Apéndice 9: Estudio Hidrológico Hidráulico

HYDROTEC
HYDROLOGIC - HYDRAULIC & ENVIRONMENTAL ENGINEERS ARCHITECTS AND PLANNERS
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HYDRAULIC STUDY FOR THE PROPOSED CONSTRUCTION OF MARINA PUERTO REAL *FAJARDO , P.R*

MAY 2001

Executive Summary

The hydraulic study for the construction of Marina Puerto Real was conducted under the applicable regulations for floodable zones in Puerto Rico. The project will be located south east of the PR Ports Authority facilities and in front of the existing Isleta Marina Dock facilities.

In 1995 the US corps of Engineers performed the Final Detailed Project Report for the Rio Fajardo recommending a levee system to protect the Fajardo Town of the flooding of Rio Fajardo for various recurrence intervals. It is indicated that under large flood events the majority of the flood of Rio Fajardo is conveyed to the broad floodplain along the south bank and directed to the sea. The proposed project is located on the lower flood risk potential on the north bank of Rio Fajardo. The USACOE project is not an officially adopted flood control project and was not used for development of this study.

According to Federal Emergency Management Agency (FEMA) Panel 720000 0129E the site is located within the flood prone area (Zone AE) of the Fajardo River with flood stages of 2.4 meters. The floodway starts about 1.5 kilometers upstream of the project. The Puerto Rico Planning Board regulation 13 subsection 7.04 establish that any

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proposed development within a flood prone area where base elevations were determine and no floodway data is available must demonstrate with a hydrologic and hydraulic study that the project is above the 100 year flood elevation and it will not raise flood stages more than 0.15 meters for developed areas. This constitutes the base objective of the hydraulic analysis.

The National Flood Insurance Program (NFIP) guidelines procedures to evaluate flooding conditions for projects within an officially adopted Federal Insurance Rate Map (FIRM) were used in the study. The use of the same hydraulic model used to develop the *original Federal Insurance Rate Map (FIRM) is mandatory whenever* the model exists in the FEMA files.

Based on the available original data the project impact in flood stages was structured in three basic models:

(1) *Duplicate Effective Original Model*: The HEC-2 original data as presented in hydraulic model from FEMA to reproduce regulatory FEMA values.

(2) *Corrected Model*: The Duplicate Effective Model including interpolated cross sections (CS-1.25 and CS-2.75) to represent location of project. New starting water surface elevation of 2.4 meters (7.87") as indicated in the FEMA panel 0129E is also *included in the corrected model.*

(3) *Proposed Model*: Corrected model modified to include post-project conditions reflecting proposed project fill.

The corrected model (2) represents the base scenario for comparison with the proposed conditions (with project) model (3). Final results of simulations are indicated in

table 3.4

Table 3.4
FEMA Flood Stages (meters) at Selected Sites (100-year event)

Cross Section	Corrected		Proposed	
	Feet	*meters*	*Feet*	*Meters*
1	7.87	2.40	7.87	2.40
1.25	7.87	2.40	7.87	2.40
2	7.88	2.40	7.88	2.40
2.75	7.89	2.40	7.89	2.40
3	8.06	2.45	8.05	2.45
4	7.85	2.39	7.84	2.39
5	10.30	3.14	10.30	3.14

- **Project is located between sections 1.25 and 2.75**

Results from the Corrected and Proposed models shows that the proposed project of Marina Puerto Real will not increase base flood elevation beyond regulatory levels of 0.15 meters in compliance with the objective set forth in PRPB regulation 13 sub-sections 7.04.

Finish grade elevation must be 2.55 meters to include a 0.15 free board elevation over the obtained 2.4 meters in compliance with the Planning regulations 13 amendments of March 2001. The project seaward boundary is within the Costal High Hazard area Zone VE with flood levels of 3.2 meters that must be considered in the final design.

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HYDRAULIC STUDY

FOR THE PROPOSED CONSTRUCTION

OF MARINA PUERTO REAL

FAJARDO , P.R.

Submitted for

Mr. Jose Mercado Fernandez

Prepared By

IVÁN VELÁZQUEZ AND ASSOCIATES

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May 2001

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CHAPTER 1

INTRODUCTION

1.1 General

Marina Puerto Real is planning to construct their facilities in a plot of land located in Puerto Real Ward in the Municipality of Fajardo. The project will be located south east of the PR Ports Authority facilities and in front of the existing Isleta Marina Dock facilities. Neighborhood includes dwellings, and commercial buildings related to the economic activity of the area. Tourism and commercial activity is high and the project will create additional harbor and boat facilities that are expected to be beneficial in socio-economic terms. Figure 1 shows the project location map.

The site is located within the flood prone area of the Fajardo River as indicated in The Federal Emergency Management Agency (FEMA) Panel 720000 0129E. The Fajardo River runs in a west to east direction passing about 100 meters from the south limit of the project and discharging along a meander reach to the Sonda de Vieques. According to FEMA map the projects is located in a Zone AE with flood elevations of 2.4 meters and in the Costal Zone VE with elevation of 3.2 meters along north seaward boundary. The floodway limits starts upstream of the project at section A of FEMA map. Thus, there is no established floodway along the project location reach.

The Puerto Rico Planning Board regulation 13 subsection 7.04 establish that any proposed development within a flood prone area where base elevations were determine and no floodway data is available must demonstrate with a hydrologic and hydraulic study

that the project is above the 100 year flood elevation and it will not raise flood stages more than 0.15 meters for developed areas. This will be the base objective of the hydraulic analysis.

1.2 Purpose of the Study

The purpose of this hydraulic study is to provide basic parameters and recommendations on the extension and level of fill for the proposed project and any required compensatory measure in order to comply with Federal Emergency Management (NFIP) and PR Planning Board regulation 13 subsection 7.04 requirements.

1.3 Scope of Work

The scope of the study includes the following:

1. Compilation of available hydrologic and hydraulic information from Federal Emergency Management Agency (FEMA) and Puerto Rico Planning Board.
2. Collection of necessary stream and floodplain information involving profiles, cross-sections and roughness characteristics by means of field data, topographic maps and site visits.
3. Computation of flood stage elevations under the present natural conditions, using the available original hydraulic model used to develop the adopted FIRM map 0124E.
4. Computations of the same parameters as in step 3, considering proposed project fill elevated above the 100 year flood stages at the vicinity of the project.
5. Analysis of the impact of project on the flood conditions in the area, with the objective that such project will not result in an increase in flood stage elevations of more than

0.15 meters during the regulatory average 100-year storm.

1.4 Study procedure and requirements

The National Flood Insurance Program (NFIP) established study procedures to evaluate flooding conditions for projects within an officially adopted Federal Insurance Rate Map Flooding conditions of the area will be evaluated based on the original FEMA hydraulic model input data for the Hydrologic Engineering Center (HEC-2) computer model used to develop the effective FIRM Map (0129E). The FEMA approach will be used in agreement with the applicable requirements of the PRPB procedures for performing hydrologic and hydraulic studies. The specific format of the study can be adequately covered using the FEMA procedure, which is consistent with the intended required information for the evaluation of the study under the NFIP program.

The use of the same hydraulic model used to develop the original Federal Insurance Rate Map (FIRM) is mandatory whenever the model exists in the FEMA files. This requirement permits the evaluation of the project in the same basic parameters and conditions used for the development of the original officially adopted FIRM. The use of alternative models or modification of the original data is not FEMA encouraged unless technical explanation is provided. A corrected model is prepared to include new topographic data along the project site as well as other information intended to correct any error or discrepancy in the original model.

The following documents were used in the preparation of the study.

1. Plans of the site submitted by project consultants.

2. FEMA hydraulic data for Floodway, HEC-2 Input Data and Results for Fajardo River. (See Appendix B for Original Data).
3. FEMA original working map used to develop the adopted FIRM panel 0129E.
4. Final Detailed Project Report and Environmental assessment for Rio Fajardo, US Corps of Engineers, June 1995.

1.5 Other flood studies in the area.

In 1995 the US corps of Engineers performed the Final Detailed Project Report for the Rio Fajardo. Under this study the USACOE proposed a levee system to protect the Fajardo Town of the flooding of Rio Fajardo for various recurrence intervals. Figure 4 shows the proposed alternative. The use of this study was limited to the evaluation of the general hydraulic data used to develop the flood control alternative.

The bank full discharge of the Rio Fajardo is very low and is exceeded with events of 2-year frequency. It is indicated that under large flood events the majority of the flood of Rio Fajardo is conveyed to the broad floodplain along the south bank and directed to the sea. The Town of Fajardo and the proposed project are located on the north bank of Rio Fajardo.

The starting water surface elevation used in USACOE study was established as 2.46, meters, which is consistent with the reported stages by FEMA in FIRM panel 0129E. The discharge used by The US corps of Engineers is lower than used by FEMA.

Even the proposed flood control works will protect the area of the project from recurrent and high discharges and floods levels, they were not considered since

its construction is not actually completed nor officially adopted. The use of FEMA data constitutes a conservative approach for the project.

CHAPTER 2

HYDROLOGIC STUDY

2.1 Hydrologic Data

Discharge information for the hydraulic analysis was obtained from FEMA report. The hydrologic data used for the project is based on hydrologic results from FEMA original study.

Table 2.1 Discharge from FEMA Original Study at Fajardo River

Cross Section	Discharge
CS-1 (few feet from the sea)	56900cfs (1612 CMS)

CHAPTER 3

HYDRAULIC ANALYSIS

3.1 General

FEMA provided data of the original hydraulic model and the working map used to develop the original model. The units of the maps are in meters and the units of the hydraulic data are in English units system. Flood stages presented in the FEMA original report are based on a Step Backwater computation using HEC-2 model at selected sites within the floodplain of Fajardo River.

In the Fajardo River model FEMA used a starting water surface elevation of 2 feet at section 1 several feet from sea. From this initial run the water surface elevation of section 5 (A in FEMA map-Figure 2) was used to compute the floodway for the upstream reaches. No floodway was established for the reach from the sea to section 5.

The Marina Puerto Real hydraulic analysis was performed from cross section 1 from FEMA original hydraulic model to cross-section 5 of input data (Section A in FEMA map). If no increase in flood stages are induced by the project in section 5, it is expected that no changes would be induced further upstream. This approach is consistent with the sub-critical flow regime in which the downstream conditions controls the flood stages upstream.

Under the proposed conditions the model was adjusted (corrected effective model) to represents changes in topographic data and correction of any errors or discrepancies encountered in the original model.

The project is located within the area bounded by section 2 as shown in figure 3. The analyses performed and presented in this report were structured in three basic models:

(1) *Duplicate Effective Model*: The HEC-2 original data as presented in hydraulic model from FEMA to reproduce regulatory FEMA values.

(2) *Corrected Model*: The Duplicate Effective Model with interpolated cross sections to represent location of proposed project, adjustment to original cross sections to represent existing site elevations and a new starting water surface elevation of 2.4 meters (7.87") as indicated in the FEMA panel 0129E.

(3) *Proposed Model*: Corrected model including post-project conditions model reflecting proposed fill.

Table 3.1 shows a description of the modifications included in each of the computer simulations performed. Reference to this summary is encouraged when analyzing the results.

Table 3.1 Description of Modifications for Hydraulic Simulations

File Name	Description
0105eff.dat	Duplication of original effective FEMA model
0105corr.dat	Duplicated FEMA model corrected to include new cross section information and starting water surface elevation.
0105prj.dat	Corrected FEMA model to include proposed project fill

3.2 Development of Hydraulic Models

The HEC-2 models to simulate the various scenarios were prepared using the

following steps:

1. The Flood Insurance Rate map (FIRM)and working data map from FEMA and the topographic data from surveyor were used for the location of project within the flood prone area of Fajardo River . Project is located at the west bank of section 2 of the FEMA original report. Figure 3 shows the location of the project in the working map obtained from FEMA.
2. The corrected model includes the existing topographic conditions at the site as represented by the introduction of new data in section 2 and interpolated cross sections 1.25 and 2.75 at upstream and downstream boundaries of the project. Distance between cross sections was adjusted to consider new cross section location.
3. Once HEC-2 corrected model was set, the proposed project fill was introduced. Cross sections 1.25, 2 and 2.75 were modified to include the fill for the building and parking area with the rest of the grade points remaining the same as in the effective and corrected model. A fringe located between the north boundary of the lot and the proposed building was considered at existing ground elevation and a Roughness factor (n-value) corresponding to pavement surfaces was used.

3.2.1 Duplicate Effective Model

The HEC-2 original model from FEMA was reproduced by re-coding the data and running the model until exact agreement was obtained without variation to original model. As mentioned this duplication was performed from section 1 to section 5 (A in FEMA FIRM panel 0129E).

Appendix B includes hydraulic output of Original Effective Model and Appendix C

surface elevation. This is consistent with the data published in the FEMA panel 0129E. In order to compare in the same conditions the effective model was also run with the initial starting water surface elevation of 2.4 meters (7.87 feet)

The corrected model represents the base scenario for comparison with the proposed conditions (with project) model. Appendix D includes hydraulic output for the Corrected Effective Model. Table 3.3 shows results for this simulation.

Table 3.3 FEMA Flood Stages (meters) at Selected Sites (100-year event) for the Corrected Model

Cross Section	Effective **		Corrected	
	Feet	*meters*	*Feet*	*meters*
1	7.87	2.40	7.87	2.40
1.25			7.87	2.40
2	7.87	2.40	7.88	2.40
2.75			7.89	2.40
3	8.05	2.45	8.06	2.45
4	7.83	2.38	7.85	2.39
5	10.30	3.14	10.30	3.14

*** Project is located between at sections 1.25 and 2.75**
**** Effective model (table 3.2) with new starting water surface elevation**

Results from the Corrected Model shows a slightly difference in cross sections 2, 3 and 4 due to the introduction of new cross sections 1.25 and 2.75 and the additional topographic points.

3.2.3 Proposed model

The Corrected Model was modified to represent fill of proposed project. All other grading points in cross sections remain as in the corrected model. Roughness factor were modified to consider a fringe of pavement surface between the north property boundary

surface elevation. This is consistent with the data published in the FEMA panel 0129E. In order to compare in the same conditions the effective model was also run with the initial starting water surface elevation of 2.4 meters (7.87 feet)

The corrected model represents the base scenario for comparison with the proposed conditions (with project) model. Appendix D includes hydraulic output for the Corrected Effective Model. Table 3.3 shows results for this simulation.

Table 3.3 FEMA Flood Stages (meters) at Selected Sites (100-year event) for the Corrected Model

Cross Section	Effective **		Corrected	
	Feet	*meters*	*Feet*	*meters*
1	7.87	2.40	7.87	2.40
1.25			7.87	2.40
2	7.87	2.40	7.88	2.40
2.75			7.89	2.40
3	8.05	2.45	8.06	2.45
4	7.83	2.38	7.85	2.39
5	10.30	3.14	10.30	3.14

*** Project is located between at sections 1.25 and 2.75**
**** Effective model (table 3.2) with new starting water surface elevation**

Results from the Corrected Model shows a slightly difference in cross sections 2, 3 and 4 due to the introduction of new cross sections 1.25 and 2.75 and the additional topographic points.

3.2.3 Proposed model

The Corrected Model was modified to represent fill of proposed project. All other grading points in cross sections remain as in the corrected model. Roughness factor were modified to consider a fringe of pavement surface between the north property boundary

and the main project building. This might be considered as a compensatory measure since the high roughness coefficient used by FEMA in this section is reduced to account for the pavement surface. Figure 6 shows proposed project. Figure 7 shows typical cross section and proposed fill at project. Appendix E includes hydraulic output from the Proposed Model. Table 3.4 shows results from this simulation.

Table 3.4 FEMA Flood Stages (meters) at Selected Sites (100-year event) for the Existing Model

Cross Section	Corrected		Proposed	
	Feet	*meters*	*Feet*	*meters*
1	7.87	2.40	7.87	2.40
1.25	7.87	2.40	7.87	2.40
2	7.88	2.40	7.88	2.40
2.75	7.89	2.40	7.89	2.40
3	8.06	2.45	8.05	2.45
4	7.85	2.39	7.84	2.39
5	10.30	3.14	10.30	3.14

*** Project is located between sections 1.25 and 2.75**

Results from the Corrected and Proposed models shows no increase in base flood elevation from cross section 1 to 5. Water surface elevation decreased slightly at cross sections 3 and 4. Results from the Proposed Model were evaluated to address the impact in flood levels with the proposed fill and roughness value modification. Hydraulic parameters as conveyance and velocities were inspected for consistency with the hydraulic behavior of the reach. No noticeable changes in hydraulic parameters were detected on the models for the corrected and proposed (with project conditions)

3.3 Discussion of results

The results indicates that the proposed construction of Marina de Puerto Real will not increase flood levels beyond the maximum permissible surcharge of 0.15 meters along the study reach. This in compliance with the objective set forth in PRPB regulation 13 sub-section 7.04.

The inspection of output in appendix D shows that the majority of flow is conveyed in the Fajardo River system with 50885 cfs by north floodplain, 4799 by the principal channel and 1314 along the north floodplain where project is located. This location is beneficial to the project as indicated by the no impact result due to the high stages and low flow relationship involved.

After the construction of the USACOE Flood control project the Marina Puerto Real will be located in low flood risk area protected by the proposed levee system that will protect the Fajardo Town and Harbor area.

Nevertheless, the actual analysis for the Marina Puerto Real uses the conservative actual officially adopted FEMA scenario. The project must consider adequate local drainage to diminish the impact of the proposed fill under the occurrence of local more frequent non-regulatory flood events.

CHAPTER 4

CONCLUSIONS AND RECOMMENDATIONS

4.1 Conclusions

Based on the analysis of the information resulted from this evaluation, the following conclusions and recommendations must be considered:

1. Contributing discharge at project site corresponds to 56900cfs (1612 CMS), value obtained from FEMA hydraulic data for Fajardo River.
2. Proposed project is located between cross sections 1.25, 2 and 2.75. of FEMA sections.
3. The final proposed fill would not increase the existing flood stages at section 5 (A in FEMA panel 0129E) of Fajardo River for an average 100-year frequency discharge indicating no impact on the existing Floodway of Rio Fajardo. The obtained values are within the maximum permissible value of .15 for developed areas in compliance with regulations 13.sectoion 7.04.
4. The slight reduction in flood levels at sections 3 and 4 responds to the effect of roughness factor (n-value) in the pavement fringe at project north boundary.

4.2 Recommendations

In view of the results obtained, the proposed project must include a compensatory measure as followed:

1. Finish grade elevation will be over 2.4 meters corresponding to the water surface elevations obtained in this study. Free board should be provided depending on structural, architectural and operational characteristics of the project
2. Entrance-doors, windows and other openings must be above flooding elevations. Owners of the project may provide all necessary security measures to assure life and property within the project area.
3. The study area is located in the flood prone area of Fajardo River and its sea ward boundary is within the Costal High Hazard area Zone VE with flood levels of 3.2 meters. The study presented herein includes only the effect of the flood caused by the Fajardo River using a starting flood level of 2.4 meters for the riverine hydraulic analysis. Coastal analysis must be performed to address the effect of Coastal surges as indicated in the FEMA panel 0129E. The decision of whether to modify the finish floor elevation will reside in the most reasonable critical condition for the project after performing the Coastal analysis. This analysis is out of the scope of this hydraulic study. Oceanographic studies that will be performed for the establishment of the marina must consider the evaluation of the Coastal Hazard Area in compliance with FEMA regulations for designated Zones V.
4. The regulation for areas with floodway determined in PRPB regulation 13 sections 7.03-3 is applicable for this project. According to section 7.03-3 any elevated structure that contains closed wall or closed spaces with exterior walls located below the base

flood elevation used only for parking lots will be designed to automatically equalized hydrostatic forces and permit flow through. The design must comply or evaluate the requirements of the PRPB sections 7.03-3a,b,c,d,e, where the previous consideration is described.

5. Planning regulation 13 sections 7.01-4 includes additional design consideration that must be evaluated.
6. Internal drainage and flow conveyance of surrounding properties affected by the proposed fill must be adequately designed to avoid undesirable effects under moist frequent and non-regulatory flood vents. Provision must be undertaken to reduce the discharge of the project site or to mitigate the effect of these in the existing drainage or receiving bodies.

4.3 General comments

The results of this study are based on free flow conditions. Obstruction to flow due to improper maintenance or other reasons may impair the results of this study. This study is based only in the data officially submitted to us by FEMA. For all practical purposes and in compliance with regulations the use of the computer runs performed in the original study and sent to us upon request for this project is mandatory in the evaluation of project within official declared flood areas according to the National Flood insurance Program (NFIP).

CHAPTER 5

REFERENCES

Federal Emergency Management Agency, August 1984. Conditions and Criteria for Floodway Revisions. Washington, D.C.

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U.S. Army Corps of Engineers, 1990. Water Surface Profile Model (HEC-2), User's Manual. Hydrologic Engineering Center, Davis, California.

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U.S. Army Corps of Engineers, Final Detailed Project Report and Environmental assessment for Rio Fajardo, June 1995.

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U.S. Army Corps of Engineers, 1990. Water Surface Profile Model (HEC-2), User's Manual. Hydrologic Engineering Center, Davis, California.

Appendix A

Figures

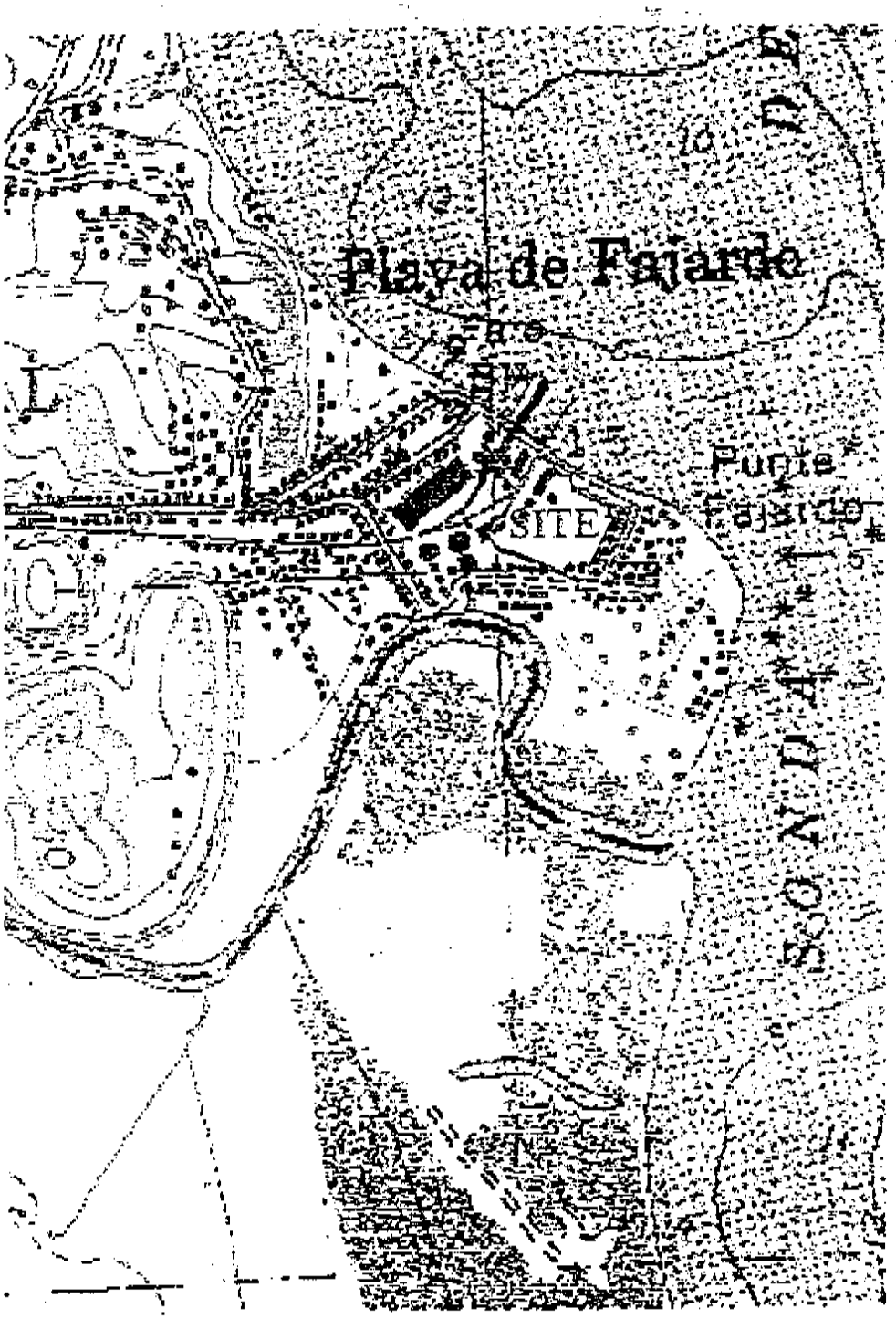

Figure 1 Location of Proposed Project
Scale 1:10,000.

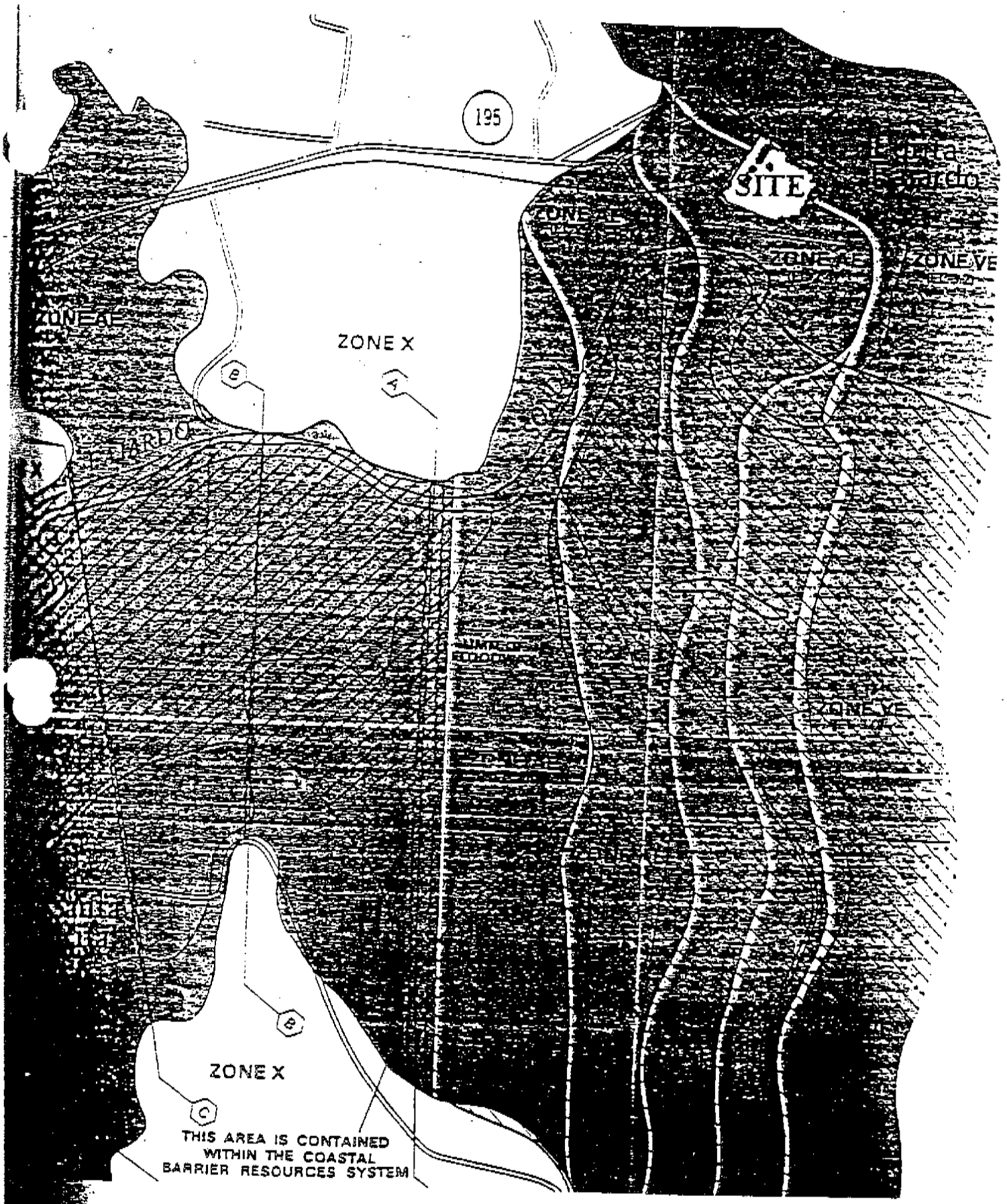

Figure 2 - FEMA Map Community Panel 720000 0129E for Fajardo River
Scale 1:10000

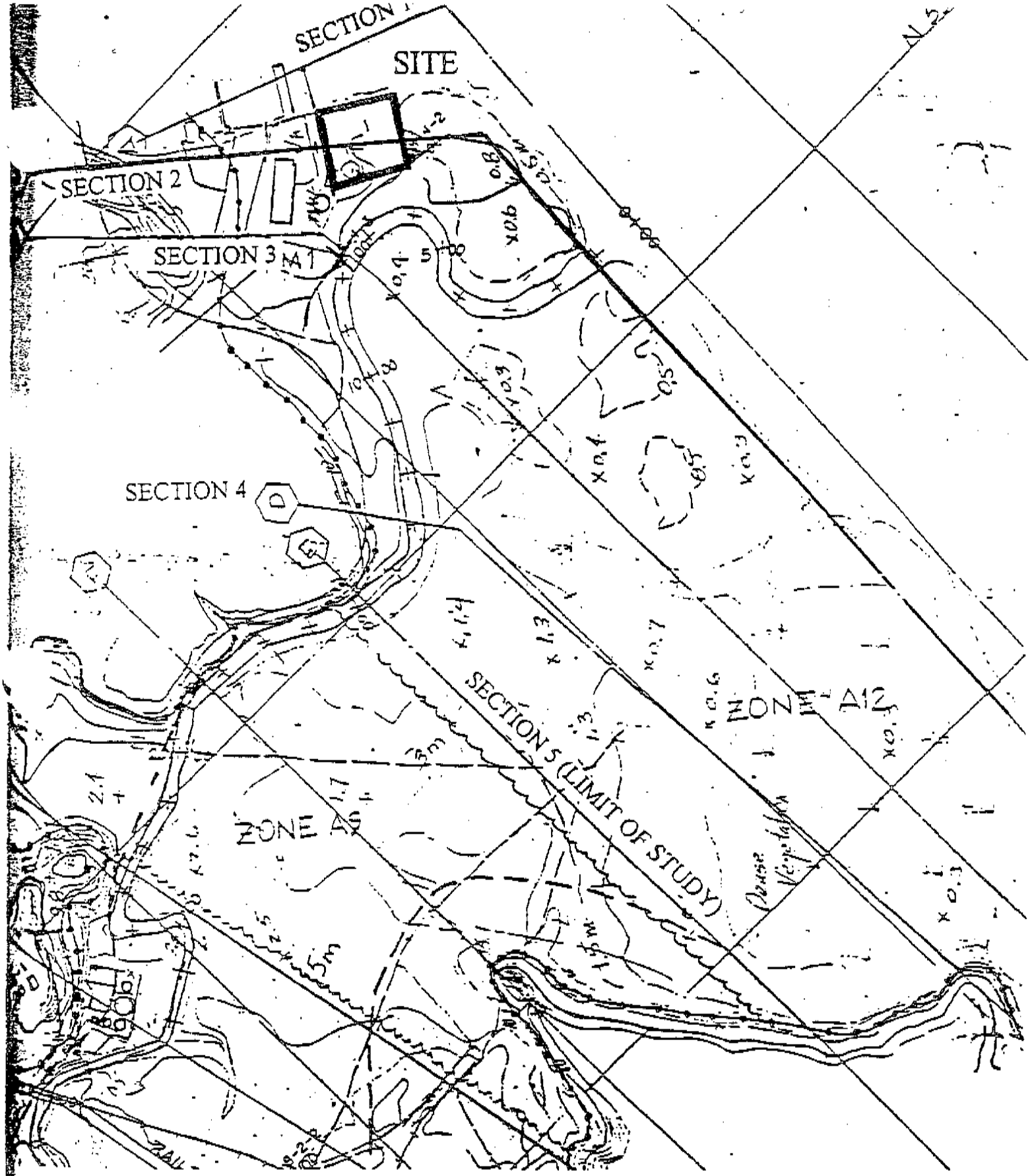

Figure 3 - Project location on FEMA working topographic map of Fajardo River
Scale 1:10000

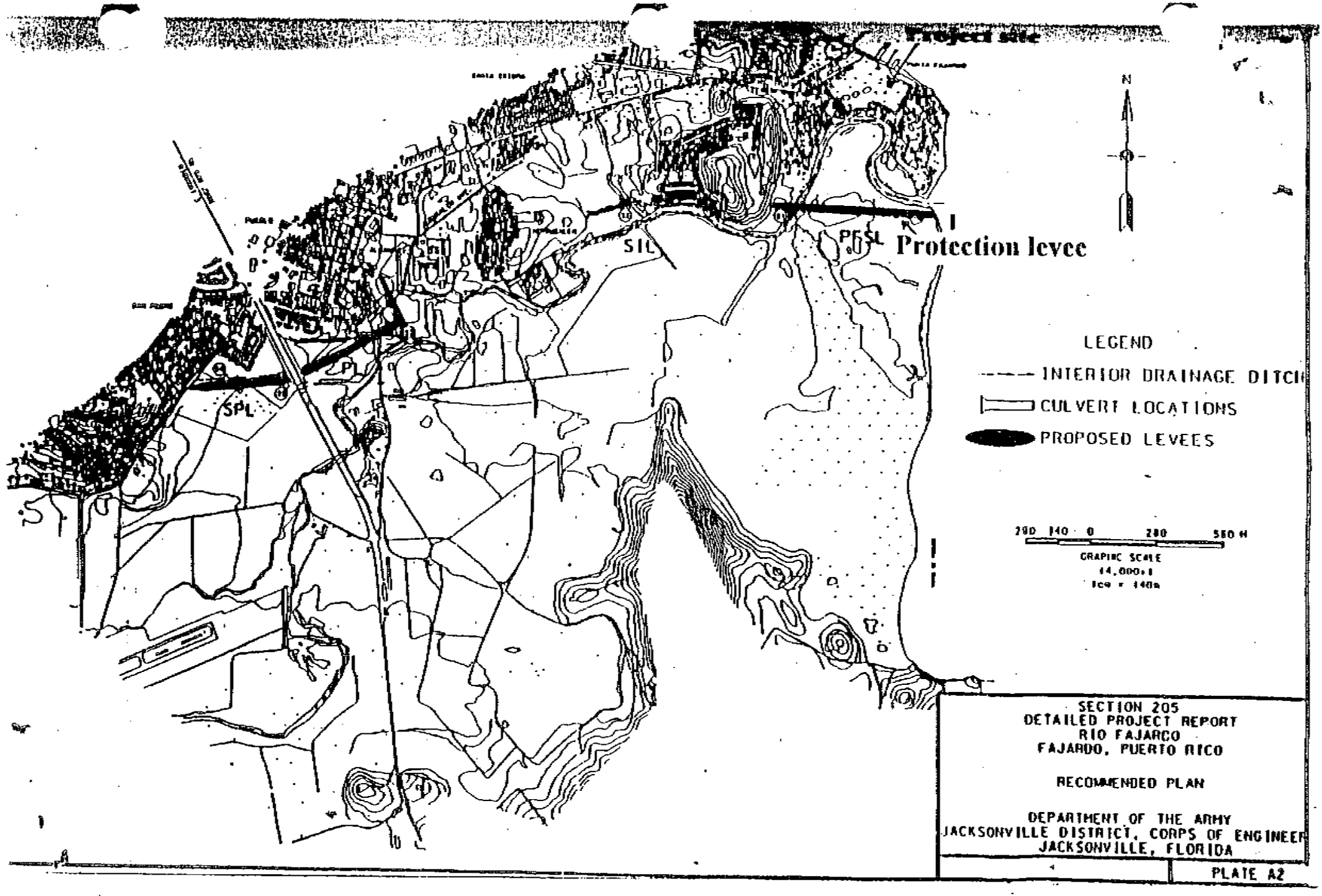

Figure 4 - US Corps of Engineers recommend plan for Rio Fajardo

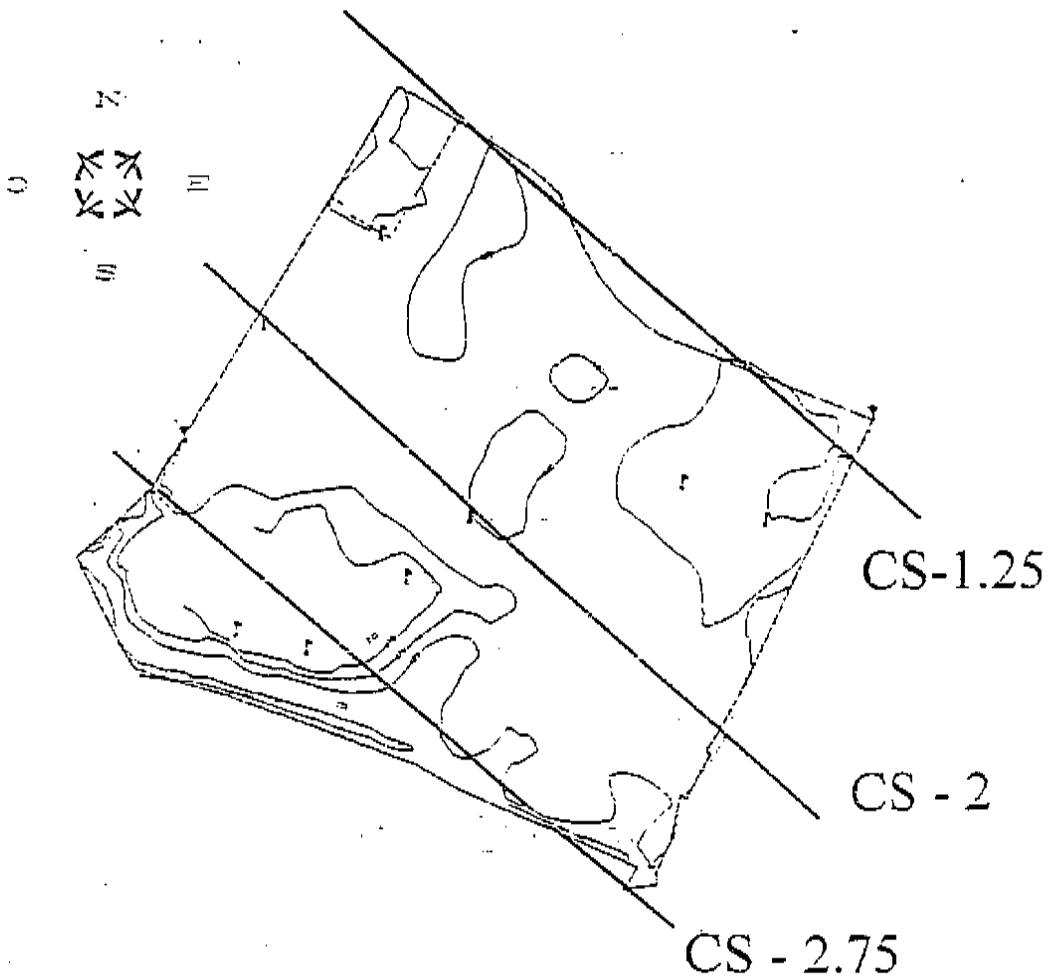

Figure 5 existing conditions at project site with new cross sections

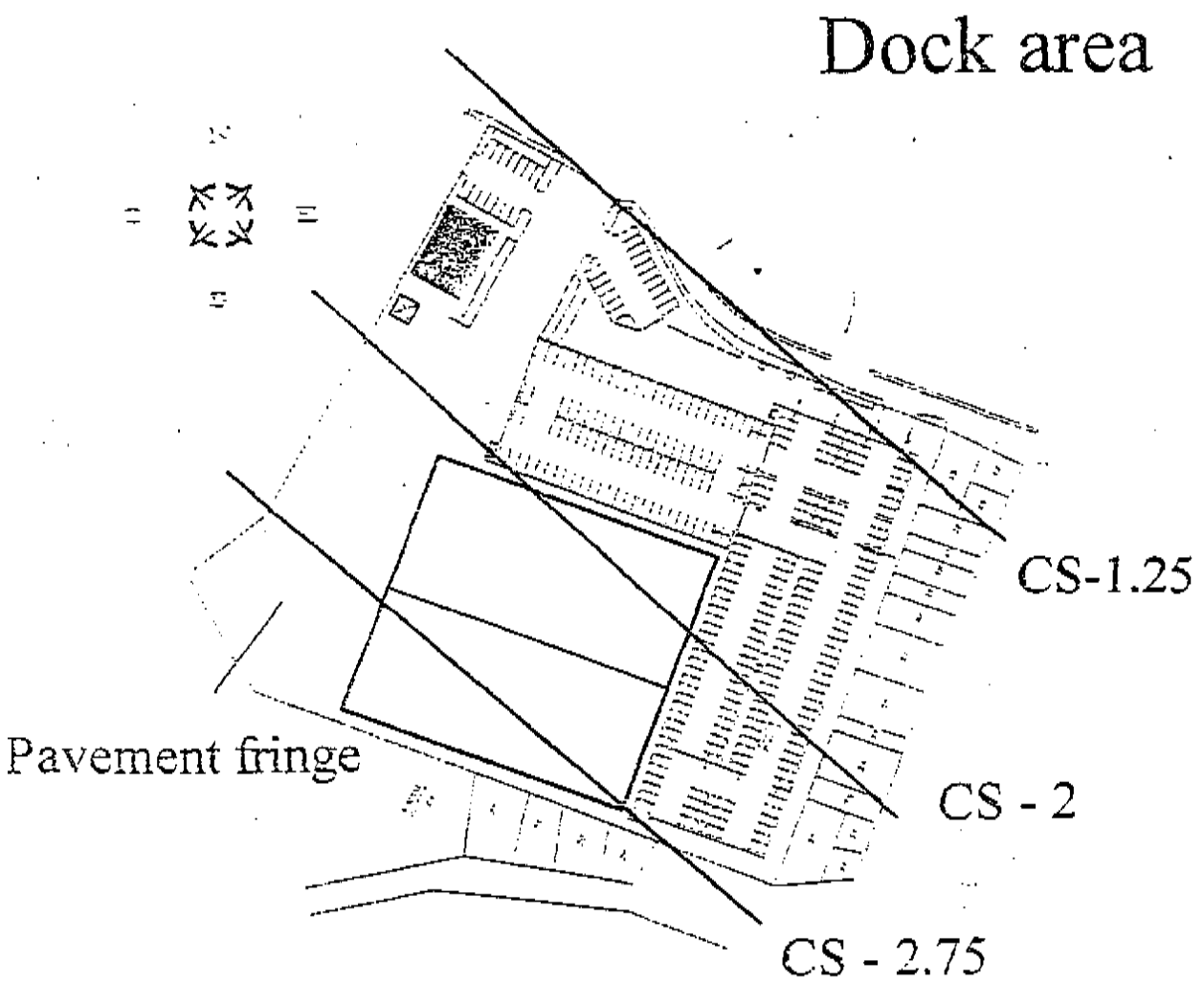

Figure 6 Proposed marina Puerto Real project site with new cross sections

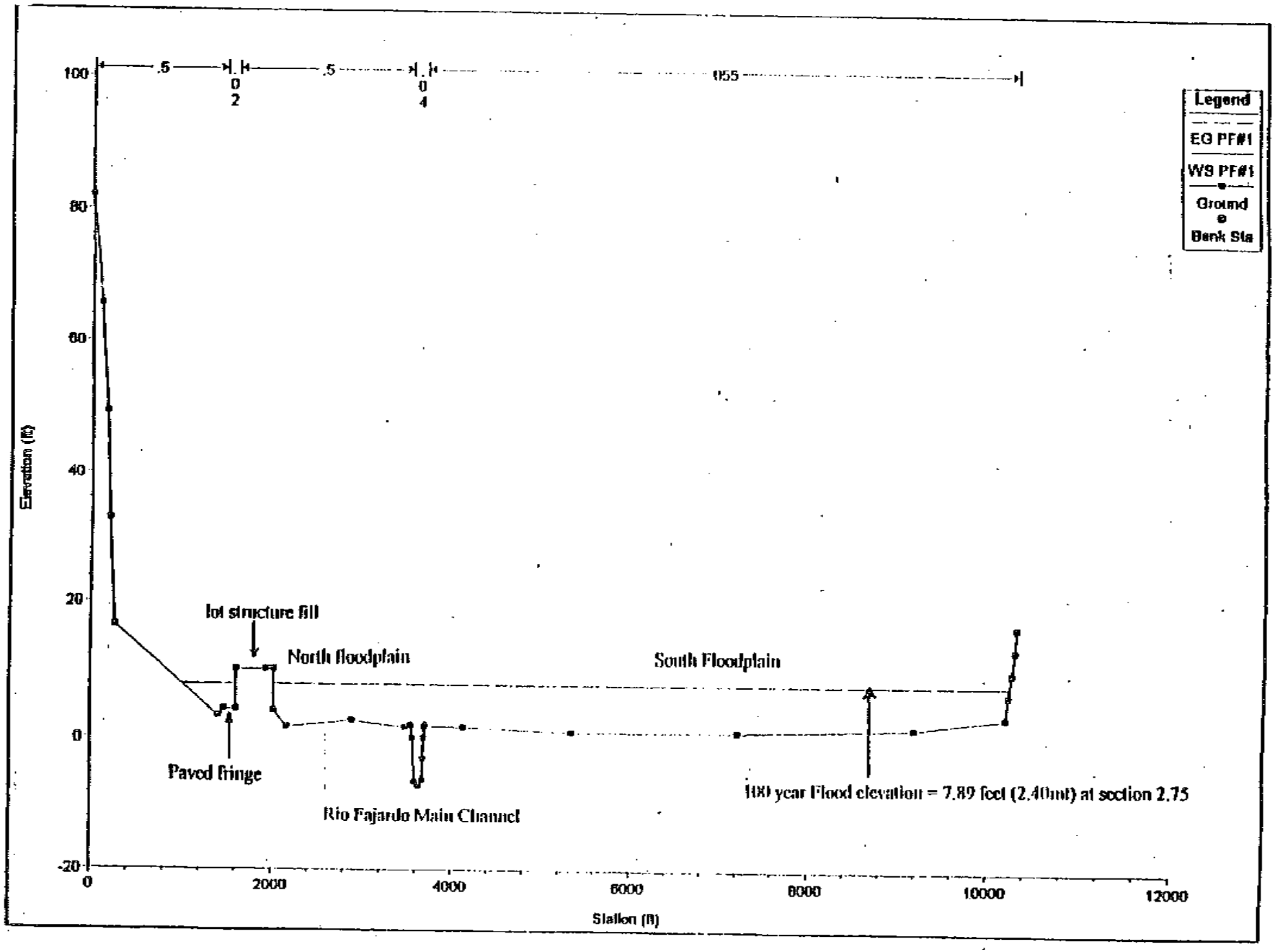

Figure 7 - Typical cross section and proposed fill along project site

Appendix B

FEMA Hydraulic Data for Floodway, HEC-2 Input Data

and Results for Fajardo River

RUN DATE 80/05/05. TIME 11.49.57.

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(916) 440-2105 (FTS) 448-2105

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X      X  XXXXXXX   XXXXX              XXXXX
X      X  X         X     X            X     X
X      X  X         X                  X     X
XXXXXXX   XXXX      X          XXXXX    XXXXX
X      X  X         X                  X
X      X  X         X     X            X
X      X  XXXXXXX   XXXXX              XXXXXXX
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effective copy

10.4

RECEIVED
MAY 12 1980
DAMES AND MOORE

REVISED
MAY 5 1980

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HEC2         DATED NOV 76 UPDATED JULY1979
ERROR            01.02.03
MODIFICATION -   50,51,52,53
**********************************************************

T1      FLOOD INSURANCE STUDY
T2      10 YEAR FLOOD
T3      RIO FAJARDO

J1  ICHECK    INQ    NINV    IDIR    STRT      METRIC   HVINS   Q     WSEL    FQ
       0.      2.      0.      0.  0.000000     0.00     0.0    0.    2.000   0.000

J2  NPROF   IPLOT   PRFVS   XSECV   XSECH   FN      ALLDC   IBW     CHNIM   ITRACE
     0.000   0.000  -1.000   0.000   0.000   0.000  -1.000   0.000   0.000   0.000

NC     .000      .000      .040        .300        .500       0.000     0.000     0.000     0.000     0.000
GT    4.000  22200.000  49100.000  56900.000  80000.000       0.000     0.000     0.000     0.000     0.000

        CR-SEC I IS TAKING ON THE SEA A FEW FEET FROM THE COAST

X1     1.000     14.000   3411.000   3772.000      0.000      0.000      0.000      0.000      0.000      0.000
GR A  16.400      0.000      1.600    328.000     -6.500    850.000     -4.500   2296.000     -9.000   3411.000
GR    -8.000   3772.000     -6.500   9084.000     -8.000   5578.000     -6.500   6232.000     -2.800   4800.000
GR    -8.000   8056.000     -3.500  10332.000      3.300  10760.000     16.400  10020.000      0.000      0.000
NC      .500       .055      0.000      0.000      0.000      0.000      0.000      0.000      0.000      0.000

        CR-SEC 2 AND 3 IS DENSELY POPULATED ON LEFT OVERBANK

X1 B   2.000     26.000   3542.000   3499.000    377.000    377.000    377.000      0.000      0.000      0.000
GR    82.000      0.000     65.600     98.000     49.200    164.000     32.000    197.000     16.400    242.000
GR     3.300   1410.000      1.600   2165.000      2.600   2084.000      1.600   3477.000      1.000   3542.000
GR      .070   3583.000     -6.330   3580.000     -7.080   3629.000     -6.230   3669.000     -3.150   3679.000
GR      .070   3689.000      1.750   3699.000      1.600   4133.000      1.000   5346.000      1.000   7216.000
GR    11.600   9184.000      3.300  10200.000      6.600  10234.000      9.000  10266.000     13.100  10300.000
GR    18.400  10316.000      0.000      0.000      0.000      0.000      0.000      0.000      0.000      0.000

X1     3.000     29.000   1140.000   1284.000    787.000   1050.000   2083.000      0.000      0.000      0.000
GR C  98.400      0.000     82.000     33.000     65.600     49.000     49.200     82.000     32.800    131.000
GR    16.400    100.000      3.300    853.000      2.000   1140.000      -.060   1161.000    -10.130   1170.000
GR    -8.650   1210.000     -6.790   1257.000     -3.560   1272.000       .010   1279.000      1.940   1286.000
GR     1.000   2788.000      1.300   3280.000      2.000   4590.000      1.000   5900.000      1.600   8040.000
GR     3.300   8266.000      6.600   8280.000      9.800   8290.000     13.100   8331.000     16.400   8364.000
NC      .220       .220      0.000      0.000      0.000      0.000      0.000      0.000      0.000      0.000

X1 D   4.000     21.000    377.000    471.000   1797.000    722.000   1804.000      0.000      0.000      0.000
GR    32.000      0.000     16.400     33.000      3.300    328.000      2.120    377.000      -.100    381.000
GR   -13.920    391.000    -10.220    420.000     -7.350    450.000     -4.000    463.000      -.650    468.000
GR     2.120    471.000      3.300    590.000      4.600    722.000      4.300   1640.000      3.300   2066.000
GR     2.000   2624.000      1.000   3280.000      1.000   4796.000      3.300   5039.000     16.400   5100.000
GR    32.000   5150.000      0.000      0.000      0.000      0.000      0.000      0.000      0.000      0.000
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GR		292.000	3.300	344.000	4.400	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
GR		2427.000	2.600	3214.000	3.300	41	16.400	4297.000	32.800	4420.000
GR	49.200	4477.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
NI	F 8.000	20.000	164.000	260.000	1115.000	1115.000	1197.000	0.000	0.000	0.000
GR	32.800	0.000	18.400	98.000	2.120	164.000	-.180	168.000	-13.920	170.000
GR	-19.220	817.000	-7.350	255.000	-4.000	260.000	-.650	265.000	2.120	260.000
GR	3.300	912.000	3.300	918.000	5.600	1443.000	6.600	1771.000	6.600	2493.000
GR	9.800	2624.000	13.100	2780.000	18.400	2821.000	32.800	2884.000	49.500	2985.000
NI	G 7.000	23.000	230.000	329.000	1345.000	984.000	1328.000	0.000	0.000	0.000
GR	24.600	0.000	23.000	16.000	19.700	66.000	16.400	131.000	13.100	148.000
GR	9.800	197.000	8.500	230.000	0.000	246.000	-.400	247.000	-1.400	287.000
GR	-4.400	288.000	-3.850	303.000	-.250	313.000	8.400	329.000	6.600	329.000
GR	8.200	1443.000	13.100	2099.000	13.100	2460.000	13.100	3378.000	13.100	3474.000
GR	16.400	3723.000	32.800	3654.000	49.200	4133.000	0.000	0.000	0.000	0.000
NI	H 0.000	24.000	888.000	984.000	853.000	797.000	1640.000	0.000	0.000	0.000
GR	49.200	0.000	32.800	164.000	29.500	197.000	23.000	230.000	19.700	262.000
GR	18.400	295.000	16.400	689.000	8.500	885.000	.600	901.000	-.400	902.000
GR	-1.400	912.000	-4.400	935.000	-3.850	950.000	-.250	960.000	8.400	984.000
GR	9.800	1151.000	9.800	1476.000	13.100	2099.000	16.400	2493.000	19.700	3870.000
GR	19.700	4330.000	23.000	4461.000	32.800	4802.000	49.200	4707.000	0.000	0.000
NC	1500	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
NI	0.000	32.000	1115.000	1251.000	672.000	606.000	778.000	0.000	0.000	0.000
GR	32.000	0.000	23.000	925.000	16.400	784.000	19.000	1115.000	11.400	1115.000
GR	8.300	1131.000	8.300	1134.000	3.300	1164.000	2.900	1166.000	-.900	1169.000
GR	-.600	1192.000	-.600	1194.000	-.600	1197.000	-.600	1199.000	-2.100	1221.000
GR	1.900	1221.000	1.600	1223.000	2.700	1226.000	4.900	1249.000	6.900	1249.000
GR	8.900	1251.000	15.000	1251.000	13.100	1443.000	13.100	2230.000	13.100	3460.000
GR	16.400	3739.000	19.700	4346.000	23.000	4526.000	23.000	4807.000	23.000	5201.000
GR	26.200	5707.000	32.800	5756.000	0.000	0.000	0.000	0.000	0.000	0.000

NO X3 CARD ON CROSS SECTION 9.0 BECAUSE OF HIGH SUBMERGENCE

NI	I 9.000	0.000	0.000	0.000	50.000	50.000	50.000	0.000	0.000	0.000
NC	0.000	0.000	.020	0.000	0.000	0.000	0.000	0.000	0.000	0.000

ABANDONED RAILROAD BRIDGE

NI	9.100	0.000	0.000	0.000	1.000	1.000	1.000	0.000	0.000	0.000
BT	18.000	1115.000	15.000	11.400	1131.000	15.000	11.400	1131.000	18.000	9.300
BT	1134.000	18.000	8.300	1134.000	15.000	11.400	1166.000	15.000	11.400	1166.000
BT	15.000	2.900	1169.000	15.000	-.900	1169.000	15.000	11.400	1194.000	18.000
BT	11.400	1194.000	15.000	-.600	1197.000	15.000	-.600	1197.000	15.000	11.400
BT	1223.000	15.000	11.400	1223.000	15.000	2.700	1226.000	15.000	2.700	1226.000
BT	15.000	11.400	1251.000	15.000	11.400	0.000	0.000	0.000	0.000	0.000
NI	9.200	0.000	0.000	0.000	10.000	10.000	10.000	0.000	0.000	0.000
X2	0.000	0.000	0.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000
NC	.500	.220	.040	0.000	0.000	0.000	0.000	0.000	0.000	0.000

HEC-2 DATED NOV 76 UPDATED JULY 1979
ERR - 01,02,03
MODIFICATION - 50,51,52,53

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

RIO PAJARDO

SUMMARY PRINTOUT TABLE 150

	NCENO	XLCH	ELTRD	ELLC	ELMIN	Q	CWSEL	CRIWS	EG	10K*S	VCH	AREA	.01R
	1.000	0.00	0.00	0.00	-8.00	22200.00	2.00	-5.24	2.00	.19	.59	72000.61	51479.20
A	1.000	0.00	0.00	0.00	-8.00	45100.00	2.00	-4.60	2.01	.77	1.19	72000.61	51479.20
	1.000	0.00	0.00	0.00	-8.00	56900.00	2.00	-4.39	2.01	1.22	1.50	72000.61	51479.20
	1.000	0.00	0.00	0.00	-8.00	80000.00	2.00	-4.02	2.02	2.42	2.11	72000.61	51479.20
	2.000	377.00	0.00	0.00	-7.00	22200.00	2.40	2.40	2.99	44.30	0.60	8267.07	3338.40
B	2.000	377.00	0.00	0.00	-7.00	45100.00	2.94	2.94	3.64	71.70	11.52	12424.60	5326.14
	2.000	377.00	0.00	0.00	-7.00	56900.00	3.20	3.20	3.93	77.76	12.20	14000.02	6492.63
	2.000	377.00	0.00	0.00	-7.00	80000.00	3.56	3.56	4.43	92.09	13.07	16047.78	8300.06
	3.000	2003.00	0.00	0.00	-10.13	22200.00	4.12	2.53	4.18	3.40	3.14	20361.07	18047.00
C	3.000	2003.00	0.00	0.00	-10.13	45100.00	5.30	3.14	5.37	4.79	4.02	29100.96	20607.40
	3.000	2003.00	0.00	0.00	-10.13	56900.00	5.75	3.27	5.82	5.45	4.49	32522.61	24377.67
	3.000	2003.00	0.00	0.00	-10.13	80000.00	6.52	3.68	6.61	6.42	4.98	38413.26	31579.29
	4.000	1004.00	0.00	0.00	-13.92	22200.00	4.38	4.18	5.03	40.43	11.98	10300.06	3491.48
D	4.000	1004.00	0.00	0.00	-13.92	45100.00	6.27	6.27	8.06	58.46	15.82	17200.82	6002.29
	4.000	1004.00	0.00	0.00	-13.92	56900.00	7.04	7.04	8.99	68.78	16.67	22920.80	7898.38
	4.000	1004.00	0.00	0.00	-13.92	80000.00	8.06	8.06	10.27	75.30	19.38	27825.11	9210.99
	5.000	807.00	0.00	0.00	-13.92	22200.00	6.87	5.35	7.60	16.03	8.98	14178.37	5615.99
E	5.000	807.00	0.00	0.00	-13.92	45100.00	9.67	7.74	10.58	20.57	10.99	23670.97	9044.15
	5.000	807.00	0.00	0.00	-13.92	56900.00	10.66	8.54	11.62	22.80	11.98	29020.76	11915.79
	5.000	807.00	0.00	0.00	-13.92	80000.00	12.45	9.79	13.50	25.32	13.39	37303.49	15897.01
	6.000	1197.00	0.00	0.00	-13.92	22200.00	8.88	4.06	9.66	15.48	9.10	10007.66	8040.07
F	6.000	1197.00	0.00	0.00	-13.92	45100.00	11.89	9.50	13.30	22.38	12.36	18108.71	9833.78
	6.000	1197.00	0.00	0.00	-13.92	56900.00	13.12	10.64	14.70	25.15	13.02	21430.01	11346.06
	6.000	1197.00	0.00	0.00	-13.92	80000.00	15.17	12.50	17.03	29.25	15.60	26900.71	14792.79
	7.000	1328.00	0.00	0.00	-4.40	22200.00	11.36	11.21	13.48	54.27	13.67	8360.04	3019.50
G	7.000	1328.00	0.00	0.00	-4.40	45100.00	15.28	14.57	16.99	42.60	14.63	17276.59	6918.30
	7.000	1328.00	0.00	0.00	-4.40	56900.00	16.75	15.54	18.28	38.77	14.88	22409.67	9137.48
	7.000	1328.00	0.00	0.00	-4.40	80000.00	19.49	16.96	20.00	32.14	14.82	32188.61	14111.18
	8.000	1640.00	0.00	0.00	-4.40	22200.00	16.83	12.67	17.47	18.20	9.27	6814.78	8499.07
H	8.000	1640.00	0.00	0.00	-4.40	45100.00	19.47	17.12	20.98	24.27	13.92	18397.85	9154.93
	8.000	1640.00	0.00	0.00	-4.40	56900.00	20.56	18.46	22.25	27.32	14.32	22644.28	10886.39
	8.000	1640.00	0.00	0.00	-4.40	80000.00	22.64	20.70	24.37	28.85	15.46	31288.88	14694.66

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HEC2-1        DATED NOV 76 UPDATED JULY1979
ERROR CORR -  01,02,03
MODIFICATION -  50,51,52,53
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0
T1      FLOOD INSURANCE STUDY
T2      100 YEAR FLOOD
T3      RIO PAJARDO

J1  ICHECK    INQ     NINV    IDIM    STRT    METRIC  HVINS   Q       WSEL    FQ
        0.      2.      0.      0.  0.000000    0.00    0.0     0.    10.660  0.000

J2  NPROF     IPLOT   PRFVS   XSECV   XSECH   FN      ALLDC   IBW     CHNIM   ITRACE
    0.000   0.000  -1.000   0.000   0.000   0.000  -1.000   0.000   0.000   0.000

J3  VARIABLE CODES FOR SUMMARY PRINTOUT
    010.000 200.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000

J5  LPRNT   NUMSEC                 ********REQUESTED SECTION NUMBERS********
    PRN.000 -10.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
J6      .220    .220    .040    .300    .500   0.000   0.000   0.000   0.000   0.000
GT    0.000  56900.000 80000.000 56900.000 96900.000   0.000   0.000   0.000   0.000   0.000
GT    0.000   0.000   0.100  98.000 3418.700   0.000   0.000   0.000   0.000   0.000

X1 E  0.000  21.000  58.000 202.000   0.000   0.000   0.000   0.000   0.000   0.000
GR   32.000   0.000  18.400  33.000   3.300  82.000   2.120  98.000  -.180 102.000
GR  -13.220 -112.000 -18.220 151.000  -7.380 189.000  -4.000 194.000  -.680 199.000
GR    2.120 202.000   3.300 344.000   4.600 820.000   4.900 1082.000   4.900 1730.000
GR    3.300 2427.000  2.600 3214.000  3.300 4116.000  16.400 4297.000  32.800 4420.000
GR   49.200 4477.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
GT    0.000   0.000   0.100 164.000 2103.160   0.000   0.000   0.000   0.000   0.000

X1 F  0.000  26.000 144.000 266.000 1115.000 1115.000 1197.000   0.000   0.000   0.000
GR   32.800   0.000  18.400  98.000   2.120 164.000  -.180 168.000 -13.920 170.000
GR  -18.220 217.000 -7.380 255.000  -4.000 240.000  -.656 265.000   2.120 268.000
GR    3.300 312.000   3.300 918.000   5.000 1443.000   6.400 1771.000   6.600 2493.000
GR    9.800 2824.000 13.100 2700.000  16.400 2821.000  32.800 2886.000  49.500 2935.000
GT    0.000   0.000   0.100 230.000 2176.360   0.000   0.000   0.000   0.000   0.000

X1 G  7.000  23.000 230.000 329.000 1345.000  984.000 1328.000   0.000   0.000   0.000
GR   24.600   0.000  23.000  16.000  19.700  86.000  16.400 131.000  13.100 140.000
GR    9.800 197.000   8.500 230.000   0.000 246.000  -.400 247.000  -1.400 287.000
GR   -4.400 289.000  -3.850 303.000  -.250 313.000   8.400 329.000   6.600 329.000
GR    0.200 1443.000 13.100 2099.000 13.100 2460.000 13.100 3378.000 13.100 3474.000
GR   16.400 3723.000 32.800 3854.000 49.200 4133.000   0.000   0.000   0.000   0.000
GT    0.000   0.000   0.100 941.430 2533.420   0.000   0.000   0.000   0.000   0.000

X1 H  0.000  24.000 885.000 984.000 853.000 787.000 1648.000   0.000   0.000   0.000
GR   49.200   0.000  32.800 164.000  29.500 197.000  23.000 230.000  19.700 262.000
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HECR RELEASE DATED NOV 76 UPDATED JULY1979
ERROR CORR - 01,02,03
MODIFICATION - 50,51,52,53

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

RIO PAJARDO

SUMMARY PRINTOUT TABLE 110

	SECNO	CWSEL	DIFKWS	EG	TOPWID	GLOB	OCH	QROB	PERENC	STENCL	STCHL	STCHR	STENCR
E	5.000	10.68	0.00	11.62	4163.22	239.42	24183.89	32476.68	0.00	0.00	98.00	202.00	0.00
	5.000	11.66	1.00	12.61	3320.70	0.00	24936.09	31963.90	3320.70	98.00	98.00	202.00	3418.70
F	6.000	13.12	0.00	14.70	2474.98	290.35	30955.58	25654.06	0.00	0.00	164.00	240.00	0.00
	6.000	14.14	1.03	15.52	2019.16	0.00	30436.24	26463.76	2019.16	164.00	164.00	240.00	2183.16
G	7.000	16.78	0.00	18.28	3601.39	759.49	25379.52	30760.99	0.00	0.00	230.00	329.00	0.00
	7.000	17.56	.81	19.17	1946.36	0.00	26582.09	30317.11	1946.36	230.00	230.00	329.00	2176.36
H	8.000	20.86	0.00	22.25	4119.46	3818.19	29898.81	23186.00	0.00	0.00	884.00	984.00	0.00
	8.000	21.57	.01	23.03	1991.99	3248.27	30515.14	23136.60	1991.99	841.43	884.00	984.00	2833.42
	8.800	23.27	0.00	23.85	4805.94	1348.67	25018.06	30535.28	0.00	0.00	1115.00	1251.00	0.00
	8.800	23.99	.72	24.61	2455.10	0.00	26195.06	30704.14	2455.10	1115.00	1115.00	1251.00	3870.10
I	9.000	23.35	0.00	23.92	4823.14	1368.95	24880.23	30658.01	0.00	0.00	1115.00	1281.00	0.00
	9.000	24.07	.72	24.68	2455.10	0.00	26095.09	30884.11	2455.10	1115.00	1115.00	1251.00	3870.10
	9.100	23.35	0.00	23.96	4886.28	1629.40	19120.36	36194.24	0.00	0.00	1115.00	1281.00	0.00
	9.100	24.25	.70	24.72	2522.56	0.00	20546.42	36353.98	2522.56	1115.00	1115.00	1281.00	3837.56
	9.200	23.87	0.00	23.90	4860.94	1627.50	19105.37	36167.13	0.00	0.00	1115.00	1281.00	0.00
	9.200	24.27	.70	24.74	2520.72	0.00	20543.28	36356.71	2520.72	1115.00	1115.00	1281.00	3839.72
J	9.300	23.80	0.00	24.05	4849.03	1382.74	24668.66	30848.61	0.00	0.00	1115.00	1281.00	0.00
	9.300	24.21	.71	24.80	2472.20	0.00	25864.98	31035.02	2472.20	1115.00	1115.00	1251.00	3987.20
	9.500	23.58	0.00	24.11	4863.41	1393.47	24961.91	30944.42	0.00	0.00	1115.00	1281.00	0.00
	9.500	24.29	.71	24.87	2472.20	0.00	25783.83	31116.17	2472.20	1115.00	1115.00	1281.00	3987.20
K	10.000	25.40	0.00	25.86	4802.21	7896.65	15531.04	33472.91	0.00	0.00	1489.00	1771.00	0.00
	10.000	26.17	.77	26.76	2950.31	5572.65	17494.69	33832.46	2950.31	1238.00	1489.00	1771.00	4197.10
	10.500	26.15	0.00	26.95	4237.79	4502.56	24534.19	27783.23	0.00	0.00	1415.00	1946.00	0.00
	10.500	26.99	.85	27.78	2978.77	3640.91	25153.02	28106.07	2978.77	959.84	1415.00	1946.00	3938.61
L	11.000	26.29	0.00	27.06	4269.95	4639.31	24294.77	27965.92	0.00	0.00	1415.00	1946.00	0.00
	11.000	27.12	.82	27.88	2978.77	3676.06	24990.40	28233.55	2978.77	959.84	1415.00	1946.00	3938.61

Appendix C

Input Data and Results from HEC-2 Duplicate Effective Model

APPENDIX C INPUT DATA AND RESULTS FROM HEC-2 DUPLICATE EFFECTIVE MODEL

```
1*****************************************
*************************************
 *  HEC-2 WATER SURFACE PROFILES                    *
ENGINEERS        *                                  *
 *                                                  *
CENTER       *                                      *
 *  Version    4.6.2;  May 1991                     *
SUITE D          *                                  *
 *                                                  *
95616-4687        *                                 *
 *  RUN DATE     29MAY01     TIME    18:48:37       *
*
 ****************************************
************************************
```

```
*  U.S. ARMY CORPS OF
*  HYDROLOGIC ENGINEERING
*  609 SECOND STREET,
*  DAVIS, CALIFORNIA
*           (916) 756-1104
```

```
X     X  XXXXXXX   XXXXX                 XXXXX
X     X  X        X     X              X     X
X     X  X        X                          X
XXXXXXX  XXXX     X           XXXXX     XXXXX
X     X  X        X                    X
X     X  X        X     X              X
X     X  XXXXXXX   XXXXX                XXXXXXX
```

```
1
    29MAY01        18:48:37
1
```

PAGE

18:48:37 THIS RUN EXECUTED 29MAY01

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

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


T1       Flood insurance study
T2            100 YEAR FLOOD
T3       RIO FAJARDO   EFFECTIVE MODEL 0105EFF

J1  ICHECK    INQ       NINV      IDIR      STRT      METRIC    HVINS     Q         WSEL      FQ

     -1        2         0         0         0         0         0         0        7.87       0

J2  NPROF     IPLOT     PRFVS     XSECV     XSECH     FN        ALLDC     IBW       CHNIM     ITRACE

     -1        0        -1         0         0         0        -1         0         0         0


J3  VARIABLE CODES FOR SUMMARY PRINTOUT

      0       150       200         0         0         0         0         0         0         0

NC    .080      .08       .04       .3        .5         0         0         0         0         0
QT       2    56900     56900        0         0         0         0         0         0         0
ET                       10.4
            CR-SEC I IS TAKEN ON THE SEA A FEW FEET FROM THE COAST
X1       1       14      3411      3772         0         0         0         0         0         0
GR    16.4        0       1.6       320      -6.5       656      -4.5      2296        -5      3411
GR      -5     3772      -6.5      5084        -8      5576      -6.5      6232      -2.5      6888
GR      -6     8856      -3.5     10332       3.3     10760      16.4     10820

NC      .5      .055
            CR-SEC2 AND 3 DENSELY POPULATED ON LEFT OVERBANK
X1       2       26      3542      3699       377       377       377
GR      B2        0      65.6        90      49.2       164      32.8       197      16.4       262
GR     3.3     1410       1.6      2165       2.6      2086       1.6      3477       1.8      3542
GR     .07     3563     -6.33      3588     -7.08      3629     -6.23      3669     -3.15      3679
GR     .07     3689      1.75      3699       1.6      4133         1      5346         1      7216
```

```
GR      1.6       9184       3.3      10200       6.6      10234       9.8      10266     13.10      10300
GR    16.40      10316

X1        3         25      1140       1286       787       1050      2083
GR     98.4          0        82         33      65.6         49      49.2         02      32.8        131
GR     16.4        180       3.3        853         2       1148      -.06       1161    -10.13       1178
GR    -8.65       1218     -6.79       1257     -3.56       1272       .01       1279      1.94       1286
GR        1       2788       1.3       3280         2       4590         1       5900       1.6       8040
GR      3.3       8266       6.6       8200       9.8       8298     13.10       8331     16.40       8364
1
    29MAY01      10:48:37                                                                                PAGE
2


NC      .22        .22
X1        4         21        377        471      1797        722      1804
GR    32.80          0       16.4         33      3.30        328      2.12        377      -.18        381
GR   -13.92        391     -10.22        420     -7.35        458        -4        463      -.65        468
GR     2.12        471       3.30        590      4.60        722      4.30       1640      3.30       2066
GR        2       2624          1       3280         1       4756       3.3       5035      16.4       5100
GR     32.8       5150

X1        5         21         98        202       525        771       607
GR    32.80          0       16.4         33       3.3         82      2.12         98      -.18        102
GR   -13.92        112     -10.22        151     -7.35        189        -4        194      -.65        199
GR     2.12        202       3.3        344       4.6        820      4.90       1082      4.90       1738
GR      3.3       2427       2.6       3214       3.3       4116      16.4       4297      32.8       4428
GR     49.2       4477
1
    29MAY01      10:48:37                                                                                PAGE
3


     SECNO     DEPTH     CWSEL     CRIWS     WSELK     EG        HV        HL        OLOSS     L-BANK ELEV
     Q         QLOB      QCH       QROB      ALOB      ACH       AROB      VOL       TWA       R-BANK ELEV
     TIME      VLOB      VCH       VROB      XNL       XNCH      XNR       WTN       ELMIN     SSTA
     SLOPE     XLOBL     XLCH      XLOBR     ITRIAL    IDC       ICONT     CORAR     TOPWID    ENDST

 *PROF 1
```

```
CRITICAL DEPTH TO BE CALCULATED AT ALL CROSS SECTIONS
0

CCHV=      .300 CEHV=      .500
*SECNO 1.000
     1.000     15.87      7.87     -4.35      7.87      7.87       .00       .00       .00     -5.00
   56900.0   16234.0    3821.8   36844.1   39818.7    4646.1   89280.2        .0        .0     -5.00
       .08       .41       .82       .41      .080      .040      .080      .000     -8.00    189.04
   .000016        0.        0.        0.         0        15         0       .00  10591.09  10780.93

*SECNO 2.000

3302 WARNING:  CONVEYANCE CHANGE OUTSIDE OF ACCEPTABLE RANGE,  KRATIO =   .31

     2.000     14.95      7.87      3.19       .00      7.90       .03       .01       .01      1.80
   56900.0    1524.7    4689.3   50686.0   12994.0    1889.5   42088.9     825.3      85.8      1.75
       .08       .12      2.48      1.20      .500      .040      .055      .000     -7.08   1008.98
   .000165      377.      377.      377.         0        21         0       .00   9237.78  10246.76

*SECNO 3.000
     3.000     18.18      8.05      3.37       .00      8.07       .03       .17       .00      2.00
   56900.0     209.1    4897.6   51793.3    2170.4    1944.3   45974.8    2115.3     283.9      1.94
       .34       .10      2.52      1.13      .500      .040      .055      .000    -10.13    609.18
   .000141      787.     2083.     1050.         2        19         0       .00   7678.96   8200.13

*SECNO 4.000

3301 HV CHANGED MORE THAN HVINS

3302 WARNING:  CONVEYANCE CHANGE OUTSIDE OF ACCEPTABLE RANGE,  KRATIO =   .18

     4.000     21.75      7.83      6.96       .00      9.08      1.24       .40       .61      2.12
   56900.0     502.8   21843.2   34554.0     483.9    1525.5   24759.4    2828.1     399.0      2.12
       .38      1.04     14.32      1.40      .220      .040      .220      .000    -13.92    225.70
   .004194     1797.     1804.      722.         2        12         0       .00   4831.84   5057.54

1
```

SECNO	DEPTH	CWSEL	CRIWS	WSELK	EG	HV	HL	OLOSS	L-BANK ELEV
Q	QLOB	QCH	QROB	ALOB	ACH	AROB	VOL	TWA	R-BANK ELEV
TIME	VLOB	VCH	VROB	XNL	XNCH	XNR	WTN	ELMIN	SSTA
SLOPE	XLOBL	XLCH	XLOBR	ITRIAL	IDC	ICONT	CORAR	TOPWID	ENDST
*SECNO 5.000									
5.000	24.22	10.30	8.58	.00	11.40	1.10	2.29	.04	2.12
56900.0	231.9	24998.2	31669.8	212.8	1979.4	26091.4	3306.8	477.6	2.12
.41	1.09	12.63	1.21	.220	.040	.220	.000	-13.92	55.84
.002600	525.	607.	771.	3	9	0	.00	4156.77	4212.61

THIS RUN EXECUTED 29MAY01

18:40:37

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

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

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

RIO FAJARDO EFFECTIVE

SUMMARY PRINTOUT TABLE 150

SECNO	XLCH	ELTRD	ELLC	ELMIN	Q	CWSEL	CRIWS	EG	10*KS	VCH	AREA	.01K

	1.000	.00	.00	.00	-8.00	56900.00	7.87	-4.35	7.87	.16	.02	133744.90	141137.30
*	2.000	377.00	.00	.00	-7.08	56900.00	7.87	3.19	7.90	1.65	2.40	56972.37	44357.41
	3.000	2083.00	.00	.00	-10.13	56900.00	8.05	3.37	8.07	1.41	2.52	50089.48	47929.03
*	4.000	1804.00	.00	.00	-13.92	56900.00	7.83	6.96	9.08	41.94	14.32	26768.73	8786.64
	5.000	607.00	.00	.00	-13.92	56900.00	10.30	8.58	11.40	26.00	12.63	28283.55	11158.28

RIO FAJARDO EFFECTIVE

SUMMARY PRINTOUT TABLE 150

	SECNO	Q	CWSEL	DIFWSP	DIFWSX	DIFKWS	TOPWID	XLCH
	1.000	56900.00	7.87	.00	.00	.00	10591.89	.00
*	2.000	56900.00	7.87	.00	.00	.00	9237.78	377.00
	3.000	56900.00	8.05	.00	.17	.00	7678.96	2083.00
*	4.000	56900.00	7.83	.00	-.21	.00	4831.84	1804.00
	5.000	56900.00	10.30	.00	2.47	.00	4156.77	607.00

SUMMARY OF ERRORS AND SPECIAL NOTES

```
WARNING SECNO=      2.000  PROFILE=  1  CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE

WARNING SECNO=      4.000  PROFILE=  1  CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE
```

APPENDIX D

INPUT DATA AND RESULTS FROM HEC-2 CORRECTED MODEL

```
1*****************************************
*************************************
 *  HEC-2 WATER SURFACE PROFILES            *                                  *  U.S. ARMY CORPS OF
ENGINEERS       *
 *                                          *                                  *  HYDROLOGIC ENGINEERING
CENTER      *
 *  Version   4.6.2;  May 1991              *                                  *  609 SECOND STREET,
SUITE D         *
 *                                          *                                  *  DAVIS, CALIFORNIA
95616-4687       *
 *  RUN DATE    29MAY01    TIME   10:48:44  *                                  *          (916) 756-1104
*
 *****************************************
*************************************

                                          X     X  XXXXXXX   XXXXX              XXXXX
                                          X     X  X        X     X            X     X
                                          X     X  X        X                        X
                                          XXXXXXX  XXXX     X          XXXXX    XXXXX
                                          X     X  X        X                  X
                                          X     X  X        X     X            X
                                          X     X  XXXXXXX   XXXXX             XXXXXXX
1
    29MAY01      10:48:44                                                                                    PAGE
1
```

```
18:48:44                                                                THIS RUN EXECUTED 29MAY01
 ************************************
  HEC-2 WATER SURFACE PROFILES

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


 T1       Flood insurance study
 T2            100 YEAR FLOOD
 T3       RIO FAJARDO   corrected MODEL 0105corr.dat

 J1  ICHECK    INQ       NINV      IDIR      STRT      METRIC    HVINS     Q         WSEL      FQ

       -1        2         0         0         0         0         0         0       7.87        0

 J2  NPROF     IPLOT     PRFVS     XSECV     XSECH     FN        ALLDC     IBW       CHNIM     ITRACE

       -1        0        -1         0         0         0        -1         0         0         0


 J3  VARIABLE CODES FOR SUMMARY PRINTOUT

       0       150       200         0         0         0         0         0         0         0

 NC     .080       .08       .04        .3        .5         0         0         0         0         0
 QT        2     56900     56900         0         0         0         0         0         0         0
 *T                        10.4
              CR-SEC I IS TAKEN ON THE SEA A FEW FEET FROM THE COAST
 X1        1        14      3411      3772         0         0         0         0         0         0
 GR     16.4         0       1.6       328      -6.5       656      -4.5      2296        -5      3411
 GR       -5      3772      -6.5      5084        -8      5576      -6.5      6232      -2.5      6888
 GR       -6      8856      -3.5     10332       3.3     10760      16.4     10820
                                       :
 NC       .5      .055
              INT. CROS SECTION 1.25  DS END OF PROJECT
 X1     1.25        32      3542      3699       302       302       302
 GR       82         0      65.6        98      49.2       164      32.8       197      16.4       262
 GR      3.3      1410      4.36      1476      4.26      1603      4.26      1603      4.10      1932
 GR     4.10      1932       4.1      2014       1.6      2165       2.6      2806       1.6      3477
```

```
GR      1.8       3542       .07       3563      -6.33      3580      -7.08      3629      -6.23      3669
GR    -3.15       3679       .07       3689       1.75      3699       1.6       4133         1       5346
GR        1       7216      1.60       9184        3.3     10200       6.6      10234       9.8      10266
GR    13.10      10300     16.40      10316

            CR-SEC2 AND 3 DENSELY POPULATED ON LEFT OVERBANK
            PROJECT IS LOCATED BET. GR1476 AND GR2014

X1        2         32       3542       3699        75        75        75
GR       82          0       65.6         98      49.2       164      32.8       197       16.4       262
GR      3.3       1410       4.36       1476      4.26      1603      4.26      1603       4.10      1932
GR     4.10       1932        4.1       2014       1.6      2165       2.6      2886        1.6      3477
GR      1.8       3542        .07       3563     -6.33      3580     -7.08      3629      -6.23      3669
GR    -3.15       3679        .07       3689      1.75      3699       1.6      4133         1       5346
GR        1       7216       1.60       9184       3.3     10200       6.6      10234       9.8      10266
1
   29MAY01      10:48:44                                                                                PAGE
2

GR    13.10      10300      16.40      10316
            INT. CROSS SECTION 2.75  US END OF PROJECT

X1     2.75         37       3542       3699        45        45        45
GR       82          0       65.6         98      49.2       164      32.8       197       16.4       262
GR      3.3       1410        3.3       1476      6.07      1603      6.07      1603       6.56      1623
GR     6.56       1715        4.1       1761       4.1      1800      4.10      1900       4.10      1932
GR     4.10       1932       3.54       2014       1.6      2165       2.6      2886        1.6      3477
GR      1.8       3542        .07       3563     -6.33      3580     -7.08      3629      -6.23      3669
GR    -3.15       3679        .07       3689      1.75      3699       1.6      4133         1       5346
GR        1       7216       1.60       9184       3.3     10200       6.6      10234       9.8      10266
GR    13.10      10300      16.40      10316

X1        3         25       1148       1286       742      1005      2038
GR     98.4          0         82         33      65.6        49      49.2         82      32.8       131
GR     16.4        180        3.3        853         2      1148      -.06       1161    -10.13      1178
GR    -8.65       1218      -6.79       1257     -3.56      1272       .01       1279      1.94      1286
GR        1       2788        1.3       3280         2      4590         1       5900       1.6      8040
GR      3.3       8266        6.6       8280       9.8      8298     13.10       8331     16.40      8364

NC      .22        .22
X1        4         21        377        471      1797       722      1804
```

```
GR     32.80          0       16.4        33       3.30       328       2.12       377       -.10       381
GR    -13.92        391     -10.22       420      -7.35       458         -4       463       -.65       468
GR      2.12        471       3.30       590       4.60       722       4.30      1640       3.30      2066
GR         2       2624          1      3280          1      4756        3.3      5035       16.4      5100
GR      32.8       5150

X1         5         21         98       202        525       771        607
GR     32.80          0       16.4        33        3.3        82       2.12        98       -.10       102
GR    -13.92        112     -10.22       151      -7.35       189         -4       194       -.65       199
GR      2.12        202        3.3       344        4.6       820       4.90      1082       4.90      1738
GR       3.3       2427        2.6      3214        3.3      4116       16.4      4297       32.8      4428
GR      49.2       4477
1
    29MAY01      10:48:44                                                                                PAGE
3


     SECNO      DEPTH      CWSEL      CRIWS      WSELK      EG         HV         HL         OLOSS      L-BANK ELEV
     Q          QLOB       QCH        QROB       ALOB       ACH        AROB       VOL        TWA        R-BANK ELEV
     TIME       VLOB       VCH        VROB       XNL        XNCH       XNR        WTN        ELMIN      SSTA
     SLOPE      XLOBL      XLCH       XLOBR      ITRIAL     IDC        ICONT      CORAR      TOPWID     ENDST

 *PROF 1

 CRITICAL DEPTH TO BE CALCULATED AT ALL CROSS SECTIONS
0

 CCHV=      .300 CEHV=      .500
 1340 CARD NOT RECOGNIZED OR CARD OUT OF ORDER
 *T       .0000      .0000    10.4000      .0000      .0000      .0000      .0000      .0000      .0000      .0000
 *SECNO 1.000
      1.000     15.87      7.87     -4.35      7.87      7.87       .00       .00       .00     -5.00
    56900.0   16234.0    3821.8   36044.1   39818.7    4646.1   89280.2        .0        .0     -5.00
       .00       .41       .82       .41      .080      .040      .080      .000     -8.00    189.04
   .000016        0.        0.        0.         0        15         0       .00  10591.89  10780.93


 *SECNO 1.250

 3302 WARNING:  CONVEYANCE CHANGE OUTSIDE OF ACCEPTABLE RANGE,  KRATIO =    .31
```

```
     1.250      14.95       7.87       3.20        .00       7.90        .03        .01        .01       1.80
   56900.0     1337.3     4705.8    50856.9   11890.8     1089.3    42080.9      657.3      60.7       1.75
       .07        .11       2.49       1.21       .500       .040       .055       .000      -7.08    1009.08
   .000166       302.       302.       302.          0         21          0        .00    9237.66   10246.75

*SECNO 2.000
     2.000      14.96       7.88       3.26        .00       7.91        .03        .01        .00       1.80
   56900.0     1337.4     4705.4    50857.3   11900.7     1089.4    42085.9      753.5      84.6       1.75
       .08        .11       2.49       1.21       .500       .040       .055       .000      -7.08    1009.02
   .000166        75.        75.        75.          0         17          0        .00    9237.74   10246.76

*SECNO 2.750
     2.750      14.97       7.89       3.27        .00       7.92        .03        .01        .00       1.80
   56900.0     1314.3     4700.6    50885.1   11685.5     1891.5    42171.5      811.1      94.2       1.75
       .09        .11       2.49       1.21       .500       .040       .055       .000      -7.08    1007.87
   .000165        45.        45.        45.          0         17          0        .00    9239.02   10246.89

*SECNO 3.000
     3.000      18.19       8.06       3.37        .00       8.08        .03        .17        .00       2.00
   56900.0      209.4     4891.4    51799.3    2176.0     1945.7    46047.2     2036.6     283.6       1.94
       .33        .10       2.51       1.12       .500       .040       .055       .000     -10.13     608.64
   .000140        742.      2038.      1005.          2         19          0        .00    7679.55    8288.19

1
   29MAY01      18:48:44                                                                                    PAGE
4

    SECNO      DEPTH      CWSEL      CRIWS      WSELK      EG         HV         HL         OLOSS      L-BANK ELEV
    Q          QLOB       QCH        QROB       ALOB       ACH        AROB       VOL        TWA        R-BANK ELEV
    TIME       VLOB       VCH        VROB       XNL        XNCH       XNR        WTN        ELMIN      SSTA
    SLOPE      XLOBL      XLCH       XLOBR      ITRIAL     IDC        ICONT      CORAR      TOPWID     ENDST

*SECNO 4.000

3301 HV CHANGED MORE THAN HVINS
```

3302 WARNING: CONVEYANCE CHANGE OUTSIDE OF ACCEPTABLE RANGE, KRATIO = .10

4.000	21.77	7.85	6.96	.00	9.08	1.23	.39	.60	2.12
56900.0	503.9	21813.4	34582.7	485.6	1526.6	24811.8	2750.7	398.7	2.12
.38	1.04	14.29	1.39	.220	.040	.220	.000	-13.92	225.44
.004172	1797.	1804.	722.	2	12	0	.00	4832.15	5057.60

*SECNO 5.000

5.000	24.22	10.30	8.58	.00	11.40	1.10	2.28	.04	2.12
56900.0	231.9	25004.3	31663.8	212.7	1979.1	26080.8	3229.7	477.3	2.12
.41	1.09	12.63	1.21	.220	.040	.220	.000	-13.92	55.85
.002603	525.	607.	771.	3	9	0	.00	4156.72	4212.58

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29MAY01 10:48:44 PAGE
5

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10:48:44
****
HEC-2 WATER SURFACE PROFILES

Version 4.6.2; May 1991
****

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

RIO FAJARDO corrected

SUMMARY PRINTOUT TABLE 150

SECNO	XLCH	ELTRD	ELLC	ELMIN	Q	CWSEL	CRIWS	EG	10*KS	VCH	AREA	.01K
1.000	.00	.00	.00	-8.00	56900.00	7.87	-4.35	7.87	.16	.82	133744.90	141137.30

*	1.250	302.00	.00	.00	-7.08	56900.00	7.87	3.20	7.90	1.66	2.49	55868.94	44194.45
	2.000	75.00	.00	.00	-7.08	56900.00	7.88	3.26	7.91	1.66	2.49	55875.95	44202.83
	2.750	45.00	.00	.00	-7.08	56900.00	7.89	3.27	7.92	1.65	2.49	55748.43	44327.55
	3.000	2038.00	.00	.00	-10.13	56900.00	8.06	3.37	8.08	1.40	2.51	50168.88	48049.05
*	4.000	1804.00	.00	.00	-13.92	56900.00	7.85	6.96	9.08	41.72	14.29	26823.94	8808.99
	5.000	607.00	.00	.00	-13.92	56900.00	10.30	8.58	11.40	26.03	12.63	28272.54	11152.97

1

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RIO FAJARDO corrected

SUMMARY PRINTOUT TABLE 150

	SECNO	Q	CWSEL	DIFWSP	DIFWSX	DIFKWS	TOPWID	XLCH
	1.000	56900.00	7.87	.00	.00	.00	10591.89	.00
*	1.250	56900.00	7.87	.00	.00	.00	9237.66	302.00
	2.000	56900.00	7.88	.00	.01	.00	9237.74	75.00
	2.750	56900.00	7.89	.00	.01	.00	9239.02	45.00
	3.000	56900.00	8.06	.00	.17	.00	7679.55	2038.00
*	4.000	56900.00	7.85	.00	-.21	.00	4832.15	1804.00
	5.000	56900.00	10.30	.00	2.45	.00	4156.72	607.00

1

29MAY01 18:48:44 PAGE

7

Appendix E

Input Data and Results from HEC-2 Proposed Model

SUMMARY OF ERRORS AND SPECIAL NOTES

```
WARNING SECNO=      1.250  PROFILE=  1  CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE

WARNING SECNO=      4.000  PROFILE=  1  CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE
```

Appendix E Input Data and Results from HEC-2 Proposed Model

```
*****************************************************
*************************************
 *  HEC-2 WATER SURFACE PROFILES            *                                          *  U.S. ARMY CORPS OF
ENGINEERS        *
 *                                          *                                          *  HYDROLOGIC ENGINEERING
CENTER       *
 *  Version   4.6.2;  May 1991              *                                          *  609 SECOND STREET,
SUITE D          *
 *                                          *                                          *  DAVIS, CALIFORNIA
95616-4687        *
 *  RUN DATE    30MAY01    TIME   12:07:26  *                                          *          (916) 756-1104
*
 ******************************************
*************************************
```

```
X     X  XXXXXXX   XXXXX              XXXXX
X     X  X        X     X            X     X
X     X  X        X                        X
XXXXXXX  XXXX     X          XXXXX    XXXXX
X     X  X        X                  X
X     X  X        X     X            X
X     X  XXXXXXX   XXXXX             XXXXXXX
```

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12:07:26
 ************************************
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```
HEC-2 WATER SURFACE PROFILES

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


T1      Flood insurance study
T2           100 YEAR FLOOD
T3      RIO FAJARDO   project  MODEL 0105prj.dat

J1  ICHECK    INQ       NINV      IDIR      STRT      METRIC    HVINS     Q         WSEL      FQ

     -1        2         0         0         0         0         0         0        7.87       0

J2  NPROF     IPLOT     PRFVS     XSECV     XSECH     FN        ALLDC     IBW       CHNIM     ITRACE

     -1        0        -1         0         0         0        -1         0         0         0


J3  VARIABLE CODES FOR SUMMARY PRINTOUT

     0       150       200         0         0         0         0         0         0         0

NC    .080      .08       .04       .3        .5        0         0         0         0         0
QT      2    56900     56900        0         0        0         0         0         0         0
ET                       4.1       799      9957
             CR-SEC 1 IS TAKEN ON THE SEA A FEW FEET FROM THE COAST
X1      1       14      3411      3772         0        0         0         0         0         0
GR   16.4        0       1.6       328      -6.5      656      -4.5      2296        -5      3411
GR     -5     3772      -6.5      5084        -8     5576      -6.5      6232      -2.5      6888
GR     -6     8856      -3.5     10332       3.3    10760      16.4     10820

NC    .50     .055
NH      5      .50      1476       .02      1603       .5      3542      .040      3699      .055
NH  10316
ET                       4.1      3542      8023
            INT. CROS SECTION 1.25  DS END OF PROJECT
            PROJECT IS LOCATED BET. GR1476 AND GR2014
X1   1.25       32      3542      3699       302      302       302
GR     82        0      65.6        98      49.2      164      32.8       197      16.4       262
GR    3.3     1410      4.36      1476      4.26     1603     10.00      1603     10.00      1932
GR  10.00     2014       4.1      2014       1.6     2165       2.6      2886       1.6      3477
```

```
GR      1.8       3542       .07       3563      -6.33      3588      -7.08      3629      -6.23      3669
GR    -3.15       3679       .07       3689       1.75      3699       1.6       4133        1        5346
GR        1       7216      1.60       9184        3.3     10200       6.6      10234       9.8      10266
GR    13.10      10300     16.40      10316

NH        5        .50      1476        .02       1603        .5       3542       .040       3699       .055
NH    10316
ET                          4.1       3542       8630
            CR-SEC2 AND 3 DENSELY POPULATED ON LEFT OVERBANK
            PROJECT IS LOCATED BET. GR1476 AND GR2014
1
   30MAY01      12:07:26                                                                                  PAGE
2

X1        2         32      3542       3699         75         75         75
GR       82          0      65.6         98       49.2        164       32.8        197       16.4        262
GR      3.3       1410      4.36       1476       4.26       1603      10.00       1603      10.0       1932
GR    10.00       2014       4.1       2014        1.6       2165        2.6       2886       1.6       3477
GR      1.8       3542       .07       3563      -6.33       3588      -7.08       3629      -6.23       3669
GR    -3.15       3679       .07       3689       1.75       3699       1.6       4133        1        5346
GR        1       7216      1.60       9184        3.3     10200       6.6      10234       9.8      10266
GR    13.10      10300     16.40      10316
            INT. CROSS SECTION 2.75  US END OF PROJECT
            PROJECT IS LOCATED BET. GR1476 AND GR2014

ET                          4.1       3542       8705
NH        5        .50      1476        .02       1603        .5       3542       .040       3699       .055
NH    10316
X1     2.75         37      3542       3699         45         45         45
GR       82          0      65.6         98       49.2        164       32.8        197       16.4        262
GR      3.3       1410       3.3       1476       6.07       1603      10.00       1603      10.00       1623
GR    10.00       1715      10.0       1761       10.0       1800       10.0       1900       10.0       1932
GR    10.00       2014      3.54       2014        1.6       2165        2.6       2886       1.6       3477
GR      1.8       3542       .07       3563      -6.33       3588      -7.08       3629      -6.23       3669
GR    -3.15       3679       .07       3689       1.75       3699       1.6       4133        1        5346
GR        1       7216      1.60       9184        3.3     10200       6.6      10234       9.8      10266
GR    13.10      10300     16.40      10316

ET                          4.1       1148       7391
NC      .50       .055       .04         .3         .5
X1        3         25      1148       1286        742       1005       2038
```

```
GR      98.4        0       82       33     65.6       49     49.2       82     32.8      131
GR      16.4      180      3.3      853        2     1148     -.06     1161   -10.13     1178
GR     -8.65     1218    -6.79     1257    -3.56     1272      .01     1279     1.94     1286
GR         1     2700      1.3     3280        2     4590        1     5900      1.6     8040
GR       3.3     8266      6.6     8280      9.8     8298    13.10     8331    16.40     8364

NC       .22      .22
ET                          4.1      377     4634
X1         4       21      377      471     1797      722     1804
GR     32.80        0     16.4       33     3.30      320     2.12      377     -.18      381
GR    -13.92      391   -10.22      420    -7.35      450       -4      463     -.65      460
GR      2.12      471     3.30      590     4.60      722     4.30     1640     3.30     2066
GR         2     2624        1     3280        1     4756      3.3     5035     16.4     5100
GR      32.8     5150

ET                          4.1       98    3410.7
X1         5       21       98      202      525      771      607
GR     32.80        0     16.4       33      3.3       82     2.12       98     -.10      102
GR    -13.92      112   -10.22      151    -7.35      189       -4      194     -.65      199
GR      2.12      202      3.3      344      4.6      820     4.90     1082     4.90     1730
GR       3.3     2427      2.6     3214      3.3     4116     16.4     4297     32.8     4420
GR      49.2     4477
1
   30MAY01      12:07:26                                                                  PAGE
3

     SECNO      DEPTH      CWSEL      CRIWS      WSELK      EG         HV         HL         OLOSS      L-BANK ELEV
     Q          QLOB       QCH        QROB       ALOB       ACH        AROB       VOL        TWA        R-BANK ELEV
     TIME       VLOB       VCH        VROB       XNL        XNCH       XNR        WTN        ELMIN      SSTA
     SLOPE      XLOBL      XLCH       XLOBR      ITRIAL     IDC        ICONT      CORAR      TOPWID     ENDST

 *PROF 1

 CRITICAL DEPTH TO BE CALCULATED AT ALL CROSS SECTIONS
0

 CCHV=      .300 CEHV=      .500
 *SECNO 1.000
      1.000     15.87      7.87     -4.35      7.87      7.87       .00       .00       .00     -5.00
    56900.0   16234.0    3821.0   36844.1   39810.7    4646.1   89280.2        .0        .0     -5.00
```

```
     .00        .41        .82        .41       .080       .040       .080       .000      -0.00     189.04
 .000016         0.         0.         0.          0         15          0        .00   10591.89   10780.93


1490 NH CARD USED
*SECNO 1.250

3265 DIVIDED FLOW


3302 WARNING:  CONVEYANCE CHANGE OUTSIDE OF ACCEPTABLE RANGE,  KRATIO =   .32

    1.250      14.95       7.87       3.20        .00       7.90        .03        .01        .01       1.80
 56900.0     2117.4     4639.7    50142.9    10373.6     1889.3    42080.9      652.0       67.3       1.75
     .07        .20       2.46       1.19       .278       .040       .055       .000      -7.08    1009.08
 .000161       302.       302.       302.          0         21          0        .00    8826.66   10246.75


1490 NH CARD USED
*SECNO 2.000

3265 DIVIDED FLOW

    2.000      14.96       7.88       3.27        .00       7.91        .03        .01        .00       1.80
 56900.0     2117.7     4639.1    50143.2    10375.9     1889.5    42088.0      745.6       82.5       1.75
     .08        .20       2.46       1.19       .278       .040       .055       .000      -7.08    1008.99
 .000161        75.        75.        75.          0         17          0        .00    8826.77   10246.76


1490 NH CARD USED
*SECNO 2.750

3265 DIVIDED FLOW

1                                                                                                          PAGE
   30MAY01       12:07:26
4

    SECNO      DEPTH      CWSEL      CRIWS      WSELK       EG         HV         HL      OLOSS    L-BANK ELEV
    Q          QLOB       QCH        QROB       ALOB       ACH        AROB       VOL       TWA    R-BANK ELEV
    TIME       VLOB       VCH        VROB       XNL        XNCH       XNR        WTN       ELMIN  SSTA
```

SLOPE	XLOBL	XLCH	XLOBR	ITRIAL	IDC	ICONT	CORAR	TOPWID	ENDST
2.750	14.97	7.09	3.27	.00	7.92	.03	.01	.00	1.80
56900.0	1981.8	4644.2	50274.0	10432.5	1891.4	42171.1	801.8	91.6	1.75
.09	.19	2.46	1.19	.300	.040	.055	.000	-7.08	1007.88
.000161	45.	45.	45.	0	17	0	.00	8828.01	10246.89

CCHV= .300 CEHV= .500

*SECNO 3.000

3.000	18.18	8.05	3.37	.00	8.00	.03	.16	.00	2.00
56900.0	209.3	4893.5	51797.2	2174.1	1945.2	46022.1	2016.3	277.5	1.94
.34	.10	2.52	1.13	.500	.040	.055	.000	-10.13	608.83
.000140	742.	2038.	1005.	2	19	0	.00	7679.34	8208.17

*SECNO 4.000

3301 HV CHANGED MORE THAN HVINS

3302 WARNING: CONVEYANCE CHANGE OUTSIDE OF ACCEPTABLE RANGE, KRATIO = .18

4.000	21.76	7.84	6.96	.00	9.08	1.24	.39	.60	2.12
56900.0	503.5	21824.0	34572.4	485.0	1526.2	24793.0	2729.9	392.6	2.12
.38	1.04	14.30	1.39	.220	.040	.220	.000	-13.92	225.54
.004180	1797.	1804.	722.	2	12	0	.00	4832.04	5057.58

*SECNO 5.000

5.000	24.22	10.30	8.58	.00	11.40	1.10	2.28	.04	2.12
56900.0	231.9	25002.0	31666.1	212.7	1979.2	26084.9	3208.8	471.2	2.12
.41	1.09	12.63	1.21	.220	.040	.220	.000	-13.92	55.85
.002602	525.	607.	771.	3	9	0	.00	4156.74	4212.59

	SECNO	Q	CWSEL	DIFWSP	DIFWSX	DIFKWS	TOPWID	XLCH
	1.000	56900.00	7.87	.00	.00	.00	10591.89	.00
*	1.250	56900.00	7.87	.00	.00	.00	8826.66	302.00
	2.000	56900.00	7.88	.00	.01	.00	8826.77	75.00
	2.750	56900.00	7.89	.00	.01	.00	8828.01	45.00
	3.000	56900.00	8.05	.00	.16	.00	7679.34	2038.00
*	4.000	56900.00	7.84	.00	-.21	.00	4832.04	1804.00
	5.000	56900.00	10.30	.00	2.46	.00	4156.74	607.00

1
30MAY01 12:07:26 PAGE
7

SUMMARY OF ERRORS AND SPECIAL NOTES

WARNING SECNO= 1.250 PROFILE= 1 CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE

WARNING SECNO= 4.000 PROFILE= 1 CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE

Apéndice 10: Estudio de Tránsito / Estudio de Accesos (Fin de Semana)

Traffic Consulting Group

Estudio de Accesos - Fin de Semana
Marina Puerto Real
Fajardo, PR

Preparado para:
Puerto Real Inc.
Abril 2006

1606 PONCE DE LEÓN SUITE 603 • SAN JUAN, PR 00909
TEL: (787)724-2007 • FAX: (787)724-0690
INFO@TRAFFICPR.COM • WWW.TRAFFICPR.COM

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1 INTRODUCCIÓN

La Autoridad de Carreteras y Transportación en su documento titulado "Guías para la Preparación de Estudios Operacionales de Acceso y de Tránsito para Puerto Rico" establece la necesidad y ámbito de los estudios relacionados al tema del tránsito según el tamaño del desarrollo. El documento establece dos (2) tipos de estudios para determinar el efecto que un desarrollo tendrá en su área de influencia; estudio de acceso y estudio de tránsito. El primero se define como aquel recomendable para proyectos pequeños, los cuales podrán tener un impacto significativo en las intersecciones formadas por los accesos propuestos y no, necesariamente, en el sistema vial.

El siguiente informe presenta un estudio de accesos en el área destinada para la construcción de las facilidades de la Marina Puerto Real, en el barrio Puerto Real de Fajardo, PR. En junio de 2001 preparamos un Estudio de Tránsito para un día de semana típico. En dicho estudio se demostró que el proyecto propuesto es uno viable. Sin embargo, algunas personas expresaron preocupación por el efecto que tendría el proyecto en fines de semana, por lo que se nos solicitó que realizáramos un estudio que evaluará esta condición. Dado que el proyecto es uno de una baja generación de viajes aún en fin de semana, entendemos que el estudio pertinente es un Estudio de Accesos. Este informe evalúa las condiciones presentes del área y el impacto que tendrá la acción propuesta. Se modelará el funcionamiento de la intersección de acceso al nuevo desarrollo mediante el uso del programa de computadoras para el análisis de intersecciones "Signalised & unsignalised Intersection Design & Research Aid", con el fin de determinar el efecto final del mismo.

2 LOCALIZACIÓN Y DESCRIPCIÓN DE LA ACCIÓN PROPUESTA

Marina Puerto Real Inc. propone la construcción de una marina en el sector Maternillo del barrio Puerto Real de Fajardo. Dicha marina se encontraría aledaña al muelle del Ferry que da acceso a Isleta Marina y cerca del muelle de la Autoridad de los Puertos con servicio hacia y desde Vieques y Culebra. El área es accesada utilizando la carretera PR-195, la cual es de dos vías. Una vez se termina la carretera PR-195, la calle Cometa es la calle que permite el acceso hacia la calle del embarcadero, la cual discurre paralela a la costa. Para salir de esta zona, es necesario tomar la calle Unión, la cual corre en una sola dirección hacia la carretera PR-195. La marina contaría con un total de 193 espacios para lanchas en el agua, y 350 espacios estibados en tierra ("Dry Stack"). La Figura 1 muestra el mapa de localización proyecto.

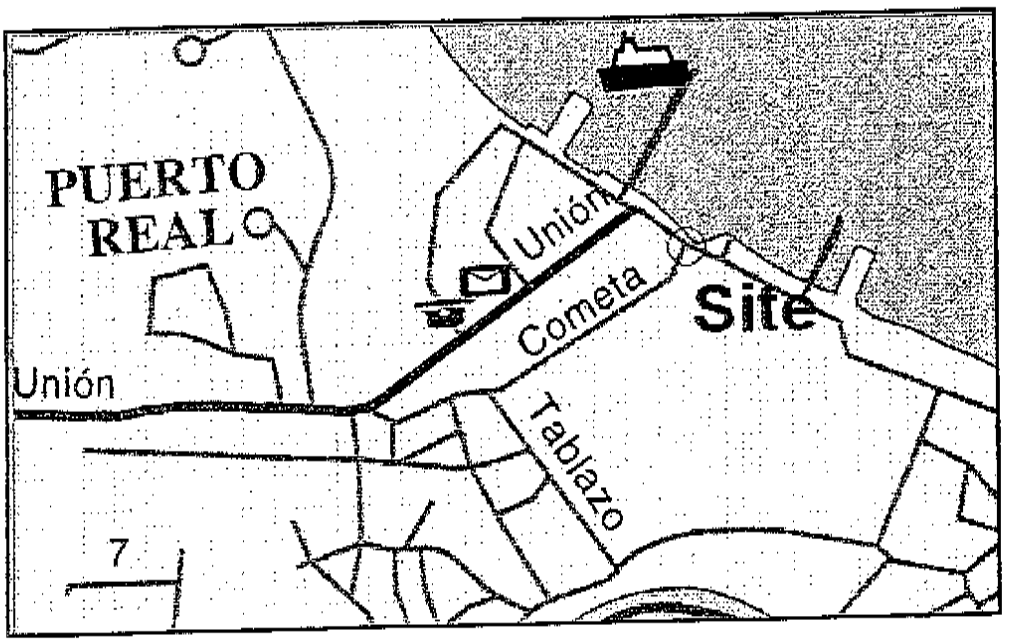

Figura 1 Mapa de Localización

3 METODOLOGÍA PARA LA EVALUACIÓN DEL ACCESO CORRESPONDIENTA A LA ACCIÓN PROPUESTA

1. El sábado 25 de marzo de 2006 se realizaron conteos de vehículos en la intersección de las calles Cometa y Embarcadero. Esta intersección serviría como acceso al proyecto. Los horarios de los conteos realizados fueron de 12:00 PM a 6:00 PM. Estos conteos se realizaron para determinar el número de vehículos que utilizan las vías de tránsito cercanas al proyecto; donde el mismo conectará en la red vial.

2. Dado que el proyecto no estará completado hasta el año 2009, los flujos existentes fueron expandidos a ese momento usando un factor de crecimiento anual de 2%.

3. Utilizando como referencia el Manual de Generación de Viajes del ITE se estimó el número de viajes que se generarían desde y hacia el proyecto propuesto.

4. Con todos los datos recopilados se procedió a analizar la intersección que se formará en el punto de acceso del desarrollo. Esto con el propósito de caracterizar la operación existente en el área. Para realizar este análisis se utilizó el programa de computadoras aaSIDRA 2.1. Las situación estudiada fue el período pico de la tarde de un sábado con los flujos existentes, y la misma situación al añadirse el crecimiento anual esperado y los flujos generados por el proyecto. No existe datos de generación de viajes para el periodo de la mañana.

4 TEORÍA

4.1 Evaluación sobre el Nivel de Servicio (LOS) para una intersección:

El nivel de servicio es la metodología más conocida utilizada para la evaluación de una facilidad. El nivel de servicio representa las condiciones de operación de las intersecciones: el nivel de servicio "A" representa las condiciones excelentes de tránsito y el nivel "F", las peores condiciones. Tanto las intersecciones semaforizadas como las no semaforizadas pueden ser categorizadas utilizando esta metodología. Estos niveles de servicio a su vez se encuentran basados en las demoras promedio que tienen los vehículos en las intersecciones. A continuación se definen las categorías para cada nivel de servicio.

LOS A: Excelente

Esta es una condición de flujo libre, acompañada por bajos volúmenes de tránsito y altas velocidades. Hay poca o ninguna restricción en maniobrabilidad del conductor y los conductores pueden mantener sus deseadas velocidades con poco o ningún retraso.

LOS B: Muy Buena

En esta condición, las velocidades de operación comienzan a estar restringidas un tanto por las condiciones del tránsito. Los conductores aún tienen una libertad considerable para seleccionar su velocidad y carril de operación.

LOS C: Buena

Las velocidades y maniobrabilidad se vuelven más controladas por volúmenes de tránsito más altos. La mayoría de los conductores están restringidos en su libertad para seleccionar su propia velocidad, cambiar de carril o pasar.

LOS D: Aceptable

Este nivel de servicio se acerca a un flujo inestable, con velocidades operacionales tolerables siendo mantenidas, aunque considerablemente afectadas por los cambios en las condiciones operacionales. Los conductores tienen poca libertad para maniobrar y la comodidad y conveniencia son bajas.

LOS E: Capacidad

El flujo de tránsito se vuelve inestable y podría haber paradas momentáneas.

LOS F: Mala

En esta condición, la velocidad operacional podría bajar a cero y resultar en colas de tránsito.

4.2 Relación entre demoras y Nivel de Servicio

La Tabla 1, muestra las diferentes relaciones entre el nivel de servicio y las demoras promedio por cada vehículo en las intersecciones controladas ya sea por semáforo, señales de PARE o CEDA, o en rotondas. (Manual de aaSIDRA 2.1). Estas demoras tienen como componentes la demora de viajar a través de la intersección más la demora de la detención como consecuencia de la intersección.

Tabla 1 Criterio del Nivel de Servicio para intersecciones

NIVEL DE SERVICIO	DEMORA DE VEHICULOS (SEG.)	
	Semáforo y Rotonda	PARE y CEDA
A	$d \leq 10$	$d \leq 10$
B	$10 < d \leq 20$	$10 < d \leq 15$
C	$20 < d \leq 35$	$15 < d \leq 25$
D	$35 < d \leq 55$	$25 < d \leq 35$
E	$55 < d \leq 80$	$35 < d \leq 50$
F	$80 < d$	$50 < d$

4.3 Glosario

A continuación se presenta una lista de términos comunes en la práctica de la ingeniería de tránsito, según definidos por la Autoridad de Carreteras y Transportación.

1) **Acceso (intersección)** – está caracterizado por un grupo de carriles en una dirección de la intersección, incluyendo los movimientos a la izquierda, recto y a la derecha.

2) **ADT** – "Average Daily Traffic", tránsito promedio diario en una facilidad de una carretera.

3) **Área de estudio** – área geográfica que contiene las intersecciones y segmentos más críticos de una carretera, los cuales se esperan sean afectados por el tránsito a ser generado por el desarrollo.

4) **Ciclo** – el periodo de tiempo requerido para una secuencia completa de indicaciones del semáforo.

5) **Desarrollo** – proyectos residenciales, comerciales, de oficinas, de hospederías e industriales, entre otros, que serán construidos en un predio de terreno sin desarrollar o que forman parte de una reconstrucción o expansión de una edificación existente.

6) **Día típico** – un martes, miércoles o jueves durante los días de clase entre los meses de enero a mayo y de agosto a diciembre. Para los usos comerciales, el sábado podrá incluirse entre los días típicos.

7) **Estudio operacional** – el análisis del impacto potencial al tránsito causado por un desarrollo propuesto. Este tipo de estudio dependerá del tipo y tamaño del proyecto. Para propósitos de este documento, un estudio operacional consistirá de un estudio de accesos o un estudio de tránsito.

8) **Factor de hora pico** – una medida de la fluctuación en la demanda vehicular dentro de la hora pico.

9) **Fase** – una parte del ciclo asignado a un movimiento de tránsito que tenga el derecho de paso o a una combinación de movimientos de tránsito que tengan simultáneamente el derecho de paso durante uno o más intervalos.

10) **Hora pico** – un período de una hora durante la mañana (AM) o durante la tarde (PM) que representa el volumen de tránsito más alto en el sistema, resultado de la suma de los volúmenes de cuatro (4) períodos de quince (15) minutos consecutivos.

11) **Modelos de micro simulación** – modelos que simulan el movimiento individual de vehículos, basados en teorías de cambio de carril, dirección de los vehículos y forma de conducir.

12) **Nivel de servicio ("Level of Service" - LOS)** – una medida cualitativa que describe las condiciones operacionales de un componente del sistema de transportación. Generalmente descrito por los siguientes factores: velocidad, tiempo de viaje, demora, interrupciones en el tránsito y seguridad.

13) **Semáforo actuado** – un tipo de sistema de semáforos mediante el cual se varían los intervalos de tiempo de acuerdo con las demandas del tránsito registradas por la actuación de los detectores localizados en el pavimento de rodaje.

14) **Semáforo semiactuado** – un tipo de sistema de semáforos donde los detectores son colocados en los accesos de menor flujo vehicular para permitirle prioridad de verde a los accesos principales.

15) **Semáforo de tiempo fijo** – un tipo de sistema de semáforos que opera con programas predeterminados de ciclos en intervalos.

16) **Volumen** – el número de personas o vehículos pasando por un punto de un carril o un segmento de carretera durante cierto intervalo de tiempo.

5 ANÁLISIS DE TRÁNSITO

5.1 Afluencia vehicular

A modo de determinar el patrón de viajes actuales del sector se realizaron conteos manuales en la intersección de las calles Cometa y Embarcadero, donde se localizará el acceso al proyecto bajo estudio. Dichos conteos se realizaron en periodos de quince (15) minutos de 12:00 PM a 6:00 PM el sábado 25 de marzo de 2006.

La tabla en el apéndice 1 ilustra el flujo vehicular obtenido mediante dicho conteo manual. Para determinar la hora pico se buscaron los cuatro períodos consecutivos de 15 minutos con más flujo. Una vez se encontraba esta hora, se buscaba el período de 15 minutos con mayor flujo, y este valor multiplicado por cuatro era el que se utilizaba para la modelación. Dado que ya se está usando el valor del período de 15 minutos más alto, el factor de hora pico a utilizarse es 1.0.

Los flujos mostrados están identificados por dos letras separadas por un guión. La primera representa el acceso de procedencia del movimiento en inglés: North, South, East & West. La segunda letra representa el tipo de movimiento: Left, Thru & Right.

La siguiente tabla muestran los flujos vehiculares por acceso de la intersección medida.

Tabla 2 Flujos Int. c. Cometa y c. Embarcadero (Condición Presente)

2006	Cometa		Embarcadero	
	S-L	S-R	E-T	Total
Pico PM	260	72	120	452

5.2 Crecimiento anual

Los flujos obtenidos en el año 2006 fueron expandidos al año 2009, cuando entendemos que el proyecto estará operando. Los flujos de la zona fueron expandidos utilizando un factor de 2.0% de crecimiento anual.

5.3 Generación de viajes del proyecto

Para el cómputo de la generación de viajes se utilizo la categoría 210 del Manual de Generación de Viajes de ITE como clasificación del uso del terreno. La variable independiente utilizada fue la cantidad de residencias a construirse. La siguiente tabla muestra los resultados obtenidos.

Tabla 3 Generación de Viajes del proyecto Marina Puerto Real

Categoría				ADT Sábado			Pico AM Sábado			Pico PM Sábado		
Uso	ITE	Total	Unidades	Total	In	Out	Total	In	Out	Total	In	Out
Marina	420	543	berths	1717	859	859	N/A	N/A	N/A	147	65	82

5.4 Distribución de Viajes

Para realizar la distribución de los viajes que generará el proyecto bajo estudio, presumimos que todos los viajes llegaran a través de la calle Cometa, doblando a la derecha al llegar a la calle Embarcadero, y para salir, utilizaran la calle Embarcadero en dirección a la calle Unión.

5.5 Tránsito Futuro

Para la modelación de la situación futura se tomaron los flujos de la situación base, se multiplicaron por el factor de crecimiento anual y se le añadieron los flujos que se obtuvieron en la etapa de generación de viajes, repartidos de acuerdo a la distribución que se explicó anteriormente. Las siguientes tablas muestran los flujos futuros.

Tabla 4 Flujos PR-121 y Acceso Villas del Río (Condición Futuro)

2009 + P							
	S-L	S-R	E-L	E-T	W-T	W-R	Total
Pico AM	25	60	20	183	72	8	368
Pico PM	17	40	67	149	212	29	514

Tabla 5 Flujos Int. c. Cometa y c. Embarcadero (Condición Futuro)

2009 + P	Cometa		Embarcadero	
	S-L	S-R	E-T	Total
Pico PM	276	141	209	626

5.6 Modelación de Tránsito

Para la evaluación de las intersecciones afectadas se utilizó el programa aaSIDRA 2.1. Este modelo permite la evaluación de intersecciones semaforizadas y de prioridad, además de la optimización de las de semáforo, y es preferido debido a su capacidad de predicción, aún en situaciones de sobresaturación. Se realizaron modelaciones para los períodos pico de la mañana y de la tarde para la situación actual y la situación futura. La siguiente figura muestra un

5.6.1 Intersección c. Cometa y c. Embarcadero

Esta intersección tiene una configuración en "T" y está controlada por Pare. La calle Cometa discurre desde la carretera PR-195 hasta la calle del Embarcadero. Al llegar a la calle del Embarcadero, los vehículos tienen dos opciones: Virar a la derecha, hacia donde se encontraría la marina propuesta, o hacia la izquierda.

La siguiente figura muestra un esquema de la intersección.

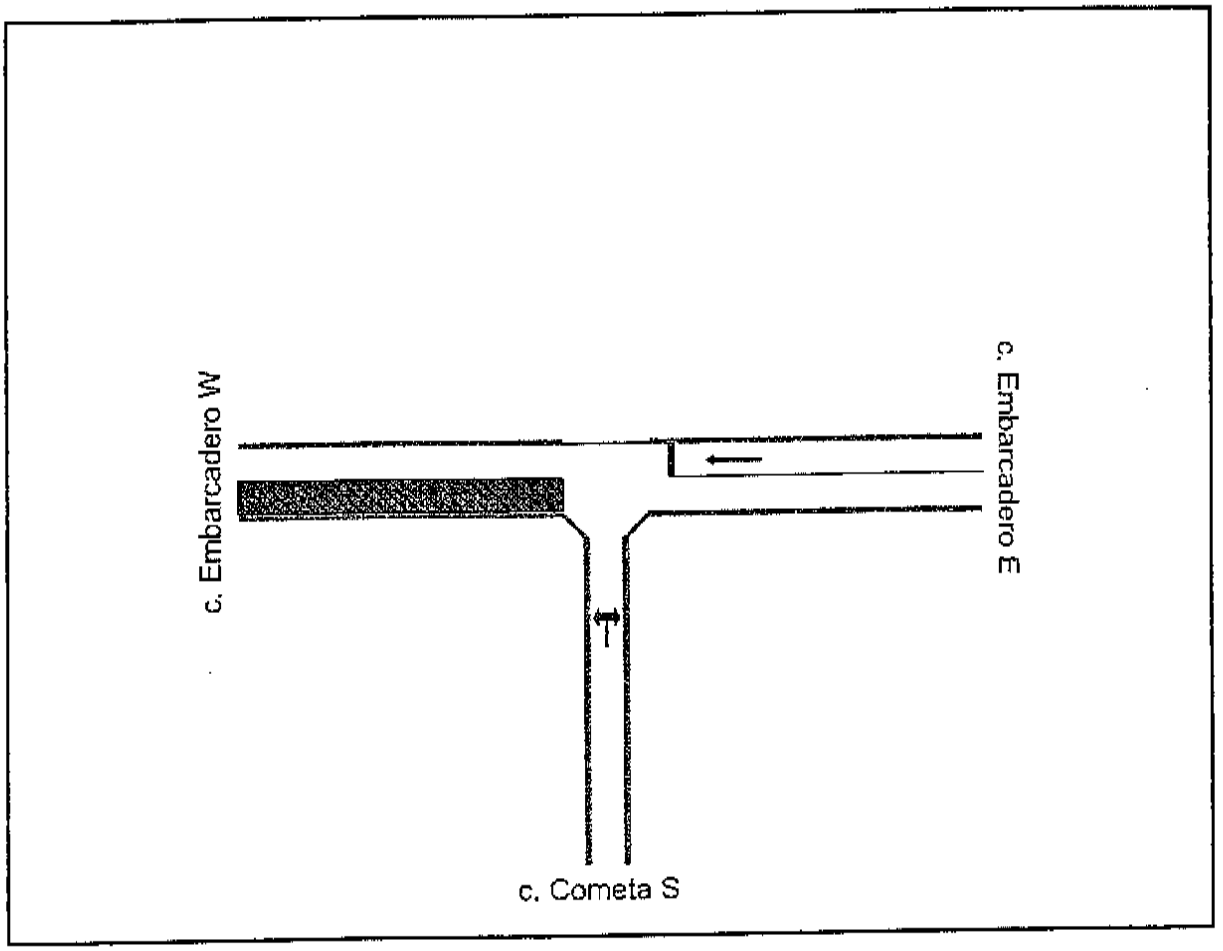

Figura 2 Esquema Int. c. Cometa y c. Embarcadero

La siguiente tabla muestra los resultados obtenidos para las distintas situaciones modeladas.

Tabla 6 Resultados modelación Int. c. Cometa y c. Embarcadero

	Demora Promedio por Vehículo [seg.] y Nivel de Servicio (LOS)				
	Cola Promedio [metros]				
	Acceso Sur c. Cometa	Acceso Este Embarcadero	Acceso Norte N/A	Acceso Oeste N/A	Total Int.
Base 2006					
Sábado	8.8 A	13.4 B	N/A	N/A	10.0
PM	0	1			
Futuro 2009					
Sábado	8.7 A	15.3 C	N/A	N/A	10.9
PM	0	2			

Como se puede observar de la tabla anterior, esta intersección operará bajo niveles de servicio excelentes. Se desprende del análisis realizado que esta intersección tendrá capacidad para manejar el tránsito esperado durante la hora pico de un sábado típico.

En el apéndice 3 se muestran los resultados de las modelaciones de aaSIDRA.

6 CONCLUSIONES Y RECOMENDACIONES

El análisis del impacto generado por el propuesto desarrollo se realizó analizando la intersección que servirá de acceso al mismo. Basados en los análisis de las modelaciones realizadas para este estudio podemos concluir que el acceso al desarrollo será capaz de manejar la totalidad de los viajes que generará el mismo en los sábados, teniendo un nivel de servicio excelente. Entendemos que este informe puede aclarar cualquier duda sobre el efecto que tendrá el proyecto propuesto en el tránsito de fin de semana. Este resultado era de esperarse ya que en fin de semana, aunque el tránsito total de un día es mayor, los picos son menos pronunciados que en los días de semana regular. Mantenemos nuestra opinión que el proyecto es viable en donde se pretende desde el punto de vista de tránsito.

7 CERTIFICACIÓN

Certifico que la información presentada en este estudio es cierta, correcta y completa, y que fue obtenida utilizando los criterios de la practica usual y aceptada de la ingeniería de tránsito

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8 REFERENCIAS

1. Trip Generation Manual, Institute of Transportation Engineers, 7th edition, 2003
2. Trip Generation Handbook: An ITE Recommended Practice, Institute of Transportation Engineers, March 2001
3. "Signalised & unsignalised Intersection Design & Research Aid". aaSIDRA

9 APÉNDICES

9.1 Apéndice 1: Flujos Obtenidos Mediante Conteos

Conteo Int. Calle Cometa y calle del Embarcadero

Beginning	Movement			
of Period	S-L	S-R	E-T	Total
12:00	10	8	14	32
12:15	14	16	21	51
12:30	13	9	13	35
12:45	34	20	13	67
13:00	28	20	14	62
13:15	22	13	16	51
13:30	26	11	19	56
13:45	30	12	14	56
14:00	37	12	17	66
14:15	52	22	16	90
14:30	**65**	**18**	**30**	**113**
14:45	53	18	14	85
15:00	38	17	11	66
15:15	51	10	20	81
15:30	18	13	17	48
15:45	21	10	17	48
16:00	20	10	15	45
16:15	16	11	24	51
16:30	22	4	12	38
16:45	21	6	14	41
17:00	22	11	10	43
17:15	23	9	15	47
17:30	19	12	13	44
17:45	35	15	13	63

9.2 Apéndice 2: Listado de Archivos de Modelaciones

Archivo	Lugar	Periodo
01_Cometa y Embarcadero_BPMSat.OUT	01 Int c. Cometa y c. Embarcadero	Pico PM Sabado Base
01_Cometa y Embarcadero_FPMSat.OUT	01 Int c. Cometa y c. Embarcadero	Pico PM Sabado Futuro

9.3 Apéndice 3: Resultados corridas de aaSIDRA

Akcelik & Associates Pty Ltd - aaSIDRA 2.1.3.356

Traffic Consulting Group
Carlos M. Contreras User ID: M0276
Licence Type: Multi Computer

Time and Date of Analysis 1:18 PM, 10 Apr 2006

Filename: C:\Documents and Settings\Carlos M Contreras\My Documents\aaTraffic\aaSIDRA Projects\Marina Puerto Real Rev06\01_Cometa y Embarcadero_BPMSat.OUT

01 Int c. Cometa y c. Embarcadero
Pico PM Sabado Base
Intersection ID: 1

RUN INFORMATION

* Basic Parameters:
  Intersection Type: Unsignalised - Two-Way Stop Control
  Driving on the right-hand side of the road
  Input data specified in Metric units
  Default Values File No. 30
  Peak flow period (for performance): 15 minutes
  Unit time (for volumes): 60 minutes (Hourly Rate)
  Delay definition: Control delay
  Geometric delay included
  aaSIDRA Standard Delay and Queue models used
  Level of Service based on: Delay (HCM method)
  Queue definition: Cycle average queue, Average

---

01 Int c. Cometa y c. Embarcadero
Pico PM Sabado Base
Intersection ID: 1
Stop Sign Controlled Intersection

Table S.0 - TRAFFIC FLOW DATA

Mov No.	Left LV	Left HV	Through LV	Through HV	Right LV	Right HV	Flow Scale	Peak Flow Factor
VEHICLES Demand flows in veh/hour as used by the program								
South: c. Cometa S								
1	260	0	0	0	0	0	1.00	1.00
3	0	0	0	0	72	0	1.00	1.00
East: c. Embarcadero E								
4	0	0	120	0	0	0	1.00	1.00

Based on unit time = 60 minutes.
Flow Scale and Peak Hour Factor effects included in flow values.

01 Int c. Cometa y c. Embarcadero
Pico PM Sabado Base
Intersection ID: 1
Stop Sign Controlled Intersection

Table S.2 - MOVEMENT CAPACITY PARAMETERS

Mov No.	Demand Flow (veh/h)	HV (%)	Opposing Movement Flow (veh/h)	HV (%)	Adjust. Flow (pcu/h)	Total Cap. (veh /h)	Prac. Deg. Satn xp	Prac. Spare Cap. (%)	Lane Util (%)	Deg. Satn x
South: c. Cometa S										
1 L	260	0.0	0			1454	0.80	347	100	0.179
3 R	72	0.0	0			403	0.80	348	100	0.179
East: c. Embarcadero E										
4 T	120	0.0	296+	0.0	296	658	0.80	339	100	0.182*

+ Percentage of exiting flow included in total opposing flow

01 Int c. Cometa y c. Embarcadero
Pico PM Sabado Base
Intersection ID: 1
Stop Sign Controlled Intersection

Table S.3 - INTERSECTION PARAMETERS

Intersection Level of Service	=	NA
Worst movement Level of Service	=	B
Average intersection delay (s)	=	10.0
Largest average movement delay (s)	=	13.4
Largest cycle-average queue, mean (m)	=	1
Performance Index	=	7.83
Degree of saturation (highest)	=	0.182
Practical Spare Capacity (lowest)	=	339 %
Effective intersection capacity, (veh/h)	=	2478
Total vehicle flow (veh/h)	=	452
Total person flow (pers/h)	=	678
Total vehicle delay (veh-h/h)	=	1.26
Total person delay (pers-h/h)	=	1.88
Total effective vehicle stops (veh/h)	=	348
Total effective person stops (pers/h)	=	522
Total vehicle travel (veh-km/h)	=	271.8
Total cost ($/h)	=	181.66
Total fuel (L/h)	=	31.0
Total CO2 (kg/h)	=	77.55

NA Not Applicable - Intersection Level of Service is not calculated at two-way stop control or give-way/yield controlled intersections. See Table S.15 or Movement Displays for individual movement LOS values.

01 Int c. Cometa y c. Embarcadero
Pico PM Sabado Base
Intersection ID: 1
Stop Sign Controlled Intersection

Table S.5 - MOVEMENT PERFORMANCE

Mov No.	Total Delay (veh-h/h)	Total Delay (pers-h/h)	Aver. Delay (sec)	Prop. Queued	Eff. Stop Rate	Longest Queue Cycle (vehs)	Longest Queue Aver. (m)	Perf. Index	Aver. Speed (km/h)
South: c. Cometa S									
1 L	0.65	0.97	8.9	0.00	0.73	0.0	0	4.31	48.1
3 R	0.16	0.25	8.2	0.00	0.67	0.0	0	1.16	49.0
East: c. Embarcadero E									
4 T	0.45	0.67	13.4	0.50	0.92	0.1	1	2.37	44.7

01 Int c. Cometa y c. Embarcadero
Pico PM Sabado Base
Intersection ID: 1
Stop Sign Controlled Intersection

Table S.6 - INTERSECTION PERFORMANCE

Total Flow (veh/h)	Deg. Satn x	Total Delay (veh-h/h)	Total Delay (pers-h/h)	Aver. Delay (sec)	Prop. Queued	Eff. Stop Rate	Longest Queue (m)	Perf. Index	Aver. Speed (km/h)
South: c. Cometa S									
332	0.179	0.81	1.21	8.8	0.00	0.72	0	5.46	48.3
East: c. Embarcadero E									
120	0.182	0.45	0.67	13.4	0.50	0.92	1	2.37	44.7
ALL VEHICLES:									
452	0.182	1.26	1.88	10.0	0.13	0.77	1	7.83	47.3
INTERSECTION (persons):									
678	0.182		1.88	10.0	0.13	0.77		7.83	47.3

Queue values in this table are mean cycle-average queue (metres).

01 Int c. Cometa y c. Embarcadero
Pico PM Sabado Base
Intersection ID: 1
Stop Sign Controlled Intersection

Table S.7 - LANE PERFORMANCE

	Dem	Q u e u e

Lane No.	Mov No.	Flow (veh /h)	Cap (veh /h)	Deg. Satn x	Aver. Delay (sec)	Eff. Stop Rate	Cycle Aver. (vehs)	Cycle Aver. (m)	Short Lane (m)
South: c. Cometa S									
1 LR	1, 3	332	1857	0.179	8.8	0.72	0.0	0	
East: c. Embarcadero E									
1 T	4	120	658	0.182	13.4	0.92	0.1	1	

01 Int c. Cometa y c. Embarcadero
Pico PM Sabado Base
Intersection ID: 1
Stop Sign Controlled Intersection

Table S.8A - LANE FLOW AND CAPACITY INFORMATION

Lane No.	Mov No.	Dem Flow (veh/h) Lef	Thru	Rig	Tot	Min Cap (veh /h)	Tot Cap (veh /h)	Deg. Satn x	Lane Util %
South: c. Cometa S									
1 LR	1, 3	260	0	72	332	332	1857	0.179	100
East: c. Embarcadero E									
1 T	4	0	120	0	120	120	658	0.182	100

The capacity value for priority and continuous movements is obtained by adjusting the basic saturation flow for heavy vehicle and turning vehicle effects. Saturation flow scale applies if specified.

01 Int c. Cometa y c. Embarcadero
Pico PM Sabado Base
Intersection ID: 1
Stop Sign Controlled Intersection

Table S.12A - FUEL CONSUMPTION, EMISSIONS AND COST - TOTAL

Mov No.	Fuel Total L/h	Cost Total $/h	HC Total kg/h	CO Total kg/h	NOX Total kg/h	CO2 Total kg/h
South: c. Cometa S						
1 L	17.8	102.95	0.078	3.78	0.108	44.4
3 R	4.8	28.06	0.021	0.98	0.029	12.0
	22.5	131.01	0.099	4.77	0.137	56.4

East: c. Embarcadero E						
4 T	8.5	50.65	0.037	1.78	0.051	21.2
	8.5	50.65	0.037	1.78	0.051	21.2
INTERSECTION:	31.0	181.66	0.136	6.54	0.189	77.6

PARAMETERS USED IN COST CALCULATIONS

Pump price of fuel ($/L)	=	0.900
Fuel resource cost factor	=	0.50
Ratio of running cost to fuel cost	=	3.0
Average income ($/h)	=	27.00
Time value factor	=	0.60
Average occupancy (persons/veh)	=	1.5
Light vehicle mass (1000 kg)	=	1.4
Heavy vehicle mass (1000 kg)	=	11.0
Light vehicle idle fuel rate (L/h)	=	1.350
Heavy vehicle idle fuel rate (L/h)	=	2.000

The idle fuel and vehicle mass parameters given above are the default values (data given in RIDES may override some of these parameters).

---

01 Int c. Cometa y c. Embarcadero
Pico PM Sabado Base
Intersection ID: 1
Stop Sign Controlled Intersection

Table S.14 - SUMMARY OF INPUT AND OUTPUT DATA

Lane No.	Demand Flow (veh/h) L	T	R	Tot	%HV	Adj. Basic Satf.	Eff Grn (secs) 1st	2nd	Deg Sat x	Aver. Delay (sec)	Longest Queue (m)	Shrt Lane (m)
South: c. Cometa S												
1 LR	260		72	332	0				0.179	8.8	0	
	260	0	72	332	0				0.179	8.8		
East: c. Embarcadero E												
1 T		120		120	0				0.182	13.4	1	
	0	120	0	120	0				0.182	13.4	1	

ALL VEHICLES	Total Flow	% HV	Max X	Aver. Delay	Max Queue
	452	0	0.182	10.0	1

Total flow period = 60 minutes. Peak flow period = 15 minutes.

Queue values in this table are mean cycle-average queue (metres).

Note: Basic Saturation Flows are not adjusted at roundabouts or sign-controlled intersections and apply only to continuous lanes.

---

01 Int c. Cometa y c. Embarcadero
Pico PM Sabado Base
Intersection ID: 1
Stop Sign Controlled Intersection

Table S.15 - CAPACITY AND LEVEL OF SERVICE

Mov No.	Mov Typ	Total Flow (veh /h)	Total Cap. (veh /h)	Deg. of Satn (v/c)	Aver. Delay (sec)	LOS	Longest Queue Cycle (vehs)	Aver. (m)
South: c. Cometa S								
1	L	260	1454	0.179	8.9	A	0.0	0
3	R	72	403	0.179	8.2	A	0.0	0
		332		0.179	8.8	A	0.0	0
East: c. Embarcadero E								
4	T	120	658	0.182*	13.4	B	0.1	1
		120		0.182	13.4	B	0.1	1
ALL VEHICLES:		452		0.182	10.0	NA	0.1	1

Level of Service calculations are based on
average control delay including geometric delay (HCM criteria),
independent of the current delay definition used.
For the criteria, refer to the "Level of Service" topic in the
aaSIDRA Output Guide or the Output section of the on-line help.

NA Not Applicable - Intersection Level of Service is not calculated at two-way stop control or give-way/yield controlled intersections.

* Maximum v/c ratio, or critical green periods

--- End of aaSIDRA Output ---

C:\Documents and Settings\Carlos M Contreras\My Documents\aaTraffic\aaSIDRA Projects\Marina Puerto Real Rev06\01_Cometa y Embarcadero_BPMSat.OUT
Produced by aaSIDRA 2.1.3.356
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Generated 1:18 PM, 10 Apr 2006

Akcelik & Associates Pty Ltd - aaSIDRA 2.1.3.356

Traffic Consulting Group
Carlos M. Contreras User ID: M0276
Licence Type: Multi Computer

Time and Date of Analysis 1:21 PM, 10 Apr 2006

Filename: C:\Documents and Settings\Carlos M Contreras\My Documents\aaTraffic\aaSIDRA Projects\Marina Puerto Real Rev06\01_Cometa y Embarcadero_FPMSat.OUT

01 Int c. Cometa y c. Embarcadero
Pico PM Sabado Futuro
Intersection ID: 1

RUN INFORMATION

* Basic Parameters:
  Intersection Type: Unsignalised - Two-Way Stop Control
  Driving on the right-hand side of the road
  Input data specified in Metric units
  Default Values File No. 30
  Peak flow period (for performance): 15 minutes
  Unit time (for volumes): 60 minutes (Hourly Rate)
  Delay definition: Control delay
  Geometric delay included
  aaSIDRA Standard Delay and Queue models used
  Level of Service based on: Delay (HCM method)
  Queue definition: Cycle average queue, Average

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Table S.0 - TRAFFIC FLOW DATA

Mov No.	Left LV	Left HV	Through LV	Through HV	Right LV	Right HV	Flow Scale	Peak Flow Factor
VEHICLES Demand flows in veh/hour as used by the program								
South: c. Cometa S								
1	276	0	0	0	0	0	1.00	1.00
3	0	0	0	0	141	0	1.00	1.00
East: c. Embarcadero E								
4	0	0	209	0	0	0	1.00	1.00

Based on unit time = 60 minutes.
Flow Scale and Peak Hour Factor effects included in flow values.

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Table S.2 - MOVEMENT CAPACITY PARAMETERS

Mov No.	Demand Flow (veh/h)	HV (%)	Opposing Movement Flow (veh/h)	HV (%)	Adjust. Flow (pcu/h)	Total Cap. (veh /h)	Prac. Deg. Satn xp	Prac. Spare Cap. (%)	Lane Util (%)	Deg. Satn x
South: c. Cometa S										
1 L	276	0.0	0			1229	0.80	256	100	0.225
3 R	141	0.0	0			628	0.80	256	100	0.225
East: c. Embarcadero E										
4 T	209	0.0	347+	0.0	347	601	0.80	130	100	0.348*

\+ Percentage of exiting flow included in total opposing flow

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Table S.3 - INTERSECTION PARAMETERS

Intersection Level of Service	=	NA
Worst movement Level of Service	=	C
Average intersection delay (s)	=	10.9
Largest average movement delay (s)	=	15.3
Largest cycle-average queue, mean (m)	=	2
Performance Index	=	11.28
Degree of saturation (highest)	=	0.348
Practical Spare Capacity (lowest)	=	130 %
Effective intersection capacity, (veh/h)	=	1800
Total vehicle flow (veh/h)	=	626
Total person flow (pers/h)	=	939
Total vehicle delay (veh-h/h)	=	1.90
Total person delay (pers-h/h)	=	2.84
Total effective vehicle stops (veh/h)	=	507
Total effective person stops (pers/h)	=	760
Total vehicle travel (veh-km/h)	=	376.6
Total cost ($/h)	=	255.19
Total fuel (L/h)	=	43.2
Total CO2 (kg/h)	=	107.91

NA Not Applicable - Intersection Level of Service is not calculated at two-way stop control or give-way/yield controlled intersections. See Table S.15 or Movement Displays for individual movement LOS values.

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Table S.5 - MOVEMENT PERFORMANCE

Mov No.	Total Delay (veh-h/h)	Total Delay (pers-h/h)	Aver. Delay (sec)	Prop. Queued	Eff. Stop Rate	Longest Cycle (vehs)	Queue Aver. (m)	Perf. Index	Aver. Speed (km/h)
South: c. Cometa S									
1 L	0.69	1.03	8.9	0.00	0.73	0.0	0	4.57	48.1
3 R	0.32	0.48	8.2	0.00	0.67	0.0	0	2.26	49.0
East: c. Embarcadero E									
4 T	0.89	1.33	15.3	0.60	1.01	0.3	2	4.45	43.1

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Table S.6 - INTERSECTION PERFORMANCE

Total Flow (veh/h)	Deg. Satn x	Total Delay (veh-h/h)	Total Delay (pers-h/h)	Aver. Delay (sec)	Prop. Queued	Eff. Stop Rate	Longest Queue (m)	Perf. Index	Aver. Speed (km/h)
South: c. Cometa S									
417	0.225	1.01	1.51	8.7	0.00	0.71	0	6.83	48.4
East: c. Embarcadero E									
209	0.348	0.89	1.33	15.3	0.60	1.01	2	4.45	43.1
ALL VEHICLES:									
626	0.348	1.90	2.84	10.9	0.20	0.81	2	11.28	46.5
INTERSECTION (persons):									
939	0.348		2.84	10.9	0.20	0.81		11.28	46.5

Queue values in this table are mean cycle-average queue (metres).

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Table S.7 - LANE PERFORMANCE