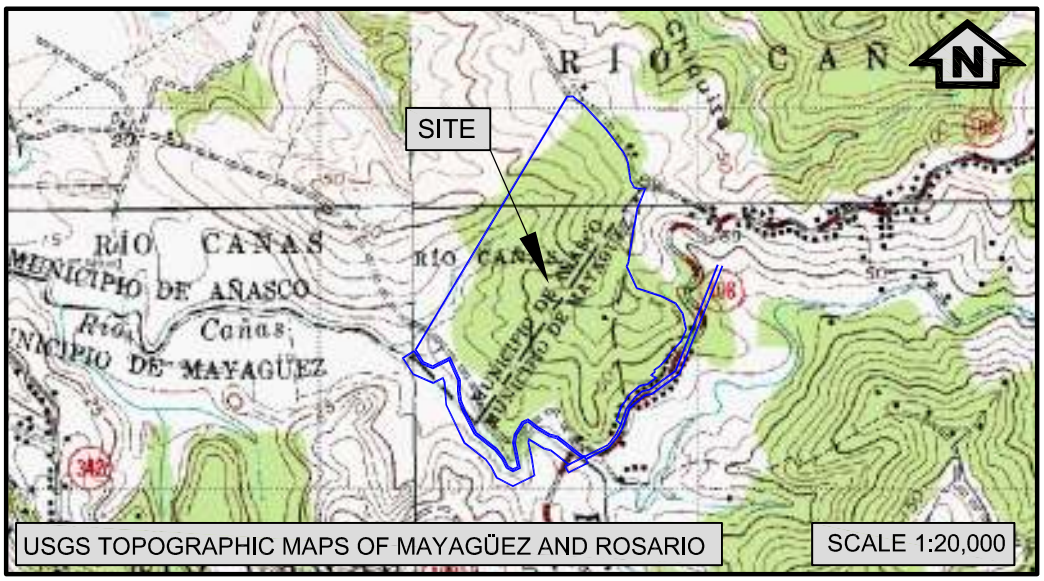
MENAR HYDROSYSTEMS ENGINEERING, P.S.C.
Hydrology • Hydraulics • Sediment Transport

HYDROLOGIC-HYDRAULIC STUDY
FOR MONTE VERDE RESIDENTIAL DEVELOPMENT
AÑASCO-MAYAGÜEZ, PUERTO RICO

PREPARED FOR:

ENG. JOSÉ NELSON VÉLEZ MATÍAS



PREPARED BY:

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MARCH 2007

WORKSHEET: CURVE NUMBER

Project: Monte Verde By: GAS Date: May 29, 2006

Location: Mayagüez Checked: MMF Date: May 29, 2006

BASIN NAME: **RÍO CAÑAS BASIN (EXT)** **CONDITION:** **ALL**

BASIN AREA (Ac) = 7,277

BASIN AREA (mi^2) = 11.37

HYDROLOGIC SOIL GROUP	LAND USE	CN*	AREA, (Ac)	PRODUCT OF AREA x CN
B	Grass	65	473	30745
B	Woods	60	1,659	99,540
C	Grass	76	1,584	120,384
C	Woods	73	3,522	257,106
C	Roads	98	34	3332
D	Woods	79	5	395
				0
				0
		Totals	7,277	511,502

CN	70

* Antecedent moisture condition II

WORKSHEET: CURVE NUMBER

Project:	Monte Verde	By:	GAS	Date:	May 29, 2006
Location:	Mayagüez	Checked:	MMF	Date:	May 29, 2006

BASIN NAME: **BASIN SOUTH EAST (BSE)** **CONDITION:** **EXISTING**

BASIN AREA (Ac) = 17.29

BASIN AREA (mi^2) = 0.0270

HYDROLOGIC SOIL GROUP	LAND USE	CN*	AREA, (Ac)	PRODUCT OF AREA x CN
C	Woods	70	17.29	1210.3
		Totals	17.29	1210.3

CN	70

* Antecedent moisture condition II

WORKSHEET: CURVE NUMBER

Project:	Monte Verde	By:	GAS	Date:	May 29, 2006
Location:	Mayagüez	Checked:	MMF	Date:	May 29, 2006

BASIN NAME: **BASIN SOUTH WEST (BWE)** **CONDITION:** **EXISTING**

BASIN AREA (Ac) = 25.86

BASIN AREA (mi^2) = 0.0404

HYDROLOGIC SOIL GROUP	LAND USE	CN*	AREA, (Ac)	PRODUCT OF AREA x CN
C	Woods	70	25.86	1810.2
		Totals	25.86	1810.2

CN	70

* Antecedent moisture condition II

WORKSHEET: CURVE NUMBER

Project:	Monte Verde	By:	GAS	Date:	May 29, 2006
Location:	Mayagüez	Checked:	MMF	Date:	May 29, 2006

BASIN NAME: **BASIN CREEK 1 (BC1)** **CONDITION:** **EXISTING**

BASIN AREA (Ac) = 37.87

BASIN AREA (mi^2) = 0.0592

HYDROLOGIC SOIL GROUP	LAND USE	CN*	AREA, (Ac)	PRODUCT OF AREA x CN
C	Woods	70	37.87	2650.9
		Totals	53.22	3725.4

CN	70

* Antecedent moisture condition II

WORKSHEET: CURVE NUMBER

Project:	Monte Verde	By:	GAS	Date:	May 29, 2006
Location:	Mayagüez	Checked:	MMF	Date:	May 29, 2006

BASIN NAME: **BASIN CREEK 2 (BC2)** **CONDITION:** **EXISTING**

BASIN AREA (Ac) = 15.37

BASIN AREA (mi^2) = 0.0240

HYDROLOGIC SOIL GROUP	LAND USE	CN*	AREA, (Ac)	PRODUCT OF AREA x CN
C	Woods	70	15.32	1072.4
		Totals	15.32	1072.4

CN	70

* Antecedent moisture condition II

WORKSHEET: CURVE NUMBER

Project:	Monte Verde	By:	GAS	Date:	May 29, 2006
Location:	Mayagüez	Checked:	MMF	Date:	May 29, 2006

BASIN NAME: **NORTH BASIN (BN)** **CONDITION:** **EXISTING**

BASIN AREA (Ac) = 11.49

BASIN AREA (mi^2) = 0.0180

HYDROLOGIC SOIL GROUP	LAND USE	CN*	AREA, (Ac)	PRODUCT OF AREA x CN
C	Woods	70	11.49	804.3
		Totals	11.49	804.3

CN	70

* Antecedent moisture condition II

WORKSHEET: CURVE NUMBER

Project:	Monte Verde	By:	GAS	Date:	May 29, 2006
Location:	Mayagüez	Checked:	MMF	Date:	May 29, 2006

BASIN NAME: **PROJECT (PROJ)** **CONDITION:** **PROPOSED**

BASIN AREA (Ac) = 91.92

BASIN AREA (mi^2) = 0.1436

HYDROLOGIC SOIL GROUP	LAND USE	CN*	AREA, (Ac)	PRODUCT OF AREA x CN
C	Residential	90	91.92	8272.8
		Totals	91.92	8272.8

CN	90

* Antecedent moisture condition II

WORKSHEET: TIME OF CONCENTRATION (Tc)

CONDITIÓN: **Existing** **BASIN NAME:** **External**

L = 21,550 meters x 3.28 = 70,702.10 feet

S = 458.8 (top) – 14.3 (bottom) = 444.50 ÷ 21,550 = 0.0206

Equation

$$Tc = \frac{0.00013L^{0.77}}{S^{0.385}}$$

$$Tc = 0.00013 \times \frac{(70{,}702.10)^{0.77}}{(0.0206)^{0.385}}$$

Total = 3.142 x 60 = 188.52 minutes*

Tc = 188 minutes

*If the total is less than 5 minutes use 5 min.

RAINFALL INCHES

Latitude: 18.24297222 N **Longitude: 67.1254167 W**

Rainfall Event

Duration, hr	0.083	0.25	1	2	3	6	12	24
Rainfall ,in 100 YR	0.80	1.40	3.32	4.41	4.86	6.13	8.33	11.01
Rainfall ,in 2 YR	0.52	0.90	2.14	2.70	2.81	3.13	3.38	3.81

WORKSHEET: TIME OF CONCENTRATION (Tc)

CONDITIÓN: **Existing** **BASIN NAME:** **South East**

L = 240 meters x 3.28 = 787.40 feet

S = 80 (top) – 50 (bottom) = 30.00 ÷ 240 = 0.1250

Equation

$$Tc = \frac{0.00013L^{0.77}}{S^{0.385}}$$

$$Tc = 0.00013 \times \frac{(787.40)^{0.77}}{(0.1250)^{0.385}}$$

Total = 0.049 x 60 = 2.94 minutes*

Tc = 5 minutes

*If the total is less than 5 minutes use 5 min.

RAINFALL INCHES

Latitude: 18.24297222 N **Longitude: 67.1254167 W**

Rainfall Event

Duration, hr	0.083	0.25	1	2	3	6	12	24
Rainfall ,in 100 YR	0.80	1.40	3.32	4.41	4.86	6.13	8.33	11.01
Rainfall ,in 2 YR	0.52	0.90	2.14	2.70	2.81	3.13	3.38	3.81

WORKSHEET: TIME OF CONCENTRATION (Tc)

CONDITIÓN: **Existing** **BASIN NAME:** **South West**

L = 440 meters x 3.28 = 1,443.57 feet

S = 80 (top) – 35 (bottom) = 45.00 ÷ 440 = 0.1023

Equation

$$Tc = \frac{0.00013L^{0.77}}{S^{0.385}}$$

$$Tc = 0.00013 \times \frac{(1{,}443.57)^{0.77}}{(0.1023)^{0.385}}$$

Total = 0.085 x 60 = 5.1 minutes*

Tc = 5 minutes

*If the total is less than 5 minutes use 5 min.

RAINFALL INCHES

Latitude: 18.24297222 N **Longitude: 67.1254167 W**

Rainfall Event

Duration, hr	0.083	0.25	1	2	3	6	12	24
Rainfall ,in 100 YR	0.80	1.40	3.32	4.41	4.86	6.13	8.33	11.01
Rainfall ,in 2 YR	0.52	0.90	2.14	2.70	2.81	3.13	3.38	3.81

WORKSHEET: TIME OF CONCENTRATION (Tc)

CONDITIÓN: **Existing** **BASIN NAME:** **North**

L = 276 meters x 3.28 = 905.51 feet

S = 50 (top) – 30 (bottom) = 20.00 ÷ 276 = 0.0725

Equation

$$Tc = \frac{0.00013L^{0.77}}{S^{0.385}}$$

$$Tc = 0.00013 \times \frac{(905.51)^{0.77}}{(0.0725)^{0.385}}$$

Total = 0.068 x 60 = 4.08 minutes*

Tc = 5 minutes

*If the total is less than 5 minutes use 5 min.

RAINFALL INCHES

Latitude: 18.24297222 N **Longitude: 67.1254167 W**

Rainfall Event

Duration, hr	0.083	0.25	1	2	3	6	12	24
Rainfall ,in 100 YR	0.80	1.40	3.32	4.41	4.86	6.13	8.33	11.01
Rainfall ,in 2 YR	0.52	0.90	2.14	2.70	2.81	3.13	3.38	3.81

PROJECT: Monte Verde

LOCATION: Mayagüez

DATE: May 29, 2006

HYDROLOGIC DATA RESULTS
EXISTING 100-yr

BASIN	AREA, ac (mi^2)	CN	T_C, min	Q, cfs (cms)
BC1	37.87 (0.0592)	70	5	224 (6.34)
BC2	15.37 (0.0240)	70	5	91 (2.58)
Combination (COMBC)				315 (8.92)
BSE	17.29 (0.0270)	70	5	102 (2.89)
BSW	25.86 (0.0104)	70	5	153 (4.33)
Combination (COMBP)				570 (16.14)
EXT	7,277 (11.37)	70	188	9,067 (256.74)
Combination (COMB)				9,105 (257.82)
BN	11.49 (0.0180)	70	5	68 (1.93)

PROJECT: Monte Verde

LOCATION: Mayagüez

DATE: May 29, 2006

HYDROLOGIC DATA RESULTS
PROPOSED 100-yr

BASIN	AREA, ac (mi^2)	CN	T_C, min	Q, cfs (cms)
BC2	15.37 (0.0240)	70	5	91 (2.58)
PROJ	91.92 (0.1436)	90	5	689 (19.51)
Combination (COMBP)				779 (22.05)
EXT	7,277 (11.37)	70	188	9,067 (256.75)
Combination (COMB)				9,114 (258.08)

PROJECT: Monte Verde

LOCATION: Mayagüez

DATE: May 29, 2006

HYDROLOGIC DATA RESULTS
EXISTING 2-yr

BASIN	AREA, ac (mi^2)	CN	T_C, min	Q, cfs (cms)
BC1	37.87 (0.0592)	70	5	64 (1.81)
BC2	15.37 (0.0240)	70	5	26 (0.74)
Combination (COMBC)				90 (2.55)
BSE	17.29 (0.0270)	70	5	29 (0.82)
BSW	25.86 (0.0104)	70	5	44 (1.25)
Combination (COMBP)				164 (4.64)
EXT	7,277 (11.37)	70	188	2,292 (64.90)
Combination (COMB)				2,298 (65.07)
BN	11.49 (0.0180)	70	5	20 (0.57)

PROJECT: Monte Verde

LOCATION: Mayagüez

DATE: May 29, 2006

HYDROLOGIC DATA RESULTS
PROPOSED 2-yr

BASIN	AREA, ac (mi^2)	CN	T_C, min	Q, cfs (cms)
BC2	15.37 (0.0240)	70	5	26 (0.74)
PROJ	91.92 (0.1436)	90	5	383 (10.84)
Combination (COMBP)				410 (1161)
EXT	7,277 (11.37)	70	188	2,292 (64.90)
Combination (COMB)				2,302 (65.18)

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1****************************************
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 *                                      *                                                  *
*
 *   FLOOD HYDROGRAPH PACKAGE  (HEC-1)  *                                                  *    U.S. ARMY CORPS OF ENGINEERS
*
 *              JUN   1998              *                                                  *    HYDROLOGIC ENGINEERING CENTER
*
 *           VERSION 4.1                *                                                  *          609 SECOND STREET
*
 *                                      *                                                  *       DAVIS, CALIFORNIA 95616
*
 *  RUN DATE   23MAR07  TIME  13:02:00  *                                                  *           (916) 756-1104
*
 *                                      *                                                  *
*
 ****************************************
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X     X  XXXXXXX   XXXXX          X
X     X  X        X     X        XX
X     X  X        X               X
XXXXXXX  XXXX     X        XXXXX  X
X     X  X        X               X
X     X  X        X     X         X
X     X  XXXXXXX   XXXXX         XXX
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THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL   LOSS RATE:GREEN AND AMPT INFILTRATION
KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM
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```
1                                                HEC-1 INPUT                                                PAGE  1

          LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

            1           ID        HYDROLOGIC ANALYSIS FOR RIO CA¥AS, A¥ASCO
            2           ID        EXISTING CONDITION
            3           ID        MAY 2006: FILENAME=EXIS2.DAT: MENAR HYDROSYSTEMS
            4           ID        24-HOUR BALANCED STORM DISTRIBUTION : AMC II
            5           ID        2-YEAR FREQUENCY STORM
            6           IT       3 29MAY06       0     300 29MAY06    2400
            7           IO       3
                        *
                        *DIAGRAM
                        *
                        *
                        *  BASIN CREEK 1
                        *
                        *

            8           KK     BC1
            9           BA  0.0592
           10           LS       0      70
           11           UD    0.05
           12           PH       0       0    0.52    0.90    2.14    2.70    2.81    3.13    3.38    3.81
                        *
                        *
                        *  BASIN CREEK 2
                        *

           13           KK     BC2
           14           BA   0.024
           15           LS       0      70
           16           UD    0.05
                        *
                        *
                        *  COMBINATION CREEK
                        *
                        *

           17           KK    COMC
           18           HC       2
                        *
                        *
                        *  BASIN SOUTH EAST
                        *
                        *

           19           KK     BSE
           20           BA  0.0270
           21           LS       0      70
           22           UD    0.05
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                        *
                        *
                        *  SOUTH WEST BASIN
                        *
                        *
1                                                HEC-1 INPUT                                                PAGE  2

          LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10


            23          KK     BSW
            24          BA  0.0404
            25          LS       0      70
            26          UD    0.05
                        *
                        *
                        *  COMBINATION PROJECT
                        *
                        *

            27          KK   COMBP
            28          HC       3
                        *
                        *
                        *  RIO CANAS BASIN
                        *
                        *

            29          KK     EXT
            30          BA   11.37
            31          LS       0      70
            32          UD    1.88
                        *
                        *
                        *  COMBINATION
                        *
                        *

            33          KK    COMB
            34          HC       2
                        *
                        *
                        *  BASIN NORTH
                        *
                        *

            35          KK      BN
            36          BA   0.018
            37          LS       0      70
            38          UD    0.05
                        *
                        *
            39          ZZ
1
                 SCHEMATIC DIAGRAM OF STREAM NETWORK
 INPUT
  LINE      (V) ROUTING          (--->) DIVERSION OR PUMP FLOW

   NO.      (.) CONNECTOR        (<---) RETURN OF DIVERTED OR PUMPED FLOW

     8         BC1
                .
                .
    13          .         BC2
                .           .
                .           .
    17        COMC............
                .
                .
    19          .         BSE
                .           .
                .           .
    23          .           .         BSW
                .           .           .
                .           .           .
    27       COMBP........................
                .
                .
    29          .         EXT
                .           .
                .           .
    33        COMB............
                .
                .
    35          .          BN

 (***) RUNOFF ALSO COMPUTED AT THIS LOCATION
1****************************************
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 *                                    *                                                    *
*
 *   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *                                                    *    U.S. ARMY CORPS OF ENGINEERS
*
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 *              JUN   1998              *                                                    *    HYDROLOGIC ENGINEERING CENTER
*
 *            VERSION 4.1               *                                                    *          609 SECOND STREET
*
 *                                      *                                                    *       DAVIS, CALIFORNIA 95616
*
 *  RUN DATE   23MAR07  TIME  13:02:00  *                                                    *           (916) 756-1104
*
 *                                      *                                                    *
*
 ****************************************
*************************************


                              HYDROLOGIC ANALYSIS FOR RIO CA¥AS, A¥ASCO
                              EXISTING CONDITION
                              MAY 2006: FILENAME=EXIS2.DAT: MENAR HYDROSYSTEMS
                              24-HOUR BALANCED STORM DISTRIBUTION : AMC II
                              2-YEAR FREQUENCY STORM

    7 IO          OUTPUT CONTROL VARIABLES
                        IPRNT           3  PRINT CONTROL
                        IPLOT           0  PLOT CONTROL
                        QSCAL          0.  HYDROGRAPH PLOT SCALE

      IT          HYDROGRAPH TIME DATA
                         NMIN           3  MINUTES IN COMPUTATION INTERVAL
                        IDATE     29MAY 6  STARTING DATE
                        ITIME        0000  STARTING TIME
                           NQ         481  NUMBER OF HYDROGRAPH ORDINATES
                       NDDATE     30MAY 6  ENDING DATE
                       NDTIME        0000  ENDING TIME
                       ICENT          19  CENTURY MARK

                  COMPUTATION INTERVAL     .05 HOURS
                       TOTAL TIME BASE   24.00 HOURS

          ENGLISH UNITS
               DRAINAGE AREA         SQUARE MILES
               PRECIPITATION DEPTH   INCHES
               LENGTH, ELEVATION     FEET
               FLOW                  CUBIC FEET PER SECOND
               STORAGE VOLUME        ACRE-FEET
               SURFACE AREA          ACRES
               TEMPERATURE           DEGREES FAHRENHEIT


 *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***
***


            **************
            *            *
    8 KK    *       BC1  *
            *            *
            **************

               SUBBASIN RUNOFF DATA

    9 BA          SUBBASIN CHARACTERISTICS
                        TAREA         .06  SUBBASIN AREA

                  PRECIPITATION DATA

   12 PH                                DEPTHS FOR   0-PERCENT HYPOTHETICAL STORM
                  ..... HYDRO-35 ......   ............... TP-40 ...............   ........... TP-49 ...........
                  5-MIN  15-MIN  60-MIN    2-HR    3-HR    6-HR   12-HR   24-HR   2-DAY   4-DAY   7-DAY  10-DAY
                    .52     .90    2.14    2.70    2.81    3.13    3.38    3.81     .00     .00     .00     .00

                                                 STORM AREA =     .06

   10 LS          SCS LOSS RATE
                        STRTL         .86  INITIAL ABSTRACTION
                       CRVNBR       70.00  CURVE NUMBER
                        RTIMP         .00  PERCENT IMPERVIOUS AREA

   11 UD          SCS DIMENSIONLESS UNITGRAPH
                         TLAG         .05  LAG

                                                                 ***

                                                            UNIT HYDROGRAPH
                                                         7 END-OF-PERIOD ORDINATES
               289.      315.      106.       37.       12.        4.        1.

      ***            ***            ***            ***            ***

                        HYDROGRAPH AT STATION      BC1

     TOTAL RAINFALL =    3.81, TOTAL LOSS =    2.61, TOTAL EXCESS =    1.20
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  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR     24.00-HR
+   (CFS)       (HR)
                          (CFS)
+      64.     12.05                    7.          2.          2.           2.
                        (INCHES)     1.057       1.203       1.203        1.203
                         (AC-FT)        3.          4.          4.           4.

                         CUMULATIVE AREA =     .06 SQ MI


 *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***
***


            **************
            *            *
   13 KK    *       BC2  *
            *            *
            **************

               SUBBASIN RUNOFF DATA

   14 BA          SUBBASIN CHARACTERISTICS
                        TAREA         .02  SUBBASIN AREA

                  PRECIPITATION DATA

   12 PH                                 DEPTHS FOR   0-PERCENT HYPOTHETICAL STORM
                  ..... HYDRO-35 ......   ............... TP-40 ...............   ........... TP-49 ...........
                  5-MIN  15-MIN  60-MIN    2-HR    3-HR    6-HR   12-HR   24-HR   2-DAY   4-DAY   7-DAY  10-DAY
                    .52     .90    2.14    2.70    2.81    3.13    3.38    3.81     .00     .00     .00     .00

                                                 STORM AREA =     .02

   15 LS          SCS LOSS RATE
                        STRTL         .86  INITIAL ABSTRACTION
                       CRVNBR       70.00  CURVE NUMBER
                        RTIMP         .00  PERCENT IMPERVIOUS AREA

   16 UD          SCS DIMENSIONLESS UNITGRAPH
                         TLAG         .05  LAG

                                                                 ***

                                                            UNIT HYDROGRAPH
                                                         7 END-OF-PERIOD ORDINATES
               117.      128.       43.       15.        5.        2.        1.

      ***            ***            ***            ***            ***

                        HYDROGRAPH AT STATION      BC2

    TOTAL RAINFALL =    3.81, TOTAL LOSS =    2.61, TOTAL EXCESS =    1.20

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR     24.00-HR
+   (CFS)       (HR)
                          (CFS)
+      26.     12.05                    3.          1.          1.           1.
                        (INCHES)     1.057       1.203       1.203        1.203
                         (AC-FT)        1.          2.          2.           2.

                         CUMULATIVE AREA =     .02 SQ MI


 *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***
***


            **************
            *            *
   17 KK    *      COMC  *
            *            *
            **************

   18 HC          HYDROGRAPH COMBINATION
                        ICOMP           2  NUMBER OF HYDROGRAPHS TO COMBINE

                                                                 ***

      ***            ***            ***            ***            ***

                        HYDROGRAPH AT STATION     COMC

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR     24.00-HR
+   (CFS)       (HR)
                          (CFS)
```

```
+      90.     12.05                    9.          3.          3.          3.
                       (INCHES)     1.057       1.203       1.203       1.203
                        (AC-FT)        5.          5.          5.          5.

                        CUMULATIVE AREA =     .08 SQ MI


 *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***
***


            **************
            *            *
   19 KK    *       BSE  *
            *            *
            **************

               SUBBASIN RUNOFF DATA

   20 BA          SUBBASIN CHARACTERISTICS
                        TAREA         .03  SUBBASIN AREA

                  PRECIPITATION DATA

   12 PH                              DEPTHS FOR   0-PERCENT HYPOTHETICAL STORM
                  ..... HYDRO-35 .....   ............... TP-40 ...............   ........... TP-49 ...........
                  5-MIN  15-MIN  60-MIN    2-HR    3-HR    6-HR   12-HR   24-HR   2-DAY   4-DAY   7-DAY  10-DAY
                    .52     .90    2.14    2.70    2.81    3.13    3.38    3.81     .00     .00     .00     .00

                                                   STORM AREA =     .03

   21 LS          SCS LOSS RATE
                        STRTL         .86  INITIAL ABSTRACTION
                       CRVNBR       70.00  CURVE NUMBER
                        RTIMP         .00  PERCENT IMPERVIOUS AREA

   22 UD          SCS DIMENSIONLESS UNITGRAPH
                         TLAG         .05  LAG

                                                                 ***

                                                          UNIT HYDROGRAPH
                                                     7 END-OF-PERIOD ORDINATES
               132.      143.       48.       17.        6.        2.        1.

      ***             ***             ***             ***             ***

                         HYDROGRAPH AT STATION      BSE

     TOTAL RAINFALL =    3.81, TOTAL LOSS =    2.61, TOTAL EXCESS =    1.20

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR     24.00-HR
+   (CFS)       (HR)
                           (CFS)
+      29.     12.05                    3.          1.          1.          1.
                       (INCHES)     1.057       1.203       1.203       1.203
                        (AC-FT)        2.          2.          2.          2.

                        CUMULATIVE AREA =     .03 SQ MI


 *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***
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            **************
            *            *
   23 KK    *       BSW  *
            *            *
            **************

               SUBBASIN RUNOFF DATA

   24 BA          SUBBASIN CHARACTERISTICS
                        TAREA         .04  SUBBASIN AREA

                  PRECIPITATION DATA

   12 PH                              DEPTHS FOR   0-PERCENT HYPOTHETICAL STORM
                  ..... HYDRO-35 .....   ............... TP-40 ...............   ........... TP-49 ...........
                  5-MIN  15-MIN  60-MIN    2-HR    3-HR    6-HR   12-HR   24-HR   2-DAY   4-DAY   7-DAY  10-DAY
                    .52     .90    2.14    2.70    2.81    3.13    3.38    3.81     .00     .00     .00     .00

                                                   STORM AREA =     .04

   25 LS          SCS LOSS RATE
                        STRTL         .86  INITIAL ABSTRACTION
                       CRVNBR       70.00  CURVE NUMBER
                        RTIMP         .00  PERCENT IMPERVIOUS AREA
```

```
  26 UD          SCS DIMENSIONLESS UNITGRAPH
                       TLAG        .05  LAG

                                                          ***

                                                   UNIT HYDROGRAPH
                                               7 END-OF-PERIOD ORDINATES
              198.      215.       72.       25.        8.        3.        1.

      ***             ***             ***             ***             ***

                        HYDROGRAPH AT STATION      BSW

    TOTAL RAINFALL =    3.81, TOTAL LOSS =    2.61, TOTAL EXCESS =    1.20

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR     24.00-HR
+   (CFS)       (HR)
                          (CFS)
+      44.     12.05                  5.          1.          1.          1.
                        (INCHES)     1.057       1.203       1.203       1.203
                         (AC-FT)       2.          3.          3.          3.

                        CUMULATIVE AREA =     .04 SQ MI


 *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***
***

            **************
            *            *
  27 KK     *     COMBP  *
            *            *
            **************

  28 HC          HYDROGRAPH COMBINATION
                       ICOMP           3  NUMBER OF HYDROGRAPHS TO COMBINE

                                                          ***

      ***             ***             ***             ***             ***

                        HYDROGRAPH AT STATION    COMBP

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR     24.00-HR
+   (CFS)       (HR)
                          (CFS)
+     164.     12.05                 17.          5.          5.          5.
                        (INCHES)     1.057       1.203       1.203       1.203
                         (AC-FT)       8.         10.         10.         10.

                        CUMULATIVE AREA =     .15 SQ MI


 *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***
***

            **************
            *            *
  29 KK     *       EXT  *
            *            *
            **************

               SUBBASIN RUNOFF DATA

  30 BA          SUBBASIN CHARACTERISTICS
                       TAREA       11.37  SUBBASIN AREA

                 PRECIPITATION DATA

  12 PH                                DEPTHS FOR   0-PERCENT HYPOTHETICAL STORM
                 ..... HYDRO-35 ......   ............... TP-40 ...............   ........... TP-49 ...........
                 5-MIN  15-MIN  60-MIN    2-HR    3-HR    6-HR   12-HR   24-HR   2-DAY   4-DAY   7-DAY  10-DAY
                   .52     .90    2.14    2.70    2.81    3.13    3.38    3.81     .00     .00     .00     .00

                                                     STORM AREA =   11.37

  31 LS          SCS LOSS RATE
                       STRTL         .86  INITIAL ABSTRACTION
                      CRVNBR       70.00  CURVE NUMBER
                       RTIMP         .00  PERCENT IMPERVIOUS AREA

  32 UD          SCS DIMENSIONLESS UNITGRAPH
                       TLAG        1.88  LAG

                                                          ***
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                                                  UNIT HYDROGRAPH
                                              190 END-OF-PERIOD ORDINATES
                23.       45.       68.       97.      150.      203.      255.      314.      382.      450.
               519.      600.      690.      781.      872.      986.     1107.     1228.     1349.     1492.
              1635.     1779.     1920.     2041.     2162.     2283.     2392.     2475.     2558.     2641.
              2705.     2750.     2796.     2841.     2860.     2867.     2875.     2882.     2876.     2869.
              2861.     2850.     2805.     2759.     2714.     2667.     2614.     2561.     2508.     2451.
              2391.     2330.     2269.     2199.     2123.     2048.     1972.     1883.     1793.     1702.
              1612.     1536.     1460.     1385.     1314.     1261.     1208.     1155.     1105.     1060.
              1015.      969.      928.      891.      853.      815.      785.      758.      730.      702.
               675.      647.      619.      593.      570.      547.      525.      502.      479.      457.
               434.      415.      400.      385.      370.      355.      340.      325.      309.      298.
               286.      275.      264.      252.      241.      230.      219.      211.      203.      194.
               186.      178.      169.      161.      155.      149.      143.      138.      132.      126.
               121.      115.      111.      107.      103.       98.       94.       90.       86.       82.
                79.       76.       73.       70.       67.       64.       61.       59.       56.       54.
                52.       50.       47.       45.       43.       41.       40.       38.       37.       35.
                34.       32.       31.       30.       29.       28.       28.       27.       26.       25.
                24.       23.       22.       21.       20.       19.       18.       18.       17.       16.
                15.       14.       13.       12.       12.       11.       10.        9.        9.        8.
                 7.        6.        6.        5.        4.        3.        3.        2.        1.        0.

      ***            ***            ***            ***            ***

                        HYDROGRAPH AT STATION      EXT

    TOTAL RAINFALL =    3.76, TOTAL LOSS =    2.59, TOTAL EXCESS =    1.17

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                       6-HR       24-HR       72-HR     24.00-HR
+   (CFS)       (HR)
                           (CFS)
+    2292.     14.20                 1170.        342.        342.         342.
                        (INCHES)      .956       1.120       1.120        1.120
                         (AC-FT)      580.        679.        679.         679.

                        CUMULATIVE AREA =   11.37 SQ MI


 *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***
***

            **************
            *            *
   33 KK    *      COMB  *
            *            *
            **************

   34 HC          HYDROGRAPH COMBINATION
                        ICOMP           2  NUMBER OF HYDROGRAPHS TO COMBINE

                                                                  ***

      ***            ***            ***            ***            ***

                        HYDROGRAPH AT STATION     COMB

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                       6-HR       24-HR       72-HR     24.00-HR
+   (CFS)       (HR)
                           (CFS)
+    2298.     14.20                 1176.        347.        347.         347.
                        (INCHES)      .949       1.121       1.121        1.121
                         (AC-FT)      583.        689.        689.         689.

                        CUMULATIVE AREA =   11.52 SQ MI


 *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***
***

            **************
            *            *
   35 KK    *        BN  *
            *            *
            **************

              SUBBASIN RUNOFF DATA

   36 BA        SUBBASIN CHARACTERISTICS
                      TAREA         .02  SUBBASIN AREA

                PRECIPITATION DATA

   12 PH                              DEPTHS FOR   0-PERCENT HYPOTHETICAL STORM
                ..... HYDRO-35 .....   ............... TP-40 ...............   ........... TP-49 ...........
                5-MIN  15-MIN  60-MIN    2-HR    3-HR    6-HR   12-HR   24-HR   2-DAY   4-DAY   7-DAY  10-DAY
```

```
                .52     .90    2.14    2.70    2.81    3.13    3.38    3.81     .00     .00     .00     .00

                                                STORM AREA =     .02

  37 LS          SCS LOSS RATE
                       STRTL         .86  INITIAL ABSTRACTION
                      CRVNBR       70.00  CURVE NUMBER
                       RTIMP         .00  PERCENT IMPERVIOUS AREA

  38 UD          SCS DIMENSIONLESS UNITGRAPH
                        TLAG         .05  LAG

                                                                ***

                                                          UNIT HYDROGRAPH
                                                     7 END-OF-PERIOD ORDINATES
               88.       96.       32.       11.        4.        1.        0.

     ***            ***            ***            ***            ***

                        HYDROGRAPH AT STATION       BN

    TOTAL RAINFALL =    3.81, TOTAL LOSS =    2.61, TOTAL EXCESS =    1.20

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                      6-HR       24-HR       72-HR     24.00-HR
+   (CFS)       (HR)
                                    (CFS)
+      20.     12.05                    2.          1.          1.          1.
                                (INCHES)     1.057       1.203       1.203       1.203
                                 (AC-FT)        1.          1.          1.          1.

                                CUMULATIVE AREA =     .02 SQ MI

1
                                                          RUNOFF SUMMARY
                                                     FLOW IN CUBIC FEET PER SECOND
                                                   TIME IN HOURS,  AREA IN SQUARE MILES

                                          PEAK   TIME OF     AVERAGE FLOW FOR MAXIMUM PERIOD      BASIN     MAXIMUM     TIME OF
          OPERATION       STATION        FLOW     PEAK                                          AREA      STAGE     MAX STAGE
+                                                                 6-HOUR     24-HOUR     72-HOUR

          HYDROGRAPH AT
+                            BC1         64.   12.05           7.          2.          2.        .06

          HYDROGRAPH AT
+                            BC2         26.   12.05           3.          1.          1.        .02

          2 COMBINED AT
+                           COMC         90.   12.05           9.          3.          3.        .08

          HYDROGRAPH AT
+                            BSE         29.   12.05           3.          1.          1.        .03

          HYDROGRAPH AT
+                            BSW         44.   12.05           5.          1.          1.        .04

          3 COMBINED AT
+                          COMBP        164.   12.05          17.          5.          5.        .15

          HYDROGRAPH AT
+                            EXT       2292.   14.20        1170.        342.        342.      11.37

          2 COMBINED AT
+                           COMB       2298.   14.20        1176.        347.        347.      11.52

          HYDROGRAPH AT
+                             BN         20.   12.05           2.          1.          1.        .02


 *** NORMAL END OF HEC-1 ***
```

POINT PRECIPITATION FREQUENCY ESTIMATES FROM NOAA ATLAS 14

Puerto Rico 18.24297222 N 67.1254167 W 108 feet

from "Precipitation-Frequency Atlas of the United States" NOAA Atlas 14, Volume 3, Version 3
G.M. Bonnin, D. Martin, B. Lin, T. Parzybok, M.Yekta, and D. Riley
NOAA, National Weather Service, Silver Spring, Maryland, 2006

Extracted: Thu Feb 15 2007

Confidence Limits | Seasonality | Location Maps | Other Info. | GIS data | Maps | Help | Docs

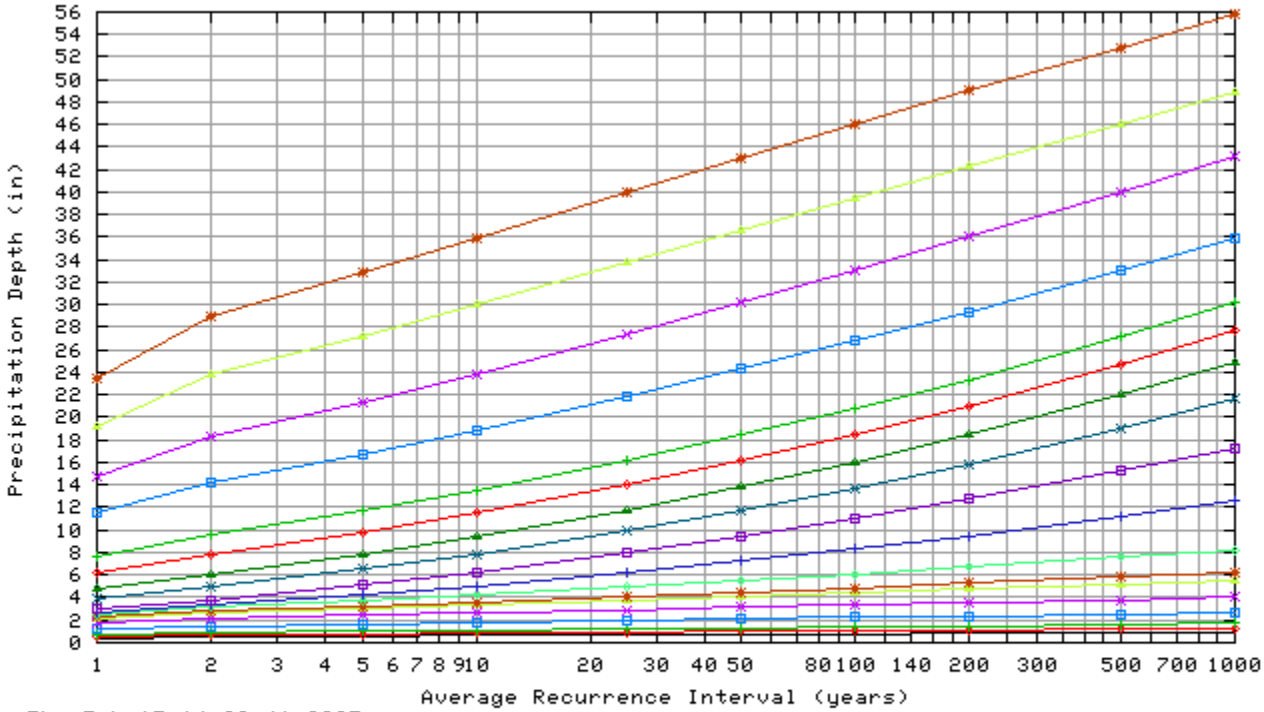
Precipitation Frequency Estimates (inches)

ARI* (years)	5 min	10 min	15 min	30 min	60 min	120 min	3 hr	6 hr	12 hr	24 hr	48 hr	4 day	7 day	10 day	20 day	30 day
1	0.42	0.57	0.74	1.18	1.75	2.19	2.28	2.51	2.68	2.97	3.90	4.80	6.27	7.64	11.51	14.77
2	0.52	0.70	0.90	1.45	2.14	2.70	2.81	3.13	3.38	3.81	4.97	6.09	7.88	9.55	14.26	18.26
5	0.58	0.79	1.02	1.63	2.41	3.09	3.27	3.79	4.27	5.13	6.51	7.85	9.80	11.66	16.75	21.28
10	0.63	0.86	1.11	1.77	2.63	3.37	3.60	4.30	5.06	6.28	7.89	9.44	11.53	13.53	18.92	23.88
25	0.70	0.95	1.22	1.96	2.90	3.78	4.09	4.99	6.25	7.99	9.98	11.79	14.05	16.20	21.93	27.42
50	0.75	1.02	1.31	2.10	3.12	4.10	4.48	5.55	7.25	9.44	11.77	13.80	16.18	18.41	24.33	30.23
100	0.80	1.09	1.40	2.24	3.32	4.41	4.86	6.13	8.33	11.01	13.72	15.99	18.46	20.76	26.79	33.07
200	0.84	1.16	1.48	2.37	3.52	4.72	5.25	6.74	9.50	12.74	15.87	18.43	20.94	23.30	29.39	36.0
500	0.91	1.25	1.60	2.56	3.80	5.14	5.79	7.57	11.19	15.24	19.01	22.00	24.66	27.16	33.04	40.06
1000	0.97	1.32	1.69	2.71	4.02	5.46	6.20	8.23	12.57	17.31	21.63	24.98	27.73	30.30	35.95	43.28

Text version of table

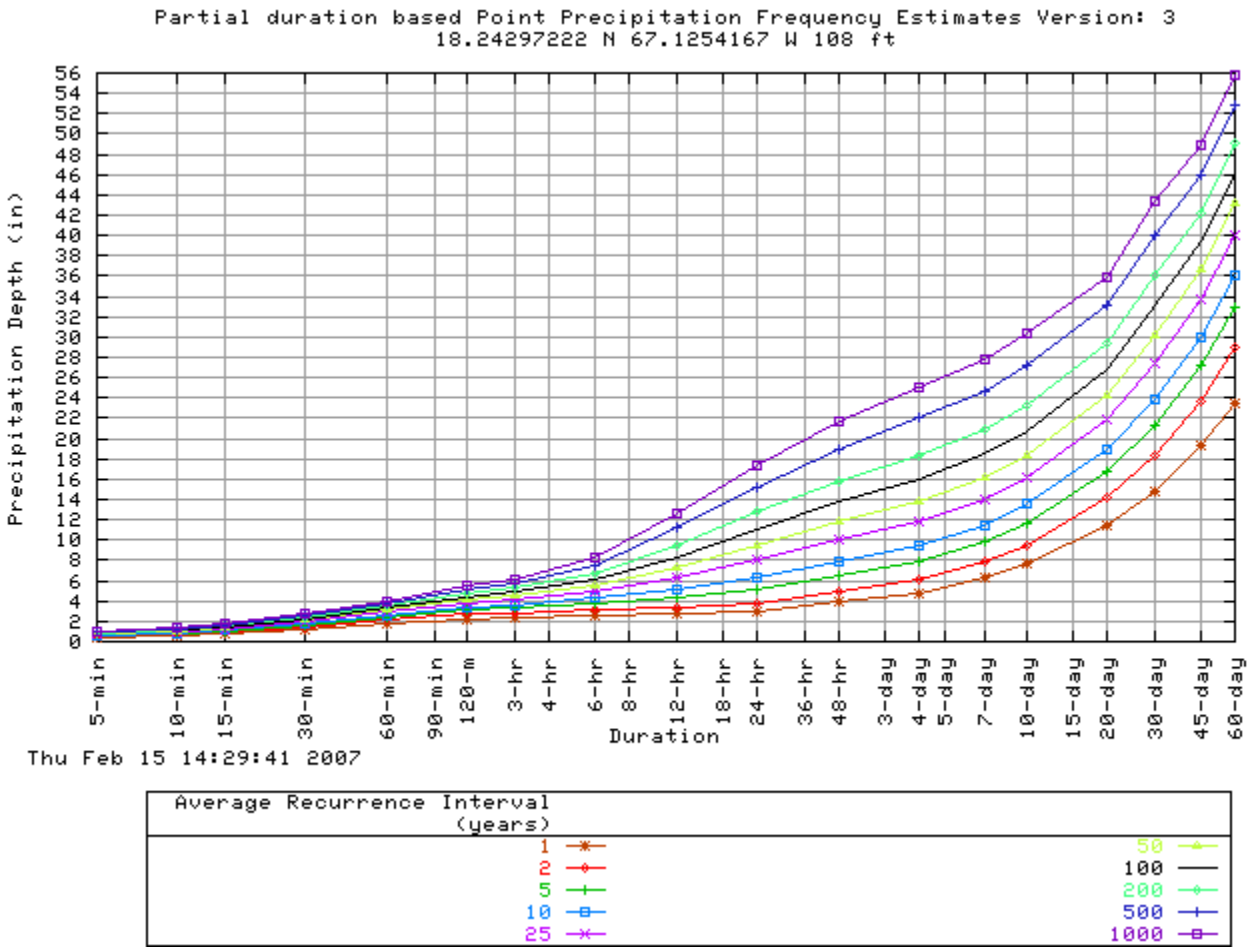
* These precipitation frequency estimates are based on a partial duration series. **ARI** is the Average Recurrence Interval. Please refer to the documentation for more information. NOTE: Formatting forces estimates near zero to appear as zero.

Partial duration based Point Precipitation Frequency Estimates Version: 3
18.24297222 N 67.1254167 W 108 ft



Thu Feb 15 14:29:41 2007

Duration			
5-min	120-m	48-hr	30-day
10-min	3-hr	4-day	45-day
15-min	6-hr	7-day	60-day
30-min	12-hr	10-day	
60-min	24-hr	20-day	



Confidence Limits -

* Upper bound of the 90% confidence interval Precipitation Frequency Estimates (inches)																
ARI** (years)	5 min	10 min	15 min	30 min	60 min	120 min	3 hr	6 hr	12 hr	24 hr	48 hr	4 day	7 day	10 day	20 day	30 day
1	0.45	0.61	0.78	1.25	1.86	2.34	2.45	2.73	2.96	3.30	4.27	5.24	6.76	8.19	12.23	15.66
2	0.52	0.71	0.91	1.46	2.17	2.73	2.84	3.16	3.74	4.23	5.44	6.66	8.54	10.30	15.21	19.43
5	0.58	0.80	1.03	1.64	2.44	3.12	3.30	3.83	4.69	5.63	7.09	8.59	10.65	12.60	17.91	22.68
10	0.67	0.92	1.18	1.88	2.79	3.40	3.64	4.34	5.63	6.87	8.63	10.36	12.57	14.67	20.29	25.53
25	0.74	1.01	1.30	2.08	3.08	3.82	4.13	5.04	6.31	8.84	11.07	13.10	15.49	17.73	23.72	29.52
50	0.80	1.09	1.40	2.24	3.32	4.14	4.53	5.61	7.32	10.54	13.28	15.56	18.04	20.36	26.51	32.76
100	0.86	1.18	1.51	2.42	3.58	4.45	4.91	6.19	8.41	12.49	15.80	18.34	20.85	23.22	29.45	36.14
200	0.92	1.26	1.62	2.59	3.85	4.77	5.30	6.80	9.59	14.67	18.63	21.51	23.96	26.35	32.65	39.76
500	1.01	1.38	1.77	2.84	4.21	5.19	5.85	7.64	11.30	17.96	22.91	26.26	28.77	31.26	37.23	44.88
1000	1.08	1.48	1.90	3.04	4.51	5.51	6.27	8.31	12.70	20.72	26.59	30.28	32.88	35.34	40.98	49.04

* The **upper** bound of the confidence interval at 90% confidence level is the value which 5% of the simulated quantile values for a given frequency are **greater** than.
** These precipitation frequency estimates are based on a partial duration series. **ARI** is the Average Recurrence Interval.
Please refer to the documentation for more information. NOTE: Formatting prevents estimates near zero to appear as zero.

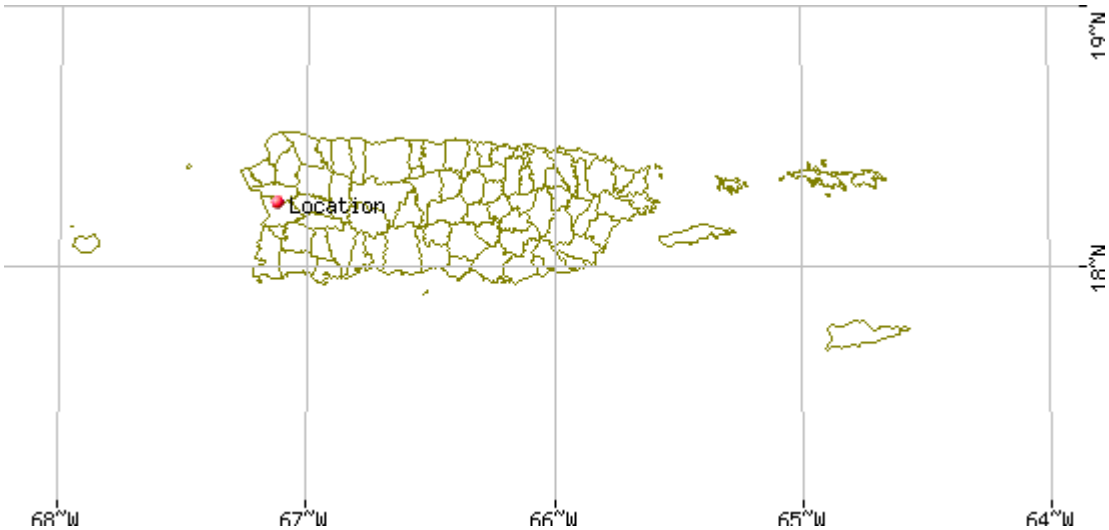
* Lower bound of the 90% confidence interval Precipitation Frequency Estimates (inches)																

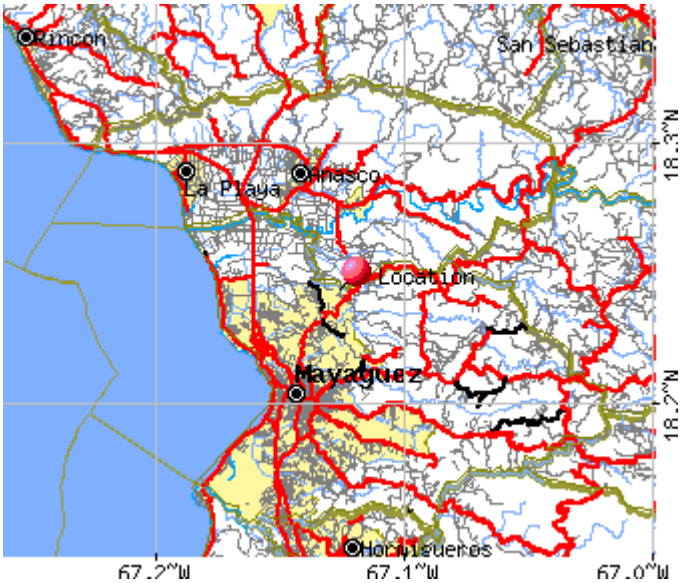
ARI** (years)	5 min	10 min	15 min	30 min	60 min	120 min	3 hr	6 hr	12 hr	24 hr	48 hr	4 day	7 day	10 day	20 day	30 day
1	0.40	0.54	0.69	1.11	1.64	2.06	2.13	2.33	2.44	2.72	3.59	4.44	5.84	7.15	10.87	13.96
2	0.48	0.66	0.84	1.35	2.01	2.52	2.62	2.89	3.07	3.48	4.56	5.62	7.34	8.94	13.45	17.27
5	0.57	0.78	1.01	1.61	2.39	2.88	3.06	3.52	3.91	4.68	5.97	7.21	9.08	10.87	15.75	20.06
10	0.62	0.85	1.09	1.75	2.60	3.15	3.36	3.96	4.58	5.69	7.17	8.59	10.58	12.50	17.68	22.39
25	0.69	0.94	1.21	1.94	2.87	3.51	3.79	4.55	5.53	7.13	8.89	10.52	12.67	14.75	20.25	25.43
50	0.74	1.01	1.30	2.08	3.08	3.77	4.09	4.97	6.28	8.30	10.29	12.10	14.36	16.55	22.25	27.78
100	0.79	1.08	1.38	2.21	3.29	4.02	4.39	5.38	7.04	9.52	11.74	13.75	16.11	18.39	24.24	30.09
200	0.84	1.14	1.47	2.35	3.49	4.27	4.67	5.83	7.84	10.82	13.29	15.54	17.99	20.33	26.30	32.44
500	0.90	1.24	1.58	2.54	3.77	4.58	5.05	6.39	8.93	12.64	15.50	18.08	20.73	23.20	29.08	35.53
1000	0.96	1.31	1.68	2.69	3.98	4.81	5.34	6.83	9.76	14.11	17.27	20.11	22.90	25.50	31.25	37.95

* The **lower** bound of the confidence interval at 90% confidence level is the value which 5% of the simulated quantile values for a given frequency are **less** than.
** These precipitation frequency estimates are based on a partial duration maxima series. **ARI** is the Average Recurrence Interval.

Please refer to the documentation for more information. NOTE: Formatting prevents estimates near zero to appear as zero.

Maps -





These maps were produced using a direct map request from the U.S. Census Bureau Mapping and Cartographic Resources **Tiger Map Server**.

Please read disclaimer for more information.

LEGEND

State
County
Indian Resv
Lake/Pond/Ocean
Street
Expressway
Highway
Connector
Stream
Military Area
National Park
Other Park
City
County

Scale 1:228583
0 2 4 6 8 mi
0 2 4 6 8 10 km
*average--true scale depends on monitor resolution

Other Maps/Photographs -

View USGS digital orthophoto quadrangle (DOQ) covering this location from TerraServer; **USGS Aerial Photograph** may also be available
from this site. A DOQ is a computer-generated image of an aerial photograph in which image displacement caused by terrain relief and camera tilts has been removed. It combines the image characteristics of a photograph with the geometric qualities of a map. Visit the USGS for more information.

Watershed/Stream Flow Information -

Find the Watershed for this location using the U.S. Environmental Protection Agency's site.

Climate Data Sources -

Precipitation frequency results are based on data from a variety of sources, but largely NCDC. The following links provide general information
about observing sites in the area, regardless of if their data was used in this study. For detailed information about the stations used in this study,
please refer to our documentation.

Using the National Climatic Data Center's (NCDC) station search engine, locate other climate stations within:

+/-30 minutes ...OR... +/-1 degree of this location (18.24297222/-67.1254167). Digital ASCII data can be obtained directly from NCDC.

Hydrometeorological Design Studies Center
DOC/NOAA/National Weather Service
1325 East-West Highway
Silver Spring, MD 20910

(301) 713-1669
Questions?: HDSC.Questions@noaa.gov

Disclaimer

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1****************************************                                                    ****************************************
 *                                      *                                                    *                                      *
 *   FLOOD HYDROGRAPH PACKAGE  (HEC-1)  *                                                    *    U.S. ARMY CORPS OF ENGINEERS      *
 *              JUN   1998              *                                                    *    HYDROLOGIC ENGINEERING CENTER     *
 *           VERSION 4.1                *                                                    *          609 SECOND STREET           *
 *                                      *                                                    *       DAVIS, CALIFORNIA 95616        *
 *  RUN DATE   23MAR07  TIME  13:00:37  *                                                    *           (916) 756-1104             *
 *                                      *                                                    *                                      *
 ****************************************                                                    ****************************************


                                                X     X  XXXXXXX   XXXXX           X
                                                X     X  X        X     X         XX
                                                X     X  X        X                X
                                                XXXXXXX  XXXX     X        XXXXX   X
                                                X     X  X        X                X
                                                X     X  X        X     X          X
                                                X     X  XXXXXXX   XXXXX          XXX


          THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

          THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
          THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
          NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
          DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL   LOSS RATE:GREEN AND AMPT INFILTRATION
          KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM

1                                                   HEC-1 INPUT                                                   PAGE  1

          LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

            1           ID        HYDROLOGIC ANALYSIS FOR RIO CA¥AS, A¥ASCO
            2           ID        EXISTING CONDITION
            3           ID        MAY 2006: FILENAME=EXIS.DAT: MENAR HYDROSYSTEMS
            4           ID        24-HOUR BALANCED STORM DISTRIBUTION : AMC II
            5           ID        100-YEAR FREQUENCY STORM
            6           IT       3 29MAY05       0     300 29MAY06    2400
            7           IO       3
                        *
                        *DIAGRAM
                        *
                        *
                        *  BASIN CREEK 1
                        *
                        *

            8           KK     BC1
            9           BA  0.0592
           10           LS       0      70
           11           UD    0.05
           12           PH       0       0    0.80    1.40    3.32    4.41    4.86    6.13    8.33   11.01
                        *
                        *
                        *  BASIN CREEK 2
                        *

           13           KK     BC2
           14           BA   0.024
           15           LS       0      70
           16           UD    0.05
                        *
                        *
                        *  COMBINATION CREEK
                        *
                        *

           17           KK    COMC
           18           HC       2
                        *
                        *
                        *  BASIN SOUTH EAST
                        *
                        *

           19           KK     BSE
           20           BA  0.0270
           21           LS       0      70
           22           UD    0.05
                        *
                        *
                        *  SOUTH WEST BASIN
                        *
                        *
1                                                   HEC-1 INPUT                                                   PAGE  2

          LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

           23           KK     BSW
           24           BA  0.0404
           25           LS       0      70
           26           UD    0.05
                        *
                        *
                        *  COMBINATION PROJECT
                        *
                        *
```

```
            27          KK   COMBP
            28          HC       3
                        *
                        *
                        *  RIO CANAS BASIN
                        *
                        *

            29          KK     EXT
            30          BA   11.37
            31          LS       0      70
            32          UD    1.88
                        *
                        *
                        *  COMBINATION
                        *
                        *

            33          KK    COMB
            34          HC       2
                        *
                        *
                        *  BASIN NORTH
                        *
                        *

            35          KK      BN
            36          BA   0.018
            37          LS       0      70
            38          UD    0.05
                        *
                        *
            39          ZZ
1
                SCHEMATIC DIAGRAM OF STREAM NETWORK
 INPUT
  LINE      (V) ROUTING          (--->) DIVERSION OR PUMP FLOW

   NO.      (.) CONNECTOR        (<---) RETURN OF DIVERTED OR PUMPED FLOW

     8         BC1
                .
                .
    13          .         BC2
                .           .
                .           .
    17        COMC............
                .
                .
    19          .         BSE
                .           .
                .           .
    23          .           .         BSW
                .           .           .
                .           .           .
    27       COMBP........................
                .
                .
    29          .         EXT
                .           .
                .           .
    33        COMB............
                .
                .
    35          .          BN

 (***) RUNOFF ALSO COMPUTED AT THIS LOCATION
1****************************************                                    ****************************************
 *                                      *                                    *                                      *
 *   FLOOD HYDROGRAPH PACKAGE  (HEC-1)  *                                    *    U.S. ARMY CORPS OF ENGINEERS      *
 *               JUN   1998             *                                    *    HYDROLOGIC ENGINEERING CENTER     *
 *            VERSION 4.1               *                                    *          609 SECOND STREET           *
 *                                      *                                    *       DAVIS, CALIFORNIA 95616        *
 *  RUN DATE   23MAR07  TIME  13:00:37  *                                    *           (916) 756-1104             *
 *                                      *                                    *                                      *
 ****************************************                                    ****************************************


                                HYDROLOGIC ANALYSIS FOR RIO CA¥AS, A¥ASCO
                                EXISTING CONDITION
                                MAY 2006: FILENAME=EXIS.DAT: MENAR HYDROSYSTEMS
                                24-HOUR BALANCED STORM DISTRIBUTION : AMC II
                                100-YEAR FREQUENCY STORM

 *** ERROR *** SPECIFIED START AND END DATES RESULT IN TOO MANY TIME PERIODS

    7 IO          OUTPUT CONTROL VARIABLES
                        IPRNT           3  PRINT CONTROL
                        IPLOT           0  PLOT CONTROL
                        QSCAL          0.  HYDROGRAPH PLOT SCALE

      IT          HYDROGRAPH TIME DATA
                         NMIN           3  MINUTES IN COMPUTATION INTERVAL
                        IDATE     29MAY 5  STARTING DATE
                        ITIME        0000  STARTING TIME
                           NQ        2000  NUMBER OF HYDROGRAPH ORDINATES
                       NDDATE      2JUN 5  ENDING DATE
                       NDTIME        0357  ENDING TIME
                       ICENT           19  CENTURY MARK

                   COMPUTATION INTERVAL     .05 HOURS
                        TOTAL TIME BASE   99.95 HOURS
```

```
          ENGLISH UNITS
               DRAINAGE AREA         SQUARE MILES
               PRECIPITATION DEPTH   INCHES
               LENGTH, ELEVATION     FEET
               FLOW                  CUBIC FEET PER SECOND
               STORAGE VOLUME        ACRE-FEET
               SURFACE AREA          ACRES
               TEMPERATURE           DEGREES FAHRENHEIT


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***


            **************
            *            *
   8 KK     *       BC1  *
            *            *
            **************

               SUBBASIN RUNOFF DATA

   9 BA          SUBBASIN CHARACTERISTICS
                      TAREA         .06  SUBBASIN AREA

                 PRECIPITATION DATA

  12 PH                                DEPTHS FOR   0-PERCENT HYPOTHETICAL STORM
                 ..... HYDRO-35 .....   ............... TP-40 ...............   ........... TP-49 ...........
                 5-MIN  15-MIN  60-MIN    2-HR    3-HR    6-HR   12-HR   24-HR   2-DAY   4-DAY   7-DAY  10-DAY
                   .80    1.40    3.32    4.41    4.86    6.13    8.33   11.01     .00     .00     .00     .00

                                                   STORM AREA =     .06

  10 LS          SCS LOSS RATE
                      STRTL         .86  INITIAL ABSTRACTION
                     CRVNBR       70.00  CURVE NUMBER
                      RTIMP         .00  PERCENT IMPERVIOUS AREA

  11 UD          SCS DIMENSIONLESS UNITGRAPH
                       TLAG         .05  LAG

                                                                 ***

                                                          UNIT HYDROGRAPH
                                                      7 END-OF-PERIOD ORDINATES
               289.      315.      106.       37.       12.        4.        1.

      ***             ***             ***             ***             ***

                        HYDROGRAPH AT STATION      BC1

     TOTAL RAINFALL =   11.01, TOTAL LOSS =    3.87, TOTAL EXCESS =    7.14

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                        6-HR       24-HR       72-HR     99.95-HR
+   (CFS)       (HR)
                          (CFS)
+     224.     12.05                     30.         11.          4.           3.
                        (INCHES)     4.757       7.138       7.138        7.138
                         (AC-FT)       15.         23.         23.          23.

                        CUMULATIVE AREA =     .06 SQ MI


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***


            **************
            *            *
  13 KK     *       BC2  *
            *            *
            **************

               SUBBASIN RUNOFF DATA

  14 BA          SUBBASIN CHARACTERISTICS
                      TAREA         .02  SUBBASIN AREA

                 PRECIPITATION DATA

  12 PH                                DEPTHS FOR   0-PERCENT HYPOTHETICAL STORM
                 ..... HYDRO-35 .....   ............... TP-40 ...............   ........... TP-49 ...........
                 5-MIN  15-MIN  60-MIN    2-HR    3-HR    6-HR   12-HR   24-HR   2-DAY   4-DAY   7-DAY  10-DAY
                   .80    1.40    3.32    4.41    4.86    6.13    8.33   11.01     .00     .00     .00     .00

                                                   STORM AREA =     .02

  15 LS          SCS LOSS RATE
                      STRTL         .86  INITIAL ABSTRACTION
                     CRVNBR       70.00  CURVE NUMBER
                      RTIMP         .00  PERCENT IMPERVIOUS AREA

  16 UD          SCS DIMENSIONLESS UNITGRAPH
                       TLAG         .05  LAG

                                                                 ***

                                                          UNIT HYDROGRAPH
                                                      7 END-OF-PERIOD ORDINATES
               117.      128.       43.       15.        5.        2.        1.
```

```
      ***            ***            ***            ***            ***

                        HYDROGRAPH AT STATION      BC2

     TOTAL RAINFALL =   11.01, TOTAL LOSS =    3.87, TOTAL EXCESS =    7.14

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                      6-HR       24-HR       72-HR     99.95-HR
+   (CFS)       (HR)
                                 (CFS)
+      91.     12.05                  12.          5.          2.           1.
                            (INCHES)     4.757       7.139       7.139        7.139
                             (AC-FT)        6.          9.          9.           9.

                            CUMULATIVE AREA =     .02 SQ MI


 *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***


            **************
            *            *
   17 KK    *      COMC  *
            *            *
            **************

   18 HC          HYDROGRAPH COMBINATION
                        ICOMP           2  NUMBER OF HYDROGRAPHS TO COMBINE

                                                                  ***

      ***            ***            ***            ***            ***

                        HYDROGRAPH AT STATION     COMC

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                      6-HR       24-HR       72-HR     99.95-HR
+   (CFS)       (HR)
                                 (CFS)
+     315.     12.05                  43.         16.          5.           4.
                            (INCHES)     4.757       7.139       7.139        7.139
                             (AC-FT)       21.         32.         32.          32.

                            CUMULATIVE AREA =     .08 SQ MI


 *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***


            **************
            *            *
   19 KK    *       BSE  *
            *            *
            **************

               SUBBASIN RUNOFF DATA

   20 BA          SUBBASIN CHARACTERISTICS
                        TAREA         .03  SUBBASIN AREA

                  PRECIPITATION DATA

   12 PH                                 DEPTHS FOR   0-PERCENT HYPOTHETICAL STORM
                  ..... HYDRO-35 .....   ............... TP-40 ...............   ........... TP-49 ...........
                  5-MIN  15-MIN  60-MIN    2-HR    3-HR    6-HR   12-HR   24-HR   2-DAY   4-DAY   7-DAY  10-DAY
                    .80    1.40    3.32    4.41    4.86    6.13    8.33   11.01     .00     .00     .00     .00

                                                     STORM AREA =     .03

   21 LS          SCS LOSS RATE
                        STRTL         .86  INITIAL ABSTRACTION
                       CRVNBR       70.00  CURVE NUMBER
                        RTIMP         .00  PERCENT IMPERVIOUS AREA

   22 UD          SCS DIMENSIONLESS UNITGRAPH
                         TLAG         .05  LAG

                                                                  ***

                                                          UNIT HYDROGRAPH
                                                       7 END-OF-PERIOD ORDINATES
               132.      143.       48.       17.        6.        2.        1.

      ***            ***            ***            ***            ***

                        HYDROGRAPH AT STATION      BSE

     TOTAL RAINFALL =   11.01, TOTAL LOSS =    3.87, TOTAL EXCESS =    7.14

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                      6-HR       24-HR       72-HR     99.95-HR
+   (CFS)       (HR)
                                 (CFS)
+     102.     12.05                  14.          5.          2.           1.
                            (INCHES)     4.757       7.139       7.139        7.139
                             (AC-FT)        7.         10.         10.          10.

                            CUMULATIVE AREA =     .03 SQ MI
```

```
*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

              **************
              *            *
   23 KK      *       BSW  *
              *            *
              **************

                 SUBBASIN RUNOFF DATA

   24 BA           SUBBASIN CHARACTERISTICS
                        TAREA         .04  SUBBASIN AREA

                   PRECIPITATION DATA

   12 PH                                 DEPTHS FOR   0-PERCENT HYPOTHETICAL STORM
                   ..... HYDRO-35 .......   ............... TP-40 ...............   ........... TP-49 ...........
                   5-MIN  15-MIN  60-MIN    2-HR    3-HR    6-HR   12-HR   24-HR   2-DAY   4-DAY   7-DAY  10-DAY
                     .80    1.40    3.32    4.41    4.86    6.13    8.33   11.01     .00     .00     .00     .00

                                                      STORM AREA =     .04

   25 LS           SCS LOSS RATE
                        STRTL         .86  INITIAL ABSTRACTION
                       CRVNBR       70.00  CURVE NUMBER
                        RTIMP         .00  PERCENT IMPERVIOUS AREA

   26 UD           SCS DIMENSIONLESS UNITGRAPH
                         TLAG         .05  LAG

                                                                  ***

                                                              UNIT HYDROGRAPH
                                                          7 END-OF-PERIOD ORDINATES
                 198.      215.       72.       25.        8.        3.        1.

       ***             ***             ***             ***             ***

                          HYDROGRAPH AT STATION      BSW

     TOTAL RAINFALL =   11.01, TOTAL LOSS =    3.87, TOTAL EXCESS =    7.14

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                      6-HR       24-HR       72-HR     99.95-HR
+   (CFS)       (HR)
                          (CFS)
+     153.     12.05                   21.          8.          3.          2.
                        (INCHES)     4.757       7.139       7.139       7.139
                         (AC-FT)       10.         15.         15.         15.

                        CUMULATIVE AREA =     .04 SQ MI


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

              **************
              *            *
   27 KK      *     COMBP  *
              *            *
              **************

   28 HC           HYDROGRAPH COMBINATION
                        ICOMP           3  NUMBER OF HYDROGRAPHS TO COMBINE

                                                                  ***

       ***             ***             ***             ***             ***

                          HYDROGRAPH AT STATION    COMBP

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                      6-HR       24-HR       72-HR     99.95-HR
+   (CFS)       (HR)
                          (CFS)
+     570.     12.05                   77.         29.         10.          7.
                        (INCHES)     4.757       7.139       7.139       7.139
                         (AC-FT)       38.         57.         57.         57.

                        CUMULATIVE AREA =     .15 SQ MI


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

              **************
              *            *
   29 KK      *       EXT  *
              *            *
              **************

                 SUBBASIN RUNOFF DATA

   30 BA           SUBBASIN CHARACTERISTICS
                        TAREA       11.37  SUBBASIN AREA

                   PRECIPITATION DATA

   12 PH                                 DEPTHS FOR   0-PERCENT HYPOTHETICAL STORM
```

```
                  ..... HYDRO-35 ......   ............... TP-40 ...............   ........... TP-49 ...........
                  5-MIN  15-MIN  60-MIN    2-HR    3-HR    6-HR   12-HR   24-HR   2-DAY   4-DAY   7-DAY  10-DAY
                    .80    1.40    3.32    4.41    4.86    6.13    8.33   11.01     .00     .00     .00     .00

                                                STORM AREA =   11.37

  31 LS           SCS LOSS RATE
                        STRTL         .86  INITIAL ABSTRACTION
                       CRVNBR       70.00  CURVE NUMBER
                        RTIMP         .00  PERCENT IMPERVIOUS AREA

  32 UD           SCS DIMENSIONLESS UNITGRAPH
                         TLAG        1.88  LAG

                                                          ***

                                                     UNIT HYDROGRAPH
                                                 190 END-OF-PERIOD ORDINATES
                 23.       45.       68.       97.      150.      203.      255.      314.      382.      450.
                519.      600.      690.      781.      872.      986.     1107.     1228.     1349.     1492.
               1635.     1779.     1920.     2041.     2162.     2283.     2392.     2475.     2558.     2641.
               2705.     2750.     2796.     2841.     2860.     2867.     2875.     2882.     2876.     2869.
               2861.     2850.     2805.     2759.     2714.     2667.     2614.     2561.     2508.     2451.
               2391.     2330.     2269.     2199.     2123.     2048.     1972.     1883.     1793.     1702.
               1612.     1536.     1460.     1385.     1314.     1261.     1208.     1155.     1105.     1060.
               1015.      969.      928.      891.      853.      815.      785.      758.      730.      702.
                675.      647.      619.      593.      570.      547.      525.      502.      479.      457.
                434.      415.      400.      385.      370.      355.      340.      325.      309.      298.
                286.      275.      264.      252.      241.      230.      219.      211.      203.      194.
                186.      178.      169.      161.      155.      149.      143.      138.      132.      126.
                121.      115.      111.      107.      103.       98.       94.       90.       86.       82.
                 79.       76.       73.       70.       67.       64.       61.       59.       56.       54.
                 52.       50.       47.       45.       43.       41.       40.       38.       37.       35.
                 34.       32.       31.       30.       29.       28.       28.       27.       26.       25.
                 24.       23.       22.       21.       20.       19.       18.       18.       17.       16.
                 15.       14.       13.       12.       12.       11.       10.        9.        9.        8.
                  7.        6.        6.        5.        4.        3.        3.        2.        1.        0.

      ***             ***             ***             ***             ***

                         HYDROGRAPH AT STATION      EXT

     TOTAL RAINFALL =   10.85, TOTAL LOSS =    3.86, TOTAL EXCESS =    7.00

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                      6-HR       24-HR       72-HR     99.95-HR
+   (CFS)       (HR)
                          (CFS)
+    9067.     14.05                 5396.       2138.        713.         514.
                        (INCHES)     4.412       6.992       6.998        6.998
                         (AC-FT)     2676.       4240.       4243.        4243.

                         CUMULATIVE AREA =   11.37 SQ MI


 *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***


            **************
            *            *
  33 KK     *      COMB  *
            *            *
            **************

  34 HC           HYDROGRAPH COMBINATION
                        ICOMP           2  NUMBER OF HYDROGRAPHS TO COMBINE

                                                          ***

      ***             ***             ***             ***             ***

                         HYDROGRAPH AT STATION     COMB

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                      6-HR       24-HR       72-HR     99.95-HR
+   (CFS)       (HR)
                          (CFS)
+    9105.     14.05                 5440.       2167.        722.         521.
                        (INCHES)     4.390       6.994       7.000        7.000
                         (AC-FT)     2697.       4297.       4301.        4301.

                         CUMULATIVE AREA =   11.52 SQ MI


 *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***


            **************
            *            *
  35 KK     *        BN  *
            *            *
            **************

               SUBBASIN RUNOFF DATA

  36 BA           SUBBASIN CHARACTERISTICS
                        TAREA         .02  SUBBASIN AREA

                  PRECIPITATION DATA

  12 PH                                 DEPTHS FOR   0-PERCENT HYPOTHETICAL STORM
```

```
                  ..... HYDRO-35 .....   ............... TP-40 ...............   ........... TP-49 ...........
                  5-MIN  15-MIN  60-MIN    2-HR    3-HR    6-HR   12-HR   24-HR   2-DAY   4-DAY   7-DAY  10-DAY
                    .80    1.40    3.32    4.41    4.86    6.13    8.33   11.01     .00     .00     .00     .00

                                                STORM AREA =     .02

  37 LS           SCS LOSS RATE
                        STRTL         .86  INITIAL ABSTRACTION
                       CRVNBR       70.00  CURVE NUMBER
                        RTIMP         .00  PERCENT IMPERVIOUS AREA

  38 UD           SCS DIMENSIONLESS UNITGRAPH
                         TLAG         .05  LAG

                                                          ***

                                                   UNIT HYDROGRAPH
                                              7 END-OF-PERIOD ORDINATES
                88.       96.       32.       11.        4.        1.        0.

     ***             ***             ***             ***             ***

                        HYDROGRAPH AT STATION       BN

    TOTAL RAINFALL =   11.01, TOTAL LOSS =    3.87, TOTAL EXCESS =    7.14

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR     99.95-HR
+   (CFS)       (HR)
                              (CFS)
+      68.     12.05                 9.          3.          1.          1.
                          (INCHES)     4.757       7.139       7.139       7.139
                           (AC-FT)       5.          7.          7.          7.

                         CUMULATIVE AREA =     .02 SQ MI

1
                                                   RUNOFF SUMMARY
                                              FLOW IN CUBIC FEET PER SECOND
                                           TIME IN HOURS,  AREA IN SQUARE MILES

                                      PEAK   TIME OF     AVERAGE FLOW FOR MAXIMUM PERIOD      BASIN     MAXIMUM     TIME OF
          OPERATION       STATION     FLOW     PEAK                                          AREA      STAGE     MAX STAGE
+                                                          6-HOUR     24-HOUR     72-HOUR

          HYDROGRAPH AT
+                            BC1      224.   12.05          30.         11.          4.        .06

          HYDROGRAPH AT
+                            BC2       91.   12.05          12.          5.          2.        .02

          2 COMBINED AT
+                           COMC      315.   12.05          43.         16.          5.        .08

          HYDROGRAPH AT
+                            BSE      102.   12.05          14.          5.          2.        .03

          HYDROGRAPH AT
+                            BSW      153.   12.05          21.          8.          3.        .04

          3 COMBINED AT
+                          COMBP      570.   12.05          77.         29.         10.        .15

          HYDROGRAPH AT
+                            EXT     9067.   14.05        5396.       2138.        713.      11.37

          2 COMBINED AT
+                           COMB     9105.   14.05        5440.       2167.        722.      11.52

          HYDROGRAPH AT
+                             BN       68.   12.05           9.          3.          1.        .02


 *** NORMAL END OF HEC-1 ***
```

```
1****************************************                                                    ****************************************
 *                                      *                                                    *                                      *
 *   FLOOD HYDROGRAPH PACKAGE  (HEC-1)  *                                                    *    U.S. ARMY CORPS OF ENGINEERS      *
 *              JUN   1998              *                                                    *    HYDROLOGIC ENGINEERING CENTER     *
 *           VERSION 4.1                *                                                    *          609 SECOND STREET           *
 *                                      *                                                    *       DAVIS, CALIFORNIA 95616        *
 *  RUN DATE   23MAR07  TIME  13:02:39  *                                                    *           (916) 756-1104             *
 *                                      *                                                    *                                      *
 ****************************************                                                    ****************************************


                                                X     X  XXXXXXX   XXXXX          X
                                                X     X  X        X     X         XX
                                                X     X  X        X                X
                                                XXXXXXX  XXXX     X        XXXXX   X
                                                X     X  X        X                X
                                                X     X  X        X     X          X
                                                X     X  XXXXXXX   XXXXX         XXX


          THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

          THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
          THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
          NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
          DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL   LOSS RATE:GREEN AND AMPT INFILTRATION
          KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM

1                                                   HEC-1 INPUT                                                   PAGE  1

         LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

            1          ID        HYDROLOGIC ANALYSIS FOR RIO CA¥AS, A¥ASCO
            2          ID        PROPOSED CONDITION
            3          ID        MAY 2006: FILENAME=PROP2.DAT: MENAR HYDROSYSTEMS
            4          ID        24-HOUR BALANCED STORM DISTRIBUTION : AMC II
            5          ID        2-YEAR FREQUENCY STORM
            6          IT       3 29MAY06       0     300 29MAY06    2400
            7          IO       3
                       *
                       *
                       *DIAGRAM
                       *
                       *  BASIN CREEK 2
                       *
                       *

            8          KK     BC2
            9          BA   0.024
           10          LS       0      70
           11          UD    0.05
           12          PH       0       0    0.52    0.90    2.14    2.70    2.81    3.13    3.38    3.81
                       *
                       *
                       *  BASIN PROJECT
                       *
                       *

           13          KK    PROJ
           14          BA  0.1436
           15          LS       0      90
           16          UD    0.05
                       *
                       *
                       *  COMBINATION PROJECT
                       *
                       *

           17          KK   COMBP
           18          HC       2
                       *
                       *
                       *  BASIN RIO CA¥AS
                       *
                       *

           19          KK     EXT
           20          BA   11.37
           21          LS       0      70
           22          UD    1.88
                       *
                       *
                       *  COMBINATION
                       *
                       *
1                                                   HEC-1 INPUT                                                   PAGE  2

         LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10


           23          KK    COMB
           24          HC       2
                       *
                       *
 *** WARNING *** ZZ-CARD MISSING
           25          ZZ
1
                SCHEMATIC DIAGRAM OF STREAM NETWORK
```

```
INPUT
 LINE      (V) ROUTING          (--->) DIVERSION OR PUMP FLOW

  NO.      (.) CONNECTOR        (<---) RETURN OF DIVERTED OR PUMPED FLOW

    8         BC2
                .
                .
   13           .        PROJ
                .           .
                .           .
   17       COMBP............
                .
                .
   19           .         EXT
                .           .
                .           .
   23        COMB............

 (***) RUNOFF ALSO COMPUTED AT THIS LOCATION
1****************************************                                          ****************************************
 *                                      *                                          *                                      *
 *   FLOOD HYDROGRAPH PACKAGE  (HEC-1)  *                                          *    U.S. ARMY CORPS OF ENGINEERS      *
 *              JUN   1998              *                                          *    HYDROLOGIC ENGINEERING CENTER     *
 *           VERSION 4.1                *                                          *          609 SECOND STREET           *
 *                                      *                                          *       DAVIS, CALIFORNIA 95616        *
 *  RUN DATE   23MAR07  TIME  13:02:39  *                                          *           (916) 756-1104             *
 *                                      *                                          *                                      *
 ****************************************                                          ****************************************


                              HYDROLOGIC ANALYSIS FOR RIO CA¥AS, A¥ASCO
                              PROPOSED CONDITION
                              MAY 2006: FILENAME=PROP2.DAT: MENAR HYDROSYSTEMS
                              24-HOUR BALANCED STORM DISTRIBUTION : AMC II
                              2-YEAR FREQUENCY STORM

   7 IO          OUTPUT CONTROL VARIABLES
                       IPRNT           3  PRINT CONTROL
                       IPLOT           0  PLOT CONTROL
                       QSCAL          0.  HYDROGRAPH PLOT SCALE

     IT          HYDROGRAPH TIME DATA
                        NMIN           3  MINUTES IN COMPUTATION INTERVAL
                       IDATE     29MAY 6  STARTING DATE
                       ITIME        0000  STARTING TIME
                          NQ         481  NUMBER OF HYDROGRAPH ORDINATES
                      NDDATE     30MAY 6  ENDING DATE
                      NDTIME        0000  ENDING TIME
                      ICENT          19  CENTURY MARK

                  COMPUTATION INTERVAL     .05 HOURS
                       TOTAL TIME BASE   24.00 HOURS

          ENGLISH UNITS
               DRAINAGE AREA         SQUARE MILES
               PRECIPITATION DEPTH   INCHES
               LENGTH, ELEVATION     FEET
               FLOW                  CUBIC FEET PER SECOND
               STORAGE VOLUME        ACRE-FEET
               SURFACE AREA          ACRES
               TEMPERATURE           DEGREES FAHRENHEIT


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***


            **************
            *            *
   8 KK     *       BC2  *
            *            *
            **************

               SUBBASIN RUNOFF DATA

   9 BA          SUBBASIN CHARACTERISTICS
                       TAREA         .02  SUBBASIN AREA

                 PRECIPITATION DATA

  12 PH                                 DEPTHS FOR   0-PERCENT HYPOTHETICAL STORM
                 ..... HYDRO-35 ......   ............... TP-40 ...............   ........... TP-49 ...........
                 5-MIN  15-MIN  60-MIN    2-HR    3-HR    6-HR   12-HR   24-HR   2-DAY   4-DAY   7-DAY  10-DAY
                   .52     .90    2.14    2.70    2.81    3.13    3.38    3.81     .00     .00     .00     .00

                                                   STORM AREA =     .02

  10 LS          SCS LOSS RATE
                       STRTL         .86  INITIAL ABSTRACTION
                      CRVNBR       70.00  CURVE NUMBER
                       RTIMP         .00  PERCENT IMPERVIOUS AREA

  11 UD          SCS DIMENSIONLESS UNITGRAPH
                        TLAG         .05  LAG

                                                                 ***

                                                          UNIT HYDROGRAPH
                                                       7 END-OF-PERIOD ORDINATES
               117.      128.       43.       15.        5.        2.        1.
```

```
      ***            ***            ***            ***            ***

                        HYDROGRAPH AT STATION      BC2

     TOTAL RAINFALL =    3.81, TOTAL LOSS =    2.61, TOTAL EXCESS =    1.20

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR     24.00-HR
+   (CFS)       (HR)
                          (CFS)
+      26.     12.05                   3.          1.          1.          1.
                       (INCHES)     1.057       1.203       1.203       1.203
                        (AC-FT)        1.          2.          2.          2.

                       CUMULATIVE AREA =     .02 SQ MI


 *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***


            **************
            *            *
   13 KK    *      PROJ  *
            *            *
            **************

               SUBBASIN RUNOFF DATA

   14 BA          SUBBASIN CHARACTERISTICS
                        TAREA         .14  SUBBASIN AREA

                  PRECIPITATION DATA

   12 PH                              DEPTHS FOR   0-PERCENT HYPOTHETICAL STORM
                  ..... HYDRO-35 .....   ............... TP-40 ...............   ........... TP-49 ...........
                  5-MIN  15-MIN  60-MIN    2-HR    3-HR    6-HR   12-HR   24-HR   2-DAY   4-DAY   7-DAY  10-DAY
                    .52     .90    2.14    2.70    2.81    3.13    3.38    3.81     .00     .00     .00     .00

                                                      STORM AREA =     .14

   15 LS          SCS LOSS RATE
                        STRTL         .22  INITIAL ABSTRACTION
                       CRVNBR       90.00  CURVE NUMBER
                        RTIMP         .00  PERCENT IMPERVIOUS AREA

   16 UD          SCS DIMENSIONLESS UNITGRAPH
                         TLAG         .05  LAG

                                                                 ***

                                                          UNIT HYDROGRAPH
                                                       7 END-OF-PERIOD ORDINATES
                  702.      763.      256.       89.       30.       10.        3.

      ***            ***            ***            ***            ***

                        HYDROGRAPH AT STATION     PROJ

     TOTAL RAINFALL =    3.81, TOTAL LOSS =    1.07, TOTAL EXCESS =    2.74

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR     24.00-HR
+   (CFS)       (HR)
                          (CFS)
+     383.     12.05                  38.         11.         11.         11.
                       (INCHES)     2.433       2.737       2.737       2.737
                        (AC-FT)       19.         21.         21.         21.

                       CUMULATIVE AREA =     .14 SQ MI


 *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***


            **************
            *            *
   17 KK    *     COMBP  *
            *            *
            **************

   18 HC          HYDROGRAPH COMBINATION
                        ICOMP           2  NUMBER OF HYDROGRAPHS TO COMBINE

                                                                 ***

      ***            ***            ***            ***            ***

                        HYDROGRAPH AT STATION    COMBP

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR     24.00-HR
+   (CFS)       (HR)
                          (CFS)
+     410.     12.05                  40.         11.         11.         11.
                       (INCHES)     2.232       2.517       2.517       2.517
                        (AC-FT)       20.         23.         23.         23.

                       CUMULATIVE AREA =     .17 SQ MI
```

*** ***

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              **************
              *            *
   19 KK      *       EXT  *
              *            *
              **************

                 SUBBASIN RUNOFF DATA

   20 BA          SUBBASIN CHARACTERISTICS
                        TAREA       11.37  SUBBASIN AREA

                  PRECIPITATION DATA

   12 PH                                 DEPTHS FOR   0-PERCENT HYPOTHETICAL STORM
                  ..... HYDRO-35 .......   ............... TP-40 ...............   ........... TP-49 ...........
                  5-MIN  15-MIN  60-MIN    2-HR    3-HR    6-HR   12-HR   24-HR   2-DAY   4-DAY   7-DAY  10-DAY
                    .52     .90    2.14    2.70    2.81    3.13    3.38    3.81     .00     .00     .00     .00

                                                   STORM AREA =   11.37

   21 LS          SCS LOSS RATE
                        STRTL         .86  INITIAL ABSTRACTION
                       CRVNBR       70.00  CURVE NUMBER
                        RTIMP         .00  PERCENT IMPERVIOUS AREA

   22 UD          SCS DIMENSIONLESS UNITGRAPH
                         TLAG        1.88  LAG

                                                                  ***

                                                          UNIT HYDROGRAPH
                                                       190 END-OF-PERIOD ORDINATES
                 23.       45.       68.       97.      150.      203.      255.      314.      382.      450.
                519.      600.      690.      781.      872.      986.     1107.     1228.     1349.     1492.
               1635.     1779.     1920.     2041.     2162.     2283.     2392.     2475.     2558.     2641.
               2705.     2750.     2796.     2841.     2860.     2867.     2875.     2882.     2876.     2869.
               2861.     2850.     2805.     2759.     2714.     2667.     2614.     2561.     2508.     2451.
               2391.     2330.     2269.     2199.     2123.     2048.     1972.     1883.     1793.     1702.
               1612.     1536.     1460.     1385.     1314.     1261.     1208.     1155.     1105.     1060.
               1015.      969.      928.      891.      853.      815.      785.      758.      730.      702.
                675.      647.      619.      593.      570.      547.      525.      502.      479.      457.
                434.      415.      400.      385.      370.      355.      340.      325.      309.      298.
                286.      275.      264.      252.      241.      230.      219.      211.      203.      194.
                186.      178.      169.      161.      155.      149.      143.      138.      132.      126.
                121.      115.      111.      107.      103.       98.       94.       90.       86.       82.
                 79.       76.       73.       70.       67.       64.       61.       59.       56.       54.
                 52.       50.       47.       45.       43.       41.       40.       38.       37.       35.
                 34.       32.       31.       30.       29.       28.       28.       27.       26.       25.
                 24.       23.       22.       21.       20.       19.       18.       18.       17.       16.
                 15.       14.       13.       12.       12.       11.       10.        9.        9.        8.
                  7.        6.        6.        5.        4.        3.        3.        2.        1.        0.

      ***             ***             ***             ***             ***

                         HYDROGRAPH AT STATION      EXT

     TOTAL RAINFALL =    3.76, TOTAL LOSS =    2.59, TOTAL EXCESS =    1.17

  PEAK FLOW     TIME                           MAXIMUM AVERAGE FLOW
                                        6-HR       24-HR       72-HR     24.00-HR
+   (CFS)       (HR)
                                 (CFS)
+    2292.     14.20                 1170.        342.        342.         342.
                               (INCHES)      .956       1.120       1.120       1.120
                                (AC-FT)      580.        679.        679.         679.

                         CUMULATIVE AREA =   11.37 SQ MI
```

*** ***

```
              **************
              *            *
   23 KK      *      COMB  *
              *            *
              **************

   24 HC          HYDROGRAPH COMBINATION
                        ICOMP           2  NUMBER OF HYDROGRAPHS TO COMBINE

                                                                  ***

      ***             ***             ***             ***             ***

                         HYDROGRAPH AT STATION     COMB

  PEAK FLOW     TIME                           MAXIMUM AVERAGE FLOW
                                        6-HR       24-HR       72-HR     24.00-HR
+   (CFS)       (HR)
                                 (CFS)
+    2302.     14.20                 1181.        354.        354.         354.
                               (INCHES)      .952       1.140       1.140       1.140
                                (AC-FT)      586.        702.        702.         702.

                         CUMULATIVE AREA =   11.54 SQ MI
```


RUNOFF SUMMARY

FLOW IN CUBIC FEET PER SECOND
TIME IN HOURS, AREA IN SQUARE MILES

	OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD 6-HOUR	24-HOUR	72-HOUR	BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
+	HYDROGRAPH AT	BC2	26.	12.05	3.	1.	1.	.02		
+	HYDROGRAPH AT	PROJ	383.	12.05	38.	11.	11.	.14		
+	2 COMBINED AT	COMBP	410.	12.05	40.	11.	11.	.17		
+	HYDROGRAPH AT	EXT	2292.	14.20	1170.	342.	342.	11.37		
+	2 COMBINED AT	COMB	2302.	14.20	1181.	354.	354.	11.54		

*** NORMAL END OF HEC-1 ***

```
1****************************************                                                    ****************************************
 *                                      *                                                    *                                      *
 *   FLOOD HYDROGRAPH PACKAGE  (HEC-1)  *                                                    *    U.S. ARMY CORPS OF ENGINEERS      *
 *              JUN   1998              *                                                    *    HYDROLOGIC ENGINEERING CENTER     *
 *            VERSION 4.1               *                                                    *          609 SECOND STREET           *
 *                                      *                                                    *       DAVIS, CALIFORNIA 95616        *
 *  RUN DATE   23MAR07  TIME  13:02:21  *                                                    *           (916) 756-1104             *
 *                                      *                                                    *                                      *
 ****************************************                                                    ****************************************


                                                X     X  XXXXXXX   XXXXX           X
                                                X     X  X        X     X         XX
                                                X     X  X        X                X
                                                XXXXXXX  XXXX     X        XXXXX   X
                                                X     X  X        X                X
                                                X     X  X        X     X          X
                                                X     X  XXXXXXX   XXXXX          XXX


          THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

          THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
          THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
          NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
          DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL   LOSS RATE:GREEN AND AMPT INFILTRATION
          KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM

1                                                   HEC-1 INPUT                                                   PAGE  1

         LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

            1          ID        HYDROLOGIC ANALYSIS FOR RIO CA¥AS, A¥ASCO
            2          ID        PROPOSED CONDITION
            3          ID        MAY 2006: FILENAME=PROP.DAT: MENAR HYDROSYSTEMS
            4          ID        24-HOUR BALANCED STORM DISTRIBUTION : AMC II
            5          ID        100-YEAR FREQUENCY STORM
            6          IT       3 29MAY06       0     300 29MAY06    2400
            7          IO       3
                       *
                       *DIAGRAM
                       *
                       *
                       *  BASIN CREEK 2
                       *
                       *

            8          KK     BC2
            9          BA   0.024
           10          LS       0      70
           11          UD    0.05
           12          PH       0       0    0.80    1.40    3.32    4.41    4.86    6.13    8.33   11.01
                       *
                       *
                       *  BASIN PROJECT
                       *
                       *

           13          KK    PROJ
           14          BA  0.1436
           15          LS       0      90
           16          UD    0.05
                       *
                       *
                       *  COMBINATION PROJECT
                       *
                       *

           17          KK   COMBP
           18          HC       2
                       *
                       *
                       *  BASIN RIO CA¥AS
                       *
                       *

           19          KK     EXT
           20          BA   11.37
           21          LS       0      70
           22          UD    1.88
                       *
                       *
                       *  COMBINATION
                       *
                       *
1                                                   HEC-1 INPUT                                                   PAGE  2

         LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

           23          KK    COMB
           24          HC       2
                       *
                       *
```

```
            25          ZZ
1
                 SCHEMATIC DIAGRAM OF STREAM NETWORK
 INPUT
  LINE      (V) ROUTING          (--->) DIVERSION OR PUMP FLOW

   NO.      (.) CONNECTOR        (<---) RETURN OF DIVERTED OR PUMPED FLOW

     8         BC2
                .
                .
    13          .        PROJ
                .           .
                .           .
    17       COMBP............
                .
                .
    19          .         EXT
                .           .
                .           .
    23        COMB............

 (***) RUNOFF ALSO COMPUTED AT THIS LOCATION
1****************************************                                          ****************************************
 *                                      *                                          *                                      *
 *   FLOOD HYDROGRAPH PACKAGE  (HEC-1)  *                                          *    U.S. ARMY CORPS OF ENGINEERS      *
 *              JUN   1998              *                                          *    HYDROLOGIC ENGINEERING CENTER     *
 *           VERSION 4.1                *                                          *          609 SECOND STREET           *
 *                                      *                                          *       DAVIS, CALIFORNIA 95616        *
 *  RUN DATE   23MAR07  TIME  13:02:21  *                                          *           (916) 756-1104             *
 *                                      *                                          *                                      *
 ****************************************                                          ****************************************


                              HYDROLOGIC ANALYSIS FOR RIO CA¥AS, A¥ASCO
                              PROPOSED CONDITION
                              MAY 2006: FILENAME=PROP.DAT: MENAR HYDROSYSTEMS
                              24-HOUR BALANCED STORM DISTRIBUTION : AMC II
                              100-YEAR FREQUENCY STORM

    7 IO          OUTPUT CONTROL VARIABLES
                        IPRNT           3  PRINT CONTROL
                        IPLOT           0  PLOT CONTROL
                        QSCAL          0.  HYDROGRAPH PLOT SCALE

      IT          HYDROGRAPH TIME DATA
                         NMIN           3  MINUTES IN COMPUTATION INTERVAL
                        IDATE     29MAY 6  STARTING DATE
                        ITIME        0000  STARTING TIME
                           NQ         481  NUMBER OF HYDROGRAPH ORDINATES
                       NDDATE     30MAY 6  ENDING DATE
                       NDTIME        0000  ENDING TIME
                       ICENT          19  CENTURY MARK

                  COMPUTATION INTERVAL     .05 HOURS
                       TOTAL TIME BASE   24.00 HOURS

          ENGLISH UNITS
               DRAINAGE AREA         SQUARE MILES
               PRECIPITATION DEPTH   INCHES
               LENGTH, ELEVATION     FEET
               FLOW                  CUBIC FEET PER SECOND
               STORAGE VOLUME        ACRE-FEET
               SURFACE AREA          ACRES
               TEMPERATURE           DEGREES FAHRENHEIT


 *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***


            **************
            *            *
    8 KK    *       BC2  *
            *            *
            **************

               SUBBASIN RUNOFF DATA

    9 BA          SUBBASIN CHARACTERISTICS
                        TAREA         .02  SUBBASIN AREA

                  PRECIPITATION DATA

   12 PH                                 DEPTHS FOR   0-PERCENT HYPOTHETICAL STORM
                  ..... HYDRO-35 ......   ............... TP-40 ...............   ........... TP-49 ...........
                  5-MIN  15-MIN  60-MIN    2-HR    3-HR    6-HR   12-HR   24-HR   2-DAY   4-DAY   7-DAY  10-DAY
                    .80    1.40    3.32    4.41    4.86    6.13    8.33   11.01     .00     .00     .00     .00

                                                   STORM AREA =     .02

   10 LS          SCS LOSS RATE
                        STRTL         .86  INITIAL ABSTRACTION
                       CRVNBR       70.00  CURVE NUMBER
                        RTIMP         .00  PERCENT IMPERVIOUS AREA

   11 UD          SCS DIMENSIONLESS UNITGRAPH
                         TLAG         .05  LAG

                                                                  ***

                                                          UNIT HYDROGRAPH
```

```
                                                  7 END-OF-PERIOD ORDINATES
              117.      128.       43.       15.        5.        2.        1.

      ***             ***             ***             ***             ***

                        HYDROGRAPH AT STATION      BC2

    TOTAL RAINFALL =   11.01, TOTAL LOSS =    3.87, TOTAL EXCESS =    7.14

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR     24.00-HR
+   (CFS)       (HR)
                          (CFS)
+      91.     12.05                 12.          5.          5.          5.
                       (INCHES)     4.757       7.127       7.127       7.127
                        (AC-FT)       6.          9.          9.          9.

                       CUMULATIVE AREA =     .02 SQ MI


 *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***


            **************
            *            *
   13 KK    *      PROJ  *
            *            *
            **************

               SUBBASIN RUNOFF DATA

   14 BA          SUBBASIN CHARACTERISTICS
                        TAREA         .14  SUBBASIN AREA

                  PRECIPITATION DATA

   12 PH                              DEPTHS FOR   0-PERCENT HYPOTHETICAL STORM
                  ..... HYDRO-35 .....   ............... TP-40 ...............   ........... TP-49 ...........
                  5-MIN  15-MIN  60-MIN    2-HR    3-HR    6-HR   12-HR   24-HR   2-DAY   4-DAY   7-DAY  10-DAY
                    .80    1.40    3.32    4.41    4.86    6.13    8.33   11.01     .00     .00     .00     .00

                                                      STORM AREA =     .14

   15 LS          SCS LOSS RATE
                        STRTL         .22  INITIAL ABSTRACTION
                       CRVNBR       90.00  CURVE NUMBER
                        RTIMP         .00  PERCENT IMPERVIOUS AREA

   16 UD          SCS DIMENSIONLESS UNITGRAPH
                         TLAG         .05  LAG

                                                             ***

                                                      UNIT HYDROGRAPH
                                                  7 END-OF-PERIOD ORDINATES
              702.      763.      256.       89.       30.       10.        3.

      ***             ***             ***             ***             ***

                        HYDROGRAPH AT STATION     PROJ

    TOTAL RAINFALL =   11.01, TOTAL LOSS =    1.23, TOTAL EXCESS =    9.78

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR     24.00-HR
+   (CFS)       (HR)
                          (CFS)
+     689.     12.05                 92.         38.         38.         38.
                       (INCHES)     5.951       9.765       9.765       9.765
                        (AC-FT)      46.         75.         75.         75.

                       CUMULATIVE AREA =     .14 SQ MI


 *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***


            **************
            *            *
   17 KK    *     COMBP  *
            *            *
            **************

   18 HC          HYDROGRAPH COMBINATION
                        ICOMP           2  NUMBER OF HYDROGRAPHS TO COMBINE

                                                             ***

      ***             ***             ***             ***             ***

                        HYDROGRAPH AT STATION    COMBP

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR     24.00-HR
+   (CFS)       (HR)
                          (CFS)
+     779.     12.05                104.         42.         42.         42.
                       (INCHES)     5.770       9.387       9.387       9.387
                        (AC-FT)      52.         84.         84.         84.

                       CUMULATIVE AREA =     .17 SQ MI
```

```
*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***


            **************
            *            *
  19 KK     *       EXT  *
            *            *
            **************

               SUBBASIN RUNOFF DATA

  20 BA          SUBBASIN CHARACTERISTICS
                       TAREA       11.37  SUBBASIN AREA

                 PRECIPITATION DATA

  12 PH                                 DEPTHS FOR   0-PERCENT HYPOTHETICAL STORM
                 ..... HYDRO-35 ......   ............... TP-40 ...............   ........... TP-49 ...........
                 5-MIN  15-MIN  60-MIN    2-HR    3-HR    6-HR   12-HR   24-HR   2-DAY   4-DAY   7-DAY  10-DAY
                   .80    1.40    3.32    4.41    4.86    6.13    8.33   11.01     .00     .00     .00     .00

                                                   STORM AREA =   11.37

  21 LS          SCS LOSS RATE
                       STRTL         .86  INITIAL ABSTRACTION
                      CRVNBR       70.00  CURVE NUMBER
                       RTIMP         .00  PERCENT IMPERVIOUS AREA

  22 UD          SCS DIMENSIONLESS UNITGRAPH
                        TLAG        1.88  LAG

                                                                 ***

                                                          UNIT HYDROGRAPH
                                                     190 END-OF-PERIOD ORDINATES
                 23.       45.       68.       97.      150.      203.      255.      314.      382.      450.
                519.      600.      690.      781.      872.      986.     1107.     1228.     1349.     1492.
               1635.     1779.     1920.     2041.     2162.     2283.     2392.     2475.     2558.     2641.
               2705.     2750.     2796.     2841.     2860.     2867.     2875.     2882.     2876.     2869.
               2861.     2850.     2805.     2759.     2714.     2667.     2614.     2561.     2508.     2451.
               2391.     2330.     2269.     2199.     2123.     2048.     1972.     1883.     1793.     1702.
               1612.     1536.     1460.     1385.     1314.     1261.     1208.     1155.     1105.     1060.
               1015.      969.      928.      891.      853.      815.      785.      758.      730.      702.
                675.      647.      619.      593.      570.      547.      525.      502.      479.      457.
                434.      415.      400.      385.      370.      355.      340.      325.      309.      298.
                286.      275.      264.      252.      241.      230.      219.      211.      203.      194.
                186.      178.      169.      161.      155.      149.      143.      138.      132.      126.
                121.      115.      111.      107.      103.       98.       94.       90.       86.       82.
                 79.       76.       73.       70.       67.       64.       61.       59.       56.       54.
                 52.       50.       47.       45.       43.       41.       40.       38.       37.       35.
                 34.       32.       31.       30.       29.       28.       28.       27.       26.       25.
                 24.       23.       22.       21.       20.       19.       18.       18.       17.       16.
                 15.       14.       13.       12.       12.       11.       10.        9.        9.        8.
                  7.        6.        6.        5.        4.        3.        3.        2.        1.        0.

      ***             ***             ***             ***             ***

                         HYDROGRAPH AT STATION      EXT

     TOTAL RAINFALL =   10.85, TOTAL LOSS =    3.86, TOTAL EXCESS =    7.00

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR     24.00-HR
+   (CFS)       (HR)
                            (CFS)
+    9067.     14.05                5396.       2002.       2002.        2002.
                         (INCHES)     4.412       6.549       6.549        6.549
                          (AC-FT)     2676.       3971.       3971.        3971.

                         CUMULATIVE AREA =   11.37 SQ MI


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***


            **************
            *            *
  23 KK     *      COMB  *
            *            *
            **************

  24 HC          HYDROGRAPH COMBINATION
                       ICOMP           2  NUMBER OF HYDROGRAPHS TO COMBINE

                                                                 ***

      ***             ***             ***             ***             ***

                         HYDROGRAPH AT STATION     COMB

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR     24.00-HR
+   (CFS)       (HR)
                            (CFS)
+    9114.     14.05                5451.       2045.       2045.        2045.
                         (INCHES)     4.393       6.590       6.590        6.590
                          (AC-FT)     2703.       4055.       4055.        4055.

                         CUMULATIVE AREA =   11.54 SQ MI
```

1

RUNOFF SUMMARY
FLOW IN CUBIC FEET PER SECOND
TIME IN HOURS, AREA IN SQUARE MILES

	OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD 6-HOUR	24-HOUR	72-HOUR	BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
+	HYDROGRAPH AT	BC2	91.	12.05	12.	5.	5.	.02		
+	HYDROGRAPH AT	PROJ	689.	12.05	92.	38.	38.	.14		
+	2 COMBINED AT	COMBP	779.	12.05	104.	42.	42.	.17		
+	HYDROGRAPH AT	EXT	9067.	14.05	5396.	2002.	2002.	11.37		
+	2 COMBINED AT	COMB	9114.	14.05	5451.	2045.	2045.	11.54		

*** NORMAL END OF HEC-1 ***

HEC-RAS Version 3.1.3 May 2005
U.S. Army Corp of Engineers
Hydrologic Engineering Center
609 Second Street
Davis, California

```
X     X  XXXXXX    XXXX        XXXX       XX      XXXX
X     X  X        X    X      X   X     X  X    X
X     X  X        X           X   X    X    X   X
XXXXXXX  XXXX     X       XXX XXXX     XXXXXX    XXXX
X     X  X        X           X  X     X    X        X
X     X  X        X    X      X   X    X    X        X
X     X  XXXXXX    XXXX       X    X   X    X   XXXXX
```

****

PROJECT DATA
Project Title: H-H Analysis for Monte Verde Development
Project File : MONTE_VERDE.prj
Run Date and Time: 3/23/2007 1:28:50 PM

Project in SI units

Project Description:
Hydraulic Analysis- Rio Cañas

****

PLAN DATA

Plan Title: Existing
Plan File : C:\Trabajos en proceso\CAÑAS\Ras\MONTE_VERDE.p01

Geometry Title: Existing
Geometry File : C:\Trabajos en proceso\CAÑAS\Ras\MONTE_VERDE.g01

Flow Title : Existing
Flow File : C:\Trabajos en proceso\CAÑAS\Ras\MONTE_VERDE.f01

Plan Summary Information:
Number of: Cross Sections = 15 Multiple Openings = 0
Culverts = 0 Inline Structures = 0
Bridges = 1 Lateral Structures = 0

Computational Information
Water surface calculation tolerance = 0.003
Critical depth calculation tolerance = 0.003
Maximum number of iterations = 20
Maximum difference tolerance = 0.1
Flow tolerance factor = 0.001

Computation Options
Critical depth computed at all cross sections
Conveyance Calculation Method: At breaks in n values only
Friction Slope Method: Average Conveyance
Computational Flow Regime: Subcritical Flow

Encroachment Data
Equal Conveyance = True
Left Offset = 0
Right Offset = 0

River = Rio Cañas Reach = 1

RS	Profile	Method	Value1	Value2
11	Floodway	4	.1	
10	Floodway	4	.07	
9	Floodway	4	.07	
8.9	Floodway	4	.06	
8	Floodway	4	.15	
7	Floodway	4	.15	
6	Floodway	4	.05	
5	Floodway	4	.09	
4	Floodway	4	.15	
3	Floodway	4	.08	

River = Rio Cañas Reach = 2

RS	Profile	Method	Value1	Value2
2	Floodway	4	.07	
1	Floodway	4	.15	

River = Creek Reach = 1

RS	Profile	Method	Value1	Value2
14	Floodway	4	.05	
13	Floodway	4	.05	
12	Floodway	4	.05	

****

FLOW DATA

Flow Title: Existing
Flow File : C:\Trabajos en proceso\CAÑAS\Ras\MONTE_VERDE.f01

Flow Data (m3/s)
****
* River Reach RS * 100-yr Floodway *

```
* Creek          1              14      *           8.92           8.92 *
* Rio Cañas      1              11      *         257.82         257.82 *
* Rio Cañas      2              2       *         257.82         257.82 *
*************************************************************************

Boundary Conditions
*****************************************************************************************************
* River          Reach          Profile          *           Upstream                Downstream    *
*****************************************************************************************************
* Creek          1              100-yr           *             Critical                            *
* Creek          1              Floodway         *             Critical                            *
* Rio Cañas      1              100-yr           *             Critical                            *
* Rio Cañas      1              Floodway         *             Critical                            *
* Rio Cañas      2              100-yr           *                                     Critical    *
* Rio Cañas      2              Floodway         *                                     Critical    *
*****************************************************************************************************

*****************************************************************************

GEOMETRY DATA

Geometry Title: Existing
Geometry File : C:\Trabajos en proceso\CAÑAS\Ras\MONTE_VERDE.g01

Reach Connection Table
*****************************************************************************
* River           Reach            *  Upstream Boundary  * Downstream Boundary *
*****************************************************************************
* Creek           1                *                     *   TRIB              *
* Rio Cañas       1                *                     *   TRIB              *
* Rio Cañas       2                *   TRIB              *                     *
*****************************************************************************

JUNCTION INFORMATION

Name: TRIB
Description:
Energy computation Method

    Length across Junction             Tributary
     River          Reach               River          Reach        Length   Angle
Rio Cañas       1                to Rio Cañas       2                    61
Creek           1                to Rio Cañas       2                   109

CROSS SECTION


RIVER: Creek
REACH: 1                  RS: 14

INPUT
Description: XS-13
Station Elevation Data    num=       9
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
*****************************************************************************
       0   21.37    18.6    20.4   23.55   20.95   31.98  20.136   34.82   18.96
  36.191  18.046   49.77   22.65   55.78    27.8  62.609   29.84

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
***********************************************
       0     .06   31.98     .04   49.77     .06

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
          31.98   49.77             76.5   88.62   74.77             .1       .3

CROSS SECTION


RIVER: Creek
REACH: 1                  RS: 13

INPUT
Description: XS-14
Station Elevation Data    num=       6
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
*****************************************************************************
       0   20.55   25.99   18.65   27.38  17.037   28.69   18.34   57.79   18.92
  134.89    23.9

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
***********************************************
       0     .06   25.99     .04   28.69     .06

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
          25.99   28.69            139.8  105.11   58.48             .1       .3

CROSS SECTION


RIVER: Creek
REACH: 1                  RS: 12

INPUT
Description: XS-12
Station Elevation Data    num=       7
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
*****************************************************************************
       0   19.59   16.89   18.52   20.32   15.96   22.42   16.88   46.84   18.78
   60.39   18.39   87.09    19.4

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
***********************************************
```

```
       0     .06   16.89     .04   22.42     .06

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
         16.89   22.42                0       0       0             .1       .3

CROSS SECTION


RIVER: Rio Cañas
REACH: 1                  RS: 11

INPUT
Description: T-26
Station Elevation Data    num=      14
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
*******************************************************************************
       0   23.49   23.16   23.44   34.77   22.85   40.99   21.36   52.29   21.13
    59.6   19.99   62.97   17.83    72.1   17.84   79.39    19.8   81.19   20.17
   97.37   20.13  113.02   20.03  127.76   20.56  204.36    27.9

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
***********************************************
       0     .06   52.29     .04   81.19     .06

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
         52.29   81.19            38.47   97.17  141.77             .1       .3

CROSS SECTION


RIVER: Rio Cañas
REACH: 1                  RS: 10

INPUT
Description: T-25
Station Elevation Data    num=      14
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
*******************************************************************************
       0   25.06    7.78   22.86   29.49   22.28    44.8   21.88   60.12   19.67
   62.27   17.48   69.98   17.49   72.18   18.58   77.91   19.49   81.59   21.51
   90.83   22.06   93.61   22.92  128.27   23.66  139.76   24.11

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
***********************************************
       0     .06   60.12     .04   77.91     .06

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
         60.12   77.91            50.01   52.86   39.02             .1       .3

CROSS SECTION


RIVER: Rio Cañas
REACH: 1                  RS: 9

INPUT
Description: T-21
Station Elevation Data    num=      13
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
*******************************************************************************
       0   24.87   16.56    24.3   24.01   23.17    39.9   22.66   47.28   19.71
   63.75   19.29    70.4   17.36  78.171   17.35   78.59   18.65   84.54   21.68
   91.34   22.34  107.32   22.56  118.52   23.16

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
***********************************************
       0     .06   47.28     .04   78.59     .06

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
         47.28   78.59                16      16      16             .2       .4

BRIDGE


RIVER: Rio Cañas
REACH: 1                  RS: 8.95

INPUT
Description:
Distance from Upstream XS =      .9
Deck/Roadway Width        =      15
Weir Coefficient          =    1.44
Upstream  Deck/Roadway Coordinates
    num=       2
     Sta Hi Cord Lo Cord     Sta Hi Cord Lo Cord
***********************************************
       0    22.9   20.82     200    22.6   20.52

Upstream Bridge Cross Section Data
Station Elevation Data    num=      13
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
*******************************************************************************
       0   24.87   16.56    24.3   24.01   23.17    39.9   22.66   47.28   19.71
   63.75   19.29    70.4   17.36  78.171   17.35   78.59   18.65   84.54   21.68
   91.34   22.34  107.32   22.56  118.52   23.16

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
***********************************************
       0     .06   47.28     .04   78.59     .06

Bank Sta: Left   Right    Coeff Contr.   Expan.
```

```
         47.28   78.59             .2       .4

Downstream  Deck/Roadway Coordinates
    num=       2
     Sta Hi Cord Lo Cord     Sta Hi Cord Lo Cord
**********************************************
       0    22.9   20.82     200    22.6   20.52

Downstream Bridge Cross Section Data
Station Elevation Data    num=      13
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
*********************************************************************************
       0   24.87   16.56    24.3   24.01   23.17    39.9   22.66   47.28   19.71
   63.75   19.29    70.4   17.36  78.171   17.35   78.59   18.65   84.54   21.68
   91.34   22.34  107.32   22.56  118.52   23.16

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
**********************************************
       0     .06   47.28     .04   78.59     .06

Bank Sta: Left   Right    Coeff Contr.   Expan.
         47.28   78.59             .2       .4

Upstream Embankment side slope              =       0 horiz. to 1.0 vertical
Downstream Embankment side slope            =       0 horiz. to 1.0 vertical
Maximum allowable submergence for weir flow =     .95
Elevation at which weir flow begins         =
Energy head used in spillway design         =
Spillway height used in design              =
Weir crest shape                            = Broad Crested

Number of Bridge Coefficient Sets =  1

Low Flow Methods and Data
       Energy
Selected Low Flow Methods = Highest Energy Answer

High Flow Method
       Energy Only

Additional Bridge Parameters
       Add Friction component to Momentum
       Do not add Weight component to Momentum
       Class B flow critical depth computations use critical depth
           inside the bridge at the upstream end
       Criteria to check for pressure flow = Upstream energy grade line

CROSS SECTION


RIVER: Rio Cañas
REACH: 1                  RS: 8.9

INPUT
Description: T-21
Station Elevation Data    num=      13
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
*********************************************************************************
       0   24.87   16.56    24.3   24.01   23.17    39.9   22.66   47.28   19.71
   63.75   19.29    70.4   17.36  78.171   17.35   78.59   18.65   84.54   21.68
   91.34   22.34  107.32   22.56  118.52   23.16

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
**********************************************
       0     .06   47.28     .04   78.59     .06

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
         47.28   78.59               33      44   61.08             .2       .4

CROSS SECTION


RIVER: Rio Cañas
REACH: 1                  RS: 8

INPUT
Description: T-24
Station Elevation Data    num=      11
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
*********************************************************************************
       0   21.97    2.76      21   23.57   20.66   25.09    18.6   29.49   18.72
   31.55   17.32   41.42   17.34   57.59   20.81    72.6   21.21   86.97   23.91
   97.41   28.32

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
**********************************************
       0     .06   23.57     .04   57.59     .06

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
         23.57   57.59             87.4  100.27   120.4             .1       .3

CROSS SECTION


RIVER: Rio Cañas
REACH: 1                  RS: 7

INPUT
Description: T-23
XS-7
Station Elevation Data    num=      14
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
```

```
********************************************************************************
  -124.9      30       0   19.74   34.58   19.97   40.64   20.71   44.41   20.75
   48.54   19.31   52.29   17.01   61.06   16.99   64.29   19.25   73.47   20.06
    79.2   19.43  104.67   21.83 115.212  21.737  147.73   24.52

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
***********************************************
  -124.9     .06   44.41     .04   73.47     .06

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
         44.41   73.47           149.82  190.96  196.06             .1       .3

CROSS SECTION


RIVER: Rio Cañas
REACH: 1                  RS: 6

INPUT
Description: T-125
Station Elevation Data    num=      12
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
********************************************************************************
       0    34.5   29.86    22.8   37.19    22.4   42.41   19.92  47.704   18.76
   51.95   16.78   57.18   16.38   65.24   16.37   68.04   19.34   91.72    19.1
 113.112   19.43  184.91      26

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
***********************************************
       0     .06  47.704     .04   68.04     .06

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
        47.704   68.04           107.76   93.61   57.89             .1       .3

CROSS SECTION


RIVER: Rio Cañas
REACH: 1                  RS: 5

INPUT
Description: T-144
Station Elevation Data    num=      11
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
********************************************************************************
       0   31.46      18   25.22   38.98   18.88   48.75   18.67   52.38    16.5
   54.42   16.24   60.86   16.23   63.08   18.96   65.91   18.71   99.89   19.36
  117.67   22.86

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
***********************************************
       0     .06   48.75     .04   63.08     .06

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
         48.75   63.08           133.87  105.63   80.67             .1       .3

CROSS SECTION


RIVER: Rio Cañas
REACH: 1                  RS: 4

INPUT
Description: T-159
Station Elevation Data    num=      10
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
********************************************************************************
  -165.7      25       0   18.56   12.32   18.67   50.65   19.26   53.62   15.97
   63.08   15.95   65.91   19.06   74.86    18.4  100.46   18.16  114.31   22.35

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
***********************************************
  -165.7     .06   50.65     .04   65.91     .06

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
         50.65   65.91           156.26  211.92  175.42             .1       .3

CROSS SECTION


RIVER: Rio Cañas
REACH: 1                  RS: 3

INPUT
Description: T-174
Station Elevation Data    num=      10
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
********************************************************************************
   -32.5      20       0   17.48     5.6    17.5   25.93    17.7   50.38   18.39
   52.22   15.43   62.44   15.42   67.04    17.9  113.86    18.3  125.53   21.59

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
***********************************************
   -32.5     .06   50.38     .04   67.04     .06

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
         50.38   67.04              137     169     196             .1       .3

CROSS SECTION
```

RIVER: Rio Cañas
REACH: 2 RS: 2

INPUT
Description: T-189
Station Elevation Data num= 8

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	19.01	14.32	18.77	19.23	17.06	58.87	16.51	62.05	14.7
70.72	14.68	71.52	16.53	125.23	24.8				

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.06	58.87	.04	71.52	.06

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
58.87	71.52	44.33	89.8	125.22	.1	.3

CROSS SECTION

RIVER: Rio Cañas
REACH: 2 RS: 1

INPUT
Description: T-198
Station Elevation Data num= 10

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	21.23	17.08	19.09	20.32	16.98	25.72	17.01	32.63	15.52
51.95	14.373	59.73	14.348	63.174	17.26	97.3	19.37	113.112	19.43

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.06	25.72	.04	63.174	.06

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
25.72	63.174	0	0	0	.1	.3

SUMMARY OF MANNING'S N VALUES

River:Creek

Reach	River Sta.	n1	n2	n3
1	14	.06	.04	.06
1	13	.06	.04	.06
1	12	.06	.04	.06

River:Rio Cañas

Reach	River Sta.	n1	n2	n3
1	11	.06	.04	.06
1	10	.06	.04	.06
1	9	.06	.04	.06
1	8.95	Bridge		
1	8.9	.06	.04	.06
1	8	.06	.04	.06
1	7	.06	.04	.06
1	6	.06	.04	.06
1	5	.06	.04	.06
1	4	.06	.04	.06
1	3	.06	.04	.06
2	2	.06	.04	.06
2	1	.06	.04	.06

SUMMARY OF REACH LENGTHS

River: Creek

Reach	River Sta.	Left	Channel	Right
1	14	76.5	88.62	74.77
1	13	139.8	105.11	58.48
1	12	0	0	0

River: Rio Cañas

Reach	River Sta.	Left	Channel	Right
1	11	38.47	97.17	141.77
1	10	50.01	52.86	39.02
1	9	16	16	16
1	8.95	Bridge		
1	8.9	33	44	61.08
1	8	87.4	100.27	120.4
1	7	149.82	190.96	196.06
1	6	107.76	93.61	57.89
1	5	133.87	105.63	80.67
1	4	156.26	211.92	175.42
1	3	137	169	196
2	2	44.33	89.8	125.22
2	1	0	0	0

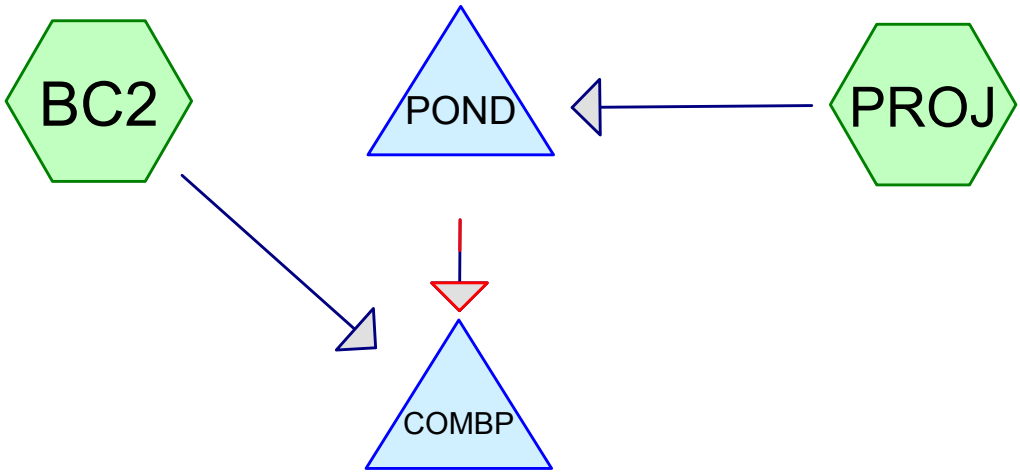
****

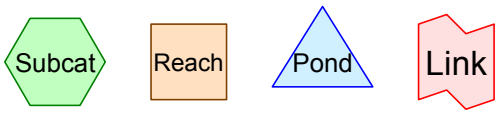
SUMMARY OF CONTRACTION AND EXPANSION COEFFICIENTS
River: Creek

Reach	River Sta.	Contr.	Expan.
1	14	.1	.3
1	13	.1	.3
1	12	.1	.3

River: Rio Cañas

Reach	River Sta.	Contr.	Expan.
1	11	.1	.3
1	10	.1	.3
1	9	.2	.4
1	8.95	Bridge	
1	8.9	.2	.4
1	8	.1	.3
1	7	.1	.3
1	6	.1	.3
1	5	.1	.3
1	4	.1	.3
1	3	.1	.3
2	2	.1	.3
2	1	.1	.3





Drainage Diagram for MITI CAÑAS2
Prepared by Menar Hydrosystems Engineering
HydroCAD® 8.00 s/n 001583 © 2006 HydroCAD Software Solutions LLC

Area Listing (all nodes)

Area (acres)	CN	Description (subcats)
15.370	66	(BC2)
91.920	86	(PROJ)
107.290		

Time span=5.00-20.00 hrs, dt=0.05 hrs, 301 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment BC2: Runoff Area=15.370 ac Runoff Depth>0.87"
Tc=5.0 min CN=66 Runoff=25.83 cfs 1.113 af

Subcatchment PROJ: Runoff Area=91.920 ac Runoff Depth>2.21"
Tc=4.7 min CN=86 Runoff=390.10 cfs 16.922 af

Pond COMBP: Inflow=160.63 cfs 17.422 af
Primary=160.63 cfs 17.422 af

Pond POND: Peak Elev=67.84' Storage=5.686 af Inflow=390.10 cfs 16.922 af
Primary=143.05 cfs 16.309 af Secondary=0.00 cfs 0.000 af Outflow=143.05 cfs 16.309 af

Total Runoff Area = 107.290 ac Runoff Volume = 18.035 af Average Runoff Depth = 2.02"
100.00% Pervious Area = 107.290 ac 0.00% Impervious Area = 0.000 ac

Subcatchment BC2:

[49] Hint: Tc<2dt may require smaller dt

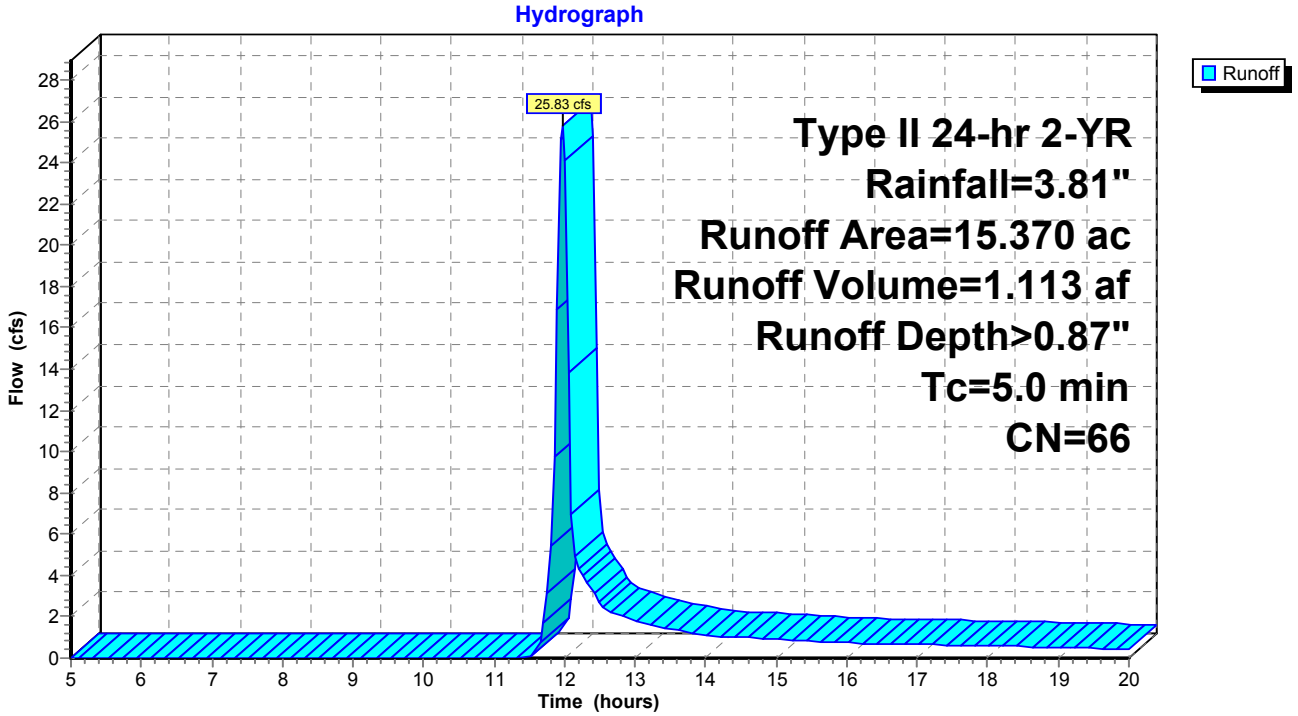
Runoff = 25.83 cfs @ 11.97 hrs, Volume= 1.113 af, Depth> 0.87"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 2-YR Rainfall=3.81"

Area (ac)	CN	Description
15.370	66	
15.370		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment BC2:



Subcatchment PROJ:

[49] Hint: Tc<2dt may require smaller dt

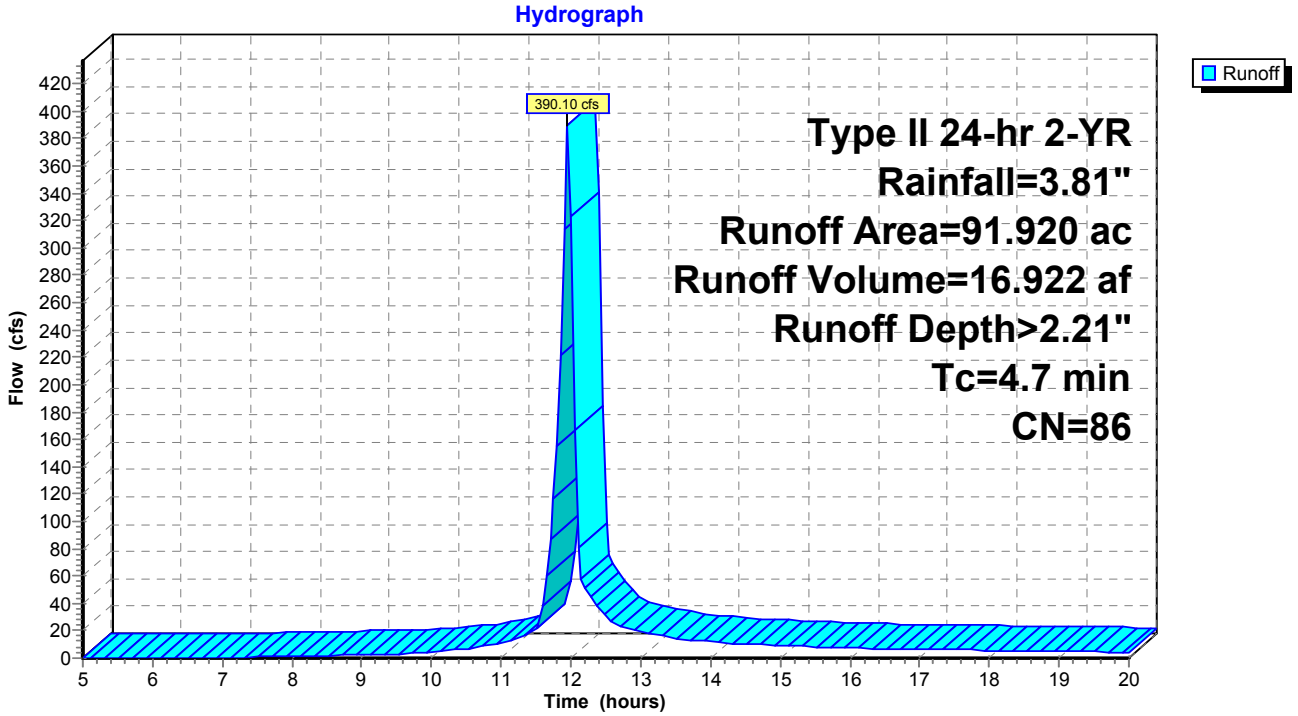
Runoff = 390.10 cfs @ 11.95 hrs, Volume= 16.922 af, Depth> 2.21"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 2-YR Rainfall=3.81"

Area (ac)	CN	Description
91.920	86	
91.920		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.7					**Direct Entry,**

Subcatchment PROJ:



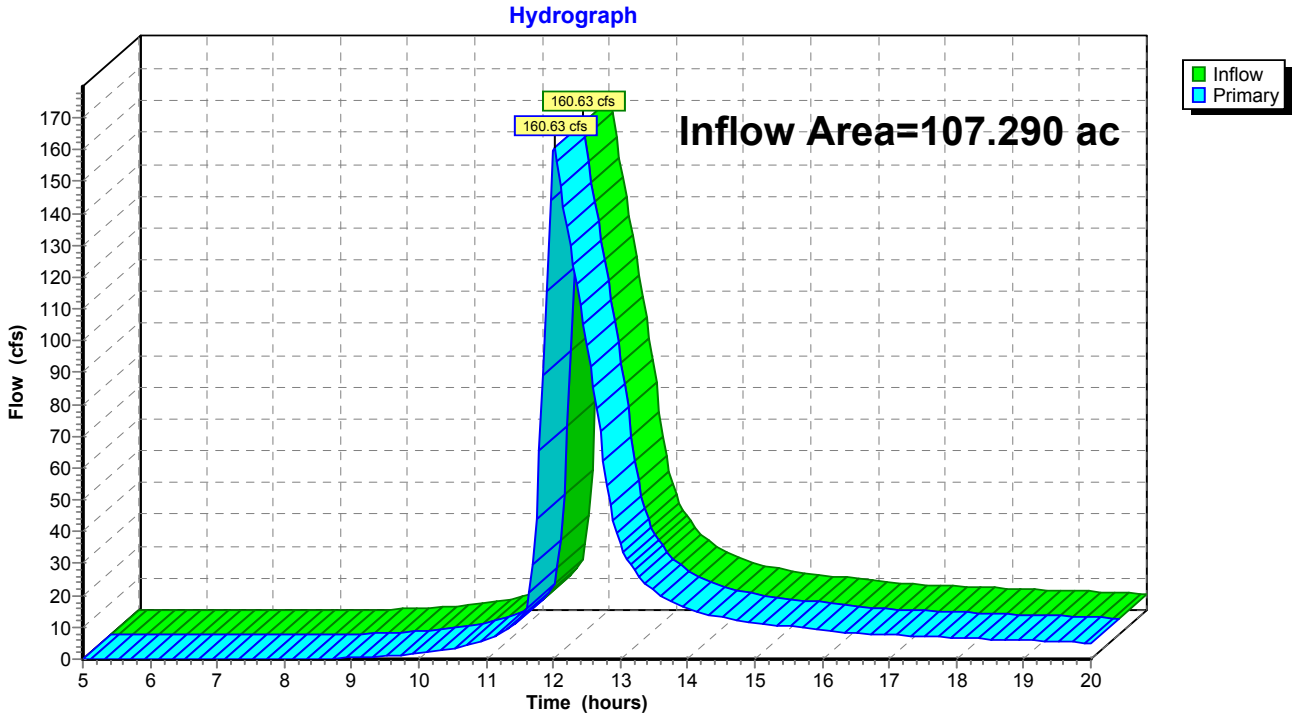
Pond COMBP:

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 107.290 ac, Inflow Depth > 1.95" for 2-YR event
Inflow = 160.63 cfs @ 12.02 hrs, Volume= 17.422 af
Primary = 160.63 cfs @ 12.02 hrs, Volume= 17.422 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

Pond COMBP:



Pond POND:

Inflow Area = 91.920 ac, Inflow Depth > 2.21" for 2-YR event
Inflow = 390.10 cfs @ 11.95 hrs, Volume= 16.922 af
Outflow = 143.05 cfs @ 12.07 hrs, Volume= 16.309 af, Atten= 63%, Lag= 7.0 min
Primary = 143.05 cfs @ 12.07 hrs, Volume= 16.309 af
Secondary = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 67.84' @ 12.07 hrs Surf.Area= 1.057 ac Storage= 5.686 af

Plug-Flow detention time= 40.9 min calculated for 16.309 af (96% of inflow)
Center-of-Mass det. time= 26.8 min (799.5 - 772.7)

Volume	Invert	Avail.Storage	Storage Description
#1	62.32'	10.135 af	**Custom Stage Data (Prismatic)** Listed below

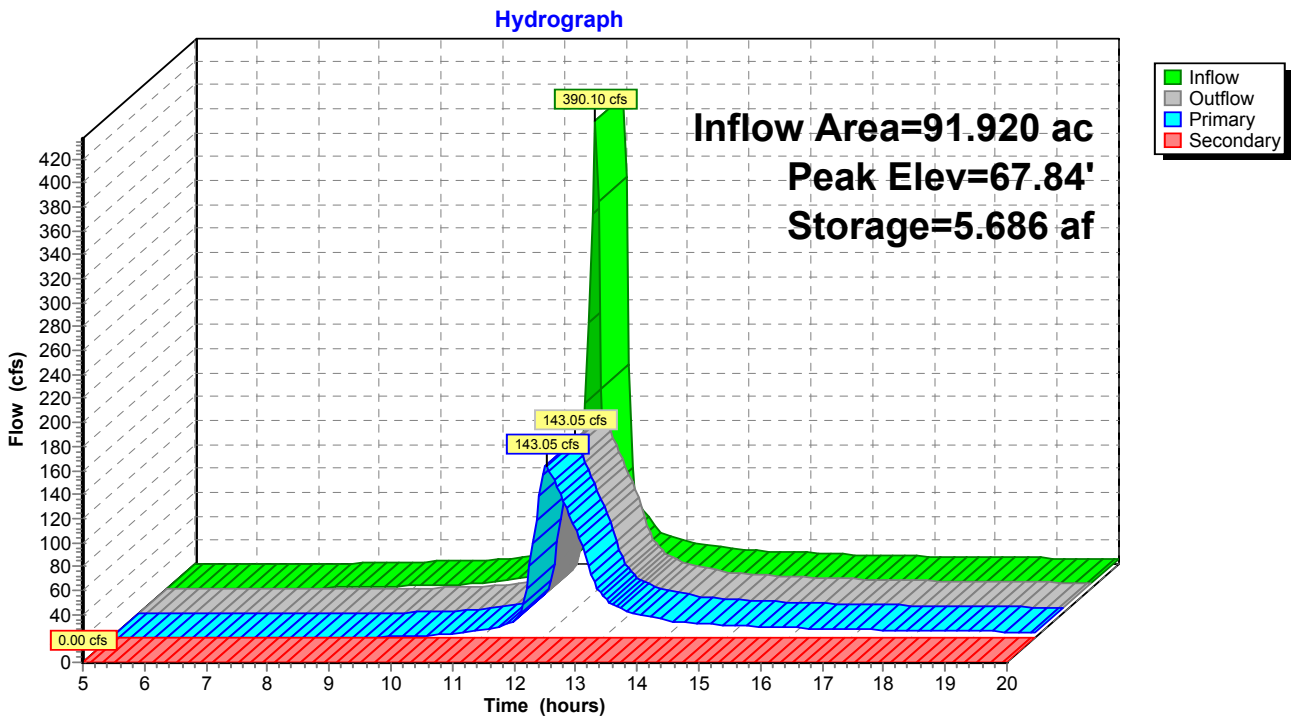
Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
62.32	0.810	0.000	0.000
72.16	1.250	10.135	10.135

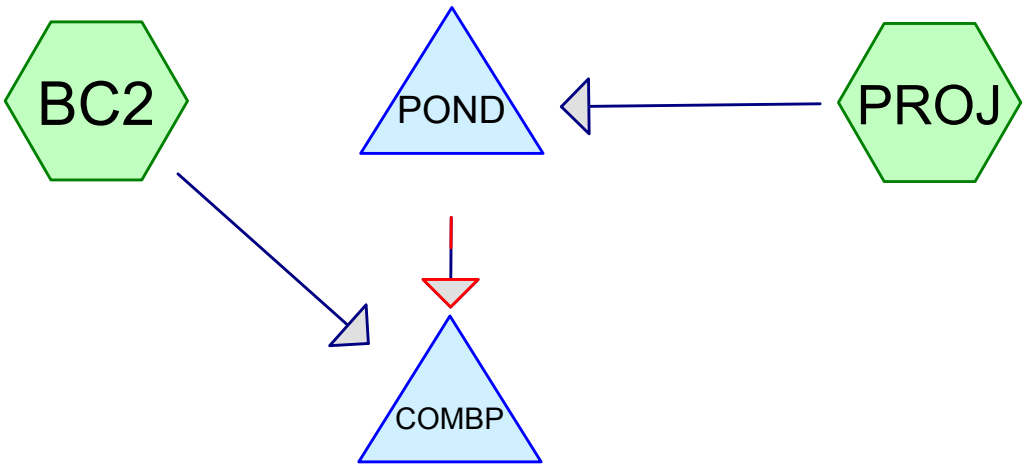
Device	Routing	Invert	Outlet Devices
#1	Primary	62.32'	**48.0" x 23.3' long Culvert X 4.00** RCP, square edge headwall, Ke= 0.500 Outlet Invert= 62.09' S= 0.0099 '/' Cc= 0.900 n= 0.050
#2	Device 1	62.32'	**3.50' W x 2.00' H Vert. Orifice/Grate X 2.00** C= 0.600
#3	Device 1	68.00'	**6.50' W x 2.00' H Vert. Orifice/Grate** C= 0.600
#4	Secondary	71.16'	**12.0' long x 10.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64

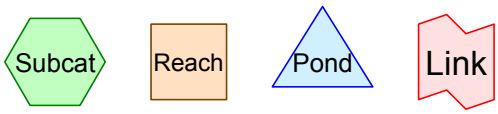
Primary OutFlow Max=142.12 cfs @ 12.07 hrs HW=67.78' TW=60.81' (Fixed TW Elev= 60.81')
└─**1=Culvert** (Passes 142.12 cfs of 293.22 cfs potential flow)
  ├─**2=Orifice/Grate** (Orifice Controls 142.12 cfs @ 10.15 fps)
  └─**3=Orifice/Grate** (Controls 0.00 cfs)

Secondary OutFlow Max=0.00 cfs @ 5.00 hrs HW=62.32' (Free Discharge)
└─**4=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond POND:


Hydrograph
Inflow
Outflow
Primary
Secondary
390.10 cfs
143.05 cfs
143.05 cfs
0.00 cfs
Inflow Area=91.920 ac
Peak Elev=67.84'
Storage=5.686 af
Flow (cfs)
Time (hours)





Drainage Diagram for MITI CAÑAS
Prepared by Menar Hydrosystems Engineering
HydroCAD® 8.00 s/n 001583 © 2006 HydroCAD Software Solutions LLC

Area Listing (all nodes)

Area (acres)	CN	Description (subcats)
15.370	44	(BC2)
91.920	49	(PROJ)
107.290		

Time span=5.00-20.00 hrs, dt=0.05 hrs, 301 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment BC2: Runoff Area=15.370 ac Runoff Depth>3.04"
Tc=5.0 min CN=44 Runoff=91.92 cfs 3.898 af

Subcatchment PROJ: Runoff Area=91.920 ac Runoff Depth>3.75"
Tc=4.7 min CN=49 Runoff=690.64 cfs 28.700 af

Pond COMBP: Inflow=329.15 cfs 31.725 af
Primary=329.15 cfs 31.725 af

Pond POND: Peak Elev=70.95' Storage=8.889 af Inflow=690.64 cfs 28.700 af
Primary=272.98 cfs 27.827 af Secondary=0.00 cfs 0.000 af Outflow=272.98 cfs 27.827 af

Total Runoff Area = 107.290 ac Runoff Volume = 32.598 af Average Runoff Depth = 3.65"
100.00% Pervious Area = 107.290 ac 0.00% Impervious Area = 0.000 ac

Subcatchment BC2:

[49] Hint: Tc<2dt may require smaller dt

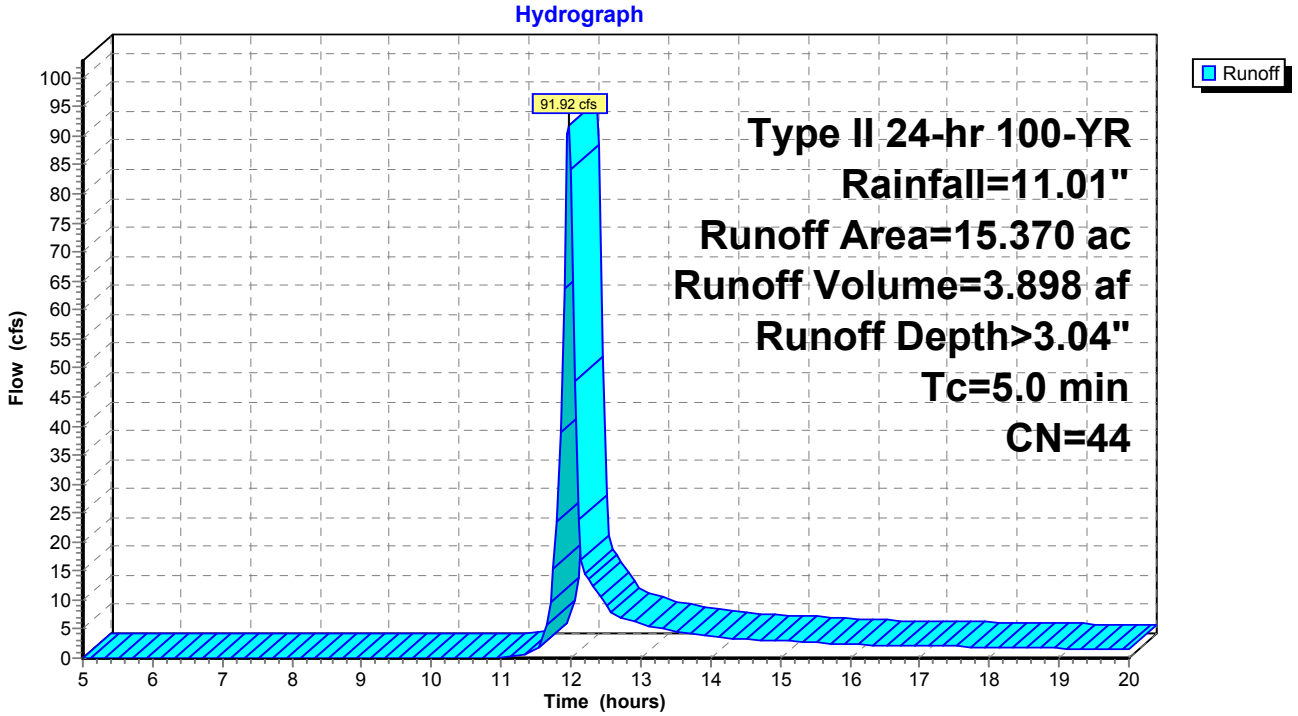
Runoff = 91.92 cfs @ 11.97 hrs, Volume= 3.898 af, Depth> 3.04"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-YR Rainfall=11.01"

Area (ac)	CN	Description
15.370	44	
15.370		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment BC2:



Subcatchment PROJ:

[49] Hint: Tc<2dt may require smaller dt

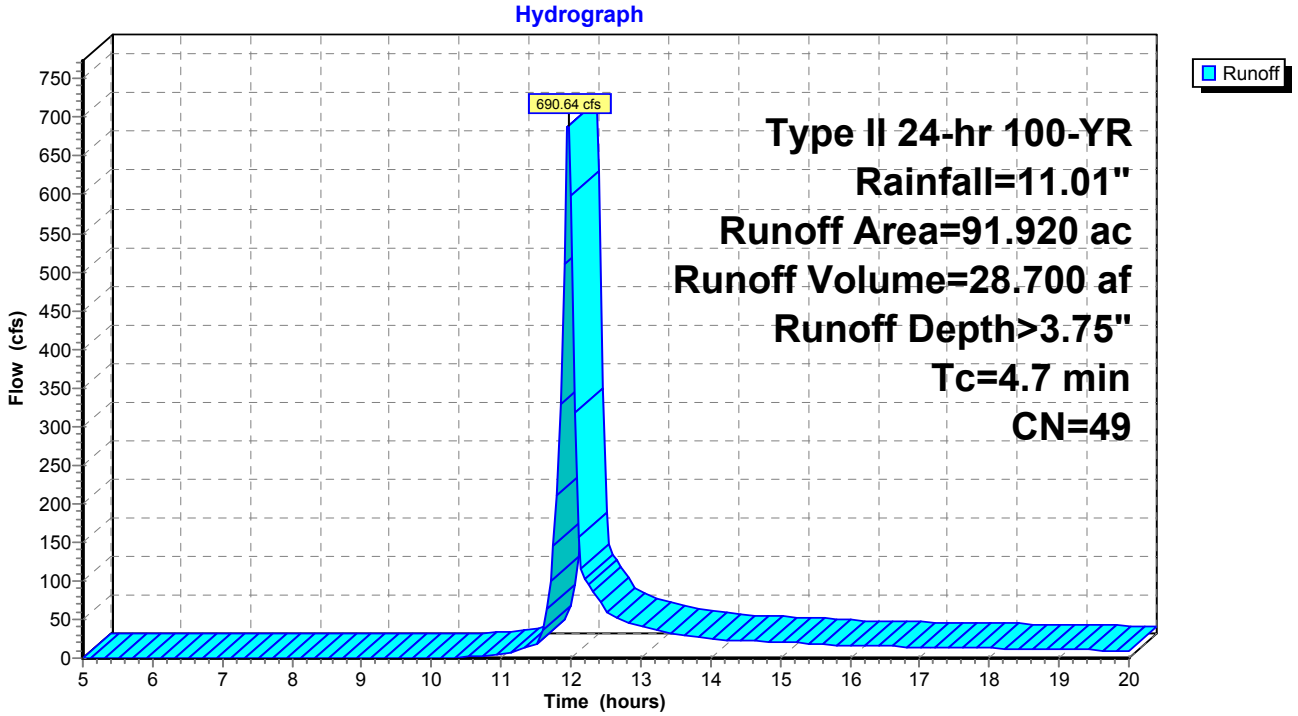
Runoff = 690.64 cfs @ 11.96 hrs, Volume= 28.700 af, Depth> 3.75"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-YR Rainfall=11.01"

Area (ac)	CN	Description
91.920	49	
91.920		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.7					**Direct Entry,**

Subcatchment PROJ:



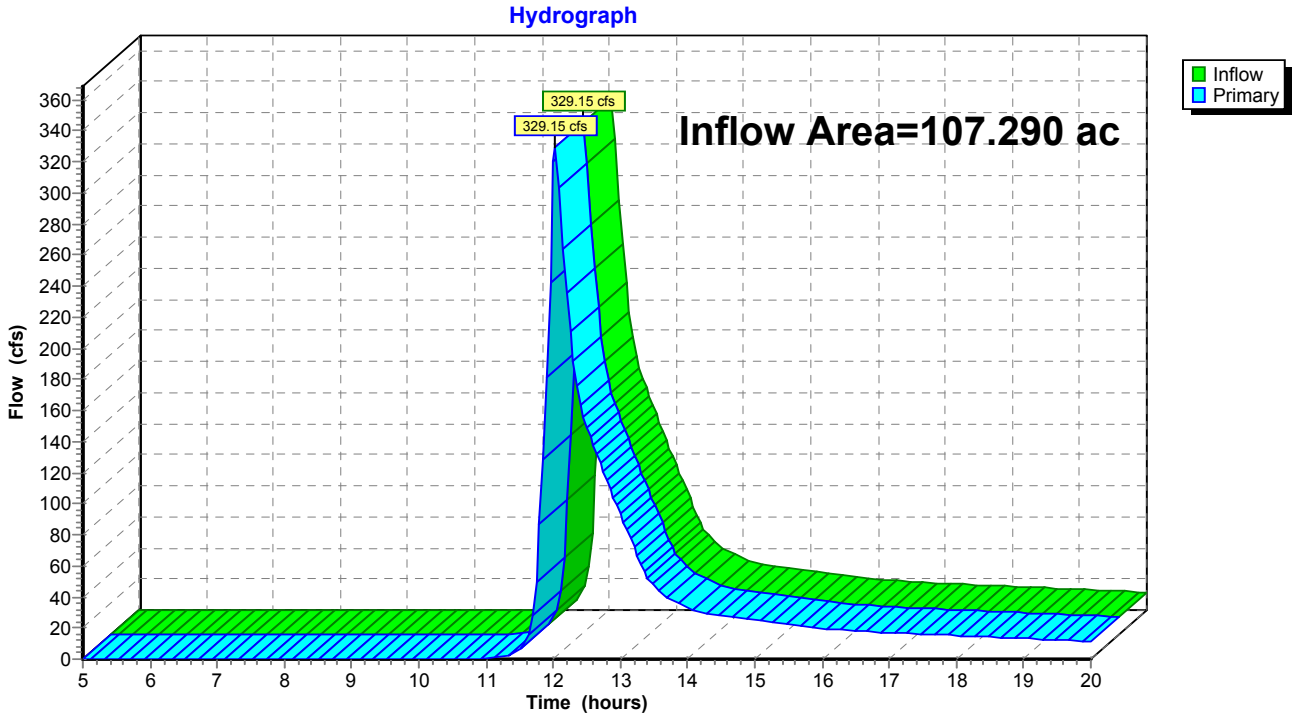
Pond COMBP:

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 107.290 ac, Inflow Depth > 3.55" for 100-YR event
Inflow = 329.15 cfs @ 12.02 hrs, Volume= 31.725 af
Primary = 329.15 cfs @ 12.02 hrs, Volume= 31.725 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

Pond COMBP:



Pond POND:

Inflow Area = 91.920 ac, Inflow Depth > 3.75" for 100-YR event
Inflow = 690.64 cfs @ 11.96 hrs, Volume= 28.700 af
Outflow = 272.98 cfs @ 12.07 hrs, Volume= 27.827 af, Atten= 60%, Lag= 6.6 min
Primary = 272.98 cfs @ 12.07 hrs, Volume= 27.827 af
Secondary = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 70.95' @ 12.07 hrs Surf.Area= 1.196 ac Storage= 8.889 af

Plug-Flow detention time= 32.2 min calculated for 27.827 af (97% of inflow)
Center-of-Mass det. time= 20.7 min (821.9 - 801.2)

Volume	Invert	Avail.Storage	Storage Description
#1	62.32'	10.135 af	**Custom Stage Data (Prismatic)** Listed below

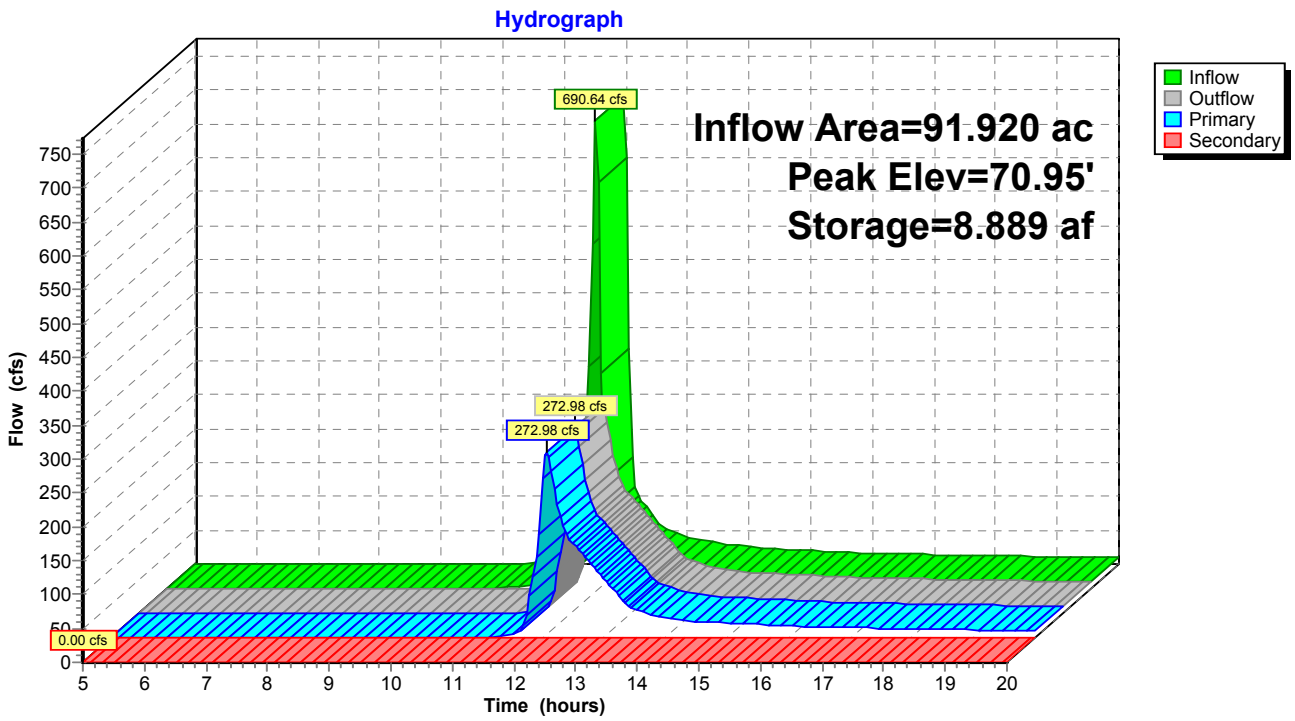
Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
62.32	0.810	0.000	0.000
72.16	1.250	10.135	10.135

Device	Routing	Invert	Outlet Devices
#1	Primary	62.32'	**48.0" x 23.3' long Culvert X 4.00** RCP, square edge headwall, Ke= 0.500 Outlet Invert= 62.09' S= 0.0099 '/' Cc= 0.900 n= 0.050
#2	Device 1	62.32'	**3.50' W x 2.00' H Vert. Orifice/Grate X 2.00** C= 0.600
#3	Device 1	68.00'	**6.50' W x 2.00' H Vert. Orifice/Grate** C= 0.600
#4	Secondary	71.16'	**12.0' long x 10.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64

Primary OutFlow Max=268.45 cfs @ 12.07 hrs HW=70.84' TW=60.81' (Fixed TW Elev= 60.81')
└─**1=Culvert** (Passes 268.45 cfs of 490.97 cfs potential flow)
  ├─**2=Orifice/Grate** (Orifice Controls 184.70 cfs @ 13.19 fps)
  └─**3=Orifice/Grate** (Orifice Controls 83.76 cfs @ 6.44 fps)

Secondary OutFlow Max=0.00 cfs @ 5.00 hrs HW=62.32' (Free Discharge)
└─**4=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond POND:


Hydrograph
690.64 cfs
272.98 cfs
272.98 cfs
0.00 cfs
Inflow Area=91.920 ac
Peak Elev=70.95'
Storage=8.889 af
Inflow
Outflow
Primary
Secondary
Flow (cfs)
Time (hours)

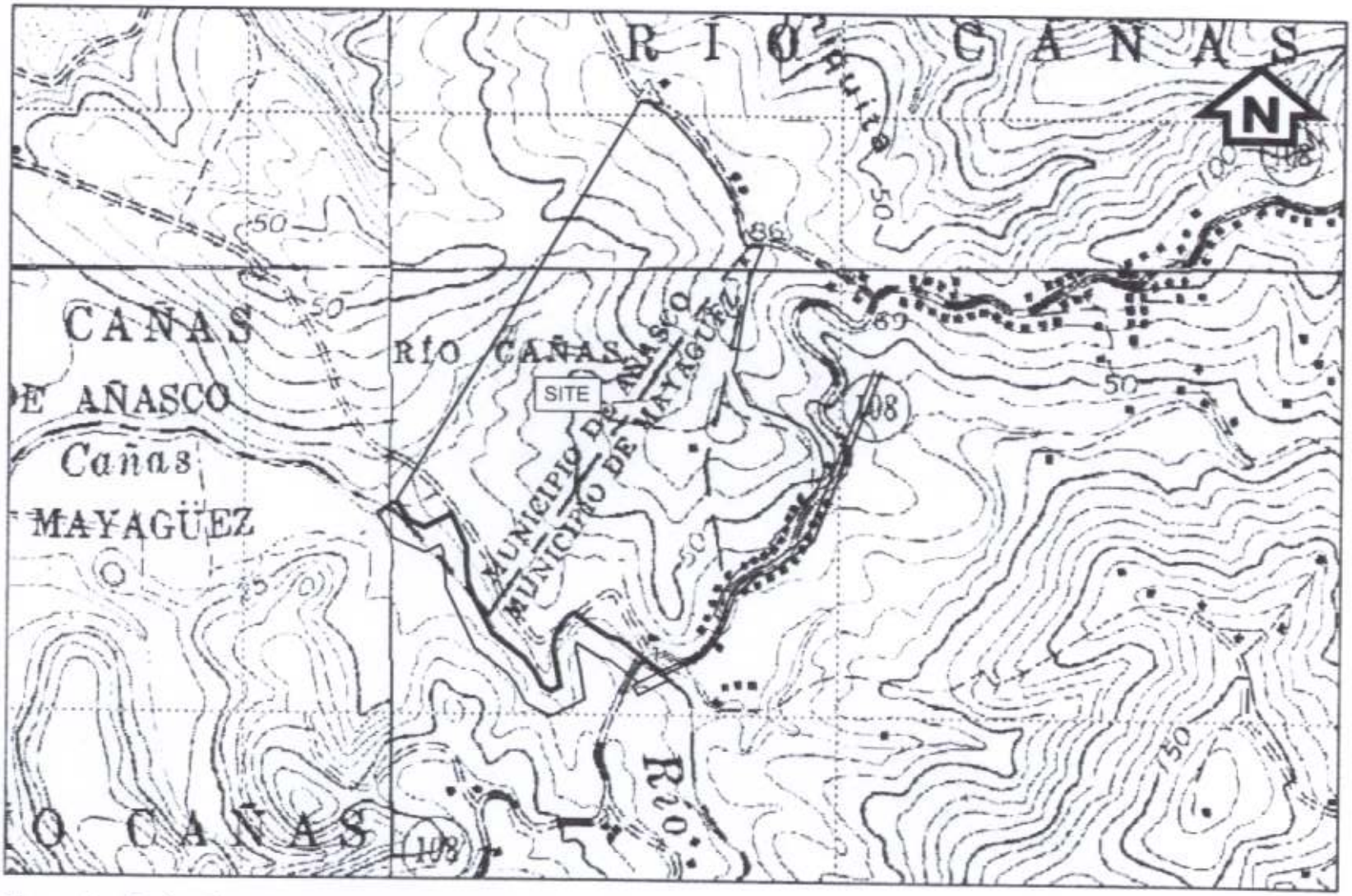


Figure 1. Project location on the USGS topographic maps of Mayagüez and Añasco (scale 1:10,000).

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Hydrology • Hydraulics • Sediment Transport

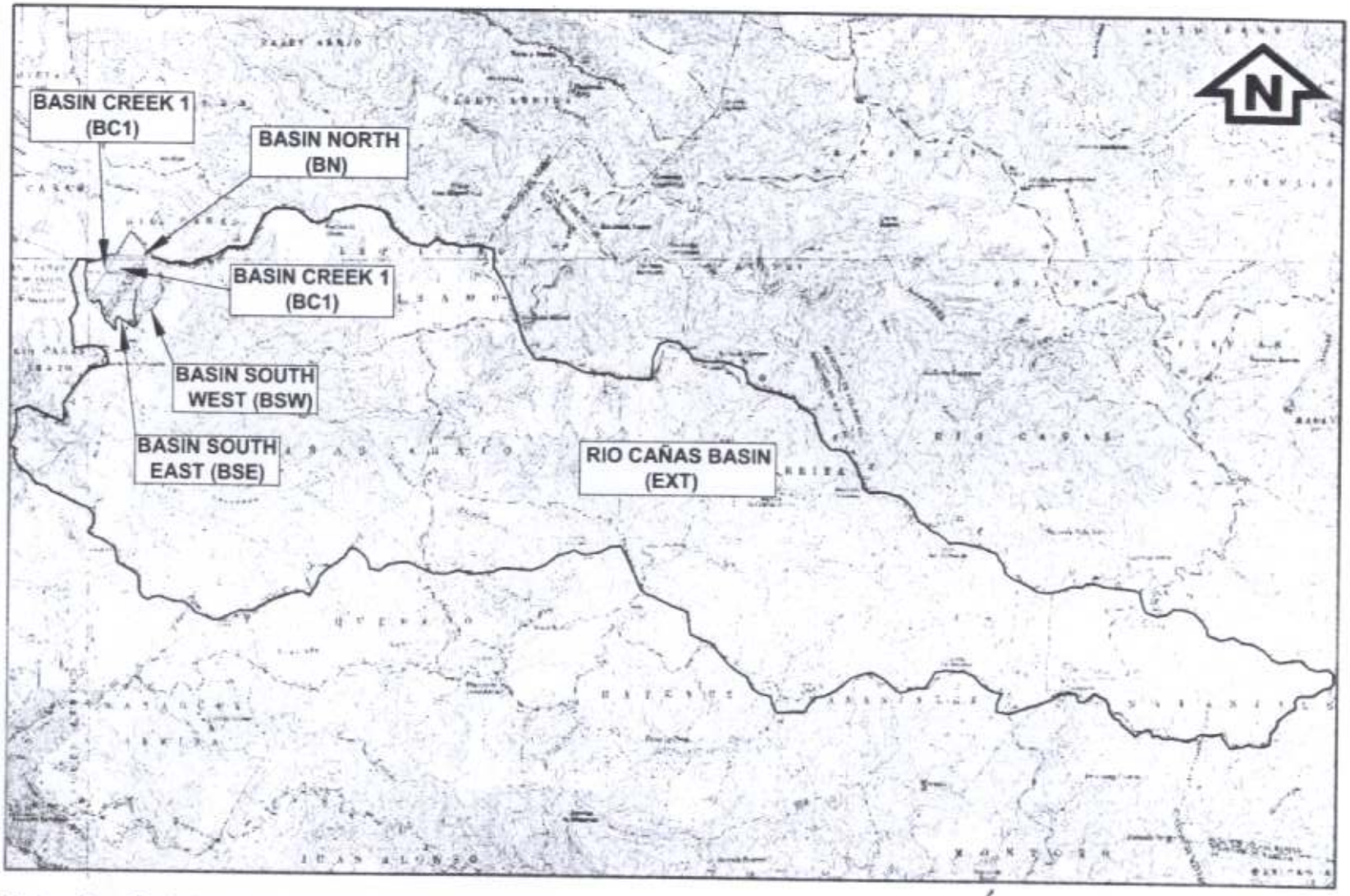

Figure 2. Drainage watershed limits for the existing condition (scale 1:60,000).

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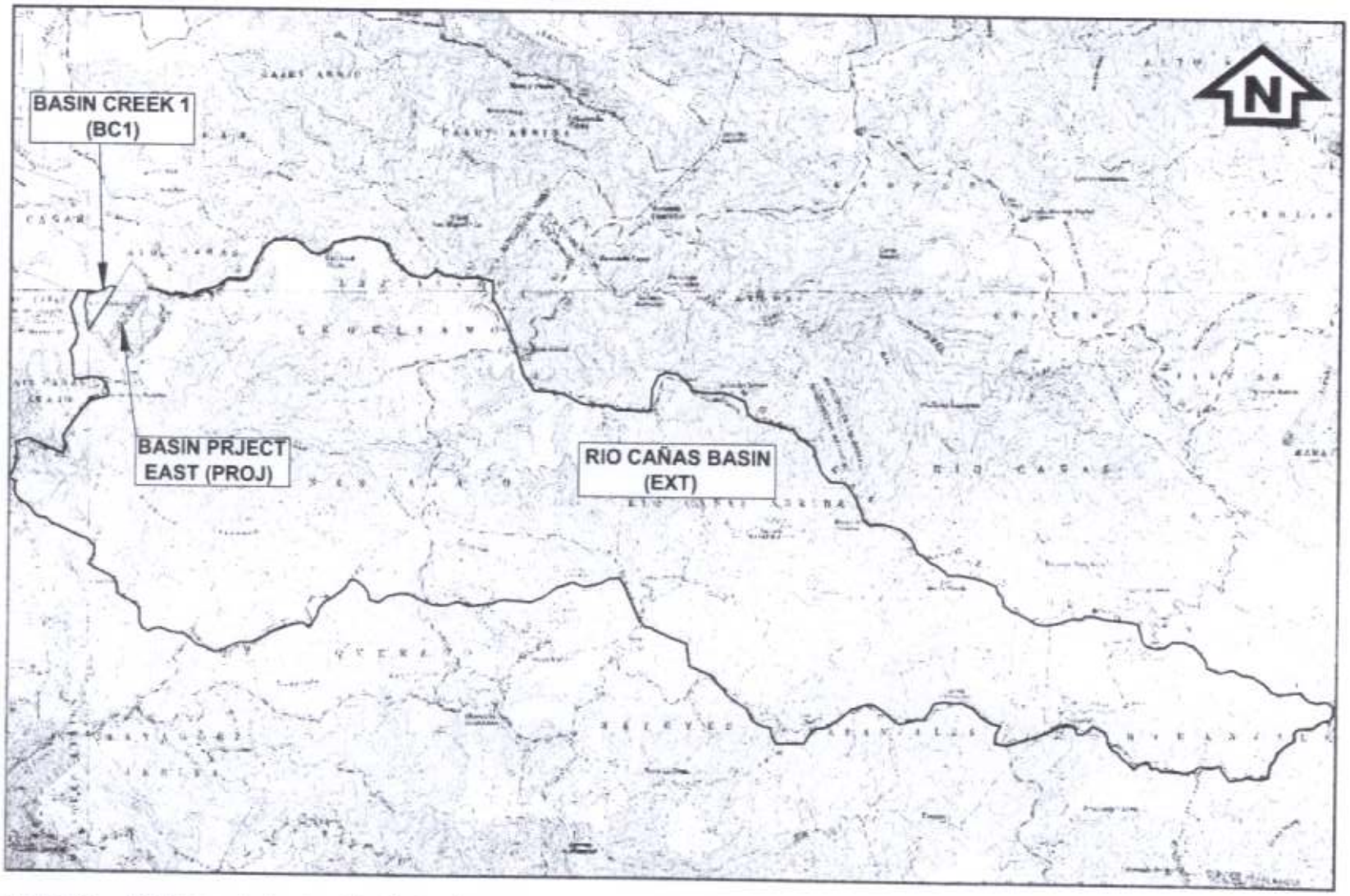

Figure 3. Drainage watershed limits for the proposed condition (scale 1:60,000).

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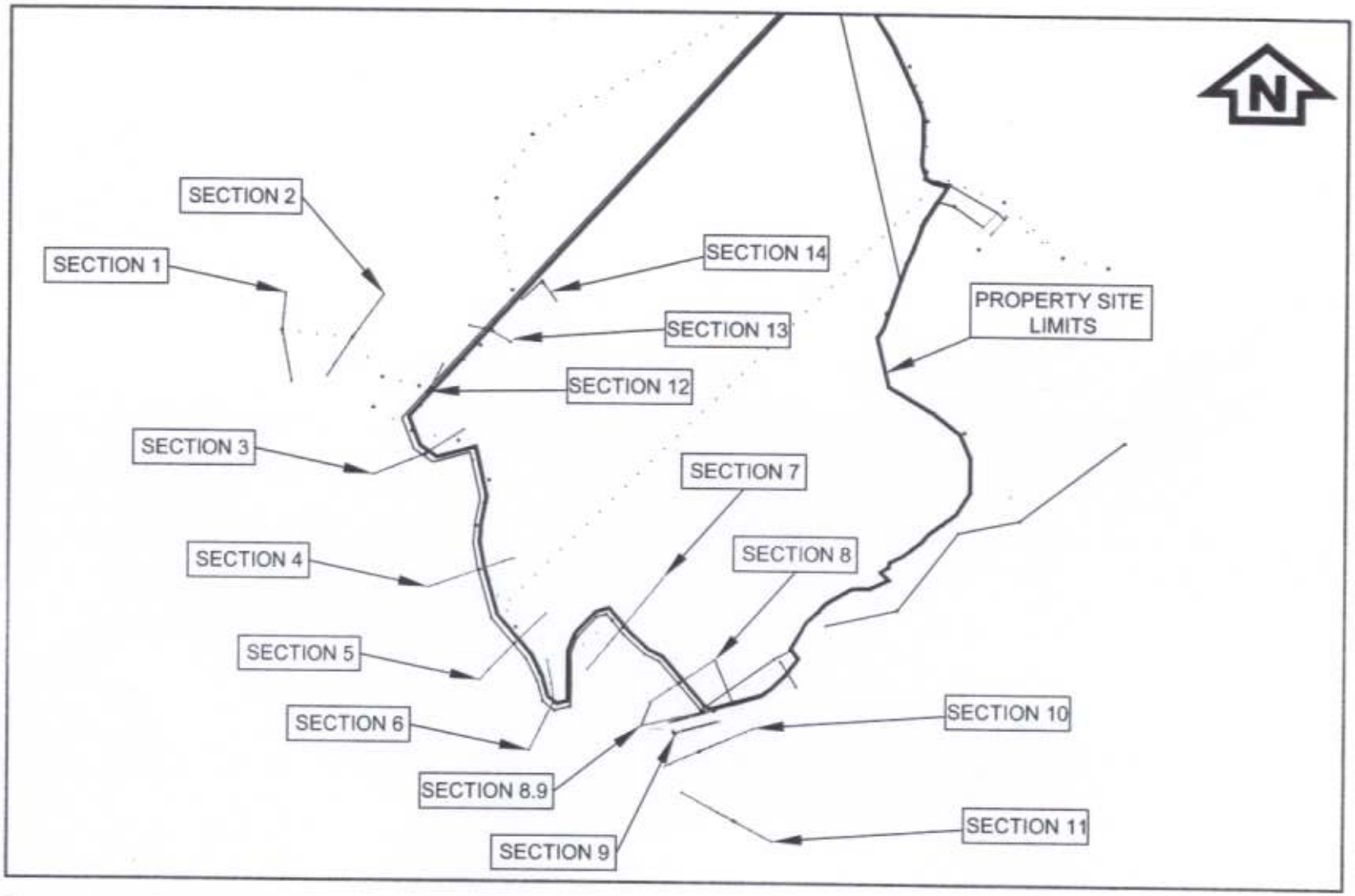

Figure 4. Cross sections location plan (scale 1:7,500).

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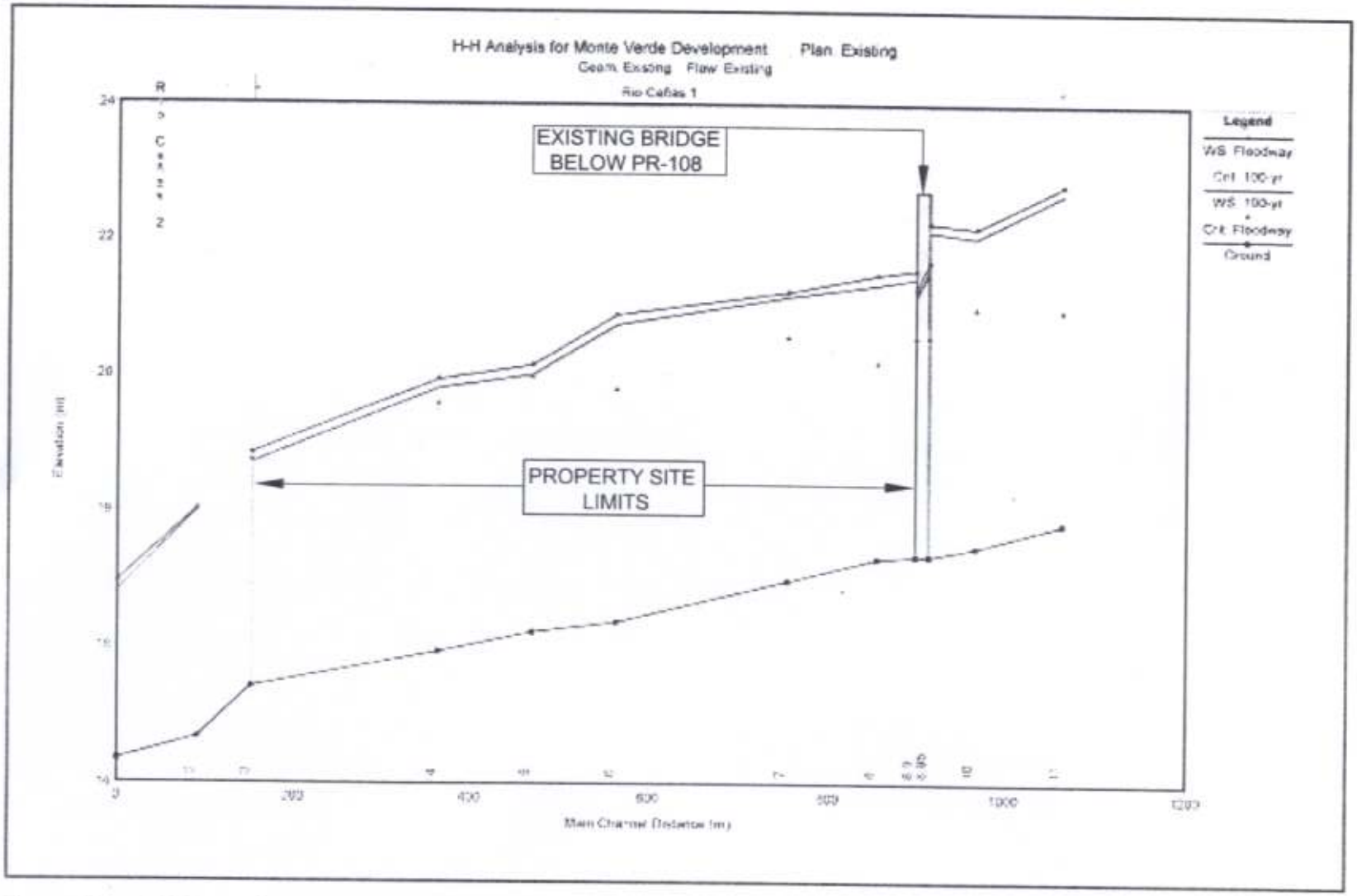

Figure 5. Water surface profiles for the existing condition: 100-year flood and floodway: Río Cañas (scale as shown).

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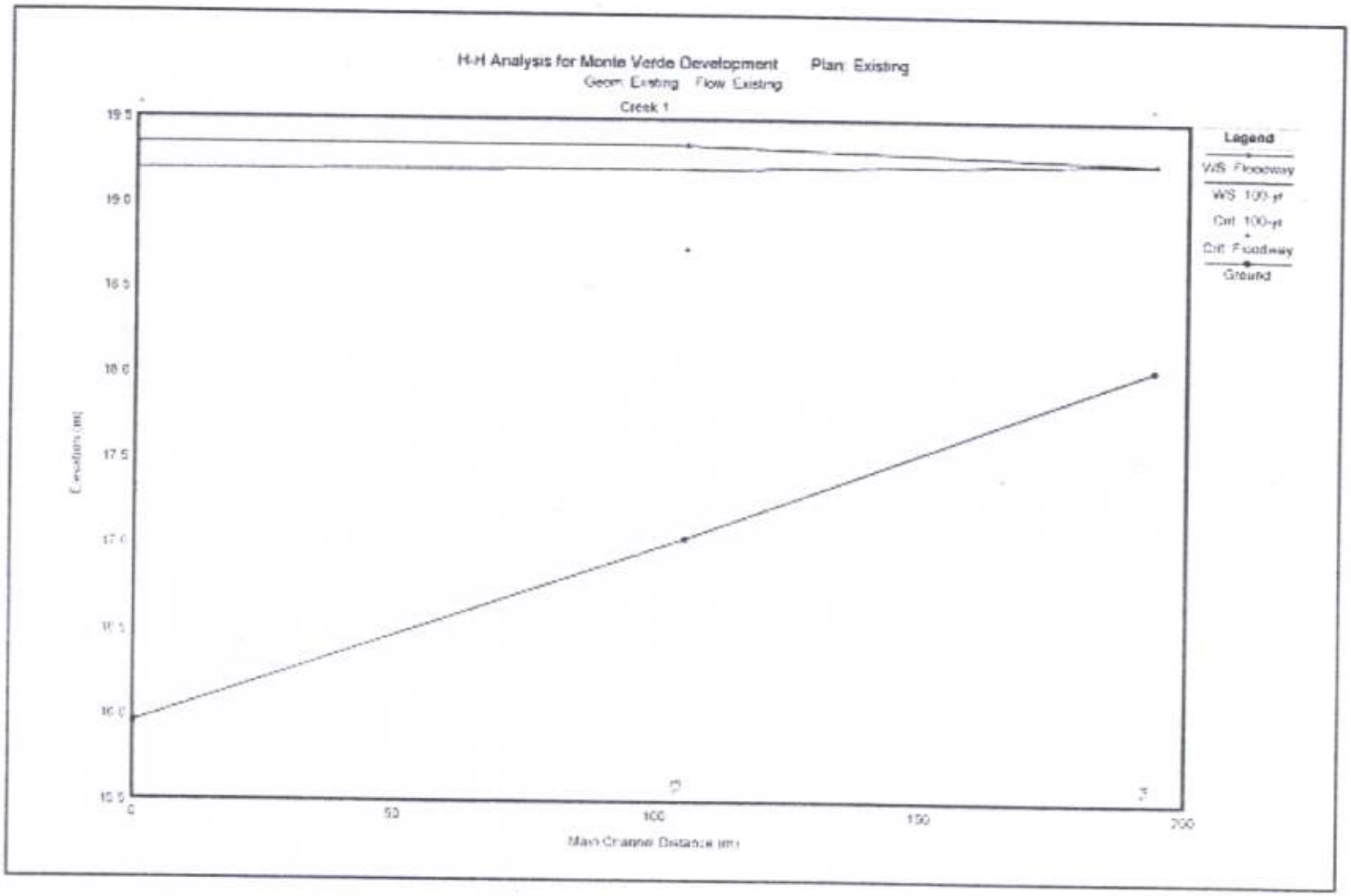

Figure 6. Water surface profiles for the existing condition: 100-year flood and floodway: Creek (scale as shown).

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Figure 7. 100-year flood and floodway limits for the existing condition (scale 1:10,000).

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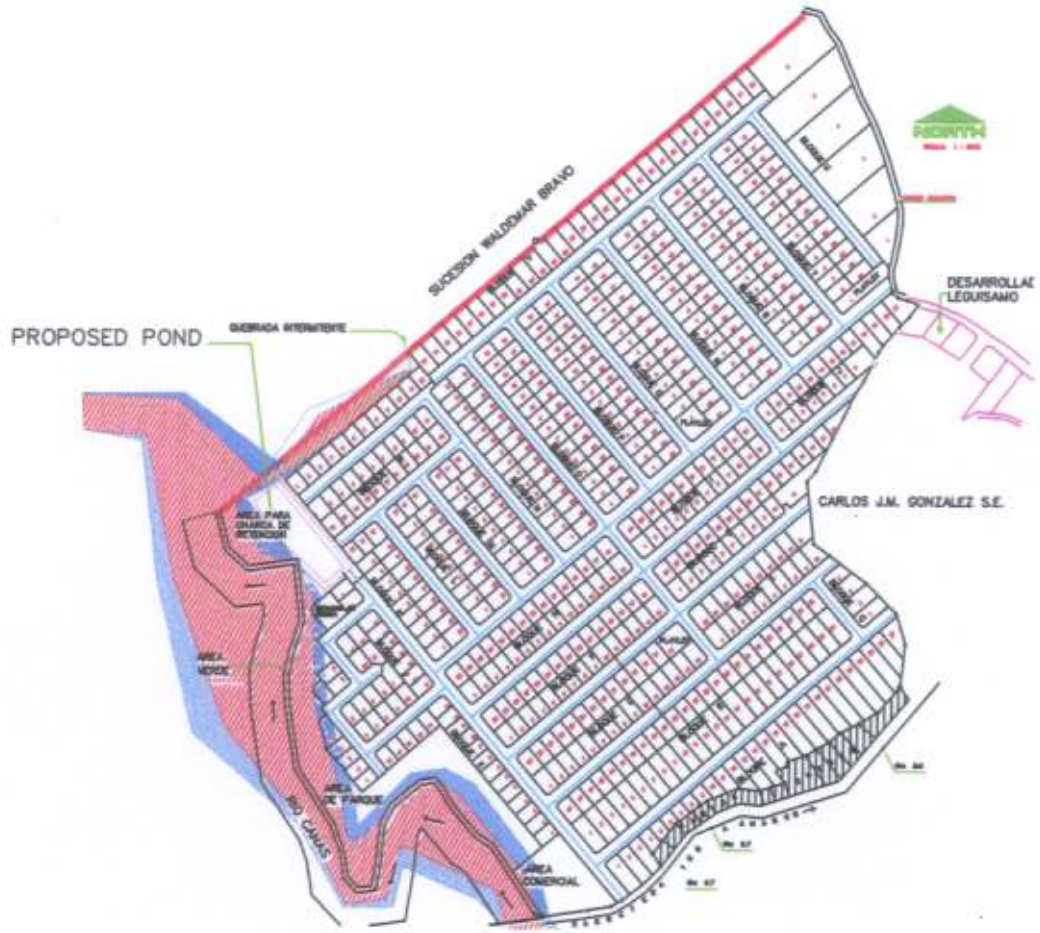

Figure 8. Location plan of the proposed detention pond (scale 1:5,000).

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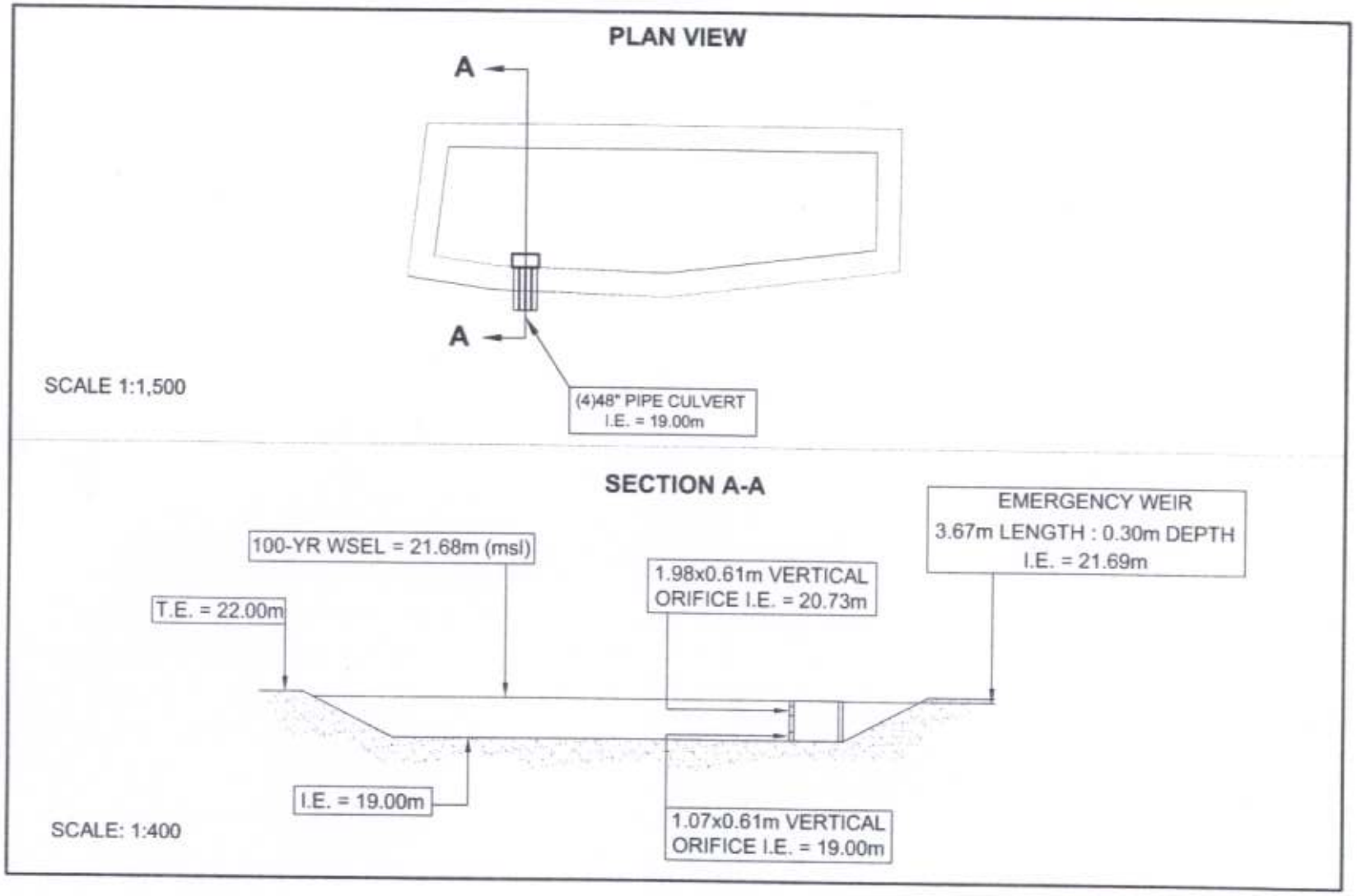

Figure 9. Conceptual scheme of the proposed detention pond (scale as shown).

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Hydrology*Hydraulics*Sediment Transport

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EXISTING CONDITION (100-YR FREQUENCY): EXIS.DAT
PROPOSED CONDITION (2-YR FREQUENCY): PROP2.DAT
PROPOSED CONDITION (100-YR FREQUENCY): PROP.DAT

D. HEC-RAS INPUT AND OUTPUT DATA (FILENAME: MONTE_VERDE.PRJ)

GEOMETRY: EXISTING

E. HYDROCAD INPUT AND OUTPUT DATA

MITIGATION CONDITION (2-YR FREQUENCY): MITI CAÑAS2.HCP
MITIGATION CONDITION (100-YR FREQUENCY): MITI CAÑAS.HCP

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8. Location plan of the proposed detention pond (scale 1:5,000).
9. Conceptual scheme of the proposed detention pond (scale as shown).

HYDROLOGIC-HYDRAULIC STUDY FOR MONTE VERDE RESIDENTIAL DEVELOPMENT AÑASCO-MAYAGÜEZ, PUERTO RICO

Menar Hydrosystems Engineering, P.S.C.
July 2007

I. INTRODUCTION

General

Eng. José Nelson Velez, civil designer, is currently developing the site plans for residential project in a property located at the State Road PR-108, Rio Cañas ward, of the Municipalities of Añasco and Mayagüez. For the feasibility of this project it is necessary to determine the flood levels for the 100-year rainfall event at the Río Cañas and unnamed creek draining at south and west side of the property respectively. After the determination of the flood levels and limits along the Río Cañas and unnamed creek the minimum finish floor elevations will be determined. Figure 1 shows the property location on the topographic quadrangles of Mayagüez and Rosario, published by the US Geological Survey [USGS, 1982]. The area proposed for development is estimated in 91.92 acres.

The property is not located within flooding zone. The FEMA's Flood Insurance Rate Map (FIRM) was not published because it does not show any flooding zone. The Planning Regulation No. 13 [PRPB, 2005a] will be applied for the design of the grading plan of the proposed project. That is, the 100-year flood levels along the studied reaches should not be increased more than 0.15 meter at any location as a result of the

proposed project. In addition, a flow mitigation analysis will be performed in fulfillment of the Planning Regulation No. 3 of the PR Planning Board [PRPB, 2005b].

Authorization

Eng. José Nelson Vélez, authorized this study, through an agreement with Mr. Miguel Menar Figueroa, P.E., representative of Menar Hydrosystems Engineering, P.S.C.

Scope of Work

The scope of work for the hydrologic-hydraulic study includes the following tasks.

- Site visit to determine existing hydrologic and hydraulic conditions.
- Hydrologic and hydraulic modeling of existing and proposed conditions.
- Determine the hydraulic profile for the 100-year flood and floodway for the existing and proposed conditions at the Río Cañas and unnamed creek.
- Determine the floodway limits for the existing and proposed conditions.
- Determine the flow velocities on the floodplain and in the main channel of the Río Cañas and unnamed creek.
- Determine the minimum required structure for flow mitigation as required by the Planning Regulation No. 3 of the PRPB. This structure will be designed for the 2 and 100-year peak flow discharges.

This study is divided in two phases: 1) Hydrologic Analysis, and 2) Hydraulic Analysis. Therefore, the results shown in the hydrologic analysis section will be described for the analyzed watersheds, while the hydraulic analysis is divided in two sections; 1) Flood Profiles Analysis and; 2) Flow Mitigation Analysis.

II. HYDROLOGIC ANALYSIS

Methodology

A Hydrologic Analysis was performed to determine the peak flow discharges corresponding to the 100-year (100-yr) and 2-year (2-yr) rainfall events in the studied watersheds. This analysis employed the Unit Hydrograph methodology developed by the U.S. Soil Conservation Service (SCS) and implemented in the June 1998 edition of the HEC-1 computer program (version 4.1) [USACE, 1998]. Discharges were computed at each basin outlet (see Figures 2 and 3).

Watershed Description

Drainage watersheds were delimited on the USGS 1:20,000 topographic maps of Mayagüez and Rosario. Figures 2 and 3 show the drainage watershed delimitation for the existing and proposed conditions respectively.

For the existing condition Río Cañas Basin was delimited (***EXT***). The project area was subdivided in four (4) sub-basins. Basin South East (***BSE***), and Basin South West (***BSW***) for the project area at south east and south west respectively, Basin North (***BN***) for the project area draining at north of the project area, Basin Creek 1 (***BC1***) for project area draining at the unnamed creek in the left side of the project area and Basin Creek 2 (***BC2***) for the external area draining to the unnamed creek. See Figure 2.

For the proposed condition the total project area was analyzed (***PROJ***). External basins, Río Cañas Basin was delimited (***EXT***) and Basin Creek 2 (***BC2***) were included in the proposed condition. Figure 3 shows watershed limits for the proposed condition.

Flood History

The P.R. Planning Board has no determined that the property site proposed for development a special flood area.

Rainfall Data

Average point rainfalls depths for the 2- and 100-year events were taken from the Frequency Data Server available online and developed for NOAA's National Weather Services in NOAA Atlas 14 Volume 3, Version 3.0 [U.S. Department of Commerce, et. al 2006]. This data is included in Appendix B.

Frequency based hypothetical storm used by the runoff model for the basin hydrologic response analysis were generated using the data in Table 1. The total storm is automatically distributed according to the specified depth per duration data for each analyzed exceedance probability (2- and 100-year).

A triangular precipitation distribution (balanced storm) was constructed such that the depth specified for any duration occurs during the central part of the storm.

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Table 1. Cumulative rainfall depth used in the HEC-1 model.

Duration, hr	0.083	0.25	1	2	3	6	12	24
2-yr, in	0.52	0.90	2.14	2.70	2.81	3.13	3.38	3.81
100-yr, in	0.80	1.40	3.32	4.41	4.86	6.13	8.33	11.01

Soils

The soil types were taken from the Soil Survey of Mayagüez Area of Western Puerto Rico, prepared by the Soil Conservation Service [SCS, 1977]. These are composed mostly of soils with hydrologic soil group *C*.

Time of Concentration

The time of concentration (Tc) is defined as the time it takes for the most hydraulically remote drop of water to travel to the basin outlet. Time of Concentration within each sub-basin was estimated using the Kirpich equation,

$$T_c = 0.00013*(L^{0.77}/S^{0.385}) \quad (1)$$

where, T_c is the time of concentration in hour, L is the length of the overland flow in feet, and S is the average overland slope in ft/ft.

Appendix A shows the computations for the time of concentration and lag time for the existing and proposed conditions.

Peak Discharges

The HEC-1 modeling was performed using: 1) the rainfall depths; 2) the basins areas; 3) the curve numbers (CN) and; 4) the basin's lag times ($0.6T_c$). Peak flow discharges for the 2-, and 100-year events were computed at each basin outlet. The hydrologic analysis results are shown in Tables 2 and 3 for the 100- and 2-year rainfall events respectively for all sub-basins. The estimated CN values and peak flow discharges for each sub-basin are shown in these tables (for antecedent moisture condition II [AMC II]).

Table 2. Peak flow discharges for the 100-year frequency event.

CONDITION	BASIN	AREA, ac (mi^2)	CN	T_C, min	Q, ft^3/s (m^3/s)
EXISTING	BC1	37.87 (0.0592)	70	5	224 (6.34)
	BC2	15.37 (0.0240)	70	5	91 (2.58)
	Combination (COMBC)				315 (8.92)
	BSE	17.29 (0.0270)	70	5	102 (2.89)
	BSW	25.86 (0.0104)	70	5	153 (4.33)
	Combination (COMBP)				570 (16.14)
	EXT	7,277 (11.37)	70	188	9,067 (256.74)
	Combination (COMB)				9,105 (257.82)
	BN	11.49 (0.0180)	70	5	68 (1.93)
PROPOSED	BC2	15.37 (0.0240)	70	5	91 (2.58)
	PROJ	91.92 (0.1436)	90	5	689 (19.51)
	Combination (COMBP)				779 (22.05)
	EXT	7,277 (11.37)	70	188	9,067 (256.75)
	Combination (COMB)				9,114 (258.08)

Table 3. Peak flow discharges for the 2-year frequency event.

CONDITION	BASIN	AREA, ac (mi^2)	CN	T_C, min	Q, ft^3/s (m^3/s)
EXISTING	BC1	37.87 (0.0592)	70	5	64 (1.81)
	BC2	15.37 (0.0240)	70	5	26 (0.74)
	Combination (COMBC)				90 (2.55)
	BSE	17.29 (0.0270)	70	5	29 (0.82)
	BSW	25.86 (0.0104)	70	5	44 (1.25)
	Combination (COMBP)				164 (4.64)
	EXT	7,277 (11.37)	70	188	2,292 (64.90)
	Combination (COMB)				2,298 (65.07)
	BN	11.49 (0.0180)	70	5	20 (0.57)
PROPOSED	BC2	15.37 (0.0240)	70	5	26 (0.74)
	PROJ	91.92 (0.1436)	90	5	383 (10.84)
	Combination (COMBP)				410 (1161)
	EXT	7,277 (11.37)	70	188	2,292 (64.90)
	Combination (COMB)				2,302 (65.18)

As noted in Tables 2 and 3, the peak flow discharges at the project outlet (COMP) is higher during the proposed condition for the2-and 100-year events. Peak flow discharges are increased from 164 to 410 ft^3/s and from 570 to 779 ft^3/s for the 2- and 100-year events respectively.

A flow mitigation structure should be provided within the project area limits to obtain a discharge equal or lower than the calculated for the existing condition for the 2- and 100-year events. Appendix A includes the corresponding hydrologic parameters calculation.

Detailed results obtained from HEC-1 hydrologic modeling are included in Appendix C for the existing and proposed conditions.

III. FLOOD PROFILES ANALYSIS

Methodology

The hydraulic analysis was performed using the River Analysis System (HEC-RAS 3.1.3) model, developed by the U.S. Army Corps of Engineers [USACE, 2005]. The existing condition was analyzed.

The hydraulic model geometry was conceptualized for two reaches: *Rio Cañas* and *Creek* for the creek draining at the left side of the project. Field survey data submitted by Ing José Nelson Velez was used to construct the hydraulic model geometry. Fourteen (14) cross sections were field surveyed, sections 1 and 11 for Río Cañas reach and sections 12 and 14 for the creek.

A copy of this data is included in the Appendix F. The cross sections location plan is shown in Figure 4. Starting elevation for was assumed as critical depth elevation for.

Coefficients Values

Manning's roughness coefficients were determined by visual inspection of the site. The values used for the existing condition were 0.04 in the main channel and 0.06 in the

floodplain. Contraction and expansion coefficients of 0.1 and 0.3 respectively were used for gradual transitions, and 0.2 and 0.4 for abrupt transitions.

Existing Condition Model

A hydraulic profile was computed to determine the flood and floodway limits and water surface elevations for the 100-yr event. The equal conveyance reduction (Method 4) option was used to determine the encroachment limits. Maximum water level increase was set at 0.15m. Computed water levels and velocities at each cross section along reaches *Rio Cañas* and *Creek* for the 100-yr flood are presented in Table 4. Figure 5 shows the water surface profiles for flood and floodway for the 100-yr flood event. HEC-RAS input and output data [Geometry: Existing] are also included in Appendix D.

Table 4. Hydraulic modeling results for the existing condition model: 100-year flood event: Río Cañas.

River sta	Profile	Q total	Min Ch El	W.S. Elev	Vel Chnl
		(m^3/s)	(m)	(m)	(m/s)
1	100-yr	257.82	14.35	16.81	4.13
	Floodway	257.82	14.35	16.96	3.80
2	100-yr	257.82	14.68	17.99	4.39
	Floodway	257.82	14.68	18.01	4.59
3	100-yr	257.82	15.42	18.70	3.61
	Floodway	257.82	15.42	18.79	3.65
4	100-yr	257.82	15.95	19.80	2.84
	Floodway	257.82	15.95	19.90	3.02

Table 4. Hydraulic modeling results for the existing condition model: 100-year flood event: Río Cañas (continued).

River sta	Profile	Q total	Min Ch El	W.S. Elev	Vel Chnl
		(m^3/s)	(m)	(m)	(m/s)
5	100-yr	257.82	16.23	20.00	4.14
	Floodway	257.82	16.23	20.13	4.12
6	100-yr	257.82	16.37	20.75	2.41
	Floodway	257.82	16.37	20.89	2.34
7	100-yr	257.82	16.99	21.16	2.37
	Floodway	257.82	16.99	21.25	2.54
8	100-yr	257.82	17.32	21.36	2.55
	Floodway	257.82	17.32	21.49	2.52
8.9	100-yr	257.82	17.35	21.44	2.86
	Floodway	257.82	17.35	21.57	2.83
8.95	Existing bridge below State Road PR-108				
9	100-yr	257.82	17.35	22.25	2.18
	Floodway	257.82	17.35	22.38	2.21
10	100-yr	257.82	17.48	22.17	3.27
	Floodway	257.82	17.48	22.32	3.24
11	100-yr	257.82	17.83	22.75	1.42
	Floodway	257.82	17.83	22.90	1.42

Table 5. Hydraulic modeling results for the existing condition model: 100-year flood event: Creek.

River sta	Profile	Q total	Min Ch El	W.S. Elev	Vel Chnl
		(m^3/s)	(m)	(m)	(m/s)
12	100-yr	8.92	15.96	19.20	0.27
	Floodway	8.92	15.96	19.34	0.24
13	100-yr	8.92	17.04	19.21	0.74
	Floodway	8.92	17.04	19.34	0.62
14	100-yr	8.92	18.05	19.32	2.45
	Floodway	8.92	18.05	19.32	2.45

IV. FLOW MITIGATION ANALYSIS

The proposed mitigation system was conceptualized for Basin Project (***PROJ***) and external Basin Creek 2 (***BC2***). At this point, a second model was developed using the HydroCAD computer program [Applied Microcomputer Systems, 2006]. The reason was to take advantage from the modeling options and graphical aids available in this program for the design of a stormwater detention structure. For example, the available and required storage volume at the property proposed to receive the storm water discharge can be simulated without the need for direct or indirect external computations. As noted, this exercise will be performed only for use in the flow mitigation analysis.

The first step in this analysis was to reproduce the peak flow discharges computed in the HEC-1 models developed in the Hydrologic Analysis. Since HydroCAD does not have the

capability to distribute a given rainfall depth according to a specified depth/duration data it was necessary to modify the Curve Numbers (CN) to reproduce the peak flow discharges obtained from the HEC-1 results. The CN values used in HydroCAD to reproduce the results obtained with the HEC-1 are shown in Table 6. Peak flow discharges reproduced using HydroCAD are shown in Table 7.

Table 6. Peak flow discharges reproduced in HydroCAD.

BASIN	CONDITION	Peak Flow (ft^3/s)			
		HEC-1		HydroCAD	
		100-yr	2-yr	100-yr	2-yr
BC2	PROPOSED	91	26	92	26
PROJ		689	383	690	390
COMBP		779	410	329*	161*

*After mitigation.

Table 7. Curve number equivalences between HEC-1 and HydroCAD models.

BASIN	CONDITION	CN			
		HEC-1		HydroCAD	
		100-yr	2-yr	100-yr	2-yr
BC2	PROPOSED	90	90	66	44
PROJ		90	90	86	49

The proposed stormwater system was conceptualized as Basin Project (***PROJ***) discharging directly into the flow mitigation structure (see Figure 8). The design criterion for the proposed mitigation structure was to provide the minimum storage volume to keep the proposed flow discharge equal or lower that the existing at the project outlet. That is, the outflow discharge should be equal or lower than 570 and 164 ft^3/s, for the 100- and 2-year events respectively.

The proposed mitigation structure is a detention pond. The location of this structure is shown in Figure 8 and was designed considering the existing ground elevations.

The storage volume of the proposed box was determined as a function of the outlet structure. To keep the fill works in a minimum extent the structure was designed with a depth of 3.0 meters. The flow discharges computed at the Project outlet after mitigation for the proposed condition are 329 and 161 ft^3/s for the 100- and 2-year events respectively (see Table 8).

The recommended detention box has a top area of 5,070 m^2 (1.25 ac) and 3.0 m depth (including freeboard). It has an outlet structure consisting of a vertical orifice of 1.07 x 0.61 m (width x height) with an invert elevation of 19.0m (msl), a vertical orifice of 1.98 x 0.61 m (width x height) with an invert elevation of 20.73 m (msl), and four reinforced concrete pipe culvert of 48 inches diameter (I.D.) with a 1% slope (min). Table 8 shows the results of the flow mitigation analysis for the proposed pond.

Table 8. Detention structure analysis results for the proposed pond.

Structure	Pond
Storage Volume	12,501 m^3
Pond Top Elevation	22.0 m
Pond Invert Elevation	19.0 m
100-year Existing Discharge at Project Outlet	570 ft^3/s
100-year Outflow Discharge at Project Outlet (BEFORE MITIGATION)	779 ft^3/s
100-year Outflow Discharge at Project Outlet (AFTER MITIGATION)	329 ft^3/s
2-year Existing Discharge at Project Outlet	164 ft^3/s
2-year Outflow Discharge at Project Outlet (BEFORE MITIGATION)	410 ft^3/s
2-year Existing Discharge at Project Outlet (AFTER MITIGATION)	161 ft^3/s
100-year Water Level	21.62 m
2-year Water Level	20.68 m
Primary Outflow Device	(3) 48" PIPE @ 19.0m (msl) entrance I.E. and 1% min. slope
Outlet Device #1	1.07 x 0.61m(WIDTH X HEIGTH) vertical orifice @ 19.0m (msl) I.E.
Outlet Device #2	1.98 x 0.61m (WIDTH X HEIGTH) vertical orifice @ 20.73m (msl) I.E.
Emergency Outlet	3.67 x 0.30 m (LENGTHxDEPTH) Broad-Crested Rectangular Weir @21.69m (msl) I.E.

Figures 8 and 9 shows conceptual schemes of the proposed box. All the input and output data generated in this analysis using HydroCAD is included in Appendix E.

V. CONCLUSIONS AND RECOMMENDATIONS

Conclusions

1. The 100- and 2-year peak flow discharges at the project basin outlet are increased from 164 to 410 ft^3/s and from 570 to 779 ft^3/s for each event respectively. Therefore, a flow mitigation structure should be provided within the project limits.
2. The recommended detention box will reduce the peak flow discharge at project outlet from 779 to 329 ft^3/s, which is lower than 570 ft^3/s, the existing flow discharge for the 100-year event. For the 2-year event this is reduced from 410 to 161 ft^3/s, which is lower than 164 ft^3/s, the existing flow discharge. Therefore, it complies with the Planning Regulation No. 3 of the PR Planning Board. Specifications of this structure are indicated in Table 8.
3. The flood and floodway analysis was performed to determine the encroachments limits based on the equal conveyance reduction method. Figure 7 show the flood and floodway limits for the Rio Cañas and Creek in the project area.

Recommendations

1. The minimum required flow detention structure recommended must be as specified at Table 8 and Figure 9. Location of this structure is shown in Figure 8.
2. The recommended detention box has a top area of 5,070 m^2 (1.25 ac) and 3.0 m depth (including freeboard). It has an outlet structure consisting of a vertical orifice of 1.07 x 0.61 m (width x height) with an invert elevation of 19.0m (msl), a vertical orifice of 1.98 x 0.61 m (width x height) with an invert elevation of 20.73 m (msl), and four reinforced concrete pipe culvert of 48 inches diameter (I.D.) with a 1% slope (min). Table 8 shows the results of the flow mitigation analysis for the proposed pond.
3. Dimensions of the proposed detention pond can be changed to fit the site civil design. However, minimum storage volume, outlet structure and, relative minimum invert elevations should be as recommended.
4. Finish floor elevation for all the habitable structures within the property proposed for development must be equal to or higher than 22.22m (100-year water level in the proposed detention structure plus 0.6 meter).
5. The project developer should establish a routine maintenance inspection program once the stormwater facilities have been completed and placed in service. The inspections should be conducted on an annual or semi-annual basis, as well as following major storms and it should be documented. When any repair work has been performed, it should be also recorded.

Study Limitations

All recommendations specified herein must be implemented to assure performance in accordance with the design. The results of this study are based on free flow conditions through the recommended hydraulic structures. Proper maintenance is required to assure this condition since, the accumulation of debris can severely obstruct flow, producing backwater much higher than presented herein. This analysis is based on the field data as submitted by Ing. José Nelson Velez. Inaccuracies in this data may total or partially invalidate the results and recommendations contained in this study.

VI. CERTIFICATION

I certify that the hydrologic-hydraulic study presented herein was performed by me and the information is true, correct, and complete as per my knowledge. I know and accept the consequences of include and submit incomplete, unfinished or false information in this document. To state this, I sign the present certification in *Carolina, Puerto Rico*, on July 24, 2007.

Miguel Menar Figueroa, MSCE, PE
Lic. #13051

VII. REFERENCES

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FIGURES

APPENDIX A

HYDROLOGIC DATA

APPENDIX B

PRECIPITATION DATA (NOAA ATLAS 14, VOL 3, VERSION 3.0)

APPENDIX C

HEC-1 INPUT AND OUTPUT DATA

EXISTING CONDITION (2-YR FREQUENCY): EXIS2.DAT

EXISTING CONDITION (100-YR FREQUENCY): EXIS.DAT

PROPOSED CONDITION (2-YR FREQUENCY): PROP2.DAT

PROPOSED CONDITION (100-YR FREQUENCY): PROP.DAT

APPENDIX D

HEC-RAS INPUT AND OUTPUT DATA

FILENAME: MONTE_VERDE.PRJ

GEOMETRY: EXISTING

APPENDIX E

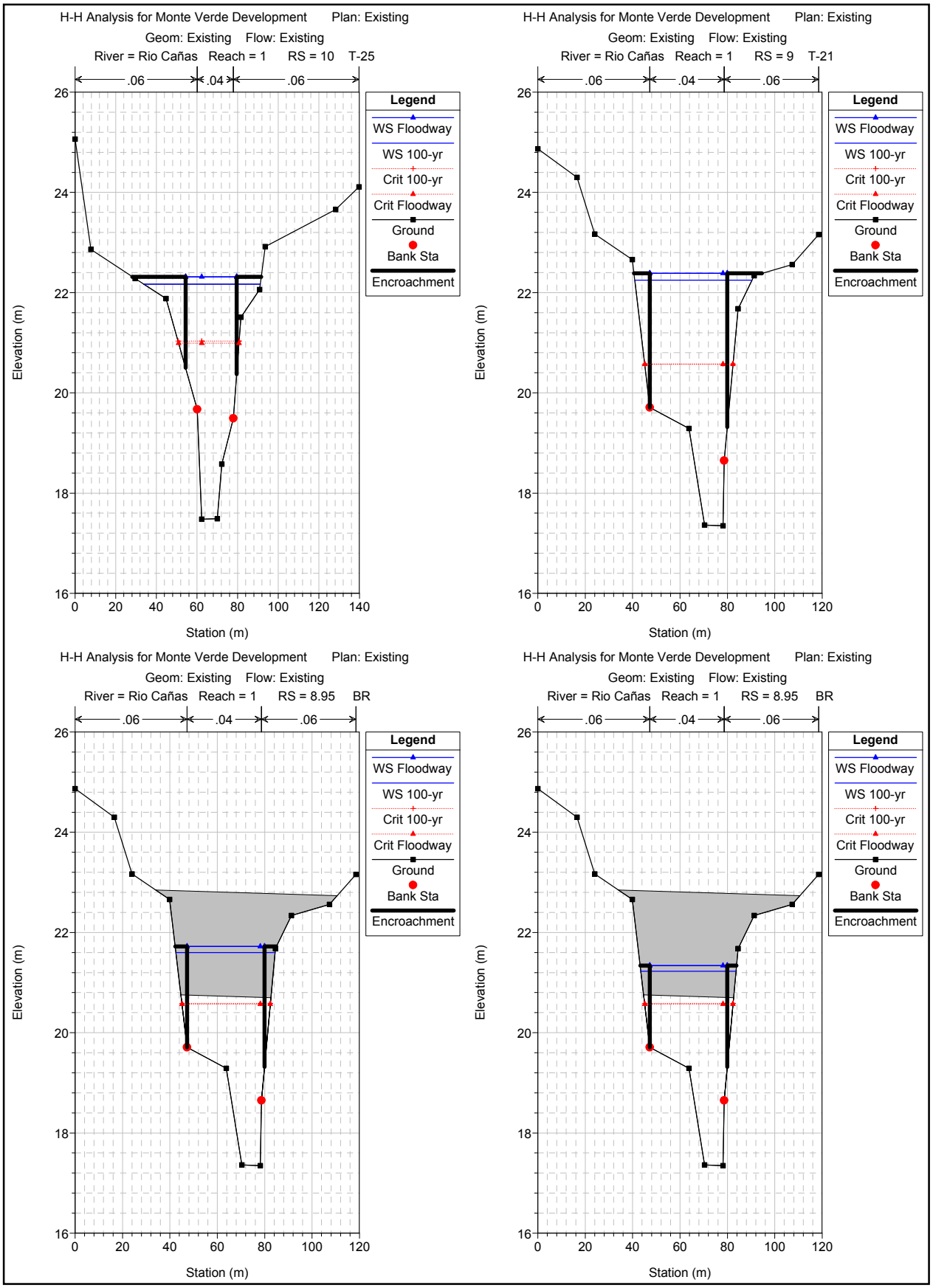
HYDROCAD INPUT AND OUTPUT DATA

MITIGATION CONDITION (2-YR FREQUENCY): MITI CAÑAS2.HCP

MITIGATION CONDITION (100-YR FREQUENCY): MITI CAÑAS.HCP

APPENDIX F

FIELD DATA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Legend
WS Floodway
WS 100-yr
Crit 100-yr
Crit Floodway
Ground
Bank Sta
Encroachment
Elevation (m)
Station (m)
H-H Analysis for Monte Verde Development Plan: Existing
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Bank Sta
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Encroachment
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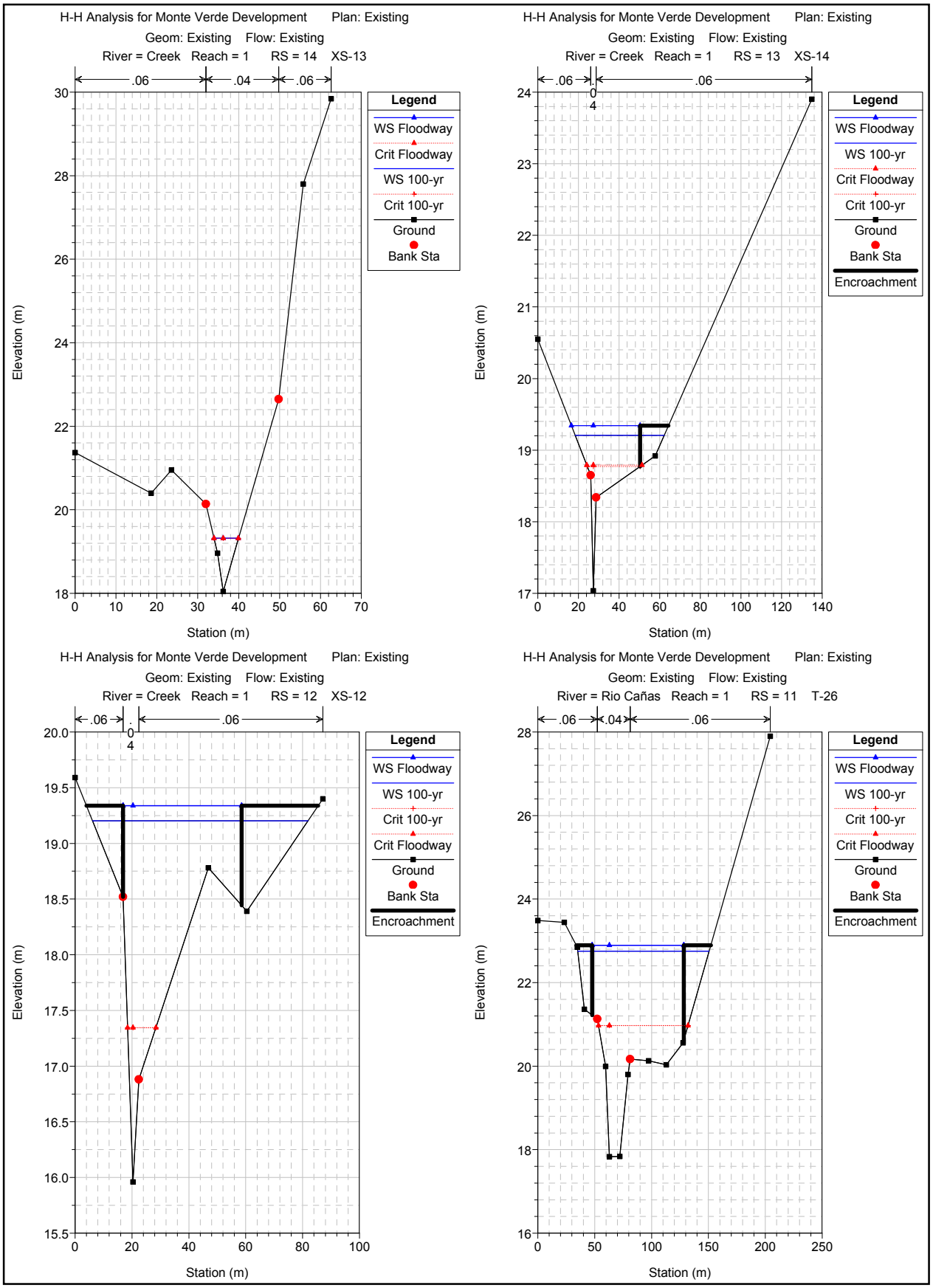
Station (m)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Crit Floodway
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Crit 100-yr
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H-H Analysis for Monte Verde Development Plan: Existing
Geom: Existing Flow: Existing
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Elevation (m)
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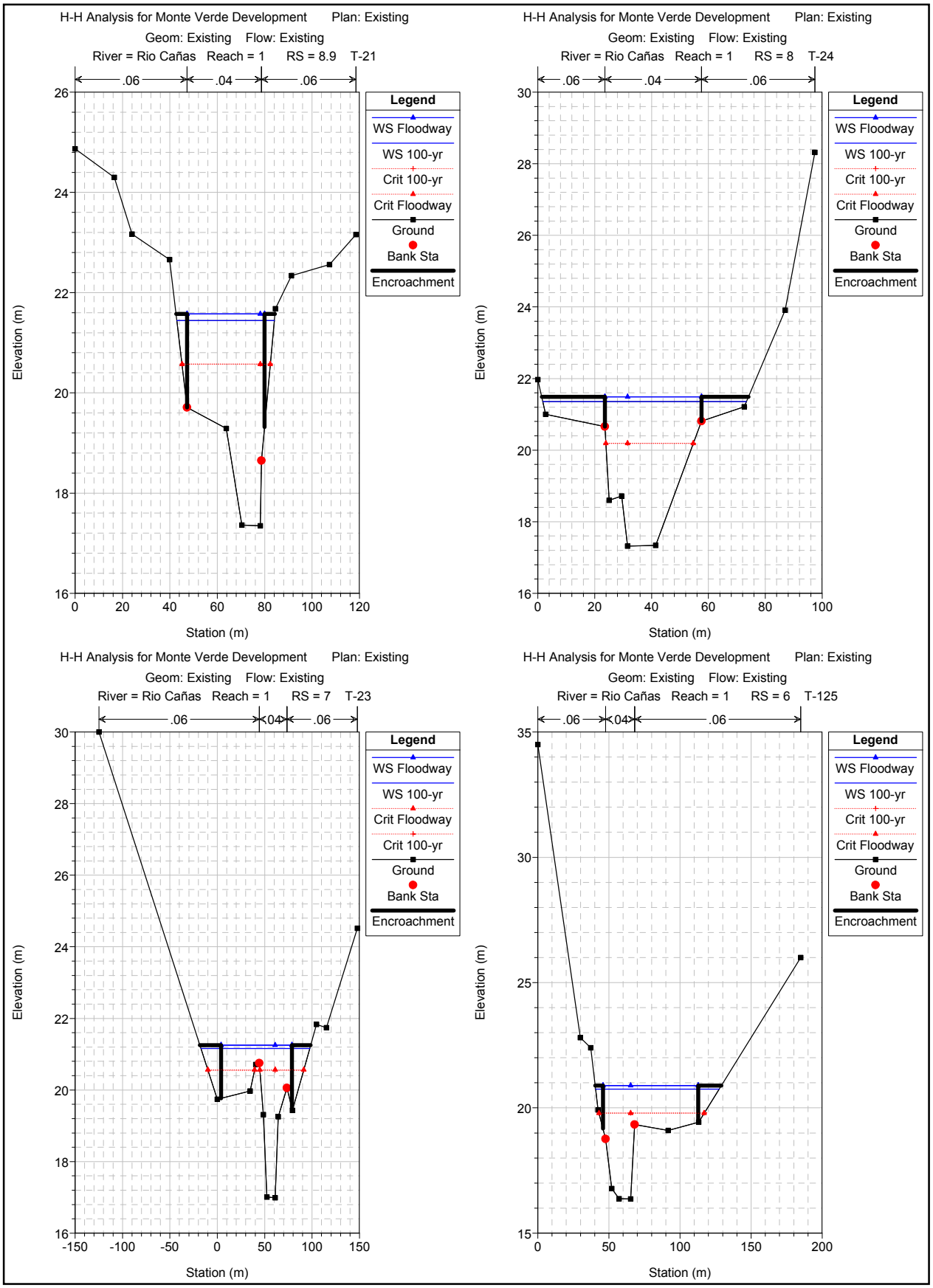
Bank Sta
Encroachment
Elevation (m)
Station (m)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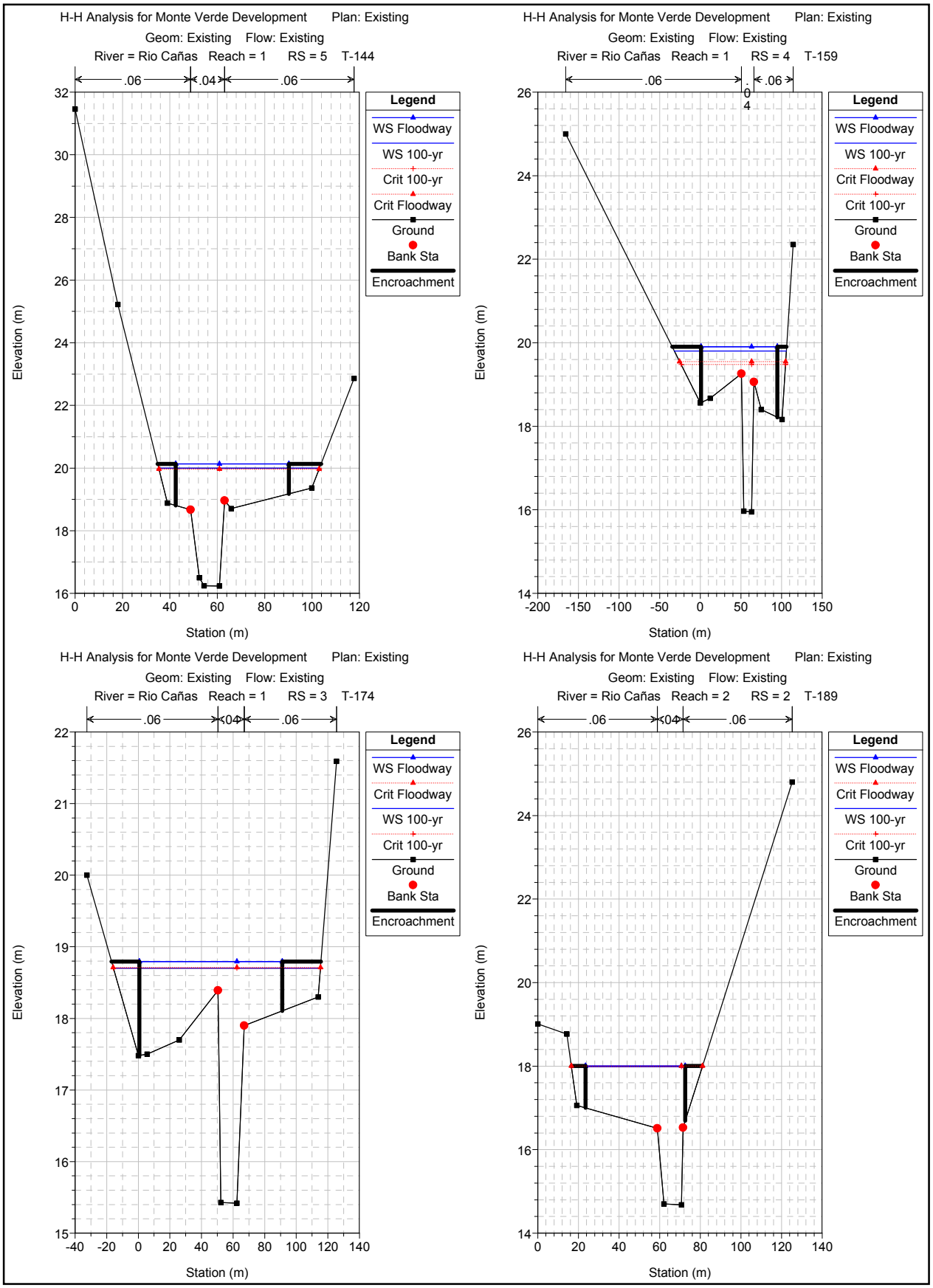
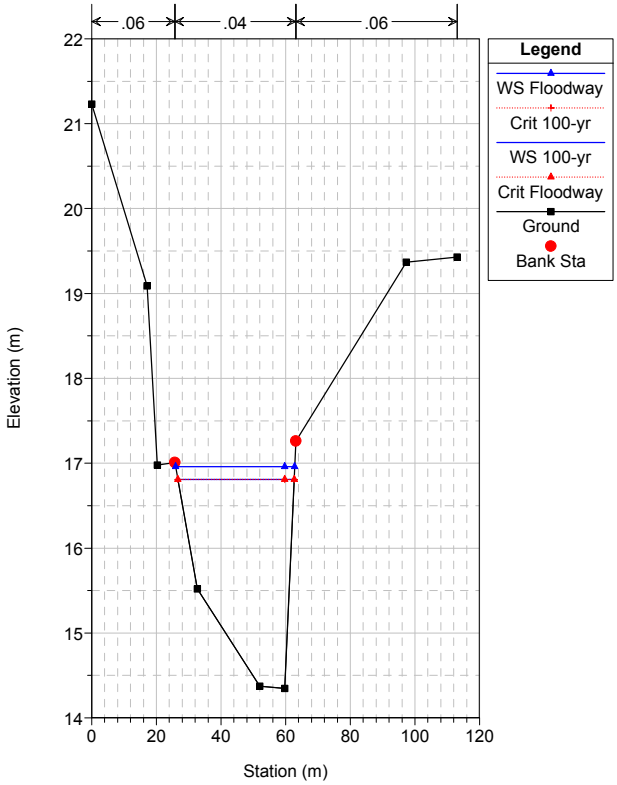
.06 .04 .06
Legend
WS Floodway
WS 100-yr
Crit 100-yr
Crit Floodway
Ground
Bank Sta
Encroachment
Elevation (m)
Station (m)
H-H Analysis for Monte Verde Development Plan: Existing
Geom: Existing Flow: Existing
River = Rio Cañas Reach = 1 RS = 8 T-24
.06 .04 .06
Legend
WS Floodway
WS 100-yr
Crit 100-yr
Crit Floodway
Ground
Bank Sta
Encroachment
Elevation (m)
Station (m)
H-H Analysis for Monte Verde Development Plan: Existing
Geom: Existing Flow: Existing
River = Rio Cañas Reach = 1 RS = 7 T-23
.06 .04 .06
Legend
WS Floodway
WS 100-yr
Crit Floodway
Crit 100-yr
Ground
Bank Sta
Encroachment
Elevation (m)
Station (m)
H-H Analysis for Monte Verde Development Plan: Existing
Geom: Existing Flow: Existing
River = Rio Cañas Reach = 1 RS = 6 T-125
.06 .04 .06
Legend
WS Floodway
WS 100-yr
Crit 100-yr
Crit Floodway
Ground
Bank Sta
Encroachment
Elevation (m)
Station (m)


H-H Analysis for Monte Verde Development Plan: Existing
Geom: Existing Flow: Existing
River = Rio Cañas Reach = 1 RS = 5 T-144
.06
.04
.06
Legend
WS Floodway
WS 100-yr
Crit 100-yr
Crit Floodway
Ground
Bank Sta
Encroachment
Elevation (m)
Station (m)
H-H Analysis for Monte Verde Development Plan: Existing
Geom: Existing Flow: Existing
River = Rio Cañas Reach = 1 RS = 4 T-159
.06
.06
Legend
WS Floodway
WS 100-yr
Crit Floodway
Crit 100-yr
Ground
Bank Sta
Encroachment
Elevation (m)
Station (m)
H-H Analysis for Monte Verde Development Plan: Existing
Geom: Existing Flow: Existing
River = Rio Cañas Reach = 1 RS = 3 T-174
.06
.04
.06
Legend
WS Floodway
Crit Floodway
WS 100-yr
Crit 100-yr
Ground
Bank Sta
Encroachment
Elevation (m)
Station (m)
H-H Analysis for Monte Verde Development Plan: Existing
Geom: Existing Flow: Existing
River = Rio Cañas Reach = 2 RS = 2 T-189
.06
.04
.06
Legend
WS Floodway
Crit Floodway
WS 100-yr
Crit 100-yr
Ground
Bank Sta
Encroachment
Elevation (m)
Station (m)

H-H Analysis for Monte Verde Development Plan: Existing

Geom: Existing Flow: Existing

River = Rio Cañas Reach = 2 RS = 1 T-198