779	0.47592	0.00857
47.1304	7.06957	5.6331876	12.7028	41.4972	53.6974	1.39613
87.1846	12.8154	9.9048482	22.7202	77.2798	100	2.6348 = Gs for sample

For water content to be 32.9%, mass of water = 24.76 and mass of solids = 75.24.
Therefore: factor mass of water.

14.6992 29.4

100

input
check
output

Calc. Of Gs

P3_UW04
10 - 22 ft

Component	wet mass % total	X solids density kg / m3	X moisture content % gravim.	Y moisture content % gravim.
Textiles	[illegible]	1500	0	10
Plastics	[illegible]	1200	0	2
Glass	[illegible]	2700	0	2
Metals	[illegible]	7000	0	2
Paper	[illegible]	1500	3.7	6
Ash / Fines	[illegible]	2600	15	7
Organics	[illegible]	1800	224.4	70
Other Inerts	[illegible]	2600	15	7
Total	[illegible]			
Total (with MC)	[illegible]			
measured	w	0.291		
	Mw	22.5407		
	Ms	77.4593	diff Mw	9.146094

Using data from X
For a 100 kg sample

Msolids	Mw	prop. Extra Mw	New Mw	new Ms	%Ds	Gs
0	0	0	0	0	0	0
5.9	0	0	0	5.9	7.6169	0.0914
0.3	0	0	0	0.3	0.3873	0.01046
11.1	0	0	0	11.1	14.3301	1.00311
9.45034	0.34966	1.0838177	1.43348	8.36652	10.8012	0.16202
21.3913	3.2087	2.7208035	5.9293	18.6707	24.1039	0.6267
1.94205	4.35795	0.8967399	5.05469	1.24531	1.60769	0.02894
36.5217	5.47826	4.6449329	10.1232	31.8768	41.153	1.06998
86.6054	13.3946	9.146094	22.5407	77.4593	100	2.9926 = Gs for sample

15.4662 29.1

100

input
check
output

6/18/02

Calc. Of Gs

X = SA data from Table B.1 (Morris, 2001) Actual data from SCS Engineers study (2002)

Y = US data from Table 4-1 (Tchobanoglous, et al., 1993)

P4_UW05
0 - 10 ft

Component	wet mass % total	X solids density kg / m3	X moisture content % gravim.	Y moisture content % gravim.
Textiles	0	1500	0	10
Plastics	9.3	1200	0	2
Glass	0.7	2700	0	2
Metals	1.3	7000	0	2
Paper	26.3	1500	3.7	6
Ash / Fines	26.5	2600	15	7
Organics	17.6	1800	224.4	70
Other Inerts	18.3	2600	15	7
Total	100			
Total (with MC)	88.7			
measured	w	0.211		
	Mw	17.4236		
	Ms	82.5764	diff Mw	-1.532841

Using data from X

For a 100 kg sample

Msolids	Mw	prop. Extra Mw	New Mw	new Ms	%Ds	Gs
0	0	0	0	0	0	0
9.3	0	0	0	9.3	11.2623	0.13515
0.7	0	0	0	0.7	0.8477	0.02289
1.3	0	0	0	1.3	1.5743	0.1102
25.3616	0.93838	-0.454495	0.48388	25.8161	31.2633	0.46895
23.0435	3.45652	-0.457951	2.99857	23.5014	28.4602	0.73997
5.4254	12.1746	-0.304149	11.8705	5.72955	6.93848	0.12489
15.913	2.38696	-0.316246	2.07071	16.2293	19.6537	0.511
81.0435	18.9565	-1.532841	17.4236	82.5764	100	2.11304 = Gs for sample

For water content to be 32.9%, mass of water = 24.76 and mass of solids = 75.24.

Therefore: factor mass of water.

23.3905 21.1 100

input
check
output

Calc. Of Gs

P4_UW05
10 - 20 ft

Component	wet mass % total	X solids density kg / m3	X moisture content % gravim.	Y moisture content % gravim.
Textiles	[illegible]	1500	0	10
Plastics	[illegible]	1200	0	2
Glass	[illegible]	2700	0	2
Metals	[illegible]	7000	0	2
Paper	[illegible]	1500	3.7	6
Ash / Fines	[illegible]	2600	15	7
Organics	[illegible]	1800	224.4	70
Other Inerts	[illegible]	2600	15	7
Total	[illegible]			
Total (with MC)	75			
measured	w	0.241		
	Mw	19.4198		
	Ms	80.5802	diff Mw	6.706545

Using data from X

For a 100 kg sample

Msolids	Mw	prop. Extra Mw	New Mw	new Ms	%Ds	Gs
0	0	0	0	0	0	0
17.8	0	0	0	17.8	22.0898	0.26508
0.8	0	0	0	0.8	0.9928	0.02681
6.4	0	0	0	6.4	7.9424	0.55597
20.4436	0.75641	1.8957168	2.65213	18.5479	23.0179	0.34527
20.3478	3.05217	2.0924421	5.14462	18.2554	22.6549	0.58903
2.7127	6.0873	0.7869013	6.8742	1.9258	2.38992	0.04302
18.7826	2.81739	1.931485	4.74888	16.8511	20.9122	0.54372
87.2867	12.7133	6.7065451	19.4198	80.5802	100	2.36888 = Gs for sample

14.565 24.1 100

input
check
output

Calc. Of Gs — X = SA data from Table B.1 (Morris, 2001) — Actual data from SCS Engineers study (2002)

Y = US data from Table 4-1 (Tchobanoglous, et al., 1993)

P5_UW08

0 - 10 ft

Component	wet mass % total	X solids density kg / m3	X moisture content % gravim.	Y moisture content % gravim.	Using data from X For a 100 kg sample Msolids	Mw	prop. Extra Mw	New Mw	new Ms	%Ds	Gs
Textiles	0	1500	0	10	0	0	0	0	0	0	0
Plastics	4.1	1200	0	2	4.1	0	0	0	4.1	4.9323	0.059188
Glass	0.2	2700	0	2	0.2	0	0	0	0.2	0.2406	0.006496
Metals	4.2	7000	0	2	4.2	0	0	0	4.2	5.0526	0.353682
Paper	17.8	1500	3.7	6	17.1649	0.635101	-0.3270066	0.308095	17.49191	21.04276	0.315641
Ash / Fines	22.6	2600	15	7	19.65217	2.947826	-0.4151881	2.532638	20.06736	24.14104	0.627867
Organics	14.8	1800	224.4	70	4.562269	10.23773	-0.2718931	9.965838	4.834182	5.815497	0.104679
Other Inerts	36.3	2600	15	7	31.56522	4.734783	-0.6668729	4.06791	32.23209	38.7752	1.008155
Total	100				81.44456	18.55544	-1.6809607	16.87448	83.12552	100	2.475508 = Gs for sample
Total (with MC)	91.5										
measured	w	0.203									
	Mw	16.87448				22.78291			20.3		
	Ms	83.12552	diff Mw	-1.68096				100			

input / check / output

Calc. Of Gs

P5_UW08

10 - 20 ft

Component	wet mass % total	X solids density kg / m3	X moisture content % gravim.	Y moisture content % gravim.	Using data from X For a 100 kg sample Msolids	Mw	prop. Extra Mw	New Mw	new Ms	%Ds	Gs
Textiles	0	1500	0	10	0	0	0	0	0	0	0
Plastics	9.4	1200	0	2	9.4	0	0	0	9.4	11.703	0.140436
Glass	1	2700	0	2	1	0	0	0	1	1.245	0.033615
Metals	10.9	7000	0	2	10.9	0	0	0	10.9	13.5705	0.949935
Paper	22.7	1500	3.7	6	21.89007	0.809932	0.63186788	1.4418	21.2582	26.46646	0.396997
Ash / Fines	17.3	2600	15	7	15.04348	2.256522	0.4815557	2.738077	14.56192	18.12959	0.471369
Organics	15.7	1800	224.4	70	5.147965	11.55203	0.46485434	12.01689	4.683111	5.830473	0.104949
Other Inerts	22	2600	15	7	19.13043	2.869565	0.61238297	3.481948	18.51805	23.05497	0.599429
Total	100				82.51195	17.48805	2.19066088	19.67871	80.32129	100	2.69573 = Gs for sample
Total (with MC)	78.7										
measured	w	0.245									
	Mw	19.67871				21.19457			24.5		
	Ms	80.32129	diff Mw	2.190661				100			

input / check / output

Calc. Of Gs

P5_UW08

20 - 30 ft

Component	wet mass % total	X solids density kg / m3	X moisture content % gravim.	Y moisture content % gravim.	Using data from X For a 100 kg sample Msolids	Mw	prop. Extra Mw	New Mw	new Ms	%Ds	Gs
Textiles	0	1500	0	10	0	0	0	0	0	0	0
Plastics	11	1200	0	2	11	0	0	0	11	14.872	0.178464
Glass	0.2	2700	0	2	0.2	0	0	0	0.2	0.2704	0.007301
Metals	2.7	7000	0	2	2.7	0	0	0	2.7	3.6504	0.255528
Paper	7.2	1500	3.7	6	6.943105	0.256895	0.19205554	0.44895	6.75105	9.127419	0.136911
Ash / Fines	19.2	2600	15	7	16.69565	2.504348	0.5121481	3.016496	16.1835	21.8801	0.568883
Organics	23.5	1800	224.4	70	7.244143	16.25586	0.62684794	16.8827	6.617295	8.946583	0.161038
Other Inerts	36.2	2600	15	7	31.47826	4.721739	0.96561257	5.687352	30.51265	41.2531	1.072581
Total	100				76.26116	23.73884	2.29666415	26.0355	73.9645	100	2.380705 = Gs for sample
Total (with MC)	86.1										
measured	w	0.352									
	Mw	26.0355				31.12835			35.2		
	Ms	73.9645	diff Mw	2.296664				100			

input / check / output

Calc. Of Gs

X = SA data from Table B.1 (Morris, 2001) Actual data from SCS Engineers study (2002)

Y = US data from Tabla 4-1 (Tchobanoglous, et al., 1993)

P5_UW09
0 - 10 ft

Using data from X
For a 100 kg sample

Component	wet mass % total	X solids density kg / m3	X moisture content % gravim.	Y moisture content % gravim.	Msolids	Mw	prop. Extra Mw	New Mw	new Ms	%Ds	Gs
Textiles		1500	0	10	0	0	0	0	0	0	0
Plastics		1200	0	2	3.9	0	0	0	3.9	4.6683	0.05602
Glass		2700	0	2	0.1	0	0	0	0.1	0.1197	0.00323
Metals		7000	0	2	1.2	0	0	0	1.2	1.4364	0.10055
Paper		1500	3.7	6	10.4147	0.38534	-0.337993	0.04735	10.7527	12.8709	0.19306
Ash / Fines		2600	15	7	28.5217	4.27826	-1.026497	3.25176	29.5482	35.3692	0.9196
Organics		1800	224.4	70	4.43896	9.96104	-0.450657	9.51038	4.88962	5.85288	0.10535
Other Inerts		2600	15	7	32	4.8	-1.15168	3.64832	33.1517	39.6826	1.03175
Total					80.5754	19.4246	-2.966828	16.4578	83.5422	100	2.40956 = Gs for sample
Total (with MC)	94.8										
measured	w	0.197									
	Mw	16.4578									
	Ms	83.5422	diff Mw	-2.966828							

For water content to be 32.9%, mass of water = 24.76 and mass of solids = 75.24.
Therefore: factor mass of water.

24.1074 19.7 100

input
check
output

Calc. Of Gs

P5_UW09
10 - 20 ft

Using data from X
For a 100 kg sample

Component	wet mass % total	X solids density kg / m3	X moisture content % gravim.	Y moisture content % gravim.	Msolids	Mw	prop. Extra Mw	New Mw	new Ms	%Ds	Gs
Textiles	0	1500	0	10	0	0	0	0	0	0	0
Plastics	6.3	1200	0	2	6.3	0	0	0	6.3	7.7616	0.09314
Glass	0.7	2700	0	2	0.7	0	0	0	0.7	0.8624	0.02328
Metals	1.6	7000	0	2	1.6	0	0	0	1.6	1.9712	0.13798
Paper	17.6	1500	3.7	6	16.972	0.62797	0.3654024	0.99337	16.6066	20.4594	0.30689
Ash / Fines	17.1	2600	15	7	14.8696	2.23043	0.3550217	2.58546	14.5145	17.8819	0.46493
Organics	11.9	1800	224.4	70	3.66831	8.23169	0.2470619	8.47875	3.42125	4.21498	0.07587
Other Inerts	44.8	2600	15	7	38.9565	5.84348	0.9301153	6.77359	38.0264	46.8485	1.21806
Total	100				83.0664	16.9336	1.8976012	18.8312	81.1688	100	2.32016 = Gs for sample
Total (with MC)	91.4										
measured	w	0.232									
	Mw	18.8312									
	Ms	81.1688	diff Mw	1.897601							

20.3856 23.2 100

input
check
output

Calc of e and n (Gs,w from previous sheets)

Location	Boring	Depth ft	Gs	w	A γb pcf	B γb pcf	A e	B e	A n	B n	A γd pcf	B γd pcf	A S	B S	A γsat pcf	B γsat pcf
P2	UW02	0-10	2.71	0.329	53.8	40.0	3.187	4.631	0.761	0.822	40.5	30.1	0.281	0.193	88.0	81.4
		10-21	2.39	0.496	59.2	44.0	2.769	4.071	0.735	0.803	39.6	29.4	0.429	0.291	85.4	79.5
P2	UW02A	0-10	2.59	0.486												
		10-20	2.00	0.424	64.2	47.7	1.768	2.726	0.639	0.732	45.1	33.5	0.480	0.311	84.9	79.1
		20-28	2.02	0.365	76.0	56.5	1.269	2.052	0.559	0.672	55.7	41.4	0.583	0.361	90.5	83.3
P3	UW04	0-10	2.63	0.294	60.0	44.6	2.547	3.772	0.718	0.790	46.3	34.5	0.305	0.206	91.2	83.8
		10-22	2.99	0.291	79.2	58.9	2.045	3.095	0.672	0.756	61.3	45.6	0.427	0.282	103.2	92.8
P4	UW05	0-10	2.11	0.211	41.3	30.7	2.868	4.203	0.741	0.808	34.1	25.3	0.156	0.106	80.4	75.7
		10-20	2.37	0.241	108.1	80.3	0.698	1.285	0.411	0.562	87.1	64.7	0.820	0.445	112.7	99.8
P5	UW08	0-10	2.48	0.203	62.5	46.5	1.975	2.998	0.664	0.750	51.9	38.6	0.255	0.168	93.4	85.4
		10-20	2.70	0.245	61.4	45.6	2.414	3.596	0.707	0.782	49.3	36.6	0.274	0.184	93.4	85.4
		20-30	2.38	0.352	80.6	59.9	1.493	2.355	0.599	0.702	59.6	44.3	0.562	0.357	97.0	88.1
P5	UW09	0-10	2.41	0.197	63.7	47.3	1.827	2.807	0.646	0.737	53.2	39.5	0.261	0.170	93.5	85.5
		10-20	2.32	0.232	72.2	53.6	1.472	2.329	0.595	0.700	58.6	43.5	0.367	0.232	95.7	87.1

notes:
A = assuming 36-in boring diameter
B = assuming 16% overbore on diameter
w = moisture content (gravimetric)
Gs = specific gravity
γb = bulk density (pcf)
γw = 62.4 pcf (1000 kg/m^3)
γd = dry density (pcf)
γsat = saturated density (pcf)
e = voids ratio
n = porosity
S = degree of saturation

APPENDIX O-7.4

CALCULATION OF WASTE UNIT WEIGHT FROM SMALL DIAMETER BORING SAMPLES

Written by: JWF Morris Date: 02/04/23 Reviewed by: C. Pendleton Date: 02/04/29

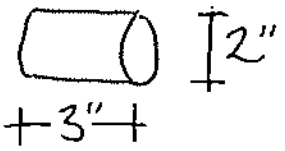
Client: DSWA Project: C1L Project/Proposal No.: ME0250 Task No.: 1.3.6

– Calculation of γ_{msw} from SPT Split Spoon sample:

Location: SPT4, 53'–53.5' depth.

V. stiff, wet MSW (see photograph with borelogs)

Sample:



Mass = 240 g = 0.529 lb.

$Vol = \frac{\pi 2^2}{4} \times 3 = 9.425$ cu.in.

$= 5.45 \times 10^{-3}$ cf.

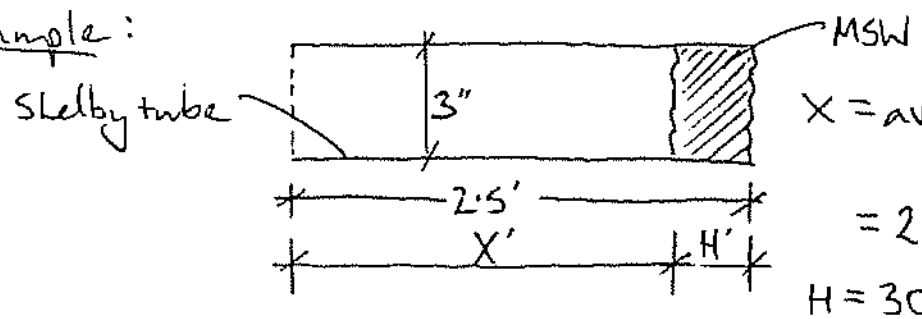
$$\gamma_{msw} = \frac{Mass}{Vol.}$$

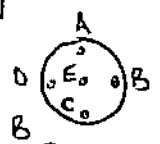
$$= \frac{0.529}{5.45 \times 10^{-3}} = 97.0 \text{ pcf.}$$

– Calculation of γ_{msw} from Shelby Tube, SPT drilling:

Location: SPT3, 34'–35' depth. V stiff, sat. MSW

Sample:





$X = ave(\overset{A}{2.17}, \overset{B}{2.18}, \overset{C}{2.23}, \overset{D}{2.24}, \overset{E}{2})$

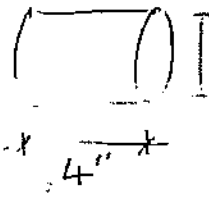
$= 2.164' = 25.97''$

$H = 30'' - 26'' = 4''$.

Mass shelby tube + MSW = 6.08 lb

Mass shelby tube = 4.845 lb

Mass MSW = 1.235 lb.



$Vol. = \frac{\pi 3^2}{4} \cdot 4 = 28.274$ cu.in.

$= 16.36 \times 10^{-3}$ cf.

$\gamma_{msw} = \frac{1.235}{\ldots} = 75.5$ pcf

APPENDIX O-8

BORING RECORDS

GEOSYNTEC CONSULTANTS
(410) 381-4333

Procedural Record & Visual Classification Form (PRVCF)

BOREHOLE LOCATION NO.: UW03 WEATHER: Sunny, hot

CONTRACTOR: Kellett's DATE (MM.DD.YY): 03 / 14 / 02

FIELD ENGINEER: J. Morris Auger Dia. 36 (in) Gas Pipe Dia. 6 (in)

CIL: Test Boring and Sampling Project No. ME0250 Task No. 1.3.4

Time	Depth (ft.)	Structure	Moisture Content	Compaction	Degradation	Composition	Depth Int. (ft)	Waste Mass (tons)	Total Waste Mass (tons)	Depth Int. (ft)	Gravel Mass (Begin) (tons)	Gravel Mass (End) (tons)	Notes/Comments Visual Classification Legend on rear of form.
12:15	10'		1		2	1	0-10	~~4440~~	4,200				Cover = 1-2" Stab. Ash-Gri
	20'						10-20	~~5220~~	4,980				
2:20	28'	2-3	2-3	2	3-4	1,9	20-28	~~5420~~	5180				Hit water @ 27'
													Sample for Lab Testing from 27-28'
													3/15 Water level = 26'
9:40									(36)	28-22	65240	61480	
									(32)	22-13.5	45200	39380	Pipe in @ 17'
10:00									(36)	13.5-2.5	61480	53920	

Reviewed By: _____ WASTE GRAVEL

REFUSE VISUAL CLASSIFICATION
LEGEND

GEOSYNTEC CONSULTANTS

MOISTURE CONTENT
1= DRY-DAMP MOISTURE LEVELS
2=WET MOISTURE LEVELS
3=STANDING WATER

COMPACTION
1= SLIGHT - REFUSE EASILY FALLS OUT OF BUCKET AUGER
2= MODERATE - REFUSE FALLS OUT OF BUCKET AUGER UPON IMPACT
3= HEAVY - REFUSE FALLS OUT OF BUCKET AUGER ONLY AFTER BEING STRUCK MULTIPLE TIMES

DEGRADATION
1=NONE - NEWSPAPERS VERY LEGIBLE, NO REFUSE DISCOLORATION
2=SLIGHT - SOME NEWSPAPERS STILL LEGIBLE, DISCOLORATION
3=MODERATE - NEWPAPER PARTLY LEGIBLE, HIGHLY DISCOLORED
4=HIGH - NEWSPAPER HIGHLY FADED GRAY TO BLACK

COMPOSITION
1=HOUSEHOLD- PAPER AND PLASTICS
2=PUTRESCIBLE ORGANICS
3=CONCRETE, BRICKS
4=WIRING
5=METAL
6=NON FERROUS METAL
7=TIRES
8=ASPHALT
9=SOIL
10=MEDICAL
11=INDISTINGUISHIBLE
12=GLASS
13=OTHER (SPECIFY)

STRUCTURE
1=LAYERED - WASTE CONSTITUENTS ORIENTED WITH LONG AXIS IN A PREFERRED DIRECTION (E.G., HORIZONTAL) (NOTE: DIRECTION IN DIFFERENT COLUMN)
2=ENCAPSULATED - WASTE CONSTITUENTS ENCAPSULATED IN A SOIL MATRIX
3=FIBROUS - WASTE CONSTITUENTS INTERTWINED
4=INTERLOCKED - WASTE CONSTITUENTS INTERLOCKED ("COMPACT, "GRANULAR" TYPE STRUCTURE)
5=INDISTINGUISHABLE

GEOSYNTEC CONSULTANTS
(410) 381-4333

Procedural Record & Visual Classification Form (PRVCF)

BOREHOLE LOCATION NO.: UW02A WEATHER: as 02

CONTRACTOR: Kellett's DATE (MM.DD.YY): 03 / 11 / 02

FIELD ENGINEER: J. Morris Auger Dia. 36 (in) Gas Pipe Dia. — (in)

CIL: Test Boring and Sampling Project No. ME0250 Task No. 1.3.4

Time	Depth (ft.)	Structure	Moisture Content	Compaction	Degradation	Composition	Depth Int. (ft)	Waste Mass (tons)	Total Waste Mass (tons)	Depth Int. (ft)	Gravel Mass (Begin) (tons)	Gravel Mass (End) (tons)	Notes/Comments Visual Classification Legend on rear of form.
11:40	10'	2	1	2-3	2-3	1,9	0-10'	~~3440~~					<1' cover soil Classif. by SCS (C)
12:05	20'	3	1	1	1	1	10-20'	~~4550~~	4,540				V. Dry, Undegr. C. Paper Jan '91 More degr. from 18'
13:00	28'	2	1	1-2	2-3	1,9	20-28'	~~4780~~	4,300				C. Hit water @ 28' Abandon BH.
15:25										9.75-28	55080	43060	
15:45									(36)	9.75-35	57660	53660	

Reviewed By: _____ WASTE GRAVEL Page No 1 of 1

REFUSE VISUAL CLASSIFICATION
LEGEND

GEOSYNTEC CONSULTANTS

MOISTURE CONTENT
1= DRY-DAMP MOISTURE LEVELS
2=WET MOISTURE LEVELS
3=STANDING WATER

COMPACTION
1= SLIGHT - REFUSE EASILY FALLS OUT OF BUCKET AUGER
2= MODERATE - REFUSE FALLS OUT OF BUCKET AUGER UPON IMPACT
3= HEAVY - REFUSE FALLS OUT OF BUCKET AUGER ONLY AFTER BEING STRUCK MULTIPLE TIMES

DEGRADATION
1=NONE - NEWSPAPERS VERY LEGIBLE, NO REFUSE DISCOLORATION
2=SLIGHT - SOME NEWSPAPERS STILL LEGIBLE, DISCOLORATION
3=MODERATE - NEWPAPER PARTLY LEGIBLE, HIGHLY DISCOLORED
4=HIGH - NEWSRAPER HIGHLY FADED GRAY TO BLACK

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4=INTERLOCKED - WASTE CONSTITUENTS INTERLOCKED ("COMPACT, "GRANULAR" TYPE STRUCTURE)
5=INDISTINGUISHABLE

Reviewed By _____

GEOSYNTEC CONSULTANTS
(410) 381-4333

Procedural Record & Visual Classification Form (PRVCF)

BOREHOLE LOCATION NO.: 02-UW02 WEATHER: Clear, Cold, Windy

CONTRACTOR: Kellett's DATE (MM.DD.YY): 03 / 11 / 02

FIELD ENGINEER: J Morris Auger Dia. 36 (in) Gas Pipe Dia. — (in)

CIL: Test Boring and Sampling Project No. ME0250 Task No. 1.3.4

Time	Depth (ft.)	Structure	Moisture Content	Compaction	Degradation	Composition	Depth Int. (ft)	Waste Mass (tons)	Total Waste Mass (tons)	Depth Int. (ft)	Gravel Mass (Begin) (tons)	Gravel Mass (End) (tons)	Notes/Comments Visual Classification Legend on rear of form.
9.45	10'	1-2	1	2-3	2-3	1,9,13	0-10	~~37,700~~	~~3,780~~	3,800			2' soil cover SCS Eng. classif. (c) 13=Wood.
10.15	21'	5	2-3	2-3	3	←	10-21	~~4,580~~	4,600				c.
10.40	28'		3										Gas Wells 42, 38 off @ 10.35. c. Standing Water @ 20.5'
													Abandoned BH @ 26'
													15.00 Water @ 21.5'
15.00							28-34			26-21	65400	63900	
							21-17			21-17	63620	55020	
15.25							17-0			17-0	63900	57660	

Reviewed By: _____ WASTE GRAVEL

REFUSE VISUAL CLASSIFICATION
LEGEND

GEOSYNTEC CONSULTANTS

MOISTURE CONTENT
1= DRY-DAMP MOISTURE LEVELS
2=WET MOISTURE LEVELS
3=STANDING WATER

COMPACTION
1= SLIGHT - REFUSE EASILY FALLS OUT OF BUCKET AUGER
2= MODERATE - REFUSE FALLS OUT OF BUCKET AUGER UPON IMPACT
3= HEAVY - REFUSE FALLS OUT OF BUCKET AUGER ONLY AFTER BEING STRUCK MULTIPLE TIMES

DEGRADATION
1=NONE - NEWSPAPERS VERY LEGIBLE, NO REFUSE DISCOLORATION
2=SLIGHT - SOME NEWSPAPERS STILL LEGIBLE, DISCOLORATION
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5=INDISTINGUISHABLE

Reviewed By: _____

SAMPLE
FROM UW03
(27-28' DEPTH)

GEOSYNTEC CONSULTANTS
(410) 381-4333

Procedural Record & Visual Classification Form (PRVCF)

BOREHOLE LOCATION NO.: UW-04 WEATHER: overcast, 40's

CONTRACTOR: Kellet's DATE (MM.DD.YY): 03 / 12 / 02

FIELD ENGINEER: Doug Mandeville Auger Dia. 36 (in) Gas Pipe Dia. 6 (in)

CIL: Test Boring and Sampling Project No. ME0250 Task No. 1.3.4

Time	Depth (ft.)	Structure	Moisture Content	Compaction	Degradation	Composition	Depth Int. (ft)	Waste Mass (tons)	Total Waste Mass (tons)	Depth Int. (ft)	Gravel Mass (Begin) (tons)	Gravel Mass (End) (tons)	Notes/Comments Visual Classification Legend on rear of form.
2:45	0'						0-10	~~4,000~~	4,240				C Cover = 1' Comp. Clay
3:30							10-20	~~6,600~~ →	6,720				over 2' stab. sludge/ash. will weigh 3/13
4:00							20-22	←					hit ~~[illegible]~~ water at about 23'
													L = 45/4 3/12 water level @ 19'
11:10							~~[illegible]~~		(35)	22-18	63900	61520	3/14, 8:35 Water level = 20.5'
									(35)	18-10	61520	56100	Pipe in @ 18'
11:30									(29)	10-2.5	63440	58380	

Reviewed By: _____ WASTE GRAVEL

REFUSE VISUAL CLASSIFICATION
LEGEND

GEOSYNTEC CONSULTANTS

MOISTURE CONTENT
1= DRY-DAMP MOISTURE LEVELS
2=WET MOISTURE LEVELS
3=STANDING WATER

COMPACTION
1= SLIGHT - REFUSE EASILY FALLS OUT OF BUCKET AUGER
2= MODERATE - REFUSE FALLS OUT OF BUCKET AUGER UPON IMPACT
3= HEAVY - REFUSE FALLS OUT OF BUCKET AUGER ONLY AFTER BEING STRUCK MULTIPLE TIMES

DEGRADATION
1=NONE - NEWSPAPERS VERY LEGIBLE, NO REFUSE DISCOLORATION
2=SLIGHT - SOME NEWSPAPERS STILL LEGIBLE, DISCOLORATION
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4=HIGH - NEWSPAPER HIGHLY FADED GRAY TO BLACK

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4=INTERLOCKED - WASTE CONSTITUENTS INTERLOCKED ("COMPACT, "GRANULAR" TYPE STRUCTURE)
5=INDISTINGUISHABLE

Reviewed By: _____

GEOSYNTEC CONSULTANTS
(410) 381-4333

Procedural Record & Visual Classification Form (PRVCF)

BOREHOLE LOCATION NO.: 02-UWOS WEATHER: As·02

CONTRACTOR: Kellett's DATE (MM.DD.YY): 03 / 11 / 02

FIELD ENGINEER: J. Morris Auger Dia. 36 (in) Gas Pipe Dia. 6 (in)

CIL: Test Boring and Sampling Project No. ME0250 Task No. 1.3.4

Time	Depth (ft.)	Structure	Moisture Content	Compaction	Degradation	Composition	Depth Int. (ft)	Waste Mass (tons)	Total Waste Mass (tons)	Depth Int. (ft)	Gravel Mass (Begin) (tons)	Gravel Mass (End) (tons)	Notes/Comments Visual Classification Legend on rear of form.
14:00	10'	3	1	1	1-2	1	0-10	~~2,900~~	2,920				<1' cover, soil+woodchips Fresh MSW C.
14:15	20'						10-20	~~7,640~~	7,640				C.
15:45	28'						20-28	~~5,480~~	5,480				C. Hit Water @ 25' Abandon @ 28'
													water at 25' 2:30 pm 3/12/02
													3/14, 8:30 Water level = 24.5'
12:10									(29)	28-17	58380	51900	Pipe in @ 17'
12:30									(29)	17-2.5	51900	39880	

Reviewed By: _____ WASTE GRAVEL

REFUSE VISUAL CLASSIFICATION
LEGEND

GEOSYNTEC CONSULTANTS

MOISTURE CONTENT
1= DRY-DAMP MOISTURE LEVELS
2=WET MOISTURE LEVELS
3=STANDING WATER

COMPACTION
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3= HEAVY - REFUSE FALLS OUT OF BUCKET AUGER ONLY AFTER BEING STRUCK MULTIPLE TIMES

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COMPOSITION
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3=FIBROUS - WASTE CONSTITUENTS INTERTWINED
4=INTERLOCKED - WASTE CONSTITUENTS INTERLOCKED ("COMPACT, "GRANULAR" TYPE STRUCTURE)
5=INDISTINGUISHABLE

GEOSYNTEC CONSULTANTS
(410) 381-4333

Procedural Record & Visual Classification Form (PRVCF)

BOREHOLE LOCATION NO.: UW06 WEATHER: Hazy, Warm

CONTRACTOR: Kellett's DATE (MM.DD.YY): 03/14/02

FIELD ENGINEER: J. Morris Auger Dia. 36 (in) Gas Pipe Dia. 6 (in)

CIL: Test Boring and Sampling Project No. ME0250 Task No. 1.3.4

Time	Depth (ft.)	Structure	Moisture Content	Compaction	Degradation	Composition	Depth Int. (ft)	Waste Mass (tons)	Total Waste Mass (tons)	Depth Int. (ft)	Gravel Mass (Begin) (tons)	Gravel Mass (End) (tons)	Notes/Comments Visual Classification Legend on rear of form.
7.50	0-10	3	1	1	1-2	1, 13	0-10	~~4400~~	4,160				Cover = <1' Mulch. 13 = Mulch/Woodchips
	10-20		1				10-20	~~5400~~	5300				
11.55	20-31	3	1	1	1-2	1	20-31	~~5200~~	5,000				
													is March 9.00 No Water.
9.05									(32)	31-20	64080	56740	
9.30									(32)	20-2.5	56740	45200	Pipe in @ 16'

Reviewed By: _____ WASTE GRAVEL Page No 1 of 1

REFUSE VISUAL CLASSIFICATION
LEGEND

GEOSYNTEC CONSULTANTS

MOISTURE CONTENT
1= DRY-DAMP MOISTURE LEVELS
2=WET MOISTURE LEVELS
3=STANDING WATER

COMPACTION
1= SLIGHT - REFUSE EASILY FALLS OUT OF BUCKET AUGER
2= MODERATE - REFUSE FALLS OUT OF BUCKET AUGER UPON IMPACT
3= HEAVY - REFUSE FALLS OUT OF BUCKET AUGER ONLY AFTER BEING STRUCK MULTIPLE TIMES

DEGRADATION
1=NONE - NEWSPAPERS VERY LEGIBLE, NO REFUSE DISCOLORATION
2=SLIGHT - SOME NEWSPAPERS STILL LEGIBLE, DISCOLORATION
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4=HIGH - NEWSPAPER HIGHLY FADED GRAY TO BLACK

COMPOSITION
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5=INDISTINGUISHABLE

Reviewed By _____

GEOSYNTEC CONSULTANTS
(410) 381-4333

Procedural Record & Visual Classification Form (PRVCF)

BOREHOLE LOCATION NO.: NW07 WEATHER: Sunny, Wind

CONTRACTOR: Kellett's DATE (MM.DD.YY): 03 / 14 / 02

FIELD ENGINEER: J. Morris Auger Dia. 36 (in) Gas Pipe Dia. 6 (in)

CIL: Test Boring and Sampling Project No. ME0250 Task No. 1.3.4

Time	Depth (ft.)	Structure	Moisture Content	Compaction	Degradation	Composition	Depth Int. (ft)	Waste Mass (tons)	Total (tons) Waste Mass	Depth Int. (ft)	Gravel Mass (Begin) (tons)	Gravel Mass (End) (tons)	Notes/Comments Visual Classification Legend on rear of form.
2.40	10'	3	1	1	1-2	1,9	0-10	~~4,020~~	4,020				Cover = 1' Mulch/soil Sample for Stokoe 8-10'
	20'	3	1	1-2	1-2	1,9	10-20	~~5,880~~	5,440				
4.00	22'												V. Wet from 20' Stop @ 22' Not weigh 20-22'
													3/15 10.05 Water level = 16.5'
10.05									(32)	22-14.5	39380	34400	Pipe in @ 15.5'
									(36)	14.5-2.5	53920	45820	Note: Significant overbore from 1-2' - not measured.

WASTE GRAVEL

Reviewed By: _____

REFUSE VISUAL CLASSIFICATION
LEGEND

GEOSYNTEC CONSULTANTS

MOISTURE CONTENT
1= DRY-DAMP MOISTURE LEVELS
2=WET MOISTURE LEVELS
3=STANDING WATER

COMPACTION
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2= MODERATE - REFUSE FALLS OUT OF BUCKET AUGER UPON IMPACT
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5=INDISTINGUISHABLE

Reviewed By _____

GEOSYNTEC CONSULTANTS
(410) 381-4333

Procedural Record & Visual Classification Form (PRVCF)

BOREHOLE LOCATION NO.: 02-UW-08 WEATHER: Overcast, 40's

CONTRACTOR: Kellet's DATE (MM.DD.YY): 03, 12, 02

FIELD ENGINEER: D. Mandeville Auger Dia. 30" (in) Gas Pipe Dia. 4" (in)

CIL: Test Boring and Sampling Project No. ME0250 Task No. 1.3.4

Time	Depth (ft.)	Structure	Moisture Content	Compaction	Degradation	Composition	Depth Int. (ft)	Waste Mass (tons)	Total Waste Mass (tons)	Depth Int. (ft)	Gravel Mass (Begin) (tons)	Gravel Mass (End) (tons)	Notes/Comments Visual Classification Legend on rear of form.
8:00							0-10	~~4400~~	4,420				C Cover: 1' Mulch/Soil
8:20							10-20	~~4320~~	4,340				C
9:00	25	2	2	1	1	1,2	20-30	~~5680~~	5,700				Water level at 29' hole to 32'
										22-30	5900		62220 - 56320 1 5900
										10-22	8360		49360 57720 57720 4430 8360 Truck 22 start
										10-10	~~4290~~	4,340	- 51980
													-56320 56320 51980 4290
													Pipe bottom at 24' bgs

Reviewed By: _____ WASTE GRAVEL Page No. 1 of 1

REFUSE VISUAL CLASSIFICATION
LEGEND

GEOSYNTEC CONSULTANTS

MOISTURE CONTENT
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5=INDISTINGUISHABLE

Reviewed By: _____

GEOSYNTEC CONSULTANTS
(410) 381-4333

Procedural Record & Visual Classification Form (PRVCF)

BOREHOLE LOCATION NO.: 0 UW09 WEATHER: overcast 40's

CONTRACTOR: Kellet's DATE (MM.DD.YY): 03 / 12 / 02

FIELD ENGINEER: D. Mandeville Auger Dia. 36" (in) Gas Pipe Dia. 6 (in)

CIL: Test Boring and Sampling Project No. ME0250 Task No. 1.3.4

Time	Depth (ft.)	Structure	Moisture Content	Compaction	Degradation	Composition	Depth Int. (ft)	Waste Mass (tons)	Total Waste Mass (tons)	Depth Int. (ft)	Gravel Mass (Begin) (tons)	Gravel Mass (End) (tons)	Notes/Comments Visual Classification Legend on rear of form.
11:00 am							0-10	~~4500~~	4,500				Cover: 3' Mulch/Soil
1:30		2	2	2	3	1,2	10-20	~~5000~~	5,100				
2:00							20-22						did not weigh hit water at about 20' hole ended at 22' bgs
													3/14, 8:25 Water level = 20'
11:35									(35)	22-14	56100	51460	Pipe in @ 14'
12:00									(35)	14-3	51460	44160	

Reviewed By: _____ WASTE GRAVEL Page No. 1 of 1

REFUSE VISUAL CLASSIFICATION
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GEOSYNTEC CONSULTANTS

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5=INDISTINGUISHABLE

APPENDIX O-8.1

PROCEDURAL RECORD AND VISUAL CLASSIFICATION FORMS FROM LARGE DIAMETER TEST BORING PROGRAM

APPENDIX O-8.2

BORING LOGS FROM SMALL DIAMETER TEST BORING PROGRAM (INCLUDING PHOTOGRAPHS)

GEOSYNTEC CONSULTANTS
COLUMBIA, MARYLAND

Boring: SPT IW (10' from MW08)
Client: DSWA
Site: CIL
Project No.: ME0250/1.3.4

Drilling Co.: Summit
Method & Tools: 8"ϕ rotary auger
Rig:
Driller: Chad
Logged By: J Morris
Checked By:
Date: 4/10/02

Ground Elevation (msl): 84'
Elev. of Top of Riser (msl): —
Height of Riser: —
Northing:
Easting:

Elevation (ft)	Depth (ft)	Lithology Log	Symbol	Well Diagram	SPT Blows/6"	Sample Rec.	Drilling Log
8.30	0.0	MSW					Shelby 37.5' Bent No Rec.
	10 ~~5.0~~	8' ▽ 14.8' ▽ 13.5' ▽		Spn. = split spoon (2" dia.)			Shelby 38' Bent No Rec. Smear inside tube
	20 ~~10.0~~			Shel. = Shelby Tube (3" dia.)			Spoon 38' V. Stiff (wood) 4" Rec. MSW, we
		↓becoming v. moist ▽ 29' (MW08, Mar 12)					Spoon 39' 6" Rec. MSW, sat. Pole wet for n2c
	30 ~~15.0~~						Spoon 40'
		El. 46.5 ↓saturated			Shel. 37.5 38	Spn. 38 39 40	Much liquid, black Push 2' MSW 1.5' LCS 6"
11.30	40 ~~20.0~~	Sample 1-A					Sample 1-A P27, P26
1.00	1'?	LCS			42		Shelby 42'
		↓dredge silt] Sample 1-B 44' 44' 1.40 1.25 39' 11.30		denotes auger depth.			Push 2' Into Dredge Keep Sample 1-B
	~~25.0~~	end 44'					
		P25 - auger pulled to 30' Backfill					
	~~30.0~~	P24 - left over MSW (representative of 0'-35')					
		1.40 finish					
	35.0						

J:\MDENG\PLOTLOG\TEMPLATE.PL3 CFW-1 2-17-97

GEOSYNTEC CONSULTANTS
COLUMBIA, MARYLAND

Boring: SPT 2W (10' from MW07)
Client: DSWA
Site: CIL
Project No.: ME0250/1.3.4

Drilling Co.: Summit
Method & Tools: 8" ϕ Rot. Auger
Rig:
Driller: Chad
Logged By: J Morris
Checked By:
Date: 4/10/02

Ground Elevation (msl): 79'
Elev. of Top of Riser (msl): —
Height of Riser: —
Northing:
Easting:

Elevation (ft)	Depth (ft)	Lithology Log	Symbol	Well Diagram	SPT Blows/6"	Sample	Rec.	Drilling Log
1.45	0.0	MSW						Spoon 35' V. little recovery Saturated Gritty MSW Slimy
	10 ~~5.0~~							Spoon 36' Push 2' No rec. Gritty MSW Slimy.
		16.5 ▽ (MW07, Mar 14)						
	20 ~~10.0~~	↓becoming v. wet /saturated						Shelby 38' No rec. Small clumps of dredge (Sample 2-A) Pole slippery & wet for 20'
	30 ~~15.0~~							
		↓saturated LCS?			Shel.	Spn.	35 36	
3.20	40 ~~20.0~~	Dredge] Sample 2-B			38		38	Spoon 38' Try same loc. as Shelby. Push 2' 1' rec. - dredge Sample 2-B P23
		↓ ↑ end 40'						
		40' Could not dip-hole caved @ 3-4' (3.50)						
	25 ~~10.0~~	P22 - pulling up auger (30') P21 - end of boring (left over)						
	30 ~~0.0~~							
	35 ~~-5.0~~							

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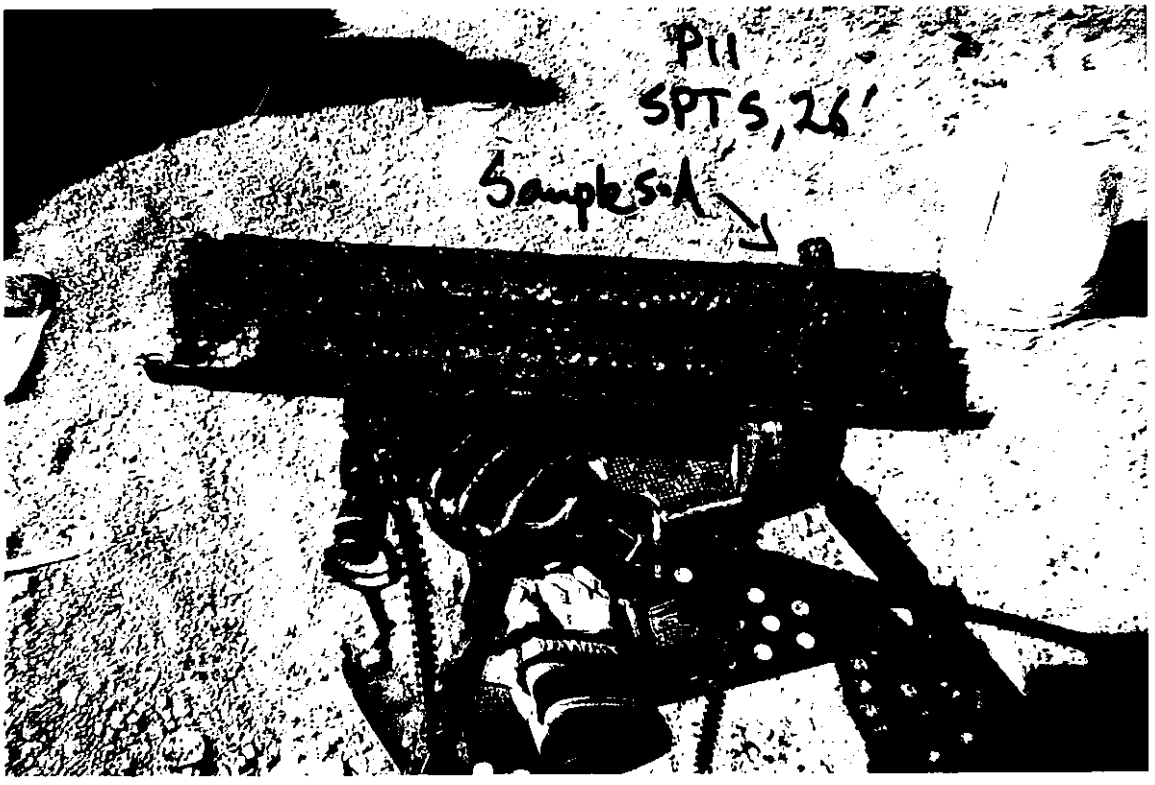
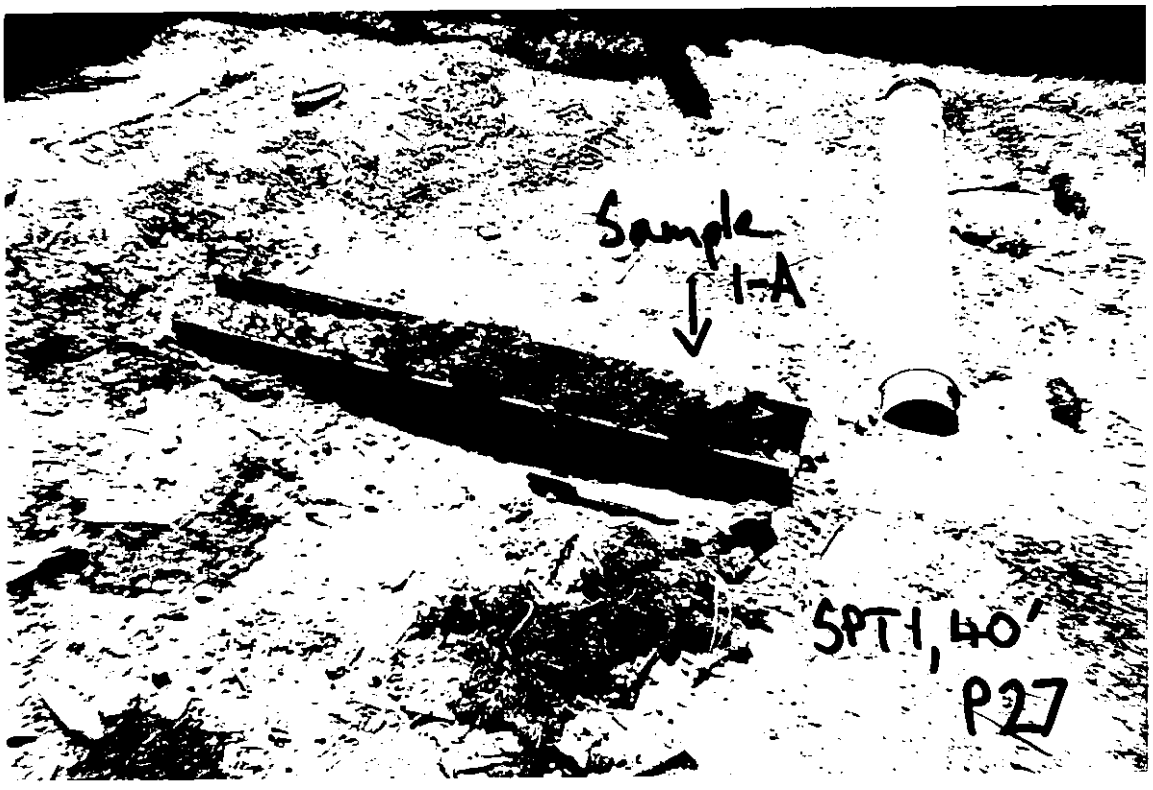

P11
SPTS, 26'
Samples-A

P10
SPTSA, 24'

P20
SPT3, 30'

P19, SPT3
35'

P24
SPT2
End


Sample
1-A
SPT1, 40'
P27

P24
SPT1 End

GEOSYNTEC CONSULTANTS
COLUMBIA, MARYLAND

Boring: SPT 3W (30' sth of P3-SP-2)
Client: DSWA
Site: CIL
Project No.: ME0250/1.3.4

Drilling Co.: Summit
Method & Tools: 8" ø R.A.
Rig:
Driller: Chad
Logged By: J Morris
Checked By:
Date: 4/10/02

Ground Elevation (msl): (est. 76')
Elev. of Top of Riser (msl): —
Height of Riser: —
Northing:
Easting:

Elevation (ft)	Depth (ft)	Lithology Log	Symbol	Well Diagram	SPT Blows/6"	Sample Rec.	Drilling Log
3.50	0.0	MSW, v. decomposed					Shelby 34' Push 1' Much leachate 6" rec., MSW Sample 3-A
	10 5.0	↓Saturated Hard drilling V. little spoils from drilling					Spoon 35' Push 1' MSW, P19
	20 10.0						Spoon 37' Cannot Push
							Spoon 38' Push 2' Much leachate
4.40	30 15.0	Liquid - P20 — Drier, but still sat. — easier drilling			Sled. 34	Spn. 35 37 38 40	Low rec, into LCS? Gritty material P18
4.50							
5.35	40 20.0	] LCS? end 42' ↓ Dredge, ↓ satur.					Spoon 40' Push 2' Pole wet form 30' Sat. dredge P17 (bot. on RHS) 1½-2' rec. Sample 3-B (from bottom)
	25.0						
	30.0	P16 - leachate gushing during auger withdrawal.					
	35.0						

7.5' ▽

42' 6.05 Could not dip-hole collapsed @ 2'

42' 5.50

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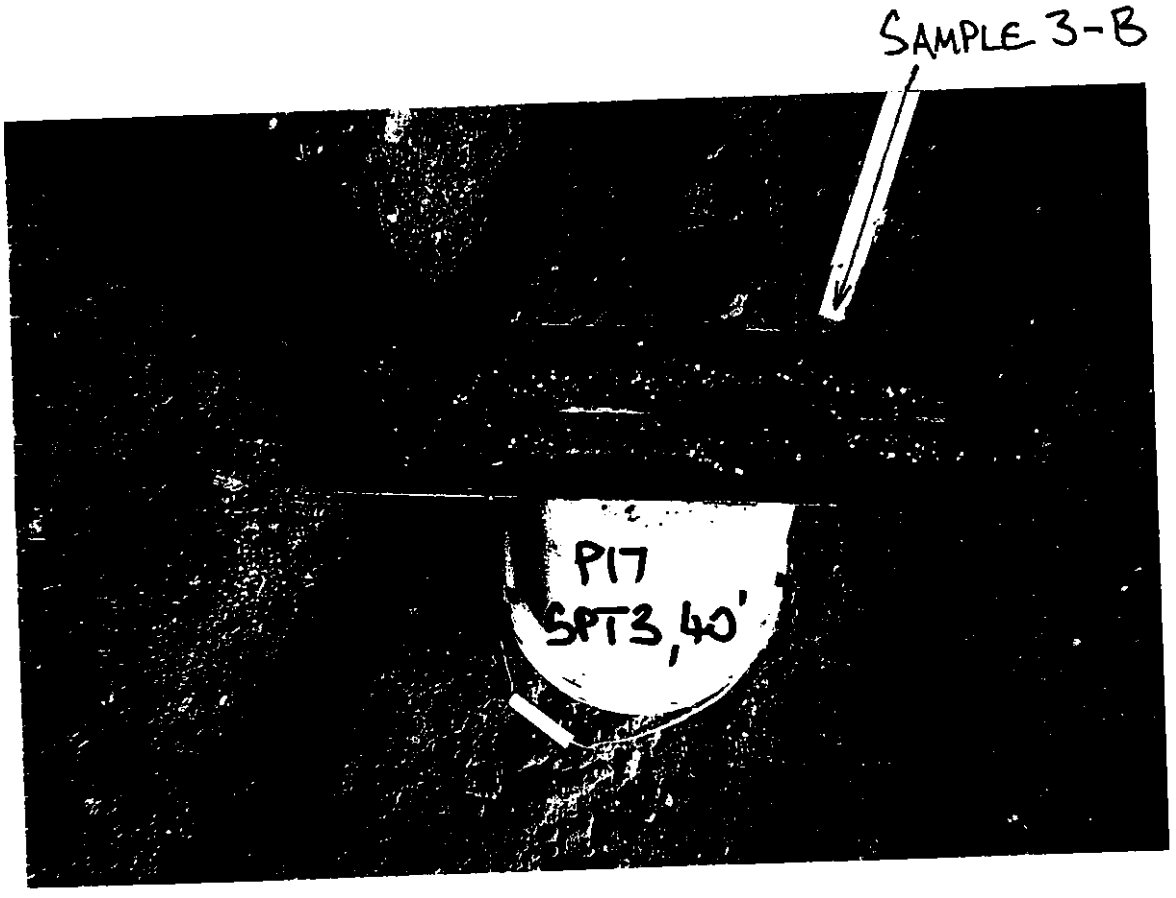
SAMPLE 3-B
P17
SPT3, 40'

4E36701
P17 SPT2

GeoSyntec Consultants
COLUMBIA, MARYLAND

Boring: SPT 4W (10' from P2_SP_8)
Client: DSWA
Site: CIL
Project No.: ME0250/13.4

Drilling Co.: Summit
Method & Tools: 8" ø R.A.
Rig:
Driller: Chad
Logged By: J Morris
Checked By:
Date: 4/11/02

Ground Elevation (msl): (est. 94')
Elev. of Top of Riser (msl): —
Height of Riser: —
Northing:
Easting:

Elevation (ft)	Depth (ft)	Lithology Log	Symbol	Well Diagram	SPT Blows/6"	Sample	Rec.	Drilling Log
10.10	0.0	MSW, v. decomposed						Spoon 48.5'
								V. stiff, push 1.5'
								6" rec., MSW
		↑ sloppy						Damp, woody/stones
	10 ~~5.0~~							Pole dry
		↓ damp, firmer						Spoon 50'
								Cannot advance
	20 ~~10.0~~	22' ▽						Spoon 51'
								Push 2'
								Rec. 6" MSW, v. wet
								Much leachate
								V. stiff
	30 ~~15.0~~							Pole wet
								Spoon 53'
								Push 1'
								V. stiff, v. wet MSW
								1' rec.
	40 ~~20.0~~							6" MSW, 6" soil/grit/
								Wood at bot.
								P14
11.00		Hard drilling						MSW sample for γ
					Shel.		Spn.	(sample 4-B)
							48.5	Shelby 54'
12.00	50 ~~25.0~~						50	Push 6"
		↓ v. wet, leachate					51	6" rec., MSW (woody)
		53' 54' 6" MSW: Sample 4-B $\gamma_{MSW} = 97$ pcf					53	
12.30					54		54	Spoon 54'
2.00		6" soil/ash					57	Push 2'
2.10	60 ~~30.0~~	↓ end 59.5' Sample 4-A	59.5' 2.10					6" rec., Gritty MSW
								P13
		$\gamma_{MSW} = \frac{240g \times \frac{2.2}{1000} lb}{2" \times 3" L \times \frac{\pi}{4} in^3}$						Spoon 57'
								V. stiff, push <6"
	70 ~~35.0~~	[illegible] = 96.8 pcf						Leachate in spoon
								Pole wet
								Sat. MSW, woody

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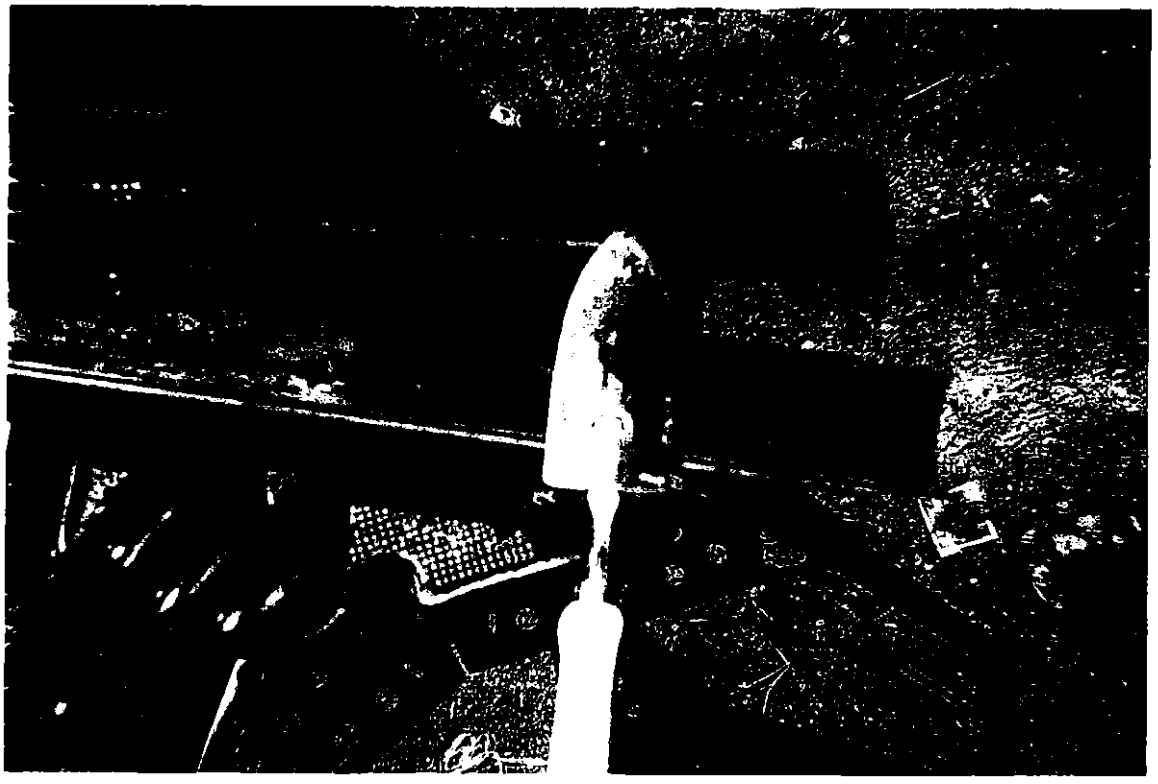

GeoSyntec Consultants
COLUMBIA, MARYLAND

Boring: SPT 5W [SPT 5AW] (10' from P3_SP_8)
Client: DSWA
Site: CIL
Project No.: ME0250/1.3.4

Drilling Co.: Summit
Method & Tools: 8" ϕ R.A.
Rig:
Driller: Chad
Logged By: J Morris
Checked By:
Date: 4/11/02

Ground Elevation (msl): (est. 64')
Elev. of Top of Riser (msl): —
Height of Riser: —
Northing:
Easting:

Elevation (ft)	Depth (ft)	Lithology Log	Symbol	Well Diagram	SPT Blows/6"	Sample	Rec.	Drilling Log
3.00	0.0	MSW, v. decomposed SPT5 Damp						Spoon 26' Push 2', rec. 2' soft, dredge P11 Sample 5-A (26'-26.5')
	10 ~~5.0~~							
	20 ~~10.0~~	20'						
3.30		Wet			Shel.		Spn. 26	
	30 ~~15.0~~	26' 3.45						
4.00	0 ~~20.0~~	MSW, v. decomposed SPT5A Damp						Spoon 24' Stiff-v. stiff Rec. 6" MSW + LC LCS=gravel @ 24.5' P10 Pole slimey ~10' Spoon 24.5' V. little rec. Gravel, grittymat.
	10 ~~25.0~~							
	20 ~~30.0~~	Soil layer (yellow-or. clay) Damp			Shel.		Spn. 24 24.5	
4.20		LCS, gravel						
	35.0	24.5' 4.25						

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GEOSYNTEC CONSULTANTS
COLUMBIA, MARYLAND

Boring: SPT 6W (10' from P2_SP_7)
Client: DSWA
Site: CIL
Project No.: ME02250/1.3.4

Drilling Co.: Summit
Method & Tools: 8" ø R.A.
Rig:
Driller: Chad
Logged By: J Morris
Checked By:
Date: 4/12/02

Ground Elevation (msl): (est. 88')
Elev. of Top of Riser (msl): —
Height of Riser: —
Northing:
Easting:

Elevation (ft)	Depth (ft)	Lithology Log	Symbol	Well Diagram	SPT Blows/6"	Sample	Rec.	Drilling Log
8.30	0.0	MSW, v. degr. Damp Sludge-like						No samples.
	10 ~~5.0~~							
	20 ~~10.0~~							
	30 ~~15.0~~	P9 @ 35' Waste is pastey, with fibre (ground asbestos?) Black, tarry, damp.						
9.15 9.45	40 ~~20.0~~	Hard drilling						
10.00		45' Abandon boring - asbestos disposal advisory.						
	50 ~~25.0~~							
	~~30.0~~							
	35.0							

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GEOSYNTEC CONSULTANTS
COLUMBIA, MARYLAND

Boring: SPT 7A, SPT 7AW (10' from P2-SP-5)
Client: DSWA
Site: CIL
Project No.: ME0250/1.2.4

Drilling Co.: Summit
Method & Tools: 8" ø R.A.
Rig:
Driller: Chad
Logged By: J. Morris
Checked By:
Date: 4/12/02

Ground Elevation (msl): (est. 93')
Elev. of Top of Riser (msl): —
Height of Riser: —
Northing:
Easting:

Elevation (ft)	Depth (ft)	Lithology Log	Symbol	Well Diagram	SPT Blows/6"	Sample	Rec.	Drilling Log
1.50	0.0	Clinker Slag / Stabilized Sludge. Gritty, sl. damp — SPT 7A						No Samples
	10 ~~5.0~~	some MSW						
	20 ~~10.0~~	↓ MSW Hard drilling						
2.35								
	30 ~~15.0~~							
3.00		v. Wet MSW & Sludge, sloppy						
	40 ~~20.0~~	↓ PB, sat. MSW						
3.30		↑ Stop, abandon BH (v. slow progress) Sample 7A-A (drill cuttings)						
12.30	~~25.0~~ 0	Clinker Slag 1-2' Stab. sludge 2-4' Damp – moist — SPT 7						No Samples
	10 ~~30.0~~	Stab. sludge, some MSW						
1.15		Hard drilling ↑ Stop, abandon (hit obstruction						
	35.0							

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APPENDIX O-9

CALCULATION OF STANDING LIQUID ELEVATION FROM CPT DISSIPATION TEST DATA

ConeTec Pore Pressure Dissipation Plots

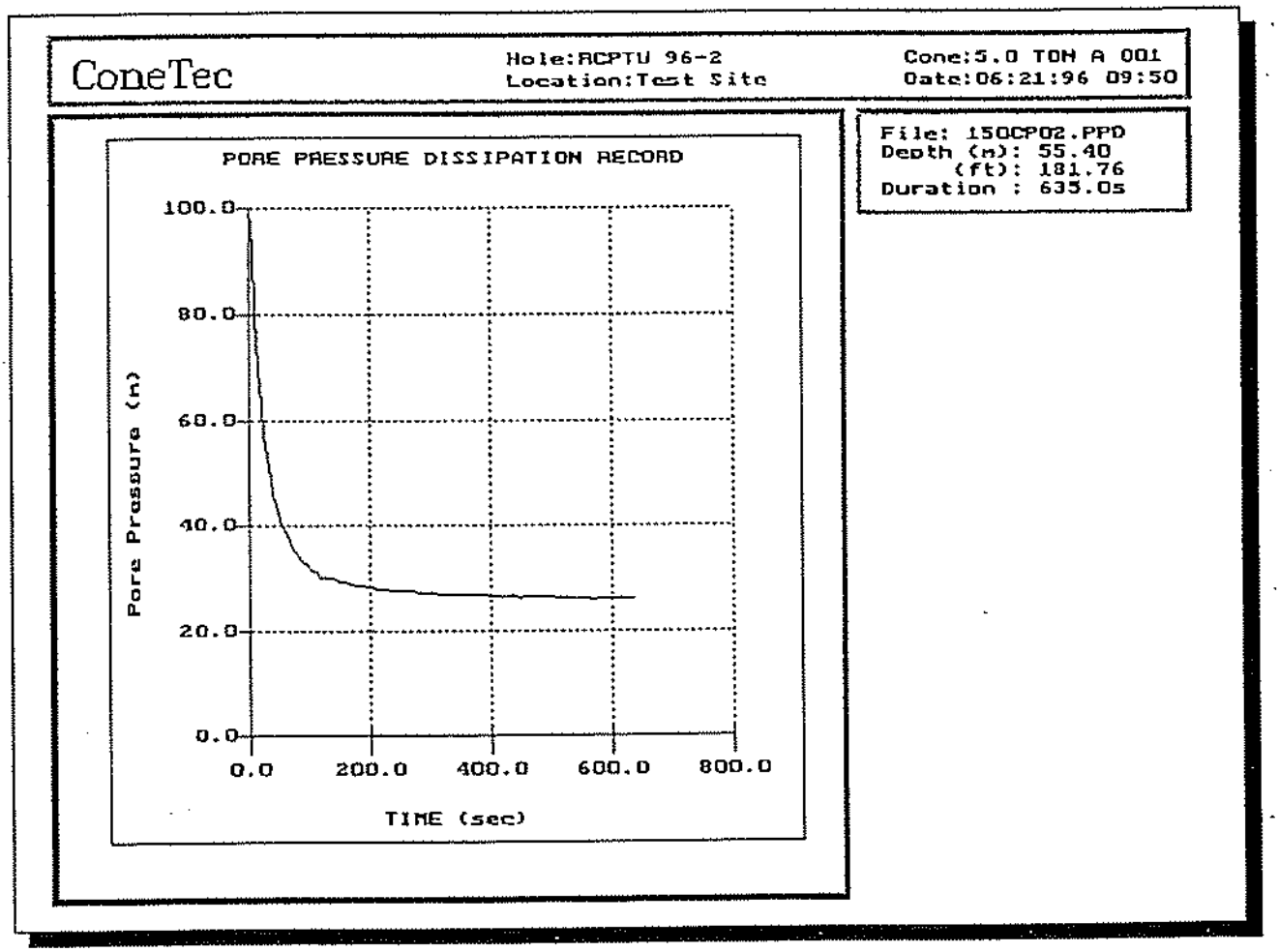

Figure 4

CONETEC
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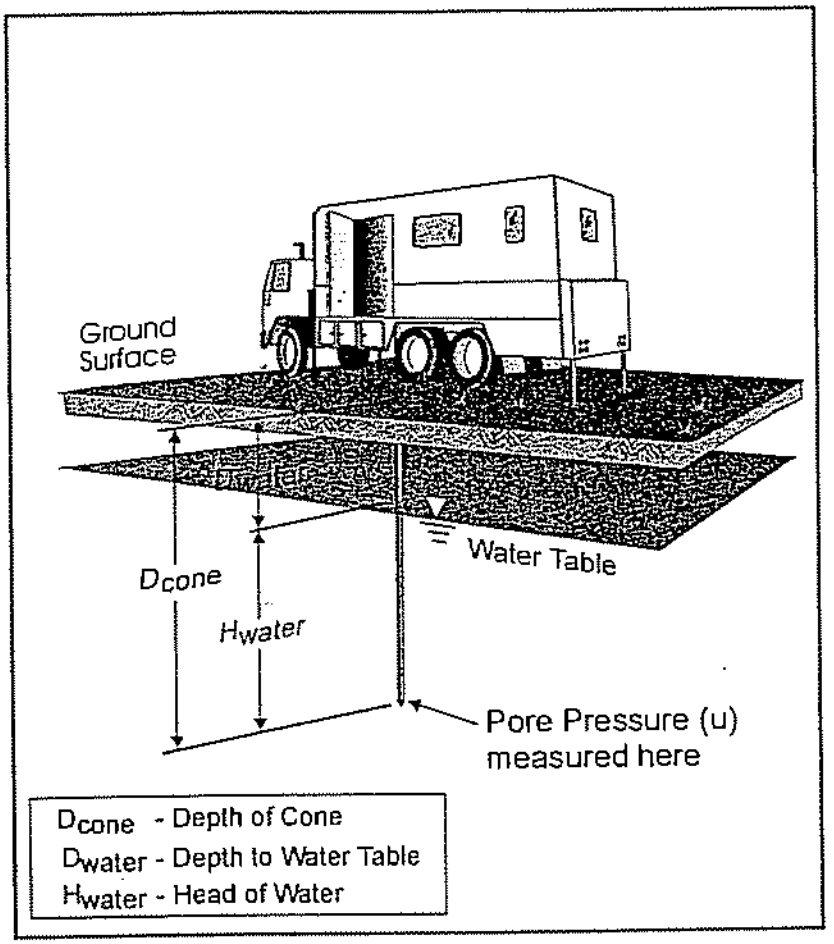
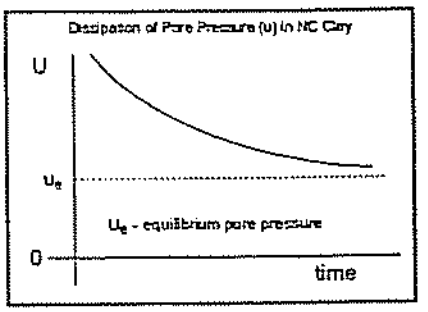
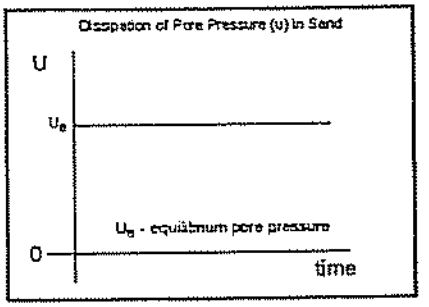
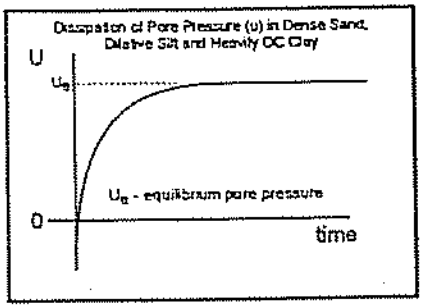
Tel: (732) 752-1711 • Fax (732) 752-2155 • Email: conetecnj@mcione.com

Estimation of Ground Water Table from CPT Dissipation Tests









Water Table Calculation

$$D_{water} = D_{cone} - H_{water}$$

where $H_{water} = U_e$ (depth units)

Useful Conversion Factors:

1psi = 0.704m = 2.31 feet (water)
1tsf = 0.958 bar = 13.9 psi
1m = 3.28 feet

CONETEC

Geotechnical and Environmental In Situ Testing Contractors

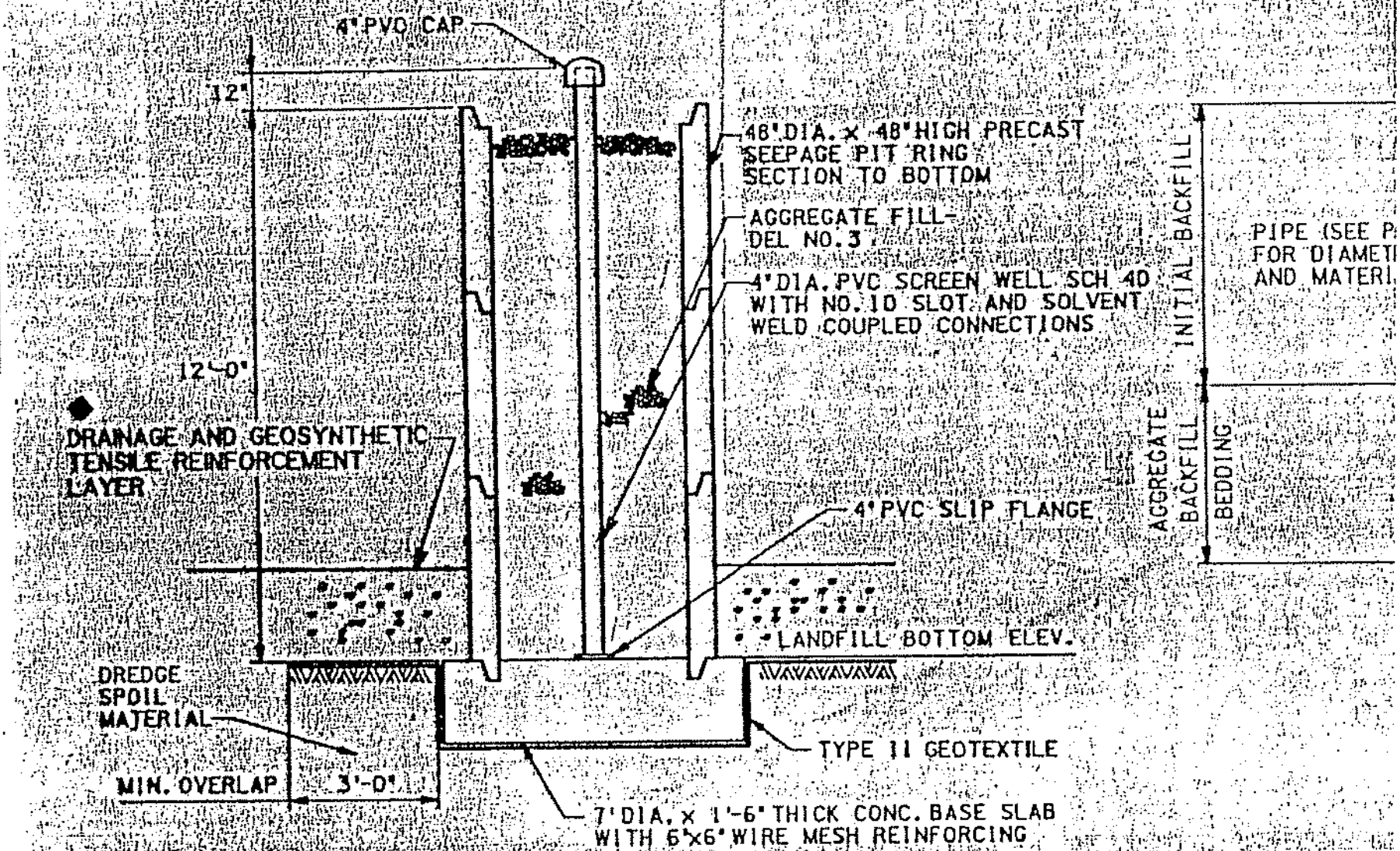
ConeTec (732) 752-1711 • New Jersey • Salt Lake City • Vancouver • Los Angeles • San Francisco • Houston

APPENDIX O-10

GAS WELL DIPPING PROGRAM

APPENDIX O-10.1

TYPICAL GAS VENT DETAIL



NEW GAS VENT AND LEACHATE MONITORING WELL

G-1

NO SCALE

MISCELLANEOUS DETAILS

◆ THIS SHEET HAS BEEN AMENDED TO CONFORM WITH ADDENDUM NO.1

JOB NO.	SHEET NO.
26680	9
DATE	DRAWING NO.
JUNE 1991	1-38807

APPENDIX O-10.2

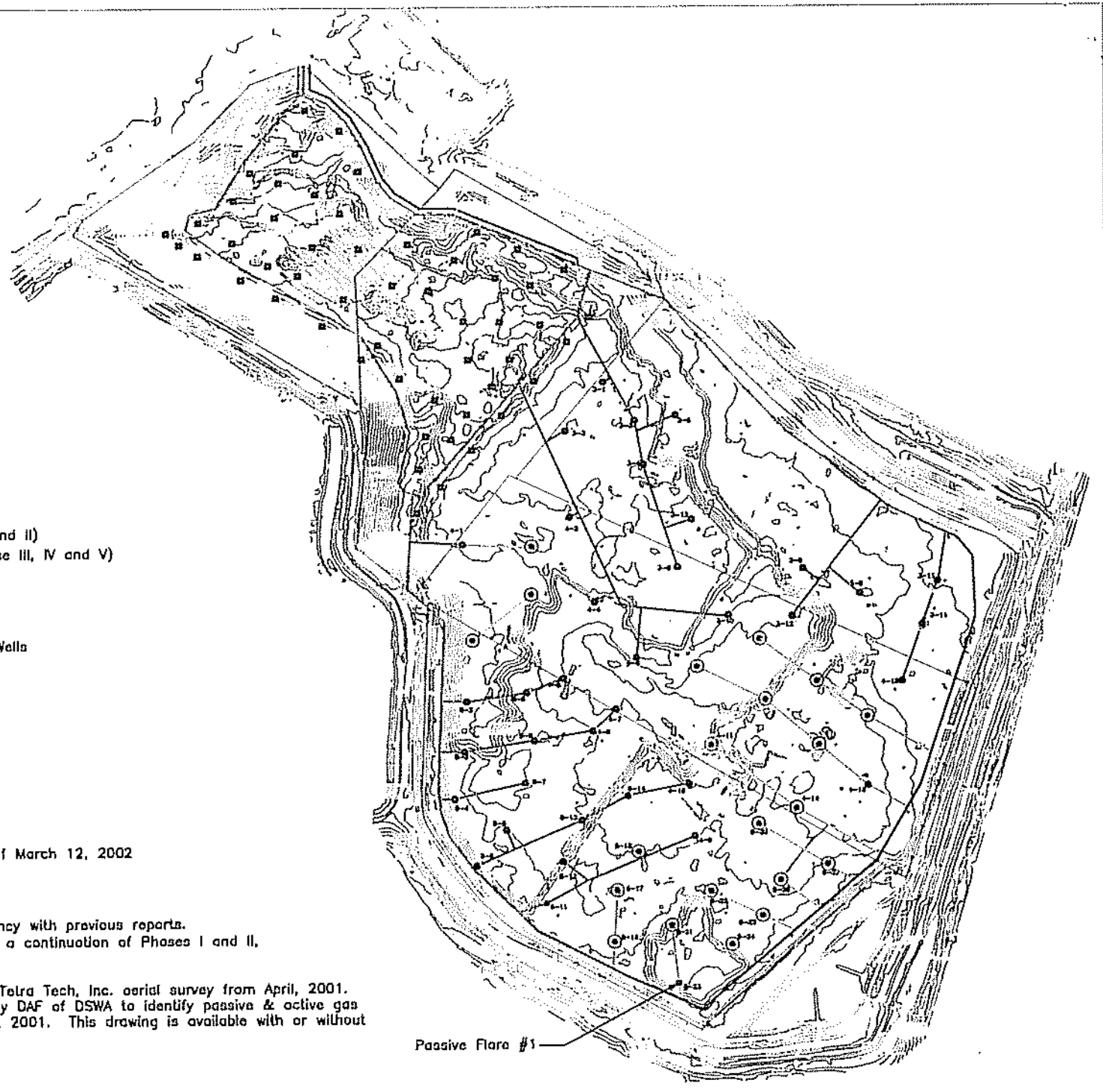
OWT DRILLING AND GAS WELL COMPLETION LOGS

TETRA TECH

CHERRY ISLAND LANDFILL

APRIL 2001

OVERALL SITE TOPO



- Extraction Well (Phase I and II)
- Converted into Wells (Phase III, IV and V)
- Existing 8" Header
- Existing 4" Laterals
- Proposed 8" Header
- Proposed Gas Extraction Wells
- Proposed 4" Laterals
- Proposed 12" Header

Landfill Gas Expansion Plan as of March 12, 2002

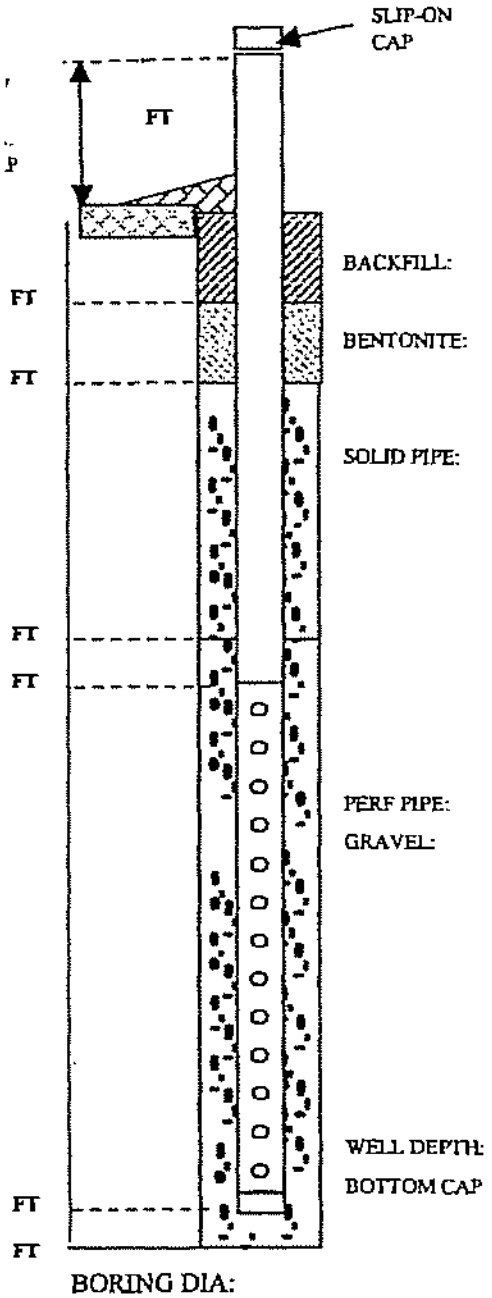
NOTES:

Well IDs are labeled for consistency with previous reports.
Gas wells will be renumbered as a continuation of Phases I and II, after system is complete.

This drawing is a composite of Tetra Tech, Inc. aerial survey from April, 2001. Additions of layers were made by DAF of DSWA to identify passive & active gas system components on June 12, 2001. This drawing is available with or without a 30 Meter Grid overlay.

OWT DRILLING & COMPLETION LOG

Project Name: CHERRY ISLAND
Project No.: 836442
Date: 3-25-02
Well No.



DRILL		WEATHER	
COMP.		START	6:30
ABAN.		STOP	3:00
SOLID			
PERF.			

DEPTH	COMPOSITION & TEMPERATURE	DEGREE OF DECOMPOSITION	AMOUNT OF MOISTURE
0-__			
__-20			
21-30			
31-40			
41-50			
51-60			
61-70			
71-80			
81-90			
91-100			
101-110			
111-120			
121-130			
131-140			

TD:

COMMENTS:

On Site w/ Sean, Todd, Jeff go to Safety meeting w/ Client Slopted pipe and Set up Rig

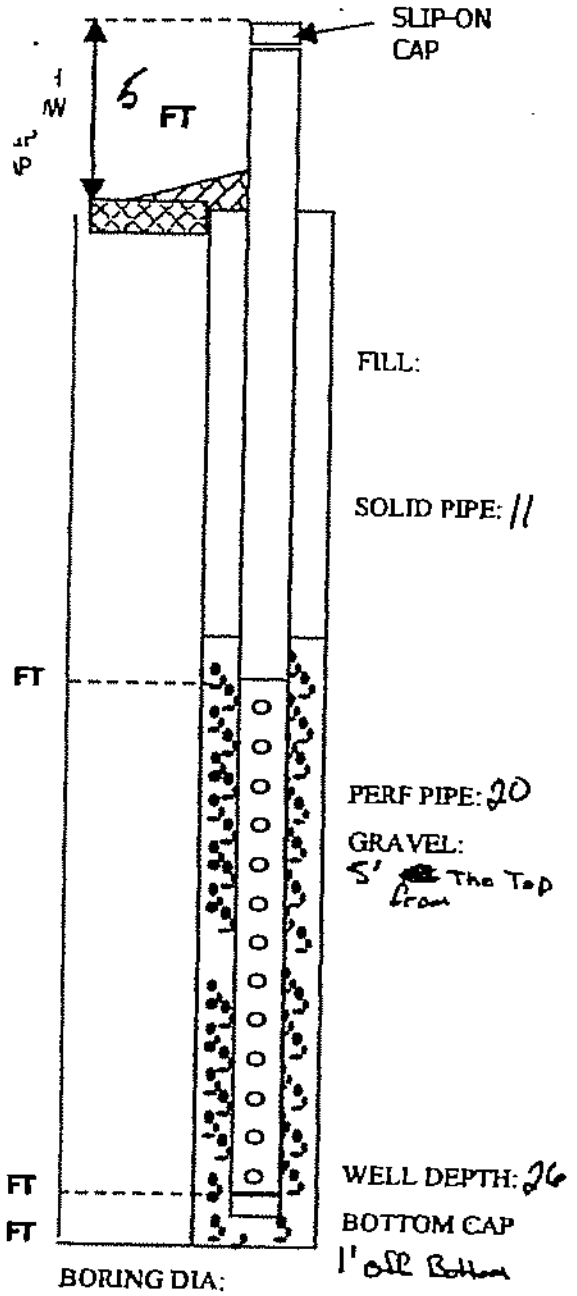
Tom Lewis
CLIENT REPRESENTATIVE DATE
NAME & TITLE

Jeff T. Hunt
OWT SITE SUPERVISOR DATE

TOT. FT. 726'

OWT DRILLING & COMPLETION LOG

Project Name: Cherry Island
Project No.: 836442
Date: 3-26-02
Well No. 1



DRILL	26	WEATHER	
COMP.	26	START	6:30
ABAN.	0	STOP	5:30
SOLID	11		
PERF.	20		

DEPTH	COMPOSITION & TEMPERATURE	DEGREE OF DECOMPOSITION	AMOUNT OF MOISTURE
0-2	Cover		
2-20	H.H.T		
21-30	H.H.T w/ 2" pipe		
31-40			
41-50			
51-60			
61-70			
71-80			
81-90			
91-100			
101-110			
111-120			
121-130			
131-140			

TD: 26

COMMENTS:

on Site w/ Sean Todd Jeff Set on well #1 run in to 2" pipe Stanley Steel Drilling four 90 min Tom pernlee ok set well goto well # 2-3-4

Total Drilling - 134
Total completion - 134

0 Bag Bent Seal in the top of well 1' of Dirt ontop of gravel

Tom Perrin
CLIENT REPRESENTATIVE DATE

Jeff T. Shel
OWT SITE SUPERVISOR DATE

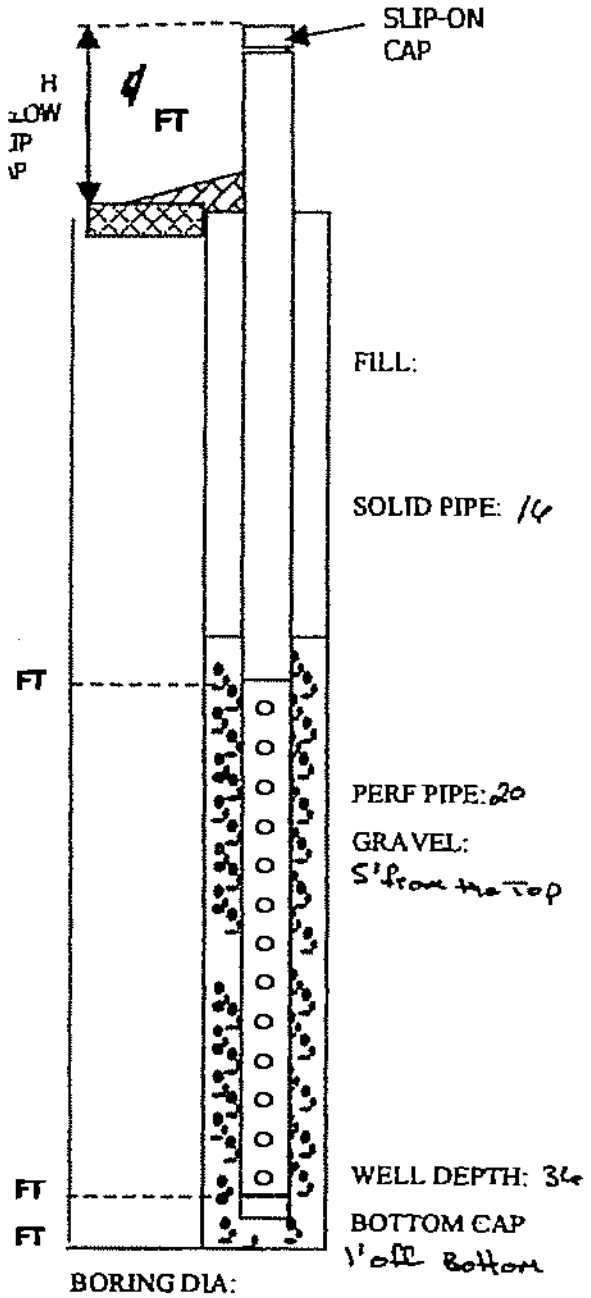
OWT DRILLING & COMPLETION LOG

Project Name: Cherry Island

Project No.: 836442

Date: 3-26-08

Well No. 2



DRILL	36	WEATHER	
COMP.	36	START	
ABAN.		STOP	
SOLID	16		
PERF.	20		

DEPTH	COMPOSITION & TEMPERATURE	DEGREE OF DECOMPOSITION	AMOUNT OF MOISTURE
0-2	Cover		
2-20	H.H.T wood	Slight	Moust
21-30	wire H.H.T wood		
31-40	dirt light Trash		
41-50			
51-60			
61-70			
71-80			
81-90			
91-100			
101-110			
111-120			
121-130			
131-140			

TD: 36

COMMENTS:

1-10 Bag Bent Seal in the Top of well 1' of Dirt on top of gravel

Tom Perrin

CLIENT REPRESENTATIVE DATE

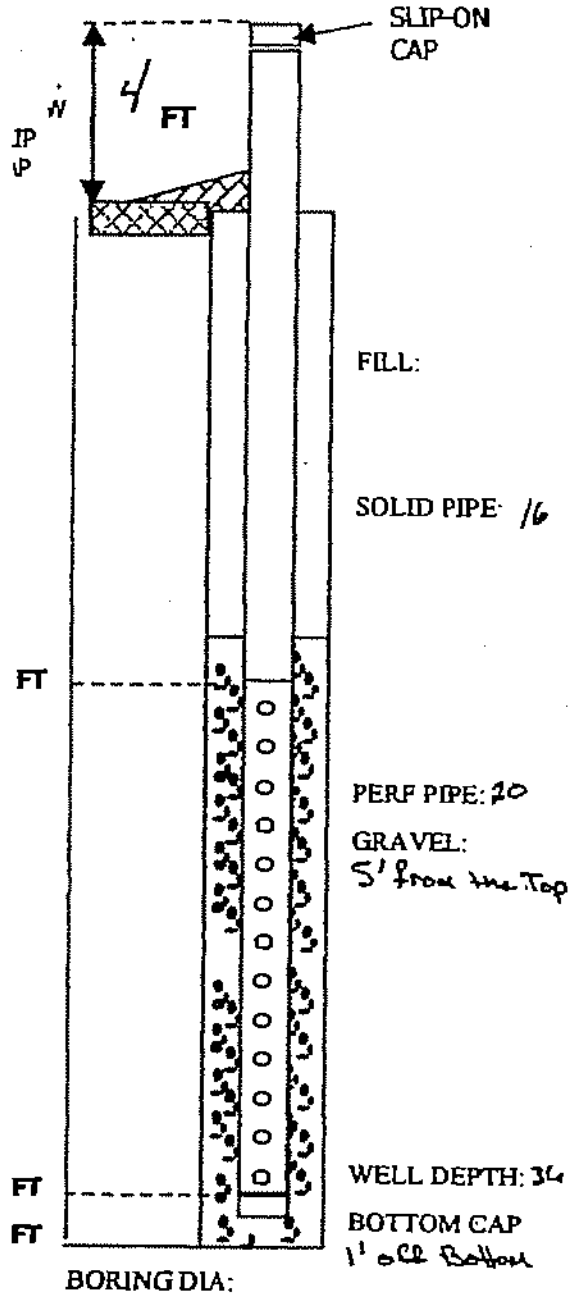
Jeff T. [illegible]

OWT SITE SUPERVISOR DATE

OWT DRILLING & COMPLETION LOG

Project Name: Cherry Island
Project No.: 85442
Date: 3-26
Well No. 3

DRILL	36	WEATHER	
COMP.	36	START	
ABAN.		STOP	
SOLID	16		
PERF.	20		



DEPTH	COMPOSITION & TEMPERATURE	DEGREE OF DECOMPOSITION	AMOUNT OF MOISTURE
0-2	Cover		
2-20	wet Trash	wet	wet \ WATER
21-30			
31-40			
41-50			
51-60			
61-70			
71-80			
81-90			
91-100			
101-110			
111-120			
121-130			
131-140			

TD: 36

COMMENTS:

1-10 Bag Bent Seal in the Top of well 1' of Dirt ontop of gravel

Hit WATER AT 22' WAS INSTRUCKED TO DRILL TO PEE GRAVEL.

Tom Perrin
CLIENT REPRESENTATIVE DATE

OWT SITE SUPERVISOR DATE

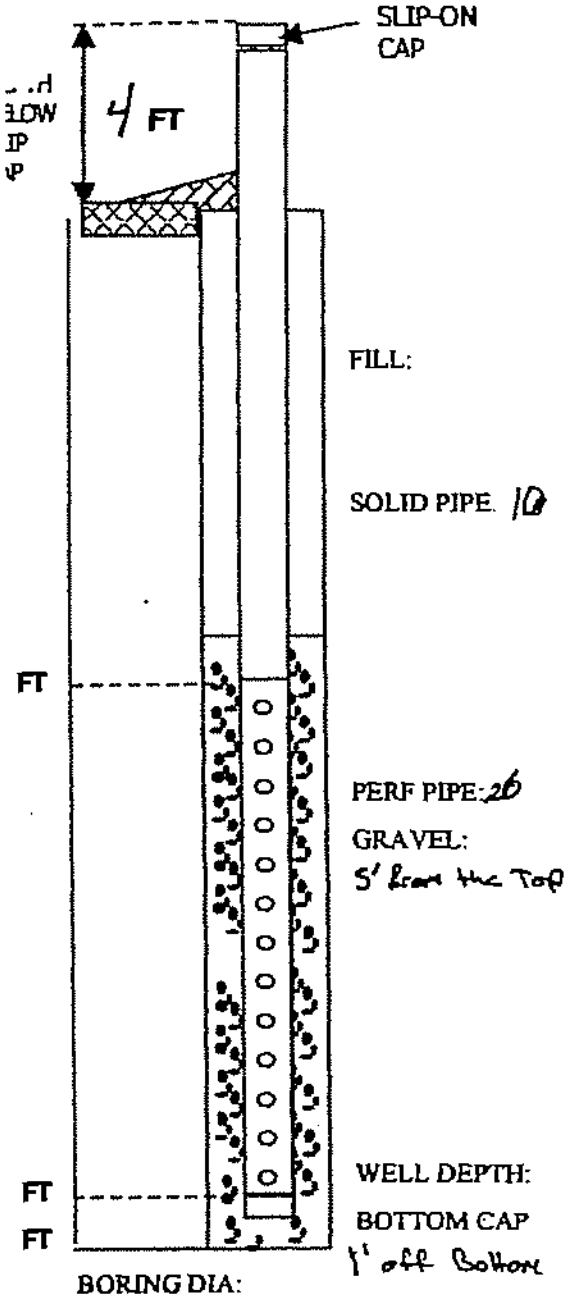
OWT DRILLING & COMPLETION LOG

Project Name: Cherry [illegible]

Project No.: 8 86442

Date: 3-26-04

Well No. 4



DRILL	36	WEATHER	
COMP.	36	START	
ABAN.		STOP	
SOLID	10		
PERF.	20		

DEPTH	COMPOSITION & TEMPERATURE	DEGREE OF DECOMPOSITION	AMOUNT OF MOISTURE
0-0	Cover		
0-20	H.H.T	Slight	Moust
21-30	wood Paper		
31-40	dirt light Trash		
41-50			
51-60			
61-70			
71-80			
81-90			
91-100			
101-110			
111-120			
121-130			
131-140			

TD: 36

COMMENTS:

1- 10 Bag Bent Seal in the Top of well 1' of Dirt on top of gravel

Tom Pierson

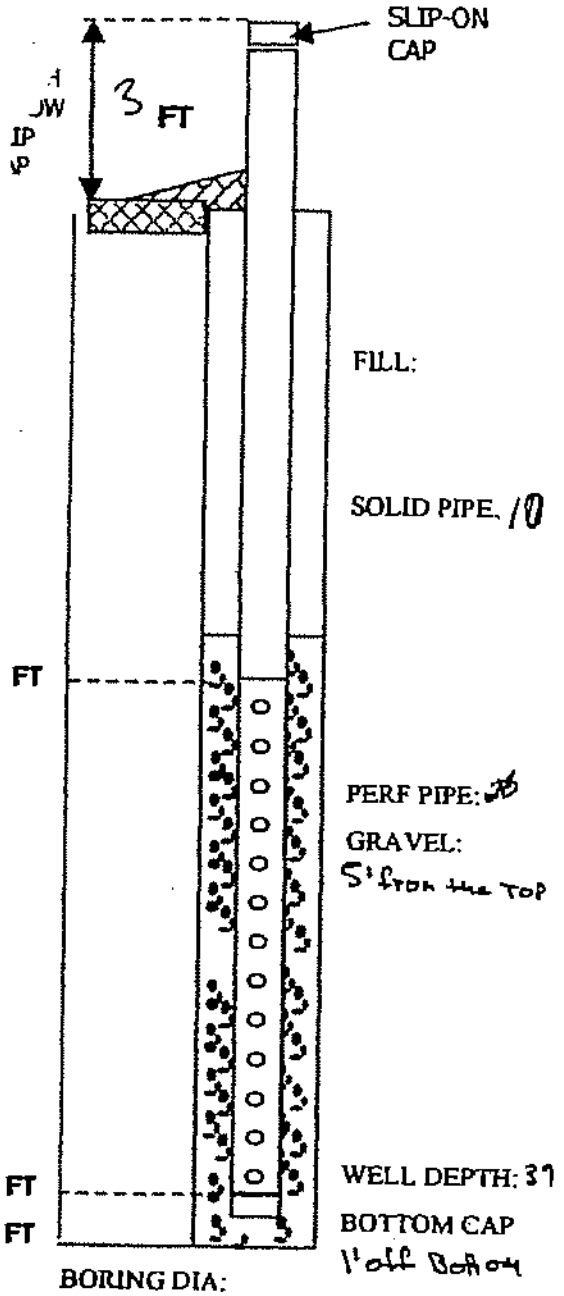
CLIENT REPRESENTATIVE DATE

[illegible]

OWT SITE SUPERVISOR DATE

OWT DRILLING & COMPLETION LOG

Project Name: Cheney Island
Project No.: 836442
Date: 3-27-02
Well No. 5



DRILL	37	WEATHER	
COMP.	37	START	6:30
ABAN.		STOP	5:30
SOLID	10		
PERF.	20		

DEPTH	COMPOSITION & TEMPERATURE	DEGREE OF DECOMPOSITION	AMOUNT OF MOISTURE
0-2	Cover		
2-20	H.H.T wood	Slight	Moust
21-30	dirt light Trash		
31-40			
41-50			
51-60			
61-70			
71-80			
81-90			
91-100			
101-110			
111-120			
121-130			
131-140			

TD: 37

COMMENTS:

on Site w/ Sean Todd Jeff Setup on well # 5-6-7-8-9
on well # 9 Hit peagravel at 26' Call Tom pernlee Set well

Total Drilling - 174
Total completion - 174

1-10 Bag Bent Seal in the of well 1' of Dirt ontop of gravel

Tom Perrin
CLIENT REPRESENTATIVE DATE

Jeff T. Shad
OWT SITE SUPERVISOR DATE

OWT DRILLING & COMPLETION LOG

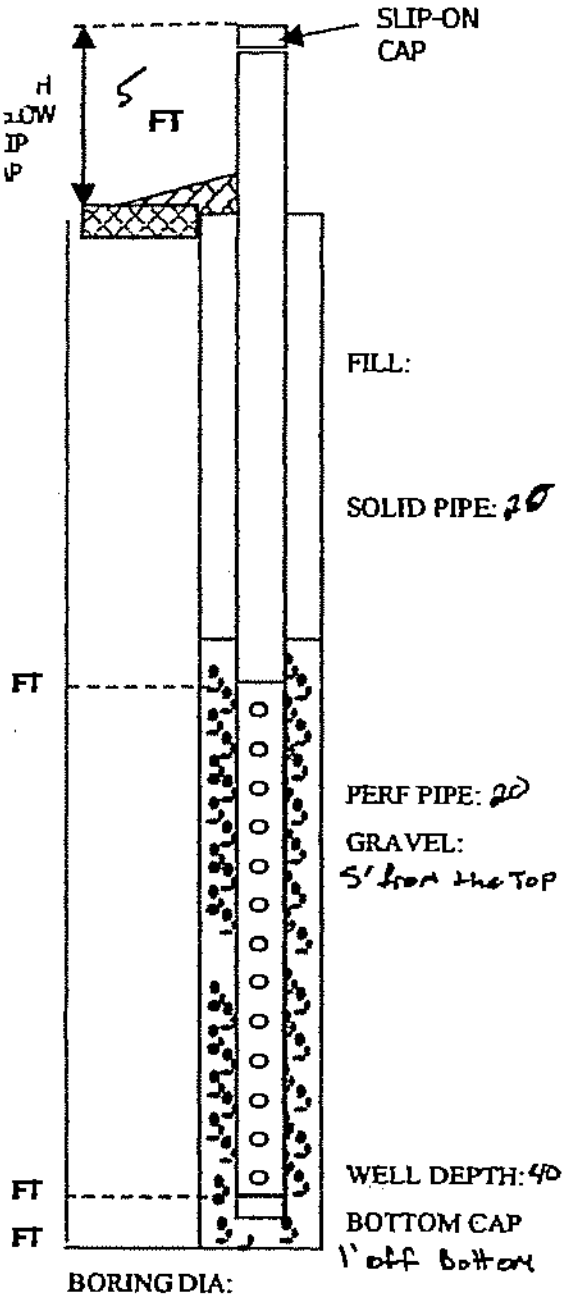
Project Name: Cherry Island

Project No.: 836442

Date: 3-29-00

Well No. 6

DRILL	40	WEATHER	
COMP.	40	START	
ABAN.		STOP	
SOLID	20		
PERF.	20		



DEPTH	COMPOSITION & TEMPERATURE	DEGREE OF DECOMPOSITION	AMOUNT OF MOISTURE
0-2	Cover		
2-20	wood H.H.T	Slight	Moust
21-30	H. H. T		
31-40	dirt light Trash		
41-50			
51-60			
61-70			
71-80			
81-90			
91-100			
101-110			
111-120			
121-130			
131-140			

TD: 40

COMMENTS:

1-10 Bag Bent Seal in top of well 1' of Dirt on top of gravel

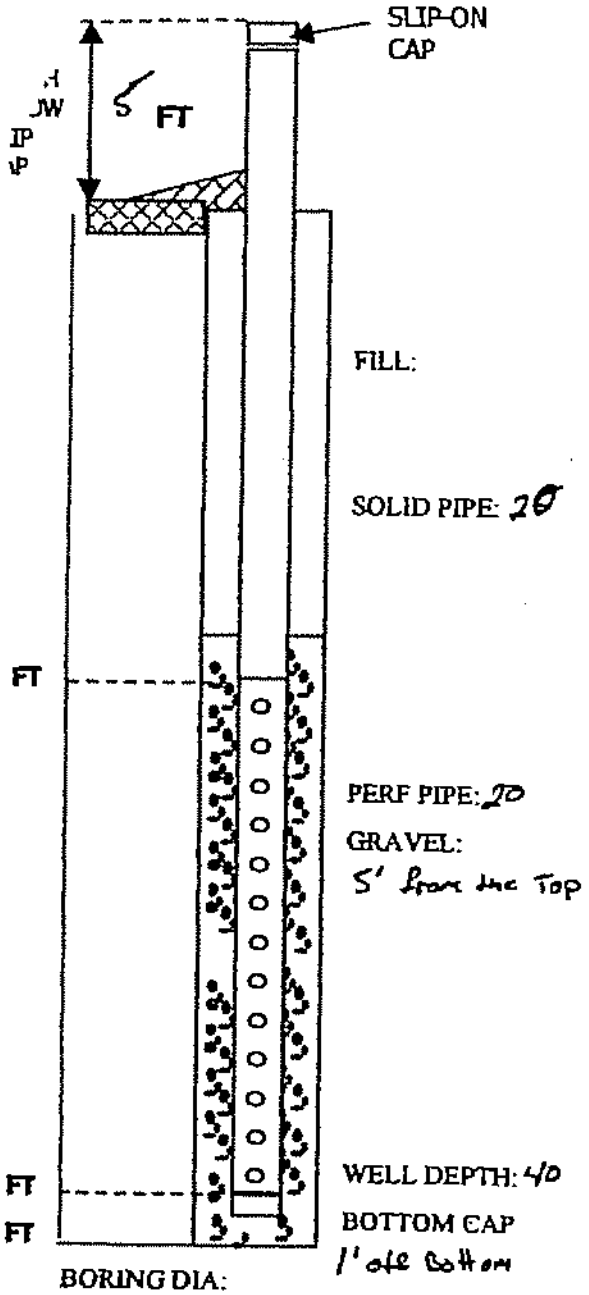
Tom Pierson
CLIENT REPRESENTATIVE DATE

OWT SITE SUPERVISOR DATE

OWT DRILLING & COMPLETION LOG

Project Name: Cherry Island
Project No.: 836442
Date: 3-24-02
Well No. 7

DRILL	40	WEATHER	
COMP.	40	START	
ABAN.		STOP	
SOLID	10		
PERF.	20		



DEPTH	COMPOSITION & TEMPERATURE	DEGREE OF DECOMPOSITION	AMOUNT OF MOISTURE
0-2	Cover		
2-20	H.H.T + wire	Slight	moist
21-30	wood Paper plastic		
31-40	dirt light Trash		
41-50			
51-60			
61-70			
71-80			
81-90			
91-100			
101-110			
111-120			
121-130			
131-140			

TD: 40

COMMENTS:

1-10 Bag Bent Seal in the top of well 1' of Dirt ontop of gravel

Tom Lemmin
CLIENT REPRESENTATIVE DATE

OWT SITE SUPERVISOR DATE

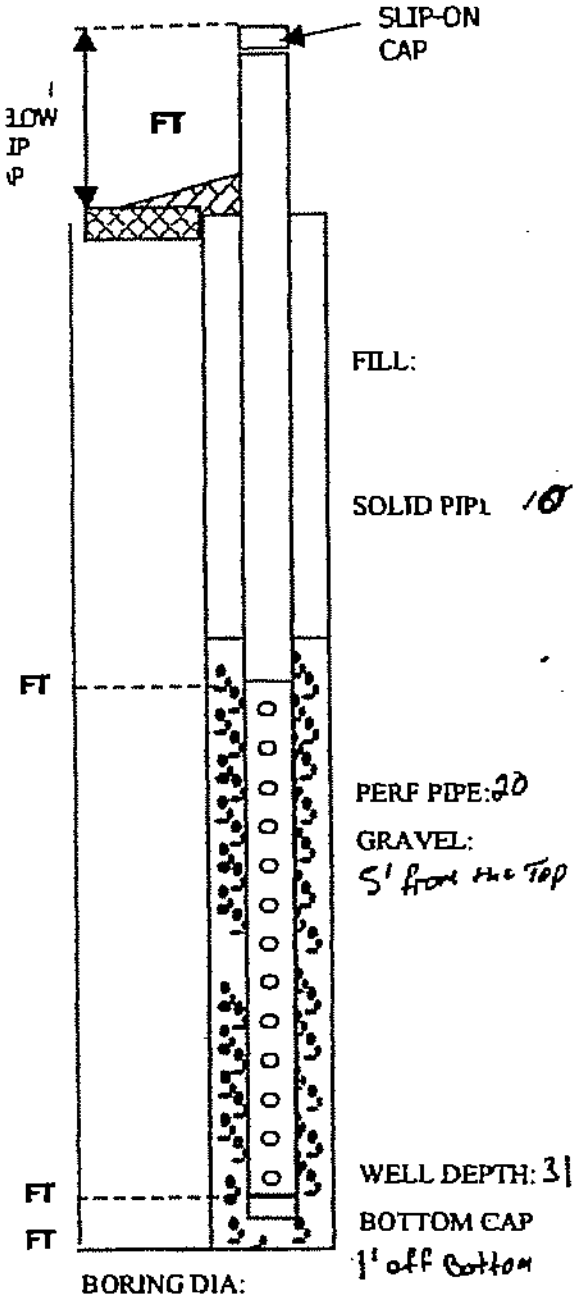
Project Name: Cherry Island

Project No.: 836402

Date: 3-21-07

Well No. 8

OWT DRILLING & COMPLETION LOG



DRILL	31	WEATHER	
COMP.	31	START	
ABAN.		STOP	
SOLID	10		
PERF.	20		

DEPTH	COMPOSITION & TEMPERATURE	DEGREE OF DECOMPOSITION	AMOUNT OF MOISTURE
0-2	Cover		
2-20	wet Trash	wet	wet
21-30	1		
31-40	Hit peagravel		
41-50			
51-60			
61-70			
71-80			
81-90			
91-100			
101-110			
111-120			
121-130			
131-140			

TD: 31

COMMENTS:

Hit peagravel At 31'

1-10 Bag Bent Seal in the Top of well 1' of Dirt ontop of gravel

Tom Perrin

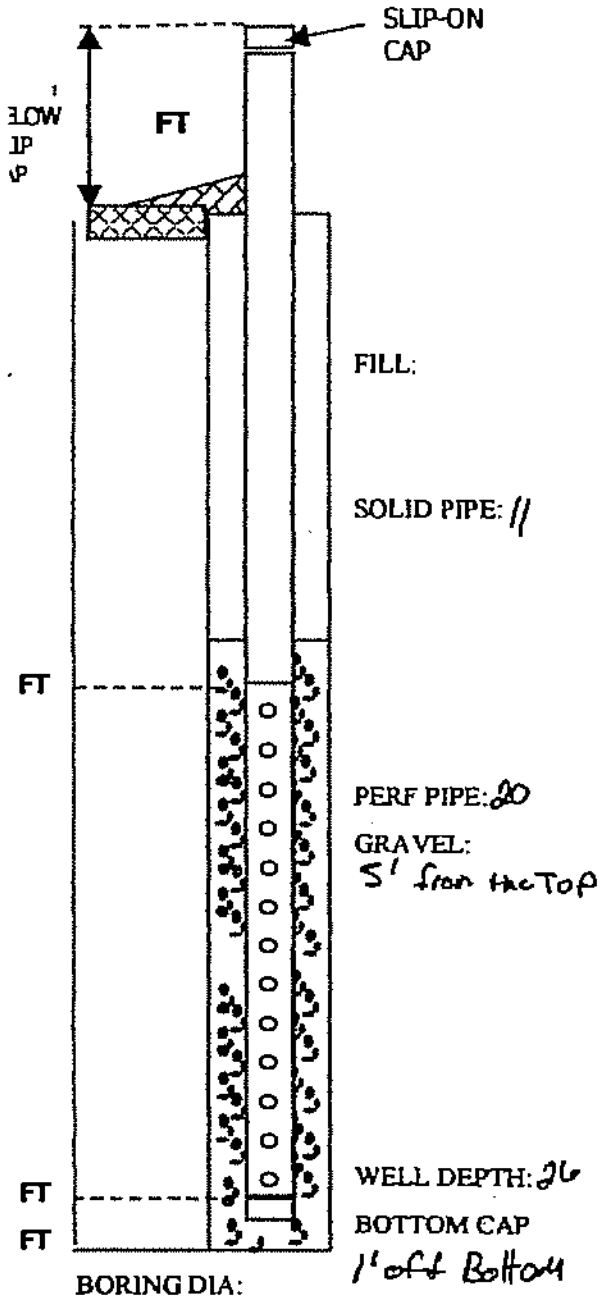
CLIENT REPRESENTATIVE DATE

OWT SITE SUPERVISOR DATE

OWT DRILLING & COMPLETION LOG

Project Name: Cherry Island
Project No.: 836442
Date: 3-27-02
Well No. 9

DRILL	26	WEATHER	
COMP.	26	START	
ABAN.		STOP	
SOLID	11		
PERF.	20		



DEPTH	COMPOSITION & TEMPERATURE	DEGREE OF DECOMPOSITION	AMOUNT OF MOISTURE
0-1	Cover		
1-20	dirt light Trash	Slight	Moust
21-30	wet Hot pegravel	wet	wet
31-40			
41-50			
51-60			
61-70			
71-80			
81-90			
91-100			
101-110			
111-120			
121-130			
131-140			

TD: 26

COMMENTS:

Hot pegravel at 26'

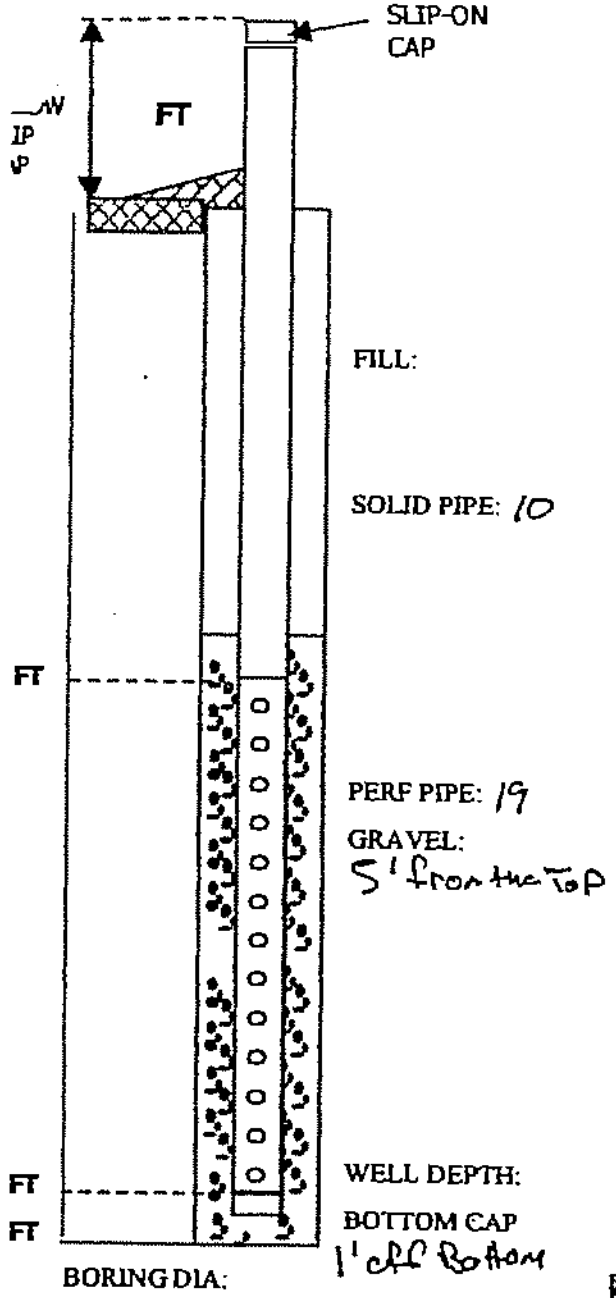
1' 10 Bag Bent Seal in the Top well 1' of Dirt ontop of gravel

Tom Perna
CLIENT REPRESENTATIVE DATE

OWT SITE SUPERVISOR DATE

OWT DRILLING & COMPLETION LOG

Project Name: Cherry Island
Project No.: 836442
Date: 3-28-06
Well No. 10



DRILL	24	WEATHER	
COMP.	24	START	6:30
ABAN.		STOP	5:30
SOLID	10		
PERF.	19		

DEPTH	COMPOSITION & TEMPERATURE	DEGREE OF DECOMPOSITION	AMOUNT OF MOISTURE
0-2	Cover		
2-20	H.H.T wet		
21-30	wet		
31-40			
41-50			
51-60			
61-70			
71-80			
81-90			
91-100			
101-110			
111-120			
121-130			
131-140			

TD: 24

COMMENTS:

on site w/ Sean Todd Jaff Set wells 10-11-12-13-14 Hat Peagravel in All of The well

Total Drilling 135
Total completion 135

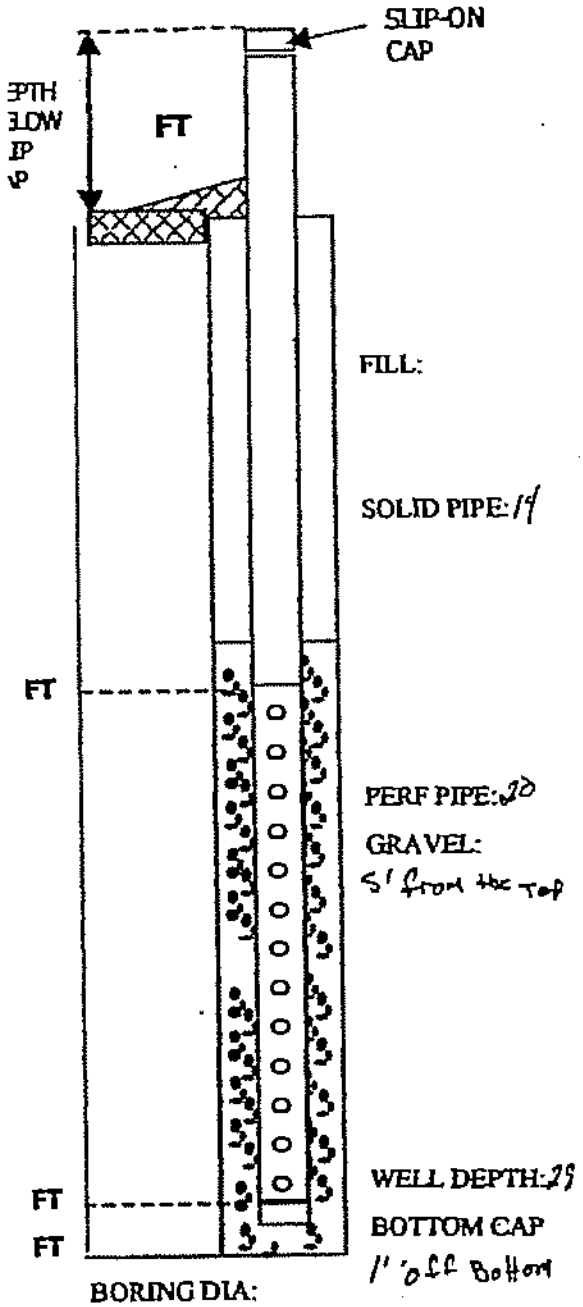
1-10 Bag Bent Seal in the top of well 1' of Dirt on top of gravel

Tom Perrin
CLIENT REPRESENTATIVE DATE

OWT SITE SUPERVISOR DATE

OWT DRILLING & COMPLETION LOG

Project Name: Okerry Road
Project No.: 836442
Date: 3-28-02
Well No. 11-



DRILL	29	WEATHER	
COMP.	29	START	
ABAN.		STOP	
SOLID	14		
PERF.	20		

DEPTH	COMPOSITION & TEMPERATURE	DEGREE OF DECOMPOSITION	AMOUNT OF MOISTURE
0-2	Cover		
2-20	H.H.T wet		
21-30	Peagravel	WET	WATER
31-40			
41-50			
51-60			
61-70			
71-80			
81-90			
91-100			
101-110			
111-120			
121-130			
131-140			

TD: 29

COMMENTS:

1-10 Bag Bent Seal in the Top of well
1' of Dirt ontop of Gravel

* Drilled To PEE GRAVEL

CLIENT REPRESENTATIVE DATE

OWT SITE SUPERVISOR DATE

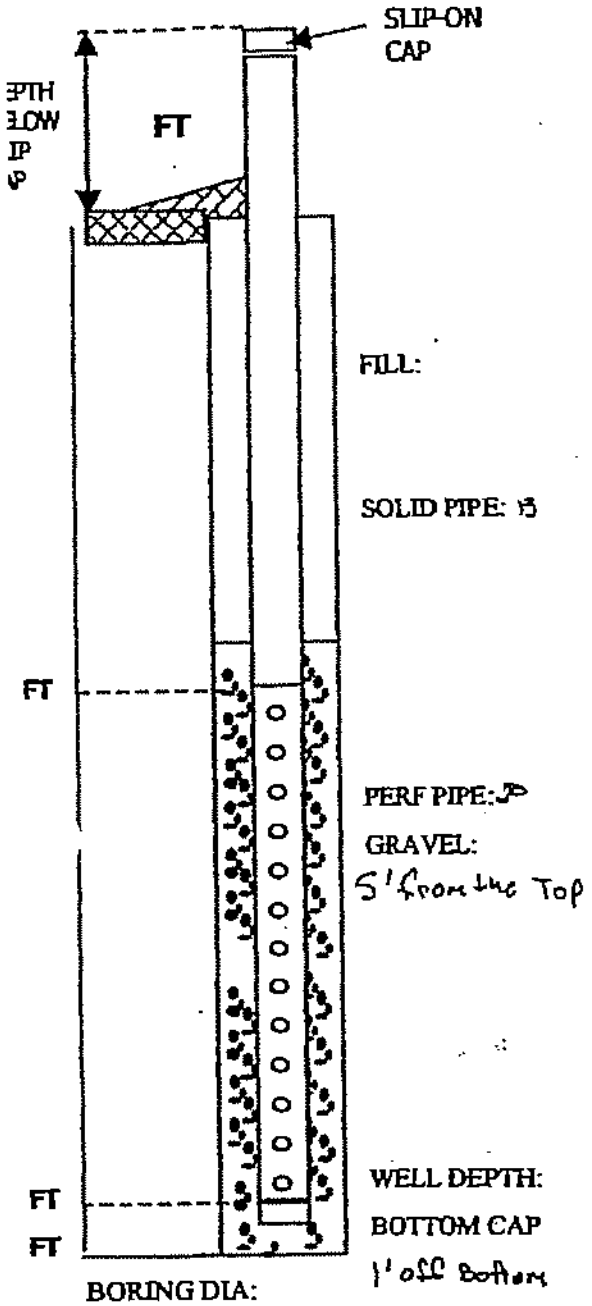
OWT DRILLING & COMPLETION LOG

Project Name: Chrcey Island

Project No.: 830442

Date: 3-28-02

Well No. 12



DRILL	20	WEATHER	
COMP.	28	START	
ABAN.		STOP	
SOLID	13		
PERF.	20		

DEPTH	COMPOSITION & TEMPERATURE	DEGREE OF DECOMPOSITION	AMOUNT OF MOISTURE
0-2	Cover		
1-20	H.H.T wet		
21-30	Peg grave		
31-40			
41-50			
51-60			
61-70			
71-80			
81-90			
91-100			
101-110			
111-120			
121-130			
131-140			

TD: 28

COMMENTS:

1-10 Bag Bent Seal in the Top of well
1' of Dirt on top of Gravel

Tom Penn

CLIENT REPRESENTATIVE DATE

OWT SITE SUPERVISOR DATE

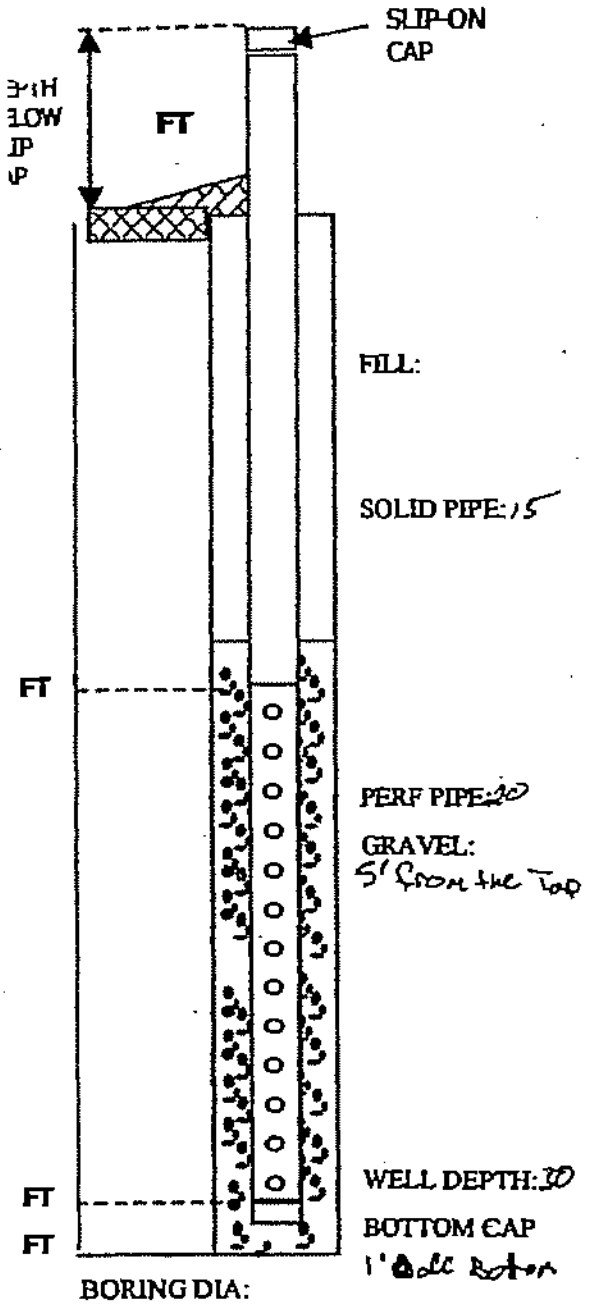
OWT DRILLING & COMPLETION LOG

Project Name:

Project No.:

Date: 3-28-02

Well No. 13



DRILL	30	WEATHER	
COMP.	30	START	
ABAN.		STOP	
SOLID	15		
PERF.	20		

DEPTH	COMPOSITION & TEMPERATURE	DEGREE OF DECOMPOSITION	AMOUNT OF MOISTURE
0-2	Cover		
2-20	H.H.T wet		
21-30	Dry gravel		
31-40			
41-50			
51-60			
61-70			
71-80			
81-90			
91-100			
101-110			
111-120			
121-130			
131-140			

TD: 30

COMMENTS:

1' 10 Bag Bent Seal in the Top of well
1' of Dirt on top of gravel

Tom Perri
CLIENT REPRESENTATIVE DATE

OWT SITE SUPERVISOR DATE

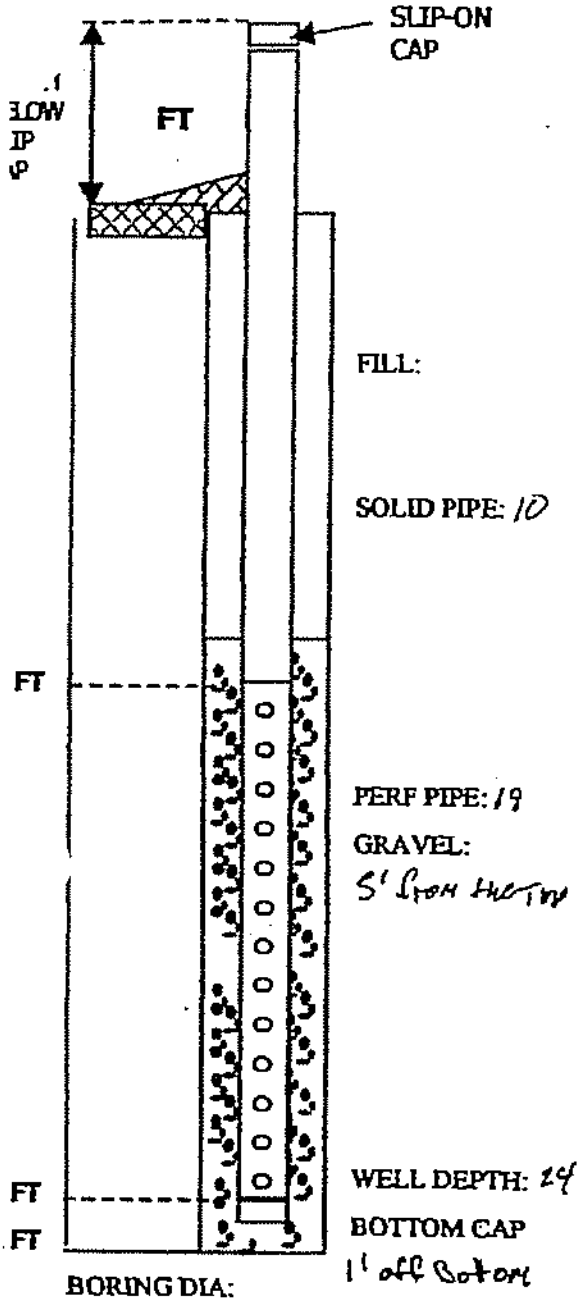
OWT DRILLING & COMPLETION LOG

Project Name:

Project No.:

Date: 3-28-00

Well No. 14



DRILL	24	WEATHER	
COMP.	24	START	
ABAN.		STOP	
SOLID	10		
PERF.	19		

DEPTH	COMPOSITION & TEMPERATURE	DEGREE OF DECOMPOSITION	AMOUNT OF MOISTURE
0-2	Cover		
2-20	H.A.T wet		
21-30	PEA gravel		
31-40			
41-50			
51-60			
61-70			
71-80			
81-90			
91-100			
101-110			
111-120			
121-130			
131-140			

TD: 24

COMMENTS:

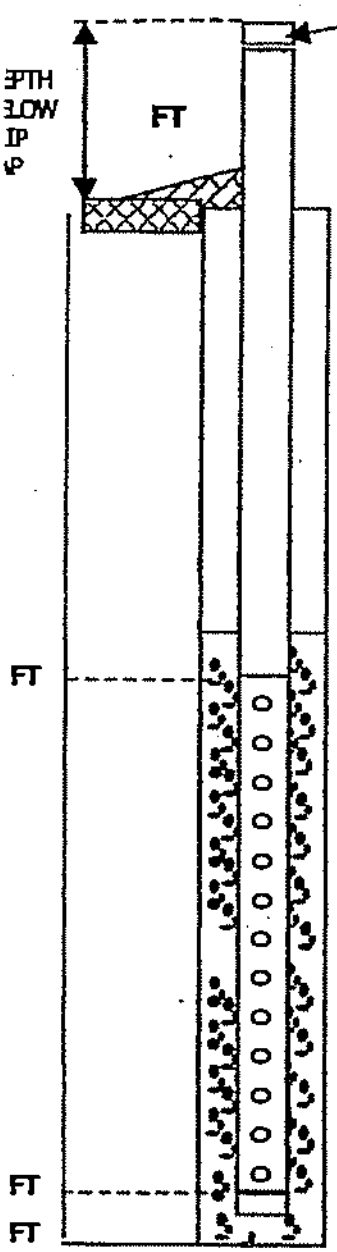
1' 10 Bag Bent Seal in the Top of well
1' of Dirt on Top of gravel

Tom Perri
CLIENT REPRESENTATIVE DATE

OWT SITE SUPERVISOR DATE

OWT DRILLING & COMPLETION LOG

Project Name: Chicey Island
Project No.: 836 44C
Date: 3-29-02
Well No. 15



DRILL	36	WEATHER	
COMP.	36	START	
ABAN.		STOP	
SOLID	15		
PERF.	20		

FILL:

SOLID PIPE: 15

PERF PIPE: 20

GRAVEL: 5' from the Top

WELL DEPTH: 36

BOTTOM CAP 1' off Bottom

BORING DIA:

DEPTH	COMPOSITION & TEMPERATURE	DEGREE OF DECOMPOSITION	AMOUNT OF MOISTURE
0-2	Cover		
2-20	H.H.T wood + paper	Slight	Moust
21-30	Peagravel		
31-40			
41-50			
51-60			
61-70			
71-80			
81-90			
91-100			
101-110			
111-120			
121-130			
131-140			

TD: 36

COMMENTS:

on site w/ Sean Todd Jeff four TD is Hetiny peagravel
Stop and Completion the well

" Bag Bent Seal in the Top of well
of Dirt ontop of Gravel

Tom Perrin
CLIENT REPRESENTATIVE DATE

OWT SITE SUPERVISOR DATE

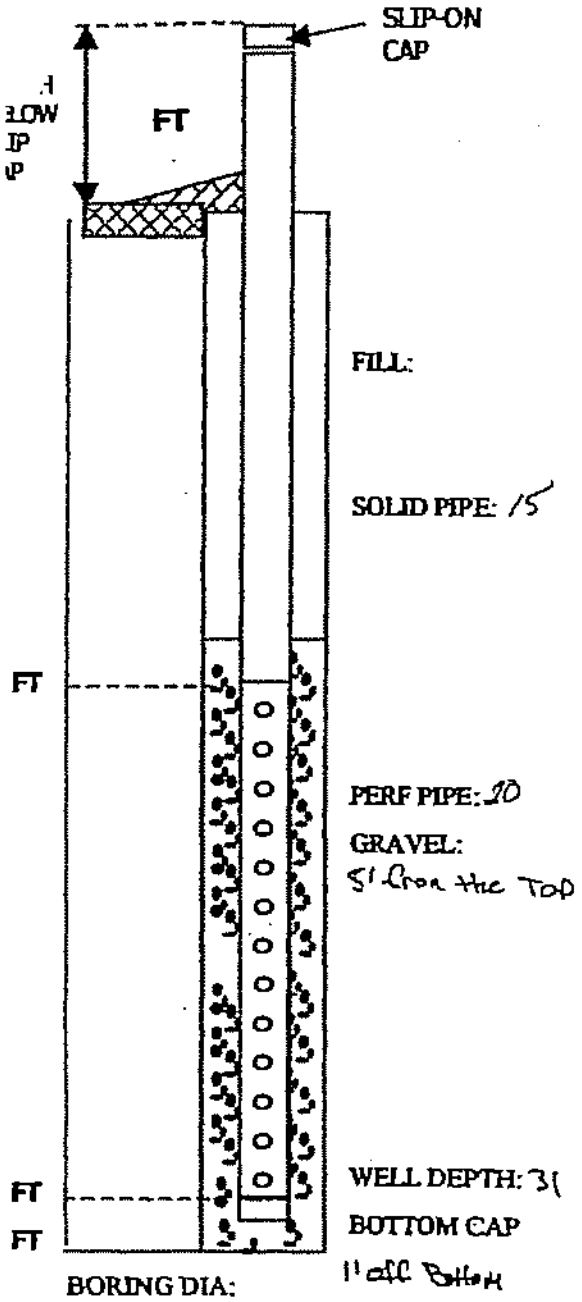
OWT DRILLING & COMPLETION LOG

Project Name:

Project No.:

Date: 3-29-02

Well No. 16



DRILL	31	WEATHER	
COMP.	31	START	
ABAN.		STOP	
SOLID	15		
PERF.	do		

DEPTH	COMPOSITION & TEMPERATURE	DEGREE OF DECOMPOSITION	AMOUNT OF MOISTURE
0-2	Cover		
2-20	H.H.T wood	Slight	Dry
21-30	wood	Slight	Moust
31-40	Peg gravel		
41-50			
51-60			
61-70			
71-80			
81-90			
91-100			
101-110			
111-120			
121-130			
131-140			

TD: 31

COMMENTS:

1-10 Bag Dent Seal in the Top of well
1' of Dirt ontop of gravel

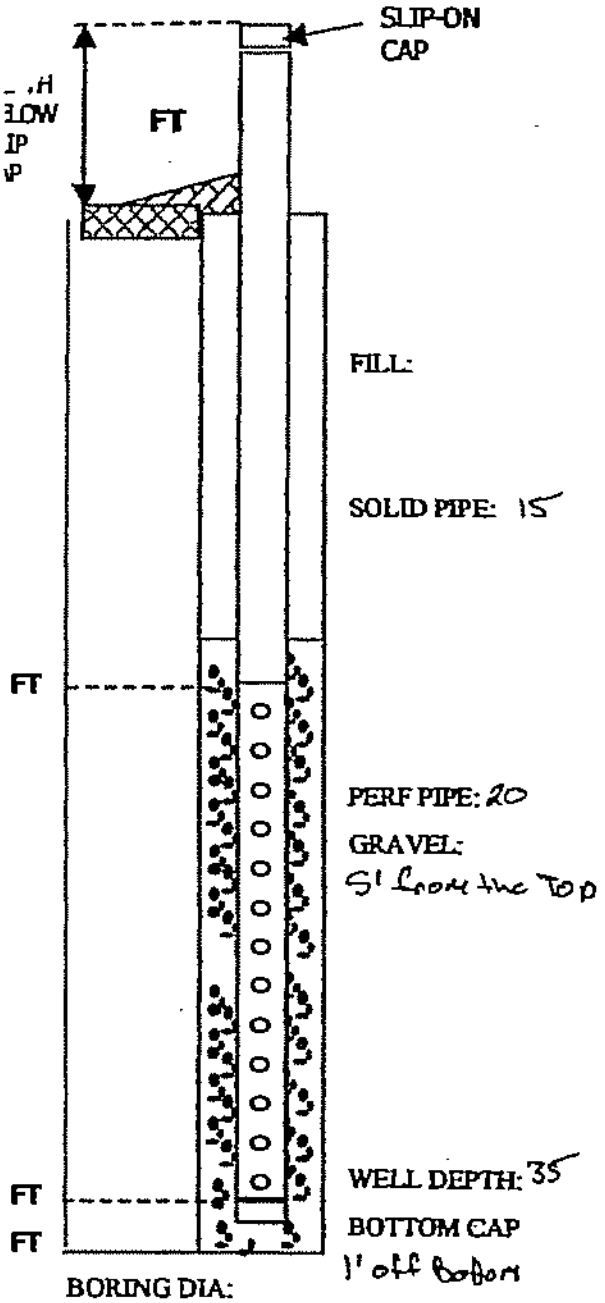
Tom Penn
CLIENT REPRESENTATIVE DATE

OWT SITE SUPERVISOR DATE

OWT DRILLING & COMPLETION LOG

Project Name: Cherry Island
Project No.: 856142
Date: 3-29-02
Well No. 17

DRILL	35	WEATHER	
COMP.	35	START	
ABAN.		STOP	
SOLID	15		
PERF.	20		



DEPTH	COMPOSITION & TEMPERATURE	DEGREE OF DECOMPOSITION	AMOUNT OF MOISTURE
0-2	Cover		
2-20	wood paper	Slight	Moist
21-30	H.H.T		
31-40	Deagravel		
41-50			
51-60			
61-70			
71-80			
81-90			
91-100			
101-110			
111-120			
121-130			
131-140			

TD: 35

COMMENTS:

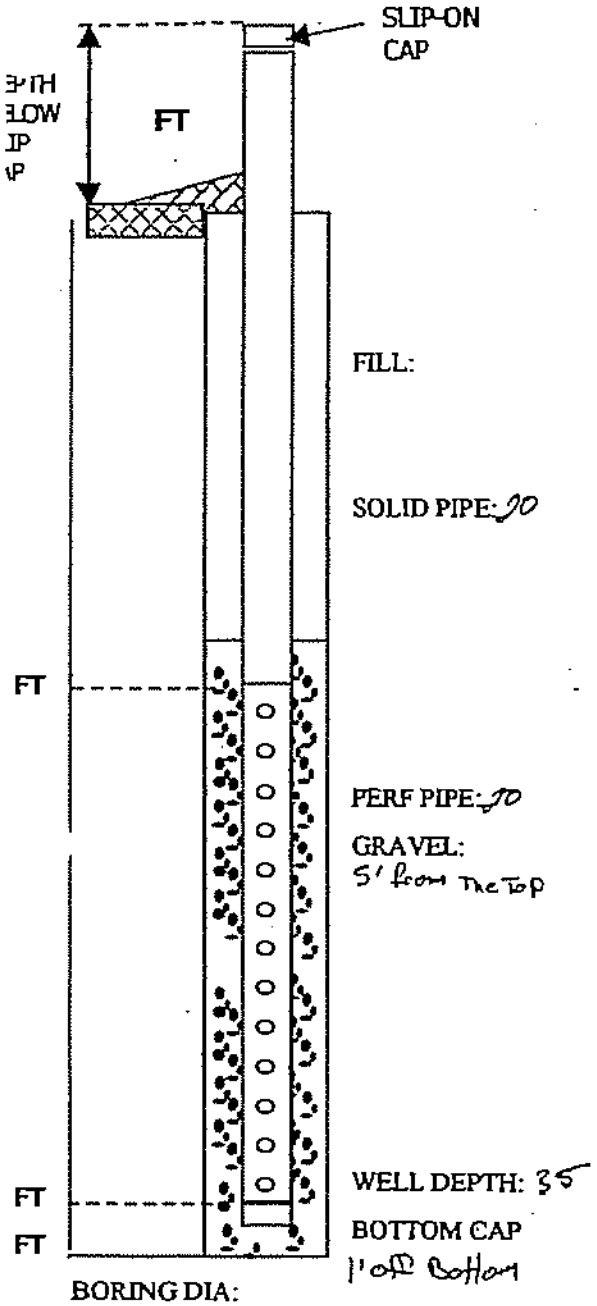
1-10 Bag Bent Seat in Top of well
1' of Dirt on Top of Gravel

Tom Penn
CLIENT REPRESENTATIVE DATE

OWT SITE SUPERVISOR DATE

OWT DRILLING & COMPLETION LOG

Project Name: Cherry Island
Project No.: 85644/2
Date: 4-1-02
Well No. 18



DRILL	35	WEATHER	
COMP.	35	START	
ABAN.		STOP	
SOLID	20		
PERF.	20		

DEPTH	COMPOSITION & TEMPERATURE	DEGREE OF DECOMPOSITION	AMOUNT OF MOISTURE
0-1	Cover		
1-20	H.H.T wet	wet	wet
21-30	wood wet		
31-40	pea gravel		
41-50			
51-60			
61-70			
71-80			
81-90			
91-100			
101-110			
111-120			
121-130			
131-140			

TD: 35

COMMENTS:

On site w/ Sean Todd Jeff Drilling wells 18-19-20 Heting peagravel stop and comp All well Blown hydrolyaice Hose Call united Ren four Track Loader

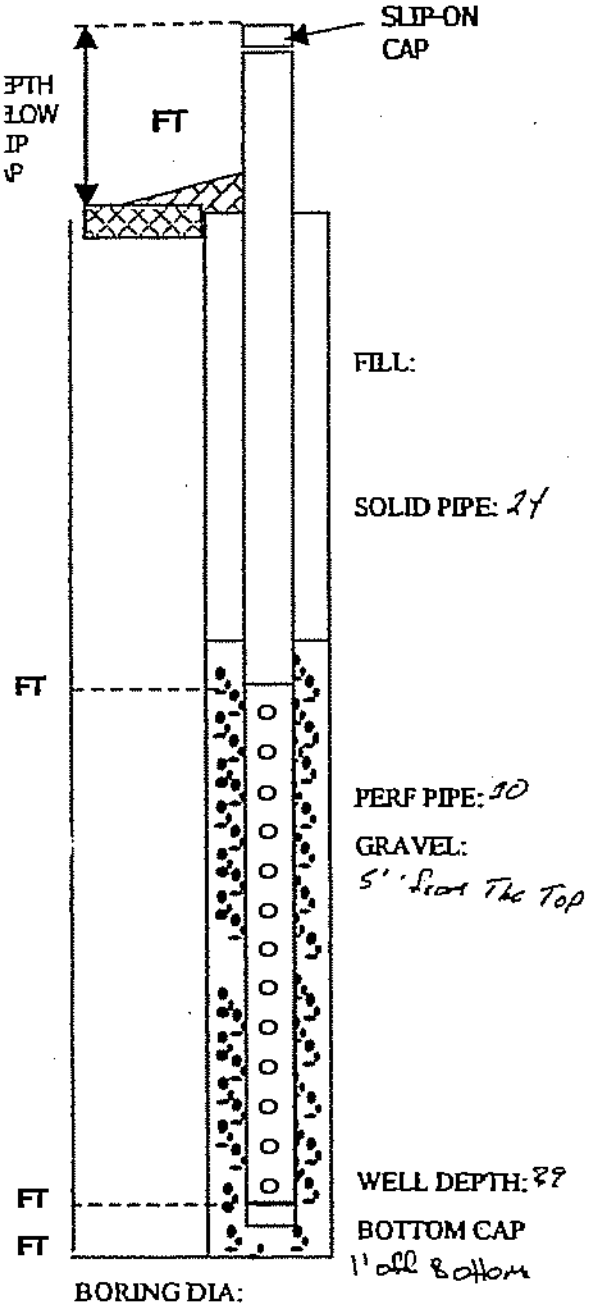
CLIENT REPRESENTATIVE DATE

OWT SITE SUPERVISOR DATE

OWT DRILLING & COMPLETION LOG

Project Name: Cherry Island
Project No.: 836442
Date: 4-1-02
Well No. 19

DRILL	39	WEATHER	
COMP.	39	START	
ABAN.		STOP	
SOLID	24		
PERF.	30		



DEPTH	COMPOSITION & TEMPERATURE	DEGREE OF DECOMPOSITION	AMOUNT OF MOISTURE
0-2	Cover		
2-20	H.H.T wood	Soling	Moist
21-30	loper wood		WATER
31-40	Peagravel		
41-50			
51-60			
61-70			
71-80			
81-90			
91-100			
101-110			
111-120			
121-130			
131-140			

TD: 39

COMMENTS:

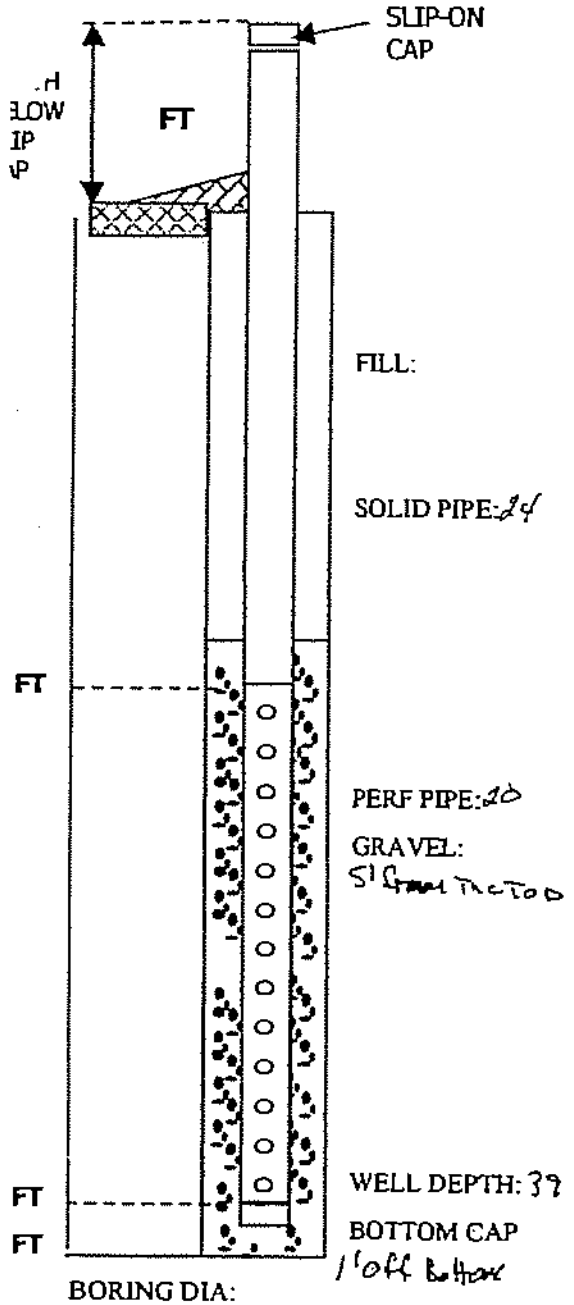
* TALKED W/ TOM - P Drilled To PEE GRAVEL

CLIENT REPRESENTATIVE DATE

OWT SITE SUPERVISOR DATE

OWT DRILLING & COMPLETION LOG

Project Name: Cherry Island
Project No.: 856442
Date: 4-1-02
Well No. 20



DRILL	39	WEATHER	
COMP.	39	START	
ABAN.		STOP	
SOLID	24		
PERF.	20		

DEPTH	COMPOSITION & TEMPERATURE	DEGREE OF DECOMPOSITION	AMOUNT OF MOISTURE
0-2	Cover		
2-20	wood Trash	Slight	Moist
21-30	wood		
31-40	peg gravel		
41-50			
51-60			
61-70			
71-80			
81-90			
91-100			
101-110			
111-120			
121-130			
131-140			

TD: 39

COMMENTS:

CLIENT REPRESENTATIVE DATE

OWT SITE SUPERVISOR DATE

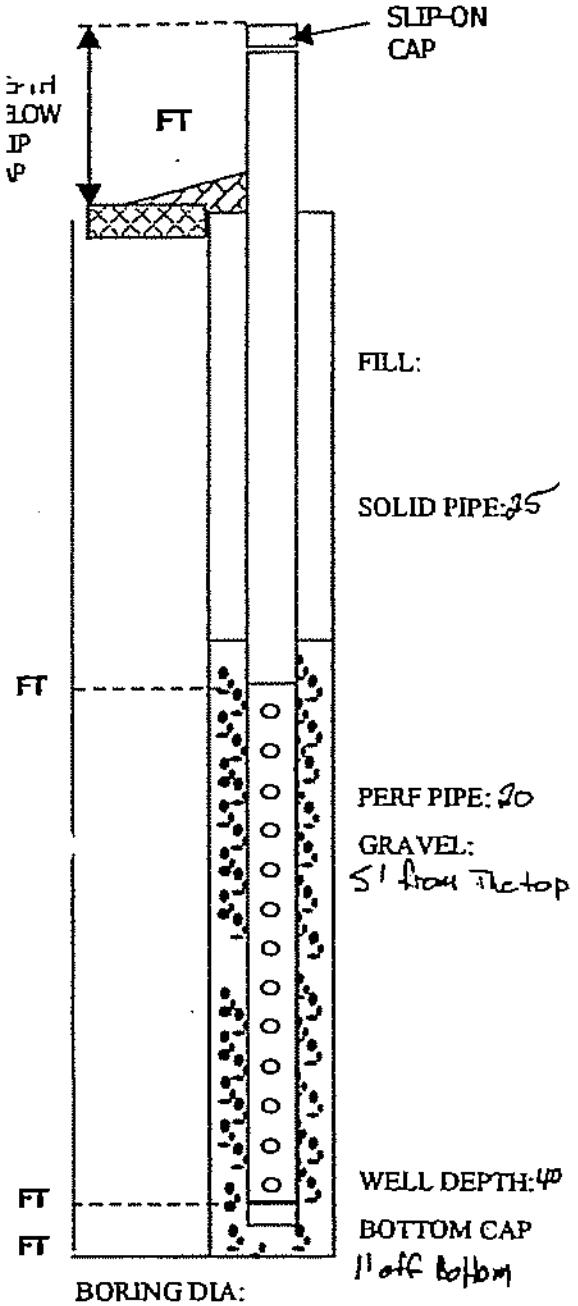
OWT DRILLING & COMPLETION LOG

Project Name: Cherry Island

Project No.: 83644 2

Date: 4-2-02

Well No. 21



DRILL	40	WEATHER	
COMP.	40	START	
ABAN.		STOP	
SOLID	25		
PERF.	20		

DEPTH	COMPOSITION & TEMPERATURE	DEGREE OF DECOMPOSITION	AMOUNT OF MOISTURE
0-2	Cover		
2-20	H.H.T	Slight	moist
21-30	wood		
31-40	dirt light Trash		
41-50			
51-60			
61-70			
71-80			
81-90			
91-100			
101-110			
111-120			
121-130			
131-140			

TD: 40

COMMENTS:

On Site w/ Sean Todd IoCC Drilling wells # 21-22 Hot pea gravel in well # 22 Not on well 21 Cleanup around Site

CLIENT REPRESENTATIVE DATE

OWT SITE SUPERVISOR DATE

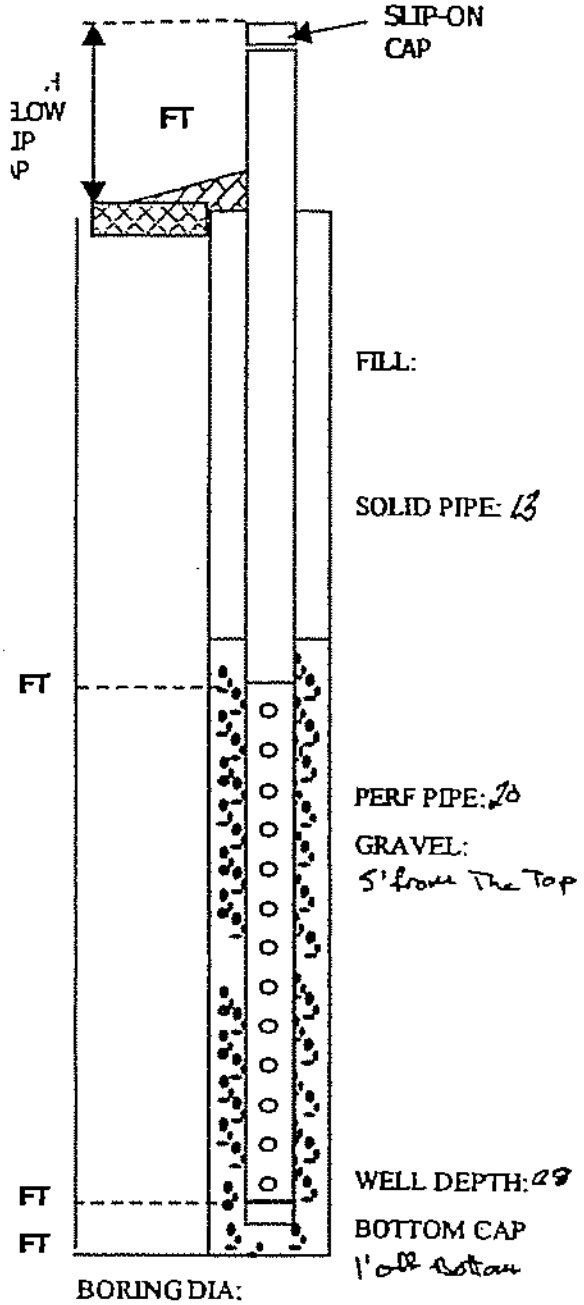
OWT DRILLING & COMPLETION LOG

Project Name:

Project No.:

Date: 4-9-96

Well No. 21



DRILL	28	WEATHER	
COMP.	28	START	
ABAN.		STOP	
SOLID	13		
PERF.	20		

DEPTH	COMPOSITION & TEMPERATURE	DEGREE OF DECOMPOSITION	AMOUNT OF MOISTURE
0-2	Cover		
2-20	wood paper H.H.T	Slight	
21-30	wet Sludge		
31-40			
41-50			
51-60			
61-70			
71-80			
81-90			
91-100			
101-110			
111-120			
121-130			
131-140			

TD: 28

COMMENTS:

CLIENT REPRESENTATIVE DATE

OWT SITE SUPERVISOR DATE

APPENDIX O-10.3

COMPREHENSIVE SUMMARY OF GAS WELL AND BORING DATA

ID	Northing	Easting	Surface Elevation	Top of LCS Elevation	Thickness of Waste	Date Drilled	Date Dipped / Surveyed	Depth of Boring / Well	Depth to Liquid	Liquid Elevation	Liquid Head on LCS	Liquid Head on Bottom of Boring / Well
	(feet)	(feet)	(feet)	(feet)	(feet)			(feet)	(feet)	(feet)	(feet)	(feet)
P1_02_SASW01	630281	470240	87.5	-5.3	92.8		03/08/02					
P1_02_C063						04/12/02						
P1_02_C064						04/12/02						
P1_02_SASW11	630131	469976	38.9	-5.3	44.2		03/08/02					
P1_02_EGW01	630938	470727	60.2	2.0	58.2		04/11/02	39.6	37.9	22.3	20.3	1.7
P1_02_EGW03							04/11/02	4.4	-	-	-	-
P1_02_EGW05	630390	470201	82.9	-4.3	87.2		04/11/02	39.2	20.4	62.6	66.9	18.8
P1_02_EGW10	630291	470368	88.7	-4.3	93.0		04/11/02	35.7	34.7	54.0	58.3	1.0
P1_02_EGW11	630229	470199	78.4	-4.3	82.7		04/11/02	31.2	29.2	49.2	53.5	2.0
P1_02_EGW13	630415	470574	80.8	-4.3	85.1		04/11/02	7.8	-	-	-	-
P1_02_EGW14	630111	470409	81.5	-4.3	85.8		04/11/02	46.0	38.3	43.2	47.5	7.7
P1_02_EGW16	630635	470983	74.2	16.1	58.1		04/11/02	64.7	49.6	24.6	8.5	15.1
P1_02_EGW21	629887	470800	80.0	6.6	73.4		04/11/02	57.2	38.0	42.0	35.4	19.2
P1_02_EGW22							04/11/02	33.3	-	-	-	-
P1_02_EGW24	630439	470891	87.8	7.4	80.4		04/11/02	79.3	33.2	54.6	47.2	46.1
P2_02_UW02	630130	471943	76.8	30.3	46.5	03/11/02		26	21.5	55.3	25.0	4.5
P2_02_SASW02	630191	471824	78.9	30.3	48.6		03/08/02					
P2_02_UW02A	629970	471816	87.2	30.3	56.9	03/11/02		28	28	59.2	28.9	0.0
P2_02_C065	629487	471615	93.1	30.0	63.1	04/12/02						
P2_02_C066						04/12/02						
P2_02_SPT4W	629733	471529	93.5	24.6	69.0	04/11/02		59.5	51	42.5	17.9	8.5
P2_02_SPT6W	630021	471286	88.2	14.6	74.0	04/12/02		45	-	-	-	-
P2_02_SPT7AW	629893	471647	92.4	21.4	71.0	04/12/02		43	41	51.4	30.0	2.0
P2_02_SPT7W						04/12/02		14	-	-	-	-
P2_02_EGW26	630281	471216	74.4	22.8	51.6		04/11/02	23.3	-	-	-	-
P2_02_EGW30	630336	471554	77.2	29.6	47.6		04/11/02	6.7	-	-	-	-
P2_02_EGW31	630202	471444	79.4	22.8	56.6		04/11/02	12.5	-	-	-	-
P2_02_EGW34	630115	471638	88.2	31.3	56.9		04/11/02	31.7	-	-	-	-
P2_02_EGW35	629913	471484	91.2	21.3	69.9		04/11/02	24.5	-	-	-	-
P2_02_EGW38							04/11/02	18.1	12.8			5.3
P2_02_EGW40	629715	471502	93.0	21.3	71.7		04/11/02	14.2	-	-	-	-
P2_02_EGW41	629524	471346	83.2	30.0	53.2		04/11/02	15.4	-	-	-	-

ID	Northing	Easting	Surface Elevation	Top of LCS Elevation	Thickness of Waste	Date Drilled	Date Dipped / Surveyed	Depth of Boring / Well	Depth to Liquid	Liquid Elevation	Liquid Head on LCS	Liquid Head on Bottom of Boring / Well
	(feet)	(feet)	(feet)	(feet)	(feet)			(feet)	(feet)	(feet)	(feet)	(feet)
P2_02_EGW43	629883	471853	90.5	21.3	69.2		04/11/02	32.6	32.3	58.1	36.8	0.3
P2_02_EGW45	629453	471497	91.4	30.0	61.4		04/11/02	37.2	-	-	-	-
P2_02_EGW46	629344	471298	77.7	30.0	47.7		04/11/02	33.2	32.5	45.2	15.2	0.7
P2_02_EGW47	629190	471270	76.5	28.7	47.8		04/11/02	29.7	23.3	53.2	24.5	6.4
P2_02_EGW56	629337	471420	89.6	30.0	59.6		04/11/02	38.8	-	-	-	-
P3_02_UW03	629212	472281	79.0	40.4	38.6	03/14/02		28	26	53.0	12.6	2.0
							04/10/02	17	-	-	-	-
P3_02_SASW03							03/08/02					
P3_02_UW04	628685	473476	63.1	40.6	22.5		03/12/02	22	20.5	42.6	2.0	1.5
P3_02_SASW04							03/08/02					
P3_02_C067	629025	472943	63.3	39.7	24.5	04/12/02						
P3_02_SPT5W						04/11/02		26	-	-	-	-
P3_02_SPT5AW						04/11/02		24.5	-	-	-	-
P3_02_C062	629212	472282	77.2	41.1	38.0	04/12/02						
P3_02_SPT3W						04/10/02		42	10	67.2	26.1	32.0
P3_02_EGW3-2	629360	471975	76.8	41.1	35.7		04/11/02	16.4	-	-	-	-
P3_02_EGW3-5	629448	472525	77.5	41.4	36.1		04/11/02	38.1	32.7	44.7	3.3	5.3
P3_02_EGW3-9	628642	473430	63.1	39.7	23.4		04/11/02	22.4	19.8	43.4	3.7	2.7
P3_02_EGW3-11	628629	473791	63.1	39.5	23.6		04/11/02	9.5	5.5	57.6	18.1	4.0
P3_02_EGW3-13	628940	472600	79.7	40.4	39.3		04/11/02	21.5	16.1	63.5	23.1	5.4
P4_02_UW05	628598	471935	82.6	45.1	37.5	03/11/02		28	24.5	58.12	13.02	3.5
							04/10/02	17	-	-	-	-
P4_02_SASW05							03/08/02					
P4_02_C068						04/12/02						
P4_02_UW06	627660	473400	74.8	43.1	31.7	03/14/02		31	-	-	-	-
							04/10/02		-	-	-	-
P4_02_SASW06							03/08/02					
P4_02_OWT03	627596	472991	82.9	46.9	36	03/26/02		36	22	60.9	14.0	14.0
							04/10/02	36	32.7	50.2	3.3	3.3
P4_02_OWT04	627728	472818	84.2	48.2	36	03/26/02		36	-	-	-	-
							04/10/02	36	34.7	49.5	1.3	1.3

ID	Northing	Easting	Surface Elevation	Top of LCS Elevation	Thickness of Waste	Date Drilled	Date Dipped / Surveyed	Depth of Boring / Well	Depth to Liquid	Liquid Elevation	Liquid Head on LCS	Liquid Head on Bottom of Boring / Well
	(feet)	(feet)	(feet)	(feet)	(feet)			(feet)	(feet)	(feet)	(feet)	(feet)
P4_02_OWT05	627865	472632	85.9	48.9	37	03/27/02		37	-	-	-	-
							04/10/02	37	-	-	-	-
P4_02_OWT06	628025	472801	87.5	47.5	40	03/27/02		40	-	-	-	-
P4_02_OWT07	627882	472973	84.8	44.8	40	03/27/02		40	-	-	-	-
							04/10/02	40	-	-	-	-
P4_02_OWT16	628012	473463	76.4	45.4	31	03/29/02		31	-	-	-	-
P4_02_OWT17	627799	473134	76.4	41.4	35	03/29/02		35	-	-	-	-
							04/10/02	35	-	-	-	-
P4_02_OWT18	628182	472996	79.3	44.3	35	04/01/02		35	-	-	-	-
P4_02_OWT19	628841	471737	81.4	42.4	39	04/01/02		39	25	56.4	14.0	14.0
							04/10/02	39	39	42.4	0.0	0.0
P4_02_OWT21	628460	471821	83.4	< 43.4	> 40	04/02/02		40	-	-	-	-
							04/10/02	40	-	-	-	-
P4_02_OWT22	627657	473428	74.7	46.7	28	04/02/02		28	-	-	-	-
P4_02_EGW4-2	628953	472002	79.9	42.1	37.9		04/11/02	21.7	-	-	-	-
P4_02_EGW4-8	627925	472111	81.1	46.7	34.4		04/11/02	37.1	-	-	-	-
P4_02_EGW4-70							04/11/02	27.5	18.4			9.0
P5_02_UW07	627775	471780	78.9	40.9	38	03/14/02		22	16.5	62.4	21.5	5.5
							04/10/02	15.75	-	-	-	-
P5_02_SASW07							03/08/02					
P5_02_C061						04/12/02						
P5_02_SPT2W				40.9	38	04/10/02		40	35	43.9	3.0	5.0
P5_02_UW08	627760	472380	83.8	41.8	42	03/12/02		30	29	54.8	13.0	1.0
P5_02_SASW08							03/08/02					
P5_02_C060						04/12/02						
P5_02_SPT1W				41.8	42	04/10/02		44	36.5	47.3	5.5	7.5
P5_02_UW09	627025	472700	71.3	43.4	27.9	03/12/02		22	20	51.3	7.9	2.0
							04/10/02	14	-	-	-	-
P5_02_SASW09							03/08/02					
P5_02_SASW10	626682	472959	50.6	43.4	7.2		03/08/02					
P5_02_OWT01	627328	473035	73.1	45.0	28.1	03/26/02		26	-	-	-	-
							04/10/02	26	25.0	48.2	3.2	1.0

ID	Northing	Easting	Surface Elevation	Top of LCS Elevation	Thickness of Waste	Date Drilled	Date Dipped / Surveyed	Depth of Boring / Well	Depth to Liquid	Liquid Elevation	Liquid Head on LCS	Liquid Head on Bottom of Boring / Well
	(feet)	(feet)	(feet)	(feet)	(feet)			(feet)	(feet)	(feet)	(feet)	(feet)
P5_02_OWT02	627452	472885	81.7	45.7	36	03/26/02		36	-	-	-	-
							04/10/02	36	34.8	46.8	1.2	1.2
P5_02_OWT08	627124	472585	70.7	39.7	31	03/27/02		31	-	-	-	-
							04/10/02	26.1	24.1	46.6	6.9	2.0
P5_02_OWT09	626914	472489	67.2	41.2	26	03/27/02		26	-	-	-	-
							04/10/02	26	24.1	43.0	1.9	1.9
P5_02_OWT10	626874	472710	69.8	45.8	24	03/28/02		24	-	-	-	-
							04/10/02	24	-	-	-	-
P5_02_OWT11	627170	472750	71.5	42.5	29	03/28/02		29	29	42.5	0.0	0.0
							04/10/02	29	26.0	45.5	3.0	3.0
P5_02_OWT12	627046	472869	70.9	42.9	28	03/28/02		28	-	-	-	-
							04/10/02	28	28	42.9	0.0	0.0
P5_02_OWT13	627065	472270	69.3	39.3	30	03/28/02		30	-	-	-	-
							04/10/02	30	26.5	42.8	3.5	3.5
P5_02_OWT14	626921	472169	66.4	42.4	24	03/28/02		24	-	-	-	-
							04/10/02	24	-	-	-	-
P5_02_OWT15	627253	472340	79.5	43.5	36	03/29/02		36	-	-	-	-
							04/10/02	36	35.7	43.8	0.3	0.3
P5_02_OWT20	628323	471505	81.6	42.6	39	04/01/02		39	-	-	-	-
							04/10/02	39	39	42.6	0.0	0.0
P5_02_EGW5-3	627449	471692	71.2	42.0	29.2		04/11/02	29.2	-	-	-	-
P5_02_EGW5-7	627664	471760	73.9	43.5	30.4		04/11/02	30.4	-	-	-	-

SPECTRAL ANALYSIS OF SURFACE WAVES (SASW) TESTING

SASW Testing at the Cherry Island Landfill to Determine Shear Wave Velocity Profiles and to Estimate Total Unit Weights of the Waste Materials

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SASW Testing at the Cherry Island Landfill to Determine Shear Wave Velocity Profiles and to Estimate Total Unit Weights of the Waste Materials

1.0 Introduction

The spectral-analysis-of-surface-waves (SASW) method was used to determine shear wave velocity profiles at nine locations on the Cherry Island Landfill and at two locations around the base of the landfill. Shear wave velocity (V_S) profiles were determined to depths of approximately 100 ft to 150 ft. These profiles encompassed the waste material, the dredged material underlying the waste, and in many cases, the natural material underlying the dredged material. In addition to the V_S profiles, a second goal of the study was to correlate V_S values of the waste material with measured total unit weights of the waste in the top 20 ft to 30 ft. This correlation was then used to estimate total unit weights of the waste materials at greater depths.

The SASW test methodology and field procedure are discussed below. The procedure used to estimate total unit weights from the shear wave velocity measurements is also described. The resulting shear wave velocity profiles and the estimated total unit weights of the waste are then presented.

2.0 SASW Testing

2.1 SASW Methodology

The SASW test method is a nondestructive and nonintrusive seismic method. The method utilizes the dispersive nature of Rayleigh-type surface waves propagating through a layered material to determine the shear wave velocity profile in the material (Stokoe et al., 1994). Dispersion in surface wave velocity (V_R) arises from changing stiffness properties of the subsurface material with depth. This phenomenon is illustrated in Figure 1 for a multi-layered solid. A high-frequency surface wave, which propagates with a short wavelength (λ_1), only stresses material near the exposed surface and thus only samples the properties of the shallow, near-surface material (Figure 1b). A lower-frequency surface wave, which has a longer wavelength (λ_2), stresses material to a greater depth and thus samples the properties of the shallower and deeper materials (Figure 1c). Spectral analysis is used to separate the waves by frequency (f) and wavelength (λ) so that the experimental ("field") dispersion curve for the site can be determined. The dispersion curve is presented herein as a plot of V_R versus log λ. An analytical procedure is then used to theoretically match the field dispersion curve with a one-dimensional layered system of varying layer stiffnesses and thicknesses (Joh, 1996). The one-dimensional shear wave velocity profile that generates a dispersion curve matching the field dispersion curve is presented as the shear wave velocity profile at the site. Although the matching process does not result in a unique solution (V_S profile), the V_S profiles presented herein well represent the waste and underlying materials.

SASW testing involves generating surface waves at one point on the exposed material surface and measuring the motions perpendicular to the surface created by the passage of the surface waves at two or more locations. All measurement points are arranged on the exposed surface along a single radial path from the source. Successively longer spacings between the receivers and between the source and first receiver are typically used to measure progressively longer and longer wavelengths. This general testing configuration for one source/receiver set-up is illustrated in Figure 2. The distance between the source and first receiver (d) is kept equal to the distance between receivers (d) as shown in Figure 2. Testing is performed with several (typically 5 or more) sets of source-receiver spacings. The totality of all sets of source-receiver spacings employed at one location is used to construct the field dispersion curve which is also called a composite experimental dispersion curve.

Propagation velocities of surface waves between the receivers are measured for each receiver spacing. The velocities are measured in the frequency domain in terms of a phase shift at each frequency. The measurements result in a record of phase versus frequency for each receiver spacing, as shown in Figure 3. From each phase plot, the phase velocity of the surface wave can be calculated at each frequency from:

$$V_R = f \bullet \frac{360}{\phi} \bullet d \qquad (1)$$

where V_R is the phase velocity in ft/sec or m/s, f is the frequency in Hertz (cycles per sec), ϕ is the phase angle in degrees (at frequency f), and d is the distance between the receivers in the same length units as used to represent V_R. From this calculation, a plot of phase velocity versus frequency, called an individual dispersion curve, is generated. This procedure is repeated for all source-receiver spacings used at the site. Typically, there is significant overlapping in the dispersion data between adjacent receiver sets. The individual dispersion curves from all receiver spacings are combined to form a single composite dispersion curve. Figure 4 presents a composite experimental dispersion curve created from a set of SASW tests with seven receiver spacings that was performed by the writers for work at Yucca Mountain.

Once the composite dispersion curve is generated for the site, an iterative forward modeling procedure is used to create a theoretical dispersion curve to match the experimental curve (Joh, 1996). The stiffness profile that provides the best match to the experimental dispersion curve is presented as the V_S profile at the site. Figure 5 presents the matching theoretical dispersion curve for the experimental dispersion curve shown in Figure 4. Figure 6 presents the final V_S profile at this site. An example comparison between V_S profiles measured by SASW testing and by independent crosshole seismic tests is presented in Figure 7 (Joh, 1996).

2.2 Field Testing at the Cherry Island Landfill

SASW testing was performed at eleven locations on and around the Cherry Island Landfill. A map of the landfill showing the locations of the eleven SASW arrays is

presented in Figure 8. Nine of the SASW arrays (SASW01 to SASW09) were located on the top of the existing landfill. These nine SASW arrays were located near existing boreholes where addition information about the waste material had been measured. Two of the SASW arrays (SASW10 and SASW11) were located at the base of the landfill.

At each SASW array location, receiver spacings of 5 ft, 10 ft, 20 ft, 40 ft, 80 ft, and 160 ft were used. Mark Product L4 geophones (resonant frequency of 1 Hz) were used to measure the vertical component of the surface wave motions at all receiver spacings. Surface wave energy was excited with a sledge hammer for the 5-ft, 10-ft, and 20-ft spacings. A Cat D7H, Series II bulldozer was used to excite the lower-frequency surface wave motions for the 40-ft, 80-ft, and 160-ft receiver spacings. The bulldozer was simply tracked back and forth over about a 10-ft distance during each measurement sequence which lasted from approximately 5 to 15 minutes at each receiver spacing. The bulldozer in operation at SASW02 is shown in Figure 9. All data were collected and recorded using an Agilent Dynamic Signal Analyzer, Model 35670A. The signal analyzer and Dr. Rosenblad are shown in Figure 10. One test in progress at a receiver spacing of 160 ft at SASW06 is shown in Figure 11.

2.3 Shear Wave Velocity Profiles from SASW Testing

The experimental dispersion curves, theoretical dispersion curves, and shear wave velocity profiles from the 11 SASW arrays are presented in Appendix A. The shear wave velocity profiles extend to depths of 100 ft to 150 ft (except at Site SASW04 which only extends to a depth of 40 ft due to poor quality data at long receiver spacings). The profile layering that was used in the modeling was based on layering provided by GeoSyntec Consultants. Generally, the layering consists of a 2-ft to 3-ft thick soil/mulch cover layer underlain by waste material that varies in thickness from 23 ft to 93 ft (sites SASW10 and SASW 11 had no waste). Below the waste is a layer of dredged material underlain by the natural alluvial material. Based on boring information, the dredged material and natural alluvial material consist of soft clayey silts. Below the natural alluvial material is the top of a sand layer with gravelly zones called the Columbia formation. The layer thicknesses provided by GeoSyntec Consultants for all 11 sites are presented in Table B1 in Appendix B. The V_S profiles are briefly summarized and discussed below.

2.3.1 Waste Material

The shear wave velocities of the waste material at sites SASW02 to SASW09 are presented together in Figure 12. All profiles are presented in terms of depth below the existing waste surface; hence, all profiles begin at a depth of zero feet. Also, the profiles were generated using the final measured or estimated total unit weights discussed below. The tabular form of the shear wave velocity profile for each site can be found in Appendix A. The waste material is identified by the "W" in column 2 in each table.

Upon reviewing Figure 12, it can be seen that there is significant scatter in the V_S values over the depth range of 0 to 15 ft. In this depth range, the V_S values are quite variable, ranging from 155 ft/s to 450 ft/s (neglecting the top 2 ft to 3 ft of soil/mulch cover). The variation in the top 15 ft is likely due to differences in the water content and composition of the waste. Moisture affects the shear wave velocities by adding mass and

also decreasing stiffness (particularly in waste with paper). Dry waste generally exhibits higher shear wave velocities, while wetter waste generally has lower shear wave velocities even though it has a higher total unit weight than dry waste (Menq et al., 2001). Below 15 ft, the profiles show a similar trend, with V_S increasing slightly with depth and ranging from a low of 300 ft/sec at 15 ft to a high of 375 ft/s at 45 ft.

Site SASW01 is discussed separately because it has the deepest waste material (92 ft) and exhibits the highest V_S values. It is the oldest site and has a 15-ft to 20-ft thick top layer (as reported to the writers by Dr. Jeremy Morris of GeoSyntec Consultants) with a very high total unit weight. The V_S profile at site SASW01 is shown in Figure 13 and is compared in this figure with the V_S profiles at sites SASW02 through SASW09. Clearly, the shear wave velocities at this site are the highest velocities in the waste. These high values are assumed to result from several causes. First, the higher velocities in the upper 15 ft to 20 ft are assumed to result from the unusual waste in this depth range. Dr. Morris reported that this waste is a metal waste product which likely has very stiff particles and a total unit weight above 160 pcf, or more than twice the total unit weight of much of the waste. The stiffness of the metal waste particles likely increases the shear wave velocity of this material. In addition, the higher unit weight of this material increases the stress on the waste material below it, resulting in somewhat higher velocities at depth.

2.3.2 Dredged Material

Shear wave velocities of the dredged material were measured at 10 of the 11 SASW sites. (No dredged material was reported to be beneath SASW01). This material is reported to be a soft, clayey silt in boring logs provided to the writers. The V_S values are presented in the tables in Appendix A where the dredged material is identified by "D" in column 2 in each table. The velocities are quite low, ranging from 315 ft/s to 500 ft/s where there is more than 15 ft of overburden material above the dredged material.

To examine the shear wave velocity of the dredged material in more detail, the velocities were plotted versus the mean effective stress. The results are shown by the solid circles in Figure 14. The mean effective stress, $\overline{\sigma}_O$, associated with each dredged layer was calculated at the mid-point in the layer from:

$$\overline{\sigma}_O = \frac{1}{3}\left(\overline{\sigma}_V + 2\overline{K}_O\overline{\sigma}_V\right) \qquad (2)$$

where $\overline{\sigma}_V$ equals the vertical effective stress and $\overline{K}_O$ (at-rest effective earth pressure coefficient) was assumed equal to 0.5. The water table was assumed to be at the base of the dredged layer throughout the site, with the exception of site SASW11 were the water table was assumed to be at a depth of 5 ft based on observations in the field. Negative pore pressures were assumed to exist in the dredged material above the water table. The dredged material was assumed to be saturated and a linear distribution of negative pore pressures was assumed. The mean effective stress and velocity values shown in Figure 14 are presented in Table 1.

As seen in Figure 14, the dredged material shows a general trend of increasing velocity with depth. However, there are only two points at mean effective stresses less

than 2000 psf, so this trend is not well defined. On the other hand, it is well known that a power function can be used to describe the increase in V_S with $\bar{\sigma}_o$ for a normally consolidated material (Hardin and Drnevich, 1972). The power function trend shown in Figure 14 generally fits both the dredged material and natural alluvium, as discussed below.

2.3.3 Natural Alluvium Below Dredged Material

Below the dredged material is the natural alluvial material. This material is generally described as a soft, clayey silt in the boring logs provided to the writers. Reliable shear wave velocities were measured in this material at 9 of the SASW sites. The profile at SASW04 did not extend deep enough due to poor data quality at long receiver spacings. At SASW01, the natural alluvial layer was too deep and thin to be accurately resolved. The V_S value of 600 ft/s at SASW01 is approximate and was not presented with the other alluvial velocities. The V_S values of the alluvium are given in the tables in Appendix A with the material identified by "A" in column 2 in the tables. The V_S values measured in the alluvium are quite similar to those measured in the dredged material. The close comparison is shown in Figure 14, where the alluvial results are shown by the solid triangular symbols. The velocities are plotted at the estimated mean effective stresses at the mid-layer depth following the same procedure used to calculate the $\bar{\sigma}_o$ values for the dredged material. The velocities and effective stresses are presented in Table 2.

A power function was fit to all data in Figure 14. The function has the form:

$$V_S = V_{S1} * \left(\bar{\sigma}_o / P_a \right)^n \tag{3}$$

where V_{S1} is the shear wave velocity at a mean effective stress of one atmosphere, P_a is a reference pressure of one atmosphere, and n is a dimensionless exponent. The power function shows a reasonable fit to the data indicating the material is behaving like a normally consolidated soil. The value of V_{S1} of about 370 ft/s indicates a soft soil and the exponent of about 0.23 is near the lower bound of the range found for many normally consolidated soils (n~0.20 to 0.35).

2.3.4 Columbia Formation Below the Alluvium

Boring logs provided to the writers indicated a sand layer with gravelly zones below the alluvium layer. This zone was identified as the top of the Columbia formation in the boring logs. In general, the SASW measurements did not involve long enough wavelengths to accurately resolve the V_S values near the top of the Columbia formation. The most reliable estimates of the shear wave velocity below the alluvial layer were determined at Sites SASW01, SASW10, and SASW11. These results show a distinct increase in V_S relative to the overlying alluvium with V_S values in the Columbia formation of 1100 ft/s and 1500 ft/s. At other sites, the V_S values were not well resolved

and represent the lowest possible values. A V_S value of 1100 ft/s or greater is the best estimate of the shear wave velocity of the top of the Columbia formation.

2.3.5 V_S Profiles at Sites Next to the Landfill

SASW measurements were performed at two sites, SASW10 and SASW11, that are not located on waste material. The locations of these sites are shown in Figure 8. The shear wave velocity profiles at these two sites are presented in Figure 15. The results from SASW11 provided shear wave velocities of the dredged material under very low effective stresses. The V_S values were very low (200 to 315 ft/s) as expected. At site SASW10 the velocity of the dredged material was higher (500 ft/s) because the site was located on fifteen feet of compacted earth fill which provided additional overburden. The difference in the depth to the top of the stiffer Columbia formation at these two sites is clearly evident in Figure 15. Site SASW11 provided the most reliable value of the shear wave velocity near the top of the Columbia formation because it was only 59 ft below the surface. The velocity of the Columbia formation from Site SASW10 was 1100 ft/s and was consistent with that measured at site SASW11.

3.0 Procedure to Estimate Total Unit Weight

3.1 Initial Approach

The second goal of this study – in addition to determining shear wave velocities of the waste and underlying materials – was to estimate total unit weights of the waste material at depths greater than those at which total unit weights were measured. The general rationale of this approach was initially based upon the weight-velocity relationship for soils; that is, denser soil (soil with a higher dry unit weight) has a higher shear wave velocity than looser soil due to tighter packing of the soil particles. Therefore, with measured total unit weights of the waste and the corresponding shear wave velocities, a relationship could be developed to estimate total unit weight at other depths where this parameter was not measured but the shear wave velocity was measured. This approach has been applied successful in the past with Dr. Edward Kavazanjian of GeoSyntec Consultants at several landfills in Southern California and is reasonable for dry or nearly dry waste. However, this approach is greatly complicated if the waste contains paper combined with significant water as exists at the Cherry Island Landfill. Increasing water content will tend to increase the total unit weight of the waste but decrease the shear wave velocity (Menq et al, 2001). Therefore, plots of shear wave velocity vs. total unit weight did not show the trend of increasing total unit weight with increasing velocity.

As an example of the lack of a simple correlation between total unit weight of the waste and shear wave velocity, consider the following results. Tables 3 through 10 present the measured total unit weights provided by GeoSyntec Consultants at the eight borehole sites. (No borehole was drilled at Site SASW01 so no water content or total unit weight determinations were performed at this site). The values presented in Tables 3 through 10 are the average of the minimum and maximum possible total unit weights that were provided by GeoSyntec Consultants. The shear wave velocities at these eight

sites are shown in Figure 16, where they are plotted versus the mean effective stress, $\bar{\sigma}_O$. The values of $\bar{\sigma}_O$ were calculated following the same procedure used for the dredged and alluvial materials that is described by Equation 2. A power function described by Equation 3 was fit through the data so that the influence of confining pressure could be evaluated. In the case of the waste where total unit weights were measured, the shear wave velocity can be represented by:

$$V_S = V_{S1} * \left(\bar{\sigma}_O / P_a \right)^n = 434 * \left(\bar{\sigma}_O / P_a \right)^{0.238} \tag{4}$$

Once the influence of confining pressure was determined, it was removed by dividing the measured shear wave velocity by the pressure term $\left(\bar{\sigma}_O / P_a \right)^{0.238}$. In this case, the shear wave velocity is called the stress-corrected shear wave velocity which is actually the measured velocity projected to a mean effective stress of one atmosphere. Figure 17 presents a plot of the average total unit weight versus stress-corrected shear wave velocity. It is observed that the expected trend in the data (for soils or drier waste) of increasing unit weight with increasing velocity is not apparent. Therefore, a different approach to estimate total unit weight had to be employed at this site. This procedure is described below.

3.2 Final Approach

The modified procedure used to analyze the data from the Cherry Island Landfill where the water content and composition of the waste varied significantly is described in general as follows. First, using the total unit weights measured in the top 20 ft to 30 ft (Tables 3 through 10, column 2) and the shear wave velocities determined from the SASW method (Appendix A), a plot of low-strain shear modulus (G_{max}) versus mean effective stress ($\bar{\sigma}_o$) was developed. Mean effective stress was calculated from the total unit weights (γ_t) and depths to the water table supplied by Geosyntec Consultants (Appendix B) following the procedure described in Equation 2. The low-strain shear modulus was calculated from:

$$G_{max} = \frac{\gamma_t}{g} \bullet V_S^2 \tag{5}$$

In solid waste, the shear-modulus-confining-pressure relationship follows a general power function as (Menq et al, 2001):

$$G_{max} = G_1 \bullet \left(\frac{\bar{\sigma}_o}{P_a} \right)^n \tag{6}$$

where G_1 is the low-strain shear modulus at one atmosphere and reflects (among other factors) the structure and the total unit weight of the material. A best-fit curve was determined using the power function, and values of G_1 and n were determined.

The information provided by Geosyntec Consultants indicated that a water table existed at eight of the nine SASW array locations. It was assumed, therefore, that the material below the water table was saturated. The shear modulus values calculated from the measured V_S values and assumed total unit weights below the water table were added to the plot of shear modulus versus mean effective stress determined from measured V_S values and measured total unit weights.. In the calculation of mean effective stress and shear modulus below the water table, a saturated unit weight in the range of 80 pcf to 95 pcf was assumed. The assumed values of total unit weights are presented in column 3 of Tables 3 through 10. In addition, positive pore pressures were assumed below the location of the water table supplied by Geosyntec Consultants. The assumed unit weights below the water table were adjusted so that the data from waste below the water table fit the trend determined from the measured data. The details of this procedure and results are presented below.

3.3 Results and Discussion:

3.3.1 Total Unit Weight Estimation

The low-strain shear modulus versus mean effective stress relationship for the data with measured total unit weights is shown in Figure 18. The data follow a power function trend with some outlying data points. The outlying data are discussed below. The best fit to this trend (excluding the four outlying data points indicated in Figure 18) yielded a relationship of the form:

$$G_{max} = 419 \bullet \left(\frac{\overline{\sigma}_o}{P_a} \right)^{0.600} \tag{7}$$

where P_a is atmospheric pressure in the same units as $\overline{\sigma}_o$.

With the trend line established in Figure 18, the results predicted from the initial estimated saturated unit weights and measured shear wave velocities below standing water (presumed water table) were added to the "measured" data set. This complete set of data (measured and assumed total unit weights) is presented in Figure 19. The G_{max} values versus $\overline{\sigma}_O$ data points from the depths located below the presumed water table are shown as black symbols. It is clear from Figure 19 that all of the values from depths below the presumed water table plot above the relationship determined from the G_{max} versus $\overline{\sigma}_O$ values determined with measured total unit weights. It appears that the total unit weights that were assumed below the water table to calculate G_{max} were too high.

To correct the G_{max} values where total unit weights have been assumed, the assumed total unit weights were changed and the G_{max} values were recalculated. In most cases the total unit weight required to move the data points to the expected trend fell below the expected range for saturated unit weights. At sites SASW02, SASW03, SASW05, and SASW06, it appeared that no standing water was evident (with the

possible exception of perched layers). Therefore, the effective stress values were also recalculated assuming no standing water (and hence no positive porewater pressure) in the waste. At sites SASW04, SASW07, SASW08, and SASW09, the bottom most layers of the waste had unit weights that could be saturated (considering the expected range in void ratio and specific gravity). At these sites, the mean effective stresses were recalculated assuming standing water existed in the bottom layer of the waste. It is not possible to say with certainty that standing water exists or does not exist, but the assumption was made that it did exist at some sites where the unit weights indicated it was possible. The last column in Tables 3 through 10 present the total unit weights that were either measured or were finally estimated by adjusting G_{max} (and effective stress as described above) to meet the expected general trend.

The final data set is presented in Figure 20. Clearly, a very reasonable trend exists. However, there also appear to be systematic differences. For example, the measured data set from location SASW02 plotted below the expected trend at all effective stress values. Therefore, when the data points for SASW02 were adjusted, they were made to fit below the trend so that they would be consistent with the other points from SASW02. In addition, two of the measured total unit weight values at SASW02 appear to be too low. These data points are denoted by "1" next to the solid circles, and the final estimated unit weights represented by these points were increased slightly to better fit the trend. The fact that SASW02 followed a different trend may be an indication of the age, degradation of the waste or other unknown factors at this location. SASW04 and SASW09, on the other hand, followed a trend slightly above the expected trend. In addition, there are three outlying points in Figure 20, indicated by the circle. These data may indicate drier waste material. Laboratory studies at the University of Texas have shown significantly higher velocities in simulated waste (sand and paper) that is dry compared to wet simulated waste material (Menq et al., 2001). However, other unknown factors could also affect the waste.

One way to study the trend in total unit weights that were used to generate Figure 20 is to plot γ_t versus $\bar{\sigma}_o$. This plot is shown in Figure 21. The general trend of γ_t increasing somewhat with increasing $\bar{\sigma}_o$ seems quite reasonable.

4.0 Summary and Conclusions

The SASW method was used at the Cherry Island Landfill to determine shear wave velocity profiles at nine locations on the landfill and at two locations around the base of the landfill. Shear wave velocities of the waste, dredged material below the waste, and natural alluvium below the dredged material were measured The measurements show all of these materials to be very soft, with V_S values generally ranging from 155 ft/s to 450 ft/s for the waste (excluding SASW01), 330 ft/s to 500 ft/s for the dredged material (excluding the shallow material at SASW11), and 400 ft/s to 600 ft/s for the natural alluvium.

The shear wave velocities of the waste were then used with measured total unit weights of the waste (supplied by GeoSyntec Consultants) to estimate total unit weights of the waste at depths below which the total unit weights could be measured directly. It was found that low-strain shear modulus, not shear wave velocity, was more appropriate for estimating total unit weights at depths below standing water in the borehole. The

estimated total unit weights formed a consistent trend with the measured values as shown in Figure 21.

Respectfully Submitted,

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Table 1 Shear Wave Velocity and Effective Stress Values of the Dredged Material

Site Location	Shear Wave Velocity, fps	Total Vertical Stress, psf	Porewater Pressure, psf *	Vertical Effective Stress, psf	Mean Effective Stress, ** psf
SASW02	450	4943	-936	5879	3919
SASW03	380	3269	-2184	5453	3635
SASW03	380	5469	-936	6405	4270
SASW04	400	2147	-2246	4393	2929
SASW04	400	2999	-1747	4823	3215
SASW05	400	5307	-1404	6711	4474
SASW06	350	4351	-1341	5693	3795
SASW07	330	5019	-1341	6360	4240
SASW08	400	4996	-1435	6431	4287
SASW09	380	4333	-1373	5706	3804
SASW10	500	2350	-1872	4222	2815
SASW10	500	4275	-780	5055	3370
SASW11+	200	405	-93.6	499	333
SASW11+	315	2440	1061	1379	919

* Water table assumed at bottom of dredged material (except at SASW11). Linear trend of negative porewater pressures assumed in the dredge material

** Assuming $K_O = 0.5$

+ At SASW11 water table assumed to be at a depth of 5 ft

Table 2 Shear Wave Velocity and Effective Stress Values of the Alluvial Material

Site Location	Shear Wave Velocity, fps	Total Vertical Stress, psf	Porewater Pressure, psf *	Vertical Effective Stress, psf	Mean Effective Stress, ** psf
SASW02	600	7748	655	7093	4729
SASW03	450	8329	686	7642	5095
SASW05	400	9432	936	8496	5664
SASW05	600	11467	2090	9377	6251
SASW06	400	8091	780	7311	4874
SASW07	400	9639	1279	8360	5573
SASW08	400	9616	1186	8430	5620
SASW09	450	8293	874	7419	4946
SASW10	600	8510	1622	6888	4592
SASW11+	500	5410	2746	2664	1776

* Water table assumed at bottom of dredged material (except at SASW11). Linear trend of negative porewater pressures assumed in the dredged material

** Assuming $K_O = 0.5$

+ At SASW11 water table assumed to be at a depth of 5 ft

Table 3: Unit Weight Values at Site 02

Layer Thickness, ft	Initial Unit Weight, pcf		Final Estimated Unit Weight, pcf ***
	Measured *	Assumed **	
1.5 - Cover	-	-	N/A
8.5	46	-	46
8	54	-	54
3	54	-	65+
5	66	-	75+
10	-	80	65
13	-	90	82

* Average of maximum and minimum values provided by Geosyntec (see Appendix B)

** Assumed values based on estimated saturated unit weights

*** Final values determined after analysis of stiffness vs. effective stress relationship

\+ Analysis indicates that measured unit weights are too low

Table 4: Unit Weight Values at Site 03

Layer Thickness, ft	Initial Unit Weight, pcf		Final Estimated Unit Weight, pcf ***
	Measured *	Assumed **	
2 - Cover	-	-	N/A
8	52	-	52
10	62	-	62
6	80	-	80
2	-	95	75
10	-	95	82

* Average of maximum and minimum values provided by Geosyntec (see Appendix B)

** Assumed values based on estimated saturated unit weights

*** Final values determined after analysis of stiffness vs. effective stress relationship

Table 5: Unit Weight Values at Site 04

Layer Thickness, ft	Initial Unit Weight, pcf		Final Estimated Unit Weight, pcf ***
	Measured *	Assumed **	
3 - Cover	-	-	N/A
7	52	-	52
10.5	69	-	69
3	-	85	85

* Average of maximum and minimum values provided by Geosyntec (see Appendix B)

** Assumed values based on estimated saturated unit weights

*** Final values determined after analysis of stiffness vs. effective stress relationship

Table 6: Unit Weight Values at Site 05

Layer Thickness, ft	Initial Unit Weight, pcf		Final Estimated Unit Weight, pcf ***
	Measured *	Assumed **	
2 - Cover	-	-	N/A
8	36	-	36
5	94	-	80+
5	94	-	60+
4.5	85	-	.70+
13.5	-	95	70

* Average of maximum and minimum values provided by Geosyntec (see Appendix B)

** Assumed values based on estimated saturated unit weights

*** Final values determined after analysis of stiffness vs. effective stress relationship

\+ Analysis indicates that measured unit weights are too low

Table 7: Unit Weight Values at Site 06

Layer Thickness, ft	Initial Unit Weight, pcf		Final Estimated Unit Weight, pcf ***
	Measured *	Assumed **	
2-Cover	-	-	N/A
8	51	-	51
10	65	-	65
5	56	-	65+
6	56	-	75+

* Average of maximum and minimum values provided by Geosyntec (see Appendix B)

** Assumed values based on estimated saturated unit weights

*** Final values determined after analysis of stiffness vs. effective stress relationship

\+ Analysis indicates that measured unit weights are too low

Table 8: Unit Weight Values at Site 07

Layer Thickness, ft	Initial Unit Weight, pcf		Final Estimated Unit Weight, pcf ***
	Measured *	Assumed **	
0.7-Cover	-	-	N/A
9.3	49	-	49
6.5	67	-	67
3.5	-	85	70
5	-	90	80
11	-	95	90

* Average of maximum and minimum values provided by Geosyntec (see Appendix B)

** Assumed values based on estimated saturated unit weights

*** Final values determined after analysis of stiffness vs. effective stress relationship

Table 9: Unit Weight Values at Site 08

Layer Thickness, ft	Initial Unit Weight, pcf		Final Estimated Unit Weight, pcf ***
	Measured *	Assumed **	
2-Cover	-	-	N/A
8	55	-	55
10	54	-	54
9	70	-	70
9	-	88	88

* Average of maximum and minimum values provided by Geosyntec (see Appendix B)

** Assumed values based on estimated saturated unit weights

*** Final values determined after analysis of stiffness vs. effective stress relationship

Table 10: Unit Weight Values at Site 09

Layer Thickness, ft	Initial Unit Weight, pcf		Final Estimated Unit Weight, pcf ***
	Measured *	Assumed **	
2-Cover	-	-	N/A
8	56	-	56
10	63	-	63
8	-	88	88

* Average of maximum and minimum values provided by Geosyntec (see Appendix B)

** Assumed values based on estimated saturated unit weights

*** Final values determined after analysis of stiffness vs. effective stress relationship

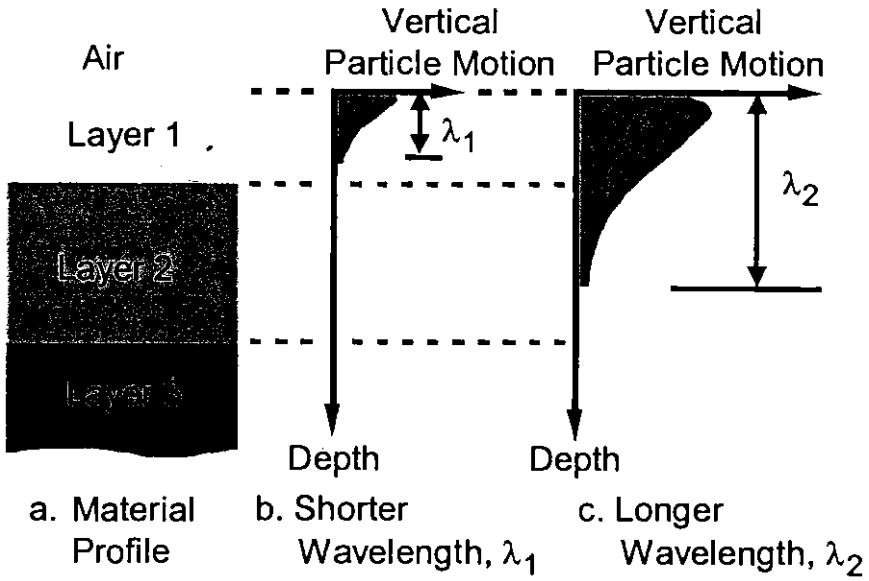


Figure 1 Illustration of Surface Waves with Different Wavelengths Sampling Different Materials in a Layered System which Results in Dispersion in Wave Velocities

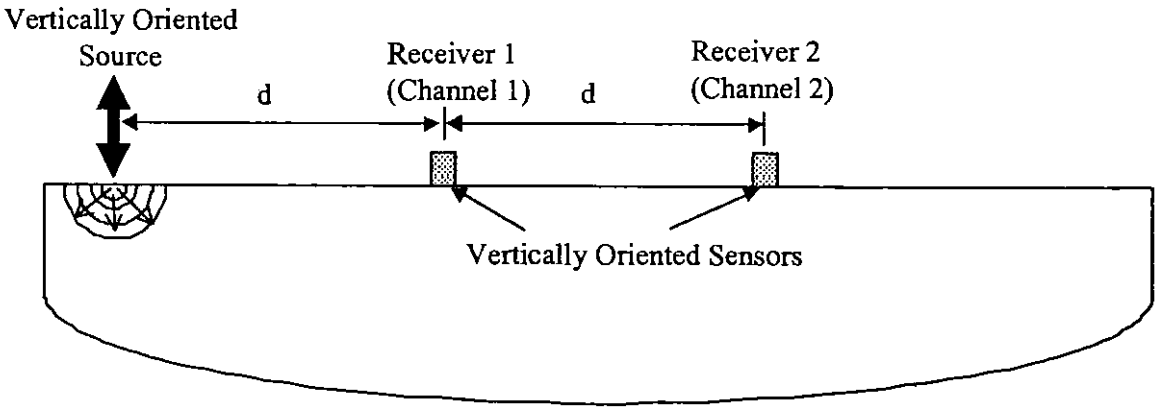


Figure 2 Typical Source-Receiver Arrangement for One Receiver Set-up Used in SASW Testing (Typically, testing is composed of 5 or more receiver set-ups with increasing values of "d")

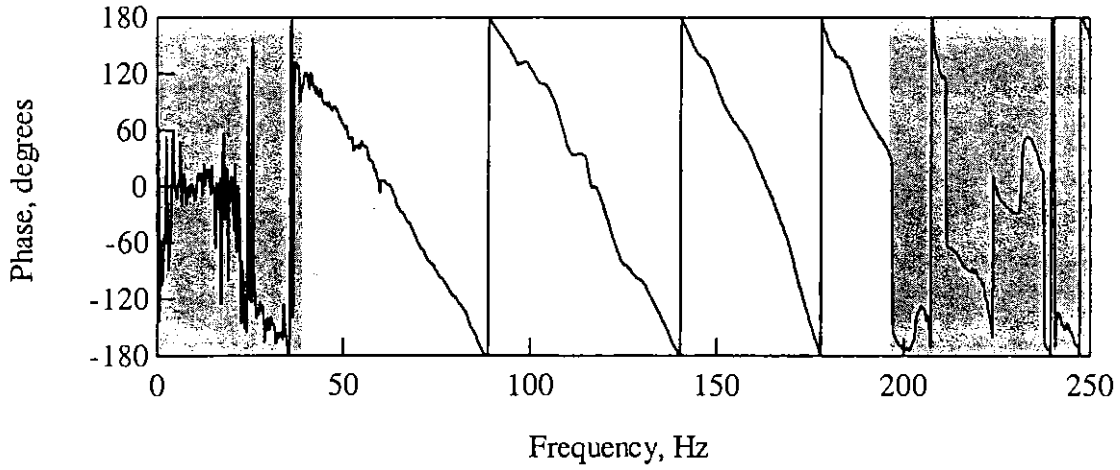


Figure 3 Phase Plots Measured by SASW Testing with 12-ft Receiver Spacing (data not used in analysis is shown as shaded)

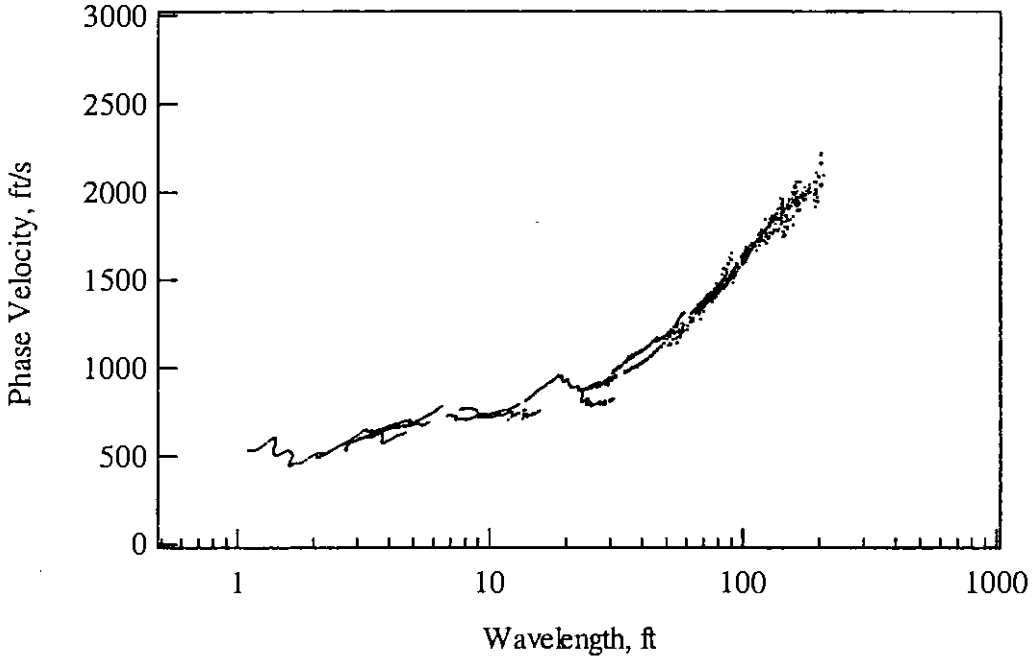


Figure 4 Experimental Dispersion Curve from Seven Receiver Spacings of 3 ft, 6 ft, 12 ft, 25 ft, 50 ft, 100 ft, and 200 ft

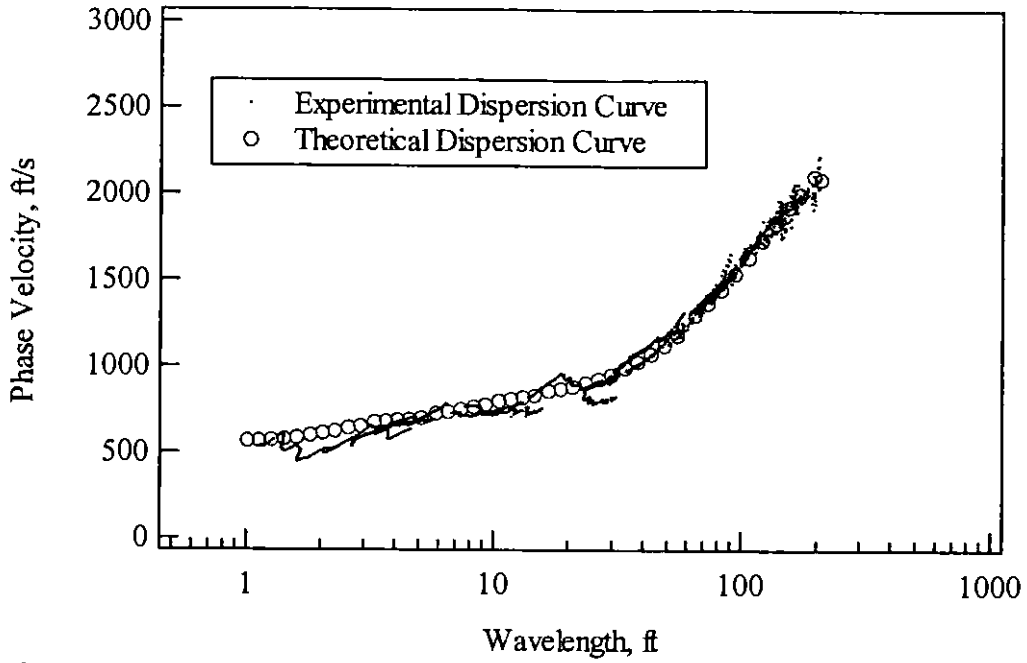


Figure 5 Experimental Dispersion Curve Shown in Figure 4 and Matching Theoretical Dispersion Curve

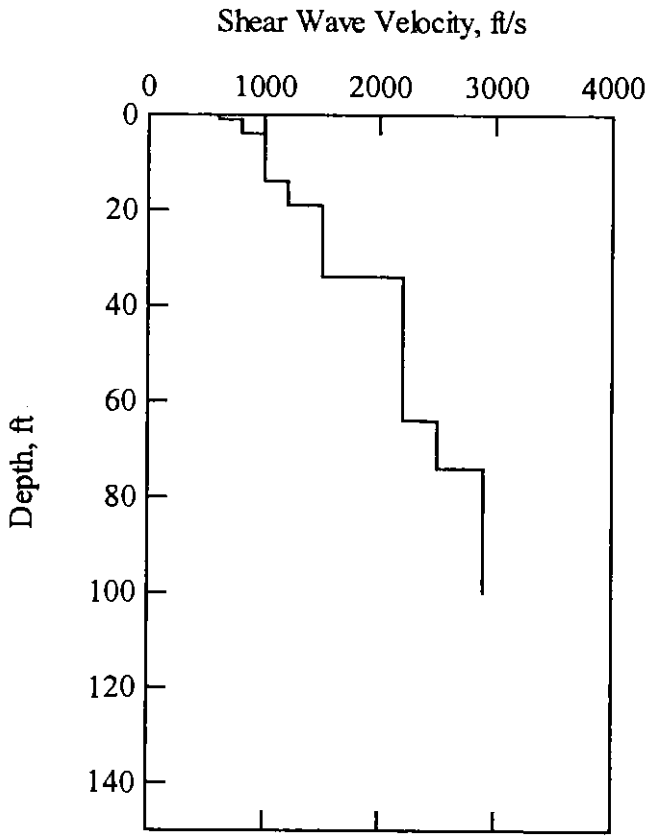


Figure 6 Shear Wave Velocity Profile from SASW Testing

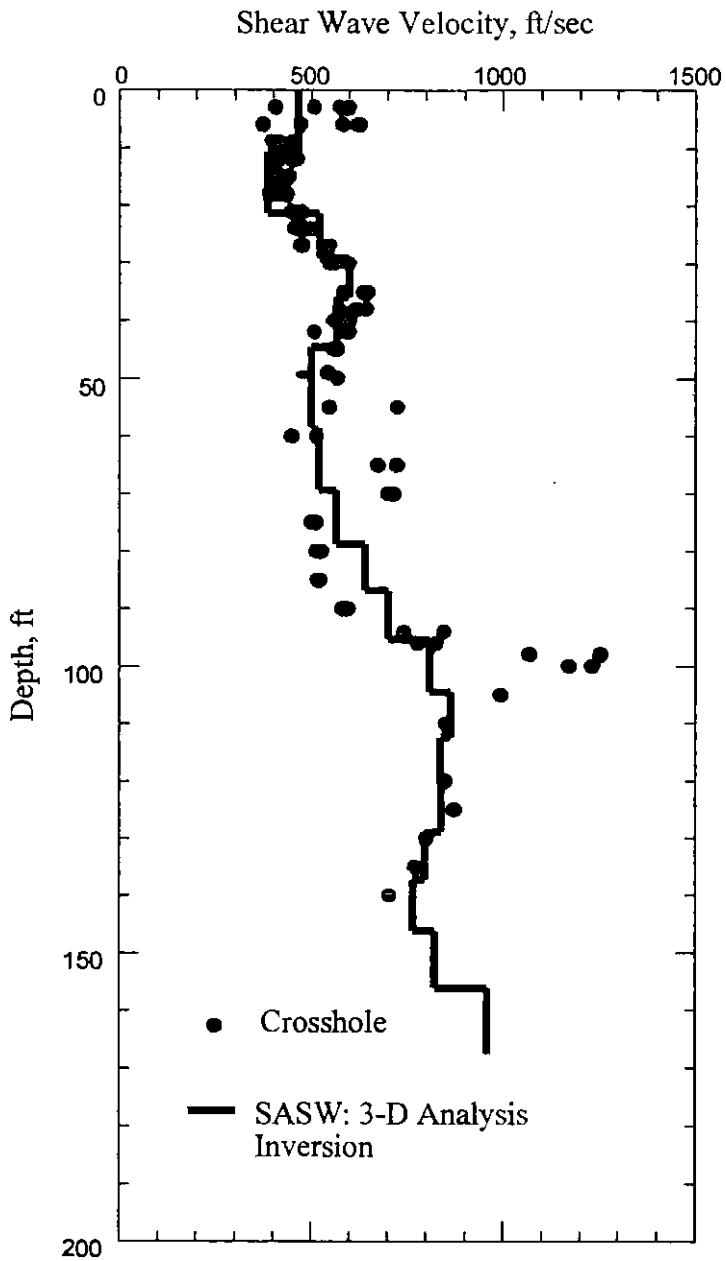


Figure 7 Comparison of Shear Wave Velocity Profiles from SASW and Crosshole Measurements Performed at the Treasure Island Site in California (from Joh, 1996)

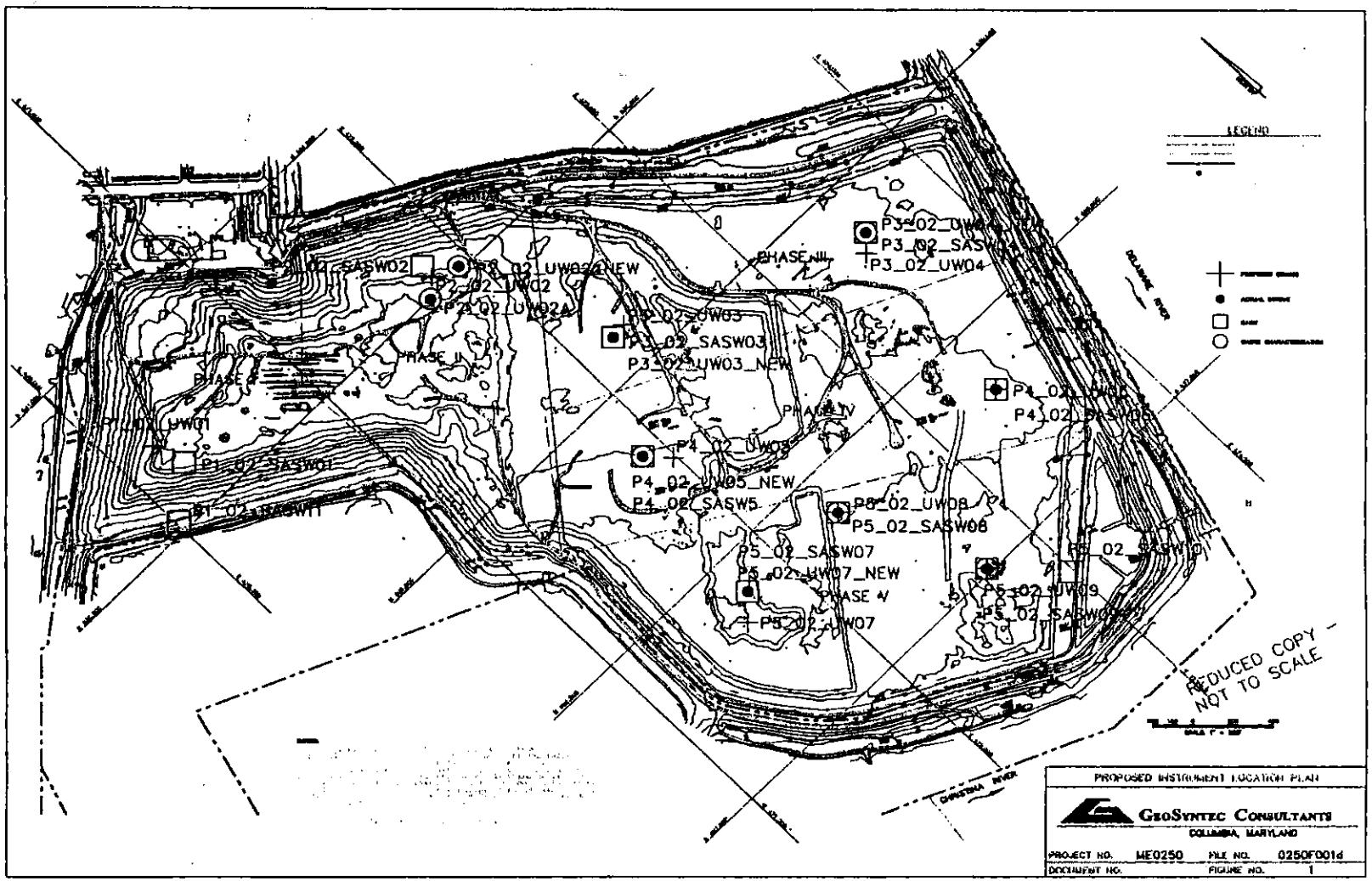


Figure 8 Map of Borehole and SASW Locations on and Around the Cherry Island Landfill (from Geosyntec Consultants)

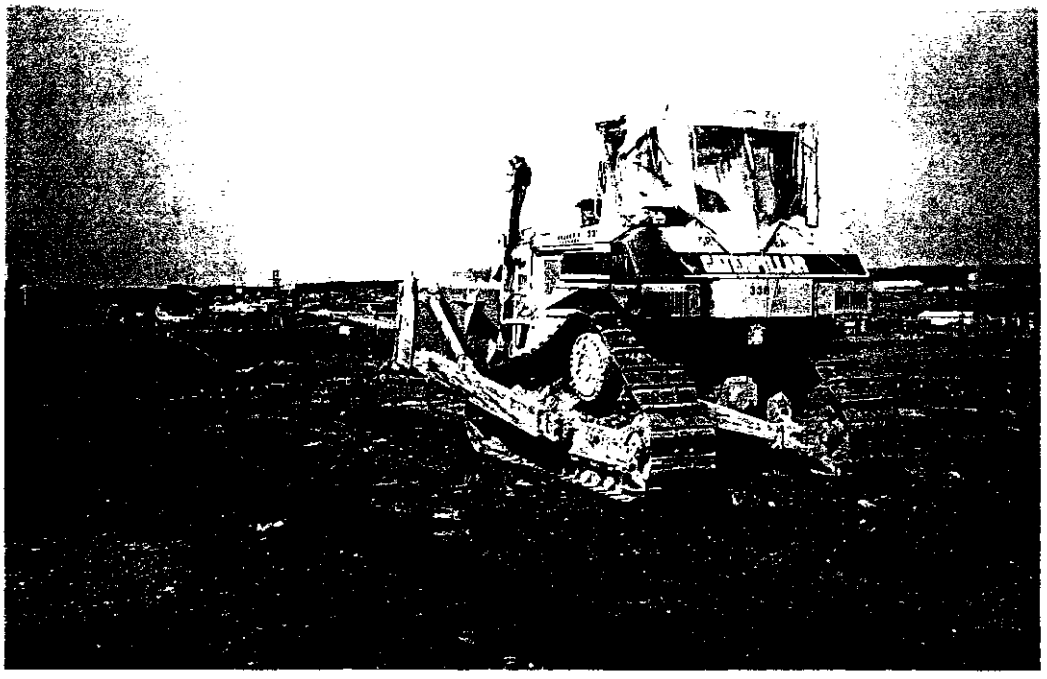


Figure 9 Bulldozer in Operation at Site SASW02

Figure 10 Dynamic Signal Analyzer used for Data Collection and Dr. Rosenblad

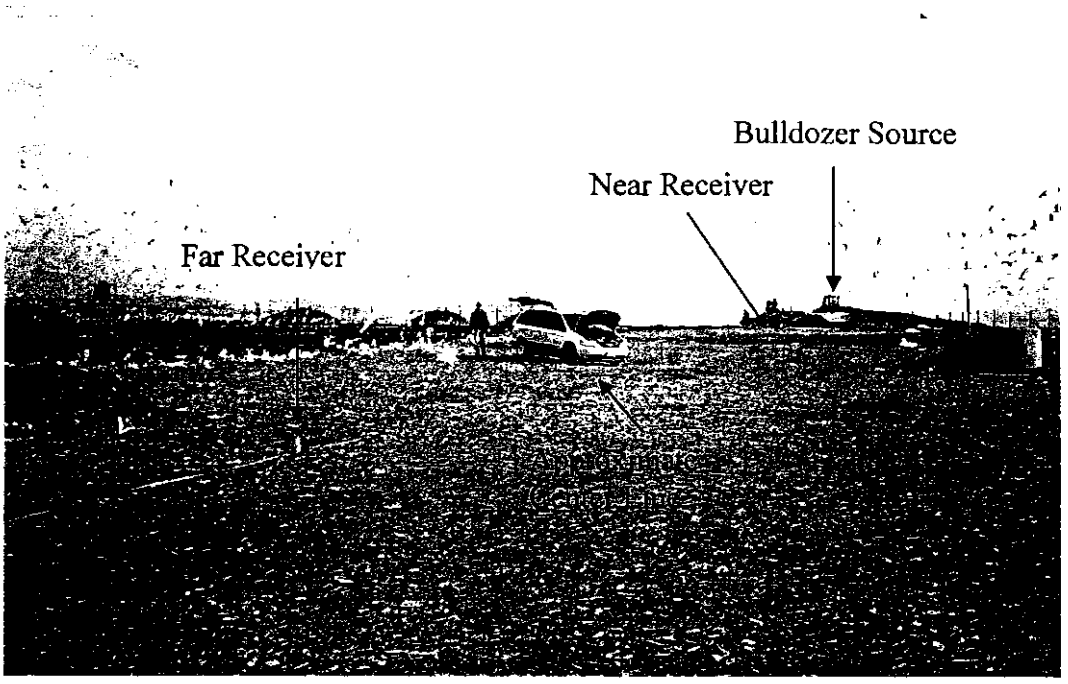


Figure 11 SASW Testing with a Receiver Spacing of 160 ft at Location SASW06

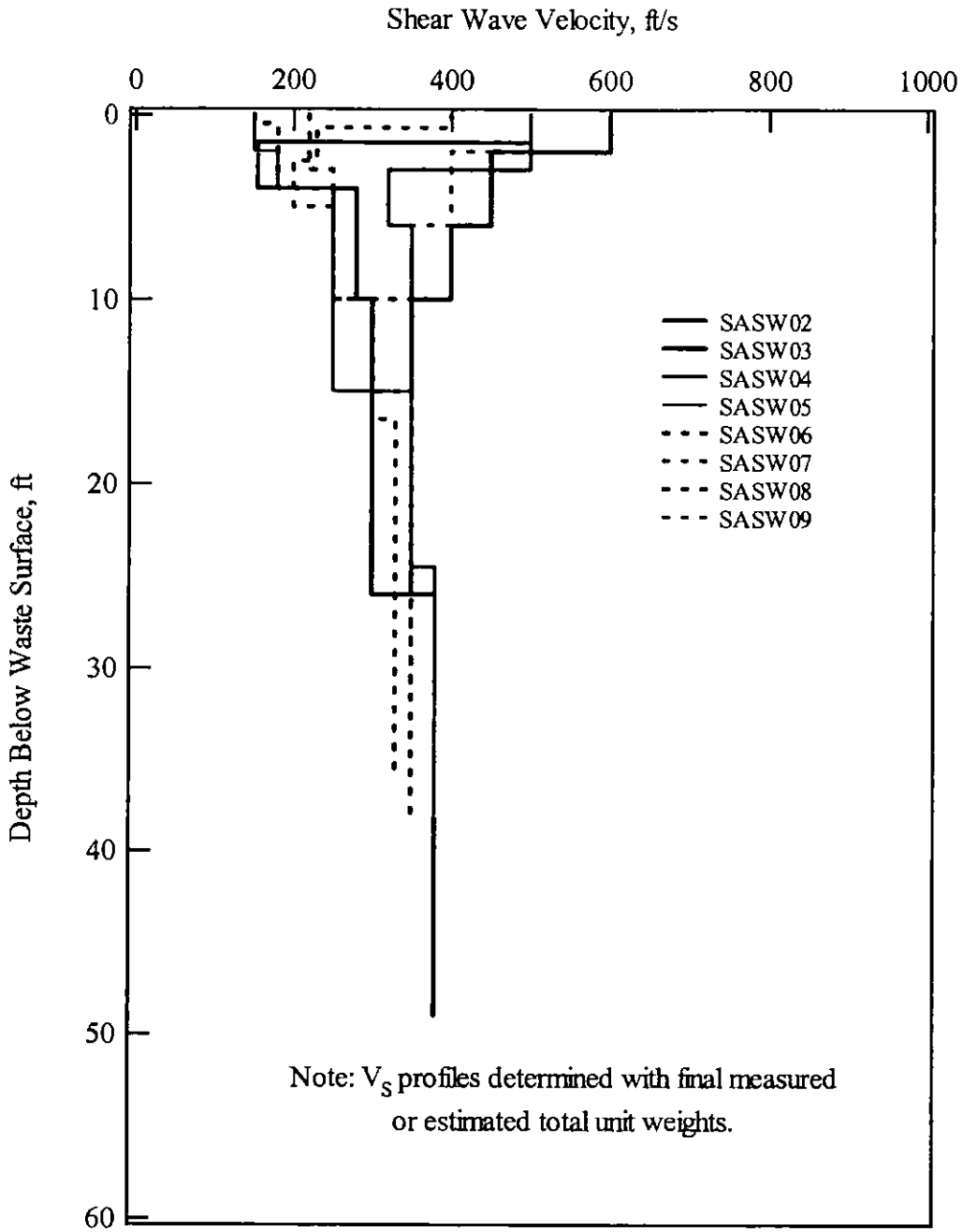


Figure 12 Shear Wave Velocity Profiles Measured in Waste Materials at Sites SASW02 through SASW09

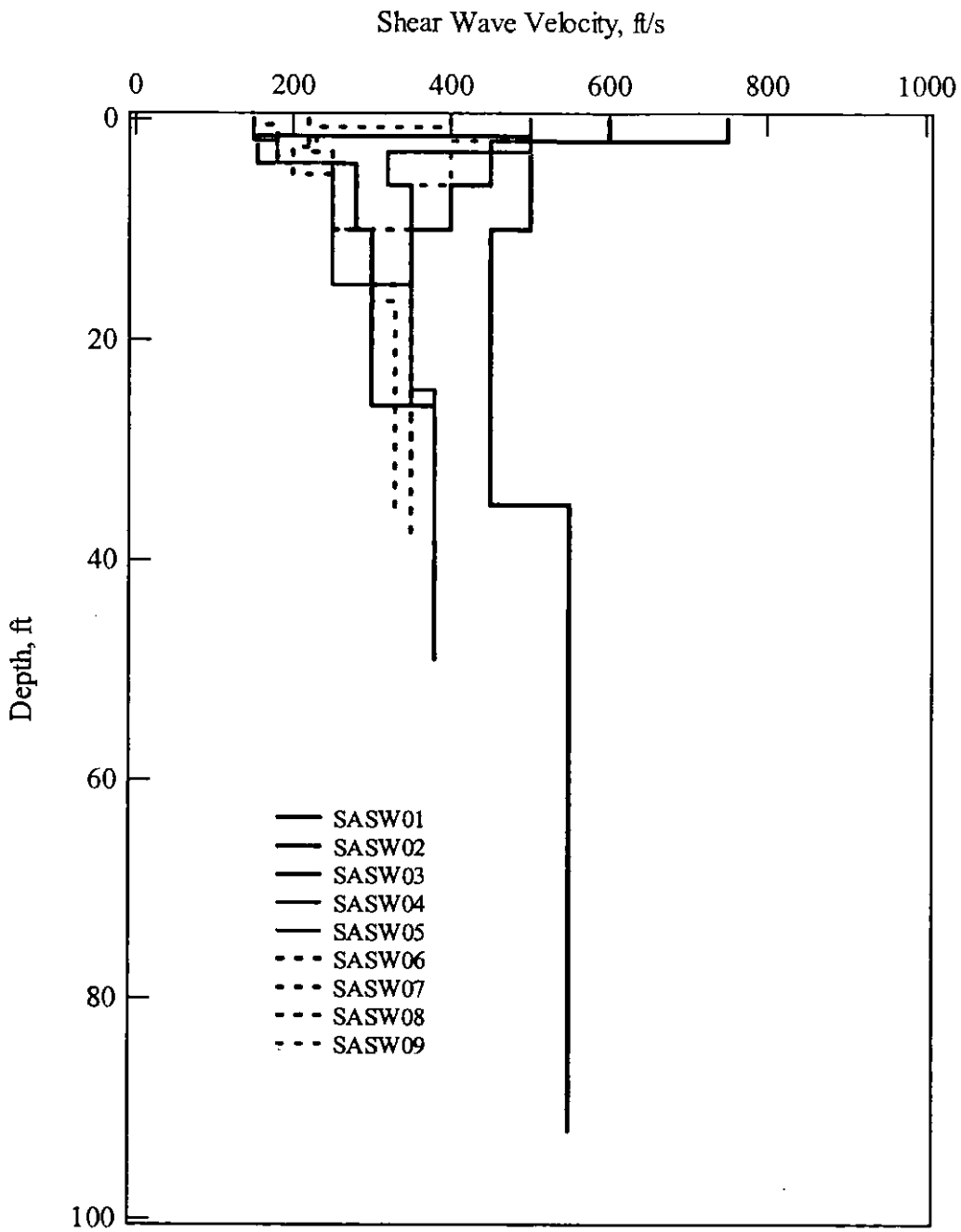


Figure 13 Shear Wave Velocity Profile Measured at SASW01 Compared with Profiles Measured in Waste Materials at Sites SASW02 through SASW09

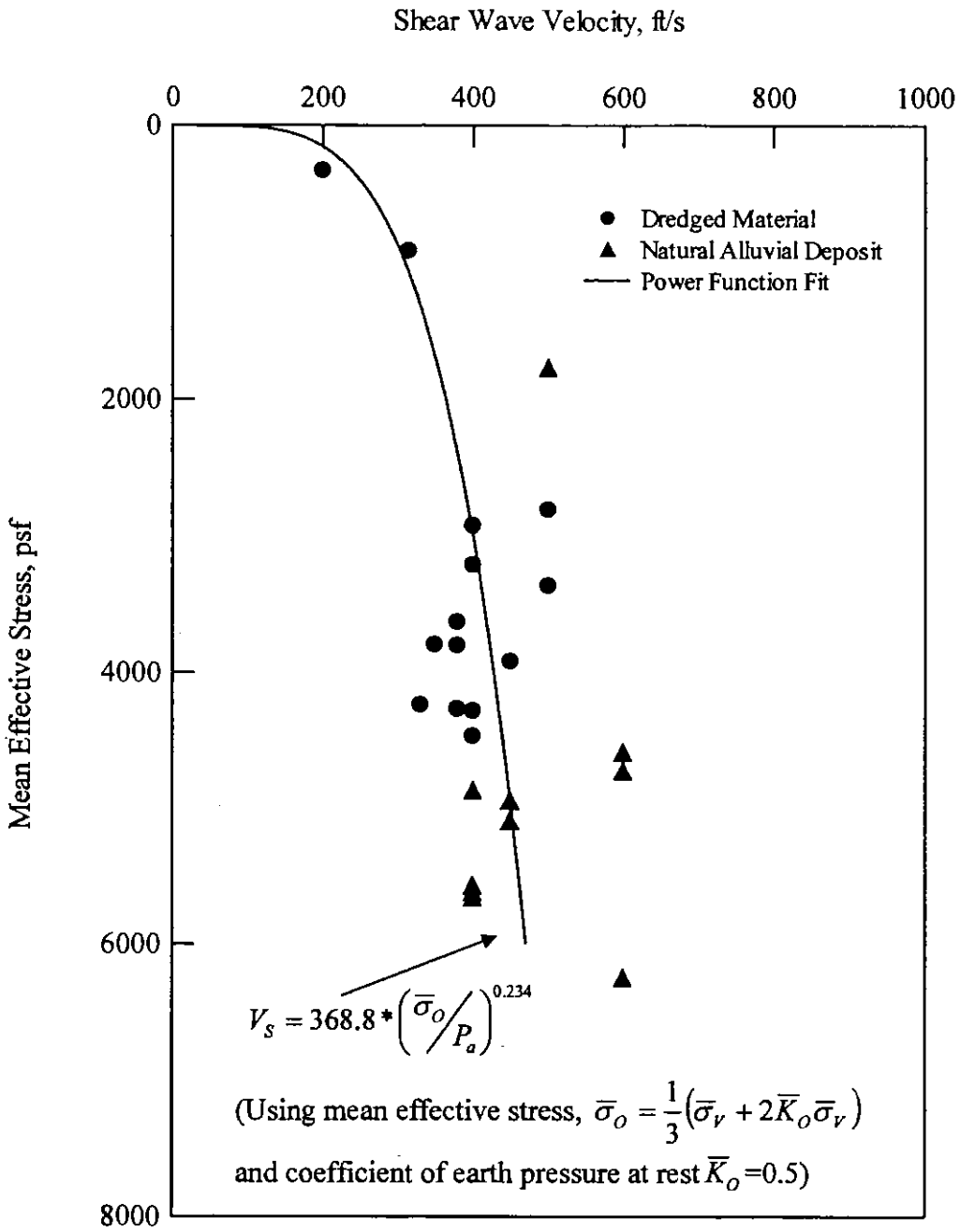


Figure 14 Shear Wave Velocity Profiles Measured in the Dredged Material and the Natural Alluvium at Sites SASW02 through SASW09

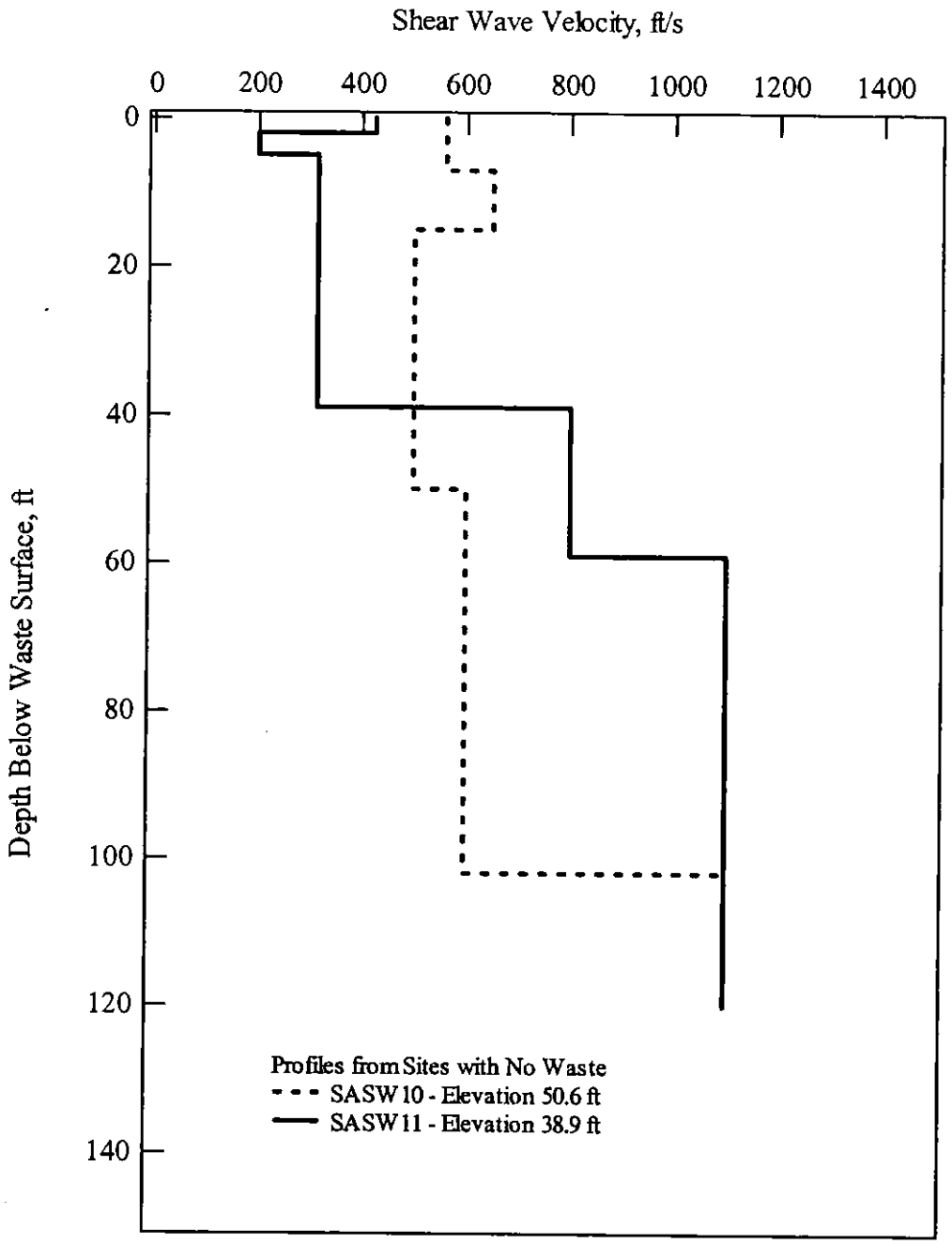


Figure 15 V_S Profiles at Sites SASW10 and SASW11 which Contain No Waste Materials in the Profile

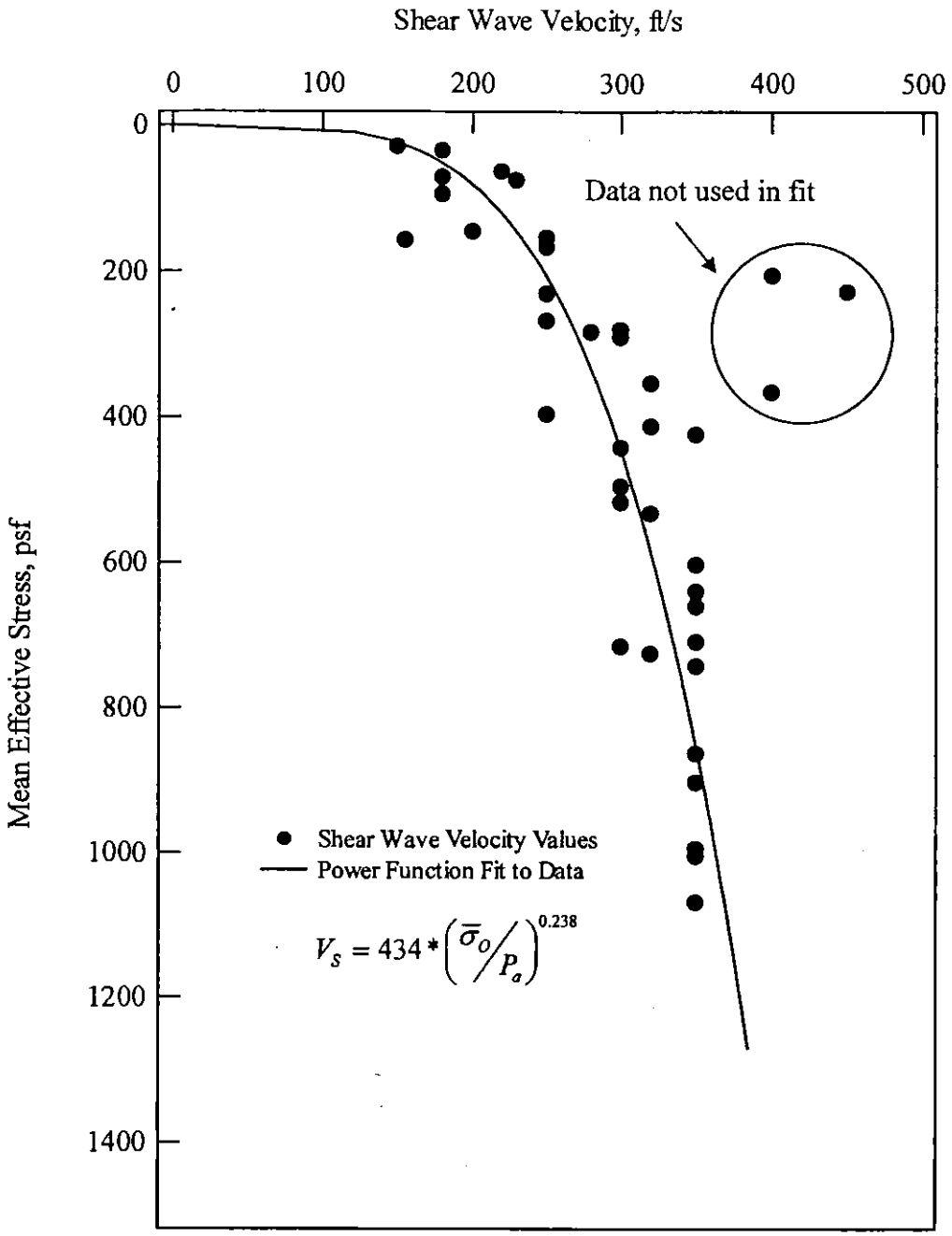


Figure 16 Relationship between Shear Wave Velocity and Mean Effective Stress for Waste Material where Total Unit Weight was Measured

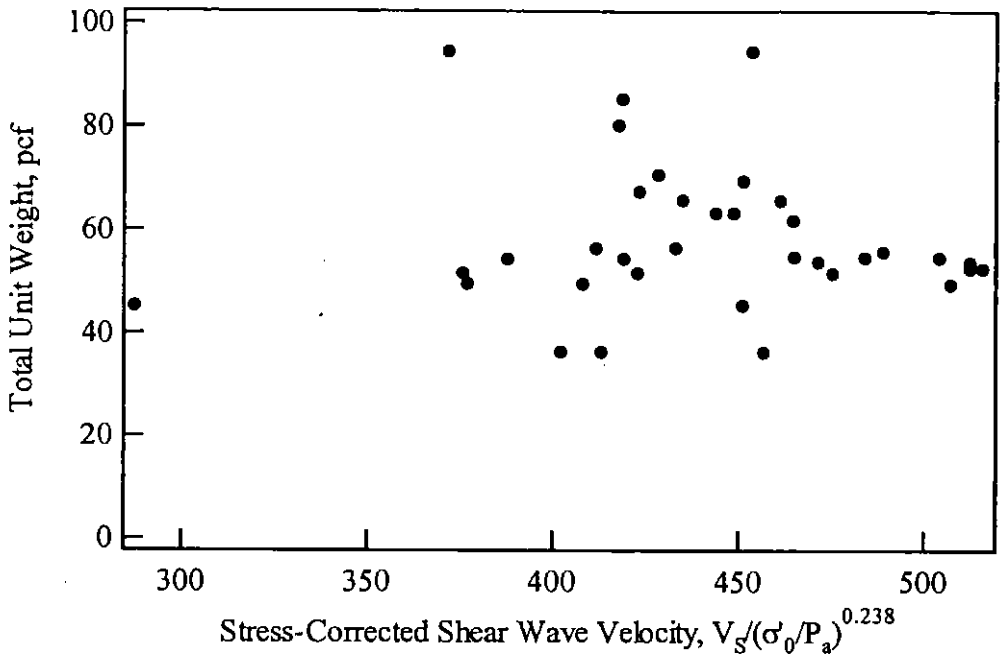


Figure 17 Relationship between Stress-Corrected Shear Wave Velocity and Total Unit Weight for Waste Material where Total Unit Weight was Measured

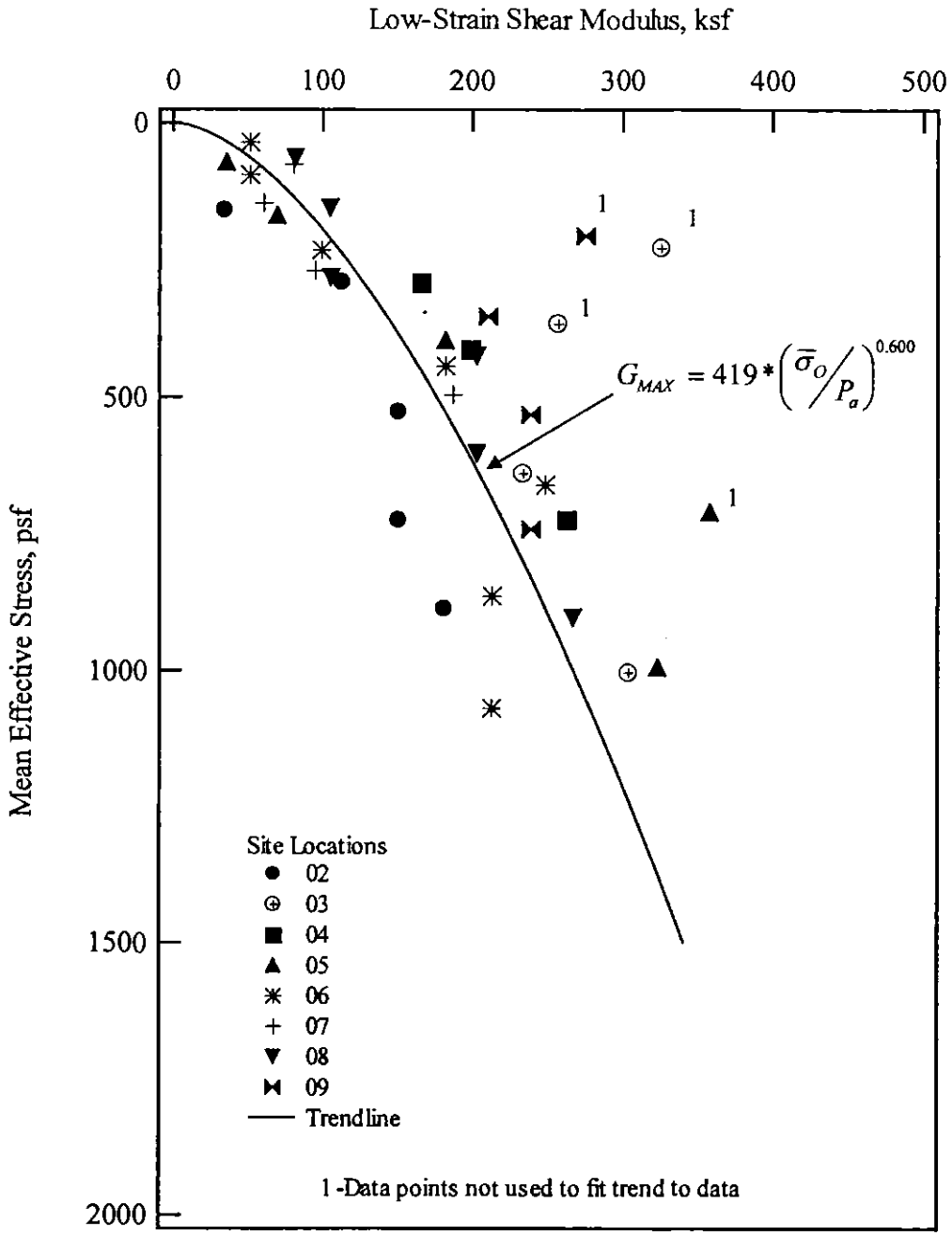


Figure 18 Relationship between Low-Strain Shear Modulus (G_{max}) and Mean Effective Stress ($\bar{\sigma}_o$) for Waste with Measured Total Unit Weights

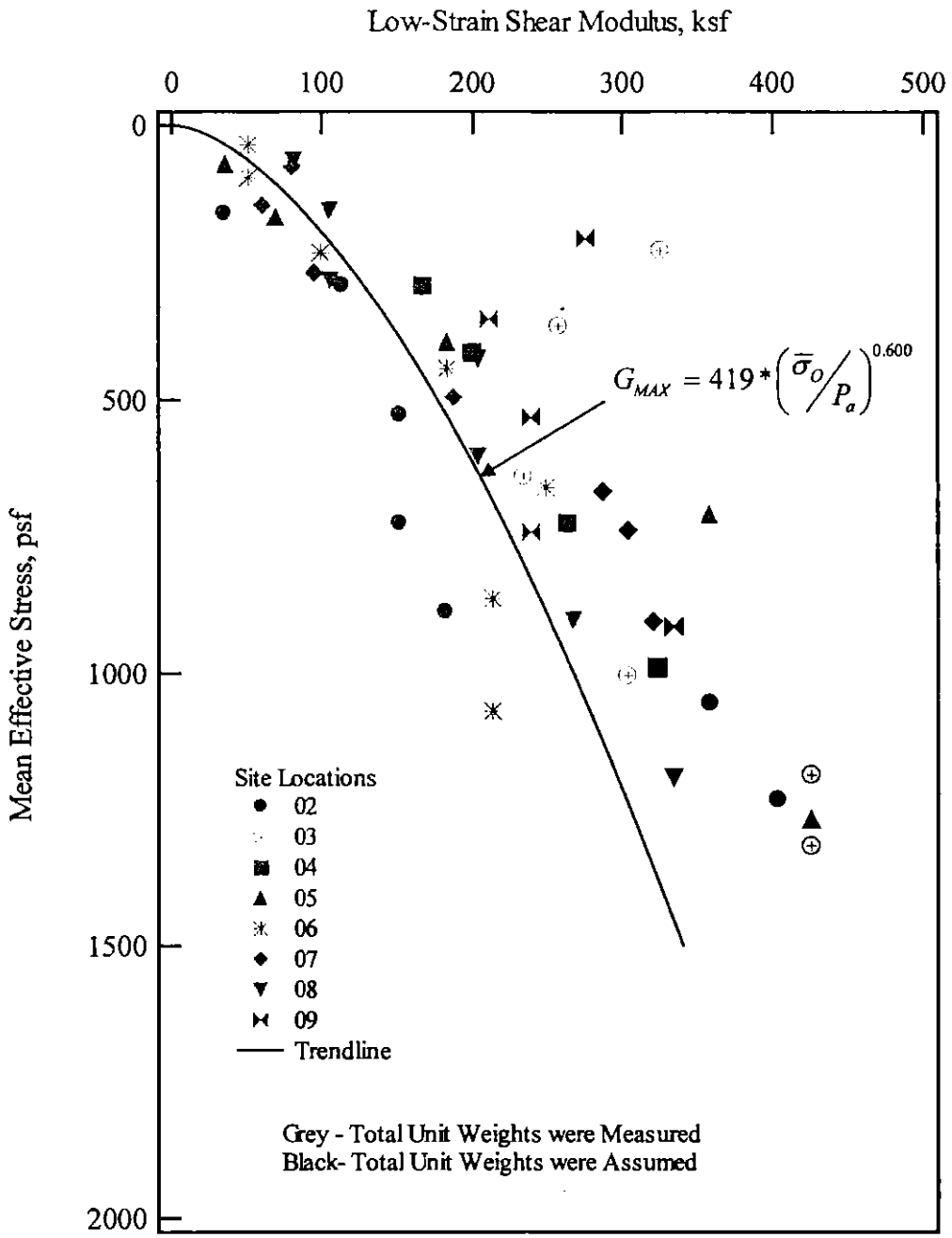


Figure 19 G_{max} versus Mean Effective Stress ($\bar{\sigma}_O$)for Waste with Measured Total Unit Weights (Grey) and Waste with Initially Assumed Total Unit Weights (Black)

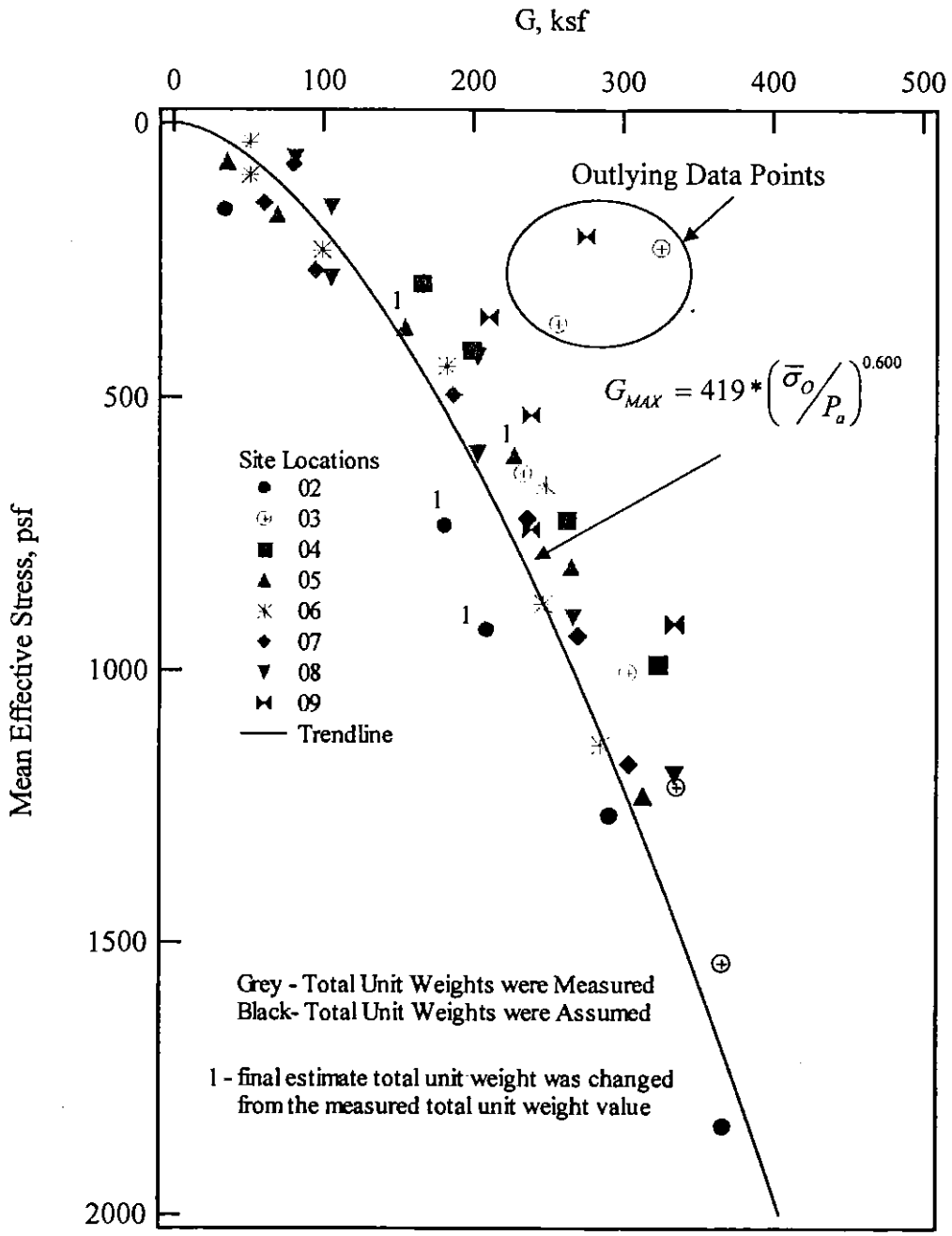


Figure 20 G_{max} versus Mean Effective Stress ($\bar{\sigma}_O$) for Waste with Measured Unit Weights and Adjusted Values of Initial Measured and with Assumed Unit Weights

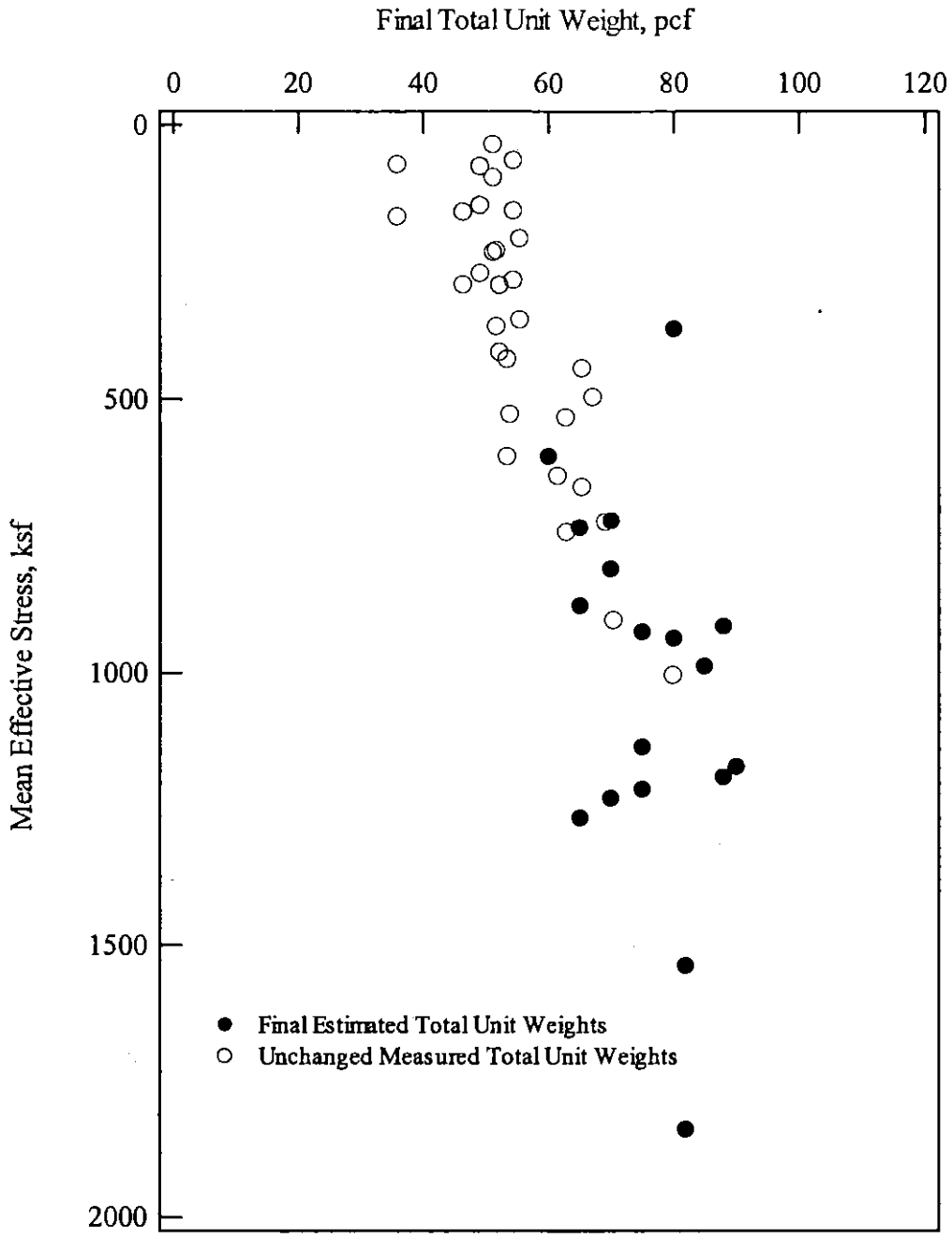


Figure 21 General Trend in Total Unit Weight with Mean Effective Stress Determined from Measured and Estimated Values

APPENDIX A

Results from Eleven SASW Arrays Located On and Around the Cherry Island Landfill

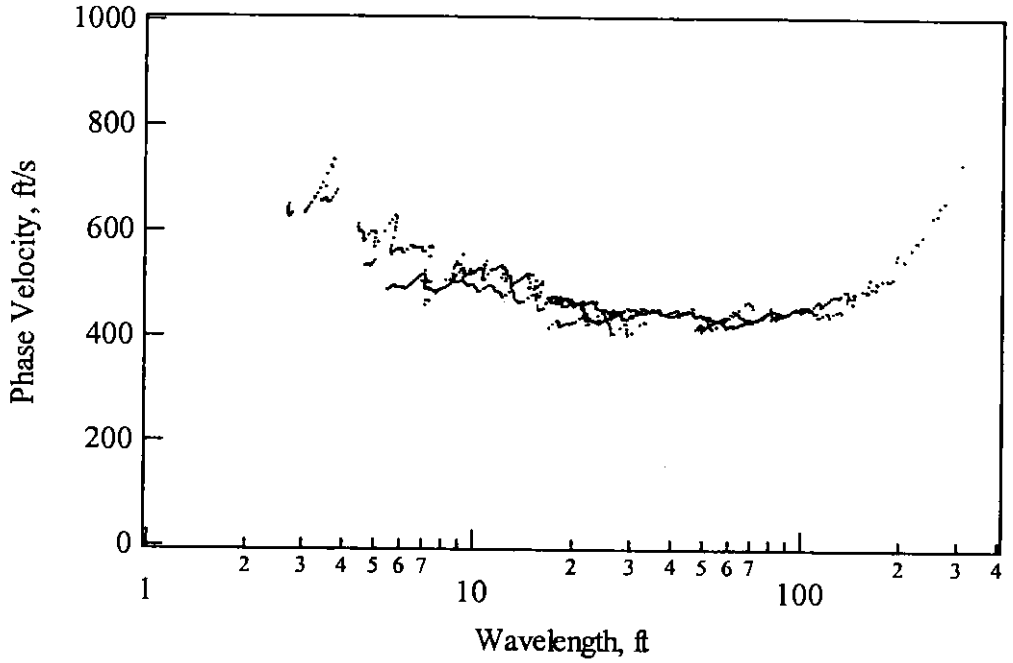


Figure A1 Experimental Dispersion Curve from SASW Testing at Site SASW01

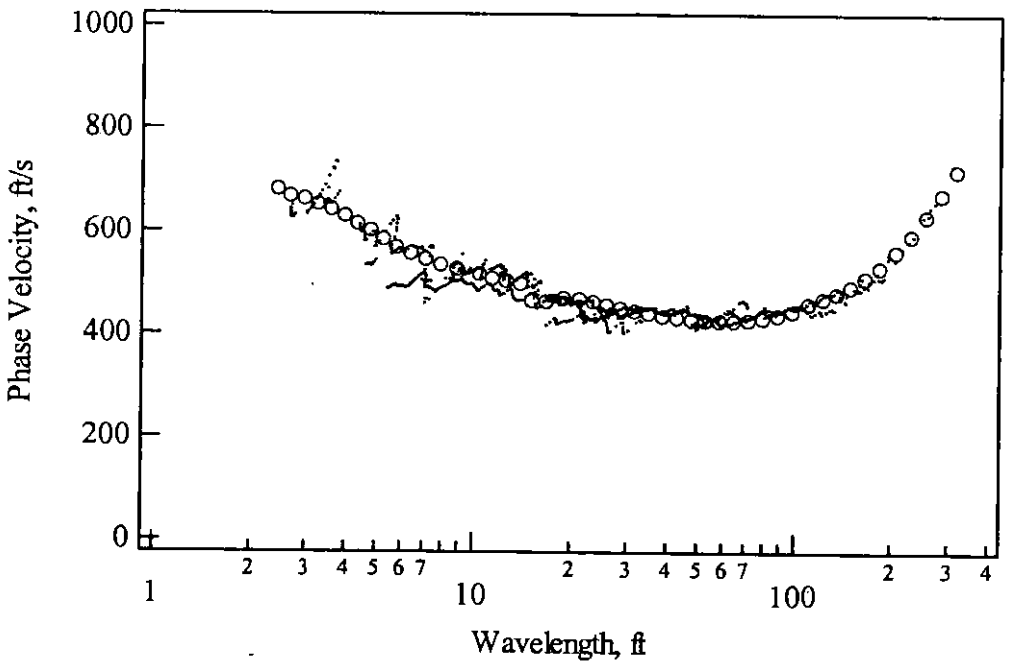


Figure A2 Theoretical and Experimental Dispersion Curve from SASW Testing at Site SASW01

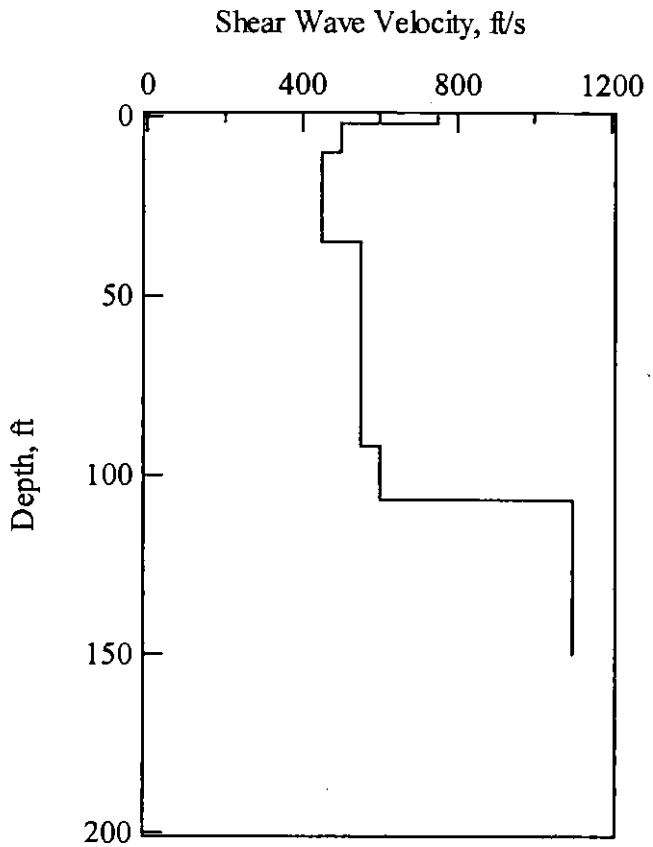


Figure A3 Shear Wave Velocity Profile Determined at Site SASW01

Table A1 Profile Parameters Used to Develop Theoretical Dispersion Curve at Site SASW01

Layer No.	Material Type *	Thickness, ft	P-Wave Velocity, ft/s	S-Wave Velocity, ft/s	Poisson's Ratio	Unit Weight, pcf ***
1	C	2	1403	750	0.3	120
2	W	8	935	500	0.3	160
3	W	5	842	450	0.3	160
4	W	5	842	450	0.3	85
5	W	15	842	450	0.3	85
6	W	57	1347	550	0.4	95
7	A	15	5000	~600**	0.493	110
8	CO	43	5000	1100	0.475	110

*C- Cover; W-Waste; D-Dredge Material; A-Alluvium; CO-Columbia Formation

** Layer too deep and too thin to accurately resolve V_S

*** Assumed values, no unit weights estimated at SASW01

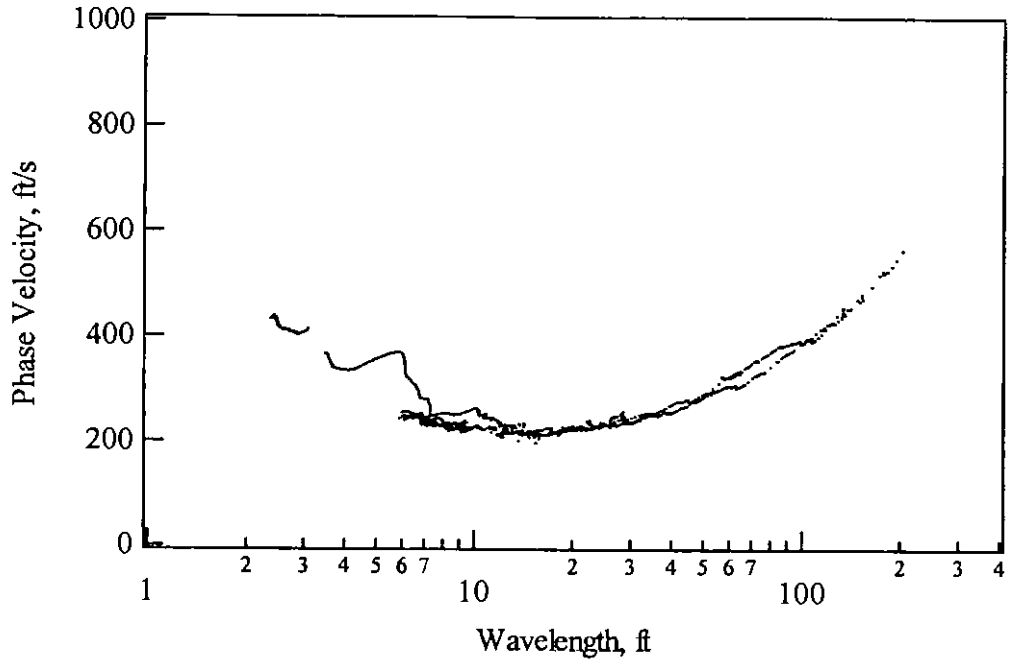


Figure A4 Experimental Dispersion Curve from SASW Testing at Site SASW02

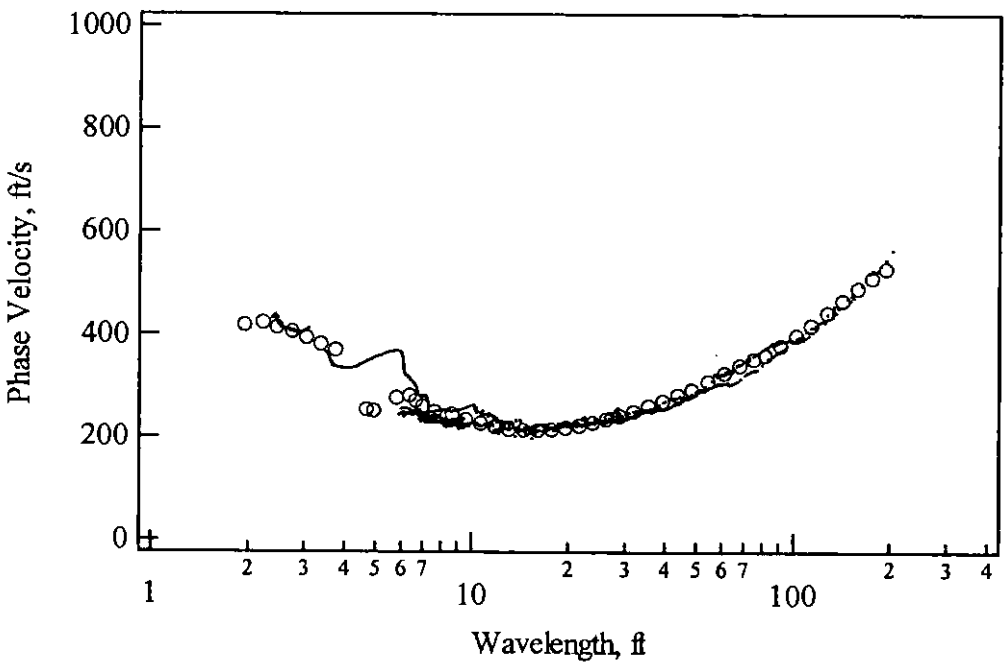


Figure A5 Theoretical and Experimental Dispersion Curve from SASW Testing at Site SASW02

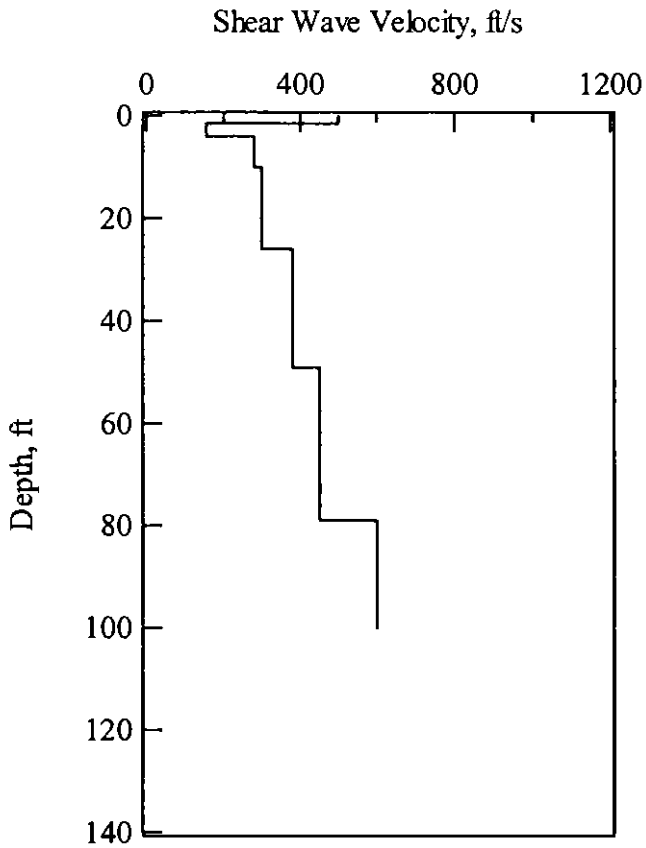


Figure A6 Shear Wave Velocity Profile Determined at Site SASW02

Table A2 Profile Parameters Used to Develop Theoretical Dispersion Curve at Site SASW02

Layer No.	Material Type *	Thickness, ft	P-Wave Velocity, ft/s	S-Wave Velocity, ft/s	Poisson's Ratio	Unit Weight, pcf
1	C	1.5	935	500	0.3	120
2	W	2.5	290	155	0.3	46
3	W	6	524	280	0.3	46
4	W	8	561	300	0.3	54
5	W	3	561	300	0.3	65
6	W	5	735	300	0.4	75
7	W	10	931	380	0.4	65
8	W	13	931	380	0.4	82
9	D	30	5000	450	0.496	110
10	A	21	5000	600	0.494	110

*C- Cover; W-Waste; D-Dredge Material; A-Alluvium; CO-Columbia Formation

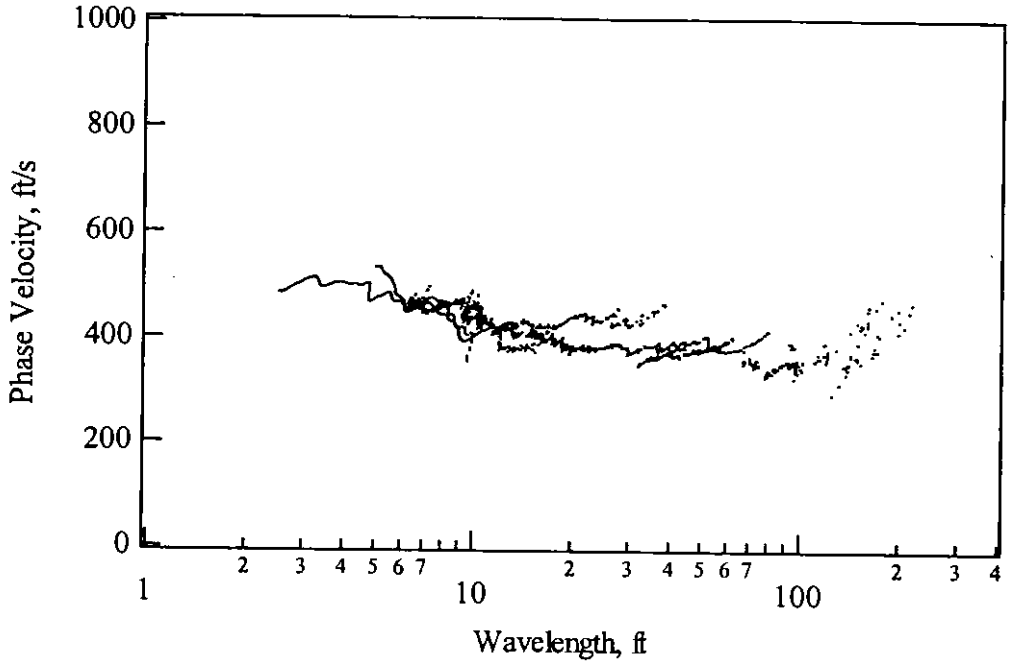


Figure A7 Experimental Dispersion Curve from SASW Testing at Site SASW03

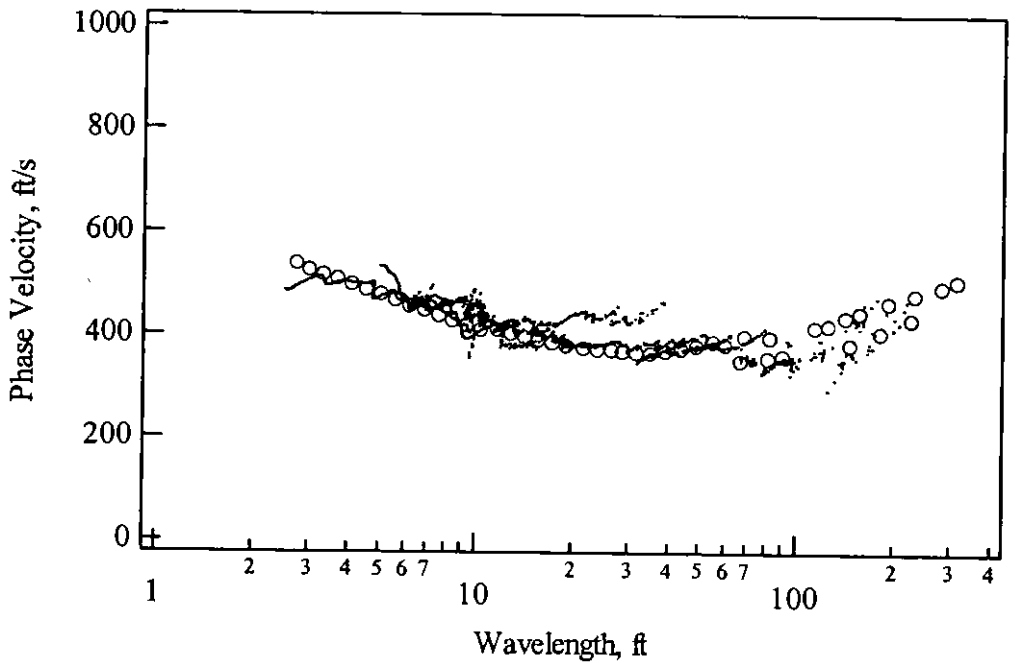


Figure A8 Theoretical and Experimental Dispersion Curve from SASW Testing at Site SASW03

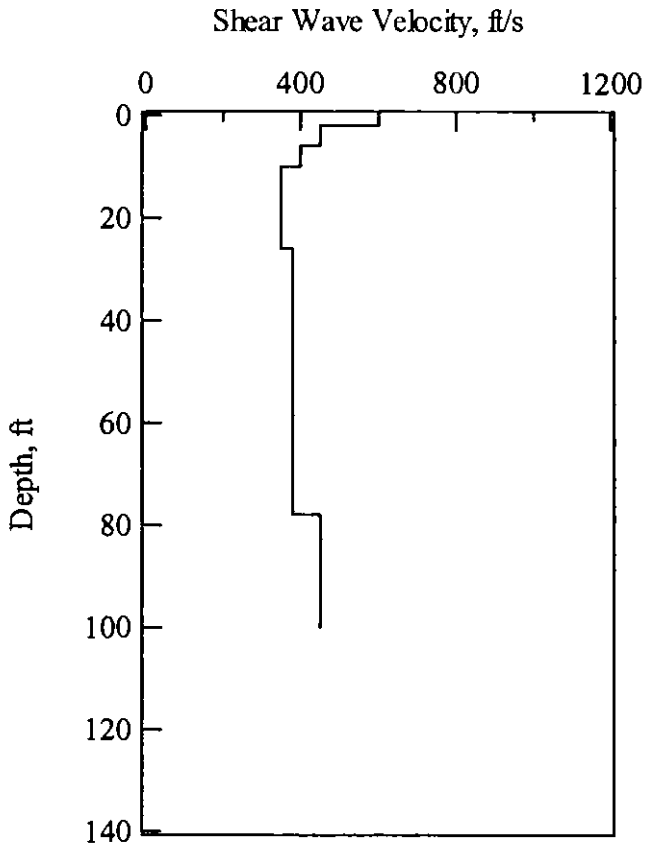


Figure A9 Shear Wave Velocity Profile Determined at Site SASW03

Table A3 Profile Parameters Used to Develop Theoretical Dispersion Curve at Site SASW03

Layer No.	Material Type *	Thickness, ft	P-Wave Velocity, ft/s	S-Wave Velocity, ft/s	Poisson's Ratio	Unit Weight, pcf
1	C	2	1123	600	0.3	120
2	W	4	842	450	0.3	52
3	W	4	748	400	0.3	52
4	W	10	655	350	0.3	62
5	W	6	655	350	0.3	80
6	W	2	931	380	0.4	75
7	W	10	931	380	0.4	82
8	D	10	5000	380	0.497	110
9	D	30	5000	380	0.497	110
10	A	22	5000	450	0.496	110

*C- Cover; W-Waste; D-Dredge Material; A-Alluvium; CO-Columbia Formation

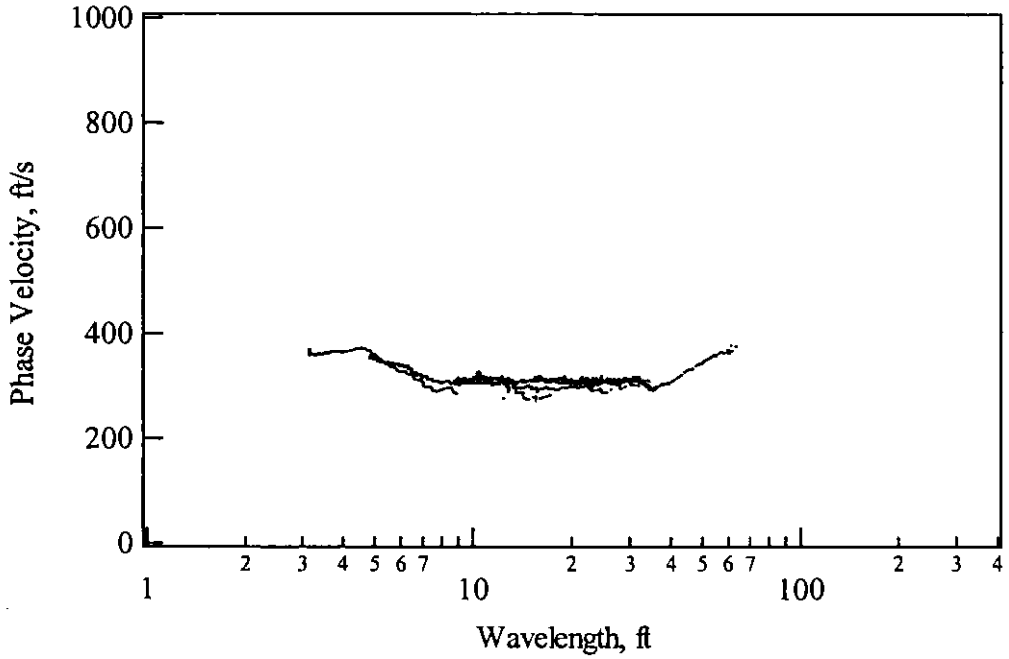


Figure A10 Experimental Dispersion Curve from SASW Testing at Site SASW04

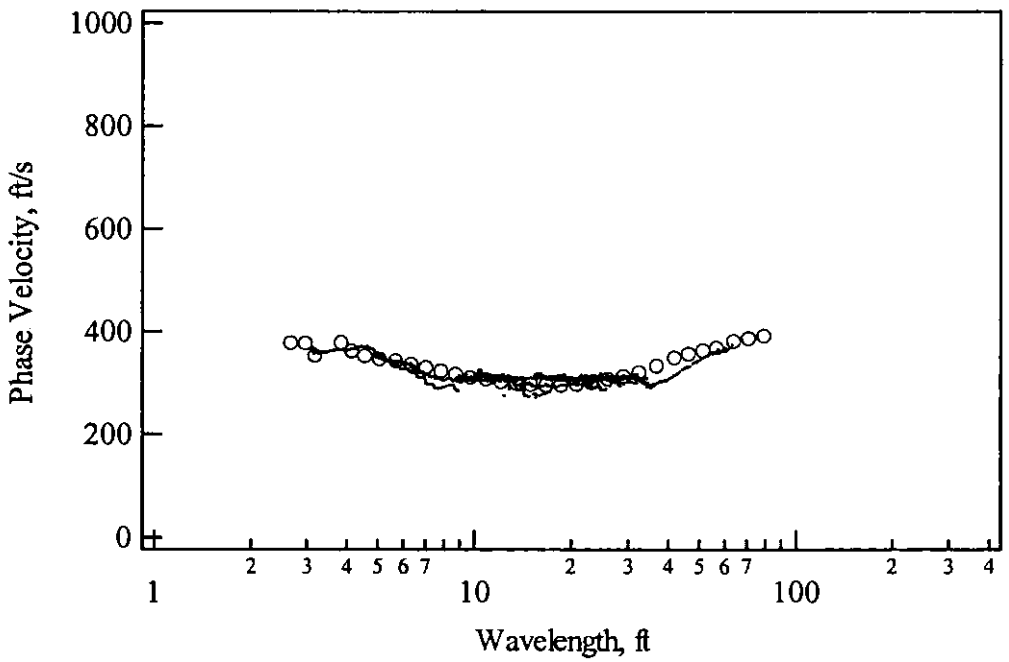


Figure A11 Theoretical and Experimental Dispersion Curve from SASW Testing at Site SASW04

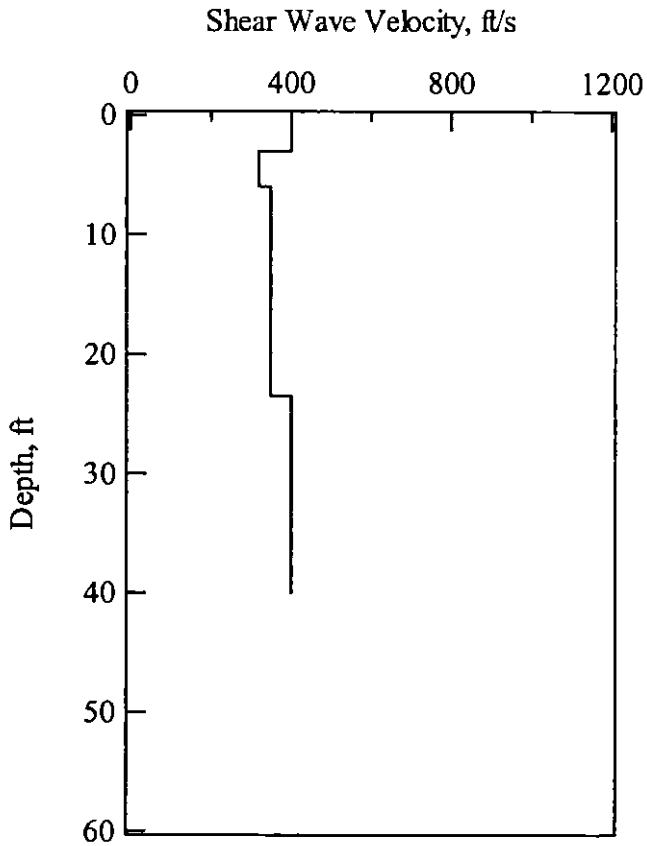


Figure A12 Shear Wave Velocity Profile Determined at Site SASW04

Table A4 Profile Parameters Used to Develop Theoretical Dispersion Curve at Site SASW04

Layer No.	Material Type *	Thickness, ft	P-Wave Velocity, ft/s	S-Wave Velocity, ft/s	Poisson's Ratio	Unit Weight, pcf
1	C	1	935	400	0.3	120
2	C	2	935	400	0.3	120
3	W	3	599	320	0.3	52
4	W	4	655	350	0.3	52
5	W	10.5	655	350	0.3	69
6	W	3	857	350	0.4	85
7	D	8	5000	400	0.497	110
8	D	8.5	5000	400	0.497	110

*C- Cover; W-Waste; D-Dredge Material; A-Alluvium; CO-Columbia Formation

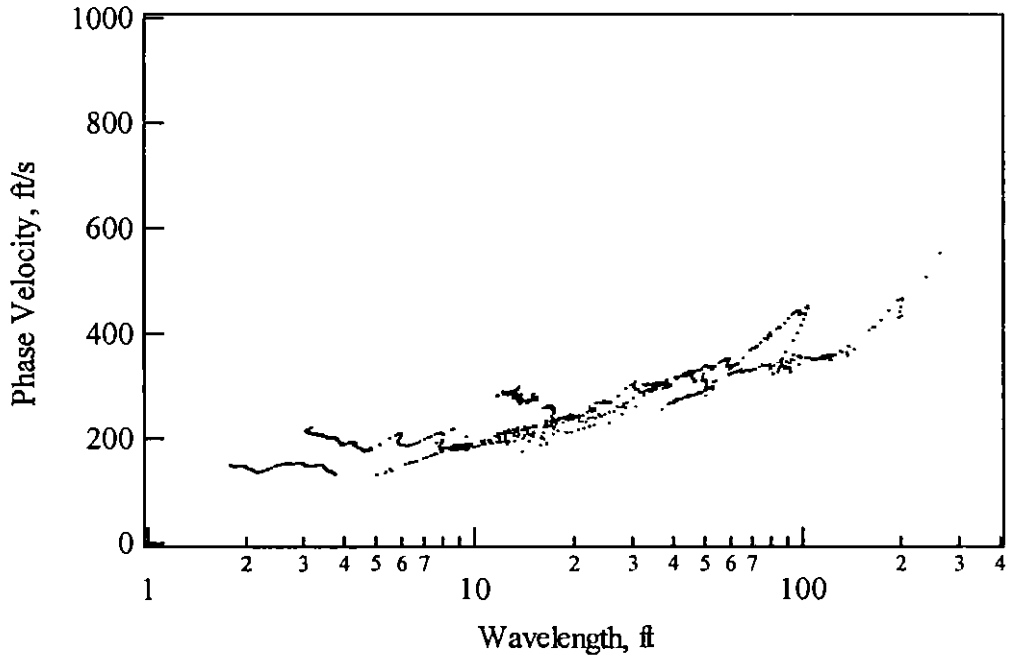


Figure A13 Experimental Dispersion Curve from SASW Testing at Site SASW05

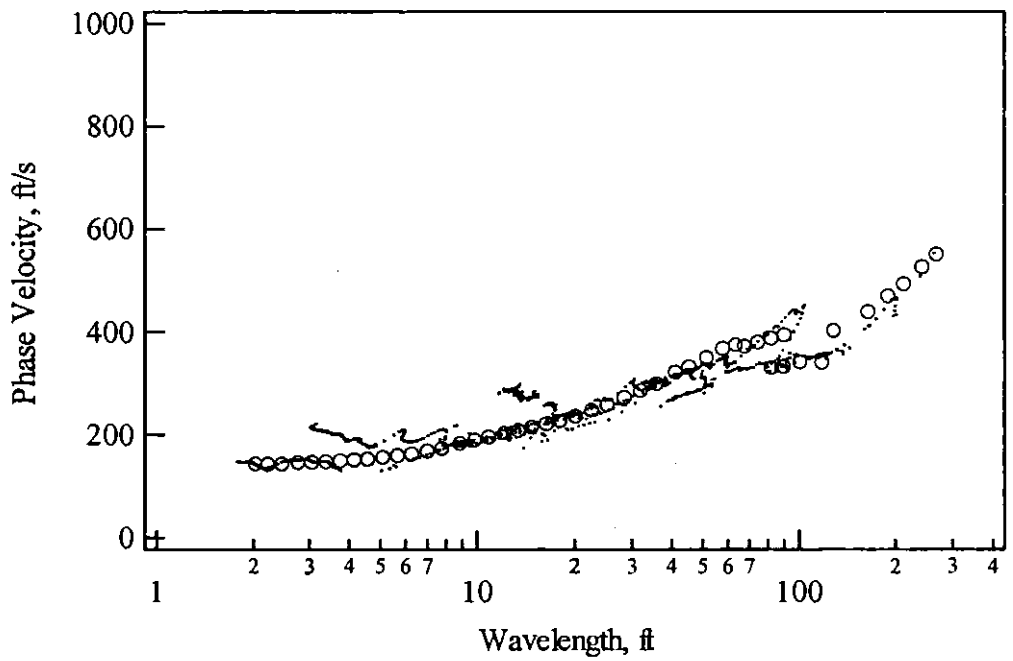


Figure A14 Theoretical and Experimental Dispersion Curve from SASW Testing at Site SASW05

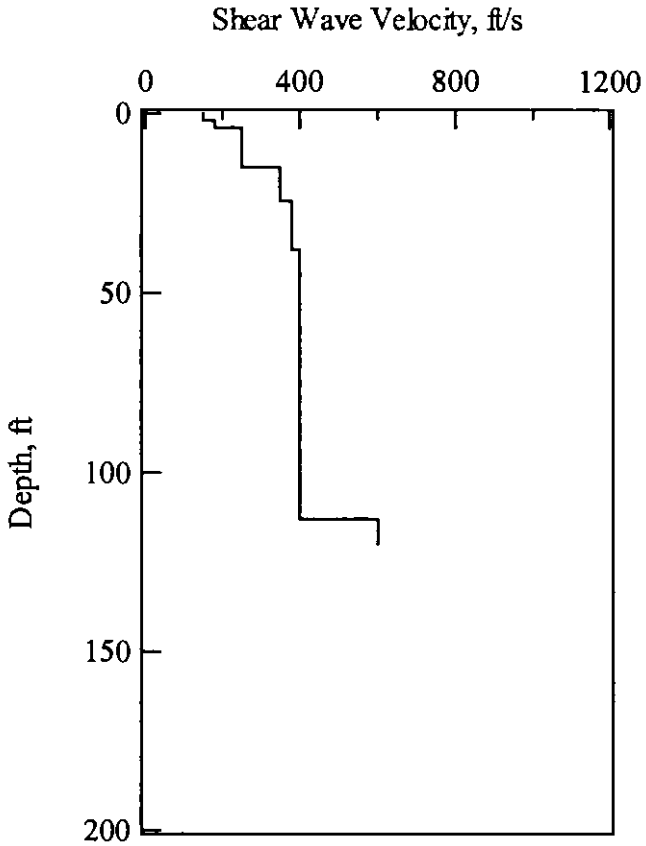


Figure A15 Shear Wave Velocity Profile Determined at Site SASW05

Table A5 Profile Parameters Used to Develop Theoretical Dispersion Curve at Site SASW05

Layer No.	Material Type *	Thickness, ft	P-Wave Velocity, ft/s	S-Wave Velocity, ft/s	Poisson's Ratio	Unit Weight, pcf
1	C	0.5	281	150	0.3	36
2	C	1.5	281	150	0.3	36
3	W	2	337	180	0.3	36
4	W	6	468	250	0.3	36
5	W	5	468	250	0.3	80
6	W	5	655	350	0.3	60
7	W	4.5	655	350	0.3	70
8	W	13.5	931	380	0.4	70
9	D	45	5000	400	0.497	110
10	A	30	5000	400	0.497	110
11	CO	7	5000	600 or greater**	0.493	110

*C- Cover; W-Waste; D-Dredge Material; A-Alluvium; CO-Columbia Formation
** Poorly resolved

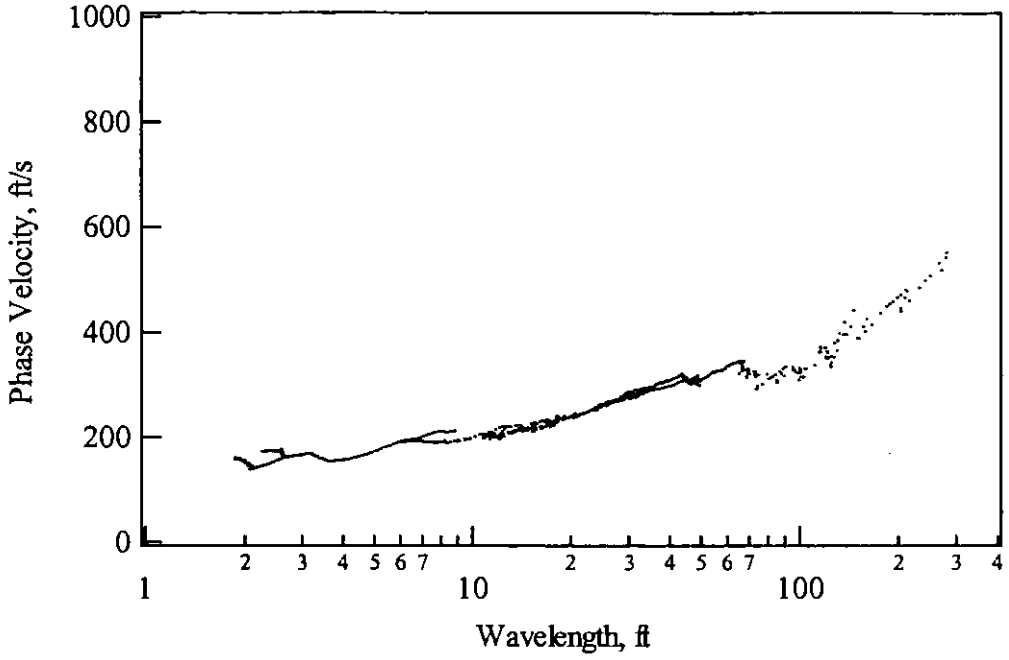


Figure A16 Experimental Dispersion Curve from SASW Testing at Site SASW06

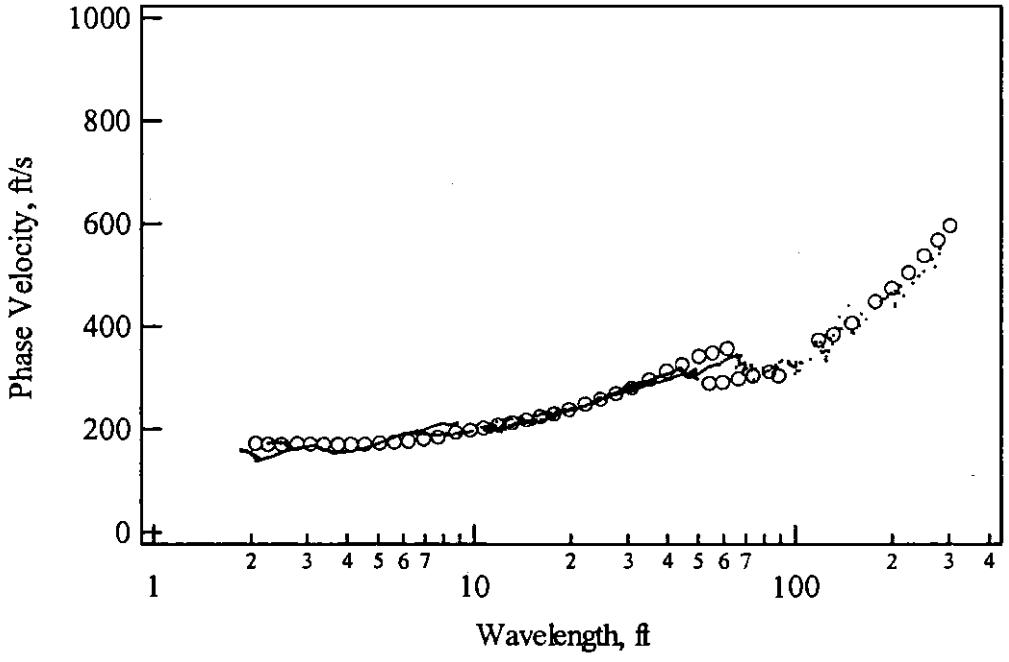


Figure A17 Theoretical and Experimental Dispersion Curve from SASW Testing at Site SASW06

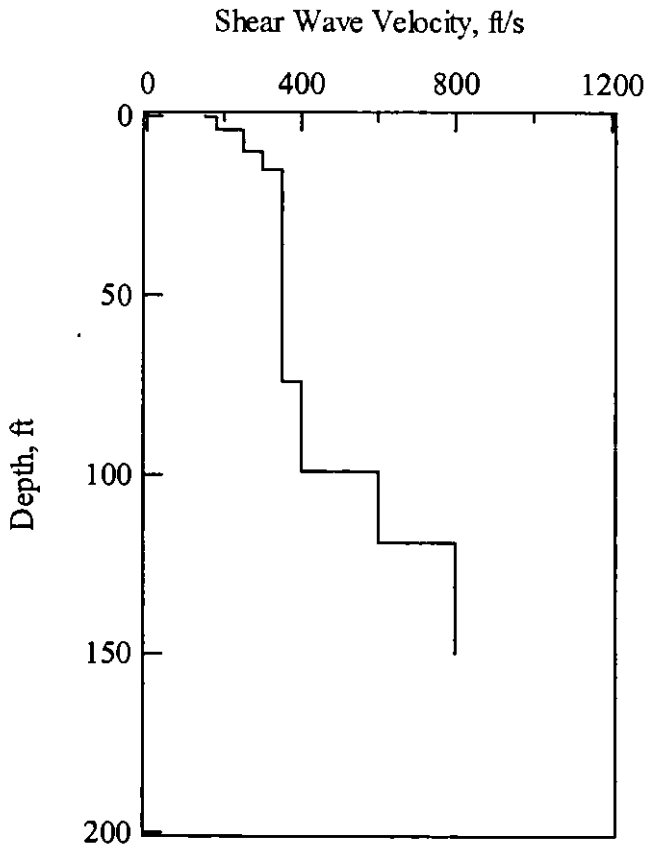


Figure A18 Shear Wave Velocity Profile Determined at Site SASW06

Table A6 Profile Parameters Used to Develop Theoretical Dispersion Curve at Site SASW06

Layer No.	Material Type *	Thickness, ft	P-Wave Velocity, ft/s	S-Wave Velocity, ft/s	Poisson's Ratio	Unit Weight, pcf
1	C	0.5	281	150	0.3	30
2	C	1.5	337	180	0.3	51
3	W	2	337	180	0.3	51
4	W	6	468	250	0.3	51
5	W	5	561	300	0.3	65
6	W	5	655	350	0.3	65
7	W	5	655	350	0.3	65
8	W	6	655	350	0.3	75
9	D	43	5000	350	0.497	110
10	A	25	5000	400	0.497	110
11	CO	20	5000	600 or greater **	0.493	110
12	CO	31	5000	800 or greater **	0.487	110

*C- Cover; W-Waste; D-Dredge Material; A-Alluvium; CO-Columbia Formation
** Poorly resolved

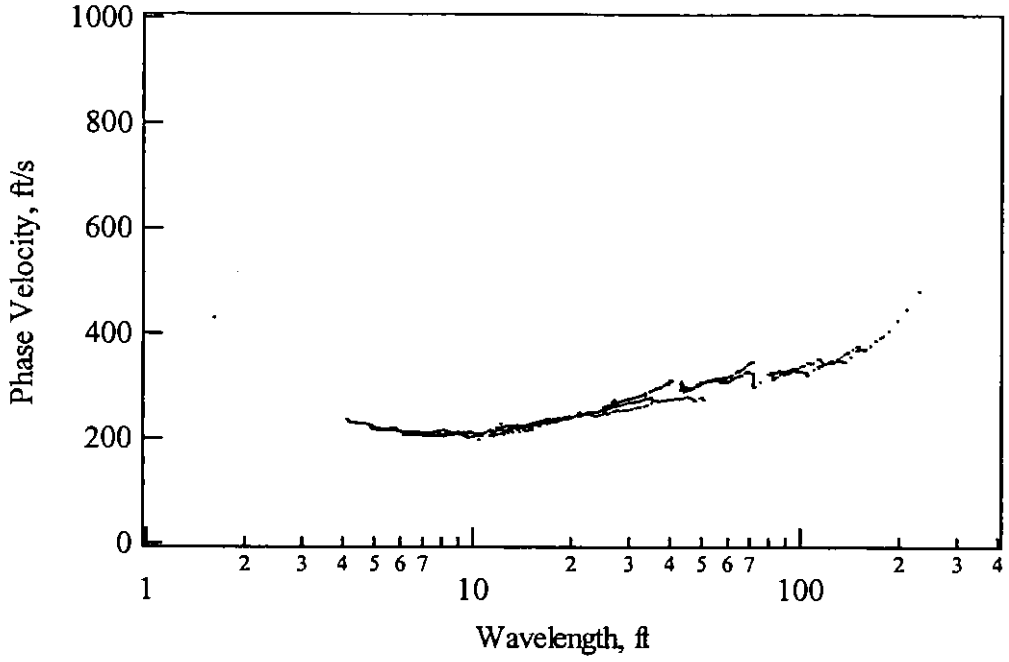


Figure A19 Experimental Dispersion Curve from SASW Testing at Site SASW07

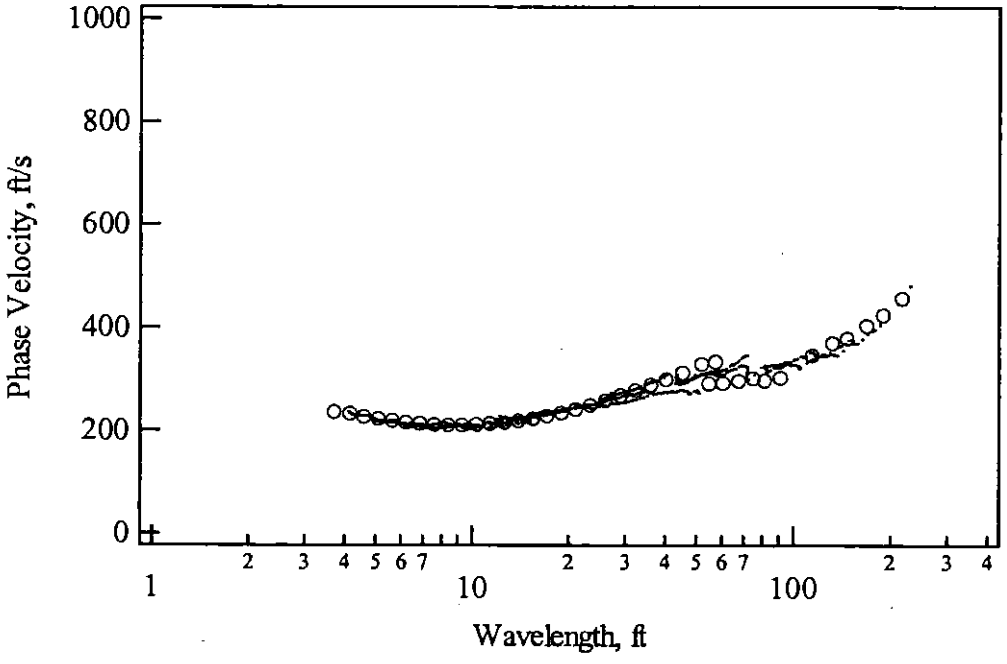


Figure A20 Theoretical and Experimental Dispersion Curve from SASW Testing at Site SASW07

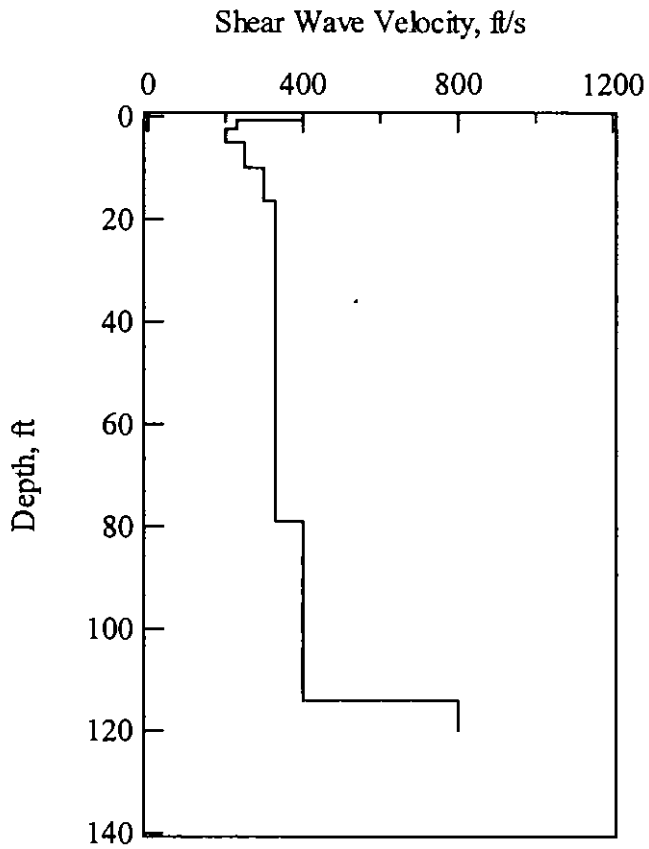


Figure A21 Shear Wave Velocity Profile Determined at Site SASW07

Table A7 Profile Parameters Used to Develop Theoretical Dispersion Curve at Site SASW07

Layer No.	Material Type *	Thickness, ft	P-Wave Velocity, ft/s	S-Wave Velocity, ft/s	Poisson's Ratio	Unit Weight, pcf
1	C	0.7	748	400	0.3	100
2	W	1.8	430	230	0.3	49
3	W	2.5	374	200	0.3	49
4	W	5	468	250	0.3	49
5	W	6.5	561	300	0.3	67
6	W	3.5	808	330	0.4	70
7	W	5	808	330	0.4	80
8	W	11	808	330	0.4	90
9	D	43	5000	330	0.498	110
10	A	35	5000	400	0.497	110
11	CO	6	5000	800 or greater **	0.487	110

*C- Cover; W-Waste; D-Dredge Material; A-Alluvium; CO-Columbia Formation
** Poorly resolved

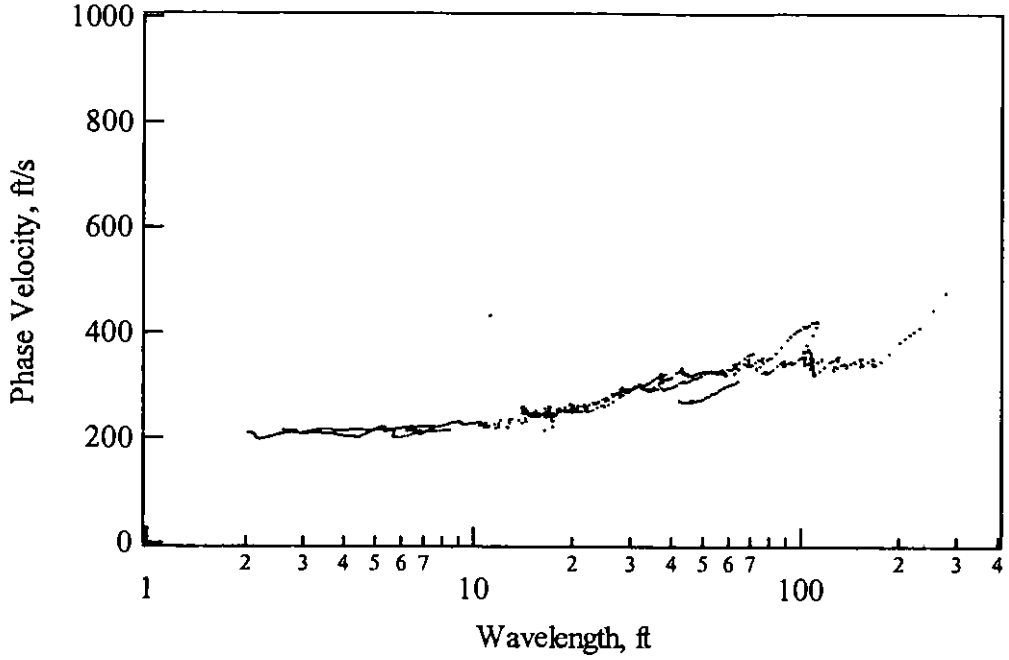


Figure A22 Experimental Dispersion Curve from SASW Testing at Site SASW08

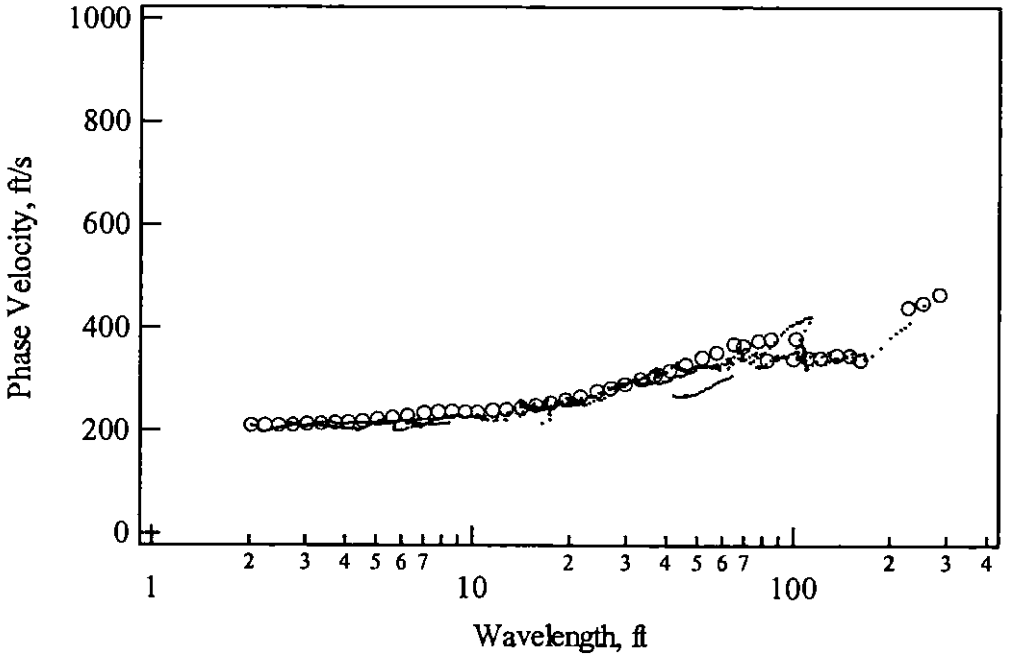


Figure A23 Theoretical and Experimental Dispersion Curve from SASW Testing at Site SASW08

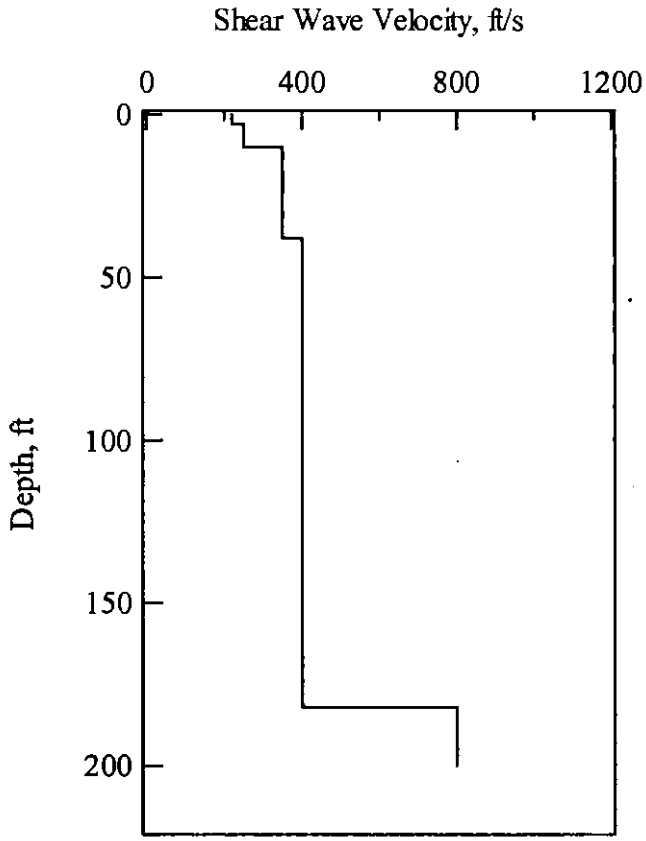


Figure A24 Shear Wave Velocity Profile Determined at Site SASW08

Table A8 Profile Parameters Used to Develop Theoretical Dispersion Curve at Site SASW08

Layer No.	Material Type *	Thickness, ft	P-Wave Velocity, ft/s	S-Wave Velocity, ft/s	Poisson's Ratio	Unit Weight, pcf
1	C	2	337	220	0.3	35
2	W	1	337	220	0.3	55
3	W	4	468	250	0.3	55
4	W	3	468	250	0.3	55
5	W	5	561	350	0.3	54
6	W	5	655	350	0.3	54
7	W	9	655	350	0.3	70
8	W	9	857	350	0.4	88
9	D	46	5000	400	0.497	110
10	A	38	5000	400	0.497	110
11	CO	60	5000	400 or greater **	0.497	110
12	CO	18	5000	800 or greater **	0.487	110

*C- Cover; W-Waste; D-Dredge Material; A-Alluvium; CO-Columbia Formation
** Poorly resolved

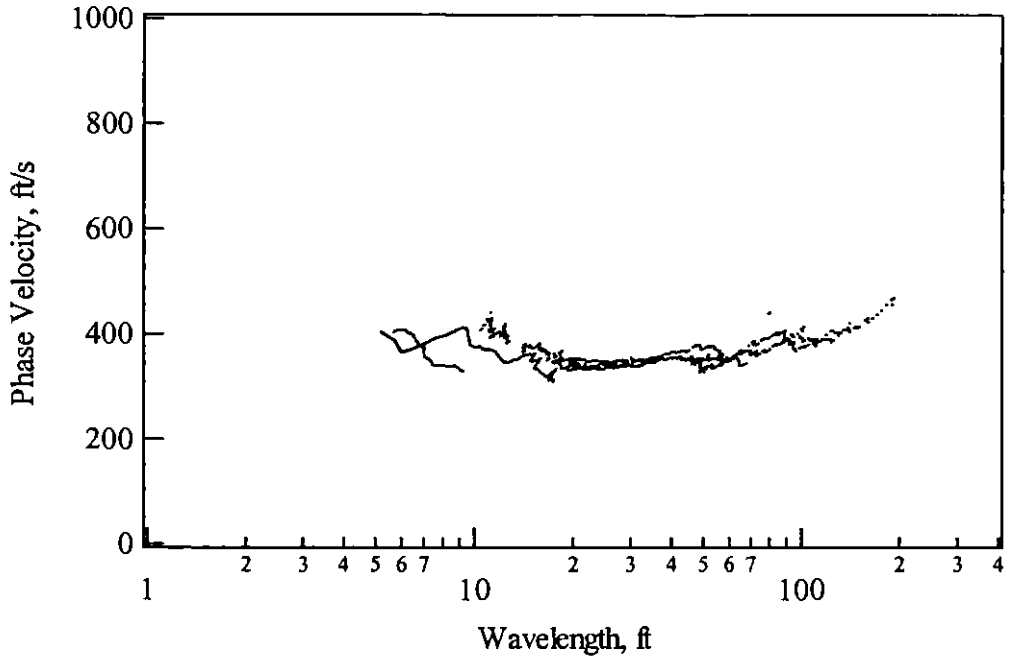


Figure A25 Experimental Dispersion Curve from SASW Testing at Site SASW09

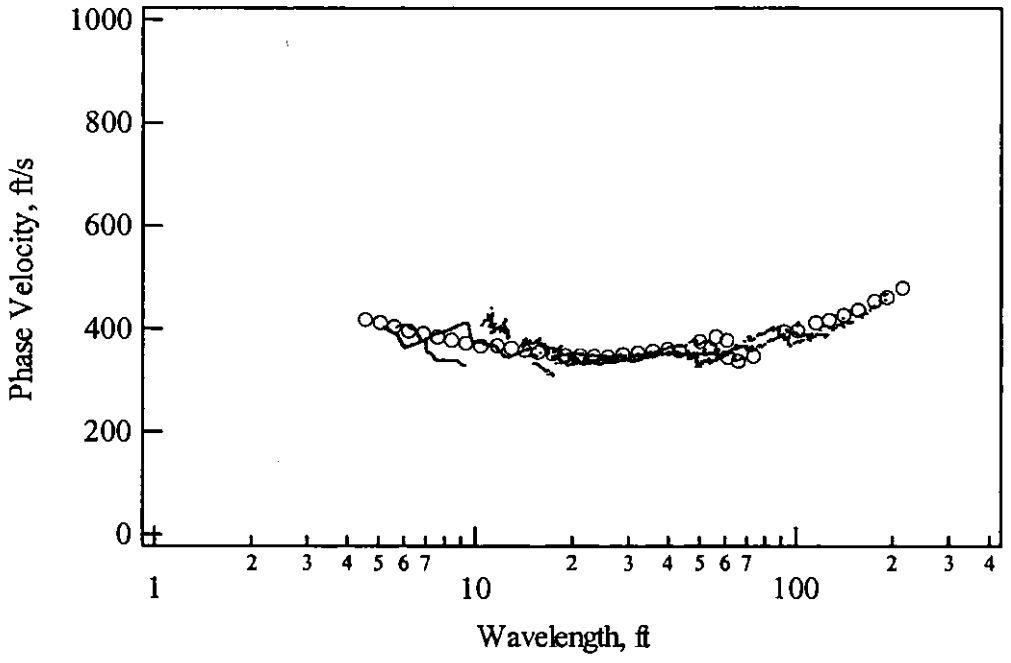


Figure A26 Theoretical and Experimental Dispersion Curve from SASW Testing at Site SASW09

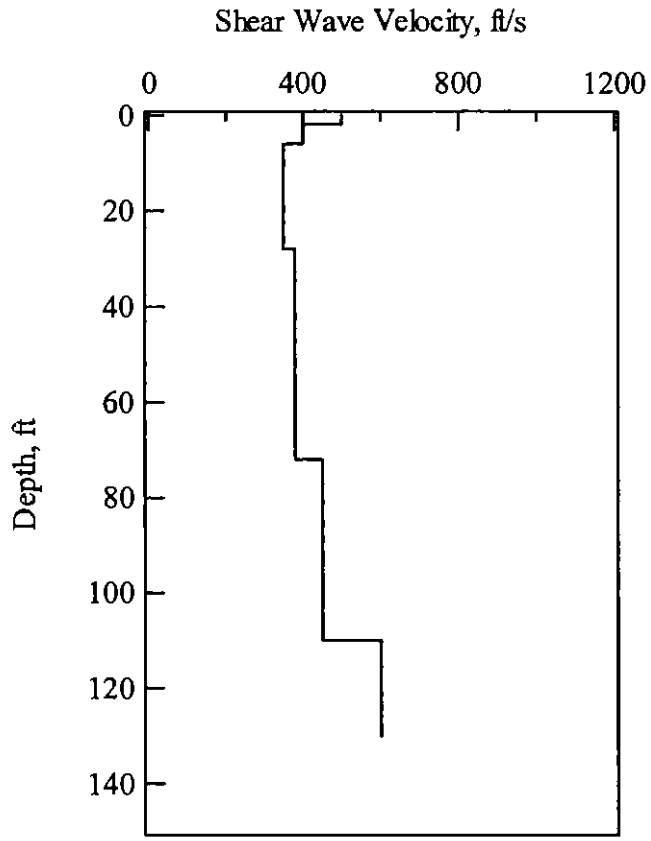


Figure A27 Shear Wave Velocity Profile Determined at Site SASW09

Table A9 Profile Parameters Used to Develop Theoretical Dispersion Curve at Site SASW09

Layer No.	Material Type *	Thickness, ft	P-Wave Velocity, ft/s	S-Wave Velocity, ft/s	Poisson's Ratio	Unit Weight, pcf
1	C	2	935	500	0.3	100
2	W	4	748	400	0.3	56
3	W	4	655	350	0.3	56
4	W	5	655	350	0.3	63
5	W	5	655	350	0.3	63
6	W	8	857	350	0.4	88
7	D	44	5000	380	0.497	110
8	A	38	5000	450	0.496	110
9	CO	20	5000	600 or greater **	0.493	110

*C- Cover; W-Waste; D-Dredge Material; A-Alluvium; CO-Columbia Formation
** Poorly resolved

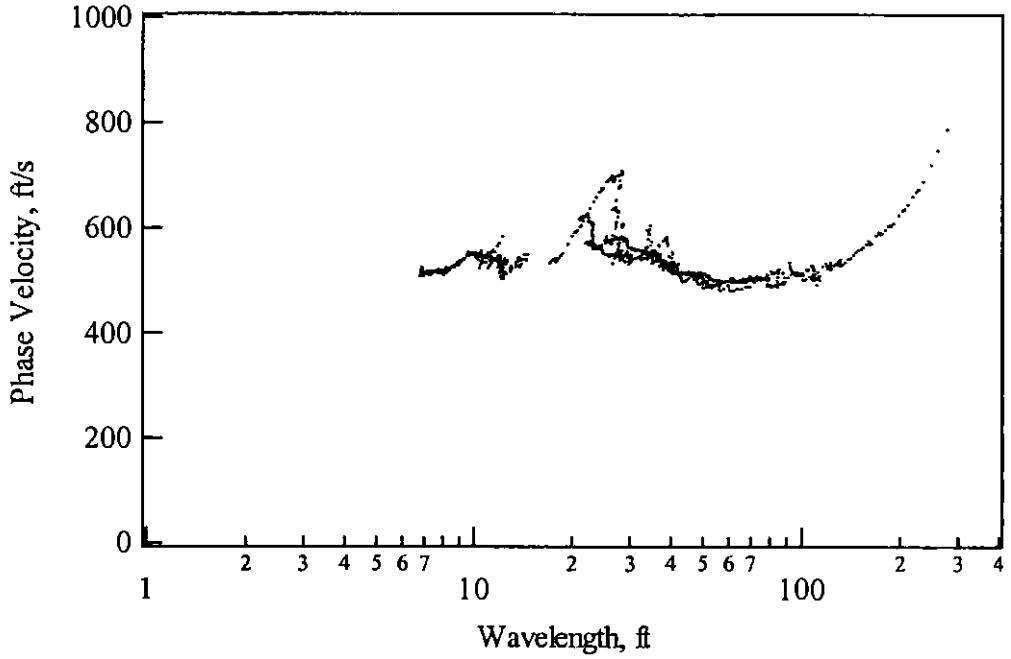


Figure A28 Experimental Dispersion Curve from SASW Testing at Site SASW10

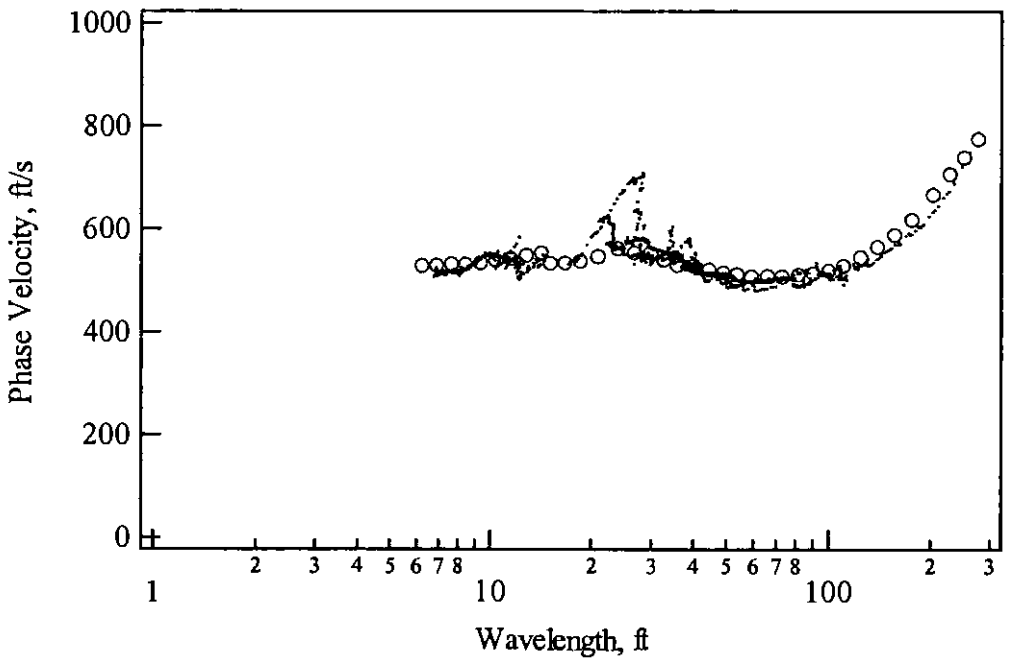


Figure A29 Theoretical and Experimental Dispersion Curve from SASW Testing at Site SASW10

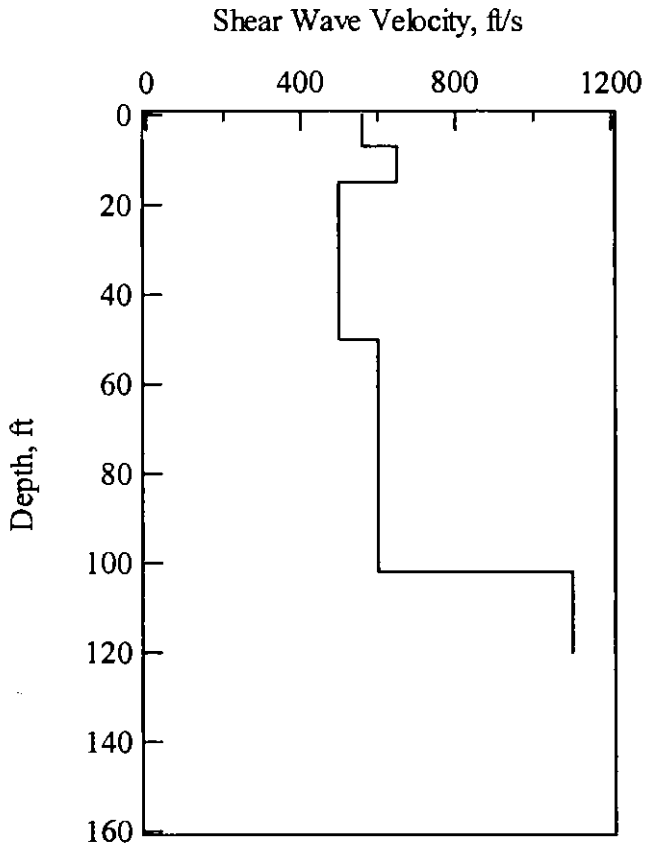


Figure A30 Shear Wave Velocity Profile Determined at Site SASW10

Table A10 Profile Parameters Used to Develop Theoretical Dispersion Curve at Site SASW10

Layer No.	Material Type *	Thickness, ft	P-Wave Velocity, ft/s	S-Wave Velocity, ft/s	Poisson's Ratio	Unit Weight, pcf
1	C	7	1048	560	0.3	120
2	C	8	1216	650	0.3	120
3	D	10	5000	500	0.495	110
4	D	25	5000	500	0.495	110
5	A	52	5000	600	0.493	110
6	CO	18	5000	1100	0.475	110

*C- Cover; W-Waste; D-Dredge Material; A-Alluvium; CO-Columbia Formation

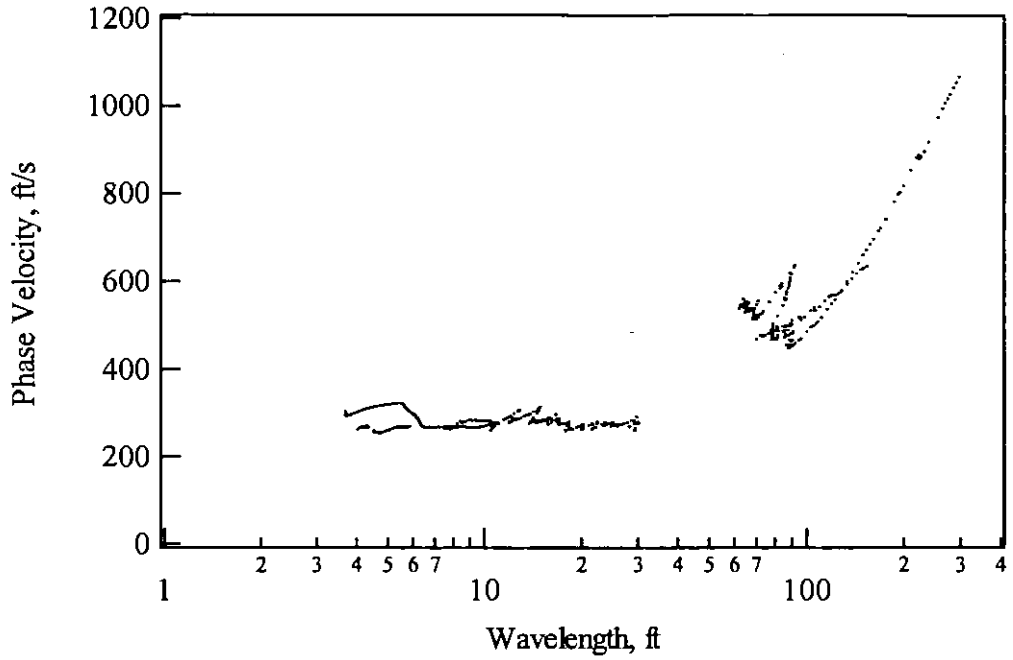


Figure A31 Experimental Dispersion Curve from SASW Testing at Site SASW11

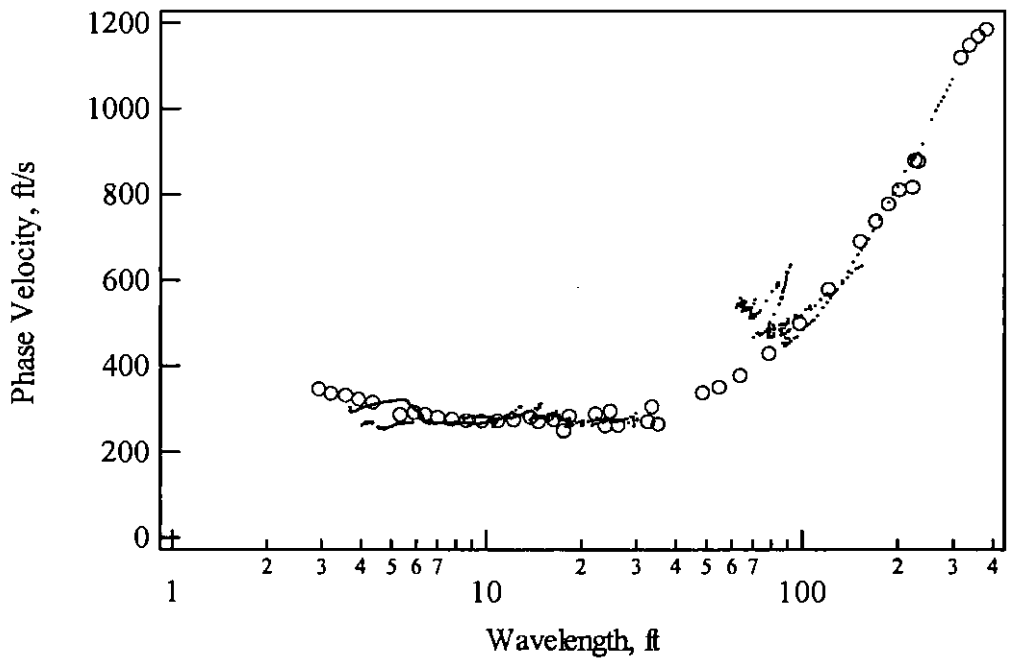


Figure A32 Theoretical and Experimental Dispersion Curve from SASW Testing at Site SASW11

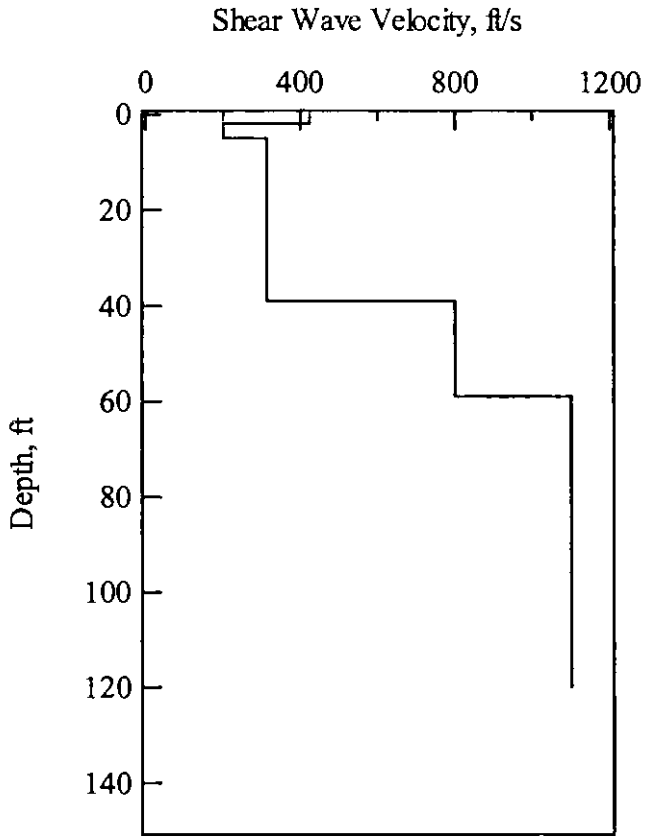


Figure A33 Shear Wave Velocity Profile Determined at Site SASW11

Table A11 Profile Parameters Used to Develop Theoretical Dispersion Curve at Site SASW11

Layer No.	Material Type *	Thickness, ft	P-Wave Velocity, ft/s	S-Wave Velocity, ft/s	Poisson's Ratio	Unit Weight, pcf
1	C	2	795	425	0.3	120
2	D	3	374	200	0.3	110
3	D	34	5000	315	0.498	110
4	A	20	5000	800	0.469	110
5	CO	61	5000	1100	0.469	110

*C- Cover; W-Waste; D-Dredge Material; A-Alluvium; CO-Columbia Formation

APPENDIX B

Waste and Soil Properties at the Cherry Island Landfill Supplied by GeoSyntec Consultants

Table B1 Layer Thicknesses Near the Eleven SASW Sites

ID	Surface Elevation (feet)	Waste Depth (feet)	Depth of Earth Fill (feet)	Dredge Thickness (feet)	Recent Deposit Thickness (feet)	Depth to Liquid (feet)
P1_02_SASW01	87.49	92.79		0	15	Note 2
P2_02_SASW02	78.9	48.6		30.3	20	
P3_02_SASW03	79.03	38.63		40.4	25	
P3_02_SASW04	63.12	22.52		40.6	50	
P4_02_SASW05	82.62	37.52		45.1	30	
P4_02_SASW06	74.8	31.7		43.1	25	
P5_02_SASW07	78.89	35.37		43.52	35	
P5_02_SASW08	83.8	38.22		45.58	38	
P5_02_SASW09	71.3	27.89		43.41	38	
P5_02_SASW10	50.6	0	15	35	52	
P1_02_SASW11	38.89	0		38.89	20	

Note:
1. Recent deposits are alluvial material, underlying dredge. Very similar material to dredge, assumed to be the same. The bottom of the dredge material and top of alluvial deposits is nominally assumed to be at datum (0-ft elevation).
2. May be calculated soon. Will let you know.

Table B2 Information from Boreholes Near Sites SASW02 through SASW 09

Boring	Surface Elevation (feet)	Depth to Liquid (feet)	Top of Liquid Elevation (feet)	Top of LCS Elevation (feet)	Total Depth of Boring (feet)	Total Depth of Waste (feet)	Head of Liquid (feet)
P2_02_UW02	77.5	21.5	56	31.3	26	46.2	24.7
P2_02_UW02A	85.8	28	57.8	31.3	28	54.5	26.5
P3_02_UW03	79.0	26	53	40.4	28	38.6	12.6
P3_02_UW04	63.1	20.5	42.6	39.4	22	23.7	3.2
P4_02_UW05	82.6	24.5	58.1	45.1	28	37.5	13
P4_02_UW06	74.8	-	-	43.1	31	31.7	-
P5_02_UW07	78.9	16.5	62.4	43.5	22	35.4	18.9
P5_02_UW08	83.8	29	54.8	45.6	30	38.2	9.2
P5_02_UW09	71.3	20	51.3	43.4	22	27.9	7.9

Table B3 Measured Total Unit Weight Information Summary at Sites SASW02 through SASW09

	Borehole	Borehole Depth ft	Depth Interval ft	Bulk Unit Weight pcf (max)	Bulk Unit Weight pcf (min)
assume	UW_02	26	0 - 10	53.8	40.0
these are			10 - 21	59.2	44.0
similar to	UW_02A	28	0 - 10	51.5	38.3
conditions			10 - 20	64.2	47.7
at SASW2			20 - 28	76.0	56.5
	UW_03	28	0 - 10	59.4	44.2
			10 - 20	70.5	52.4
			20 - 28	91.6	68.1
	UW_04	22	0 - 10	60.0	44.6
			10 - 22	79.2	58.9
	UW_05	28	0 - 10	41.3	30.7
suspect			10 - 20	108.1	80.3
values			20 - 28	96.9	72.0
	UW_06	31	0 - 10	58.9	43.7
			10 - 20	75.0	55.7
			20 - 31	64.3	47.8
	UW_07	22	0 - 10	56.9	42.3
			10 - 20	77.0	57.2
	UW_08	30	0 - 10	62.5	46.5
			10 - 20	61.4	45.6
			20 - 30	80.6	59.9
	UW_09	22	0 - 10	63.7	47.3
			10 - 20	72.2	53.6

Table B4 Measured Weight-Volume Information Summary from Boreholes Near SASW02, SASW04, SASW05, SASW08 and SASW09

Location	Boring	Depth ft	Gs	w	max pb pcf	min pb pcf	min e	max e	[redacted]	[redacted]	max S	min S	max psat pcf	min psat pcf	measured psat pcf	
P2	UW02	0-10	2.71	0.329	53.8	40.0	3.187	4.631	[redacted]	[redacted]	0.281	0.193	88.0	81.4		
		10-21	2.39	0.496	59.2	44.0	2.769	4.071	[redacted]	[redacted]	0.429	0.291	85.4	79.5		
P2	UW02A	0-10	2.59	0.486	51.5	38.3	3.673	5.283	[redacted]	[redacted]	0.344	0.239	83.7	78.2		
		10-20	2.00	0.424	64.2	47.7	1.768	2.726	[redacted]	[redacted]	0.480	0.311	84.9	79.1		
		20-28	2.02	0.365	76.0	56.5	1.269	2.052	[redacted]	[redacted]	0.583	0.361	90.5	83.3		
P2	SPTW4	53													97.0	from sample recoverec
P3	UW04	0-10	2.63	0.294	60.0	44.6	2.547	3.772	[redacted]	[redacted]	0.305	0.206	91.2	83.8		
		10-22	2.99	0.291	79.2	58.9	2.045	3.095	[redacted]	[redacted]	0.427	0.282	103.2	92.8		
P4	UW05	0-10	2.11	0.211	41.3	30.7	2.868	4.203	[redacted]	[redacted]	0.156	0.106	80.4	75.7		
		10-20	2.37	0.241	108.1	80.3	0.698	1.285	87.1	64.7	0.820	0.445	112.7	99.8		suspect values
P4	SPTW3	34													75.5	from sample recoverec
P5	UW08	0-10	2.48	0.203	62.5	46.5	1.975	2.998	[redacted]	[redacted]	0.255	0.168	93.4	85.4		
		10-20	2.70	0.245	61.4	45.6	2.414	3.596	[redacted]	[redacted]	0.274	0.184	93.4	85.4		
		20-30	2.38	0.352	80.6	59.9	1.493	2.355	[redacted]	[redacted]	0.562	0.357	97.0	88.1		
P5	UW09	0-10	2.41	0.197	63.7	47.3	1.827	2.807	[redacted]	[redacted]	0.261	0.170	93.5	85.5		
		10-20	2.32	0.232	72.2	53.6	1.472	2.329	[redacted]	[redacted]	0.367	0.232	95.7	87.1		

pb = bulk density pd = dry density psat = saturated density

For Phases I and II, use psat = 80 - 95 pcf.
For Phases III to V, use psat = 75 - 95 pcf.

Table B5 Waste Composition from Samples P2-02, P2-1S, P4-02

Tare Weight 6.1

Bore Hole ID	P2-02		P2-02		P2-1S		P2-1S		P2-1S		P4-02		P4-02	
Depth (ft)	10		20		10		20		28		10		20	
Waste Total (lbs)	139.30		151.39		158.90		151.86		129.40		131.30		145.10	
	Weight	Percentage	Weight	Percentage	Weight	Percentage	Weight	Percentage	Weight	Percentage	Weight	Percentage	Weight	Percentage
Paper	7.96	5.71%	15.12	9.99%	7.28	4.58%	35.66	23.48%	43.90	33.93%	34.50	26.28%	30.70	21.16%
Plastics	3.32	2.38%	6.68	4.41%	17.54	11.04%	28.66	18.87%	11.50	8.89%	12.30	9.37%	25.90	17.85%
Glass	0.18	0.13%	0.00	0.00%	0.70	0.44%	0.88	0.58%	0.00	0.00%	0.90	0.69%	1.10	0.76%
Metals	5.64	4.05%	2.70	1.78%	7.14	4.49%	2.56	1.69%	2.50	1.93%	1.70	1.29%	9.30	6.41%
Organics	6.28	4.51%	44.42	29.34%	16.44	10.35%	27.14	17.87%	29.50	22.80%	23.10	17.59%	12.70	8.75%
Other Inerts	77.42	55.58%	67.56	44.63%	59.56	37.48%	25.98	17.11%	17.40	13.45%	24.00	18.28%	31.40	21.64%
Fines	38.50	27.64%	14.91	9.85%	50.24	31.62%	30.98	20.40%	24.60	19.01%	34.80	26.50%	34.00	23.43%

Table B6 Waste Composition from Samples P5-02-8, P5-02-9, P3-02-4

P5-02-8		P5-02-8		P5-02-8		P5-02-9		P5-02-9		P3-02-4		P3-02-4		Total	
10		20		30		10		20		10		20		238	
153.32		130.90		128.40		159.30		158.20		176.20		174.40		2085.97	
Weight	Percentage	Weight	Percentage	Weight	Percentage	Weight	Percentage	Weight	Percentage	Weight	Percentage	Weight	Percentage	Weight	Percentage
27.30	17.81%	29.70	22.69%	9.30	7.24%	17.30	10.86%	27.50	17.61%	11.70	6.64%	17.10	9.81%	315.02	15.10%
6.30	4.11%	12.30	9.40%	14.10	10.98%	6.30	3.95%	9.90	6.34%	3.30	1.87%	10.30	5.91%	168.40	8.07%
0.30	0.20%	1.30	0.99%	0.30	0.23%	0.10	0.06%	1.10	0.70%	0.10	0.06%	0.50	0.29%	7.46	0.36%
6.50	4.24%	14.30	10.92%	3.50	2.73%	1.90	1.19%	2.50	1.60%	4.70	2.67%	19.30	11.07%	84.24	4.04%
22.70	14.81%	21.90	16.73%	30.10	23.44%	22.90	14.38%	18.50	11.84%	3.10	1.76%	11.10	6.36%	289.88	13.90%
55.60	36.26%	28.80	22.00%	46.40	36.14%	58.60	36.79%	70.00	44.81%	95.60	54.26%	73.20	41.97%	731.52	35.07%
34.62	22.58%	22.60	17.27%	24.70	19.24%	52.20	32.77%	26.70	17.09%	57.70	32.75%	42.90	24.60%	489.45	23.46%

Table B-8 Moisture Analysis of Waste from Samples P2-02, P2-1S, P4-02, P5-02-8, P5-02-9, P3-02-4

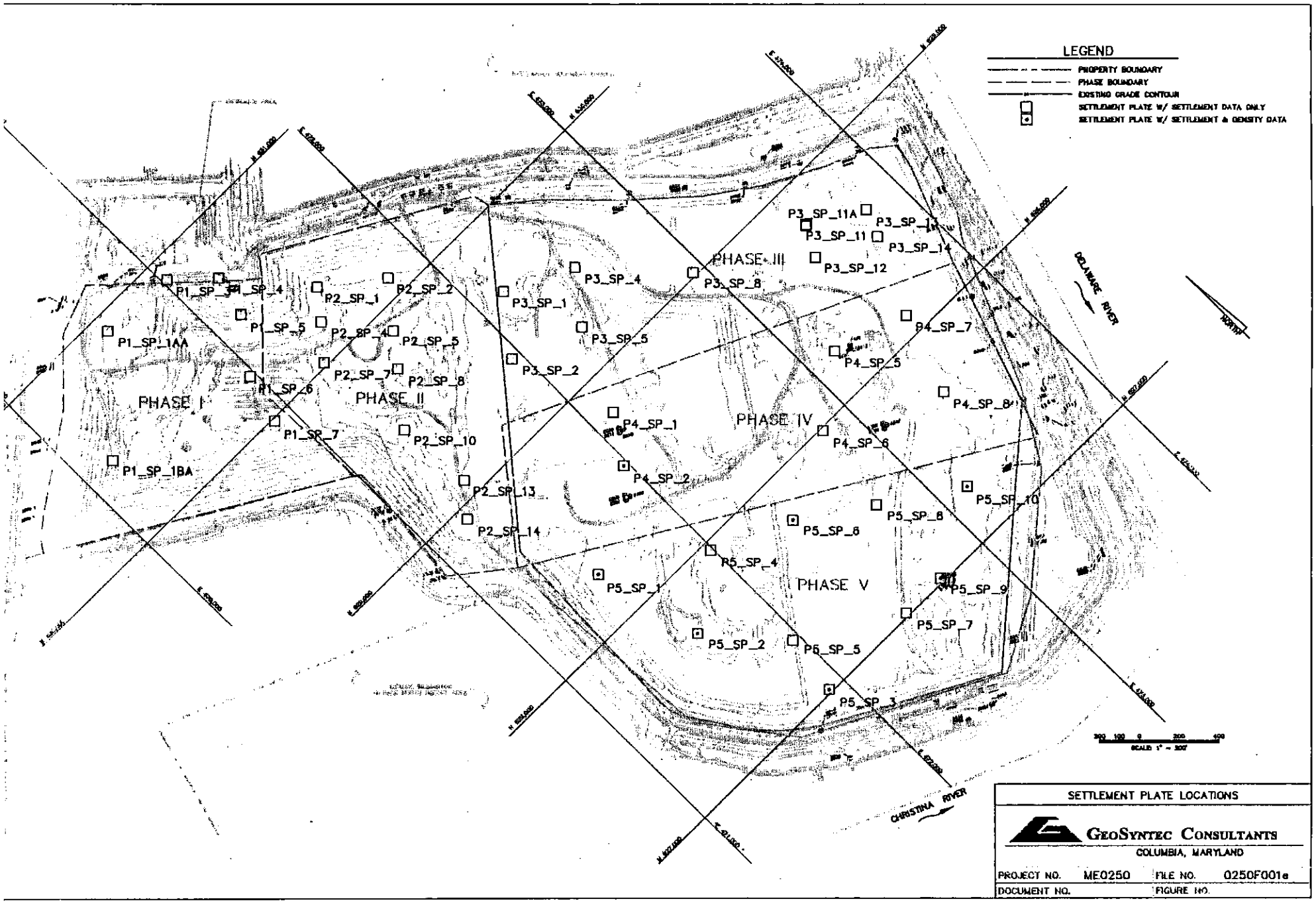
Moisture Analysis
SCS Engineers-Cherry Island

Environmental Engineering Laboratory

Date Started: 3/18/2002 by DCB

geosyntec boring ID	SCS Sample ID	% moisture	actual depth interval	
uw02	P2-02-10ft	32.9%	0 - 10	
uw02	P2-02-20ft	49.6%	10 - 20	
uw02	P2-02-25ft	53.5%	20 - 26	standing water at 21.5ft
uw02a	PS-1S-10ft	48.6%	0 - 10	
uw02a	PS-1S-20ft	42.4%	10 - 20	
uw02a	PS-1S-28ft	36.5%	20 - 28	
uw05	P4-02-10ft	21.1%	0 - 10	
uw05	P4-02-20ft	24.1%	10 - 20	
uw05	P4-02-30ft	34.1%	20 - 28	standing water at 24.5ft
uw08	P5-02-8-10ft	20.3%	0 - 10	
uw08	P5-02-8-20ft	24.5%	10 - 20	
uw08	P5-02-8-30ft	35.2%	20 - 30	standing water at 29 ft
uw09	P5-02-9-10ft	19.7%	0 - 10	
uw09	P5-02-9-20ft	23.2%	10 - 20	
uw04	P3-02-4-10ft	29.4%	0 - 10	
uw04	P3-02-4-20ft	29.1%	10 - 22	standing water at 20.5ft

SETTLEMENT PLATES AND TOTAL PRESSURE CELLS: LOCATIONS, DATA, AND PLOTS



SETTLEMENT PLATE LOCATIONS

GEOSYNTEC CONSULTANTS
COLUMBIA, MARYLAND

PROJECT NO.	ME0250	FILE NO.	0250F001e
DOCUMENT NO.		FIGURE NO.	

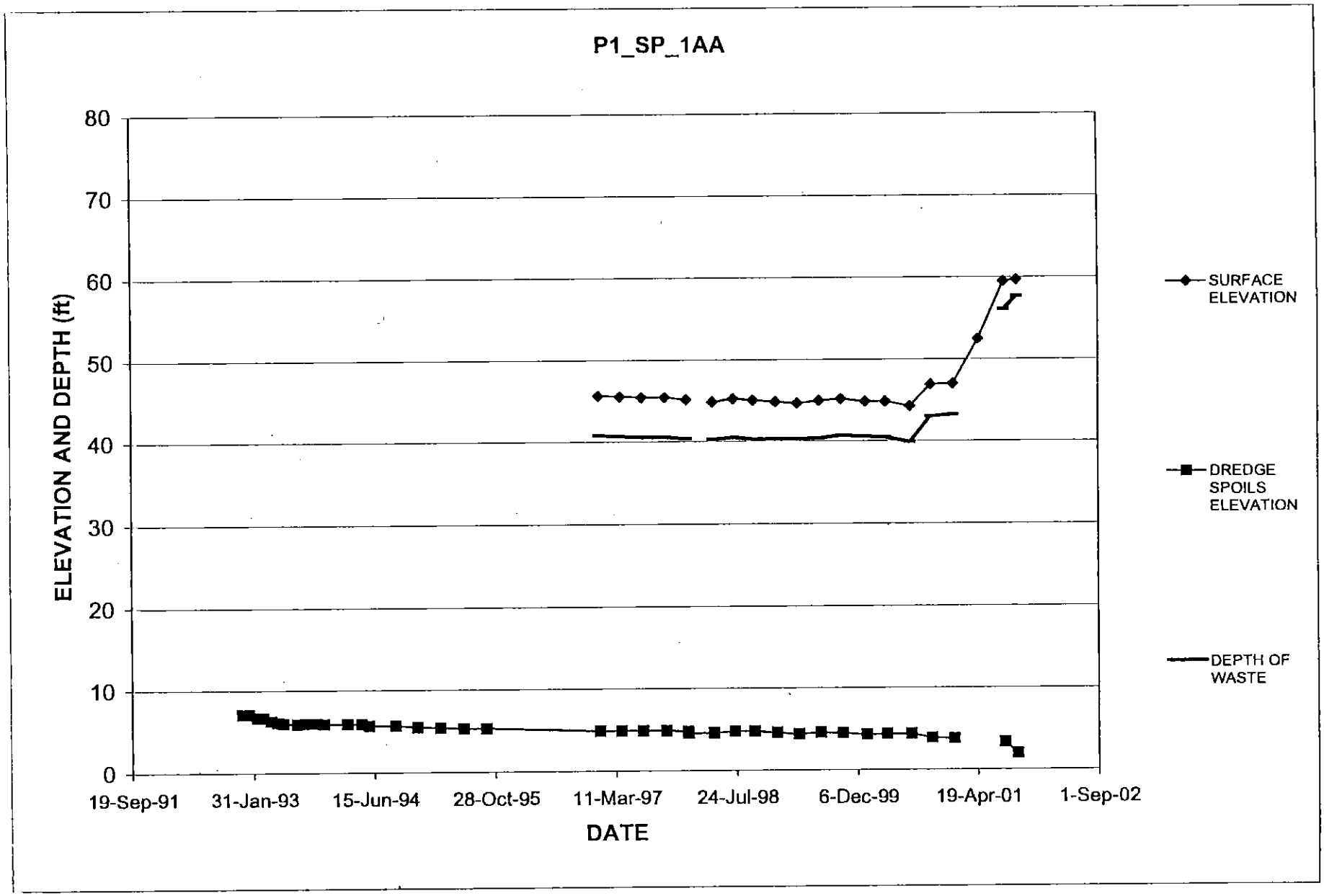
Settlement Plates

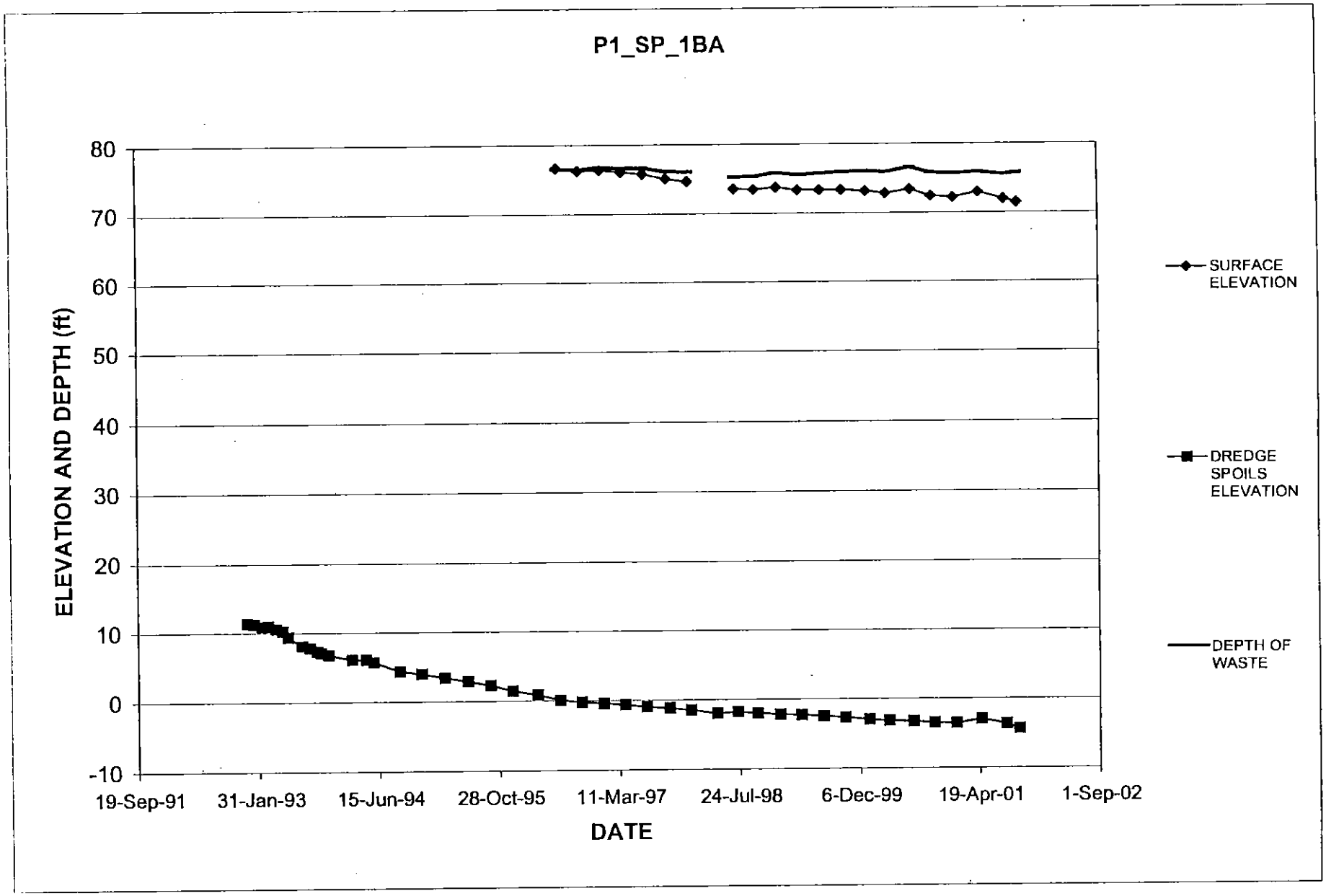
INST_ID	Northing	Easting	Phase
P1_SP_1AA	630913	470627	P1
P1_SP_1BA	630428	470177	P1
P1_SP_3	630887	471023	P1
P1_SP_4	630709	471214	P1
P1_SP_5	630492	471162	P1
P1_SP_6	630236	470966	P1
P1_SP_7	629984	470897	P1

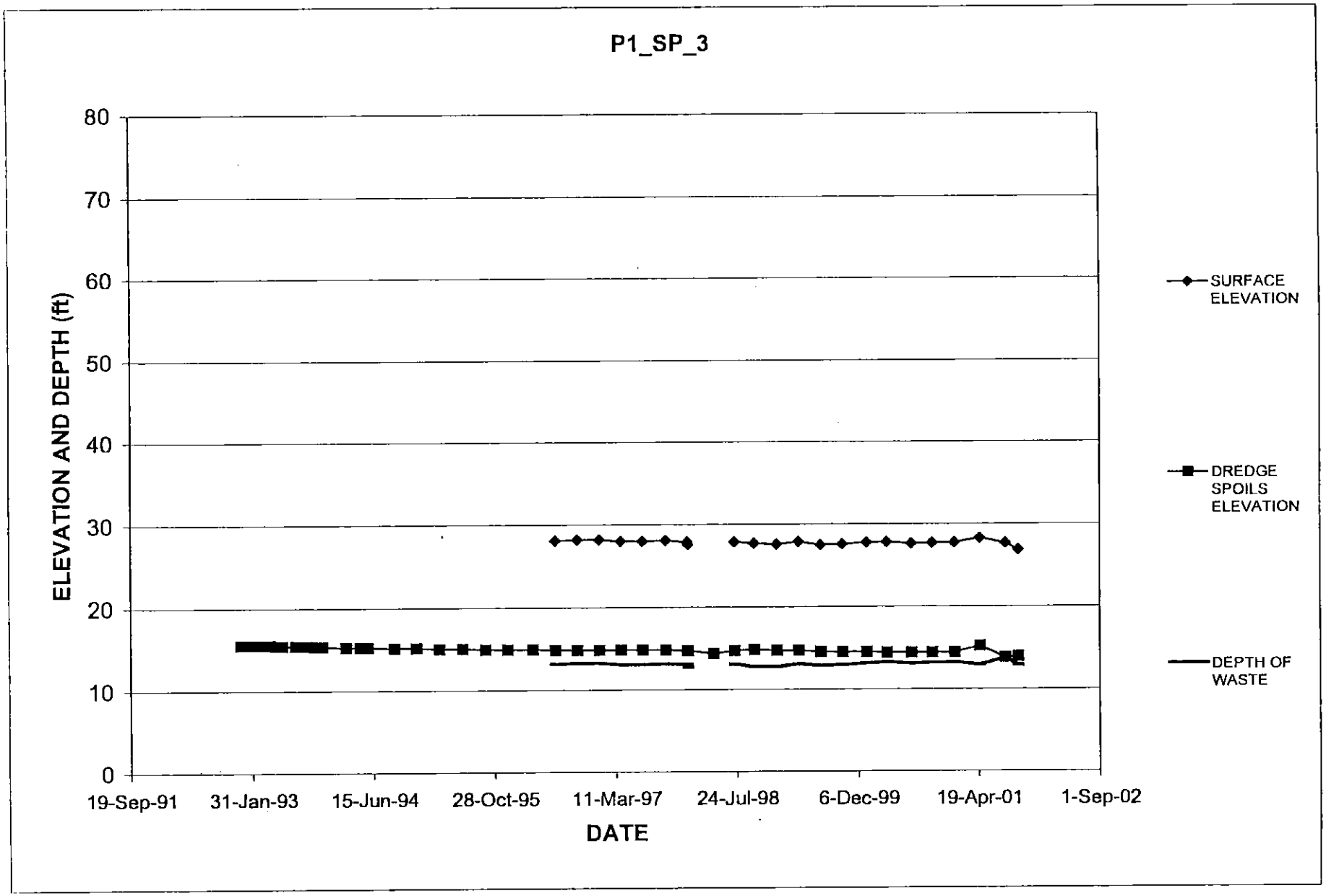
BASE PLATE	ORIGINAL ELEV
P1_SP_1AA	14.3
P1_SP_1BA	19.2
P1_SP_3	18.5
P1_SP_4	18.8
P1_SP_5	24.2
P1_SP_6	27
P1_SP_7	30.2

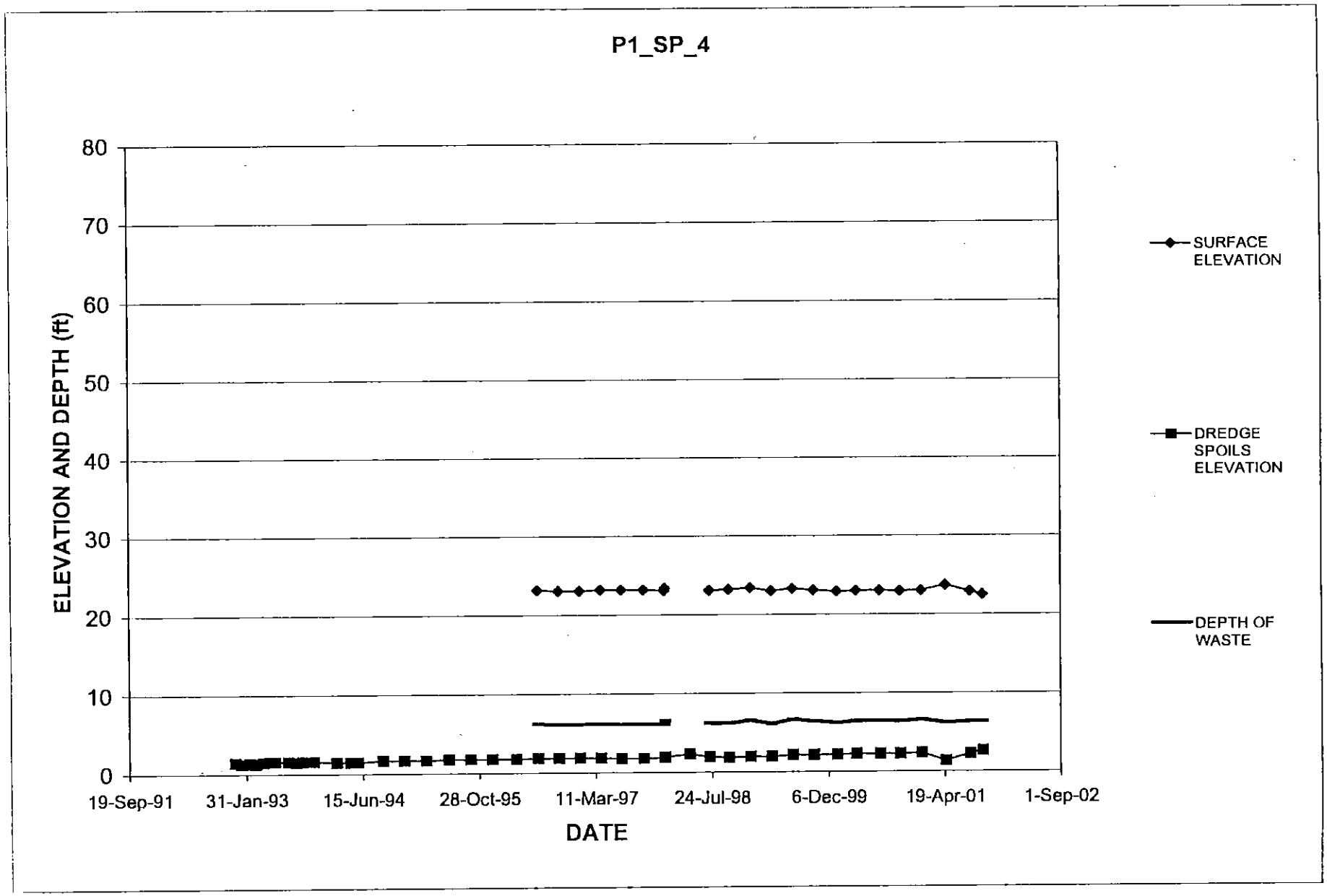
NOTES:

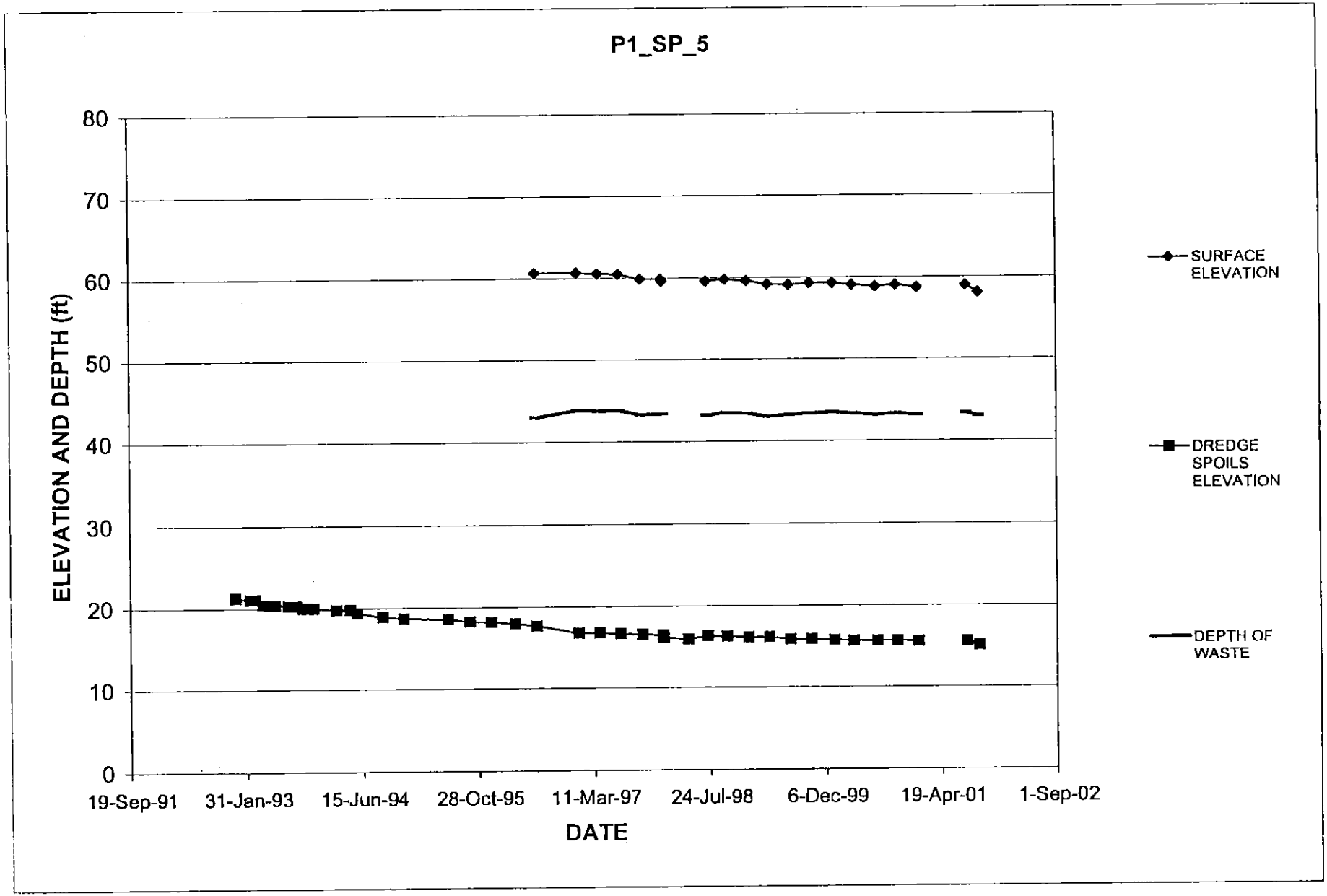
ASSUME: SP PLACED DIRECTLY ONTO SUBGRADE
SHOWN ON DWG E-CE-132 (TERRAQUA, 84)
86-90 DATA FROM GF REPORT, AUG90
92-01 DATA FROM GIS
GF REPORT, AUG90 HAS SP_1CA AND SP_1DA
IN PHASES 1C AND 1D
SETTLEMENT FROM 86-90
NO COORDINATES DATA.
P1_SP_3 - P1_SP_7 ARE ON OLD ACCESS ROAD
ALL DATA FROM GIS

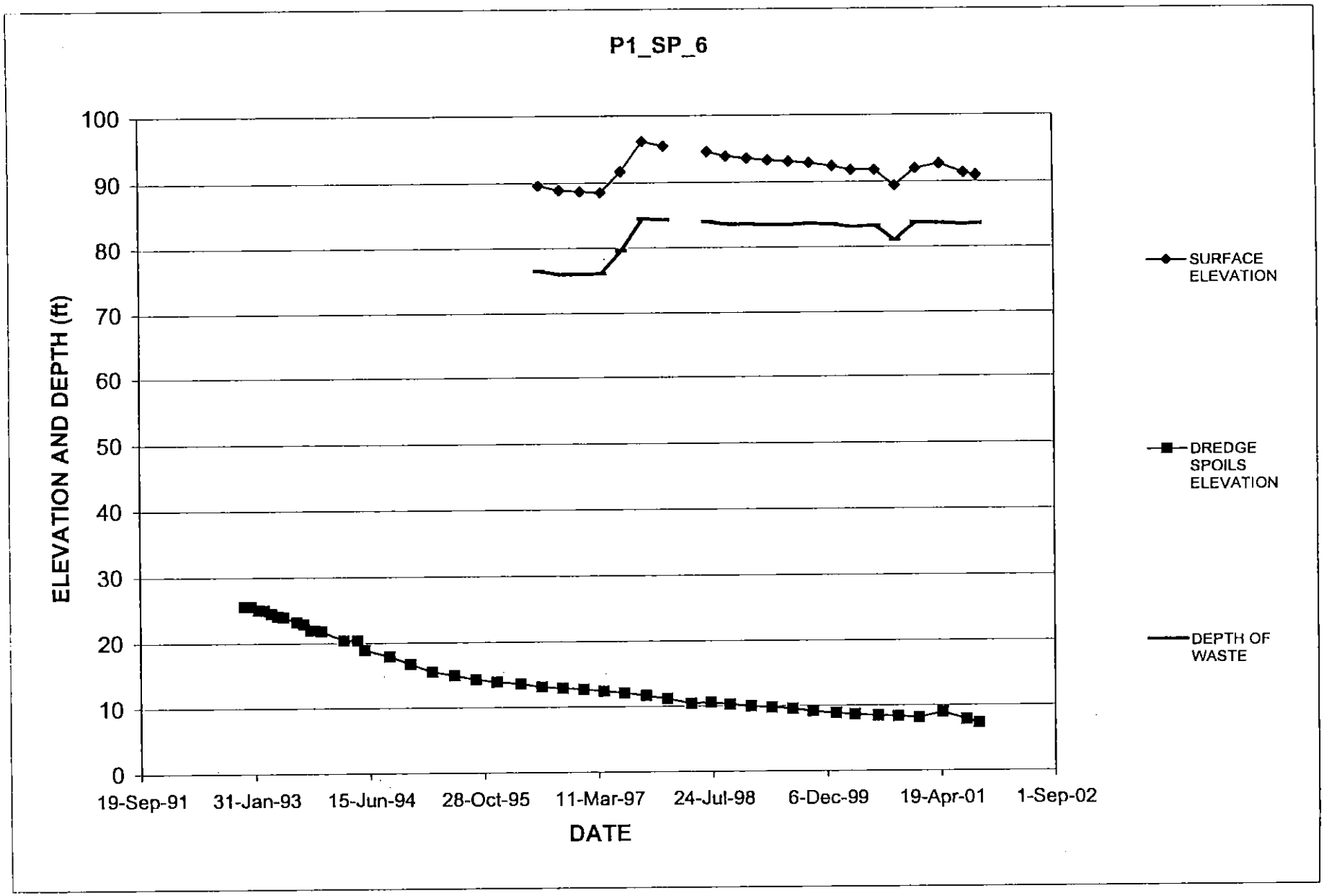

P1_SP_1AA
ELEVATION AND DEPTH (ft)
80
70
60
50
40
30
20
10
0
19-Sep-91
31-Jan-93
15-Jun-94
28-Oct-95
11-Mar-97
24-Jul-98
6-Dec-99
19-Apr-01
1-Sep-02
DATE
SURFACE ELEVATION
DREDGE SPOILS ELEVATION
DEPTH OF WASTE

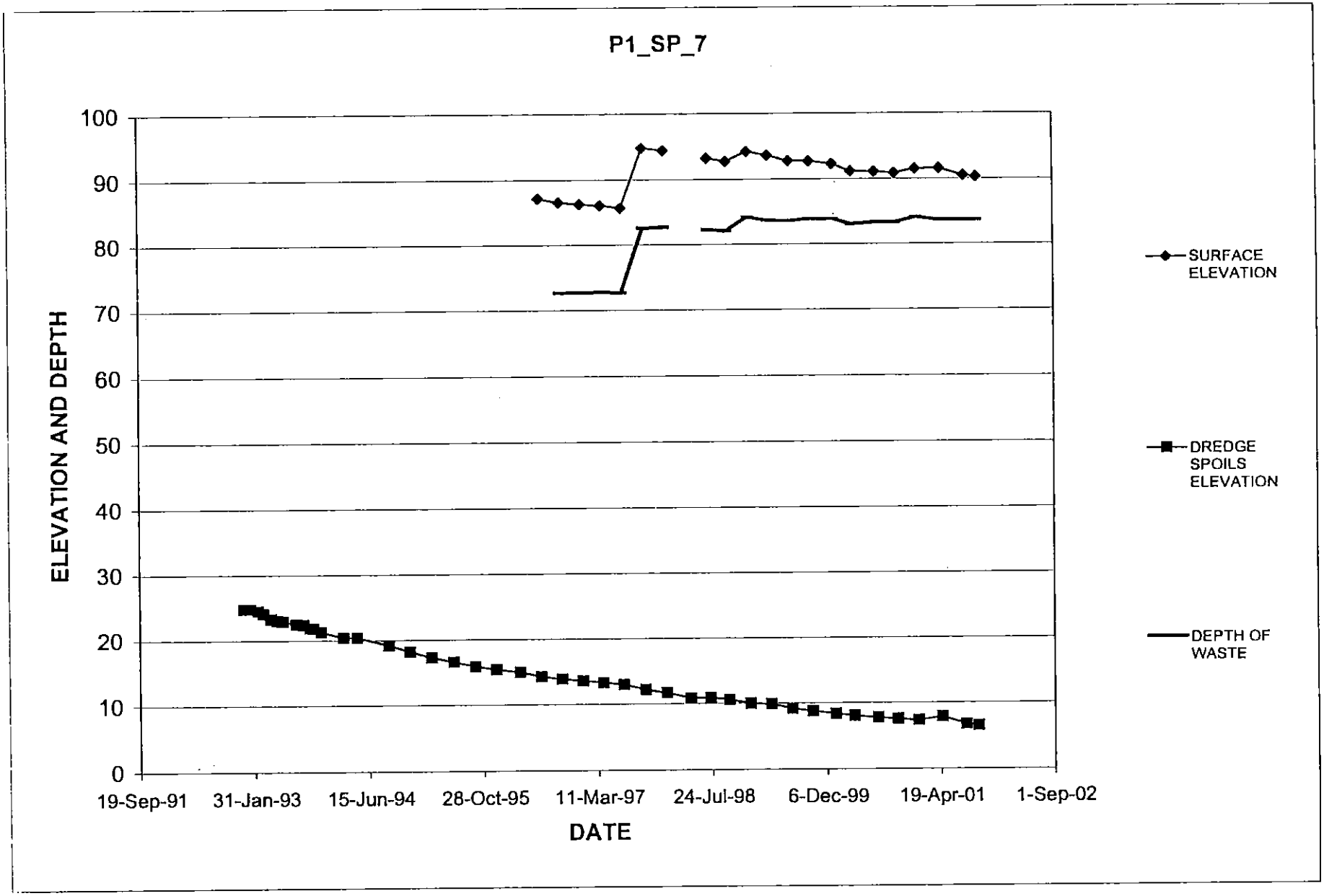

P1_SP_1BA
ELEVATION AND DEPTH (ft)
80
70
60
50
40
30
20
10
0
-10
19-Sep-91
31-Jan-93
15-Jun-94
28-Oct-95
11-Mar-97
24-Jul-98
6-Dec-99
19-Apr-01
1-Sep-02
DATE
SURFACE ELEVATION
DREDGE SPOILS ELEVATION
DEPTH OF WASTE


P1_SP_3
ELEVATION AND DEPTH (ft)
80
70
60
50
40
30
20
10
0
19-Sep-91
31-Jan-93
15-Jun-94
28-Oct-95
11-Mar-97
24-Jul-98
6-Dec-99
19-Apr-01
1-Sep-02
DATE
SURFACE ELEVATION
DREDGE SPOILS ELEVATION
DEPTH OF WASTE


P1_SP_4
ELEVATION AND DEPTH (ft)
80
70
60
50
40
30
20
10
0
19-Sep-91
31-Jan-93
15-Jun-94
28-Oct-95
11-Mar-97
24-Jul-98
6-Dec-99
19-Apr-01
1-Sep-02
DATE
SURFACE ELEVATION
DREDGE SPOILS ELEVATION
DEPTH OF WASTE


P1_SP_5
ELEVATION AND DEPTH (ft)
80
70
60
50
40
30
20
10
0
19-Sep-91
31-Jan-93
15-Jun-94
28-Oct-95
11-Mar-97
24-Jul-98
6-Dec-99
19-Apr-01
1-Sep-02
DATE
SURFACE ELEVATION
DREDGE SPOILS ELEVATION
DEPTH OF WASTE


P1_SP_6
ELEVATION AND DEPTH (ft)
100
90
80
70
60
50
40
30
20
10
0
19-Sep-91
31-Jan-93
15-Jun-94
28-Oct-95
11-Mar-97
24-Jul-98
6-Dec-99
19-Apr-01
1-Sep-02
DATE
SURFACE ELEVATION
DREDGE SPOILS ELEVATION
DEPTH OF WASTE


P1_SP_7
ELEVATION AND DEPTH
100
90
80
70
60
50
40
30
20
10
0
19-Sep-91
31-Jan-93
15-Jun-94
28-Oct-95
11-Mar-97
24-Jul-98
6-Dec-99
19-Apr-01
1-Sep-02
DATE
SURFACE ELEVATION
DREDGE SPOILS ELEVATION
DEPTH OF WASTE

Settlement Plates

INST_ID	Northing	Easting	Phase
P2_SP_1	630323	471530	P2
P2_SP_2	630103	471820	P2
P2_SP_4	630183	471423	P2
P2_SP_5	629893	471647	P2
P2_SP_7	630021	471286	P2
P2_SP_8	629733	471529	P2
P2_SP_10	629492	471330	P2
P2_SP_13	629094	471362	P2
P2_SP_14	628940	471237	P2

BASE PLATE	ORIGINAL ELEV.
P2_SP_1	35.8
P2_SP_2	35.8
P2_SP_4	35.3
P2_SP_5	35
P2_SP_7	35.3
P2_SP_8	35.6
P2_SP_10	36.6
P2_SP_13	37.5
P2_SP_14	38.1

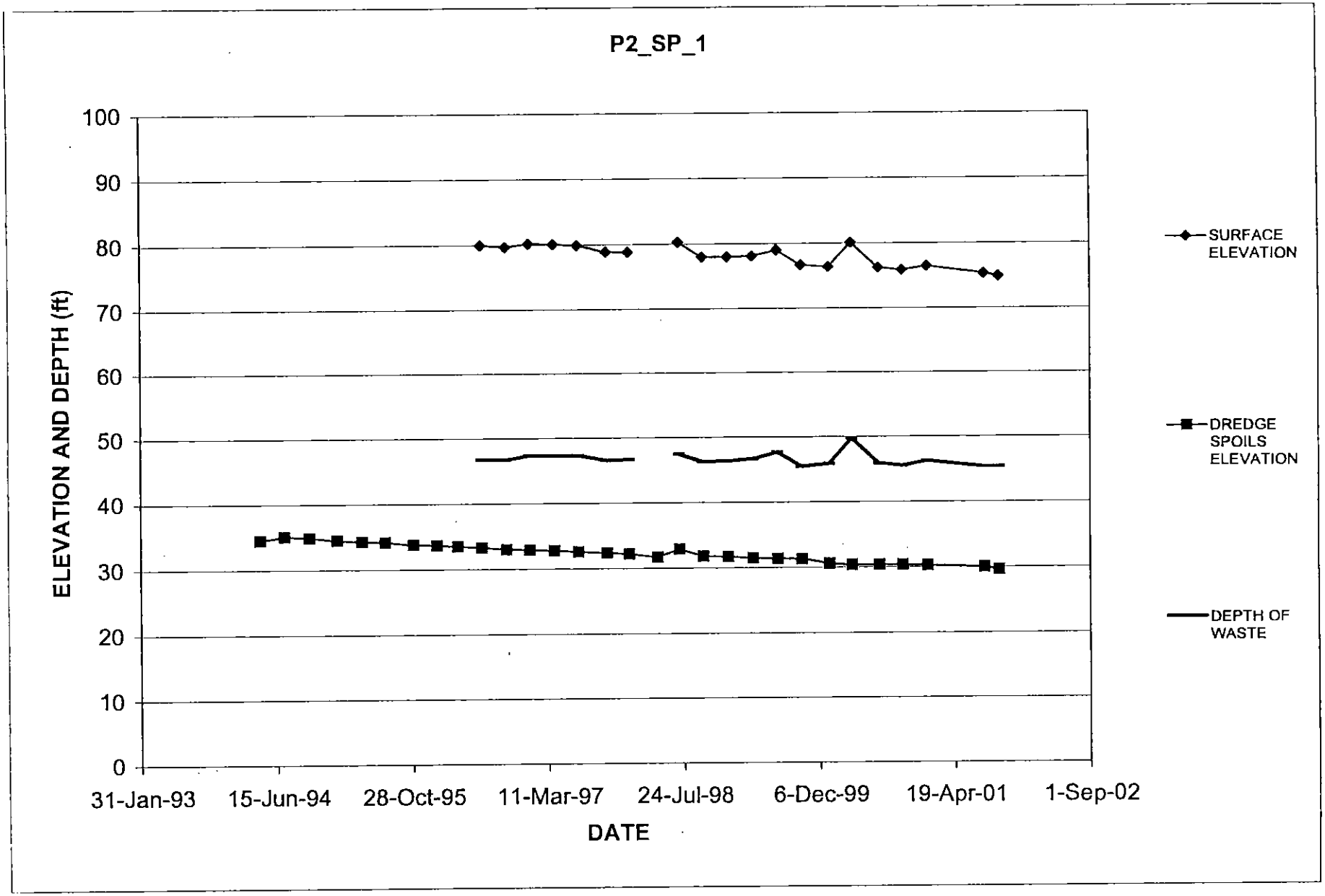
NOTES:

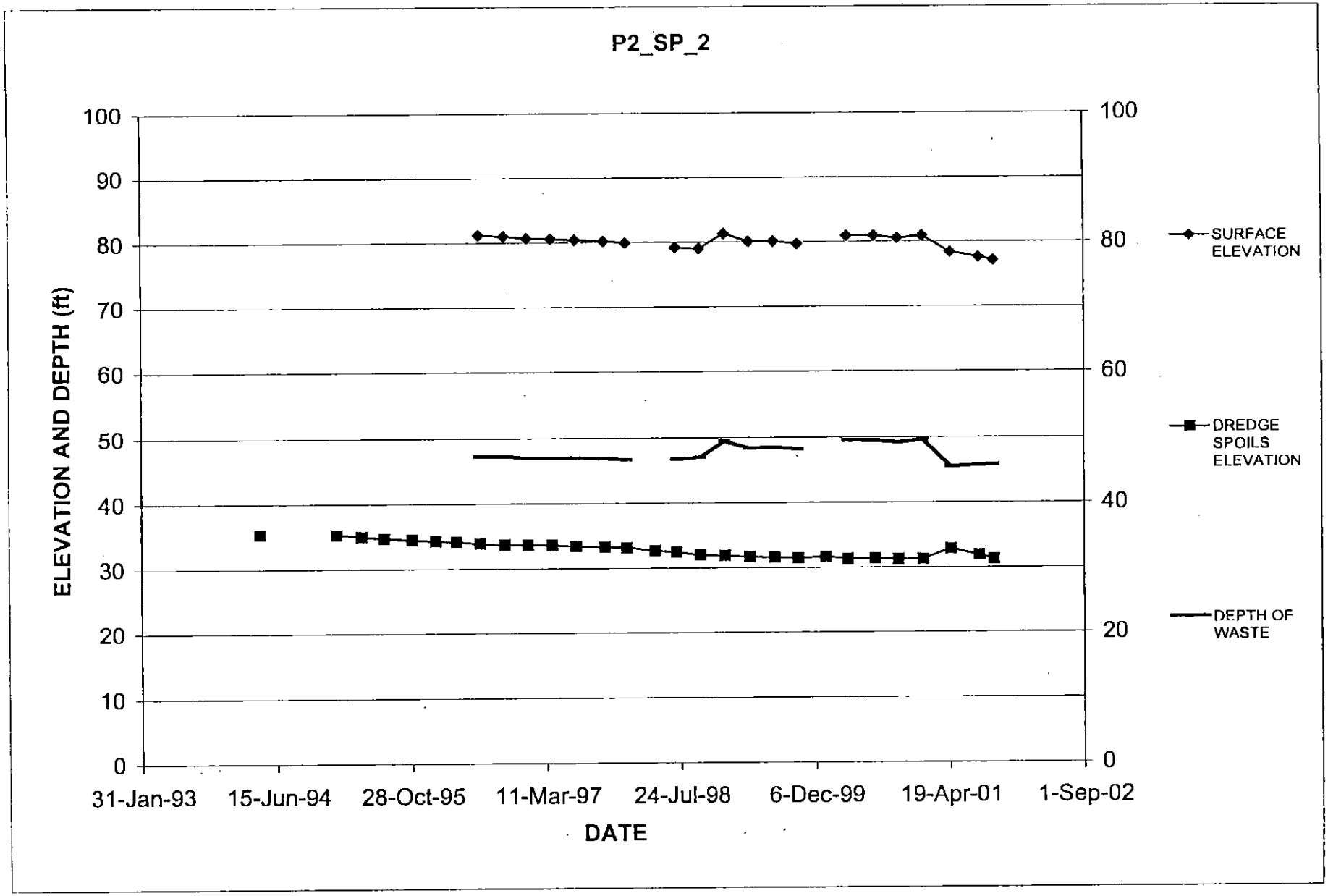
ASSUME: SP PLACED DIRECTLY ONTO SUBGRADE

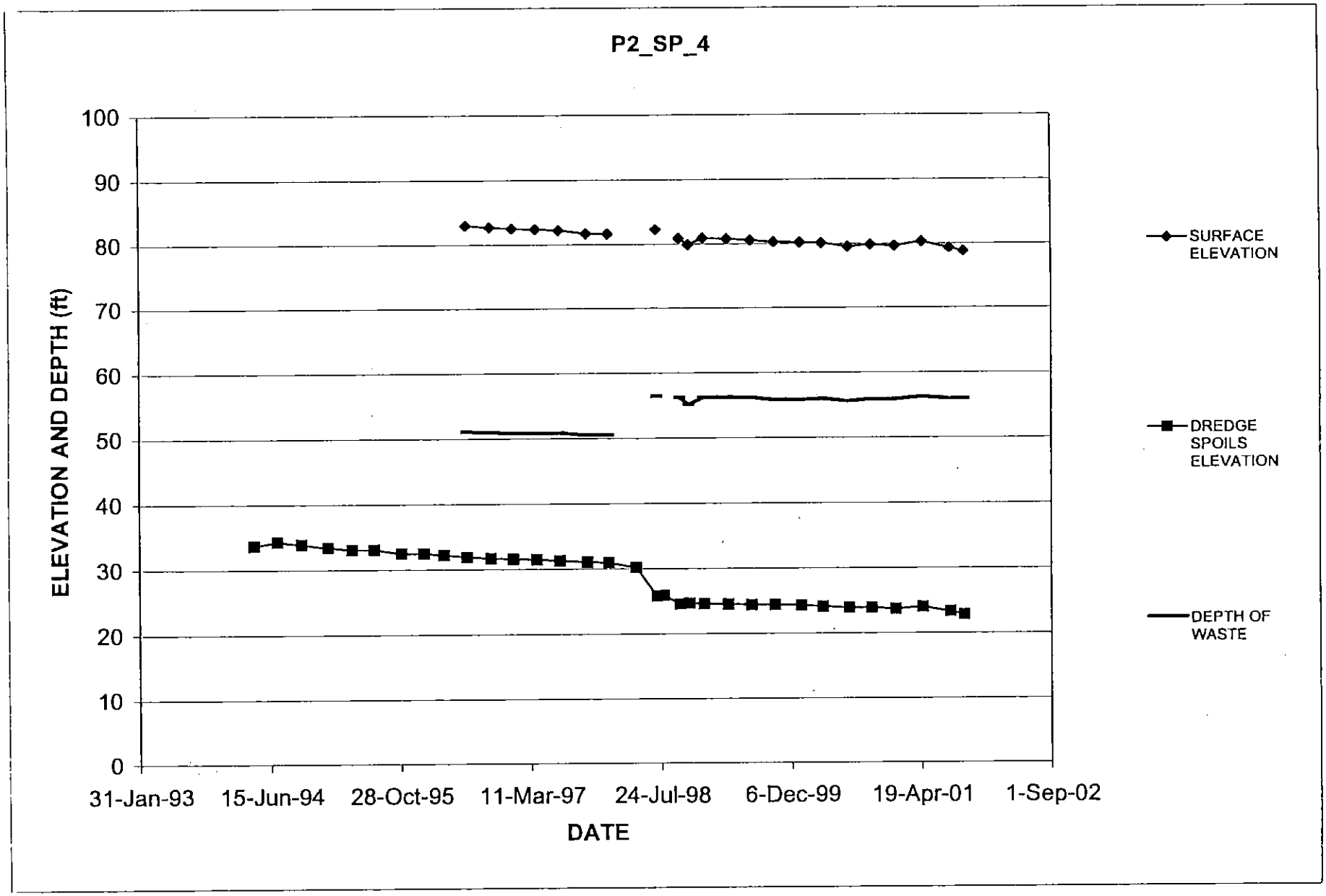
PLACED AS PER DETAIL ON CONSTR. DWG 12

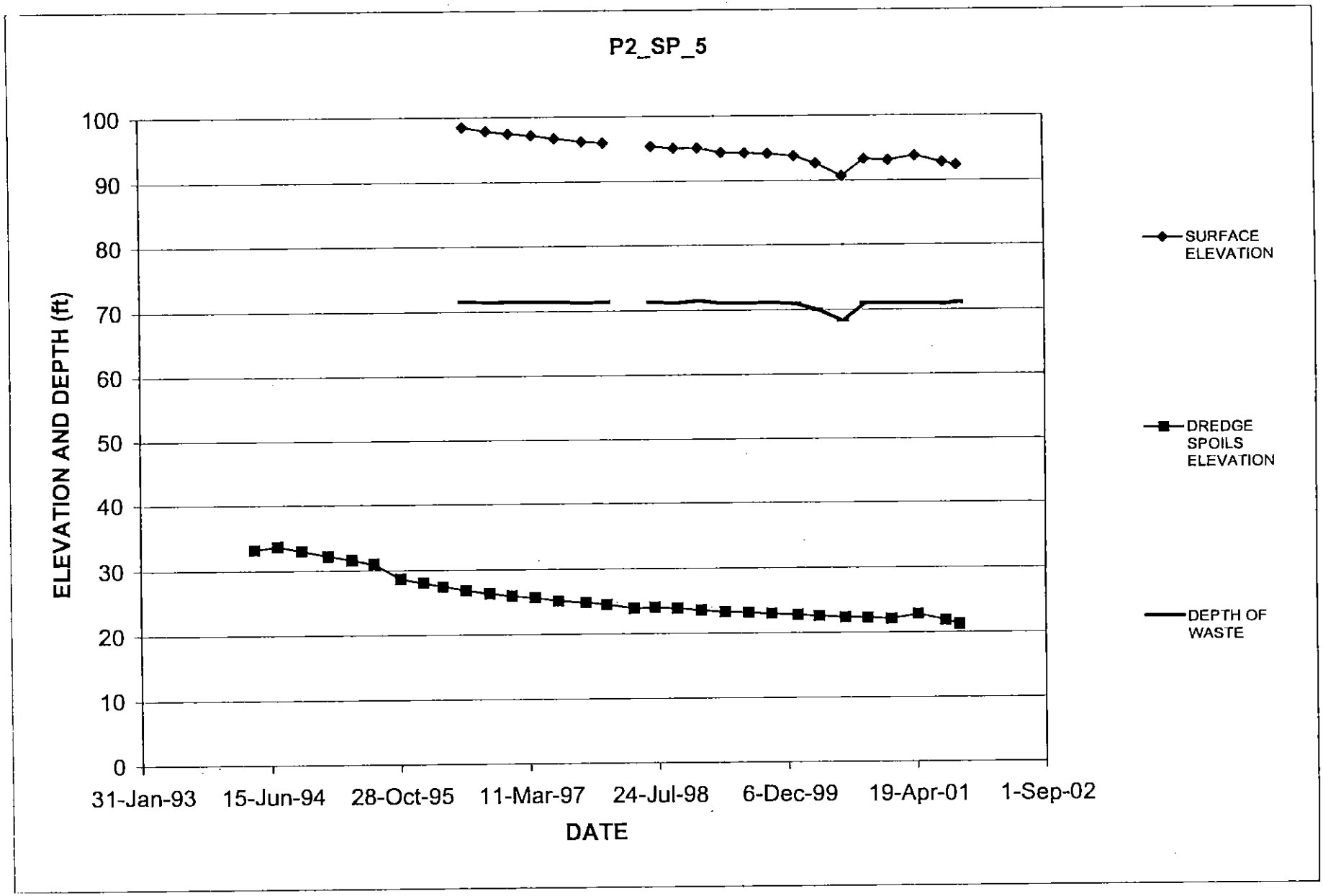
ALL DATA FROM GIS

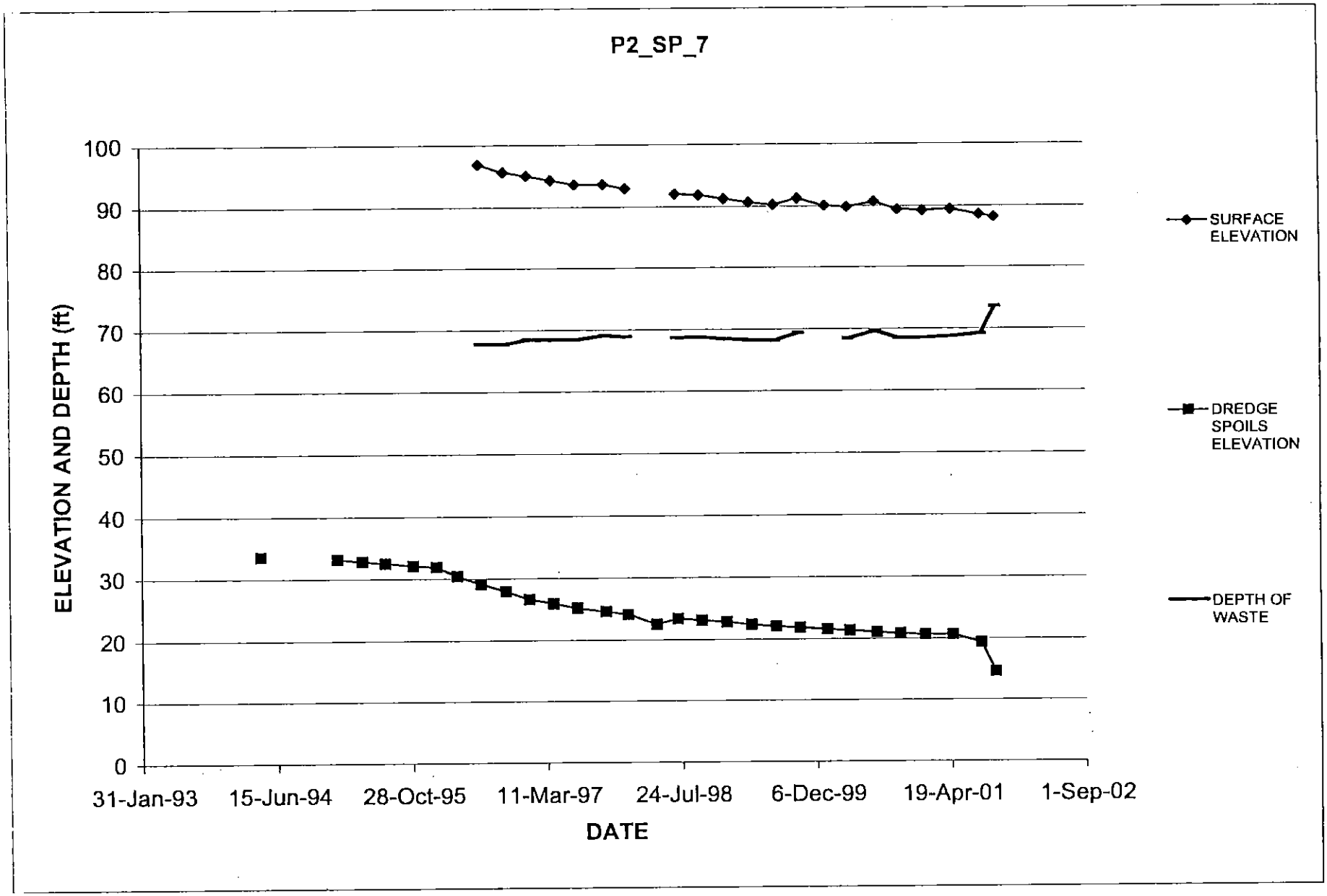
DWGS = GF (1986)

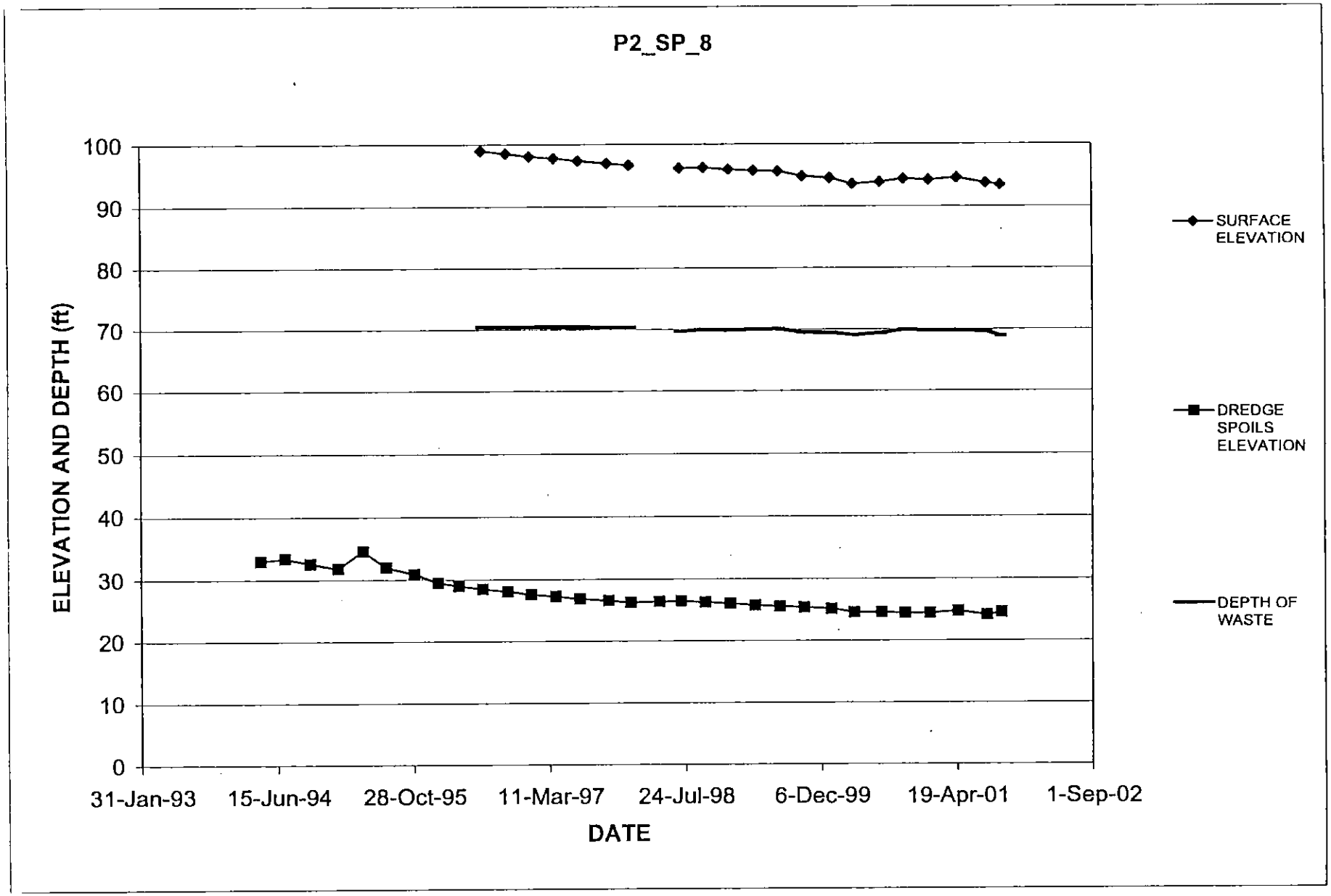

P2_SP_1
ELEVATION AND DEPTH (ft)
100
90
80
70
60
50
40
30
20
10
0
31-Jan-93
15-Jun-94
28-Oct-95
11-Mar-97
24-Jul-98
6-Dec-99
19-Apr-01
1-Sep-02
DATE
SURFACE ELEVATION
DREDGE SPOILS ELEVATION
DEPTH OF WASTE

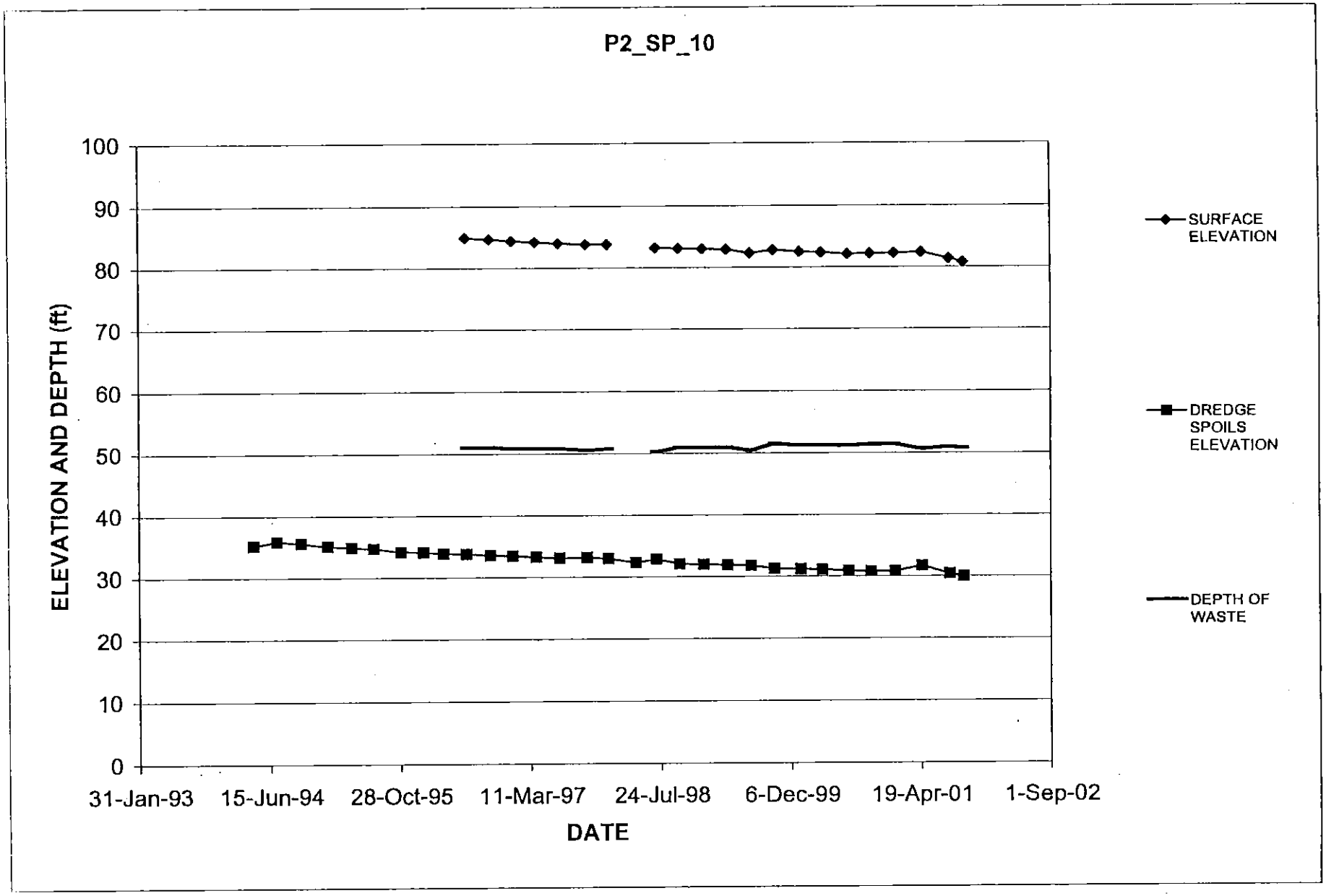

P2_SP_2
ELEVATION AND DEPTH (ft)
100
90
80
70
60
50
40
30
20
10
0
31-Jan-93
15-Jun-94
28-Oct-95
11-Mar-97
24-Jul-98
6-Dec-99
19-Apr-01
1-Sep-02
DATE
SURFACE ELEVATION
DREDGE SPOILS ELEVATION
DEPTH OF WASTE

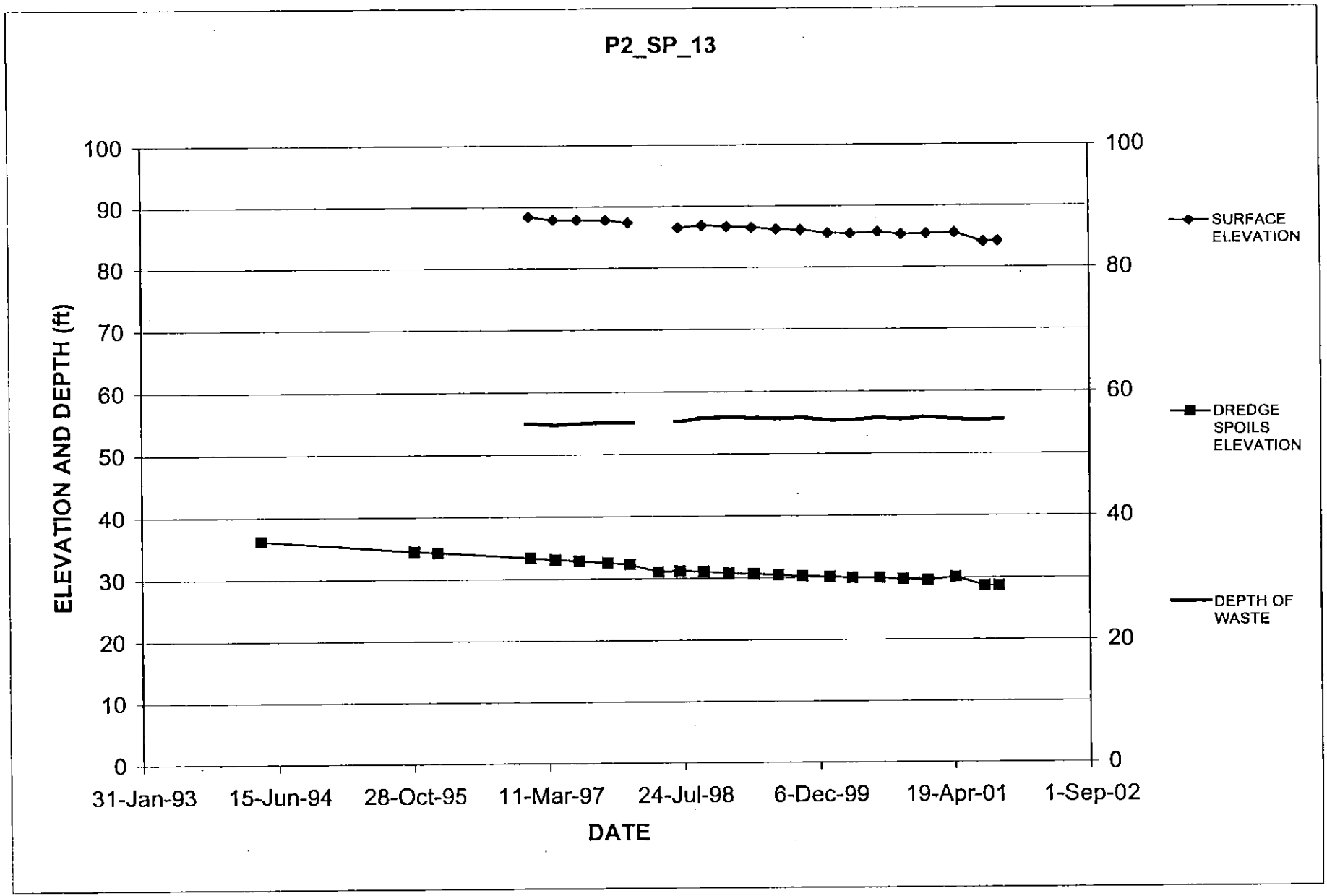

P2_SP_4
ELEVATION AND DEPTH (ft)
100
90
80
70
60
50
40
30
20
10
0
31-Jan-93
15-Jun-94
28-Oct-95
11-Mar-97
24-Jul-98
6-Dec-99
19-Apr-01
1-Sep-02
DATE
SURFACE ELEVATION
DREDGE SPOILS ELEVATION
DEPTH OF WASTE

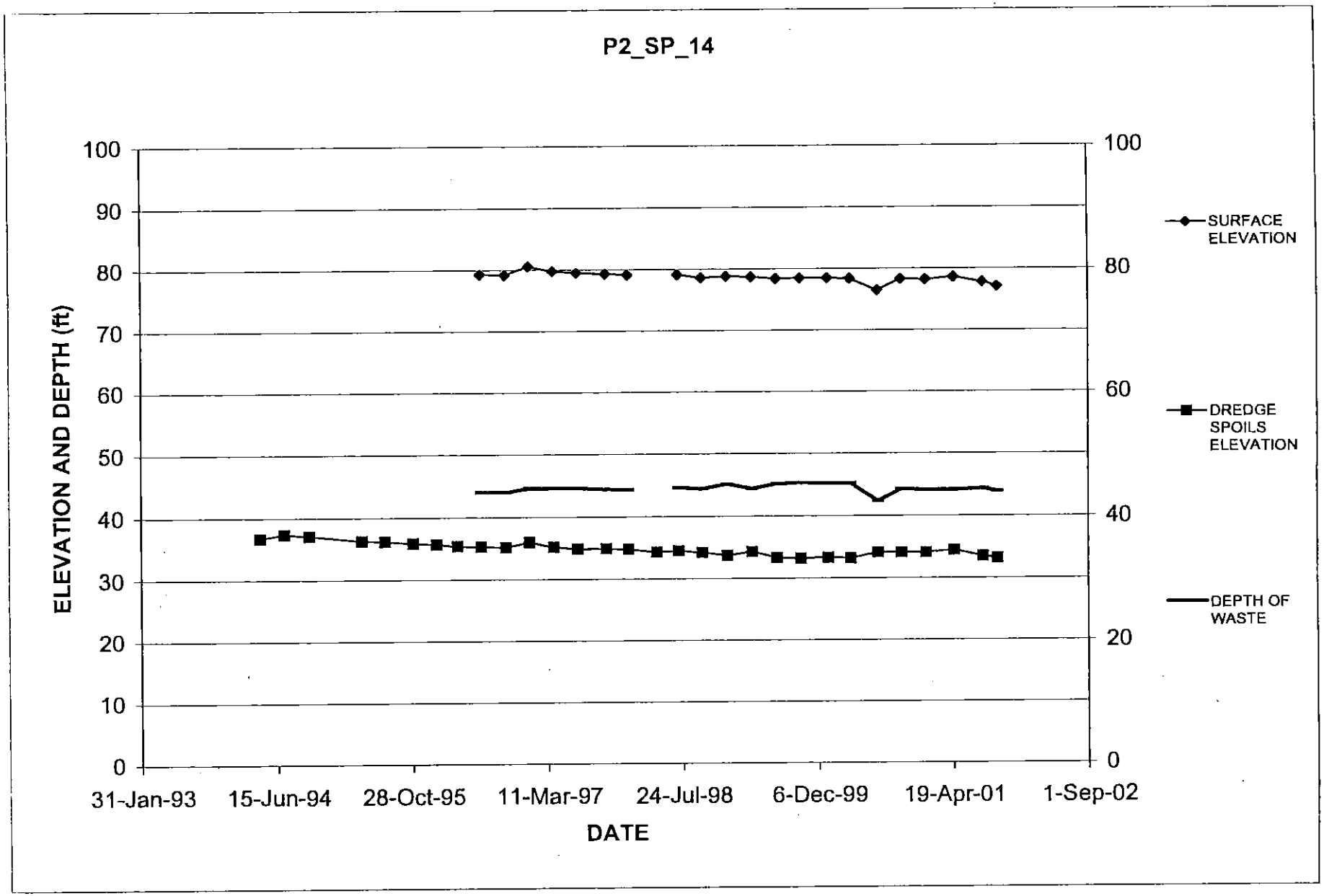

P2_SP_5
ELEVATION AND DEPTH (ft)
100
90
80
70
60
50
40
30
20
10
0
31-Jan-93
15-Jun-94
28-Oct-95
11-Mar-97
24-Jul-98
6-Dec-99
19-Apr-01
1-Sep-02
DATE
SURFACE ELEVATION
DREDGE SPOILS ELEVATION
DEPTH OF WASTE


P2_SP_7
ELEVATION AND DEPTH (ft)
100
90
80
70
60
50
40
30
20
10
0
31-Jan-93
15-Jun-94
28-Oct-95
11-Mar-97
24-Jul-98
6-Dec-99
19-Apr-01
1-Sep-02
DATE
SURFACE ELEVATION
DREDGE SPOILS ELEVATION
DEPTH OF WASTE


P2_SP_8
ELEVATION AND DEPTH (ft)
100
90
80
70
60
50
40
30
20
10
0
31-Jan-93
15-Jun-94
28-Oct-95
11-Mar-97
24-Jul-98
6-Dec-99
19-Apr-01
1-Sep-02
DATE
SURFACE ELEVATION
DREDGE SPOILS ELEVATION
DEPTH OF WASTE


P2_SP_10
ELEVATION AND DEPTH (ft)
100
90
80
70
60
50
40
30
20
10
0
31-Jan-93
15-Jun-94
28-Oct-95
11-Mar-97
24-Jul-98
6-Dec-99
19-Apr-01
1-Sep-02
DATE
SURFACE ELEVATION
DREDGE SPOILS ELEVATION
DEPTH OF WASTE


P2_SP_13
ELEVATION AND DEPTH (ft)
100
90
80
70
60
50
40
30
20
10
0
31-Jan-93
15-Jun-94
28-Oct-95
11-Mar-97
24-Jul-98
6-Dec-99
19-Apr-01
1-Sep-02
DATE
SURFACE ELEVATION
DREDGE SPOILS ELEVATION
DEPTH OF WASTE


P2_SP_14
ELEVATION AND DEPTH (ft)
100
90
80
70
60
50
40
30
20
10
0
31-Jan-93
15-Jun-94
28-Oct-95
11-Mar-97
24-Jul-98
6-Dec-99
19-Apr-01
1-Sep-02
DATE
SURFACE ELEVATION
DREDGE SPOILS ELEVATION
DEPTH OF WASTE

Settlement Plates

INST_ID	Northing	Easting	Phase
P3_SP_1	629636	472186	P3
P3_SP_2	629360	471975	P3
P3_SP_4	629467	472533	P3
P3_SP_5	629224	472340	P3
P3_SP_8	629025	472943	P3
P3_SP_11	628788	473514	P3
P3_SP_11A	628793	473519	P3
P3_SP_12	628642	473430	P3
P3_SP_13	628629	473791	P3
P3_SP_14	628494	473737	P3

Total Pressure Cells

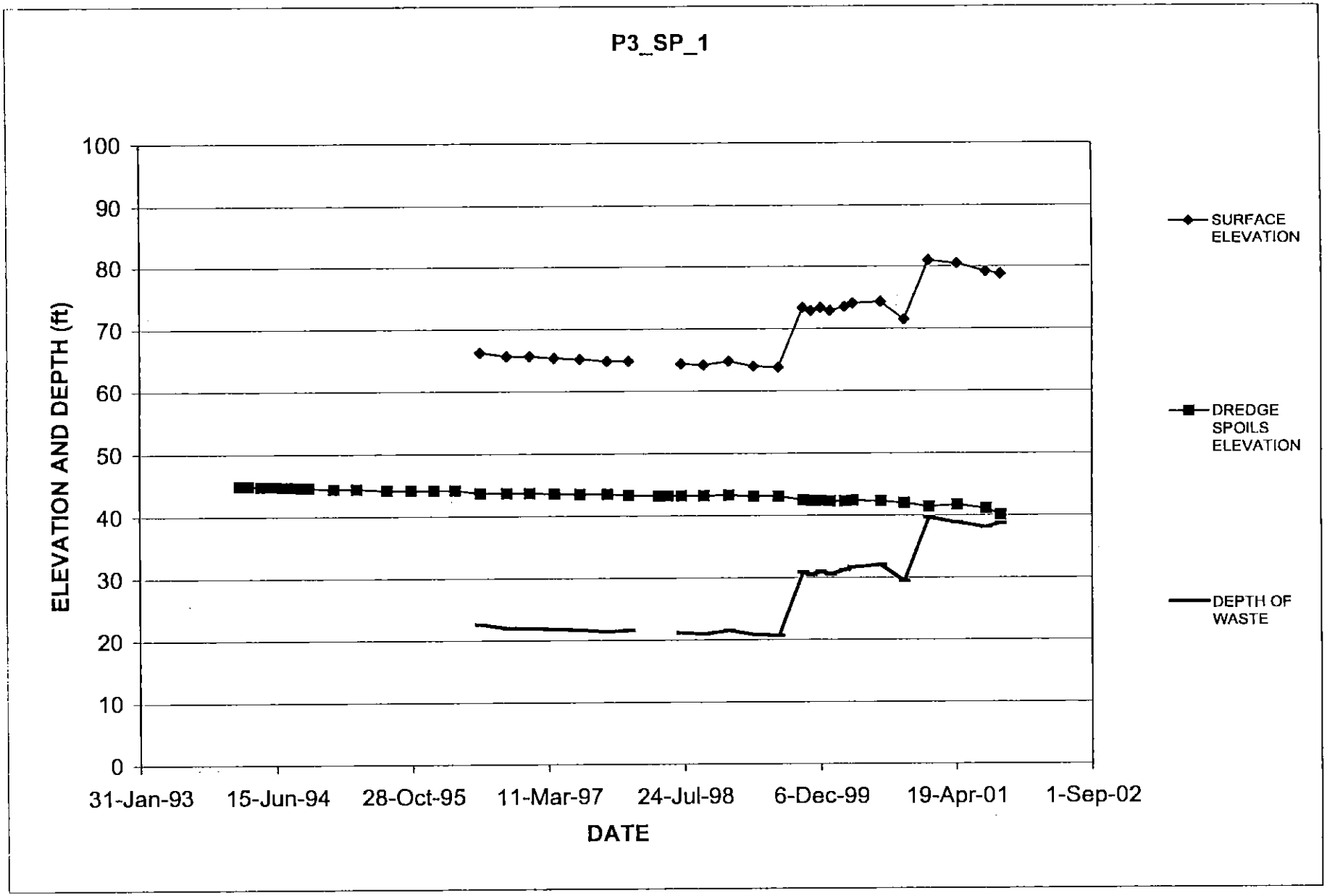
INST_ID	Northing	Easting	Phase
P3_TPC_1	628781	473171	P3
P3_TPC_2	628783	473173	P3
P3_TPC_3	628785	473175	P3
P3_TPC_4	628787	473177	P3
P3_TPC_5	628789	473179	P3
P3_TPC_6	629108	472539	P3
P3_TPC_7	629110	472541	P3
P3_TPC_8	629112	472543	P3
P3_TPC_9	629114	472545	P3
P3_TPC_10	629116	472547	P3

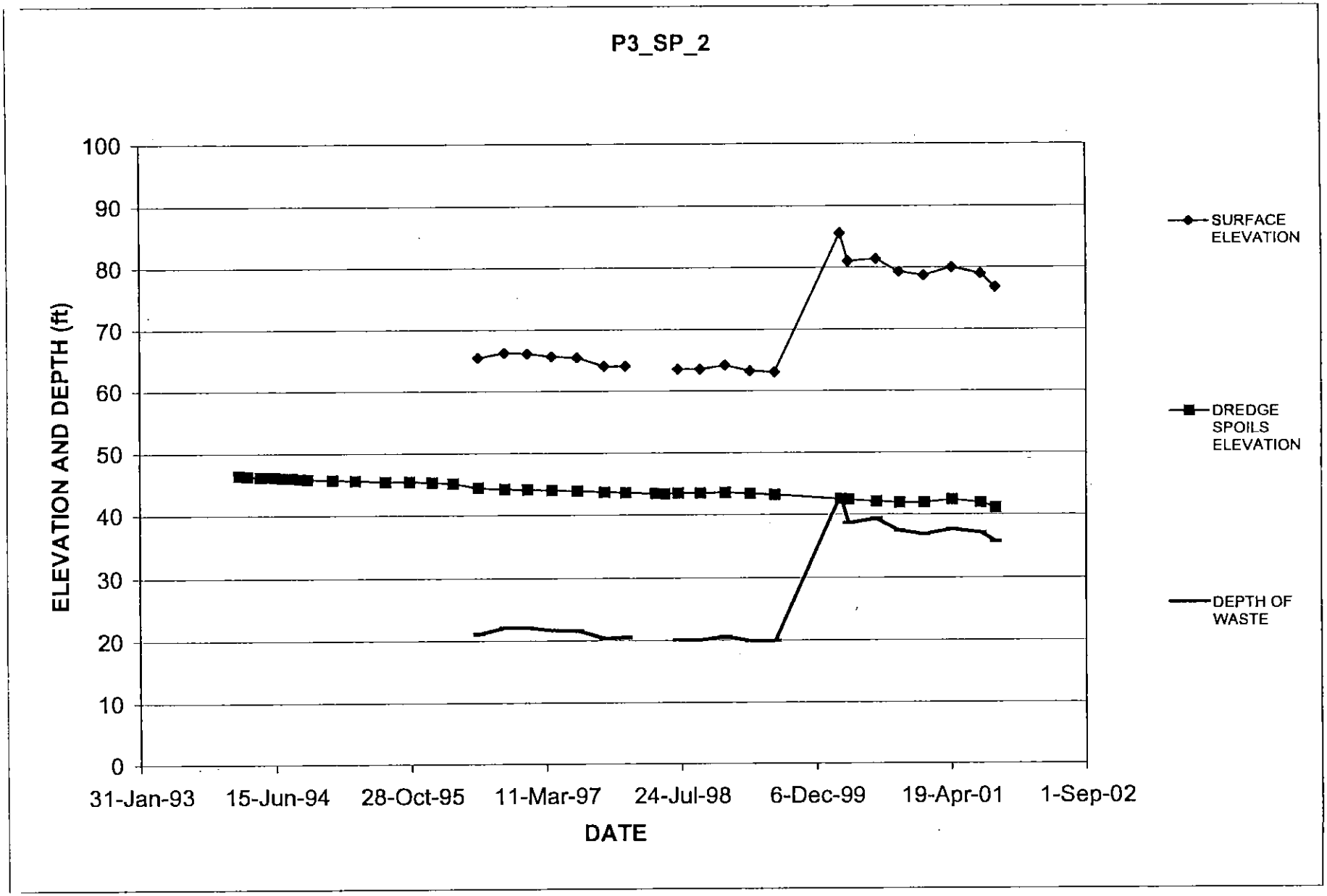
BASE PLATE	ORIGINAL ELEV
P3_SP_1	45
P3_SP_2	46.5
P3_SP_4	45.7
P3_SP_5	45.5
P3_SP_8	43.8
P3_SP_11	45
P3_SP_11A	45
P3_SP_12	44.8
P3_SP_13	44.4
P3_SP_14	44

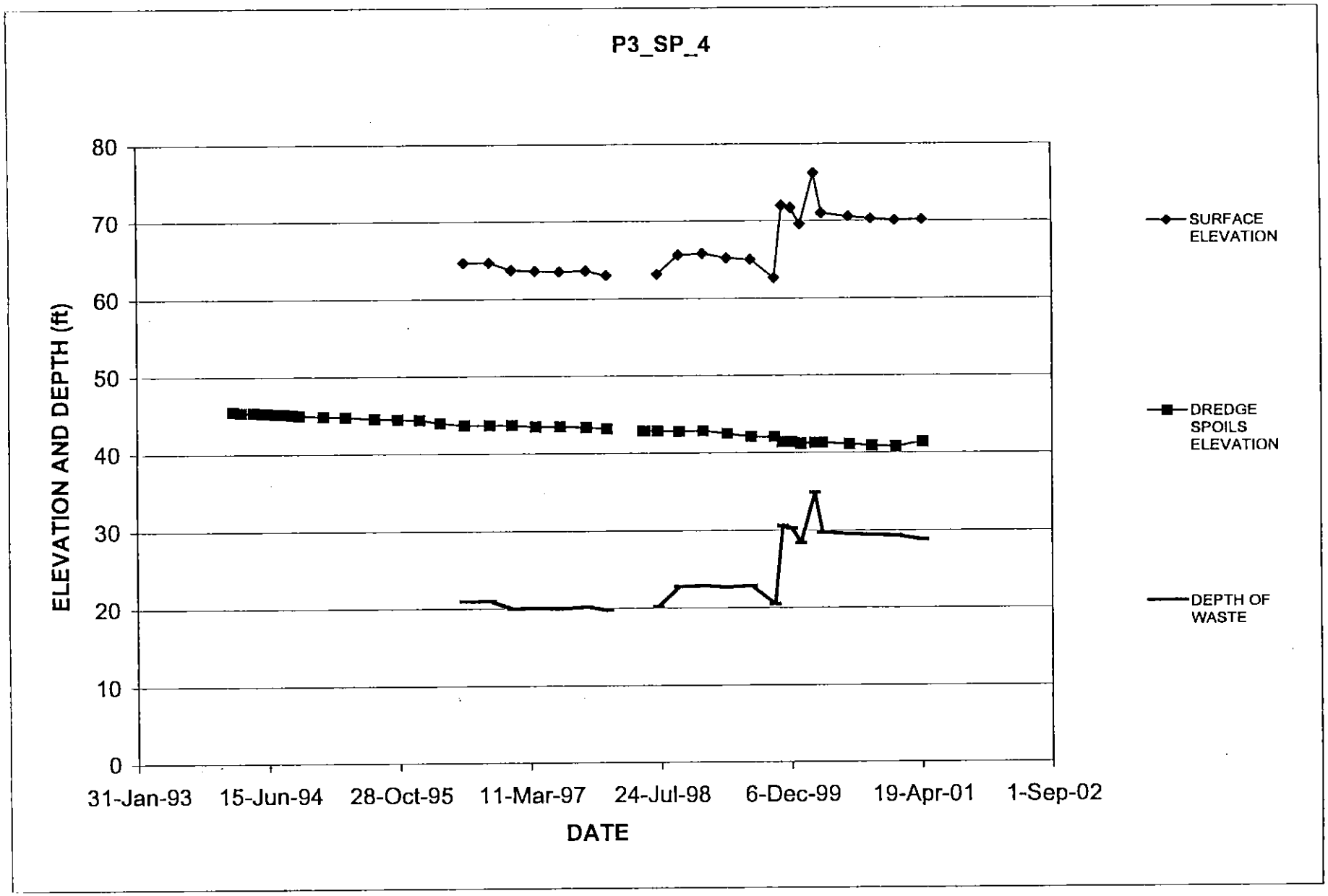
NOTES:

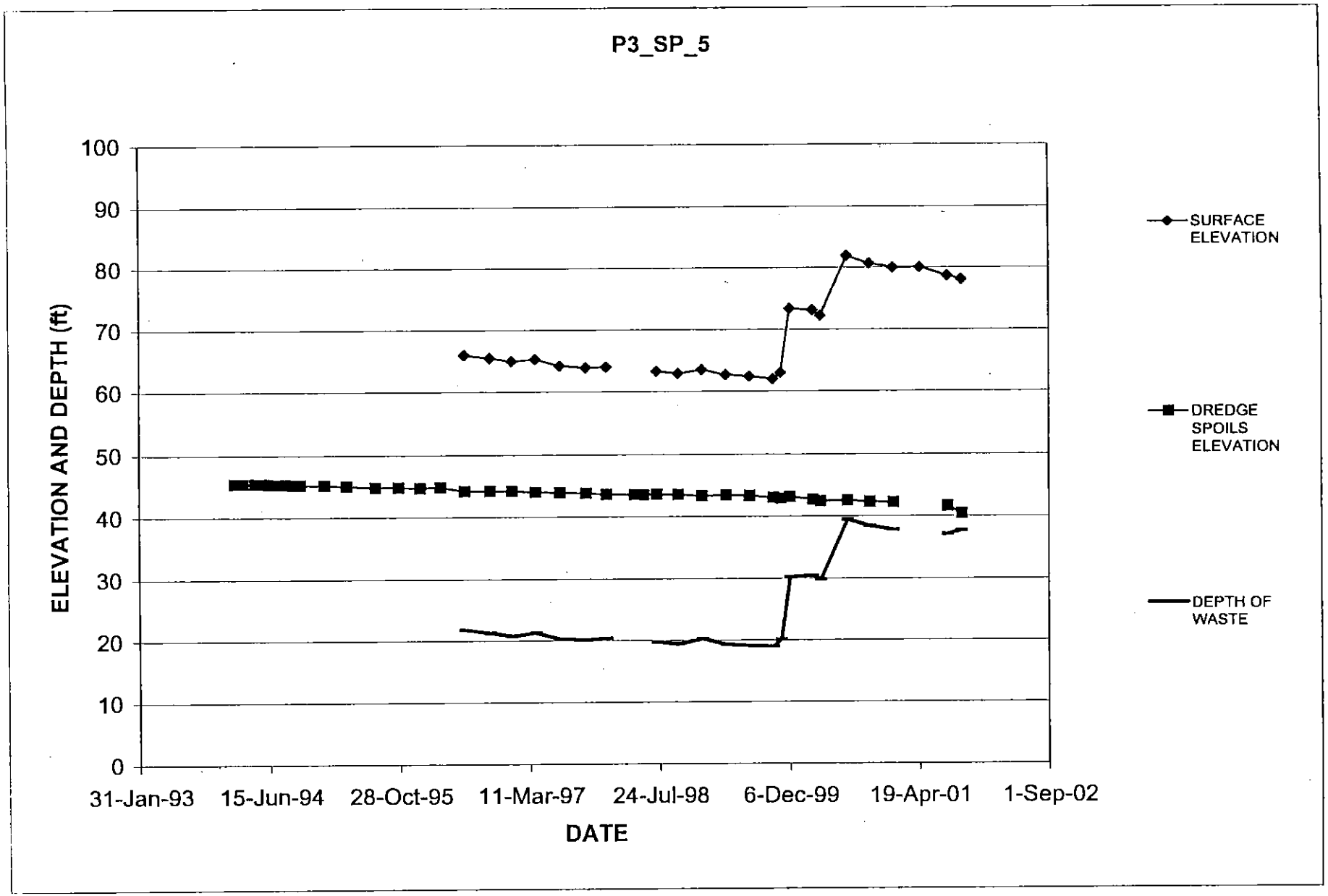
ASSUME: SP PLACED 1-FT. ABOVE BASEGRADE SHOWN ON CONSTR. DWG

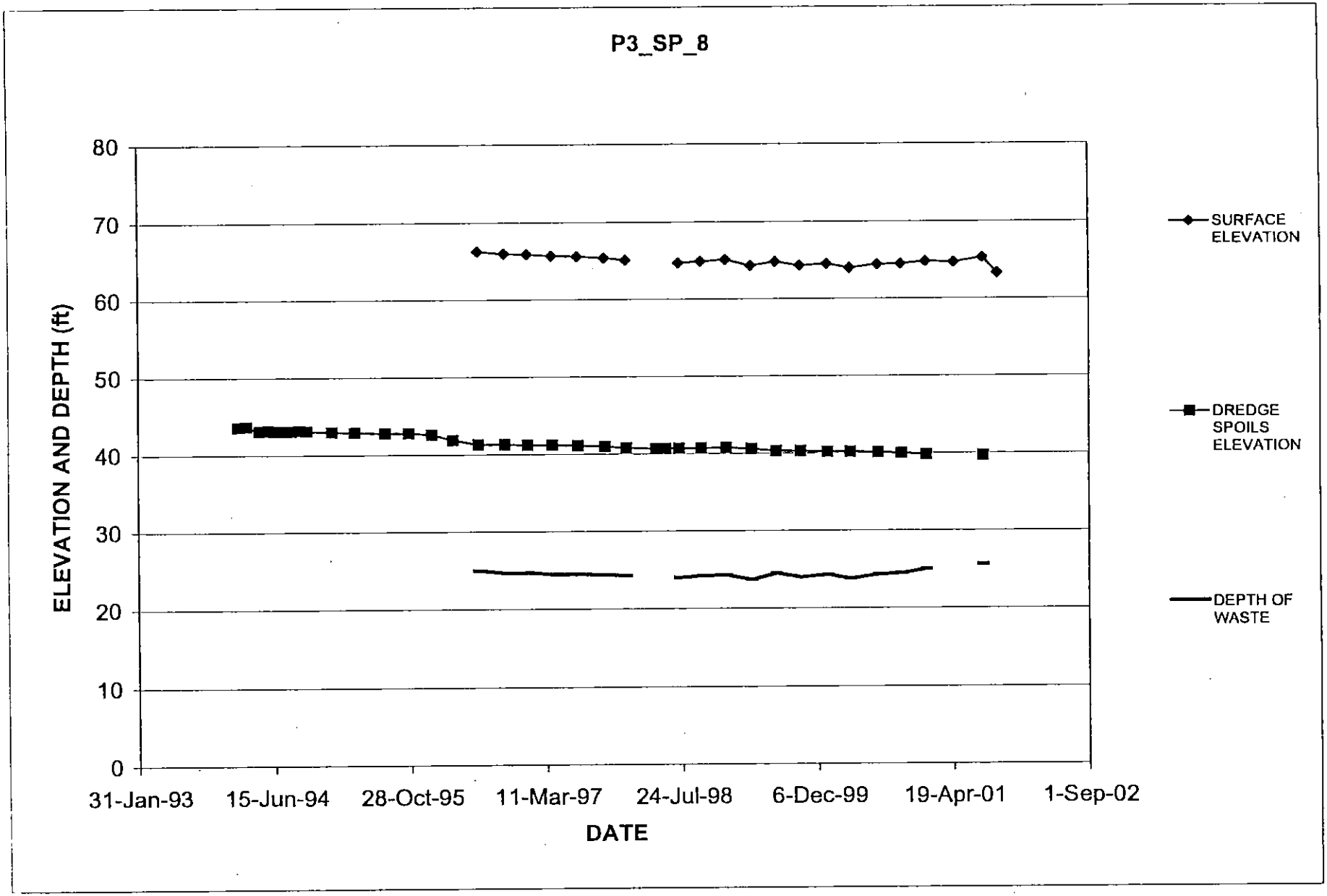
ALL DATA FROM GIS

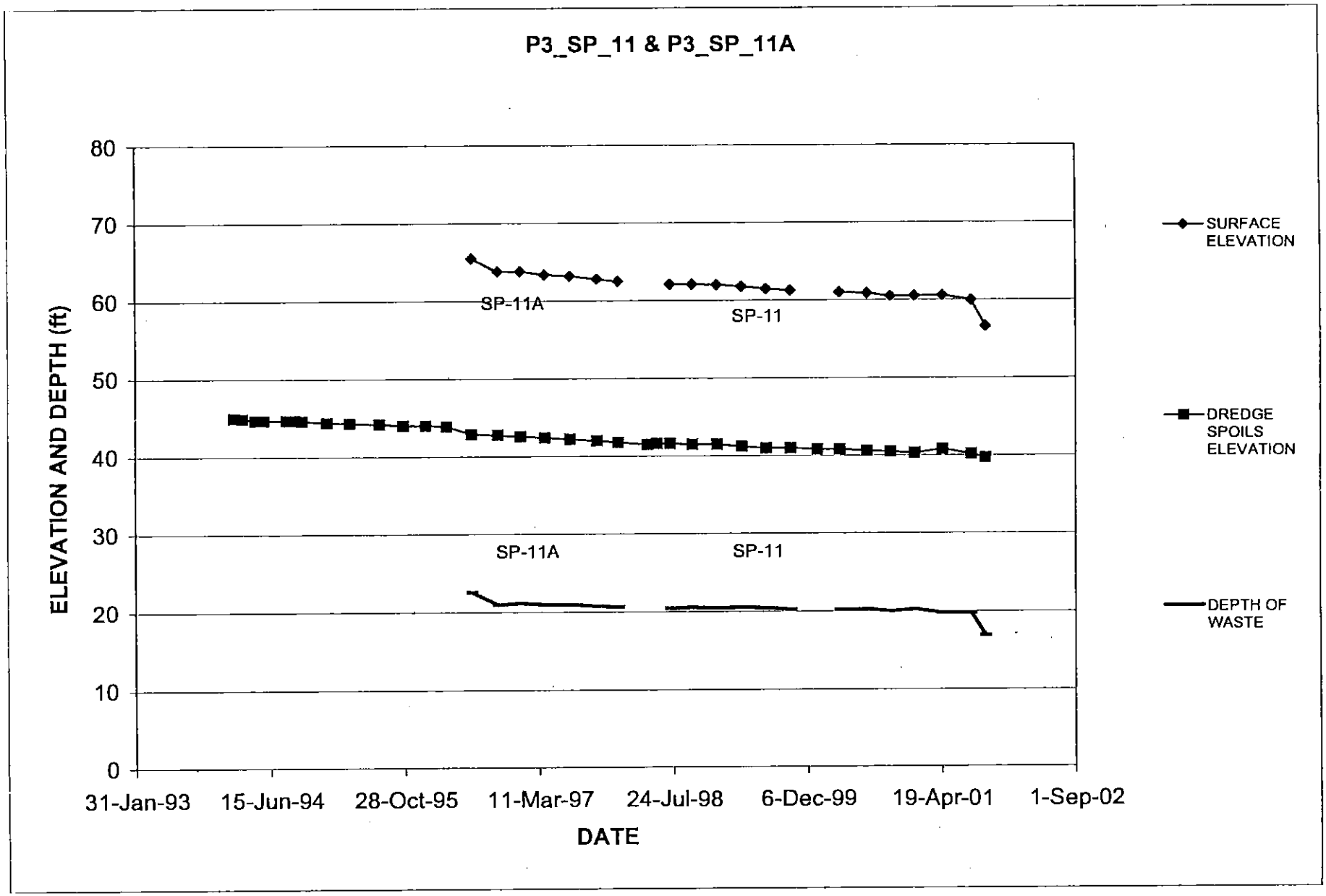

P3_SP_1
ELEVATION AND DEPTH (ft)
100
90
80
70
60
50
40
30
20
10
0
31-Jan-93
15-Jun-94
28-Oct-95
11-Mar-97
24-Jul-98
6-Dec-99
19-Apr-01
1-Sep-02
DATE
SURFACE ELEVATION
DREDGE SPOILS ELEVATION
DEPTH OF WASTE

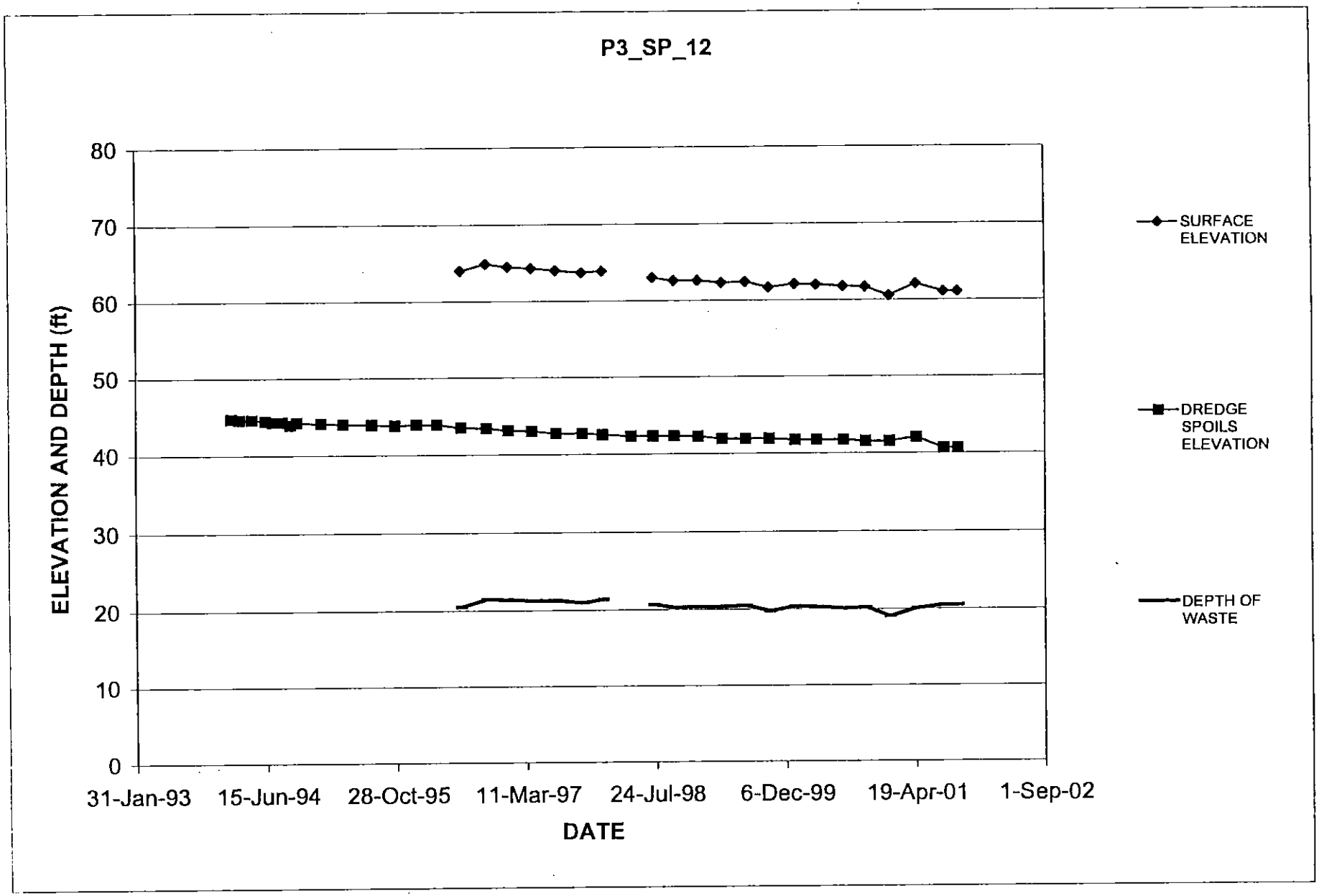

P3_SP_2
ELEVATION AND DEPTH (ft)
100
90
80
70
60
50
40
30
20
10
0
31-Jan-93
15-Jun-94
28-Oct-95
11-Mar-97
24-Jul-98
6-Dec-99
19-Apr-01
1-Sep-02
DATE
SURFACE ELEVATION
DREDGE SPOILS ELEVATION
DEPTH OF WASTE

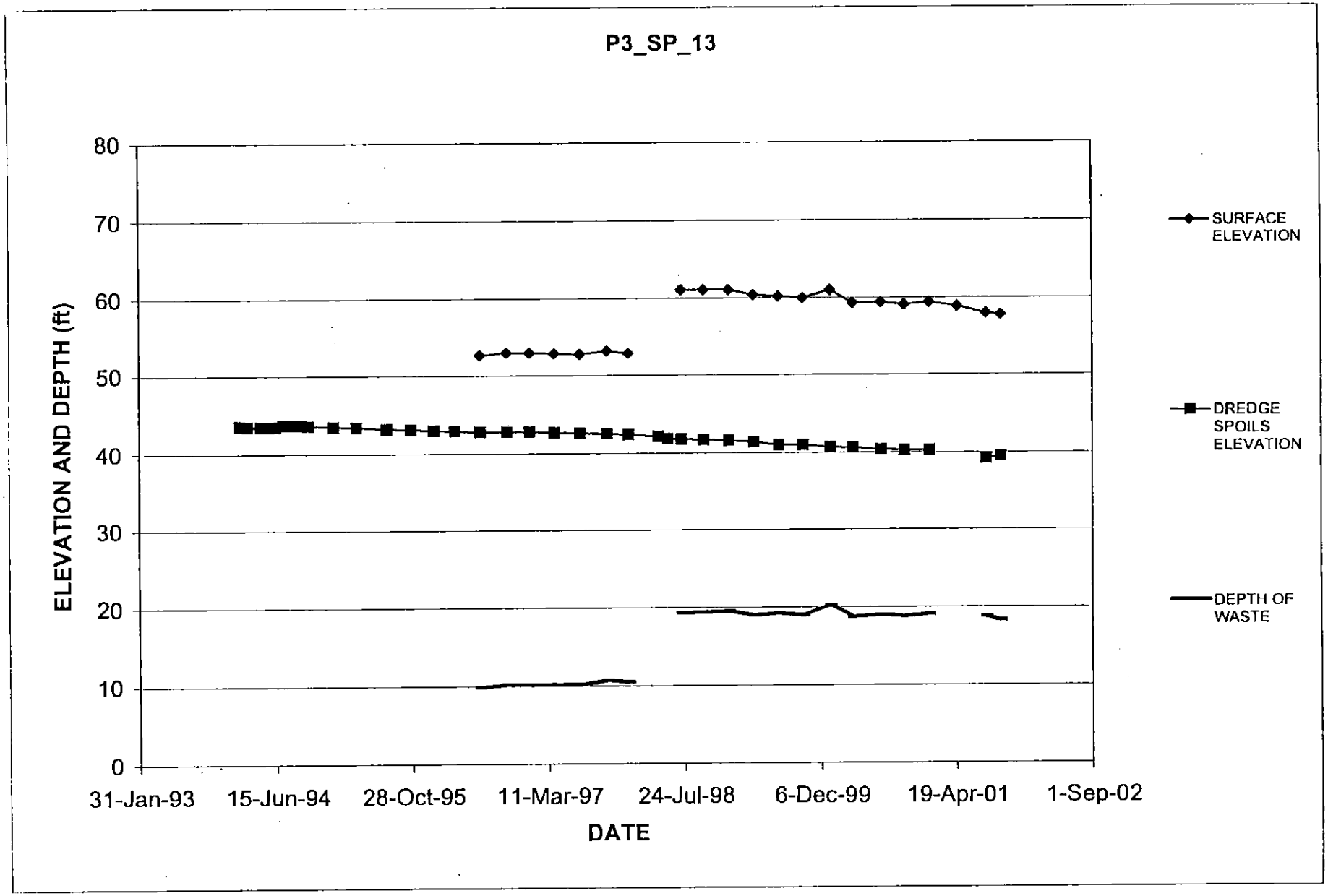

P3_SP_4
ELEVATION AND DEPTH (ft)
80
70
60
50
40
30
20
10
0
31-Jan-93
15-Jun-94
28-Oct-95
11-Mar-97
24-Jul-98
6-Dec-99
19-Apr-01
1-Sep-02
DATE
SURFACE ELEVATION
DREDGE SPOILS ELEVATION
DEPTH OF WASTE

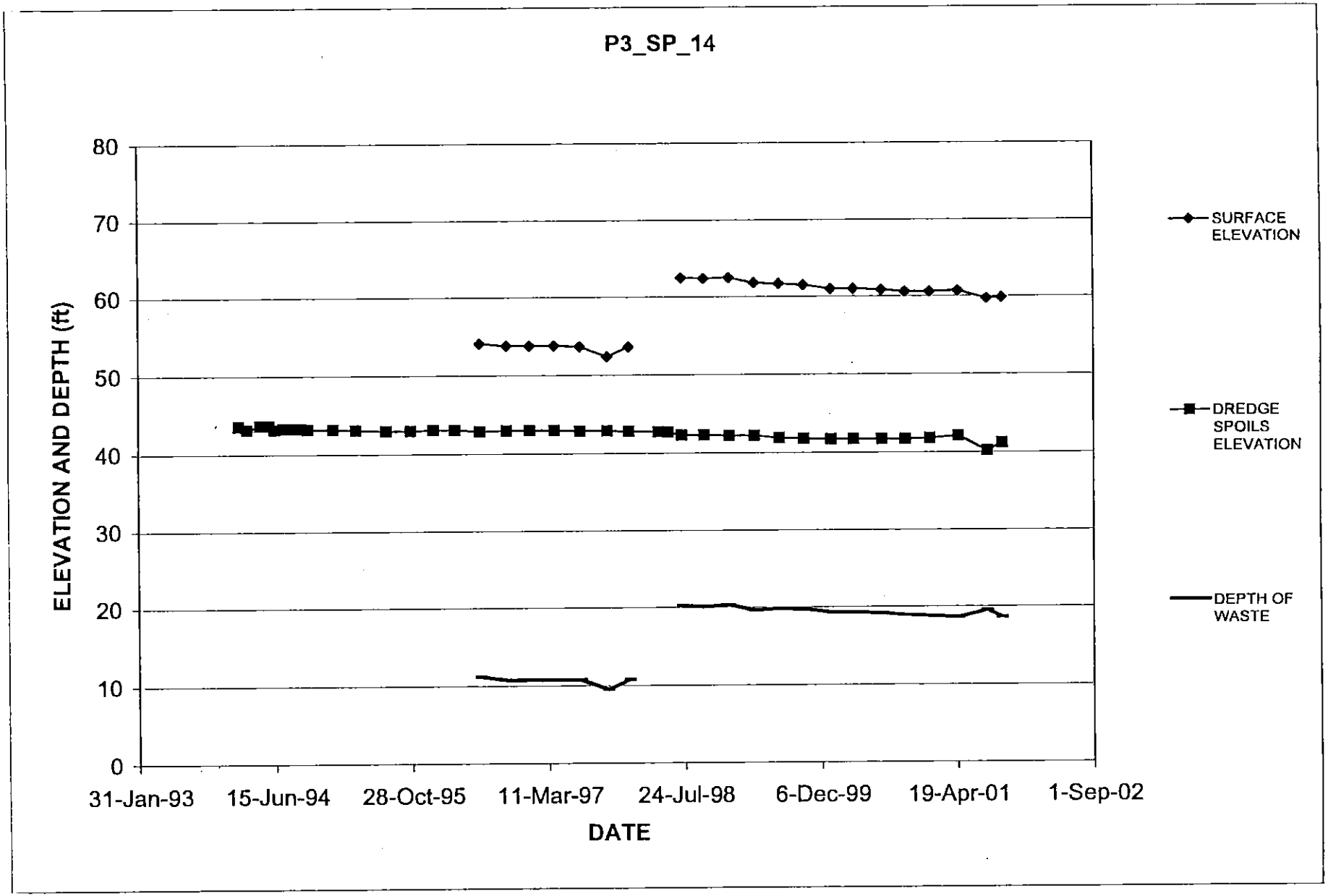

P3_SP_5
ELEVATION AND DEPTH (ft)
100
90
80
70
60
50
40
30
20
10
0
31-Jan-93
15-Jun-94
28-Oct-95
11-Mar-97
24-Jul-98
6-Dec-99
19-Apr-01
1-Sep-02
DATE
SURFACE ELEVATION
DREDGE SPOILS ELEVATION
DEPTH OF WASTE


P3_SP_8
ELEVATION AND DEPTH (ft)
80
70
60
50
40
30
20
10
0
31-Jan-93
15-Jun-94
28-Oct-95
11-Mar-97
24-Jul-98
6-Dec-99
19-Apr-01
1-Sep-02
DATE
SURFACE ELEVATION
DREDGE SPOILS ELEVATION
DEPTH OF WASTE


P3_SP_11 & P3_SP_11A
ELEVATION AND DEPTH (ft)
80
70
60
50
40
30
20
10
0
31-Jan-93
15-Jun-94
28-Oct-95
11-Mar-97
24-Jul-98
6-Dec-99
19-Apr-01
1-Sep-02
DATE
SP-11A
SP-11
SP-11A
SP-11
SURFACE ELEVATION
DREDGE SPOILS ELEVATION
DEPTH OF WASTE


P3_SP_12
ELEVATION AND DEPTH (ft)
80
70
60
50
40
30
20
10
0
31-Jan-93
15-Jun-94
28-Oct-95
11-Mar-97
24-Jul-98
6-Dec-99
19-Apr-01
1-Sep-02
DATE
SURFACE ELEVATION
DREDGE SPOILS ELEVATION
DEPTH OF WASTE


P3_SP_13
ELEVATION AND DEPTH (ft)
80
70
60
50
40
30
20
10
0
31-Jan-93
15-Jun-94
28-Oct-95
11-Mar-97
24-Jul-98
6-Dec-99
19-Apr-01
1-Sep-02
DATE
SURFACE ELEVATION
DREDGE SPOILS ELEVATION
DEPTH OF WASTE


P3_SP_14
ELEVATION AND DEPTH (ft)
80
70
60
50
40
30
20
10
0
31-Jan-93
15-Jun-94
28-Oct-95
11-Mar-97
24-Jul-98
6-Dec-99
19-Apr-01
1-Sep-02
DATE
SURFACE ELEVATION
DREDGE SPOILS ELEVATION
DEPTH OF WASTE

Settlement Plates

INST_ID	Northing	Easting	Phase
P4_SP_1	628803	472145	P4
P4_SP_2	628569	471990	P4
P4_SP_5	628229	473160	P4
P4_SP_6	627982	472832	P4
P4_SP_7	628103	473545	P4
P4_SP_8	627688	473406	P4

Total Pressure Cells

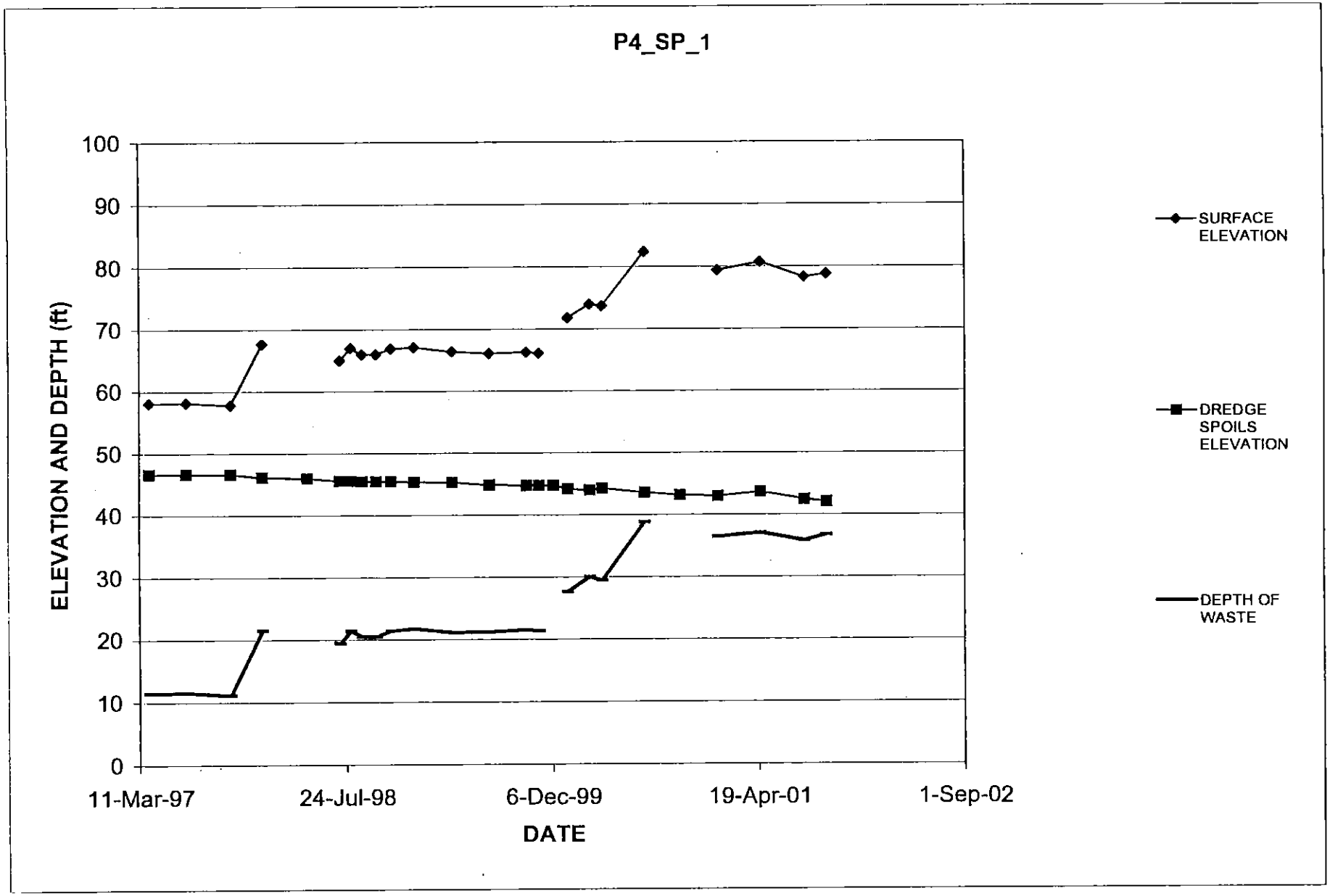
INST_ID	Northing	Easting	Phase
P4_TPC_1	627912	473271	P4
P4_TPC_2	627914	473273	P4
P4_TPC_3	627916	473275	P4
P4_TPC_4	627918	473277	P4
P4_TPC_5	627920	473279	P4
P4_TPC_6	628583	471991	P4
P4_TPC_7	628585	471993	P4
P4_TPC_8	628587	471995	P4
P4_TPC_9	628589	471997	P4
P4_TPC_10	628591	471999	P4

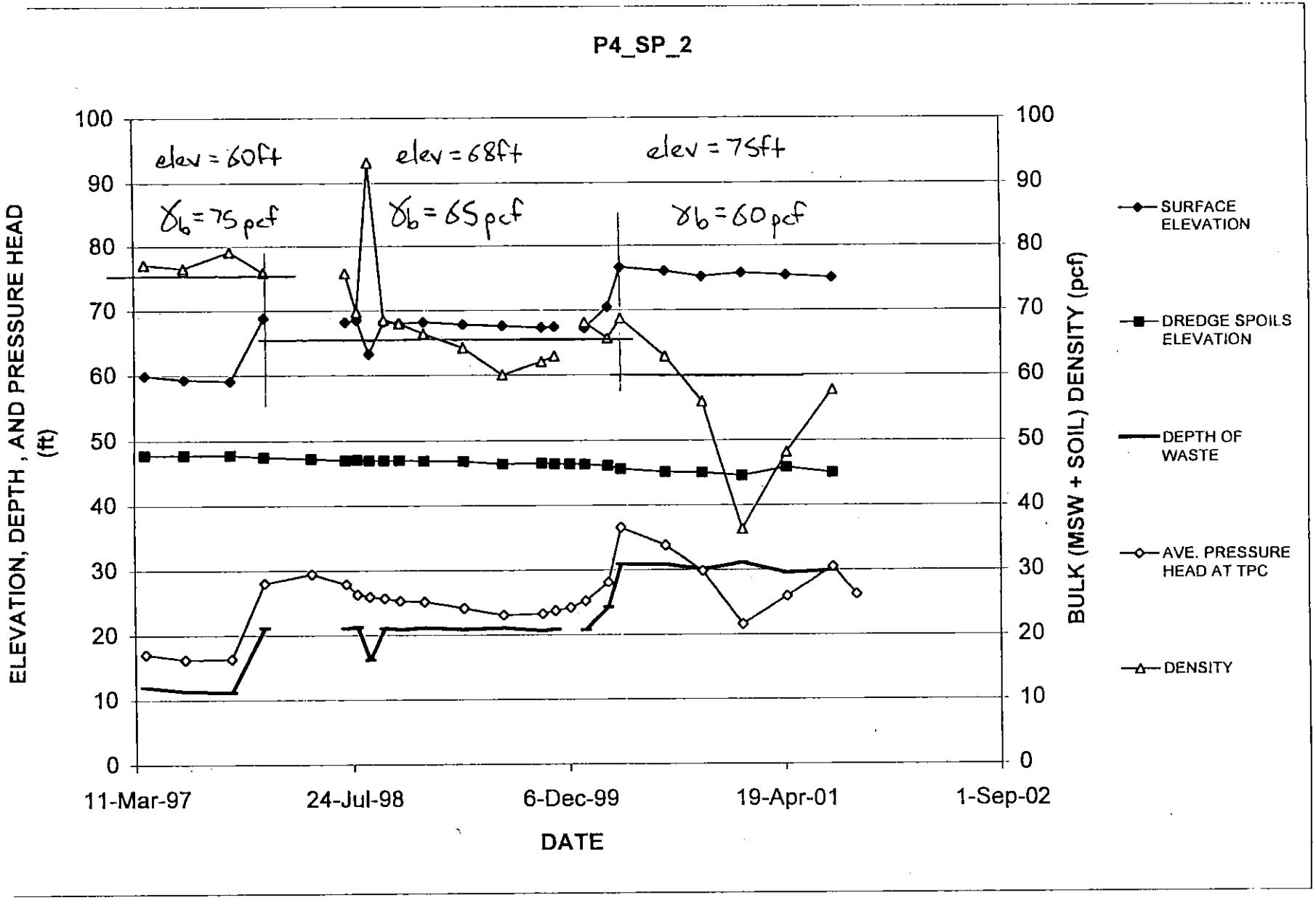
BASE PLATE	ORIGINAL ELEV.
P4_SP_1	46.75
P4_SP_2	48
P4_SP_5	46
P4_SP_6	49
P4_SP_7	47.25
P4_SP_8	47.5

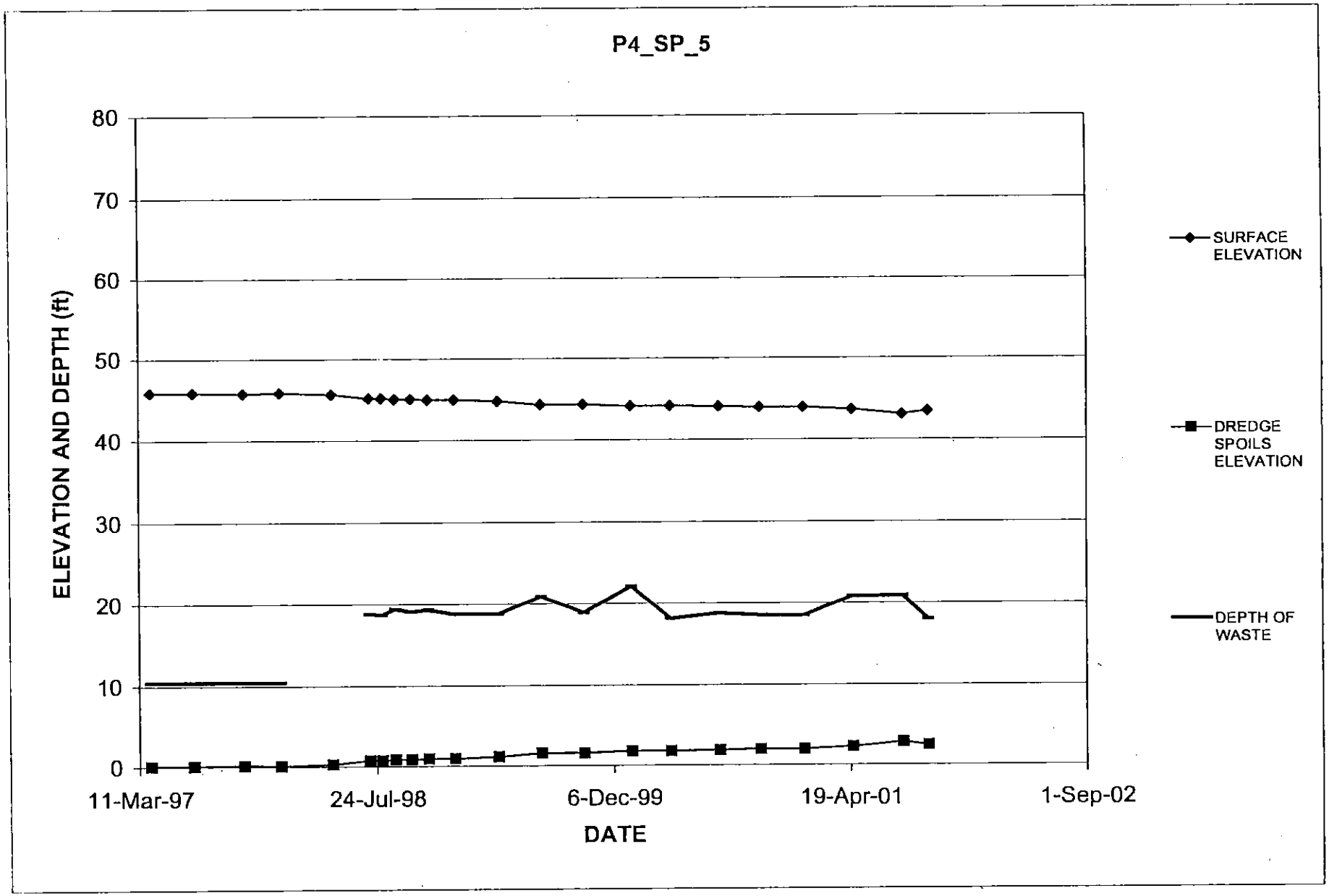
NOTES:

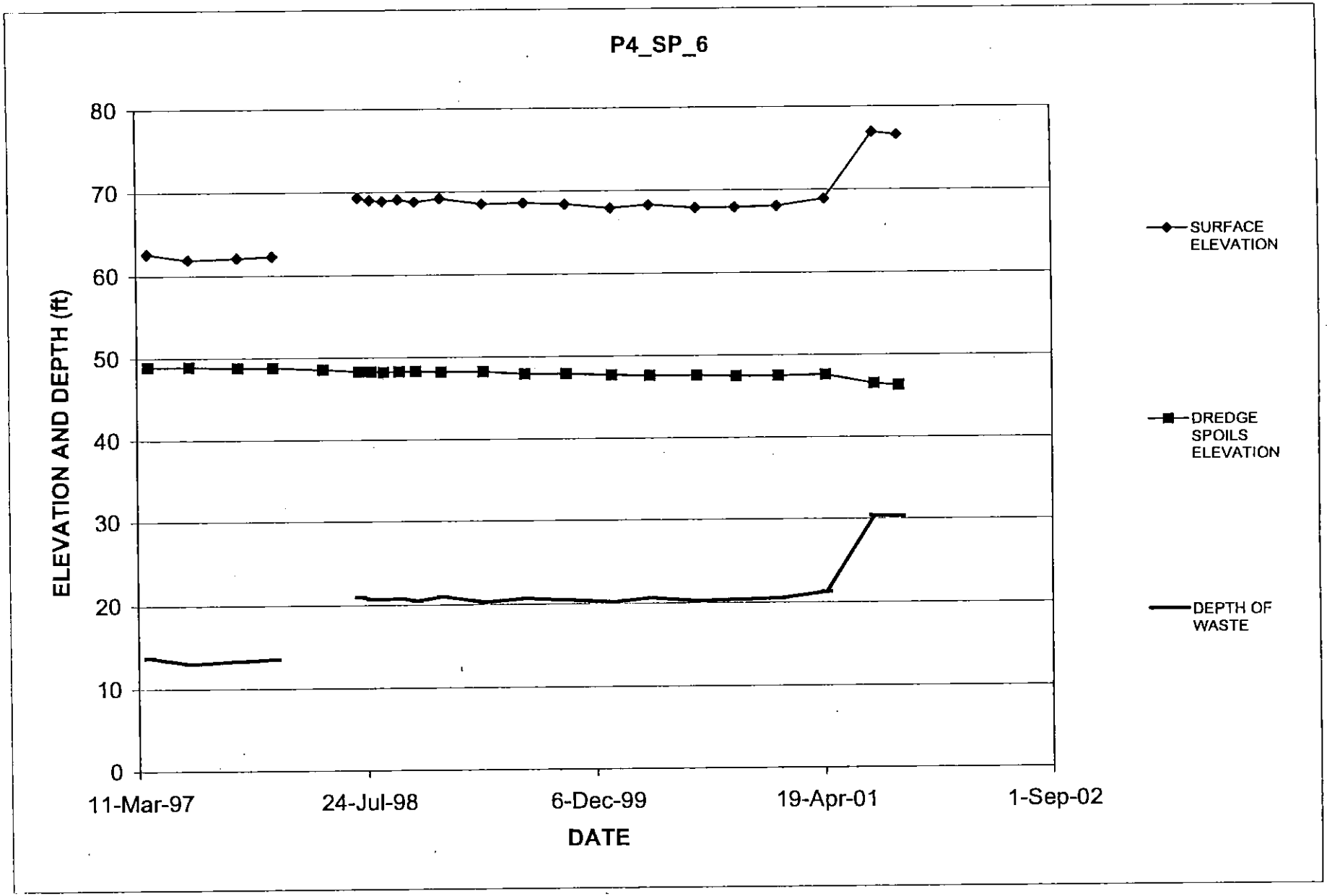
ASSUME: SP BASEGRADE 1-FT. ABOVE SUBGRADES SHOWN IN CONSTRUCTION DWG. 203A (WESTON, 96)

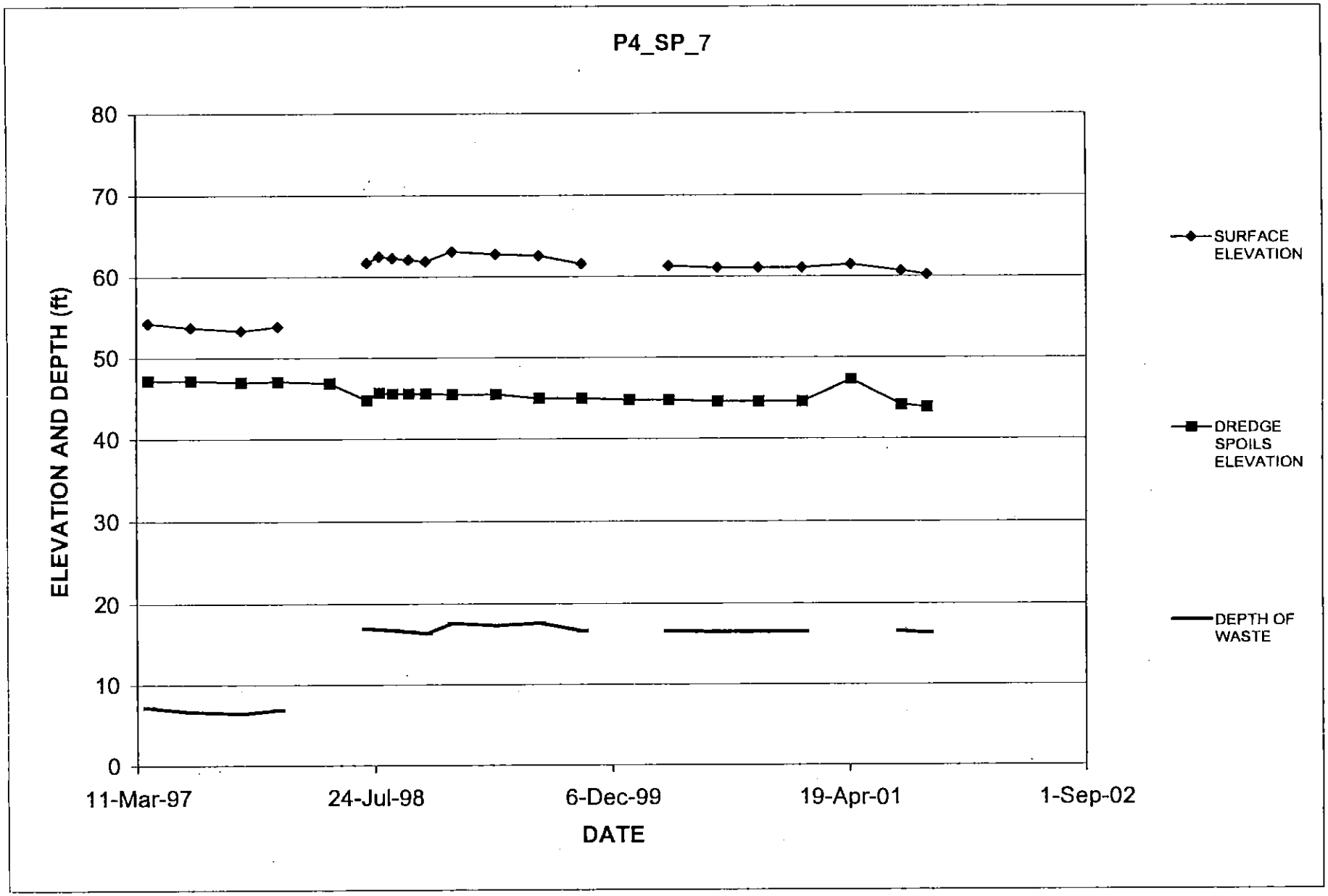
ALL DATA FROM GIS

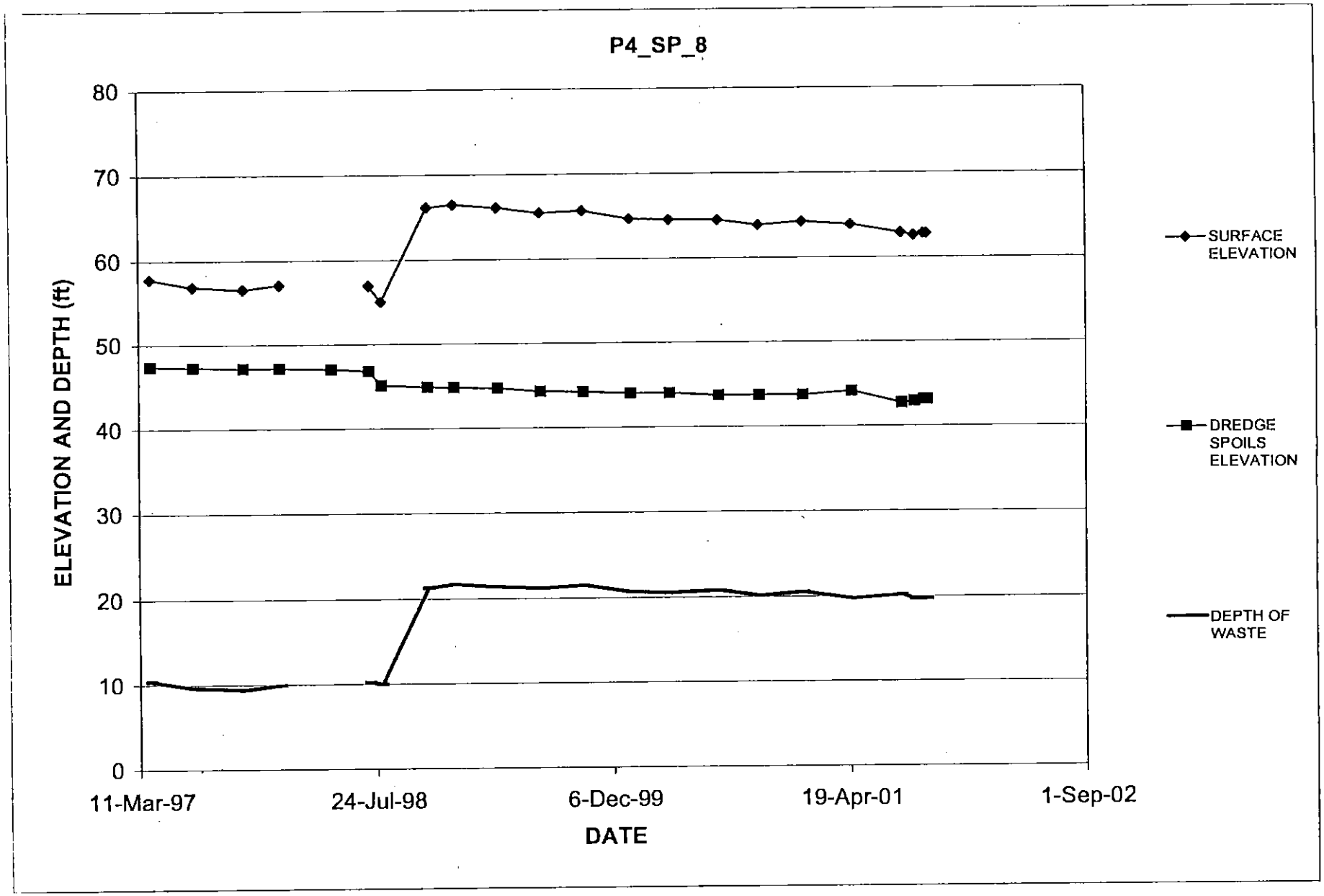

P4_SP_1
ELEVATION AND DEPTH (ft)
100
90
80
70
60
50
40
30
20
10
0
11-Mar-97
24-Jul-98
6-Dec-99
19-Apr-01
1-Sep-02
DATE
SURFACE ELEVATION
DREDGE SPOILS ELEVATION
DEPTH OF WASTE


P4_SP_2
elev = 60ft
γ_b = 75 pcf
elev = 68ft
γ_b = 65 pcf
elev = 75ft
γ_b = 60 pcf
ELEVATION, DEPTH , AND PRESSURE HEAD (ft)
BULK (MSW + SOIL) DENSITY (pcf)
DATE
11-Mar-97
24-Jul-98
6-Dec-99
19-Apr-01
1-Sep-02
SURFACE ELEVATION
DREDGE SPOILS ELEVATION
DEPTH OF WASTE
AVE. PRESSURE HEAD AT TPC
DENSITY


P4_SP_5
ELEVATION AND DEPTH (ft)
80
70
60
50
40
30
20
10
0
11-Mar-97
24-Jul-98
6-Dec-99
19-Apr-01
1-Sep-02
DATE
SURFACE ELEVATION
DREDGE SPOILS ELEVATION
DEPTH OF WASTE


P4_SP_6
ELEVATION AND DEPTH (ft)
80
70
60
50
40
30
20
10
0
11-Mar-97
24-Jul-98
6-Dec-99
19-Apr-01
1-Sep-02
DATE
SURFACE ELEVATION
DREDGE SPOILS ELEVATION
DEPTH OF WASTE


P4_SP_7
ELEVATION AND DEPTH (ft)
80
70
60
50
40
30
20
10
0
11-Mar-97
24-Jul-98
6-Dec-99
19-Apr-01
1-Sep-02
DATE
SURFACE ELEVATION
DREDGE SPOILS ELEVATION
DEPTH OF WASTE


P4_SP_8
ELEVATION AND DEPTH (ft)
80
70
60
50
40
30
20
10
0
11-Mar-97
24-Jul-98
6-Dec-99
19-Apr-01
1-Sep-02
DATE
SURFACE ELEVATION
DREDGE SPOILS ELEVATION
DEPTH OF WASTE

Settlement Plates

INST_ID	Northing	Easting	Phase
P5_SP_1	628262.4	471501	P5
P5_SP_2	627697.4	471647	P5
P5_SP_3	627017	471914	P5
P5_SP_4	627952.1	471998	P5
P5_SP_5	627335.1	471965	P5
P5_SP_6	627770.7	472404	P5
P5_SP_7	627019.9	472473	P5
P5_SP_8	627524.5	472760	P5
P5_SP_9	627025	472723	P5
P5_SP_10	627258.4	473148	P5

Total Pressure Cells

INST_ID	Northing	Easting	Phase
P5_TPC_1A	628278	471499	P5
P5_TPC_1B	628280	471495	P5
P5_TPC_2A	627698	471646	P5
P5_TPC_2B	627695	471640	P5
P5_TPC_3A	627014	471918	P5
P5_TPC_3B	627010	471925	P5
P5_TPC_6A	627782	472413	P5
P5_TPC_6B	627785	472420	P5
P5_TPC_9A	627036	472742	P5
P5_TPC_9B	627040	472745	P5
P5_TPC_10A	627260	473162	P5
P5_TPC_10B	627265	473165	P5

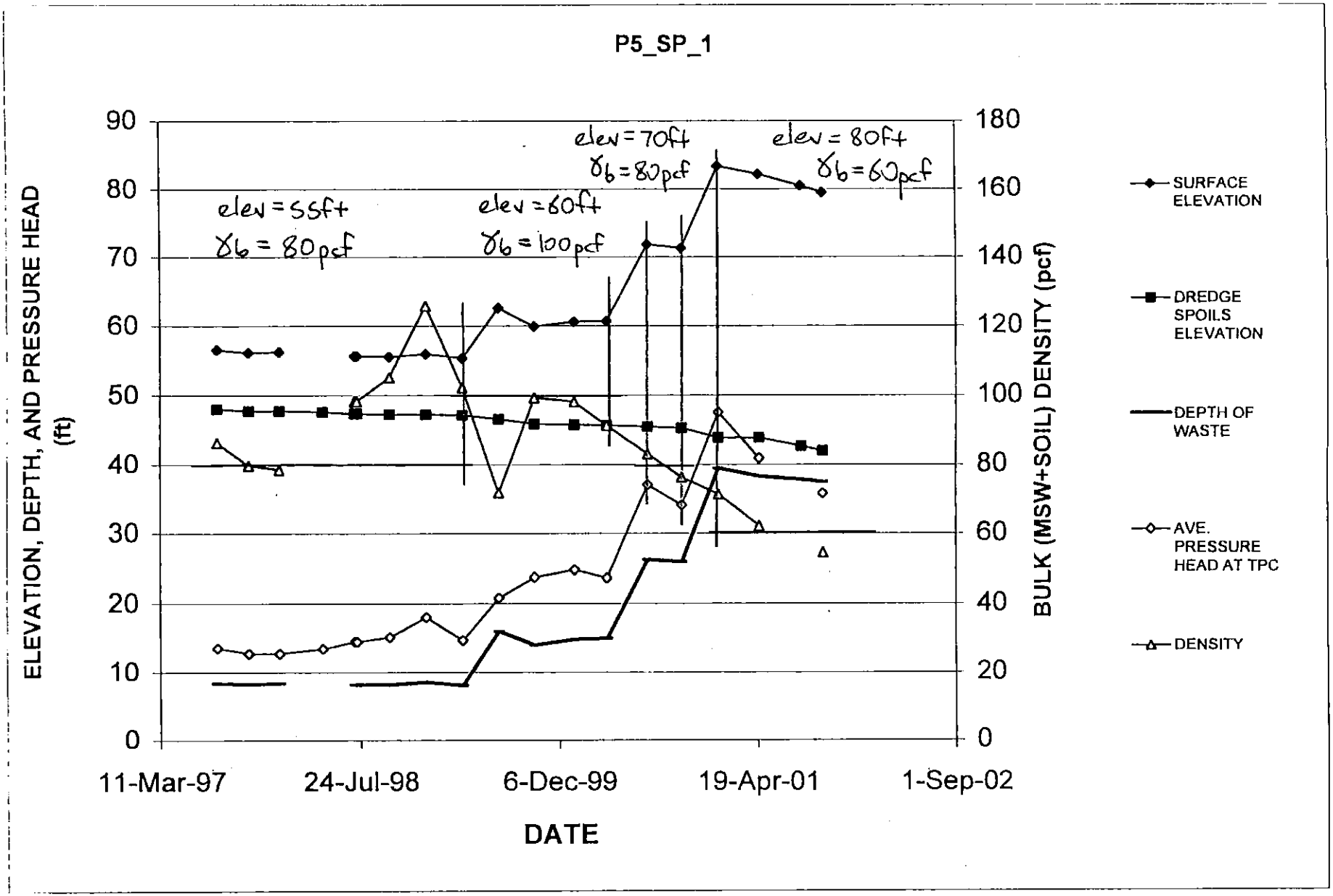
SP BASE	ORIGINAL ELEV.	
P5_SP_1	48.33	
P5_SP_2	48.12	
P5_SP_3	48.88	
P5_SP_4	49.09	
P5_SP_5	48.58	
P5_SP_6	48.28	
P5_SP_7	48.37	
P5_SP_8	47.84	DWG 204A SHOWS AS 47.48
P5_SP_9	48.21	
P5_SP_10	48.22	

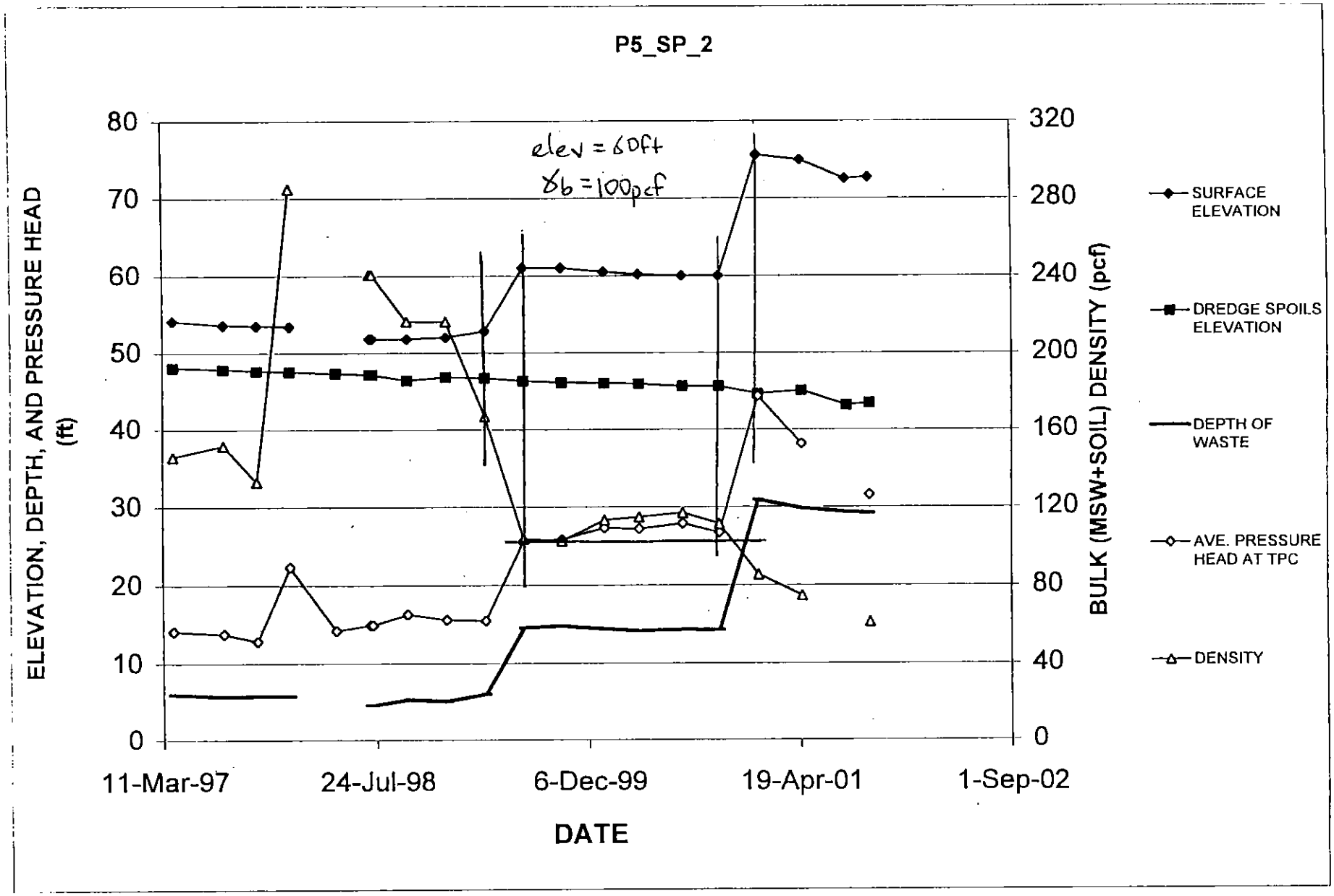
NOTES:

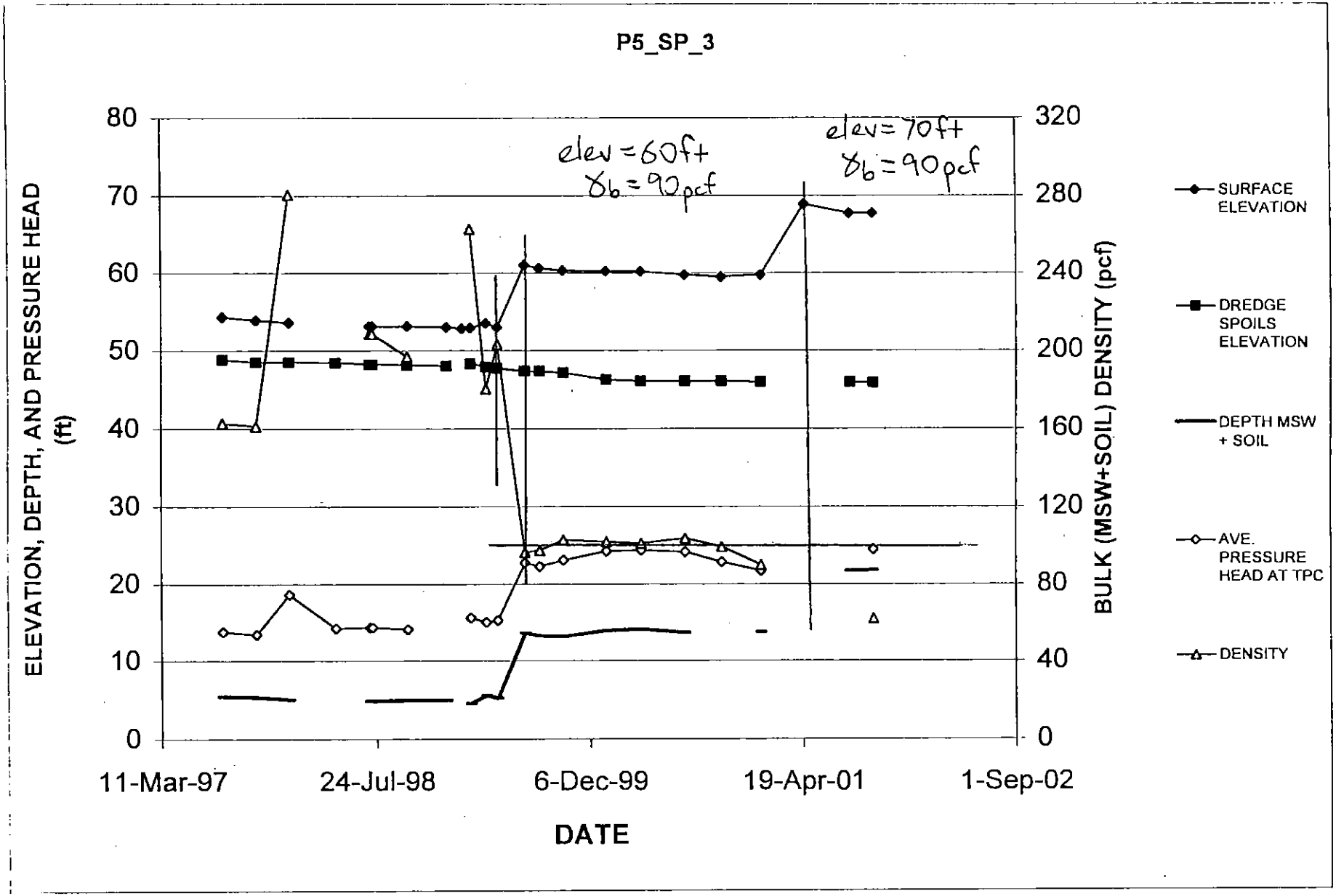
SP BASE ELE. SHOWN IN TABLE 3 OF WESTON REPORT (1998)

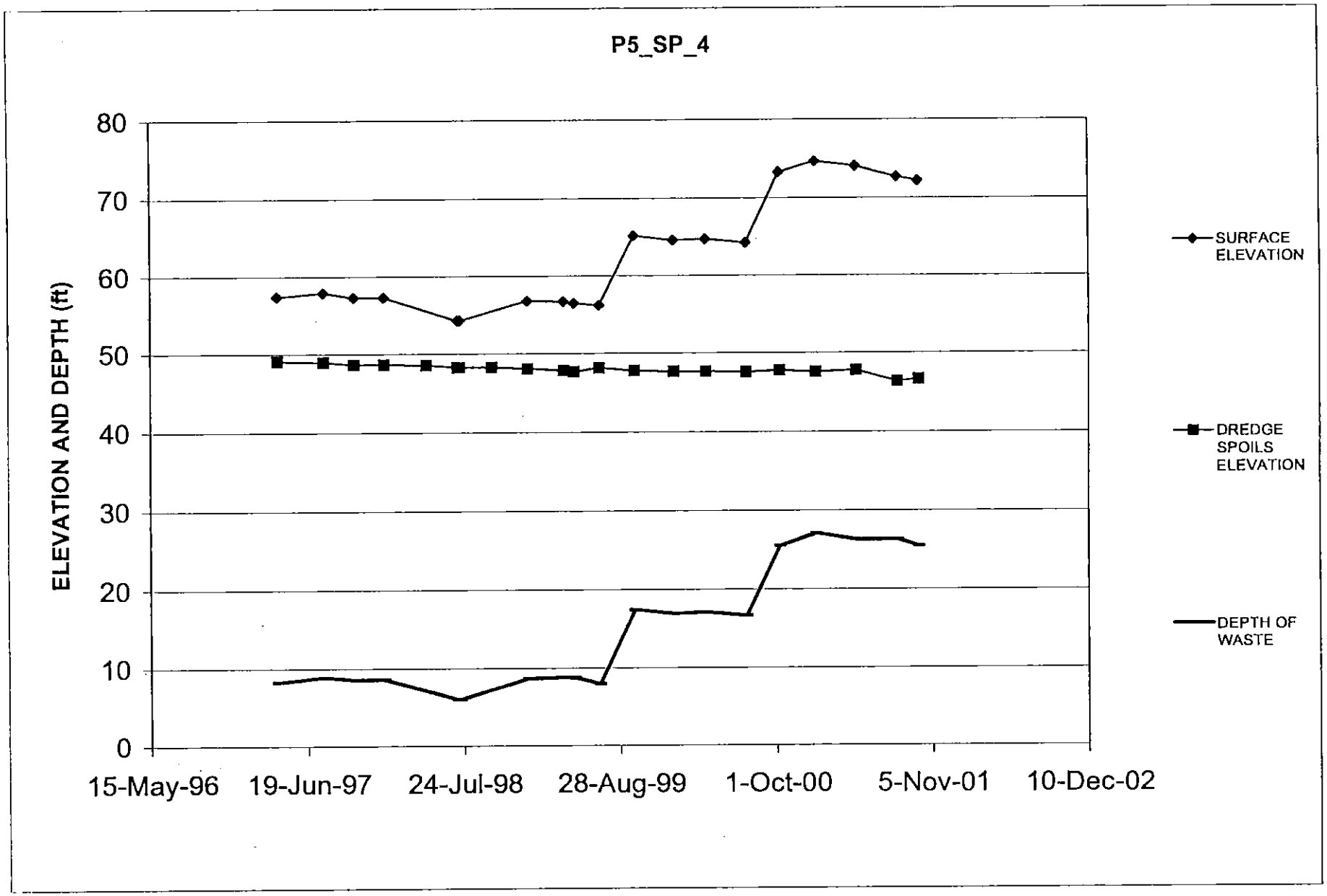
1-FT. ADDED FOR LCS AS SHOWN IN FIG. 1 OF WESTON (98)

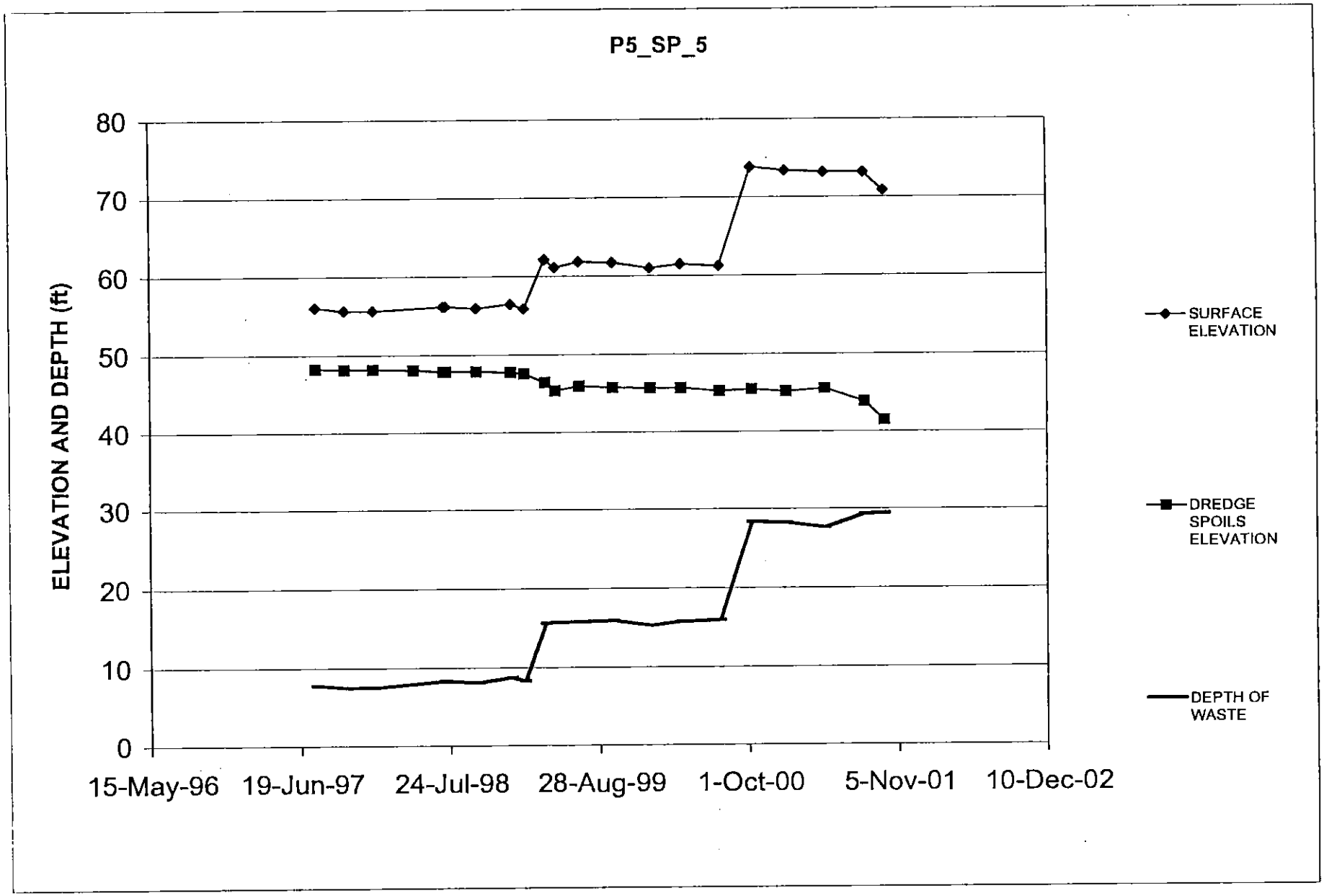
ALL SP DATA FROM GIS

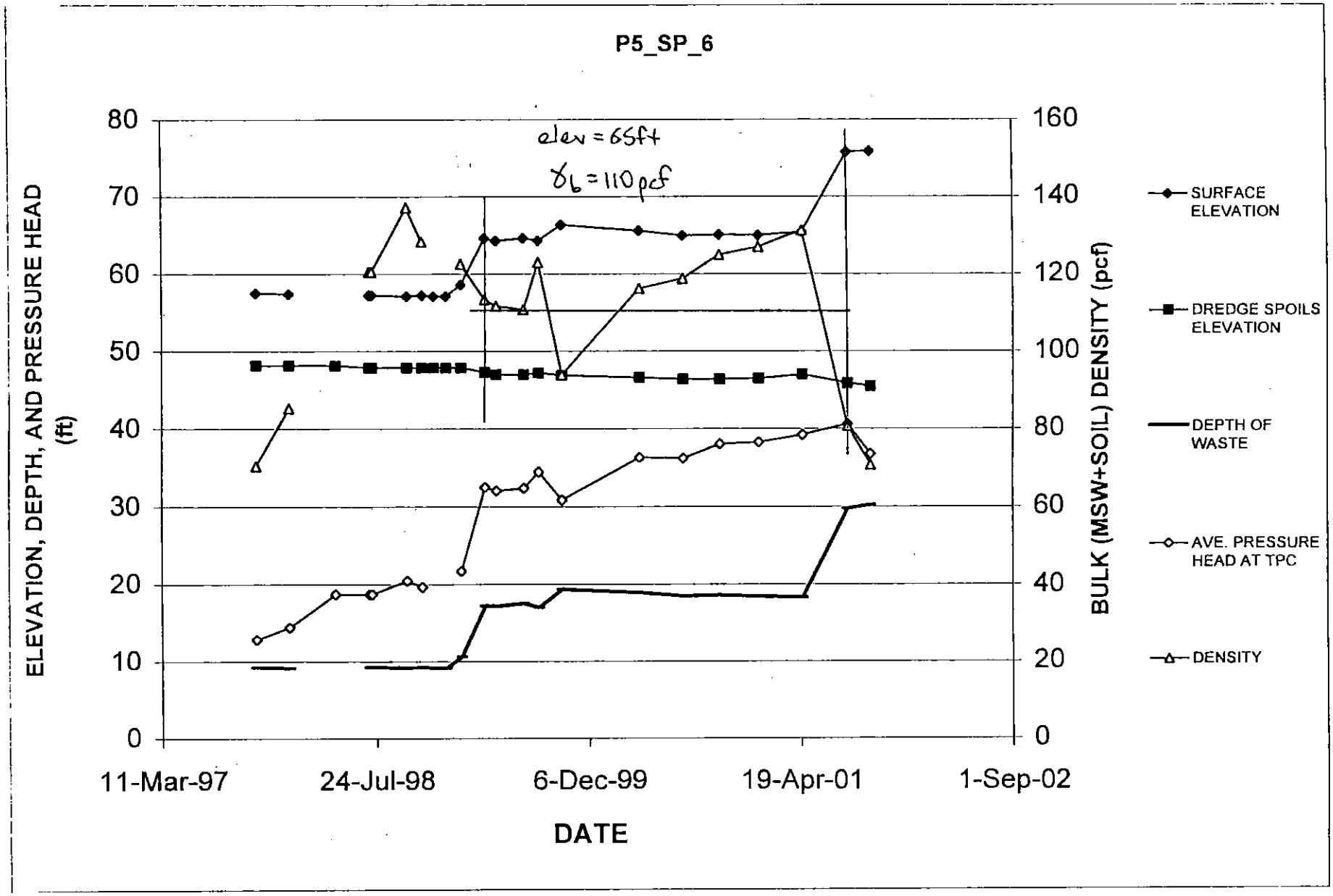

P5_SP_1
ELEVATION, DEPTH, AND PRESSURE HEAD (ft)
BULK (MSW+SOIL) DENSITY (pcf)
DATE
90
80
70
60
50
40
30
20
10
0
180
160
140
120
100
80
60
40
20
0
11-Mar-97
24-Jul-98
6-Dec-99
19-Apr-01
1-Sep-02
elev = 55ft
γb = 80pcf
elev = 60ft
γb = 100pcf
elev = 70ft
γb = 80pcf
elev = 80ft
γb = 60pcf
SURFACE ELEVATION
DREDGE SPOILS ELEVATION
DEPTH OF WASTE
AVE. PRESSURE HEAD AT TPC
DENSITY

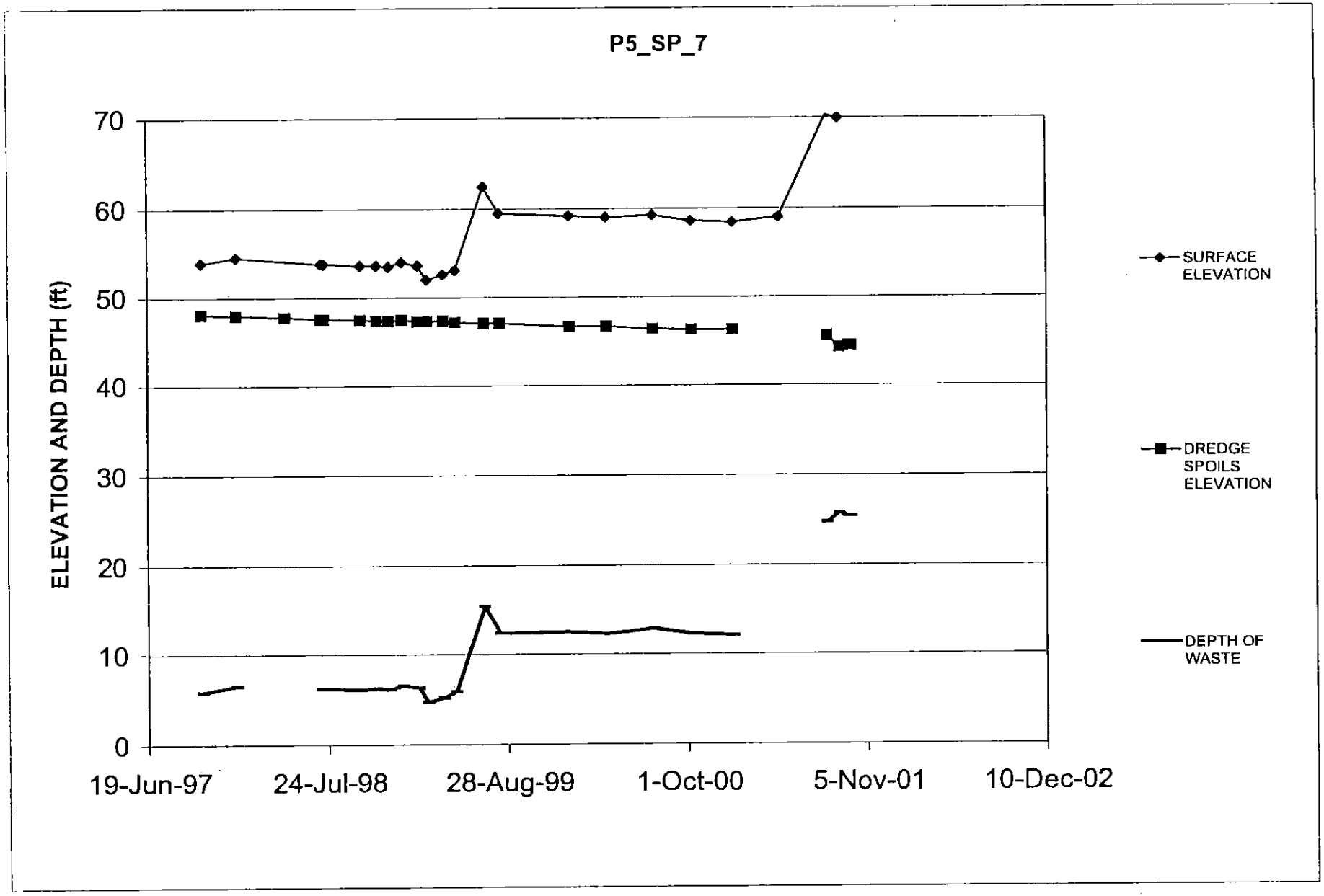

P5_SP_2
elev = 60ft
γ_b = 100pcf
ELEVATION, DEPTH, AND PRESSURE HEAD (ft)
BULK (MSW+SOIL) DENSITY (pcf)
DATE
11-Mar-97
24-Jul-98
6-Dec-99
19-Apr-01
1-Sep-02
0
10
20
30
40
50
60
70
80
0
40
80
120
160
200
240
280
320
SURFACE ELEVATION
DREDGE SPOILS ELEVATION
DEPTH OF WASTE
AVE. PRESSURE HEAD AT TPC
DENSITY

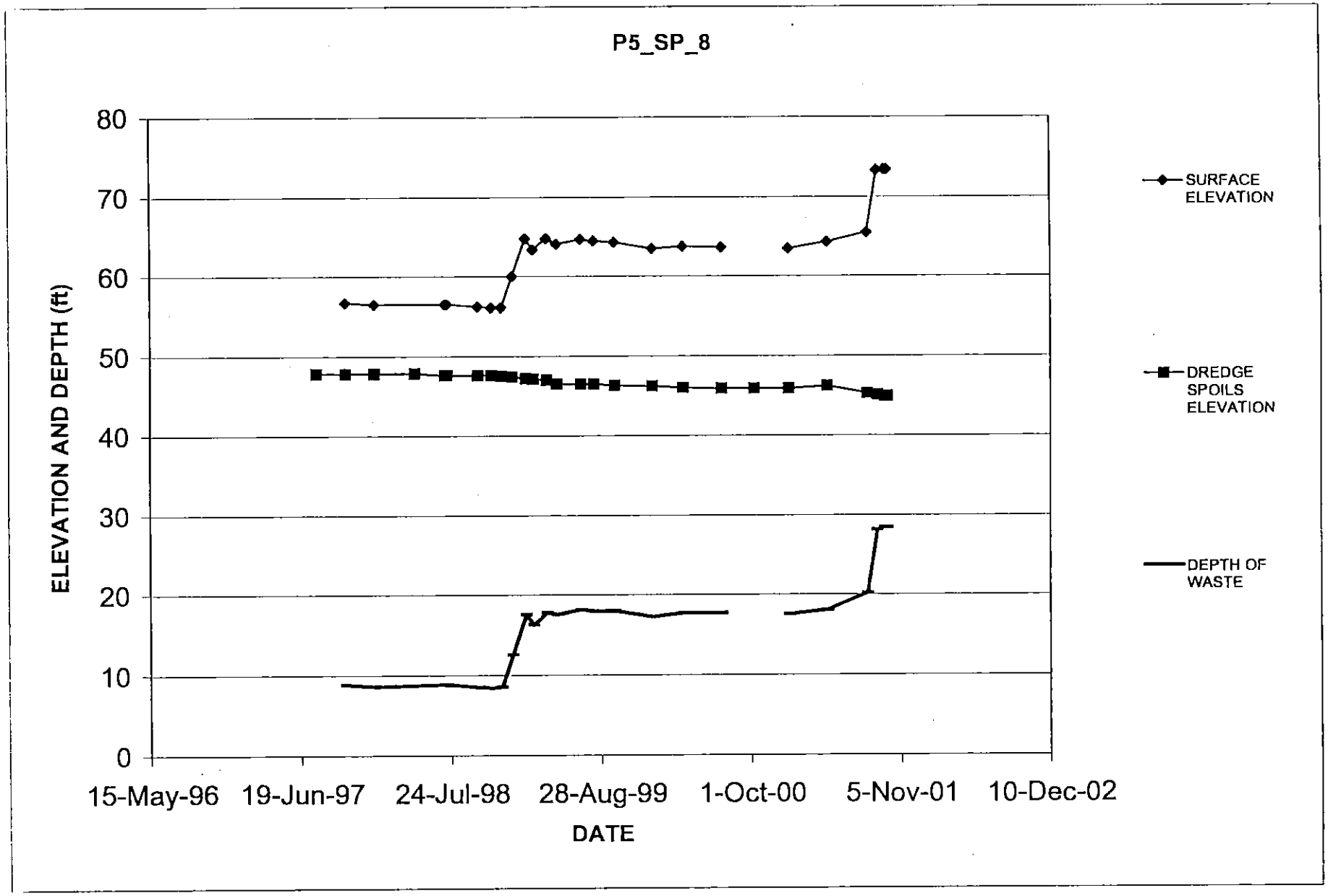

P5_SP_3
ELEVATION, DEPTH, AND PRESSURE HEAD (ft)
BULK (MSW+SOIL) DENSITY (pcf)
DATE
0
10
20
30
40
50
60
70
80
0
40
80
120
160
200
240
280
320
11-Mar-97
24-Jul-98
6-Dec-99
19-Apr-01
1-Sep-02
elev = 60ft
γ_b = 90pcf
elev = 70ft
γ_b = 90pcf
SURFACE ELEVATION
DREDGE SPOILS ELEVATION
DEPTH MSW + SOIL
AVE. PRESSURE HEAD AT TPC
DENSITY

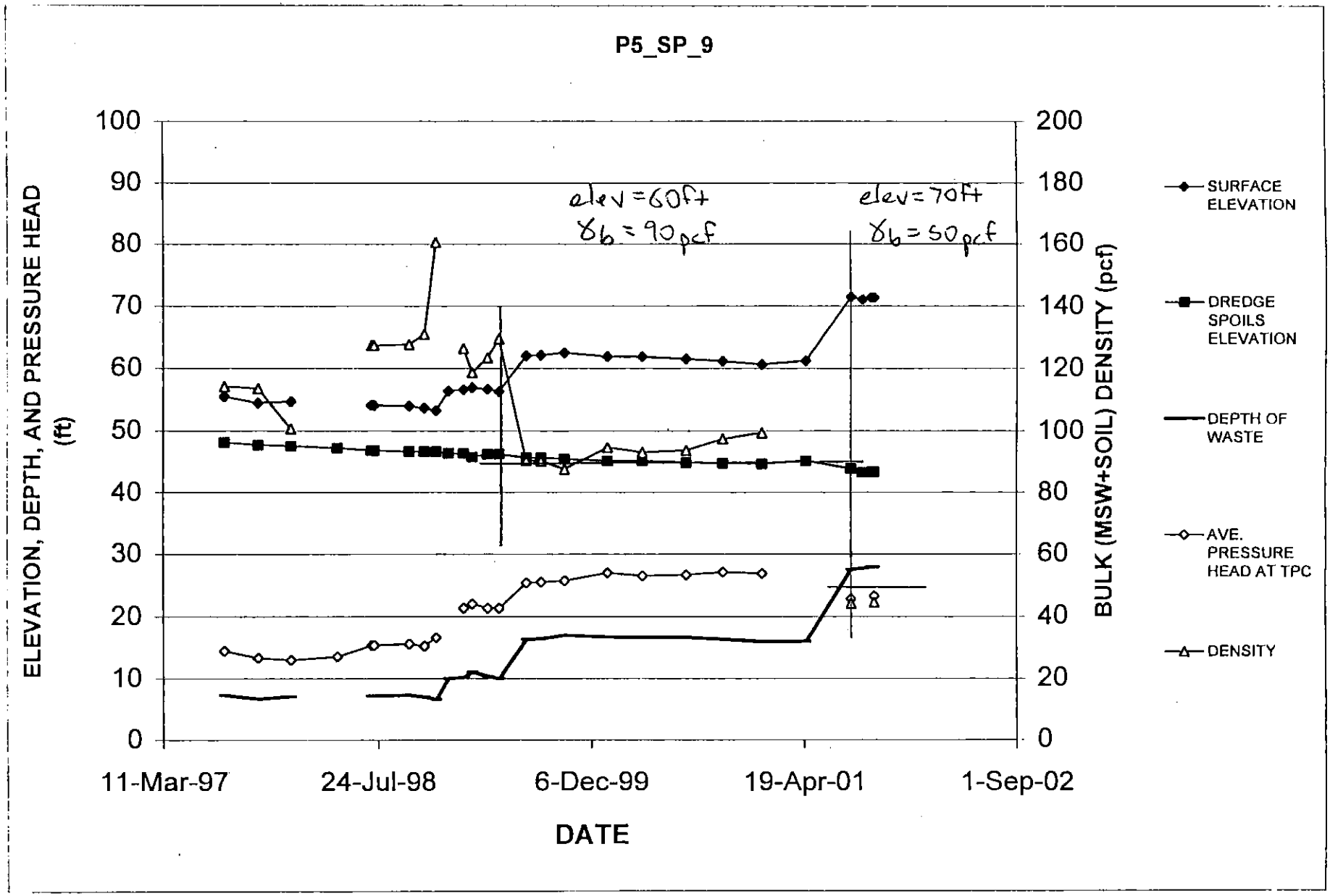

P5_SP_4
ELEVATION AND DEPTH (ft)
80
70
60
50
40
30
20
10
0
15-May-96
19-Jun-97
24-Jul-98
28-Aug-99
1-Oct-00
5-Nov-01
10-Dec-02
SURFACE ELEVATION
DREDGE SPOILS ELEVATION
DEPTH OF WASTE

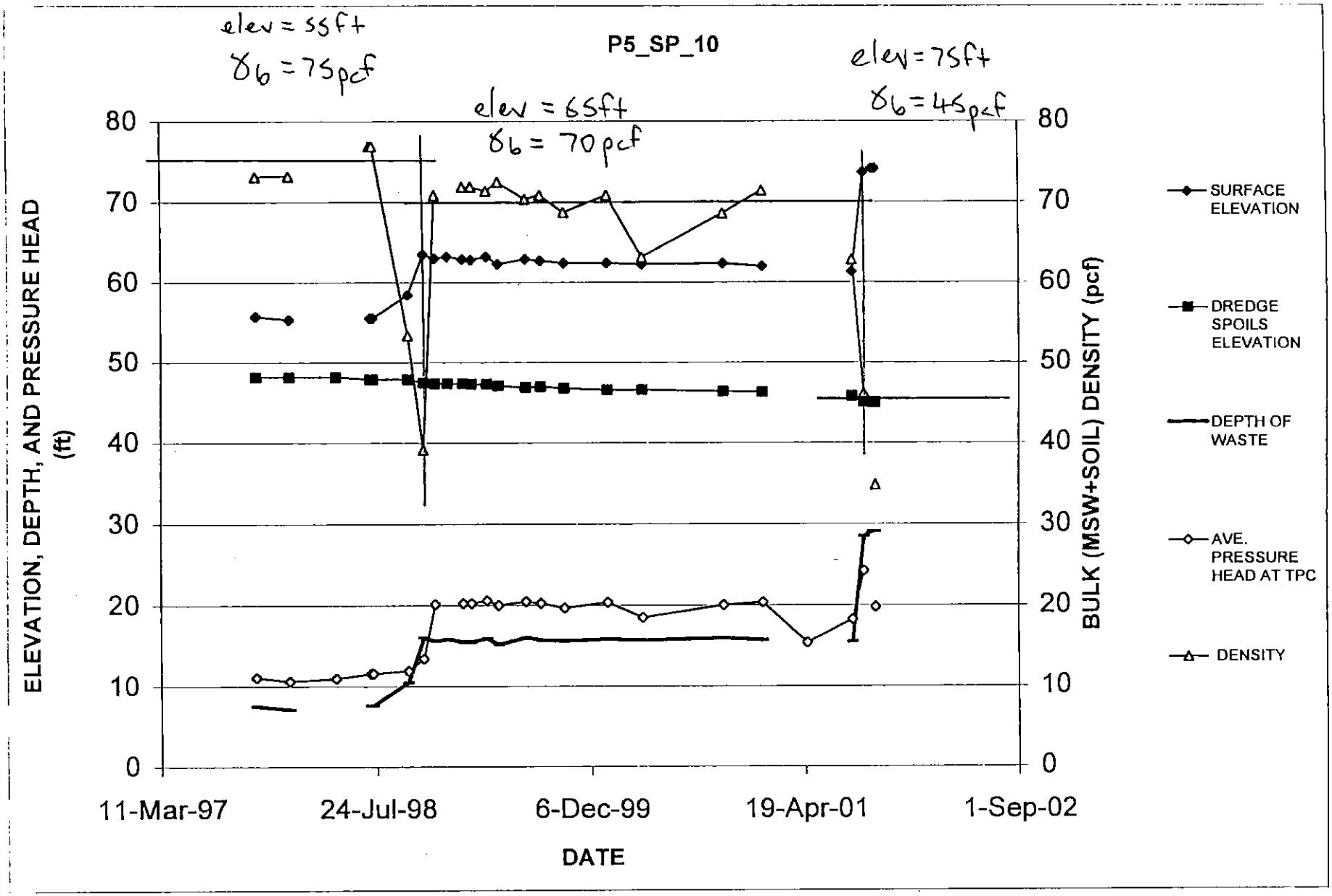

P5_SP_5
ELEVATION AND DEPTH (ft)
80
70
60
50
40
30
20
10
0
15-May-96
19-Jun-97
24-Jul-98
28-Aug-99
1-Oct-00
5-Nov-01
10-Dec-02
SURFACE ELEVATION
DREDGE SPOILS ELEVATION
DEPTH OF WASTE


P5_SP_6
elev = 65ft
γ_b = 110 pcf
ELEVATION, DEPTH, AND PRESSURE HEAD (ft)
BULK (MSW+SOIL) DENSITY (pcf)
DATE
0
10
20
30
40
50
60
70
80
0
20
40
60
80
100
120
140
160
11-Mar-97
24-Jul-98
6-Dec-99
19-Apr-01
1-Sep-02
SURFACE ELEVATION
DREDGE SPOILS ELEVATION
DEPTH OF WASTE
AVE. PRESSURE HEAD AT TPC
DENSITY


P5_SP_7
ELEVATION AND DEPTH (ft)
70
60
50
40
30
20
10
0
19-Jun-97
24-Jul-98
28-Aug-99
1-Oct-00
5-Nov-01
10-Dec-02
SURFACE ELEVATION
DREDGE SPOILS ELEVATION
DEPTH OF WASTE


P5_SP_8
ELEVATION AND DEPTH (ft)
80
70
60
50
40
30
20
10
0
15-May-96
19-Jun-97
24-Jul-98
28-Aug-99
1-Oct-00
5-Nov-01
10-Dec-02
DATE
SURFACE ELEVATION
DREDGE SPOILS ELEVATION
DEPTH OF WASTE


P5_SP_9
ELEVATION, DEPTH, AND PRESSURE HEAD (ft)
BULK (MSW+SOIL) DENSITY (pcf)
DATE
100
90
80
70
60
50
40
30
20
10
0
200
180
160
140
120
100
80
60
40
20
0
11-Mar-97
24-Jul-98
6-Dec-99
19-Apr-01
1-Sep-02
elev = 60ft
γ_b = 90pcf
elev = 70ft
γ_b = 50pcf
SURFACE ELEVATION
DREDGE SPOILS ELEVATION
DEPTH OF WASTE
AVE. PRESSURE HEAD AT TPC
DENSITY


P5_SP_10
elev = 55ft
γb = 75pcf
elev = 65ft
γb = 70pcf
elev = 75ft
γb = 45pcf
ELEVATION, DEPTH, AND PRESSURE HEAD (ft)
BULK (MSW+SOIL) DENSITY (pcf)
DATE
0
10
20
30
40
50
60
70
80
11-Mar-97
24-Jul-98
6-Dec-99
19-Apr-01
1-Sep-02
SURFACE ELEVATION
DREDGE SPOILS ELEVATION
DEPTH OF WASTE
AVE. PRESSURE HEAD AT TPC
DENSITY