GEOTECHNICAL REPORT
NEW RIVER ROAD BRIDGE LEVEE
EAST OF I-17 FRONTAGE ROAD
AND NEW RIVER ROAD
NEW RIVER, ARIZONA

KLEINFELDER

An employee owned company

GEOTECHNICAL REPORT
NEW RIVER ROAD BRIDGE LEVEE
EAST OF I-17 FRONTAGE ROAD
AND NEW RIVER ROAD
NEW RIVER, ARIZONA

FCD Contract No. 2001C003
Assignment No. 3

Kleinfelder, Inc.
1335 West Auto Drive
Tempe, Arizona 85284
(480) 763-1200

September, 2002

KLEINFELDER
An employee owned company

September 13, 2002
File No.: 17112

Mr. Warren Rosebraugh, PE
Flood Control District of Maricopa County.
2801 West Durango
Phoenix, Arizona 85009

SUBJECT: New River Road Bridge Levees
FCD Contract No. 2001C003, Assignment No. 3
East of I-17 Frontage Road and New River Road
New River, Arizona

Dear Mr. Rosebraugh:

Kleinfelder, Inc. (Kleinfelder) is pleased to present the attached geotechnical study report for the subject project. The purpose of our study was to evaluate the subsurface soil conditions of the existing New River Levees in order to develop geotechnical-engineering recommendations to selected sections of the Federal Emergency Management Agency (FEMA) form 81-89G. It is Kleinfelder's professional opinion that the existing levees meet the geotechnical-related requirements of Section 6 "Embankment Protection", Section 7 "Embankment and Foundation Stability", Section 9 "Settlement", and Section 11 "Liquefaction, Hydrocompaction, Heave Differential Movement".

We appreciate the opportunity of providing our services for this project. If you have questions regarding this report or if we may be of further assistance, please contact the undersigned.

Sincerely,

KLEINFELDER, INC.

Heriberto (Eddie) Coria
Project Manager

Reviewed by:

B. Dwaine Sergent, PE for
Director of Engineering

Steven A. Haire, PE
Senior Geotechnical Engineer

KLEINFELDER 1335 West Auto Drive, Tempe, AZ 85284 (480) 763-1200 (480) 763-1212 fax

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1. INTRODUCTION

1.1 General

In this report we present the results of our geotechnical study of the existing New River levees located adjacent to the New River Road Bridge, east of Interstate 17 frontage road, in New River, Arizona (see Plates 1 and 2). The purpose of the study was to explore and evaluate the subsurface conditions at various locations on the existing levees in order to develop geotechnical-engineering recommendations to selected sections of FEMA Form 81-89G.

Our study included a subsurface exploration, representative soil sampling, field testing, engineering analyses, and preparation of this report. The recommendations contained in this report are subject to the limitations presented herein. Attention is directed to the "Limitations" section of this report.

1.2 Project Description

We understand that the existing levees were constructed in 1997. The levees vary in height from approximately seven feet to 12 feet. It is anticipated that the height of each levee will be increased by two feet to meet freeboard requirements. The levees appear to be constructed from onsite silt, sand, gravel, and cobbles. The four levee segments vary in length for approximately 250 feet to 800 feet and contain gabions as sloped revetments.

Kleinfelder performed this investigation and analyses in order to assist the Flood Control District of Maricopa County (FCD) with completing selected sections of FEMA Form 81-89G. As-Built plans and stream flow information were provided by the FCD to assist us with our investigation. Copies of the stream flow data are presented in Appendix D.

The analysis of the existing levees include:

<u>Form 81-89G Section 6. Embankment Protection</u>

- Analysis / verification of existing gabion slope protection

Form 81-89G Section 7. Embankment and Foundation Stability

- Embankment and foundation stability analysis on a 2-foot height increase on the existing levees
- Seepage analysis
- Piping potential

Form 81-89G Section 9. Settlement

- Settlement

Form 81-89G Section 11. Other Design Criteria

- Liquefaction
- Hydrocompaction
- Heave differential movement due to high shrink/swell soils

2. FIELD EXPLORATION

A total of 8 borings were planned for drilling during the field study. Geomechanics Southwest Inc., Phoenix, Arizona, was subcontracted to drill the borings. Of the eight borings planned, we were only able to advance five borings to the panned depths, due to extremely difficult drilling conditions. The borings were advanced using a track-mounted drill rig equipped with 6 5/8-inch hollow-stem auger. In addition, the track-mounted drill rig was modified with an air rotary drilling system in attempt to improve drilling. Nonetheless, we were unable to advance three of the eight planned borings, due to the large amount of coarse gavel, cobbles, and boulders present.

Four test pits were excavated with a Caterpillar 416B backhoe to determine the depth of embedment of the gabions below the existing river bottom surface elevation.

Prior to the start of field exploration, the Arizona Bluestake Center was contacted to locate existing utilities at the site. Upon completion, the boreholes and test pits were filled with soil cuttings.

The soils encountered in the borings were examined, visually classified, and logged by a Kleinfelder representative. Disturbed samples were taken at the direction of the field engineer during drilling, using a Standard Penetration/Split Spoon Sampler (SPT) with a 1.5-inch inside diameter and 2-inch outside diameter. The SPT samplers were driven 18 inches, using a 140-pound hammer falling 30 inches, and blow counts for successive 6-inch penetration intervals were recorded. After the sampler was withdrawn from the borehole, the samples were removed and sealed to minimize moisture loss. Sample Classifications, blow counts recorded during sampling, and other related information were recorded on the soil boring logs. The boring logs for the project are presented in Appendix A.

Soil samples were recovered and transported to our laboratory for additional testing, as appropriate. The soil samples collected were deemed not representative due to the coarse nature of the onsite soils; thus, they were not tested. A map showing approximate boring and backhoe pit locations is presented on Plate 2.

3. GENERAL SITE CONDITIONS

3.1 Geology

The site is located in the Basin and Range Geologic Province, which is characterized by broad alluvial valleys bound by steep, relatively rugged mountain ranges. The mountain ranges contain numerous rock strata that have been extensively folded and faulted during the Mesozoic and Cenozoic Eras. The valleys are generally underlain by segments of consolidated sediments (gravel, sand, silt, and clays) that are the main aquifers for the region. Coarse cobbles of Precambrian metamorphic rocks line the New River channel at the site.

3.2 Surface Conditions

The subject site contained 4 levees. The levees are both upstream and downstream of the New River Road Bridge. The levees appear to be constructed from onsite silt, sand, gravel, and cobbles. The levees vary in length for approximately 250 feet to 800 feet and contain gabions

(sometimes referred to as Reno mattresses) as sloped revetments. The levees vary in height from approximately seven feet to 12 feet, per the as-built plans. A filter fabric was observed between the levees and the gabion cages. The individual gabion cages measured approximately 3.5 feet by 10 feet. The gabion elongated hexagon mesh dimensions were measured to be three inches (D measurement) by five inches. Moderate to sparse desert vegetation including brush and small trees was observed on top of the levees, with isolated brush on the sides of the levees.

3.3 Subsurface Conditions

The soils encountered during our field investigation consisted predominantly by coarse-grained soils. The native soils generally consisted of sandy gravel with cobbles (GP) throughout the depth drilled, with occasional lenses and zones of gravelly sand to gravelly silty sand (SP to SM). The granular alluvial soils are underlain by bedrock, according to a to a report by Thomas-Hartig & Associates (THA) entitled, "Geotechnical Engineering Services New River Road Bridge Over New River", and dated January 1, 1993. The report states that the bedrock is clay shale and a conglomerate with a clayey sandstone matrix at elevations ranging from 1999 feet to 2009 feet. The exploration logs and laboratory test results from the THA report are resented in Appendix B.

Prior to our field investigation, two utility pole foundation caissons were drilled and lined with corrugated metal casing on the southeast and southwest abutments of the New River Bridge. The depth of excavation for the southeast and southwest caissons was 17 feet and 19 feet below the existing levee/abutment elevation respectively. Visual observations of the bottom of the excavations and the excavation spoils indicated that the soil matrix consisted of silt, sand, gravel, and cobbles to their respective depths.

During our field investigation, groundwater was not encountered in any of the borings to the depths explored. However, in November 1992, as reported in the THA report in Appendix B, perched groundwater was reported to be on the order 5.5 feet to 15 feet below the river bottom. It should be noted that soil moisture conditions within the area will vary depending on rainfall and/or runoff conditions not apparent at the time of our field study.

3.4 Seismic Conditions

The project is located in Central Arizona, which is an area of low seismic activity. The design horizontal acceleration at bedrock is 0.042g, as recommended in the Seismic Acceleration Contour Maps prepared for ADOT by Euge, Schell, and Lam under Federal Contract Number HPR-PL-1(37)344. This value of acceleration has a 90 percent probability of not being exceeded in 50 years.

4. ENGINEERING ANALYSES AND RECOMMENDATIONS

4.1 General

It is Kleinfelder's professional opinion that the existing levees meet the geotechnical-related requirements of FEMA form 81-89G Section 6 "Embankment Protection", Section 7 "Embankment and Foundation Stability", Section 9 "Settlement", and Section 11 "Liquefaction, Hydrocompaction, Heave Differential Movement", as discussed below.

4.2 Form 81-89G Section 6. Embankment Protection

4.2.1 Analysis / verification of existing gabion mattress

According the as-built plans, the thickness of the gabion mattress on the levee slope is 12 inches. Through visual observations, the average size of the rocks filling the gabion cages was approximately three to eight inches. Recommendations contained within the "Solutions in Environmental Engineering Short Course" published by Maccaferri Gabions, Inc., state that the gabion thickness should be at least 1.5 time greater than the maximum size of the rocks used in the gabion cages. With an eight-inch rock size, the gabion thickness should be 12 inches. It should be noted that in some areas, a small percentage of rocks within the gabions appeared to be smaller than the mesh opening.

Table 4, on page 6.20 of the above referenced manual illustrates the required thickness of the gabion and filling stone size based on critical velocity and limit velocity. Given that the limit velocity is 13.8 ft/ sec, then a gabion requires a d_{50} (stone size where 50 percent of the stones are smaller) of 3.5 inches. Also, the filling stone size should vary from three inches to four inches, and the minimum recommended thickness for the gabion is six inches, using Table 4. If the peak velocity of 8.4 ft/sec, given by Flood Control District, approaches the limit velocity if 13.8 ft/sec the existing gabions are adequate as sloped revetments. Furthermore, a 12-inch gabion thickness requires a d_{50} of four inches and a stone filling size ranging from three inches to five inches and is suitable for a limit velocity of 18 ft/sec. A copy of the above referenced Table 4, along with our embankment protection calculations, are presented in Appendix C.

The embankment slopes under the gabions were lined with filter fabric. Assuming that the filter fabric meets the specification as listed in as-built plans, the permittivity of the AMOCC 4551 fabric is 1.5 sec^{-1}. The permittivity of geotextiles is the volumetric flow rate of water per unit cross sectional area per unit head under laminar flow conditions, in the normal direction through a geotextile. An average coefficient of permeability for coarse sand and gravel is about 10^{-2} cm/sec to 10^{-3} cm/sec (U. S. Department of the Army). Under a 1-foot head, the calculated flow rate through the filter fabric is several orders of magnitude greater than the flow through a 1 square-foot cross section of levee soil under a unit hydraulic gradient. Therefore, the existing filter fabric will not impede flow between the gabion mattress and the embankment. The AMOCC 4551 fabric has an apparent opening size of the number 100 sieve (0.15mm). Based on the U.S. Army Corps of Engineers filter criteria, the ratio of the soil d_{85} to the opening diameter should be greater than one to two. Based on inspection of the boring logs and test results presented in the THA report, the d_{85} of the embankment is conservatively greater than the No. 4 sieve (greater than 4.75mm). Therefore, the ratio of d_{85} embankment to the opening diameter is greater than about 30, and the opening size is easily small enough to meet the filter criteria.

Based on the information presented above, the system of gabion mattresses, as designed, provides adequate protection of the levee from erosion caused by the specified design water flow velocity.

4.2.2 Gabion Depth of Embedment

Four test pits were excavated to determine the depth of embedment of the gabions below the existing channel surface elevation. The depth of embedment for the northeast and northwest levees was approximately 4.1 feet and 6.9 feet below the existing river bottom surface elevation, respectively. The depth of embedment for the southeast and southwest levees was approximately four feet and six feet below the existing river bottom surface elevation, respectively. It should be noted that the as-built plans indicated an embedment depth of six feet below channel bottom for each of the levee segments.

4.3 Form 81-89G Section 7. Embankment and Foundation Stability

The following assumptions were used in our slope stability analyses:

- A critical embankment height of 14 feet (relative to the riverside) is assumed. This includes the current 12-foot height plus two feet that may be added for extra freeboard.
- Both the riverside and landside slopes are 2H:1V. The width of the top of the levee is 12 feet. This assumes that the existing levee width is 20 feet as shown on the plans, which will reduce to 12 feet with the addition of two feet of freeboard.
- Slopes were analyzed using commercial computer program XSTABL Version 5.2, Interactive Software Design, Inc., searching for critical circular failure using the Simplified Bishop Method.
- Assumed soil parameters for both the levees and the foundation soils:

Material	Total Unit Wt. (pcf)	Submerged Unit Wt. (pcf)	Angle of Internal Friction (deg.)	Cohesion (psf)
Embankment and underlying native sandy gravel soils	130	140	38	0
Gabion Gravels	90	120	36	0*

*conservatively neglect the strength of the gabion cage

4.3.1 Embankment Stability Analyses

A summary of the results of the slope stability analyses is presented in the table below:

Case	Loading Conditions	Calculated Safety Factor	Criteria (min.)
I	End of Construction	1.46	1.3
II	Sudden Drawdown	1.21	1.0
III	Critical Flood Stage	1.43	1.4
IV	Steady Seepage at Flood Stage	1.43	1.4
VI	Earthquake (end of construction)	1.32	1.0

Both cases III and IV were analyzed assuming the conservative case of steady seepage at the maximum anticipated water depth. This is a very conservative model because, as discussed in Section 5.3.2 below, the actual flow in the levee will not reach a state of steady seepage due to the short duration of the design flood.

4.3.2 Seepage Analysis

The levee is constructed with the native sand, gravel and cobble soils, which contain a small amount of fines (generally less than about 5-10% passing #200). The fines exhibit variable plasticities ranging from non-plastic to low plasticity. The permeability of these soils probably range from about 10^{-2} to 10^{-3} cm/sec. For our analysis, we conservatively assumed the larger value, or 10^{-2} cm/sec, for both the embankment and for the underlying native soils.

For a steady state flow condition at maximum flood water level (11-foot head on the riverside of the levee), the top flow line in the critical 14-foot high embankment was approximated using the "tangent" method. For this case, the length of the top flow line was about 42 feet and the elevation difference between entrance and exit near the toe of the slope was about nine feet. Thus, the average hydraulic gradient along the top flow line was approximately 9/42 = 0.2. The approximate velocity of the seepage along the top flow line was calculated to be about 1 ft per hour, based on v = ki/n (Darcy's Law), where:

$k = 10^{-2}$ cm/sec = 1.2 ft/hr permeability

i = 0.2, hydraulic gradient

n = 0.23, porosity based on an assumed void ratio e = 0.3

Thus, it will take on the order of 42 hours or more to establish steady flow in the levee, assuming a constant 11-foot head on the riverside of the levee.

4.3.3 Piping potential

The piping potential on the landside face of the levee is very low because the flood duration is so short. As noted in Section 5.3.2 above, steady state seepage which emerges on the landside slope near the toe of the levee would require on the order of 40 hours or more assuming a constant 11-foot head on the riverside of the levee. Based on the stage and hydrograph data presented in Appendix D, the duration of flow deeper than 10 feet is only 2 hours. The duration of flow deeper than 4 feet is only about 9 hours. Thus, there will be insufficient time to generate a groundwater flow which will exit on the landside levee slope, so flow which could result in piping or uplift on the toe of the levee is not possible.

4.4 Form 81-89G Section 9. Settlement

4.4.1 Estimated Settlements

Both the levee and the foundation soils are composed of coarse-grained medium dense to dense granular soils, which exhibit low compressibility potential. In addition, bedrock is fairly shallow, at a depth of about eight to 12 feet below the channel. Thus, calculated settlements due to the embankment loads are low, and should have occurred during and within a short time after construction. Calculated total settlement is about 0.1 feet. The future addition of two feet of soil to the top of the levees to increase freeboard will result in less than 0.01 feet of additional settlement.

4.5 Form 81-89G Section 11. Other Design Criteria

4.5.1 Liquefaction

Liquefaction should not be a concern for this site. The moisture contents of the site soils were well below saturation at the time of our investigation, although groundwater maybe perched at

other times. Also, the area is not prone to significant seismic activity, and the design horizontal acceleration is low (0.042g), as discussed in Section 4.4.

4.5.2 Hydrocompaction

Hydrocompaction generally occurs in low-density soils with considerable fines content (generally more than about 20 percent passing the #200 sieve). The native foundation and levee soils are generally very coarse-grained with low fines contents, and they generally exhibit high sampler blowcounts, indicating medium to high relative densities. Thus, there is no significant hydrocompaction potential at the site.

4.5.3 Heave Differential Movement due to High Shrink/Swell Soils

The native foundation and levee soils are generally very coarse-grained non-cohesive sands and gravels with low fines contents. The fines exhibit variable plasticities, generally ranging from non-plastic to low plasticity. Thus, the shrink/swell potential of these soils under varying moisture conditions will not be significant.

5. CLOSURE

5.1 Limitations

The recommendations contained in this report are based on our field explorations, as-built plans, and information provided by Flood Control District of Maricopa County personnel. The subsurface data used in the preparation of this report were obtained from the five borings drilled during the field study. It is anticipated that some variations in the soil conditions will exist between the points explored. The nature and extent of variations may not be evident until construction occurs. If any conditions are encountered at this site which are different from those described in this report, our firm should be immediately notified so that we may make any necessary revisions to the recommendations contained in this report. In addition, if the scope of the proposed construction changes from that described in this report, our firm should also be notified. This report was prepared in accordance with the generally accepted standard of practice

in Arizona at the time the report was written. No warranty, expressed or implied, is made. It is the Client's responsibility to see that all parties to the project including the Designer, Contractor, Subcontractors, etc. are made aware of this report in its entirety. The use of information contained in this report for bidding purposes should be done at the Contractor's option and risk.

This report may be used only by the client and only for the purposes stated, within a reasonable time from its issuance. Land use, site conditions (both on and offsite) or other factors may change over time, and additional work may be required with the passage of time. Any party other than the client who wishes to use this report shall notify Kleinfelder of such intended use. Based on the intended use of the report, Kleinfelder may require that additional work be performed and that an updated report be issued. Non-compliance with any of these requirements by the client or anyone else will release Kleinfelder from any liability resulting from the use of this report by any unauthorized party.

We appreciate the opportunity to be of service on this project. Should you have any questions regarding this report or wish to discuss additional services, please do not hesitate to contact us.

6. REFERENCES

Chronic, Halka, Roadside Geology of Arizona, 1983, Mountain Press Publishing Company, page 143.

Euge, Schell, and Lam, Development of Seismic Acceleration Contour Maps for Arizona, 1992, ADOT, Report No. AZ92-344.

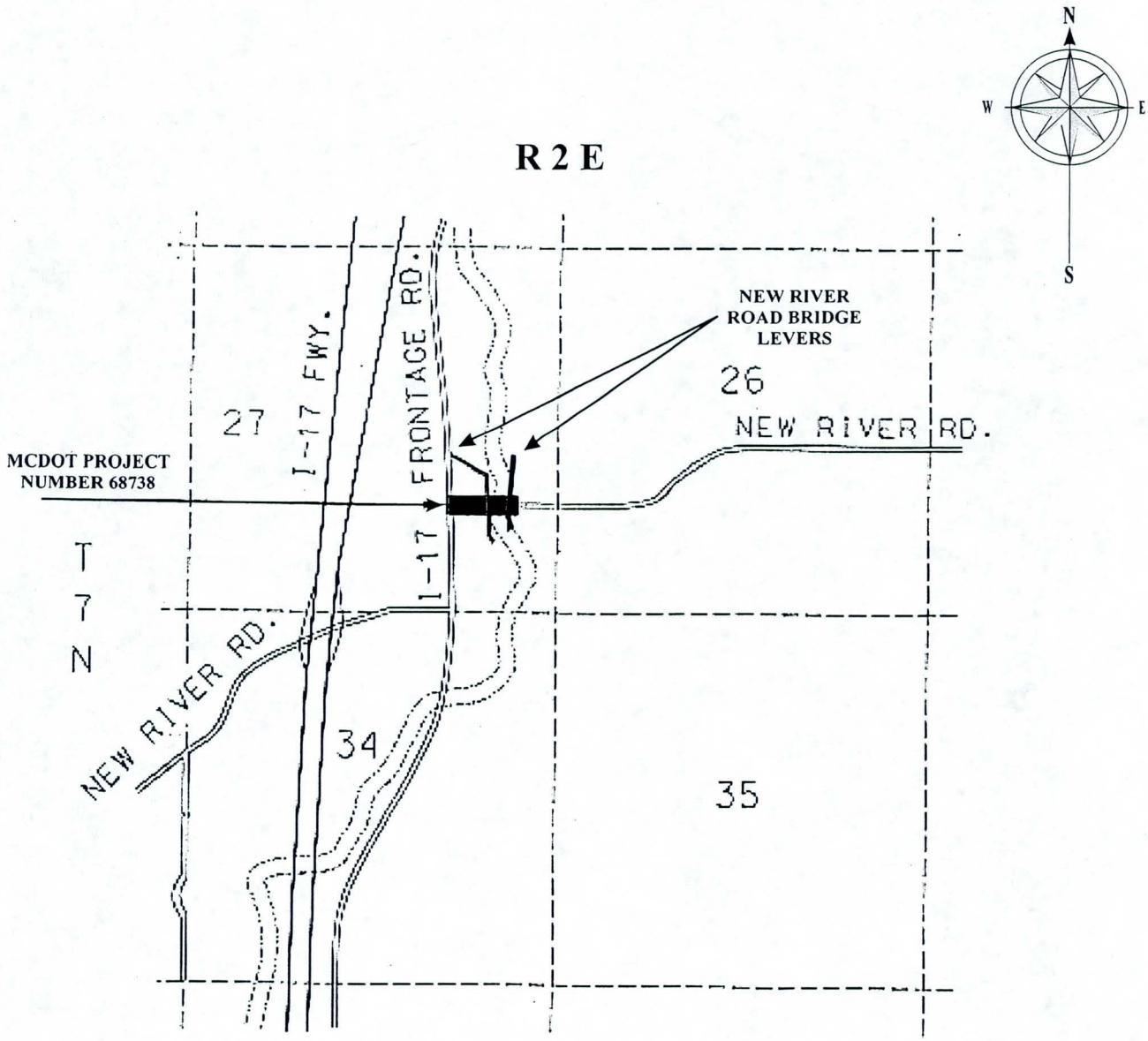
Fellows, Larry D., Earthquake Hazard in Arizona, http://www.azgs.state.az.us/Spring2000.htm, Spring 2000—Vol. 30, No. 1.

Maccaferri Gabions, Inc., Solutions in Environmental Engineering Short Course, 1999.

U. S. Department of the Army. Technical Manual TM 5-818-5: Dewatering and groundwater control for deep excavations, Washington, D.C., November, 1983. (AFM 88-5, chap 6; NAVFAC P-418)

PLATES

graphics\projects\17112\ location map.cdr /skc



NOT TO SCALE

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August 2002

Flood Control District
Maricopa County

SITE LOCATION MAP

PLATE

1

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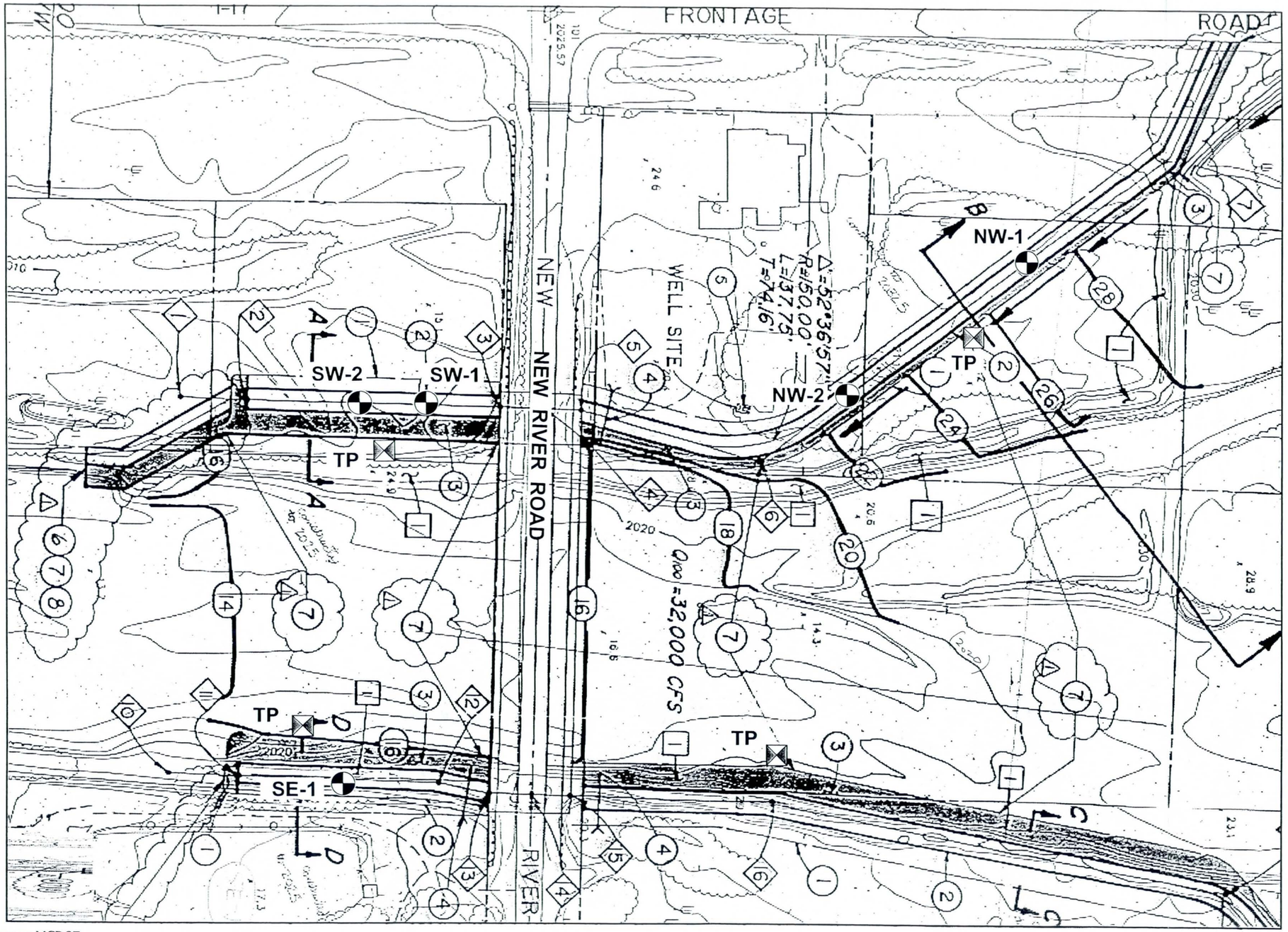

Basemap: MCDOT
NEW RIVER ROAD
Bridge at New River, Project Number 68738, Sheet Number 15
Gabion Bank Protection Revision, 1997

NOT TO SCALE

LEGEND

NW-1 Test Boring Location

TP Test Pit

Flood Control District
Maricopa County

EXPLORATION LOCATION PLAN

PLATE **2**

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Project Number 17112

August 2002

APPENDIX A

Field Investigation

APPENDIX A

Field Investigation

BORINGS

The subsurface conditions at the site were explored on September 25, 2001, by drilling borings using a CME 75 truck-mounted drill rig equipped with 6 5/8-inch-diameter hollow stem auger. The locations of borings performed for this study are shown on Plate 2 of the report.

The locations of borings shown on Plate 2 were located by visual sighting and pacing from existing site features and, therefore, should be considered approximate. Actual boring locations may vary from those indicated on Plate 2.

Our staff professional maintained a log of the borings, visually classified soils encountered according to the Unified Soil Classification System (see A-1) and obtained samples of the subsurface materials. A key to the Logs of Borings is presented on A-2 of this appendix.

SAMPLING PROCEDURES

Soil samples were obtained from the borings using either a 2-1/2 inch inside diameter ring sampler or a Standard Penetration Sampler driven 18 inches (unless otherwise noted) into undisturbed soil using a 30 inch drop of a 140-pound hammer. Blow counts were recorded at six-inch intervals for each sample attempt and are reported on the logs in terms of blows-per-foot for the last foot of penetration. Soil samples obtained from the borings were packaged and sealed in the field to reduce moisture loss and disturbance, and returned to our laboratory for further testing. After borings were completed, they were backfilled with the drill cuttings.

LIST OF ATTACHMENTS

The following plates are attached and complete this appendix.

A-1 Unified Soil Classification System
A-2 Log Key
A-3 Charts & Definitions
Logs of Borings

Northing and Easting:		Date Started:	6/3/2002
Groundwater (ft):	No Free Groundwater Encountered	Date Completed:	
Drilling Company:	GSI	Equipment:	CME-75 Track Mounted Rig
Logged By:	Wail Mokhtar		
Hole Diameter (in):	6 5/8	Drilling Method:	Hollow Stem Auger
Hammer Type:	Automatic	Total Depth (ft):	15.0

FIELD				LABORATORY								
Sample Interval	Blow Counts per 6" Interval	Sample Type	Continuous Penetration Resistance	Dry Density (pcf) / Moisture Content (%)	Liquid Limit / Plasticity Index	Passing #4 Sieve (%) / Passing #200 Sieve (%)	Other Tests	Graphical Log	USCS Classification	DESCRIPTION
										0.0 to 15.0 feet
										Appx. Surface Elevation (ft): 2032.50 Surface Condition: Sand, gravel, and cobble levee with sparse to moderate desert vegetation
		BULK							GP	**Sandy Gravel, Cobbles and Boulders,** predominantly fine grained sand, subangular to angular gravel, light brown, slightly moist, dense to very dense, non plastic Note: Coarse gravel, cobbles and boulders were encountered throughout the boring
5	41 31 24	SPT								
10	23 31 50/2	SPT								Note: Increase in percent sand
15	50/4	SPT								Boring terminated at 15.0 feet Sampling stopped at 15.5 feet Caved to 3.0 feet
20										
25										
30										
35										

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Drafted By:	Wail
Date:	July, 2002
Project Number:	17112

LOG OF BORING NW-1
NEW RIVER ROAD BRIDGE LEVEES
Flood District of Maricopa County
East of I-17 Frontage Road and New River Road
New River, Arizona

BORING
NW-1
Page 1 of 1

GEO_ADOT_E 17112.GPJ cnewman@kleinfelder.com 07/29/2002

Northing and Easting:		Date Started:	6/3/2002
Groundwater (ft):	No Free Groundwater Encountered	Date Completed:	
Drilling Company:	GSI	Equipment:	CME-75 Track Mounted Rig
Logged By:	Wail Mokhtar		
Hole Diameter (in):	6 5/8	Drilling Method:	Hollow Stem Auger
Hammer Type:	Automatic	Total Depth (ft):	15.0

FIELD				LABORATORY								
Sample Interval	Blow Counts per 6" Interval	Sample Type	Continuous Penetration Resistance	Dry Density (pcf) — Moisture Content (%)	Liquid Limit — Plasticity Index	Passing #4 Sieve (%) — Passing #200 Sieve (%)	Other Tests	Graphical Log	USCS Classification	DESCRIPTION 0.0 to 15.0 feet Appx. Surface Elevation (ft): 2032.50 Surface Condition: Sand, gravel, and cobble levee with sparse to moderate desert vegetation
		BULK							GP	**Sandy Gravel, Cobbles and Boulders**, predominantly fine grained sand, subangular to angular gravel, brown, slightly moist, dense to very dense, non plastic Note: Coarse gravel, cobbles and boulders were encountered throughout the boring
	23 29 21	SPT								
	10 5 6	SPT							SP	**Gravelly Sand, Cobbles and Boulders,** trace clay, predominantly fine grained sand, subangular to angular gravel, brown, slightly moist, medium dense to dense, non plastic
	12 16 17	SPT								
										Boring terminated at 15.0 feet Sampling stopped at 16.5 feet Caved to 9.0 feet

5 10 15 20 25 30 35

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Drafted By:	Wail
Date:	July, 2002
Project Number:	17112

LOG OF BORING NW-2
NEW RIVER ROAD BRIDGE LEVEES
Flood District of Maricopa County
East of I-17 Frontage Road and New River Road
New River, Arizona

BORING
NW-2
Page 1 of 1

GEO_ADOT_E 17112.GPJ cnewman@kleinfelder.com 07/29/2002

Northing and Easting:		Date Started:	6/3/2002
Groundwater (ft):	No Free Groundwater Encountered	Date Completed:	
Drilling Company:	GSI	Equipment:	CME-75 Track Mounted Rig
Logged By:	Wail Mokhtar		
Hole Diameter (in):	6 5/8	Drilling Method:	Hollow Stem Auger
Hammer Type:	Automatic	Total Depth (ft):	8.0

FIELD				LABORATORY								
Sample Interval	Blow Counts per 6" Interval	Sample Type	Continuous Penetration Resistance	Dry Density (pcf) / Moisture Content (%)	Liquid Limit / Plasticity Index	Passing #4 Sieve (%) / Passing #200 Sieve (%)	Other Tests	Graphical Log	USCS Classification	DESCRIPTION
		BULK							GP	0.0 to 8.0 feet Appx. Surface Elevation (ft): 2025.00 Surface Condition: Sand, gravel, and cobble levee with sparse to moderate desert vegetation **Sandy Gravel, Cobbles and Boulders**, predominantly fine grained sand, subangular to angular gravel, light brown, slightly moist, dense to very dense, non plastic Note: Boulder @ 1' below existing ground surface elevation Note: Boulder @ 2.5' below existing ground surface elevation Note: Boulder @ 6' below existing ground surface elevation Note: Boulder @ 7.5' below existing ground surface elevation Boring terminated at 8.0 feet Sampling stopped at 6.5 feet
	8 14 24	SPT								

5 10 15 20 25 30 35

KLEINFELDER

Drafted By:	Wail
Date:	July, 2002
Project Number:	17112

LOG OF BORING SE-1
NEW RIVER ROAD BRIDGE LEVEES
Flood District of Maricopa County
East of I-17 Frontage Road and New River Road
New River, Arizona

BORING
SE-1
Page 1 of 1

GEO_ADOT_E 17112.GPJ cnewman@kleinfelder.com 07/29/2002

Northing and Easting:		Date Started:	6/3/2002
Groundwater (ft):	No Free Groundwater Encountered	Date Completed:	
Drilling Company:	GSI	Equipment:	CME-75 Track Mounted Rig
Logged By:	Wail Mokhtar		
Hole Diameter (in):	6 5/8	Drilling Method:	Hollow Stem Auger
Hammer Type:	Automatic	Total Depth (ft):	15.0

FIELD				LABORATORY								
Sample Interval	Blow Counts per 6" Interval	Sample Type	Continuous Penetration Resistance	Dry Density (pcf)	Moisture Content (%)	Liquid Limit	Plasticity Index	Passing #4 Sieve (%)	Passing #200 Sieve (%)	Other Tests	Graphical Log	USCS Classification
		BULK										GP
	24 23 29	SPT										
	50/6 32 38	SPT										
	50/2	SPT										

DESCRIPTION

0.0 to 15.0 feet

Appx. Surface Elevation (ft): 2025.00

Surface Condition: Sand, gravel, and cobble levee with sparse to moderate desert vegetation

Sandy Gravel, Cobbles and Boulders, , predominantly fine grained sand, subangular to angular gravel, light brown, slightly moist, dense to very dense, non plastic

Note: Coarse gravel, cobbles and boulders were encountered throughout the boring

Note: Increase in percent sand

Boring terminated at 15.0 feet

Sampling stopped at 15.5 feet

5 10 15 20 25 30 35

KLEINFELDER

Drafted By:	Wail
Date:	July, 2002
Project Number:	17112

LOG OF BORING SW-1
NEW RIVER ROAD BRIDGE LEVEES
Flood District of Maricopa County
East of I-17 Frontage Road and New River Road
New River, Arizona

BORING

SW-1

GEO_ADOT_E 17112.GPJ cnewman@kleinfelder.com 07/29/2002

Northing and Easting:		Date Started:	6/3/2002
Groundwater (ft):	No Free Groundwater Encountered	Date Completed:	
Drilling Company:	GSI	Equipment:	CME-75 Track Mounted Rig
Logged By:	Wail Mokhtar		
Hole Diameter (in):	6 5/8	Drilling Method:	Hollow Stem Auger
Hammer Type:	Automatic	Total Depth (ft):	15.0

FIELD				LABORATORY								
Sample Interval	Blow Counts per 6" Interval	Sample Type	Continuous Penetration Resistance	Dry Density (pcf) — Moisture Content (%)	Liquid Limit — Plasticity Index	Passing #4 Sieve (%) — Passing #200 Sieve (%)	Other Tests	Graphical Log	USCS Classification	DESCRIPTION
										0.0 to 15.0 feet
										Appx. Surface Elevation (ft): 2025.00 Surface Condition: Sand, gravel, and cobble levee with sparse to moderate desert vegetation
		BULK							GP	**Sandy Gravel, Cobbles and Boulders,** predominantly fine grained sand, subangular to angular gravel, light brown, slightly moist, very dense, non plastic Note: Coarse gravel, cobbles and boulders were encountered throughout the boring
	22 26 50/2	SPT								
	26 23 27	SPT								Note: Increase in percent sand
	30 50/4	SPT								
										Boring terminated at 15.0 feet Sampling stopped at 16.0 feet

5 10 15 20 25 30 35

KLEINFELDER

Drafted By:	Wail	Project Number:	17112
Date:	July, 2002		

LOG OF BORING SW-2
NEW RIVER ROAD BRIDGE LEVEES
Flood District of Maricopa County
East of I-17 Frontage Road and New River Road
New River, Arizona

BORING
SW-2
Page 1 of 1

GEO_ADOT_E 17112.GPJ cnewman@kleinfelder.com 07/29/2002

APPENDIX B

Exploration Logs and Laboratory Data from THA Investigation

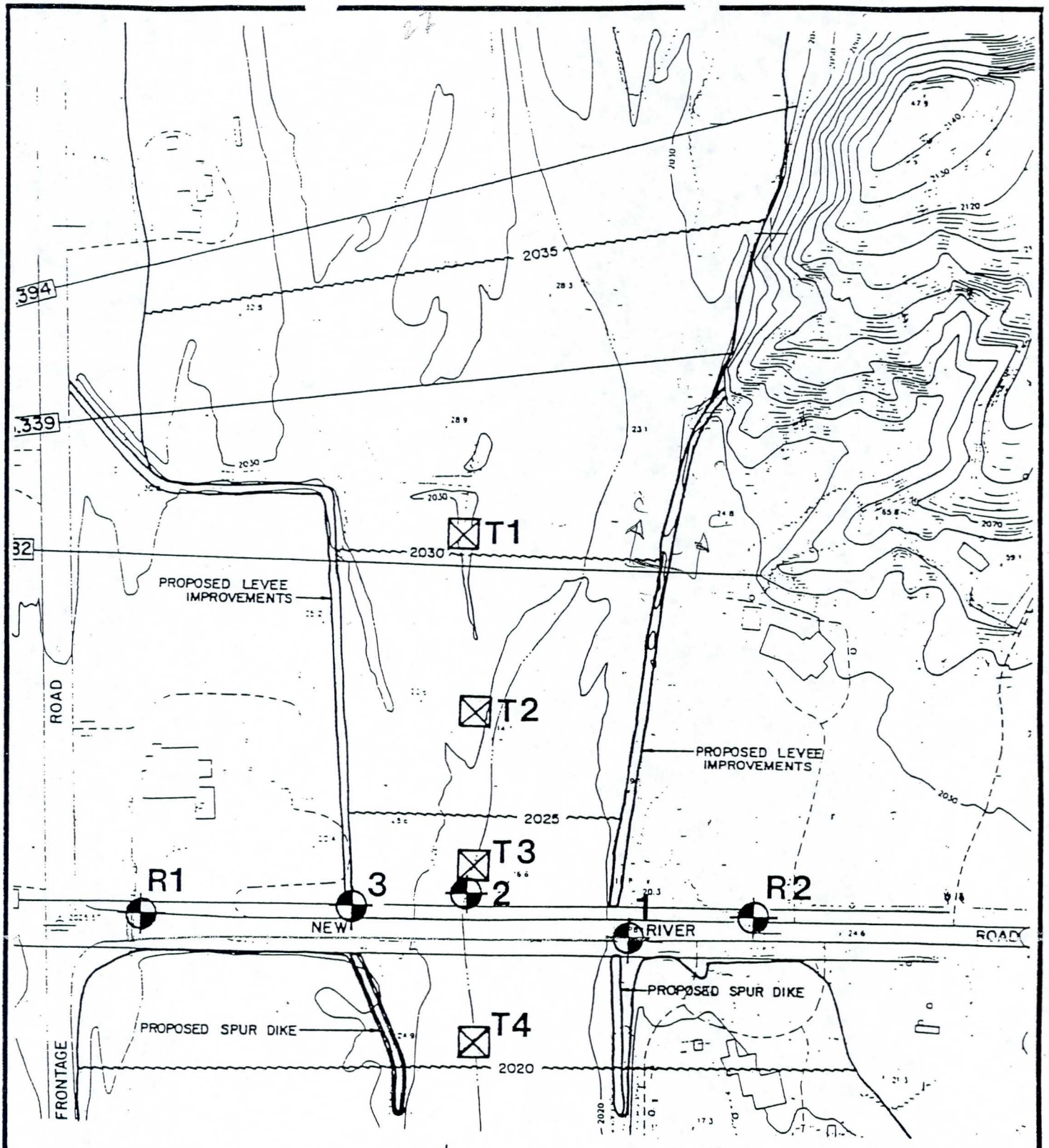
REPORT FOR
GEOTECHNICAL ENGINEERING SERVICES
NEW RIVER ROAD BRIDGE
OVER NEW RIVER
MARICOPA COUNTY, ARIZONA
MCDOT Work Order No. 68738

Submitted To:

Kaminski-Hubbard Engineering, Inc.
Attention: Daniel L. Kaminski, P.E. RLS
4550 North Black Canyon Highway, Suite C
Phoenix, Arizona 85017

Project No. 93-0060

21 January 1993



Test Boring Location

Test Trench Location

Note: Test Boring and Test Trench Elevation Interpolated from Topographic Plan by Kaminski-Hubbard

N

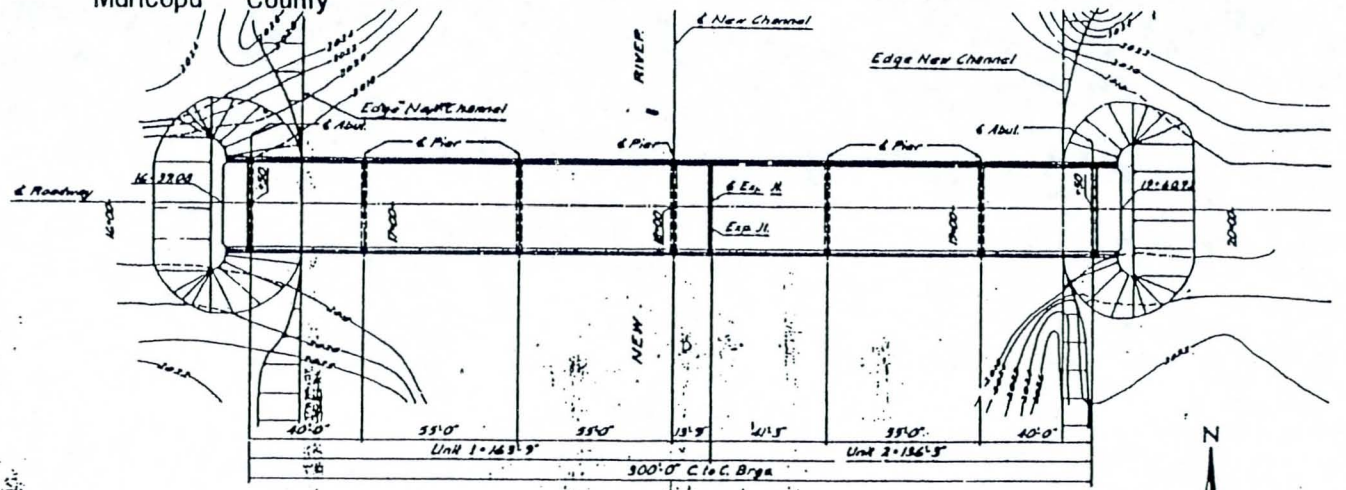
Site Plan

Project No. 93-0060

THOMAS-HARTIG & ASSOCIATES, INC.

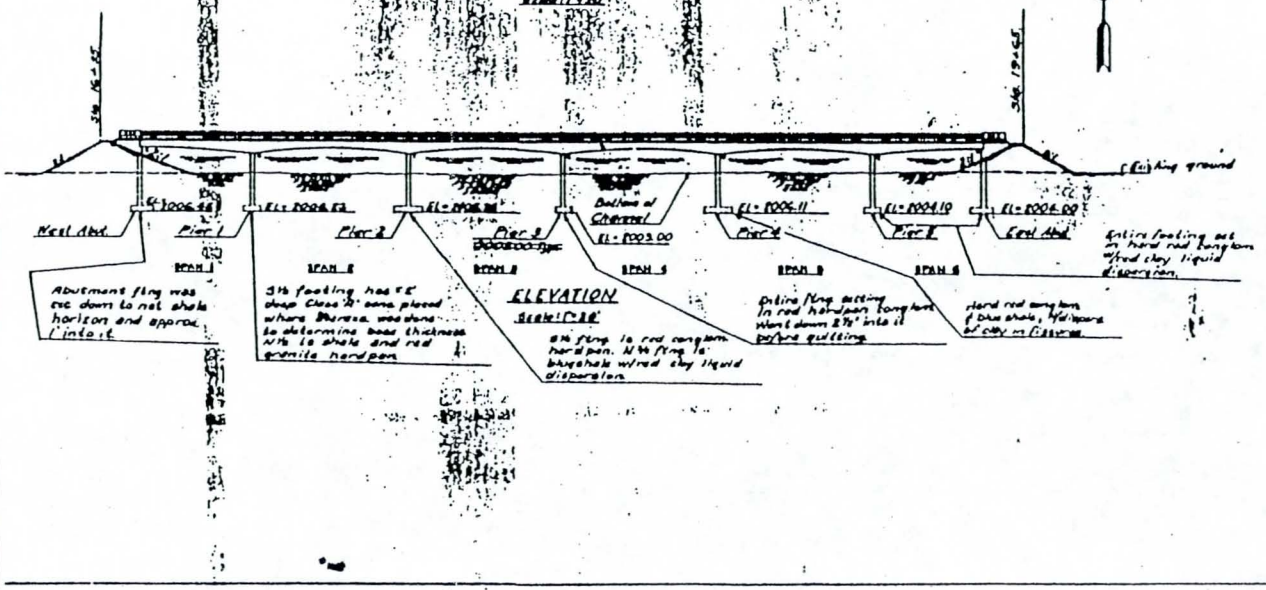
NEW RIVER ROAD–BRIDGE OVER NEW RIVER

Maricopa County



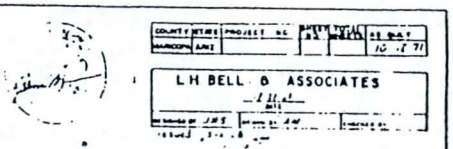
PLAN

Scale 1" = 20'



ELEVATION

Scale 1" = 8'



General Notes

Construction - Standard Specifications Maricopa County Highway Department - 1955 Edition.

Design - A.A.S.H.O. Standard Specifications for Highway Bridges 1961.

Loading - H 20-S16-44

Stresses - Class A Concrete f_c = 1000 psi; n = 12
Class D Concrete f_c = 1200 psi; n = 10
Reinforcing Steel f_s = 20,000 psi
Structural Steel f_s = 20,000 psi

All Substructure Concrete shall be Class 'A'. Superstructure Concrete shall be Class 'D' with max. Aggregate 100% passing 1½".

Reinforcing Steel shall be intermediate grade and shall conform to A.S.T.M. Specs. A15 and A305.

Structural Steel shall conform to A.S.T.M. A36 unless otherwise noted.

All Welding shall conform to American Welding Society Spec. for Welded Highway and Railroad Bridges, 1969 Edition.

All Dimensions for Reinforcing Steel shall be Center to Center of Bars.

2" Clear Cover shall be maintained for all Reinforcing Steel unless otherwise noted.

All Horizontal Measurements are at 70° F. and Proper Adjustments must be made in Locating Anchor Bolts and Setting Bearing Plates and Expansion Angles for the actual temperatures at the time of Construction.

All Exposed Concrete Corners shall have ¾" Chamfer unless otherwise noted.

Exposed faces of curbs, guard rail posts and outside surfaces of the deck, curbs, parapets and all curb tops, inside faces of curbs, parapets shall be hand rubbed finish.

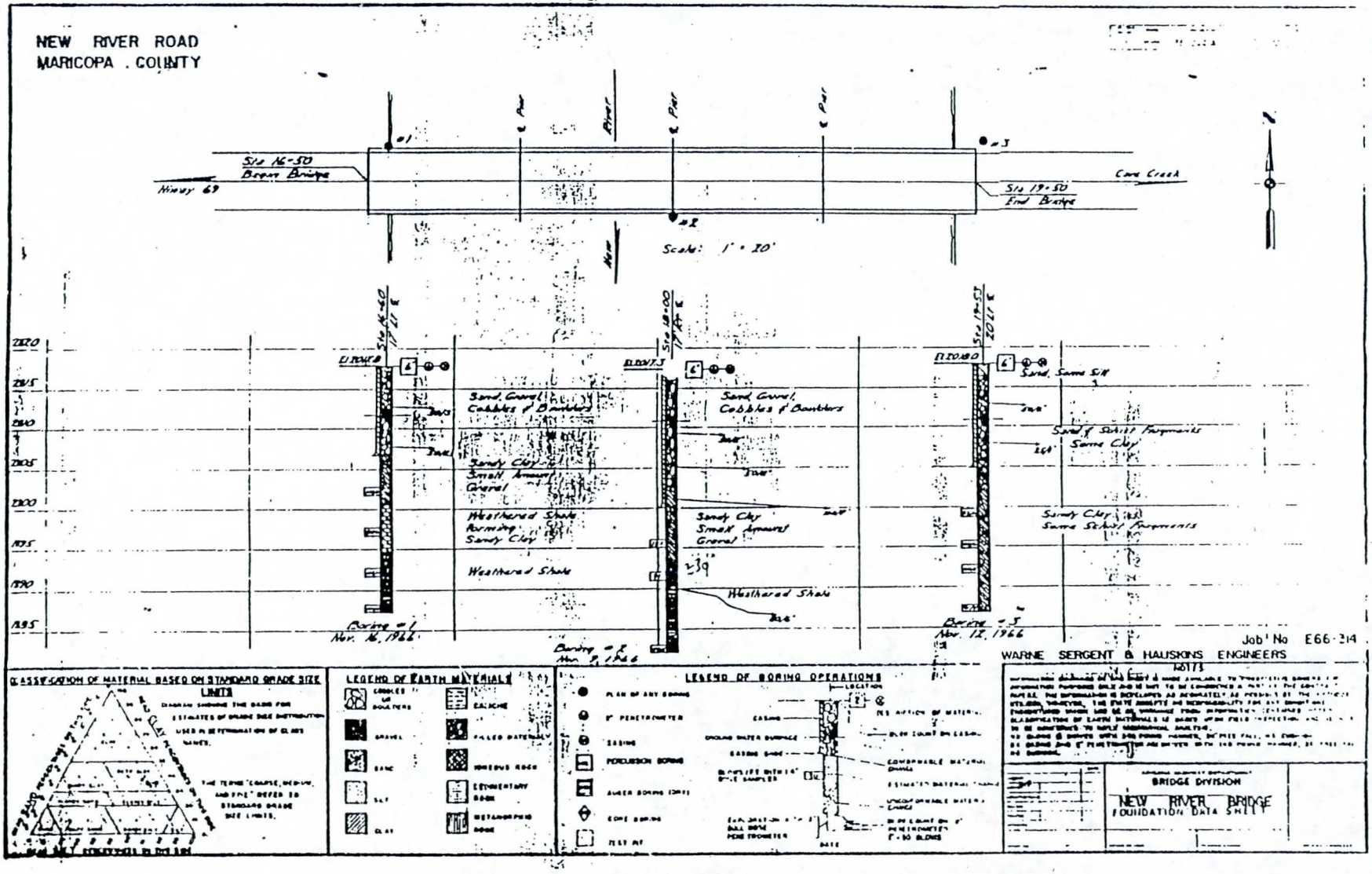
Structural Steel shall be encased with concrete for permanent.

Estimated Quantities

Item	Units	Estimated Quantities
Borrow	C.Y.	1800
Concrete		
Class 'A'	C.Y.	190
Class 'D'	C.Y.	950
Reinf. Steel	lbs	237,600
Special Comp	C.Y.	1855 (Non Pay Item)
Handrail	Lin. Ft.	603.67
Struct. Excav.	C.Y.	1810
Aggregate Base	Ton	30

As-Built Plans
For Existing
Bridge
Project No. 93-0060

THOMAS-HARTIG & ASSOCIATES, INC.



As-Built Plans for Existing Bridge

Project No. 93-0060

THOMAS-HARTIG & ASSOCIATES, INC.

LEGEND

SOIL CLASSIFICATION

COARSE-GRAINED SOIL

More than 50% larger than 200 sieve size

SYMBOL	LETTER	DESCRIPTION	MAJOR DIVISIONS
	GW	WELL-GRADED GRAVELS OR GRAVEL-SAND MIXTURES, LESS THAN 5% - #200 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% - #200 FINES	
	GM	SILTY GRAVELS, GRAVEL-SAND-SILT MIXTURES, MORE THAN 12% - #200 FINES	
	GC	CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES, MORE THAN 12% - #200 FINES	
	SW	WELL-GRADED SANDS OR GRAVELLY SANDS, LESS THAN 5% - #200 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% - #200 FINES	
	SM	SILTY SANDS, SAND-SILT MIXTURES MORE THAN 12% - #200 FINES	
	SC	CLAYEY SANDS, SAND-CLAY MIXTURES MORE THAN 12% - #200 FINES	

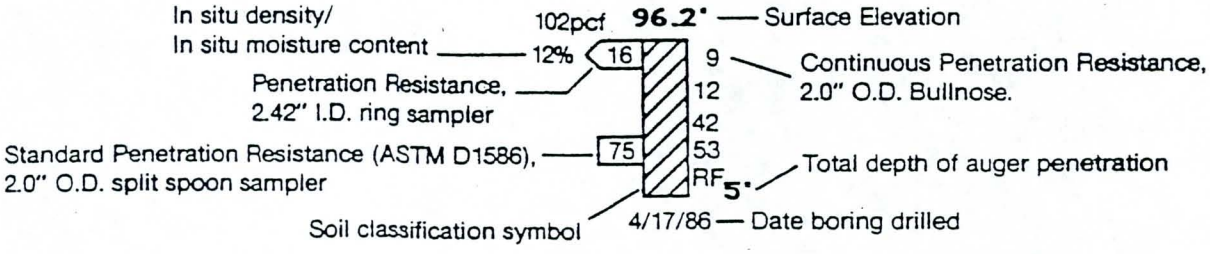
FINE-GRAINED SOIL

More than 50% smaller than 200 sieve size

SYMBOL	LETTER	DESCRIPTION	MAJOR DIVISIONS
	ML	INORGANIC SILTS, ROCK FLOUR, AND FINE SANDY OR CLAYEY SILTS OF LOW TO MEDIUM PLASTICITY	SILTS AND CLAYS Liquid limit less than 50
	CL	INORGANIC CLAYS, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, AND LEAN CLAYS OF LOW TO MEDIUM PLASTICITY	
	OL	ORGANIC SILTS AND ORGANIC SILT-CLAY MIXTURES OF LOW TO MEDIUM PLASTICITY	
	MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS, AND FINE SANDY OR CLAYEY SILTS OF HIGH PLASTICITY	SILTS AND CLAYS Liquid limit greater than 50
	CH	INORGANIC CLAYS, FAT CLAYS, AND SILTY CLAYS OF HIGH PLASTICITY	
	OH	ORGANIC CLAYS AND ORGANIC SILTS OF MEDIUM TO HIGH PLASTICITY	
	PT	PEAT AND OTHER HIGHLY ORGANIC SOILS	

LEGEND FOR GRAPHICAL BORING LOGS:

Log denotes visual approximation unless accompanied by mechanical analysis and Atterberg limits.



PENETRATION RESISTANCE: Blows per foot using 140 lb. hammer with 30" free-fall unless otherwise noted.

GRAIN SIZES								
U.S. STANDARD SERIES SIEVE					CLEAR SQUARE SIEVE OPENINGS			
200	40	10	4		3/4"	3"	12"	
SILTS & CLAYS DISTINGUISHED ON BASIS OF PLASTICITY	SAND				GRAVEL		COBBLES	BOULDERS
	FINE	MEDIUM	COARSE		FINE	COARSE		

MOISTURE CONDITION (INCREASING MOISTURE →)

DRY — SLIGHTLY DAMP — DAMP (Plastic Limit) — MOIST — VERY MOIST — WET (SATURATED) (Liquid Limit)

CONSISTENCY CORRELATION		RELATIVE DENSITY CORRELATION	
CLAYS & SILTS	BLOWS/FOOT*	SANDS & GRAVELS	BLOWS/FOOT*
VERY SOFT	0-2	VERY LOOSE	0-4
SOFT	2-4	LOOSE	4-10
FIRM	4-8	MEDIUM DENSE	10-30
STIFF	8-16	DENSE	30-50
VERY STIFF	16-32	VERY DENSE	OVER 50
HARD	OVER 32		

*Number of blows of 140 lb. hammer falling 30" to drive a 2" O.D. (1-3/8" I.D.) split-spoon sampler (ASTM D1586).

Project No. 93-0060

LEGEND OF SOIL TYPES

ASPHALT CONCRETE OVER AGGREGATE BASE (See individual logs for thicknesses).

FILL MATERIAL - SILTY SAND AND GRAVEL (SM-GM); brown; medium dense to loose; slightly damp; none plastic fines.

FILL MATERIAL - SILTY VERY FINE SAND (SM); grayish brown; medium dense; slightly damp; non-plastic fines; some gravel and cobbles below 3 feet.

SANDY GRAVEL COBBLES AND BOULDERS (GP); brown; medium dense; slightly damp; traces silt; stratified with layers of sand and occasional clayey sand.

SANDY GRAVEL COBBLES AND BOULDERS (GP); reddish brown; dense to very dense; damp to wet; traces medium plasticity clay fines; stratified with some clayey sand and sand layers.

CLAY SHALE; gray to dark gray with some reddish brown zones along laminations and beddng planes; thinly laminated, moderately bedded; hard to very hard; laminations and bedding planes moderately sloping; moderately weathered upper 2 to 5 feet; slightly weathered to fresh below; nearly dry below weathered zone.

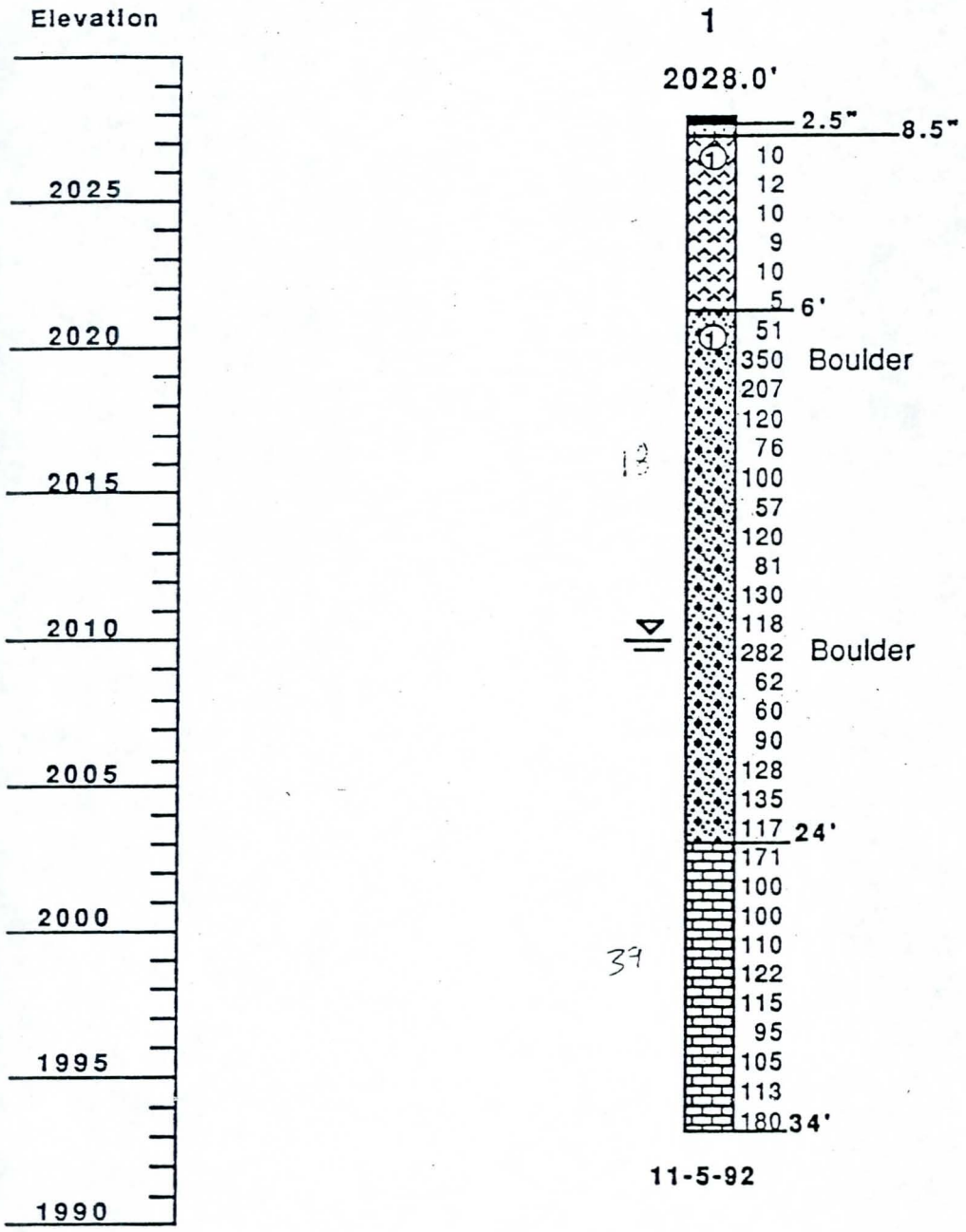
CONGLOMERATE; reddish brown; clayey sandstone matrix around subrounded to angular clastics of volcanic, quartz and sedimentary rocks; hard; nearly dry.

SILTY SAND WITH GRAVEL AND COBBLES (SM); brown; medium dense; slightly damp; none to low plasticity fines.

CLAYEY SAND (SC); reddish brown; medium dense; damp; medium plasticity fines.

NOTE: The data presented on the boring logs represents subsurface conditions only at the specific locations and at the time designated. This data may not represent conditions at other locations and/or times. Contacts between soil strata are approximate and changes between soil types may be gradual rather than abrupt. This boring data was compiled primarily for design purposes and should not be construed as part of the plans governing construction or defining construction techniques. Bidders are fully responsible for interpretations or conclusions they draw from the boring log.

GRAPHICAL BORING LOGS

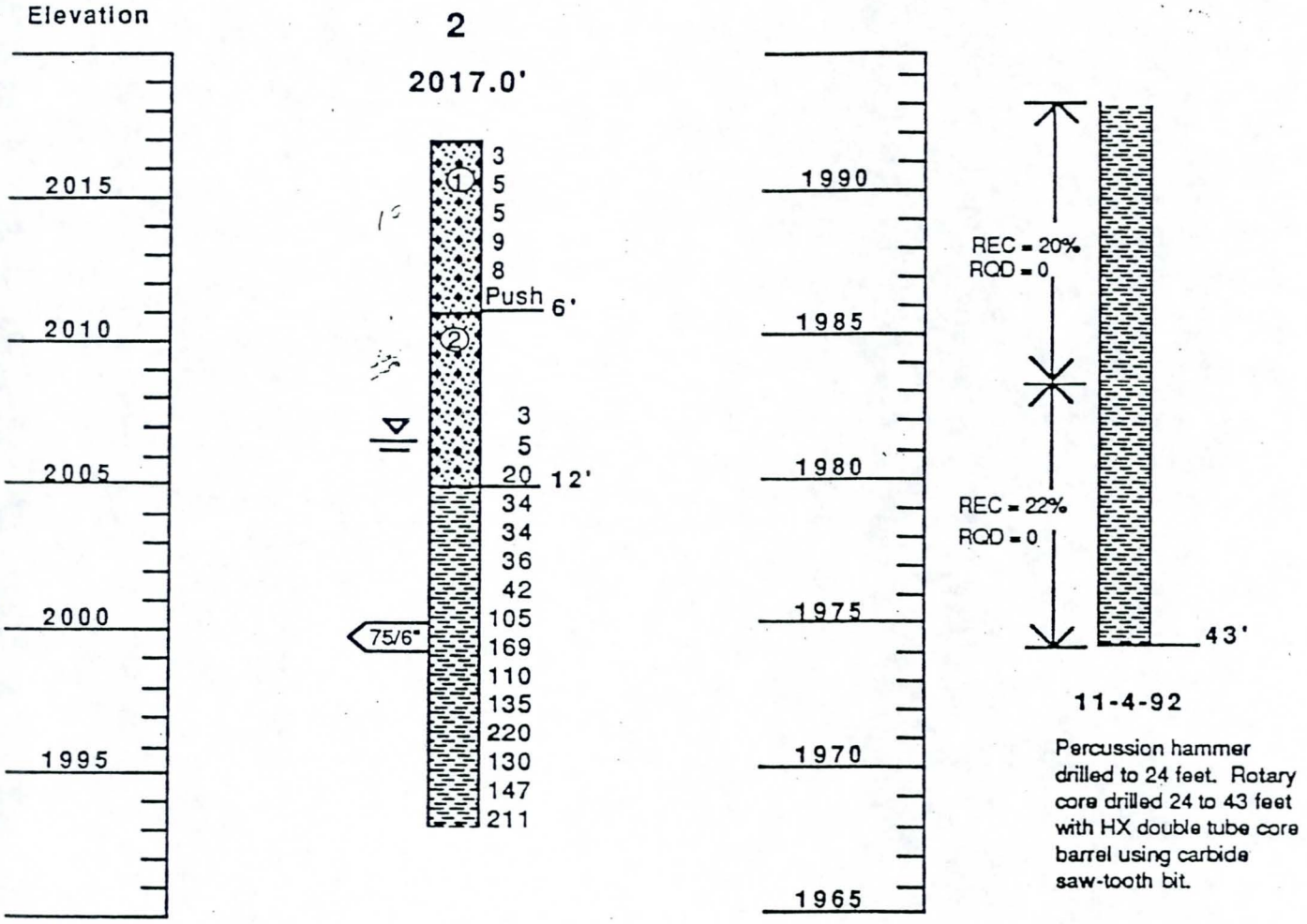


Boring drilled with 9" OD DWP by AP1000 drill rig

NOTE: The data presented on the boring logs represents subsurface conditions only at the specific locations and at the time designated. This data may not represent conditions at other locations and/or times. Contacts between soil strata are approximate and changes between soil types may be gradual rather than abrupt. This boring data was compiled primarily for design purposes and should not be construed as part of the plans governing construction or defining construction techniques. Bidders are fully responsible for interpretations or conclusions they draw from the boring log.

Project No. 93-0060
Thomas-Hartig & Associates

GRAPHICAL BORING LOGS



11-4-92

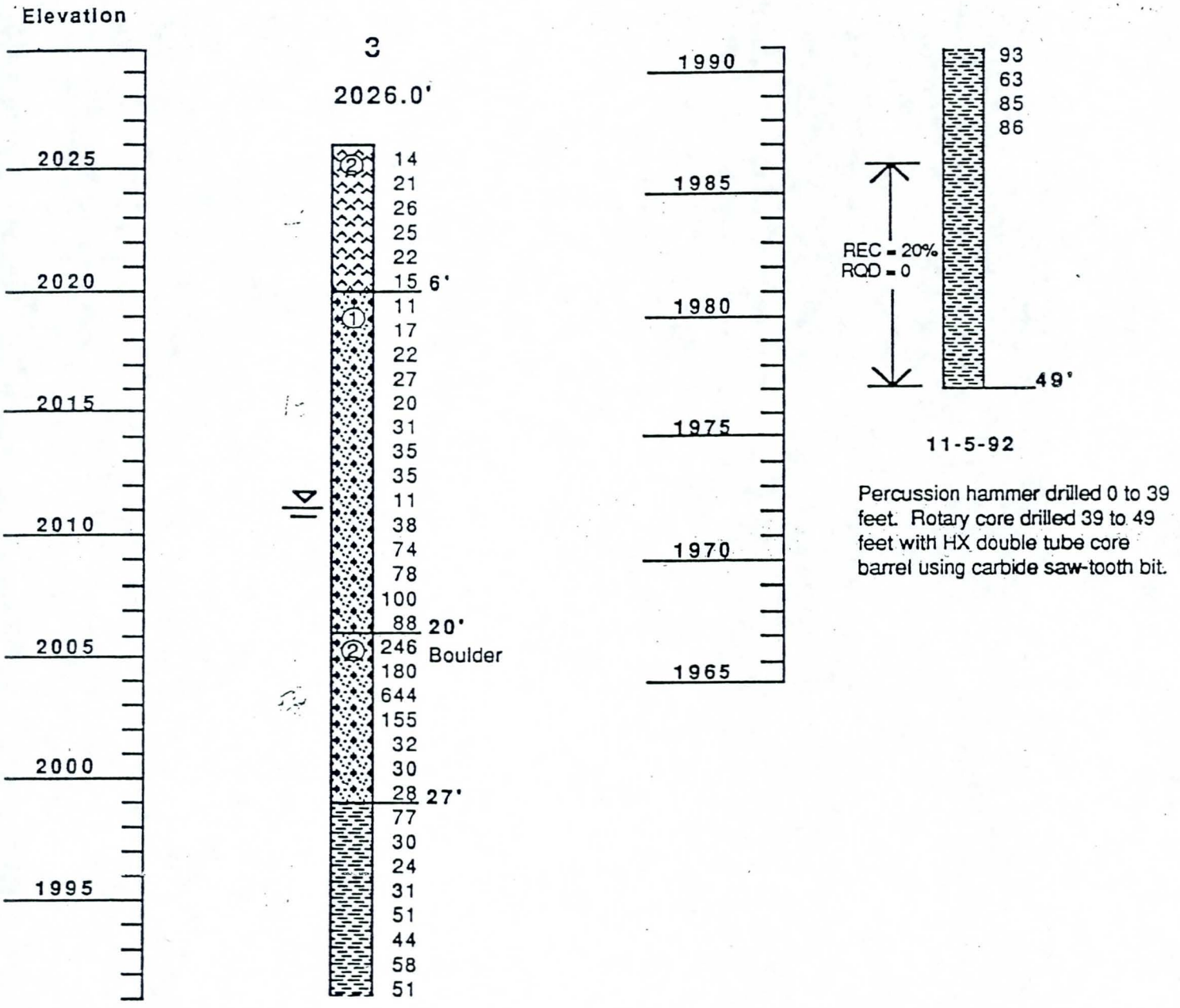
Percussion hammer drilled to 24 feet. Rotary core drilled 24 to 43 feet with HX double tube core barrel using carbide saw-tooth bit.

Boring drilled with 9" OD DWP by AP1000 drill rig

NOTE: The data presented on the boring logs represents subsurface conditions only at the specific locations and at the time designated. This data may not represent conditions at other locations and/or times. Contacts between soil strata are approximate and changes between soil types may be gradual rather than abrupt. This boring data was compiled primarily for design purposes and should not be construed as part of the plans governing construction or defining construction techniques. Bidders are fully responsible for interpretations or conclusions they draw from the boring log.

Project No. 93-0060
Thomas-Hartig & Associates

GRAPHICAL BORING LOGS



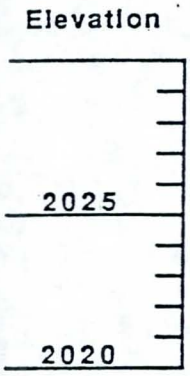
Percussion hammer drilled 0 to 39 feet. Rotary core drilled 39 to 49 feet with HX double tube core barrel using carbide saw-tooth bit.

Boring drilled with 9" OD DWP by AP1000 drill rig

NOTE: The data presented on the boring logs represents subsurface conditions only at the specific locations and at the time designated. This data may not represent conditions at other locations and/or times. Contacts between soil strata are approximate and changes between soil types may be gradual rather than abrupt. This boring data was compiled primarily for design purposes and should not be construed as part of the plans governing construction or defining construction techniques. Bidders are fully responsible for interpretations or conclusions they draw from the boring log.

Project No. 93-0060
Thomas-Hartig & Associates

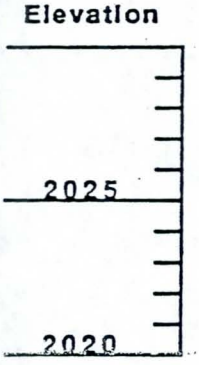
GRAPHICAL BORING LOGS



R1

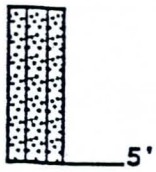
2025.5'

11-9-92



R2

2025.8'



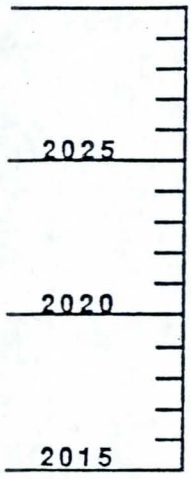
11-9-92

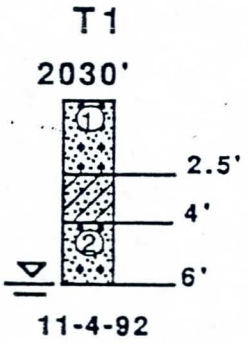
No free groundwater was encountered in any of the borings during drilling.

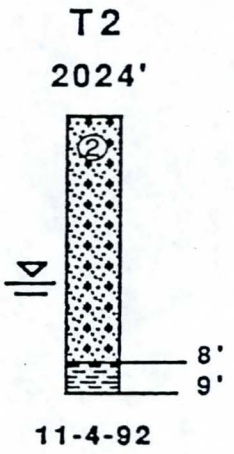
All borings drilled with CME 55 using 4" diameter auger unless otherwise noted.

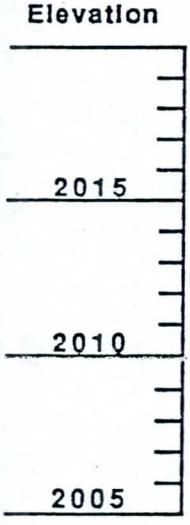
NOTE: The data presented on the boring logs represents subsurface conditions only at the specific locations and at the time designated. This data may not represent conditions at other locations and/or times. Contacts between soil strata are approximate and changes between soil types may be gradual rather than abrupt. This boring data was compiled primarily for design purposes and should not be construed as part of the plans governing construction or defining construction techniques. Bidders are fully responsible for interpretations or conclusions they draw from the boring log.

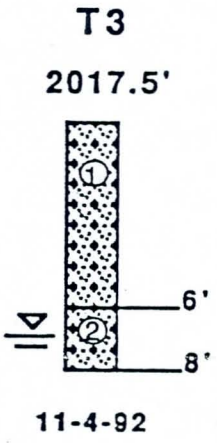
GRAPHICAL TRENCH LOGS

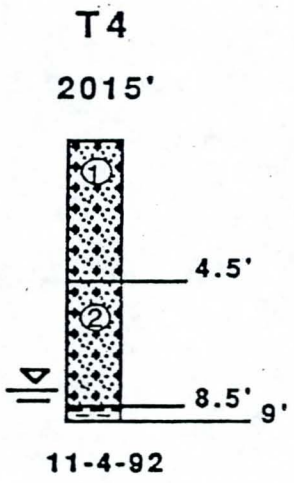












Test Trenches Excavated with an old D-7 Cat

NOTE: The data presented on the trench logs represents subsurface conditions only at the specific locations and at the time designated. This data may not represent conditions at other locations and/or times. Contacts between soil strata are approximate and changes between soil types may be gradual rather than abrupt. This data was compiled primarily for design purposes and should not be construed as part of the plans governing construction or defining construction techniques. Bidders are fully responsible for interpretations or conclusions they draw from the trench log.

REPORT ON FIELD TESTS

SAMPLE: Date: 12-14-92

Source: Noted Below
Type: Subsoil
Material: Subsoil
Sampled By: TH/Thompson/Ricker

TESTED: Visual Estimates of Plus 3-inch material (cobble & boulders) in Test Trench Walls

TEST RESULTS

Location	Estimated % Plus 3-inch
T1; 0 - 2 1/2'	50 to 60
T1; 2 1/2 - 4'	0
T1; 4 - 8'	10 to 20
T2; 0 - 8'	50 to 60
T3; 0 - 3'	20 to 30
T3; 3 - 6'	20 to 30
T3; 6 - 8'	10 to 20
T4; 0 - 4 1/2'	30 to 50
T4; 4 1/2 - 8'	10 to 20

APPENDIX B - LABORATORY RESULTS

REPORT ON SIEVE ANALYSIS AND PLASTICITY INDEX

SAMPLE: Date: 12-14-92

Source: Noted Below
Type: Bulk
Material: Subsoil
Sampled By: TH/Thompson/Ricker

TESTED: Sieve Analysis and Atterberg Limits

RESULTS

			Sieve Size - Accumulative % Passing											*
Sample	LL	PI	200	100	50	30	16	8	4	3/4"	1"	2"	3"	Class.
2; 15'	33	10	25	28	31	35	41	51	61	88	97	100		GC
R1; 0 - 3'	–	NP	18	25	33	44	57	70	79	100				SM
R2; 0 - 3'	23	4	20	27	35	44	54	63	74	100				SM
T1; 0 - 2-1/2"	–	NP	2	3	5	9	18	30	37	58	65	90	** 100	GP
T1; 2-1/2 - 4'	41	23	34	43	48	59	80	96	98	100				SC
T2; 0 - 8'	31	16	5	6	9	16	29	41	49	69	74	93	** 100	GP-GC
T3; 0 - 3'	23	4	9	11	15	24	36	49	56	75	79	95	** 100	GP-GM
T3; 3 - 6'	–	NP	1	1	2	5	16	30	37	54	61	81	** 100	GP
T3; 6 - 8'	32	15	5	6	10	23	41	57	64	78	83	95	** 100	GP-GC
T4; 0 - 4-1/2'	–	NP	1	2	3	8	17	29	36	53	58	77	*** 93	GP
T4; 4-1/2 - 8'	32	17	4	5	7	15	27	38	43	60	66	81	*** 93	GP

NP - Non-Plastic

*Unified Soil Classification

** Sieve Analysis on minus 3-inch material (see page 22 for estimated plus 3-inch material)

*** Sieve analysis on minus 6-inch material (see page 22 for estimate of plus 3-inch material).

REPORT ON pH/RESISTIVITY

SAMPLE: Date: 12-14-92

Source: Noted Below
Type: Bulk
Material: Subgrade
Sampled By: TH/Thompson

TESTED: pH and Minimum Resistivity

TEST RESULTS

Location	Minimum Resistivity (ohm-cm)	pH
R-1; 3 - 5	2168	7.93
R-2; 3 - 5	2201	7.86

REPORT ON UNCONFINED COMPRESSION AND UNIT WEIGHT

SAMPLE: Date: 12-14-92

Source: Test Trench T2
Type: Piece of Bedrock
Material: Shale
Sampled By: TH/Ricker

TESTED: Unconfined compress & unit weight of rock core from shale piece

TEST RESULTS

Unit Weight	Unconfined Compression
168.7 pcf	7559 psi

APPENDIX C

Embankment Protection Calculations

KLEINFELDER

SHEET 1 OF 3

PROJECT NO. 17112

PROJECT New River Levee REVIEWED BY DK DATE 8-15-02

SUBJECT Gabion Design Calculations BY E. C DATE 7/15/02

Hydraulic Shear Stress

$\tau_b = \gamma_w * y * i$ $\quad i = \frac{2030' - 2010'}{1100'}$

$= 62.4\ ^{lb}/_{ft^3} * 11.9\ ft * 0.018\ ^{ft}/_{ft}$

$= 13.37\ ^{lb}/_{ft^2}$

γ_w = Unit Wt. Water
y = Water depth
i = bed. gradient

Critical Shear

$\tau_c = C^*(\gamma_s - \gamma_w) d_m$

$\tau_c \leq \tau_b$ most critical case

$\therefore \tau_b = C^*(\gamma_s - \gamma_w) d_m$

$d_m = \frac{\tau_b}{C^*(\gamma_s - \gamma_w)}$

C^* = Shield Coeff. (0.10 usually)
γ_s = Unit Wt Soil
γ_w = Unit Wt Water
d_m = medium size of the Rocks

$d_m = \frac{13.37\ ^{lb}/_{ft^2}}{0.10 * (147.0\ ^{lb}/_{ft^3} - 62.4\ ^{lb}/_{ft^3})}$

$d_m = 1.58\ ft$

$\therefore d_m \geq 1.58\ ft$ so that $\tau_c \leq \tau_b$

Determining Rock Size and Lining Thickness

Table 4 page 6.20 in "Solution in Environmental Engineering Short Course" presented by MACCAFERRI

Note: MACCAFERRI recommends the gabion thickness to be 1.5 times greater than the maximum size of the rock used in filling the gabion

NE levee 3.JPG → 7"-3"
NE Levee 2.JPG → 8"-3"
NE Levee 1.JPG → 6-3" Note: some aggregate is smaller than the Mesh.

Next page (2)

KLEINFELDER

SHEET 2 OF 3

PROJECT NO.

PROJECT New River Levees REVIEWED BY SA DATE 8-15-02

SUBJECT Gabion Design Calculations BY Eddie Cortez DATE 7/15/02

NW Levee 1.jpg. 7'-3" ??

NW levee 2.jpg 8-3" ??

NW Levee 3.jpg. 7-3" ??

Note: Probable Rockinfilling in gabions is 8"-3"

∴ min. gabion thickness 8"*1.5 = 12" OK ✓

Table 4 page 6.20

peak velocity @peakflow = 84 ft/sec. given by Dave. D. w/ Maricopa Flood Control.

peak velocity ≈ (approaches) Limit Velocity ∴ using table 4

∴ 13.8 ft/sec Limit flow requires d_{50} = 3.5", Filling Rock 3"-4", & 6" gabion thick

Again Using Table 4

∴ 12" gabion thickness (existing) requires Filling Rock(min) 3'-5" Rock, a d_{50} = 4" ⇒ which can handle a Limit Velocity of 18.0 ft/sec

∴ The existing gabion 1'x 9.8'x 98.4' per plans ⇒ 1' g thickness with 8"-3" g Rock filling can adequately handle a peak (Limit) Velocity of 8.4 ft/sec.

note: d_{50} = rock size where 50% g the rock is smaller

*If Lining thickness were the reduce by 50% due to the water's peak velocity going beyond 8.4 ft/sec and achieving 18.0 ft/sec (approximately doubling) then:

$$\frac{\Delta z}{d_m} \leq 2\left(\frac{t}{d_m} - 1\right)$$

$$\Delta z = 2\left(\frac{t}{d_m} - 1\right) * d_m$$

$$\Delta z = 2\left(\frac{12"}{5"} - 1\right) 5"$$

Δz = 14" ∴ No effect due to deformed gabion

Must check. But 18.0 ft/sec highly unlikely

Δz = ht diff between highest/lowest p. in gabion

d_m = median Rock size

t = mattress thickness

M-4A

KLEINFELDER

SHEET 5 OF 3

PROJECT NO. 17112

PROJECT New River Levee REVIEWED BY SAH DATE 8-15-02

SUBJECT Gabion Design / Calculations BY Edd. e Coria DATE 7/15/02

Filter Fabic

Velocity at the Gabion / base soil Interface

$$V_b = \frac{1.486}{n_f}\left(\frac{dm}{2}\right)^{2/3} S^{1/2}$$

$dm = 5''$

$$V_b = \frac{1.486}{0.02}\left(\frac{(5/12)'}{2}\right)^{2/3}(0.5)^{1/2}$$

$V_b = 18.46$ ft/sec

with the $dm = 4''$

$V_b = 18.46$

With $dm = 3''$

$V_b = 13.13$

V_b = Velocity @ interface

n_f = Channel Roughness (0.02)

" possible 0.023 from McGraw-Hill Series "Water Resources & Envir. Eng" page 314 table 10.1

dm = medium Stone size in feet.

S = interface gradient. (2:1)

Erosion Velocity

$V_e = 1.67\, d^{1/2}$ for noncohesive soils

d = soil particles to be retained (in mm)

*In existing system the Filter Fabric retain 100 sieve (0.15mm)

$V_e = 1.67 (0.15)^{1/2}$

$V_e = 0.65$

$V_b > V_e$ ∴ filter is needed.

*note: Assume Filter Fabric used meets or exceeds the AMOCCO 4551 specs

Refer to the back of these calculations for specifications

Flow Rate of AMOCO 4551 = 110 gal/min/ft²

Permittivity " " = 1.5 sec^{-1} ⇒ 1.5 cm/sec.

note: Permittivity of 1.5 sec = 71 gal/min/ft²

* According to the Department of Army, Navy, & Air forces November 1983 Manual on Dewatering and Groundwater Control table 3-4 page 3-6:

typical Coefficients of Permeability for Coarse Sand & gravel = $2\times10^{-2} - 5\times10^{-2}$ m/s

∴ Levees & Filter Fabric will drain at approximately the same rate and the Filter will retain (100 sieve) sufficient fines, due to the coarse nature of the soil within the levee such that the loss of fines is negligible.

M-4A

$$\tau_c = C^*(\gamma_s - \gamma_w)d_m \quad (39)$$

where, C^* is the Shields coefficient (equal to 0.10);

γ_s = unit weight of the soil

γ_w = unit weight of water

d_m = median size of the filling rocks

The check is satisfied when the hydraulic shear stress, τ_b is less than the critical shear stress, τ_c. The Shields coefficient for gabions is approximately 0.10, for rip rap it is reduced to 0.047. This means that for any given hydraulic condition the average size of the rocks needed in gabion mattresses is roughly one third of that required for rip rap (*Figure 59*).

Determining The Rock Size And Lining Thickness

To match the critical shear stress to the required hydraulic shear stress, the appropriate median rock size needs to be determined. Once the required rock size has been determined, the thickness of the lining can then be evaluated. Maccaferri recommends that the thickness of the lining be 1.5 times larger than the maximum size of the rock used in filling the gabion mattress (assuming a variable range of rock size is used). For instance, if a 4-8 inch rock size is used, the minimum thickness of the basket should not be less than 12 inches.

Figure 60 - Lining thickness needs to be 1.5 x max rock size

It is also important to use a rock size that is not less than the nominal size of the gabion mesh openings. For gabions, it is recommended to use a minimum rock size of not less than four inches and for Reno mattresses a minimum rock size not less than three inches.

Critical Velocity vs. Limit Velocity

When further increases in shear stress go beyond the critical shear stress (or when the water velocity becomes supercritical), rocks within the gabion mattress begin to start moving towards the downstream end of the basket. At this point the gabion basket begins to deform until a new equilibrium is reached (*Figure 61*). This deformation however, does not significantly affect the mattresses from providing a similar degree of protection to the bedding material, as long as the deformation does not reduce the lining thickness

Type	Thickness of Lining		Filling Stones				Critical Velocity†		Limit Velocity†	
	(mm)	(in)	Stone Size		d_{50}		(m/s)	(ft/sec)	(m/s)	(ft/sec)
			(mm)	(in)	(mm)	(in)				
Reno Mattresses	150	6	70 - 100	3 - 4	85	3.5	3.5	11.5	4.2	13.8
			70 - 150	3 - 6	110	4.5	4.2	13.8	4.5	14.8
	230	9	70 - 100	3 - 4	85	3.5	3.6	11.8	5.5	18.0
			70 - 150	3 - 6	120	4.5	4.5	14.8	6.1	20.0
Gabions or Gabion Mats	300	12	70 - 120	3 - 5	100	4	4.2	13.8	5.5	18.0
			100 - 150	4 - 6	125	5	5.0	16.4	6.4	21.0
Gabions	500	18	100 - 200	4 - 8	150	6	5.8	19.0	7.6	24.9
			120 - 250	5 - 10	190	7.5	6.4	21.0	8.0	26.2

†The values of velocity reported were obtained experimentally for Froude numbers ≤ 1; values > have to be intended as purely indicative and approximated.

Table 4 - The required lining thicknesses and median stone size required for various critical water velocities

AMOCO FABRICS AND FIBERS COMPANY
900 Circle 75 Parkway, Suite 300
Atlanta, GA 30339
PH: (770) 984-4444 (800) 445-7732
FX: (770) 956-2430

STYLE 4551

Amoco Style 4551 is a polypropylene nonwoven needlepunched fabric. This engineered geotextile is stabilized to resist degradation due to ultraviolet exposure. It is resistant to commonly encountered soil chemicals, mildew and insects, and is non-biodegradable. Polypropylene is stable within a ph range of 2 to 13, making it one of the most stable polymers available for geotextiles today. We wish to advise that **Amoco Style 4551** meets the following minimum average roll values:

Property	Test Method	Minimum Average Roll Value ENGLISH	Minimum Average Roll Value METRIC
Grab Tensile	ASTM D 4632	160 lb	0.71 kN
Grab Elongation	ASTM D 4632	50 %	50 %
Mullen Burst	ASTM D 3786	315 psi	2170 kPa
Puncture	ASTM D 4833	90 lb	0.4 kN
Trapezoidal Tear	ASTM D 4533	65 lb	0.285 kN
UV Resistance	ASTM D 4355	70%@500 hrs	70%@500 hrs
AOS	ASTM D 4751	100 sieve	0.15 mm
Permittivity	ASTM D 4491	1.5 sec^{-1}	1.5 sec^{-1}
Flow Rate	ASTM D 4491	110 $gal/min/ft^2$	4470 $L/min/m^2$

Amoco Fabrics and Fibers Company manufacturers the nonwoven fabric indicated above. The values listed are a result of testing conducted in on-site laboratories. A letter certifying the minimum average roll values will be issued from the manufacturing plant by the Quality Control Manager at the time shipment is made.

DATE ISSUED: 01/01/98

APPENDIX D

Hydrograph and Stage vs. Flow Data
Provided by Flood Control District of Maricopa County

Fax Cover Sheet

FLOOD CONTROL DISTRICT
OF
MARICOPA COUNTY

Flood Control District of Maricopa County
2801 West Durango Street
Phoenix, Arizona 85009-6399
Telephone(602) 506-1501
FAX: 1-900-555-6232

FLOODPLAIN INFORMATION

To: JIM WILSON

Company or Department: 602-712-8138 KLEINFELDER

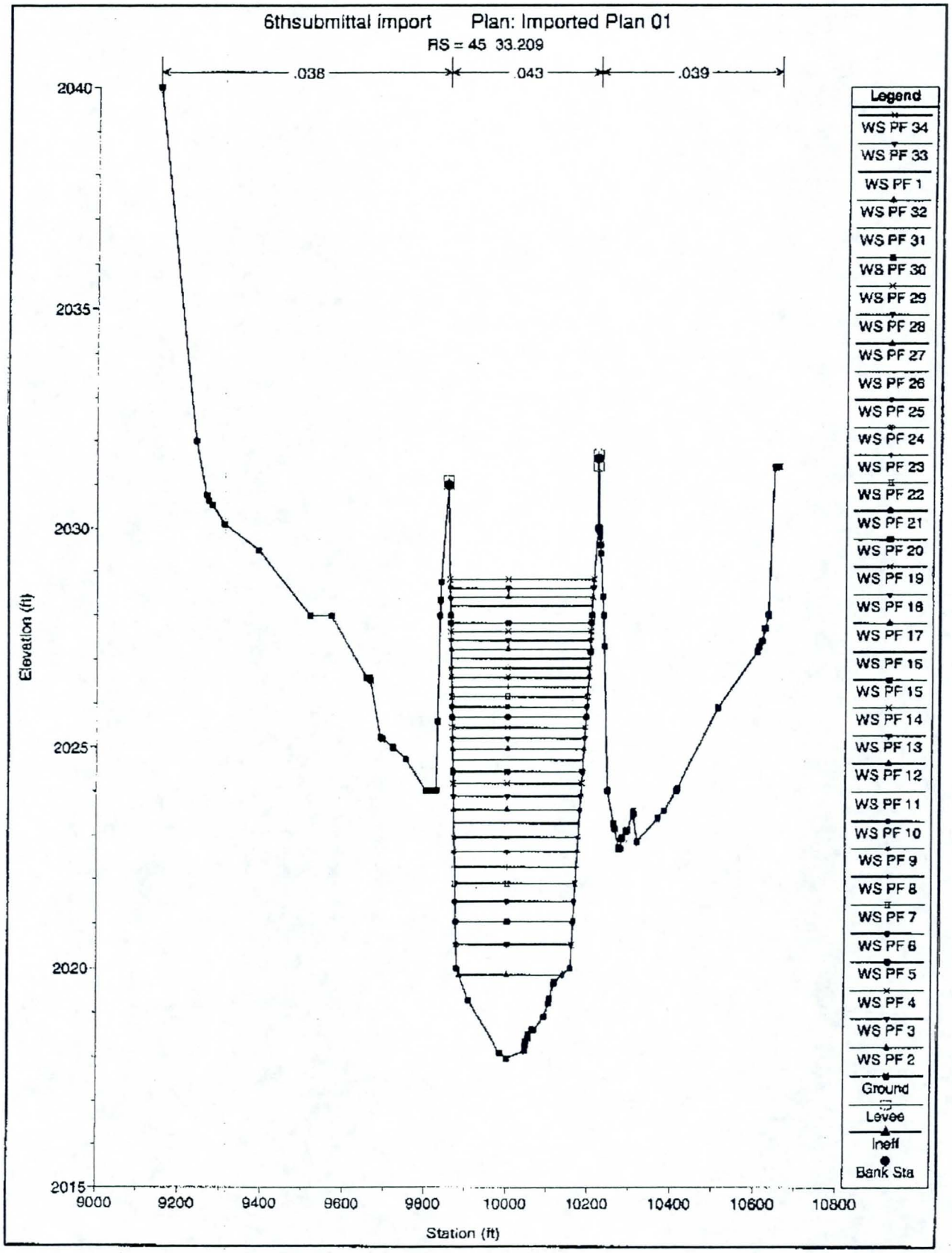
Fax Number:

From: DAVE DEGERNESS

Number of pages being sent including cover sheet: 3

If there are any problems or questions, please call (602)506-1501

Comments:


6thsubmittal import Plan: Imported Plan 01
RS = 45 33.209
.038
.043
.039
Elevation (ft)
2040
2035
2030
2025
2020
2015
9000
9200
9400
9600
9800
10000
10200
10400
10600
10800
Station (ft)
Legend
WS PF 34
WS PF 33
WS PF 1
WS PF 32
WS PF 31
WS PF 30
WS PF 29
WS PF 28
WS PF 27
WS PF 26
WS PF 25
WS PF 24
WS PF 23
WS PF 22
WS PF 21
WS PF 20
WS PF 19
WS PF 18
WS PF 17
WS PF 16
WS PF 15
WS PF 14
WS PF 13
WS PF 12
WS PF 11
WS PF 10
WS PF 9
WS PF 8
WS PF 7
WS PF 6
WS PF 5
WS PF 4
WS PF 3
WS PF 2
Ground
Levee
Ineff
Bank Sta

River station 33.209: Upstream of New River Road Bridge, north portion of levee

HEC-RAS Plan: Imported Pla River: RIVER-1 Reach: Reach-1

Reach	River Sta	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Max Chl Dpth (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
Reach-1	45	32000	2017.96	2028.61	10.65	2026.14	2030.34	0.005302	10.55	3032.12	350.25	0.63
Reach-1	45	1000	2017.96	2019.85	1.89	2019.44	2020.05	0.009512	3.6	278.04	252.16	0.6
Reach-1	45	2000	2017.96	2020.54	2.58	2020.02	2020.82	0.007739	4.26	469.08	282.19	0.58
Reach-1	45	2000	2017.96	2020.54	2.58	2020.02	2020.82	0.007739	4.26	469.08	282.19	0.58
Reach-1	45	3000	2017.96	2021.05	3.09	2020.39	2021.42	0.00723	4.88	614.64	286.74	0.59
Reach-1	45	4000	2017.96	2021.5	3.53	2020.72	2021.95	0.00697	5.39	742.68	290.67	0.59
Reach-1	45	5000	2017.96	2021.9	3.94	2021.02	2022.42	0.006774	5.81	860.74	294.26	0.6
Reach-1	45	6000	2017.96	2022.28	4.32	2021.3	2022.87	0.006589	6.17	972.81	297.62	0.6
Reach-1	45	7000	2017.96	2022.63	4.67	2021.56	2023.29	0.00644	6.49	1079.09	300.78	0.6
Reach-1	45	8000	2017.96	2022.97	5.01	2021.81	2023.68	0.006332	6.78	1179.78	303.74	0.61
Reach-1	45	9000	2017.96	2023.29	5.33	2022.05	2024.06	0.006222	7.04	1277.75	306.59	0.61
Reach-1	45	10000	2017.96	2023.59	5.63	2022.27	2024.42	0.006144	7.29	1371.27	309.28	0.61
Reach-1	45	11000	2017.96	2023.88	5.92	2022.49	2024.76	0.006069	7.52	1462.34	311.89	0.61
Reach-1	45	12000	2017.96	2024.17	6.21	2022.71	2025.1	0.006002	7.74	1550.99	314.4	0.61
Reach-1	45	13000	2017.96	2024.44	6.48	2022.91	2025.42	0.00595	7.94	1636.71	316.81	0.62
Reach-1	45	14000	2017.96	2024.7	6.74	2023.11	2025.73	0.005896	8.13	1721.02	319.17	0.62
Reach-1	45	15000	2017.96	2024.96	7	2023.31	2026.03	0.005856	8.32	1802.7	321.43	0.62
Reach-1	45	16000	2017.96	2025.21	7.25	2023.51	2026.33	0.005814	8.5	1883.22	323.65	0.62
Reach-1	45	17000	2017.96	2025.45	7.49	2023.69	2026.62	0.00577	8.66	1962.9	325.83	0.62
Reach-1	45	18000	2017.96	2025.69	7.73	2023.87	2026.9	0.005724	8.82	2041.71	327.97	0.62
Reach-1	45	19000	2017.96	2025.93	7.96	2024.05	2027.18	0.005696	8.97	2117.53	330.02	0.62
Reach-1	45	20000	2017.96	2026.15	8.19	2024.23	2027.45	0.005661	9.12	2193.34	332.05	0.63
Reach-1	45	21000	2017.96	2026.38	8.42	2024.4	2027.71	0.005634	9.26	2267.17	334.02	0.63
Reach-1	45	22000	2017.96	2026.6	8.64	2024.58	2027.97	0.005601	9.4	2341.1	335.98	0.63
Reach-1	45	23000	2017.96	2026.81	8.85	2024.75	2028.22	0.005572	9.53	2413.78	337.9	0.63
Reach-1	45	24000	2017.96	2027.03	9.07	2024.91	2028.48	0.005528	9.65	2487.99	339.84	0.63
Reach-1	45	25000	2017.96	2027.24	9.27	2025.07	2028.72	0.005507	9.78	2557.45	341.41	0.63
Reach-1	45	26000	2017.96	2027.44	9.48	2025.23	2028.96	0.005468	9.9	2626.89	342.31	0.63
Reach-1	45	27000	2017.96	2027.64	9.68	2025.4	2029.2	0.005436	10.02	2694.88	343.19	0.63
Reach-1	45	28000	2017.96	2027.83	9.87	2025.55	2029.43	0.005401	10.14	2762.62	344.06	0.63
Reach-1	45	30000	2017.96	2028.22	10.26	2025.86	2029.89	0.005354	10.36	2896.5	346.78	0.63
Reach-1	45	31000	2017.96	2028.41	10.45	2025.99	2030.11	0.005336	10.46	2963.08	348.49	0.63
Reach-1	45	32000	2017.96	2028.61	10.65	2026.14	2030.34	0.005302	10.55	3032.12	350.25	0.63
Reach-1	45	33000	2017.96	2028.82	10.86	2026.28	2030.57	0.005251	10.63	3104.23	352.09	0.63

*** ***

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          **************
          *            *
208 KK    *    ADD8    *
          *            *
          **************

209 KO          OUTPUT CONTROL VARIABLES
                     IPRNT          1  PRINT CONTROL
                     IPLOT          2  PLOT CONTROL
                     QSCAL          0.  HYDROGRAPH PLOT SCALE

211 HC          HYDROGRAPH COMBINATION
                     ICOMP          2  NUMBER OF HYDROGRAPHS TO COMBINE

                                                    ***
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****

HYDROGRAPH AT STATION ADD8
SUM OF 2 HYDROGRAPHS

****

DA	MON	HRMN	ORD	FLOW	DA	MON	HRMN	ORD	FLOW	DA	MON	HRMN	ORD	FLOW	DA	MON	HRMN	ORD	FLOW
4	DEC	0000	1	0.	4	DEC	1025	126	1044.	4	DEC	2050	251	7027.	5	DEC	0715	376	172.
4	DEC	0005	2	0.	4	DEC	1030	127	1095.	4	DEC	2055	252	6862.	5	DEC	0720	377	160.
4	DEC	0010	3	0.	4	DEC	1035	128	1147.	4	DEC	2100	253	6705.	5	DEC	0725	378	148.
4	DEC	0015	4	0.	4	DEC	1040	129	1201.	4	DEC	2105	254	6554.	5	DEC	0730	379	138.
4	DEC	0020	5	0.	4	DEC	1045	130	1257.	4	DEC	2110	255	6410.	5	DEC	0735	380	128.
4	DEC	0025	6	0.	4	DEC	1050	131	1315.	4	DEC	2115	256	6272.	5	DEC	0740	381	118.
4	DEC	0030	7	0.	4	DEC	1055	132	1374.	4	DEC	2120	257	6140.	5	DEC	0745	382	110.
4	DEC	0035	8	0.	4	DEC	1100	133	1436.	4	DEC	2125	258	6013.	5	DEC	0750	383	102.
4	DEC	0040	9	0.	4	DEC	1105	134	1499.	4	DEC	2130	259	5892.	5	DEC	0755	384	94.
4	DEC	0045	10	0.	4	DEC	1110	135	1565.	4	DEC	2135	260	5777.	5	DEC	0800	385	87.
4	DEC	0050	11	0.	4	DEC	1115	136	1632.	4	DEC	2140	261	5666.	5	DEC	0805	386	80.
4	DEC	0055	12	0.	4	DEC	1120	137	1702.	4	DEC	2145	262	5561.	5	DEC	0810	387	74.
4	DEC	0100	13	0.	4	DEC	1125	138	1774.	4	DEC	2150	263	5459.	5	DEC	0815	388	69.
4	DEC	0105	14	0.	4	DEC	1130	139	1849.	4	DEC	2155	264	5361.	5	DEC	0820	389	64.
4	DEC	0110	15	0.	4	DEC	1135	140	1927.	4	DEC	2200	265	5267.	5	DEC	0825	390	59.
4	DEC	0115	16	0.	4	DEC	1140	141	2008.	4	DEC	2205	266	5175.	5	DEC	0830	391	54.
4	DEC	0120	17	0.	4	DEC	1145	142	2094.	4	DEC	2210	267	5087.	5	DEC	0835	392	50.
4	DEC	0125	18	0.	4	DEC	1150	143	2183.	4	DEC	2215	268	5001.	5	DEC	0840	393	46.
4	DEC	0130	19	0.	4	DEC	1155	144	2277.	4	DEC	2220	269	4919.	5	DEC	0845	394	43.
4	DEC	0135	20	0.	4	DEC	1200	145	2376.	4	DEC	2225	270	4840.	5	DEC	0850	395	39.
4	DEC	0140	21	0.	4	DEC	1205	146	2480.	4	DEC	2230	271	4763.	5	DEC	0855	396	36.
4	DEC	0145	22	1.	4	DEC	1210	147	2592.	4	DEC	2235	272	4690.	5	DEC	0900	397	33.
4	DEC	0150	23	1.	4	DEC	1215	148	2710.	4	DEC	2240	273	4622.	5	DEC	0905	398	31.
4	DEC	0155	24	1.	4	DEC	1220	149	2835.	4	DEC	2245	274	4558.	5	DEC	0910	399	28.
4	DEC	0200	25	1.	4	DEC	1225	150	2970.	4	DEC	2250	275	4496.	5	DEC	0915	400	26.
4	DEC	0205	26	2.	4	DEC	1230	151	3115.	4	DEC	2255	276	4437.	5	DEC	0920	401	24.
4	DEC	0210	27	2.	4	DEC	1235	152	3270.	4	DEC	2300	277	4382.	5	DEC	0925	402	22.
4	DEC	0215	28	2.	4	DEC	1240	153	3487.	4	DEC	2305	278	4328.	5	DEC	0930	403	20.
4	DEC	0220	29	2.	4	DEC	1245	154	3771.	4	DEC	2310	279	4275.	5	DEC	0935	404	19.
4	DEC	0225	30	3.	4	DEC	1250	155	4124.	4	DEC	2315	280	4223.	5	DEC	0940	405	17.
4	DEC	0230	31	3.	4	DEC	1255	156	4575.	4	DEC	2320	281	4173.	5	DEC	0945	406	16.
4	DEC	0235	32	3.	4	DEC	1300	157	5180.	4	DEC	2325	282	4124.	5	DEC	0950	407	14.
4	DEC	0240	33	3.	4	DEC	1305	158	5935.	4	DEC	2330	283	4075.	5	DEC	0955	408	13.
4	DEC	0245	34	3.	4	DEC	1310	159	6823.	4	DEC	2335	284	4029.	5	DEC	1000	409	12.
4	DEC	0250	35	4.	4	DEC	1315	160	7848.	4	DEC	2340	285	3983.	5	DEC	1005	410	11.
4	DEC	0255	36	4.	4	DEC	1320	161	8968.	4	DEC	2345	286	3939.	5	DEC	1010	411	10.
4	DEC	0300	37	4.	4	DEC	1325	162	10223.	4	DEC	2350	287	3896.	5	DEC	1015	412	9.
4	DEC	0305	38	4.	4	DEC	1330	163	11550.	4	DEC	2355	288	3853.	5	DEC	1020	413	8.
4	DEC	0310	39	4.	4	DEC	1335	164	12929.	5	DEC	0000	289	3813.	5	DEC	1025	414	8.
4	DEC	0315	40	4.	4	DEC	1340	165	14206.	5	DEC	0005	290	3772.	5	DEC	1030	415	7.
4	DEC	0320	41	4.	4	DEC	1345	166	15381.	5	DEC	0010	291	3733.	5	DEC	1035	416	7.
4	DEC	0325	42	5.	4	DEC	1350	167	16545.	5	DEC	0015	292	3694.	5	DEC	1040	417	6.
4	DEC	0330	43	5.	4	DEC	1355	168	17621.	5	DEC	0020	293	3658.	5	DEC	1045	418	5.
4	DEC	0335	44	5.	4	DEC	1400	169	18548.	5	DEC	0025	294	3622.	5	DEC	1050	419	5.
4	DEC	0340	45	5.	4	DEC	1405	170	19423.	5	DEC	0030	295	3587.	5	DEC	1055	420	5.
4	DEC	0345	46	5.	4	DEC	1410	171	20252.	5	DEC	0035	296	3554.	5	DEC	1100	421	4.
4	DEC	0350	47	5.	4	DEC	1415	172	21090.	5	DEC	0040	297	3522.	5	DEC	1105	422	4.
4	DEC	0355	48	6.	4	DEC	1420	173	21865.	5	DEC	0045	298	3492.	5	DEC	1110	423	3.
4	DEC	0400	49	6.	4	DEC	1425	174	22596.	5	DEC	0050	299	3462.	5	DEC	1115	424	3.
4	DEC	0405	50	6.	4	DEC	1430	175	23340.	5	DEC	0055	300	3434.	5	DEC	1120	425	3.
4	DEC	0410	51	6.	4	DEC	1435	176	24007.	5	DEC	0100	301	3408.	5	DEC	1125	426	3.
4	DEC	0415	52	6.	4	DEC	1440	177	24767.	5	DEC	0105	302	3382.	5	DEC	1130	427	2.
4	DEC	0420	53	6.	4	DEC	1445	178	25539.	5	DEC	0110	303	3358.	5	DEC	1135	428	2.
4	DEC	0425	54	7.	4	DEC	1450	179	26368.	5	DEC	0115	304	3332.	5	DEC	1140	429	2.
4	DEC	0430	55	7.	4	DEC	1455	180	27184.	5	DEC	0120	305	3307.	5	DEC	1145	430	2.
4	DEC	0435	56	7.	4	DEC	1500	181	27966.	5	DEC	0125	306	3281.	5	DEC	1150	431	2.
4	DEC	0440	57	7.	4	DEC	1505	182	28770.	5	DEC	0130	307	3252.	5	DEC	1155	432	2.
4	DEC	0445	58	7.	4	DEC	1510	183	29514.	5	DEC	0135	308	3222.	5	DEC	1200	433	1.
4	DEC	0450	59	7.	4	DEC	1515	184	30213.	5	DEC	0140	309	3187.	5	DEC	1205	434	1.
4	DEC	0455	60	7.	4	DEC	1520	185	30845.	5	DEC	0145	310	3149.	5	DEC	1210	435	1.
4	DEC	0500	61	7.	4	DEC	1525	186	31390.	5	DEC	0150	311	3109.	5	DEC	1215	436	1.
4	DEC	0505	62	7.	4	DEC	1530	187	31894.	5	DEC	0155	312	3065.	5	DEC	1220	437	1.
4	DEC	0510	63	7.	4	DEC	1535	188	32304.	5	DEC	0200	313	3018.	5	DEC	1225	438	1.
4	DEC	0515	64	8.	4	DEC	1540	189	32670.	5	DEC	0205	314	2968.	5	DEC	1230	439	1.
4	DEC	0520	65	8.	4	DEC	1545	190	32946.	5	DEC	0210	315	2919.	5	DEC	1235	440	1.
4	DEC	0525	66	8.	4	DEC	1550	191	33149.	5	DEC	0215	316	2869.	5	DEC	1240	441	1.
4	DEC	0530	67	8.	4	DEC	1555	192	33280.	5	DEC	0220	317	2819.	5	DEC	1245	442	1.
4	DEC	0535	68	8.	4	DEC	1600	193	33341.	5	DEC	0225	318	2768.	5	DEC	1250	443	1.
4	DEC	0540	69	8.	4	DEC	1605	194	33334.	5	DEC	0230	319	2716.	5	DEC	1255	444	1.

4	DEC	0545	70	8.	*	4	DEC	1610	195	33223.	*	5	DEC	0235	320	2664.	*	5	DEC	1300	445	0.
4	DEC	0550	71	8.	*	4	DEC	1615	196	33030.	*	5	DEC	0240	321	2613.	*	5	DEC	1305	446	0.
4	DEC	0555	72	8.	*	4	DEC	1620	197	32761.	*	5	DEC	0245	322	2562.	*	5	DEC	1310	447	0.
4	DEC	0600	73	8.	*	4	DEC	1625	198	32418.	*	5	DEC	0250	323	2511.	*	5	DEC	1315	448	0.
4	DEC	0605	74	8.	*	4	DEC	1630	199	32020.	*	5	DEC	0255	324	2459.	*	5	DEC	1320	449	0.
4	DEC	0610	75	8.	*	4	DEC	1635	200	31574.	*	5	DEC	0300	325	2406.	*	5	DEC	1325	450	0.
4	DEC	0615	76	9.	*	4	DEC	1640	201	31097.	*	5	DEC	0305	326	2352.	*	5	DEC	1330	451	0.
4	DEC	0620	77	9.	*	4	DEC	1645	202	30561.	*	5	DEC	0310	327	2298.	*	5	DEC	1335	452	0.
4	DEC	0625	78	10.	*	4	DEC	1650	203	29969.	*	5	DEC	0315	328	2242.	*	5	DEC	1340	453	0.
4	DEC	0630	79	11.	*	4	DEC	1655	204	29336.	*	5	DEC	0320	329	2184.	*	5	DEC	1345	454	0.
4	DEC	0635	80	12.	*	4	DEC	1700	205	28669.	*	5	DEC	0325	330	2125.	*	5	DEC	1350	455	0.
4	DEC	0640	81	13.	*	4	DEC	1705	206	27976.	*	5	DEC	0330	331	2066.	*	5	DEC	1355	456	0.
4	DEC	0645	82	15.	*	4	DEC	1710	207	27278.	*	5	DEC	0335	332	2005.	*	5	DEC	1400	457	0.
4	DEC	0650	83	17.	*	4	DEC	1715	208	26577.	*	5	DEC	0340	333	1944.	*	5	DEC	1405	458	0.
4	DEC	0655	84	19.	*	4	DEC	1720	209	25878.	*	5	DEC	0345	334	1882.	*	5	DEC	1410	459	0.
4	DEC	0700	85	22.	*	4	DEC	1725	210	25164.	*	5	DEC	0350	335	1820.	*	5	DEC	1415	460	0.
4	DEC	0705	86	25.	*	4	DEC	1730	211	24444.	*	5	DEC	0355	336	1758.	*	5	DEC	1420	461	0.
4	DEC	0710	87	29.	*	4	DEC	1735	212	23720.	*	5	DEC	0400	337	1695.	*	5	DEC	1425	462	0.
4	DEC	0715	88	34.	*	4	DEC	1740	213	22996.	*	5	DEC	0405	338	1632.	*	5	DEC	1430	463	0.
4	DEC	0720	89	40.	*	4	DEC	1745	214	22277.	*	5	DEC	0410	339	1569.	*	5	DEC	1435	464	0.
4	DEC	0725	90	46.	*	4	DEC	1750	215	21568.	*	5	DEC	0415	340	1506.	*	5	DEC	1440	465	0.
4	DEC	0730	91	53.	*	4	DEC	1755	216	20875.	*	5	DEC	0420	341	1444.	*	5	DEC	1445	466	0.
4	DEC	0735	92	61.	*	4	DEC	1800	217	20198.	*	5	DEC	0425	342	1381.	*	5	DEC	1450	467	0.
4	DEC	0740	93	70.	*	4	DEC	1805	218	19539.	*	5	DEC	0430	343	1320.	*	5	DEC	1455	468	0.
4	DEC	0745	94	80.	*	4	DEC	1810	219	18901.	*	5	DEC	0435	344	1260.	*	5	DEC	1500	469	0.
4	DEC	0750	95	91.	*	4	DEC	1815	220	18280.	*	5	DEC	0440	345	1202.	*	5	DEC	1505	470	0.
4	DEC	0755	96	104.	*	4	DEC	1820	221	17675.	*	5	DEC	0445	346	1145.	*	5	DEC	1510	471	0.
4	DEC	0800	97	117.	*	4	DEC	1825	222	17088.	*	5	DEC	0450	347	1089.	*	5	DEC	1515	472	0.
4	DEC	0805	98	132.	*	4	DEC	1830	223	16515.	*	5	DEC	0455	348	1035.	*	5	DEC	1520	473	0.
4	DEC	0810	99	148.	*	4	DEC	1835	224	15959.	*	5	DEC	0500	349	982.	*	5	DEC	1525	474	0.
4	DEC	0815	100	165.	*	4	DEC	1840	225	15423.	*	5	DEC	0505	350	930.	*	5	DEC	1530	475	0.
4	DEC	0820	101	184.	*	4	DEC	1845	226	14904.	*	5	DEC	0510	351	880.	*	5	DEC	1535	476	0.
4	DEC	0825	102	203.	*	4	DEC	1850	227	14404.	*	5	DEC	0515	352	832.	*	5	DEC	1540	477	0.
4	DEC	0830	103	225.	*	4	DEC	1855	228	13922.	*	5	DEC	0520	353	786.	*	5	DEC	1545	478	0.
4	DEC	0835	104	247.	*	4	DEC	1900	229	13465.	*	5	DEC	0525	354	742.	*	5	DEC	1550	479	0.
4	DEC	0840	105	271.	*	4	DEC	1905	230	13026.	*	5	DEC	0530	355	700.	*	5	DEC	1555	480	0.
4	DEC	0845	106	296.	*	4	DEC	1910	231	12604.	*	5	DEC	0535	356	659.	*	5	DEC	1600	481	0.
4	DEC	0850	107	322.	*	4	DEC	1915	232	12197.	*	5	DEC	0540	357	621.	*	5	DEC	1605	482	0.
4	DEC	0855	108	350.	*	4	DEC	1920	233	11807.	*	5	DEC	0545	358	584.	*	5	DEC	1610	483	0.
4	DEC	0900	109	378.	*	4	DEC	1925	234	11432.	*	5	DEC	0550	359	548.	*	5	DEC	1615	484	0.
4	DEC	0905	110	408.	*	4	DEC	1930	235	11073.	*	5	DEC	0555	360	515.	*	5	DEC	1620	485	0.
4	DEC	0910	111	439.	*	4	DEC	1935	236	10728.	*	5	DEC	0600	361	483.	*	5	DEC	1625	486	0.
4	DEC	0915	112	471.	*	4	DEC	1940	237	10394.	*	5	DEC	0605	362	453.	*	5	DEC	1630	487	0.
4	DEC	0920	113	504.	*	4	DEC	1945	238	10074.	*	5	DEC	0610	363	425.	*	5	DEC	1635	488	0.
4	DEC	0925	114	538.	*	4	DEC	1950	239	9767.	*	5	DEC	0615	364	398.	*	5	DEC	1640	489	0.
4	DEC	0930	115	574.	*	4	DEC	1955	240	9473.	*	5	DEC	0620	365	372.	*	5	DEC	1645	490	0.
4	DEC	0935	116	610.	*	4	DEC	2000	241	9191.	*	5	DEC	0625	366	348.	*	5	DEC	1650	491	0.
4	DEC	0940	117	648.	*	4	DEC	2005	242	8922.	*	5	DEC	0630	367	325.	*	5	DEC	1655	492	0.
4	DEC	0945	118	687.	*	4	DEC	2010	243	8671.	*	5	DEC	0635	368	304.	*	5	DEC	1700	493	0.
4	DEC	0950	119	727.	*	4	DEC	2015	244	8430.	*	5	DEC	0640	369	283.	*	5	DEC	1705	494	0.
4	DEC	0955	120	769.	*	4	DEC	2020	245	8201.	*	5	DEC	0645	370	264.	*	5	DEC	1710	495	0.
4	DEC	1000	121	811.	*	4	DEC	2025	246	7981.	*	5	DEC	0650	371	246.	*	5	DEC	1715	496	0.
4	DEC	1005	122	855.	*	4	DEC	2030	247	7771.	*	5	DEC	0655	372	229.	*	5	DEC	1720	497	0.
4	DEC	1010	123	901.	*	4	DEC	2035	248	7571.	*	5	DEC	0700	373	214.	*	5	DEC	1725	498	0.
4	DEC	1015	124	947.	*	4	DEC	2040	249	7381.	*	5	DEC	0705	374	199.	*	5	DEC	1730	499	0.
4	DEC	1020	125	995.	*	4	DEC	2045	250	7200.	*	5	DEC	0710	375	185.	*	5	DEC	1735	500	0.
					*						*						*					

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PEAK FLOW	TIME	MAXIMUM AVERAGE FLOW			
		6-HR	24-HR	72-HR	41.58-HR
+ (CFS)	(HR)				
		(CFS)			
+ 33341.	16.00	23546.	8091.	4674.	4674.
		(INCHES) 2.513	3.455	3.458	3.458
		(AC-FT) 11676.	16048.	16063.	16063.

CUMULATIVE AREA = 87.10 SQ MI

-----DSS---ZOPEN: Existing File Opened, File: EDDYDSS.DSS
Unit: 71; DSS Version: 6-JG
-----DSS---ZWRITE Unit 71; Vers. 6: /FLOW AT NEW RIVER RD BRIDGE/LEVEE SECTION/FLOW/03DEC1985/5MIN/100YR 24HR/
-----DSS---ZWRITE Unit 71; Vers. 6: /FLOW AT NEW RIVER RD BRIDGE/LEVEE SECTION/FLOW/04DEC1985/5MIN/100YR 24HR/
-----DSS---ZWRITE Unit 71; Vers. 6: /FLOW AT NEW RIVER RD BRIDGE/LEVEE SECTION/FLOW/05DEC1985/5MIN/100YR 24HR/

1 STATION ADD8

(O) OUTFLOW

0. 4000. 8000. 12000. 16000. 20000. 24000. 28000. 32000. 36000. 0. 0. 0.

DAHRMN PER

40000 10O---------.---------.---------.---------.---------.---------.---------.---------.---------.---------.---------.---------.
40005 20 . . . .
40010 30 . . . .
40015 40 . . . .
40020 50 . . . .
40025 60 . . . .
40030 70 . . . .
40035 80 . . . .
40040 90 . . . .
40045 100 . . . .
40050 110 . . . .
40055 120 . . . .
40100 130 . . . .
40105 140 . . . .
40110 150 . . . .
40115 160 . . . .
40120 170 . . . .
40125 180 . . . .
40130 190 . . . .
40135 200 . . . .
40140 210 . . . .
40145 220 . . . .