REPORT

FOUNDATION INVESTIGATION
PROPOSED BRIDGE
DYSART ROAD AT THE LUKE AFB DRAIN
MARICOPA COUNTY, ARIZONA

FOR MARICOPA COUNTY HIGHWAY DEPARTMENT

D.E. CLARK

Geotechnical Engineer

Registered Professional Engineer (Civil)
CERTIFICATE NO.
04905
DONALD E.
CLARK
Date Signed 8/12/88
ARIZONA, U.S.A.

REPORT

FOUNDATION INVESTIGATION
PROPOSED BRIDGE
DYSART ROAD AT THE LUKE AFB DRAIN
MARICOPA COUNTY, ARIZONA

FOR MARICOPA COUNTY HIGHWAY DEPARTMENT

D.E. CLARK
Geotechnical Engineer

ENGINEERING DIVISION

LETTER OF TRANSMITTAL

MARICOPA COUNTY
DEPARTMENT OF TRANSPORTATION
2901 W. DURANGO STREET
PHOENIX, AZ 85009

DATE: SEPT. 8, 1994
ATTENTION: DON RERICK
RE: PROJECT NO. -
DYSART RD. BRIDGE -
DYSART DRAIN

TO: F.C.D.

GENTLEMEN: WE ARE SENDING YOU THE FOLLOWING ITEMS:

☒ Attached ☐ Under separate cover via: _____

☐ Copy of letter ☐ Prints ☐ Plans ☐ Examples ☐ Change order
☐ _____

ITEM	DATE	COPIES	DESCRIPTION
1	-	1	SOILS REPORT FOR PROPOSED BRIDGE

THESE ARE BEING TRANSMITTED FOR THE PURPOSE(S) CHECKED BELOW:

☒ For your use ☐ Accepted as submitted ☐ Resubmit ____ copies for approval
☐ As requested ☐ Accepted as noted ☐ Submit ____ copies for distribution
☐ For review and comment ☐ Returned for corrections ☐ Return ____ corrected prints
☐ _____

FLOOD CONTROL DISTRICT
RECEIVED
SEP 13 '94

CHENG		P & PM	
DEP		HYDRO	
ADMIN		LMGT	
FINANCE		FILE	
C & O			
ENGR			

REMARKS

REMARKS: _____

COPY TO:

☐ Central Files
☐ Design Supervisor
☐ _____

PREPARED BY P. EPSTEIN

PHONE 506-8625

If enclosures are not as noted, kindly notify us at once.

D.E. CLARK, *Geotechnical Engineer*
17814 Conquistador Drive, Sun City West, Arizona 85375-5118 *(602) 584-6847*

August 12, 1988
Our Job No. 44B

Maricopa County Highway Department
3325 West Durango Street
Phoenix, Arizona 85009

Attention: Philip Epstein, P.E.
Chief, Design Branch

Enclosed herewith is our report titled "Foundation Investigation, Proposed Bridge, Dysart Road at the Luke AFB Drain, Maricopa County, Arizona, For Maricopa County Highway Department (MCHD Project No. 68460)."

The work was done in accordance with our proposal of April 5, 1988, duly executed by County officials, and returned with the Department's letter of June 20, 1988.

The report presents results of borings and tests, interprets the subsurface conditions, presents a chart of computed pile capacities, comments on installation procedures, and suggests an equivalent fluid pressure to use in design of the abutments. An appendix presents a design memo with pile capacity computations.

Yours very truly,

D. E. CLARK
Geotechnical Engineer

Donald E. Clark

Donald E. Clark, P.E.

DEC/dc

Copies to addressee: 4

Enclosure with each: report

August 12, 1988
Our Job No. 44B

Registered Professional Engineer (Civil)
CERTIFICATE NO.
04905
DONALD E.
CLARK
Date Signed 8/12/88
ARIZONA, U.S.A.

CONTENTS

	Page
INTRODUCTION	1
SITE CONDITIONS	2
PROPOSED CONSTRUCTION	2
PURPOSES OF THE INVESTIGATION	2
SCOPE OF THE INVESTIGATION	3
INTERPRETATION OF SUBSURFACE CONDITIONS	4
PILE CAPACITIES	4
INSTALLATION PROCEDURES	4
EQUIVALENT FLUID PRESSURES	4
CLOSURE	5

ATTACHMENTS

Plate 1 - Plot Plan
Plate 2 - Unified Soil Classification System
Plate 3 - Descriptive Terms
Plate 4 - Boring Log Notes
Plates 5 and 6 - Boring Logs
Plate 7 - Pile Capacities

APPENDIX

Design Memo and Computations

D.E. CLARK
Geotechnical Engineer

August 12, 1988
Our Job No. 44B

REPORT
FOUNDATION INVESTIGATION
PROPOSED BRIDGE
DYSART ROAD AT THE DUKE AFB DRAIN
MARICOPA COUNTY, ARIZONA
FOR MARICOPA COUNTY HIGHWAY DEPARTMENT

MCHD Project No. 68460

INTRODUCTION

This is the report of my (Donald E. Clark's) foundation investigation for a replacement bridge to carry Dysart Road over the Luke AFB Drain in Maricopa County. The site is about midway between Glendale Avenue and Northern Avenue, near the town of Litchfield Park. The attached Plot Plan, Plate 1, shows the existing bridge, the proposed replacement bridge, and nearby features.

A March 30 letter of transmittal from Philip Epstein, P.E., provided information on the types of piles that are proposed, provided estimates of loads the individual piles are to carry, and transmitted a copy of a Location Plan prepared by the Maricopa County Highway Department, dated November 27, 1987. I have since talked with Mr. Epstein by phone, and have looked at the site.

Based on the documents and activities described in the previous paragraph, the report describes my understanding of the site conditions, the proposed construction, and the purposes of the investigation. It then describes the scope of the investigation, interprets subsurface soil and groundwater conditions, presents a chart of computed pile capacities, comments on installation procedures, and suggests an equivalent fluid pressure to use in design of the bridge abutments. Appended are a design memo and its attached computations that together provide the basis for the capacity chart.

D.E. CLARK
Geotechnical Engineer

SITE CONDITIONS

The site is within a nearly level area of deep alluvium with a relatively deep groundwater level. Surrounding land uses consist of an open field, a school yard, and commercial property used for solution mining of salt.

The canal is lined with concrete and has roads down each side at an elevation slightly above that of the adjacent land. In the vicinity of the bridge there are overhead utility lines, buried utility lines, and buried pipelines.

PROPOSED CONSTRUCTION

The proposed bridge is to be supported on either 12-inch-diameter pipe piles or 18-inch-diameter, drilled, cast-in-place concrete piles. The piles are to be in widely separated rows, and center-to-center spacing of the piles is to be more than three diameters. Total design loads on the individual piles are to range up to 55 tons. The allowable settlement of any individual pile is approximately a half inch.

PURPOSES OF THE INVESTIGATION

The purposes of the investigation were to explore subsurface soil and groundwater conditions, to develop a chart of computed pile capacities, to consider whether there may be notable problems with pile installation, and to suggest a value of equivalent fluid pressure to use in design of the bridge abutments.

SCOPE OF THE INVESTIGATION

At locations shown on the Plot Plan, we drilled two, 40-foot-deep borings with a seven-inch-diameter, hollow-stem auger. I logged the borings and obtained 11 "undisturbed" samples of soils encountered. I later reexamined the samples and selected those to be tested.

The soils were classified in accordance with the procedures in ASTM Designation: D 2488-85, Standard Practice for Description and Identification of Soils (Visual-Manual Procedure). General features of the classification system are illustrated on Plate 2, Unified Soil Classification System. Plate 3, Descriptive Terms, lists and describes other terms used on the boring logs. Other data are presented on Plate 4, Boring Log Notes, and on Plates 5 and 6, Boring Logs. The boring logs show the blows per foot needed to drive the sampler, and show approximate Standard Penetration Test N-values computed from the relationships described on Plate 3.

All of the undisturbed samples were tested for moisture content and dry density, and two of them were tested to obtain six direct shear test points. Results of the moisture content and dry density tests are presented on the boring logs. Results of the direct shear tests are presented in the following table:

DIRECT SHEAR TESTS

	Surcharge Pressure, psf	Peak Shear Strength, psf
Boring 1 @ 15 feet	1000	1850
	2000	2150
	3000	2350
Boring 2 @ 30 feet	1000	1950
	2000	2450
	3000	2750

Using the data from the borings and tests, I performed engineering analyses oriented toward the purposes of the investigation.

INTERPRETATION OF SUBSURFACE CONDITIONS

With the exception of some surficial fill apparently placed for road construction, the soils in the borings were basically cohesive: primarily sandy clay, secondarily clayey sand. In consistency they ranged from stiff to hard.

The samples were mostly logged as "damp," some as "moist," and one as "wet." No groundwater was encountered.

PILE CAPACITIES

Plate 7, Pile Capacities, presents a chart of pile penetration vs. carrying capacity for each of the two types of pile. Appended are a design memo and its attached computations that together provide the basis for the capacity chart.

INSTALLATION PROCEDURES

At this stage of design, there is no information about driving equipment, drilling equipment, other installation equipment, or installation procedures.

I do not see that the data suggests a liklihood of notable installation problems. However, (1) the 55-ton drilled piles have a penetration of about 45 feet (Plate 7), a depth large enough to have a potential for installation problems, and (2) the driven piles may encounter some hard driving below depths of about 20 to 30 feet, which may cause soil vibrations sufficient to affect buried utilities and pipelines.

EQUIVALENT FLUID PRESSURES

Assuming granular backfill material similar to the existing road fill, I suggest designing the abutments to resist an equivalent fluid pressure of 30 pounds per cubic foot.

CLOSURE

The report is completed by the attached plates, and the attached design memo and computation sheets.

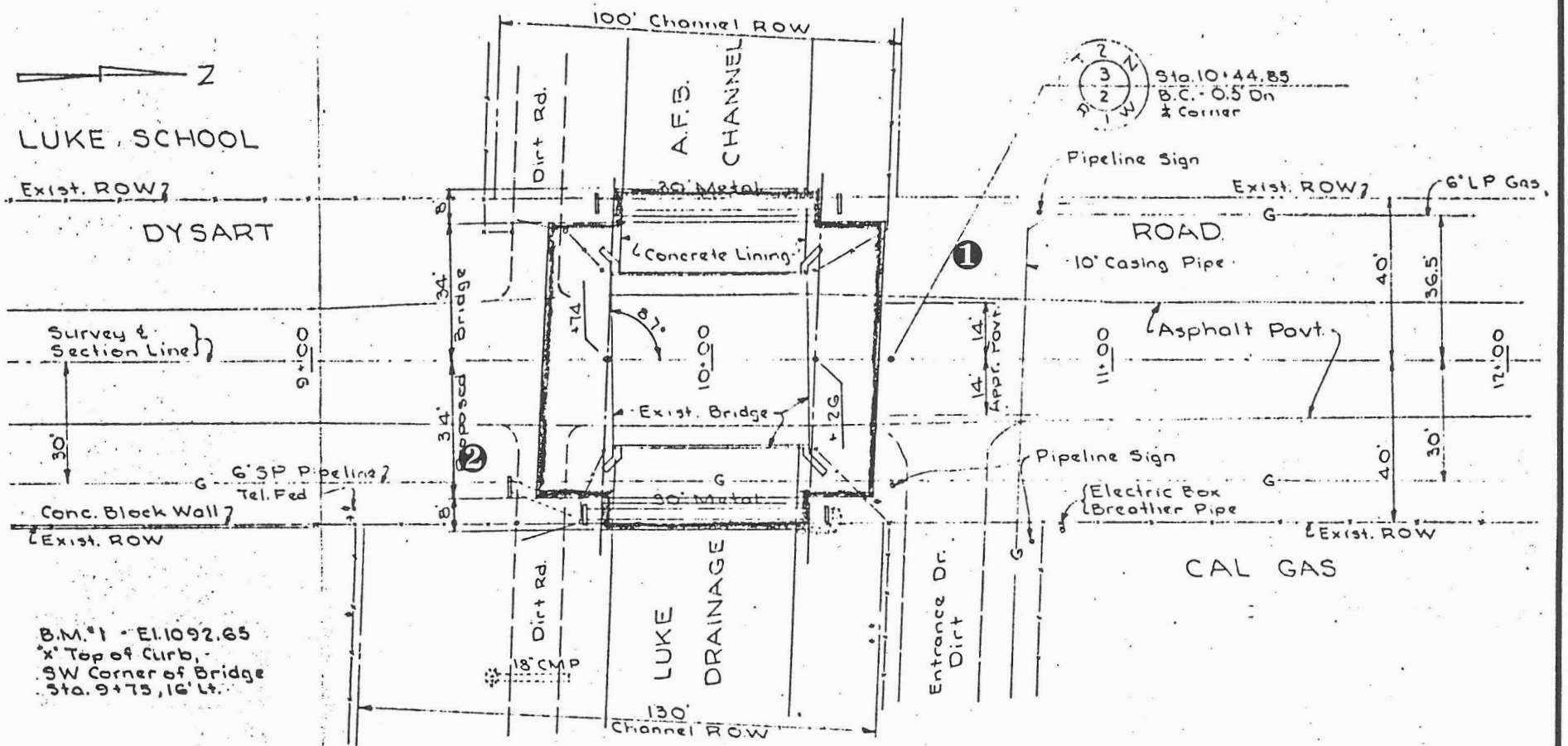
DEC/dc

D.E. CLARK
Geotechnical Engineer

JOB NO. 44B CLIENT/OWNER Maricopa Co. Hwy Dept JOB LOCATION Litchfield Park

PREPARED BY: D. Clark DRAFTED BY: MCHD CHECKED BY: D. Clark DATE 8/12/88

PLOT PLAN



PLAN
Scale: 1" = 20'

REDUCED TO
1" = 40'

1 = BORING NUMBER

REFERENCE: A plan prepared by the Maricopa County Highway Department, titled "Location Plan, Dysart Road - Luke AFB Drain," dated 11/27/87, identified as MCHD Project No. 68460, Drawing No. P-1.

D.E. CLARK

Plate 1

COARSE-GRAINED SOILS

LESS THAN 50% FINES*

GROUP SYMBOLS	DESCRIPTION	MAJOR DIVISIONS
GW	WELL-GRADED GRAVELS OR GRAVEL-SAND MIXTURES, LESS THAN 5% FINES	GRAVELS More than half of coarse fraction is larger than No. 4 sieve size
GP	POORLY-GRADED GRAVELS OR GRAVEL-SAND MIXTURES, LESS THAN 5% FINES	
GM	SILTY GRAVELS, GRAVEL-SAND-SILT MIXTURES, MORE THAN 12% FINES	
GC	CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES, MORE THAN 12% FINES	
SW	WELL-GRADED SANDS OR GRAVELLY SANDS, LESS THAN 5% FINES	SANDS More than half of coarse fraction is smaller than No. 4 sieve size
SP	POORLY-GRADED SANDS OR GRAVELLY SANDS, LESS THAN 5% FINES	
SM	SILTY SANDS, SAND – SILT MIXTURES, MORE THAN 12% FINES	
SC	CLAYEY SANDS, SAND-CLAY MIXTURES, MORE THAN 12% FINES	

NOTE:
Coarse grained soils receive dual symbols if they contain 5 to 12% fines (e.g. SW-SM, GP-GC, etc.)

FINE-GRAINED SOILS

MORE THAN 50% FINES*

GROUP SYMBOLS	DESCRIPTION	MAJOR DIVISIONS
ML	INORGANIC SILTS, VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS	SILTS AND CLAYS Liquid limit less than 50
CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS	
OL	ORGANIC SILTS OR ORGANIC SILTY-CLAYS OF LOW PLASTICITY	
MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SANDS OR SILTS, ELASTIC SILTS	SILTS AND CLAYS Liquid Limit more than 50
CH	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS	
OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY	
PT	PEAT, MUCK, AND OTHER HIGHLY ORGANIC SOILS	HIGHLY ORGANIC SOILS

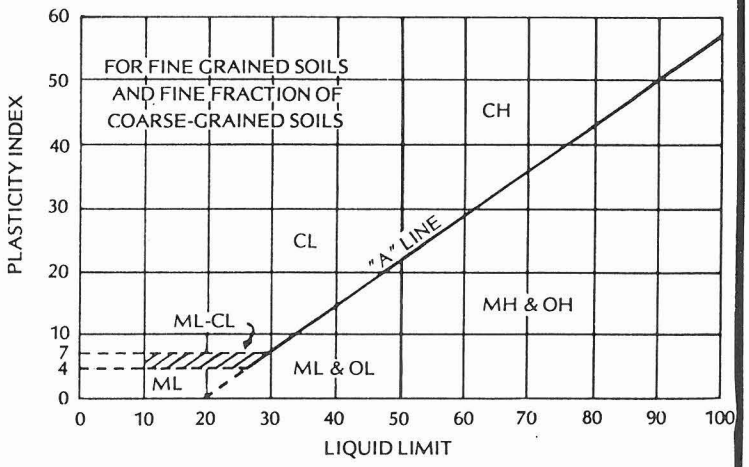
NOTE:
Fine grained soils receive dual symbols if their limits plot in the hatched zone on the Plasticity Chart (ML-CL)

SOIL SIZES

COMPONENT	SIZE RANGE
BOULDERS	ABOVE 12 in.
COBBLES	3 in. to 12 in.
GRAVEL	No. 4 to 3 in.
Coarse	¾ in. to 3 in.
Fine	No. 4 to ¾ in.
SAND	No. 200 to No. 4
Coarse	No. 10 to No. 4
Medium	No. 40 to No. 10
Fine	No. 200 to No. 40
*FINES (Silt or Clay)	BELOW No. 200

NOTE:
Only sizes smaller than three inches are used to classify soils.

PLASTICITY CHART



UNIFIED SOIL CLASSIFICATION SYSTEM

D.E. CLARK **Plate 2**

JOB NO. ___ CLIENT/OWNER ___ JOB LOCATION ___

PREPARED BY: D. CLARK DRAFTED BY: ___ CHECKED BY: ___ DATE 3/15/88

DESCRIPTIVE TERMS FOR SOIL BORING LOGS

GENERAL: Always include the soil color and classification (Group Name and Group Symbol), always designate any fill that is present, and generally estimate the moisture condition and the relative density or cohesive strength.

COLOR: Use simple descriptions sufficient to aid later identification of strata in excavations, colors such as white, tan, brown, dark brown, reddish-brown, olive, gray, dark gray, etc. Describe any mottling. Describe the color at the field moisture condition.

MOISTURE CONDITION: Use only the terms dry, damp, moist, wet, and saturated.

RELATIVE DENSITY OF GRANULAR SOILS: (Ref 1)

Very Loose	N=0-4*	RD=0-50	Push 1/2" Reinforcing Rod by Hand
Loose	N=5-10	"	"
Firm	N=11-20	RD=50-70	Easily Drive 1/2" Reinforcing Rod
Very Firm	N=21-30	"	"
Dense	N=31-50	RD=70-90	Drive 1/2" Reinforcing Rod 1 Foot
Very Dense	N>50	RD=90-100	Drive 1/2" Reinforcing Rod a Few Inches

* N= blows per foot in the Standard Penetration Test. In granular soils, with the 3" d ring sampler, 140-lb weight, divide the blow count by 2 to get N (Ref 2).

CONSISTENCY OF COHESIVE SOILS: (Ref 1)

Very Soft	N=0-1**	C=0-250 psf	Squeezes Between Fingers
Soft	N=2-4	C=250-500 psf	Easily Molded
Firm	N=5-8	C=500-1000 psf	Molded by Strong Pressure
Stiff	N=9-15	C=1000-1500 psf	Dented by Finger Pressure
Very Stiff	N=16-30	C=1500-2000 psf	Dented Slightly by Finger Pressure
Hard	N>30	C>2000 psf	Dented Slightly by Pencil Point

** N=Blows per foot in the Standard Penetration Test. In cohesive soils, with the 3" d ring sampler, 140-lb weight, divide the blow count by 1.2 to get N (Ref 2).

FIELD IDENTIFICATION PROCEDURES: (Ref 3)

Clays are plastic, are tough, and exhibit high dry strength
Silts are non-plastic, exhibit little dry strength, and respond to the dilatency test

OTHER DESCRIPTIVE TERMS: (Ref 3)

Angularity: angular, subangular, subrounded, rounded
Range in particle size
HCl reaction: none, weak, strong
Cementation: weak, moderate, strong
Structure: stratified, laminated, fissured, slickensided, blocky, lensed, homogeneous
Odor, gases
Vesicles, root holes, and roots
Caliche and other salts

xxxx

JOB NO. 44B CLIENT/OWNER Maricopa County Hwy Dept JOB LOCATION Litchfield Park

PREPARED BY: D. Clark DRAFTED BY D. Clark CHECKED BY D. Clark DATE 8/12/88

GENERAL NOTES FOR BORING LOGS:

These notes, and the boring logs, are intended for use only in conjunction with the text, and for only the purposes the text outlined for our services.

The plate "Method of Soil Classification" illustrates the method used to classify the soils. The soils were visually classified in the field; the classifications were modified by visual examination of samples in the laboratory, supported, where indicated on the logs, by tests of liquid limit, plasticity index, and/or gradation. In addition to the interpretations for sample classification, there are interpretations of where stratum changes occur between samples, where gradational changes substantively occur, and when minor changes within a stratum are significant enough to log.

There may be variations in subsurface conditions between borings. Soil characteristics change with variations in moisture content, with exchange of ions, with loosening and densifying, and for other reasons. Groundwater levels change with seasons, with pumping, from leaks, and for other reasons. Thus, boring logs depict interpretations of subsurface conditions only at the locations indicated and only on the date(s) noted.

In general, terms on the logs conform with ASTM D 653, Standard Definitions of Terms and Symbols Relating to Soil and Rock Mechanics.

SPECIAL NOTES FOR THIS REPORT:

1. The borings were drilled on June 24, 1988, using a truck-mounted, CME 75 drill rig turning a seven-inch-diameter, hollow-stem auger.

2. Borings were positioned in the field by measuring from existing improvements. The boring locations are shown on the Plot Plan, Plate 1.

3. Boring elevations were estimated from existing surface profiles shown on the plan referenced on Plate 1.

4. Both borings were stopped at their planned depth of 40 feet.

5. The following symbol ☐ denotes an "undisturbed" sample taken in a ring-lined, 2.42-inch ID, 3.00-inch OD sampler driven with a 140-pound weight dropped 30 inches (ASTM D 3550).

6. The following symbol ⊡ denotes an attempted undisturbed sample with no recovery or with the sample partially disturbed.

7. The soils' Group Names (e.g. Sandy Clay) and Group Symbols (e.g. CL) were visually assigned in accordance with procedures in ASTM D 2488; other terms are described on Plate 3.

8. Groundwater was not encountered in either boring.

T1-4 (6-84)

JOB NO. 445 CLIENT/OWNER MCHD JOB LOCATION Lightning Fork DATE 8/12/88

PREPARED BY: D. Clark DRAFTED BY: D. Clark CHECKED BY: D. Clark

BORING 1

ELEVATION 1087 FEET

DEPTH (FT.)	LABORATORY: GRAVEL (%)	SAND (%)	FINES (%)	LIQUID LIMIT	PLASTICITY INDEX	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	FIELD: SOUNDING (BLOWS/FT.)	SAMPLES (BLOWS/FT.)
0								*	
								50+	50/0"
10						26.2	96	40	48
						33.0	92	15	18
20						29.8	94	38	45
30						19.9	107	30+	50/10'
40						25.9	98	25	30
50									

SAMPLES

SM	Brown Silty Sand, fine grained, damp, firm FILL down to 2.5(?) feet
	Light gray Caliche, damp, hard
CL	Brown Sandy Clay, moist, very stiff
	Hard
	Wet, stiff, more clayey
CL	Gray Sandy Clay, damp, hard
SC	Brown Clayey Sand, damp, hard
	Very stiff

Boring stopped at 40 feet; planned depth

* Approximate Standard Penetration Test N-Values computed from the relationships described on Plate 3.

LOG OF BORING | **D.E. CLARK** | **Plate 5**

JOB NO. 44B CLIENT/OWNER MCHD JOB LOCATION Litchfield Park DATE 8/12/88

PREPARED BY: D. Clark DRAFTED BY: D. Clark CHECKED BY: D. Clark

BORING 2

ELEVATION 1088 FEET

DEPTH (FT.)	LABORATORY: GRAVEL (%)	SAND (%)	FINES (%)	LIQUID LIMIT	PLASTICITY INDEX	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	FIELD: SOUNDING (BLOWS/FT.)	SAMPLES (BLOWS/FT.)
0								*	
						11.1	118	30+	50/ 11"
10						28.3	92	23	28
						25.5	98	20	24
20						23.4	96	30+	50/ 6"
30						16.3	108	30+	50/ 10"
						8.5	118	30+	50/ 8"
40									
50									

SAMPLES

SM	Brown Silty Sand, fine grained, damp, firm FILL down to 2.5(?) feet
SC	Brown Clayey Sand With Gravel, damp, hard
CL	Brown Sandy Clay, moist very stiff
CL	Gray Sandy Clay, damp, very stiff
CL	Hard
SC	Brown Clayey Sand, damp, hard
CL	Gray Sandy Clay With Gravel, damp, hard
CL	Alternately brown and sandy
CL	More gravel, dense

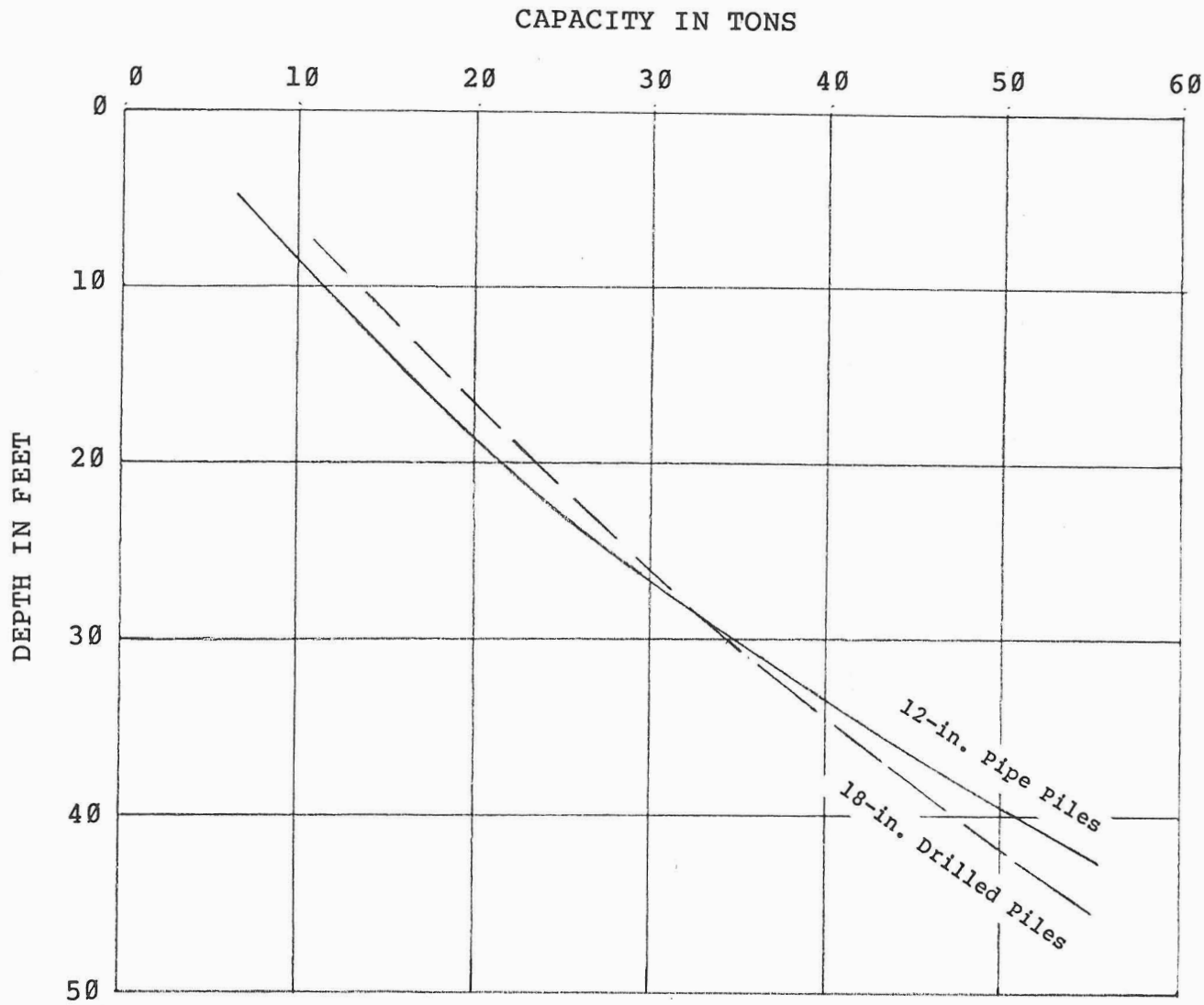
Boring stopped at 40 feet; planned depth

* Approximate Standard Penetration Test N-Values computed from the relationships described on Plate 3.

LOG OF BORING | **D.E. CLARK** | **Plate 6**

JOB NO. 4AB CLIENT/OWNER MCHD JOB LOCATION Litchfield Park DATE 8/12/88

PREPARED BY: D. Clark DRAFTED BY: D. Clark CHECKED BY: D. Clark



NOTES:

1. The pile capacities are based on the design memo and computations appended to the report.

2. The computations include a safety factor of 2.5.

3. The pile capacity curves start at depths equal to five diameters.

4. The capacities apply to dead-plus-real-live, frequently applied loads. The capacities can be increased by 1/3 when the design forces include transient loads from such things as wind and earthquakes.

PILE CAPACITIES	D.E. CLARK	Plate 7

APPENDIX

DESIGN MEMO AND COMPUTATIONS

D.E. CLARK
Geotechnical Engineer

MEMO

TO: File 44B, Maricopa County Highway Department, in the Litchfield Park Area

FROM: Don Clark

DATE: August 12, 1988

SUBJECT: Design Memo for the Pile Capacity Computations

This memo and its attached computations provide the basis for the capacity chart in the report for Job No. 44B, prepared for the Maricopa County Highway Department.

The computations are based on the book Pile Design and Construction Practice, by M. J. Tomlinson, Viewpoint Publications, London, 3rd Ed., 1987. Unless otherwise noted, page references are to this book.

The memo describes the assigned soil parameters, describes the groundwater assumptions, describes the pile data, presents installation comments, describes computational assumptions, and indexes the attached computation sheets.

ASSIGNED SOIL PARAMETERS

With the exception of some surficial fill, the soils logged in the borings are basically cohesive: primarily sandy clay, and secondarily clayey sand.

Based on the direct shear test data, the soils were assigned a cohesion of 1,650 pounds per square foot at the surface, increasing with depth at a rate defined by an angle of 11 degrees (See Sheet 1 of the computations).

Based on the moisture-density tests, the soils were assigned a wet unit weight of 122 pounds per cubic foot.

D.E. CLARK
Geotechnical Engineer

GROUNDWATER ASSUMPTIONS

Groundwater was not encountered in the borings, is not considered in the design computations, and, assuming no change in canal leakage or nearby surface irrigation, is not expected to be a factor in pile installation.

PILE DATA

Pipe Piles (Driven Displacement Piles)

I understand that these are to be steel pipes, 12 inches in outside diameter, driven with a closed end, filled with concrete, and reinforced, at least near their upper ends.

Drilled, Cast-In-Place Concrete Piles (Bored, Cast-In-Place, Non-Displacement Piles).

I understand that these are to be drilled with an 18-inch-diameter auger, promptly filled with concrete, and reinforced, at least near their upper ends.

INSTALLATION COMMENTS

At this stage of design, there is no information about driving equipment, drilling equipment, other installation equipment, or installation procedures.

I do not see that the data suggests a liklihood of notable installation problems, although there may be some hard driving below depths of about 20 to 30 feet.

COMPUTATIONAL ASSUMPTIONS

Safety Factor

The computations use a safety factor of 2.5 (p. 100). The plotted results are for dead-plus-real-live loads, frequently applied. The plotted capacities can be increased by 1/3 when the design forces include transient loads from such things as wind and earthquakes.

Minimum Pile Depths

The computed capacities would not be valid at depths less than five pile diameters (p. 100 and p. 113), so the pile capacity curves start at depths of five diameters.

COMPUTATIONS

Seven sheets of computations are attached:

Sheet 1 contains the shear summary plot and the plot of depth vs. cohesive strength derived from the shear summary and the wet unit weight.

Sheets 2 and 3 contain capacity computations for the 12-inch-diameter pipe piles.

Sheets 4 and 5 contain capacity computations for the 18-inch-diameter drilled piles.

Sheet 6 presents a plot of the computed pile capacities vs. penetration depths.

Sheet 7 contains check computations.

DEC/dc

Attached: seven computation sheets

D.E. CLARK
Geotechnical Engineer

COMPUTATION SHEET

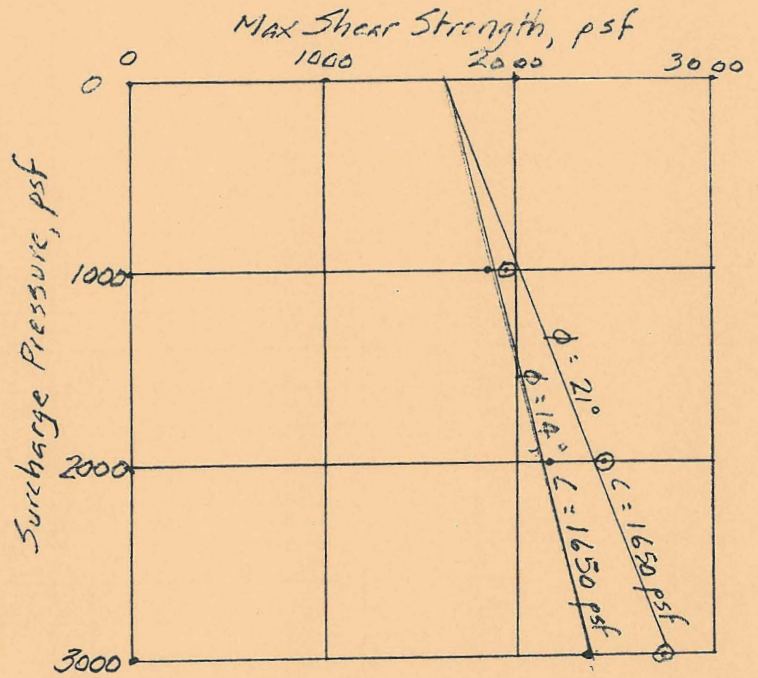
Subject: Pile Capacities (max. load 55 tons)

Sheet 1 of 7

Job No. 44B Client MLHD

Computed By D. Clark Date 8/11/88

Checked By D. Clark Date 8/12/88



Direct Shear Tests

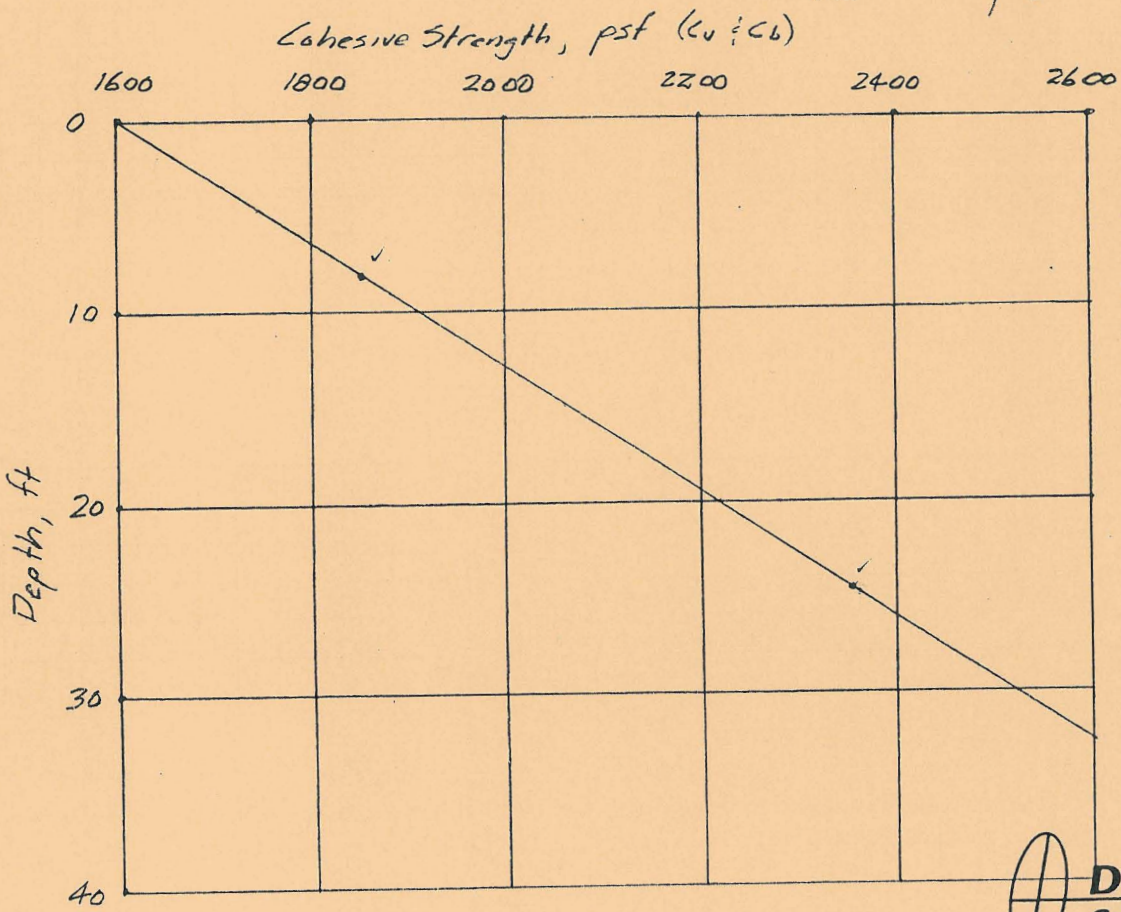
- • Bor 1 @ 15'
- ⊙ Bor 2 @ 30'

For design, use:

$\phi = 0$

$c = 1650$ psf at surface (curve for Bor 1 @ 15')

$\gamma_m = 122$ pcf



5' =	1740 psf
10' =	1910
15' =	2060
20	2220
25	2360 ✓
30	2520
35	2680
40	2840

$\frac{1000}{122}$ ✓ = 8.2 ft

$\frac{3000}{122}$ ✓ 24.6 ft

D.E. CLARK
Geotechnical Engineer

OE1(2/87)

COMPUTATION SHEET

Subject: Pile Capacities

Sheet 2 of 7

Job No. 44B Client MCHD

Computed By D. Clark Date 8/11/88

Checked By D. Clark Date 8/12/88

12-in. PIPE PILES

$Q_p = Q_b + Q_s$ (ignore pile weight) (Eq. 4.1, p. 98)

$Q_b = N_c \cdot c_b \cdot A_b$ (Eq. 4.2, p. 100)

$N_c = 9$ (p. 100)

$A_b = \pi (0.5)^2 = 0.785 \text{ ft}^2$

$= 7.06\, c_b$

$Q_s = \alpha c_u A_s$ (Eq. 4.5, p. 102)

$\alpha = f(c_u)$ (Fig 4.7 bottom, p. 104)

$A_s = \pi d L = 3.14 L$

Pile Tip at 10 ft [$c_b = 1910$ psf ; $c_u = 1740$ psf]

$Q_p = 7.06(1910) + 0.75(1740)(3.14 \times 10)$

$= 13{,}500 + 41{,}000 = 54{,}500$ lb

Use safety factor of 2.5 (p. 100), and convert to tons

$= \dfrac{54{,}500}{2.5\,(2000)} = \underline{\underline{11 \text{ tons}}}$

D.E. CLARK
Geotechnical Engineer

OE1(2/87)

COMPUTATION SHEET

Subject: Pile Capacities

Sheet 3 of 7

Job No. 448 Client MCHD

Computed By D. Clark Date 8/11/88

Checked By D. Clark Date 8/12/88

12-in. PIPE PILES (CONT)

Pile Tip at 20 ft [c_b = 2220 psf; c_u = 1910 psf]

Q_p = 7.06 (2220) + 0.75 (1910) (3.14 × 20)

= 15,700 + 90,000 = 105,700 lb

= 21 tons

Pile Tip at 30 ft [c_b = 2520 psf; c_u = 2060 psf]

Q_p = 7.06 (2520) + 0.80 (2060) (3.14 × 30)

= 17,800 + 155,300 = 173,100 lb

= 35 tons

Pile Tip at 40 ft [c_b = 2840 psf; c_u = 2220 psf]

Q_p = 7.06 (2840) + 0.85 (2220) (3.14 × 40)

= 20,100 + 237,000 = 257,100 lb

= 51 tons

D.E. CLARK
Geotechnical Engineer

OE1(2/87)

COMPUTATION SHEET

Subject: Pile Capacities

Sheet 4 of 7

Job No. 44B Client MCHD

Computed By D. Clark Date 8/11/88

Checked By D. Clark Date 8/12/88

18" CIP Drilled Piers

Relative to the 12" piles, Q_b at each depth is larger in proportion to the base areas ... i.e. in proportion to the squares of the diameters – $1.5^2/1^2 = 2.25$ (p. 108)

For the Q_s computation $\alpha = 0.45$ at all depths, which assumes normal drilling and placing conditions – reasonably prompt placement of the concrete. (p. 108)

$$Q_s = \alpha c_u A_s$$

$$\alpha = 0.45$$

$$A_s = \pi d L = \pi(1.5)L = 4.72\,L$$

Pile Tip at 10 ft [$c_u = 1740$ psf]

$$Q_p = 2.25\,(13{,}500) + 0.45\,(1740)(4.72 \times 10)$$

$$= 30{,}400 + 37{,}000 = 67{,}400 \text{ lb}$$

$$= \frac{67{,}400}{5{,}000} = \underline{\underline{13 \text{ tons}}}$$

D.E. CLARK
Geotechnical Engineer

OE1(2/87)

COMPUTATION SHEET

Subject: Pile Capacities

Sheet 5 of 7

Job No. 448 Client MCHD

Computed By D. Clark Date 8/11/88

Checked By D. Clark Date 8/12/88

18" CIP DRILLED PIERS (CONT)

Pile Tip at 20 ft [C_u = 1910 psf]

$$Q_p = 2.25\,(15{,}700) + 0.45\,(1910)(4.72 \times 20)$$

$$= 35{,}300 + 81{,}100 = 116{,}400 \text{ lb}$$

$$= \frac{116\,400}{5{,}000} = \underline{\underline{23 \text{ tons}}}$$

Pile Tip at 30 ft [C_u = 2060 psf]

$$Q_p = 2.25\,(17{,}800) + 0.45\,(2060)(4.72 \times 30)$$

$$= 40{,}000 + 131{,}300 = 171{,}300 \text{ lb}$$

$$= \underline{\underline{34 \text{ tons}}}$$

Pile Tip at 40 ft [C_u = 2220 psf]

$$Q_p = 2.25\,(20{,}100) + 0.45\,(2220)(4.72 \times 40)$$

$$= 45{,}200 + 188{,}600 = 233{,}800 \text{ lb}$$

$$= \underline{\underline{47 \text{ tons}}}$$

D.E. CLARK
Geotechnical Engineer

OE1(2/87)

COMPUTATION SHEET

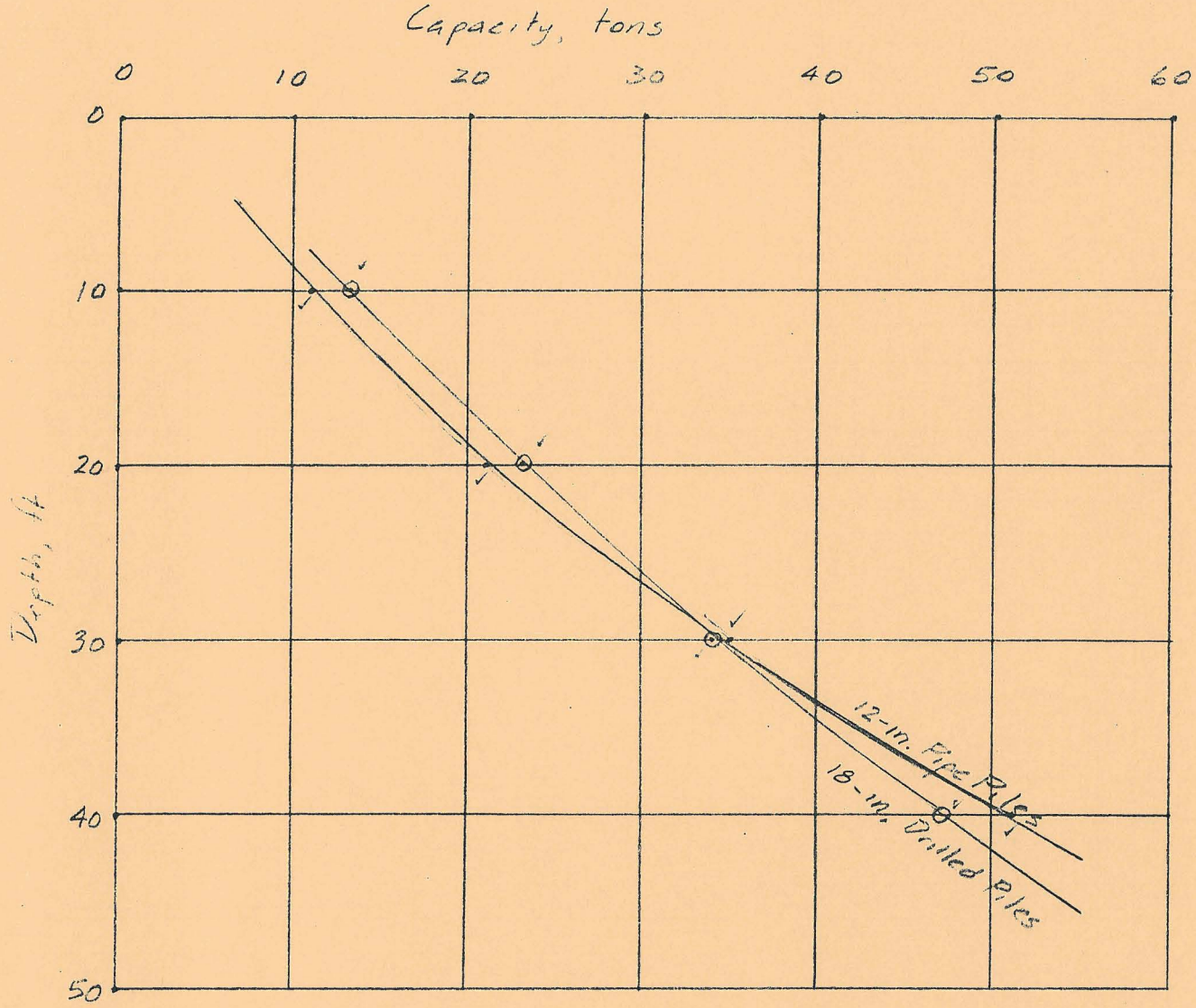
Subject: Pile Capacities

Sheet 6 of 7

Job No. 44B Client MCHD

Computed By D. Clark Date 8/11/88

Checked By D. Clark Date 8/12/88



D.E. CLARK
Geotechnical Engineer

OE1(2/87)

COMPUTATION SHEET

Subject: Pile Capacities

Sheet 7 of 7

Job No. 44B Client MCHD

Computed By D. Clark Date 8/11/88

Checked By D. Clark Date 8/12/88

CHECKS

12-in. Pipe Piles

Average skin friction at 50 tons, no end bearing

$$\frac{100{,}000}{39.5(\pi)(1)} = 806 \text{ lb/ft}^2 \qquad \text{OK}$$

$$\text{w/ end bearing} \cong \frac{237}{257}(806) = 743 \text{ lb/ft}^2 \qquad \text{OK}$$

18-in. Drilled Piles

$$\frac{100{,}000}{42(\pi)(1.5)} = 505 \text{ lb/ft}^2 \qquad \text{OK}$$

$$\frac{189}{234}(505) = 408 \text{ lb/ft}^2 \qquad \text{OK}$$

D.E. CLARK
Geotechnical Engineer

OE1(2/87)