# FINAL CLOSURE PLAN
# LOPEZ CANYON SANITARY LANDFILL
# LAKEVIEW TERRACE, CALIFORNIA

# VOLUME IV OF IV REPLACEMENT
# AMENDMENT TO FINAL CLOSURE PLAN

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# FINAL CLOSURE PLAN
# LOPEZ CANYON SANITARY LANDFILL
# TABLE OF CONTENTS
# VOLUME IV OF IV REPLACEMENT - AMENDMENT TO FINAL CLOSURE PLAN

**FINAL CLOSURE PLAN**
**LOPEZ CANYON SANITARY LANDFILL**
**TABLE OF CONTENTS (continued)**
**VOLUME IV OF IV REPLACEMENT - AMENDMENT TO FINAL CLOSURE PLAN**

**FINAL CLOSURE PLAN**
**LOPEZ CANYON SANITARY LANDFILL**
**TABLE OF CONTENTS (continued)**
**VOLUME IV OF IV REPLACEMENT - AMENDMENT TO FINAL CLOSURE PLAN**

# FINAL CLOSURE PLAN
# LOPEZ CANYON SANITARY LANDFILL
# TABLE OF CONTENTS (continued)
# VOLUME IV OF IV REPLACEMENT - AMENDMENT TO FINAL CLOSURE PLAN

Page

# FINAL CLOSURE PLAN
# LOPEZ CANYON SANITARY LANDFILL
## TABLE OF CONTENTS (continued)
## VOLUME IV OF IV REPLACEMENT - AMENDMENT TO FINAL CLOSURE PLAN

TABLES



FIGURES

**FINAL CLOSURE PLAN**
**LOPEZ CANYON SANITARY LANDFILL**
**TABLE OF CONTENTS (continued)**
**VOLUME IV OF IV REPLACEMENT - AMENDMENT TO FINAL CLOSURE PLAN**

FIGURES (continued)

**FINAL CLOSURE PLAN**
**LOPEZ CANYON SANITARY LANDFILL**
**TABLE OF CONTENTS (continued)**
**VOLUME IV OF IV REPLACEMENT - AMENDMENT TO FINAL CLOSURE PLAN**

# FINAL CLOSURE PLAN
# LOPEZ CANYON SANITARY LANDFILL
# TABLE OF CONTENTS (continued)
# VOLUME IV OF IV REPLACEMENT - AMENDMENT TO FINAL CLOSURE PLAN

DRAWINGS

# FINAL CLOSURE PLAN
# LOPEZ CANYON SANITARY LANDFILL
# TABLE OF CONTENTS
# VOLUME I OF IV - FINAL CLOSURE PLAN

**Page**

**FINAL CLOSURE PLAN**
**LOPEZ CANYON SANITARY LANDFILL**
**TABLE OF CONTENTS (continued)**
**VOLUME I OF IV - FINAL CLOSURE PLAN**

**Page**

**FINAL CLOSURE PLAN**
**LOPEZ CANYON SANITARY LANDFILL**
**TABLE OF CONTENTS (continued)**
**VOLUME I OF IV - FINAL CLOSURE PLAN**

Page

**FINAL CLOSURE PLAN**
**LOPEZ CANYON SANITARY LANDFILL**
**TABLE OF CONTENTS (continued)**
**VOLUME I OF IV - FINAL CLOSURE PLAN**

**FINAL CLOSURE PLAN**
**LOPEZ CANYON SANITARY LANDFILL**
**TABLE OF CONTENTS (continued)**
**VOLUME I OF IV - FINAL CLOSURE PLAN**

Page

# FINAL CLOSURE PLAN
# LOPEZ CANYON SANITARY LANDFILL
# TABLE OF CONTENTS (continued)
# VOLUME I OF IV - FINAL CLOSURE PLAN

Page

# FINAL CLOSURE PLAN
# LOPEZ CANYON SANITARY LANDFILL
# TABLE OF CONTENTS (continued)
# VOLUME I OF IV - FINAL CLOSURE PLAN

Page

**FINAL CLOSURE PLAN**
**LOPEZ CANYON SANITARY LANDFILL**
**TABLE OF CONTENTS (continued)**
**VOLUME I OF IV - FINAL CLOSURE PLAN**

**Page**

**FINAL CLOSURE PLAN**
**LOPEZ CANYON SANITARY LANDFILL**
**TABLE OF CONTENTS (continued)**
**VOLUME I OF IV - FINAL CLOSURE PLAN**

**Page**

# FINAL CLOSURE PLAN
# LOPEZ CANYON SANITARY LANDFILL
# TABLE OF CONTENTS (continued)
# VOLUME I OF IV - FINAL CLOSURE PLAN

**FINAL CLOSURE PLAN**
**LOPEZ CANYON SANITARY LANDFILL**
**TABLE OF CONTENTS (continued)**
**VOLUME I OF IV - FINAL CLOSURE PLAN**

TABLES

# FINAL CLOSURE PLAN
# LOPEZ CANYON SANITARY LANDFILL
# TABLE OF CONTENTS (continued)
# VOLUME I OF IV - FINAL CLOSURE PLAN

FIGURES

# FINAL CLOSURE PLAN
# LOPEZ CANYON SANITARY LANDFILL
# TABLE OF CONTENTS (continued)
# VOLUME I OF IV - FINAL CLOSURE PLAN

FIGURES (continued)

# FINAL CLOSURE PLAN
# LOPEZ CANYON SANITARY LANDFILL
# TABLE OF CONTENTS (continued)
# VOLUME I OF IV - FINAL CLOSURE PLAN

FIGURES (continued)

# FINAL CLOSURE PLAN
# LOPEZ CANYON SANITARY LANDFILL
# TABLE OF CONTENTS (continued)
# VOLUME I OF IV - FINAL CLOSURE PLAN

FIGURES (continued)

# FINAL CLOSURE PLAN
# LOPEZ CANYON SANITARY LANDFILL
# TABLE OF CONTENTS (continued)
# VOLUME I OF IV - FINAL CLOSURE PLAN

FIGURES (continued)

# FINAL CLOSURE PLAN
# LOPEZ CANYON SANITARY LANDFILL
# TABLE OF CONTENTS (continued)
# VOLUME II OF IV - FINAL CLOSURE PLAN (APPENDICES)

APPENDICES

**FINAL CLOSURE PLAN**
**LOPEZ CANYON SANITARY LANDFILL**
**TABLE OF CONTENTS (continued)**
**VOLUME III OF IV - FINAL CLOSURE PLAN (DRAWINGS)**

DRAWINGS

# FINAL CLOSURE PLAN
# LOPEZ CANYON SANITARY LANDFILL
# TABLE OF CONTENTS (continued)
# VOLUME III OF IV - FINAL CLOSURE PLAN (DRAWINGS)

DRAWINGS (continued)

# FINAL CLOSURE PLAN
# LOPEZ CANYON SANITARY LANDFILL
# TABLE OF CONTENTS (continued)
# VOLUME IV OF IV - FINAL CLOSURE PLAN

Page

**FINAL CLOSURE PLAN**
**LOPEZ CANYON SANITARY LANDFILL**
**TABLE OF CONTENTS (continued)**
**VOLUME IV OF IV - FINAL CLOSURE PLAN**

**Page**

**FINAL CLOSURE PLAN**
**LOPEZ CANYON SANITARY LANDFILL**
**TABLE OF CONTENTS (continued)**
**VOLUME IV OF IV - FINAL CLOSURE PLAN**

# FINAL CLOSURE PLAN
# LOPEZ CANYON SANITARY LANDFILL
# TABLE OF CONTENTS (continued)
# VOLUME IV OF IV - FINAL CLOSURE PLAN

# FINAL CLOSURE PLAN
# LOPEZ CANYON SANITARY LANDFILL
# TABLE OF CONTENTS (continued)
# VOLUME IV OF IV - FINAL CLOSURE PLAN

## DRAWINGS



## APPENDICES

# FINAL POST-CLOSURE MAINTENANCE PLAN
# LOPEZ CANYON SANITARY LANDFILL
# TABLE OF CONTENTS
# VOLUME I OF II - FINAL POST-CLOSURE MAINTENANCE PLAN

**Page**



## SECTION A - MAINTENANCE PROCEDURES

# FINAL POST-CLOSURE MAINTENANCE PLAN
# LOPEZ CANYON SANITARY LANDFILL
# TABLE OF CONTENTS (continued)
# VOLUME I OF II - FINAL POST-CLOSURE MAINTENANCE PLAN

**FINAL POST-CLOSURE MAINTENANCE PLAN**
**LOPEZ CANYON SANITARY LANDFILL**
**TABLE OF CONTENTS (continued)**
**VOLUME I OF II - FINAL POST-CLOSURE MAINTENANCE PLAN**

Page

# FINAL POST-CLOSURE MAINTENANCE PLAN
# LOPEZ CANYON SANITARY LANDFILL
# TABLE OF CONTENTS (continued)
# VOLUME I OF II - FINAL POST-CLOSURE MAINTENANCE PLAN

Page

**FINAL POST-CLOSURE MAINTENANCE PLAN**
**LOPEZ CANYON SANITARY LANDFILL**
**TABLE OF CONTENTS (continued)**
**VOLUME I OF II - FINAL POST-CLOSURE MAINTENANCE PLAN**

**Page**



## SECTION B - MONITORING PROCEDURES

**FINAL POST-CLOSURE MAINTENANCE PLAN**
**LOPEZ CANYON SANITARY LANDFILL**
**TABLE OF CONTENTS (continued)**
**VOLUME I OF II - FINAL POST-CLOSURE MAINTENANCE PLAN**

Page



**SECTION C - EMERGENCY RESPONSE AND SITE SAFETY PLANS**

**FINAL POST-CLOSURE MAINTENANCE PLAN**
**LOPEZ CANYON SANITARY LANDFILL**
**TABLE OF CONTENTS (continued)**
**VOLUME I OF II - FINAL POST-CLOSURE MAINTENANCE PLAN**

# FINAL POST-CLOSURE MAINTENANCE PLAN
# LOPEZ CANYON SANITARY LANDFILL
# TABLE OF CONTENTS (continued)
# VOLUME I OF II - FINAL POST-CLOSURE MAINTENANCE PLAN

# FINAL POST-CLOSURE MAINTENANCE PLAN
# LOPEZ CANYON SANITARY LANDFILL
# TABLE OF CONTENTS (continued)
# VOLUME I OF II - FINAL POST-CLOSURE MAINTENANCE PLAN

FIGURES (continued)



EXHIBITS

# FINAL POST-CLOSURE MAINTENANCE PLAN
# LOPEZ CANYON SANITARY LANDFILL
## TABLE OF CONTENTS (continued)
## VOLUME I OF II - FINAL POST-CLOSURE MAINTENANCE PLAN

EXHIBITS (continued)

# FINAL POST-CLOSURE MAINTENANCE PLAN
# LOPEZ CANYON SANITARY LANDFILL
# TABLE OF CONTENTS (continued)
# VOLUME I OF II - FINAL POST-CLOSURE MAINTENANCE PLAN

APPENDICES

**FINAL POST-CLOSURE MAINTENANCE PLAN**
**LOPEZ CANYON SANITARY LANDFILL**
**TABLE OF CONTENTS (continued)**
**VOLUME II OF II - FINAL POST-CLOSURE MAINTENANCE PLAN**

**Page**

**FINAL POST-CLOSURE MAINTENANCE PLAN**
**LOPEZ CANYON SANITARY LANDFILL**
**TABLE OF CONTENTS (continued)**
**VOLUME II OF II - FINAL POST-CLOSURE MAINTENANCE PLAN**

# SUMMARY OF REVISIONS
# FINAL CLOSURE AND POST-CLOSURE MAINTENANCE PLANS
# LOPEZ CANYON SANITARY LANDFILL

This Summary of Revisions outlines the amendments to the Final Closure Plan (FCP) and the Final Post-Closure Maintenance Plan (FPCMP) for Lopez Canyon Landfill. The FCP is comprised of the Partial Closure Plan (PCP) (Volumes I through III) dated April 1993 and the Amendment to the PCP (Volume IV of IV), dated February 1994. The Amendment (Volume IV of IV) transformed the PCP into the FCP. The FPCMP is comprised of the Partial Post-Closure Maintenance Plan (PPCMP) (Volume I) dated January 1993 and the Amendment to the PPCMP (Volume II of II) dated February 1994. The Amendment (Volume II of II) transformed the PPCMP into the FPCMP.

This document (Volume IV of IV Replacement) replaces in whole the February 1994 Volume IV of IV and amends the FCP and the FPCMP per attached Summary of Revisions Table. Significant portions of the FCP and the FPCMP were not revised. To clarify the revisions to the FCP and the FPCMP, each section of the Volume IV of IV Replacement is cross-referenced to the appropriate amended section and/or drawing of the FCP and/or the FPCMP in the summary of revisions table in the Table section of this report.

# 1. INTRODUCTION

## 1.1 Terms of Reference

This volume presents an amendment to the Final Closure Plan (FCP) for the Lopez Canyon Sanitary Landfill. The objective of this amendment is to incorporate into the FCP information on the closure of the deck area of Disposal Areas A and B, and the deck and slopes of Disposal Areas AB+ and C sufficient to constitute a Final Closure Plan (FCP) for the entire landfill. This volume includes revisions to the FCP necessitated by changes in the design of the landfill since submission of the FCP. These changes require revisions to the final cover, final grading plan, post-closure settlement estimates, surface-water drainage controls, soil loss analysis, landfill gas control system, cost estimate for closure, closure implementation schedule, and final cover construction quality assurance (CQA) plan for the landfill.

This report was prepared by GeoSyntec Consultants (GeoSyntec) for the Bureau of Sanitation, Department of Public Works of the City of Los Angeles (BOS). The report was written by Mr. Michael S. Snow, P.E., and Dr. Neven Matasović and was reviewed by Dr. Edward Kavazanjian, Jr., P.E., G.E., of GeoSyntec. GeoSyntec prepared this report as a task within the scope of a general consulting services contract with the City of Los Angeles entitled "Engineering Services for the Development of Disposal Area C and Partial Closure of Disposal Areas A and B at the Lopez Canyon Sanitary Landfill, Lakeview Terrace, California, Contract #C-85555." The scope of work for this task was presented to the BOS in a letter entitled, "Proposal for Amendment to the Partial Closure and Post-Closure Maintenance Plans, Lopez Canyon Sanitary Landfill, Lakeview Terrace, California," dated 29 November 1993 and was verbally approved by Mr. Luther Derian, P.E., of the BOS on 6 December 1993.

## 1.2 Purpose of Amendment

The purpose of this amendment to the FCP is to provide the Local Enforcement Agency (LEA), Los Angeles Regional Water Quality Control Board (RWQCB), and California Integrated Waste Management Board (CIWMB) with the necessary information to consider the FCP and this amendment as the FCP for the entire landfill in accordance with §18262. of Title 14 of the California Code of Regulations. Closure requirements for municipal solid waste landfills are contained in Title 14 (Title 14) and Chapter 15, Division 3, Title 23 (Chapter 15) of the California Code of Regulations, RWQCB Order No. 93-062, and in §258. of Title 40 of the Code of Federal Regulations, commonly referred to as Subtitle D of the Resource Conservation and Recovery Act (Subtitle D).

The Partial Closure Plan-Volumes I through III (PCP) was submitted in January 1993, revised in April 1993, and approved by the RWQCB on 21 July 1993, by the LEA on 4 November 1993, and by the CIWMB on 16 December 1993. The amendment to the PCP (Volume IV of IV) was first submitted in February 1994. The PCP and the amendment to the PCP constitute the FCP. The amendment of the PCP has been revised (Volume IV of IV Replacement) and is being resubmitted as the amended FCP to replace in whole the February 1994 submittal.

The PCP (Volumes I through III) was prepared in order to accommodate closure of the slopes of Disposal Areas A and B in advance of the remaining areas. The amendment to the PCP was prepared to address additional information on the closure of the deck areas of Disposal Areas A and B, and the deck and slope areas of Disposal Areas AB+ and C. The amendment to the FCP addresses the additional information on the closure of the deck area of Disposal Areas A and B, and the deck and slope areas at Disposal Areas AB+ and C resulting from the change in final elevation of the deck of Disposal Area C. The FCP proposed that the closure of the landfill be accomplished in two phases. Phase I closure includes the slopes of Disposal Areas A and B. Phase I closure began in the Spring of 1994. Phase I closure was to be completed by Summer 1996. As a result of the suspension of closure activities in order to allow city resources to work on future CUP areas, the Phase I closure will not be completed by 1996. Phase II closure includes the top decks of Disposal Areas A and B and all of Disposal Areas AB+ and C. Phase II closure is currently scheduled to commence in the Spring of 1998.

The FCP was prepared to a level of detail consistent with the state requirements of a FCP contained in Title 14 and Chapter 15. However, changes in the design of the landfill since submission of the FCP necessitate revisions to the FCP. The changes in design necessitating revisions to the FCP include changes in the final cover, the final elevation of Disposal Area C, and grading changes for the deck areas of Disposal Areas A, B, AB+, and C and for the slope areas of Disposal Areas AB+ and C.

The PCP called for an earthen final cover over the entire landfill. In order to conform to the requirements of Subtitle D, Chapter 15, and RWQCB Order No. 93-062, the final cover design for Disposal Area C has been modified to incorporate a geomembrane infiltration barrier in the deck and bench areas as discussed in the amendment to the PCP which constitutes the FCP. The FCP included a final grading plan for Disposal Areas AB+ and C with a single top deck area at elevation 1,770 ft above mean sea level (msl). However, based upon the closure date of July 1, 1996, the projected final elevation of the deck in Disposal Area C at closure is 1,600 msl. Therefore, in this amended FCP the final grading design for Disposal Areas AB+ and C was modified to incorporate a split-deck, with the final elevation of Disposal Area AB+ at 1,770 ft msl and the final elevation of Disposal Area C at 1,600 ft msl.

## 1.3 Report Organization

The remainder of this report is organized into sections which describe the necessary revisions to the FCP as follows:

- Section 2 presents a description of the revised final cover design;

- Section 3 presents the revised final grading plan for the decks of Disposal Areas A, B, AB+, and C, and the slopes of Disposal Areas AB+ and C;

- Section 4 presents revised post-closure settlement estimates for Disposal Areas A, B, AB+, and C resulting from the modifications to the final grading plan;

- Section 5 presents the revisions to the surface-water drainage design for the decks of Disposal Areas A, B, AB+, and C, and slopes of Areas AB+ and C resulting from the modifications to the final grading plan;

- Section 6 presents revised soil loss estimates for Disposal Areas A, B, AB+, and C resulting from the modifications to the final grading plan, surface-water drainage system, and final cover cross-section;

- Section 7 presents the revisions to the landfill gas control system resulting from the modifications to the final grading plan;

- Section 8 presents the revised landscaping and irrigation design resulting from the changes to the final grading plan;

- Section 9 presents revised cost estimates for implementing closure resulting from the modifications described in Sections 1 through 8;

- Section 10 presents an updated closure implementation schedule;

- Section 11 presents revisions to construction quality assurance (CQA) procedures resulting from modifications to the final cover cross-section;

- Appendix A presents the Updated Site Facilities Map which amends the Site Facilities Map of Volume III of IV of the FCP;

- Appendix B presents the Updated Site Radius Maps which amend the Site Radius Maps of Volume III of IV of the FCP;

- Appendix C presents the Updated Ground-Water Monitoring Network which amends Drawing No. 1 of Volume II of II of the FPCMP;

- Appendix D presents the Updated Figures 1-1 and 3-1 which amend Figures 1-1 and 3-1 of Volume II of II of the FPCMP;

- Appendix E presents the Revised Post-Closure Maintenance Cost Estimate which amends Section 4 of Volume II of II of the FPCMP;

- Appendix F presents the updated Closure and Post-Closure Cost Estimates – Revised Initial Cost Estimate Worksheet which amends the Appendix K of Volume II of IV of the FCP and Table 4-1 of Volume II of II of the FPCMP;

- Appendix G presents the 10 October 1995 letter from the CIWMB approving the revised final cover design;

- Appendix H presents a Final Cover Performance Evaluation report, including water balance (infiltration) and slope stability analyses for the final cover of Disposal Area C; and

- Appendix I presents a revised CQA Plan for implementing the procedures presented in Section 11.

# 2. REVISED FINAL COVER DESIGN

## 2.1 General

The final cover for Disposal Area C has been revised from the design presented in the PCP to conform to the requirements of Subtitle D, Chapter 15, and RWQCB Order No. 93-062 for final covers over bottom liners which include a geomembrane. This revised final cover design was submitted to the CIWMB in February 1994 and was approved on 10 October 1995. A copy of the approval is presented in Appendix G. The final cover presented in the PCP employed an infiltration barrier layer composed of compacted soil only. The revised design for Disposal Area C incorporates a geomembrane in the infiltration barrier layer in the deck and bench areas. The geomembrane was included in the deck and bench areas in accordance with the prescribed minimum construction standards of Subtitle D and Chapter 15. On the slopes of the waste face, an engineered alternative final cover is employed. The alternative slope final cover was designed in accordance with state and federal regulatory standards for a performance-based design of an engineered alternative final cover.

A performance evaluation of the Disposal Area C alternative slope final cover was conducted to demonstrate compliance with applicable state and federal regulations. The performance evaluation included an infiltration analysis and a slope stability assessment for the alternative slope final cover design. The performance evaluation also included a demonstration that the construction of the prescriptive final cover provided in state and federal regulations on the side slopes was burdensome and impractical and would not promote attainment of the performance goals for final covers, as required by the state regulations. A detailed presentation of the performance evaluation is contained in the Final Cover Performance Evaluation report presented as Appendix H of this addendum. A summary of the performance evaluation is presented herein.

## 2.2 Regulatory Framework

State of California regulations concerning design and construction of final covers for closure of municipal solid waste landfills are found in Title 14, Chapter 15, and RWQCB Order No. 93-062. Federal regulations for final covers are provided in Subtitle D. State and federal regulations both provide a minimum prescriptive construction standard for the final cover of Municipal Solid Waste Landfills (MSWLFs) that includes a protective vegetative erosion control layer and a low-permeability soil infiltration barrier layer. State regulations are somewhat more restrictive than federal regulations with respect to these layers, requiring a thicker erosion control layer and an order of magnitude lower hydraulic conductivity for the barrier layer. The state and federal regulations both require that the final cover have a "permeability" less than or equal to that of any bottom liner or underlying material. This requirement is generally interpreted as an implied prescriptive requirement that a geomembrane be included in the final cover barrier layer above areas which incorporate a geomembrane in the bottom liner. This "permeability" requirement is also interpreted as a performance standard requiring less infiltration of surface water through the final cover than liquid flux through the base of the landfill.

Based upon the state and federal regulations and considering that Disposal Area C does have a geomembrane bottom liner, the prescriptive final cover for Disposal Area C is inferred to consist of (from top to bottom):

- a vegetative layer at least 12-in. (300-mm) thick and of greater thickness than the rooting depth of any vegetation planted on the final cover;

- a geomembrane infiltration barrier;

- a compacted soil barrier layer not less than 12-in. (300-mm) thick with a maximum hydraulic conductivity of 1 x $10^{-6}$ cm/sec;

- a foundation layer at least 24-in. (600-mm) thick; and

- a design which provides for the minimum maintenance possible.

Both federal and state regulations provide for design of an alternative to the prescriptive final cover. Federal regulations allow the director of an approved state to approve an alternative design shown to be equivalent or superior to the performance of the prescriptive design with respect to infiltration and wind and water erosion. California is an approved state.

Section 17773. of Title 14 provides for the approval of alternative final covers when the owner demonstrates that:

- the prescriptive standard described in Chapter 15 is not feasible; and

- the engineered alternative is consistent with the performance goal of the prescriptive standard and provides equivalent protection to the ground water;

To establish that the prescriptive standard of Chapter 15 is not feasible, the owner must further demonstrate that the prescriptive final cover:

- is reasonably and unnecessarily burdensome and will cost substantially more; and

- is impractical and will not promote attainment of the performance goals.

The state and federal requirement that the final cover have a "permeability" less than or equal to the bottom liner or underlying material is generally interpreted as an implied final cover infiltration performance standard that the flux through the cover should be less than the flux through the base liner. United States Environmental Protection Agency (USEPA) has confirmed this interpretation of the implied prescriptive requirement and performance standard of the Subtitle D closure requirement in the "Final rule; corrections" for Subtitle D published in the Federal Register of 26 June 1992 (Vol. 57, No. 124, pp. 28626-28628). USEPA's comments on the prescriptive and performance standards for final cover design are discussed in detail in the Final Cover Performance Evaluation report presented in Appendix H.

The Final Cover Performance Evaluation report presented in Appendix H of this addendum contains the demonstration required by state regulations that construction of the prescriptive final cover on the slopes of the waste face of Disposal Area C is both burdensome and impractical and will not promote attainment of the performance goals for final covers. On the basis of this demonstration, an engineered alternative final cover for the Disposal Area C waste slopes was developed.

## 2.3 Revised Final Cover Configuration

### 2.3.1 Disposal Area C Deck/Bench Areas

The final cover on deck and bench areas of Disposal Area C satisfies the prescriptive standard in the California regulations. The deck and bench area final cover, shown in Figure 2-1, consists of the following components (from top to bottom):

- vegetative layer at least 24-in. (600-mm) thick;
- 12 oz/yd$^2$ (410 g/m$^2$) non-woven geotextile cushion;
- 40-mil (1-mm) thick very-flexible polyethylene (VFPE) geomembrane (smooth on the deck areas and textured on the bench areas);
- 12-in. (300-mm) thick barrier layer of compacted low-permeability soil, with a hydraulic conductivity no greater than 1 x $10^{-6}$ cm/s; and
- 24-in. (600-mm) thick foundation layer.

### 2.3.2 Disposal Area A, B, and AB+ Deck Areas

The final cover on the deck of Disposal Areas A, B, and AB+ has been modified from that presented in the PCP to delete the geotextile between the vegetative layer and the low-permeability soil barrier layer. In addition, a geosynthetic clay liner (GCL) with a hydraulic conductivity no greater than 5 x $10^{-9}$ cm/s may be used as a barrier layer. The use of a GCL will depend on the availability of low-permeability soil. The modified final cover is presented in Figure 2-2.

### 2.3.3 Disposal Area C Slope Areas

An engineered alternative final cover was developed for the slope areas of the Disposal Area C waste face. The engineered alternative was developed on the basis of the demonstration included in Appendix H of this amendment, the Final Cover Performance Evaluation report, that inclusion of a geomembrane in the slope areas of the Disposal Area C final cover would be burdensome and impractical and would not promote attainment of the performance goals of a final cover. Use of a geomembrane in the final cover on the waste slopes was deemed burdensome and impractical due to constructability, stability, and cost considerations. Furthermore, the maintenance requirements for a slope final cover incorporating a geomembrane were deemed contrary to the performance goal of minimizing final cover maintenance.

The engineered alternative final cover design for the slope areas of the Disposal Area C waste face is shown in Figure 2-3. The final cover for the slope area consists of the following components (from top to bottom):

- vegetative layer at least 24-in. (600-mm) thick;
- 12-in. (300-mm) thick barrier layer of compacted low-permeability soil with a hydraulic conductivity no greater than 1 x $10^{-6}$ cm/s; and
- 24-in. (600-mm) thick foundation layer.

### 2.3.4 Disposal Areas A, B, and AB+ Slope Areas

The change in the final elevation of Disposal Area C has produced a split-deck final grading plan, with the deck of Disposal Area C at elevation 1,600 ft msl and the deck of Disposal Area AB+ at elevation 1770 ft msl. This split deck has created a need for construction of a final cover on the waste slopes of Disposal Area AB+ between the decks of Disposal Areas AB+ and C. The same final cover used on the Disposal Area C slopes will be used on the slopes of Disposal Areas A, B, and AB+. This final cover for the A and B slopes is different than that which was originally submitted in the PCP. The monolithic cover was replaced with the final cover as described in the above section. This modification was submitted to the CIWMB on 31 May 1994 and approved on 10 October 1995. A copy of the approval letter is presented in Appendix G. This final cover is shown in Figures 2-2 and 2-3 and described in the preceding section. As Disposal Areas A, B, and AB+ are not underlain by a geomembrane liner, the final cover for the decks and benches in these areas do not require a geomembrane. The final cover conforms to the prescriptive design standard.

## 2.4 Infiltration Analyses

Use of an engineered alternative final cover on the waste slopes of Disposal Area C requires a demonstration that the alternative design provides equivalent protection to ground water and resistance to infiltration compared to the prescriptive design. The potential for infiltration of surface water through the alternative final cover on the slopes of the waste face was evaluated using two USEPA-developed water balance models: (i) HELP Model Version 2 [USEPA; 1984 a,b]; and (ii) the SW-168

Model developed by Fenn et al. [1975]. The infiltration calculations are included in Appendix H of this addendum, the Final Cover Performance Evaluation report.

Neither the HELP nor the SW-168 Model predicted infiltration through the cover. One factor influencing the lack of infiltration is the high percentage of run-off from the 2H:1V Disposal Area C slopes. In addition, the annual precipitation is significantly less than the annual pan evaporation rate. As a result, the soil moisture storage capacity was not exceeded in either short term or long term conditions, resulting in no infiltration through the final cover barrier layer. Because there was no infiltration through the barrier layer, the engineered alternative final cover design for the Disposal Area C slopes meets the infiltration performance standard of less infiltration through the final cover than through the bottom liner.

## 2.5 Final Cover Slope Stability

Both one-dimensional (infinite slope) and two-dimensional slope stability analyses of the Disposal Area C final cover were performed. Slope stability calculations are included in Appendix H of this report, the Final Cover Performance Evaluation report. The one-dimensional slope stability analyses were performed using the methodology suggested by Matasović [1991]. Two-dimensional slope stability analyses were performed using the computer program PC STABL 5M [Achilleos, 1988].

One-dimensional stability analyses yielded a minimum (static) factor of safety of 2.0 for a failure surface passing through the waste immediately below the existing foundation layer. The corresponding pseudo-static factor of safety for a seismic coefficient of 0.2 was 1.41. GeoSyntec considers this pseudo-static factor of safety acceptable based upon the conclusions of Seed [1979]. Based upon observations of the performance of slopes and embankments in earthquakes around the world, Seed [1979] concluded that slopes designed with a pseudo-static factor of safety of 1.15 for a seismic coefficient of 0.15 experienced "acceptable" deformations (less than 1 ft (0.3 m)) in earthquakes of all magnitudes and intensities. However, to substantiate this conclusion, maximum permanent seismic displacements were estimated using charts developed by Hynes and Franklin [1984] using Newmark analyses. Predicted displacements for the critical final cover failure surface were on the order of 2 in. (50 mm) for the design peak ground acceleration of 0.69 g. Two-dimensional slope stability analyses yielded a minimum (static) factor of safety of 2.86 and a pseudo-static factor of safety of 2.0.

The infiltration analyses indicated the potential for development of down slope seepage parallel to the face of the slope within the vegetative cover layer was negligible, even for the 100-year, 24-hour storm. However, stability analyses were conducted for the limiting case of seepage parallel to the slope. Stability analyses for the condition of seepage parallel to the slope yielded a minimum (static) factor of safety of 2.5 for this condition.

The final cover on the slopes of the Disposal Area AB+ waste face will have the same cross section as the final cover on the Disposal Area C waste face. However, the inclination of the slopes on the Disposal Area AB+ waste face is 2.5H:1V, flatter than the 2H:1V inclination of the slopes on the Disposal Area C waste face. As the final cover on the Disposal Area C waste face was demonstrated to be stable, separate stability calculations for the flatter Disposal Area AB+ final cover were not considered necessary.

The stability calculations are included in Appendix H of this addendum, the Final Cover Performance Evaluation report.

# 3. REVISED FINAL GRADING DESIGN

## 3.1 General

Revisions to the final grading design presented in Section 4 of the FCP are described in this section. These revisions were primarily related to the reduction of the final deck elevation of Disposal Area C from the permitted elevation of 1,770 ft msl to the final elevation of 1,600 ft msl currently projected at closure. The final slope and deck grading for Disposal Area AB+ was revised in order to accommodate the revision to the deck of Disposal Area C. The final deck grading for Disposal Areas A and B was revised to reflect the refuse settlement. Also, the grading on the slopes of Disposal Area A in the lower canyon has changed to accommodate an energy dissipator instead of a sedimentation basin. This revised grading in the Lower A Canyon was submitted to the CIWMB on 31 May 1994 and was approved on 10 October 1995. A copy of the approval is in Appendix G. The revised final grading design is shown in Figure 3-1 and Drawing No. 1 of this amendment.

## 3.2 Deck Areas

The revisions to the final grading design have resulted in a split-level deck for Disposal Areas AB+ and C. The top deck elevation of Disposal Area AB+ remains at 1,770 ft msl. However, the contours of Disposal Area AB+ have been modified to direct surface water runoff to a single downchute (see Section 5) and to minimize the maintenance associated with the post-closure settlements of the landfill. In re-grading the top deck of Disposal Area AB+, a minimum grade of two percent and a maximum grade of five percent has been provided for the deck area immediately after closure to promote surface water runoff and control erosion.

The final grading design for the deck area of Disposal Area C has been modified to correspond to the projected maximum elevation of 1,600 ft msl. The deck area of Disposal Area C has a minimum three percent and a maximum five percent grade. The contouring of the Disposal Area C deck has been designed to direct surface water runoff to downchutes (see Section 5) and to minimize the maintenance associated with the anticipated post-closure settlements of the landfill.

The revisions to the grading of the Disposal Areas A and B decks were necessitated to better reflect the refuse settlement. The refuse settlement occurred in part as a result of the soil stockpiles which were placed in the area. The soil stockpiles have been largely removed to reduce the need to import off-site soils. The revised grading was developed to reduce the need for substantial re-grading following removal of the soil stockpiles.

## 3.3 Slope Areas

The revised split-deck final grading design for Disposal Areas AB+ and C creates two slope areas: (i) below the Disposal Area C deck (Disposal Area C slope); and (ii) between the Disposal Areas AB+ and C decks (Disposal Area AB+ slope). The Disposal Area C slopes and the north facing portion of the Disposal Area AB+ slopes have about a 2H:1V (horizontal:vertical) slope with 18-ft (6-m) wide benches spaced about every 40 ft (12 m) in height. The resulting average slope is about 2.5H:1V. The west facing portion of the Disposal Area AB+ slope has about a 2.5H:1V slope with benches spaced about every 40 ft (12 m) in height. The resulting average slope is about 3.0H:1V.

The benches on the Disposal Area AB+ and C slopes are graded and banked to convey surface-water drainage along the back of the benches. The surface water runoff collected on the benches is directed to downchutes and/or channels which empty into the existing debris basins located to the south of Disposal Area C.

## 3.4 Access Roads and Benches

Access to the deck and slope areas of Disposal Areas AB+ and C is provided by access roads and benches which connect to the existing paved haul road at the Lopez Canyon Sanitary Landfill. Access to the slope areas is provided by the benches which lead to an unpaved access road which parallels the existing haul road along the western and northern boundaries of Disposal Areas AB+ and C. The proposed access road is connected to the existing paved haul road by two short structures which bridge over the existing perimeter channel separating the proposed access and existing haul roads.

Access to the Disposal Area C deck is provided directly from the proposed access road on the north side of the deck. Access to the Disposal Area AB+ top deck is provided directly from the adjoining top deck areas of Disposal Areas A and B and along a dirt access road at the northwestern corner of the deck.

## 3.5 Slope Stability

Slope stability of the final cover was addressed in Section 2.5 of this addendum. Slope stability analyses of the waste mass for a final deck elevation for Disposal Area C of 1,770 ft msl were previously presented by Vector Engineering [1993]. Since reducing the deck elevation to 1,600 ft msl results in a reduction in the driving forces in the stability analysis, the revisions to the final grading plan lead to improved slope stability conditions compared to those evaluated by Vector Engineering and presented in the FCP. As a result, re-analysis of the overall stability of the waste mass was not performed.

## 3.6 Refuse Disposal

As a result of the revised final grading design for Disposal Areas AB+ and C, revised refuse disposal projections for each area and for the entire landfill have been prepared by the BOS. These volume projections are based on available information on subgrade elevations, the bottom liner grading plan for Disposal Area C, the revised final cover design, the revised final grading plan, and a daily cover ratio. The volume projection computations indicate total refuse disposal of about 2,600,000 tons for Disposal Area C. The revised total refuse disposal projection for the entire Lopez Canyon Sanitary Landfill is 16,500,000 tons.

# 4. REVISED POST-CLOSURE SETTLEMENTS

Final cover post-closure settlement estimates were presented in Section 4.8 of the FCP as 30 percent of the total waste thickness. Based on the revised final grading design for Disposal Areas AB+ and C (Figure 3-1, Drawing 1 of this addendum), the bottom liner grading plan for Disposal Area C, and historical topographic maps for Disposal Area AB+, a revised post-closure settlement contour map was developed for Disposal Areas AB+ and C. The revised post-closure settlement contour map is presented as Figure 4-1 and Drawing No. 2 of this amendment.

The FCP presented the location of ten settlement monuments. Due to the revisions to the final grading design, several of these settlement monuments were relocated and two additional settlement monuments are proposed. The revised locations of the settlement monuments are presented in Figure 4-2 and Drawing No. 3 of this amendment.

# 5. REVISED SURFACE-WATER DRAINAGE SYSTEM

## 5.1 General

This section describes revisions to the surface-water drainage system design for Disposal Areas A, AB+, and C presented in Section 5 of the FCP. These revisions were prepared to reflect the modifications to the final grading plan presented in Section 3 of this amendment. The layout of the revised surface-water drainage system is shown on Figure 3-1 and Drawing No. 1 of this amendment, and is described in the following sections. The total watershed area and the relative proportions of deck and slope areas are essentially unchanged from the FCP, hence the total surface water run-off is also essentially unchanged from the FCP. The surface-water drainage system revisions were developed such that the total flows entering into the upper and lower debris basins, located to the south of Disposal Area C, are similar to those presented in the FCP. The various components of the revised surface-water drainage system are also essentially the same as those presented in the FCP. However, descriptions of the various surface-water drainage system components are included herein for completeness.

## 5.2 Disposal Area A

The surface-water drainage system on the slope at Disposal Area A has been modified since the 1993 submittal of the PCP. The modification is that the proposed sedimentation basin in A Canyon has been changed to an energy dissipator.

## 5.3 Disposal Area AB+

### 5.3.1 Deck Area

The top deck area of Disposal Area AB+ has been designed to direct surface water runoff to one inlet structure located along the northern perimeter of the top deck. Surface water runoff collected at the inlet structure flows into a downchute to the existing perimeter channel and into the upper debris basin. The location of the inlet structure corresponds to an area where ultimate post-closure settlements are expected to be relatively large. This design feature is intended to reduce the post-closure maintenance required for correcting surface-water drainage patterns.

### 5.3.2 Slope Area

Surface water runoff from the north facing slopes of Disposal Area AB+ is either: (i) collected on benches, conveyed to downchutes then into the existing perimeter channel, and into the upper debris basin; or (ii) flows directly off the slope, across the proposed access road, into the existing perimeter channel, and into the upper debris basin.

Surface water runoff from the west facing slopes is collected on the benches where it is conveyed to either: (i) two proposed downchutes, into a proposed diversion channel, to an existing downchute, and into the lower debris basin; or (ii) to the existing perimeter channel and into the upper debris basin. The proposed diversion channel is located on the lowest bench of the west facing slopes.

## 5.4 Disposal Area C

### 5.4.1 Deck Area

The deck area of Disposal Area C has been designed to direct surface water runoff to two inlet structures located along the southwest perimeter of the deck. The locations of the inlet structures correspond to areas where ultimate post-closure settlements are expected to be relatively large. This design feature is intended to reduce the post-closure maintenance required for correcting surface-water drainage patterns. The inlet structures are connected to downchutes which will convey the surface water runoff to either: (i) the upper debris basin; or (ii) the lower debris basin.

### 5.4.2 Slope Area

The slope area of Disposal Areas C is described in Section 3 of this amendment. Surface water runoff from the slope area is collected on benches where it is conveyed to either: (i) three proposed downchutes which lead to the upper and lower debris basins, respectively; (ii) directly into the existing perimeter channel and into the upper debris basin; or (iii) an existing downchute located to the southeast of Disposal Area C and into the lower debris basin.

## 5.5 Surface Water Drainage Controls

### 5.5.1 Benches

Surface water runoff from finished slopes will be collected by approximately 18-ft (6-m) wide benches constructed along the face of the slope at approximately 40-ft

(12-m) vertical intervals. The benches will be graded so that surface water runoff will drain to the heel of the bench and then to: (i) inlet structures at the proposed downchutes; (ii) the existing perimeter channel; or (iii) the existing downchute located southeast of Disposal Area C.

### 5.5.2 Downchutes

The downchutes for the site will be constructed of either metal and/or polyethylene. Downchutes will be anchored to the slope. Downchutes will be designed with "slip collars" to accommodate settlement and will be capable of withstanding the anticipated differential movement between the benches. A splash wall/energy dissipater will be located at the base of the proposed downchutes located on the Disposal Area AB+ west facing slope.

### 5.5.3 Inlet Structures

Inlet structures will be used to direct surface water runoff from the benches and the Disposal Area AB+ and C deck areas to downchutes. The inlet structures will include metal grating to retain debris, and concrete or asphalt bases to control erosion in the vicinity of the inlet structures.

# 6. REVISED SOIL LOSS ESTIMATES

Soil loss estimates were presented in Table 4-1 in Section 4.7 of Volume I of IV of the FCP based on the Universal Soil Loss Equation developed by the United States Soil Conservation Service. The deck and slope areas were subdivided into 26 study areas. For this amendment to the FCP, the final grading design changed on the deck areas of A, B, AB+ and C, and the slope areas of AB+ and C. Due to this change, the deck and slope areas needed to be subdivided into twenty (20) study areas. These study areas are presented in Figure 6-1. The revised study areas were evaluated and the revised soil loss analysis results are presented in Table 6-1.

The estimated soil losses over a 30-year post-closure period is 0.16 percent of the 24-in. (600-mm) thick vegetative cover thickness on both the deck and slope areas. These soil loss estimates are essentially unchanged and are consistent with the requirement of the Title 14 regulations to minimize maintenance for the final cover.

# 7. REVISED LANDFILL GAS CONTROL SYSTEM

## 7.1 General

The original landfill gas control system was installed at the Lopez Canyon Sanitary Landfill in 1989 and was upgraded in 1992. Initial start up of the system was conducted in December 1989. The landfill gas control system design consists of horizontal and vertical landfill gas wells, lateral collectors, and headers over a large portion of the landfill. The current flare station consists of nine flares. The collected landfill gas is delivered to the flare station where it is disposed of by combustion. Monitoring of the landfill gas control system is performed with perimeter monitoring probes and a landfill gas surface monitoring grid. The landfill gas monitoring system is unchanged from that presented in the FCP.

Revisions to the landfill gas control system presented in the FCP were required as a result of the modifications to the final grading plans in Disposal Area C. Revisions were made only to the layout of the landfill gas control system in this area. The specific components of the system (e.g., headers, wells, etc.) are unchanged from those described in the FCP. The revised layout of the landfill gas control system is presented as Figure 7-1 and Drawing No. 4 of this amendment. Descriptions of the system components are presented below.

## 7.2 Landfill Gas Control System

### 7.2.1 General System Layout

The existing landfill gas control system in Disposal Areas A,B, and AB+ was installed prior to the placement of final cover and consists of vertical and horizontal landfill gas wells buried in the intermediate cover which are designed to allow landfill gas condensate to flow to the sumps located at low points around the site. The system modifications described in the following sections will effectively incorporate Disposal Area C into the existing landfill gas control system and will accommodate any increased condensate volumes the system may experience when Disposal Area C has been added. Any additional modifications made to the landfill gas control system during the closure and post-closure maintenance period will be submitted to the LEA and the CIWMB for approval in accordance with §17783.(d) of Title 14.

### 7.2.2 Disposal Area C

The design of the landfill gas control system for Disposal Area C incorporates a series of horizontal gas wells and collection header lines (see Figure 7-1 and Drawing No. 4 of this amendment). Horizontal wells and collection header lines are installed as the waste is placed.

As Disposal Area C is filled, a system of horizontal landfill gas wells will be installed. A total of five levels of horizontal landfill gas wells will be installed under the Disposal Area C deck. The horizontal spacing between adjacent landfill gas wells lines will be approximately 100 ft (30 m). The vertical distance between each layer of horizontal landfill gas wells will be approximately 40 ft (12 m). The top layer of horizontal landfill gas wells will be approximately 20 ft (6 m) below the final cover.

Each horizontal landfill gas well outlet line will be individually valved and connected to a main landfill gas collection header. The main purpose of the horizontal landfill gas wells is to allow for collection of landfill gas from the center of the landfill. Their chief advantages are lower cost and compatibility with ongoing fill operations.

# 8. REVISED LANDSCAPING AND IRRIGATION

## 8.1 Introduction

The proposed landscape design for the closed Lopez Canyon Landfill is an interim open space landscape revegetated with California native plant materials suited for Southern California. The primary purpose of the vegetative cover will be the protection of surface soils against erosive elements such as water and wind. Secondary or indirect purposes of the cover include aesthetic enhancement and restoration and replacement of native grass and sage scrub species. The deck and slope areas of the landfill will receive vegetative types which respond to site factors such as solar orientation, degree of erosion potential, and water conservation. Figures 8-1 through 8-5 show slope and deck planting areas; with typical planting legends and details in Figures 8-6 and 8-7.

All deck and south/southwest oriented areas of the landfill will be planted with native grassland species of Southern California with additional non-native, noncompetitive grasses. Pioneer plant species will be included to rejuvenate the soil environment. All north/northeast oriented slopes will be revegetated with native shrubs and grasses typical of the local slope areas adjacent to little water, little maintenance, and will be shallow rooted to avoid penetration of the low-permeability final cover layer.

It is intended that whenever possible, the deck areas will be seeded during the rainy months in order to reduce the amount of supplemental irrigation. It is also anticipated that construction schedule demands may not allow waiting for a rainy season. There may also be little or no rain in any given year. Therefore, at the discretion of the Engineer, temporary overhead spray irrigation systems may be used to assist germination and establishment of seed on the deck areas. These systems may be rented and left in place until the vegetation is well established, a period between six and eighteen months.

As an alternative to permanent irrigation systems, temporary irrigation systems may be used for all or part of the landfill. However, permanent overhead spray irrigation systems will be designed for all slope areas. In some areas, sufficient natural vegetation may already have become established by the time irrigation construction is ready to begin. The Engineer may exercise the option to postpone installation of permanent irrigation on some slope areas, or to use temporary irrigation systems, for areas which have well established vegetation, or which are not over the waste prism and would not affect the final cover system.

A water balance study was performed to determine if irrigation of the final cover would create excess infiltration of water into the trash prism. Based on the results of the study, irrigation of the final cover to establish vegetation will not result in unacceptable percolation through the cover, even under the wettest conditions. A water balance study for the Lopez Canyon Landfill was prepared by Law Environmental dated March 27, 1992, and is included as Appendix J of Volume II of IV of the FCP. In addition, periodic monitoring of watering by a landscape architect representative will be conducted until final cover vegetation is established.

## 8.2 Post-Closure End Use

The proposed interim end use for the site is open space and will be planted with foothill grass plant species and inland sage scrub plant species. The vegetation established on the slopes at the completion of closure should be compatible with most ultimate end uses. The cover has been designed to accommodate irrigation so as not to limit any future end use selected for the site.

## 8.3 Landscape Materials

### 8.3.1 General Description

All plant species for the site have been selected because of their adaptability to a limiting set of site criteria. The more important criteria includes low water consumption, tolerance of high salt content in the soils, adaptability to clay soils, ease of maintenance, low fire fuel load, shallow root systems and wind tolerance. The layout of containerized plants which is shown on the plans is intended as a general design. The actual number and layout of plants will be determined in the field by the Site Engineer based on actual conditions at the time of planting.

### 8.3.2 Deck and Slope Area Plant Materials

All deck and south/southwest oriented areas will be vegetated with a select grass seed mix comprised of native annual and perennial bunch grass species. Individual species selected as the vegetative cover are identified in Table 8-1. The grasses will provide a green vegetative color during the wet season and a light green/light brown color during the dry season. Several grass species are warm season perennials providing green foliage during the summer months on limited water. Their warm season perennial characteristic should limit fire fuel load buildup. Establishment of the grass should occur in the first two to three growing seasons.

All north/northeast oriented slopes will be revegetated with perennial shrubs common to the local slopes of the area. The shrubs will provide visual integration of these disposal areas to the adjacent open space areas. The ultimate height of the vegetative cover will be approximately four feet with most species reaching two feet in height. Establishment of the shrubs should occur in the fourth or fifth growing season. Individual species selected as the vegetative cover are identified in Table 8-1.

The lower slope area of Disposal Area A can be seeded and/or planted with deeper rooting shrubs. The shrubs will not threaten cover integrity since the final cover design in this area provides for a vegetative layer 10 to 40 feet thick. During cover construction, soil depths should be noted to ensure proper placement of deeper rooted plants.

Shrub and tree species common to the chaparral belt plant community can be installed on the Disposal Area A slopes where deeper vegetative soil layers will be placed. These shrubs and trees are not available in seed source and should be installed from field containers following the first stage of plant establishment. These shrub species are identified in Table 8-1.

### 8.3.3 Soil Amendment

Prior to seeding, a soil activator/conditioner will be applied to the decks and slopes. The soil activator will provide an available nutrient base for quick establishment and will provide a long-term fertile soil environment for full plant development. The soil activator is formulated to provide an appropriate soil environment for the native plant species proposed as a vegetative cover.

## 8.4 Landscape Installation

### 8.4.1 Weed Eradication

Upon completion of closure construction, and prior to seeding operations, an aggressive weed eradication program should be implemented to eliminate invasive weeds such as mustard and thistles. These undesirable plants are natural to disturbed sites of the region and their control will be necessary to ensure proper establishment of the desired plant species, to reduce fire potential, and to eliminate possible penetration of the final cover by undesirable deep rooting species. The weed eradication program for each area may be modified by the Engineer, depending upon the condition of the area and project schedule.

The initial removal of weeds may be accomplished by mechanical means and/or by herbicides, as determined during a site inspection by a State licensed Agricultural Advisor and the Engineer. During testing of the irrigation system and following the first-stage of weed removal, dormant weed seeds will germinate. Two to three weeks following the appearance of these weeds, a second eradication effort is required to kill the second generation weeds. This is usually accomplished by herbicide application. Following eradication of the second generation of weeds, the slopes are ready for planting.

After seeding and germination, each area should receive continued weed monitoring during the plant establishment period, with supplemental weed eradication activities as necessary.

### 8.4.2 Slope Preparation

The slopes will be constructed to limit water infiltration and allow for proper establishment of the vegetative cover. The minimum cover thickness required for vegetation will be 24 inches and may be highly compacted. Slope scarification and texturing will eliminate high run-off velocities of water and will create pockets for seed dispersal and germination. The selected method for texturing will produce surface pockets to a minimum depth of two inches normal to the slope at not greater than eight inches apart. Prior to slope texturing, the surface will be dampened to a minimum depth of two inches.

### 8.4.3 Hydroseeding Procedures

Seeding procedures for the deck area will be performed by mechanical drill seeding. This technique provides better contact between the seeds and the soil which will increase the germination percentages. Prior to drill seeding, and the addition of soil activators, all compacted soils should be watered to reduce soil compaction in the upper three inches of soil. This step increases the drill seeding equipment's efficiency at dropping seeds into the soil and will incorporate the soil activator with existing cover soils. Drill seeding can occur following the installation of the temporary irrigation system and weed eradication.

Installation of the slope vegetative cover will be performed by two-stage hydroseeding in the fall months after weed eradication. The two-stage hydroseed installation creates a better growth environment resulting in increased landscape coverage. The first stage of the process is an application of the seed mix and soil activator in the form of a light slurry on the textured slope. The second stage is an application of a tackifier and mulch over the seed. This process provides soil contact between the seed and soil and provides a heavy mulch cover over the seed which will reduce exposure to the sun. The tackifier prevents loss of the mulch from rain or irrigation and wind.

## 8.5 Irrigation System

The final cover irrigation system will consist of a pressured water supply line, the existing one million gallon (1 MG) water tank, a booster pump at the reservoir, mainline distribution networks on the irrigated areas, permanent or temporary sprinkler systems on the slopes, and irrigation controllers sufficient to operate each area of the landfill.

The existing landfill water supply system is designed to lift water from the Los Angeles Department of Water & Power main pipeline on Lopez Canyon Road to the 1 MG water tank. This system consists of two 400 gallon per minute (gpm) pumps and an above ground ten inch diameter cast iron pipeline to the 1 MG water tank at the top of the landfill. Irrigation scheduling will account for the rate of filling and depletion of the tank reservoir. This limitation will restrict the size of area which can be irrigated at full germination rates during any period. Water Management will be the responsibility of the Site Engineer.

A 485 gpm duplex booster pump station is located at the reservoir in order to pressurize the upper deck and upper slope distribution systems which do not receive sufficient head pressure from the tank. These pumps could be operated up to 24 hours per day to meet demand during critical seed germination periods, depending on the limitations of the water supply system.

Air and vacuum release valves will be located at all high points in the system. Blow-off valves will be placed at low points, with a lateral connection to the storm drain for all discharges. Pressure regulating valves will be located at main supply lines that feed slopes to reduce the water pressure to acceptable levels. Pressure relief valves will also be installed in the supply line to eliminate pressure surges. Isolation valves will be installed at a spacing of approximately 1,000 feet to provide for flexibility during operation and maintenance of the system

### 8.5.1 Deck Area Irrigation

The deck area irrigation system for the Lopez Canyon landfill is proposed to be a temporary manually operated system.

The major components of the system will be rented and consist of a mainline, lateral pipes, risers, manual valves, and sprinkler heads. The point of connection to the water supply for the deck systems will be a flange fitting, located at the edge of the deck area. The booster pumps may be used to provide adequate pressure for the deck systems. Sprinkler laterals will be placed directly on the ground and spring check valves will be utilized at all risers to minimize gravity drainage from the laterals. This will eliminate the wasting of water and reduce the potential for erosion. The supply system will be designed to provide a minimum of 40 psi pressure to the sprinkler heads.

### 8.5.2 Slope Area Irrigation System

The proposed method of irrigation for slope areas is permanent, automatically operated systems. Layout and installation details are shown in Figures 8-8 through 8-17. Typical layout will include a supply line and a lateral line placed along the outside of each bench at the top of the slopes. These pipes would be buried in the vegetative layer for protection from physical and ultraviolet (U.V.) damage. Other lateral lines may run under benches or down slopes as necessary for adequate coverage on large slope areas. Laterals on slope faces should be avoided if possible. Most mainline and lateral lines will be PVC with U.V. inhibitors. The main system distribution lines will be steel. Sleeves will be installed at bench crossing to protect the PVC pipe.

Sprinkler heads will have a gear driven rotary design with part circle coverage at the top of the slopes, and full circle heads at mid-slope where necessary. The supply system will be designed to provide a minimum of 40 psi pressure to the sprinklers. The sprinkler nozzle sizes will vary depending on the water pressure and desired coverage at each head. Check valves will be used to minimize drainage and reduce the potential for erosion and rutting.

An alternative, less expensive method for irrigating slopes will be to use temporary rental type systems. The Engineer will make the final determination of which type of system will be used, depending upon conditions and schedule requirements when the slopes are ready for irrigation and seeding. Temporary systems for slopes will include a mainline, lateral pipes, risers, manual valves, and sprinkler heads which will be placed on the surface of the cover at the outer edge of the bench above the slope. The source of irrigation water for temporary systems on slopes would be points of connection at the permanent mainlines at the end of each bench.

## 8.6 Description of Figures

Figures 8-1, 8-2, and 8-3 illustrate Decks A, B, C, and AB+; Slopes areas AB+ and C; and the Haul Road landscape areas. Figures 8-4 and 8-5 illustrate A and B Slopes landscaping.

Figures 8-8, 8-9, and 8-10 illustrate Decks A, B, C, and AB+; Slopes areas AB+ and C; and the Haul Road irrigation areas. Figures 8-11, 8-12, and 8-13 illustrate A and B Slopes irrigation areas.

# 9. REVISED CLOSURE COST ESTIMATE

## 9.1 General

This section presents the February 1995 revised cost estimate for closure of the Lopez Canyon Sanitary Landfill. This estimate supersedes the estimate presented in Section 11 of the PCP and supersedes the estimate presented in Section 8 of the amendment to the PCP (FCP) submitted in February 1994. The modifications to the closure cost estimate are related to the modifications in the final cover design and final grading, landfill gas control system, irrigation system, and surface-water drainage system. In addition, the City of Los Angeles maintains a fully funded trust fund for the entire value of the closure cost estimate.

## 9.2 Cost Categories

### 9.2.1 Final Cover

The Lopez Canyon Sanitary Landfill Disposal Areas A, B, AB+, and C are comprised of about 84 acres (34 hectares) of deck surface area and about 77 acres (31 hectares) of slope surface area. A minimum 24-in. (600-mm) thick layer of interim cover will exist over the entire landfill area once filling is complete. This cover is placed during the normal landfill operations at the site. The planned final cover for the deck area of Disposal Areas A, B, and AB+ and the slope area of Disposal Areas A, B, AB+, and C consists of a compacted low-permeability soil barrier layer approximately 12-in. (300-mm) thick, and a 24-in. (600-mm) thick protective soil vegetation layer.

The final cover design for the deck and bench areas of Disposal Area C consists of an 12-in. (150-mm) thick compacted low-permeability soil barrier layer, a 40-mil (1-mm) thick VFPE geomembrane, a 12 oz/yd$^2$ (410 g/m$^2$) nonwoven geotextile cushion, and a 24-in. (600-mm) thick protective soil vegetative layer. The final cover for the slope areas of Disposal Areas AB+ and C differs from the deck and bench areas of Disposal Area C in that no geotextile cushion or geomembrane is used. The deck/bench surface area of Disposal Area C is about 24.1 acres (9.8 hectares) while the slope surface area is about 10.9 acres (4.4 hectares). The deck surface area of Disposal Area AB+ is about 31.6 acres (12.8 hectares). The Disposal Area AB+ deck includes about 4.8 acres (2.0 hectares) and about 2,000 linear feet of the existing paved haul road and concrete trapezoidal perimeter channel to the north of the proposed access road. The slope surface area of Disposal Area AB+ is about 17.5 acres (7.1 hectares).

The revised cost estimate for final cover construction reflects the supply and installation of the geotextile cushion and VFPE geomembrane on the deck and bench areas of Disposal Area C, the revised quantity of earthen material used in the final cover for Disposal Areas AB+ and C, the changes in surface areas resulting from the final grading design modifications, and the need to reconstruct the existing haul road and perimeter channel.

Installation of the geotextile cushion and VFPE geomembrane is estimated to cost about $1,070,176 based on a unit cost of $0.71 per square foot ($7.64 per square meter) which includes construction quality assurance. The revised final grading design for Disposal Areas AB+ and C resulted in a decrease in earthwork quantities (i.e., low-permeability clay and vegetative cover). This resulted in a decrease of $1,535,386 in earthwork costs. The cost of demolishing and reconstructing those portions of the existing haul road and perimeter channel that overly waste has been estimated at $305,640. As a result of the above changes, the total cost of final cover construction has decreased from $10,687,998 to $10,278,252 in 1995 dollars.

### 9.2.2 Revegetation and Irrigation

Revegetation and irrigation costs cover the cost of soil preparation and planting of the vegetative cover, and temporary and permanent irrigation systems on the deck and slope areas, respectively. The revised revegetation and irrigation plan and figures are presented in Section 8 of this document. The revised cost estimate for revegetation reflects the decrease of about 5 acres (4 hectares) in the total surface area of the landfill to be revegetated. At a unit cost of about $3,225 per acre ($8,000 per hectare) for soil preparation, planting, fertilizing, and mulching, the revised surface area results in a revegetation cost savings of $16,125. The elimination of the temporary irrigation system on the deck areas resulted in an additional cost savings of $232,000. The permanent slope irrigation system has a unit cost of about $19,000 per acre ($47,000 per hectare). The revised final grading plan resulted in a decrease of slope surface area of about 16.5 acres (hectares). The revised surface area results in a decrease in irrigation costs of about $313,500. The total cost for revegetation and irrigation decreased from $2,382,350 to $1,821,823 in 1995 dollars.

### 9.2.3 Landfill Gas Control System

The cost estimate for the landfill gas control system is essentially unchanged from that presented in the FCP since the proposed vertical and horizontal landfill gas wells in Disposal Area C will already be in place when closure is implemented.

### 9.2.4 Surface-Water Drainage System

Costs for the surface-water drainage system include construction of the on-site drainage facilities. The revised cost for the surface-water drainage system reflects the decrease of about 5 acres (2 hectares) in the total landfill surface area and the corresponding changes to the surface-water drainage system presented in the FCP and which are described in Section 5 of this amendment. These changes result in: (i) a reduction of about 780 ft (240 m) in the total length of downchutes; (ii) a reduction of 6 inlet structures and bench crossings; (iii) the addition of about 1,000 ft (305 m) of diversion channel; and (iv) the addition of two splash walls.

In addition, several surface-water drainage elements included in the closure cost estimate presented in the FCP have either been: (i) built since the FCP was issued; or (ii) eliminated as a result of design modifications. These elements include: (i) three detention basins ($980,000); (ii) one debris basin ($180,000); (iii) 6,100 ft (1,860 m) of concrete trapezoidal channel ($176,530); (iv) 2,070 ft (630 m) of reinforced concrete pipe; (v) 6,000 square feet (560 square meters) of grouted riprap ($48,000); and (vi) 143,250 square feet (13,310 square meters) of 4-in. (100-mm) thick asphaltic concrete paving for access roads ($14,800). As a result of all the above changes, the total cost for the surface-water drainage system has decreased from $2,394,989 to $829,870 in 1995 dollars.

### 9.2.5 Security Installation

This category includes installation of the signs and perimeter fence and the cost is unchanged from that presented in the FCP.

### 9.2.6 Contingency

A 20 percent contingency factor has been added to the closure construction cost estimate presented in Section 9.3. This percentage is unchanged from the FCP.

## 9.3 Cost Estimate

Table 9-1 presents a summary of costs for the closure features previously described by category. The revised total cost for closure implementation has decreased from $21,849,558 to $17,538,990 in 1995 dollars. Appendix K of the FCP Volume II of IV has been revised to include the updated closure cost estimate. Appendix K is provided as Appendix F of this document.

# 10. UPDATED CLOSURE PLAN IMPLEMENTATION SCHEDULE

## 10.1 General

The updated closure implementation schedule presented herein reflects the changes in the final grading design and volume projections presented in Section 3.

## 10.2 Closure Process

Closure activities initially started on the slope of Disposal Area A in the Spring of 1994. However, some staff were released to the Bureau of Street Maintenance later that year due to budgetary reasons. The remaining staff were unable to continue with this slope closure. The closure of Lopez will commence again after July 1, 1996, when the last shipment of refuse is received.

The length of time for closure construction depends on the amount of staff available. Staff currently performing actual trash disposal activities will be reassigned to closure construction. Attrition rates will then be a factor, as that will determine remaining available staff for construction.

The closure construction process will be implemented in two phases: (i) Phase I will include the slopes of Disposal Areas A and B; and (ii) Phase II will include the remainder of the landfill. The schedules will delineate the estimated time frame to complete tasks relative to the closure activities associated with the slopes of Disposal Areas A and B (Phase I) and the decks of Disposal Areas A, B and Disposal Areas AB+ and C (Phase II).

# 10. UPDATED CLOSURE PLAN IMPLEMENTATION SCHEDULE

## 10.1 General

The updated closure implementation schedule presented herein reflects the changes in the final grading design and volume projections presented in Section 3.

## 10.2 Closure Process

Closure activities initially started on the slope of Disposal Area A in the Spring of 1994. However, some staff were released to the Bureau of Street Maintenance later that year due to budgetary reasons. The remaining staff were unable to continue with this slope closure. The closure of Lopez will commence again after July 1, 1996, when the last shipment of refuse is received.

The length of time for closure construction depends on the amount of staff available. Staff currently performing actual trash disposal activities will be reassigned to closure construction. Attrition rates will then be a factor, as that will determine remaining available staff for construction.

The closure construction process will be implemented in two phases: (i) Phase I will include the slopes of Disposal Areas A and B; and (ii) Phase II will include the remainder of the landfill. The schedules will delineate the estimated time frame to complete tasks relative to the closure activities associated with the slopes of Disposal Areas A and B (Phase I) and the decks of Disposal Areas A, B and Disposal Areas AB+ and C (Phase II).

### 10.2.1 Phase I Closure

As shown on Figure 10-1, closure construction activities for Phase I will recommence July 1, 1996 and will continue until December 1998.

Phase I closure shall start with abandonment of vertical gas wells followed by the rough grading of the slopes, which includes some clearing and grubbing. During preparation of the slopes for final cover placement, the final cover materials will be stockpiled on the decks of Disposal Areas A and B. Borrow material will continue to be transported and stockpiled on site during construction of the final cover, as necessary.

Placement of the final cover materials will begin after rough grading of the slopes has been initiated. It is anticipated that construction and testing of the final cover will continue until about February 1998. As placement of the final cover progresses, landfill gas control system modifications and surface-water drainage controls will be constructed.

The integration of the landfill gas control system with placement of the final cover will include lateral extensions of the horizontal landfill gas wells through the final cover and connection to the main landfill gas collection header. Existing vertical landfill gas wells will also be extended up through the final cover or abandoned and redrilled as necessary at the time of closure.

Landfill gas control system modifications will begin approximately one month before placement of final cover begins, and will be conducted one lift at a time to reduce as much as possible any down-time of the system. Landscaping and irrigation will begin after final cover placement has been initiated and will continue until December 1998. The estimated time for completion of the Phase I closure construction is 29 months.

All waste materials generated from closure construction, including, but not limited to, drill cuttings, waste from clearing and grubbing, corrugated metal pipe, concrete, masonry, excavated trash, spoils, asphalt, non-salvageable gas system pipe, and all other construction debris will be disposed of on-site in Disposal Area C. In addition, all non-recyclable refuse generated at the landfill during closure construction by, but not limited to, BOS personnel, consultants, and contractors, will also be disposed of on-site in Disposal Area C.

### 10.2.2 Phase II Closure

As shown on Figure 10-1, closure construction activities for Phase II will commence in March 1998 and will continue until July 2000. It is anticipated that the final cover borrow source for Phases I and II may be different. As a result, an additional test pad may be required for the new borrow source. Equipment mobilized for Phase I will also be used for Phase II.

Rough grading of the site can begin after the final lift of refuse has been placed. Final cover placement will begin with the slopes (upper and lower) of Disposal Area C. During preparation of the site for final cover placement, the final cover materials will be stockpiled on the deck in such a manner so as not to interfere with final cover placement, or it will be stockpiled in a nearby location. Borrow material will continue to be transported and stockpiled on site during construction of the final cover, as necessary.

Placement of the final cover materials will begin after rough grading of the site. Abandonment of landfill gas wells for the slopes, if necessary, will take place in conjunction with final cover placement. As placement of the final cover progresses, landfill gas control system modifications and surface-water drainage controls can be constructed. The construction of the surface-water drainage controls and landfill gas control system modifications will be completed just after completion of the final cover construction.

The integration of the landfill gas control system with placement of the final cover will include lateral extensions of the horizontal landfill gas wells through the final cover to the main landfill gas collection header. Existing vertical landfill gas wells at the time of closure will also be extended up through the final cover or abandoned and redrilled, if necessary. Landscaping and irrigation will begin prior to completion of the placement of final cover.

Waste materials generated during Phase II closure activities including, but not limited to, drill cuttings, waste from clearing and grubbing, corrugated metal pipe, concrete, masonry, excavated trash, spoils, asphalt, non-salvageable gas system pipe, and all other construction debris will be disposed of on-site in Disposal Area C. In addition, all non-recyclable refuse generated at the landfill during closure construction by, but not limited to, BOS personnel, consultants, and contractors, will also be disposed of on-site in Disposal Area C. Waste (construction debris and non-recyclable on-site refuse) generated after completion of closure construction will be disposed of off-site.

Upon completion of the tasks described for closure, existing site structures will be utilized for post-closure maintenance activities and potential post-closure end uses. The estimated time for completion of all Phase II closure construction is 28 months.

# 11. REVISED CONSTRUCTION QUALITY ASSURANCE PLAN

The construction quality assurance (CQA) plan presented in the PCP has been revised to reflect the changes in the final cover design presented in Section 2 of this amendment. The revised CQA Plan is presented in Appendix I and contains descriptions of:

- site and project control meetings;
- documentation requirements;
- VFPE geomembrane CQA;
- geotextile cushion CQA; and
- soils CQA, including construction of the low-permeability soil barrier layer.

## REFERENCES

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Vector Engineering, Inc., "*Slope Stability Analyses for the Disposal Area C at the Lopez Canyon Landfill*," prepared for Law/Crandall, Inc., February 1993.

# TABLE - SUMMARY OF REVISIONS
# CROSS-REFERENCE FOR THE AMENDMENTS TO FCP AND FPCMP
# LOPEZ CANYON SANITARY LANDFILL

| SECTIONS, DRAWINGS, DETAILS TO BE SUBSTITUTED/AMENDED | | SUBSTITUTED/ AMENDED BY | SECTIONS, DRAWINGS, DETAILS WHICH SUBSTITUTE/AMEND THE ORIGINAL ONES | | COMMENTS |
|---|---|---|---|---|---|
| Section 3 | "Final Cover" of Volume I of FCP | Amended by | Section 2 | "Revised Final Cover Design" of the Replacement to Volume IV of the FCP | Includes use of geosynthetics in Area C cover. |
| Section 4 | "Final Grading" (with the exception of Subsections 4.7 and 4.8) Volume I of the FCP | Amended by | Section 3 | "Revised Final Grading Design" of the Replacement to Volume IV of the FCP | Revised final grading presented for Deck Areas A, B, AB+, and C, and Slope Areas AB+ and C to address closure in 1996. |
| Section 4.7 | "Erosion Potential and Soil Loss Analysis" of Volume I of the FCP | Amended by | Section 6 | "Revised Soil Loss Estimates" of the Replacement to Volume IV of the FCP | Revised soil loss estimates presented as a result of revised grading. |
| Section 4.8 | "Settlement Analyses" of Volume I of the FCP | Amended by | Section 4 | "Revised Post-Closure Settlements" of the Replacement to Volume IV of the FCP | Revised settlement in Area C due to revised grading. |
| Section 5 | "Final Drainage" of Volume I of the FCP | Amended by | Section 5 | "Revised Surface-Water Drainage System" of the Replacement to Volume IV of the FCP | Describes revised drainage system resulting from modified grading. |
| Section 6 | "Landfill Gas Control System" of Volume I of the FCP | Amended by | Section 7 | "Revised Landfill Gas Control System" of the Replacement to Volume IV of the FCP | Describes revised gas system resulting from modified grading. |
| Section 8 | "Landscaping and Irrigation" of Volume I of the FCP | Amended by | Section 8 | "Revised Landscaping and Irrigation Design" of the Replacement to Volume IV of the FCP | Describes the revised landscaping and irrigation design resulting from the modified grading. |
| Drawings | "Landscaping and Irrigation Drawings" of Volume I of the FCP | Amended by | Figures 8-1 through 8-17 | "Revised Landscaping and Irrigation Drawings" of the Replacement to Volume IV of the FCP | Presents the revised landscaping and irrigation drawings resulting from the modified grading. |
| Section 10 | "Closure Implementation" (with the exception of Subsection 10.3.4) of Volume I of the FCP | Amended by | Section 10 | "Updated Closure Implementation Schedule" of the Replacement to Volume IV of the FCP | Updates the previous schedule. |
| Section 10.3.4 | "QA/QC for Cover Placement" of Volume I of the FCP | Amended by | Section 11 | "Revised Construction Quality Assure Plan" of the Replacement to Volume IV of the FCP | Addresses the addition of geosynthetics in the final cover. |
| Section 11 | "Cost Estimate" of Volume I of the FCP | Amended by | Section 9 | "Revised Closure Cost Estimate" of the Replacement to Volume IV of the FCP | See the revised cost worksheet presented herein for details. |
| Drawing 1 | "Revised Ground-Water Monitoring Network" of Volume II of the FPCMP | Amended by | Appendix C | "Updated Ground-Water Monitoring Network" of the Replacement to Volume IV of the FCP | Presents the addition of new ground water wells. |

# TABLE - SUMMARY OF REVISIONS (continued)
# CROSS-REFERENCE FOR THE AMENDMENTS TO FCP AND FPCMP
# LOPEZ CANYON SANITARY LANDFILL

| SECTIONS, DRAWINGS, DETAILS TO BE SUBSTITUTED/AMENDED | | SUBSTITUTED/ AMENDED BY | SECTIONS, DRAWINGS, DETAILS WHICH SUBSTITUTE/AMEND THE ORIGINAL ONES | | COMMENTS |
|---|---|---|---|---|---|
| Section 4 | "Revised Post-Closure Maintenance Cost Estimate" of Volume II of the FPCMP | Amended by | Appendix E | "Revised Post-Closure Maintenance Cost Estimate" of the Replacement to Volume IV of the FCP | See the revised cost worksheet presented herein for details. |
| Figure A.8.1, of Volume I of the FCP | | Amended by | Figure 4-2 and Drawing No. 3 | "Revised Settlement Monument Locations" of the Replacement to Volume IV of the FCP | Indicates revised monument locations resulting from modified grading. |
| Drawing | "Site Facilities Map" of Volume III of the FCP | Amended by | Appendix A | "Updated Site Facilities Map" of the Replacement to Volume IV of the FCP | Updated Site Facilities Map reflects previous changes. |
| Drawings | "Site Radius Maps" of Volume III of the FCP | Amended by | Appendix B | "Updated Site Radius Maps" of the Replacement to Volume IV of the FCP | Updated Site Radius Maps reflect previous changes. |
| Drawings | "Proposed Final Grading Plan" of Volume III of the FCP | Amended by | Figure 3-1 and Drawing No. 1 | "Revised Final Grading and Surface -Water Drainage Plan" of the Replacement to Volume IV of the FCP | Presents revised final grading and drainage for Deck Areas A, B, AB+, and C, and Slope Areas AB+ and C. |
| Drawing | "Final Elevation Gas Control System-Disposal Area C" of Volume III of the FCP | Amended by | Drawing No. 4 | "Revised Landfill Gas Control System Layout" of the Replacement to Volume IV of the FCP | Presents revised gas control system to reflect changes in grading. |
| Figure 4-11 | "50-Year Elevation Contours-Disposal Area C" of Volume III of the FCP | Amended by | Figure 4-1 and Drawing No. 2 | "Revised Post-Closure Settlement Contours" of the Replacement to Volume IV of the FCP | Presents revised settlement contours for Areas A, B, AB+, and C. |
| Appendix K | "Initial Cost Estimate Worksheet", Volume II of the FCP | Amended by | Appendix F | "Updated Closure and Post-Closure Monitoring Cost Estimates - Revised Initial Cost Estimate Worksheet" of the Replacement to Volume IV of the FCP | Revised costs reflect previous changes. |
| Table 4-1 | "Revised Summary of Post Closure Maintenance Cost Estimate", Amendment to Partial Post-Closure Maintenance Plan, Volume II of II | Amended by | Appendix F | "Updated Closure and Post-Closure Monitoring Cost Estimates - Revised Initial Cost Estimate Worksheet" of the Replacement to Volume IV of the FCP | Revised costs reflect previous changes. |
| Figure 1-1 | "Revised Final Grading and Surface Water Drainage Plan" of Volume II of the FPCMP | Amended by | Appendix D | "Revised Final Grading and Surface Water Drainage Plan" of the Replacement to Volume IV of the FCP | Presents revised final grading and surface water drainage for the Deck Areas A, B, AB+, and C, and for the Slope Areas AB+ and C. |
| Figure 3-1 | "Revised Ground-Water Monitoring Network" of Volume II of the FPCMP | Amended by | Appendix D | "Revised Ground-Water Monitoring Network" of the Replacement to Volume IV of the FCP | Presents the addition of new ground-water wells. |

# T E 6-1

## REVISED SOIL LOSS ESTIMATES
## AMENDMENT TO PARTIAL CLOSURE PLAN
## LOPEZ CANYON SANITARY LANDFILL

| STUDY ZONE | | SLOPE | | QUANTIFIABLE FACTORS[1] | | | | | ANNUAL SOIL LOSS | |
|---|---|---|---|---|---|---|---|---|---|---|
| LABEL (-) | AREA acres (hectares) | INCLINAT. (%) | LENGTH feet (m) | R (-) | K tons/acre (metric tons/hectare) | LS (-) | C (-) | P (-) | AVERAGE[2] tons/acre (metric tons/hectare) | TOTAL tons (metric tons) |
| 1 | 4.44 | 235 | 36 | 50 | 0.28 (0.63) | 16.6 | 0.01 | 1 | 2.32 (5.23) | 10.31 (23.19) |
| 2 | 4.81 | 186 | 36 | 50 | 0.28 (0.63) | 14.2 | 0.01 | 1 | 1.99 (4.47) | 9.57 (21.52) |
| 3 | 2.53 | 141 | 33 | 50 | 0.28 (0.63) | 13 | 0.01 | 1 | 1.82 (4.10) | 4.60 (10.34) |
| 4 | 0.60 | 414 | 3.3 | 50 | 0.28 (0.63) | 0.53 | 0.01 | 1 | 0.07 (0.17) | 0.04 (0.10) |
| 5 | 11.12 | 398 | 3.3 | 50 | 0.28 (0.63) | 0.52 | 0.01 | 1 | 0.07 (0.16) | 0.81 (0.82) |
| 6 | 4.75 | 380 | 3.3 | 50 | 0.28 (0.63) | 0.46 | 0.01 | 1 | 0.06 (0.14) | 0.31 (0.69) |
| 7 | 5.87 | 260 | 33 | 50 | 0.28 (0.63) | 15.8 | 0.01 | 1 | 2.21 (4.98) | 12.97 (29.119) |
| 8 | 2.72 | 300 | 33 | 50 | 0.28 (0.63) | 16.4 | 0.01 | 1 | 2.30 (5.17) | 6.255 (14.07) |
| 9 | 3.20 | 220 | 33 | 50 | 0.28 (0.63) | 12 | 0.01 | 1 | 1.68 (3.78) | 5.377 (12.10) |
| 10 | 4.79 | 300 | 33 | 50 | 0.28 (0.63) | 16.4 | 0.01 | 1 | 2.30 (5.17) | 10.996 (24.74) |
| 11 | 4.31 | 319 | 33 | 50 | 0.28 (0.63) | 16.8 | 0.01 | 1 | 2.35 (5.29) | 10.141 (22.82) |
| 12 | 4.10 | 1230 | 3 | 50 | 0.28 (0.63) | 0.58 | 0.01 | 1 | 0.08 (0.18) | 0.333 (0.75) |
| 13 | 9.94 | 900 | 3 | 50 | 0.28 (0.63) | 0.55 | 0.01 | 1 | 0.08 (0.17) | 0.766 (1.72) |

# REVISED SOIL LOSS ESTIMATES
# AMENDMENT TO PARTIAL CLOSURE PLAN
# LOPEZ CANYON SANITARY LANDFILL

| STUDY ZONE | | SLOPE | | QUANTIFIABLE FACTORS[1] | | | | | ANNUAL SOIL LOSS | |
|---|---|---|---|---|---|---|---|---|---|---|
| LABEL (-) | AREA acres (hectares) | INCLINAT. (%) | LENGTH feet (m) | R (-) | K tons/acre (metric tons/hectare) | LS (-) | C (-) | P (-) | AVERAGE[2] tons/acre (metric tons/hectare) | TOTAL tons (metric tons) |
| 14 | 10.43 | 1000 | 3 | 50 | 0.28 (0.63) | 0.57 | 0.01 | 1 | 0.08 (0.18) | 0.833 (6.87) |
| 15 | 4.76 | 385 | 3.3 | 50 | 0.28 (0.63) | 0.46 | 0.01 | 1 | 0.06 (0.14) | 0.306 (0.69) |
| 16 | 0.29 | 75 | 50 | 50 | 0.28 (0.63) | 15 | 0.01 | 1 | 2.10 (4.73) | 0.612 (1.38) |
| 17 | 9.06 | 328 | 5 | 50 | 0.28 (0.63) | 0.99 | 0.01 | 1 | 0.14 (0.32) | 1.255 (2.82) |
| 18 | 5.51 | 700 | 5 | 50 | 0.28 (0.63) | 1.4 | 0.01 | 1 | 0.20 (0.44) | 1.080 (2.43) |
| 19 | 6.92 | 550 | 5 | 50 | 0.28 (0.63) | 1.25 | 0.01 | 1 | 0.18 (0.39) | 1.211 (2.72) |
| 20 | 2.71 | 120 | 33 | 50 | 0.28 (0.63) | 10.3 | 0.01 | 1 | 1.44 (3.24) | 3.901 (8.78) |

Notes: [1]The factor are as follows: R, Rainfall and runoff erosivity i ndex; K, Soil erodibility factor; LS, Slope length/Slope steepness factor; C, Cover - management factor; P, Practice factor.
[2]Average annual soil loss, A, calculated as: A = R*K*LS*C*P.

| | |
|---|---|
| TONS PER ACRE PER YEAR: | 21.53 |
| (metric tons/hectare) | (48.45) |
| TONS PER ACRE PER 30 YEARS: | 646.002 |
| (metric tons) | (1,453.5) |
| INCHES: | 3.09 |
| (mm) | (79.4) |

## TABLE 8-1

## REVEGETATION PLANT SPECIES

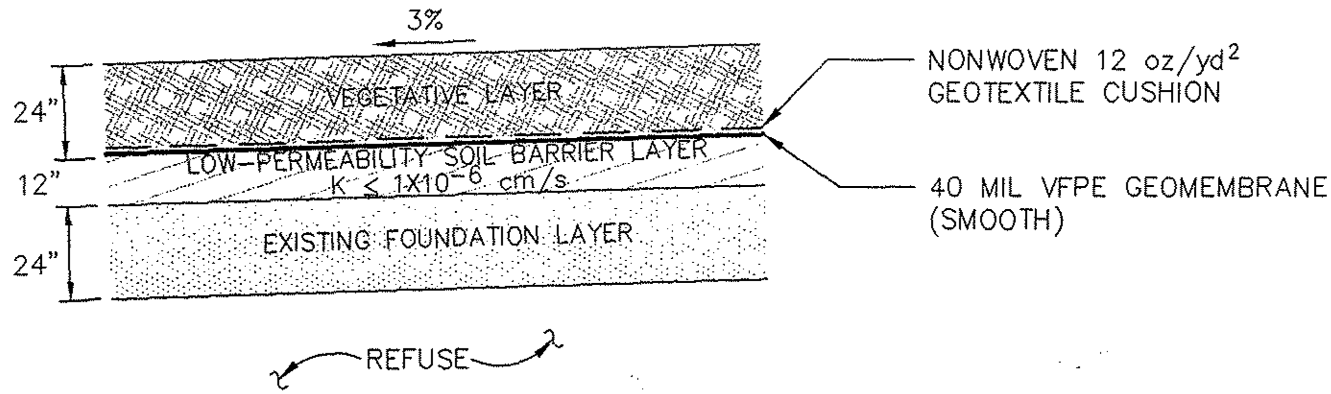
| DECK AREA SEED MIX | | REMARKS |
|---|---|---|
| Aristida spp. | | |
| Festuca megalura | Zorro Fescue | California Native |
| Stipa cernua | Nodding Stipa | California Native |
| Stipa pulchra | Purple Stipa | California Native |
| Melica califomica | Melic | California Native |
| Poa scrabella | Pine Bluegrass | California Native |
| **SLOPE AREA SEED MIX - SOUTH / SOUTHWEST SLOPES** | | |
| Aristida spp. | | |
| Festuca megalura | Zorro Fescue | California Native |
| Stipa cernua | Nodding Stipa | California Native |
| Stipa pulchra | Purple Stipa | California Native |
| Melica califomica | Melic | California Native |
| Poa scrabella | Pine Bluegrass | California Native |
| Encelia califomica | Bush Sunflower | California Native |
| Lotus scoparius | Deerweed | California Native |
| **SLOPE AREAS SEED MIX - NORTH / NORTHEAST SLOPES** | | |
| Artemisia califomica | Sagebrush | California Native |
| Atriplex semibaccata | Saltbrush | |
| Baccharius pilularis | Coyote Bush | |
| Encelia california | Bush Sunflower | California Native |
| Eriogonum giganticum | St. Catherine's Lace | California Native |
| Eriogonum cinerium | Ashy Leaf Buckwheat | California Native |
| Eschscholzia california | Poppy | California Native |
| Lotus scoparius | Deerweed | California Native |
| Lupinus succulentus | Lupine | California Native |
| Salvia apiana | White Sage | California Native |
| Salvia leucophylla | Purple Sage | California Native |
| Salvia mellifera | Black Sage | California Native |
| Stipa pulchra | Purple Stipa | California Native |
| Stipa cernua | Nodding Stipa | California Native |
| Melica califomica | California Metic | California Native |
| Melica imperfecta | Coastrange Melic | California Native |
| Bromus carinatus | California Brome | California Native |
| Lymus glacus | Blue Wildrye | California Native |
| **DISPOSAL AREA A - TREES AND SHRUBS** | | |
| Heteromeles arbutifolia | Toyon | 1 to 15 gallon |
| prunus Ilicifolia | Hollyleaf Cherry | 1 to 15 gallon |
| Quercus dumosa | Scrub Oak | 1 to 15 gallon |
| Rhamnus alaternafolius | Coffeeberry | 1 to 15 gallon |
| Rhus integrifolia | Lemonade Berry | 1 to 15 gallon |
| Rhus ovata | Sugar Bush | 1 to 15 gallon |

## TABLE 9-1

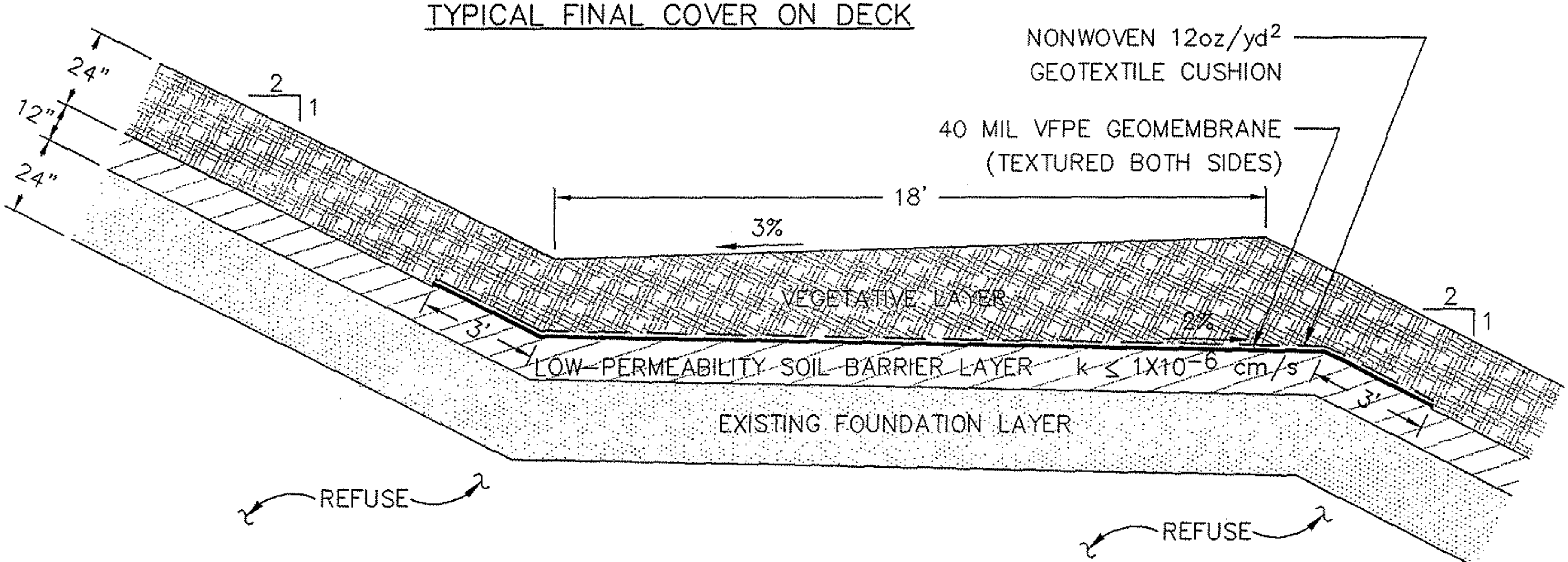
## REVISED SUMMARY OF CLOSURE COST ESTIMATE
## PARTIAL CLOSURE PLAN AMENDMENT
## LOPEZ CANYON SANITARY LANDFILL

| CLOSURE FEATURE | ESTIMATED COST (1995 Dollars) |
|---|---|
| Final Cover Construction* | $ 5,407,249 |
| Revegetation/Irrigation* | $1,821,823 |
| Surface-Water Drainage System Installation* | $829,870 |
| Site Security Installation | $33,000 |
| Other (landfill gas system modifications, ground-water monitoring modifications, vadose zone monitoring modifications, and construction management) | $6,523,883 |
| I. Subtotal | $14,615,825 |
| II. Contingency Costs (20 percent) | $2,923,165 |
| III. Total Closure Costs | $17,538,990 |

Note: * Cost estimate features changed from the PCP.




TYPICAL FINAL COVER ON DECK



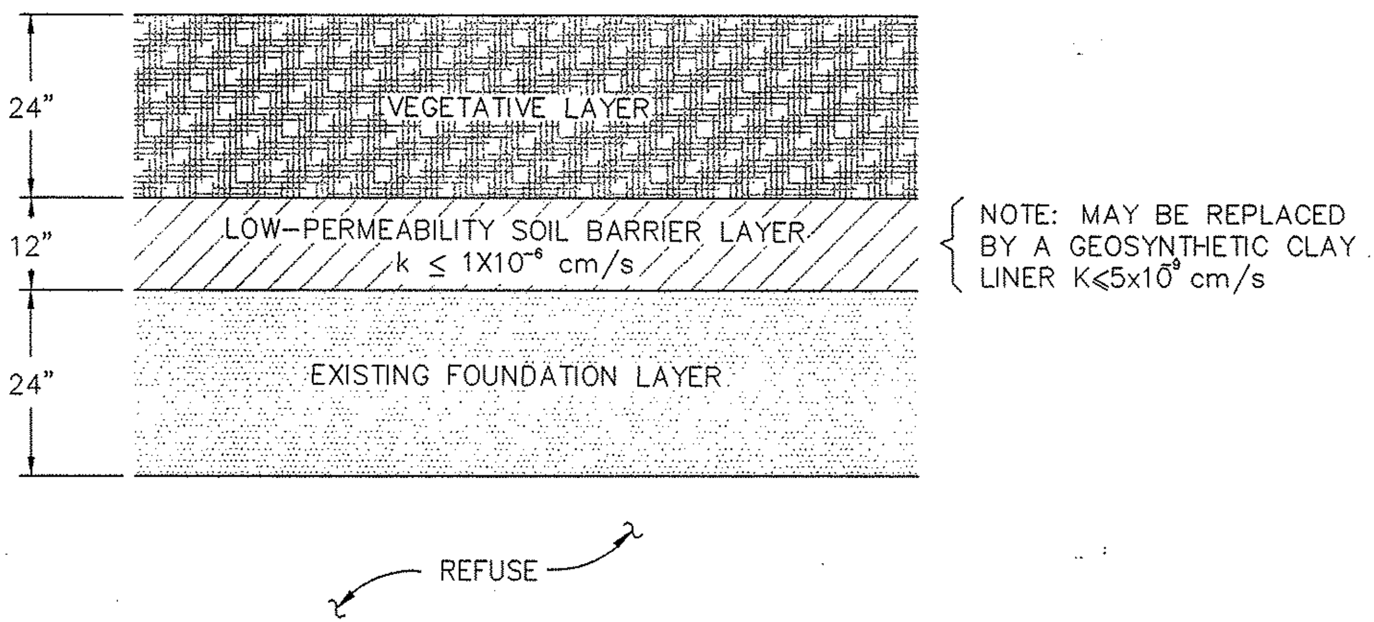

TYPICAL FINAL COVER ON BENCH

APPROXIMATE SCALE: 1" = 2'

GEOSYNTEC CONSULTANTS

| FINAL COVER ON DECK/BENCH AREAS<br>DISPOSAL AREA C<br>LOPEZ CANYON SANITARY LANDFILL | FIGURE NO. | 2-1 |
|---|---|---|
| | PROJECT NO. | CE4100-04 |
| | DATE: | DEC-07-93 |

DWG: 4100F031 199606040821 LP

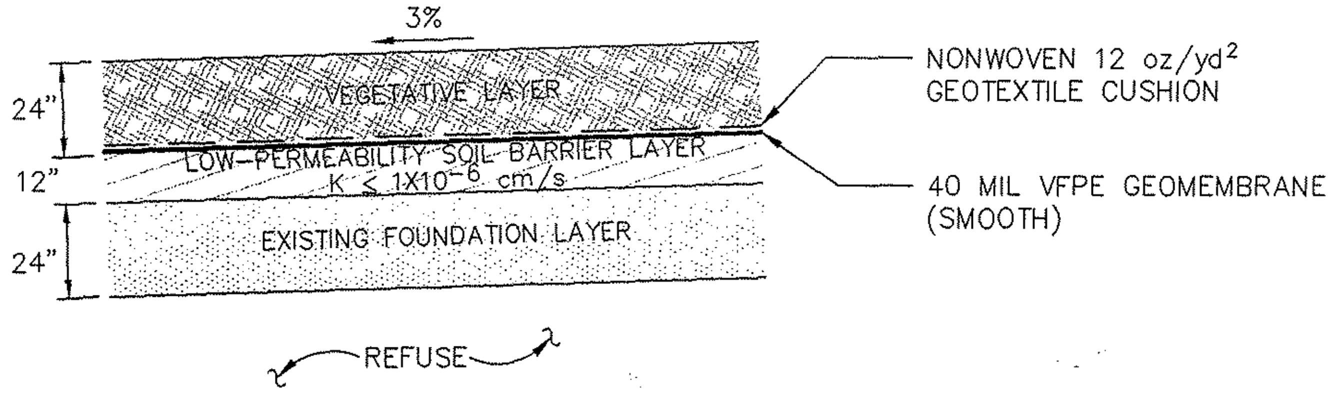



MODIFIED 02-29-96
TO REMOVE GEOTEXTILE

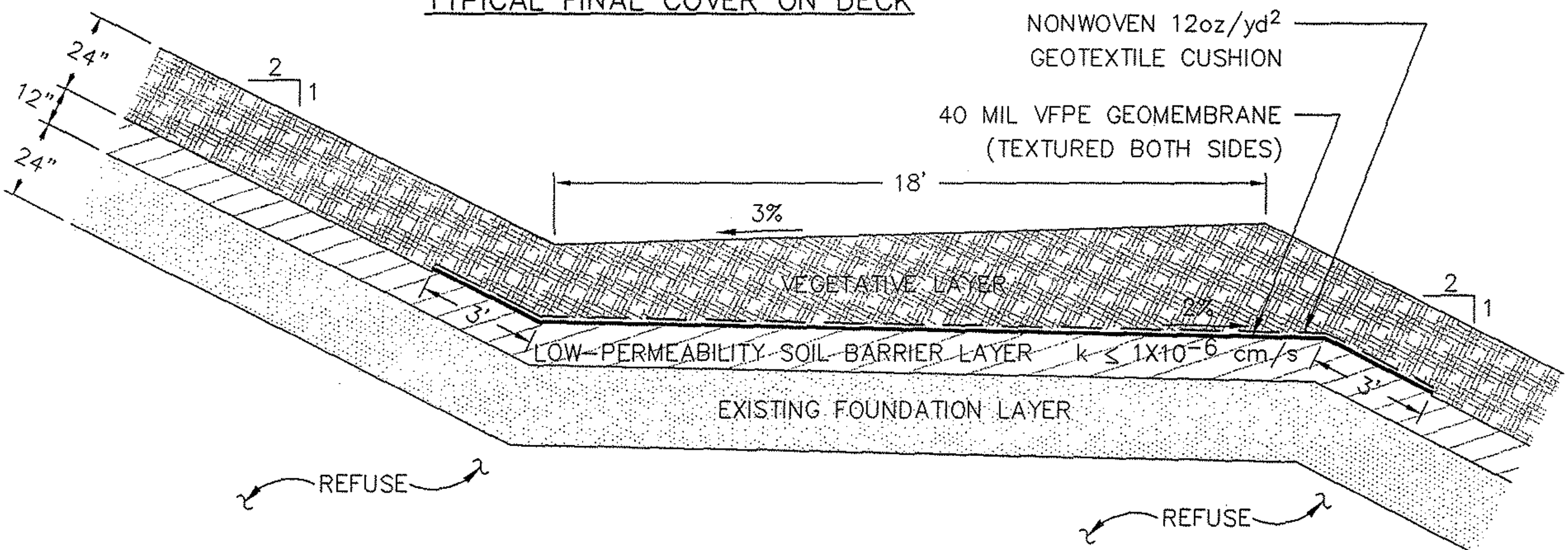
GEOSYNTEC CONSULTANTS

| | | |
|---|---|---|
| FINAL COVER ON DECK AREAS<br>DISPOSAL AREA A, B, AND AB+<br>LOPEZ CANYON SANITARY LANDFILL | FIGURE NO. | 2-2 |
| | PROJECT NO. | CE4100-04 |
| | DATE: | MAR-21-96 |

DWG: 4100F031 199603221103 AB




TYPICAL FINAL COVER ON DECK



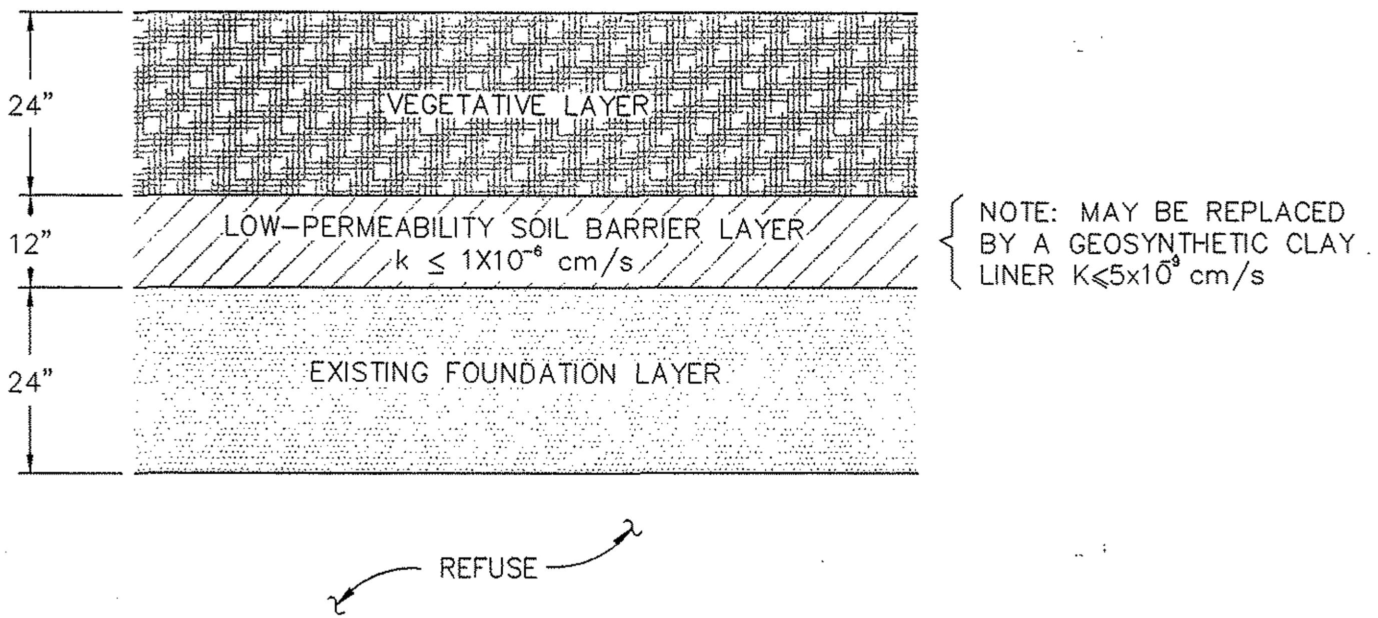

TYPICAL FINAL COVER ON BENCH

APPROXIMATE SCALE: 1" = 2'

GEOSYNTEC CONSULTANTS

| | | |
|---|---|---|
| FINAL COVER ON DECK/BENCH AREAS<br>DISPOSAL AREA C<br>LOPEZ CANYON SANITARY LANDFILL | FIGURE NO. | 2-1 |
| | PROJECT NO. | CE4100-04 |
| | DATE: | DEC-07-93 |

DWG: 4100F031 199606040821 LP



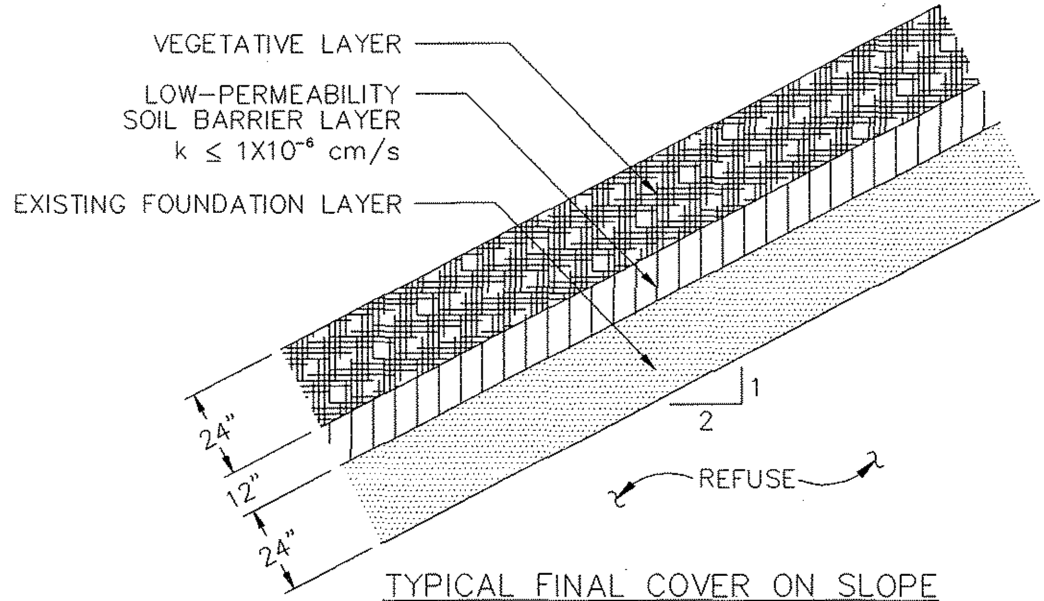

MODIFIED 02–29–96
TO REMOVE GEOTEXTILE

GEOSYNTEC CONSULTANTS

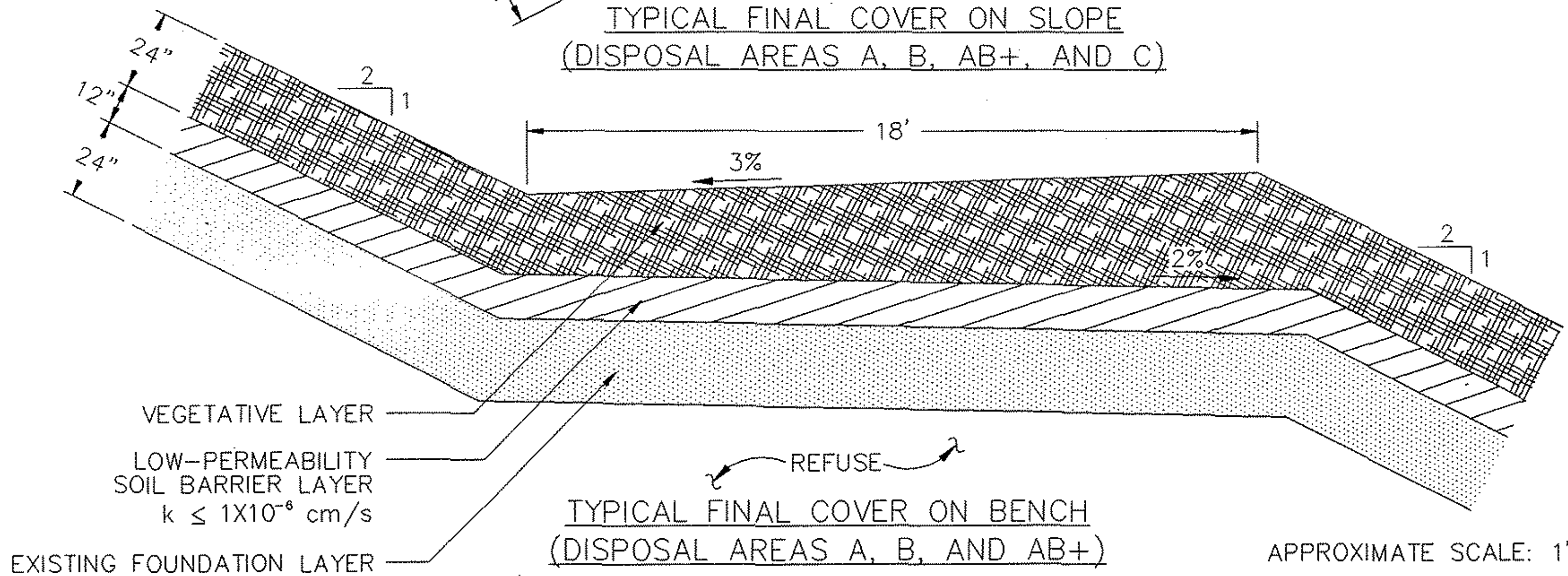
FINAL COVER ON DECK AREAS
DISPOSAL AREA A, B, AND AB+
LOPEZ CANYON SANITARY LANDFILL

| | |
|---|---|
| FIGURE NO. | 2–2 |
| PROJECT NO. | CE4100–04 |
| DATE: | MAR–21–96 |

DWG: 4100F031 199603221103 AB




TYPICAL FINAL COVER ON SLOPE
(DISPOSAL AREAS A, B, AB+, AND C)




TYPICAL FINAL COVER ON BENCH
(DISPOSAL AREAS A, B, AND AB+)

APPROXIMATE SCALE: 1" = 2'

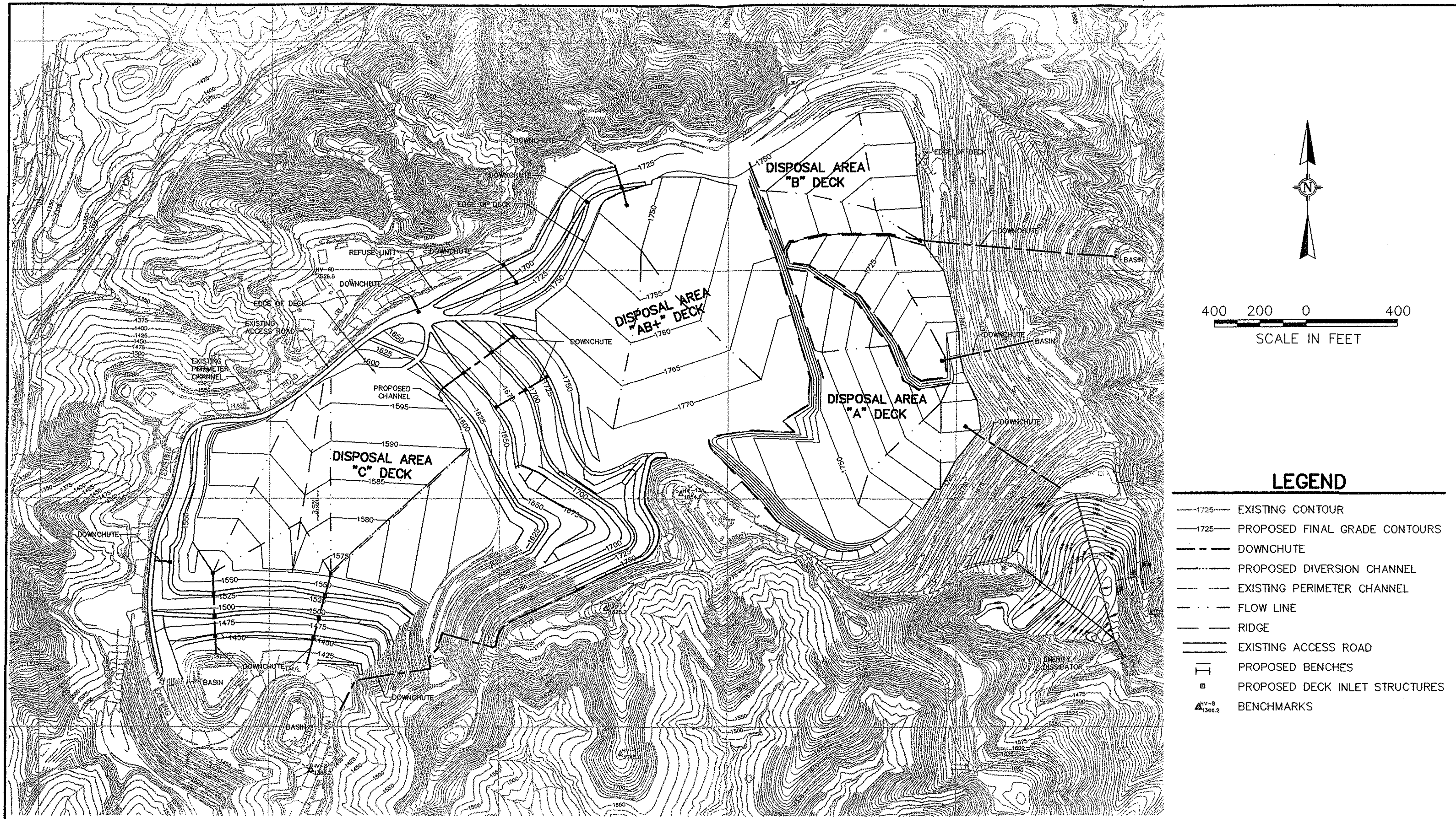
GEOSYNTEC CONSULTANTS

FINAL COVER ON SLOPE/BENCH AREAS

LOPEZ CANYON SANITARY LANDFILL

| | |
|---|---|
| FIGURE NO. | 2-3 |
| PROJECT NO. | CE4100-04 |
| DATE: | APR-25-96 |

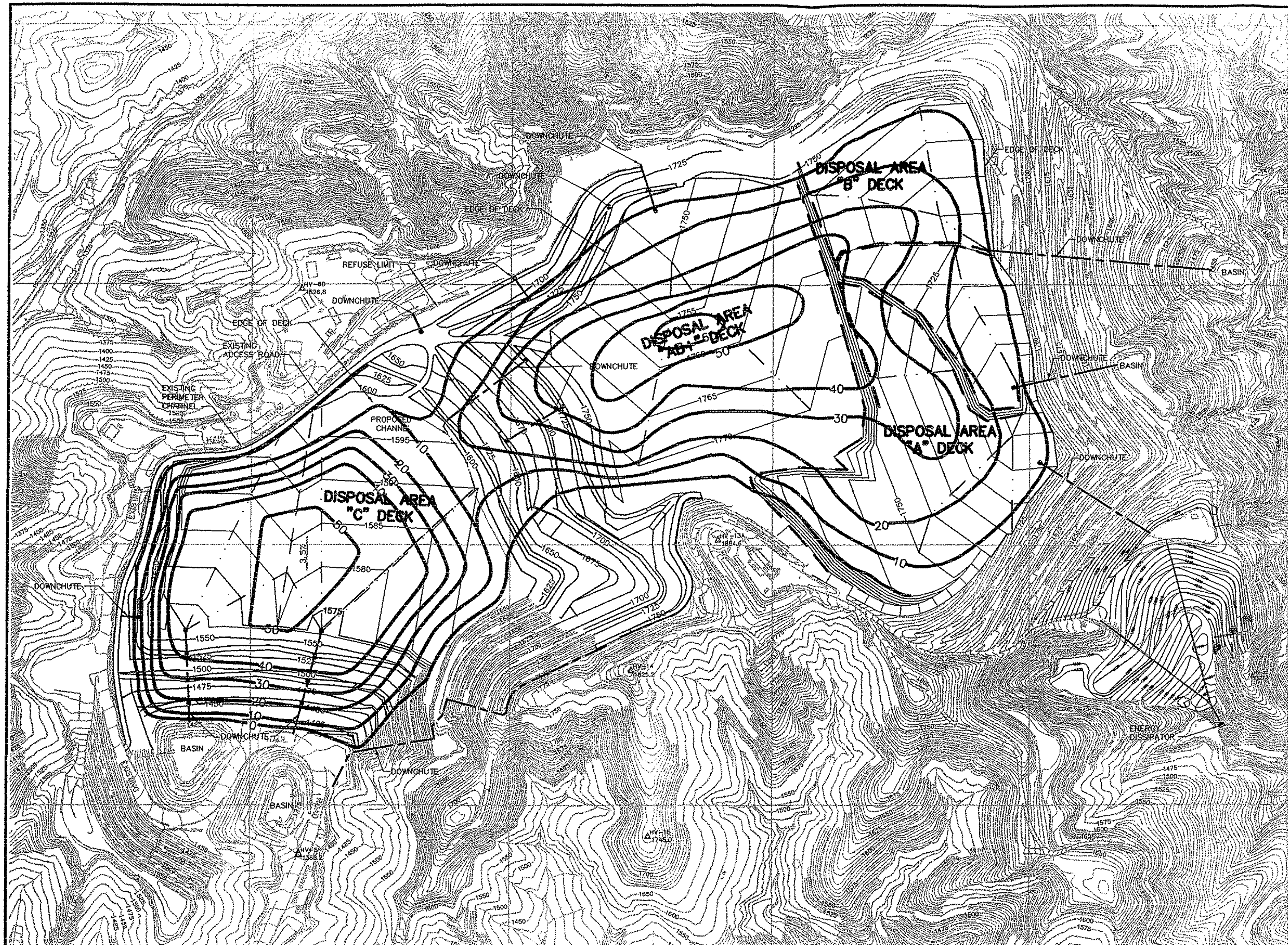
DWG: 4100F401 199604261017 LP




GEOSYNTEC CONSULTANTS

| | |
|---|---|
| REVISED FINAL GRADING AND SURFACE WATER DRAINAGE PLAN DISPOSAL AREA A, B, AB+, AND C LOPEZ CANYON SANITARY LANDFILL LOS ANGELES, CALIFORNIA | FIGURE NO. 3-1 |
| | PROJECT NO. CE4100-04 |
| | DATE: APR-25-96 |

DWG: 4100F114 199604261125 LP




## LEGEND

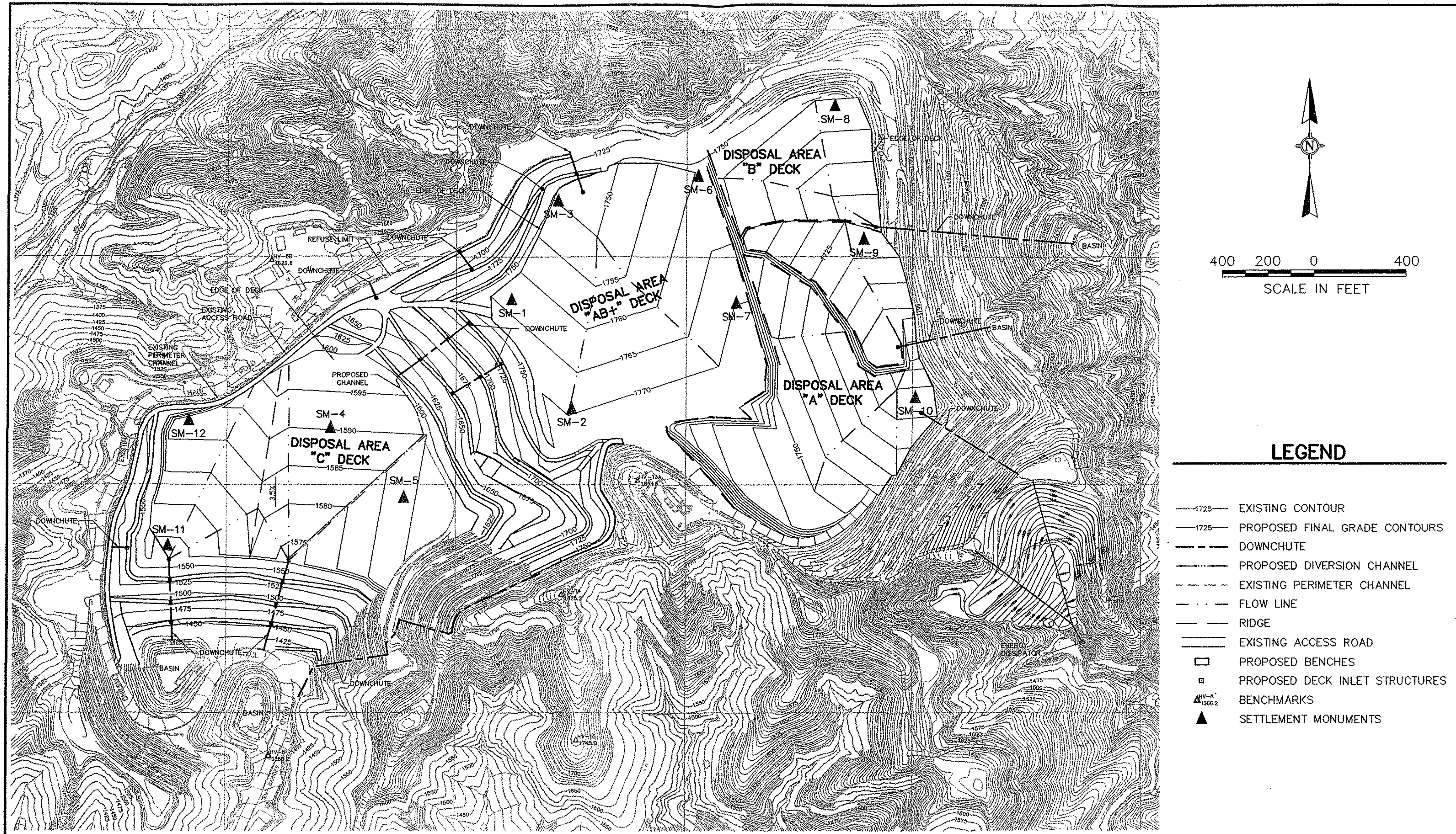
| | |
|---|---|
| 1725 | EXISTING CONTOUR |
| 1725 | PROPOSED FINAL GRADE CONTOURS |
| | DOWNCHUTE |
| | PROPOSED DIVERSION CHANNEL |
| | EXISTING PERIMETER CHANNEL |
| | FLOW LINE |
| | RIDGE |
| | EXISTING ACCESS ROAD |
| | PROPOSED BENCHES |
| | PROPOSED DECK INLET STRUCTURES |
| HV-8 1366.2 | BENCHMARKS |
| 10 | POST-CLOSURE SETTLEMENT CONTOURS (FEET) |

GeoSyntec Consultants

REVISED POST-CLOSURE SETTLEMENT CONTOURS
LOPEZ CANYON SANITARY LANDFILL
LOS ANGELES, CALIFORNIA

FIGURE NO. 4-1
PROJECT NO. CE4100-04
DATE: APR-26-96

DWG: 4100F113 199605151641 AB

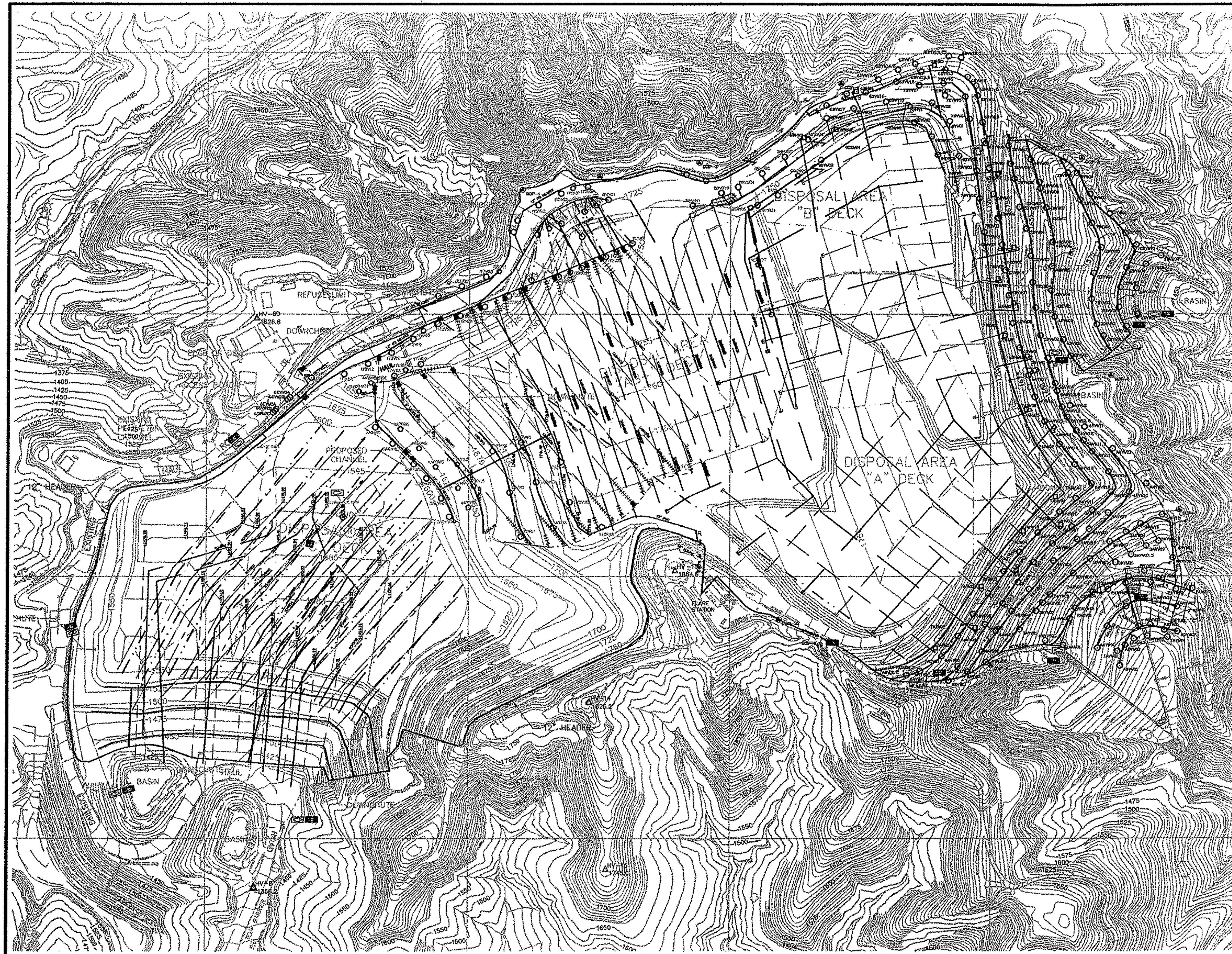



GeoSyntec Consultants

REVISED SETTLEMENT MONUMENT LOCATIONS
LOPEZ CANYON SANITARY LANDFILL
LOS ANGELES, CALIFORNIA

| | |
|---|---|
| FIGURE NO. | 4-2 |
| PROJECT NO. | CE4100-04 |
| DATE: | APR-25-96 |

DWG: 4100F112 199604261101 LP




## LEGEND

- EXISTING CONTOUR
- PROPOSED FINAL GRADE CONTOURS
- DOWNCHUTE
- PROPOSED DIVERSION CHANNEL
- EXISTING PERIMETER CHANNEL
- FLOW LINE
- RIDGE
- EXISTING ACCESS ROAD
- PROPOSED BENCHES
- PROPOSED DECK INLET STRUCTURES
- BENCHMARKS
- VALVE
- SLOPE OR GROUND PENETRATION BY PIPE
- HEADER
- HORIZ. COLLECTOR NO PERFORATION
- HORIZ. COLLECTOR PERFORATED
- UNDERGROUND WELL EXTENSION TO HEADER (UNDERGROUND, GRIDS 93 TO 96)
- UNDERGROUND WELL EXTENSION TO HEADER (UNDERGROUND GRIDS 93 TO 96)
- COLLECTOR CAP
- ( U. N. O. ) UNLESS NOTED OTHERWISE
- 2AAW08 GAS WELL I.D.
- HORIZONTAL WELL
- SHALLOW VERTICAL WELL
- DEEP VERTICAL WELL
- GAS COLLECTION INDICATOR PROBES (GCIP)
- CONDENSATE TANK
- CONDENSATE PUMP AND PUMP MODEL NUMBER
- LIFT 1CH HORIZONTAL WELLS
- LIFT 2CH HORIZONTAL WELLS
- LIFT 3CH HORIZONTAL WELLS
- LIFT 4CH HORIZONTAL WELLS
- LIFT 5CH HORIZONTAL WELLS

400 200 0 400 800

SCALE IN FEET

GeoSyntec Consultants

REVISED LANDFILL GAS COLLECTION SYSTEM LAYOUT
LOPEZ CANYON SANITARY LANDFILL
LOS ANGELES, CALIFORNIA

| | |
|---|---|
| FIGURE NO. | 7-1 |
| PROJECT NO. | CE4100-06 |
| DATE: | JUN-4-96 |

DWG: 4100-630 199606041552 AB

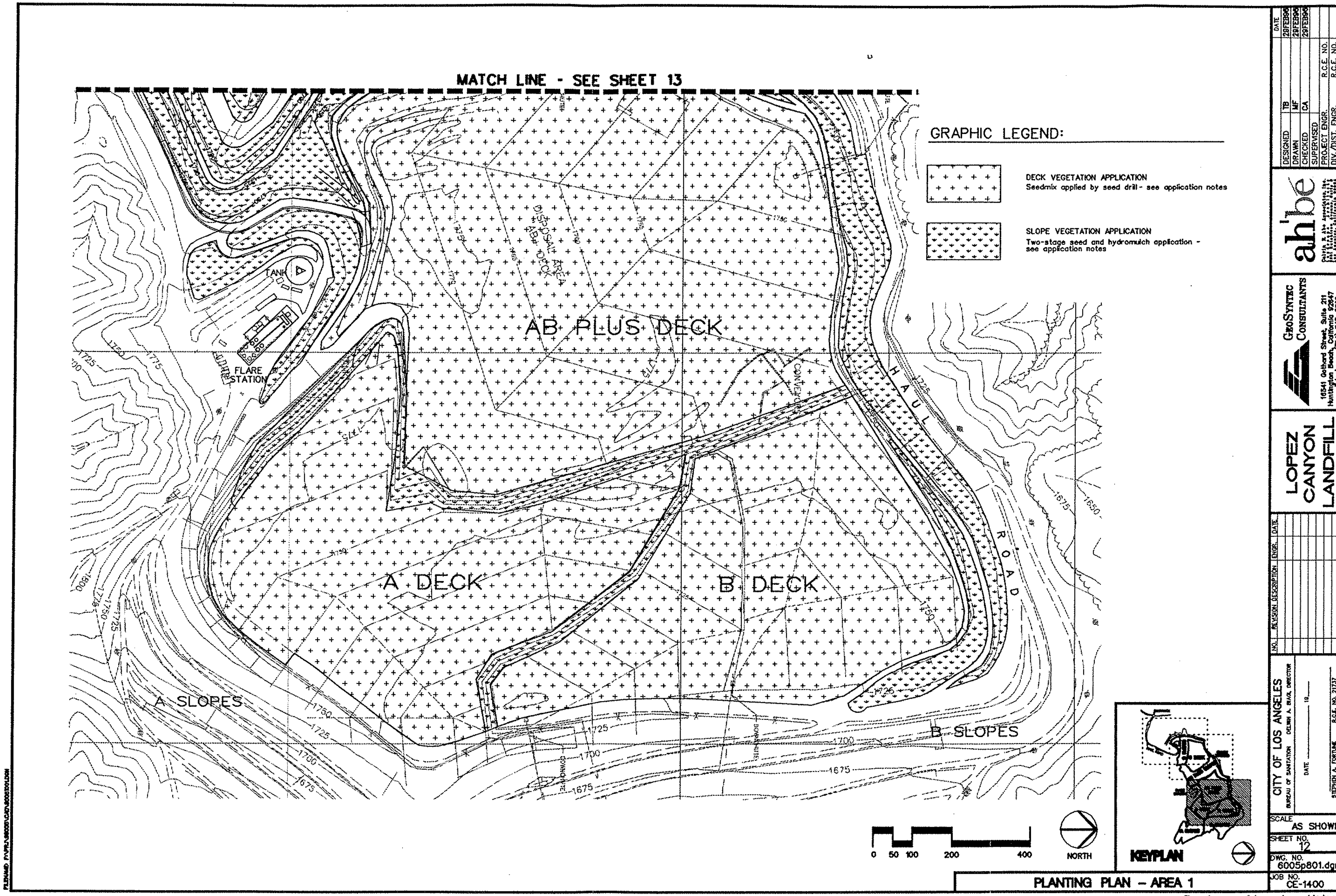
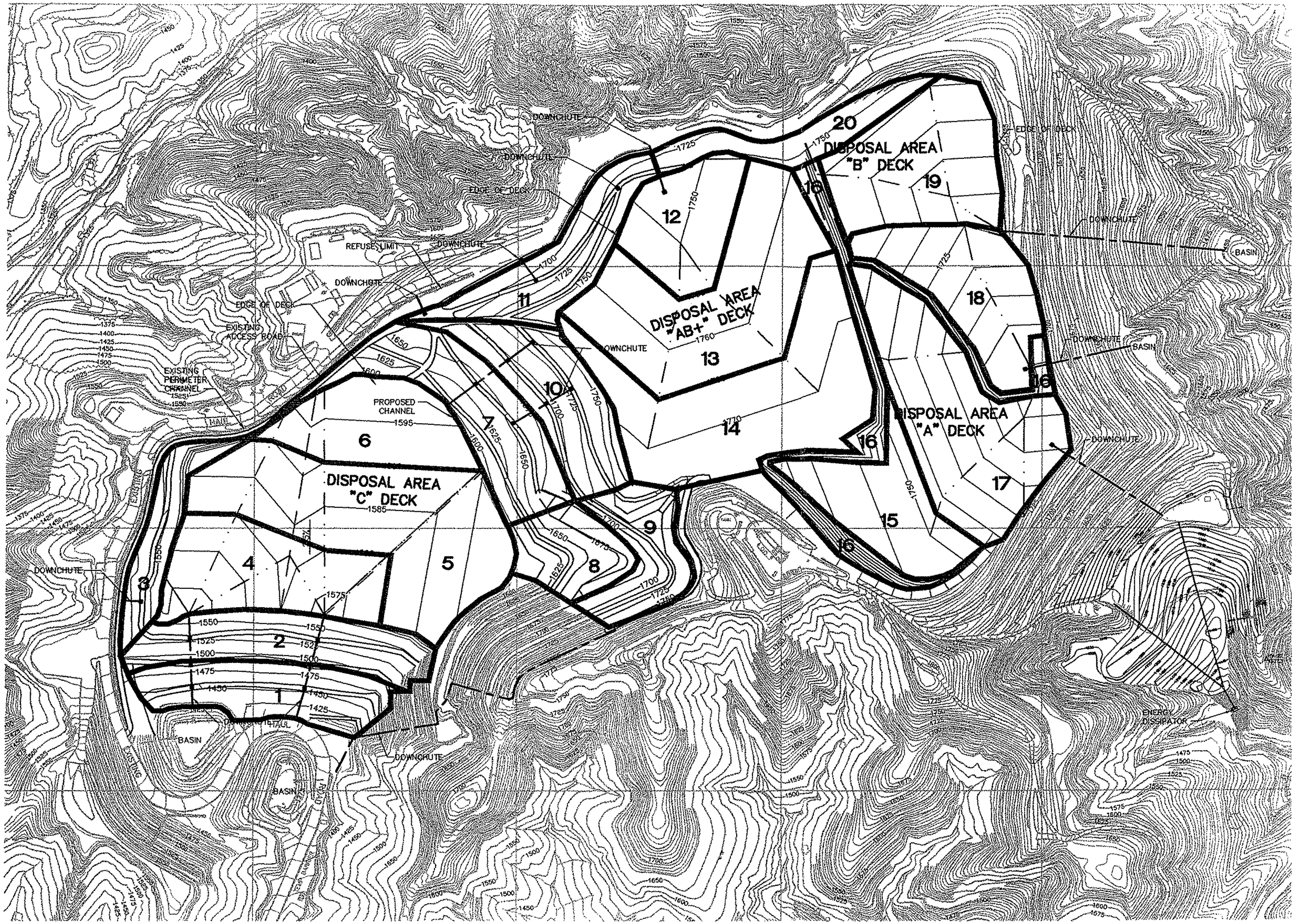



FIGURE 8-1

These plans are preliminary and are not to be used for bidding or construction until signed and approved.




N

400 200 0 400

SCALE IN FEET

## LEGEND

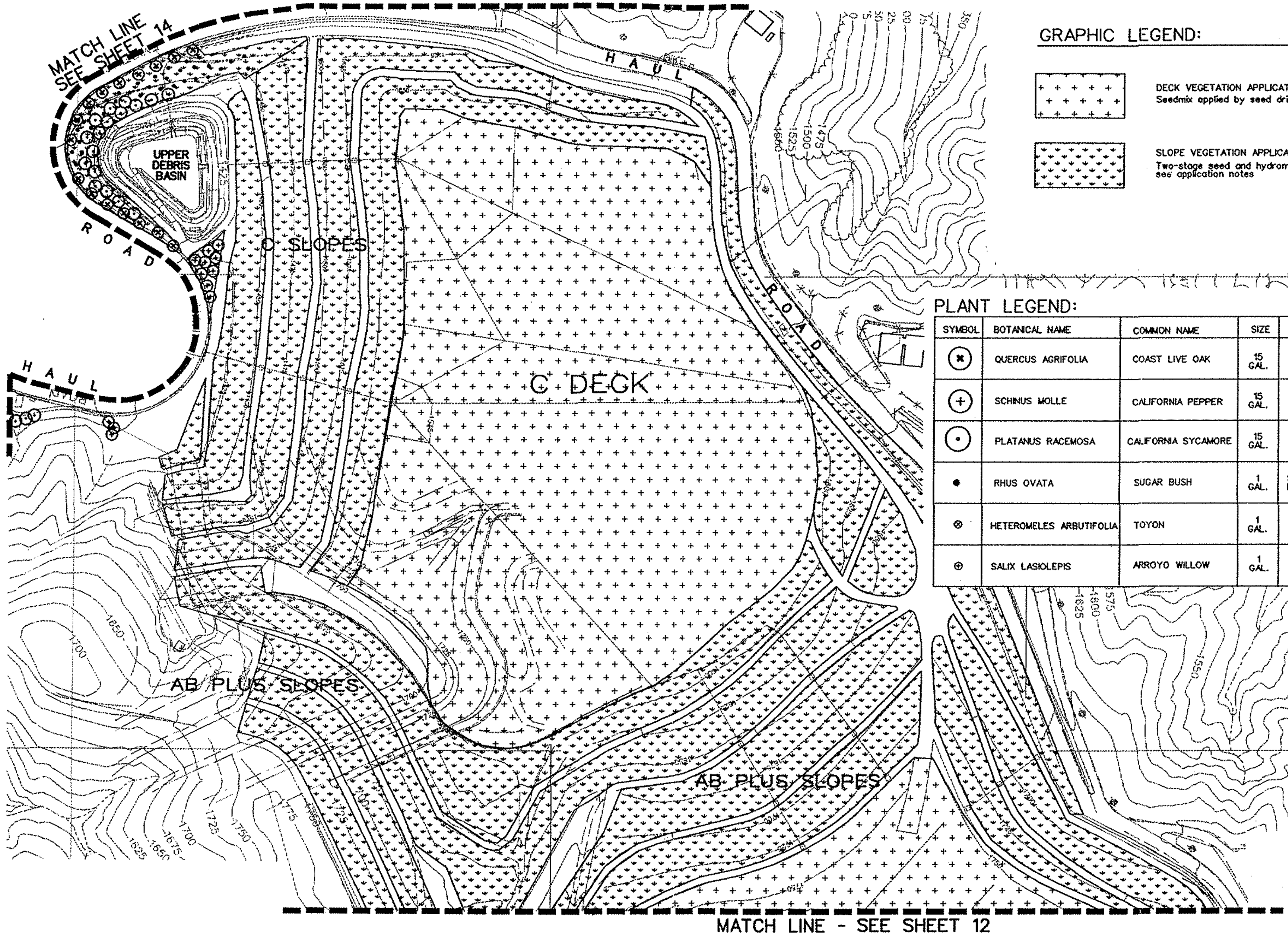
| | |
|---|---|
| ——1725—— | EXISTING CONTOUR |
| ——1725—— | PROPOSED FINAL GRADE CONTOURS |
| —— — —— | DOWNCHUTE |
| ——◄——◄—— | PROPOSED DIVERSION CHANNEL |
| — — — — | EXISTING PERIMETER CHANNEL |
| —— · · —— | FLOW LINE |
| — — — | RIDGE |
| ═══ | EXISTING ACCESS ROAD |
| ▭ | PROPOSED BENCHES |
| ⊡ | PROPOSED DECK INLET STRUCTURES |
| ▬▬ | SOIL LOSS LIMIT |

GEOSYNTEC CONSULTANTS

REVISED SOIL LOSS STUDY ZONES
LOPEZ CANYON SANITARY LANDFILL
LOS ANGELES, CALIFORNIA

FIGURE NO. 6-1
PROJECT NO. CE4100-11
DATE: 25-MAR-96

DWG: 4100F111 199604261250 LP




## GRAPHIC LEGEND:

DECK VEGETATION APPLICATION
Seedmix applied by seed drill - see application notes

SLOPE VEGETATION APPLICATION
Two-stage seed and hydromulch application - see application notes

## PLANT LEGEND:

| SYMBOL | BOTANICAL NAME | COMMON NAME | SIZE | REMARKS | DETAIL |
|---|---|---|---|---|---|
| ⊗ | QUERCUS AGRIFOLIA | COAST LIVE OAK | 15 GAL. | UNSTAKED SHRUB FORM WITH BRANCHES TO THE GROUND | 15 |
| ⊕ | SCHINUS MOLLE | CALIFORNIA PEPPER | 15 GAL. | LOW BRANCHING FORM | 15 |
| ⊙ | PLATANUS RACEMOSA | CALIFORNIA SYCAMORE | 15 GAL. | LOW BRANCHING FORM | 15 |
| • | RHUS OVATA | SUGAR BUSH | 1 GAL. | SEE CONTAINER PLANT SPECS | 15 |
| ⊗ | HETEROMELES ARBUTIFOLIA | TOYON | 1 GAL. | SEE CONTAINER PLANT SPECS | 15 |
| ⊛ | SALIX LASIOLEPIS | ARROYO WILLOW | 1 GAL. | SEE CONTAINER PLANT SPECS | 15 |

| | | | |
|---|---|---|---|
| DESIGNED | TB | | 29FEB96 |
| DRAWN | MF | | 29FEB96 |
| CHECKED | CA | | 29FEB96 |
| SUPERVISED | | | |
| PROJECT ENGR. | | R.C.E. NO. | |
| DIV./DIST. ENGR. | | R.C.E. NO. | |

ahbe

GEOSYNTEC CONSULTANTS
16541 Gothard Street, Suite 211
Huntington Beach, California 92647
Telephone: (714) 843-6866

LOPEZ CANYON LANDFILL

| NO. | REVISION DESCRIPTION | ENGR. | DATE |
|---|---|---|---|

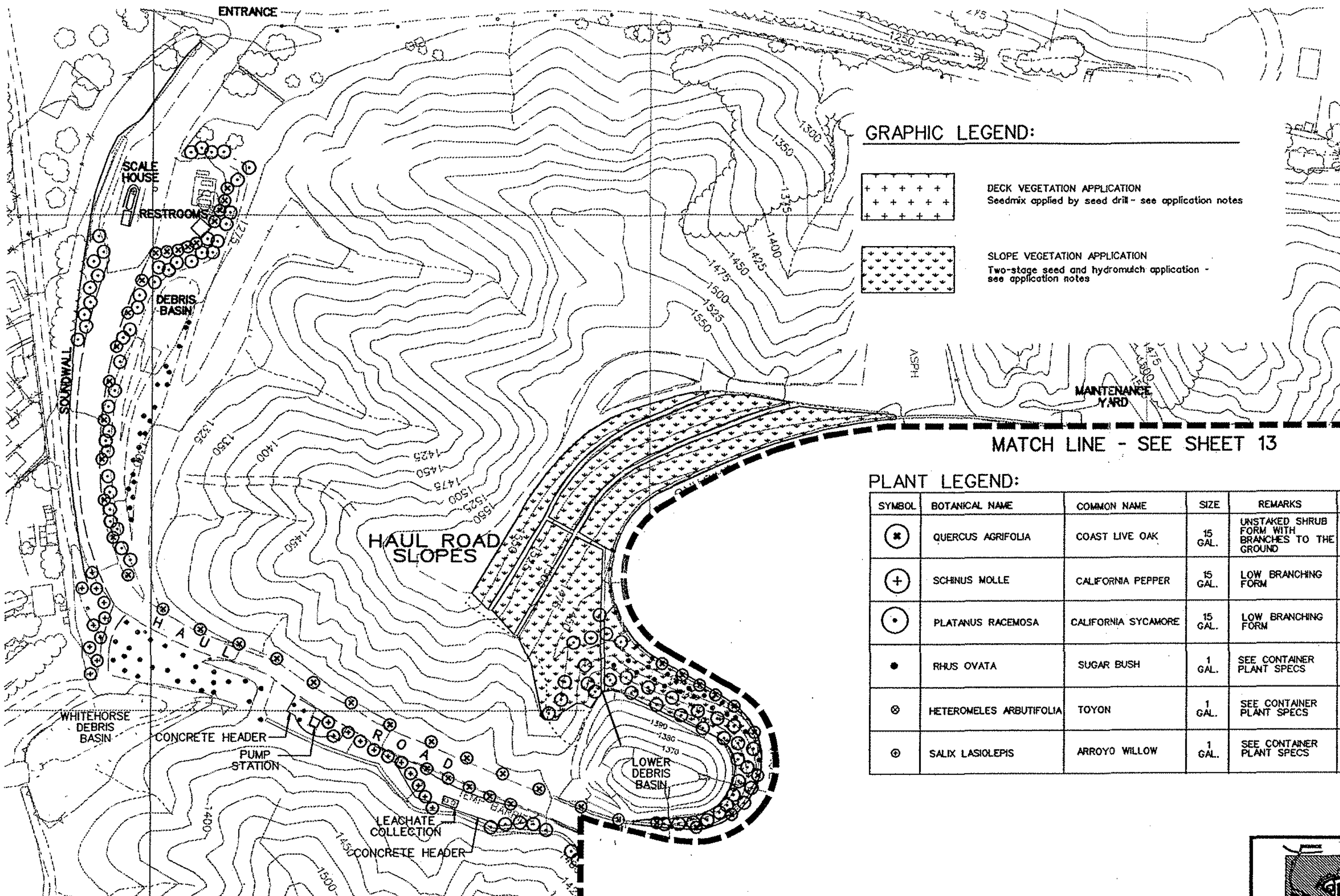
CITY OF LOS ANGELES
BUREAU OF SANITATION DELWIN A. BIAGI, DIRECTOR
DATE ______ 19___
STEPHEN A. FORTUNE R.C.E. NO. 21737
DIV. DIST. ENGR.

SCALE AS SHOWN
SHEET NO. 13
DWG. NO. 6005p802.dgn
JOB NO. CE-1400

**PLANTING PLAN - AREA 2**

FIGURE 8-2

These plans are preliminary and are not to be used for bidding or construction until signed and approved.




PLANT LEGEND:

| SYMBOL | BOTANICAL NAME | COMMON NAME | SIZE | REMARKS | DETAIL |
|---|---|---|---|---|---|
| ⊛ | QUERCUS AGRIFOLIA | COAST LIVE OAK | 15 GAL. | UNSTAKED SHRUB FORM WITH BRANCHES TO THE GROUND | 15 |
| ⊕ | SCHINUS MOLLE | CALIFORNIA PEPPER | 15 GAL. | LOW BRANCHING FORM | 15 |
| ⊙ | PLATANUS RACEMOSA | CALIFORNIA SYCAMORE | 15 GAL. | LOW BRANCHING FORM | 15 |
| • | RHUS OVATA | SUGAR BUSH | 1 GAL. | SEE CONTAINER PLANT SPECS | 15 |
| ⊗ | HETEROMELES ARBUTIFOLIA | TOYON | 1 GAL. | SEE CONTAINER PLANT SPECS | 15 |
| ⊙ | SALIX LASIOLEPIS | ARROYO WILLOW | 1 GAL. | SEE CONTAINER PLANT SPECS | 15 |

| DESIGNED | TB | | DATE 20FEB96 |
|---|---|---|---|
| DRAWN | MF | | 20FEB96 |
| CHECKED | CA | | 20FEB96 |
| SUPERVISED | | | |
| PROJECT ENGR. | | R.C.E. NO. | |
| DIV./DIST. ENGR. | | R.C.E. NO. | |

ahbé

GeoSyntec Consultants
16541 Gothard Street, Suite 211
Huntington Beach, California 92647
Telephone (714) 843-0866

LOPEZ CANYON LANDFILL

NO. | REVISION DESCRIPTION | ENGR. | DATE

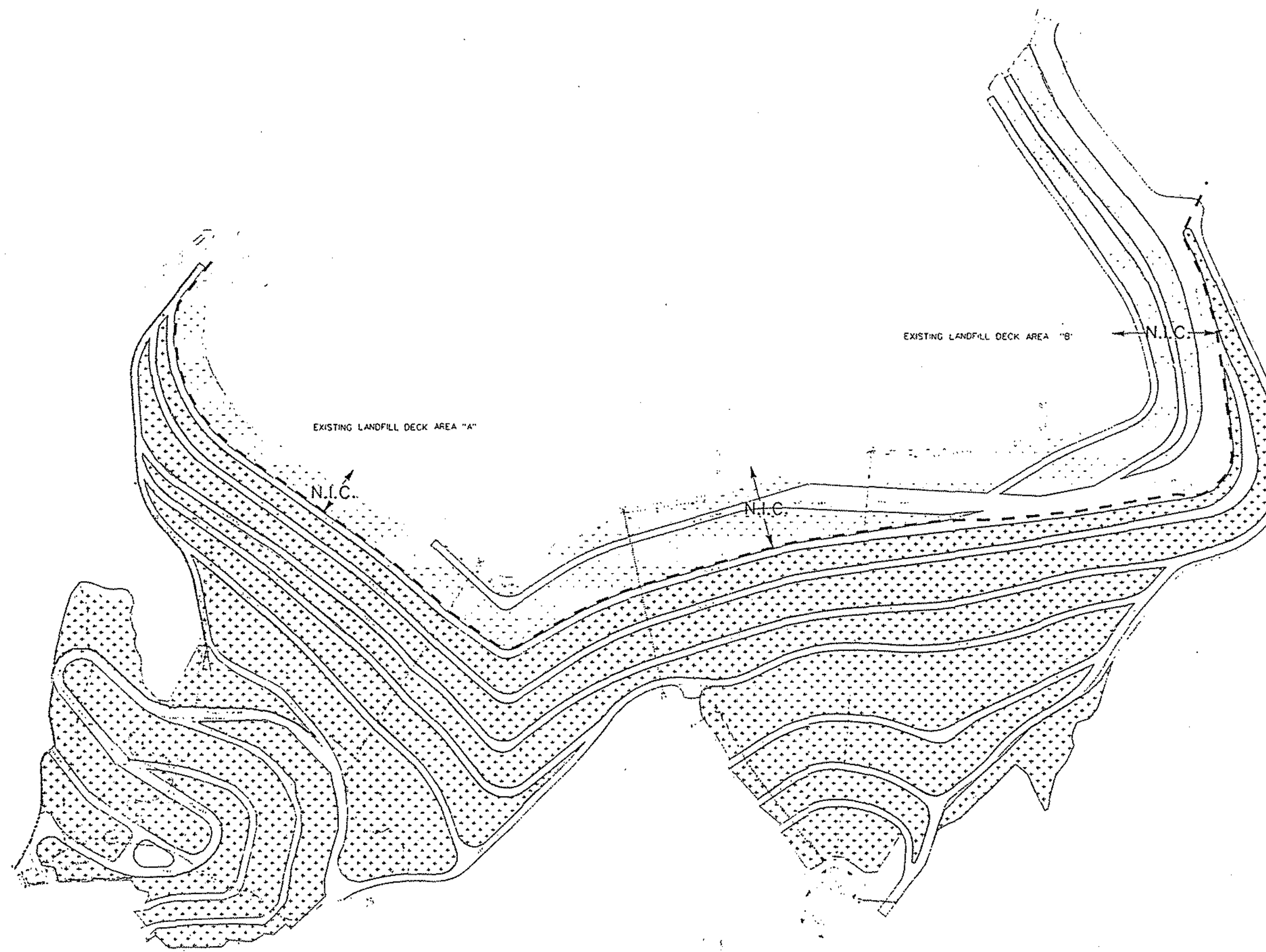
CITY OF LOS ANGELES
BUREAU OF SANITATION DELWIN A. BIAGI, DIRECTOR
DATE 19
STEPHEN A. FORTUNE R.C.E. NO. 21737
DIV. DIST. ENGR.

SCALE AS SHOWN
SHEET NO. 14
DWG. NO. 6005p803.dgn
JOB NO. CE-1400

PLANTING PLAN - AREA 3

FIGURE 8-3

These plans are preliminary and are not to be used for bidding or construction until signed and approved.




## HYDROMULCHING NOTES

1. CLEAR ANY WEED GROWTH TO EXPOSE BARE SOIL PRIOR TO HYDROMULCHING. THE ENGINEER MAY WAIVE THIS REQUIREMENT IF WEED GROWTH IS INSIGNIFICANT, OR IF EROSION MAY RESULT FROM REMOVAL OF GROWTH.
2. HYDROMULCH ONLY AFTER OCTOBER 1, AND BEFORE JANUARY 31. THE ENGINEER MAY WAIVE THIS CONSTRAINT IF CONDITIONS WARRANT
3. APPLY HYDROMULCH MATERIALS AS NOTED BELOW IN A TWO STEP PROCESS WITH AN APPROXIMATE 24 HOUR DRYING PERIOD BETWEEN STEPS. ALL DATES FOR HYDROMULCHING TO BE APPROVED BY THE ENGINEER FOR A DRY WEATHER PERIOD
4. A. HYDROMULCH STEP ONE: SEED AND SOIL CONDITIONER APPLICATION
   THOROUGHLY MIX, ACCORDING TO THE SPECIFICATIONS, THE FOLLOWING MATERIALS:

   1) SEED MIX

| SPECIES | PURITY / GERMINATION | POUNDS / ACRE |
|---|---|---|
| ARTEMESIA CALIFORNICA | 15 / 60 | 2 |
| ENCELIA CALIFORNICA | 40 / 60 | 3 |
| ERIOGONUM FASCICULATUM | 50 / 10 | 4 |
| LOTUS SCOPARIUS | 90 / 60 | 6 |
| MIMULUS LONGIFLORIUS | 2 / 55 | 2 |
| SALVIA APIANA | 70 / 50 | 3 |
| SALVIA MELLIFERA | 85 / 50 | 4 |
| SALVIA LEUCOPHYLLA | 75 / 70 | 3 |
| TRIFOLIUM HIRTUM - (INNOCULATED HYKON) | 95 / 85 | 10 |
| VULPIA MYUROS | 90 / 20 | 3 |
| STIPA CERNUA | 80 / 50 | 8 |
| HORDEUM CALIFORNICA | 90 / 80 | 9 |
| BROMUS CARINATUS | 95 / 80 | 6 |
| ESCHSCHOLZIA CALIFORNICA | 98 / 75 | 2 |
| LUPINUS BICOLOR | 98 / 80 | 4 |

   SEED IS AVAILABLE THROUGH S&S SEEDS (805) 684-0435. SUBMIT CERTIFICATION OF PURITY AND GERMINATION, WITH ONE POUND OF SEED MIX TO ENGINEER

   2. HYDROBLEND SOIL CONDITIONER:

| PRODUCT | RATE |
|---|---|
| LANDTECH HYDROBLEND SOIL ACTIVATOR (AVAILABLE FROM LANDTECH, (909) 684-3200 | 3,000 LBS. PER ACRE |
| GRO-POWER CONTROLLED RELEASE | 200 LBS PER ACRE |

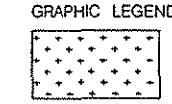
   APPLY ACCORDING TO SPECIFICATIONS AND MANUFACTURER'S RECOMMENDATIONS. MIX SHALL BE ALLOWED TO DRY NO LESS THAN 24 HOURS BEFORE APPLYING HYDROMULCH STEP TWO. SUBMIT MANUFACTURERS CUT SHEET

   B. HYDROMULCH STEP TWO: GERMINATION LAYER
   APPLY, PER SPECIFICATIONS AND MANUFACTURERS SPECIFICATIONS, THE FOLLOWING MATERIALS:

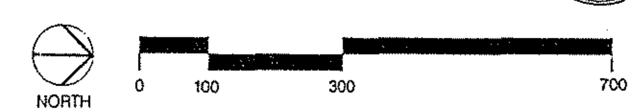
| PRODUCT | RATE |
|---|---|
| WOOD FIBER MULCH | 2,500 LBS. PER ACRE |
| M-BINDER | 120 LBS PER ACRE |

5. NO FERTILIZER OF ANY SORT SHALL BE INCORPORATED IN THE HYDROMULCH MIXES, OTHER THAN THE PRODUCTS SPECIFIED HEREIN

GRAPHIC LEGEND:



HYDROMULCH APPLICATION




SEP 06 1994

CALVIN R. ABE & ASSOCIATES, INC.

GEOSYNTEC CONSULTANTS
Huntington Beach, California
(714) 843-6866

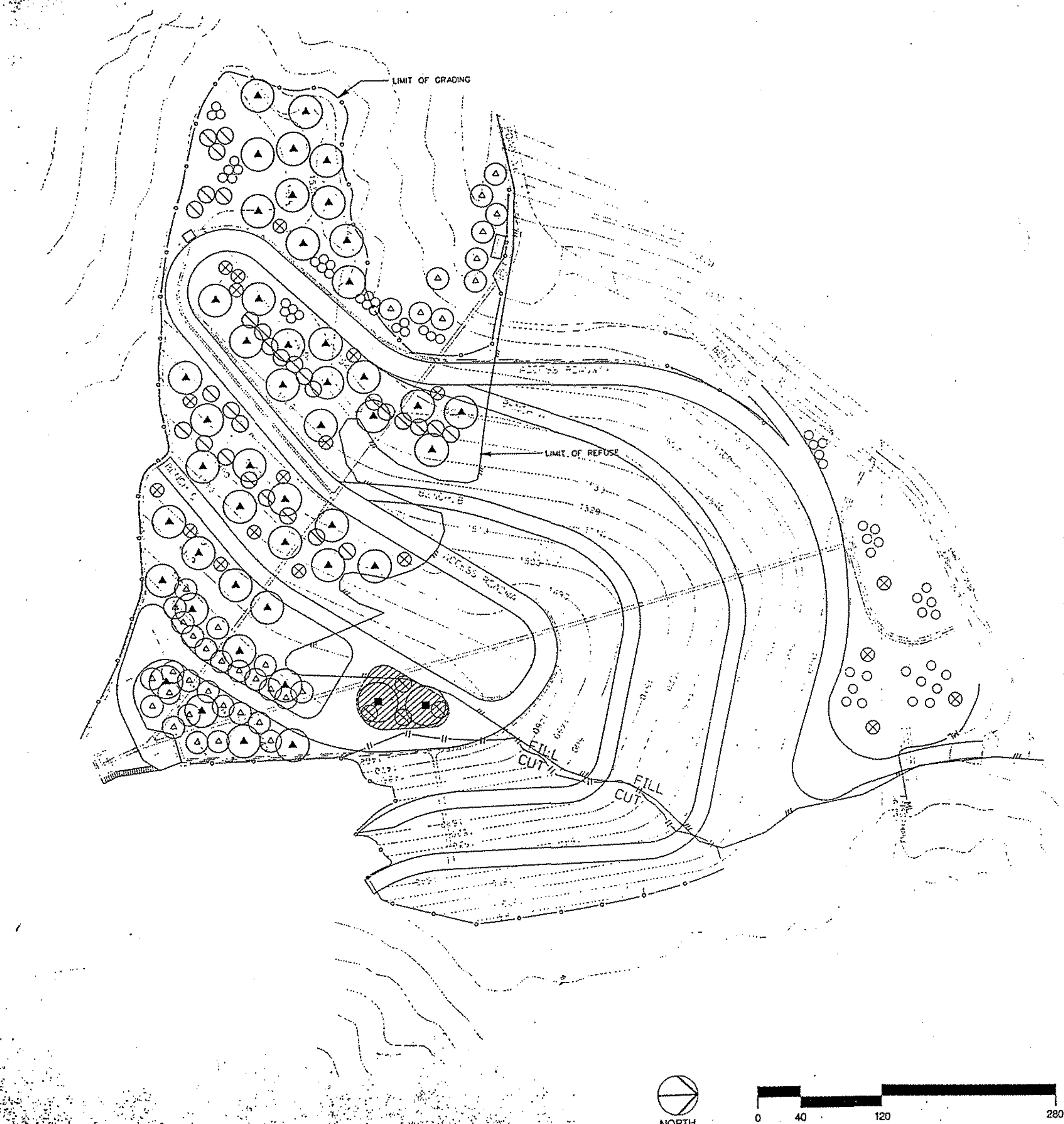
CITY OF LOS ANGELES
BUREAU OF SANITATION

SHEET NO. L-8

JOB NO. 94004

SHEET 8 OF 10 | HYDROMULCH PLAN

FIGURE 8-4




PLANT LEGEND:

| SYMBOL | BOTANICAL NAME | COMMON NAME | QUANTITY | SIZE | REMARKS | DETAIL |
|---|---|---|---|---|---|---|
| ▲ (large circle) | QUERCUS AGRIFOLIA | COAST LIVE OAK | 46 | 15 GAL. | UNSTAKED SHRUB FORM WITH BRANCHES TO THE GROUND | B/L-10 |
| ■ (large circle) | QUERCUS AGRIFOLIA | COAST LIVE OAK | 2 | 36" BOX | LOW BRANCHING SPECIMANS | A/L-10 |
| △ (circle) | ROMNEYA COULTERI | MATILIJA POPPY | 37 | 1 GAL. | | C/L-10 D/L-10 |
| ⊗ | CERCOCARPUS BETULOIDES | SWEET BRUSH | 19 | 1 GAL. | | C/L-10 D/L-10 |
| ⃠ | HETEROMELES ARBUTIFOLIA | TOYON | 34 | 1 GAL. | | C/L-10 D/L-10 |
| ○ | RHUS OVATA | SUGAR BUSH | 56 | 1 GAL. | | C/L-10 D/L-10 |

(hatched box) 3" THICK LAYER OF SHREDDED MULCH MATERIAL

## CONTAINER PLANT INSTALLATION NOTES

1. CONTAINER PLANTS SHALL BE PRODUCED IN A NURSERY WHICH SPECIALIZES IN THE PRODUCTION OF CALIFORNIA NATIVE PLANTS, SUCH AS:

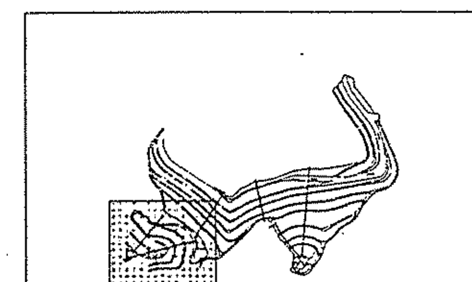
| NAME | TELEPHONE NUMBER |
|---|---|
| TREE OF LIFE WHOLESALE NURSERY SAN JUAN CAPISTRANO, CALIFORNIA | (714) 728-0685 |
| NATIVE SONS WHOLESALE NURSERY, INC. ARROYO GRANDE, CALIFORNIA | (805) 481-5996 |
| THEODORE PAYNE FOUNDATION SUNLAND, CALIFORNIA | (818) 768-1802 |

2. CONTAINER PLANTS SHALL BE INNOCULATED WITH MYCORRHIZAE. BIDDING NURSERY SHALL SUBMIT A STATEMENT WHICH INCLUDES THE FOLLOWING:
   A) LIST OF PLANTS SUPPLIED FOR PROJECT WITH MYCORRHIZA
   B) GENERAL DESCRIPTION OF SOURCE OF INOCULUM AND METHOD USED
   C) PROPORTION OF INOCULATED PLANTS EXPECTED TO BE SUCCESSFULLY MADE MYCORRHIZAL BY DELIVERY DATE
3. WITHIN 25 WORKING DAYS OF AWARD OF CONTRACT, CONTRACTOR SHALL SUBMIT DOCUMENTATION THAT THE PLANT MATERIAL HAS BEEN PROCURED AND IS AVAILABLE AS SPECIFIED, WITH EARLIEST AVAILABLE DELIVERY DATE FOR EACH TYPE OF PLANT.
4. CONTAINER PLANTS SHALL BE PLANTED ONLY AFTER OCTOBER 1 AND BEFORE APRIL 1, UNLESS APPROVED OTHERWISE BY ENGINEER. ANY CONFLICT WITH THIS TIME CONSTRAINT AND THE AVAILABILITY OF PLANT MATERIAL SHALL BE RESOLVED BY THE ENGINEER'S DECISION.
5. LAYOUT EACH PLANT LOCATION FOR APPROVAL OF ENGINEER PRIOR TO INSTALLATION OF SPRINKLER HEAD OR PLANTING.
6. PAY SPECIAL ATTENTION TO THE DETAILS FOR CONTAINER METHODS PROVIDED ON THE DRAWINGS, ESPECIALLY RODENT CONTROL BASKETS.
7. TOPDRESS ALL CONTAINER PLANTS WITH 2" THICK LAYER OF COMPOST MATERIAL PROVIDED BY THE CITY. PLACE COMPOST IN A 6' RADIUS AROUND EACH PLANT.
8. PLACE A 2" THICK LAYER OF APPROVED SHREDDED MULCH MATERIAL IN A 10' DIAMETER AREA AROUND EACH CONTAINER PLANT (ON TOP OF COMPOST), AND AS SHOWN ON THE PLANS.
9. THE ONLY BACKFILL AMENDMENT SHALL BE CONTROLLED RELEASE FERTILIZER (SEE SPECIFICATIONS). THROUGHLY MIX THE FERTILIZER INTO THE PLANT BACKFILL SOIL AT THE FOLLOWING RATES:

| PLANT SIZE | BACKFILL VOLUME | ACTUAL NITROGEN* |
|---|---|---|
| 1 GAL PLANT | 7 CU FT | 3 OUNCES |
| 5 GAL PLANT | 9 CU FT | 5 OUNCES |
| 15 GAL PLANT | 42 CU FT | 1 POUND |
| 36" BOX TREE | 60 CU FT | 1.5 POUNDS |

NO FERTILIZER SHALL BE APPLIED AS TOPDRESSING.

* ADJUST AMOUNT OF FERTILIZER ACCORDING TO % OF NITROGEN IN PRODUCT




KEY PLAN
NTS

SEP 06 1994

SHEET 9 OF 10 CONTAINER PLANTING PLAN

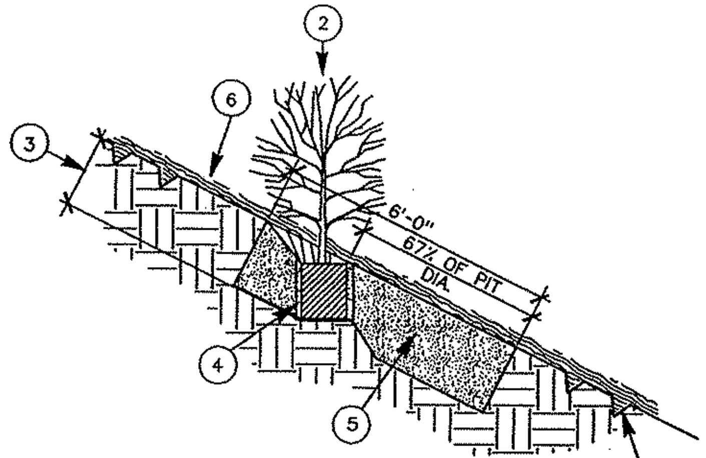
CALVIN R. ABE & ASSOCIATES, INC.
LANDSCAPE ARCHITECTS

GEOSYNTEC CONSULTANTS
Huntington Beach, California
(714) 843-6866

CITY OF LOS ANGELES
BUREAU OF SANITATION

SCALE 1" = 40'-0"
SHEET NO. L-9
JOB NO. 94004

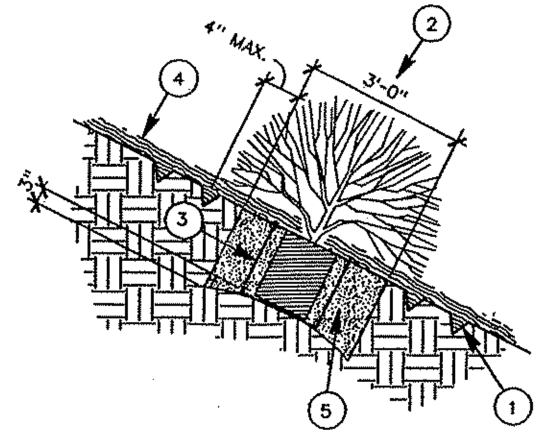
FIGURE 8-5




LEGEND:

1. HORIZONTAL SCARIFICATIONS-CENTERED ON TREE, 72" LONG AND 2" DEEP MIN. ABOVE AND BELOW TREE
2. PLANT TREES VERTICAL ON SLOPE LEAVE ½" OF ROOTBALL EXPOSED AT SLOPE
3. DEPTH OF PIT TO EQUAL CONTAINER DEPTH
4. RODENT PROTECTION BASKET, NON-GALVANIZED 1" CHICKEN WIRE
5. BACKFILL MIX
6. COMPOST AND MULCH LAYERS KEEP 3" RADIUS CLEAR AROUND TRUNK

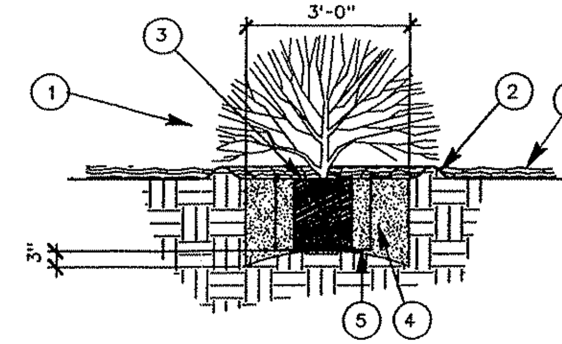
(C) NATIVE TREE PLANTING (2:1 SLOPES)
N.T.S.




LEGEND:

1. HORIZONTAL SCARIFICATIONS-CENTERED ON SHRUB, 36" LONG AND 3" DEEP MIN. 12" APART. ABOVE AND BELOW SHRUB
2. PLANT SHRUB PERPENDICULAR TO SLOPE. TOP OF ROOT BALL TO BE ½" ABOVE SURROUNDING SOIL
3. RODENT PROTECTION BASKET. NON-GALVANIZED 1" CHICKEN WIRE.
4. COMPOST AND MULCH LAYERS, KEEP 3" RADIUS CLEAR AROUND TRUNK
5. BACKFILL MIX

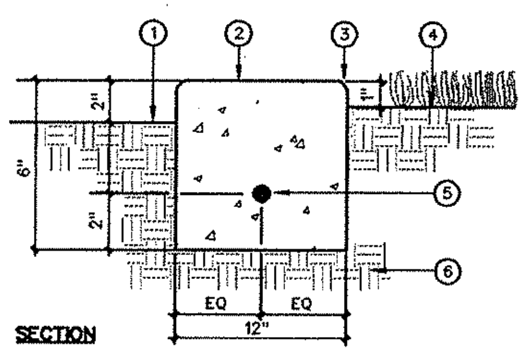
(B) NATIVE SHRUB PLANTING (2:1 SLOPES)
N.T.S.



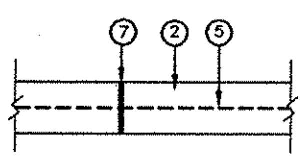

LEGEND:

1. SHRUB
2. 4" DEPTH WATER BASIN SET BACK 6" FROM PIT.
3. TOP OF ROOTBALL TO BE ½" ABOVE SURROUNDING SOIL
4. BACKFILL MIX
5. RODENT PROTECTION BASKET, NON-GALVANIZED 1" CHICKEN WIRE
6. COMPOST AND MULCH LAYERS, KEEP 3" RADIUS CLEAR AROUND TRUNK

(A) NATIVE SHRUB PLANTING (4:1 SLOPES OR LESS)
N.T.S.




SECTION



PLAN

**LEGEND**

1. FINISH GRADE IN GROUNDCOVER OR SHRUB AREA
2. CONCRETE, SMOOTH TROWEL FINISH
3. ¼" RADIUS TOOLED EDGE
4. FINISH GRADE IN TURF AREA
5. #3 REBAR, CONTINUOUS
6. COMPACTED SUBGRADE (90%)
7. SCORE JOINT @ 10' O.C., TYPICAL

**CONCRETE BAND**
N.T.S. CH02:1.5.95

## CONTAINER PLANT INSTALLATION NOTES

1. CONTAINER PLANTS SHALL BE PRODUCED IN A NURSERY WHICH SPECIALIZES IN THE PRODUCTION OF CALIFORNIA NATIVE PLANTS, SUCH AS:

| NAME | TELEPHONE NUMBER |
|---|---|
| TREE OF LIFE WHOLESALE NURSERY<br>SAN JUAN CAPISTRANO, CALIFORNIA | (714) 728-0685 |
| NATIVE SONS WHOLESALE NURSERY, INC.<br>ARROYO GRANDE, CALIFORNIA | (805) 481-5996 |
| THEODORE PAYNE FOUNDATION<br>SUNLAND, CALIFORNIA | (818) 768-1802 |

2. CONTAINER PLANTS SHALL BE INNOCULATED WITH MYCORRHIZAE. BIDDING NURSERY SHALL SUBMIT A STATEMENT WHICH INCLUDES THE FOLLOWING:
   A) LIST OF PLANTS SUPPLIED FOR PROJECT WITH MYCORRHIZA
   B) GENERAL DESCRIPTION OF SOURCE OF INOCULUM AND METHOD USED
   C) PROPORTION OF INNOCULATED PLANTS EXPECTED TO BE SUCCESSFULLY MADE MYCORRHIZAL BY DELIVERY DATE
3. WITHIN 25 WORKING DAYS OF AWARD OF CONTRACT, CONTRACTOR SHALL SUBMIT DOCUMENTATION THAT THE PLANT MATERIAL HAS BEEN PROCURED AND IS AVAILABLE AS SPECIFIED, WITH EARLIEST AVAILABLE DELIVERY DATE FOR EACH TYPE OF PLANT.
4. CONTAINER PLANTS SHALL BE PLANTED ONLY AFTER OCTOBER 1 AND BEFORE APRIL 1, UNLESS APPROVED OTHERWISE BY ENGINEER. ANY CONFLICT WITH THIS TIME CONSTRAINT AND THE AVAILABILITY OF PLANT MATERIAL SHALL BE RESOLVED BY THE ENGINEER'S DECISION.
5. LAYOUT EACH PLANT LOCATION FOR APPROVAL OF ENGINEER PRIOR TO INSTALLATION OF SPRINKLER HEAD OR PLANTING.
6. PAY SPECIAL ATTENTION TO THE DETAILS FOR CONTAINER METHODS PROVIDED ON THE DRAWINGS, ESPECIALLY RODENT CONTROL BASKETS.
7. TOPDRESS ALL CONTAINER PLANTS WITH 2" THICK LAYER OF COMPOST MATERIAL PROVIDED BY THE CITY. PLACE COMPOST IN A 6' RADIUS AROUND EACH PLANT.
8. PLACE A 2" THICK LAYER OF APPROVED SHREDDED MULCH MATERIAL IN A 10' DIAMETER AREA AROUND EACH CONTAINER PLANT (ON TOP OF COMPOST), AND AS SHOWN ON THE PLANS.
9. THE ONLY BACKFILL AMENDMENT SHALL BE CONTROLLED RELEASE FERTILIZER (SEE SPECIFICATIONS). THROUGHLY MIX THE FERTILIZER INTO THE PLANT BACKFILL SOIL AT THE FOLLOWING RATES:

| PLANT SIZE | BACKFILL VOLUME | ACTUAL NITROGEN* |
|---|---|---|
| 1 GAL PLANT | 7 CU FT | 3 OUNCES |
| 5 GAL PLANT | 9 CU FT | 5 OUNCES |
| 15 GAL PLANT | 42 CU FT | 1 POUND |
| 36" BOX TREE | 60 CU FT | 1.5 POUNDS |

NO FERTILIZER SHALL BE APPLIED AS TOPDRESSING.

* ADJUST AMOUNT OF FERTILIZER ACCORDING TO % OF NITROGEN IN PRODUCT

CONTAINER PLANTING DETAILS AND NOTES

LOPEZ CANYON LANDFILL

CITY OF LOS ANGELES

GEOSYNTEC CONSULTANTS

ah'be

SCALE AS NOTED
SHEET NO. 15
DWG. NO. 6005pd01.dgn
JOB NO. CE-1400

# FIGURE 8-6

These plans are preliminary and are not to be used for bidding or construction until signed and approved.

## DECK SEED APPLICATION NOTES

1. SEEDING OPERATIONS SHALL BE SCHEDULED BY THE ENGINEER TO TAKE ADVANTAGE OF THE RAINY SEASON, AND AS GRADING WORK IS COMPLETED. THE ENGINEER SHALL DETERMINE WHETHER TEMPORARY IRRIGATION WILL BE REQUIRED TO SUSTAIN SEED GERMINATION AND ESTABLISHMENT ON THE DECK AREAS
2. MECHANICALLY CLEAR WEED GROWTH AS NECESSARY TO EXPOSE BARE SOIL PRIOR TO SEEDING. THE ENGINEER MAY WAIVE THIS REQUIREMENT IF WEED GROWTH IS INSIGNIFICANT, OR IF EROSION MAY RESULT FROM REMOVAL OF EXISTING VEGETATION.
3. AFTER SOIL IS CLEARED, AND PRIOR TO SEEDING, PERFORM ONE "GROW AND KILL" CYCLE TO ERADICATE AGGRESSIVE WEED SPECIES. THE GROW AND KILL CYCLE SHALL INCLUDE WATERING (IF IRRIGATION IS USED) AND FERTILIZING TO ENCOURAGE WEED GERMINATION, AND SUBSEQUENT APPLICATION OF BROAD SPECTRUM HERBICIDE TO ERADICATE THE WEED GROWTH.
4. UPON COMPLETION OF WEED REMOVAL TO THE ENGINEER'S SATISFACTION, PREPARE THE SEED BED BY LIGHTLY DISCING OR TILLING THE SOIL TO A DEPTH OF 3". APPLY A LIGHT APPLICATION OF IRRIGATION (IF IT IS USED) TO MOISTEN THE SEEDBED PRIOR TO SEEDBED PREPARATION.
5. APPLY SEED MIX TO DECK AREAS BY MECHANICAL SEED DRILL, WITH SEPARATE BOXES FOR LARGE, MEDIUM, AND SMALL SEED TYPES.

## DECK SEED MIX

| SPECIES | PURITY / GERMINATION | POUNDS / ACRE |
|---|---|---|
| ARISTIDA SP. | | |
| FESTUCA MEGALURA | | |
| STIPA CERNUA | | |
| STIPA PULCHRA | | |
| MELICA CALIFORNICA | | |
| POA SCRABELLA | | |

SEED IS AVAILABLE THROUGH S&S SEEDS (805) 684-0436. SUBMIT CERTIFICATION OF PURITY AND GERMINATION, WITH ONE POUND OF SEED MIX TO ENGINEER.

## SLOPE SEED HYDROMULCHING APPLICATION NOTES

1. SEEDING OPERATIONS SHALL BE SCHEDULED BY THE ENGINEER TO TAKE ADVANTAGE OF THE RAINY SEASON, AND AS GRADING WORK IS COMPLETED. COMPLETE IRRIGATION INSTALLATION AND TESTING TO THE ENGINEER'S SATISFACTION PRIOR TO BEGINNING SLOPE SEEDING
2. MECHANICALLY CLEAR WEED GROWTH AS NECESSARY TO EXPOSE BARE SOIL PRIOR TO SEEDING. THE ENGINEER MAY WAIVE THIS REQUIREMENT IF WEED GROWTH IS INSIGNIFICANT, OR IF EROSION MAY RESULT FROM REMOVAL OF GROWTH.
3. AFTER SOIL IS CLEARED, AND PRIOR TO SEEDING, PERFORM ONE "GROW AND KILL" CYCLE TO ERADICATE AGGRESSIVE WEED SPECIES. THE GROW AND KILL CYCLE SHALL INCLUDE WATERING AND FERTILIZING TO ENCOURAGE WEED GERMINATION, AND SUBSEQUENT APPLICATION OF BROAD SPECTRUM HERBICIDE TO ERADICATE WEED GROWTH.
4. UPON COMPLETION OF WEED REMOVAL TO THE ENGINEER'S SATISFACTION, APPLY HYDROMULCH MATERIALS AS NOTED BELOW IN A TWO-STAGE PROCESS WITH AN APPROXIMATE 24 HOUR DRYING PERIOD BETWEEN STAGES

### HYDROMULCH APPLICATION STAGE ONE: SEED AND SOIL CONDITIONER APPLICATION

THOROUGHLY MIX, ACCORDING TO THE SPECIFICATIONS, THE FOLLOWING MATERIALS:

1) SEED MIX AS NOTED ON THIS SHEET
2) HYDROBLEND SOIL CONDITIONER & FERTILIZER:

| PRODUCT | RATE |
|---|---|
| HYDROBLEND SOIL ACTIVATOR (AVAILABLE FROM EARTHWORKS) | 3,000 LBS. PER ACRE |
| GRO-POWER CONTROLLED RELEASE | 200 LBS PER ACRE |

APPLY ACCORDING TO SPECIFICATIONS AND MANUFACTURER'S RECOMMENDATIONS. MIX SHALL BE ALLOWED TO DRY NO LESS THAN 24 HOURS BEFORE APPLYING HYDROMULCH STAGE TWO.

### HYDROMULCH STAGE TWO: GERMINATION LAYER

APPLY, PER SPECIFICATIONS AND MANUFACTURERS SPECIFICATIONS, THE FOLLOWING MATERIALS:

| PRODUCT | RATE |
|---|---|
| WOOD FIBER MULCH | 2,500 LBS. PER ACRE |
| M-BINDER | 120 LBS PER ACRE |

NO FERTILIZER OF ANY SORT SHALL BE INCORPORATED IN THE HYDROMULCH MIXES, OTHER THAN THE PRODUCTS SPECIFIED HEREIN.

## SLOPES SEED MIX

| SPECIES | PURITY / GERMINATION | POUNDS / ACRE |
|---|---|---|
| ARTEMESIA CALIFORNICA | 15 / 60 | 2 |
| ENCELIA CALIFORNICA | 40 / 60 | 3 |
| ERIOGONUM FASCICULATUM | 50 / 10 | 4 |
| LOTUS SCOPARIUS | 90 / 60 | 6 |
| MIMULUS LONGIFLORIUS | 2 / 55 | 2 |
| SALVIA APIANA | 70 / 50 | 3 |
| SALVIA MELLIFERA | 85 / 50 | 4 |
| SALVIA LEUCOPHYLLA | 75 / 70 | 3 |
| TRIFOLIUM HIRTUM - (INNOCULATED HYKON) | 95 / 85 | 10 |
| VULPIA MYUROS | 90 / 80 | 3 |
| STIPA CERNUA | 80 / 50 | 8 |
| HORDEUM CALIFORNICA | 90 / 80 | 8 |
| BROMUS CARINATUS | 95 / 80 | 6 |
| ESCHSCHOLZIA CALIFORNICA | 98 / 75 | 2 |
| LUPINUS BICOLOR | 98 / 80 | 4 |

SEED IS AVAILABLE THROUGH S&S SEEDS (805) 684-0436. SUBMIT CERTIFICATION OF PURITY AND GERMINATION, WITH ONE POUND OF SEED MIX TO ENGINEER.

DESIGNED TB
DRAWN MF
CHECKED CA
SUPERVISED
PROJECT ENGR. R.C.E. NO.
DIV./DIST. ENGR. R.C.E. NO.

GEOSYNTEC CONSULTANTS
16541 Gothard Street, Suite 211
Huntington Beach, California 92647
Telephone: (714) 843-6866

LOPEZ CANYON LANDFILL

CITY OF LOS ANGELES
BUREAU OF SANITATION

SCALE NONE
SHEET NO. 16
DWG. NO. 6005PD02.dgn
JOB NO. CE-1400

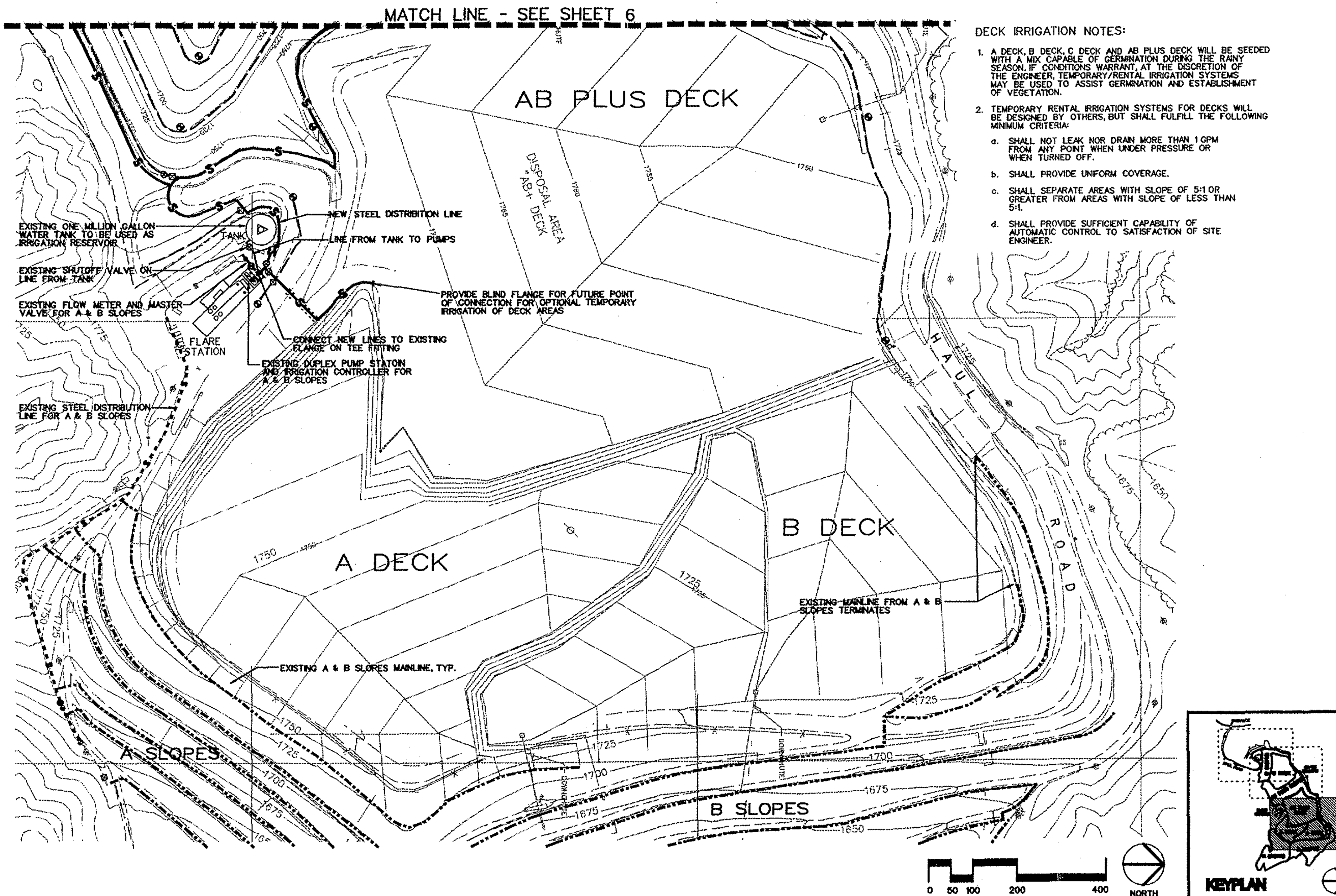
SEED APPLICATION LEGENDS AND NOTES

FIGURE 8-7

These plans are preliminary and are not to be used for bidding or construction until signed and approved.

DECK IRRIGATION NOTES:

1. A DECK, B DECK, C DECK AND AB PLUS DECK WILL BE SEEDED WITH A MIX CAPABLE OF GERMINATION DURING THE RAINY SEASON. IF CONDITIONS WARRANT, AT THE DISCRETION OF THE ENGINEER, TEMPORARY/RENTAL IRRIGATION SYSTEMS MAY BE USED TO ASSIST GERMINATION AND ESTABLISHMENT OF VEGETATION.
2. TEMPORARY RENTAL IRRIGATION SYSTEMS FOR DECKS WILL BE DESIGNED BY OTHERS, BUT SHALL FULFILL THE FOLLOWING MINIMUM CRITERIA:
   a. SHALL NOT LEAK NOR DRAIN MORE THAN 1 GPM FROM ANY POINT WHEN UNDER PRESSURE OR WHEN TURNED OFF.
   b. SHALL PROVIDE UNIFORM COVERAGE.
   c. SHALL SEPARATE AREAS WITH SLOPE OF 5:1 OR GREATER FROM AREAS WITH SLOPE OF LESS THAN 5:1.
   d. SHALL PROVIDE SUFFICIENT CAPABILITY OF AUTOMATIC CONTROL TO SATISFACTION OF SITE ENGINEER.




IRRIGATION PLAN - AREA 1

| | | |
|---|---|---|
| DESIGNED | TB | 29FEB00 |
| DRAWN | MF | 29FEB00 |
| CHECKED | CA | 29FEB00 |
| SUPERVISED | | |
| PROJECT ENGR. | R.C.E. NO. | |
| DIV./DIST. ENGR. | R.C.E. NO. | |

ah'be

GEOSYNTEC CONSULTANTS
16541 Gothard Street, Suite 211
Huntington Beach, California 92647
Telephone: (714) 843-6866

LOPEZ CANYON LANDFILL

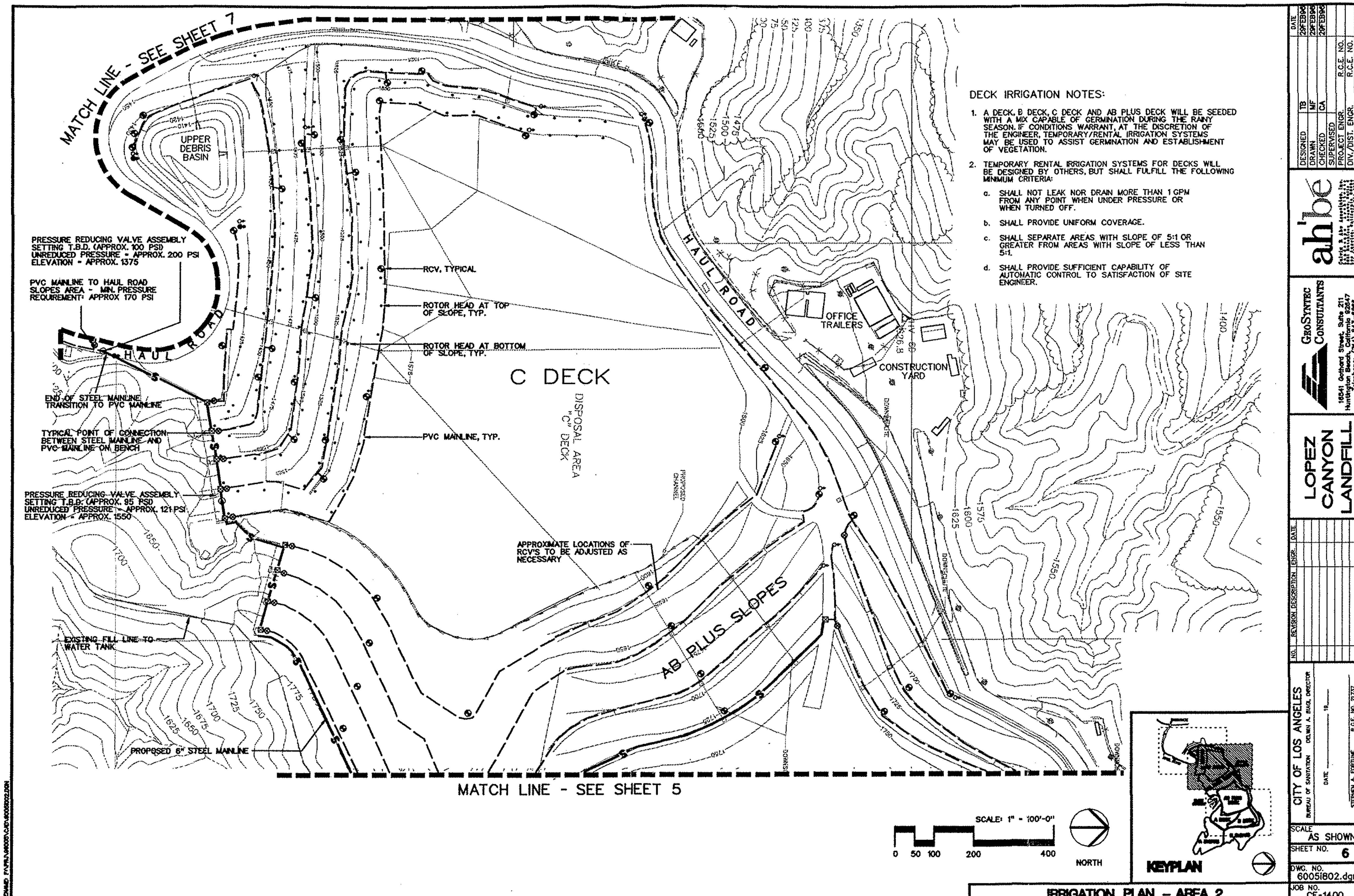
| NO. | REVISION DESCRIPTION | ENGR. | DATE |
|---|---|---|---|

CITY OF LOS ANGELES
BUREAU OF SANITATION DELWIN A. BIAGI, DIRECTOR
DATE ______ 19__
STEPHEN A. FORTUNE DIV. DIST. ENGR. R.C.E. NO. 21737

SCALE AS SHOWN
SHEET NO. 5
DWG. NO. 6005i801.dgn
JOB NO. CE-1400

FIGURE 8-8

These plans are preliminary and are not to be used for bidding or construction until signed and approved.




These plans are preliminary and are not to be used for bidding or construction until signed and approved.

FIGURE 8-9

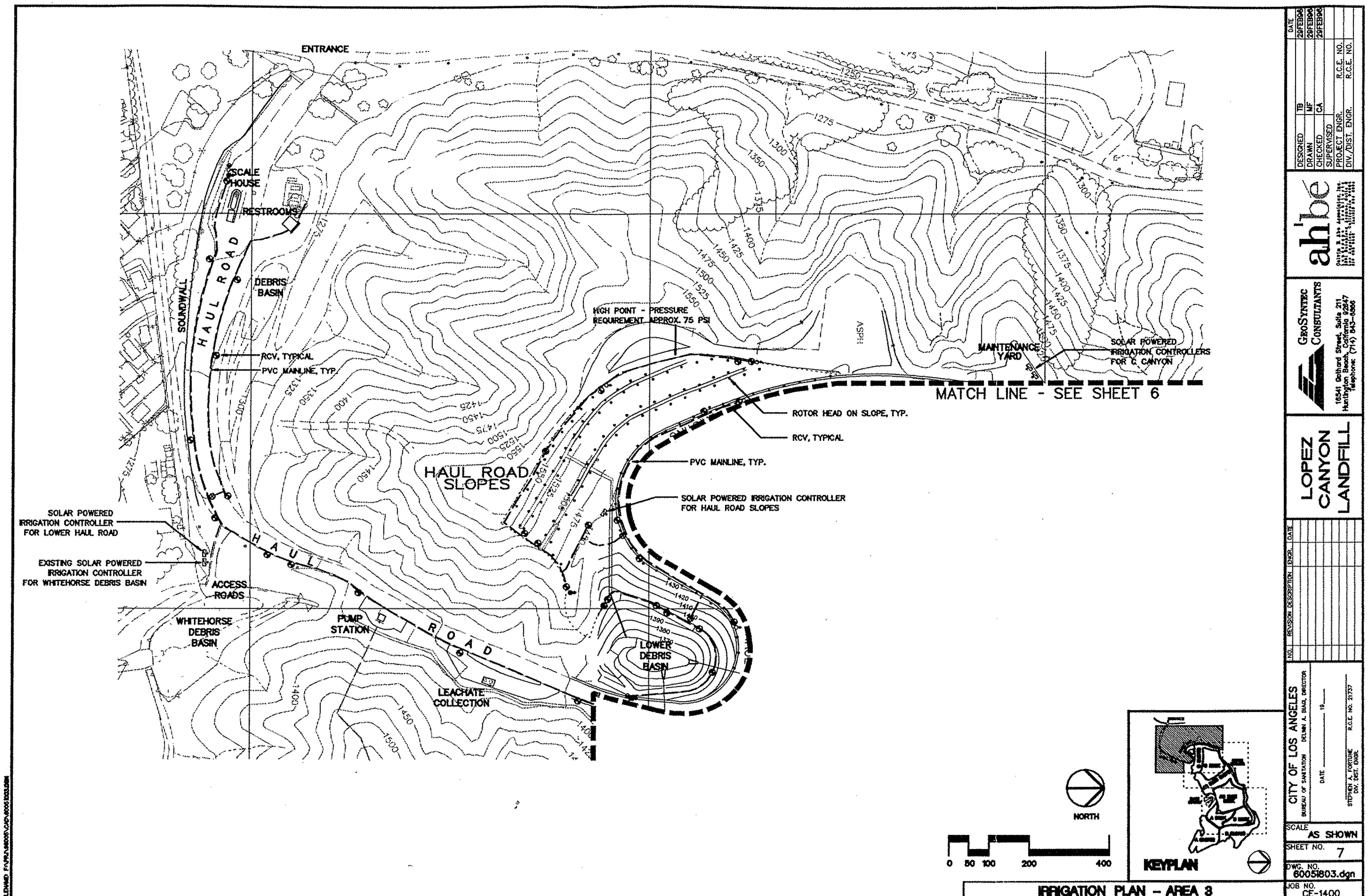
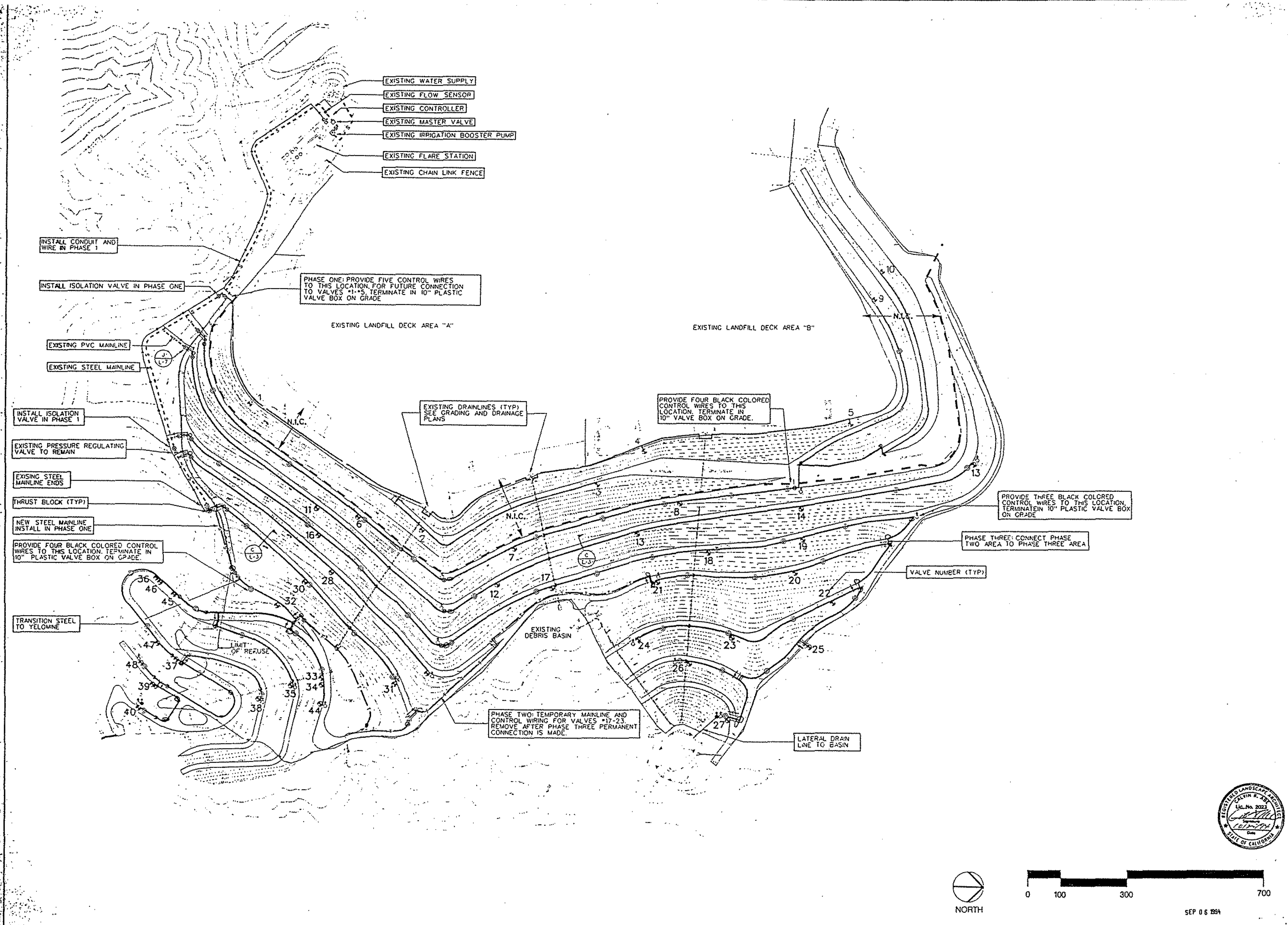



FIGURE 8-10

These plans are preliminary and are not to be used for bidding or construction until signed and approved.




| | |
|---|---|
| DESIGNED | TB |
| DRAWN | SG |
| CHECKED | TB |
| SUPERVISED C.A. | |
| PROJECT ENGR. R.E. NO. | |
| ASST. DIV./DIST. ENGR. R.E. NO. | |

CALVIN R. ABE & ASSOCIATES, INC.

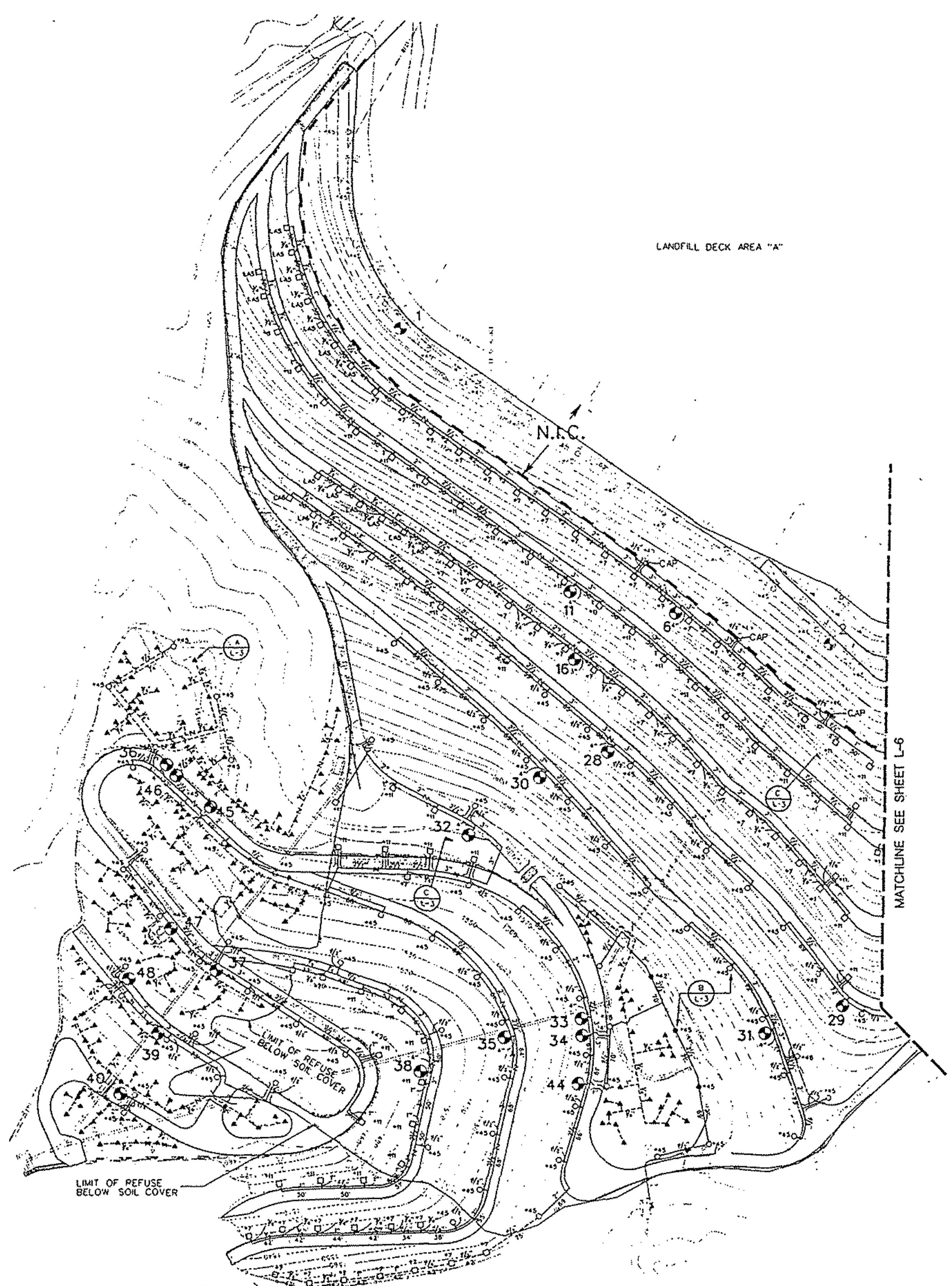
GEOSYNTEC CONSULTANTS
Huntington Beach, California
(714) 843-6866

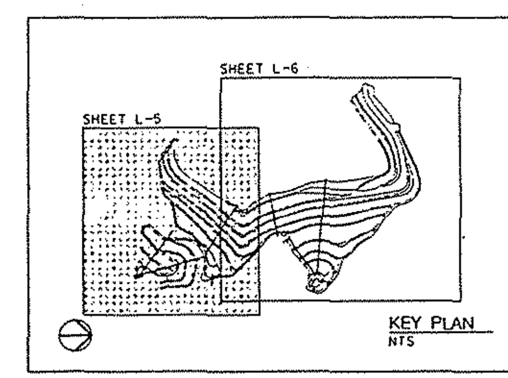
CITY OF LOS ANGELES
BUREAU OF SANITATION

SCALE 1" = 100'-0"
SHEET NO. L-4
DWG. NO.
JOB NO. 94004

SHEET 4 OF 10 | IRRIGATION MAINLINE PLAN

FIGURE 8-11




NORTH

0 60 180 420

SEP 0 6 1994

| | | | |
|---|---|---|---|
| DESIGNED | TB | | |
| DRAWN | SG | | |
| CHECKED | TB | | SEP 07 1994 |
| SUPERVISED | CA | | SEP 07 1994 |
| PROJECT ENGR. | | R.E. NO. | |
| ASST. DIV./DIST. ENGR. | | R.E. NO. | |

CALVIN R. ABE & ASSOCIATES, INC.
LANDSCAPE ARCHITECTS

GEOSYNTEC CONSULTANTS
Huntington Beach, California
(714) 843-6866

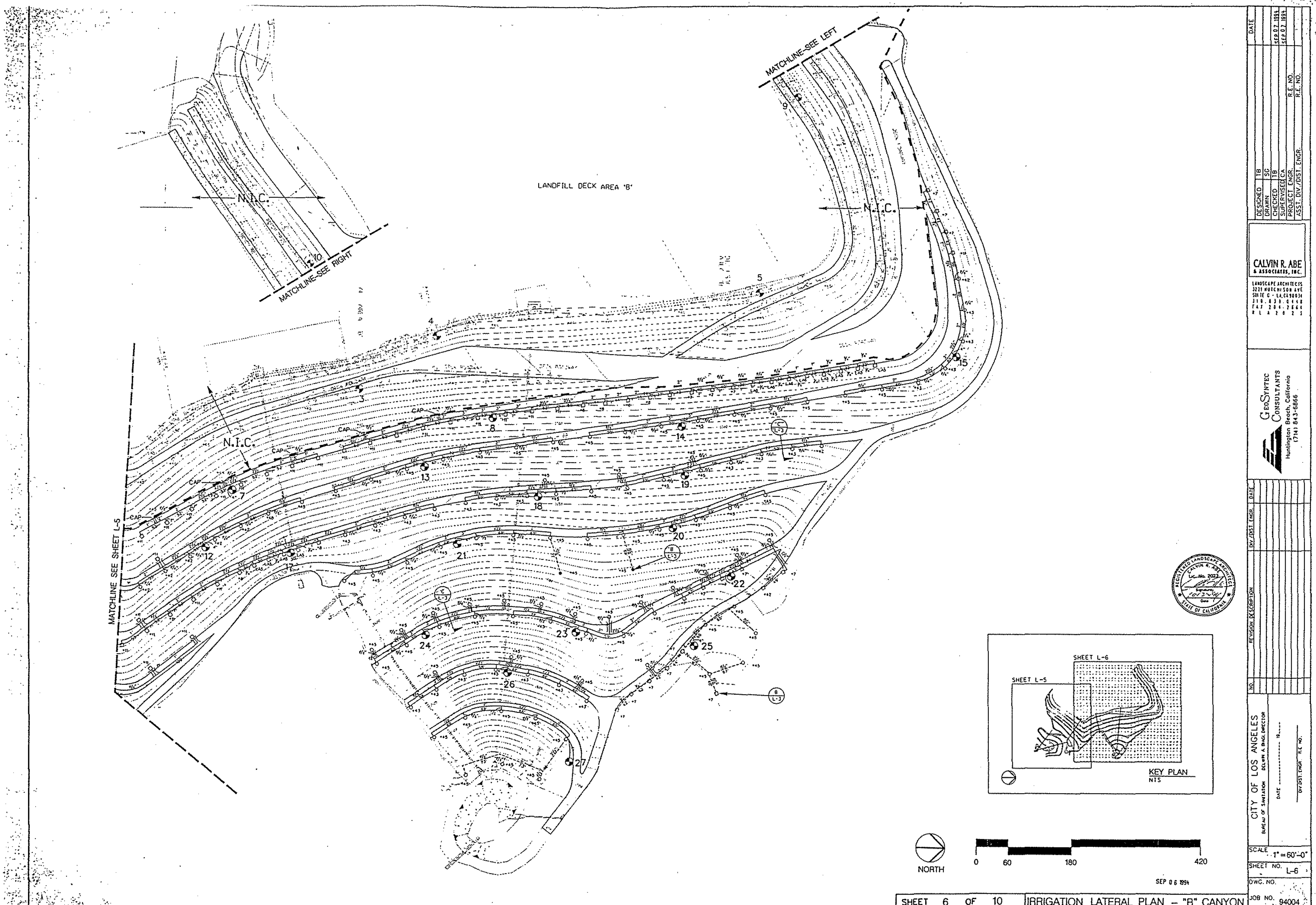
REGISTERED LANDSCAPE ARCHITECT CALVIN R. ABE Lic. No. 2023 STATE OF CALIFORNIA

CITY OF LOS ANGELES
BUREAU OF SANITATION DELWIN A. BIAGI, DIRECTOR

SCALE 1" = 60'-0"
SHEET NO. L-5
DWG. NO.
JOB NO. 94004

SHEET 5 OF 10 IRRIGATION LATERAL PLAN – "A" CANYON

FIGURE 8-12



LANDFILL DECK AREA 'B'
N.I.C.
MATCHLINE-SEE RIGHT
MATCHLINE-SEE LEFT
MATCHLINE SEE SHEET L-5
CAP
KEY PLAN
NTS
SHEET L-5
SHEET L-6
NORTH
0 60 180 420
SEP 06 1994
SHEET 6 OF 10
IRRIGATION LATERAL PLAN - "B" CANYON
CALVIN R. ABE & ASSOCIATES, INC.
LANDSCAPE ARCHITECTS
GEOSYNTEC CONSULTANTS
Huntington Beach, California
(714) 843-6866
CITY OF LOS ANGELES
BUREAU OF SANITATION
DESIGNED TB
DRAWN SG
CHECKED TB
SUPERVISED CA
PROJECT ENGR. R.E. NO.
ASST. DIV./DIST. ENGR. R.E. NO.
SEP 02 1994
REVISION DESCRIPTION
DIV./DIST. ENGR.
DATE
SCALE 1" = 60'-0"
SHEET NO. L-6
DWG. NO.
JOB NO. 94004


FIGURE 8-13

## VALVE SCHEDULES

### C CANYON SLOPES

| VALVE NUMBER | GPM | VALVE SIZE | PRESSURE SETTING | INSTALLATION PHASE | PUMP BOOST NEEDED |
|---|---|---|---|---|---|
| 1 | | | | | |
| 2 | | | | | |
| 3 | | | | | |
| 4 | | | | | |
| 5 | | | | | |
| 6 | | | | | |
| 7 | | | | | |
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| 16 | | | | | |
| 17 | | | | | |
| 18 | | | | | |
| 19 | | | | | |
| 20 | | | | | |

### AB PLUS SLOPES

| VALVE NUMBER | GPM | VALVE SIZE | PRESSURE SETTING | INSTALLATION PHASE | PUMP BOOST NEEDED |
|---|---|---|---|---|---|
| 1 | | | | | |
| 2 | | | | | |
| 3 | | | | | |
| 4 | | | | | |
| 5 | | | | | |
| 6 | | | | | |
| 7 | | | | | |
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| 14 | | | | | |
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| 16 | | | | | |
| 17 | | | | | |
| 18 | | | | | |
| 19 | | | | | |
| 20 | | | | | |
| 21 | | | | | |

### HAUL ROAD SLOPES

| VALVE NUMBER | GPM | VALVE SIZE | PRESSURE SETTING | INSTALLATION PHASE | PUMP BOOST NEEDED |
|---|---|---|---|---|---|
| 1 | | | | | |
| 2 | | | | | |
| 3 | | | | | |
| 4 | | | | | |
| 5 | | | | | |
| 6 | | | | | |
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| 34 | | | | | |

## IRRIGATION NOTES

1. EXCAVATION OR TRENCHING OVER REFUSE: DO NOT EXCAVATE OR PENETRATE SOIL DEEPER THAN 18" DEPTH WITHOUT PRIOR APPROVAL OF ENGINEER. DO NOT EXCAVATE TRENCHES DEEPER THAN AS REQUIRED IN DRAWINGS.
2. PVC PIPE SHALL BE JOINED WITH CERTA-LOK COUPLINGS. WHERE SOLVENT WELD JOINING IS NECESSARY, FITTINGS SHALL BE SCHEDULE 80 PVC.
3. PLACE THRUST BLOCKS WHERE INDICATED ON PLANS, AND AS REQUIRED BY THE ENGINEER.
4. TORO 216 PRESSURE REGULATING VALVES CAN BE REGULATED PRIOR TO ACTIVATION OF CONTROLLER. SEE MANUFACTURER'S INSTRUCTIONS.
5. LV CONTROL WIRES:
   * EACH WIRE SHALL BE COLOR CODED ACCORDING TO THE
   * FIELD SPLICES OF LV CONTROL WIRES SHALL BE PLACED IN 10" DIAMETER PLASTIC VALVE BOXES.
   * LV CONTROL WIRES SHALL BE PLACED IN CONDUIT WHEREVER NOT BURIED, UNLESS OTHERWISE NOTED ON DRAWINGS.
6. LAYOUT LOCATIONS OF CONTAINER PLANTS AND SPRAY HEADS (DETAIL , SHEET L-) FOR APPROVAL OF ENGINEER PRIOR TO INSTALLING SPRINKLER HEADS OR PLANTS.
7. ADJUST SPRINKLERS SO THAT WATER IS NOT THROWN ON BENCHES OR ROADWAYS.
8. SCHEDULING NOTES: SLOPE AREAS SHALL BE WATERED WITH REPEAT LIGHT APPLICATIONS SO THAT RUNOFF OR SOIL EROSION DO NOT OCCUR.

## DECK IRRIGATION NOTES:

1. A DECK, B DECK, C DECK AND AB PLUS DECK WILL BE SEEDED WITH A MIX CAPABLE OF GERMINATION DURING THE RAINY SEASON. IF CONDITIONS WARRANT, AT THE DISCRETION OF THE ENGINEER, TEMPORARY/RENTAL IRRIGATION SYSTEMS MAY BE USED TO ASSIST GERMINATION AND ESTABLISHMENT OF VEGETATION.
2. TEMPORARY RENTAL IRRIGATION SYSTEMS FOR DECKS WILL BE DESIGNED BY OTHERS, BUT SHALL FULFILL THE FOLLOWING MINIMUM CRITERIA:
   a. SHALL NOT LEAK NOR DRAIN MORE THAN 1 GPM FROM ANY POINT WHEN UNDER PRESSURE OR WHEN TURNED OFF.
   b. SHALL PROVIDE UNIFORM COVERAGE.
   c. SHALL SEPARATE AREAS WITH SLOPE OF 5:1 OR GREATER FROM AREAS WITH SLOPE OF LESS THAN 5:1.
   d. SHALL PROVIDE SUFFICIENT CAPABILITY OF AUTOMATIC CONTROL TO SATISFACTION OF SITE ENGINEER.

## NOZZLE SCHEDULE:

| NOZZLE NUMBER | HEAD TYPE | OPERATING PRESSURE | RADIUS * | GPM |
|---|---|---|---|---|
| LA-4 | HUNTER PGS | 60 PS1 | 28' | 2.0 |
| LA-5 | HUNTER PGS | 60 PS1 | 30' | 2.3 |
| LA-6 | HUNTER PGS | 60 PS1 | 35' | 3.0 |
| LA-7 | HUNTER PGS | 60 PS1 | 37' | 3.8 |
| LA-8 | HUNTER PGS | 60 PS1 | 38' | 4.7 |
| 7 | HUNTER PGS | 60 PS1 | 42' | 3.7 |
| 8 | HUNTER PGS | 60 PS1 | 44' | 4.6 |
| 9 | HUNTER PGS | 60 PS1 | 48' | 6.0 |
| 10 | HUNTER PGS | 60 PS1 | 49' | 7.6 |
| 11 | HUNTER I-40 | 60 PS1 | 50' | 9.8 |
| 41 | HUNTER I-40 | 60 PS1 | 53' | 11.5 |
| 42 | HUNTER I-40 | 60 PS1 | 55' | 12.3 |
| 43 | HUNTER I-40 | 60 PS1 | 59' | 15.5 |
| 44 | HUNTER I-40 | 60 PS1 | 65' | 20.0 |
| 45 | HUNTER I-40 | 60 PS1 | 69' | 22.0 |

* DO NOT USE RADIUS FOR SPACING HEADS. SEE SPACING CALLED OUT ON PLANS

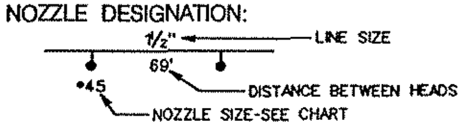
## EQUIPMENT LEGEND:

| SYMBOL | DESCRIPTION | REMARKS | DETAIL/REF |
|---|---|---|---|
| | CONTROLLER | RAINBIRD ESP-XX-C OR EQUAL SEE PLANS FOR NO. OF STATIONS | |
| P | EXISTING DUPLEX PUMP STATION | | |
| | POINT OF CONNECTION, EXISTING MAINLINE TO NEW MAINLINE | FURNISH AND INSTALL ANY NECESSARY FITTINGS | |
| | PRESSURE REGULATING REMOTE CONTROL VALVE ASSEMBLY | TORO 216-27-XX OR EQUAL SIZE PER VALVE SCHEDULE | |
| | ISOLATION VALVE ASSEMBLY | | |
| | QUICK COUPLER ASSEMBLY | | |
| | AIR & VACUUM RELIEF VALVE ASSEMBLY | | |
| | PRESSURE RELIEF VALVE ASSEMBLY | | |
| | DRAIN VALVE ASSEMBLY | | |
| | PRESSURE REDUCING VALVE ASSEMBLY | | |
| | FLOW SENSOR | | |
| S | EXISTING 6" STEEL MAINLINE | BY OTHERS | |
| S | NEW 6" STEEL MAINLINE | | |
| | EXISTING PVC MAINLINE | JOIN WITH CERTA-LOK REMOVABLE COUPLINGS. BURY PER DETAILS | |
| | NEW PVC MAINLINE | | |
| E E | CONDUIT FOR LV CONTROL WIRES | SCH 40 UVR PVC. PLACE ON GRADE NEXT TO MAIN. ANCHOR AT 10' O.C. MIN. BURY AT ALL BENCH OR ROAD CROSSINGS | |
| | SLEEVE | GALVANIZED STEEL | |
| | | | |
| | SCH 40 UVR PVC LATERAL LINE AND FITTINGS SIZE AS NOTED | BURY ALONG BENCHES AND ROADS REST ON SURFACE AND ANCHOR ON SLOPE FACES | |
| | SCH 40 UVR PVC LATERAL LINE AND FITTINGS ON SURFACE | "BROWNLINE", "SUNSTOP", OR EQUAL | |
| | IN-LINE SPRING LOADED CHECK VALVE | SEE CHECK VALVE CHART. LOCATE PER PLAN WHERE WATER FLOWS DOWNHILL | |
| N | IN-LINE SWING CHECK VALVE | FLO-CONTROL 1520 SERIES OR EQUAL. LOCATE PER PLAN WHERE WATER FLOWS UPHILL | |
| | THRUST BLOCK | | |

## SPRINKLER HEAD LEGEND:

| SYMBOL | DESCRIPTION | MANUF. & PART NO. | OPERATING PRESSURE | REMARKS | DETAIL |
|---|---|---|---|---|---|
| ● | ADJUSTABLE ARC ROTOR | HUNTER PGS-ADJ-XX | 60 P.S.I. | SEE NOZZLE SCHEDULE FOR GPM | C/L-2 B/L-2 |
| ○ | FULL CIRCLE ROTOR | HUNTER PGS-36V-XX | 60 P.S.I. | SEE NOZZLE SCHEDULE FOR GPM | C B |
| ■ | ADJUSTABLE ARC ROTOR | HUNTER I-40 | 60 P.S.I. | SEE NOZZLE SCHEDULE FOR GPM | C B |
| □ | FULL CIRCLE ROTOR | HUNTER I-40 | 60 P.S.I. | SEE NOZZLE SCHEDULE FOR GPM | C B |
| ▲ | SPRAY HEAD ON RISER | RAINBIRD PA-85 WITH 10Q-LA MPR NOZZLE AND PCS-030 SCREEN | 30 P.S.I. | 3' RAD. LOCATE HEAD UPSLOPE FROM PLANTING BASIN | A |

### NOZZLE DESIGNATION:




| DESIGNED | TB | | DATE 29FEB96 |
|---|---|---|---|
| DRAWN | MF | | 29FEB96 |
| CHECKED | CA | | 29FEB96 |
| SUPERVISED | | | 08AUG95 |
| PROJECT ENGR. | | R.C.E. NO. | |
| DIV./DIST. ENGR. | | R.C.E. NO. | |

ah'be

GEOSYNTEC CONSULTANTS
16541 Gothard Street, Suite 211
Huntington Beach, California 92647
Telephone: (714) 843-6866

LOPEZ CANYON LANDFILL

| NO. | REVISION DESCRIPTION | ENGR. | DATE |
|---|---|---|---|

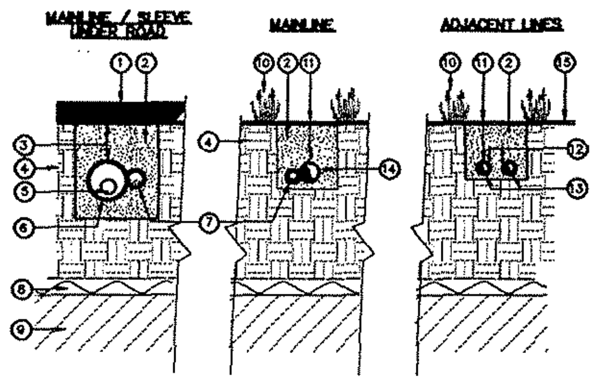
CITY OF LOS ANGELES
BUREAU OF SANITATION DELWIN A. BIAGI, DIRECTOR
DATE ________ 19____
STEPHEN A. FORTUNE R.C.E. NO. 21737
DIV. DIST. ENGR.

SCALE AS NOTED
SHEET NO. 8
DWG. NO. 6005id01.dgn
JOB NO. CE-1400

IRRIGATION LEGENDS AND NOTES

These plans are preliminary and are not to be used for bidding or construction until signed and approved.

FIGURE 8-14

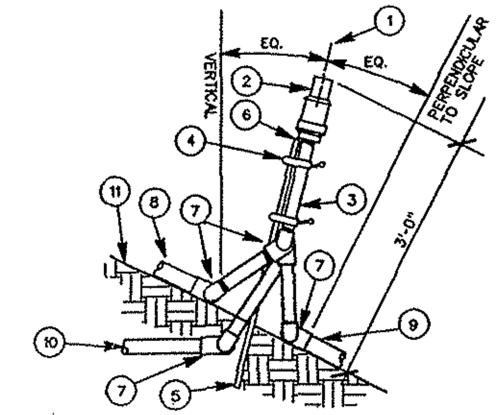



**LEGEND:**

1. BENCH OR ROAD. SEE GRADING PLANS.
2. COMPACTED SAND BACKFILL.
3. 12" CLEAR.
4. VEGETATIVE LAYER SOIL.
5. IRRIGATION LINE IN SLEEVE.
6. IRRIGATION SLEEVE UNDER ROAD.
7. CONDUIT WITH IRRIGATION CONTROL WIRES.
8. LOW PERMEABILITY LAYER - SEE COVER SYSTEM PLANS.
9. FOUNDATION LAYER.
10. VEGETATION.
11. 12" MINIMUM BELOW FINISH GRADE, TYPICAL.
12. 4" CLEAR BETWEEN IRRIGATION LINES, TYPICAL.
13. ADJACENT IRRIGATION LINES, SEE PLANS FOR SIZE
14. IRRIGATION MAINLINE AND CONTROL WIRES.
15. FINISH GRADE, TYPICAL.

**(D) IRRIGATION TRENCH DEPTHS**

N.T.S.

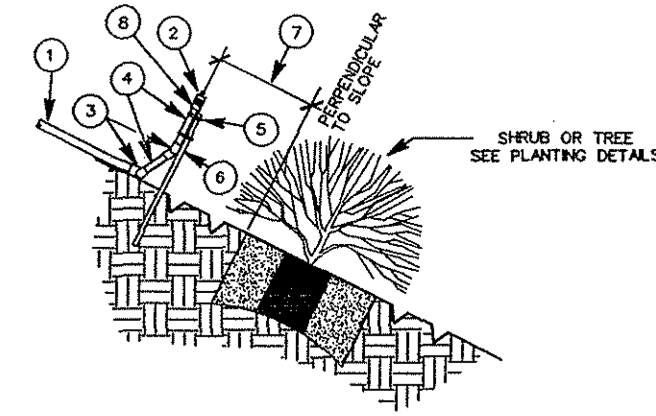



**LEGEND:**

1. ANGLE SPRINKLER ASSEMBLY MIDWAY BETWEEN VERTICAL AND PERPENDICULAR TO SLOPE FACE FOR OPTIMUM PERFORMANCE.
2. ROTOR TYPE SPRINKLER HEAD.
3. 12" SCH 80 TBE NIPPLE-SIZE PER ROTOR INLET
4. V.I.T. SPRINKLER TIE OR EQUAL (2 REQ'D)
5. #5 x 42" STEEL REBAR. DRIVE INTO SLOPE FACE 18" BELOW GRADE AND 24" ABOVE GRADE AT
6. CORRECT ANGLE AS SHOWN.
7. TOP OF REBAR EVEN WITH BASE OF SPRINKLER
8. SCH 40 UVR PVC THREADED ELLS-SIZE PER ROTOR INLET
9. UVR PVC LATERAL LINE ON SLOPE FACE. SIZE PER PLAN.
10. ANCHOR PER STD. PLAN 515-0
11. ALTERNATE LATERAL LINE POSITION PIPELINE POSITION AT BENCH PER DETAIL SLOPE FACE

**(B) ROTOR SPRINKLER ASSEMBLY**

N.T.S.

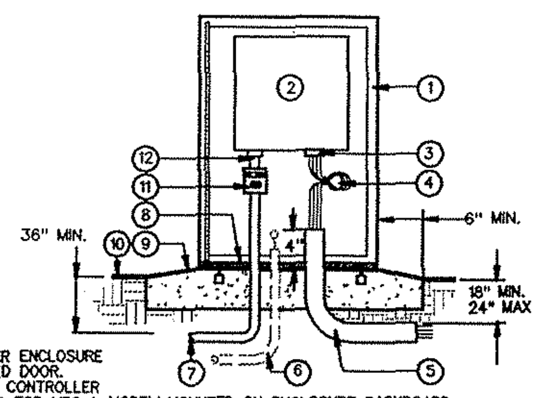



**LEGEND:**

1. UVR PVC LATERAL LINE
2. SPRAY HEAD PER PLAN
3. UVR THREADED ELLS
4. ½" x 8" SCH 80 NIPPLE
5. V.I.T. SPRINKLER TIE OR EQUAL (2 REQ'D)
6. #4 x 24" REBAR STAKE
7. 12" FOR 1 GAL. SHRUBS 24" FOR TREES
8. ½" ANTI-DRAIN CHECK VALVE- AS NECESSARY

**(A) SPRAY HEAD FOR CONTAINER PLANTING**

N.T.S.

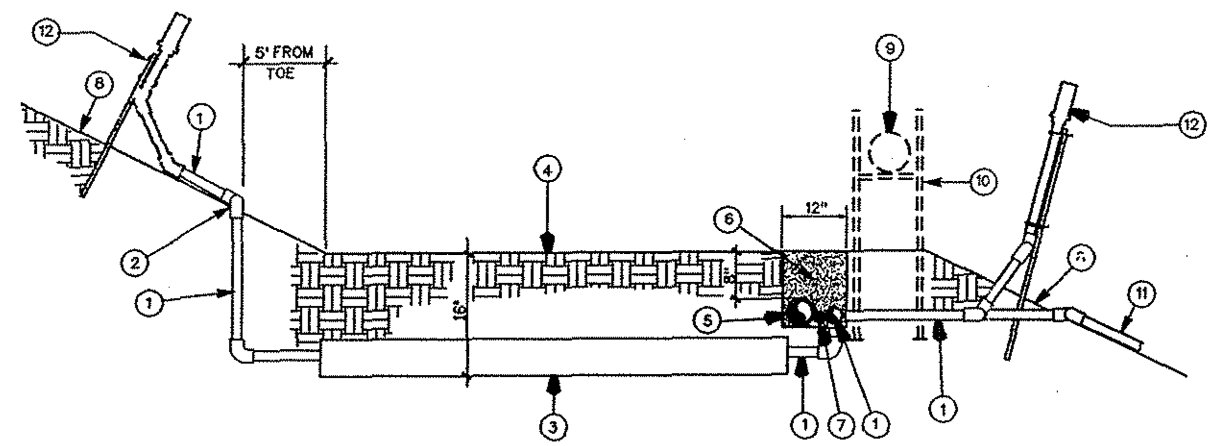



**LEGEND**

1. CONTROLLER ENCLOSURE WITH HINGED DOOR.
2. AUTOMATIC CONTROLLER (SEE PLANS FOR MFG. & MODEL) MOUNTED ON ENCLOSURE BACKBOARD.
3. INSTALL INSULATION ELECTRICAL BUSHING AT CONTROLLER TO AVOID WEAR ON CONTROL WIRES.
4. DIRECT BURIAL CONTROL WIRES TO CONTROL VALVES. INCLUDE 2' EXPANSION LOOP W/ ZIPLOCK TIES BELOW CONTROLLER.
5. 3" PVC LONG SWEEP ELL.
6. ¾" SCH 40 CONDUIT WITH PULL CORD FOR COMMUNICATION CABLE (WHERE APPLICABLE).
7. POWER SUPPLY WIRES IN CONDUIT.
8. ENCLOSURE BASE PLATE. INSTALL PER MANUFACTURER'S SPECIFICATION.
9. CAST IN PLACE CONCRETE BASE-6" MINIMUM THICKNESS, OR AS REQUIRED BY MANUFACTURER'S SPECIFICATION. EXTEND CONCRETE IN FRONT OF CABINET TO ALLOW UNOBSTRUCTED AREA FOR DOOR TO OPEN WITHOUT HITTING PLANT MATERIAL. SLOPE FINISH SURFACE AWAY FROM ENCLOSURE FOR DRAINAGE.
10. FINISH GRADE TO BE 1" BELOW FINISH SURFACE OF BASE IN TURF, 2" IN GROUNDCOVER.
11. 120 VOLT ON/OFF SWITCH W/15 AMP BREAKER, SQUARE D BREAKER BOX (MODEL #Q02-4L70S, OR EQUAL). INCLUDE CONVENIENCE OUTLET WITH BREAKER ASSEMBLY. 120 VOLT POWER & GROUND CONNECTION SHALL BE AT BREAKER BOX. MOUNT INSIDE ENCLOSURE.
12. CONDUIT FOR POWER SUPPLY WIRES FROM BREAKER BOX TO CONTROLLER.

**(E) AUTOMATIC CONTROLLER W/ ENCLOSURE**

N.T.S — IC01:4.28.95




**LEGEND:**

1. UVR SCH 40 PVC LATERAL LINE, SIZE PER PLAN
2. UVR SCH 40 PVC THREADED ELLS SWING JOINT
3. PVC SLEEVE PER SPECS
4. LANDFILL ROAD OR BENCH
5. IRRIGATION MAINLINE PER PLANS
6. BACKFILL TRENCH PER SPECS
7. LV CONTROL WIRES IN CONDUIT
8. SLOPE FACE
9. EXISTING LANDFILL GAS COLLECTION PIPE - SEE GAS PLANS
10. EXISTING NON-CONTINUOUS GAS PIPE SUPPORT RACK BY OTHERS - SEE GAS PLANS
11. ALTERNATE PIPE POSITION
12. ROTOR SPRINKLER ASSEMBLY - SEE DETAIL

**(C) IRRIGATION PIPELINE POSITIONING ON LANDFILL BENCH**

N.T.S.

| | | |
|---|---|---|
| DESIGNED | TB | 29FEB96 |
| DRAWN | MF | 29FEB96 |
| CHECKED | CA | 29FEB96 |
| SUPERVISED | | |
| PROJECT ENGR. | R.C.E. NO. | |
| DIV./DIST. ENGR. | R.C.E. NO. | |

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LOPEZ CANYON LANDFILL

CITY OF LOS ANGELES
BUREAU OF SANITATION — DELWIN A. BIAGI, DIRECTOR

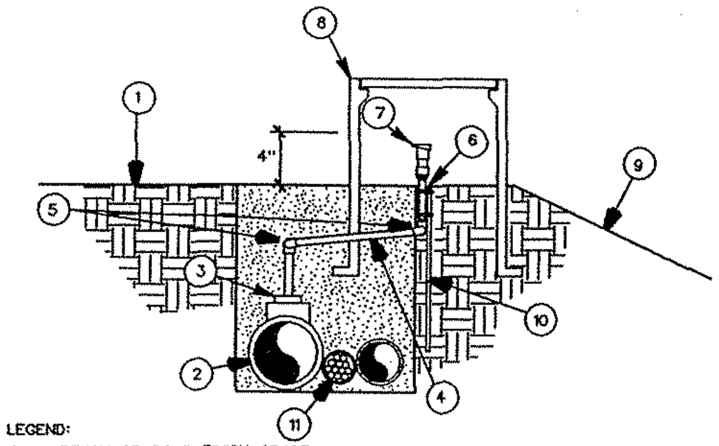
STEPHEN A. FORTUNE, DIV. DIST. ENGR. — R.C.E. NO. 21737

SCALE: AS NOTED
SHEET NO. 9
DWG. NO. 6005id02.dgn
JOB NO. CE-1400

IRRIGATION DETAILS I

FIGURE 8-15

These plans are preliminary and are not to be used for bidding or construction until signed and approved.

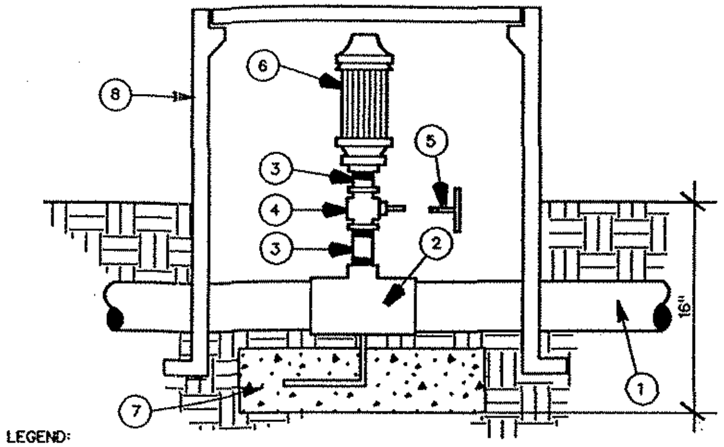



LEGEND:

1. BENCH OR ROAD FINISH GRADE
2. SLIP TEE ON PVC MAINLINE
3. REDUCING FITTING
4. SCH. 80 TBE NIPPLE
5. 1" SCH 80 THREADED ELLS SWING JOINT
6. 1" x 6" SCH 80 TBE NIPPLE
7. QUICK COUPLER- TORO 474-11 OR EQUAL (LOCATE PER PLAN)
8. 12" x 17" x 18" DEEP PLASTIC VALVE BOX, CARSON #C1015H-1 OR EQUAL WITH SOLID BOLD DOWN LID
9. SLOPE FACE
10. 18" #4 REBAR STAKE W/ TWO STAINLESS STEEL HOSE CLAMPS
11. CONTROL WIRES IN CONDUIT

**(E) QUICK COUPLER ASSEMBLY**

N.T.S.

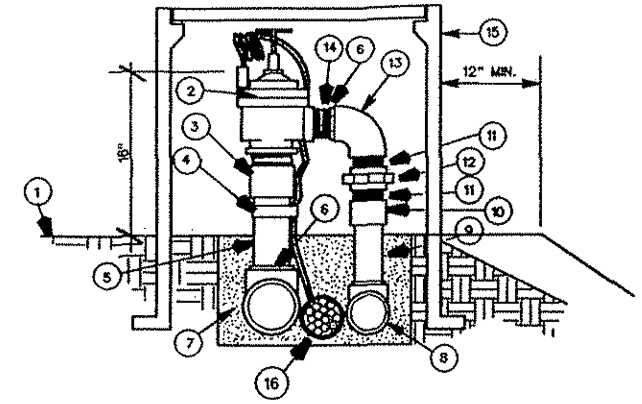



LEGEND:

1. BURIED PVC MAINLINE
2. SCH 80 PVC TEE WITH 2" NIPT OUTLET
3. 2"x4" SCH 80 PVC NIPPLE
4. 2" GATE VALVE, NORMALLY OPEN NIBCO T-136L WITH LOCKSHIELD KEY, OR EQUAL
5. LOCKSHIELD KEY
6. 2" COMBINATION AIR RELEASE VALVE BERMAD #4415, OR EQUAL
7. 12"x12"x4" THICK CONCRETE SUPPORT BLOCK WITH #4 REBAR-LENGTH AS REQUIRED STAKE NOT TO EXCEED HEIGHT OF ASSEMBLY. ATTACH ASSEMBLY WITH NON-CORROSIVE PIPE SUPPORT STRAP.
8. 12" x 17" x 24" DEEP PLASTIC VALVE BOX, CARSON #C1015H-1 OR EQUAL WITH SOLID BOLT DOWN LID. BORE 8 1" DIA. HOLES IN LID.

**(G) AIR AND VACUUM RELEASE ASSEMBLY**

N.T.S.

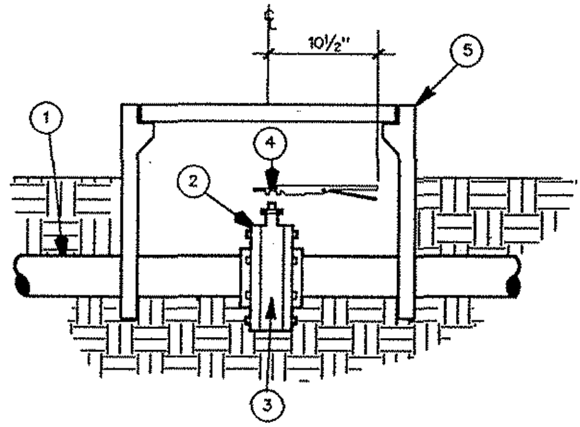



LEGEND:

1. LANDFILL BENCH OR ROAD
2. 3" OR 21/2" REMOTE CONTROL VALVE (RCV). SMALLER VALVES ARE GLOBE PATTERN, ADJUST FITTINGS AS NECESSARY
3. SCH 80 PVC MALE ADAPTOR
4. CONTROL WIRES TAPED TO PIPE
5. SCH 80 PVC OR YELOMINE PVC PIPE SIZE PER # 9
6. SCH 80 PVC REDUCING BUSHING IF NECESSARY
7. YELOMINE PVC MAINLINE FITTING-LINE SIZE
8. SCH 40 UVR PVC LATERAL LINE FITTING
9. SCH 40 UVR PVC LATERAL LINE, SIZE PER PLAN
10. SCH 40 UVR PVC MALE ADAPTOR SIZE PER #9
11. SCH 80 PVC TBE NIPPLE SIZE PER #9
12. GALVANIZED STEEL UNION SIZE PER #9
13. SCH 80 PVC ELL SIZE PER #9
14. SCH 80 PVC TBE NIPPLE SIZE PER RCV OUTLET
15. 12" x 17" x 24" DEEP PLASTIC VALVE BOX, CARSON #C1015H-1 OR EQUAL WITH SOLID BOLT DOWN COVER ADD EXTENSIONS IF NECESSARY
16. CONTROL WIRES IN CONDUIT

**(H) REMOTE CONTROL VALVE ASSEMBLY**

N.T.S.

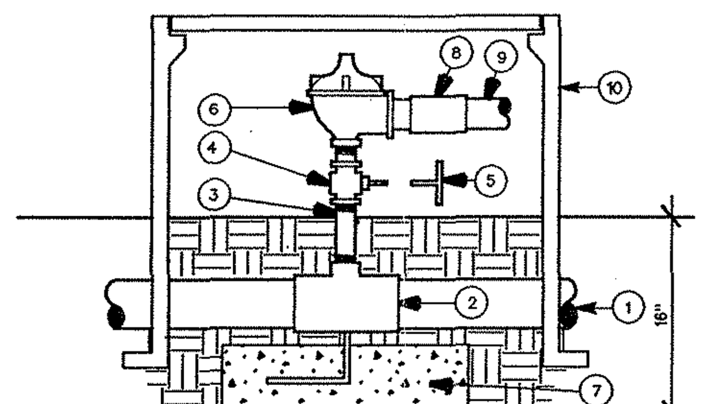



LEGEND:

1. BURIED PVC MAINLINE
2. SCH 80 PVC TRANSITION FITTING WITH NEW BOLTS AND GASKETS
3. BUTTERFLY VALVE, LINE SIZED, NIBCO LD 2000 WITH 47078 LEVER LOCK OR EQUAL
4. LEVER LOCK OPERATOR
5. 24" x 36" PLASTIC METER BOX, CARSON #1730 OR EQUAL. WITH BOLT DOWN LID

**(F) ISOLATION VALVE**

N.T.S.

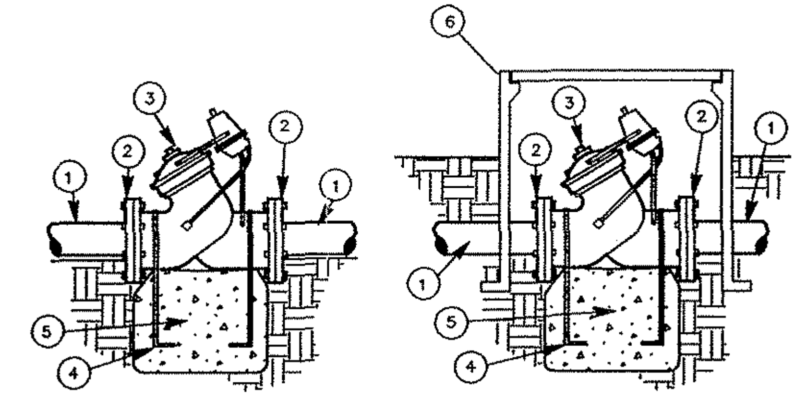



LEGEND:

1. BURIED PVC MAINLINE.
2. PVC TEE WITH 2" NIPT OUTLET
3. 2"x4" SCH 80 PVC TBE NIPPLE.
4. 2" GATE VALVE, NORMALLY OPEN NIBCO T-136L WITH LOCKSHEILD AND KEY, OR EQUAL.
5. 4"x4"x2" SST SCH 80 PVC TEE. SOLVENT WELD ON MAINLINE. LOCKSHEILD KEY
6. 2" PRESSURE RELIEF VALVE WITH 145-180 PSI RANGE CLAYTON MODEL# 50A-01, BAILEY MODEL 118, OR EQ. ADJUST TO 150 PSI LIMIT
7. 12"x12"x4" THICK CONCRETE SUPPORT BLOCK WITH #4 REBAR-LENGTH AS REQUIRED. STAKE NOT TO EXCEED HEIGHT OF ASSEMBLY. ATTACH ASSEMBLY WITH NON-CORROSIVE PIPE SUPPORT STRAPS
8. 2" URV PVC MALE ADAPTER
9. 2" UVR PVC SHC 40 PIPE. EXTEND 10' DOWN SLOPE AWAY FROM ASSEMBLY
10. 12" x 17" x 24" DEEP PLASTIC VALVE BOX, CARSON #C1015H-1 OR EQUAL WITH SOLID BOLT DOWN LID

**(C) PRESSURE RELIEF ASSEMBLY**

N.T.S.



ON GRADE

BELOW GRADE

LEGEND:

1. MAINLINE-PIPE TYPE VARIES
2. TRANSITION FLANGE FOR MAINLINE PIPE
3. PRESSURE REDUCING VALVE 3" BERMAD 720 OR EQUAL, ADJUST DOWNSTREAM PRESSURE TO MINIMUM NECESSARY FOR OPTIMUM OPERATION OF DOWNSTREAM ASSEMBLIES
4. STEEL ANCHOR ROD; LOOP OVER VALVE
5. THRUST BLOCK-MIN. 2 CU. FT.
6. 12" x 17" x 24" DEEP PLASTIC VALVE BOX CARSON #C1015H-1 OR EQUAL WITH SOLID BOLT DOWN LID

**(D) PRESSURE REDUCING VALVE ASSEMBLY**

N.T.S.

| | |
|---|---|
| DESIGNED | TB | 29FEB96 |
| DRAWN | MF | 29FEB96 |
| CHECKED | CA | 29FEB96 |
| SUPERVISED | | |
| PROJECT ENGR. | R.C.E. NO. | |
| DIV./DIST. ENGR. | R.C.E. NO. | |

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16541 Gothard Street, Suite 211
Huntington Beach, California 92647
Telephone: (714) 843-6866

LOPEZ CANYON LANDFILL

NO. | REVISION DESCRIPTION | ENGR. | DATE

CITY OF LOS ANGELES
BUREAU OF SANITATION DELWIN A. BIAGI, DIRECTOR
DATE ________ 19___
STEPHEN A. FORTUNE R.C.E. NO. 21737
DIV. DIST. ENGR.

SCALE AS NOTED

SHEET NO. 10

DWG. NO. 6005id03.dgn

JOB NO. CE-1400

IRRIGATION DETAILS II

FIGURE 8-16

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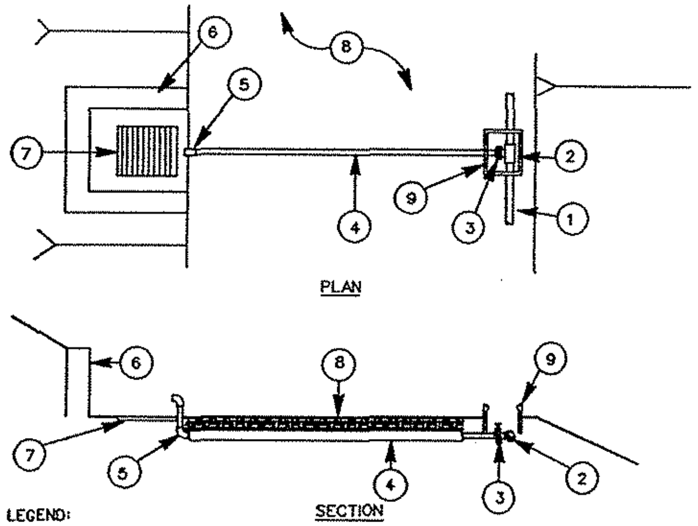



LEGEND:

1. BURIED PVC MAINLINE
2. PVC TEE-LINE SIZE
3. BUTTERFLY VALVE, LINE SIZED, NIBCO LD 2000 WITH 47078 LEVER LOCK OR EQUAL
4. 3" UVR PVC PIPE-SLEEVE BELOW BENCH OR ROAD
5. FIT UVR PVC ELLS AND PIPE TO EXIT OVER CATCH BASIN
6. RETAINING WALL-SEE GRADING AND DRAINAGE PLANS
7. CATCH BASIN INLET-SEE GRADING AND DRAINAGE PLANS
8. BENCH OR ROADWAY
9. 24" x 36" PLASTIC VALVE BOX, CARSON #1730 OR EQUAL, WITH BOLT DOWN LID

## (A) DRAIN VALVE ASSEMBLY

N.T.S.

WATER LINE SLEEVING

| ≤ SCH. 40 PVC PIPE SIZE | SLEEVE SIZE |
|---|---|
| ½" | 2" |
| ¾" | 2" |
| 1" | 2½" |
| 1¼" | 3" |
| 1½" | 3" |
| 2" | 4" |
| 2½" | 6" |
| 3" | 6" |
| 4" | 8" |

CONTROL WIRE SLEEVING

| MAX. NO. OF #14 UF WIRES | SCH. 40 PVC SLEEVE SIZE |
|---|---|
| 7 | ¾" |
| 11 | 1" |
| 16 | 1¼" |
| 23 | 1½" |
| 35 | 2" |
| 47 | 2½" |
| 70 | 3" |

## (B) IRRIGATION SLEEVING SCHEDULES

| DESCRIPTION | LINE SIZE | MANUFACTURER | PART NO. | PSI RANGE | REMARKS |
|---|---|---|---|---|---|
| ADJUSTABLE SPRING SPRING CHECK VALVE | 1" | FLO-CONTROL INC OR EQUAL | 1205-10 | 0-14 | THREADED PVC SOLVENT WELD PVC |
| ADJUSTABLE SPRING SPRING CHECK VALVE | 1¼" | FLO-CONTROL INC OR EQUAL | 1205-12 | 0-14 | THREADED PVC |
| ADJUSTABLE SPRING SPRING CHECK VALVE | 1½" | FLO-CONTROL INC OR EQUAL | 1205-15 | 0-14 | THREADED PVC |
| ADJUSTABLE SPRING SPRING CHECK VALVE | 2" | FLO-CONTROL INC OR EQUAL | 1205-20 | 0-14 | THREADED PVC |
| ADJUSTABLE SPRING SPRING CHECK VALVE | 2½" | FLO-CONTROL INC OR EQUAL | 1205-25 | 0-14 | THREADED PVC |
| ADJUSTABLE HYDRAULIC CHECK VALVE | 3" | RAIN FOR RENT (805) 525-3306 OR EQUAL | 3"-43Q.0-30 | 0-30 | THREADED METAL |

## (I) SPRING TYPE CHECK VALVE CHART

DESIGNED TB 29FEB96
DRAWN MF 29FEB96
CHECKED CA 29FEB96
SUPERVISED
PROJECT ENGR. R.C.E. NO.
DIV./DIST. ENGR. R.C.E. NO.

GEOSYNTEC CONSULTANTS
16541 Gothard Street, Suite 211
Huntington Beach, California 92647
Telephone: (714) 843-6866

LOPEZ CANYON LANDFILL

NO. | REVISION DESCRIPTION | ENGR. | DATE

CITY OF LOS ANGELES
BUREAU OF SANITATION DELWIN A. BIAGI, DIRECTOR
DATE ________ 19__
STEPHEN A. FORTUNE R.C.E. NO. 21737 DIV. DIST. ENGR.

SCALE AS NOTED
SHEET NO. 11
DWG. NO. 6005id04.dgn
JOB NO. CE-1400

IRRIGATION DETAILS III

FIGURE 8-17

These plans are preliminary and are not to be used for bidding or construction until signed and approved.

# LOPEZ CLOSURE SCHEDULE (CITY FORCES ONLY)

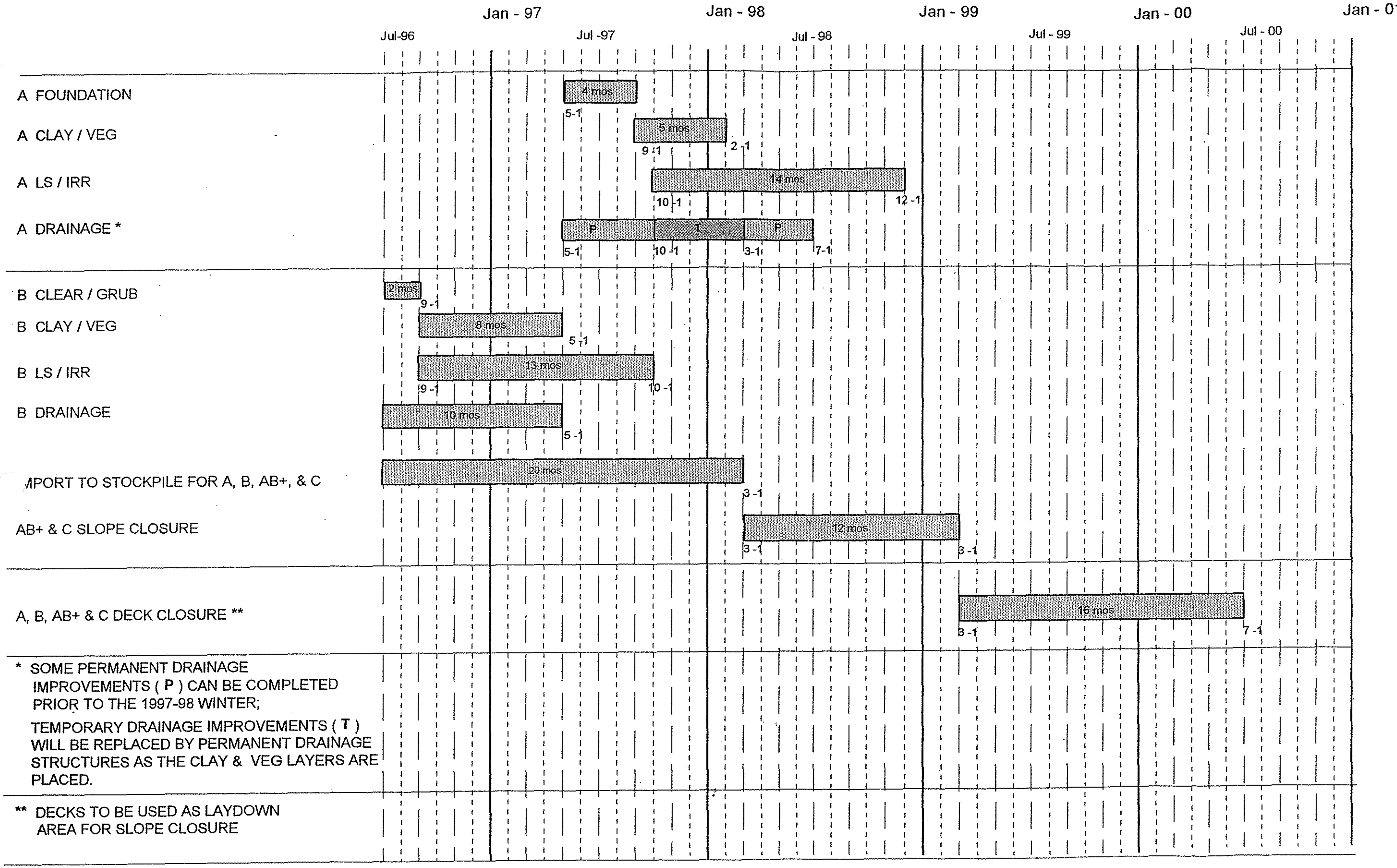
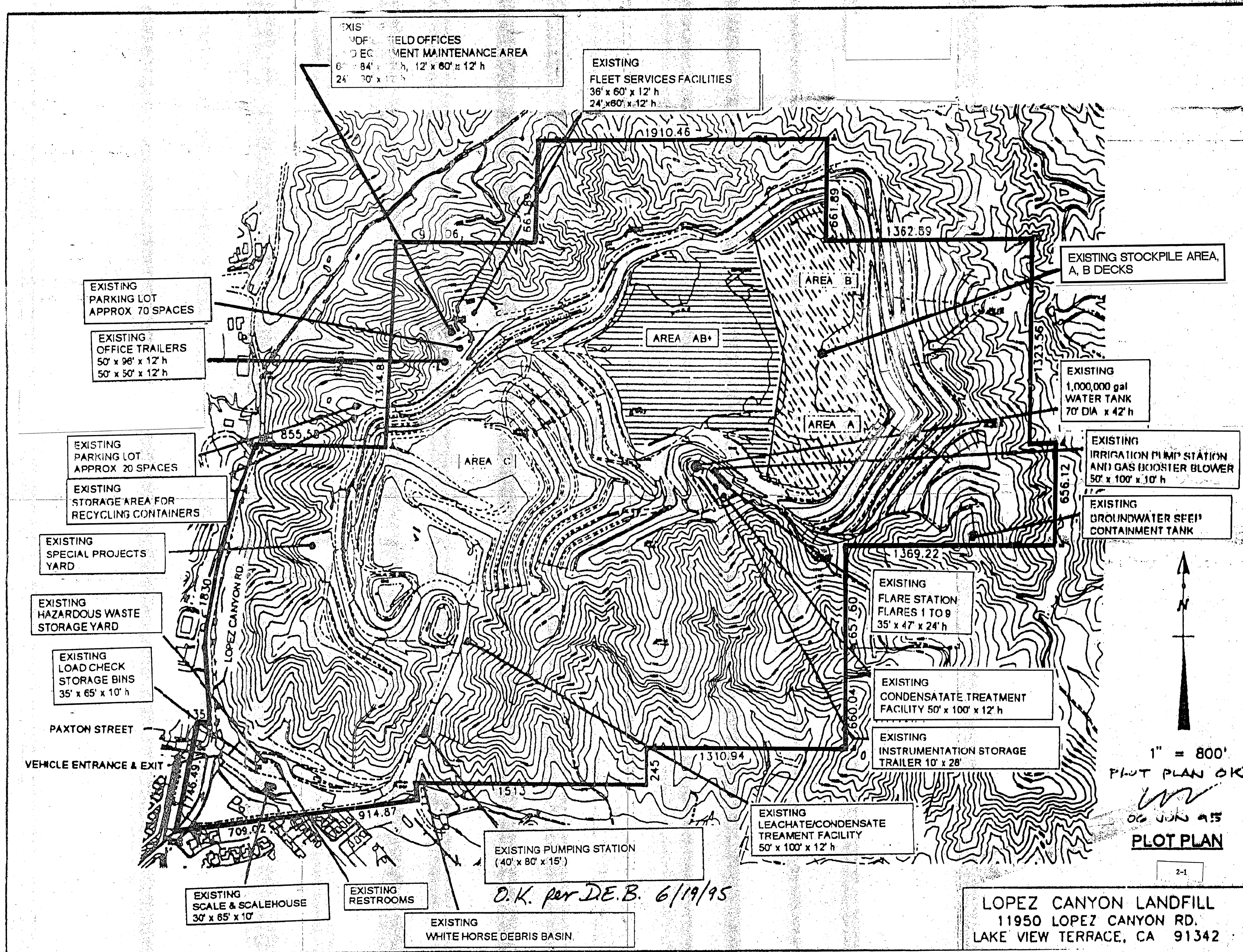
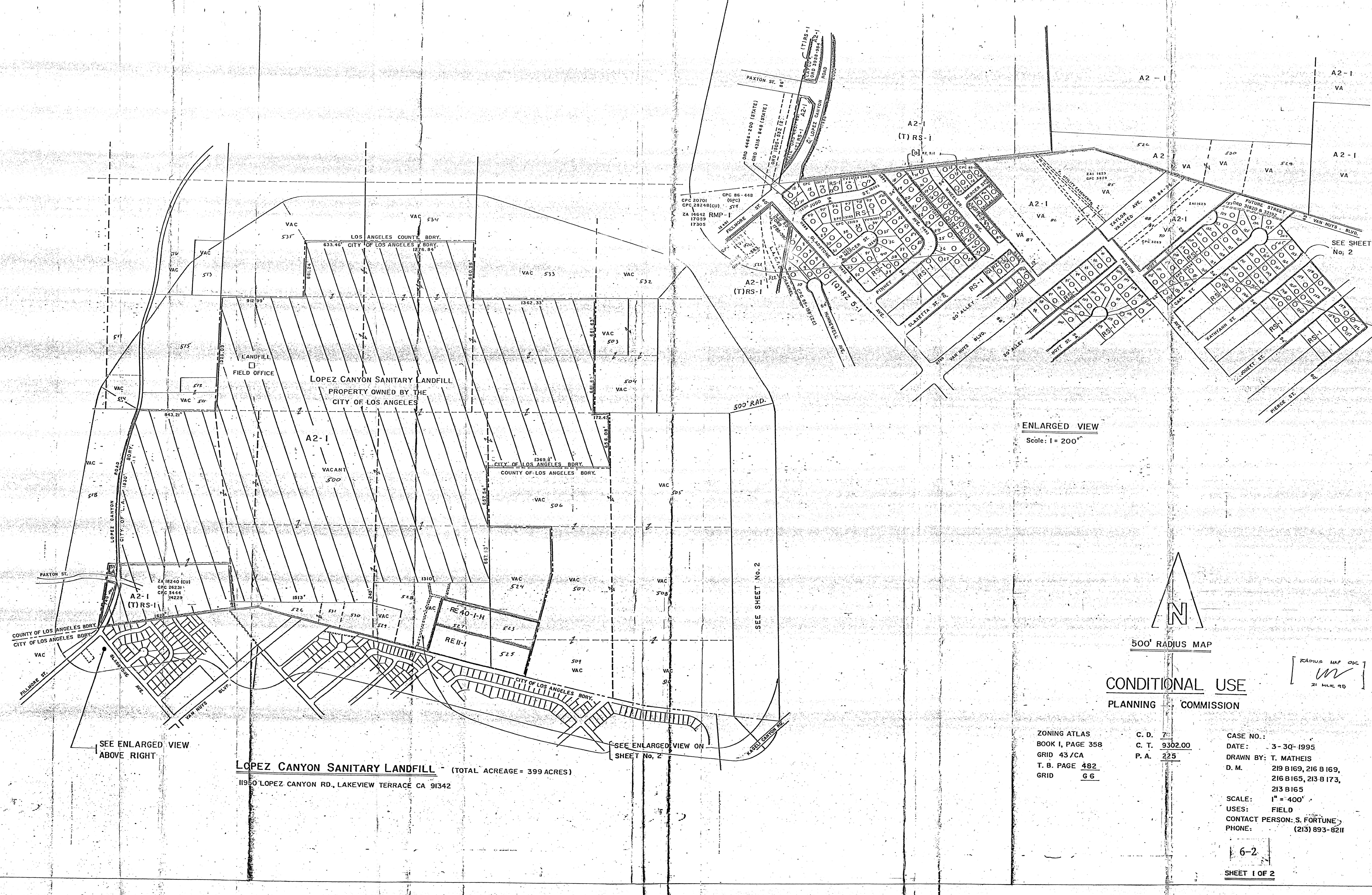
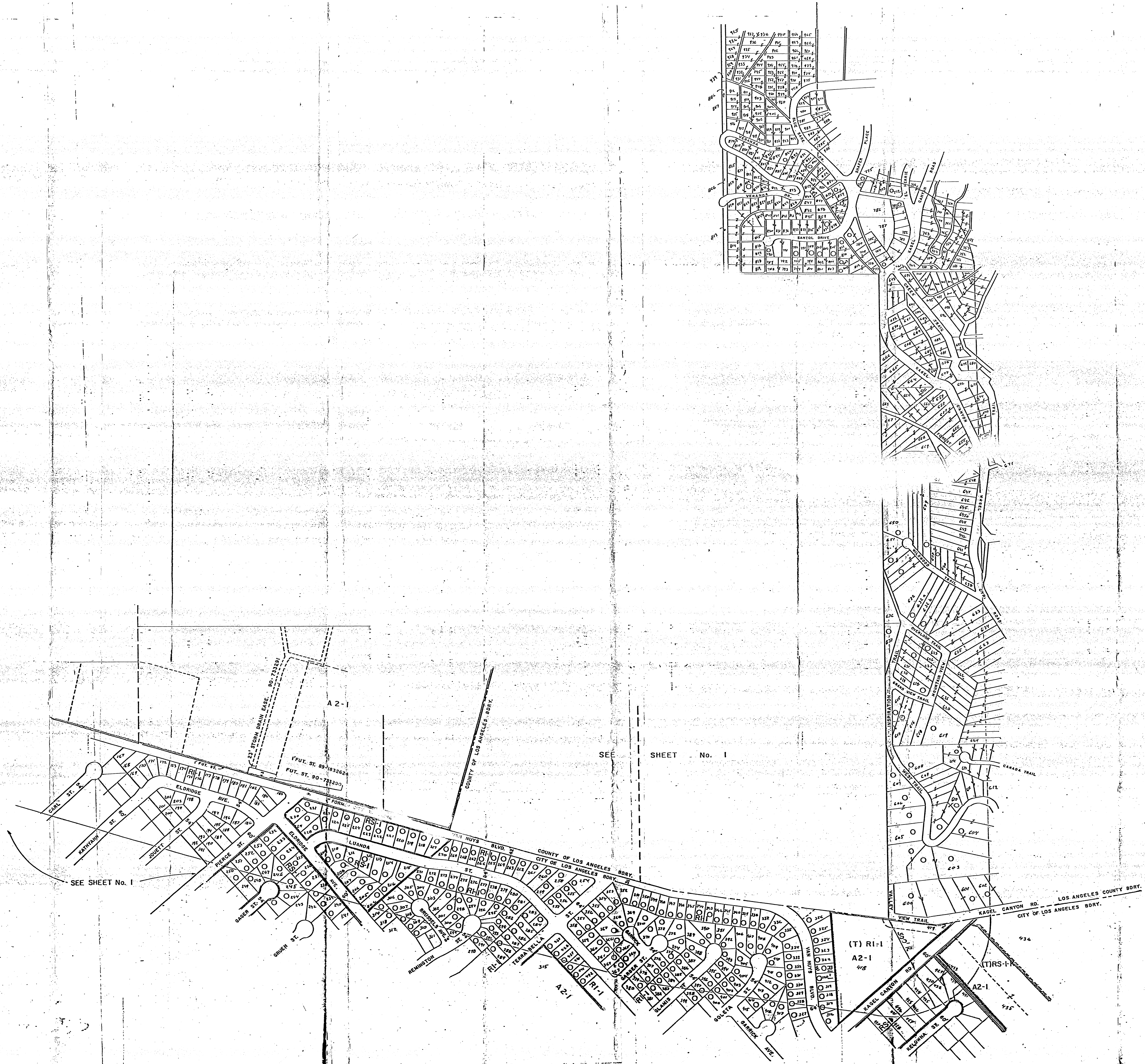



**FIGURE 10-1**


ELD OFFICES
MENT MAINTENANCE AREA
12' x 60' x 12' h
EXISTING
FLEET SERVICES FACILITIES
36' x 60' x 12' h
24' x 60' x 12' h
1910.46
661.89
1362.89
EXISTING STOCKPILE AREA, A, B DECKS
AREA B
AREA AB+
AREA A
AREA C
1323.56
EXISTING
1,000,000 gal
WATER TANK
70' DIA x 42' h
EXISTING
IRRIGATION PUMP STATION
AND GAS BOOSTER BLOWER
50' x 100' x 10' h
656.12
EXISTING
GROUNDWATER SEEP
CONTAINMENT TANK
1369.22
EXISTING
FLARE STATION
FLARES 1 TO 9
35' x 47' x 24' h
657.60
EXISTING
CONDENSATATE TREATMENT
FACILITY 50' x 100' x 12' h
660.04
EXISTING
INSTRUMENTATION STORAGE
TRAILER 10' x 28'
1310.94
245
1513
EXISTING
LEACHATE/CONDENSATE
TREAMENT FACILITY
50' x 100' x 12' h
EXISTING PUMPING STATION
(40' x 80' x 15')
914.87
709.72
746.49
EXISTING
WHITE HORSE DEBRIS BASIN
EXISTING
RESTROOMS
EXISTING
SCALE & SCALEHOUSE
30' x 65' x 10'
VEHICLE ENTRANCE & EXIT
PAXTON STREET
EXISTING
LOAD CHECK
STORAGE BINS
35' x 65' x 10' h
EXISTING
HAZARDOUS WASTE
STORAGE YARD
LOPEZ CANYON RD.
1830
EXISTING
SPECIAL PROJECTS
YARD
EXISTING
STORAGE AREA FOR
RECYCLING CONTAINERS
EXISTING
PARKING LOT
APPROX. 20 SPACES
855.58
1314.8
EXISTING
OFFICE TRAILERS
50' x 96' x 12' h
50' x 50' x 12' h
EXISTING
PARKING LOT
APPROX. 70 SPACES
N
1" = 800'
PLOT PLAN OK
06 JUN 95
PLOT PLAN
2-1
O.K. per D.E.B. 6/19/95
LOPEZ CANYON LANDFILL
11950 LOPEZ CANYON RD.
LAKE VIEW TERRACE, CA 91342


LOPEZ CANYON SANITARY LANDFILL
PROPERTY OWNED BY THE
CITY OF LOS ANGELES
LANDFILL FIELD OFFICE
A2-1
VACANT
500
LOS ANGELES COUNTY BDRY.
CITY OF LOS ANGELES BDRY.
COUNTY OF LOS ANGELES BDRY.
500' RAD.
SEE SHEET No. 2
PAXTON ST.
A2-1
(T) RS-1
ZA 16240 (CU)
CPC 26231
CPC 5444
14229
RE 40-1-H
RE 11-1
FILLMORE ST.
GLADSTONE AVE.
VAN NUYS BLVD.
KAGEL CANYON RD.
SEE ENLARGED VIEW ABOVE RIGHT
SEE ENLARGED VIEW ON SHEET No. 2
LOPEZ CANYON SANITARY LANDFILL (TOTAL ACREAGE = 399 ACRES)
11950 LOPEZ CANYON RD., LAKEVIEW TERRACE CA 91342
ENLARGED VIEW
Scale: 1 = 200'
SEE SHEET No. 2
TAYLOR AVE. VACATED
FUTURE STREET
VAN NUYS BLVD.
PIERCE ST.
JOUETT ST.
CARL ST.
FENTON AVE.
HOYT ST.
CLAZETTA ST.
PINNEY ST.
RS-1
A2-1
VA
RMP-1
(Q) RZ 5-1
N
500' RADIUS MAP
CONDITIONAL USE
PLANNING COMMISSION
ZONING ATLAS
BOOK I, PAGE 358
GRID 43/CA
T. B. PAGE 482
GRID G6
C. D. 7
C. T. 9302.00
P. A. 225
CASE NO.:
DATE: 3-30-1995
DRAWN BY: T. MATHEIS
D. M. 219 B 169, 216 B 169, 216 B 165, 213 B 173, 213 B 165
SCALE: 1" = 400'
USES: FIELD
CONTACT PERSON: S. FORTUNE
PHONE: (213) 893-8211
6-2
SHEET 1 OF 2




N

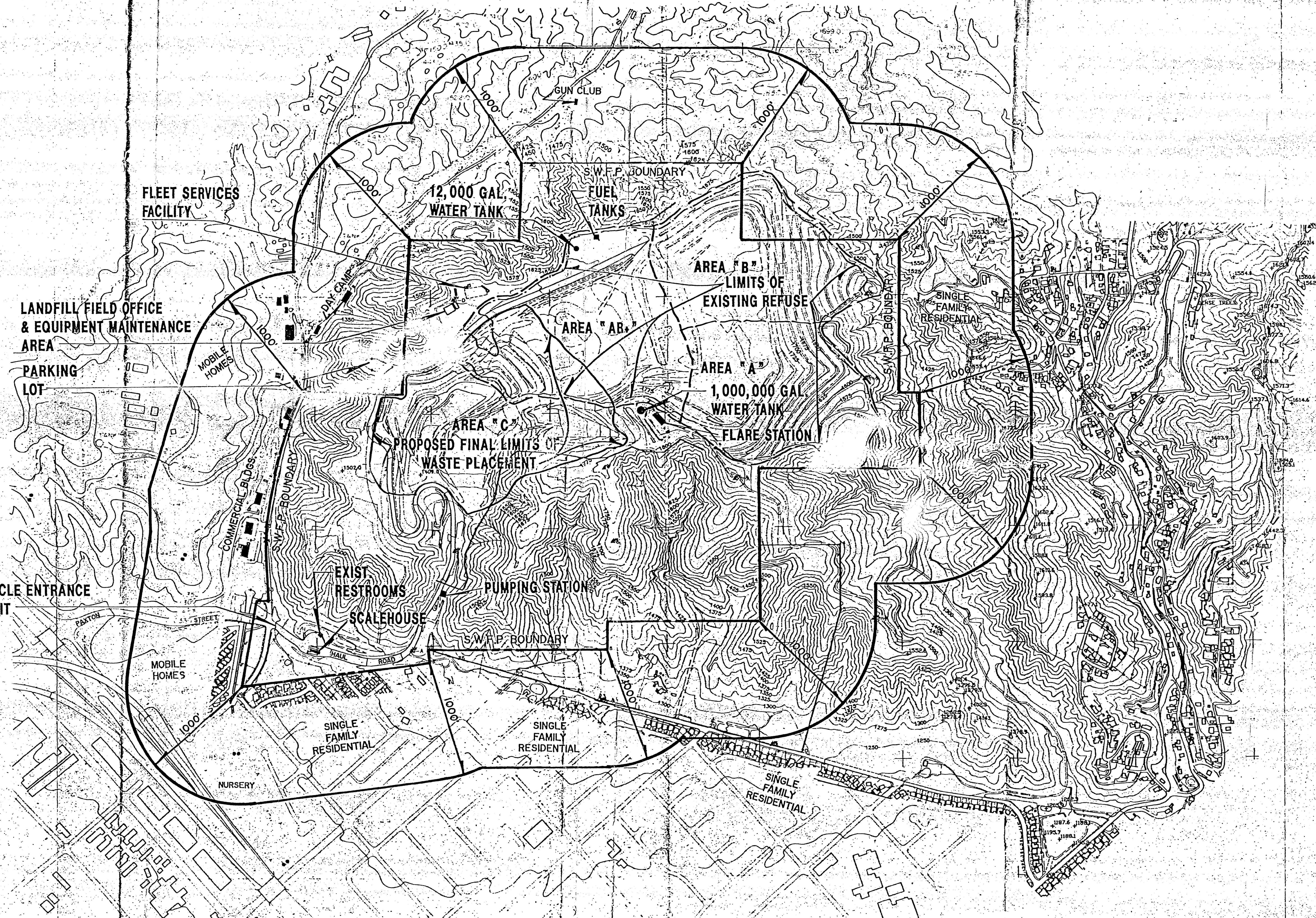
500' RADIUS MAP

SCALE: 1" = 200'

6-2

CASE No.
DATE: 3-30-1995

SHEET 2 OF 2




N

GRAPHIC SCALE

500 0 250 500 1000 2000

( IN FEET )
1 inch = 500 ft.

TOTAL ACREAGE UNDER SOLID WASTE FACILITY PERMIT ( S.W.F.P. ) ( INCLUDES SEVEN ACRE PARCEL LEASED FROM THE U.S. FOREST SERVICE ) = 399 ACRES

NOT FOR CONSTRUCTION

CLOSURE PLAN
1000' RADIUS MAP

| | |
|---|---|
| DESIGNED | DATE |
| DRAWN | |
| CHECKED | |
| SUPERVISED | |
| PROJECT ENGR. | R.E. NO. |
| ASST. DIV./DIST. ENGR. | R.E. NO. |

BAS
BRYAN A. STIRRAT & ASSOCIATES
CIVIL AND ENVIRONMENTAL ENGINEERS
1360 VALLEY VISTA DRIVE
DIAMOND BAR, CA. 91765
(714)860-7777

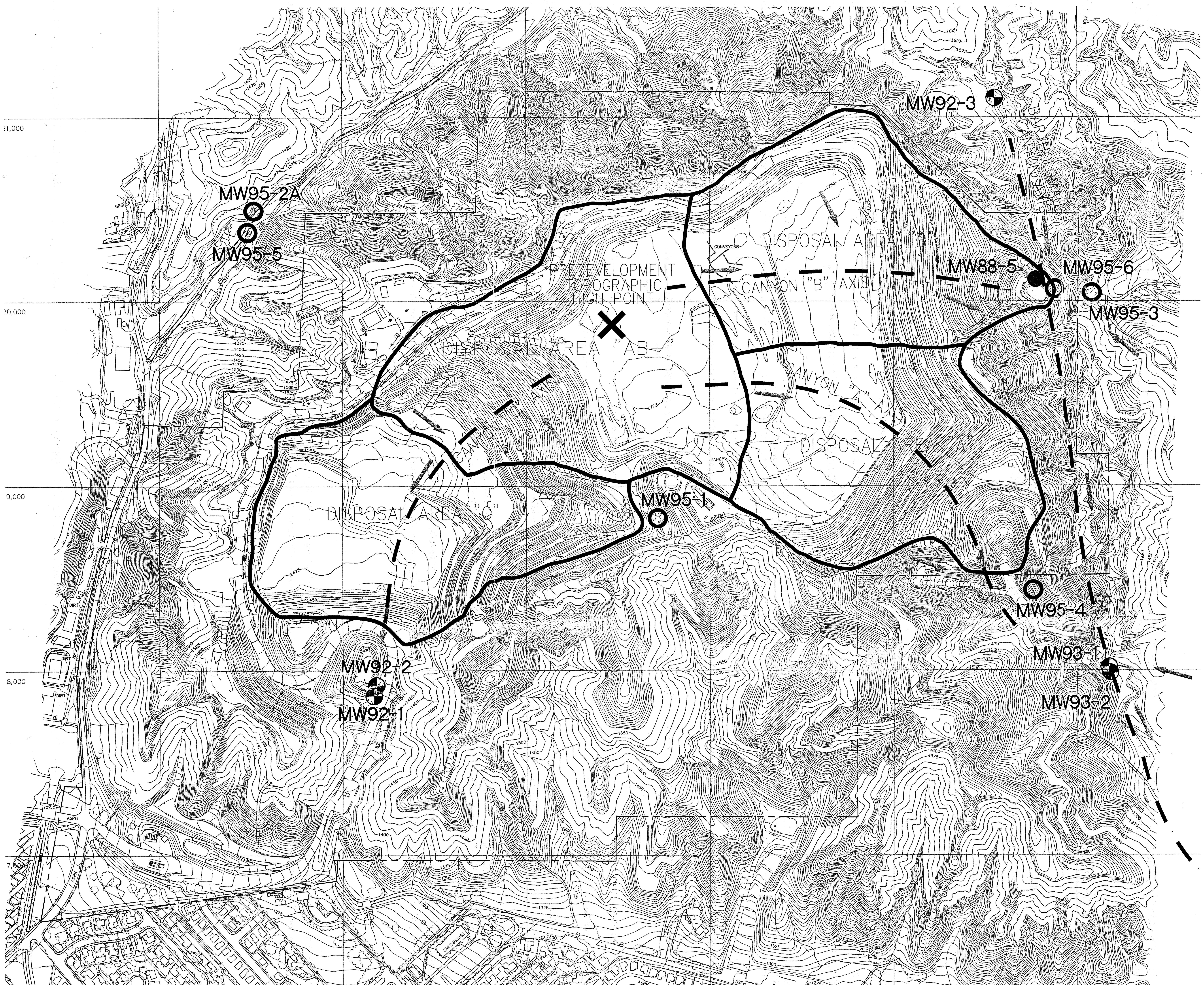
LOPEZ CANYON LANDFILL

GENERAL REVISIONS — REVISION DESCRIPTION — DIV./DIST. ENGR. — DATE
SPD / KG — JAN 93

CITY OF LOS ANGELES

SCALE
SHEET NO.
DWG. NO. 6-1

SCALES HORIZ. 1"= VERT. 1"= | SHEET OF | INDEX NUMBER




## LEGEND

| | |
|---|---|
| MW88-4 | GROUND-WATER MONITORING WELLS CONSTRUCTED IN 1988 |
| MW93-1 | GROUND-WATER MONITORING WELLS CONSTRUCTED IN 1992/1993 |
| MW95-4 | GROUND-WATER MONITORING WELLS CONSTRUCTED IN 1995 |
| | APPROXIMATE LANDFILL BOUNDARIES (TO BE REVISED ALONG ACCESS ROAD) |
| | WASTE DISPOSAL BOUNDARIES |
| | GROUND WATER FLOW DIRECTION |
| | CANYON AXIS |

250 125 0 250 500
SCALE IN FEET

DWG: 4100-414 199603221045 AB

# REVISED GROUND-WATER MONITORING NETWORK

| | | | |
|---|---|---|---|
| DESIGNED | MSS | | 02-16-96 |
| DRAWN | JT | | 02-20-96 |
| CHECKED | EK | | 02-29-96 |
| SUPERVISED | EK | | 02-29-96 |
| PROJECT ENGR. | | R.C.E. NO. | |
| DIV./DIST. ENGR. | | R.C.E. NO. | |

GEOSYNTEC CONSULTANTS
2100 Main Street, Suite 150
Huntington Beach, California 92648
Telephone: (714) 969-0800

LOPEZ CANYON LANDFILL

| NO. | REVISION DESCRIPTION | ENGR. | DATE |
|---|---|---|---|

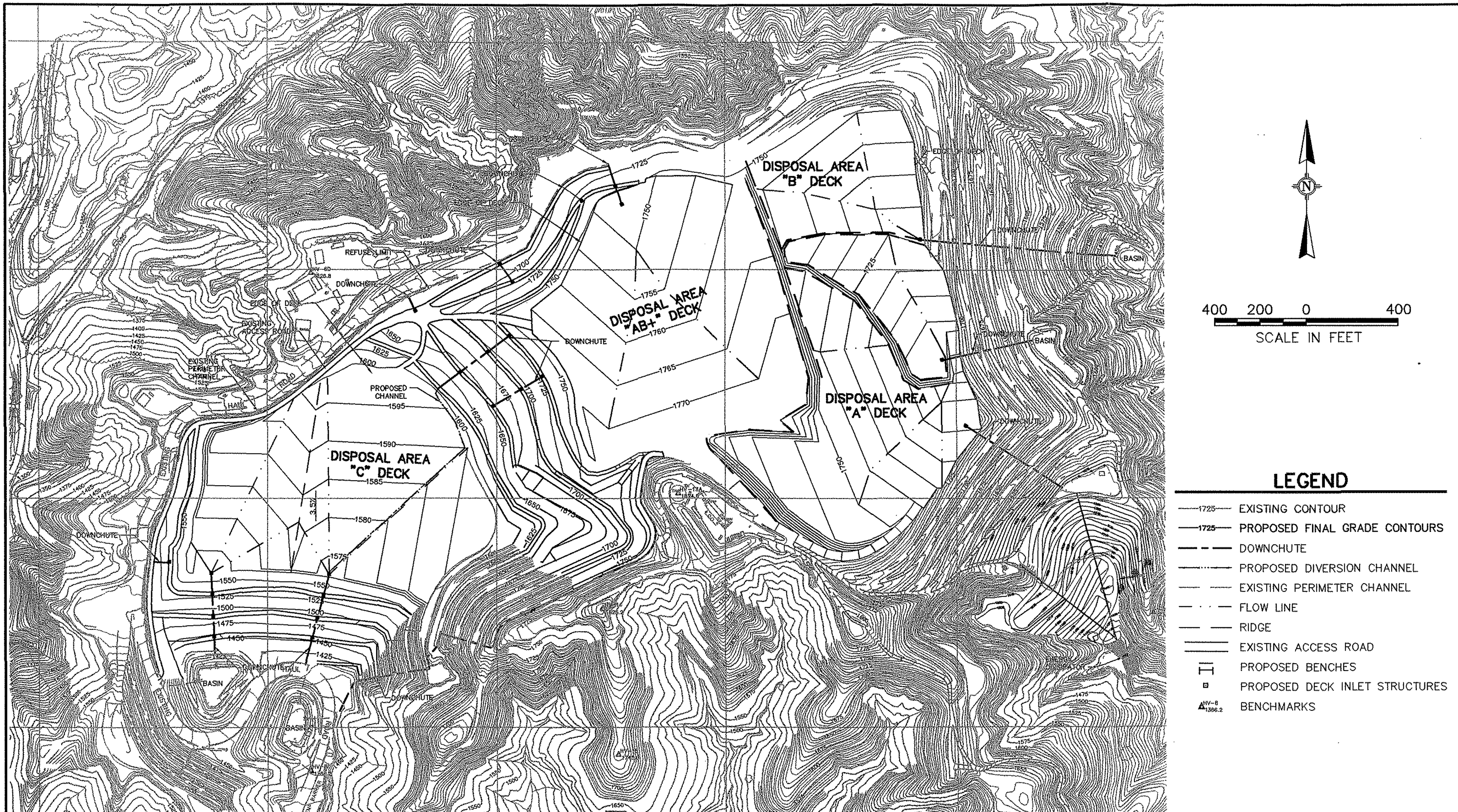
CITY OF LOS ANGELES
BUREAU OF SANITATION DELWIN A. BIAGI, DIRECTOR
DATE ______________ 19____
STEPHEN A. FORTUNE R.C.E. NO. 21737
DIV. DIST. ENGR.

SCALE AS SHOWN
SHEET NO.
DWG. NO. 4100-414
JOB NO. CE4100-04

# APPENDIX D

# UPDATED FIGURES 1-1 AND 3-1

# AMENDS FIGURES 1-1 AND 3-1 OF VOLUME II OF II OF THE FPCMP

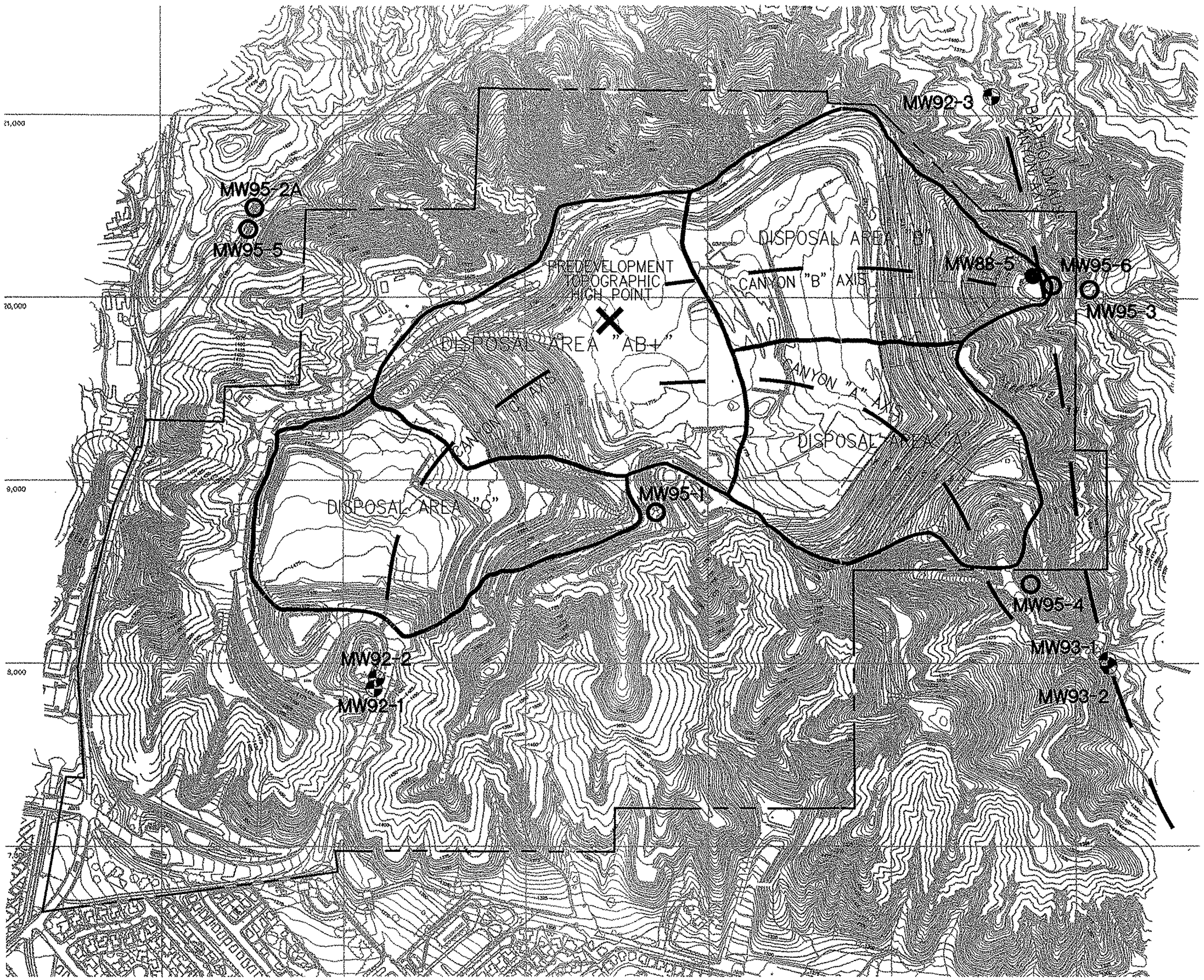


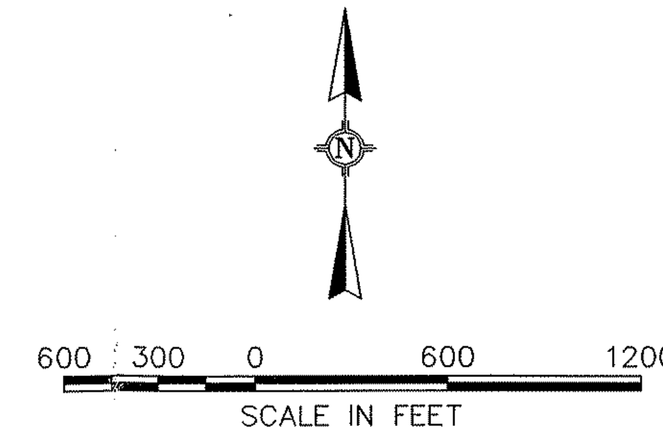

GeoSyntec Consultants

REVISED FINAL GRADING AND SURFACE WATER DRAINAGE PLAN DISPOSAL AREA A, B, AB+, AND C
LOPEZ CANYON SANITARY LANDFILL
LOS ANGELES, CALIFORNIA

FIGURE NO. 1-1
PROJECT NO. CE4100-04
DATE: APR-26-96

DWG: 4100F114 199604261728 AB




# LEGEND

| | |
|---|---|
| MW88-4 | GROUND-WATER MONITORING WELLS CONSTRUCTED IN 1988 |
| MW93-1 | GROUND-WATER MONITORING WELLS CONSTRUCTED IN 1992/1993 |
| MW95-4 | GROUND-WATER MONITORING WELLS CONSTRUCTED IN 1995 |
| | APPROXIMATE LANDFILL BOUNDARIES (TO BE REVISED ALONG ACCESS ROAD) |
| | WASTE DISPOSAL BOUNDARIES |
| | GROUND WATER FLOW DIRECTION |
| | CANYON AXIS |

GEOSYNTEC CONSULTANTS

| | |
|---|---|
| REVISED GROUND-WATER MONITORING NETWORK<br>LOPEZ CANYON SANITARY LANDFILL<br>LOS ANGELES, CALIFORNIA | FIGURE NO. 3-1<br>PROJECT NO. CE4100-04<br>DATE: APR-26-96 |

DWG: 4100F115 199604261816 AB

# APPENDIX E

# REVISED POST-CLOSURE MAINTENANCE COST ESTIMATE

# AMENDS SECTION 4 OF VOLUME II OF II OF THE FPCMP

## REVISED POST-CLOSURE MAINTENANCE COST ESTIMATE

This section presents revisions to the post-closure maintenance cost estimate resulting from the modifications to the final cover post-closure maintenance requirements and ground-water monitoring activities described herein. The use of a geotextile cushion and a VFPE geomembrane in the final cover of the deck and bench areas of Disposal Area C, a reduction in the total surface area of the landfill, and the addition of two more wells to the ground-water monitoring network will have an impact on the post-closure maintenance cost estimate.

The total area of geotextile cushion and VFPE geomembrane to be used in final cover construction for the deck and bench areas of Disposal Area C is about 1,051,160 $ft^2$ (97,650 $m^2$). The additional annual cost of repairing and/or replacing areas underlain by the geotextile cushion and the VFPE geomembrane has been estimated assuming that about 5,000 $ft^2$ (460 $m^2$) of geotextile cushion and VFPE geomembrane will be replaced annually. Based on a furnished and installed cost of about \$1.10/$ft^2$ (\$11.80/$m^2$) for the geotextile and geomembrane, the annual additional cost of repairing or replacing areas of the geotextile cushion and VFPE geomembrane is about \$5,500 in 1995 dollars. The annual cost of providing construction quality assurance (CQA) during these repairs is estimated to be 25 percent of the construction cost, or \$1,375 in 1995 dollars. Therefore, the total annual cost of repairing the geotextile cushion and VFPE geomembrane, and providing CQA is \$6,875 in 1995 dollars. The revised final cover maintenance costs also include 17,500 $ft^2$ (1,625 $m^2$) of earthen final cover repair and CQA at a total annual cost of \$11,783 in 1995 dollars.

The addition of six ground-water monitoring wells will result in additional post-closure monitoring costs for the Lopez Canyon Sanitary Landfill. Based on an annual monitoring and maintenance cost of about \$6,800 (i.e., four samples per year) per ground-water monitoring well, the additional annual monitoring costs for the six new wells is about $40,800 in 1995 dollars. The revised cost for ground-water monitoring also reflects an increase from one to four in the annual frequency of sampling for the six wells described in the Partial PCMP. This results in an additional cost of $30,600 in 1995 dollars.

Semi-annual sampling of leachate from the leachate collection and removal system (LCRS), performed in accordance with RWQCB Order No. 93-062 for the purposes of building the Constituents of Concern (COC) list, is also included in the revised ground-water monitoring costs. Assuming that samples will be recovered and tested from the LCRS for both Areas AB+ and C in October and April for COCs results in an additional annual cost of $6,500 in 1995 dollars.

The "revegetation" cost presented in the Partial Closure Plan for irrigation and fertilizer use over the first four to six years following closure was reduced due to the smaller surface area associated with the revised final grading plan (i.e., 161 vs. 166 acres [65 vs. 67 hectares]). The revised cost for revegetation is therefore $1,485,362 in 1995 dollars, reflecting a decrease of $46,133.

The revised total post-closure maintenance cost increases from $34,578,685 to $36,838,848 in 1995 dollars over a 30 year period as a result of the additional final cover maintenance costs, monitoring costs for quarterly sampling of eight ground-water monitoring wells, semi-annual sampling of leachate from Areas AB+ and C, and revegetation costs. The revised total post-closure maintenance cost is summarized in Table E-1.

The revised post-closure maintenance cost was developed based on the anticipated post-closure land use of the Lopez Canyon Sanitary Landfill. The post-closure land use of the landfill is vegetated open space.

## TABLE E-1

## REVISED SUMMARY OF POST-CLOSURE MAINTENANCE COST ESTIMATE
## AMENDMENT TO POST-CLOSURE MAINTENANCE PLAN
## LOPEZ CANYON SANITARY LANDFILL

| **POST-CLOSURE MAINTENANCE AND MONITORING FEATURES** | **ESTIMATED COST (1995 Dollars)** |
|---|---|
| Final Cover Maintenance* | $18,658 |
| Leachate Management | $63,223 |
| Landfill Gas Management | $277,500 |
| Ground Water Monitoring* | $94,267 |
| Surface Water Drainage | $37,000 |
| Site Security | $7,000 |
| Landfill Inspection | $300,000 |
| Other: Supervision, Surface Water Monitoring, Health and Safety, Site Monitoring) | $390,150 |
| I. Annual Cost | $1,187,798 |
| II. Annual Cost x 30 years | $35,633,940 |
| III. Revegetation* | $1,204,908 |
| Total Post-Closure Maintenance Costs (Item II + Item III) | $36,838,848 |

Note: * cost estimate features changed from the Partial PCMP

# APPENDIX F

## UPDATED CLOSURE AND POST-CLOSURE ESTIMATES - REVISED INITIAL COST ESTIMATE WORKSHEET

## AMENDS APPENDIX K OF VOLUME II OF IV OF THE FCP AND TABLE 4-1 OF VOLUME II OF II OF THE FPCMP

SWIS # 19-AA-0820

**INITIAL COST ESTIMATE WORKSHEET**
(rev. 10/89)

**SITE DESCRIPTION**

The following questions will provide general information regarding the site description, the type of waste accepted at the site and basic geological information. This information will aid in assessing factors that may affect the initial cost estimates.

Prepared By: GeoSyntec Consultants

General Site Information:

Name of Solid Waste Landfill: Lopez Canyon Sanitary Landfill

Solid Waste Facilities Permit Number: 19-AA-0820

Facility Operator: CITY OF LOS ANGELES BUREAU OF SANITATION

Site Owner: CITY OF LOS ANGELES BUREAU OF SANITATION

Site Location (California coordinates, township & range or longitude/latitude, preferred)

Section 6

Assessors Parcel Number ____________________

Site Address: 11950 Lopez Canyon Road, Lakeview Terrace, CA 91342

1. What is the existing State Water Resources Control Board classification of the solid waste landfill? (mark the appropriate response)

| NEW<br>If Waste Discharge Requirements (WDR) revised since 11-84 | | OLD | |
|---|---|---|---|
| ______ | Class I | ______ | Class I |
| | | X | Class II-1 |

Note: The solid waste landfill is excluded from these requirements, if the facility is a hazardous waste facility or co-disposal facility of both hazardous and nonhazardous waste as a RCRA Subtitle C facility subject to specific closure plan requirements.

| | | | |
|---|---|---|---|
| ______ | Class II | ______ | Class II-2 |
| X | Class III | ______ | Class III |

2. What is the anticipated closing date for the existing permitted landfill? Proposed expansions which have not been approved by the Board and LEA are not to be included in these calculations. Include calculations supporting the estimate date. (Attach additional sheets as necessary.)

month February , year 1996

Note: All facilities with an anticipated closure date of September 28, 1992, or earlier, will be required to submit their closure and postclosure maintenance plan no later than July 1, 1990.

Type of Fill

3. Type of Fill (check appropriate type)

| | | | |
|---|---|---|---|
| ______ | Trench | X | Canyon |
| X | Area | ______ | Other (describe) |
| ______ | Pit | | |

Volume of Waste

| | | |
|---|---|---|
| 4. | What is the estimated in-place volume of landfilled wastes at the site in cubic yards? | 13,320,000 |
| 5. | What is the design capacity of the site in cubic yards? | 26,562,000 |
| 6. | Minimum thickness of waste (ft)? | 25' |
| 7. | Average thickness of waste (ft)? | 120' |
| 8. | Maximum thickness of waste (ft)? | 245' |
| 9. | Average height above surrounding terrain (ft)? | N/A |
| 10. | Typical inclination of side slopes, in slope ratio (horizontal:vertical)? (e.g., 5:1, 2:1) | 2:1 |

Note: ______________________________

| | | |
|---|---|---|
| 11. | Quantity of waste typically received (tons/day)? | 4,000 |
| 12. | Total permitted site acreage? | 399 |
| 13. | Waste disposal area acreage? | 161 |

Waste Description

14. Estimate of solid waste received (total of entries for residential, commercial, industrial, demolition and other should add up to 100%).

% Residential__85__ % Commercial_____

% Industrial_______ % Demolition_____

% Other (special waste streams, such as ash, auto shredder waste, infectious waste, sludge, asbestos)

Describe material under "other" and give its percentage.

| Material | Percentage |
|---|---|
| Street Sweeping | 15 |

Resid. + Indus. + Comm. + Demo. + Other = 100%

Site Geology and Groundwater Data

15. Briefly describe the underlying geology of the site. (Mark as many boxes that apply).

___X___ Shallow alluvium <50' __________ Deep alluvium >50'

___X___ Sedimentary __________ Igneous

________ Metamorphic

a. What is the name of the nearest major fault? San Fernando Zone

b. Distance from site (miles)? Onsite

c. On-site fault(s), if known? Yes

16. What are the groundwater characteristics?

a. What is the depth to groundwater (ft)? A seasonal water table was obtained from MW 88-5 drilled to a depth of 42 ft or 1429.7 ft MSL

This will be the range of water levels, from well data, in a groundwater well network. Note: Consider seasonal variations from rainy to dry periods, wet and dry years, well locations and variations in the subsurface geology.

Highest recorded level (depth in ft) ELEV. 42 ft, 1429.7 ft MSL

Well Number MW 88-5 Date Recorded 3/9/88

Lowest recorded level (depth in ft) ELEV. N/A

Well Number N/A Date Recorded N/A

Typical N/A

b. What direction does the groundwater flow?

The apparent ground water flow direction is north to south.

c. What is the groundwater gradient?

Data is insufficient to determine ground water gradient.

## CLOSURE COSTS

### Final Cover

17. Area of Landfill for Final Cover

| | |
|---|---|
| a. Area of top deck to be capped ($ft^2$) $A_d$= | 3,673,850 |
| b. Area of side slopes to be capped ($ft^2$) $A_s$= (map area) | 2,985,603 |

| Side Slopes Horizontal:Vertical | Conversion Factor (C) |
|---|---|
| 5 : 1 | 1.02 |
| 4 : 1 | 1.03 |
| 3 : 1 | 1.05 |
| 2½: 1 | 1.08 |
| 2 : 1 | 1.12 |
| 1¾: 1 | 1.15 |

18. Final Cover Soil - Foundation Layer (Already in place)

a. Thickness

1) Top deck (minimum 3 feet of soil)

$T_d$ = (≥ 3') 0

2) Side slope (minimum 3 feet normal to slope)
$T_s$ = (≥ 3') 0

| | | |
|---|---|---|
| b. | Volume = [($T_d$ x $A_d$) + ($T_s$ x $A_s$ x Conv. factor)]/27 ($yd^3$) | ______ |
| c. | % Native soil | ______ |
| d. | Native material acquisition cost (excavation, hauling,etc.) ($/$yd^3$) | ______ |
| e. | Native soil cost ($)<br>(Line 18b x Line 18c x Line 18d) | ______ |
| f. | % Imported soil | ______ |
| g. | Imported material acquisition cost (purchase, delivery, etc.) ($/$yd^3$) | ______ |
| h. | Imported soil cost ($)<br>(Line 18b x Line 18f x Line 18g) | ______ |
| i. | Placement, grading and compaction (to achieve relative compaction of .90) unit cost ($/$yd^3$) | ______ |
| j. | Placement, grading and compaction cost ($)<br>(Line 18b x Line 18i) | ______ |
| k. | Subtotal final cover soil ($)<br>(Line 18e + Line 18h + Line 18j) | $0 |

19. Clay Layer

| | | |
|---|---|---|
| a. | Area to be capped ($ft^2$) of A, B and AB+Decks | 2,691,572 |
| b. | Thickness (ft) (minimum 1 foot) | 1.00 |
| c. | Volume ($yd^3$)<br>(Line 19a x Line 19b)/27 | $99,688 |
| d. | <u>% On-site Clay</u> | 100 |
| e. | On-site material acquisition cost (excavation, hauling, etc.) ($/$yd^3$) | $0 |
| f. | On-site clay cost ($)<br>(Line 19c x Line 19d x Line 19e) | $0 |
| g. | <u>% Imported Clay</u> | 100 |
| h. | Imported material acquisition cost (purchase, delivery, etc.) ($/$yd^3$) | $6.50 |
| i. | Imported clay cost ($)<br>(Line 19c x Line 19g x Line 19h) | $647,972 |

| | | |
|---|---|---|
| j. | Placement/spreading, grading, compaction (to achieve permeability no greater than 1 x 10-6 cm/sec) unit costs ($/yd$^3$) | $8.35 |
| k. | Placement, grading and compaction cost ($) (Line 19c x Line 19j) | $832,395 |
| l. | Subtotal clay costs ($) (Line 19f + Line 19i + Line 19k) | $1,480,367 |

20. Synthetic Membrane

Note: This item must be estimated in addition to the clay barrier layer unless/until an alternative final cover design has been approved in the closure plan.

| | | |
|---|---|---|
| a. | Type of membrane (e.g., HDPE, CPE, PVC) | VLDPE |
| | Thickness (minimum 30 mils) | 40 |
| b. | Quantity (ft$^2$) | 1,051,158 |
| c. | Purchase, delivery and installation unit cost ($/ft$^2$) | $0.45 |
| d. | Synthetic layer testing (percent of total synthetic membrane unit cost) (%/100) | 0.15 |
| e. | Synthetic layer costs ($) (Line 20b x Line 20c x (1 +20d) | $543,974 |

21. What other types of materials/layers are included in the design (e.g., asphalt-tar, gravel for gas venting)?

16 oz.geotextile cushion layer, 1 ft. thick drainage layer, 8 oz. geotextile filter layer, 1 ft. thick erosion layer

a. Geotextile filter (8 oz. nonwoven)

| | | |
|---|---|---|
| 1) | Quantity (ft$^2$) | 2,691,572 |
| 2) | Purchase, delivery and installation unit cost ($/ft$^2$) | $0.17 |
| a. | Synthetic layer testing (% of total synthetic membrane unit cost) (%/100) | 0.15 |
| 3) | Geotextile layer costs ($) | $526,202 |

b. Drainage layer (1-ft thick sand layer, min. $k=10^{-2}$ cm/sec) ______

1) Quantity ($yd^3$)

2) Purchase, delivery and installation unit cost ($/$yd^3$) ______

3) Drainage layer costs $0

c. Erosion layer (2-ft thick native soil layer) (A,B, AB+, and C)

| | | |
|---|---|---|
| 1) | Volume of soil on deck areas (A, B, AB+ and C) ($yd^3$) | 272,137 |
| 2) | Purchase, delivery and installation on decks unit cost ($/$yd^3$) | $4.00 |
| 3) | Volume of soil on slope areas (A, B, AB+, and C) ($yd^3$) | 247,695 |
| 4) | Purchase, delivery and installation on slopes unit cost ($/$yd^3$) | $4.50 |
| 5) | Total cost of erosion layer (Line $21^{c1}$ x Line $21^{c2}$ + Line $21^{c3}$ x Line $21^{c4}$) | $2,203,176 |

d. Total other types of layers ($)
(Line 21a.3 + Line 21b.3 + Line 21c.5) $2,729,378

NOTE: Thickness of individual layers may be modified depending on the integrated cover design.

22. Construction Quality Assurance

The following cost estimates apply to the quality assurance activities necessary to ensure that the final cover is installed properly, as specified in the design parameters, and fulfill the conditions mandated by regulations.

a. Monitoring costs incurred while evaluating the final cover system components:

| | | |
|---|---|---|
| 1) | Laboratory test fees (e.g., soil permeability, soil density and moisture content) ($) | $136,990 |
| 2) | Field test expenditures (e.g., test pad field permeability tests, relative compaction tests) ($) | $75,000 |
| b. | Inspections (e.g., initial inspection of native and imported soil or clay, visual check of completed cover) ($) | $244,000 |
| c. | Reporting costs (e.g., daily reporting procedures, corrective measure report, as-built reports) ($) | $63,040 |
| d. | Engineering design costs ($) | $134,500 |

| | | |
|---|---|---|
| | e. Quality assurance costs ($) (Line 22a1 + Line 22a2 + Line 22b + Line 22c + Line 22d) | $653,530 |
| 23. | Final Cover Subtotal ($) (Line 18k + Line 19l + Line 20e + Line 21d+ Line 22e) | $5,407,249 |

**Revegetation**

| | | |
|---|---|---|
| 24. | Soil Preparation | |
| | a. Area to be vegetated, including closed areas that need replanting (acres) (Line 17a + Line 17b)/43560 | 161.1 |
| | b. Preparation unit cost ($/acre) | $325 |
| | c. Soil preparation subtotal ($) (Line 24a x Line 24b) | $52,358 |
| 25. | Planting | |
| | a. Type of vegetation | Annual and perennial native grasses and flowers |
| | b. Planting unit cost (e.g., seeding, sprigging, plugs) (include cost of seeds, sprigs, plugs) ($/acre) | $2,000 |
| | c. Planting cost ($) (Line 24a x Line 25b) | $322,200 |
| 26. | Fertilizing | |
| | a. Type of fertilizer | Root stimulant |
| | b. Fertilizer unit cost ($/acre) | $300 |
| | c. Fertilizing cost ($) (Line 24a x Line 26b) | $48,330 |
| 27. | Mulching | |
| | a. Mulch unit cost ($/acre) | $600.00 |
| | b. Mulching cost ($) (Line 24a x Line 27a) | $96,660 |
| 28. | Irrigation installation cost ($) (temporary) | $1,302,275 |
| 29. | Revegetation Subtotal ($) (Line 24c + Line 25c + Line 26c + Line 27b + Line 28) | $1,821,823 |

**Landfill Gas Monitoring and Control**

30. Does the landfill have a gas monitoring network?

YES X NO______

If NO,

a. What will be the spacing between monitoring wells (≤ 1000 ft)? ______

b. What criteria was used to select this spacing?

______

______

c. Total number of gas monitoring wells? ______

Note: Depth of probes should equal at least 1 x depth of refuse within 1000'.

d. Number of probes per wellbore? ______

Suggested minimum;

1. Surface (5-10 ft)
2. Intermediate (half the depth of boring)
3. Deep (to depth of boring)

e. Cost of Design ($) 0.00

f. Cost of drilling, materials ($) 0.00

g. Cost of installation ($) 0.00

h. Subtotal for monitoring network ($) (Line 30e + Line 30f + Line 30g) 0.00

If YES,

i. How many gas monitoring wells are in place? 52

j. What is the lateral spacing between gas monitoring wells? <1,000 ft

k. What is the number of probes per wellbore? one to four

l. Additional monitoring wells required at closure? None

m. Number of probes per boring? N/A

n. Cost to expand existing monitoring network (design, drilling, and installation)? $0.00

31. Is there a gas control system operating at the landfill?

YES X NO

If YES,

a. What type(s) (e.g., recovery, perimeter extraction, air injection, etc.) is/are in place? Extraction

b. What type of system will be installed during closure? None

c. Cost of design ($) 0.00

d. Cost of materials ($) 0.00

e. Cost of installation ($) 0.00

f. Subtotal for control system ($) (Line 31c + Line 31d + Line 31e) 0.00

32. Landfill Gas Subtotal ($) (Line 30h + Line 30n + Line 31f) 0.00

<u>Groundwater Monitoring Installations</u>

33. Does the landfill have a ground-water monitoring network?

YES X NO

If YES,

a. Number of upgradient (minimum 1) wells 4

b. Number of downgradient (minimum 3) wells (number of background wells) 0

If less than minimum or NO,

c. Number of wells to be installed (minimum 1 upgradient and minimum 3 downgradient). 0

d. Drilling total footage (ft) 0

e. Cost of design ($) 0

f. Developing, installing, materials ($)

34. Groundwater monitoring subtotal ($)
(Line 33e + Line 33f) $0

**Drainage**

35. Is there a surface water runon and runoff control system existing at the site:

YES X NO

If NO,

a. What will be the estimated cost of installation and construction of the drainage conveyance system to accommodate anticipated runoff (e.g., diversion ditches, downdrains, energy dissipators) and protection from runon (e.g., dikes, levees, protective berms)? ($) $747,283

b. Cost of grading and drainage design ($) $82,587

c. Drainage subtotal ($)
(Line 35a + Line 35b) $829,870

**Security**

36. Is there a security system established at the landfill (e.g., fencing, access gates, locks on the gates, informational signs)?

YES X NO

a. What is presently in place at the site? (mark appropriate boxes)

| | | | |
|---|---|---|---|
| X | Fencing | X | Locks |
| X | Gates | | Other (describe) |
| X | Signs | | |

b. What will be the estimated cost of installing a security fence, access gates with locks, and/or informational signs (e.g., either around site perimeter or around enclosures) to protect equipment and the public and is compatible with postclosure use? $33,000

c. What will be the estimated cost of dismantling and removing security equipment not necessary after closure and incompatible with postclosure use? $00

| | |
|---|---|
| d. Security system costs ($) (Line 36b + line 36c) | $33,000 |

<u>**SUPPLEMENTAL DATA**</u>

37. Itemize cost on additional worksheets for closure procedures, specific to this solid waste disposal site, and attach at the end of this worksheet. Make sure each page is appropriately labeled with site name and SWIS number.

| | |
|---|---|
| Other Closure Costs (Lines: 55l + 80o + 81d + 84i + 85n + 86c + 87c) | $4,868,254 |
| Administrative Costs - Construction Management (Line 88) | $1,655,629 |

<u>**POSTCLOSURE MONITORING AND MAINTENANCE COSTS**</u>

<u>**Revegetation**</u>

38. Fertilizing (first 2 years)

| | |
|---|---|
| a. Area to be fertilized (acres) | 161 |
| b. Type of fertilizer | 7-1-7 starter and 8-5-1 slow release |
| c. Fertilizer unit cost ($/acre/yr) | $1,000 |
| d. Fertilizing cost (first 2 years) (Line 38a x Line 38c) | $322,000 |
| e. Fertilizing costs for the four year period | $644,000 |

39. Irrigation (first 4 years)

| | |
|---|---|
| a. Type of irrigation system | Overhead spray |
| b. Quantity (gallon/day) | 165,422 |
| c. Unit cost ($/gallon) | $0.0011 |
| d. How many irrigation days per week? | 7 |
| e. Annual irrigation costs ($/yr) {(Line 39b x Line 39c) x Line 39d} x 52 wk/yr | $66,235 |
| f. Annual maintenance costs ($/yr) | $73,992 |

g. Irrigation costs ($/yr)
(Line 39e + line 39f) $140,227

h. Irrigation costs for a four-year period $560,908

40. Revegetation Subtotal (first 4 years)
(Line 38e + Line 39h) $1,204,908

**Leachate Management**

41. Does the solid waste disposal site have a liner?

YES X (Disposal Area C) NO X (Disposal Areas A,B, and AB+)

42. Does the landfill have a leachate collection/removal system? (e.g., leachate barrier and recovery system, dendritic system)

YES X NO If YES,

a. What type of system? A leachate seepage cut-off barrier wall at the downstream end of disposal area AB+ with a gravel collector placed upstream of the barrier wall. The leachate collection and removal system for Disposal Area C consists of a drainage blanket on the liner with an integrated drainage system on the bottom canyon.

b. Annual cost of operation and maintenance of system ($/yr). $29,000

43. List types of leachate (including leachate-affected water and landfill gas condensate) treatment used and that will continue to be used during closure and postclosure maintenance (e.g., discharge to sewer, on-site or off-site management).

a. Type of treatment (on-site).

Landfill Gas Condensate pH Adjustment
(Note: Leachate production is not anticipated and has not been detected to-date.)

b. Volume/unit frequency (e.g., gals/day, gals/month) 210 gal/day

c. Unit cost of treatment ($/gal.) $0.38/gal

d. Annual costs of on-site treatment. ($/yr) $29,127

44. Type of treatment (off-site) N/A

a. Volume/unit frequency (e.g., gals/day, gals/month) N/A

b. Unit cost of treatment - including hauling ($) N/A

c. Annual costs of off-site treatment. ($/yr) $0

d. Other (explain)

45. Leachate sampling and testing

| | |
|---|---|
| a. Number of samples/round | 1 |
| b. Sampling costs/round ($) | $40 |
| c. Frequency of sampling per year | 52 |
| d. Annual sampling costs ($/yr) (Line 45b x Line 45c) | $2,080 |
| e. Testing costs/sample ($) | $58 |
| f. Annual testing costs ($/yr) (Line 45a x Line 45c x Line 45e) | $3,016 |
| g. Annual sampling/testing cost subtotal ($) (Line 45d + Line 45f) | $5,096 |

46. Leachate management costs ($/yr) (Line 42b + Line 43d + Line 44c + Line 45g) — $63,223

**Monitoring**

47. Gas Monitoring Systems

a. Monitoring devices of principal gases (e.g., Gastech, OVA, etc.) — OVA Meters; Gas Chromatography; Flame Ionization Detector

b. Frequency of monitoring (e.g., daily, weekly, monthly)

Note: See supplemental cost worksheets for additional gas monitoring costs.

| | |
|---|---|
| c. On-site annual monitoring costs for principal gases? ($/yr) | $0.00 |
| d. Annual sampling costs for trace gases ($/yr) | $0.00 |
| e. Annual testing costs for trace gases ($/yr) | $0.00 |
| f. Assumed replacement frequency, of probes, in years. | 52 |
| g. Installation unit cost for probes ($) | $2,500 |

h. Annual replacement costs ($)
(Line 30i x Line 47g)/Line 47f — $2,500

i. Annual maintenance costs ($/yr) — $3,000

j. Gas monitoring subtotal ($/yr) (Line 47c + Line 47d + Line 47e + Line 47h + Line 47i) — $5,500

48. Is the vadose (unsaturated) zone monitored at this landfill?

YES ________ NO ___X___

If YES,

a. What type of monitoring procedures and equipment are utilized? (e.g., vacuum/pressure lysimeter)

b. How many monitoring devices are utilized? ________

c. Annual sampling costs ($/yr) ________

d. Annual testing costs ($/yr) ________

e. Assumed replacement frequency, of devices, in years ________

f. Installation unit cost of devices ($) ________

g. Annual replacement cost ($/yr)
(Line 48b x Line 48f)/Line 48e ________

h. Annual maintenance costs ($/yr) ________

i. Vadose zone monitoring subtotal ($/yr)
(Line 48c + Line 48d + Line 48g + Line 48h) — $0.00

49. Ground-Water Monitoring

a. Number of wells — 12

b. Frequency of monitoring, per year — 4

c. Analytical methods (e.g., EPA 601 and 602 or 624, and 625)

EPA 624 and 625, and 8080, Metals (unfiltered), pH, electrical conductivity, BOD, COD, TDS, Total Hardness

d. Number of samples/round — 1

e. Testing costs/sample ($) — $1,700

| | | |
|---|---|---|
| f. | Annual groundwater sampling & testing costs ($/yr)<br>[(Line 49d x Line 49e) x Line 49a] x Line 49b | $81,600 |
| g. | Annual monitoring costs ($/yr) | $5,267 |
| h. | Assumed replacement frequency, of wells, in years | 20 years |
| i. | Installation unit cost of wells ($) | $8,333 |
| j. | Annual replacement cost ($/yr)<br>(Line 49a x Line 49i)/Line 49h | $5,000 |
| k. | Annual maintenance costs ($/yr) | $2,400 |
| l. | Ground-water monitoring subtotal ($/yr)<br>(Line 49f + Line 49g + Line 49j + Line 49k) | $94,267 |

50. Monitoring Cost Subtotal ($/yr)
(Line 48i + Line 49l) — $94,267

See supplemental worksheets for additional monitoring costs.

**Drainage**

51. How often do you anticipate the need to perform maintenance activities (e.g., clear material from runoff surface water conveyances, erosion repair, minor grading, repair of articulated drains; also problems with runon maintenance and repairs of levees, dikes, protective berms)?

Once during the summer months and after each heavy rainfall.

a. Annual maintenance costs ($/yr) — $37,000

**Security**

52. What are the estimated annual maintenance costs to repair/replace fencing, gates, locks, signs, and/or other security equipment at the landfill site? ($/yr) — $7,000

**Inspection**

53. What will be the routine maintenance inspection frequency of the landfill during postclosure (minimum semi-annually)?

Varies (see Post-Closure Plan)

a. Inspection unit cost ($) — $0.00

b. Annual inspection costs during the postclosure care period? ($/yr) — $300,000

Components that should be inspected include, but are not limited to:

- Final cover - erosion damage
- Final grading - ponding caused by settlement
- Drainage control systems - continuity of articulated drains, sediment choked conduits
- Gas collection/control systems
- Leachate collection and treatment systems effectiveness, and continuity
- Security - fences, gates and signs
- Vector and fire control
- Monitoring equipment
- Litter control

## SUPPLEMENTAL DATA

54. Itemize annual costs on additional worksheets for monitoring and postclosure maintenance procedures, specific to this solid waste disposal site, and attach at the end of this worksheet. Make sure each page is appropriate labeled with site name and SWIS number.

| | |
|---|---|
| Other-Annual Postclosure Maintenance Costs (Lines 66c, 67c, 68c, 69f, 70e, 71b, 72g, 73d, 74b 75d, 76b, 78d, and 79b) | $390,150 |
| Administrative Costs | |

**SUMMARY OF COST ESTIMATES**

**Facility Name** Lopez Canyon SWIS #19-AA-0820

| | |
|---|---|
| **Closure** | |
| Final Cover (Line 23) | $5,407,249 |
| Revegetation (Line 29) | $1,821,823 |
| Landfill Gas Monitoring and Control (Line 32) | $0 |
| Groundwater Monitoring Installations (Line 34) | $0 |
| Drainage Installation (Line 35c) | $829,870 |
| Security Installation (Line 36d) | $33,000 |
| Other (Line 37) | $6,523,883 |
| **I. Subtotal Closure** | $14,615,825 |
| **II. Subtotal I x 20% Contingency Costs** | $2,923,165 |
| **Total Closure Cost** | $17,538,990 |
| **Monitoring and Postclosure Maintenance** | |
| Leachate Management (Line 46) | $63,223 |
| Water Monitoring (Line 48i + 49l) | $94,267 |
| Drainage (Line 51a) | $37,000 |
| Security (Line 52) | $7,000 |
| Inspection (Line 53b) | $300,000 |
| Landfill Gas Management (Line 47j, 56e, 57d, 58b,59c, 60e, 61e, 62e, 63e, 64d, 65c) | $277,500 |
| Other (Line 54) | $390,150 |
| Final Cover Maintenance (82f, 83b) | $18,658 |
| **III. Subtotal** | $1,187,798 |
| **IV. Subtotal III x 30 years** | $35,633,940 |

| | |
|---|---|
| **V. Revegetation (Line 40)** | $1,204,908 |
| **TOTAL COSTS** **Total Postclosure Maintenance Cost**<br>(Item I, Item II, Item IV, Item V)<br>(Total Closure and Postclosure Maintenance Cost) | $54,377,838 |

N/A: NOT APPLICABLE TOWARDS CLOSURE
SUPPLEMENTAL WORKSHEETS

55. Clay Layer (C Deck)

| | | |
|---|---|---|
| a. | Area to be capped ($ft^2$) of C Deck | 982,278 |
| b. | Thickness (ft) (minimum 1 foot) | 1.00 |
| c. | Volume ($yd^3$) (Line 55a x Line 55b)/27 | 36,381 |
| d. | % On-site Clay | 0 |
| e. | On-site material acquisition cost (excavation, hauling, etc.) ($\$/yr^3$) | 0 |
| f. | On-site clay cost ($) (Line 55c x Line 55d x Line 55e) | $0 |
| g. | % Imported clay | 100 |
| h. | Imported material acquisition cost (purchase, delivery, etc.) ($\$/yd^3$) | 6.50 |
| i. | Imported clay cost ($) (Line 55c x Line 55g x Line 55h) | $236,477 |
| j. | Placement/spreading, grading, compaction (to achieve permeability no greater than $1 \times 10^{-6}$ cm/sec) unit costs ($\$/yd^3$) | 8.37 |
| k. | Placement, grading and compaction cost ($) (Line 55c x Line 55j) | $304,509 |
| l. | Subtotal clay costs ($) (Line 55f + Line 55i+ + Line 55k) | $540,986 |

**GAS RECOVERY SYSTEM MONITORING**

56. a. Monitoring devices of principal gases (e.g., Gastech, OVA, etc.)

Kuetz velocity meter, thermometer, magnehelic, differential pressure gauge, Gas-tech NP-204

b. Frequency of monitoring (e.g., daily, weekly, monthly) — Quarterly

c. On-site monitoring costs? ($/yr) — $16,000

d. Annual analysis costs ($/yr) — $3,000

e. Gas Recovery System monitoring subtotal ($/yr) Line 56c + Line 56d) — $19,000

57. Gas Migration Control System - Gas Collection Indicator Probe (GCIP) Monitoring

a. Monitoring devices of principal gases (e.g., Gastech, OVA, etc.)

OVA, Gas Tech NP-204, Magnehelic, Differential Pressure Gauge, Barometer

b. Frequency of monitoring (e.g., daily, weekly, monthly) — Quarterly

c. On-site monitoring costs? ($/yr) — $7,000

d. Gas Migration System - (GCIP) Monitoring Subtotal ($/yr) — $7,000

58. Visual Inspection of Landfill Surface

a. Frequency of monitoring (e.g., daily, weekly, monthly) — Weekly

b. On-site monitoring costs? ($/yr) — $20,000

59. Instantaneous Surface Emissions Monitoring

a. Monitoring devices of principal gases (e.g., Gastech, OVA, etc.) — Organic Vapor Analyzer

b. Frequency of monitoring (e.g., daily, weekly, monthly)

c. On-site monitoring costs? ($/yr) — $28,000

60. Integrated Surface Emissions Monitoring

a. Monitoring devices of principal gases (e.g., Gastech, OVA, etc.) — Organic Vapor Analyzer, Integrated Surface Sampler

b. Frequency of monitoring (e.g., daily, weekly, monthly)

c. On-site monitoring costs? ($/yr) $74,500

d. Annual analysis costs ($/yr) $10,000

e. Integrated Surface Emissions monitoring subtotal ($/yr) $84,500

61. Sampling Gas in Branch Line, Probes, and Headers

a. Monitoring devices of principal gases (e.g., Gastech, OVA, etc.) Kurtz Velocity Meter, Magnehelic Differential Pressure Gauge, Gas Tech NP-204

b. Frequency of monitoring (e.g., daily, weekly, monthly) Quarterly

c. On-site monitoring costs? ($/yr) $1,000

d. Annual analysis costs ($/yr) $5,500

e. Sampling gas in branch lines, probes and headers subtotal ($/yr) $6,500

62. Ambient Air Sampling at Perimeter of the Site

a. Monitoring devices of principal gases (e.g., Gastech, OVA, etc.) Integrated Ambient Air Sampling Unit, Line Monitoring Station, Organic Vapor Analyzer

b. Frequency of monitoring (e.g., daily, weekly, monthly) Quarterly

c. On-site monitoring costs? ($/yr) $10,000

d. Annual analysis costs ($/yr) $35,000

e. Integrated Surface Emissions monitoring subtotal ($/yr) $45,000

63. Gas Recovery System - Flare Station Sampling

a. Monitoring devices of principal gases (e.g., Gastech, OVA, etc.) Tedlar Bag, Organic Vapor Analyzer

b. Frequency of testing (e.g., daily, weekly, monthly) Quarterly

c. On-site monitoring costs? ($/yr) $500

d. Annual analysis costs? ($/yr) $2,500

| | | | |
|---|---|---|---|
| | e. | Flare Station Sampling subtotal ($/yr) | $3,000 |
| 64. | Flare Source Testing | | |
| | a. | Frequency of testing (e.g., daily, weekly, monthly) | Annually |
| | b. | On-site monitoring costs ($/yr) | 0.00 |
| | c. | Annual analysis costs ($/yr) | $52,000 |
| | d. | Flare Source Testing subtotal ($/yr) | $52,000 |
| 65. | Gas Recovery System Monitoring - Sumps and Condensate Drain Lines | | |
| | a. | Monitoring devices of principal gases (e.g., Gastech, OVA, etc.)<br>OVA meters, Gas Chromatography, Gas Sampling Equipment | |
| | b. | Frequency of monitoring (e.g., daily, weekly, monthly) | Weekly |
| | c. | On-site monitoring costs? ($/yr) | $7,000 |
| 66. | Reseeding and Mulching | | |
| | a. | Labor | $13,150 |
| | b. | Materials | $13,000 |
| | c. | Reseeding and Mulching Total ($/yr.) | $26,150 |
| 67. | Monitoring Supervisor | | |
| | a. | Duties<br>Supervise and coordinate post-closure monitoring activities and provide QA/QC. | |
| | b. | On-site costs ($/yr) | $90,000 |
| | c. | Supervisor subtotal ($/yr) | $90,000 |
| 68. | Health and Safety Officer | | |
| | a. | Duties<br>Supervise, coordinate, and administrate health and safety activities relative to post-closure monitoring and maintenance. | |
| | b. | On-site costs ($/yr) | $38,000 |

c. Health and Safety subtotal ($/yr) $38,000

69. Monitoring Equipment Maintenance and Repair

a. Monitoring Devices

Organic Vapor Analyzer, Kurz Velocity Meters, Thermometers, Magnehelic, Differential Pressure Gauges, Gas Tech NP-204, Wind Monitoring Stations, Integrated Ambient Air Sampling units, Vacuum Pumps, Integrated Surface Sampler, Barometer

b. Frequency of maintenance Monthly

c. Frequency of Repair As Required

d. On-site maintenance and repair costs ($/yr) $40,000

e. Replacement parts costs ($/yr) $15,000

f. Equipment Maintenance and Repair subtotal ($/yr) $55,000

70. Monitoring Equipment Replacement Amortization

a. Monitoring Devices

Organic Vapor Analyzer, Kurz Velocity Meters, Thermometers, Magnehelic, Differential Pressure Gauges, Gas Tech NP-204, Wind Monitoring Stations, Integrated Ambient Air Sampling units sample train, Integrated Surface Sampler, Organic Vapor Monitor

b. Average equipment life or replacement cycle. Every 5 years

c. Equipment Cost List

| | | | |
|---|---|---|---|
| OVA - 8 @ | $8,500/ea. | | $68,000 |
| Kurz - 5 @ | $1,200/ea. | | $6,000 |
| Magnehelic - 5 @ | $300/ea. | | $1,500 |
| NP-204 - 2 @ | $1,500/ea. | | $3,000 |
| Wind Station - 3 @ | $2,700/ea. | | $8,100 |
| Ambient Air Sampling Unit - 5 @ | $2,200/ea. | | $11,000 |
| Sample Train - 4 @ | $2,500/ea. | | $10,000 |
| Surface Sampler - 5 @ | $750/ea. | | $3,750 |
| OVM - 2 @ | $1,800/ea. | | $3,600 |
| | | TOTAL | $114,950 |

d. Amortization Costs ($/yr) $23,000

e. Amortization Subtotal ($/yr) $23,000

71. Monitoring Materials

a. Material Items

Tedlar bags, Tygon Tubing, Calibration Gases, Safety Equipment, Misc. Tools, cleaning and maintenance supplies

| | |
|---|---|
| b. On-site Material Costs ($/yr) | $25,000 |

72. Monitoring Vehicles

a. Type of Vehicles

4-Wheel drive vehicles

| | |
|---|---|
| b. Number of Vehicles | 6 |
| c. Unit cost of vehicles | $18,000 |
| d. Average vehicle life or replacement cycle | 5 years |
| e. Estimated trade-in value | $2,000 |
| f. Amortization costs ($/yr) | $16,000 |
| g. Monitoring Vehicle Cost ($/yr) | $19,000 |

73. Weather Station Management

| | |
|---|---|
| a. Number of Stations | 3 |
| b. Frequency of monitoring | Weekly |
| c. On-site monitoring costs ($/yr) | $72,000 |
| d. Weather Station Management Subtotal ($/yr) | $72,000 |

74. Subdrain Collection System Maintenance

| | |
|---|---|
| a. Frequency of monitoring (e.g., daily, weekly, monthly) | As Required |
| b. On-site monitoring costs? ($/yr) | $5,000 |

75. Subdrain Collection System Sampling

| | |
|---|---|
| a. Frequency of monitoring, per year | Quarterly |
| b. On-site monitoring costs? ($/yr) | $3,000 |

| | | |
|---|---|---|
| | c. Annual analysis costs ($/yr) | $2,000 |
| | d. Subdrain Collection System Monitoring subtotal ($/yr) | $5,000 |
| 76. | Outfall System Inspection | |
| | a. Frequency of monitoring, per year | Quarterly |
| | b. On-site monitoring costs? ($/yr) | $10,000 |
| 77. | Final Closure/Post-Closure Plan Preparation | $0.00 |
| 78. | Surface Water Monitoring | |
| | a. Frequency of monitoring, per year | Two times annually during discharges |
| | b. On-site monitoring costs | $3,000 |
| | c. Annual analytical costs | $12,000 |
| | d. Annual surface water sampling & testing costs ($/yr) Line 78b + 78c | $15,000 |
| 79. | Gas Recovery System Monitoring - Sumps and Condensate Drainlines | |
| | a. Frequency of monitoring | Weekly |
| | b. On-site monitoring costs? ($/yr) | $7,000 |
| 80. | Clay Layer (Slope) | |
| | a. Total Area to be Capped ($ft^2$) (Line 17b x Conv. Factor) | 3,343,875 |
| | b. Area of A and B slopes to be capped ($ft^2$) | 2,103,704 |
| | c. Thickness (ft) on slopes of Disposal Areas A and B | 1.00 |
| | d. Area of AB+ and C slopes to be capped ($ft^2$) | 1,240,171 |
| | e. Thickness (ft) on slopes of Disposal Areas AB+ and C | 1.00 |
| | f. Volume of slope areas (A, B, AB+ and C) ($yd^3$) (Line b x Line c + Line d x Line e) /27 | 123,847 |
| | g. Percent on-site clay | 0 |

| | | |
|---|---|---|
| h. | On-site material acquisition cost (excavation, hauling, etc.) ($/yd$^3$) | $0 |
| i. | On-site clay cost ($) (Line 80f x Line 80g x Line 80h) | $0 |
| j. | Percent imported clay | 100% |
| k. | Imported mat. acquisition cost (purchase, delivery, etc.) ($/yd$^3$) | $6.50 |
| l. | Imported clay cost ($) (Line 80f x Line 80j x Line 80k) | $805,006 |
| m. | Placement/spreading, grading, compaction (to achieve permeability no greater than 1x10$^{-6}$ cm/sec) unit costs ($/yd$^3$) | $15.91 |
| n. | Placement, grading and compaction cost ($) (Line 80f x Line 80m) | $1,970,406 |
| o. | Subtotal clay cost ($) (Line 80i + Line 80l + Line 80n) | $2,775,412 |

81. Geotextile Cushion (12 oz./yd$^3$ nonwoven)

| | | |
|---|---|---|
| a. | Quantity (ft$^2$) | 1,051,158 |
| b. | Purchase, delivery and installation unit cost ($/ft$^2$) | $0.20 |
| c. | Cushion fabric testing (percent of total cushion fabric unit cost (%/100) | 0.15 |
| d. | Geotextile layer cost ($) (Line 81a x Line 81b x [1 + 81c]) | $241,766 |

**FINAL COVER MAINTENANCE**

82. Repair and Replacement of VLDPE Geomembrane and of Geotextile Cushion

| | | |
|---|---|---|
| a. | Assumed repair/replacement frequency | Annually |
| b. | Assumed area of repair/replacement (ft$^2$) | 5,000 |
| c. | Purchase, delivery and installation unit cost ($/ft$^2$) | $1.10 |
| d. | Cost of repair/replacement ($) | $5,500 |

| | | |
|---|---|---|
| e. | Annual cost of providing construction quality assurance (CQA) during the repairs (25% of the construction cost) ($) | $1,375 |
| f. | Total annual cost of repairs ($) | $6,875 |

83. Final Cover Earthen Repair

| | | |
|---|---|---|
| a. | Assumed area to be repaired ($ft^2$) | 17,500 |
| b. | Total annual cost of earthen cover repair (including CQA during the repair) ($) | $11,783 |

84. Rebuilding of Haul Road and Channel

| | | |
|---|---|---|
| a. | Total length of the Haul Road to rebuild (ft) | 2,000 |
| b. | Haul Road rebuild unit cost ($/ft) | $90 |
| c. | Total Haul Road rebuild cost ($) (Line 84a x Line 84b) | $180,000 |
| d. | Total length of channel to rebuild | 1,660 |
| e. | Channel rebuild unit cost ($/ft) | $45 |
| f. | Total channel rebuild cost ($) (Line 84d x Line 84e) | $74,700 |
| g. | Total rebuild cost ($) (Line 84c + Line 84f) | $254,700 |
| h. | Design cost ($) (20%/100 Line 84g) | $50,940 |
| i. | Total Haul Road and Channel Cost (Line 84g + Line 84h) | $305,640 |

85. Gas System Modifications

| | | |
|---|---|---|
| a. | Decommission Existing Shallow Vertical Wells | |
| | 1. Wells at 12.5' (#23) | 288 ft. |
| | 2. Wells at 37.5' (#81) | 3,038 ft. |
| | 3. Wells at 62.5 (#106) | 6,625 ft. |
| b. | Subtotal Decommissioning Wells @ $5/ft. | $50,000 |
| c. | Abandonment Materials and Labor | |
| | 1. Sand - 1,000 bags @ $8/bag | $8,000 |
| | 2. Bentonite Chips - 350 bags @ $9/bag | $3,150 |

| | | | |
|---|---|---|---|
| 3. | Labor (2 per Crew) - 130 hours @ $20/hr. | | $2,600 |
| 4. | Backhoe - 130 hours @ $90/hr. | | $11,700 |
| 5. | Foreman - 130 hours @ $35/hr. | | $4,550 |
| 6. | Water Truck - 130 hours @ $60/hr. | | $7,800 |

d. Subtotal Abandonment Materials and Labor $37,800

e. New Shallow Well Construction - 10,333 LF @ $36/ft. $372,000

f. Well disconnection materials and labor (Disposal Area C) - 186 @ $20 ea. $3,720

g. Well Connection Materials

| | | | |
|---|---|---|---|
| 1. | 2" Slide Gate Valve | 450 @ $12 ea. | $5,400 |
| 2. | 6" PVC Tee | 450 @ $25 ea. | $11,250 |
| 3. | 6" Cap PVC | 450 @ $10 ea. | $4,500 |
| 4. | 6"x2" PVC Red | 450 @ $20 ea. | $9,000 |
| 5. | 2" PVC El | 450 @ $5 ea. | $2,250 |
| 6. | 1" Make Adapter-PVC | 450 @ $3 ea. | $1,350 |
| 7. | 1" PVC Cap | 450 @ $2 ea. | $900 |
| 8. | 2" Flex Cplg. | 450 @ $75 ea. | $33,750 |
| 9. | 2" PVC pipe | 450 @ $5 ea. | $2,250 |

h. Connection Assembly-Labor 450 @ $17.50 ea. $7,875

i. Connection Installation 450 @ $26,40 ea. $11,880

j. Subtotal Well Connection Materials $90,405

k. Relocate and Replace Header System - 36,780 LF @ $8/ft. $294,240

l. Relocate condensate sumps - 8 @ $4,000/ea. $32,000

m. Gas Well Protection - 233 @ $425/ea. $99,025

n. Total Gas System Modifications
(Line 85b + Line 85d + Line 85e + Line 85f + Line 85j
+ Line 85k + Line 85l + Line 85m) $979,190

86. Groundwater Monitoring Well Abandonment and Replacement at Closure

a. Abandonment of Wells MW 88-5 and MW 88-4 $5,240

b. Replacement of Wells MW 88-5 and MW 88-4 $10,300

c. Groundwater Well Replacement Total $15,540

87. Lysimeter Abandonment and Replacement at Closure

| | | |
|---|---|---|
| a. | Abandonment of Lysimeters 88-1 and 88-2 | $1,320 |
| b. | Replacement of Lysimeters | $8,400 |
| c. | Lysimeter Replacement Total | $9,720 |

88. Construction Management - QA/QC (Note: does not include final cover QA/QC) $1,655,629

# APPENDIX G

# 10 OCTOBER 1995 APPROVAL LETTER FROM CALIFORNIA INTEGRATED WASTE MANAGEMENT BOARD (CIWMB)

2.1.11

C: SWF Luther Ken Jeff

STATE OF CALIFORNIA

CALIFORNIA INTEGRATED WASTE MANAGEMENT BOARD

88[illegible] Center Drive

Sa[illegible]ito, California 95826

OCT 10 1995

Mr. Delwin Biagi
Los Angeles City Bureau of Sanitation
200 N. Main Street, Room 1400, City Hall East
Los Angeles, California 90012

Subject: Approval of the Final Closure and Postclosure Maintenance Plans for Lopez Canyon Sanitary Landfill, City of Los Angeles, Facility No. 19-AA-0820

Dear Mr. Biagi:

On September 25, 1995, the California Integrated Waste Management Board (Board) received your responses to the City of Los Angeles Environmental Affairs Department (Local Enforcement Agency [LEA]) comments of August 24, 1995 regarding adequacy of the final closure and postclosure maintenance plans (Plans) for the above facility. These materials included:

1. A letter from Mr. Delwin Biagi to Mr. Wayne Tsuda, dated September 7, 1995 with responses to the LEA's comments of August 24, 1995.

2. Two design drawings: Landfill Gas Perimeter Probe System, Site Improvements Map, and Landfill Gas Perimeter Probe System, Well Construction Details.

In addition to this latest submittal, we have previously received the following documents:

3. Final Closure and Postclosure Maintenance Plan, Volumes I, II, III, and IV, dated February 1, 1994.

4. Environmental Assessment and Negative Declaration addressing closure of Lopez Canyon Sanitary Landfill, dated June 1993.

5. Set of design drawings.

6. Revised Closure and Postclosure Maintenance Cost Estimate, dated February 21, 1995.

The LEA approved the Plans on September 21, 1995. The Los Angeles Regional Water Quality Control Board approved the Plans on March 8, 1995.

The Plans have been found to comply with the closure and postclosure maintenance regulations contained in Title 14, California Code of Regulations (14 CCR), Division 7, Chapter 3, Article 7.8 and Chapter 5, Article 3.4. Therefore, the Plans are hereby approved.

Should you have any questions, please contact Peter Janicki at (916) 255-1195 or myself at (916) 255-2431.

Sincerely,

Douglas P. Okumura, Deputy Director
Permitting and Enforcement Division

cc: Wayne Tsuda, City of Los Angeles Environmental Affairs Department
Rod Nelson, Los Angeles Regional Water Quality Control Board
Elizabeth Haven, State Water Resources Control Board

# APPENDIX H

# FINAL COVER PERFORMANCE EVALUATION REPORT

# DISPOSAL AREA C
# FINAL COVER PERFORMANCE EVALUATION

# LOPEZ CANYON SANITARY LANDFILL
# LAKE VIEW TERRACE, CALIFORNIA

Prepared for

**Bureau of Sanitation**
Department of Public Works
City of Los Angeles
419 South Spring Street, Suite 800
Los Angeles, California 90013

Prepared by

**GeoSyntec Consultants**
16541 Gothard Street
Huntington Beach, California 92647

Project Number CE4100-06

24 January 1994

# DISPOSAL AREA C
# FINAL COVER PERFORMANCE EVALUATION
# LOPEZ CANYON SANITARY LANDFILL

## TABLE OF CONTENTS

Page

# DISPOSAL AREA C
# FINAL COVER PERFORMANCE EVALUATION
# LOPEZ CANYON SANITARY LANDFILL

## TABLE OF CONTENTS (continued)

Page

# DISPOSAL AREA C
# FINAL COVER PERFORMANCE EVALUATION
# LOPEZ CANYON SANITARY LANDFILL

## TABLE OF CONTENTS (continued)

TABLES



FIGURES



APPENDICES

# 1. INTRODUCTION

## 1.1 Terms of Reference

This report has been prepared for the Bureau of Sanitation (BOS), Department of Public Works of the City of Los Angeles, California. The report was prepared by Dr. Neven Matasović and Mr. Michael S. Snow, P.E., of GeoSyntec Consultants. The report was reviewed by Dr. Edward Kavazanjian, Jr., P.E., G.E., of GeoSyntec Consultants in accordance with the internal review policy of the firm.

## 1.2 Objective of the Report

The objective of this report is to demonstrate that the final cover configuration proposed for Disposal Area C at the City of Los Angeles Lopez Canyon Sanitary Landfill (Disposal Area C) satisfies the standards established in state and federal regulations for design of municipal solid waste landfill facilities (MSWLFs). Disposal Area C is fitted with a composite bottom liner in accordance with Subtitle D of the Resource Conservation and Recovery Act (Subtitle D) and Los Angeles Regional Water Quality Control Board (RWQCB) Order 93-062. GeoSyntec's interpretation of state and federal regulations for design of MSWLFs is that the prescriptive minimum design requirements for the final cover of Disposal Area C consists of a 12-in. (300-mm) thick vegetative protection and erosion control layer underlain by a composite infiltration barrier layer. The composite barrier layer is composed of a geomembrane underlain by a minimum of 12 in. (300 mm) of compacted low permeability soil with a maximum hydraulic conductivity of $1 \times 10^{-6}$ cm/s.

The final cover configuration proposed for the Disposal Area C deck and bench areas satisfies the state and federal prescriptive minimum design standards. On the slopes of the Disposal Area C final cover, an alternative configuration is proposed in which the geomembrane component used in the infiltration barrier layer of the deck and bench area final cover is eliminated. This report presents a demonstration that, for the site specific conditions at the Lopez Canyon landfill, this alternative final cover proposed for the slopes of the Disposal Area C waste face satisfies state and federal final cover performance standards, including the requirement that surface water infiltration through the final cover is less than or equal to the liquid flux through the base of the landfill.

## 1.3 Regulatory Framework

State of California regulations for design of the final cover for closure of MSWLFs are found in Title 14 (Title 14) and Chapter 15, Division 3 Title 23 (Chapter 15) of the California Code of Regulations. Federal standards relevant to the design of final covers are presented in the §258.60, Closure and Post Closure, of Title 40, Subpart F (Subtitle D) of the Code of Federal Regulations. Title 40, Subpart F of the Code of Federal Regulations is commonly known as the Resource Conservation and Recovery Act (RCRA). Section 258 of RCRA is commonly known as Subtitle D.

State and federal regulations for design of MSWLFs include both prescriptive minimum construction standards and alternative, performance-based standards for final cover design. Performance-based designs must be approved by the governing regulatory agencies. The California regulatory program for MSWLFs was approved by the United States Environmental Protection Agency (USEPA) as in conformance with Subtitle D on 7 October 1993. Because the California regulatory program has been approved by USEPA, California state agencies have the authority to approve performance-based design alternatives for MSWLFs without federal review. Therefore, only the approval of the state and local regulatory agencies is required for implementation of a non-prescriptive final cover design for a MWSLF in California based upon the performance standards in state and federal regulations.

In California, regulatory responsibility for design of final covers for MSWLFs is jointly held by the RWQCB, the Local Enforcement Agency (LEA), and the California Integrated Waste Management Board (CIWMB). For the Lopez Canyon Sanitary Landfill, the LEA is the City of Los Angeles Environmental Affairs Department. The demonstration presented in this report is intended to provide the RWQCB, the LEA, and the CIWMB with the information necessary to make the determination that the performance-based alternative design proposed for the slopes of Disposal Area C final cover is in compliance with state and federal regulations for closure of MSWLFs.

## 1.4 Organization of the Report

The remainder of this report is organized as follows:

- background information on regulatory requirements for the design of final covers for MSWLFs and on-site conditions at the Lopez Canyon Sanitary Landfill is presented in Section 2;

- a demonstration that the proposed final cover for Disposal Area C satisfies the state and federal performance standards for MSWLFs is presented in Section 3;

- a discussion of the ability of the proposed final cover for Disposal Area C to meet applicable state and federal requirements is presented in Section 4; and

- a summary and conclusions are presented in Section 5.

In addition, appendices which contain detailed information on the final cover performance analyses, including the method of analyses, input data, and the results of the calculations, are attached to this report.

# 2. BACKGROUND INFORMATION

## 2.1 Regulatory Requirements for Landfill Final Covers

### 2.1.1 Prescriptive Design Standards

State of California regulations concerning design and construction of the final cover for closure of municipal solid waste landfills are found in Title 14 and Chapter 15. Federal regulations for final covers are provided in Subtitle D. RWQCB Order No. 93-062 contains additional information on the policies of the Los Angeles Regional Water Quality Control Board for application of the state and federal regulations to the Lopez Canyon Sanitary Landfill. The regulations applicable to the prescriptive design standards for final covers are summarized in the following paragraphs.

Section 2581.(a) of Chapter 15 provides the following requirements for the final cover of Class III (municipal solid waste) landfills:

- a foundation layer of a least 24 in. (600 mm) in thickness, unless the RWQCB finds that differential settlement of the waste and ultimate land use allow for a lesser thickness without impacting the integrity of the final cover;

- a "barrier" layer not less than 12-in. (300-mm) thick with a maximum permeability of 1 x $10^{-6}$ cm/s and a permeability equal to or less than any bottom liner or underlying natural materials;

- a vegetative layer containing no waste or leachate, placed on top of the barrier layer, of not less than 12 in. (300 mm) in thickness and of greater thickness than the rooting depth of any vegetation planted on the final cover; and

- design and construction of the final cover such that post-closure maintenance is minimized.

Section 2580.(e) of Chapter 15 provides for selection of vegetation for the final cover which minimizes irrigation and maintenance and does not impair the integrity of the containment structures (including the barrier layer).

Section 2547.(a) of Chapter 15 states that *"Class III waste management units shall be designed to withstand the maximum probable earthquake without damage to the foundation or to the structures which control leachate, surface drainage, erosion, or gas."*

Section 17777. of Title 14 states that the *"...maximum expected horizontal acceleration in rock at the site be determined for the Maximum Probable Earthquake (MPE)..."*, as defined in California Division of Mines and Geology (CDMG) Note 43. The same section states that a factor safety for the critical slope at least 1.5 is required under dynamic conditions. This section goes on to state that *"In lieu of achieving a factor of safety of 1.5 under dynamic conditions, a more rigorous analytical method that provides a quantified estimate of the magnitude of movement may be employed."*

Federal regulations in §258.60 of Subtitle D, effective 9 October 1993, provide that the final cover of a MSWLF:

- be designed to minimize infiltration and erosion;

- include a barrier layer with a minimum thickness of 18 in. (450 mm), a maximum hydraulic conductivity of 1 x $10^{-5}$ cm/s, and a permeability less than or equal to the bottom liner system and natural subsoils present; and

- include an erosion layer a minimum of 6 in. (150 mm) in thickness capable of sustaining native plant growth.

Section 14 of RWQCB Order No. 93-062 requires a closure plan that complies with Chapter 15 and §258.60 of Subtitle D for MSWLFs that received waste on or after 9 October 1991 and that had not initiated final closure by 9 October 1993. This requirement applies to the Lopez Canyon Sanitary Landfill.

### 2.1.2 Alternative Design Standards

Section 17773. of Title 14 provides the following requirements for design of an alternative final cover:

- the final cover shall be designed by a registered civil engineer or certified engineering geologist;

- engineering alternatives shall only be approved when the owner demonstrates that:

    - the prescriptive standard described in Chapter 15 is not feasible; and

- the engineered alternative is consistent with the performance goal of the prescriptive standard and provides equivalent protection to the ground water;

To establish that the prescriptive standard of Chapter 15 is not feasible, Section 17773. of Title 14 requires the owner to demonstrate that:

- the prescriptive standard is reasonably and unnecessarily burdensome and will cost substantially more; and

- the prescriptive standard is impractical and will not promote attainment of the performance goals of a final cover.

Section 258.60(b) of Subtitle D allows the director of a state with a USEPA-approved regulatory program to approve an alternative final cover design with a barrier layer and an erosion layer shown to be equivalent or superior to the final cover prescribed in §258.60(a) of Subtitle D with respect to surface water infiltration and wind and water erosion resistance.

### 2.1.3 Implications for Disposal Area C Final Cover Design

Both state and federal criteria for the design of final covers contain the requirement that the final cover system be designed and constructed to have a permeability that is less than or equal to the permeability of any bottom liner system or natural subsoils present. This requirement has been widely interpreted as a prescriptive standard that requires a geomembrane in the final cover over all areas of the landfill which have a geomembrane in the bottom liner. This interpretation is substantiated by comments contained in the "Final rule; corrections" for Subtitle D issued by USEPA, published in the Federal Register of 26 June 1992 (Vol. 57, No. 124, pages 28626-28628). In the Summary section, USEPA states that the agency is "*...clarifying its interpretation of the final cover requirements for the Criteria.*" In the Supplemental Information section, USEPA states that "*...the Agency has always interpreted this rule language to mean if there was a synthetic membrane in the bottom of a MSWLF, a synthetic membrane would, given today's technologies, be necessary as part of the final cover.*" As an "*illustration of the correct interpretation of this rule language,*" a final cover consisting of a "*minimum infiltration layer of 18-inches of 1 x $10^{-5}$ cm/s. earthen material overlain by a synthetic liner (Agency recommends minimum 20 mils; if HDPE, 60 mils) overlain by a minimum 6-inch erosion layer*" is presented as the "*minimum final cover*" in areas underlain by a prescriptive composite bottom liner.

CIWMB personnel have indicated in telephone conversations with GeoSyntec personnel that California also interprets the requirement that the final cover have a permeability less than or equal to the permeability of the bottom liner as a prescriptive requirement for a geomembrane component in the final cover over areas with geomembrane bottom liners. The California prescriptive barrier layer of 12 in. (300 mm) of soil with a maximum saturated hydraulic conductivity of 1 x $10^{-6}$ cm/s can be easily demonstrated to be a more effective infiltration barrier than the prescriptive soil barrier layer in the federal regulations of 18 in. (450 mm) of soil with a maximum saturated hydraulic conductivity of 1 x $10^{-5}$ cm/s. Therefore, a prescriptive final cover for a California landfill with a Subtitle D prescriptive bottom liner may be inferred to consist of a vegetative final cover layer with a minimum thickness of 12 in. (300 mm), a geomembrane, a low-permeability compacted soil layer with a minimum thickness of 12 in. (300 mm) and a maximum saturated hydraulic conductivity of 1 x $10^{-6}$ cm/s, and a foundation layer with a minimum thickness of 24 in. (600 mm).

Both state and federal regulations provide for engineered alternatives to the prescriptive final cover. The state provides explicit requirements for a final cover, as summarized in Section 2.1.2 of this report. Subtitle D requirements for an alternative final cover are less clear. However, from the USEPA comments in the Subtitle D "Final rule; corrections," it seems clear that there is flexibility in the Subtitle D final cover design criteria to allow for a performance-based alternative final cover design tailored to site specific conditions. Discussing the design criteria for final covers in the "Final rule; corrections" for Subtitle D, USEPA states that "*EPA intended, and has always interpreted, the language in this section to be a performance standard ...*" USEPA further states that the purpose of the permeability standard for the final cover infiltration layer was to "*prevent the 'bathtub effect' from occurring. The 'bathtub effect' occurs when a landfill fills up with liquids because the infiltration layer of the final cover is more permeable than the bottom liner system or natural subsoils present.*" This language suggests a final cover infiltration performance standard whereby surface water infiltration through the final cover must be less than the liquid flux through the base of the landfill.

USEPA states that while the clarifying language of the "Final rule; corrections" includes prescribed minimum final cover standards "*... intended to eliminate any confusion regarding the correct interpretation of this rule language. This clarification language does not remove any of the flexibility in § 258.60(b) regarding alternative final cover designs approved by the Director of a State/Tribal program that has been deemed adequate by EPA.*" Thus, it seems clear that there is the flexibility in the Subtitle D final cover design criteria to allow for an alternative final cover design on the basis of an implied performance standard whereby surface water infiltration through the final cover is less than the liquid flux through the bottom liner.

Both state and federal regulations require an alternative final cover design to be consistent with the performance goals of a final cover for MSWLF. In a recent research project for the CIWMB on development of performance criteria for landfill covers [GeoSyntec, 1993b], the following four goals for performance of final cover systems for landfills were identified:

- adjust landfill surface topography to provide appropriate slopes to promote runoff and controlled drainage of surface water;
- separate the waste from plants and animals;
- minimize infiltration of water into the waste; and
- control release of gas out of the waste.

## 2.2 Lopez Canyon Sanitary Landfill

### 2.2.1 Site Location and Landfill Description

The Lopez Canyon Sanitary Landfill was established as an operating solid waste disposal facility in 1975. The landfill operation is a key element of the City of Los Angeles (City) integrated solid waste management system. The landfill provides sanitary disposal capacity for the City's collected residential refuse and City Bureaus and contracted waste haulers. It serves the residential waste disposal needs of the North-Central, South-Central, East Valley, West Valley, and West Los Angeles refuse collection districts of the City.

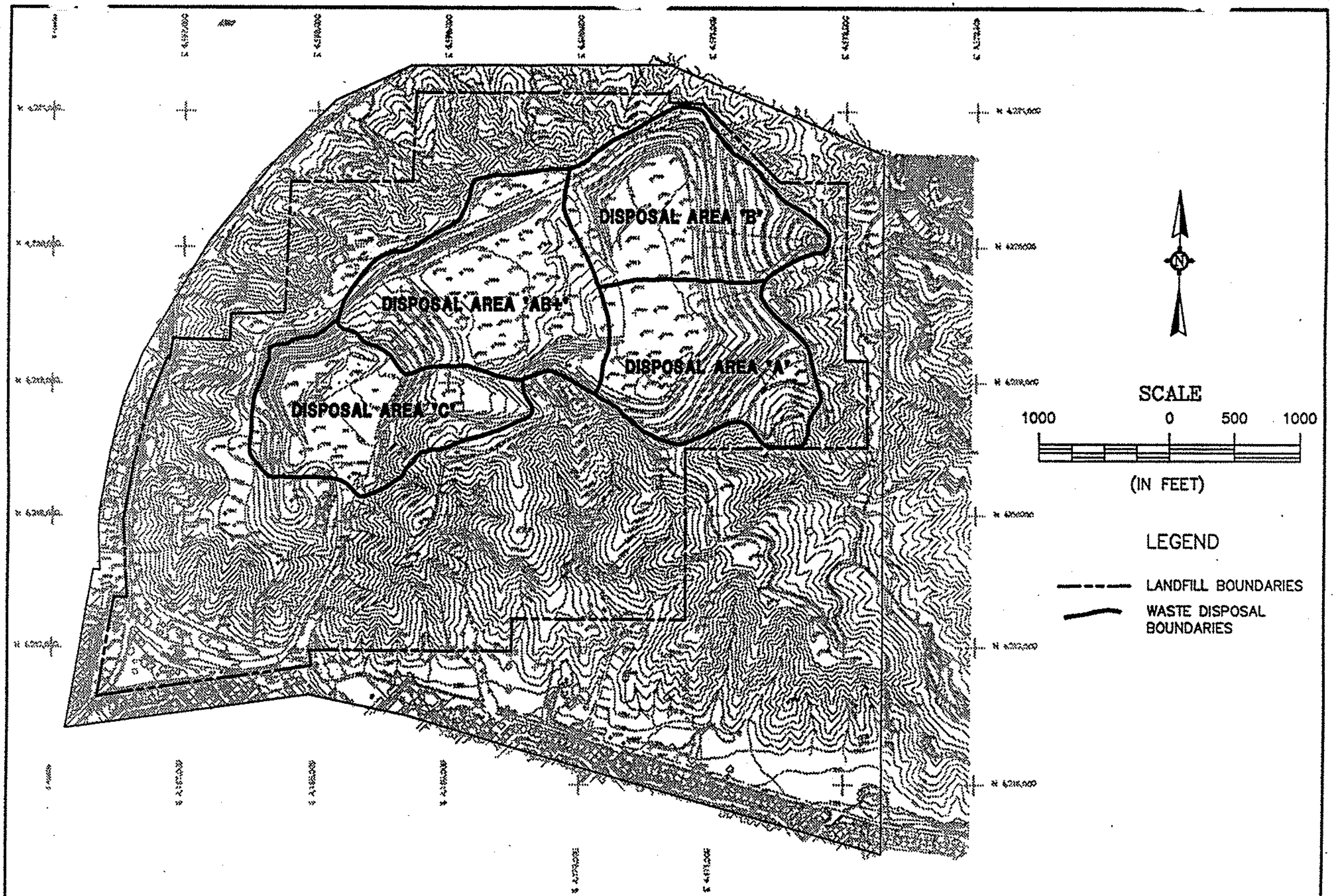
The site is operated according to state and local regulations for Class III disposal facilities as established by the State Water Resources Control Board (SWRCB), CIWMB, and the South Coast Air Quality Management District.

The site is currently comprised of four disposal areas referred to as Disposal Areas A, B, AB+ and C (see Figure 2-1). Disposal Areas A and B are unlined areas filled to capacity, with commencement of final closure activities anticipated in the near future. Disposal Area AB+, also unlined, is near capacity and is currently used only for wet weather operations. Currently, most refuse is being accepted in Disposal Area C. Disposal Area C is lined with a composite bottom liner and leachate collection system designed in accordance with Subtitle D and RWQCB Order No. 93-062. Closure of Disposal Areas AB+ and C are scheduled to commence concurrently following expiration of the landfills Conditional Use Permit (CUP) and Solid Waste Facilities Permit (SWFP). These permits are currently scheduled to expire on 4 February 1996.

The Lopez Canyon Sanitary Landfill had received approximately 14 million tons (12.7 million metric tons) of residential refuse, street sweepings, and inert waste as of 31 January 1993. Residue and grit from sewer cleanings and sewage treatment processes were received in the past, however, this type of waste is no longer accepted at the site. Asbestos wastes may have been disposed of on-site prior to the designation of asbestos as a hazardous waste. No liquids or hazardous wastes were knowingly accepted at the site.

### 2.2.2 Climatic Conditions

The Lopez Canyon Sanitary Landfill lies in the climatologic area known as the Los Angeles Basin (Basin). The climate of the Basin is relatively mild, with cool, wet winters and warm, dry summers, both moderated by sea breezes. This is caused by a semi-permanent high pressure system from the eastern Pacific Ocean. During the summer months, this high pressure zone is located in its northern-most position and prevents weak storms from moving through the area bringing predominantly frontal precipitation. Normally the rainy season in the Basin is between November and April.




BASE TOPOGRAPHY JUNE 1993

GeoSyntec Consultants

SITE PLAN
LOPEZ CANYON SANITARY LANDFILL
LAKE VIEW TERRACE, CALIFORNIA

| | |
|---|---|
| FIGURE NO. | 2-1 |
| PROJECT NO. | CE4100-06 |
| DRAWN BY: | LPR |
| DATE: | 12-23-93 |

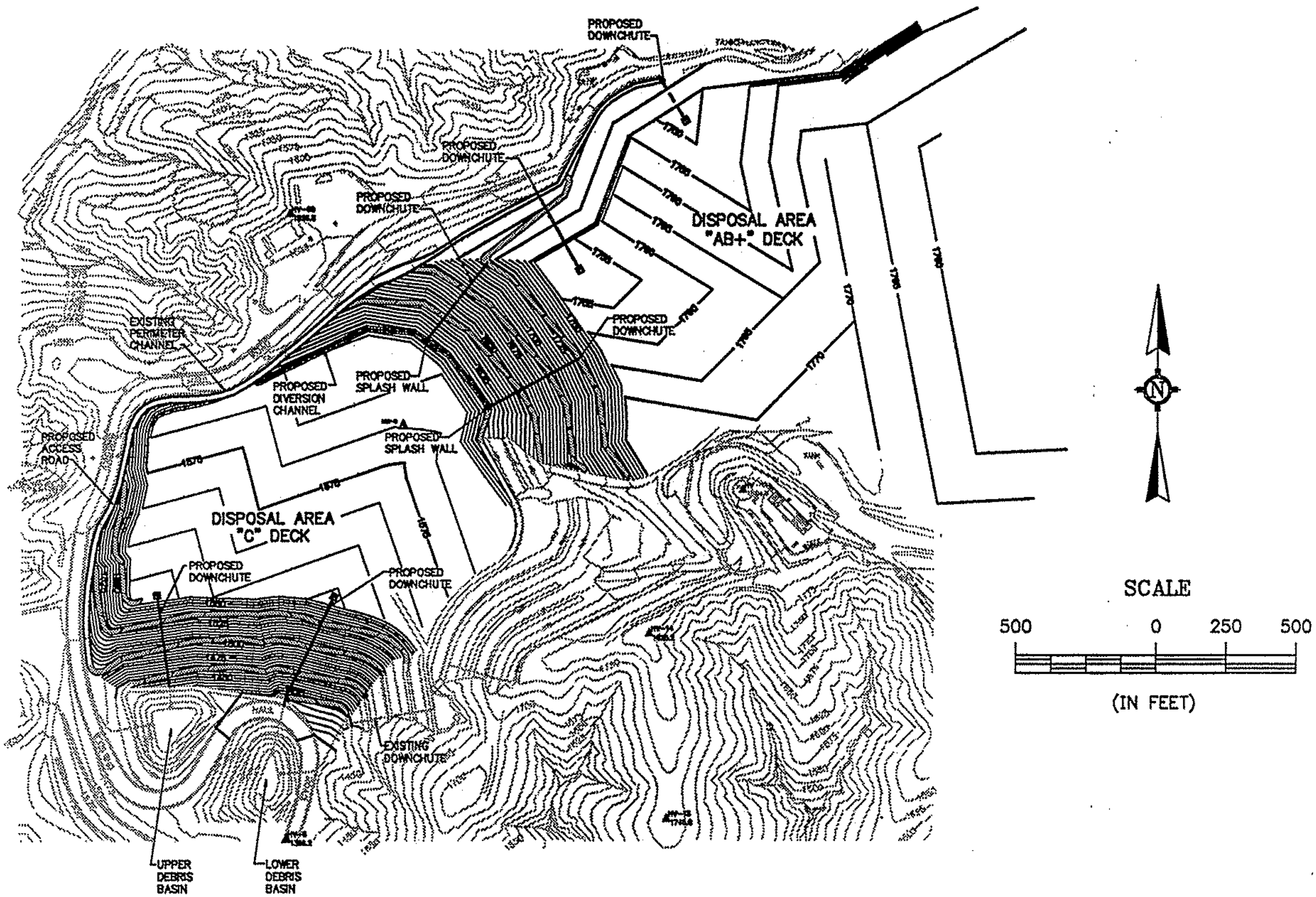
DWG: 4100F033 199401261442 LP

The nearest precipitation station to the site is the Hansen Dam, Station 3751, located about 2 miles (3.2 km) south of the site. However, Pacoima Dam, Station 6602, which is about 3 miles (4.8 km) north of the site, has an orographic setting closer to that of the landfill. Precipitation at the Lopez Canyon site is expected to fall somewhere between the levels estimated for these two stations. Based upon this assumption, the 100-year mean rainfall in the vicinity of the site is estimated to be approximately 16 in. (406 mm) per year [Bryan A. Stirrat & Associates (BAS); 1992].

The nearest evaporation measurements to the Lopez Canyon site are from Pacoima Dam, Station 293BE, operated by the Los Angeles County Flood Control District. The mean annual evaporation rate at this station is 89.59 in./year (2,275 mm/year). The maximum and minimum annual evaporation rates recorded at Station 293BE were 95.58 in./year (2,427 mm/year) and 73.60 in./year (1,869 mm/year), respectively. Maximum evaporation rates occur during the summer months (May through September).

### 2.2.3 Disposal Area C Development

Currently, most waste disposal operations at the Lopez Canyon Sanitary Landfill are conducted in Disposal Area C. Disposal Area C has a maximum permitted fill elevation of 1,765 feet in accordance with Conditional Use Permit (CUP) No. 90-0271CU. However, based upon current daily rates of refuse disposal, Disposal Area C will be filled only to elevation 1,585 ft on the scheduled closure date of 4 February 1996. This elevation is based upon the following assumptions: the refuse volume is 78% of the total volume; daily and intermediate cover is 22% of the total volume; the in-place refuse will have a density of approximately 1,250 pounds per cubic yard (7.3 $kN/m^3$); and the waste face will have a slope of 2H:1V (horizontal:vertical) with 18 ft (5.5 m) wide benches every 40 ft (12.1 m) in height. Figure 2-2 presents the top of final cover grading plan for a final elevation of 1,585 ft.




BASE TOPOGRAPHY JUNE 1993

GEOSYNTEC CONSULTANTS

DISPOSAL AREA C FINAL GRADING PLAN
LOPEZ CANYON SANITARY LANDFILL
LAKE VIEW TERRACE, CALIFORNIA

| | |
|---|---|
| FIGURE NO. | 2-2 |
| PROJECT NO. | CE4100-06 |
| DRAWN BY: | LPR |
| DATE: | 12-23-93 |

DWG: 4100F034 199401261435 LP

Disposal Area C is fitted with base and side slope liner systems that conform to the requirements of Subtitle D and RWQCB Order No. 93-062. The bottom liner system was designed and constructed in accordance with the prescriptive requirements for containment systems. It consists of the a 24-in. (600-mm) thick protective soil cover underlain by a geotextile filter layer, a 12-in. (300-mm) thick leachate collection and removal gravel drainage layer, geotextile cushion layer, an 80-mil (2-mm) thick high density polyethylene (HDPE) geomembrane bottom liner, and a 24-in. (600-mm) thick compacted low-permeability soil liner amended with bentonite to achieve a saturated hydraulic conductivity of no more than 1 x $10^{-7}$ cm/s.

The side slope liner system for Disposal Area C is an alternative containment system designed in accordance with the Subtitle D and RWQCB provisions for alternative designs. It consists of a 24-in. (600-mm) thick protective soil cover underlain by a geotextile filter layer, a leachate collection and removal geonet drainage layer, an 80-mil (2-mm) thick HDPE geomembrane liner, a geosynthetic clay liner (GCL) with a saturated hydraulic conductivity of no more than 5 x $10^{-9}$ cm/s, and a 3-in. (760-mm) thick reinforced air-sprayed slope veneer of pneumatically applied concrete. Conformance of this liner system to the Subtitle D and RWQCB requirements for design of alternatives to the prescriptive containment system has been demonstrated by GeoSyntec to the satisfaction of the RWQCB [GeoSyntec, 1993a].

# 3. FINAL COVER PERFORMANCE EVALUATION

## 3.1 Basis for Use of an Alternative Final Cover

In order to employ an alternative final cover for closure of a Class III landfill, California regulations require demonstration that not only will the alternative design achieve the performance goals for a final cover but also that the prescriptive final cover is both burdensome and impractical. As Disposal Area C is lined with a composite bottom liner, the prescriptive final cover for Disposal Area C is inferred to consist of a 12-in. (300-mm) thick protective vegetative and erosion control layer underlain by a composite infiltration barrier layer (see Section 2.1.3). The composite infiltration barrier layer is composed of a geomembrane underlain by a low-permeability compacted soil layer a minimum of 12-in. (300-mm) thick with a maximum hydraulic conductivity of 1 x $10^{-6}$ cm/s. Use of this prescriptive final cover on the waste slopes of the final cover is both impractical and burdensome, as it would be difficult and costly to construct and would significantly reduce the volume of waste that Disposal Area C can accommodate.

The use of a geomembrane in the final cover for the Disposal Area C waste face slopes raises both stability and constructibility concerns. If the conventional configuration of a nonwoven cushion geotextile on top of a textured geomembrane is used, the vegetative soil-geotextile interface will likely be the weakest interface in the final cover system and will control the stability of the design. Laboratory testing often shows both adhesive and frictional components to soil-geosynthetic interface shear strength. However, experience has demonstrated that the adhesion strength component of a soil-geosynthetic interface on sloping ground cannot be relied upon to contribute to long term stability. Creep of the vegetative cover soil, waste settlement, thermal strains, and other environmental factors combine to reduce and sometimes eliminate this adhesive strength component. Therefore, only the frictional component of the interface shear strength can be counted upon for stability. Typical friction angles for a soil-nonwoven geotextile interface are on the order of 20 degrees, with values as high as 26 degrees reported for judiciously selected geotextiles and cover soils. Thus, even for a judiciously selected cover soil with an interface friction angle of 26 degrees, a final cover inclination flatter than 3H:1V is required to achieve a satisfactory minimum static factor of safety of 1.5. Therefore, for slopes steeper than 3H:1V, special design details and/or construction procedures are required to achieve a satisfactory static factor of safety.

One approach to achieve a satisfactory static factor of safety with a slope inclination of 2.5H:1V for a final cover with a geomembrane infiltration barrier would be to eliminate the cushion geotextile on top of the geomembrane. The vegetative cover soil would be placed directly against a textured geomembrane in order to achieve adequate interface shear strength. The frictional strength of a soil-textured geomembrane interface is typically about 80 percent of the internal frictional shear strength of the soil. Thus, if a textured geomembrane is used and a soil with an internal friction angle of 37 degrees is placed directly on top of it, a typical interface shear strength would be represented by a friction angle of 30 degrees. With an interface shear strength friction angle of 30 degrees, a slope angle no steeper than 2.5H:1V is required to yield a static factor of safety of 1.5. In order to minimize the potential for damage to the geomembrane, the overlying soil must be either a fine grained soil or must be screened to eliminate oversized particles. Furthermore, in order to maintain a satisfactory factor of safety, the vegetative soil layer will have to be thick enough to prevent complete saturation due to surface water infiltration. Complete saturation of the vegetative soil layer would result in the development of seepage parallel to the slope and a significant reduction in the factor of safety.

Special compaction procedures will be required for placement of the soil directly on top of a geomembrane in order to avoid damaging the geomembrane during compaction. These special compaction procedures will be particularly burdensome for maintenance of the final cover, as mobilization of special equipment would likely be necessary every time maintenance is required.

Based upon the permitted final elevation, estimates of the waste volume reduction in Disposal Area C if the final cover slopes are laid back from the 2H:1V slopes currently planned to an inclination of 2.5H:1V indicate that approximately 750,000 tons (680,000 metric tons) of waste capacity would be lost at an estimated cost of $18,000,000 to the City of Los Angeles. Laying the final cover back slopes to 3H:1V would incur loss of an additional 750,000 tons (680,000 metric tons) of capacity and incur an additional $18,000,000 in costs to the City for disposal of refuse elsewhere.

Based upon the stability, constructibility, and maintenance problems incurred by using a geomembrane on the slopes of the final cover and the loss of waste disposal capacity associated with flattening the cover slopes to mitigate these problems, it may be concluded that use of the prescriptive final cover on the slopes of the waste face at Lopez Canyon is both impractical and burdensome and that the use of an alternative final cover on these slopes is justified.

## 3.2 Proposed Disposal Area C Final Cover Design

In order to maintain the inclination of the Disposal Area C waste face slopes at 2H:1V while providing a stable, constructible, low maintenance final cover, an engineered alternative to the prescriptive final cover design was developed. The alternative design uses a final cover configuration that satisfies the prescriptive standards on the top deck and benches areas, where ponding can occur due to differential settlement and erosion. On the final cover slopes, where the inclination of the slope minimizes the potential for ponding and infiltration, the geomembrane is omitted from the infiltration barrier layer of the final cover. Infiltration analyses show that, due to the high percentage of surface water run-off from the final cover slopes and the arid climate at Lopez Canyon, this alternative final cover on the slopes of the Disposal Area C waste face will satisfy final cover performance standards, including the performance standard for surface water infiltration.

A final cover satisfying the prescriptive minimum standard will be used on deck and bench areas of Disposal Area C. The final cover cross-section proposed for the deck and bench areas is shown in Figure 3-1. This deck and bench area final cover consists of the following components, from top to bottom:

- 24-in. (600-mm) thick, minimum, vegetative layer (thickness varies from about 26 in. (650 mm) to 35 in. (875 mm) on bench areas);

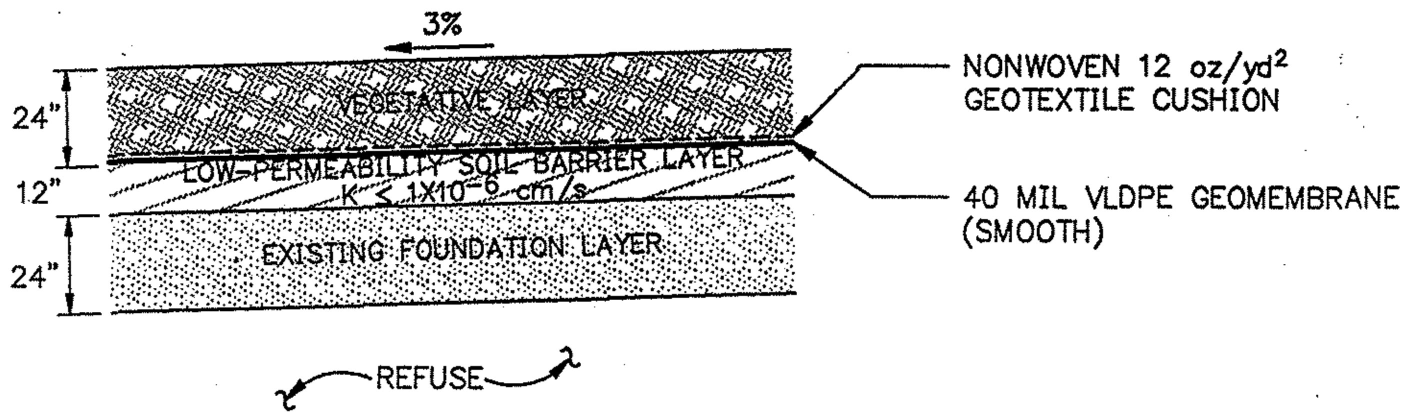
- 12 oz/yd$^2$ (410 g/m$^2$) nonwoven geotextile cushion;

- 40-mil (1-mm) thick VLDPE geomembrane (both sides textured on bench areas);

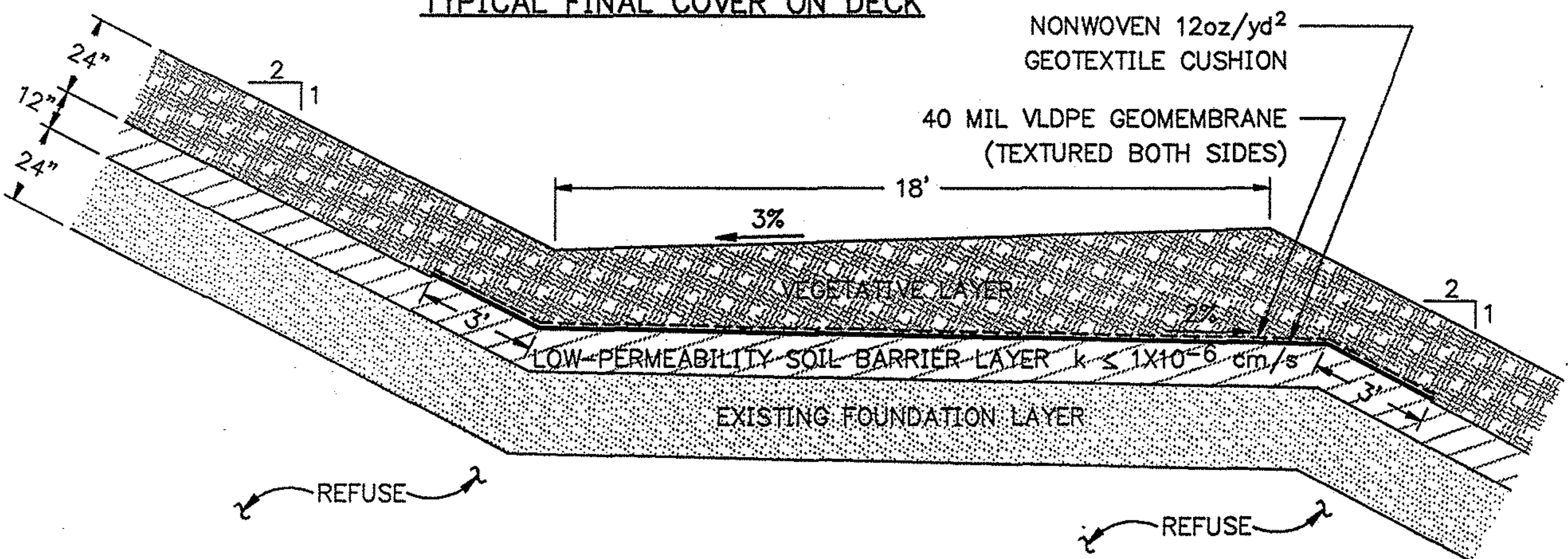
- 12-in. (300-mm) thick compacted low-permeability soil barrier layer having a saturated hydraulic conductivity no greater than 1 x 10$^{-6}$ cm/s; and

- 24-in. (600-mm) thick foundation layer (existing at the time of closure).

The alternative final cover cross-section proposed for the slopes of the Disposal Area C waste face is shown in Figure 3-2. It consists of the following components, from top to bottom:




TYPICAL FINAL COVER ON DECK




TYPICAL FINAL COVER ON BENCH

APPROXIMATE SCALE: 1" = 2'

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FINAL COVER ON DECK/BENCH AREAS
DISPOSAL AREA C
LOPEZ CANYON SANITARY LANDFILL

| | |
|---|---|
| FIGURE NO. | 3-1 |
| PROJECT NO. | CE4100-06 |
| DRAWN BY: | LPR |
| DATE: | 12-07-93 |

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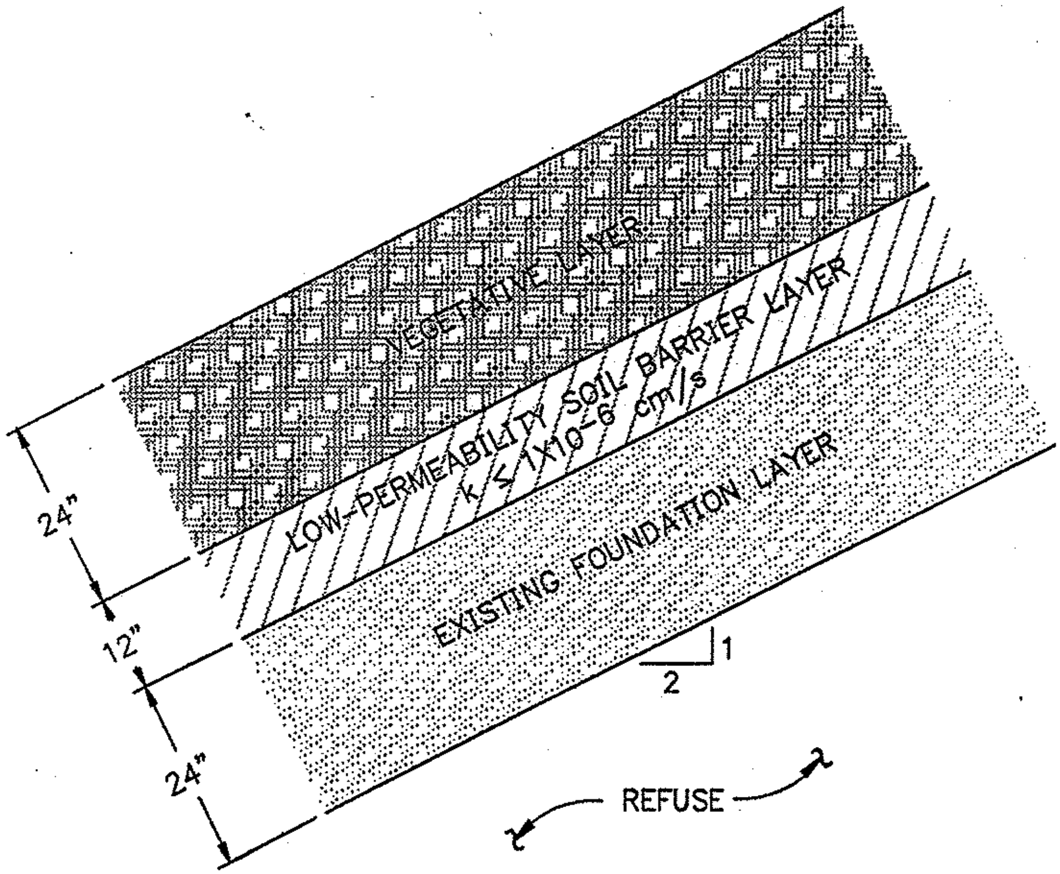


SCALE: 1" = 2'

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FINAL COVER ON SLOPE AREAS
DISPOSAL AREA C
LOPEZ CANYON SANITARY LANDFILL

| | |
|---|---|
| FIGURE NO. | 3-2 |
| PROJECT NO. | CE4100-06 |
| DRAWN BY: | LPR |
| DATE: | 12-07-93 |

DWG: 4100F031 19940120123 LP

- 24-in. (600-mm) thick vegetative layer (protective layer);

- 12-in. (300-mm) thick compacted low-permeability soil barrier layer having a saturated hydraulic conductivity no greater than 1 x $10^{-6}$ cm/s; and

- 24-in. (600-mm) thick foundation layer (existing at the time of closure).

In the following section, a demonstration is provided that, due to the site specific conditions at Lopez Canyon, the alternative final cover cross-section proposed for the slopes of the waste face of Disposal Area C satisfies the final cover performance standards in state and federal regulations. The alternative final cover of the waste face slopes is shown to provide protection against infiltration of surface water into the waste and erosion resistance equivalent to that of the prescriptive cover while isolating the waste from the environment.

## 3.3 Water Balance Analyses

### 3.3.1 Introduction

Water balance analyses were performed to demonstrate that the alternative final cover cross-section proposed for Disposal Area C final cover slopes satisfies the performance requirement of less surface water infiltration through the final cover of the landfill than liquid flux through the bottom liner. Water balance analyses were performed for the post-closure period using both the USEPA HELP (Hydrologic Evaluation of Landfill Performance) model [USEPA; 1984a, b] and the USEPA SW-168 model [Fenn et al., 1975].

Input parameters for the water balance analyses include final cover cross section, soil properties, and climatological data. Design parameters for climatological conditions and final cover configuration are discussed in Sections 2.2.1 and 3.2 of this report. The cross-section of the final cover slopes for which the water balance analyses were performed is shown in Figure 3-2. With respect to soil properties, values of saturated hydraulic conductivity, porosity, field capacity, initial soil water content, and wilting point are needed for use in water balance analyses. Values used for these properties were based upon conservative estimates of typical properties for the soil types to be used in final cover construction. Based upon the available on-site borrow soils, the vegetative layer was assumed to be composed of either silty sand (classified as SM in the Unified Soil Classification System (USCS)) or sandy silt (classified as ML in the USCS). The barrier layer was assumed to be composed of compacted low plasticity clayey material (classified as CL in the USCS). The foundation layer was assumed to be composed of low plasticity silty material (classified as ML in the USCS). The soil properties used in the water balance analyses for these typical soil types are presented in Table 3-1.

Different, but consistent, climatological data sets were employed for the two water balance analyses. For the SW-168 analysis, the following climatological data sets built into the model were used:

- potential evapo-transpiration (PET) - Mean monthly values derived from Thornthwaite's PET equation [Thornthwaite and Mather; 1957] based on a 25 year period for Los Angeles; and

- precipitation (P) - Mean monthly values based on data obtained from the U.S. Weather Bureau for a 25 year period in Los Angeles.

# TABLE 3-1

## WATER BALANCE ANALYSES
## MATERIAL PROPERTIES
## FINAL COVER PERFORMANCE EVALUATION
## LOPEZ CANYON SANITARY LANDFILL

| LAYER NO. | DESCRIPTION | CLASSIFICATION(1) | POROSITY(2) | FIELD CAPACITY(3) | WILTING POINT(4) | INITIAL SOIL WATER CONTENT | SATURATED HYDRAULIC CONDUCTIVITY cm/s |
|---|---|---|---|---|---|---|---|
| 1 | Vegetative Layer | SM/ML | 0.437 | 0.1053 | 0.0466 | 0.1053 | $1 \times 10^{-4}$ |
| 2 | Barrier Layer<br>Low-Permeability Soil | CL | 0.452 | 0.3710 | 0.2700 | 0.4520 | $1 \times 10^{-6}$ |
| 3 | Existing Foundation Layer | ML | 0.437 | 0.1063 | 0.0480 | 0.1063 | $1 \times 10^{-5}$ |

Note: (1) Soil classifications according to the Unified Soil Classification System.
(2) Volume of voids in a layer of material (or volume of water in a saturated layer) divided by the total volume of the layer.
(3) Volume of water remaining in a layer of material after it ceases to drain by gravity divided by the total volume of the layer. It corresponds to the moisture content remaining when the material exerts a soil suction of 1/3 atmospheres.
(4) Volume of water remaining in a layer of material after a plant extracts as much water as possible and goes into a permanent wilt, divided by the total volumes of the layer. It corresponds to the moisture content remaining when the material exhibits a soil suction of 15 atmospheres.

For the HELP analyses, evapo-transpiration and rainfall data were synthetically generated for a five year period using generation routines built into HELP. Rainfall data synthetically generated based upon southern California wet and dry seasons was scaled to yield an average annual rate 20 percent greater than the mean annual rainfall at the site, with a one year maximum approximately twice the mean annual rate. Evapo-transpiration rates were synthetically generated based upon representative temperatures and solar radiation rates for the Los Angeles Basin built into HELP.

Both water balance analyses are considered to be conservative with respect to the information on climate conditions at the site provided in the "Report of Disposal Site Information" (RDSI) [BAS; 1992] and summarized in Section 2.2.2 of this report. The precipitation data employed in the SW-168 analysis results in an annual rainfall 6 percent below the 100-year mean annual rainfall for the site reported in the RDSI. However, the SW-168 climatological data set has a total annual evaporation of 33 in. (840 mm), only 37 percent of the mean annual evaporation of 90 in. (2,275 mm) estimated for the site in the RDSI. The combination of a marginally lower annual precipitation rate (less than 1 in. (25 mm) below the 100-year mean annual value) and a significantly lower annual evaporation rate (more than 50 in. (1,270 mm) less than the mean annual value) results in a conservative assessment of the potential for surface water infiltration through the final cover slopes.

In the HELP model, the annual rainfall for the five year synthetic record exceeded the 100-year mean rainfall from the RDSI by 20 percent on average and by as much as 100 percent in one year. The annual evapo-transpiration rate never exceeded 9 in. (229 mm) in the HELP analyses. Thus, the HELP analyses employed a greater than average annual rainfall and a low evapo-transpiration rate.

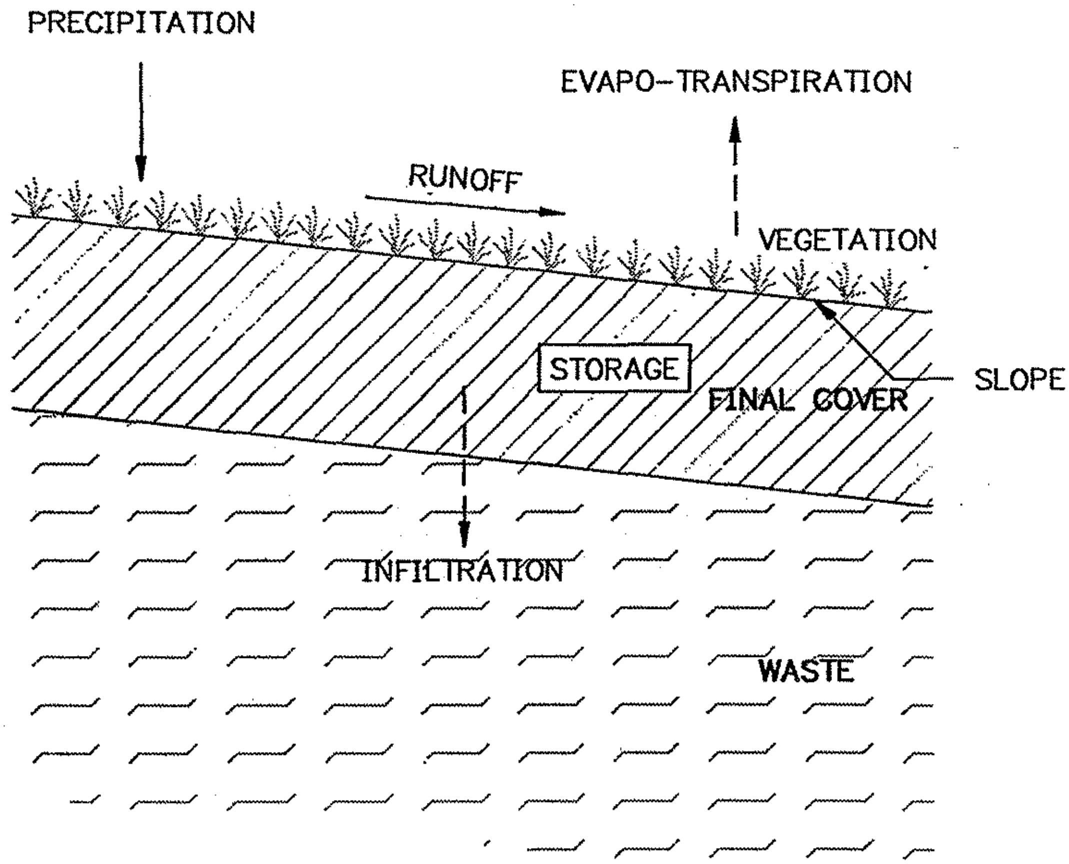
### 3.3.2 USEPA SW-168 Model

The SW-168 model was developed prior to the HELP model and is still widely used for water balance analyses due to its simplicity. GeoSyntec used the USEPA SW-168 model as one of the analytical tools for performing the water balance analyses for the Lopez Canyon Sanitary Landfill Disposal Area C.

The SW-168 model is a one-dimensional model for water balance calculations that, like the HELP model, considers the effect of precipitation, evapo-transpiration, surface runoff, and soil moisture storage on the extent of infiltration that may occur. These critical factors in a water balance analysis are schematically presented in Figure 3-3.

Soil moisture storage includes hydroscopic water (water held tightly in the soil) and available water (water undergoing capillary movement and evapo-transpiration losses). The soil moisture storage of the final cover is important because the soil capacity to store water directly influences the potential infiltration. The amount of available water that can be stored in the final cover soil is dependent on the type of soil and depth of the root zone.

Evapo-transpiration represents the amount of water in the soil that is lost to the atmosphere from a given area through direct evaporation from the soil and transpiration from plant tissues. The rate of evapo-transpiration depends upon climate conditions (temperature, relative humidity), vegetative cover, and soil moisture content. When soil moisture is at or near field capacity, evapo-transpiration occurs at its maximum potential rate. However, as soil moisture approaches the wilting point (the moisture content below which moisture is unavailable for withdrawal by plants), the amount of water available begins to restrict the rate of evapo-transpiration, resulting in reduced water losses.

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HYDROLOGYC MODEL OF THE FINAL COVER
LOPEZ CANYON SANITARY LANDFILL
LAKE VIEW TERRACE, CALIFORNIA

| | |
|---|---|
| FIGURE NO. | 3-3 |
| PROJECT NO. | CE4100 |
| DRAWN BY: | LPR |
| DATE: | 12-21-93 |

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The third parameter of major importance for water balance analyses is surface runoff, i.e., that portion of rainfall which will run off the site in lieu of entering the cover soil. Variables affecting runoff include intensity and duration of rainfall, existing soil moisture, hydraulic conductivity, slopes, and type of vegetative cover.

In brief, the basic equation in the SW-168 model for determining the amount of infiltration anticipated at a given site is as follows:

$$PERC = P - R/O - \Delta ST - AET \qquad \text{Equation 1}$$

where: PERC = percolation (the liquid that infiltrates through the cover by means of gravity); P = precipitation (the mean value over the time period of interest is used); R/O = surface runoff; $\Delta$ST = change in soil moisture storage (change in soil moisture from month to month); and AET = actual evapo-transpiration of the vegetative soil cover (amount of water loss during a given month).

Infiltration through the slopes of the Disposal Area C final cover (for the post-closure period) was estimated by the SW-168 model, assuming the following:

- "poor" grass vegetation conditions exist on the final cover surface;
- root zone is limited by the depth of vegetation cover;
- surface runoff is negligible during the "dry" months;
- the hydraulic characteristics of the final cover soil materials are uniform in all directions; and
- water movement within the final cover slopes is vertically downward.

Based on the proposed Disposal Area C final cover geometry, relative compaction, and vegetation, a run-off coefficient, $C_{R/O}$, of 0.35 was assumed [Johnson and Chang, 1984] (35 percent of the direct precipitation runs off as surface drainage) for the SW-168 model. This is the maximum value cited for the run-off coefficient by Johnson and Chang for a vegetated surface and corresponds to grass cover on a natural soil surface with a slope of 7 degrees. As the inclination of the Disposal Area C final cover slopes is approximately 26 degrees (50 percent), the run-off coefficient for the final cover slopes is expected to be significantly higher than 0.35. However, as 0.35 was the maximum value provided by Johnson and Chang, it was conservatively assumed as the run-off coefficient for the SW-168 analyses.

The analyses performed using the SW-168 model predicted no infiltration. This is because the annual precipitation is less than the annual evapo-transpiration and the transient infiltration in the "wet" months does not exceed the soil moisture storage capacity, as required to produce infiltration. A detailed presentation of the input data and calculations for the SW-168 model are presented in Appendix I.

### 3.3.3 HELP Model

The HELP model is a computer program that incorporates a quasi-two-dimensional water balance method into computation of water infiltration and leachate generation for municipal solid waste landfills. The program contains provisions for evaluating daily run-off, evapo-transpiration, percolation (i.e., infiltration), liquid flow, and liquid migration at MSWLFs. Input parameters include climatological data, soil data, and design data. GeoSyntec used the HELP model as one of the analytical tools for water balance analyses of the Disposal Area C final cover slopes.

Climatological data used in the HELP model include daily precipitation, daily mean temperature, daily solar radiation, maximum leaf area index, growing season, and evaporative zone depth. Daily precipitation data can be specified by the user or can be selected from a default data set that has data for most major cities in the United States. Synthetic generation of daily precipitation data using a synthetic weather generator incorporated in the program is also possible. Daily mean temperature and daily solar radiation data is synthetically generated based upon latitude using data sets incorporated into the program. Remaining climatological data have to be specified by the user.

Soil data includes porosity, field capacity, wilting point, initial soil water content, and saturated hydraulic conductivity. Default data sets for the properties are available in the HELP manual, but use of site-specific data is highly recommended. The values used for these parameters, based upon the site-specific conditions at Lopez Canyon, are given in Table 3-1.

Design data for determining run-off of precipitation consists of the Soil Conservation Service (SCS) run-off curve number, surface area, runoff area, and description of the layers, their order and function, and their thickness. The SCS curve number allows computation of run-off using an empirical method developed by the SCS for small watersheds (about 30 to 500 acres (10 to 200 hectares)) with mild slopes (about 3 to 7 percent). The method correlates daily run-off with daily rainfall for watersheds with a variety of soils, types of vegetation, land management practices, and antecedent moisture conditions (levels of prior rainfall). It should be noted that while this method accounts for changes in run-off as a function of soil type, soil moisture, and vegetative conditions, it is essentially for relatively level ground (mild slopes of 3 to 7 percent) and does not account for steeper slopes. Therefore, for slopes inclined at 26.6 degrees (2H:1V) to the horizontal (such as the Disposal Area C final cover slopes), use of SCS run-off curves is considered very conservative.

Analyses of the potential for infiltration through the Disposal Area C final cover slopes (for the post-closure period) were performed with the HELP model using the following assumptions:

- "poor" grass vegetation conditions exist on the final cover surface;
- the evaporative zone is 24-in. (600-mm) deep;
- the 24-in. (600-mm) thick vegetative layer (layer 1) behaves as a "vertical percolation layer"; and
- the 24-in. (600-mm) thick foundation layer (layer 3) that underlies 12-in. (300-mm) thick low-permeability soil barrier layer (layer 2) behaves as a "vertical percolation layer".

The site latitude of 34° 15' was specified to synthetically generate the climatological data set. SCS run-off curve No. 96, corresponding to all soil types for western desert urban areas was used.

Using the HELP model, climatological data was generated for a five year period. The average annual rainfall over this period was 19 in. (483 mm), varying from a low of about 9 in. (230 mm) in year one to a high of about 34 in. (865 mm) in year five. Run-off as a percent of precipitation varied from about 30 percent in year one to 80 percent in year five. Evapo-transpiration varied from approximately 8 in. (205 mm) in year two to less than 7 in. (180 mm) in year five The water balance calculated with the HELP model resulted in no infiltration through the cover, the same result obtained using the SW-168 model. Detailed presentation of input data as well as monthly and yearly results of the HELP calculations are presented in Appendix I.

## 3.4 Slope Stability Analyses

### 3.4.1 Introduction

Slope stability analyses were performed to demonstrate that the proposed final cover conforms to the requirements of Title 14. The final cover slope evaluated in the stability analysis consists of a 24-in. (600-mm) thick protective vegetative layer overlying a 12-in. (300-mm) thick low-permeability soil barrier layer. The barrier layer overlies a foundation layer a minimum of 24-in. (600-mm) thick. The foundation layer overlies municipal solid waste. The inclination of the final cover on the slopes is 2H:1V. The final cover cross-section on the bench areas is essentially the same as on the slope, except that a cushion geotextile and a geomembrane are introduced between the vegetative cover and the low-permeability soil barrier layers and the bench is essentially horizontal. Shear strength and unit weight values assumed for these materials for purposes of the stability analyses are presented in Table 3-2. Upper-bound values were used for typical unit weights and lower bound values were used for typical shear strength parameters to provide a conservative basis for the stability assessment. The basis for the properties used in the stability analyses is described in the subsequent paragraphs. Construction specifications and conformance testing will provide for field verification of these values.

All soil materials were assigned a total unit weight of 120 pcf (18.9 kN/m$^3$). This value was chosen as a reasonable upper bound for sandy silt compacted to 90 percent of the modified Proctor maximum dry density (ASTM D-1557) and for silt and clay compacted to 95 percent of the modified Proctor maximum dry density. An internal friction angle of 35 degrees and a cohesion of 100 psf (4.8 kPa) was assumed for the drained strength of the vegetative soil cover layer as a lower bound shear strength for a sandy silt compacted to 90 percent of the modified Proctor maximum dry density. For the low plasticity silt foundation layer and the low-permeability clayey soil

# TABLE 3-2

## SLOPE STABILITY ANALYSES
## MATERIAL PROPERTIES
## FINAL COVER PERFORMANCE EVALUATION
## LOPEZ CANYON SANITARY LANDFILL

| LAYER/MATERIAL | CLASSIFICATION[1] | UNIT WEIGHT pcf ($kN/m^3$) | FRICTION ANGLE degrees | COHESION psf (kPa) |
|---|---|---|---|---|
| Vegetative Layer | SM/ML | 120 (18.9) | 35 | 100 (4.8) |
| Geomembrane/Geotextile Interface | -- | -- | 8 | 0 |
| Low-Permeability Soil Barrier Layer (drained) | CL | 120 (18.9) | 30 | 200 (9.6) |
| Low-Permeability Soil Barrier Layer (undrained) | CL | 120 (18.9) | 0 | 500 (24.0) |
| Existing Foundation Layer | ML | 120 (18.9) | 30 | 200 (9.6) |
| Municipal Solid Waste (High Confining Stress) | -- | N/A | 28 | 100 (4.8) |
| Municipal Solid Waste (Low Confining Stress) | -- | N/A | 0 | 600 (28.7) |

Note: [1] According to the Unified Soil Classification System.

barrier layer, an internal friction angle of 30 degrees and a cohesion of 200 psf (9.6 kPa) was assigned to the drained shear strength. Based upon the assumption of compaction to 90 percent of the modified Proctor maximum dry density for the barrier layer, an undrained shear strength represented by a cohesion of 500 psf (24 kPa) was assumed for use in seismic analyses. An interface friction angle of 8 degrees was assumed for the geomembrane/geotextile/soil interface, representative of a nonwoven geotextile overlying a smooth geomembrane. A textured geomembrane is currently proposed for use on the bench areas. The use of an interface shear strength representative of a smooth geomembrane on the bench areas provides an additional margin of safety with respect to the safety factors computed herein.

Municipal solid waste was assigned a purely cohesive strength of 600 psf (28.7 kPa) at low confining pressures. A primarily frictional shear strength consisting of an internal friction angle of 28 degrees and a cohesion of 100 psf (4.8 kPa) was employed for higher confining pressures. A cohesion of 600 psf (28.7 kPa) at low confining pressures is consistent with the results of field and laboratory shear strength tests on municipal solid waste and with observations that vertical trenches in waste can be excavated to depths of up to 20 ft (6 m) and vertical waste faces can be constructed to heights of over 20 ft (6 m). An internal friction angle of 28 degrees and a cohesion of 100 psf (4.8 kPa) at high confining pressures is consistent with field and laboratory shear strength tests and shear strength parameters back-calculated from observation of stable waste slopes. Note that the interim waste face of Disposal Area A at the Lopez Canyon Sanitary Landfill is typically 2H:1V and as steep as 1.75H:1V in places and shows no evidence of instability. To maintain a stable waste face at an inclination of 1.75H:1V requires a minimum internal friction angle of 30 degrees, while an internal friction angle of at least 27 degrees is required for 2H:1V slopes, to remain stable.

### 3.4.2 Loading and Stability Criteria

In addition to gravitational loads, stability analyses also considered seepage forces and seismic loading. Gravitational loads are governed by the unit weights of the soil materials listed in Table 3-2. Seepage and seismic loading are discussed below.

During precipitation, water may percolate vertically into the ground and saturate the upper layers of soil. Once the soil saturates, if the surficial soils are underlain by a material with a lower saturated hydraulic conductivity, down slope flow parallel to the slope may occur. Down slope flow reduces the factor of safety of the slope. Field studies and analytical work on saturation of surficial soils in the Los Angeles area performed by Pradel and Raad [1993] indicates that the 24-in. (600-mm) thick vegetative cover layer is highly unlikely to saturate, even following the 24-hour, 100-year storm. This result is consistent with the HELP analyses which also indicated that the vegetative cover layer would not be saturated. Even though seepage parallel to the slope was demonstrated to be extremely unlikely, slope stability analyses were still conducted for this limiting condition.

The seismic loading for the design of the final cover is based upon the Maximum Probable Earthquake (MPE) prescribed by the California regulations, as discussed in Section 2.1.1. Vector Engineering Inc. [1993] has previously defined the following parameters for the MPE at the Lopez Canyon Sanitary Landfill: earthquake magnitude of 6.5; free field peak horizontal ground acceleration of 0.69 g; and seismic coefficient for stability analyses, $k_s$, equal to 0.2.

Stability criteria for the landfill final cover are also provided in the California regulations. As discussed in Section 2.1.1, a factor of safety of at least 1.5 under dynamic conditions (pseudo-static factor of safety) is prescribed. However, in lieu of achieving a pseudo-static factor of safety of 1.5, a more rigorous analytical method that provides an estimate of the magnitude of movement may be employed. In areas of high seismicity such as the Lopez Canyon site, a pseudo-static factor of safety of 1.5 is difficult to achieve in a cost effective manner and deformation analyses to estimate the magnitude of movement are usually employed. A maximum permanent displacement (i.e., magnitude of movement) of 12 in. (300 mm) is adopted herein as the acceptable limiting permanent deformation for the final cover from a seismic deformation analysis, in accordance with recommendations given in Seed and Bonaparte (1992) for design of bottom liner systems. This criterion for acceptable bottom liner permanent seismic deformation is considered conservative for final cover design. Cover soil deformation and cover soil damage is readily observed in post-earthquake inspections and, if necessary, repairable. Therefore, the acceptable limiting permanent seismic deformation for the cover may logically be assumed to be greater than that established for the bottom liner.

The requirement for a dynamic factor of safety of 1.5 unless a deformation analysis is performed is commonly interpreted as also requiring a minimum static factor of safety of 1.5 for the final cover. CIWMB personnel confirmed in telephone conversations that they generally require a static factor of safety of 1.5 for the final cover, even though California regulations do not explicitly state this as the minimum acceptable value. Therefore, a minimum static factor of safety of 1.5 was required for the final cover.

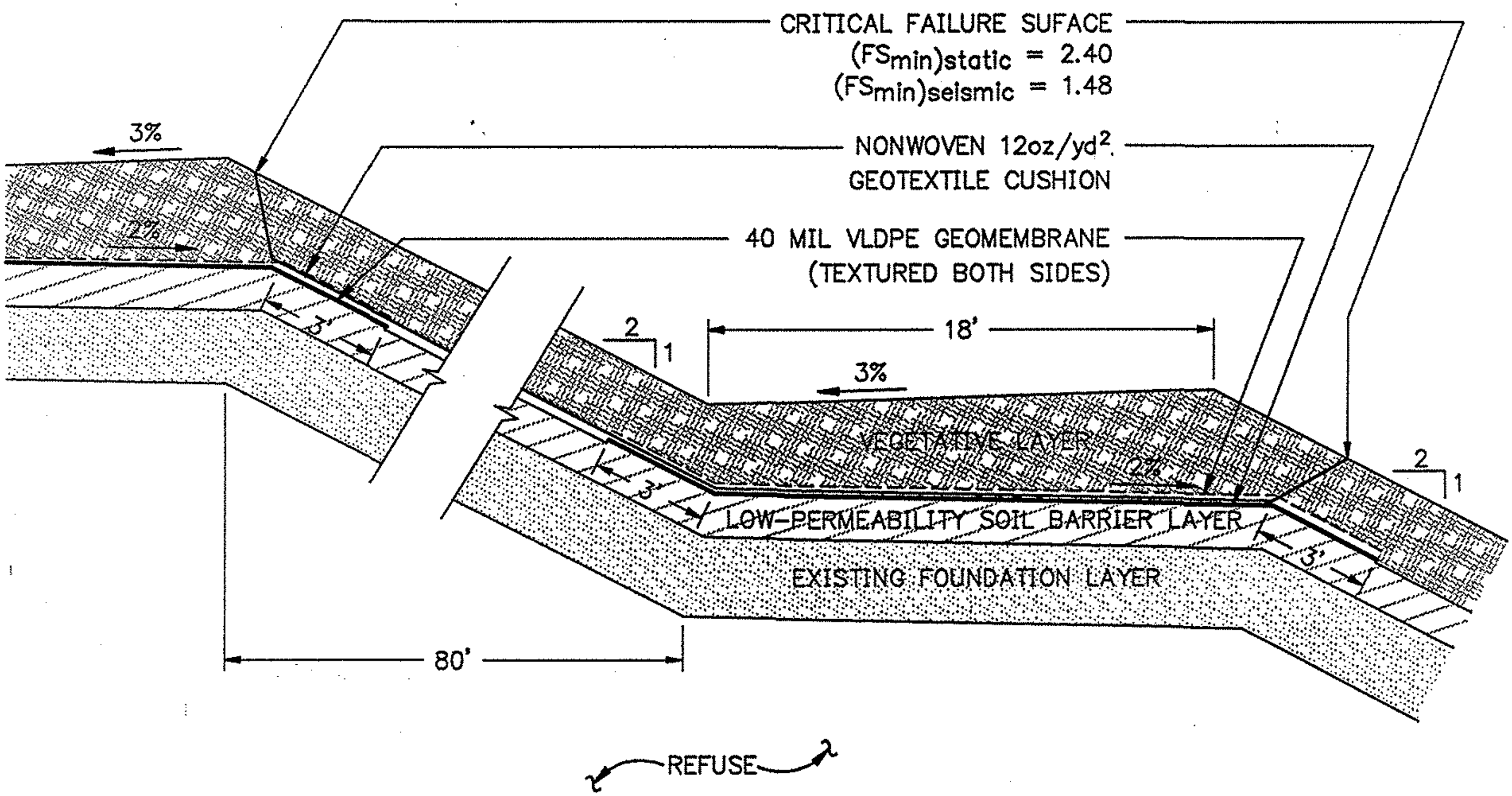
### 3.4.3 Results of Analyses

Slope stability analyses were performed using one-dimensional and two-dimensional limit equilibrium analyses. For the one-dimensional analyses, the basic equations employed can be found in most soil mechanics textbooks. The general form of these equations, modified to accommodate a variable depth of water table and seismic loading, can be found in the paper included as Appendix II [Matasović, 1991]. Permanent seismic displacements were estimated using charts prepared by Hynes and Franklin [1984] (also enclosed in Appendix II) which were developed based upon the Newmark method of analysis [Newmark, 1965].

Two-dimensional slope stability analyses were performed using the modified Janbu method, as incorporated in the computer program PC STABL 5M [Achilleos, 1988]. The cross-section analyzed in the stability analyses is shown in Figure 3-4. In the one-dimensional analysis, infinite slope conditions were assumed. Two-dimensional analysis was carried out to account for the limited length of slope between benches and the stabilizing effect of the benches. Wherever reasonable, failure surfaces followed layer interfaces, assuming the shear strength of the weaker material.

Material properties employed in both one- and two-dimensional analyses are listed in Table 3-2. Drained strength parameters were used for all materials except for the low-permeability soil barrier layer. Analyses which included surfaces passing through the barrier layer were conducted using drained (long term) parameters for static conditions and undrained (short term) strength parameters for seismic and seepage analyses.

Results of the slope stability analyses performed for the Disposal Area C final cover are presented in Table 3-3. The lowest factors of safety were from the one-dimensional analyses. The assumption of one-dimensional conditions is conservative as it ignores the stabilizing effects of the benches. One-dimensional analyses yielded a minimum static factor of safety of 1.60 for the vegetative layer for seepage parallel to the slope (Case 1). For the case of no seepage, the minimum factor of safety was 1.90, for a failure surface passing through the waste immediately below the interface with the existing foundation layer (Case 7). The corresponding minimum pseudo-static safety factor using a seismic coefficient of $k_s = 0.2$ was 1.27. The yield acceleration




NOT TO SCALE

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TWO-DIMENSIONAL SLOPE MODEL
DISPOSAL AREA C
LOPEZ CANYON SANITARY LANDFILL

| | |
|---|---|
| FIGURE NO. | 3-4 |
| PROJECT NO. | CE4100-06 |
| DRAWN BY: | LPR |
| DATE: | 12-28-93 |

DWG: 4100F031 19940120123 LP

# TABLE 3-3

## SLOPE STABILITY ANALYSES RESULTS FINAL COVER PERFORMANCE EVALUATION LOPEZ CANYON SANITARY LANDFILL

| REFERENCE CASE | DEPTH TO THE FAILURE SURFACE feet (m) | STRENGTH PARAMETERS | | SAFETY FACTORS | | |
|---|---|---|---|---|---|---|
| | | FRICTION ANGLE degrees | COHESION psf (kPa) | STATIC ($k_s$ = 0.0) | PSEUDO-STATIC ($k_s$ = 0.2) | YIELD ACCEL. (g) |
| 1[1] | 2.24 (0.68) | 35.0 | 100 (4.8) | 1.60[1] | -- | -- |
| 2[1] | 2.24 (0.68) | 30.0 | 200 (9.6) | 2.41[1] | -- | -- |
| 3 | 2.24 (0.68) | 35.0 | 100 (4.8) | 2.33 | 1.56 | 0.49 |
| 4 | 3.35 (1.02) | 30.0 | 200 (9.6) | 3.01 | 2.07 | 0.78 |
| 5 | 3.35 (1.02) | 30.0 | 200 (9.6) | 2.40 | 1.63 | 0.54 |
| 6[2] | 3.35 (1.02) | 0.0 | 500 (23.9) | 3.11 | 2.22 | 1.05 |
| 7 | 5.59 (1.70) | 30.0 | 200 (9.6) | 1.90 | 1.27[4] | 0.35 |
| 8[2] | 5.59 (1.70) | 0.0 | 600 (28.7) | 2.24 | 1.60 | 0.62 |
| 9[3] | Variable | Variable | Variable | 2.40 | 1.48[5] | 0.42 |

Notes: [1] Seepage parallel to the slope surface is assumed. Earthquake loading is not imposed simultaneously with seepage.
[2] Undrained analysis.
[3] Two dimensional analysis.
[4] Maximum permanent displacement is 2.0 in. (50 mm) for a peak ground acceleration of 0.69 g.
[5] Maximum permanent displacement is 1.7 in. (43 mm) for a peak ground acceleration of 0.69 g.

for this critical surface was calculated as 0.35 g. Detailed stability calculations are presented in Appendix II.

Based upon observations of the performance of slopes and embankments in earthquakes around the world, Seed [1979] concluded that, in the absence of liquefaction, slopes designed with a pseudo-static factor of safety of 1.15 using a seismic coefficient of 0.15 experience acceptable deformations in earthquakes of all intensities for magnitudes up to 7.5. Based upon this conclusion of Seed's, GeoSyntec considers a factor of safety of 1.2 with a pseudo-static coefficient of 0.2 to be acceptable with respect to permanent seismic deformations of final cover slopes in earthquakes of all intensities for magnitudes up to 7.5. On this basis, the dynamic stability of the final cover for Disposal Area C is satisfactory. However, as a precaution, a simplified deformation analysis was performed for the critical failure surface using the calculated yield acceleration of 0.35 g and the MPE peak ground acceleration of 0.69 g and the deformation charts of Hynes and Franklin [1984]. The estimated permanent displacement for a 0.69 g peak acceleration was on the order of 2.0 in. (50 mm), well below the limiting value of 12 in. (300 mm). This simplified seismic deformation calculation substantiated the conclusion, based upon Seed's [1979] conclusions, that the one-dimensional stability analyses demonstrated that the dynamic stability of the final cover for Disposal Area C was satisfactory.

Two-dimensional slope stability analysis, also presented in Appendix II, yielded relatively high factors of safety. The minimum static safety factor obtained for the two-dimensional analysis was 2.40. The factor of safety with a seismic coefficient of 0.2 was 1.48 for the critical surface. The yield acceleration for the critical surface was calculated as 0.42 g. The estimated permanent displacement for a 0.69 g peak acceleration was on the order of 1.7 in. (43 mm). These values indicate adequate stability for the final cover based upon the two-dimensional analyses.

# 4. COMPLIANCE WITH STATE AND FEDERAL REQUIREMENTS

## 4.1 Applicable Regulations

State and federal regulations for the design of a final cover for MSWLFs require either a design satisfying a prescriptive minimum standard or an engineered alternative design. The use of an engineered alternative must be consistent with the performance goals of a final cover and provide protection against erosion and infiltration equivalent or superior to that of the prescriptive standard. In California, the prescriptive standard for areas that include a geomembrane in the bottom liner consists of, from top to bottom:

- a protective vegetative erosion control layer of not less than 12 in. (300 mm) in thickness;
- a composite infiltration barrier layer composed of a geomembrane overlying a soil layer not less than 12 in. (300 mm) in thickness and compacted such that the saturated hydraulic conductivity is no greater less than 1 x $10^{-6}$ cm/s; and
- a foundation layer of at least 24 in. (600 mm) in thickness.

The prescriptive final cover requirements in the federal regulations are somewhat less restrictive than the California regulations, requiring only a 6-in. (150-mm) thick vegetative cover and a low-permeability soil barrier layer 18-in. (450-mm) thick with a maximum saturated hydraulic conductivity of 1 x $10^5$ cm/s.

To employ an alternative cover design, California regulations require:

- a demonstration that the prescriptive final cover is reasonably and unnecessarily burdensome and impractical; and

- a demonstration that the alternative final cover provides equivalent protection to the ground water.

California standards also require that the alternative (and prescriptive) final cover be designed to:

- minimize maintenance; and

- resist the maximum expected horizontal acceleration in rock at the site due to the Maximum Probable Earthquake, either by maintaining a factor of safety of at least 1.5 under dynamic conditions or by demonstrating that seismic deformations are within acceptable limits.

Federal regulations require only a demonstration of equivalent or superior performance with respect to infiltration and wind and water erosion for the alternative final cover. Federal regulations also require a design that minimizes infiltration and erosion.

## 4.2 Regulatory Compliance

The final cover proposed for Disposal Area C employs a final cover that satisfies the prescriptive standard on the deck and bench areas and an engineered alternative design that satisfies the performance standards for final covers on the slopes of the waste face. The bench and deck area final cover consists of (from top to bottom):

- 24-in. (600-mm) thick vegetative erosion control layer;
- 12 oz/yd$^2$ (410 g/m$^2$) cushion geotextile;
- composite infiltration barrier layer consisting of a 40-mil (1-mm) thick geomembrane underlain by 12 in. (300 mm) of compacted soil with a saturated hydraulic conductivity that does not exceed 1 x $10^{-6}$ cm/s; and
- 24-in. (600-mm) thick foundation layer.

Use of the prescriptive cover on the 2H:1V Disposal Area C final cover slopes is both burdensome and impractical due to:

- stability problems associated with use of a geomembrane on the slopes steeper than 3H:1V;
- special construction procedures and equipment required for placement of the vegetative layer directly on top of a geomembrane on slopes;
- loss of waste capacity due to use of a final cover slope flatter than 3H:1V;
- the construction cost of placement of a geomembrane on the side slopes;

- greater frequency of maintenance if a geomembrane is used on the final cover slopes; and

- the cost and difficulty in repair of a geomembrane on the final cover slopes.

On this basis, use of an engineered alternative final cover on the Disposal Area C final cover slopes was considered justified.

The alternative final cover for the slopes of the waste face consists of the final cover satisfying the prescriptive standard used on the bench and deck areas minus the cushion geotextile and the geomembrane component of the infiltration barrier. The ability of the alternative final cover on the waste face slopes to provide equivalent protection to the ground water compared to a cover satisfying the prescriptive standard was demonstrated using water balance analyses. Water balance analyses were performed using both the USEPA HELP model and the SW-168 infiltration model. Due to the arid climate at Lopez Canyon and the high percentage of surface water run-off associated with a 2H:1V slope face, both water balance analyses predict zero infiltration through the slopes of the final cover. This conclusion is substantiated by field data for the Los Angeles area from Pradl and Raad [1993] which shows that, even under extreme weather conditions, it is unlikely that the vegetative cover layer will become saturated. Saturation of the vegetative cover layer is a necessary precondition for significant infiltration through the cover. On this basis, the alternative final cover developed for the slopes of the waste face is deemed to provide infiltration resistance and ground water protection equivalent to that of the prescriptive final cover.

Slope stability analyses demonstrate that the alternative final cover on the slopes of the waste face has a factor of safety in excess of 1.5 for static conditions and for the condition of seepage parallel to the slope. Seismic deformation analyses yielded a permanent seismic deformation of approximately 2 in. (50 mm) from the Maximum Probable Earthquake. On the basis of these analyses, the stability of the alternative side slope final cover was deemed to be adequate.

As the vegetative layer for the alternative final cover on the slopes of the waste face is thicker than that of the prescriptive final cover, the erosion protection provided by the alternative final-cover is superior to that of the prescriptive design.

On the basis of the above considerations, the alternative final cover proposed for the slopes of the waste face for Disposal Area C at the Lopez Canyon Sanitary Landfill satisfies both California and federal performance standards for the design of final covers for MSWLFs.

# 5. SUMMARY AND CONCLUSIONS

Because Disposal Area C has a geomembrane bottom liner, the prescriptive final cover provided for in state and federal regulations is interpreted to consist of, from top to bottom, a 12-in. (300-mm) thick vegetative erosion protection layer, a geomembrane, a 12-in. (300-mm) thick layer of soil compacted such that the saturated hydraulic conductivity of the layer will not exceed 1 x $10^{-6}$ cm/s, and a foundation layer with a minimum thickness of 24 in. (600 mm). The final cover design proposed for Disposal Area C of the City of Los Angeles Lopez Canyon Sanitary Landfill consists of a final cover design that satisfies the prescriptive standard provided for in state and federal regulations on the deck and bench areas and an engineered alternative final cover on the slopes of the waste face that satisfies the performance standards set forth in these regulations.

The engineered alternative final cover on the slopes of the waste face has been shown to conform to state and federal performance standards for design of an alternative final cover for MSWLFs on the basis of:

- the demonstration in Section 3.1 of this report that the use of the prescriptive final cover on the slopes of the waste face is unnecessarily burdensome, impractical, costly, and is not consistent with the performance goals of the final cover;

- the demonstration in Section 3.2 of this report that the alternative final cover on the slopes of the waste face provides infiltration resistance and protection to ground water equivalent or superior to that of the prescriptive final cover; and

- the demonstration in Section 3.3 of the report that the alternative slope final cover on the slopes of the waste face meets stability criteria for static, seismic, and steady state seepage conditions.

Based upon the above cited demonstrations and the use of an erosion control layer in the alternative final cover on the slopes of the waste face that is thicker than the erosion control layer in the prescriptive design, it is concluded that the final cover design for Disposal Area C of the Lopez Canyon Sanitary Landfill satisfies applicable state and federal regulations for closure of municipal solid waste landfill facilities.

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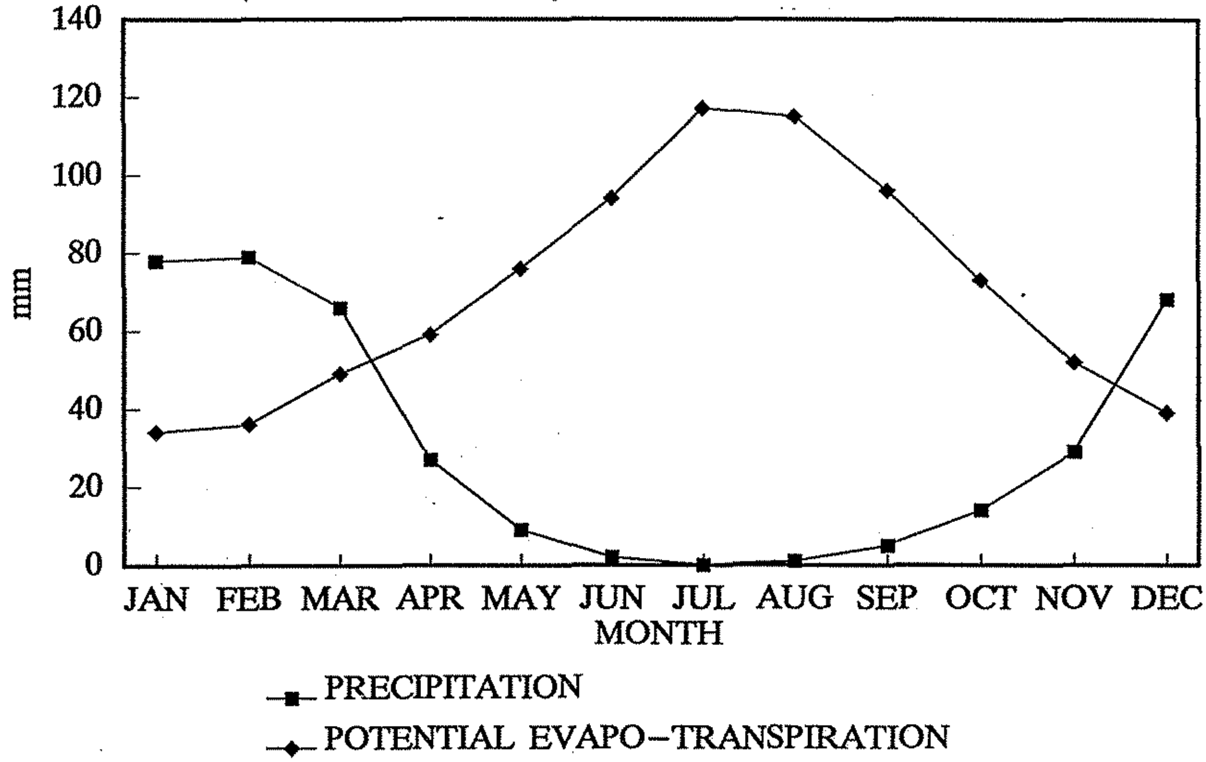
# APPENDIX I

# WATER BALANCE ANALYSES RESULTS

# LOPEZ CANYON SANITARY LANDFILL

DATA SET (FOR LOS ANGELES) USED WITH THE USEPA SW–168 MODEL




(MEAN MONTHLY VALUES, 25–YR. PERIOD)

| | |
|---|---|
| CLIENT / PROJECT: | *CLA / LOPEZ CANYON SANITARY LANDFILL* |
| PROJECT / TASK NO: | *CE 4100-6* |
| TASK: | *FINAL COVER PERFORMANCE EVALUATION* |
| MICROLOCATION: | *DISPOSAL AREA "C"* |
| ANALYSIS BY: | *Neven Matasovic* DATE: *24-Jan-94* |
| REVIEWED BY: | DATE: |

# WATER BALANCE ANALYSIS

AVAILABLE WATER *: 150 (mm/m)
ASSUMED DEPTH OF THE ROOT ZONE: 0.34 (m)
CALCULATED SOIL MOISTURE STORAGE**: 51 (mm)

**Model:**

USEPA Model SW-168

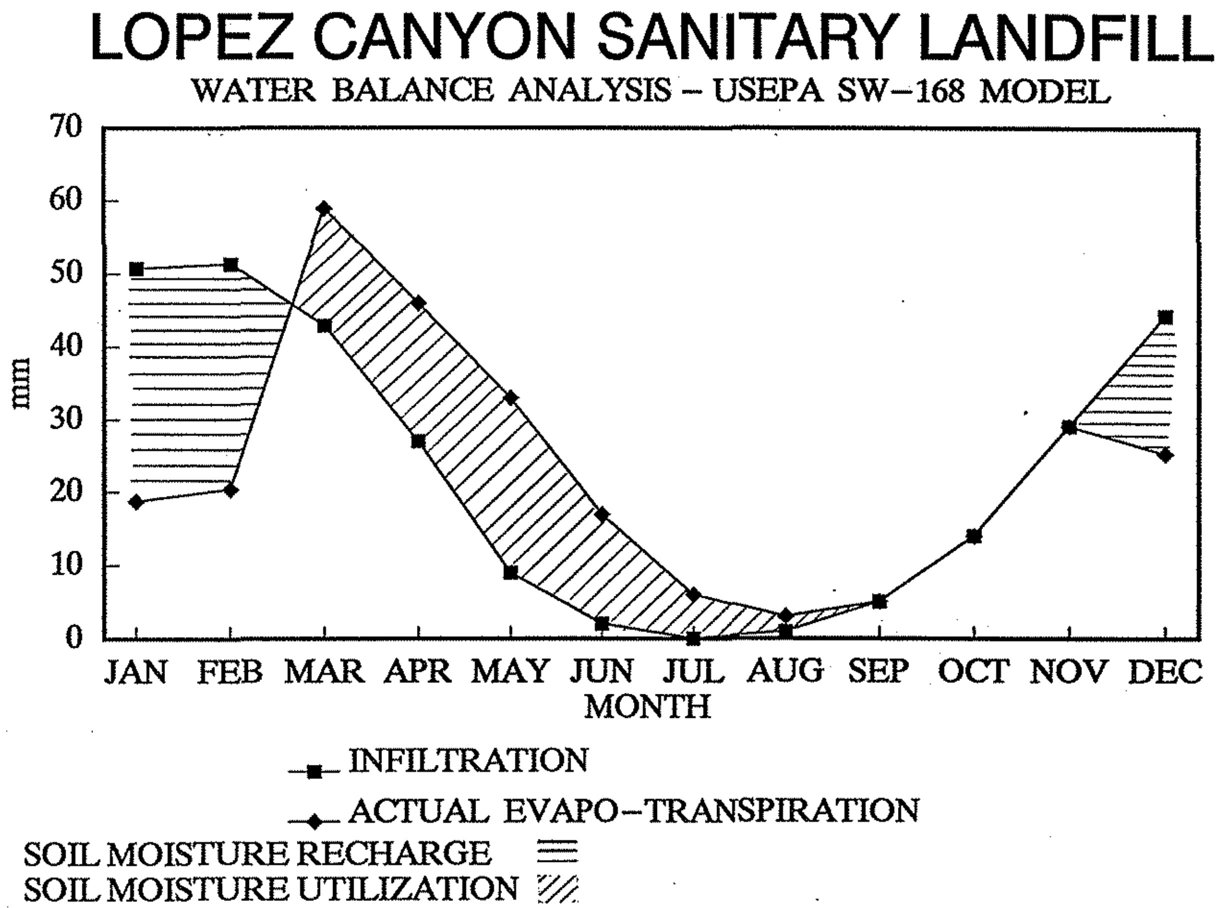
**Reference:**

Fenn, D.G., Hanley, K.J. and DeGeare, T.V. (1975) "Use of Water Balance Method for Predicting Leachate Generation from Solid Waste Disposal Sites," U.S. Environmental Protection Agency, Report SW-168, 1975, 39 p.

| PARAMETER[1] | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC | ANNUAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PET[2] | 34 | 36 | 49 | 59 | 76 | 94 | 117 | 115 | 96 | 73 | 52 | 39 | 840 |
| P[3] | 78 | 79 | 66 | 27 | 9 | 2 | 0 | 1 | 5 | 14 | 29 | 68 | 378 |
| $C_{R/O}$ [4] | 0.35 | 0.35 | 0.35 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.35 | N/A |
| R/O[5] = P * $C_{R/O}$ | 27.3 | 27.7 | 23.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 23.8 | 101.8 |
| I[6] = P - R/O | 50.7 | 51.4 | 42.9 | 27.0 | 9.0 | 2.0 | 0.0 | 1.0 | 5.0 | 14.0 | 29.0 | 44.2 | 276.2 |
| I - PET | 16.7 | 15.4 | -6.1 | -32.0 | -67.0 | -92.0 | -117.0 | -114.0 | -91.0 | -59.0 | -23.0 | 5.2 | -563.9 |
| SUM NEG (I-PET)[7] | N/A | N/A | -39 | -71 | -138 | -230 | -347 | -461 | -552 | -611 | -634 | N/A | N/A |
| ST[8] | 52 | 83 | 67 | 48 | 24 | 9 | 3 | 1 | 1 | 1 | 1 | 20 | N/A |
| (DELTA ST)[9] | 32 | 31 | -16 | -19 | -24 | -15 | -6 | -2 | 0 | 0 | 0 | 19 | N/A |
| AET[10] | 18.7 | 20.4 | 58.9 | 46.0 | 33.0 | 17.0 | 6.0 | 3.0 | 5.0 | 14.0 | 29.0 | 25.2 | 276.2 |
| PERC[11] | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

[1] All values are in mm (1 in = 25.4 mm).
[2] PET = Potential Evapotranspiration; data for the Los Angeles Basin provided in Fenn et al. (1975).
[3] P = Precipitation; data for the Los Angeles Basin provided in Fenn et al. (1975).
[4] $C_{R/O}$ = Runoff coefficient; surface runoff is assumed to be negligible for the dry months in an arid climate such as in the Los Angeles Basin.
[5] R/O = Surface runoff.
[6] I = Infiltration.
[7] SUM NEG (I - PET) = Accumulated water loss.
[8] ST = Soil moisture storage; based on available water in soil and accumulated water loss, see Table 9 in Fenn et al. (1975).
[9] (DELTA ST) = Change in water storage from previous month, i.e., change in soil cover moisture storage.
[10] AET = Actual evapotranspiration of the vegetative soil cover, i.e., amount of water loss during a given month.
[11] PERC = Percolation, i.e., liquid that infiltrates through the cover by means of gravity calculated as PERC = P - R/O - (DELTA ST) - AET.

* Defined as the difference between field capacity and wilting point. Estimated from Table 2 in Fenn et al. (1975) to estimate available water.
** Defined as the product of available water and root zone.


LOPEZ CANYON SANITARY LANDFILL
WATER BALANCE ANALYSIS – USEPA SW–168 MODEL
70
60
50
40
30
20
10
0
mm
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC
MONTH
INFILTRATION
ACTUAL EVAPO–TRANSPIRATION
SOIL MOISTURE RECHARGE
SOIL MOISTURE UTILIZATION

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LOPEZ CANYON SANITARY LANDFILL
DISPOSAL AREA "C" FINAL COVER PERFORMANCE EVALUATION
GeoSyntec Consultants

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LAYER 1

VERTICAL PERCOLATION LAYER

| | | |
|---|---|---|
| THICKNESS | = | 26.88 INCHES |
| POROSITY | = | 0.4370 VOL/VOL |
| FIELD CAPACITY | = | 0.1053 VOL/VOL |
| WILTING POINT | = | 0.0466 VOL/VOL |
| INITIAL SOIL WATER CONTENT | = | 0.1053 VOL/VOL |
| SATURATED HYDRAULIC CONDUCTIVITY | = | 0.000099999997 CM/SEC |

LAYER 2

BARRIER SOIL LINER

| | | |
|---|---|---|
| THICKNESS | = | 13.44 INCHES |
| POROSITY | = | 0.4520 VOL/VOL |
| FIELD CAPACITY | = | 0.3710 VOL/VOL |
| WILTING POINT | = | 0.2700 VOL/VOL |
| INITIAL SOIL WATER CONTENT | = | 0.4520 VOL/VOL |
| SATURATED HYDRAULIC CONDUCTIVITY | = | 0.000001000000 CM/SEC |

LAYER 3

VERTICAL PERCOLATION LAYER

| | | |
|---|---|---|
| THICKNESS | = | 26.88 INCHES |
| POROSITY | = | 0.4370 VOL/VOL |
| FIELD CAPACITY | = | 0.1063 VOL/VOL |
| WILTING POINT | = | 0.0480 VOL/VOL |
| INITIAL SOIL WATER CONTENT | = | 0.1063 VOL/VOL |
| SATURATED HYDRAULIC CONDUCTIVITY | = | 0.000010000000 CM/SEC |



GENERAL SIMULATION DATA

| | | |
|---|---|---|
| SCS RUNOFF CURVE NUMBER | = | 96.00 |
| TOTAL AREA OF COVER | = | 2723807. SQ FT |
| EVAPORATIVE ZONE DEPTH | = | 24.00 INCHES |
| UPPER LIMIT VEG. STORAGE | = | 10.4880 INCHES |
| INITIAL VEG. STORAGE | = | 2.5272 INCHES |
| INITIAL SNOW WATER CONTENT | = | 0.0000 INCHES |
| INITIAL TOTAL WATER STORAGE IN SOIL AND WASTE LAYERS | = | 11.7627 INCHES |

SOIL WATER CONTENT INITIALIZED BY USER.

CLIMATOLOGICAL DATA

SYNTHETIC RAINFALL WITH SYNTHETIC DAILY TEMPERATURES AND
SOLAR RADIATION FOR LOS ANGELES CALIFORNIA

| | | |
|---|---|---|
| MAXIMUM LEAF AREA INDEX | = | 1.00 |
| START OF GROWING SEASON (JULIAN DATE) | = | 67 |
| END OF GROWING SEASON (JULIAN DATE) | = | 16 |

NORMAL MEAN MONTHLY TEMPERATURES, DEGREES FAHRENHEIT

| JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|
| 56.80 | 58.40 | 59.00 | 61.20 | 63.40 | 66.30 |
| 70.30 | 72.20 | 71.30 | 67.50 | 61.60 | 57.40 |

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MONTHLY TOTALS FOR YEAR 1

| | JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|---|
| PRECIPITATION (INCHES) | 0.85 | 0.42 | 5.20 | 0.45 | 0.00 | 0.00 |
| | 0.00 | 0.00 | 0.00 | 0.51 | 0.00 | 1.41 |
| RUNOFF (INCHES) | 0.065 | 0.001 | 2.324 | 0.005 | 0.000 | 0.000 |
| | 0.000 | 0.000 | 0.000 | 0.068 | 0.000 | 0.195 |
| EVAPOTRANSPIRATION (INCHES) | 1.203 | 0.901 | 1.848 | 0.930 | 1.053 | 0.000 |
| | 0.000 | 0.000 | 0.000 | 0.240 | 0.201 | 0.152 |

| | | | | | | |
|---|---|---|---|---|---|---|
| PERCOL[illegible]OM LAYER 2 (INCHES) | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0000 | 0.0000 |
| | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| PERCOLATION FROM LAYER 3 (INCHES) | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

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MONTHLY SUMMARIES FOR DAILY HEADS

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| | | | | | | |
|---|---|---|---|---|---|---|
| AVG. DAILY HEAD ON LAYER 2 (INCHES) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| STD. DEV. OF DAILY HEAD ON LAYER 2 (INCHES) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

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ANNUAL TOTALS FOR YEAR 1

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| | (INCHES) | (CU. FT.) | PERCENT |
|---|---|---|---|
| PRECIPITATION | 8.84 | 2006538. | 100.00 |
| RUNOFF | 2.656 | 602973. | 30.05 |
| EVAPOTRANSPIRATION | 6.528 | 1481836. | 73.85 |
| PERCOLATION FROM LAYER 2 | 0.0003 | 62. | 0.00 |
| PERCOLATION FROM LAYER 3 | 0.0001 | 15. | 0.00 |
| CHANGE IN WATER STORAGE | -0.345 | -78286. | -3.90 |
| SOIL WATER AT START OF YEAR | 11.76 | 2669941. | |
| SOIL WATER AT END OF YEAR | 11.42 | 2591655. | |
| SNOW WATER AT START OF YEAR | 0.00 | 0. | |
| SNOW WATER AT END OF YEAR | 0.00 | 0. | |
| ANNUAL WATER BUDGET BALANCE | 0.00 | 0. | 0.00 |

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MONTHLY TOTALS FOR YEAR 2

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| | JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|---|
| PRECIPITATION (INCHES) | 2.48 | 4.84 | 4.69 | 0.01 | 0.12 | 0.00 |
| | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.00 |
| RUNOFF (INCHES) | 0.431 | 2.643 | 2.035 | 0.000 | 0.000 | 0.000 |
| | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.092 |
| EVAPOTRANSPIRATION (INCHES) | 2.127 | 2.289 | 2.588 | 0.695 | 0.356 | 0.041 |
| | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.184 |
| PERCOLATION FROM LAYER 2 (INCHES) | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| PERCOLATION FROM LAYER 3 (INCHES) | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

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MONTHLY SUMMARIES FOR DAILY HEADS

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| | | | | | | |
|---|---|---|---|---|---|---|
| AVG. DAILY HEAD ON LAYER 2 (INCHES) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| STD. DEV. OF DAILY HEAD ON LAYER 2 (INCHES) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

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ANNUAL TOTALS FOR YEAR 2

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| | (INCHES) | (CU. FT.) | PERCENT |
|---|---|---|---|
| PRECIPITATION | 13.14 | 2982569. | 100.00 |
| RUNOFF | 5.200 | 1180241. | 39.57 |
| EVAPOTRANSPIRATION | 8.279 | 1879278. | 63.01 |
| PERCOLATION FROM LAYER 2 | 0.0000 | 0. | 0.00 |
| PERCOLATION FROM LAYER 3 | 0.0001 | 15. | 0.00 |
| CHANGE IN WATER STORAGE | -0.339 | -76965. | -2.58 |
| SOIL WATER AT START OF YEAR | 11.42 | 2591655. | |
| SOIL WATER AT END OF YEAR | 11.08 | 2514690. | |
| SNOW WATER AT START OF YEAR | 0.00 | 0. | |

| | | | |
|---|---|---|---|
| SNOW [illegible] L END OF YEAR | 0.00 | 0. | |
| ANNUAL WATER BUDGET BALANCE | 0.00 | 0. | 0.00 |

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MONTHLY TOTALS FOR YEAR 3

| | JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|---|
| PRECIPITATION (INCHES) | 0.63 | 8.59 | 0.00 | 0.46 | 0.04 | 0.00 |
| | 7.69 | 0.00 | 0.00 | 0.52 | 0.00 | 2.98 |
| RUNOFF (INCHES) | 0.146 | 6.604 | 0.000 | 0.009 | 0.000 | 0.000 |
| | 6.570 | 0.000 | 0.000 | 0.002 | 0.000 | 0.531 |
| EVAPOTRANSPIRATION (INCHES) | 0.129 | 1.328 | 0.381 | 0.475 | 1.141 | 0.231 |
| | 0.212 | 0.908 | 0.000 | 0.151 | 0.309 | 2.027 |
| PERCOLATION FROM LAYER 2 (INCHES) | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| PERCOLATION FROM LAYER 3 (INCHES) | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

MONTHLY SUMMARIES FOR DAILY HEADS

| | | | | | | |
|---|---|---|---|---|---|---|
| AVG. DAILY HEAD ON LAYER 2 (INCHES) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| STD. DEV. OF DAILY HEAD ON LAYER 2 (INCHES) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

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ANNUAL TOTALS FOR YEAR 3

| | (INCHES) | (CU. FT.) | PERCENT |
|---|---|---|---|
| PRECIPITATION | 20.91 | 4746233. | 100.00 |
| RUNOFF | 13.862 | 3146442. | 66.29 |



| | | | |
|---|---|---|---|
| EVAPOTRANSPIRATION | 7.292 | 1655182. | |
| PERCOLATION FROM LAYER 2 | 0.0000 | 0. | 0.00 |
| PERCOLATION FROM LAYER 3 | 0.0001 | 15. | 0.00 |
| CHANGE IN WATER STORAGE | -0.244 | -55405. | -1.17 |
| SOIL WATER AT START OF YEAR | 11.08 | 2514690. | |
| SOIL WATER AT END OF YEAR | 10.83 | 2459285. | |
| SNOW WATER AT START OF YEAR | 0.00 | 0. | |
| SNOW WATER AT END OF YEAR | 0.00 | 0. | |
| ANNUAL WATER BUDGET BALANCE | 0.00 | 0. | 0.00 |

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MONTHLY TOTALS FOR YEAR 4

| | JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|---|
| PRECIPITATION (INCHES) | 0.93 | 1.53 | 1.33 | 0.05 | 0.03 | 0.00 |
| | 12.33 | 0.00 | 0.00 | 1.40 | 0.00 | 1.16 |
| RUNOFF (INCHES) | 0.035 | 0.179 | 0.258 | 0.000 | 0.000 | 0.000 |
| | 10.053 | 0.000 | 0.000 | 0.315 | 0.000 | 0.055 |
| EVAPOTRANSPIRATION (INCHES) | 1.167 | 1.559 | 0.523 | 0.403 | 0.226 | 0.000 |
| | 0.786 | 1.504 | 0.000 | 0.260 | 0.424 | 0.774 |
| PERCOLATION FROM LAYER 2 (INCHES) | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| PERCOLATION FROM LAYER 3 (INCHES) | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

MONTHLY SUMMARIES FOR DAILY HEADS

| | | | | | | |
|---|---|---|---|---|---|---|
| AVG. DAILY HEAD ON LAYER 2 (INCHES) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| STD. DEV. OF DAILY HEAD ON LAYER 2 (INCHES) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

***** [illegible] ************************************************************

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ANNUAL TOTALS FOR YEAR 4

| | (INCHES) | (CU. FT.) | PERCENT |
|---|---|---|---|
| PRECIPITATION | 18.76 | 4258218. | 100.00 |
| RUNOFF | 10.896 | 2473223. | 58.08 |
| EVAPOTRANSPIRATION | 7.627 | 1731112. | 40.65 |
| PERCOLATION FROM LAYER 2 | 0.0000 | 0. | 0.00 |
| PERCOLATION FROM LAYER 3 | 0.0001 | 15. | 0.00 |
| CHANGE IN WATER STORAGE | 0.237 | 53868. | 1.27 |
| SOIL WATER AT START OF YEAR | 10.83 | 2459285. | |
| SOIL WATER AT END OF YEAR | 11.07 | 2513153. | |
| SNOW WATER AT START OF YEAR | 0.00 | 0. | |
| SNOW WATER AT END OF YEAR | 0.00 | 0. | |
| ANNUAL WATER BUDGET BALANCE | 0.00 | 0. | 0.00 |

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MONTHLY TOTALS FOR YEAR 5

| | JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|---|
| PRECIPITATION (INCHES) | 3.13 | 1.88 | 1.39 | 0.42 | 0.07 | 0.00 |
| | 24.98 | 0.00 | 0.00 | 0.11 | 0.00 | 1.73 |
| RUNOFF (INCHES) | 1.635 | 0.816 | 0.173 | 0.002 | 0.000 | 0.000 |
| | 23.776 | 0.000 | 0.000 | 0.000 | 0.000 | 0.433 |
| EVAPOTRANSPIRATION | 1.779 | 1.238 | 0.725 | 0.712 | 0.528 | 0.000 |
| (INCHES) | 0.057 | 1.166 | 0.000 | 0.091 | 0.000 | 0.247 |
| PERCOLATION FROM | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| LAYER 2 (INCHES) | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| PERCOLATION FROM | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |



| | | | | | | |
|---|---|---|---|---|---|---|
| LAYER 3 (INCHES) | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.[illegible] | [illegible]000 |

MONTHLY SUMMARIES FOR DAILY HEADS

| | | | | | | |
|---|---|---|---|---|---|---|
| AVG. DAILY HEAD ON | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| LAYER 2 (INCHES) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| STD. DEV. OF DAILY HEAD | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| ON LAYER 2 (INCHES) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

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ANNUAL TOTALS FOR YEAR 5

| | (INCHES) | (CU. FT.) | PERCENT |
|---|---|---|---|
| PRECIPITATION | 33.71 | 7651627. | 100.00 |
| RUNOFF | 26.834 | 6090900. | 79.60 |
| EVAPOTRANSPIRATION | 6.544 | 1485430. | 19.41 |
| PERCOLATION FROM LAYER 2 | 0.0000 | 0. | 0.00 |
| PERCOLATION FROM LAYER 3 | 0.0001 | 15. | 0.00 |
| CHANGE IN WATER STORAGE | 0.332 | 75283. | 0.98 |
| SOIL WATER AT START OF YEAR | 11.07 | 2513153. | |
| SOIL WATER AT END OF YEAR | 11.40 | 2588436. | |
| SNOW WATER AT START OF YEAR | 0.00 | 0. | |
| SNOW WATER AT END OF YEAR | 0.00 | 0. | |
| ANNUAL WATER BUDGET BALANCE | 0.00 | 0. | 0.00 |

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 5

| JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|

PREC

| | | | | | | |
|---|---|---|---|---|---|---|
| TOTALS | 1.60 | 3.45 | 2.52 | 0.28 | 0.05 | 0.00 |
| | 9.00 | 0.00 | 0.00 | 0.51 | 0.00 | 1.66 |
| STD. DEVIATIONS | 1.13 | 3.30 | 2.29 | 0.23 | 0.05 | 0.00 |
| | 10.37 | 0.00 | 0.00 | 0.55 | 0.00 | 0.79 |

RUNOFF

| | | | | | | |
|---|---|---|---|---|---|---|
| TOTALS | 0.462 | 2.048 | 0.958 | 0.003 | 0.000 | 0.000 |
| | 8.080 | 0.000 | 0.000 | 0.077 | 0.000 | 0.261 |
| STD. DEVIATIONS | 0.674 | 2.753 | 1.123 | 0.004 | 0.000 | 0.000 |
| | 9.786 | 0.000 | 0.000 | 0.136 | 0.000 | 0.211 |

EVAPOTRANSPIRATION

| | | | | | | |
|---|---|---|---|---|---|---|
| TOTALS | 1.281 | 1.463 | 1.213 | 0.643 | 0.661 | 0.054 |
| | 0.211 | 0.716 | 0.000 | 0.149 | 0.187 | 0.677 |
| STD. DEVIATIONS | 0.760 | 0.519 | 0.962 | 0.210 | 0.414 | 0.100 |
| | 0.333 | 0.687 | 0.000 | 0.108 | 0.188 | 0.796 |

PERCOLATION FROM LAYER 2

| | | | | | | |
|---|---|---|---|---|---|---|
| TOTALS | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| STD. DEVIATIONS | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

PERCOLATION FROM LAYER 3

| | | | | | | |
|---|---|---|---|---|---|---|
| TOTALS | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| STD. DEVIATIONS | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 5

| | (INCHES) | (CU. FT.) | PERCENT |
|---|---|---|---|
| PRECIPITATION | 19.07 ( 9.456) | 4329037. | 100.00 |
| RUNOFF | 11.890 ( 9.463) | 2698756. | 62.34 |
| EVAPOTRANSPIRATION | 7.254 ( 0.745) | 1646568. | 38.04 |
| PERCOLATION FROM LAYER 2 | 0.0001 ( 0.0001) | 12. | 0.00 |
| PERCOLATION FROM LAYER 3 | 0.0001 ( 0.0000) | 15. | 0.00 |

| | | | | |
|---|---|---|---|---|
| CHANGE IN WATER STORAGE | -0.072 ( 0.329) | -16301. | 8 |

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 5

| | (INCHES) | (CU. FT.) |
|---|---|---|
| PRECIPITATION | 24.98 | 5670058.0 |
| RUNOFF | 23.776 | 5396664.5 |
| PERCOLATION FROM LAYER 2 | 0.0000 | 0.5 |
| HEAD ON LAYER 2 | 0.0 | |
| PERCOLATION FROM LAYER 3 | 0.0000 | 0.0 |
| SNOW WATER | 0.00 | 0.0 |

MAXIMUM VEG. SOIL WATER (VOL/VOL) 0.1650

MINIMUM VEG. SOIL WATER (VOL/VOL) 0.0458

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FINAL WATER STORAGE AT END OF YEAR 5

| LAYER | (INCHES) | (VOL/VOL) |
|---|---|---|
| 1 | 2.47 | 0.0919 |
| 2 | 6.07 | 0.4520 |
| 3 | 2.86 | 0.1063 |
| SNOW WATER | 0.00 | |

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# APPENDIX II

# SLOPE STABILITY ANALYSES RESULTS

| | |
|---|---|
| CLIENT / PROJECT: | *CLA / LOPEZ CANYON SANITARY LANDFILL* |
| PROJECT / TASK NO: | *CE 4100-6* |
| TASK: | *FINAL COVER PERFORMANCE EVALUATION* |
| MICROLOCATION: | AREA "C" |
| ANALYSIS BY: | *Neven Matasovic* DATE: *13-Jan-94* |
| REVIEWED BY: | DATE: |

# SLOPE STABILITY ANALYSIS

**Model:**

Infinite Slope

**References:**


Newmark, N.M. (1965) "Effects of Earthquakes on Dams and Embankments," Geotechnique, Vol. 15, No. 2, pp. 139-160.

Hynes, M.E. and Franklin, A.G. (1984) "Rationalizing the Seismic Coefficient Method," Miscellaneous Paper GL-84-13, U.S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi, 34 p.

Matasovic, N. (1991) "Selection of Method for Seismic Slope Stability Analysis," Proc. Second International Conference on Recent Advances in Geotechnical Earthquake Engineering and Soil Dynamics, St. Louis, Missouri, Vol. 2, pp. 1057-1062.

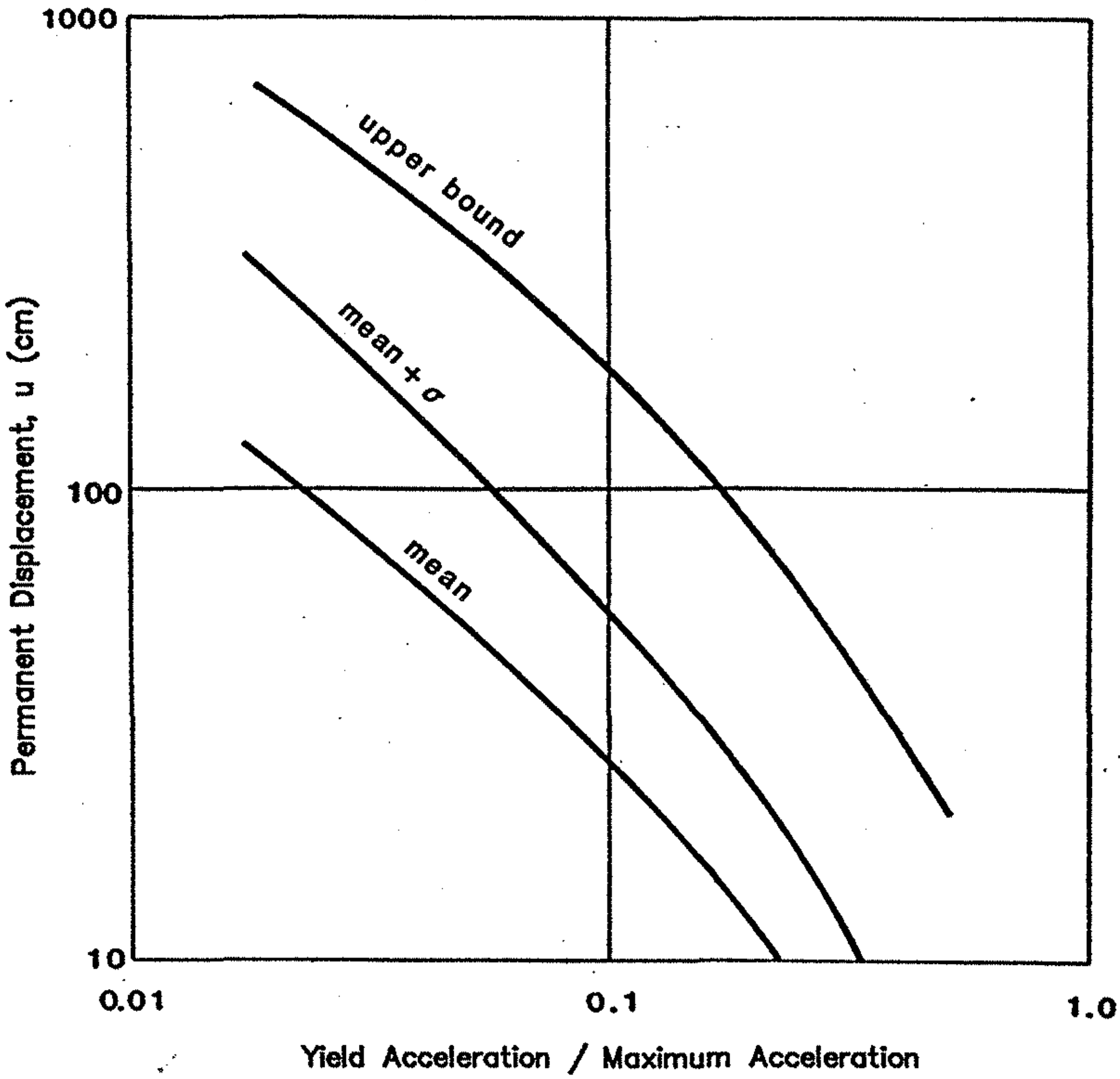

| SLOPE | | |
|---|---|---|
| INCLINATION | | ANGLE |
| Horizontal | Vertical | (deg) |
| 2 | 1 | 26.6 |

| LAYER | | | INTERFACE | |
|---|---|---|---|---|
| LABEL (-) | THICK.* (feet) | UNIT WT. (pcf) | DEPTH (feet) | UNIT WT.** (pcf) |
| SM / ML | 2.0 | 120 | 2.24 | 120 |
| CL | 1.0 | 120 | 3.35 | 120 |
| ML | 2.0 | 120 | 5.59 | 120 |
| WASTE | - | - | N / A | N / A |
| | | | | |

| REFERENCE CASE | SLOPE ANGLE | DEPTH TO THE | | UNIT WEIGHT OF (AVERAGE VALUES) | | STRENGTH PARAM. | | STATIC SAFETY FACTOR[1] | SEISMIC COEFFICIENT $k_s$ | PSEODOSTAT. SAFETY FACTOR[2] | YIELD ACCEL.[3] | NORMALIZED YIELD ACCEL.[4] | MAXIMUM PERMANENT DISPL.[5] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | FAILURE SURFACE | WATER TABLE | WATER | MATERIAL | FRICTION ANGLE, ø | COHESION, c | | | | | | |
| (-) | (deg) | (feet) | (feet) | (pcf) | (pcf) | (deg) | (psf) | (-) | (-) | (-) | (g) | (-) | (inches) |
| 1 | 26.6 | 2.24 | 0.00 | 62.4 | 120 | 35.0 | 100 | 1.60 | 0.20 | 1.04 | 0.22 | 0.32 | 3.1 |
| 2 | 26.6 | 2.24 | 0.00 | 62.4 | 120 | 30.0 | 200 | 2.41 | 0.20 | 1.64 | 0.55 | 0.80 | 1.3 |
| 3 | 26.6 | 2.24 | 2.24 | N / A | 120 | 35.0 | 100 | 2.33 | 0.20 | 1.56 | 0.49 | 0.71 | 1.5 |
| 4 | 26.6 | 2.24 | 2.24 | N / A | 120 | 30.0 | 200 | 3.01 | 0.20 | 2.07 | 0.78 | 1.13 | 0.9 |
| 5 | 26.6 | 3.35 | 3.35 | N / A | 120 | 30.0 | 200 | 2.40 | 0.20 | 1.63 | 0.54 | 0.79 | 1.3 |
| 6 | 26.6 | 3.35 | 3.35 | N / A | 120 | 0.0 | 500 | 3.11 | 0.20 | 2.22 | 1.05 | 1.53 | 0.7 |
| 7 | 26.6 | 5.59 | 5.59 | N / A | 120 | 30.0 | 200 | 1.90 | 0.20 | 1.27 | 0.35 | 0.51 | 2.0 |
| 8 | 26.6 | 5.59 | 5.59 | N / A | 120 | 0.0 | 600 | 2.24 | 0.20 | 1.60 | 0.62 | 0.90 | 1.2 |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |

[1] Various forms of the infinite slope equation can be found in almost any soil mechanics textbook. General form of the equation, modified to accomodate for both seismic loading and seepage parallel to the slope can be found in Matasovic (1991).
[2] Pseudostatic analysis, see equation 1 in Matasovic (1991).
[3] Pseudostatic acceleration needed to obtain safety factor of 1.0; see equation 2 in Matasovic (1991).
[4] Yield acceleration normalized by the peak horizontal ground acceleration of 0.69 (g)
[5] Maximum permanent displacement estimated on the basis on Newmark's (1965) principles using Hynes and Franklin (1984) charts (mean value).

* Thickness measured from the slope surface; Total thickness = 5.0 (feet).
** Unit Weight averaged up to the corresponding depth.




FROM HYNES AND FRANKLIN (1984)

GEOSYNTEC CONSULTANTS

PERMANENT DISPLACEMENTS VERSUS
NORMALIZED YIELD ACCELERATION

| | |
|---|---|
| FIGURE NO. | |
| PROJECT NO. | |
| DRAWN BY: | |
| DATE: | |

DWG: 4061F002 199310070949 LP

Proceedings: Second International Conference on Recent Advances in Geotechnical Earthquake Engineering and Soil Dynamics, March 11-15, 1991, St. Louis, Missouri, Paper No. 7.20

# Selection of Method for Seismic Slope Stability Analysis

Neven Matasovic'
Graduate Student, University of California, Los Angeles, California

SYNOPSIS: The seismic stability of natural slopes in clayey materials is a subject about which much uncertainty still exists. Therefore, selection of the method for the seismic slope stability analysis is an important part of solving the problem. In this paper the basic elements of the pseudo-static method, the sliding block method and the Ishihara's method are discussed. A case history of seismic stability analysis of an Adriatic coast flysch slope has been employed to evaluate the applicability and reliability of these methods. The slope is treated as an infinite slope. Although no definitive conclusions can be drawn from a single case history study, results may be used in future evaluations of seismic stability of similar slopes in cohesive materials.

## INTRODUCTION

The sliding of natural slopes usually occurs during, or follows strong earthquakes. In most cases such sliding is governed by a combination of geological conditions and earthquake loading. Although various modes of seismically induced failures have been identified and classified (e.g., Keefer, 1984), it is still very difficult to analytically forecast the failures. The most important reasons for that are the difficulties associated with the determination of reliable material parameters on the contact of different layers, usually expensive and inadequate characterization of the material behavior under irregular cyclic loading and the uncertainty associated with evaluation of seismic loads that are never explicitly known. In other words, the accuracy of the methods of numerical analysis greatly exceeds the accuracy with which the required numerous geotechnical and seismical parameters can be estimated.

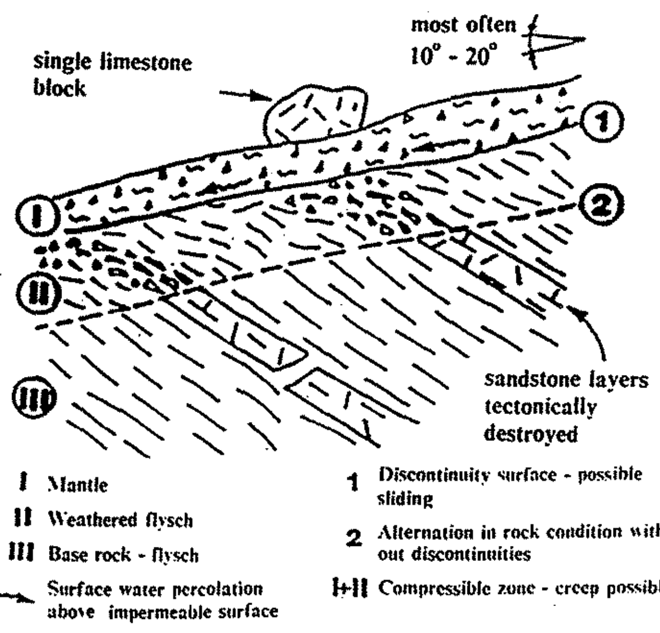



Fig. 1 Engineering geology elements of a flysch slope (After Jurak et al., 1987)

To examine various approaches to the seismic stability analysis of natural slopes in clayey materials. given the difficulties mentioned above, a seismically induced failure of a slope is analyzed in this paper. The failure was reported after the 1979 Montenegro earthquake ($M_L$ = 7.1) in a small village, Velji Kaliman, Yugoslavia. Movement of a mantle on a flysch base was along well defined sliding surface. The sliding mass was of constant height and approximately 500m long. Engineering geology elements of the slope, which represents a rather typical flysch slope of the Adriatic coast, are shown in Figure 1 (Jurak et Al. 1987, after Ivanovic, 1979). The infinite slope model employed has been modified to meet specific requirements of modeling the flysch slope. The seismic stability analysis was provided using three of the most popular analytical methods.

## METHODS FOR SEISMIC SLOPE STABILITY ANALYSES

Today, the evaluation of the seismic stability of natural slopes in clayey materials is most often carried out using various modifications of the following three methods: the pseudo-static method, the sliding block method (Newmark. 1965) and the Ishihara's method (Ishihara, 1985).

### Analysis by Pseudo-static Method

The pseudo-static method for seismic slope stability analysis is based on assumptions of the limit equilibrium and is still the most popular method among practicing engineers. In addition to the vertical force G, (Figure 2a), which can be expressed as a product of the total mass m and the acceleration of gravity g, horizontal force $H = k_s G$ proportional to G is introduced to simulate earthquake loading. The proportionality factor, $k_s$ is called the *seismic coefficient*. If the infinite slope model is used, additional assumptions have to be introduced as follow:

- the sliding surface is a straight plane parallel to the surface
- interslice forces are equal in every vertical cross section and parallel to the ground surface
- the direction of steady state seepage is parallel to the ground surface
- sliding mass is affected by pseudo-static inertia force proportional to its total weight and parallel to base acceleration
- the base acceleration is horizontal

- the magnitude of acceleration is constant in the soil mass above the sliding surface, i.e. free field acceleration is applied at the bottom of the slice
- there is no pore pressure increase in the soil mass during shaking.

The influences of the vertical acceleration component and the pore pressure increase during shaking (flysch is partially saturated cohesive material) are neglected because it is believed they are small in this particular case.

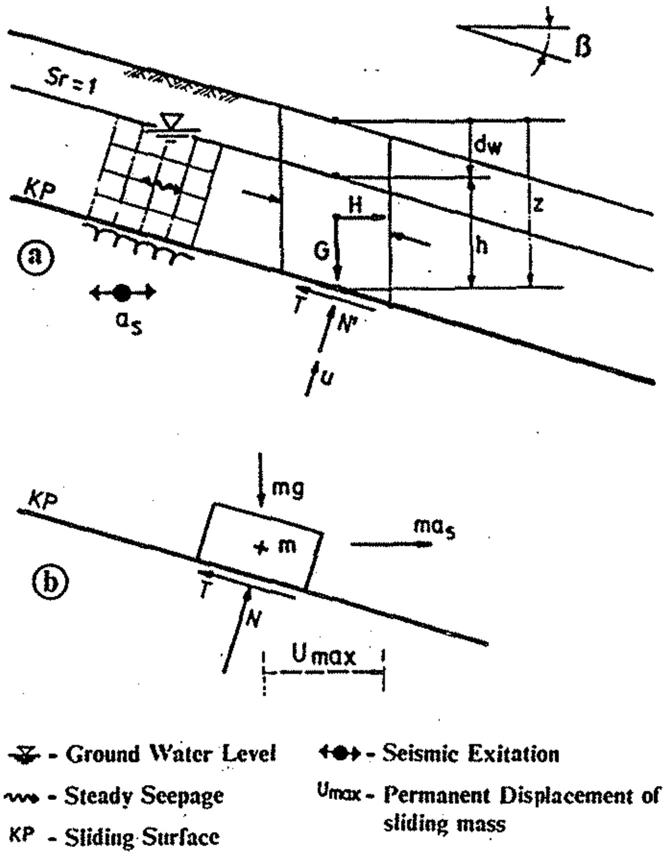



Fig. 2 Model of an infinite slope

Based on the above assumptions, the principles of limit equilibrium and the notation introduced in Figure 2, the following expression for the factor of safety, $F_s$, has been derived (Matasovic, 1989):

$$F_s = \frac{c/(\gamma z \cos^2 \beta) + \tan \Phi[1 - \gamma_w(z-d_w)/(\gamma z)] - k_s \tan \beta \tan \Phi}{k_s + \tan \beta} \quad (1)$$

where $\gamma$, $\gamma_w$, c and $\Phi$ are the unit weight of slope material, the unit weight of water, cohesion and the angle of internal friction respectively.

Equation (1) defines the factor of safety for a general case of infinite slope stability. A similar expression, but for stability of cohesionless materials with pore pressure increase due to seismic loading, has been used by Hadj-Hamou and Kavazanjian (1985).

It should be noted that the value of factor of safety calculated by Equation (1) diminishes with depth in cohesive ($c \neq 0$, $\varphi \neq 0$) materials. Also, since the equation has been set for a case of limit equilibrium when $F_s = 1$, it is assumed that slope will generally resist seismic loading and will be stable if $F_s > 1.0$.

Analysis by sliding block method

The sliding block method (Newmark, 1965) has been universally applied in dam engineering. Basic elements of slope stability analysis by this method are shown on an idealized model of an infinite slope in Figure 2b. According to D' Alembert's principle, under seismic excitation of the base $a_s$, the reaction of the sliding weight G would be the pseudo-static inertial force $m\,a_s = k\,G$. The limiting value of that inertial force, i.e. the limiting value of the acceleration because the mass is constant, which leads mass to the state of the limit equilibrium, depends on the shear resistance of material on a sliding surface. This acceleration is called critical acceleration, $a_{sc}$ and can be expressed as $a_{sc} = k_c\,g$, where g is the acceleration of gravity and $k_c$ is the factor of proportionality called *coefficient of critical acceleration*. According to the premises of this method, if the critical acceleration is exceeded, a sliding of the mass will occur. After each increment of shaking with acceleration greater than $a_{sc}$ and associated down slope sliding, the mass will stop in a new position with respect to its original location. At the end of shaking such increments of dislocation will amount to a final and maximum permanent displacement of the sliding mass, $u_{max}$.

To estimate $u_{max}$, it is necessary, as a first step, to determine $a_{sc}$ expressed by the product $k_c\,g$. The coefficient $k_c$ can be determined iteratively by varying the amount of horizontal force until it reaches the value that gives the $F_s = 1$. However, for the model of infinite slope the coefficient of critical acceleration can be expressed explicitly by inserting $F_s = 1$ in Equation (1) and rearranging the variables:

$$k_c = \frac{c / (\gamma z \cos^2 \beta) + \tan \Phi\,[1 - \gamma_w(z - d_w)/(\gamma z)] - \tan \beta}{1 + \tan \beta \tan \Phi} \quad (2)$$

For a case without steady state seepage in the slope (if we insert $d_w = z$), Equation (2) becomes the expression for $k_c$ used by Chang et Al. (1984).

After the critical acceleration has been determined, permanent displacements can be estimated by using various close form solutions available (e.g., Ambraseys and Menu, 1988), or by treating the appropriate accelerogram using the Makdisi and Seed (1978) procedure based on Newmark's (1965) approach.

The main practical problem related to the application of sliding block method in analysis of natural slopes is how to define the allowable permanent displacement. The limits on calculated values could be related to functionality of structures on the slope or to the stability of the slope itself after the earthquake. For example, if an earthquake has caused cracking of the slope, water percolation in earthquake opened cracks can significantly change the static stability. One of a very few tentative criteria set for natural slopes is the one established by the State of Alaska's Geotechnical Evaluation Criteria Committee, given in Table 1 (based on 1964 Great Alaskan Earthquake, quoted in Idriss, 1985).

TABLE 1. Orientational stability criteria for the sliding block seismic stability analysis of natural slopes

| Failure Category (State of Alaska Criteria) | Amount of Corresponding Perm. Lat. Displacement |
|---|---|
| I Catastrophic Ground Failure | 300 cm |
| II Major Ground Adjustment | 90 cm |
| III Moderate Ground Adjustment | 30 cm |
| IV Minor Ground Adjustment | 15 cm |
| V Little or no Ground Adjustment | < 3 cm |

Analysis by Ishihara's method

An interesting approach to the seismic analysis of natural slope stability has been proposed by Ishihara (1985). The main difference from the pseudo-static method is the definition of the seismic loads ~~d the estimate of the dynamic shear strength of soils. Instead of the ratio $a_{max}/g$ is used while the dynamic strength of soils is ~rmined by loading the specimen in a triaxial apparatus with an ~gular load history that is proportional to the selected accelerogram. Thus, the factor of safety of an infinite slope can be also determined in terms of Isihara's method, i.e. by using the Equation (1), stability criteria of pseudo-static method, and seismic loads and shear strength parameters determined in above mentioned way.

Ishihara (1985) showed that this method provides good results in the back calculated analyses. However, since shear strength parameters depend on a priori unknown loads, a good engineering judgment is needed for selection of the seismic load and corresponding prediction of slope sliding. Also, its practical application is related to non standard cyclic triaxial tests and it is therefore quite expensive. To avoid these shortcomings, Ishihara (1985) suggested tentative criteria for dynamic shear strength estimation based on static test data, which are discussed later in detail.

## SELECTION OF SEISMIC LOADS PARAMETERS

Earthquakes are very complex natural phenomena with forces that are practically impossible to accurately simulate or quantify. In addition to forces generated by shear and compressive waves, there are two types of surface waves, both acting simultaneously, which add to the complexity of the applied dynamic loads. In engineering calculations, the problem is usually simplified by using time histories of the ground surface accelerations. However, the ground surface accelerograms are in general, still too complicated to be used in routine seismic stability analyses of natural slopes. Also, it is impossible to accurately predict their shape, length and frequency. Therefore, in engineering practice the characterization of the seismic ~ is further simplified by using a simple value of the ground ~ce acceleration. It is evident that it would be too conservative ~ect for this purpose the peak value of the strong motion record, $a_{max}$, because it lasts for a very short time and appears only once in the record. So, instead of $a_{max}$, it's fraction $k_s\ a_{max}/g$ is used, where $k_s$ is called *the seismic coefficient*.

Different magnitudes of $k_s$ have been proposed by various authors, mostly based on back analysis of actual cases and compilation of empirical data. For example Marcuson (1981) stated that the appropriate value of the $k_s$ probably lies between 1/2 and 1/3 $a_{max}/g$ when seismic stability of earthfill dams and embankments is analyzed and amplification of the earth structure is included in $a_{max}$ value. Matsuo et Al. (1984) recommended 0.65 $a_{max}/g$, as quoted and used by Taniguchi and Sasaki (1985) in back analysis of a landslide. These two recommendations are combined in Figure 3.

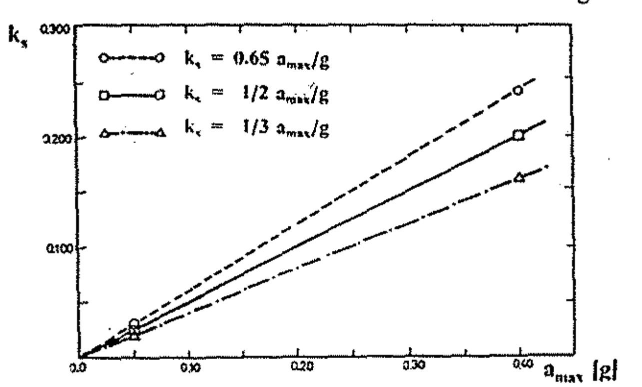



Fig 3 Seismic coefficient related to the peak gnd. acceleration

It can be seen that, when describing seismic loadings by seismic coefficient, an additional assumption is introduced into seismic stability analysis. Using the sliding block method, the stability criteria are rough and not completely clear. On the other hand Ishihara's method avoids these two problems, but additional assumptions on the shear strength of the material during seismic loading are introduced.

## SELECTION OF SHEAR STRENGTH PARAMETERS

When studying the seismic stability of natural slopes, particular care should be devoted to the evaluation of the shear strength parameters of the material. Because the shear strength of a material depends on the rate of loading, it is correct to choose material parameters that correspond to the rate of seismic loading and initial state of stresses immediately before the earthquake shaking. The rate of pore pressure buildup and simultaneous dissipation due to existing drainage conditions also should be considered. This can be simulated the best by the Ishihara's method, which however involves a quite expensive laboratory testing.

In practice, when it is not possible to perform complex experimental investigations, shear strength parameters are usually obtained in a fast direct shear tests, on fully saturated cohesive specimens consolidated to initial state of stresses acting before seismic excitation. However, to check whether significant drop of strength during shaking with respect to static direct shear strength can be expected, recommendations by Silver (1987) based on simple classification tests and summarized in Figure 4 can be used.

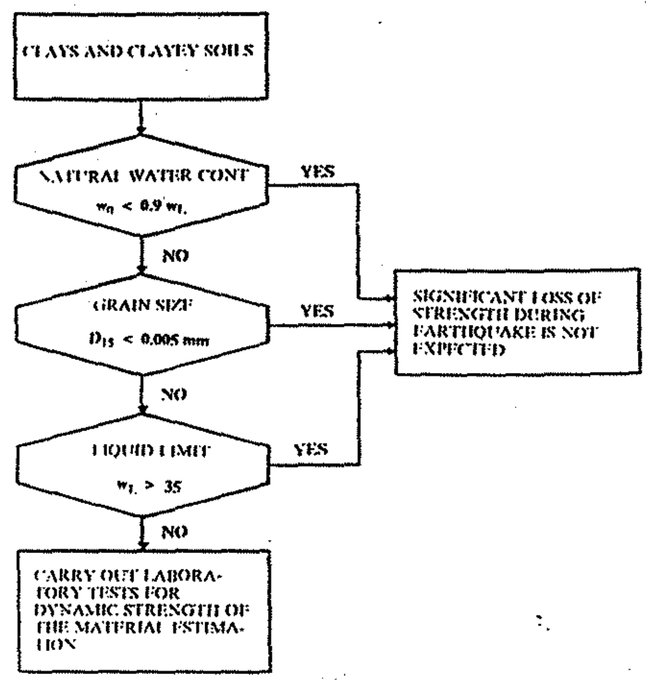



Fig. 4 Flow chart for preliminary dynamic stability of cohesive soil estimation (After Silver, 1987)

Another aspect to look at is whether "in situ" shear strength of cohesive soils during earthquake shaking is always smaller than the strength in static conditions. Ishihara (1985) noticed on unsaturated specimens of volcanic sandy clays that the cohesion value under drained dynamic loading is at least 60% greater than the one under static loading. He also noticed that the strength increase is higher in materials having higher plasticity index ($I_p$), while the angle of internal friction remains approximately the same. Based on that, Ishihara suggested seismic analyses carried out with static cohesion values increased by 50% while using seismic coefficient defined by ratio $a_{max}/g$. This is called in this text the simplified Ishihara's method.

The expected behavior of the material during seismic excitation also can be a key factor for choosing the appropriate slope stability analysis method. Ishihara (1985) has noticed that there is no use in calculating permanent displacement in very brittle materials, where among the others, pseudo-static methods provide acceptable results. Wroth and Houlsby (1985) stated that the clay samples with low values of OCR deform generally in a ductile manner. The commonly used criterion OCR < 5 has been selected on flow chart in Figure 5 as a tentative value for distinguishing brittle and ductile clayey materials in which is reasonable to calculate permanent displacements. The post cyclic behavior of the material on Figure 5 has been characterized by another tentative criterion, based on Vaughan and Walbancke observation (quoted in Wroth and Houlsby, 1985) that significant drop in strength only occurs in clays with a plasticity index greater than about 26% and where very large shear deformations have occurred.

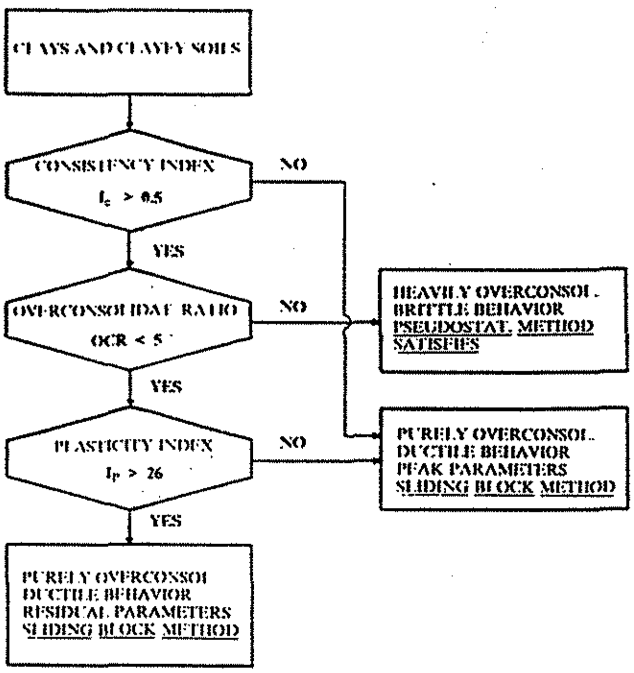



Fig. 5 Flow chart for selecting adequate seismic stability analysis method

## THE VELJI KALIMAN CASE HISTORY

To examine the applicability of the seismic stability analysis methods described above, a stratigraphycally simple landslide has been selected (Figure 1). The slide occurred after the Montenegro earthquake of April 15, 1979 ($M_L$ = 7.1) in a small village Velji Kaliman, Yugoslavia, about 11 km north of the town of Ulcinj (see Figure 6). Although the cracks occurred during the earthquake, the sliding started two days later after heavy rains. The sliding mass was approximately 500m long, 200m wide, 5m high and inclined to the horizontal at 15° (Ivanovic, 1979). Since flysch slopes are sensitive to water percolation through contact of mantle and weathered flysch, it was concluded that sliding was induced along the contact by water inflow in the earthquake opened cracks.

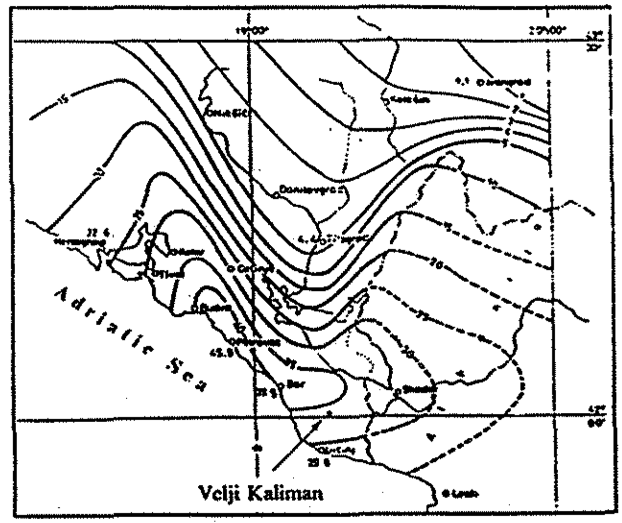



Fig. 6 Isolines of amax [g] distribution during April 15, 1979 Montenegro earthquake (After Petrovski et al., 1979)

The maximum acceleration value at the site of 0.34g is estimated by linear interpolating between the maximum acceleration isolines presented by Petrovski et Al. (1979), as shown in Figure 6. Given this estimate, the maximum permanent displacement has been calculated by the sliding block method using N-S component of the accelerogram *ULCINJ-2* (IZIIS, 1984). For comparison, the same accelerogram was scaled to different acceleration levels and the permanent displacement curve, plotted in Figure 7 by the solid line, was obtained. It is evident that the calculated curve is in good agreement with the dashed lines curves reproduced from Makdisi and Seed (1978) that were obtained by the same methodology. These two curves also represent the band of possible permanent displacements induced by earthquakes of $M_L$ 7.5, which is close to the Montenegro earthquake magnitude.

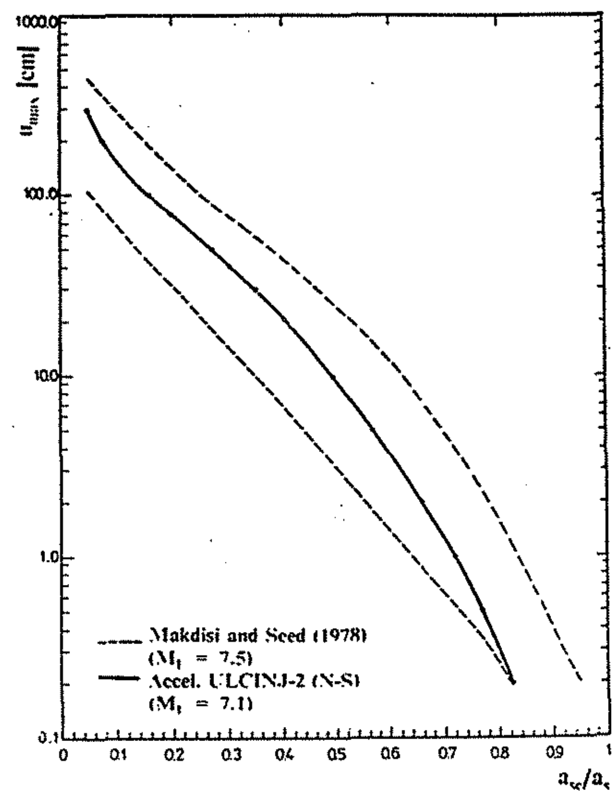



Fig. 7 Permanent displacement estimation chart

Engineering geology elements of the sliding are shown on Figure 1. More details, as well as physical and mechanical properties of the Adriatic coast flysch, can be found in Ivanovic (1979) and Jurak et Al. (1987). These studies show that the following average values are typical for the weathered flysch: $w_L > 35$; $D_{15} < 0.005$ mm; $w_0$ ).9$w_L$; $I_c > 0.5$; OCR < 5; $I_p > 26$; $\gamma = 22$ kN/m$^3$; $82 < S_r < 85\%$, here index properties have been defined on Figures 4 & 5, $D_{15}$ is the grain diameter (in mm) corresponding to 15% passing by weight and $S_r$ is the degree of saturation. The average values of the shear strength parameters were also adopted from above mentioned studies and are summarized in Table 2.

The analyses were performed using expressions (1) and (2). The steady state seepage parallel to the slope was assumed. Based on $a_{max} = 0.34$g, the value $k_s = 0.18$ was chosen as a mean value from Figure 3. Since the weathered flysch is pretty similar by its composition and saturation to the properties of materials Ishihara (1985) tested, and since the empirical criteria from Figure 4 do not predict any loss of strength during shaking, it was possible to hypothesize that dynamic cohesion of weathered flysch could be higher than the static one. Thus the calculations by simplified Ishihara's method were carried out by using the same Φ as in the static case, but the cohesion value was increased by 50%. Basic elements and results of the analysis are summarized in Table 2.

TABLE 2. Basic elements of stability analyses

| | Analysis Type | | | |
|---|---|---|---|---|
| Parameter | Static | Pseudo--static | Sliding block | Ishihara's simplified |
| c [kPa] | 25 | 25 | 25 | 38 |
| Φ [deg] | 23 | 23 | 23 | 23 |
| $a_s$ [g] | - | 0.34 | 0.34 | 0.34 |
| $k_s$ [-] | - | 0.18 | 0.34 | 0.34 |
| $k_c$ [-] | - | - | 0.186 | - |
| $F_s$ [-] | 1.77 | 1.01 | - | 0.93 |
| $u_{max}$ [cm] | 0 | - | 5 | - |

For the pseudo-static and simplified Ishihara's method analysis values of $F_s$ are also calculated for different levels of assumed $a_{max}$ and are shown in Figure 8.

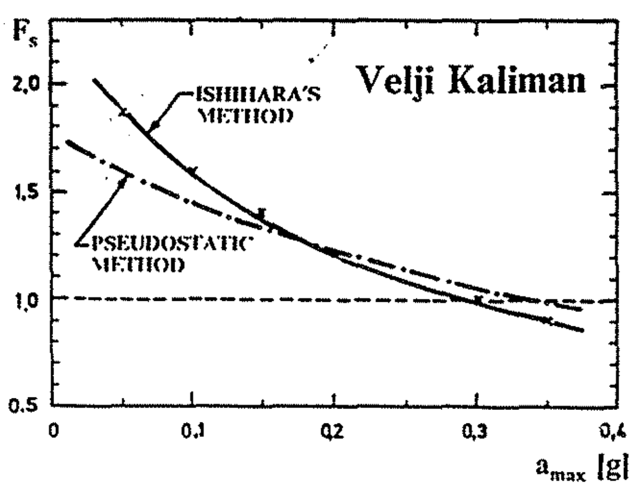



Fig. 8 Summary of analysis results

Figure 8 shows that Ishihara's method is more sensitive to the magnitude of the seismic loads than conventional pseudo-static method. Both methods reach the zone of instability close to 0.34g. On the other hand the sliding block analysis gave permanent displacement of about 5cm (minor ground adjustment, see Table 1). Application of the tentative criteria from Figure 5 on given material properties leads to the conclusion that this is also acceptable result.

## CONCLUSIONS

The seismic stability of natural slopes is a subject about which much uncertainty still exist. The main problems associated with predicting slope behavior during and after earthquake shaking are connected with selection of shear strength parameters of the material and estimation of adequate seismic loadings.

All three analyses provided here are in agreement. The pseudo-static method and the simplified Ishihara's method did not give complete failure, but they indicated instability ($F_s \approx 1$). The sliding block method calculated relatively small permanent displacement. All these point to cracks that actually developed during the shaking. Subsequent slide is another matter.

The flow chart shown in Figure 4 is useful as a starting point for the estimation of eventual material strength loss during shaking, assessing whether simplified Ishihara's method can give reasonable results and, if there is a need for carrying out expensive laboratory tests. It is shown that, if criteria from Figure 4 are applied to the average value of Adriatic coast flysch parameters, they do not predict loss of strength during shaking. Whether there is some strength increase is still not completely clear, although weathered flysch is similar to the materials in which the increase was observed. The assumption on 50% cohesion value increase in weathered flysch should be examined by irregular cyclic tests. After that, the applicability of Ishihara's methods in flysch materials can be finally evaluated.

The flow chart from Figure 5 should help with dilemmas about whether to carry out the stability analysis by the pseudo-static or by the sliding block method. If these criteria are applied on the average values of the Adriatic coast weathered flysch it turns out that the application of the sliding block method can give acceptable results.

Finally, no definitive conclusion can be drawn from a single case history study. All hypotheses set and conclusions derived here should be further examined by analyzing other case histories to derive general conclusions on applicability of the pseudo-static method, the sliding block method and Ishihara's method for seismic analyses of natural slopes in cohesive materials.

## ACKNOWLEDGEMENTS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** PCSTABL5 **

by
Purdue University

1

--Slope Stability Analysis--
Simplified Janbu, Simplified Bishop
or Spencer`s Method of Slices

Run Date:
Time of Run:
Run By: N.M.
Input Data Filename: cover01.in
Output Filename: cover01.out
Plotted Output Filename: cover01.plt

PROBLEM DESCRIPTION LOPEZ CANYON - ALTERNATIVE FINAL COVER EVALUATION

BOUNDARY COORDINATES

3 Top Boundaries
7 Total Boundaries

| Boundary No. | X-Left (ft) | Y-Left (ft) | X-Right (ft) | Y-Right (ft) | Soil Type Below Bnd |
|---|---|---|---|---|---|
| 1 | .00 | 5.55 | 9.80 | 10.50 | 1 |
| 2 | 9.80 | 10.50 | 27.80 | 10.00 | 1 |
| 3 | 27.80 | 10.00 | 108.10 | 50.30 | 1 |
| 4 | 5.90 | 6.30 | 8.60 | 7.70 | 2 |
| 5 | 8.60 | 7.70 | 28.40 | 8.10 | 2 |
| 6 | 28.40 | 8.10 | 31.10 | 9.40 | 2 |
| 7 | 105.00 | 46.36 | 108.10 | 47.90 | 2 |

1

ISOTROPIC SOIL PARAMETERS

2 Type(s) of Soil

| Soil Type No. | Total Unit Wt. (pcf) | Saturated Unit Wt. (pcf) | Cohesion Intercept (psf) | Friction Angle (deg) | Pore Pressure Param. | Pressure Constant (psf) | Piez. Surface No. |
|---|---|---|---|---|---|---|---|
| 1 | 120.0 | 120.0 | 100.0 | 35.0 | .00 | .0 | 0 |
| 2 | 120.0 | 120.0 | .0 | 8.0 | .00 | .0 | 0 |



A Horizontal Earthquake Loading Coefficient
Of .000 Has Been Assigned

A Vertical Earthquake Loading Coefficient
Of .000 Has Been Assigned

Cavitation Pressure = .0 psf

1

A Critical Failure Surface Searching Method, Using A Random Technique For Generating Sliding Block Surfaces, Has Been Specified.

10 Trial Surfaces Have Been Generated.

3 Boxes Specified For Generation Of Central Block Base

Length Of Line Segments For Active And Passive Portions Of Sliding Block Is 6.0

| Box No. | X-Left (ft) | Y-Left (ft) | X-Right (ft) | Y-Right (ft) | Height (ft) |
|---|---|---|---|---|---|
| 1 | 8.10 | 7.60 | 8.60 | 7.70 | .50 |
| 2 | 28.10 | 8.10 | 28.40 | 8.10 | 1.00 |
| 3 | 102.10 | 44.90 | 103.10 | 45.40 | 1.00 |

1

Following Are Displayed The Ten Most Critical Of The Trial Failure Surfaces Examined. They Are Ordered - Most Critical First.

* * Safety Factors Are Calculated By The Modified Janbu Method * *

Failure Surface Specified By 5 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 6.09 | 8.63 |
| 2 | 8.49 | 7.58 |
| 3 | 28.40 | 8.01 |
| 4 | 102.86 | 45.44 |
| 5 | 103.81 | 48.14 |

*** 2.400 ***

Failure Surface Specified By 5 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 7.11 | 9.14 |
| 2 | 8.52 | 7.75 |
| 3 | 28.22 | 7.87 |
| 4 | 102.58 | 44.98 |
| 5 | 105.56 | 49.03 |

*** 2.444 ***

1

Failure Surface Specified By 5 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 4.33 | 7.74 |
| 2 | 8.41 | 7.52 |
| 3 | 28.21 | 8.12 |
| 4 | 102.37 | 44.63 |
| 5 | 104.18 | 48.33 |

*** 2.451 ***

Failure Surface Specified By 5 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 6.43 | 8.80 |
| 2 | 8.49 | 7.75 |
| 3 | 28.34 | 7.92 |
| 4 | 102.99 | 45.48 |
| 5 | 106.49 | 49.49 |

*** 2.509 ***

1

Failure Surface Specified By 5 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 5.78 | 8.47 |
| 2 | 8.30 | 7.69 |
| 3 | 28.26 | 8.09 |
| 4 | 102.55 | 45.40 |
| 5 | 106.52 | 49.51 |

*** 2.522 ***

Failure Surface Specified By 5 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 6.90 | 9.04 |
| 2 | 8.29 | 7.78 |
| 3 | 28.16 | 7.91 |
| 4 | 103.06 | 45.73 |
| 5 | 106.93 | 49.71 |

*** 2.640 ***

1

Failure Surface Specified By 5 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 6.84 | 9.00 |
| 2 | 8.53 | 7.49 |
| 3 | 28.34 | 8.46 |
| 4 | 102.49 | 44.96 |
| 5 | 105.96 | 49.23 |

*** 2.841 ***

Failure Surface Specified By 5 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 5.43 | 8.29 |
| 2 | 8.21 | 7.56 |
| 3 | 28.19 | 8.53 |
| 4 | 102.29 | 44.65 |
| 5 | 103.99 | 48.24 |

*** 2.883 ***

1

Failure Surface Specified By 5 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 6.61 | 8.89 |
| 2 | 8.57 | 7.84 |
| 3 | 28.10 | 8.23 |
| 4 | 102.34 | 44.55 |
| 5 | 104.65 | 48.57 |

*** 2.914 ***

Failure Surface Specified By 6 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 7.16 | 9.17 |
| 2 | 8.56 | 7.90 |
| 3 | 28.24 | 8.44 |
| 4 | 103.01 | 44.94 |
| 5 | 107.07 | 49.36 |
| 6 | 107.82 | 50.16 |

*** 2.941 ***

1

```
             Y         A     X     I     S          F     T

             .00    13.51    27.03    40.54    54.05    67.56

 X      .00 +---*-----+---------+---------+---------+---------+
            -
            -     3
            -    *12
            -     * *
            -
      13.51 +
            -
            -
            -
            -
            -
 A    27.03 +     9*
            -     *
            -      *
            -
```



```
            -
            -
 X    40.54 +
            -
            -
            -
            -
            -
 I    54.05 +
            -
            -
            -
            -
            -
 S    67.56 +
            -
            -
            -
            -
            -
      81.08 +
            -
            -
            -
            -
            -
 F    94.59 +
            -
            -
            -                                  3
            -                                  21 1
            -                                   * 24
 T   108.10 +                                    * *
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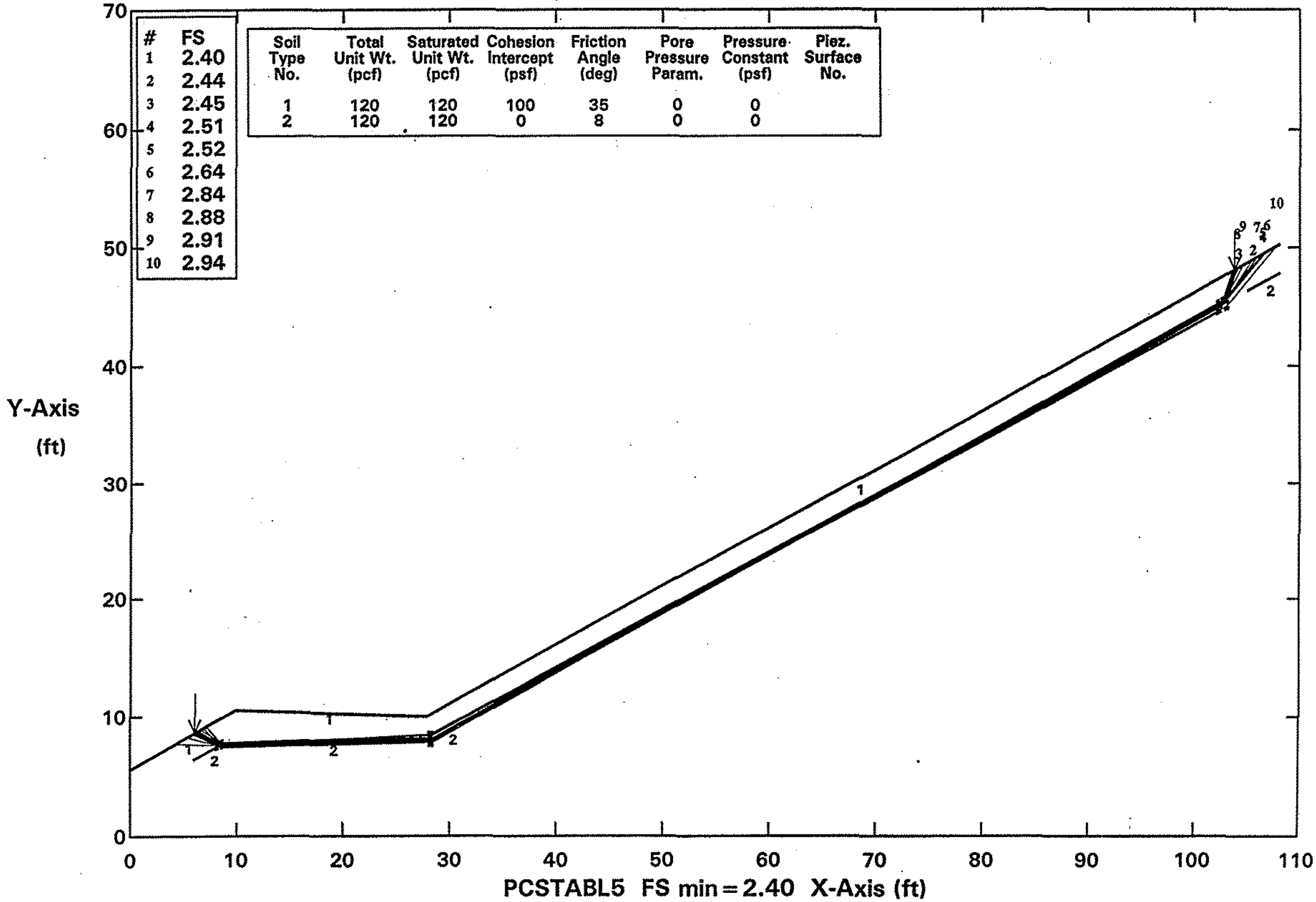
# LOPEZ CANYON - ALTERNATIVE FINAL COVER E VALUATION

## Ten Most Critical. K:COVER01.PLT



** PCSTABL5 **

by
Purdue University

1

--Slope Stability Analysis--
Simplified Janbu, Simplified Bishop
or Spencer's Method of Slices

Run Date:
Time of Run:
Run By: N.M.
Input Data Filename: cover01.in
Output Filename: cover01.ous
Plotted Output Filename: cover01.plt

PROBLEM DESCRIPTION LOPEZ CANYON - ALTERNATIVE FINAL COVER EVALUATION

BOUNDARY COORDINATES

3 Top Boundaries
7 Total Boundaries

| Boundary No. | X-Left (ft) | Y-Left (ft) | X-Right (ft) | Y-Right (ft) | Soil Type Below Bnd |
|---|---|---|---|---|---|
| 1 | .00 | 5.55 | 9.80 | 10.50 | 1 |
| 2 | 9.80 | 10.50 | 27.80 | 10.00 | 1 |
| 3 | 27.80 | 10.00 | 108.10 | 50.30 | 1 |
| 4 | 5.90 | 6.30 | 8.60 | 7.70 | 2 |
| 5 | 8.60 | 7.70 | 28.40 | 8.10 | 2 |
| 6 | 28.40 | 8.10 | 31.10 | 9.40 | 2 |
| 7 | 105.00 | 46.36 | 108.10 | 47.90 | 2 |

1

ISOTROPIC SOIL PARAMETERS

2 Type(s) of Soil

| Soil Type No. | Total Unit Wt. (pcf) | Saturated Unit Wt. (pcf) | Cohesion Intercept (psf) | Friction Angle (deg) | Pore Pressure Param. | Pressure Constant (psf) | Piez. Surface No. |
|---|---|---|---|---|---|---|---|
| 1 | 120.0 | 120.0 | 100.0 | 35.0 | .00 | .0 | 0 |
| 2 | 120.0 | 120.0 | .0 | 8.0 | .00 | .0 | 0 |



A Horizontal Earthquake Loading Coefficient
Of .200 Has Been Assigned

A Vertical Earthquake Loading Coefficient
Of .000 Has Been Assigned

Cavitation Pressure = .0 psf

1

A Critical Failure Surface Searching Method, Using A Random Technique For Generating Sliding Block Surfaces, Has Been Specified.

10 Trial Surfaces Have Been Generated.

3 Boxes Specified For Generation Of Central Block Base

Length Of Line Segments For Active And Passive Portions Of Sliding Block Is 6.0

| Box No. | X-Left (ft) | Y-Left (ft) | X-Right (ft) | Y-Right (ft) | Height (ft) |
|---|---|---|---|---|---|
| 1 | 8.10 | 7.60 | 8.60 | 7.70 | .50 |
| 2 | 28.10 | 8.10 | 28.40 | 8.10 | 1.00 |
| 3 | 102.10 | 44.90 | 103.10 | 45.40 | 1.00 |

1

Following Are Displayed The Ten Most Critical Of The Trial Failure Surfaces Examined. They Are Ordered - Most Critical First.

* * Safety Factors Are Calculated By The Modified Janbu Method * *

Failure Surface Specified By 5 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 6.09 | 8.63 |
| 2 | 8.49 | 7.58 |
| 3 | 28.40 | 8.01 |
| 4 | 102.86 | 45.44 |
| 5 | 103.81 | 48.14 |

*** 1.481 ***

Failure Surface Specified By 5 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 4.33 | 7.74 |
| 2 | 8.41 | 7.52 |
| 3 | 28.21 | 8.12 |
| 4 | 102.37 | 44.63 |
| 5 | 104.18 | 48.33 |

*** 1.526 ***

1

Failure Surface Specified By 5 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 7.11 | 9.14 |
| 2 | 8.52 | 7.75 |
| 3 | 28.22 | 7.87 |
| 4 | 102.58 | 44.98 |
| 5 | 105.56 | 49.03 |

*** 1.539 ***

Failure Surface Specified By 5 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 5.78 | 8.47 |
| 2 | 8.30 | 7.69 |
| 3 | 28.26 | 8.09 |
| 4 | 102.55 | 45.40 |
| 5 | 106.52 | 49.51 |

*** 1.564 ***

1

Failure Surface Specified By 5 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 6.43 | 8.80 |
| 2 | 8.49 | 7.75 |



| | | |
|---|---|---|
| 3 | 28.34 | 7.92 |
| 4 | 102.99 | 45.48 |
| 5 | 106.49 | 49.49 |

*** 1.570 ***

Failure Surface Specified By 5 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 6.90 | 9.04 |
| 2 | 8.29 | 7.78 |
| 3 | 28.16 | 7.91 |
| 4 | 103.06 | 45.73 |
| 5 | 106.93 | 49.71 |

*** 1.657 ***

1

Failure Surface Specified By 5 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 6.84 | 9.00 |
| 2 | 8.53 | 7.49 |
| 3 | 28.34 | 8.46 |
| 4 | 102.49 | 44.96 |
| 5 | 105.96 | 49.23 |

*** 1.801 ***

Failure Surface Specified By 5 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 5.43 | 8.29 |
| 2 | 8.21 | 7.56 |
| 3 | 28.19 | 8.53 |
| 4 | 102.29 | 44.65 |
| 5 | 103.99 | 48.24 |

*** 1.827 ***

1

Failure Surface Specified By 5 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 6.61 | 8.89 |
| 2 | 8.57 | 7.84 |
| 3 | 28.10 | 8.23 |
| 4 | 102.34 | 44.55 |
| 5 | 104.65 | 48.57 |

*** 1.862 ***

Failure Surface Specified By 6 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 7.16 | 9.17 |
| 2 | 8.56 | 7.90 |
| 3 | 28.24 | 8.44 |
| 4 | 103.01 | 44.94 |
| 5 | 107.07 | 49.36 |
| 6 | 107.82 | 50.16 |

*** 1.892 ***

1

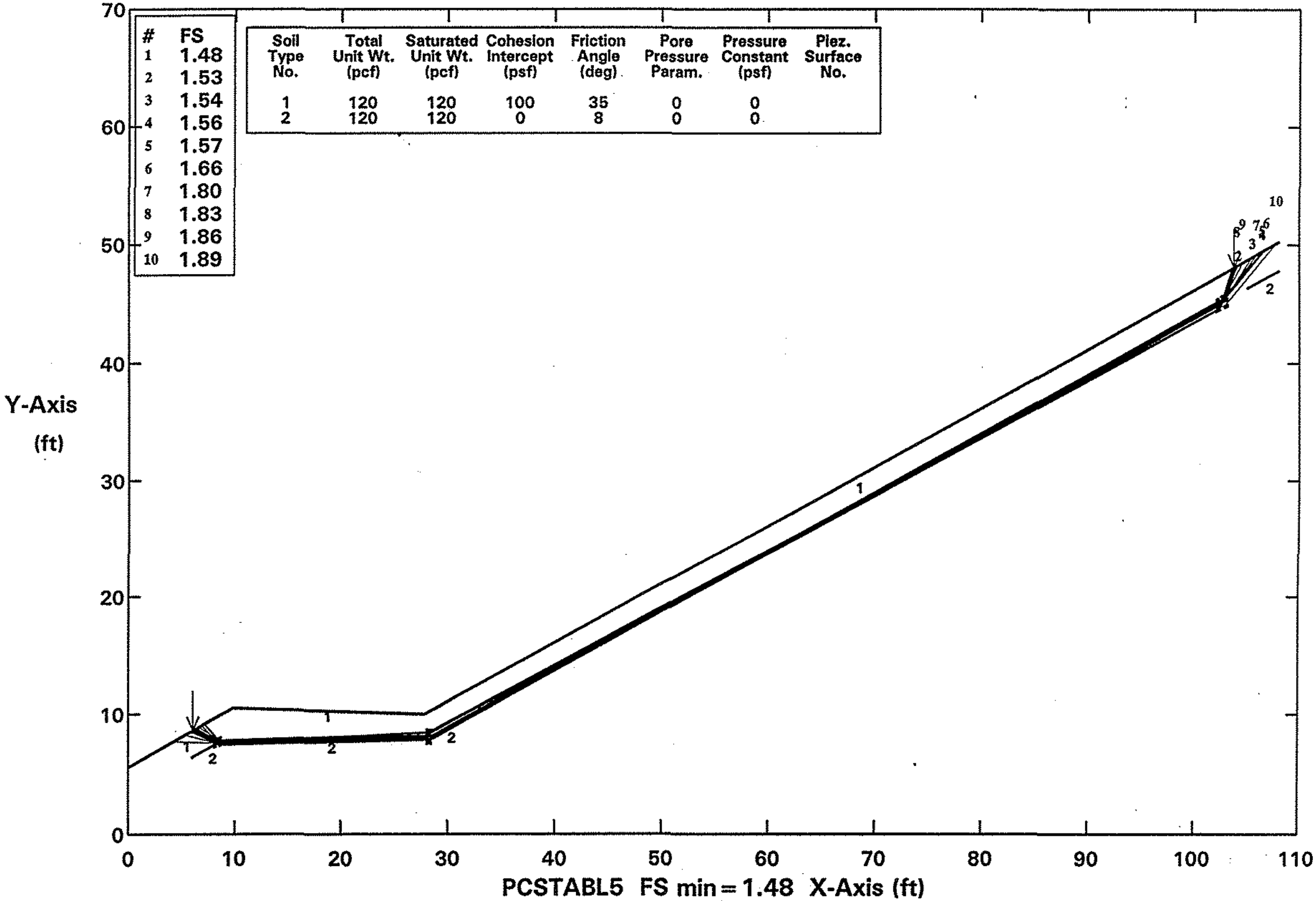
```
               Y         A    X    I    S         F    T

               .00    13.51   27.03   40.54   54.05   67.56

 X       .00 +---*-----+---------+---------+---------+---------+
             -
             -    2
             -   *13
             -    * *
             -
       13.51 +
             -
             -
             -
             -
             -
 A     27.03 +    9*
             -    *
             -     *
             -
             -
             -
 X     40.54 +
             -
             -
             -
             -
             -
 I     54.05 +
             -
             -
             -
             -
             -
 S     67.56 +
             -
             -
             -
             -
             -
       81.08 +
             -
             -
             -
             -
             -
 F     94.59 +
             -
             -
             -                                2
             -                                31 1
             -                                 * 34
 T    108.10 +                                  * *
```

## LOPEZ CANYON - ALTERNATIVE FINAL COVER EVALUATION

Ten Most Critical. K:COVER01.PLT By: N.M.



** PCSTABL5 **

by
Purdue University

1

--Slope Stability Analysis--
Simplified Janbu, Simplified Bishop
or Spencer`s Method of Slices

Run Date:
Time of Run:
Run By: N.M.
Input Data Filename: cover01.in
Output Filename: cover01.ouy

PROBLEM DESCRIPTION LOPEZ CANYON - ALTERNATIVE FINAL COVER
EVALUATION

BOUNDARY COORDINATES

3 Top Boundaries
7 Total Boundaries

| Boundary No. | X-Left (ft) | Y-Left (ft) | X-Right (ft) | Y-Right (ft) | Soil Type Below Bnd |
|---|---|---|---|---|---|
| 1 | .00 | 5.55 | 9.80 | 10.50 | 1 |
| 2 | 9.80 | 10.50 | 27.80 | 10.00 | 1 |
| 3 | 27.80 | 10.00 | 108.10 | 50.30 | 1 |
| 4 | 5.90 | 6.30 | 8.60 | 7.70 | 2 |
| 5 | 8.60 | 7.70 | 28.40 | 8.10 | 2 |
| 6 | 28.40 | 8.10 | 31.10 | 9.40 | 2 |
| 7 | 105.00 | 46.36 | 108.10 | 47.90 | 2 |

1

ISOTROPIC SOIL PARAMETERS

2 Type(s) of Soil

| Soil Type No. | Total Unit Wt. (pcf) | Saturated Unit Wt. (pcf) | Cohesion Intercept (psf) | Friction Angle (deg) | Pore Pressure Param. | Pressure Constant (psf) | Piez. Surface No. |
|---|---|---|---|---|---|---|---|
| 1 | 120.0 | 120.0 | 100.0 | 35.0 | .00 | .0 | 0 |
| 2 | 120.0 | 120.0 | .0 | 8.0 | .00 | .0 | 0 |

A Horizontal Earthquake Loading Coefficient
Of .420 Has Been Assigned

A Vertical Earthquake Loading Coefficient
Of .000 Has Been Assigned

Cavitation Pressure = .0 psf

1

A Critical Failure Surface Searching Method, Using A Random Technique For Generating Sliding Block Surfaces, Has Been Specified.

10 Trial Surfaces Have Been Generated.

3 Boxes Specified For Generation Of Central Block Base

Length Of Line Segments For Active And Passive Portions Of Sliding Block Is 6.0

| Box No. | X-Left (ft) | Y-Left (ft) | X-Right (ft) | Y-Right (ft) | Height (ft) |
|---|---|---|---|---|---|
| 1 | 8.10 | 7.60 | 8.60 | 7.70 | .50 |
| 2 | 28.10 | 8.10 | 28.40 | 8.10 | 1.00 |
| 3 | 102.10 | 44.90 | 103.10 | 45.40 | 1.00 |

1

Following Are Displayed The Ten Most Critical Of The Trial Failure Surfaces Examined. They Are Ordered - Most Critical First.

* * Safety Factors Are Calculated By The Modified Janbu Method * *

Failure Surface Specified By 5 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 6.09 | 8.63 |
| 2 | 8.49 | 7.58 |
| 3 | 28.40 | 8.01 |
| 4 | 102.86 | 45.44 |
| 5 | 103.81 | 48.14 |

*** .996 ***

Failure Surface Specified By 5 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 4.33 | 7.74 |
| 2 | 8.41 | 7.52 |
| 3 | 28.21 | 8.12 |
| 4 | 102.37 | 44.63 |
| 5 | 104.18 | 48.33 |

*** 1.032 ***

1

Failure Surface Specified By 5 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 5.78 | 8.47 |
| 2 | 8.30 | 7.69 |
| 3 | 28.26 | 8.09 |
| 4 | 102.55 | 45.40 |
| 5 | 106.52 | 49.51 |

*** 1.056 ***

Failure Surface Specified By 5 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 6.43 | 8.80 |
| 2 | 8.49 | 7.75 |
| 3 | 28.34 | 7.92 |
| 4 | 102.99 | 45.48 |
| 5 | 106.49 | 49.49 |

*** 1.071 ***

1

Failure Surface Specified By 5 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 7.11 | 9.14 |
| 2 | 8.52 | 7.75 |
| 3 | 28.22 | 7.87 |



| | | |
|---|---|---|
| 4 | 102.58 | 44.98 |
| 5 | 105.56 | 49.03 |

*** 1.072 ***

Failure Surface Specified By 5 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 6.90 | 9.04 |
| 2 | 8.29 | 7.78 |
| 3 | 28.16 | 7.91 |
| 4 | 103.06 | 45.73 |
| 5 | 106.93 | 49.71 |

*** 1.145 ***

1

Failure Surface Specified By 5 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 6.84 | 9.00 |
| 2 | 8.53 | 7.49 |
| 3 | 28.34 | 8.46 |
| 4 | 102.49 | 44.96 |
| 5 | 105.96 | 49.23 |

*** 1.254 ***

Failure Surface Specified By 5 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 5.43 | 8.29 |
| 2 | 8.21 | 7.56 |
| 3 | 28.19 | 8.53 |
| 4 | 102.29 | 44.65 |
| 5 | 103.99 | 48.24 |

*** 1.262 ***

1

Failure Surface Specified By 5 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 6.61 | 8.89 |
| 2 | 8.57 | 7.84 |
| 3 | 28.10 | 8.23 |
| 4 | 102.34 | 44.55 |
| 5 | 104.65 | 48.57 |

*** 1.297 ***

Failure Surface Specified By 6 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|---|---|---|
| 1 | 7.16 | 9.17 |
| 2 | 8.56 | 7.90 |
| 3 | 28.24 | 8.44 |
| 4 | 103.01 | 44.94 |
| 5 | 107.07 | 49.36 |
| 6 | 107.82 | 50.16 |

*** 1.329 ***

1

```
            Y          A     X     I     S           F     T

           .00    13.51    27.03    40.54    54.05    67.56

X      .00 +---*-----+---------+---------+---------+---------+
           -
           -     2
           -    *14
           -     * *
           -
     13.51 +
           -
           -
           -
           -
           -
A    27.03 +     9*
           -     *
           -      *
           -
           -
X    40.54 +
           -
           -
           -
           -
           -
I    54.05 +
           -
           -
           -
           -
           -
S    67.56 +
           -
           -
           -
           -
           -
     81.08 +
           -
           -
           -
           -
           -
F    94.59 +
           -
           -
           -                                   2
           -                                   51 1
           -                                    * 53
T   108.10 +                                     * *
```

# APPENDIX I

# REVISED CONSTRUCTION QUALITY ASSURANCE PLAN

# REVISED
# CONSTRUCTION QUALITY ASSURANCE PLAN
# FINAL COVER CONSTRUCTION
# LOPEZ CANYON SANITARY LANDFILL
# LAKE VIEW TERRACE, CALIFORNIA

Prepared for

**Bureau of Sanitation**
Department of Public Works
City of Los Angeles
600 South Spring Street, Suite 600
Los Angeles, California 90014

Prepared by

**GeoSyntec Consultants**
16541 Gothard Street, Suite 211
Huntington Beach, California 92647

GeoSyntec Consultants Project No. CE4100

Revised February 1994

# REVISED CONSTRUCTION QUALITY ASSURANCE PLAN
# FINAL COVER CONSTRUCTION
# LOPEZ CANYON SANITARY LANDFILL
# TABLE OF CONTENTS

# REVISED CONSTRUCTION QUALITY ASSURANCE PLAN
# FINAL COVER CONSTRUCTION
# LOPEZ CANYON SANITARY LANDFILL
# TABLE OF CONTENTS (continued)

# REVISED CONSTRUCTION QUALITY ASSURANCE PLAN
# FINAL COVER CONSTRUCTION
# LOPEZ CANYON SANITARY LANDFILL
# TABLE OF CONTENTS (continued)

**Page**

# REVISED CONSTRUCTION QUALITY ASSURANCE PLAN
# FINAL COVER CONSTRUCTION
# LOPEZ CANYON SANITARY LANDFILL
# TABLE OF CONTENTS (continued)

# CONSTRUCTION QUALITY ASSURANCE PLAN

## 1. SITE AND PROJECT CONTROL

## 1.1 Project Coordination Meetings

To guarantee a high degree of quality during installation, clear, open channels of communication are essential. To this end, meetings of key project personnel are necessary.

### 1.1.1 Resolution Meeting

Following the completion of the design, plans, and specifications for the project, a Resolution Meeting will be held. This meeting will include the Geosynthetic CQA Managing Engineer, the Geosynthetic Site CQA Manager, the Soils CQA Managing Engineer, the Soils Site CQA Manager, the Engineer, and the Project Manager.

The purpose of this meeting is to begin planning for coordination of construction tasks, anticipate any installation problems which might cause difficulties and delays in construction, and, above all, present the CQA Plan to all of the parties involved. It is very important that the criteria regarding testing, repair, etc., be known and accepted by all parties prior to the installation of geosynthetic materials and construction of the soil components of the final cover system.

### 1.1.2 Preconstruction Meeting

A Preconstruction Meeting will be held at the site prior to installation of the geosynthetic materials and construction of soil components. As a minimum, the Preconstruction Meeting will be attended by the Geosynthetic Installer's Superintendent, the Geosynthetic CQA Managing Engineer, the Soils CQA Managing Engineer, the Geosynthetic Site CQA Manager, the Soils CQA Manager, the Earthwork Contractor, and the Project Manager.

### 1.1.3 Progress Meetings

A weekly progress meeting will be held between the Soils Site CQA Manager, the Geosynthetic Site CQA Manager, the Geosynthetic Installer's Superintendent, the Earthworks Contractor, the Project Manager, and any other concerned parties. The progress meetings will be used to discuss current progress, planned activities for the upcoming week, and any new business or revisions to the work. The Site CQA Managers will document any problems, decisions, or questions arising at this meeting in their daily reports. Any matter requiring action which is raised in this meeting will be reported to the appropriate parties. Minutes of the weekly progress meetings shall be documented by the Project Manager or his representative and distributed to all appropriate parties.

### 1.1.4 Problem or Work Deficiency Meeting

A special meeting will be held when and if a problem or deficiency is present or likely to occur. The meeting will be attended by the affected contractors, the Project Manager, the Site CQA Manager(s), and other parties as appropriate. If the problem requires a design modification, the Engineer should either be present at, consulted prior to, or notified immediately upon conclusion of this meeting. The purpose of the work deficiency meeting is to define and resolve the problem or work deficiency.

## 1.2 Project Control Visits

Periodically, the construction site will be visited by each CQA Managing Engineer and/or each CQA Project Manager (if different from the CQA Managing Engineer). If possible, each such visit should be coordinated with a similar visit by the Engineer. State of California regulatory officials may be informed of the dates of the visits.

# 2. DOCUMENTATION

## 2.1 General

An effective CQA plan depends largely on recognition of all construction activities that should be monitored, and on assigning responsibilities for the monitoring of each activity. This is most effectively accomplished and verified by the documentation of quality assurance activities. Each CQA Representative will document that all quality assurance requirements have been addressed and satisfied.

Each Site CQA Manager will provide the Project Manager with signed descriptive remarks, data sheets, and logs to verify that all monitoring activities have been carried out. Each Site CQA Manager will also maintain at the job site a complete file of plans and specifications, a CQA plan, checklists, test procedures, daily logs, and other pertinent documents.

## 2.2 Daily Recordkeeping

Standard reporting procedures will include preparation of daily CQA documentation which, at a minimum, will consist of: (i) field notes, including memoranda of meetings and/or discussions with the Earthwork Contractor, Installer, or Project Manager; (ii) CQA monitoring logs, and testing data sheets; and (iii) construction problem and solution summary sheets. This information will be regularly submitted to and reviewed by the Project Manager.

### 2.2.1 Monitoring Logs and Testing Data Sheets

Monitoring logs and testing data sheets will be prepared daily. At a minimum, these logs and data sheets will include the following information:

- an identifying sheet number for cross referencing and document control;
- date, project name, location, and other identification;
- data on weather conditions;
- a Site Plan showing work areas and test locations;
- descriptions and locations of ongoing construction;
- equipment and personnel in each work area, including subcontractors;
- descriptions and specific locations of areas, or units, of work being tested and/or observed and documented;
- locations where tests and samples were taken;
- a summary of test results;
- calibrations or recalibrations of test equipment, and actions taken as a result of recalibration;

- delivery schedule of off-site materials received, including quality control documentation;

- decisions made regarding acceptance of units of work, and/or corrective actions to be taken in instances of substandard testing results; and

- signature of the respective Site CQA Manager(s) and/or the Field Monitor(s).

In any case, all logs must be completely filled out with no items left blank.

### 2.2.2 Construction Problems

The Project Manager will be made aware of any significant recurring nonconformance with the construction plans, project specifications or CQA Plan. The cause of the nonconformance will be determined and appropriate changes in procedures or specifications will be recommended. These changes will be submitted to the Engineer for approval. When this type of evaluation is made, the results will be documented, and any revision to procedures or specifications will be approved by the City and Engineer.

A summary of all supporting data sheets, along with final testing results and the respective Site CQA Manager's approval of the work, will be required upon completion of construction.

## 2.3 Photographic Reporting

Photographs will serve as a pictorial record of work progress, problems, and mitigation activities. The primary project file will contain color prints; negatives will also be stored in a separate file. These records will be presented to the Project Manager upon completion of the project.

## 2.4 Design and/or Specifications Changes

Design and/or specifications changes may be required during construction. In such cases, the respective Site CQA Manager will notify the Project Manager.

Design and/or specifications changes will be made only with the written agreement of the Project Manager and the Engineer, and will take the form of an amendment to the specifications.

## 2.5 Final Report

At the completion of the work, the Soils and Geosynthetic CQA Representatives will submit to the Project Manager a signed and sealed final report. These reports will acknowledge: (i) that the work has been performed in compliance with the plans and specifications; (ii) physical sampling and testing has been conducted at the appropriate frequencies; and (iii) that the summary document provides the necessary supporting information.

At a minimum, this report will include:

- summaries of all construction activities;
- monitoring logs and testing data sheets including sample location plans;
- construction problems and solutions summary sheets;
- changes from design and material specifications;
- record drawings; and
- a summary statement indicating compliance with project plans and specifications which is signed and sealed by a Registered Civil Engineer or Certified Engineering Geologist in the State of California.

The record drawings will include scale drawings depicting the location of the construction and details pertaining to the extent of construction (e.g., depths, plan dimensions, elevations, soil component thicknesses, etc.). These documents will be prepared by the appropriate CQA Representative and included as part of the CQA plan documentation.

# 3. VERY LOW DENSITY POLYETHYLENE GEOMEMBRANE QUALITY ASSURANCE

## 3.1 Design

A copy of the VLDPE geomembrane construction drawings and specifications prepared by the Engineer will be given to the Geosynthetics CQA Representative. The Geosynthetics CQA Representative will review these items for familiarity. This review should not be considered as the peer review of the design. Peer review should have been conducted at an earlier stage.

## 3.2 Manufacturing

The VLDPE Geomembrane Manufacturer (Manufacturer) will provide the Project Manager with a list of guaranteed "minimum average roll value" properties for the type of geomembrane to be delivered. The Manufacturer will also provide the Project Manager with a written certification signed by a responsible representative of the Manufacturer that the materials actually delivered have "minimum average roll value" properties which meet or exceed all certified property values for that type of geomembrane.

The Manufacturer will also provide the Project Manager with the following information:

- the origin (Resin Supplier's name and resin production plant), identification (brand name, lot number), and production date of the resin; and

- a copy of the quality control certificates issued by the Resin Supplier.

The Geosynthetics CQA Representative will examine all of the Manufacturer and resin suppliers certificates to ensure that the property values listed on the certifications meet or exceed those specified. Any deviations will be reported to the Project Manager.

## 3.3 Shipment and Storage

During shipment and storage, the VLDPE geomembrane will be protected from puncture, cutting, or any other damaging or deleterious conditions. The Geosynthetics CQA Representative will observe rolls upon delivery to the site and any deviations from the above requirements will be reported to the Project Manager. Any damaged rolls will be rejected and replaced at no cost to the City.

## 3.4 Conformance Testing

### 3.4.1 Testing Procedures

In order to ensure that the VLDPE to be installed for this project meets the design requirements, a minimum Design Yield Point is specified. For the purpose of these specifications, the Design Yield Point is defined as the point on the stress-strain curve at which the tangent modulus first becomes 290 psi. The stress-strain curve will be determined based on testing method ASTM D 882.

The following test procedures will also be conducted:

- thickness (ASTM D 374 Method C or ASTM D 1593);
- specific gravity (ASTM D 792 Method A or ASTM D 1505);
- carbon black content (ASTM D 1603); and
- carbon black dispersion (ASTM D 2663 or ASTM D 3015).

Where optional procedures are noted in the test method, the requirements of the specifications shall prevail.

### 3.4.2 Sampling Procedures

Upon delivery of the geomembrane rolls, the Geosynthetics CQA Representative will ensure that samples are obtained from individual rolls at the frequency specified in this CQA plan. The samples will be forwarded to the Geosynthetics CQA Laboratory for testing to ensure conformance to both the design specifications and the list of physical properties certified by the Manufacturer.

Samples will be taken across the entire width of the roll and will not include the first lineal 3 ft (1 m). Unless otherwise specified, samples will be 3 ft (1 m) long by the roll width. The Geosynthetics CQA Representative will indicate the machine direction on the samples by marking an arrow on each sample.

Unless otherwise specified, conformance samples of the VLDPE geomembrane rolls will be taken at a frequency of one sample per lot or one per 100,000 $ft^2$

(10,000 $m^2$) of material delivered to the site, whichever requires the greater number of samples.

### 3.4.3 Test Results

The Geosynthetics CQA Representative will examine all results from laboratory conformance testing and compare results to the project specifications. The criteria used to determine acceptability are presented in the Specifications. The Geosynthetics CQA Representative will report any nonconformance to the Project Manager.

## 3.5 Handling and Placement

Transportation of the geomembrane is the responsibility of the Manufacturer, Installer, or other party as agreed upon. All handling on site is the responsibility of the Installer.

During the installation, the Geosynthetics CQA Representative will verify that:

- handling equipment used on the site is adequate to handle the geomembrane without causing damage to the geomembrane; and

- the Installer's personnel handle the geomembrane with care.

Upon delivery at the site, the Installer and the Geosynthetics CQA Representative will, to the best of his or her ability, conduct a surface observation of all rolls or factory panels for defects and damage. This examination will be conducted without unrolling each individual roll unless an above average frequency of defects or damage is observed or suspected. The Geosynthetics CQA Representative will report to the Project Manager:

- any rolls or portions thereof, which should be rejected and removed from the site because they have severe manufacturing defects or damage; and

- any rolls which exhibit an average occurrence of manufacturing defects or damage which are considered by the Geosynthetics CQA Representative as repairable flaws.

## 3.6 Storage

The Installer will be responsible for the storage of the geomembrane on site. The Project Manager will designate storage space in a location (or several locations) such that on-site transportation and handling are optimized if possible. Storage space should be protected from theft, vandalism, passage of vehicles, stormwater runon, etc. The storage space, if unpaved, should be graded and rolled smooth in order to protect the geomembrane materials from puncture.

The Geosynthetics CQA Representative will verify that storage of the geomembrane ensures adequate protection against dirt and sources of damage.

## 3.7 Geomembrane Installation

### 3.7.1 Surface Preparation

The Earthwork Contractor will be responsible for preparing the soil subbase which supports the geomembrane materials according to the Engineer's specifications.

The Geosynthetics CQA Representative will verify that:

- a qualified geotechnical engineer, normally the Soils CQA Representative, has verified that the supporting soil meets maximum dry density and moisture specifications (if applicable);

- the surface to be lined has been rolled and compacted so as to be free of irregularities, ruts, protrusions, loose soil, and abrupt changes in grade;

- the surface of the supporting soil does not contain angular to subangular stones, debris, or other objects which may damage the geomembrane; and

- there is no area of the supporting soils excessively softened by high moisture content.

The Installer will certify in writing that the surface on which the geomembrane will be installed is acceptable. The certificate of subgrade acceptance for the area under consideration will be given by the Installer to the Project Manager prior to commencement of geomembrane installation. The Geosynthetics CQA Representative will be furnished a copy of this certificate by the Project Manager.

After the supporting soil has been accepted by the Installer, it will be the Installer's responsibility to indicate to the Project Manager any change in the supporting soil condition that may require repair work. If the Geosynthetics CQA Representative and/or Soils CQA Representative concurs with the Installer assessment of the subgrade damage, then the Project Manager will ensure that the supporting soil is repaired.

### 3.7.2 Geomembrane Placement

#### 3.7.2.1 Field Panel Identification

A field panel is the unit area of geomembrane which is to be seamed in the field (i.e., a field panel is a roll or a portion of roll cut in the field).

It will be the responsibility of the Geosynthetics CQA Representative to ensure that each field panel is given an "identification code" (number or letter-number) which may or may not be consistent with the Installer's proposed layout plan. This identification code will be agreed upon by the Project Manager, Installer, and Geosynthetics CQA Representative. This field panel identification code should be as simple and logical as possible. (Note: roll numbers established in the manufacturing plant are usually cumbersome and are not related to location in the field.) It will be the responsibility of the Installer to ensure that each field panel placed is marked with the original roll number. The roll number will be marked at a location agreed upon by the Project Manager, Installer, and Geosynthetics CQA Representative. The Geosynthetics CQA Representative will record the identification code, dimensions, weather conditions, time, location, and date of installation for each field panel.

The Geosynthetics CQA Representative will establish a table or chart showing correspondence between roll numbers, factory panels, and field panel identification codes. The field panel identification code will be used for all requisite quality assurance documentation.

#### 3.7.2.2 Field Panel Placement

The Geosynthetics CQA Representative will verify that field panels are installed in the manner indicated in the geomembrane seam layout plan, as approved or modified.

Field panels will be placed one at a time, and each field panel will be seamed immediately after its placement (in order to minimize the number of unseamed field panels exposed to wind).

Geomembrane placement will not proceed at an ambient temperature below 40°F (5°C) or above 100°F (38°C) unless otherwise authorized by the Project Manager. Geomembrane placement will not be conducted during precipitation events, in an area of ponded water, or in the presence of excessive winds as determined by the Geosynthetics CQA Representative or Project Manager. The Geosynthetics CQA Representative will verify that the above conditions are fulfilled. The Geosynthetics Site CQA Manager will inform the Project Manager if the above conditions are not fulfilled.

The Geosynthetics CQA Representative will visually observe each panel, after placement and prior to seaming, for damage. The Geosynthetics Site CQA Manager will advise the Project Manager which panels, or portions of panels, should be rejected, repaired, or accepted. Damaged panels or portions of damaged panels which have been rejected will be marked and their removal from the work area recorded by the

Geosynthetics CQA Representative. Repairs will be made according to procedures described in Section 3.7.4.

### 3.7.3 Field Seaming

#### 3.7.3.1 Seam Layout

The Installer will provide the Project Manager and the Geosynthetics CQA Representative with a seam layout drawing, i.e., a drawing of the facility to be lined showing all expected seams. The Geosynthetics CQA Representative will review the seam layout drawing and verify that it is consistent with the accepted state-of-practice and this CQA Plan. Seams not specifically shown on the seam layout drawing may not be constructed without the Project Manager's prior approval. A seam numbering system compatible with the panel numbering system will be agreed upon at the Resolution and/or Pre-Construction Meeting.

#### 3.7.3.2 Seaming Equipment and Products

Approved field seaming processes are fillet extrusion seaming and double-track fusion seaming. Proposed alternate processes will be documented and submitted to the Project Manager for approval. Only seaming apparatus which have been specifically approved by make and model will be used. The Installer will ensure that all seaming equipment used on this project are in good working order including accurate temperature gauging devices.

The Project Manager will submit all seaming documentation provided by the Installer to the Geosynthetics CQA Representative for his concurrence.

*Extrusion Process*

The extrusion seaming apparatus will be equipped with gauges giving the relevant temperatures of the apparatus such as the temperatures of the extrudate, nozzle, and preheat. The Installer will verify equipment operating temperature with a pyrometer to ensure that accurate temperatures are being achieved throughout the course of the geomembrane installation.

The Geosynthetics CQA Representative will record machine operating temperatures, extrudate temperatures, and ambient temperatures at appropriate intervals. Ambient temperatures will be measured approximately 6 in. (150 mm) above the geomembrane surface.

*Fusion Process*

The fusion-seaming apparatus must be automated vehicular-mounted devices. The fusion-seaming apparatus will be equipped with gauges indicating operating temperatures. Pinch roller pressure settings will be adjusted by the Installer as required.

The Geosynthetics CQA Representative will record ambient temperatures, seaming apparatus temperatures, and speeds. Ambient temperatures will be measured approximately 6 in. (150 mm) above the geomembrane surface.

#### 3.7.3.3 Seam Preparation

The Geosynthetics CQA Representative will monitor the preparation of the geomembrane for seaming operations to assure that:

- prior to seaming, the seam area is clean and free of moisture, dust, dirt, debris of any kind, and foreign material;

- if seam overlap grinding is required, the process is completed according to the Geomembrane Manufacturer's instructions within one hour of the seaming operation, and in a way that does not damage the geomembrane;

- the abrading does not extend more than 0.5 in. (12 mm) on either side of the extruded weld; and

- seams are aligned to minimize the number of wrinkles and "fishmouths".

The Geosynthetics Site CQA Manager will inform the Project Manager if the conditions identified above are not met.

3.7.3.4 Trial Seams

Trial seams will be made using extraneous pieces of VLDPE geomembrane to verify that seaming conditions are adequate. Such trial seams will be made at the beginning of each seaming period, and at least once every five hours, for both fusion and extrusion seaming apparatus used during the seaming period. A trial seam will also be made in the event that the ambient temperature varies more than 18°F (10°C) since the last passing trial seam test. The ambient temperature will be measured approximately 6 in. (150 mm) above the liner. Also, each seaming technician will make at least one trial seam for each seaming period. Trial seams will be made under the same conditions as actual seams. If any seaming apparatus is turned off for any reason, a new passing trial seam must be completed for that specific seaming apparatus.

If a trial seam specimen fails according to the criteria identified in the project specifications, the entire trial seam testing operation should be repeated. If a specimen fails in the subsequent testing, the seaming apparatus and seamer will not be accepted and will not be used for seaming until the deficiencies are corrected and two consecutive successful full trial seams are achieved.

Additional testing of trial seams may be conducted if agreed upon between the parties involved. Any such agreements will be documented by the Geosynthetics CQA Representative. After completion of the testing described above, the remainder of the trial seam sample may be cut into three pieces and distributed, one to be retained in the City's archives, one to be given to the Installer, and one to be provided to the Geosynthetics CQA Laboratory for the additional testing, as required. If a trial seam sample fails a test conducted by the Geosynthetics CQA Laboratory, then a destructive sample will be taken from each of the seams completed by the seaming technician and apparatus subsequent to the successful field trial seam test. The conditions of this paragraph will be considered as met for a given seam if a corresponding destructive sample has already been taken and meet or exceed the requirements of the project specifications and this CQA plan.

### 3.7.3.5 Nondestructive Testing

*Concept*

The Installer will nondestructively test all field seams over their full length using a vacuum test, spark test, air pressure test (for double-track fusion seams only), or other approved method. Vacuum testing and air pressure testing are described in the *Vacuum Testing* and the *Air Pressure Testing* of this section, respectively. The purpose of nondestructive tests is to check the continuity of seams. It does not provide any information on seam strength. Nondestructive testing will be carried out as the seaming work progresses, not at the completion of all field seaming. Nondestructive testing will not be permitted without adequate illumination unless the Installer demonstrates capabilities to do so to the satisfaction of the Project Manager.

The Geosynthetics CQA Representative will:

- observe all nondestructive testing;
- record location, date, test unit number, name of tester, and outcome of all testing; and
- inform the Installer and Project Manager of any required repairs.

The Installer will complete any required repairs in accordance with Section 3.7.4.

In some cases, seams may be inaccessible for nondestructive testing due to the design of the closure system. Provisions may be made to prefabricate portions of the geomembrane to allow nondestructive testing of seams that would otherwise be inaccessible. Once tested, the prefabricated portions may be installed. In those cases where no provisions can be made to nondestructively test a seam, the seam must be capped following the method described in Section 3.7.4.3. The seaming and capping operation will be observed by the Geosynthetics CQA Representative for uniformity and completeness.

The seam number, date of observation, name of tester, and outcome of the test or observation will be recorded by the Geosynthetics CQA Representative.

*Vacuum Testing*

The equipment for seam vacuum testing will consist of the following:

- a vacuum box assembly consisting of a rigid housing, a transparent viewing window, a soft neoprene gasket attached to the bottom, port hole or valve assembly, and a vacuum gauge;
- a vacuum tank and pump assembly equipped with a pressure controller and pipe connections;
- a pressure/vacuum hose with fittings and connections;
- an approved applicator; and
- a soapy solution.

The following procedures will be followed:

- if vacuum testing a fusion seam, the flap must be removed prior to testing;
- energize the vacuum pump to maintain a tank pressure of approximately 5 psi (34 kPa) gauge;

- with a soapy solution, wet a strip of geomembrane which is 6 in. (150 mm) larger in area than the vacuum box;

- place the box over the wetted area;

- close the bleed valve and open the vacuum valve;

- ensure that a leak tight seal is created;

- for a period of not less than 10 seconds, examine the geomembrane seam through the viewing window for the presence of leaks indicated by soap bubbles;

- if no leak indications appear after 10 seconds, close the vacuum valve and open the bleed valve. Before moving the box over the next adjoining area, place a mark (with an approved marker) on the geomembrane at the leading edge of the viewing window, then move the box over the next adjoining area so that the last mark on the geomembrane is at the rear of the viewing window, and repeat the process; and

- all areas where leaks appear will be marked by the vacuum testing technician and repaired by the Installer in accordance with Section 3.7.4.3.

*Air Pressure Testing (For Double-Track Fusion Seams Only)*

The following procedures are applicable to those processes which produce a double seam with an enclosed air channel space.

The equipment will be comprised of the following:

- an air pump equipped with a pressure gauge capable of generating and sustaining a pressure between 25 to 30 psi (175 and 210 kPa) and mounted on a cushion to protect the geomembrane;

- a hose with fittings and connections; and

- a sharp hollow needle, or other approved air pressure feed device and pressure gauge.

The following procedures will be followed:

- insert a protective cushion between the air pump and the geomembrane;

- seal both ends of the seam to be tested;

- insert the needle or other approved pressure feed device into the channel created by the fusion seam;

- insert the needle with the pressure gauge into the channel at the opposite end of the seam where the pressure feed device is located;

- energize the air pump to a pressure between 25 and 30 psi (175 and 210 kPa), close the valve, and sustain the pressure for a minimum period of 5 minutes;

- if any loss of pressure exceeds 2 psi (15 kPa) on the gauge at the opposite end of the seam to the pressure feed device or if the pressure does not stabilize, locate the faulty area and repair it in accordance with Section 5.8.4.3;

- verify the relief of the air pressure of the end of the seam opposite the pressure gauge; and

- remove the needles or other approved pressure feed devices and repair all holes created during the test procedures.

#### 3.7.3.6 Destructive Testing

*Concept*

Destructive seam tests will be performed at selected locations. The purpose of these tests is to evaluate seam strength. Seam strength testing will be conducted as the seaming work progresses, not at the completion of production seaming.

*Location and Frequency*

The Geosynthetics Site CQA Manager will select locations where seam samples will be cut out for laboratory testing. Those locations will be established as follows:

- A minimum average frequency of one test per 500 lineal ft (150 lineal m) of seam length. This minimum frequency is to be determined as an average taken over the total length of the geomembrane seams constructed for the final cover system.

- A maximum frequency will be agreed upon by the Installer, Project Manager and Geosynthetics Site CQA Manager at the Resolution and/or Pre-Construction Meeting.

- Test locations will be determined during seaming at the Geosynthetics Site CQA Manager's discretion. Selection of such locations may be prompted by suspicion of excess crystallinity, contamination, offset seams, or any other potential cause of inadequate seaming.

The Installer will not be informed in advance of the locations where the seam samples will be taken.

*Sampling Procedure*

Samples will be marked by the Geosynthetic CQA Representative and removed by the Installer for field and laboratory testing as the seaming progresses. This procedure will allow review of laboratory test results before the geomembrane is covered by another material. The Geosynthetics CQA Representative will:

- observe sample removal;

- assign a number to each sampling location, and mark the sample removed from that location accordingly;

- record the sample location on the layout drawing; and

- record the reason for taking the sample at this location (e.g., statistical routine, suspicious feature of the geomembrane).

All holes in the geomembrane resulting from the destructive sampling procedures will be immediately repaired by the Installer in accordance with repair procedures described in Section 3.7.4.3. The continuity of the new seams constructed as part of the repaired area will be tested according to the *Vacuum Testing* of Section 3.7.3.5.

Prior to the removal of a sample, two specimens for field testing should be taken. Each of these specimens will be 1 in. (25 mm) wide by 8 in. (200 mm) long, with the seam centered parallel to the width. The distance between these two specimens will be 44 in. (1.1 m). If both specimens pass the field peel tests described in the *Field Testing* of Section 3.7.3.6, a sample for laboratory testing will be taken. If either specimen fails the testing, the seam should be repaired in accordance with the procedures identified in Section 3.7.4.3.

*Size and Distribution of Samples*

The sample for laboratory testing will be located between the two specimens removed for field testing as described in the *Sampling Procedure* of Section 3.7.3.6. The destructive sample will be 12 in. (0.3 m) wide by 42 in. (1.1 m) long with the seam centered lengthwise. The sample will be cut into three parts and distributed as follows:

- one portion, measuring 12 in. x 12 in. (0.3 m x 0.3 m), to the Installer for laboratory testing (if required);
- one portion, measuring 12 in. x 12 in. (0.3 m x 0.3 m), to the City for archive storage; and

- one portion, measuring 12 in. x 18 in. (0.3 m x 0.45 m), for Geosynthetic CQA Laboratory testing.

Final determination of the destructive sample dimensions and distribution will be made at the Pre-Construction Meeting.

*Field Testing*

The two 1 in. (25 mm) wide specimens mentioned in the *Sampling Procedure* of Section 3.7.3.6 will be tested in the field for peel. The testing will be conducted using a gauged tensiometer which has been calibrated within the last six months. If any field test sample fails to pass the criteria identified in the specifications, then the procedures outlined in the *Procedures for Destructive Test Failures* of Section 3.7.3.6 will be followed.

The Geosynthetics CQA Representative will witness all field destructive testing and record the date, seam number, panel numbers, location, the assigned destructive sample number, and the results of the field tests.

*Geosynthetics Construction Quality Assurance Laboratory Testing*

Destructive test samples will be packaged and shipped, if necessary, by the Geosynthetics CQA Representative in a manner that will not damage the test sample. The Project Manager will verify that packaging and shipping conditions are acceptable. The Project Manager will be responsible for storing the archive samples. This procedure will be fully outlined at the Resolution and Pre-Construction Meetings. Destructive samples will be tested by the Geosynthetics CQA Laboratory. The Geosynthetics CQA Laboratory will be selected by the Geosynthetics CQA Representative with the concurrence of the City.

Testing will include "Seam Strength" (ASTM D 4437 as modified in NSF 54 Appendix A), and "Peel Strength" (ASTM D 4437 as modified in NSF 54, Appendix A). Modifications to the testing procedures and the minimum acceptable values to be obtained in these tests are indicated in the Specifications. At least five specimens will be tested for each test method. Specimens will be selected alternately by test from the samples (i.e., peel, shear, peel, shear...).

The Geosynthetics CQA Laboratory will provide test results to the Geosynthetic Site CQA Manager no more than 24 hours after receipt of the samples. The Geosynthetics Site CQA Manager will review laboratory test results as soon as they become available and make appropriate recommendations to the Project Manager.

Acceptable seams must be bounded by two locations which meet the following criteria: (i) where destructive samples have passed all laboratory tests; (ii) the entire production seam length and seaming apparatus in question is capped; and (iii) constructed by the seamer. Whenever a reconstructed seam length exceeds 150 ft (50 m), a sample will be taken from the zone in which the seam has been reconstructed. This sample must pass destructive testing or the procedure outlined in this section must be repeated.

The Geosynthetics CQA Representative will document all actions taken in conjunction with destructive test failures.

### 3.7.4 Defects and Repairs

#### 3.7.4.1 Identification

Seams and non-seam areas of the geomembrane will be examined by the Geosynthetics CQA Representative for identification of defects, holes, blisters, undispersed raw materials and any sign of contamination by foreign matter. The surface of the geomembrane will be clean at the time of examination. The geomembrane surface will be swept or washed by the Installer if debris of any kind inhibits examination.

#### 3.7.4.2 Evaluation

Each suspect location both in seam and non-seam areas will be nondestructively tested using the methods described in the *Vacuum Testing* of Section 3.7.3.5. Each location which fails the nondestructive testing will be marked by the Installer or the Geosynthetics CQA Representative and repaired by the Installer. Work will not proceed with any materials which will cover geomembrane locations that have been repaired until laboratory destructive test results have been approved by the Geosynthetic CQA Representative.

#### 3.7.4.3 Repair Procedures

Any portion of the geomembrane exhibiting a flaw or failing a destructive or nondestructive test will be repaired. Several procedures exist for the repair of these areas. The final decision as to the appropriate repair procedure will be agreed upon between the Project Manager, Installer, and Geosynthetics Site CQA Manager. The procedures available include:

- patching, used to repair large holes, tears, undispersed raw materials, and contamination by foreign matter;
- grinding and reseaming, used to repair small sections, less than 1 ft (0.3 m) of extruded seams;
- spot seaming, used to repair small tears, pinholes, or other minor, localized flaws; and
- capping, used to repair failed seams.

In addition, the following provisions will be satisfied:

- surfaces of the geomembrane that are to be repaired will be abraded no more than one hour prior to the repair;
- all surfaces must be clean and dry at the time of the repair;
- all seaming equipment used in repairing procedures must have passed the most recent seaming periods of trial seam testing;
- the repair procedures, materials, and techniques will be approved in advance of the specific repair by the Project Manager, Geosynthetic Site CQA Manager, and Installer;

- patches or caps will extend at least 6 in. (150 mm) beyond the edge of the defect, and all corners of patches will be rounded with a radius of at least 3 in. (75 mm); and

- the geomembrane below large caps should be appropriately cut to avoid water or gas collection between the two sheets.

### 3.7.5 Geosynthetic Final Cover System Acceptance

The Installer will retain all responsibility for the installed geosynthetics until accepted by the City.

The installed geosynthetics will be accepted by the City when:

- the installation is finished;

- verification of the adequacy of all seams and repairs, including passing nondestructive and destructive tests, are complete;

- Installer's representative furnishes the Project Manager with certification that the VLDPE geomembrane was installed in accordance with the Manufacturer's recommendations as well as the plans and specifications;

- all documentation of installation is completed; and

- the Geosynthetics CQA Representative's Final Report and Record Drawings, sealed by a Professional Engineer registered by the State of Illinois, have been received by the City.

# 4. GEOTEXTILE CONSTRUCTION QUALITY ASSURANCE

## 4.1 Design

A copy of the geotextile construction drawings and project specifications prepared by the Engineer will be given to the Geosynthetic CQA Representative. The Geosynthetic CQA Representative will review these items for familiarity. This review should not be considered as the peer review of the design. Peer review should have been conducted at an earlier stage.

## 4.2 Manufacturing

The Geotextile Manufacturer (Manufacturer) will provide the Project Manager with a list of certified "minimum average roll value" properties for the type of geotextile to be delivered. The Manufacturer will also provide the Project Manager with a written certification signed by a responsible representative of the Manufacturer that the materials actually delivered have "minimum average roll values" properties which meet or exceed all certified property values for that type of geotextile.

The Geosynthetic CQA Representative will examine all the Manufacturers' certifications to ensure that the property values listed on the certifications meet or exceed those specified for the particular type of geotextile. Any deviations will be reported to the Project Manager.

## 4.3 Labeling

The Manufacturer will identify all rolls of geotextile with the following:

- Geotextile Manufacturer's name;
- product identification;
- lot number;
- roll number;
- roll weight; and
- roll dimensions.

The Geosynthetic CQA Representative will examine rolls upon delivery and any deviation from the above requirements will be reported to the Project Manager.

## 4.4 Shipment and Storage

During shipment and storage, the geotextile will be protected from ultraviolet light exposure, precipitation or other inundation, mud, dirt, dust, puncture, cutting or any other damaging or deleterious conditions. To that effect, geotextile rolls will be shipped and stored in relatively opaque and watertight wrappings. The Geosynthetic CQA Representative will observe rolls upon delivery to the site and any deviation from the above requirements will be reported to the Project Manager. Any damaged rolls will be rejected and replaced at no cost to the Owner.

## 4.5 Conformance Testing

### 4.5.1 Tests

Upon delivery of the geotextile rolls, the Geosynthetic CQA Representative will ensure that samples are removed and forwarded to the Geosynthetic CQA Laboratory for testing to ensure conformance to both the design specifications and the list of guaranteed properties.

As a minimum, the following tests will be performed on geotextiles in accordance with the referenced ASTM Standards:

- mass per unit area (ASTM D 3776);
- grab strength (ASTM D 4632);
- tear strength (ASTM D 4533);
- burst strength (ASTM D 3786); and
- puncture strength (ASTM D 3787).

### 4.5.2 Sampling Procedures

Upon delivery of the geotextile rolls, the Geosynthetics CQA Representative will ensure that samples are obtained from individual rolls at the frequency specified in this CQA plan. The samples will be forwarded to the Geosynthetics CQA

Laboratory for testing to ensure conformance to both the design specifications and the list of physical properties certified by the Manufacturer.

Samples will be taken across the entire width of the roll and will not include the first linear 3 ft (1 m). Unless otherwise specified, samples will be 3 ft (1 m) long by the roll width. The Geosynthetic CQA Representative will mark the machine direction on the samples with an arrow. Samples will be taken at a rate of one per manufactured lot or one per 100,000 $ft^2$ (9,300 $m^2$), whichever requires the greater number of samples.

### 4.5.3 Test Results

The Geosynthetic CQA Representative will examine all results from laboratory conformance testing and compare results to the project specifications. The criteria used to determine acceptability are presented in the Specifications. The Geosynthetic CQA Representative will report any nonconformance to the Project Manager.

### 4.5.4 Conformance Test Failure

The following procedure will apply whenever a sample fails a conformance test that is conducted by the Geosynthetic CQA Laboratory:

- The Manufacturer will replace every roll of geotextile that is in nonconformance with the specifications with a roll that meets specifications.

- The Installer will remove conformance samples for testing by the Geosynthetic CQA Laboratory from the closest numerical rolls on both sides of the failed roll. These two samples must conform to the specifications. If either of these samples fail, the numerically closest rolls on the side of the failed sample that is not tested, will be tested by the Geotextile CQA Laboratory. These samples must conform to the specifications. If any of these samples fail, every roll of geotextile on site from this lot and every subsequently delivered roll that is from the same lot must be tested by the Geosynthetic CQA Laboratory for conformance to the specifications. This additional conformance testing will be at the expense of the Manufacturer.

The Geosynthetics CQA Representative will document actions taken in conjunction with conformance test failures.

## 4.6 Handling and Placement

The Installer will handle all geotextiles in such a manner as to ensure they are not damaged in any way. The Installer will comply with the following:

- In the presence of wind, the geotextile will be weighted with sandbags or the equivalent. Sandbags will be used during installation only and will remain until replaced with the appropriate protective cover soils.

- The geotextile will be kept continually under tension to minimize the presence of wrinkles in the geotextile.

- The geotextile will be cut using an approved geotextile cutter only. If in place, special care must be taken to protect other materials from damage which could be caused by the cutting of the geotextile.

- The Installer will take any necessary precautions to prevent damage to the underlying VLDPE geomembrane during placement of the geotextile.

- During placement of geotextile, care will be taken not to entrap stones, excessive dust, or moisture that could damage the geotextile, cause clogging, or hamper subsequent seaming.

- A visual examination of the geotextile will be carried out over the entire surface, after installation to ensure that no potentially harmful foreign objects are present.

The Geosynthetics CQA Representative will note any noncompliance and report it to the Project Manager.

## 4.7 Geotextile Seams and Overlaps

All geotextile seams will be sewn using thread approved by the Manufacturer and which is resistant to ultraviolet radiation. Spot sewing is not permitted. Thermal bonding is not permitted without written approval of the Engineer. Geotextiles shall be overlapped a minimum of 6 in. (150 mm) prior to seaming. No horizontal seams will be allowed on side slopes steeper than 20 percent (i.e. seams will be along, not across, slopes steeper than 5H:1V), except as part of a patch or for seams connecting the ends of two panels of geotextile deployed parallel to the slope (referred to as cross seams). Cross seams shall not be continuous across two or more panel widths.

## 4.8 Geotextile Repair

Any holes or tears in the geotextile will be repaired using a patch made from the same geotextile. Geotextile patches will extend a minimum of 1 ft (0.3 m) beyond the damaged area. Geotextile patches will be sewn into place no closer than 1 in. (25 mm) from any panel edge. Should any tear exceed 50 percent of the width of the roll, that roll will be removed from the slope and replaced. Care will be taken to remove any soil or other material which may have penetrated the torn geotextile.

The Geosynthetic CQA Representative will observe any repair, note any noncompliance with the above requirements and report them to the Project Manager.

## 4.9 Placement of Soil Materials

The Earthwork Contractor will place all soil materials located on top of a geotextile in such a manner as to ensure:

- no damage to the geotextile;
- minimal slippage of the geotextile on underlying layers; and
- no excess tensile stresses in the geotextile.

Any noncompliance will be noted by the Geosynthetic CQA Representative and reported to the Project Manager.

# 5. SOILS CONSTRUCTION QUALITY ASSURANCE

Soils CQA will be performed on all soil components used during construction of the final cover. The criteria to be used for the determination of acceptability of the construction work will be as identified in Table 5-1.

## 5.1 Monitoring

The Soils CQA Consultant will monitor and document the construction of all soils components. Monitoring the construction work includes the following:

- monitoring the quality of the material stockpiles, obtaining borrow soil samples for conformance testing;
- testing to determine the moisture content and unit weight of each lift during placement and compaction of soil used in construction of the foundation, low-permeability soil barrier, and vegetative layers;
- recording test results and locations;
- noting any deficiencies;
- monitoring the thickness of lifts as loosely placed and as compacted;
- monitoring that the total thickness of the foundation, low-permeability soil barrier, and vegetative layers is as indicated on the construction plans;

# TABLE 5-1

## SOILS FIELD AND LABORATORY TESTING SUMMARY
## FINAL COVER CONSTRUCTION
## LOPEZ CANYON SANITARY LANDFILL

| TEST METHOD | MINIMUM TESTING FREQUENCY | ACCEPTANCE CRITERIA |
|---|---|---|
| **FOUNDATION AND VEGETATIVE LAYERS** | | |
| Grain Size Distribution (ASTM D 422) | 1 test per 10,000 $yd^3$ (7,650 $m^3$) | Maximum particle size of 6 in. |
| Modified Proctor (ASTM D 1557) | 1 test per 10,000 $yd^3$ (7,650 $m^3$) | N/A |
| In-Place Moisture/Density Nuclear Method (ASTM D 2911) | 1 test per 1,000 $yd^3$ (765 $m^3$) | Dry density no less than 90% of the max. dry density for top 6 to 8 inches of the foundation layer, no less than 85% of the max dry density for the vegetative layer moisture content no less than the optimum moisture content, as measured by ASTM D 1557. |
| In-Place Moisture/Density Sand Cone Method (ASTM D 1556) | 1 test per 10,000 $yd^3$ (7,650 $m^3$) | Dry density no less than 90% of the max. dry density for the foundation layer, no less than 85% of the max dry density for the vegetative layer moisture content no less than the optimum moisture content, as measured by ASTM D 1557. |
| **LOW-PERMEABILITY SOIL BARRIER LAYER** | | |
| Grain Size Distribution (ASTM D 422) | 1 test per 5,000 $yd^3$ (3,820 $m^3$) | Minimum fines content of 50%. Maximum particle size of 3 in. (75 mm). |
| Atterberg Limits (ASTM D 4318) | 1 test per 5,000 $yd^3$ (3,820 $m^3$) | Criteria to be determined by Engineer prior to construction following test pad evaluation. |
| In-Place Moisture/Density Nuclear Method (ASTM D 2911) | 1 test per 250 $yd^3$ (190 $m^3$) Minimum of 4 tests per day | Criteria to be determined by Engineer prior to construction following test pad evaluation. |
| In-Place Moisture/Density Sand Cone Method (ASTM D 1556) | 1 test per 2,500 $yd^3$ (1,900 $m^3$) | Criteria to be determined by Engineer prior to construction following test pad evaluation. |
| Modified Proctor (ASTM D 1557) | 1 test per 5,000 $yd^3$ (3,820 $m^3$) | N/A |
| BAT Hydraulic Conductivity | 1 test per 2,000 $yd^3$ (1,530 $m^3$) | Maximum saturated hydraulic conductivity of 1 x $10^{-6}$ cm/s based upon correlation between BAT test and in situ hydraulic conductivity from test pad. |

- monitoring the action of the compaction and heavy hauling equipment on the construction surface (i.e., penetration, pumping, cracking, etc.); and

- monitoring the repair of nonconforming areas and testing perforations.

Monitoring the earthwork for the foundation layer specifically includes the following:

- monitor clearing, grubbing, and stripping of the existing interim cover surface;

- monitor the scarification of the interim cover surface to a depth of 6 to 8 in. (150 to 200 mm) and recompaction;

- reviewing documentation of quality control test results;

- visually monitoring the physical condition of the material during placement; and

- visually monitoring the foundation layer stability under the action of the compaction equipment.

Monitoring the earthwork for the compacted low-permeability soil barrier layer specifically includes the following:

- reviewing documentation of the quality control test results;

- monitoring the soil for deleterious material;

- monitoring moisture conditioning and preprocessing, if any, of the borrow soil material;

- monitoring the thickness of lifts during placement of the material;

- monitoring that the surface of each lift is scarified to a depth of 2 to 4 in. (50 to 100 mm) prior to placement of the following lift;

- recording the construction equipment used for material placement;

- performing BAT hydraulic conductivity tests and recording the test results and location;

- monitoring the protection of the final surface of the low-permeability soil barrier layer from excessive moisture loss prior to placement of the vegetative cover layer; and

- monitoring preparation and smoothness of the surface prior to the installation of the VLDPE geomembrane in 'C' Canyon.

Monitoring the earthwork for the vegetative layer specifically includes the following:

- reviewing documentation of the quality control test results;

- monitoring soil for deleterious material;

- monitoring the thickness of lifts during placement of the materials;
- monitoring wrinkles that may appear in the underlying geotextile cushion on VLDPE geomembrane during placement of the vegetative layer in 'C' Canyon; and
- recording field density and field moisture content measurement at location of each test on test logs.

## 5.2 Laboratory and Field Tests

The laboratory and field test methods, laboratory and field testing frequencies, and criteria used to determine acceptability are presented in Table 5-1. A special testing frequency will be used at the discretion of the Landfill Engineer or the Soils CQA Consultant when visual observations of construction performance indicate a potential or recurring deficiency.

## 5.3 Survey

The top of the low-permeability soil barrier shall be surveyed before the installation of the immediately overlying vegetative cover layer. The thickness of the low-permeability soil barrier shall be determined by comparing the survey of the finished foundation layer and the top of the low-permeability soil barrier layer.

## 5.4 Deficiencies

### 5.4.1 General

If a defect is discovered in the earthwork product, the Soils Site Monitor will immediately inform the Soils CQA Managing Engineer or his designated representative. The Soils Site Monitor, in consultation with the Soils CQA Managing Engineer, will determine the extent and nature of the defect. If the defect is indicated by an unsatisfactory test result, extent of the deficient area will be determined by additional tests, observations, a review of records, or other means that the Soils CQA Managing Engineer deems appropriate.

If the defect is related to adverse site conditions, such as overly wet soils or surface desiccation, the Soils Site Monitor, in consultation with the Soils CQA Managing Engineer, will define the limits and nature of the defect.

### 5.4.2 Notification

After determining the extent and nature of a defect, the Soils CQA Site Manager will notify the Landfill Engineer and Landfill Manager and schedule appropriate retests when the work deficiency is to be corrected.

### 5.4.3 Corrective Action

At locations where the field testing of the soil indicates that the compacted unit weight, moisture content, or field or laboratory hydraulic conductivities do not meet the requirements presented in Table 5-1, the failing area will be reworked as indicated below:

- If the results of any in-situ moisture or dry density, or field hydraulic conductivity value fails to meet the specified criteria presented in Table 5-1, two additional tests of the same type will be performed in the vicinity of the failed test. If either of the two additional tests results in a failure, then this area of the low-permeability soil barrier will be considered in nonconformance and will be removed, reworked, and recompacted to meet the requirements specified in Table 5-1.

- Perform in-place density and moisture content testing in the vicinity of a nonconforming area to evaluate deficiency in-place density and moisture content.

- Obtain samples of low-permeability soil liner material from nonconforming areas for potential laboratory testing to evaluate differences in soil properties that could contribute to the nonconforming test results.

Criteria to be used for determination of acceptability will be as identified herein. Other tests conducted on hydraulic conductivity samples will consist of Atterberg limits and grain size distribution.

### 5.4.4 Repairs and Retesting

The City's work force will correct the deficiency to the satisfaction of the Soils CQA Consultant. If a project specification criterion cannot be met, or unusual weather conditions hinder work, then the Soils CQA Consultant will develop and present to the Landfill Engineer suggested solutions for approval.

All retests recommended by the Soils CQA Consultant must verify that the defect has been corrected before any additional work is performed by the City's work force in the area of the deficiency. The Soils CQA Consultant will also verify that all installation requirements are met.

Penetrations into the compacted low-permeability soil barrier resulting from sampling or other activities shall be properly backfilled with hand-tamped select low-permeability material and/or bentonite powder. CQA personnel will repair nuclear density, sand cone, and BAT hole perforations. The City's work force shall repair perforations and/or excavations resulting from CQA sampling and testing. All repairs will be inspected by the Site Soils Monitor for compliance.

# APPENDIX

# DATA FORMS

Recommendations from latest test Pad report dated August 1996



96 OCT 29 AM 11:04

## TABLE 7-1

## FOUNDATION LAYER CONFORMANCE TESTING
## FINAL COVER SYSTEM
## LOPEZ CANYON SANITARY LANDFILL

| TEST METHOD | MINIMUM TEST FREQUENCY |
|---|---|
| Moisture-Density Compaction Curve (ASTM D 1557) | 1 test per 10,000 $yd^3$ (7,650 $m^3$) |
| In-Place Moisture-Density Nuclear Method (ASTM D 2922/3017) | 1 test per 1,000 $yd^3$ (765 $m^3$) |
| In-Place Moisture-Density Sand Cone Method (ASTM D 1556) or Drive Cylinder Method (ASTM D 2937) | 1 test per 10,000 $yd^3$ (7,650 $m^3$) |

# TABLE 7-2

## LOW-PERMEABILITY SOIL BARRIER LAYER
## CONFORMANCE TESTING
## FINAL COVER SYSTEM
## LOPEZ CANYON SANITARY LANDFILL

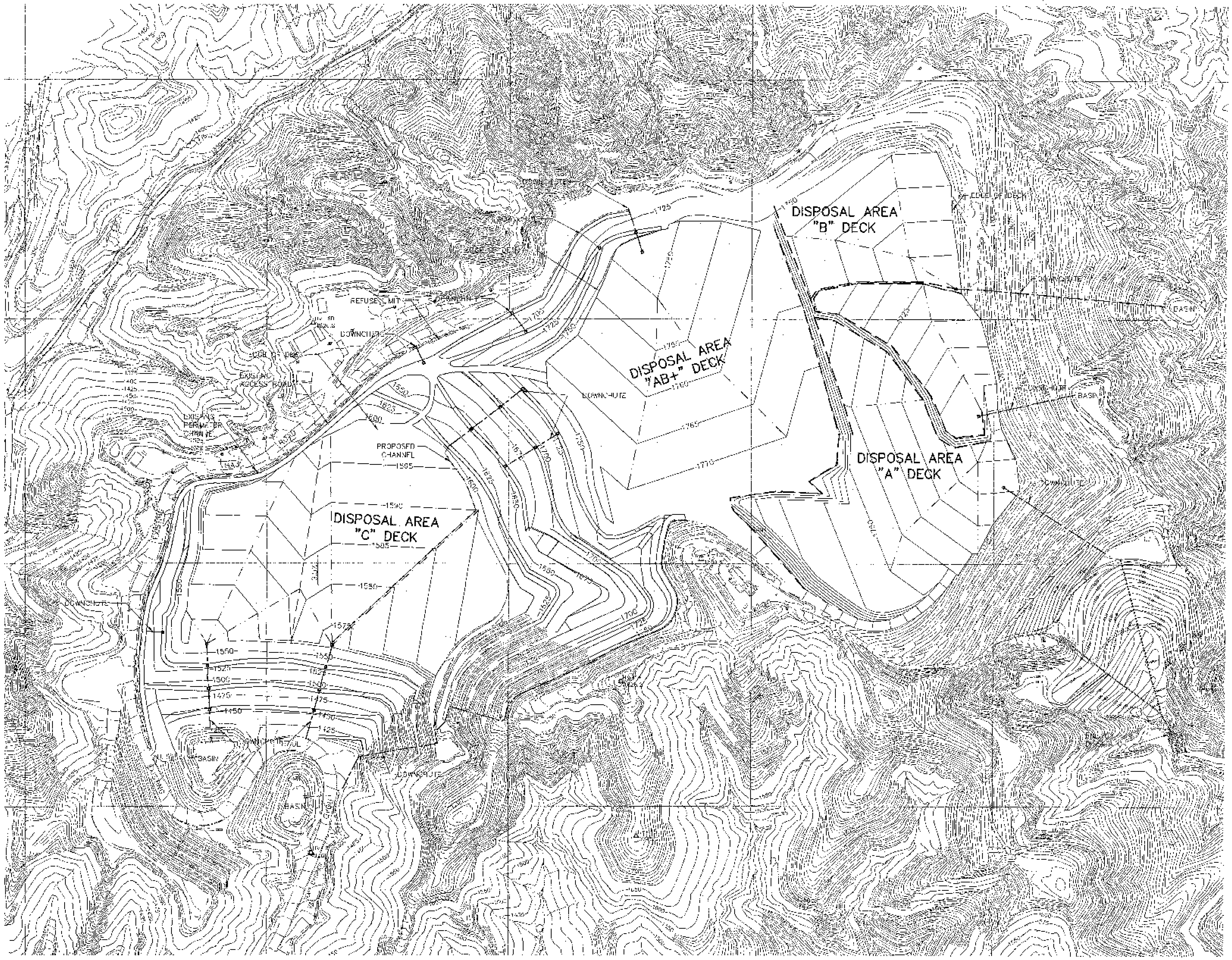
| TEST DESCRIPTION | MINIMUM FREQUENCY |
|---|---|
| In-Place Moisture-Density, Nuclear Method (ASTM D 2922) | 1 test per 250 $yd^3$ (190 $m^3$) (min. of 5 tests per week) |
| In-Place Moisture-Density, Sand Cone Method (ASTM D 1556) or Drive Cylinder Method (ASTM D 2937) | 1 test per 2,500 $yd^3$ (1,900 $m^3$) (for correlation) (minimum of 1 test per week) |
| Moisture-Density Compaction Curve (ASTM D 698) | 1 test per 5,000 $yd^3$ (3,820 $m^3$) |
| Field Permeability Test (BAT Permeameter, Manufacturer's Specifications) | 1 test per 2,000 $yd^3$ (1,530 $m^3$) |
| Laboratory Permeability Test(1) (ASTM D 5084) | 1 test per 4,000 $yd^3$ (3,060 $m^3$) (on Shelby tube soil samples) |
| Sieve Analysis (ASTM D 422) | 1 test per 4,000 $yd^3$ (3,060 $m^3$) |
| Atterberg Limits (ASTM D 4318) | 1 test per 4,000 $yd^3$ (3,060 $m^3$) |

(1) Performed at a confining stress of 1.6 psi (11 kPa).

# DRAWING NO. 1

# REVISED FINAL GRADING AND SURFACE-WATER DRAINAGE PLAN

# AMENDS DRAWING NO. 1 OF VOLUME IV OF IV OF THE FCP




## LEGEND

| | |
|---|---|
| —1725— | EXISTING CONTOUR |
| —1725— | PROPOSED FINAL GRADE CONTOURS |
| | DOWNCHUTE |
| | PROPOSED DIVERSION CHANNEL |
| | EXISTING PERIMETER CHANNEL |
| | FLOWLINE |
| | RIDGE |
| | EXISTING ACCESS ROAD |
| | PROPOSED BENCHES |
| | PROPOSED DECK INLET STRUCTURES |
| 1366.2 | BENCHMARKS |

200 100 0 200 400
SCALE IN FEET

| | | | DATE |
|---|---|---|---|
| DESIGNED | MSS | | 02-16-96 |
| DRAWN | JT | | 02-20-96 |
| CHECKED | EK | | 02-29-96 |
| SUPERVISED | EK | | 02-29-96 |
| PROJECT ENGR. | | R.C.E. NO. | |
| DIV./DEPT. ENGR. | | R.C.E. NO. | |

GEOSYNTEC CONSULTANTS
2100 Main Street, Suite 150
Huntington Beach, California 92648
Telephone (714) 969-0800

# LOPEZ CANYON LANDFILL

| NO. | REVISION DESCRIPTION | APPROVED | DATE |
|---|---|---|---|

CITY OF LOS ANGELES
BUREAU OF SANITATION

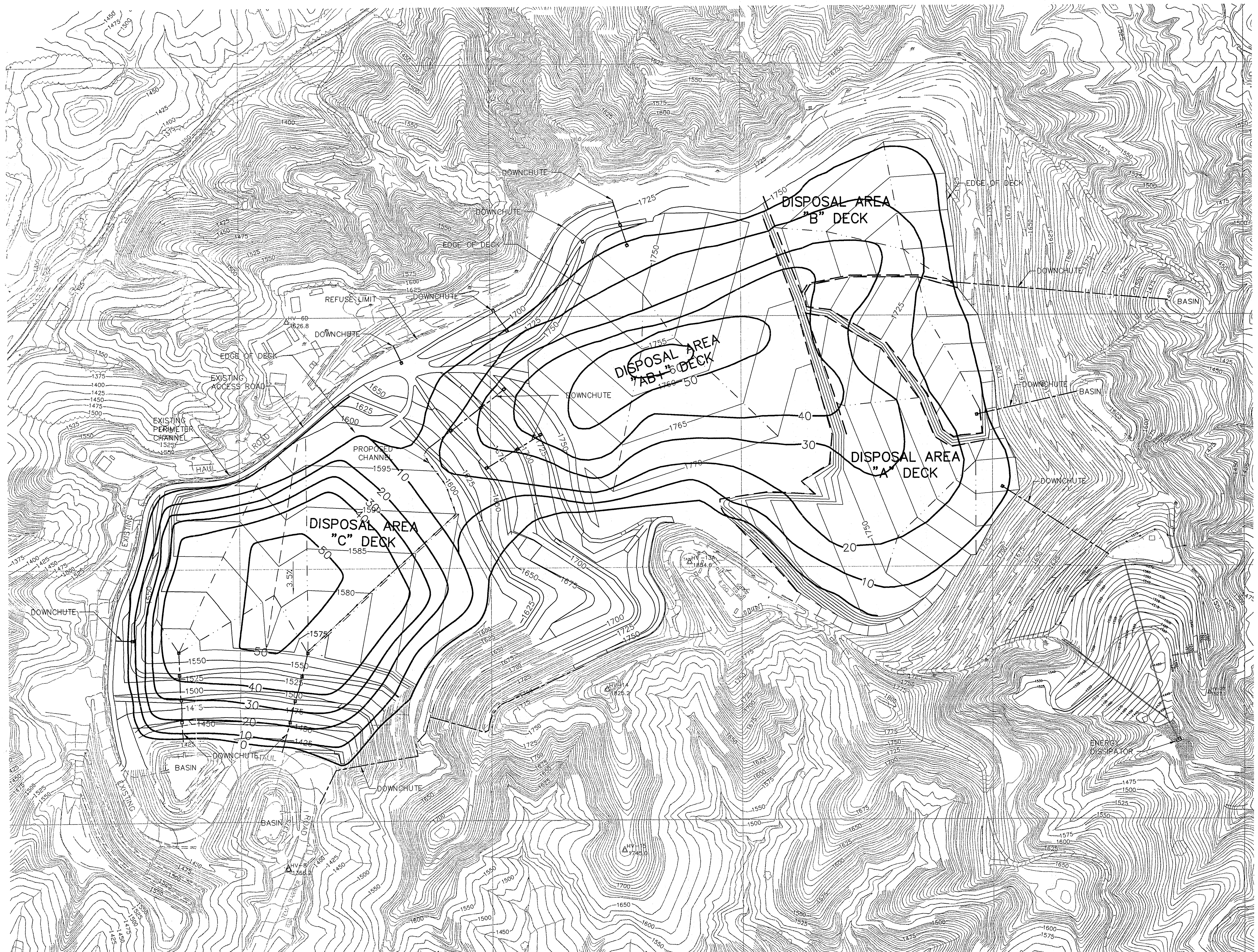
SCALE AS SHOWN
DWG NO. 1
FILE NO. 4100-412
JOB NO. CE4100-04

REVISED FINAL GRADING AND SURFACE WATER DRAINAGE PLAN DISPOSAL AREA A, B, AB+, AND C

# DRAWING NO. 2

# REVISED POST-CLOSURE SETTLEMENT CONTOURS

# AMENDS DRAWING NO. 2 OF VOLUME IV OF IV OF THE FCP




## LEGEND

| | |
|---|---|
| ——1725—— | EXISTING CONTOUR |
| ——1725—— | PROPOSED FINAL GRADE CONTOURS |
| —·—·— | DOWNCHUTE |
| —··—··— | PROPOSED DIVERSION CHANNEL |
| - - - - | EXISTING PERIMETER CHANNEL |
| —·—·— | FLOW LINE |
| — — — | RIDGE |
| ═══ | EXISTING ACCESS ROAD |
| ▭ | PROPOSED BENCHES |
| ▣ | PROPOSED DECK INLET STRUCTURES |
| △ HV-8 1366.2 | BENCHMARKS |
| ——10—— | POST-CLOSURE SETTLEMENT CONTOURS (FEET) |

200 100 0 200 400
SCALE IN FEET

| | | DATE |
|---|---|---|
| DESIGNED | MSS | 02-16-96 |
| DRAWN | JT | 02-20-96 |
| CHECKED | EK | 02-29-96 |
| SUPERVISED | EK | 02-29-96 |
| PROJECT ENGR. | R.C.E. NO. | |
| DIV./DIST. ENGR. | R.C.E. NO. | |

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Huntington Beach, California 92648
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# LOPEZ CANYON LANDFILL

| NO. | REVISION DESCRIPTION | ENGR. | DATE |
|---|---|---|---|

CITY OF LOS ANGELES
BUREAU OF SANITATION DELWIN A. BIAGI, DIRECTOR
DATE 19
STEPHEN A. FORTUNE DIV. DIST. ENGR. R.C.E. NO. 21737

SCALE AS SHOWN
DWG NO. 2
FILE NO. 4100-415
JOB NO. OE4100-04

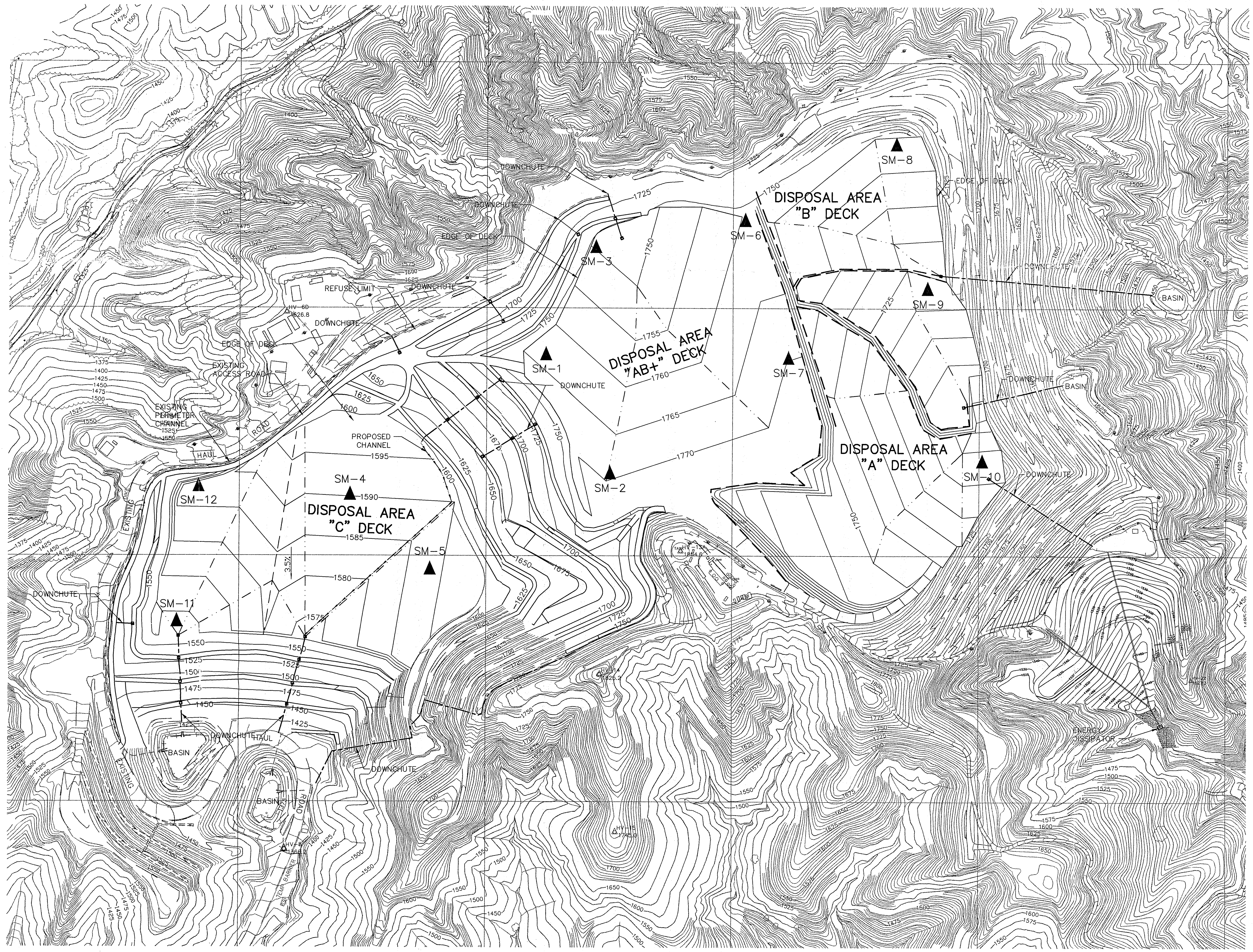
# REVISED POST-CLOSURE SETTLEMENT CONTOURS

DWG: 4100-415 199605151609 AB

# DRAWING NO. 3

## REVISED SETTLEMENT MONUMENT LOCATIONS

## AMENDS DRAWING NO. 3 OF VOLUME IV OF IV OF THE FCP




## LEGEND

- 1725 — EXISTING CONTOUR
- 1725 — PROPOSED FINAL GRADE CONTOURS
- DOWNCHUTE
- PROPOSED DIVERSION CHANNEL
- EXISTING PERIMETER CHANNEL
- FLOW LINE
- RIDGE
- EXISTING ACCESS ROAD
- PROPOSED BENCHES
- PROPOSED DECK INLET STRUCTURES
- HV-8 1366.2 BENCHMARKS
- SETTLEMENT MONUMENTS

200 100 0 200 400
SCALE IN FEET

# REVISED SETTLEMENT MONUMENT LOCATIONS

| | | DATE |
|---|---|---|
| DESIGNED | MSS | 02-16-96 |
| DRAWN | JT | 02-20-96 |
| CHECKED | EK | 02-29-96 |
| SUPERVISED | EK | 02-29-96 |
| PROJECT ENGR. | R.C.E. NO. | |
| DIV./DIST. ENGR. | R.C.E. NO. | |

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## LOPEZ CANYON LANDFILL

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|---|---|---|---|

CITY OF LOS ANGELES
BUREAU OF SANITATION DELWIN A. BIAGI, DIRECTOR
DATE 19
STEPHEN A. FORTUNE R.C.E. NO. 21757
DIV. DIST. ENGR.

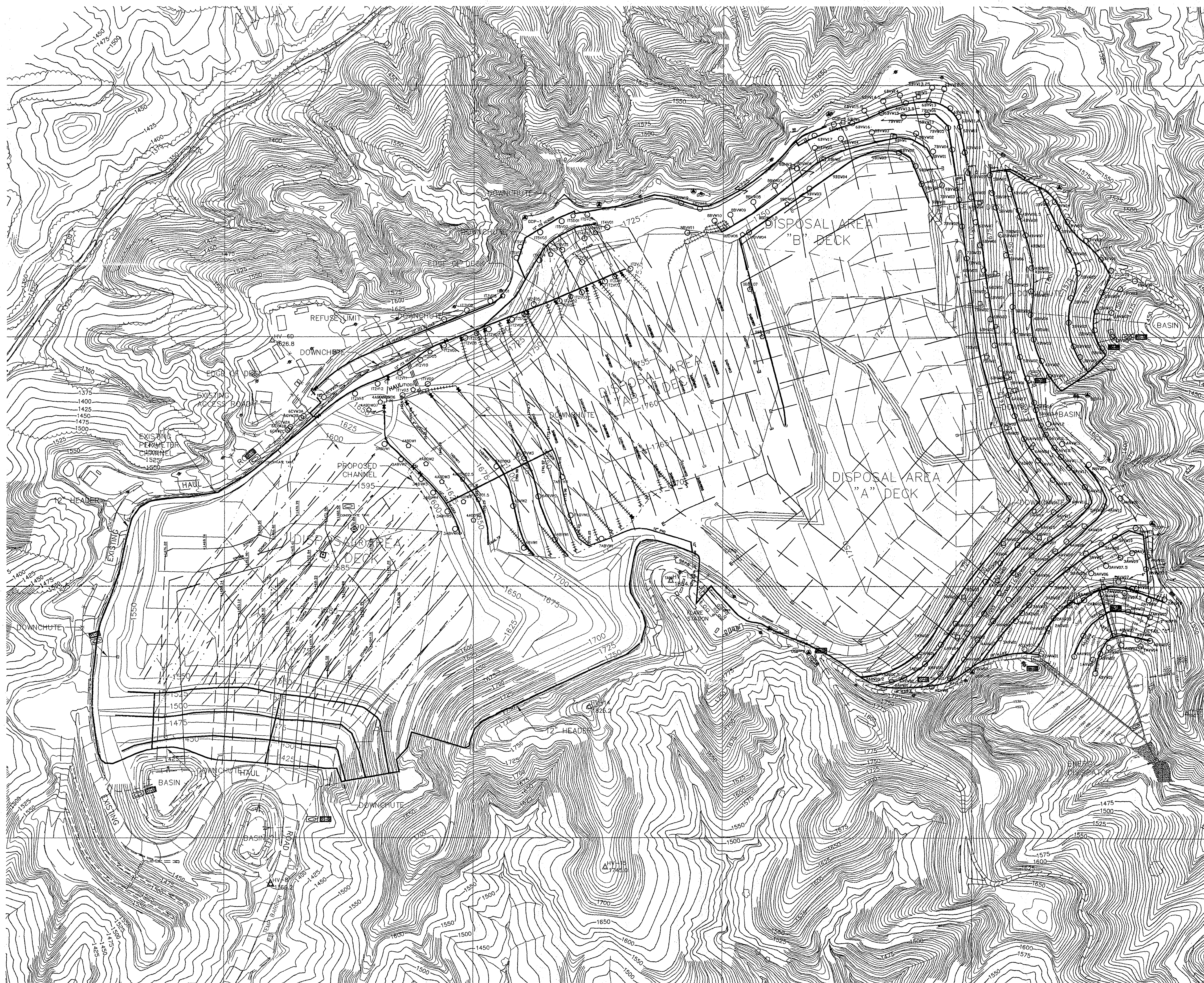
SCALE AS SHOWN
DWG NO. 3
FILE NO. 4100-413
JOB NO. CE4100-04

DWG: 4100-413 199604261043 LP

# DRAWING NO. 4

# REVISED LANDFILL GAS CONTROL SYSTEM LAYOUT

# AMENDS DRAWING NO. 4 OF VOLUME IV OF IV OF THE FCP




200 100 0 200 400
SCALE IN FEET

## LEGEND

| | |
|---|---|
| 1725 | EXISTING CONTOUR |
| 1725 | PROPOSED FINAL GRADE CONTOURS |
| | DOWNCHUTE |
| | PROPOSED DIVERSION CHANNEL |
| | EXISTING PERIMETER CHANNEL |
| | FLOW LINE |
| | RIDGE |
| | EXISTING ACCESS ROAD |
| | PROPOSED BENCHES |
| | PROPOSED DECK INLET STRUCTURES |
| HV-8 1366.2 | BENCHMARKS |
| | VALVE |
| OR | SLOPE OR GROUND PENETRATION BY PIPE |
| | HEADER |
| | HORIZ. COLLECTOR NO PERFORATION |
| | HORIZ. COLLECTOR PERFORATED |
| | UNDERGROUND WELL EXTENSION TO HEADER (UNDERGROUND, GRIDS 93 TO 96) |
| | UNDERGROUND WELL EXTENSION TO HEADER (UNDERGROUND GRIDS 93 TO 96) |
| | COLLECTOR CAP |
| ( U. N. O. ) | UNLESS NOTED OTHERWISE |
| 2AAW08 | GAS WELL I.D. |
| | HORIZONTAL WELL |
| | SHALLOW VERTICAL WELL |
| | DEEP VERTICAL WELL |
| | GAS COLLECTION INDICATOR PROBES (GCIP) |
| | CONDENSATE TANK |
| | CONDENSATE PUMP AND PUMP MODEL NUMBER |
| | LIFT 1CH HORIZONTAL WELLS |
| | LIFT 2CH HORIZONTAL WELLS |
| | LIFT 3CH HORIZONTAL WELLS |
| | LIFT 4CH HORIZONTAL WELLS |
| | LIFT 5CH HORIZONTAL WELLS |

| | | DATE |
|---|---|---|
| DESIGNED | BHC | 05-17-96 |
| DRAWN | JT | 05-17-96 |
| CHECKED | BHC/MSS | 05-17-96 |
| SUPERVISED | EK | 05-17-96 |
| PROJECT ENGR. | R.C.E. NO. | |
| DIV./DIST. ENGR. | R.C.E. NO. | |

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# LOPEZ CANYON LANDFILL

| NO. | REVISION DESCRIPTION | ENGR. | DATE |
|---|---|---|---|

CITY OF LOS ANGELES
BUREAU OF SANITATION DELWIN A. BIAGI, DIRECTOR
DATE 19
STEPHEN A. FORTUNE R.C.E. NO. 21737
DIV. DIST. ENGR.

SCALE AS SHOWN
DWG NO. 4
FILE NO. 4100-420
JOB NO. CE4100-06

# REVISED LANDFILL GAS COLLECTION SYSTEM LAYOUT

DWG: 4100-420 199606041626 AB