NEW RIVER
FROM GRAND AVENUE TO GREENWAY ROAD

Contract FCD 93-02

WOOD/PATEL ASSOCIATES

Civil Engineers
Hydrologists
Land Surveyors

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NEW RIVER
FROM GRAND AVENUE TO GREENWAY ROAD

Contract FCD 93-02

February 23, 1994

Prepared for:

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
2801 West Durango Street
Phoenix, AZ 85009
(602) 506-1501

Prepared by:

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Registered Professional Engineer (Civil)
CERTIFICATE NO.
10512
ASHOK C.
PATEL
Date Signed 2/23/94
ARIZONA, U.S.A.

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February 28, 1994

Mr. R.W. Shobe, P.E.
Flood Control District
of Maricopa County
2801 West Durango Street
Phoenix, Arizona 85009

Re: **New River Drop Structure at Desert Harbor**
Contract FCD 93-02
(Construction Contract FCD 94-04)
WP #91755.02

Dear R.W.:

In accordance with the referenced contract, we are herewith submitting the following items:

- Final Design Plans, & Design Report including Quantity Estimate (7 sets)
- New River HEC-2 Data, ADOT Drop HEC-2 (1 computer floppy)
- Draft - Special Provisions (3 sets)
- Draft - Special Provisions on 1 computer floppy
- At your direction a set of plans and report is being submitted to Mr. Dan Nissen, P.E., City of Peoria
- Cost Estimates for Phases I & II (1 set under separate cover)
- Redline blueprints from the 80% Review

This submittal incorporates all comments received from the District and City of Peoria for the 80% submittal. As you have been informed, Mr. Ray Jordan, P.E. from the Arizona Department of Transportation has verbally approved the Agua Fria Freeway outlet drop structure and approval letter is anticipated in the near future. Once available, a copy of that letter will be furnished to the District.

Once accepted and approved by your office, a set of mylars will be submitted for your use.

Please call me if you require clarification on this submittal.

Very truly yours,

WOOD, PATEL & ASSOCIATES, INC.

Ashok C. Patel, P.E., R.L.S.
Principal

ACP/lfc

enclosures

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1.0 INTRODUCTION

1.1 Purpose

The Flood Control District of Maricopa County (the District) has contracted with Wood, Patel & Associates, Inc. (Wood/Patel) to provide engineering services for the New River project. Wood/Patel, according to the contract Scope of Work, shall provide the District with the Standard Project Flood (SPF) delineation and construction plans and special provisions for a drop structure and other elements within the project reach of New River between Grand Avenue and Greenway Road (extension).

1.2 Project Location

The study area for this report is located on New River between Grand Avenue and Greenway Road (extension) in the City of Peoria. Plate 1 depicts the project map.

Presently, there are two bridged crossings of New River in this project. These are located at Grand Avenue and Thunderbird Road. The Agua Fria Expressway by the Arizona Department of Transportation (ADOT) bridges Skunk Creek north of the confluence with New River. The expressway is adjacent to the New River and parallel to the east bank.

1.3 Background

Historically, a flood hazard has existed in the metropolitan Phoenix area along Cave Creek, Skunk Creek, New River, Agua Fria River, and downstream of the Arizona Canal. As a means to help mitigate potential flooding the U.S. Corps of Engineers (Corps) in conjunction with the District and other municipalities, implemented a comprehensive flood control plan consisting of both structural and non-structural improvements.

1.3 Background (Continued)

As part of the overall plan, the Arizona Canal Diversion Channel (ACDC) was designed to intercept 100-year flows from as far east as Cudia City Wash and convey them to an outlet at Skunk Creek, a tributary to New River which, in turn, is a tributary of the Agua Fria River.

Under an agreement with the Corps, the District plans to acquire flowage easements along Skunk Creek, New River, and the Agua Fria River to the confluence with the Gila River, as authorized by Federal legislation.

Structural improvements have been made along the Agua Fria River and some easements have been acquired. The Corps also has recently completed a construction contract for channel improvements along New River from Grand Avenue south to Olive Avenue. However, due to schedule and cost constraints, flowage easement agreements have not yet been established for a portion of New River, including this study reach. To minimize flowage easement requirement and to alleviate a potential flooding problem due to the completion of the ACDC and the associated liability risk to the District, a decision to provide channel improvements for this study reach of the New River was analyzed.

Recommended improvements to handle the SPF are proposed to be in the form of partial channelization and bank protection of a portion of New River from Grand Avenue to Greenway Road (extension).

2.0 SCOPE OF WORK

2.1 SPF Delineation

In 1989, a hydraulic analysis was performed by the District for portions of New River and Skunk Creek. This analysis included a flood insurance study, as well as floodplain delineation for the SPF. The study was subsequently submitted to and accepted by the Federal Emergency Management Agency (FEMA) for the Conditional Letter of Map Revision (CLOMR) process.

2.1 SPF Delineation (Continued)

The study concluded that a certain portion of the New River channel section near Thunderbird Road was not adequate in size to contain the SPF highwater within the banks. In August, 1991, the District completed a feasibility study for this reach through Wood/Patel which included the following tasks:

1. Create a working HEC-2 model using the digitized data (1991 mapping) for the 3.5 mile long reach of New River between Grand Avenue and Bell Road.

2. Establish a SPF profile based on the Corps flood peak of 68,000 cfs for New River downstream of the Skunk Creek confluence. The SPF profile will be matched to the existing profile at the study limits.

3. Evaluate the riverbanks to check if the SPF is contained within the banks.

4. If the SPF is not contained within the banks, perform alternative analysis for channel modification to contain the SPF. This may require lowering of the channel thalweg and channel excavation.

5. Finalize the SPF profile based on the recommended channel excavation option.

6. Prepare SPF delineations with and without channel improvement conditions on the available topographic map.

7. Prepare a letter report documenting the methods used for the SPF delineation and provide earthwork estimate together with summary and conclusion.

In April, 1993, the District retained Wood/Patel to prepare construction plans and special provisions for a drop structure and other elements, including SPF delineation as part of the design phase of this project.

2.1 SPF Delineation (Continued)

Based on input received from various departments within the District, as well as the City of Peoria, the Scope of Services were outlined for the design phase. As the design phase progressed, several tasks were modified as a result of input from District staff. The following is a brief summary of the elements included in the design phase.

1. The channel bottom immediately north of the existing improvements at Grand Avenue will be widened by extending the east bank. These channel improvements will transition back to match the existing channel geometry approximately 500′ south of Thunderbird Road.

2. The above channel widening will necessitate the removal and reconstruction of an existing ADOT outlet drop structure.

3. Several bank areas within this project will require fill to contain the SPF elevation. These areas are further described in Section 4.0.

4. Thunderbird Avenue bridge will not be provided with bed lining at the direction of the District.

5. A drop structure is proposed downstream of the Skunk Creek and New River confluence. This structure will be designed for 100-year flows.

6. Soil cement bank protection will be provided from the new drop structure along the east bank of Skunk Creek to the Agua Fria Expressway and along the west bank of New River, from the drop structure to the 91st Avenue channel (Greenway Road extension). The soil cement banks will be constructed to contain the 100-year flows with three (3) feet of freeboard. The SPF flow elevation will exceed the top of soil cement bank but will be contained within the channel banks.

3.0 DATA COLLECTION

The following data was collected in conjunction with this study:

Reports:

Dames & Moore, *"Hydraulic and Geotechnical Engineering Studies, Channel Bank Stabilization, and Protection New River and Skunk Creek"* for Ellis-Murphy, Inc., April 27, 1987.

Ellis-Murphy Gannett Fleming of Arizona, Inc., *"Desert Harbor Erosion Study"*, Desert Harbor Study, September, 1988.

Construction Inspection & Testing Co., *"Soil Investigation for Erosion Study, Desert Harbor"*, April 22, 1988.

Ellis-Murphy, *Skunk Creek HEC-2*, June, 1987.

Coe & Van Loo Consultants, Inc., *New River/Skunk Creek SPF Delineation (including data on HEC-2 input/output)*, December, 1989.

Chamani, M. R and N. Rajaratnam, *"Jet Flow on Stepped Spillways,"* Draft Report, University of Alberta, Edmonton, 1993.

Federal Highway Administration, *"HEC-14, Hydraulic Design of Energy Dissipators for Culverts and Channels,"* September 1983.

Rajaratnam, N., *"Skimming Flow in Stepped Spillways,"* Journal of Hydraulic Engineering, Vol. 116, No. 4, April 1990.

Simons, Li & Associates, *"Final Sediment Transport Report for the New River and Skunk Creek"*, January, 1985.

3.0 Data Collection (Continued)

Thomas Hartig & Associates, Inc., *"Report for Geotechnical Engineering Services, New River Channelization Grand Avenue to Greenway Road"*, July 14, 1993. Including subsequent addendum.

AMWEST, *"Plaza Del Rio On-Site Drainage Report"*, May, 1990.

Plans:

Maricopa County Highway Department, *Thunderbird Road Bridge*, January, 1981.

Maricopa County Highway Department, *Bell Road Bridge*, December 1981.

Flood Control District of Maricopa County, *83rd Avenue Bridge*, December, 1990.

Flood Control District of Maricopa County, *topographic maps of New River* prepared by Kaminski-Hubbard Engineering and Kenney Aerial Mapping Company, April, 1991.

Flood Control District of Maricopa County, *91st Avenue Channel Improvements* by Dibble & Associates, November, 1990.

Arizona Department of Transportation, *partial set of plans, Agua Fria Freeway Bridge over Skunk Creek*, April, 1987.

U.S. Army Corps of Engineers, *partial set of improvement plans, Grand Avenue at New River*, December, 1990.

Ellis-Murphy, *Desert Harbor Drop Structure in New River, City of Peoria*, October, 1984 (unapproved set of plans).

3.0 Data Collection (Continued)

Wood, Patel & Associates for the Flood Control District of Maricopa County, *"New River Between Grand Avenue and Bell Road, Standard Project Flood Delineations and Bank Stability Evaluation,"* August 29, 1991.

Morris, Clester, Abegglen, & Associates, *partial set of plans for Freedom Plaza*, November, 1990.

Parker, Johnson & Associates, *partial set of plans for Thunderbird Road west of New River*, April, 1984.

AMWEST, *partial set of plans for Plaza Del Rio*, (undated).

City of Peoria and Utilities Serving Area, *Miscellaneous Utility Maps*.

4.0 DESIGN ELEMENTS

Various key elements which have been incorporated into this design are described in the following sections.

4.1 Grading Design Concept

The proposed channel improvements will generate an excess in excavated material. Excavated materials which are free of organic matter, debris, rubble and material 8" or larger may be used as fill material. In order to minimize export from the site, several areas of fill have been identified and prioritized as follows:

1. Several areas identified on the plans as requiring fill to contain the SPF will have engineered fill placed as a first priority.

2. An existing depressed area located northeast of the proposed drop structure will be filled with material excavated from the drop structure site.

4.1 Grading Design Concept (Continued)

3. At the south end of this project, the west bank will require fill to contain the SPF as shown on the plan. This area will be filled from material excavated from the channel bottom widening and the east bank relocation in this reach.

4. Immediately north of the proposed drop structure, the east bank to the Agua Fria Expressway embankment will require fill to contain the SPF.

4.2 Lined Drainage Outlets

In addition to general unlined drainage outlets, there are several lined drainage outlets into this reach which will be treated as follows:

Station 376+93, ADOT Outlet, East Bank

This outlet consists of a concrete drop structure with wing walls and rail bank outlet protection. Construction plans for this structure were prepared by Franzoy Corey, Outer Loop Highway (SR 417), Project No. RBM-600-0-502. As-built plans were provided by ADOT. However, site visits and subsequent field surveys established that the structure was not constructed per as-built plans. In order to maintain this structure and avoid disturbing a 30-inch City of Peoria sanitary sewer on the opposite west bank, a constriction in the channel geometry would be required. This constriction would have the undesirable effect of substantially increasing water surface elevations in this reach. Several alternatives were analyzed and discussed with the District to determine the most feasible option.

Several Hydraulic models of the proposed reconstructed outlet channel and drop structure were analyzed and it was determined the relocation causes no adverse impact to the performance of the Agua Fria Expressway 2-barrel, 8′ X 7′ box culvert. One HEC-2 model was created for each the existing and the proposed structures. Each model contains two profiles; one uses the 100-year water surface elevation in New River and the 10-year flow in the outlet structure; the other uses the 10-year water surface elevation in the New River and the 100-year flow in the outlet structure. The proposed condition water surface

4.2 Lined Drainage Outlets (Continued)

elevations at the west face of the Agua Fria Expressway box culvert in both cases are less than those for the existing condition. See Appendix I for HEC-2 models. To resolve this condition, it was determined that the channel bottom would be extended to the east and the existing ADOT structure would be demolished and reconstructed to match the new east bank alignment.

ADOT has approved the relocation of this structure. However, once reconstructed, maintenance of this structure will be the responsibility of the District. The District has been made aware of this responsibility and as understood has agreed.

Station 461+09, ADOT Outlet - Skunk Creek, East Bank

This outlet consists of a concrete headwall for two 42-inch pipes with rail bank protection to the north and south. Construction plans for this structure were prepared by Franzoy Corey, Outer Loop Highway (SR 417), Project No. RBM-600-0-502. As-built plans were provided by ADOT. However, site visits and subsequent field surveys established that the structure did not match as-built plans. This structure will remain as is. Soil cement embankment protection, which is proposed for the east bank upstream from the new drop structure to this outlet, will transition into and match the existing rail bank slope protection. For embankment protection north of this structure, see Section 4.4, ADOT protection.

Station 475+67, Greenway Channel - New River, West Bank

This outlet consists of a concrete drop structure with grouted riprap wings and outlet protection. Construction plans for this structure were prepared by Dibble & Associates, 91st Avenue Channel Improvements, Project No. 91-01. As-built plans were provided by the District. The grouted riprap south bank and channel bottom at the channel outlet will be removed to the existing shotcrete channel

4.2 Lined Drainage Outlets (Continued)

limits. The new soil cement embankment protection along the west bank of New River will extend into the 91st Avenue Alignment along the south bank and tie into the existing shotcrete structure.

4.3 Unlined Drainage Outlets

There are a number of unlined drainage channels which outlet into this project reach. These outlets will be treated individually as follows:

Station 360+30, Plaza del Rio Channel, West Bank

This channel drains a portion of Plaza Del Rio and outlets into New River directly north of the existing channel improvements. Currently, the channel alignment makes a severe turn at the outlet to New River, creating an erosion problem on the south channel bank. This channel outlet will be improved by realigning the outlet and lining a portion of the channel bottom and sideslopes with gunite. These improvements will tie into existing Corps soil cement improvements and prevent future erosion from occurring behind the Corps improvements.

Station 368+40, ADOT Drainage Swale, East Bank

This swale drains a small area (6±Ac) between the Agua Fria Expressway and the New River. A grouted riprap spillway has been designed in the new east bank at this swale outfall location to provide erosion protection.

Station 381+30, Plaza Del Rio Channel, West Bank

This channel drains a portion of Plaza Del Rio. Since there are no channel improvements on the west bank in this area, no modifications are proposed at this outlet.

Station 394+00, City of Peoria Storm Drainage Channel, West Bank

This channel is used to direct City of Peoria storm drainage into New River. Again, since there are no proposed revisions to the west bank in this area, no improvements are proposed at this outlet.

4.4 Additional Construction Items

Embankment Fill

At the northwest corner of Thunderbird Road and New River, a 2- to 3-foot high concrete masonry unit wall has been constructed along the west bank as part of the Desert Harbor Development. The natural ground adjacent to this wall is, for the most part, above the SPF water surface elevation. However, there is a short section approximately 250 feet long where the existing ground dips below the SPF elevation. Embankment fill varying from 0 to 1.3 feet deep is proposed adjacent to the wall in this area in order to prevent water from flowing directly against the wall.

ADOT Protection

There is a short section of river bank north of the ADOT Skunk Creek outlet rail bank and the Agua Fria Expressway Bridge riprap which has no embankment protection. This 40-foot section will be provided with grouted riprap embankment protection with toedown to match existing ADOT bank.

Power Pole

There is an existing 69 KV power pole on the east bank at Station 386+62 which lies at the top of the proposed bank. Based on input from Arizona Public Service (APS) which owns this facility, a 5-foot pad will be maintained at the base of this pole and riprap embankment protection will be included on the plan for the bank slope adjacent to the pole.

Channel Access/Maintenance Roads

There were no channel access/maintenance roads included in the initial scope of work for this project. However, as the project progressed, maintenance roads on the east bank, Thunderbird Road to the ADOT outlet at the Agua Fria Expressway, and on the west bank from the drop structure to Greenway Road alignment were added.

4.4 Additional Construction Items (Continued)

Channel Access Ramps

Channel access ramps have been discussed and agreed upon with the District. Two ramps will be constructed in the existing natural channel banks. These ramps will be constructed of aggregate base course (ABC) and will be located immediately upstream of Thunderbird Road and immediately downstream of the new drop structure. In addition to these ramps, two ramps will be constructed in the new soil cement embankment. One ramp will be located in the east bank immediately upstream of the drop structure. The second ramp will be located immediately downstream of the 91st Avenue channel outlet (Greenway Road Alignment).

City of Peoria Sewer

The City of Peoria maintains a 30-inch diameter sewer which crosses under New River at station, approximately 361 + 20 ±. An analysis of the impact of this project on the sewer line is included in Appendix IV. No additions to the existing protective measures will be implemented with the project.

4.5 Right-of-Way/Easement Requirements

In order to contain the SPF adjacent to private land, it will be necessary to place engineered bank fill in several areas. These fill areas will require additional right-of-way or temporary construction easements as follows:

1. **Additional Right-of-Way, Station 386 + 50 to Station 401 + 00**
   Due to channel widening in this reach, it will be necessary to extend the top of bank into land which is currently privately held. The additional 2.0 acres of right-of-way was determined by providing a 10-foot buffer beyond the new top of slope.

4.5 Right-of-Way/Easement Requirements (Continued)

2. **Additional Right-of-Way, Station 449+20 to Station 453+00**
   Due to channel widening at the proposed drop structure, it will be necessary to extend the top of bank into land which is currently privately held. The additional 0.19 acres of right-of-way was determined by providing a 10-foot buffer beyond the access road.

3. **Temporary Construction Easements**
   Several reaches will require temporary construction easements for fill placement as described in Section 4.1. Station 424+30 to Station 432+70 will require a 30-foot wide easement, or 0.58 acres. Station 433+70 to Station 436+70 will require a 60-foot wide easement, or 0.41 acres.

5.0 DROP STRUCTURE

As part of the final design, Wood/Patel reviewed and analyzed various types of drop structures including vertical hard basin, sloping concrete, stepped stilling basin, baffle chute, and stepped drop structures. After reviewing cost feasibility and hazard considerations and per direction from the District, a stepped drop structure was determined to best represent technical needs and, therefore, recommended for the final design.

The hydraulic design for a stepped drop structure was adjusted to account for considerations of public hazard. Accordingly, the following modifications have been incorporated into the preliminary design:

1. Provided a stepped drop to enhance safety during the low and nuisance flows.

2. Provided a 3:1 slope for the drop in lieu of 1:1 slope which was initially considered for its better hydraulic performance. The 3:1 slope provides a somewhat inferior hydraulic performance but enhances safety during nuisance and low flows. The steps are selected to have a 1.83-foot vertical height and a 5.5-foot horizontal length for landing areas. This feature will also improve safety during dry conditions.

5.0 Drop Structure (Continued)

3. The Scope of Work initially required about 16 feet of vertical drop due to the SPF design parameters. The District felt that to help reduce the vertical height (for safety concerns), the design be performed for a 100-year storm. With 100-year design parameters, it is possible to reduce the vertical drop from 16 feet to 11 feet.

Appendix II includes hydraulic calculations for the 100-year SPF flood conditions. Please note that a full hydraulic jump will form only for the peak flows which are less than the 10-year frequency storms. Due to submerged conditions created by greater flood peaks, bank protection is extended an additional 100 L.F. downstream of the drop structure outlet.

Toedown depths are based on an analysis of long term degradation, contraction scour, bend scour, channel incisement and bedforms. This analysis is included in Appendix IV.

6.0 STANDARD PROJECT AND 100-YEAR BACKWATER ANALYSIS

Based on the topographic maps dated April, 1991 at a scale of one inch equals 200 feet (1" = 200'), 2-foot contour interval floodplain delineation was performed for the study reach. The hydraulic analysis was conducted using the U.S. Army Corps of Engineers' HEC-2 computer model to develop a water surface profile.

Study Parameters

Study Reach: New River from Grand Avenue to Bell Road

Manning's Roughness Coefficient:

	For channel	n = .03
	For overbanks	n = .045

6.0 STANDARD PROJECT AND 100-YEAR BACKWATER ANALYSIS (Continued)

Summary of Flood Peaks

NEW RIVER REACH LOCATION	SPF PEAK FLOW	100-YEAR PEAK FLOW	10-YEAR PEAK FLOW
Grand Avenue to Skunk Creek Confluence	68,000 cfs	41,000 cfs	10,500 cfs
Skunk Creek Confluence to Bell Road	38,000 cfs	19,000 cfs	5,100 cfs

Starting water surface elevations were based on the SPF and 100-year analysis by Coe & Van Loo and the slope area method. The SPF delineation, based on existing conditions, is depicted on Plate 2, Appendix V. The SPF delineation, based on proposed conditions is depicted on Plate 3, Appendix V.

7.0 SEDIMENT TRANSPORT ANALYSIS

Preliminary sediment transport analyses were performed using Zeller's Equation and the Meyer-Peter-Muller Equation in conjunction with the equilibrium slope methodology outlined in the Arizona Department of Water Resources (ADWR) publication entitled Design Manual for Engineering Analysis of Fluvial Systems. Zeller's Equation is an alternative to the empirical power relationship developed by Simons, Li and Fullerton (1981) to estimate the total bed-material discharge in sand-bed channels. Due to extensive gravel and cobble armoring of the channel bed within and upstream of the project reach, however, the Zeller's Equation analysis may not be the most appropriate method for this situation. A more appropriate analysis is the Meyer-Peter-Muller equation, which is better suited to gravel and boulder stream beds. This method is therefore the preferred method.

7.1 Equalibrium Slopes

New River and Skunk Creek were divided into hydraulically uniform reaches throughout and upstream of the project area. Reach boundaries were selected to provide segments of similar hydraulic characteristics. The equilibrium slope was calculated for each reach utilizing the following procedure.

1. **Determine the dominant discharge.** The 10-year discharge value of 10,500 cfs was chosen as the dominant discharge for this project. The equilibrium slope analysis was performed for the 100-year peak discharge value of 41,000 cfs as well.

2. **Compute the sediment supply.** Both Zeller's equation and the Meyer-Peter and Muller equation were used to determine the sediment supply. Zeller's equation appears below:

$$q_s = 0.0064 \frac{n^{1.77} V^{4.32} G^{0.45}}{Y_h^{0.30} D_{50}^{0.61}}$$

q_s = sediment discharge
n = mannings coefficient
V = velocity
G = gradation coefficient
Y = depth
D_{50} = median diameter

A gradation coefficient and D_{50} particle size must be determined for use in this equation. The gradation coefficient was determined by the following equation:

2. **Compute the sediment supply (Continued)**

$$G=\frac{1}{2}\left(\frac{D_{84.1}}{D_{50}}+\frac{D_{50}}{D_{15.9}}\right)$$

G = gradation coefficient
$D_{15.9}$ = particle size
D_{50} = particle size
$D_{84.1}$ = particle size

The Meyer-Peter-Muller equation was also used to compute sediment supply:

$$Q_s=\frac{8W}{\sqrt{\rho}\delta'_s}(\tau-\tau_\partial)^{1.5}$$

where

W = stream width, ft.
ρ = density of water (y/g)
δ' =
s = specific gravity of the submerged bed material

shear stress, τ = γRS

where

γ = specific weight of water (62.4 lb/ft^3)
R = hydraulic radius (ft)
S = bed slope

2. **Compute the sediment supply (Continued)**

critical shear, τ_c = 0.0047 γ_s DM

where

γ_s = specific weight of submerged material (γ_s - γ), (lb/ft^3)

DM = median sediment diameter, mm

A reach upstream of the project site was chosen as the supply reach. This reach determines the volume of sediment flowing to the project site. The channel invert would either aggrade or degrade dependent upon the sediment balance in each reach.

3. **Compute equilibrium slope.** An iterative procedure is employed to compute the sediment transport capacity for each cross section. The U.S. Army Corps of Engineers HEC-2 computer program was used to determine hydraulic parameters, while Zeller's equation and the Meyer-Peter and Muller equation were used to compute transport capacity. To determine the equilibrium slope, the bed slope value is adjusted until the transport rate equals the supply rate. A comparison of the existing slope to the equilibrium slope determined whether the section would aggrade, degrade, or remain stable.

7.2 Summary of Sediment Transport Analysis

Figures 1 and 2 and Tables 3 and 4 in Appendix III show the results of the equilibrium slope analyses using Zeller's Equation and the results of Meyer-Peter-Muller Equation for the 10-year and 100-year flows are presented by Figures 3 and 4 and Tables 5 and 6. The results of the two methods are rather dissimilar. The Meyer-Peter-Muller Equation analysis indicates aggradation between Thunderbird Road and the drop structure, and degradation between Grand Avenue and Thunderbird Road. These results are indicated for both the 10-year and the 100-year flows.

7.2 Summary of Sediment Transport Analysis (Continued)

The analysis using Zeller's Equation, on the other hand, indicates very little degradation or aggradation in the dominant 10-year flow situation, but some degradation throughout the project reach in the 100-year flow.

As stated above, the Meyer-Peter-Muller Equation is expected to give more realistic results for the cobble stream bed within the project reach; therefore, aggradation north of Thunderbird Road and degradation south of Thunderbird Road may be expected. Inspection of the profile plots indicates that this is an expected result. The flatter existing bed slope between Thunderbird Road and the drop structure (compared to adjacent upstream and downstream reaches) may tend aggrade.

Based on the Scope of Work, an attempt was made to quantify the potential for aggradation/degradation without the use of detailed methodologies. Several factors listed below will influence the river behavior:

1. Man's influence in the future on the river system.

2. Clear water base flow releases from Adobe Dam.

3. Long duration of base flow releases from New River Dam.

4. Sediment free peak flows contributed by the ACDC watershed.

5. Short duration of peak flow producing thunderstorms and their influence on the river's tendency to achieve equilibrium slope.

   It is possible that the river will tend to move toward equilibrium slope, but since it consists primarily of sandy/gravelly/cobbly bed, the estimate using Zeller's equation may not be valid.

7.2 Summary of Sediment Transport Analysis (Continued)

6. It is likely that New River below downstream of the drop structure will receive flows from either the upstream New River or Skunk Creek watershed. These conditions will have a major influence on the aggradation/degradation behavior.

7. The proposed drop structure will reduce the aggradation impact for the downstream area due to controlled grade elevation created by the drop as well as added bank protection for the upstream reach.

8.0 SCOUR ANALYSES

Scour analyses were performed for several reaches of the New River channelization project. These reaches included the following:

1) ADOT drainage outfall for the Aqua Fria Expressway;

2) Proposed Drop structure;

3) Soil cement embankment protection upstream of the drop structure.

8.1 ADOT Drainage Outfall

The existing ADOT drainage outfall for the Aqua Fria Expressway constricts the New River channel. The sediment transport capacity is increased due to acceleration through the contraction. Procedures and methodologies outlined in the FHWA publication entitled Scour at Bridges, HEC-18, was utilized to estimate the contraction scour in this reach. Laursen's (case 2) equation listed on the next page was selected for the analyses.

8.1 ADOT Drainage Outfall

$$\frac{Y_2}{Y_1}=\left(\frac{Q_{mc2}}{Q_{mc1}}\right)^{\frac{6}{7}}\left(\frac{W_{c1}}{W_{c2}}\right)^{k_1}\left(\frac{n_2}{n_1}\right)^{k_2}$$

where

Y_1	=	average depth in main channel section
Y_2	=	average depth in contracted channel section
W_{c1}	=	bottom width of main channel section
W_{c2}	=	bottom width of contracted section
Q_{mc1}	=	flow in approach channel that is transporting sediment
Q_{mc2}	=	flow in contracted section
n_1	=	Manning's n for main channel section
n_2	=	Manning's n for contracted section
K_1	=	Coefficient (Mode of Bed Material Transport)
K_2	=	Coefficient (Mode of Bed Material Transport)

The depth of scour was estimated to be 1.76 feet and 2.23 feet for the 100-year and 500-year events, respectively.

The proposed channel widening will reduce the velocity and sediment transport capacity and minimize contraction scour in this reach.

8.2 Drop Structure

Scour protection for the drop structure consists of three independent elements. First, a stilling basin was designed downstream of the drop structure to contain the hydraulic jump generated by the 100-year event. Second, a cutoff wall was designed to prevent local scour from undermining the stilling basin. Third, a grouted rip-rap blanket was designed along the downstream edge of the stilling basin to minimize the formation of a scour hole adjacent to the structure. The redundant nature of this design helps ensure that the scour potential is reduced for the area adjacent to the drop structure. The following sections describe the above scour mitigation measures in more detail.

8.3 Stilling Basin Design

A stilling basin was designed downstream of the drop strucutre to help mitigate local scour during the 100-year event. Procedures and methodologies outlined in the Federal Highway Administration's publication entitled Hydraulic Design of Energy Dissipators for Culverts and Channels, (HEC-14) were utilized for design of the stilling basin. Engineering calculations are shown in Appendix IV.

A cutoff wall was designed at the downstream edge of the stilling basin to prevent scour from undermining the structure. The cutoff wall also prevents the structure from failure due to sliding and/or overturning forces. Procedures and methodologies outlined in Sediment Transport Technology, Simon & Sentruk and Computing Degradation and Local Scour, Technical Guideline for Bureau of Reclamation were utilized for design of the cutoff.

Equations outlined in Sediment Transport Technology are for local scour below a free-falling structure rather than scour below a stilling basin. These equations were included as guidelines for determination of scour depths. Computing Degradation and Local Scour references the Zimmerman and Maniak equation specifically developed for determination of local scour below a stilling basin. The 18 feet deep cutoff wall should prevent the stilling basin from failure due to scour. Engineering calculations for the cutoff wall are shown in Appendix IV.

8.4 Embankment Protection Upstream of Drop Structure

The embankment protection upstream of the drop structure will be subjected to contraction and bend scour. Long term degradation will be minimized by the drop structure located immediately downstream. Contraction scour was calculated using Laursen's equation. The contraction scour for the 100-year and 500-year events were 3.4 feet and 4.3 feet, respectively.

8.4 Embankment Protection Upstream of Drop Structure (Continued)

Bend scour was determined utilizing procedures outlined in ADWR's Engineering Analysis of Fluvial Systems. Discharges for the bend scour analyses were determined by assuming full flow in the New River and partial flow in Skunk Creek. Skunk Creek is aligned with the section downstream of the confluence, therefore, the bend scour for this reach is caused by flow in the New River. Engineering calculations for the soil cement bank protection are shown in Appendix IV.

The total scour predicted for the embankment protection above the drop structure was 9.2 feet and 13.89 feet for the 100-year and 500-year events respectively. A toedown elevation of 15 was selected for the entire eastern bank and for the western bank from station 460+00 to station 475+68.9. A toedown elevation of 10-feet was selected for remaining portion of the west bank. The reduction in the soil cement toedown is due to the fact that bend scour will not impact the western bank upstream of station 460+00.

9.0 BANK STABILITY ENHANCEMENT

Several lining alternatives were previously investigated in the feasibility study to determine the most cost-effective method of protecting the bank from erosion. Criteria used in the selection process included strength and durability of the material, cost and feasibility of construction, slope stability, aesthetics, and maintenance expenses. The alternatives explored include gabions, soil cement, loose riprap, reinforced gunite, reinforced concrete, and grouted riprap.

Soil Cement:

This material was considered for its demonstrated ability to adequately protect the surface in other projects of a similar nature, including those designed by the Corps of Engineers. The soil cement alternative calls for placement of 4" to 9" lifts of 8- to 8.5-foot wide soil cement, compacted with a vibratory smooth roller. The material would then be trimmed on the channel side to a relatively smooth surface. With its massive size and properties, this alternative is expected to be the least expensive in maintenance. Although the width could be reduced, it is anticipated that any savings, due to a reduction in material, would be offset by increased costs in construction since the standard width for soil cement placement (dictated by the width of the trucks placing the material) is 8 to 8.5 feet. Aesthetically, this alternative would draw the least attention to itself as the color and gradation would closely match the surrounding soil conditions.

Bank Toedown:

As indicated on the construction plans for the bank lining material, a toedown of 10-15 feet has been determined. See Appendix IV for toedown analysis. This toedown depth is consistent with previous design work by the Corps. Similar toedown depth has also been adopted by the District's New River Channelization project immediately downstream of Olive Avenue.

Freeboard:

The soil cement banks will be constructed to contains the 100-year flows with three (3) feet of freeboard. The SPF flow will exceed the top of soil cement bank but will be contained within the channel banks. See Appendix I for Soil Cement Bank, Freeboard Estimate calculations.

9.0 BANK STABILITY ENHANCEMENT (Continued)

The project site is located on a relatively straight segment of the New River. Proposed improvements will be constructed so that sediment continuity is maintained throughout the project. Total scour for the bank protection is determined by the following components:

1. **Long Term Aggradation/Degradation** was minimized by constructing channel improvements at the equilibrium slope and by constructing a structure which limits channel degradation. Sediment continuity was maintained through the reach.

2. **Local Scour** (abutment scour, pier scour, etc.) is expected to occur at bridge crossings. It is not included in calculation of toedown requirements in other areas.

3. **General Scour** occurs at transitions (contractions) in cross section geometry. Channelization was designed to provide uniform sections with gradual transitions to minimize contraction scour.

4. **Low Flow Channel Incisement** occurs throughout the project and must be accounted for in the bank protection design. Field investigations indicate a three foot low flow channel. The bank protection toedown is designed to account for the possible migration of the low flow channel.

5. **Sand Wave Troughs** are not expected to be a significant factor in the determination of toedown for the project. Field investigations indicate a large portion of the bed is comprised of cobbles. Cobble beds tend to inhibit the formation of bed forms.

A toedown of 10-15 feet was determined to be appropriate for the proposed design. This toedown matches the design parameters used on adjacent sections, and was determined to be conservative for the subject reach.

10.0 ESTIMATED QUANTITIES

Quantities have been estimated for flood control improvements including channelization, earthwork, bank protection, and a drop structure.

The earthwork estimate for channel improvements is based upon an end area method and by the use of HEC-2 analysis. It is assumed that excavated material will be disposed of along the channel overbank areas or within a two mile radius.

Estimates for the bank protection material have been based upon similar projects and similar lining material within the Phoenix metropolitan area.

A summary of estimated quantities is presented in Table 1.

28-Feb-94

TABLE 1
CHANNEL IMPROVEMENT QUANTITIES
NEW RIVER IMPROVEMENTS GRAND AVENUE TO GREENWAY ROAD

100-YEAR DESIGN AND SPF CONTAINMENT

Phase I : Thunderbird Road To Greenway Road
Phase II : Grand Avenue to Thunderbird Road

ITEM	DESCRIPTION	PHASE I QUANTITY	PHASE II QUANTITY	TOTAL QUANTITY
1	DROP STRUCTURE	1 EA	0 EA	1 EA
	-Excavation and compacted placement of fill in site "B"	54,000 CY	0 CY	54,000 CY
2	EXCAVATION	20,197 CY	245,685 CY	265,882 CY
	-Excavation to be used as compacted fill onsite	20,197 CY	93,271 CY	113,468 CY
	-Excavation to be stockpiled/sold by contractor	0 CY	152,414 CY	152,414 CY
3	BANK PROTECTION U/S OF DROP			
	- West Bank, soil cement	14,850 CY	0 CY	14,850 CY
	- East Bank, soil cement	6,600 CY	0 CY	6,600 CY
4	ADOT OUTFALL STRUCTURE			
	- Remove & Replace Structure	0 EA	1 EA	1 EA
5	PLAZA DEL RIO CHANNEL			
	-Gunite Outlet Protection	0 SF	8,200 SF	8,200 SF
6	MAINTENANCE ROAD, A.B.C.	10,528 SY	0 SY	10,528 SY
7	ADJUST MANHOLE RIM TO GRADE	0 EA	2 EA	2 EA
8	FENCE	220 LF	0 LF	220 LF
	Thunderbird Road Access			
9	FENCE GATE	4 EA	0 EA	4 EA
	-91st Ave Channel, Thunderbird Road			
10	SAFETY RAIL	3,390 LF	0 LF	3,390 LF
	-On soil Cement and Drop Structure			
11	LOOSE RIP RAP (Types I & II)	3,564 CY	0 CY	3,564 CY
12	GROUTED RIP RAP	143 CY	218 CY	361 CY

q:\newriver\quantot.wq2

11.0 CONCLUSIONS

In general, the design elements such as drop structure and bank protection proposed on this project create a positive impact within the project reach. The drop structure will stabilize the channel bed elevation and thereby reduce head cutting and excessive degradation within the subject reaches of New River and Skunk Creek.

The channel widening proposed north of Grand Avenue will lower the SPF elevation, thereby creating a positive impact. Due to reduced flooding depth and enlarged channel sections, the velocities will be reduced as well.

No channel modifications are recommended for the reach immediately north of Thunderbird Road to the proposed drop structure. Therefore, the proposed design will have no adverse influence on the existing condition of the channel.

The drop structure will also help in containing the hydraulic jump for the majority of flood events, thereby reducing erosive wave action within a shorter channel reach.

Based on this study, the following conclusions are made:

1. With recent partial channelization of New River within the study reach, the SPF is significantly contained within the channel banks. However, the SPF breaks out into the overbank areas immediately north of Grand Avenue to Station 402+50, as depicted on Plate 2, Appendix VI.

2. To contain the SPF within the channel banks and generally within the District's flowage easement, channelization of New River is necessary. The design plans depict the improvement area. Hydraulic analysis was performed using the CHIMP routine of HEC-2 as listed below:

Channel Reach	East Bank Sideslope	Bottom Width by Widening of Channel East of Channel Centerline
Station 360+00 to 395+50	3:1	200 feet

11.0 CONCLUSIONS (Continued)

Station 395+50 to 402+50	3:1 to 7:1	Taper from widened channel to match existing.

With channel widening, the SPF water surface elevation is lowered and by placing fill on portions of the west bank SPF flows can be prevented from breaking out of the channel. Therefore, the District can avoid the costs associated with acquiring a flowage easement.

3. A 11-foot high roller compacted concrete stepped drop structure will be constructed downstream of the New River and Skunk Creek confluence. This structure will be designed for 100-year flows. This structure will be protected from possible washout from the SPF by providing additional toedown depth and increased height of sidewall.

4. Soil cement bank protection will be provided upstream from the new drop structure along the east bank of Skunk Creek to the Agua Fria Expressway and along the west bank of New River from the drop structure to the 91st Avenue channel (Greenway Road extension). The soil cement banks will be constructed to contains the 100-year flows with three (3) feet of freeboard. The SPF flow will exceed the top of soil cement bank but will be contained within the channel banks.

5. Channel widening between Grand Avenue and Station 402+50 will necessitate the removal and reconstruction of an existing ADOT outlet drop structure at Station 376+93.

REPORT\91755SML.204

12.0 REFERENCES

12.1 Bibliography

Flood Control District of Maricopa County, *"New River, Skunk Creek, and Agua Fria River Flood Control Master Plan"*, Draft, May, 1983.

U.S. Army Corps of Engineers, Office of the Chief of Engineers, *"Hydraulic Design of Flood Control Channels"*, July, 1970.

U.S. Army Corps of Engineers, Hydrology Engineering Center, *"HEC-2 Water Surface Profiles"*, Users Manual, September, 1982.

U.S. Army Corps of Engineers, Los Angeles District, *Design Memorandum No. 2, Gila River Basin*.

U.S. Army Corps of Engineers, Los Angeles District, *"New River and Phoenix City Streams, Arizona, Design Memorandum No. 2, Hydrology Part 1"*, October, 1974.

U.S. Army Corps of Engineers, Los Angeles District, *"New River and Phoenix City Streams, Arizona, Design Memorandum No. 3, Skunk Creek and the New and Agua Fria Rivers"*, Draft, July, 1985.

U.S. Army Corps of Engineers, Los Angeles District, *"Design Memorandum No. 3, Skunk Creek and the New and Agua Fria Rivers"*, Final, May, 1986.

Soil Conservation Service, *"Design of Open Channels, TR-25"*, October, 1977.

Federal Highway Administration, *"Hydraulic Design of Energy Dissipators for Culverts and Channels, HEC-14"*, September, 1983.

Chamani, M. R and N. Rajaratnam, *"Jet Flow on Stepped Spillways,"* Draft Report, University of Alberta, Edmonton, 1993.

Federal Highway Administration, *"HEC-14, Hydraulic Design of Energy Dissipators for Culverts and Channels,"* September 1983.

Rajaratnam, N., *"Skimming Flow in Stepped Spillways,"* Journal of Hydraulic Engineering, Vol. 116, No. 4, April 1990.

Construction Industry Research and Information Association, *"The Hydraulic Design of Stepped Spillways, Report 33"*, June, 1971.

12.1 Bibliography (Continued)

Burgess & Niple, *"Modification of "Killer" Dams for Safer Recreational Floodplain Use"*.

Simons, Li & Associates, *"Hydraulic Model Study of Local Scour Downstream of Rigid Grade Control Structures"* , March 20, 1986.

Bureau of Reclamation, *"Computing Degradation and Local Scour"*, January, 1984.

Engineering Societies Monographics, *"Hydraulic Energy Dissipators"*, 1959.

Simons & Sentruk, *"Sediment Transport Technology"*, 1977.

Bureau of Reclamation, *"Design of Small Dams"*, 1987.

See Section 3.0 DATA COLLECTION for reports and plans collected with this study.

APPENDIX I

HEC-2 ANALYSIS

- 10-Year Frequency Storm
  100-Year Frequency Storm
  Standard Project Flood

- Soil Cement Bank, Freeboard Estimate

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*******************************************
*  HEC-2 WATER SURFACE PROFILES           *
*                                         *
*  Version   4.6.2;  May 1991             *
*                                         *
*  RUN DATE    21FEB94    TIME   09:00:53 *
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*  U.S. ARMY CORPS OF ENGINEERS        *
*  HYDROLOGIC ENGINEERING CENTER       *
*  609 SECOND STREET, SUITE D          *
*  DAVIS, CALIFORNIA 95616-4687        *
*          (916) 756-1104              *
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X     X  XXXXXXX   XXXXX              XXXXX
X     X  X        X     X            X     X
X     X  X        X                        X
XXXXXXX  XXXX     X          XXXXX    XXXXX
X     X  X        X                  X
X     X  X        X     X            X
X     X  XXXXXXX   XXXXX              XXXXXXX
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THIS RUN EXECUTED 21FEB94 09:00:53

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************************************
HEC-2 WATER SURFACE PROFILES

Version   4.6.2;  May 1991
************************************

T1      91755.02
T2      NEW RIVER - GRAND AVENUE TO SKUNK CREEK        FILE: NRSFINAL.DAT
T3      10-YEAR, 100-YEAR, AND SPF FLOWS - PARTIAL CHANNELIZATION
T4      9/8/93 REVISE CHANNEL BASED ON NEW TOPO AND MCFCD MEETING OF 9/7/93
T4      IMPROVED CHANNEL ON THE EAST SIDE ONLY FROM CORP IMPROVEMENTS
T4      TO SECTION 402. EAST BANK TOE OF SLOPE BEGINS 200' EAST OF CHANNEL
T4      CENTERLINE.
T4      8/31/93 ADDED CHIMP SEC 449.1 TO REMOVE HIGH GROUND S. OF DROP
T4      11/2/93 REMOVE CHIMP SEC 358 (THIS SECTION IS WITHIN CORP IMPS. MATCH
T4              EXISTING CHANNEL GEOMETRY AT THIS SECTION.BEGIN CHIMP @ SEC 365)
T4      11/5/93 REVISE CHANNEL BOTTOM WIDTH AT DROP STRUCTURE FROM 275' TO 250'
T4              (REVISE SECTIONS 449.1, 451.0 AND 451.1 ALL HYDRAULICS AND COST
T4               ESTIMATES ARE BASED ON 250' WIDTH)
T4      11/10/93 ADD SEC 452.1 UPSTREAM OF DROP. BOTTOM EL 2.5' BELOW CREST .ADD
T4               CROSS SEC 454.7 BETWEEN 452.1 AND 457.0.
T4      11/22/93 BRIDGE, DROP STRUCTURE AND CROSS SECTIONS REVISED BY JJH SECT
T4               SECTIONS ADDED TO MODEL ADOT OUTLET
T4      12/01/93 REVISED MODEL WITH 10-YEAR, 100-YEAR, AND SPF FLOWS
T       02/01/94 EXTEND CROSS SECTIONS 452.73, 453.23, & 455.63 AND REVISE CROSS
1                SEC. IDENTIFICATION NO. TO MATCH CHANNEL IMP. PLAN STATIONING
T4               WITHIN PROJECT REACH.

J1  ICHECK    INQ      NINV     IDIR     STRT     METRIC   HVINS    Q        WSEL     FQ

      0        2        0        0     0.0042      0       0.0     10500   1117.36

J2  NPROF     IPLOT    PRFVS    XSECV    XSECH    FN       ALLDC    IBW      CHNIM    ITRACE

      1        0       -1        0        0       0       -1       -6.0      0.0

J3  VARIABLE CODES FOR SUMMARY PRINTOUT

    150                38       39        8       10        1        4       67       25

J5  LPRNT    NUMSEC                 ********REQUESTED SECTION NUMBERS********

    -10      -10

NC    0.045     0.045     0.035      0.1       0.3
        NEW RIVER CHANNELIZATION BY CORPS & ADOT ARE REFLECTED NEAR
        GRAND AVENUE AND AGUA FRIA FREEWAY ON THE NEW TOPOGRAPHIC MAPS BY THE
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        DISTRICT.  THE MAPS WERE PREPARED BY KAMINSKI-HUBBARD/KENNEY AERIAL
        MAPPING COMPANY DATED APRIL 1991.
        STATIONING IS IN 100 FT STATIONS FROM THE CONFLUENCE WITH AGUA FRIA
        RIVER.  (EXAMPLE 337.0 = 33,700 FT)
X1    337.0       25     9806.7   10176.4      0.0      0.0      0.0      1.0      0.0
GR   1131.7   9493.4     1129.2    9508.8   1127.7   9524.0   1127.6   9594.4   1128.5   9624.7
GR   1128.5   9649.0     1129.3    9668.1   1130.6   9726.6   1130.8   9806.7   1113.2   9824.8
GR   1113.3   9900.7     1112.8   10000.0   1113.0  10091.3   1112.4  10152.3   1130.2  10176.4
GR   1130.5  10194.8     1131.6   10211.8   1131.3  10245.7   1127.4  10275.7   1127.2  10300.3
GR   1128.7  10319.6     1129.8   10337.2   1129.0  10357.5   1126.8  10377.8   1127.8  10409.0

NC    0.045   0.045      0.030       0.1       0.3
QT        3   10500      41000     68000
X1    342.0      25     9854.2   10234.6     500.0    520.0    510.0      1.0      0.0
X3       10     0.0        0.0       0.0       0.0      0.0      0.0      0.0      0.0
GR   1133.7   9502.7     1130.3    9525.2   1128.9   9546.7   1128.8   9568.7   1129.7   9616.7
GR   1130.2   9646.0     1129.2    9698.2   1130.8   9751.0   1132.0   9854.2   1114.8   9873.1
GR   1115.4  10000.0     1115.3   10034.1   1116.4  10047.3   1115.3  10084.9   1115.9  10125.9
GR   1114.8  10201.5     1119.2   10207.3   1118.9  10219.8   1131.8  10234.6   1131.7  10275.5
GR   1130.2  10279.7     1130.2   10307.0   1133.4  10319.0   1130.3  10359.9   1130.0  10424.3

X1    343.7      22     9838.5   10202.7     140.0    220.0    180.0      1.0      0.0
X3       10     0.0        0.0       0.0       0.0      0.0      0.0      0.0      0.0
GR   1134.3   9495.7     1133.1    9514.6   1131.3   9538.0   1129.0   9555.2   1128.5   9567.5
GR   1130.0   9591.3     1130.9    9720.4   1132.4   9780.5   1132.8   9838.5   1116.6   9857.6
GR   1115.8   9939.8     1116.2    9952.9   1116.0  10000.0   1116.3  10049.5   1116.7  10118.0
GR   1116.1  10183.8     1133.1   10202.7   1132.8  10230.1   1131.9  10232.7   1131.8  10279.3
GR   1132.3  10346.7     1135.9   10355.6

X.    345.5       6       9824   10186.1     180.0    200.0    190.0        0        0
X3       10                                                            1141.9   1141.9
GR   1141.9    9824     1134.3    9824.1   1117.0    9840   1117.0    10170   1134.3    10186
GR   1141.9  10186.1

SB      1.1    1.56        2.9       0.0      330.     36.5   5279.0      1.0
  GRAND AVENUE BRIDGE
        GRAND AVENUE BRIDGE
X1    346.4       6       9824   10186.1      100.     100.     100.        0        0
X2      0.0     0.0          1    1134.3    1141.9      0.0        0      0.0      0.0
X3       10     0.0        0.0       0.0       0.0      0.0      0.0   1141.9   1141.9
BT       -2    9824     1141.9    1134.3   10186.1   1141.9   1134.3
GR   1141.9    9824     1134.3    9824.1   1117.4    9840   1117.4    10170   1134.3    10186
GR   1141.9  10186.1

X1    346.8      34     9827.0   10187.3      25.0     25.0     25.0      1.0      0.0
X3        0     0.0        0.0    9827.0       0.0  10187.3      0.0      0.0      0.0
GR   1136.7   9443.5     1136.7    9494.7   1137.1   9553.7   1136.8   9633.5   1136.6   9682.2
GR   1136.6   9722.1     1138.2    9744.6   1136.4   9753.1   1135.1   9805.3   1134.3   9816.7
GR   1134.2   9827.0     1118.1    9854.6   1118.2   9898.0   1118.3  10000.0   1118.1  10016.8
GR   1118.1  10082.6     1118.5   10160.8   1131.8  10187.3   1131.9  10214.8   1132.7  10231.4
GR   1131.3  10291.7     1131.7   10337.0   1132.3  10400.5   1132.0  10478.8   1131.8  10535.8
GR   1132.2  10611.2     1132.7   10686.6   1133.4  10745.5   1133.9  10801.8   1134.7  10859.6
GR   1135.4  10938.7     1136.6   10976.5   1137.1  11037.9   1136.6  11169.3
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X1	347.1	22	9823	10187.1	30	30	30			
X3	10							1141	1140.1	
GR	1141.	9823.	1136.	9823.1	1118.3	9840.	1118.3	9882.	1118.3	9882.1
GR	1118.3	9889.	1118.3	9889.1	1118.3	9937.	1118.3	9940.	1118.3	9947.
GR	1118.3	9950.	1118.3	10057.	1118.3	10058.	1118.3	10069.	1118.3	10070.
GR	1118.3	10117.	1118.3	10120.	1118.3	10129.	1118.3	10130.	1118.3	10170.
GR	1135.	10187.	1141.	10187.1						
X1	347.11	22	9823.	10187.1	1	1	1	0	0	
BT	-12	9823	1141	1141	9823.1	1141	1136	9892.4	1140.8	1135.6
BT		9899.2	1140.8	1135.6	9965.2	1140.6	1135.4	9972.0	1140.6	1135.4
BT		10038.0	1140.4	1135.2	10044.8	1140.4	1135.2	10110.8	1140.2	1135.0
BT		10117.6	1140.2	1135.0	10187	1140.1	1134.9	10187.1	1140.1	1134.9
GR	1141	9823.	1136.	9823.1	1118.3	9840.	1118.3	9892.3	1135.6	9892.4
GR	1135.6	9899.2	1118.3	9899.3	1118.3	9965.1	1135.4	9965.2	1135.4	9972.0
GR	1118.3	9972.1	1118.3	10037.9	1135.2	10038.0	1135.2	10044.8	1118.3	10044.9
GR	1118.3	10110.7	1135.0	10110.8	1135.0	10117.6	1118.3	10117.7	1118.3	10170.
GR	1134.9	10187	1140.1	10187.1						
X1	347.4	22	9823	10187.1	30.0	30.0	30.0	1.0	0.0	
X2	0	0	0	0	0					
X3	0	0.0	0.0	9823	0.0	10187.1	0.0	0.0	0.0	
BT	-12	9823	1141	1141	9823.1	1141	1136	9892.4	1140.8	1135.6
BT		9899.2	1140.8	1135.6	9965.2	1140.6	1135.4	9972.0	1140.6	1135.4
BT		10038.0	1140.4	1135.2	10044.8	1140.4	1135.2	10110.8	1140.2	1135.0
BT		10117.6	1140.2	1135.0	10187	1140.1	1134.9	10187.1	1140.1	1134.9
GR	1141	9823.	1136.	9823.1	1118.5	9840.	1118.5	9892.3	1135.6	9892.4
GR	1135.6	9899.2	1118.5	9899.3	1118.5	9965.1	1135.4	9965.2	1135.4	9972.0
GR	1118.5	9972.1	1118.5	10037.9	1135.2	10038.0	1135.2	10044.8	1118.5	10044.9
GR	1118.5	10110.7	1135.0	10110.8	1135.0	10117.6	1118.5	10117.7	1118.5	10170.
GR	1134.9	10187	1140.1	10187.1						
X1	347.41	22	9823	10187.1	1	1	1	0	0	
X3	0	0.0	0.0	9823	0.0	10187.1	0.0	0.0	0.0	
GR	1141	9823.	1136.	9823.1	1118.5	9840.	1118.5	9882.	1118.5	9882.1
GR	1118.5	9889.	1118.5	9889.1	1118.5	9937.	1118.5	9940.	1118.5	9947.
GR	1118.5	9950.	1118.5	10057.	1118.5	10058.	1118.5	10069.	1118.5	10070.
GR	1118.5	10117.	1118.5	10120.	1118.5	10129.	1118.5	10130.	1118.5	10170.
GR	1134.9	10187	1140.1	10187.1						

FROM SEC 352.4 SECTION ID NO. CORRESPONDS TO IMP PLANS CENTERLINE STATIONING

X1	352.4	53	9824.6	10232.3	430.0	520.0	460.0	1.0	0.0	
X3	0	0.0	0.0	9404.3	0.0	10652.7	0.0	0.0	0.0	
GR	1122.6	9327.5	1123.6	9336.7	1133.2	9380.8	1137.6	9404.3	1134.2	9429.7
GR	1133.4	9448.6	1132.6	9457.6	1132.5	9491.6	1132.8	9530.2	1133.3	9568.2
GR	1133.8	9603.6	1133.1	9616.7	1133.4	9665.7	1133.6	9681.2	1132.0	9694.4
GR	1132.0	9752.4	1131.8	9784.7	1132.5	9792.7	1132.8	9812.6	1133.4	9824.6
GR	1121.2	9836.2	1121.2	9858.9	1121.2	9922.0	1122.4	9951.9	1122.5	10000.0
GR	1123.1	10046.5	1122.1	10082.6	1121.3	10116.1	1120.6	10137.4	1121.0	10148.9
GR	1120.1	10165.4	1121.9	10170.9	1121.9	10178.2	1126.7	10186.9	1126.7	10197.8
GR	1132.3	10205.8	1132.6	10220.1	1134.5	10232.3	1135.7	10263.1	1136.7	10318.0
GR	1137.5	10361.1	1138.0	10404.6	1138.4	10472.8	1139.8	10538.6	1140.2	10589.3
GR	1140.7	10652.7	1137.2	10683.8	1131.8	10702.6	1128.0	10725.6	1128.4	10733.0

G	1140.6	10752.3	1140.0	10760.5	1140.1	10899.4				
X1	358.25	57	9828.2	10175.7	610.0	600.0	600.0	1.0	0.0	
X3	0	0.0	0.0	9400.7	0.0	10175.7	0.0	0.0	0.0	
GR	1137.3	9364.0	1137.6	9365.5	1137.5	9378.0	1138.8	9400.7	1135.0	9430.2
GR	1133.8	9446.8	1134.7	9471.1	1135.5	9507.4	1134.6	9530.6	1135.0	9577.3
GR	1134.6	9640.8	1134.0	9708.2	1133.6	9753.1	1134.0	9784.8	1133.8	9828.2
GR	1124.9	9836.8	1124.7	9859.5	1123.9	9875.7	1123.9	9938.8	1124.5	10000.0
GR	1125.4	10032.0	1125.1	10083.7	1126.0	10119.6	1125.3	10165.4	1133.6	10175.7
GR	1133.6	10204.5	1133.1	10269.3	1133.8	10297.5	1133.4	10335.9	1133.9	10357.1
GR	1133.5	10378.0	1133.8	10415.2	1133.4	10447.5	1133.8	10484.1	1136.1	10504.6
GR	1133.8	10532.0	1136.1	10554.4	1137.1	10593.2	1134.9	10609.0	1137.4	10623.2
GR	1137.2	10721.0	1138.4	10733.7	1138.6	10798.9	1139.5	10828.0	1140.4	10955.0
GR	1140.2	11000.6	1141.1	11035.1	1142.8	11121.7	1140.5	11148.0	1140.6	11223.2
GR	1143.7	11240.1	1141.8	11269.0	1142.6	11355.3	1130.4	11385.4	1130.7	11400.7
GR	1140.1	11422.7	1140.8	11500.1						
X1	365.4	69	9817.7	10112.7	690.0	700.0	700.0	1.0	0.0	
CI	9900	-1	0	3	.1	200				
X3	0	0.0	0.0	9418.2	0.0	10358.7	0.0	0.0	0.0	
GR	1147.1	9418.2	1147.0	9427.9	1138.3	9467.1	1134.3	9503.9	1137.8	9521.1
GR	1135.9	9541.5	1135.8	9637.5	1135.3	9728.8	1134.7	9750.7	1135.1	9760.0
GR	1134.9	9796.6	1134.2	9817.7	1130	9831.7	1130	9863.2	1130	9878.9
GR	1130	9892.6	1130	9905.0	1130	9917.0	1129.7	9925.5	1128.7	9937.5
GR	1126.2	9956.6	1124.9	9961.6	1124.9	10000.0	1124.9	10031.3	1124.9	10045.1
GR	1127.1	10057.0	1126.0	10062.0	1127.0	10084.7	1135.1	10112.7	1131.8	10130.5
GR	1134.2	10189.4	1134.0	10209.8	1136	10220	1136	10290	1135.1	10349.9
GR	1136.6	10358.7	1137.2	10420.6	1137.6	10469.6	1138.6	10520.1	1138.4	10610.8
G	1137.8	10670.9	1138.4	10676.2	1138.3	10700.0	1137.9	10702.2	1138.0	10734.1
G	1139.1	10742.3	1137.9	10751.4	1137.9	10782.4	1138.3	10785.8	1138.6	10809.7
GR	1137.0	10822.5	1137.5	10940.0	1137.6	11099.3	1138.1	11232.6	1138.4	11301.0
GR	1139.4	11330.9	1138.8	11358.4	1140.0	11391.3	1140.8	11405.3	1140.9	11437.6
GR	1140.3	11439.3	1140.3	11480.7	1141.0	11491.5	1140.3	11501.0	1140.8	11539.3
GR	1141.2	11543.4	1141.6	11574.5	1140.9	11584.9	1141.6	11642.5		
X1	370.65	84	9814.5	10225.7	550.0	530.0	535.0	1.0	0.0	
X3	0	0.0	0.0	9735.8	0.0	10225.7	0.0	0.0	0.0	
GR	1148.6	9424.4	1145.5	9444.9	1138.1	9479.9	1138.1	9503.5	1138.1	9532.0
GR	1138.1	9553.5	1138.1	9566.6	1138.1	9588.6	1140.6	9617.5	1137.9	9647.0
GR	1138.4	9668.2	1137.4	9735.8	1138.1	9754.8	1137.9	9779.3	1137.2	9792.4
GR	1138.0	9814.5	1138	9837	1134	9860	1132	9885	1130.9	9895.5
GR	1130.6	9934.5	1128.1	9970.0	1125.5	9980.0	1125.5	10000.0	1125.5	10011.2
GR	1127.2	10024.1	1127.9	10035.4	1127.8	10059.5	1128.4	10074.6	1127.9	10111.7
GR	1128.9	10125.0	1133.6	10150.9	1135.2	10173.3	1135.4	10210.0	1137.8	10225.7
GR	1138.1	10270.1	1137.6	10295.0	1137.4	10313.1	1136.9	10318.0	1137.6	10331.1
GR	1137.5	10352.5	1134.9	10392.1	1134.2	10397.7	1137.0	10427.2	1137.5	10453.1
GR	1135.8	10469.3	1137.4	10508.1	1139.2	10536.3	1138.4	10540.2	1138.7	10567.9
GR	1138.8	10597.3	1140.7	10611.3	1140.6	10688.3	1141.2	10711.2	1141.4	10766.8
GR	1141.0	10809.5	1141.2	10841.3	1140.9	10890.6	1140.1	10954.1	1140.5	10959.1
GR	1140.5	10981.2	1140.1	10983.0	1140.3	11013.7	1141.3	11024.6	1140.3	11030.5
GR	1140.4	11061.2	1140.8	11064.9	1141.2	11086.5	1140.2	11092.1	1140.2	11178.5
GR	1140.9	11195.8	1140.3	11317.2	1140.4	11363.6	1142.1	11399.0	1142.7	11444.0
GR	1143.5	11460.3	1143.9	11504.8	1144.3	11537.6	1144.3	11636.3	1144.7	11643.8
GR	1144.8	11656.6	1144.2	11658.3	1145.2	11739.8	1144.4	11802.3		

X1	373.75	66	9834.2	10155.4	320.0	330.0	320.0	1.0	0.0	
X3	0	0	0	0	0	10269.1				
GR	1148.7	9399.5	1144.9	9420.7	1140.7	9452.2	1140.7	9470.0	1140.7	9497.4
GR	1140.7	9509.1	1139.7	9613.1	1139.0	9681.4	1138.3	9748.3	1138.3	9777.7
GR	1138.0	9811.6	1139.0	9834.2	1134.6	9854.2	1133.0	9882.9	1131.6	9890.4
GR	1131.8	9920.2	1129.6	9950.3	1126.5	9973.2	1125.9	10000.0	1125.9	10007.9
GR	1128.0	10026.2	1129.3	10062.1	1130.8	10110.8	1137.7	10135.2	1139.2	10155.4
GR	1139.2	10195.5	1139.5	10269.1	1138.7	10336.0	1138.9	10391.5	1138.8	10466.4
GR	1137.8	10505.0	1134.9	10529.8	1134.6	10562.7	1139.3	10603.2	1140.3	10628.7
GR	1140.5	10652.2	1142.4	10660.7	1142.2	10724.7	1142.4	10793.0	1142.6	10862.0
GR	1142.3	10933.0	1142.5	10991.4	1141.9	11039.2	1141.3	11041.2	1141.8	11065.1
GR	1142.7	11072.2	1141.5	11076.9	1141.2	11101.3	1141.7	11108.1	1141.9	11121.2
GR	1141.1	11122.5	1141.1	11131.7	1143.5	11152.5	1143.3	11205.5	1143.0	11218.6
GR	1143.8	11231.4	1144.8	11329.9	1145.3	11348.0	1146.2	11386.5	1145.8	11425.7
GR	1145.5	11471.1	1143.8	11477.4	1143.8	11484.2	1141.9	11500.8	1142.2	11545.1
GR	1144.4	11564.5								
X1	376.75	16	9850	10155	300	300	300			
X3	0	0	0	9505						
GR	1144	9380	1140	9400	1138	9430	1138	9470	1140	9505
GR	1140	9850	1130	9940	1127	9970	1127	10030	1130	10050
GR	1132	10070	1134	10090	1136	10110	1138	10130	1140	10155
GR	1142	10175								
X1	379.75	18	9850	10140	300	300	300			
GR	1146	9300	1142	9340	1140	9350	1140	9440	1142	9590
GR	1142	9780	1140	9850	1130	9960	1128.1	10015	1128.1	10040
GR	1130	10065	1132	10080	1134	10090	1136	10100	1138	10120
GR	1140	10140	1142	10155	1144	10200				
X1	384.50	65	9822.6	10236.5	470.0	470.0	470.0	1.0	0.0	
X3	0	0.0	0.0	9700.0	0.0	10210.0	0.0	0.0	0.0	
GR	1149.8	9169.7	1141.4	9211.0	1140.9	9236.1	1139.6	9250.3	1142.0	9288.4
GR	1144.1	9319.4	1144.5	9365.6	1143.8	9446.0	1143.4	9496.6	1143.9	9511.4
GR	1144.0	9571.7	1143.9	9607.8	1144.6	9626.6	1144.4	9682.8	1144.7	9744.7
GR	1144.4	9807.4	1147.4	9822.6	1144.3	9834.5	1141.8	9859.8	1137.6	9891.4
GR	1132.0	9912.0	1129.4	9925.8	1130.7	9943.0	1128.9	9978.0	1128.9	10000.0
GR	1128.9	10049.2	1129.8	10074.5	1130.4	10085.5	1130.7	10104.5	1135.3	10132.5
GR	1144.9	10175.6	1145.7	10191.7	1147.0	10205.1	1147.7	10236.5	1147.7	10272.7
GR	1147.2	10300.9	1146.0	10340.8	1146.5	10357.2	1146.7	10408.5	1145.7	10440.8
GR	1145.3	10472.9	1144.3	10538.9	1144.6	10580.9	1145.0	10587.3	1145.6	10604.4
GR	1144.9	10606.0	1145.4	10630.6	1146.1	10637.7	1145.1	10643.2	1145.1	10667.0
GR	1145.5	10670.1	1145.4	10686.9	1144.1	10707.0	1144.8	10740.0	1145.4	10789.8
GR	1146.0	10935.7	1146.6	11011.0	1147.5	11160.5	1147.6	11289.9	1148.3	11361.6
GR	1148.4	11453.1	1147.9	11504.0	1148.4	11531.7	1148.5	11560.4	1155.9	11583.3
X1	388.50	81	9799.5	10277.2	420.0	400.0	410.0	1.0	0.0	
X3	0	0.0	0.0	9700.0	0.0	10210.0	0.0	0.0	0.0	
GR	1151.8	9031.9	1145.5	9067.7	1145.6	9119.1	1144.5	9122.2	1146.5	9127.9
GR	1145.0	9132.5	1144.8	9172.2	1144.7	9235.8	1142.0	9281.2	1146.1	9312.1
GR	1146.8	9330.0	1146.5	9348.6	1145.9	9395.0	1146.1	9465.1	1145.8	9524.3
GR	1146.5	9549.9	1146.2	9574.3	1145.6	9616.8	1145.7	9663.4	1142.4	9675.0
GR	1140.5	9691.7	1150.1	9715.5	1148.4	9720.4	1148.2	9768.8	1148.0	9793.5

GR	1150.5	9799.5	1146.4	9807.2	1143.6	9833.3	1137.1	9880.8	1129.5	9918.8
GR	1129.5	9940.4	1132.6	9948.0	1130.2	9956.3	1131.2	9978.1	1131.4	10000.0
GR	1131.0	10061.6	1130.3	10065.8	1130.3	10096.2	1131.6	10106.4	1132.1	10114.5
GR	1141.6	10146.5	1147.1	10172.2	1147.6	10197.5	1151.4	10206.2	1152.2	10277.2
GR	1152.2	10277.3	1151.4	10309.3	1149.4	10346.9	1148.1	10392.6	1147.6	10440.5
GR	1146.7	10492.2	1145.3	10589.6	1144.1	10600.9	1145.7	10617.9	1146.7	10650.5
GR	1143.8	10661.2	1146.0	10674.5	1146.0	10695.2	1145.3	10696.6	1145.9	10728.0
GR	1146.8	10736.2	1146.1	10744.6	1146.1	10774.6	1146.6	10785.0	1146.6	10800.0
GR	1146.0	10804.0	1146.7	10869.0	1146.3	10900.6	1146.7	10928.1	1143.1	10950.2
GR	1143.2	10960.0	1145.0	10970.3	1146.7	10998.8	1146.9	11027.1	1147.8	11075.5
GR	1147.0	11120.4	1146.4	11189.1	1145.8	11255.2	1148.7	11270.1	1149.4	11315.1
GR	1149.3	11360.6								
X1	392.00	80	9772.5	10182.7	350.0	350.0	350.0	1.0	0.0	
X3	0	0.0	0.0	9700.0	0.0	10210.0	0.0	0.0	0.0	
GR	1152.5	8934.9	1147.0	8966.0	1146.9	9019.2	1146.4	9037.0	1146.5	9209.6
GR	1148.0	9214.3	1146.4	9217.5	1148.7	9222.4	1146.7	9227.3	1146.5	9273.3
GR	1146.6	9330.0	1146.9	9357.3	1144.0	9367.0	1144.2	9387.7	1143.6	9421.9
GR	1147.6	9441.8	1147.8	9467.9	1147.4	9511.4	1146.6	9531.6	1147.7	9543.9
GR	1150.2	9550.0	1149.9	9606.2	1149.4	9669.5	1149.2	9733.6	1149.1	9763.3
GR	1152.9	9772.5	1147.5	9783.3	1144.2	9818.9	1137.9	9874.3	1131.7	9916.6
GR	1130.1	9959.7	1130.6	9980.0	1131.2	10000.0	1131.7	10018.5	1131.1	10045.2
GR	1131.6	10054.3	1131.0	10089.5	1132.3	10101.0	1139.2	10128.5	1147.2	10158.6
GR	1147.9	10182.7	1145.7	10207.7	1146.7	10231.7	1147.6	10325.1	1147.9	10341.7
GR	1148.6	10393.4	1147.8	10564.7	1147.7	10660.2	1147.5	10683.9	1148.9	10742.6
GR	1148.7	10797.9	1148.9	10824.0	1146.5	10832.2	1146.6	10867.9	1148.1	10877.4
GR	1147.8	10900.2	1147.3	10902.3	1147.9	10935.8	1148.7	10946.1	1147.9	10951.9
GR	1147.9	10984.5	1148.4	10992.5	1149.1	11019.5	1148.5	11060.2	1148.5	11074.2
GR	1148.9	11113.4	1148.1	11150.6	1148.6	11191.2	1148.0	11229.4	1148.8	11270.8
GR	1149.2	11282.7	1149.4	11297.2	1149.1	11315.7	1149.3	11319.3	1149.5	11351.8
GR	1148.9	11353.2	1148.8	11373.7	1149.3	11398.9	1149.7	11400.2	1149.8	11434.7
X1	395.50	67	9799.6	10178.3	340.0	360.0	350.0	1.0	0.0	
X3	0	0.0	0.0	9700.0	0.0	10180.0	0.0	0.0	0.0	
GR	1153.7	8887.7	1148.3	8920.2	1147.9	9074.9	1148.0	9181.0	1147.8	9289.8
GR	1147.9	9308.8	1149.8	9311.2	1147.5	9313.9	1150.3	9321.2	1149.2	9366.5
GR	1149.6	9429.8	1148.7	9475.3	1145.9	9483.1	1146.1	9533.4	1150.6	9552.5
GR	1151.1	9581.0	1151.0	9638.7	1151.1	9708.1	1150.4	9735.8	1150.3	9772.7
GR	1148.7	9799.6	1145.8	9827.3	1144.6	9848.7	1134.4	9910.7	1132.8	9953.3
GR	1131.3	9964.9	1131.5	10000.0	1131.7	10006.5	1132.5	10022.5	1132.0	10080.0
GR	1133.3	10085.7	1132.8	10090.5	1136.3	10111.1	1137.1	10126.6	1148.4	10178.3
GR	1148.7	10195.0	1135.5	10212.1	1136.1	10230.2	1149.4	10247.7	1149.6	10288.2
GR	1149.1	10326.7	1148.0	10350.4	1149.5	10403.2	1148.2	10608.4	1151.1	10630.0
GR	1150.0	10643.2	1149.7	10658.2	1148.5	10670.1	1150.6	10718.1	1150.8	10727.8
GR	1149.7	10742.8	1148.8	10808.3	1149.4	10868.2	1149.9	10943.3	1149.7	10999.3
GR	1149.3	11088.9	1149.8	11115.0	1149.3	11136.0	1148.8	11138.0	1149.1	11165.6
GR	1150.3	11176.1	1150.3	11176.3	1149.6	11180.7	1149.8	11208.8	1150.1	11212.7
GR	1150.4	11286.2	1150.1	11345.6						

END EAST BANK CHANNEL IMPROVEMENTS

X.	402.5	57	9852	10190	725.0	710.0	720.0	1.0	0.0	
CI	0	0	0	0	0	.01				
X3	0	0.0	0.0	9700.0	0.0	10200.0	0.0	0.0	0.0	
X4	1	1150	9852							
GR	1156.1	8564.0	1156.6	8588.7	1155.3	8592.9	1154.6	8602.9	1154.9	8614.7
GR	1156.8	8622.1	1155.0	8695.1	1152.0	8719.7	1151.7	8756.8	1152.1	8763.3
GR	1152.1	8776.0	1150.9	8784.0	1150.3	9057.8	1148.5	9063.5	1152.4	9073.9
GR	1150.3	9082.4	1151.3	9090.1	1150.8	9119.9	1149.3	9128.6	1151.0	9138.7
GR	1151.2	9274.8	1152.1	9363.6	1152.3	9424.7	1152.5	9520.4	1153.1	9550.9
GR	1153.1	9610.9	1153.3	9703.3	1153.9	9722.3	1153.6	9755.3	1143.4	9814.8
GR	1134.8	9871.3	1135.0	9889.8	1133.6	9896.9	1133.8	9938.5	1133.8	10000.0
GR	1132.9	10061.1	1134.2	10066.8	1133.3	10073.9	1133.2	10085.0	1134.5	10092.4
GR	1140	10130	1150	10190	1151.6	10209.3	1152.0	10251.6	1151.2	10280.9
GR	1150.6	10284.2	1151.0	10350.0	1151.1	10416.1	1151.9	10479.1	1151.2	10510.3
GR	1151.3	10546.0	1151.5	10581.4	1140.8	10606.4	1140.8	10614.2	1145.8	10626.9
GR	1151.0	10647.8	1150.6	10723.4						
X1	406.5	38	9773.6	10212.3	410.0	390.0	400.0	1.0	0.0	
X3	0	0.0	0.0	9773.6	0.0	10234.6	0.0	0.0	0.0	
GR	1161.1	8418.3	1161.0	8425.0	1158.6	8441.3	1159.4	8452.7	1161.2	8462.3
GR	1158.2	8547.6	1153.2	8586.3	1152.9	8609.8	1152.7	8836.4	1152.9	8975.7
GR	1154.3	8978.5	1151.5	8983.0	1154.0	8987.1	1153.6	8998.2	1153.9	9028.2
GR	1154.1	9132.8	1153.5	9172.2	1154.1	9237.3	1153.5	9340.8	1150.7	9353.2
GR	1153.8	9370.1	1154.8	9483.4	1155.9	9672.5	1155.6	9712.9	1156.2	9743.7
GR	1155.5	9773.6	1142.2	9846.7	1134.4	9896.8	1135.5	9902.3	1135.5	9961.2
GR	1134.3	10000.0	1134.7	10061.2	1136.1	10083.7	1143.2	10116.0	1149.5	10152.3
GR	1151.0	10196.1	1154.3	10212.3	1154.5	10234.6				
X	409.5	24	9850	10150	315	315	315	.896		
X3	10							1162.3	1161.6	
GR	1156.5	9140	1156.7	9370	1158	9500	1160	9600	1162.3	9850
GR	1155.9	9850.1	1138.0	9890.0	1136.0	9900.0	1135.9	9923.0	1135.9	9925.0
GR	1135.9	9927.0	1135.9	9928.0	1134.7	9997.0	1134.7	9998.0	1134.7	10000.0
GR	1135.8	10003.0	1135.8	10073.0	1135.7	10075.0	1135.7	10077.0	1135.6	10078.0
GR	1136	10095	1152.2	10149.9	1161.6	10150	1161.6	10260		
SB	1.05	1.56	2.7	0.0	167.33	9	4000	2	0	0

THUNDERBIRD ROAD BRIDGE

THUNDERBIRD ROAD BRIDGE

X1	410.54	24	9850	10150	83.5	83.5	83.5	.896	0	
X2	0	0	1	1156.1	1161.6	0	0	0	.896	
X3	10	0	0	0	0	0	0	1162.3	1161.6	
BT	-10	9140	1162.3	1162.3	9500	1162.3	1162.3	9850	1162.3	1162.3
BT		9850.1	1162.3	1155.9	9925	1162.47	1156.1	10000	1162.4	1156.1
BT		10075	1162.13	1155.8	10149.9	1161.6	1155.2	10150	1161.6	1161.6
BT		10260	1161.6	1161.6						
GR	1162.3	9140	1162.3	9370	1162.3	9500	1162.3	9600	1162.3	9850
GR	1155.9	9850.1	1138.0	9890.0	1136.0	9900.0	1135.9	9923.0	1135.9	9925.0
GR	1135.9	9927.0	1135.9	9928.0	1135.8	9997.0	1134.8	9998.0	1134.8	10000.0
GR	1134.8	10003.0	1135.8	10073.0	1135.8	10075.0	1135.8	10077.0	1135.8	10078.0
GR	1136	10095	1155.2	10149.9	1161.6	10150	1161.6	10260		

X_	412.76	64	9833.8	10202.8	223	223	223	0	0	
X3	0	0.0	0.0	9800.3	0.0	10230.0	0.0	0.0	0.0	
GR	1160.0	8285.3	1160.3	8343.2	1159.7	8361.3	1160.9	8364.7	1159.7	8368.3
GR	1159.5	8387.7	1157.5	8397.7	1158.3	8403.0	1157.6	8493.1	1156.5	8561.2
GR	1156.2	8594.1	1158.2	8655.8	1158.7	8691.4	1157.8	8731.5	1158.0	8773.5
GR	1157.2	8798.5	1156.6	8827.8	1156.7	8910.4	1157.1	8950.6	1153.9	8961.2
GR	1156.1	8973.8	1155.2	8976.7	1154.9	9018.2	1155.8	9027.0	1156.4	9063.0
GR	1156.5	9150.5	1156.3	9189.1	1155.9	9222.6	1155.6	9244.1	1155.8	9291.8
GR	1155.7	9338.8	1156.1	9357.8	1153.9	9383.5	1154.3	9473.7	1154.0	9565.1
GR	1153.7	9627.1	1152.1	9675.8	1153.9	9693.2	1154.1	9765.8	1157.6	9798.7
GR	1158.1	9821.3	1158.1	9833.8	1151.1	9863.5	1141.5	9896.3	1135.4	9923.2
GR	1135.1	9966.3	1136.9	10000.0	1137.9	10020.9	1137.9	10039.2	1136.0	10050.3
GR	1137.2	10081.2	1143.1	10111.3	1153.3	10159.8	1156.0	10187.6	1157.6	10202.8
GR	1157.3	10280.7	1156.8	10372.5	1156.4	10474.9	1155.9	10597.2	1155.7	10677.3
GR	1154.9	10731.5	1155.4	10769.0	1154.7	10842.0	1155.1	10891.5		
X1	418.97	60	9770.0	10204.3	600.0	660.0	620.0	1.0	0.0	
X3	0	0.0	0.0	9770.0	0.0	10250.0	0.0	0.0	0.0	
GR	1159.8	8429.5	1159.8	8455.6	1159.4	8494.3	1161.3	8498.2	1159.6	8503.7
GR	1159.3	8522.3	1158.3	8531.1	1156.8	8685.3	1156.3	8736.1	1157.3	8775.3
GR	1158.1	8794.0	1158.3	8871.3	1157.8	8924.9	1157.6	8984.2	1156.8	8988.4
GR	1157.4	8993.2	1156.8	9063.6	1156.3	9111.3	1156.5	9158.8	1156.3	9208.2
GR	1157.3	9216.2	1157.3	9275.7	1156.7	9311.7	1157.6	9379.1	1157.4	9413.3
GR	1155.5	9423.3	1155.6	9436.6	1157.5	9447.5	1158.4	9545.9	1158.2	9595.6
GR	1156.3	9602.4	1156.5	9716.5	1156.7	9751.5	1160.3	9770.0	1159.9	9800.1
GR	1158.2	9815.5	1148.5	9866.0	1141.0	9914.6	1135.8	9940.1	1135.9	9961.4
GR	1137.3	9971.4	1137.9	10000.0	1139.3	10027.4	1136.8	10031.8	1136.8	10064.5
G"	1143.6	10103.8	1151.0	10144.8	1156.7	10185.3	1160.9	10204.3	1160.1	10217.3
G.	1160.7	10242.9	1161.1	10244.9	1161.1	10258.0	1160.3	10260.0	1159.9	10286.0
GR	1160.3	10296.3	1160.3	10356.1	1160.3	10427.1	1160.4	10499.0	1160.7	10533.5
X1	424.17	64	9790.9	10195.1	500.0	550.0	520.0	1.0	0.0	
X3	0	0.0	0.0	9790.3	0.0	10200.0	0.0	0.0	0.0	
GR	1159.4	8489.3	1159.4	8523.7	1159.2	8577.4	1161.4	8589.8	1159.0	8610.3
GR	1160.4	8621.1	1160.5	8634.8	1161.8	8642.1	1161.8	8655.2	1159.2	8662.0
GR	1158.5	8759.0	1158.1	8801.7	1158.5	8827.1	1158.3	8887.4	1158.7	8917.4
GR	1158.9	8934.2	1158.3	8937.9	1158.2	8965.9	1157.6	9000.5	1156.7	9035.6
GR	1157.6	9072.8	1158.7	9083.6	1158.7	9144.3	1159.0	9161.7	1158.9	9183.0
GR	1157.3	9205.8	1157.8	9213.9	1158.2	9245.0	1157.8	9253.8	1157.9	9320.3
GR	1157.9	9446.3	1158.3	9564.7	1158.2	9631.6	1158.5	9711.1	1159.1	9747.8
GR	1161.4	9766.9	1161.6	9790.9	1156.4	9822.2	1148.6	9867.4	1144.4	9892.5
GR	1141.1	9924.3	1136.6	9938.8	1136.7	9968.1	1138.3	9976.2	1138.2	10000.0
GR	1138.7	10005.7	1139.8	10011.5	1139.3	10033.5	1137.1	10042.9	1137.6	10061.6
GR	1148.5	10116.0	1154.7	10155.3	1162.4	10195.1	1162.4	10208.9	1161.7	10210.5
GR	1162.3	10235.2	1162.6	10237.4	1162.8	10250.4	1162.0	10252.6	1161.8	10278.6
GR	1161.7	10308.2	1162.0	10333.1	1163.3	10369.6	1164.1	10472.5		
X1	429.37	60	9744.7	10204.4	490.0	520.0	500.0	1.0	0.0	
X3	0	0.0	0.0	9744.8	0.0	10250.0	0.0	0.0	0.0	
GR	1163.6	8411.8	1164.6	8425.6	1161.5	8474.4	1161.3	8506.7	1160.7	8509.9
GR	1160.5	8680.1	1160.5	8842.3	1160.5	8992.0	1161.4	8996.8	1161.2	9018.7
GR	1161.4	9024.0	1157.9	9042.2	1159.3	9050.8	1158.8	9056.9	1158.7	9101.6
GR	1158.8	9180.6	1158.6	9237.0	1158.3	9245.0	1158.9	9260.6	1159.4	9332.3

G	1159.6	9456.6	1160.2	9601.7	1160.8	9646.8	1160.6	9668.5	1162.1	9676.2
G.	1159.6	9681.5	1160.4	9691.7	1161.6	9744.7	1161.2	9784.7	1158.3	9800.9
GR	1151.9	9819.5	1151.2	9833.2	1149.5	9841.5	1149.8	9864.6	1142.4	9905.9
GR	1137.6	9936.5	1138.2	9977.0	1140.0	9987.9	1140.0	10000.0	1140.5	10027.3
GR	1138.5	10033.5	1139.2	10063.9	1142.4	10081.3	1153.7	10140.9	1163.3	10192.5
GR	1163.0	10204.4	1162.2	10206.3	1163.0	10231.8	1163.3	10234.2	1163.5	10245.9
GR	1162.7	10248.0	1162.7	10274.4	1163.1	10279.7	1160.0	10293.5	1161.7	10305.7
GR	1162.6	10363.8	1163.0	10365.4	1164.1	10430.7	1163.5	10649.4	1163.4	10716.4
X1	435.37	59	9820	10201.9	590.0	620.0	600.0	1.0	0.0	
X3	0	0.0	0.0	9761.8	0.0	10201.9	0.0	0.0	0.0	
GR	1163.7	8368.0	1163.2	8386.4	1162.8	8426.3	1162.8	8662.4	1162.9	8851.5
GR	1163.0	9034.3	1163.0	9211.4	1164.6	9218.3	1162.7	9221.5	1164.0	9225.5
GR	1163.9	9236.3	1162.3	9243.8	1162.1	9403.4	1161.9	9564.7	1163.1	9579.3
GR	1163.2	9592.5	1161.0	9598.5	1163.3	9605.3	1161.7	9616.6	1162.1	9637.7
GR	1162.7	9667.1	1163.1	9695.0	1162.1	9729.1	1162.9	9737.4	1163.0	9761.8
GR	1160	9820	1158	9830	1156	9840	1154	9850	1152	9860
GR	1150	9870	1143.3	9911.7	1141.6	9929.4	1138.1	9941.6	1138.2	9969.5
GR	1139.9	9973.1	1140.6	10000.0	1141.0	10023.9	1140.5	10041.2	1139.5	10044.2
GR	1139.5	10069.5	1141.3	10078.6	1148.4	10118.3	1158.6	10177.8	1164.1	10201.9
GR	1163.8	10214.4	1163.4	10216.3	1163.9	10251.6	1164.3	10252.7	1164.4	10256.3
GR	1163.8	10258.6	1163.6	10284.4	1163.9	10289.1	1163.3	10292.1	1163.5	10308.6
GR	1163.4	10347.2	1164.0	10367.5	1163.2	10449.8	1162.8	10599.0		
X1	441.6	46	9783.5	10215.2	610.0	610.0	610.0	1.0	0.0	
CI	10000	1139	0.0	3	3	120				
X3	0	0.0	0.0	9783.5	0.0	10215.2	0.0	0.0	0.0	
GR	1167.4	8348.4	1167.0	8354.1	1165.4	8359.3	1164.7	8423.7	1164.9	8625.9
G	1165.0	8764.6	1166.4	8770.8	1164.6	8773.6	1166.6	8778.5	1166.8	8788.9
G.	1165.2	8796.8	1164.8	8907.5	1165.6	9288.3	1164.7	9427.8	1164.7	9561.8
GR	1165.2	9670.6	1164.8	9680.5	1165.2	9693.4	1163.2	9697.3	1165.7	9702.0
GR	1165.6	9714.6	1166.6	9720.3	1167.3	9783.5	1167.2	9822.3	1153.4	9881.8
GR	1143.2	9932.2	1143.3	10000.0	1141.9	10042.3	1139.5	10053.3	1139.6	10079.0
GR	1142.3	10088.0	1142.5	10097.4	1150.1	10130.9	1162.2	10197.7	1166.4	10215.2
GR	1166.1	10229.7	1165.4	10231.1	1166.0	10256.5	1166.4	10258.2	1166.3	10271.2
GR	1165.6	10272.7	1165.6	10298.5	1165.9	10301.3	1166.3	10331.7	1166.6	10479.4
GR	1165.7	10543.1								
X1	446.87	56	9809.5	10208.3	560.0	560.0	560.0	1.0	0.0	
CI	10000	1140	0.0	3	3	120				
X3	0	0.0	0.0	9809.5	0.0	10208.3	0.0	0.0	0.0	
GR	1169.4	8475.7	1168.6	8498.0	1166.9	8508.6	1167.1	8558.8	1167.9	8565.4
GR	1168.5	8573.4	1166.3	8576.1	1168.5	8581.8	1167.0	8591.8	1167.6	8731.7
GR	1167.6	9132.3	1167.2	9517.7	1166.7	9659.6	1167.4	9670.8	1164.2	9676.0
GR	1167.3	9682.4	1166.9	9689.2	1167.8	9700.6	1168.2	9774.6	1168.4	9809.5
GR	1162.7	9840.3	1151.7	9896.5	1149.0	9904.3	1144.1	9929.2	1142.3	9945.6
GR	1142	9955.1	1142	9972.4	1142	10000.0	1142	10004.0	1142.0	10013.4
GR	1142	10042.8	1142.8	10049.0	1145.6	10070.8	1146.1	10088.3	1145.5	10097.1
GR	1147.9	10108.7	1147.9	10114.2	1149.4	10119.2	1162.8	10181.1	1168.2	10208.3
GR	1167.5	10229.5	1166.3	10240.7	1166.8	10266.9	1167.2	10269.9	1166.9	10282.5
GR	1166.3	10283.6	1166.2	10309.5	1166.4	10312.5	1166.3	10326.5	1168.2	10338.3
GR	1167.1	10372.7	1164.2	10409.2	1163.5	10443.7	1163.3	10491.5	1160.1	10504.5
GR	1160.1	10591.0								

CHIMP TO REMOVE HIGH NG IN BOTTOM S. OF DROP

```
X1   449.05        6     9811.5    10188.5       232        232        232        1.0        0.0
CI        0        0        0.0          0         0        .01
GR     1166     9800       1166     9811.5    1140.3       9940     1140.3      10060       1166    10188.5
GR     1166    10200
  BEGIN RIP RAP EMBANKMENT PROTECTION

X1   450.23        6     9779.3    10220.7       100        100        100
GR     1166     9770       1166     9779.3    1140.7     9905.8     1140.7    10094.2       1166    10220.7
GR     1166    10230
  END OF STILLING BASIN TOE DOWN

X1   451.05        6       9800      10200        82         82         82
GR     1166     9750       1166       9800      1141       9875       1141      10125       1166      10200
GR     1166    10250
  DOWNSTREAM END OF STILLING BASIN

X1   451.23        6       9848      10152        18         18         18
GR     1168     9830       1168       9848      1141       9875       1141      10125       1168      10152
GR     1168    10170
  UPSTREAM END OF STILLING BASIN

X1   452.23        6       9847      10153       100        100        100
GR     1168     9830       1168       9847      1141       9875       1141      10125       1168      10153
GR     1168    10170
  DOWNSTREAM CREST OF PROPOSED DROP, DROP HEIGHT= 11 FT

        PROPOSED DROP STRUCTURE, DROP HEIGHT=11 Ft.
X    452.50        6       9859      10141      27.5       27.5       27.5
G.     1168     9850       1168       9859      1152       9875       1152      10125       1168      10141
GR     1168    10150

X1   452.65        6       9859      10141        15         15         15
GR     1168     9850       1168       9859      1152       9875       1152      10125       1168      10141
GR     1168    10150
  UPSTREAM CREST OF PROPOSED DROP

X1   452.73        9     9852.2    10147.8         8          8          8
GR     1168     9800       1168       9810    1167.5       9815     1167.5       9829     1167.2     9852.2
GR     1152     9875       1152      10125    1167.2    10147.8       1169      10220
  END RIP RAP UPSTREAM OF DROP STRUCTURE

X1   453.23       11     9854.8    10145.3        50         50         50
GR     1168     9805       1168       9812      1166       9820       1166       9834       1166       9840
GR   1165.5   9854.8       1152       9875      1152      10125     1165.5    10145.3       1166      10155
GR     1170    10220

X1   455.63       13       9803      10195       270        200        240
GR     1171     9770       1171       9777      1167       9789       1167       9803       1154       9830
GR     1152     9930       1152      10060      1152      10070       1154      10170       1167      10195
GR     1167    10210       1170      10240    1170.8      10280
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X1    458.5       28     9306.5   10231.7      310      240      290      1.0      0.0
X3        0      0.0        0.0    9306.5      0.0  10231.7      0.0      0.0      0.0
GR   1181.3   9224.2     1180.7    9260.4   1176.6   9280.6   1172.0   9306.5   1171.2   9334.7
GR   1170.7   9399.0     1169.4    9468.8   1167.9   9544.0   1167.8   9572.0   1159.1   9590.5
GR   1154.2   9610.5     1154.0    9713.4   1153.0  10000.0   1153.2  10009.5   1152.1  10016.7
GR   1152.1  10031.3     1154.3   10038.5   1154.0  10047.5   1154.8  10059.4   1154.2  10093.0
GR   1156.5  10103.0     1156.2   10146.9   1154.7  10152.0   1156.4  10163.9   1161.2  10186.1
GR   1172.0  10231.7     1171.5   10313.3   1170.2  10405.5

QT        3     5100      19000     38000
  NEW RIVER CROSS SECTION UPSTREAM OF SKUNK CREEK CONFLUENCE
X1    462.6       46     9708.7     10190     450.0    410.0    410.0      1.0      0.0
X3        0      0.0        0.0      9750       0.0  10219.5      0.0      0.0      0.0
GR   1169.6   9708.7       1166      9730      1163     9760     1160     9790     1158     9800
GR   1158.0   9810.5     1157.9    9830.2    1156.5   9834.0   1157.3   9851.9   1156.6   9857.1
GR   1157.4   9882.3     1157.7    9951.1    1158.1   9956.9   1158.0  10000.0   1157.9  10000.0
GR   1157.2  10105.3     1158.4   10113.9    1156.9  10117.6   1157.1    10125   1157.8    10130
GR     1170    10190     1173.2   10219.5    1172.8  10296.7   1170.3  10435.3   1169.7  10476.4
GR   1168.4  10480.5     1168.9   10490.7    1168.8  10524.5   1169.4  10530.0   1170.3  10577.5
GR   1169.5  10636.7     1168.4   10641.3    1168.4  10649.0   1167.7  10650.2   1167.4  10677.2
GR   1167.8  10679.5     1167.9   10691.6    1167.1  10693.1   1166.8  10719.3   1167.1  10725.7
GR   1168.3  10729.7     1168.7   10737.8    1168.7  10818.0   1167.9  10824.0   1168.2  10866.6
GR   1167.5  10952.2

X1    466.6       31     9702.5   10191.4     400.0    400.0    400.0      1.0      0.0
GR   1173.3   9472.9     1173.1    9520.7    1174.0   9538.7   1174.7   9548.8   1188.1   9577.9
GR   1188.8   9586.5     1195.8    9610.8    1196.8   9655.7   1199.6   9687.8   1199.3   9702.5
GR   1194.3   9729.6       1180      9770      1176     9784     1174     9800     1172     9825
GR     1170     9830       1160      9845    1159.8   9950.5   1159.3  10000.0   1158.9  10035.8
GR   1158.9  10069.4     1159.4   10076.6    1158.0  10082.0   1159.0  10090.0   1158.9  10103.9
GR     1160    10125       1172     10175    1175.2  10191.4   1175.2  10207.0   1173.9  10209.5
GR   1174.4  10255.0

X1    471.3       42       9802     10170     470.0    470.0    470.0      1.0      0.0
GR   1182.9   9463.8     1183.2    9471.7    1175.6   9506.6   1174.3   9517.5   1173.8   9547.2
GR   1176.7   9559.0     1176.4    9578.5    1177.9   9598.9   1177.7   9632.8   1178.6   9650.4
GR   1177.9   9672.7     1175.0    9691.5      1180     9740     1176     9748     1174     9775
GR     1172     9790       1170      9802      1168     9810     1166     9815     1164     9970
GR     1162     9990     1159.7   10000.0    1159.3  10033.8   1160.2  10054.8   1159.5  10060.3
GR   1160.4  10081.6       1160     10110      1170    10170     1176    10190     1178    10245
GR   1180.7    10255     1182.4     10265    1182.1  10274.8   1183.1  10301.4   1184.2  10378.0
GR   1183.9  10401.7     1183.8   10436.8    1184.6  10476.0   1181.9  10483.1   1181.1  10498.2
GR   1182.4  10506.3     1182.4   10522.8

X1    475.8       27     9865.6   10202.8     450.0    450.0    450.0      1.0      0.0
GR   1182.4   9537.3     1182.4    9545.1    1177.6   9570.8   1176.5   9616.2   1177.1   9689.1
GR   1177.2   9756.5     1177.3    9811.3    1177.6   9865.6   1169.7   9891.2   1164.1   9919.8
GR   1162.1   9941.0     1162.5   10000.0    1162.7  10066.4   1163.8  10075.7   1163.3  10086.5
GR   1175.4  10125.8     1178.2   10149.4    1181.0  10173.3   1182.1  10202.8   1181.3  10228.4
GR   1179.2  10249.8     1179.1   10274.9    1178.8  10347.1   1178.7  10477.5   1178.6  10523.5
GR   1177.8  10638.9     1177.4   10690.0
  END OF NEW RIVER CHANNEL IMPROVEMENTS FOR THIS PROJECT.
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UPSTREAM OF SKUNK CREEK CONFLUENCE

X1	8.978	33	9752.9	10196.9	500.0	500.0	500.0	1.0	0.0	
X3	0	0.0	0.0	9752.9	0.0	10196.9	0.0	0.0	0.0	
GR	1185.3	9616.4	1185.0	9623.9	1177.8	9665.3	1178.7	9671.1	1179.8	9693.0
GR	1180.1	9752.9	1173.7	9782.9	1164.9	9824.8	1163.9	9836.9	1164.3	9905.1
GR	1164.4	9947.3	1164.8	10000.0	1164.5	10124.2	1163.9	10163.6	1169.3	10178.0
GR	1177.7	10196.9	1176.8	10209.4	1178.2	10216.3	1178.4	10244.4	1177.4	10286.5
GR	1177.9	10346.6	1177.1	10378.2	1177.1	10422.6	1178.7	10452.1	1177.4	10486.3
GR	1177.5	10529.5	1179.0	10555.0	1177.4	10558.5	1179.1	10561.3	1179.0	10574.1
GR	1178.3	10578.2	1179.0	10585.7	1179.3	10675.8				
X1	9.072	44	9686.4	10235.4	525.0	520.0	520.0	1.0	0.0	
X3	0	0.0	0.0	9686.4	0.0	10235.4	0.0	0.0	0.0	
GR	1188.0	9604.4	1182.8	9638.4	1181.1	9662.2	1182.2	9686.4	1181.9	9703.1
GR	1175.4	9732.5	1167.0	9768.7	1165.8	9781.6	1165.9	9806.9	1166.3	9811.1
GR	1165.4	9854.0	1166.1	9878.3	1165.5	9886.1	1166.0	9912.3	1165.7	9922.6
GR	1166.5	9927.7	1166.8	9971.3	1166.7	10000.0	1166.8	10017.1	1167.2	10069.3
GR	1167.2	10113.9	1167.8	10135.8	1168.7	10141.1	1168.5	10166.5	1167.8	10187.5
GR	1168.0	10207.9	1171.5	10220.6	1182.7	10235.4	1187.3	10253.1	1180.6	10264.0
GR	1180.3	10292.1	1180.1	10345.2	1180.9	10379.1	1180.0	10405.2	1179.5	10442.8
GR	1180.6	10471.2	1179.6	10489.6	1179.6	10532.9	1181.1	10560.2	1179.3	10562.5
GR	1181.6	10566.3	1182.5	10580.6	1181.7	10583.2	1182.0	10600.1		
X1	9.167	26	9844.4	10218.8	525.0	520.0	520.0	1.0	0.0	
X3	0	0.0	0.0	9844.4	0.0	10218.8	0.0	0.0	0.0	
GR	1185.3	9706.9	1185.2	9761.2	1184.5	9789.7	1184.4	9826.8	1183.6	9844.4
GR	1175.7	9883.2	1174.0	9903.3	1171.9	9955.3	1170.3	9981.6	1168.8	9988.2
GR	1168.9	10000.0	1168.3	10028.1	1170.8	10044.7	1171.6	10057.6	1173.3	10112.5
GR	1174.2	10136.3	1179.4	10169.0	1181.2	10218.8	1181.6	10295.1	1181.2	10361.9
GR	1181.8	10416.2	1181.2	10457.4	1182.4	10497.4	1182.7	10536.8	1181.4	10539.6
GR	1184.2	10546.6								
X1	9.262	31	9739.1	10228.7	470.0	530.0	500.0	1.0	0.0	
X3	0	0.0	0.0	9739.1	0.0	10228.7	0.0	0.0	0.0	
GR	1192.1	9683.4	1190.7	9694.9	1189.1	9710.4	1186.5	9723.8	1185.9	9739.1
GR	1173.0	9765.0	1171.7	9815.2	1171.0	9866.7	1171.0	9904.9	1171.0	9952.4
GR	1171.0	10000.0	1170.8	10022.8	1172.0	10042.3	1173.4	10071.6	1173.4	10094.9
GR	1174.1	10103.7	1174.1	10155.2	1174.8	10166.3	1175.5	10185.0	1176.6	10194.6
GR	1176.9	10212.9	1183.8	10228.7	1183.5	10331.3	1183.7	10388.2	1183.8	10459.0
GR	1183.8	10549.5	1184.2	10635.5	1184.4	10702.5	1184.9	10708.4	1184.1	10710.8
GR	1187.1	10719.6								
X1	9.356	32	9782.9	10287.8	490.0	490.0	490.0	1.0	0.0	
GR	1194.3	9729.0	1192.1	9750.4	1189.5	9765.6	1189.2	9782.9	1173.7	9814.3
GR	1174.2	9831.1	1173.3	9855.8	1174.3	9920.6	1174.6	9972.5	1174.0	10000.0
GR	1173.5	10024.0	1174.4	10033.0	1174.5	10057.3	1174.9	10120.0	1175.6	10131.9
GR	1176.2	10196.8	1176.7	10229.0	1179.8	10257.6	1180.4	10280.3	1185.4	10287.8
GR	1186.0	10294.0	1186.4	10384.1	1186.2	10425.5	1185.8	10499.3	1185.6	10579.8
GR	1185.8	10643.0	1186.1	10721.6	1186.1	10746.8	1188.1	10752.3	1186.2	10754.8
GR	1188.8	10760.0	1189.4	10776.0						

X1	9.451	37	9848.5	10244.3	500.0	510.0	500.0	1.0	0.0	
GR	1196.7	9792.8	1193.3	9822.7	1192.0	9827.7	1191.6	9848.5	1178.5	9874.8
GR	1178.7	9882.6	1176.5	9885.2	1178.1	9899.0	1178.6	9966.0	1178.3	10000.0
GR	1178.3	10004.7	1179.0	10008.0	1179.1	10039.2	1179.6	10073.0	1179.2	10110.8
GR	1179.7	10127.9	1180.2	10171.7	1180.0	10184.6	1179.7	10197.5	1180.7	10204.2
GR	1181.0	10226.3	1190.2	10244.3	1190.4	10298.1	1190.4	10361.9	1190.4	10432.7
GR	1190.6	10439.6	1190.2	10444.6	1190.2	10455.8	1191.1	10464.2	1190.2	10469.8
GR	1190.3	10483.6	1190.8	10489.5	1190.3	10496.7	1190.2	10507.3	1190.6	10518.6
GR	1190.4	10523.1	1190.3	10545.1						
X1	9.546	21	9838.2	10245.3	500.0	500.0	500.0	1.0	0.0	
GR	1202.6	9796.3	1201.8	9804.7	1195.2	9838.2	1194.4	9845.9	1180.0	9873.6
GR	1179.1	9932.3	1179.9	9943.8	1177.9	9954.2	1178.0	10000.0	1178.0	10120.8
GR	1178.5	10135.4	1181.1	10169.5	1181.7	10185.2	1181.8	10225.4	1193.8	10245.3
GR	1194.3	10315.5	1193.7	10343.8	1193.7	10386.3	1194.6	10419.8	1193.6	10488.5
GR	1193.3	10552.9								
X1	9.641	24	9789.3	10146.5	510.0	490.0	500.0	1.0	0.0	
GR	1207.3	9661.8	1200.0	9705.2	1197.8	9722.6	1196.3	9774.6	1196.3	9782.6
GR	1195.6	9789.3	1178.4	9823.2	1180.0	9838.7	1181.3	9870.0	1182.2	9920.2
GR	1182.3	9960.1	1181.3	9963.1	1181.2	10000.0	1181.4	10012.2	1183.5	10028.2
GR	1184.5	10047.0	1184.6	10089.7	1186.9	10114.2	1186.5	10134.6	1195.4	10146.5
GR	1195.5	10236.0	1195.4	10301.2	1195.5	10408.8	1195.3	10545.7		
X1	9.735	38	9907.7	10126.7	510.0	490.0	500.0	1.0	0.0	
GR	1201.0	9634.2	1199.7	9645.2	1198.5	9689.3	1198.0	9750.3	1197.2	9796.8
GR	1197.1	9849.5	1196.8	9885.4	1197.7	9893.9	1197.0	9907.7	1184.2	9933.9
GR	1183.5	9940.2	1185.8	9954.1	1186.1	10000.0	1185.6	10023.4	1186.2	10044.6
GR	1185.1	10062.9	1183.5	10068.0	1184.1	10071.7	1184.0	10087.6	1192.2	10105.5
GR	1200.3	10126.7	1200.6	10136.0	1199.3	10140.9	1199.9	10152.6	1200.8	10176.9
GR	1199.6	10179.0	1200.1	10228.6	1199.6	10293.8	1199.9	10356.0	1200.7	10386.4
GR	1200.2	10431.6	1198.8	10439.0	1198.6	10449.2	1199.4	10456.2	1199.7	10508.4
GR	1200.0	10540.9	1200.8	10550.8	1200.6	10601.5				
X1	9.783	27	9833.7	10115.3	27.0	0 220	250.0	1.0	0.0	
X3	0	0.0	0.0	9900.0	0.0	10115.3	0.0	0.0	0.0	
GR	1197.5	9687.0	1198.6	9753.7	1198.9	9775.0	1200.2	9785.8	1200.5	9797.9
GR	1199.6	9810.5	1202.1	9824.1	1202.3	9833.7	1199.4	9847.7	1196.4	9872.2
GR	1196.0	9896.9	1195.2	9905.8	1190.6	9922.3	1187.7	9934.9	1189.3	9945.4
GR	1189.3	9952.7	1187.6	9958.5	1189.8	9975.2	1186.1	10000.0	1186.2	10006.8
GR	1188.0	10035.8	1188.1	10066.0	1187.6	10091.3	1200.2	10115.3	1200.7	10127.1
GR	1199.8	10146.0	1200.1	10195.4						
X1	9.786	23	9787.8	10114.3	20.0	20.0	20.0	1.0	0.0	
X3	0	0.0	0.0	9900.0	0.0	10114.3	0.0	0.0	0.0	
GR	1202.6	9701.3	1202.2	9769.9	1201.2	9787.8	1199.2	9816.7	1195.2	9837.3
GR	1197.1	9867.7	1196.7	9894.1	1193.5	9898.2	1196.5	9905.5	1189.6	9919.5
GR	1189.5	9935.8	1190.4	9954.3	1190.0	9969.8	1189.3	10000.0	1189.3	10039.7
GR	1189.8	10072.6	1189.2	10080.0	1189.0	10090.5	1201.2	10114.3	1201.3	10121.2
GR	1199.7	10127.5	1200.3	10166.3	1200.5	10225.3				

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X1    9.832       38    9833.8   10123.1     220.0     245.0     225.0       1.0       0.0
X3       10      0.0       0.0         0       0.0         0       0.0      1205      1204
GR   1204.1    9548.0    1203.7    9562.8    1203.7    9604.5    1202.9    9633.1    1201.5    9666.8
GR   1200.9    9696.0    1203.1    9735.0    1203.6    9760.7    1203.4    9825.2    1203.1    9833.8
GR   1193.4    9869.1    1192.6    9897.9    1194.5    9907.3    1192.4    9938.1    1192.8    9971.8
GR   1189.7    9979.2    1189.3   10000.0    1189.2   10005.7    1192.2   10024.3    1190.6   10057.3
GR   1191.4   10080.6    1194.6   10102.0    1203.3   10123.1    1201.4   10145.3    1202.0   10159.4
GR   1202.0   10197.5    1202.4   10254.8    1202.1   10293.0    1201.8   10360.7    1201.6   10407.8
GR   1201.1   10465.5    1201.1   10567.1    1201.8   10614.4    1202.5   10621.9    1203.0   10645.8
GR   1202.5   10685.1    1201.7   10693.6    1201.3   10723.5

SB       0.9      1.56       2.6       0.0       200      20.0    2500.0       2.5
  BELL ROAD BRIDGE
        BELL ROAD BRIDGE
X1     9.850       12    9825.0   10110.0     100.0     100.0     100.0       1.0       0.0
X2       0.0      0.0         1    1199.2      1205       0.0         0       0.0       0.0
X3        10      0.0       0.0       0.0       0.0       0.0       0.0      1205      1204
X4         2     1205      9826    1205.8     10109
BT        -5     9800      1205      1205      9825      1205    1205.0      9826    1205.0    1198.4
BT              10109    1205.8    1199.2     10110    1205.8    1205.8
GR   1205.0    9800.0    1204.0    9825.0    1196.0    9845.0    1194.0    9860.0    1192.0    9890.0
GR   1192.0    9980.0    1190.0   10015.0    1190.0   10025.0    1190.0   10035.0    1194.0   10060.0
GR   1205.8   10110.0    1204.0   10635.0

X1     9.902       48    9847.1   10174.9     255.0     270.0     260.0       1.0       0.0
X3         0      0.0       0.0    9547.6       0.0   10568.3       0.0       0.0       0.0
GR   1206.5    9462.5    1206.4    9480.2    1205.2    9494.3    1204.6    9514.5    1203.9    9547.6
GR   1197.3    9559.0    1197.4    9609.6    1198.4    9625.7    1199.3    9645.7    1199.3    9676.8
GR   1197.7    9698.2    1196.0    9739.0    1195.9    9783.0    1195.8    9815.6    1199.9    9825.4
GR   1198.5    9843.2    1200.2    9847.1    1194.6    9864.9    1191.9    9881.5    1192.8    9901.7
GR   1193.5    9943.4    1195.0    9975.3    1195.2    9994.7    1193.7   10000.0    1193.1   10010.7
GR   1194.1   10055.4    1191.8   10067.1    1191.3   10076.1    1194.3   10087.4    1194.8   10104.1
GR   1195.9   10114.0    1196.5   10140.2    1197.9   10162.4    1203.8   10174.9    1204.0   10188.9
GR   1202.9   10192.3    1203.3   10204.1    1203.7   10310.7    1203.4   10400.9    1203.2   10469.8
GR   1203.4   10568.3    1203.4   10628.1    1204.1   10633.9    1203.7   10638.1    1204.3   10661.9
GR   1204.2   10691.5    1203.2   10697.8    1202.9   10793.9

QT         3     10500     41000     68000
  NEW RIVER SKUNK CREEK CONFLUENCE
X1    -458.5        28    9306.5   10231.7       800       400       550
X3                                  9306.5               10231.7
GR   1181.3    9224.2    1180.7    9260.4    1176.6    9280.6    1172.0    9306.5    1171.2    9334.7
GR   1170.7    9399.0    1169.4    9468.8    1167.9    9544.0    1167.8    9572.0    1159.1    9590.5
GR   1154.2    9610.5    1154.0    9713.4    1153.0   10000.0    1153.2   10009.5    1152.1   10016.7
GR   1152.1   10031.3    1154.3   10038.5    1154.0   10047.5    1154.8   10059.4    1154.2   10093.0
GR   1156.5   10103.0    1156.2   10146.9    1154.7   10152.0    1156.4   10163.9    1161.2   10186.1
GR   1172.0   10231.7    1171.5   10313.3    1170.2   10405.5
```

```
NC    0.032     0.032     0.032       0.1       0.3
QT        3      9200     35000     55000
  SKUNK CREEK CROSS SECTIONS UPSTREAM OF NEW RIVER CONFLUENCE
X1    462.8        11    9837.1   10180.6       420       420       420
X3       10         0         0         0         0         0         0      1188      1188
GR   1174.8    9837.1    1160.2    9865.0    1160.2    9872.9    1154.7    9880.7    1153.9    9892.1
GR   1154.4    9932.7    1154.1   10000.0    1154.0   10071.3    1154.2   10141.6    1169.1   10180.6
GR   1169.2   10196.6

SB     1.05        1.        2.8        .0       269        15      7148         2    1155.5    1155.1
  END OF SKUNK CREEK CHANNEL IMPROVEMETS FOR THIS PROJECT.
X1    19.00         8      9859    10180.       440       440       440
X2        0         0         1    1179.5    1188.0         0         0      1.33         0         0
X3       10         0         0         0         0         0         0      1188      1188
GR   1174.0      9859    1170.0      9871    1160.0      9883    1155.7      9893    1155.7     10000
GR   1155.7     10142    1160.0     10146    1174.0     10180

X1    20.90        21    9898.6   10233.9       200       200       200
GR   1173.4    9539.4    1173.2    9561.6    1173.8    9668.8    1173.5    9778.1    1172.7    9833.4
GR   1173.5    9852.5    1173.3    9870.6    1173.9    9898.6    1168.3    9902.7    1167.9    9916.9
GR   1156.3    9930.8    1157.0    9951.3    1156.8    9972.6    1155.4   10000.0    1156.6   10042.9
GR   1155.8   10077.5    1155.8   10150.3    1156.1   10187.7    1155.2   10212.3    1172.9   10233.9
GR   1173.9   10247.4

NC    0.032     0.032     0.032        .1        .3
X1    24.89        15    9898.8   10231.0       380       380       380
GR   1175.9    9869.7    1173.6    9888.9    1173.4    9898.8    1155.9    9917.7    1157.3    9945.1
GR   1157.3   10000.0    1155.8   10051.6    1156.3   10093.8    1157.3   10141.3    1157.5   10205.1
GR   1155.4   10211.3    1173.4   10231.0    1175.9   10282.5    1177.0   10353.9    1177.0   10450.1

X1    24.90         8    9906.8   10236.2         6         6         6
GR   1172.4    9906.8    1162.2    9919.8    1162.0   10000.0    1162.3   10079.3    1162.2   10188.1
GR   1161.9   10222.7    1174.4   10236.2    1176.7   10335.6

X1    25.40         7      9855     10200        50        50        50
GR   1176.0      9851    1175.0      9855    1162.9      9868    1162.9     10000    1162.9     10163
GR   1174.5     10175    1175.0     10200

NC    0.032     0.032     0.032        .3        .5
X1    26.70         5      9862     10183       130       130       130         0         0         0
X3       10         0         0         0         0         0         0    1185.5    1185.5
GR   1176.4      9862    1163.2      9875    1163.2     10000    1163.2     10170    1176.4     10183

SB     1.05       1.0       2.8         0       315        12      4980         1    1163.3    1163.2
X1    27.80         5      9867     10159       110       110       110         0         0         0
X2        0         0         1    1177.5    1185.5         0         0                   0         0
X3       10         0         0         0         0         0         0    1185.5    1185.5
GR   1177.1      9867    1163.5      9880    1163.5     10000    1163.5     10145    1177.1     10159
```

NC	0.032	0.032	0.032	.1	.3					
X1	29.60	5	9870	10195	180	180	180			
GR	1179.3	9870	1163.9	9885	1163.9	10000	1163.9	10180	1179.3	10195
NC	0.050	0.050	0.050	.2	.4					
X1	30.00	6	9859	10198	44	40	40			
GR	1180.0	9859	1164.0	9875	1165.0	9955	1164.0	10000	1164.0	10182
GR	1180.0	10198								
X1	31.75	17	9782	10222	200	152	175	0	0	0
GR	1181.3	9782	1164.2	9816	1165.0	9847	1166.0	9875	1166.0	9885
GR	1165.0	9896	1164.3	9925	1165.0	10000	1165.0	10030	1164.0	10033
GR	1163.4	10037	1164.0	10039	1165.0	10042	1166.0	10046	1166.0	10070
GR	1164.7	10189	1181.3	10222						
X1	33.00	21	9800	10190	180	135	125			
GR	1183.0	9800	1180.0	9804	1175.0	9816	1170.0	9826	1165.0	9836
GR	1167.0	9880	1167.0	9908	1166.0	9923	1165.0	9929	1164.3	9935
GR	1165.0	9940	1166.0	9967	1166.1	10000	1166.0	10064	1165.0	10069
GR	1164.1	10075	1165.0	10083	1166.0	10085	1166.0	10100	1165.2	10174
GR	1181.5	10190								
X1	35.00	14	9817	10166	205	180	200			
GR	1183.0	9817	1180.0	9825	1175.0	9840	1170.0	9847	1166.0	9855
GR	1167.0	9905	1167.0	9925	1166.0	9930	1165.9	9934	1166.0	9938
GR	1166.8	10000	1166.0	10055	1166.0	10150	1182.1	10166		
NC	0.040	0.040	0.040							
X1	37.00	10	9831	10153	185	184	200			
GR	1183.0	9831	1180.0	9843	1175.0	9853	1170.0	9859	1166.9	9860
GR	1167.0	9900	1167.0	9980	1166.9	10000	1166.9	10137	1182.7	10153
NC	0.032	0.032	0.032	.1	.3					
X1	38.32	11	9831	10151	132	132	132	0	0	0
GR	1184.0	9831	1180.0	9838	1175.0	9849	1170.0	9861	1167.5	9865
GR	1167.5	10000	1167.5	10120	1170.0	10125	1175.0	10139	1180.0	10145
GR	1183.0	10151								
X1	40.05	15	9817	10156	173	173	173			
GR	1188.0	9817	1185.0	9825	1180.0	9850	1175.0	9858	1170.0	9870
GR	1169.0	9878	1168.0	9883	1167.6	9900	1167.2	9935	1166.5	10000
GR	1167.2	10123	1170.2	10130	1175.0	10141	1180.0	10149	1183.7	10156
X1	43.00	18	9818	10180	258	330	295			
GR	1188.0	9799	1188.0	9818	1186.0	9827	1185.0	9843	1180.0	9853
GR	1175.0	9863	1170.0	9886	1167.2	9893	1166.7	10000	1167.2	10080
GR	1167.5	10100	1168.0	10124	1170.0	10127	1175.0	10142	1180.0	10149
GR	1183.0	10153	1184.0	10179	1184.5	10180				

X1	46.92	20	9826	10172	324	474	392			
GR	1189.0	9798	1189.0	9826	1187.0	9831	1186.0	9847	1185.0	9850
GR	1180.0	9862	1175.0	9871	1170.0	9890	1168.0	9895	1167.6	10000
GR	1168.0	10040	1168.0	10058	1168.0	10100	1169.0	10117	1170.0	10123
GR	1175.0	10136	1180.0	10143	1185.0	10149	1186.0	10162	1186.8	10172
X1	50.90	23	9820	10177	398	398	398			
GR	1191.0	9820	1190.0	9823	1189.0	9826	1189.0	9838	1188.0	9843
GR	1185.0	9849	1180.0	9859	1175.0	9869	1170.0	9888	1169.0	9892
GR	1168.0	9940	1168.0	9967	1168.0	9982	1168.1	10000	1168.3	10025
GR	1169.0	10117	1170.0	10123	1175.0	10135	1180.0	10144	1185.0	10152
GR	1186.0	10155	1186.9	10159	1187.0	10177				
X1	55.00	16	9819	10156	500	314	410			
GR	1192.0	9819	1191.5	9826	1191.0	9837	1190.0	9839	1185.0	9853
GR	1180.0	9865	1175.0	9875	1170.0	9889	1169.0	9893	1169.0	10000
GR	1169.0	10119	1170.0	10123	1175.0	10134	1180.0	10142	1185.0	10152
GR	1187.1	10156								
X1	60.00	18	9835	10163	522	470	500			
GR	1194.0	9835	1193.0	9839	1190.0	9847	1185.0	9857	1180.0	9863
GR	1175.0	9877	1170.0	9893	1170.0	9907	1170.0	9916	1169.7	10000
GR	1170.0	10047	1170.0	10060	1170.0	10074	1171.0	10128	1175.0	10138
GR	1180.0	10145	1185.0	10156	1189.0	10163				
X1	64.00	17	9839	10151	400	400	400			
GR	1195.0	9839	1190.0	9851	1185.0	9859	1180.0	9868	1175.0	9879
GR	1171.0	9893	1170.5	9958	1170.9	10000	1171.0	10004	1171.0	10027
GR	1171.0	10058	1171.0	10063	1171.0	10095	1172.0	10120	1175.0	10128
GR	1185.0	10136	1190.0	10151						
X1	65.45	14	9812	10152	130	160	145			
GR	1195.9	9812	1195.0	9816	1190.0	9828	1185.0	9837	1180.0	9849
GR	1175.0	9878	1171.0	9886	1171.0	10000	1171.0	10106	1175.0	10114
GR	1180.0	10125	1185.0	10138	1190.0	10145	1191.0	10152		
X1	66.90	14	9818	10152	145	145	145			
GR	1197.0	9818	1195.0	9825	1190.0	9835	1185.0	9843	1180.0	9851
GR	1175.0	9864	1171.2	9872	1171.2	10000	1171.2	10108	1175.0	10116
GR	1180.0	10130	1185.0	10140	1190.0	10150	1191.0	10152		
X1	67.90	15	9820	10151	100	100	100	0	0	0
GR	1197.5	9820	1197.0	9822	1195.0	9827	1190.0	9838	1185.0	9845
GR	1180.0	9856	1175.0	9869	1171.3	9876	1171.3	10000	1171.3	10105
GR	1175.0	10112	1180.0	10127	1185.0	10139	1190.0	10146	1191.0	10151
X1	68.69	14	9820	10146	73	73	73			
GR	1198.0	9820	1195.0	9830	1190.0	9840	1185.0	9846	1180.0	9857
GR	1175.0	9868	1171.4	9875	1171.4	10000	1171.4	10107	1175.0	10114
GR	1180.0	10124	1185.0	10134	1190.0	10143	1192.0	10146		

X.	68.70	12	9820	10146	7	7	7	0		
GR	1198.0	9820	1195.0	9830	1190.0	9840	1185.0	9847	1180.0	9857
GR	1178.4	9860	1178.4	10000	1178.4	10121	1180.0	10124	1185.0	10134
GR	1190.0	10143	1192.0	10146						
X1	69.10	13	9820	10144	40	40	40	0	0	0
GR	1198.2	9820	1198.0	9822	1195.0	9831	1190.0	9841	1185.0	9848
GR	1180.0	9857	1178.5	9860	1178.5	10000	1178.5	10119	1180.0	10122
GR	1185.0	10133	1190.0	10140	1193.0	10144				
X1	70.10	13	9823	10141	100	100	100	0	0	0
GR	1198.6	9823	1198.0	9826	1195.0	9832	1190.0	9843	1185.0	9852
GR	1180.0	9860	1178.8	9862	1178.8	10000	1178.8	10117	1180.0	10119
GR	1185.0	10130	1190.0	10137	1193.6	10141				
X1	71.80	12	9827	10136	170	170	170	0	0	0
GR	1199.0	9827	1195.0	9836	1190.0	9845	1185.0	9854	1180.0	9865
GR	1179.3	9867	1179.3	10000	1179.3	10111	1180.0	10113	1185.0	10125
GR	1190.0	10133	1193.2	10136						
X1	73.50	18	9815	10147	170	170	170			
GR	1200.0	9815	1199.0	9819	1195.0	9827	1190.0	9836	1185.0	9847
GR	1180.0	9857	1179.7	9863	1179.7	9868	1179.7	9873	1179.7	9932
GR	1179.7	10000	1179.7	10103	1180.0	10106	1185.0	10118	1190.0	10126
GR	1193.0	10131	1193.5	10132	1194.8	10147				
X1	76.32	18	9824	10160	210	338	282	0	0	0
G"	1201.0	9824	1200.0	9830	1195.0	9838	1190.0	9850	1185.0	9859
G.	1180.0	9871	1179.0	9874	1178.8	9878	1179.0	9883	1179.9	10000
GR	1180.0	10015	1180.2	10065	1181.0	10114	1185.0	10121	1190.0	10131
GR	1195.0	10142	1195.7	10145	1196.0	10160				
X1	81.00	20	9841	10157	468	468	468			
GR	1202.0	9841	1200.0	9846	1195.0	9855	1190.0	9864	1185.0	9875
GR	1181.0	9887	1180.5	9892	1180.8	9902	1180.8	9932	1181.0	9971
GR	1181.1	10000	1181.0	10026	1180.8	10055	1181.0	10073	1181.4	10100
GR	1182.0	10121	1185.0	10131	1190.0	10139	1195.0	10148	1199.0	10157
X1	84.70	20	9807	10160	358	380	370			
GR	1202.6	9807	1202.0	9808	1200.0	9814	1195.0	9823	1190.0	9833
GR	1185.0	9843	1183.0	9851	1182.0	9854	1181.2	9894	1182.0	9941
GR	1182.0	9982	1181.8	10000	1181.2	10055	1182.0	10112	1183.0	10129
GR	1185.0	10133	1190.0	10142	1195.0	10153	1198.0	10157	1198.9	10160

T 91755.02
T2 NEW RIVER - GRAND AVENUE TO SKUNK CREEK FILE: NRFINAL.DAT
T3 10-YEAR, 100-YEAR, AND SPF FLOWS - PARTIAL CHANNELIZATION

J1	ICHECK	INQ	NINV	IDIR	STRT	METRIC	HVINS	Q	WSEL	FQ
	0	3	0	0	0.0042	0	0.0	41000	1122.85	

J2	NPROF	IPLOT	PRFVS	XSECV	XSECH	FN	ALLDC	IBW	CHNIM	ITRACE
	2	0	-1	0	0	0	-1	-6.0	0.0	

T1 91755.02
T2 NEW RIVER - GRAND AVENUE TO SKUNK CREEK FILE: NRFINAL.DAT
T3 10-YEAR, 100-YEAR, AND SPF FLOWS - PARTIAL CHANNELIZATION

J1	ICHECK	INQ	NINV	IDIR	STRT	METRIC	HVINS	Q	WSEL	FQ
	0	4	0	0	0.0042	0	0.0	69000	1126.48	

J2	NPROF	IPLOT	PRFVS	XSECV	XSECH	FN	ALLDC	IBW	CHNIM	ITRACE
	3	0	-1	0	0	0	-1	-6.0	0.0	

THIS RUN EXECUTED 21FEB94 09:01:12

****
HEC-2 WATER SURFACE PROFILES

Version 4.6.2; May 1991
****

NOTE- ASTERISK (*) AT LEFT OF CROSS-SECTION NUMBER INDICATES MESSAGE IN SUMMARY OF ERRORS LIST

10-YEAR, 100-YEAR, AND S

SUMMARY PRINTOUT

	SECNO	XLCH	DEPTH	HV	CWSEL	TOPWID	SHEAR	AREA
	337.000	.00	4.96	.81	1117.36	338.49	1.12	1456.93
	337.000	.00	10.45	2.32	1122.85	351.57	2.51	3351.16
	337.000	.00	14.08	3.43	1126.48	360.22	3.38	4643.07
	342.000	510.00	4.59	.94	1119.39	352.30	.99	1352.20
	342.000	510.00	9.93	2.45	1124.73	364.29	1.99	3264.27
	342.000	510.00	13.62	3.36	1128.42	372.58	2.46	4624.85
	343.700	180.00	4.30	1.07	1120.10	334.77	1.14	1264.06
	343.700	180.00	9.29	2.97	1125.09	346.22	2.44	2965.75
	343.700	180.00	12.73	4.14	1128.53	354.08	3.08	4166.73
	345.500	190.00	4.08	.92	1121.08	337.52	.96	1360.74
	345.500	190.00	9.20	2.69	1126.20	346.98	2.18	3117.83
	345.500	190.00	12.53	3.92	1129.53	353.12	2.91	4282.20
*	346.400	100.00	4.18	.88	1121.58	337.89	.91	1396.57
*	346.400	100.00	10.82	1.93	1128.22	350.43	1.49	3681.55
*	346.400	100.00	15.20	2.62	1132.60	358.68	1.84	5232.73
*	346.800	25.00	3.40	1.63	1121.50	318.00	1.82	1024.62
	346.800	25.00	9.60	2.77	1127.70	341.00	2.22	3069.57
	346.800	25.00	14.04	3.36	1132.14	356.78	2.41	4620.33
*	347.100	30.00	4.19	.87	1122.49	338.26	.90	1399.71
	347.100	30.00	10.13	2.20	1128.43	349.98	1.74	3442.75
	347.100	30.00	14.41	2.92	1132.71	358.42	2.08	4958.61
	347.110	1.00	4.01	1.13	1122.31	310.14	1.24	1229.17
	347.110	1.00	9.67	2.87	1127.97	321.60	2.81	3016.30
	347.110	1.00	13.82	3.76	1132.12	330.02	3.65	4371.00

	SECNO	XLCH	DEPTH	HV	CWSEL	TOPWID	SHEAR	AREA
	347.400	30.00	3.95	1.17	1122.45	310.09	1.29	1208.27
	347.400	30.00	9.59	2.92	1128.09	321.65	2.86	2989.10
	347.400	30.00	13.73	3.81	1132.23	330.15	3.70	4339.98
	347.410	1.00	4.36	.81	1122.86	338.73	.82	1457.91
*	347.410	1.00	10.60	2.01	1129.10	351.20	1.56	3606.92
*	347.410	1.00	14.96	2.70	1133.46	359.94	1.90	5158.34
*	352.400	460.00	4.74	1.54	1124.84	350.79	1.76	1055.34
*	352.400	460.00	9.85	3.06	1129.95	374.57	2.59	2919.63
	352.400	460.00	14.29	3.09	1134.39	803.32	2.37	5263.18
*	358.250	600.00	5.00	.91	1128.90	336.93	.95	1369.82
	358.250	600.00	9.12	3.38	1133.02	346.03	2.83	2778.21
*	358.250	600.00	12.61	3.94	1136.51	757.24	3.10	4834.12
*	365.400	700.00	5.99	.57	1130.89	316.14	.54	1728.76
*	365.400	700.00	12.17	1.53	1137.07	868.90	1.20	4757.95
*	365.400	700.00	15.73	1.69	1140.63	902.07	1.34	7926.76
	370.650	535.00	6.29	.50	1131.79	359.77	.47	1858.44
	370.650	535.00	12.76	1.27	1138.26	489.90	.98	4540.44
	370.650	535.00	15.77	2.02	1141.27	489.90	1.45	6014.92
	373.750	320.00	6.34	.58	1132.23	334.88	.56	1712.60
	373.750	320.00	12.65	1.66	1138.55	422.39	1.26	3968.52
	373.750	320.00	15.71	2.44	1141.60	823.69	1.77	6021.29
	376.750	300.00	5.71	.78	1132.71	294.31	.75	1485.02
	376.750	300.00	11.98	2.03	1138.98	378.14	1.59	3583.34
	376.750	300.00	14.98	2.97	1141.98	669.81	2.19	5286.16
	379.750	300.00	5.33	.79	1133.43	303.16	.77	1469.88
	379.750	300.00	11.68	2.03	1139.78	372.82	1.58	3590.25
	379.750	300.00	14.86	2.84	1142.96	846.36	2.08	5587.29
	384.500	470.00	5.75	.53	1134.64	345.75	.51	1790.26
	384.500	470.00	12.49	1.41	1141.39	397.34	1.06	4301.10
	384.500	470.00	15.74	2.26	1144.64	455.21	1.58	5635.45
	388.500	410.00	5.80	.58	1135.30	342.68	.56	1724.39
	388.500	410.00	12.49	1.51	1141.99	385.80	1.14	4159.81
	388.500	410.00	15.87	2.37	1145.37	415.48	1.63	5509.40
	392.000	350.00	5.81	.60	1135.91	332.83	.57	1695.02
	392.000	350.00	12.45	1.58	1142.55	378.47	1.20	4058.14
	392.000	350.00	15.92	2.45	1146.02	407.76	1.61	5410.08
	395.500	350.00	5.26	.74	1136.56	331.64	.73	1522.08
	395.500	350.00	11.84	1.69	1143.14	389.82	1.30	3927.73
	395.500	350.00	15.43	2.49	1146.73	416.90	1.76	5369.61

	SECNO	XLCH	DEPTH	HV	CWSEL	TOPWID	SHEAR	AREA
	402.500	720.00	5.69	1.31	1138.59	253.93	1.32	1142.42
*	402.500	720.00	11.04	3.84	1143.94	300.15	3.02	2610.25
*	402.500	720.00	14.25	5.49	1147.15	360.38	4.08	3671.76
	406.500	400.00	6.11	1.26	1140.41	245.15	1.23	1166.57
	406.500	400.00	12.42	3.04	1146.72	314.39	2.39	2927.89
	406.500	400.00	16.77	3.66	1151.07	398.50	2.71	4431.94
	409.500	315.00	6.89	1.30	1141.59	207.84	1.23	1145.83
	409.500	315.00	12.43	4.63	1147.13	235.70	3.60	2373.55
*	409.500	315.00	16.27	6.53	1150.97	255.03	4.69	3315.51
	410.540	83.50	7.11	1.19	1141.91	206.64	1.10	1199.98
*	410.540	83.50	14.56	3.18	1149.36	240.62	2.35	2866.53
*	410.540	83.50	19.84	4.07	1154.64	264.68	2.76	4199.96
	412.760	223.00	7.49	1.25	1142.59	216.15	1.18	1168.61
	412.760	223.00	15.58	2.57	1150.68	282.48	1.91	3187.83
	412.760	223.00	21.44	2.85	1156.54	352.23	1.96	5019.47
	418.970	620.00	8.88	1.00	1144.68	218.99	.92	1307.33
	418.970	620.00	16.86	2.22	1152.66	312.20	1.66	3428.49
	418.970	620.00	22.39	2.52	1158.19	376.46	1.73	5340.86
	424.170	520.00	9.36	.91	1145.96	220.17	.83	1368.91
	424.170	520.00	17.38	2.12	1153.98	314.66	1.58	3508.07
	424.170	520.00	22.58	2.56	1159.18	373.00	1.76	5293.12
	429.370	500.00	9.45	.80	1147.05	225.90	.71	1466.50
	429.370	500.00	17.83	1.72	1155.43	340.96	1.27	3898.66
	429.370	500.00	22.89	2.18	1160.49	388.78	1.48	5738.25
	435.370	600.00	10.02	.72	1148.12	235.09	.64	1542.31
	435.370	600.00	18.37	1.72	1156.47	327.68	1.25	3896.52
	435.370	600.00	23.30	2.26	1161.40	397.21	1.52	5653.41
	441.600	610.00	10.03	.54	1149.03	222.81	.45	1775.23
	441.600	610.00	18.52	1.61	1157.52	307.85	1.14	4029.17
	441.600	610.00	23.35	2.27	1162.35	355.07	1.51	5628.27
	446.870	560.00	9.53	.72	1149.53	217.06	.63	1537.04
	446.870	560.00	18.20	1.86	1158.20	296.61	1.33	3748.38
	446.870	560.00	23.07	2.55	1163.07	344.15	1.71	5306.29
	449.050	232.00	9.61	.66	1149.91	216.11	.56	1615.15
	449.050	232.00	18.44	1.70	1158.74	304.45	1.21	3914.47
	449.050	232.00	23.40	2.34	1163.70	353.96	1.56	5544.34
*	450.230	100.00	9.65	.33	1150.35	284.90	.27	2283.58
*	450.230	100.00	19.03	.90	1159.73	378.77	.61	5398.57
*	450.230	100.00	24.27	1.27	1164.97	431.24	.81	7523.50

	SECNO	XLCH	DEPTH	HV	CWSEL	TOPWID	SHEAR	AREA
	451.050	82.00	9.48	.25	1150.48	306.85	.20	2638.29
	451.050	82.00	18.91	.78	1159.91	363.47	.52	5801.12
	451.050	82.00	24.12	1.19	1165.12	394.71	.74	7774.56
	451.230	18.00	9.46	.28	1150.46	268.91	.23	2453.46
	451.230	18.00	18.75	1.03	1159.75	287.49	.70	5037.84
	451.230	18.00	23.78	1.69	1164.78	297.55	1.08	6509.41
	452.230	100.00	9.50	.28	1150.50	269.69	.23	2467.24
	452.230	100.00	18.82	1.01	1159.82	289.04	.68	5073.66
	452.230	100.00	23.88	1.67	1164.88	299.54	1.06	6562.55
*	452.500	27.50	3.77	1.87	1155.77	257.53	2.02	955.65
*	452.500	27.50	9.24	4.55	1161.24	268.48	3.73	2395.27
*	452.500	27.50	12.92	6.22	1164.92	275.85	4.64	3397.78
	452.650	15.00	4.48	1.32	1156.48	258.97	1.34	1140.86
	452.650	15.00	10.42	3.55	1162.42	270.82	2.81	2711.53
	452.650	15.00	14.35	4.99	1166.35	278.70	3.62	3792.94
	452.730	8.00	4.63	1.21	1156.63	263.90	1.21	1190.37
	452.730	8.00	11.04	3.02	1163.04	283.09	2.34	2940.41
	452.730	8.00	15.41	4.05	1167.41	320.27	2.85	4211.24
	453.230	50.00	5.02	1.02	1157.02	265.08	1.00	1294.45
	453.230	50.00	11.47	2.78	1163.47	284.43	2.12	3066.71
	453.230	50.00	15.89	3.75	1167.89	373.35	2.60	4470.49
*	455.630	240.00	6.11	.47	1158.11	356.43	.44	1910.18
*	455.630	240.00	13.66	1.17	1165.66	386.63	.85	4714.86
*	455.630	240.00	18.64	1.59	1170.64	493.98	1.04	6865.30
	458.500	290.00	6.56	.24	1158.66	582.05	.24	2649.93
*	458.500	290.00	14.54	.46	1166.64	634.58	.34	7508.80
*	458.500	290.00	19.89	.54	1171.99	925.10	.38	11565.68
*	462.600	410.00	2.99	.96	1159.49	345.76	1.28	648.62
*	462.600	410.00	10.37	.45	1166.87	424.59	.37	3545.75
*	462.600	410.00	15.62	.66	1172.12	459.54	.47	5853.71
*	466.600	400.00	4.35	.59	1162.35	293.33	.69	827.41
*	466.600	400.00	8.84	1.16	1166.84	318.75	1.01	2200.62
*	466.600	400.00	13.90	1.48	1171.90	349.34	1.11	3888.68
	471.300	470.00	4.95	1.12	1164.25	184.59	1.24	600.84
*	471.300	470.00	8.68	1.88	1167.98	347.86	1.82	1726.00
	471.300	470.00	13.23	1.96	1172.53	392.37	1.54	3407.65
	475.800	450.00	4.60	.80	1166.70	190.99	.85	709.64
	475.800	450.00	7.95	2.87	1170.05	218.37	2.56	1397.38
*	475.800	450.00	11.45	4.63	1173.55	241.05	3.69	2200.53

	SECNO	XLCH	DEPTH	HV	CWSEL	TOPWID	SHEAR	AREA
*	8.978	500.00	4.33	.23	1168.23	366.19	.24	1337.40
*	8.978	500.00	9.62	.49	1173.52	403.70	.40	3372.83
*	8.978	500.00	14.70	.74	1178.60	436.96	.53	5513.70
*	9.072	520.00	3.64	.40	1169.04	451.74	.51	1001.19
	9.072	520.00	8.57	.51	1173.97	485.22	.44	3321.34
	9.072	520.00	13.64	.65	1179.04	514.58	.48	5857.88
*	9.167	520.00	5.64	1.29	1173.94	224.59	1.56	560.51
*	9.167	520.00	9.08	2.66	1177.38	281.40	2.53	1452.14
*	9.167	520.00	12.50	3.59	1180.80	349.44	3.07	2498.00
*	9.262	500.00	5.24	.15	1176.04	430.82	.16	1630.68
*	9.262	500.00	9.87	.40	1180.67	471.90	.33	3752.53
*	9.262	500.00	13.98	.68	1184.78	487.36	.50	5732.60
*	9.356	490.00	3.14	.72	1176.44	403.82	.97	746.47
*	9.356	490.00	7.64	.74	1180.94	481.49	.68	2751.99
	9.356	490.00	11.71	1.00	1185.01	495.88	.78	4745.85
	9.451	500.00	4.52	.92	1181.02	356.61	1.23	662.27
*	9.451	500.00	7.08	2.23	1183.58	366.73	2.26	1585.96
*	9.451	500.00	9.66	3.46	1186.16	376.98	3.04	2547.42
*	9.546	500.00	5.04	.22	1182.94	359.35	.23	1363.50
*	9.546	500.00	8.73	.76	1186.63	372.55	.65	2711.65
*	9.546	500.00	12.03	1.43	1189.93	384.39	1.09	3962.74
*	9.641	500.00	5.61	1.27	1184.01	225.69	1.55	563.83
*	9.641	500.00	8.94	2.41	1187.34	330.14	2.40	1525.82
*	9.641	500.00	11.77	3.67	1190.17	339.50	3.15	2473.36
	9.735	500.00	5.04	1.45	1188.54	172.51	1.67	527.49
*	9.735	500.00	9.19	3.42	1192.69	190.28	3.06	1279.59
*	9.735	500.00	13.29	5.10	1196.79	209.36	4.02	2097.23
*	9.783	250.00	4.93	1.48	1191.03	177.07	1.72	522.20
*	9.783	250.00	9.07	3.31	1195.17	199.80	2.97	1302.03
*	9.783	250.00	12.97	5.00	1199.07	213.15	4.00	2118.20
*	9.786	20.00	3.54	1.46	1192.54	183.87	1.70	526.65
*	9.786	20.00	7.60	3.25	1196.60	205.33	2.98	1313.75
*	9.786	20.00	11.43	5.02	1200.43	212.80	4.09	2113.85
	9.832	225.00	5.63	.89	1194.83	238.64	1.04	672.81
*	9.832	225.00	10.23	1.67	1199.43	266.54	1.46	1834.86
*	9.832	225.00	16.18	.99	1205.38	1175.50	.87	6357.36
	9.850	100.00	5.11	.89	1195.11	212.96	.99	674.72
	9.850	100.00	9.95	1.73	1199.95	248.06	1.48	1799.76
	9.850	100.00	18.31	.97	1208.31	835.00	.74	5961.43

	SECNO	XLCH	DEPTH	HV	CWSEL	TOPWID	SHEAR	AREA
	9.902	260.00	5.33	.64	1196.63	377.36	.74	831.89
*	9.902	260.00	10.45	.54	1201.75	619.23	.54	3612.42
*	9.902	260.00	17.89	.28	1209.19	1020.70	.26	10538.84
	-458.500	550.00	6.56	.24	1158.66	582.05	.24	2650.00
	-458.500	550.00	14.54	.46	1166.64	634.58	.34	7508.41
	-458.500	550.00	19.89	.54	1171.99	924.94	.38	11561.95
*	462.800	420.00	4.96	.81	1158.86	279.00	.92	1272.14
*	462.800	420.00	12.29	1.57	1166.19	319.47	1.35	3484.15
*	462.800	420.00	17.57	1.72	1171.47	337.14	1.32	5225.06
*	19.000	440.00	4.06	1.22	1159.76	262.21	1.46	1037.37
	19.000	440.00	10.81	2.28	1166.51	286.62	2.02	2889.80
	19.000	440.00	16.04	2.38	1171.74	308.74	1.90	4441.48
*	20.900	200.00	5.91	.62	1161.11	294.47	.69	1455.83
	20.900	200.00	12.57	1.58	1167.77	310.59	1.36	3472.58
	20.900	200.00	17.53	1.80	1172.73	337.42	1.42	5102.00
	24.890	380.00	6.58	.55	1161.98	307.36	.61	1550.28
	24.890	380.00	13.24	1.43	1168.64	321.85	1.24	3645.70
	24.890	380.00	17.94	1.75	1173.34	332.08	1.38	5184.04
*	24.900	6.00	3.30	1.51	1165.20	310.29	1.98	931.62
*	24.900	6.00	7.64	3.60	1169.54	320.50	3.55	2299.75
*	24.900	6.00	10.19	4.81	1172.09	326.51	4.35	3125.97
*	25.400	50.00	3.09	1.55	1165.99	301.52	2.01	922.05
*	25.400	50.00	7.47	3.72	1170.37	310.75	3.67	2261.27
*	25.400	50.00	10.09	4.94	1172.99	316.27	4.46	3082.43
*	26.700	130.00	4.53	.71	1167.73	303.93	.82	1357.75
*	26.700	130.00	9.92	2.08	1173.12	314.53	1.89	3022.06
*	26.700	130.00	12.99	2.94	1176.19	320.60	2.47	3999.64
	27.800	110.00	4.34	.96	1167.84	273.62	1.12	1169.52
	27.800	110.00	10.03	2.50	1173.53	284.91	2.27	2757.23
	27.800	110.00	13.31	3.43	1176.81	291.42	2.88	3701.99
	29.600	180.00	4.87	.62	1168.77	304.49	.69	1460.90
	29.600	180.00	11.06	1.66	1174.96	316.54	1.46	3381.06
	29.600	180.00	14.65	2.29	1178.55	323.54	1.86	4530.53
*	30.000	40.00	4.92	.61	1168.92	316.82	1.69	1469.72
*	30.000	40.00	11.23	1.54	1175.23	329.46	3.31	3511.70
*	30.000	40.00	14.91	2.09	1178.91	336.82	4.14	4736.42
	31.750	175.00	6.57	.37	1169.97	394.96	1.02	1877.92
	31.750	175.00	13.24	.90	1176.64	421.49	1.88	4601.79
	31.750	175.00	17.19	1.19	1180.59	437.16	2.27	6293.77

SECNO	XLCH	DEPTH	HV	CWSEL	TOPWID	SHEAR	AREA
33.000	125.00	6.31	.53	1170.41	353.93	1.48	1577.02
33.000	125.00	12.75	1.24	1176.85	373.87	2.65	3919.00
33.000	125.00	16.60	1.62	1180.70	386.16	3.18	5385.04
35.000	200.00	5.51	.55	1171.41	310.34	1.49	1544.21
35.000	200.00	11.66	1.55	1177.56	329.16	3.31	3503.69
35.000	200.00	15.35	2.08	1181.25	343.50	4.11	4747.41
37.000	200.00	5.26	.61	1172.16	285.92	1.06	1466.61
37.000	200.00	11.36	1.79	1178.26	302.02	2.46	3256.13
37.000	200.00	14.96	2.47	1181.86	316.57	3.14	4364.85
38.320	132.00	4.96	.76	1172.46	276.81	.85	1314.83
38.320	132.00	11.03	2.01	1178.53	302.01	1.76	3079.12
38.320	132.00	14.61	2.69	1182.11	314.91	2.18	4181.79
40.050	173.00	6.57	.54	1173.07	273.93	.57	1559.47
40.050	173.00	12.77	1.71	1179.27	296.66	1.46	3335.12
40.050	173.00	16.35	2.39	1182.85	318.61	1.90	4431.42
43.000	295.00	6.84	.52	1173.54	267.92	.54	1591.42
43.000	295.00	13.24	1.64	1179.94	295.79	1.38	3409.46
43.000	295.00	16.86	2.31	1183.56	321.53	1.84	4504.70
46.920	392.00	6.51	.60	1174.11	259.32	.63	1484.79
46.920	392.00	13.02	1.79	1180.62	283.23	1.52	3257.10
46.920	392.00	16.66	2.53	1184.26	296.33	1.99	4312.01
50.900	398.00	6.83	.53	1174.83	264.92	.55	1571.56
50.900	398.00	13.62	1.59	1181.62	290.82	1.33	3460.83
50.900	398.00	17.38	2.24	1185.38	304.90	1.74	4580.65
55.000	410.00	6.43	.53	1175.43	260.56	.55	1574.95
55.000	410.00	13.35	1.58	1182.35	287.33	1.32	3464.61
55.000	410.00	17.15	2.23	1186.15	304.39	1.74	4588.32
60.000	500.00	6.48	.56	1176.18	265.93	.58	1536.85
60.000	500.00	13.57	1.53	1183.27	293.12	1.28	3526.01
60.000	500.00	17.45	2.14	1187.15	307.05	1.66	4688.24
64.000	400.00	6.33	.65	1176.83	254.49	.69	1425.14
64.000	400.00	13.34	1.77	1183.84	273.99	1.49	3280.44
64.000	400.00	17.17	2.48	1187.67	289.28	1.95	4355.41
65.450	145.00	6.12	.64	1177.12	252.92	.68	1429.15
65.450	145.00	13.28	1.63	1184.28	297.40	1.37	3419.30
65.450	145.00	17.27	2.18	1188.27	311.48	1.71	4637.75
66.900	145.00	6.28	.53	1177.48	265.42	.56	1570.00
66.900	145.00	13.52	1.46	1184.72	295.98	1.21	3611.07
66.900	145.00	17.50	2.02	1188.70	310.32	1.56	4818.13

	SECNO	XLCH	DEPTH	HV	CWSEL	TOPWID	SHEAR	AREA
	67.900	100.00	6.32	.56	1177.62	257.67	.59	1528.78
	67.900	100.00	13.53	1.53	1184.83	293.21	1.28	3520.55
	67.900	100.00	17.50	2.12	1188.80	304.63	1.64	4707.38
	68.690	73.00	6.35	.55	1177.75	257.51	.57	1550.07
	68.690	73.00	13.55	1.54	1184.95	287.79	1.28	3515.95
	68.690	73.00	17.50	2.14	1188.90	299.74	1.66	4680.11
*	68.700	7.00	3.34	1.65	1181.74	273.96	2.09	892.99
*	68.700	7.00	8.03	3.85	1186.43	291.58	3.72	2221.70
*	68.700	7.00	10.77	5.11	1189.17	300.35	4.51	3032.42
*	69.100	40.00	4.16	1.06	1182.66	275.64	1.26	1112.23
	69.100	40.00	9.17	2.95	1187.67	292.48	2.73	2538.91
	69.100	40.00	12.00	4.12	1190.50	300.66	3.53	3376.96
	70.100	100.00	4.42	.97	1183.22	271.24	1.13	1162.39
	70.100	100.00	9.44	2.89	1188.24	288.36	2.65	2567.66
	70.100	100.00	12.19	4.13	1190.99	297.28	3.52	3373.57
	71.800	170.00	4.64	.93	1183.94	266.14	1.07	1186.13
	71.800	170.00	9.84	2.77	1189.14	285.09	2.51	2622.09
	71.800	170.00	12.69	3.95	1191.99	293.46	3.34	3446.91
	73.500	170.00	4.97	.80	1184.67	269.55	.89	1284.15
	73.500	170.00	10.58	2.33	1190.28	290.99	2.07	2858.95
	73.500	170.00	13.70	3.28	1193.40	301.92	2.71	3781.75
	76.320	282.00	6.73	.63	1185.53	264.02	.68	1441.08
	76.320	282.00	12.66	2.01	1191.46	287.71	1.75	3073.54
	76.320	282.00	15.92	2.88	1194.72	302.71	2.33	4036.19
	81.000	468.00	6.00	.71	1186.50	261.68	.77	1358.53
	81.000	468.00	12.17	2.05	1192.67	284.60	1.78	3045.43
	81.000	468.00	15.51	2.91	1196.01	297.07	2.35	4015.80
	84.700	370.00	6.24	.49	1187.44	299.27	.52	1641.36
	84.700	370.00	12.99	1.35	1194.19	326.60	1.14	3751.92
	84.700	370.00	16.70	1.89	1197.90	339.09	1.48	4988.46

EAR, 100-YEAR, AND S

SUMMARY PRINTOUT TABLE 150

	SECNO	XLCH	ELTRD	ELLC	ELMIN	Q	CWSEL	CRIWS	EG	10*KS	VCH	AREA	.01K
	337.000	.00	.00	.00	1112.40	10500.00	1117.36	1116.13	1118.17	41.69	7.21	1456.93	1626.19
	337.000	.00	.00	.00	1112.40	41000.00	1122.85	1120.74	1125.17	42.23	12.23	3351.16	6309.04
	337.000	.00	.00	.00	1112.40	69000.00	1126.48	1123.91	1129.91	42.04	14.86	4643.07	10641.34
	342.000	510.00	.00	.00	1114.80	10500.00	1119.39	1118.49	1120.33	41.44	7.77	1352.20	1631.16
	342.000	510.00	.00	.00	1114.80	41000.00	1124.73	1123.02	1127.18	35.50	12.56	3264.27	6880.86
	342.000	510.00	.00	.00	1114.80	68000.00	1128.42	1126.01	1131.77	31.80	14.70	4624.85	12059.08
	343.700	180.00	.00	.00	1115.80	10500.00	1120.10	1119.43	1121.17	48.37	8.31	1264.06	1509.81
	343.700	180.00	.00	.00	1115.80	41000.00	1125.09	1124.06	1128.06	45.57	13.82	2965.75	6073.83
	343.700	180.00	.00	.00	1115.80	68000.00	1128.53	1127.14	1132.66	41.95	16.32	4166.73	10498.65
	345.500	190.00	.00	.00	1117.00	10500.00	1121.08	1120.14	1122.00	38.35	7.72	1360.74	1695.50
	345.500	190.00	.00	.00	1117.00	41000.00	1126.20	1124.77	1128.89	38.90	13.15	3117.83	6573.82
	345.500	190.00	.00	.00	1117.00	68000.00	1129.53	1127.84	1133.45	38.42	15.88	4282.20	10970.52
*	346.400	100.00	1141.90	1134.30	1117.40	10500.00	1121.58	.00	1122.46	35.23	7.52	1396.57	1769.13
*	346.400	100.00	1141.90	1134.30	1117.40	41000.00	1128.22	.00	1130.15	22.75	11.14	3681.55	8596.20
*	346.400	100.00	1141.90	1134.30	1117.40	68000.00	1132.60	.00	1135.22	20.25	13.00	5232.73	15110.64
*	346.800	25.00	.00	.00	1118.10	10500.00	1121.50	1121.50	1123.13	90.55	10.25	1024.62	1103.46
	346.800	25.00	.00	.00	1118.10	41000.00	1127.70	1126.28	1130.47	39.55	13.36	3069.57	6519.13
	346.800	25.00	.00	.00	1118.10	68000.00	1132.14	1129.45	1135.50	29.82	14.72	4620.33	12452.73
*	347.100	30.00	.00	.00	1118.30	10500.00	1122.49	1121.44	1123.36	35.00	7.50	1399.71	1774.84
	347.100	30.00	.00	.00	1118.30	41000.00	1128.43	1126.04	1130.63	28.31	11.91	3442.75	7705.86
	347.100	30.00	.00	.00	1118.30	68000.00	1132.71	1129.11	1135.63	24.12	13.71	4958.61	13847.20
	347.110	1.00	1140.10	1141.00	1118.30	10500.00	1122.31	1121.62	1123.45	54.74	8.54	1229.17	1419.15
	347.110	1.00	1140.10	1141.00	1118.30	41000.00	1127.97	1126.49	1130.83	52.04	13.59	3016.30	5683.24
	347.110	1.00	1140.10	1141.00	1118.30	68000.00	1132.12	1129.76	1135.88	47.81	15.56	4371.00	9834.28
	347.400	30.00	1140.10	1141.00	1118.50	10500.00	1122.45	1121.82	1123.63	57.81	8.69	1208.27	1380.96
	347.400	30.00	1140.10	1141.00	1118.50	41000.00	1128.09	1126.69	1131.01	53.50	13.72	2989.10	5605.38
	347.400	30.00	1140.10	1141.00	1118.50	68000.00	1132.23	1129.96	1136.04	48.84	15.67	4339.98	9730.65
	347.410	1.00	.00	.00	1118.50	10500.00	1122.86	1121.64	1123.67	30.62	7.20	1457.91	1897.42
*	347.410	1.00	.00	.00	1118.50	41000.00	1129.10	1126.24	1131.10	24.38	11.37	3606.92	8304.45
*	347.410	1.00	.00	.00	1118.50	68000.00	1133.46	1129.31	1136.16	21.28	13.18	5158.34	14740.24
*	352.400	460.00	.00	.00	1120.10	10500.00	1124.84	1124.84	1126.38	93.84	9.95	1055.34	1083.89
*	352.400	460.00	.00	.00	1120.10	41000.00	1129.95	1129.30	1133.02	53.19	14.04	2919.63	5621.84
	352.400	460.00	.00	.00	1120.10	68000.00	1134.39	1132.57	1137.48	33.35	14.28	5263.18	11775.59
*	358.250	600.00	.00	.00	1123.90	10500.00	1128.90	1127.92	1129.81	37.34	7.67	1369.82	1718.25
	358.250	600.00	.00	.00	1123.90	41000.00	1133.02	1132.56	1136.40	56.53	14.76	2778.21	5452.96
*	358.250	600.00	.00	.00	1123.90	68000.00	1136.51	1136.51	1140.45	43.19	16.27	4834.12	10346.70

	SECNO	XLCH	ELTRD	ELLC	ELMIN	Q	CWSEL	CRIWS	EG	10*KS	VCH	AREA	.01K
*	365.400	700.00	.00	.00	1124.90	10500.00	1130.89	1128.56	1131.46	15.73	6.07	1728.76	2647.63
*	365.400	700.00	.00	.00	1124.90	41000.00	1137.07	1133.64	1138.60	17.46	10.21	4757.95	9812.97
*	365.400	700.00	.00	.00	1124.90	68000.00	1140.63	1137.60	1142.32	14.75	11.30	7926.76	17705.60
	370.650	535.00	.00	.00	1125.50	10500.00	1131.79	1129.47	1132.28	14.65	5.65	1858.44	2743.54
	370.650	535.00	.00	.00	1125.50	41000.00	1138.26	1134.08	1139.53	16.12	9.05	4540.44	10210.63
	370.650	535.00	.00	.00	1125.50	68000.00	1141.27	1137.16	1143.29	18.15	11.43	6014.92	15962.26
	373.750	320.00	.00	.00	1125.90	10500.00	1132.23	1130.05	1132.82	17.48	6.13	1712.60	2511.25
	373.750	320.00	.00	.00	1125.90	41000.00	1138.55	1134.89	1140.21	19.63	10.35	3968.52	9253.30
	373.750	320.00	.00	.00	1125.90	68000.00	1141.60	1138.01	1144.05	21.59	12.75	6021.29	14634.98
	376.750	300.00	.00	.00	1127.00	10500.00	1132.71	1130.90	1133.48	23.68	7.07	1485.02	2157.77
	376.750	300.00	.00	.00	1127.00	41000.00	1138.98	1136.25	1141.01	26.85	11.44	3583.34	7912.70
	376.750	300.00	.00	.00	1127.00	68000.00	1141.98	1139.35	1144.95	29.02	13.98	5286.16	12622.36
	379.750	300.00	.00	.00	1128.10	10500.00	1133.43	1131.83	1134.23	25.53	7.14	1469.88	2078.09
	379.750	300.00	.00	.00	1128.10	41000.00	1139.78	1136.96	1141.81	26.23	11.42	3590.25	8005.05
	379.750	300.00	.00	.00	1128.10	68000.00	1142.96	1140.46	1145.80	26.58	13.72	5587.29	13190.64
	384.500	470.00	.00	.00	1128.90	10500.00	1134.64	1132.39	1135.18	15.73	5.87	1790.26	2647.69
	384.500	470.00	.00	.00	1128.90	41000.00	1141.39	1137.09	1142.80	15.63	9.53	4301.10	10372.08
	384.500	470.00	.00	.00	1128.90	68000.00	1144.64	1140.13	1146.91	18.98	12.07	5635.45	15610.26
	388.500	410.00	.00	.00	1129.50	10500.00	1135.30	1133.25	1135.88	17.75	6.09	1724.39	2492.46
	388.500	410.00	.00	.00	1129.50	41000.00	1141.99	1137.93	1143.50	16.93	9.86	4159.81	9965.75
	388.500	410.00	.00	.00	1129.50	68000.00	1145.37	1141.00	1147.74	19.97	12.35	5509.40	15217.31
	392.000	350.00	.00	.00	1130.10	10500.00	1135.91	1133.85	1136.51	18.03	6.19	1695.02	2473.06
	392.000	350.00	.00	.00	1130.10	41000.00	1142.55	1138.65	1144.13	17.87	10.10	4058.14	9699.75
	392.000	350.00	.00	.00	1130.10	68000.00	1146.02	1141.76	1148.47	20.48	12.57	5410.08	15025.71
	395.500	350.00	.00	.00	1131.30	10500.00	1136.56	1134.99	1137.30	25.58	6.90	1522.08	2075.86
	395.500	350.00	.00	.00	1131.30	41000.00	1143.14	1139.79	1144.83	20.63	10.44	3927.73	9026.27
	395.500	350.00	.00	.00	1131.30	68000.00	1146.73	1142.85	1149.22	21.94	12.66	5369.61	14517.54
	402.500	720.00	.00	.00	1132.90	10500.00	1138.59	1137.79	1139.91	46.86	9.19	1142.42	1533.90
*	402.500	720.00	.00	.00	1132.90	41000.00	1143.94	1143.44	1147.78	55.87	15.72	2610.25	5485.00
*	402.500	720.00	.00	.00	1132.90	68000.00	1147.15	1147.15	1152.65	58.38	18.85	3671.76	8900.06
	406.500	400.00	.00	.00	1134.30	10500.00	1140.41	1139.40	1141.67	41.50	9.00	1166.57	1629.97
	406.500	400.00	.00	.00	1134.30	41000.00	1146.72	1145.27	1149.76	41.17	14.00	2927.89	6389.53
	406.500	400.00	.00	.00	1134.30	68000.00	1151.07	1148.80	1154.72	39.02	15.34	4431.94	10885.72
	409.500	315.00	.00	.00	1134.70	10500.00	1141.59	1140.28	1142.90	35.64	9.16	1145.83	1758.91
	409.500	315.00	.00	.00	1134.70	41000.00	1147.13	1146.81	1151.76	57.31	17.27	2373.55	5415.71
*	409.500	315.00	.00	.00	1134.70	68000.00	1150.97	1150.97	1157.50	57.82	20.51	3315.51	8942.77
	410.540	83.50	1161.60	1156.10	1134.80	10500.00	1141.91	.00	1143.10	30.42	8.75	1199.98	1903.83
*	410.540	83.50	1161.60	1156.10	1134.80	41000.00	1149.36	.00	1152.54	31.64	14.30	2866.53	7288.82
*	410.540	83.50	1161.60	1156.10	1134.80	68000.00	1154.64	.00	1158.71	27.89	16.19	4199.96	12876.11

	SECNO	XLCH	ELTRD	ELLC	ELMIN	Q	CWSEL	CRIWS	EG	10*KS	VCH	AREA	.01K
	412.760	223.00	.00	.00	1135.10	10500.00	1142.59	1141.23	1143.85	35.02	8.99	1168.61	1774.35
	412.760	223.00	.00	.00	1135.10	41000.00	1150.68	1147.64	1153.25	27.09	12.86	3187.83	7877.84
	412.760	223.00	.00	.00	1135.10	68000.00	1156.54	1151.60	1159.39	22.04	13.55	5019.47	14485.83
	418.970	620.00	.00	.00	1135.80	10500.00	1144.68	1142.53	1145.68	24.61	8.03	1307.33	2116.45
	418.970	620.00	.00	.00	1135.80	41000.00	1152.66	1149.15	1154.88	24.25	11.96	3428.49	8326.12
	418.970	620.00	.00	.00	1135.80	68000.00	1158.19	1153.04	1160.70	19.55	12.73	5340.86	15379.28
	424.170	520.00	.00	.00	1136.60	10500.00	1145.96	1143.50	1146.88	21.27	7.67	1368.91	2276.58
	424.170	520.00	.00	.00	1136.60	41000.00	1153.98	1150.18	1156.11	22.70	11.69	3508.07	8604.89
	424.170	520.00	.00	.00	1136.60	68000.00	1159.18	1154.11	1161.74	19.90	12.85	5293.12	15242.95
	429.370	500.00	.00	.00	1137.60	10500.00	1147.05	1144.21	1147.85	17.45	7.16	1466.50	2513.29
	429.370	500.00	.00	.00	1137.60	41000.00	1155.43	1150.95	1157.15	17.76	10.52	3898.66	9729.98
	429.370	500.00	.00	.00	1137.60	68000.00	1160.49	1154.56	1162.67	16.07	11.85	5738.25	16960.45
	435.370	600.00	.00	.00	1138.10	10500.00	1148.12	1145.04	1148.84	15.58	6.81	1542.31	2660.12
	435.370	600.00	.00	.00	1138.10	41000.00	1156.47	1151.56	1158.19	16.88	10.52	3896.52	9979.03
	435.370	600.00	.00	.00	1138.10	68000.00	1161.40	1155.39	1163.66	15.98	12.07	5653.41	17008.87
	441.600	610.00	.00	.00	1139.00	10500.00	1149.03	1144.45	1149.58	9.10	5.91	1775.23	3480.60
	441.600	610.00	.00	.00	1139.00	41000.00	1157.52	1151.43	1159.13	13.94	10.18	4029.17	10982.19
	441.600	610.00	.00	.00	1139.00	68000.00	1162.35	1155.56	1164.61	15.24	12.08	5628.27	17419.77
	446.870	560.00	.00	.00	1140.00	10500.00	1149.53	1146.10	1150.26	14.22	6.83	1537.04	2784.41
	446.870	560.00	.00	.00	1140.00	41000.00	1158.20	1152.97	1160.06	16.91	10.94	3748.38	9970.49
	446.870	560.00	.00	.00	1140.00	68000.00	1163.07	1157.17	1165.62	17.82	12.81	5306.29	16108.43
	449.050	232.00	.00	.00	1140.30	10500.00	1149.91	1145.98	1150.57	11.93	6.50	1615.15	3040.60
	449.050	232.00	.00	.00	1140.30	41000.00	1158.74	1153.01	1160.45	15.08	10.47	3914.47	10558.28
	449.050	232.00	.00	.00	1140.30	68000.00	1163.70	1157.21	1166.03	15.91	12.26	5544.34	17045.90
*	450.230	100.00	.00	.00	1140.70	10500.00	1150.35	1145.09	1150.68	5.42	4.60	2283.58	4510.52
*	450.230	100.00	.00	.00	1140.70	41000.00	1159.73	1151.00	1160.63	6.89	7.59	5398.57	15617.66
*	450.230	100.00	.00	.00	1140.70	68000.00	1164.97	1154.63	1166.24	7.47	9.04	7523.50	24885.73
	451.050	82.00	.00	.00	1141.00	10500.00	1150.48	1144.73	1150.72	3.71	3.98	2638.29	5448.68
	451.050	82.00	.00	.00	1141.00	41000.00	1159.91	1150.07	1160.69	5.18	7.07	5801.12	18014.68
	451.050	82.00	.00	.00	1141.00	68000.00	1165.12	1153.48	1166.31	6.02	8.75	7774.56	27724.46
	451.230	18.00	.00	.00	1141.00	10500.00	1150.46	1144.77	1150.74	4.07	4.28	2453.46	5206.04
	451.230	18.00	.00	.00	1141.00	41000.00	1159.75	1150.23	1160.77	6.36	8.14	5037.84	16256.61
	451.230	18.00	.00	.00	1141.00	68000.00	1164.78	1153.92	1166.47	7.92	10.45	6509.41	24168.12
	452.230	100.00	.00	.00	1141.00	10500.00	1150.50	1144.76	1150.78	4.00	4.26	2467.24	5247.13
	452.230	100.00	.00	.00	1141.00	41000.00	1159.82	1150.25	1160.84	6.25	8.08	5073.66	16405.82
	452.230	100.00	.00	.00	1141.00	68000.00	1164.88	1153.92	1166.55	7.76	10.36	6562.55	24417.53
*	452.500	27.50	.00	.00	1152.00	10500.00	1155.77	1155.77	1157.64	87.02	10.99	955.65	1125.57
*	452.500	27.50	.00	.00	1152.00	41000.00	1161.24	1161.24	1165.79	66.99	17.12	2395.27	5009.28
*	452.500	27.50	.00	.00	1152.00	68000.00	1164.92	1164.92	1171.14	60.36	20.01	3397.78	8752.31

	SECNO	XLCH	ELTRD	ELLC	ELMIN	Q	CWSEL	CRIWS	EG	10*KS	VCH	AREA	.01K
	452.650	15.00	.00	.00	1152.00	10500.00	1156.48	1155.77	1157.79	48.72	9.20	1140.86	1504.36
	452.650	15.00	.00	.00	1152.00	41000.00	1162.42	1161.28	1165.97	45.02	15.12	2711.53	6110.63
	452.650	15.00	.00	.00	1152.00	68000.00	1166.35	1164.93	1171.34	42.62	17.93	3792.94	10416.33
	452.730	8.00	.00	.00	1152.00	10500.00	1156.63	1155.77	1157.84	43.15	8.82	1190.37	1598.46
	452.730	8.00	.00	.00	1152.00	41000.00	1163.04	1161.21	1166.06	36.07	13.94	2940.41	6827.13
	452.730	8.00	.00	.00	1152.00	68000.00	1167.41	1164.81	1171.46	32.11	16.16	4211.24	11999.57
	453.230	50.00	.00	.00	1152.00	10500.00	1157.02	1155.76	1158.05	32.86	8.11	1294.45	1831.65
	453.230	50.00	.00	.00	1152.00	41000.00	1163.47	1161.24	1166.25	31.58	13.37	3066.71	7295.92
	453.230	50.00	.00	.00	1152.00	68000.00	1167.89	1164.85	1171.64	27.87	15.58	4470.49	12880.29
*	455.630	240.00	.00	.00	1152.00	10500.00	1158.11	1155.67	1158.58	13.23	5.50	1910.18	2887.08
*	455.630	240.00	.00	.00	1152.00	41000.00	1165.66	1160.18	1166.83	11.19	8.70	4714.86	12257.32
*	455.630	240.00	.00	.00	1152.00	68000.00	1170.64	1163.17	1172.23	9.79	10.14	6865.30	21735.14
	458.500	290.00	.00	.00	1152.10	10500.00	1158.66	1156.09	1158.90	8.52	3.96	2649.93	3598.28
*	458.500	290.00	.00	.00	1152.10	41000.00	1166.64	1159.45	1167.10	4.55	5.46	7508.80	19224.68
*	458.500	290.00	.00	.00	1152.10	68000.00	1171.99	1161.66	1172.53	4.89	5.88	11565.68	30742.66
*	462.600	410.00	.00	.00	1156.50	5100.00	1159.49	1159.49	1160.45	109.41	7.86	648.62	487.58
*	462.600	410.00	.00	.00	1156.50	19000.00	1166.87	1162.15	1167.31	7.02	5.36	3545.75	7173.09
*	462.600	410.00	.00	.00	1156.50	38000.00	1172.12	1164.69	1172.78	5.69	6.51	5853.71	15937.11
*	466.600	400.00	.00	.00	1158.00	5100.00	1162.35	1161.60	1162.94	39.08	6.16	827.41	815.86
*	466.600	400.00	.00	.00	1158.00	19000.00	1166.84	1164.59	1167.99	23.42	8.63	2200.62	3926.44
*	466.600	400.00	.00	.00	1158.00	38000.00	1171.90	1167.53	1173.38	15.96	9.77	3888.68	9511.44
	471.300	470.00	.00	.00	1159.30	5100.00	1164.25	1163.65	1165.37	61.22	8.49	600.84	651.80
*	471.300	470.00	.00	.00	1159.30	19000.00	1167.98	1167.47	1169.87	58.69	11.01	1726.00	2480.11
	471.300	470.00	.00	.00	1159.30	38000.00	1172.53	1170.20	1174.48	26.94	11.23	3407.65	7321.49
	475.800	450.00	.00	.00	1162.10	5100.00	1166.70	1165.71	1167.50	36.82	7.19	709.64	840.54
	475.800	450.00	.00	.00	1162.10	19000.00	1170.05	1169.78	1172.92	64.11	13.60	1397.38	2373.00
*	475.800	450.00	.00	.00	1162.10	38000.00	1173.55	1173.55	1178.18	64.70	17.27	2200.53	4724.35
*	8.978	500.00	.00	.00	1163.90	5100.00	1168.23	1166.33	1168.45	10.58	3.81	1337.40	1567.76
*	8.978	500.00	.00	.00	1163.90	19000.00	1173.52	1168.94	1174.01	7.70	5.63	3372.83	6847.55
*	8.978	500.00	.00	.00	1163.90	38000.00	1178.60	1171.53	1179.33	6.69	6.89	5513.70	14689.14
*	9.072	520.00	.00	.00	1165.40	5100.00	1169.04	1168.31	1169.44	36.67	5.09	1001.19	842.22
	9.072	520.00	.00	.00	1165.40	19000.00	1173.97	1170.61	1174.47	10.33	5.72	3321.34	5911.94
	9.072	520.00	.00	.00	1165.40	38000.00	1179.04	1172.84	1179.69	6.78	6.49	5857.88	14596.75
*	9.167	520.00	.00	.00	1168.30	5100.00	1173.94	1173.94	1175.22	99.97	9.10	560.51	510.07
*	9.167	520.00	.00	.00	1168.30	19000.00	1177.38	1177.38	1180.04	78.61	13.08	1452.14	2142.95
*	9.167	520.00	.00	.00	1168.30	38000.00	1180.80	1180.80	1184.39	68.88	15.21	2498.00	4578.53
*	9.262	500.00	.00	.00	1170.80	5100.00	1176.04	1173.55	1176.19	6.78	3.13	1630.68	1959.12
*	9.262	500.00	.00	.00	1170.80	19000.00	1180.67	1176.16	1181.07	6.63	5.06	3752.53	7376.48
*	9.262	500.00	.00	.00	1170.80	38000.00	1184.78	1178.47	1185.47	6.79	6.63	5732.60	14579.85

	SECNO	XLCH	ELTRD	ELLC	ELMIN	Q	CWSEL	CRIWS	EG	10*KS	VCH	AREA	.01K
*	9.356	490.00	.00	.00	1173.30	5100.00	1176.44	1176.28	1177.17	84.07	6.83	746.47	556.23
*	9.356	490.00	.00	.00	1173.30	19000.00	1180.94	1178.66	1181.68	19.12	6.90	2751.99	4344.97
	9.356	490.00	.00	.00	1173.30	38000.00	1185.01	1180.99	1186.01	13.01	8.01	4745.85	10536.21
	9.451	500.00	.00	.00	1176.50	5100.00	1181.02	1180.98	1181.94	106.54	7.70	662.27	494.10
*	9.451	500.00	.00	.00	1176.50	19000.00	1183.58	1183.58	1185.80	83.89	11.98	1585.96	2074.44
*	9.451	500.00	.00	.00	1176.50	38000.00	1186.16	1186.16	1189.62	72.02	14.92	2547.42	4477.80
*	9.546	500.00	.00	.00	1177.90	5100.00	1182.94	1180.68	1183.16	9.68	3.74	1363.50	1638.90
*	9.546	500.00	.00	.00	1177.90	19000.00	1186.63	1183.56	1187.39	14.35	7.01	2711.65	5015.36
*	9.546	500.00	.00	.00	1177.90	38000.00	1189.93	1186.16	1191.36	16.99	9.59	3962.74	9218.13
*	9.641	500.00	.00	.00	1178.40	5100.00	1184.01	1184.01	1185.28	99.40	9.05	563.83	511.54
*	9.641	500.00	.00	.00	1178.40	19000.00	1187.34	1187.34	1189.75	83.07	12.45	1525.82	2084.62
*	9.641	500.00	.00	.00	1178.40	38000.00	1190.17	1190.17	1193.84	69.34	15.36	2473.36	4563.35
	9.735	500.00	.00	.00	1183.50	5100.00	1188.54	1188.46	1190.00	87.55	9.67	527.49	545.07
*	9.735	500.00	.00	.00	1183.50	19000.00	1192.69	1192.69	1196.12	72.98	14.85	1279.59	2224.07
*	9.735	500.00	.00	.00	1183.50	38000.00	1196.79	1196.79	1201.88	64.38	18.12	2097.23	4735.97
*	9.783	250.00	.00	.00	1186.10	5100.00	1191.03	1191.03	1192.51	93.36	9.77	522.20	527.83
*	9.783	250.00	.00	.00	1186.10	19000.00	1195.17	1195.17	1198.47	73.04	14.59	1302.03	2223.14
*	9.783	250.00	.00	.00	1186.10	38000.00	1199.07	1199.07	1204.07	64.48	17.94	2118.20	4732.28
*	9.786	20.00	.00	.00	1189.00	5100.00	1192.54	1192.54	1194.00	95.05	9.68	526.65	523.12
*	9.786	20.00	.00	.00	1189.00	19000.00	1196.60	1196.60	1199.85	74.72	14.46	1313.75	2197.99
*	9.786	20.00	.00	.00	1189.00	38000.00	1200.43	1200.43	1205.45	65.99	17.98	2113.85	4677.96
	9.832	225.00	.00	.00	1189.20	5100.00	1194.83	1194.38	1195.72	59.34	7.58	672.81	662.04
*	9.832	225.00	.00	.00	1189.20	19000.00	1199.43	1197.84	1201.10	33.90	10.36	1834.86	3263.11
*	9.832	225.00	.00	.00	1189.20	38000.00	1205.38	1201.14	1206.37	11.48	8.78	6357.36	11213.15
	9.850	100.00	1205.00	1199.20	1190.00	5100.00	1195.11	.00	1196.00	50.24	7.56	674.72	719.51
	9.850	100.00	1205.00	1199.20	1190.00	19000.00	1199.95	.00	1201.68	32.71	10.56	1799.76	3321.93
	9.850	100.00	1205.00	1199.20	1190.00	38000.00	1208.31	.00	1209.28	8.32	8.33	5961.43	13172.06
	9.902	260.00	.00	.00	1191.30	5100.00	1196.63	1196.01	1197.27	45.40	6.48	831.89	756.95
*	9.902	260.00	.00	.00	1191.30	19000.00	1201.75	1198.88	1202.28	11.86	6.39	3612.42	5517.28
*	9.902	260.00	.00	.00	1191.30	38000.00	1209.19	1201.14	1209.47	2.88	5.00	10538.84	22388.43
	-458.500	550.00	.00	.00	1152.10	10500.00	1158.66	.00	1158.90	8.51	3.96	2650.00	3598.44
	-458.500	550.00	.00	.00	1152.10	41000.00	1166.64	.00	1167.10	4.55	5.46	7508.41	19223.10
	-458.500	550.00	.00	.00	1152.10	68000.00	1171.99	.00	1172.53	4.90	5.88	11561.95	30729.67
*	462.800	420.00	.00	.00	1153.90	9200.00	1158.86	1157.49	1159.67	32.41	7.23	1272.14	1615.93
*	462.800	420.00	.00	.00	1153.90	35000.00	1166.19	1162.23	1167.76	19.79	10.05	3484.15	7868.04
*	462.800	420.00	.00	.00	1153.90	55000.00	1171.47	1164.92	1173.19	13.68	10.53	5225.06	14870.23
*	19.000	440.00	1188.00	1179.50	1155.70	9200.00	1159.76	.00	1160.98	59.06	8.87	1037.37	1197.15
	19.000	440.00	1188.00	1179.50	1155.70	35000.00	1166.51	.00	1168.79	32.16	12.11	2889.80	6171.80
	19.000	440.00	1188.00	1179.50	1155.70	55000.00	1171.74	.00	1174.12	21.11	12.38	4441.48	11969.88

	SECNO	XLCH	ELTRD	ELLC	ELMIN	Q	CWSEL	CRIWS	EG	10*KS	VCH	AREA	.01K
*	20.900	200.00	.00	.00	1155.20	9200.00	1161.11	1159.23	1161.73	22.38	6.32	1455.83	1944.74
	20.900	200.00	.00	.00	1155.20	35000.00	1167.77	1163.75	1169.35	19.55	10.08	3472.58	7915.73
	20.900	200.00	.00	.00	1155.20	55000.00	1172.73	1166.47	1174.53	14.96	10.78	5102.00	14218.79
	24.890	380.00	.00	.00	1155.40	9200.00	1161.98	1159.92	1162.52	19.32	5.93	1550.28	2093.19
	24.890	380.00	.00	.00	1155.40	35000.00	1168.64	1164.30	1170.07	17.54	9.60	3645.70	8358.06
	24.890	380.00	.00	.00	1155.40	55000.00	1173.34	1166.90	1175.09	14.15	10.61	5184.04	14623.80
*	24.900	6.00	.00	.00	1161.90	9200.00	1165.20	1165.20	1166.71	105.44	9.88	931.62	895.94
*	24.900	6.00	.00	.00	1161.90	35000.00	1169.54	1169.54	1173.13	79.39	15.22	2299.75	3928.23
*	24.900	6.00	.00	.00	1161.90	55000.00	1172.09	1172.09	1176.90	72.75	17.59	3125.97	6448.29
*	25.400	50.00	.00	.00	1162.90	9200.00	1165.99	1165.99	1167.54	105.14	9.98	922.05	897.24
*	25.400	50.00	.00	.00	1162.90	35000.00	1170.37	1170.37	1174.09	80.79	15.48	2261.27	3893.89
*	25.400	50.00	.00	.00	1162.90	55000.00	1172.99	1172.99	1177.93	73.32	17.84	3082.43	6423.11
*	26.700	130.00	.00	.00	1163.20	9200.00	1167.73	1166.29	1168.44	29.42	6.78	1357.75	1696.22
*	26.700	130.00	.00	.00	1163.20	35000.00	1173.12	1170.71	1175.20	31.52	11.58	3022.06	6233.80
*	26.700	130.00	.00	.00	1163.20	55000.00	1176.19	1173.32	1179.13	31.68	13.75	3999.64	9771.73
	27.800	110.00	1185.50	1177.50	1163.50	9200.00	1167.84	.00	1168.80	42.10	7.87	1169.52	1417.97
	27.800	110.00	1185.50	1177.50	1163.50	35000.00	1173.53	.00	1176.03	37.65	12.69	2757.23	5704.05
	27.800	110.00	1185.50	1177.50	1163.50	55000.00	1176.81	.00	1180.23	36.29	14.86	3701.99	9130.10
	29.600	180.00	.00	.00	1163.90	9200.00	1168.77	1167.00	1169.39	23.13	6.30	1460.90	1912.74
	29.600	180.00	.00	.00	1163.90	35000.00	1174.96	1171.40	1176.62	21.96	10.35	3381.06	7469.50
	29.600	180.00	.00	.00	1163.90	55000.00	1178.55	1174.01	1180.84	21.28	12.14	4530.53	11921.98
*	30.000	40.00	.00	.00	1164.00	9200.00	1168.92	1167.21	1169.53	58.32	6.26	1469.72	1204.68
*	30.000	40.00	.00	.00	1164.00	35000.00	1175.23	1171.51	1176.77	49.75	9.97	3511.70	4962.06
*	30.000	40.00	.00	.00	1164.00	55000.00	1178.91	1174.05	1181.00	47.18	11.61	4736.42	8006.95
	31.750	175.00	.00	.00	1163.40	9200.00	1169.97	1167.71	1170.35	34.36	4.90	1877.92	1569.50
	31.750	175.00	.00	.00	1163.40	35000.00	1176.64	1171.45	1177.54	27.59	7.61	4601.79	6663.44
	31.750	175.00	.00	.00	1163.40	55000.00	1180.59	1173.65	1181.77	25.31	8.74	6293.77	10932.32
	33.000	125.00	.00	.00	1164.10	9200.00	1170.41	1168.66	1170.94	53.38	5.83	1577.02	1259.26
	33.000	125.00	.00	.00	1164.10	35000.00	1176.85	1172.66	1178.09	40.53	8.93	3919.00	5497.53
	33.000	125.00	.00	.00	1164.10	55000.00	1180.70	1175.02	1182.32	36.50	10.21	5385.04	9103.72
	35.000	200.00	.00	.00	1165.90	9200.00	1171.41	1169.40	1171.96	48.07	5.96	1544.21	1326.97
	35.000	200.00	.00	.00	1165.90	35000.00	1177.56	1173.76	1179.11	49.79	9.99	3503.69	4960.14
	35.000	200.00	.00	.00	1165.90	55000.00	1181.25	1176.36	1183.34	47.60	11.59	4747.41	7971.51
	37.000	200.00	.00	.00	1166.90	9200.00	1172.16	1170.17	1172.77	33.01	6.27	1466.61	1601.26
	37.000	200.00	.00	.00	1166.90	35000.00	1178.26	1174.78	1180.05	36.63	10.75	3256.13	5783.18
	37.000	200.00	.00	.00	1166.90	55000.00	1181.86	1177.51	1184.32	36.50	12.60	4364.85	9103.36
	38.320	132.00	.00	.00	1167.50	9200.00	1172.46	1170.89	1173.22	28.74	7.00	1314.83	1716.19
	38.320	132.00	.00	.00	1167.50	35000.00	1178.53	1175.67	1180.54	27.72	11.37	3079.12	6647.27
	38.320	132.00	.00	.00	1167.50	55000.00	1182.11	1178.41	1184.79	26.28	13.15	4181.79	10729.48

	SECNO	XLCH	ELTRD	ELLC	ELMIN	Q	CWSEL	CRIWS	EG	10*KS	VCH	AREA	.01K
	40.050	173.00	.00	.00	1166.50	9200.00	1173.07	1170.53	1173.61	16.03	5.90	1559.47	2297.83
	40.050	173.00	.00	.00	1166.50	35000.00	1179.27	1175.36	1180.98	20.75	10.49	3335.12	7682.64
	40.050	173.00	.00	.00	1166.50	55000.00	1182.85	1178.16	1185.24	21.95	12.41	4431.42	11739.69
	43.000	295.00	.00	.00	1166.70	9200.00	1173.54	1170.70	1174.06	14.56	5.78	1591.42	2411.37
	43.000	295.00	.00	.00	1166.70	35000.00	1179.94	1175.73	1181.58	19.21	10.27	3409.46	7985.34
	43.000	295.00	.00	.00	1166.70	55000.00	1183.56	1178.58	1185.88	21.07	12.21	4504.70	11981.54
	46.920	392.00	.00	.00	1167.60	9200.00	1174.11	1171.64	1174.71	17.54	6.20	1484.79	2196.74
	46.920	392.00	.00	.00	1167.60	35000.00	1180.62	1176.68	1182.41	21.14	10.75	3257.10	7611.61
	46.920	392.00	.00	.00	1167.60	55000.00	1184.26	1179.56	1186.79	21.94	12.76	4312.01	11742.03
	50.900	398.00	.00	.00	1168.00	9200.00	1174.83	1172.06	1175.36	14.93	5.85	1571.56	2380.84
	50.900	398.00	.00	.00	1168.00	35000.00	1181.62	1177.06	1183.20	17.87	10.11	3460.83	8279.45
	50.900	398.00	.00	.00	1168.00	55000.00	1185.38	1179.98	1187.62	18.59	12.01	4580.65	12754.93
	55.000	410.00	.00	.00	1169.00	9200.00	1175.43	1172.63	1175.96	14.55	5.84	1574.95	2412.07
	55.000	410.00	.00	.00	1169.00	35000.00	1182.35	1177.65	1183.93	17.58	10.10	3464.61	8348.22
	55.000	410.00	.00	.00	1169.00	55000.00	1186.15	1180.58	1188.38	18.48	11.99	4588.32	12794.40
	60.000	500.00	.00	.00	1169.70	9200.00	1176.18	1173.60	1176.74	16.19	5.99	1536.85	2286.30
	60.000	500.00	.00	.00	1169.70	35000.00	1183.27	1178.55	1184.80	17.02	9.93	3526.01	8483.36
	60.000	500.00	.00	.00	1169.70	55000.00	1187.15	1181.42	1189.28	17.43	11.73	4688.24	13173.05
	64.000	400.00	.00	.00	1170.50	9200.00	1176.83	1174.58	1177.48	19.68	6.46	1425.14	2074.05
	64.000	400.00	.00	.00	1170.50	35000.00	1183.84	1179.62	1185.61	19.97	10.67	3280.44	7831.79
	64.000	400.00	.00	.00	1170.50	55000.00	1187.67	1182.55	1190.15	20.76	12.63	4355.41	12070.03
	65.450	145.00	.00	.00	1171.00	9200.00	1177.12	1174.74	1177.76	19.35	6.44	1429.15	2091.64
	65.450	145.00	.00	.00	1171.00	35000.00	1184.28	1179.96	1185.91	19.15	10.24	3419.30	7998.84
	65.450	145.00	.00	.00	1171.00	55000.00	1188.27	1182.84	1190.46	18.35	11.86	4637.75	12837.77
	66.900	145.00	.00	.00	1171.20	9200.00	1177.48	1174.77	1178.02	15.08	5.86	1570.00	2369.27
	66.900	145.00	.00	.00	1171.20	35000.00	1184.72	1179.76	1186.18	15.93	9.69	3611.07	8769.99
	66.900	145.00	.00	.00	1171.20	55000.00	1188.70	1182.60	1190.72	16.14	11.42	4818.13	13690.28
	67.900	100.00	.00	.00	1171.30	9200.00	1177.62	1174.95	1178.18	15.86	6.02	1528.78	2310.45
	67.900	100.00	.00	.00	1171.30	35000.00	1184.83	1180.04	1186.36	17.09	9.94	3520.55	8465.77
	67.900	100.00	.00	.00	1171.30	55000.00	1188.80	1182.96	1190.92	17.03	11.68	4707.38	13327.98
	68.690	73.00	.00	.00	1171.40	9200.00	1177.75	1175.01	1178.30	15.15	5.94	1550.07	2363.86
	68.690	73.00	.00	.00	1171.40	35000.00	1184.95	1180.06	1186.49	16.80	9.95	3515.95	8538.38
	68.690	73.00	.00	.00	1171.40	55000.00	1188.90	1183.00	1191.05	17.05	11.75	4680.11	13321.63
*	68.700	7.00	.00	.00	1178.40	9200.00	1181.74	1181.74	1183.39	102.64	10.30	892.99	908.10
*	68.700	7.00	.00	.00	1178.40	35000.00	1186.43	1186.43	1190.29	78.15	15.75	2221.70	3959.09
*	68.700	7.00	.00	.00	1178.40	55000.00	1189.17	1189.17	1194.28	71.63	18.14	3032.42	6498.40
*	69.100	40.00	.00	.00	1178.50	9200.00	1182.66	1181.86	1183.72	49.86	8.27	1112.23	1302.91
	69.100	40.00	.00	.00	1178.50	35000.00	1187.67	1186.57	1190.62	50.47	13.79	2538.91	4926.52
	69.100	40.00	.00	.00	1178.50	55000.00	1190.50	1189.33	1194.62	50.32	16.29	3376.96	7753.02

SECNO	XLCH	ELTRD	ELLC	ELMIN	Q	CWSEL	CRIWS	EG	10*KS	VCH	AREA	.01K
70.100	100.00	.00	.00	1178.80	9200.00	1183.22	1182.19	1184.19	42.20	7.91	1162.39	1416.26
70.100	100.00	.00	.00	1178.80	35000.00	1188.24	1186.97	1191.12	47.77	13.63	2567.66	5063.75
70.100	100.00	.00	.00	1178.80	55000.00	1190.99	1189.75	1195.12	49.78	16.30	3373.57	7795.60
71.800	170.00	.00	.00	1179.30	9200.00	1183.94	1182.78	1184.88	38.39	7.76	1186.13	1484.78
71.800	170.00	.00	.00	1179.30	35000.00	1189.14	1187.62	1191.91	43.79	13.35	2622.09	5288.99
71.800	170.00	.00	.00	1179.30	55000.00	1191.99	1190.44	1195.95	45.51	15.96	3446.91	8152.91
73.500	170.00	.00	.00	1179.70	9200.00	1184.67	1183.16	1185.47	29.99	7.16	1284.15	1679.93
73.500	170.00	.00	.00	1179.70	35000.00	1190.28	1188.01	1192.61	33.76	12.24	2858.95	6023.51
73.500	170.00	.00	.00	1179.70	55000.00	1193.40	1190.80	1196.68	34.69	14.54	3781.75	9338.46
76.320	282.00	.00	.00	1178.80	9200.00	1185.53	1183.33	1186.17	19.91	6.38	1441.08	2061.63
76.320	282.00	.00	.00	1178.80	35000.00	1191.46	1188.26	1193.47	26.19	11.39	3073.54	6839.38
76.320	282.00	.00	.00	1178.80	55000.00	1194.72	1191.14	1197.60	28.03	13.63	4036.19	10387.54
81.000	468.00	.00	.00	1180.50	9200.00	1186.50	1184.60	1187.21	23.88	6.77	1358.53	1882.54
81.000	468.00	.00	.00	1180.50	35000.00	1192.67	1189.54	1194.72	26.59	11.49	3045.43	6788.11
81.000	468.00	.00	.00	1180.50	55000.00	1196.01	1192.42	1198.92	27.83	13.70	4015.80	10426.63
84.700	370.00	.00	.00	1181.20	9200.00	1187.44	1184.95	1187.93	15.20	5.61	1641.36	2359.37
84.700	370.00	.00	.00	1181.20	35000.00	1194.19	1189.49	1195.54	15.90	9.33	3751.92	8776.43
84.700	370.00	.00	.00	1181.20	55000.00	1197.90	1192.14	1199.79	16.09	11.03	4988.46	13710.82

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SUMMARY PRINTOUT TABLE 150

	SECNO	Q	CWSEL	DIFWSP	DIFWSX	DIFKWS	TOPWID	XLCH
	337.000	10500.00	1117.36	.00	.00	.00	338.49	.00
	337.000	41000.00	1122.85	5.49	.00	.00	351.57	.00
	337.000	69000.00	1126.48	3.63	.00	.00	360.22	.00
	342.000	10500.00	1119.39	.00	2.03	.00	352.30	510.00
	342.000	41000.00	1124.73	5.34	1.88	.00	364.29	510.00
	342.000	68000.00	1128.42	3.68	1.94	.00	372.58	510.00
	343.700	10500.00	1120.10	.00	.71	.00	334.77	180.00
	343.700	41000.00	1125.09	4.99	.36	.00	346.22	180.00
	343.700	68000.00	1128.53	3.43	.11	.00	354.08	180.00
	345.500	10500.00	1121.08	.00	.98	.00	337.52	190.00
	345.500	41000.00	1126.20	5.13	1.11	.00	346.98	190.00
	345.500	68000.00	1129.53	3.33	1.00	.00	353.12	190.00
*	346.400	10500.00	1121.58	.00	.51	.00	337.89	100.00
*	346.400	41000.00	1128.22	6.64	2.02	.00	350.43	100.00
*	346.400	68000.00	1132.60	4.38	3.07	.00	358.68	100.00
*	346.800	10500.00	1121.50	.00	-.08	.00	318.00	25.00
	346.800	41000.00	1127.70	6.21	-.52	.00	341.00	25.00
	346.800	68000.00	1132.14	4.43	-.46	.00	356.78	25.00
*	347.100	10500.00	1122.49	.00	.99	.00	338.26	30.00
	347.100	41000.00	1128.43	5.94	.72	.00	349.98	30.00
	347.100	68000.00	1132.71	4.28	.57	.00	358.42	30.00
	347.110	10500.00	1122.31	.00	-.18	.00	310.14	1.00
	347.110	41000.00	1127.97	5.65	-.46	.00	321.60	1.00
	347.110	68000.00	1132.12	4.16	-.58	.00	330.02	1.00
	347.400	10500.00	1122.45	.00	.14	.00	310.09	30.00
	347.400	41000.00	1128.09	5.63	.12	.00	321.65	30.00
	347.400	68000.00	1132.23	4.14	.11	.00	330.15	30.00
	347.410	10500.00	1122.86	.00	.41	.00	338.73	1.00
*	347.410	41000.00	1129.10	6.23	1.01	.00	351.20	1.00
*	347.410	68000.00	1133.46	4.36	1.23	.00	359.94	1.00
*	352.400	10500.00	1124.84	.00	1.98	.00	350.79	460.00
*	352.400	41000.00	1129.95	5.11	.86	.00	374.57	460.00
	352.400	68000.00	1134.39	4.44	.93	.00	803.32	460.00
*	358.250	10500.00	1128.90	.00	4.06	.00	336.93	600.00
	358.250	41000.00	1133.02	4.12	3.07	.00	346.03	600.00
*	358.250	68000.00	1136.51	3.49	2.12	.00	757.24	600.00

	SECNO	Q	CWSEL	DIFWSP	DIFWSX	DIFKWS	TOPWID	XLCH
*	365.400	10500.00	1130.89	.00	1.99	.00	316.14	700.00
*	365.400	41000.00	1137.07	6.18	4.05	.00	868.90	700.00
*	365.400	68000.00	1140.63	3.55	4.11	.00	902.07	700.00
	370.650	10500.00	1131.79	.00	.90	.00	359.77	535.00
	370.650	41000.00	1138.26	6.47	1.18	.00	489.90	535.00
	370.650	68000.00	1141.27	3.01	.64	.00	489.90	535.00
	373.750	10500.00	1132.23	.00	.45	.00	334.88	320.00
	373.750	41000.00	1138.55	6.32	.29	.00	422.39	320.00
	373.750	68000.00	1141.60	3.05	.34	.00	823.69	320.00
	376.750	10500.00	1132.71	.00	.47	.00	294.31	300.00
	376.750	41000.00	1138.98	6.27	.43	.00	378.14	300.00
	376.750	68000.00	1141.98	3.00	.38	.00	669.81	300.00
	379.750	10500.00	1133.43	.00	.73	.00	303.16	300.00
	379.750	41000.00	1139.78	6.35	.80	.00	372.82	300.00
	379.750	68000.00	1142.96	3.18	.98	.00	846.36	300.00
	384.500	10500.00	1134.64	.00	1.21	.00	345.75	470.00
	384.500	41000.00	1141.39	6.75	1.61	.00	397.34	470.00
	384.500	68000.00	1144.64	3.25	1.68	.00	455.21	470.00
	388.500	10500.00	1135.30	.00	.66	.00	342.68	410.00
	388.500	41000.00	1141.99	6.69	.60	.00	385.80	410.00
	388.500	68000.00	1145.37	3.38	.72	.00	415.48	410.00
	392.000	10500.00	1135.91	.00	.61	.00	332.83	350.00
	392.000	41000.00	1142.55	6.63	.55	.00	378.47	350.00
	392.000	68000.00	1146.02	3.47	.65	.00	407.76	350.00
	395.500	10500.00	1136.56	.00	.65	.00	331.64	350.00
	395.500	41000.00	1143.14	6.58	.60	.00	389.82	350.00
	395.500	68000.00	1146.73	3.59	.72	.00	416.90	350.00
	402.500	10500.00	1138.59	.00	2.04	.00	253.93	720.00
*	402.500	41000.00	1143.94	5.35	.80	.00	300.15	720.00
*	402.500	68000.00	1147.15	3.21	.42	.00	360.38	720.00
	406.500	10500.00	1140.41	.00	1.82	.00	245.15	400.00
	406.500	41000.00	1146.72	6.30	2.78	.00	314.39	400.00
	406.500	68000.00	1151.07	4.35	3.91	.00	398.50	400.00
	409.500	10500.00	1141.59	.00	1.18	.00	207.84	315.00
	409.500	41000.00	1147.13	5.53	.41	.00	235.70	315.00
*	409.500	68000.00	1150.97	3.84	-.10	.00	255.03	315.00
	410.540	10500.00	1141.91	.00	.32	.00	206.64	83.50
*	410.540	41000.00	1149.36	7.45	2.24	.00	240.62	83.50
*	410.540	68000.00	1154.64	5.28	3.67	.00	264.68	83.50

	SECNO	Q	CWSEL	DIFWSP	DIFWSX	DIFKWS	TOPWID	XLCH
	412.760	10500.00	1142.59	.00	.68	.00	216.15	223.00
	412.760	41000.00	1150.68	8.09	1.32	.00	282.48	223.00
	412.760	68000.00	1156.54	5.85	1.89	.00	352.23	223.00
	418.970	10500.00	1144.68	.00	2.08	.00	218.99	620.00
	418.970	41000.00	1152.66	7.98	1.97	.00	312.20	620.00
	418.970	68000.00	1158.19	5.53	1.65	.00	376.46	620.00
	424.170	10500.00	1145.96	.00	1.29	.00	220.17	520.00
	424.170	41000.00	1153.98	8.02	1.33	.00	314.66	520.00
	424.170	68000.00	1159.18	5.20	.99	.00	373.00	520.00
	429.370	10500.00	1147.05	.00	1.09	.00	225.90	500.00
	429.370	41000.00	1155.43	8.38	1.44	.00	340.96	500.00
	429.370	68000.00	1160.49	5.06	1.31	.00	388.78	500.00
	435.370	10500.00	1148.12	.00	1.07	.00	235.09	600.00
	435.370	41000.00	1156.47	8.34	1.04	.00	327.68	600.00
	435.370	68000.00	1161.40	4.93	.91	.00	397.21	600.00
	441.600	10500.00	1149.03	.00	.91	.00	222.81	610.00
	441.600	41000.00	1157.52	8.49	1.06	.00	307.85	610.00
	441.600	68000.00	1162.35	4.82	.95	.00	355.07	610.00
	446.870	10500.00	1149.53	.00	.50	.00	217.06	560.00
	446.870	41000.00	1158.20	8.67	.68	.00	296.61	560.00
	446.870	68000.00	1163.07	4.86	.72	.00	344.15	560.00
	449.050	10500.00	1149.91	.00	.38	.00	216.11	232.00
	449.050	41000.00	1158.74	8.83	.54	.00	304.45	232.00
	449.050	68000.00	1163.70	4.95	.63	.00	353.96	232.00
*	450.230	10500.00	1150.35	.00	.44	.00	284.90	100.00
*	450.230	41000.00	1159.73	9.38	.99	.00	378.77	100.00
*	450.230	68000.00	1164.97	5.24	1.28	.00	431.24	100.00
	451.050	10500.00	1150.48	.00	.13	.00	306.85	82.00
	451.050	41000.00	1159.91	9.44	.18	.00	363.47	82.00
	451.050	68000.00	1165.12	5.21	.14	.00	394.71	82.00
	451.230	10500.00	1150.46	.00	-.02	.00	268.91	18.00
	451.230	41000.00	1159.75	9.29	-.17	.00	287.49	18.00
	451.230	68000.00	1164.78	5.03	-.34	.00	297.55	18.00
	452.230	10500.00	1150.50	.00	.04	.00	269.69	100.00
	452.230	41000.00	1159.82	9.32	.08	.00	289.04	100.00
	452.230	68000.00	1164.88	5.06	.11	.00	299.54	100.00
*	452.500	10500.00	1155.77	.00	5.27	.00	257.53	27.50
*	452.500	41000.00	1161.24	5.47	1.42	.00	268.48	27.50
*	452.500	68000.00	1164.92	3.68	.04	.00	275.85	27.50

	SECNO	Q	CWSEL	DIFWSP	DIFWSX	DIFKWS	TOPWID	XLCH
	452.650	10500.00	1156.48	.00	.71	.00	258.97	15.00
	452.650	41000.00	1162.42	5.94	1.18	.00	270.82	15.00
	452.650	68000.00	1166.35	3.93	1.43	.00	278.70	15.00
	452.730	10500.00	1156.63	.00	.15	.00	263.90	8.00
	452.730	41000.00	1163.04	6.41	.62	.00	283.09	8.00
	452.730	68000.00	1167.41	4.37	1.06	.00	320.27	8.00
	453.230	10500.00	1157.02	.00	.39	.00	265.08	50.00
	453.230	41000.00	1163.47	6.45	.44	.00	284.43	50.00
	453.230	68000.00	1167.89	4.42	.48	.00	373.35	50.00
*	455.630	10500.00	1158.11	.00	1.08	.00	356.43	240.00
*	455.630	41000.00	1165.66	7.55	2.18	.00	386.63	240.00
*	455.630	68000.00	1170.64	4.99	2.75	.00	493.98	240.00
	458.500	10500.00	1158.66	.00	.55	.00	582.05	290.00
*	458.500	41000.00	1166.64	7.98	.98	.00	634.58	290.00
*	458.500	68000.00	1171.99	5.36	1.35	.00	925.10	290.00
*	462.600	5100.00	1159.49	.00	.83	.00	345.76	410.00
*	462.600	19000.00	1166.87	7.38	.23	.00	424.59	410.00
*	462.600	38000.00	1172.12	5.25	.13	.00	459.54	410.00
*	466.600	5100.00	1162.35	.00	2.86	.00	293.33	400.00
*	466.600	19000.00	1166.84	4.49	-.03	.00	318.75	400.00
*	466.600	38000.00	1171.90	5.06	-.22	.00	349.34	400.00
	471.300	5100.00	1164.25	.00	1.90	.00	184.59	470.00
*	471.300	19000.00	1167.98	3.74	1.15	.00	347.86	470.00
	471.300	38000.00	1172.53	4.54	.63	.00	392.37	470.00
	475.800	5100.00	1166.70	.00	2.45	.00	190.99	450.00
	475.800	19000.00	1170.05	3.35	2.07	.00	218.37	450.00
*	475.800	38000.00	1173.55	3.50	1.02	.00	241.05	450.00
*	8.978	5100.00	1168.23	.00	1.53	.00	366.19	500.00
*	8.978	19000.00	1173.52	5.29	3.46	.00	403.70	500.00
*	8.978	38000.00	1178.60	5.08	5.05	.00	436.96	500.00
*	9.072	5100.00	1169.04	.00	.81	.00	451.74	520.00
	9.072	19000.00	1173.97	4.93	.45	.00	485.22	520.00
	9.072	38000.00	1179.04	5.07	.44	.00	514.58	520.00
*	9.167	5100.00	1173.94	.00	4.90	.00	224.59	520.00
*	9.167	19000.00	1177.38	3.45	3.42	.00	281.40	520.00
*	9.167	38000.00	1180.80	3.41	1.76	.00	349.44	520.00
*	9.262	5100.00	1176.04	.00	2.10	.00	430.82	500.00
*	9.262	19000.00	1180.67	4.63	3.28	.00	471.90	500.00
*	9.262	38000.00	1184.78	4.12	3.99	.00	487.36	500.00

	SECNO	Q	CWSEL	DIFWSP	DIFWSX	DIFKWS	TOPWID	XLCH
*	9.356	5100.00	1176.44	.00	.40	.00	403.82	490.00
*	9.356	19000.00	1180.94	4.50	.28	.00	481.49	490.00
	9.356	38000.00	1185.01	4.07	.23	.00	495.88	490.00
	9.451	5100.00	1181.02	.00	4.58	.00	356.61	500.00
*	9.451	19000.00	1183.58	2.55	2.63	.00	366.73	500.00
*	9.451	38000.00	1186.16	2.59	1.15	.00	376.98	500.00
*	9.546	5100.00	1182.94	.00	1.92	.00	359.35	500.00
*	9.546	19000.00	1186.63	3.69	3.05	.00	372.55	500.00
*	9.546	38000.00	1189.93	3.31	3.77	.00	384.39	500.00
*	9.641	5100.00	1184.01	.00	1.07	.00	225.69	500.00
*	9.641	19000.00	1187.34	3.33	.71	.00	330.14	500.00
*	9.641	38000.00	1190.17	2.83	.24	.00	339.50	500.00
	9.735	5100.00	1188.54	.00	4.53	.00	172.51	500.00
*	9.735	19000.00	1192.69	4.15	5.35	.00	190.28	500.00
*	9.735	38000.00	1196.79	4.09	6.61	.00	209.36	500.00
*	9.783	5100.00	1191.03	.00	2.48	.00	177.07	250.00
*	9.783	19000.00	1195.17	4.14	2.47	.00	199.80	250.00
*	9.783	38000.00	1199.07	3.91	2.29	.00	213.15	250.00
*	9.786	5100.00	1192.54	.00	1.51	.00	183.87	20.00
*	9.786	19000.00	1196.60	4.07	1.44	.00	205.33	20.00
*	9.786	38000.00	1200.43	3.83	1.36	.00	212.80	20.00
	9.832	5100.00	1194.83	.00	2.29	.00	238.64	225.00
*	9.832	19000.00	1199.43	4.61	2.83	.00	266.54	225.00
*	9.832	38000.00	1205.38	5.94	4.95	.00	1175.50	225.00
	9.850	5100.00	1195.11	.00	.29	.00	212.96	100.00
	9.850	19000.00	1199.95	4.84	.52	.00	248.06	100.00
	9.850	38000.00	1208.31	8.36	2.93	.00	835.00	100.00
	9.902	5100.00	1196.63	.00	1.51	.00	377.36	260.00
*	9.902	19000.00	1201.75	5.12	1.79	.00	619.23	260.00
*	9.902	38000.00	1209.19	7.44	.87	.00	1020.70	260.00
	-458.500	10500.00	1158.66	.00	-37.97	.00	582.05	550.00
	-458.500	41000.00	1166.64	7.98	-35.11	.00	634.58	550.00
	-458.500	68000.00	1171.99	5.36	-37.19	.00	924.94	550.00
*	462.800	9200.00	1158.86	.00	.20	.00	279.00	420.00
*	462.800	35000.00	1166.19	7.33	-.44	.00	319.47	420.00
*	462.800	55000.00	1171.47	5.28	-.52	.00	337.14	420.00
*	19.000	9200.00	1159.76	.00	.90	.00	262.21	440.00
	19.000	35000.00	1166.51	6.75	.32	.00	286.62	440.00
	19.000	55000.00	1171.74	5.23	.27	.00	308.74	440.00

	SECNO	Q	CWSEL	DIFWSP	DIFWSX	DIFKWS	TOPWID	XLCH
*	20.900	9200.00	1161.11	.00	1.35	.00	294.47	200.00
	20.900	35000.00	1167.77	6.67	1.26	.00	310.59	200.00
	20.900	55000.00	1172.73	4.95	.99	.00	337.42	200.00
	24.890	9200.00	1161.98	.00	.87	.00	307.36	380.00
	24.890	35000.00	1168.64	6.66	.86	.00	321.85	380.00
	24.890	55000.00	1173.34	4.70	.62	.00	332.08	380.00
*	24.900	9200.00	1165.20	.00	3.22	.00	310.29	6.00
*	24.900	35000.00	1169.54	4.34	.90	.00	320.50	6.00
*	24.900	55000.00	1172.09	2.55	-1.25	.00	326.51	6.00
*	25.400	9200.00	1165.99	.00	.79	.00	301.52	50.00
*	25.400	35000.00	1170.37	4.37	.83	.00	310.75	50.00
*	25.400	55000.00	1172.99	2.62	.89	.00	316.27	50.00
*	26.700	9200.00	1167.73	.00	1.74	.00	303.93	130.00
*	26.700	35000.00	1173.12	5.39	2.75	.00	314.53	130.00
*	26.700	55000.00	1176.19	3.08	3.21	.00	320.60	130.00
	27.800	9200.00	1167.84	.00	.11	.00	273.62	110.00
	27.800	35000.00	1173.53	5.69	.41	.00	284.91	110.00
	27.800	55000.00	1176.81	3.28	.61	.00	291.42	110.00
	29.600	9200.00	1168.77	.00	.93	.00	304.49	180.00
	29.600	35000.00	1174.96	6.19	1.43	.00	316.54	180.00
	29.600	55000.00	1178.55	3.59	1.74	.00	323.54	180.00
*	30.000	9200.00	1168.92	.00	.15	.00	316.82	40.00
*	30.000	35000.00	1175.23	6.31	.27	.00	329.46	40.00
*	30.000	55000.00	1178.91	3.68	.36	.00	336.82	40.00
	31.750	9200.00	1169.97	.00	1.05	.00	394.96	175.00
	31.750	35000.00	1176.64	6.67	1.41	.00	421.49	175.00
	31.750	55000.00	1180.59	3.95	1.68	.00	437.16	175.00
	33.000	9200.00	1170.41	.00	.44	.00	353.93	125.00
	33.000	35000.00	1176.85	6.44	.21	.00	373.87	125.00
	33.000	55000.00	1180.70	3.85	.12	.00	386.16	125.00
	35.000	9200.00	1171.41	.00	1.00	.00	310.34	200.00
	35.000	35000.00	1177.56	6.15	.71	.00	329.16	200.00
	35.000	55000.00	1181.25	3.70	.55	.00	343.50	200.00
	37.000	9200.00	1172.16	.00	.75	.00	285.92	200.00
	37.000	35000.00	1178.26	6.10	.70	.00	302.02	200.00
	37.000	55000.00	1181.86	3.60	.60	.00	316.57	200.00
	38.320	9200.00	1172.46	.00	.30	.00	276.81	132.00
	38.320	35000.00	1178.53	6.07	.27	.00	302.01	132.00
	38.320	55000.00	1182.11	3.58	.25	.00	314.91	132.00

	SECNO	Q	CWSEL	DIFWSP	DIFWSX	DIFKWS	TOPWID	XLCH
	40.050	9200.00	1173.07	.00	.61	.00	273.93	173.00
	40.050	35000.00	1179.27	6.20	.74	.00	296.66	173.00
	40.050	55000.00	1182.85	3.58	.74	.00	318.61	173.00
	43.000	9200.00	1173.54	.00	.47	.00	267.92	295.00
	43.000	35000.00	1179.94	6.40	.67	.00	295.79	295.00
	43.000	55000.00	1183.56	3.63	.72	.00	321.53	295.00
	46.920	9200.00	1174.11	.00	.57	.00	259.32	392.00
	46.920	35000.00	1180.62	6.51	.68	.00	283.23	392.00
	46.920	55000.00	1184.26	3.64	.69	.00	296.33	392.00
	50.900	9200.00	1174.83	.00	.71	.00	264.92	398.00
	50.900	35000.00	1181.62	6.79	1.00	.00	290.82	398.00
	50.900	55000.00	1185.38	3.76	1.12	.00	304.90	398.00
	55.000	9200.00	1175.43	.00	.61	.00	260.56	410.00
	55.000	35000.00	1182.35	6.91	.73	.00	287.33	410.00
	55.000	55000.00	1186.15	3.80	.77	.00	304.39	410.00
	60.000	9200.00	1176.18	.00	.75	.00	265.93	500.00
	60.000	35000.00	1183.27	7.09	.93	.00	293.12	500.00
	60.000	55000.00	1187.15	3.88	1.00	.00	307.05	500.00
	64.000	9200.00	1176.83	.00	.65	.00	254.49	400.00
	64.000	35000.00	1183.84	7.01	.57	.00	273.99	400.00
	64.000	55000.00	1187.67	3.83	.52	.00	289.28	400.00
	65.450	9200.00	1177.12	.00	.29	.00	252.92	145.00
	65.450	35000.00	1184.28	7.16	.44	.00	297.40	145.00
	65.450	55000.00	1188.27	3.99	.60	.00	311.48	145.00
	66.900	9200.00	1177.48	.00	.37	.00	265.42	145.00
	66.900	35000.00	1184.72	7.23	.44	.00	295.98	145.00
	66.900	55000.00	1188.70	3.98	.43	.00	310.32	145.00
	67.900	9200.00	1177.62	.00	.13	.00	257.67	100.00
	67.900	35000.00	1184.83	7.21	.11	.00	293.21	100.00
	67.900	55000.00	1188.80	3.97	.10	.00	304.63	100.00
	68.690	9200.00	1177.75	.00	.13	.00	257.51	73.00
	68.690	35000.00	1184.95	7.20	.12	.00	287.79	73.00
	68.690	55000.00	1188.90	3.95	.11	.00	299.74	73.00
*	68.700	9200.00	1181.74	.00	3.99	.00	273.96	7.00
*	68.700	35000.00	1186.43	4.69	1.48	.00	291.58	7.00
*	68.700	55000.00	1189.17	2.74	.27	.00	300.35	7.00
*	69.100	9200.00	1182.66	.00	.92	.00	275.64	40.00
	69.100	35000.00	1187.67	5.01	1.24	.00	292.48	40.00
	69.100	55000.00	1190.50	2.82	1.33	.00	300.66	40.00

SECNO	Q	CWSEL	DIFWSP	DIFWSX	DIFKWS	TOPWID	XLCH
70.100	9200.00	1183.22	.00	.56	.00	271.24	100.00
70.100	35000.00	1188.24	5.02	.56	.00	288.36	100.00
70.100	55000.00	1190.99	2.76	.49	.00	297.28	100.00
71.800	9200.00	1183.94	.00	.73	.00	266.14	170.00
71.800	35000.00	1189.14	5.20	.91	.00	285.09	170.00
71.800	55000.00	1191.99	2.85	1.00	.00	293.46	170.00
73.500	9200.00	1184.67	.00	.73	.00	269.55	170.00
73.500	35000.00	1190.28	5.61	1.13	.00	290.99	170.00
73.500	55000.00	1193.40	3.12	1.41	.00	301.92	170.00
76.320	9200.00	1185.53	.00	.86	.00	264.02	282.00
76.320	35000.00	1191.46	5.93	1.18	.00	287.71	282.00
76.320	55000.00	1194.72	3.26	1.32	.00	302.71	282.00
81.000	9200.00	1186.50	.00	.96	.00	261.68	468.00
81.000	35000.00	1192.67	6.17	1.21	.00	284.60	468.00
81.000	55000.00	1196.01	3.34	1.29	.00	297.07	468.00
84.700	9200.00	1187.44	.00	.94	.00	299.27	370.00
84.700	35000.00	1194.19	6.75	1.52	.00	326.60	370.00
84.700	55000.00	1197.90	3.72	1.90	.00	339.09	370.00

SUMMARY OF ERRORS AND SPECIAL NOTES

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CAUTION SECNO=    346.400  PROFILE=  1  HYDRAULIC JUMP D.S.
CAUTION SECNO=    346.400  PROFILE=  2  HYDRAULIC JUMP D.S.
CAUTION SECNO=    346.400  PROFILE=  3  HYDRAULIC JUMP D.S.

CAUTION SECNO=    346.800  PROFILE=  1  CRITICAL DEPTH ASSUMED
CAUTION SECNO=    346.800  PROFILE=  1  MINIMUM SPECIFIC ENERGY

WARNING SECNO=    347.100  PROFILE=  1  CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE

WARNING SECNO=    347.410  PROFILE=  2  CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE
WARNING SECNO=    347.410  PROFILE=  3  CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE

CAUTION SECNO=    352.400  PROFILE=  1  CRITICAL DEPTH ASSUMED
CAUTION SECNO=    352.400  PROFILE=  1  MINIMUM SPECIFIC ENERGY
WARNING SECNO=    352.400  PROFILE=  2  CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE

WARNING SECNO=    358.250  PROFILE=  1  CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE
CAUTION SECNO=    358.250  PROFILE=  3  CRITICAL DEPTH ASSUMED
CAUTION SECNO=    358.250  PROFILE=  3  MINIMUM SPECIFIC ENERGY

WARNING SECNO=    365.400  PROFILE=  1  CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE
WARNING SECNO=    365.400  PROFILE=  2  CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE
WARNING SECNO=    365.400  PROFILE=  3  CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE

W.    NG SECNO=   402.500  PROFILE=  2  CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE
CAUTION SECNO=    402.500  PROFILE=  3  CRITICAL DEPTH ASSUMED
CAUTION SECNO=    402.500  PROFILE=  3  MINIMUM SPECIFIC ENERGY

CAUTION SECNO=    409.500  PROFILE=  3  CRITICAL DEPTH ASSUMED
CAUTION SECNO=    409.500  PROFILE=  3  MINIMUM SPECIFIC ENERGY

CAUTION SECNO=    410.540  PROFILE=  2  HYDRAULIC JUMP D.S.
CAUTION SECNO=    410.540  PROFILE=  3  HYDRAULIC JUMP D.S.
WARNING SECNO=    410.540  PROFILE=  3  CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE

WARNING SECNO=    450.230  PROFILE=  1  CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE
WARNING SECNO=    450.230  PROFILE=  2  CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE
WARNING SECNO=    450.230  PROFILE=  3  CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE

CAUTION SECNO=    452.500  PROFILE=  1  CRITICAL DEPTH ASSUMED
CAUTION SECNO=    452.500  PROFILE=  1  MINIMUM SPECIFIC ENERGY
CAUTION SECNO=    452.500  PROFILE=  2  CRITICAL DEPTH ASSUMED
CAUTION SECNO=    452.500  PROFILE=  2  MINIMUM SPECIFIC ENERGY
CAUTION SECNO=    452.500  PROFILE=  3  CRITICAL DEPTH ASSUMED
CAUTION SECNO=    452.500  PROFILE=  3  MINIMUM SPECIFIC ENERGY

WARNING SECNO=    455.630  PROFILE=  1  CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE
WARNING SECNO=    455.630  PROFILE=  2  CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE
WARNING SECNO=    455.630  PROFILE=  3  CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE

WARNING SECNO=    458.500  PROFILE=  2  CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE
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W   NG SECNO=    458.500  PROFILE=  3  CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE

CAUTION SECNO=   462.600  PROFILE=  1  CRITICAL DEPTH ASSUMED
CAUTION SECNO=   462.600  PROFILE=  1  MINIMUM SPECIFIC ENERGY
WARNING SECNO=   462.600  PROFILE=  2  CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE
WARNING SECNO=   462.600  PROFILE=  3  CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE

WARNING SECNO=   466.600  PROFILE=  1  CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE
WARNING SECNO=   466.600  PROFILE=  2  CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE
WARNING SECNO=   466.600  PROFILE=  3  CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE

WARNING SECNO=   471.300  PROFILE=  2  CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE

CAUTION SECNO=   475.800  PROFILE=  3  CRITICAL DEPTH ASSUMED
CAUTION SECNO=   475.800  PROFILE=  3  MINIMUM SPECIFIC ENERGY

WARNING SECNO=     8.978  PROFILE=  1  CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE
WARNING SECNO=     8.978  PROFILE=  2  CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE
WARNING SECNO=     8.978  PROFILE=  3  CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE

WARNING SECNO=     9.072  PROFILE=  1  CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE

CAUTION SECNO=     9.167  PROFILE=  1  CRITICAL DEPTH ASSUMED
CAUTION SECNO=     9.167  PROFILE=  1  MINIMUM SPECIFIC ENERGY
CAUTION SECNO=     9.167  PROFILE=  2  CRITICAL DEPTH ASSUMED
CAUTION SECNO=     9.167  PROFILE=  2  MINIMUM SPECIFIC ENERGY
CAUTION SECNO=     9.167  PROFILE=  3  CRITICAL DEPTH ASSUMED
CAUTION SECNO=     9.167  PROFILE=  3  MINIMUM SPECIFIC ENERGY

W   NG SECNO=      9.262  PROFILE=  1  CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE
WARNING SECNO=     9.262  PROFILE=  2  CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE
WARNING SECNO=     9.262  PROFILE=  3  CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE

WARNING SECNO=     9.356  PROFILE=  1  CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE
WARNING SECNO=     9.356  PROFILE=  2  CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE

CAUTION SECNO=     9.451  PROFILE=  2  CRITICAL DEPTH ASSUMED
CAUTION SECNO=     9.451  PROFILE=  2  MINIMUM SPECIFIC ENERGY
CAUTION SECNO=     9.451  PROFILE=  3  CRITICAL DEPTH ASSUMED
CAUTION SECNO=     9.451  PROFILE=  3  MINIMUM SPECIFIC ENERGY

WARNING SECNO=     9.546  PROFILE=  1  CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE
WARNING SECNO=     9.546  PROFILE=  2  CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE
WARNING SECNO=     9.546  PROFILE=  3  CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE

CAUTION SECNO=     9.641  PROFILE=  1  CRITICAL DEPTH ASSUMED
CAUTION SECNO=     9.641  PROFILE=  1  MINIMUM SPECIFIC ENERGY
CAUTION SECNO=     9.641  PROFILE=  2  CRITICAL DEPTH ASSUMED
CAUTION SECNO=     9.641  PROFILE=  2  MINIMUM SPECIFIC ENERGY
CAUTION SECNO=     9.641  PROFILE=  3  CRITICAL DEPTH ASSUMED
CAUTION SECNO=     9.641  PROFILE=  3  MINIMUM SPECIFIC ENERGY

CAUTION SECNO=     9.735  PROFILE=  2  CRITICAL DEPTH ASSUMED
CAUTION SECNO=     9.735  PROFILE=  2  MINIMUM SPECIFIC ENERGY
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C    ON SECNO=      9.735  PROFILE=  3  CRITICAL DEPTH ASSUMED
C.   .ON SECNO=     9.735  PROFILE=  3  MINIMUM SPECIFIC ENERGY

CAUTION SECNO=      9.783  PROFILE=  1  CRITICAL DEPTH ASSUMED
CAUTION SECNO=      9.783  PROFILE=  1  MINIMUM SPECIFIC ENERGY
CAUTION SECNO=      9.783  PROFILE=  2  CRITICAL DEPTH ASSUMED
CAUTION SECNO=      9.783  PROFILE=  2  MINIMUM SPECIFIC ENERGY
CAUTION SECNO=      9.783  PROFILE=  3  CRITICAL DEPTH ASSUMED
CAUTION SECNO=      9.783  PROFILE=  3  MINIMUM SPECIFIC ENERGY

CAUTION SECNO=      9.786  PROFILE=  1  CRITICAL DEPTH ASSUMED
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CAUTION SECNO=      9.786  PROFILE=  2  CRITICAL DEPTH ASSUMED
CAUTION SECNO=      9.786  PROFILE=  2  MINIMUM SPECIFIC ENERGY
CAUTION SECNO=      9.786  PROFILE=  3  CRITICAL DEPTH ASSUMED
CAUTION SECNO=      9.786  PROFILE=  3  MINIMUM SPECIFIC ENERGY

WARNING SECNO=      9.832  PROFILE=  2  CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE
WARNING SECNO=      9.832  PROFILE=  3  CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE

WARNING SECNO=      9.902  PROFILE=  2  CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE
WARNING SECNO=      9.902  PROFILE=  3  CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE

WARNING SECNO=    462.800  PROFILE=  1  CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE
WARNING SECNO=    462.800  PROFILE=  2  CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE
WARNING SECNO=    462.800  PROFILE=  3  CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE

CAUTION SECNO=     19.000  PROFILE=  1  HYDRAULIC JUMP D.S.

W.   .NG SECNO=    20.900  PROFILE=  1  CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE

CAUTION SECNO=     24.900  PROFILE=  1  CRITICAL DEPTH ASSUMED
CAUTION SECNO=     24.900  PROFILE=  1  MINIMUM SPECIFIC ENERGY
CAUTION SECNO=     24.900  PROFILE=  2  CRITICAL DEPTH ASSUMED
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CAUTION SECNO=     24.900  PROFILE=  3  CRITICAL DEPTH ASSUMED
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CAUTION SECNO=     25.400  PROFILE=  1  CRITICAL DEPTH ASSUMED
CAUTION SECNO=     25.400  PROFILE=  1  MINIMUM SPECIFIC ENERGY
CAUTION SECNO=     25.400  PROFILE=  2  CRITICAL DEPTH ASSUMED
CAUTION SECNO=     25.400  PROFILE=  2  MINIMUM SPECIFIC ENERGY
CAUTION SECNO=     25.400  PROFILE=  3  CRITICAL DEPTH ASSUMED
CAUTION SECNO=     25.400  PROFILE=  3  MINIMUM SPECIFIC ENERGY

WARNING SECNO=     26.700  PROFILE=  1  CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE
WARNING SECNO=     26.700  PROFILE=  2  CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE
WARNING SECNO=     26.700  PROFILE=  3  CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE

WARNING SECNO=     30.000  PROFILE=  1  CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE
WARNING SECNO=     30.000  PROFILE=  2  CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE
WARNING SECNO=     30.000  PROFILE=  3  CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE

CAUTION SECNO=     68.700  PROFILE=  1  CRITICAL DEPTH ASSUMED
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C   ON SECNO=     68.700  PROFILE=  1  MINIMUM SPECIFIC ENERGY
C   ON SECNO=     68.700  PROFILE=  2  CRITICAL DEPTH ASSUMED
CAUTION SECNO=    68.700  PROFILE=  2  MINIMUM SPECIFIC ENERGY
CAUTION SECNO=    68.700  PROFILE=  3  CRITICAL DEPTH ASSUMED
CAUTION SECNO=    68.700  PROFILE=  3  MINIMUM SPECIFIC ENERGY

WARNING SECNO=    69.100  PROFILE=  1  CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE
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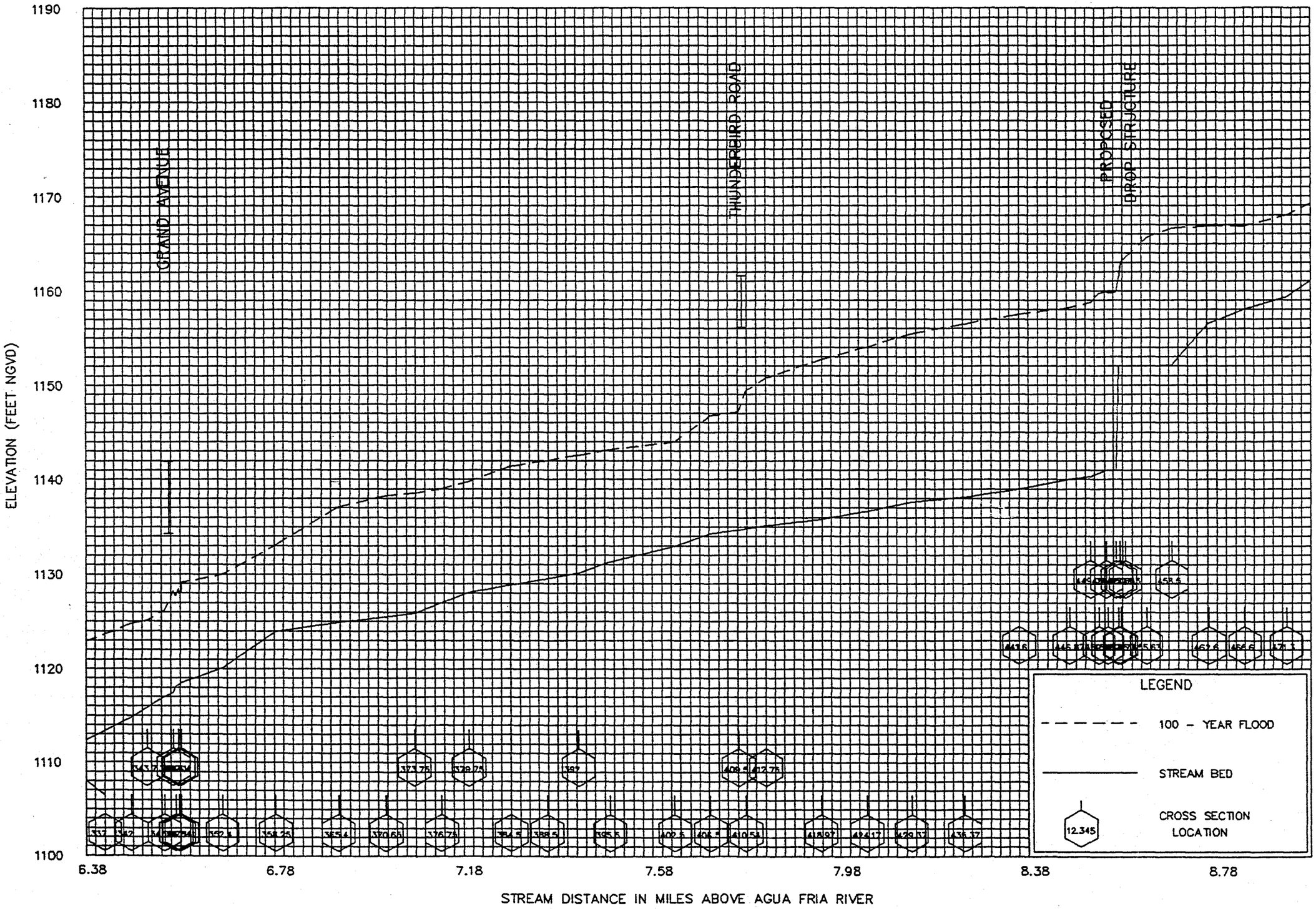
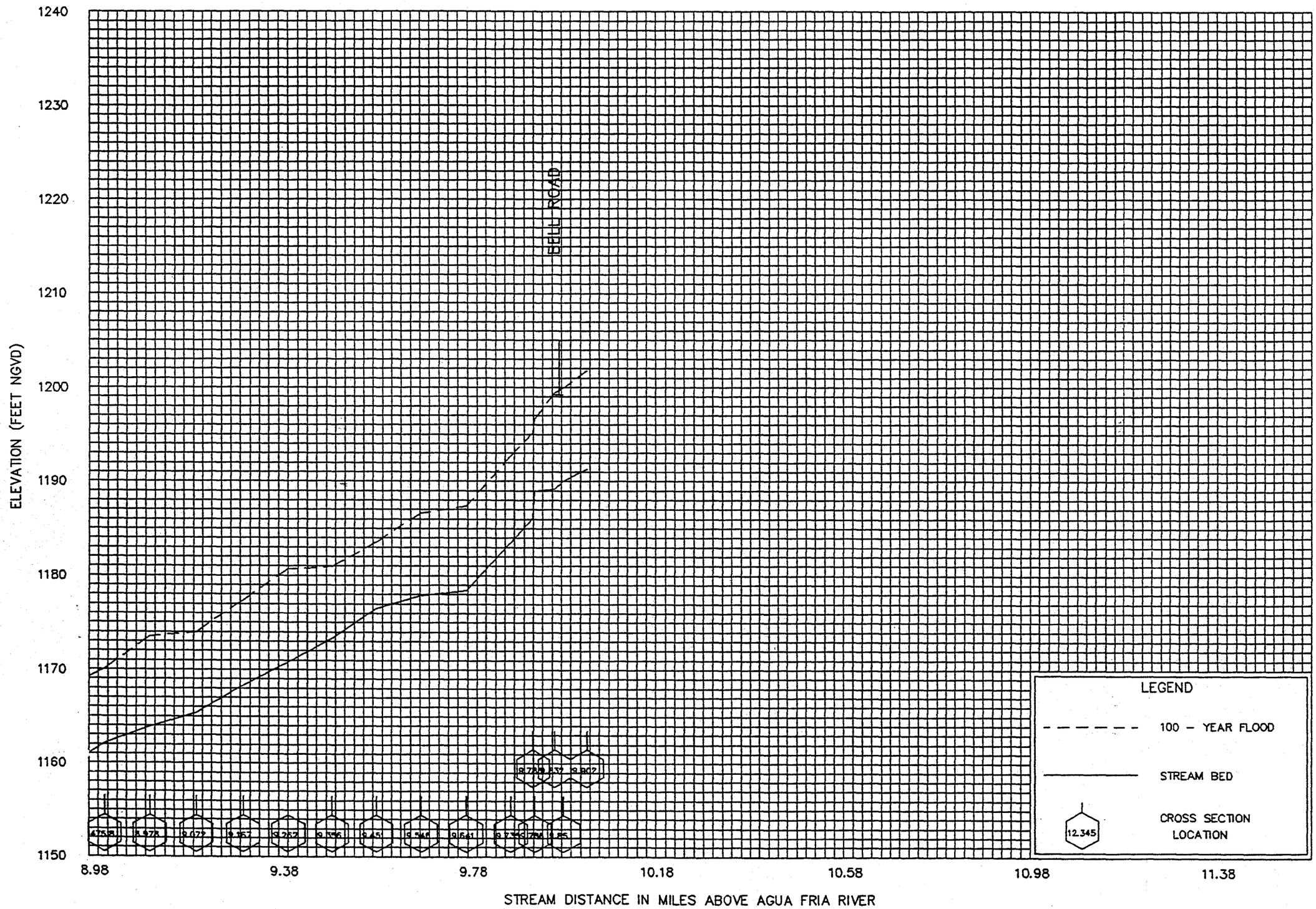


FLOOD PROFILES

NEW RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

WATER SURFACE PROFILE
100-YEAR FLOW

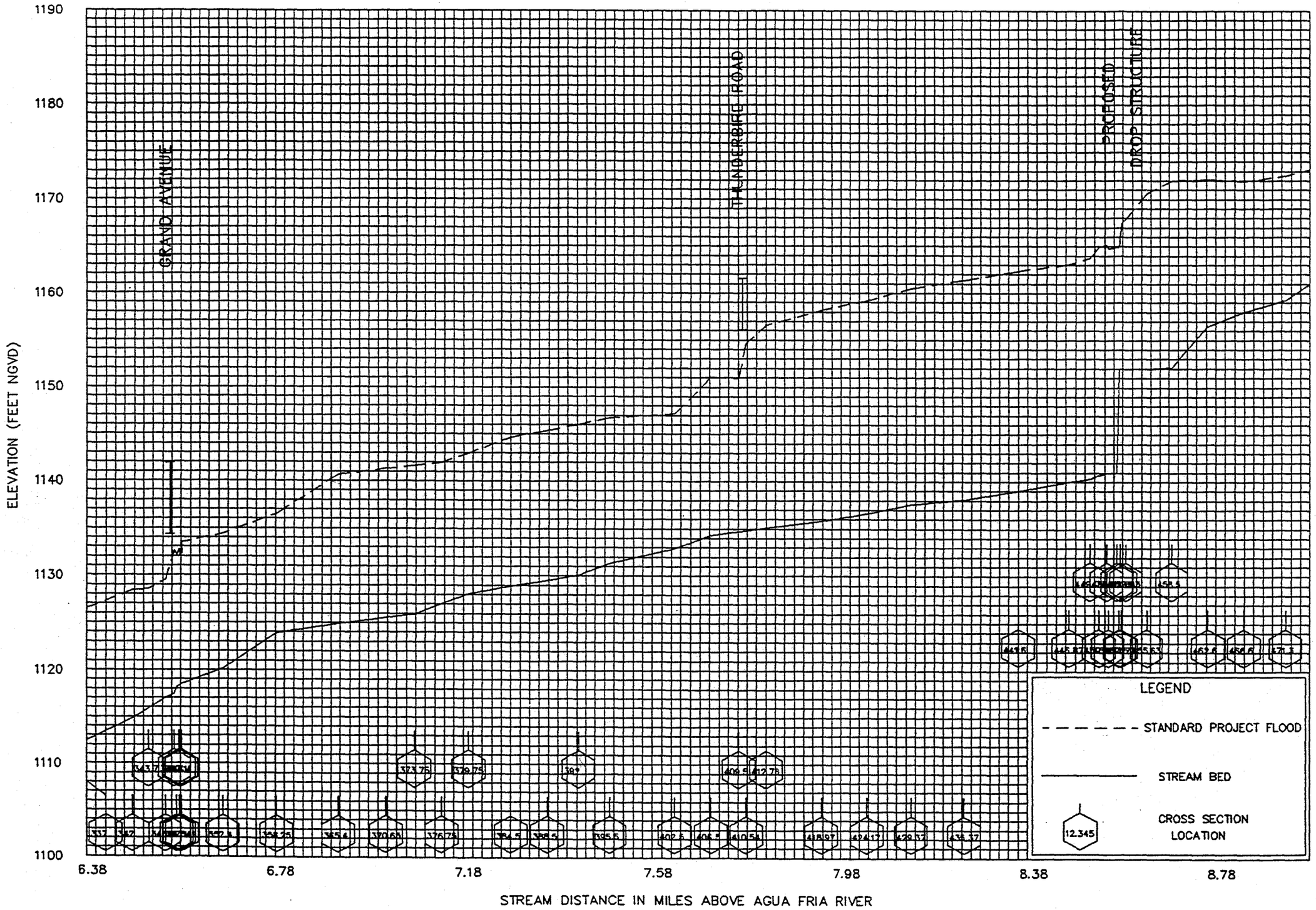


FLOOD PROFILES

NEW RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

WATER SURFACE PROFILE
100-YEAR FLOW



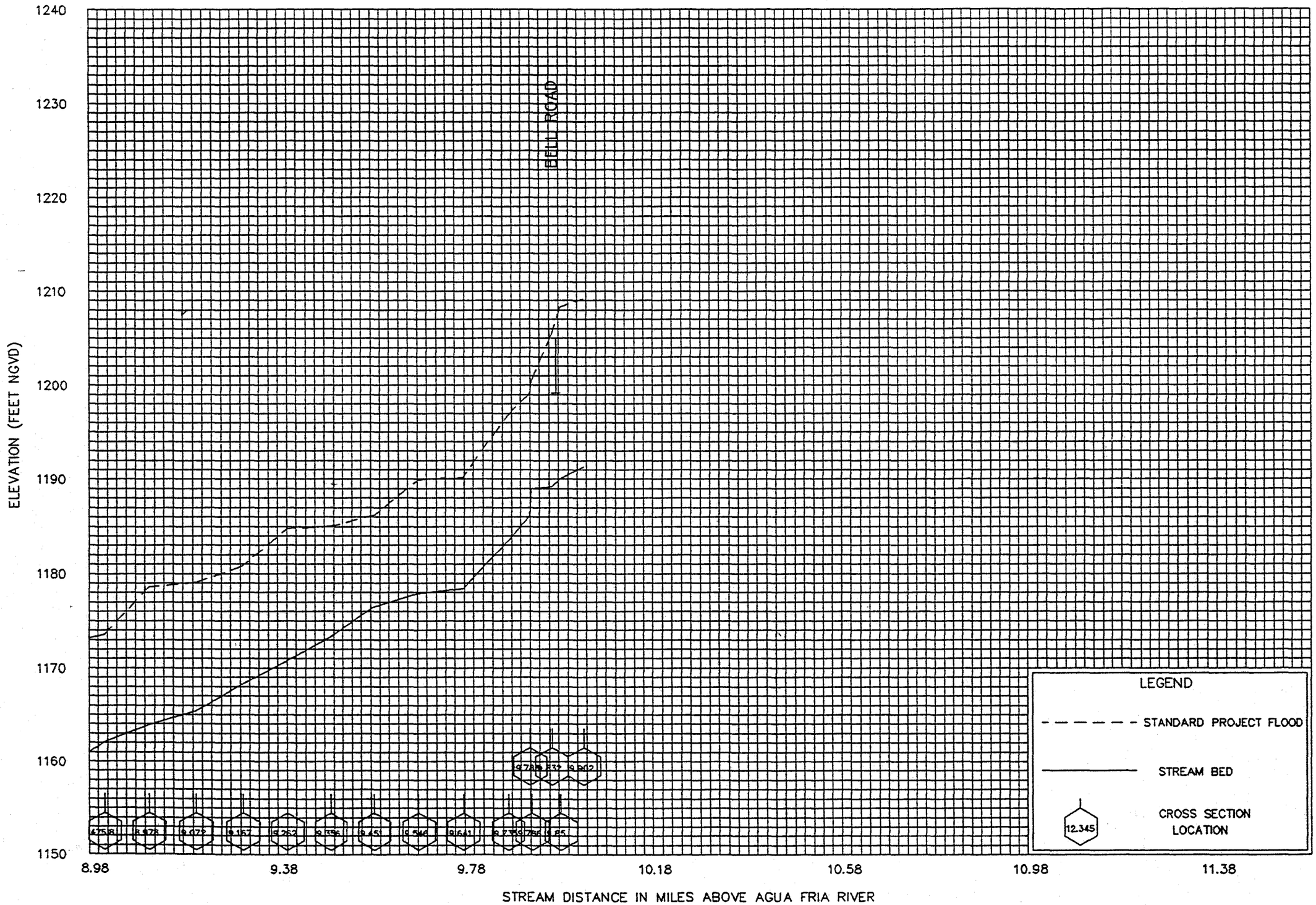
FLOOD PROFILES

NEW RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

WATER SURFACE PROFILE

SPF FLOW



FLOOD PROFILES

NEW RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

WATER SURFACE PROFILE

SPF FLOW

22-Feb-94

NEWRIVER CHANNELIZATION

Freeboard Estimates:

HEC2 SECTION (identification)	DEPTH (ft)	CWSEL (MSL)	HV (vel head) (ft)	FREEBOARD (FCDMC) (ft) (depth+HV)/4	FREEBOARD (SCS) (ft) (depthx0.2)	TOP OF BANK (Recommended) (MSL) (CWSEL+3)
452.50	9.24	1161.24	4.55	3.45	2.31	1164.2
453.23	11.48	1163.48	2.77	3.56	2.87	1166.5
455.63	13.66	1165.66	1.17	3.71	3.42	1168.7
458.50	14.54	1166.64	0.46	3.75	3.64	1169.6
462.60	10.37	1166.87	0.45	2.71	2.59	1169.9
466.60	8.84	1166.84	1.16	2.50	2.21	1169.8
471.30	8.68	1167.98	1.88	2.64	2.17	1171.0
475.80	7.95	1170.05	2.87	2.71	1.99	1173.1
Average				***3.13***	***2.65***	

RECOMMENDED FREEBOARD: 3 ft

w:\newriver\freebrd.wq1

APPENDIX II

DROP STRUCTURE HYDRAULICS

- 10-Year Frequency Storm
- 100-Year Frequency Storm
- Standard Project Flood
- Seepage and Uplift Computations
- Existing ADOT Outlet Structure
- Proposed ADOT Outlet Structure

STEPPED SPILLWAY DROP STRUCTURE

17-Feb-94

HYDRAULIC ANALYSIS
Stilling Basin without Baffle Blocks
File: drop10b.wq2

10-YEAR ANALYSIS

REFERENCES:

Chamani, M. R. and N. Rajaratnam, "Jet Flow on Stepped Spillways," Department of Civil Engineering, University of Alberta, Edmonton, Alberta, Canada, 1993.

Federal Highway Administration, Hydraulic Engineering Circular No. 14, Hydraulic Design of Energy Dissipators for Culverts and Channels, September 1983.

Rajaratnam, N., "Skimming flow in Stepped Spillways," Journal of Hydraulic Engineering, Vol. 166 No. 4, April 1990.

GIVEN DATA:

FLOW	10500	CFS	
SPILLWAY WIDTH	250	FT	
TAILWATER DEPTH	9.46	FT	
SPILLWAY CREST ELEVATION	1152	MSL	
STILLING BASIN BOTTOM ELEV	1141	MSL	need
DOWNSTREAM FLOWLINE ELEV	1141	MSL	
alpha (if jet flow)	0.15		
NUMBER OF STEPS	6		
STEP HEIGHT/LENGTH RATIO	0.33333333		

SOLUTION:

HYDRAULIC PARAMETERS:

DISCHARGE INTENSITY q = Q/W	42	cfs/ft
DROP HEIGHT (H)	11	ft
STEP HEIGHT (h)	1.83333333	ft
STEP LENGTH (L)	5.5	ft
Yc=.315*q ^ .667	3.81	ft
Yc/h	2.08	**SKIMMING FLOW**
Vc=q/Yc	11.02	fps

RELATIVE ENERGY LOSS ACROSS DROP	0.66	ft/ft
E0 = H + 1.5 * Yc	16.72	ft
E1 = y1 + (V1 ^ 2)/(2g)	5.71	ft
q = V1 * y1	42	cfs/ft
ENERGY LOSS ACROSS DROP	11.00	ft
USING assumed trial values of y1=	1.334	
then V1=	31.48	
and E1=	16.73	
THEREFORE, V1=	31.48	fps
AND y1=	1.334	ft
Froude Fr1=V1/(g*y1) ^ .5	4.80	

STILLING BASIN:

For known value of Fr1, read from Figure VI-11, HEC-14:

Lb/y1 =	37	
therefore, Lb=	49.4	ft

CHECK TAILWATER REQUIREMENTS:

		1141.00	downstream flowline elevation
	+	9.46	ft (tailwater depth)
tailwater per channel hydraulics		**1150.46**	
		1141.00	basin bottom elevation
y2 = y1*0.5*((1+8*Fr1 ^ 2) ^ 0.5-1)		8.42	ft
tailwater required for hyd jump		**1149.42**	

ADJUSTMENT REQUIRED TO BASIN BOTTOM ELEVATION: **0.00 ft**

STEPPED SPILLWAY DROP STRUCTURE

17-Feb-94

HYDRAULIC ANALYSIS
Stilling Basin without Baffle Blocks
File: drop100b.wq2

100-YEAR ANALYSIS

REFERENCES:

Chamani, M. R. and N. Rajaratnam, "Jet Flow on Stepped Spillways," Department of Civil Engineering, University of Alberta, Edmonton, Alberta, Canada, 1993.

Federal Highway Administration, Hydraulic Engineering Circular No. 14, Hydraulic Design of Energy Dissipators for Culverts and Channels, September 1983.

Rajaratnam, N., "Skimming flow in Stepped Spillways," Journal of Hydraulic Engineering, Vol. 166 No. 4, April 1990.

GIVEN DATA:

FLOW	41000	CFS	
SPILLWAY WIDTH	250	FT	
TAILWATER DEPTH	18.75	FT	
SPILLWAY CREST ELEVATION	1152	MSL	
STILLING BASIN BOTTOM ELEV	1141	MSL	need
DOWNSTREAM FLOWLINE ELEV	1141	MSL	
alpha (if jet flow)	0.15		
NUMBER OF STEPS	6		
STEP HEIGHT/LENGTH RATIO	0.33333333		

SOLUTION:

HYDRAULIC PARAMETERS:

DISCHARGE INTENSITY q = Q/W	164	cfs/ft
DROP HEIGHT (H)	11	ft
STEP HEIGHT (h)	1.83333333	ft
STEP LENGTH (L)	5.5	ft
Yc=.315*q^.667	9.45	ft
Yc/h	5.16	**SKIMMING FLOW**
Vc=q/Yc	17.35	fps

RELATIVE ENERGY LOSS ACROSS DROP	0.37	ft/ft
E0 = H + 1.5 * Yc	25.18	ft
E1 = y1 + (V1 ^ 2)/(2g)	15.86	ft
q = V1 * y1	164	cfs/ft
ENERGY LOSS ACROSS DROP	9.32	ft
USING assumed trial values of y1=	4.495	
then V1=	36.48	
and E1=	25.17	
THEREFORE, V1=	36.48	fps
AND y1=	4.495	ft
Froude Fr1=V1/(g*y1)^.5	3.03	

STILLING BASIN:

For known value of Fr1, read from Figure VI-11, HEC-14:

Lb/y1 =	20	
therefore, Lb=	89.9	ft

CHECK TAILWATER REQUIREMENTS:

		1141.00	downstream flowline elevation
	+	18.75	ft (tailwater depth)
tailwater per channel hydraulics		**1159.75**	
		1141.00	basin bottom elevation
y2 = y1*0.5*((1+8*Fr1 ^ 2) ^ 0.5-1)		17.16	ft
tailwater required for hyd jump		**1158.16**	

ADJUSTMENT REQUIRED TO BASIN BOTTOM ELEVATION: **0.00 ft**

22-Feb-94

ESTIMATED QUANTITIES FOR STEPPED DROP STRUCTURE:

Drop structure designed for 100-year flows.

ITEM	QUANTITY
UPSTREAM RIPRAP	993.00 CY
ROLLER COMPACTED CONCRETE UPSTREAM CUTOFF WALL	889.00 CY
ROLLER COMPACTED CONCRETE DROP STRUCTURE	8850.00 CY
ROLLER COMPACTED CONCRETE DOWNSTREAM CUTOFF WALL	1094.00 CY
DOWNSTREAM RIPRAP	2571.00 CY
FILTER BLANKET BENEATH RIPRAP (Upstream and Downstream of Drop)	1286.00 CY
ROLLER COMPACTED CONCRETE STEPS	245 CY
STEPS - FORMWORK	3024 SF
GRANULAR FILTER BEDDING	2979.00 CY
PERFORATED DRAINAGE PIPE	1650 LF

w:/newriver/drpquanc.wq2

STEPPED SPILLWAY DROP STRUCTURE

17-Feb-94

HYDRAULIC ANALYSIS
Stilling Basin without Baffle Blocks
File:dropspfb.wq2

SPF ANALYSIS

REFERENCES:

Chamani, M. R. and N. Rajaratnam, "Jet Flow on Stepped Spillways," Department of Civil Engineering, University of Alberta, Edmonton, Alberta, Canada, 1993.

Federal Highway Administration, Hydraulic Engineering Circular No. 14, Hydraulic Design of Energy Dissipators for Culverts and Channels, September 1983.

Rajaratnam, N., "Skimming flow in Stepped Spillways," Journal of Hydraulic Engineering, Vol. 166 No. 4, April 1990.

GIVEN DATA:

FLOW	68000	CFS	
SPILLWAY WIDTH	250	FT	
TAILWATER DEPTH	23.78	FT	
SPILLWAY CREST ELEVATION	1152	MSL	
STILLING BASIN BOTTOM ELEV	1141	MSL	need
DOWNSTREAM FLOWLINE ELEV	1141	MSL	
alpha (if jet flow)	0.15		
NUMBER OF STEPS	6		
STEP HEIGHT/LENGTH RATIO	0.33333333		

SOLUTION:

HYDRAULIC PARAMETERS:

DISCHARGE INTENSITY q = Q/W	272	cfs/ft
DROP HEIGHT (H)	11	ft
STEP HEIGHT (h)	1.83333333	ft
STEP LENGTH (L)	5.5	ft
Yc=.315*q ^ .667	13.25	ft
Yc/h	7.23	**SKIMMING FLOW**
Vc=q/Yc	20.53	fps

RELATIVE ENERGY LOSS ACROSS DROP	0.24	ft/ft
E0 = H + 1.5 * Yc	30.87	ft
E1 = y1 + (V1 ^ 2)/(2g)	23.56	ft
q = V1 * y1	272	cfs/ft
ENERGY LOSS ACROSS DROP	7.31	ft
USING assumed trial values of y1=	6.927	
then V1=	39.27	
and E1=	30.87	
THEREFORE, V1=	39.27	fps
AND y1=	6.927	ft
Froude Fr1=V1/(g*y1) ^ .5	2.63	

STILLING BASIN:

For known value of Fr1, read from Figure VI-11, HEC-14:

Lb/y1 =	17	
therefore, Lb=	117.8	ft

CHECK TAILWATER REQUIREMENTS:

		1141.00	downstream flowline elevation
	+	23.78	ft (tailwater depth)
tailwater per channel hydraulics		**1164.78**	
		1141.00	basin bottom elevation
y2 = y1*0.5*((1+8*Fr1 ^ 2) ^ 0.5-1)		22.52	ft
tailwater required for hyd jump		**1163.52**	

ADJUSTMENT REQUIRED TO BASIN BOTTOM ELEVATION: **0.00 ft**

NEWRIVER CHANNELIZATION JOB NO.: 91755.02

DROP STRUCTURE

SEEPAGE AND UPLIFT COMPUTATION:

LANE'S WEIGHTED CREEP METHOD

DGN BY: JJH DATE: 12/21/93

PROCEDURE FROM CRSS (GEORGE COTTON) CHK BY: RLH DATE: 02/23/94

revised 2/21/94 file=NWRVWCM6.WQ1

Effective Length Calculation

Path	Direction	Length (ft)	Cum. Length (ft)	Weight Factor	Effective Length (ft)	Fractional Length
1-2	V	12	12	1	12.00	0.11
2-3	H	8	20	0.333	14.66	0.14
3-4	V	8	28	1	22.66	0.21
4-5	H	14.5	42.5	0.333	27.49	0.26
5-6	V	1.5	44	1	28.99	0.27
6-7	H	30	74	0.333	38.98	0.37
7-8	H	98	172	0.333	71.62	0.68
8-9	V	13.5	185.5	1	85.12	0.80
9-10	H	8	193.5	0.333	87.78	0.83
10-11	V	18	211.5	1	105.78	1.00

Total Creep Calculation

STAGE	at Crest	at Endsill	Creep
Low Flow	1152	1141	9.62
10-yr.	1155.8	1152.1	28.59
100-yr.	1160.53	1160.4	813.70
SPF	1163.83	1165.5	63.34

Uplift Head Calculation

		Pizometric Profile				Uplift Head			
Point	Elevation	Low Flow	10-yr.	100-yr.	SPF	Low FLow	10-yr.	100-yr.	SPF
1	1152.00	1152.00	1155.80	1160.53	1163.83	0.00	3.80	8.53	11.83
2	1140.00	1150.75	1155.38	1160.52	1164.02	10.75	15.38	20.52	24.02
3	1140.00	1150.48	1155.29	1160.51	1164.06	10.48	15.29	20.51	24.06
4	1148.00	1149.64	1155.01	1160.50	1164.19	1.64	7.01	12.50	16.19
5	1148.00	1149.14	1154.84	1160.50	1164.26	1.14	6.84	12.50	16.26
6	1146.5	1148.99	1154.79	1160.49	1164.29	2.49	8.29	13.99	17.79
7	1136.50	1147.95	1154.44	1160.48	1164.45	11.45	17.94	23.98	27.95
8	1136.50	1144.55	1153.29	1160.44	1164.96	8.05	16.79	23.94	28.46
9	1123.00	1143.15	1152.82	1160.43	1165.17	20.15	29.82	37.43	42.17
10	1123.00	1142.87	1152.73	1160.42	1165.22	19.87	29.73	37.42	42.22
11	1141.00	1141.00	1152.10	1160.40	1165.50	0.00	11.10	19.40	24.50

Fx and Fy Calculations
Low Flow Conditions (post hydrograph)

Surface	Surface Area per ft.	Pressure Centroid	Centroid Coordinate xc	Centroid Coordinate yc	Pressure	Fx	Fy
1-2	16.97	11.31	21.00	21.00	5693	4025	4025
2-3	8	3.98	20.98	17.00	5298	0	5298
3-4	11.31	4.28	28.03	20.03	4276	3023	3023
4-5	14.5	6.81	39.81	25.00	1260	0	1260
5-6	1.5	0.84	47.50	24.16	170	170	0
6-7	31.62	19.20	65.72	17.43	13744	4346	13039
7-8	98	46.16	123.66	13.50	59620	0	59620
8-9	19.09	8.18	181.28	7.72	16797	11876	11876
9-10	8	4.01	193.00	0.00	9989	0	9989
10-11	25.46	8.49	191.00	6.00	15785	11160	11160

Fx and Fy Calulations
100-year Flow Condition

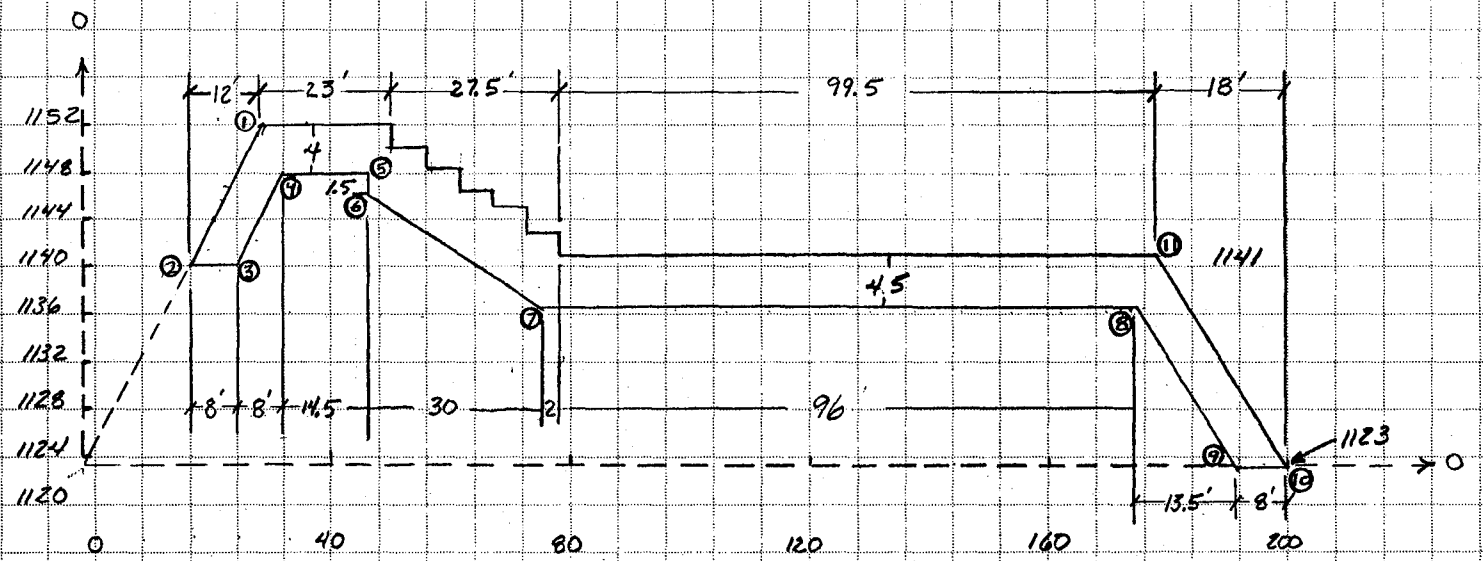
Surface	Surface Area per ft.	Pressure Centroid	Centroid Coordinate xc	Centroid Coordinate yc	Pressure	Fx	Fy
1-2	16.97	9.65	22.17	22.17	15378	10873	10873
2-3	8.00	4.00	21.00	17.00	10240	0	10240
3-4	11.31	5.20	28.67	20.67	11650	8236	8236
4-5	14.50	7.25	40.25	25.00	11309	0	11309
5-6	1.50	0.76	47.50	24.24	1240	1240	0
6-7	31.62	17.20	63.82	18.06	37465	11847	35543
7-8	98.00	49.01	126.51	13.50	146533	0	146533
8-9	19.09	8.85	181.76	7.23	36551	25841	25841
9-10	8.00	4.00	193.00	0.00	18682	0	18682
10-11	25.46	11.38	188.95	8.04	45137	31912	31912

Fx and Fy Calculations
SPF Condition

Surface	Surface Area per ft.	Pressure Centroid	Centroid Coordinate xc	Centroid Coordinate yc	Pressure	Fx	Fy
1-2	16.97	9.45	22.32	22.32	18981	13420	13420
2-3	8.00	4.00	21.00	17.00	12001	0	12001
3-4	11.31	5.29	28.74	20.74	14203	10041	10041
4-5	14.50	7.24	40.24	25.00	14681	0	14681
5-6	1.50	0.76	47.50	24.24	1594	1594	0
6-7	31.62	16.98	63.61	18.13	45118	14266	42803
7-8	98.00	48.85	126.35	13.50	172467	0	172467
8-9	19.09	10.16	182.68	6.32	42070	29744	29744
9-10	8.00	4.00	193.00	0.00	21064	0	21064
10-11	25.46	11.60	188.80	8.20	52996	37468	37468

PROJECT New River Drop Structure
PROJECT NO. 91755.02 SHEET NO. 1 OF 7
CALCULATED BY WH DATE 2/1/94
CHECKED BY RLH DATE 2/23/94

STEPS 5.5 (H)
1.83 (V)



NEW RIVER DROP STRUCTURE

1 SQUARE = 8 FEET (H)
1 SQUARE = 4 FEET (V)

WOOD/PATEL ASSOCIATES
Civil Engineers
Hydrologists
Land Surveyors

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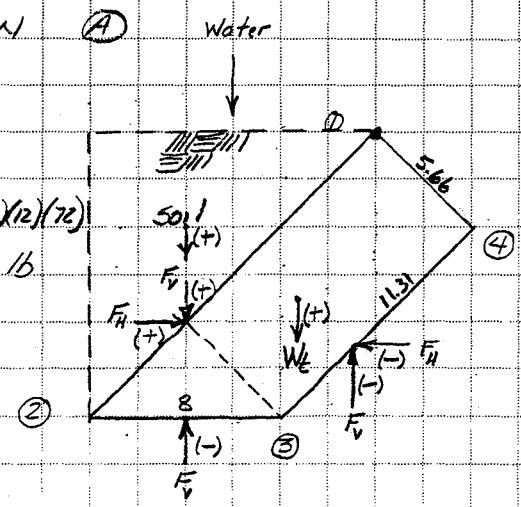
Land Surveyors

PROJECT: New River Dmp Structure
PROJECT NO. 91755.02 SHEET NO. 2 OF 7
CALCULATED BY: JJH DATE: 2/1/94
CHECKED BY: RH DATE: 2/10/94

100-YEAR DEPTH = 8.53 FT
SPF DEPTH = 11.83 FT

SECTION (A)



$W_{SAT} = (0.5)(12)(12)(72)$
$= 5184$ lb

AREA $= (5.66)(11.31) + (0.5)(5.66)^2$

AREA $= 80.05$ ft^2

$W_t = (145\ \text{lb/ft}^3)(80.05\ \text{ft}^2/\text{ft})$

$W_t = 11{,}607$ lb

Water $(8.53)(12)(62.4) = 6.39$ K
$(11.83)(12)(62.4) = 8.86$ K

CENTER OF GRAVITY

$$X_c = \frac{(4)[(0.5)(5.66)^2] + (10)[(5.66)(11.31)]}{80.05}$$

$X_c = 8.80$ ft

$$Y_c = \frac{\frac{4}{3}(16) + 6(64)}{80.05}$$

$Y_c = 5.06$ ft

OVERTURNING (Moment about (D))

$$\circlearrowleft + SF = \frac{\underbrace{(4.025)(8)}_{(1\to2)} + \underbrace{(4.025)(8)}_{(1\to2)} + \underbrace{(11.6)(3.2)}_{(W_t)} + \underbrace{(5.184)(8)}_{(W_{soil})}}{\underbrace{(5.298)(8.02)}_{(2\to3)} + \underbrace{(3.023)(0.96)}_{(3\to4)} + (3.023)(8.96)}$$

$$SF = \frac{142.99}{72.47} = 1.97$$

$$\circlearrowleft + SF_{100} = \frac{\underbrace{(10.873)(6.82)}_{1\to2} + \underbrace{(10.873)(6.82)}_{1\to2} + \underbrace{(11.6)(3.2)}_{W_t} + \underbrace{(5.184)(8)}_{\text{sat soil}} + \underbrace{(6.39)(6)}_{\text{water}}}{\underbrace{(10.24)(8)}_{2\to3} + \underbrace{(8.236)(0.33)}_{3\to4} + (8.236)(8.33)} = \frac{265}{154} = \frac{1.72}{2}$$

$$\circlearrowleft SF_{SPF} = \frac{(13.420)(6.67) + (13.420)(6.67) + (11.6)(3.2) + (5.184)(8) + (8.86)(6)}{(12.0)(8) + (10.04)(0.26) + (10.04)(8.26)} = \frac{310.8}{181.5} = \frac{1.71}{2}$$

WOOD/PATEL ASSOCIATES
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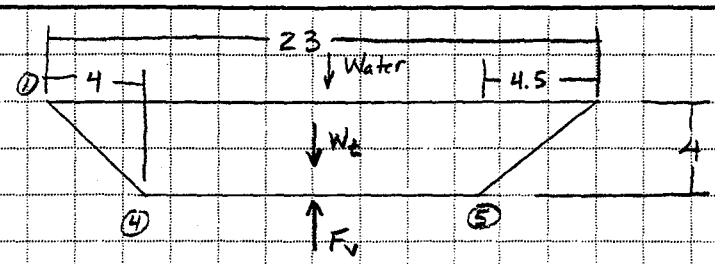
PROJECT: New River Drop Structure
PROJECT NO. 91755.02 SHEET NO. 3 OF
CALCULATED BY: JNH DATE 2/21/94
CHECKED BY: RLH DATE 2/22/94

SECTION B



100 YR = 8.53 FT
SPF = 11.83 FT

AREA = (0.5)(4)(4) + (14.5)(4) + (0.5)(4)(4.5)

AREA = 8 + 58 + 9 = 75 FT^2

WEIGHT = (75)(145) = 10,875 lb

DETERMINE CENTER OF GRAVITY

$\bar{x}$ = [(2.67)(8) + (11.25)(58) + (20)(9)] / 75 = 11.38 FT FROM PT ①

DETERMINE OVERTURNING ABOUT ①

$$SF = \frac{(10.88)(11.38)}{(1.26)(10.81)} = \frac{123.9}{13.6} = \frac{9.1}{1}$$

$$SF_{100} = \frac{(10.88)(11.38) + (12.24)(11.50)}{(11.309)(11.25)} = \frac{264.6}{127.2} = \frac{2.08}{1}$$

$$SF_{SPF} = \frac{(10.88)(11.38) + (16.98)(11.50)}{(14.68)(11.24)} = \frac{319.1}{165.0} = \frac{1.93}{1}$$

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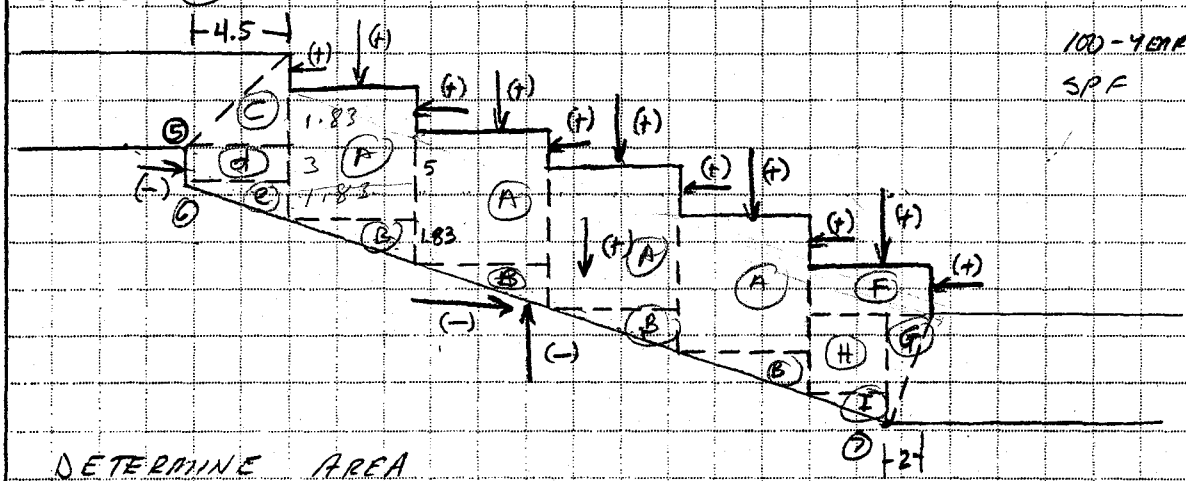
PROJECT: New River Drop Structure
PROJECT NO. 91755.02 SHEET NO. ____ OF ____
CALCULATED BY: JJH DATE: 2/21/94
CHECKED BY: RLH DATE: 2/22/94

SECTION (C)



100-YEAR = 1160.53
SPF = 1163.83

DETERMINE AREA

AREA = (4)(5.5)(5) + (4)(0.5)(5.5)(1.83) + (0.5)(4.5)(1.5) + (1.5)(4.5) + (0.5)(4.5)(4) + (5.5)(1.83) + (3.5)(3.33) + (0.5)(3.5)(1.17) + (0.5)(2)(4.5)

AREA = 110 + 20.1 + 3.38 + 6.75 + 9 + 10.1 + 11.7 + 2.05 + 4.5 = 177.6 FT²

WEIGHT = (177.6 FT)(145) = 25,750 lb

DETERMINE CENTER OF GRAVITY

$\bar{X}$ = [(7.25)(27.5) + (12.75)(27.5) + (18.25)(27.5) + (23.75)(27.5) + (8.17)(5.03) + (13.67)(5.03) + (19.17)(5.03) (24.67)(5.03) + (3)(3.38) + (6.75)(2.25) + (9)(3) + (10.1)(29.25) + (28.25)(11.7) + (28.83)(2.04) + (4.5)(30.67)] / (177.6)

$\bar{X}$ = 2910.5/177.6 = 16.39 FT FROM PT (6)

DETERMINE OVERTURNING ABOUT (7)

$$SF = \frac{(25.75)(13.61)}{(0.17)(10.66) + (3.93)(4.35) + (11.78)(13.04)} = \frac{350.5}{172.5} = \underline{2.03}$$

$$SF_{100} = \frac{[(25.75)(13.61) + (3.55)(22.75) + (4.18)(17.75) + (4.81)(11.75) + (5.44)(6.25) + (6.07)(0.75) + (1.08)(14.59) + (1.29)(12.76) + (1.50)(10.93) + (1.71)(9.10) + (1.91)(7.27) + (2.12)(5.44)]}{[(1.24)(10.74) + (4.56)(11.85) + (13.68)(35.54)]}$$

SF_{100} = 688 / 553.5 = 1.24

WOOD / PATEL ASSOCIATES

Civil Engineers
Hydrologists
Land Surveyors

PROJECT New River Drop Structure
PROJECT NO. 91755.02 SHEET NO. ____ OF ____
CALCULATED BY JJH DATE 2/21/94
CHECKED BY RLH DATE 2/22/94

$$SF_{SPF} = \frac{[(25.75)(13.61) + (4.69)(22.75) + (5.32)(17.25) + (5.94)(11.75) + (6.57)(6.25) + (7.20)(0.75) + (1.46)(14.59) + (1.66)(12.76) + (1.87)(10.93) + (2.08)(9.10) + (2.29)(7.27) + (2.50)(5.44)]}{(1.59)(10.74) + (14.27)(4.63) + (42.80)(13.89)}$$

$$SF_{SPF} = 777.2 / 677.6 = \underline{1.15}$$

WOOD / PATEL ASSOCIATES
Civil Engineers
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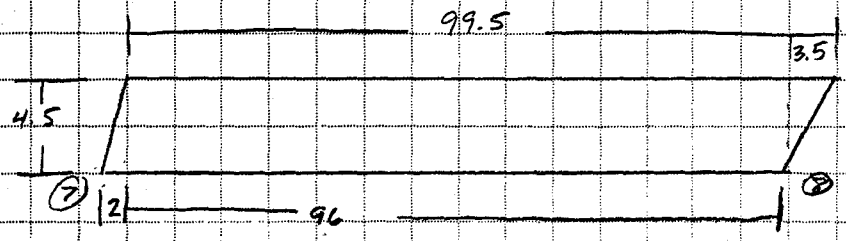
Land Surveyors

PROJECT: New River Dump Structure
PROJECT NO. 91755.02 SHEET NO. ____ OF ____
CALCULATED BY: JJH DATE: 2/21/94
CHECKED BY: RLH DATE: 2/21/94

SECTION ⓪



DETERMINE AREA

AREA = (0.5)(2)(4.5) + (96)(4.5) + (0.5)(3.5)(4.5) = 444.4 FT^2

WEIGHT = (446.6)(145) = 64,430 lbs

DETERMINE CENTER OF GRAVITY

$\bar{X}$ = [(4.5)(1.33) + (432)(50) + (7.9)(99.5)] / 444.4 = 50.39 FT from pt ⑦

DETERMINE OVERTURNING ABOUT ⑧

$$SF = \frac{(64.43)(47.61)}{(59.62)(51.84)} = \frac{3067.5}{3090.7} = 1.00$$

$$SF_{100} = \frac{(64.43)(47.61) + (120.45)(46.25)}{(146.53)(48.99)} = \frac{8638.3}{7178.5} = \underline{1.20}$$

$$SF_{SPF} = \frac{(64.43)(47.61) + (152.36)(46.25)}{(172.47)(49.15)} = \frac{10114.2}{8476.9} = \underline{1.19}$$

* NOTE: ABOVE ANALYSES ASSUME NO WEEP HOLES

SECTION (D) (CONT)

LOW FLOW IS THE WORST CONDITION
WEEP HOLES ARE RECOMMENDED TO RELIEVE UPLIFT PRESSURE

WITH WEEP HOLES 100% EFFECTIVE

$$SF \doteq \frac{145}{62.4} = \underline{\underline{2.32}}$$

ASSUMING LINEAR RELATIONSHIP; THE SF FOR WEEP HOLES 30% OPEN WOULD BE:

1.00	0
SF	30
2.32	100

$\therefore$ SF = 1.40

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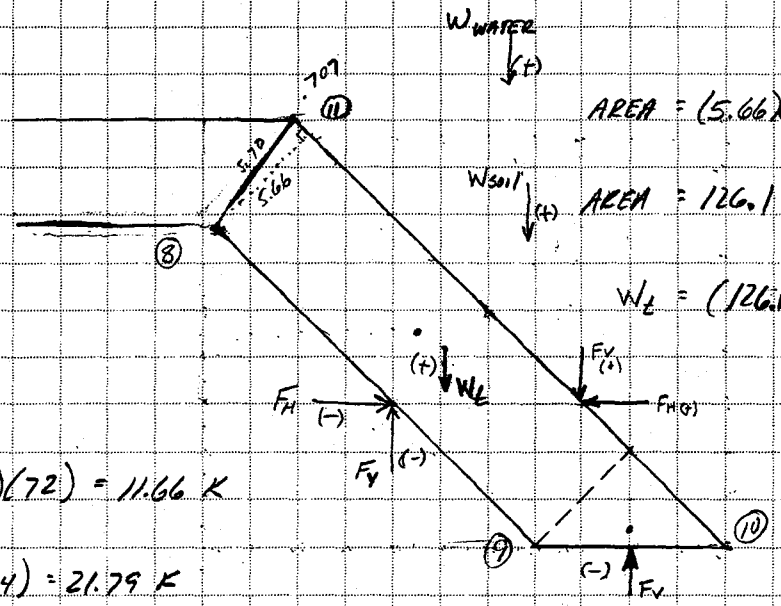
PROJECT: NEW RIVER DROP STRUCTURE
PROJECT NO. 91755.02 SHEET NO. 7 OF 7
CALCULATED BY: WH DATE: 2/3/94
CHECKED BY: RH DATE: 2/10/94

SECTION (E)



100 YEAR = 19.4 FT
SPF = 24.5 FT

$AREA = (5.66)(19.1) + (4)(8)(0.5) + (0.5)(0.707)(5.656)$

$AREA = 126.1\ ft^2/ft$

$W_L = (126.1)(145) = 18{,}285\ lb$

$SOIL = (18)(18)(0.5)(72) = 11.66\ K$

$WATER = (18)(19.4)(62.4) = 21.79\ K$
$(18)(24.5)(62.4) = 27.52\ K$

CENTER OF GRAVITY

$$X_c = \frac{(108.11)(8.75) + (16)(17.5) + (2)(2.66)}{126.1} = 9.76\ ft$$

OVERTURNING ABOUT (11)

$$\circlearrowleft + SF = \frac{\overset{WL}{(18.28)(6.26)} + \overset{(10-11)}{(11.16)(12)} + (11.16)(12) + \overset{SOIL}{(11.664)(12)}}{\underset{(8\to9)}{(11.876)(1.78) + (11.876)(9.78)} + \underset{(9\to10)}{(9.99)(14.0)}} = \frac{522.2}{277.1} = \frac{1.88}{2}$$

$$\circlearrowleft + SF_{100} = \frac{(18.28)(6.26) + (31.912)(9.95) + (31.912)(9.95) + (11.664)(12) + (21.79)(9)}{(25.841)(2.26) + (25.841)(10.26) + (18.682)(14.0)} = \frac{1085.6}{585} = \frac{1.85}{2}$$

$$\circlearrowleft + SF_{SPF} = \frac{(18.28)(6.26) + (37.468)(9.8) + (37.468)(9.8) + (11.664)(12) + (27.52)(9)}{(29.744)(3.18) + (29.744)(11.18) + (21.07)(14.0)} = \frac{1236.5}{722} = \frac{1.71}{2}$$

The locations and extent of these devices to obtain optimum safety and economy of design depend on many conditions. Therefore, only devices or combinations of devices which might be used with relatively simple diversion dams are discussed.

178. *Aprons.*—A concrete apron may be placed upstream of the dam in conjunction with one of the various types of cutoff walls. The function of the apron is to increase the length of the path of percolation in order to reduce uplift under the main portion of the dam. Usually the apron is connected to the dam and to a concrete cap over the cutoff with flexible waterstops, which allow differential movement to take place without accompanying detrimental cracking. The safety of the structure may be further improved by placing an impervious earth blanket over a portion of the concrete apron and the streambed upstream from it.

Downstream concrete aprons have two functions. They lengthen the path of percolation in the foundations and also provide a basin where the energy of the overflowing water may be safely dissipated. Energy dissipation on the concrete helps to prevent dangerous erosion at the toe of the dam. In cases where it is not feasible to construct a concrete apron of sufficient length to avoid erosion completely, additional protection may be gained by placing riprap downstream from the apron.

179. *Cutoff Walls.*—Cutoff walls may be constructed of timber, concrete, cement-bound curtains, steel sheet piling, or impervious earth compacted in a trench. Each type can be effective under appropriate circumstances.

Timber piling may be used as cutoffs under upstream or downstream aprons. Dimension timber piling is not recommended where driving is necessary. Better construction practice consists of erecting overlapping treated timbers in an excavated open trench and then backfilling and compacting impervious material in the trench around the timbers. This method prevents brooming or splitting of the timbers which results when timber is driven through sand and gravel. If the piling is seated on an impervious stratum and is properly connected to the concrete apron, a tight barrier to underseepage is provided.

Concrete cutoffs may be used under aprons or under the overflow section. They may be constructed by trenching with a machine or by hand labor and backfilling against the undisturbed sides of the trench, or they may be constructed by forming the concrete wall in an open excavated trench and then backfilling and compacting impervious material in the trench and around the wall. A concrete cutoff is probably the best type of wall for preventing underseepage and is often used. In addition to acting as a cutoff, such a cutoff can be designed to contribute substantially to the stability (sliding resistance) of the dam when placed under the overflow section.

Cement-bound curtain cutoffs have been used under the upstream apron of a few concrete gravity structures by the Bureau of Reclamation. The construction of this type of cutoff is described in section 131(e).

Sheet piling cutoffs of interlocking steel sections are often used under the aprons of diversion dams. A discussion of sheet piling cutoffs will be found in section 131(d).

180. *Filters and Drains.*—Reduction of uplift pressure under downstream apron or downstream toe of the dam may be accomplished by pipe drains. Drains are often of sewer pipe and are laid in graded material which acts as a filter. They may be perforated pipe or plain pipe laid with open joints. The drains may be located at the downstream toe of the dam, at selected places under the downstream apron, and immediately upstream from the downstream cutoff.

Weep holes are commonly used for reduction of uplift pressure under aprons and excessive pressure behind walls. It is important that the gradation of the filter materials used in conjunction with the weep holes be carefully selected with respect to the gradation of the foundation materials to prevent piping. Both uniform grain-size and graded filters are used. The design of filters is given in section 131(h) and (i).

181. *Uplift and Seepage.*—Cutoff walls, aprons, and drains are installed for two reasons: To control the amount of seepage under the dam, and to limit the intensity of the uplift

so that the stability of the structure will not be threatened. Several factors such as head on the dam, permeability of the foundation, length of upstream and downstream aprons, depths and tightness of cutoff, and effectiveness of drains enter into consideration of underseepage and uplift.

The magnitude and distribution of seepage pressures in the foundation and the amount of underseepage for a given coefficient of permeability can be obtained from a flow net. Flow nets properly constructed are more accurate than Lane's weighted-creep theory (discussed below), and result in more realistic determinations of seepage pressures and piping. An excellent discussion of flow nets is given in reference [33] of chapter VI.

The amount of underseepage can be approximated by use of the Darcy formula, as given in section 130(b). The weighted-creep theory, as developed by Lane [5] may be used as a means for designing low concrete dams on pervious foundations. Although this is an empirical method, considerable confidence has been placed in it by many engineers and it has been successfully used for the design of many structures.

Mr. Lane gives credit for various concepts of creep analysis to the early investigators, Clibborn, Beresford, Bligh, Griffith, and others. He did, however, test his theory by analysis of more than 200 dams on pervious foundations, both failures and nonfailures. His main conclusions (omitting those regarding the "short-path" which is not applicable here) were as follows:

(1) The weighted-creep distance of a cross section of a dam is the sum of the vertical creep distances (steeper than 45°) plus one-third of the horizontal creep distances (less than 45°).

(2) The weighted-creep head ratio is the weighted-creep distance divided by the effective head.

(3) Reverse filter drains, weep holes, and pipe drains are aids to security from underseepage, and recommended safe weighted-creep head ratios may be reduced as much as 10 percent if they are used.

(4) Care must be exercised to insure that cutoffs are properly tied in at the ends so that the water will not outflank them.

(5) The upward pressure to be used in design may be estimated by assuming that the drop in pressure from headwater to tailwater along the contact line of the dam and foundation is proportional to the weighted-creep distance.

Based on his findings, Mr. Lane recommended the weighted-creep ratios shown below:

Material:	*Ratio*
Very fine sand or silt	8.5
Fine sand	7.0
Medium sand	6.0
Coarse sand	5.0
Fine gravel	4.0
Medium gravel	3.5
Coarse gravel including cobbles	3.0
Boulders with some cobbles and gravel	2.5
Soft clay	3.0
Medium clay	2.0
Hard clay	1.8
Very hard clay or hardpan	1.6

Figure 224 is an example of the application of Lane's weighted-creep theory to the design of a concrete dam. In this example, the design is investigated to determine on what types of foundations this dam would be judged safe from piping and the magnitudes of the uplift at various points under the structures are calculated. For the purposes of this example, it is assumed that the maximum head differential occurs with the headwater at the elevation of the crest. All other combinations of head-

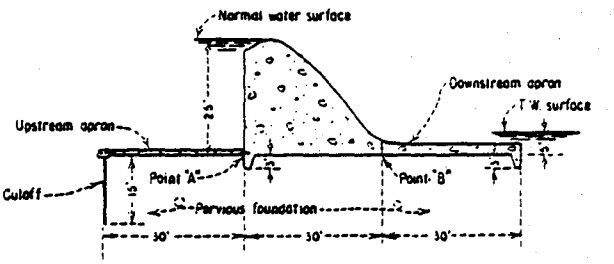


Figure 224. Typical section of a concrete dam on a pervious foundation. 288-D-2511.

water and tailwater should be investigated to establish maximum loading conditions.

For figure 224:

Weighted length of path$=15+15+(4\times3)+\frac{1}{3}(30+30+30)=72$ feet

Head on structure=Headwater−tailwater $=25-5=20$ feet

$$\text{Weighted-creep ratio}=\frac{72}{20}=3.6$$

According to Lane's recommended ratios, this dam would be safe from piping on clay or on medium and coarse gravel, but not on silt, sand, or fine gravel. With properly placed drains and filters, the structure would probably be considered safe on a fine gravel foundation as indicated by conclusion (3).

$$\text{Uplift, point A}=20-\frac{(15+15+10)}{72}\times20+5 \text{ (depth of tailwater above foundation level)}$$

$$=20-11.1+5$$

$$=13.9 \text{ feet.}$$

$$\text{Uplift, point B}=20-\frac{(15+15+10+3+3+10)}{72}\times20+5$$

$$=20-15.6+5$$

$$=9.4 \text{ feet.}$$

$$\text{Total uplift}=\frac{(13.9+9.4)}{2}\times62.5\times30$$

$=21{,}840$ pounds per foot of crest length of dam.

The uplift may be computed as indicated by conclusion (5).

The weighted-creep head ratio can be increased by increasing the depth of the upstream cutoff or by increasing the apron length. Either of these alternatives would also decrease the uplift under the structure. The dam shown in figure 224 is a rather common installation and the example was simplified to illustrate the method. Discussion of a more complicated design such as a dam with two or more deep cutoffs, which requires application of the "short-path" theory, has been omitted. Mr. Lane's article [5] should be consulted for details for complex designs.

In addition to the flow net and weighted-creep methods of estimating the distribution of uplift pressure are Khosla's method of independent variables [6] and Rao's relaxation method [7] which can be used for making computations of uplift at critical points along the base of the structure. Because these theories are highly mathematical they are not discussed in this text.

Seepage forces and piping in a pervious foundation are discussed in section 130(c). The possibility of piping may be alleviated by several methods. As shown on figure 224, a cutoff may be constructed at the downstream end of the apron. A drain laid in graded material which acts as a filter may be placed immediately upstream of the cutoff, or riprap on a graded blanket of gravel may be placed on the material downstream of the apron to increase the downward forces.

E. DETAILS OF LAYOUT AND DESIGN

182. *General.*—If a concrete dam is appreciably more than 50 feet in length, it is necessary to divide the structure into blocks by providing transverse contraction joints. The spacing of the joints is determined by the capacity of the concreting facilities to be used and considerations of volumetric changes and attendant cracking caused by shrinkage and temperature variations. The possibilities of detrimental cracking can be greatly reduced by the selection of the proper type of cement and by careful control of mixing and placing procedures (see appendix F). In no case, however, is it advisable to exceed 50-foot spacing of contraction joints in constructing small concrete dams. Where foundation conditions are such that undesirable differential settlement or displacement between adjacent blocks will occur, shear keys are formed in the contraction joints. These may be formed vertically, horizontally,

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PROJECT DESCRIPTION :

PROJECT TITLE : NEW RIVER
PROJECT NUMBER : 91755.02
DESCRIPTION : ADOT DROP STRUCTURE/CHANNEL EXIST COND
ENGINEER : WOOD, PATEL & ASSOCIATES, INC.
DATE OF RUN : 12/08/1993
TIME OF RUN : 2:00 pm

```
T1      91755.02
T2      NEW RIVER
T3      ADOT DROP STRUCTURE/CHANNEL EXIST COND
T4      PROFILE 1:  100-YEAR NEW RIVER WATER SURFACE ELEVATION, 10-YEAR
T4                  FLOW IN ADOT STRUCTURE
T4      PROFILE 2:  10-YEAR NEW RIVER WATER SURFACE ELEVATION, 100-YEAR
T4                  FLOW IN ADOT STRUCTURE
T4      NOTE:  NORMAL DEPTH GOVERNS THE STARTING WATER SURFACE ELEVATION
T4             IN PROFILE 2; THE NEW RIVER 10-YEAR WATER SURFACE ELEVATION
T4             IS LESS THAN THE ADOT CHANNEL NORMAL DEPTH WATER SURFACE
T4             ELEVATION.
```

JOB PARAMETERS :

	ICHECK	INQ	NINV	IDIR	STRT	METRIC	HVINS	Q	WSEL	FQ
J1	0	2	0	0	0.0	0	0.0	260.0	1142.24	

	NPROF	IPLOT	PRFVS	XSECV	XSECH	FN	ALLDC	IBW	CHNIM	ITRACE
J2	1	1	0.0	0.0	0.0	0.0	0.0	-6.0	0.0	

REQUESTED CROSS-SECTION PRINTOUTS (J5) :

```
     -10       -10

NC    0.035     0.035     0.035     0.3       0.5
  STA 112+82; CONFLUENCE WITH NEW RIVER
STA 112+82; CONFLUENCE WITH NEW RIVER

X1       0         6       0.0      46.2       0.0       0.0       0.0       1.0       0.0
GR   1141.5       0.0    1132.8      13.1   1128.51      15.6   1128.51      30.6    1132.8      33.1
GR   1141.5      46.2

NC    0.013     0.013       0.0       0.0       0.0
  TOP OF SILL OF STILLING BASIN
TOP OF SILL OF STILLING BASIN

X1       1         4       0.0      15.2      30.0      30.0      30.0       1.0       0.0
GR   1140.7       0.0   1128.58       0.1   1128.58      15.1   1140.79      15.2
  BOTTOM OF SILL OF STILLING BASIN

BOTTOM OF SILL OF STILLING BASIN

         2         4       0.0      15.2       1.0       1.0       1.0       1.0       0.0
GR   1140.7       0.0   1127.23       0.1   1127.23      15.1   1140.79      15.2
  TOE OF DROP STRUCTURE
```

TOE OF DROP STRUCTURE

X1	3	4	0.0	15.2	61.0	61.0	61.0	1.0	0.0
GR	1140.7	0.0	1127.23	0.1	1127.23	15.1	1140.79	15.2	

CREST OF DROP STRUCTURE

CREST OF DROP STRUCTURE

X1	4	4	0.0	15.2	1.0	1.0	1.0	1.0	0.0
GR	1140.7	0.0	1132.25	0.1	1132.25	15.1	1140.79	15.2	

50 FT UPSTREAM OF DROP STRUCTURE

50 FT UPSTREAM OF DROP STRUCTURE

X1	5	4	0.0	42.6	50.0	50.0	50.0	1.0	0.0
GR	1140.7	0.0	1132.62	16.3	1132.62	26.3	1140.79	42.6	

127 FT UPSTREAM OF DROP STRUCTURE

127 FT UPSTREAM OF DROP STRUCTURE

X1	6	4	0.0	44.4	77.0	77.0	77.0	1.0	0.0
	1141.5	0.0	1132.89	17.2	1132.89	27.2	1141.5	44.4	

227 FT UPSTREAM OF DROP STRUCTURE

227 FT UPSTREAM OF DROP STRUCTURE

X1	7	4	0.0	47.0	100.0	100.0	100.0	1.0	0.0
GR	1142.5	0.0	1133.24	18.5	1133.24	28.5	1142.5	47.0	

327 FT UPSTREAM OF DROP STRUCTURE

327 FT UPSTREAM OF DROP STRUCTURE

X1	8	4	0.0	42.0	100.0	100.0	100.0	1.0	0.0
GR	1141.6	0.0	1133.59	16.0	1133.59	26.0	1141.60	42.0	

399 FT UPSTREAM OF DROP STRUCTURE

399 FT UPSTREAM OF DROP STRUCTURE

X1	9	4	0.0	35.6	72.0	72.0	72.0	1.0	0.0
GR	1140.2	0.0	1133.82	12.8	1133.82	22.8	1140.20	35.6	

DOWNSTREAM FACE OF HWY 101 BOX CULVERT

DOWNSTREAM FACE OF HWY 101 BOX CULVERT

X1	10	4	0.0	17.2	50.0	50.0	50.0	1.0	0.0
GR	1141.5	0.0	1133.80	0.1	1133.80	17.1	1141.55	17.2	

91755.02
- NEW RIVER
T3 ADOT DROP STRUCTURE/CHANNEL EXIST COND

JOB PARAMETERS :

J1	ICHECK	INQ	NINV	IDIR	STRT	METRIC	HVINS	Q	WSEL	FQ
	0	3	0	0	0.0	0	0.0	895.0	1136.3	
J2	NPROF	IPLOT	PRFVS	XSECV	XSECH	FN	ALLDC	IBW	CHNIM	ITRACE
	15	1	0.0	0.0	0.0	0.0	0.0	-6.0	0.0	

SPECIAL NOTE :

An asterisk (*) to the left of the cross-section number indicates a special note is present in the SUMMARY OF WARNING AND STATUS MESSAGES section.

ARY PRINTOUT TABLE 150 : NEW RIVER
ADOT DROP STRUCTURE/CHANNEL EXIST COND
91755.02

	Cross-Section Number SECNO	Channel Reach Length (ft) XLCH	Top of Roadway Elevation (ft MSL) ELTRD	Max. Low Chord Elevation (ft MSL) ELLC	Minimum C. S. Elevation (ft MSL) ELMIN	Discharge Flow (cfs) Q	Computed W. S. Elevation (ft MSL) CWSEL	Critical W. S. Elevation (ft MSL) CRIWS	Energy Gradient Elevation (ft MSL) EG	Energy Gradient Slope * 10,000 10K*S	Channel Mean Flow Velocity (ft/s) VCH	Cross-Section Area (sq ft) AREA	Index Q (0.01 * Convey.) .01K
	.000	.00	.00	.00	1128.51	260.00	1142.24	.00	1142.25	.18	.65	397.23	609.24
	.000	.00	.00	.00	1128.51	895.00	1136.30	.00	1136.77	23.39	5.47	163.52	185.04
*	1.000	30.00	.00	.00	1128.58	260.00	1142.23	.00	1142.26	1.06	1.26	206.42	252.07
*	1.000	30.00	.00	.00	1128.58	895.00	1136.16	.00	1137.11	57.76	7.84	114.19	117.77
	2.000	1.00	.00	.00	1127.23	260.00	1142.24	.00	1142.26	.85	1.15	226.68	282.81
	2.000	1.00	.00	.00	1127.23	895.00	1136.59	.00	1137.22	33.08	6.34	141.15	155.62
	3.000	61.00	.00	.00	1127.23	260.00	1142.24	.00	1142.26	.84	1.15	226.85	283.07
	3.000	61.00	.00	.00	1127.23	895.00	1136.83	.00	1137.42	31.05	6.19	144.64	160.63
*	4.000	1.00	.00	.00	1132.25	260.00	1142.23	.00	1142.28	2.34	1.72	150.95	169.89
*	4.000	1.00	.00	.00	1132.25	895.00	1137.03	1137.03	1139.43	204.93	12.44	71.93	62.52
	5.000	50.00	.00	.00	1132.62	260.00	1142.28	.00	1142.29	.48	.93	278.95	375.13

	Cross-Section Number SECNO	Channel Reach Length (ft) XLCH	Top of Roadway Elevation (ft MSL) ELTRD	Max. Low Chord Elevation (ft MSL) ELLC	Minimum C. S. Elevation (ft MSL) ELMIN	Discharge Flow (cfs) Q	Computed W. S. Elevation (ft MSL) CWSEL	Critical W. S. Elevation (ft MSL) CRIWS	Energy Gradient Elevation (ft MSL) EG	Energy Gradient Slope * 10,000 10K*S	Channel Mean Flow Velocity (ft/s) VCH	Cross-Section Area (sq ft) AREA	Index Q (0.01 * Convey.) .01K
*	5.000	50.00	.00	.00	1132.62	895.00	1139.88	.00	1140.27	20.64	5.02	178.45	197.01
	6.000	77.00	.00	.00	1132.89	260.00	1142.28	.00	1142.29	.55	.97	269.17	350.84
	6.000	77.00	.00	.00	1132.89	895.00	1140.04	.00	1140.45	22.30	5.17	173.27	189.53
	7.000	100.00	.00	.00	1133.24	260.00	1142.29	.00	1142.30	.67	1.02	253.92	316.77
	7.000	100.00	.00	.00	1133.24	895.00	1140.26	.00	1140.69	24.12	5.32	168.30	182.24
	8.000	100.00	.00	.00	1133.59	260.00	1142.29	.00	1142.31	.77	1.10	237.31	295.84
	8.000	100.00	.00	.00	1133.59	895.00	1140.49	.00	1140.96	25.86	5.46	164.01	176.01
	9.000	72.00	.00	.00	1133.82	260.00	1142.30	.00	1142.32	.87	1.18	220.11	278.46
	9.000	72.00	.00	.00	1133.82	895.00	1140.67	.00	1141.15	25.66	5.51	162.32	176.67
*	10.000	50.00	.00	.00	1133.80	260.00	1142.29	.00	1142.34	2.56	1.79	145.33	162.56
	10.000	50.00	.00	.00	1133.80	895.00	1140.64	.00	1141.55	54.76	7.66	116.81	120.95

SUMMARY PRINTOUT TABLE 150 : NEW RIVER
---------- ADOT DROP STRUCTURE/CHANNEL EXIST COND
91755.02

	Cross-Section Number SECNO	Discharge Flow (cfs) Q	Computed W. S. Elevation (ft MSL) CWSEL	W.S. Elev Diff per Profile (ft) DIFWSP	W.S. Elev Diff per Section (ft) DIFWSX	W.S. Elev Diff per Know/Comp (ft) DIFKWS	Water Surface Top Width (ft) TOPWID	Channel Reach Length (ft) XLCH
	.000	260.00	1142.24	.00	.00	.00	46.20	.00
	.000	895.00	1136.30	-5.94	.00	.00	30.54	.00
*	1.000	260.00	1142.23	.00	-.01	.00	15.20	30.00
*	1.000	895.00	1136.16	-6.07	-.14	.00	15.12	30.00
	2.000	260.00	1142.24	.00	.01	.00	15.20	1.00
	2.000	895.00	1136.59	-5.64	.43	.00	15.14	1.00
	3.000	260.00	1142.24	.00	.01	.00	15.20	61.00
	3.000	895.00	1136.83	-5.42	.23	.00	15.14	61.00
	4.000	260.00	1142.23	.00	-.01	.00	15.20	1.00

	Cross-Section Number SECNO	Discharge Flow (cfs) Q	Computed W. S. Elevation (ft MSL) CWSEL	W.S. Elev Diff per Profile (ft) DIFWSP	W.S. Elev Diff per Section (ft) DIFWSX	W.S. Elev Diff per Know/Comp (ft) DIFKWS	Water Surface Top Width (ft) TOPWID	Channel Reach Length (ft) XLCH
*	4.000	895.00	1137.03	-5.20	.20	.00	15.11	1.00
*	5.000	260.00	1142.28	.00	.05	.00	42.60	50.00
*	5.000	895.00	1139.88	-2.39	2.86	.00	39.14	50.00
	6.000	260.00	1142.28	.00	.00	.00	44.40	77.00
	6.000	895.00	1140.04	-2.24	.15	.00	38.53	77.00
	7.000	260.00	1142.29	.00	.01	.00	46.14	100.00
	7.000	895.00	1140.26	-2.03	.22	.00	38.01	100.00
	8.000	260.00	1142.29	.00	.01	.00	42.00	100.00
	8.000	895.00	1140.49	-1.80	.24	.00	37.56	100.00
	9.000	260.00	1142.30	.00	.00	.00	35.60	72.00
	9.000	895.00	1140.67	-1.62	.18	.00	35.60	72.00
*	10.000	260.00	1142.29	.00	-.01	.00	17.20	50.00
*	10.000	895.00	1140.64	-1.65	-.04	.00	17.18	50.00

SUMMARY OF WARNING AND STATUS MESSAGES :

Section 1, profile 1, conveyance change outside acceptable range.

Section 1, profile 2, conveyance change outside acceptable range.

Section 4, profile 1, conveyance change outside acceptable range.

Section 4, profile 2, critical depth assumed.

Section 4, profile 2, probable minimum specific energy.

Section 4, profile 2, 20 trials attempted to balance water surface elevation.

Section 5, profile 1, conveyance change outside acceptable range.

Section 5, profile 2, conveyance change outside acceptable range.

'ection 10, profile 1, conveyance change outside acceptable range.

Section 10, profile 2, conveyance change outside acceptable range.

10 Warning and status message(s) generated

END OF OUTPUT

==========
B O S S H E C - 2 (tm)
==========

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PROJECT DESCRIPTION :

PROJECT TITLE : NEW RIVER
'ROJECT NUMBER : 91755.02
DESCRIPTION : ADOT DROP STRUCTURE/CHANNEL PROP CONDIT
ENGINEER : WOOD, PATEL & ASSOCIATES, INC.
DATE OF RUN : 12/08/1993
TIME OF RUN : 1:51 pm

```
T1      91755.02
T2      NEW RIVER
T3      ADOT DROP STRUCTURE/CHANNEL PROP CONDIT
T4      PROFILE 1: 100-YEAR WATER SURFACE ELEVATION IN NEW RIVER, 10-YEAR
T4                 FLOW IN ADOT STRUCTURE
T4      PROFILE 2: 10-YEAR WATER SURFACE ELEVATION IN NEW RIVER, 100-YEAR
T4                 FLOW IN ADOT STRUCTURE
T4      NOTE:  NORMAL DEPTH GOVERNS THE STARTING WATER SURFACE ELEVATION
T4             IN PROFILE 2; THE NEW RIVER 10-YEAR WATER SURFACE ELEVATION
T4             IS LESS THAN THE ADOT CHANNEL NORMAL DEPTH WATER SURFACE
T4             ELEVATION.
```

JOB PARAMETERS :

	ICHECK	INQ	NINV	IDIR	STRT	METRIC	HVINS	Q	WSEL	FQ
J1	0	2	0	0	0.0	0	0.0	260.0	1139.1	

	NPROF	IPLOT	PRFVS	XSECV	XSECH	FN	ALLDC	IBW	CHNIM	ITRACE
J2	1	1	0.0	0.0	0.0	0.0	0.0	-6.0	0.0	

REQUESTED CROSS-SECTION PRINTOUTS (J5) :

```
    -10      -10

NC    0.035     0.035     0.035      0.3       0.5
  STA 113+57.48; CONFLUENCE WITH NEW RIVER
STA 113+57.48; CONFLUENCE WITH NEW RIVER

X1        0         6       0.0      46.2       0.0       0.0       0.0       1.0       0.0
GR   1141.5       0.0    1132.8      13.1    1128.51      15.6    1128.51      30.6    1132.8      33.1
GR   1141.5      46.2

NC    0.013     0.013     0.013       0.0       0.0
  TOP OF SILL OF STILLING BASIN
TOP OF SILL OF STILLING BASIN

X1        1         4       0.0      15.2      30.0      30.0      30.0       1.0       0.0
GR   1140.7       0.0   1128.58       0.1   1128.58      15.1   1140.79      15.2
  BOTTOM OF SILL OF STILLING BASIN

BOTTOM OF SILL OF STILLING BASIN

          2         4       0.0      15.2       1.0       1.0       1.0       1.0       0.0
GR   1140.7       0.0   1127.23       0.1   1127.23      15.1   1140.79      15.2
  TOE OF DROP STRUCTURE
```

TOE OF DROP STRUCTURE

```
X1        3        4      0.0      15.2      61.0      61.0      61.0       1.0       0.0
GR   1140.7      0.0  1127.23       0.1   1127.23      15.1   1140.79      15.2
  CREST OF DROP STRUCTURE
```

CREST OF DROP STRUCTURE

```
X1        4        4      0.0      15.2       1.0       1.0       1.0       1.0       0.0
GR   1140.7      0.0  1132.25       0.1   1132.25      15.1   1140.79      15.2
  50 FT UPSTREAM OF DROP STRUCTURE
```

50 FT UPSTREAM OF DROP STRUCTURE

```
X1        5        4      0.0      42.6      50.0      50.0      50.0       1.0       0.0
GR   1140.7      0.0  1132.88      16.3   1132.88      26.3   1140.79      42.6
  152 FT UPSTREAM OF DROP STRUCTURE
```

152 FT UPSTREAM OF DROP STRUCTURE

```
         7        4      0.0      47.0     102.0     102.0     102.0       1.0       0.0
    1142.5      0.0  1133.23      18.5   1133.23      28.5    1142.5      47.0
  252 FT UPSTREAM OF DROP STRUCTURE
```

252 FT UPSTREAM OF DROP STRUCTURE

```
X1        8        4      0.0      42.0     100.0     100.0     100.0       1.0       0.0
GR   1141.6      0.0  1133.59      16.0   1133.59      26.0   1141.60      42.0
  329 FT UPSTREAM OF DROP STRUCTURE
```

329 FT UPSTREAM OF DROP STRUCTURE

```
X1        9        4      0.0      35.6      72.0      72.0      72.0       1.0       0.0
GR   1140.2      0.0  1133.82      12.8   1133.82      22.8   1140.20      35.6
  DOWNSTREAM FACE OF HWY 101 BOX CULVERT
```

DOWNSTREAM FACE OF HWY 101 BOX CULVERT

```
X1       10        4      0.0      17.2      50.0      50.0      50.0       1.0       0.0
GR   1141.5      0.0  1133.80       0.1   1133.80      17.1   1141.55      17.2
T1      91755.02
T2      NEW RIVER
T3      ADOT DROP STRUCTURE/CHANNEL PROP CONDIT
```

JOB PARAMETERS :

J1	ICHECK	INQ	NINV	IDIR	STRT	METRIC	HVINS	Q	WSEL	FQ
	0	3	0	0	0.0	0	0.0	895.0	1136.3	

J2	NPROF	IPLOT	PRFVS	XSECV	XSECH	FN	ALLDC	IBW	CHNIM	ITRACE
	15	1	0.0	0.0	0.0	0.0	0.0	-6.0	0.0	

SPECIAL NOTE :

An asterisk (*) to the left of the cross-section number indicates a special note is present in the SUMMARY OF WARNING AND STATUS MESSAGES section.

ARY PRINTOUT TABLE 150 : NEW RIVER
ADOT DROP STRUCTURE/CHANNEL PROP CONDIT
91755.02

	Cross-Section Number SECNO	Channel Reach Length (ft) XLCH	Top of Roadway Elevation (ft MSL) ELTRD	Max. Low Chord Elevation (ft MSL) ELLC	Minimum C. S. Elevation (ft MSL) ELMIN	Discharge Flow (cfs) Q	Computed W. S. Elevation (ft MSL) CWSEL	Critical W. S. Elevation (ft MSL) CRIWS	Energy Gradient Elevation (ft MSL) EG	Energy Gradient Slope * 10,000 10K*S	Channel Mean Flow Velocity (ft/s) VCH	Cross-Section Area (sq ft) AREA	Index Q (0.01 * Convey.) .01K
	.000	.00	.00	.00	1128.51	260.00	1139.10	.00	1139.12	.57	1.00	260.84	343.72
	.000	.00	.00	.00	1128.51	895.00	1136.30	.00	1136.77	23.39	5.47	163.52	185.04
*	1.000	30.00	.00	.00	1128.58	260.00	1139.09	.00	1139.13	.28	1.64	158.63	487.12
*	1.000	30.00	.00	.00	1128.58	895.00	1136.08	.00	1137.06	8.18	7.92	113.05	312.86
	2.000	1.00	.00	.00	1127.23	260.00	1139.10	.00	1139.13	.21	1.45	179.00	567.75
	2.000	1.00	.00	.00	1127.23	895.00	1136.53	.00	1137.16	4.65	6.39	140.16	415.17
	3.000	61.00	.00	.00	1127.23	260.00	1139.10	.00	1139.13	.21	1.45	179.11	568.20
	3.000	61.00	.00	.00	1127.23	895.00	1136.56	.00	1137.19	4.60	6.36	140.70	417.23
*	4.000	1.00	.00	.00	1132.25	260.00	1139.07	.00	1139.17	.89	2.53	102.82	275.58
*	4.000	1.00	.00	.00	1132.25	895.00	1137.03	1137.03	1139.43	28.26	12.44	71.93	168.35
	5.000	50.00	.00	.00	1132.88	260.00	1139.13	.00	1139.18	.44	1.81	143.59	392.86

	Cross-Section Number SECNO	Channel Reach Length (ft) XLCH	Top of Roadway Elevation (ft MSL) ELTRD	Max. Low Chord Elevation (ft MSL) ELLC	Minimum C. S. Elevation (ft MSL) ELMIN	Discharge Flow (cfs) Q	Computed W. S. Elevation (ft MSL) CWSEL	Critical W. S. Elevation (ft MSL) CRIWS	Energy Gradient Elevation (ft MSL) EG	Energy Gradient Slope * 10,000 10K*S	Channel Mean Flow Velocity (ft/s) VCH	Cross-Section Area (sq ft) AREA	Index Q (0.01 * Convey.) .01K
*	5.000	50.00	.00	.00	1132.88	895.00	1139.56	1137.47	1140.05	3.93	5.62	159.14	451.32
	7.000	102.00	.00	.00	1133.23	260.00	1139.13	.00	1139.20	.58	2.02	128.82	342.06
	7.000	102.00	.00	.00	1133.23	895.00	1139.54	.00	1140.15	5.20	6.27	142.64	392.57
	8.000	100.00	.00	.00	1133.59	260.00	1139.13	.00	1139.21	.75	2.22	116.95	300.05
	8.000	100.00	.00	.00	1133.59	895.00	1139.54	.00	1140.27	6.66	6.88	130.17	346.87
	9.000	72.00	.00	.00	1133.82	260.00	1139.13	.00	1139.22	.89	2.37	109.89	275.48
	9.000	72.00	.00	.00	1133.82	895.00	1139.55	.00	1140.37	7.77	7.27	123.06	321.16
	10.000	50.00	.00	.00	1133.80	260.00	1139.12	.00	1139.25	1.28	2.86	90.94	229.88
	10.000	50.00	.00	.00	1133.80	895.00	1139.30	.00	1140.71	13.80	9.52	94.02	240.90

ARY PRINTOUT TABLE 150 : NEW RIVER
---------- ADOT DROP STRUCTURE/CHANNEL PROP CONDIT
91755.02

	Cross-Section Number SECNO	Discharge Flow (cfs) Q	Computed W. S. Elevation (ft MSL) CWSEL	W.S. Elev Diff per Profile (ft) DIFWSP	W.S. Elev Diff per Section (ft) DIFWSX	W.S. Elev Diff per Know/Comp (ft) DIFKWS	Water Surface Top Width (ft) TOPWID	Channel Reach Length (ft) XLCH
	.000	260.00	1139.10	.00	.00	.00	38.97	.00
	.000	895.00	1136.30	-2.80	.00	.00	30.54	.00
*	1.000	260.00	1139.09	.00	-.01	.00	15.17	30.00
*	1.000	895.00	1136.08	-3.00	-.22	.00	15.12	30.00
	2.000	260.00	1139.10	.00	.01	.00	15.18	1.00
	2.000	895.00	1136.53	-2.57	.44	.00	15.14	1.00
	3.000	260.00	1139.10	.00	.00	.00	15.18	61.00
	3.000	895.00	1136.56	-2.54	.03	.00	15.14	61.00
*	4.000	260.00	1139.07	.00	-.03	.00	15.16	1.00
*	4.000	895.00	1137.03	-2.04	.47	.00	15.11	1.00
	5.000	260.00	1139.13	.00	.07	.00	35.92	50.00

Cross-Section Number SECNO	Discharge Flow (cfs) Q	Computed W. S. Elevation (ft MSL) CWSEL	W.S. Elev Diff per Profile (ft) DIFWSP	W.S. Elev Diff per Section (ft) DIFWSX	W.S. Elev Diff per Know/Comp (ft) DIFKWS	Water Surface Top Width (ft) TOPWID	Channel Reach Length (ft) XLCH
* 5.000	895.00	1139.56	.42	2.53	.00	37.67	50.00
7.000	260.00	1139.13	.00	.00	.00	33.59	102.00
7.000	895.00	1139.54	.41	-.01	.00	35.19	102.00
8.000	260.00	1139.13	.00	.00	.00	32.16	100.00
8.000	895.00	1139.54	.41	.00	.00	33.77	100.00
9.000	260.00	1139.13	.00	.00	.00	31.34	72.00
9.000	895.00	1139.55	.41	.01	.00	32.98	72.00
10.000	260.00	1139.12	.00	-.01	.00	17.14	50.00
10.000	895.00	1139.30	.19	-.24	.00	17.14	50.00

'MARY OF WARNING AND STATUS MESSAGES :

Section 1, profile 1, conveyance change outside acceptable range.

Section 1, profile 2, conveyance change outside acceptable range.

Section 4, profile 1, conveyance change outside acceptable range.

Section 4, profile 2, critical depth assumed.

Section 4, profile 2, probable minimum specific energy.

Section 4, profile 2, 20 trials attempted to balance water surface elevation.

Section 5, profile 1, conveyance change outside acceptable range.

Section 5, profile 2, conveyance change outside acceptable range.

8 Warning and status message(s) generated

END OF OUTPUT

APPENDIX III

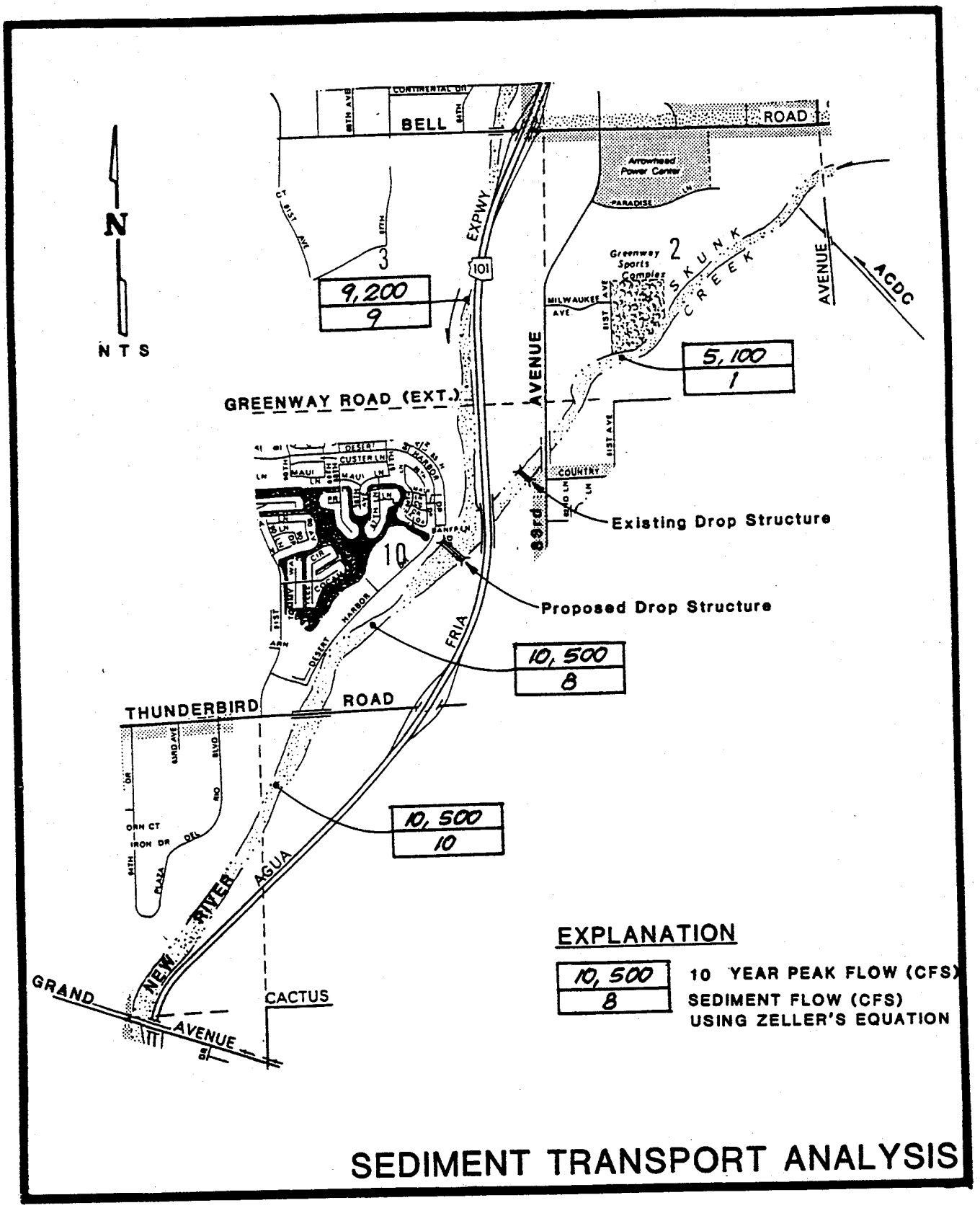
SEDIMENT TRANSPORT ANALYSIS

- Equilibrium Slope Analysis
- Meyer-Peter-Muller Equation Analysis

TABLE 2

SEDIMENT TRANSPORT PARAMETER TABLE

REACH NO.	STREAM NAME	D/S LIMIT SECTION	U/S LIMIT SECTION	D(15.9) (mm)	D(50) (mm)	D(84.1) (mm)	G	Manning's n
1	New River	337.000	358.000	1.1	42	125	20.579004	0.03
2		358.000	377.000	0.47	10.8	51	13.850473	0.03
3		377.000	410.540	0.42	8.2	41.8	12.310685	0.03
4		410.000	449.900	0.34	4.7	36.2	10.762829	0.03
5		449.900	9.356	0.38	7.1	38.5	12.053373	0.03
6		9.356	9.902	0.8	26	125	18.653846	0.03
7	Skunk Creek	14.500	24.890	13	70	160	3.8351648	0.03
8		24.890	25.400	13	70	160	3.8351648	0.03
9		25.400	38.320	13	70	160	3.8351648	0.03
10		38.320	68.690	13	70	160	3.8351648	0.03
11		68.690	84.700	13	70	160	3.8351648	0.034



SEDIMENT TRANSPORT ANALYSIS

FIGURE 1

09/14/93

TABLE 3

NEW RIVER CHANNELIZATION - SEDIMENT TRANSPORT WORKSHEET
NEW RIVER FROM GRAND AVENUE TO BELL ROAD, SKUNK CREEK FROM NEW RIVER TO ACDC
10-YEAR FLOWS, NO CHANNELIZATION NORTH OF THUNDERBIRD ROAD
PARTIAL CHANNELIZATION BETWEEN GRAND AVE AND TBIRD RD FILE NRSC10Z.WQ1

Cross-Section Number SECNO	Channel Reach Length (ft) XLCH	Flow Depth (ft) DEPTH	Mean Velocity Head (ft) HV	Section Mean Velocity (fps)	Computed W. S. Elevation (ft MSL) CWSEL	Water Surface Top Width (ft) TOPWID	Channel Boundary Shear (lb/s ft) SHEAR	Cross Sectional Area (sq ft) AREA	Hydraulic Depth (ft)	Reach Length (ft)	Average Reach Depth (ft)	Average Reach Velocity (fps)	Average Reach Top Width (ft)	Gradation Coefficient G	Sediment Discharge (cfs/ft)	Sediment Discharge (cfs)	Section/ Reach Description
337	0	4.96	0.81	7.2	1117.36	338.49	1.12	1456.31	4.30								Q(10) = 10,500 cfs
342	510	4.59	0.94	7.8	1119.39	352.3	0.99	1352.2	3.84								
343.7	180	4.3	1.07	8.3	1120.1	334.77	1.14	1264.06	3.78								
345.5	190	4.08	0.92	7.7	1121.08	337.52	0.96	1360.74	4.03								
346.4	100	4.18	0.88	7.5	1121.58	338.14	0.91	1397.08	4.13								Grand Avenue Bridge
346.8	25	3.4	1.63	10.2	1121.5	318	1.82	1024.62	3.22								
347.1	30	4.19	0.87	7.5	1122.49	338.26	0.9	1399.71	4.14								
347.11	1	3.83	1.4	9.5	1122.13	294.22	1.47	1107.34	3.76								
347.4	30	3.86	1.38	9.4	1122.36	294.42	1.44	1114.98	3.79								
347.41	1	4.58	0.73	6.9	1123.08	339.17	0.73	1532.3	4.52								
352	460	4.93	1.54	10.0	1125.03	350.82	1.77	1053.84	3.00								
358	600	4.81	0.66	6.5	1128.41	339.61	0.65	1609.3	4.74	2127	3.94	8.21	331.31	20.579004	0.03	10.1	
365	700	6.37	0.55	6.0	1129.77	313.41	0.51	1760.64	5.62								
370	535	7.21	0.46	5.4	1130.61	356.01	0.43	1934.05	5.43								
373	320	6.69	0.58	6.1	1130.99	332.13	0.55	1723.36	5.19								
377	400	4.08	1.72	10.5	1131.48	279.96	1.85	998.61	3.57	1955	4.95	7.01	320.38	13.850473	0.03	8.8	

09/14/93

NEW RIVER CHANNELIZATION - SEDIMENT TRANSPORT WORKSHEET
NEW RIVER FROM GRAND AVENUE TO BELL ROAD, SKUNK CREEK FROM NEW RIVER TO ACDC
10-YEAR FLOWS, NO CHANNELIZATION NORTH OF THUNDERBIRD ROAD
PARTIAL CHANNELIZATION BETWEEN GRAND AVE AND TBIRD RD FILE NRSC10Z.WQ1

Cross-Section Number SECNO	Channel Reach Length (ft) XLCH	Flow Depth (ft) DEPTH	Mean Velocity Head (ft) HV	Section Mean Velocity (fps)	Computed W. S. Elevation (ft MSL) CWSEL	Water Surface Top Width (ft) TOPWID	Channel Boundary Shear (lb/s ft) SHEAR	Cross Sectional Area (sq ft) AREA	Hydraulic Depth (ft)	Reach Length (ft)	Average Reach Depth (ft)	Average Reach Velocity (fps)	Average Reach Top Width (ft)	Gradation Coefficient G	Sediment Discharge (cfs/ft)	Sediment Discharge (cfs)	Section/ Reach Description
384	660	5.56	0.58	6.1	1134.96	347.09	0.56	1716.97	4.95								
388	410	6.7	0.44	5.3	1135.7	346.74	0.41	1972.41	5.69								
391.5	350	5.99	0.56	6.0	1136.09	334.1	0.53	1755.39	5.25								
395	350	5.37	0.7	6.7	1136.67	334.35	0.69	1562.32	4.67								
402	720	5.7	1.27	9.0	1138.6	263.92	1.26	1160.85	4.40								
406	400	6.07	1.26	9.1	1140.37	244.68	1.26	1156.1	4.72								
409.7	315	6.88	1.31	9.2	1141.58	207.78	1.23	1143.29	5.50								Thunderbird Rd. Bridge
410.54	83.5	7.1	1.19	8.8	1141.9	206.59	1.11	1198.04	5.80	3289	5.12	7.53	285.66	12.310685	0.04	11.9	
412	223	7.49	1.26	9.0	1142.59	216.1	1.18	1167.45	5.40								
418	520	8.59	1.1	8.4	1144.39	215.56	1.02	1245.34	5.78								
423	520	9.27	0.94	7.8	1145.87	219.16	0.85	1348.66	6.15								
428	500	9.41	0.81	7.2	1147.01	225.43	0.72	1456.86	6.46								
434	600	10	0.73	6.9	1148.1	234.03	0.64	1534.71	6.56								
440	610	9.6	0.97	7.9	1149.1	223.45	0.89	1327.94	5.94								
445.5	560	9.92	0.8	7.2	1150.42	223.74	0.71	1466.14	6.55								
449.1	370	10.39	0.17	3.3	1151.29	337.36	0.13	3182.34	9.43								
449.9	62	10.26	0.24	3.9	1151.26	270.52	0.19	2670.34	9.87	3965	6.91	6.85	240.59	10.762829	0.03	8.0	Drop Structure
451.1	113	3.54	1.76	10.6	1155.54	282.08	1.93	985.77	3.49								
457	575	6.36	0.27	4.2	1158.46	580.3	0.27	2533.16	4.37								
8.655	410	2.91	0.94	7.8	1159.41	358.52	1.07	655.68	1.83								Upstream of Skunk Creek Confluence; Q(10) = 9,200 cfs
8.731	400	4.2	0.58	6.1	1162.2	287.97	0.67	832.94	2.89								
8.807	470	4.87	0.76	7.0	1164.17	274.92	0.9	730.23	2.66								

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NEW RIVER CHANNELIZATION - SEDIMENT TRANSPORT WORKSHEET
NEW RIVER FROM GRAND AVENUE TO BELL ROAD, SKUNK CREEK FROM NEW RIVER TO ACDC
10-YEAR FLOWS, NO CHANNELIZATION NORTH OF THUNDERBIRD ROAD
PARTIAL CHANNELIZATION BETWEEN GRAND AVE AND TBIRD RD FILE NRSC10Z.WQ1

Cross-Section Number SECNO	Channel Reach Length (ft) XLCH	Flow Depth (ft) DEPTH	Mean Velocity Head (ft) HV	Section Mean Velocity (fps)	Computed W. S. Elevation (ft MSL) CWSEL	Water Surface Top Width (ft) TOPWID	Channel Boundary Shear (lb/s ft) SHEAR	Cross Sectional Area (sq ft) AREA	Hydraulic Depth (ft)	Reach Length (ft)	Average Reach Depth (ft)	Average Reach Velocity (fps)	Average Reach Top Width (ft)	Gradation Coefficient G	Sediment Discharge (cfs/ft)	Sediment Discharge (cfs)	Section/ Reach Description
8.883	450	4.26	0.97	7.9	1166.36	188.15	1.06	645.24	3.43								
8.978	500	4.29	0.23	3.8	1168.19	365.88	0.25	1321.85	3.61								
9.072	520	3.82	0.41	5.1	1169.02	451.61	0.52	994.25	2.20								
9.167	520	5.64	1.29	9.1	1173.94	224.61	1.56	560.62	2.50								
9.262	500	5.24	0.15	3.1	1176.04	430.82	0.16	1630.62	3.78								
9.356	490	3.14	0.72	6.8	1176.44	403.83	0.97	746.52	1.85	4948	2.96	6.51	349.88	12.053373	0.03	9.9	
9.451	500	4.52	0.92	7.7	1181.02	356.61	1.23	662.22	1.86								
9.546	500	5.04	0.22	3.8	1182.94	359.35	0.23	1363.55	3.79								
9.641	500	5.61	1.27	9.0	1184.01	225.7	1.55	563.91	2.50								
9.735	500	5.04	1.45	9.7	1188.54	172.51	1.67	527.45	3.06								
9.783	250	4.93	1.48	9.8	1191.03	177.07	1.72	522.22	2.95								
9.786	20	3.54	1.46	9.7	1192.54	183.87	1.7	526.65	2.86								
9.832	225	5.63	0.89	7.6	1194.83	238.64	1.04	672.81	2.82								
9.85	100	5.08	0.91	7.7	1195.08	212.64	1.02	667.11	3.14								Bell Rd. Bridge
9.902	280	5.33	0.64	6.4	1196.63	377.66	0.74	834.34	2.21	2855	2.80	7.92	256.01	18.653846	0.04	9.5	
-457	550	6.36	0.27	4.2	1158.46	580.29	0.27	2532.87	4.36								
14.5	340	4.67	0.93	7.7	1158.57	277.83	1.07	1191.66	4.29								
19	440	4.06	1.22	8.9	1159.76	262.21	1.46	1037.37	3.96								Skunk Creek above New River Q(10) = 5,100 cfs
20.9	200	5.91	0.62	6.3	1161.11	294.47	0.69	1455.69	4.94								
24.89	380	6.58	0.55	6.0	1161.98	307.36	0.61	1550.35	5.04	1360	4.56	7.22	285.47	3.8351648	0.01	1.6	
24.9	6	3.3	1.51	9.9	1165.2	310.29	1.98	931.62	3.00								
25.4	50	3.09	1.55	10.0	1165.99	301.52	2.01	922.05	3.06	56	3.03	9.93	305.91	3.8351648	0.03	7.9	

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NEW RIVER CHANNELIZATION - SEDIMENT TRANSPORT WORKSHEET
NEW RIVER FROM GRAND AVENUE TO BELL ROAD, SKUNK CREEK FROM NEW RIVER TO ACDC
10-YEAR FLOWS, NO CHANNELIZATION NORTH OF THUNDERBIRD ROAD
PARTIAL CHANNELIZATION BETWEEN GRAND AVE AND TBIRD RD FILE NRSC10Z.WQ1

Cross-Section Number SECNO	Channel Reach Length (ft) XLCH	Flow Depth (ft) DEPTH	Mean Velocity Head (ft) HV	Section Mean Velocity (fps)	Computed W. S. Elevation (ft MSL) CWSEL	Water Surface Top Width (ft) TOPWID	Channel Boundary Shear (lb/s ft) SHEAR	Cross Sectional Area (sq ft) AREA	Hydraulic Depth (ft)	Reach Length (ft)	Average Reach Depth (ft)	Average Reach Velocity (fps)	Average Reach Top Width (ft)	Gradation Coefficient G	Sediment Discharge (cfs/ft)	Sediment Discharge (cfs)	Section/ Reach Description
26.7	130	4.53	0.71	6.8	1167.73	303.93	0.82	1357.75	4.47								
27.8	110	4.34	0.96	7.9	1167.84	273.62	1.12	1169.52	4.27								
29.6	180	4.87	0.62	6.3	1168.77	304.49	0.69	1460.9	4.80								
30	40	4.92	0.61	6.3	1168.92	316.82	1.69	1469.72	4.84								
31.75	175	6.57	0.37	4.9	1169.97	394.96	1.02	1877.92	4.75								
33	125	6.31	0.53	5.8	1170.41	353.93	1.48	1577.02	4.46								
35	200	5.51	0.55	6.0	1171.41	310.34	1.49	1544.21	4.98								
37	200	5.26	0.61	6.3	1172.16	285.92	1.06	1466.61	5.13								
38.32	132	4.96	0.76	7.0	1172.46	276.81	0.85	1314.83	4.75	1162	4.69	6.35	313.42	3.8351648	0.00	1.0	
40.05	173	6.57	0.54	5.9	1173.07	273.93	0.57	1559.47	5.69								
43	295	6.84	0.52	5.8	1173.54	267.92	0.54	1591.42	5.94								
46.92	392	6.51	0.6	6.2	1174.11	259.32	0.63	1484.79	5.73								
50.9	398	6.83	0.53	5.8	1174.83	264.92	0.55	1571.56	5.93								
55	410	6.43	0.53	5.8	1175.43	260.56	0.55	1574.95	6.04								
60	500	6.48	0.56	6.0	1176.18	265.93	0.58	1536.85	5.78								
64	400	6.33	0.65	6.5	1176.83	254.49	0.69	1425.14	5.60								
65.45	145	6.12	0.64	6.4	1177.12	252.92	0.68	1429.15	5.65								
66.9	145	6.28	0.53	5.8	1177.48	265.42	0.56	1570	5.92								
67.9	100	6.32	0.56	6.0	1177.62	257.67	0.59	1528.78	5.93								
68.69	73	6.35	0.55	6.0	1177.75	257.51	0.57	1550.07	6.02	3031	5.84	6.03	261.87	3.8351648	0.00	0.6	
68.7	7	3.34	1.65	10.3	1181.74	273.96	2.09	892.99	3.26								
69.1	40	4.16	1.06	8.3	1182.66	275.64	1.26	1112.23	4.04								

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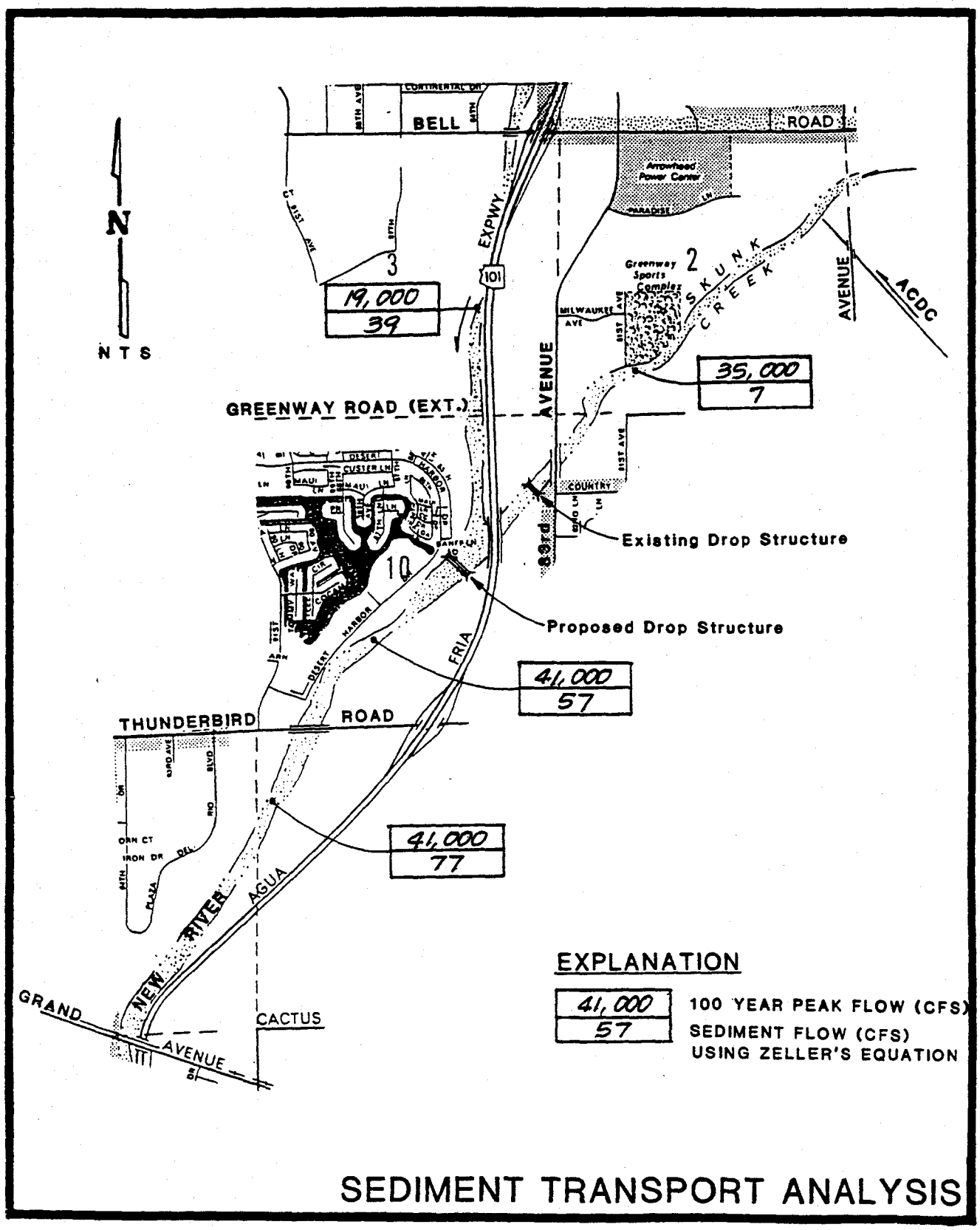
NEW RIVER CHANNELIZATION - SEDIMENT TRANSPORT WORKSHEET
NEW RIVER FROM GRAND AVENUE TO BELL ROAD, SKUNK CREEK FROM NEW RIVER TO ACDC
10-YEAR FLOWS, NO CHANNELIZATION NORTH OF THUNDERBIRD ROAD
PARTIAL CHANNELIZATION BETWEEN GRAND AVE AND TBIRD RD FILE NRSC10Z.WQ1

Cross-Section Number SECNO	Channel Reach Length (ft) XLCH	Flow Depth (ft) DEPTH	Mean Velocity Head (ft) HV	Section Mean Velocity (fps)	Computed W. S. Elevation (ft MSL) CWSEL	Water Surface Top Width (ft) TOPWID	Channel Boundary Shear (lb/s ft) SHEAR	Cross Sectional Area (sq ft) AREA	Hydraulic Depth (ft)	Reach Length (ft)	Average Reach Depth (ft)	Average Reach Velocity (fps)	Average Reach Top Width (ft)	Gradation Coefficient G	Sediment Discharge (cfs/ft)	Sediment Discharge (cfs)	Section/ Reach Description
70.1	100	4.42	0.97	7.9	1183.22	271.24	1.13	1162.39	4.29								
71.8	170	4.64	0.93	7.7	1183.94	266.14	1.07	1186.13	4.46								
73.5	170	4.97	0.8	7.2	1184.67	269.55	0.89	1264.15	4.76								
76.32	282	6.73	0.63	6.4	1185.53	264.02	0.68	1441.08	5.46								
81	468	6	0.71	6.8	1186.5	261.68	0.77	1358.53	5.19								
84.7	370	6.24	0.49	5.6	1187.44	299.27	0.52	1641.36	5.48	1607	4.62	7.52	272.69	3.8351648	0.01	2.3	



SEDIMENT TRANSPORT ANALYSIS

FIGURE 2

TABLE 4

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NEW RIVER CHANNELIZATION - SEDIMENT TRANSPORT WORKSHEET
NEW RIVER FROM GRAND AVENUE TO BELL ROAD, SKUNK CREEK FROM NEW RIVER TO ACDC
100-YEAR FLOWS, NO CHANNELIZATION NORTH OF THUNDERBIRD ROAD
PARTIAL CHANNELIZATION BETWEEN GRAND AVE AND TBIRD RD FILE NRSC100Z.WQ1

Cross-Section Number SECNO	Channel Reach Length (ft) XLCH	Flow Depth (ft) DEPTH	Mean Velocity Head (ft) HV	Section Mean Velocity (fps)	Computed W. S. Elevation (ft MSL) CWSEL	Water Surface Top Width (ft) TOPWID	Channel Boundary Shear (lb/s ft) SHEAR	Cross Sectional Area (sq ft) AREA	Hydraulic Depth (ft)	Reach Length (ft)	Average Reach Depth (ft)	Average Reach Velocity (fps)	Average Reach Top Width (ft)	Gradation Coefficient G	Sediment Discharge (cfs/ft)	Sediment Discharge (cfs)	Section/ Reach Description
																	Q(100) = 41,000 cfs
337	0	10.45	2.32	12.2	1122.85	351.57	2.51	3351.16	9.53								
342	510	9.93	2.45	12.6	1124.73	364.29	1.99	3264.27	8.96								
343.7	180	9.29	2.97	13.8	1125.09	346.22	2.44	2965.75	8.57								
345.5	190	9.2	2.69	13.2	1126.2	346.98	2.18	3117.83	8.99								
346.4	100	10.82	1.92	11.1	1128.22	351.07	1.49	3685.01	10.50								Grand Avenue Bridge
346.8	25	9.6	2.77	13.4	1127.7	340.99	2.22	3067.94	9.00								
347.1	30	10.13	2.2	11.9	1128.43	349.97	1.74	3441.73	9.83								
347.11	1	9.23	3.48	15.0	1127.53	308.79	3.27	2737.83	8.87								
347.4	30	9.23	3.48	15.0	1127.73	309.08	3.27	2737.9	8.86								
347.41	1	11.04	1.84	10.9	1129.54	352.11	1.42	3766.4	10.70								
352	460	10.06	3.04	14.0	1130.16	374.9	2.56	2930.25	7.82								
358	600	9.72	2.39	12.4	1133.32	350.06	1.91	3301.83	9.43	2127	9.25	12.95	345.50	20.579004	0.17	58.2	
365	700	12.31	1.87	11.0	1135.71	478.43	1.41	3788.59	7.92								
370	535	13.97	1.21	8.8	1137.37	464.82	0.92	4654.07	10.01								
373	320	13.53	1.57	10.1	1137.63	375.52	1.18	4072.13	10.84								
377	400	10.33	2.94	13.8	1137.73	352.75	2.39	2977.64	8.44	1955	9.30	10.90	417.88	13.850473	0.15	64.1	

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NEW RIVER CHANNELIZATION - SEDIMENT TRANSPORT WORKSHEET
NEW RIVER FROM GRAND AVENUE TO BELL ROAD, SKUNK CREEK FROM NEW RIVER TO ACDC
100-YEAR FLOWS, NO CHANNELIZATION NORTH OF THUNDERBIRD ROAD
PARTIAL CHANNELIZATION BETWEEN GRAND AVE AND TBIRD RD FILE NRSC100Z.WQ1

Cross-Section Number SECNO	Channel Reach Length (ft) XLCH	Flow Depth (ft) DEPTH	Mean Velocity Head (ft) HV	Section Mean Velocity (fps)	Computed W. S. Elevation (ft MSL) CWSEL	Water Surface Top Width (ft) TOPWID	Channel Boundary Shear (lb/s ft) SHEAR	Cross Sectional Area (sq ft) AREA	Hydraulic Depth (ft)	Reach Length (ft)	Average Reach Depth (ft)	Average Reach Velocity (fps)	Average Reach Top Width (ft)	Gradation Coefficient G	Sediment Discharge (cfs/ft)	Sediment Discharge (cfs)	Section/ Reach Description
384	660	11.67	1.65	10.3	1141.06	393.36	1.26	3979.17	10.12								
388	410	13.04	1.41	9.5	1142.04	387.67	1.06	4297.48	11.09								
391.5	350	12.39	1.6	10.2	1142.49	378.02	1.21	4032.93	10.67								
395	350	11.8	1.71	10.5	1143.1	389.42	1.31	3907.19	10.03								
402	720	11.29	3.31	14.6	1144.19	325.47	2.66	2809.74	8.63								
406	400	11.75	3.52	15.1	1146.05	306.94	2.81	2722.35	8.87								
409.7	315	12.15	4.89	17.7	1146.85	234.33	3.83	2309.26	9.85								Thunderbird Rd. Bridge
410.54	83.5	14.56	3.18	14.3	1149.36	240.62	2.35	2866.53	11.91	3289	10.15	12.77	331.98	12.310685	0.33	110.3	
412	223	15.58	2.57	12.9	1150.68	282.46	1.91	3187.03	11.28								
418	520	16.5	2.37	12.4	1152.3	307.77	1.79	3316.93	10.78								
423	520	17.2	2.2	11.9	1153.8	312.28	1.64	3446.65	11.04								
428	500	17.73	1.75	10.6	1155.33	340.13	1.29	3864.53	11.36								
434	600	16.55	1.48	9.8	1156.65	381.04	1.1	4203.39	11.03								
440	610	17.83	2.12	11.7	1157.33	306.02	1.56	3509.41	11.47								
445.5	560	18.11	2.01	11.4	1158.61	300.56	1.46	3602.72	11.99								
449.1	370	19.5	0.64	6.4	1160.4	367.8	0.42	6405.64	17.42								
449.9	62	19.18	0.99	8.0	1160.18	280	0.67	5146.06	18.38	3965	12.75	10.55	319.78	10.762829	0.18	57.4	Drop Structure
451.1	113	8.71	4.27	16.6	1160.71	292.42	3.55	2471.49	8.45								
457	575	13.53	0.55	6.0	1165.63	628.13	0.41	6867.66	10.93								
8.655	410	9.49	0.47	5.5	1165.99	465.79	0.4	3447.41	7.40								Upstream of Skunk Creek Confluence; Q(100) = 19,000 cfs
8.731	400	7.91	1.47	9.7	1165.91	315.12	1.33	1951.22	6.19								
8.807	470	8.37	1.57	10.1	1167.67	353.67	1.48	1890.13	5.34								

09/14/93

NEW RIVER CHANNELIZATION - SEDIMENT TRANSPORT WORKSHEET
NEW RIVER FROM GRAND AVENUE TO BELL ROAD, SKUNK CREEK FROM NEW RIVER TO ACDC
100-YEAR FLOWS, NO CHANNELIZATION NORTH OF THUNDERBIRD ROAD
PARTIAL CHANNELIZATION BETWEEN GRAND AVE AND TBIRD RD FILE NRSC100Z.WQ1

Cross-Section Number SECNO	Channel Reach Length (ft) XLCH	Flow Depth (ft) DEPTH	Mean Velocity Head (ft) HV	Section Mean Velocity (fps)	Computed W. S. Elevation (ft MSL) CWSEL	Water Surface Top Width (ft) TOPWID	Channel Boundary Shear (lb/s ft) SHEAR	Cross Sectional Area (sq ft) AREA	Hydraulic Depth (ft)	Reach Length (ft)	Average Reach Depth (ft)	Average Reach Velocity (fps)	Average Reach Top Width (ft)	Gradation Coefficient G	Sediment Discharge (cfs/ft)	Sediment Discharge (cfs)	Section/ Reach Description
8.883	450	7.68	3.13	14.2	1169.78	216.56	2.83	1337.46	6.18								
8.978	500	9.65	0.49	5.6	1173.55	403.98	0.4	3389.24	8.39								
9.072	520	8.6	0.5	5.7	1174	485.36	0.44	3332.95	6.87								
9.167	520	9.08	2.66	13.1	1177.38	281.4	2.53	1452.1	5.16								
9.262	500	9.87	0.4	5.1	1180.67	471.9	0.33	3752.53	7.95								
9.356	490	7.64	0.74	6.9	1180.94	481.49	0.68	2751.99	5.72	4948	7.14	8.94	399.62	12.053373	0.09	34.2	
9.451	500	7.08	2.23	12.0	1183.58	366.73	2.26	1586.05	4.32								
9.546	500	8.73	0.76	7.0	1186.63	372.55	0.65	2711.6	7.28								
9.641	500	8.94	2.41	12.5	1187.34	330.14	2.4	1525.82	4.62								
9.735	500	9.19	3.42	14.8	1192.69	190.28	3.06	1279.59	6.72								
9.783	250	9.07	3.31	14.6	1195.17	199.8	2.97	1302.03	6.52								
9.786	20	7.6	3.25	14.5	1196.6	205.33	2.98	1313.75	6.40								
9.832	225	10.23	1.67	10.4	1199.43	266.54	1.46	1834.86	6.88								
9.85	100	9.91	1.74	10.6	1199.91	249.82	1.49	1794.01	7.18								Bell Rd. Bridge
9.902	260	10.42	0.54	5.9	1201.72	619.12	0.55	3595.72	5.81	2855	6.19	11.36	311.15	18.653646	0.14	43.0	
-457	550	13.53	0.55	6.0	1165.63	628.16	0.41	6870.49	10.94								
14.5	340	11.09	1.98	11.3	1164.99	314	1.75	3101.91	9.88								
19	440	9.82	2.8	13.4	1165.52	283.03	2.55	2608.07	9.21								Skunk Creek above New River Q(100) = 35,000 cfs
20.9	200	12.12	1.71	10.5	1167.32	309.5	1.5	3332.62	10.77								
24.89	380	12.93	1.51	9.9	1168.33	321.17	1.32	3546.45	11.04	1360	10.23	11.27	306.93	3.8351648	0.03	9.5	
24.9	6	7.64	3.59	15.2	1169.54	320.52	3.55	2302.42	7.16								
25.4	50	7.46	3.72	15.5	1170.36	310.74	3.67	2259.97	7.27	56	7.23	15.34	315.63	3.8351648	0.13	41.0	

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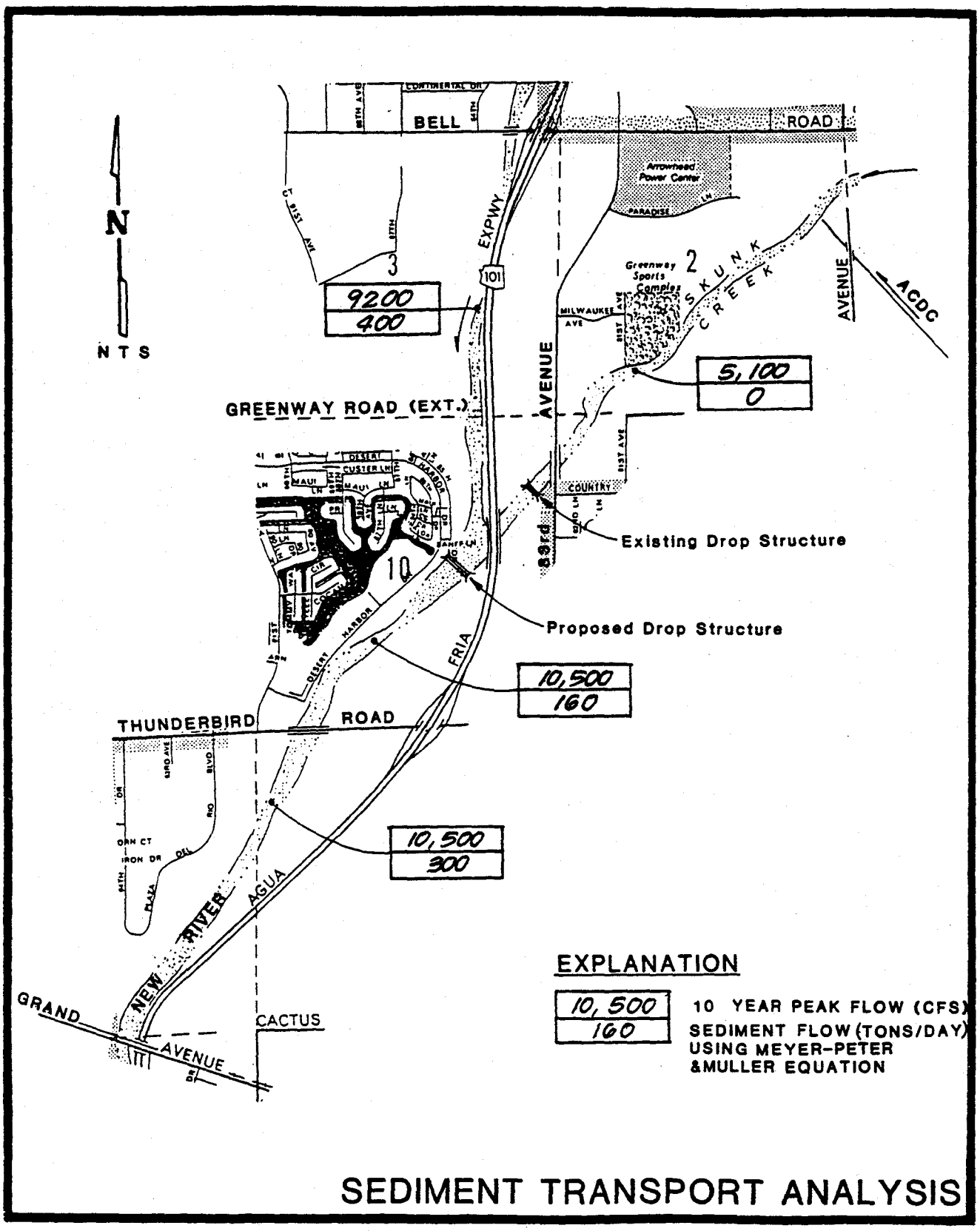
NEW RIVER CHANNELIZATION - SEDIMENT TRANSPORT WORKSHEET
NEW RIVER FROM GRAND AVENUE TO BELL ROAD, SKUNK CREEK FROM NEW RIVER TO ACDC
100-YEAR FLOWS, NO CHANNELIZATION NORTH OF THUNDERBIRD ROAD
PARTIAL CHANNELIZATION BETWEEN GRAND AVE AND TBIRD RD FILE NRSC100Z.WQ1

Cross-Section Number SECNO	Channel Reach Length (ft) XLCH	Flow Depth (ft) DEPTH	Mean Velocity Head (ft) HV	Section Mean Velocity (fps)	Computed W. S. Elevation (ft MSL) CWSEL	Water Surface Top Width (ft) TOPWID	Channel Boundary Shear (lb/s ft) SHEAR	Cross Sectional Area (sq ft) AREA	Hydraulic Depth (ft)	Reach Length (ft)	Average Reach Depth (ft)	Average Reach Velocity (fps)	Average Reach Top Width (ft)	Gradation Coefficient G	Sediment Discharge (cfs/ft)	Sediment Discharge (cfs)	Section/ Reach Description
26.7	130	9.92	2.08	11.6	1173.12	314.54	1.89	3023.06	9.61								
27.8	110	10.03	2.5	12.7	1173.53	284.91	2.27	2757.92	9.68								
29.6	180	11.06	1.66	10.3	1174.96	316.54	1.46	3381.44	10.68								
30	40	11.23	1.54	10.0	1175.23	329.46	3.31	3512.14	10.66								
31.75	175	13.24	0.9	7.6	1176.64	421.49	1.88	4602.15	10.92								
33	125	12.75	1.24	8.9	1176.85	373.88	2.65	3919.46	10.48								
35	200	11.66	1.55	10.0	1177.56	329.16	3.31	3503.8	10.64								
37	200	11.36	1.79	10.7	1178.26	302.03	2.46	3256.2	10.78								
38.32	132	11.03	2.01	11.4	1178.53	302.01	1.76	3079.27	10.20	1162	10.41	10.36	330.45	3.8351648	0.02	7.0	
40.05	173	12.77	1.71	10.5	1179.27	296.66	1.46	3335.08	11.24								
43	295	13.24	1.64	10.3	1179.94	295.79	1.38	3409.64	11.53								
46.92	392	13.02	1.79	10.7	1180.62	283.23	1.52	3257.14	11.50								
50.9	398	13.62	1.59	10.1	1181.62	290.82	1.33	3460.9	11.90								
55	410	13.35	1.58	10.1	1182.35	287.33	1.32	3464.68	12.06								
60	500	13.57	1.53	9.9	1183.27	293.12	1.28	3525.94	12.03								
64	400	13.34	1.77	10.7	1183.84	273.99	1.49	3280.47	11.97								
65.45	145	13.28	1.63	10.2	1184.28	297.4	1.37	3419.23	11.50								
66.9	145	13.52	1.46	9.7	1184.72	295.98	1.21	3611.07	12.20								
67.9	100	13.53	1.53	9.9	1184.83	293.22	1.28	3520.73	12.01								
68.69	73	13.55	1.54	10.0	1184.95	287.79	1.28	3515.99	12.22	3031	11.83	10.19	290.48	3.8351648	0.02	5.6	
68.7	7	8.03	3.85	15.7	1186.43	291.58	3.72	2221.7	7.62								
69.1	40	9.17	2.95	13.8	1187.67	292.48	2.73	2538.91	8.68								

09/14/93

NEW RIVER CHANNELIZATION - SEDIMENT TRANSPORT WORKSHEET
NEW RIVER FROM GRAND AVENUE TO BELL ROAD, SKUNK CREEK FROM NEW RIVER TO ACDC
100-YEAR FLOWS, NO CHANNELIZATION NORTH OF THUNDERBIRD ROAD
PARTIAL CHANNELIZATION BETWEEN GRAND AVE AND TBIRD RD FILE NRSC100Z.WQ1

Cross-Section Number SECNO	Channel Reach Length (ft) XLCH	Flow Depth (ft) DEPTH	Mean Velocity Head (ft) HV	Section Mean Velocity (fps)	Computed W. S. Elevation (ft MSL) CWSEL	Water Surface Top Width (ft) TOPWID	Channel Boundary Shear (lb/s ft) SHEAR	Cross Sectional Area (sq ft) AREA	Hydraulic Depth (ft)	Reach Length (ft)	Average Reach Depth (ft)	Average Reach Velocity (fps)	Average Reach Top Width (ft)	Gradation Coefficient G	Sediment Discharge (cfs/ft)	Sediment Discharge (cfs)	Section/ Reach Description
70.1	100	9.44	2.89	13.6	1188.24	288.36	2.65	2567.66	8.90								
71.8	170	9.84	2.77	13.4	1189.14	285.09	2.51	2622.09	9.20								
73.5	170	10.58	2.33	12.2	1190.28	290.99	2.07	2858.95	9.82								
76.32	282	12.66	2.01	11.4	1191.46	287.71	1.75	3073.54	10.68								
81	468	12.17	2.05	11.5	1192.67	284.6	1.78	3045.43	10.70								
84.7	370	12.99	1.35	9.3	1194.19	326.6	1.14	3751.92	11.49	1607	9.64	12.62	293.43	3.8351648	0.06	18.8	



SEDIMENT TRANSPORT ANALYSIS

FIGURE 3

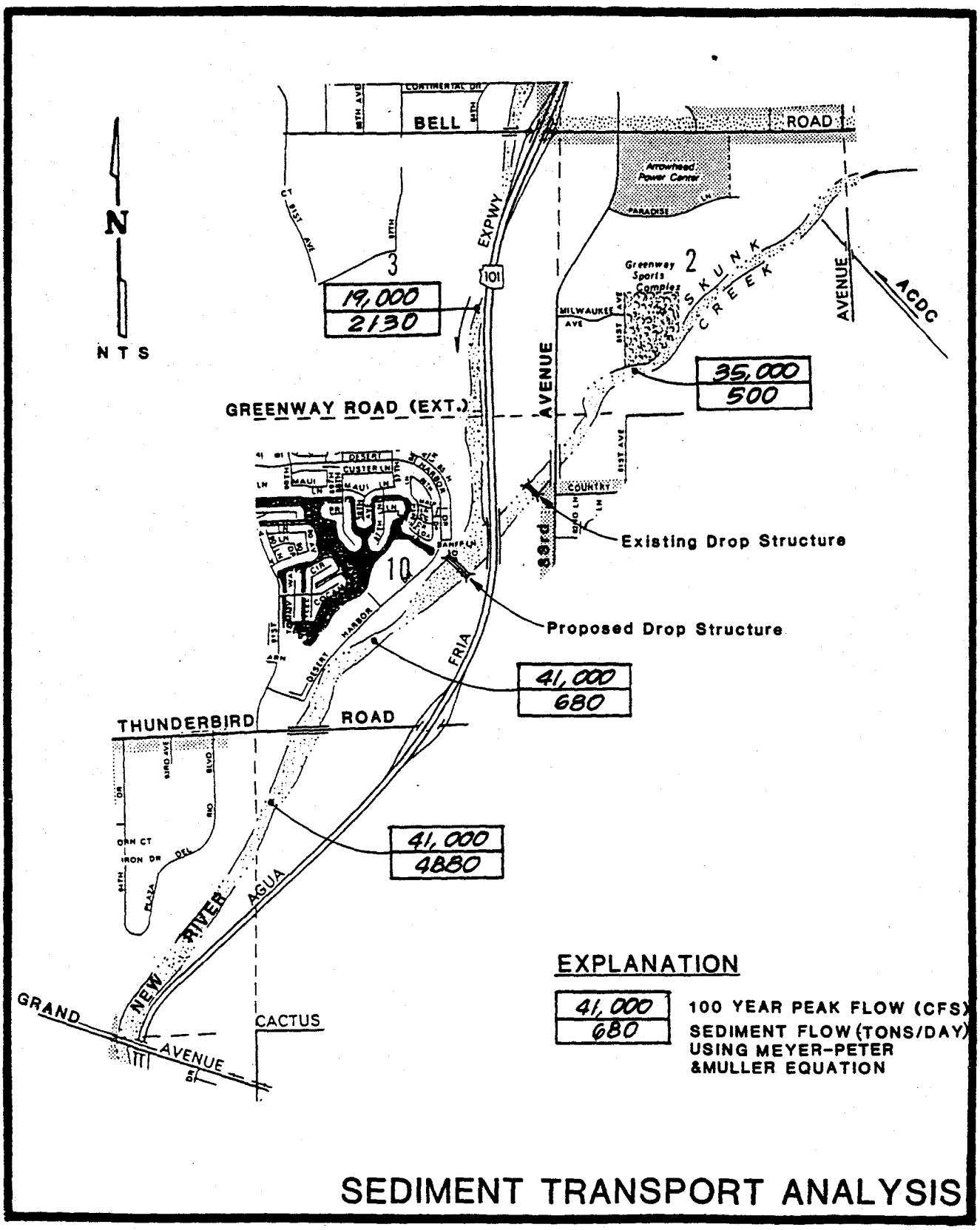
TABLE 5

SEDIMENT TRANSPORT USING MEYER-PETER-MULLER'S METHOD

10-YEAR FLOWS

REACH NO.	DEPTH (FT.)	WIDTH (FT)	D_{50} (MM)	AVG. SLOPE (FT/FT)	Z (FT/FT)	Qs (TONS/DAY)
1	3.94	331	42	.00527	.01	370
2	4.95	320	10.8	.00194	.01	202
3	5.12	286	8.2	.00247	.01	346
4	6.91	241	4.7	.00135	.01	158
5	2.96	350	7.1	.00435	.01	471
6	2.8	256	26	.00630	.01	334
7	4.56	285	70	.00243	.01	0.0
8	3.03	306	70	.0200	.01	3088
9	4.69	313	70	.00356	.01	0
10	5.84	262	70	.00129	.01	0
11	4.62	273	70	.00610	.01	298

SPECIFIC GRAVITY OF BED MATERIAL = 2.65



SEDIMENT TRANSPORT ANALYSIS

FIGURE 4

TABLE 6

SEDIMENT TRANSPORT USING MEYER-PETER-MULLER'S METHOD

100-YEAR FLOWS

REACH NO.	DEPTH (FT.)	WIDTH (FT)	D_{50} (MM)	AVG. SLOPE (FT/FT)	Z (FT/FT)	Qs (TONS/DAY)
1	9.25	346	42	.00527	.01	2,762
2	9.3	418	10.8	.00194	.01	870
3	10.15	332	8.2	.00247	.01	1,248
4	12.75	320	4.7	.00135	.01	682
5	7.4	400	7.1	.00435	.01	2,250
6	6.19	311	26	.00630	.01	2,007
7	10.23	307	70	.00243	.01	146
8	7.23	316	70	.0200	.01	15,700
9	10.4	330	70	.00356	.01	872
10	11.8	290	70	.00129	.01	0
11	9.64	293	70	.00610	.01	2,517

SPECIFIC GRAVITY OF BED MATERIAL = 2.65

APPENDIX IV

SCOUR ANALYSIS

- Local Scour Below Drop Structure
- Scour Potential Above Drop Structure
- Riprap/Filter Blanket at Drop Structure
- Contraction Scour At ADOT Structure
- Degradation At Sewer Line Crossing

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PROJECT: New River Drop Structure
PROJECT NO. 91755.02 SHEET NO. 1 OF 4
CALCULATED BY: JJH DATE: 2/ /91
CHECKED BY: DATE:

LOCAL SCOUR BELOW DROP

TASK: DETERMINE REQUIRED TOE DOWN ELEVATION FOR THE CUT OFF WALL BELOW THE DROP STRUCTURE

ASSUME: FREE FALL CONDITION (DROP NOT SUBMERGED)
STILLING BASIN NOT INCLUDED IN ANALYSES

REF: SEDIMENT TRANSPORT TECHNOLOGY → SIMON & SENTURK
COMPUTING DEGRADATION AND LOCAL SCOUR → BUREAU OF REC

GIVEN:

	10-YEAR		100-YEAR	
Q =	10,500 CFS	(297.33 cms)	41,000 CFS	(1161 cms)
b =	250 FT	(76.2 m)	250 FT	(76.2 m)
q =	42 CFS/FT	(3.90 cms/m)	164 CFS/FT	(15.24 m)
H =	7.14 FT	(2.18 m)	6.00 FT	(1.83 m)
h_d =	9.5 FT	(2.90 m)	19.4 FT	(5.91 m)
D_{90} =	3 in	(76.2 mm)	100 mm	

EQUATION ①
FOR 10-YEAR

$$S = 6\left(H^{0.25} q^{0.5} \left(\frac{h_d}{D_{90}}\right)^{1/3}\right) - h_d$$

JÄGERS EQUATION (Page 703)

$$S = 6\left[(2.18)^{0.25}(3.90)^{0.5}\left(\frac{2.90}{76.2}\right)^{0.33}\right] - 2.90$$

$$S = 1.94\ m = 6.37\ FT$$

FOR 100-YEAR

$$S = 6\left[(1.83\ m)^{0.25}(15.24)^{0.5}\left(\frac{5.91}{76.2}\right)^{0.33}\right] - 5.91$$

$$S = 5.71\ m = 18.73\ FT$$

* EQUATION NOT VALID FOR SUBMERGED CONDITION

EQUATION 2 57.64 53.77 65.79
FOR 10-YEAR 50.5 59.8

$$S = 4.75 \frac{H^{0.2} q^{0.5}}{D_{90}^{0.32}} - h_d$$

Schoklitsch Equation
Page 701

$$S = 4.75 \frac{(2.18)^{0.2}(3.90)^{0.5}}{(76.2)^{0.32}} - 2.90$$

$$S = -0.16 \text{ m}$$

FOR 100-YEAR

$$S = 4.75 \frac{(1.83)^{0.2}(15.24)^{0.5}}{(76.2)^{0.32}} - 5.91$$

$$S = -0.68 \text{ m}$$

EQUATION 3
FOR 10-YEAR

VERONESE EQUATION
Pg 42 (BoR)

$$d_s = K H_T^{0.225} q^{0.54} - d_m$$

$$d_s = (1.90)(2.18)^{0.225}(3.90)^{0.54} - 2.90$$

$$d_s = 1.82 \text{ m} = \underline{5.98 \text{ FT}}$$

FOR 100-YEAR

$$d_s = (1.90)(1.83)^{0.225}(15.24)^{0.54} - 5.91$$

$$d_s = 3.57 \text{ m} = \underline{11.7 \text{ FT}}$$

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PROJECT: NEW RIVER DROP STRUCTURE
PROJECT NO. 91755.02 SHEET NO. 3 OF 4
CALCULATED BY: NH DATE: 2/ /94
CHECKED BY: DATE:

EQUATION (4)

10-YEAR

$$d_s = K\left(\frac{q_f^{0.82}}{D_{85}^{0.23}}\right)\left(\frac{d_m}{q_f^{0.67}}\right)^{0.93} - d_m$$

ZIMMERMAN & MANIAK (BoR)

$$d_s = 2.89\left(\frac{(3.90)^{0.82}}{(70)^{0.23}}\right)\left(\frac{2.90}{(3.90)^{0.67}}\right)^{0.93} - 2.90$$

$$d_s = 0.94\ m = \underline{\underline{3.10\ FT}}$$

100-YEAR

$$d_s = 2.89\left(\frac{(15.24)^{0.82}}{(70)^{0.23}}\right)\left(\frac{5.91}{(15.24)^{0.67}}\right)^{0.93} - 5.91$$

$$d_s = 3.88\ m = \underline{\underline{12.7\ FT}}$$

SUMMARY

THE SCHOKLITSCH EQUATIONS DESCRIBED IN THE REFERENCES VARY SLIGHTLY. NEITHER RELATIONSHIP YIELDS A REALISTIC SCOUR DEPTH. THEREFORE, THEY WERE NOT USED IN THE ANALYSES.

JAGERS' EQUATION AND VERONESE'S EQUATION WERE USED TO PREDICT SCOUR DEPTH. VALUES FROM THESE EQUATIONS SHOULD BE CONSERVATIVE FOR THE NEW RIVER DROP STRUCTURE APPLICATION. THE EQUATIONS ASSUME A "FREE-FALL" CONDITION WITH NO STILLING BASIN.

THE 10-YEAR SCOUR DEPTHS WERE 6.37 FT AND 5.98 FT FOR THE JÄGER AND VERONESE EQUATIONS, RESPECTIVELY.

THE 100-YEAR SCOUR DEPTHS WERE 18.73 FT AND 11.7 FT FOR THE JÄGER AND VERONESE EQUATIONS, RESPECTIVELY.

THE ZIMMERMAN AND MANIAR EQUATION IS SPECIFICALLY FOR ESTIMATING SCOUR BELOW A STILLING BASIN. IT APPEARS TO BE THE BEST EQUATION FOR USE IN THE NEW RIVER DESIGN.

THE 10-YEAR AND 100-YEAR SCOUR DEPTHS WERE 3.10 FT AND 12.7 FT, RESPECTIVELY.

THE 18 FOOT TOE DOWN FOR THE CUT OFF IS ADEQUATE FOR THE NEW RIVER DROP.

18 > 12.7 ok

COMPUTING DEGRADATION AND LOCAL SCOUR

by

Ernest L. Pemberton
Joseph M. Lara

FROM THE
LIBRARY OF
WOOD/PATEL

TECHNICAL GUIDELINE FOR
BUREAU OF RECLAMATION

SI METRIC

SEDIMENTATION AND RIVER HYDRAULICS SECTION
HYDROLOGY BRANCH
DIVISION OF PLANNING TECHNICAL SERVICES
ENGINEERING AND RESEARCH CENTER

DENVER, COLORADO

JANUARY 1984

The use of figure 12 and table 8 recommended by Neill (1973) has had limited application in Reclamation, but appears to be a potential useful technique for many Reclamation studies on scour and armoring of the channel.

Equation Type C (See Table 6)

The principal references for design of midchannel structures for scour such as at bridge piers are National Cooperative Highway Research Program Synthesis 5 (1970), C. R. Neill (1973), Federal Highway Administration, Training and Design Manual (1975), Federal Highway Administration (1980), and S. C. Jain (1981). The numerous empirical relationships for computing scour at bridge piers include one or more of the following hydraulic parameters: pier width and skewness, flow depth, velocity, and size of sediment. The many relations available were further broken down by Jain (1981) to two different approaches: (1) regime, and (2) rational.

The Federal Highway Administration has funded numerous research projects to assist in improving their designs of bridge piers. This research has not resulted in any one recommended procedure. Reclamation's need for scour estimates at midchannel structures is limited. The procedures adopted are to try at least two techniques and apply engineering judgment in selecting an average of most reliable method. The regime approach is to use either equations 26, 27, 28, or 30 and a Z value from table 7. An appropriate Z value to use for piers is 1.0 as found for the railway bridge piers applied to the Lacey equation 29 reported by Central Board of Irrigation and Power (1971).

The rational equation selected for scour at piers is described by Jain (1981) in the form:

$$\frac{d_s}{b} = 1.84 \left(\frac{d}{b}\right)^{0.3} \left(F_c\right)^{0.25} \qquad (33)$$

where:

d_s = Depth of scour below streambed, ft (m)
b = Pier size, ft (m)
d = Flow depth, ft (m)
$F_c = V_c/\sqrt{gd}$ = Threshold Froude number
V_c = Threshold velocity, ft/s (m/s) from figure 12
g = Acceleration due to gravity, 32.2 ft/s^2 (9.81 m/s^2)

Equation Type D (See Table 6)

Immediately downstream from any hydraulic structure the riverbed is subject to the erosive action created by the structure. Some type of stilling basin or energy dissipator as described by Reclamation (1977) is provided in the design of such structures to dissipate the energy thereby reducing the erosion potential. There still remains at most structures, below the point where the structure ends and the natural riverbed material begins, a potential for scour. The magnitude of this scour hole will depend on a combination of flow velocity, turbulence, and vortices generated by the structure. Simons and Senturk (1977) describe many of the available equations.

IF the $d_{75} > 0.4$ mm $\simeq 40$ Sediment Laden Flow
$d_{75} > .2$ mm $\simeq 60$ " Free "

FOR d_{es}

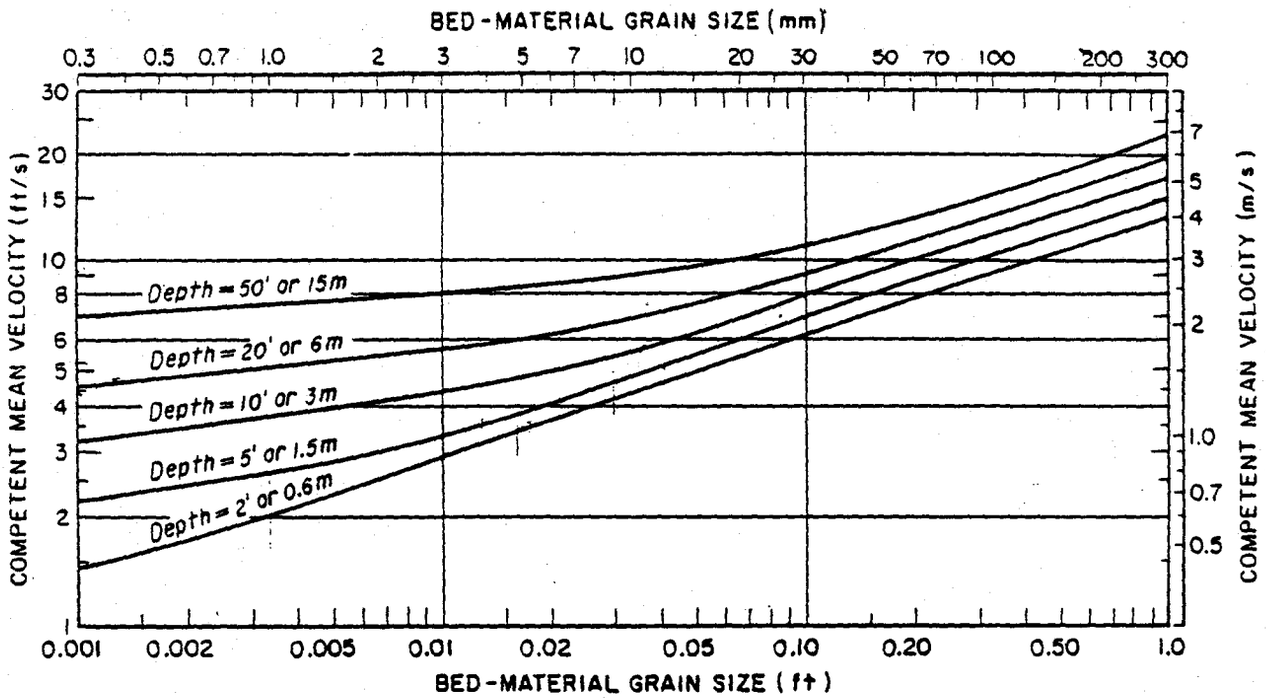

Figure 12. - Suggested competent mean velocities for significant bed movement of cohesionless materials, in terms of grain size and depth of flow (after Neill, 1973).

If your D_{50} bed material is 0.5 mm

Then the depth of flow is 5' then the velocity is 2.5 ft/sec. If the V = 2.5 ft/sec you do not [illegible] if v is more than 2.5 then

Assume V = 7.5 ft/sec then you go to pg. 35 equation 3.2

$$d_s = d_m\left(\frac{V_m}{V_c} - 1\right)$$

$$d_s = 5\left(\frac{7}{2.5} - 1\right) = 10'$$

Methods adopted by Reclamation for computing local scour below a hydraulic structure across the river channel are based on either the regime or rational approach. Scour computations should be made by several methods and engineering judgment used to select the most appropriate. In the regime approach, the Lacey or Blench equations 26, 27, 29, and 30, respectively, with Z values from table 7 are applicable.

The most appropriate empirically developed rational methods for scour below a structure are those by Schoklitsch (1932), Veronese (1937), or Zimmerman and Maniak (1967). Scour computations by Schoklitsch are made by:

$$d_s = \frac{K\ (H)^{0.2}\ q^{0.57}}{D_{90}^{0.32}} - d_m \qquad (34)$$

where:

d_s = Depth of scour below streambed, ft (m)
K = 3.15 inch-pound units (K = 4.70 metric units)
H = Vertical distance between the water level upstream and downstream of the structure, ft (m)
q = Design discharge per unit width, ft^3/s per ft (m^3/s per m)
D_{90} = Particle size for which 90 percent is finer than, mm
d_m = Downstream mean water depth, ft (m)

The Veronese (1937) equation for computing the scour hole depth below a low head stilling basin design is as follows:

$$d_s = K\ H_T^{0.225}\ q^{0.54} - d_m \qquad (35)$$

where:

d_s = Maximum depth of scour below streambed, ft (m)
K = 1.32 inch-pound units (K = 1.90 metric units)
H_T = The head from upstream reservoir to tailwater level, ft (m)
q = Design discharge per unit width, ft^3/s per ft (m^3/s per m)
d_m = Downstream mean water depth, ft (m)

The Zimmerman and Maniak (1967) equation for local scour below a stilling basin can be calculated by:

$$d_s = K \left(\frac{q^{0.82}}{D_{85}^{0.23}}\right) \left(\frac{d_m}{q^{2/3}}\right)^{0.93} - d_m \qquad (36)$$

where:

d_s = Depth of scour below streambed, ft (m)
K = 1.95 inch-pound units (K = 2.89 metric units)
q = Design discharge per unit width, ft^3/s per ft (m^3/s per m)
D_{85} = Particle size for which 85 percent is finer than, mm
d_m = Downstream mean water depth, ft (m)

SEDIMENT TRANSPORT TECHNOLOGY

by

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and

FUAT ŞENTÜRK

Water Resources Publications
Fort Collins, Colorado 80522, USA
1977

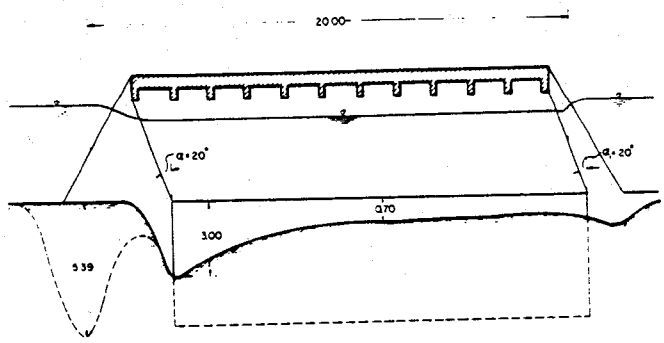

Fig. 9.17 Solution of Example Problem 9.1

If the bridge is located near the sea, as high flows and low tide occur an increase in average channel velocity at the bridge site may cause additional scour.

The bridge may collapse if this condition persists. Many coastal bridges in Italy, France and Turkey have collapsed because of inadequate depth of foundation resulting from inadequate scour analysis.

9.3.2.4 Local scour downstream of hydraulic structures

9.3.2.4.1 Flow conditions downstream of hydraulic structures

The scour downstream of hydraulic structures such as stilling basins, diversion work, etc., constitutes an important field of research due to its frequent occurrence in engineering applications. Several solutions to this problem were proposed in Europe by Schoklitch (1932), Eggenberger (1943), Jäger (1939), Altinbilek and Okyay (1973), etc., and in the USA by Simons and Stevens (1971), Carstens (1966), LeFeuvre (1965), etc.

Figure 9.18 summarizes the possible flow conditions downstream of hydraulic structures. Figure 9.18b shows the vortex with a horizontal axis downstream of a stilling basin and how it affects the magnitude of scour. Figure 9.18a represents the same flow without the vortex. The term S represents the depth of scour, q is the discharge per unit of width and h_d the depth of flow downstream of the structure. Figure 9.18c illustrates flow taking place simultaneously over and under a sluice gate. The discharge q_u is that over the gate and q_d is that beneath the gate or orifice. Figure 9.18d represents the flow under a gate at the downstream end of a hydraulic structure and Fig. 9.18e shows the flow from the flip bucket of a spillway. These flows cause scour downstream of the hydraulic structure. A universal scour formula does not exist that is capable of handling the different flows shown on Fig. 9.18. The existing approaches that can be used to estimate the local scour are summarized.

9.3.2.4.2 Determination of the depth of scour downstream of hydraulic structures

One of the earliest formulas defining the scour depth was proposed by Schoklitsch in 1932. It can be written as

$$d_s = S + h_d = 4.75 \frac{H^{0.2}\, q^{0.5}}{D_{90}^{0.32}} \qquad (9.23)$$

where d_s is the distance from the deepest point of the scour hole to the downstream water surface
S is the depth of the scour hole
h_d is the downstream water depth
q is the water discharge per unit of width and
D_{90} is the particle size for which 90 percent of the material is finer
H is the vertical distance between the energy grade line and the bottom of the stilling basin

This formula is in metric units. It gives good results for relatively large D_{90} values with flow conditions as defined by Fig. 9.18a.

Two similar formulas were proposed by Eggenberger (1943) and Jäger (1939) for Middle Europe and for the conditions illustrated in Fig. 9.18c.

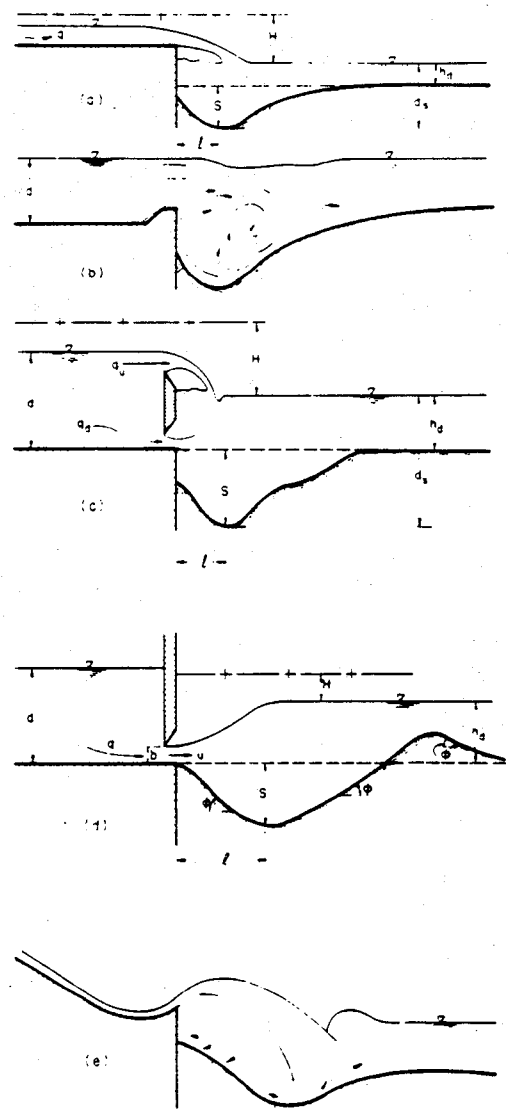

Fig. 9.18 Different kinds of erosion that can take place downstream of gates.

Eggenberger's formula is

$$d_s = S + h_d = C \frac{H^{0.5}\, q^{0.6}}{D_{90}^{0.4}} \tag{9.24}$$

and Jäger's formula is

$$d_s = S + h_d = 6\, H^{0.25}\, q^{0.5} \left(\frac{h_d}{D_{90}}\right)^{1/3} \tag{9.25}$$

In these relations C is a constant, d_s, H and h_d are in meters, D_{90} is in millimeters and q in m^3/sec-m (see Fig. 9.18). The coefficient C in Eq. 9.24 is defined by Eq. 9.26 and Fig. 9.19.

$$C = 22.8 - \frac{1}{0.0049\left(\frac{q_u}{q_d}\right)^3 - 0.0063\left(\frac{q_u}{q_d}\right)^2 - 0.029\left(\frac{q_u}{q_d}\right) + 0.064} \tag{9.26}$$

where q_u is the discharge per unit width over the gate (Fig. 9.18e) and q_d is the unit discharge from the orifice.

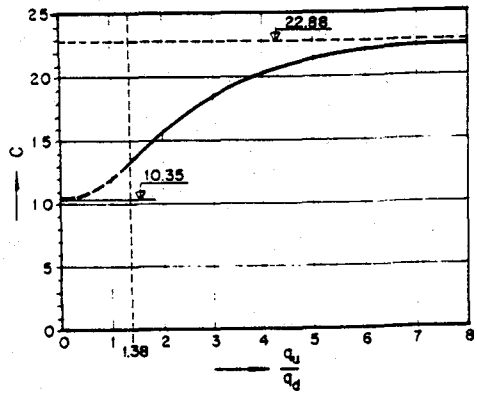

Fig. 9.19 Values of C, as a function of q_u/q_d and D_{90} (R. Mueller and W. Eggenberger).

For the flow condition illustrated by Fig. 9.18a with $q_d = 0$, Eq. 9.26 yields $C = 22.8$. This is the highest possible value for the coefficient C considering the cases illustrated by Figs. 9.18a to 9.18d, inclusive. The minimum value of C

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SCOUR POTENTIAL ABOVE DROP STRUCTURE

① LONG TERM DEGRADATION

LONG TERM DEGRADATION WILL BE MINIMAL DUE TO THE DROP STRUCTURE LOCATED IMMEDIATELY DOWNSTREAM FROM THE BANK PROTECTION.

② CONTRACTION SCOUR

SECTION	=	455.63	453.23
DISCHARGE	=	41,000 CFS	41,000 CFS
VELOCITY	=	8.65 FT/SEC	13.37 FT/SEC
DEPTH	=	13.89 FT	11.47 FT
TOP WIDTH	=	413 FT	285 FT

$$\frac{Y_2}{Y_1} = \cancel{\left(\frac{Q_{mc2}}{Q_{mc1}}\right)^{6/7}}^{\,1} \left(\frac{W_{c1}}{W_{c2}}\right)^{K_1} \cancel{\left(\frac{n_2}{n_1}\right)^{K_2}}^{\,1}$$

Laursen Contraction Scour (HEC-18)

$$\frac{Y_2}{Y_1} = \left(\frac{W_{c1}}{W_{c2}}\right)^{K_1}$$

CASE 2 (HEC-18)
NO OVERBANK FLOW
MANNINGS 'N' EQUAL IN BOTH SECTIONS

$$Y_2 = \left(\frac{413}{285}\right)^{0.59} (13.89)$$

$$Y_2 = 17.3 \text{ FT}$$

$$Y_S = Y_2 - Y_1$$

$$Y_S = 17.3 - 13.89$$

$$\boxed{Y_S = 3.4 \text{ FT}}$$

③ BEND SCOUR ASSUME Q = 25,000 CFS (19,000 NR + 6000 ACDC)

$$\Delta Z_{bs} = \frac{0.0685\, Y\, V^{0.8}}{Y_h^{0.4}\, S_e^{0.3}} \left[2.1 \left(\frac{\sin^2 \alpha}{\cos \alpha} \right)^{0.2} - 1 \right]$$

WHERE
Y = MAXIMUM FLOW DEPTH (10.32 FT)
Y_h = HYDRAULIC DEPTH (A/T_W) = $3313/388$ = (8.54 FT)
V = VELOCITY (7.55 FT/SEC)
S_e = ENERGY GRADE LINE SLOPE (0.0025 FT/FT)
α = BEND ANGLE (30°)

$$\Delta Z_{bs} = \frac{0.0685\,(10.32)(7.55)^{0.8}}{(8.54)^{0.4}\,(0.0025)^{0.3}} \left[2.1 \left(\frac{\sin^2 30}{\cos 30} \right)^{0.2} - 1 \right]$$

ΔZ_{bs} = 5.82 FT

④ LOW FLOW CHANNEL INCISEMENT
SCOUR DEPTHS TO BE MEASURED FROM THALWEG
∴ DON'T ADD TO SCOUR DEPTH

⑤ BEDFORMS
COBBLE BED CHANNEL → BEDFORMS WILL BE MINIMAL

TOTAL SCOUR DEPTH = 5.8 + 3.4 = 9.2 USE 10 FT

FOR SAFETY FACTOR OF 1.5 USE

(10)(1.5) = **15 FT**

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PROJECT: NEW RIVER
PROJECT NO. 91755.02 SHEET NO. 3 OF 5
CALCULATED BY: WH DATE
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① DETERMINE CONTRACTION SCOUR FOR SPF

$$\frac{y_2}{y_1} = \cancel{\left(\frac{Q_{m2}}{Q_{m1}}\right)^{6/7}}^{1} \left(\frac{W_{c1}}{W_{c2}}\right)^{k_1} \cancel{\left(\frac{n_2}{n_1}\right)^{k_2}}^{1}$$

		SECTION 453.23
$\frac{y_2}{y_1} = \left(\frac{W_{c1}}{W_{c2}}\right)^{k_1}$	69,000	69,000 CFS
	9.97 FT/SEC	15.75 FT/SEC
	19.1 FT	15.98 FT
$y_2 = \left(\frac{445}{315}\right)^{0.59}(19.1)$	445 FT	315 FT

$y_2 = 23.4$ FT

$y_s = y_2 - y_1 = 23.4 - 19.1$

$y_s = 4.32$ FT

② DETERMINE BEND SCOUR ASSUME Q = 48,000 (38,000 NR + 10,000 ACOC)

$$\Delta z_{bs} = \frac{0.0685\,(13.73)(10.69)^{0.8}}{(11.08)^{0.4}(0.002\bar{z})^{0.3}}\left[2.1\left(\frac{\sin^2 30}{\cos 30}\right)^{0.2} - 1\right]$$

$\Delta z_{bs} = 9.57$ FT

③ LOW FLOW CHANNEL INCISEMENT
SCOUR DEPTHS MEASURED FROM THALWEG
∴ DON'T ADD TO SCOUR DEPTH

④ BED FORMS
COBBLE BED CHANNEL → BED FORMS WILL BE MINIMAL

TOTAL SCOUR ESTIMATE SPF = 4.32 + 9.57 = 13.89 FT

ARMORING POTENTIAL

THE BED OF THE NEW RIVER IS MAINLY COMPOSED OF COBBLES. THIS WOULD INDICATE THAT THE WATER COURSE HAS A GOOD POTENTIAL FOR ARMORING.

$$D_c = \frac{\tau}{0.047(\gamma_s - \gamma)}$$

$$d = \frac{A}{T} = \frac{4741}{413} = 11.5 \text{ FEET}$$

$$\frac{b}{d} = \frac{413}{11.5} = 36 > 10 \quad \therefore \quad \gamma d s = \gamma R S$$

FROM Figure 4.4

$$\frac{\tau_{max}}{\gamma d s} = 1.0$$

$$\tau_{max} = \gamma d s = (62.4)(11.5)(.0060)$$

$$\tau_{max} = 4.30 \text{ lb/ft}^2$$

$$D_c = \frac{4.30}{0.047(165-62.4)}$$

$D_c = 0.89$ FT $\Longrightarrow$ ASSUME D_{90}

* COMPLETE GRADATION NOT PERFORMED BY THOMAS-HARTIG DID NOT ANALYZE PARTICLES GREATER THAN 3" FROM PHOTOS AND FIELD VISIT ESTIMATE .90 = D_{90}

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PROJECT: NEW RIVER

PROJECT NO. 91755.02 SHEET NO. 5 OF 5

CALCULATED BY: JNH DATE

CHECKED BY DATE

DETERMINE DEPTH TO ARMOR

$$\Delta Z_A = Y_a \left(\frac{1}{P_c} - 1 \right)$$

$$\Delta Z_A = 2(0.90) \left(\frac{1}{0.10} - 1 \right)$$

$$\Delta Z_A = 16.2 \text{ FT}$$

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PROJECT: New River Rip Rap Design
PROJECT NO. 91755.02 SHEET NO. 1 OF 4
CALCULATED BY: JJH DATE
CHECKED BY: DATE

RIP RAP/FILTER BLANKET @ DROP

TASK: DETERMINE SIZE OF RIP-RAP REQUIRED FOR NEW RIVER DROP STRUCTURE (UPSTREAM)

REF: 1) DRAINAGE DESIGN MANUAL FOR MARICOPA COUNTY, AZ VOLUME II, HYDRAULICS

2) HYDRAULIC DESIGN OF FLOOD CONTROL CHANNELS

3) HIGHWAYS IN THE RIVER ENVIRONMENT

4) DESIGN MANUAL FOR ENGINEERING ANALYSIS OF FLUVIAL SYSTEMS

GIVEN: $Q = 41{,}000$ CFS
$S = 0.0038$ (Energy slope from 452.73 to 453.23)
$A = 2940$ FT^2 (AVERAGE)
$P = 281.8$ FT
$V = 13.66$ FT/SEC
$R = A/P = 10.43$ FT

① DETERMINE SHEAR STRESS

$$\tau = \gamma R S$$

$$\tau = (62.4)(10.43)(0.0038)$$

$$\tau = 2.47 \text{ lb/ft}^2$$

② CALCULATE THE REQUIRED RIP-RAP SIZE

$$D_{50} = \frac{\tau}{0.047(\gamma_s - \gamma_w)}$$ SHIELDS EQ

$$D_{50} = \frac{2.47}{0.047(165-62.4)}$$

$$D_{50} = \underline{\underline{0.51 \text{ FT}}}$$

③ CALCULATE THE REQUIRED RIP-RAP SIZE FOR SF = 1.5

ASSUME $\phi = 40°$
$\theta = 18.43°$
$n = 0.67$ from Figure 5.2.2 Highways in River Environment
SF = 1.5

$$D_m = \frac{21\tau}{(S_s-1)\gamma n}$$ Eq 5.2.5 (H.R.E)

$$D_m = \frac{21(2.47)}{(2.65-1)(62.4)(0.67)} = \boxed{0.75 \text{ FT}}$$

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PROJECT: New River Rip-Rap Design
PROJECT NO. 91755.02 SHEET NO. 3 OF 4
CALCULATED BY: JJH DATE 2/ /94
CHECKED BY: DATE

TASK: DETERMINE SIZE OF RIP-RAP REQUIRED FOR NEW DROP STRUCTURE (DOWNSTREAM)

GIVEN: $Q = 41{,}000$ CFS
$S = 0.0014$ (Energy slope from 450.23 to 451.23)
$A = 5218.2$ FT^2
$P = 369.5$ FT
$R = A/P = 14.1$ FT
$V = 7.87$ FT/SEC

① DETERMINE THE SHEAR STRESS

$\tau = \gamma R S$

$\tau = (62.4)(14.1)(0.0014)$

$\tau = 1.23$ lb/ft^2

② DETERMINE THE REQUIRED RIP-RAP SIZE FOR BED

$$D_{50} = \frac{\tau}{0.047(\gamma_s - \gamma_w)}$$ SHIELDS EQ

$$D_{50} = \frac{1.23}{0.047(165 - 62.4)}$$

$D_{50} = \underline{0.26 \text{ FT}}$

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PROJECT: New River Rip-Rap Size
PROJECT NO. 91755.02 SHEET NO. 4 OF 4
CALCULATED BY: JJH DATE 2/ /94
CHECKED BY: DATE

③ DETERMINE REQUIRED RIP-RAP SIZE FOR CHANNEL INVERT (SF=1.5)

ASSUME $\phi = 40°$
$\theta = 18.43°$
$n = 0.67$
$SF = 1.5$
$S_s = 2.65$

$$D_m = \frac{21\,\tau_o}{(S_s-1)\gamma n}$$

$$D_m = \frac{(21)(1.23)}{(2.65-1)(62.4)(0.67)} = 0.37 \text{ FT}$$

④ DETERMINE REQUIRED RIP-RAP SIZE FOR SIDE SLOPES (SF=1.5)

$\phi = 40°$
$\theta = 18.43$
$n = 0.40$ → Figure 5.2.2 (HIRE)

$$D_m = \frac{21\,\tau}{(S_s-1)\gamma n}$$

$$D_m = \frac{21(1.23)}{(2.65-1)(62.4)(0.40)}$$

$$\boxed{D_m = 0.63 \text{ FT}}$$

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PROJECT New River Rip Rap
PROJECT NO. 91755.02 SHEET NO. 1 OF 3
CALCULATED BY _____ DATE _____
CHECKED BY _____ DATE _____

TASK: DESIGN FILTER BLANKET FOR RIP-RAP DOWNSTREAM OF DROP STRUCTURE

GIVEN: RIP-RAP DISTRIBUTION

90-100	16"
70-85	12"
30-50	8"
5-15	5"
0-5	3"

ASSUME D_{85} = 12" 305 mm
D_{50} = 8" 203.2 mm
D_{15} = 5" 127 mm

NATIVE SOIL DISTRIBUTION

D_{85} = 25.4 mm
D_{50} = 2.38 mm
D_{15} = 0.09 mm

$$\frac{D_{50}\,(\text{Filter})}{D_{50}\,(\text{Base})} < 40 \Rightarrow D_{50}\,(\text{Filter}) < (40)(2.38)$$
95.2 mm

$$\frac{D_{15}\,(\text{Filter})}{D_{15}\,(\text{Base})} < 40 \Rightarrow D_{15}\,(\text{Filter}) < (40)(0.090)$$
3.60 mm

$$\frac{D_{15}\,(\text{Filter})}{D_{85}\,(\text{Base})} < 5 \Rightarrow D_{15}\,(\text{Filter}) < (5)(25.4)$$
127 mm

$$\frac{D_{15}\,(\text{Filter})}{D_{15}\,(\text{Base})} > 5 \Rightarrow D_{15}\,(\text{Filter}) > (5)(0.090)$$
0.45 mm

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PROJECT: New River Rip Rap Filter Blanket

PROJECT NO. 91755.02 SHEET NO. 2 OF 3

CALCULATED BY: JJH DATE

CHECKED BY: DATE

① $\frac{D_{50}(\text{Riprap})}{D_{50}(\text{Filter})} < 40 \Rightarrow D_{50}(\text{Filter}) > \frac{D_{50}(\text{riprap})}{40} = \frac{203.2}{40} = 5.08 \text{ mm}$

② $\frac{D_{15}(\text{riprap})}{D_{15}(\text{Filter})} > 5 \rightarrow D_{15}(\text{Filter}) < \frac{D_{15}(\text{riprap})}{5} = \frac{127}{5} = 25.4 \text{ mm}$

③ $\frac{D_{15}(\text{rip rap})}{D_{15}(\text{Filter})} < 40 \Rightarrow D_{15}(\text{Filter}) > \frac{D_{15}(\text{riprap})}{40} = \frac{127}{40} = 3.18 \text{ mm}$

④ $\frac{D_{15}(\text{riprap})}{D_{85}(\text{Filter})} < 5 \rightarrow D_{85}(\text{Filter}) > \frac{D_{15}(\text{riprap})}{5} = \frac{127}{5} = 25.4 \text{ mm}$

With Respect to the Base

$0.45 \text{ mm} < D_{15} < 3.60 \text{ mm}$

$D_{50} < 95.2 \text{ mm}$

With Respect to the Rip Rap

$3.18 \text{ mm} < D_{15} < 25.4 \text{ mm}$

$5.08 \text{ mm} < D_{50}$

$25.4 \text{ mm} < D_{85}$

SELECTED FILTER: $D_{85} = 100 \text{ mm}$

$D_{50} = 25 \text{ mm}$

$D_{15} = 3.5 \text{ mm}$

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PROJECT New River Drop
PROJECT NO. 91755.02 SHEET NO. ____ OF ____
CALCULATED BY JJH DATE ____
CHECKED BY ____ DATE ____

DETERMINE THICKNESS OF RIP-RAP

CRITERIA PER HIGHWAYS IN RIVER ENVIRONMENT (FHWA)

① MINIMUM OF 12 INCHES
② NOT LESS THAN UPPER LIMIT OF D_{100}
③ NOT LESS THAN 1.5 UPPER LIMIT D_{50}

CRITERIA PER DRAINAGE DESIGN MANUAL (VOLUME II – HYDRAULICS)

④ NOT LESS THAN $1.5 \times D_{100}$

THICKNESS > 12 INCHES
> D_{100} = 16 INCHES
> $1.5 \times D_{50}$ = (1.5)(8 INCHES) = 1 FT
> $1.5 \times D_{100}$ = (1.5)(16 INCHES) = 2 FT ← CONTROL

USE 2 FOOT THICK RIP-RAP

FILTER BLANKET SHOULD BE 0.5 × RIP-RAP THICKNESS

(0.5)(2) = 1 FOOT

USE 1 FOOT FILTER BLANKET

OR

APPROPRIATE GEOTEXTILE FABRIC

HIGHWAYS IN THE RIVER ENVIRONMENT

Prepared for

U.S. DEPARTMENT OF TRANSPORTATION

Federal Highway Administration

Prepared by

Civil Engineering Department
Engineering Research Center
Colorado State University
Fort Collins, Colorado

E.V. Richardson
D.B. Simons
P.Y. Julien

January 1987

revetment surface. Keyed riprap is more stable than loose riprap revetment because of reduced drag on individual stones, its angle of repose if higher, and its cost is less because a lesser volume of rock per unit area is required.

5.2.6 Filters For Riprap

Filters are used under riprap to allow water to drain easily from the bank without carrying our soil particles. Filters must meet two basic requirements: stability and permeability. The filter material must be fine enough to prevent the base material from escaping through the filter, but it must be more permeable than the base material. There is no standard filter that can be used in all cases. Two types of filters are commonly used: gravel filters and plastic filter cloths.

- **Gravel filters**

A layer or blanket of well-graded gravel should be placed over the embankment or riverbank prior to riprap placement. Sizes of gravel in the filter blanket should be from 3/16 in. to an upper limit depending on the gradation of the riprap with maximum sizes of about 3 to 3-1/2 in. Thickness of the filter may vary depending upon the riprap thickness but should not be less than 6 to 9 inches. Filters that are one-half the thickness of the riprap are quite satisfactory. Suggested specifications for gradation are as follows:

$$(1) \quad \frac{D_{50}\ (\text{Filter})}{D_{50}\ (\text{Base})} < 40 \qquad (5.2.22)$$

$$(2) \quad 5 < \frac{D_{15}\ (\text{Filter})}{D_{15}\ (\text{Base})} < 40 \qquad (5.2.23)$$

$$(3) \quad \frac{D_{15}\ (\text{Filter})}{D_{85}\ (\text{Base})} < 5 \qquad (5.2.24)$$

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PROJECT: NEW RIVER
PROJECT NO. 91755.02 SHEET NO. 1 OF 1
CALCULATED BY: RH DATE: 12/7/93
CHECKED BY: DATE:

CONTRACTION SCOUR DUE TO ADOT STRUCTURE

REF: EVALUATING SCOUR AT BRIDGES (HEC-18)

LAURSEN'S CONTRACTION SCOUR FOR CASE 2 – NO OVERBANK FLOW AND THE CHANNEL NARROWS

$$\frac{Y_2}{Y_1} = \left(\frac{W_{c_1}}{W_{c_2}}\right)^{K_1}$$

WHERE: Y_1 = AVG. DEPTH IN MAIN CHANNEL
Y_2 = AVG DEPTH IN CONTRACTED SECTION
W_{c_1} = BOTTOM WIDTH OF MAIN CHANNEL
W_{c_2} = BOTTOM WIDTH OF CONTRACTED SECTION
K_1 = 0.59 (MOSTLY CONTACT BED MATERIAL DISCHARGE)
Y_s = AVERAGE SCOUR DEPTH

FOR 100 YR.

$$Y_2 = \left(\frac{150}{120}\right)^{0.59}(12.49')$$

$$Y_2 = 14.25'$$

$$Y_s = Y_2 - Y_1$$

$$Y_s = 14.25' - 12.49' = 1.76'$$

FOR 500 YR

$$Y_2 = \left(\frac{150}{120}\right)^{0.59}(15.83)$$

$$Y_2 = 18.05'$$

$$Y_s = 18.05' - 15.83' = 2.23'$$

THE CONTRACTION SCOUR COMPONENT WILL BE ELIMINATED IN THE DESIGN CONDITION. THE ADOT STRUCTURE WILL MOVE APPROXIMATELY 50 FEET TO THE EAST. THE CHANNEL WILL NO LONGER BE "CHOKED" AT THE ADOT OUTFALL.

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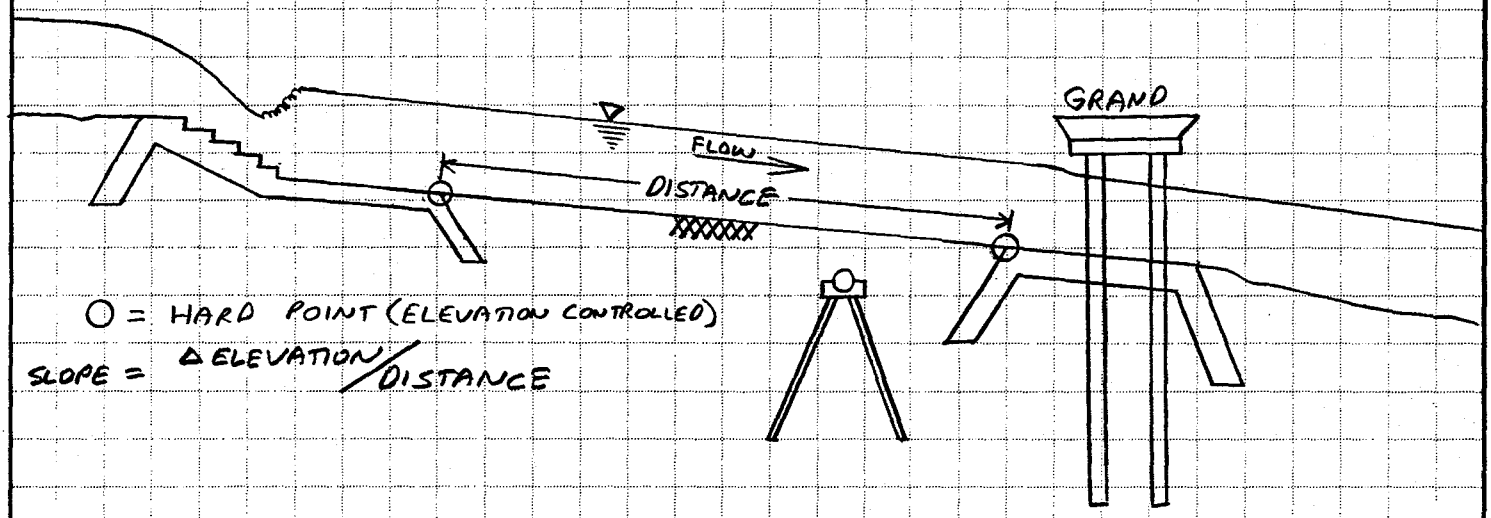
PROJECT NEW RIVER
PROJECT NO. 91755.02 SHEET NO. 1 OF 1
CALCULATED BY J. HOLZMEISTER DATE
CHECKED BY DATE

DISCUSSION REGARDING THE SEWER LINE LOCATED NORTH OF GRAND AVENUE

THE SEWER LINE WILL BE LOCATED BETWEEN A CHECK STRUCTURE AT GRAND AVENUE (STA. 347+50±) AND THE PROPOSED DROP STRUCTURE (STA. 376+50±). THE TOE DOWN ELEVATION OF EACH FACILITY SHOULD PROVIDE ADEQUATE PROTECTION (SEE DETAIL)

THE CHECK STRUCTURES WILL PREVENT LONG TERM DEGRADATION FROM OCCURING IN THIS REACH. THEREFORE, THE SEWER LINE MUST BE ABLE TO WITHSTAND "LOCAL" EROSION. FIELD SURVEYS INDICATE THAT THE SEWER LINE IS LOCATED SIX FEET BELOW THE CHANNEL INVERT AND THAT IT IS SUPPORTED BY A PILE SYSTEM (SEE DETAIL) THAT EXTENDS DOWN 30 FEET. THIS DESIGN SHOULD BE ADEQUATE FOR SCOUR PROTECTION. NOTE: HYDRAULIC FORCES ON THE PIPE LINE WERE NOT EVALUATED. THESE MAY BE CAPABLE OF DAMAGING THE SYSTEM



THE CHANNEL CANNOT DEGRADE SIGNIFICANTLY BETWEEN THESE CHECK STRUCTURES, THEREFORE, THE BANKS MAY EXPERIENCE ADDITIONAL EROSION IF THE STUDY REACH IS A SUPPLY REACH.

REPORT FOR
GEOTECHNICAL ENGINEERING SERVICES
NEW RIVER CHANNELIZATION
GRAND AVENUE TO GREENWAY ROAD
PEORIA , ARIZONA

For

Wood, Patel & Associates, Inc.
Attention: Ash Patel
1550 East Missouri, Suite 203
Phoenix, Arizona 85014

Project No. 93-0472

13 July 1993

THOMAS-HARTIG & ASSOCIATES, INC.

Geotechnical, Materials Testing, and Environmental Consultants

7031 West Oakland Street • Chandler, Arizona 85226

Chandler: Phone (602) 961-1169, Fax (602) 940-0952 • Phoenix: Phone (602) 437-5450

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John C. Patton
Kenneth D. Walsh, P.E.

13 July 1993

Wood, Patel & Associates, Inc.
1550 East Missouri, Suite 203
Phoenix, Arizona 85014

Attention: Ash Patel

Subject: Report for Geotechnical Engineering Services
New River Channelization
Grand Avenue to Greenway Road
Peoria County, Arizona

Project No. 93-0472

This report presents the results of the geotechnical engineering services authorized on the site for the New River Channelization in Maricopa County, Arizona.

The purpose of these services is to determine the soil conditions at the locations indicated which thereby provide a basis for the design discussions and recommendations presented herein. This firm should be notified for evaluation if conditions other than described herein are encountered during construction.

The recommendations presented in this report are based upon the project information received and described in "Scope" Part I. This firm should be contacted for review if the design conditions are changed substantially.

If requested, we will be available to review project plans and specifications relative to compliance to the intent of this report.

Respectfully submitted,

THOMAS-HARTIG & ASSOCIATES, INC.

By:

Registered Professional Engineer (Civil) CERTIFICATE NO. 10971 KENNETH L. RICKER Date Signed 7-14-93 ARIZONA, U.S.A.

/cm

Addressee (5)

Reviewed By:

Registered Professional Engineer (Civil) CERTIFICATE NO. 7354 JOHN P BOYD Date Signed 7-14-93 ARIZONA, U.S.A.

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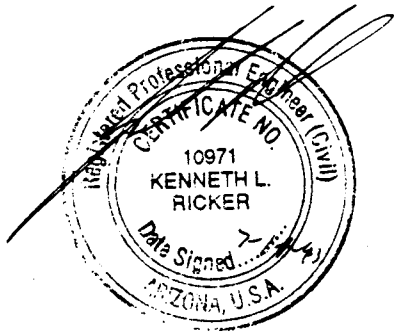
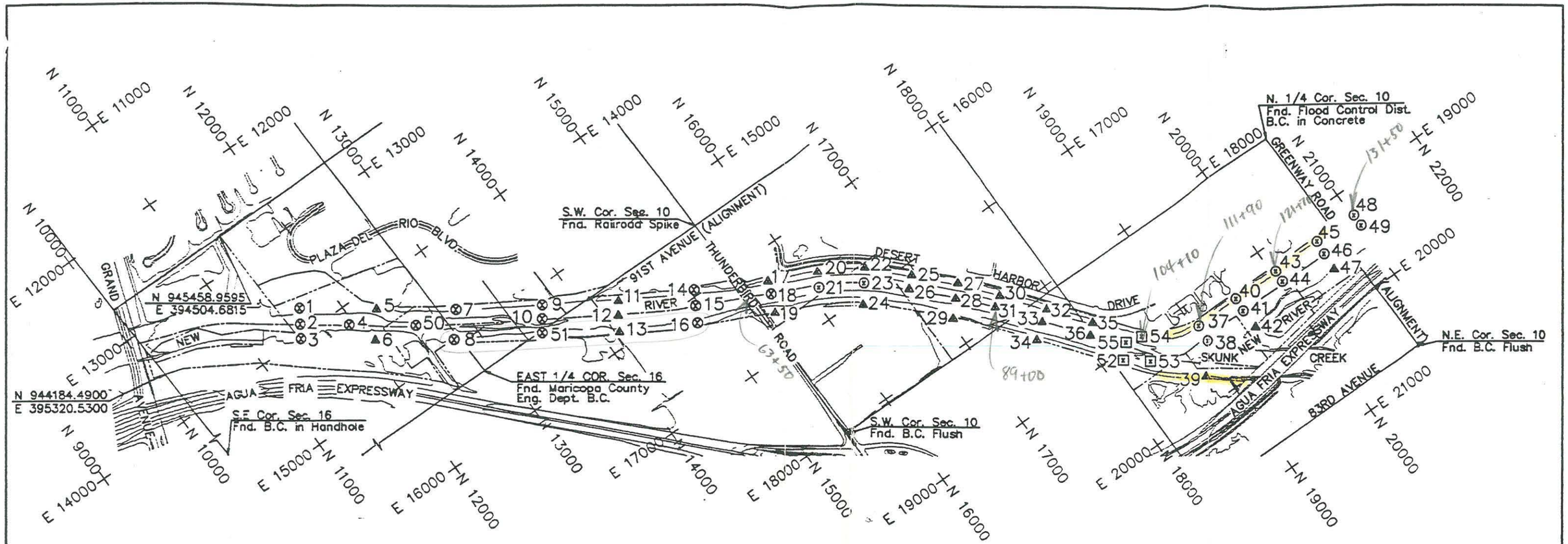


PROJECT NO. 93-0472



GENERAL NOTES

1. Location And Elevations of The Explorations Are Approximate.
2. All Test Pits Were Excavated in May 1993. See Test Pit Log For Day.
3. Test Pits 1 Thru 51 Were Excavated By A Backhoe With 24" Wide Bucket.
4. Test Pits 52 Thru 55 Were Excavated By A Link-Belt Trackhoe.
5. Percentages of Plus 3" Material Shown on Test Pit Logs Were Visually Estimated.
6. No Free Ground Water Was Excavated in Any of The Test Pits During Execavation Except Test Pits 4,5, And 50 as Shown on Test Logs.

SCALE: 1 IN. = 1000 FT.

1000 0 1000 2000

MAP LEGEND

ⓧ 2	Location And Number of Test Pit – 5' Deep
△ 5	Location And Number of Test Pit – 10' Deep
[x] 53	Location And Number of Test Pit – 25' Deep

WOOD, PATEL & ASSOC., INC.
1550 EAST MISSOURI SUITE 203
PHOENIX, ARIZONA (602)234-1344

FOUNDATION INVESTIGATION TEST PIT LOCATION MAP

DATE	SCALE	SHEET
NOV., 1993	1"=1000'	1 OF 1
JOB NO.	DESIGN JGT	CHECK ACP
91755.02	DRAWN VF	FILE -

N:\931009\TSTPIT17.DWG

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Kenneth D. Walsh, P.E.

Wood, Patel & Associates
1550 East Missouri, Suite 203
Phoenix, Arizona 85014

15 November 1993

Attention: Ash Patel

Subject: Report for Geotechnical Engineering Services
New River Channelization
Grand Avenue to Greenway Road
Peoria County, Arizona

Project No. 93-0472
Addendum No. 1

At your request this firm has reviewed the subject geotechnical report with respect to review comments from the Flood Control District of Maricopa County as presented in your letter dated October 29, 1993 and your FAX dated November 11, 1993.

1. Drop Structure: A sample specification for the roller compaction concrete is attached. The material must be placed in horizontal lifts. The width or thickness of the sloping side walls of the structure were not given on the plan. This should be added and should be wide enough to accommodate horizontal placement and compaction of the concrete. The following equivalent fluid active and passive pressure may be used in design.

   Lateral active pressure:
   - Granular ..... 32 psf/ft.
   - Granular soils (submerged) ..... 78 psf/ft.
   - Clays and silts ..... 40 psf/ft.
   - Clays and silts (submerged) ..... 82 psf/ft.

   Lateral passive pressure:
   - Granular ..... 300 psf/ft.
   - Granular (submerged) ..... 212 psf/ft.
   - Clay and silt ..... 180 psf/ft.
   - Clay and silt (submerged) ..... 152 psf/ft.

   Submerged pressure includes hydrostatic pressure.

2. Fill Material: Materials obtained from channel excavations which are free of organic matter, debris, rubble and material 8 inches or larger in size may be used as fill in the bank areas.

3. Soil Cement: All granular soils encountered in the excavations and channel areas which are free of organic matter, rubble, debris and material greater than 3 inches in size may be used in soil cement. The sandy clay and sandy silt soils should not be used in soil cement.

4. Riprap Material: A majority of the material encountered in our field explorations is less than 8 inches in size. Therefore little or no riprap material will be generated by screening site soils. A limited amount of 4-to 8-inch material is available for use in filling gabions.

5. Landfill Areas: Other than the areas described in our original report, we have no further information on the location, extent or limits of landfills along the channel improvements. Groundwater table along the stream channel will be dependent upon the length of time since the last flow in the river channel has occurred and the duration of that flow and could influence construction. In addition, localized perched water conditions may exist along the top of the sandy clay and sandy silt deposits which occur on the channel and which take longer to disapate.

This addendum shall be attached to the original report and shall become a part thereof. Please call if you have any questions or if we may be of further service.

Respectfully submitted,

THOMAS-HARTIG & ASSOCIATES, INC.

By: Registered Professional Engineer (Civil) CERTIFICATE NO. 10971 KENNETH L. RICKER Date Signed 11-16-93 ARIZONA, U.S.A.

Reviewed by: Registered Professional Engineer (Civil) CERTIFICATE NO. 7354 JOHN P. BOYD Date Signed 11-16-93 ARIZONA, U.S.A.

/cm
Copies to: Addressee (5)

PART I - REPORT

SCOPE

The proposed New River Channelization will extend from 1000 feet north of Grand Avenue to the alignment of Greenway Road along the New River in Peoria, Arizona. The improvements will include:

1. The construction of approximately 12,500 linear feet of bank protection on each side of the river and along a short section of Skunk Creek.

2. Establishing a new flow line for the river.

3. A drop structure approximately 800 feet south of the confluence of the New River and Skunk Creek.

PURPOSE

The purpose of these geotechnical services is to provide subsurface information, laboratory test data and geotechnical engineering information with respect to:

1. How site conditions, such as the location of landfills, in the channelization area which are identified during the field exploration will effect the proposed improvements.

2. Foundation recommendations for the drop structures.

3. Site preparation and fill placement criteria for bank protection and the drop structure.

4. Recommendation for cement treated materials.

5. Analysis and recommendations for temporary and permanent cut and fill slopes.

SITE DESCRIPTION AND SITE HISTORY

The proposed improvements are within the existing channel of the New River and extend from 1000 feet north of Grand Avenue to the alignment of Greenway Road in Peoria, Arizona. For purposes of this report, the centerline of Grand Avenue is assumed to be Sta. 0+00 of the centerline of the New River Channel. Stationing increases upstream along the channel. At the time of our field explorations the limits of the channel were fairly well defined but these limits are constantly being changed by filling along the banks.

The following landfill areas were observed during our field work:

1. Sta. 40+00 to 47+00 the upper 1/3 of the left bank contains loose fill.

2. Sta. 79+00 to 88+00 the area at the top and behind the right bank contains buried and dumped debris, rubble and trash.

3. Sta. 105+00 and extending for a distance of 800 to 900 feet behind the crest of the right bank contains a garbage and debris landfill.

Other areas of the banks and channel have been cut and filled over the years as the area was being developed. As the result of recent rain, numerous areas of ponded water existed in the channel bottom. For the most part, the remainder of the channel is very sparsely to moderately vegetated with weeds and brush and also contain sand bars, gravel bars and near Sta. 96+00 a hard clay layer. The channel bottom was very irregular with numerous depressions and local rises.

INVESTIGATION

Test pits were excavated with a Case 580 rubber tire backhoe using a 24-inch wide bucket at 51 locations along the alignment. An additional 4 test pits (Test Pits 52 to 55) were excavated by a Link-belt 4300 track hoe in the drop structure area. The stations and off-sets of the field explorations are listed in Appendix A. During the field explorations the soils encountered were visually classified, the amount of plus 3-inch material estimated and representative samples of the minus 3 inch material obtained at selected depths. At two locations (Test Pits 20 and 22) the amount of plus 3-inch material was measured in the field. The

results of the field explorations are presented on Appendix A "Field Results". An estimate of the amount of plus 3 inch material observed at each field exploration location is presented on the boring logs.

Representative samples obtained during the field exploration were subjected to the following laboratory analyses:

Test	Sample(s)	Purpose
Sieve Analyses & Plasticity Index	Representative (60)	Classification and aggregate evaluation

The results of the laboratory testing are presented in Appendix B.

SOIL CONDITIONS

The soil profile encountered at the field exploration locations was somewhat variable. Detailed descriptions of the materials encountered are presented on the test pit logs in Appendix A. The soils for the most part were granular deposits containing various amounts and combinations of sand, gravel, cobbles and lesser amounts of silt and clay. However, in the channel bottom starting in Test Pit 21 and going upstream to Test Pit 39, a hard sandy clay deposit which graded in some areas to a very dense clayey sand and a stiff sand silt was encountered at various locations and depths below existing channel grades. This deposit was also observed in some of the four deep test pits excavated at the drop structures.

Groundwater in and adjacent to the river channel will vary considerably with location, releases from the upstream dam and discharges from local runoff from the ACDC and drainage facilities at and upstream from the improvements. Groundwater or perched water conditions resulting from ponded water was encountered in Test Pits 4, 5 and 50 at depths ranging from 1.5 to 8.5 feet below existing grade at the time of our field exploration. No groundwater was encountered in the remainder of the field explorations accomplished for this project.

DISCUSSION AND RECOMMENDATIONS

General: Geotechnical engineering recommendations for development of the channel, bank protection, and drop structure for the proposed New River improvements are presented in the following sections. These recommendations are based upon the results of the field and laboratory testing which are presented in Appendicies A and B of this report.

Channel Development: In order to provide permanent channelization and bank protection of the New River area, approximately 12,500 linear feet of bank protection will be developed on each side of the channel. The channel section heights will vary along different reaches of the channel improvements.

The channel bottom and slopes will be constructed with materials obtained from the channel improvement area. We recommend that the channel bottom and slope fills be constructed with the sand and gravel soils which contain no to some silty and clayey fines.

Slope stability analysis of the proposed 1.5H:1V slope configurations were performed. The following parameters were used in the evaluation.

1. Embankment fill and native alluvium
   ϕ = 41 degrees
   C = o psf
   In-place density = 135 pcf
   Submerged = 72 pcf
2. Materials at submerged conditions
3. Rapid draw-down

This embankment configuration has resulted in calculated factors of safety for the various conditions and configuration in the range of 1.4 to 4.3. The analyses was conservative in that the strength of bank protection was ignored. Therefore, it is our opinion that embankments may be satisfactorily constructed.

Bank Construction: The proposed channel development will include the construction of various heights and widths of fills. Foundation preparation in the fill area should include, as a minimum, the complete removal of all sandy silty, sand and silt sand, soils and debris and rubble laden materials. Any landfill

which encroaches on the channel improvements should be removed from below the improvement area. After removal of the various materials, the foundation area should be scarified to a minimum depth of 8 inches, compacted and the fill material placed and compacted in horizontal lifts. Scarified soil and fill materials should be compacted to at least 98 percent of the maximum dry density as determined by ASTM D698 at a moisture content in the range of 3 percent below to 3 percent above optimum.

Cement Stabilized Alluvium: Erosion bank protection along the proposed channel may include either rip-rap placed on 3 to 1 (H to V) slopes and cement stabilized alluvium placed on a 1.5 to 1 (H to V) slope. The cement stabilized alluvium should be at least 8 feet wide (horizontally) and extend below existing grade down to the channel thalweg. Depending on groundwater conditions at the time of construction, dewatering of this bank protection excavation area may be required. The design of the dewatering system should be accomplished by the contractor and approved by the project designer. During the design of the dewatering system, the effect of seepage on slope stability should be considered.

In general, the cement stabilized alluvium will consist of the clean sand, gravel and cobble deposits which are non-plastic and have been processed to the following requirements.

Sieve Size	Percent Passing
3"	100
#4	40 - 60
#200	0 - 8

The aggregate should be blended with 10 to 12 percent (estimated) cement/fly ash and water in a mixing plant and transported to the construction area. The mixture shall have minimum 7 day compressive strength of 500 psi. The material should be uniformly spread so that compacted horizontal lift thickness does not exceed 9 inches. The materials should be compacted to at least 98 percent of the maximum dry density as determined by ASTM D698. All exposed portions of the compacted material should be kept moist for at least 7 days. Compaction of the cement stabilized alluvium should be completed within one

hour after the water is added to the mix. The surface of the compacted materials which has not been worked for more than two hours should be scarified to a depth of 1 inch, and the loose material removed prior to placing additional materials.

Drop Structure: The drop structures will lower the channel grade approximately 14 feet and will consist of a soil cement or cement stabilized alluvium.

In order to provide uniform support of the drop structure, we recommend that foundation preparation below the entire structure include:

1. The complete removal of the loose recent alluvium, estimated to be 5 to 12 feet thick, and any fills, debris or landfill materials.

2. All areas which have been over-excavated and which require the placement of fill should be scarified to a minimum depth of 8 inches and compacted.

3. All fill materials required below the structure should be placed in horizontal lifts, moisture conditioned to a uniform moisture content in the range of 3 percent below to 3 percent above optimum and compacted to at least 98 percent of the maximum dry density as determined in accordance with ASTM D698.

4. Granular soils obtained during excavation of the drop structure or from other parts of the channelization project may be used as fill materials provided these materials are free of organic matter, debris, rubble and garbage.

Excavation Conditions: The field exploration and sampling at the site was performed for design purposes. It is not possible to accurately correlate results of the various methods of field explorations with the ease or difficulty of digging for various types and sizes of excavation equipment. We present the following general comments regarding excavatability for the designer's information with the understanding that they are approximations based only on field exploration data. More accurate information regarding excavatability should be evaluated

by contractors or other interested parties from test excavations using the intended equipment.

Excavations into the site soils should be possible with conventional excavating equipment. Due to the granular nature of these soils, the presence of relatively clean sand layers, possible shallow groundwater and the presence of cobble sized material, excavations may be slow and difficult to accomplish. Excavations into the underlying, hard sandy clay layer may be difficult and may require the assistance of specialized heavy duty equipment.

Temporary Construction Slopes: Temporary slopes required for the construction of various aspects of the project will be dependent on the materials encountered, groundwater conditions, seepage conditions and the location, type, extent and weight of surcharge loads. In general, the following temporary slopes may be used in design but flatter or steeper slopes may be accomplished or required in the field as dictated by specific conditions.

Material	*Temporary Slope Configuration (Horizontal to Vertical)
Sand, gravel & cobbles	1 to 1
Sand, silty sand, sandy silt	1.5 to 1
Sandy Clay	0.5 to 1

*These slopes are for soils at relatively low water contents not subjected to seepage forces or submerged. Flatter slopes will be required for these conditions.

APPENDIX A

FIELD RESULTS

APPENDIX V

GEOTECHNICAL REPORT

Test Pit Locations

Sta. 0+00 =℄ of Grand Avenue on ℄ of New River Channel (All Test Pit elevations interpolated from topo shown on plan).

Test Pits 1 to 51 excavated with a Case 580 rubber tire backhoe. Test Pits 52 to 55 excavated with a Link Belt 4300 track hoe.

Test Pit No.	Location
1	Sta. 17+50 L 160'
2	Sta. 17+50 ℄
3	Sta. 17+50 R 150'
4	Sta. 21+20 ℄
5	Sta. 25+50 L 160'
6	Sta. 25+50 R 160'
7	Sta. 33+70 L 140'
8	Sta. 33+40 R 170'
9	Sta. 42+50 L 140'
10	Sta. 42+50 ℄
11	Sta. 50+00 L 150'
12	Sta. 50+-00 ℄
13	Sta. 50+00 R 180'
14	Sta. 58+00 L 160'
15	Sta. 58+00 ℄
16	Sta. 58+00 R 170'
C T-Bird	Sta. 63+50
17	Sta. 65+70 L 130'
18	Sta. 65+70 ℄
19	Sta. 65+70 R 150'
20	Sta. 70+80 L 160'
21	Sta. 70+80 ℄

Test Pit No.	Location
22	Sta. 75+50 L 160'
23	Sta. 75+50 ℄
24	Sta. 75+50 R 150'
25	Sta. 80+20 L 150'
26	Sta. 80+20 ℄
27	Sta. 85+00 L 160'
28	Sta. 85+00 ℄
29	Sta. 85+00 R 130'
30	Sta. 89+00 L 120'
31	Sta. 89+00 ℄
32	Sta. 94+10 L 140'
33	Sta. 94+10 ℄
34	Sta. 94+10 R 150'
35	Sta. 99+20 L 140'
36	Sta. 97+70 ℄
37	Sta. 111+90 L 140'
38	Sta. 111+90 R 40'
39	Sta. 108+60 R 240'
40	Sta. 116+80 L 150'
41	Sta. 116+80 ℄
42	Sta. 116+80 R 200'
43	Sta. 121+70 L 150'
44	Sta. 121+70 L 30'
45	Sta. 126+80 L 150'
46	Sta. 126+80 ℄
47	Sta. 126+80 R 180'
48	Sta. 131+50 L 150'
49	Sta. 131+50 L 20'
50	Sta. 31+40 ℄
51	Sta. 42+50 L 114'
52	Sta. 102+90 R 140'
53	Sta. 105+40 R 50'
54	Sta. 104+10 L 140'
55	Sta. 102+70 L 40'

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	

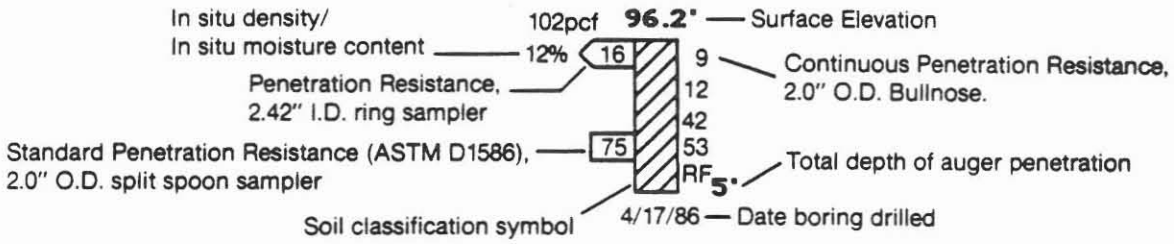
FINE-GRAINED SOIL

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. 93-0472

THOMAS-HARTIG & ASSOCIATES, INC.

LEGEND OF SOIL TYPES

FILL MATERIAL - SILTY SAND AND GRAVEL WITH COBBLES (SM/GM); brown; some debris; loose; slightly damp.

GRAVELLY SAND (SP/SW); light brown; some cobbles; medium dense; slightly damp.

GRAVELLY COBBLES (GP); brown; some sand; medium dense; slightly damp.

CLAYEY SANDY GRAVEL AND COBBLES (GC); reddish brown; medium dense; damp.

SILTY SAND AND GRAVEL WITH COBBLES (SM/GM); brown; loose; slightly damp.

SAND - SOME SILT AND GRAVEL (SP/SM); brown; occasional to some cobbles; medium dense; slightly damp to saturated.

SILTY GRAVELLY SAND (SM); light brown; some cobbles; loose; slightly damp.

SANDY GRAVEL AND COBBLES (GP); brown; loose; slightly damp.

GRAVELLY SAND (SP); brown; some to occasional cobbles; medium dense; damp.

SANDY GRAVEL WITH COBBLES (GP/GC); brown; some clay; medium dense; damp.

GRAVELLY SAND (SP/SC); reddish brown; some clay; medium dense; damp.

CLAYEY GRAVELLY SAND (SC); reddish brown; medium dense to dense; damp.

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.

LEGEND OF SOIL TYPES

GRAVELLY SAND WITH COBBLES (SP/SC); reddish brown; some clay; medium dense; damp.

CLAYEY GRAVELLY SAND WITH COBBLES (SC); reddish brown; medium dense; damp.

GRAVELLY SAND (SP); brown; loose; damp.

SANDY CLAY (CL); reddish brown; stiff to very hard; damp; medium plasticity; moderate to very heavy cementation.

SANDY SILT (MH); brown; stiff; damp; highly elastic.

SANDY GRAVEL (GP/GM); reddish brown; trace to some silt and cobbles; medium dense; damp.

SAND AND GRAVEL WITH COBBLES (GP/SC); reddish brown; some clay; medium dense; damp.

FILL MATERIAL - CLAYEY SANDY GRAVEL WITH COBBLES, CONCRETE DEBRIS, PLASTIC (GC); dark brown; loose; damp.

SANDY SILT (ML); brown; firm; slightly damp.

SILTY TO CLAYEY GRAVELLY SAND (SM/SC); brown; medium dense; damp.

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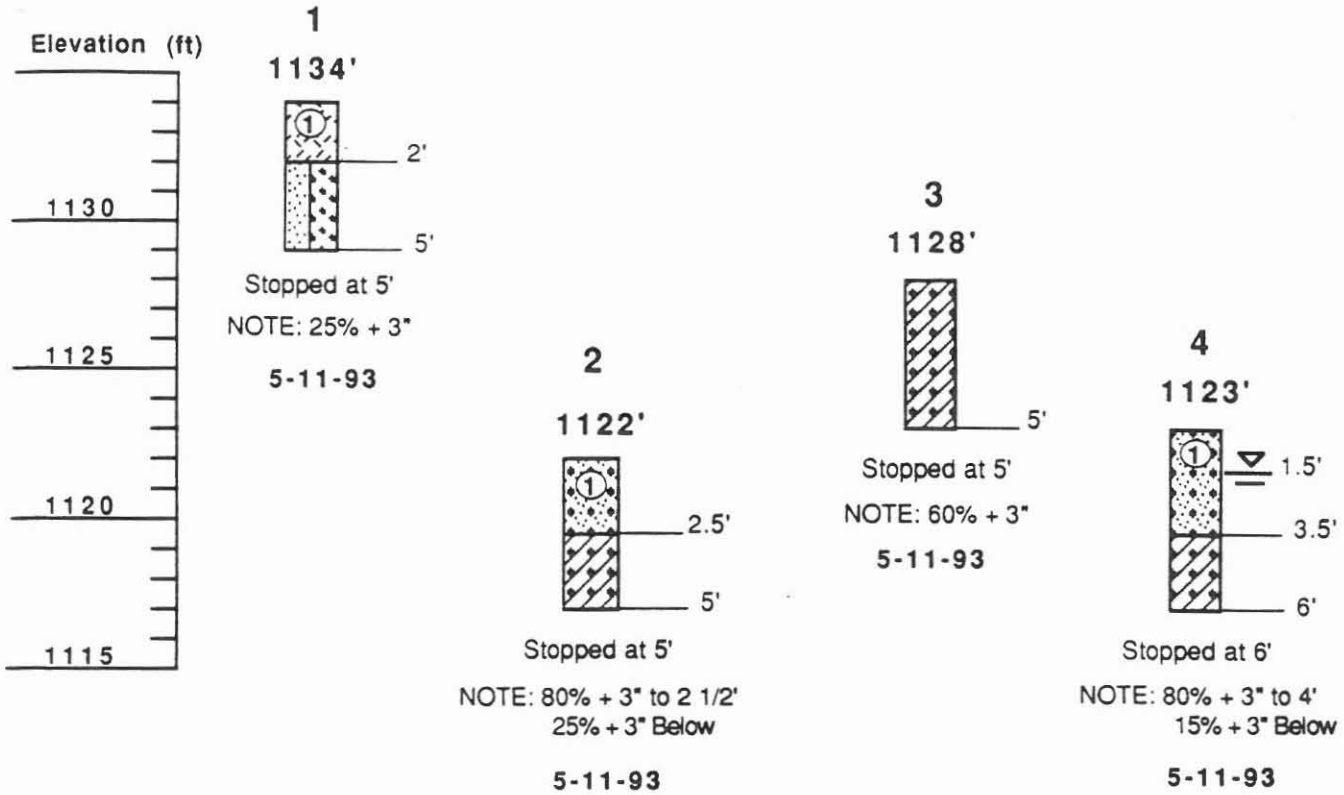
TEST PIT LOGS



No free groundwater was encountered in any of the test pits during excavation except Test Pit 4 as shown.

All test pits excavated with 24-inch wide bucket.

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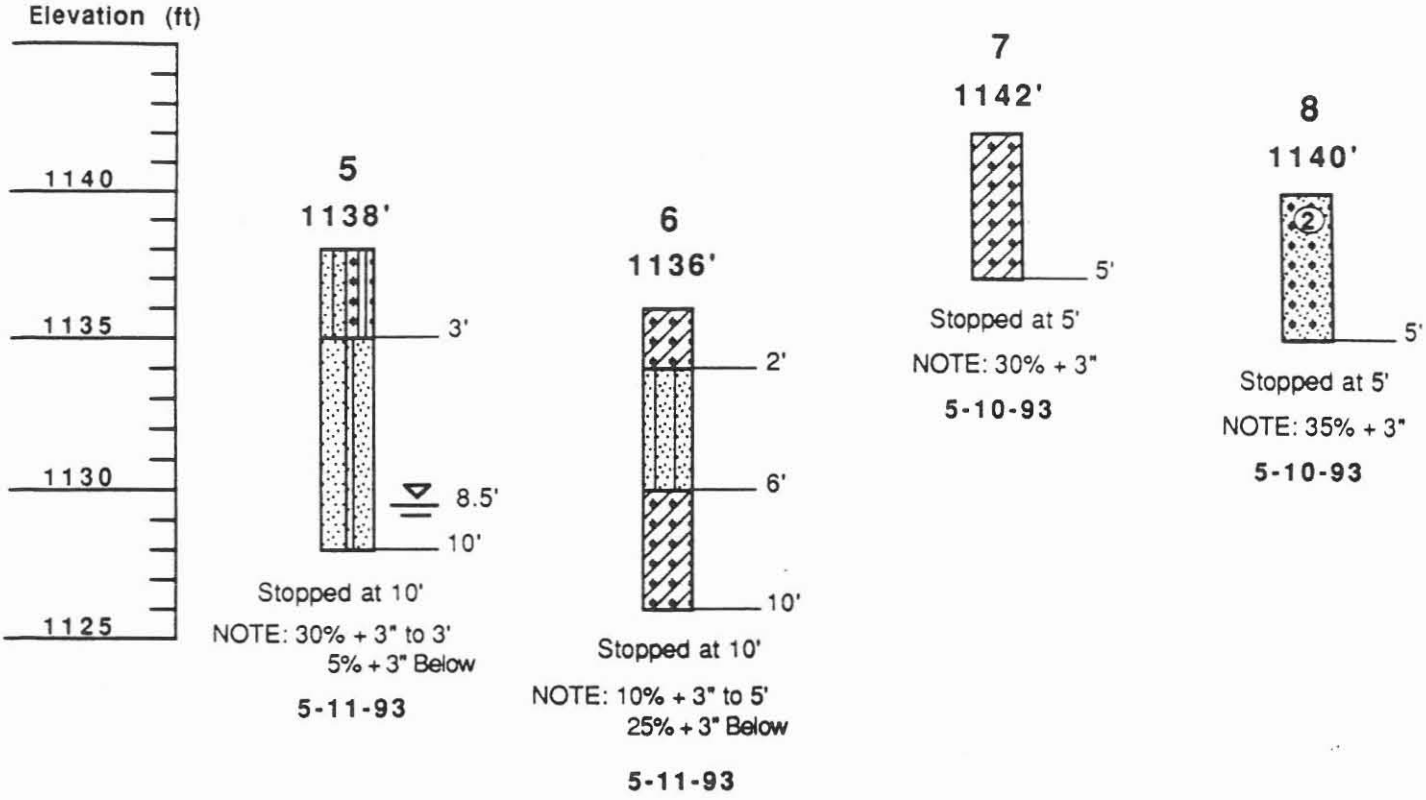
TEST PIT LOGS



No free groundwater was encountered in any of the test pits during excavation except Test Pit 5 as shown.

All test pits excavated with 24-inch wide bucket.

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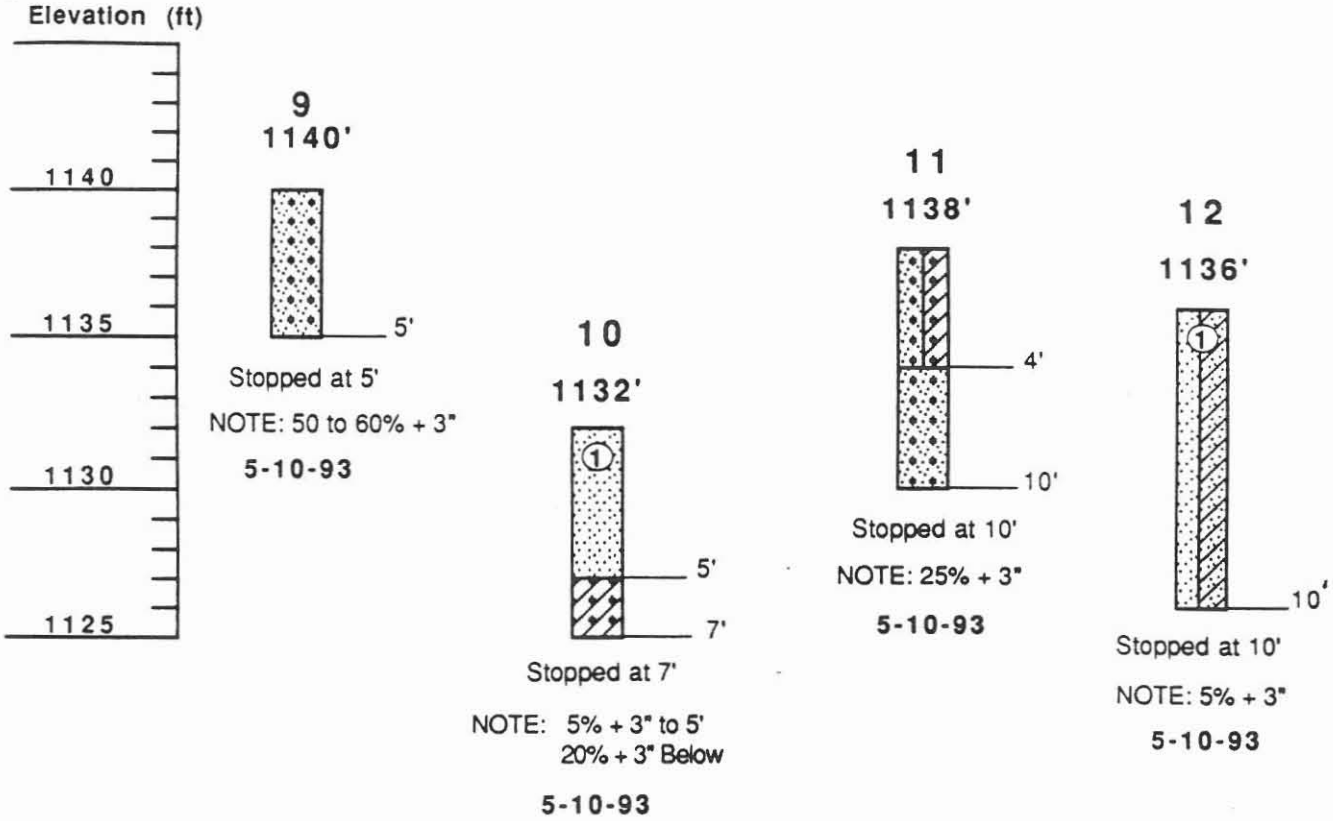
TEST PIT LOGS



No free groundwater was encountered in any of the test pits during excavation.

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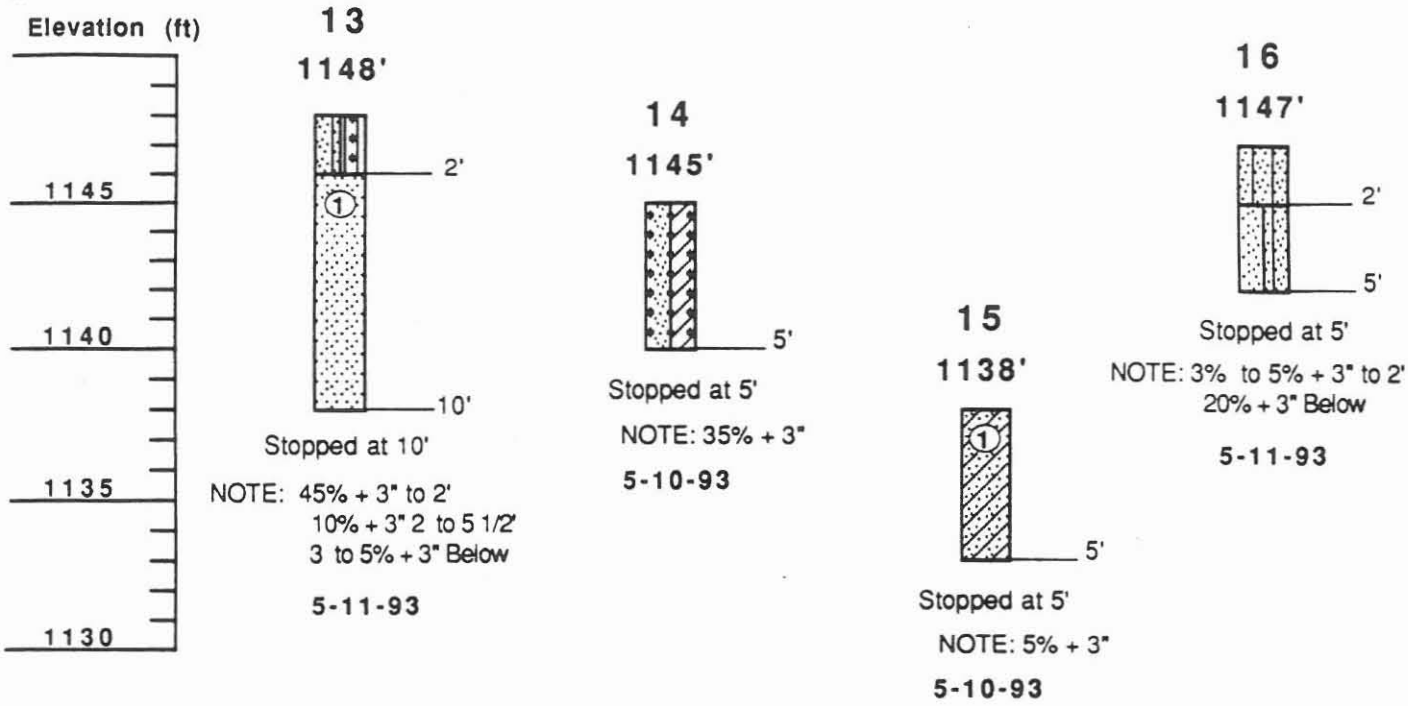
TEST PIT LOGS



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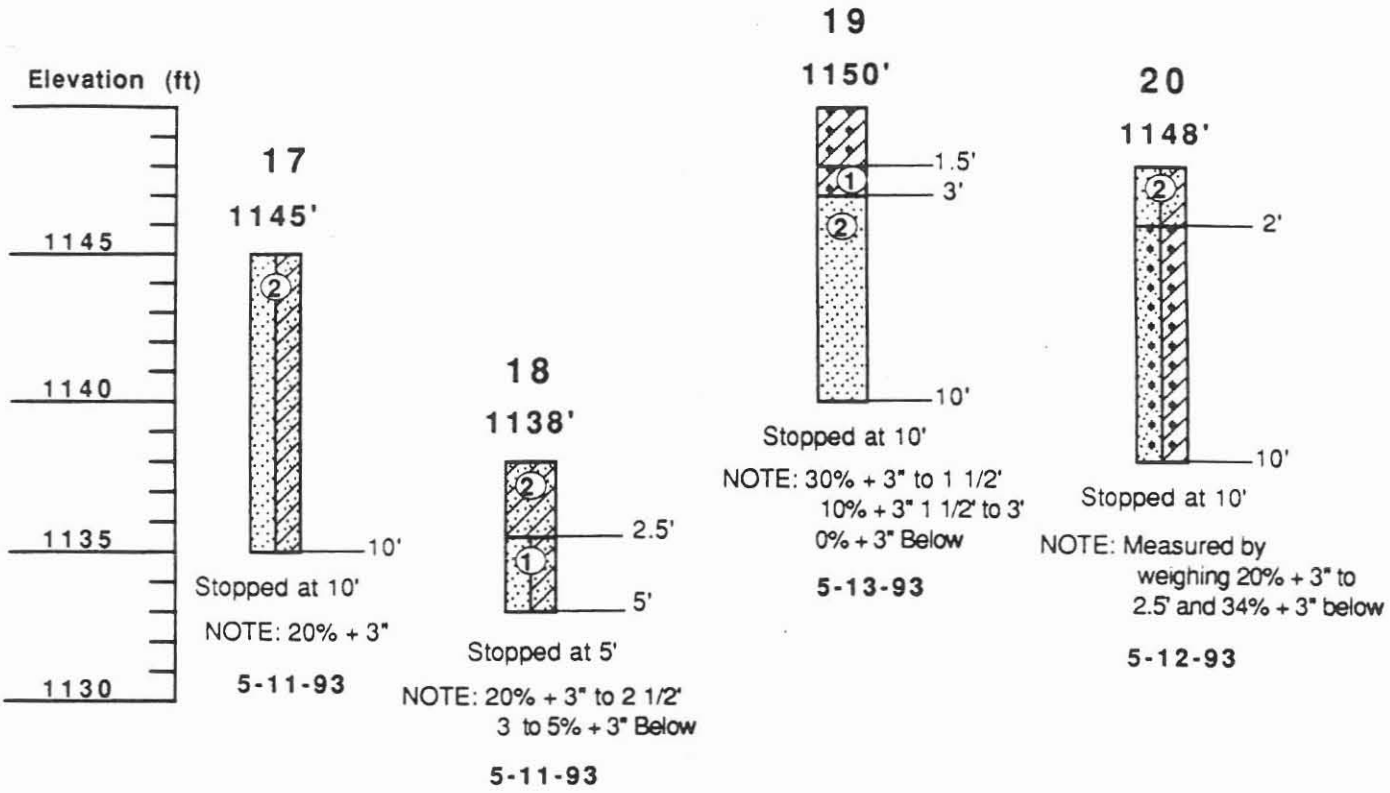
TEST PIT LOGS



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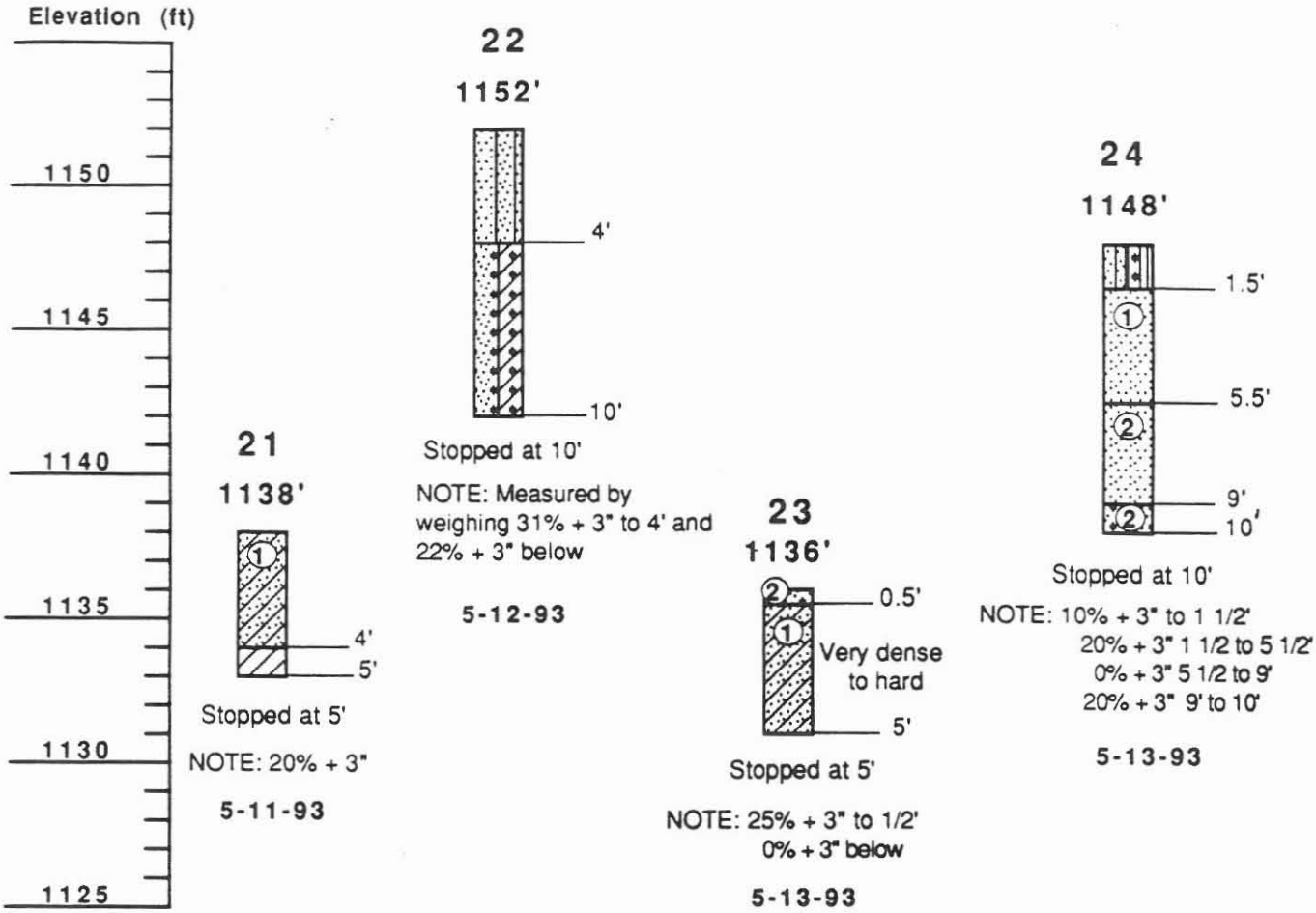
TEST PIT LOGS



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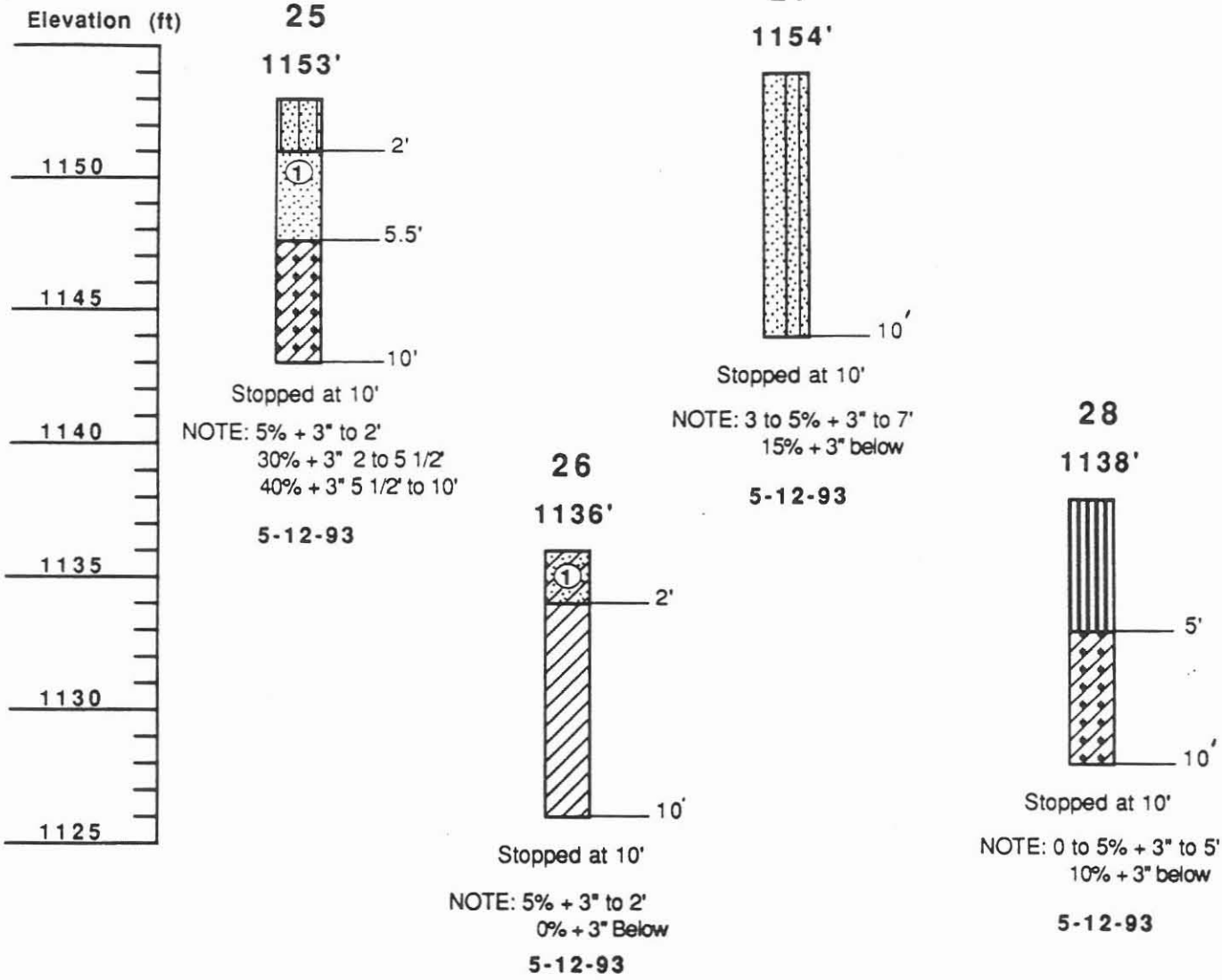

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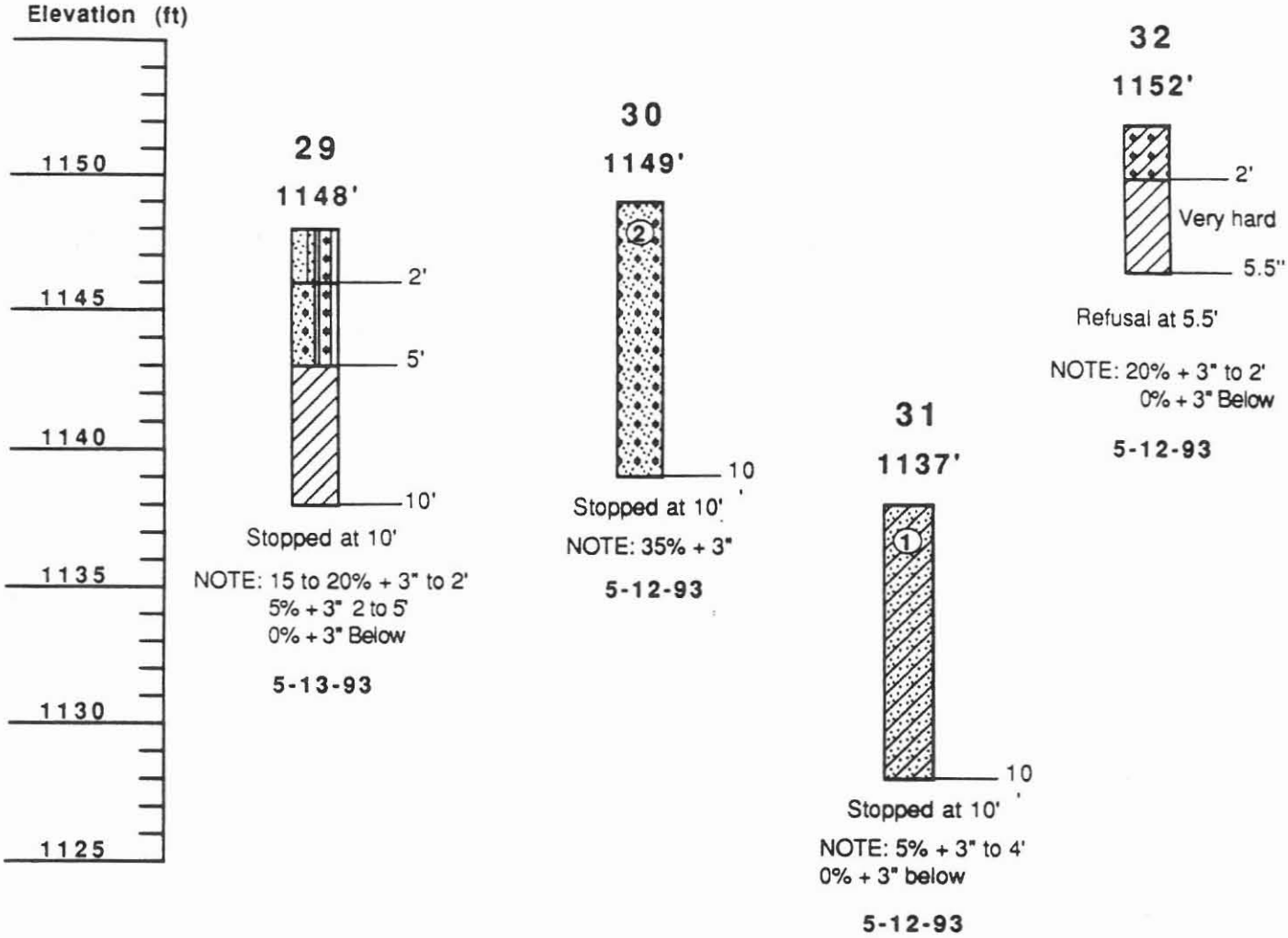

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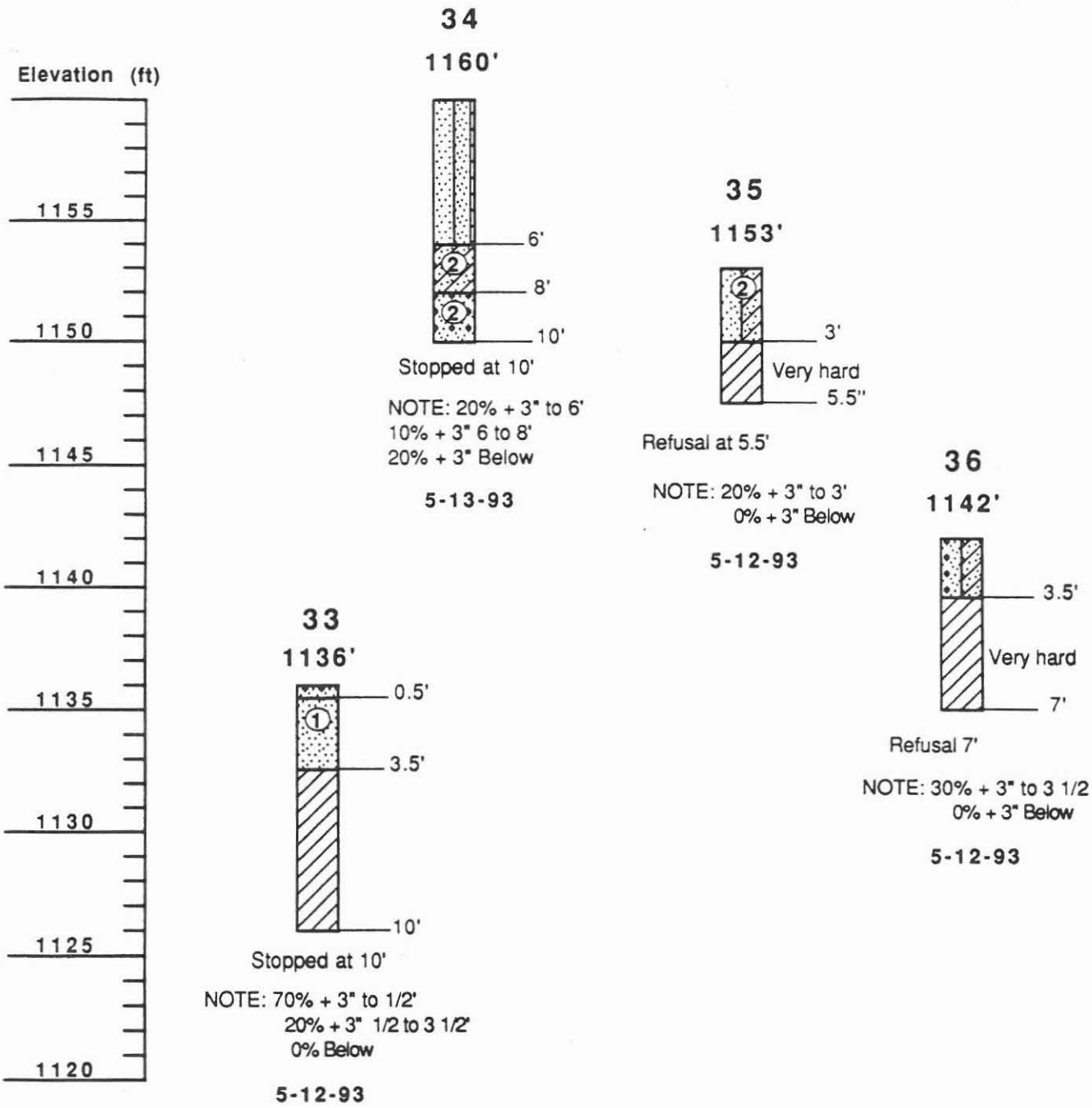

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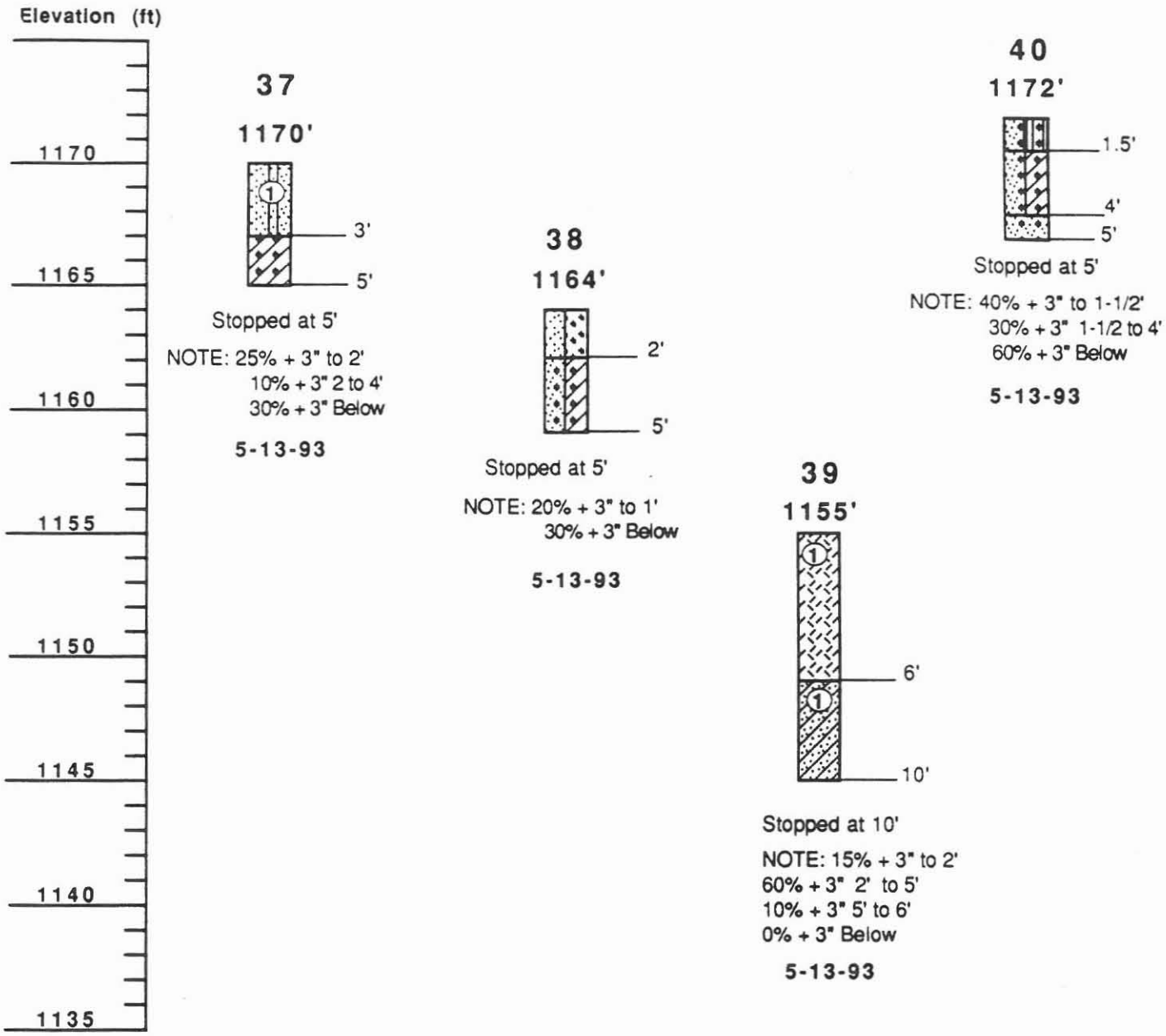

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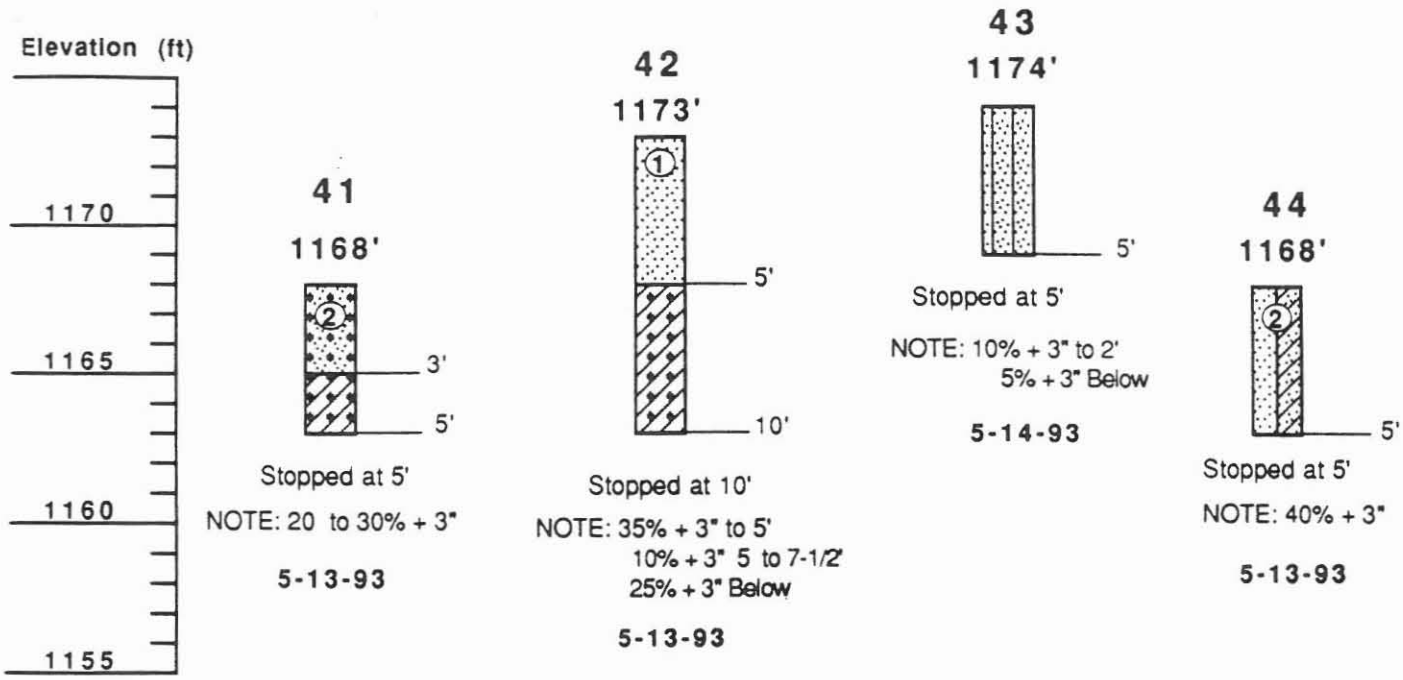
Project No. 93-0472
Thomas-Hartig & Associates

TEST PIT LOGS



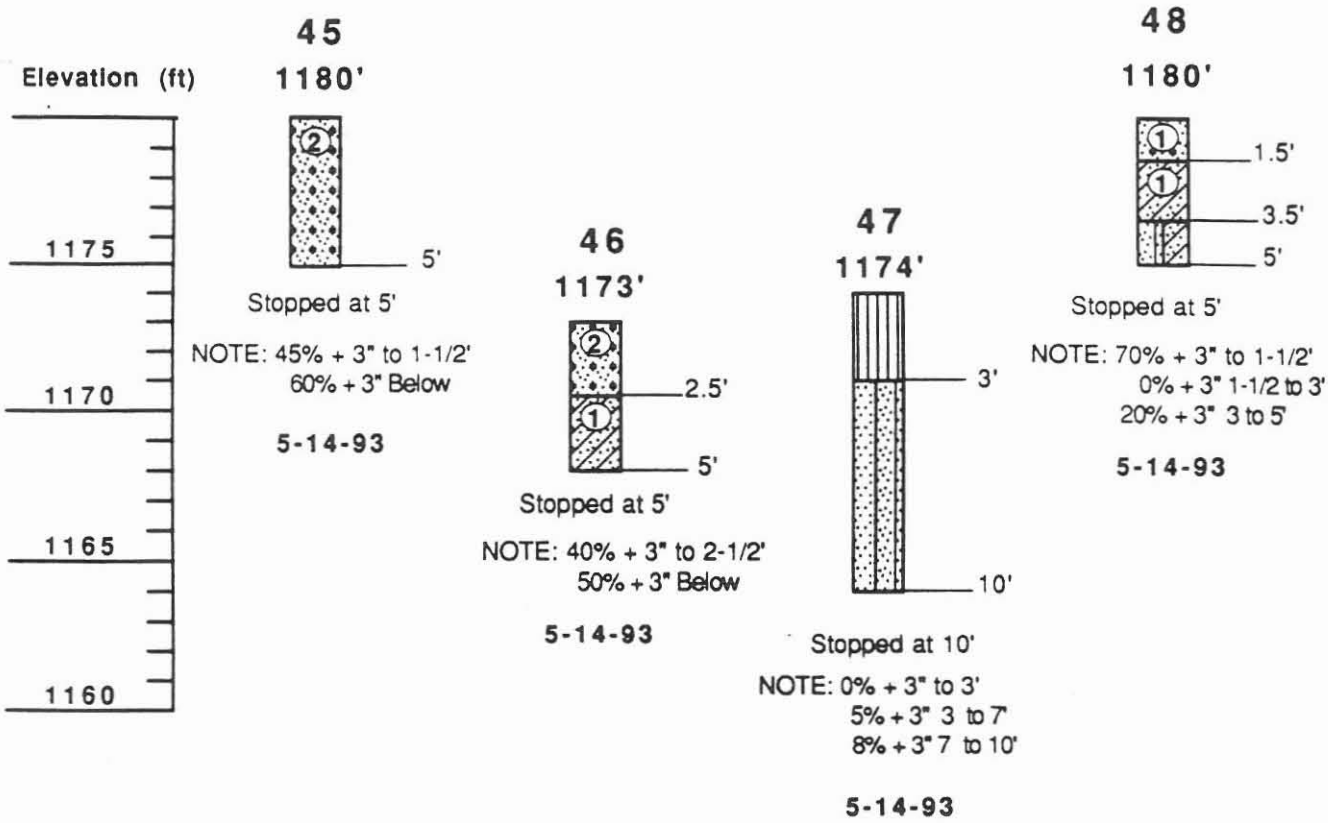
No free groundwater was encountered in any of the test pits during excavation.

All test pits excavated with 24-inch wide bucket.

NOTE: The data presented on the test pits 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 test pit 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 test pit.

Project No. 93-0472
Thomas-Hartig & Associates

TEST PIT LOGS

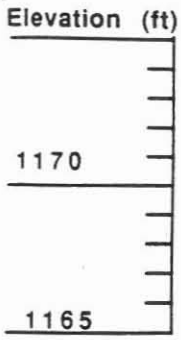


No free groundwater was encountered in any of the test pits during excavation.

All test pits excavated with 24-inch wide bucket.

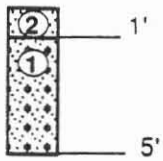
NOTE: The data presented on the test pits represents subsurface conditions only at the specific locations and at the time designated. This data may not represent conditions at other locations and/or times. Contacts between soil strata are approximate and changes between soil types may be gradual rather than abrupt. This test pit 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 test pit.

TEST PIT LOGS



49

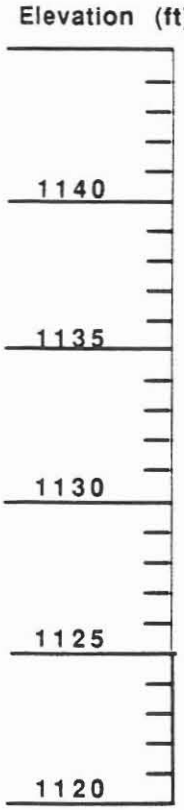
1173'



Stopped at 5'

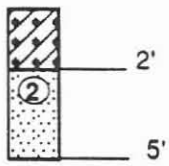
NOTE: 0% + 3" to 1'
50% + 3" Below

5-14-93



51

1142'



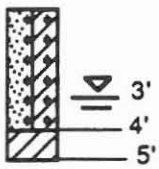
Stopped at 5'

NOTE: 25% + 3" to 2'
3-5% + 3" Below

5-11-93

50

1128'



Stopped at 5'

NOTE: 25% + 3" to 1'
3 to 5% + 3" Below

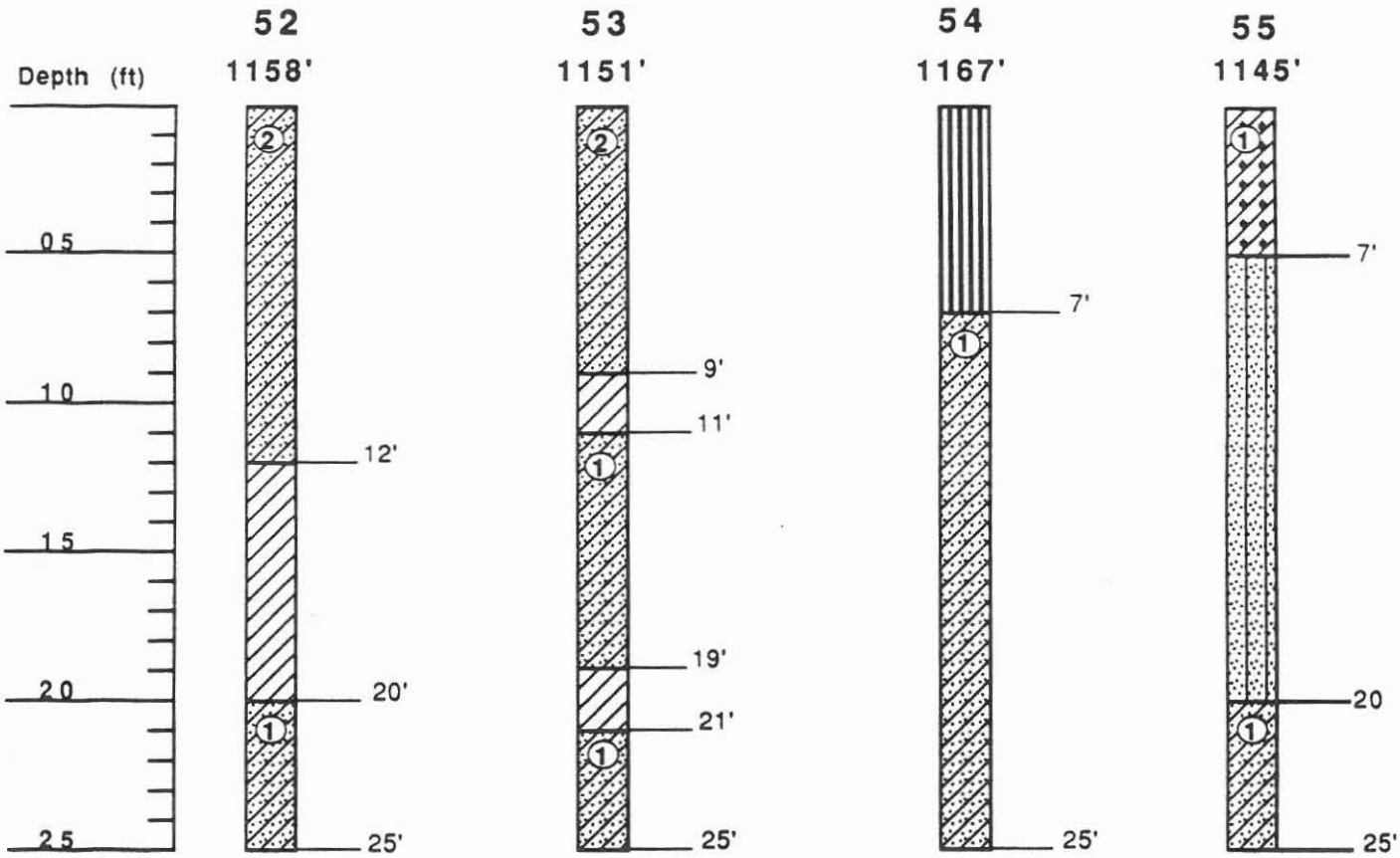
5-10-93

No free groundwater was encountered in any of the test pits during excavation, except Test Pit 50 as shown.

All test pits excavated with 24-inch wide bucket.

NOTE: The data presented on the test pits 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 test pit 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 test pit.

TEST BORING LOGS



52

Stopped at 25'

0% + 3" 12 to 20'
5% + 3" 20 to 25'

5-20-93

53

Stopped at 25'

NOTE: 15 to 20% + 3" to 9'
Less than 5% to 3" Below

5-20-93

54

Stopped at 25'

NOTE:0% + 3" to 7'
0% to 5% +3" Below

5-20-93

55

Stopped at 25'

NOTE: 10% + 3" to 5'
5 to 10% + 3" 5 to 25'
0 to 5" + 3" 20 to 25'

5-20-93

No free groundwater was encountered in any of the test pits during excavation.

All test pits excavated with 24-inch wide bucket.

NOTE: The data presented on the test pits 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 test pit 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 test pit.

APPENDIX B

LABORATORY RESULTS

REPORT ON SIEVE ANALYSIS AND PLASTICITY INDEX

SAMPLE: Date: 6-10-93

Source: Noted Below
Type: Grab Samples
Material: Subsoils
Sampled By: TH/Sercu

TESTED: Sieve Analysis and Plasticity Index

RESULTS

			Sieve Size -					Accumulative % Passing						*
Sample	LL	PI	200	100	50	30	16	8	4	3/4"	1"	2"	3"	Class.
1; 2 - 5'		NP	3	6	11	24	43	53	58	71	76	92	100	SP/SW
2; 0 - 2 1/2'		NP	2	2	3	8	18	26	31	46	51	75	100	GP
3; 0 - 3'	30	10	15	19	24	29	36	44	49	60	64	82	100	GC
4; 0 - 3'	No Samples Obtained For Testing													
5; 3 - 10'		NP	10	16	30	55	74	82	86	90	93	100		SP/SM
6; 3 - 6'		NP	17	25	33	46	58	66	69	80	84	95	100	SM
7; 0 - 5'	30	13	5	6	7	13	22	30	35	50	57	77	100	GC
8; 0 - 5'		NP	2	4	5	10	20	30	38	57	63	85	100	GP
9; 0 - 5'		NP	3	4	6	14	24	33	38	55	62	83	**99	GP
10; 0 - 5'		NP	2	3	5	17	37	50	58	74	79	91	100	SP
11; 0 - 4'	36	17	9	11	15	25	38	47	52	68	74	89	100	GP/GC
12; 1 - 10'	54	26	6	9	15	28	43	51	56	70	75	85	**98	SP/SC
13; 5 1/2 - 10'		NP	3	4	8	25	50	64	71	83	87	98	100	SP
14; 0 - 5'	28	9	6	8	11	17	26	35	43	59	65	84	100	GP/GC
15; 1 - 5'	54	29	12	15	19	37	59	69	73	84	88	91	**97	SC
16; 2 - 5'		NP	6	9	17	34	53	59	62	71	74	86	**98	SP/SM
17; 0 - 10'	40	22	7	8	12	26	47	53	58	68	74	88	100	SP/SC

NP = Non-Plastic

*Unified Soil Classification

**100% Passing 6" Sieve

Project No. 93-0472

Thomas-Hartig & Associates, Inc.

REPORT ON SIEVE ANALYSIS AND PLASTICITY INDEX

SAMPLE: Date: 6-10-93

Source: Noted Below
Type: Grab Samples
Material: Subsoils
Sampled By: TH/Sercu

TESTED: Sieve Analysis and Plasticity Index

RESULTS

			Sieve Size - Accumulative % Passing											*
Sample	LL	PI	200	100	50	30	16	8	4	3/4"	1"	2"	3"	Class.
18; 0 - 2 1/2'	34	14	12	15	21	33	49	58	64	78	83	94	100	SC
19; 3 - 10'		NP	2	4	10	36	64	76	80	89	92	100		SP
20; 0 - 2 1/2'	30	8	9	12	17	31	50	61	66	78	82	98	100	SP/SC
20; 2 1/2 - 10'	81	37	9	11	15	22	32	40	45	64	71	89	100	GP/GC
21; 0 - 4'	46	20	24	29	36	49	64	74	81	87	91	100		SC
22; 0 - 4'		NP	7	10	13	22	37	52	62	74	80	94	100	SP/SM
22; 4 - 10'	41	20	7	9	13	24	37	47	53	70	75	90	100	GP/GC
23; 1/2 - 5'	32	10	37	44	55	68	77	83	87	92	92	100		SC
24; 2 - 6'		NP	2	4	8	21	42	49	52	64	69	85	100	SP
25; 2 - 5 1/2'		NP	2	3	5	15	34	47	53	66	72	87	**95	SP
26; 0 - 2'	47	15	23	29	36	48	62	75	85	97	97	100		SC
27; 0 - 7'		NP	5	12	30	51	71	82	86	92	95	100		SP/SM
28; 0 - 4 1/2'	53	18	75	82	89	94	98	95	99	100				MH
29; 2 1/2 - 5 1/2'	62	29	5	8	10	18	29	35	39	51	57	83	100	GP/GM
30; 0 - 10'		NP	4	6	12	24	34	40	44	57	62	80	100	GP
31; 0 - 4'	41	23	15	18	23	33	45	57	67	86	91	100		SC
32; 2.5 - 5.5'	42	23	55	62	69	77	84	88	89	95	98	100		CL

NP = Non-Plastic

*Unified Soil Classification

**100% Passing 6" Sieve

Project No. 93-0-472

REPORT ON SIEVE ANALYSIS AND PLASTICITY INDEX

SAMPLE: Date: 6-10-93

Source: Noted Below
Type: Grab Samples
Material: Subsoils
Sampled By: TH/Sercu

TESTED: Sieve Analysis and Plasticity Index

RESULTS

			Sieve Size - Accumulative % Passing											*
Sample	LL	PI	200	100	50	30	16	8	4	3/4"	1"	2"	3"	Class.
33; 0 - 3 1/2'	35	12	3	5	7	19	38	51	59	81	86	97	100	SP
34; 0 - 6 1/2'		NP	6	9	12	21	33	47	59	76	80	91	100	SP/SM
35; 0 - 3 1/2'	34	16	7	8	12	27	47	57	63	77	81	90	100	SP/SC
36; 0 - 4'	35	8	6	8	11	22	36	46	53	69	79	89	100	GP/SC
37; 1 1/2 - 4'		NP	7	10	19	36	56	67	71	82	87	94	100	SP/SM
38; 1 - 5'	69	37	11	13	16	20	31	44	52	73	82	95	100	GP/GC
39; 6 - 10'	48	24	13	19	27	38	59	73	81	93	96	100		SC
40; 2 - 4 1/2'	60	31	7	8	11	17	27	36	41	57	64	79	100	GP/GC
41; 0 - 3'		NP	3	4	6	13	26	38	46	70	76	98	100	GP
42; 2 - 5 1/2'		NP	3	5	10	28	53	64	68	78	80	95	100	SP
43; 0 - 5'		NP	28	38	50	63	75	81	83	87	88	100		SM
44; 0 - 5'	30	11	5	5	8	18	31	41	46	57	62	88	100	SP/SC
45; 1 1/2 - 5'		NP	2	3	5	12	24	32	37	55	64	85	**96	GP
46; 0 - 3'	30	11	4	5	7	13	21	28	33	50	57	82	100	GP
47; 0 - 3'		NP	62	79	88	94	97	99	99	100				ML
48; 3 1/2 - 5'	27	6	37	46	52	59	66	69	72	77	82	96	100	SM/SC
49; 1 - 5'		NP	2	3	4	9	17	24	30	47	55	75	**90	GP

NP = Non-Plastic

*Unified Soil Classification

**100% Passing 6" Sieve

REPORT ON SIEVE ANALYSIS AND PLASTICITY INDEX

SAMPLE: Date: 6-10-93

Source: Noted Below

Type: Grab Samples

Material: Subsoils

Sampled By: TH/Sercu

TESTED: Sieve Analysis and Plasticity Index

RESULTS

			Sieve Size -					Accumulative % Passing						*
Sample	LL	PI	200	100	50	30	16	8	4	3/4"	1"	2"	3"	Class.
50; 1 - 5'	59	30	9	11	13	18	29	38	45	60	68	87	100	GP/GC
51; 2 - 5'		NP	3	4	9	27	50	62	67	80	85	98	100	SP
52; 0 - 12'	39	26	13	16	21	28	41	54	62	75	78	95	100	SC
52; 12 - 20'	40	17	32	39	54	72	80	84	86	91	91	100		SC
53; 0 - 9'	62	28	15	19	24	34	47	58	66	84	85	93	100	SM
53; 9 - 12'	50	21	13	17	23	34	45	55	62	81	85	94	100	SM
54; 0 - 7'	66	25	55	66	76	86	94	98	99	100				MH
54; 8 - 16'	41	14	11	13	20	33	47	54	58	70	74	81	**90	SP./SC
55; 0 - 5'	63	36	13	16	20	26	41	51	56	74	81	98	100	GC
55; 5 - 20'		NP	24	32	42	59	73	83	89	97	100			SM

NP = Non-Plastic

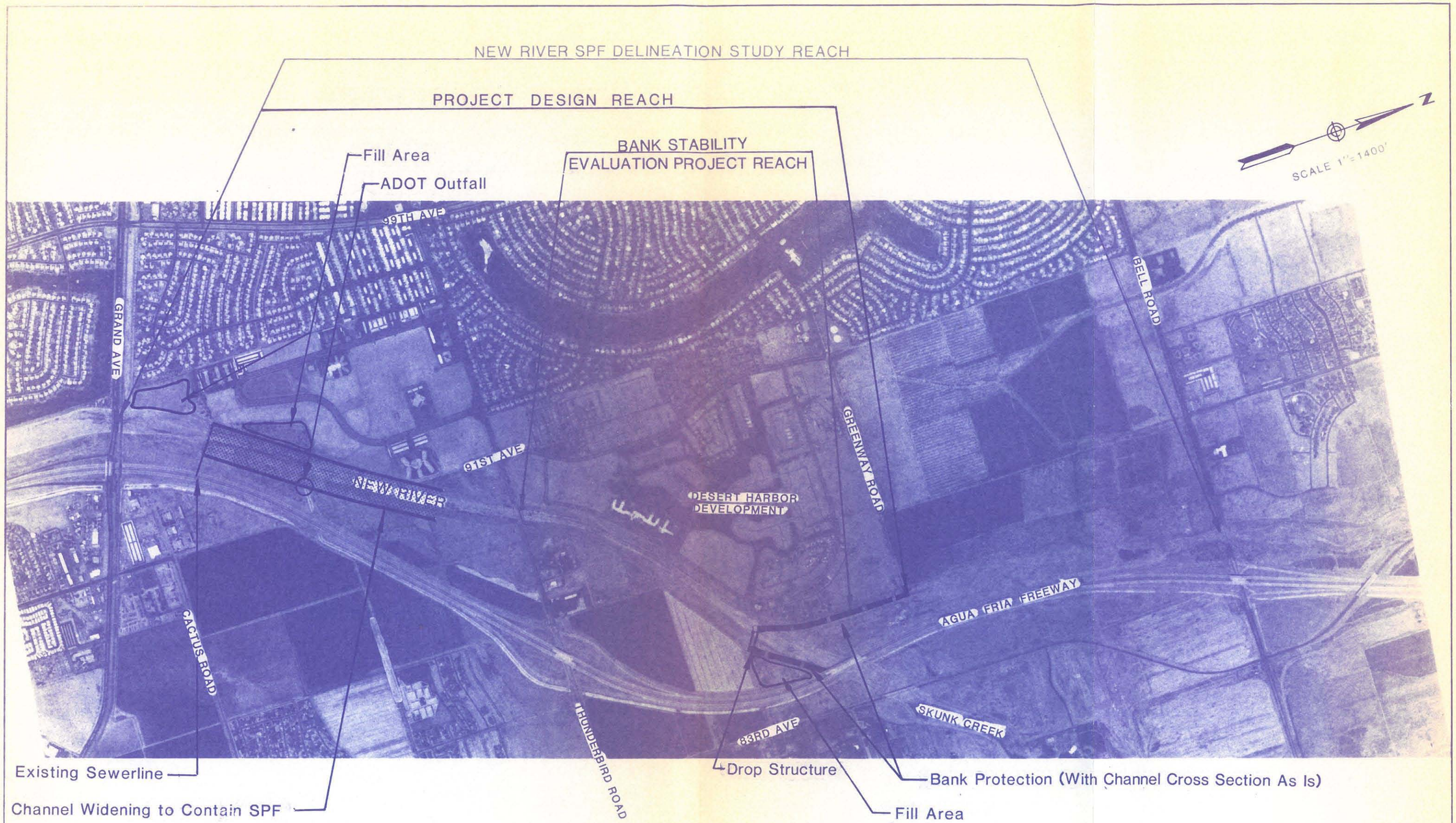
*Unified Soil Classification

**100% Passing 6" Sieve

APPENDIX V

PLATES

1. Project Map, Drop Structure at Desert Harbor
2. SPF Delineation, Existing Condition (4 sheets)
3. SPF Delineation, Proposed Condition (2 sheets)



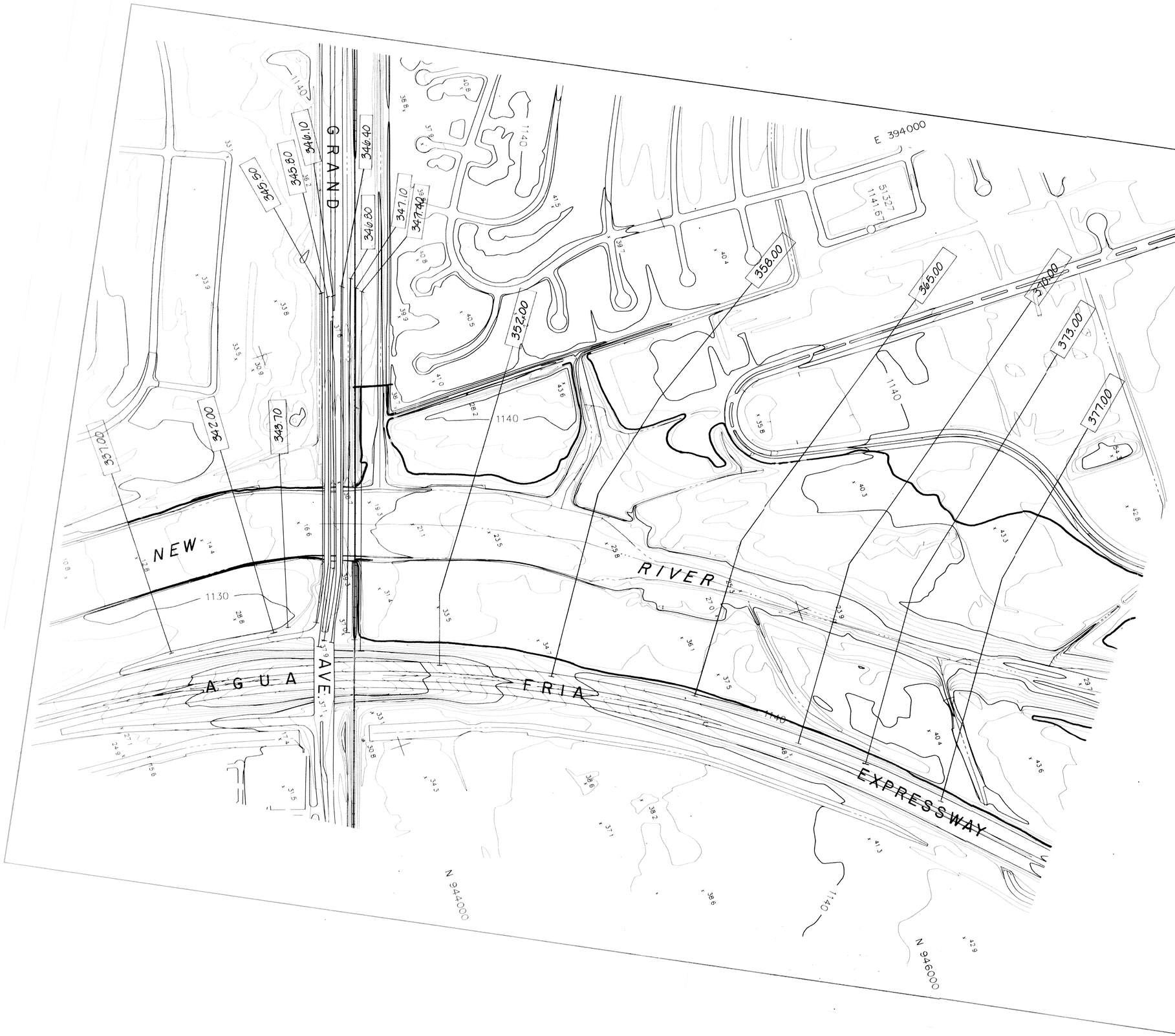
NEW RIVER

Drop Structure at Desert Harbor

WOOD, PATEL & ASSOCIATES, INC.

PROJECT MAP

PLATE 1



200 0 100 200

1 inch = 200 ft.

CONTOUR INTERVAL 2 FEET

LEGEND

- STANDARD PROJECT FLOOD LIMITS
- STATIONING IN RIVER MILES UPSTREAM FROM AGUA FRIA RIVER
- 337.00 — CROSS-SECTION NUMBER
- REFERENCE MARK
- CONTROL LINE

KEY MAP

INDEX

MAPPING NOTES

THE ORIGINAL TOPOGRAPHIC MAPPING, ENLARGED TO A SCALE OF 1"=200' ON THESE PLANS, WAS PREPARED AT A SCALE OF 1"=400' AND A 2 FOOT CONTOUR INTERVAL IN JUNE 1991. THAT MAPPING WAS PREPARED UNDER FLOOD CONTROL DISTRICT OF MARICOPA COUNTY CONTRACT NO. 90-19 BY KAMINSKI-HUBBARD ENGINEERING, INC. THE ORIGINAL MAPPING IS ON FILE AT THE DISTRICT.

EXISTING CONDITION

FEB 28 1994

WOOD, PATEL & ASSOCIATES, INC.
Civil Engineers, Hydrologists, Land Surveyors
4105 North 20th Street, Suite 130, Phoenix, Az. 85016
(602)-957-3149 Fax 955-3765

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

NEW RIVER
STANDARD PROJECT FLOOD DELINEATION
GRAND AVENUE TO BELL ROAD

RECOMMENDED BY:

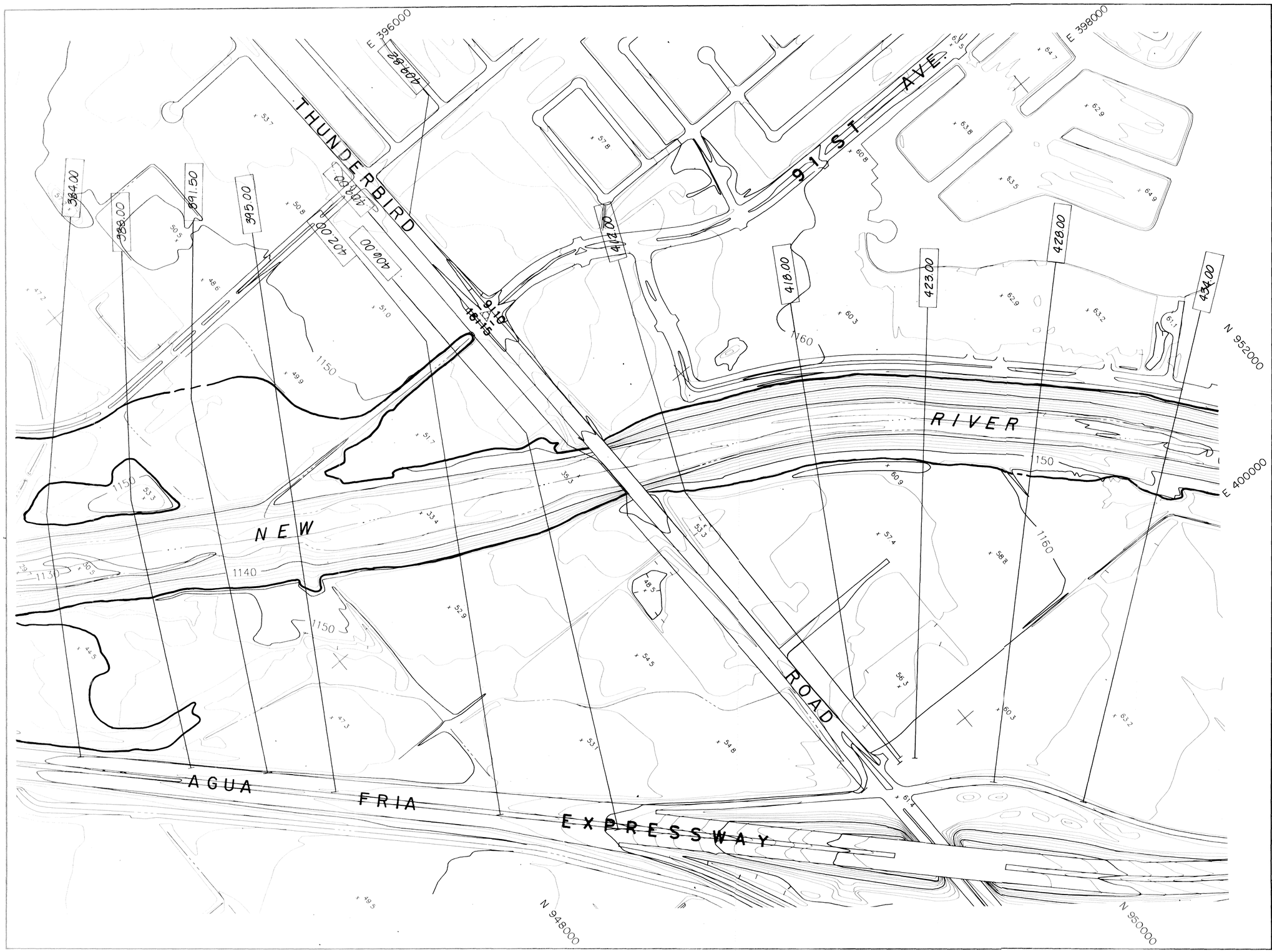
APPROVED BY: DATE:

CHIEF ENGINEER AND GENERAL MANAGER DATE:

PLATE 2
1 OF 4

FCDMC CONTRACT NO. 91-25
W.P.# 91755

KENNEY AERIAL MAPPING INC.
PHOENIX ARIZONA



200 0 100 200

1 inch = 200 ft.

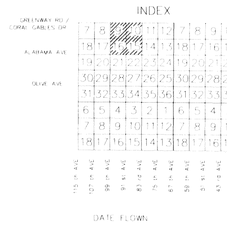
CONTOUR INTERVAL 2 FEET

LEGEND

- STANDARD PROJECT FLOOD LIMITS
- STATIONING IN RIVER MILES UPSTREAM FROM AGUA FRIA RIVER
- 337.00 — CROSS-SECTION NUMBER
- REFERENCE MARK
- CONTROL LINE

KEY MAP

INDEX



DATE FLOWN

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(602)-957-3149 Fax 955-3765

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

NEW RIVER
STANDARD PROJECT FLOOD DELINEATION

GRAND AVENUE TO BELL ROAD

RECOMMENDED BY: DATE:

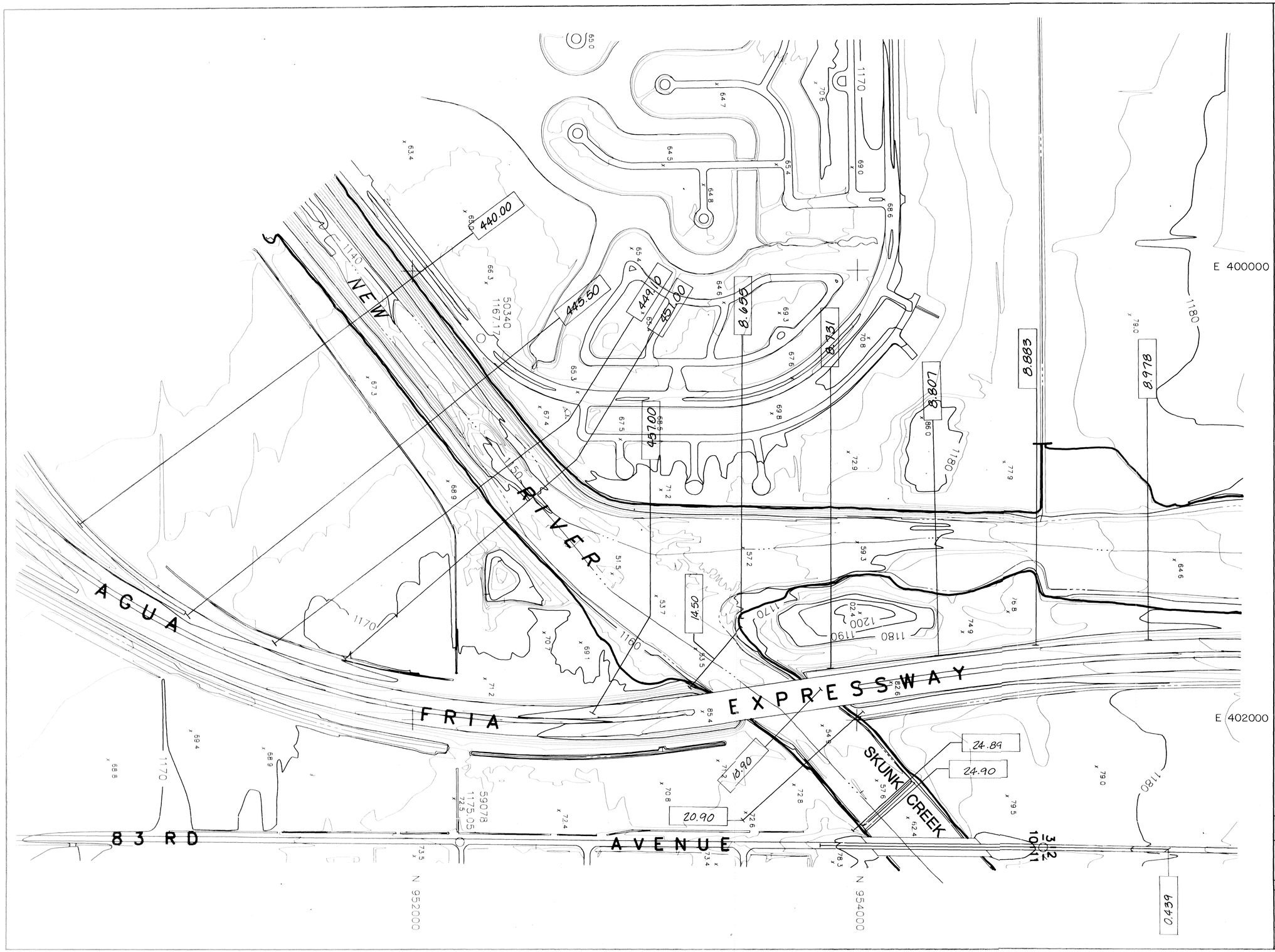
APPROVED BY: DATE:

CHIEF ENGINEER AND GENERAL MANAGER

PLATE 2
2 OF 4

FCDMC CONTRACT NO. 91-25
W.P.# 91755

KENNEY AERIAL MAPPING INC. PHOENIX, ARIZONA



200 0 100 200

1 inch = 200 ft.

CONTOUR INTERVAL 2 FEET

LEGEND

- STANDARD PROJECT FLOOD LIMITS
- STATIONING IN RIVER MILES UPSTREAM FROM AGUA FRIA RIVER
- 337.00 — CROSS-SECTION NUMBER
- REFERENCE MARK
- CONTROL LINE

KEY MAP

INDEX

DATE FLOWN

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EXISTING CONDITION

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Civil Engineers, Hydrologists, Land Surveyors
4105 North 20th Street, Suite 130, Phoenix, Az. 85016
(602)-957-3149 Fax 955-3765

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

NEW RIVER
STANDARD PROJECT FLOOD DELINEATION

GRAND AVENUE TO BELL ROAD

RECOMMENDED BY: DATE:

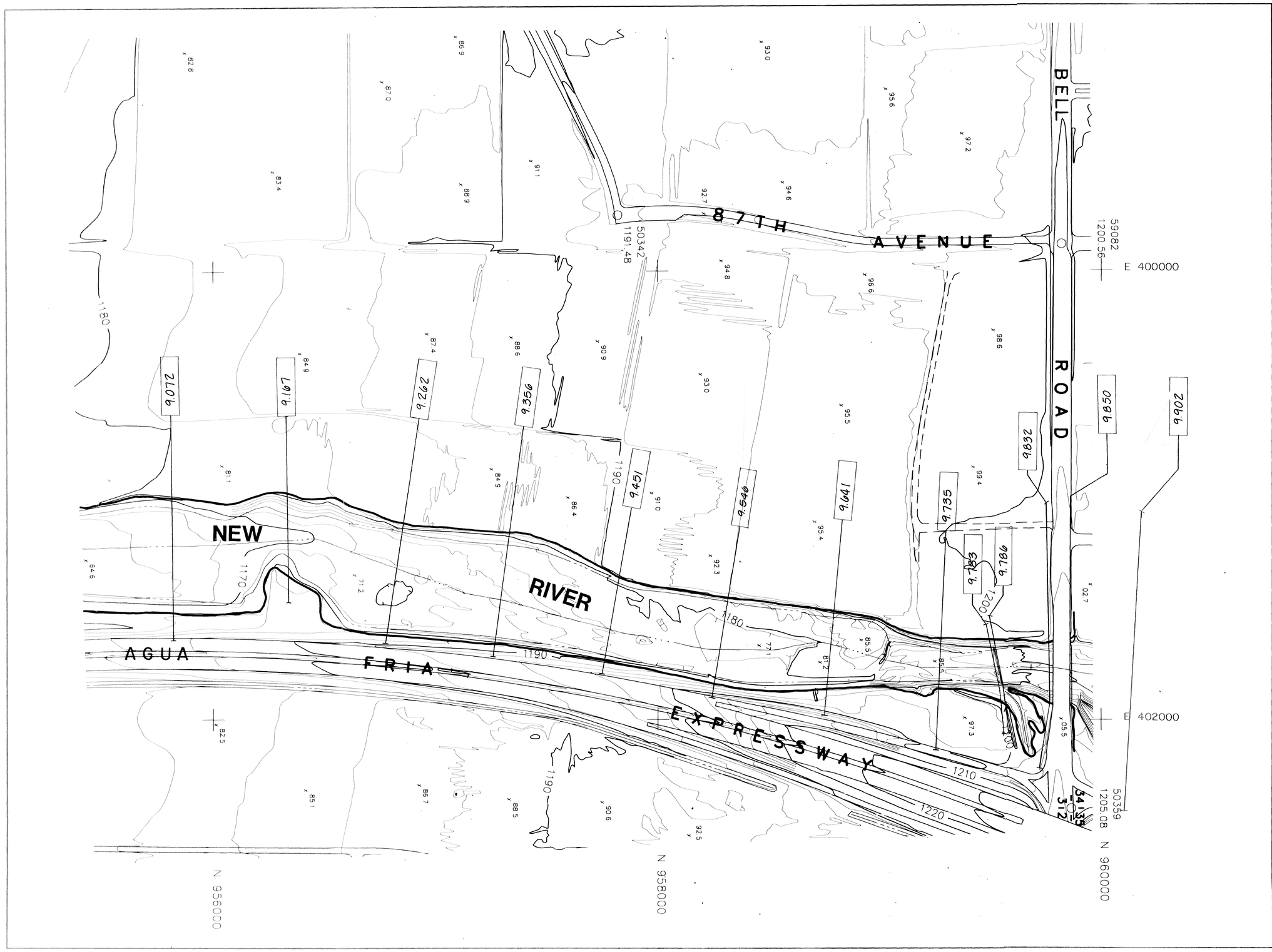
APPROVED BY: DATE:

CHIEF ENGINEER AND GENERAL MANAGER

PLATE 2 3 OF 4

FCDMC CONTRACT NO. 91-25
W.P.# 91755

KENNEY AERIAL MAPPING INC.



200 0 100 200

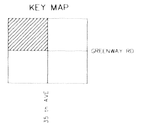
1 inch = 200 ft.

CONTOUR INTERVAL 2 FEET

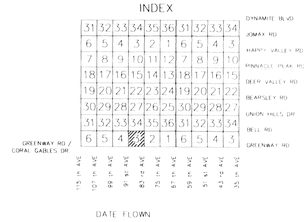
LEGEND

- STANDARD PROJECT FLOOD LIMITS
- STATIONING IN RIVER MILES UPSTREAM FROM AGUA FRIA RIVER
- 337.00 CROSS-SECTION NUMBER
- REFERENCE MARK
- CONTROL LINE

KEY MAP



INDEX



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EXISTING CONDITION

FEB 28 1994

WOOD, PATEL & ASSOCIATES, INC.
Civil Engineers, Hydrologists, Land Surveyors
4105 North 20th Street, Suite 130, Phoenix, Az. 85016
(602)-957-3149 Fax 955-3765

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

NEW RIVER
STANDARD PROJECT FLOOD DELINEATION

GRAND AVENUE TO BELL ROAD

RECOMMENDED BY: DATE:

APPROVED BY: DATE:

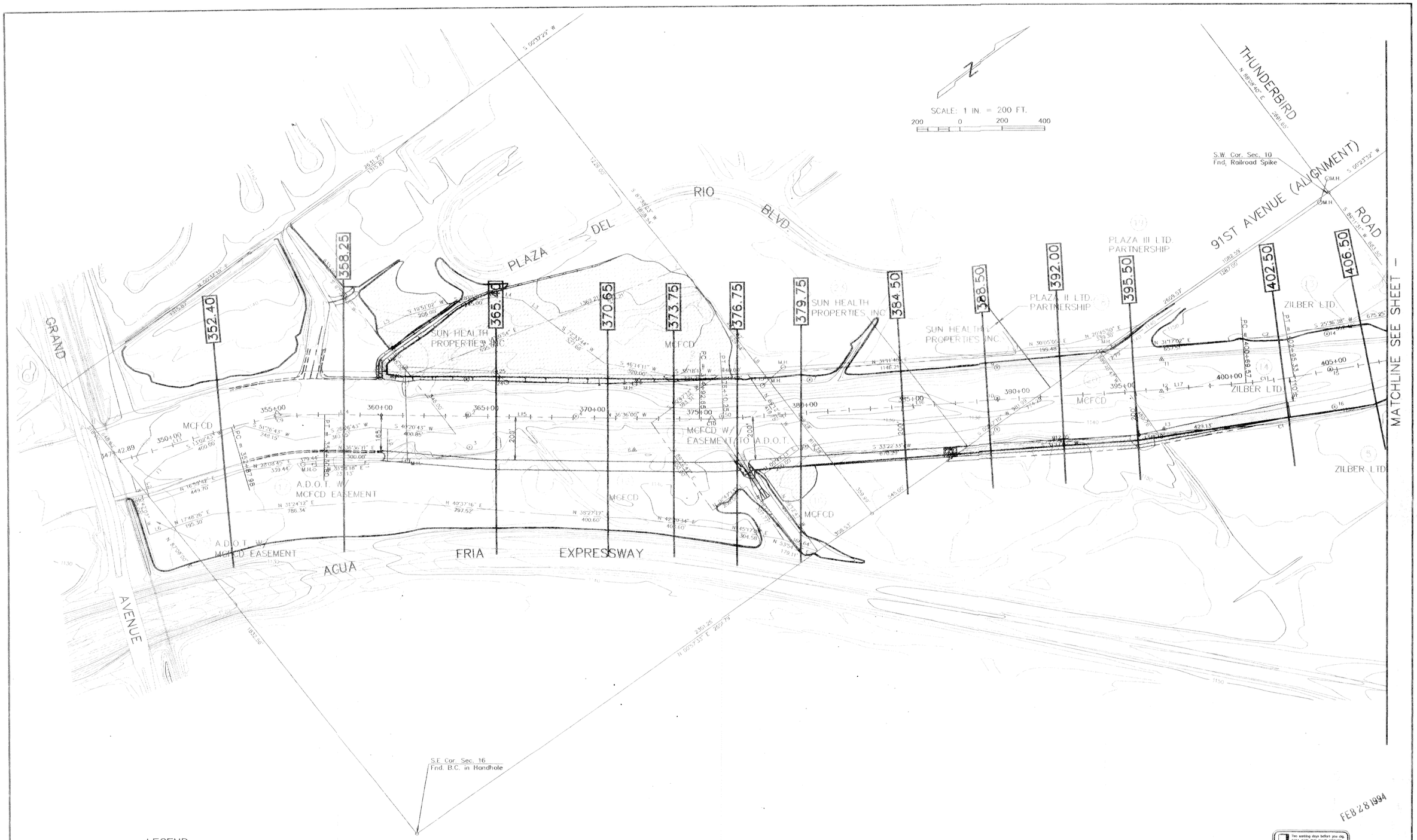
CHIEF ENGINEER AND GENERAL MANAGER

PLATE 2

4 OF 4

FCDMC CONTRACT NO. 91-25
W.P.# 91755

KENNEY AERIAL MAPPING INC.
PHOENIX ARIZONA



LEGEND

- Embankment Fill
- SPF Floodplain Limits
- Proposed Channel Bank
- Proposed Soil Cement Bank

FEB 28 1994

Two working days before you dig, CALL FOR THE BLUE STAKES
263-1100
Blue Stake Center CALL COLLECT

WOOD, PATEL & ASSOC., INC. 1550 EAST MISSOURI, SUITE 203 PHOENIX, ARIZONA (602)234-1344		
DESIGN	BY JGT	DATE 2-18-94
DESIGN CHK	ACP	2-18-94
PLANS	VF	2-18-94
PLANS CHK	JGT	2-18-94
SUBMITTED BY:		DATE:

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

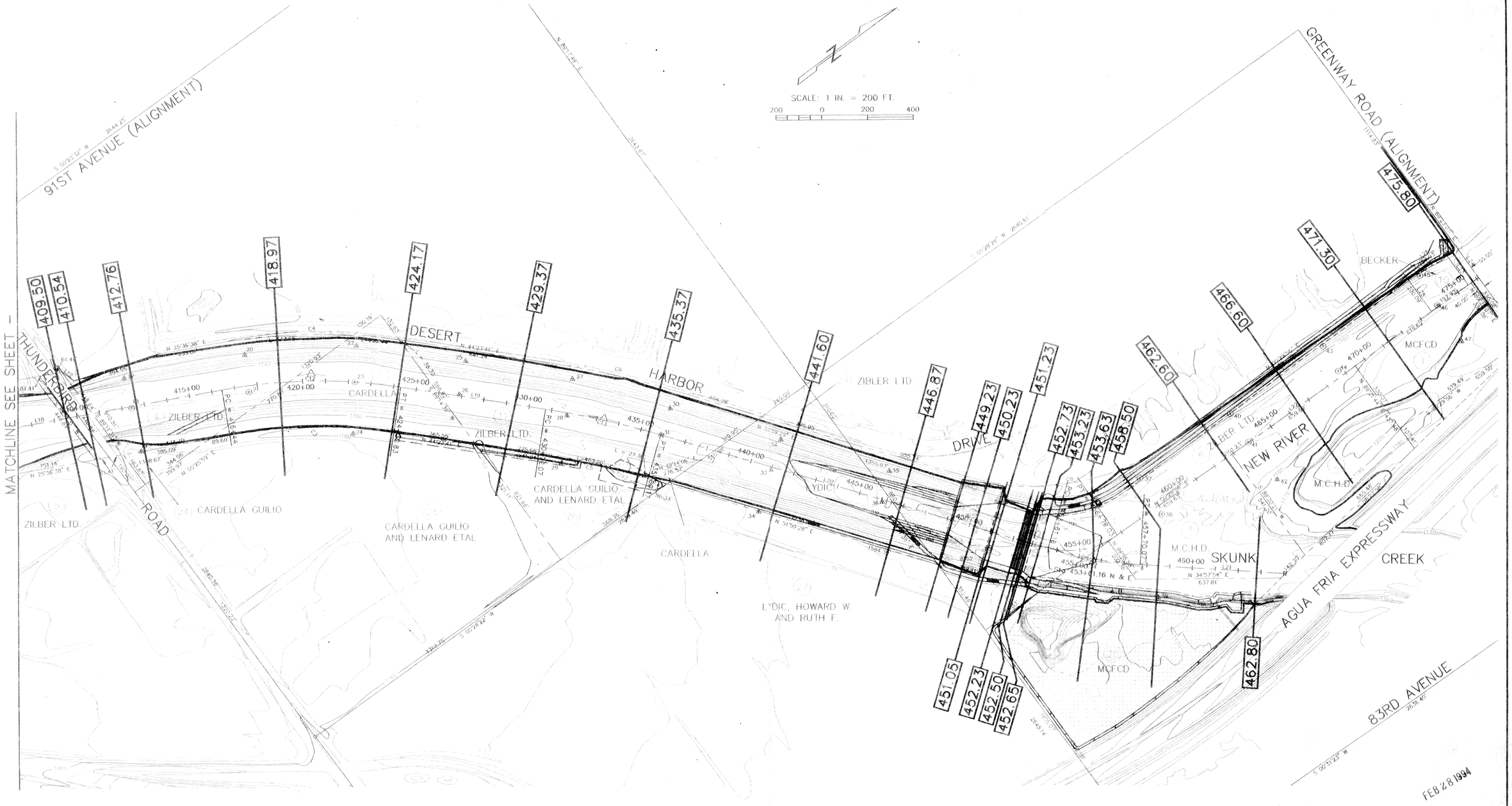
NEW RIVER FLOOD CONTROL IMPROVEMENTS

STANDARD PROJECT FLOOD DELINEATION
PROPOSED CONDITIONS

RECOMMENDED BY: DATE:
APPROVED BY: DATE:
CHIEF ENGINEER AND GENERAL MANAGER

SHEET PLATE 3
1 OF 2

PROJ. # 91755.02 FILE NAME: 931009\1009SPF1.DWG



FEB 28 1994

Two working days before you dig CALL FOR THE BLUE STAKES 263-1100 Blue Stake Center CALL COLLECT

WOOD, PATEL & ASSOC., INC.
1550 EAST MISSOURI, SUITE 203
PHOENIX, ARIZONA (602)234-1344

	BY	DATE
DESIGN	JGT	2-18-94
DESIGN CHK	ACP	2-18-94
PLANS	VF	2-18-94
PLANS CHK	JGT	2-18-94
SUBMITTED BY:		DATE:

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

NEW RIVER FLOOD CONTROL IMPROVEMENTS

STANDARD PROJECT FLOOD DELINEATION
PROPOSED CONDITIONS

RECOMMENDED BY: DATE:
APPROVED BY: DATE:
CHIEF ENGINEER AND GENERAL MANAGER

SHEET PLATE 3
2 OF 2

PROJ. # 91755.02 FILE NAME: 931009\1009SPF2.DWG