BRIDGE SCOUR ASSESSMENT REPORTS VOL. V

Final
BRIDGE SCOUR ASSESSMENT REPORTS TECHNICAL APPENDIX for 16 Maricopa County Bridges

VOLUME V
Final Geotechnical Analysis

July, 1996

MARICOPA COUNTY DEPARTMENT OF TRANSPORTATION (MCDOT)
Work Order No. 80407

Cannon & Associates, Inc.
Consulting Engineers

Final
BRIDGE SCOUR ASSESSMENT REPORTS
TECHNICAL APPENDIX
for 16 Maricopa County Bridges
CA 94046-1

VOLUME V
Final Geotechnical Analysis

July, 1996

Prepared for
MARICOPA COUNTY
DEPARTMENT OF
TRANSPORTATION (MCDOT)
2910 West Durango Street
Phoenix, Arizona 85009
602-506-8600

Submitted by
Cannon & Associates, Inc.
Consulting Engineers
2701 North 16th Street, Suite 122
Phoenix, Arizona 85016
602-230-0563

Prepared by
AGRA Earth &
Environmental, Inc.
3232 West Virginia Avenue
Phoenix, Arizona 85009-1502
(602) 272-6848

Cannon & Associates, Inc.
Consulting Engineers

MCDOT W.O. No. 80407
Maricopa County Department of Transportation
BRIDGE SCOUR ASSESSMENT

VOLUME I: FINAL BRIDGE SCOUR ASSESSMENT REPORTS
for Structure Numbers 9691, 8981, 9301, 9859, 9145, 7819, 8028, 8639

VOLUME II: FINAL BRIDGE SCOUR ASSESSMENT REPORTS
for Structure Numbers 9427, 9588, 9999, 8038, 7818, 9154, 9142, 7553

VOLUME III: TECHNICAL APPENDIX
Final Bridge Scour Hydraulic Calculations

VOLUME IV: TECHNICAL APPENDIX
Final Bridge Scour Structural Calculations

VOLUME V: TECHNICAL APPENDIX
Final Geotechnical Analysis

Cannon & Associates, Inc.
Consulting Engineers

BRIDGE SCOUR EVALUATIONS
MARICOPA COUNTY
DEPARTMENT OF TRANSPORTATION
MARICOPA COUNTY, ARIZONA

Submitted To:

Cannon & Associates, Inc.
2701 North 16th Street
Suite 122
Phoenix, Arizona 85006

Submitted By:

AGRA Earth & Environmental, Inc.
3232 West Virginia Avenue
Phoenix, Arizona 85009-1502

15 April 1996

AEE Job No. E95-36

Registered Professional Engineer (Civil)
12176
NORMAN HAROLD
WETZ
Date Signed 4/15/96
ARIZONA, U.S.A.

AGRA
Earth & Environmental

AGRA
Earth & Environmental

AGRA Earth &
Environmental, Inc.
3232 West Virginia Avenue
Phoenix, Arizona 85009-1502
Tel (602) 272-6848
Fax (602) 272-7239

15 April 1996
AEE Job No. E95-36

Cannon & Associates, Inc.
2701 North 16th Street
Suite 122
Phoenix, Arizona 85006

Attention: **David Healey, P.E.**

Gentlemen:

RE: BRIDGE SCOUR EVALUATIONS
MARICOPA COUNTY DEPARTMENT OF TRANSPORTATION
MARICOPA COUNTY, ARIZONA

Our engineering report for the referenced project is herewith submitted. The report includes the results of our field investigation and presents analyses and recommendations concerning bridge foundations.

Should any questions arise concerning this report, we would be pleased to discuss them with you.

Respectfully submitted,

AGRA Earth & Environmental, Inc.

Registered Professional Engineer (Civil) CERTIFICATE NO. 12176 NORMAN HAROLD WETZ Date Signed 4/15/96 ARIZONA, U.S.A.

Norman H. Wetz, P.E.
Senior Geotechnical Engineer

Reviewed by:

Registered Professional Engineer (Civil) CERTIFICATE NO. 13372 LAWRENCE A. HANSEN Date Signed 4/15/96 ARIZONA, U.S.A.

Lawrence A. Hansen, Ph.D., P.E.
Executive Vice President

c: Addressee (3)
jls/njf/J2-96/4-8-96

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Registered Professional Engineer (Civil)
CERTIFICATE NO.
12176
NORMAN HAROLD
WETZ
Date Signed:
ARIZONA, U.S.A.

1.0 INTRODUCTION

This report is submitted pursuant to a data review made by AGRA Earth & Environmental, Inc. (AEE) of twelve bridge structures. Refraction seismic surveys were performed at two bridge sites, New River Road over New River and I-17 Frontage Road over New River. The purpose of data review and refraction seismic surveys was to provide geotechnical information for the evaluation of the safety of the bridges during flood events.

2.0 PROJECT DESCRIPTION

Sixteen bridges initially were evaluated, with two being determined scour-critical and two being judged safe because of concrete or riprap protection. Bridges requiring further structural evaluation that are supported by deep foundations are listed as follows:

Roadway	Waterway	Scour Elevation (feet)	Type of Foundation
Bell Road	Agua Fria River	1125	Drilled piers, 5′ and 6′ diameter, tip elevation of 1080 feet.
Olive Avenue	Agua Fria River	1034	Drilled piers, 6′ diameter, tip elevation of 1010 to 1000 feet.
Camelback Road	Agua Fria River	972	Drilled piers, 4′ and 4.5′ diameter, tip elevation of 946 feet.
Indian School Road	Agua Fria River	970	Drilled piers, 5′ diameter, tip elevation of 931.7 feet.
Old U.S. Highway 80	Hassayampa River	787	Drilled piers, 5.5′ diameter, tip elevation of 770 to 795 feet.
Rittenhouse Road	Queen Creek	1423	Driven pipe piles, 16" diameter, tip elevation of 1408 feet.
Hawes Road	Queen Creek	1357	Drilled piers, 3′ diameter, tip elevation of 1340 feet.
Power Road	Queen Creek	1327	Driven 10BPx42 piles, tip elevation of 1305 feet.
Higley Road	Queen Creek	1298	Driven pipe piles, 14" diameter, tip elevation of 1285 feet.
Deer Valley Road	Unnamed Wash	1368	Drilled piers, 3′ diameter, tip elevation of 1345 feet.

The New River Road and I-17 Frontage Road bridges are supported on spread-type foundations with approximate base elevations of 2006.3 and 1977.2 feet, respectively. Scour elevations of 1996 and 1947 feet were calculated for the New River and I-17 Frontage Roads, respectively. Thus, if the spread-type foundations are not founded on competent rock, these structures will be scour-critical.

3.0 INVESTIGATION

3.1 REFRACTION SEISMIC SURVEY

Three refraction seismic surveys were performed, one at the I-17 Frontage Road bridge site over New River and two at the New River Road bridge site over New River. These lines were 120 feet in length, and were performed utilizing a Geometrics 12-channel signal enhanecment engineering seismograph and a sledgehammer energy source. Results of the refraction seismic survey are presented in Appendix A of this report, which includes a brief descripiton of refraction seismic equipment and procedures.

3.2 REVIEW OF EXISTING DATA

Geotechnical reports and as-built plans for the existing bridges, including boring logs, were reviewed.

4.0 GEOTECHNICAL PROFILE

The soils underlying the bridge sites, based on our review of existing data, are summarized as follows:

Bridge Site	Generalized Soil Profile Below Scour Depth
Bell Road	Clayey sand, gravel and cobbles, dense to very dense or very firm to hard.
Olive Avenue	Clayey sand, gravel and cobbles with some sandy clay and silt lenses, very firm to hard.
Camelback Road	Sand, gravel and cobbles with some clay and silt, very dense.
Indian School Road	Sand, gravel and cobbles with some clay, very dense to dense.
Old U.S. Highway 80	Silty sand and gravel, dense.
Rittenhouse Road	Sand and gravel, dense to very dense.
Hawes Road	Clayey sand with some gravel, hard.

Bridge Site	Generalized Soil Profile Below Scour Depth
Power Road	Sand and gravel with clay and silt, clayey sand with some gravel, dense to hard.
Higley Road	Clayey sand with some gravel, hard.
Deer Valley Road	Sand and gravel, overlying clayey sand and sandy clay, very dense or hard.
New River Road	Sand, gravel and cobbles overlying hard sandy clay or very weathered shale rock.
I-17 Frontage Road	Sand, gravel, cobbles and boulders overlying schist rock.

5.0 CAPACITIES OF EXISTING FOUNDATIONS

The ultimate downward capacities of drilled pier and driven piles for ten of the bridges were estimated based on the existing data. Estimated ultimate downward capacities for the foundations of each bridge are presented in Figures 1 through 10 in Appendix B.

In order to evaluate the lateral capacity of the deep foundations, the modulus of subgrade reaction as a function of depth below scour is required. These are presented for each bridge in Figures 11 through 21 in Appendix B. Three separate curves illustrating depth versus spring constant are presented on each figure for 1/2 inch, 1 inch and 2 inches of lateral deflection. The spring constant used in the structural analyses should be selected on the basis of the maximum deflection for specific depths.

6.0 SCOUR OF SPREAD-TYPE FOUNDATIONS

The refraction seismic survey data indicates that rock contact is somewhat variable at both the New River Road and I-17 Frontage Road bridge sites. Higher velocity materials likely representative of rock (6,000 to 10,000 feet per second) vary in depth from 2 to 13 feet at the New River Road bridge. Since foundations are about 6 to 7 feet below grade, it appears that at least some of the footings will be susceptible to scour below the foundations. Higher seismic velocity materials (6,200 to 8,000 feet per second) are present at about 2 to 7 feet below grade at the I-17 Frontage Road bridge. Thus, it appears that these foundations are founded on rock.

APPENDIX A

REFRACTION SEISMIC DATA

REFRACTION SEISMIC EQUIPMENT & PROCEDURES

Seismic Equipment - Refraction seismic surveys are performed using an EGG Geometrics Nimbus ES-1225 signal enhancement seismograph. This instrument has the capability to simultaneously record 12 channels of geophone data and produce hard copies of that data. Signal enhancement capability permits the use of a sledgehammer as the seismic energy source. A timing sensor is attached to the hammer, and for compression waves a metal plate is set securely on the ground surface and struck. Generating shear waves involves setting the plate against a wooden plank or railroad tie oriented horizontal and perpendicular to the axis of the geophone array and striking with the sledgehammer. A truck is usually driven onto the tie in order to effectively couple the tie to the ground.

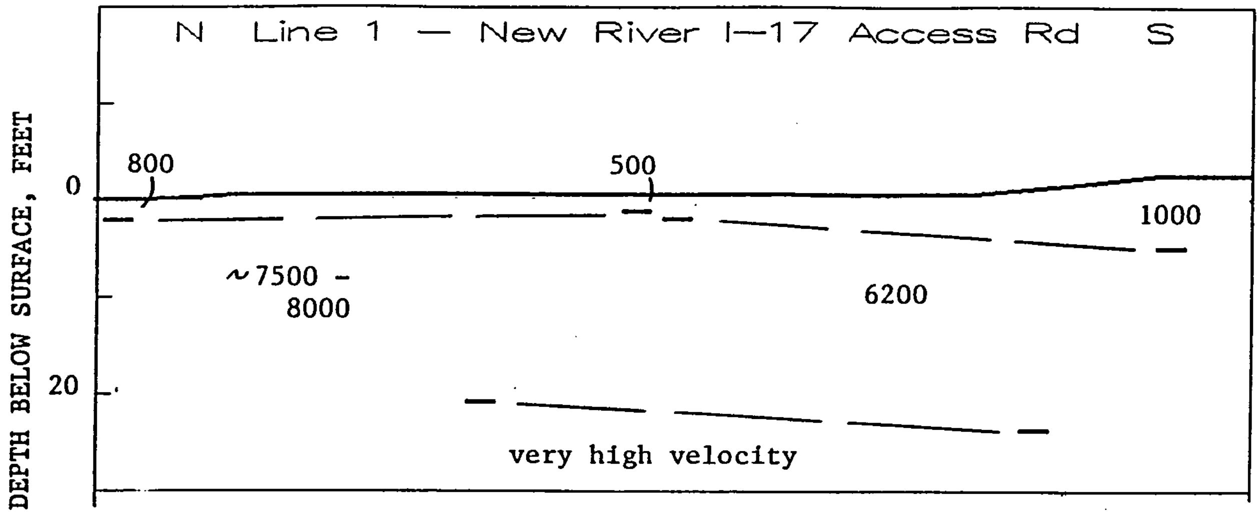
Because of the signal enhancement capability, signals from several or many strikes can be added together to increase the total signal available to obtain the seismic record. Although explosives can also be used as a compression wave seismic energy source, a sledgehammer does not require licenses or permits, or involve special limitations or regulations. A cable with 12-geophone takeout positions at 10 or 25-foot intervals with vertical and, if needed, horizontal geophones are used. The seismograph system is extremely portable. In areas where vehicular access is not possible, the equipment can be mobilized by hand or packhorse.

Field Procedures - Refraction seismic lines are generally laid out using the standard spacings on the geophone cables. A maximum depth of investigation on the order of 100 feet may be possible using the entire cable as a 300-foot array. Shorter spacings can also be used. For shorter lines with improved near-surface resolution, 10-foot spacings between geophones result in a 120-foot array with a maximum depth of investigation on the order of 30 to 40 feet. To improve the resolution of near-surface interfaces, sledgehammer source positions generally are set at 12.5 feet from the ends of a 25-foot spacing geophone array, or at 5 feet from the ends of a 10-foot spacing geophone array. Three shots usually are obtained for a refraction line: a foreshot, a backshot and a midshot. The midshot is usually placed midway between the two center geophones so that it is the same distance from the nearest geophone as the foreshot and backshot. This permits interpretation of near-surface interfaces at the center of a refraction line as well as at the endpoints. It also implicitly separates a 12-geophone refraction line into two 6-geophone refraction lines, which permits more refined interpretations of shallow and mid depth subsurface interfaces.

Compression waves are recorded for general exploration work. Shear waves are also recorded when dynamic soil properties are desired. A shear wave arrival is verified by obtaining two sets of horizontal data that are 180 degrees out of phase. The phase reversal is obtained by either reversing the horizontal geophone orientation or reversing the sledgehammer impact direction. Hard copy printouts of all field data are made and inspected as the information is collected.

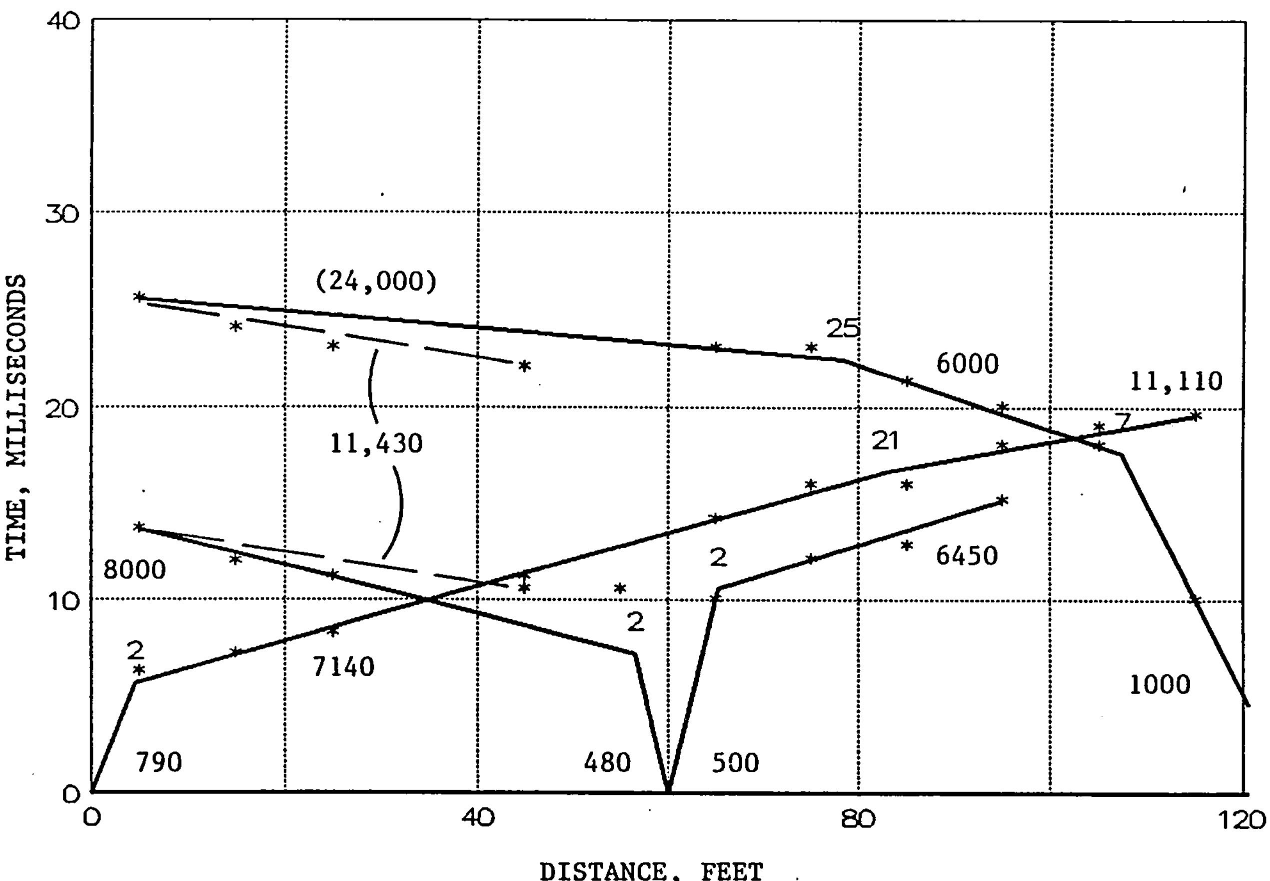
Records & Interpretation - The operations are directed by our engineer, who operates the equipment, prepares the records and examines the data in the field. Seismic data is interpreted in the office. When appropriate, preliminary interpretations are made in the field.

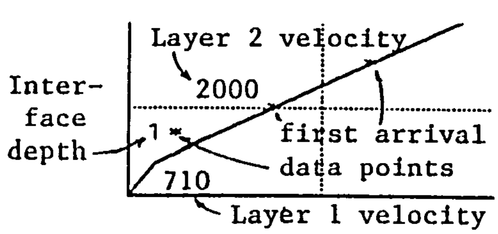
GEOLOGIC INTERPRETATION OF REFRACTION SEISMIC DATA



Notes: Depths are in feet, velocities are in feet per second
Topography, when shown, is approximate

REFRACTION SEISMIC TIME-DISTANCE PLOTS





LEGEND

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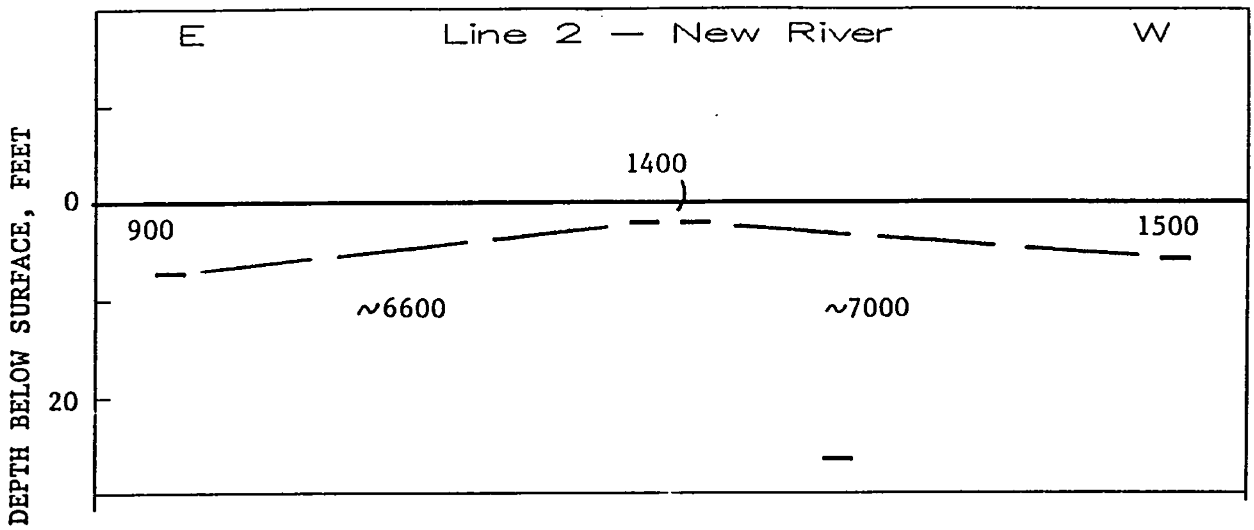
GEOLOGIC INTERPRETATION OF REFRACTION SEISMIC DATA



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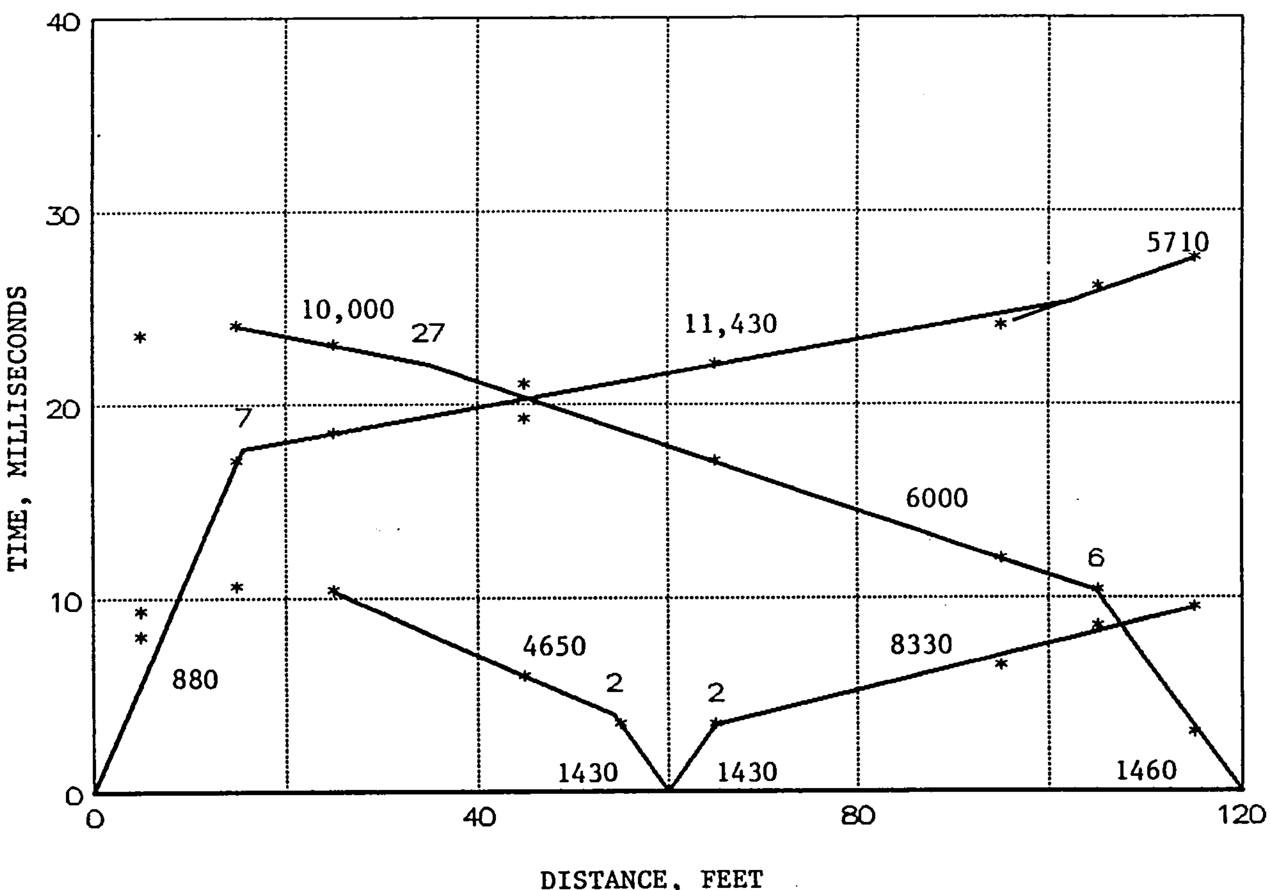
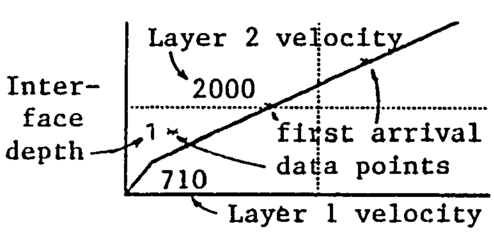
Topography, when shown, is approximate

REFRACTION SEISMIC TIME-DISTANCE PLOTS





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AEE Job No. E95-36

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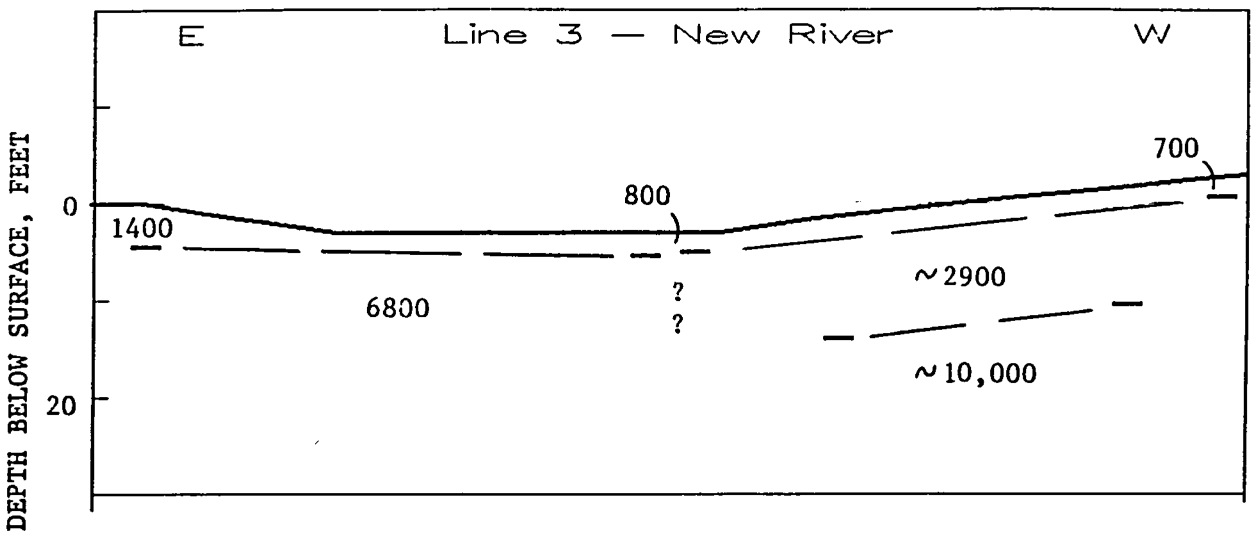
GEOLOGIC INTERPRETATION OF REFRACTION SEISMIC DATA



Notes: Depths are in feet, velocities are in feet per second
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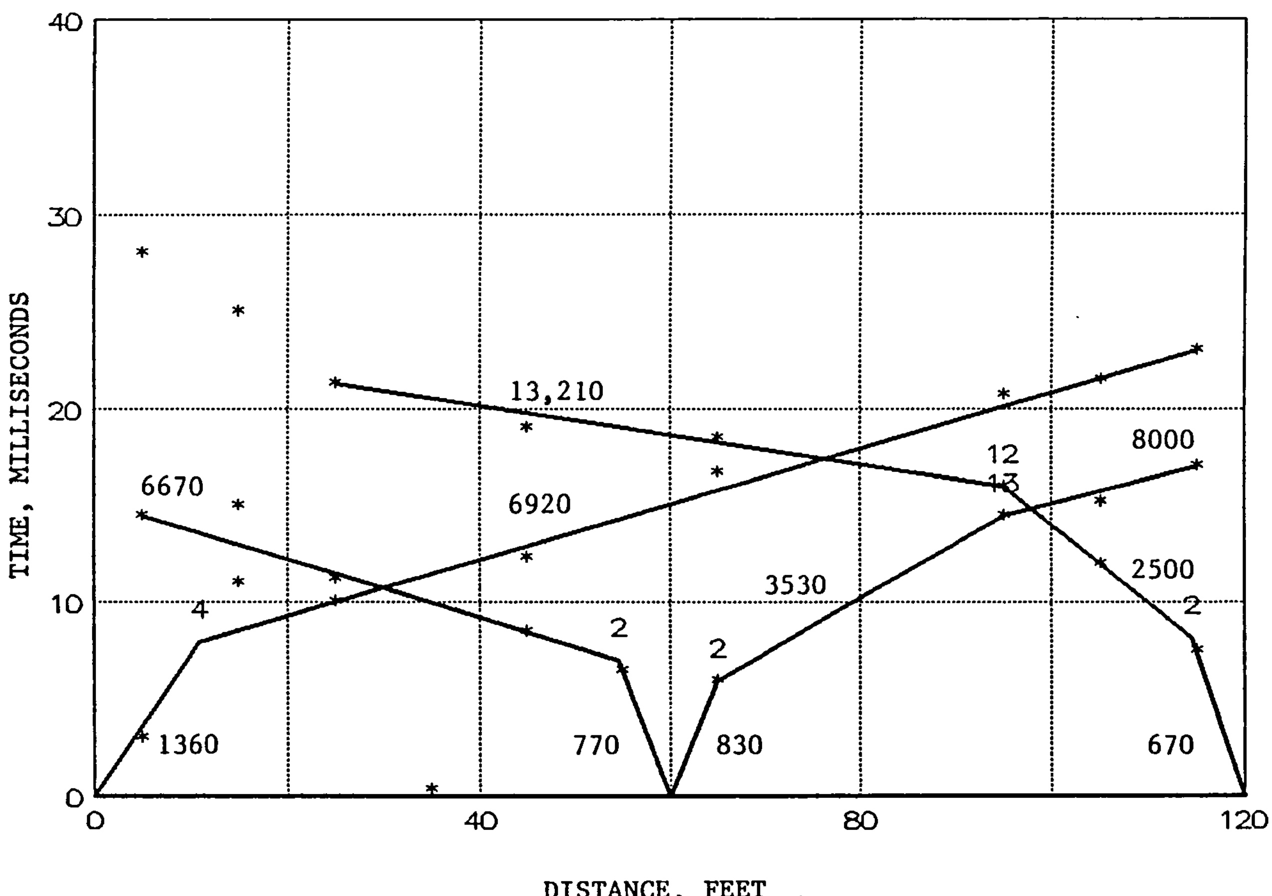
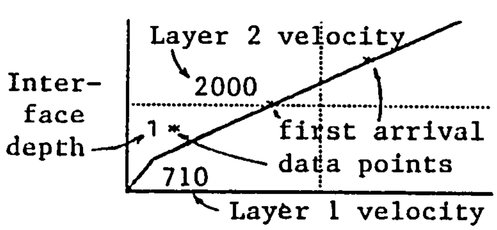
REFRACTION SEISMIC TIME-DISTANCE PLOTS





LEGEND

AEE Job No. E95-36

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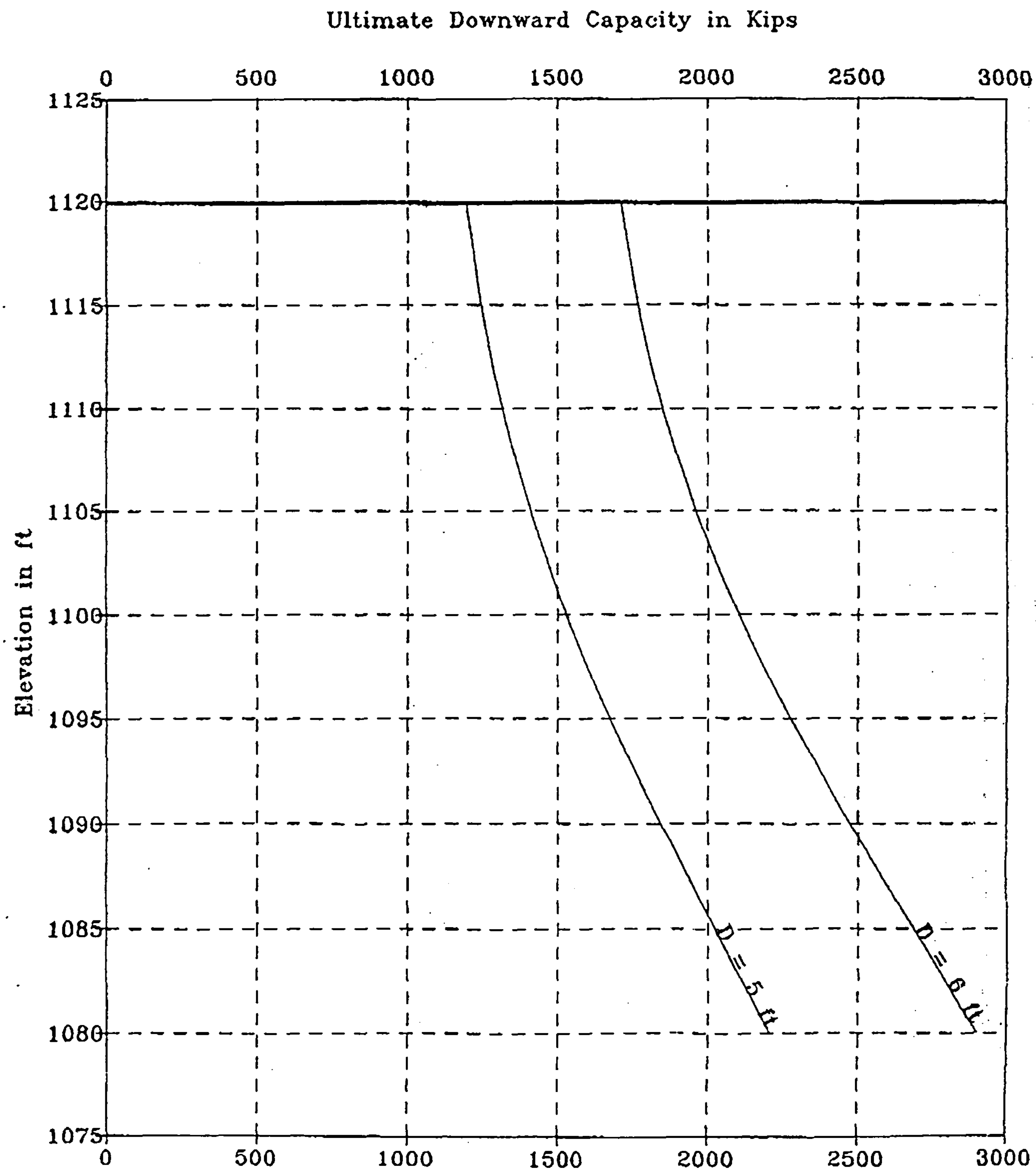
APPENDIX B

DESIGN CHARTS

Project Bell Road Bridge Job No. E95-36

FIGURE 1

ESTIMATED ULTIMATE DOWNWARD CAPACITY OF STRAIGHT, DRILLED, CAST-IN-PLACE CONCRETE PIERS



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Project Olive Avenue Bridge Job No. E95-36

FIGURE 2

ESTIMATED ULTIMATE DOWNWARD CAPACITY OF STRAIGHT, DRILLED, CAST-IN-PLACE CONCRETE PIERS

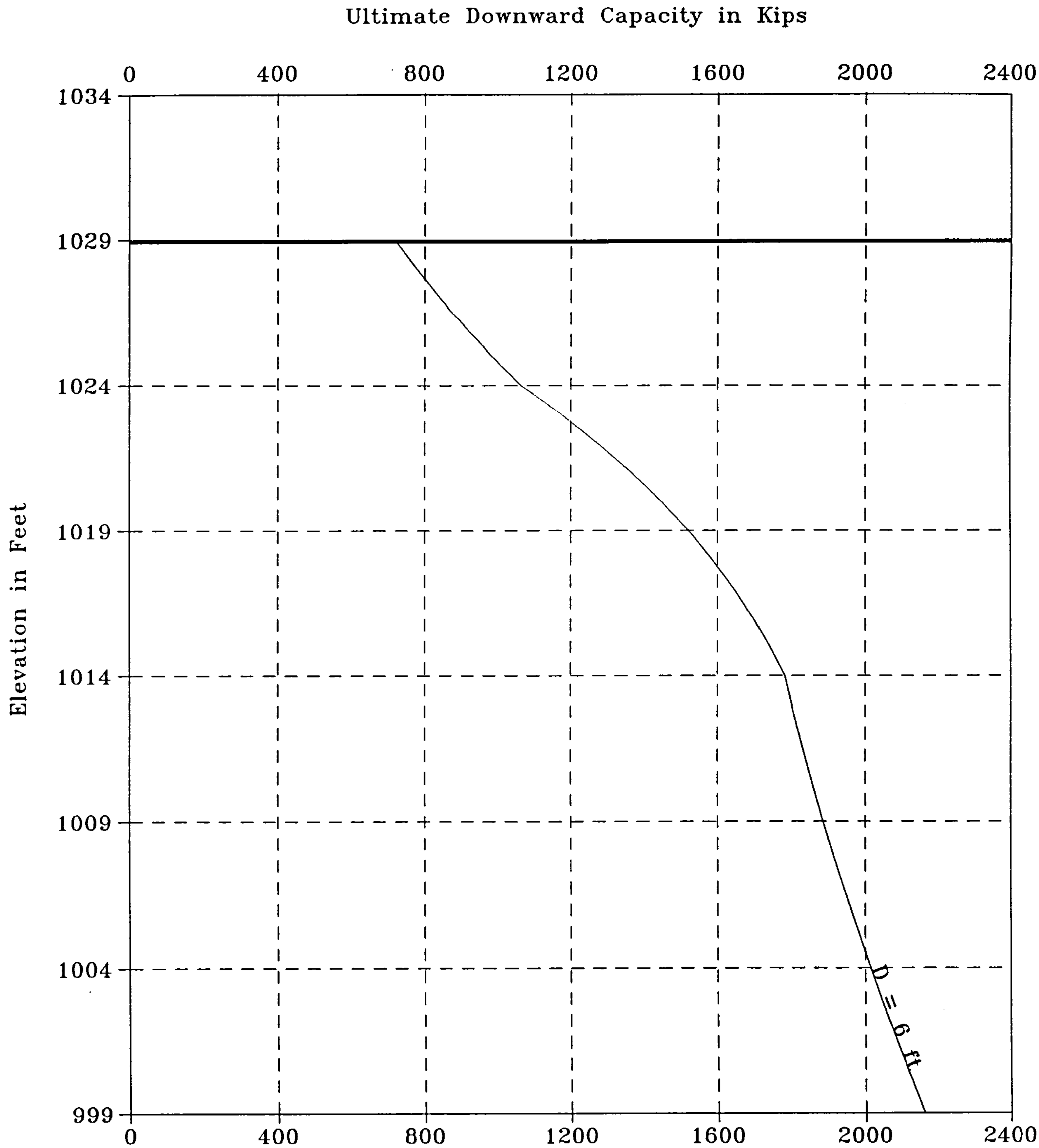

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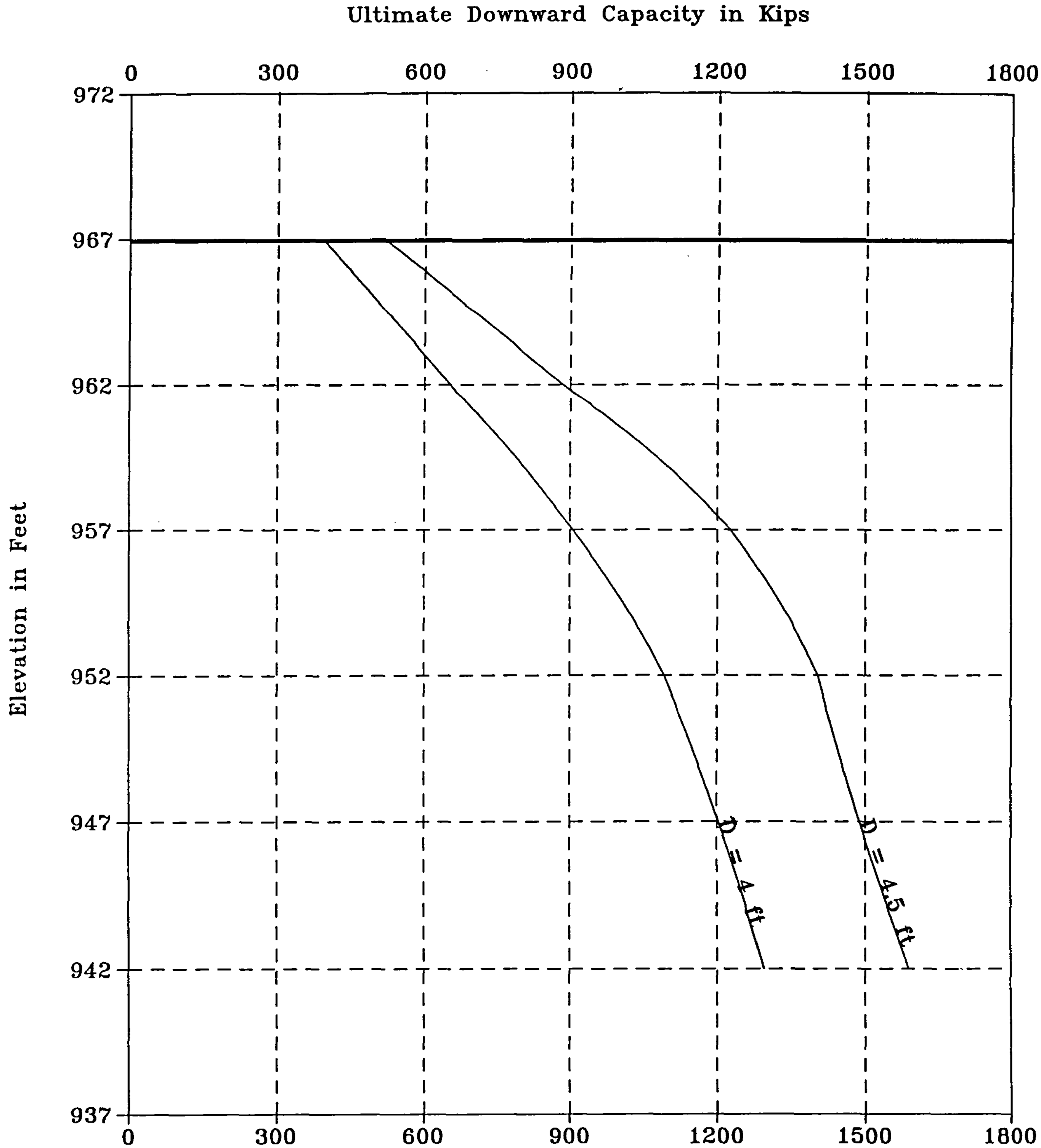
FIGURE 3

ESTIMATED ULTIMATE DOWNWARD CAPACITY OF STRAIGHT, DRILLED, CAST-IN-PLACE CONCRETE PIERS



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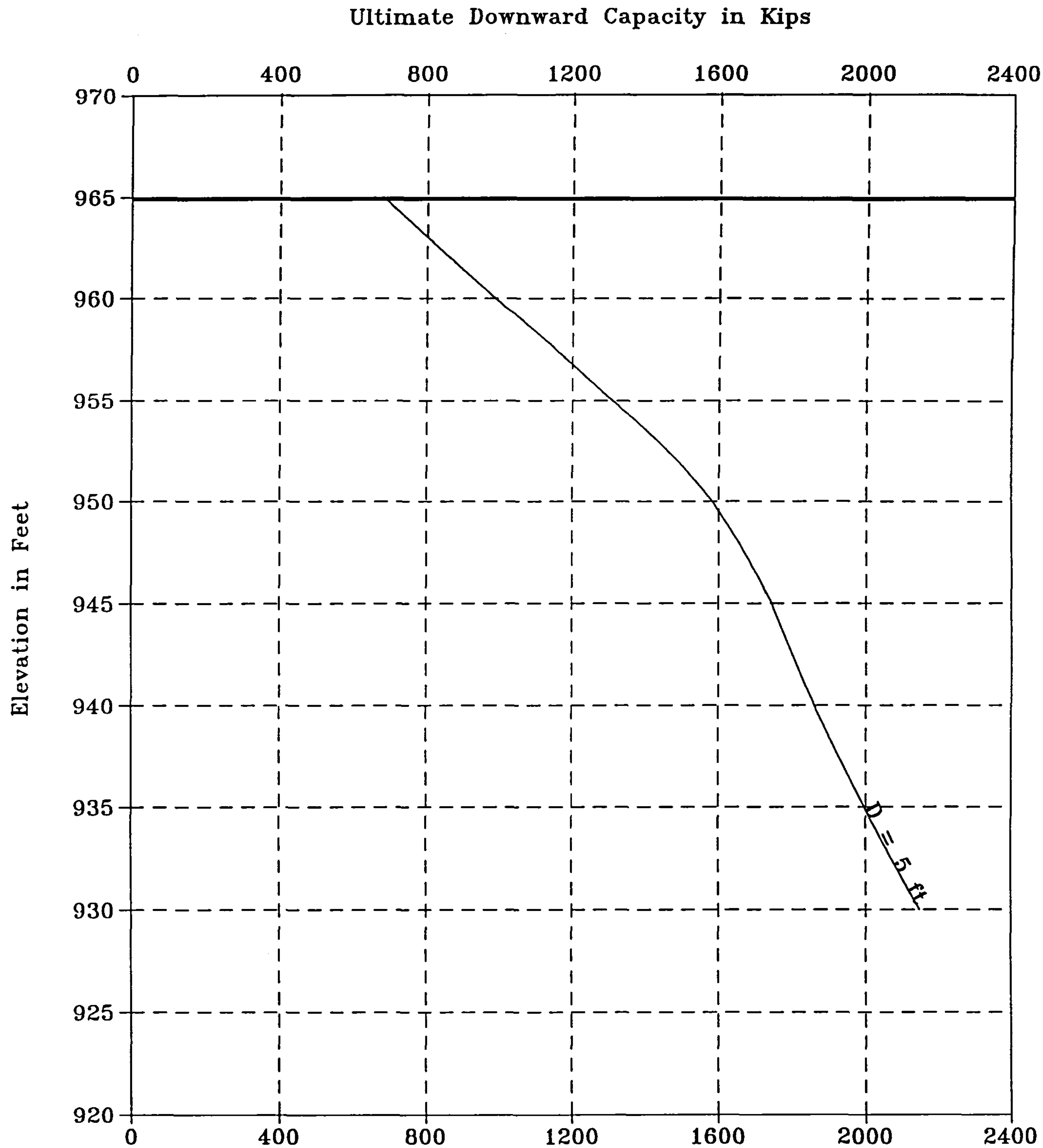
Project Indian School Road Bridge Job No. E95-36

FIGURE 4

ESTIMATED ULTIMATE DOWNWARD CAPACITY OF STRAIGHT, DRILLED, CAST-IN-PLACE CONCRETE PIERS



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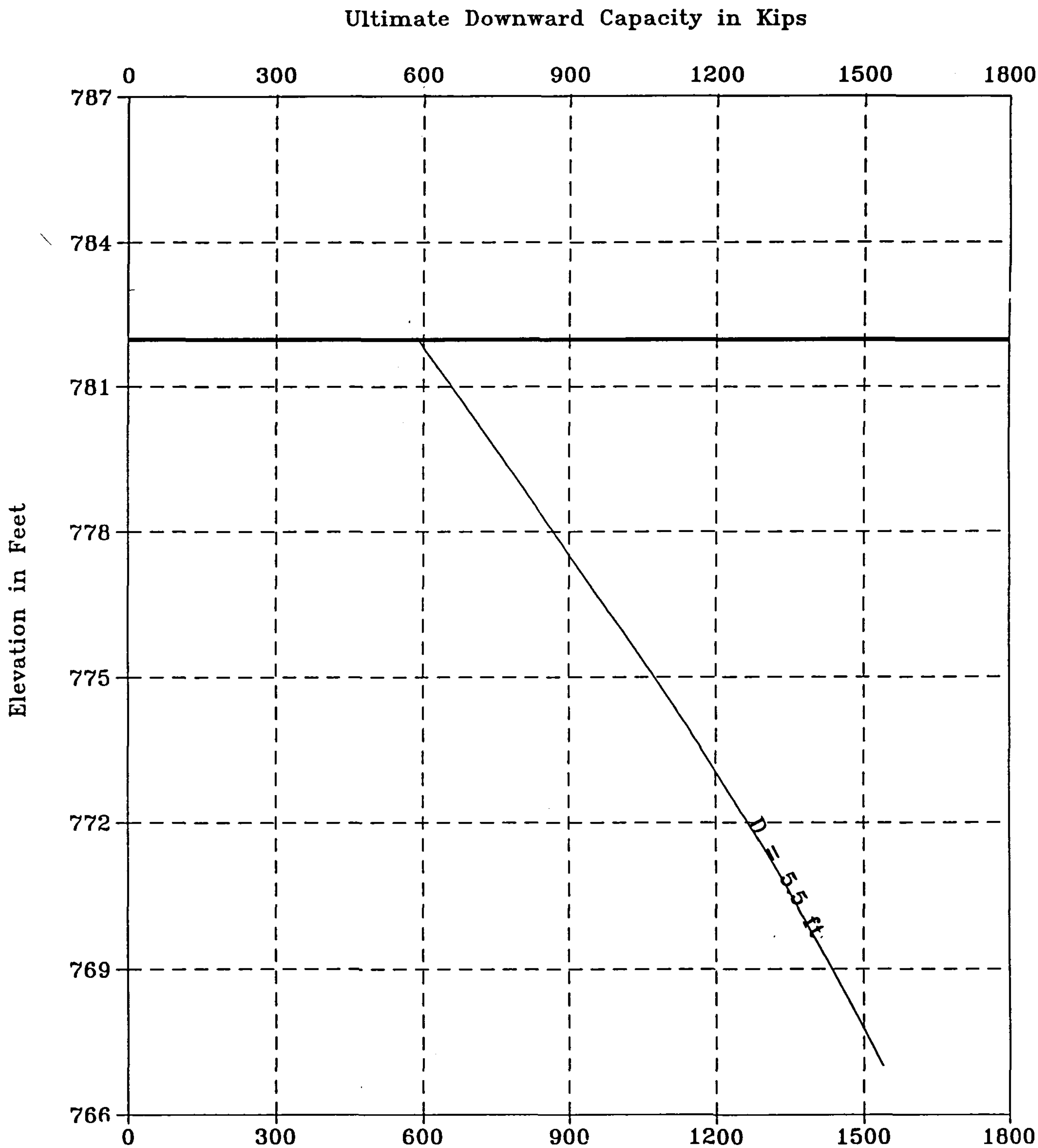
Project Old US Highway 80 Bridge Job No. E95-36

FIGURE 5

ESTIMATED ULTIMATE DOWNWARD CAPACITY OF STRAIGHT, DRILLED, CAST-IN-PLACE CONCRETE PIERS

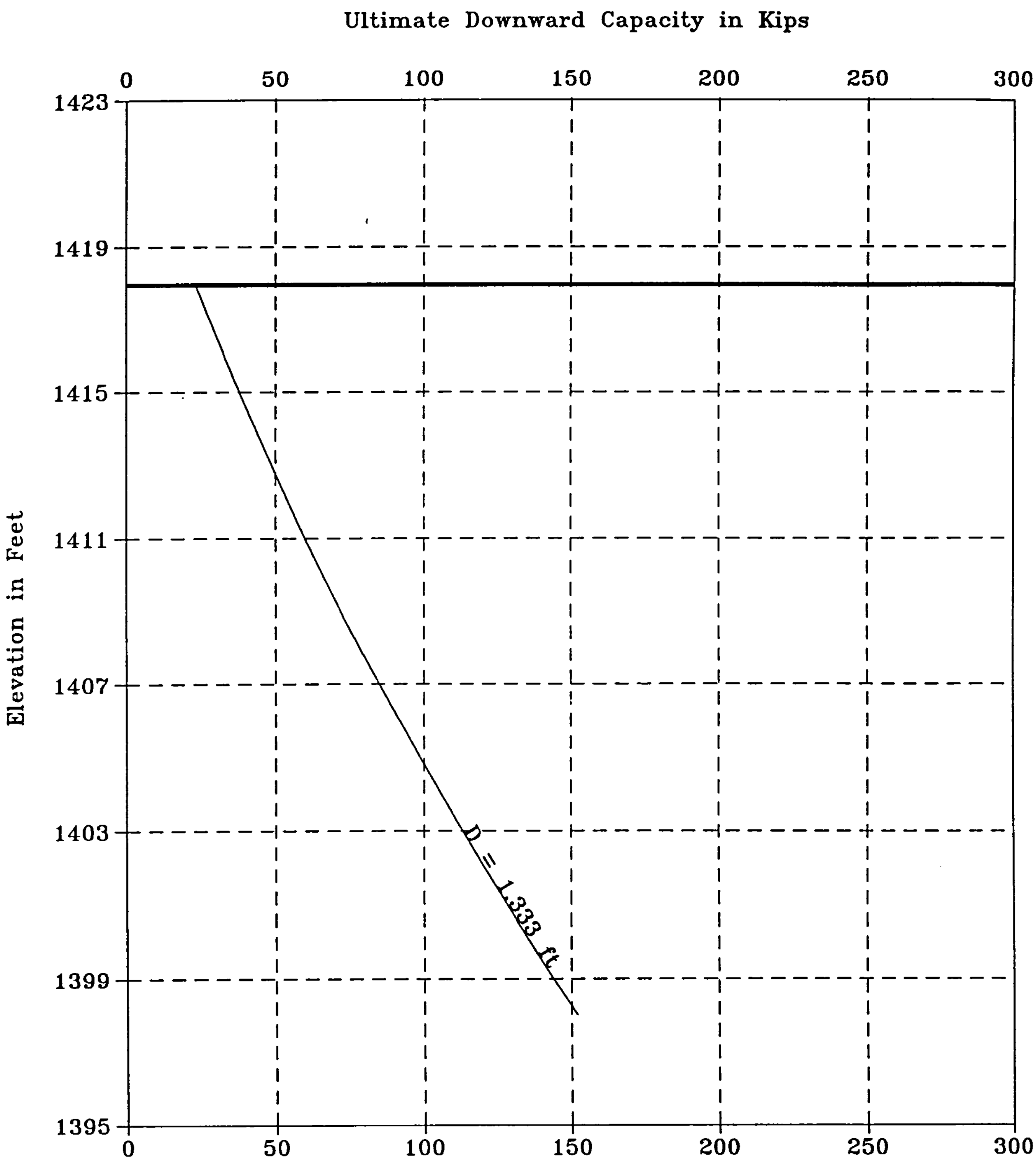


AGRA Earth & Environmental, Inc.

Project Rittenhouse Road Bridge Job No. E95-36

FIGURE 6

ESTIMATED ULTIMATE DOWNWARD CAPACITY OF DRIVEN, PIPE PILES

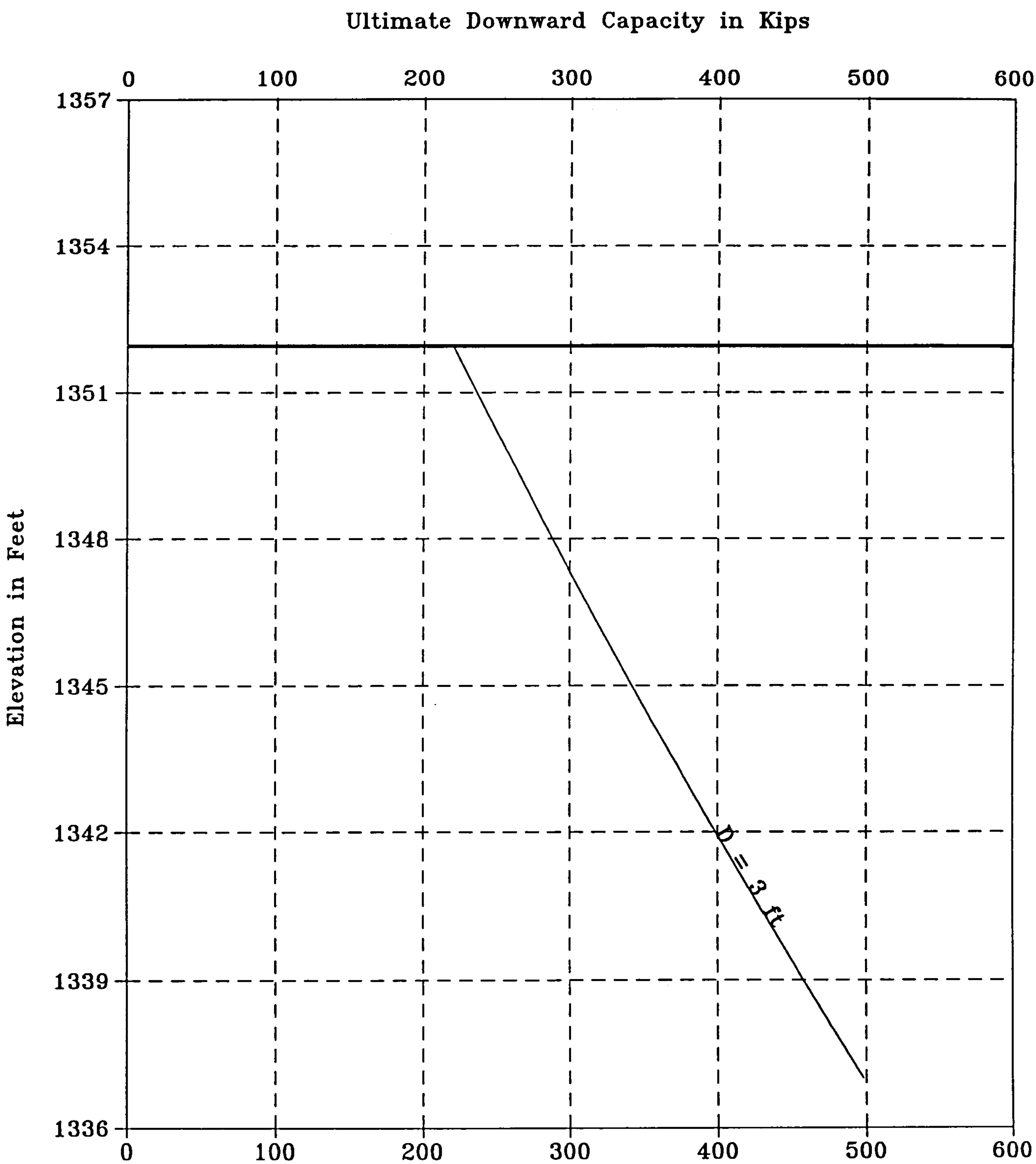


AGRA Earth & Environmental, Inc.

Project Hawes Road Bridge Job No. E95-36

FIGURE 7

ESTIMATED ULTIMATE DOWNWARD CAPACITY OF STRAIGHT, DRILLED, CAST-IN-PLACE CONCRETE PIERS



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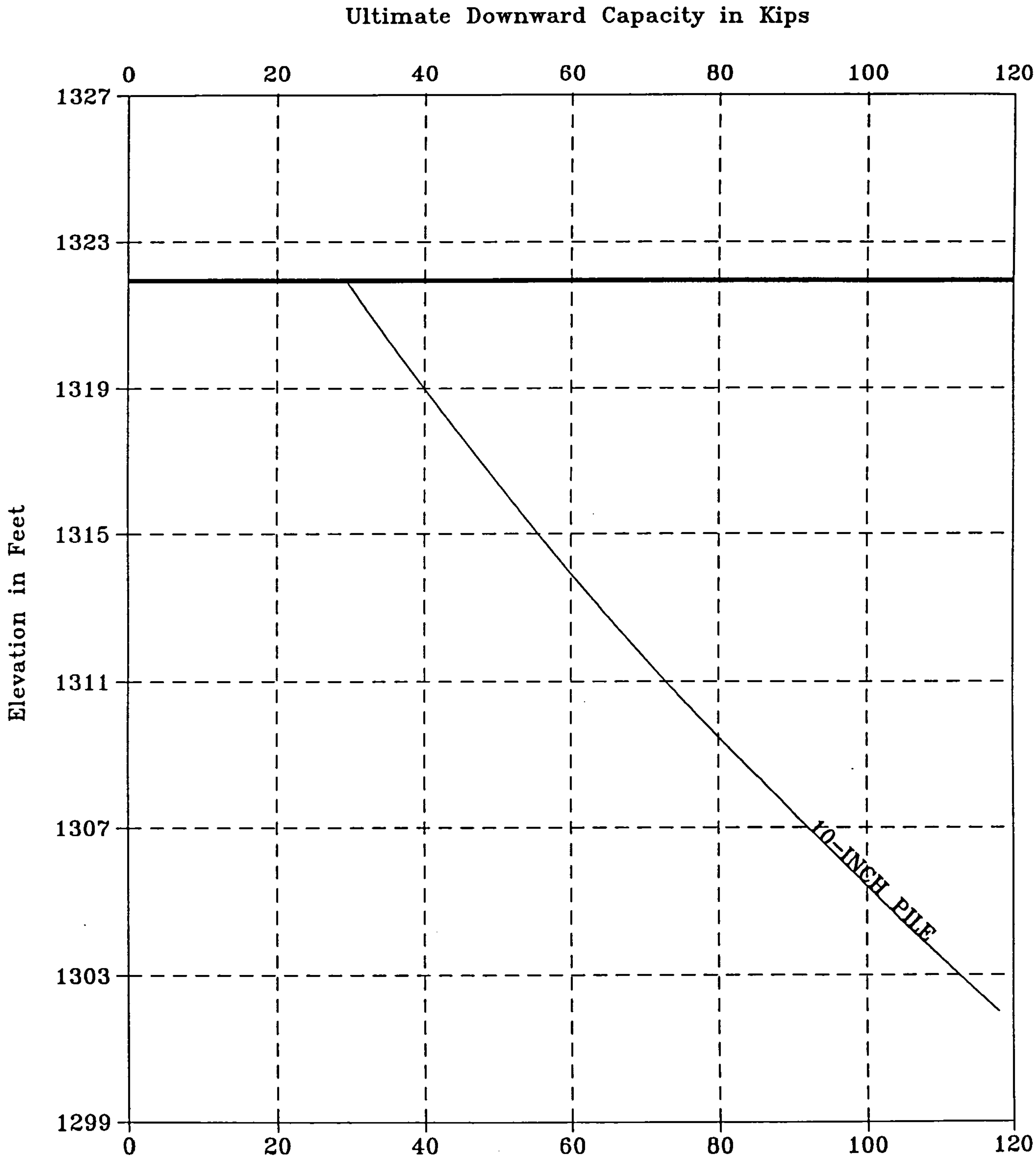
Project Power Road Bridge Job No. E95-36

FIGURE 8

ESTIMATED ULTIMATE DOWNWARD CAPACITY OF DRIVEN, 10-inch BP PILES



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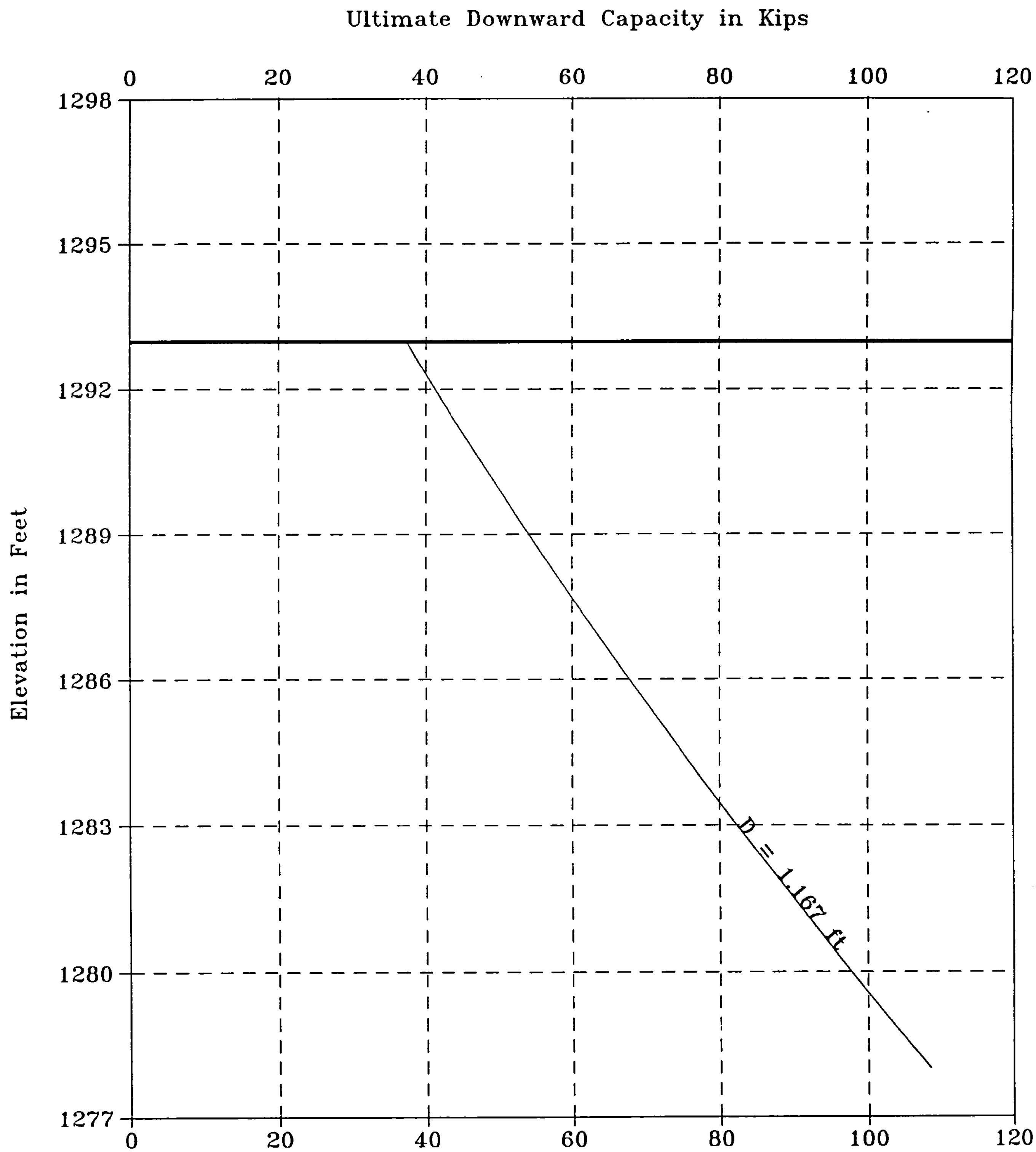
Project Higley Road Bridge Job No. E95-36

FIGURE 9

ESTIMATED ULTIMATE DOWNWARD CAPACITY OF DRIVEN, PIPE PILES



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Project Deer Valley Road Job No. E95-36

FIGURE 10

ESTIMATED ULTIMATE DOWNWARD CAPACITY OF STRAIGHT, DRILLED, CAST-IN-PLACE CONCRETE PIERS

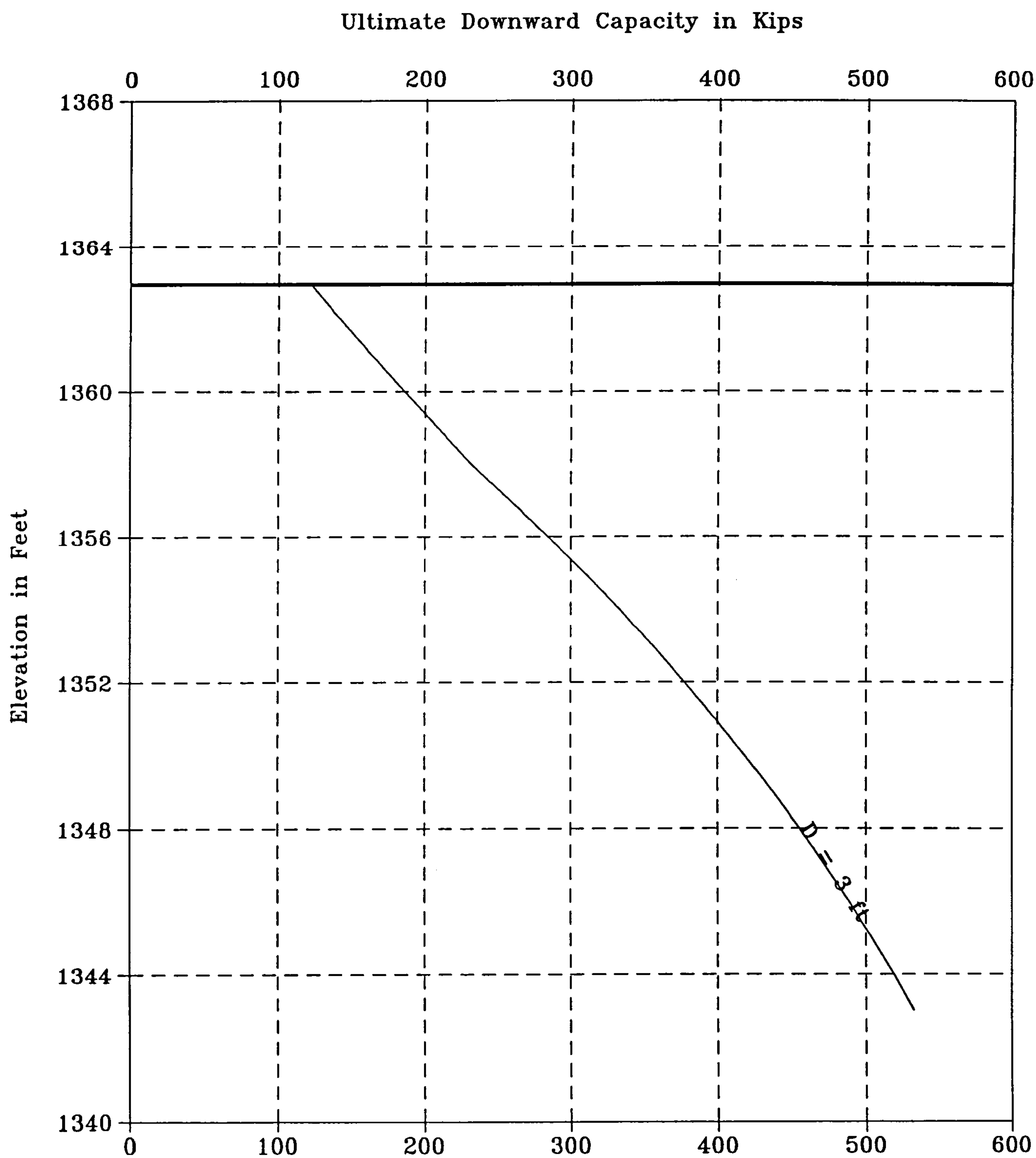

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Figure 11 Bell Road
5-Foot Diameter

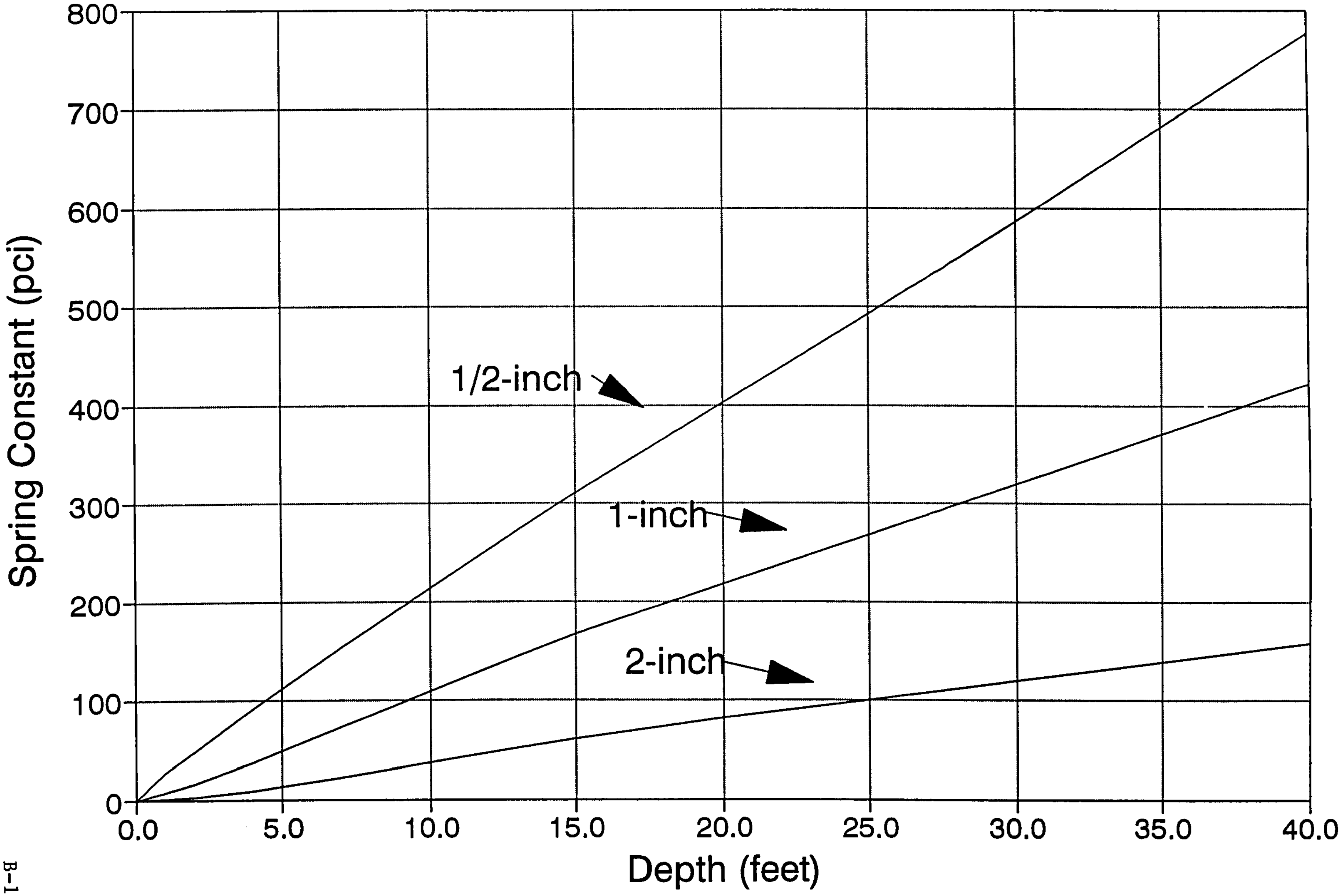

Figure 12 - Bell Road

6-Foot Diameter

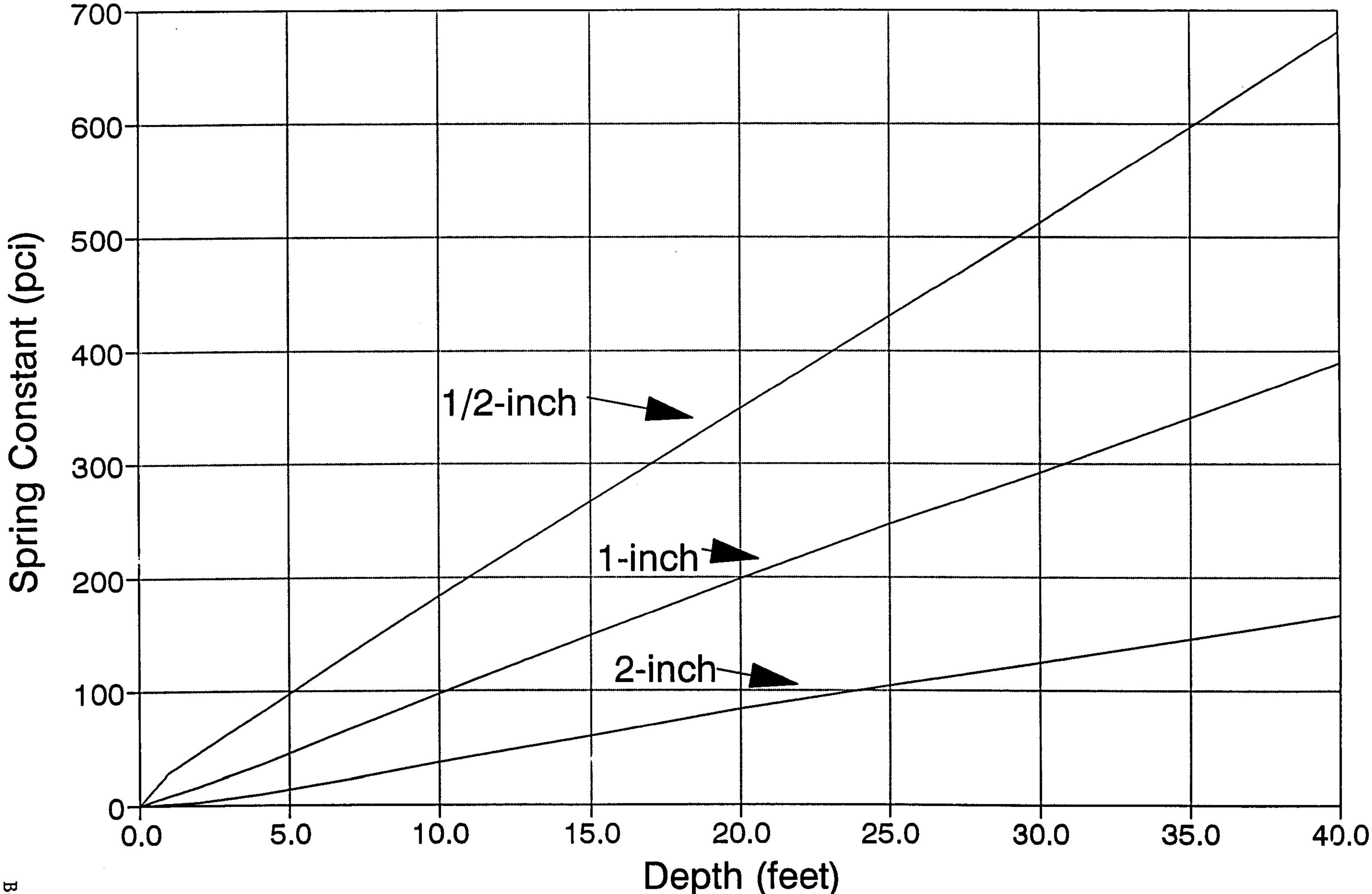

Figure 13 - Olive Avenue
6-Foot Diameter

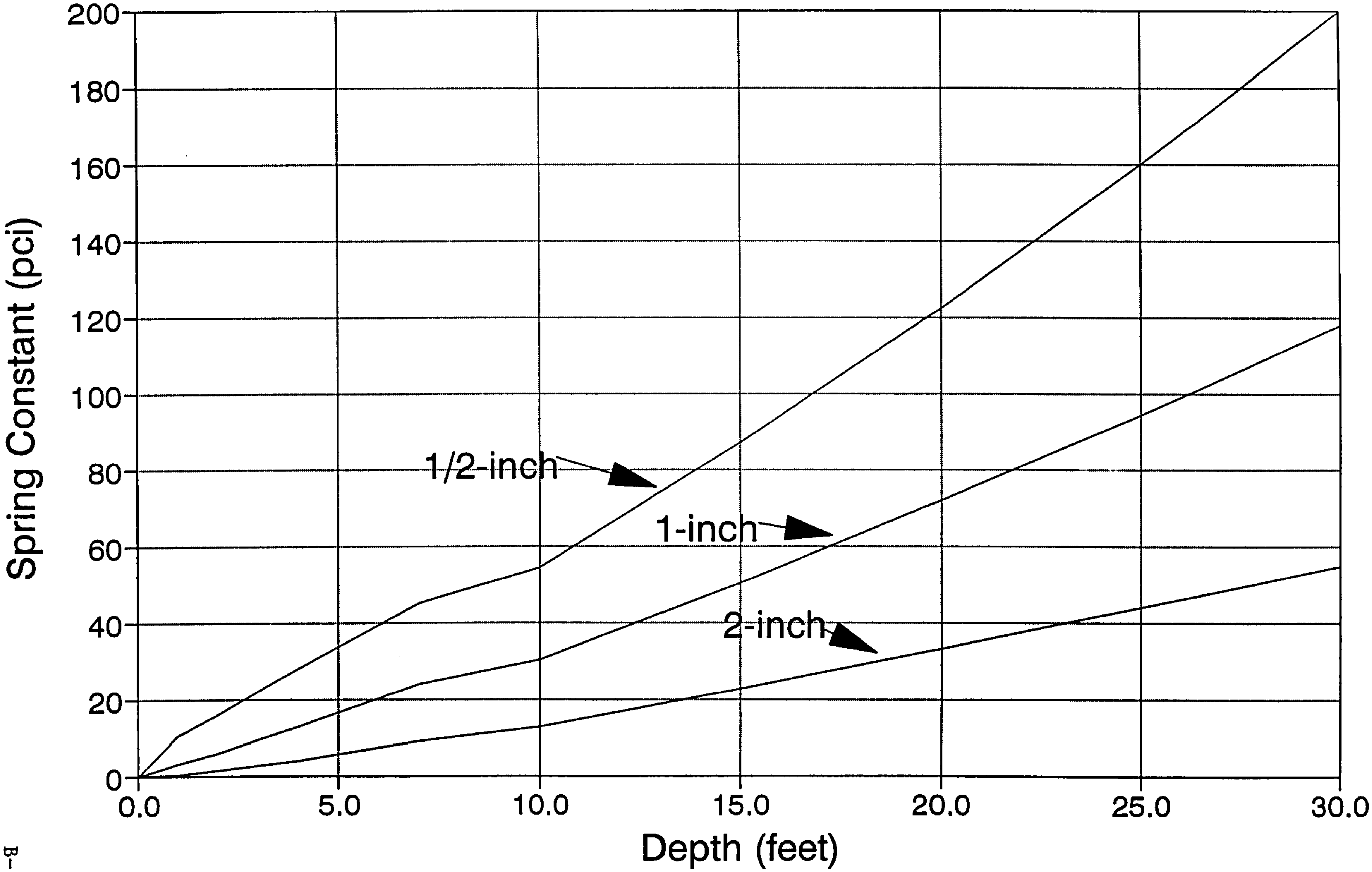

Figure 14 - Camelback Road
4.5-Foot Diameter

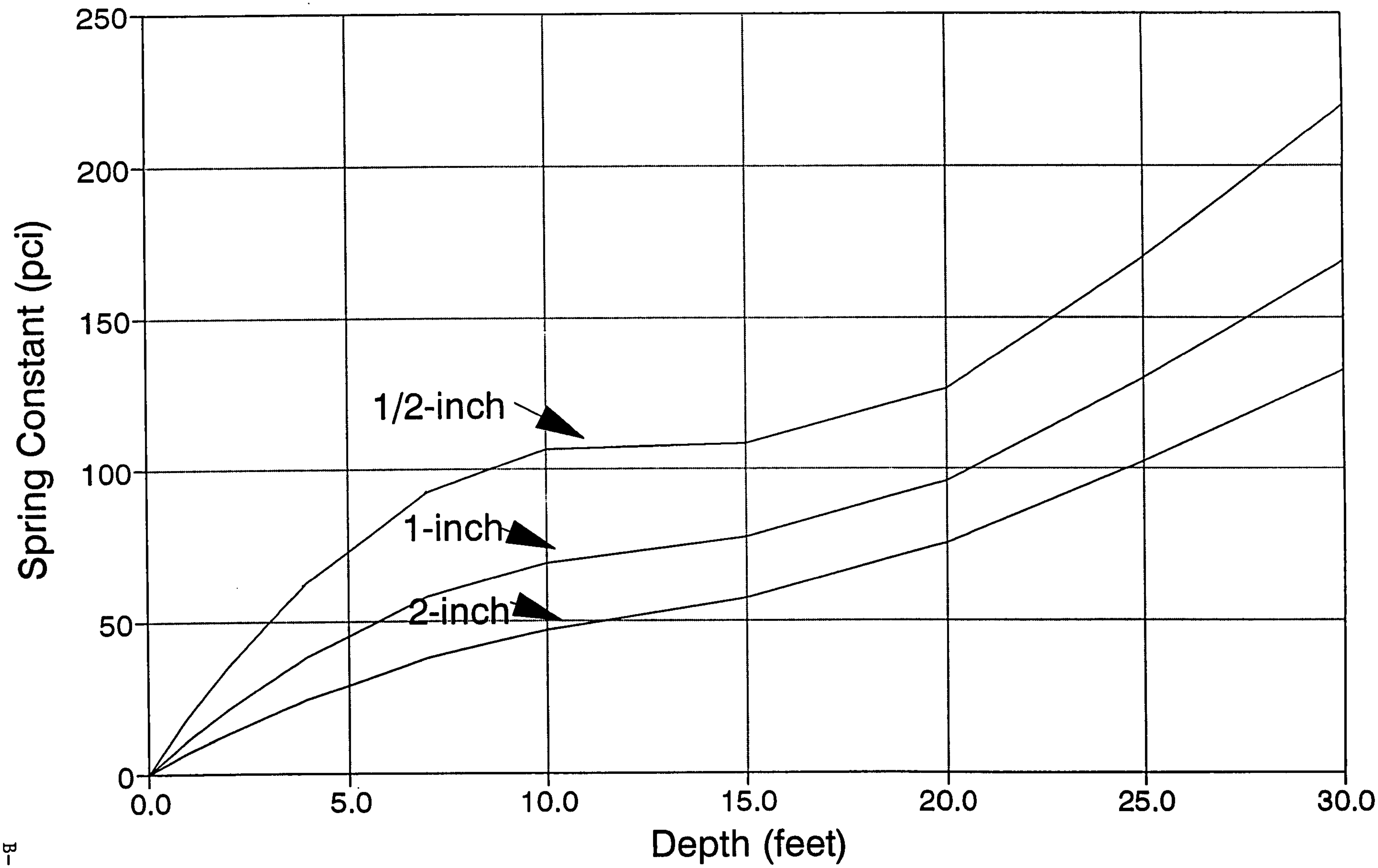

Figure 15 - Indian School Road
5-Foot Diameter

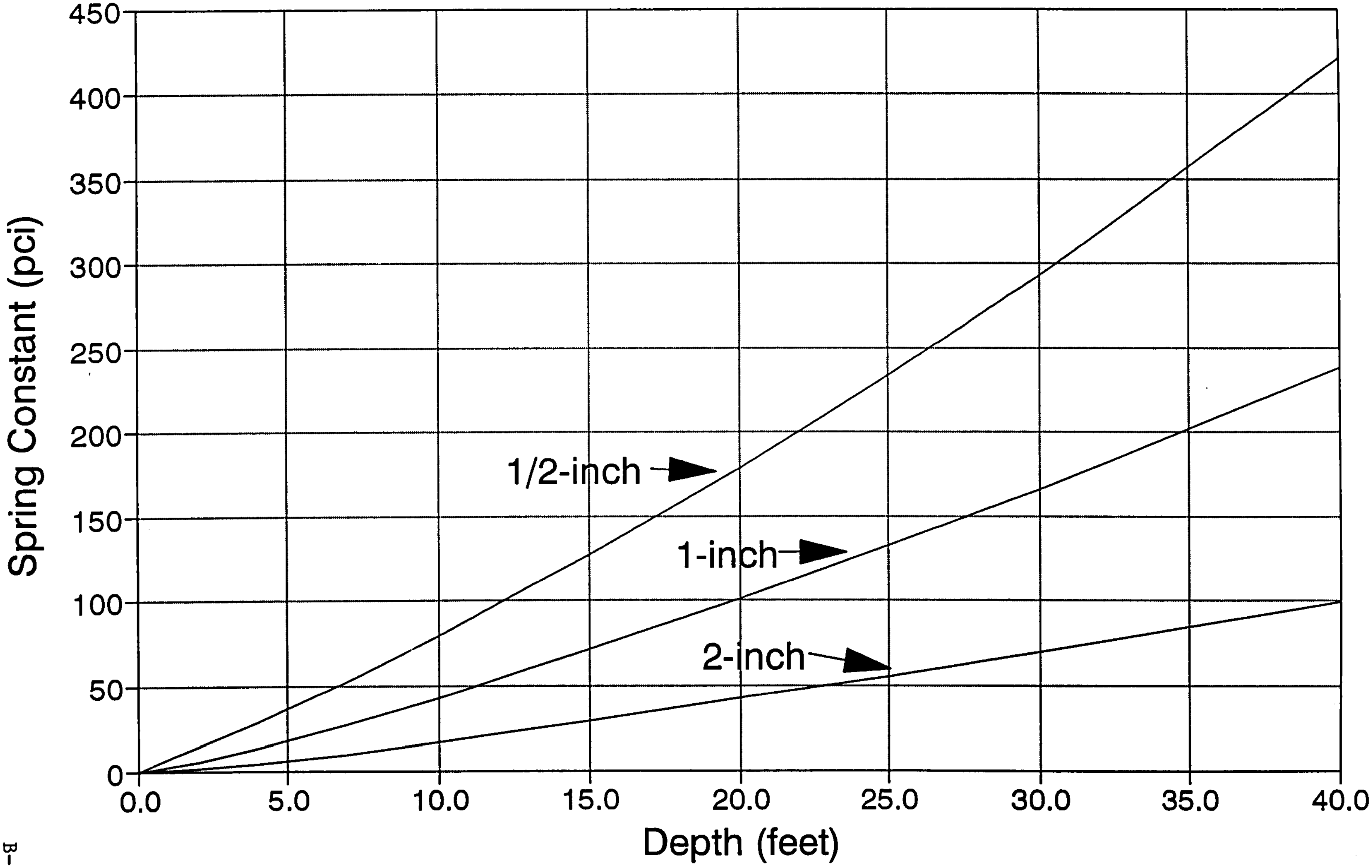

Figure 16 - Old US 80 Over Hassayampa

5.5-Foot Diameter

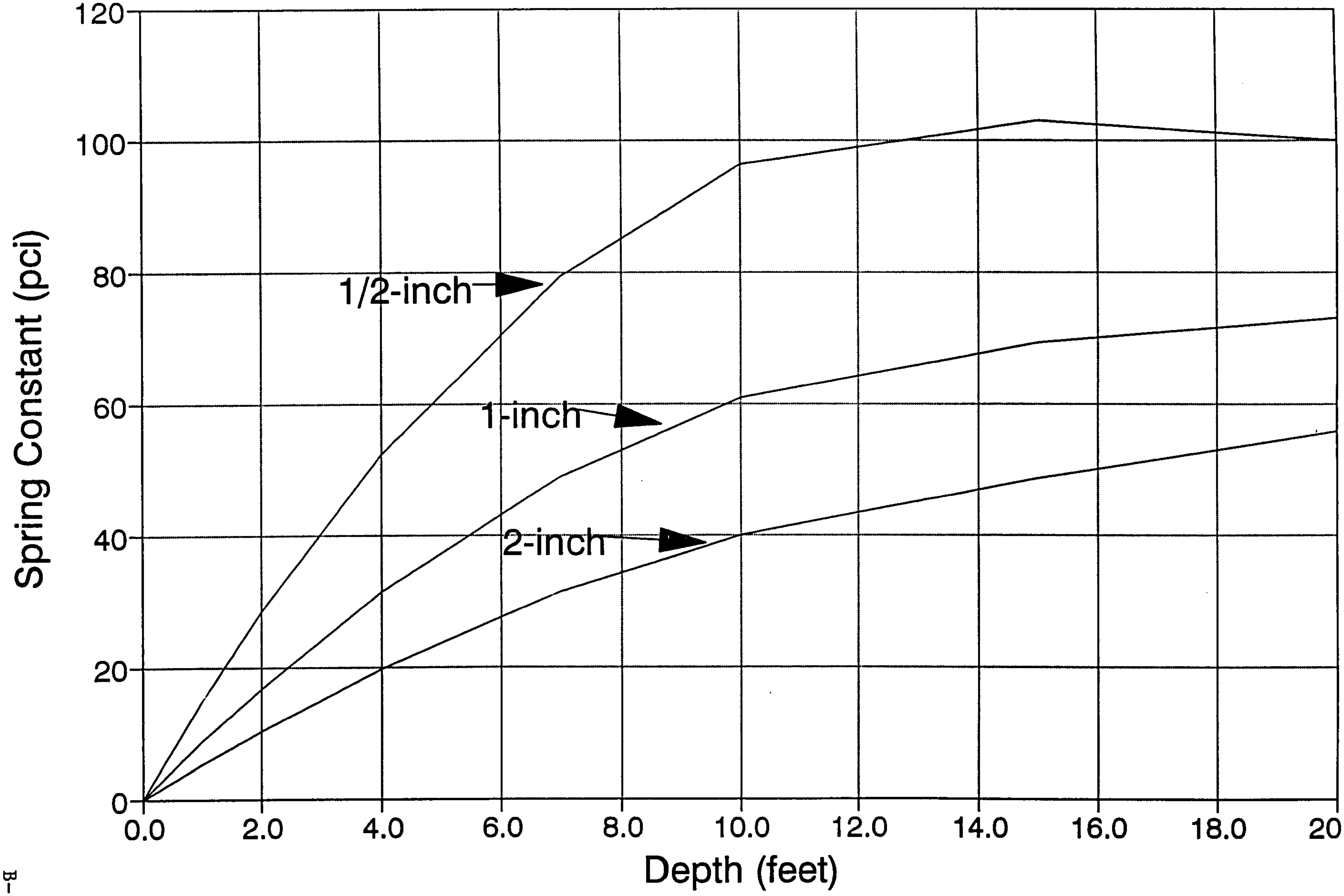

Figure 17 - Rittenhouse Road

16-Inch Pipe Pile

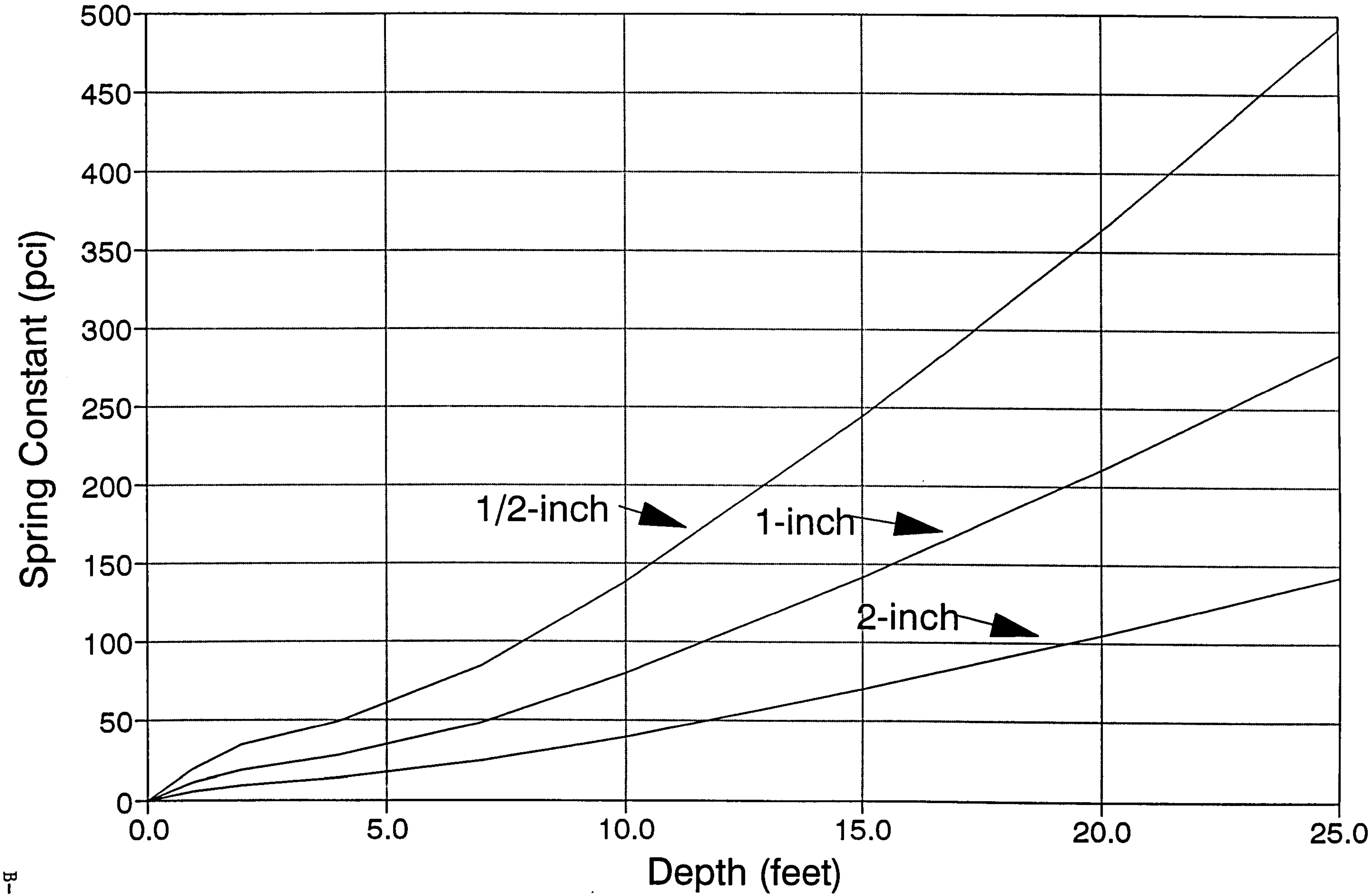

Figure 18 - Hawes Road
3-Foot Diameter

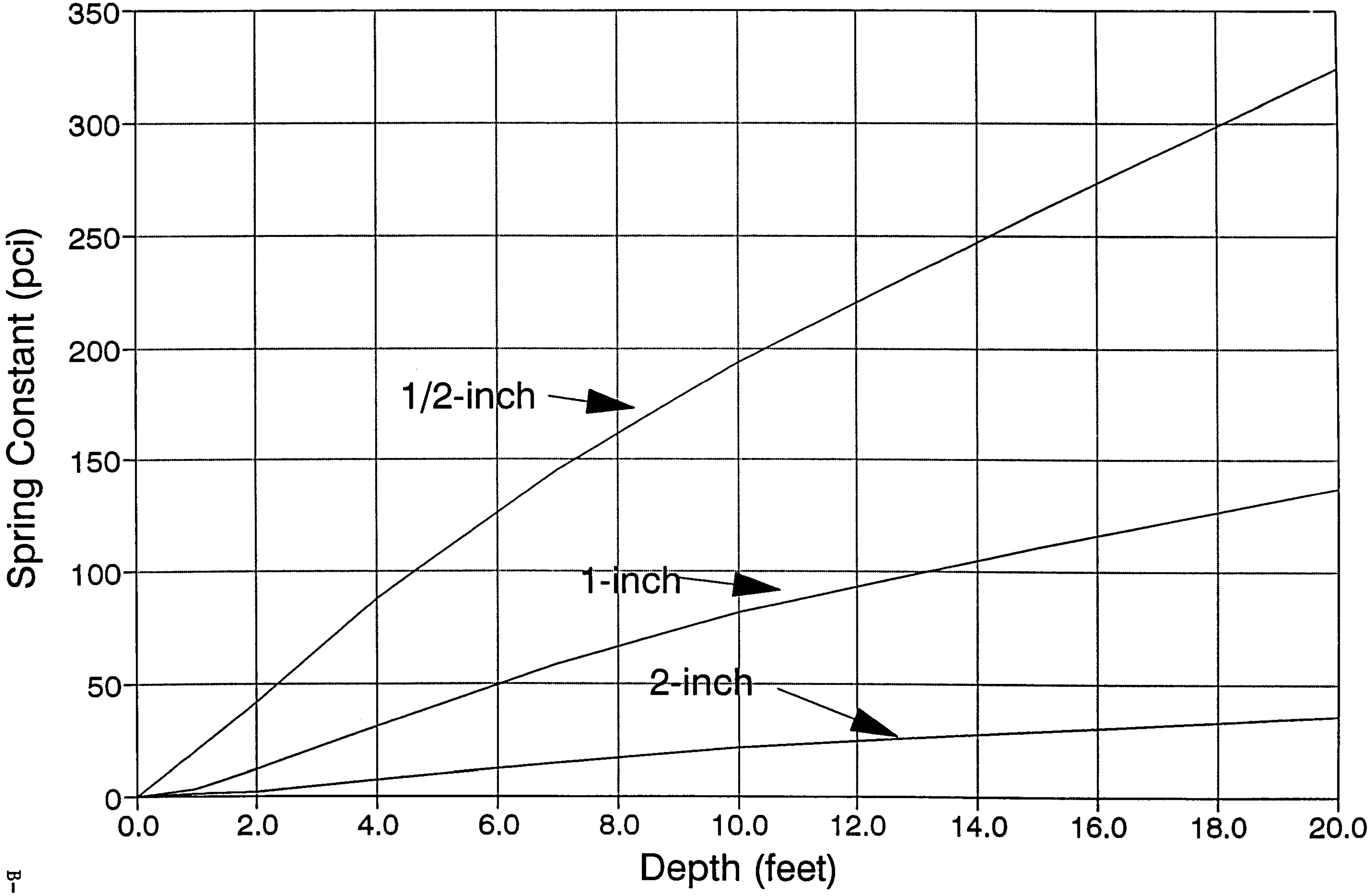

Figure 19 - Power Road
10-inch BP Pile

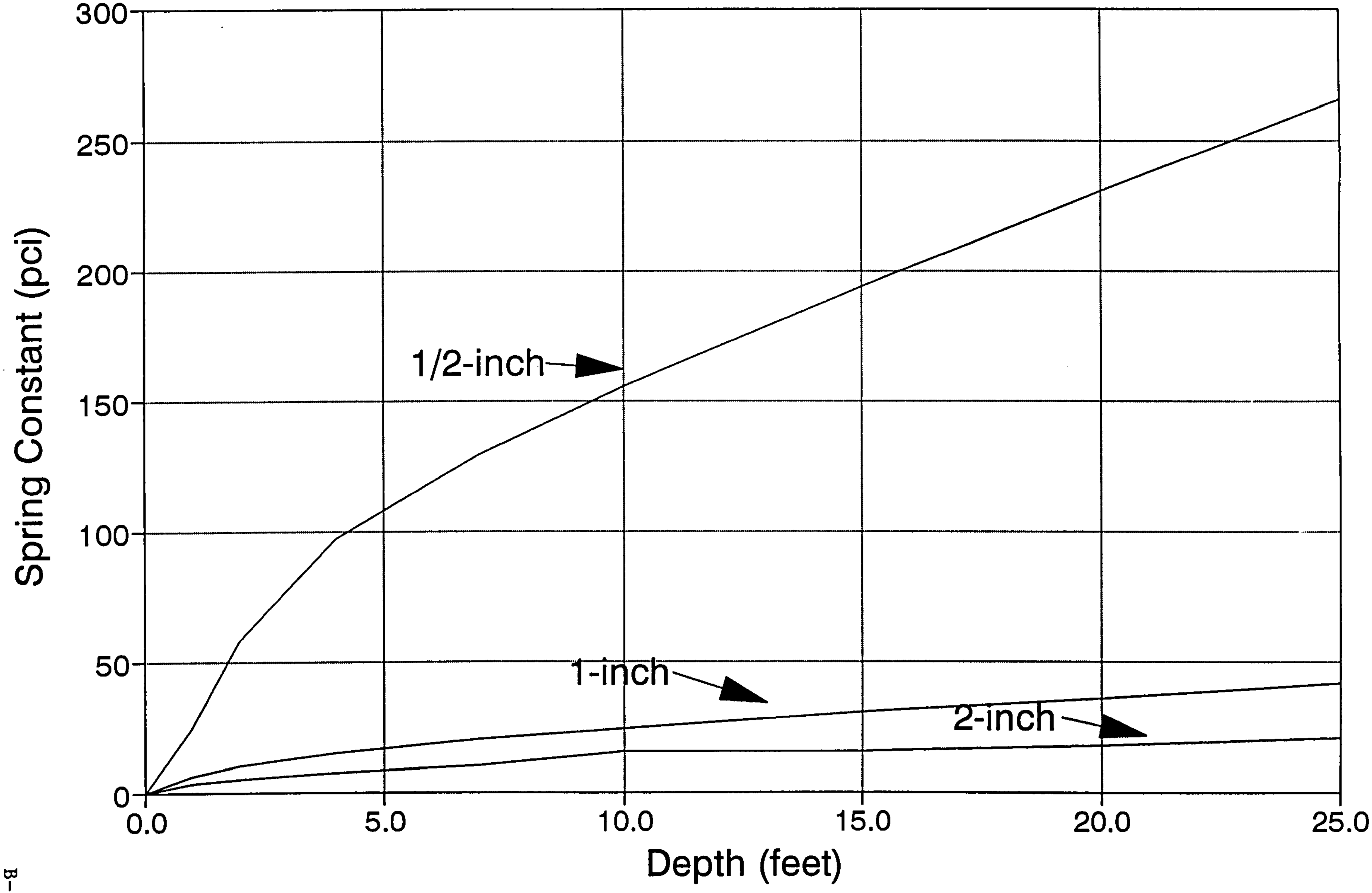

Figure 20 - Higley Road

14-inch Pipe Pile

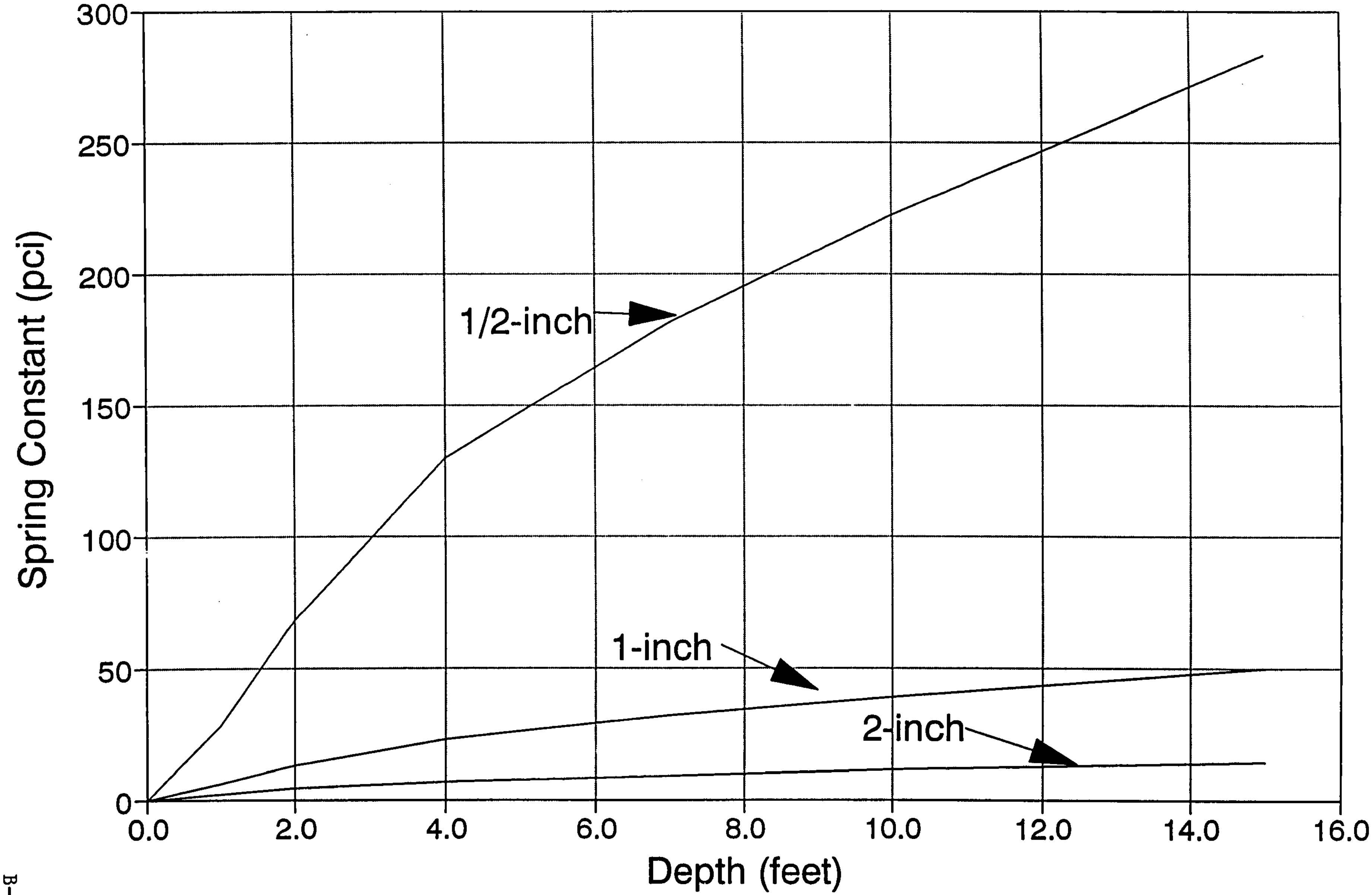

Figure 21 - Deer Valley Road
3-Foot Diameter