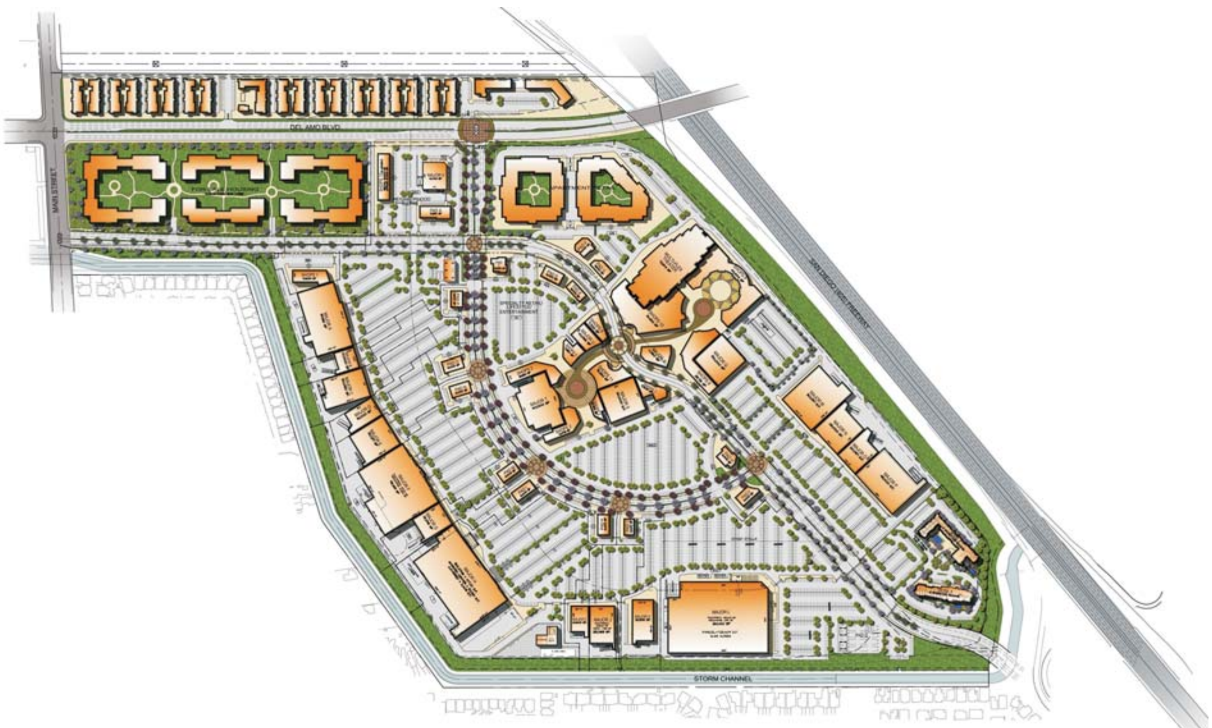
AVALON AT SOUTH BAY PROJECT

Deep Dynamic Compaction Work Plan



For

Avalon at South Bay
(Formerly Carson Marketplace)
Carson, California

April 17, 2008

Prepared by:

TETRA TECH
348 W. Hospitality Lane, Suite 100
San Bernardino, California 92408

Prepared for:

Carson Marketplace, LLC
4350 Von Karman Avenue, Suite 200
Newport Beach, California 92657

DEEP DYNAMIC COMPACTION WORK PLAN

FOR

AVALON AT SOUTH BAY
(FORMER CAL COMPACT LANDFILL)
20300 MAIN STREET
CARSON, CA

Prepared for:

Carson Marketplace, LLC
4350 Von Karman Avenue, Suite 200
Newport Beach, CA 92657

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348 West Hospitality Lane, Suite 100
San Bernardino, CA 92408

April 17, 2008

TABLE OF CONTENTS

List of Figures

List of Appendices

SECTION 1.0 INTRODUCTION

This Deep Dynamic Compaction (DDC) Work Plan (Work Plan) applies to the Avalon at South Bay development project (Site), which was previously named Carson Marketplace. This proposed brownsfield restoration project involves the development of the former Cal Compact landfill into multiple land uses, including commercial, entertainment, retail stores, restaurants, hotels, and residential. This Work Plan describes the activities to implement a DDC Program for the Project site. The test measurements from the proposed pilot test program will be used to confirm any modifications to the DDC design to ensure the most efficient method is implemented to dynamically compact the existing trash.

1.1 Site Description and Scope

Carson Marketplace, LLC (Developer) has proposed to develop the Avalon at South Bay development project (Project). The Project site comprises approximately 168 acres of land located at 20300 Main Street in Carson, California. The main property (157 acres) is bounded on the east/northeast by the San Diego Freeway (I-405), on the north by Del Amo Boulevard, on the west by Main Street and single family residences and mobile home development, and on the south by single family residences and mobile home development (Figure 1). A strip of vacant land to the north across Del Amo Boulevard, which comprises 11 acres, is also within the overall scope of the Project. This portion of the property was not part of the former landfill and the development activities planned for it are, therefore, not included in the provisions of this Work Plan.

The former Cal Compact landfill consists of five separate landfill cells numbered A1 through A5 separated by the site boundaries on the outer perimeter and by two interior roadways on the interior perimeter (Lenardo Drive and Stamps Drive). A Los Angeles County Flood Control channel (Torrance Lateral) is located adjacent to the south and west sides of the Project site and serves to separate the Project site from the adjacent residential neighborhood (Figure 2).

This Project involves the development of the former Cal Compact landfill into the following land uses: neighborhood commercial, regional commercial, commercial entertainment, big-box retail stores, restaurants, hotels, and residential (Figure 3). The construction phases of this Project will begin with mass grading of the former landfill area and relocation of some of the soil covering the landfill cells. This will be done to establish a uniform grade and minimize the thickness of suitable soil cover overlying the refuse material so that compaction of the landfill cells may commence. Soil removed in the grading process will be temporarily stockpiled onsite until it is reused for subsequent backfill. Compaction of refuse will be done using DDC to consolidate the refuse and soil below future parking and open areas to reduce future differential settling. The trash under future building locations will not be compacted. Once all compaction is complete, a landfill gas collection system with horizontal collection wells throughout the site and vertical gas collection wells below future building locations will be installed. This gas collection system will be connected to a gas flare treatment system located in a landfill operations center which will have controls and integral monitoring to detect any leakage or system failure. The landfill cells and gas collection system will then have a multi-component landfill cap installed. The first layer of this cap will be the installation of a continuous layer of linear low density polyethylene

(LLDPE) geomembrane which will serve as the primary impermeable layer of the cap system. This LLDPE geomembrane will then have drainage strips installed on top of it that will direct water off of the landfill cap so that it does not accumulate. These drainage strips will be covered by a geotextile fabric layer to resist the accumulation of silt and clogging of the drainage system. This layer will then be covered with soil.

All future buildings will be supported on driven piles. Piles will be driven through the refuse until competent native soil is reached. Pile caps will be installed and the concrete building slabs will be poured on top. The LLDPE geomembrane will be sealed to the pile caps where they penetrate it using an expansion boot to allow expansion and movement while remaining sealed.

A building protection system will be installed below all building locations to serve as a backup in case of landfill cap or primary gas collection system failure. This system will include the installation of a membrane attached to the underside of the concrete slab. The space between this membrane and the LLDPE geomembrane will have a passive gas venting system installed and will also include methane detection sensors to provide notification of any accumulation of methane under the building slabs. All buildings will be built aboveground.

The Project will also include the installation of a groundwater extraction and treatment system along the southern boundary of the Project site to contain and treat impacted groundwater. Some refuse materials in the landfill cells may need to be excavated and moved to facilitate the installation of site utilities and the landfill gas collection system.

Tetra Tech is the environmental engineer and general contractor responsible for the design and installation of these remedial systems. Tetra Tech is not, however, responsible for the design and installation of the driven piles, pile caps, and building slabs that make up the building foundations.

1.2 Objective

The purpose of DDC is to densify the upper portion of the landfill trash and provide a more stable base for the landfill cap geomembrane and any improvements in the areas under planned parking and road (open) areas. This will assist in minimizing differential settlement in the open areas and promote better surface water drainage over the long term. In addition, DDC will assist in lowering the existing elevations in the open areas by several feet with out having to remove the protective soil cover or remove and relocate any on-site trash. Lowering the elevation of the open areas during DDC will allow for a balanced site and minimize the need to import or export soil. Following DDC, the rough grade will be established.

The landfill subsurface conditions have been evaluated in various reports prepared in the mid-1990s and in 2007. Specifically, a DDC pilot test was conducted in 1995 (Woodward-Clyde 1995) and is included in Appendix A (without appendices) in this Work Plan for reference. While the landfill operations were terminated in 1964, relatively little data are available about the amount and rate of settlement that has occurred since termination of the landfill operations. Further settlement and differential settlement are anticipated; the extent of each has been estimated as best possible (Leighton 2008).

1.3 Site Background

Land use of the property prior to landfill operations was primarily agricultural, including grazing, dairy, feedlot, and cropland (Brown & Root 1995a). Prior to the 1930s, the land immediately surrounding the property was also used primarily for agriculture, with some limited residential development. During the 1940s, industry was introduced to the area and residential areas also became more extensive. The current light industry, commercial, and residential mix of surrounding land uses was fully developed by the 1970s (Brown & Root 1995a).

Between 1959 and 1964, the property was used as a Class II landfill and is currently covered by a layer of soil that varies from 4 to 32 feet in thickness (Arcadis BBL 2008). According to Los Angeles County records, Cal Compact, Inc. (Cal Compact), a California corporation, was issued an industrial waste disposal permit on July 17, 1959, which authorized Cal Compact to operate a Class II landfill on the property (Brown & Root 1995b). Landfill operations began on this property in April 1959 and continued until 1964, prior to the site closing in February 1965. The landfill operations consisted of the placement and cover of wastes in excavated trenches. All wastes were placed in trenches that were excavated adjacent to the interior haul roads. The haul road locations have remained unchanged throughout the time the landfill was in operation and are underlain by native soil materials (Brown & Root 1995b).

The landfill was permitted to accept both municipal solid waste and specified industrial liquid wastes. During the life of the landfill, approximately 6 million cubic yards of solid municipal waste and 6.3 million gallons of industrial liquid waste were received at the landfill (Brown & Root 1995c). Available records indicate that over 90 percent of the liquid wastes were drilling fluids that consisted primarily of water and clay mixtures, with minor heavy metal additives and oily residue. Other wastes received included solvents, oils, sludges, heavy metals, paint sludges, and inorganic salts.

On March 18, 1988, Remediation Action Order Number HSA87/88-040 was issued, requiring investigation of contamination at the landfill site and preparation of a remedial action plan (RAP). A RAP was prepared and approved by the Department of Toxic Substances Control (DTSC) in 1995. The objective is to develop the Project for mixed uses that benefit the surrounding community. At the same time, the RAP will be implemented to protect human health and the environment during construction and after the Project development is complete and operating.

SECTION 2.0 DESIGN CRITERIA

The 1995 DDC pilot test was used as the general basis of design for this Work Plan, with some adjustments. The previous pilot test made the following observations and recommendations that were utilized in the DDC design and approach described in this Work Plan.

1. An average 5-foot layer of soil cover above the trash was recommended. Therefore, DDC preparation on the site will be done on 3 to 5-acre sub areas. Soil will be relocated in these areas to achieve around 4 to 6 feet of soil above trash before DDC activities begin.

2. A grid spacing of 15 and 20 feet were used during the pilot test with a 27 ton weight at a height of 100 feet (Woodward-Clyde 1995 Table 5). With 5 drops per grid point, this equates to 67.5 to 120 ton-feet/square-foot (tf/sf), about a 90 tf/sf average.

3. The highest efficiency (90 percent) of crater development and trash compression (with no intermediate backfill) occurred with 5 drops (27 tons at a 100-foot drop). More drops started to produce heave and a significant drop in efficiency.

4. The majority of penetration and compaction occurred with the first 5 drops. Penetration was 0.5-foot or less per drop after this (Woodward-Clyde 1995 Figure 10). The first two drops generally developed over 60 percent of the crater depth in the 5 drop tests. The average crater depth after five drops ranged from 4 to 7 feet in the two pilot test areas. The pilot test did include DDC with up to 10 drops per location, but required intermediate backfill of the craters after 5 drops.

5. An “Ironing Phase” of 2 drops at a height of 30 feet was adequate for compacting the soil around the primary DDC area after the 100-foot drops were conducted.

6. Dust, vibration and noise monitoring during the DDC operations indicated no significant issues.

Based Tetra Tech’s analysis of the 1995 DDC pilot test results, Tetra Tech has modified the DDC design criteria as follows.

1. Recommendation 1 above is unchanged.

2. Recommendation 2 above is changed to a 14-foot grid with a 26-ton weight and a drop height of 95 feet. This will apply a minimum of 85 tf/sf during the High Energy phase of the DDC, which is estimated to be sufficient to achieve the objective of the DDC work.

3. With respect to Recommendations 3 and 4 above, a reduction of elevation of up to 5-feet will be targeted using approximately 6 to 8 drops at 95 feet as described below in Section 3.0. Backfilling will occur after the High Energy phase, unless intermediate backfilling is required before all of the High Energy Phase drops are completed to help control emissions from the craters based on on-site monitoring.

4. The Ironing Phase in Recommendation 5 is adjusted from a drop height of 30 feet to 25 feet, based on consultation with DDC experts and vendors that this height will likely be sufficient to smooth the surface sufficiently for subsequent grading activities. Backfilling and compaction of the craters may be conducted by alternate means to assist in maintaining the schedule.

5. Recommendation 6 above is unchanged.

SECTION 3.0 DDC OBJECTIVE AND APPROACH

DDC will be performed on approximately 61 acres of the site, as shown on the attached Figure 4. These areas are where parking and new roads are planned over the existing trash. DDC operations will apply a certain amount of energy to the trash and overlying soils and will compress and consolidate these materials such that future differential settlement will be reduced. Per the 1995 pilot test and the DDC scope in the Design Construct Environmental Assurance Agreement, the minimum amount of energy to be applied during DDC operations is 85 ton-feet per square foot (tf/sf). It is anticipated that the project geotechnical engineer will randomly check DDC operations to confirm that the minimum amount of energy is applied. The DDC monitor will be selected and/or provided by the City of Carson or the Developer. In addition, records of all DDC activities will be provided on a monthly basis for review by the City of Carson.

The soil stockpile areas where excess soil will be temporarily stored as a result of any DDC preparation required is shown on Figure 4. These stockpiles will ultimately be the source of soil used in the backfilling of the craters and for achieving the rough liner grade.

DDC will be performed in two phases. The first, High Energy Phase, is designed to achieve the proposed compaction. The second phase, the Ironing Phase, is intended to smooth the landfill surface in preparation for the installation of the LLDPE geomembrane at the liner grade. Areas along the existing main roads that are on native soil material will be evaluated to determine if DDC should be applied up to the edge of the road, based on proximity of the edge of landfill waste to the road. In addition and to the extent practicable, DDC will be completed such that it overlaps approximately five feet under where future building pads will be constructed in the future.

The anticipated earth moving and DDC procedures are described below.

1. A land surveyor will initially stake the corners of the building slabs and parking areas prior to the commencement of preparation for DDC.

2. Prior to the start of the High Energy Phase of DDC, excavation will occur, where necessary, to reduce the landfill soil cover to approximately 4 to 6 feet in thickness. Excavated soil cover material will be stockpiled in non-DDC areas for eventual filling of craters created by DDC, for ground leveling, or for establishing the rough grade. DDC preparation activities are described in the Soil Management Plan (Tetra Tech 2008a).

3. Following site preparation as described in Item 1 and 2 above, the High Energy Phase of DDC will be undertaken in two steps, both using a 26-ton tamper with a 95-foot drop. The goal of the High Energy Phase is to apply a cumulative average energy of least 85 tf/sf over the areas shown in Figure 4. The first step of the High Energy Phase will consist of approximately 4 to 6 drops at the primary pass locations (see Figure 5). Each DDC location will be observed for possible exposure of trash during DDC activities. The drop points will be spaced about 14 feet apart on a square grid

pattern. Wherever the High Energy Phase creates a crater that exceeds 6 feet in depth before the anticipated numbers of drops are applied, the craters may be backfilled with soil to avoid exposing trash and minimize emissions, and then the remaining drops will be applied. If excessive crater depths occur, some of the drops in the first pass of the High Energy Phase may be moved to the second pass. Alternatively, the height of the first drops may be reduced, which might require the number of drops to be increased.

4. The second step (secondary pass) of the High Energy Phase involves the same procedure as described above with approximately 2 drops applied at a 14-foot grid spacing, but at points between the drop locations of the primary pass of the High Energy Phase.

5. After application of the second step of the High Energy Phase as described in Item 4 above, depressions or craters in the soil surface of the 61-acre area will be filled with soil and compacted in order to provide a smooth foundation for the subsequent backfilling or in preparation of the Ironing Phase prior to achieving the grade for the landfill cap geomembrane.

6. After application of the second step of the High Energy Phase as described in Item 4 above and grading in Item 5, a low level energy application called the Ironing Phase may be applied over most of the DDC area in order to prepare a relatively smooth surface for subsequent preparation of the foundation and installation of the geomembrane. The Ironing Phase will consist of 1 - 2 drops of a 15- to 25-ton tamper from a height of 15' to 25' or the use of a special ironing tamper designed to provide contact pressure at the base of the ironing tamper of approximately 600 to 800 pounds per square foot (psf). Standard forms of compacting the soils in the craters shall also be considered.

7. Surface elevations will be measured in the DDC areas at a grid spacing of 25 to 50 feet center to center before starting the High Energy Phase, before the Ironing Phase, and again after the Ironing Phase. The purpose of the surface elevation measurements is to assist in determining the amount of ground densification as a result of DDC. Periodic inspection and confirmation that the Work Plan objectives are being achieved will be completed by Carson Marketplace’s geotechnical engineering firm, Leighton Group.

8. Tetra Tech will perform vibration monitoring during performance of the DDC using an approach that is compliant with Section II, Mitigation Measure H-1 (as applicable), H-2 and H-3 of the Final Environmental Impact Report dated January 2006, including conducting the required Pilot Program before commencement of the actual DDC program. Vibration monitoring will be performed using a Blastmate III or a comparable monitoring system that has the ability to monitor a broad selection of vibration. Vibration monitoring systems will be in accordance with the approved Vibration Monitoring Plan. If unacceptable vibration impacts to nearby residents or others occur, Tetra Tech will respond by 1) reducing the energy applied over an area

by decreasing the weight incrementally and/or by using a smaller DDC drop followed by re-monitoring, and/or 2) moving further away from sensitive receptors followed by re-monitoring. As an option, an isolation trench between the DDC operations and the residents may be constructed to reduce vibrations. If this option is selected, the isolation trench will be constructed parallel to the Torrance Channel or streets depending on the soil/trash interface. The trench will be 5-foot wide and up to 8 feet deep. Vibration monitoring during performance of the DDC will be performed in accordance with the Deep Dynamic Compaction Vibration Monitoring Plan, (Tetra Tech 2008b).

9. Tetra Tech will incorporate into its planning documents and field work the requirements associated with complying with the Environmental Impact Report required Mitigation Measures. In addition, Tetra Tech will be responsible for addressing any neighbor complaints, and any nearby structural damages caused by the DDC.

SECTION 4.0 PILOT TEST

Prior to starting the full-scale DDC, a pilot test will be performed at three pilot test locations (see Figure 4). The test locations are within 500 feet of each other and are positioned near the Torrance lateral, streets, and limits of fill. Simultaneous testing at these locations will demonstrate a worst case scenario for combined conditions (noise, vibration, etc.). It is anticipated that the pilot test will occur for one week. The pilot test objectives are to confirm the most effective procedure for densifying the existing landfill deposits and to confirm that monitoring procedures (vibration, noise, dust, and emissions) are adequate. Field monitoring will include measurement of the depth of crater formation following each series of drops, the average ground loss during and following completion of the High Energy Phase and the Ironing Phase, the amount of ground heave at selected locations, temperature and methane readings for the locations where the craters penetrate into the former landfill, and vibration attenuation measurements. The recommended procedure for the DDC pilot test is presented below.

4.1 Site Preparation

Prior to starting the DDC pilot test, the ground surface will be adjusted to leave 4 to 6 feet of existing cap material over the estimated landfill trash interface. This may require excavations to reduce the cap thickness.

The ground surface will be shaped to a level surface so that the equipment can travel across the area safely and without problems.

4.2 Size and Location of Test Section

Each pilot test section will be approximately 100 feet (ft) x 100 ft (Figure 4). The proposed DDC energy application of 85 tf/sf will be applied over approximately half of this area. This will consist of using a 26-ton tamper with a 95-foot drop. Five drops will be applied at each primary drop point location and 2 drops at the secondary drop point location (Figure 5). The spacing between the drop points will be 14 feet center to center.

If the 95-foot drops produce large craters greater than 6 to 7 ft, the other half of the test section area will be densified using lower drop heights, but more drops in order to apply the same unit energy of at least 85 tf/sf.

4.3 Average Ground Loss

Prior to DDC, ground surface elevations will be surveyed at points 25-feet center-to-center to establish the existing average ground elevation.

After the first phase of the high level energy applied, the ground surface will be leveled with a front end loader or dozer, and then the ground elevation determined at the same survey point locations to determine the average loss in elevation. After the second phase of energy application is applied, the procedure will again be repeated. Finally, after the Ironing Phase, the ground will again be leveled to obtain the final ground loss.

4.4 Crater Depth Information

At each location, detailed crater formation information will be obtained. This will include survey measurements taken adjacent to the drop point at distances of 5, 10, and 15 ft beyond the edge of where the tamper will strike the ground. These monitoring points will be established in the northerly, southerly, easterly, and westerly direction from the point at which the tamper strikes the ground. The purpose of this monitoring is to determine the ground heave that occurs following each drop of the tamper.

The field procedure will consist of dropping the tamper once at the drop point location and then measuring the depth of the crater penetration. The elevation of the heave measurement points will then be obtained to determine the magnitude of ground heave. After this is completed, a second drop will then be applied and the procedure repeated. This will continue until all 5 drops have been applied.

4.5 Temperature and Methane Readings

Methane monitoring will be performed prior to soil cover penetration and/or if trash is exposed. Wherever the tamper penetrates through the soil cover and exposes the underlying trash, readings of ground temperature and methane will be obtained. This information will be helpful in determining the condition of the landfill and the potential for methane gas emissions during the DDC operations.

4.6 Subsurface Exploration

Before and after DDC is completed, three borings will be completed in each test section. The borings will be extended through the trash to help determine the relative density of the dynamically compacted trash. Samples and resistance measurements will be obtained at 2.5-foot intervals, nearly continuous, using split-barrel sampling procedures in accordance with ASTM specification D-1586 for a depth of 30 feet below the trash soil interface or to first water, which ever is shallower.

As the samplers are removed, temperature readings will be taken of the soil before removal from the split-barrel sampler.

For comparison, three borings before DDC will be completed within the test area to determine the standard penetration resistance values of the unimproved landfill deposit. Temperature readings will also be taken on the samples obtained from these borings.

4.7 Pilot Test Summary Report

After the pilot test is complete; a geotechnical engineering summary report will be prepared discussing the results of the pilot test measurements and recommend any modifications to the DDC design to achieve the goal of the High Energy Phase of applying a cumulative average energy of least 85 ton-feet per square foot over the anticipated DDC areas. Also, all monitoring activities will be verified to be appropriate, and modifications will be made, as necessary.
These evaluations will occur during and immediately after the pilot test and the results will be discuss orally with representative of the City, DTSC, and Carson Marketplace. Based on the

results of the oral discussions, DDC will continue. A draft report documenting the results of the pilot test, modifications, and oral agreements will be completed within two weeks following the pilot test.

SECTION 5.0 SCHEDULE

Three DDC rigs will be used and each rig is estimated to complete 0.25 acres per day. This is equivalent to 125 work days (approximately 5 months) including mobilization and completing the pilot test.

SECTION 6.0 MONITORING

Monitoring of vibration, noise, and dust will be conducted per the approved *Deep Dynamic Compaction Vibration Monitoring Plan* (Tetra Tech 2008b), *Noise Management Plan* (Tetra Tech 2008c), and *Fugitive Dust Control Plan* (Tetra Tech 2008d). Perimeter and work zone air monitoring will also be conducted per the approved plans (AQMD Rule 1150 Excavation Management Plan [Tetra Tech 2008e] and Air Monitoring Plan [Tetra Tech 2008f]) to ensure local residents and other city occupants are not adversely impacted by the DDC operations. Personnel air monitoring of the DDC workers and observers will also be conducted per the project specific Health and Safety Plan (Tetra Tech 2008g).

SECTION 7.0 EMISSIONS CONTROL

It is not anticipated that odors, noise, vibration, or elevated concentrations of air emissions (including dust) will create a public nuisance or impact human health or the environment. In the event that the standard provisions and procedures fail, resulting in odors or monitoring data shows that the measured concentration of pollutants exceeds action levels per the AQMD Rule 1150 Excavation Management Plan, excavation or soil disturbing activities will immediately be suspended. Action will be taken to determine the cause of the odor or elevated air emissions. Tetra Tech will implement immediate corrective actions including the application of water or foam on odor or emission sources, covering of exposed refuse with plastic sheets or soil cover, or application of other mitigation measures identified in Section 9 of the AQMD Rule 1150 Excavation Management Plan (Tetra Tech 2008b).

Excavation or other soil disturbing activities will not recommence until procedures have been modified or other permanent actions have been taken to correct the problems which resulted in exceedence of the action limits listed in the AQMD Rule 1150 Excavation Management Plan. Once procedural modifications or other permanent actions have been determined and put into place, excavation or other soil disturbing activities may recommence. To ensure that the procedural changes or other corrective actions were effective after the activity has restarted, monitoring must commence immediately. Re-evaluation of the modified procedures and the new monitoring results will determine if the corrective action was effective. The exceedence of the action limit, mitigation measure applied, procedural modifications or other permanent corrective action taken, and the monitoring data from the restart will be recorded on daily construction logs. Additionally, all site personnel will be informed of the procedural changes at daily tailgate safety briefings.

SECTION 8.0 REFERENCES

Arcadis BBL

2008. Physical Site Characterization Technical Memorandum. January.

Brown & Root Environmental

1995a. Final Baseline Risk Assessment for Cal Compact Landfill, Carson, California. August.

1995b. Final Remedial Action Plan, Cal Compact Landfill, Carson, California. October.

1995c. Final Remedial Investigation for Cal Compact Landfill, Carson, California. July.

Leighton Consulting, Inc.

2008. Draft Memorandum: Summary of Settlement Calculations for Refuse Cells at the Proposed Avalon at South Bay Development. February.

Tetra Tech, Inc.

2008a. Draft Soil Management Plan.

2008b. Draft Deep Dynamic Compaction Vibration Monitoring Plan, Former Cal Compact Landfill.

2008c. Draft Noise Management Plan.

2008d. Fugitive Dust Control Plan. February.

2008e. Rule 1150 Excavation Management Plan. January.

2008f. Draft Air Monitoring Plan.

2008g. Site Health and Safety Plan. February.

Woodward-Clyde.

1995. Deep Dynamic Compaction Test Data Report LA Metro Mall, Carson, California.

FIGURES

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N
W
E
S
405
110
Del Amo Blvd.
Main St.
Former
Cal Compact
Landfill
(Site)
City of Carson
Avalon Blvd.
Carson St.
0
500
1,000
1,500
Feet
AVALON AT SOUTH BAY
Vicinity Map
Jan.
2008
TETRA TECH
Figure
1

AVALON AT SOUTH BAY

Site Map

Jan. 2008

TETRA TECH

Figure 2

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N
W E
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Development Plan Date: September 17, 2007

Ref. Nadel 2005.

AVALON AT SOUTH BAY

Development Plan

Jan. 2008

TETRA TECH

Figure 3

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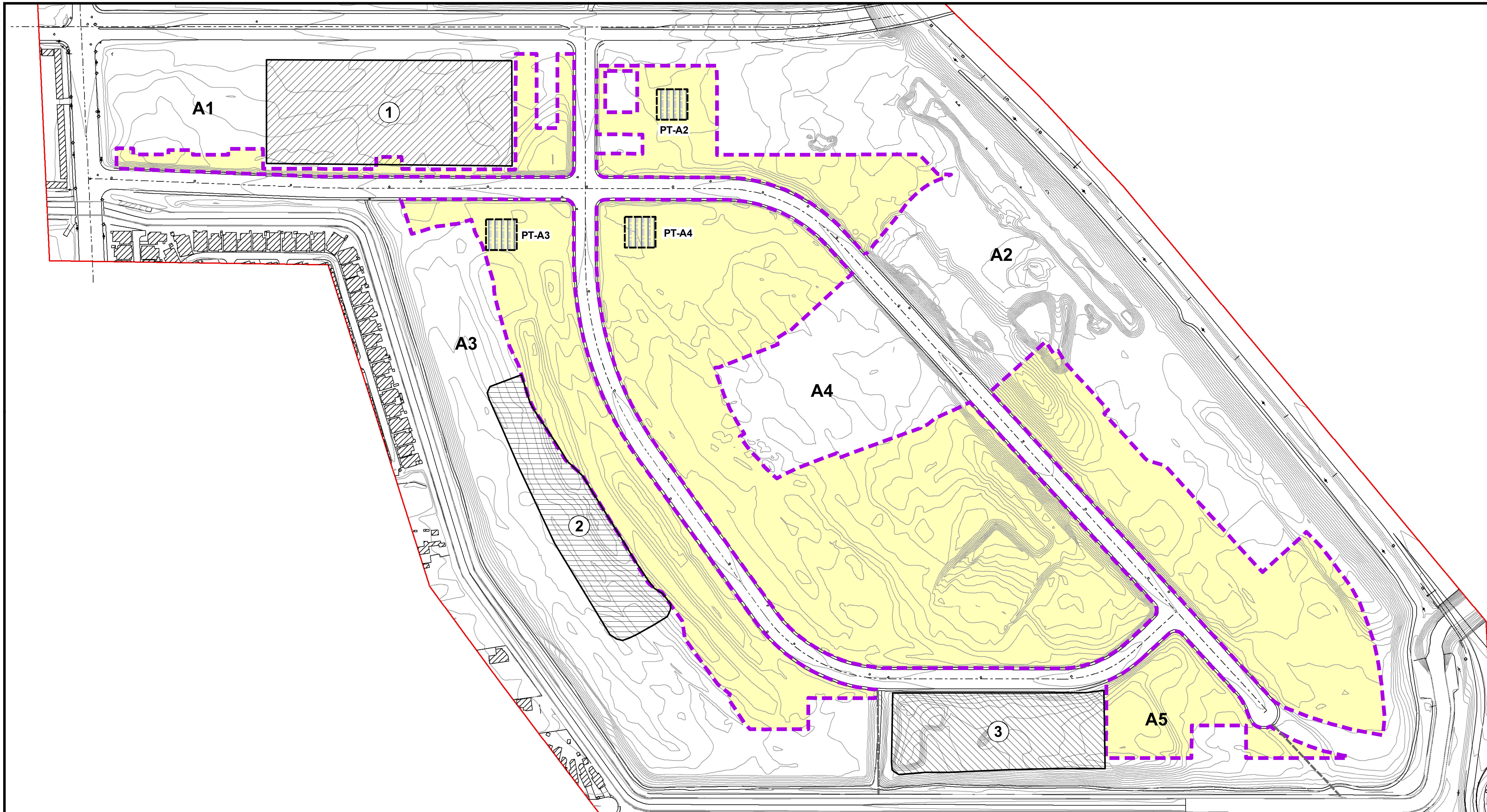

LEGEND

- DDC Pilot Test Areas (approx.)
- DDC Area
- North Stockpile Area — 1 — Stockpile area for storage of soil during DDC preparation and building pad grading
- West Stockpile Area — 2 — Stockpile area for storage of soil not meeting SMGs per Soil Management Plan. Soil to be placed under liner as backfill during DDC operations
- South Stockpile Area — 3 — Stockpile area for storage of soil during DDC preparation and building pad grading. This stockpile to be used last as Cell A5 will be graded last.

N

0 200 400
SCALE IN FEET

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SAN BERNARDINO, CALIFORNIA 92408
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TC # 21868.1.1.01		
DRAWN BY:	SH	02/18/08
CHECKED BY:		
APPROVED BY:		

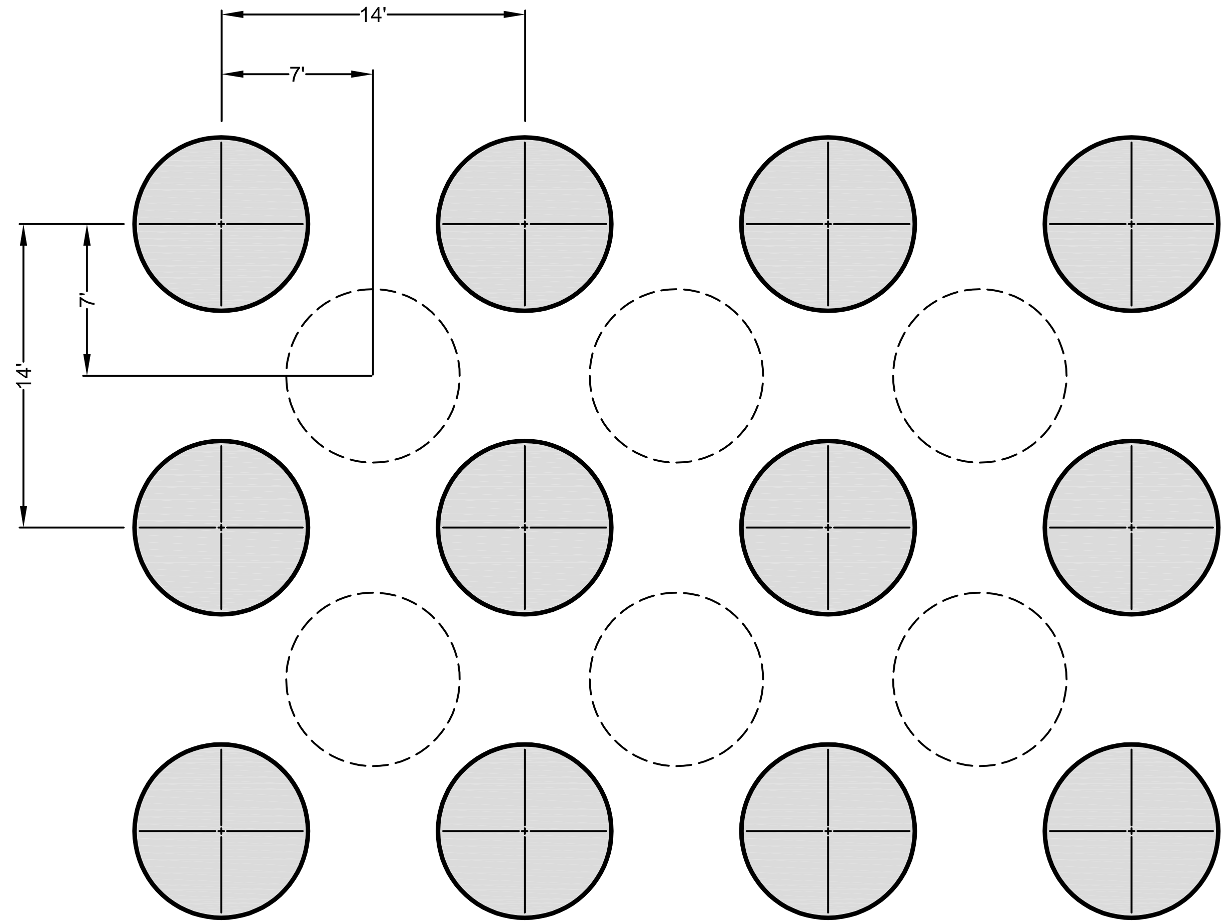
AVALON AT SOUTH BAY

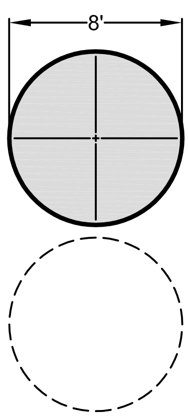
AVALON AT SOUTH BAY

Figure 4
DDC Areas

X:\GIS\CARSON-AVALON\CAD\DDC pattern.DWG

TYPICAL DROP PATTERN (14' GRID)





PRIMARY PASS:
5 DROPS FROM 100'

SECONDARY PASS:
2 DROPS FROM 100'

$$\frac{(5 + 2 \text{ DROPS})\ (100')\ (25.75 \text{ TONS})}{(14')\ (14')} = 92.0 \text{ FT-TONS/FT}^2$$

$$\text{COMPACTION DROPS} = \frac{(60 \text{ ACRES})\ (43{,}560 \text{ SF/ACRE})\ (7 \text{ DROPS/GRID})}{(14')\ (14')} = 93{,}343 \text{ DROPS}$$

$$\text{IRONING DROPS} = \frac{(60 \text{ ACRES})\ (43{,}560 \text{ SF/ACRE})\ (1 \text{ DROP/GRID})}{(7')\ (7')} = 53{,}339 \text{ DROPS}$$

AVALON AT SOUTH BAY

Figure 5

DDC Grid Pattern

APPENDIX A

REPORT

DEEP DYNAMIC COMPACTION TEST DATA REPORT LA METRO MALL CARSON, CALIFORNIA

Prepared for
Brown & Root
20400 Main
Carson, California 90745

Woodward-Clyde

2020 East First St., Suite 400
Santa Ana, California 92705

December 1995
Project No. 954E179

Woodward-Clyde

Engineering & sciences applied to the earth & its environment

December 8, 1995

Mr. Steve Smith
Brown and Root Environmental
20400 Main
Carson, California 90745

**SUBJECT: SUBMITTAL OF DYNAMIC COMPACTION TEST DATA REPORT
L.A. METROMALL PROJECT
CARSON, CALIFORNIA**

Dear Mr. Smith:

The accompanying report documents the completion of our Dynamic Compaction Testing at the two main test locations in the center cell and four isolated test locations closer to the western site boundary, as provided for in Task 1 of Subcontract #3102-001, dated October 19, 1995.

In brief, the accompanying report indicates that the Dynamic Compaction test program was effective in improving site conditions in the refuse areas and that the optimum energy for improvement was between 175 to 250 ton-ft. per sq. ft. This energy level is about 70 to 85 percent of that which was originally anticipated.

We trust that this report meets your needs at this time. Please call if you have questions.

Sincerely,

John A. Barneich, P.E.
Project Manager

REGISTERED PROFESSIONAL ENGINEER JOHN A. BARNEICH No. 017910 Exp. 6/30/97 CIVIL STATE OF CALIFORNIA

REGISTERED PROFESSIONAL ENGINEER JOHN A. BARNEICH No. 116 Exp. 6/30/97 GEOTECHNICAL STATE OF CALIFORNIA

JAB:jeo

Enclosures

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TABLE OF CONTENTS

TABLE OF CONTENTS
(CONTINUED)

LIST OF TABLES

LIST OF FIGURES

LIST OF FIGURES (CONTINUED)

LIST OF APPENDICES

1.0

INTRODUCTION

In accordance with the provisions of Task 1 of the Brown & Root Building Company subcontract #3102-001 dated October 19, 1995, a Deep Dynamic Compaction (DDC) test program was completed at the site of the proposed L. A. MetroMall development in Carson, California, as located on Figure 1. The scope of work performed as part of this program was in general accordance with the workplan dated September 7, 1995. This workplan was reviewed by the CAL EPA Department of Toxic Substances Control (DTSC) and in their letter dated October 31, 1995 they provided their acceptance. This final report is submitted to describe the test program conducted and to present the results and conclusions and recommendations developed based on the results of the program..

1.1 OBJECTIVES OF THE TEST PROGRAM

The objectives of the DDC test program are as follows:

- Evaluate compaction characteristics of the subsurface material at two locations within central landfill cell inside the loop roads to:

    1. evaluate the effectiveness of DDC to lower the elevation of the top of refuse;
    2. evaluate the effectiveness of DDC to reduce the compressibility of near surface refuse; and,
    3. develop production DDC procedures; including energy level requirements (tamper weight and drop height per unit area), grid pattern for one or more passes, and number of drops to achieve desired subsurface improvement.

DDC tests were also performed at other isolated site locations in the western landfill cell including areas progressively closer to the western boundary of the site.

- Obtain DDC production rates to estimate the cost of full-scale production.

- Evaluate potential fugitive dust, vibration, and noise effects from DDC on adjacent properties.

DDC tests were performed by dropping a 27-ton tamper weight with a "Thumper" crawler crane from heights of up to 105 ft at locations within Test Pads 9 and 10 and at other isolated other site locations (as shown on Figure 2). DDC parameters were varied to evaluate production design and procedures. The effectiveness of DDC was measured by conventional soil tests performed in borings drilled before and after DDC, by cone penetration tests, backhoe test pits, and by tamper impact velocity and crater depth measurements evaluated during DDC. Craters created from the impact of the tamper were backfilled with on-site soil. Particulate (dust), vibration, and noise measurements were made during the test program operations.

1.2 SITE DESCRIPTION

The L. A. MetroMall site was previously known as the Cal Compact Landfill. It is located at 20400 Main Street in Carson, California between Main Street and the San Diego Freeway (Interstate 405) just south of Del Amo Boulevard as located on Figure 1. The landfill encompasses an area of approximately 157 acres. Soil cover has been placed on the landfill and a paved loop road separates the central cell from the surrounding cells around the site. Based on previous investigations the soil cover is estimated to be between 5 and 20 feet thick.

The site has an irregular, roughly quadrangle-shaped configuration. Access to the property is from Main Street which is a portion of the western site boundary. The remaining portion of the western boundary, along with the southern boundary of the site, is defined by the Torrance Lateral Channel, a Los Angeles County flood control channel that flows eastward into the Dominguez Channel east of Interstate 405. The eastern side of the property is bounded by the San Diego Freeway (Interstate 405). The northern boundary of the site is Del Amo Boulevard.

Prior to landfill operations, the site was undeveloped with a gently rolling terrain. Surface elevations on the site prior to landfill usage ranged from 7 to 21 feet above Mean Sea Level (MSL). Landfill operations modified surface elevations and changed the surface water drainage patterns.

Cal Compact, Inc., a California Corporation, was issued an industrial waste disposal permit on July 17, 1959, which authorized Cal Compact to operate a Class II landfill on the site. The landfill was in operation from April 1959 until about December 1964. The approximate date of closing of landfilling operations was reported to be February 1965. During the period of landfill operation, an estimated 6.2 to 6.3 million cubic yards of municipal solid waste and 2.6 million barrels (unit of measure, not a container, equivalent volume 540,540 cubic yards) of liquid industrial waste were disposed of at the Cal Compact landfill. There are no records documenting the disposal of drummed liquids in the landfill. Adjacent land areas have also been similarly used for landfill operations.

The current surface elevations at the site range from about El. 36 above MSL in the central cell to between El. 19 and El. 58 above MSL in the outer cells. The average relief on the site is about 25 feet with the higher elevations in areas of stockpiled soil and other materials. Except where recent settlement has altered conditions, the drainage at the site is towards the roads and the property boundaries.

The site has been vacant and basically unused since closure of the landfill in 1965. Ground surfaces at the site are currently unpaved except for the loop (haul) roads and covered with a light growth of native weeds and scrub vegetation. The City of Carson has extended Del Amo Boulevard eastward across the northern portion of the site. Three trailers are present on-site and are used for field offices.

1.3 REPORT ORGANIZATION

The report is organized to present the results of the test program and to provide discussion and analysis of the results to assist in designing the production compaction operations. Data collected during the program are presented in Appendices and summarized in the report.

A brief summary of Dynamic Compaction is provided in Section 2, the test procedures and program is described in Section 3 and the results summarized in Section 4. Environmental monitoring conducted during the test program is described in Section 5. Results of the test program are discussed in Section 6 and Section 7 contains the conclusions and recommendations. Factual data upon which this report is based are contained in Appendices A through I as follows:

APPENDIX	DESCRIPTION
A	Dynamic Compaction Procedures
B	Dynamic Compaction Test Records
C	Boring Logs
D	CPT Logs
E	Trench Logs
F	Vibration Monitoring
G	Noise Monitoring
H	Dust Monitoring
I	Chemical Test Data

2.0

BACKGROUND OF DYNAMIC COMPACTION

Dynamic compaction is defined as the densification of soil deposits or other placed materials, such as landfill, by means of repeatedly dropping a heavy weight onto the ground surface. This process has also been called by other names including heavy tamping, impact densification, dynamic consolidation, pounding, deep dynamic compaction, and dynamic precompression. Most dynamic compaction is undertaken with weights ranging from 6 to 30 tons although weights as light as 2 tons or as heavy as 100 tons have been used. The drop heights generally range from 50 to 100 ft but projects have been undertaken with drop heights as low as 15 ft and as high as 120 ft.

For weights up to 20 tons and drop heights up to 100 ft, the weight is generally lifted and dropped by a conventional crane using a single cable with a free spool to allow a near free fall drop. Figure 3 shows a 125-ton capacity "Thumper" machine lifting a 27-ton weight to a height of 100 ft . For the heavier weights (greater than 20 tons) either conventional equipment is altered to reinforce certain components or specially designed equipment is used to lift and drop the weight. The "Thumper" shown in the photograph on Figure 3 is specially designed for deep compaction purposes. It uses a single-pulley drop mechanism that allows efficient delivery of the drop energy.

Densification of the subsurface materials is achieved because sufficient energy is applied to the ground to cause one or more of the following effects to occur:

- Densification of partially saturated soil in a manner similar to that which occurs when performing laboratory impact compaction by the Proctor method.
- Restructuring of the soil grains into a denser packing at a lower water content. In saturated or nearly saturated soils, excess pore water pressures develop on impact, and occasionally the soils liquefy. Following dissipation of the pore water pressures, the properties of the soil improve.

- Collapse of voids within the soil deposit that have been formed as a result of bridging or other mechanisms. In this case the void would be an opening other than the normal void space between soil particles.

The type of densification that occurs on any project depends upon the underlying material and the degree of saturation of the deposit. In a landfill such as MetroMall site, the material is partially saturated, situated well above the water table, and placed to unknown density conditions. Densification is due primarily to collapse of voids in the placed material and compaction.

In addition to soil property improvements resulting from a decrease in void ratio, large lateral strains are induced in the material mass adjacent to the impact points resulting in an increase in the coefficient of horizontal earth pressure and soil modulus. In effect, creation of a highly densified upper layer following dynamic compaction acts as a mat to help distribute the stresses transferred to the underlying deposit much the same way as a subbase layer distributed load beneath a pavement. In the case of a dynamically compacted soil, the stiffened upper layer can be as much as 20 to 25 ft in thickness, as opposed to a normal subbase of only 12 to 24 in. in thickness.

There are significant differences between dynamic compaction and conventional fill compaction. Some described below help illustrate dynamic compaction.

- In conventional compaction, the soil is placed at a water content near the optimum for compaction as determined by ASTM or other standards and then placed in thin lifts usually less than 12 in. in thickness and compacted to a desired density. In dynamic compaction, the deposits are compacted throughout the entire thickness from ground surface at their prevailing water content.

- The depth limitation of conventional compaction is generally on the order of 2 ft, although large vibrating compactors have produced densification to about 6 ft depth in granular soils. With dynamic compaction, improvements to depths of 20 ft or more can be achieved.

- Dynamic compaction has been used on deposits containing large particles, such as broken concrete or boulders, and miscellaneous material as found in a landfill. Conventional compaction is restricted to particle sizes smaller than about 6 in.

- During dynamic compaction in saturated soils, especially fine sands or silts, high excess pore water pressures develop. These may be sufficiently high to cause water to boil or emerge from the ground until the pore pressures decrease. The soil structure rearranges into a denser state of packing after the dissipation of the pore pressures. This type of densification is similar to that which occurs by vibroflotation or blasting rather than by conventional compaction.

2.1 ADVANTAGES AND DISADVANTAGES OF DYNAMIC COMPACTION

2.1.1 Advantages

Dynamic compaction is becoming increasingly utilized for subsurface improvement because it offers certain unique technical and economic advantages. These include but are not limited to:

- The equipment required to undertake dynamic compaction is relatively simple and consists primarily of a weight and crane. In recent years special cranes have been designed to implement dynamic compaction for efficient energy delivery to the ground and to manage cable and drum wear.

- Impacting of the weight into the ground serves as both a probing and a correcting tool. If weak ground conditions are present in localized areas, the weight will penetrate further into the ground causing large crater depths. This provides the field engineer with immediate feedback on ground response. A decision can then be made regarding further energy application in this area or other steps appropriate to remedy the conditions found.

- The effect of densification can be observed as the work is proceeding. This ground response can be used as a guide for the field personnel implementing dynamic compaction. The depth of the initial craters plus decreasing depth with successive passes is an indication of the resistance of the ground. Also, the average ground settlement which takes place following each pass over an area provides an indication of the overall amount of improvement being achieved.

- Dynamic compaction can be applied over a fairly wide range of deposits ranging from large boulders and broken concrete to silt size formations containing a small percentage of clay. Deposits that formerly were thought uncompactable or not controllable, such as building rubble debris or sanitary landfills, can be compacted by this process without the burden of handling and exposing the underlying material to any great extent.

- Densification usually results in a stratum having a more nearly uniform compressibility, thereby minimizing differential settlements. Weaker zones within the deposit undergo the most improvement thereby eliminating zones of potentially high compressibility.

- The costs of dynamic compaction are generally significantly less than other forms of equivalent site improvement or alternate forms of construction such as excavation and replacement using conventional compaction equipment.

- Dynamic compaction of deposits can be undertaken in inclement weather conditions.

2.1.2 Disadvantages

Some of the disadvantages of dynamic compaction are:

- Heavy tamping produces ground vibrations which can travel significant distances from the point of impact. In congested areas this may require limiting the dynamic compaction to areas well within the property lines, reducing the drop heights, or taking other appropriate measures to mitigate the effects of these vibrations. At the L.A. MetroMall site, this effect is reduced because the landfill more effectively attenuates ground motions with distance.

- The position of the water table has an influence on the dynamic compaction operations. If the imparted energy is delivered to saturated material, a rising of the water level may be observed. At the L. A. MetroMall site this is not a concern as the water is reported to be on the order of 50 ft deep.

- The compacted soil reduces the average surface elevation and may require import of soil to reach project grades. This is generally offset by settlement that would have occurred if dynamic compaction were not implemented.

- Lateral ground displacements of several inches (1 to 3 inches) have been measured at distances of 20 ft from the point of impact of heavy tampers. Utilities or buried facilities situated within the zone of influence could be displaced or damaged. At the L.A. MetroMall site, this is not a concern because existing utilities are in adjacent native soil roadways which serve to protect the utilities.

3.0
DYNAMIC COMPACTION TEST PROCEDURES

3.1 GENERAL

The dynamic compaction test program was performed at the site from November 6 through November 17, 1995. The purpose of the test program was to evaluate DDC design parameters (drop energy, spacing, cratering depth, sequencing) in order to provide input for the design of a production DDC program, as well as to assess environmental considerations including noise, vibration, and fugitive dust. The test program was performed in general accordance with the program laid out in the workplan dated September 7, 1995.

The two main dynamic compaction test pads (designated DDC 9 and DDC 10) were located in the center cell of the site as shown on Figure 2. Each of these pads measured 100 ft by 100 ft in area and was oriented generally northwest to southeast. DDC 9 was located as originally proposed in the work plan. The location of DDC 10 was moved 200 feet northwest of the originally proposed location due to excessive soil cover thickness and topography constraints. A third small test area, designated DDC 9b, was located about 18 feet west of DDC 9 to evaluate a tighter drop spacing. Three isolated DDC tests, designated DDC 12, DDC 13, and DDC 14, were located in the western cell of the site. These location are also shown on Figure 2.

The DDC test program was conducted by Geo-Con Inc. who arranged the equipment and sub-contracted with Lampson, who provided the dynamic compaction "Thumper" and operators. Mobilization and assembly of the test equipment occurred during the week of October 31, 1995. The drop apparatus consisted of a model Lampson Dynamic Compactor LDC 350 or "Thumper" as shown on Figure 3. For the MetroMall test program, an 8-foot diameter, 55,200 pound (27.6 tons) tamper weight was used to achieve the range of drop energies to be tested.

A Caterpillar D6L bulldozer was used to grade access roads and prepare the test pads. In addition, a John Deere 710C backhoe was also used for crater backfill as well as for excavating test pits for pre- and post-DDC test subsurface observations. A 2,000-gallon water truck was used for dust control of the test areas. Additional details of the dynamic compaction program are presented in Appendix A.

3.2 TEST PAD CONFIGURATIONS

Following layout of the corner points (with 50 foot offsets) of the two main test pads by surveyors from RBF, the subsurface conditions at test areas DDC 9 and DDC 10 were each investigated with a hollow stem auger boring, multiple CPT soundings, as well as several backhoe test pits. The locations of the auger borings and SPTs for both main test pads are shown on Figure 4. The hollow stem auger borings, CPT soundings, and test pits are discussed in more detail in Appendices C, D, and E, respectively. The purpose of the pre-DDC subsurface investigation was two-fold; first to better estimate the thickness of the soil cover above the refuse, and second to develop baseline data regarding the conditions and density of the refuse.

Based on the thickness of soil cover encountered the test areas were graded to generally achieve the proposed soil cover thickness of 5 to 7-1/2 feet for the test, and to develop a level pad required for the operation of the "Thumper". Based on the results of this investigation only minor grading with the bulldozer was required at Test Pad 9 to meet these criteria. At DDC test pad 10 the pre-DDC subsurface investigation indicated that approximately 8 to 11 feet of soil cover existed beneath the relocated pad. Therefore, removal of 3 to 4 feet of soil cover was required during pad preparation to achieve the soil cover thickness proposed for the DDC testing

Following grading, the test pad corner points were re-established from the 50-foot offset stakes using a 200-foot tape. The test pad was then divided into four numbered sections, and the drop patterns were then laid out in each section using blue flagging following the guidelines in the work plan, which were modified as necessary to accommodate actual field conditions. Individual drop locations were labeled with an alpha-numeric system based on grid location, i.e., A-1. Secondary drop locations were distinguished with a subscript "s" following the alpha designation. The pad layout for DDC test pad 9, including the alpha-numeric grid system, is illustrated on Figure 5. The subsurface investigation locations for pad

9 are shown on Figure 6. The pad layout for DDC test pad 10 is illustrated on Figure 7. Table 1 provides a summary of the test pad layouts and procedures for ease of reference.

In addition to the main areas, DDC test pad 9b was laid out to evaluate the potential ground improvements from a tighter drop spacing of 13-foot on center. This test included four primary drop locations and one secondary location as shown on Figure 8. Isolated drops were performed in three locations within the western cell as shown on Figure 2. DDC 12 consisted of two drop points spaced 15 feet apart, which were located about 100 feet west of the existing loop road. DDC 13 was located about 35 feet west of DDC 12. Access to areas for other isolated drops was limited by the highly irregular topography resulting from settlement within this cell. DDC 14 was located about 450 feet southeast of DDC 12.

Prior to the start of dynamic compaction a 150-foot radius exclusion zone was established around the perimeter of the test pads with yellow caution tape.

3.3 DROP PROCEDURES

Following test pad grading and layout, the "thumper" was moved to a test pad and aligned on a corner drop point. At the first drop location of each of the test areas the drop height was gradually increased in 25-foot increments to the test drop height of 100 or 105 feet. This incremental drop procedure allowed for evaluation of crater depth, ground vibration response, and the environmental parameters as drop energy increased with drop heights. The incremental drop heights were marked on the lift cable in high visibility paint. The drop weight of 55,200 pounds (27.6 tons) was not varied throughout the test program.

In general, the preferred test sequence was for the thumper to start at a corner of a test section then step backwards compacting two rows in parallel (i.e. A-1 and A-2, then B-1 and B-2, etc. as shown on Figure 6 for DDC test pad 9) before moving over to the adjacent rows. The primary drop sequence was completed first in a section, followed by the secondary drops if needed. The drop procedures used in the four sections of a test pad were varied with respect to drop spacing, drop height, number of drops, and backfill sequence. The test pad configurations for test pads 9, 10, and 9b, are shown on Figures 6, 7, and 8. The drop height, number of drops and backfill sequence are also summarized on Table 1. Details of the sequencing are presented in Appendix A.

Crater backfill was completed by the dozer or backhoe using materials stockpiled during test pad grading or from nearby topographic high spots. Dust control was accomplished with a 2000-gallon water truck to water the test areas, craters and soils used to backfill the craters. Following completion of a test area the loose crater backfill was improved with an "ironing pass", consisting of two drops from a height of 30 feet with a spacing of about 8-feet on center.

3.4 MEASUREMENT PROCEDURES

During the DDC testing, records were kept for drop sequence, cumulative crater depth for each drop, crater diameter, and other pertinent observations. A typical crater, located in section 3 of DDC 10, is shown on Figure 9. In addition, heave tests were performed at several locations in order to calculate the efficiency of the drop sequence. The velocity of the weight at impact was also recorded with video methods for several drops at test pad 9. Post-DDC investigations consisting of borings, limited CPT soundings, and test pits were also performed. The following sections summarize the measurement procedure. Details of the measurement procedures are provided in Appendix A.

<u>Crater Depth</u>

Cumulative depth of cratering was typically measured by the thumper operator observing footage marks on the DDC weight and suspending cables. Following a drop the operator would take up the slack in the cable and observe, from the cab of the "thumper," reference marks on the weight assembly versus the edge of the crater. The operator typically estimated the average depth when the weight landed at an angle. Periodic checks of the crater depths with tape measure or stadia rod indicated that this measuring procedure was accurate to about one-half-foot. Estimated crater depths were then communicated by radio from the "thumper" operator to a Geo-Con technician who recorded the data. The DDC field records are presented in Appendix B.

Heave Tests

During the DDC Test Program, heave tests were performed to assess the efficiency of the DDC opreation. Three separate tests were performed to account for different depths of soil cover and drop sequences. Test #1 was performed in DDC Test Area 9, Section 3, Drop Point C-6 as located on Figure 5. Tests #2 and #3 were conducted in DDC Test Area 10: Test #2 in Section 4, Point G-4 and Test #3 in Section 1, Point B-2 as shown on Figure 6. The heave was measured in the circular area surrounding the targeted drop point, which was divided into four orthogonal quadrants marked with four control points each, producing 16 vertical displacement measurement locations per drop sequence.

Tamper Velocity

The velocity of the tamper at the moment of impact was measured to evaluate crane drop efficiency as well as to calculate the soil/refuse resistance force and pressure. To measure the impact velocity, a 20-foot-long section of PVC pipe was marked at 1 foot intervals and vertically mounted about 40 feet away from three tamper impact locations and tamper drops from 100 feet were recorded with a conventional video camera from a distance of about 150 feet. From this measurement, the average tamper velocity over the final 10 feet of fall for the 30 recorded tamper drops was calculated.

Post-DDC Subsurface Investigations

Following completion of the Test Pads 9 and 10, post-DDC subsurface testing was performed to evaluate the ground improvements achieved. The post DDC testing consisted mainly of hollow stem auger borings along with test pits. Only two CPT soundings CPT-59 and CPT-60) were completed at Test Pad 9, because a CPT cone was broken and lost upon encountering debris within the refuse and Gregg Drilling (the CPT sub-contractor) opted to discontinued testing. A summary of the pre- and post-DDC investigations is presented in Table 1. The logs of the borings are presented in Appendix C, the CPT records are presented in Appendix D, and the test pit logs are presented in Appendix E.

4.1 DEPTH OF CRATERING

4.1.1 Test Pad DDC 9

As discussed in Section 3.1, DDC 9 required only minimal grading to achieve a level test surface. The soil cover exposed at the surface consisted of dry, sandy silt. Cratering depths for five tamper drops from a height of 100 feet ranged from 4 to 6-1/2 feet in sections 1 and 2 of DDC-9. Similar depth ranges were observed for the subsequent 5 tamper drop sequences following crater backfill. In sections 3 and 4 of DDC 9, the drop height was increased to 105 feet and similar cumulative crater depths of 5 to 6-1/2 feet were observed. In section 3, no intermediate backfill was performed after 5 drops, and the cumulative crater depth for 10 blows ranged from 7-1/2 to 10 feet, an increase in crater depth of 2 to 4 feet. In general, crater diameters observed in DDC 9 following 10 to 15 drops generally ranged from 12 to 14 feet. These dimensions indicate that the crater volumes range from 12 to 21 cubic yards for 5 drops, and from 22 to 35 cubic yards for 10 drops.

Plots of average incremental tamper penetration versus number of drops for each section of DDC 9, shown on data sheets in Appendix A, indicate that penetration generally decreases with increasing number of drops as shown typically on Figure 10. Some of the test data plots of penetration versus drop number indicated a slight increase in penetration after leveling off at progressively higher number of drops indicating potential heave as shown on Figure 9.

4.1.2 Test Pad DDC 10

The pad preparation for DDC 10 involved removing 3 to 4 feet of the dry surface cover which exposed moist, sandy silt to silty clay. Cratering depths varied slightly for DDC 10 depending on the thickness of soil cover and sequence of tamper drops. In section 3, underlain by 7-1/2 feet of soil cover, 5 drops from 100 feet produced craters ranging from 4 to 7 feet deep. An additional foot of depth was added for the two additional drops prior to backfill. The thumper operator reported heave on the order of 2 to 3 feet high in the southwest corner of section 3.

In section 4, which was underlain by 5 feet of soil cover, 5 drops from 100 feet produced craters 4-1/2 to 6 feet deep, with the two additional blows producing an increase of about 1/2 foot in crater depth. In section 2 of DDC 10, underlain by about 5 feet of soil cover, the drop height was increased to 105 feet with no intermediate backfill. The crater depths ranged from 4 to 5-1/2 feet for 5 tamper drops and 7 to 9 feet for 10 drops. These dimensions indicate that the crater volumes range from 12 to 20 cubic yards for 5 drops, and from 22 to 32 cubic yards for 10 drops.

Data plots in Appendix A, provide a summary of the average incremental tamper penetration versus number of drops for each section of DDC 10. In general these curves indicate that after 2 to 3 tamper drops penetration typically levels off at about 1/2 foot per drop. As observed at DDC 9, there is an upward trend in penetration in the last few drops of a sequence.

4.1.3 Heave Test Results

The measurement of circumferential heave at three test locations is described in Appendix A. The results of heave measurements are presented in Figures 11 through 14. Figures 11 through 13 compile the heave measured along each of the radial measurement lines for Heave Tests #1, #2, and #3, respectively. Also shown on these figures is the average heave at each radial measurement distance. Figure 14 shows the variation of DDC efficiency, represented as "crater efficiency" described below, with the number of drops.

The efficiency of DDC was evaluated by comparing the volume of the crater created by the dropped weight with the volume of material displaced by heaving. Crater and heave volumes were estimated using guidelines presented by FHWA (1986). Crater volume, V_c, was estimated by:

$$V_c = \left(\frac{\text{Dbase} + \text{Dtop}}{2}\right)^2 \left(\frac{\pi}{4}\right) H$$

where

D_{base} is the diameter at the base of the crater

D_{top} is the diameter at the top of the crater

H is the depth of the crater

D_{base} was assumed to be equal to the weight diameter (8 feet); D_{top} was measured during the heave tests; and H was estimated by crane operator (as described in Section 3.4).
Heave volume, V_h, was estimated by:

$$V_h = hl\pi(l/3 + r)$$

where

r=radius at top of crater
h=extrapolated maximum height of heave at edge of crater
l=width of heave from edge of crater to point of no heave

The "crater efficiency," Eff_c, was defined as:

$$Eff_c = \left(\frac{V_c - V_h}{V_c}\right)$$

Using this definition, the efficiency of DDC decreases as the heave volume increases or as the crater volume increases. If no heave occurs, the efficiency is 100 percent.

As described in Appendix A, backfill was placed in the crater during heave tests. To account for this added material in efficiency calculations, two approaches were used. In the first method, the volume of backfill was added to the crater volume to obtain a cumulative crater volume, which in turn was compared with the cumulative (or total) volume of heave. The other method used the change in heave volume (incremental heave) between backfills and the incremental crater volume (also between backfills).

The variation in crater efficiency, as defined above, with the number of drops is shown on Figure 14. Data on Figure 14 include both methods (incremental and cumulative) of accounting for backfill. Approximate ranges for crater efficiency using each method also are shown. The data shown in Figure 14 suggest that reductions in crater efficiency tend to taper off slightly as the number of drops increases. After an initial 5 to 7 drops (i.e., no backfill), the efficiency ranged from 88 to 93 percent (for both cumulative and incremental methods). After one to two backfills and 15 drops, the efficiency using the cumulative volume method dropped to between 75 and 82 percent, and the efficiency using the incremental method dropped to between 64 and 67 percent.

4.2 SUBSURFACE CHANGES

Following completion of the dynamic compaction at DDC 9, DDC 9b, and DDC10, borings, limited CPT's, and test pits were performed to evaluate the vertical and lateral effects of the compactive efforts. The following sections discuss the observations made in each area.

4.2.1 DDC Test Pad 9 and 9b

Two borings (DDC9-2 and DDC9-3), two CPT soundings (WCCPT-59 and 60), and three test pits were performed at DDC 9 following dynamic compaction, as shown on Figure 6. The data from the borings and CPTs, which were located near the center of individual drop points, have been summarized on Cross Section DDC A-A′, Figure 15, oriented from south to north across the test pad. In general, this data indicates that the top of refuse was lowered approximately 3 to 4 feet by the compactive effort from the DDC. Stick logs of the pre- and post-DDC borings along section A-A′ alignment, presented on Figure 16, also illustrate that the refuse was compressed following the test. However, due to the extreme heterogeniety of the refuse, SPT N-values are quite variable and apparently elevated intermittently by debris in the refuse. Figure 17 provides a summary of cumulative tip resistance versus depth for the three deep pre-DDC CPT soundings (WCCPT-1, 2, and 17). Figure 18A compares the cumulative tip resistance of WCCPT-2 and WCCPT-60 (post DDC), performed about 10 feet apart in section 1 of pad 9. This plot suggests that the resistance in the refuse was improved in the post-DDC CPT test. The raw cone resistance values for WCCPT-2 and WCCPT-60 are superimposed on Figure 18B.

The subsurface conditions observed in test pits DDC9-2A and DDC9-2B, located in section 2, indicate that the top of refuse may have been locally heaved by the compactive effort. As shown on TP DDC-2A, Figure 19A, the refuse is depressed about 7-1/2 feet below craters F-1 and F-2. However, the area between the tamper drops exposed refuse only 1-1/2 feet below ground surface (bgs). Section 2 was subjected to a high energy drop pattern of 15 drops spaced on 15-foot centers, with a secondary pass of 10 blows on the same spacing. Test Pit DDC9-3A, located in section 3 (which was improved with 10 blows on 15 foot centers with a 5 blow secondary pass), exposed refuse at a depth of 9 to 11 feet bgs with a small lens of refuse about 5 feet bgs between the two craters as shown on Figure 19B.

Three in-situ density tests performed at DDC 9 (as shown on Figure 6) following the ironing pass, indicate that this final pass compacted the soil cover to an average of about 90 percent relative compaction (relative to ASTM Test Method 1557.).

Below DDC 9b, which was tested with 10 blows on 13 foot centers with a 5 blow secondary pass, refuse was observed to be uniformly about 8 feet bgs in TP DDC9B-1. This depth of refuse is about 3 to 3.5 lower than the depth of refuse prior to DDC testing. The refuse under the approximate location of the secondary drop did not appear to be elevated.

4.2.2 DDC Test Pad 10

Three borings (DDC10-2, DDC10-3 and DDC10-4) and test pit DDC10-1A were performed following the test at DDC 10 as shown on Figure 7. The data from the pre- and post-DDC subsurface investigation have been summarized on two cross sections DDC-10A-A' and DDC-10B-B' through the test pad. Cross section DDC 10A-A' (Figure 20), oriented north to south across the pad, shows that at boring DDC10-4 the refuse has been depressed about 4 feet. However, near the center of the test pad in Section 3, the refuse appears to have been compressed about 11 feet. Cross section DDC 10B-B' (Figure 21), oriented west to east, illustrates that the refuse is also apparently depressed about 9 feet beneath boring DDC10-3 located in section 4. Unfortunately, no CPTs for additional correlation were performed in DDC 10 because of the lost cone in DDC 9. Figures 22 and 23 present stick logs of the borings at DDC 10. Boring DDC 10-1 apparently encountered significant amounts of wood and other debris which caused excessively high SPT n-values (refusal at 50 blows generally after 3 to 5 inches). Therefore, correlation of DDC 10-1 SPT values with those from Borings DDC 10-2 and DDC 10-3, which encountered much less debris and had lower n-values, are not meaningful. Test pit DDC10-3A indicates that the refuse was compressed about 3 feet in section 4 of test pad 10.

4.3 ENERGY EFFICIENCY

The average impact velocity of a tamper dropped 100 feet with the crane used in this test program is about 79 feet per second (53.9 MPH). Since the tamper does not fall freely, i.e. it has to unwind the hoist cable and thereby rotate the drum in the crane, a crane drop efficiency factor has been introduced. If the tamper were to fall freely (in the absence of frictional forces created by the crane) from a height of 100 feet, the velocity at the moment of impact would be 80.2 feet per second (54.7 MPH). The crane drop efficiency is defined as the square of the ratio of the actual impact velocity to the free-fall impact velocity. Using this definition the efficiency factor for the crane used in this test program is about 0.97.

5.1 GENERAL

Vibration, noise, fugitive dust (particulate), and health and safety monitoring was performed at the LA MetroMall site during the test programs. Vibration, noise, and fugitive dust monitoring was performed to address the environmental effects of DDC related activities on adjacent properties. Health and safety monitoring was performed to protect field personnel from hazards related to the DDC testing, hollow-stem auger drilling, cone penetrometer drilling, and trenching. The following sections describe the results of the environmental monitoring.

5.2 VIBRATION MONITORING

The objectives of the vibration monitoring were (1) to measure ambient vibration amplitudes near the surrounding residences; (2) to measure DDC test vibration amplitudes near residences at varying distances from the tamper drop; and (3) to estimate the maximum DDC vibrations levels during construction compared to ambient vibration levels at the site boundary closest to the residences. The locations of the vibration receptors are shown in Figure 24. The details of the vibration monitoring are presented in Appendix F.

Ambient vibration levels were measured by conducting 4 short-term measurements at the site boundary and 3 short-term measurements at locations adjacent to roads within the residences. Along the site boundary in the absence of vehicular traffic, results show that vibrations were below those that could be measured by the vibration system. That is vibration levels were below a peak velocity of 0.00001 inches per second (ips). Ambient vibration measurements created by vehicular traffic showed peak velocities which ranged from 0.0005 to 0.05 ips. The highest peak velocity measurements were from larger sized vehicles (i.e. cement truck, trash truck, and school bus). The dominant frequency for these measurements ranged from 4 to 40 Hertz.

Approximately 300 tamper-drop vibrations were measured at various locations during 3 days of DDC testing. As expected, the DDC vibration levels increased at decreased DDC area to receptor distances. The dominant frequency for these measurements range from 2.6 to 11.6 Hertz. The City of Carson Vibration Ordinance maximum peak velocity of 0.01 ips is reached when the tamper is dropped from a height of 100 feet at a distance of approximately 1450 feet away from the receptor. At distance of 420 feet, the peak velocity is about 0.05 ips which corresponds to the maximum peak velocity of ambient traffic measured. At a distance of 230 feet, the peak velocity is about 0.1 ips which corresponds to the upper limit of what is judged to be "easily noticeable to persons". Thirty of the tamper-drops measured exceeded the City Ordinance 0.01 ips vibration level at the west side of the channel near the residences (maximum particle velocity was 0.04 ips), and no complaints were filed with the City. Maximum ambient vibration levels also exceed the City Ordinance 0.01 ips vibration level (maximum particle velocity was 0.05 ips).

5.3 NOISE MONITORING

Noise monitoring was conducted to evaluate the effects of DDC testing on the ambient noise environment in the noise-sensitive residential areas adjacent to the site. The specific objectives of the noise monitoring program were twofold: 1) determine the existing baseline environmental noise levels on and near the site prior to DDC testing; and 2) determine the noise levels generated by the DDC testing and their potential effect on the adjacent residential neighborhoods. The locations of the monitoring equipment are shown in Figure 24. The details of the noise monitoring are presented in Appendix G..

Baseline noise levels were identified by conducting eight short-term and two 24-hour noise measurements along the site boundary adjacent to the residential land use. These measurements were made before the DDC testing activity commenced. Based on the short-term measurements the ambient daytime noise level in the adjacent residential areas is 50 dBA. This background noise level was confirmed by both of the 24-hour measurements which reported average noise levels of 51 dBA for the 24-hour period. These background, ambient noise levels are typical for suburban residential neighborhoods.

Noise was also measured during three days of DDC testing. The measurements were made at several locations in the adjacent residential areas in addition to locations closer to the DDC drop point. Forty six sound level measurements were obtained at several distances from the DDC equipment and during various DDC equipment operating modes. As expected, the DDC noise levels increased when the measuring location and test area were closer to each other. The City of Carson Noise Ordinance maximum limit of 65 dBA for construction noise is reached at distance of approximately 500 feet from the operating DDC equipment. However, the noise made by the DDC mass impacting the ground is a very short-term noise pulse lasting less than one second per drop. On an average sound level basis (over a ten minute period) the 65 dBA limit would be reached at a distance of 200 to 370 feet from the DDC equipment, depending upon the intervening terrain and ground cover. These distance estimates do not account for the noise reducing effects of a sound-attenuating earthen berm proposed to be constructed along the project site boundary adjacent to the residential uses.

5.4 DUST MONITORING

Fugitive dust (particulate) monitoring was conducted to evaluate the effects of DDC tests and site earthwork operations on ambient particulate concentrations in the vicinity of the site. The specific objectives of the monitoring were to determine: the ambient concentrations of particulates in the vicinity of the site; and the contribution of DDC tests to those concentrations. The overall monitoring effort consisted of evaluating meteorological data (wind speed / wind direction) and fugitive dust. Spot measurements were also recorded for lead and chromium. The locations of the monitoring equipment are shown in Figure 24. The details of the noise monitoring are presented in Appendix G.

Fugitive dust was monitored along the western, eastern, and northern boundary of the site. The average dust concentrations recorded on November 17th (the date that DDC activities occurred closest to the western perimeter) were similar but slightly higher than average dust levels recorded on November 3rd, 6th, and 7th. All recorded average fugitive dust concentrations, however, were consistent with the annual PM_{10} averages for Los Angeles County published in the SCAQMD's current Air Quality Monitoring Report (SCAQMD 1994).

Lead and chromium laboratory results found that chromium concentrations were less than the chromium detection limit of 1 microgram, and that lead concentrations were equal to or less than the lead detection limit of two micrograms. Thus, chromium and lead concentrations in the air samples collected would have an insignificant effect on human health.

5.5 HEALTH AND SAFETY MONITORING

General health and safety was maintained at the LA Metro Mall site by identifying the hazards, implementing good site control, establishing work zones, and performing area and personal monitoring. Engineering controls were modified as appropriate to the site conditions and field activities. Personal protective equipment (PPE) and respiratory protection was provided, utilized and upgraded when necessary.

Site control was used to minimize the potential contamination of workers, protect the public from site hazards, and prevent vandalism. The basic components of the site control program include establishing work zones, using the buddy system, providing site security, implementing safe work practices, sanitation, site communication, and visitor clearances into the work areas.

Air monitoring was performed to identify and quantify airborne levels of hazardous substances that could be present at the site. Personal and direct reading instruments were used to establish worker exposure potentials. Personal monitoring involved sampling the breathing zone of field personnel while performing work activities. Measurements for potentially carcinogenic airborne organic compounds (benzene and vinyl chloride), and dust containing metals (chromium and lead) were collected by personal air samplers. Site monitoring was accomplished by using the following direct reading instruments:

- Combustible Gas Indicator (CGI)
- Photo-Ionization Detector (PID)
- Organic Vapor Analyzer (OVA)
- Colormetric Tubes (Draeger)

Monitoring was performed by individuals trained in the use and care of the instruments to protect field personnel from overexposure to hazardous vapors. Instruments and sampling pumps were calibrated daily to ensure responsiveness and accuracy. Sampling results per work task are described in greater detail below.

Site safety meetings and general safety requirements were provided by Brown & Root Building Company. A safety meeting was held at 7:00 a.m. every Monday morning and attendance was required. Sign-in sheets are maintained by Brown & Root. The basic safety rules addressed appropriate clothing for the site, use of alcohol and/or drugs, reporting unsafe conditions, and required training. All on-site personnel wore safety glasses, hard hats, and steel toed work boots, as required. Applicable elements of the Brown & Root safety rules have been addressed in Woodward-Clyde's site health and safety plan (HSP) prepared for the test programs at the LA MetroMall.

5.5.1 Deep Dynamic Compaction Testing

The primary hazards associated with deep dynamic compaction (DDC) testing at the site include:

- Dust
- Flying Debris
- Methane

Engineering controls have been implemented to control the dust and physical hazards associated with the DDC testing. The test area is frequently misted with water to keep dust levels at a minimum. In addition, dust monitoring has been performed on the heavy equipment operator in the DDC area who backfills the compacted areas. It is anticipated that the operator would have the worse case dust exposure based on his location and job activity. The operator is often downwind of DDC testing and generates dust when backfilling the test areas. Samples 11695-2, 11795-1, 11895-2, 11995-2, and 111495-1 were collected on the frame of the D6 Dozer, next to the operator. The samples were collected on 37 mm mixed-cellulose ester filter cassettes, with a 0.8 micron pore size. Samples were collected in accordance with NIOSH Methodologies 7082 and 7024 for lead and chromium, respectively. The samples were labeled and sent to ITEK Enviro Services, Inc. (ITEK) for analysis. ITEK is accredited by the National Voluntary Accreditation Program (NVLAP) and the American Industrial

Hygiene Association (AIHA). Chain-of-custody forms accompanied the samples to the laboratory and are provided in Appendix I. Lead samples were analyzed through atomic absorption (AA), and chromium was analyzed by atomic absorption through flame (AA-F). Laboratory results indicate that lead and chromium concentrations were well below the PEL. Laboratory data is provided in Appendix I.

Direct reading instruments (i.e., OVA, PID, CGI, and Draeger tubes) were also used in the DDC test areas. Following compaction, the Site Safety Officer (SSO) entered the exclusion area and monitored the perimeter of the craters in Section 1 of DDC-9 and Section 2 of DDC-10 as shown on Figures 25 and 26, respectively. The monitoring instruments indicate that methane concentrations are greater than 10% of the LEL (>5500 ppm) in the DDC area. PID levels remained low, while FID readings often exceeded instrument detection levels. Methane is the primary chemical of concern in this area which is a potential fire hazard. Flash fires and explosions are possible in this area due to the sparking potential of the DDC weight and the Dozer blade on rocks and other debris at the site.

To mitigate physical and chemical hazards associated with DDC testing to other site personnel, an exclusion zone of 150 feet was established around the "Thumper". Based on laboratory data, this large perimeter is more than sufficient to protect other site personnel from the physical and gas hazards of DDC testing.

5.5.2 Drilling Activities

Seven deep borings were drilled to evaluate the effectiveness of the deep dynamic compaction. Deep borings DDC-9-1 and DDC-10-1 were drilled on November 2, 1995. The other five borings (DDC-9-2, DDC-9-3, DDC-10-2, DDC-10-3, and DDC-10-4) were drilled on November 14, 17, and 18, 1995. Engineering controls and air monitoring were implemented to ensure worker safety. A geologist was present to visually and instrumentally monitor the soil and collect samples. The geologist was provided with an instrument capable of detecting organic vapors. The SSO evaluated the test pad areas throughout the day, augmenting the monitoring efforts of the geologists. The SSO performed CGI, PID and Draeger analysis when elevated readings (above background) and/or significant odors were reported by the geologists. Contaminants identified by direct instruments include methane, carbon dioxide and petroleum hydrocarbons. Ethyl acetate, methyl bromide, benzene, and vinyl chloride Draeger tubes were used frequently to characterize the contaminants. The ethyl acetate and methyl bromide tubes are used as a preliminary measure to help profile the contaminant. A positive ethyl acetate tube indicates either important aromatic hydrocarbons (i.e. benzene), ketones, or alcohols are present. A positive reaction on the methyl bromide tube indicates that halogenated hydrocarbons are present (i.e., dichloroethylene, tricloroethylene). Several of the ethyl acetate tubes tested positive which was followed by benzene and vinyl chloride Draeger monitoring. The standard range of measurement for the benzene Draeger tubes is 0.5 to 10 ppm. The standard range of measurement for the vinyl chloride tubes is 1 to 10 ppm and 5 to 50 ppm depending on the number of strokes. No vinyl chloride or benzene was detected with the Draeger tubes at the deep borings. Personal monitoring was also performed by the SSO to further evaluate the potential for worker exposure.

A personal sample was established on the driller's helper for borings DDC-9-1 and DDC-10-1. The driller's helper was selected based on higher risk of exposure. Sample 11295-1 was collected in the breathing zone (at least 12 inches from mouth) of the worker. The sample was collected on a 6x70 millimeter (mm) charcoal/coconut tube with 50/100 milligram (mg) sorbent capacity. The glass ends were broken to initiate sampling and covered upon completion of the sampling episode. The charcoal tube was then labeled, chilled, and sent to ITEK for laboratory analysis. The sample was analyzed by NIOSH Method 1501 for benzene, toluene, ethyl benzene, and xylenes (BTEX). The sample was collected in accordance with NIOSH Method 1501, with a minimum air volume of 10 liters, and a collection flow rate of at least 20 milliliters per minute (ml/min). The sample was analyzed by gas chromatography-flame ionization detector (GC-FID). Based on the laboratory results of November 2, 1995, BTEX concentrations in the test pad areas are well below the permissible exposure limits (PEL). Personal monitoring was performed daily at the site from November 6th through the 10th to ensure worker exposures were well within OSHA and Cal-OSHA standards. These samples were collected while drilling outside of test pad areas 9 and 10, however; the results were incorporated into the personal monitoring data of this report to show that BTEX and vinyl chloride constituents are well below the PEL. Sample 111395-1 was collected on November 13, 1995 and was analyzed for vinyl chloride. The sample was located in the breathing zone of the driller's helper. The sample was collected and analyzed in accordance with NIOSH Method 1007. The laboratory data is provided in Appendix I which indicates that BTEX and vinyl chloride constituents are not a threat to worker health and are generally not detected at the site during intrusive operations.

In addition to air monitoring, a safe work zone of 25 feet was established around each drill rig prior to commencing drilling. The zone was established and maintained with caution tape. This acted as an exclusion zone to which other site employees did not enter without proper training and authority. Based on site conditions and air monitoring data, a distance of 25 feet around the drill rig is more than sufficient for protecting other site personnel from vapors and odors. The off-gassing episodes consist of short duration emissions which quickly dissipate from the atmosphere. An aiding factor to the quick dissipation of site gasses is the air movement at the site, which seems to increase in the afternoon.

5.5.3 Cone Penetrometer

Methane and carbon dioxide are the gasses of greatest concern during cone pentrometer activities. Methane was identified by comparison of the PID and FID readings. The PID does not detect methane and the FID does. Therefore, when PID and FID readings vary greatly it is usually a result of methane gas. FID readings under the cone pentrometer rig were usually between 30 and 50 ppm, whereas PID readings were between 0.5 and 0.8 ppm. Drilling activities were initiated to retrieve a cone head which had broken off from the tip. FID readings during drilling activities raised to 8,000 ppm and PID readings remained low (0.63 ppm). Carbon dioxide was identified through the use of Draeger tubes. The standard range of measurement for the tube used is 1 to 20 volume percent of carbon dioxide. The tube was used in the augers during drilling to retrieve the cone. The entire length of the tube discolored indicating greater than 20% by volume of carbon dioxide. Both gasses are of greater concern during cone pentrometer testing than in regular site conditions due to the confined area of the sampling truck. Air monitoring should be performed in the sampling truck and adequate ventilation should be provided.

5.5.4 Trenching Activities

Test trench areas were excavated with a backhoe to evaluate soil cover thickness laterally. The backhoe was located upwind of the trench are to minimize exposure to the operator. Odors were significant when refuse was exposed, however; monitoring indicated methane and carbon dioxide to be the two most prevalent gasses. PID readings downwind of the test trench ranged from 0.58 to 2.16 ppm. The FID readings ranged from 70 to >100 ppm. PID readings upwind of the test trench ranged from 0.58 to 0.83 ppm. The FID readings were 8.70 to 9.50 ppm. Upwind readings were equivalent to background levels at the site. The dissimilitude between PID and FID readings indicates that the primary gas is methane. This was confirmed with Draeger tube analysis. PID and Draeger tube analysis have not identified BTEX and vinyl chloride constituents. Concerns associated with methane include fire hazards from sparking items such as the teeth of the backhoe scraping along metal or rocks while digging. Flash fires and explosions are potential hazards that could occur at the site. Air monitoring should be performed during trenching, and a safe work zone of 25 feet should be established around trenches.

6.0
DISCUSSION OF RESULTS

Based on the post-DDC investigation results at test pads DDC 9 and DDC 10 it appears that the average refuse surface has been lowered about 3-1/2 to 4 feet, as observed in the borings and test pits. Borings DDC 10-2 and DDC 10-2 indicate that, at least locally, the refuse has been compressed 9 to 11 feet. This result probably represents compression in areas where large voids existed and were collapsed by the DDC process, and points out that DDC can improve uniformity of compaction thereby reducing differential settlements.

Evaluation of the data recorded for tamper versus crater depth, heave tests, and direct observations of the test pits (DDC9-2a and DDC9-2b) indicates that the high energy, 15 drop compaction passes with backfill after 5 drops, produce a large component of heave after about 10 tamper drops. Evidence for this can be seen on the heave test curves, Figures 11 through 13 by the increase in heave after 10 tamper drops. Direct observable evidence that heave was occurring in the high energy sections (section 2 of DDC 9) was recorded in two test pits where elevated peaks of refuse, only 1.5 feet bgs were present between adjacent high energy drop points. In areas where 10 tamper drops were performed (e.g. section 3 of test pad 9 and section 2 of test pad 10), the refuse surface was observed to have been compressed to a more uniform elevation. The incremental heave results indicate that from 10 to 15 tamper drops the efficiency drops from about 80 percent to between 64 and 67 percent.

The pre- and post-DDC subsurface investigation data suggest that there has been some relative improvement in density and stiffness of the refuse. The single set of comparative CPT soundings supports this result. However, the SPT results from the borings are more difficult to quantify and compare. This is due in large part to the variable composition of the refuse as well as the extreme heterogeneity of the refuse over short distances. As an example, the drive samples in DDC-10-1 apparently encountered oversized debris at most of the sampling intervals, producing very high blow counts. Boring DDC-10-2 apparently did not encounter significant oversized debris in the refuse and had much lower blow counts. It is generally accepted that in fine grained soils, such as the matrix supported landfill refuse, the dynamic method of obtaining penetration resistance is not reliable for estimating increased density or strength. Qualitative observation of the refuse at the bottom of the test pits indicated that the refuse was quite dense relative to the material exposed in the pre-DDC test pits. The compression of the refuse and heave data suggests that the 5-foot cover thickness is preferable in order to optimize improvement of the refuse and minimize heave.

Although the DDC procedure appeared to significantly disturb the soil cover, in the craters very little mixing with refuse was observed. Where mixing did occur it appeared to be due to local lenses of refuse within the soil cover or local areas of thin cover over the refuse. When refuse was encountered in a crater, the crater was partially backfilled prior to continuing DDC. The post-DDC density test performed at test pads 9 and 10 indicate that the ironing passes, consisting of two drops from 30 feet, were effective in recompacting at least the upper three feet of soil cover to 90 percent relative compaction (ASTM Test Method 1557).

During the DDC testing time records were kept as part of the drop records so that production rates could be estimated. During the testing at the two main pads, the drop rate ranged from 16 to 32 drops per hour with an average of about 25 to 27 drops per hour. The maximum rate achieved in a one-half-day period was 36 drops per hour at test pad 10 while performing 15 drops per location on the 15 foot spacing. The lower portion of the range probably reflects slower production due to ancillary testing (heave, vibration, and tamper velocity tests, etc.), slower backfill when the backhoe was used in place of the dozer, and "Thumper" downtime for repair. During testing, there was about 8 to 10 hours of thumper downtime (cable replacement, winch adjustment, radiator repair) during the approximately 95 hours of testing.

7.1 CONCLUSIONS

- Dynamic Compaction is successful in improving foundation conditions, and depth of improvement is on the order of 15 ft or more.

- Dynamic Compaction is effective in locating and collapsing near surface voids and soft spots in refuse thereby reducing the potential for highly localized differential settlement.

- Refuse is compacted and the surface of refuse depressed by about $3^1/_2$ to 4 ft or locally greater. Additional depression of refuse surface may be achieved by stripping the area compacted to within 5 feet of the new refuse elevation and repeating DDC.

- The cover thickness of 5 feet for dynamic compaction is preferred. Because the "Thumper" has a required slope tolerance for operations, the grading design should allow for the production pads to be prepared such that an average of 5 feet of cover thickness is maintained with no more than 1 percent slope.

- The efficiency of refuse compaction at this site appears optimal at energy levels of between 175 and 250 TFPSF. This is lower than previously anticipated. The heavy areas of DDC is estimated to require 250 TFPSF with light areas at 175 TFPSF.

- With control of energy levels between 175 and 250 TFPSF and cover thickness at about 5 feet, the heave of surface is manageable.

- Soil volume required to fill DDC craters is 20 to 35 cubic yards/crater for the range of light to heavy DDC test results.

- Based on DDC test operation production rates during contruction should be over 30 drops per hour.

- Vibration levels at the site boundary were "barely noticeable" when operating in the test pad areas. Measurements were made closer to rig operations and with drops in the northwestern cell within 500 feet of site boundary. Vibration levels should be able to be kept at or below the "easily noticeable" vibration levels during construction.

- Dust levels are manageable with pre-watering of the impact areas and conditioning of the backfill and cratered areas.

- Noise during tamping was measured and indicates that with sound berms, noise from tamping should, on the average, be able to be controlled to below 65 dBA.

- Vapor emissions are observed on some craters. They do not have safety impacts beyond the exclusion zone for the dynamic compaction work areas.

- Primary chemical hazards at the site are methane and carbon dioxide.

- Explosion and fire hazards are primary physical hazards during drilling, trenching, or DDC operationsat the site due to the high concentrations of methane. These hazards can be minimized by properly trained personnel and appropriate fire equipment as provided for in the Health and Safety Plan.

- Odors and gasses dissipate rapidly and do not affect site personnel that remain outside of the cordoned off areas established for each operation as follows:

Activity	Radius Around Equipment
DDC	150 feet
Drilling, CPT probes, Trenching	25 feet

- Based on laboratory data; lead, chromium, BTEX and vinyl chloride contaminants are well below the permissible exposure levels.

7.2 RECOMMENDATIONS

- Dynamic compaction design efforts should use the following results as a basis for design:

  - The pre-DDC grading plan should be developed using an average 5-foot thick cover with a minimum 3-foot thick cover.

  - Heavy DDC areas should use an energy level of 250 TFPSF.

  - Light DDC areas should use an energy level of 175 TFPSF.

  - Spacing, drop heights and tamper weights should be as follows for heavy DDC:

Run	No. of Drops	Spacing (feet)	Tamper (Tons)	Drop Height (feet)
Primary	10	15	27.6	105
Secondary	10	15	27.6	105

For light DDC the 10 drops can be reduced to 7 drops.

Other procedures to achieve comparable results will have to be demonstrated prior to acceptance of contractor procedures.

- An ironing pass of 2 drops of 30 feet or equivalent could provide for adequate compaction of soil cover.

- A volume of soil of 22 and 30 cubic yards per crater can be used in soil volume estimates for light and heavy DDC operations, respectively.

- Cordoned-off areas for construction activities relating to DDC and subsurface exploration should be maintained restricting the use of the area to essential personnel with proper health and safety training as follows:

Activity	Radius Around Equipment (feet)
DDC	150
Drilling, CPT probes, trenching	25

- Biohazards need to continually be controlled with proper decontamination and hygiene practices. This is especially important during trenching and drilling activities. Refuse needs to be washed off equipment and personnel to reduce affects on personnel to within acceptable limits.

- Direct air monitoring should be conducted anytime employees are in contact with refuse due to the dynamic nature of landfills.

- Data developed from vibration monitoring in Appendix F should be considered in developing a vibration monitoring plan and criteria as part of the DDC design.

- Data developed from noise monitoring in Appendix G should be considered in developing a noise monitoring plan and criteria as part of the DDC design.

- Although laboratory data indicates that lead, chromium, BTEX, and vinyl chloride concentrations are well below the PEL; workers should still upgrade to Level C protective equipment when the action level identified in the HSP is equaled or exceeded.

- Based on existing air data, it is suggested that personal and area organic and dust monitoring for lead, chromium, BTEX, and vinyl chloride be collected biweekly versus daily and/or weekly. Upon review of biweekly results, a monthly sampling schedule may be warranted on the proviso that Draeger analysis remains consistent with existing data.

8.0
LIMITATIONS

The professional judgments presented in this report are based on our understanding of the project, on reviews of work performed by others, on observations and investigations of the project site by Woodward-Clyde personnel, and on our general experience in the fields of engineering geology and geotechnical engineering. The conclusions and recommendations contained herein are based on the assumption that the subsurface conditions do not deviate appreciably from those reported in previous studies or observed in borings, CPT soundings, and test trenches for this study. Further, it is assumed that the DDC testing at the locations selected are representative of the range of condition that occurs at the site. In view of the general development of the area as a sanitary landfill, the possibility of different subsurface conditions cannot be discounted. We do not guarantee the performance of the project in any respect, only that the work performed and the judgments rendered meet the standard of care of our profession at this time and location.

This report is intended to be used as a data report and to provide a basis for the DDC design for the project. It is understood that some variation in actual DDC operations may be required during construction to accommodate conditions not representative of test conditions.

TABLES

TABLE 1

SUMMARY OF DDC TEST PAD LAYOUTS AND PROCEDURES

Test Pad #	Section	Approximate Soil Cover Thickness (feet)	Drop Spacing (feet) (Primary/ Secondary)	Drop Height (feet)	Number of Drops (Primary/ Secondary)	Typical Backfill Sequence
9	1	5	15/NA	100	15/NA	After each 5 drops and upon completion
	2	5	15/15	100	15/10	After each 5 drops and upon completion
	3	5 to 8	20 and 15/15	105	10/10	After each 5 drops and upon completion
	4	5	20/NA	105	10/NA	After total drop sequence completed
9b	-	5	13/*	100 105	10/5 8/NA	After total drop sequence completed
10	1	5 to 7.5	20/NA	100	Varied/NA	Varied
	2	5	15/15	105	10/5	After total drop sequence completed
	3	5 to 7.5	15/NA	100	15/NA	After first 7 drops and upon completion
	4	5	15/15	100	15/10	After first 7 drops and upon completion

Notes:
NA - not applicable (no secondary drops executed)
* - only one secondary drop executed, centered among the four primaries

TABLE 2

SUMMARY OF DEEP DYNAMIC COMPACTION INVESTIGATION BORINGS, CONE PENETROMETER TESTS, AND TEST PITS

Point I.D.	Test Pad	Date Completed	Pre-or Post-DDC	Total Depth (ft)	Location (1)		Elev. (ft)	Depth to Top of Refuse	Comments
					Northing	Easting			
Hollow-Stem Auger Borings									
DDC-9-1	9	11/2/95	Pre	55.0	19,222.2	51,978.9	33.0	5.0	
DDC 9-2	9	11/14/95	Post	54.5	19,215.9	51,981.5	32.4	7.5	See Note 1a
DDC-9-3	9	11/18/95	Post	40.0	19,295.5	51,995.5	31.4	7.5	See Note 1a
DDC-10-1	10	11/2/95	Pre	60.5	18,753.0	52,642.0	38.3	10.0	See Note 1a
DDC 10-2	10	11/17/95	Post	56.2	18,747.9	52,641.1	35.8	19.0	
DDC 10-3	10	11/17/95	Post	51.5	18,758.7	52,604.5	36.1	16.2	
DDC 10-4	10	11/18/95	Post	55.0	18,800.7	52,636.1	35.1	10.0	
Cone Penetrometer Test Soundings									
WCCPT-1	9	11/1/95	Pre	50.0	19,271.4	52,014.4	32.8	3.5	
WCCPT-2	9	11/1/95	Pre	62.2	19,263.6	51,946.1	32.7	5.5	
WCCPT-3	9	11/1/95	Pre	13.0	19,194.9	51,980.0	33.2	4.0	
WCCPT-4	9	11/1/95	Pre	10.0	19,265.2	52,051.3	32.7	3.0	
WCCPT-5	9	11/1/95	Pre	15.1	19,338.3	51,983.1	31.9	8.0	
WCCPT-6	9	11/1/95	Pre	15.1	19,270.0	51,910.0	32.6	9.5	
WCCPT-8	10	11/1/95	Pre	65.1	18,707.6	52,663.5	39.3	11.5	
WCCPT-12	10	11/1/95	Pre	15.1	18,752.1	52,709.3	40.2	11.0	
WCCPT-16	9	11/3/95	Pre	10.8	19,244.5	51,966.5	32.8	5.0	See Note 1a
WCCPT-17	9	11/3/95	Pre	59.9	19,223.0	51,990.0	33.0	5.0	See Note 1a
WCCPT-18	10	11/3/95	Pre	12.1	18,750.4	52,630.9	38.3	8.0	
WCCPT-19	10	11/3/95	Pre	47.7	18,789.6	52,637.8	38.9	9.0	
WCCPT-20	10	11/3/95	Pre	15.1	18,822.0	52,638.0	38.3	8.5	
WCCPT-21	10	11/3/95	Pre	20.0	18,750.0	52,569.9	38.3	7.5	
WCCPT-22	10	11/3/95	Pre	46.4	18,749.7	52,644.7	38.3	9.0	
WCCPT-23	10	11/3/95	Pre	23.1	18,681.4	52,638.8	40.1	11.0	
WCCPT-59	10	11/16/95	Post	11.6	19,255.9	51,944.3	31.9	10.0	
WCCPT-60	10	11/16/95	Post	30.5	19,265.9	51,955.3	31.9	8.5	

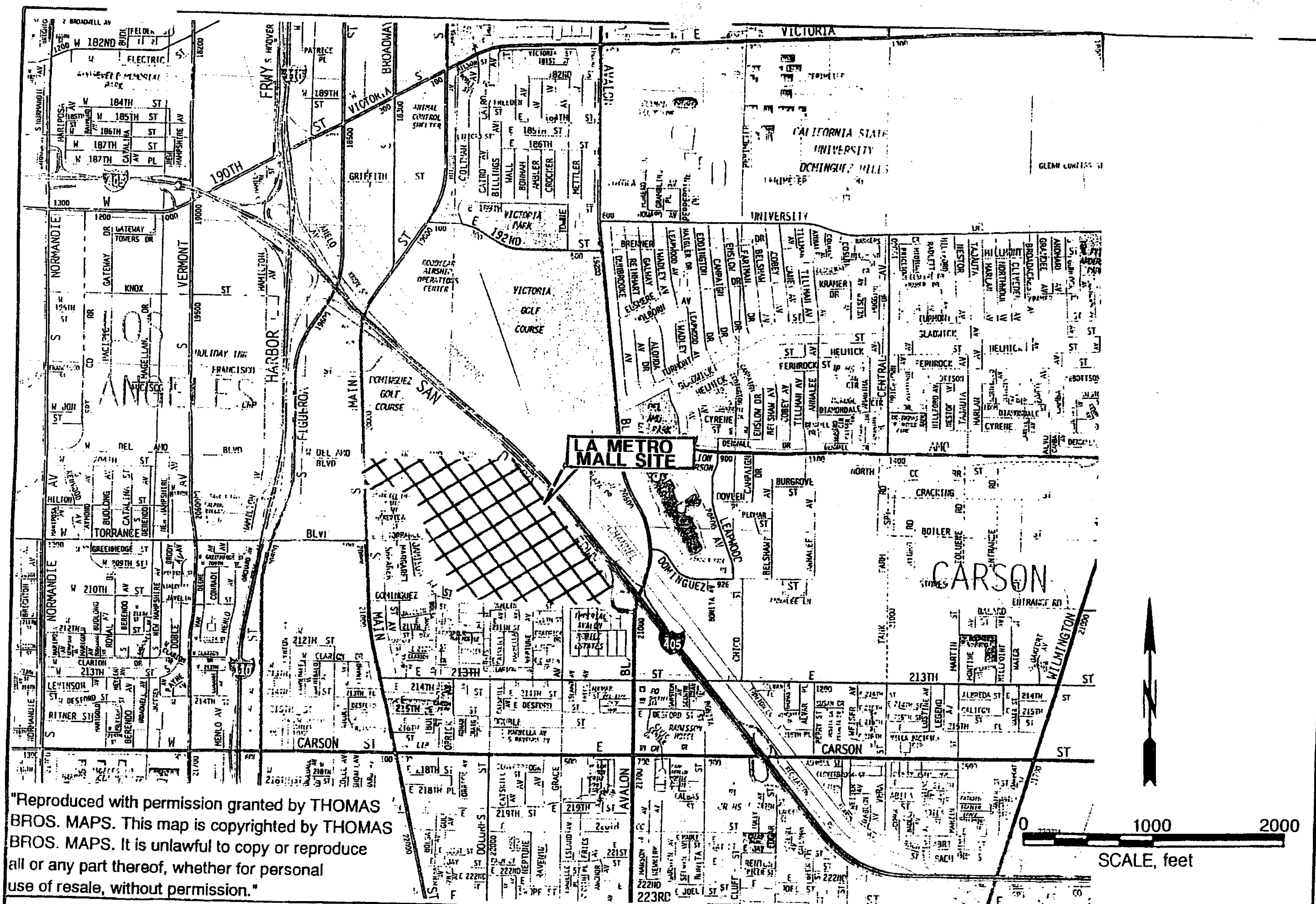
TABLE 2

SUMMARY OF DEEP DYNAMIC COMPACTION INVESTIGATION BORINGS, CONE PENETROMETER TESTS, AND TEST PITS

Point I.D.	Test Pad	Date Completed	Pre-or Post-DDC	Total Depth (ft)	Location (1)		Elev. (ft)	Depth to Top of Refuse	Comments
					Northing	Easting			
Test Pits									
DDC9-1A	9	11/1/95	Pre	11.0			31.9	9.0	
DDC9B-1A	9	11/17/95	Post	9.5			32.0	2.0 - 9.0	
DDC9-2A	9	11/15/95	Post	7.5			32.0	6.5 - 7.0	
DDC9-2B	9	11/15/95	Post	8.5			32.0	2 - 8.5	
DDC9-3A	9	11/15/95	Post	13.0			31.0	9 - 12.5	
DDC10-1A	10	11/7/95	Pre	8.2			38.3	8.0	
DDC10-2A	10	11/7/95	Pre	11.5			40.2	11.0	
DDC10-3A	10	11/17/95	Post	7.7			35.5	7.5	

Notes: (1) Locations surveyed by RBF 11/5/95, 11/17/95, and 11/20/95 unless otherwise noted.
(1a) indicates that location and elevation were measured with a level and tape from a nearby surveyed location.

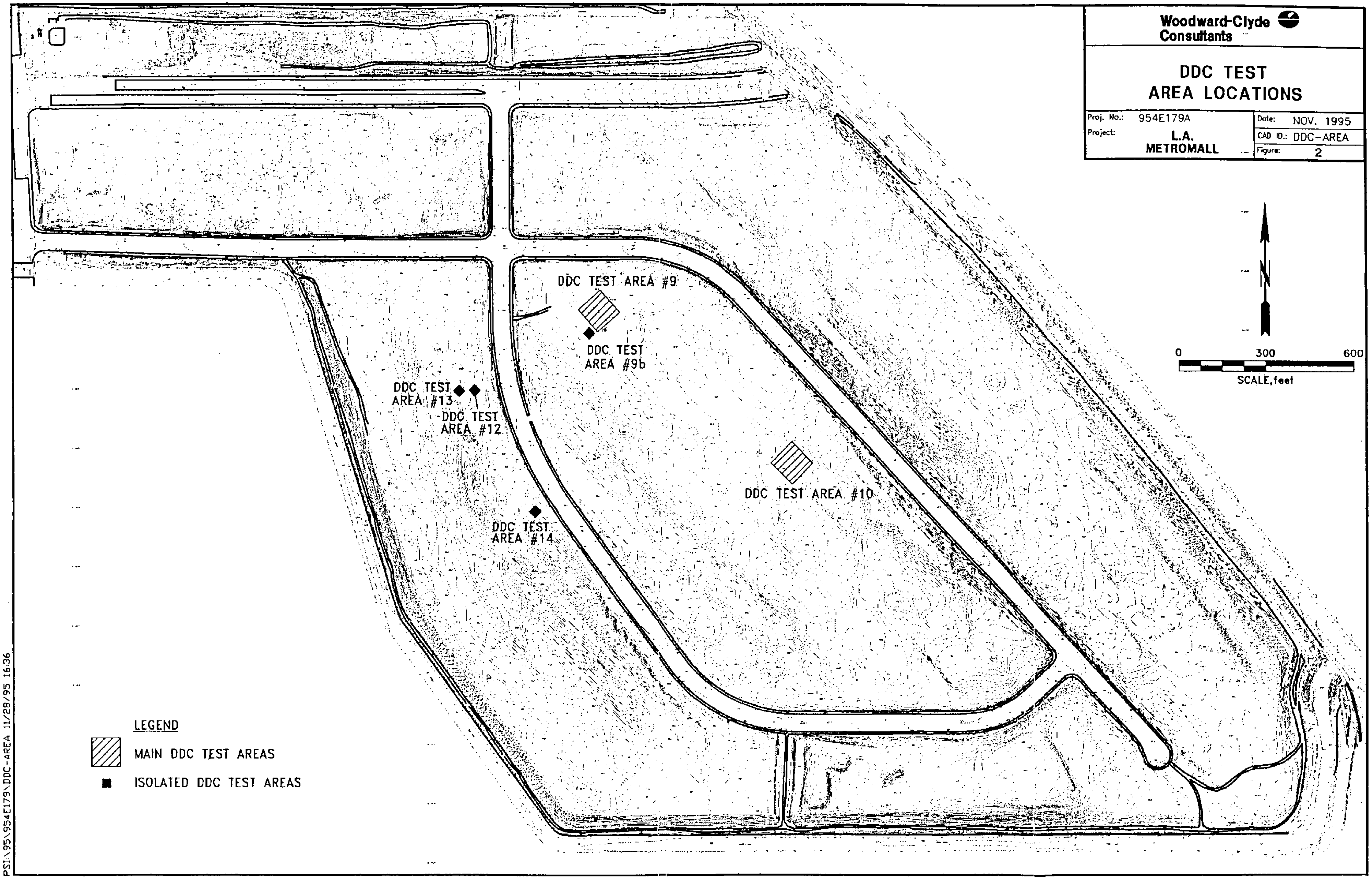
FIGURES



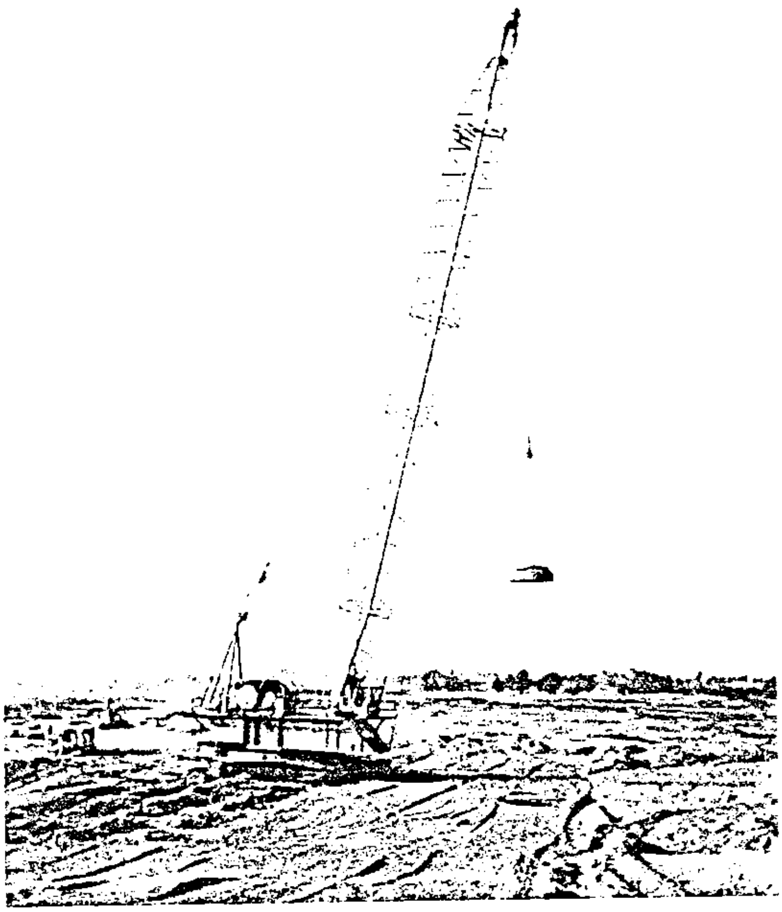
LOCATION OF LA METRO MALL SITE

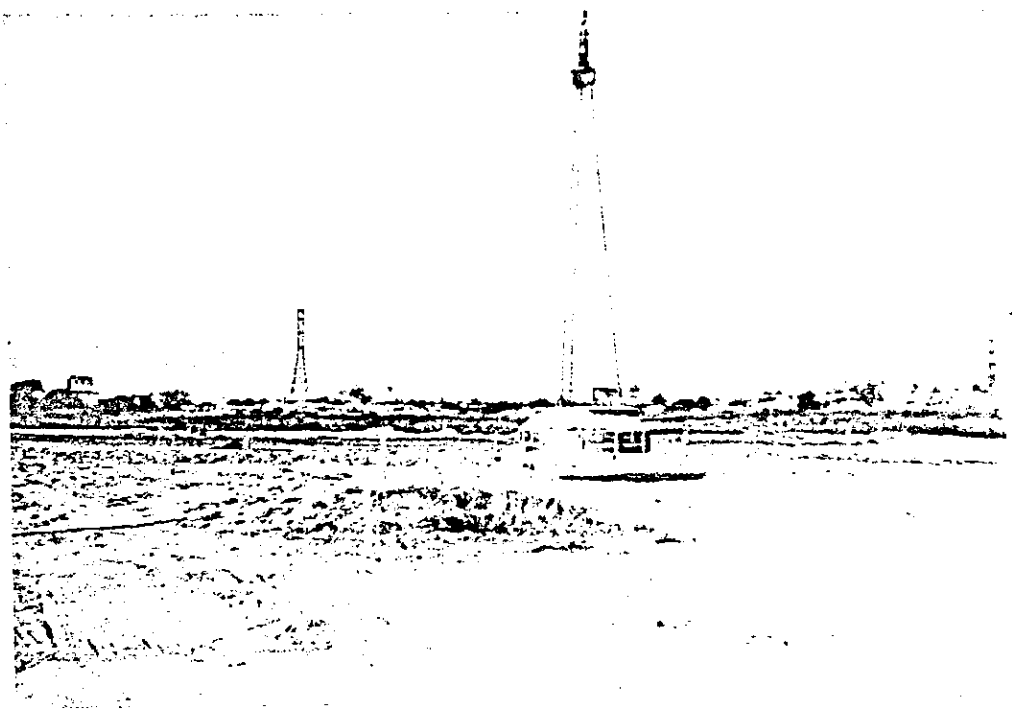
Project No.: 954E179-DDCT	Date: NOV. 1995	Project: LA METRO MALL	Fig. 1

Woodward-Clyde Consultants



PSI:\95\954E179\DDC-AREA 11/28/95 16:36

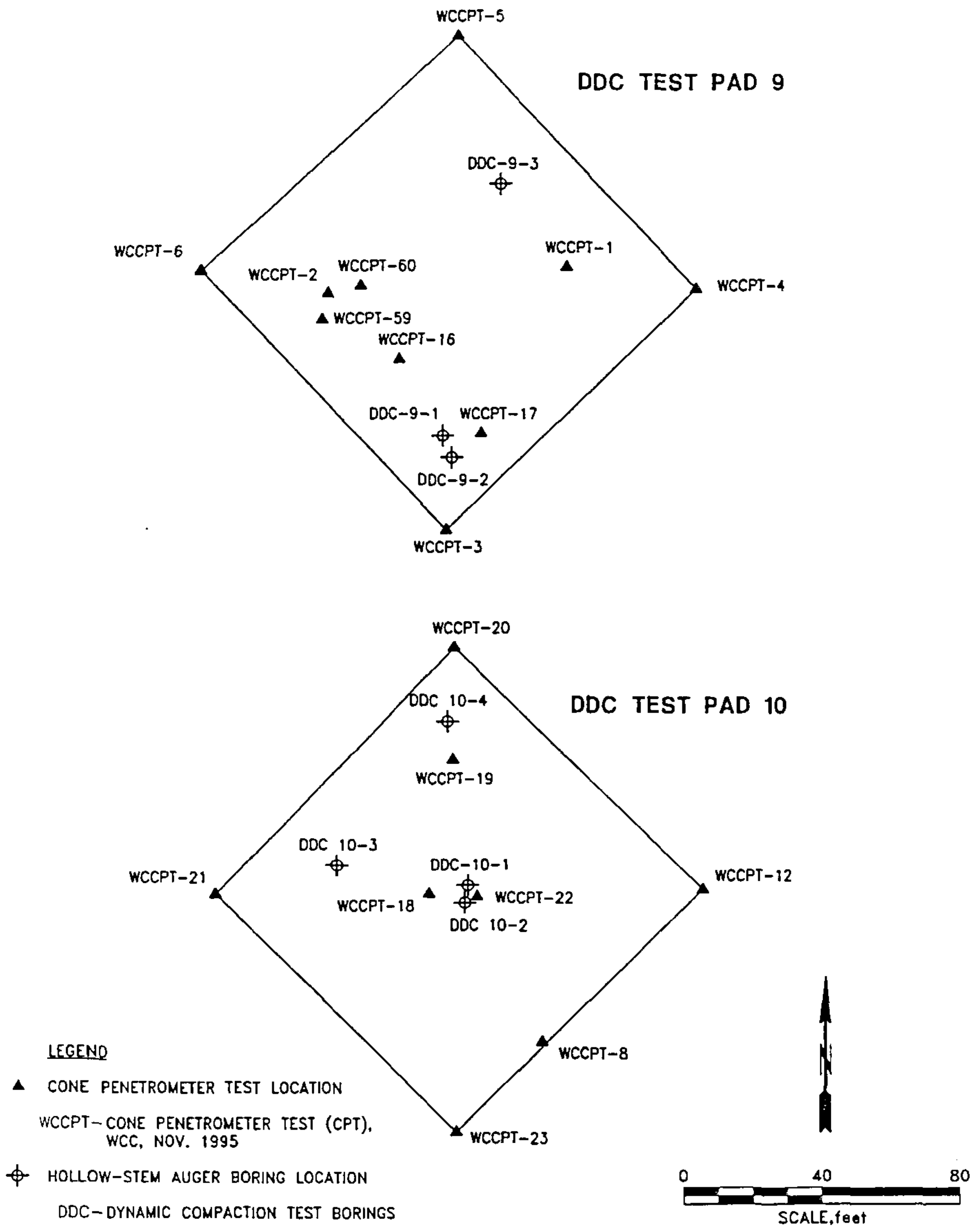




DYNAMIC COMPACTION EQUIPMENT

Project No.:	954E179	Date:	NOV.1995	Project:	LA METROMALL	Fig. 3

Woodward-Clyde Consultants

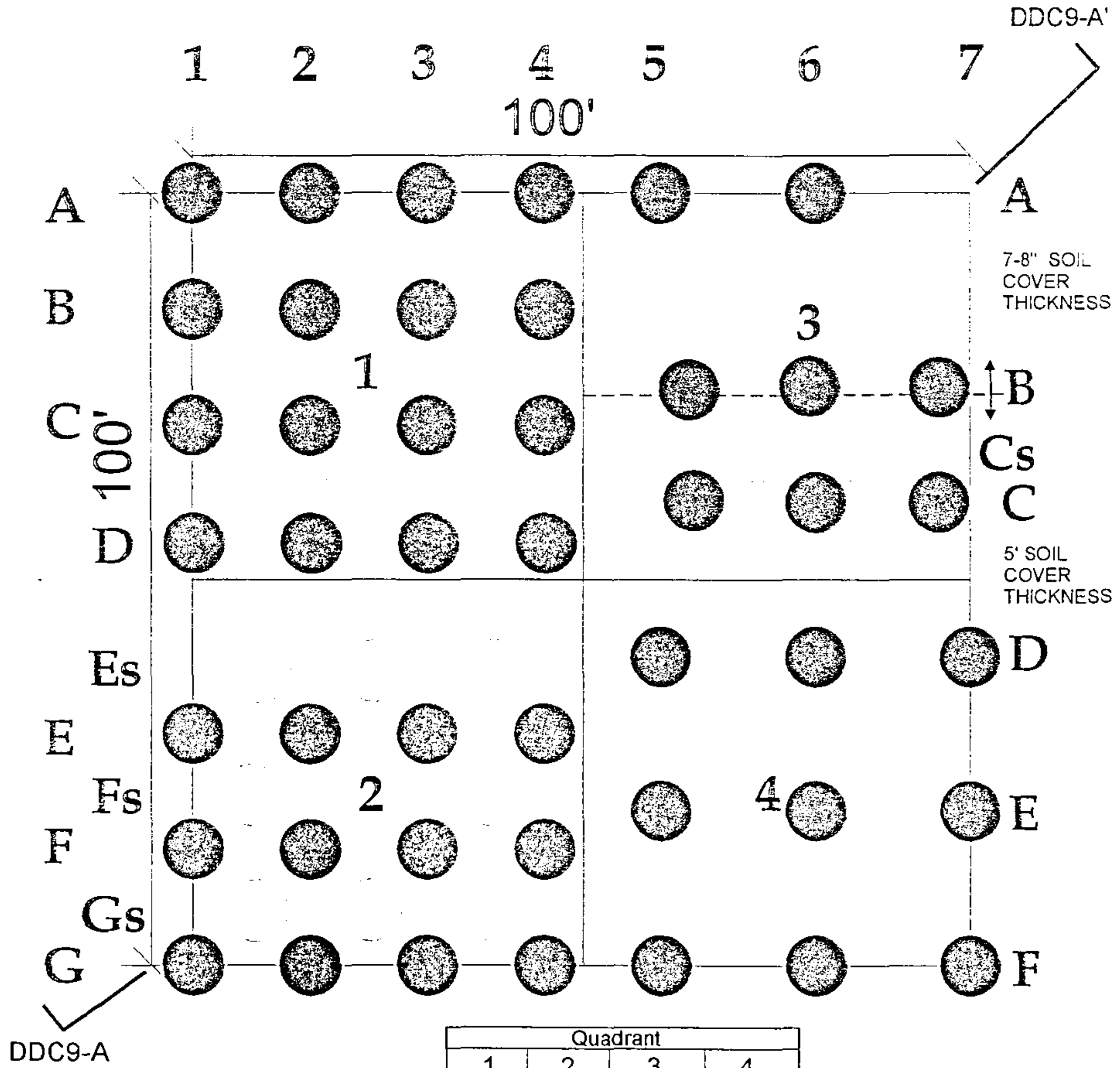


HOLLOW STEM AUGER BORINGS & CPT SOUNDINGS AT DDC TEST PADS 9 AND 10

Project No.: 954E179	Date: NOV. 1995	Project: L.A. METROMALL	Fig. 4

DDC-PT
11/30/95 09:39

Woodward-Clyde Consultants



	Quadrant			
	1	2	3	4
First Pass Drop Spacing	15'	15'	20' & 15'	20'
Second Pass Drop Spacing	-	15'	15'	-
Approx. Soil Cover Thickness	5'	5'	7' to 8'	5'

LEGEND

Impact-Point of Tamper During Primary Compaction Pass

Impact-Point of Tamper During Secondary Compaction Pass

Note: For Boring, CPT, and Test Pit Locations, See Figure 3-3.

DYNAMIC COMPACTION TEST AREA LAYOUT - PAD #9

Project No.: 954E179	Date: NOV. 1995	Project: LA METRO MALL	Fig.: 5

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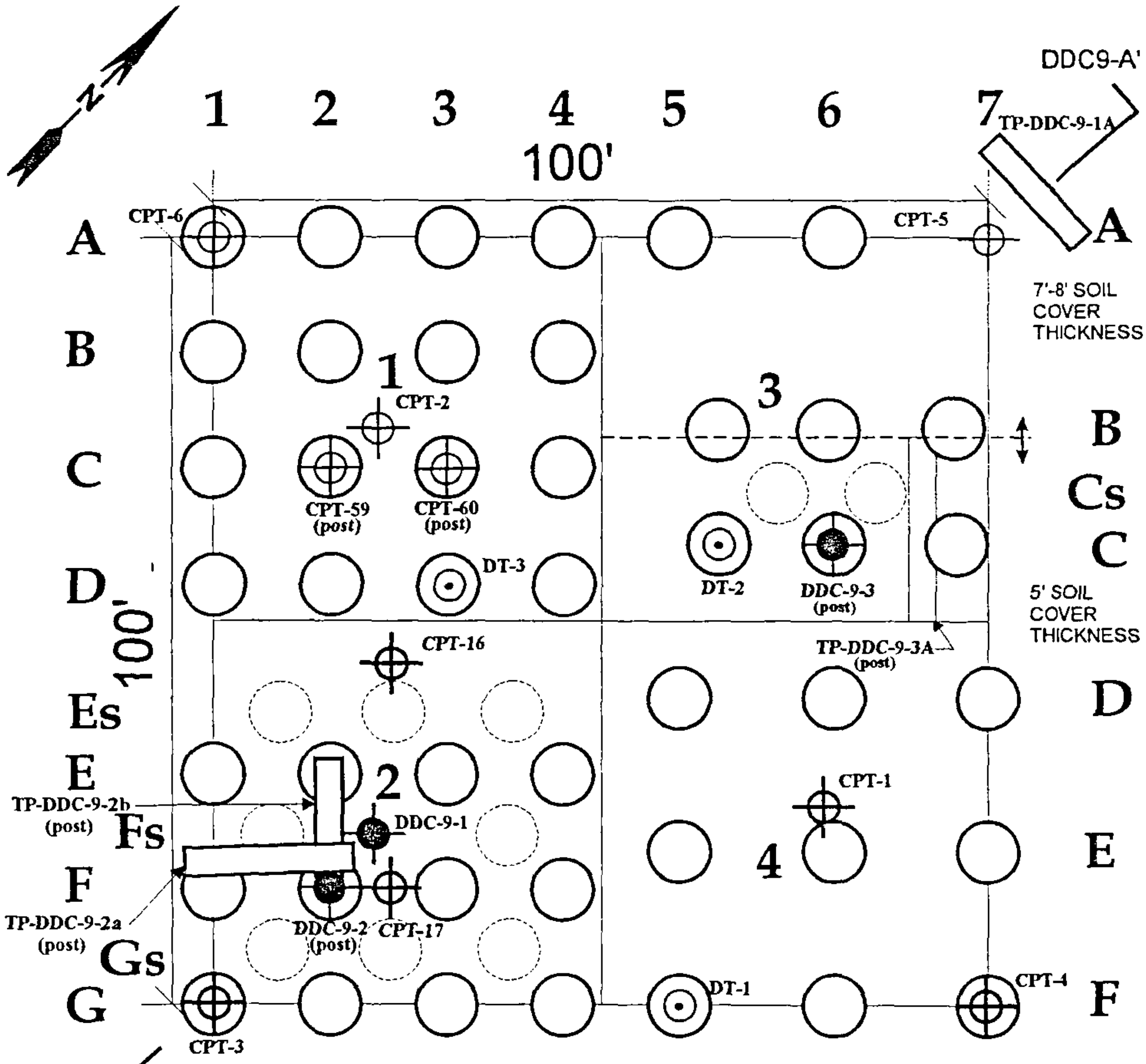

DDC9-A

	Quadrant			
	1	2	3	4
First Pass Drop Spacing	15'	15'	20' & 15'	20'
Second Pass Drop Spacing	-	15'	15'	-
Approx. Soil Cover Thickness	5'	5'	5' to 9'	5'

LEGEND

- Impact-Point of Tamper During Primary Compaction Pass
- Impact-Point of Tamper During Secondary Compaction Pass
- Approximate Location of DDC Test Boring
- Approximate Location of DDC CPT Sounding
- Density Test Location
- Test Pit Location

Note: (post) indicates testing completed after DDC.

SUBSURFACE INVESTIGATION LOCATIONS - DDC TEST PAD #9

Project No.: 954E179	Date: NOV. 1995	Project: LA METRO MALL	Fig. 6

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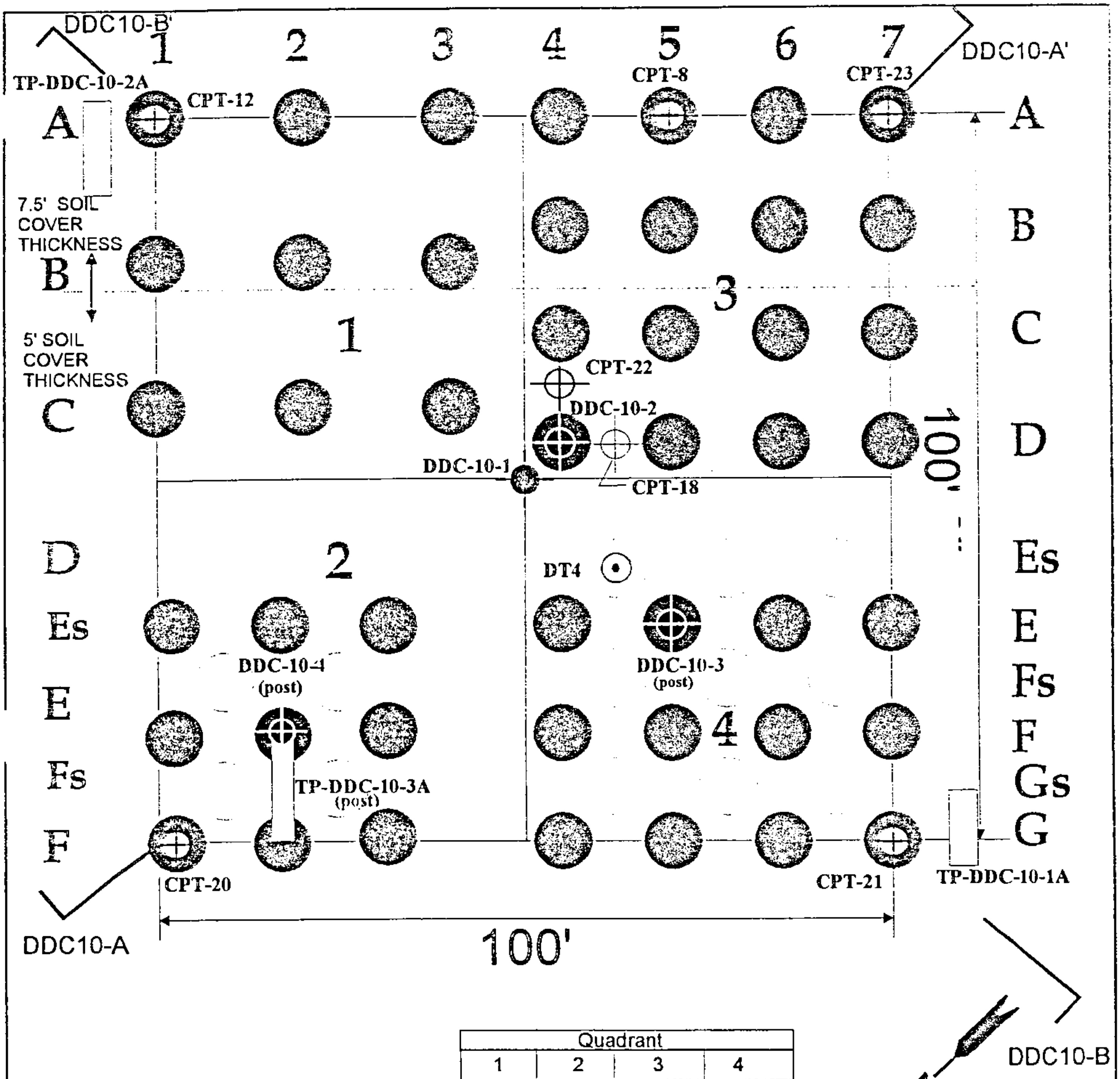

	Quadrant 1	Quadrant 2	Quadrant 3	Quadrant 4
First Pass Drop Spacing	20'	20'	15'	15'
Second Pass Drop Spacing	-	20'	-	15'
Approx. Soil Cover Thickness	5' & 7.5'	5'	5' & 7.5'	5'

LEGEND

- Impact-Point of Tamper During First Compaction Pass
- Impact-Point of Tamper During Second Compaction Pass
- Location of Pre-DDCTest Boring
- Location of Pre-DDC CPT - Sounding
- Location of Test Pit
- Location of Density Test

DYNAMIC COMPACTION TEST AREA LAYOUT - PAD #10

Project No.: 954E179	Date: SEPT. 1995	Project: LA METRO MALL	Fig.: 7

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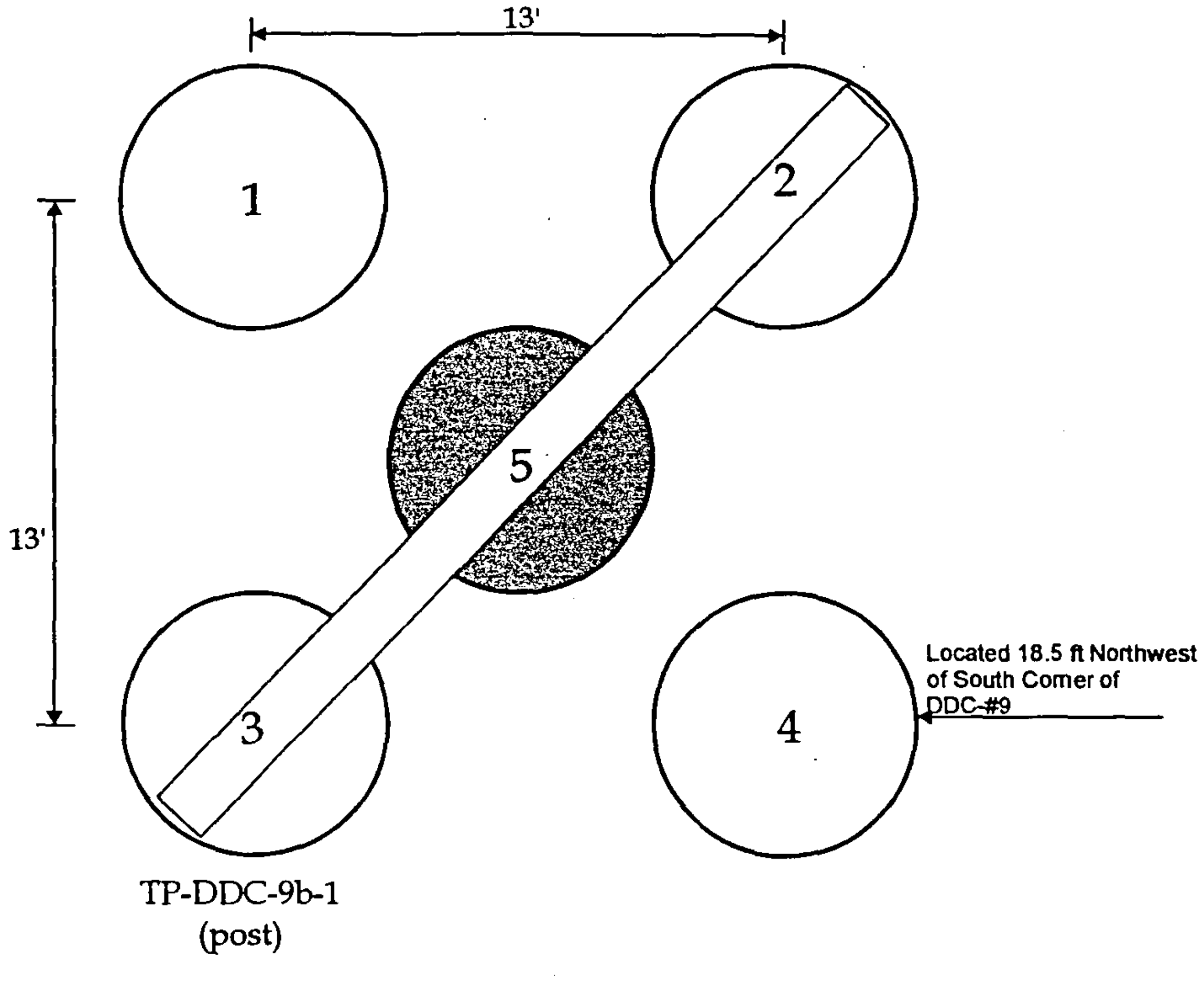

DYNAMIC COMPACTION TEST AREA LAYOUT - PAD 9b							
Project No.:	954E179	Date:	NOV. 1995	Project:	LA METRO MALL	Fig.:	8

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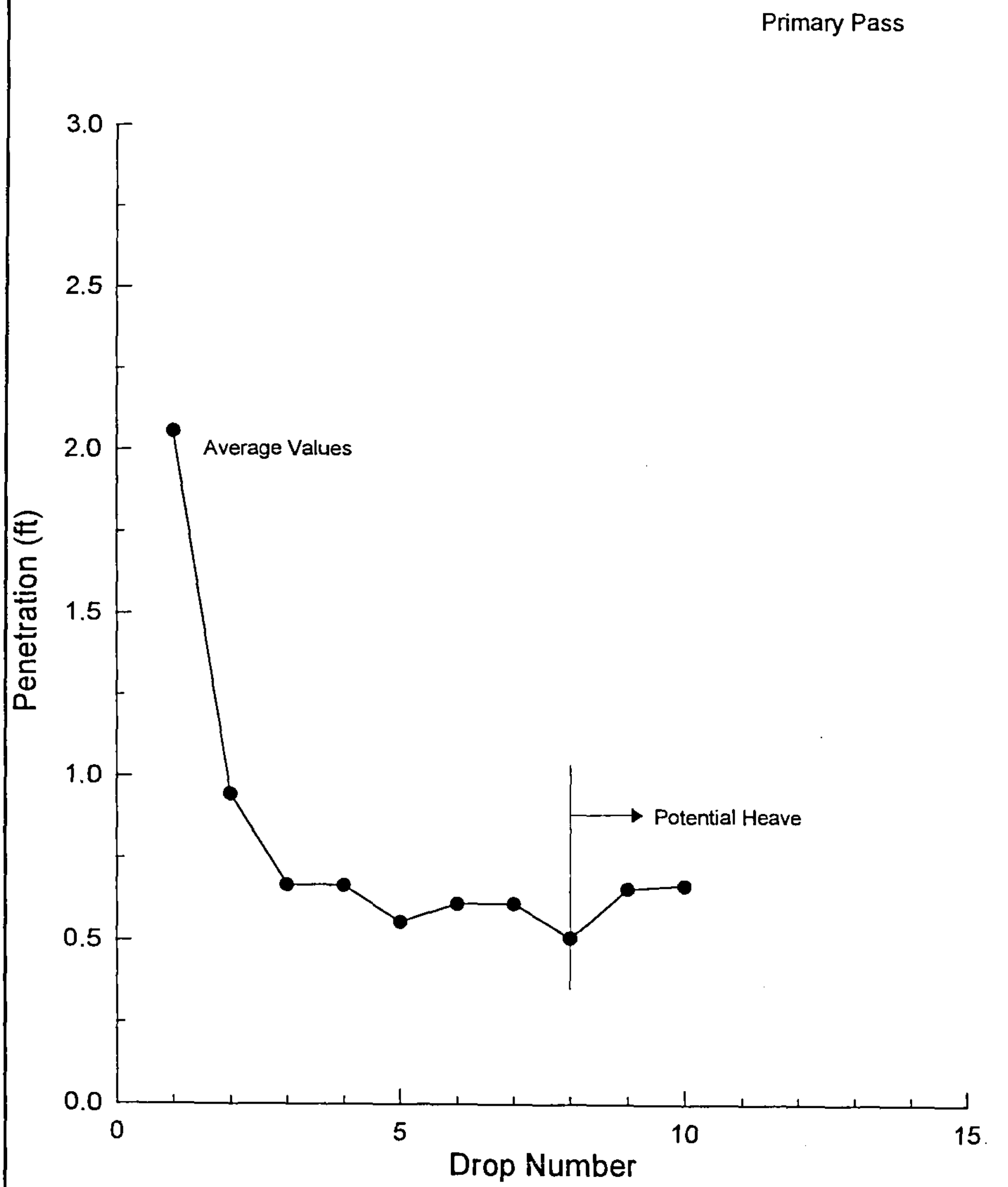
- DDC TEST AREA 10, SECTION 1, DROP POINT B-2
- CRATE DEPTH RANGED FROM 8 TO 10 FT.
- APPROXIMATE CRATER DIAMETER = 12 FT.

TYPICAL CRATER RESULTING FROM DYNAMIC COMPACTION DROP SEQUENCE

Project No.: 954E179	Date: NOV.1995	Project: LA METROMALL	Fig. 9

Woodward-Clyde Consultants



Drop Number vs Tamper Penetration **Test Pad #10, 2nd Quadrant**			
Project No. 954E179	Date: NOV. 1995	Project: LA METRO MALL	Fig. 10

d:\metro\pad10_2.grf

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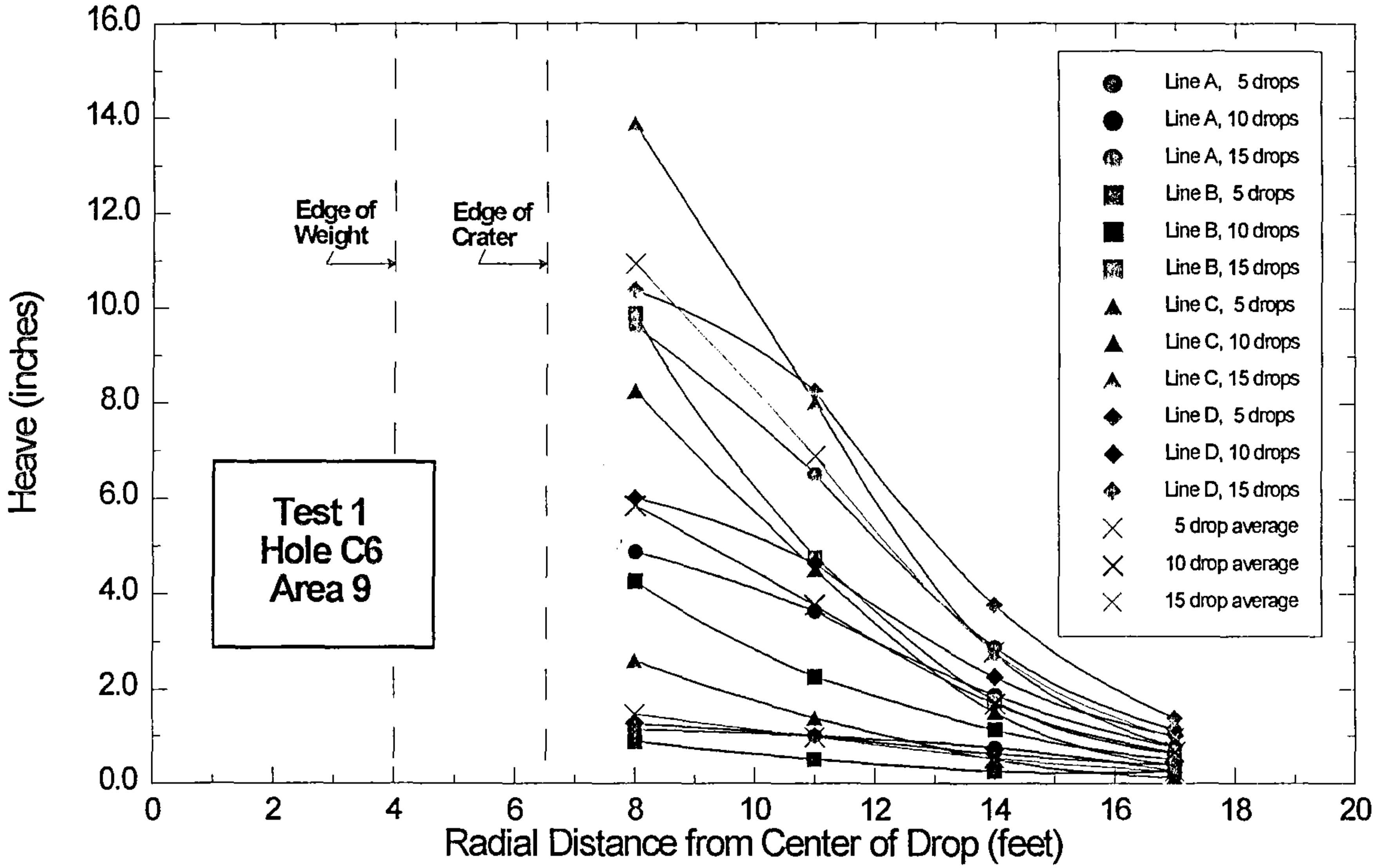
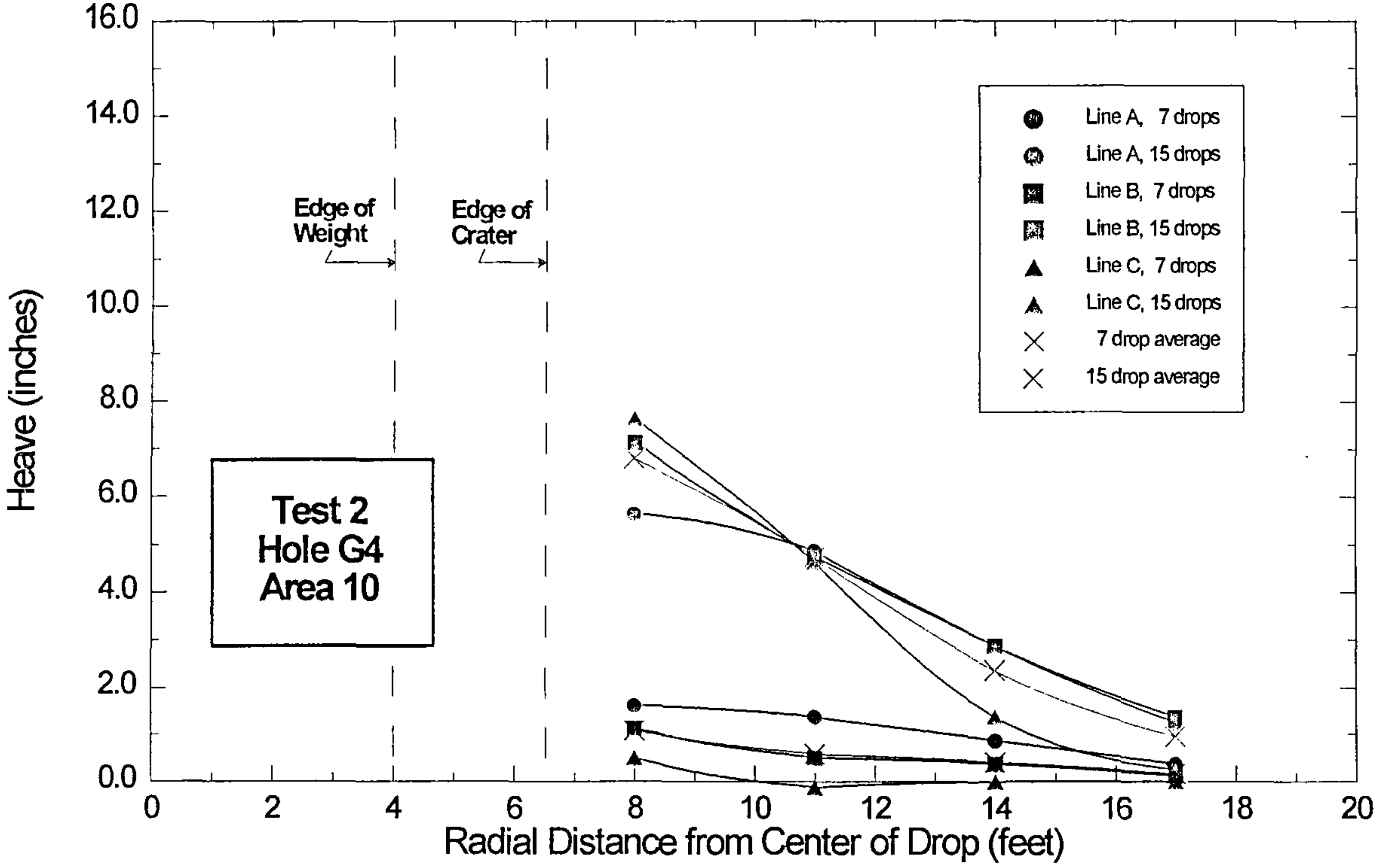


HEAVE MEASUREMENTS FOR TEST #1

Project No.: 954E179	Date: Dec. 1995	Project: L.A. METROMALL	Fig.: 11

heave_1.grf

Woodward-Clyde Consultants

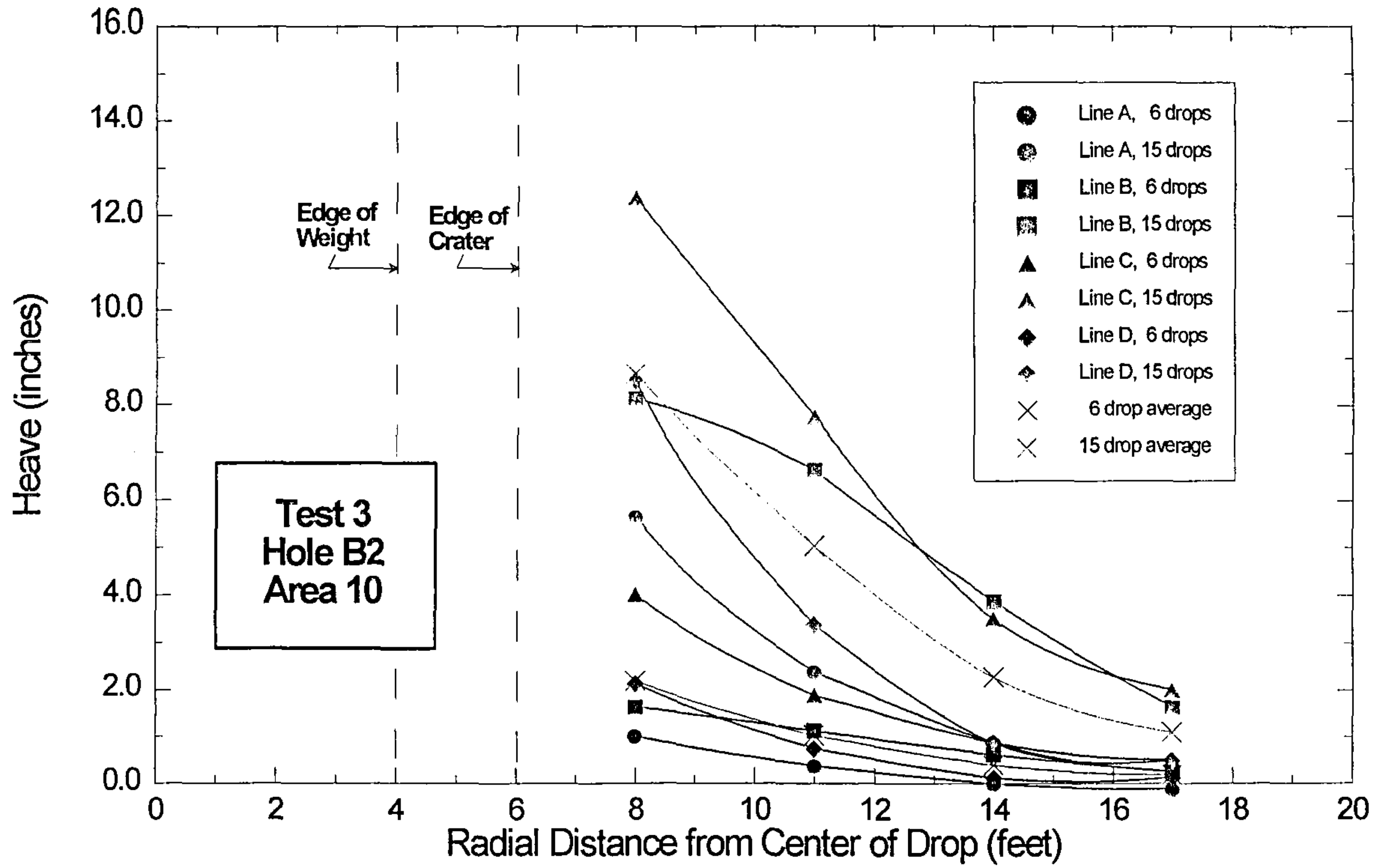


HEAVE MEASUREMENTS FOR TEST# 2

Project No.: 954E179	Date: Dec. 1995	Project: L.A. METROMALL	Fig.: 12

heave_2.grf

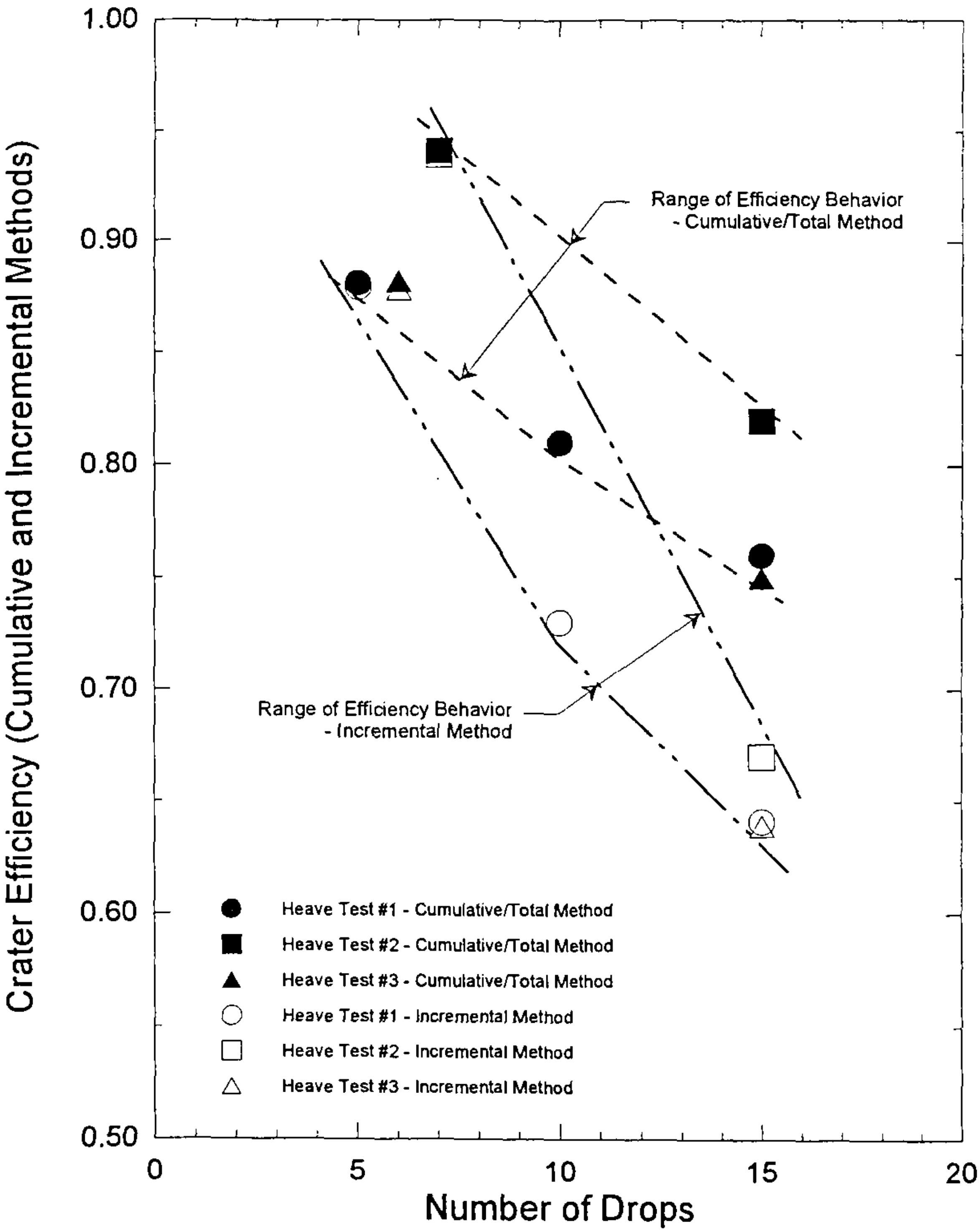
Woodward-Clyde Consultants



HEAVE MEASUREMENTS FOR TEST #3			
Project No.: 954E179	Date: Dec. 1995	Project: L.A. METROMALL	Fig.: 13

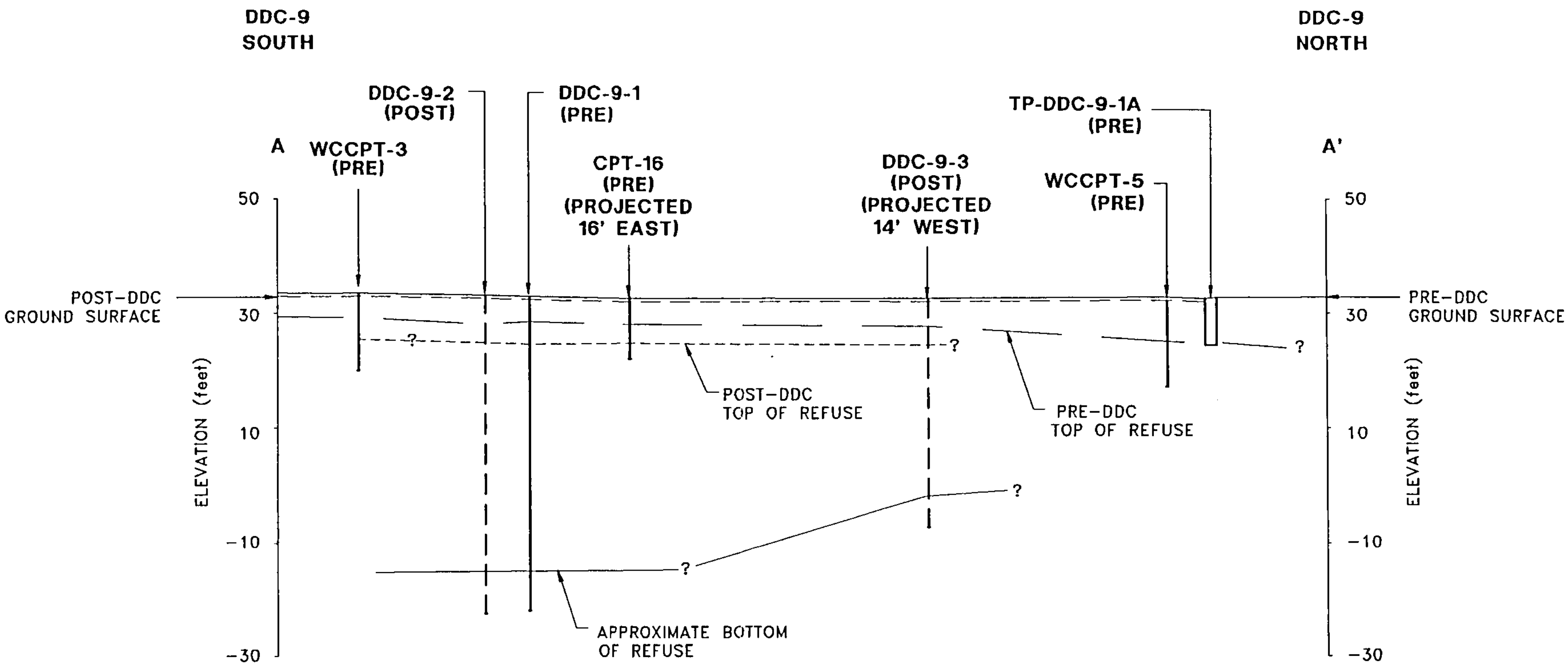
heave_3.grf

Woodward-Clyde Consultants



EFFICIENCY COMPARISON USING MEASURED HEAVE

Project No.: 954E179	Date: Dec. 1995	Project: LA Metromall	Fig.: 14



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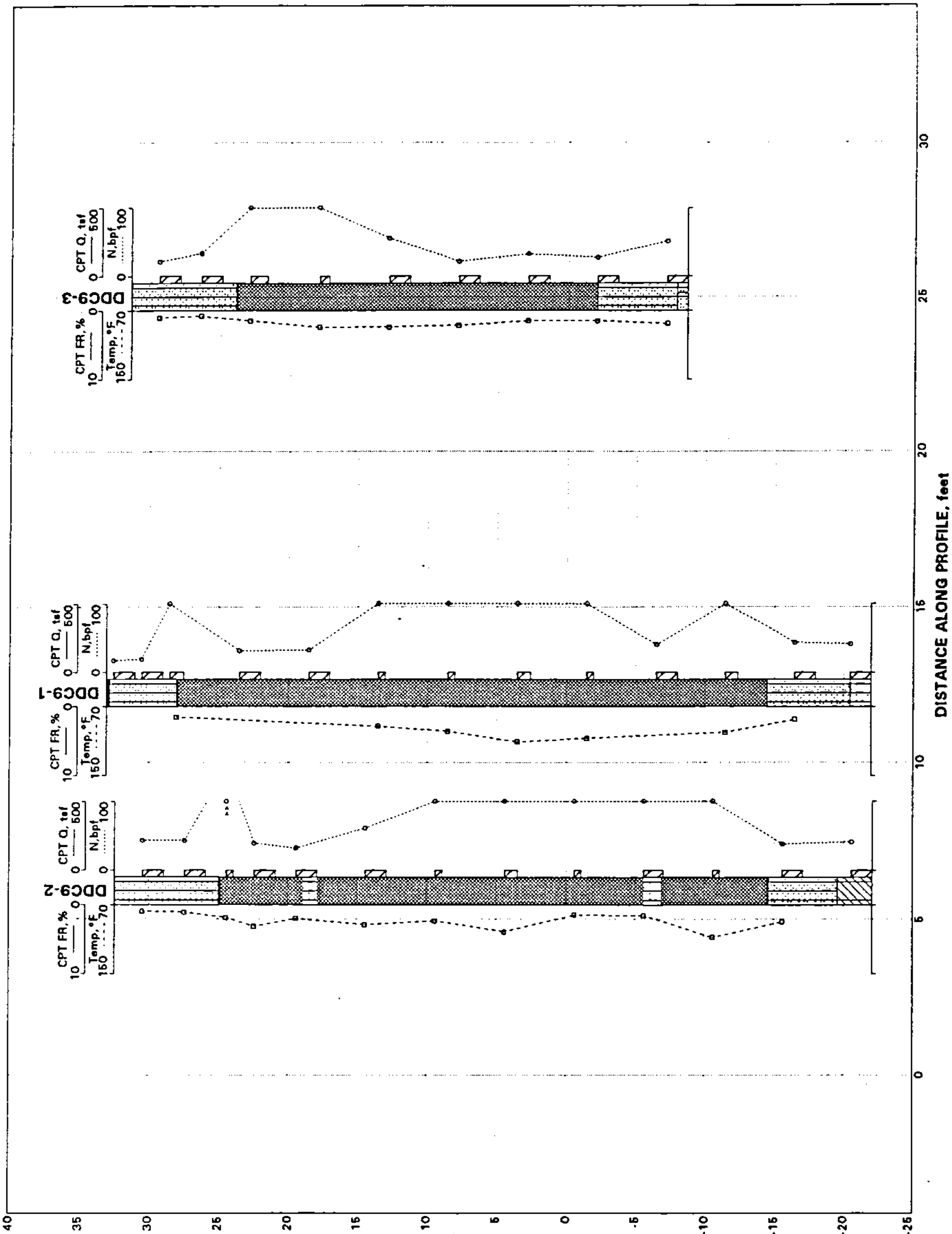
CROSS SECTION
DDC-9 A-A'
SOUTH - NORTH

Proj. No.: 954E179
Project: LA METRO MALL
Date: DEC. 1995
CAD ID.: LAXDDC9
Figure: 15

11/27/95



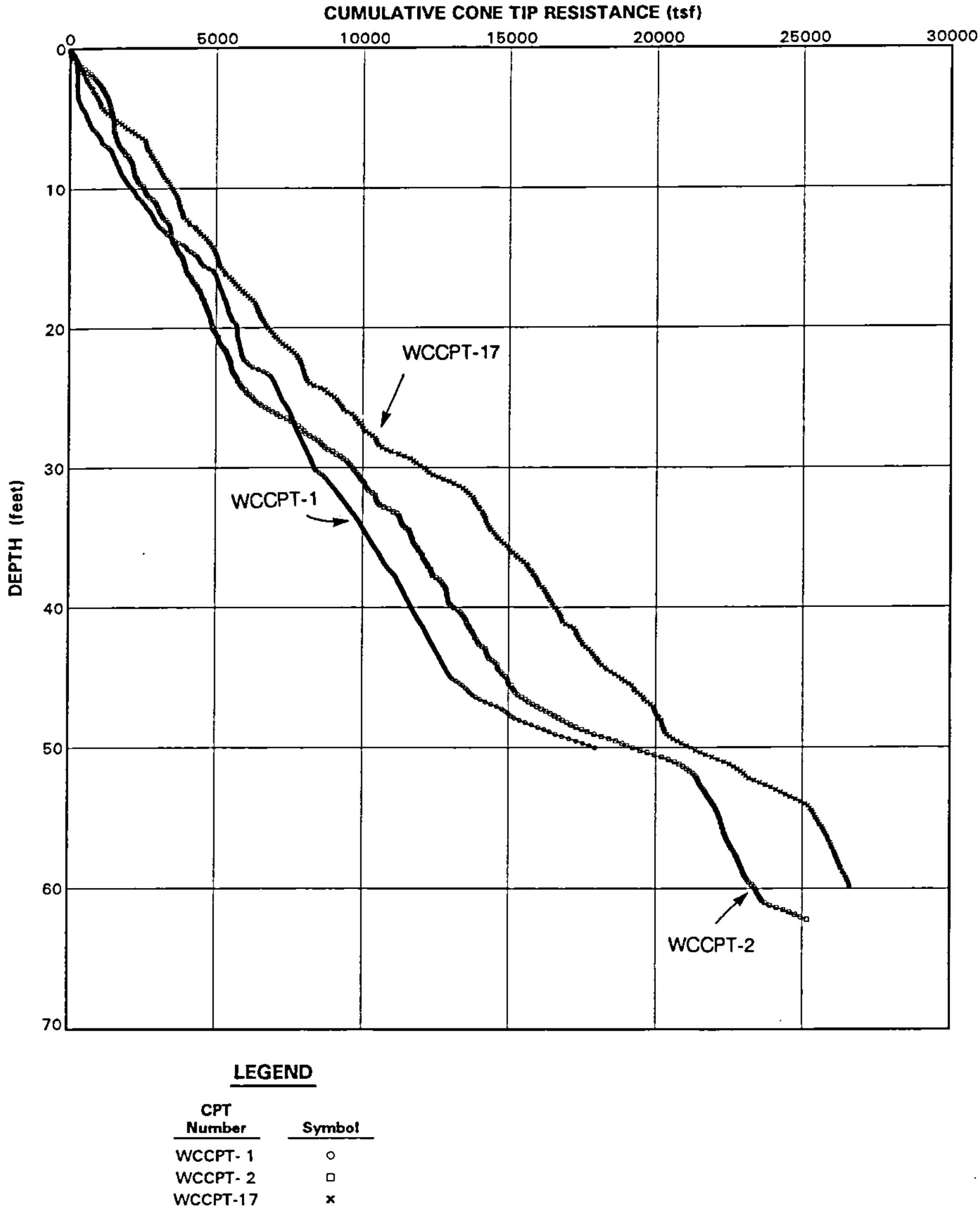
Project: LA MetroMall
Carson, California
Project Number: 954E179

SECTION DDC-9 (B-B')

Figure 16

Woodward-Clyde Consultants

SNA 12/5/95 1SECTE2 MTMAL



roject: LA MetroMall
Carson, California

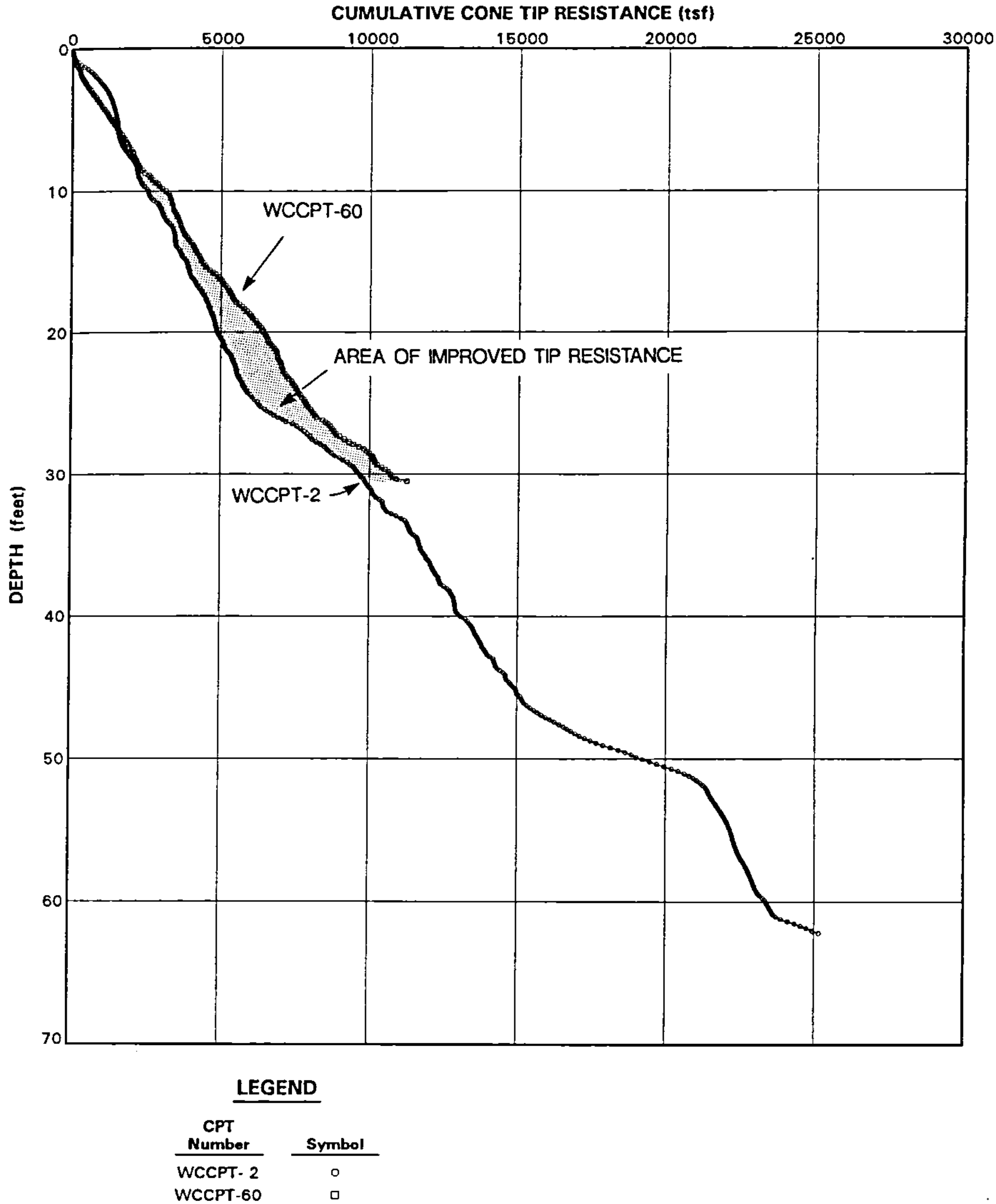
Project Number: 954E179

SNA 12/1/95 2CONECUM MTMAL

DDC-9 CUMULATIVE TIP RESISTANCE vs. DEPTH (pre-DDC)

Fig. 17

Woodward-Clyde Consultants



:roject: LA MetroMall
Carson, California

Project Number: 954E179

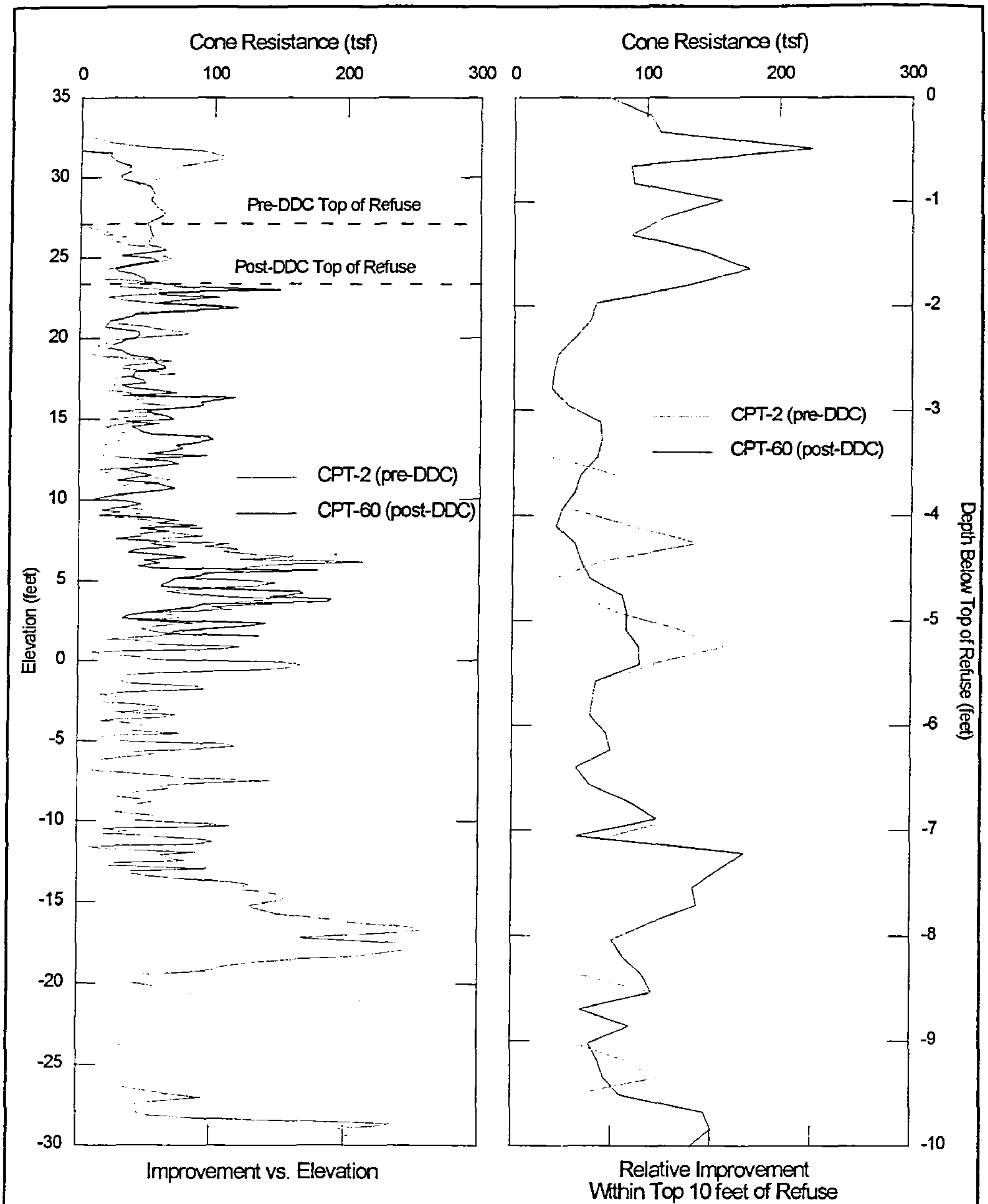
DDC-9 CUMULATIVE TIP RESISTANCE vs. DEPTH

(pre- and post-DDC)

Fig. 18A

SNA 12/1/95 2CONECUM MTMAL

Woodward-Clyde Consultants



COMPARISON OF PRE- AND POST-DDC CPT SOUNDINGS – DDC TEST AREA 9, SECTION 1

Project No.: 954E179	Date: Dec. 1995	Project: LA METROMALL	Fig. 18B

Woodward-Clyde Consultants

Date(s) Excavated	11/15/95	Logged By	E. Sabins
Excavation Contractor	GeoCon	Checked By	
Excavation Equipment	John Deere 710C	Excavation Trend	N45E
Approx. Surface Elevation (feet)	32.0	Location	South corner, DDC Test Pad #9

Log of Exploration Pit DDC9-2A

Project: LA MetroMall
Project Location: Carson, California
Project Number: 954E179

MATERIAL DESCRIPTION	FIELD TESTS	SAMPLES	LAB TESTS
SOIL COVER 1 Dry, light brown, SANDY SILT (ML) (pushed into crater). 2 Moist, dark gray, SILTY CLAY (CL). REFUSE 3 Wood, paper, brick, newspaper.			

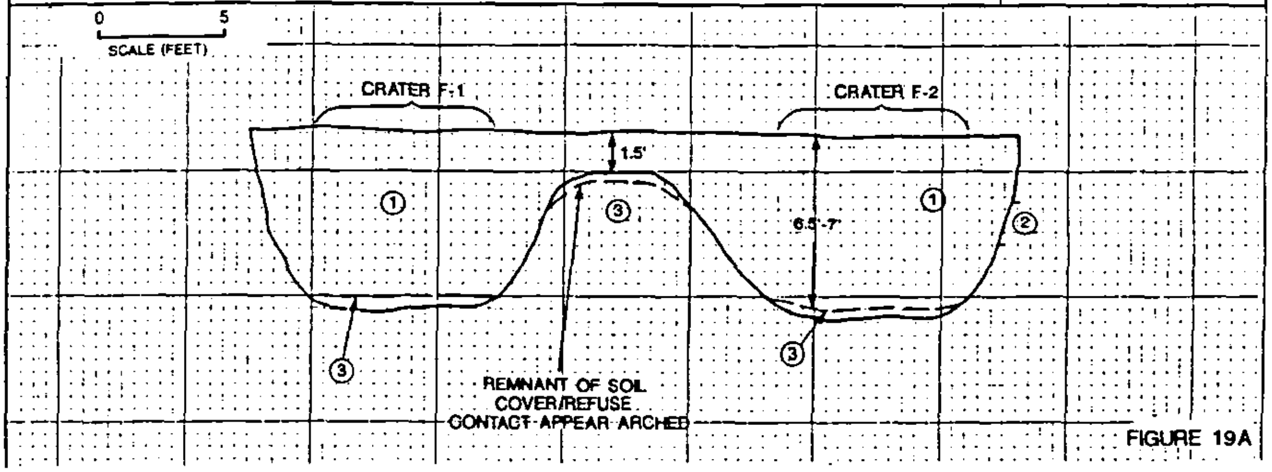


FIGURE 19A

Date(s) Excavated	11/15/95	Logged By	E. Sabins
Excavation Contractor	GeoCon	Checked By	
Excavation Equipment	John Deere 710C	Excavation Trend	N45E
Approx. Surface Elevation (feet)	31.0	Location	North corner, DDC Test Pad #9

Log of Exploration Pit DDC9-3A

Project: LA MetroMall
Project Location: Carson, California
Project Number: 954E179

MATERIAL DESCRIPTION	FIELD TESTS	SAMPLES	LAB TESTS
SOIL COVER / BACKFILL 1 Dry, light brown, SANDY SILT (ML). 2 Dry to moist, gray, SILTY CLAY (CL). 3 Moist, medium brown, SILTY CLAY (CL). REFUSE 4 Paper, wood, cardboard.			

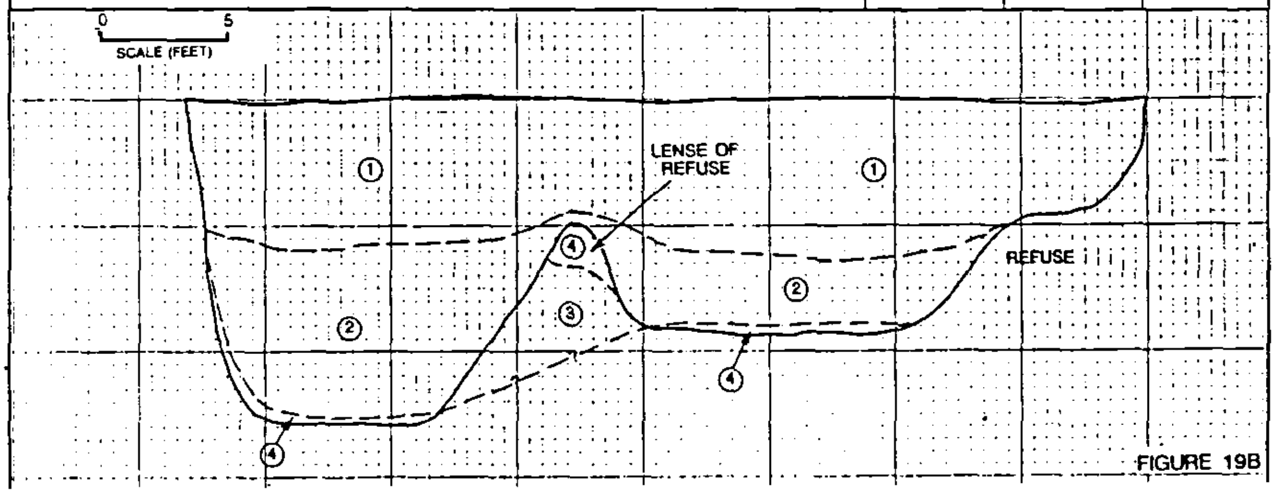
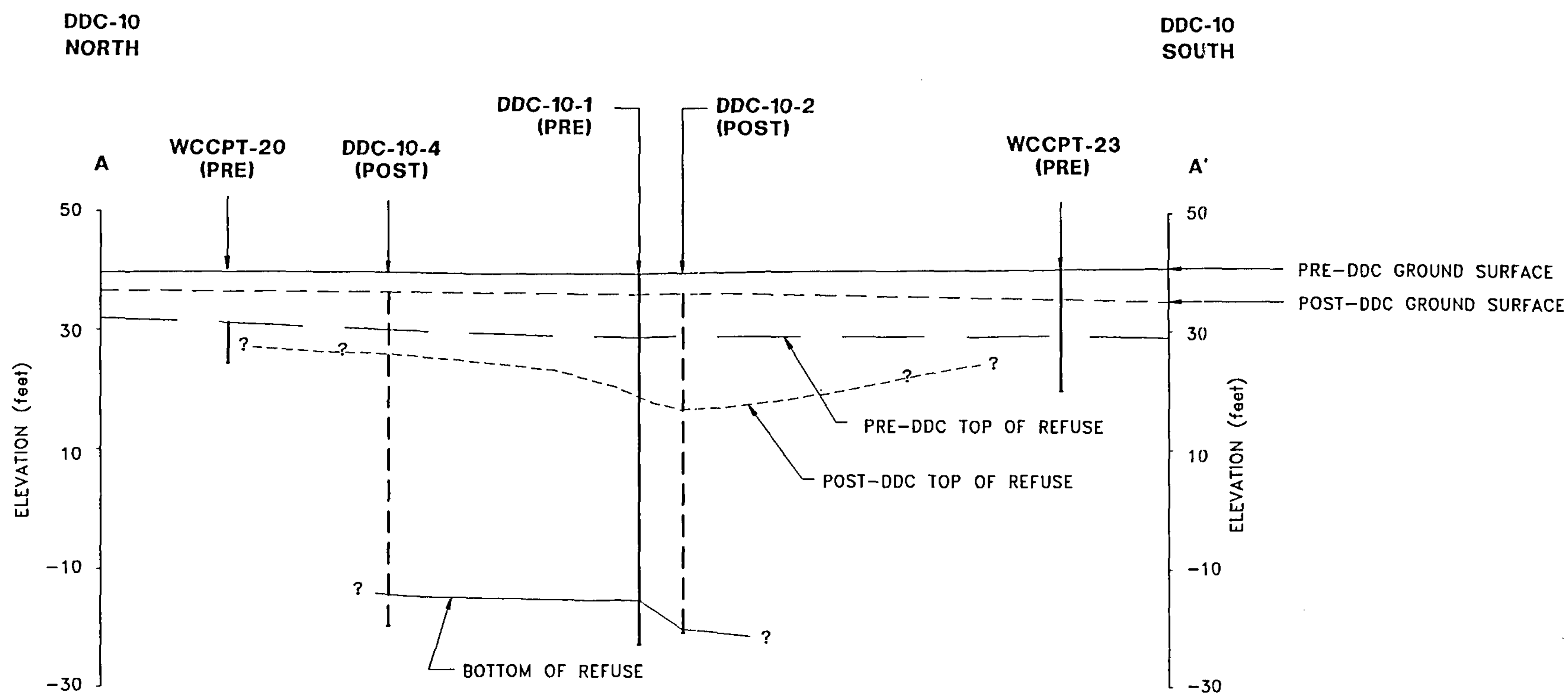


FIGURE 19B

LOGS OF TEST PITS DDC9-2A AND DDC9-3A

Project No.: 954E179	Date: NOV. 1995	Project: LA MetroMall	Fig. 19

Woodward-Clyde Consultants



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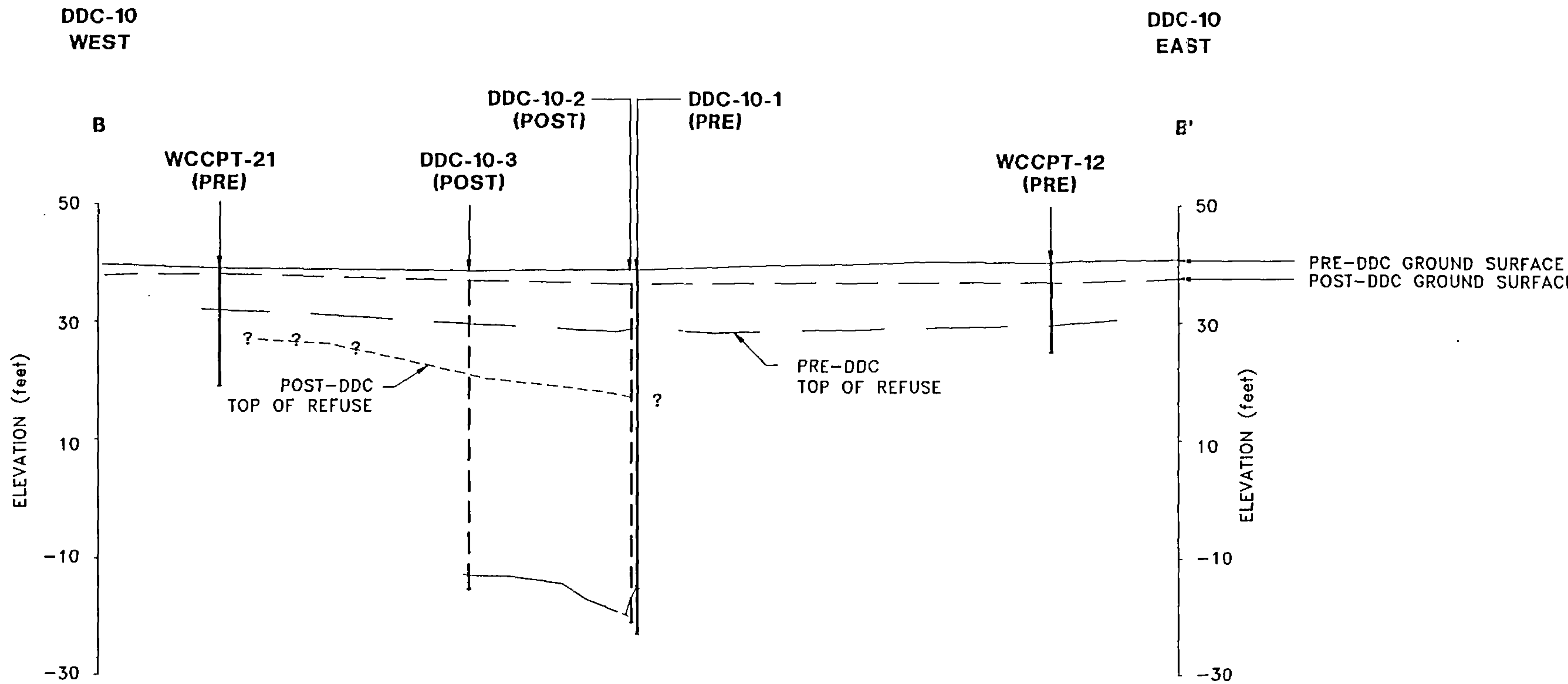
CROSS SECTION
DDC-10 A-A'
NORTH - SOUTH

Proj. No.:	954E179	Date:	DEC. 1995
Project:		CAD ID.:	LAXDC10N
	LA METRO MALL	Figure:	20

11/27/95



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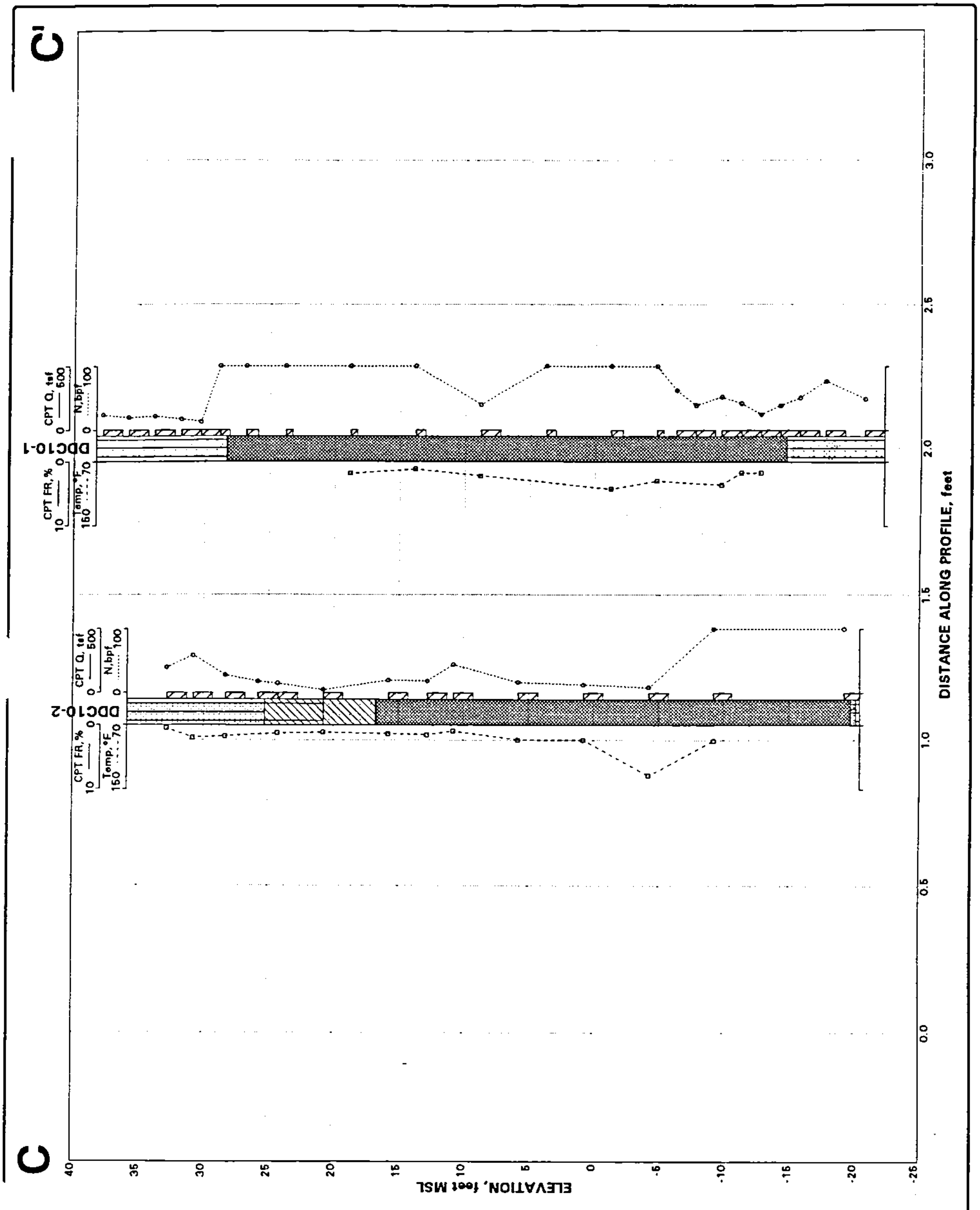
CROSS SECTION
DDC-10 B-B'
WEST - EAST

Proj. No.:	954E179	Date:	DEC. 1995
Project:		CAD ID.:	LAXDDC10
	LA METRO MALL	Figure:	21

11/27/95



oject: LA MetroMall
Carson, California
Project Number: 954E179

SECTION DDC-10 (C-C')

Fig. 22

SNA 12/1/95 1SECTE2 MTMAL

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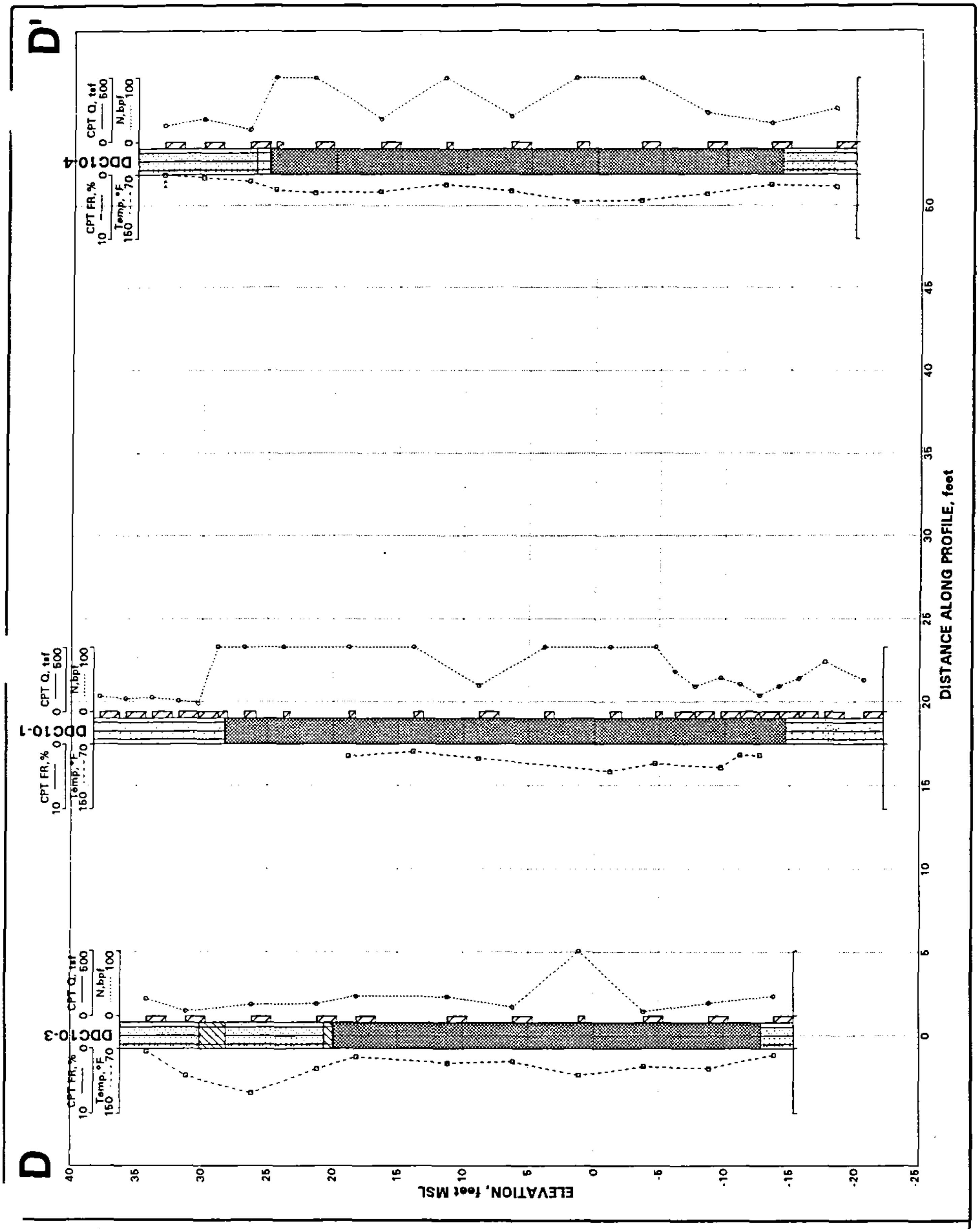

Project: LA MetroMall
Carson, California
Project Number: 954E179

SECTION DDC-10 (D-D')

Fig. 23

SNA 12/1/95 1SECTE2 MTMAL

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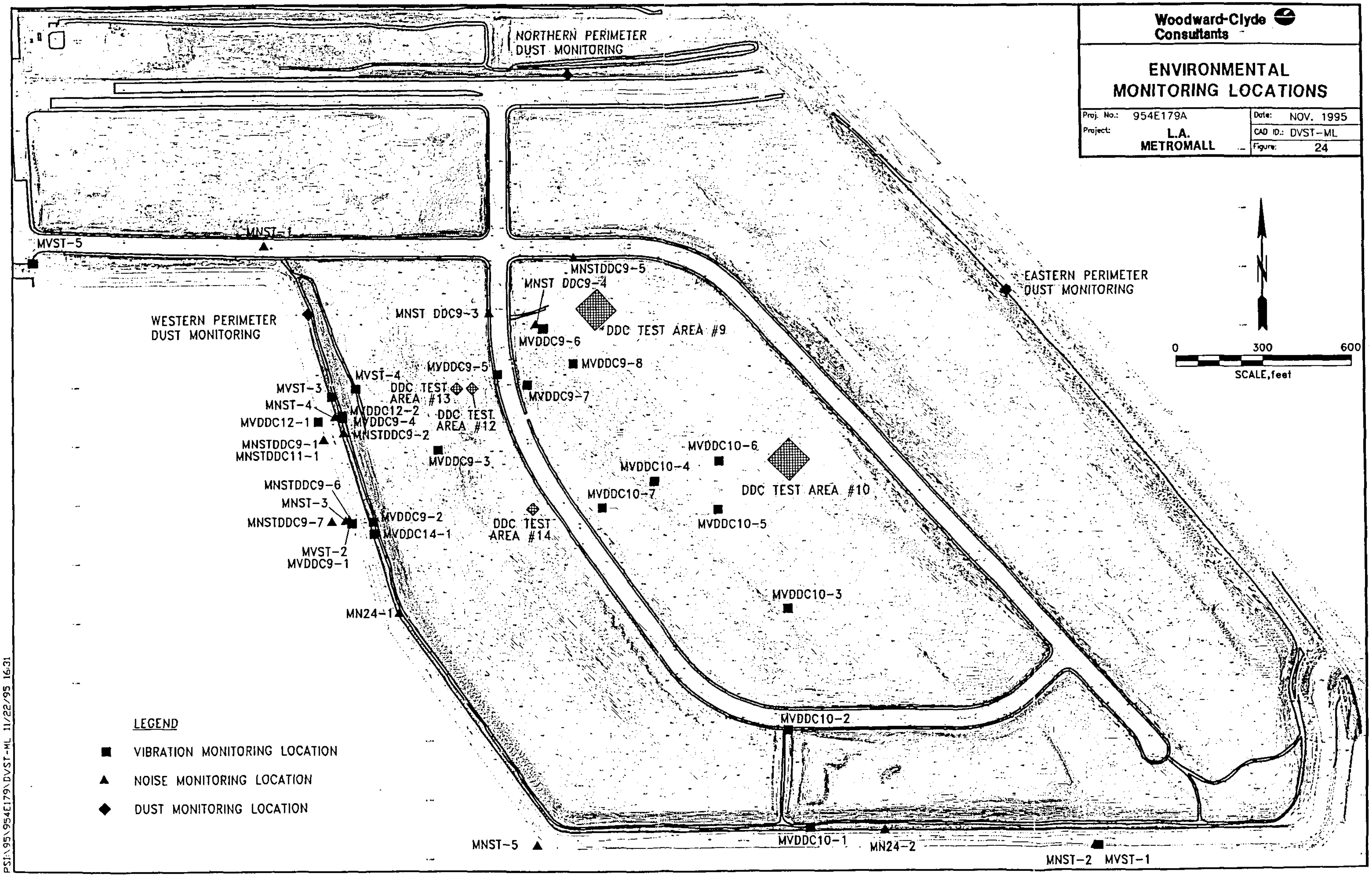
ENVIRONMENTAL MONITORING LOCATIONS

Proj. No.:	954E179A	Date:	NOV. 1995
Project:	L.A. METROMALL	CAD ID.:	DVST-ML
		Figure:	24



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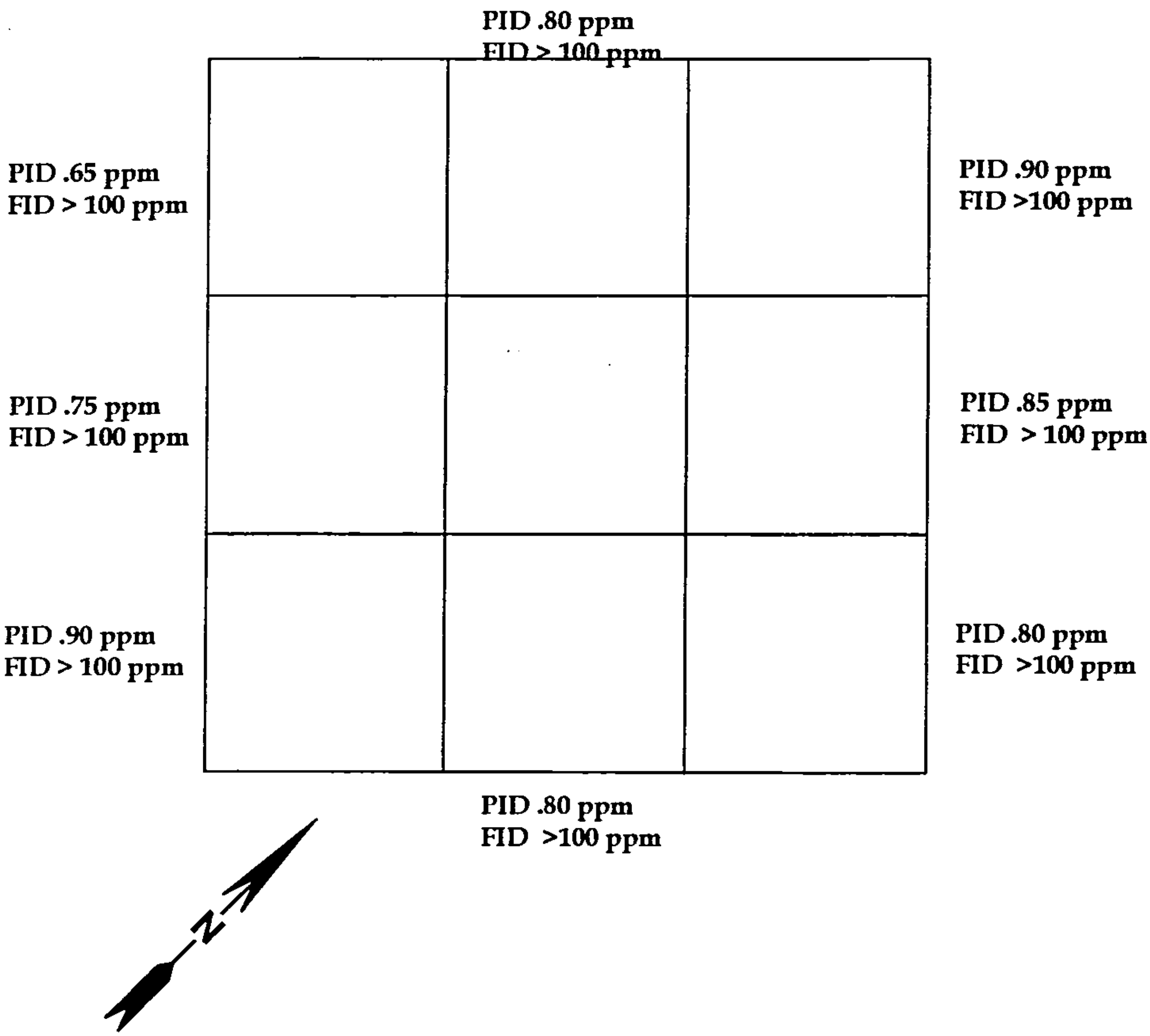

DDCT AREA - MONITORING RESULTS TEST PAD 9, SECTION 1

Project No.: 954E179	Date:	DEC. 1995	Project:	LA METRO MALL	Fig.: 25

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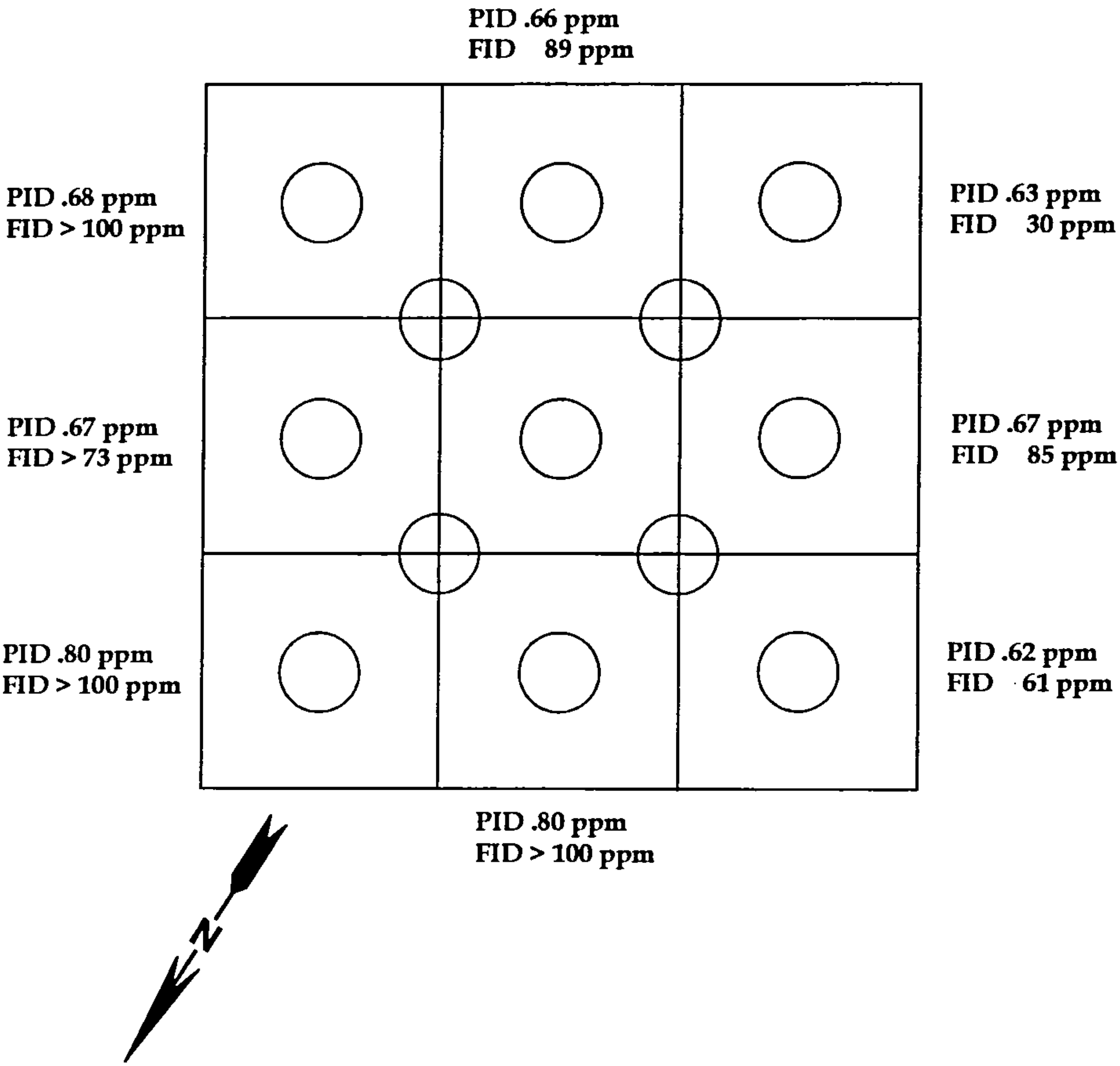

DDCT AREA - MONITORING RESULTS TEST PAD 10, SECTION 2

Project No.: 954E179	Date: SEPT. 1995	Project: LA METRO MALL	Fig.: 26

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