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TECHNICAL REPORT HL-90-18

# RIO PUERTO NUEVO FLOOD-CONTROL PROJECT SAN JUAN, PUERTO RICO

## Hydraulic Model Investigation

by

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Hydraulics Laboratory

DEPARTMENT OF THE ARMY

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<p>Three models were used to study portions of the high-velocity reaches within the Rio Puerto Nuevo basin. A 1:35-scale model of the Puerto Nuevo Channel was tested to determine the flow conditions in the transitions and curves in the supercritical channel, at the junctions with the Guara Canal Channel and Buena Vista Diversion Channel, at the bridges, and in the reach of channel where the flow transitions from supercritical to subcritical flow. Tests were conducted on a 1:25-scale model of the Josefina Channel to determine the flow conditions at the junction with the Dona Ana Channel and where the flow transitions from supercritical to subcritical flow. A 1:35-scale model of the Margarita Channel was also studied to determine the flow conditions in the vicinity of the De Diego Expressway Bridge and where the flow transitions from supercritical to subcritical flow.</p> <p style="text-align: right;">(Continued)</p>					
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It is expected that the prototype flow geometry and boundary conditions in the Puerto Nuevo Channel will result in a Manning's  $n$  value approximately equal to 0.015. However, flow conditions resulting from a Manning's  $n$  value of 0.012 were also documented so that an envelope of possible hydraulic conditions could be established. In the absence of standing waves, water-surface elevations were slightly higher with the larger  $n$  value. Flow velocities were slightly higher and standing waves created by disturbances were significantly higher with the smaller  $n$  value. The recommended design incorporates into the original proposed design straightening the channel walls from sta 205+57.70 to 204+86.94, extending the Puerto Nuevo Channel/Buena Vista Diversion Channel confluence wall 70.76 ft downstream, adding debris noses on the Pinero Avenue Bridge piers, extending the Las Americas Expressway Bridge piers upstream to sta 158+53.85, and adding two rows of 10-ft-high by 10-ft-wide baffle blocks followed by six rows of 4-ft-high by 4-ft-wide baffle blocks between sta 150+40 and 148+34.

The confluence of the Josefina and Dona Ana Channels provided an appropriate transition to converge the flow of the two channels. An oblique standing wave observed downstream of the confluence did not cause adverse effects downstream and was considered acceptable. Curves in the proposed design maintained acceptable water-surface elevations throughout the test section. The grade breaks (16+20 and 15+00) from a mild to a steep to a very mild slope forced a hydraulic jump for all test conditions and were determined to be a satisfactory design. The proposed design as tested is the recommended supercritical channel design to provide rapid transit for floodwaters in the low-lying area.

Tests conducted with the Margarita Channel model to determine the flow conditions in the vicinity of the De Diego Expressway Bridge indicated that the original design passed discharges less than or equal to 9,900 cfs under the bridge. The original design resulted in unacceptable flow conditions in the transition reach of the channel. The type 7 design transition, which consisted of a 1V on 8H transition flare in conjunction with a 3.25-ft-high sill placed at an angle on the channel invert between sta 52+77 and 52+50, was the best transition tested for distributing the flow in the transition across the channel width.

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## PREFACE

The model investigations reported herein were authorized by Headquarters, US Army Corps of Engineers (HQUSACE), on 26 September 1988 at the request of the US Army Engineer District, Jacksonville (SAJ). The studies were conducted by personnel of the Hydraulics Laboratory (HL), US Army Engineer Waterways Experiment Station (WES), during the period April 1989 to December 1989. All studies were conducted under the direction of Messrs. F. A. Herrmann, Jr., Chief, HL; R. A. Sager, Assistant Chief, HL; and G. A. Pickering, Chief, Hydraulic Structures Division (HSD), HL. The components of the models were constructed and assembled by Messrs. T. F. Beard, J. B. Blalack, E. A. Case, W. R. Landers, E. J. Lee, J. M. Lyons, and M. A. Simmons, Engineering and Construction Services Division, WES. The tests were conducted by Messrs. R. Bryant, Jr., J. E. Hite, Jr., E. L. Jefferson, J. R. Leech, T. E. Murphy, Jr., V. E. Stewart, and R. L. Stockstill, Locks and Conduits Branch, HSD, under the supervision of Messrs. J. F. George, Chief, Locks and Conduits Branch, and N. R. Oswalt, Chief, Spillways and Channels Branch, HSD. This report was prepared by Messrs. Stockstill and Leech and edited by Mrs. M. C. Gay, Information Technology Laboratory, WES.

Messrs. Bert Holler of the US Army Engineer Division, South Atlantic; LTC Charles S. Cox, Deputy District Engineer for Puerto Rico and US Virgin Islands; Emilio M. Colon, Area Engineer for Puerto Rico and US Virgin Islands; Jim Boone, Ron Hilton, Carol White, Richard Bunnell, and Jim Mangold and Ms. Gina Horri of SAJ; and representatives of the Commonwealth of Puerto Rico visited WES during the study to discuss test results and to correlate these results with concurrent design works.

Commander and Director of WES during preparation of this report was COL Larry B. Fulton, EN. Technical Director was Dr. Robert W. Whalin.

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CONVERSION FACTORS, NON-SI TO SI (METRIC)  
UNITS OF MEASUREMENT

Non-SI units of measurement used in this report can be converted to SI  
(metric) units as follows:

<u>Multiply</u>	<u>By</u>	<u>To Obtain</u>
cubic feet	0.0283	cubic metres
degree (angle)	0.01745329	radians
feet	0.3048	metres
miles (US statute)	1.609	kilometres
square feet	0.09290304	square metres
square miles	2.59	square kilometres

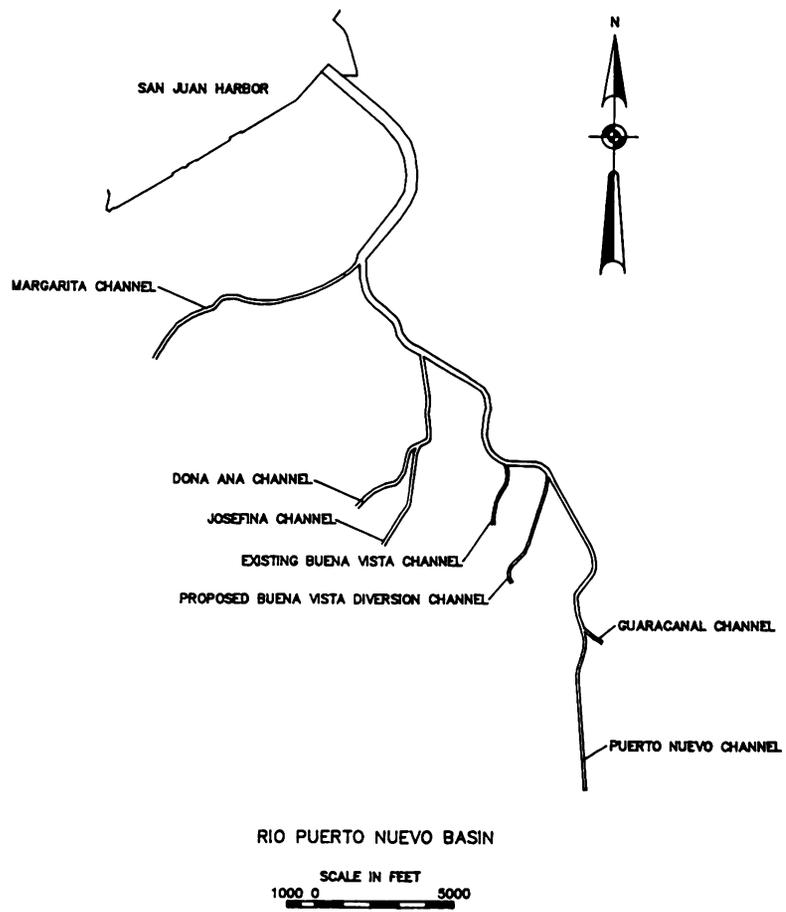
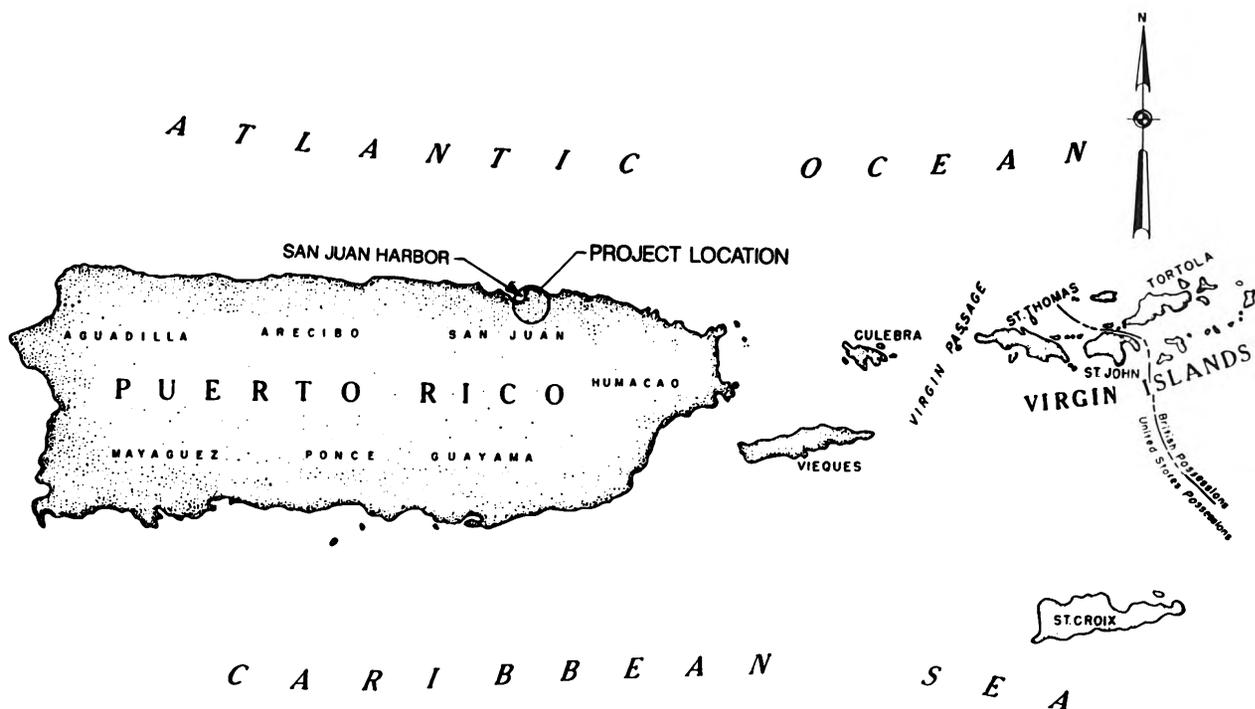


Figure 1. Vicinity and location maps

RIO PUERTO NUEVO FLOOD-CONTROL PROJECT

SAN JUAN, PUERTO RICO

Hydraulic Model Investigation

PART I: INTRODUCTION

The Prototype

1. The Rio Puerto Nuevo basin, which is drained by the Puerto Nuevo Channel and its tributaries (the Margarita Channel, the Josefina Channel, the Buena Vista Channel, and the Guara canal Channel), is within the San Juan metropolitan area (Figure 1). The basin, including the tributary streams, covers an area of approximately 24.2 square miles\* and drains into San Juan Harbor. Over 75 percent of the area is already developed, and it is expected that by the year 2000 all the undeveloped lands will be urbanized. A by-product of this process of urbanization has been an acute flooding problem, which is due in part to development in the floodplain and the lack of adequate hydraulic capacity of the stream system. This flooding problem is being compounded by continuing increases in suburban development that reduce infiltration of rainfall, which increases and accelerates runoff into the streams.

2. The proposed project improvements for the main Puerto Nuevo Channel consist of a trapezoidal earth channel with riprap for the lower reach and a concrete high-velocity rectangular channel for the upper reach. Proposed improvements for the Margarita Channel also include a trapezoidal earth channel with riprap for the lower reach and a concrete rectangular channel for the upper reach in the vicinity of the De Diego Expressway Bridge. Proposed improvements for the Josefina Channel and the Guara canal Channel include a concrete rectangular channel. It is proposed to bypass most of the Buena Vista Channel's flow into a new channel, the Buena Vista Diversion Channel.

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\* A table of factors for converting non-SI units of measurement to SI (metric) units is presented on page 3.

### Purpose and Scope of the Model Investigation

3. Three models were used to study portions of the high-velocity reaches within the Rio Puerto Nuevo basin. Tests and results are discussed separately for each model. One model study involved the Puerto Nuevo Channel. The purpose of this study was to determine the flow conditions in the transitions and curves in the supercritical channel, at the junctions with the Guaracanal and Buena Vista Diversion Channels, at the bridges, and in the reach of channel where the flow transitions from supercritical to subcritical flow and to determine water-surface elevations to be used in setting the elevation of the top of the prototype walls.

4. Another model study involving the Josefina Channel was conducted to determine the flow conditions and water-surface elevations at the junction with the Dona Ana Channel and where the flow transitions from supercritical to subcritical flow.

5. A model of the Margarita Channel was also studied. The purpose of this study was to determine the flow conditions and water-surface elevations in the vicinity of the De Diego Expressway Bridge and in the transition section where the flow transitions from supercritical to subcritical flow.

## PART II: THE PUERTO NUEVO CHANNEL MODEL

### Description

6. The model, constructed to a scale of 1:35, reproduced approximately 14,000 ft of the Puerto Nuevo Channel; 600 ft of the Guaracanal Channel; 400 ft of the Buena Vista Diversion Channel; and the Southeast Ramp, Pinero Avenue, Northeast Ramp, and the Las Americas Expressway Bridges (Figure 2, Plates 1-7). The model was constructed of transparent plastic with the invert slopes adjustable to reproduce different energy gradients equivalent to those resulting from different prototype Manning's  $n$  roughness factors. Portions of the channel containing a low-flow channel were constructed of concrete coated with epoxy paint resulting in a very smooth finish. Since prototype wall heights were to be determined by water-surface elevations measured in the model, the model walls were constructed high enough to prevent spillage.

7. The coefficient of roughness of the surface of the model channel had previously been determined to be approximately 0.009 (Manning's  $n$ ). Basing similitude on the Froudian relation, the  $n$  value would be equivalent to a prototype  $n$  of 0.016. The  $n$  value used in the design and analysis of the prototype channels varied from 0.012 to 0.015; therefore, supplementary slopes were added to the model to correct for this difference in the  $n$  values of the model and prototype.

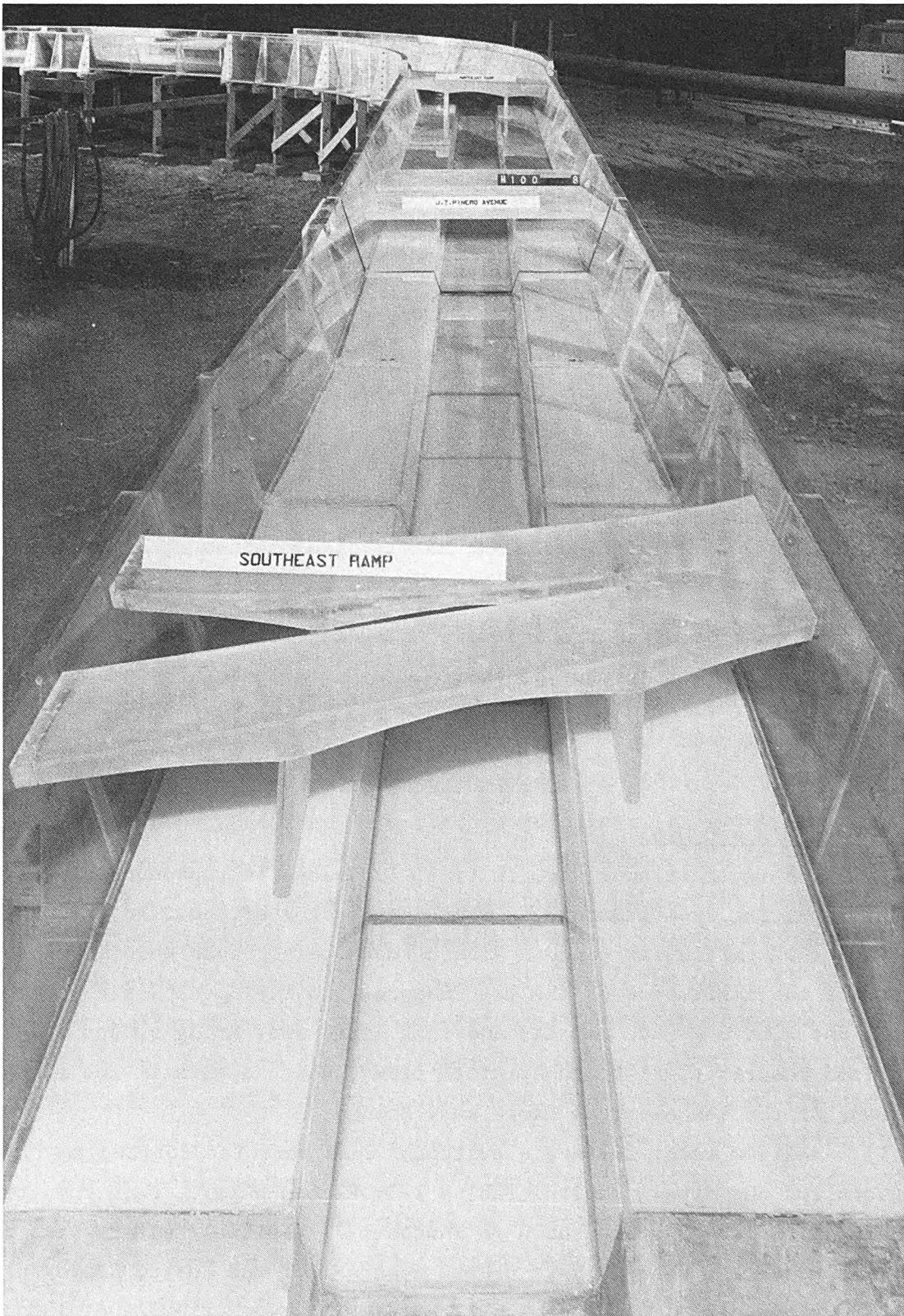
### Model Appurtenances

8. Water used in the operation of the model was supplied by a circulating system. Discharges were measured with venturi meters and orifice meters installed in the flow lines and were baffled before entering the model. Velocities were measured with a pitot tube or current meter that was mounted to permit measurement of flow from any direction and at any depth. Water-surface elevations were measured with point gages. Different designs and various flow conditions were recorded photographically.

### Scale Relations

9. The accepted equations of hydraulic similitude, based on Froudian





b. Between curves 9 and 10 (looking downstream)

Figure 2. (Concluded)

relations, were used to express mathematical relations between the dimensions and hydraulic quantities of the model and prototype. General relations for transference of model data to prototype equivalents are presented in the following tabulation:

<u>Characteristic</u>	<u>Dimension*</u>	<u>Scale Relations Model:Prototype</u>
Length	$L_r = L$	1:35
Area	$A_r = L_r^2$	1:1,225
Velocity	$V_r = L_r^{1/2}$	1:5.92
Time	$T_r = L_r^{1/2}$	1:5.92
Discharge	$Q_r = L_r^{5/2}$	1:7,247.20
Roughness coefficient	$N_r = L_r^{1/6}$	1:1.81

\* Dimensions are in terms of length.

Model measurements of discharge and water-surface elevations can be transferred quantitatively to prototype equivalents by means of the preceding scale relations.

### Tests and Results

#### Initial tests (n = 0.015)

10. The invert slopes were initially adjusted to reproduce an energy gradient resulting from a Manning's roughness factor of 0.015 in the prototype. Areas of particular concern within the modeled reach were in the vicinity of the confluence of the main channel and the Buena Vista Diversion Channel, the Pinerio Avenue and Las Americas Expressway Bridges, and the transition from supercritical to subcritical flows, which occurs in the reach just downstream of the Las Americas Expressway Bridge.

11. Maximum water-surface elevations\* were measured for design flow conditions for the type 1 design (Tables 1-3, Plates 8-14). Flow conditions for the design discharge are shown in Photos 1-7. Initial test results indicated that no design changes were needed upstream of the Puerto Nuevo/Buena Vista Diversion Channel confluence (Plate 15). However, flow conditions in

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\* All elevations (el) and stages cited herein are in feet referred to the National Geodetic Vertical Datum (NGVD).

the vicinity of this confluence were determined to be unacceptable due to the large standing waves that developed just downstream of the confluence when the flows of the two channels merged, as shown in Plate 10. The capacities of the Southeast Ramp, J. T. Pinero Avenue, and Northeast Ramp Bridges were adequate in passing the design flow. However, a buildup of the water surface (Photo 6) was observed at the Las Americas Expressway Bridge with more approach flow present along the right side of the channel because of the channel alignment immediately upstream. At the downstream end of the modeled channel reach, where the flow transitions from supercritical to subcritical, an unstable hydraulic jump formed (Photo 7) with the toe of the jump moving upstream and downstream over a 600-ft reach of channel with minor changes in tailwater depth (1 ft).

12. Due to the high potential for debris accumulations on the bridge piers, tests were conducted to determine the effects of 2 ft of debris on each side of the bridge piers on the capacity of the bridges. Flow conditions with the debris accumulation are shown in Photos 8-11. Test results indicated that the Pinero Avenue Bridge would be overtopped with a discharge of 44,600 cfs (Photo 9), and a buildup of flow was noted upstream of the center line of the piers at the other bridges. Maximum water-surface elevations resulting from debris accumulation are provided in Table 4 and Plate 16.

13. Tests were conducted with various modifications along the channel reach with the initial modifications being done in the upstream area where problems were observed and then working downstream. The first area of concern was at the Puerto Nuevo/Buena Vista Diversion Channel confluence, where standing waves were present downstream of the confluence. The walls of the main channel were realigned to produce a more streamlined reach from sta 205+57.70 to 204+86.94 (type 2 design channel, Plate 17). The original design included straight walls from sta 205+57.70 to 205+07.70 (Plate 15). Test results indicated that the type 2 design channel was of little benefit in reducing the height of the standing waves, but it did simplify the geometry of the confluence area and therefore was incorporated in subsequent modifications.

14. In addition to the type 1 (original) design shown in Plate 17, four other confluence divider walls were tested. The details of these Puerto Nuevo/Buena Vista Diversion confluence walls are presented in Plates 18-21. The type 4 design confluence wall in conjunction with the type 2 design channel resulted in satisfactory flow conditions in the confluence vicinity

(Photo 12). Maximum water-surface elevations resulting from the type 2 design channel with the type 4 design confluence wall are presented in Table 5 and Plate 22.

15. Tests involving bridge pier modifications were conducted in an attempt to increase the discharge capacities of the bridges. Modifications of the Pinero Avenue Bridge piers consisted of adding a debris nose to the upstream face of the piers as recommended in Engineer Manual (EM) 1110-2-1601\* (type 2 design, Pinero Avenue piers, Plate 23). This modification would inhibit the accumulation of debris on the piers. Flow conditions with the type 2 design piers were similar to the type 1 (original) design with no debris accumulation on the bridge piers.

16. The Las Americas Expressway Bridge piers were extended upstream to sta 158+03.85 (type 2, Plate 24) in an effort to distribute the flow uniformly across the width of the channel in this vicinity. The type 2 design Las Americas Expressway Bridge piers resulted in a more uniform distribution of flow across the width of the channel immediately upstream of the bridge. However, the standing waves resulting from the upstream pier noses were found to be at a maximum height just upstream of the bridge.

17. The Las Americas Expressway Bridge piers were further modified by extending the piers an additional 50 ft upstream (type 3 design, Plate 24, Photo 13a). Acceptable flow conditions resulted from the type 3 design bridge piers for both clean piers (Photo 13b) and piers having an accumulation of debris (Photo 13c). Maximum water-surface elevations for the type 2 design Pinero Avenue Bridge piers and the type 3 design Las Americas Expressway Bridge piers are presented in Tables 6 and 7 and Plates 25 and 26. It should be noted that tests conducted with debris on bridge piers did not include debris on the type 2 design Pinero Avenue Bridge piers since it was assumed that the design would inhibit accumulation.

18. The model was then modified in the area where the hydraulic jump forms. The transition from supercritical to subcritical flows in the original design resulted in an undular jump with waves propagating downstream. Baffle blocks were installed in this vicinity in an effort to create a stronger jump and fix the jump location.

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\* Headquarters, US Army Corps of Engineers. 1970 (1 Jul). "Hydraulic Design of Flood Control Channels," EM 1110-2-1601, US Government Printing Office, Washington, DC.

19. Various sizes and arrangements of blocks were tested in an effort to determine the optimum size, number, and location of baffle blocks required for good energy dissipation (Plate 27). The type 4 design baffle blocks consisted of two rows of 8-ft-high by 8-ft-wide blocks followed by six rows of 4-ft-high by 4-ft-wide blocks between sta 150+40 and 148+59. The type 4 design baffle blocks fixed the location of the jump and adequately dissipated the flow energy, resulting in acceptable flow conditions downstream of the jump (Photo 14).

Decreased roughness ( $n = 0.012$ )

20. The model invert slopes were adjusted to reproduce an energy gradient resulting from a Manning's roughness factor of 0.012 in the prototype. Maximum water-surface elevations and flow depths were measured for design flow conditions. These tests were conducted with the channel improvements installed that were recommended from testing with a Manning's roughness factor of 0.015. These improvements included the type 2 design channel, the type 4 design Puerto Nuevo/Buena Vista Diversion Channel confluence wall, the type 2 design Pinero Avenue Bridge piers, the type 3 design Las Americas Expressway Bridge piers, and the type 4 design baffle blocks.

21. Water-surface elevations and profiles for the entire reach of channel reproduced are shown in Tables 8-10 and Plates 28-35. Flow conditions in several reaches are shown in Photos 15-17. Flow conditions in the vicinity of the Puerto Nuevo/Guaracanal Channel confluence were deemed acceptable. However, adverse flow conditions were present at the Puerto Nuevo/Buena Vista Diversion Channel confluence with a discharge of 37,900 cfs and 4,200 cfs in the Puerto Nuevo and Buena Vista Diversion Channels, respectively. Standing waves, which initiated in curves 12 and 13 (first two curves upstream of the confluence) and at the 1-ft wall offset at sta 207+00, reverberated off the channel walls downstream of the area where the flows of the two channels merge (Photo 16). This resulted in large standing waves downstream of the confluence (within curve 11, Plate 30). Modifications of the confluence wall would not improve flow conditions downstream of the confluence because flow disturbances were initiated upstream of the confluence. Major geometrical changes, such as increasing the radius of curvature and/or incorporating spirals in curves 11, 12, and 13, would be required to improve flow conditions in the confluence vicinity.

22. Acceptable flow conditions were observed in the channel reach

having the four bridges for both clean bridge piers (Plate 32) and bridge piers having an accumulation of debris (Table 11, Plate 36). Debris was not placed on the Pinero Avenue Bridge piers since the type 2 design piers included a debris nose that would inhibit debris accumulation.

23. The type 4 design baffle blocks did not produce an acceptable jump for velocities resulting from a channel roughness of 0.012. The approaching flow sprayed over the tops of the type 4 design baffle blocks (Photo 17). Removal of the blocks resulted in an unstable undular jump located near sta 144+00 (Table 12, Plate 37).

24. Tests involving baffle block modifications were conducted in an attempt to fix and stabilize the hydraulic jump. Two additional baffle block designs were tested (types 5 and 6, Plate 38). The type 6 design baffle blocks fixed the location of the jump and adequately dissipated the flow energy, resulting in acceptable flow conditions downstream of the jump. Test results with the type 6 design baffle blocks are shown in Table 13, Photo 18, and Plate 39.

25. Representatives of the US Army Engineer District, Jacksonville, concluded that no further modifications should be made to the channel geometry to accommodate design flows with a channel roughness coefficient of 0.012. This decision was based on the fact that the expected prototype flow geometry and boundary conditions will result in a Manning's roughness coefficient approximately equal to 0.015.

#### Conclusions and Recommendations

26. The overall recommended design determined from test results for a Manning's  $n$  of 0.015 incorporates into the original proposed design straightening the channel walls from sta 205+57.70 to 204+86.94 (type 2 design channel, Plate 20), extending the Puerto Nuevo/Buena Vista Diversion Channel confluence wall 70.76 ft (type 4 design Puerto Nuevo/Buena Vista Diversion Channel confluence wall, Plate 20), adding debris noses on the Pinero Avenue Bridge piers (type 2 design Pinero Avenue Bridge piers, Plate 23), extending the Las Americas Expressway Bridge piers upstream to sta 158+53.85 (type 3 design Las Americas Expressway Bridge piers, Plate 24), and adding two rows of 8-ft-high by 8-ft-wide baffle blocks followed by six rows of 4-ft-high by 4-ft-wide baffle blocks between sta 150+40 and 148+59 (type 4 design baffle blocks, Plate 27).

27. It should be noted that the Pinero Avenue Bridge is quite sensitive to flow obstructions. The minimum distance between the water surface and the bridge's soffit is 1.6 ft for a discharge of 44,600 cfs (Plate 25). An obstruction representing an area of approximately 100 sq ft placed in the flow at the downstream edge of the bridge resulted in flow over the bridge for a discharge of 44,600 cfs. If the channel is not adequately maintained in the vicinity of Pinero Avenue, the existing bridge will be overtopped with flows at the design discharge. It is recommended that the bridge be replaced with a new bridge having a larger flow area if channel maintenance cannot be guaranteed.

28. The overall recommended design determined from test results for a Manning's  $n$  of 0.012 includes those recommended for a Manning's  $n$  of 0.015 with the exception of the baffle block design. The recommended design baffle blocks (type 6 design baffle blocks, Plate 38) consisted of two rows of 10-ft-high by 10-ft-wide baffle blocks followed by six rows of 4-ft-high by 4-ft-wide baffle blocks between sta 150+40 and 148+34.

### PART III: JOSEFINA CHANNEL MODEL

#### Description

29. The 1:25-scale model (Figure 3) reproduced approximately 3,200 ft of the Josefina Channel, 800 ft of the Dona Ana Channel, and the confluence of the two channels. The model was constructed of Plexiglas with adjustable supports to change the slope of the model to represent different prototype Manning's  $n$  roughness factors.

30. The coefficient of roughness of the surface of the model channel had previously been determined to be approximately 0.009 (Manning's  $n$ ). From the accepted equations of hydraulic similitude, based on Froudian relations, the  $n$  value would be equivalent to a prototype  $n$  of 0.0154. The  $n$  value used in the design of the prototype channels varied from 0.012 to 0.015; therefore, slope adjustments were made in the model to correct for the difference in the model and prototype  $n$  values.

#### Model Appurtenances

31. The model appurtenances are similar to those described in paragraph 8.

#### Scale Relations

32. The accepted equations of hydraulic similitude, based on the Froudian relations, were used to express mathematical relations between the dimensions and hydraulic quantities of the model and prototype. General relations expressed in terms of the model scale or length ratio  $L_r$  are presented as follows:

<u>Characteristic</u>	<u>Dimension*</u>	<u>Scale Relations Model:Prototype</u>
Length	$L_r = L$	1:25
Area	$A_r = L_r^2$	1:625
Velocity	$V_r = L_r^{1/2}$	1:5
Time	$T_r = L_r^{1/2}$	1:5
Discharge	$Q_r = L_r^{5/2}$	1:3,125
Roughness coefficient	$N_r = L_r^{1/6}$	1:71

\* Dimensions are in terms of length.



## Tests and Results

### Initial tests (n = 0.015)

33. Model tests were conducted to determine the water-surface elevations for the Josefina and Dona Ana Channels. Figure 3 shows a general view of the model looking downstream. Located in the foreground is the confluence of the Josefina and Dona Ana Channels. Curve data and stationing are presented in Plates 40 and 41, respectively. Dona Ana sta 0+00 corresponds to Josefina sta 34+34 at the confluence of the two channels. Both channels are 22 ft wide up to the confluence, where the Josefina Channel becomes 45 ft wide.

34. Water-surface profiles obtained with various discharges with the model representing a prototype Manning's  $n$  of 0.015 are presented in Plates 42-50. The model water-surface elevations at the upstream and downstream ends of the model were set to elevations furnished by the Jacksonville District. The profiles shown were measured 3 ft from the left wall (looking downstream), the center line, and 3 ft from the right wall. As expected, the hydraulic jump moved upstream with decreasing discharge and remained downstream of the grade break at sta 16+20 for all test conditions.

35. Photo 19 shows the confluence of the Dona Ana and Josefina Channels (looking upstream) with flow coming out of curve J5 with a prominent super-elevation of the water surface. Immediately downstream of the confluence divider wall, a stationary oblique standing wave (Photo 19) existed for all conditions tested. This standing wave caused no adverse effects to the flow in the channel and was accepted as satisfactory performance. Photo 20 shows flow going into curve J4 with a slight superelevation. Photo 21 shows the hydraulic jump at sta 15+50 in the Josefina Channel. The hydraulic jump formed uniformly across the channel.

### Slope adjustment (n = 0.012)

36. The model was adjusted to represent a Manning's  $n$  of 0.012. Water-surface profiles obtained with various discharges are shown in Plates 51-62. As expected, flow depths were less and the position of the hydraulic jump was farther downstream with the smoother  $n$  value. The super-elevation in curves J5 and J4 was more pronounced for the smoother  $n$  values, and the confluence performance followed the same trend as with the  $n$  of 0.015.

### Conclusions

37. The proposed design performed satisfactorily for all discharges and Manning's  $n$  values tested. The transition at the confluence created an oblique standing wave; however, this did not adversely affect the water surface going into curve J4. A uniform hydraulic jump formed as desired downstream of the grade break at sta 16+20 for each condition tested without assistance of baffle piers.

## PART IV: MARGARITA CHANNEL MODEL

### Description

38. The model, constructed to a scale of 1:35, reproduced approximately 1,900 ft of the Margarita Channel and the De Diego Expressway Bridge (Figure 4, Plate 63). The model was constructed of transparent plastic with the invert slopes adjustable to reproduce different energy gradients equivalent to those resulting from different prototype Manning's  $n$  roughness factors. The De Diego Expressway Bridge was constructed of plastic-coated plywood.

39. The coefficient of roughness of the model surface of the channel had previously been determined to be approximately 0.009 (Manning's  $n$ ). Basing similitude on the Froudian relation, the  $n$  value would be equivalent to a prototype  $n$  of 0.016. The  $n$  value used in the design and analysis of the prototype channel was 0.015. Therefore, supplementary slopes were added to the model to correct for this difference in the  $n$  values of the model and prototype.

40. Model appurtenances and scale relations are as those described in paragraphs 8 and 9.

### Tests and Results

41. The first test was conducted with a discharge of 8,800 cfs and average depths of flow set at 12.3 and 19.4 ft for sta 68+00 and 50+00, respectively. This discharge is expected to occur when the 100-year peak flow occurs on the main channel of the Puerto Nuevo system. Water-surface profiles near the left and right walls of the channel were measured and are shown in Plate 64. The De Diego Expressway Bridge was placed in the model (Figure 4) with low beam elevations of 14.01 at sta 62+63 and 13.05 at sta 60+44. Flow conditions through the bridge section are shown in Photo 22. The maximum water-surface elevation in the supercritical reach of the channel was 12.35 and occurred at sta 62+49.41, the point of curvature (PC) of curve M6. Table 14 lists the measured water-surface elevations for this test. The superelevation in the water surface was 1.7 ft for curve M6 and 2.1 ft for curve M5.





42. The toe of the hydraulic jump fluctuated around sta 53+45 along the left wall, and was not considered stable. Flow entering the transition section at sta 52+00 was concentrated along the left wall, causing the waves shown in Plate 64. This flow concentration produced a large eddy in the downstream channel, which is illustrated by the dark area shown in Photo 23. The dark area was created by placing dye in the model to highlight the inefficient flow area.

43. Another test was conducted with a discharge of 8,800 cfs and the tailwater raised 1.64 ft to el 6.10 at sta 50+00. Flow conditions upstream of sta 55+00 were the same as observed in the previous test. However, noticeable changes were observed with the upstream movement of the toe of the jump to sta 54+00 and reduced wave heights in the downstream channel. Water-surface profiles obtained with this condition are shown in Plate 65, and water-surface elevations are listed in Table 15. Velocities were measured at sta 52+76.51 (PC of curve M4), 52+00 (beginning of the transition section), and 50+40 (end of the transition section) and are shown in Plate 66. The higher velocities occurred in the left half of the channel, as would be expected with concentrated flow.

44. Additional tests were conducted for discharges of 7,400, 9,900, 11,200, and 13,500 cfs. These discharges represented various scenarios of flood routing and antecedent moisture conditions. Water-surface profiles obtained with these flows are shown in Plates 67-70, and water-surface elevations are presented in Tables 16-19. Flow conditions with a discharge of 7,400 cfs and 9,900 cfs were satisfactory in the supercritical reach of the channel, but concentrated flow occurred in the downstream channel as described previously.

45. Flow conditions near the bridge with a discharge of 11,200 cfs are shown in Photo 22b. A wave developed upstream of the De Diego Expressway Bridge and moved downstream hitting the bridge causing an increase in the water surface upstream to sta 63+50. The flow then swept underneath the bridge for a short period until the wave redeveloped and hit the bridge, starting the cycle again. Flow in the downstream portion of the channel was still concentrated along the left bank.

46. The flow conditions near the bridge with a discharge of 13,500 cfs are shown in Photo 22c. The De Diego Expressway Bridge was submerged and flow in the channel upstream of the bridge in the model was subcritical. The flow

returned to supercritical flow at sta 60+25. Flow conditions were unsatisfactory with this discharge.

47. Modifications were made to the channel in an effort to improve the flow conditions in the transition between sta 50+20 and 50+40. Initially, baffle blocks were placed in the 30-ft-wide section of the channel. This was designated the type 2 design transition, shown in Plate 71. Flow conditions were improved over the original design, but were still considered unacceptable. Velocities measured at sta 52+00 and 50+40 with the type 2 design are shown in Plate 72.

48. Various arrangements of sills were then placed on the channel invert in an attempt to improve flow conditions in the vicinity of the transition section. The sills were 3.25 ft high, which was the same height as the baffle blocks. The type 3 design (Plate 71) improved flow conditions over those with the type 2 design, but the flow was concentrated in the center of the channel, as shown in Plate 73. Additional tests conducted with the types 4 and 5 designs (Plate 71) also indicated that these modifications were not as effective as the type 3 design. This can be seen by comparing the velocities obtained with the types 4 and 5 designs to those obtained with the type 3 design (Plate 73).

49. Since the sills alone did not appear to be an effective modification, the transition flare was changed from 1 on 4 to 1 on 8. The type 6 design (Plate 74) was tested, and velocities measured at the end of the transition (sta 48+80) are provided in Plate 75. Flow conditions were improved over the original design (Plate 66), but were not as uniformly distributed as was observed with the type 3 design. The type 7 design (Plate 74) consisted of the 1 on 8 transition flare in addition to the sill arrangement used with the type 3 design. The velocities obtained with the type 7 design are shown in Plate 75. The flow conditions with the type 7 design were improved over previous modifications tested, but the flow was still not uniformly distributed in the channel.

50. Representatives of the Jacksonville District indicated that additional design of the transition would be required due to poor soil conditions in this area of the project. The Jacksonville District also stated that these design changes would not be tested in the model.

## Conclusions and Recommendations

51. The original design channel passed discharges less than or equal to 9,900 cfs under the De Diego Expressway Bridge. The type 7 design (Plate 74) was the optimum design tested for distributing the flow in the transition across the channel width.

52. If the transition area is redesigned, design considerations should include extending the 30-ft-wide channel further downstream to provide a longer straight reach of channel to distribute the flow uniformly within the channel before it reaches the transition section. A transition milder than 1 on 8 should improve flow conditions within the transition reach.

## PART V: SUMMARY AND CONCLUSIONS

### The Puerto Nuevo Channel Model

53. Tests were conducted to determine the flow conditions in the transitions and curves in the supercritical channel, at the junctions with the Guaracanal Channel and Buena Vista Diversion Channel, at the bridges, and in the reach of channel where the flow transitions from supercritical to subcritical flow.

54. It is expected that the prototype flow geometry and boundary conditions will result in a Manning's  $n$  value approximately equal to 0.015. However, flow conditions resulting from a Manning's  $n$  value of 0.012 were also documented so that an envelope of possible hydraulic conditions could be established. In the absence of standing waves, water-surface elevations were slightly higher with the larger  $n$  value. Flow velocities were slightly higher and standing waves created by disturbances were significantly higher with the smaller  $n$  value.

55. The recommended design incorporates into the original proposed design straightening the channel walls from sta 205+57.70 to 204+86.94, extending the Puerto Nuevo Channel/Buena Vista Diversion Channel confluence wall 70 ft downstream, adding debris noses on the Pinero Avenue Bridge piers, extending the Las Americas Expressway Bridge piers upstream to sta 158+53.85, and adding two rows of 10-ft-high by 10-ft-wide baffle blocks followed by six rows of 4-ft-high by 4-ft-wide baffle blocks between sta 150+40 and 148+34.

56. The supercritical channel must be adequately maintained to ensure that no unusual flow disturbances in the channel will create large energy losses resulting in subcritical flow. The channel wall heights will be designed for flow depths associated with supercritical flow and will not be adequate to contain subcritical flow. The Pinero Avenue Bridge is quite sensitive to flow obstructions. The minimum distance between the water surface and the bridge's soffit is 1.6 ft at the design discharge (44,600 cfs). If the channel is not adequately maintained in the vicinity of Pinero Avenue, the existing bridge will be overtopped with flows at the design discharge. It is recommended that the bridge be replaced with a new bridge having a larger flow area if channel maintenance cannot be guaranteed.

### The Josefina Channel Model

57. Tests were conducted to evaluate the flow conditions at the confluence with the Dona Ana Channel, curves, and grade breaks in the supercritical channel. The confluence provided an appropriate transition to converge the flow of the two channels (Josefina and Dona Ana). The oblique standing wave observed downstream of the confluence did not cause any adverse effects downstream and was considered acceptable. Curves in the proposed design maintained acceptable water-surface elevations throughout the test section. The grade breaks (16+20 and 15+00) from a mild to a steep to a very mild slope forced a hydraulic jump for all test conditions and were determined to be a satisfactory design. The proposed design as tested is the recommended supercritical channel design to provide rapid transit for floodwaters in this low-lying area.

### The Margarita Channel Model

58. Tests to determine the flow conditions in the vicinity of the De Diego Expressway Bridge indicated that the original design passed discharges less than or equal to 9,900 cfs under the bridge. The original design resulted in unacceptable flow conditions in the transition reach of the channel. The type 7 design transition, which consisted of a 1 on 8 transition flare in conjunction with a 3.25-ft-high sill placed at an angle on the channel invert between sta 52+77 and 52+50, was the best transition tested for distributing the flow in the transition across the channel width. Due to poor soil conditions, the transition is to be redesigned by the Savannah District. No model tests were conducted for the redesigned conditions.



Table 1

Water-Surface Elevations, Puerto Nuevo ChannelType 1 (Original) Design, n = 0.015

<u>Sta</u>	<u>Discharge</u> <u>cfs</u>	<u>Elevation, ft*</u>	
		<u>Left</u> <u>Side</u>	<u>Right</u> <u>Side</u>
277+57.59	26,000	57.0	57.5
277+00		57.2	56.9
276+50		56.5	56.6
276+00		55.5	55.7
275+50		55.5	55.2
275+00		55.1	55.3
274+40		54.1	53.9
274+15		53.1	55.0
274+00		54.1	54.3
273+50		54.1	54.1
273+00		53.3	54.1
272+71		53.1	54.1
272+43	34,100	55.6	54.1
272+15		52.1	54.1
271+72		51.7	54.1
271+19		55.3	54.1
270+19		—	54.1
270+31		52.9	—
269+85		55.8	—
269+68		—	56.0
269+25		51.6	—
269+00		—	52.0
268+76		54.1	—
268+50		53.8	53.8
268+00		55.6	—
267+41		—	51.2
267+15		—	54.0
267+00		53.9	54.4
266+29		51.5	51.3
265+76		55.4	—
265+00		50.7	52.9
264+50		51.3	51.0
264+10		55.3	—
264+00		—	51.2
263+25		54.3	47.1
262+68		—	52.6
262+50		52.8	—
262+00		52.2	48.6
261+38		—	48.8

(Continued)

Note: —denotes no data taken.

\* Sides of channel are referenced to downstream direction.

(Sheet 1 of 11)

Table 1 (Continued)

Sta	Discharge cfs	Elevation, ft		
		Left Side	Right Side	
261+29	34,100	56.3	—	
260+88	↓	—	48.5	
260+68		50.6	—	
260+26		55.1	50.2	
259+67		52.8	48.4	
259+45		53.1	—	
259+14		—	51.9	
258+50		50.2	—	
258+14		—	50.0	
257+96		54.3	—	
257+36		48.1	50.3	
256+89		52.4	52.1	
256+50		50.0	—	
256+14		51.4	48.7	
256+00		36,000	51.2	52.2
255+75		↓	50.6	—
255+65			—	50.6
255+30			51.9	—
255+26			—	51.2
254+75			49.5	—
254+28			—	51.2
254+07			50.6	—
253+76			—	49.5
253+00			49.7	49.8
252+50	48.8		49.5	
252+00	50.0		49.8	
251+50	49.0		49.1	
251+00	49.6		49.1	
250+50	49.0		49.3	
250+00	48.2		48.4	
249+50	48.1		48.5	
249+00	47.4		47.9	
248+50	48.4		48.7	
248+00	48.4		47.9	
247+50	48.3		47.4	
247+00	47.9		48.4	
246+62	—		47.8	
246+50	46.9		—	
245+95	47.4	—		
245+94	—	48.2		
245+28	45.7	—		
245+00	—	48.3		
244+66	46.8	47.9		
244+16	46.1	46.7		

(Continued)

(Sheet 2 of 11)

Table 1 (Continued)

<u>Sta</u>	<u>Discharge</u> <u>cfs</u>	<u>Elevation, ft</u>	
		<u>Left</u> <u>Side</u>	<u>Right</u> <u>Side</u>
243+62	36,000	46.3	—
243+50	↓	45.9	47.7
243+00		45.9	47.4
242+50		44.7	46.8
242+00		45.8	47.2
241+50		44.5	47.0
241+00		45.6	46.6
240+50		44.9	46.4
240+00		44.7	45.6
239+50		44.4	47.1
239+00		44.2	45.4
238+50		44.6	45.5
238+00		43.9	45.1
237+50		42.9	45.1
237+00		43.4	44.3
236+50		43.0	44.4
236+00		42.3	44.8
235+50		42.2	44.6
235+00		42.9	43.8
234+50		42.2	43.9
234+00		42.0	44.2
233+50		42.6	43.1
233+00		42.8	43.3
232+50		42.0	43.6
232+00		41.7	43.3
231+50		42.2	42.3
231+00		41.5	43.2
230+50		40.7	42.7
230+00		41.6	42.7
229+50		41.0	42.4
229+00		40.3	42.0
228+50		40.4	41.5
228+00		40.6	41.1
227+50	40.2	41.6	
227+00	39.9	41.3	
226+50	40.4	41.0	
226+00	39.6	41.3	
225+50	39.5	41.1	
225+00	39.6	40.6	
224+50	39.2	40.9	
224+00	38.7	40.5	
223+50	38.9	40.5	
223+00	38.7	40.0	
222+61	38.5	39.5	

(Continued)

(Sheet 3 of 11)

Table 1 (Continued)

Sta	Discharge cfs	Elevation, ft	
		Left Side	Right Side
222+00	36,000	38.8	38.7
221+50		38.7	38.8
221+00		38.6	38.9
220+50		38.5	38.6
220+00		38.6	38.0
219+71		—	36.2
219+38		37.7	—
219+22		—	38.0
219+06		37.3	37.6
218+63		36.5	—
218+50		—	34.4
218+09		39.2	—
218+00		—	34.5
217+72		—	35.0
217+39		—	34.6
217+29		35.9	—
216+82		—	35.9
216+77		38.0	—
216+39		36.4	—
216+19		—	32.3
216+00	37,900	37.7	33.1
215+50		37.6	34.1
214+84		—	35.1
214+79		35.0	—
214+50		36.1	33.9
214+00		37.9	32.2
213+88		38.1	—
213+55		—	30.8
213+00		35.9	—
212+88		—	34.6
212+50		34.7	33.9
212+00		36.0	31.4
211+73		36.0	32.1
211+50		36.7	32.2
210+82		—	35.5
210+79		32.1	—
210+50		32.6	35.2
209+69		—	32.1
209+64		36.3	—
209+18		33.3	32.6
208+70		—	37.0
208+50		30.4	36.0
208+20		29.6	—
207+87		30.9	35.5

(Continued)

(Sheet 4 of 11)

Table 1 (Continued)

Sta	Discharge cfs	Elevation, ft		
		Left Side	Right Side	
207+50	37,900	—	33.4	
207+47	↓	35.3	—	
207+00		33.3	31.4	
206+87		—	30.2	
206+50		34.0	32.1	
206+00		—	35.3	
205+84		30.0	—	
205+58		—	33.1	
205+39		42,100	27.9	—
205+11		↓	—	33.5
205+08			33.3	—
204+92			—	24.3
204+87			35.4	—
204+50			33.8	23.1
204+38			—	31.0
204+00			28.9	—
203+81			—	40.7
203+50			27.8	—
203+25			28.6	—
203+21			—	34.1
202+81			36.3	—
202+59	—		36.9	
202+28	—		35.4	
202+00	26.6		—	
201+77	—		38.4	
201+50	—		36.2	
201+37	33.4		—	
201+00	—		32.7	
200+87	29.8		—	
200+74	—	32.9		
200+58	29.8	—		
200+33	29.9	—		
200+32	—	36.2		
200+03	30.2	—		
200+00	—	34.4		
199+50	34.0	—		
199+38	—	29.2		
199+00	31.7	—		
198+76	—	36.0		
198+50	28.8	—		
198+25	—	31.8		
197+84	—	29.2		
197+68	33.5	—		
197+50	—	32.9		

(Continued)

(Sheet 5 of 11)

Table 1 (Continued)

Sta	Discharge cfs	Elevation, ft		
		Left Side	Right Side	
197+36	42,100 ↓	—	32.1	
197+06		—	30.8	
196+81		28.6	—	
196+66		—	34.7	
196+15		32.4	—	
195+94		—	29.0	
195+78		30.5	—	
195+44		30.4	—	
195+29		—	31.3	
194+89		—	32.4	
194+87		28.3	—	
194+50		29.2	—	
194+28		—	28.6	
194+03		31.0	—	
193+82		30.6	—	
193+41		—	30.4	
193+36		27.3	—	
193+00		29.0	—	
192+96		—	35.3	
192+63		30.4	—	
192+28	32.1	—		
192+08	42,100 ↓	—	25.5	
192+00		30.8	—	
191+68		—	27.3	
191+50		30.4	—	
191+24		—	30.3	
190+83		—	27.5	
190+82		28.1	—	
190+57		—	26.3	
190+30		33.0	—	
190+25		—	26.5	
190+00	30.9	27.0		
189+50	—	27.2		
189+46	43,300 ↓	28.5	—	
189+11		—	28.2	
188+68		30.3	—	
188+50		—	25.4	
188+15		28.9	—	
187+90		28.7	—	
187+68		—	27.8	
187+50		28.1	—	
187+00		44,600	28.1	25.7
186+50		44,600	—	24.9
186+47	44,600	30.1	—	

(Continued)

Table 1 (Continued)

Sta	Discharge cfs	Elevation, ft			
		Left Side	Center Line**	Right Side	
186+00	44,600	29.0	27.8	26.0	
185+57	↓	—	—	26.9	
185+50		26.9	26.9	—	
185+38		28.4	—	—	
185+00		—	—	26.5	—
184+94		—	—	—	25.0
184+88		29.6	—	—	—
184+57		—	—	—	24.6
184+50		29.6	27.3	—	—
184+00		—	—	27.5	25.9
183+78		26.6	—	—	—
183+66		—	—	—	27.9
183+50		—	—	26.7	—
183+09		27.9	—	—	—
183+00		—	—	24.6	23.9
182+50		27.7	24.6	—	22.4
182+00		25.3	24.0	—	21.8
181+84		23.7	—	—	—
181+72		—	—	—	21.0
181+68		24.8	—	—	—
181+63		—	—	—	21.8
181+50		—	—	22.4	—
181+33		24.4	—	—	—
181+00		24.1	21.6	—	21.0
180+58		22.9	—	—	—
180+50		—	—	21.8	19.9
180+00		—	—	19.2	18.7
179+89		21.6	—	—	—
179+50		21.5	—	19.2	18.7
179+25		—	—	—	18.1
179+00		—	—	19.5	—
178+65		21.4	—	—	—
178+50		—	—	18.7	16.6
178+32	22.5	—	—	—	
178+00	—	—	17.1	—	
177+82	—	—	—	17.3	
177+72	19.1	—	—	—	
177+50	—	—	18.1	—	
177+32	17.4	—	—	—	
177+00	—	—	17.1	17.4	

(Continued)

\*\* Center-line water-surface elevations were measured beginning at sta 186+00 to document clearance between the water surface and bridge soffits.

(Sheet 7 of 11)

Table 1 (Continued)

Sta	Discharge cfs	Elevation, ft		
		Left Side	Center Line	Right Side
176+95	44,600	18.6	—	—
176+50		19.2	16.2	17.5
176+00		19.3	16.4	15.3
175+77		—	17.5	—
175+54		19.3	17.1	13.8
175+31		20.6	—	—
175+13		20.1	—	—
175+00		—	—	13.0
174+85		—	17.1	—
174+71		18.9	—	—
174+59		—	—	17.2
174+50		—	17.4	—
174+16		—	18.2	—
174+15		20.2	—	—
174+00		—	17.7	—
173+96		—	—	14.3
173+80		—	—	14.0
173+63		—	19.1	—
173+57		—	—	17.9
173+38		15.2	—	—
173+20		19.6	—	—
173+19		—	15.5	—
172+73		—	—	17.8
172+50		—	—	21.5
172+23		—	17.8	—
172+00		15.7	—	—
171+88		—	—	15.7
171+75		—	19.3	—
171+50		—	—	17.2
171+39		20.2	—	—
171+09		—	15.5	—
171+00		17.1	—	19.3
170+50		17.7	18.7	15.7
169+95		—	16.0	—
169+94		16.6	—	—
169+93		—	—	19.0
169+23		18.7	—	—
169+22		—	—	17.3
169+21		—	16.9	—
168+50		18.0	17.3	16.5
168+35		18.5	—	—
168+13		—	14.1	—
168+00		—	—	15.9
167+71		14.7	17.0	—

(Continued)

(Sheet 8 of 11)

Table 1 (Continued)

Sta	Discharge cfs	Elevation, ft		
		Left Side	Center Line	Right Side
167+64	44,600	—	—	17.6
167+27		15.2	—	—
167+16		—	15.5	15.4
166+82		—	—	17.3
166+73		14.3	—	—
166+50		—	14.7	—
166+41		16.9	—	—
166+26		—	—	15.1
166+00		—	16.1	—
165+94		14.9	—	—
165+68		—	—	13.8
165+57		16.3	—	—
165+50		—	13.4	—
165+19		—	—	15.5
165+12		—	15.2	—
165+00		15.0	—	—
164+82		—	—	14.6
164+67		—	14.0	—
164+50		—	15.3	—
164+34		14.0	—	—
164+26		—	—	17.6
164+12		—	—	16.6
164+00		16.5	—	—
163+83		18.1	—	—
163+82		—	—	14.4
163+75		—	14.9	—
163+63		—	—	16.8
163+48		—	15.0	15.1
163+45		15.5	—	—
163+36		—	—	17.5
163+00		—	15.1	—
162+85		—	—	18.6
162+83		11.7	—	—
162+65	—	17.9	—	
162+22	—	—	18.8	
162+15	—	14.2	—	
162+08	11.2	—	—	
161+84	—	—	15.3	
161+66	13.4	—	—	
161+50	—	13.8	16.0	
161+19	10.5	—	—	
161+00	—	—	16.8	
160+68	—	15.3	—	
160+50	10.9	—	17.2	

(Continued)

Table 1 (Continued)

Sta	Discharge cfs	Elevation, ft			
		Left Side	Center Line	Right Side	
160+06	44,600	—	12.1	—	
160+00	↓	11.9	—	16.6	
159+50		10.8	14.0	15.0	
159+00		9.6	12.8	15.4	
158+50		12.9	12.9	16.3	
158+26		—	13.8	—	
158+04		—	—	15.3	
157+78		15.6	—	—	
157+63		—	21.3	—	
157+50		—	—	21.7	
157+43		—	19.4	—	
157+09		—	—	19.3	
156+29		13.7	—	—	
155+93		—	13.0	—	
155+80		12.5	—	—	
155+59		—	—	14.1	
155+50		11.7	—	—	
155+31		—	12.1	—	
155+00		—	9.9	—	
154+80		—	9.6	9.0	
154+61		—	—	9.7	
154+25		—	—	6.1	
154+00		44,900	6.1	5.7	—
153+80		↓	—	—	6.0
153+50			4.5	—	4.1
153+00			3.0	3.8	3.0
152+80			2.1	—	—
152+50			1.8	—	3.4
152+04			2.6	—	—
152+00			—	-0.1	1.8
151+50			0.0	-0.9	0.0
151+00	-2.5		—	—	
150+80	-2.6		-2.0	-2.6	
150+67	—		—	-1.9	
150+61	-1.6		—	—	
150+28	-1.6		—	—	
150+00	-1.2		-2.7	-1.6	
149+50	-0.8		-3.3	-0.9	
149+25	-1.1		—	—	
149+00	—		-1.9	—	
148+85	—		—	-0.6	
148+83	-0.5		—	—	
148+61	—		13.6	—	
148+40	10.6		—	—	

(Continued)

Table 1 (Concluded)

<u>Sta</u>	<u>Discharge</u> <u>cfs</u>	<u>Elevation, ft</u>		
		<u>Left</u> <u>Side</u>	<u>Center</u> <u>Line</u>	<u>Right</u> <u>Side</u>
148+27	44,900	—	—	12.9
148+00	↓	12.9	12.9	13.0
147+50		13.6	13.3	13.4
147+00		13.4	13.9	13.6
146+50		—	—	13.6
146+00		13.4	13.9	13.4
145+00		13.4	13.9	13.8
144+00		13.2	14.3	13.8
143+00		13.8	13.5	13.9
142+00		13.9	13.6	14.0
141+00		13.9	14.0	13.8
140+00		13.8	13.8	13.8
139+00		13.7	13.4	13.6
138+00		13.6	13.3	13.5

Table 2  
Water-Surface Elevations, Guaracanal Channel  
Type 1 (Original) Design, n = 0.015

<u>Sta</u>	<u>Discharge</u> <u>cfs</u>	<u>Elevation, ft*</u>		
		<u>Left</u> <u>Side</u>	<u>Right</u> <u>Side</u>	
6+50	8,000	58.0	57.8	
6+00	↓	57.6	57.7	
5+50		57.6	56.9	
5+00		57.0	56.8	
4+50		56.5	56.5	
4+00		56.3	56.1	
3+50		55.9	56.0	
3+00		55.8	55.9	
2+50		55.7	55.4	
2+08		55.4	55.4	
1+83		55.6	54.7	
1+32		56.5		
1+24			52.5	
0+50			55.2	52.7
0+00			52.9	54.8

\* Sides of channel are referenced to downstream direction.

Table 3

Water-Surface Elevations, Buena Vista Diversion ChannelType 1 (Original) Design, n = 0.015

<u>Sta</u>	<u>Discharge</u> <u>cfs</u>	<u>Elevation, ft*</u>	
		<u>Left</u> <u>Side</u>	<u>Right</u> <u>Side</u>
4+50	4,200	38.6	38.7
4+00		37.6	38.1
3+50		37.1	37.3
3+00		36.7	36.7
2+50		36.2	36.1
2+31		35.0	—
2+25		—	35.9
2+00		34.7	35.2
1+75		32.7	—
1+73		—	36.2
1+46		—	34.1
1+44		34.2	—
1+22		31.9	34.9
0+93		33.2	—
0+86		—	33.9
0+75		32.7	—
0+64		—	34.5
0+34		33.2	—
0+30		—	32.4
0+07		—	32.2
0+00		30.9	32.8

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\* Sides of channel are referenced to downstream direction.

Table 4  
Water-Surface Elevations, Puerto Nuevo Channel  
Type 1 (Original) Design with Debris on  
Bridge Piers, n = 0.015

Sta	Discharge cfs	Elevation, ft*		
		Left Side	Center Line	Right Side
180+00	44,600	21.9	19.6	18.5
179+50		21.7	18.4	18.5
179+00		20.4	19.1	17.6
178+50		—	17.7	16.2
178+41		22.1	—	—
178+23		—	—	16.6
178+00		20.8	16.1	—
177+50		—	—	21.5
177+25		—	25.3	—
177+16		14.6	—	—
177+00		—	—	21.9
176+76		—	22.7	—
176+56		30.9	—	—
176+50		—	—	22.0
176+09		—	26.5	—
176+00		27.2	—	22.0
175+62		—	21.0	—
175+54		26.9	—	23.4
175+19		—	25.1	—
175+13		21.0	—	—
175+00		—	—	24.5
174+86		—	25.0	—
174+68		28.7	—	—
174+58		—	—	24.9
174+50		—	22.6	—
174+15		—	20.4	—
174+07		19.5	—	—
173+91		—	—	24.3
173+75		—	29.6	—
173+50		29.3	—	25.7
173+32		—	23.0	—
173+00		—	28.9	26.3
172+71		24.0	—	—
172+50		—	27.0	26.2
172+35		28.7	—	—
172+00		—	26.7	26.3
171+87		23.8	—	—
171+50		—	26.5	26.5
171+43		26.2	—	—
171+00		—	29.3	27.0

(Continued)

\* Sides of channel are referenced to downstream direction

Table 4 (Continued)

Sta	Discharge cfs	Elevation, ft		
		Left Side	Center Line	Right Side
170+88	44,600	29.5	—	—
170+50		26.3	26.6	26.8
170+00		—	—	27.9
169+93		31.8	—	—
169+89		—	33.2	—
169+81		—	—	30.6
169+50		—	—	29.4
169+33		—	27.0	—
169+21		—	—	24.0
169+20		—	24.3	—
169+18		—	25.0	—
169+09		—	—	28.1
169+08		—	25.9	—
169+00		—	—	26.7
168+55		—	—	25.8
168+54		—	24.1	—
168+53		—	—	25.8
168+34		—	—	20.6
168+29		—	—	20.5
168+22		—	20.2	—
168+00		—	—	24.5
167+88		—	—	26.6
167+72		—	25.8	—
167+50		—	—	21.7
167+27		—	21.0	—
167+00		—	—	24.1
166+92		—	26.5	—
166+50		—	22.0	24.0
166+21		—	26.3	—
166+00		—	—	24.7
165+85		—	23.0	—
165+50		—	26.4	25.9
165+00		—	25.8	25.0
164+83		—	25.9	—
164+81		—	—	24.3
164+79		—	—	26.4
164+50		—	—	24.5
164+17		—	—	17.9
164+12		—	—	16.2
163+84		—	13.5	—
163+78		—	—	16.7
163+48		—	—	16.0
163+41		—	19.0	—
163+35		—	—	16.8
163+34	—	—	14.8	

(Continued)

(Sheet 2 of 3)

Table 4 (Concluded)

<u>Sta</u>	<u>Discharge</u> <u>cfs</u>	<u>Elevation, ft</u>		
		<u>Left Side</u>	<u>Center Line</u>	<u>Right Side</u>
162+90	44,600	—	21.6	—
162+84	↓	9.1	—	—
162+76		—	23.0	—
162+50		—	—	22.2
162+43		22.0	—	—
162+00		17.9	22.3	21.6
161+50		21.0	20.0	22.0
161+00		15.9	22.2	21.3
160+63		20.5	—	—
160+50		—	19.7	21.5
160+00		21.0	19.8	22.4
159+50		19.7	23.7	22.5
159+18		21.9	—	—
159+00		—	24.0	22.8
158+50		—	21.2	22.3
158+18		19.5	—	—
158+04		—	—	23.0
158+00		22.4	22.0	—
157+79		22.8	—	—
157+57		—	25.2	—
157+50		—	—	23.7
157+10	—	—	22.6	
156+29	13.9	—	—	
156+00	14.3	—	—	
155+80	—	12.9	—	
155+50	—	13.1	13.3	
155+38	9.7	—	—	
155+00	11.5	10.0	10.7	
154+69	44,900	11.0	—	
154+50	44,900	—	8.7	
154+31	44,900	7.7	—	
154+00	44,900	6.2	5.6	

Table 5

Water-Surface Elevations, Puerto Nuevo ChannelType 2 Design Channel, Type 4 DesignConfluence Wall, n = 0.015

Sta	Discharge cfs	Elevation, ft*		
		Left Side	Center Line	Right Side
210+00	37,900	35.5	33.8	33.4
209+50		36.2	34.1	32.3
209+14		—	—	32.9
209+00		32.7	34.2	—
208+71		—	—	38.2
208+50		30.5	34.8	37.2
208+29		—	37.1	—
208+13		29.8	—	—
208+00		29.8	33.5	36.3
207+50		—	33.8	33.9
207+44		35.8	—	—
207+00		33.7	32.9	31.6
206+78		—	—	30.2
206+50		34.0	34.2	32.3
206+14		—	31.3	—
206+00		—	—	35.4
205+95		30.7	—	—
205+63		—	36.2	—
205+62		30.9	—	—
205+58		—	—	33.0
205+31	31.7	—	—	
205+17	—	31.9	—	
205+00	33.6	—	—	
204+91	—	—	34.0	
204+88	32.8	—	—	
204+81	42,100	33.5	—	—
204+76		—	32.3	—
204+50		—	32.9	—
204+45		—	—	31.2
204+37		32.4	—	—
204+00		28.5	31.9	—
203+85		—	—	38.5
203+74		27.5	—	—
203+50		27.4	35.2	37.7
203+27		—	37.7	—
203+00		28.1	—	35.1
202+69		—	31.2	34.2
202+50		33.9	—	34.4
202+23		—	—	34.0
202+20		—	33.7	—

(Continued)

\* Sides of channel are referenced to downstream direction.

Table 5 (Concluded)

<u>Sta</u>	<u>Discharge</u> <u>cfs</u>	<u>Elevation, ft</u>		
		<u>Left Side</u>	<u>Center Line</u>	<u>Right Side</u>
202+00	42,100	27.5	—	35.2
201+77	↓	—	33.0	—
201+72		26.0	—	—
201+50		—	32.5	37.3
201+11		30.8	—	—
201+00		—	32.0	33.8
200+78		29.5	—	—
200+50		—	32.5	32.6
200+36		32.0	—	—
200+00		—	30.8	32.3
199+92		29.8	—	—
199+50		—	—	31.8
199+00		31.6	32.4	30.0
198+50		—	—	32.7
198+14		—	—	31.3
198+00		29.9	30.6	—
197+82		—	—	33.1
197+50		—	—	29.3
197+00		31.6	30.5	31.8
196+50		—	—	30.6
196+00		30.2	30.1	31.6
195+00	30.1	29.5	29.7	
194+00	28.6	29.2	29.8	
193+00	28.7	28.6	28.1	

Table 6

Water-Surface Elevations, Puerto Nuevo Channel, Type 2 DesignPinero Avenue Bridge Piers, Type 3 Design, Las AmericasExpressway Bridge Piers, n = 0.015

Sta	Discharge cfs	Elevation, ft*		
		Left Side	Center Line	Right Side
179+00	44,600	20.6	20.3	17.2
178+50		22.0	18.4	15.9
178+00		20.4	17.5	16.8
177+50		18.0	19.0	16.1
177+00		18.3	16.5	17.1
176+50		19.0	15.9	17.1
176+00		19.6	16.5	15.0
175+55		19.5	—	13.3
175+50		—	16.8	—
175+12		20.2	—	—
175+00		—	—	12.5
174+84		—	17.0	—
174+70		18.8	—	—
174+59		—	—	16.9
174+55		19.2	—	—
174+50		—	17.0	—
174+27		20.1	—	—
174+17		—	18.6	—
174+00		18.8	—	—
173+91		—	—	13.9
173+65		—	14.8	—
173+60		—	—	17.6
173+50		15.3	—	—
173+29		14.9	16.9	—
173+00		—	—	17.0
172+71		19.3	—	—
172+50		—	—	20.1
172+12		—	17.5	—
172+00		15.0	—	15.7
171+73		—	19.8	—
171+50		—	—	16.5
171+44		20.2	—	—
171+16		—	—	19.0
171+12		—	15.8	—
171+00		17.1	—	—
170+50		17.2	18.7	15.7
170+21		16.2	—	—
170+19		—	—	16.2
170+00		—	17.0	18.7

(Continued)

\* Sides of channel are referenced to downstream direction.

(Sheet 1 of 3)

Table 6 (Continued)

Sta	Discharge cfs	Elevation, ft			
		Left Side	Center Line	Right Side	
169+95	44,600	17.0	—	—	
169+30		18.8	—	—	
169+28		—	—	17.5	
169+23		—	—	16.7	
169+14		17.3	—	—	
168+50		18.0	—	17.3	16.7
168+13		—	—	14.1	—
168+00		16.8	—	—	15.7
167+79		14.6	—	—	—
167+73		—	—	—	16.1
167+69		—	—	16.9	—
167+50		—	—	—	16.0
167+22		16.2	—	—	—
167+21		—	—	—	15.1
167+00		—	—	15.2	—
166+95		—	—	—	17.7
166+79		14.2	—	—	—
166+50		—	—	15.0	15.2
166+40		16.7	—	—	—
166+00		14.5	—	16.0	14.0
165+50		16.3	—	13.6	13.6
165+21		—	—	—	15.0
165+00		14.8	—	15.5	14.7
164+82		—	—	—	14.1
164+50		14.2	—	15.0	—
164+32		14.2	—	—	—
164+18		—	—	17.8	—
164+13		—	—	—	16.7
164+00		15.6	—	—	—
163+81		—	—	15.8	—
163+71		17.2	—	—	—
163+50		—	—	14.8	14.8
163+45		14.9	—	—	—
163+30		—	—	—	18.3
163+00		11.6	—	16.2	17.3
162+61		—	—	18.8	—
162+50	11.0	—	—	17.7	
162+00	10.4	—	14.5	17.0	
161+50	13.3	—	—	—	
161+00	10.5	—	15.5	17.2	
160+50	11.0	—	—	—	
160+00	11.7	—	12.7	16.9	
159+50	10.5	—	14.2	—	
159+00	10.0	—	13.5	16.1	

(Continued)

(Sheet 2 of 3)

Table 6 (Concluded)

<u>Sta</u>	<u>Discharge</u> <u>cfs</u>	<u>Elevation, ft</u>			
		<u>Left Side</u>	<u>Center Line</u>	<u>Right Side</u>	
158+61	44,600	—	14.3	—	
158+50	↓	10.0	—	17.7	
158+00		11.0	19.8	16.1	
157+79		11.7	—	—	
157+72		—	—	15.5	
157+50		—	18.1	17.1	
157+10		—	—	17.1	
156+29		12.6	—	—	
156+00		12.4	—	—	
155+92		—	13.9	—	
155+59		—	—	13.2	
155+50		12.6	11.5	—	
155+00		12.0	11.6	9.0	
154+50		44,900	9.5	9.0	9.0
154+00		7.0	6.4	7.3	
153+50		3.8	4.9	3.9	
153+00		1.6	4.7	2.9	
152+50		2.5	2.3	1.9	
152+00		1.3	0.2	2.1	
151+00		↓	-2.0	-2.0	-2.1

Table 7

Water-Surface Elevations, Puerto Nuevo Channel, Type 2 Design Pinero  
Avenue Bridge Piers, Type 3 Design Las Americas Expressway  
Bridge Piers with Debris on Bridge Piers,  $n = 0.015$

Sta	Discharge cfs	Elevation, ft*		
		Left Side	Center Line	Right Side
179+00	44,600	20.4	19.9	16.9
178+50		—	—	15.9
178+37		22.4	—	—
178+00		19.9	17.5	17.0
177+50		—	—	16.3
177+25		17.0	—	—
177+00		—	15.7	17.3
176+93		18.4	—	—
176+50		18.7	—	17.0
176+00		19.3	16.1	15.0
175+62		—	—	13.1
175+50		19.5	16.9	—
175+43		—	—	16.8
175+14		20.3	—	—
175+00		—	—	18.6
174+86		—	20.9	—
174+80		21.2	—	—
174+74		—	—	18.5
174+66		—	—	19.6
174+57		25.5	—	—
174+50		—	24.8	—
174+32		—	—	19.8
174+26		20.6	—	—
174+09		—	15.7	—
174+00		16.6	—	—
173+91		—	—	14.9
173+65		—	21.1	—
173+62		21.6	—	—
173+29		—	16.4	—
173+13		—	20.4	—
173+00		17.0	20.1	18.9
172+67		—	16.7	—
172+50		17.4	—	—
172+00		20.5	—	18.8
171+66		—	17.5	—
171+50		17.8	—	—
171+00		21.3	20.4	19.6
170+50		17.2	17.1	17.5

(Continued)

\* Sides of channel are referenced to downstream direction.

(Sheet 1 of 3)

Table 7 (Continued)

Sta	Discharge cfs	Elevation, ft		
		Left Side	Center Line	Right Side
170+00	44,600	20.0	19.7	18.9
169+27		—	—	16.8
169+22		—	17.9	—
169+21		17.6	—	—
168+50		17.9	17.6	16.9
168+17		—	15.5	—
168+00		15.5	—	17.2
167+80		—	17.6	—
167+50		16.7	15.8	—
167+00		14.8	16.5	16.9
166+50		20.3	—	20.2
166+33		—	22.3	—
166+15		—	21.1	—
166+00		25.2	—	20.8
165+82		—	24.2	—
165+50		19.3	—	—
165+42		—	20.0	—
165+00		25.1	21.3	25.2
164+82		—	21.8	—
164+75		25.8	—	—
164+62		—	—	22.8
164+34		24.4	—	—
164+14		—	—	21.4
164+00		20.3	18.5	—
163+74		—	—	18.6
163+73		14.0	—	—
163+45		19.2	—	—
163+26		—	—	21.5
163+00		17.0	20.2	—
162+68		21.9	—	—
162+50		—	—	20.2
162+18		16.8	—	—
162+00		—	20.3	19.9
161+94		14.4	—	—
161+50		18.8	—	—
161+00		17.5	20.3	21.8
160+50		17.3	—	—
160+00		17.7	21.0	21.3
159+50		19.8	—	22.2
159+00		20.8	22.0	22.8
158+75		—	22.7	—
158+61		—	—	22.8
158+50		19.0	20.8	—
158+00		14.8	11.4	10.9
157+82		13.2	—	—

(Continued)

(Sheet 2 of 3)

Table 7 (Concluded)

<u>Sta</u>	<u>Discharge</u> <u>cfs</u>	<u>Elevation, ft</u>			
		<u>Left Side</u>	<u>Center Line</u>	<u>Right Side</u>	
157+68	44,600	—	16.4	—	
157+50	↓	—	—	14.0	
157+31		—	12.2	—	
157+11		—	12.1	—	
156+27		13.6	—	—	
155+91		15.2	—	—	
155+86		—	—	13.2	
155+50		9.7	10.6	12.8	
155+00		13.6	11.5	11.0	
154+50		44,900	10.1	8.0	9.3
154+00		↓	6.8	7.5	5.6
153+00	2.2		4.0	2.8	
152+00	1.2		0.0	0.9	
151+00	-2.6		-1.6	-2.1	

Table 8

Water-Surface Elevations, Entire Reach of Channel, Type 2 Design Puerto Nuevo  
Channel, Type 3 Design Puerto Nuevo/Buena Vista Diversion Channel  
Confluence Wall, Type 2 Design Pinero Avenue Bridge Piers, Type 3  
Design Las Americas Expressway Bridge Piers, Type 4 Design  
Baffle Blocks, n = 0.012

Sta	Discharge cfs	Elevation, ft*		
		Left Side	Center Line	Right Side
277+57.59	26,100	55.9	55.5	56.8
277+00		55.7	55.9	55.8
276+00		55.0	54.5	54.9
275+00		53.7	54.0	53.4
274+00		53.2	52.5	53.0
273+00		52.2	51.9	51.3
272+71		52.7	50.8	50.6
272+50	34,100	54.3	51.9	55.7
272+00		51.0	51.8	50.1
271+50		49.9	55.8	53.0
271+10		—	51.2	—
271+00		—	—	54.0
270+81		—	49.1	—
270+60		51.8	—	—
270+00		51.1	52.4	50.1
269+50		52.7	51.6	49.3
269+23		57.1	—	—
269+00		—	50.4	—
268+84		—	—	53.5
268+56		—	50.4	—
268+50		49.9	—	—
268+00		50.4	54.7	51.0
267+50		50.0	49.4	52.3
267+00		53.6	50.8	51.3
266+50		51.1	52.1	48.5
265+50		52.8	50.3	51.8
264+79		48.4	52.1	50.7
263+63		55.4	48.9	47.3
262+79		—	52.3	—
262+50		53.9	—	44.9
262+00		51.1	48.5	51.3
261+50		51.5	—	47.1
261+42		—	52.9	—
261+00		50.8	—	46.3
260+80		—	47.6	—

(Continued)

\* Sides of channel are referenced to downstream direction.

(Sheet 1 of 5)

Table 8 (Continued)

Sta	Discharge cfs	Elevation, ft		
		Left Side	Center Line	Right Side
260+50	34,100 ↓ 36,000 ↓	—	47.2	47.0
260+33		56.5	—	—
260+00		—	49.2	45.1
259+67		49.2	—	45.7
259+28		51.2	47.9	49.8
258+79		—	47.7	—
258+50		47.2	50.0	49.1
258+00		46.9	49.1	47.6
257+50		52.8	47.2	48.0
257+00		46.9	47.2	47.6
256+50		49.2	49.4	46.6
256+00		47.5	49.0	49.4
255+00		49.1	47.4	47.1
254+00		46.5	48.0	46.4
253+00		46.5	46.4	47.6
252+00		47.4	45.9	46.7
251+00		44.4	47.3	46.4
250+00		47.4	45.9	46.1
249+00		46.3	46.2	45.2
248+00		44.8	46.2	45.5
247+00	46.5	44.3	45.6	
246+62	44.8	45.6	44.1	
246+00	43.3	44.7	46.9	
245+00	42.8	44.7	45.3	
244+00	44.6	43.9	44.7	
243+00	42.5	44.2	45.1	
242+00	42.1	44.0	44.0	
241+00	41.9	42.6	45.3	
240+00	41.0	42.8	44.8	
239+00	41.5	43.1	43.0	
238+00	41.3	41.7	43.8	
237+00	40.5	42.2	42.6	
236+00	39.9	42.2	41.7	
235+00	39.8	40.5	42.4	
234+00	39.5	40.5	41.5	
233+00	39.1	41.1	40.9	
232+00	39.8	39.7	41.6	
231+00	38.9	39.7	40.6	
230+00	38.2	39.9	39.6	
229+00	38.2	38.3	40.4	
228+00	37.5	38.5	40.3	
227+00	36.9	39.2	38.9	
226+00	37.1	37.9	39.8	
225+00	37.0	37.5	39.1	

(Continued)

(Sheet 2 of 5)

Table 8 (Continued)

Sta	Discharge cfs	Elevation, ft		
		Left Side	Center Line	Right Side
224+00	36,000	35.9	38.0	38.3
223+00		36.3	36.9	38.0
222+61		35.7	37.5	37.4
222+00		37.4	36.1	36.8
221+00		36.3	35.8	35.9
220+35		35.7	35.8	37.7
219+72		34.8	36.2	30.2
219+11		36.5	33.8	35.9
218+50		35.3	35.2	32.6
218+00		35.9	36.2	32.4
217+50		38.4	33.7	32.1
216+68		34.7	34.6	31.5
215+88	37,900	36.6	33.7	35.1
215+40		36.1	34.7	30.7
215+00		36.1	35.3	30.5
214+36		36.2	32.9	32.0
213+00		35.8	33.2	31.4
211+73		34.0	33.7	30.5
211+00		32.7	31.5	34.1
210+00		30.9	32.6	33.2
209+33		34.8	32.5	31.7
209+00		32.5	32.5	31.3
208+50		29.1	32.5	34.6
208+00		27.9	31.7	38.5
207+50		—	35.0	—
207+22		28.3	32.9	33.3
206+77		38.9	30.8	28.5
206+07		31.7	34.8	28.7
205+00	42,100	29.6	29.8	40.7
204+88		27.8	35.8	31.1
204+50		27.3	33.4	31.2
204+00		34.7	28.7	33.1
203+00		23.9	35.9	37.9
202+50		21.3	31.3	40.7
201+89		33.3	31.3	33.7
201+00		28.2	32.3	33.7
200+25		25.8	29.6	36.3
199+33		40.8	29.0	27.7
199+00		32.8	33.3	28.4
198+50		26.5	28.7	30.0
198+05		28.0	28.8	37.4
197+50		27.0	29.0	28.8
196+50		31.9	27.2	27.0
195+89		28.9	30.8	26.8
195+17		26.3	26.8	31.9

(Continued)

(Sheet 3 of 5)

Table 8 (Continued)

Sta	Discharge cfs	Elevation, ft			
		Left Side	Center Line	Right Side	
194+30	42,100	26.7	28.9	26.2	
193+64	↓	31.6	27.4	27.5	
193+00		26.5	27.7	27.7	
192+00		29.5	26.4	26.2	
191+00		29.1	27.2	23.1	
190+50		27.7	26.7	28.1	
189+50		28.1	27.0	24.7	
188+64		43,300	30.3	26.2	23.7
188+00		43,300	26.2	26.5	24.8
187+50		43,300	27.3	25.4	26.1
186+14		44,700	29.6	26.0	21.8
185+25	↓	26.7	24.6	24.6	
184+50		25.7	24.5	23.0	
184+00		25.8	25.4	22.6	
183+50		27.3	23.9	21.6	
182+50		23.9	22.3	21.4	
181+50		23.3	20.9	19.6	
180+75		23.3	19.7	17.4	
180+00		20.8	19.4	17.1	
179+00		19.5	18.3	17.0	
178+00		20.3	16.2	14.9	
177+18		17.0	16.2	15.7	
176+91		18.4	16.1	15.5	
176+00		18.8	15.2	14.9	
175+16		17.2	16.6	13.6	
174+00		17.8	19.2	—	
173+87		—	—	13.3	
173+43		13.9	17.6	17.5	
172+64		17.6	16.2	15.8	
172+22		16.7	15.6	19.0	
171+75		13.3	16.8	14.7	
171+45		—	19.4	—	
171+00		18.9	—	—	
170+73		—	13.6	17.3	
170+00		15.5	17.1	14.3	
169+21		16.0	16.5	16.2	
168+25		15.2	15.0	13.2	
167+75		13.9	15.1	15.4	
167+00		14.2	13.0	14.2	
166+00		14.0	13.1	13.5	
165+00		15.0	13.3	12.5	
163+48		15.5	14.7	12.8	
163+00		10.0	14.8	16.2	
162+25		8.8	14.9	19.0	
162+00		6.6	16.3	17.0	

(Continued)

(Sheet 4 of 5)

Table 8 (Concluded)

Sta	Discharge cfs	Elevation, ft			
		Left Side	Center Line	Right Side	
161+50	44,700 ↓	5.9	13.0	16.6	
161+00		11.6	12.8	15.3	
160+00		8.0	12.0	15.0	
159+00		6.1	11.6	15.8	
158+50		6.5	13.5	15.3	
158+00		8.2	13.6	14.5	
157+50		—	13.5	13.2	
156+25		8.7	—	—	
155+50		9.7	9.3	11.6	
155+00		9.2	9.1	8.2	
154+00		44,900 ↓	6.8	5.3	3.2
153+00			2.0	4.2	2.1
152+00			0.2	-0.9	1.9
151+00			-2.8	-2.9	-1.1
150+80			-3.1	—	-1.3
150+57	—		-3.7	—	
150+36	10.7		—	—	
150+22	—		—	13.2	
150+12	—		31.2	—	
150+10	6.9		—	—	
149+84	11.0		—	—	
149+76	—		—	8.6	
149+67	—		6.7	—	
149+50	11.4		—	—	
149+35	—		14.4	—	
149+33	—		—	12.2	
149+00	12.6		12.7	12.6	
148+50	12.5		12.4	12.8	
148+00	13.5		13.2	12.0	
147+50	13.2		13.1	12.9	
147+00	12.7		12.8	14.1	
146+50	—		13.0	13.6	
146+00	13.4		12.7	13.2	
145+50	—		—	13.5	
145+00	13.7		14.0	13.6	
144+00	13.6	13.7	13.9		
143+00	13.4	13.2	14.4		
142+00	13.4	13.1	13.3		
141+00	14.0	13.6	13.5		
140+00	13.9	13.4	13.9		
139+00	14.0	13.8	14.1		
138+00	13.6	14.2	14.0		

Table 9

Water-Surface Elevations, Guaracanal ChannelType 1 (Original) Design, n = 0.012

<u>Sta</u>	<u>Discharge</u> <u>cfs</u>	<u>Elevation, ft*</u>	
		<u>Left</u> <u>Side</u>	<u>Right</u> <u>Side</u>
6+00	8,000 ↓	53.7	54.2
5+00		54.1	54.5
4+00		53.5	53.7
3+00		53.0	53.3
2+08		52.4	52.4
1+60		53.4	48.1
1+21		55.3	48.7
0+50		52.8	50.7
0+00		50.6	52.0

\* Sides of channel are referenced to downstream direction.

Table 10

Water-Surface Elevations, Buena Vista Diversion ChannelType 2 Design, n = 0.012

<u>Sta</u>	<u>Discharge</u> <u>cfs</u>	<u>Elevation, ft*</u>	
		<u>Left</u> <u>Side</u>	<u>Right</u> <u>Side</u>
4+50	4,200 ↓	37.8	37.5
3+50		35.6	36.1
3+00		35.5	34.8
2+50		34.6	34.1
2+00		33.3	33.9
1+68		31.1	35.6
1+35		32.4	33.5
1+00		30.2	34.3
0+50		30.4	31.7
0+00		30.6	32.0
0-14		30.0	--
0-20		--	32.8
0-40		33.4	30.5
0-69		30.7	31.3

\* Sides of channel are referenced to downstream direction.

Table 11

Water-Surface Elevations, Puerto Nuevo Channel, Type 2 Design Pinero  
Avenue Bridge Piers, Type 3 Design Las Americas Expressway  
Bridge Piers with Debris on Bridge Piers, n = 0.012

Sta	Discharge cfs	Elevation, ft*		
		Left Side	Center Line	Right Side
179+00	44,700	19.4	18.3	16.9
178+00		20.2	16.2	14.8
177+18		17.0	16.3	15.7
176+91		18.4	16.1	15.5
176+00		18.8	15.0	15.0
175+40		17.3	15.9	13.7
175+15		17.5	—	17.3
175+00		—	17.7	—
174+66		—	—	20.0
174+62		25.6	—	—
174+50		—	24.9	—
174+00		15.4	—	—
173+89		—	14.6	—
173+74		—	—	15.1
173+50		22.6	19.6	16.0
173+13		—	—	19.1
173+00		—	15.4	—
172+50		15.2	—	17.7
172+15		—	19.3	—
172+00		18.1	—	—
171+50		19.4	—	17.8
171+42		—	15.8	—
170+86		15.9	—	—
170+75		—	—	15.4
170+46		19.4	—	—
170+45		—	—	18.2
170+00		15.9	17.2	18.1
169+90		—	18.0	—
169+22		17.5	16.1	16.3
168+50		15.6	16.0	16.6
167+00		14.1	14.5	14.7
166+00		14.5	14.2	13.6
165+50		14.2	14.2	13.7
165+00		20.2	16.7	19.4
164+71		—	29.8	—
164+40		26.0	—	—
164+11		—	19.0	—
164+00		—	—	16.9
163+81		13.6	—	—
163+59		—	15.7	—

(Continued)

\* Sides of channel are referenced to downstream direction.

Table 11 (Concluded)

<u>Sta</u>	<u>Discharge</u> <u>cfs</u>	<u>Elevation, ft</u>		
		<u>Left Side</u>	<u>Center Line</u>	<u>Right Side</u>
163+50	44,700	—	—	17.8
163+47	↓	17.2	—	—
163+19		—	—	14.6
163+00		—	15.0	—
162+71		10.6	—	18.4
162+28		11.8	—	—
162+20		—	16.5	—
162+00		—	—	16.7
161+50		11.7	14.1	—
161+00		—	13.4	15.5
160+37		—	14.3	—
160+23		9.5	—	—
160+00		12.7	—	16.1
159+65		—	14.6	—
159+50		15.5	—	19.3
159+31		—	22.5	—
159+00		—	—	21.8
158+61		17.1	19.5	22.1
158+25		—	—	21.5
157+87		7.8	—	14.1
157+86		—	12.5	—
157+50		—	16.8	16.9
157+13		—	—	14.3
156+18		9.0	—	—
155+75		11.9	—	—
155+00		10.4	11.0	8.1
154+00	44,900	8.5	7.0	4.9
153+00	44,900	5.7	7.9	5.8
152+00	44,900	6.1	5.0	7.9
151+00	44,900	5.2	5.1	6.9

Table 12  
Water-Surface Elevations, Puerto Nuevo Channel  
Type 2 Design Channel Without Baffle Blocks,  
n = 0.012

<u>Sta</u>	<u>Discharge</u> cfs	<u>Elevation ft*</u>		
		<u>Left Side</u>	<u>Center Line</u>	<u>Right Side</u>
152+50	44,900	0.2	1.2	0.0
152+00		0.2	-1.0	1.7
151+50		-0.7	-2.4	-0.8
151+00		-1.5	-3.0	-1.3
150+80		-0.4	-3.2	-1.4
150+50		-2.0	-4.3	-1.1
150+00		-2.2	-5.0	-1.4
149+50		-2.3	-3.0	-1.9
149+00		-2.4	-2.3	-1.4
148+50		-2.9	-2.3	-2.5
148+00		-3.9	-1.2	-3.8
147+50		-3.5	-2.1	-4.3
147+00		-1.4	-1.9	-3.8
146+50		-1.2	-2.3	-2.0
146+00		-0.9	-3.3	-2.5
145+50		-1.7	-2.9	-1.5
145+27		-1.7	—	—
145+00		3.7	—	—
144+80		—	-1.4	—
144+75		8.5	—	-2.9
144+33		—	20.1	—
144+28		—	—	10.4
144+00		9.2	—	11.9
143+60		—	5.9	—
143+50		10.6	—	11.9
143+11		—	15.0	—
143+00		10.2	—	12.4
142+50		10.6	7.3	12.8
142+35		—	16.5	—
142+00		12.2	7.7	11.4
141+50		—	16.9	13.4
141+00		13.4	8.5	12.9
140+55		—	17.5	—
140+50		—	—	13.9
140+00		13.6	9.9	14.0
139+50		—	17.9	—
139+00		14.5	10.6	14.6
138+50		—	17.0	—
138+00		15.4	9.3	14.2

\* Sides of channel are referenced to downstream direction.

Table 13  
Water-Surface Elevations, Puerto Nuevo Channel  
Type 2 Design, Type 6 Baffle Blocks  
n = 0.012

<u>Sta</u>	<u>Discharge</u> <u>cfs</u>	<u>Elevation, ft*</u>		
		<u>Left Side</u>	<u>Center Line</u>	<u>Right Side</u>
151+25	44,900 ↓	-2.0	-3.1	-2.5
151+00		-2.6	-3.0	-3.0
150+50		13.3	—	—
150+35		—	16.5	14.9
150+25		11.2	—	—
150+00		11.5	—	—
149+90		—	9.1	—
149+82		—	—	10.5
149+61		—	15.2	—
149+50		13.3	—	—
149+43		—	—	15.6
149+26		—	10.0	—
149+05		—	—	10.4
149+00		14.7	13.9	—
148+77		—	—	15.8
148+50		14.6	13.4	—
148+40		—	—	11.2
148+08		—	—	15.0
148+00		14.7	13.5	—
147+72		—	—	11.8
147+48		—	—	16.0
147+25		—	—	11.7
147+00		14.0	9.7	14.5
146+50		—	—	13.7
146+00		14.4	13.4	13.4
145+50		—	—	15.1
145+00		15.2	13.5	15.0
144+00		15.0	14.4	15.5
143+00		14.3	13.7	14.9
142+00		14.2	13.8	15.2
141+00	15.2	14.0	15.3	
140+00	15.7	14.5	15.9	
139+00	15.9	14.5	15.7	
138+00	15.5	14.3	16.2	

\* Sides of channel are referenced to downstream direction.

Table 14

Water-Surface Elevations, Margarita Channel, Type 1 (Original) Design,

n = 0.015 Average Depth at Sta 68+00 = 12.32 ft, Average

Depth at Sta 50+00 = 19.38 ft

Sta	Discharge cfs	Elevation, ft*	
		Left Side	Right Side
67+00	8,800	10.2	10.5
66+00		9.8	9.8
65+00		9.3	9.5
64+16.63		9.0	9.5
63+82		7.4	11.0
63+08		8.1	10.8
62+49.41		10.4	12.4
62+00		8.9	9.1
61+00		7.5	7.9
60+10.68		7.3	7.0
59+76		9.2	5.5
59+02		8.5	4.4
58+16		8.3	4.6
58+00		7.0	3.8
57+10		-6.6	-5.7
56+52.25		-5.4	-7.1
56+00		-7.2	-5.1
55+26		-4.9	-6.8
55+00		-5.6	-5.8
54+60		-4.3	-6.3
53+47.45		-6.1	-4.5
53+19		-2.1	-6.7
52+75		6.5	0.6
52+00		5.3	3.3
51+71		6.7	3.5
51+60		1.1	—
51+50		7.7	—
51+25		1.1	—
51+00		7.6	3.8
50+75		0.8	—
50+50		7.6	—
50+40		—	4.4
50+00		0.6	—
49+50		7.6	—
49+00		—	4.8

\* Sides of channel are referenced to downstream direction.

Table 15

Water-Surface Elevations, Margarita Channel, Type 1 (Original) Designn = 0.015 , Average Depth at Sta 68+00 = 12.32 ft, Average Depthat Sta 50+00 = 21.02 ft, (Tailwater ElevationIncreased 1.64 ft)

Sta	Discharge cfs	Elevation, ft*	
		Left Side	Right Side
67+00	8,800	10.2	10.5
66+00		9.8	9.8
65+00		9.3	9.5
64+16.63		9.0	9.5
63+82		7.4	11.0
63+08		8.1	10.8
62+49.41		10.4	12.4
62+00		8.9	9.1
61+00		7.5	7.9
60+10.68		7.3	7.0
59+76		9.2	5.5
59+02		8.5	4.4
58+16		8.3	4.6
58+00		7.0	3.8
57+10		-6.6	-5.7
56+52.25		-5.4	-7.1
56+00		-7.2	-5.1
55+26		-4.9	-6.8
55+00		-5.5	-5.9
54+00		-4.3	-6.2
53+47.45		4.9	3.9
53+00		5.5	7.3
52+00		4.3	6.5
51+92		2.7	—
51+80		7.5	6.7

\* Sides of channel are referenced to downstream direction.

Table 16

Water-Surface Elevations, Margarita Channel, Type 1 (Original) Designn = 0.015 , Average Depth at Sta 67+00 = 11.06 ft, Average Depthat Sta 50+00 = 19.85 ft

Sta	Discharge cfs	Elevation, ft*	
		Left Side	Right Side
67+00	7,400	8.7	8.8
66+00		8.2	8.2
65+00		7.6	7.7
64+16.63		6.8	7.8
63+58		5.6	8.4
63+00		7.3	8.6
62+49.41		8.6	10.7
62+00		7.0	7.2
61+00		5.8	6.2
60+10.68		5.9	5.2
59+55		6.7	4.0
59+00		6.5	2.7
58+21		6.8	3.1
58+00		5.2	2.7
57+10		-8.0	-7.0
56+00		-7.9	-6.7
55+00		-6.8	-7.2
54+81		-7.4	-6.2
54+39		3.7	3.8
54+00		4.4	4.0
53+47.45		4.6	4.1
53+00		8.4	4.1
52+00		3.6	4.7
51+00		5.1	5.0
50+40		5.8	5.0
50+00		5.3	5.0
49+00		5.2	5.1

\* Sides of channel are referenced to downstream direction.

Table 17

Water-Surface Elevations, Margarita Channel,  $n = 0.015$  ,  
Average Depth at Sta 68+00 = 11.08 ft, Average Depth  
at Sta 50+00 = 20.70 ft

Sta	Discharge cfs	Elevation, ft*	
		Left Side	Right Side
67+00	9,900	10.0	9.8
66+00		9.4	9.2
65+00		9.0	9.3
64+16.63		8.5	9.1
63+89		6.9	11.5
63+25		8.1	10.1
63+00		--	10.7
62+95		6.5	--
62+49.41		--	9.7
61+91		8.6	--
61+69		--	8.5
61+49		8.5	--
61+29		--	8.1
60+53		8.0	--
60+43		--	7.8
60+10.68		7.7	7.6
59+69		9.9	5.0
59+39		8.5	7.0
59+00		9.4	4.4
58+50		8.4	5.8
58+00		8.0	4.0
57+10		-6.4	-6.2
56+52.25		-4.8	-6.7
56+00		-6.5	-4.3
55+32		-4.0	-6.5
54+73		--	-3.8
54+63		-6.3	--
54+00		-3.6	6.0
53+47.45		-5.5	-3.9
53+15		--	-2.4
52+87		5.3	--
52+00		2.8	1.0
51+87		0.8	3.6
51+42		5.6	4.4
51+18		1.3	4.3
50+86		6.2	4.4
50+00		4.7	4.5
49+00		5.9	4.7

\* Sides of channel are referenced to downstream direction.

Table 18

Water-Surface Elevations, Margarita Channel, Type 1 (Original) Designn = 0.015 Average Depth at Sta 67+00 = 13.27 ft.Average Depth at Sta 50+00 = 23.08 ft

Sta	Discharge cfs	Elevation, ft*	
		Left Side	Right Side
67+00	11,200	11.3	11.9
66+00		11.3	11.2
65+00		10.8	10.8
64+58		8.7	13.3
64+16.63		9.9	10.7
63+45		8.5	11.7
63+00		8.6	12.2
62+49.41		8.4	11.6
62+00		10.9	11.2
61+00		9.2	9.8
60+10.68		9.4	9.2
59+73		11.5	6.5
59+00		10.9	5.5
58+00		9.5	5.3
57+10		-4.9	-4.0
56+70		-3.3	-5.8
56+00		-5.7	-2.9
55+34		-2.8	-5.6
55+00		-4.1	-4.1
54+59		-5.4	-2.6
54+00		-5.0	-2.0
53+47.45		-4.5	-2.6
53+32		-2.6	-4.0
53+00		9.7	3.2
52+00		6.9	7.4
51+50		11.6	—
51+00		5.4	8.2
50+40		11.1	8.3
50+00		4.7	—
49+00		6.4	8.6

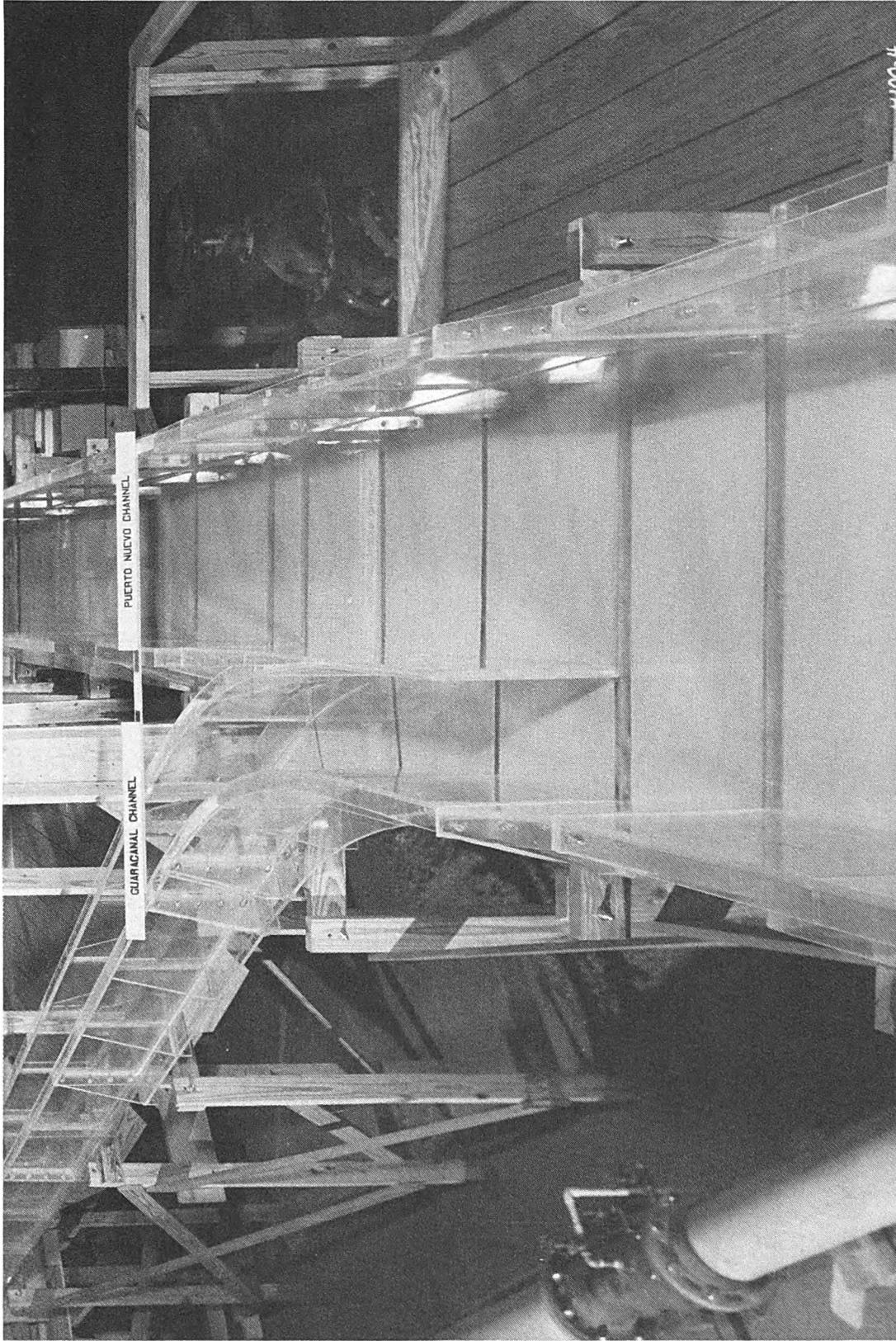
\* Sides of channel are referenced to downstream direction.

Table 19

Water-Surface Elevations, Margarita Channel, Type 1 (Original) Design,  
n = 0.015 , Average Depth at Sta 50+00 = 25.18 ft

Sta	Discharge cfs	Elevation, ft*	
		Left Side	Right Side
67+00	13,500	27.7	27.5
66+00		27.9	28.0
65+00		27.8	28.8
64+16.63		27.1	27.7
63+00		27.4	28.3
62+49.41		27.6	29.6
62+00		25.3	26.1
61+79		19.7	—
61+60		10.0	20.7
61+49		26.1	24.8
61+00		21.8	23.2
60+66		22.3	—
60+55		13.8	—
60+44		—	21.4
60+25		3.0	7.7
60+10.68		12.9	9.8
59+97		2.3	13.8
59+41		13.0	6.4
59+00		12.5	9.9
58+32		13.9	7.3
58+00		10.3	7.9
57+10		-2.6	-2.1
56+00		-2.9	-2.0
55+00		-1.9	-2.8
54+00		-1.4	-2.9
53+47.45		-2.0	-1.8
53+30		-0.4	-2.8
53+00		4.3	8.8
52+00		7.6	9.1
51+00		11.0	10.6
50+40		13.6	10.4
50+00		11.9	10.3
49+00		12.7	11.0

\* Sides of channel are referenced to downstream direction.



a. Dry bed (looking upstream)

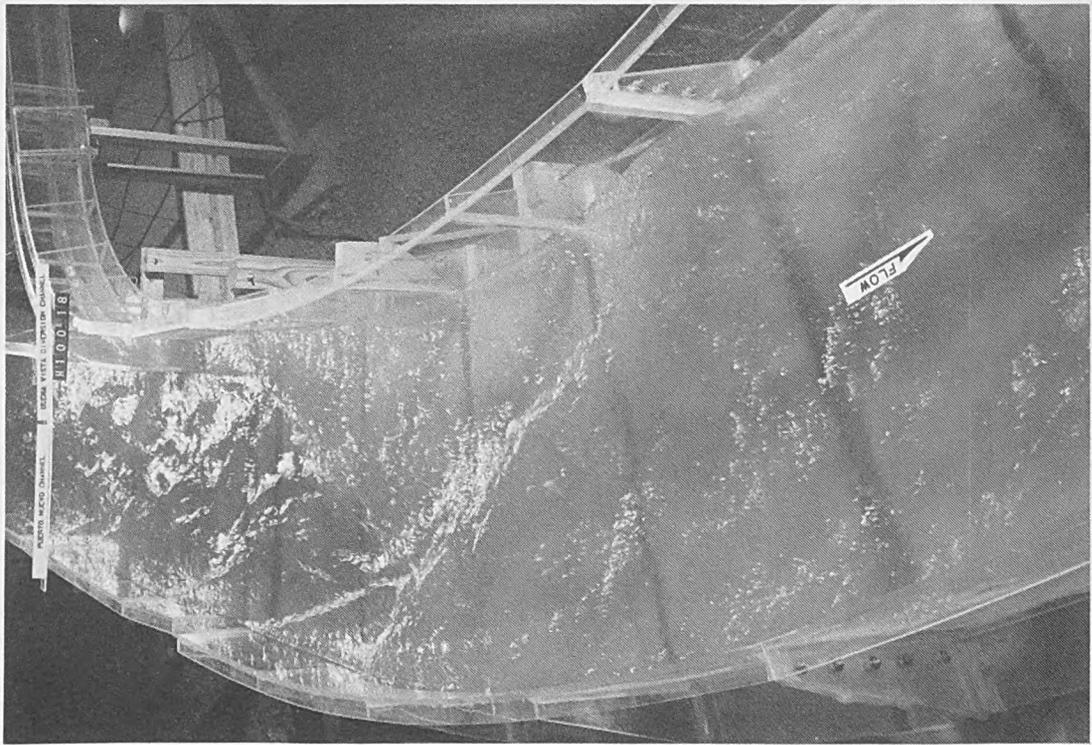
Photo 1. Flow conditions, type 1 (original) design, Puerto Nuevo/Guaracanal confluence, discharge 26,100 cfs in Puerto Nuevo, 8,000 cfs in Guaracanal,  $n = 0.015$  (Continued)



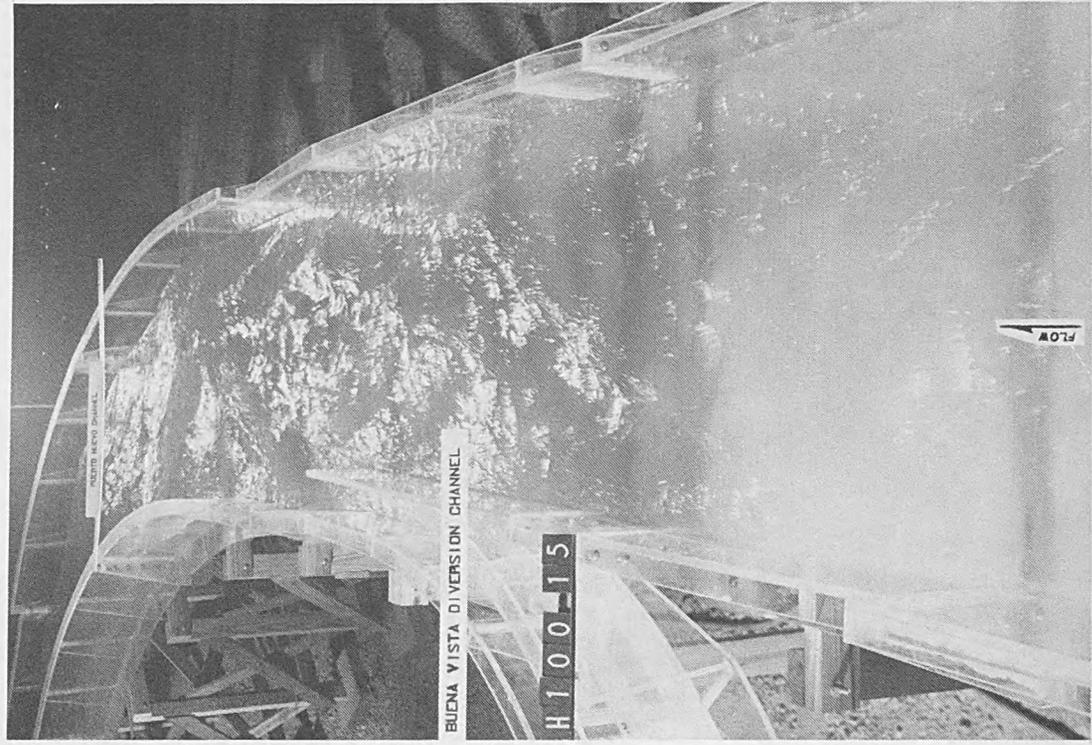


a. Dry bed (looking upstream)

Photo 2. Flow conditions, type 1 (original) design, Puerto Nuevo/Buena Vista Diversion Channel confluence, discharge 37,900 cfs in Puerto Nuevo, 4,200 cfs in Buena Vista,  $n = 0.015$  (Continued)

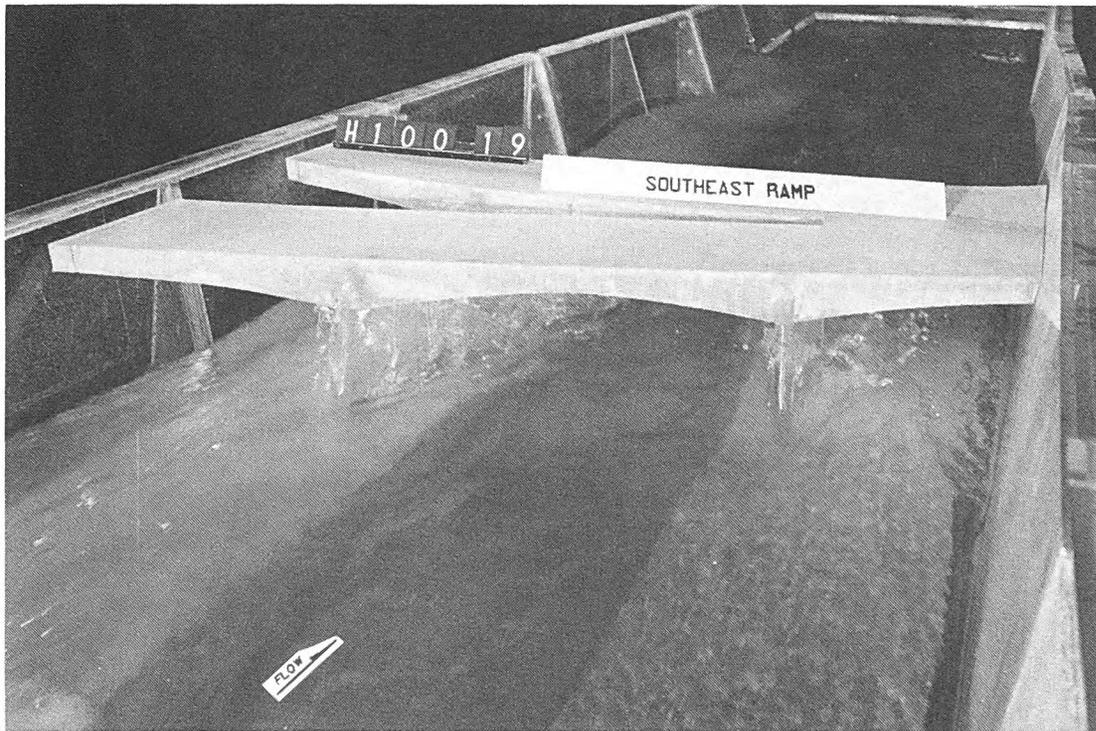


b. Looking upstream

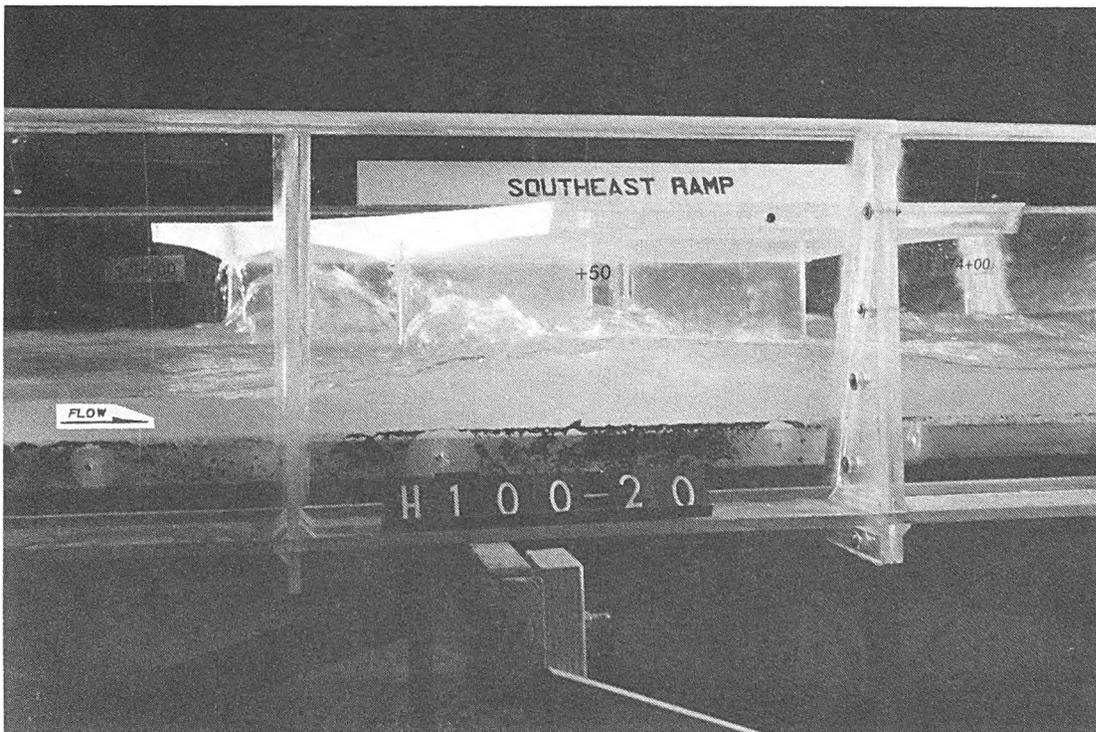


c. Looking downstream

Photo 2. (Concluded)

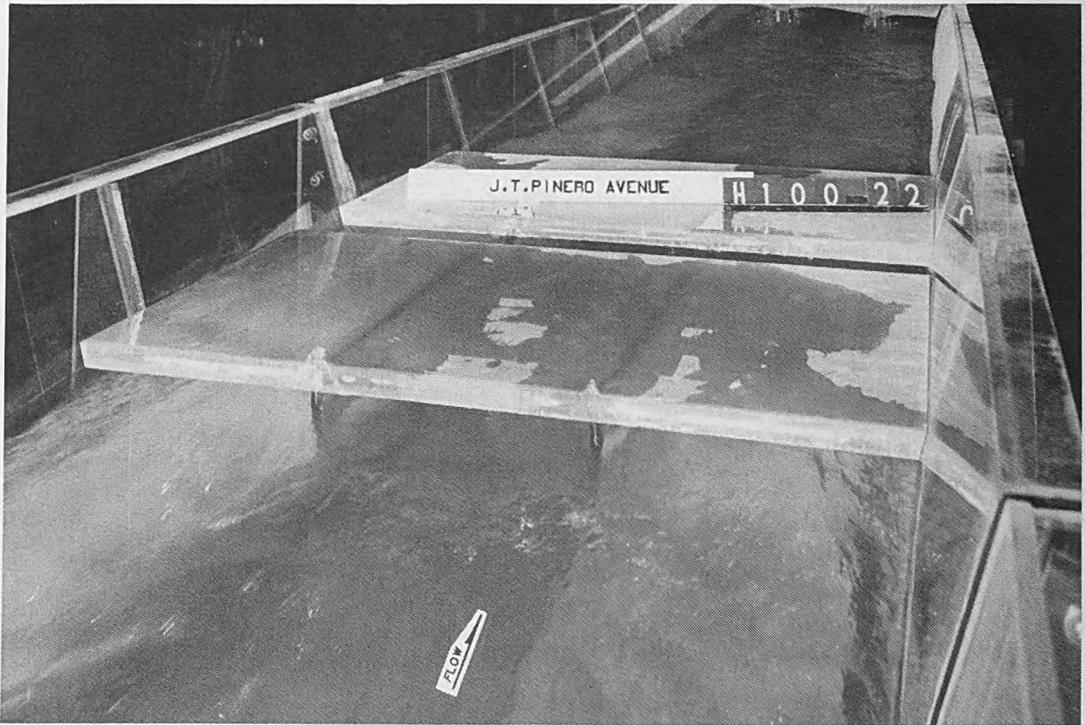


a. Looking downstream

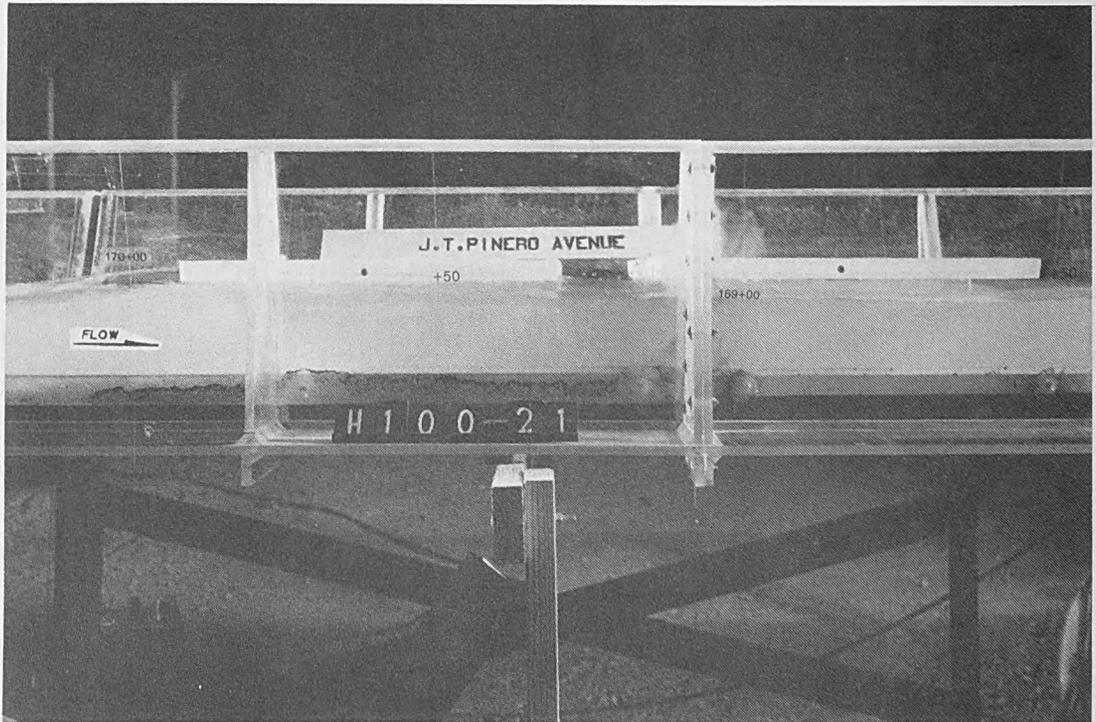


b. Elevation view

Photo 3. Flow conditions, Southeast Ramp Bridge,  
discharge 44,600 cfs,  $n = 0.015$

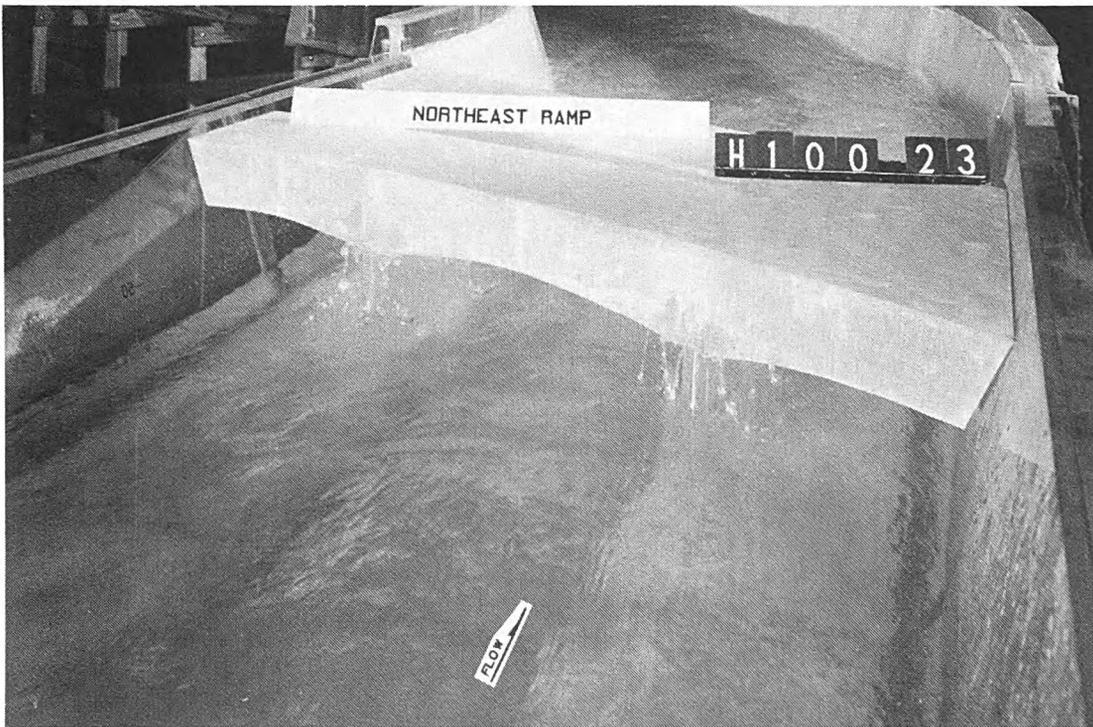


a. Looking downstream

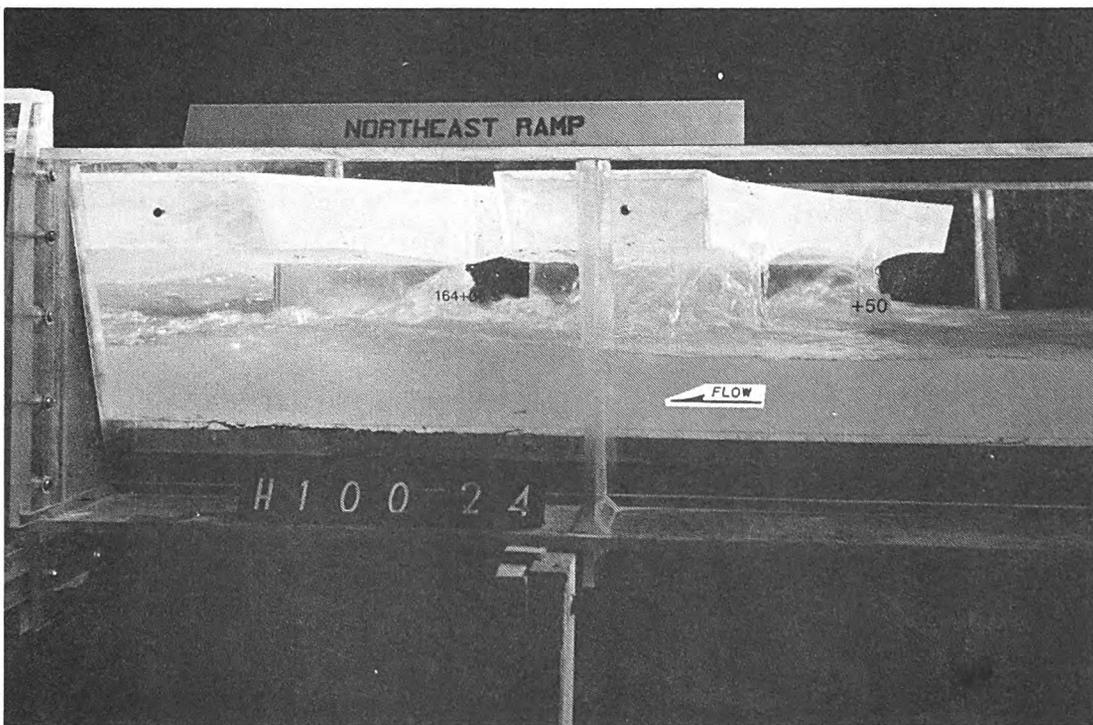


b. Elevation view

Photo 4. Flow conditions, Pinero Avenue Bridge, discharge 44,600 cfs,  $n = 0.015$



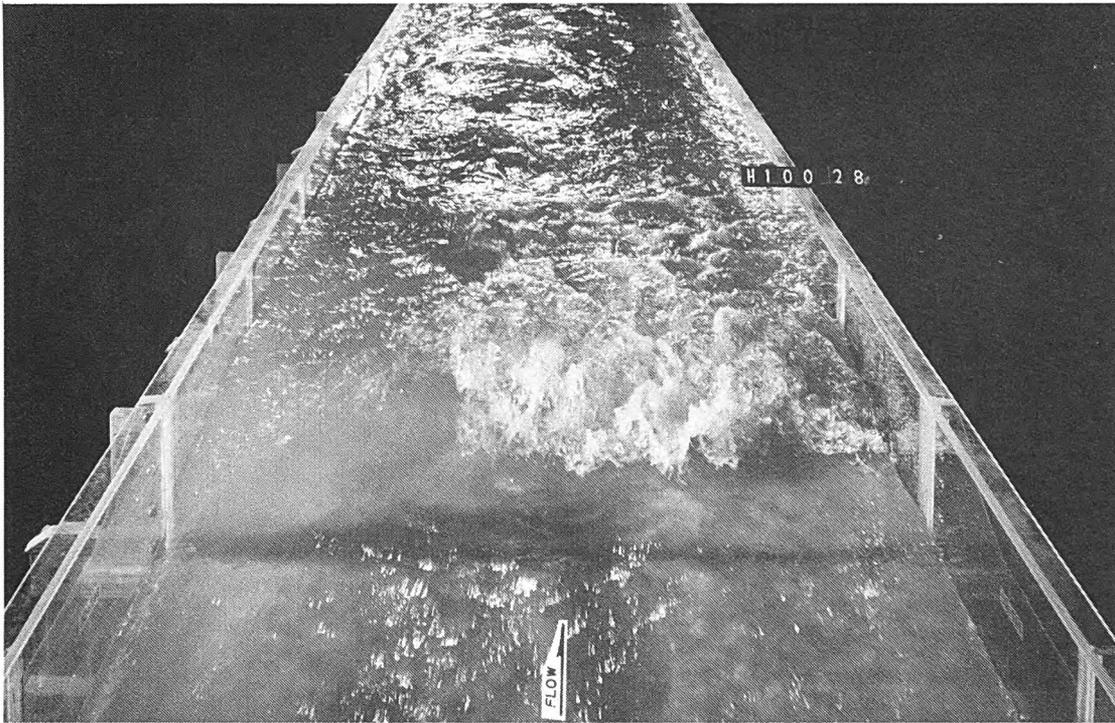
a. Looking downstream



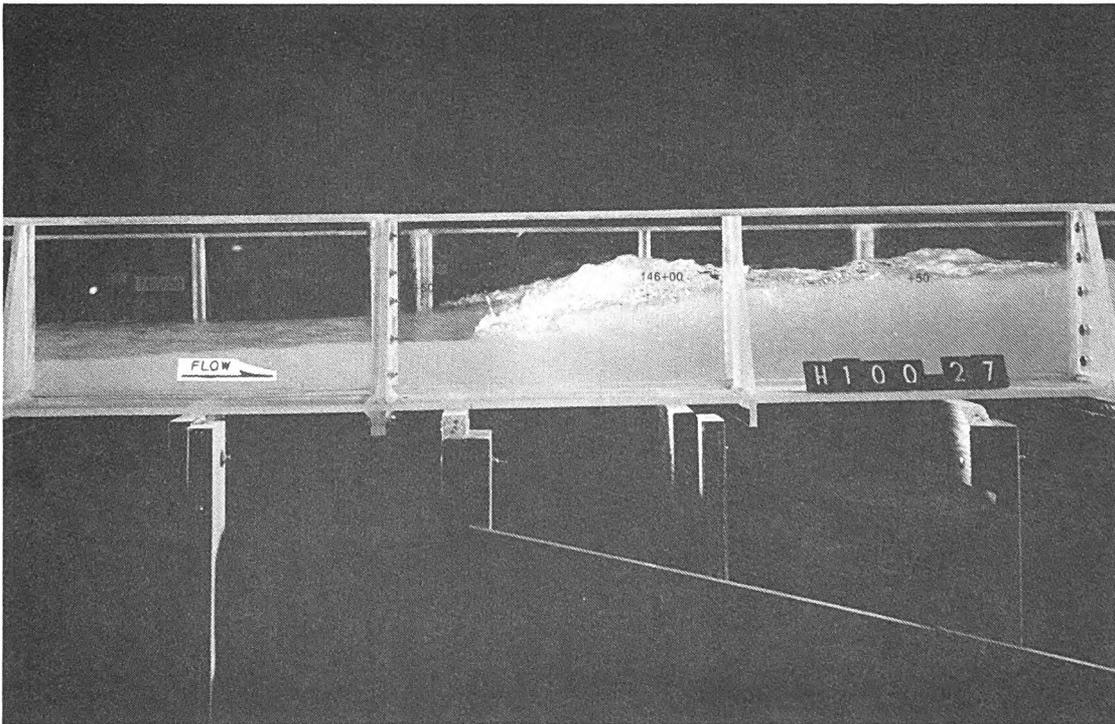
b. Elevation view

Photo 5. Flow conditions, Northeast Ramp Bridge,  
discharge 44,600 cfs,  $n = 0.015$





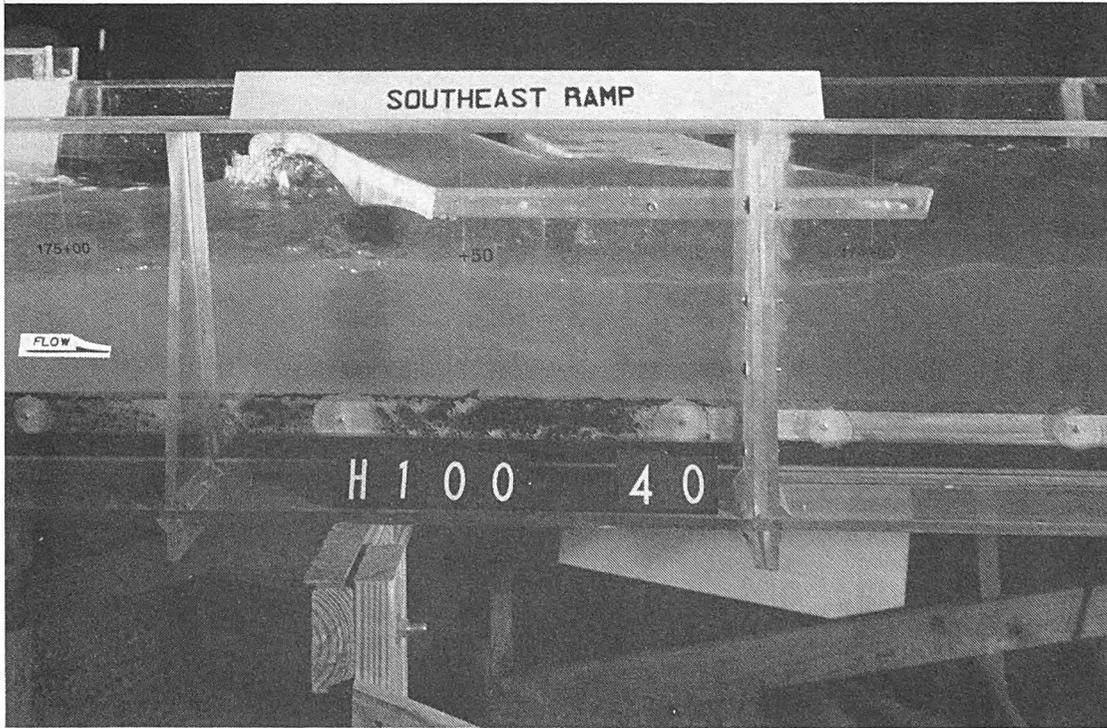
a. Looking downstream



b. Elevation view

Photo 7. Flow conditions in the vicinity of the hydraulic jump, type 1 (original) design, discharge 44,900 cfs,  $n = 0.015$

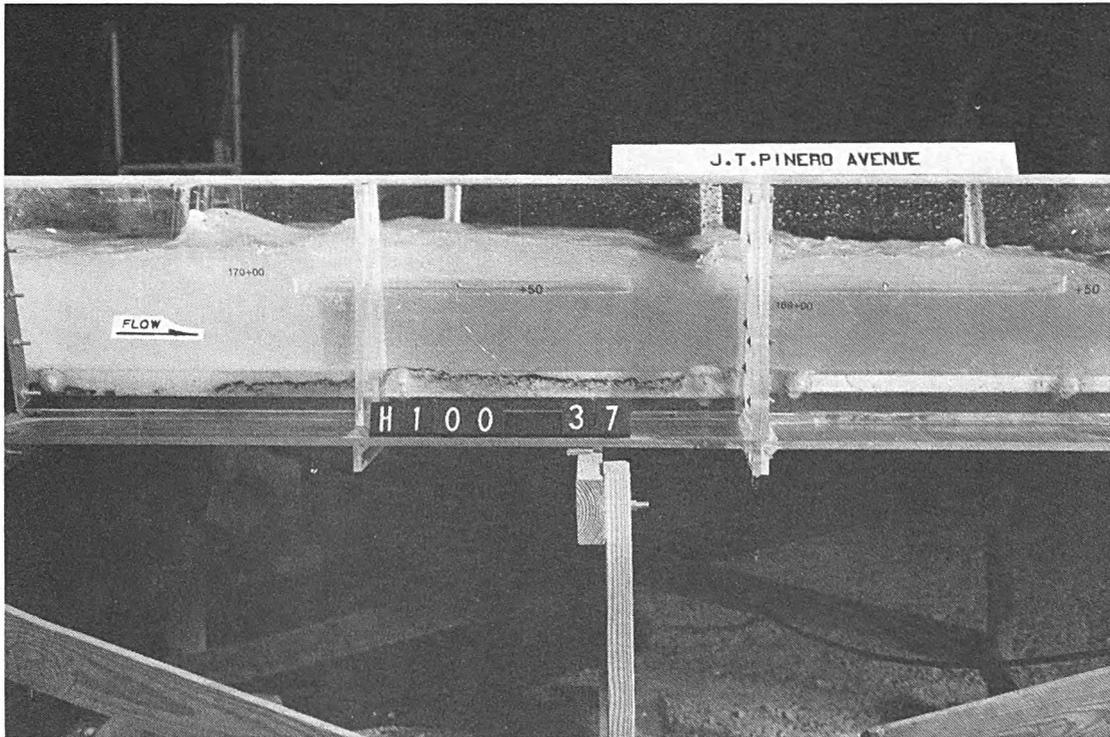




c. Elevation view

Photo 8. (Concluded)

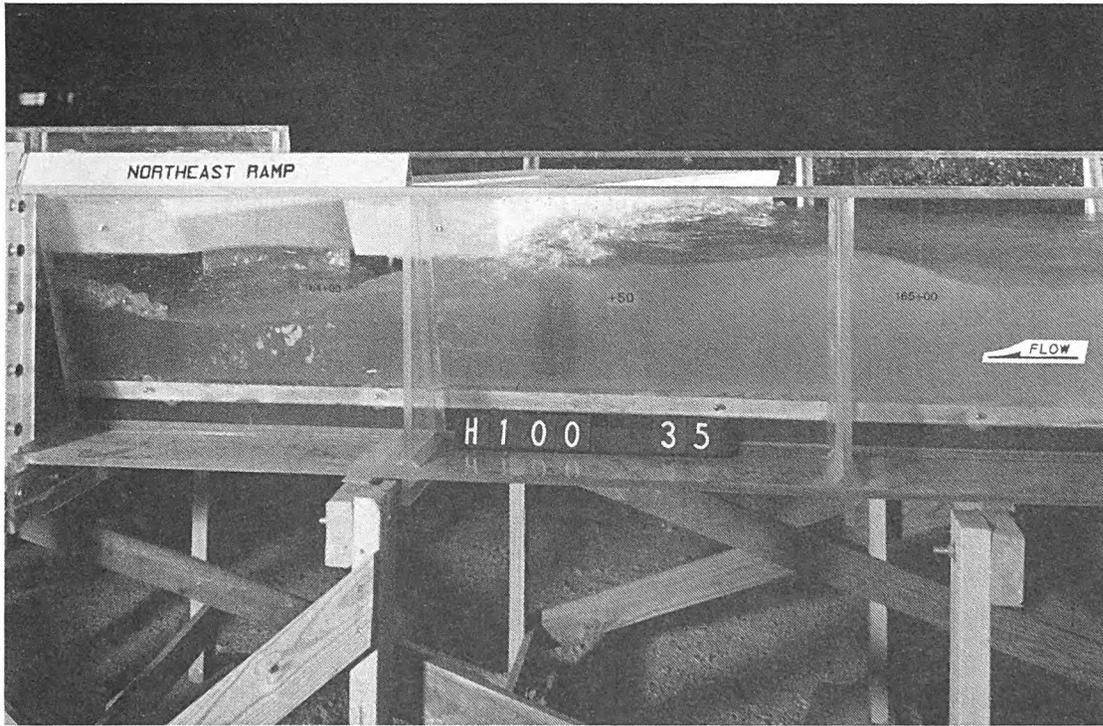




c. Elevation view

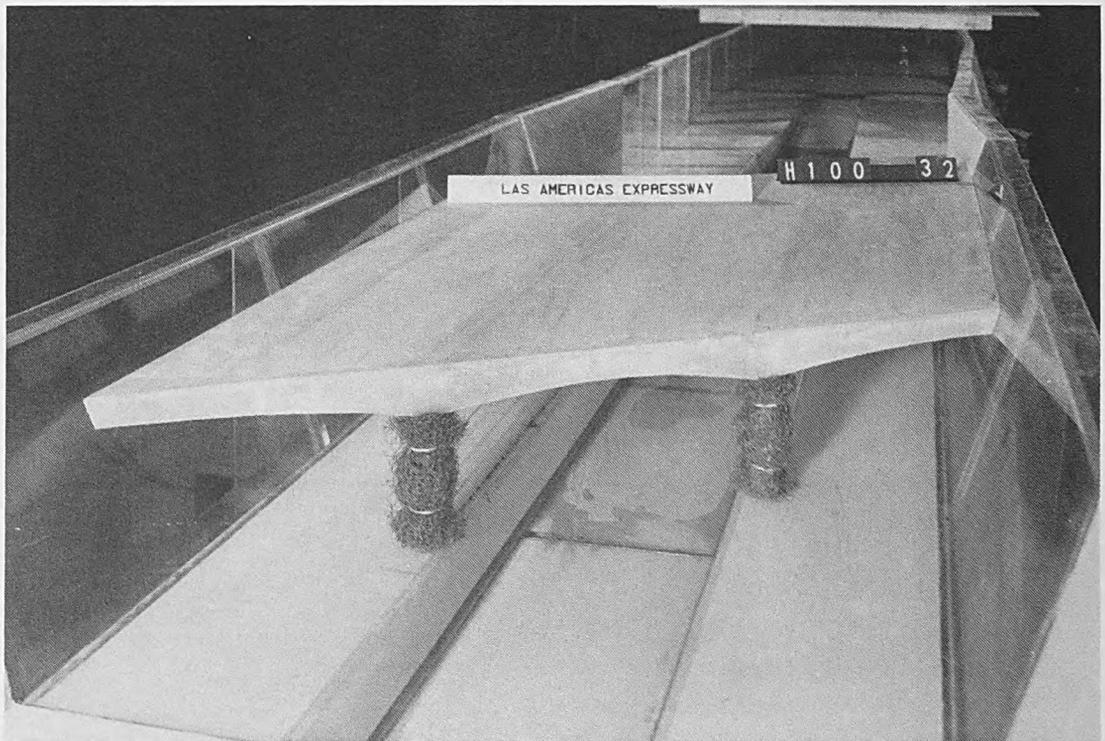
Photo 9. (Concluded)





c. Elevation view

Photo 10. (Concluded)

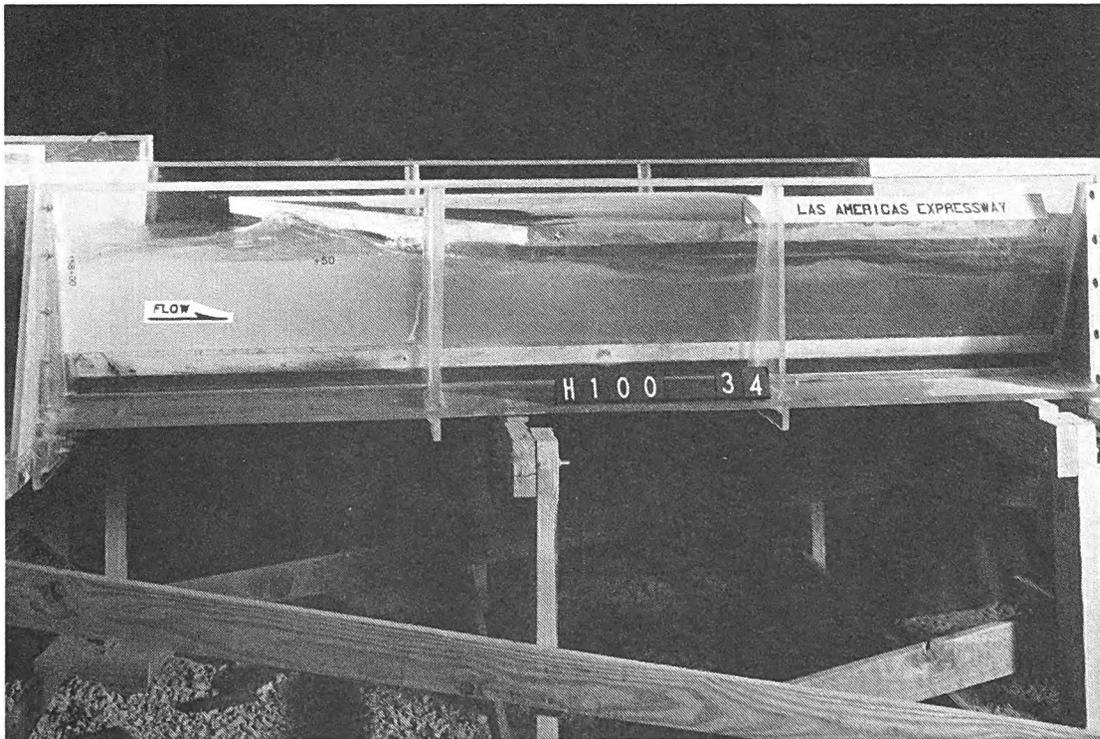


a. Dry bed looking downstream



b. Looking downstream

Photo 11. Flow conditions, Las Americas Expressway Bridge with debris on piers, discharge 44,600 cfs,  $n = 0.015$  (Continued)



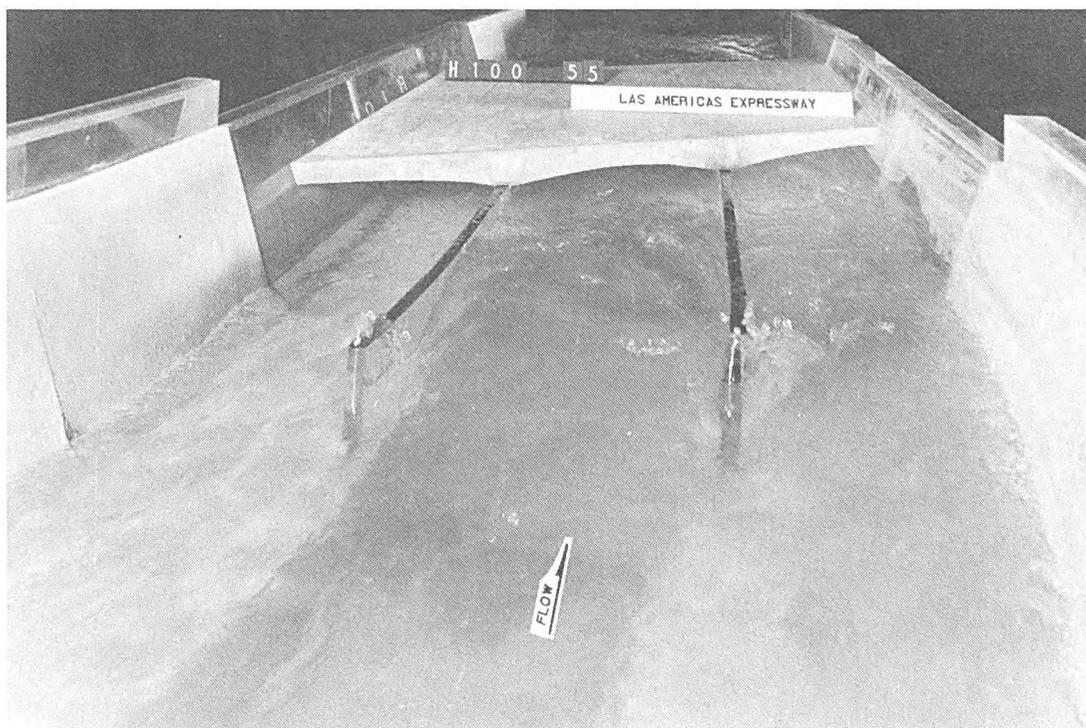
c. Elevation view

Photo 11. (Concluded)





a. Dry bed looking downstream



b. Clean piers

Photo 13. Flow conditions, type 3 design Las Americas Bridge piers, discharge 44,600 cfs,  $n = 0.015$  (Continued)

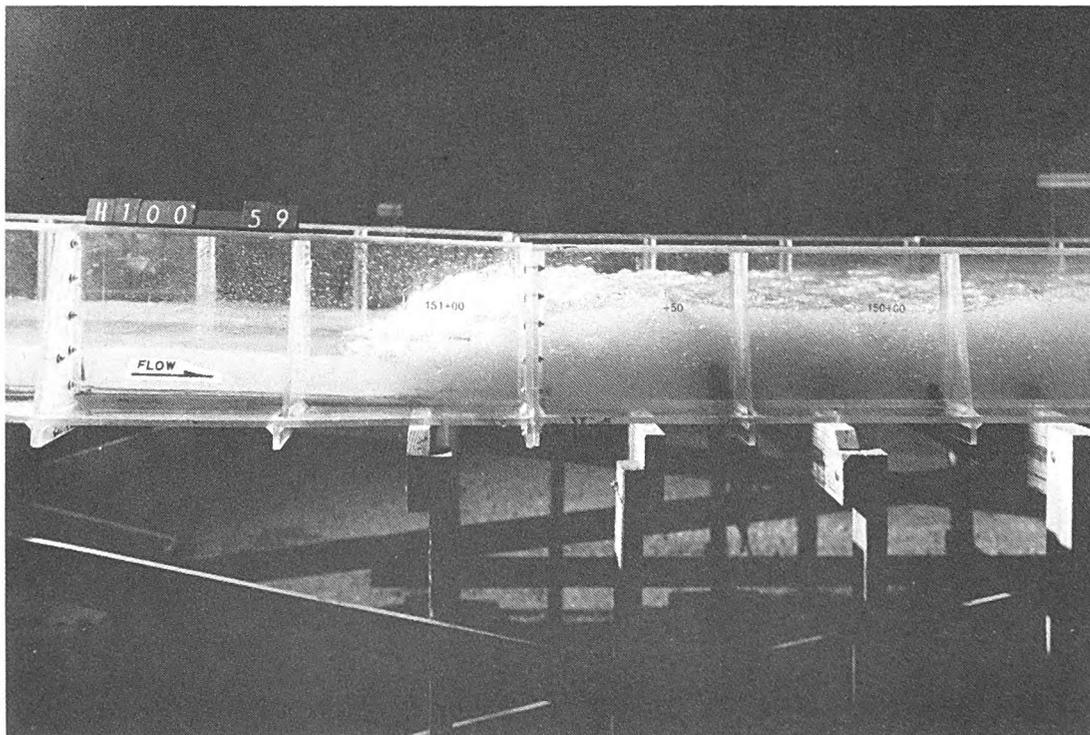


c. With debris on piers

Photo 13. (Concluded)



a. Looking downstream



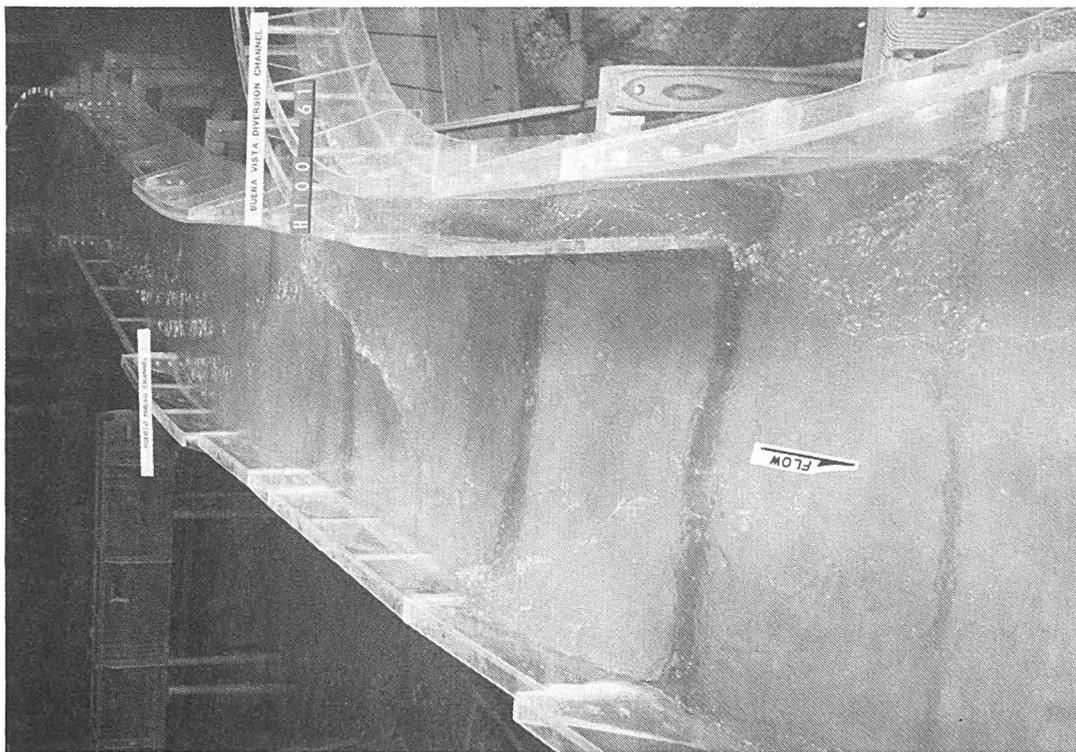
b. Elevation view

Photo 14. Flow conditions with the type 4 design baffle blocks, discharge 44,900 cfs,  $n = 0.015$





a. Looking downstream

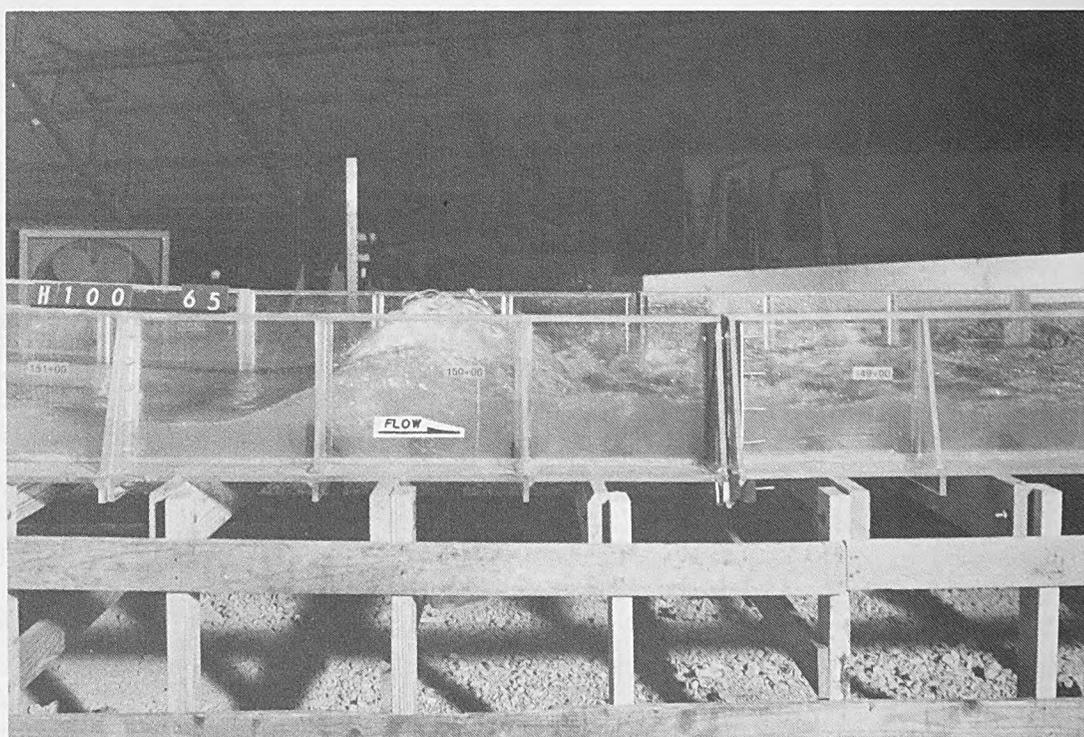


b. Looking upstream

Photo 16. Flow conditions, type 2 design channel with type 4 design Puerto Nuevo/Buena Vista Diversion Channel confluence wall, discharge 37,900 cfs in Puerto Nuevo, discharge 4,200 cfs in Buena Vista Diversion Channel,  $n = 0.012$

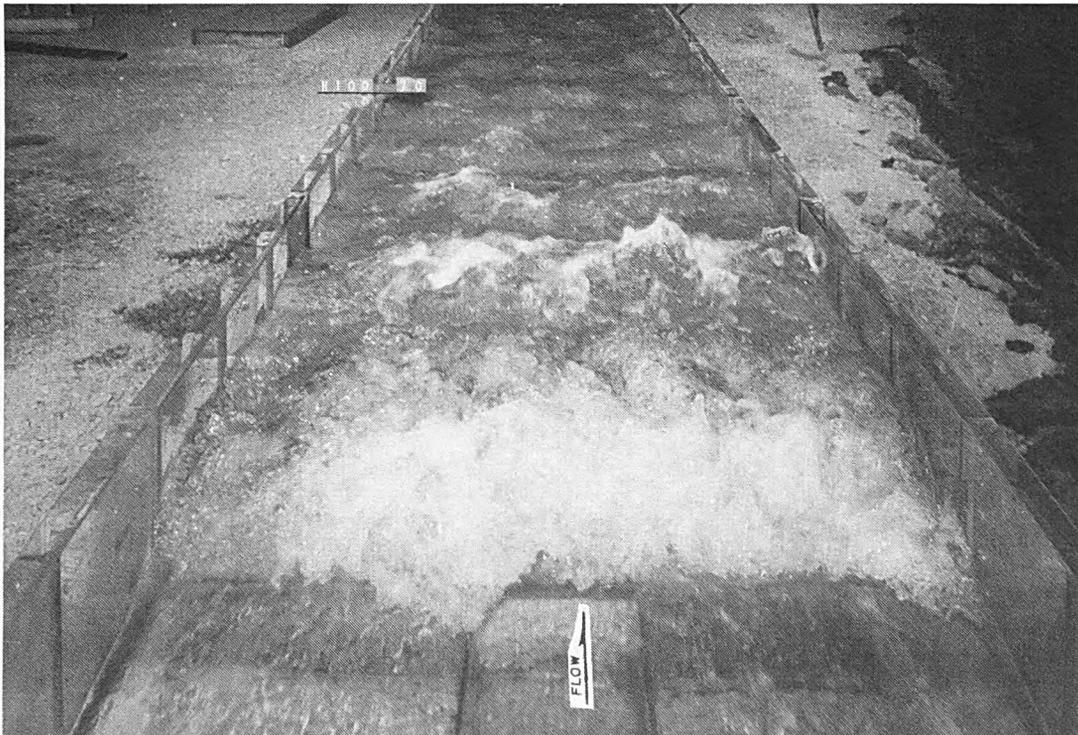


a. Looking downstream

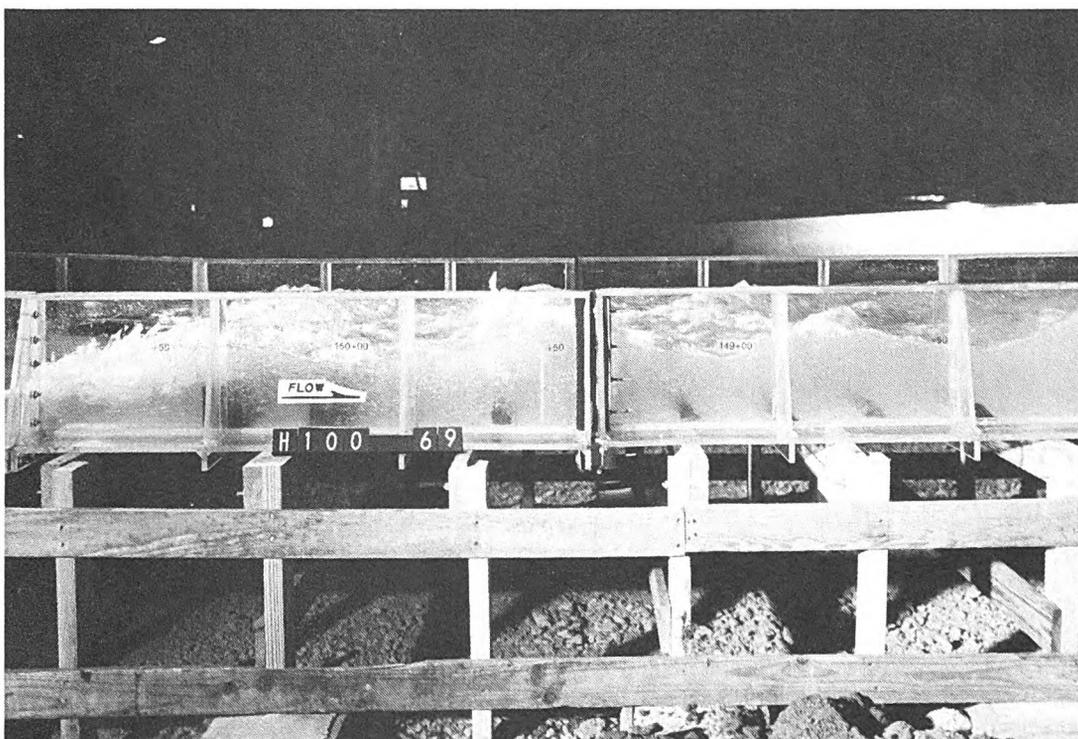


b. Elevation view

Photo 17. Flow conditions with the type 4 design baffle blocks, discharge 44,900 cfs,  $n = 0.012$



a. Looking downstream



b. Elevation view

Photo 18. Flow conditions with the type 6 design baffle blocks, discharge 44,900 cfs,  $n = 0.012$



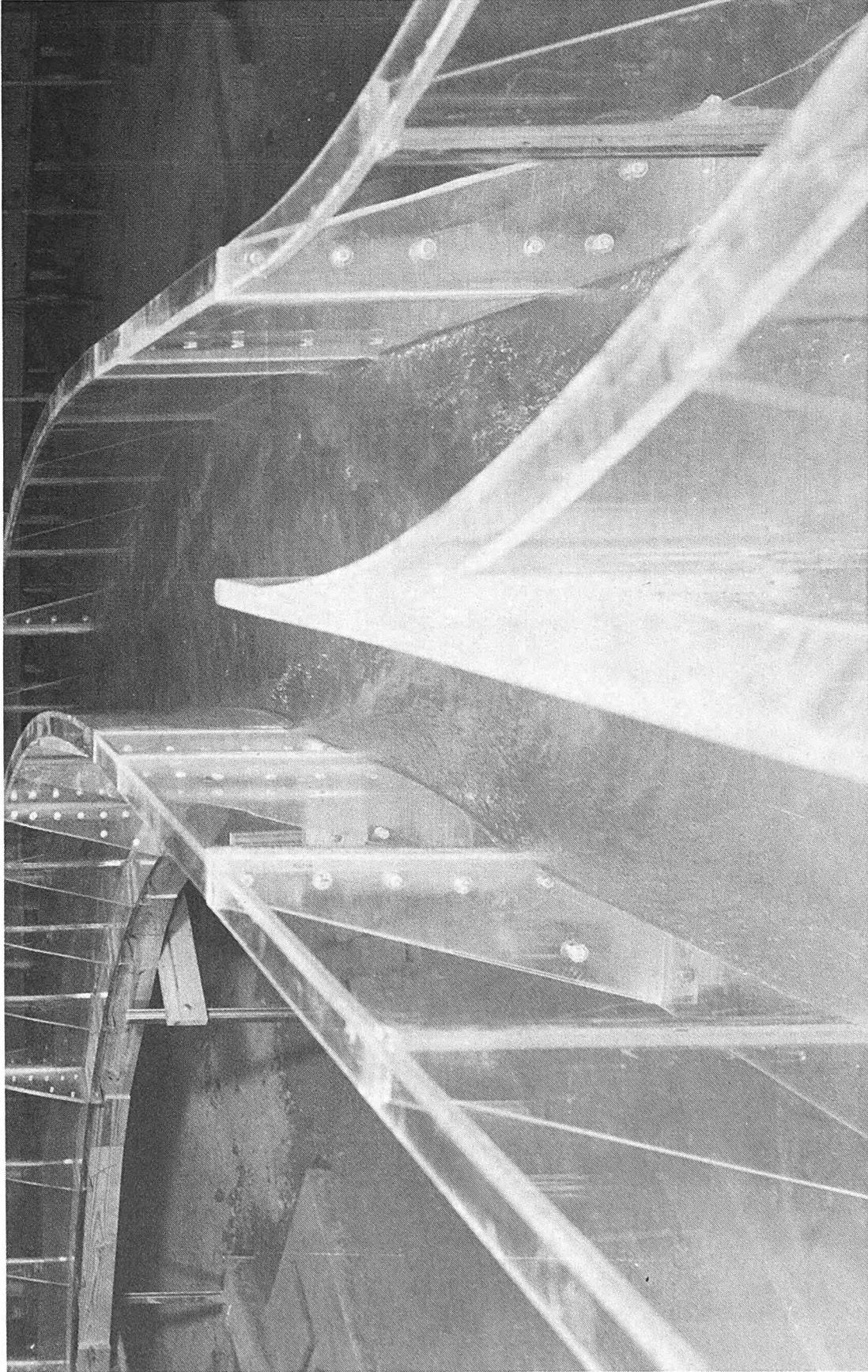
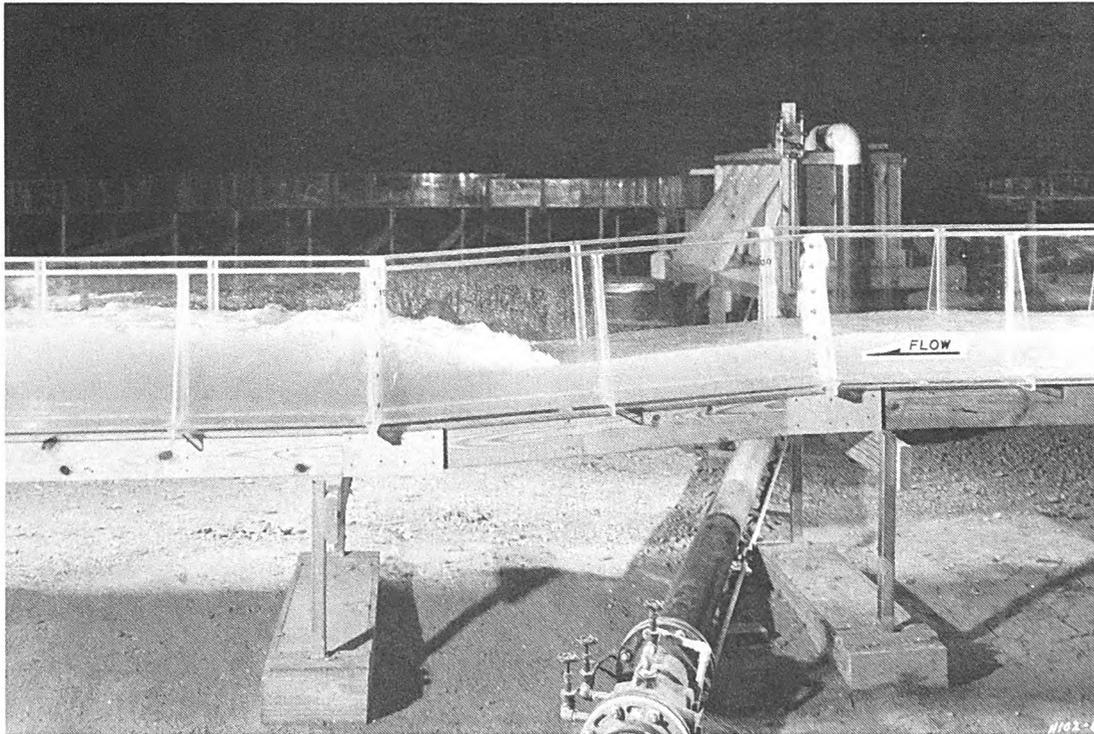


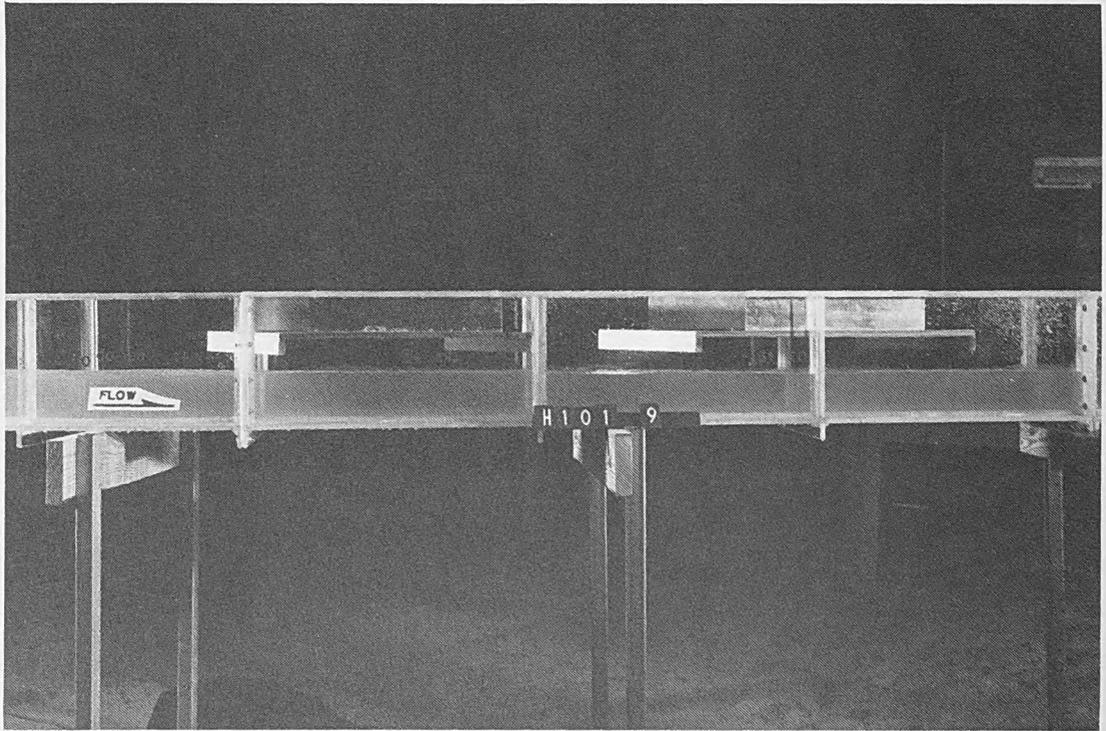
Photo 20. Flow conditions, Dona Ana-Josefina Channel confluence looking downstream,  
Dona Ana discharge 5,641 cfs, Josefina discharge 5,627 cfs,  $n = 0.015$



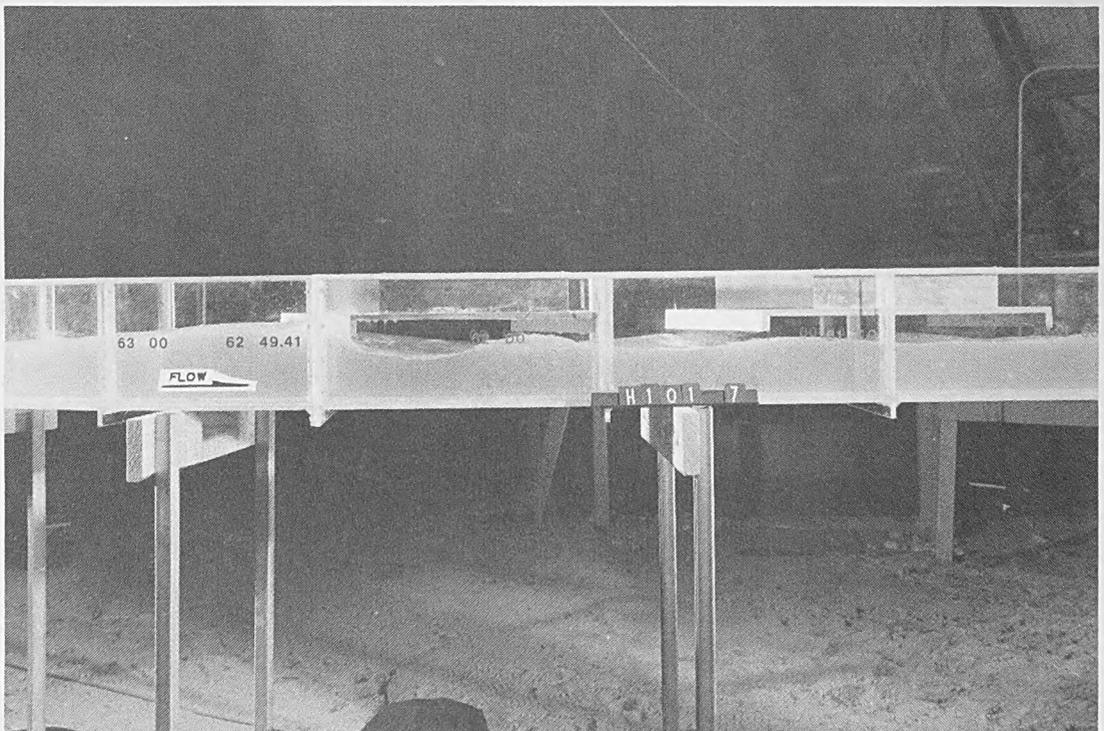


b. Profile view of the hydraulic jump

Photo 21. (Concluded)

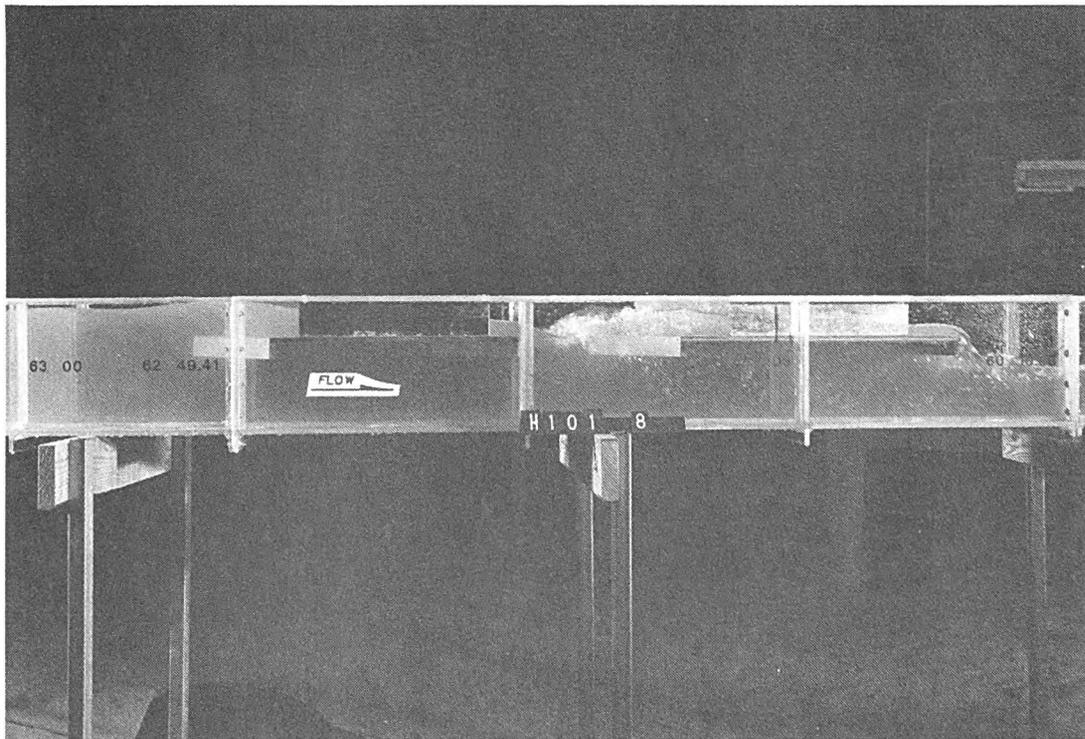


a. Discharge 8,800 cfs



b. Discharge 11,200 cfs

Photo 22. Flow conditions at the De Diego Expressway Bridge (Continued)



c. Discharge 13,500 cfs

Photo 22. (Concluded)



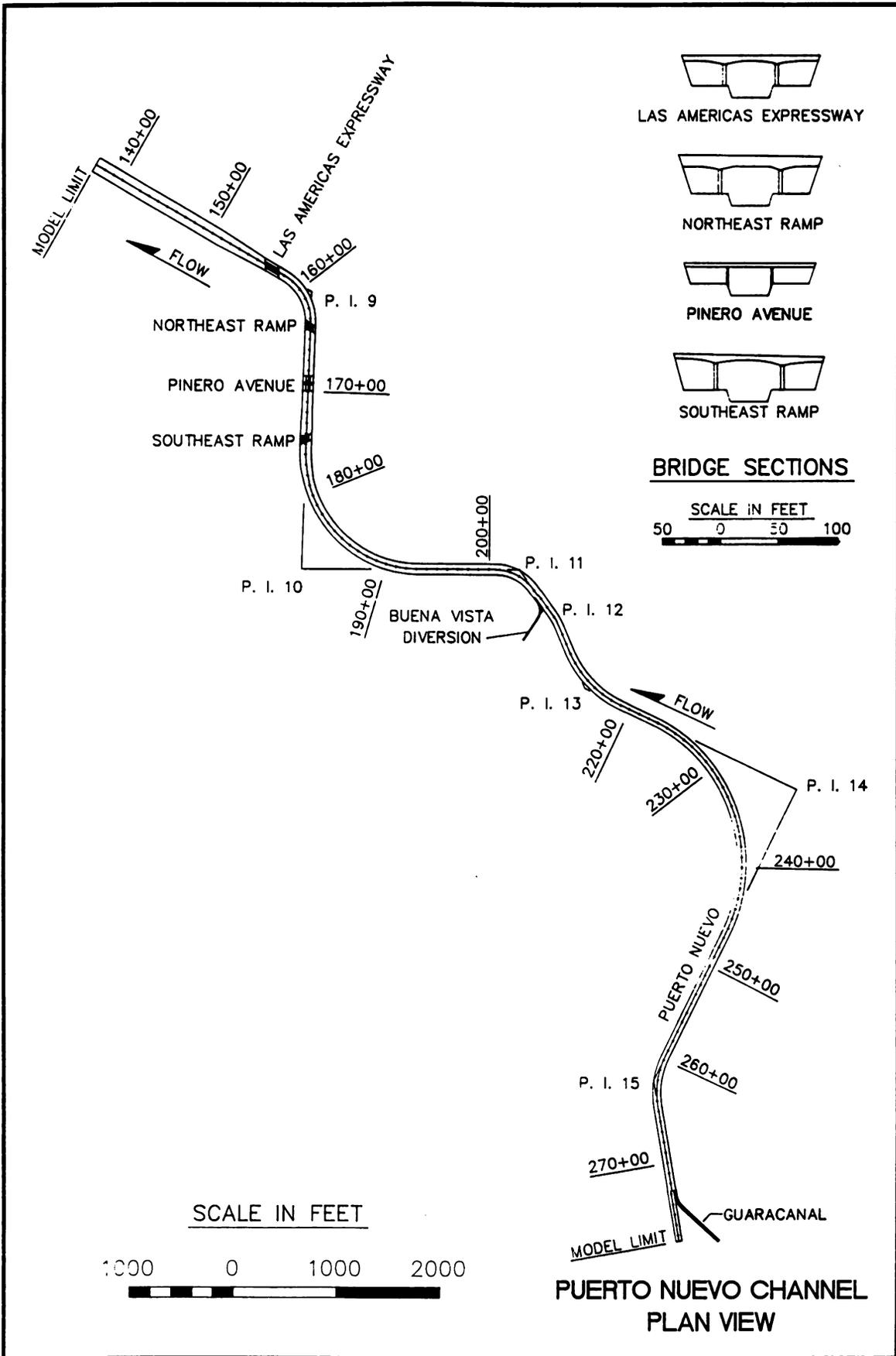
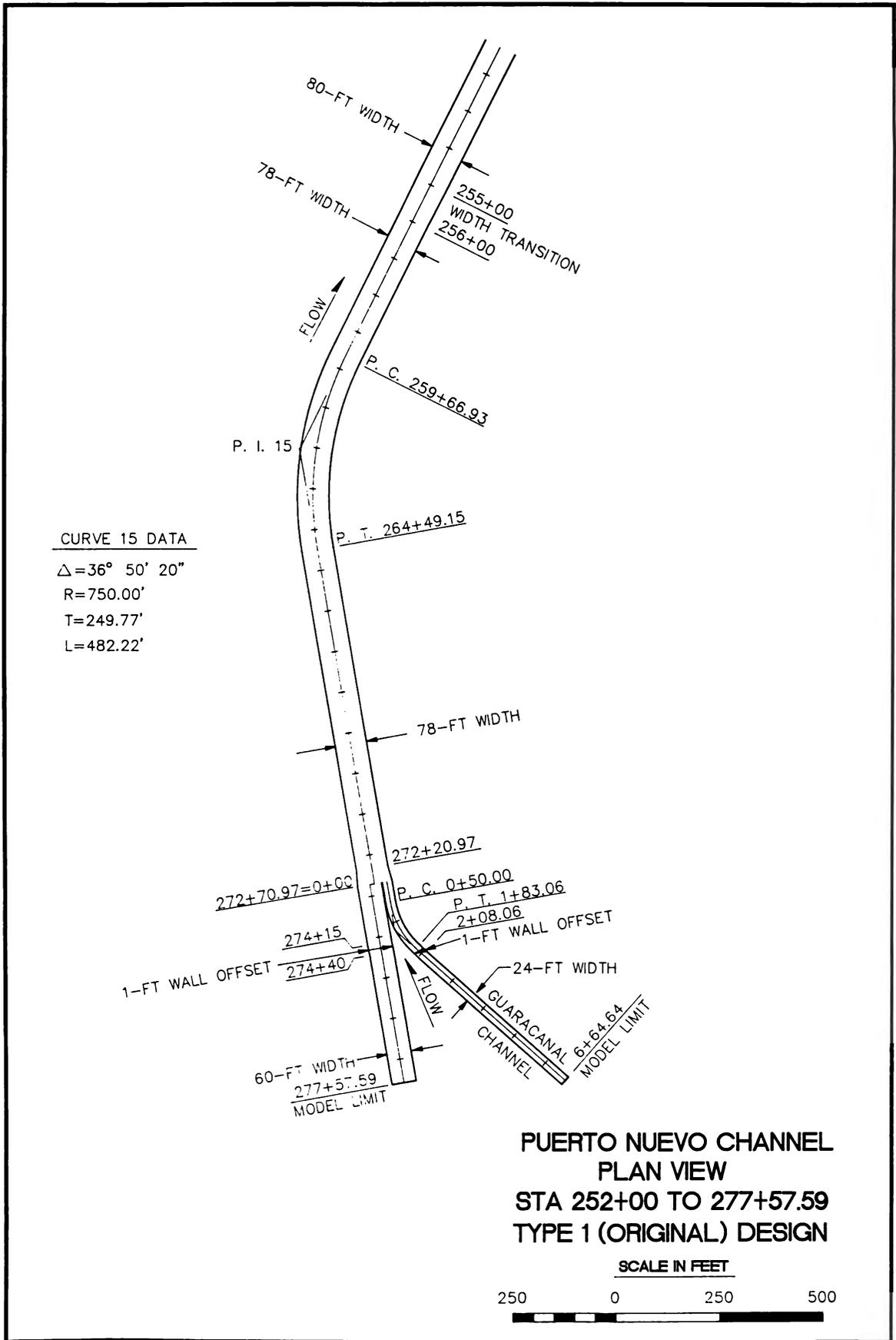
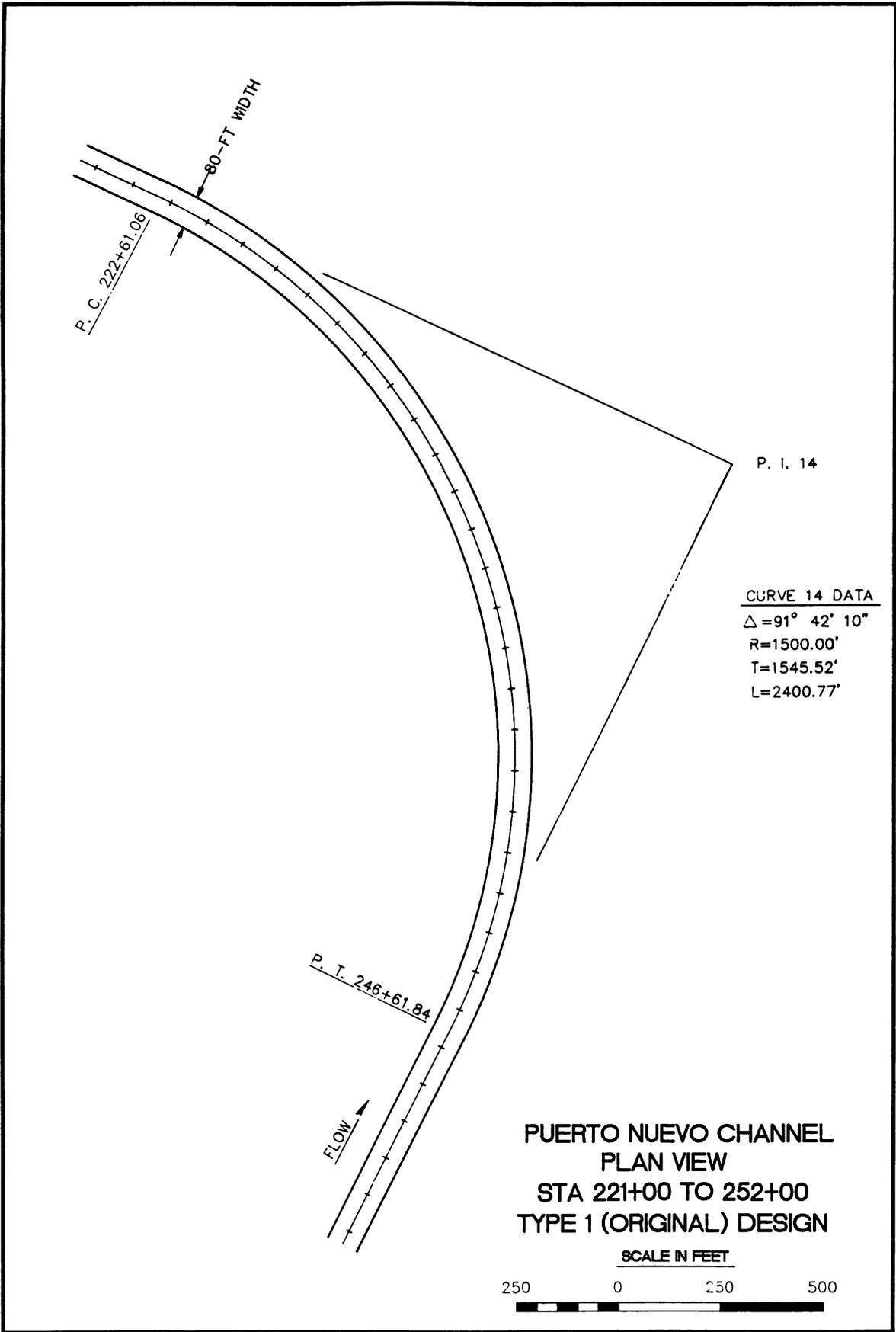
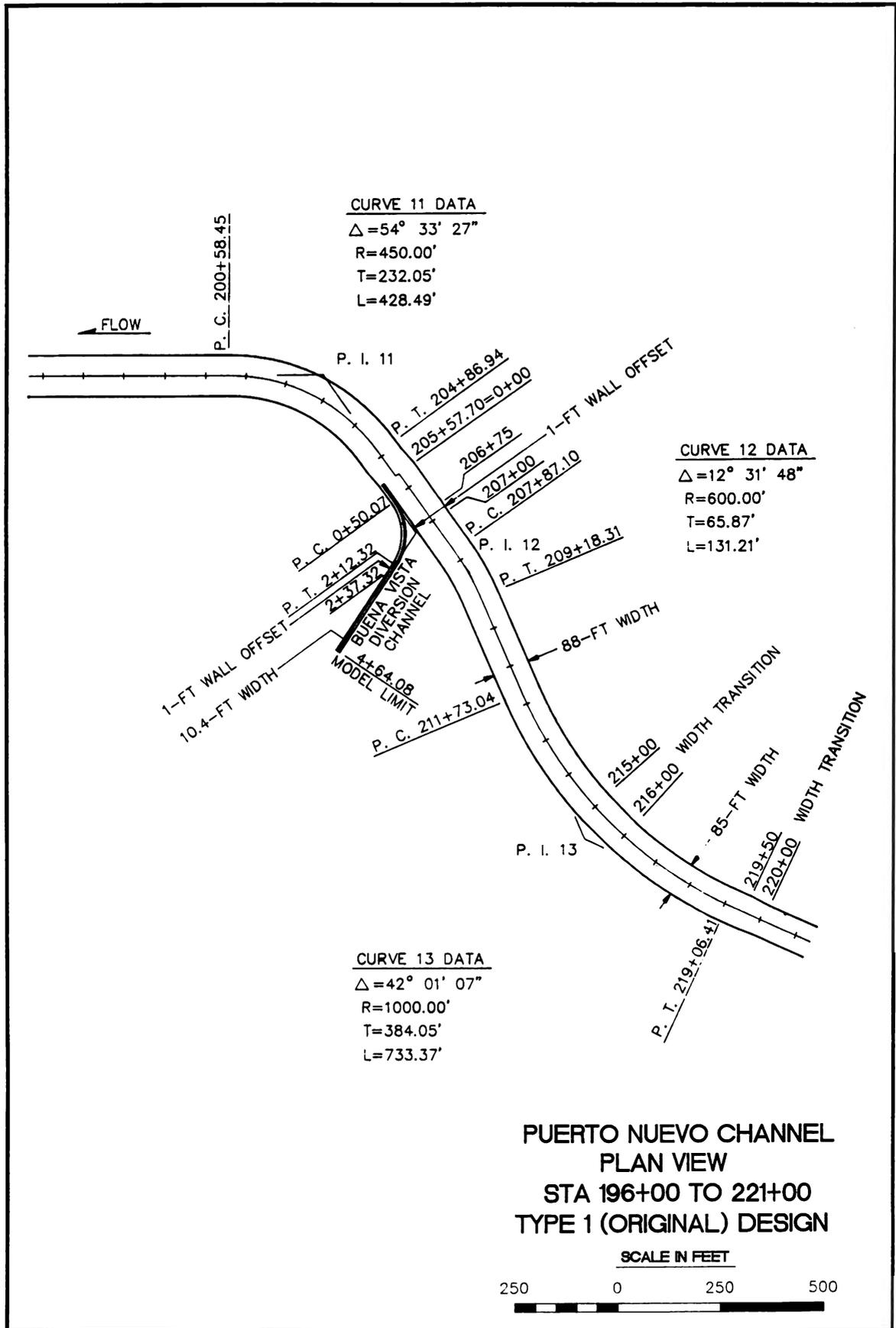


PLATE 1







CURVE 11 DATA

$\Delta = 54^\circ 33' 27''$   
 $R = 450.00'$   
 $T = 232.05'$   
 $L = 428.49'$

CURVE 12 DATA

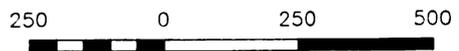
$\Delta = 12^\circ 31' 48''$   
 $R = 600.00'$   
 $T = 65.87'$   
 $L = 131.21'$

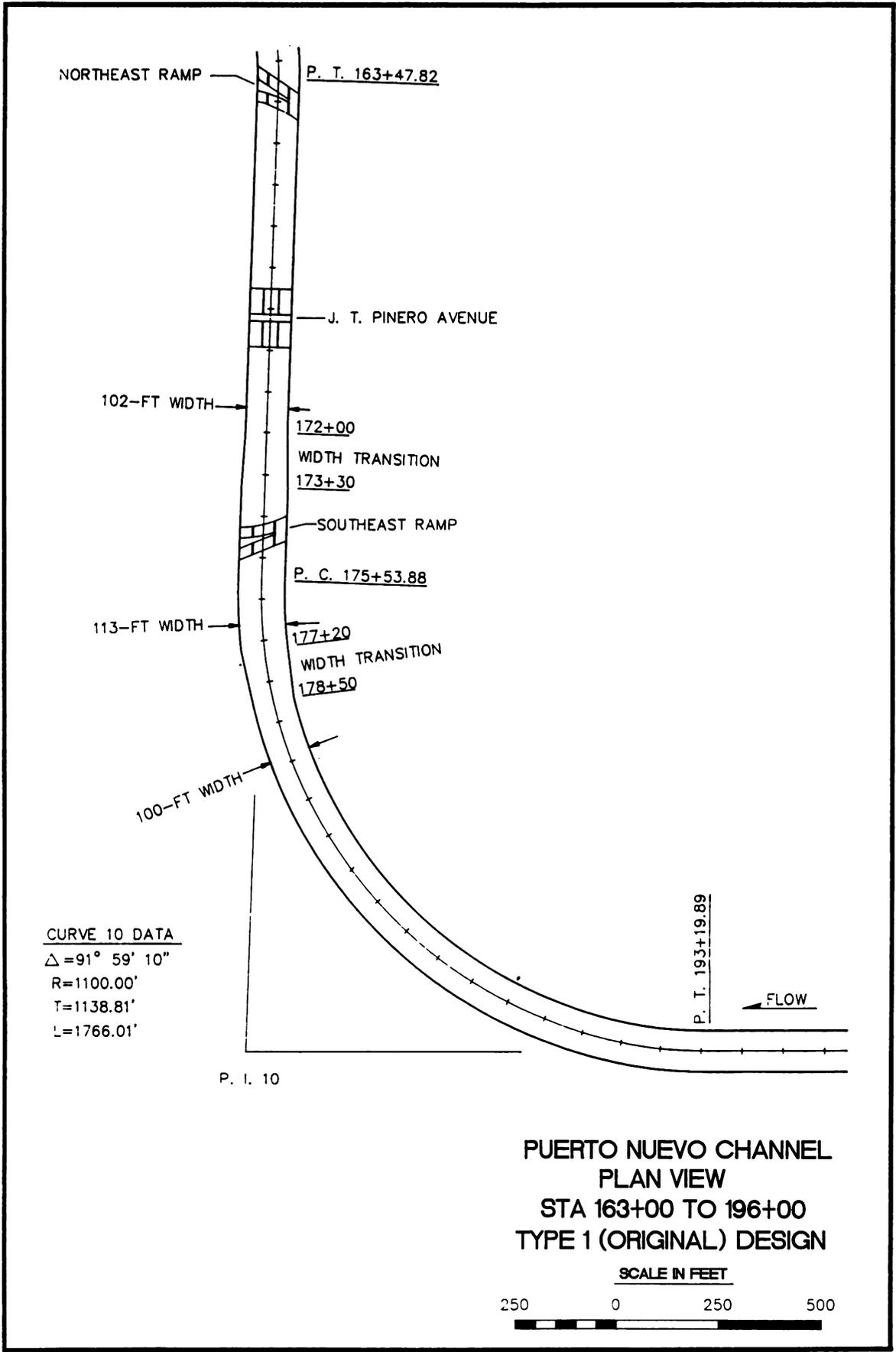
CURVE 13 DATA

$\Delta = 42^\circ 01' 07''$   
 $R = 1000.00'$   
 $T = 384.05'$   
 $L = 733.37'$

**PUERTO NUEVO CHANNEL  
 PLAN VIEW  
 STA 196+00 TO 221+00  
 TYPE 1 (ORIGINAL) DESIGN**

SCALE IN FEET





CURVE 10 DATA

$\Delta = 91^\circ 59' 10''$

$R = 1100.00'$

$T = 1138.81'$

$L = 1766.01'$

P. I. 10

**PUERTO NUEVO CHANNEL  
PLAN VIEW  
STA 163+00 TO 196+00  
TYPE 1 (ORIGINAL) DESIGN**

SCALE IN FEET

250 0 250 500

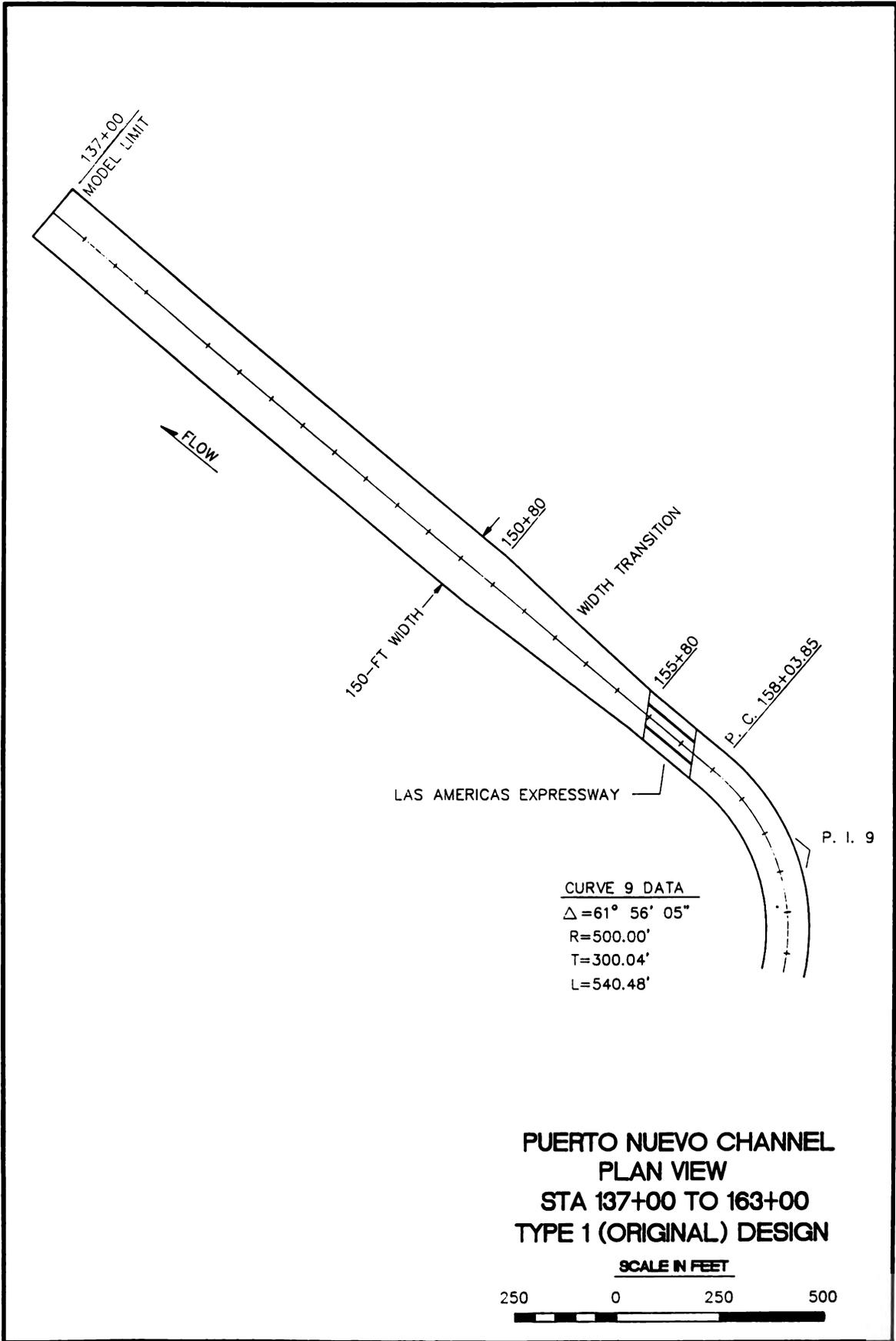
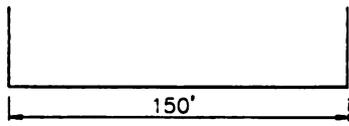
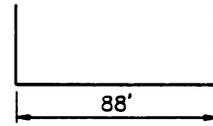


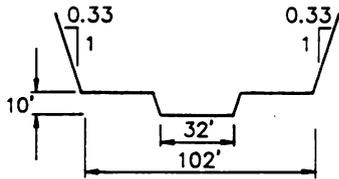
PLATE 6



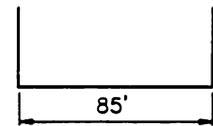
137+00 TO 150+80



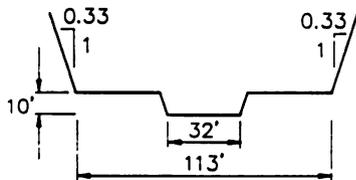
206+07.77 TO 215+00



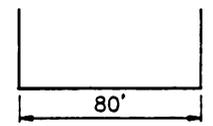
155+80 TO 172+00



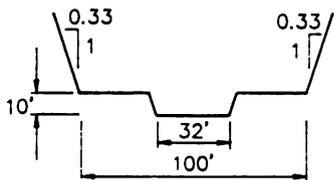
216+00 TO 219+50



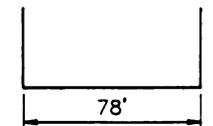
173+30 TO 177+20



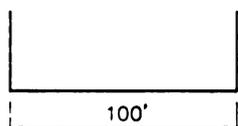
220+00 TO 255+00



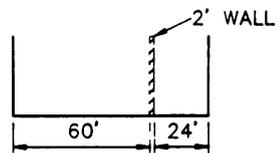
178+50 TO 179+50



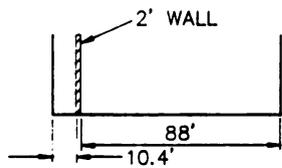
256+00 TO 272+20.97



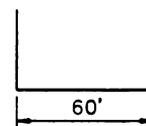
184+50 TO 205+07.70



272+70.97 TO 273+20.97

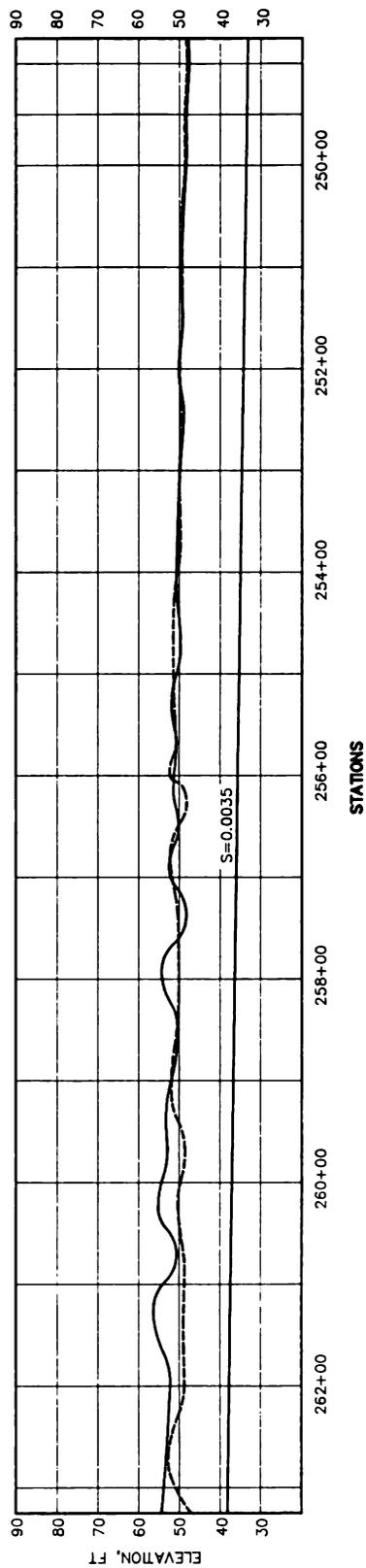
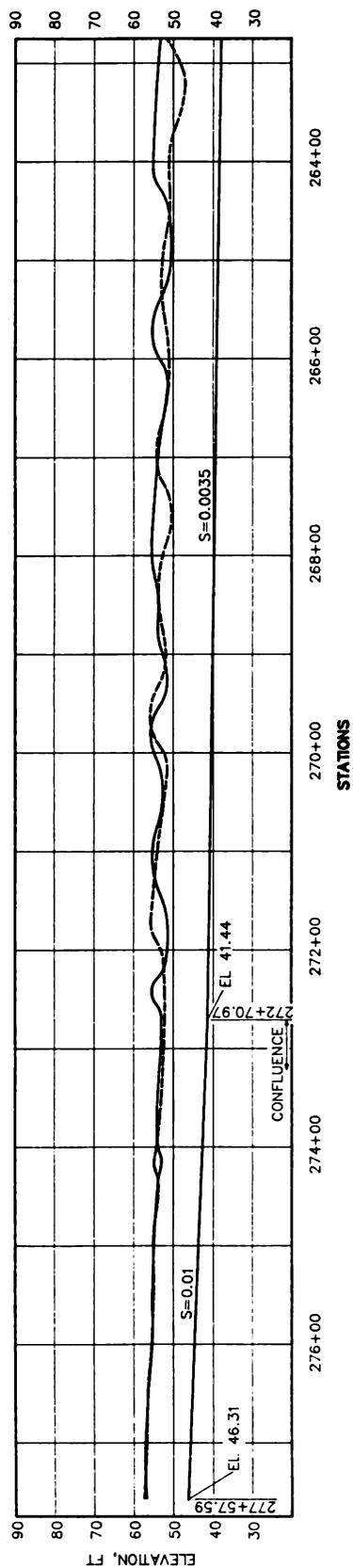


205+57.70 TO 206+07.77



273+20.97 TO 277+57.59

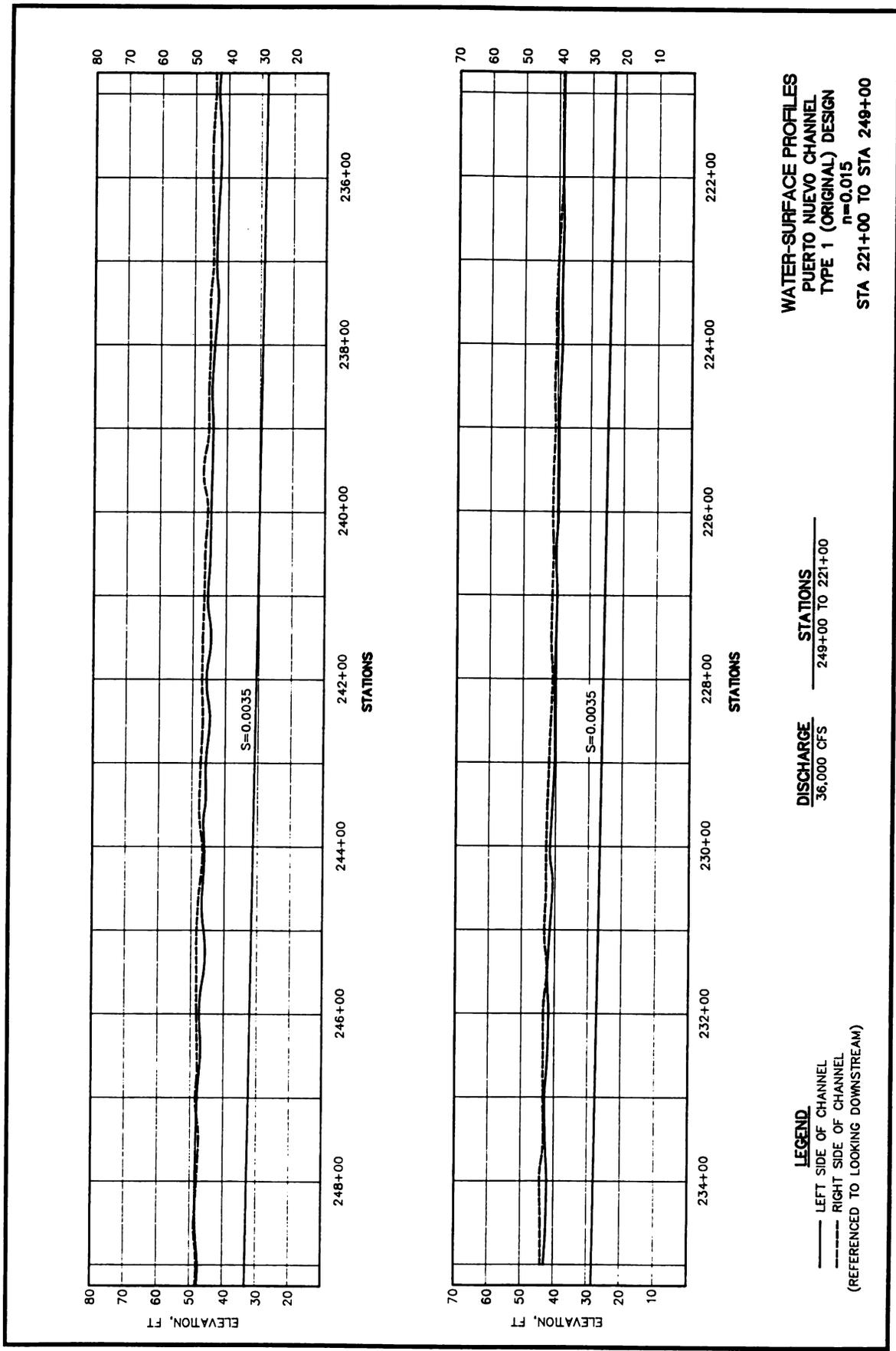
**PUERTO NUEVO CHANNEL  
TYPICAL CHANNEL SECTIONS**



**WATER-SURFACE PROFILES**  
**PUERTO NUEVO CHANNEL**  
**TYPE 1 (ORIGINAL) DESIGN**  
**n=0.015**  
**STA 249+00 TO STA 277+57.59**

DISCHARGE	STATIONS
26,100 CFS	277+57.59 TO 272+70.97
34,100 CFS	272+70.97 TO 256+00
36,000 CFS	256+00 TO 249+00

**LEGEND**  
 — LEFT SIDE OF CHANNEL  
 - - - RIGHT SIDE OF CHANNEL  
 (REFERENCED TO LOOKING DOWNSTREAM)



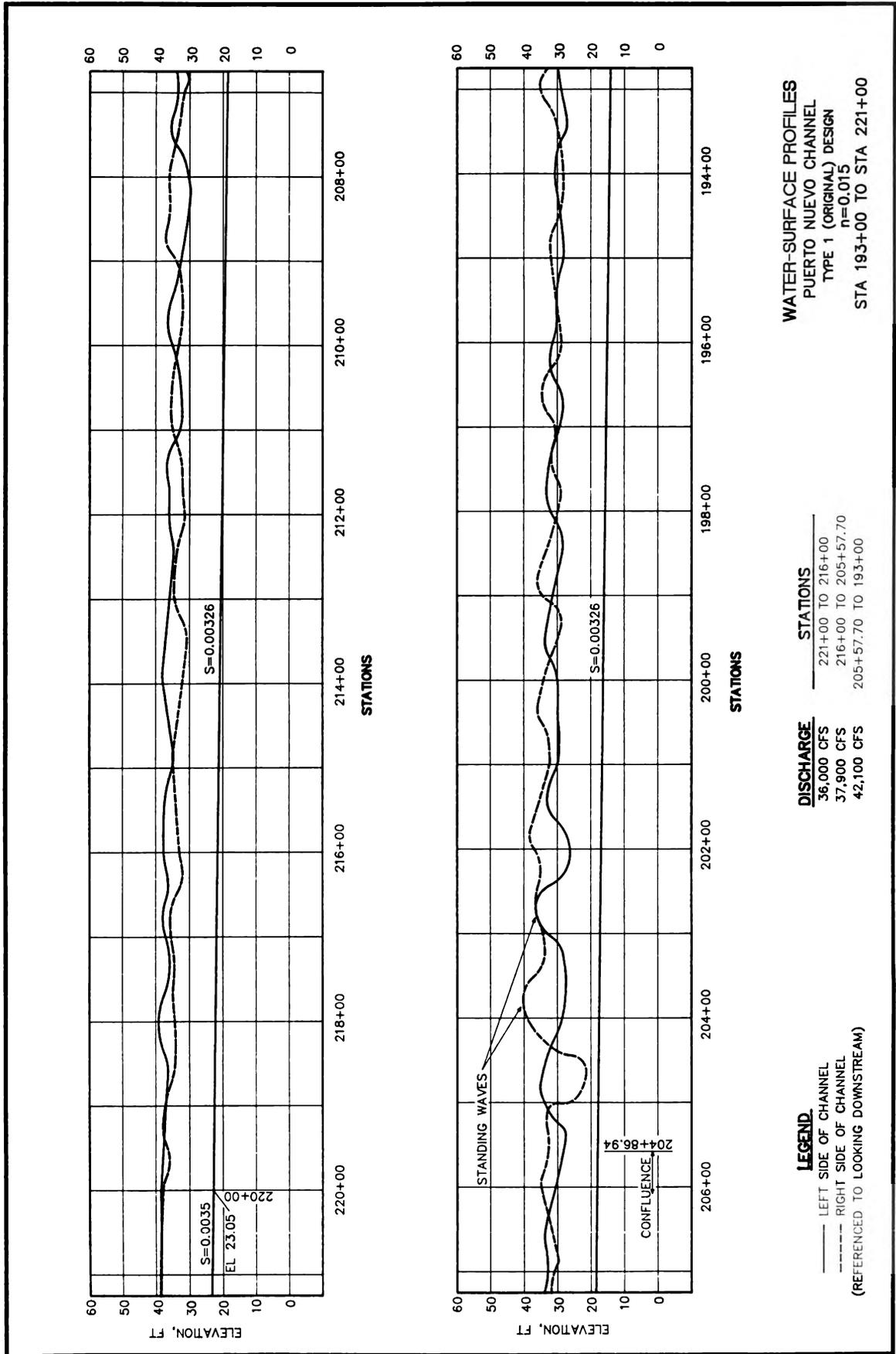


PLATE 10

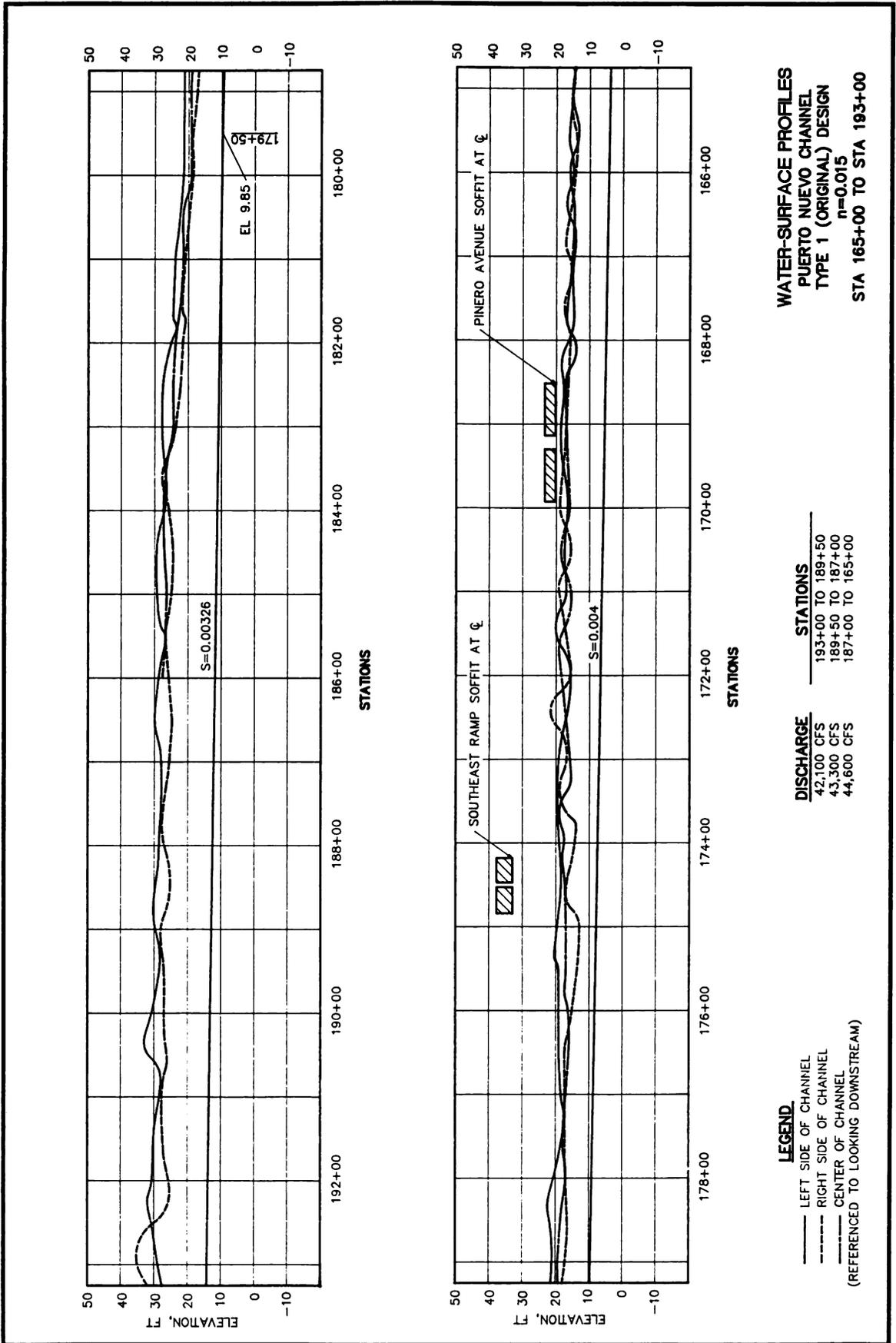
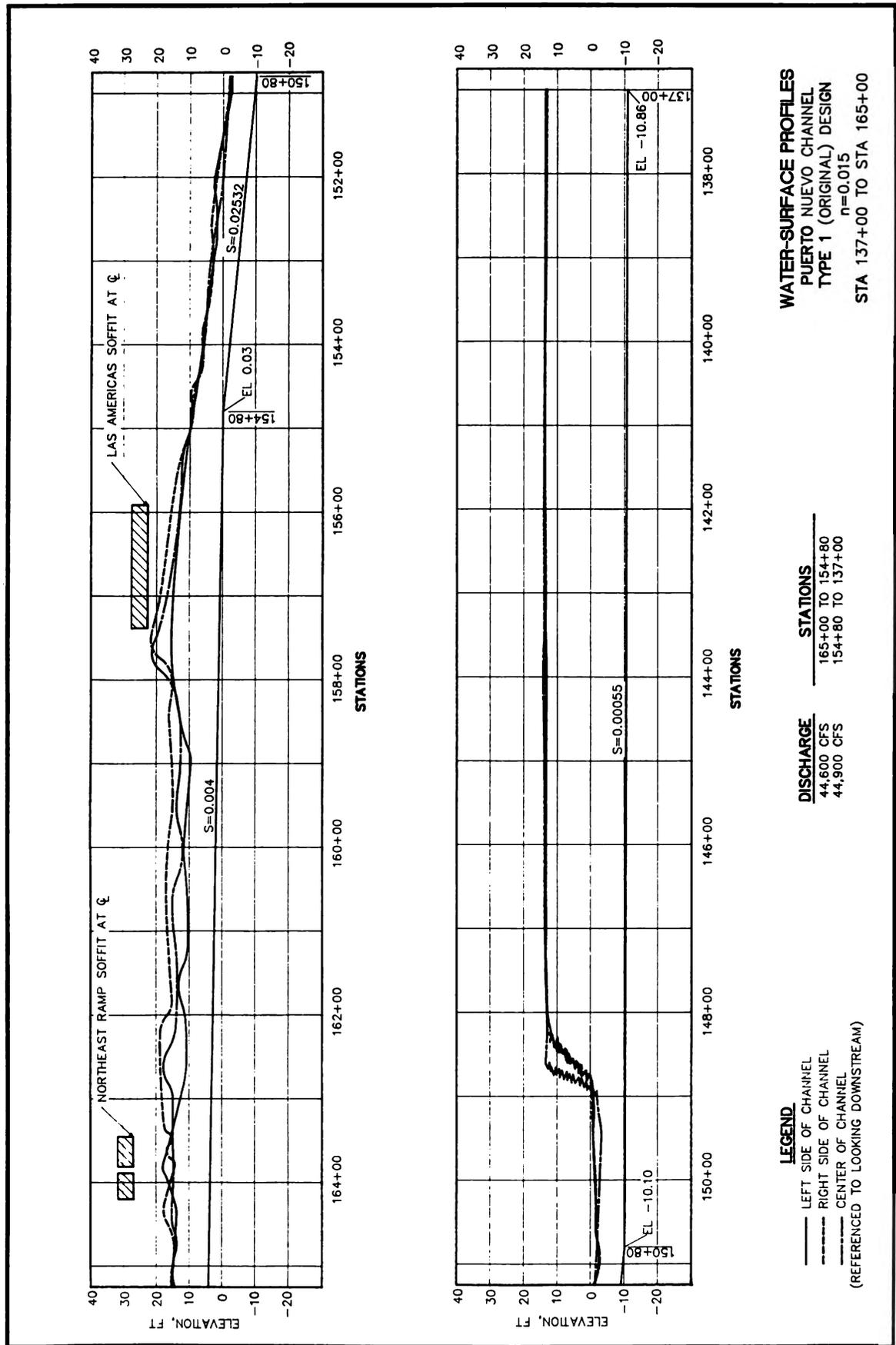
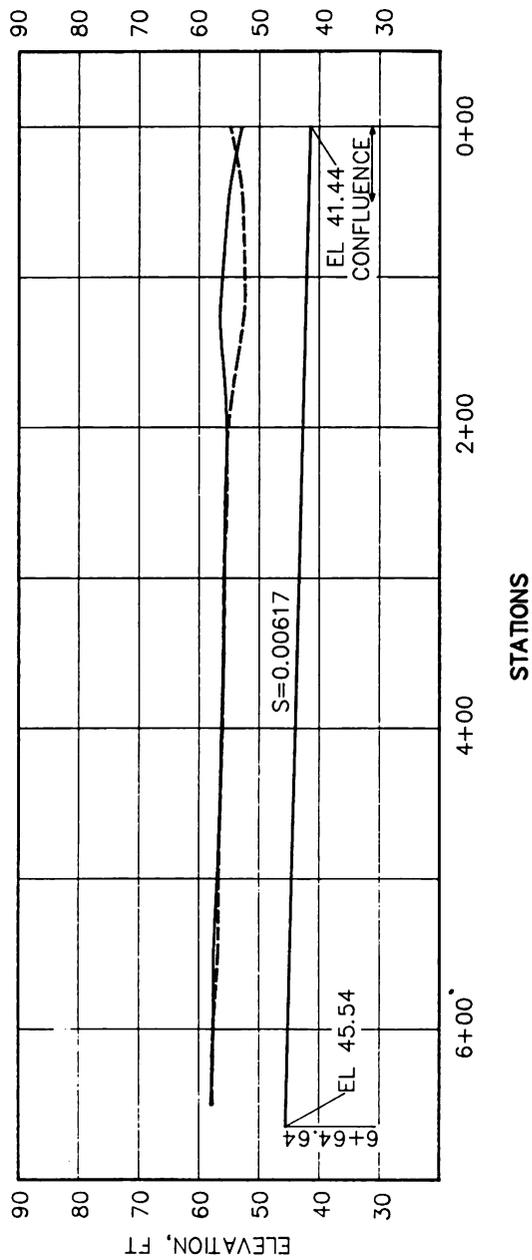


PLATE 12

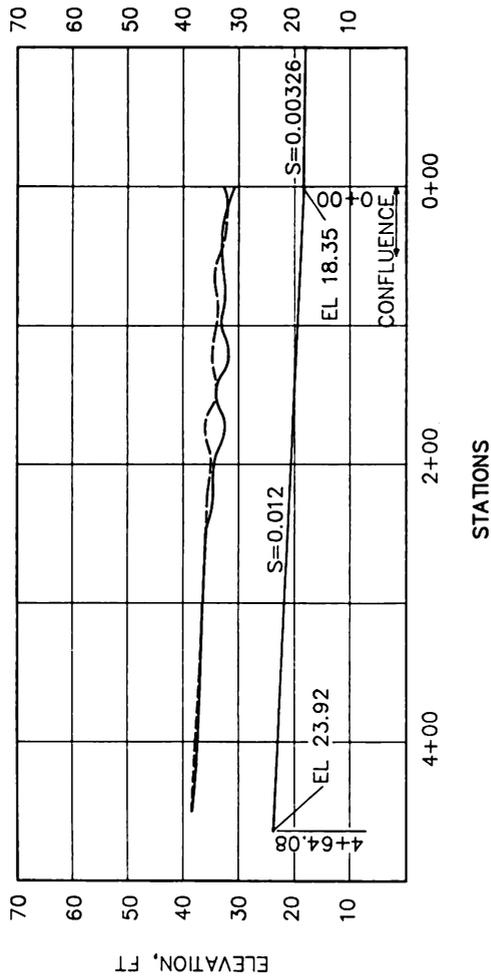




**WATER-SURFACE PROFILES**  
**GUARACANAL CHANNEL**  
**TYPE 1 (ORIGINAL) DESIGN**  
 $n=0.015$   
**STA 0+00 TO STA 6+50**

**DISCHARGE** 8,000 CFS  
**STATIONS** 6+50 TO 0+00

**LEGEND**  
 — LEFT SIDE OF CHANNEL  
 - - - RIGHT SIDE OF CHANNEL  
 (REFERENCED TO LOOKING DOWNSTREAM)

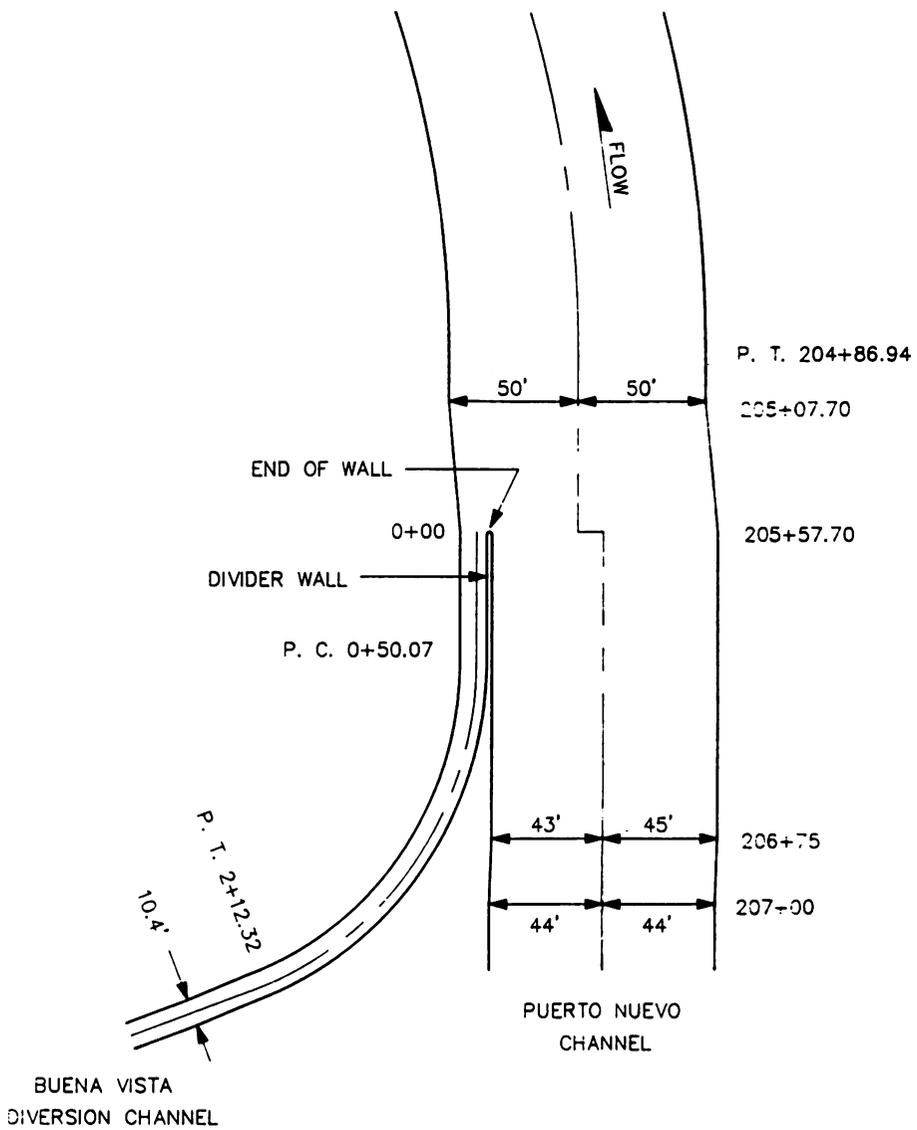


**WATER-SURFACE PROFILES**  
 BUENA VISTA DIVERSION CHANNEL  
 TYPE 1 (ORIGINAL) DESIGN  
 $n=0.015$   
 STA 0+00 TO STA 4+64.08

DISCHARGE  
 4,200 CFS

LEGEND  
 — LEFT SIDE OF CHANNEL  
 - - - - RIGHT SIDE OF CHANNEL  
 (REFERENCED TO LOOKING DOWNSTREAM)

STATIONS  
 4+64.08 TO 0+00



PUERTO NUEVO - BUENA VISTA  
 DIVERSION CONFLUENCE  
 TYPE 1 (ORIGINAL) DESIGN

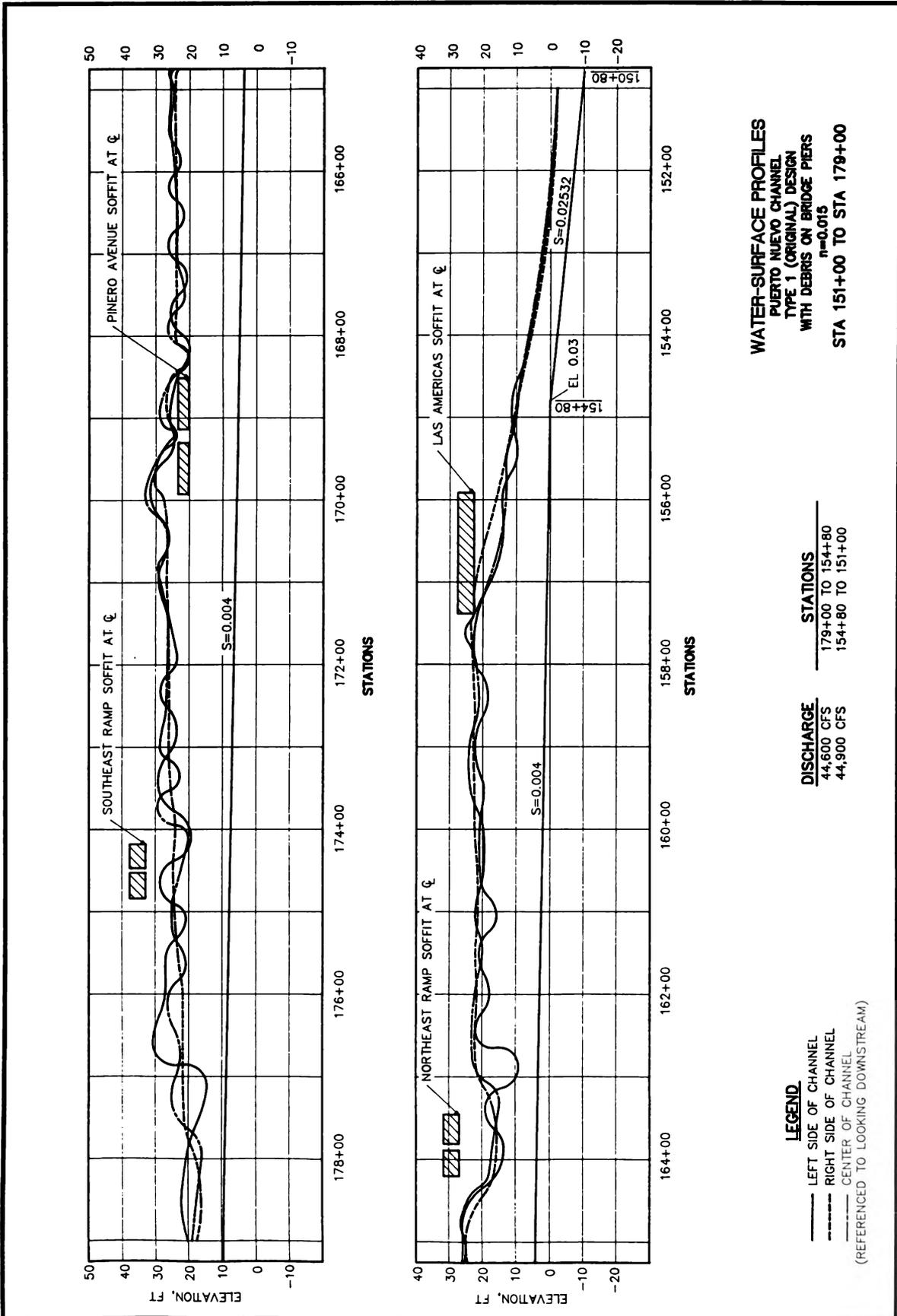
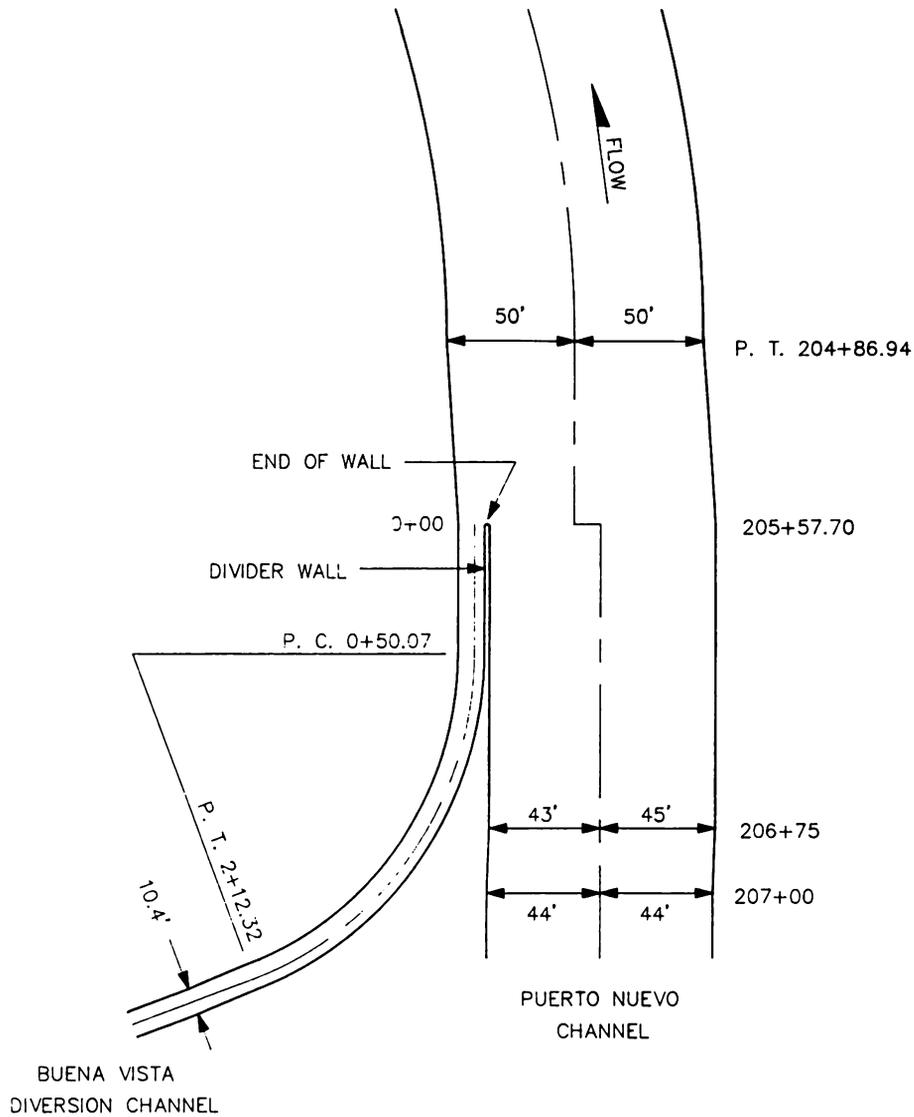
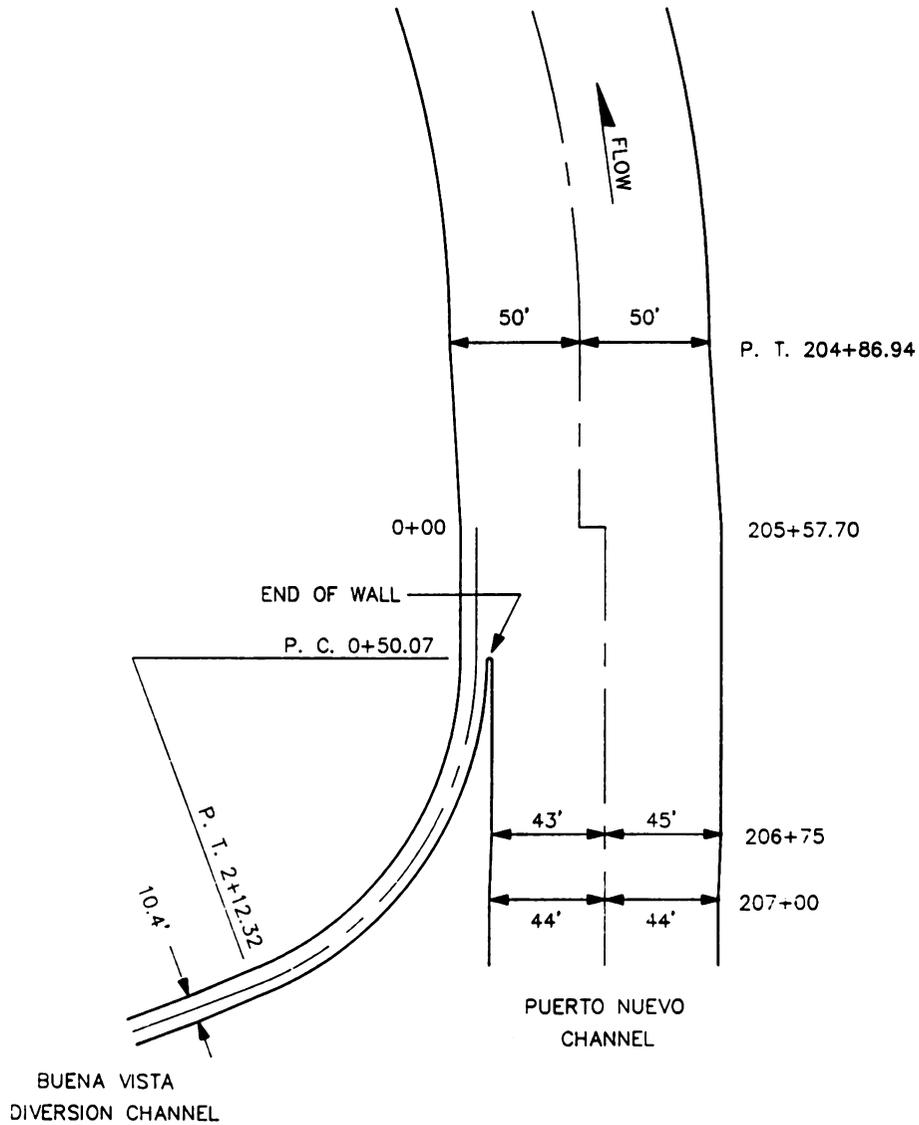


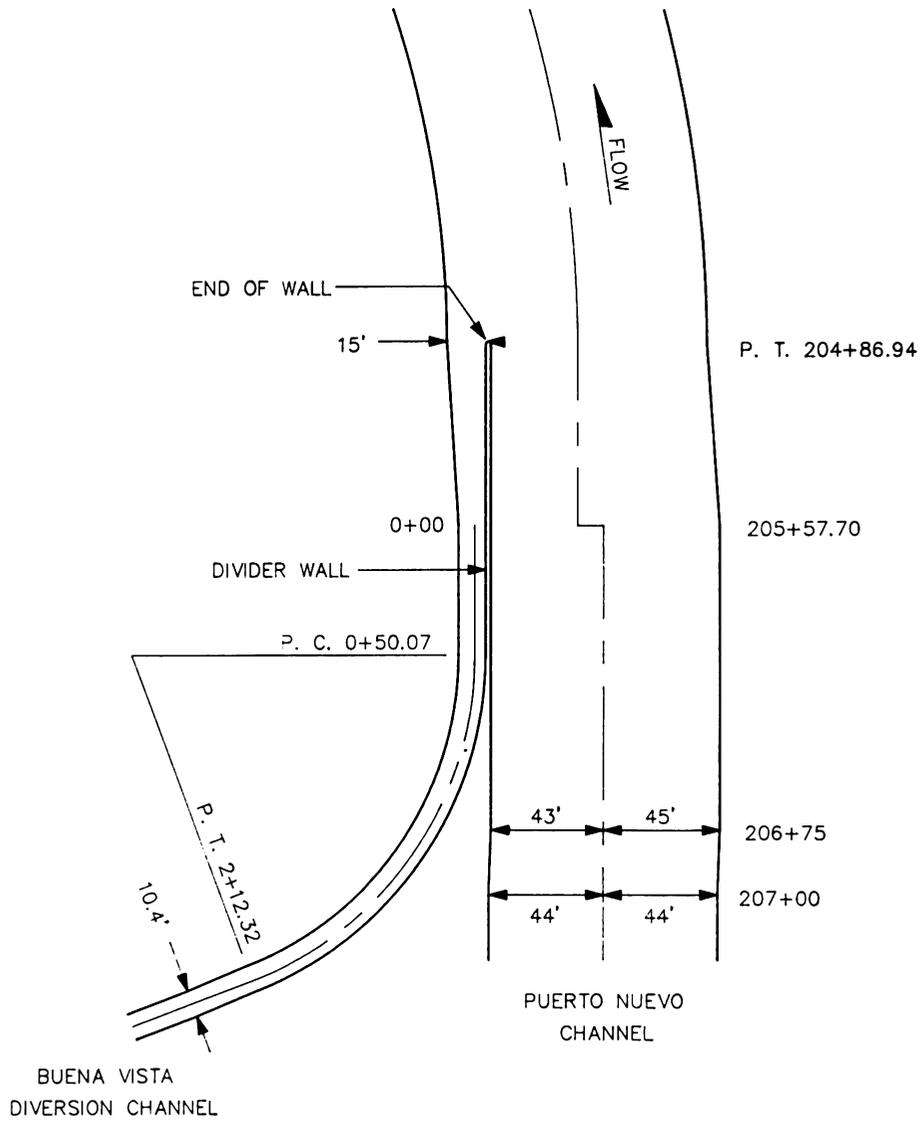
PLATE 16



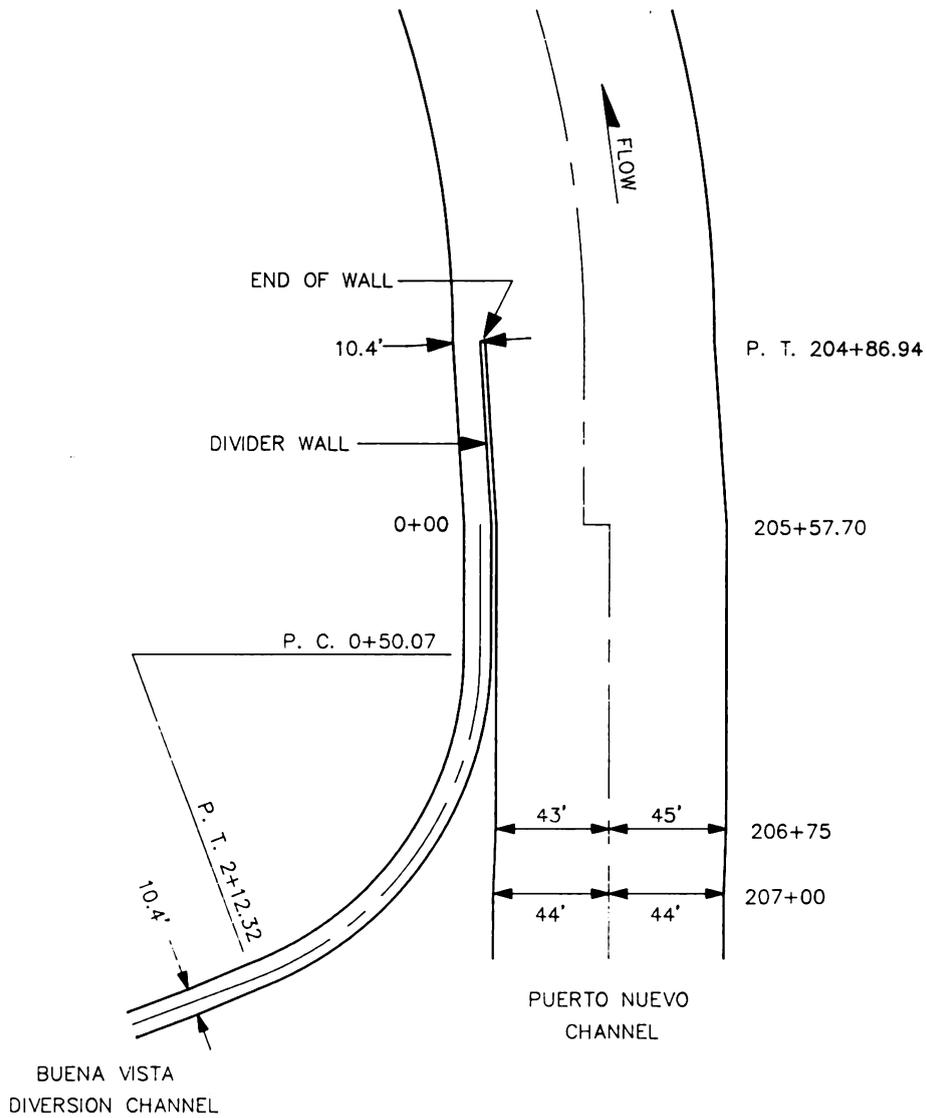
**PUERTO NUEVO - BUENA VISTA  
 DIVERSION CONFLUENCE  
 TYPE 2 DESIGN CHANNEL  
 WITH TYPE 1 DESIGN  
 CONFLUENCE WALL**



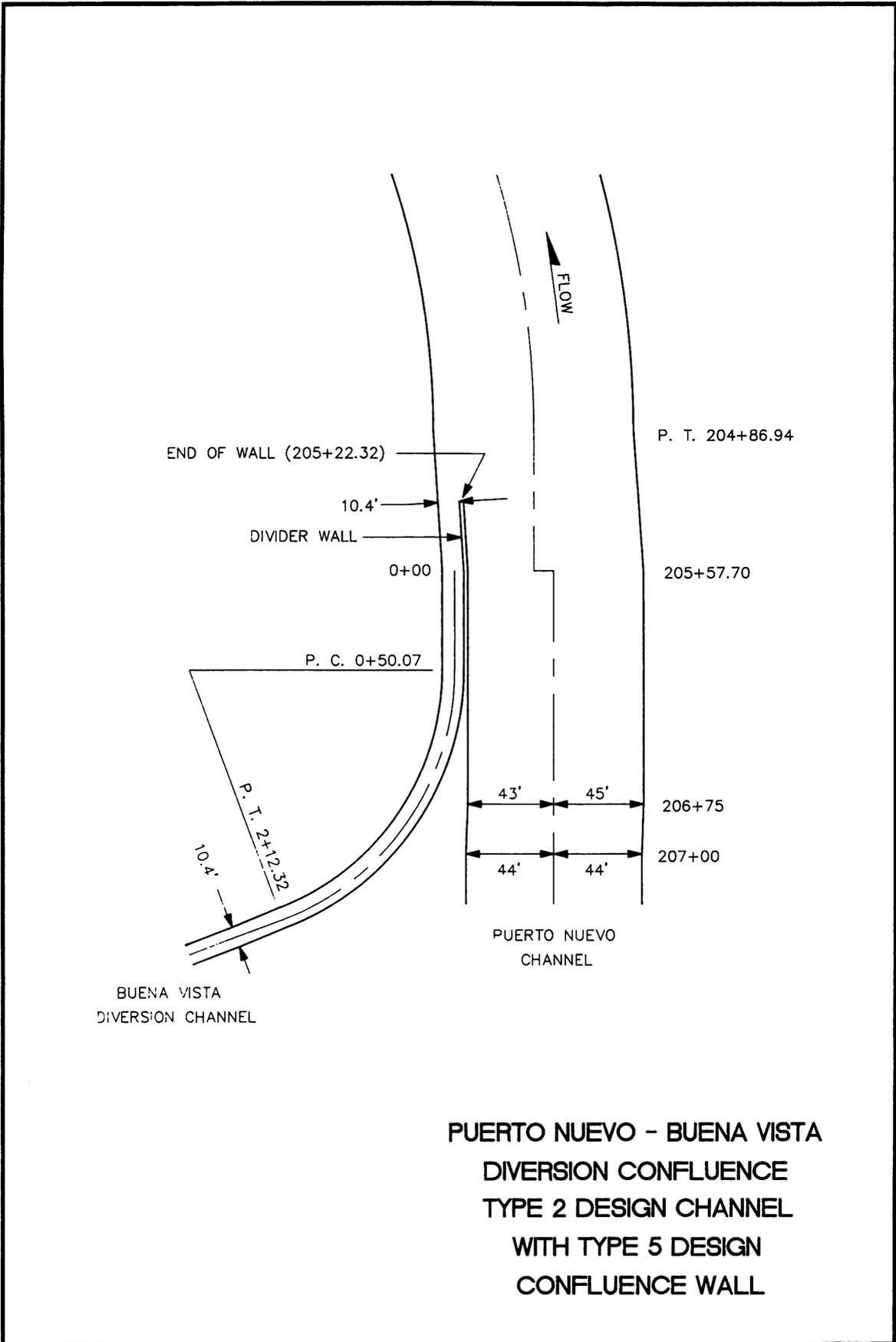
PUERTO NUEVO - BUENA VISTA  
 DIVERSION CONFLUENCE  
 TYPE 2 DESIGN CHANNEL  
 WITH TYPE 2 DESIGN  
 CONFLUENCE WALL

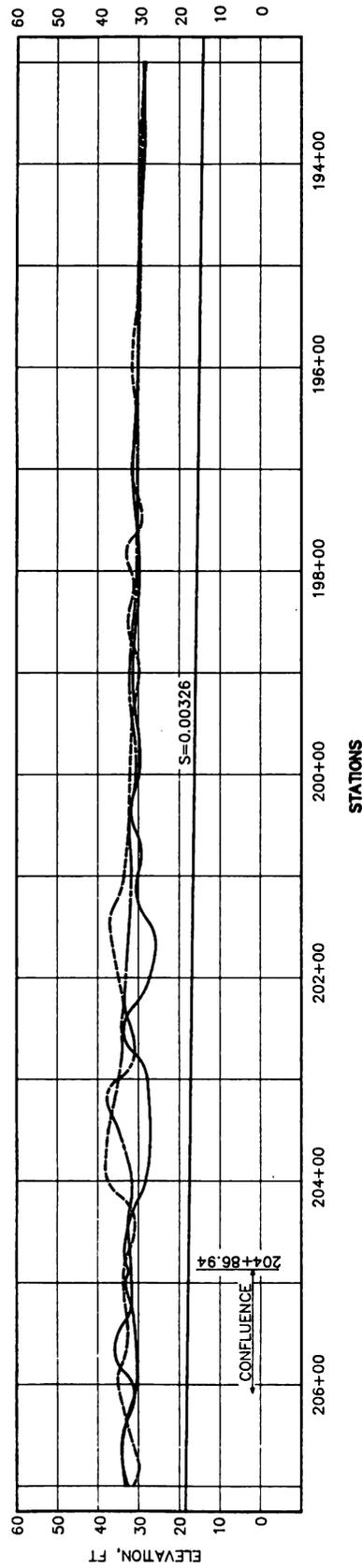


**PUERTO NUEVO - BUENA VISTA  
 DIVERSION CONFLUENCE  
 TYPE 2 DESIGN CHANNEL  
 WITH TYPE 3 DESIGN  
 CONFLUENCE WALL**



**PUERTO NUEVO - BUENA VISTA  
 DIVERSION CONFLUENCE  
 TYPE 2 DESIGN CHANNEL  
 WITH TYPE 4 DESIGN  
 CONFLUENCE WALL**



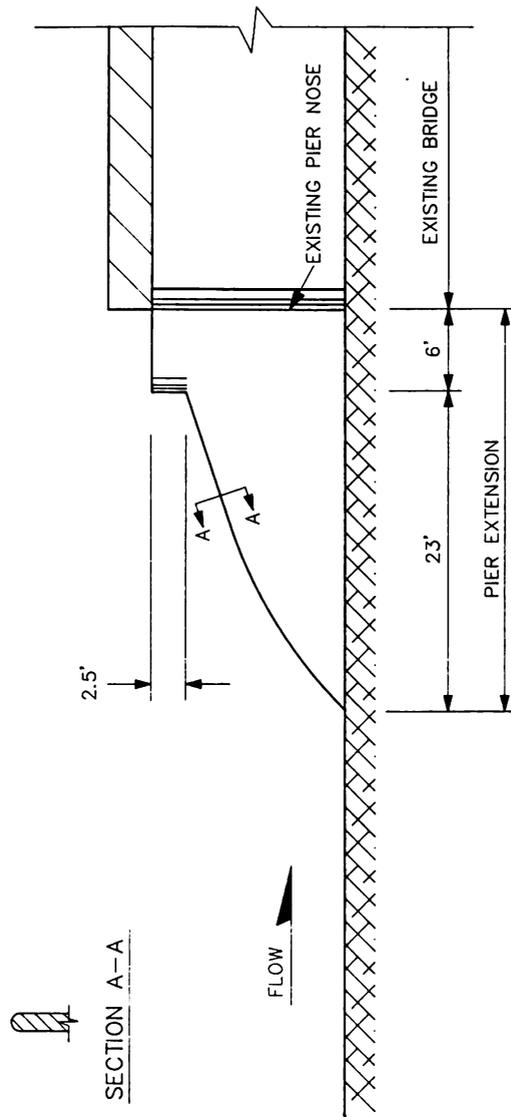
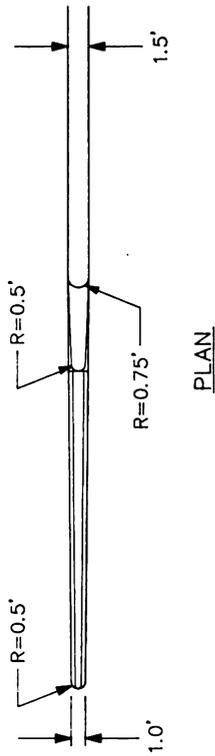


**LEGEND**  
 — LEFT SIDE OF CHANNEL  
 - - - RIGHT SIDE OF CHANNEL  
 - - - CENTER OF CHANNEL  
 (REFERENCED TO LOOKING DOWNSTREAM)

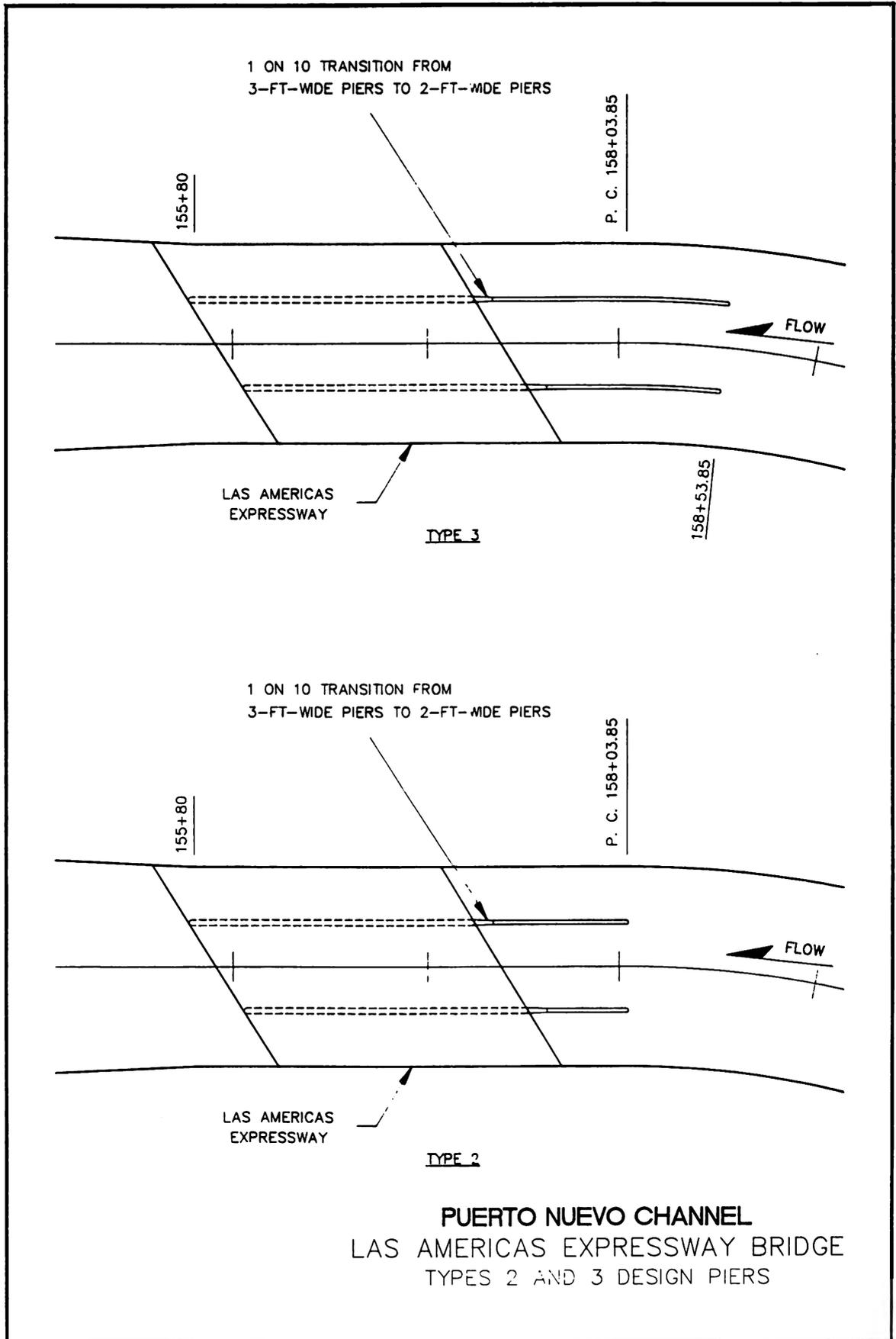
**DISCHARGE**  
 37,900 CFS  
 42,100 CFS

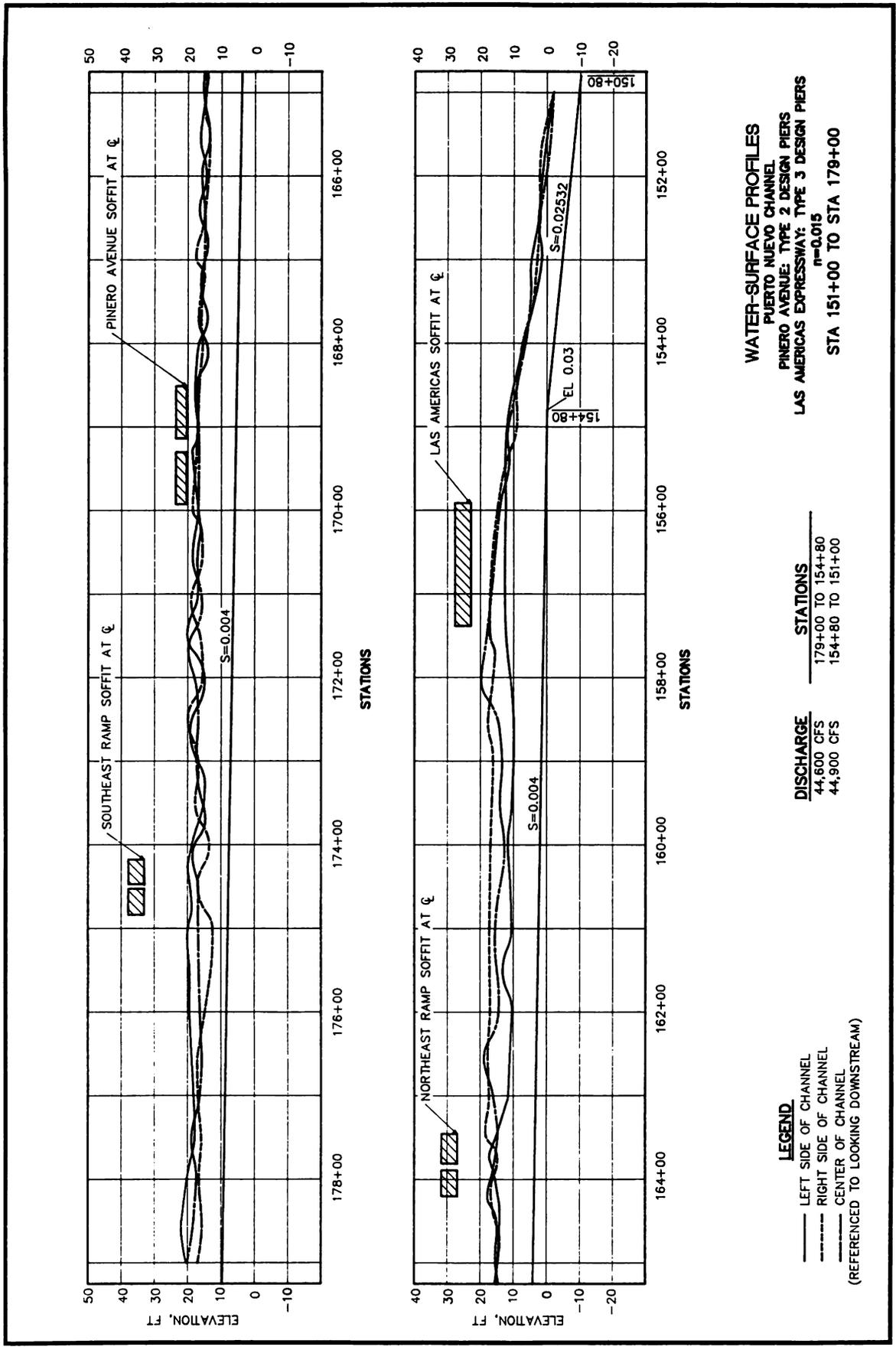
**STATIONS**  
 207+00 TO 204+86.94  
 204+86.94 TO 193+00

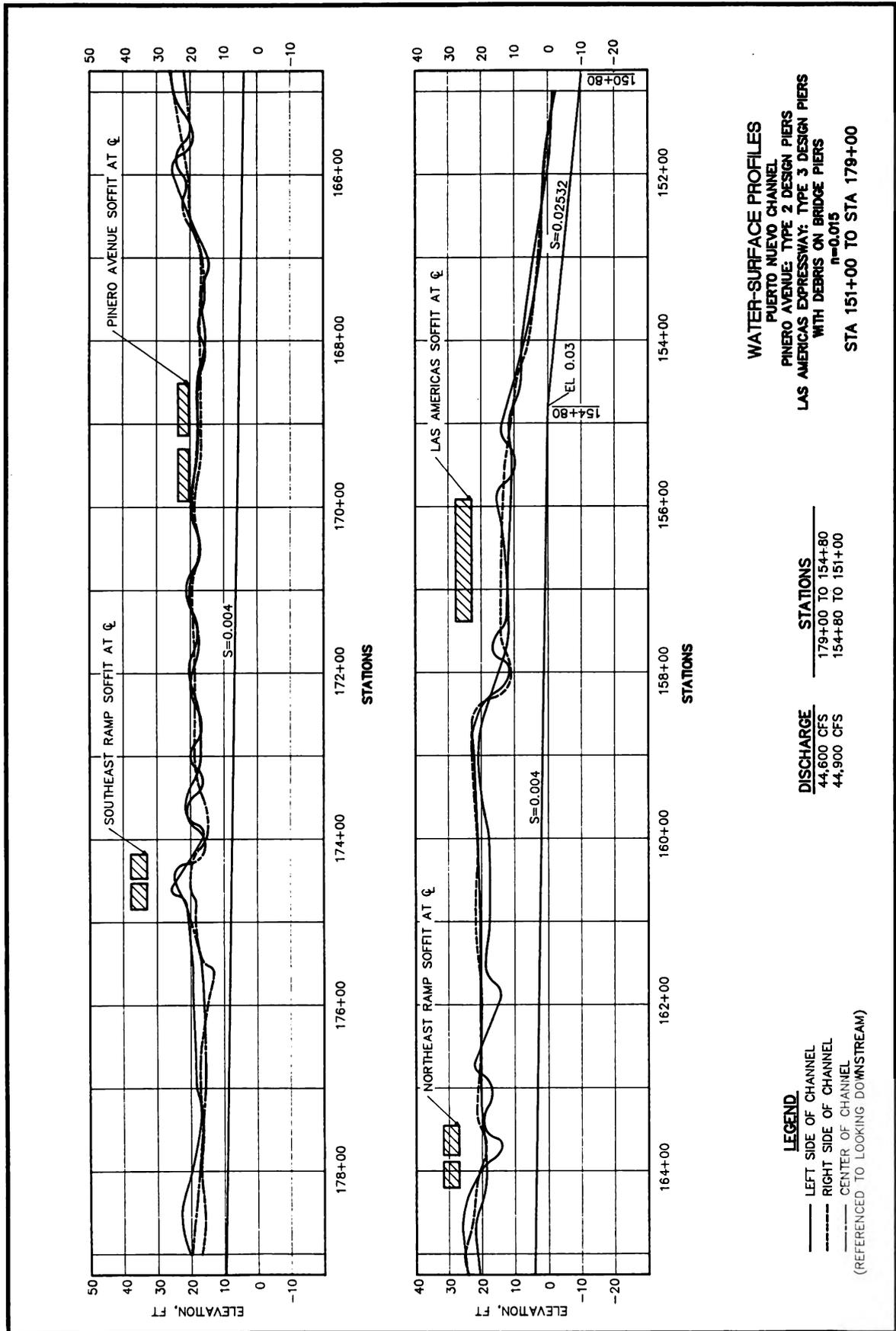
**WATER-SURFACE PROFILES**  
**PUERTO NUEVO CHANNEL**  
 TYPE 2 DESIGN CHANNEL  
 WITH TYPE 4 DESIGN PUERTO NUEVO/  
 BUENA VISTA DIVERSION CONFLUENCE WALL  
 $n=0.015$   
 STA 193+00 TO STA 207+00

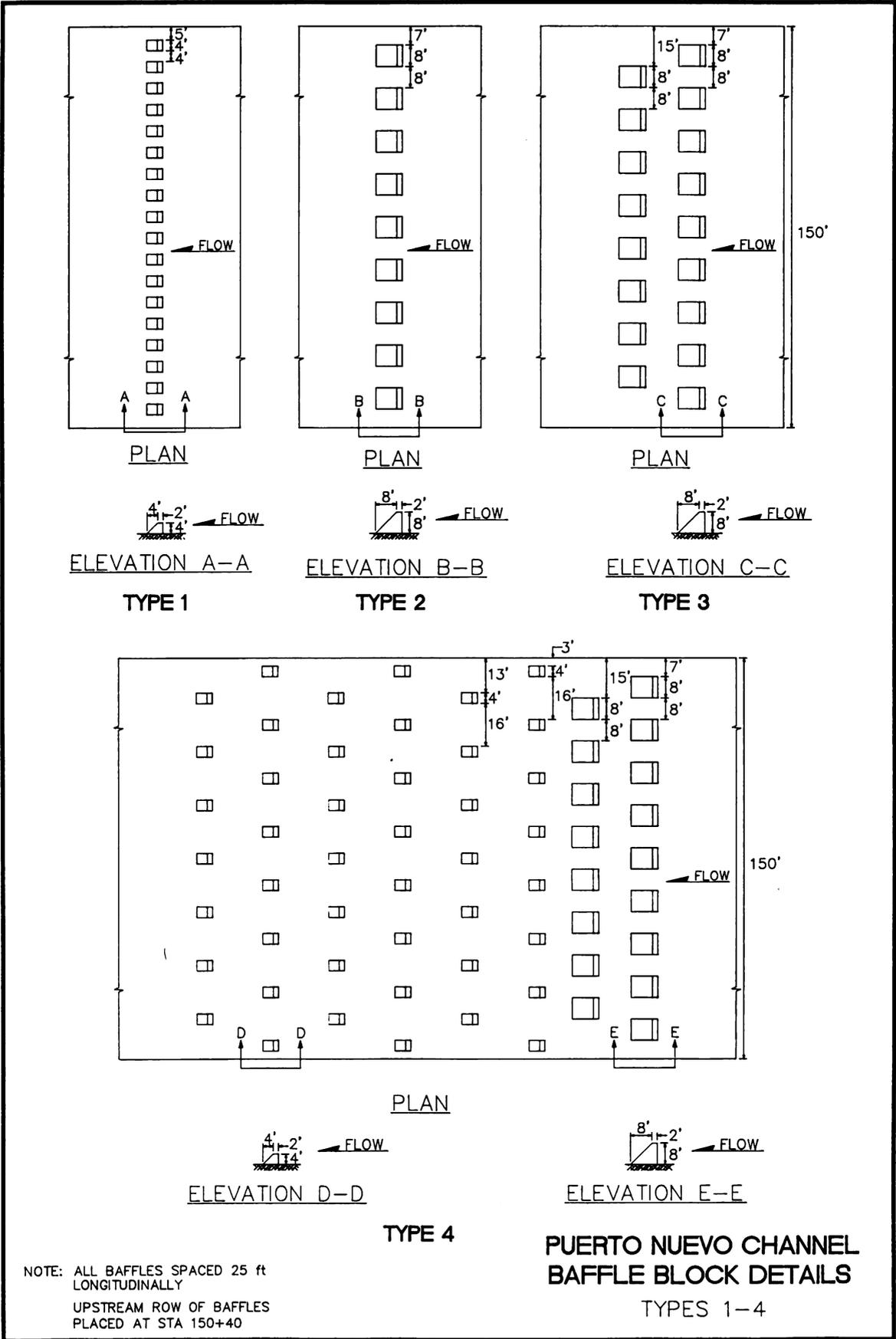


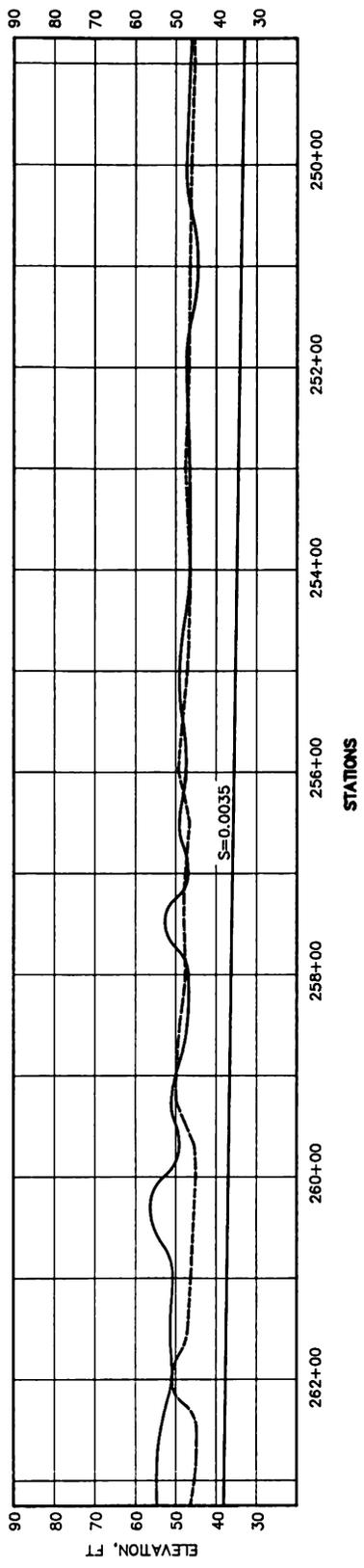
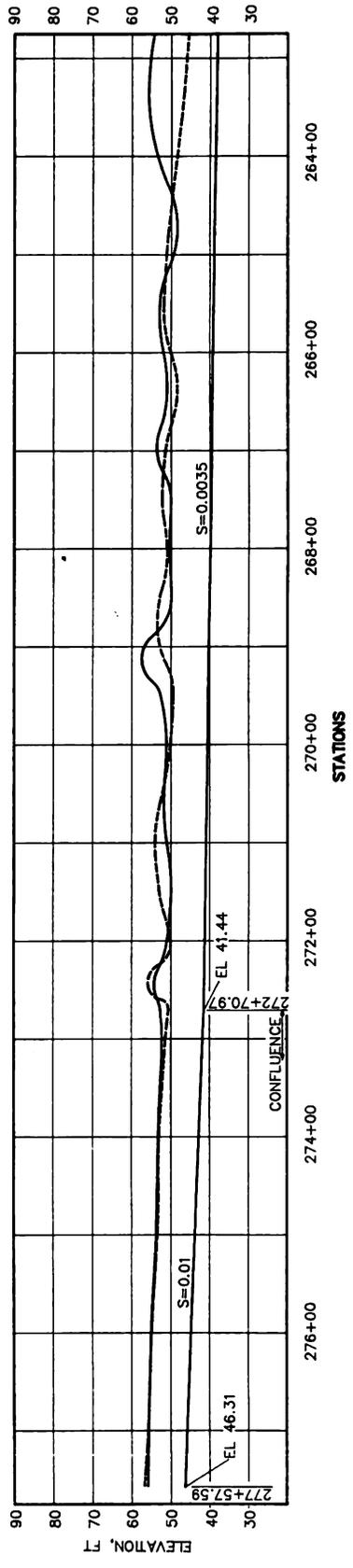
**PUERTO NUEVO CHANNEL**  
**PINERO AVENUE BRIDGE**  
 TYPE 2 DESIGN PIERS







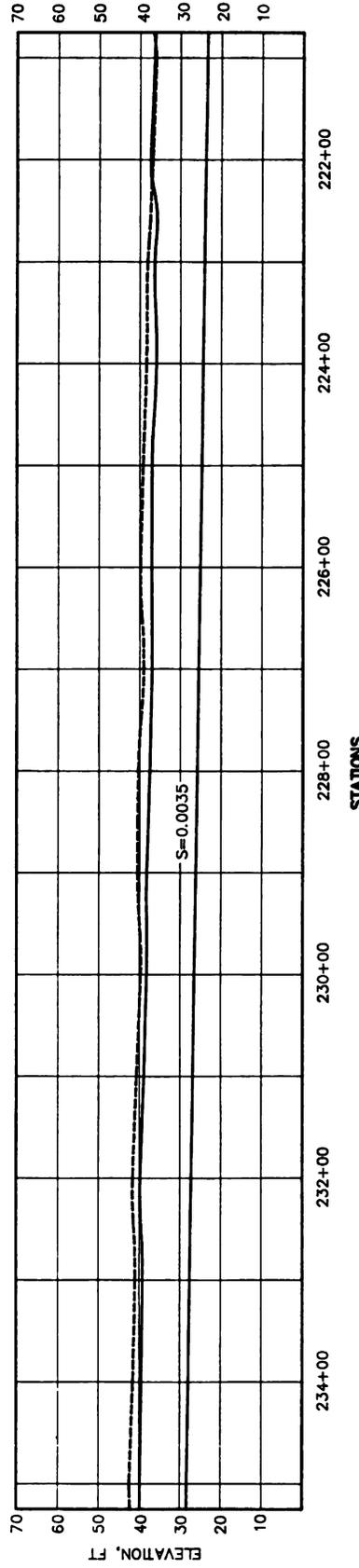
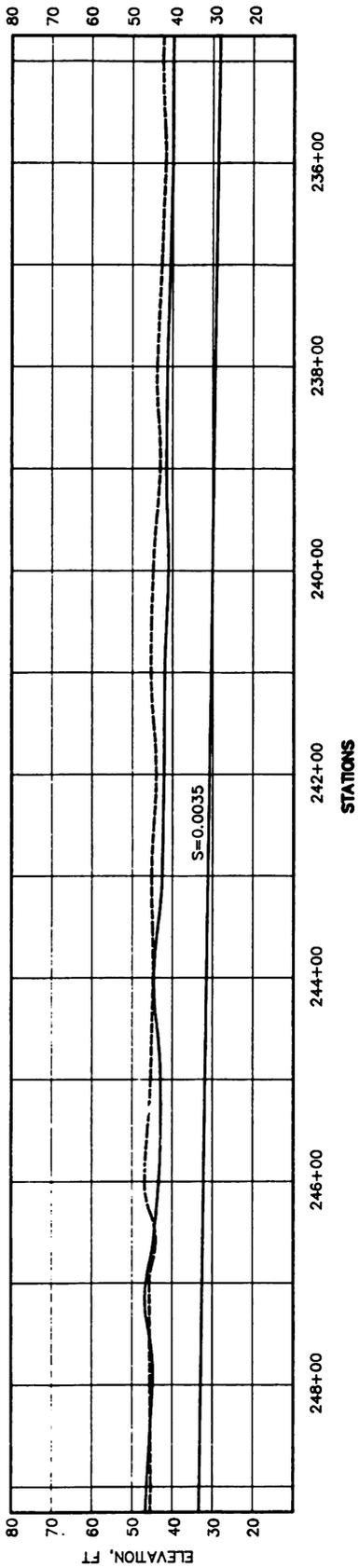




**WATER-SURFACE PROFILES**  
**PUERTO NUEVO CHANNEL**  
**TYPE 2 DESIGN CHANNEL**  
**n=0.012**  
**STA 249+00 TO STA 277+57.59**

DISCHARGE	STATIONS
26,100 CFS	277+57.59 TO 272+70.97
34,100 CFS	272+70.97 TO 256+00
36,000 CFS	256+00 TO 249+00

**LEGEND**  
 — LEFT SIDE OF CHANNEL  
 - - - RIGHT SIDE OF CHANNEL  
 (REFERENCED TO LOOKING DOWNSTREAM)



WATER-SURFACE PROFILES  
 PUERTO NUEVO CHANNEL  
 TYPE 2 DESIGN CHANNEL  
 $n=0.012$   
 STA 221+00 TO STA 249+00

**DISCHARGE**  
 36,000 CFS

**STATIONS**  
 249+00 TO 221+00

**LEGEND**  
 — LEFT SIDE OF CHANNEL  
 - - - RIGHT SIDE OF CHANNEL  
 (REFERENCED TO LOOKING DOWNSTREAM)

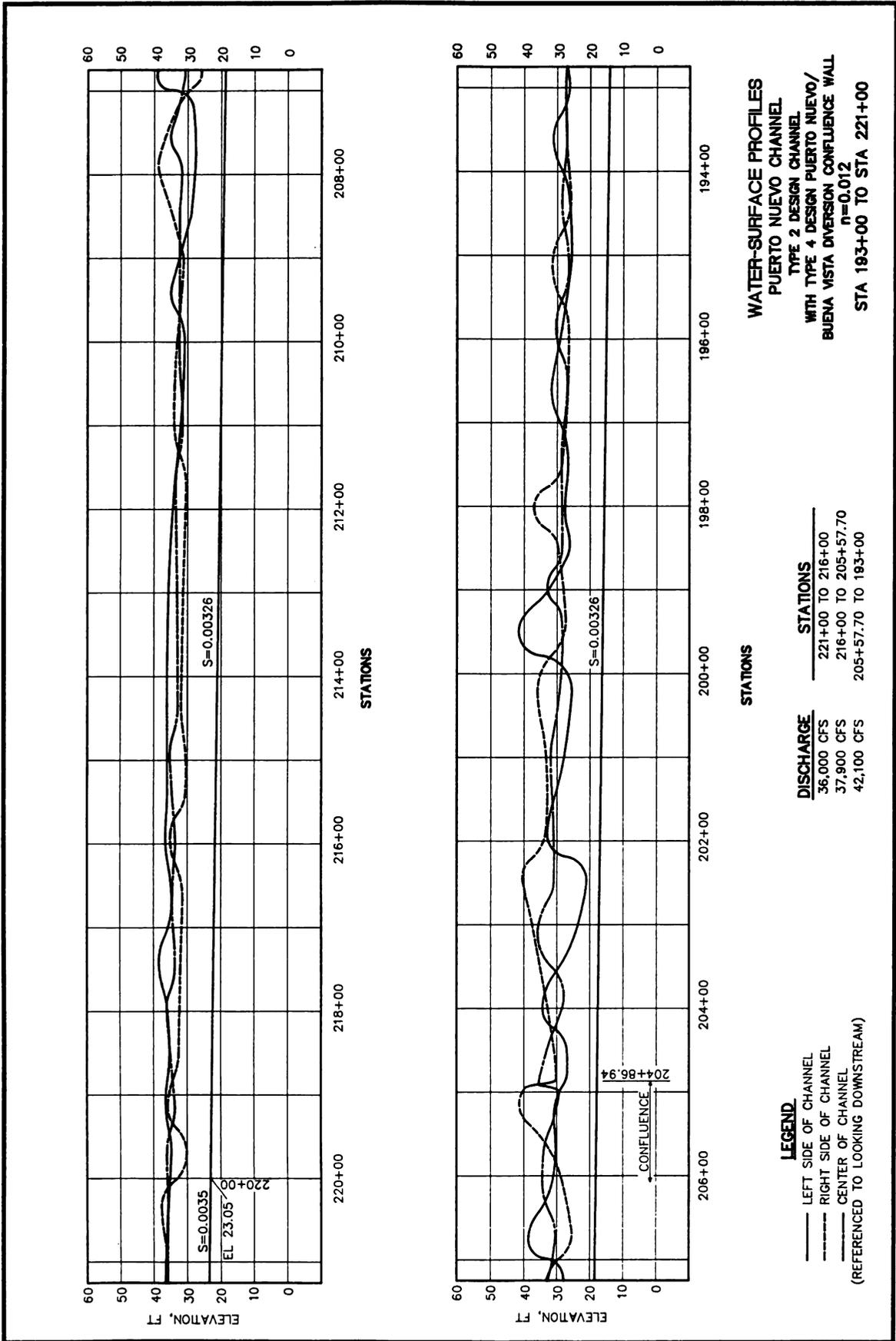
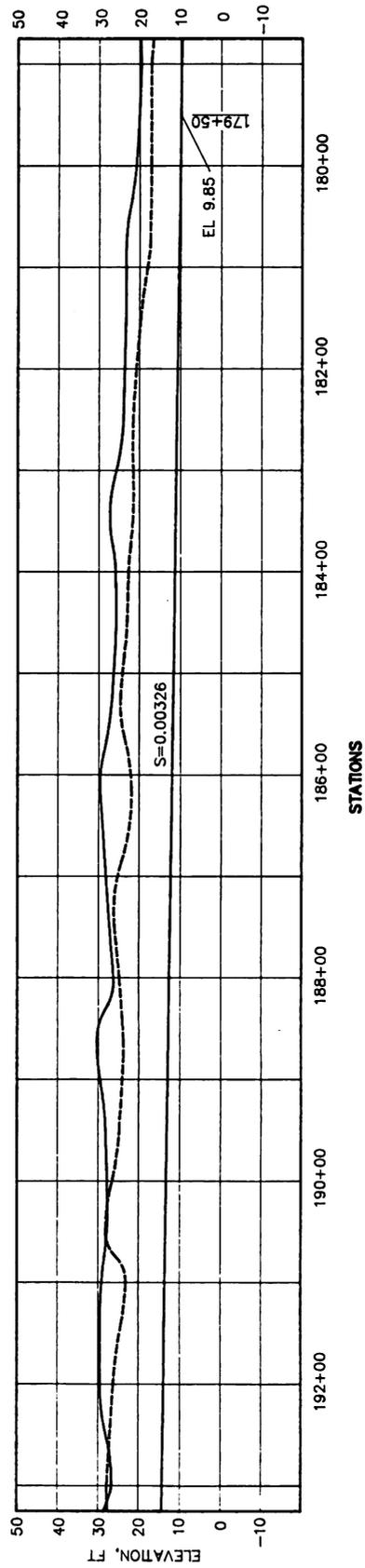


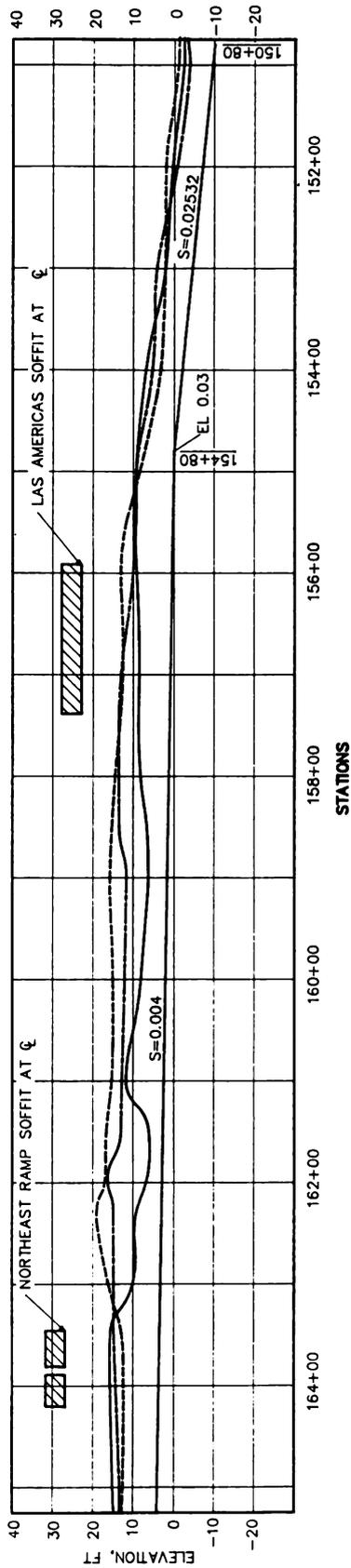
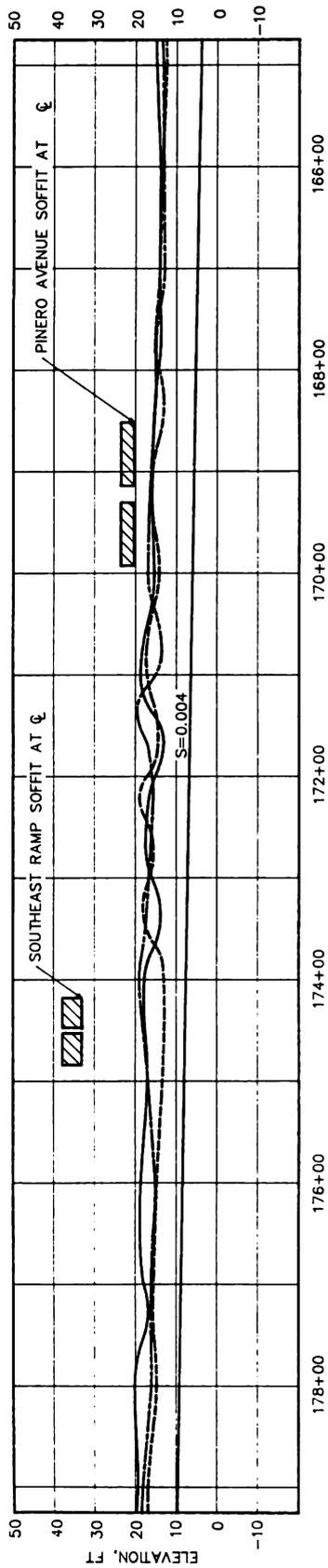
PLATE 30



**WATER-SURFACE PROFILES**  
**PUERTO NUEVO CHANNEL**  
**TYPE 2 DESIGN CHANNEL**  
 **$n=0.012$**   
**STA 179+00 TO STA 193+00**

DISCHARGE	STATIONS
42,100 CFS	193+00 TO 189+50
43,300 CFS	189+50 TO 187+00
44,600 CFS	187+00 TO 179+00

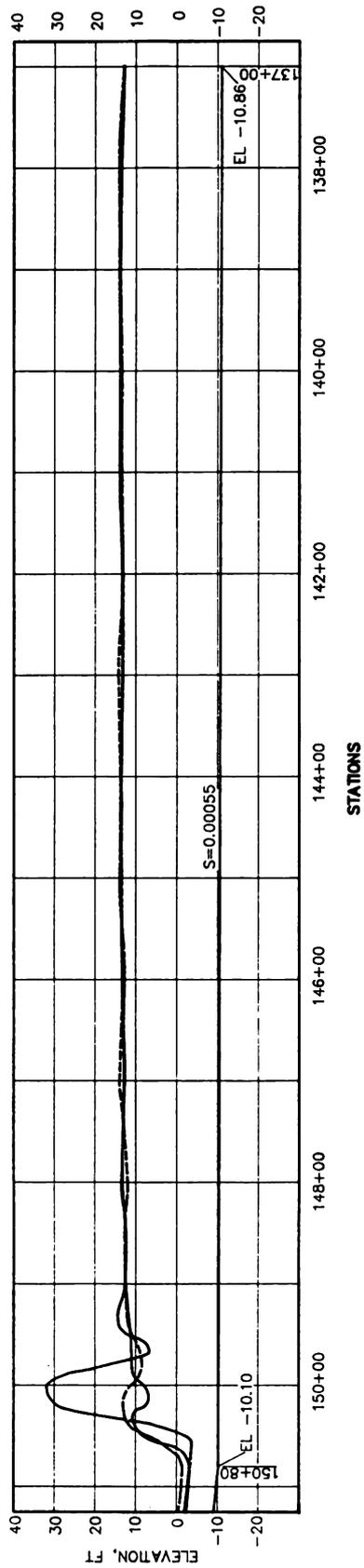
**LEGEND**  
 — LEFT SIDE OF CHANNEL  
 - - - RIGHT SIDE OF CHANNEL  
 (REFERENCED TO LOOKING DOWNSTREAM)



**WATER-SURFACE PROFILES**  
**PUERTO NUEVO CHANNEL**  
**PINERO AVENUE: TYPE 2 DESIGN PIERS**  
**LAS AMERICAS EXPRESSWAY: TYPE 3 DESIGN PIERS**  
**n=0.012**  
**STA 151+00 TO STA 179+00**

DISCHARGE	STATIONS
44,600 CFS	179+00 TO 154+80
44,900 CFS	154+80 TO 151+00

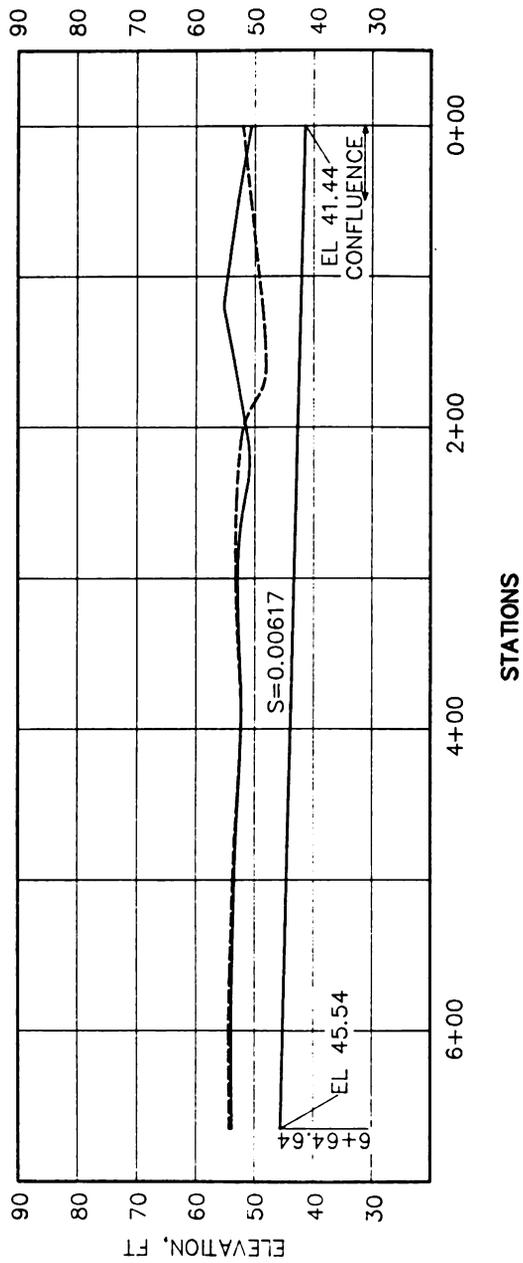
- LEGEND**
- LEFT SIDE OF CHANNEL
  - - - RIGHT SIDE OF CHANNEL
  - · - · CENTER OF CHANNEL
- (REFERENCED TO LOOKING DOWNSTREAM)



**WATER-SURFACE PROFILES**  
**PUERTO NUEVO CHANNEL**  
**TYPE 2 DESIGN CHANNEL**  
**WITH TYPE 4 DESIGN BAFFLE BLOCKS**  
 $n=0.012$   
**STA 137+00 TO 151+00**

**LEGEND**  
 — LEFT SIDE OF CHANNEL  
 - - - RIGHT SIDE OF CHANNEL  
 - · - · CENTER OF CHANNEL  
 (REFERENCED TO LOOKING DOWNSTREAM)

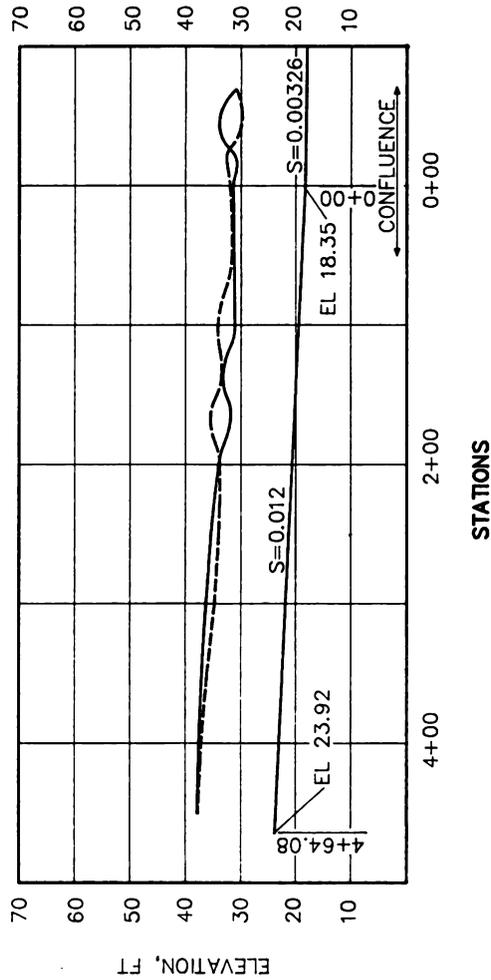
**DISCHARGE** 44,900 CFS  
**STATIONS** 151+00 TO 137+00



**WATER-SURFACE PROFILES**  
**GUARACANAL CHANNEL**  
**TYPE 1 (ORIGINAL) DESIGN**  
 $n=0.012$   
**STA 0+00 TO STA 6+50**

**DISCHARGE** \_\_\_\_\_ **STATIONS** \_\_\_\_\_  
 8,000 CFS 6+50 TO 0+00

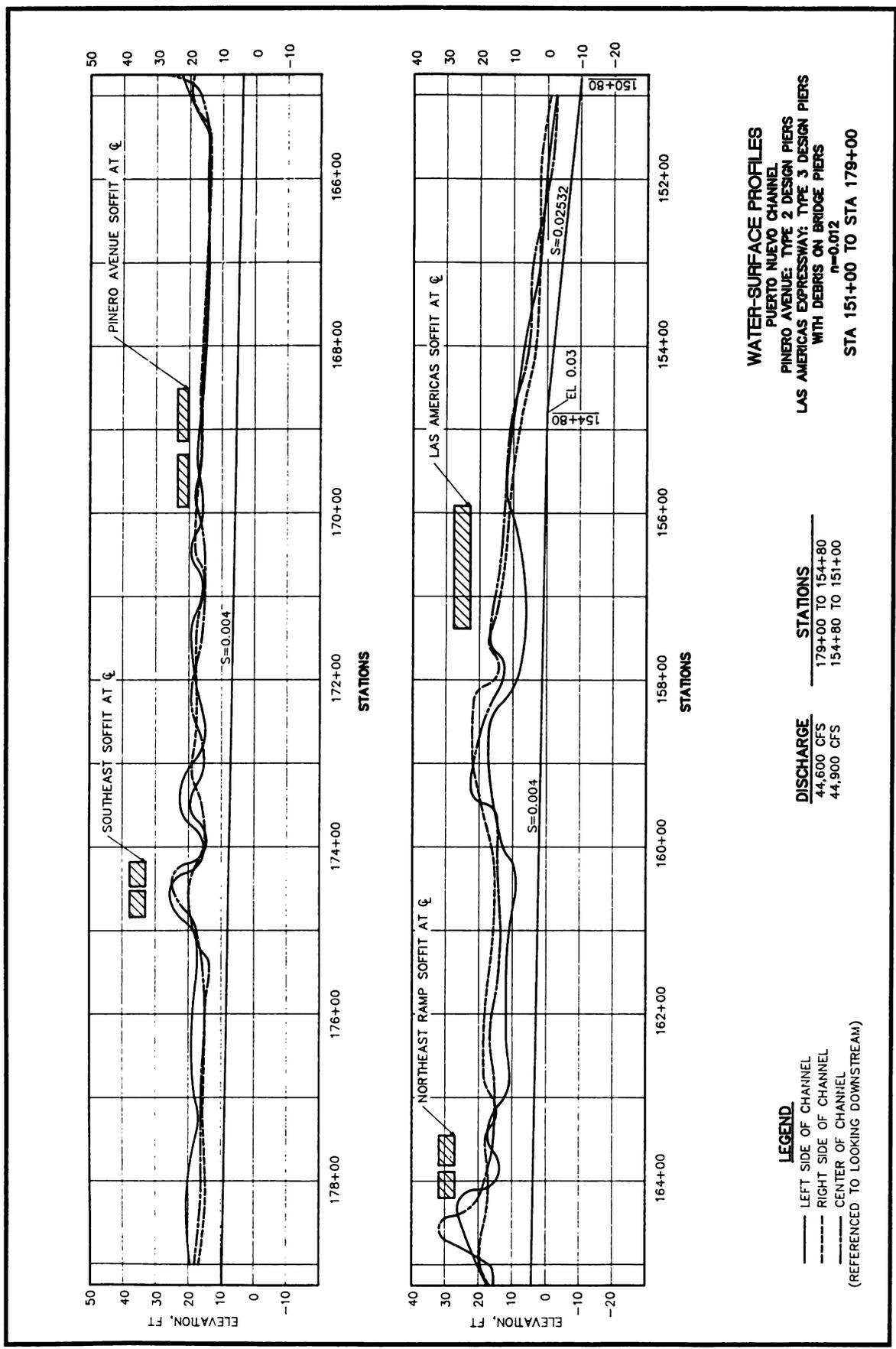
**LEGEND**  
 \_\_\_\_\_ LEFT SIDE OF CHANNEL  
 - - - - - RIGHT SIDE OF CHANNEL  
 (REFERENCED TO LOOKING DOWNSTREAM)



**WATER-SURFACE PROFILES**  
**BUENA VISTA DIVERSION CHANNEL**  
 TYPE 2 DESIGN CHANNEL  
 WITH TYPE 4 DESIGN PUERTO NUEVO/  
**BUENA VISTA DIVERSION CONFLUENCE WALL**  
 $n=0.012$   
**STA 0-70.76 TO STA 4+64.08**

**DISCHARGE** 4,200 CFS  
**STATIONS** 4+64.08 TO 0+00

**LEGEND**  
 — LEFT SIDE OF CHANNEL  
 - - - RIGHT SIDE OF CHANNEL  
 (REFERENCED TO LOOKING DOWNSTREAM)

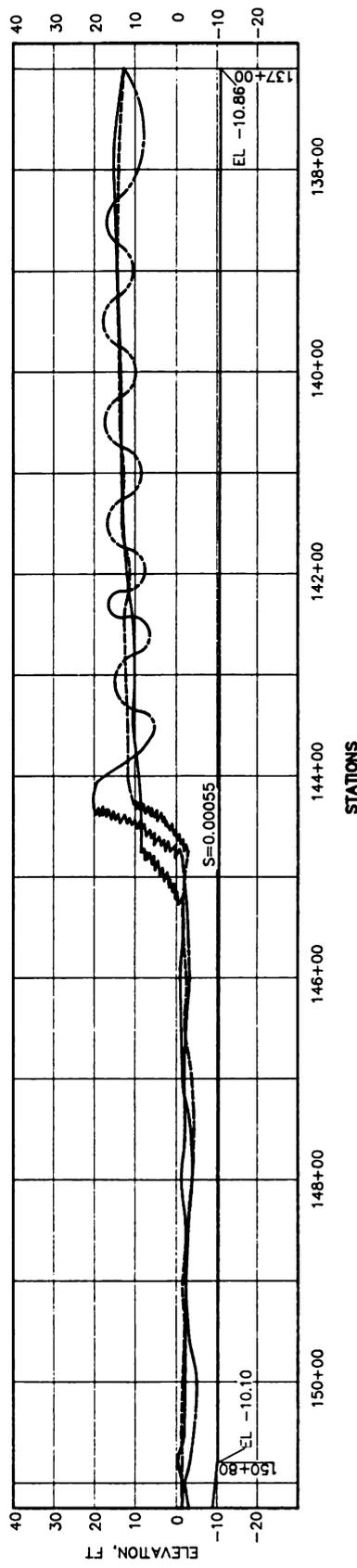


**WATER-SURFACE PROFILES**  
 PUERTO NUEVO CHANNEL  
 PINERO AVENUE: TYPE 2 DESIGN PIERS  
 LAS AMERICAS EXPRESSWAY: TYPE 3 DESIGN PIERS  
 WITH DEBRIS ON BRIDGE PIERS  
 $n=0.012$   
 STA 151+00 TO STA 179+00

**DISCHARGE**  
 44,600 CFS  
 44,900 CFS

**STATIONS**  
 179+00 TO 154+80  
 154+80 TO 151+00

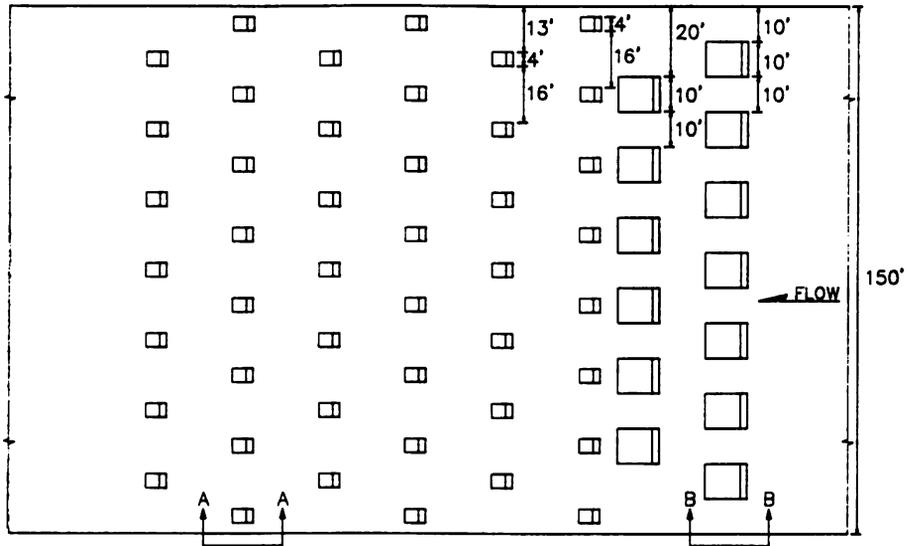
**LEGEND**  
 — LEFT SIDE OF CHANNEL  
 - - - RIGHT SIDE OF CHANNEL  
 - - - CENTER OF CHANNEL  
 (REFERENCED TO LOOKING DOWNSTREAM)



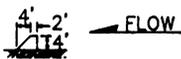
**WATER-SURFACE PROFILES**  
**PUERTO NUEVO CHANNEL**  
**TYPE 2 DESIGN CHANNEL**  
**WITHOUT BAFFLE BLOCKS**  
**n=0.012**  
**STA 137+00 TO 151+00**

**DISCHARGE** 44,900 CFS  
**STATIONS** 151+00 TO 137+00

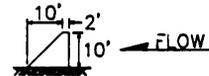
**LEGEND**  
 — LEFT SIDE OF CHANNEL  
 - - - RIGHT SIDE OF CHANNEL  
 - · - · CENTER OF CHANNEL  
 (REFERENCED TO LOOKING DOWNSTREAM)



PLAN

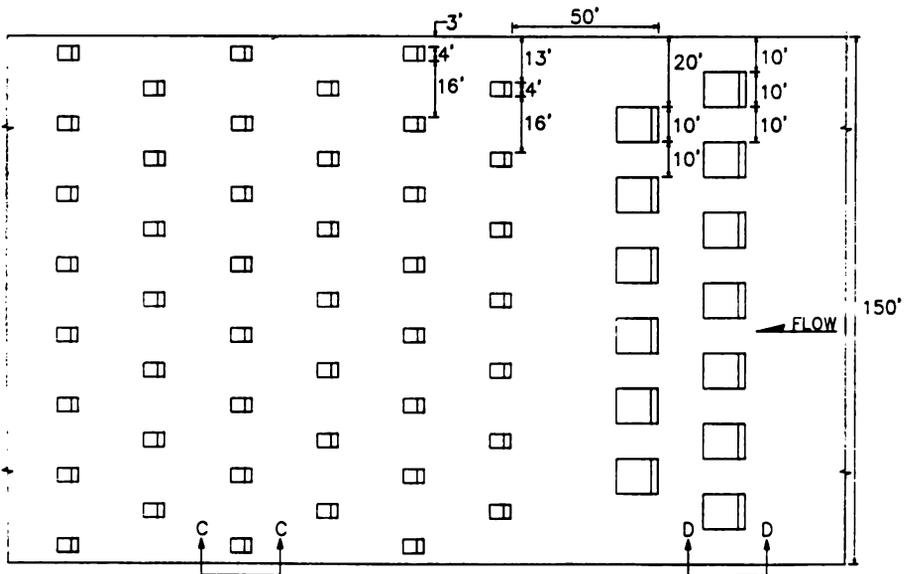


ELEVATION A-A

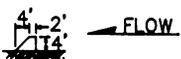


ELEVATION B-B

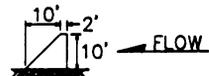
TYPE 5



PLAN



ELEVATION C-C

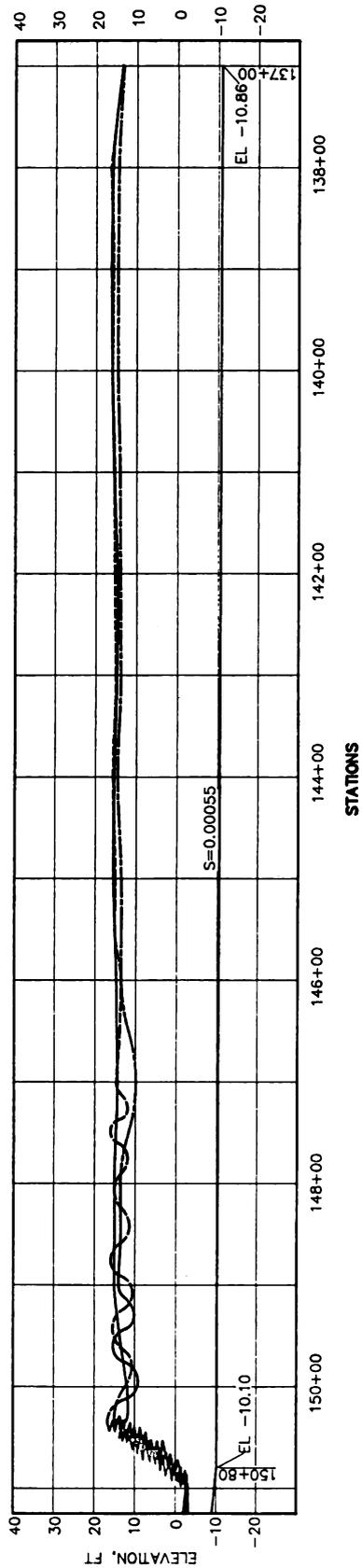


ELEVATION D-D

TYPE 6

NOTE: ALL BAFFLES SPACED 25 ft  
LONGITUDINALLY UNLESS  
NOTED OTHERWISE  
UPSTREAM ROW OF BAFFLES  
PLACED AT STA 150+40

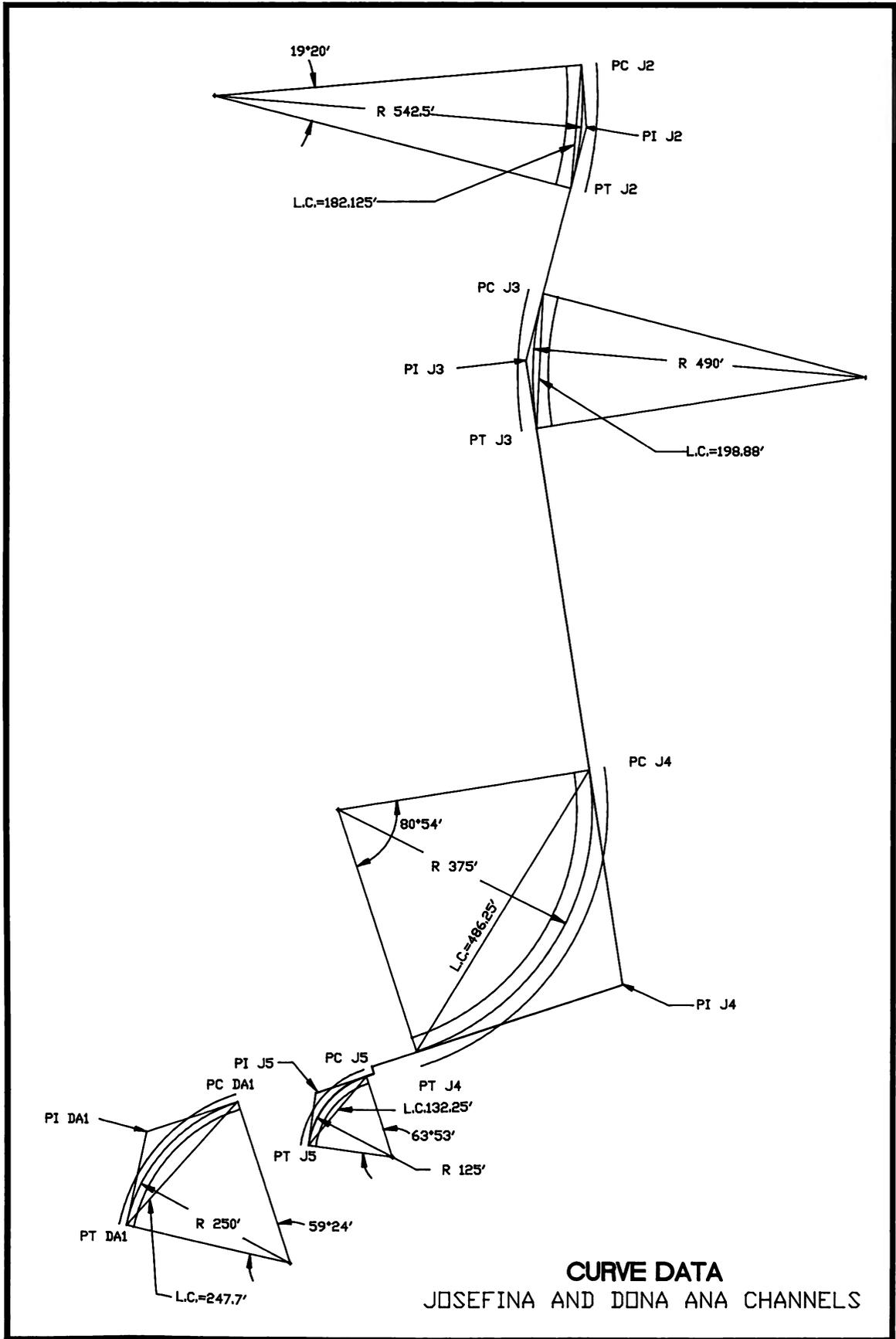
**PUERTO NUEVO CHANNEL  
BAFFLE BLOCK DETAILS**  
TYPES 5 AND 6



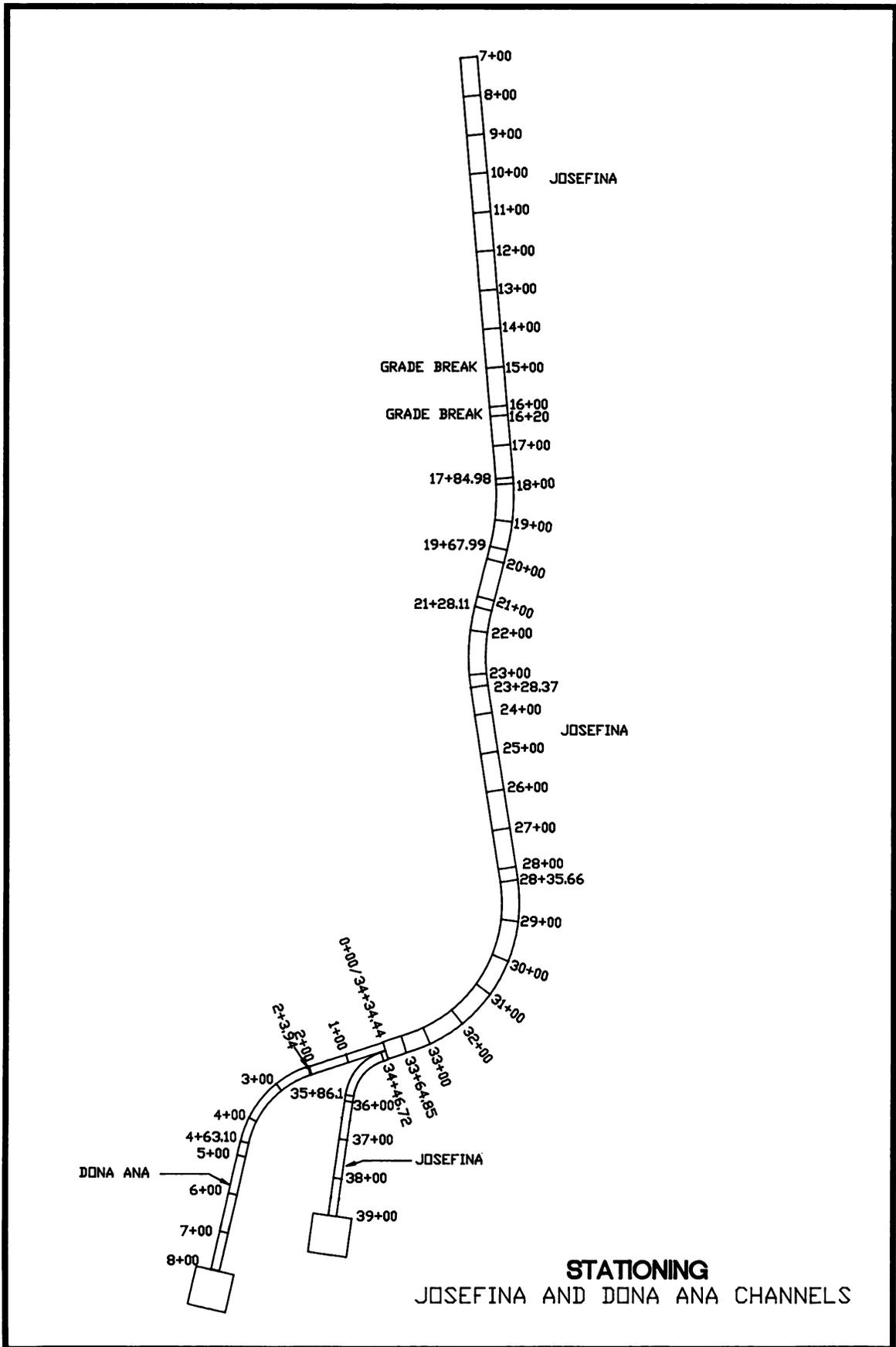
**WATER-SURFACE PROFILES**  
**PUERTO NUEVO CHANNEL**  
**TYPE 2 DESIGN CHANNEL**  
**WITH TYPE 6 DESIGN BAFFLE BLOCKS**  
 $n=0.012$   
**STA 137+00 TO 151+00**

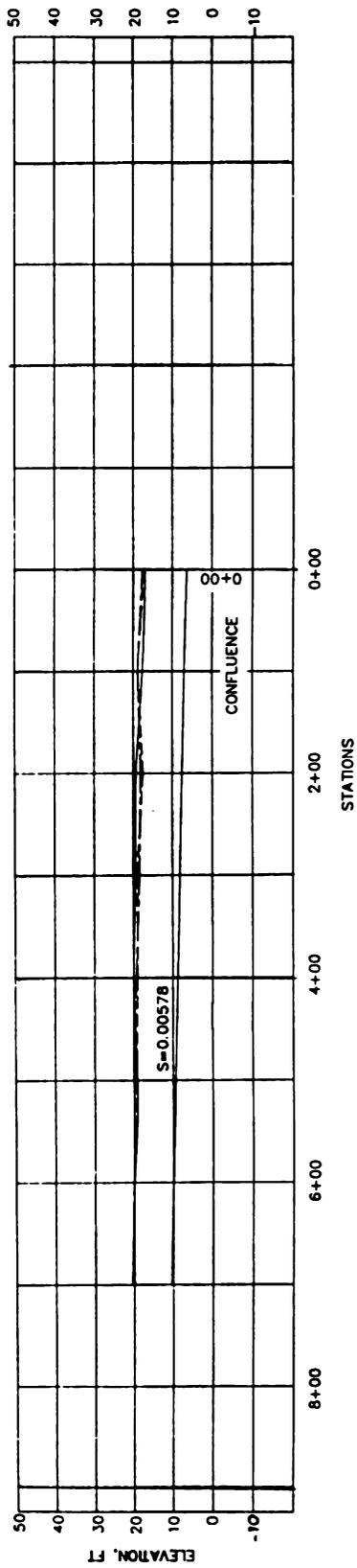
**DISCHARGE** \_\_\_\_\_ **STATIONS** \_\_\_\_\_  
 44,900 CFS                      151+00 TO 137+00

**LEGEND**  
 — LEFT SIDE OF CHANNEL  
 - - - RIGHT SIDE OF CHANNEL  
 . . . CENTER OF CHANNEL  
 (REFERENCED TO LOOKING DOWNSTREAM)



**CURVE DATA**  
 JOSEFINA AND DONA ANA CHANNELS

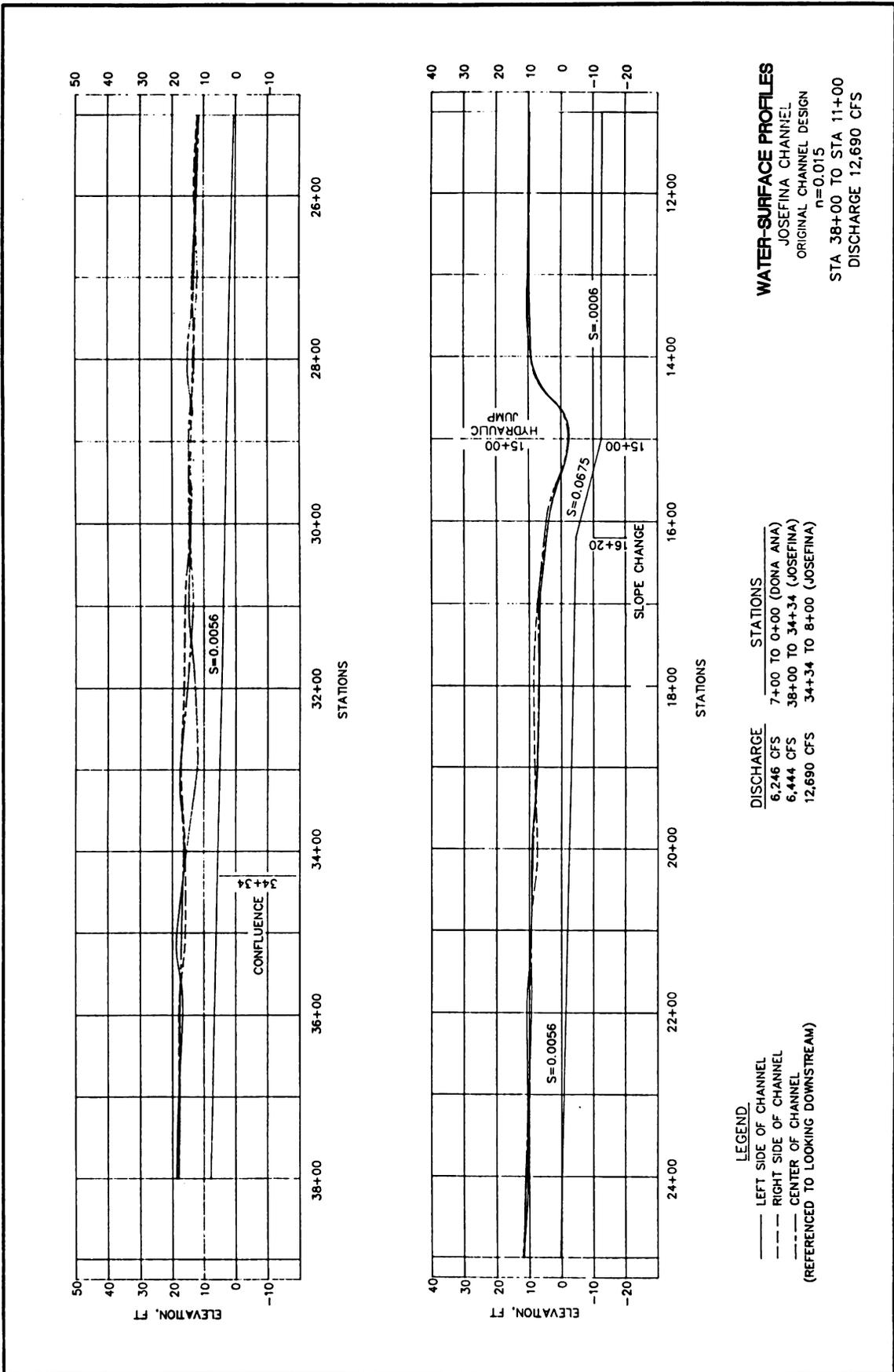




**LEGEND**  
 — LEFT SIDE OF CHANNEL  
 - - - RIGHT SIDE OF CHANNEL  
 - · - · - CENTER OF CHANNEL  
 (REFERENCED TO LOOKING DOWNSTREAM)

DISCHARGE	STATIONS
6,246 CFS	7+00 TO 0+00 (DONA ANA)
6,444 CFS	38+00 TO 34+34 (JOSEFINA)
12,690 CFS	34+34 TO 8+00 (JOSEFINA)

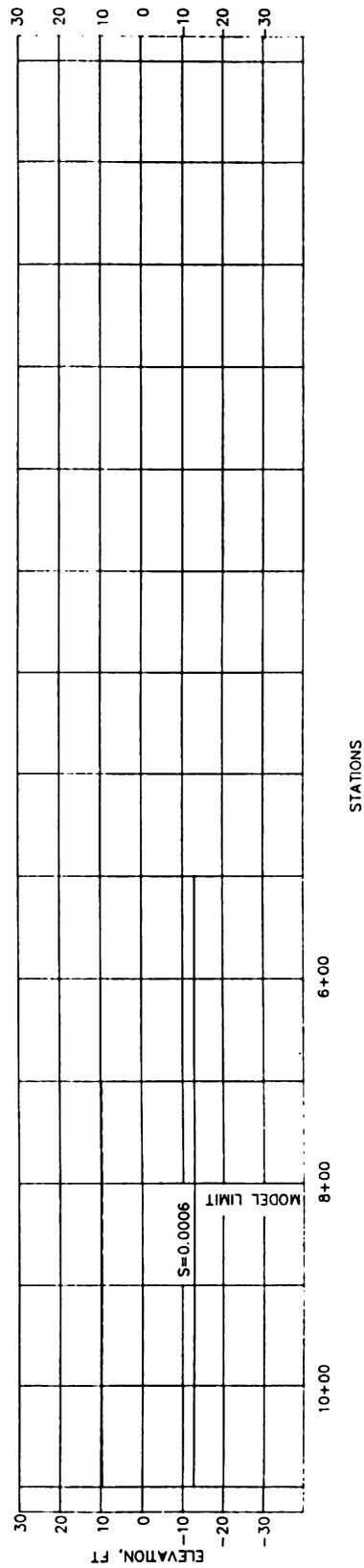
**WATER-SURFACE PROFILES**  
 DONA ANA CHANNEL  
 ORIGINAL CHANNEL DESIGN  
 n=0.015  
 STA 7+00 TO STA 0+00  
 DISCHARGE 12,690 CFS



**WATER-SURFACE PROFILES**  
 JOSEFINA CHANNEL  
 ORIGINAL CHANNEL DESIGN  
 $n=0.015$   
 STA 38+00 TO STA 11+00  
 DISCHARGE 12,690 CFS

DISCHARGE	STATIONS
6,246 CFS	7+00 TO 0+00 (DONA ANA)
6,444 CFS	38+00 TO 34+34 (JOSEFINA)
12,690 CFS	34+34 TO 8+00 (JOSEFINA)

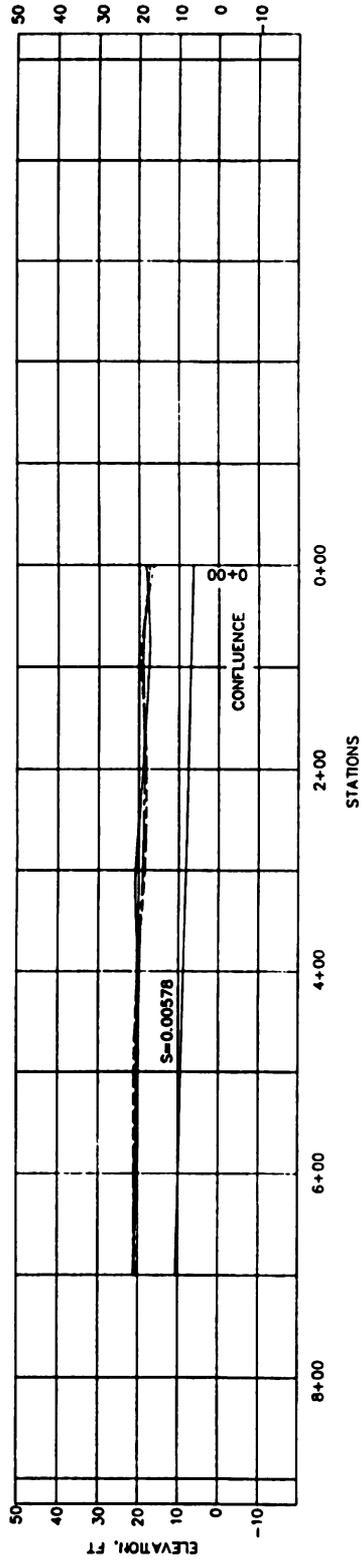
**LEGEND**  
 — LEFT SIDE OF CHANNEL  
 - - - RIGHT SIDE OF CHANNEL  
 - · - · CENTER OF CHANNEL  
 (REFERENCED TO LOOKING DOWNSTREAM)



DISCHARGE	STATIONS
6,246 CFS	7+00 TO 0+00 (DONA ANA)
6,444 CFS	38+00 TO 34+34 (JOSEFINA)
12,690 CFS	34+34 TO 8+00 (JOSEFINA)

**LEGEND**  
 ——— LEFT SIDE OF CHANNEL  
 - - - RIGHT SIDE OF CHANNEL  
 - - - CENTER OF CHANNEL  
 (REFERENCED TO LOOKING DOWNSTREAM)

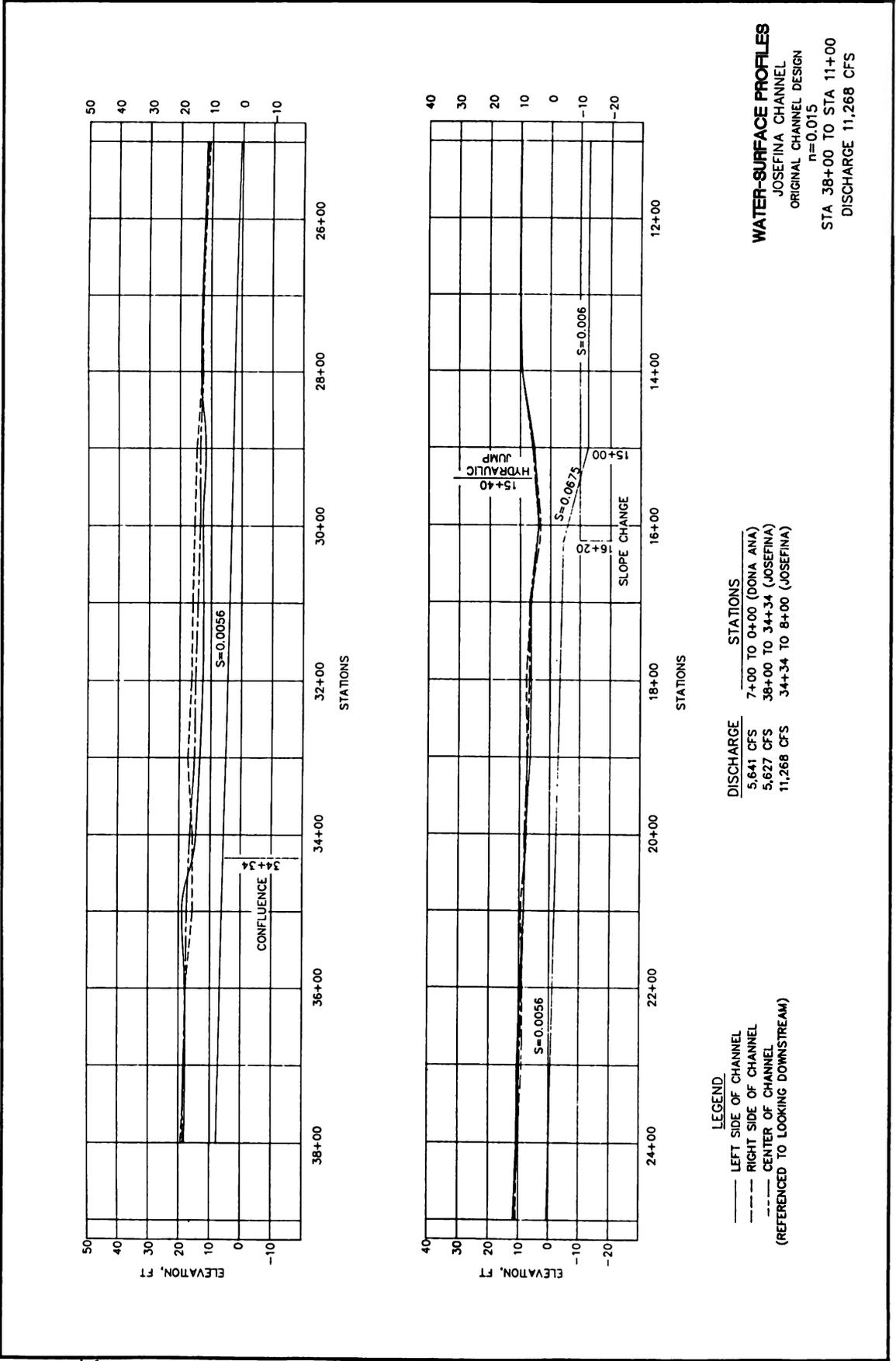
**WATER-SURFACE PROFILES**  
 JOSEFINA CHANNEL  
 ORIGINAL CHANNEL DESIGN  
 n=0.015  
 STA 11+00 TO 7+00  
 DISCHARGE 12,690 CFS



**LEGEND**  
 ——— LEFT SIDE OF CHANNEL  
 - - - RIGHT SIDE OF CHANNEL  
 - - - CENTER OF CHANNEL  
 (REFERENCED TO LOOKING DOWNSTREAM)

DISCHARGE	STATIONS
5,641 CFS	7+00 TO 0+00 (DONA ANA)
5,627 CFS	38+00 TO 34+34 (JOSEFINA)
11,268 CFS	34+34 TO 8+00 (JOSEFINA)

**WATER-SURFACE PROFILES**  
 DONA ANA CHANNEL  
 ORIGINAL CHANNEL DESIGN  
 $n=0.015$   
 STA 7+00 TO STA 0+00  
 DISCHARGE 11,268 CFS

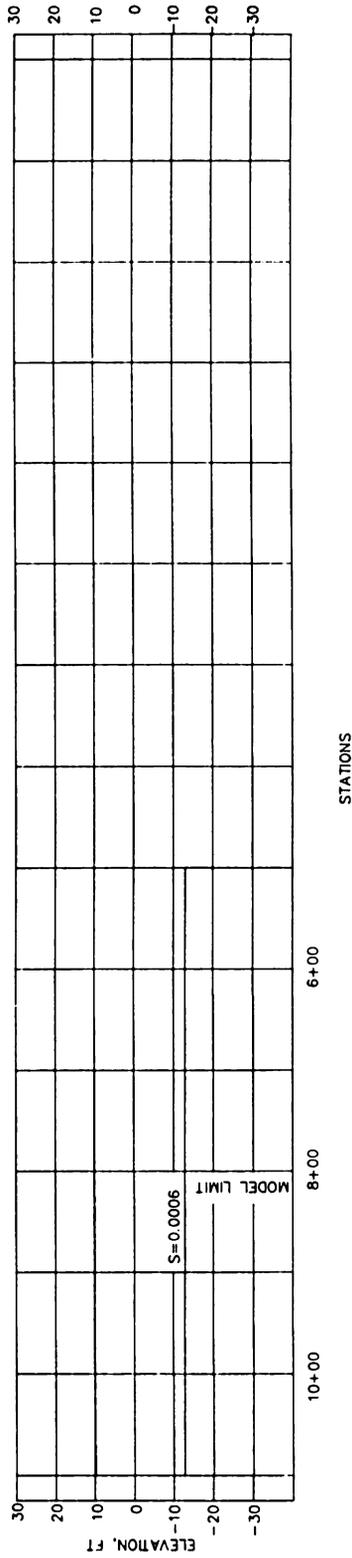


**WATER-SURFACE PROFILES**  
 JOSEFINA CHANNEL  
 ORIGINAL CHANNEL DESIGN  
 $n=0.015$   
 STA 38+00 TO STA 11+00  
 DISCHARGE 11,268 CFS

DISCHARGE	STATIONS
5,641 CFS	7+00 TO 0+00 (DONA ANA)
5,627 CFS	38+00 TO 34+34 (JOSEFINA)
11,268 CFS	34+34 TO 8+00 (JOSEFINA)

**LEGEND**  
 — LEFT SIDE OF CHANNEL  
 - - - RIGHT SIDE OF CHANNEL  
 - - - CENTER OF CHANNEL  
 (REFERENCED TO LOOKING DOWNSTREAM)

PLATE 46



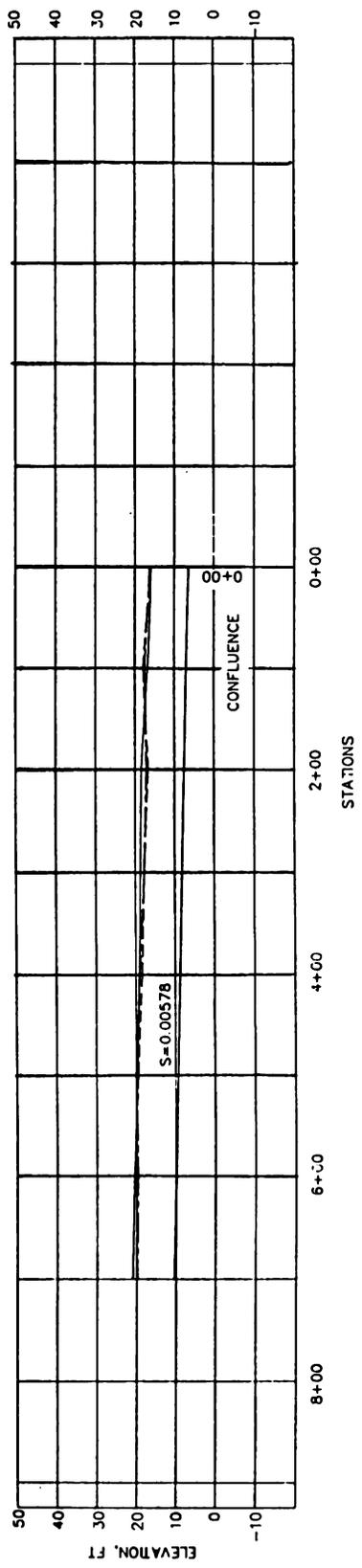
**LEGEND**

- LEFT SIDE OF CHANNEL
- - - RIGHT SIDE OF CHANNEL
- · - · - CENTER OF CHANNEL

(REFERENCED TO LOOKING DOWNSTREAM)

<b>DISCHARGE</b>	<b>STATIONS</b>
5,641 CFS	7+00 TO 0+00 (DONA ANA)
5,627 CFS	38+00 TO 34+34 (JOSEFINA)
11,268 CFS	34+34 TO 8+00 (JOSEFINA)

**WATER-SURFACE PROFILES**  
 JOSEFINA CHANNEL  
 ORIGINAL CHANNEL DESIGN  
 n=0.015  
 STA 11+00 TO 7+00  
 DISCHARGE 11,268 CFS

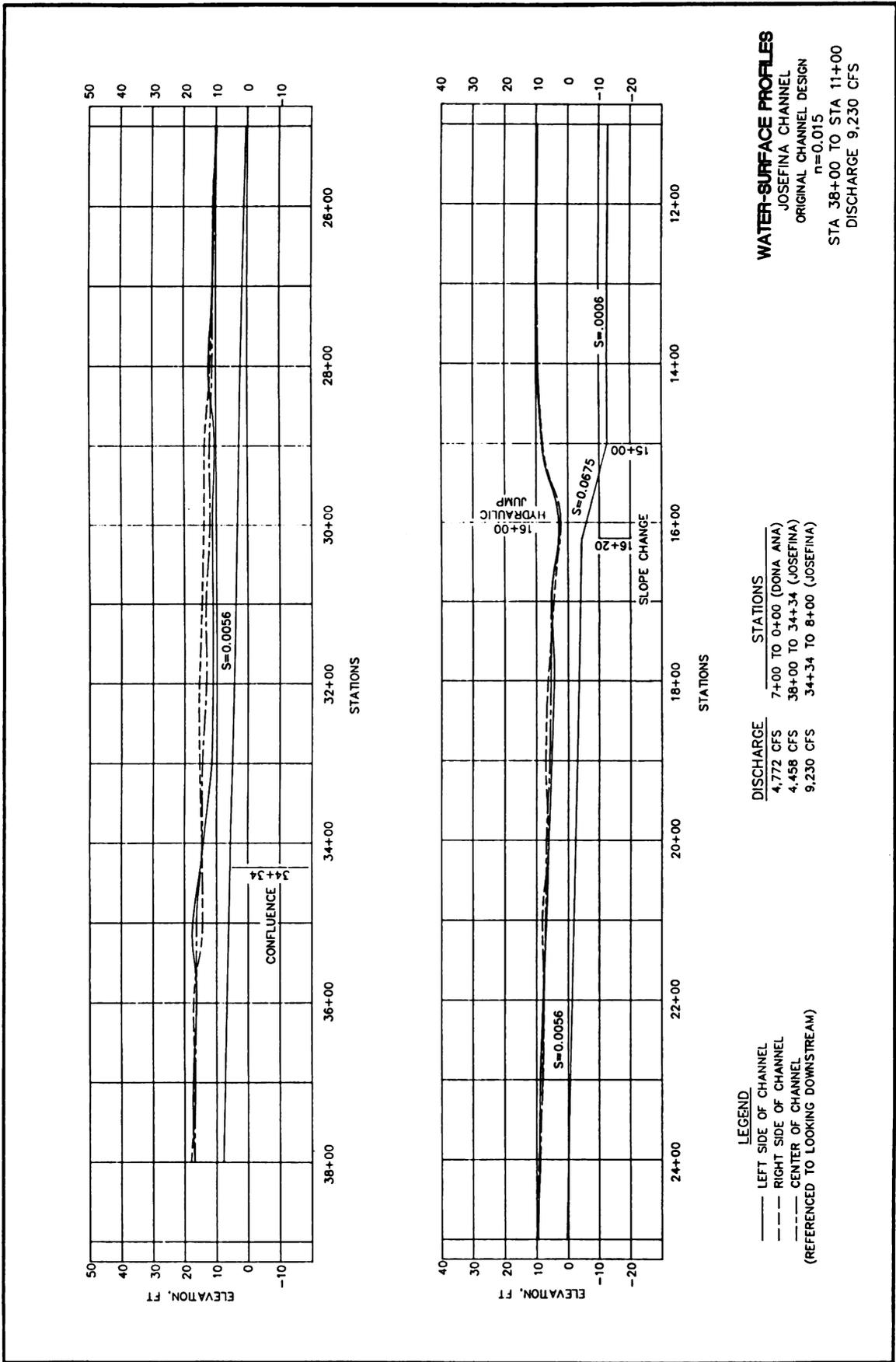


**LEGEND**

- LEFT SIDE OF CHANNEL
- - - RIGHT SIDE OF CHANNEL
- · - · - CENTER OF CHANNEL
- (REFERENCED TO LOOKING DOWNSTREAM)

DISCHARGE	STATIONS
4,772 CFS	7+00 TO 0+00 (DONA ANA)
4,458 CFS	38+00 TO 34+34 (JOSEFINA)
9,230 CFS	34+34 TO 8+00 (JOSEFINA)

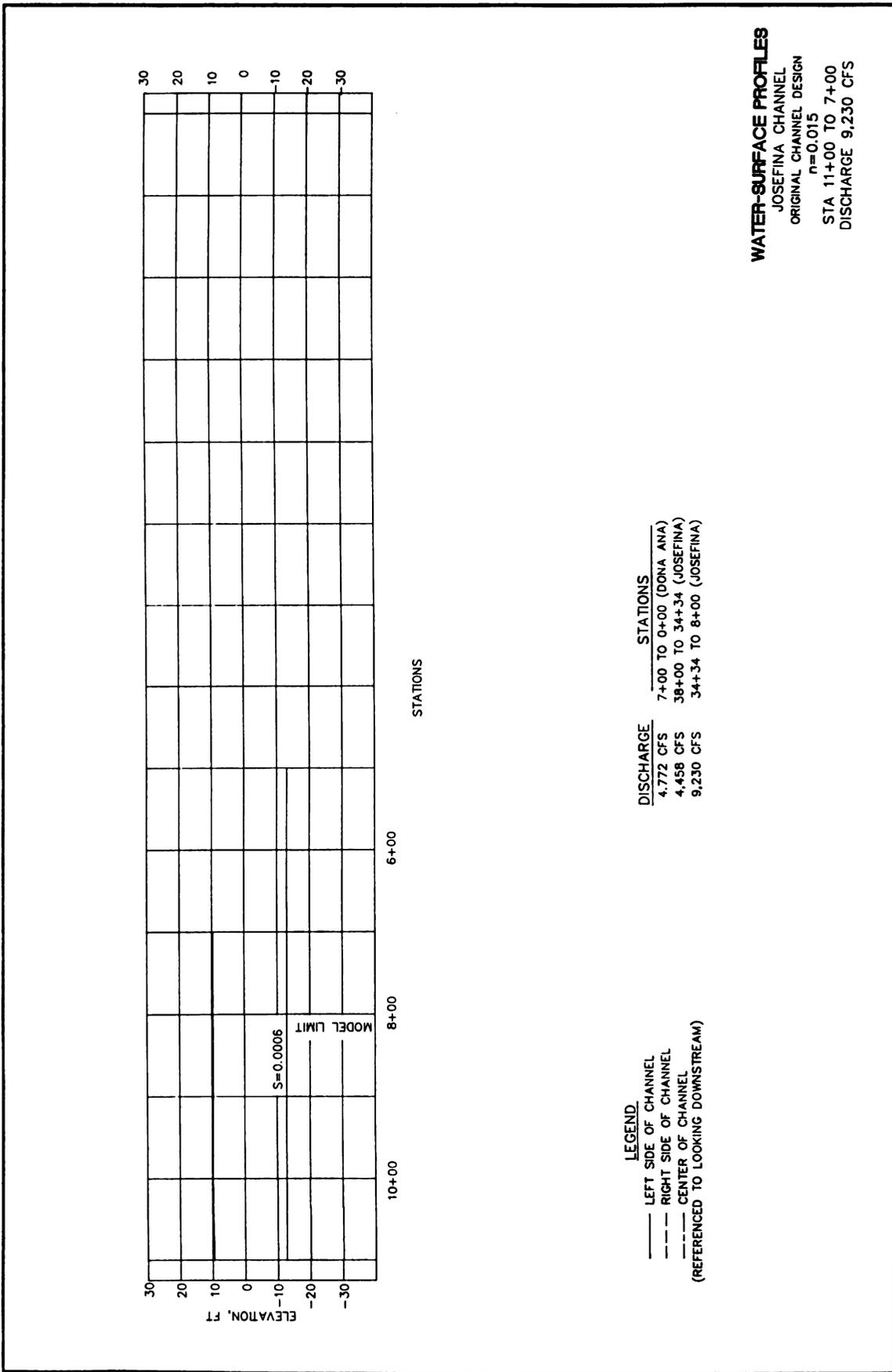
**WATER-SURFACE PROFILES**  
 DONA ANA CHANNEL  
 ORIGINAL CHANNEL DESIGN  
 $n=0.015$   
 STA 7+00 TO STA 0+00  
 DISCHARGE 9,230 CFS

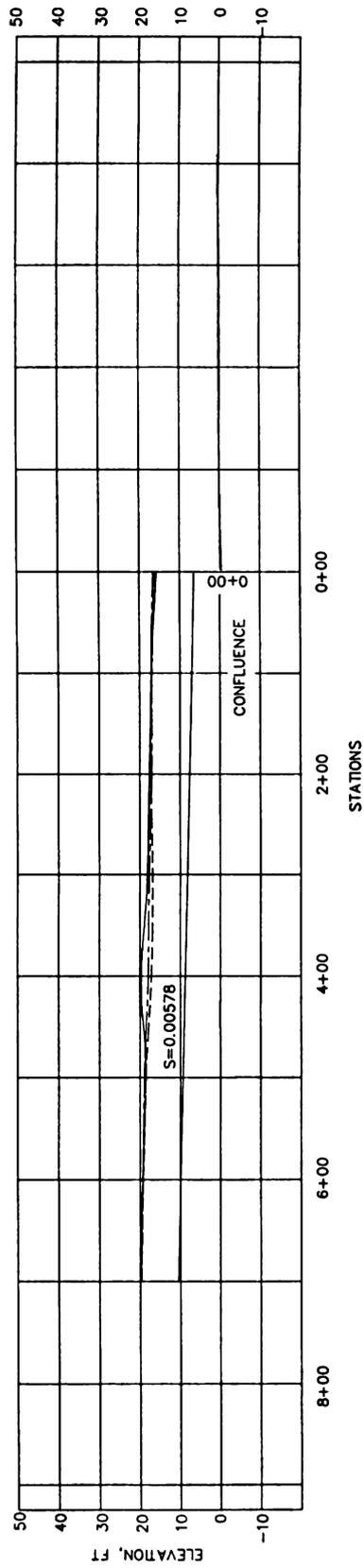


**WATER-SURFACE PROFILES**  
 JOSEFINA CHANNEL  
 ORIGINAL CHANNEL DESIGN  
 n=0.015  
 STA 38+00 TO STA 11+00  
 DISCHARGE 9,230 CFS

DISCHARGE	STATIONS
4,772 CFS	7+00 TO 0+00 (DONA ANA)
4,458 CFS	38+00 TO 34+34 (JOSEFINA)
9,230 CFS	34+34 TO 8+00 (JOSEFINA)

**LEGEND**  
 — LEFT SIDE OF CHANNEL  
 - - - RIGHT SIDE OF CHANNEL  
 . . . CENTER OF CHANNEL  
 (REFERENCED TO LOOKING DOWNSTREAM)



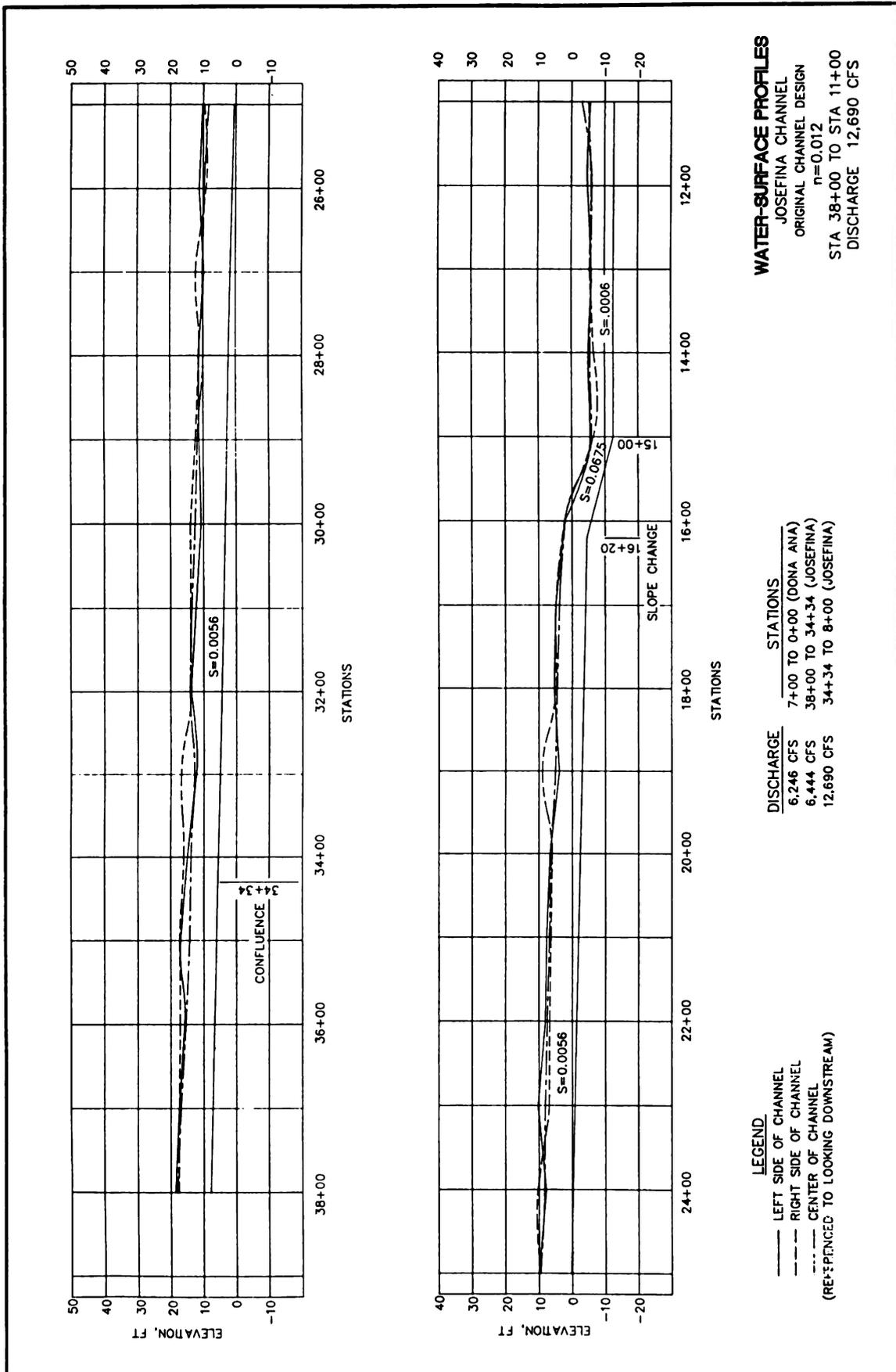


**LEGEND**

— LEFT SIDE OF CHANNEL  
 - - - RIGHT SIDE OF CHANNEL  
 - · - · CENTER OF CHANNEL  
 (REFERENCED TO LOOKING DOWNSTREAM)

DISCHARGE	STATIONS
6,246 CFS	7+00 TO 0+00 (DONA ANA)
6,444 CFS	38+00 TO 34+34 (JOSEFINA)
12,690 CFS	34+34 TO 8+00 (JOSEFINA)

**WATER-SURFACE PROFILES**  
 DONA ANA CHANNEL  
 ORIGINAL CHANNEL DESIGN  
 n=0.012  
 STA 7+00 TO STA 0+00  
 DISCHARGE 12,690 CFS

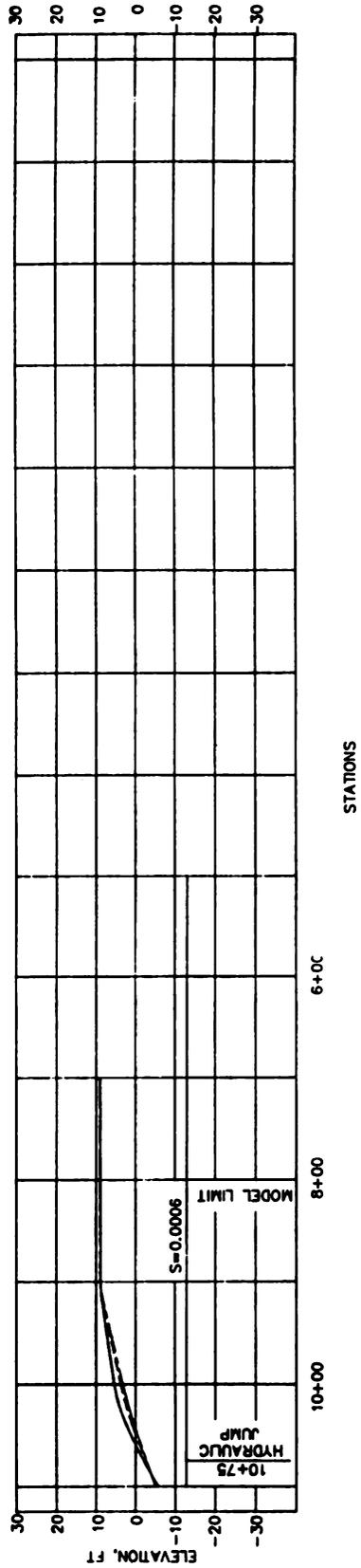


**WATER-SURFACE PROFILES**  
 JOSEFINA CHANNEL  
 ORIGINAL CHANNEL DESIGN  
 n=0.012  
 STA 38+00 TO STA 11+00  
 DISCHARGE 12,690 CFS

DISCHARGE	STATIONS
6,246 CFS	7+00 TO 0+00 (DONA ANA)
6,444 CFS	38+00 TO 34+34 (JOSEFINA)
12,690 CFS	34+34 TO 8+00 (JOSEFINA)

**LEGEND**  
 — LEFT SIDE OF CHANNEL  
 - - - RIGHT SIDE OF CHANNEL  
 ···· CENTER OF CHANNEL  
 (REF: PENCED TO LOOKING DOWNSTREAM)

PLATE 52

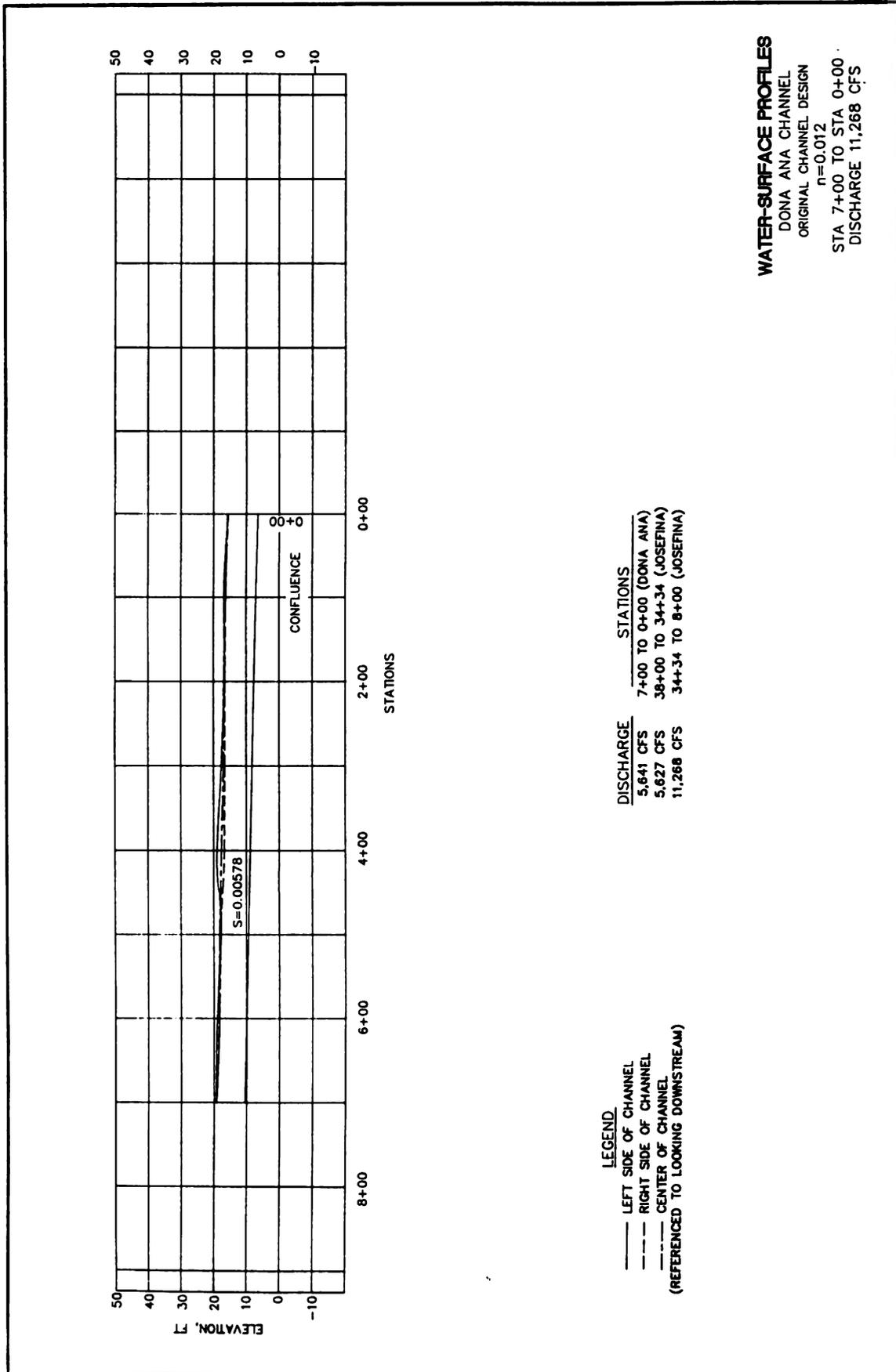


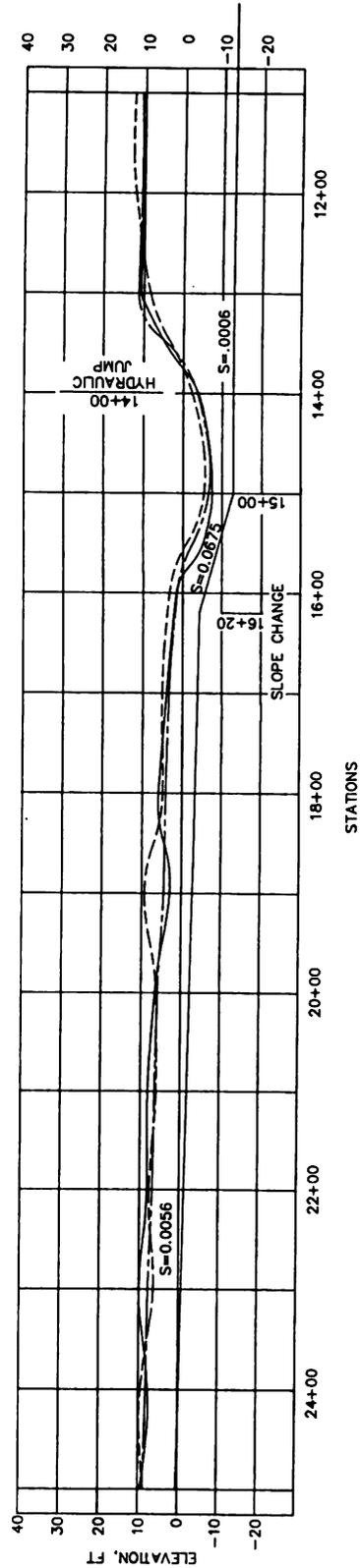
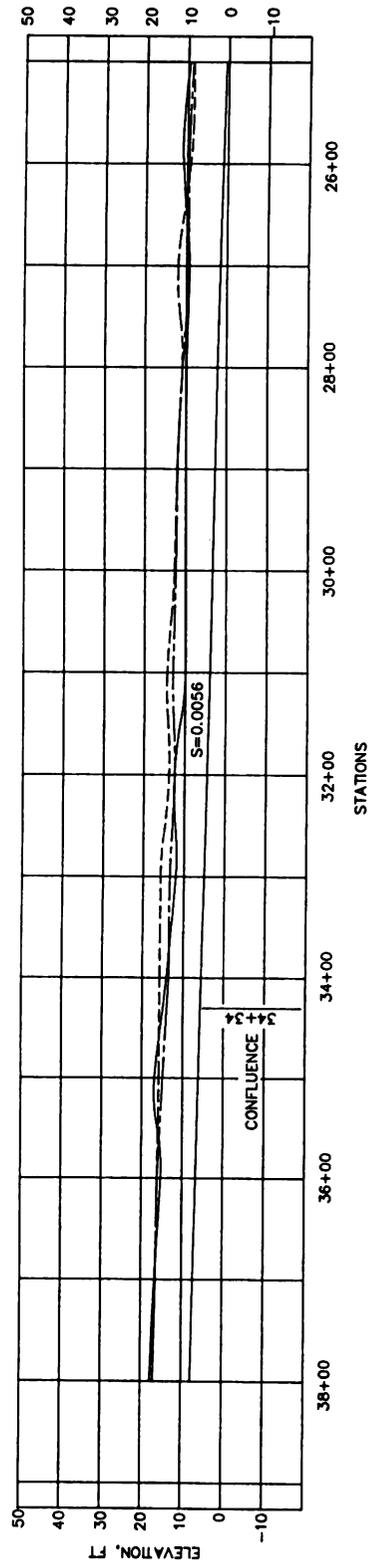
**LEGEND**  
 — LEFT SIDE OF CHANNEL  
 - - - RIGHT SIDE OF CHANNEL  
 - · - · CENTER OF CHANNEL  
 (REFERENCED TO LOOKING DOWNSTREAM)

**DISCHARGE**  
 6,248 CFS 7+00 TO 0+00 (DONA ANA)  
 6,444 CFS 38+00 TO 34+34 (JOSEFINA)  
 12,690 CFS 34+34 TO 8+00 (JOSEFINA)

**STATIONS**

**WATER-SURFACE PROFILES**  
 JOSEFINA CHANNEL  
 ORIGINAL CHANNEL DESIGN  
 n=0.012  
 STA 11+00 TO 7+00  
 DISCHARGE 12,690 CFS

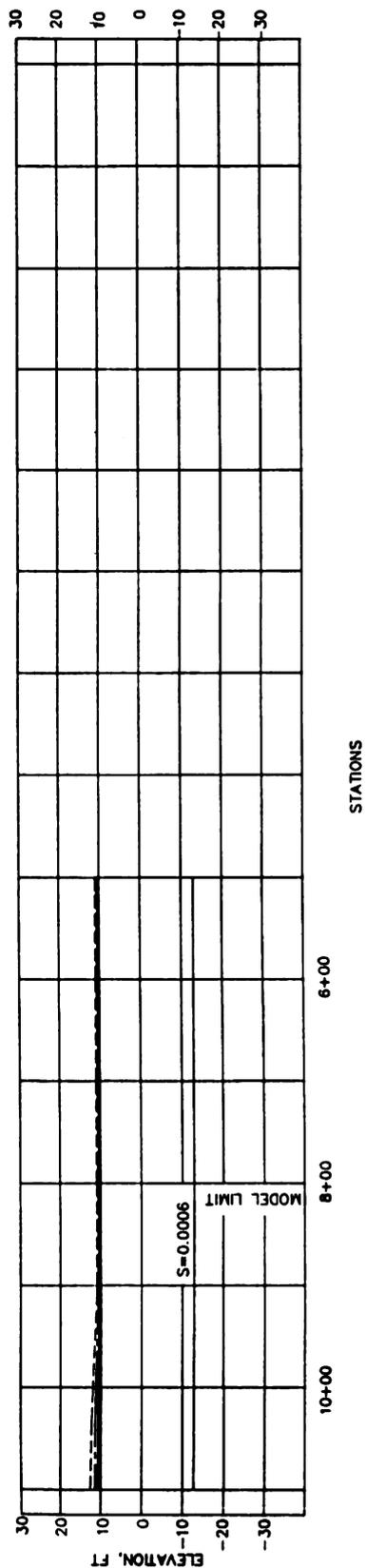




**LEGEND**  
 — LEFT SIDE OF CHANNEL  
 - - - RIGHT SIDE OF CHANNEL  
 - - - CENTER OF CHANNEL  
 (REFERENCED TO LOOKING DOWNSTREAM)

DISCHARGE	STATIONS
5,641 CFS	7+00 TO 0+00 (DONA ANA)
5,627 CFS	38+00 TO 34+34 (JOSEFINA)
11,268 CFS	34+34 TO 8+00 (JOSEFINA)

**WATER-SURFACE PROFILES**  
 JOSEFINA CHANNEL  
 ORIGINAL CHANNEL DESIGN  
 n=0.012  
 STA 38+00 TO STA 11+00  
 DISCHARGE 11,268 CFS



**LEGEND**

— LEFT SIDE OF CHANNEL

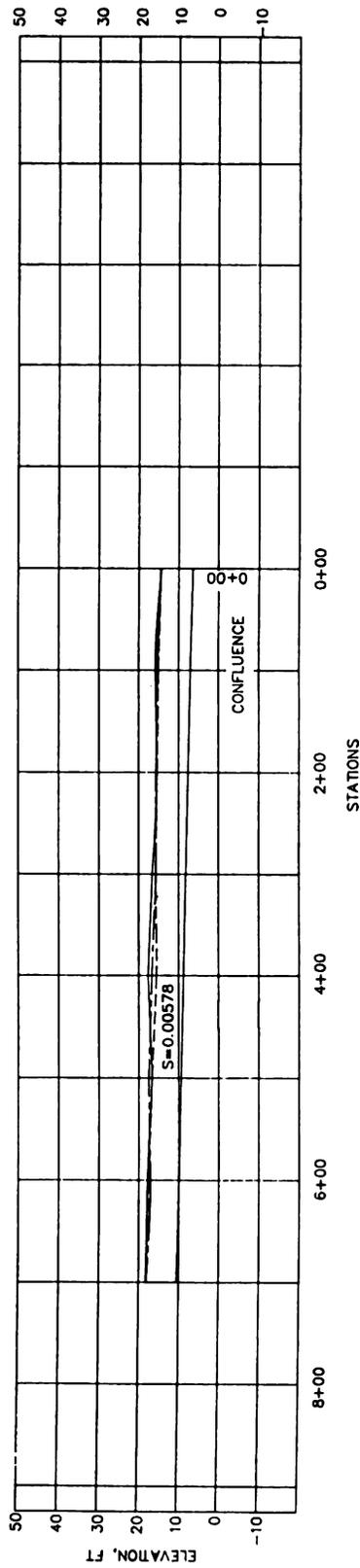
- - - RIGHT SIDE OF CHANNEL

- · - · - CENTER OF CHANNEL

(REFERENCED TO LOOKING DOWNSTREAM)

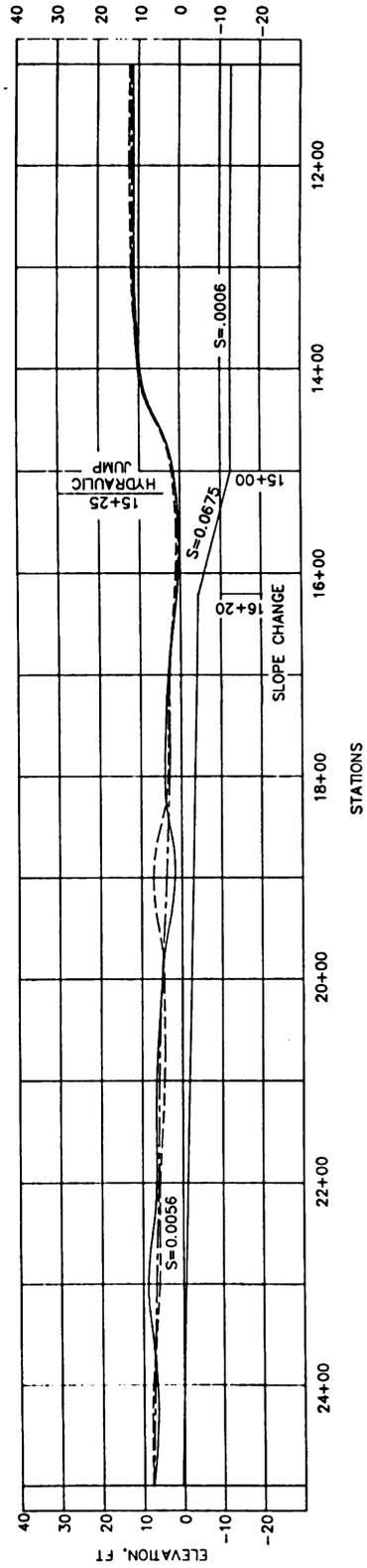
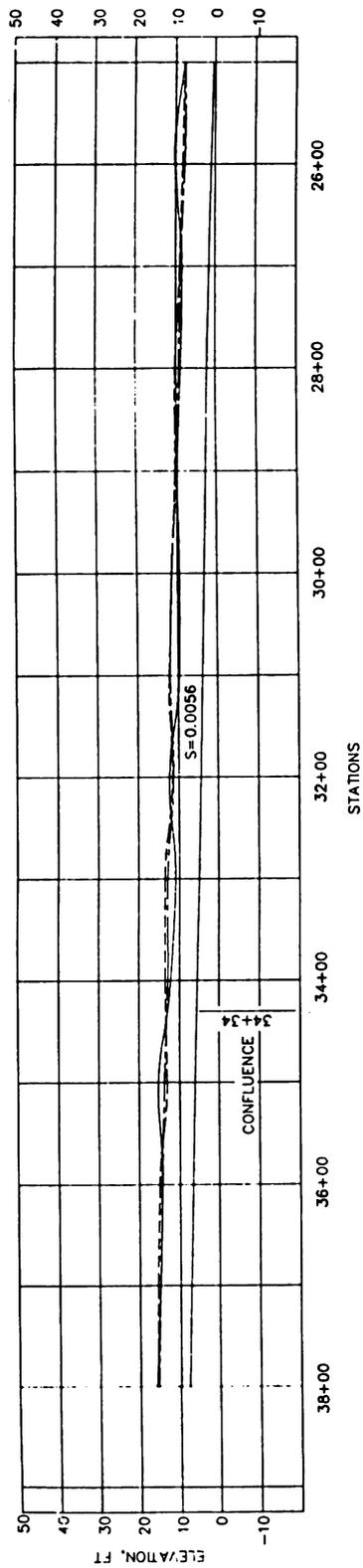
DISCHARGE	STATIONS
5,641 CFS	7+00 TO 0+00 (DONA ANA)
5,627 CFS	36+00 TO 34+34 (JOSEFINA)
11,268 CFS	34+34 TO 8+00 (JOSEFINA)

**WATER-SURFACE PROFILES**  
 JOSEFINA CHANNEL  
 ORIGINAL CHANNEL DESIGN  
 $n=0.012$   
 STA 11+00 TO 7+00  
 DISCHARGE 11,268 CFS



LEGEND		STATIONS	
—	LEFT SIDE OF CHANNEL	7+00 TO 0+00 (DONA ANA)	
- - -	RIGHT SIDE OF CHANNEL	36+00 TO 34+34 (JOSEFINA)	
- - -	CENTER OF CHANNEL	34+34 TO 8+00 (JOSEFINA)	
- - -	(REFERENCED TO LOOKING DOWNSTREAM)		
DISCHARGE		STATIONS	
4,772 CFS		7+00 TO 0+00 (DONA ANA)	
4,458 CFS		36+00 TO 34+34 (JOSEFINA)	
9,230 CFS		34+34 TO 8+00 (JOSEFINA)	

**WATER-SURFACE PROFILES**  
 DONA ANA CHANNEL  
 ORIGINAL CHANNEL DESIGN  
 $n=0.012$   
 STA 7+00 TO STA 0+00  
 DISCHARGE 9,230 CFS



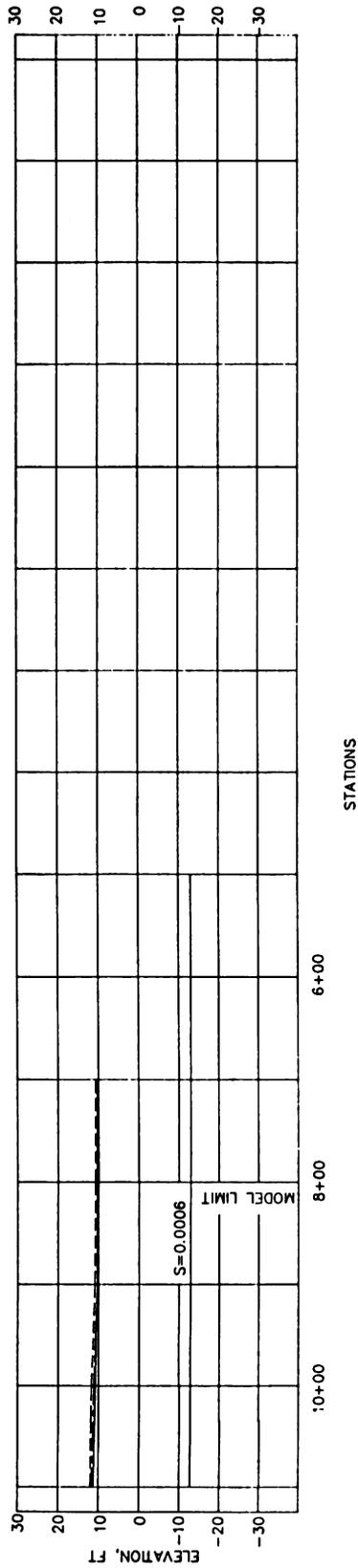
LEGEND

- LEFT SIDE OF CHANNEL
  - - - RIGHT SIDE OF CHANNEL
  - - - CENTER OF CHANNEL
- (REFERENCED TO LOOKING DOWNSTREAM)

DISCHARGE	STATIONS
4,772 CFS	7+00 TO 0+00 (DONA ANA)
4,458 CFS	38+00 TO 34+34 (JOSEFINA)
9,230 CFS	34+34 TO 8+00 (JOSEFINA)

WATER-SURFACE PROFILES

JOSEFINA CHANNEL  
 ORIGINAL CHANNEL DESIGN  
 $n=0.012$   
 STA 38+00 TO STA 11+00  
 DISCHARGE 9,230 CFS



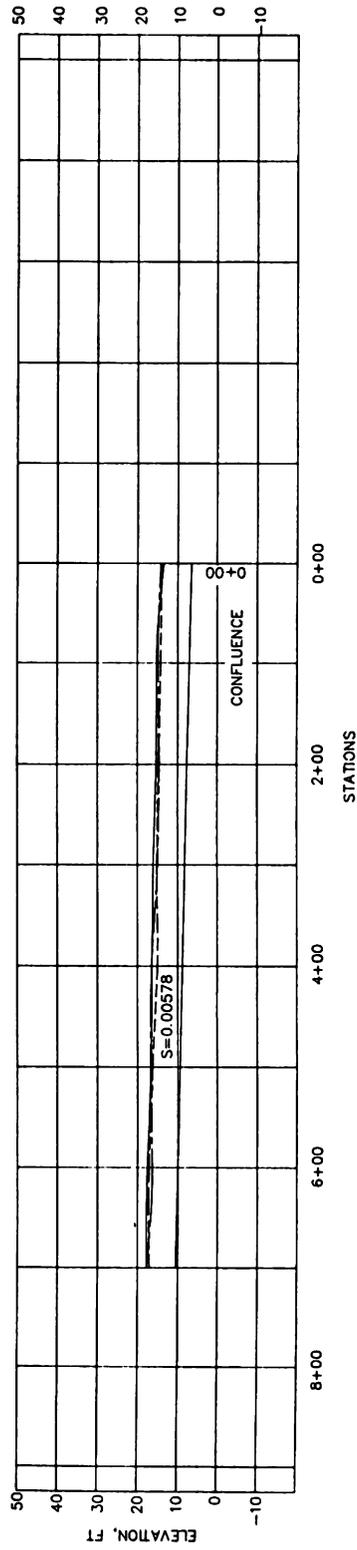
**LEGEND**

— LEFT SIDE OF CHANNEL  
 - - - RIGHT SIDE OF CHANNEL  
 ——— CENTER OF CHANNEL  
 - - - (REFERENCED TO LOOKING DOWNSTREAM)

**DISCHARGE**      **STATIONS**

4,772 CFS      7+00 TO 0+00 (DONA ANA)  
 4,458 CFS      38+00 TO 34+34 (JOSEFINA)  
 9,230 CFS      34+34 TO 8+00 (JOSEFINA)

**WATER-SURFACE PROFILES**  
 JOSEFINA CHANNEL  
 ORIGINAL CHANNEL DESIGN  
 $n=0.012$   
 STA 11+00 TO 7+00  
 DISCHARGE 9,230 CFS

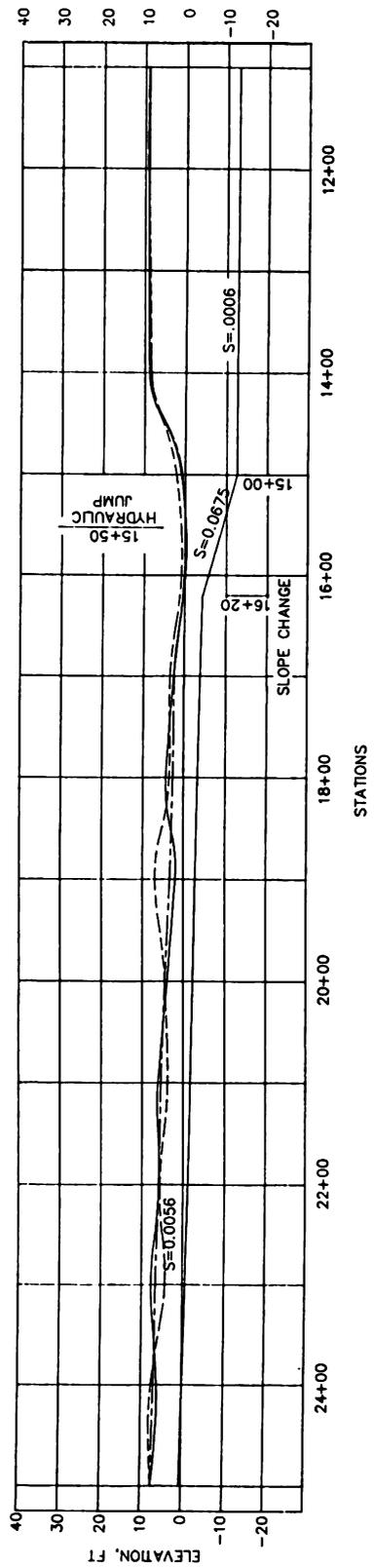
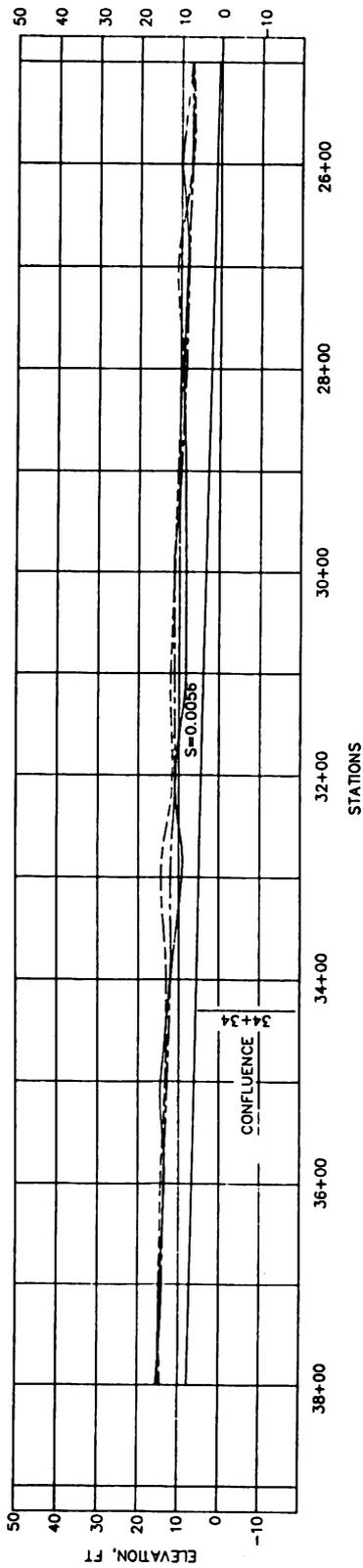


**LEGEND**  
 — LEFT SIDE OF CHANNEL  
 - - - RIGHT SIDE OF CHANNEL  
 - · - · CENTER OF CHANNEL  
 (REFERENCED TO LOOKING DOWNSTREAM)

**DISCHARGE**  
 4,418 CFS  
 4,379 CFS  
 8,797 CFS

**STATIONS**  
 7+00 TO 0+00 (DONA ANA)  
 38+00 TO 34+34 (JOSEFINA)  
 34+34 TO 8+00 (JOSEFINA)

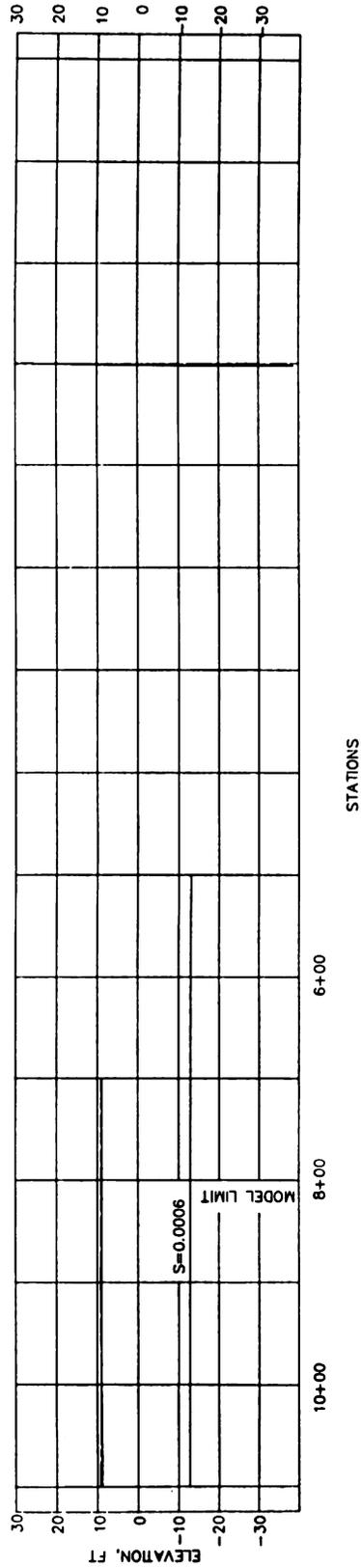
**WATER-SURFACE PROFILES**  
 DONA ANA CHANNEL  
 ORIGINAL CHANNEL DESIGN  
 $n=0.012$   
 STA 7+00 TO STA 0+00  
 DISCHARGE 8,797 CFS



**WATER-SURFACE PROFILES**  
 JOSEFINA CHANNEL  
 ORIGINAL CHANNEL DESIGN  
 $n=0.012$   
 STA 38+00 TO STA 11+00  
 DISCHARGE 8,797 CFS

DISCHARGE	STATIONS
4,418 CFS	7+00 TO 0+00 (DONA ANA)
4,379 CFS	38+00 TO 34+34 (JOSEFINA)
8,797 CFS	34+34 TO 8+00 (JOSEFINA)

**LEGEND.**  
 — LEFT SIDE OF CHANNEL  
 - - - RIGHT SIDE OF CHANNEL  
 - · - · CENTER OF CHANNEL  
 (REFERENCED TO LOOKING DOWNSTREAM)

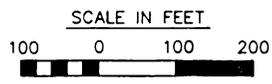
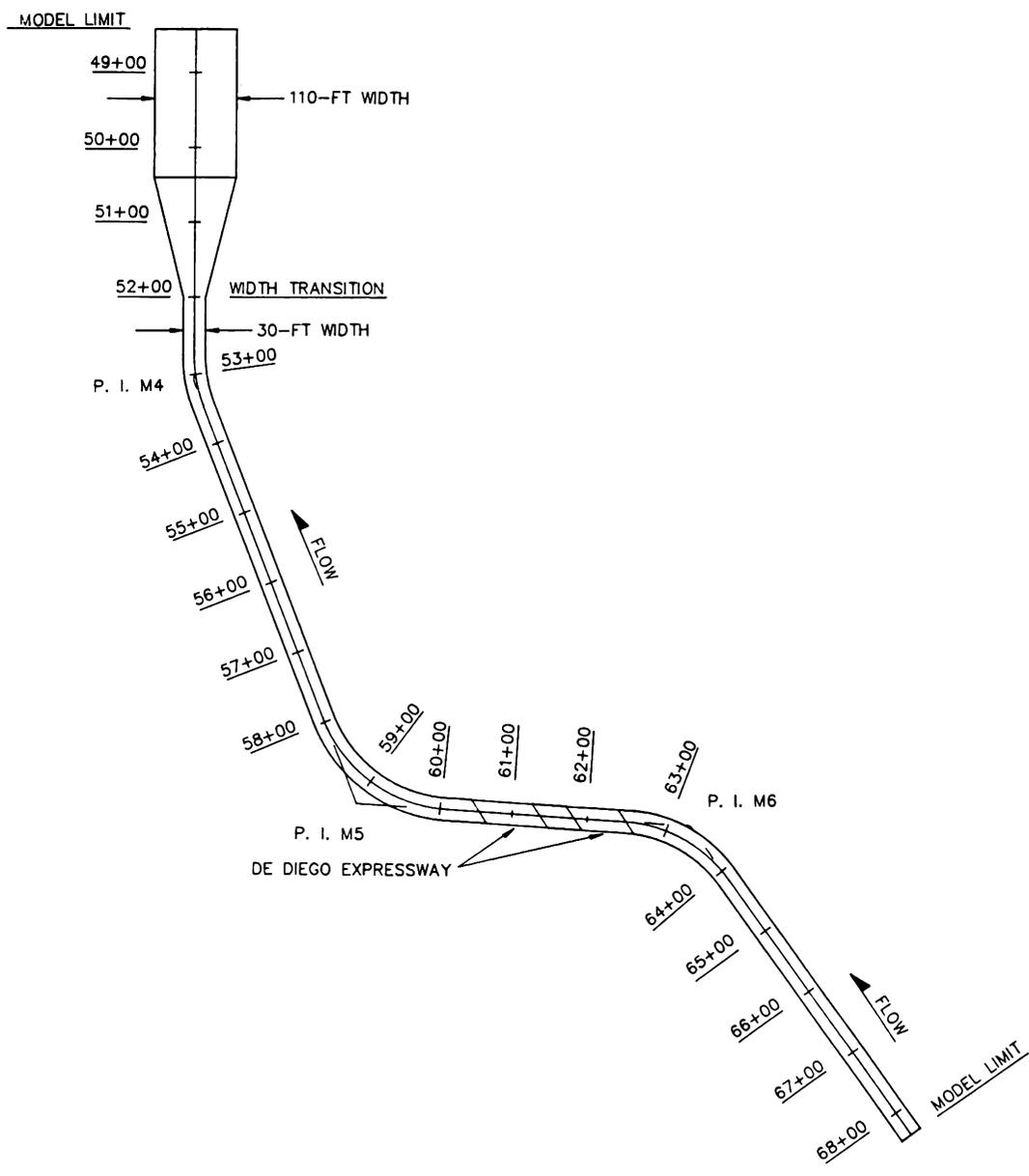


**LEGEND**  
 — LEFT SIDE OF CHANNEL  
 - - - RIGHT SIDE OF CHANNEL  
 - · - · CENTER OF CHANNEL  
 (REFERENCED TO LOOKING DOWNSTREAM)

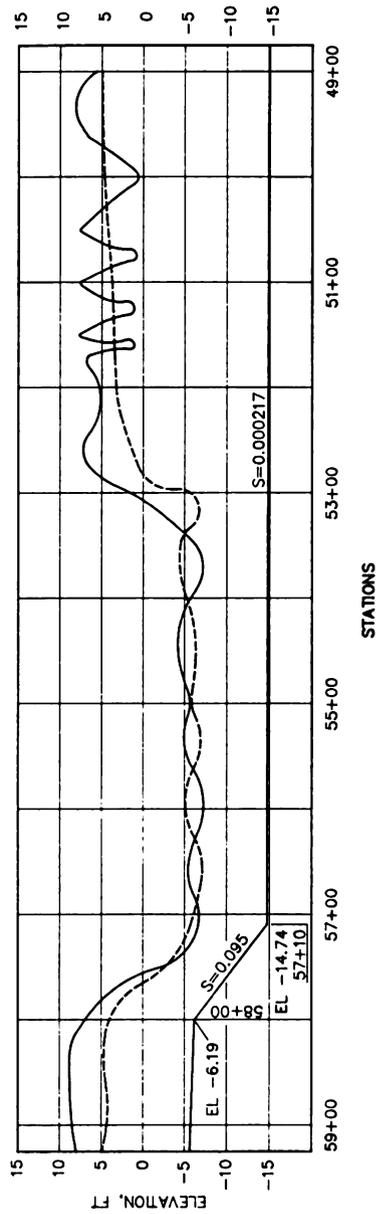
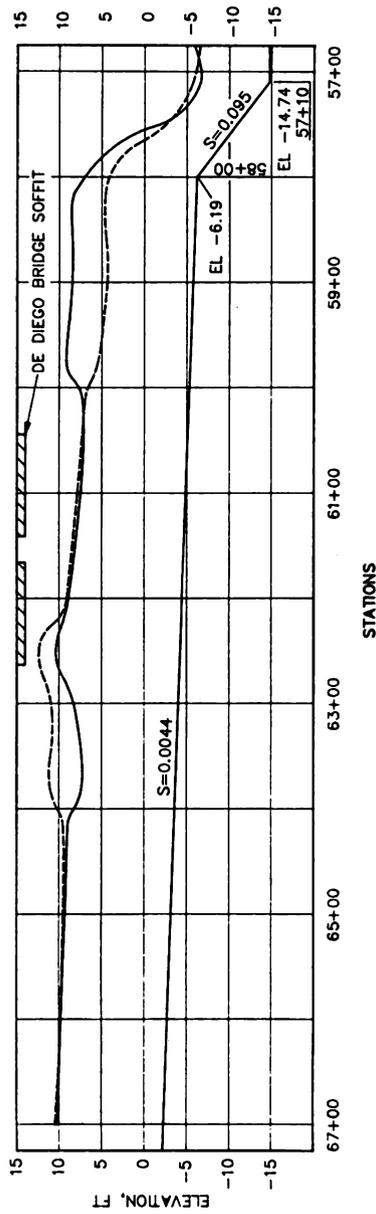
**DISCHARGE**  
 4,418 CFS 7+00 TO 0+00 (DONA ANA)  
 4,379 CFS 38+00 TO 34+34 (JOSEFINA)  
 8,797 CFS 34+34 TO 8+00 (JOSEFINA)

**STATIONS**

**WATER-SURFACE PROFILES**  
 JOSEFINA CHANNEL  
 ORIGINAL CHANNEL DESIGN  
 $n=0.012$   
 STA 11+00 TO 7+00  
 DISCHARGE 8,797 CFS



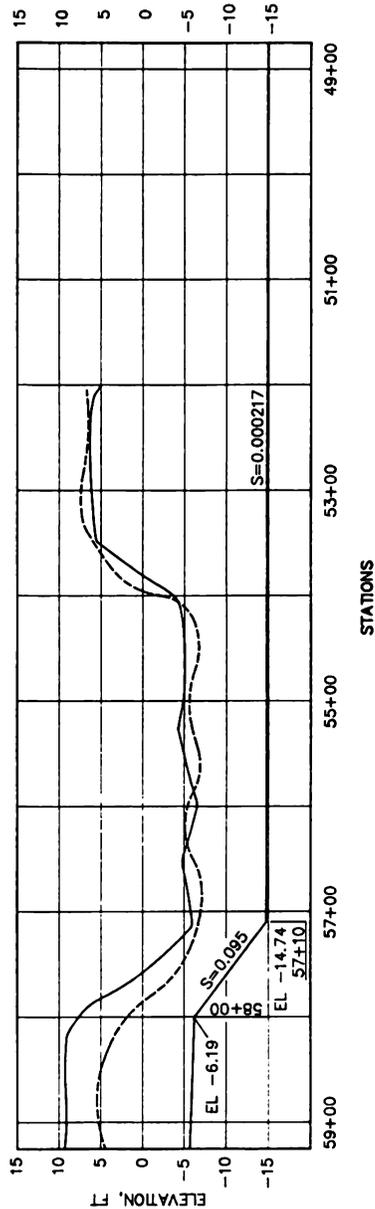
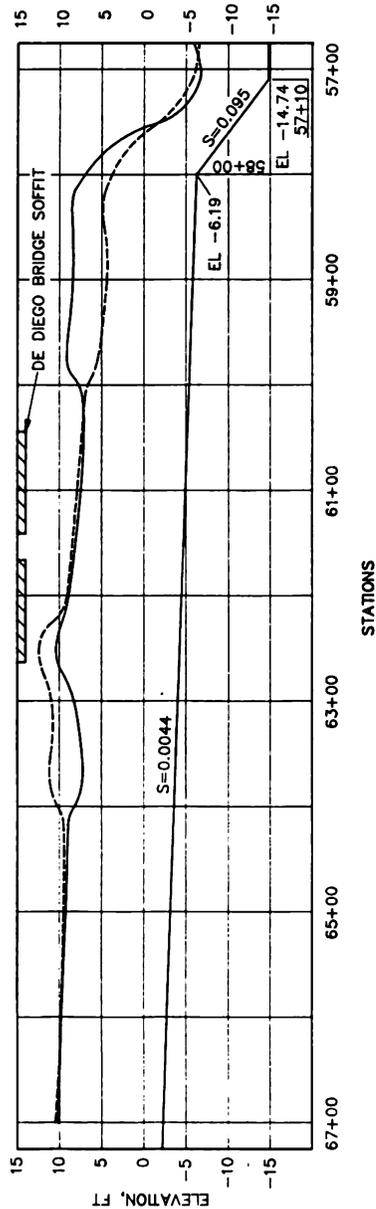
MARGARITA CHANNEL  
 PLAN VIEW  
 TYPE 1 (ORIGINAL) DESIGN



**WATER-SURFACE PROFILES**  
**MARGARITA CHANNEL**  
**TYPE 1 (ORIGINAL) DESIGN**

$n=0.015$   
 DISCHARGE 8,800 CFS  
 AVG. DEPTH AT STA 68+00 = 12.32 FT  
 AVG. DEPTH AT STA 50+00 = 19.38 FT

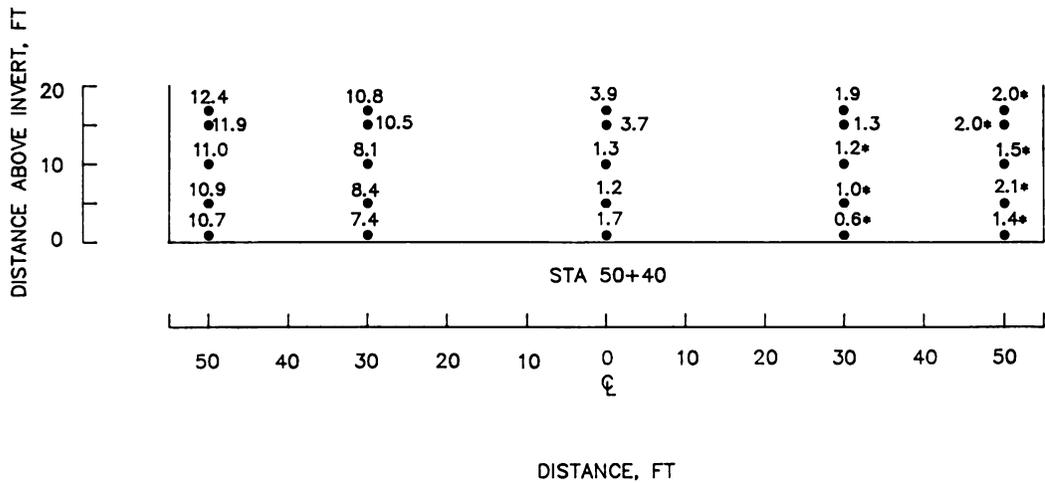
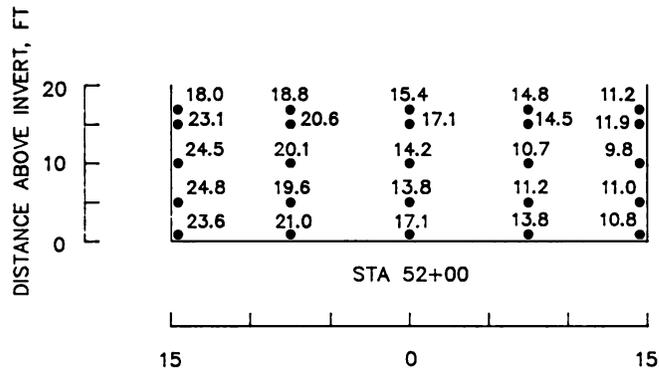
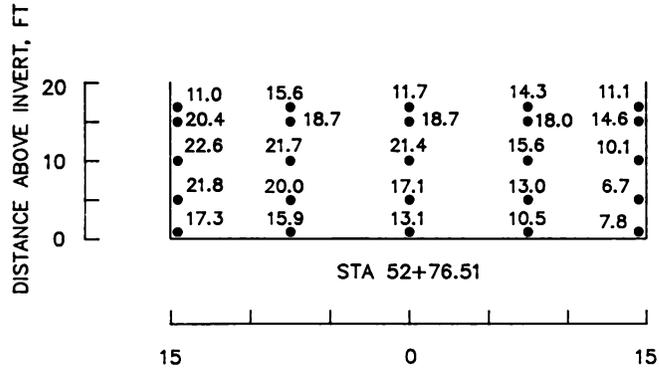
**LEGEND:**  
 ——— LEFT SIDE OF CHANNEL  
 - - - - RIGHT SIDE OF CHANNEL  
 (REFERENCED TO LOOKING DOWNSTREAM)



**WATER-SURFACE PROFILES**  
**MARGARITA CHANNEL**  
**TYPE 1 (ORIGINAL) DESIGN**

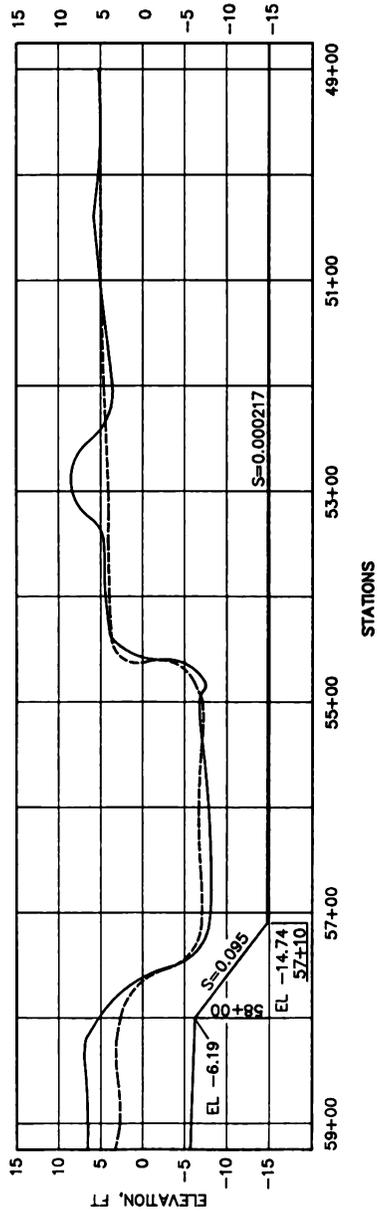
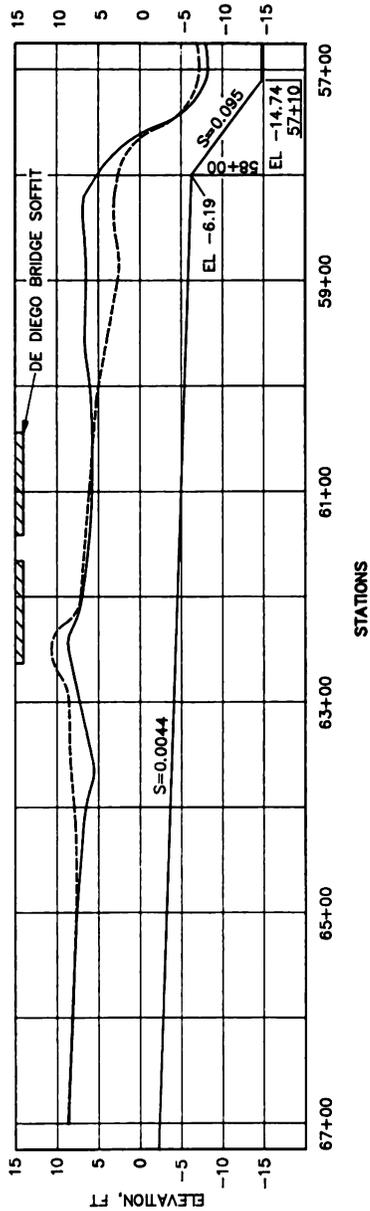
n=0.015  
 DISCHARGE 8,800 CFS  
 AVG. DEPTH AT STA 68+00 = 12.32 FT  
 AVG. DEPTH AT STA 50+00 = 21.02 FT

**LEGEND.**  
 ——— LEFT SIDE OF CHANNEL  
 - - - - RIGHT SIDE OF CHANNEL  
 (REFERENCED TO LOOKING DOWNSTREAM)



NOTE: VELOCITIES ARE IN FEET PER SECOND  
 LOOKING DOWNSTREAM  
 \* VELOCITIES ARE IN UPSTREAM DIRECTION

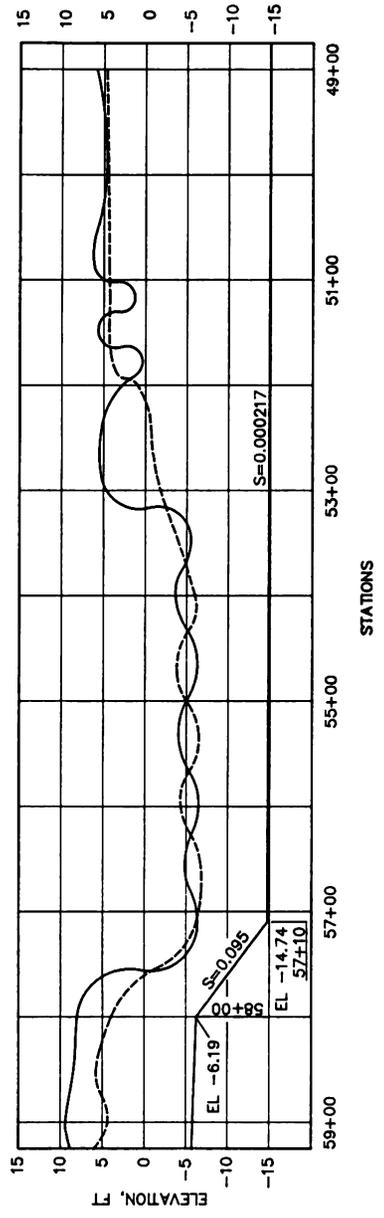
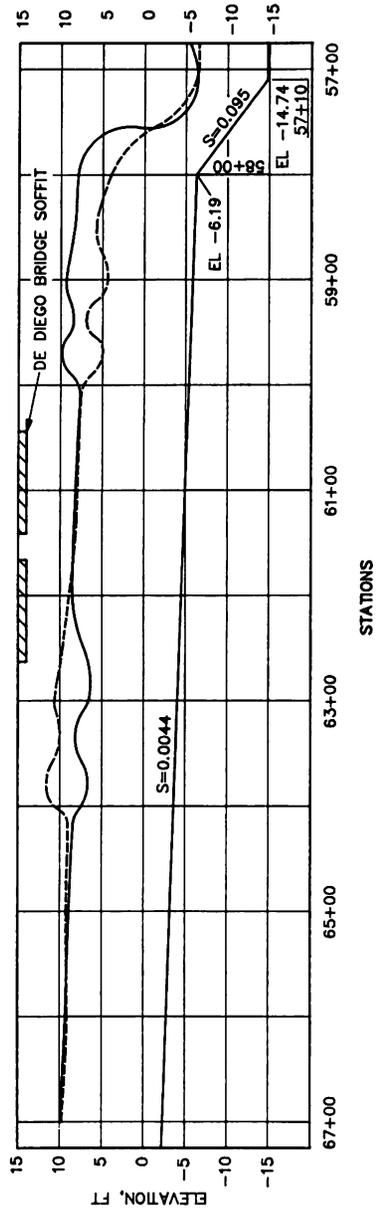
**VELOCITIES  
 MARGARITA CHANNEL  
 TYPE 1 (ORIGINAL) DESIGN  
 DISCHARGE 8,800 CFS**



**WATER-SURFACE PROFILES**  
**MARGARITA CHANNEL**  
**TYPE 1 (ORIGINAL) DESIGN**

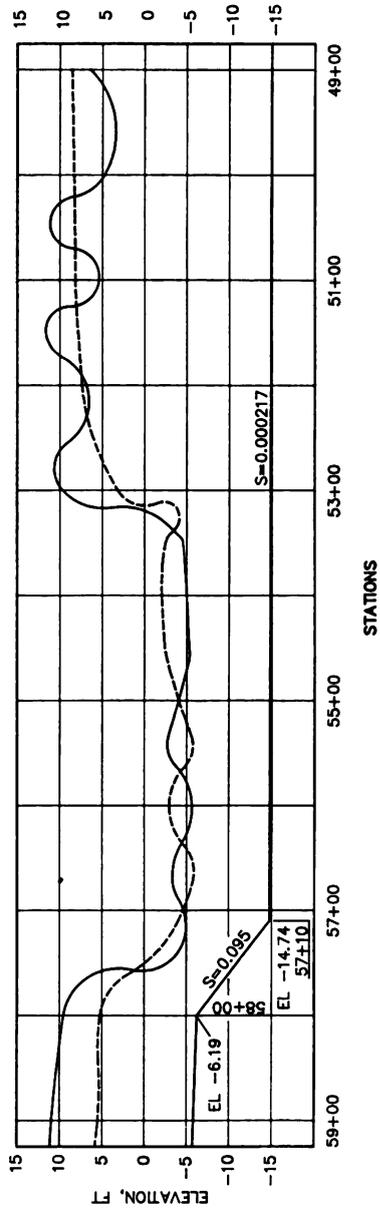
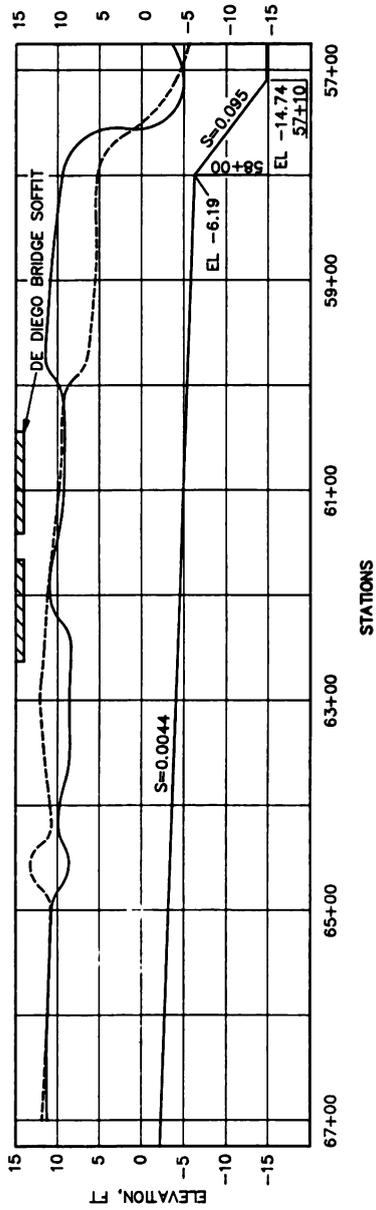
n=0.015  
 DISCHARGE 7,400 CFS  
 AVG. DEPTH AT STA 67+00 = 11.06 FT  
 AVG. DEPTH AT STA 50+00 = 19.85 FT

**LEGEND**  
 — LEFT SIDE OF CHANNEL  
 - - - RIGHT SIDE OF CHANNEL  
 (REFERENCED TO LOOKING DOWNSTREAM)



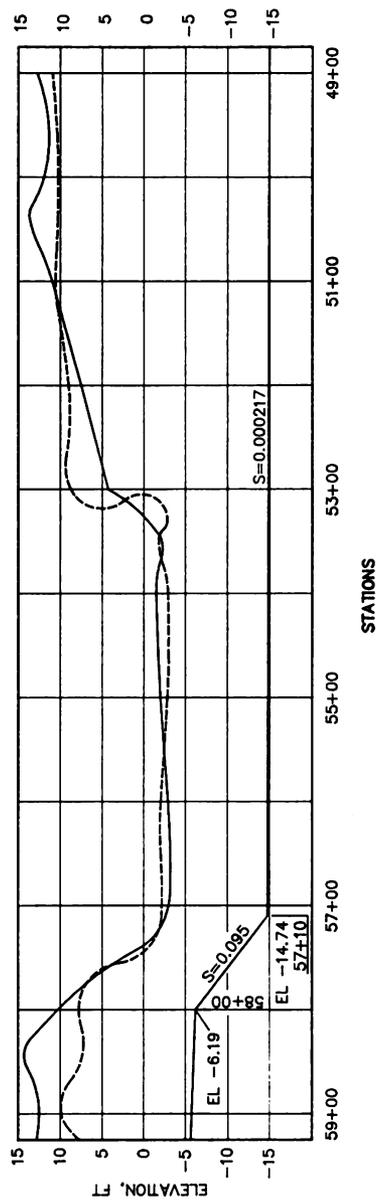
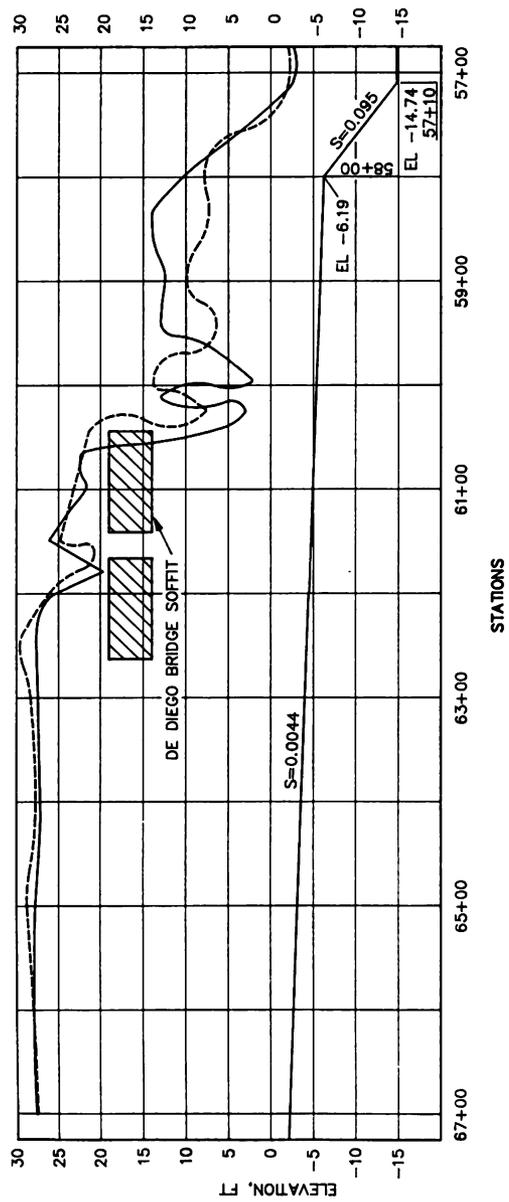
**WATER-SURFACE PROFILES**  
 MARGARITA CHANNEL  
 TYPE 1 (ORIGINAL) DESIGN  
 $n=0.015$   
 DISCHARGE 9,900 CFS  
 AVG. DEPTH AT STA 68+00 = 11.08 FT  
 AVG. DEPTH AT STA 50+00 = 20.07 FT

**LEGEND**  
 ——— LEFT SIDE OF CHANNEL  
 - - - - RIGHT SIDE OF CHANNEL  
 (REFERENCED TO LOOKING DOWNSTREAM)



**LEGEND**  
 ——— LEFT SIDE OF CHANNEL  
 - - - - - RIGHT SIDE OF CHANNEL  
 (REFERENCED TO LOOKING DOWNSTREAM)

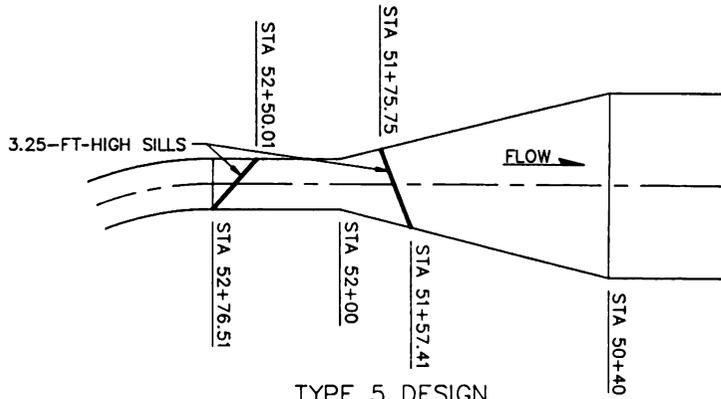
**WATER-SURFACE PROFILES**  
 MARGARITA CHANNEL  
 TYPE 1 (ORIGINAL) DESIGN  
 $n=0.015$   
 DISCHARGE 11,200 CFS  
 AVG. DEPTH AT STA 67+00 = 13.27 FT  
 AVG. DEPTH AT STA 50+00 = 23.08 FT



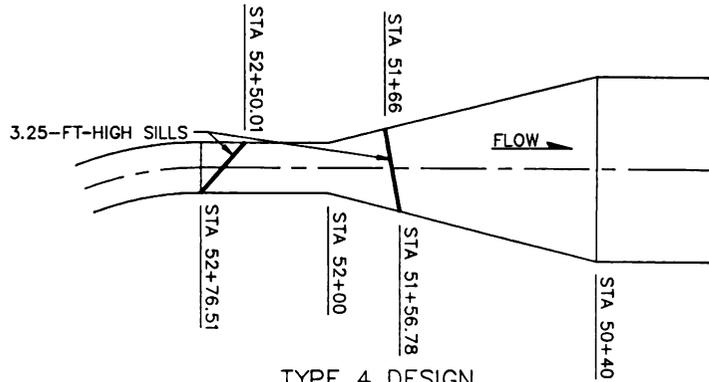
**LEGEND**  
 — LEFT SIDE OF CHANNEL  
 - - - RIGHT SIDE OF CHANNEL  
 (REFERENCED TO LOOKING DOWNSTREAM)

**WATER-SURFACE PROFILES**  
 MARGARITA CHANNEL  
 TYPE 1 (ORIGINAL) DESIGN

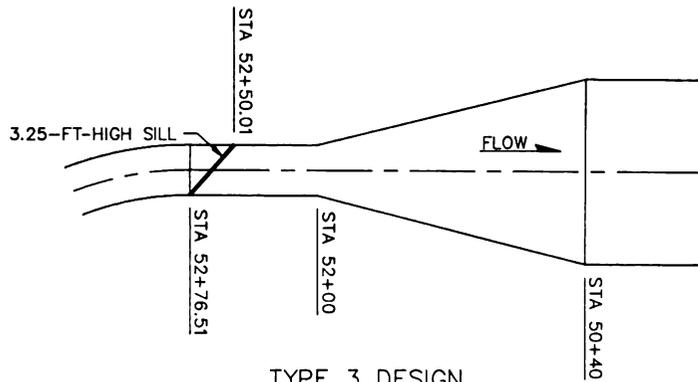
$n=0.015$   
 DISCHARGE 13,500 CFS  
 AVG. DEPTH AT STA 50+00 = 25.18 FT



TYPE 5 DESIGN

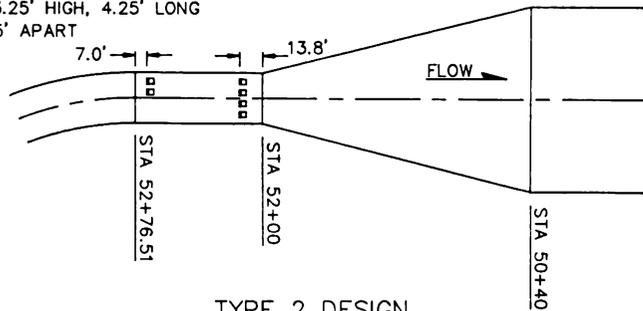


TYPE 4 DESIGN



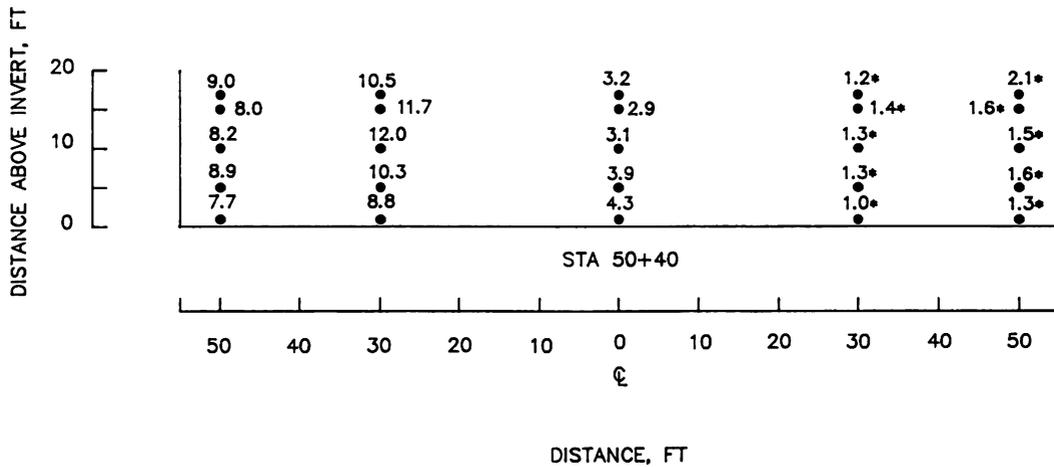
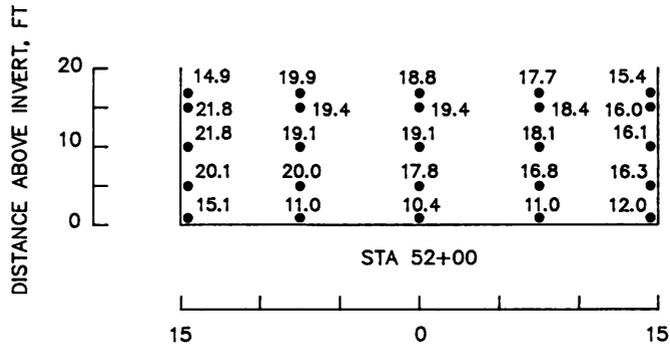
TYPE 3 DESIGN

BLOCKS ARE 3.25' WIDE, 3.25' HIGH, 4.25' LONG  
AND SPACED 3.25' APART



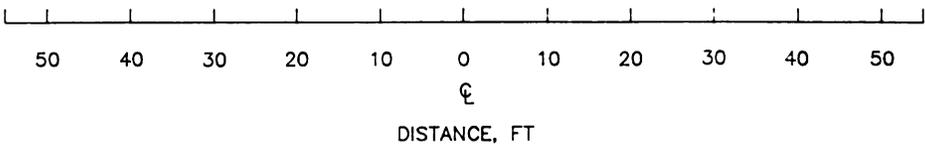
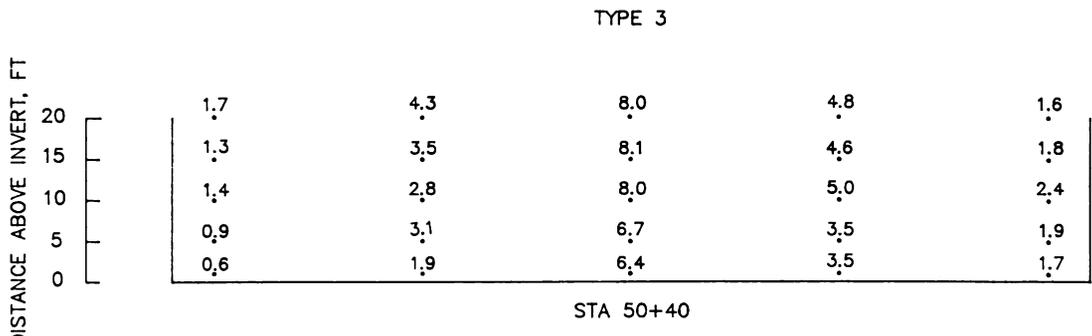
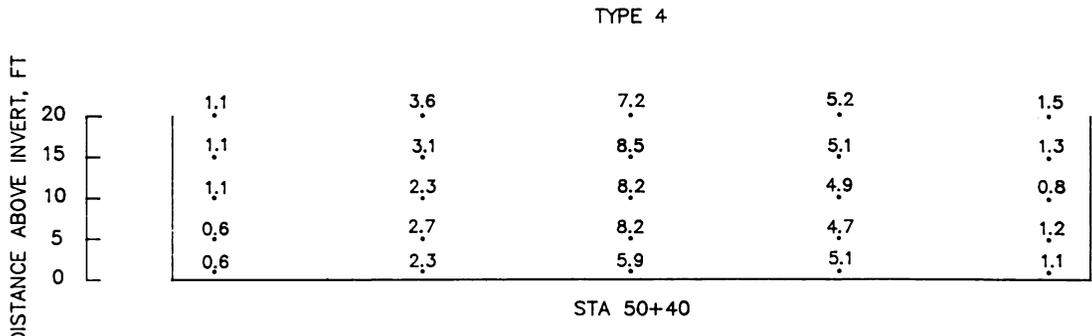
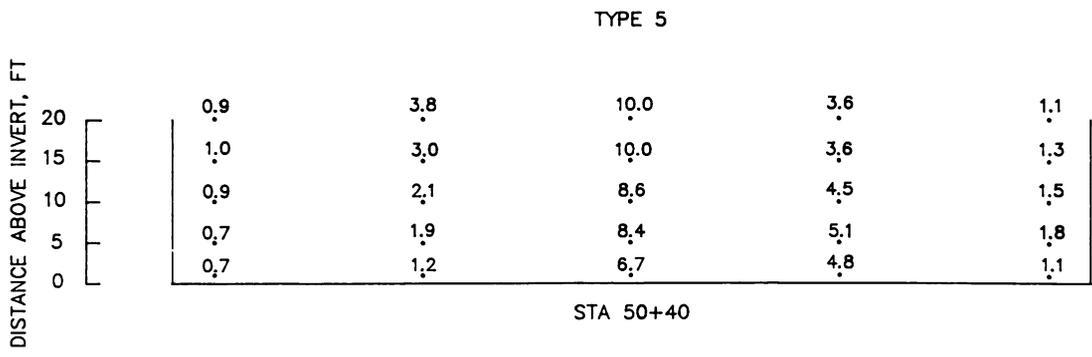
TYPE 2 DESIGN

MARGARITA CHANNEL  
TYPES 2-5 DESIGN TRANSITIONS



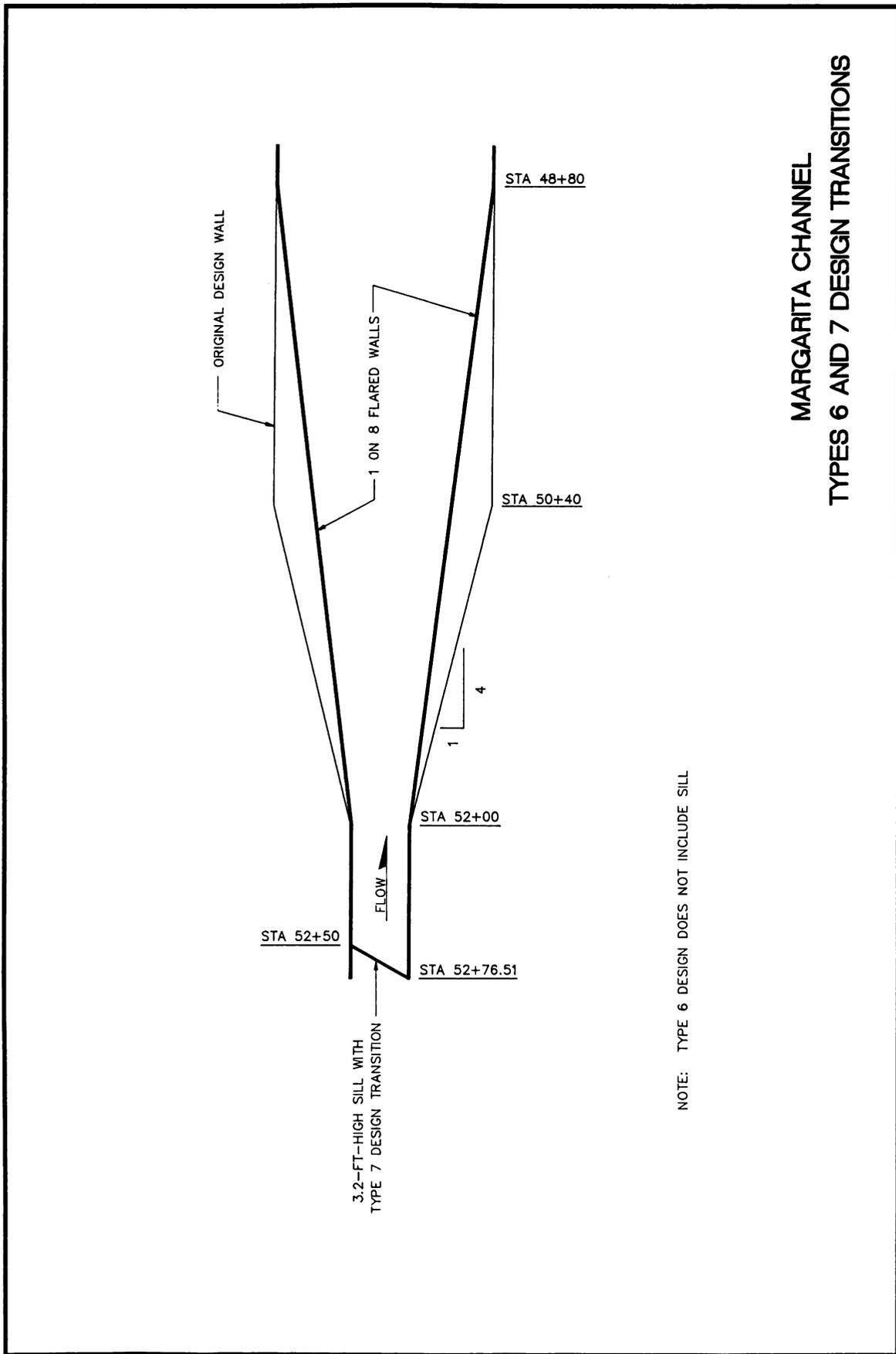
NOTE: VELOCITIES ARE IN FEET PER SECOND  
 LOOKING DOWNSTREAM  
 \* VELOCITIES ARE IN UPSTREAM DIRECTION

**VELOCITIES  
 MARGARITA CHANNEL  
 TYPE 2 DESIGN  
 DISCHARGE 8,800 CFS**



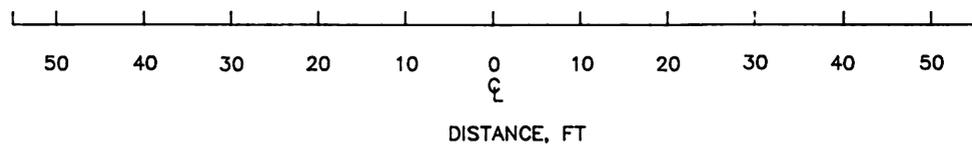
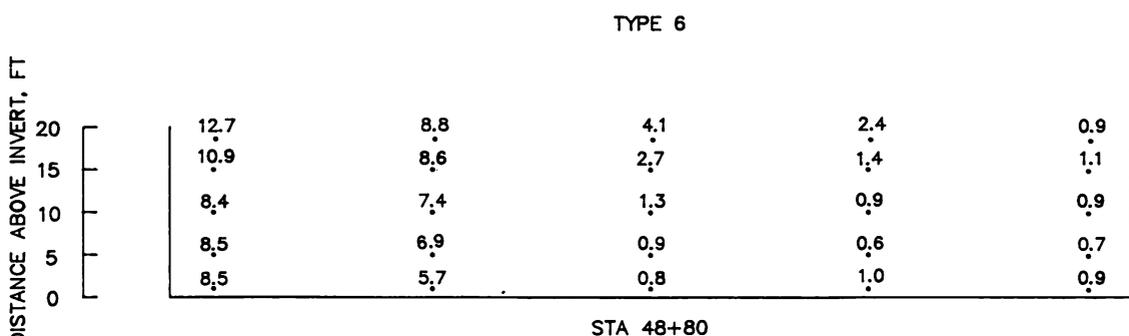
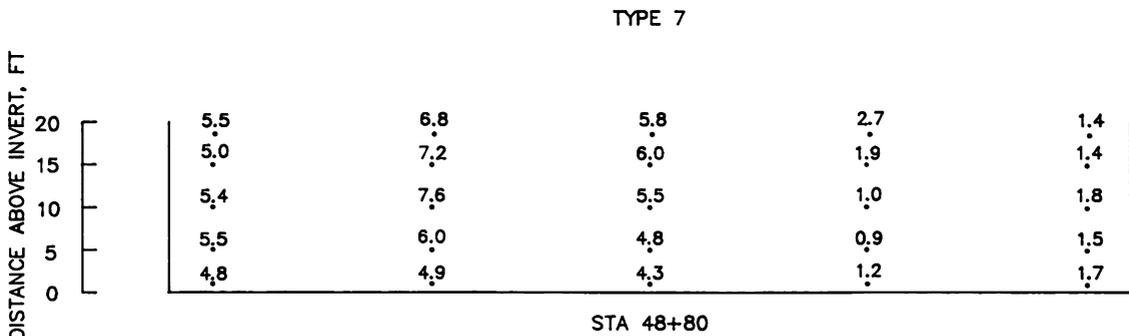
NOTE: VELOCITIES ARE IN FEET PER SECOND  
LOOKING DOWNSTREAM

**VELOCITIES  
MARGARITA CHANNEL  
TYPES 3-5 DESIGN  
DISCHARGE 8,800 CFS**



NOTE: TYPE 6 DESIGN DOES NOT INCLUDE SILL

MARGARITA CHANNEL  
TYPES 6 AND 7 DESIGN TRANSITIONS



NOTE: VELOCITIES ARE IN FEET PER SECOND  
LOOKING DOWNSTREAM

**VELOCITIES  
MARGARITA CHANNEL  
TYPES 6 AND 7 DESIGN  
DISCHARGE 8,800 CFS**





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