**Department of Energy**
West Valley Demonstration Project
10282 Rock Springs Road
West Valley, NY 14171-9799

November 6, 2007

Mr. Keith I. McConnell, Deputy Director
Decommissioning and Uranium Recovery
Licensing Directorate
Division of Waste Management and Environmental Protection
Office of Federal and State Materials and Environmental Management Programs
U.S. Nuclear Regulatory Commission
Two White Flint North
11545 Rockville Pike
Rockville, MD 20852-2738

SUBJECT: U.S. Department of Energy (DOE) Supplemental Response to U.S. Nuclear Regulatory Commission (NRC) Comments on 30% Design for the Nuclear Regulatory Commission Licensed Disposal Area (NDA) Cap and Slurry Wall

REFERENCE: Letter (97362), K. I. McConnell to B. C. Bower, "U.S. Nuclear Regulatory Commission Comments on 30% Design for NDA Cap and Slurry Wall," dated May 22, 2007

Dear Mr. McConnell:

This letter transmits the DOE response to the above referenced letter. The proposed solution compliments the final design as submitted with the Interim Measure Work Plan (IMWP) for the regulatory approval. DOE does not intend to revise the final design until the NRC reviews the response and a written confirmation is received from the NRC. Please consider responding by December 14, 2007, with the acceptability of the proposed designed changes found in the enclosure.

Should you or any of your staff have any questions, please contact Mr. Craig Rieman at (716) 942-4312 or me at (716) 942-4368.

Sincerely

Bryan C. Bower, Director
West Valley Demonstration Project

Enclosure: Response to NRC Comments on 30 Percent Design WVNS NDA Cap and Groundwater Barrier Wall, West Valley, New York

cc: See Page 2

CRR:98235 – 439

**McMahon & Mann** 2495 Main Street, Suite 432 • Buffalo, New York 14214
Consulting Engineers, P.C.

*Donald R. McMahon, P.E.*
*Michael J. Mann, P.E.*
*Kenneth L. Fishman, Ph.D., P.E.*
*James Bojarski, P.E.*
*Shawn W. Logan, P.E.*
*Andrew J. Nichols, P.E.*
*Todd Swackhamer, P.E.*

September 29, 2007
File: 07-011

Mr. Charles C. Keipper
STC Construction, Inc.
P. O. Box 459
Springville, New York 14141-0459

RE: Response to NRC Comments on 30 Percent Design
WVNS NDA Cap and Groundwater Barrier Wall
West Valley, New York

Dear Mr. Keipper:

This letter addresses comments dated May 22, 2007 from the United States Nuclear Regulatory Commission (NRC) regarding the 30 percent design submittal for the NDA Cap and Groundwater Barrier Wall. In its comment letter (Attachment A), the NRC recommends demonstrating that the design will not be adversely affected by a large flood such as the runoff from ½ of the Probable Maximum Precipitation (PMP). The NRC also recommends that the design include additional riprap erosion protection to mitigate erosion from such a large storm event.

The NRC letter includes several specific design questions and comments. Our responses to NRC's specific comments are provided below. Our responses are based on information developed for design and additional computations completed, as requested by the NRC. Stormwater computations and supporting information are attached as follows:

- Attachment B includes the pre and post-development stormwater runoff computations that we completed for design. This information was developed subsequent to the 30 percent design submittal. The computations include the design information requested by the NRC as described in the following sections.

- Attachment C includes our evaluation of the runoff from the ½ PMP.

- Attachment D includes a drawing from the design plans (Sheet 8) showing the stormwater ponds and the outlet pipe details and Figures 2 through 5 from the Stormwater Pollution Prevention Plan (SWPPP) showing the existing stormwater runoff patterns and the runoff controls and flow directions, during and after construction of the cap and groundwater barrier wall. Sketches showing the additional erosion protection requirements associated with the ½ PMP storm event are also included in Attachment D.

NRC's specific design questions and comments are italicized below followed by our response.

> *a. Rainfall Intensity and Peak Flows: It is not clear how peak discharges were determined. For all aspects of the design where rainfall intensity and peak discharge are factors, DOE should discuss the basis for computation of the rainfall intensity. For example, if the time of concentration for a specific design feature (such as a swale) was computed to be 5 minutes, DOE should provide information for the 25-year, 5-minute rainfall and the basis for computation of flow rates and times of concentration (recognizing that they will be very short over the sloping smooth liner).*

Response:

MMCE utilized the HydroCAD computer model (HydroCAD Software Solutions LLC) to estimate the peak runoff from the NDA for existing conditions and for the post-development conditions. HydroCAD is a computer aided design program for modeling the hydrology and hydraulics of stormwater runoff. The program is based on hydrologic methods developed by the Natural Resources Conservation Service (NRCS - formerly the Soil Conservation Service). The model utilizes the methods outlined by the Soil Conservation Service in its Technical Release 20 (TR-20). The pre-development runoff estimate and post-development design runoff are computed for the 1 year, 10 year and 25 year, 24-hour storm events. The program considers a Type II rainfall storm distribution as described in TR-20.

Figure 2 of the SWPPP, in Attachment D, depicts the existing stormwater runoff flow directions. Runoff from the south side of the NDA flows through a series of culverts to the southeast corner of the NDA. From there, a 24-inch diameter culvert drains the stormwater from the south side of the NDA and from a portion of the State Disposal Area (SDA) toward the north, eventually passing through SPDES Outfall S-20. Runoff from the west and north sides of the NDA flows through a series of ditches and culverts to Erdman Brook.

A map of the pre-development conditions showing the drainage areas used in the evaluation is in Attachment B-1. The HydroCAD computer model results are in Attachment B-1 and indicate that the calculated peak pre-development runoff flow rates from the NDA area are 8, 20.9 and 26.9 cubic feet per second (cfs) for the 1-year, 10-year and 25-year 24-hour events, respectively.

As requested by the NRC, we estimated the runoff associated with the ½ PMP. The HydroCAD results in Attachment C indicate that the pre-development flow from the NDA for this storm is 49.8 cfs.

Attachment B-2 shows the hydrologic conditions used for the post development analyses. The sketch in Attachment B-2 shows the subareas and basin configurations used for the analyses. As shown on the sketch, runoff flows to three stormwater basins constructed on the NDA Cap. The flow from the SDA area, south of the NDA, is routed via a new pipe into the existing 24-inch drainage culvert which also serves as the drain for Basin No. 2.

The routing calculations indicate that the perimeter ponds will safely pass the flow from the 25-year 24-hour event without overtopping the basin embankments. The discharge pipes from the basins discharge to riprap aprons designed to reduce the energy of the water flow. Swales will then convey the flow to Erdman Brook. The calculated post-development runoff flow rates to Erdman Brook for the various storm events are summarized along with the pre-development flow rates on the following table:

| Storm | Peak Runoff (cubic feet per second) | |
|---|---|---|
| | Pre-Development | Post-Development |
| 1-year | 8 | 13.6 |
| 10-year | 20.9 | 19.2 |
| 25-year | 26.9 | 21.6 |
| ½ PMP | 49.8 | 55.4 |

*b. Berms: It is not clear if the berms have sufficient capacity to safely store and pass the design flood. Also it is not clear if the berms are sufficient to prevent flood runoff from upstream drainage areas from overtopping the berms and flowing onto the lined cap area. More information such as water surface profiles and peak discharges, should be developed to assess the adequacy of the diversion berms.*

Response:

Sheet 8 of the design plans is included in Attachment D. Sheet 8 shows the basins in plan and provides details of the outlet pipes for Basins 2 and 3. The following table summarizes the inflow, outflow and water elevation in the basins for the different storm events.

| Basin No. | Top of Berm Elevation | Top of Overflow Pipe Elevation | 25-year, 24 hour Storm | | | ½ PMP | | |
|---|---|---|---|---|---|---|---|---|
| | | | Inflow (cfs) | Max. Water El. | Outflow (cfs) | Inflow (cfs) | Max. Water El. | Outflow (cfs) |
| 1. | 1381 | 1379 (invert) | 18.2 | 1380.1 | 16.1 | 16.0 | 1380.0 | 15.8 |
| 2. | 1381 | 1379.75 | 13.3 | 1379.6 | 3.6 | 11.4 | 1380.2 | 10.5 |
| 3. | 1379 | 1378.75 | 27.2 | 1378.5 | 7.5 | 26.1 | 1379.1 | 26.1 |

*c. Liner: It is not clear that the liner, especially the field seams, is capable of withstanding the flow velocities in the swales along the outer edges of the liner. We note that the swales have slopes as great as 4.1%. Such slopes are considered to be hydraulically steep and are capable of producing very high flow velocities on the smooth liner. Additional information is needed to show that the flow velocities are not excessive.*

Response:

The project specifications require that the geomembrane liner be installed such that seams are "shingled" from uphill to downhill. Therefore, surface runoff in the swales along the outer edge of the liner will flow over and not against the liner seams.

*d. Effects on State Licensed Disposal Area (SDA): It is not clear if the new NDA design will have any adverse effects on the SDA. DOE should assess the effects of flooding and flow velocities at the NDA and how the NDA design could potentially affect the SDA.*

Response:

As shown on Figure 2 in Attachment D, some of the surface water from the SDA now flows through an 18-inch diameter pipe at outfall W-06 (S-31) located near the southeast corner of the NDA and into a pond within the NDA. Currently, the water in the pond discharges into a 24-inch diameter pipe and flows to its discharge point located near the northeast corner of the NDA.

As part of the NDA cap construction, the 18-inch diameter pipe at W-06 will be shortened and connected to a catch basin as indicated on Figure 3 in Attachment D. The water from W-06 will flow through a new 12-inch diameter pipe located along Basin No. 2 and will discharge into the existing 24-inch diameter pipe.

The design for the stormwater basins includes riprap protection at the stormwater basin outlets. The riprap is designed to resist the erosive forces from the 25-year storm, but will dissipate the energy from all runoff events. The reduction in flow provided by the basins for the 10-year and 25-year storms and the erosion protection provided at the outlets addresses potential erosive conditions between the SDA and the NDA.

As indicated in the response to Comment No. 2 and the table, the outflow from the ½ PMP will flow over the berms of Basins No. 2 and 3. As recommended by the NRC, additional riprap protection is proposed on the downstream slope of the berms as well as in the swale between the NDA and the SDA. The sketches in Attachment D show the proposed extent of the additional riprap protection.

Sincerely yours,

**McMAHON & MANN CONSULTING ENGINEERS, P.C.**

Michael J. Mann, P.E.

Attachments

# ATTACHMENT A

## NRC comment letter

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

May 22, 2007

Bryan C. Bower
U.S. Department of Energy
West Valley Demonstration Project
10282 Rock Springs Road
West Valley, NY 14171-9799

SUBJECT: U.S. NUCLEAR REGULATORY COMMISSION COMMENTS ON 30% DESIGN FOR NDA CAP AND SLURRY WALL

Dear Mr. Bower:

The U.S. Nuclear Regulatory Commission has reviewed the U.S. Department of Energy 30% design for the NRC-licensed Disposal Area cap and slurry wall, and is submitting the attached comments.

If you have any questions regarding the attached comments, please contact Chad Glenn of my staff at (301) 415-6722.

Sincerely,

for

Keith I. McConnell, Deputy Director
Division of Waste Management
and Environmental Protection
Office of Federal and State Materials
and Environmental Management Programs

Enclosure: Comments on Design

cc: G. Baker, NYSDOH
P. Giardina, US EPA
S. Hammond, NYSDEC
M. John, Seneca Nation of Indians
P. Piciulo, NYSERDA
B. Youngberg, NYSDEC

WEST VALLEY

NRC COMMENTS ON 30% DESIGN FOR NDA

SURFACE WATER HYDROLOGY AND EROSION PROTECTION

1. **Selection of Design Flood**: The US Nuclear Regulatory Commission (NRC) staff notes that the NRC Licensed Disposal Areas (NDA) cover has been designed for the 25-year, 24-hour rainfall event. However, the staff considers that this design approach may not be adequately protective of public health and safety, because it is not unlikely that a larger flood could occur and cause significant damage to the proposed design. It should be recognized that the 25-year flood has about a 70% probability of being equaled or exceeded during the 30-year interim stabilization period. If a lesser probability of occurrence, such as 5%, is selected, the design flood would have a probability of occurrence of about once in 600 years. Similarly, if a 10% probability of occurrence in 30 years (90% probability of non-occurrence) is used, the design flood would be a 300-year flood.

In its regulation of nuclear facilities, the NRC has generally required that licensees either design those facilities for very large flood events or show that erosion from such floods would not result in release of regulated materials. This practice has been applied in the recent past at sites such as uranium mill tailings facilities, and the NRC staff has developed guidance on the selection of design floods for such facilities. For a wide range of design conditions and risk considerations, NUREG-1623, "Design of Erosion Protection for Long-Term Stabilization" (available on the NRC website), provides the rationale and guidance for the selection of design floods.

The staff recommends that the US Department of Energy (DOE) follow the general guidance given in NUREG-1623 and that DOE select a design flood that has a relatively low probability of occurrence. As suggested in NUREG-1623, the design flood could be about ½ of the Probable Maximum Flood (PMF), which corresponds approximately to a 200-500 year flood (which would have a 5-10% probability of occurrence in the 30-year stabilization period). Due to the lack of historic data for very small drainage areas, such as those present at the West Valley site, runoff from ½ of the Probable Maximum Precipitation (PMP) is recommended. For information purposes, ½ of the 5-minute PMP for Buffalo, New York is estimated by the NRC staff to be about 3 inches. This estimate of 3 inches in 5 minutes is inconsistent with the proposed 25-year, 24-hour value of 4 inches in 24 hours.

We recognize: (1) that the design will provide only interim stabilization; (2) that the design intent is not to provide engineering measures that are elaborate and costly; and, (3) that the design should not convey a sense of permanence. Therefore, as an alternate measure, DOE could demonstrate that the design, as currently proposed, is capable of withstanding a much larger rainfall event (such as ½ of the PMP), even though it is actually designed only for the smaller event (25-year event). The NRC staff could concur in the latter course of action. See Comment 3, below.

2. **Design Questions and Comments**: The staff recognizes that the design is only conceptual and that many analyses have not yet been done. It is not clear how much additional information DOE intends to provide in future reports, but the NRC staff has several questions and comments related to how various design factors were considered.

a. Rainfall Intensity and Peak Flows: It is not clear how peak discharges were determined. For all aspects of the design where rainfall intensity and peak discharge are factors, DOE should discuss the basis for computation of the rainfall intensity. For

example, if the time of concentration for a specific design feature (such as a swale) was computed to be 5 minutes, DOE should provide information related to the 25-year, 5-minute rainfall and the basis for computation of flow rates and times of concentration (recognizing that they will be very short over the sloping smooth liner).

b. Berms: It is not clear if the berms have sufficient capacity to safely store and pass the design flood. Also, it is not clear if the berms are sufficient to prevent flood runoff from upstream drainage areas from overtopping the berms and flowing onto the lined cap area. More information, such as water surface profiles and peak discharges, should be developed to assess the adequacy of the diversion berms.

c. Liner: It is not clear that the liner, especially the field seams, is capable of withstanding the flow velocities in the swales along the outer edges of the liner. We note that the swales have slopes as great as 4.1%. Such slopes are considered to be hydraulically steep and are capable of producing very high velocities on the smooth liner. Additional information is needed to show that the flow velocities are not excessive.

d Effects on State Licenced Disposal Area (SDA): It is not clear if the new NDA design will have any adverse effects on the SDA. DOE should assess the effects of flooding and flow velocities at the NDA and how the NDA design could potentially affect the SDA.

3. **Recommendations**: If DOE chooses to provide an analyses to show that the design will not be adversely affected by floods larger than the chosen design flood, additional information and analyses should be developed to document the conclusions. These analyses should include detailed information related to the various design factors discussed in Comment 2, above. The information should show: (1) how the facilities were designed for the 25-year flood; and, (2) how the design is capable of providing adequate protection for larger floods.

The NRC staff believes that relatively simple measures can be provided that will protect the NDA from erosion during the occurrence of a large flood event, such as the ½ of the PMF. The staff recommends that DOE consider using several simple measures to prevent erosion.

a. Assuming that the berms at the retention basins will be overtopped by the large flood, DOE could provide overflow spillways and aprons constructed with large rock to prevent erosion by the overtopping flows. All of the basins appear to be vulnerable. The capacity of the discharge pipes could also be increased to prevent overtopping.

b. Assuming that the diversion berms (which appear to be only a few feet high) will be overtopped from flows outside the NDA, the berms could be raised several feet. Water surface profiles and velocity estimates may be needed to confirm the adequacy of the berm and the capacity of the drainage swales, both inside and outside the lined area.

c. Based on the need for recent placement of rock in eroded problem areas near the NDA, rock erosion protection is probably needed in those areas where flows will concentrate or where flow velocities may be excessive. Specifically, rock will likely be needed on steeper slopes (and the toes of those slopes) and in the area of the NDA near to Erdman Brook. For example, rock spillways could be used to minimize erosion potential if the retention basins were to be overtopped by large floods. Also, rock could be used to further stabilize specific areas of erosion (such as existing nickpoints, gullies, or eroding slopes).

4. **General Comment on Future Actions:** The NRC staff may have further comments on the NDA design after discussions with DOE and further review of additional information. In addition, the staff would like to make future recommendations regarding performance monitoring after a final design has been selected. The purpose of the performance monitoring would be to develop additional information during the 30-year interim stabilization period, in keeping with stated goals to collect more information and to improve erosion models. In addition, careful site monitoring during this period may result in design changes necessary to mitigate specific erosion problems.

# ATTACHMENT B

## Stormwater Calculations for Design

## (1-year, 10-year and 25-year storm events)

**McMahon & Mann**
Consulting Engineers, P.C.

# ATTACHMENT B-1

## Pre Development Conditions

**McMahon & Mann**
Consulting Engineers, P.C.

BY AJN DATE 6/1/07 SUBJECT WVNS – NOA SHT. NO. 1 OF 9
CHKD. BY AJK DATE 6/4/07 CAP DESIGN JOB NO. 07-011
PRE-CAP STORMWATER ANALYSIS

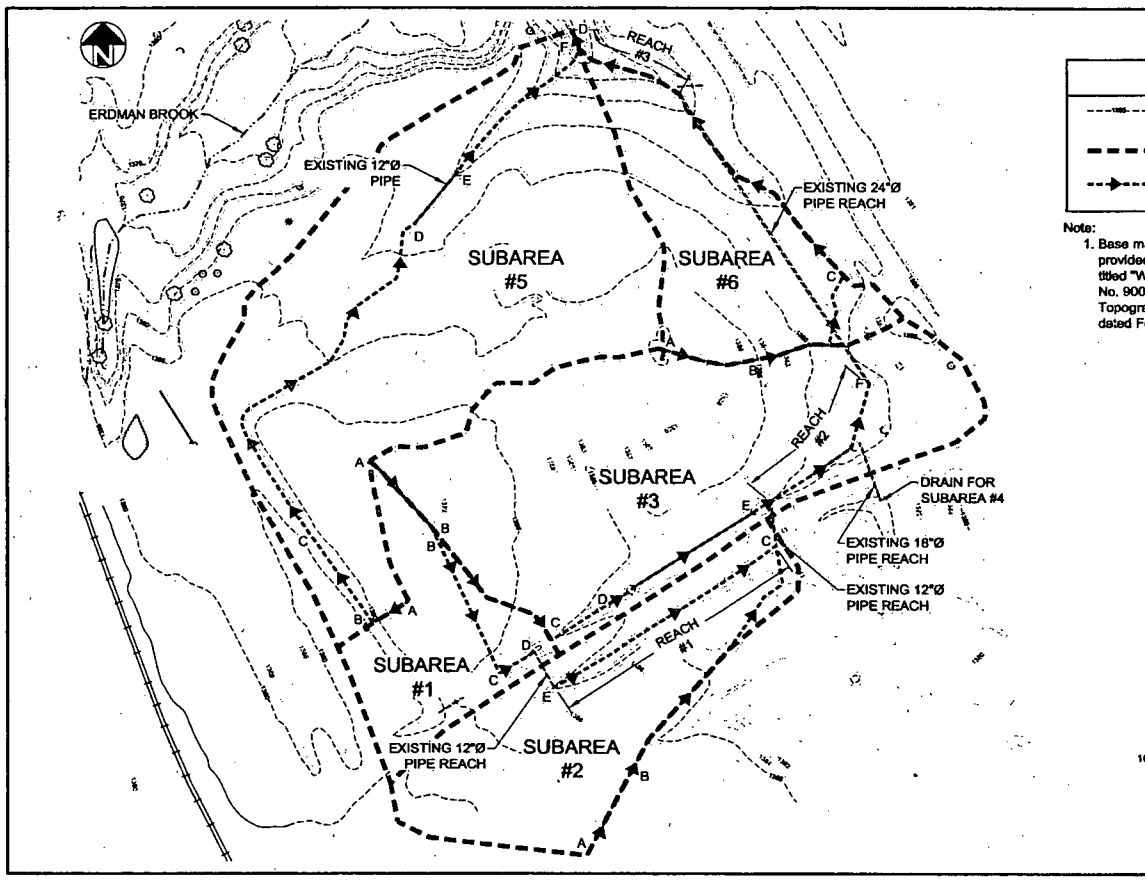
PRE CAP STORMWATER ESTIMATE – USE HYDROCAD SOFTWARE

- ESTIMATE DRAINAGE AREA TO ERDMAN BROOK (SEE ATTACHED FIGURE FOR SUBAREAS)

- USE 25 YR STORM EVENT P= 4.2" (ATTACHED FIGURE B-6 FROM TR 55)
  - WVDP SITE SPECIFIC DATA SHOWS HIGHEST DAILY EVENT TO BE 3.75" (FROM 1990 TO 2007), TR55 GIVES A HIGHER VALUE
    - USE 4.2" FOR DESIGN

STORMWATER ROUTING RATIONAL

- 6 SUBAREAS WHICH EITHER DRAIN ON THE SURFACE OR VIA PIPES TO ERDMAN BROOK
- SEE ATTACHED FIGURE FOR SUBAREAS AND REACHES




## LEGEND

- EXISTING GROUND CONTOURS
- SUBAREA BOUNDARY EXTENTS
- SURFACE WATER DRAINAGE PATH AND FLOW DIRECTION

Note:

1. Base map adapted from a combination of drawings provided by West Valley Nuclear Services Co., Inc. titled "WVDP Site Map Well Locations", Dwg. No. 900-D-5000 Rev A dated May 26, 1992 and "NDA Topographic Plan", Sketch # SKKKG020607 Rev A dated February 19, 2007.

Sheet 2 of 9

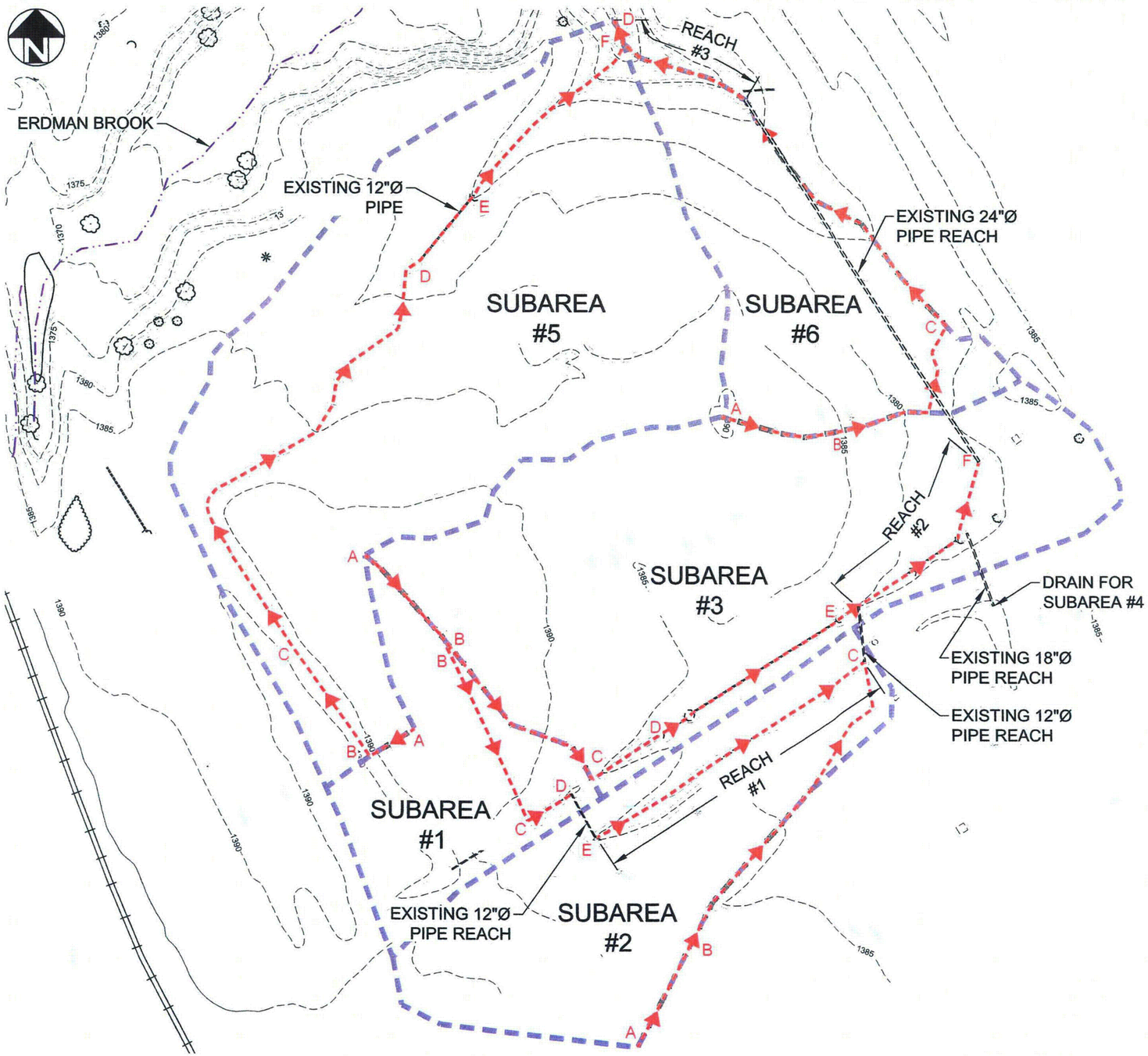
100' 0 50' 100'
SCALE: 1" = 100'

NOTE:
UNAUTHORIZED ALTERATION OR ADDITION TO ANY SURVEY, DRAWING, DESIGN, SPECIFICATION, PLAN, OR REPORT IS A VIOLATION OF SECTION 7209 PROVISION 2 OF THE NEW YORK STATE EDUCATION LAW.

McMahon & Mann Consulting Engineers, P.C.
TEL (716) 626-1000
FAX (716) 626-4600

NDA CAP AND GROUND WATER BARRIER CONSTRUCTION
WEST VALLEY NEW YORK

EXISTING DRAINAGE AREAS
FIGURE 1
DWG. NO. 07011-051




## LEGEND

| | |
|---|---|
| 1385 | EXISTING GROUND CONTOURS |
| | SUBAREA BOUNDARY EXTENTS |
| | SURFACE WATER DRAINAGE PATH AND FLOW DIRECTION |

Note:

1. Base map adapted from a combination of drawings provided by West Valley Nuclear Services Co., Inc. titled "WVDP Site Map Well Locations", Dwg. No. 900-D-5000 Rev A dated May 26, 1992 and "NDA Topographic Plan", Sketch # SKKKG020607 Rev A dated February 19, 2007.

Sheet 2 of 9

100' 0 50' 100'

SCALE: 1" = 100'

NOTE:
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NDA CAP AND GROUND WATER BARRIER CONSTRUCTION
WEST VALLEY NEW YORK

EXISTING DRAINAGE AREAS

FIGURE 1

DWG. NO. 07011-051

**McMahon & Mann**
Consulting Engineers, P.C.

BY AJN DATE 6/1/07 SUBJECT INWNS - NOA SHT. NO. 3 OF 9
CHKD. BY ATK DATE 6/4/07 CAP DESIGN JOB NO. 07-011
PRE-CAP 7-25-07 STORMWATER ANALYSIS

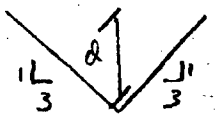
SUBAREA #1 (SOUTH WEST CORNER OF EXISTING LANDFILL)

AREA = 31,741 SF = 0.73 ACRES

CN = 80
- FROM TABLE 2-2G (TR55)

DRAINAGE PATH

- A - B (SHEET FLOW)
  - LENGTH = 100 LF
  - SLOPE = (1393.5 - 1391.9)/100 = 1.6%
  - SHORT GRASS W/ n = 0.15 $P_2$ = 2.5" (2 YR STORM)
- B - C (SHALLOW CONCENTRATED FLOW)
  - LENGTH = 165 LF
  - SLOPE = (1391.5 - 1386.25)/165 = 3.4%
  - UNPAVED (SHORT GRASS)
- C - D (CHANNEL FLOW)
  - LENGTH = 43 LF
  - SLOPE = (1386.25 - 1385)/43 = 2.9%
  - ASSUMED X-SECTION




d ≈ 2'
A = 12 SF
WP = 12.65'
n = 0.05 (MOWED GRASS)

- D - E (PIPE FLOW)
  - LENGTH = 42 LF
  - SLOPE = SAY 1%
  - 12" Φ CMP

TREAT THIS AS A REACH

**McMahon & Mann**
Consulting Engineers, P.C.

BY AJN DATE 6/1/07 SUBJECT WWNL - NSA SHT. NO. 4 OF 9
CHKD. BY AJK DATE 6/4/07 CAP DESIGN JOB NO. 07-011
PRE-CAP 7.24.07 STORMWATER ANALYSIS

SUBAREA #2 (OUTSIDE SOUTH AREA DRAINS TO 12" PIPE)

AREA = 58,655 SF = 1.35 ACRES

CN = 80
- FROM TABLE 2-2a (TR55)

DRAINAGE PATH

- A-B (SHEET FLOW)

LENGTH = 100 LF

SLOPE = (1391 - 1388.5)/100 = 2.5%

SHORT GRASS w/n = 0.15 $P_2$ = 2.5" (2 YR STORM)

- B-C (SHALLOW CONCENTRATED FLOW)

LENGTH = 294 LF

SLOPE = (1388.5 - 1379.5)/294 = 3.1%

UNPAVED SURFACE

SUBAREA #3 (SOUTH SIDE OF EXISTING LANDFILL)

AREA = 111,102 SF = 2.55 ACRES

CN = 80
- FROM TABLE 2-2a (TR55)

DRAINAGE PATH

- A-B (SHEET FLOW)

LENGTH = 100 LF

SLOPE = (1393.5 - 1391.9)/100 = 1.6%

SHORT GRASS w/n = 0.15 $P_2$ = 2.5" (2YR STORM)

- B-C (SHALLOW CONCENTRATED FLOW)

LENGTH = 177 LF

SLOPE = (1391.9 - 1386.5)/177 = 3.1%

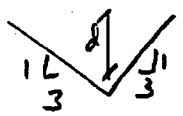
UNPAVED (SHORT GRASS)

- C-D (CHANNEL FLOW)

LENGTH = 71 LF

SLOPE = (1386.5 - 1383)/71 = 4.9%

ASSUMED X-SECTION




d = 2'
A = 12 SF
WP = 12.65'
n = 0.05 (MOWED GRASS)

**McMahon & Mann**
Consulting Engineers, P.C.

BY MJN DATE 6/1/07 SUBJECT WVNS SHT. NO. 5 OF 9
CHKD. BY AJK DATE 6/4/07 CAP DESIGN JOB NO. 07-011
PRE-CAP 7.24.07 STORMWATER ANALYSIS

• D - E (PIPE FLOW)

LENGTH = 177 LF

SLOPE = (1383 - 1381.5)/177 = 0.85 %

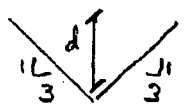
12" ϕ CMP

• E - F (CHANNEL FLOW)

LENGTH = 193 LF

SLOPE = (1381.5 - 1375.36)/193 = 3.2 %

ASSUMED X - SECTION




d ≈ 2'.
A = 12 SF
WP = 12.65'
n = 0.05 MOWED GRASS

SUBAREA #4 (FROM SDA)

- LIMITED INFO ON THIS, WVNSCO STATES THAT IT HAS:

AREA = 0.56 ACRES

• SHEET FLOW

CN = 98 ASSUMED
- FROM TABLE 2-2a (TR55)

LENGTH = 100 LF

SLOPE = 2 %

SMOOTH W/n = 0.011 $P_2$ = 2.5" (24hr STORM)

- SHALLOW CONCENTRATED FLOW

LENGTH = 100 LF

SLOPE = 2%

PAVED SURFACE

* LENGTHS AND SLOPES ASSUMED BASED ON LIMITED INFO FOR DRAINAGE AREA

• PIPE FLOW

18" DIA (CMP)

INV. START 1378.5'

INV. END 1378

LENGTH = 65 LF

SLOPE = (1378.5 - 1378)/65 = 0.77 %

THAT THIS NO. A REACH

**McMahon & Mann**
Consulting Engineers, P.C.

BY AJN DATE 6/1/07 SUBJECT WWNS-NDA SHT. NO. 6 OF 9
CHKD. BY AJK DATE 6/4/07 CAP DESIGN JOB NO. 07-011
PRE-CAP STORMWATER ANALYSIS

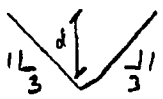
SUBAREA #5 (NORTH AND WEST SIDES OF EXISTING LANDFILL)

AREA = 144,947 SF = 3.33 ACRES

CN = 80
FROM TABLE 2-2a (TR55)

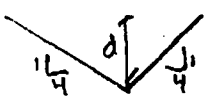
DRAINAGE PATH

- A - B (SHEET FLOW)
  - LENGTH = 44 LF
  - SLOPE = (1391.5 - 1389.5)/44 = 4.5%
  - SHORT GRASS n/a = 0.15  P2 = 2.5" (24HR STORM)
- B - C (SHALLOW CONCENTRATED FLOW)
  - LENGTH = 119 LF
  - SLOPE = (1389.5 - 1384)/119 = 0.42%
  - UNPAVED (SHORT GRASS)
- C - D (CHANNEL FLOW)
  - LENGTH = 428 LF
  - SLOPE = (1384 - 1378)/428 = 2.6%
  - ASSUMED X-SECTION




d ≈ 1.5'
A = 6.75 SF
WP = 9.5'
n = 0.05 (MANED GRASS)

- D - E (PIPE FLOW)
  - 12" Ø CMP
  - LENGTH 71 LF
  - SLOPE = (1378 - 1375)/71 = 4.2%
- E - F (CHANNEL FLOW)
  - LENGTH = 204 LF
  - SLOPE = (1375 - 1353.5)/204 = 10.5%
  - ASSUMED X-SECTION




d ≈ 3' MIN
A = 36 SF
WP = 24.74'
n = 0.03 (RIP-RAP)

**McMahon & Mann**
Consulting Engineers, P.C.

BY AGN DATE 6/1/07 SUBJECT WYNS - NDA SHT. NO. 7 OF 9
CHKD. BY AJK DATE 6/4/07 CAP DESIGN JOB NO. 07-011
PRE-CAP STORMWATER ANALYSIS

SUBAREA #6 (WEST SIDE OF EXISTING LANDFILL)

AREA = 44,779 SF = 1.03 ACRES

CN = 80
FROM TABLE 2-2a (TR55)

DRAINAGE PATH

- A-B (SHORT FLOW)

LENGTH = 100 LF

SLOPE = (1390.5 - 1385.5)/100 = 5 %

SHORT GRASS n/n = 0.15 $P_2$ = 2.5" (24hr STORM)

- B-C (SHALLOW CONCENTRATED FLOW)

LENGTH = 160 LF

SLOPE = (1385.5-1376.5)/160 = 5.6 %

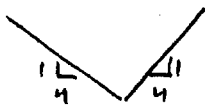
UNPAVED (SHORT GRASS)

- C-D (CHANNEL FLOW)

LENGTH = 397 LF

SLOPE = (1376.5 - 1353.5)/397 = 5.8 %

ASSUMED X-SECTION




d ≈ 3' MIN
A ≈ 36 SF
WP = 24.74'
n = 0.03 (RIP-RAP)

**McMahon & Mann**
Consulting Engineers, P.C.

BY AJN DATE 6/1/17 SUBJECT WNNS-NDA SHT. NO. 8 OF 9
CHKD. BY AJK DATE 6/4/07 CAP DESIGN JOB NO. 07-011
PRG-CAP STORMWATER ANALYSIS

REACH FOR AREA #1 TO 12" CULVERT (REACH #1)

CHANNEL

LENGTH = 275 LF

SLOPE = (1384.58 - 1379.5)/275 = 1.85 %

ASSUMED X-SECTION

d = 1.5
A = 6.75 SF
WP = 9.5'
n = 0.05 (MOWED GRASS

REACH FOR AREA #1 AND #2

PIPE FLOW

12" Ø CMP

LENGTH = 47 LF

SLOPE = SAME %

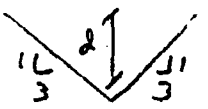
REACH FOR AREA #1 AND #2 (REACH #2)

CHANNEL (USE E TO F FROM SUBAREA #3)

LENGTH = 193 LF

SLOPE = (1381.5 - 1375.38)/193 = 3.2 %

ASSUMED X-SECTION




d = 2'
A = 12 SF
WP = 12.65'
n = 0.05 (MOWED GRASS

REACH FOR AREAS #1, #2, #3 AND #4

PIPE FLOW

24" Ø (SMOOTH WALL)

LENGTH = 362 LF

SLOPE = (1375.38 - 1366)/362 = 2.6 %

**McMahon & Mann**
Consulting Engineers, P.C.

BY AJW DATE 6/1/07 SUBJECT UWAS - NOA SHT. NO. 9 OF 9
CHKD. BY AJK DATE 6/4/07 CROSSION JOB NO. 07-011
D&R - CAP STORMWATER ANALYSIS

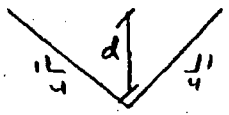
REACH FOR OUTLET OF 24" PIPE, TO END (REACH #3)

CHANNEL

LENGTH = 137 LF

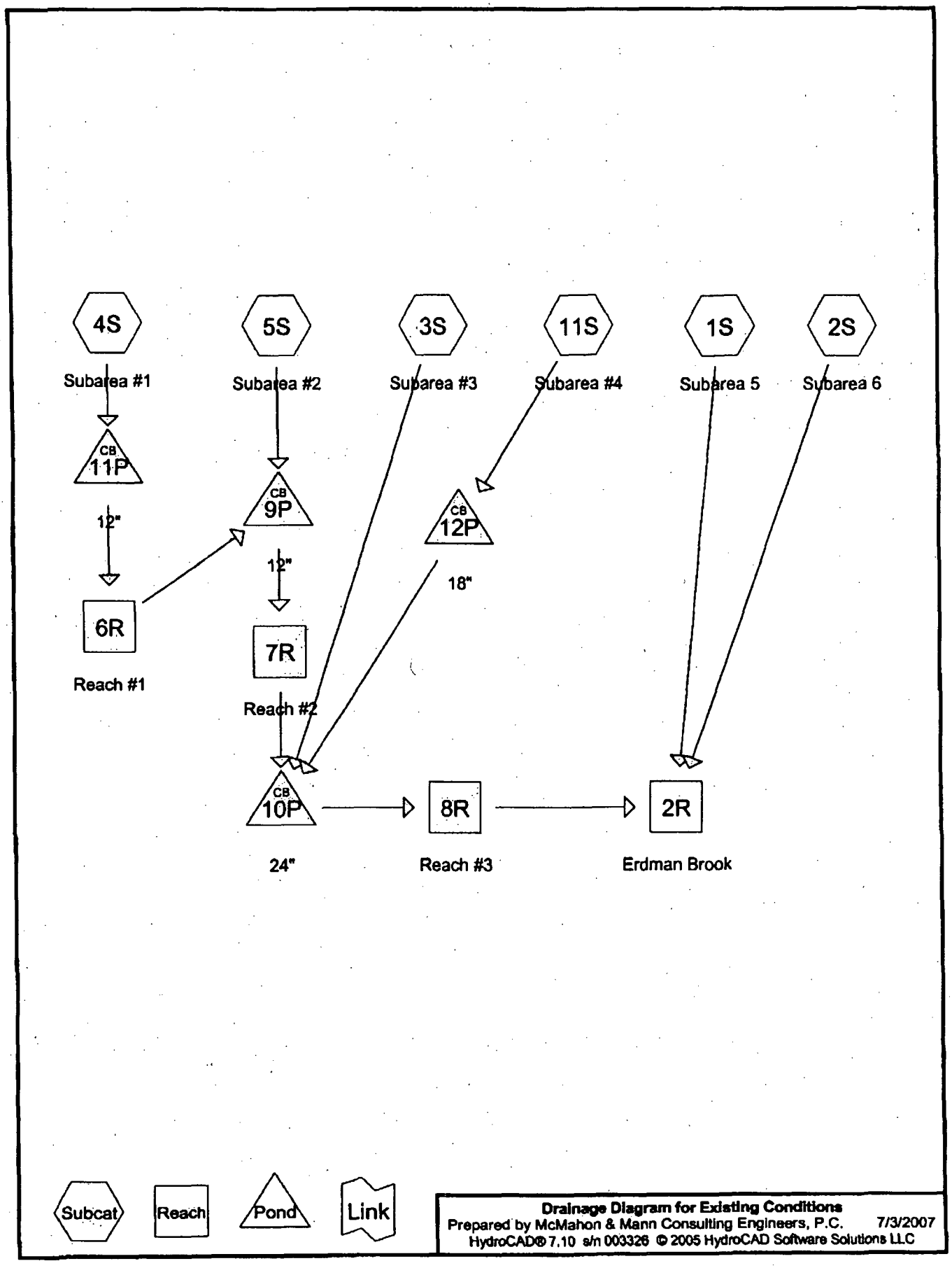
SLOPE = (1366 - 1353.5)/137 = 9.1%

ASSUMED X-SECTION




d ≈ 3' MIN
A = 36 SF
WP = 24.74'
n = 0.03 (RIP-RAP)

# EXISTING CONDITIONS
# HYDROCAD RESULTS


4S
Subarea #1
5S
Subarea #2
3S
Subarea #3
11S
Subarea #4
1S
Subarea 5
2S
Subarea 6
CB
11P
12"
6R
Reach #1
CB
9P
12"
7R
Reach #2
CB
12P
18"
CB
10P
24"
8R
Reach #3
2R
Erdman Brook
Subcat
Reach
Pond
Link
Drainage Diagram for Existing Conditions
Prepared by McMahon & Mann Consulting Engineers, P.C. 7/3/2007
HydroCAD® 7.10 s/n 003326 © 2005 HydroCAD Software Solutions LLC

Time span=1.00-48.00 hrs, dt=0.05 hrs, 941 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

**Subcatchment 1S: Subarea 5** Runoff Area=3.330 ac Runoff Depth=0.69"
Flow Length=866' Tc=10.9 min CN=80 Runoff=3.27 cfs 0.191 af

**Subcatchment 2S: Subarea 6** Runoff Area=1.030 ac Runoff Depth=0.69"
Flow Length=657' Tc=9.7 min CN=80 Runoff=1.05 cfs 0.059 af

**Subcatchment 3S: Subarea #3** Runoff Area=2.550 ac Runoff Depth=0.69"
Flow Length=718' Tc=16.7 min CN=80 Runoff=2.03 cfs 0.146 af

**Subcatchment 4S: Subarea #1** Runoff Area=0.730 ac Runoff Depth=0.69"
Flow Length=308' Tc=14.3 min CN=80 Runoff=0.63 cfs 0.042 af

**Subcatchment 5S: Subarea #2** Runoff Area=1.350 ac Runoff Depth=0.69"
Flow Length=394' Tc=11.8 min CN=80 Runoff=1.28 cfs 0.077 af

**Subcatchment 11S: Subarea #4** Runoff Area=0.560 ac Runoff Depth=1.97"
Flow Length=200' Tc=2.0 min CN=98 Runoff=1.82 cfs 0.092 af

**Reach 2R: Erdman Brook** Peak Depth=0.49' Max Vel=8.5 fps Inflow=8.00 cfs 0.608 af
n=0.030 L=5.0' S=0.2000 '/' Capacity=1,024.08 cfs Outflow=8.00 cfs 0.608 af

**Reach 6R: Reach #1** Peak Depth=0.39' Max Vel=1.3 fps Inflow=0.63 cfs 0.042 af
n=0.050 L=275.0' S=0.0185 '/' Capacity=21.73 cfs Outflow=0.59 cfs 0.042 af

**Reach 7R: Reach #2** Peak Depth=0.53' Max Vel=2.1 fps Inflow=1.79 cfs 0.119 af
n=0.050 L=193.0' S=0.0317 '/' Capacity=61.32 cfs Outflow=1.75 cfs 0.119 af

**Reach 8R: Reach #3** Peak Depth=0.43' Max Vel=5.3 fps Inflow=4.01 cfs 0.358 af
n=0.030 L=137.0' S=0.0912 '/' Capacity=691.69 cfs Outflow=4.00 cfs 0.358 af

**Pond 9P: 12"** Peak Elev=1,382.58' Inflow=1.79 cfs 0.119 af
12.0" x 47.0' Culvert Outflow=1.79 cfs 0.119 af

**Pond 10P: 24"** Peak Elev=1,376.35' Inflow=4.01 cfs 0.358 af
24.0" x 362.0' Culvert Outflow=4.01 cfs 0.358 af

**Pond 11P: 12"** Peak Elev=1,385.54' Inflow=0.63 cfs 0.042 af
12.0" x 42.0' Culvert Outflow=0.63 cfs 0.042 af

**Pond 12P: 18"** Peak Elev=1,379.35' Inflow=1.82 cfs 0.092 af
18.0" x 65.0' Culvert Outflow=1.82 cfs 0.092 af

**Total Runoff Area = 9.550 ac Runoff Volume = 0.608 af Average Runoff Depth = 0.76"**

## Subcatchment 1S: Subarea 5

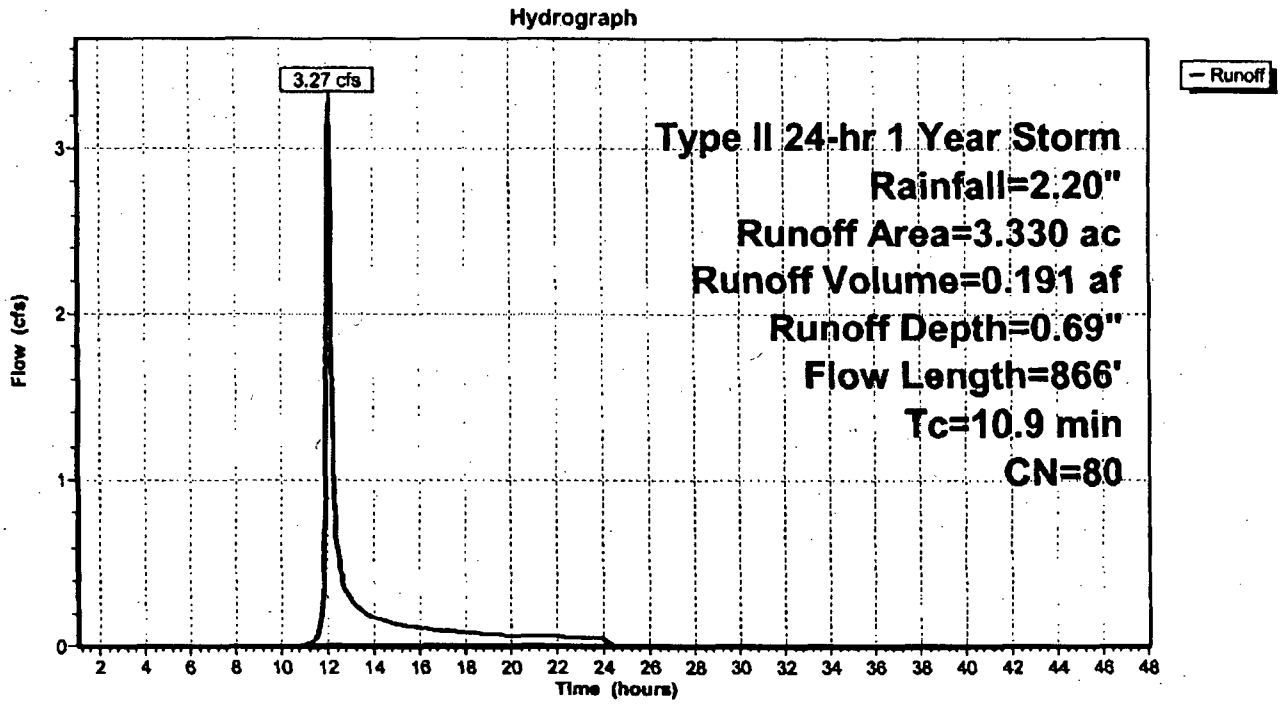
Runoff = 3.27 cfs @ 12.04 hrs, Volume= 0.191 af, Depth= 0.69"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 1 Year Storm Rainfall=2.20"

| Area (ac) | CN | Description |
|---|---|---|
| 3.330 | 80 | North and west side of existing landfill |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 4.2 | 44 | 0.0450 | 0.2 | | **Sheet Flow, A to B**<br>Grass: Short n= 0.150 P2= 2.50" |
| 4.4 | 119 | 0.0042 | 0.5 | | **Shallow Concentrated Flow, B to C**<br>Short Grass Pasture Kv= 7.0 fps |
| 1.9 | 428 | 0.0260 | 3.8 | 25.44 | **Channel Flow, C to D**<br>Area= 6.7 sf Perim= 9.5' r= 0.71' n= 0.050 |
| 0.2 | 71 | 0.0420 | 4.8 | 3.80 | **Circular Channel (pipe), D to E**<br>Diam= 12.0" Area= 0.8 sf Perim= 3.1' r= 0.25'<br>n= 0.025 Corrugated metal |
| 0.2 | 204 | 0.1050 | 20.6 | 742.79 | **Channel Flow, E to F**<br>Area= 36.0 sf Perim= 24.7' r= 1.46' n= 0.030 |
| 10.9 | 866 | Total | | | |

## Subcatchment 1S: Subarea 5



## Subcatchment 2S: Subarea 6

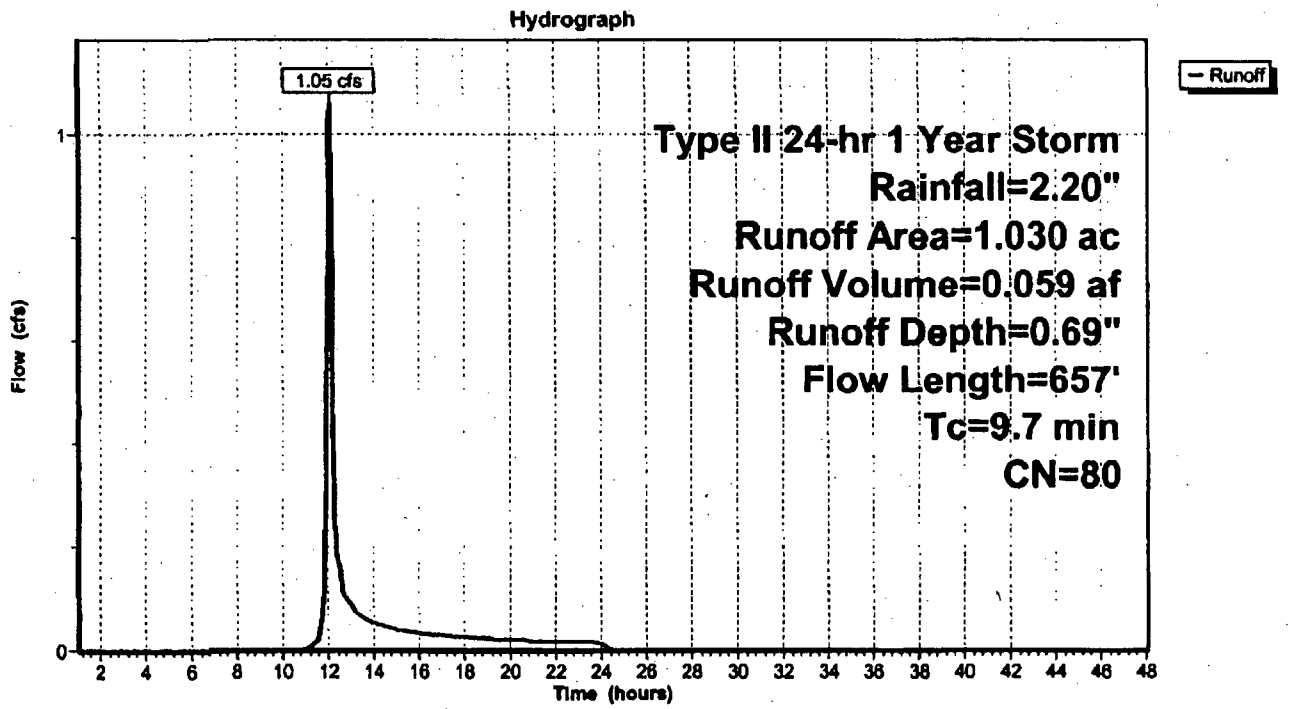
Runoff = 1.05 cfs @ 12.02 hrs, Volume= 0.059 af, Depth= 0.69"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 1 Year Storm Rainfall=2.20"

| Area (ac) | CN | Description |
|---|---|---|
| 1.030 | 80 | West side of exisiting landfill |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 7.7 | 100 | 0.0500 | 0.2 | | **Sheet Flow, A to B** Grass: Short n= 0.150 P2= 2.50" |
| 1.6 | 160 | 0.0560 | 1.7 | | **Shallow Concentrated Flow, B to C** Short Grass Pasture Kv= 7.0 fps |
| 0.4 | 397 | 0.0580 | 15.3 | 552.06 | **Channel Flow, C to D** Area= 36.0 sf Perim= 24.7' r= 1.46' n= 0.030 |
| 9.7 | 657 | Total | | | |

## Subcatchment 2S: Subarea 6



## Subcatchment 3S: Subarea #3

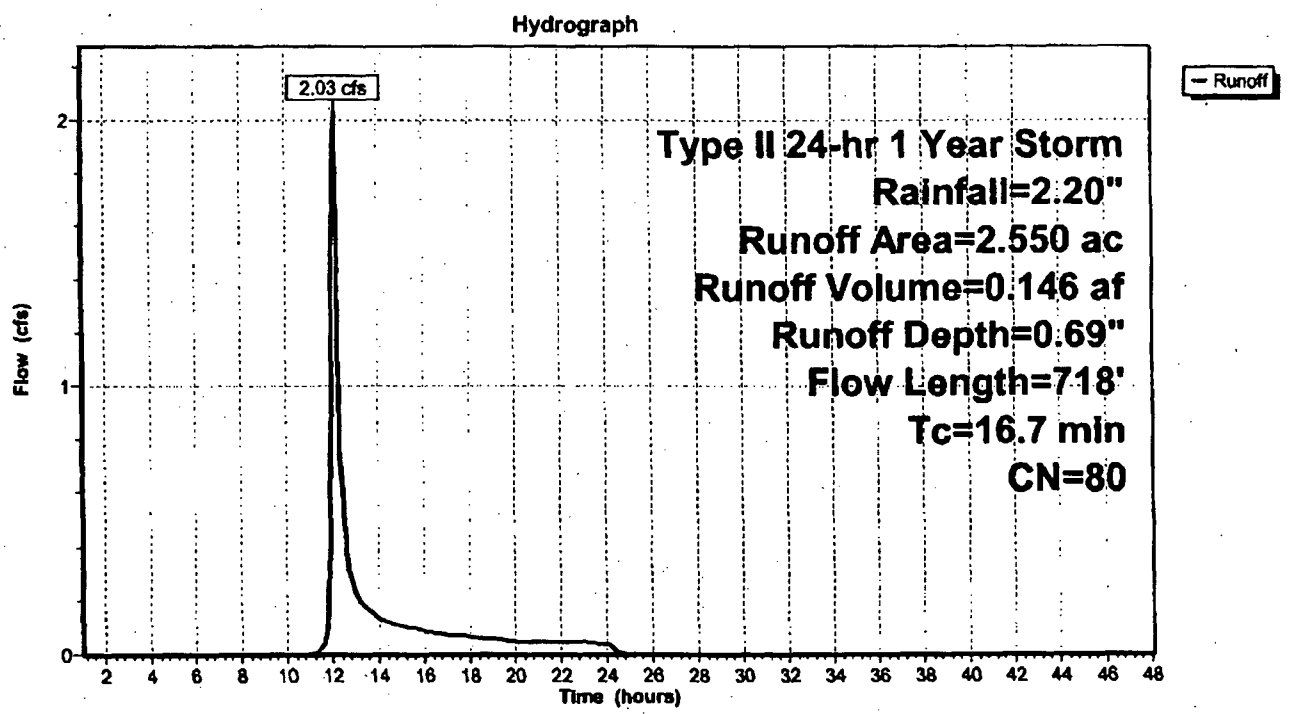
Runoff = 2.03 cfs @ 12.10 hrs, Volume= 0.146 af, Depth= 0.69"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 1 Year Storm Rainfall=2.20"

| Area (ac) | CN | Description |
|---|---|---|
| 2.550 | 80 | Southside of existing landfill |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 12.1 | 100 | 0.0160 | 0.1 | | **Sheet Flow, A to B**<br>Grass: Short n= 0.150 P2= 2.50" |
| 2.4 | 177 | 0.0310 | 1.2 | | **Shallow Concentrated Flow, B to C**<br>Short Grass Pasture Kv= 7.0 fps |
| 0.2 | 71 | 0.0490 | 6.4 | 76.42 | **Channel Flow, C to D**<br>Area= 12.0 sf Perim= 12.6' r= 0.95' n= 0.050 |
| 1.4 | 177 | 0.0085 | 2.2 | 1.71 | **Circular Channel (pipe), D to E**<br>Diam= 12.0" Area= 0.8 sf Perim= 3.1' r= 0.25'<br>n= 0.025 Corrugated metal |
| 0.6 | 193 | 0.0320 | 5.1 | 61.76 | **Channel Flow, E to F**<br>Area= 12.0 sf Perim= 12.6' r= 0.95' n= 0.050 |
| 16.7 | 718 | Total | | | |

## Subcatchment 3S: Subarea #3



## Subcatchment 4S: Subarea #1

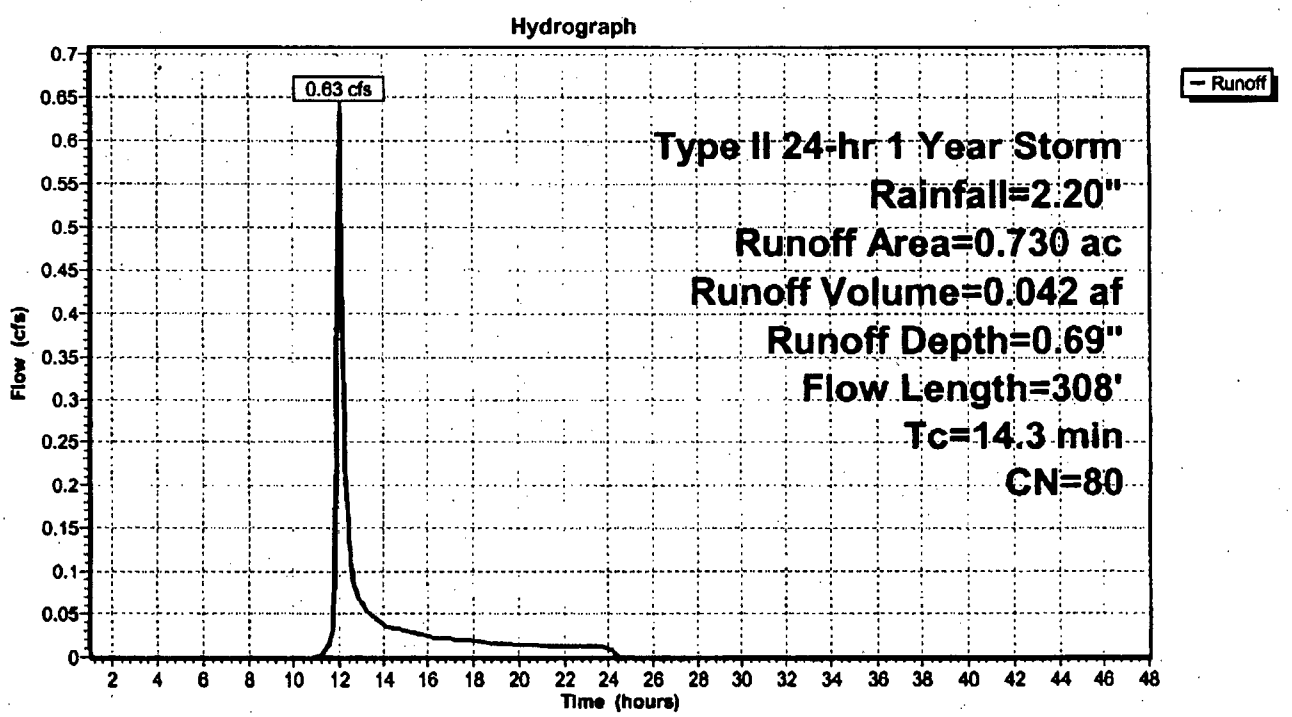
Runoff = 0.63 cfs @ 12.07 hrs, Volume= 0.042 af, Depth= 0.69"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 1 Year Storm Rainfall=2.20"

| Area (ac) | CN | Description |
|---|---|---|
| 0.730 | 80 | Southwest corner of Existing Landfill |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 12.1 | 100 | 0.0160 | 0.1 | | **Sheet Flow, A to B**<br>Grass: Short n= 0.150 P2= 2.50" |
| 2.1 | 165 | 0.0340 | 1.3 | | **Shallow Concentrated Flow, B to C**<br>Short Grass Pasture Kv= 7.0 fps |
| 0.1 | 43 | 0.0290 | 4.9 | 58.79 | **Channel Flow, C to D**<br>Area= 12.0 sf Perim= 12.6' r= 0.95' n= 0.050 |
| 14.3 | 308 | Total | | | |

## Subcatchment 4S: Subarea #1



## Subcatchment 5S: Subarea #2

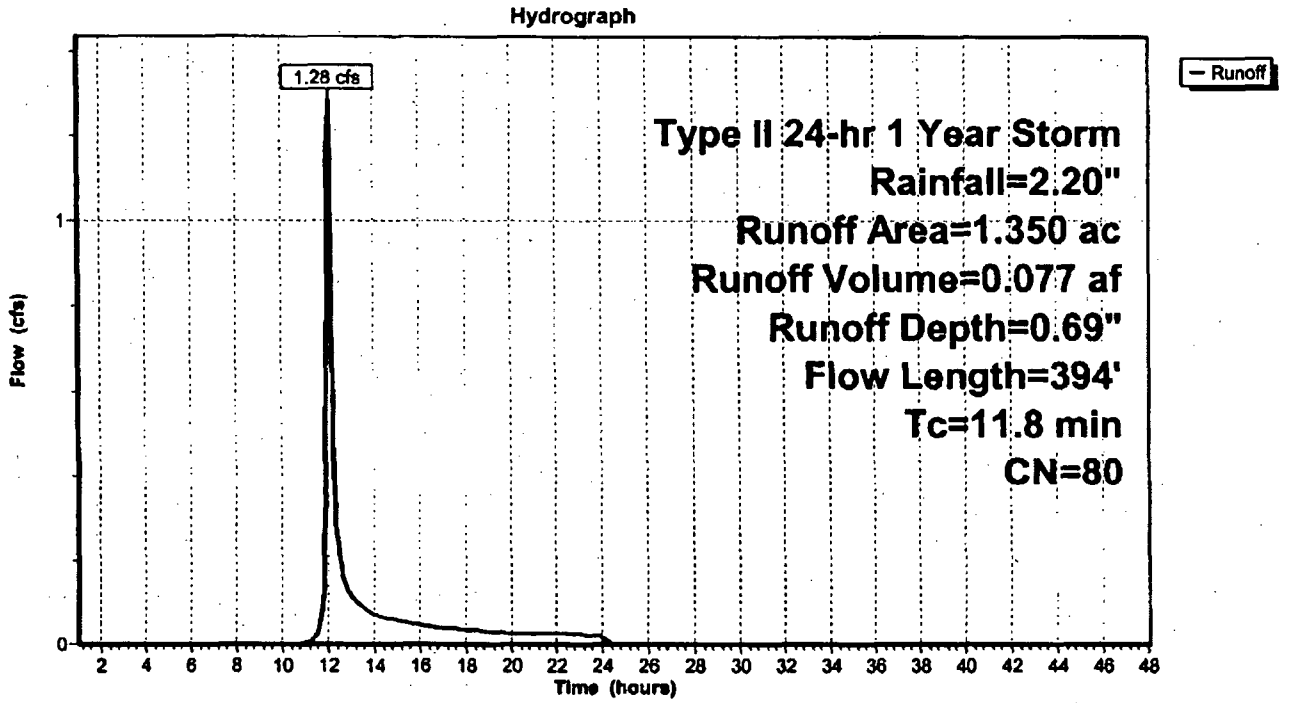
Runoff = 1.28 cfs @ 12.05 hrs, Volume= 0.077 af, Depth= 0.69"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 1 Year Storm Rainfall=2.20"

| Area (ac) | CN | Description |
|---|---|---|
| 1.350 | 80 | Outside south area draing to 12" pipe |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 10.1 | 100 | 0.0250 | 0.2 | | **Sheet Flow, A to B**<br>Grass: Short n= 0.150 P2= 2.50" |
| 1.7 | 294 | 0.0310 | 2.8 | | **Shallow Concentrated Flow, B to C**<br>Unpaved Kv= 16.1 fps |
| 11.8 | 394 | Total | | | |

## Subcatchment 5S: Subarea #2



## Subcatchment 11S: Subarea #4

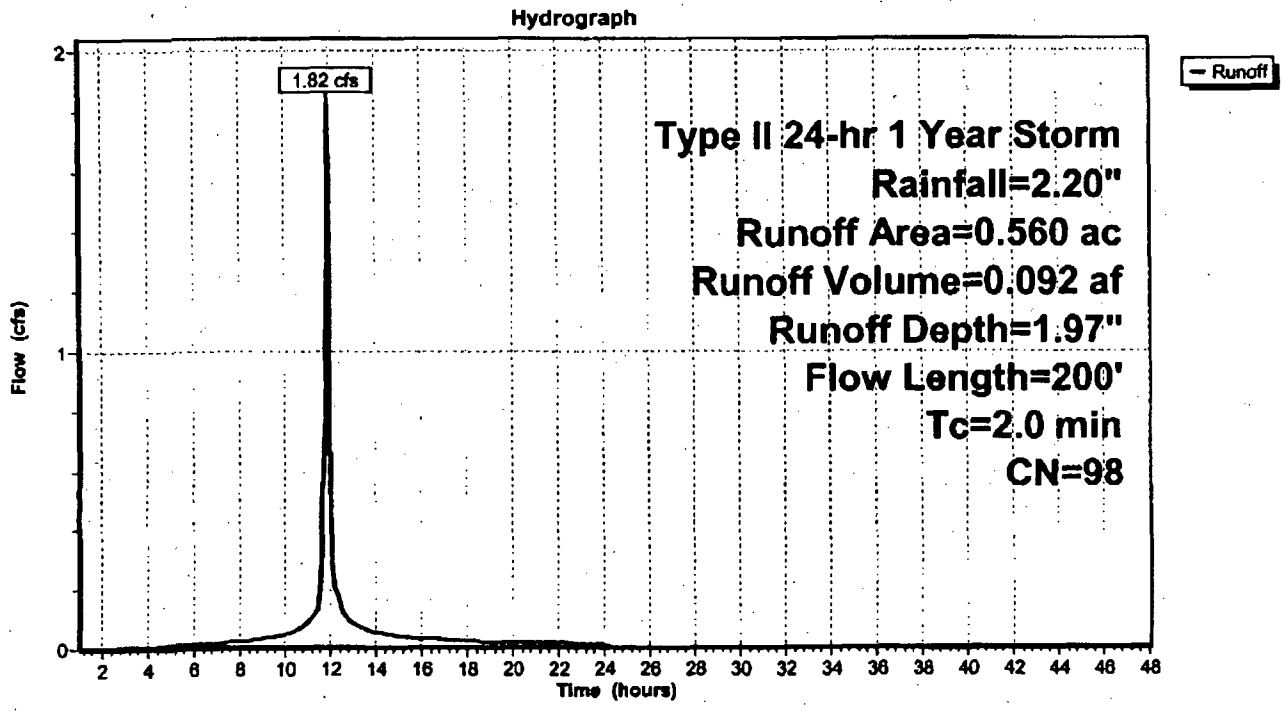
Runoff = 1.82 cfs @ 11.91 hrs, Volume= 0.092 af, Depth= 1.97"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 1 Year Storm Rainfall=2.20"

| Area (ac) | CN | Description |
|---|---|---|
| 0.560 | 98 | From SDA |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 1.4 | 100 | 0.0200 | 1.2 | | **Sheet Flow, A to B**<br>Smooth surfaces n= 0.011 P2= 2.50" |
| 0.6 | 100 | 0.0200 | 2.9 | | **Shallow Concentrated Flow, B to C**<br>Paved Kv= 20.3 fps |
| 2.0 | 200 | Total | | | |

## Subcatchment 11S: Subarea #4



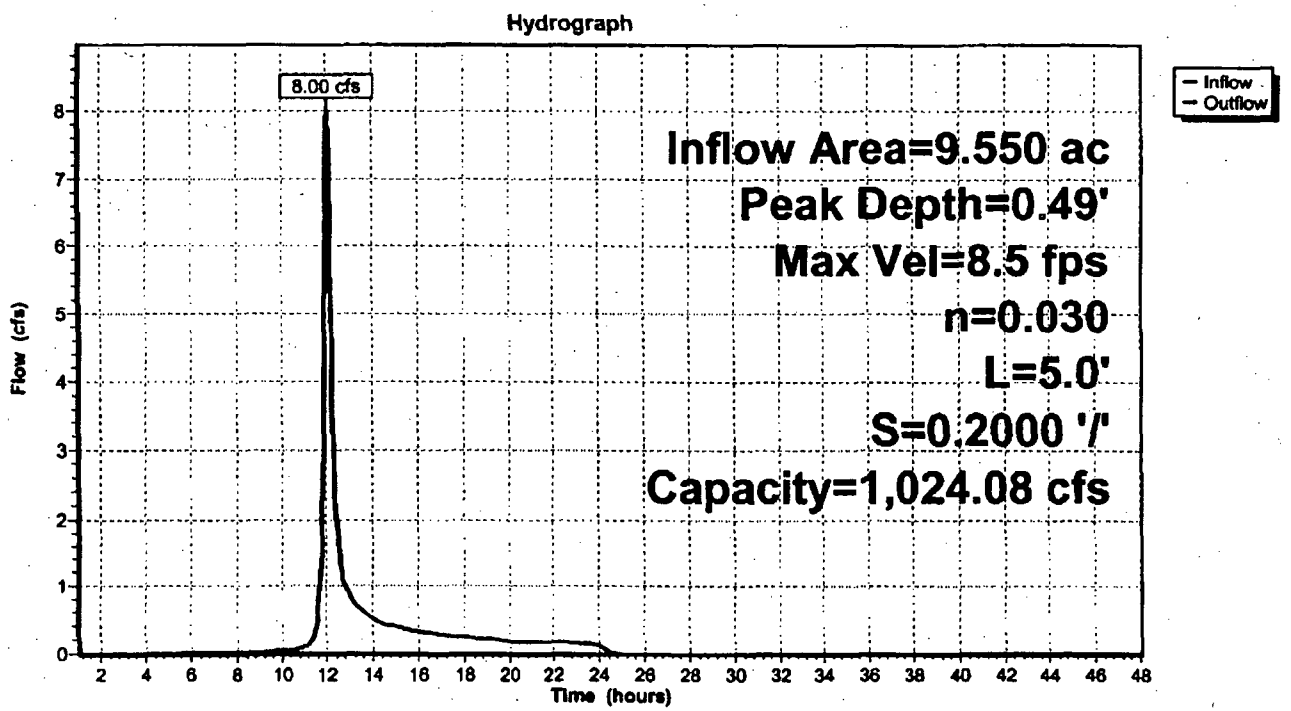
## Reach 2R: Erdman Brook

Inflow Area = 9.550 ac, Inflow Depth = 0.76" for 1 Year Storm event
Inflow = 8.00 cfs @ 12.04 hrs, Volume= 0.608 af
Outflow = 8.00 cfs @ 12.04 hrs, Volume= 0.608 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 1.00-48.00 hrs, dt= 0.05 hrs
Max. Velocity= 8.5 fps, Min. Travel Time= 0.0 min
Avg. Velocity = 3.0 fps, Avg. Travel Time= 0.0 min

Peak Depth= 0.49' @ 12.04 hrs
Capacity at bank full= 1,024.08 cfs
Inlet Invert= 1,353.50', Outlet Invert= 1,352.50'
0.00' x 3.00' deep channel, n= 0.030
Side Slope Z-value= 4.0 '/' Top Width= 24.00'
Length= 5.0' Slope= 0.2000 '/'

## Reach 2R: Erdman Brook



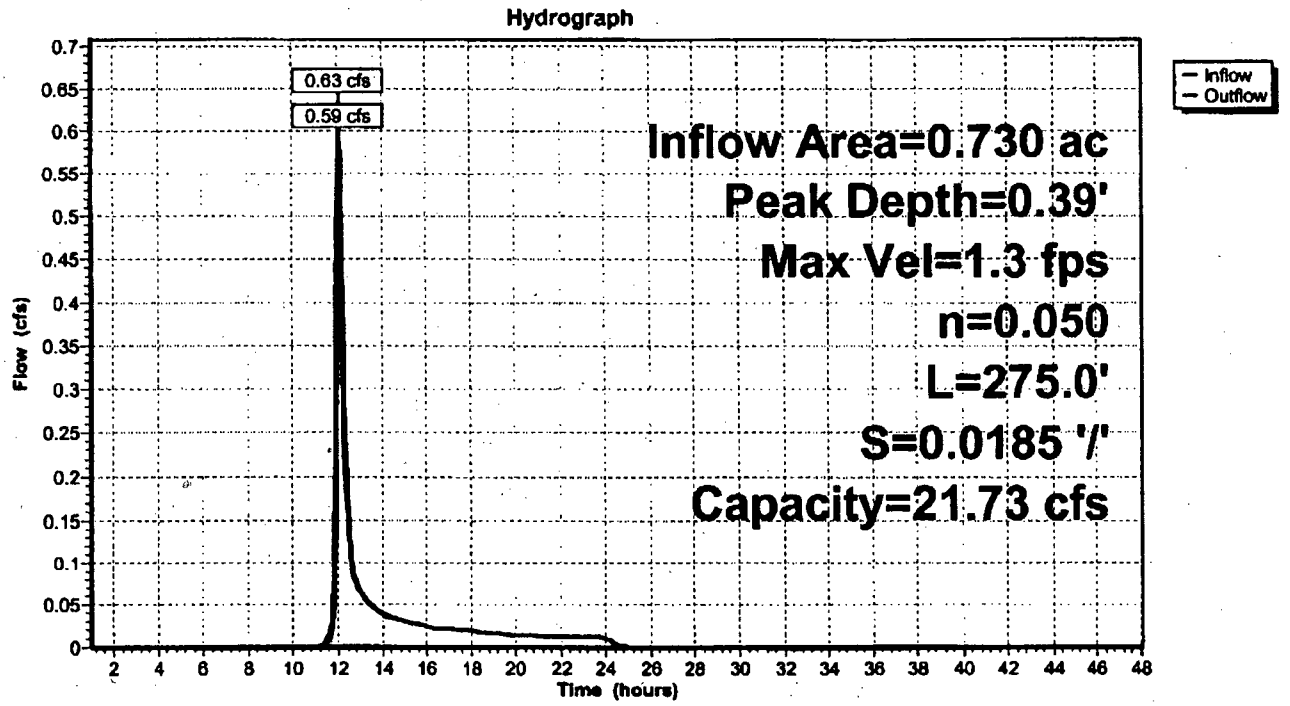
## Reach 6R: Reach #1

Inflow Area = 0.730 ac, Inflow Depth = 0.69" for 1 Year Storm event
Inflow = 0.63 cfs @ 12.07 hrs, Volume= 0.042 af
Outflow = 0.59 cfs @ 12.12 hrs, Volume= 0.042 af, Atten= 7%, Lag= 2.7 min

Routing by Dyn-Stor-Ind method, Time Span= 1.00-48.00 hrs, dt= 0.05 hrs
Max. Velocity= 1.3 fps, Min. Travel Time= 3.5 min
Avg. Velocity = 0.5 fps, Avg. Travel Time= 8.6 min

Peak Depth= 0.39' @ 12.12 hrs
Capacity at bank full= 21.73 cfs
Inlet Invert= 1,384.58', Outlet Invert= 1,379.50'
0.00' x 1.50' deep channel, n= 0.050
Side Slope Z-value= 3.0 '/' Top Width= 9.00'
Length= 275.0' Slope= 0.0185 '/'

## Reach 6R: Reach #1



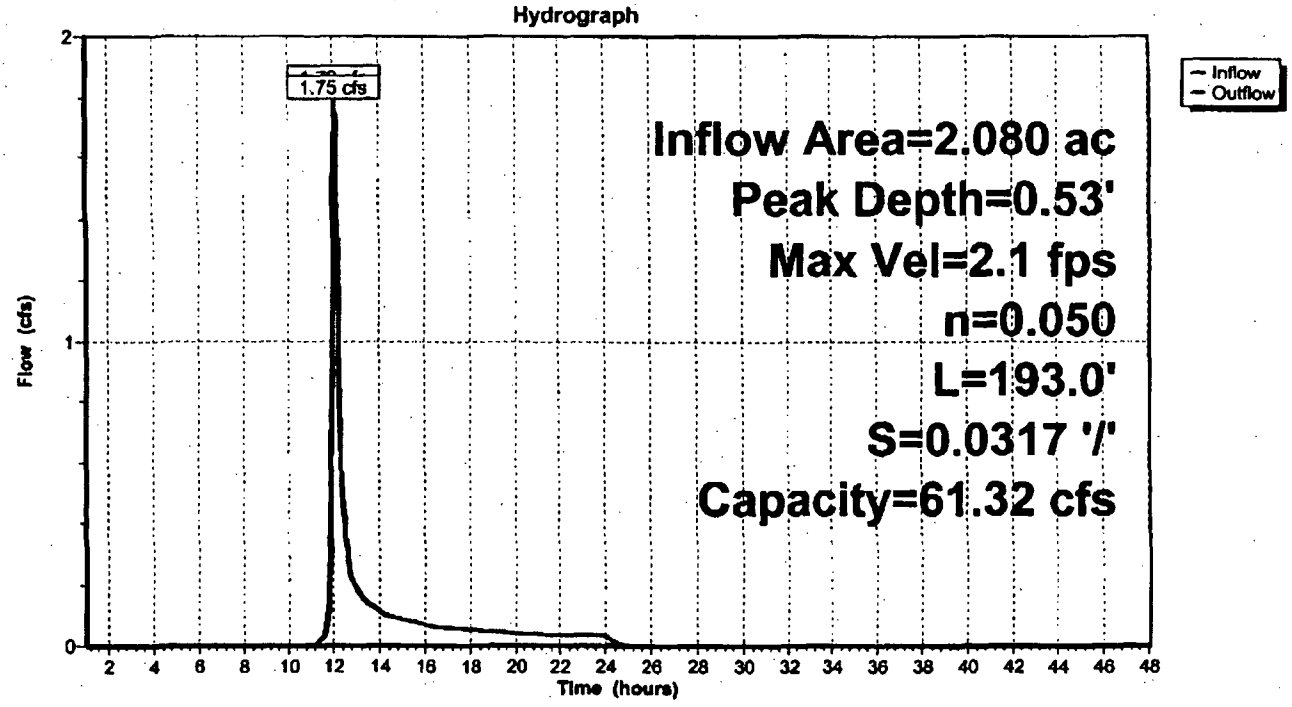
## Reach 7R: Reach #2

Inflow Area = 2.080 ac, Inflow Depth = 0.69" for 1 Year Storm event
Inflow = 1.79 cfs @ 12.06 hrs, Volume= 0.119 af
Outflow = 1.75 cfs @ 12.09 hrs, Volume= 0.119 af, Atten= 2%, Lag= 1.4 min

Routing by Dyn-Stor-Ind method, Time Span= 1.00-48.00 hrs, dt= 0.05 hrs
Max. Velocity= 2.1 fps, Min. Travel Time= 1.5 min
Avg. Velocity = 0.8 fps, Avg. Travel Time= 3.8 min

Peak Depth= 0.53' @ 12.09 hrs
Capacity at bank full= 61.32 cfs
Inlet Invert= 1,381.50', Outlet Invert= 1,375.38'
0.00' x 2.00' deep channel, n= 0.050
Side Slope Z-value= 3.0 '/' Top Width= 12.00'
Length= 193.0' Slope= 0.0317 '/'

## Reach 7R: Reach #2



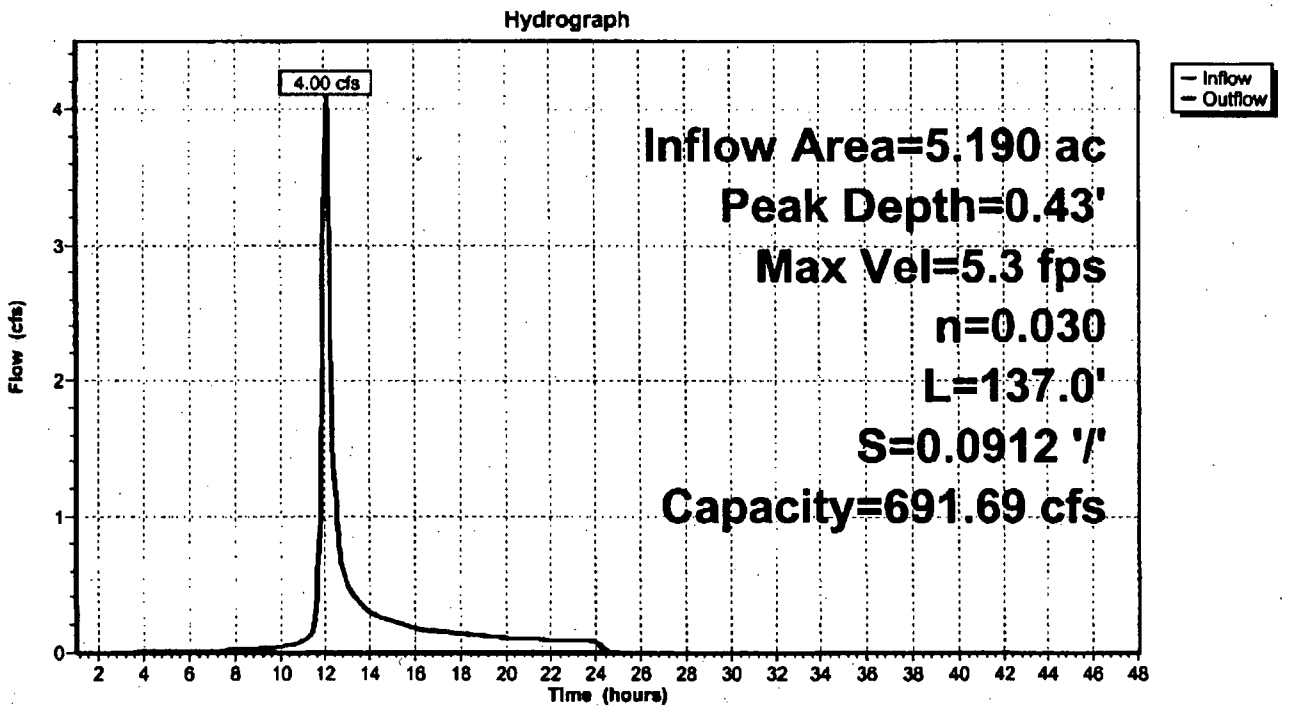
## Reach 8R: Reach #3

Inflow Area = 5.190 ac, Inflow Depth = 0.83" for 1 Year Storm event
Inflow = 4.01 cfs @ 12.09 hrs, Volume= 0.358 af
Outflow = 4.00 cfs @ 12.10 hrs, Volume= 0.358 af, Atten= 0%, Lag= 0.3 min

Routing by Dyn-Stor-Ind method, Time Span= 1.00-48.00 hrs, dt= 0.05 hrs
Max. Velocity= 5.3 fps, Min. Travel Time= 0.4 min
Avg. Velocity = 2.0 fps, Avg. Travel Time= 1.2 min

Peak Depth= 0.43' @ 12.10 hrs
Capacity at bank full= 691.69 cfs
Inlet Invert= 1,366.00', Outlet Invert= 1,353.50'
0.00' x 3.00' deep channel, n= 0.030
Side Slope Z-value= 4.0 '/' Top Width= 24.00'
Length= 137.0' Slope= 0.0912 '/'

## Reach 8R: Reach #3



## Pond 9P: 12"

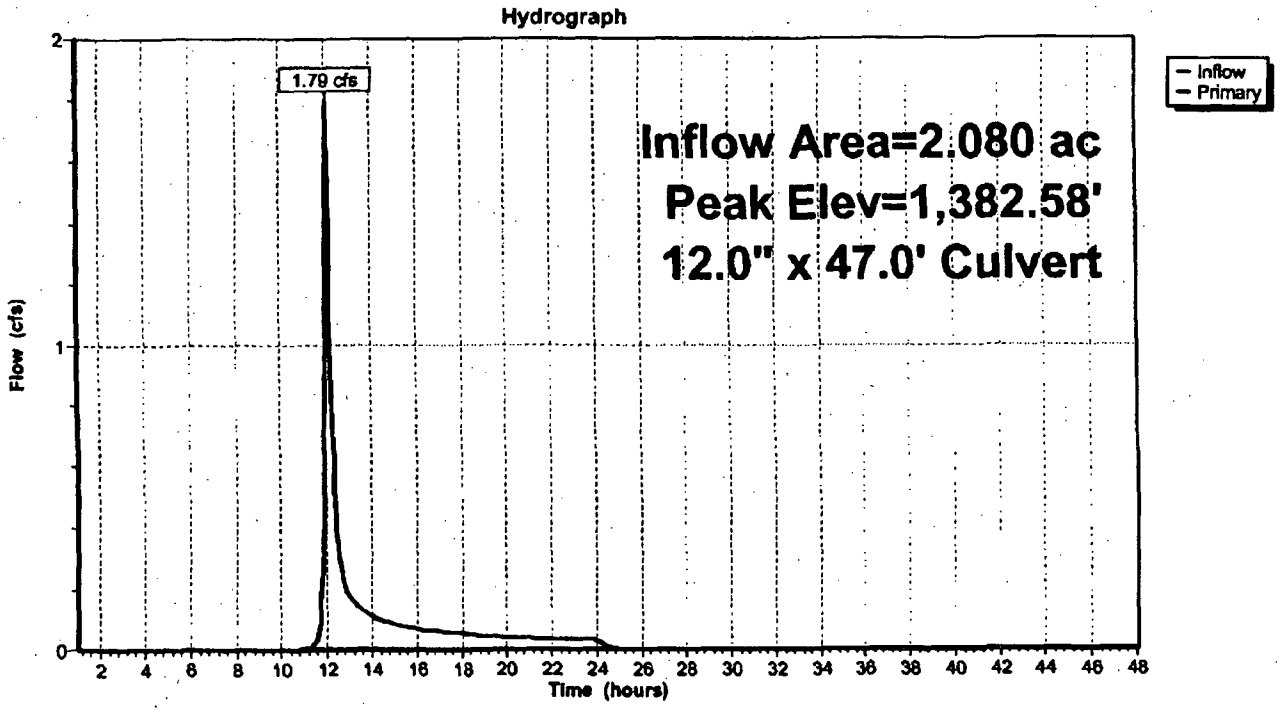
| | | | | | |
|---|---|---|---|---|---|
| Inflow Area = | 2.080 ac, | Inflow Depth = | 0.69" | for | 1 Year Storm event |
| Inflow = | 1.79 cfs @ | 12.06 hrs, | Volume= | 0.119 af | |
| Outflow = | 1.79 cfs @ | 12.06 hrs, | Volume= | 0.119 af, | Atten= 0%, Lag= 0.0 min |
| Primary = | 1.79 cfs @ | 12.06 hrs, | Volume= | 0.119 af | |

Routing by Dyn-Stor-Ind method, Time Span= 1.00-48.00 hrs, dt= 0.05 hrs
Peak Elev= 1,382.58' @ 12.07 hrs
Plug-Flow detention time= 0.0 min calculated for 0.119 af (100% of inflow)
Center-of-Mass det. time= 0.0 min ( 869.3 - 869.3 )

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 1,379.50' | **12.0" x 47.0' long Culvert** CMP, projecting, no headwall, Ke= 0.900<br>Outlet Invert= 1,379.00' S= 0.0106 '/' Cc= 0.900<br>n= 0.025 Corrugated metal |

**Primary OutFlow** Max=1.69 cfs @ 12.06 hrs HW=1,382.55' TW=1,382.02' (Dynamic Tailwater)
└**1=Culvert** (Outlet Controls 1.69 cfs @ 2.2 fps)

## Pond 9P: 12"



## Pond 10P: 24"

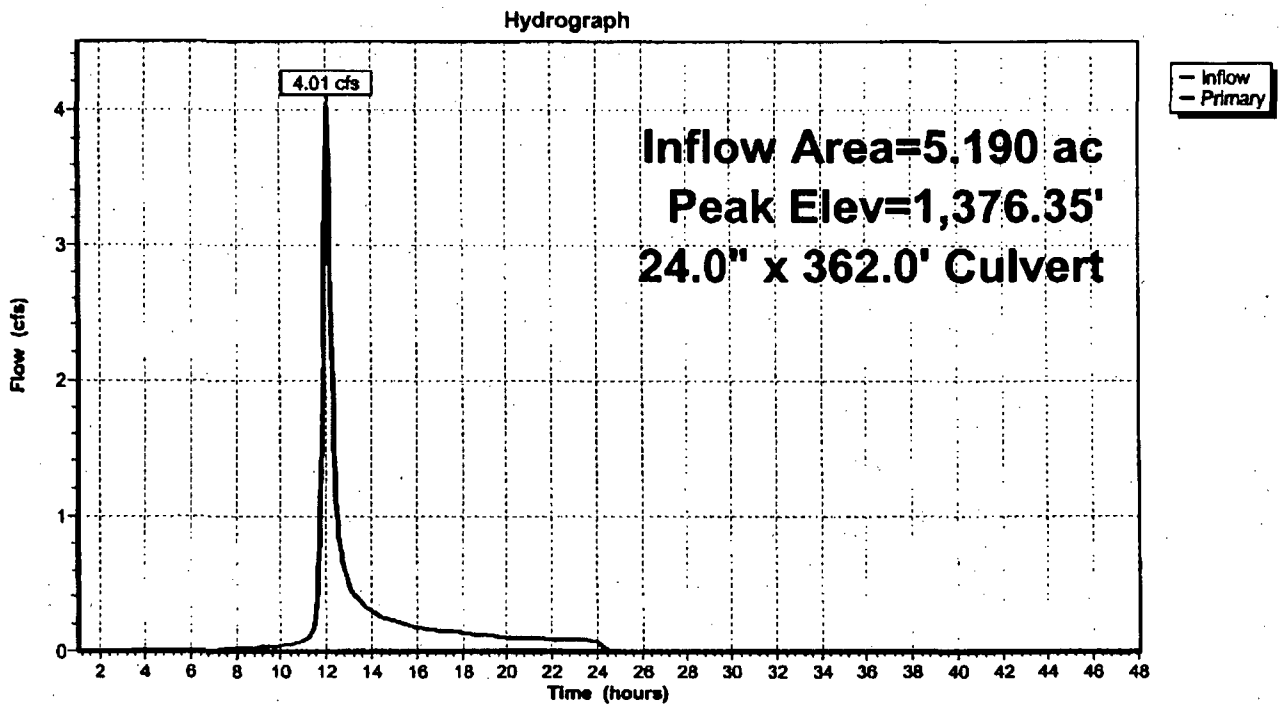
| | | | | | |
|---|---|---|---|---|---|
| Inflow Area = | 5.190 ac, | Inflow Depth = | 0.83" | for | 1 Year Storm event |
| Inflow = | 4.01 cfs @ | 12.09 hrs, | Volume= | 0.358 af | |
| Outflow = | 4.01 cfs @ | 12.09 hrs, | Volume= | 0.358 af, | Atten= 0%, Lag= 0.0 min |
| Primary = | 4.01 cfs @ | 12.09 hrs, | Volume= | 0.358 af | |

Routing by Dyn-Stor-Ind method, Time Span= 1.00-48.00 hrs, dt= 0.05 hrs
Peak Elev= 1,376.35' @ 12.09 hrs
Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 0.0 min ( 842.1 - 842.1 )

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 1,375.38' | **24.0" x 362.0' long Culvert** CPP, projecting, no headwall, Ke= 0.900<br>Outlet Invert= 1,366.00' S= 0.0259 '/' Cc= 0.900<br>n= 0.013 Corrugated PE, smooth interior |

**Primary OutFlow** Max=3.97 cfs @ 12.09 hrs HW=1,376.35' TW=1,366.43' (Dynamic Tailwater)
└**1=Culvert** (Inlet Controls 3.97 cfs @ 2.6 fps)

## Pond 10P: 24"



## Pond 11P: 12"

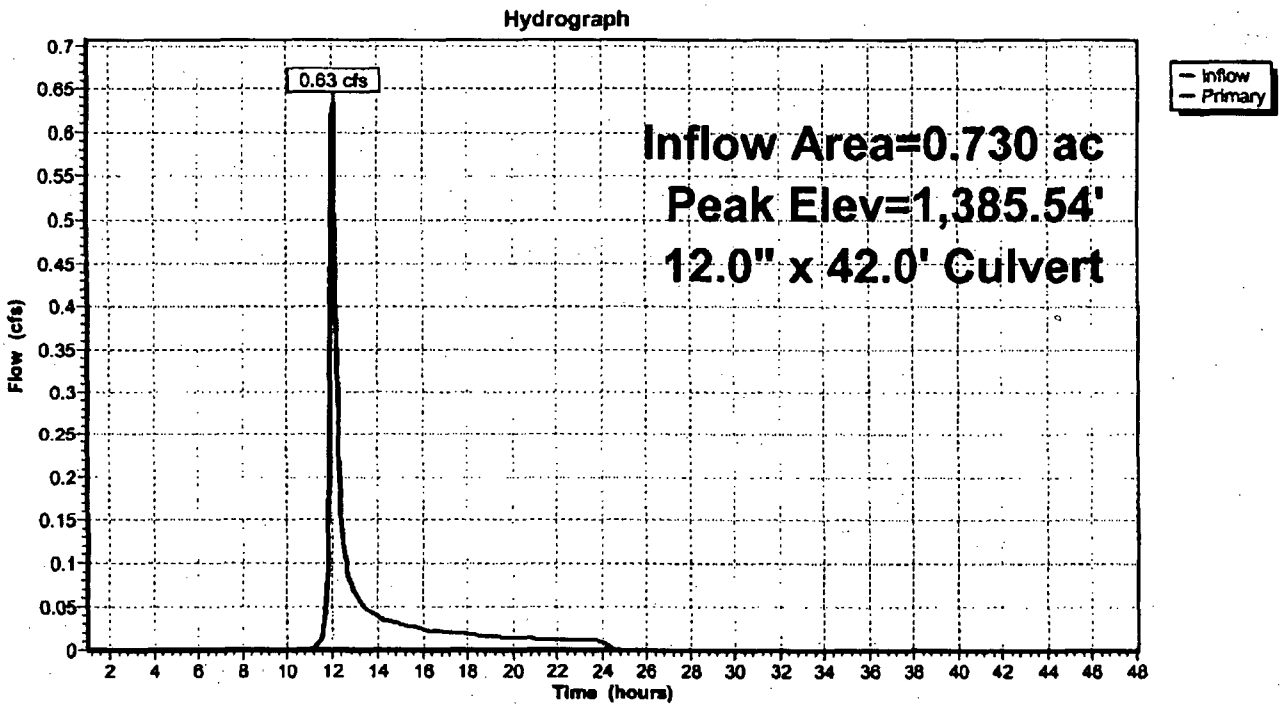
| | | | | | |
|---|---|---|---|---|---|
| Inflow Area = | 0.730 ac, | Inflow Depth = | 0.69" | for | 1 Year Storm event |
| Inflow = | 0.63 cfs @ | 12.07 hrs, | Volume= | 0.042 af | |
| Outflow = | 0.63 cfs @ | 12.07 hrs, | Volume= | 0.042 af, | Atten= 0%, Lag= 0.0 min |
| Primary = | 0.63 cfs @ | 12.07 hrs, | Volume= | 0.042 af | |

Routing by Dyn-Stor-Ind method, Time Span= 1.00-48.00 hrs, dt= 0.05 hrs
Peak Elev= 1,385.54' @ 12.07 hrs
Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 0.0 min ( 868.6 - 868.6 )

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 1,385.00' | **12.0" x 42.0' long Culvert** CMP, projecting, no headwall, Ke= 0.900<br>Outlet Invert= 1,384.58' S= 0.0100 '/' Cc= 0.900<br>n= 0.025 Corrugated metal |

**Primary OutFlow** Max=0.62 cfs @ 12.07 hrs HW=1,385.53' TW=1,384.95' (Dynamic Tailwater)
└─**1=Culvert** (Barrel Controls 0.62 cfs @ 2.1 fps)

## Pond 11P: 12"



## Pond 12P: 18"

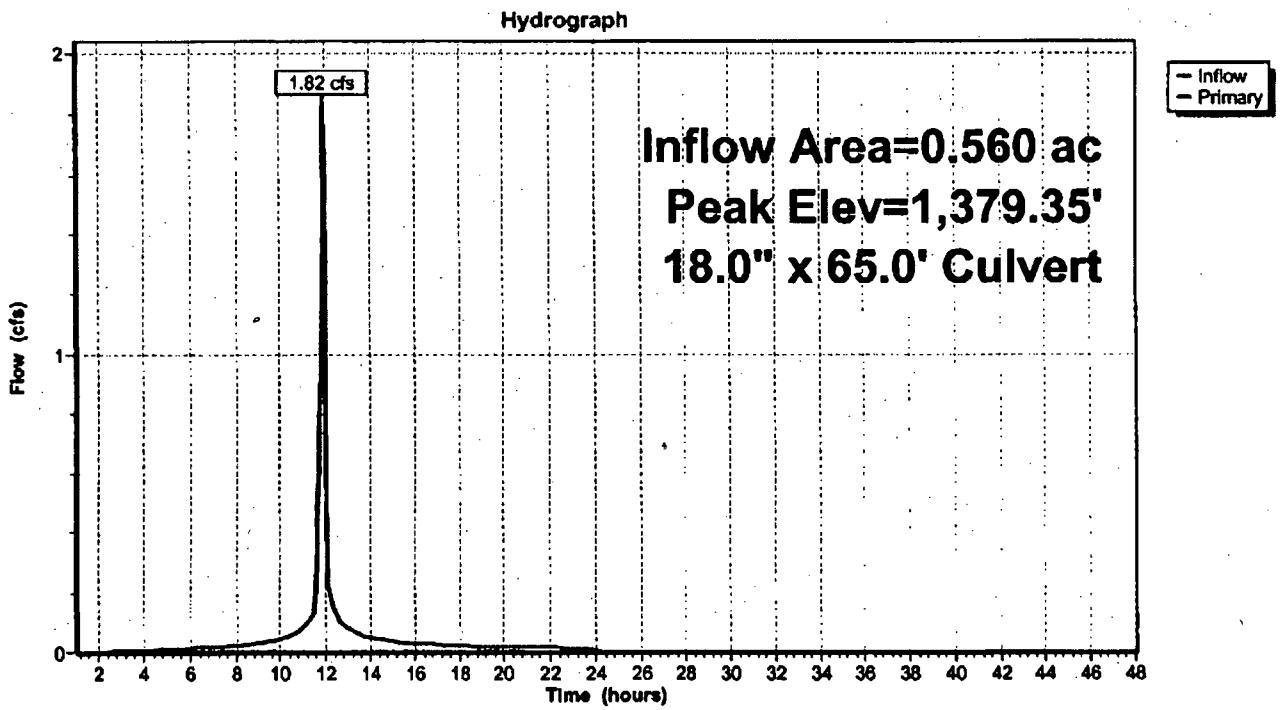
| | | | | | |
|---|---|---|---|---|---|
| Inflow Area = | 0.560 ac, | Inflow Depth = | 1.97" | for | 1 Year Storm event |
| Inflow = | 1.82 cfs @ | 11.91 hrs, | Volume= | 0.092 af | |
| Outflow = | 1.82 cfs @ | 11.91 hrs, | Volume= | 0.092 af, | Atten= 0%, Lag= 0.0 min |
| Primary = | 1.82 cfs @ | 11.91 hrs, | Volume= | 0.092 af | |

Routing by Dyn-Stor-Ind method, Time Span= 1.00-48.00 hrs, dt= 0.05 hrs
Peak Elev= 1,379.35' @ 11.91 hrs
Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 0.0 min ( 757.6 - 757.6 )

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 1,378.50' | **18.0" x 65.0' long Culvert** CMP, projecting, no headwall, Ke= 0.900<br>Outlet Invert= 1,378.00' S= 0.0077 '/' Cc= 0.900<br>n= 0.025 Corrugated metal |

**Primary OutFlow** Max=1.77 cfs @ 11.91 hrs HW=1,379.33' TW=1,376.21' (Dynamic Tailwater)
└**1=Culvert** (Barrel Controls 1.77 cfs @ 2.5 fps)

## Pond 12P: 18"



Time span=1.00-48.00 hrs, dt=0.05 hrs, 941 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

**Subcatchment 1S: Subarea 5** Runoff Area=3.330 ac Runoff Depth=1.72"
Flow Length=866' Tc=10.9 min CN=80 Runoff=8.40 cfs 0.476 af

**Subcatchment 2S: Subarea 6** Runoff Area=1.030 ac Runoff Depth=1.72"
Flow Length=657' Tc=9.7 min CN=80 Runoff=2.71 cfs 0.147 af

**Subcatchment 3S: Subarea #3** Runoff Area=2.550 ac Runoff Depth=1.72"
Flow Length=718' Tc=16.7 min CN=80 Runoff=5.32 cfs 0.365 af

**Subcatchment 4S: Subarea #1** Runoff Area=0.730 ac Runoff Depth=1.72"
Flow Length=308' Tc=14.3 min CN=80 Runoff=1.64 cfs 0.104 af

**Subcatchment 5S: Subarea #2** Runoff Area=1.350 ac Runoff Depth=1.72"
Flow Length=394' Tc=11.8 min CN=80 Runoff=3.31 cfs 0.193 af

**Subcatchment 11S: Subarea #4** Runoff Area=0.560 ac Runoff Depth=3.37"
Flow Length=200' Tc=2.0 min CN=98 Runoff=3.02 cfs 0.157 af

**Reach 2R: Erdman Brook** Peak Depth=0.70' Max Vel=10.7 fps Inflow=20.85 cfs 1.443 af
n=0.030 L=5.0' S=0.2000 '/' Capacity=1,024.08 cfs Outflow=20.85 cfs 1.443 af

**Reach 6R: Reach #1** Peak Depth=0.56' Max Vel=1.7 fps Inflow=1.64 cfs 0.104 af
n=0.050 L=275.0' S=0.0185 '/' Capacity=21.73 cfs Outflow=1.58 cfs 0.104 af

**Reach 7R: Reach #2** Peak Depth=0.76' Max Vel=2.7 fps Inflow=4.74 cfs 0.297 af
n=0.050 L=193.0' S=0.0317 '/' Capacity=61.32 cfs Outflow=4.68 cfs 0.297 af

**Reach 8R: Reach #3** Peak Depth=0.62' Max Vel=6.7 fps Inflow=10.34 cfs 0.819 af
n=0.030 L=137.0' S=0.0912 '/' Capacity=691.69 cfs Outflow=10.34 cfs 0.819 af

**Pond 9P: 12"** Peak Elev=1,386.37' Inflow=4.73 cfs 0.297 af
12.0" x 47.0' Culvert Outflow=4.74 cfs 0.297 af

**Pond 10P: 24"** Peak Elev=1,377.13' Inflow=10.34 cfs 0.819 af
24.0" x 362.0' Culvert Outflow=10.34 cfs 0.819 af

**Pond 11P: 12"** Peak Elev=1,385.96' Inflow=1.64 cfs 0.104 af
12.0" x 42.0' Culvert Outflow=1.64 cfs 0.104 af

**Pond 12P: 18"** Peak Elev=1,379.63' Inflow=3.02 cfs 0.157 af
18.0" x 65.0' Culvert Outflow=3.02 cfs 0.157 af

**Total Runoff Area = 9.550 ac Runoff Volume = 1.443 af Average Runoff Depth = 1.81"**

## Subcatchment 1S: Subarea 5

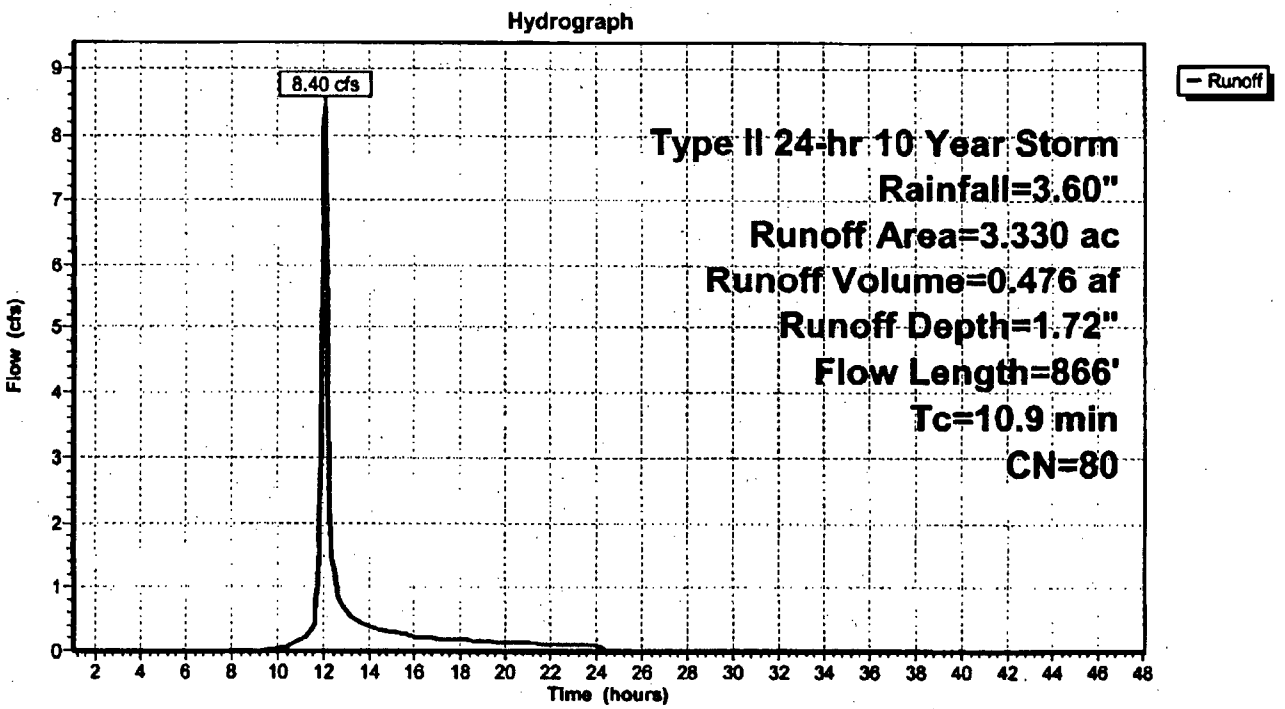
Runoff = 8.40 cfs @ 12.03 hrs, Volume= 0.476 af, Depth= 1.72"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 10 Year Storm Rainfall=3.60"

| Area (ac) | CN | Description |
|---|---|---|
| 3.330 | 80 | North and west side of existing landfill |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 4.2 | 44 | 0.0450 | 0.2 | | **Sheet Flow, A to B**<br>Grass: Short n= 0.150 P2= 2.50" |
| 4.4 | 119 | 0.0042 | 0.5 | | **Shallow Concentrated Flow, B to C**<br>Short Grass Pasture Kv= 7.0 fps |
| 1.9 | 428 | 0.0260 | 3.8 | 25.44 | **Channel Flow, C to D**<br>Area= 6.7 sf Perim= 9.5' r= 0.71' n= 0.050 |
| 0.2 | 71 | 0.0420 | 4.8 | 3.80 | **Circular Channel (pipe), D to E**<br>Diam= 12.0" Area= 0.8 sf Perim= 3.1' r= 0.25'<br>n= 0.025 Corrugated metal |
| 0.2 | 204 | 0.1050 | 20.6 | 742.79 | **Channel Flow, E to F**<br>Area= 36.0 sf Perim= 24.7' r= 1.46' n= 0.030 |
| 10.9 | 866 | Total | | | |

## Subcatchment 1S: Subarea 5



## Subcatchment 2S: Subarea 6

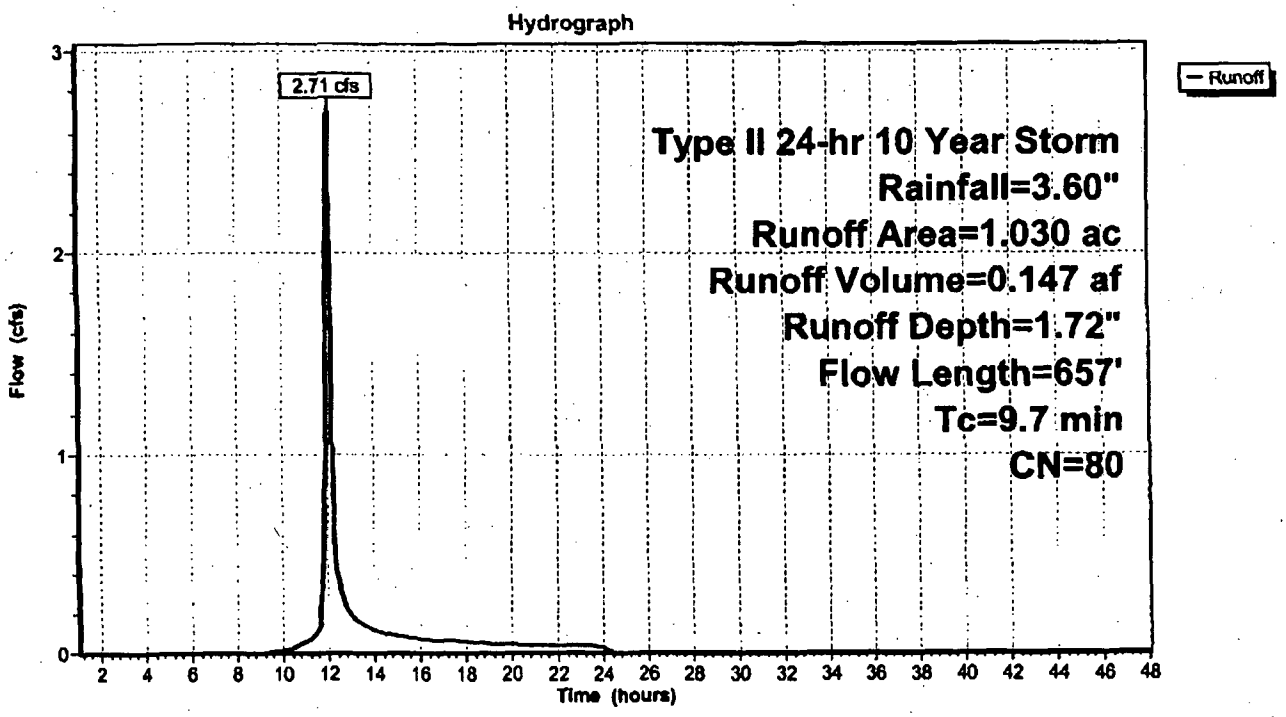
Runoff = 2.71 cfs @ 12.01 hrs, Volume= 0.147 af, Depth= 1.72"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 10 Year Storm Rainfall=3.60"

| Area (ac) | CN | Description |
|---|---|---|
| 1.030 | 80 | West side of exisiting landfill |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 7.7 | 100 | 0.0500 | 0.2 | | **Sheet Flow, A to B**<br>Grass: Short n= 0.150 P2= 2.50" |
| 1.6 | 160 | 0.0560 | 1.7 | | **Shallow Concentrated Flow, B to C**<br>Short Grass Pasture Kv= 7.0 fps |
| 0.4 | 397 | 0.0580 | 15.3 | 552.06 | **Channel Flow, C to D**<br>Area= 36.0 sf Perim= 24.7' r= 1.46' n= 0.030 |
| 9.7 | 657 | Total | | | |

## Subcatchment 2S: Subarea 6



## Subcatchment 3S: Subarea #3

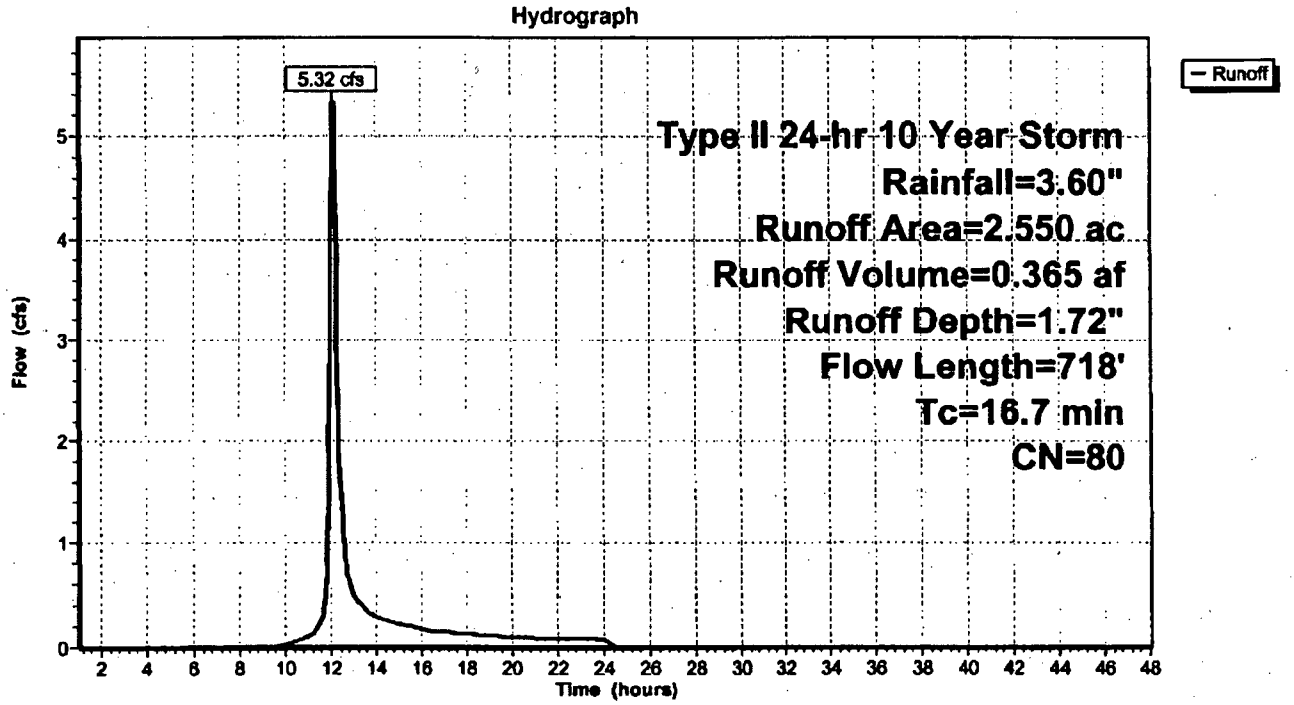
Runoff = 5.32 cfs @ 12.09 hrs, Volume= 0.365 af, Depth= 1.72"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 10 Year Storm Rainfall=3.60"

| Area (ac) | CN | Description |
|---|---|---|
| 2.550 | 80 | Southside of existing landfill |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 12.1 | 100 | 0.0160 | 0.1 | | **Sheet Flow, A to B**<br>Grass: Short n= 0.150 P2= 2.50" |
| 2.4 | 177 | 0.0310 | 1.2 | | **Shallow Concentrated Flow, B to C**<br>Short Grass Pasture Kv= 7.0 fps |
| 0.2 | 71 | 0.0490 | 6.4 | 76.42 | **Channel Flow, C to D**<br>Area= 12.0 sf Perim= 12.6' r= 0.95' n= 0.050 |
| 1.4 | 177 | 0.0085 | 2.2 | 1.71 | **Circular Channel (pipe), D to E**<br>Diam= 12.0" Area= 0.8 sf Perim= 3.1' r= 0.25'<br>n= 0.025 Corrugated metal |
| 0.6 | 193 | 0.0320 | 5.1 | 61.76 | **Channel Flow, E to F**<br>Area= 12.0 sf Perim= 12.6' r= 0.95' n= 0.050 |
| 16.7 | 718 | Total | | | |

## Subcatchment 3S: Subarea #3



## Subcatchment 4S: Subarea #1

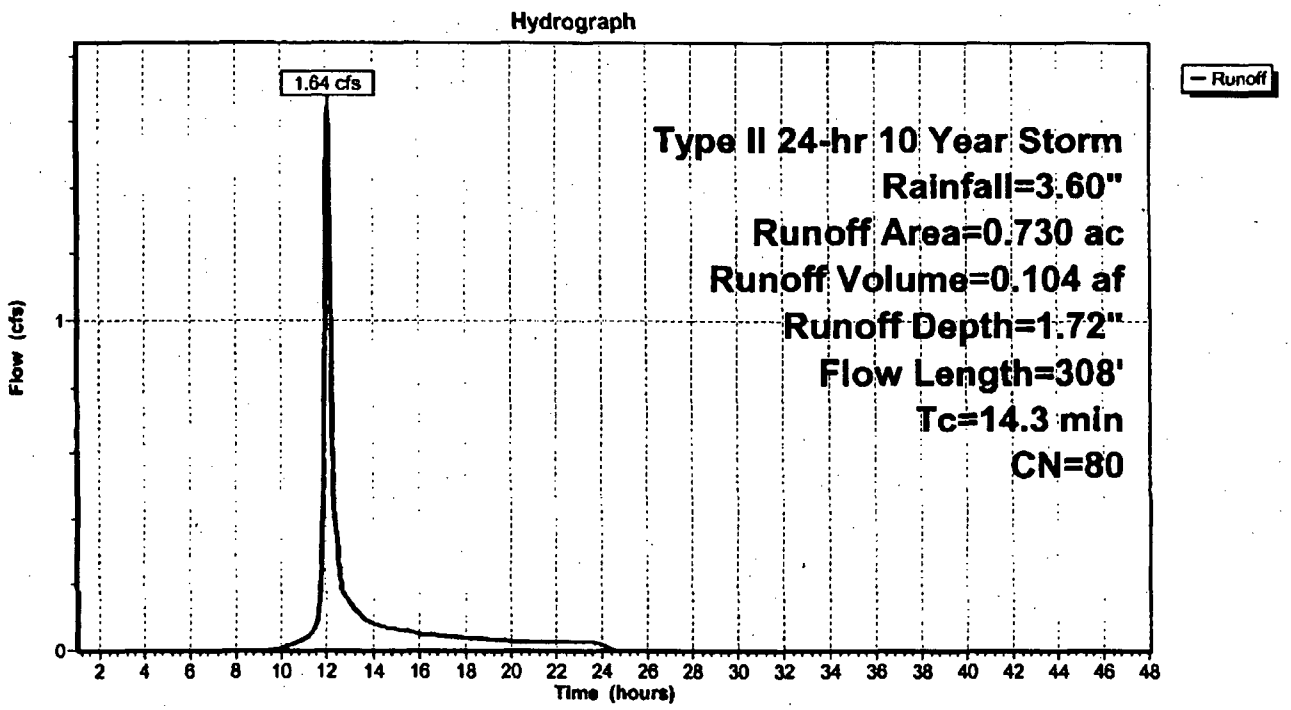
Runoff = 1.64 cfs @ 12.07 hrs, Volume= 0.104 af, Depth= 1.72"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 10 Year Storm Rainfall=3.60"

| Area (ac) | CN | Description |
|---|---|---|
| 0.730 | 80 | Southwest corner of Existing Landfill |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 12.1 | 100 | 0.0160 | 0.1 | | **Sheet Flow, A to B**<br>Grass: Short n= 0.150 P2= 2.50" |
| 2.1 | 165 | 0.0340 | 1.3 | | **Shallow Concentrated Flow, B to C**<br>Short Grass Pasture Kv= 7.0 fps |
| 0.1 | 43 | 0.0290 | 4.9 | 58.79 | **Channel Flow, C to D**<br>Area= 12.0 sf Perim= 12.6' r= 0.95' n= 0.050 |
| 14.3 | 308 | Total | | | |

## Subcatchment 4S: Subarea #1



## Subcatchment 5S: Subarea #2

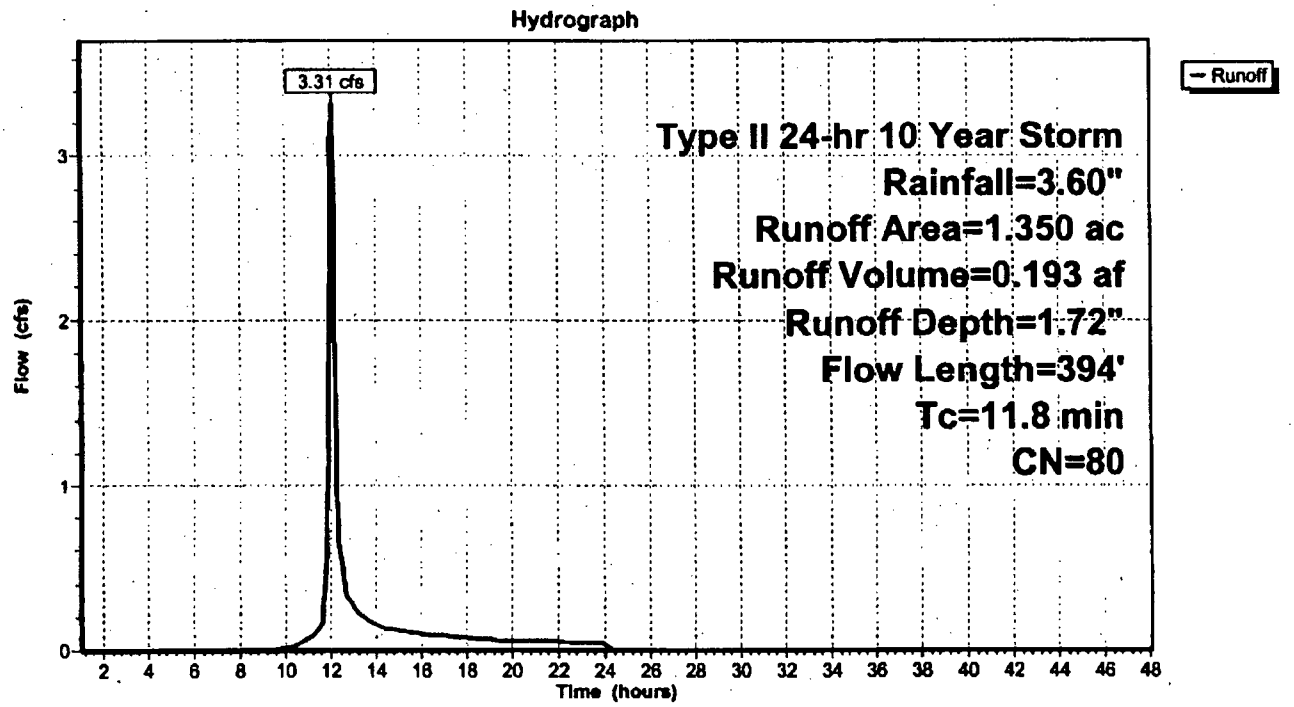
Runoff = 3.31 cfs @ 12.04 hrs, Volume= 0.193 af, Depth= 1.72"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 10 Year Storm Rainfall=3.60"

| Area (ac) | CN | Description |
|---|---|---|
| 1.350 | 80 | Outside south area draing to 12" pipe |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 10.1 | 100 | 0.0250 | 0.2 | | **Sheet Flow, A to B**<br>Grass: Short n= 0.150 P2= 2.50" |
| 1.7 | 294 | 0.0310 | 2.8 | | **Shallow Concentrated Flow, B to C**<br>Unpaved Kv= 16.1 fps |
| 11.8 | 394 | Total | | | |

## Subcatchment 5S: Subarea #2



## Subcatchment 11S: Subarea #4

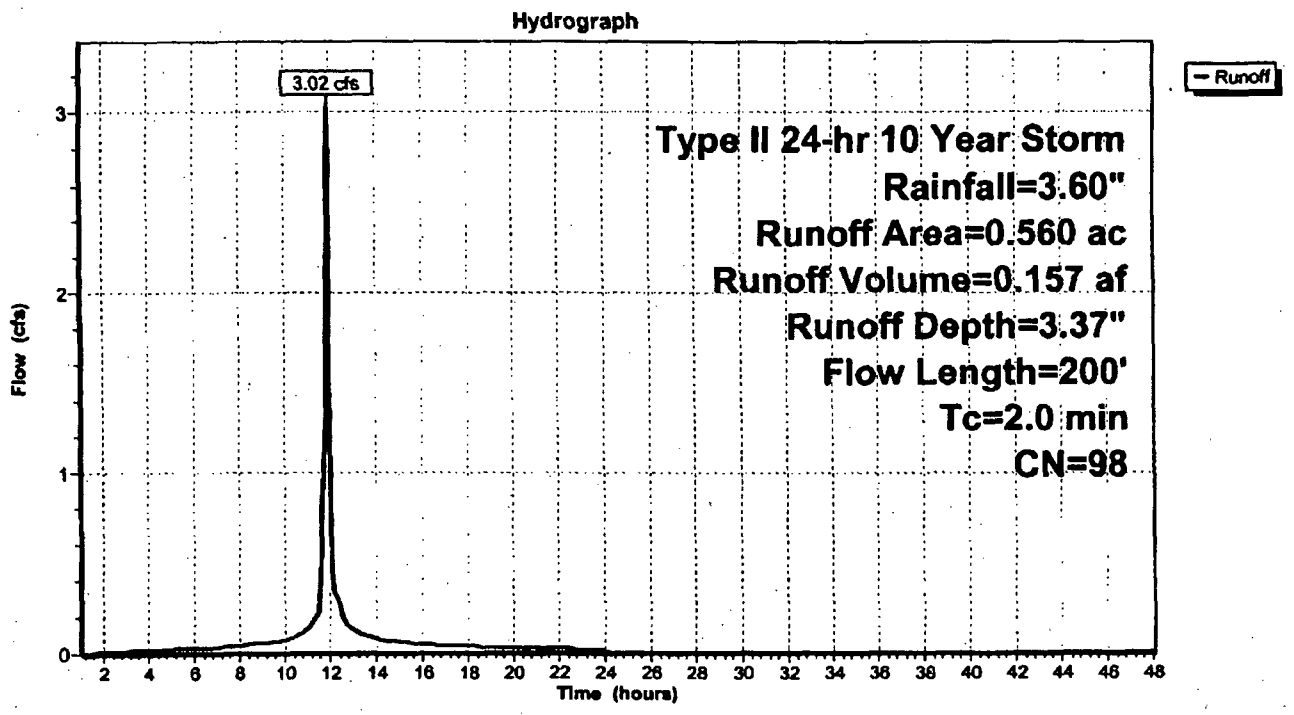
Runoff = 3.02 cfs @ 11.91 hrs, Volume= 0.157 af, Depth= 3.37"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 10 Year Storm Rainfall=3.60"

| Area (ac) | CN | Description |
|---|---|---|
| 0.560 | 98 | From SDA |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 1.4 | 100 | 0.0200 | 1.2 | | **Sheet Flow, A to B**<br>Smooth surfaces n= 0.011 P2= 2.50" |
| 0.6 | 100 | 0.0200 | 2.9 | | **Shallow Concentrated Flow, B to C**<br>Paved Kv= 20.3 fps |
| 2.0 | 200 | Total | | | |

## Subcatchment 11S: Subarea #4



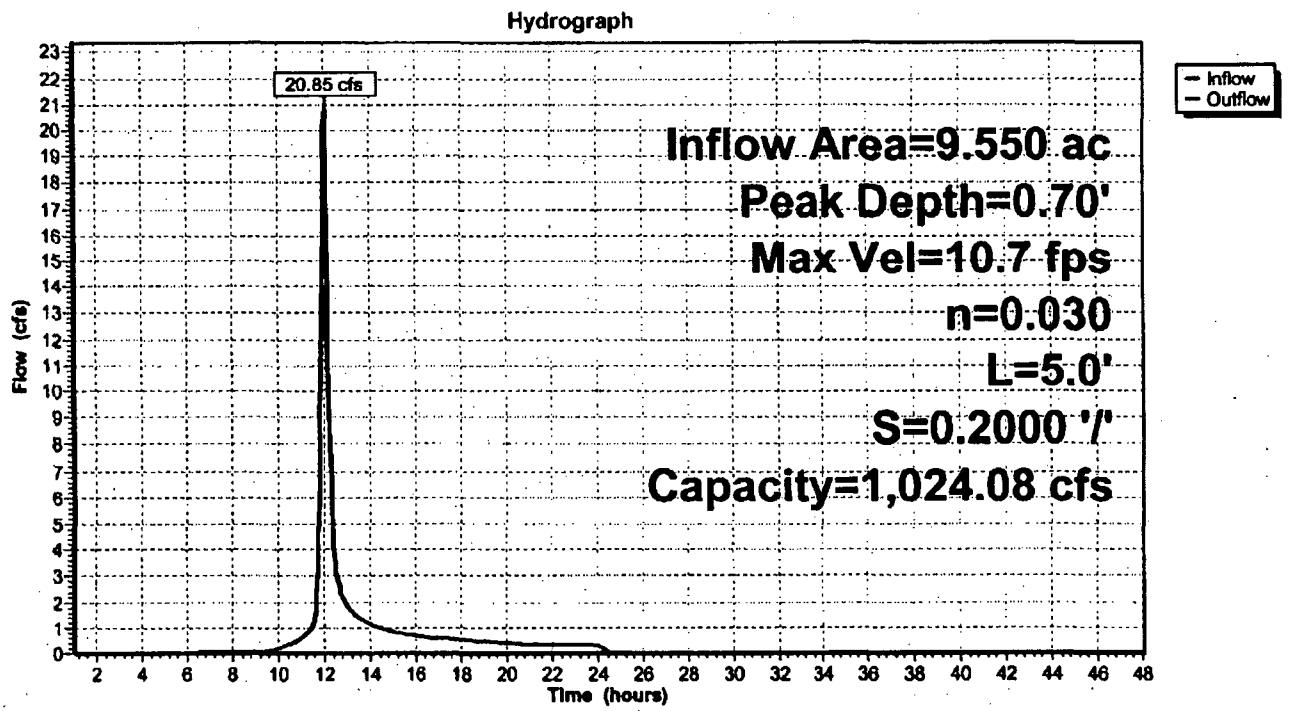
## Reach 2R: Erdman Brook

Inflow Area = 9.550 ac, Inflow Depth = 1.81" for 10 Year Storm event
Inflow = 20.85 cfs @ 12.04 hrs, Volume= 1.443 af
Outflow = 20.85 cfs @ 12.04 hrs, Volume= 1.443 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 1.00-48.00 hrs, dt= 0.05 hrs
Max. Velocity= 10.7 fps, Min. Travel Time= 0.0 min
Avg. Velocity = 3.5 fps, Avg. Travel Time= 0.0 min

Peak Depth= 0.70' @ 12.04 hrs
Capacity at bank full= 1,024.08 cfs
Inlet Invert= 1,353.50', Outlet Invert= 1,352.50'
0.00' x 3.00' deep channel, n= 0.030
Side Slope Z-value= 4.0 '/' Top Width= 24.00'
Length= 5.0' Slope= 0.2000 '/'

## Reach 2R: Erdman Brook



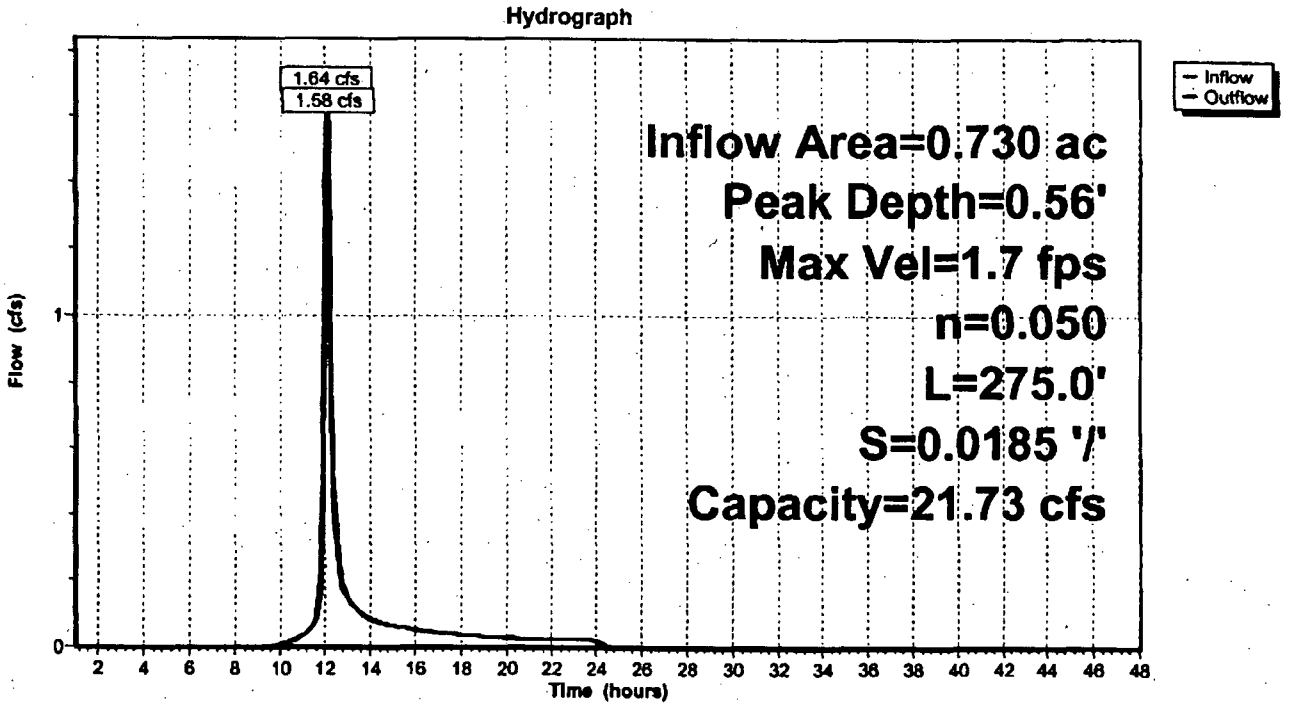
## Reach 6R: Reach #1

Inflow Area = 0.730 ac, Inflow Depth = 1.72" for 10 Year Storm event
Inflow = 1.64 cfs @ 12.07 hrs, Volume= 0.104 af
Outflow = 1.58 cfs @ 12.10 hrs, Volume= 0.104 af, Atten= 4%, Lag= 2.2 min

Routing by Dyn-Stor-Ind method, Time Span= 1.00-48.00 hrs, dt= 0.05 hrs
Max. Velocity= 1.7 fps, Min. Travel Time= 2.7 min
Avg. Velocity = 0.6 fps, Avg. Travel Time= 7.3 min

Peak Depth= 0.56' @ 12.10 hrs
Capacity at bank full= 21.73 cfs
Inlet Invert= 1,384.58', Outlet Invert= 1,379.50'
0.00' x 1.50' deep channel, n= 0.050
Side Slope Z-value= 3.0 '/' Top Width= 9.00'
Length= 275.0' Slope= 0.0185 '/'

## Reach 6R: Reach #1



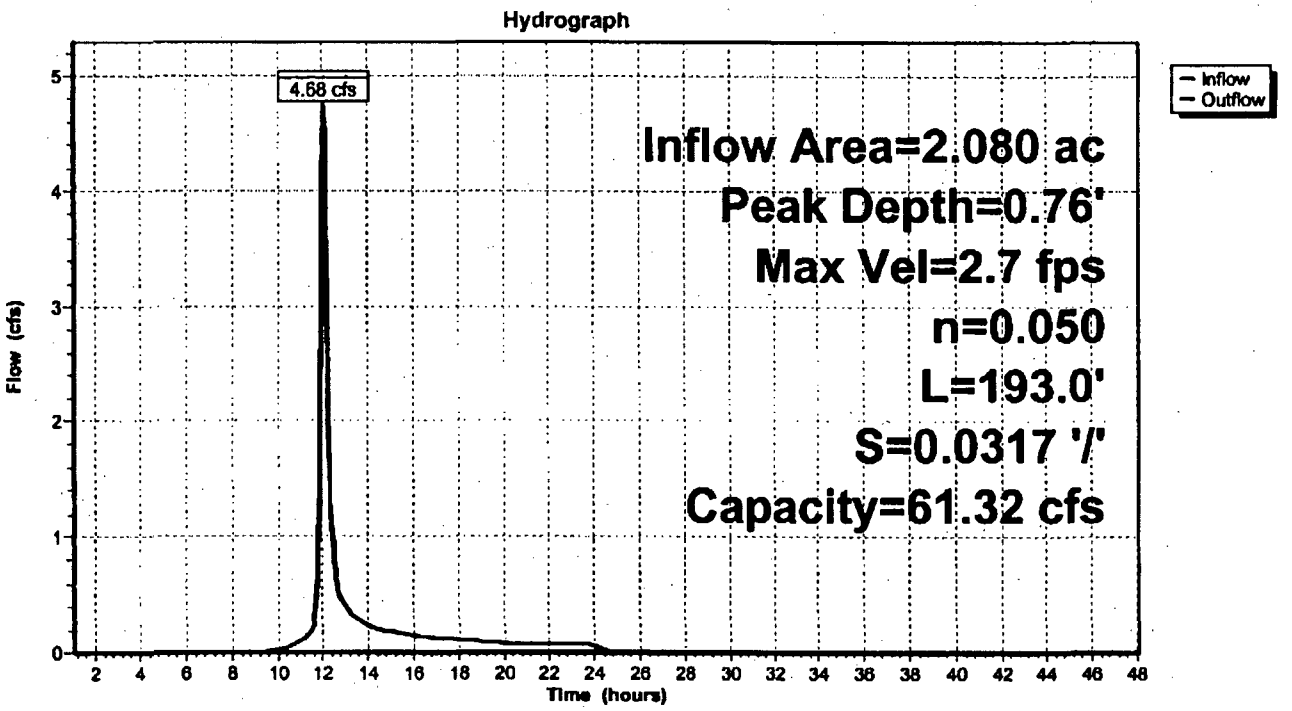
## Reach 7R: Reach #2

Inflow Area = 2.080 ac, Inflow Depth = 1.72" for 10 Year Storm event
Inflow = 4.74 cfs @ 12.05 hrs, Volume= 0.297 af
Outflow = 4.68 cfs @ 12.07 hrs, Volume= 0.297 af, Atten= 1%, Lag= 0.9 min

Routing by Dyn-Stor-Ind method, Time Span= 1.00-48.00 hrs, dt= 0.05 hrs
Max. Velocity= 2.7 fps, Min. Travel Time= 1.2 min
Avg. Velocity = 1.0 fps, Avg. Travel Time= 3.3 min

Peak Depth= 0.76' @ 12.07 hrs
Capacity at bank full= 61.32 cfs
Inlet Invert= 1,381.50', Outlet Invert= 1,375.38'
0.00' x 2.00' deep channel, n= 0.050
Side Slope Z-value= 3.0 '/' Top Width= 12.00'
Length= 193.0' Slope= 0.0317 '/'

## Reach 7R: Reach #2



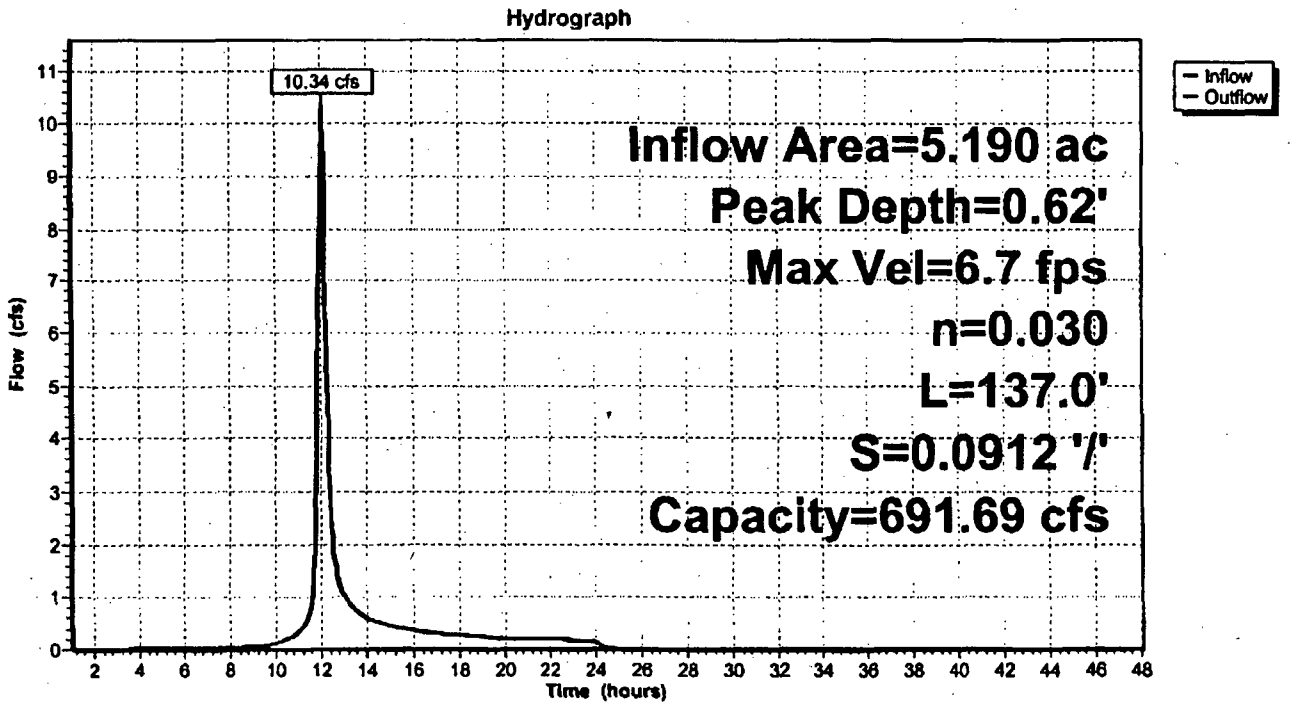
## Reach 8R: Reach #3

Inflow Area = 5.190 ac, Inflow Depth = 1.89" for 10 Year Storm event
Inflow = 10.34 cfs @ 12.08 hrs, Volume= 0.819 af
Outflow = 10.34 cfs @ 12.08 hrs, Volume= 0.819 af, Atten= 0%, Lag= 0.3 min

Routing by Dyn-Stor-Ind method, Time Span= 1.00-48.00 hrs, dt= 0.05 hrs
Max. Velocity= 6.7 fps, Min. Travel Time= 0.3 min
Avg. Velocity = 2.3 fps, Avg. Travel Time= 1.0 min

Peak Depth= 0.62' @ 12.08 hrs
Capacity at bank full= 691.69 cfs
Inlet Invert= 1,366.00', Outlet Invert= 1,353.50'
0.00' x 3.00' deep channel, n= 0.030
Side Slope Z-value= 4.0 '/' Top Width= 24.00'
Length= 137.0' Slope= 0.0912 '/'

## Reach 8R: Reach #3



## Pond 9P: 12"

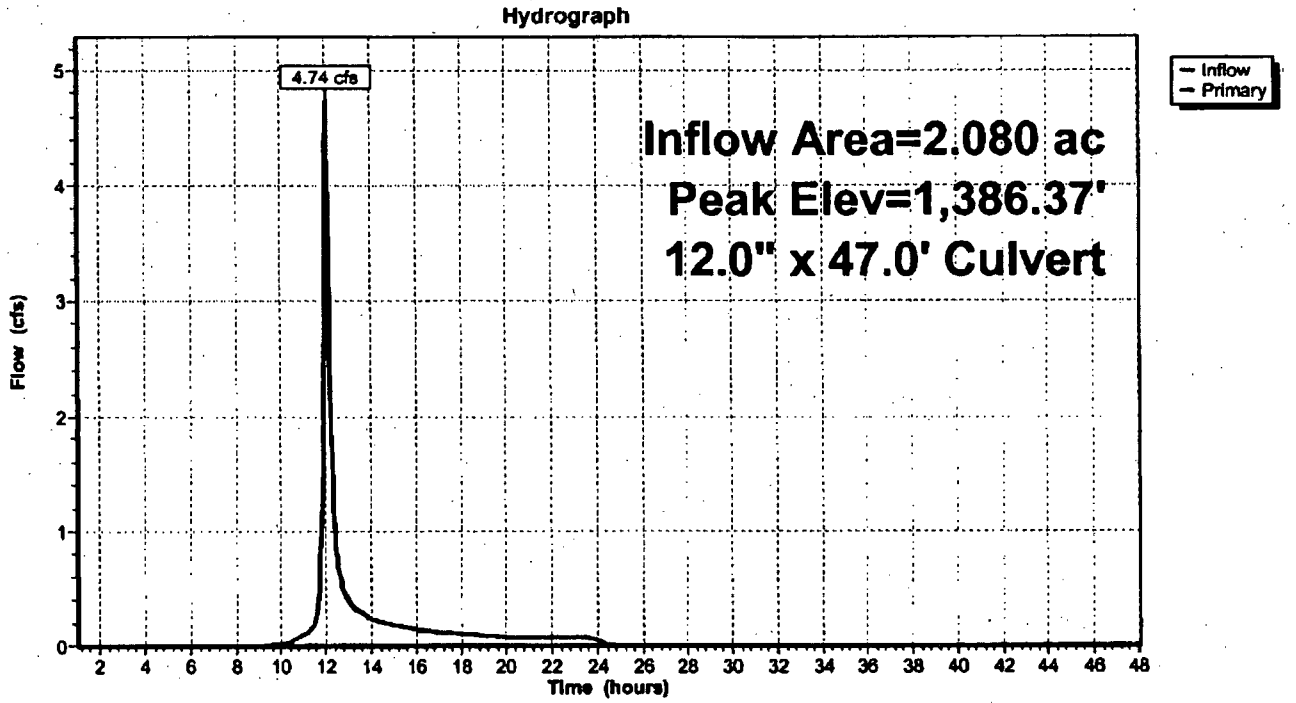
| | | | | | |
|---|---|---|---|---|---|
| Inflow Area = | 2.080 ac, | Inflow Depth = | 1.72" | for | 10 Year Storm event |
| Inflow = | 4.73 cfs @ | 12.05 hrs, | Volume= | 0.297 af | |
| Outflow = | 4.74 cfs @ | 12.05 hrs, | Volume= | 0.297 af, | Atten= 0%, Lag= 0.0 min |
| Primary = | 4.74 cfs @ | 12.05 hrs, | Volume= | 0.297 af | |

Routing by Dyn-Stor-Ind method, Time Span= 1.00-48.00 hrs, dt= 0.05 hrs
Peak Elev= 1,386.37' @ 12.06 hrs
Plug-Flow detention time= 0.3 min calculated for 0.297 af (100% of inflow)
Center-of-Mass det. time= 0.0 min ( 841.5 - 841.5 )

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 1,379.50' | **12.0" x 47.0' long Culvert** CMP, projecting, no headwall, Ke= 0.900<br>Outlet Invert= 1,379.00' S= 0.0106 '/' Cc= 0.900<br>n= 0.025 Corrugated metal |

**Primary OutFlow** Max=4.68 cfs @ 12.05 hrs HW=1,386.31' TW=1,382.26' (Dynamic Tailwater)
└─**1=Culvert** (Outlet Controls 4.68 cfs @ 6.0 fps)

## Pond 9P: 12"



## Pond 10P: 24"

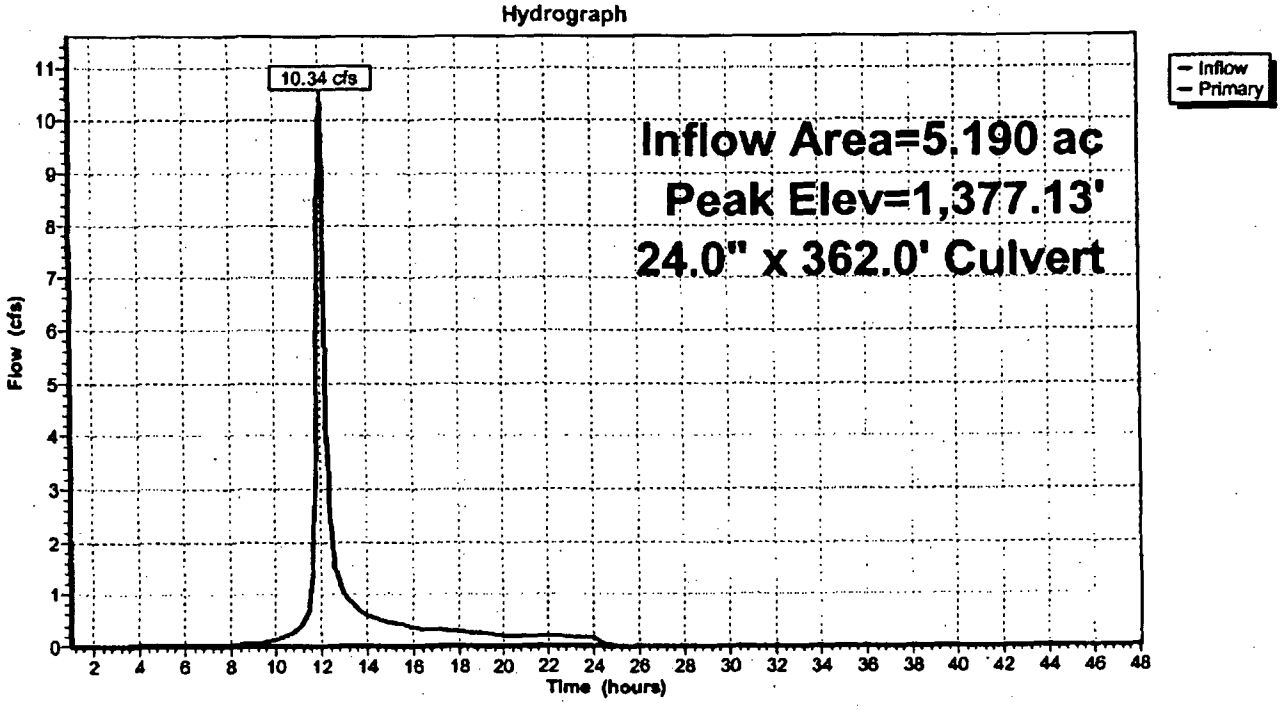
| | | | | | |
|---|---|---|---|---|---|
| Inflow Area = | 5.190 ac, | Inflow Depth = | 1.89" | for | 10 Year Storm event |
| Inflow = | 10.34 cfs @ | 12.08 hrs, | Volume= | 0.819 af | |
| Outflow = | 10.34 cfs @ | 12.08 hrs, | Volume= | 0.819 af, | Atten= 0%, Lag= 0.0 min |
| Primary = | 10.34 cfs @ | 12.08 hrs, | Volume= | 0.819 af | |

Routing by Dyn-Stor-Ind method, Time Span= 1.00-48.00 hrs, dt= 0.05 hrs
Peak Elev= 1,377.13' @ 12.08 hrs
Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 0.0 min ( 824.9 - 824.9 )

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 1,375.38' | **24.0" x 362.0' long Culvert** CPP, projecting, no headwall, Ke= 0.900<br>Outlet Invert= 1,366.00' S= 0.0259 '/' Cc= 0.900<br>n= 0.013 Corrugated PE, smooth interior |

**Primary OutFlow** Max=10.17 cfs @ 12.08 hrs HW=1,377.10' TW=1,366.62' (Dynamic Tailwater)
└**1=Culvert** (Inlet Controls 10.17 cfs @ 3.5 fps)

## Pond 10P: 24"



## Pond 11P: 12"

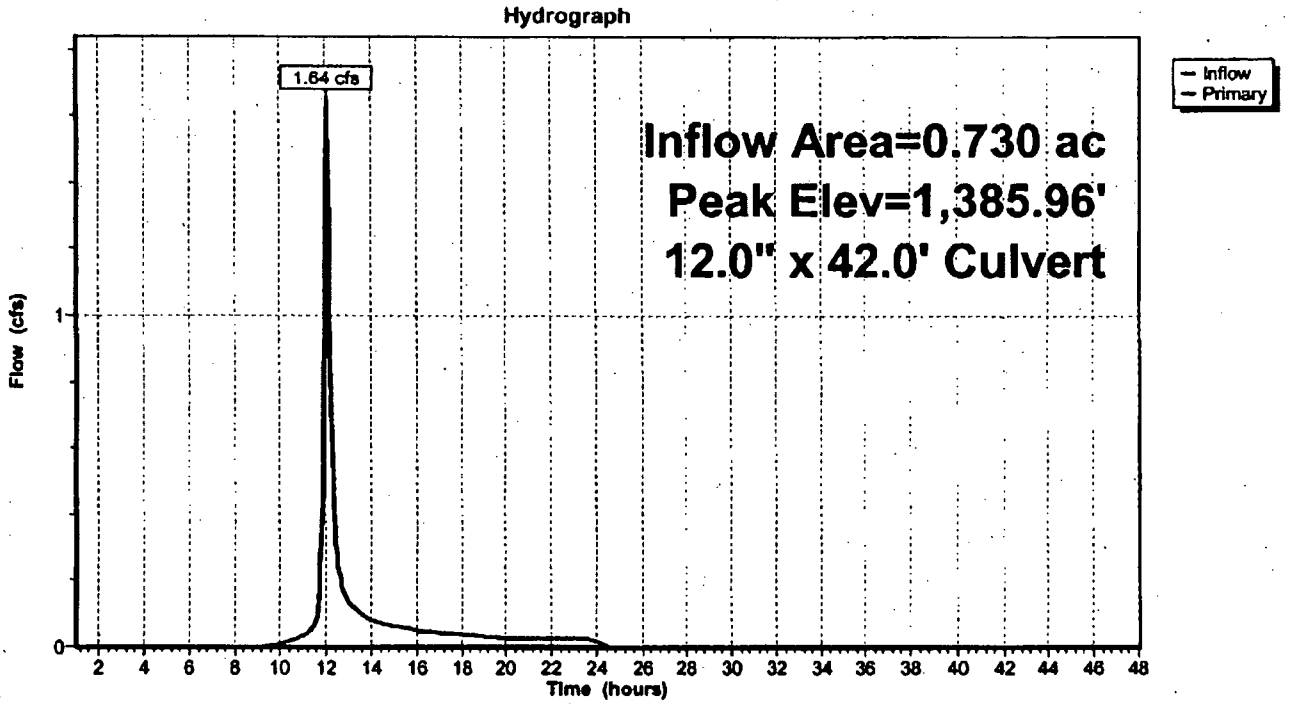
| | | | | | |
|---|---|---|---|---|---|
| Inflow Area = | 0.730 ac, | Inflow Depth = | 1.72" | for | 10 Year Storm event |
| Inflow = | 1.64 cfs @ | 12.07 hrs, | Volume= | 0.104 af | |
| Outflow = | 1.64 cfs @ | 12.07 hrs, | Volume= | 0.104 af, | Atten= 0%, Lag= 0.0 min |
| Primary = | 1.64 cfs @ | 12.07 hrs, | Volume= | 0.104 af | |

Routing by Dyn-Stor-Ind method, Time Span= 1.00-48.00 hrs, dt= 0.05 hrs
Peak Elev= 1,385.96' @ 12.07 hrs
Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 0.0 min ( 841.3 - 841.3 )

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 1,385.00' | **12.0" x 42.0' long Culvert** CMP, projecting, no headwall, Ke= 0.900<br>Outlet Invert= 1,384.58' S= 0.0100 '/' Cc= 0.900<br>n= 0.025 Corrugated metal |

**Primary OutFlow** Max=1.61 cfs @ 12.07 hrs HW=1,385.95' TW=1,385.13' (Dynamic Tailwater)
└─**1=Culvert** (Barrel Controls 1.61 cfs @ 2.7 fps)

## Pond 11P: 12"



## Pond 12P: 18"

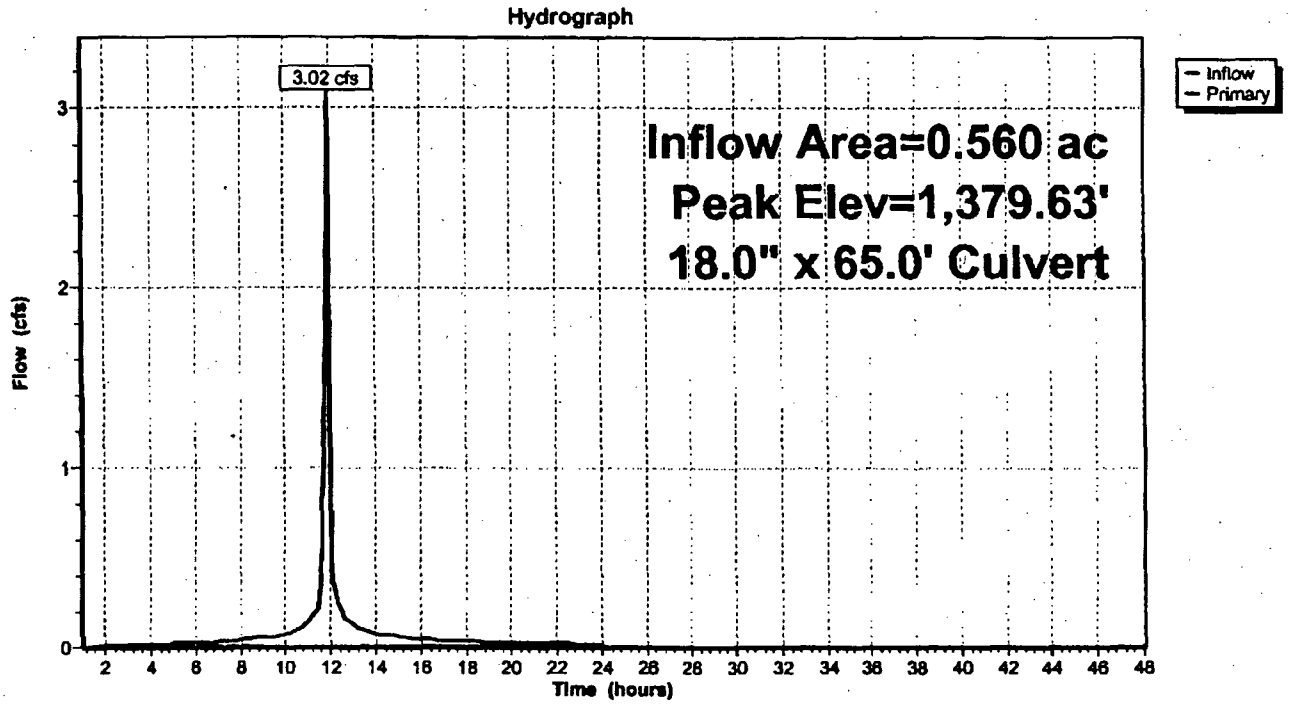
| | | | | | |
|---|---|---|---|---|---|
| Inflow Area = | 0.560 ac, | Inflow Depth = | 3.37" | for | 10 Year Storm event |
| Inflow = | 3.02 cfs @ | 11.91 hrs, | Volume= | 0.157 af | |
| Outflow = | 3.02 cfs @ | 11.91 hrs, | Volume= | 0.157 af, | Atten= 0%, Lag= 0.0 min |
| Primary = | 3.02 cfs @ | 11.91 hrs, | Volume= | 0.157 af | |

Routing by Dyn-Stor-Ind method, Time Span= 1.00-48.00 hrs, dt= 0.05 hrs
Peak Elev= 1,379.63' @ 11.91 hrs
Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 0.0 min ( 746.3 - 746.3 )

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 1,378.50' | **18.0" x 65.0' long Culvert** CMP, projecting, no headwall, Ke= 0.900<br>Outlet Invert= 1,378.00' S= 0.0077 '/' Cc= 0.900<br>n= 0.025 Corrugated metal |

**Primary OutFlow** Max=2.94 cfs @ 11.91 hrs HW=1,379.61' TW=1,376.76' (Dynamic Tailwater)
└─**1=Culvert** (Barrel Controls 2.94 cfs @ 2.9 fps)

## Pond 12P: 18"



Time span=1.00-48.00 hrs, dt=0.05 hrs, 941 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

**Subcatchment 1S: Subarea 5** Runoff Area=3.330 ac Runoff Depth=2.21"
Flow Length=866' Tc=10.9 min CN=80 Runoff=10.80 cfs 0.613 af

**Subcatchment 2S: Subarea 6** Runoff Area=1.030 ac Runoff Depth=2.21"
Flow Length=657' Tc=9.7 min CN=80 Runoff=3.48 cfs 0.190 af

**Subcatchment 3S: Subarea #3** Runoff Area=2.550 ac Runoff Depth=2.21"
Flow Length=718' Tc=16.7 min CN=80 Runoff=6.87 cfs 0.469 af

**Subcatchment 4S: Subarea #1** Runoff Area=0.730 ac Runoff Depth=2.21"
Flow Length=308' Tc=14.3 min CN=80 Runoff=2.12 cfs 0.134 af

**Subcatchment 5S: Subarea #2** Runoff Area=1.350 ac Runoff Depth=2.21"
Flow Length=394' Tc=11.8 min CN=80 Runoff=4.26 cfs 0.248 af

**Subcatchment 11S: Subarea #4** Runoff Area=0.560 ac Runoff Depth>3.96"
Flow Length=200' Tc=2.0 min CN=98 Runoff=3.54 cfs 0.185 af

**Reach 2R: Erdman Brook** Peak Depth=0.77' Max Vel=11.4 fps Inflow=26.88 cfs 1.839 af
n=0.030 L=5.0' S=0.2000 '/' Capacity=1,024.08 cfs Outflow=26.88 cfs 1.839 af

**Reach 6R: Reach #1** Peak Depth=0.62' Max Vel=1.8 fps Inflow=2.12 cfs 0.134 af
n=0.050 L=275.0' S=0.0185 '/' Capacity=21.73 cfs Outflow=2.04 cfs 0.134 af

**Reach 7R: Reach #2** Peak Depth=0.84' Max Vel=2.9 fps Inflow=6.12 cfs 0.383 af
n=0.050 L=193.0' S=0.0317 '/' Capacity=61.32 cfs Outflow=6.06 cfs 0.383 af

**Reach 8R: Reach #3** Peak Depth=0.68' Max Vel=7.1 fps Inflow=13.30 cfs 1.037 af
n=0.030 L=137.0' S=0.0912 '/' Capacity=691.69 cfs Outflow=13.30 cfs 1.037 af

**Pond 9P: 12"** Peak Elev=1,389.24' Inflow=6.12 cfs 0.383 af
12.0" x 47.0' Culvert Outflow=6.12 cfs 0.383 af

**Pond 10P: 24"** Peak Elev=1,377.62' Inflow=13.30 cfs 1.037 af
24.0" x 362.0' Culvert Outflow=13.30 cfs 1.037 af

**Pond 11P: 12"** Peak Elev=1,386.20' Inflow=2.12 cfs 0.134 af
12.0" x 42.0' Culvert Outflow=2.12 cfs 0.134 af

**Pond 12P: 18"** Peak Elev=1,379.75' Inflow=3.54 cfs 0.185 af
18.0" x 65.0' Culvert Outflow=3.54 cfs 0.185 af

**Total Runoff Area = 9.550 ac Runoff Volume = 1.839 af Average Runoff Depth = 2.31"**

## Subcatchment 1S: Subarea 5

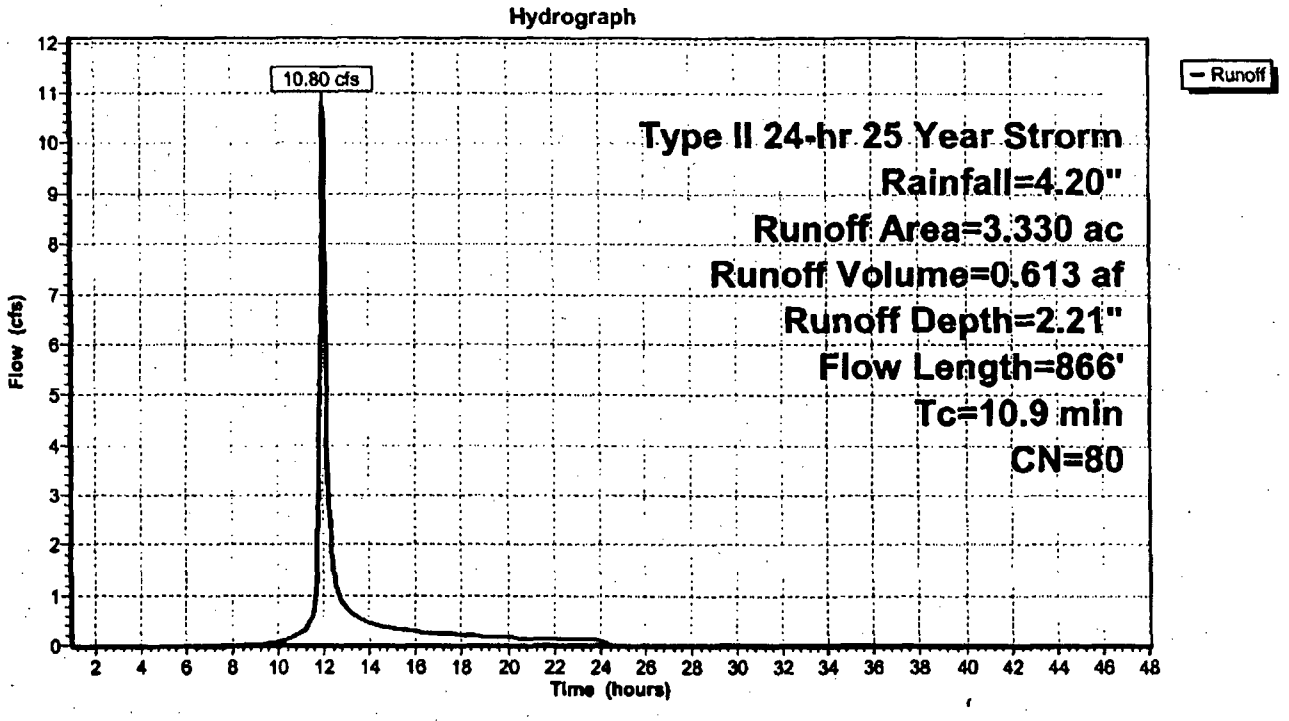
Runoff = 10.80 cfs @ 12.03 hrs, Volume= 0.613 af, Depth= 2.21"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 25 Year Strorm Rainfall=4.20"

| Area (ac) | CN | Description |
|---|---|---|
| 3.330 | 80 | North and west side of existing landfill |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 4.2 | 44 | 0.0450 | 0.2 | | **Sheet Flow, A to B**<br>Grass: Short n= 0.150 P2= 2.50" |
| 4.4 | 119 | 0.0042 | 0.5 | | **Shallow Concentrated Flow, B to C**<br>Short Grass Pasture Kv= 7.0 fps |
| 1.9 | 428 | 0.0260 | 3.8 | 25.44 | **Channel Flow, C to D**<br>Area= 6.7 sf Perim= 9.5' r= 0.71' n= 0.050 |
| 0.2 | 71 | 0.0420 | 4.8 | 3.80 | **Circular Channel (pipe), D to E**<br>Diam= 12.0" Area= 0.8 sf Perim= 3.1' r= 0.25'<br>n= 0.025 Corrugated metal |
| 0.2 | 204 | 0.1050 | 20.6 | 742.79 | **Channel Flow, E to F**<br>Area= 36.0 sf Perim= 24.7' r= 1.46' n= 0.030 |
| 10.9 | 866 | Total | | | |

## Subcatchment 1S: Subarea 5



## Subcatchment 2S: Subarea 6

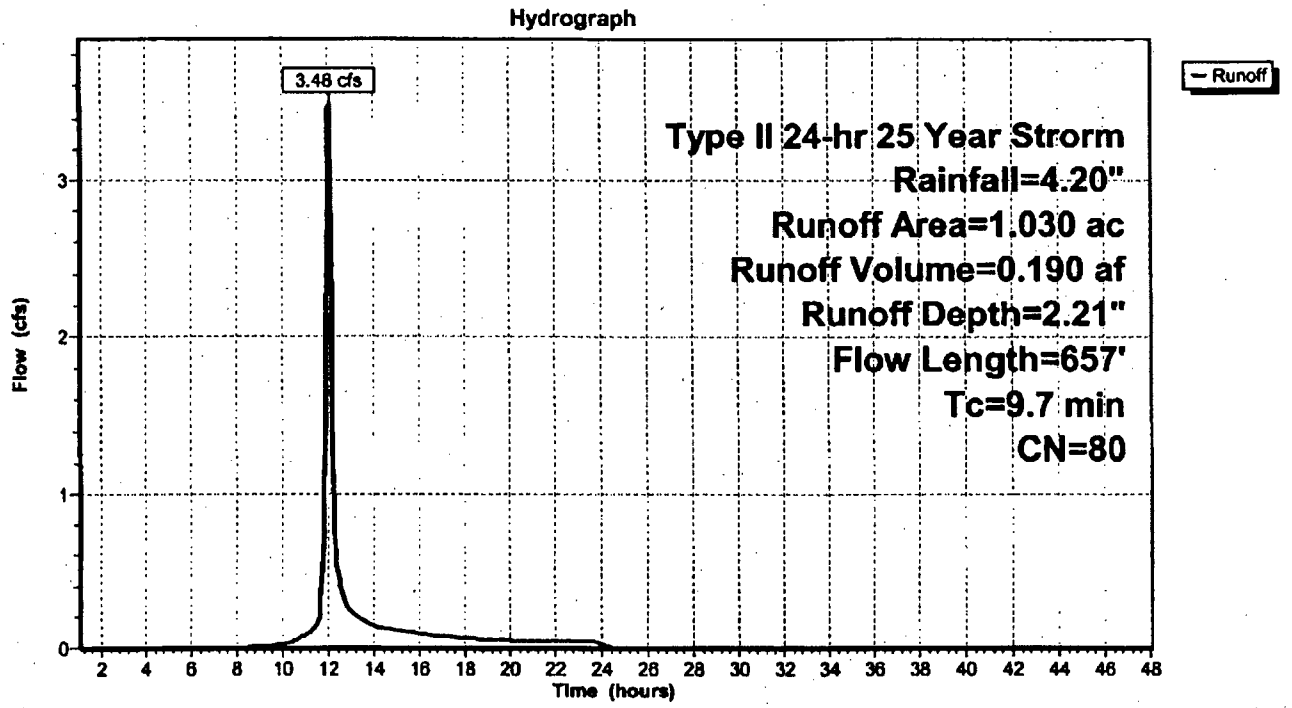
Runoff = 3.48 cfs @ 12.01 hrs, Volume= 0.190 af, Depth= 2.21"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 25 Year Stroom Rainfall=4.20"

| Area (ac) | CN | Description |
|---|---|---|
| 1.030 | 80 | West side of exisiting landfill |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 7.7 | 100 | 0.0500 | 0.2 | | **Sheet Flow, A to B**<br>Grass: Short n= 0.150 P2= 2.50" |
| 1.6 | 160 | 0.0560 | 1.7 | | **Shallow Concentrated Flow, B to C**<br>Short Grass Pasture Kv= 7.0 fps |
| 0.4 | 397 | 0.0580 | 15.3 | 552.06 | **Channel Flow, C to D**<br>Area= 36.0 sf Perim= 24.7' r= 1.46' n= 0.030 |
| 9.7 | 657 | Total | | | |

## Subcatchment 2S: Subarea 6



## Subcatchment 3S: Subarea #3

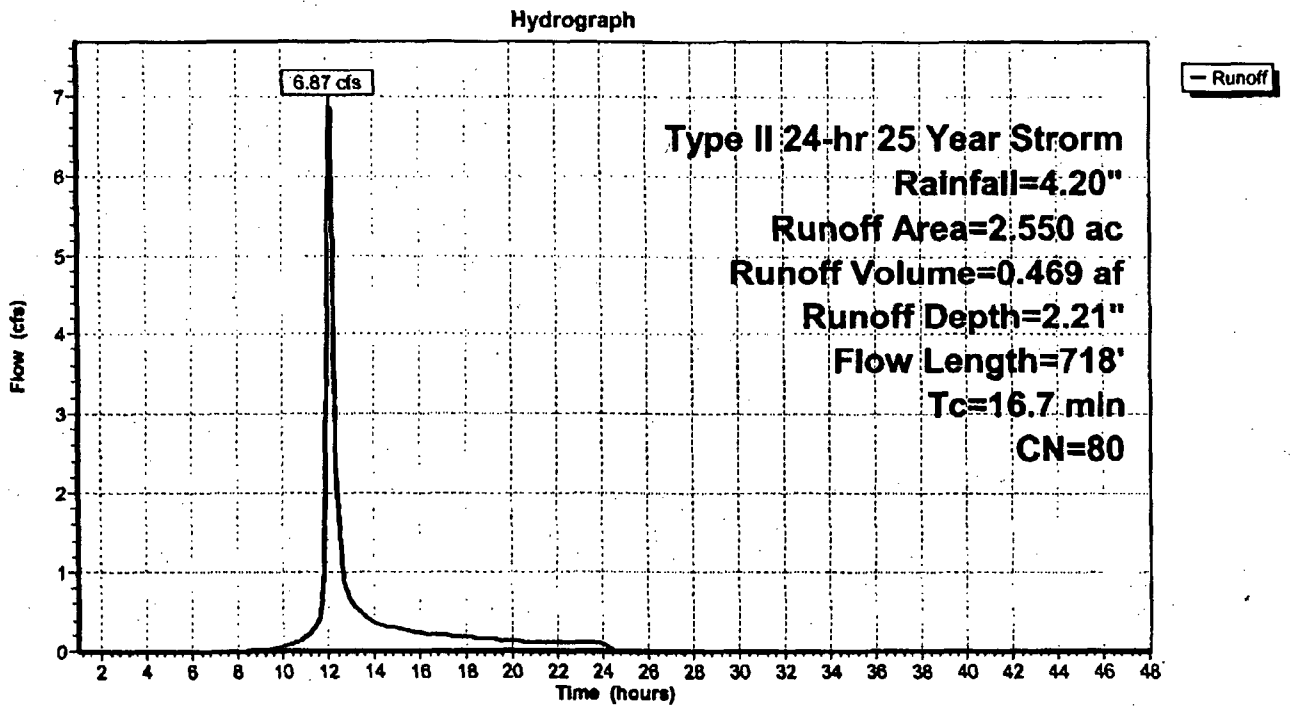
Runoff = 6.87 cfs @ 12.09 hrs, Volume= 0.469 af, Depth= 2.21"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 25 Year Strorm Rainfall=4.20"

| Area (ac) | CN | Description |
|---|---|---|
| 2.550 | 80 | Southside of existing landfill |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 12.1 | 100 | 0.0160 | 0.1 | | **Sheet Flow, A to B**<br>Grass: Short n= 0.150 P2= 2.50" |
| 2.4 | 177 | 0.0310 | 1.2 | | **Shallow Concentrated Flow, B to C**<br>Short Grass Pasture Kv= 7.0 fps |
| 0.2 | 71 | 0.0490 | 6.4 | 76.42 | **Channel Flow, C to D**<br>Area= 12.0 sf Perim= 12.6' r= 0.95' n= 0.050 |
| 1.4 | 177 | 0.0085 | 2.2 | 1.71 | **Circular Channel (pipe), D to E**<br>Diam= 12.0" Area= 0.8 sf Perim= 3.1' r= 0.25'<br>n= 0.025 Corrugated metal |
| 0.6 | 193 | 0.0320 | 5.1 | 61.76 | **Channel Flow, E to F**<br>Area= 12.0 sf Perim= 12.6' r= 0.95' n= 0.050 |
| 16.7 | 718 | Total | | | |

## Subcatchment 3S: Subarea #3



## Subcatchment 4S: Subarea #1

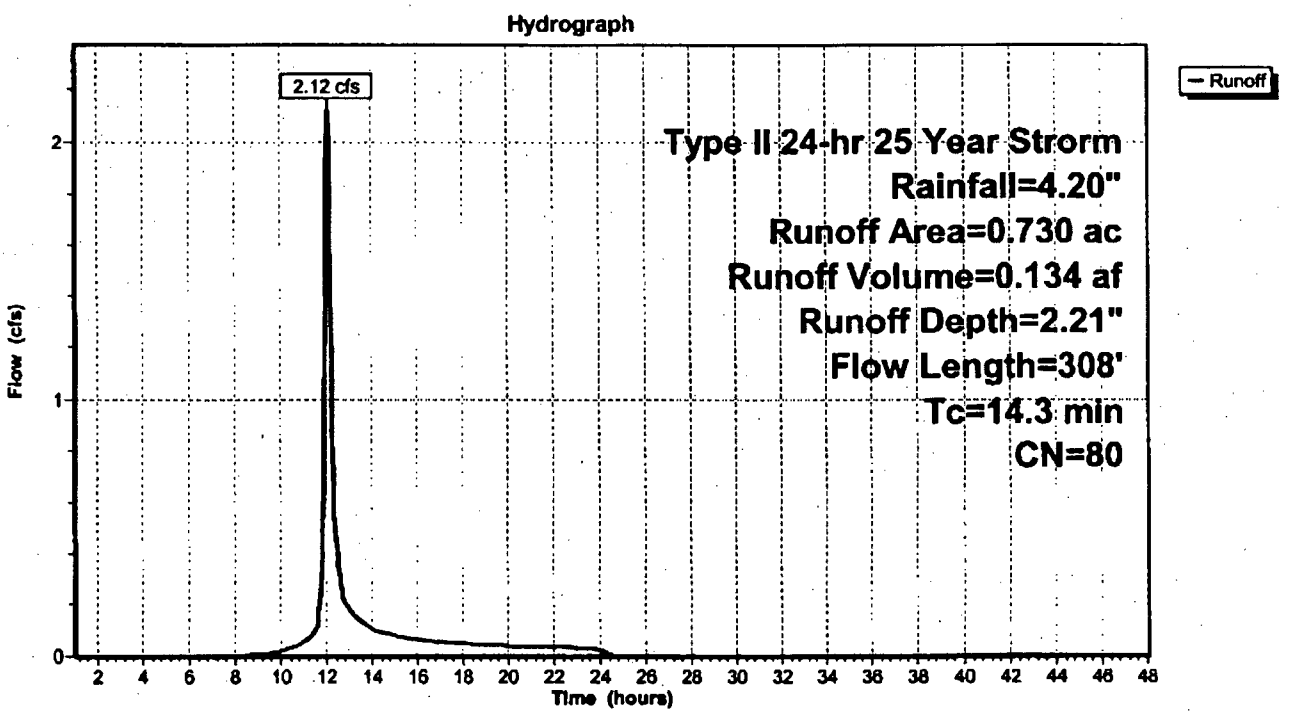
Runoff = 2.12 cfs @ 12.06 hrs, Volume= 0.134 af, Depth= 2.21"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 25 Year Strorm Rainfall=4.20"

| Area (ac) | CN | Description |
|---|---|---|
| 0.730 | 80 | Southwest corner of Existing Landfill |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 12.1 | 100 | 0.0160 | 0.1 | | **Sheet Flow, A to B**<br>Grass: Short n= 0.150 P2= 2.50" |
| 2.1 | 165 | 0.0340 | 1.3 | | **Shallow Concentrated Flow, B to C**<br>Short Grass Pasture Kv= 7.0 fps |
| 0.1 | 43 | 0.0290 | 4.9 | 58.79 | **Channel Flow, C to D**<br>Area= 12.0 sf Perim= 12.6' r= 0.95' n= 0.050 |
| 14.3 | 308 | Total | | | |

## Subcatchment 4S: Subarea #1



## Subcatchment 5S: Subarea #2

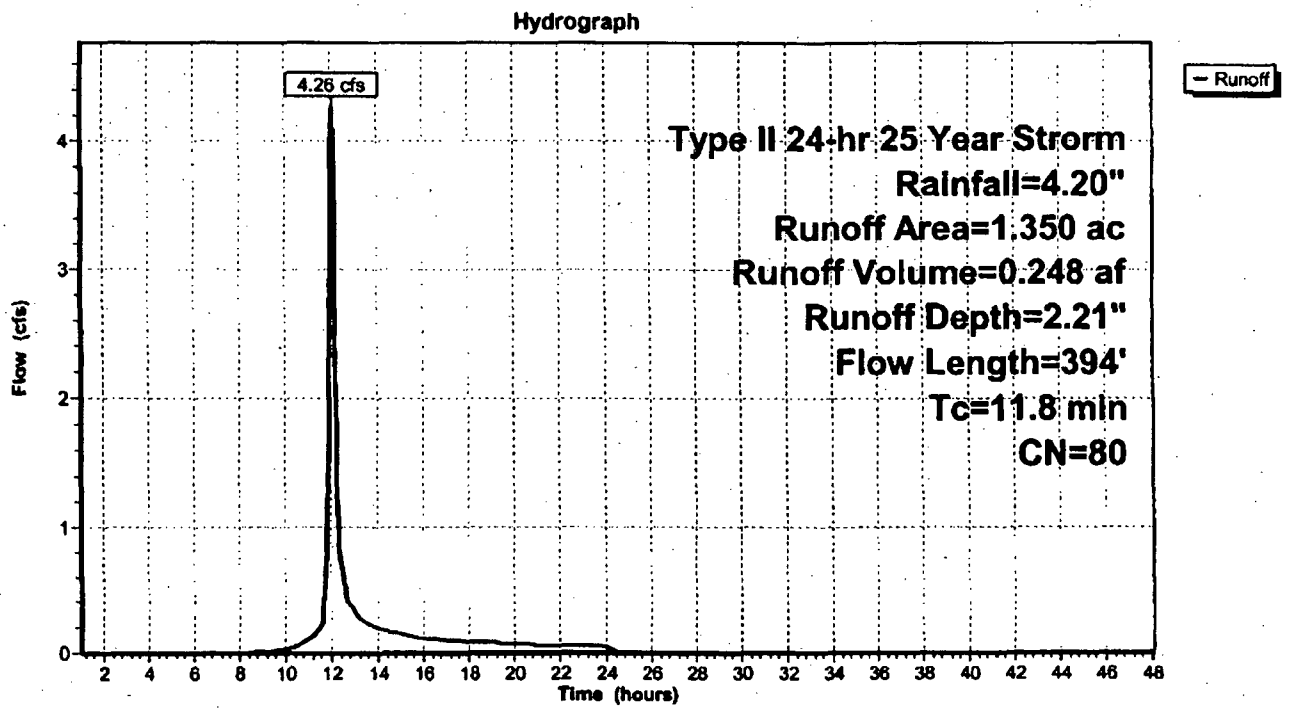
Runoff = 4.26 cfs @ 12.04 hrs, Volume= 0.248 af, Depth= 2.21"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 25 Year Strorm Rainfall=4.20"

| Area (ac) | CN | Description |
|---|---|---|
| 1.350 | 80 | Outside south area draing to 12" pipe |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 10.1 | 100 | 0.0250 | 0.2 | | **Sheet Flow, A to B**<br>Grass: Short n= 0.150 P2= 2.50" |
| 1.7 | 294 | 0.0310 | 2.8 | | **Shallow Concentrated Flow, B to C**<br>Unpaved Kv= 16.1 fps |
| 11.8 | 394 | Total | | | |

## Subcatchment 5S: Subarea #2



## Subcatchment 11S: Subarea #4

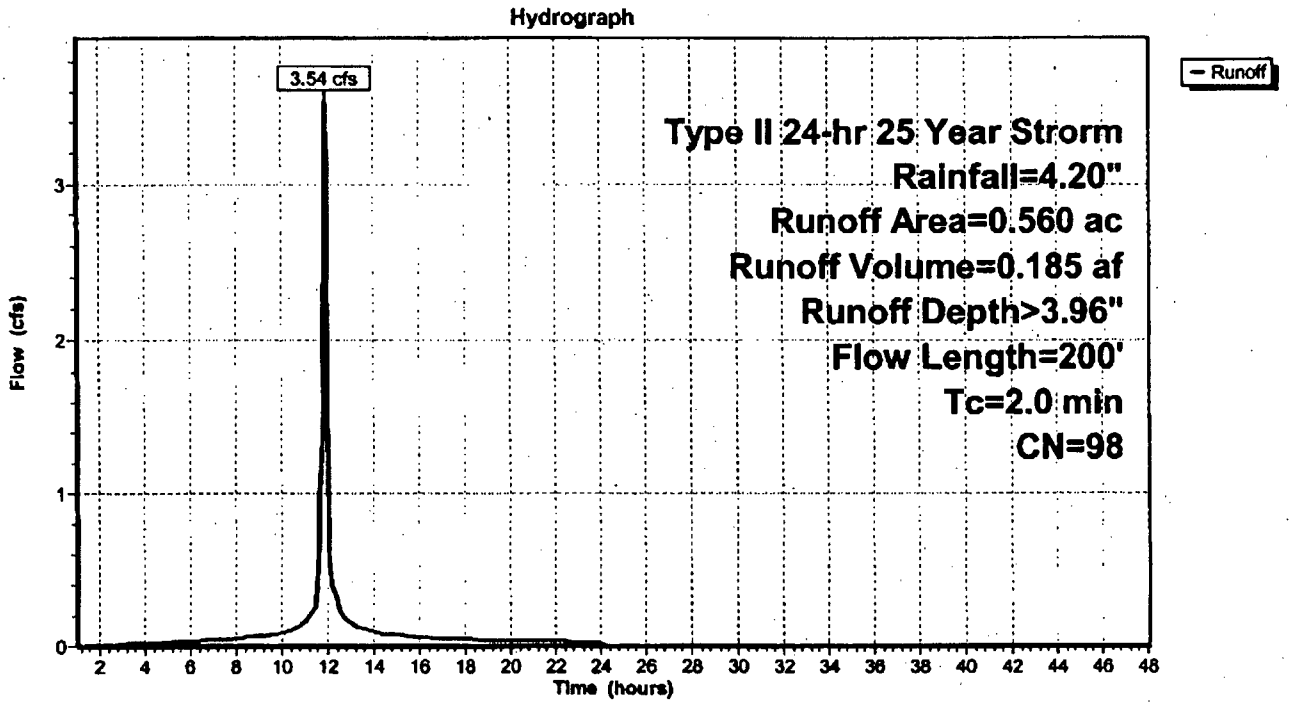
Runoff = 3.54 cfs @ 11.91 hrs, Volume= 0.185 af, Depth> 3.96"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 25 Year Strorm Rainfall=4.20"

| Area (ac) | CN | Description |
|---|---|---|
| 0.560 | 98 | From SDA |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 1.4 | 100 | 0.0200 | 1.2 | | **Sheet Flow, A to B**<br>Smooth surfaces n= 0.011 P2= 2.50" |
| 0.6 | 100 | 0.0200 | 2.9 | | **Shallow Concentrated Flow, B to C**<br>Paved Kv= 20.3 fps |
| 2.0 | 200 | Total | | | |

## Subcatchment 11S: Subarea #4



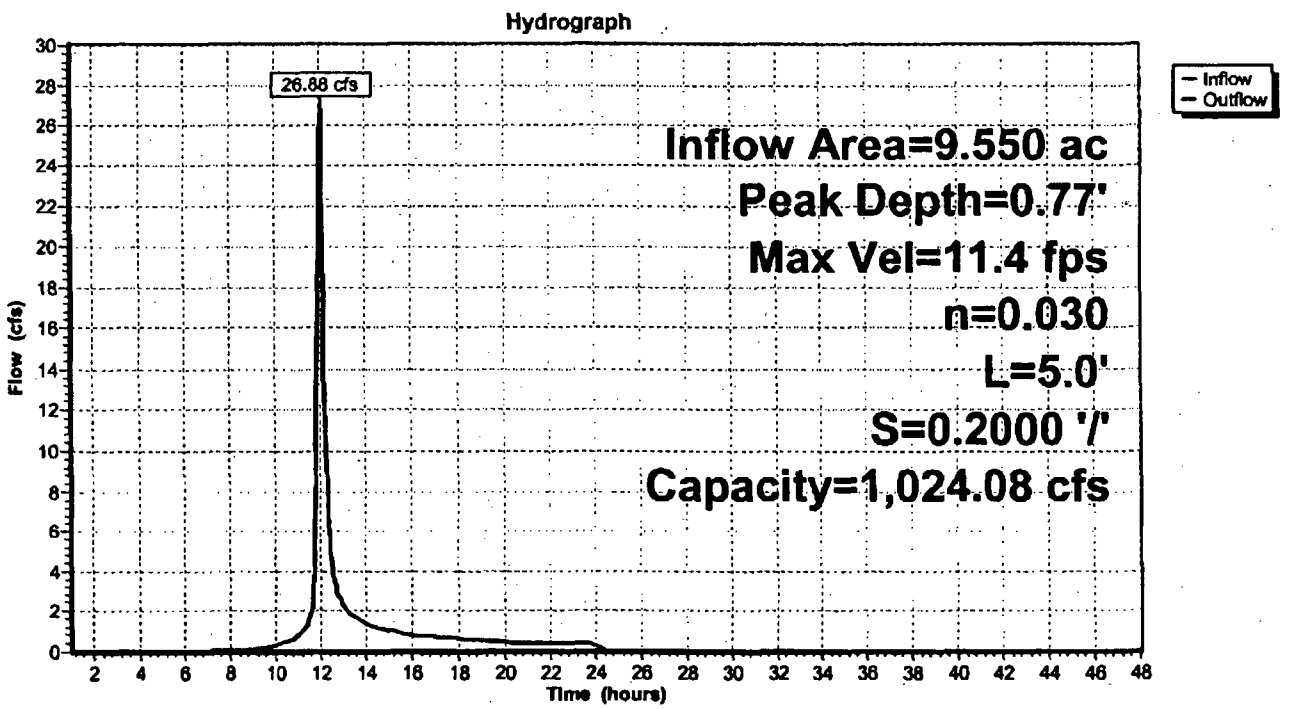
## Reach 2R: Erdman Brook

Inflow Area = 9.550 ac, Inflow Depth = 2.31" for 25 Year Strorm event
Inflow = 26.88 cfs @ 12.04 hrs, Volume= 1.839 af
Outflow = 26.88 cfs @ 12.04 hrs, Volume= 1.839 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 1.00-48.00 hrs, dt= 0.05 hrs
Max. Velocity= 11.4 fps, Min. Travel Time= 0.0 min
Avg. Velocity = 3.7 fps, Avg. Travel Time= 0.0 min

Peak Depth= 0.77' @ 12.04 hrs
Capacity at bank full= 1,024.08 cfs
Inlet Invert= 1,353.50', Outlet Invert= 1,352.50'
0.00' x 3.00' deep channel, n= 0.030
Side Slope Z-value= 4.0 '/' Top Width= 24.00'
Length= 5.0' Slope= 0.2000 '/'

## Reach 2R: Erdman Brook



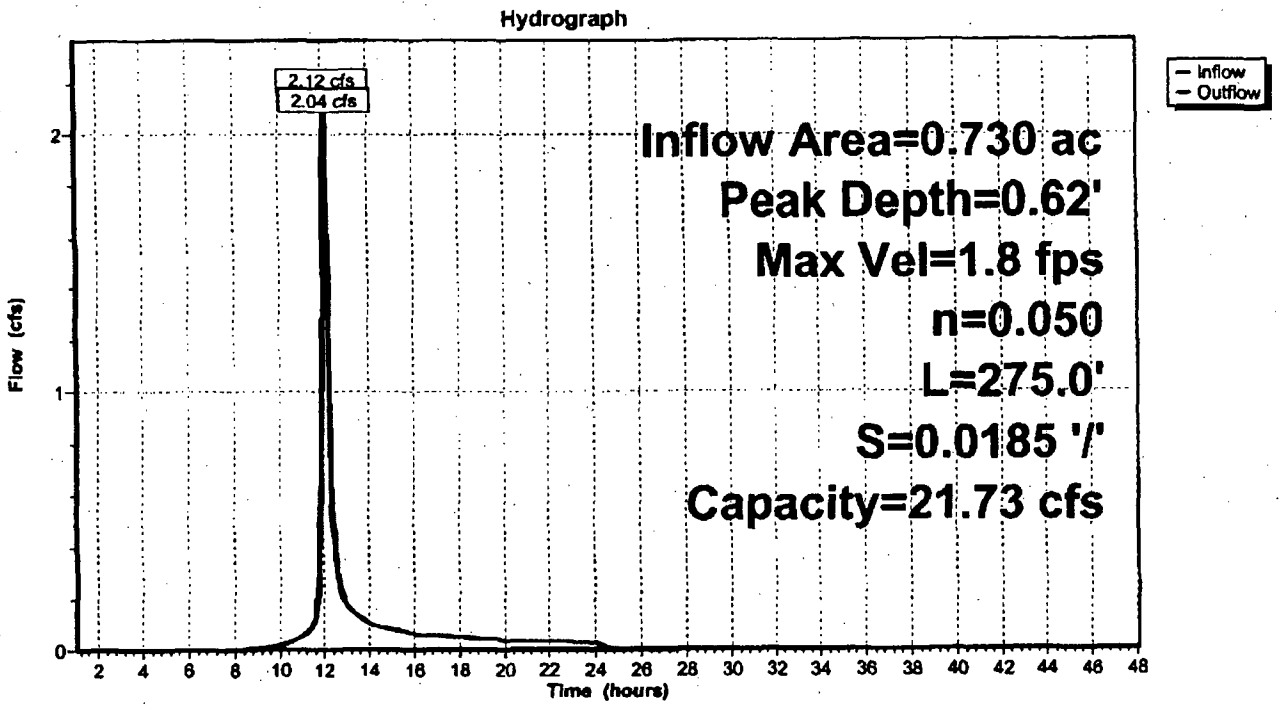
## Reach 6R: Reach #1

Inflow Area = 0.730 ac, Inflow Depth = 2.21" for 25 Year Strorm event
Inflow = 2.12 cfs @ 12.06 hrs, Volume= 0.134 af
Outflow = 2.04 cfs @ 12.10 hrs, Volume= 0.134 af, Atten= 4%, Lag= 2.0 min

Routing by Dyn-Stor-Ind method, Time Span= 1.00-48.00 hrs, dt= 0.05 hrs
Max. Velocity= 1.8 fps, Min. Travel Time= 2.6 min
Avg. Velocity = 0.7 fps, Avg. Travel Time= 7.0 min

Peak Depth= 0.62' @ 12.10 hrs
Capacity at bank full= 21.73 cfs
Inlet Invert= 1,384.58', Outlet Invert= 1,379.50'
0.00' x 1.50' deep channel, n= 0.050
Side Slope Z-value= 3.0 '/' Top Width= 9.00'
Length= 275.0' Slope= 0.0185 '/'

## Reach 6R: Reach #1



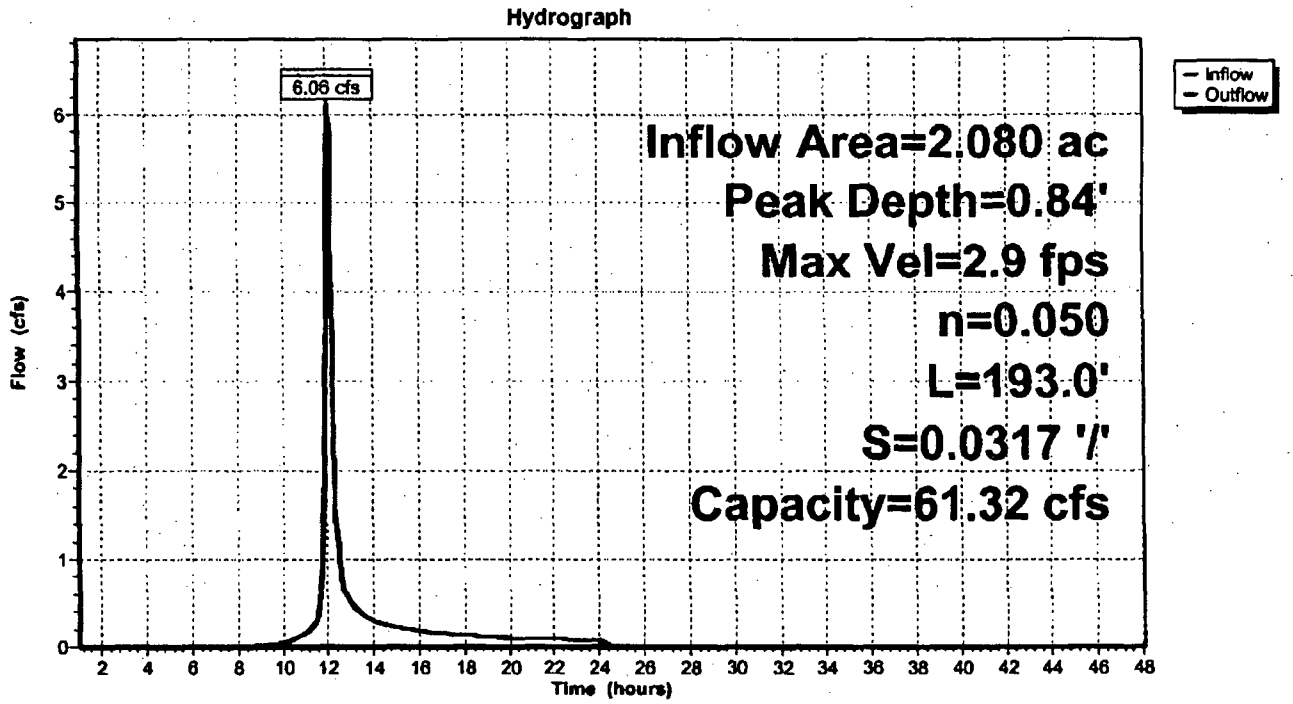
## Reach 7R: Reach #2

Inflow Area = 2.080 ac, Inflow Depth = 2.21" for 25 Year Strorm event
Inflow = 6.12 cfs @ 12.05 hrs, Volume= 0.383 af
Outflow = 6.06 cfs @ 12.07 hrs, Volume= 0.383 af, Atten= 1%, Lag= 0.9 min

Routing by Dyn-Stor-Ind method, Time Span= 1.00-48.00 hrs, dt= 0.05 hrs
Max. Velocity= 2.9 fps, Min. Travel Time= 1.1 min
Avg. Velocity = 1.0 fps, Avg. Travel Time= 3.1 min

Peak Depth= 0.84' @ 12.07 hrs
Capacity at bank full= 61.32 cfs
Inlet Invert= 1,381.50', Outlet Invert= 1,375.38'
0.00' x 2.00' deep channel, n= 0.050
Side Slope Z-value= 3.0 '/' Top Width= 12.00'
Length= 193.0' Slope= 0.0317 '/'

## Reach 7R: Reach #2



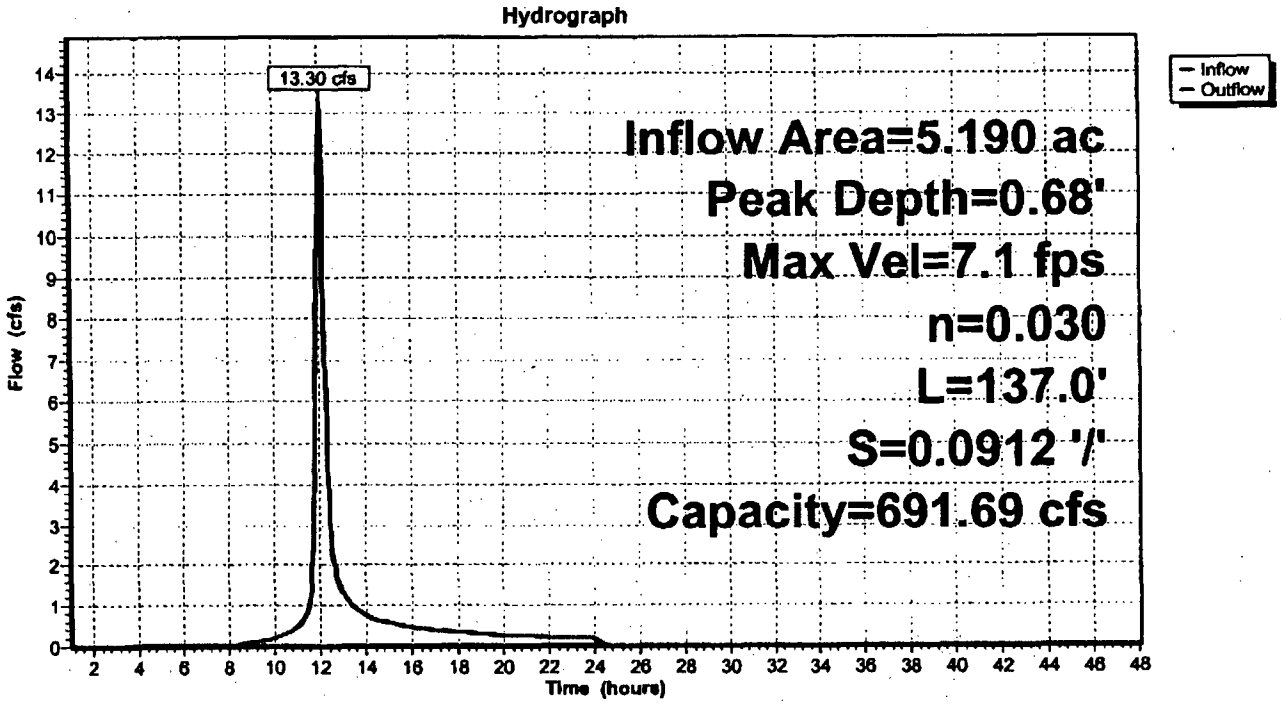
## Reach 8R: Reach #3

Inflow Area = 5.190 ac, Inflow Depth > 2.40" for 25 Year Stromm event
Inflow = 13.30 cfs @ 12.08 hrs, Volume= 1.037 af
Outflow = 13.30 cfs @ 12.08 hrs, Volume= 1.037 af, Atten= 0%, Lag= 0.3 min

Routing by Dyn-Stor-Ind method, Time Span= 1.00-48.00 hrs, dt= 0.05 hrs
Max. Velocity= 7.1 fps, Min. Travel Time= 0.3 min
Avg. Velocity = 2.5 fps, Avg. Travel Time= 0.9 min

Peak Depth= 0.68' @ 12.08 hrs
Capacity at bank full= 691.69 cfs
Inlet Invert= 1,366.00', Outlet Invert= 1,353.50'
0.00' x 3.00' deep channel, n= 0.030
Side Slope Z-value= 4.0 '/' Top Width= 24.00'
Length= 137.0' Slope= 0.0912 '/'

## Reach 8R: Reach #3



## Pond 9P: 12"

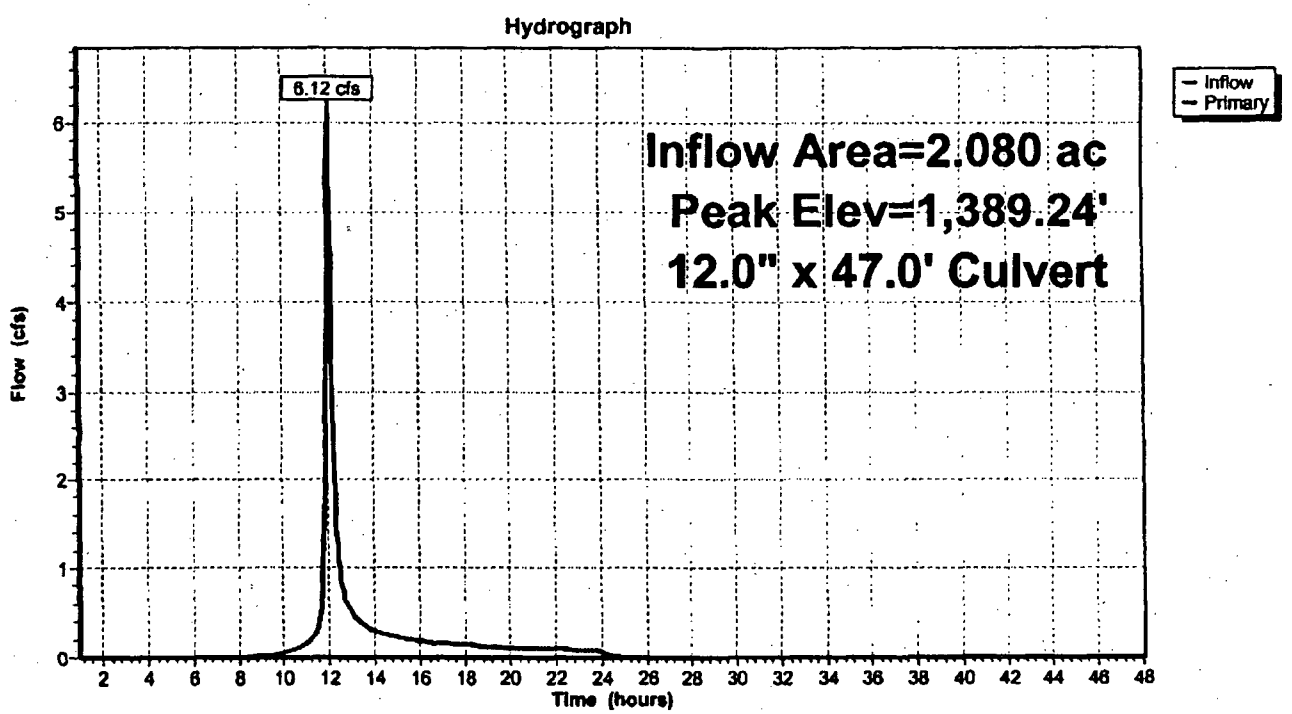
| | | | | | |
|---|---|---|---|---|---|
| Inflow Area = | 2.080 ac, | Inflow Depth = | 2.21" | for | 25 Year Strorm event |
| Inflow = | 6.12 cfs @ | 12.05 hrs, | Volume= | 0.383 af | |
| Outflow = | 6.12 cfs @ | 12.05 hrs, | Volume= | 0.383 af, | Atten= 0%, Lag= 0.0 min |
| Primary = | 6.12 cfs @ | 12.05 hrs, | Volume= | 0.383 af | |

Routing by Dyn-Stor-Ind method, Time Span= 1.00-48.00 hrs, dt= 0.05 hrs
Peak Elev= 1,389.24' @ 12.05 hrs
Plug-Flow detention time= 0.0 min calculated for 0.382 af (100% of inflow)
Center-of-Mass det. time= 0.0 min ( 834.2 - 834.2 )

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 1,379.50' | **12.0" x 47.0' long Culvert** CMP, projecting, no headwall, Ke= 0.900<br>Outlet Invert= 1,379.00' S= 0.0106 '/' Cc= 0.900<br>n= 0.025 Corrugated metal |

**Primary OutFlow** Max=6.08 cfs @ 12.05 hrs HW=1,389.18' TW=1,382.34' (Dynamic Tailwater)
└─**1=Culvert** (Outlet Controls 6.08 cfs @ 7.7 fps)

## Pond 9P: 12"



## Pond 10P: 24"

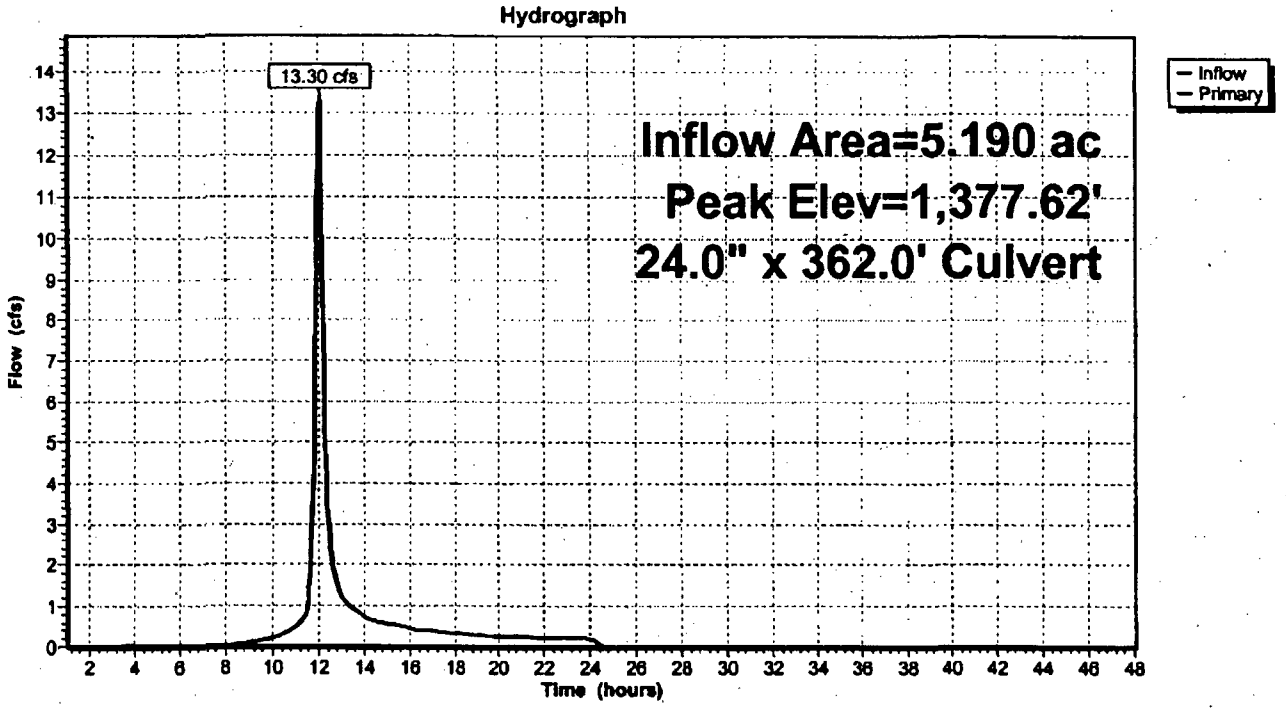
| | | | | | |
|---|---|---|---|---|---|
| Inflow Area = | 5.190 ac, | Inflow Depth > | 2.40" | for | 25 Year Strorm event |
| Inflow = | 13.30 cfs @ | 12.08 hrs, | Volume= | 1.037 af | |
| Outflow = | 13.30 cfs @ | 12.08 hrs, | Volume= | 1.037 af, | Atten= 0%, Lag= 0.0 min |
| Primary = | 13.30 cfs @ | 12.08 hrs, | Volume= | 1.037 af | |

Routing by Dyn-Stor-Ind method, Time Span= 1.00-48.00 hrs, dt= 0.05 hrs
Peak Elev= 1,377.62' @ 12.08 hrs
Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 0.0 min ( 819.7 - 819.7 )

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 1,375.38' | **24.0" x 362.0' long Culvert** CPP, projecting, no headwall, Ke= 0.900<br>Outlet Invert= 1,366.00' S= 0.0259 '/' Cc= 0.900<br>n= 0.013 Corrugated PE, smooth interior |

**Primary OutFlow** Max=13.08 cfs @ 12.08 hrs HW=1,377.58' TW=1,366.68' (Dynamic Tailwater)
└**1=Culvert** (Inlet Controls 13.08 cfs @ 4.2 fps)

## Pond 10P: 24"



## Pond 11P: 12"

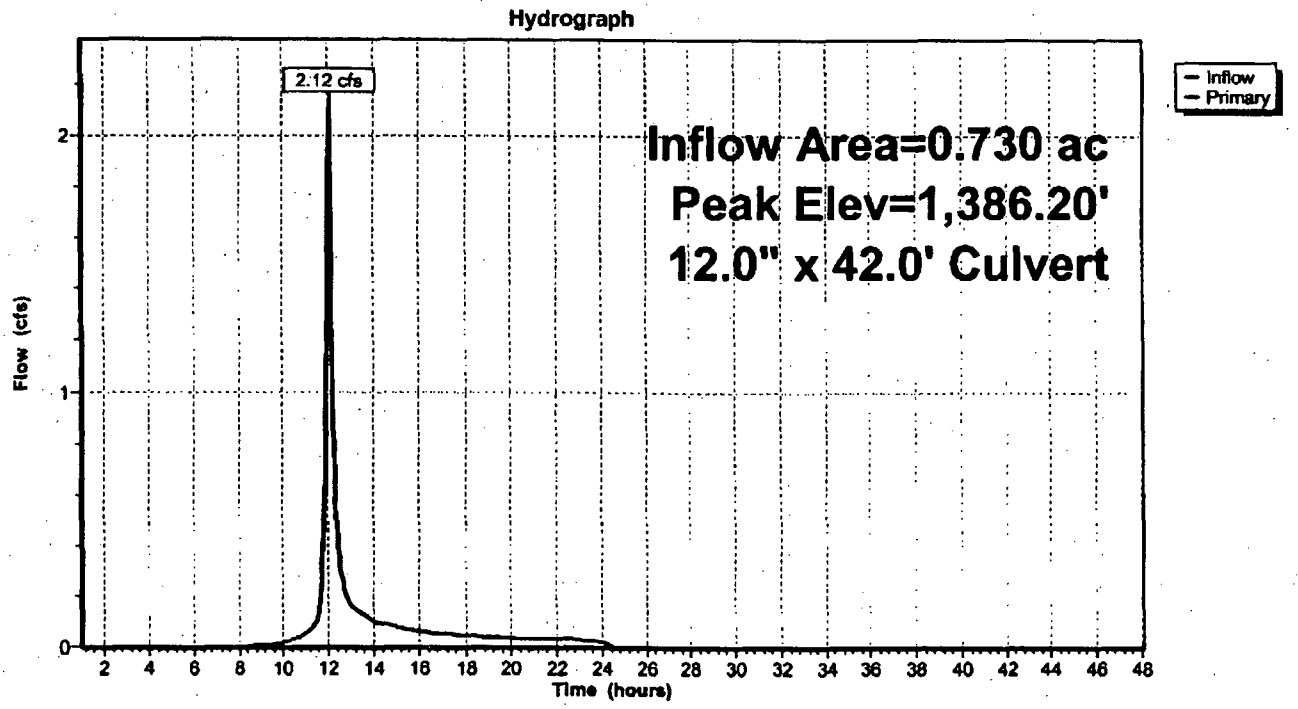
| | | | | | |
|---|---|---|---|---|---|
| Inflow Area = | 0.730 ac, | Inflow Depth = | 2.21" | for | 25 Year Strorm event |
| Inflow = | 2.12 cfs @ | 12.06 hrs, | Volume= | 0.134 af | |
| Outflow = | 2.12 cfs @ | 12.06 hrs, | Volume= | 0.134 af, | Atten= 0%, Lag= 0.0 min |
| Primary = | 2.12 cfs @ | 12.06 hrs, | Volume= | 0.134 af | |

Routing by Dyn-Stor-Ind method, Time Span= 1.00-48.00 hrs, dt= 0.05 hrs
Peak Elev= 1,386.20' @ 12.06 hrs
Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 0.0 min ( 834.1 - 834.1 )

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 1,385.00' | **12.0" x 42.0' long Culvert** CMP, projecting, no headwall, Ke= 0.900<br>Outlet Invert= 1,384.58' S= 0.0100 '/' Cc= 0.900<br>n= 0.025 Corrugated metal |

**Primary OutFlow** Max=2.08 cfs @ 12.06 hrs HW=1,386.18' TW=1,385.19' (Dynamic Tailwater)
└─**1=Culvert** (Barrel Controls 2.08 cfs @ 2.8 fps)

## Pond 11P: 12"



## Pond 12P: 18"

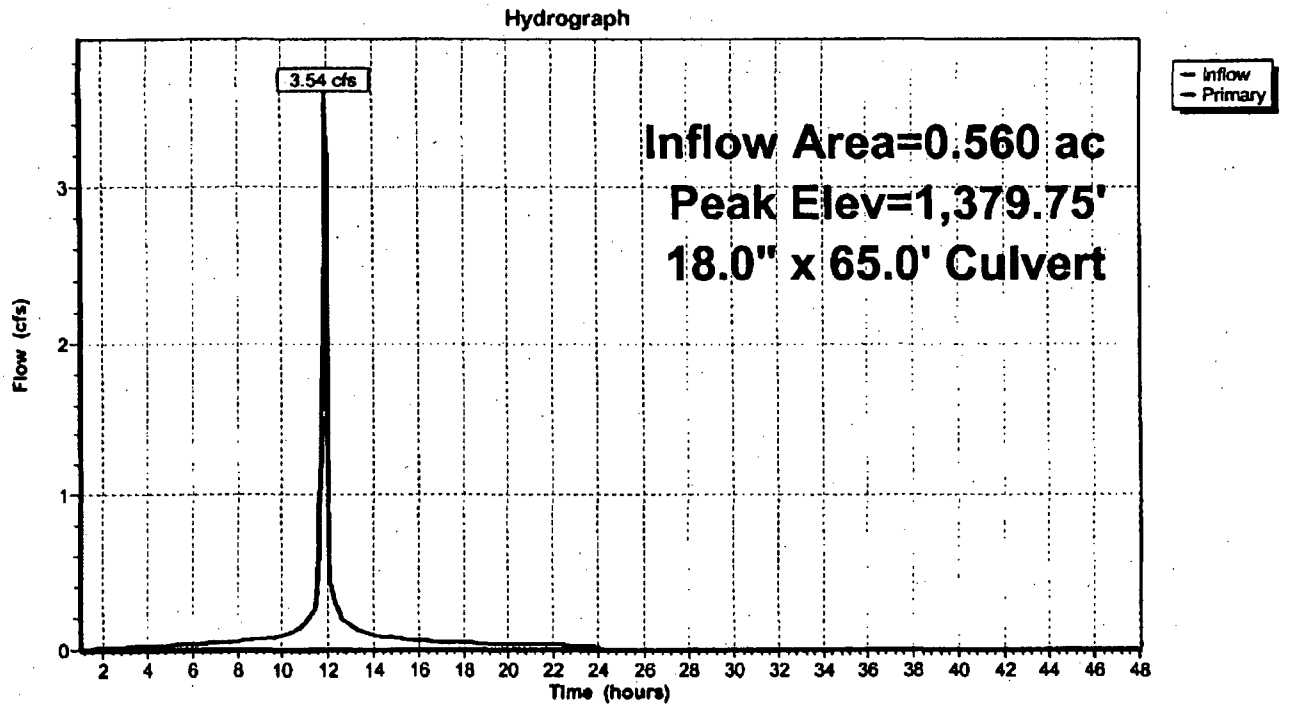
| | | | | | |
|---|---|---|---|---|---|
| Inflow Area = | 0.560 ac, | Inflow Depth > | 3.96" | for | 25 Year Strorm event |
| Inflow = | 3.54 cfs @ | 11.91 hrs, | Volume= | 0.185 af | |
| Outflow = | 3.54 cfs @ | 11.91 hrs, | Volume= | 0.185 af, | Atten= 0%, Lag= 0.0 min |
| Primary = | 3.54 cfs @ | 11.91 hrs, | Volume= | 0.185 af | |

Routing by Dyn-Stor-Ind method, Time Span= 1.00-48.00 hrs, dt= 0.05 hrs
Peak Elev= 1,379.75' @ 11.91 hrs
Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 0.0 min ( 743.3 - 743.3 )

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 1,378.50' | **18.0" x 65.0' long Culvert** CMP, projecting, no headwall, Ke= 0.900<br>Outlet Invert= 1,378.00' S= 0.0077 '/' Cc= 0.900<br>n= 0.025 Corrugated metal |

**Primary OutFlow** Max=3.44 cfs @ 11.91 hrs HW=1,379.73' TW=1,377.00' (Dynamic Tailwater)
└**1=Culvert** (Barrel Controls 3.44 cfs @ 3.0 fps)

## Pond 12P: 18"



# STORMWATER ANALYSIS
# REFERENCE INFORMATION

**Figure B-3** 2-year, 24-hr rainfall

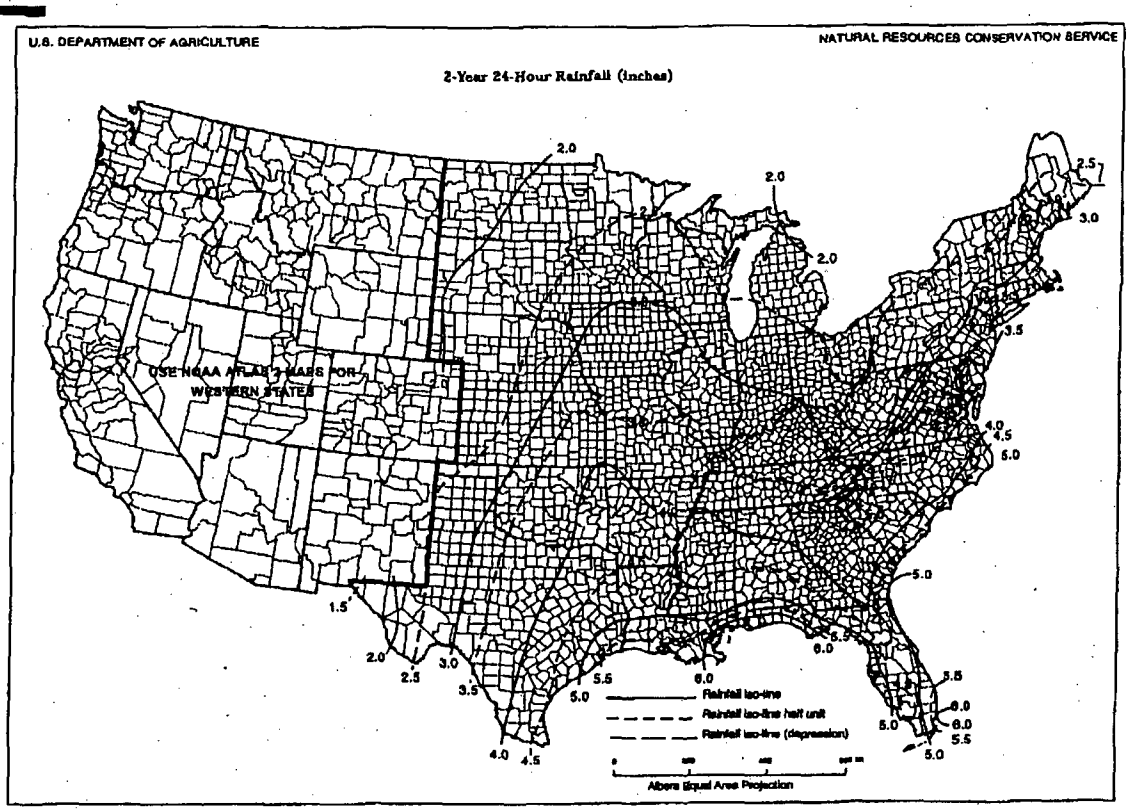



**Figure B-4** 5-year, 24-hour rainfall

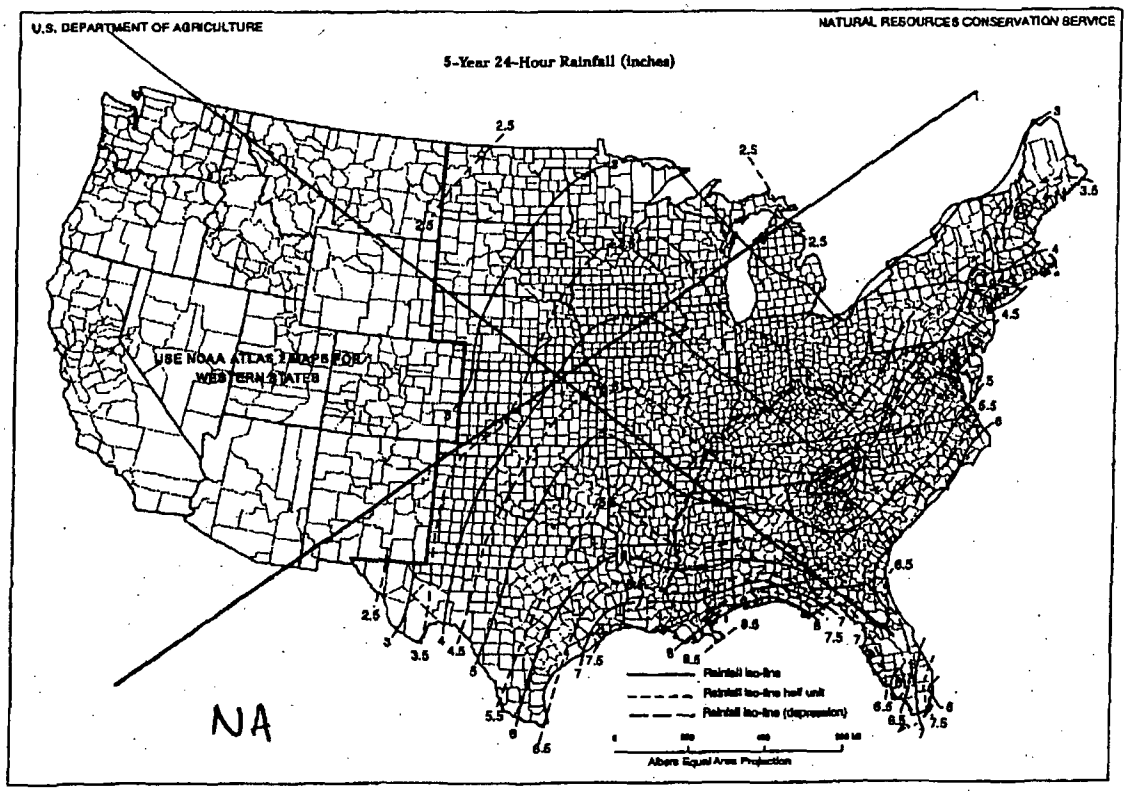


**Figure B-5** 10-year, 24-hour rainfall

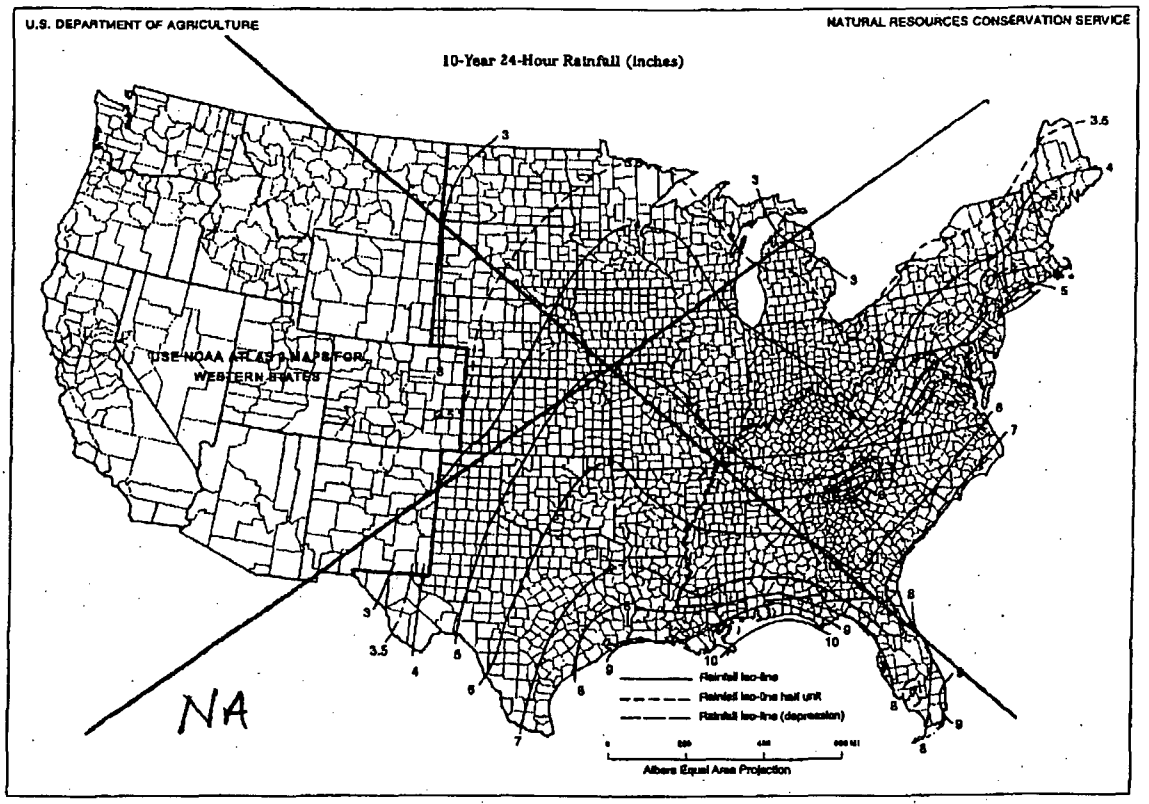
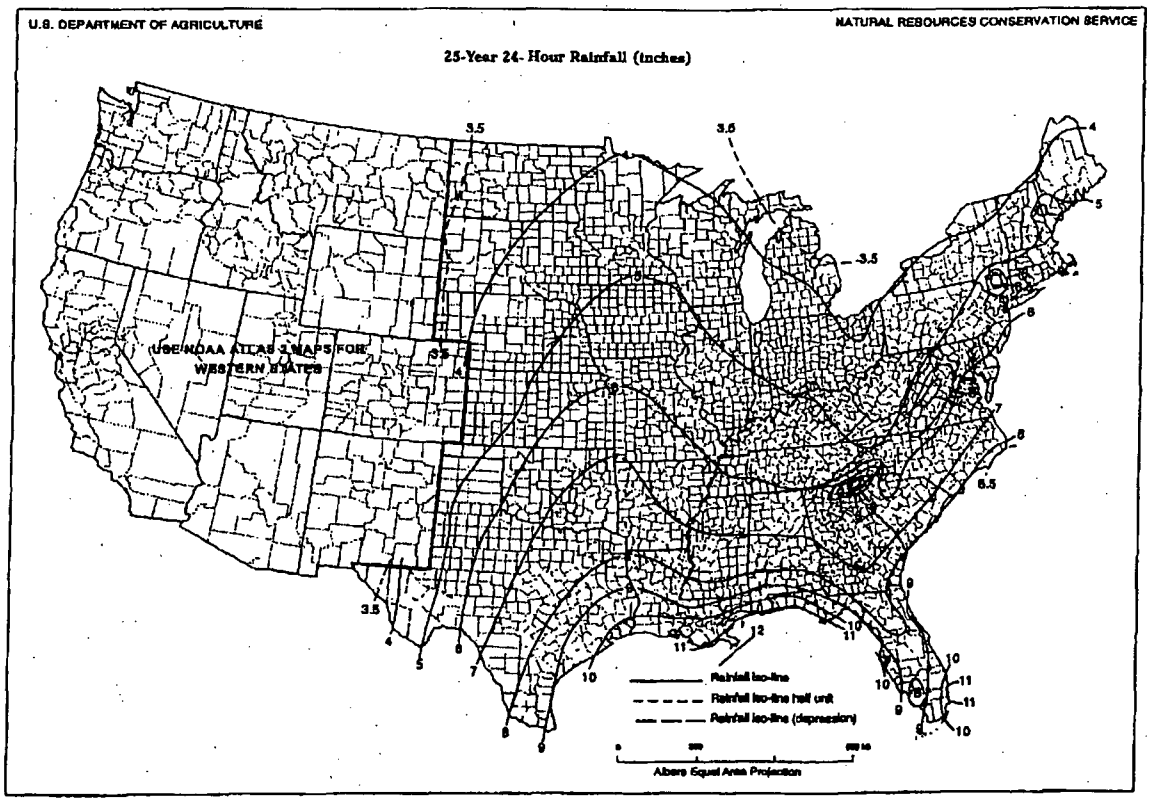



**Figure B-6** 25-year, 24-hour rainfall



# WVDP Annual/Daily Maximum Rain Fall Data
## Period: 1990-2007

| | 1990 (Inches) | 1991 (Inches) | 1992 (Inches) | 1993 (Inches) | 1994 (Inches) | 1995 (Inches) | 1996 (Inches) | 1997 (Inches) | 1998 (Inches) | 1999 (Inches) | 2000 (Inches) | 2001 (Inches) | 2002 (Inches) | 2003 (Inches) | 2004 (Inches) | 2005 (Inches) | 2006 (Inches) | 2007 (Inches) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Yearly Total | 26.64 | 32.76 | 48.63 | 37.35 | 40.13 | 34.17 | 44.89 | 43.23 | 42.76 | 30.97 | 38.85 | 31.02 | 39.96 | 40.99 | 43.21 | 38.52 | 45.06 | 3.55 |
| Daily Maximum | 1.84 | 1.45 | 1.64 | 1.43 | 1.90 | 1.22 | 1.57 | 1.70 | 3.75 | 1.86 | 1.47 | 1.40 | 1.33 | 1.39 | 1.99 | 2.25 | 1.56 | 0.83 |

- USED TO CALCULATE TO 25 YR STORM RAINFALL AMOUNT

## Don McMahon

**From:** "KK Gupta" <KK.Gupta@wvnsco.com>
**To:** <ckeipper@butlerstc.com>; <dmcmahon@mmce.net>
**Cc:** "Chris Avery" <Chris.Avery@wvnsco.com>
**Sent:** Monday, May 21, 2007 1:59 PM
**Attach:** TA Out Fall W06 Calculations.pdf
**Subject:** SDA Cal for out fall W06

Chuck:

Attached is NYSERDA SPDES outfall W06 Calculations. Use this information for developing bypass line around basin 2. I will issue this information via TA.

K. K. Gupta, Fellow Engineer
WVNSCO

- THIS IS INFORMATION USED FOR SUBAREA #4

**Drainage Area 06 and Outfall WNSTM06**

Drainage Area 06 encompasses 0.56 acres located on the western side of the southern set of SDA trenches. Drainage Area 06 is grass covered with some gravel fill. Snow melt and storm water in Drainage Area 06 is conveyed to the north via sheet flow and a shallow channel which leads to a 12-inch CMP which is used to convey the storm water discharge from the area, under a site roadway, to Outfall WNSTM06 (see Photograph 2-18 and 2-19) in DOE Drainage Area 20. Storm water is not detained prior to discharge to the outfall.

The outfall discharge pipe discharges storm water to a grassed channel into DOE Drainage Area SO-20 (see Photograph 2-20) where it combines with storm water discharges from DOE Outfall SO-18 (upstream). DOE Outfall SO-20 discharges to Erdman Brook.

U.S. EPA Form 2F, Item VII, Part D - Outfall WNSTM06

| 1. Date of Storm Event | 2. Duration of Storm Event (Minutes) | 3. Total Rainfall During The Storm Event(Inches) | 4. Number of Hours between the beginning of the storm and the end of the previous rain event | 5. Maximum Flow Rate During the Storm Event, gallons per minute (gpm) | 6. Total Flow from the Rain Event |
|---|---|---|---|---|---|
| 8/11/95 | 135 minutes | 0.54 inches | 143.25 hours | 16 gpm | 2200 gallons |

Part D, Item 7 for Outfall WNSTM06:
Part D, Items 1, 2, 3, and 4 were obtained from the actual storm event data for a monitoring event at former storm water discharge Outfall SO-19.
Item no. 5, maximum flow rate was estimated as follows:

Maximum flow rate = (Total flow identified in Part D, Item No. 6)/(Duration identified in Part D. Item No.2)
= (2200 gallons)/( 135 minutes)
= 16.30gallons per minute (gpm)

Rounded to two(2) significant figures = 16 gpm.

Item No.6 (i.e., total flow) was estimated as follows:

R = (C)(P)

P = Precipitation 0.54 in(1 ft/12 in.) 0.045 ft.

R = Total rainfall excess, in ft.

C = Run-off coefficient estimated as follows:

= 0.90 for impervious area (concrete, pavement, etc.)

= 0.25 for impervious area (gravel, #3 stone and smaller, and unimproved areas)

Rainfall excess:
Impervious Area: R = (0.90)(0.045 ft) = 0.0405 ft

Pervious Area: R = (0.25)(0.045 ft) = 0.01125 ft
From Attachment 2-1 for Outfall WNSTM06,

Impervious Area 0.02 acres = 871.2 sq. ft.

Pervious Area = 0.56 acres - 0.02 acres = 0.54 acres =23522 sq. ft.

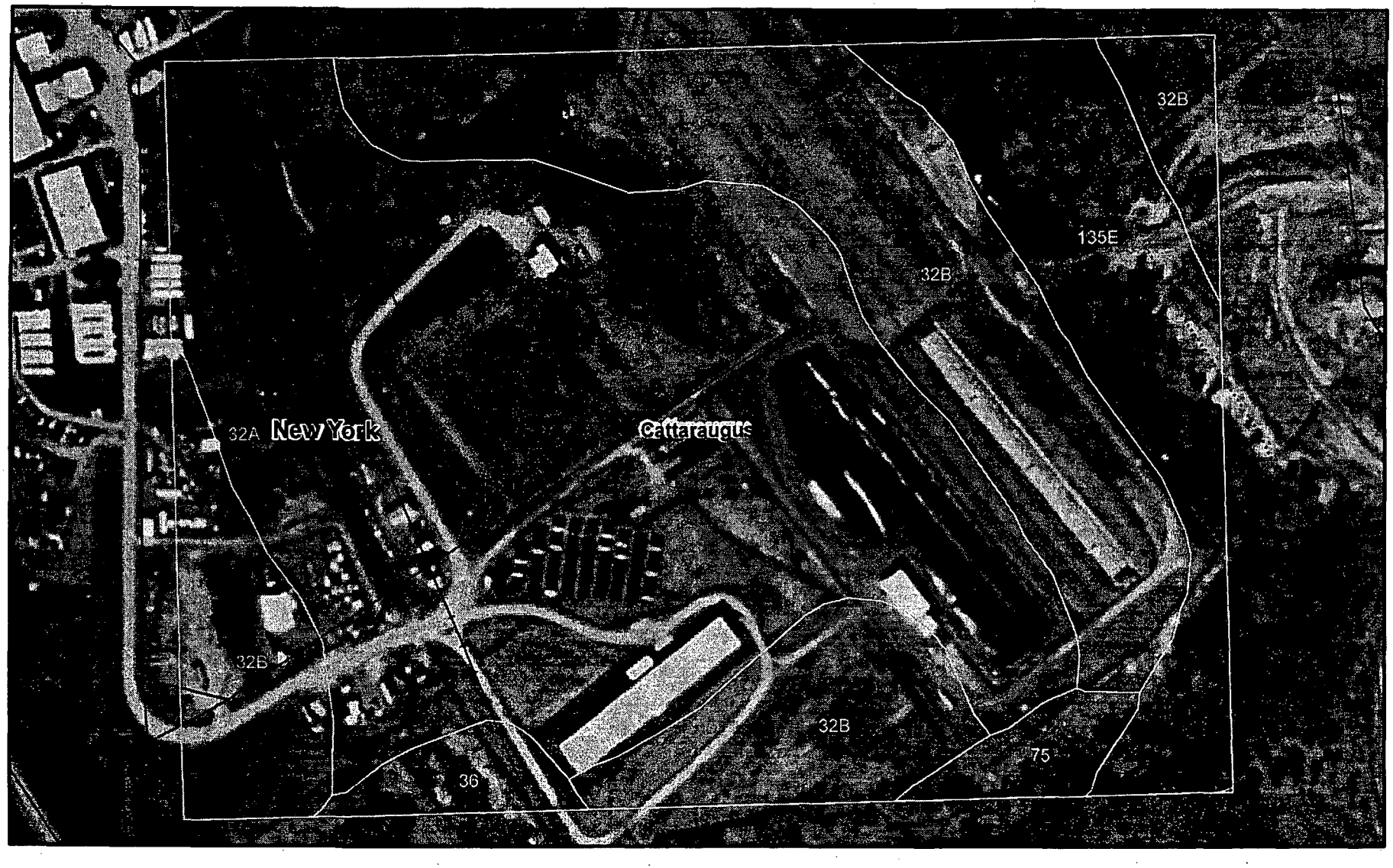
Total runoff flow (871.2 sq. ft.)(0.0405 ft.) + (23522.4 sq. ft.)(0.01125 ft.) = 35.28 cu. ft. + 264.63 cu. ft = 299.91 cu. ft. = 2243.63 gallons.

Rounding is necessary to correspond to the limiting, two (2) significant figures identified for the run-off coefficients (i.e., C).

Therefore, Total flow = 2200 gallons.

# SOIL SURVEY OF CATTARAUGUS COUNTY, NEW YORK

## WVNSCO NDA Capping Project



Meters
0 35 70 140

Feet
0 100 200 400 600 800

WVNSCO NDA Capping Project

## MAP LEGEND

- Soil Map Units
- Cities
- Detailed Counties
- Detailed States
- Interstate Highways
- Roads
- Rails
- Water
- Hydrography
- Oceans
- Escarpment, bedrock
- Escarpment, non-bedrock
- Gulley
- Levee
- Slope
- Blowout
- Borrow Pit
- Clay Spot
- Depression, closed
- Eroded Spot
- Gravel Pit
- Gravelly Spot
- Gulley
- Lava Flow
- Landfill
- Marsh or Swamp
- Miscellaneous Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Slide or Slip
- Sinkhole
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Perennial Water
- Wet Spot

## MAP INFORMATION

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov

Coordinate System: UTM Zone 17

Soil Survey Area: Cattaraugus County, New York
Spatial Version of Data: 3
Soil Map Compilation Scale: 1:24000

Map comprised of aerial images photographed on these dates:
3/28/1995

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

# Map Unit Legend Summary

Cattaraugus County, New York

| Map Unit Symbol | Map Unit Name | Acres in AOI | Percent of AOI |
|---|---|---|---|
| 32A | Churchville silt loam, 0 to 3 percent slopes | 30.6 | 50.8 |
| 32B | Churchville silt loam, 3 to 8 percent slopes | 20.1 | 33.3 |
| 36 | Canadice silty clay loam | 1.2 | 2.0 |
| 75 | Alden mucky silt loam | 1.1 | 1.8 |
| 135E | Hudson silt loam, 25 to 35 percent slope | 7.3 | 12.1 |

# ATTACHMENT B-2

## Post Development Conditions

**McMahon & Mann**
Consulting Engineers, P.C.

BY AJN DATE 5/11/07 SUBJECT WNG-NOA SHT. NO. 1 OF 13
CHKD. BY AJK DATE 6/5/07 CAP DESIGN JOB NO. 07-011
POST-CAP STORMWATER ANALYSIS

POST CAP STORMWATER ESTIMATE
- USE HYDROCAD SOFTWARE (2006)
- USDA - TR55 (JUNE 1986)

- ESTIMATE DRAINAGE AREAS TO ERDMAN BROOK (SEE ATTACHED FIGURE FOR SUBAREAS

- USE 25 YR. STORM EVENT P = 4.2" (ATTACHED FIGURE B-6 FROM TR55)
  - WVDP SITE SPECIFIC DATA SHOWS HIGHEST DAILY EVENT TO BE 3.75" (FROM 1990 - 2007), TR55 GIVES A HIGHER VALUE ∴ USE 4.2" FOR DESIGN

STORMWATER ROUTING RATIONAL,

- 3-SUBAREAS ON CAP, EACH DRAIN TO A BASIN. THE BASINS THEN DRAIN TO EITHER A SECOND BASIN OR THROUGH A PIPE TO THE OUTSIDE OF THE CAP.
- 7-SUBAREAS OUTSIDE THE CAP, THESE COLLECT WATER ALONG OUTSIDE OF BERMS, BASIN DRAINS AND EVENTUALLY MEET AT ERDMAN BROOK. (SEE ATTACHED FIGURE)
- PRECAP STORMWATER ESTIMATE FOR THE SAME RAINFALL YIELDED

Q = 26.9 CFS AT ERDMAN BROOK

∴ THESE CALCULATIONS WILL BE PREPARED TO LIMIT POST CAP RUNOFF TO THIS MAXIMUM FLOW.

CALCULATIONS YIELD Q = 21.6 CFS < 26.9 CFS ∴ OK

## LEGEND

- EXISTING GROUND CONTOURS
- SUBAREA BOUNDARY EXTENTS
- SURFACE WATER DRAINAGE PATH AND FLOW DIRECTION

Note:

1. Base map adapted from a combination of drawings provided by West Valley Nuclear Services Co., Inc. titled "WVDP Site Map Well Locations", Dwg. No. 900-D-5000 Rev A dated May 26, 1992 and "NDA Topographic Plan", Sketch # SKKKG020607 Rev A dated February 19, 2007.

Sheet 2 of 13

100' 0 50' 100'

SCALE: 1" = 100'

NOTE:
UNAUTHORIZED ALTERATION OR ADDITION TO ANY SURVEY, DRAWING, DESIGN, SPECIFICATION, PLAN, OR REPORT IS A VIOLATION OF SECTION 7209 PROVISION 2 OF THE NEW YORK STATE EDUCATION LAW.

McMahon & Mann
Consulting Engineers, P.C.
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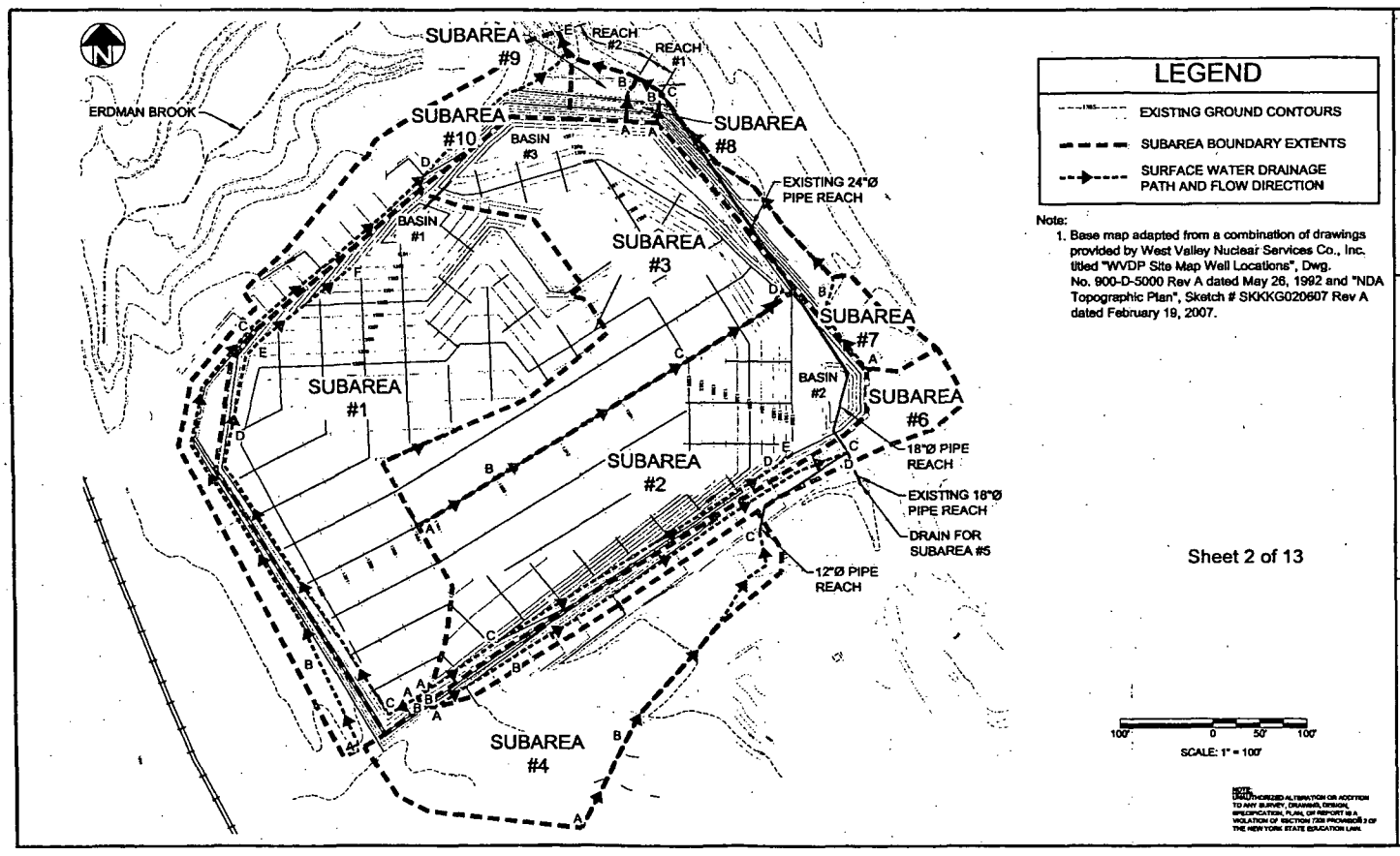
NDA CAP AND GROUND WATER BARRIER CONSTRUCTION
WEST VALLEY
NEW YORK

PROPOSED DRAINAGE AREAS

FIGURE 2

DWG. NO. 07011-052


SUBAREA #9
REACH #2
REACH #1
ERDMAN BROOK
SUBAREA #10
BASIN #3
SUBAREA #8
EXISTING 24"Ø PIPE REACH
BASIN #1
SUBAREA #3
SUBAREA #7
SUBAREA #1
BASIN #2
SUBAREA #6
18"Ø PIPE REACH
SUBAREA #2
EXISTING 18"Ø PIPE REACH
DRAIN FOR SUBAREA #5
12"Ø PIPE REACH
SUBAREA #4
LEGEND
EXISTING GROUND CONTOURS
SUBAREA BOUNDARY EXTENTS
SURFACE WATER DRAINAGE PATH AND FLOW DIRECTION
Note:
1. Base map adapted from a combination of drawings provided by West Valley Nuclear Services Co., Inc. titled "WVDP Site Map Well Locations", Dwg. No. 900-D-5000 Rev A dated May 26, 1992 and "NDA Topographic Plan", Sketch # SKKKG020607 Rev A dated February 19, 2007.
Sheet 2 of 13
100' 0 50' 100'
SCALE: 1" = 100'
NOTE:
UNAUTHORIZED ALTERATION OR ADDITION TO ANY SURVEY, DRAWING, DESIGN, SPECIFICATION, PLAN, OR REPORT IS A VIOLATION OF SECTION 7209 PROVISIONS 2 OF THE NEW YORK STATE EDUCATION LAW.
McMahon & Mann Consulting Engineers, P.C.
NDA CAP AND GROUND WATER BARRIER CONSTRUCTION
WEST VALLEY
NEW YORK
PROPOSED DRAINAGE AREAS
DWG. NO. 07011-052
FIGURE 2

**McMahon & Mann**
Consulting Engineers, P.C.

BY ASN DATE 5/11/07 SUBJECT WVNS-NOA SHT. NO. 3 OF 13
CHKD. BY ASK DATE 6/5/07 CAP DESIGN JOB NO. 07-011
POST-CAP STORMWATER ANALYSIS

CAP SUBAREA #1 (NORTH AND WEST SIDES OF CAP)

AREA = 116,042 SF = 2.66 ACRES

CN = 98 (IMPERVIOUS)
-FROM TABLE 2-2a (TR55)

DRAINAGE PATH A

• A-B (SHEET FLOW)

LENGTH = 22 LF

SLOPE = (1391.25 - 1391)/2 = 12.5%

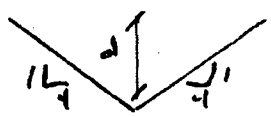
SMOOTH W/ n = 0.011 $P_2$ = 2.5" (24 HR STORM)

• B-C (CHANNEL FLOW)

LENGTH = 37 LF

SLOPE = (1391 - 1390)/37 = 2.7%

ASSUMED X-SECTION



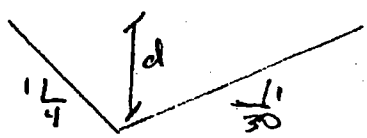

d x 1'
A = 4 SF
WP = 8.2'
n = 0.011 (SMOOTH)

• C-D (CHANNEL FLOW)

LENGTH = 357 LF

SLOPE = (1390 - 1384)/357 = 0.28%

ASSUMED X-SECTION



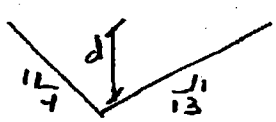

d x 1'
A = 17 SF
WP = 34.1'
n = 0.011 (SMOOTH)

• D-E (CHANNEL FLOW)

LENGTH = 104 LF

SLOPE = (1384 - 1308)/104 = 0.97%

ASSUMED X-SECTION




d x 1'
A = 8.5 SF
WP = 17.2'
n = 0.011 (SMOOTH)

**McMahon & Mann**
Consulting Engineers, P.C.

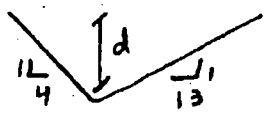
BY AJN DATE 5/11/07 SUBJECT WVNS-NDA SHT. NO. 4 OF 13
CHKD. BY ASK DATE 6/5/07 CAP DESIGN JOB NO. 07-011
POST-CAP STORMWATER ANALYSIS

• E - F (CHANNEL FLOW)

LENGTH = 129 LF

SLOPE = (1388 - 1382)/129 = 4.66 %

ASSUMED X-SECTION




d ≈ 2'
A = 34 SF
WP = 34.3'
n = 0.011 (SMOOTH)

CAP SUBAREA #2 (SOUTH SIDE OF CAP)

AREA = 82,170 SF = 1.89 ACRES

CN = 98 (IMPERVIOUS)
- FROM TABLE 2-2a (TR55)

DRAINAGE PATH

• A - B (SHEET FLOW)

LENGTH = 2 LF

SLOPE = (1391.25 - 1391)/2 = 12.5 %

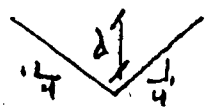
SMOOTH w/ n = 0.011 P2 = 2.5" (2YR STORM)

• B - C (CHANNEL FLOW)

LENGTH = 102 LF

SLOPE = (1491 - 1490)/102 = 1 %

ASSUMED X-SECTION




d ≈ 1'
A = 4 SF
WP = 8.2'
n = 0.011 (SMOOTH)

• C - D (CHANNEL FLOW)

LENGTH = 360 LF

SLOPE = (1390 - 1381)/360 = 2.5 %

ASSUMED X-SECTION

d ≈ 2'
A = 16 SF
WP = 16.5'
n = 0.011 (SMOOTH)

**McMahon & Mann**
Consulting Engineers, P.C.

BY AJN DATE 5/11/07 SUBJECT WVNS - NOA SHT. NO. 5 OF 13
CHKD. BY AJK DATE 6/5/07 CAP DESIGN JOB NO. 07-011
POST-CAP 7-24-07 STORMWATER ANALYSIS

• D - E (CHANNEL FLOW)

LENGTH = 22 LF

SLOPE = (1381 - 1380) / 22 = 4.5%

ASSUMED X-SECTION

d ≈ 2'
A = 16 SF
WP = 16.5'
n = 0.011 (SMOOTH)

CAP SUBAREA # 3 (NORTH AND EAST SIDES OF CAP)

AREA = 75,463 SF = 1.73 ACRES

CN - 98 (IMPERVIOUS)
- FROM TABLE 2-2a (TR55)

DRAINAGE PATH

• A - B (SHEET FLOW)

LENGTH = 100 LF

SLOPE = (1394.22 - 1392.97) / 100 = 1.3%

SMOOTH W/n = 0.011 $P_2$ = 2.5" (24 HR STORM)

• B - C (SHALLOW CONCENTRATED FLOW)

LENGTH = 243 LF

SLOPE = (1392.97 - 1390) / 243 = 1.2%

PAVED SURFACE

• C - D (SHALLOW CONCENTRATED FLOW)

LENGTH = 130 LF

SLOPE = (1390 - 1378) / 130 = 8.5%

PAVED SURFACE

**McMahon & Mann**
Consulting Engineers, P.C.

BY AJN DATE 6/1/07 SUBJECT WWAR - NOA SHT. NO. 6 OF 13
CHKD. BY AJK DATE 6/5/07 CAD DESIGN JOB NO. 07-011
POST-CAD 7.24.07 STORMWATER ANALYSIS

EXTERIOR SUBAREA #4 (SOUTH AREA DRAINING TO 12" Φ PIPE)

AREA = 56,320 SF = 1.29 ACRES

DRAINAGE PATH

• A-B (SHEET FLOW)

CN = 80
- FROM TABLE 2-2a (TR55)

LENGTH = 100 LF

SLOPE = (1391 - 1388.5)/100 = 2.5%

SHORT GRASS W/n = 0.15 $P_2$ = 2.5" (24hr STORM)

• B-C (SHALLOW CONCENTRATED FLOW)

LENGTH = 294 LF

SLOPE = (1388.5 - 1379.5)/294 = 3.1%

UNPAVED SURFACE

• C-D (PIPE FLOW)

12" Φ AT 0.5% (SMOOTH WALL)

136 LF

INV. 1379.5 (START)

INV. 1378.82 (END)

TREAT THIS AS A REACH

EXTERIOR SUBAREA #5 (FROM SDA)

- LIMITED INFO FOR THIS, WVNSCO STATES THAT IT HAS:

AREA = 0.56 ACRES

CN = 98 ) ASSUMED
- FROM TABLE 2-2a (TR55)

• SHEET FLOW

LENGTH = 100 LF

SLOPE = 2%

SMOOTH W/n = 0.011 $P_2$ = 2.5" (24hr STORM)

• SHALLOW CONCENTRATED FLOW

LENGTH = 100 LF

SLOPE = 2%

PAVED SURFACE

* LENGTHS AND SLOPES ASSUMED BASED ON LIMITED INFO FOR DRAINAGE AREA.

**McMahon & Mann**
Consulting Engineers, P.C.

BY AJN DATE 6/1/07 SUBJECT WWNS - NOA SHT. NO. 7 OF 13
CHKD. BY AJK DATE 6/5/07 CAP DESIGN JOB NO. 07-011
POST-CAP 7.24.07 STORMWATER ANALYSIS

• PIPE FLOW
18" DIA (CMP)
38 LF
INV. 1378.5 (START)
INV. 1378 (END)

TREAT THIS AS A REACH

SLOPE = (1378.5 - 1378)/38 = 1.3%

EXTERIOR SUBAREA #6 (SOUTH AREA ALONG EDGE OF CAP)

AREA = 20,530 SF = 0.47 ACRES

CN = 90
- FROM TABLE 2-2a (TR55)

DRAINAGE PATH

- A - B (SHEET FLOW)
LENGTH = 100 LF
SLOPE = (1391 - 1388.4)/100 = 2.6%

SMOOTH w/n = 0.011 $P_2$ = 2.6" (24HR STORM)

• B - C (SHALLOW CONCENTRATED FLOW)
LENGTH = 430 LF
SLOPE = (1388.4 - 1381)/430 = 1.7%

UNPAVED SURFACE

**McMahon & Mann**
Consulting Engineers, P.C.

BY AMN DATE 6/1/07 SUBJECT WVNL-N04 SHT. NO. 8 OF 13
CHKD. BY DJK DATE 6/5/07 CAP DRAIN JOB NO. 07-011
POST-CAP 7-25-07 STORMWATER ANALYSIS

EXTERIOR SUBAREA #7 (EAST SIDE)

AREA = 14,723 SF = 0.34 ACRES

CN = 80
- FROM TABLE 2-2a (TR55)

DRAINAGE PATH

· A - B (SHEET FLOW)

LENGTH = 100 LF

SLOPE = (1381 - 1379)/100 = 2.0 %

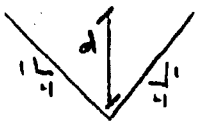
SHORT GRASS w/ n = 0.15 $P_2$ = 2.5" (24 HR STORM)

· B - C (CHANNEL FLOW)

LENGTH = 290 LF

SLOPE = (1379 - 1366)/290 = 4.5 %

ASSUMED X - SECTION




d ≈ 3' MIN
A = 36 SF
WP = 24.94'
n = 0.03 (RIP-RAP)

EXTERIOR SUBAREA #8 (NORTH SIDE, FROM 24" OUTLET TO BASIN #3 OUTLET)

AREA = 1378 SF = 0.032 ACRES

CN = 80
- FROM TABLE 2-2a (TR55)

DRAINAGE PATH

· A - B (SHEET FLOW)

LENGTH = 33 LF

SLOPE = (1379 - 1366)/33 = 39 %

SHORT GRASS w/ n = 0.15 $P_2$ = 2.5" (24 HR STORM)

**McMahon & Mann**
Consulting Engineers, P.C.

BY AJN DATE 6/1/07 SUBJECT WWNS. NOA SHT. NO. 9 OF 13
CHKD. BY AJK DATE 6/5/07 CAP DESIGN JOB NO. 07-011
POST-CAP 7.25.07 STORMWATER ANALYSIS

EXTERIOR SUBAREA #9 (NORTH SIDE, FROM BASIN #3 OUTLET TO FINAL REACH)

AREA = 3767 SF = 0.086 ACRES

CN = 80
- FROM TABLE 2-2a (TR55)

DRAINAGE PATH

- A-B (SHEET FLOW)

LENGTH = 50 LF

SLOPE = (1379 - 1364.5)/50 = 29%

SHORT GRASS n/n = 0.15 $P_2$ = 2.5" (24HR STORM)

EXTERIOR SUBAREA #10 (NORTH SIDE)

AREA = 44,673 SF = 1.03 ACRES

CN = 80
- FROM TABLE 2-2a (TR55)

DRAINAGE PATH

- A-B (SHEET FLOW)

LENGTH = 100 LF

SLOPE = (1390 - 1389.4)/100 = 0.6%

SHORT GRASS n/n = 0.15 $P_2$ = 2.5" (24HR STORM)

- B-C (SHALLOW CONCENTRATED FLOW)

LENGTH = 417 LF

SLOPE = (1389.4 - 1388.1)/417 = 0.3%

UNPAVED SURFACE

**McMahon & Mann**
Consulting Engineers, P.C.

BY AJN DATE 6/1/07 SUBJECT NNS - NDA SHT. NO. 10 OF 13
CHKD. BY AJK DATE 6/5/07 CAD DESIGN JOB NO. 07-011
POST-CAD STORMWATER ANALYSIS

C-D (SHALLOW CONCENTRATED FLOW)

LENGTH = 260 LF

SLOPE = (1388 − 1379)/260 = 3.5%

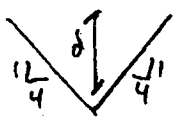
UNPAVED SURFACE

D-E (CHANNEL FLOW)

LENGTH = 221 LF

SLOPE = (1374 − 1353.5)/221 = 11.5%

ASSUMED X-SECTION




d x 3' MIN
A = 36 SF
WP = 24.74'
n = 0.03 RIP-RAP

REACH FOR EXTERIOR AREAS #4, #5 AND #6

PIPE FLOW

18" Ø (SMOOTH WALL)

93 LF

INV. 1378 (START)
INV. 1375.5 (END)

SLOPE = (1378 − 1375.5)/93 = 2.7%

REACH FOR EXTERIOR AREAS #4, #5 AND #6 COMBINED W/ BASIN #2 (CAD AREA #2)

PIPE FLOW

24" Ø (SMOOTH WALL)

362 LF

INV. 1375.36 (START)
INV. 1366 (END)

SLOPE = (1375.36 − 1366)/362 = 2.6%

**McMahon & Mann**
Consulting Engineers, P.C.

BY AJN DATE 6/1/07 SUBJECT WVNS - NOA SHT. NO. 1P OF 13
CHKD. BY AJK DATE 6/5/07 CAP DESIGN JOB NO. 07-011
POST - CAP STORMWATER ANALYSIS

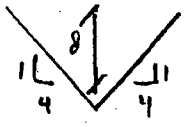
REACH FOR EXTERIOR AREAS #4, #5, #6, #7 AND #8 COMBINED W/BASIN #2 (REACH #1)

CHANNEL

LENGTH = 30LF

SLOPE = (1366 - 1364.5)/30 = 5%

ASSUMED X-SECTION




d ≈ 3' MIN
A = 36SF
WP = 24.74'

n = 0.03 (RIP-RAP)

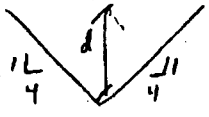
REACH FOR EXTERIOR AREAS #4, #5, #6, #7, #8 AND #9 COMBINED W/BASIN #2 AND #3 (REACH #2)

CHANNEL

LENGTH = 107LF

SLOPE = (1364.5 - 1353.5)/107 = 10.3%

ASSUMED X-SECTION




d ≈ 3' MIN
A = 36SF
WP = 24.74'
n = 0.03 (RIP-RAP)

By: A.J.N.
Date: 6/1/2007

# WVNS - NDA Cap
# Volume of Stormwater Basins

## A. Basin #1- *Used AutoCad to trace contours and to obtain area*

*Dwg. No.07011-006*

| Contour Elevation | Area ($ft^2$) | Change in Elevation (ft) | Volume ($ft^3$) | Cumulative Volume ($ft^3$) |
|---|---|---|---|---|
| 1379 | 562.59 | 0 | 0 | 0 |
| 1380 | 1726.40 | 1 | 1144.50 | 1144.50 |
| 1381 | 3591.33 | 1 | 2658.87 | 3803.36 |
| 1382 | 5810.35 | 1 | 4700.84 | 8504.20 |

## B. Basin #2 - *Used AutoCad to trace contours and to obtain area*

*Dwg. No.07011-006*

| Contour Elevation | Area ($ft^2$) | Change in Elevation (ft) | Volume ($ft^3$) | Cumulative Volume ($ft^3$) |
|---|---|---|---|---|
| 1377 | 985.63 | 0 | 0 | 0 |
| 1378 | 1613.91 | 1 | 1299.77 | 1299.77 |
| 1379 | 2372.02 | 1 | 1992.97 | 3292.74 |
| 1380 | 8153.48 | 1 | 5262.75 | 8555.49 |

## C. Basin #3 - *Used AutoCad to trace contours and to obtain area*

*Dwg. No.07011-006*

| Contour Elevation | Area ($ft^2$) | Change in Elevation (ft) | Volume ($ft^3$) | Cumulative Volume ($ft^3$) |
|---|---|---|---|---|
| 1376 | 787.20 | 0 | 0 | 0 |
| 1377 | 4310.26 | 1 | 2548.73 | 2548.73 |
| 1378 | 9553.38 | 1 | 6931.82 | 9480.55 |
| 1379 | 13690.26 | 1 | 11621.82 | 21102.37 |

By: A.J.N.
Date: 8/1/2007

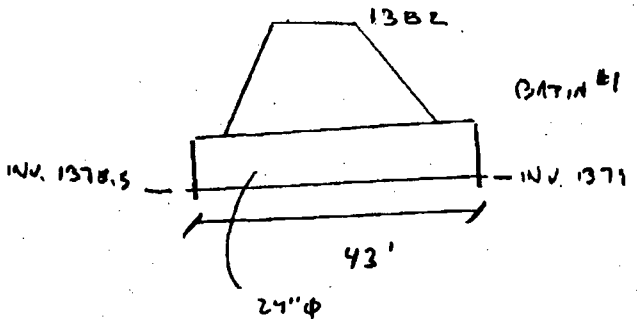
## DETERMINE THE DISCHARGE THROUGH THE OVERFLOW PIPE

### *1. Esitimate the Discharge based on Full Pipe Flow for Basin #1*

Use Bernoulli Equation - See Attached Sheet for Sample Calculation
See Attached Sketch for Layout and Components

g (ft/sec$^2$)= 32.174
$d_{pipe}$ (ft) = 1.750 (I.D. FOR SDR17, 24"ϕ HDPE)
$A_{pipe}$ (ft$^2$) = 2.40528
Pipe Outlet Ele = 1378.5
Pipe Length (ft) = 43.0
Ke (entrance) = 1.0
f = 0.011

ν = 1.41E-05
ε = 0.000005
ε / d = 0.000003



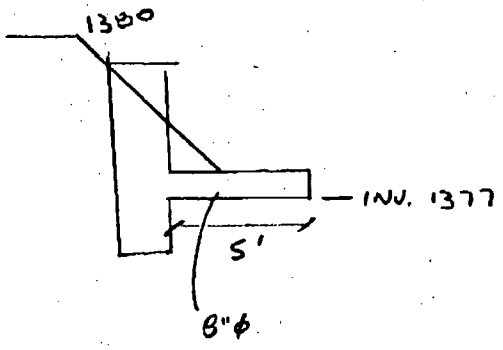

| Discharge Elevation (ft) | ΔH (ft) | Q (cfs) | V (fps) | Re |
|---|---|---|---|---|
| 1379.0 | 0.5 | 9.05 | 3.76 | 467231 |
| 1380.0 | 1.5 | 15.68 | 6.52 | 809267 |
| 1381.0 | 2.5 | 20.25 | 8.42 | 1044759 |
| 1382.0 | 3.5 | 23.96 | 9.96 | 1236176 |

### *2. Esitimate the Discharge based on Full Pipe Flow for Basin #2*

Use Bernoulli Equation - See Attached Sheet for Sample Calculation
See Attached Sketch for Layout and Components

g (ft/sec$^2$)= 32.174
$d_{pipe}$ (ft) = 0.630 (I.D. FOR SDR17, 8"ϕ PIPE)
$A_{pipe}$ (ft$^2$) = 0.31172
Pipe Outlet Ele = 1375.4
Pipe Length (ft) = 5.0
Ke (entrance) = 1.0
f = 0.0146

ν = 1.41E-05
ε = 0.000005
ε / d = 0.000008



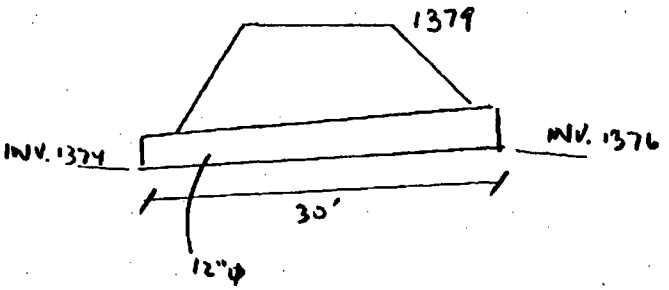

| Discharge Elevation (ft) | ΔH (ft) | Q (cfs) | V (fps) | Re |
|---|---|---|---|---|
| 1377.0 | 1.6 | 2.19 | 7.02 | 313818 |
| 1378.0 | 2.6 | 2.78 | 8.93 | 398836 |
| 1379.0 | 3.6 | 3.27 | 10.49 | 468812 |
| 1380.0 | 4.6 | 3.70 | 11.85 | 529621 |

### *3. Esitimate the Discharge based on Full Pipe Flow for Basin #3*

Use Bernoulli Equation - See Attached Sheet for Sample Calculation
See Attached Sketch for Layout and Components

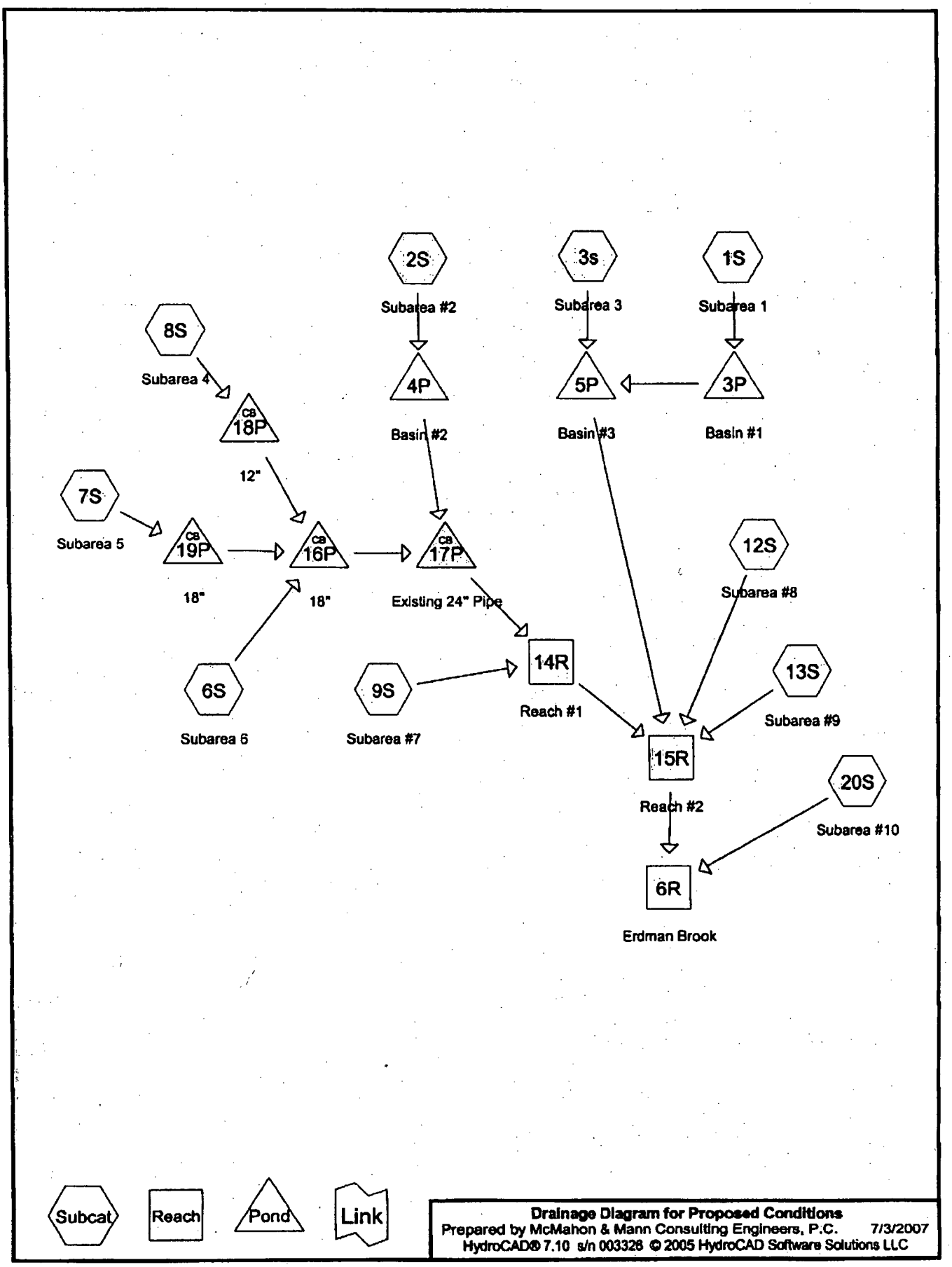
g (ft/sec$^2$)= 32.174
$d_{pipe}$ (ft) = 0.930 (I.D. FOR SDR 12"ϕ PIPE
$A_{pipe}$ (ft$^2$) = 0.67929
Pipe Outlet Ele = 1374.0
Pipe Length (ft) = 30.0
Ke (entrance) = 1.0
f = 0.012

ν = 1.41E-05
ε = 0.000005
ε / d = 0.000005




| Discharge Elevation (ft) | ΔH (ft) | Q (cfs) | V (fps) | Re |
|---|---|---|---|---|
| 1376.0 | 2.0 | 4.99 | 7.34 | 484297 |
| 1377.0 | 3.0 | 6.11 | 8.99 | 593140 |
| 1378.0 | 4.0 | 7.05 | 10.38 | 684899 |
| 1379.0 | 5.0 | 7.89 | 11.61 | 765740 |

# PROPOSED CONDITIONS
# HYDROCAD RESULTS




**Drainage Diagram for Proposed Conditions**
Prepared by McMahon & Mann Consulting Engineers, P.C. 7/3/2007
HydroCAD® 7.10 s/n 003328 © 2005 HydroCAD Software Solutions LLC

Time span=0.00-48.00 hrs, dt=0.01 hrs, 4801 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

**Subcatchment 1S: Subarea 1** Runoff Area=2.660 ac Runoff Depth=1.97"
Flow Length=629' Tc=1.6 min CN=98 Runoff=9.38 cfs 0.437 af

**Subcatchment 2S: Subarea #2** Runoff Area=1.890 ac Runoff Depth=1.97"
Flow Length=486' Tc=0.5 min CN=98 Runoff=6.85 cfs 0.311 af

**Subcatchment 3s: Subarea 3** Runoff Area=1.730 ac Runoff Depth=1.97"
Flow Length=473' Tc=3.8 min CN=98 Runoff=5.70 cfs 0.284 af

**Subcatchment 6S: Subarea 6** Runoff Area=0.470 ac Runoff Depth=1.27"
Flow Length=530' Tc=4.6 min CN=90 Runoff=1.11 cfs 0.050 af

**Subcatchment 7S: Subarea 5** Runoff Area=0.560 ac Runoff Depth=1.97"
Flow Length=200' Tc=2.0 min CN=98 Runoff=1.95 cfs 0.092 af

**Subcatchment 8S: Subarea 4** Runoff Area=1.290 ac Runoff Depth=0.69"
Flow Length=394' Tc=11.8 min CN=80 Runoff=1.24 cfs 0.074 af

**Subcatchment 9S: Subarea #7** Runoff Area=0.340 ac Runoff Depth=0.69"
Flow Length=390' Tc=11.5 min CN=80 Runoff=0.33 cfs 0.019 af

**Subcatchment 12S: Subarea #8** Runoff Area=0.032 ac Runoff Depth=0.69"
Flow Length=33' Tc=1.4 min CN=80 Runoff=0.05 cfs 0.002 af

**Subcatchment 13S: Subarea #9** Runoff Area=0.086 ac Runoff Depth=0.69"
Flow Length=50' Tc=2.2 min CN=80 Runoff=0.12 cfs 0.005 af

**Subcatchment 20S: Subarea #10** Runoff Area=1.030 ac Runoff Depth=0.69"
Flow Length=998' Tc=27.4 min CN=80 Runoff=0.60 cfs 0.059 af

**Reach 6R: Erdman Brook** Peak Depth=0.59' Max Vel=9.7 fps Inflow=13.57 cfs 1.333 af
n=0.030 L=5.0' S=0.2000 '/' Capacity=1,024.08 cfs Outflow=13.57 cfs 1.333 af

**Reach 14R: Reach #1** Peak Depth=0.60' Max Vel=4.8 fps Inflow=6.87 cfs 0.546 af
n=0.030 L=30.0' S=0.0500 '/' Capacity=512.04 cfs Outflow=6.87 cfs 0.546 af

**Reach 15R: Reach #2** Peak Depth=0.67' Max Vel=7.5 fps Inflow=13.42 cfs 1.274 af
n=0.030 L=107.0' S=0.1028 '/' Capacity=734.21 cfs Outflow=13.42 cfs 1.274 af

**Pond 3P: Basin #1** Peak Elev=1,379.57' Storage=654 cf Inflow=9.38 cfs 0.437 af
Outflow=8.95 cfs 0.437 af

**Pond 4P: Basin #2** Peak Elev=1,378.63' Storage=2,563 cf Inflow=6.85 cfs 0.311 af
Outflow=3.09 cfs 0.311 af

| | | | |
|---|---|---|---|
| **Pond 5P: Basin #3** | Peak Elev=1,377.47' Storage=5,809 cf | Inflow=14.59 cfs | 0.722 af |
| | | Outflow=6.55 cfs | 0.722 af |
| **Pond 16P: 18"** | Peak Elev=1,379.05' | Inflow=3.62 cfs | 0.216 af |
| | 18.0" x 93.0' Culvert | Outflow=3.62 cfs | 0.216 af |
| **Pond 17P: Existing 24" Pipe** | Peak Elev=1,376.69' | Inflow=6.68 cfs | 0.526 af |
| | 24.0" x 362.0' Culvert | Outflow=6.68 cfs | 0.526 af |
| **Pond 18P: 12"** | Peak Elev=1,380.19' | Inflow=1.24 cfs | 0.074 af |
| | 12.0" x 136.0' Culvert | Outflow=1.24 cfs | 0.074 af |
| **Pond 19P: 18"** | Peak Elev=1,379.43' | Inflow=1.95 cfs | 0.092 af |
| | 18.0" x 38.0' Culvert | Outflow=1.95 cfs | 0.092 af |

**Total Runoff Area = 10.088 ac Runoff Volume = 1.333 af Average Runoff Depth = 1.59"**

## Subcatchment 1S: Subarea 1

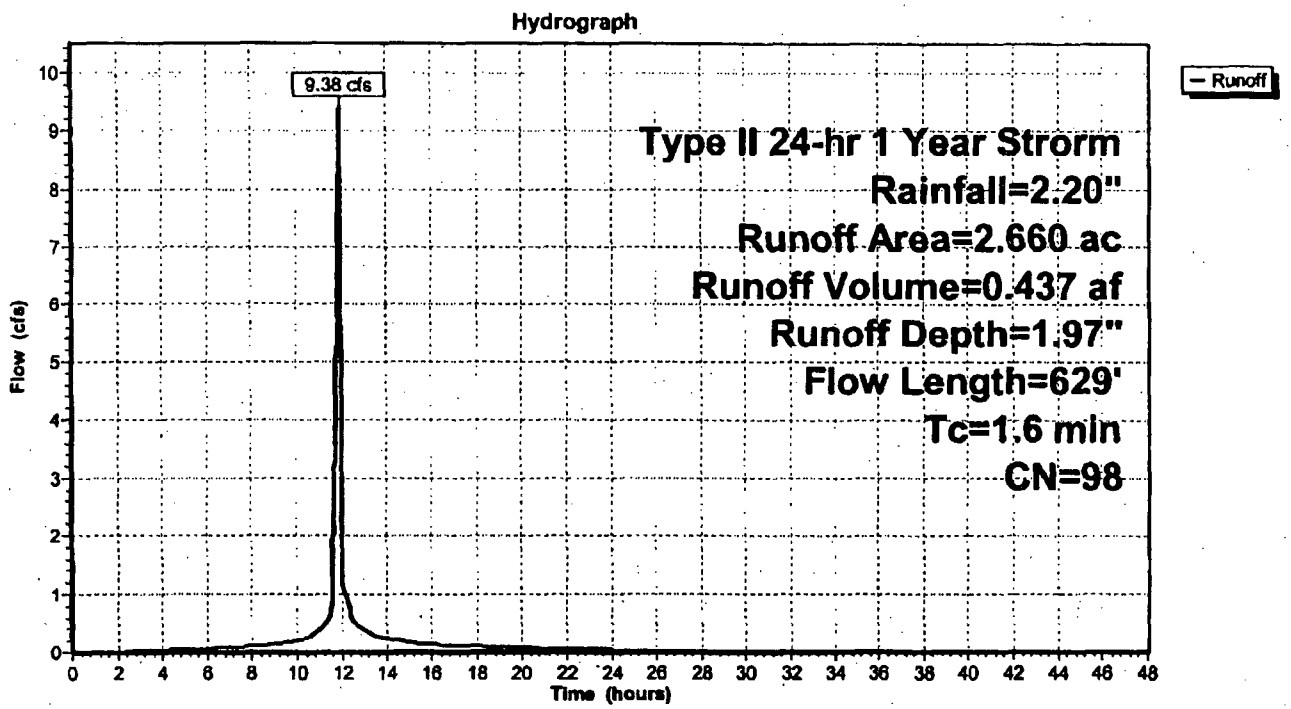
Runoff = 9.38 cfs @ 11.92 hrs, Volume= 0.437 af, Depth= 1.97"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type II 24-hr 1 Year Strorm Rainfall=2.20"

| Area (ac) | CN | Description |
|---|---|---|
| 2.660 | 98 | North and West Sides of Cap |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 0.0 | 2 | 0.1250 | 1.2 | | **Sheet Flow, A to B** Smooth surfaces n= 0.011 P2= 2.50" |
| 0.0 | 37 | 0.0270 | 13.8 | 55.02 | **Channel Flow, B to C** Area= 4.0 sf Perim= 8.2' r= 0.49' n= 0.011 |
| 1.3 | 357 | 0.0028 | 4.5 | 76.40 | **Channel Flow, C to D** Area= 17.0 sf Perim= 34.1' r= 0.50' n= 0.011 |
| 0.2 | 104 | 0.0097 | 8.3 | 70.69 | **Channel Flow, D to E** Area= 8.5 sf Perim= 17.2' r= 0.49' n= 0.011 |
| 0.1 | 129 | 0.0466 | 29.0 | 985.72 | **Channel Flow, E to F** Area= 34.0 sf Perim= 34.3' r= 0.99' n= 0.011 |
| 1.6 | 629 | Total | | | |

## Subcatchment 1S: Subarea 1



## Subcatchment 2S: Subarea #2

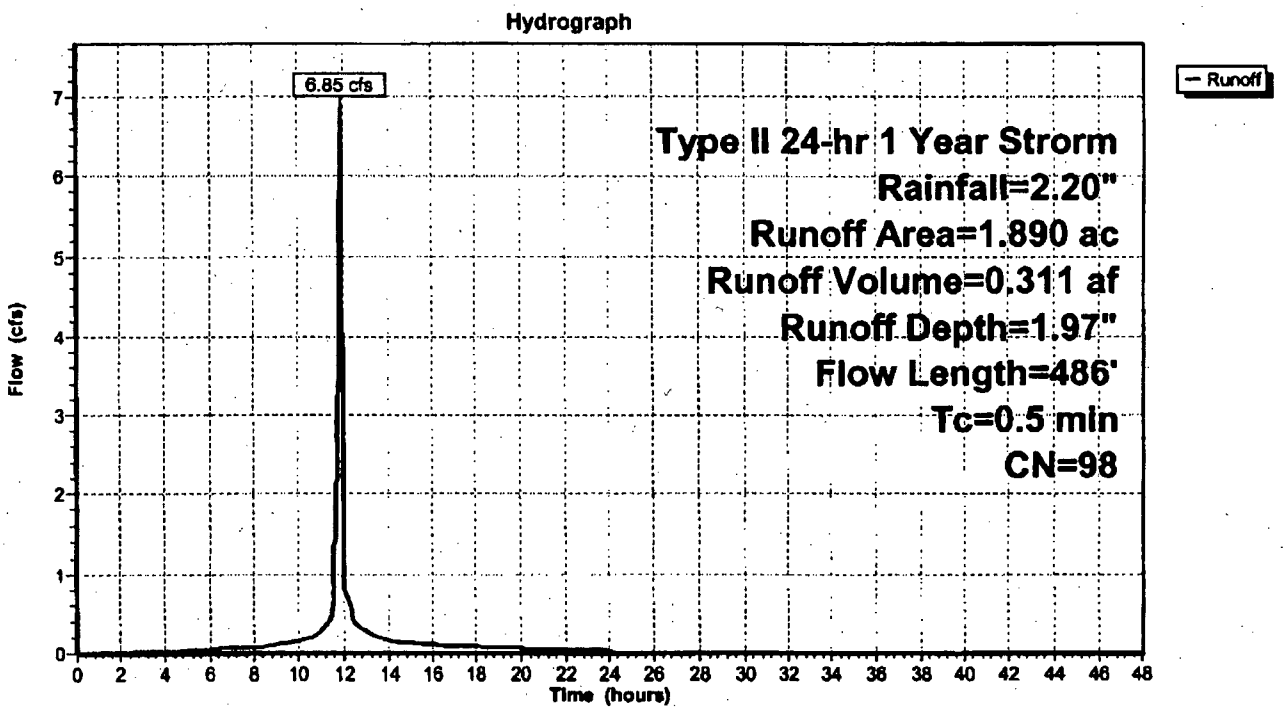
Runoff = 6.85 cfs @ 11.91 hrs, Volume= 0.311 af, Depth= 1.97"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type II 24-hr 1 Year Strorm Rainfall=2.20"

| Area (ac) | CN | Description |
|---|---|---|
| 1.890 | 98 | South Side of Cap |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 0.0 | 2 | 0.1250 | 1.2 | | **Sheet Flow, A to B** Smooth surfaces n= 0.011 P2= 2.50" |
| 0.2 | 102 | 0.0100 | 8.4 | 33.48 | **Channel Flow, B to C** Area= 4.0 sf Perim= 8.2' r= 0.49' n= 0.011 |
| 0.3 | 360 | 0.0250 | 20.9 | 334.82 | **Channel Flow, C to D** Area= 16.0 sf Perim= 16.5' r= 0.97' n= 0.011 |
| 0.0 | 22 | 0.0450 | 28.1 | 449.20 | **Channel Flow, D to E** Area= 16.0 sf Perim= 16.5' r= 0.97' n= 0.011 |
| 0.5 | 486 | Total | | | |

## Subcatchment 2S: Subarea #2



## Subcatchment 3s: Subarea 3

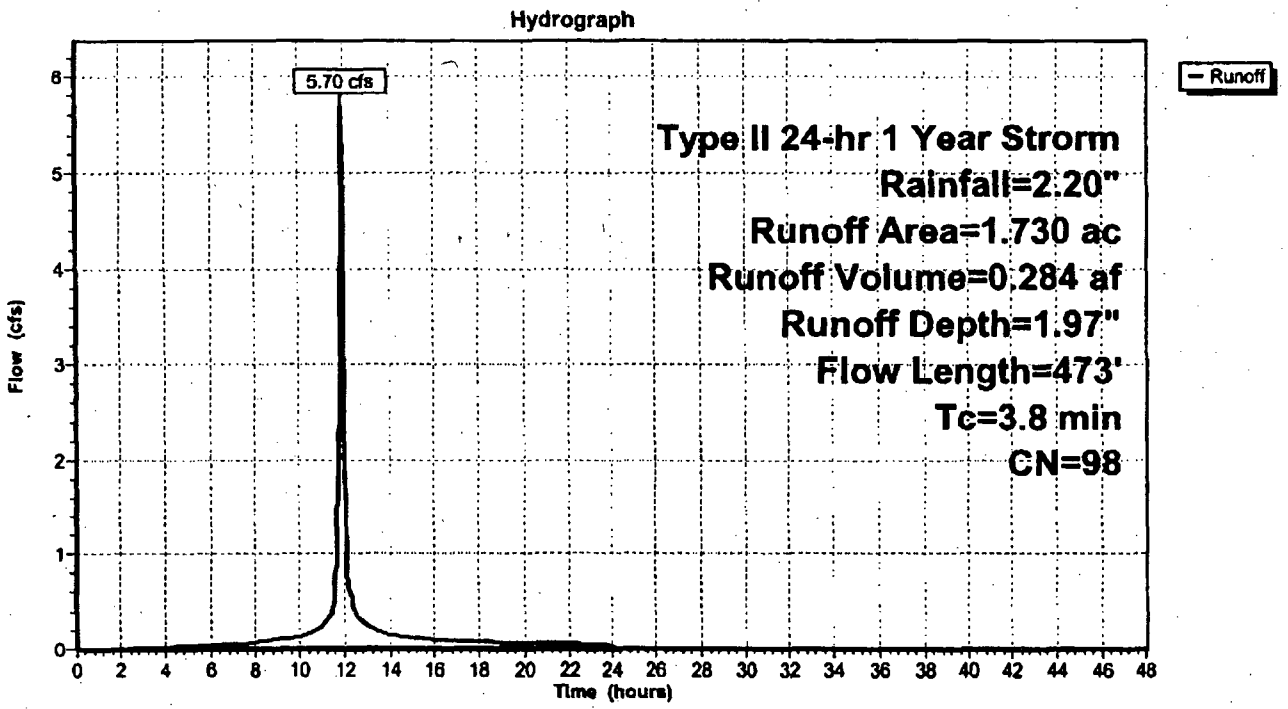
Runoff = 5.70 cfs @ 11.94 hrs, Volume= 0.284 af, Depth= 1.97"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type II 24-hr 1 Year Strorm Rainfall=2.20"

| Area (ac) | CN | Description |
|---|---|---|
| 1.730 | 98 | North and East Sides of Cap |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 1.6 | 100 | 0.0130 | 1.0 | | **Sheet Flow, A to B**<br>Smooth surfaces n= 0.011 P2= 2.50" |
| 1.8 | 243 | 0.0120 | 2.2 | | **Shallow Concentrated Flow, B to C**<br>Paved Kv= 20.3 fps |
| 0.4 | 130 | 0.0850 | 5.9 | | **Shallow Concentrated Flow, C to D**<br>Paved Kv= 20.3 fps |
| 3.8 | 473 | Total | | | |

## Subcatchment 3s: Subarea 3



## Subcatchment 6S: Subarea 6

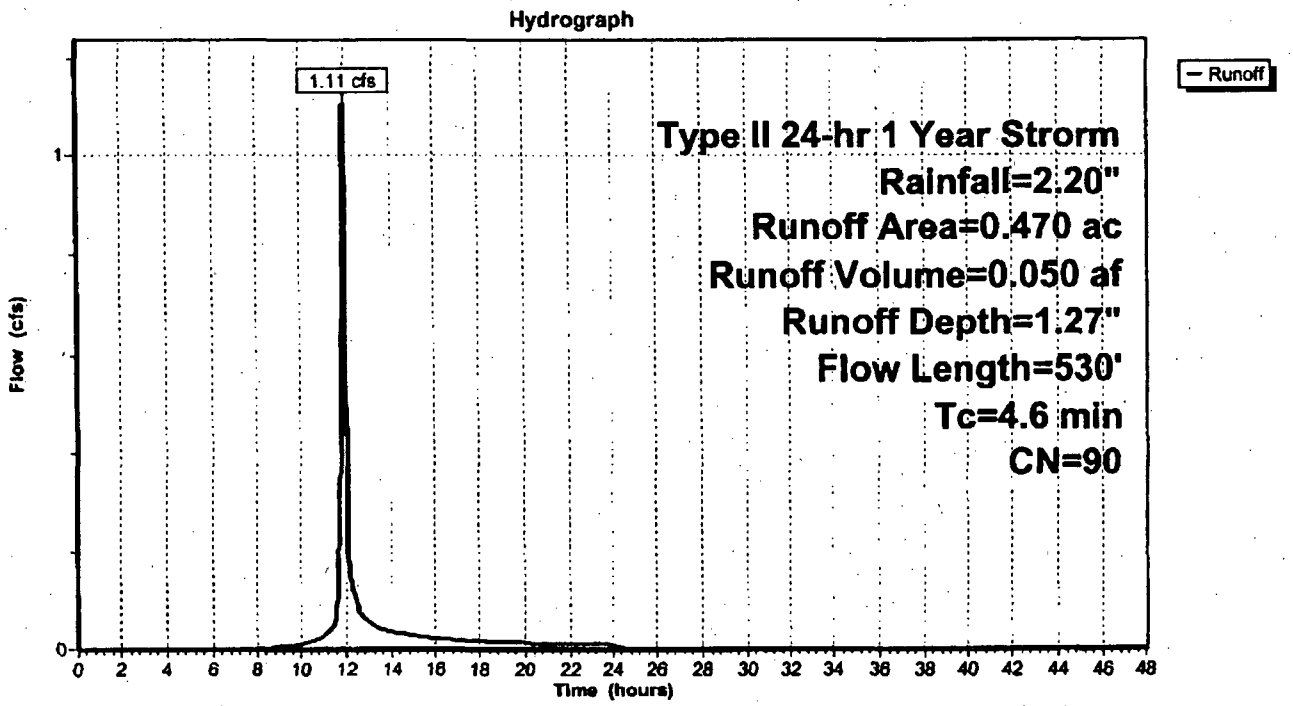
Runoff = 1.11 cfs @ 11.96 hrs, Volume= 0.050 af, Depth= 1.27"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type II 24-hr 1 Year Strorm Rainfall=2.20"

| Area (ac) | CN | Description |
|---|---|---|
| 0.470 | 90 | South area along edge of cap |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 1.2 | 100 | 0.0260 | 1.4 | | **Sheet Flow, A to B**<br>Smooth surfaces n= 0.011 P2= 2.50" |
| 3.4 | 430 | 0.0170 | 2.1 | | **Shallow Concentrated Flow, B to C**<br>Unpaved Kv= 16.1 fps |
| 4.6 | 530 | Total | | | |

## Subcatchment 6S: Subarea 6



## Subcatchment 7S: Subarea 5

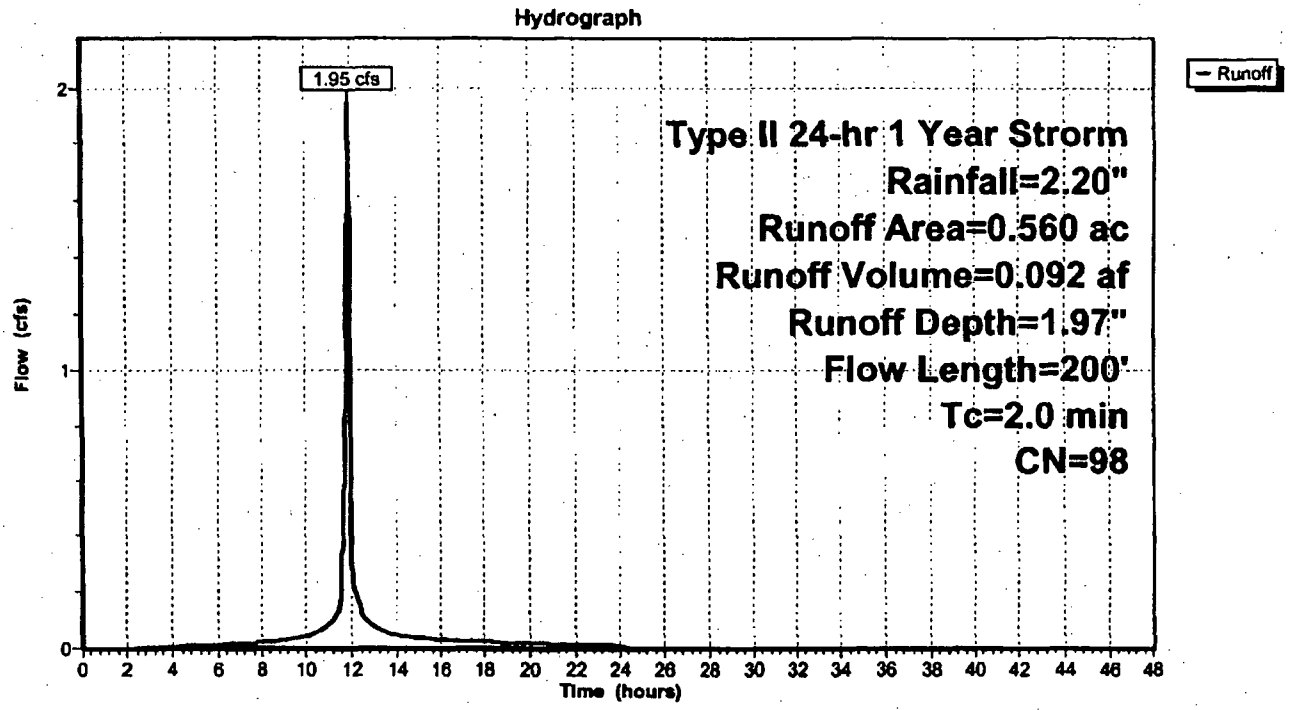
Runoff = 1.95 cfs @ 11.92 hrs, Volume= 0.092 af, Depth= 1.97"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type II 24-hr 1 Year Strorm Rainfall=2.20"

| Area (ac) | CN | Description |
|---|---|---|
| 0.560 | 98 | Area draing from SDA |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 1.4 | 100 | 0.0200 | 1.2 | | **Sheet Flow, A to B**<br>Smooth surfaces n= 0.011 P2= 2.50" |
| 0.6 | 100 | 0.0200 | 2.9 | | **Shallow Concentrated Flow, B to C**<br>Paved Kv= 20.3 fps |
| 2.0 | 200 | Total | | | |

## Subcatchment 7S: Subarea 5



## Subcatchment 8S: Subarea 4

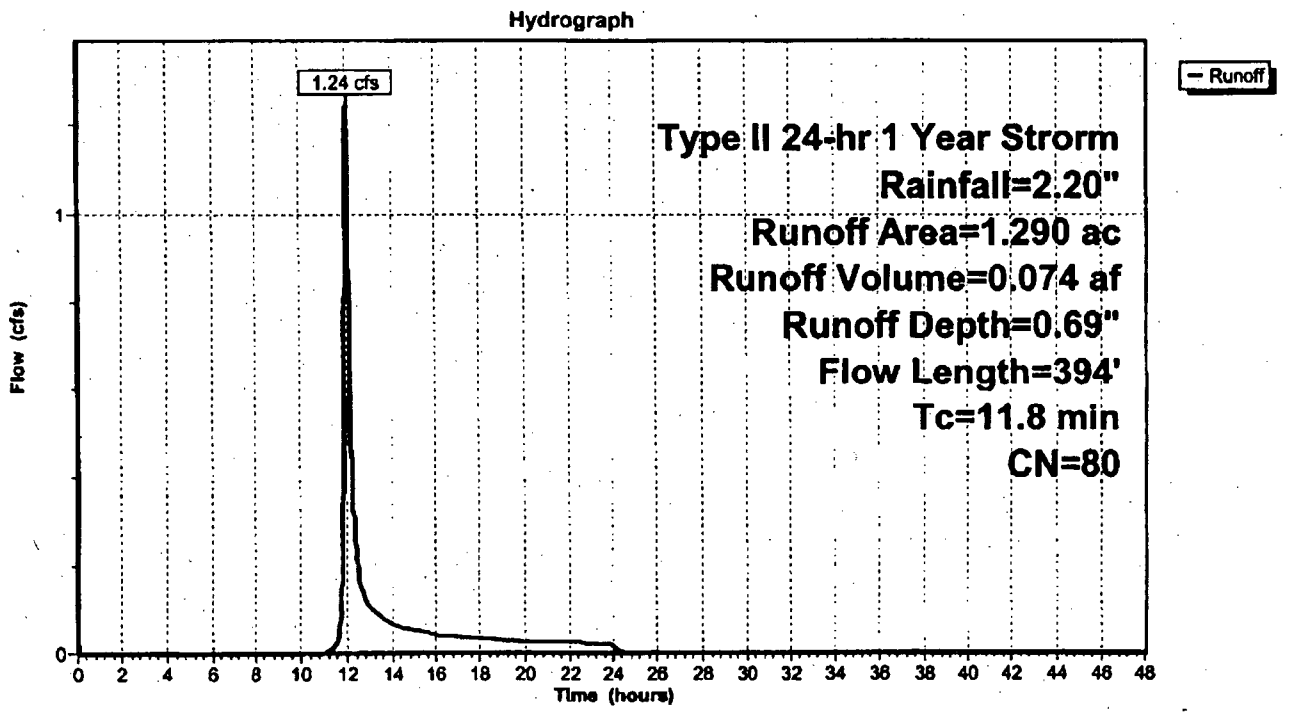
Runoff = 1.24 cfs @ 12.05 hrs, Volume= 0.074 af, Depth= 0.69"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type II 24-hr 1 Year Stroom Rainfall=2.20"

| Area (ac) | CN | Description |
|---|---|---|
| 1.290 | 80 | South area draining to 12" pipe |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 10.1 | 100 | 0.0250 | 0.2 | | **Sheet Flow, A to B**<br>Grass: Short n= 0.150 P2= 2.50" |
| 1.7 | 294 | 0.0310 | 2.8 | | **Shallow Concentrated Flow, B to C**<br>Unpaved Kv= 16.1 fps |
| 11.8 | 394 | Total | | | |

## Subcatchment 8S: Subarea 4



## Subcatchment 9S: Subarea #7

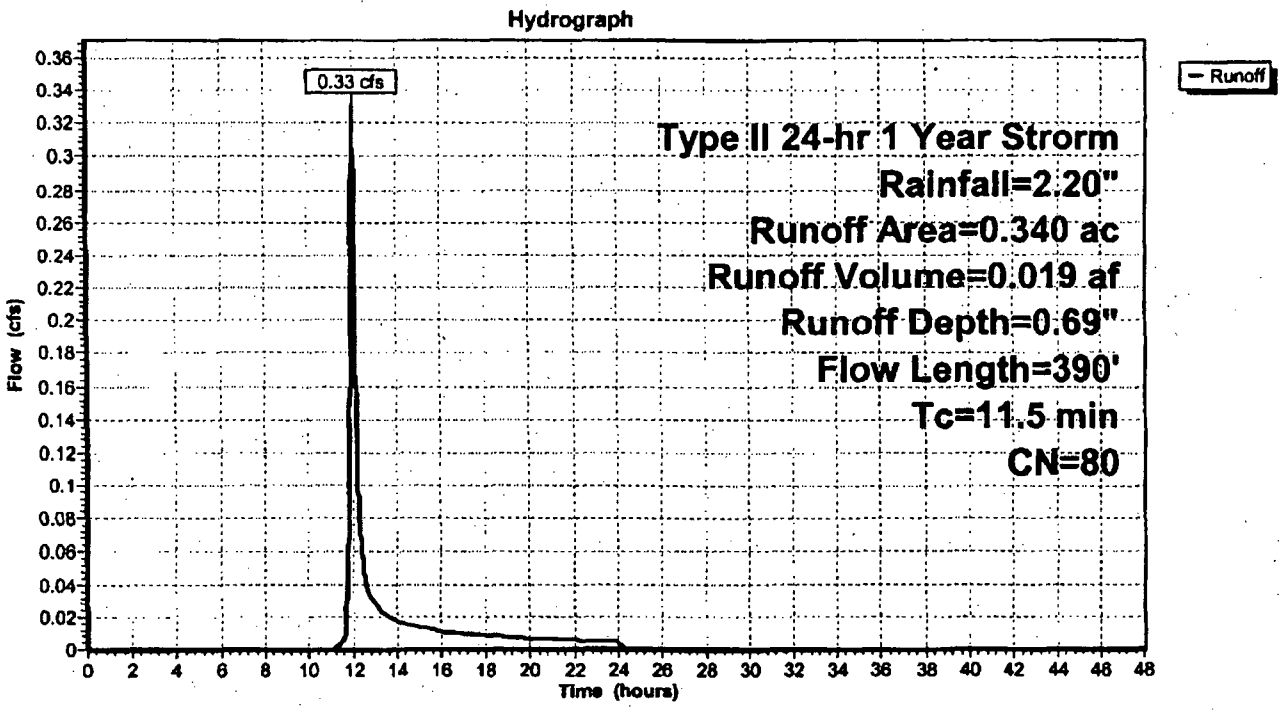
Runoff = 0.33 cfs @ 12.04 hrs, Volume= 0.019 af, Depth= 0.69"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type II 24-hr 1 Year Stroom Rainfall=2.20"

| Area (ac) | CN | Description |
|---|---|---|
| 0.340 | 80 | Exterior east side of cap |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 11.1 | 100 | 0.0200 | 0.2 | | **Sheet Flow, A to B**<br>Grass: Short n= 0.150 P2= 2.50" |
| 0.4 | 290 | 0.0450 | 13.5 | 486.27 | **Channel Flow, B to C**<br>Area= 36.0 sf Perim= 24.7' r= 1.46' n= 0.030 |
| 11.5 | 390 | Total | | | |

## Subcatchment 9S: Subarea #7



## Subcatchment 12S: Subarea #8

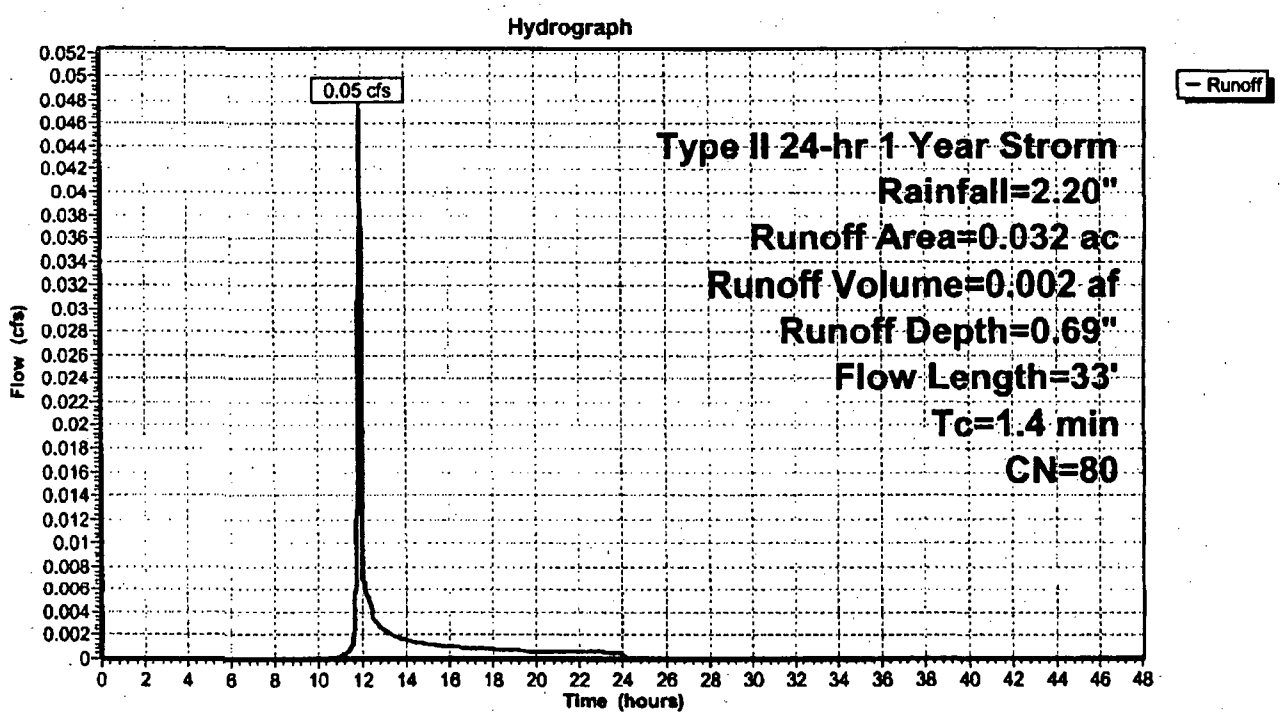
Runoff = 0.05 cfs @ 11.92 hrs, Volume= 0.002 af, Depth= 0.69"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type II 24-hr 1 Year Stroom Rainfall=2.20"

| Area (ac) | CN | Description |
|---|---|---|
| 0.032 | 80 | Northside from 24" to Basin #3 outlet |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 1.4 | 33 | 0.3900 | 0.4 | | **Sheet Flow, A to B**<br>Grass: Short n= 0.150 P2= 2.50" |

## Subcatchment 12S: Subarea #8



## Subcatchment 13S: Subarea #9

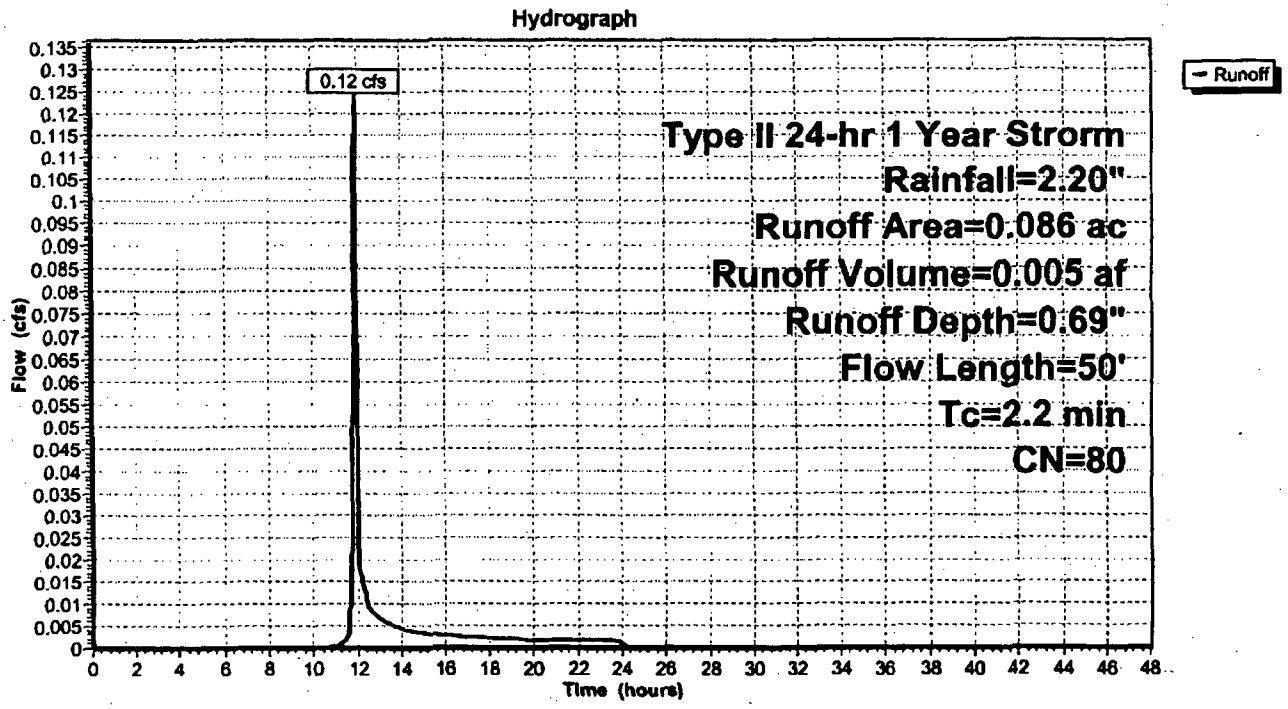
Runoff = 0.12 cfs @ 11.93 hrs, Volume= 0.005 af, Depth= 0.69"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type II 24-hr 1 Year Stroom Rainfall=2.20"

| Area (ac) | CN | Description |
|---|---|---|
| 0.086 | 80 | Northside from Basin #3 outlet to final reach |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 2.2 | 50 | 0.2900 | 0.4 | | **Sheet Flow, A to B**<br>Grass: Short n= 0.150 P2= 2.50" |

## Subcatchment 13S: Subarea #9



## Subcatchment 20S: Subarea #10

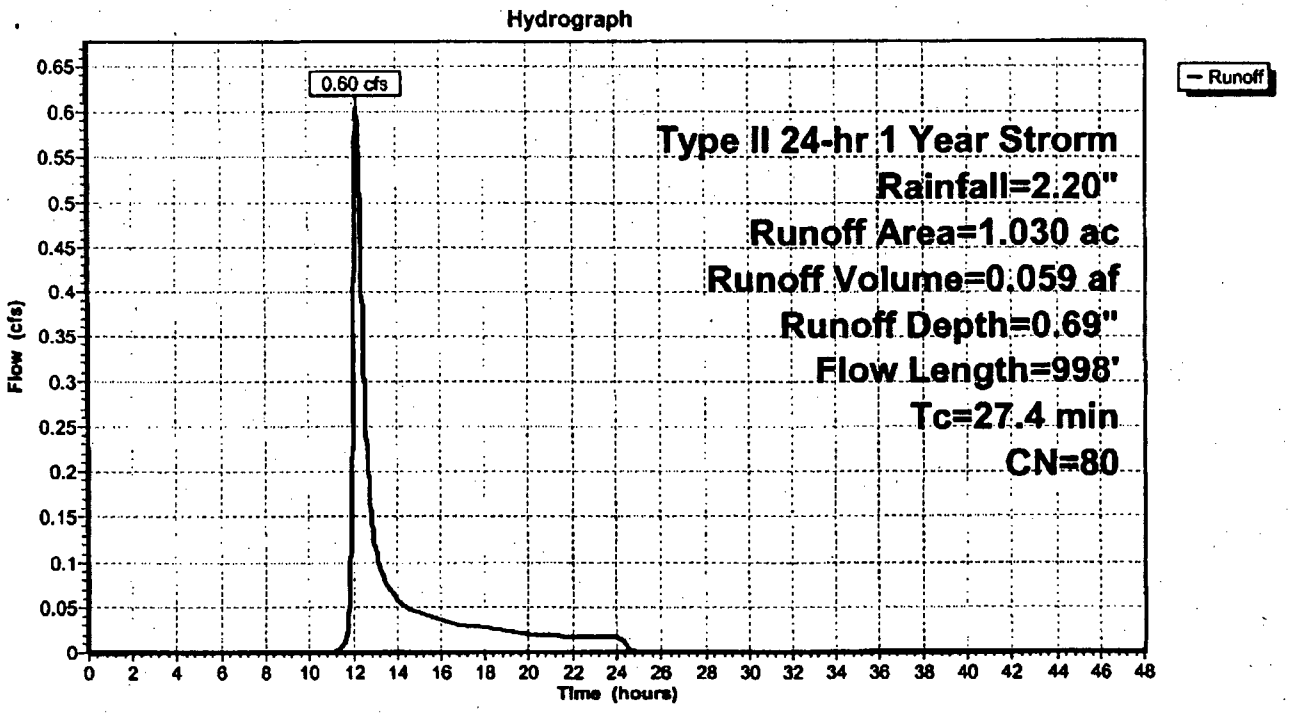
Runoff = 0.60 cfs @ 12.24 hrs, Volume= 0.059 af, Depth= 0.69"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type II 24-hr 1 Year Stroom Rainfall=2.20"

| Area (ac) | CN | Description |
|---|---|---|
| 1.030 | 80 | Northside along edge of cap |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 17.9 | 100 | 0.0060 | 0.1 | | **Sheet Flow, A to B**<br>Grass: Short n= 0.150 P2= 2.50" |
| 7.9 | 417 | 0.0030 | 0.9 | | **Shallow Concentrated Flow, B to C**<br>Unpaved Kv= 16.1 fps |
| 1.4 | 260 | 0.0350 | 3.0 | | **Shallow Concentrated Flow, C to D**<br>Unpaved Kv= 16.1 fps |
| 0.2 | 221 | 0.1150 | 21.6 | 777.35 | **Channel Flow, D to E**<br>Area= 36.0 sf Perim= 24.7' r= 1.46' n= 0.030 |
| 27.4 | 998 | Total | | | |

## Subcatchment 20S: Subarea #10



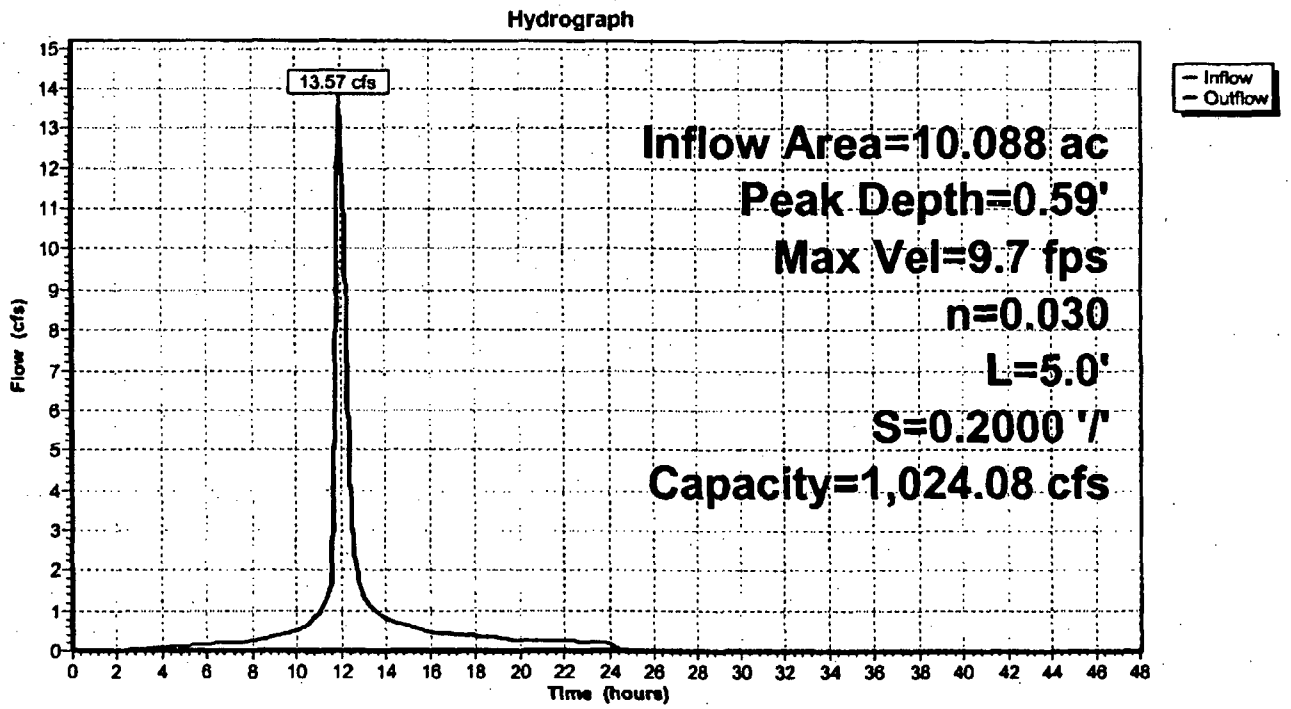
## Reach 6R: Erdman Brook

Inflow Area = 10.088 ac, Inflow Depth = 1.59" for 1 Year Stromm event
Inflow = 13.57 cfs @ 11.95 hrs, Volume= 1.333 af
Outflow = 13.57 cfs @ 11.95 hrs, Volume= 1.333 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Max. Velocity= 9.7 fps, Min. Travel Time= 0.0 min
Avg. Velocity = 3.8 fps, Avg. Travel Time= 0.0 min

Peak Depth= 0.59' @ 11.95 hrs
Capacity at bank full= 1,024.08 cfs
Inlet Invert= 1,353.50', Outlet Invert= 1,352.50'
0.00' x 3.00' deep channel, n= 0.030
Side Slope Z-value= 4.0 '/' Top Width= 24.00'
Length= 5.0' Slope= 0.2000 '/'

## Reach 6R: Erdman Brook



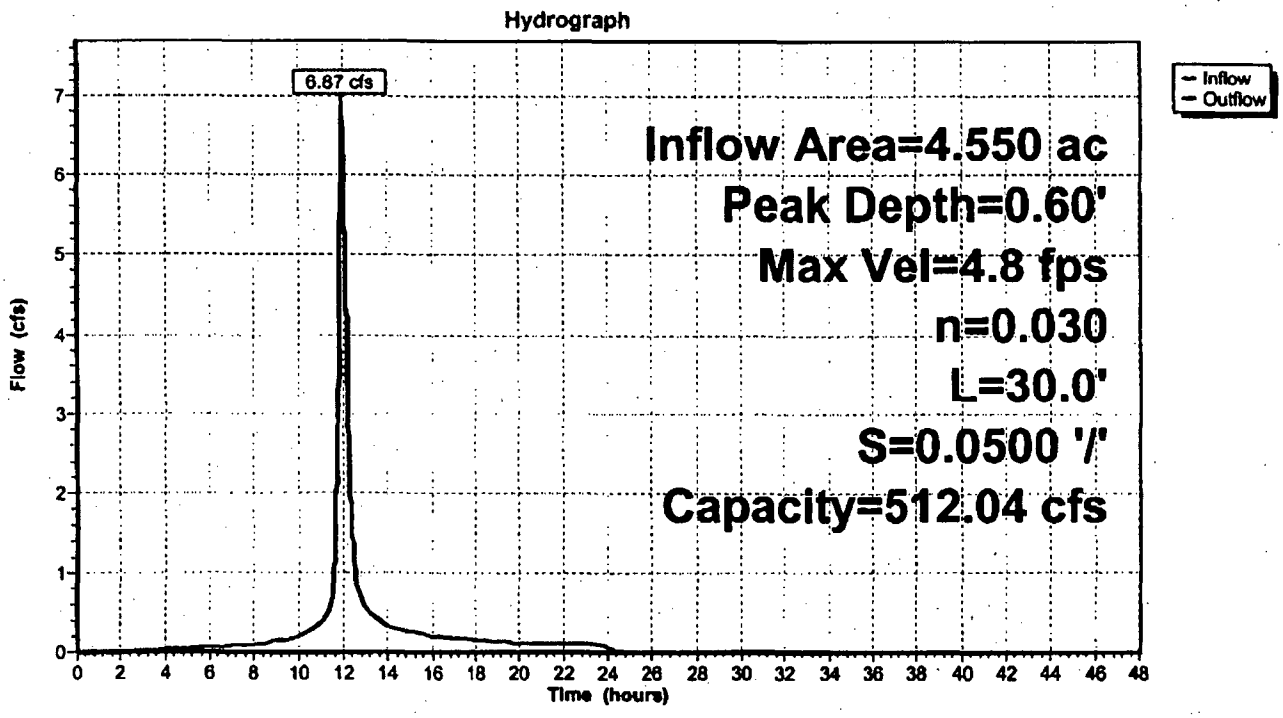
## Reach 14R: Reach #1

Inflow Area = 4.550 ac, Inflow Depth = 1.44" for 1 Year Stromm event
Inflow = 6.87 cfs @ 11.94 hrs, Volume= 0.546 af
Outflow = 6.87 cfs @ 11.94 hrs, Volume= 0.546 af, Atten= 0%, Lag= 0.1 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Max. Velocity= 4.8 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 1.8 fps, Avg. Travel Time= 0.3 min

Peak Depth= 0.60' @ 11.94 hrs
Capacity at bank full= 512.04 cfs
Inlet Invert= 1,366.00', Outlet Invert= 1,364.50'
0.00' x 3.00' deep channel, n= 0.030
Side Slope Z-value= 4.0 '/' Top Width= 24.00'
Length= 30.0' Slope= 0.0500 '/'

## Reach 14R: Reach #1



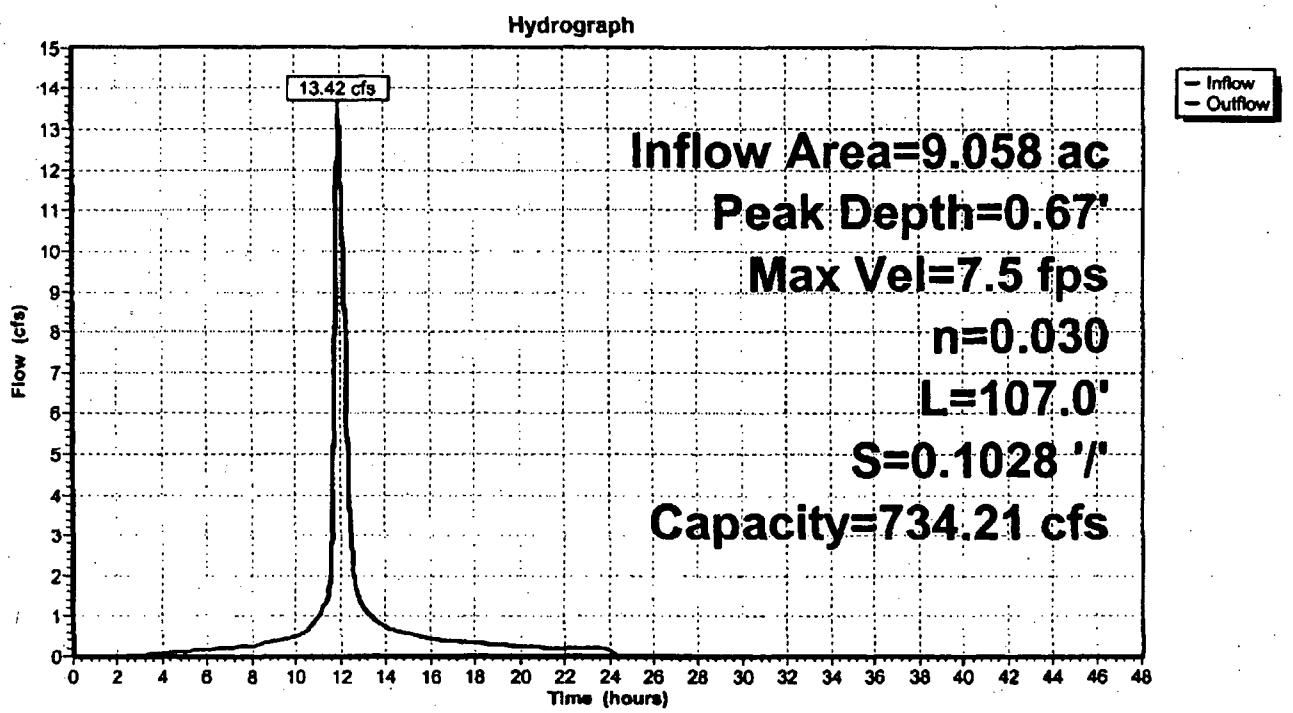
## Reach 15R: Reach #2

Inflow Area = 9.058 ac, Inflow Depth = 1.69" for 1 Year Storm event
Inflow = 13.42 cfs @ 11.95 hrs, Volume= 1.274 af
Outflow = 13.42 cfs @ 11.95 hrs, Volume= 1.274 af, Atten= 0%, Lag= 0.2 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Max. Velocity= 7.5 fps, Min. Travel Time= 0.2 min
Avg. Velocity = 3.0 fps, Avg. Travel Time= 0.6 min

Peak Depth= 0.67' @ 11.95 hrs
Capacity at bank full= 734.21 cfs
Inlet Invert= 1,364.50', Outlet Invert= 1,353.50'
0.00' x 3.00' deep channel, n= 0.030
Side Slope Z-value= 4.0 '/' Top Width= 24.00'
Length= 107.0' Slope= 0.1028 '/'

## Reach 15R: Reach #2



## Pond 3P: Basin #1

| | | | | | |
|---|---|---|---|---|---|
| Inflow Area = | 2.660 ac, | Inflow Depth = | 1.97" | for | 1 Year Stroom event |
| Inflow = | 9.38 cfs @ | 11.92 hrs, | Volume= | 0.437 af | |
| Outflow = | 8.95 cfs @ | 11.93 hrs, | Volume= | 0.437 af, | Atten= 5%, Lag= 0.8 min |
| Primary = | 8.95 cfs @ | 11.93 hrs, | Volume= | 0.437 af | |

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Peak Elev= 1,379.57' @ 11.93 hrs Surf.Area= 0 sf Storage= 654 cf
Plug-Flow detention time= 1.2 min calculated for 0.437 af (100% of inflow)
Center-of-Mass det. time= 1.2 min ( 758.4 - 757.2 )

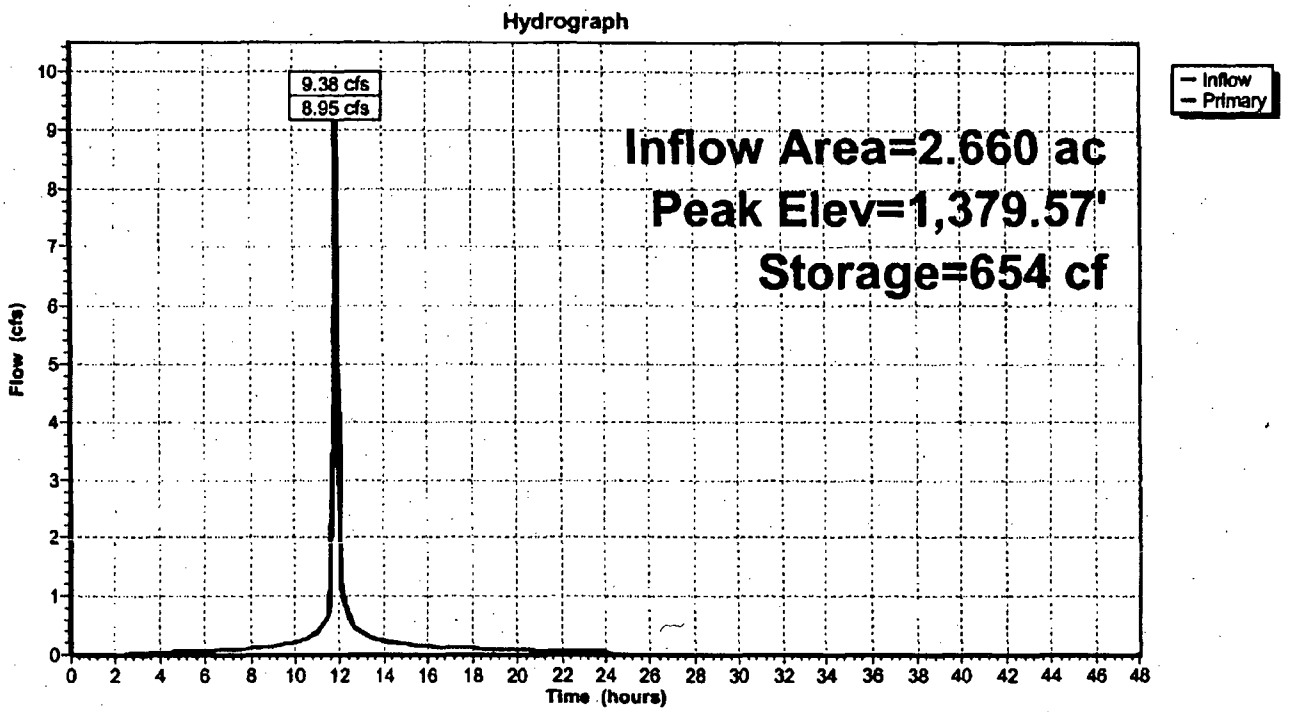
| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 1,379.00' | 8,505 cf | **Custom Stage Data** Listed below |

| Elevation (feet) | Inc.Store (cubic-feet) | Cum.Store (cubic-feet) |
|---|---|---|
| 1,379.00 | 0 | 0 |
| 1,380.00 | 1,145 | 1,145 |
| 1,381.00 | 2,659 | 3,804 |
| 1,382.00 | 4,701 | 8,505 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 0.00' | **Special & User-Defined**<br>Elev. (feet) 1,379.00 1,380.00 1,381.00 1,382.00<br>Disch. (cfs) 0.000 15.680 20.250 23.960 |

**Primary OutFlow** Max=8.94 cfs @ 11.93 hrs HW=1,379.57' TW=1,377.24' (Dynamic Tailwater)
└─**1=Special & User-Defined** (Custom Controls 8.94 cfs)

## Pond 3P: Basin #1



## Pond 4P: Basin #2

| | | | | | |
|---|---|---|---|---|---|
| Inflow Area = | 1.890 ac, | Inflow Depth = | 1.97" | for | 1 Year Stroom event |
| Inflow = | 6.85 cfs @ | 11.91 hrs, | Volume= | 0.311 af | |
| Outflow = | 3.09 cfs @ | 11.97 hrs, | Volume= | 0.311 af, | Atten= 55%, Lag= 3.9 min |
| Primary = | 3.09 cfs @ | 11.97 hrs, | Volume= | 0.311 af | |

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Peak Elev= 1,378.63' @ 11.97 hrs Surf.Area= 0 sf Storage= 2,563 cf
Plug-Flow detention time= 8.7 min calculated for 0.311 af (100% of inflow)
Center-of-Mass det. time= 8.7 min ( 764.9 - 756.2 )

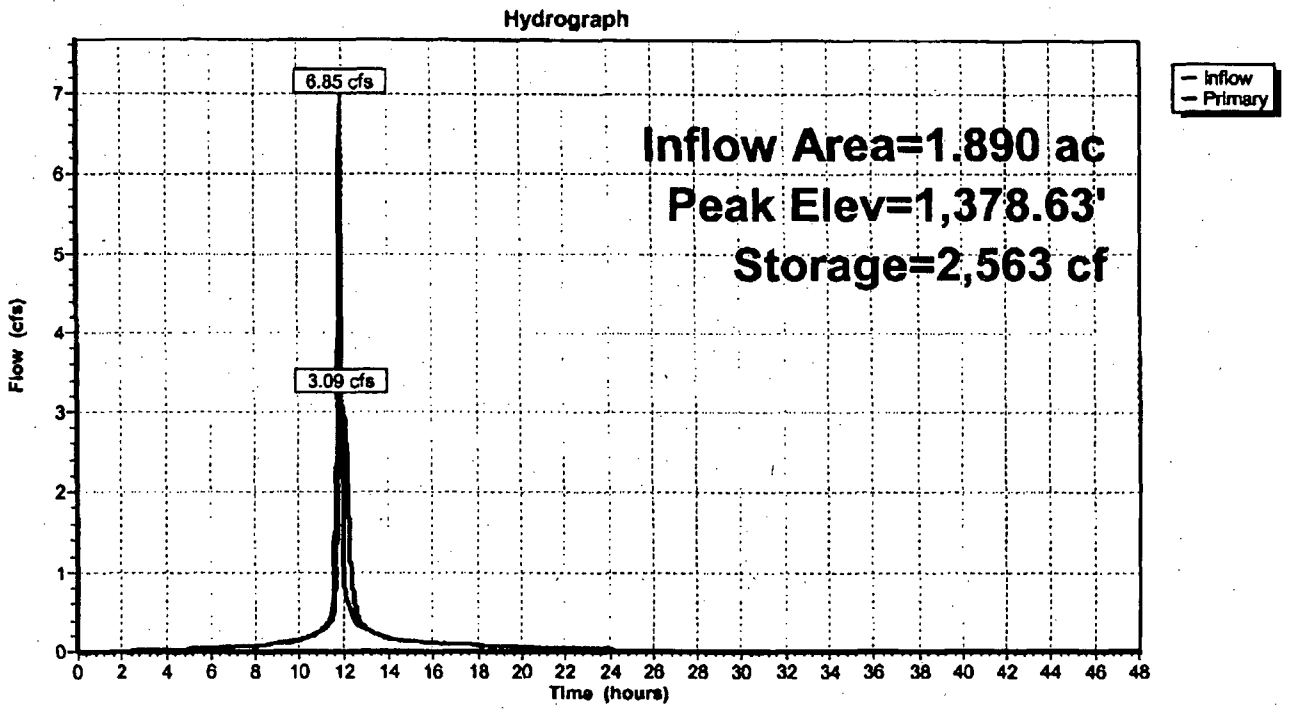
| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 1,377.00' | 8,556 cf | **Custom Stage Data** Listed below |

| Elevation (feet) | Inc.Store (cubic-feet) | Cum.Store (cubic-feet) |
|---|---|---|
| 1,377.00 | 0 | 0 |
| 1,378.00 | 1,300 | 1,300 |
| 1,379.00 | 1,993 | 3,293 |
| 1,380.00 | 5,263 | 8,556 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 0.00' | **Special & User-Defined**<br>Elev. (feet) 1,377.00 1,378.00 1,379.00 1,380.00<br>Disch. (cfs) 0.000 2.780 3.270 3.700 |

**Primary OutFlow** Max=3.09 cfs @ 11.97 hrs HW=1,378.63' TW=1,376.66' (Dynamic Tailwater)
└─**1=Special & User-Defined** (Custom Controls 3.09 cfs)

## Pond 4P: Basin #2



## Pond 5P: Basin #3

| | | | | | |
|---|---|---|---|---|---|
| Inflow Area = | 4.390 ac, | Inflow Depth = | 1.97" | for | 1 Year Stroom event |
| Inflow = | 14.59 cfs @ | 11.94 hrs, | Volume= | 0.722 af | |
| Outflow = | 6.55 cfs @ | 12.02 hrs, | Volume= | 0.722 af, | Atten= 55%, Lag= 5.0 min |
| Primary = | 6.55 cfs @ | 12.02 hrs, | Volume= | 0.722 af | |

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Peak Elev= 1,377.47' @ 12.02 hrs Surf.Area= 0 sf Storage= 5,809 cf
Plug-Flow detention time= 8.2 min calculated for 0.722 af (100% of inflow)
Center-of-Mass det. time= 8.2 min ( 767.0 - 758.8 )

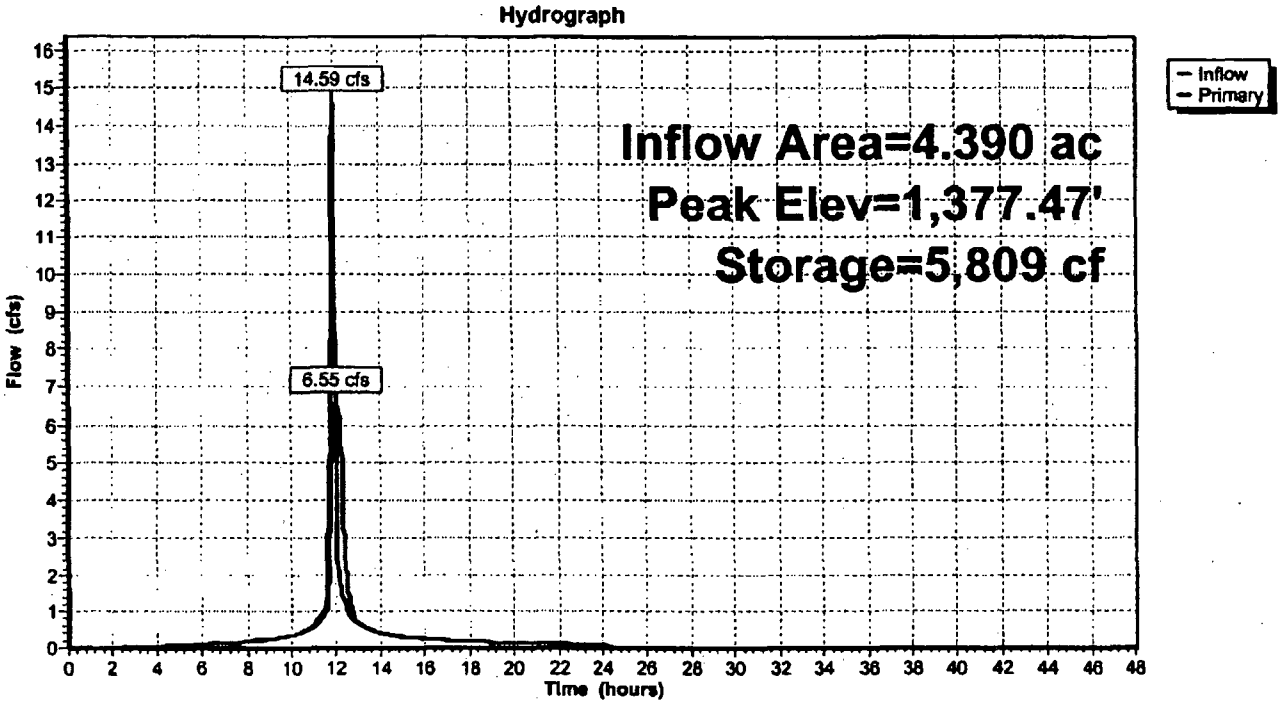
| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 1,376.00' | 21,103 cf | **Custom Stage Data** Listed below |

| Elevation (feet) | Inc.Store (cubic-feet) | Cum.Store (cubic-feet) |
|---|---|---|
| 1,376.00 | 0 | 0 |
| 1,377.00 | 2,549 | 2,549 |
| 1,378.00 | 6,932 | 9,481 |
| 1,379.00 | 11,622 | 21,103 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 0.00' | **Special & User-Defined**<br>Elev. (feet) 1,376.00 1,377.00 1,378.00 1,379.00<br>Disch. (cfs) 0.000 6.110 7.050 7.890 |

**Primary OutFlow** Max=6.55 cfs @ 12.02 hrs HW=1,377.47' TW=1,365.15' (Dynamic Tailwater)
└─**1=Special & User-Defined** (Custom Controls 6.55 cfs)

## Pond 5P: Basin #3



## Pond 16P: 18"

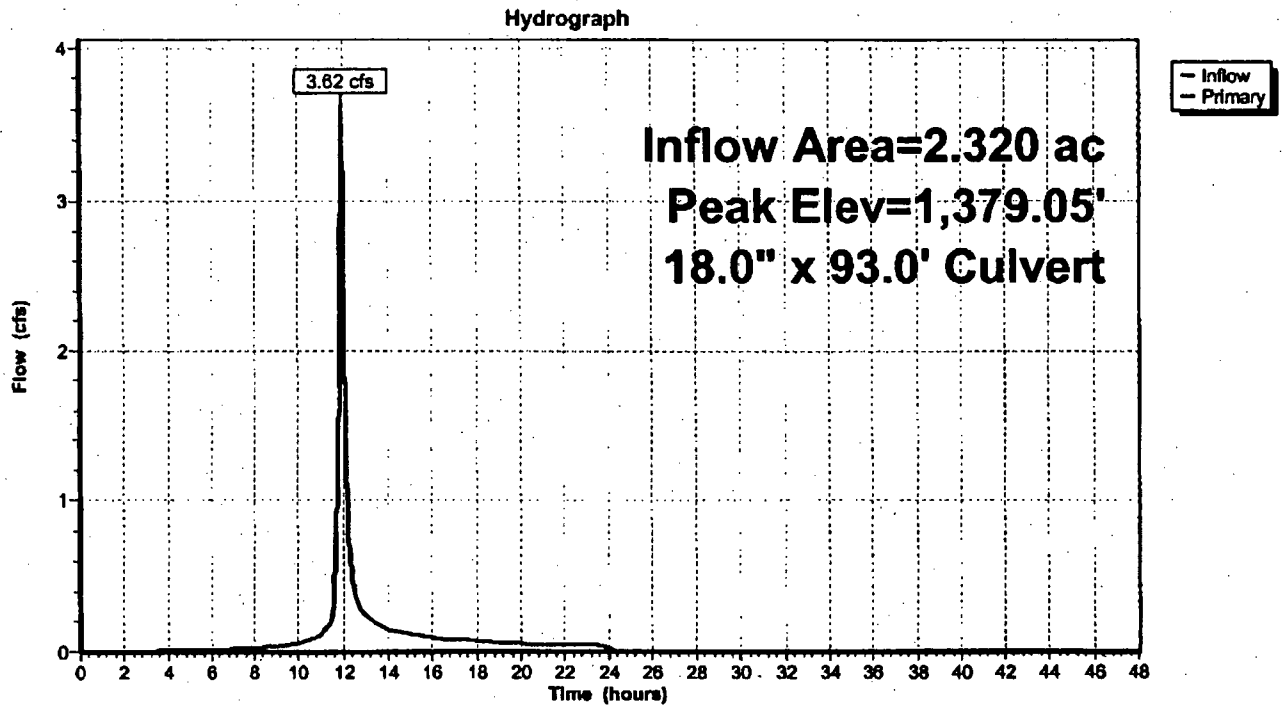
| | | | | | |
|---|---|---|---|---|---|
| Inflow Area = | 2.320 ac, | Inflow Depth = | 1.12" | for | 1 Year Stroom event |
| Inflow = | 3.62 cfs @ | 11.94 hrs, | Volume= | 0.216 af | |
| Outflow = | 3.62 cfs @ | 11.94 hrs, | Volume= | 0.216 af, | Atten= 0%, Lag= 0.0 min |
| Primary = | 3.62 cfs @ | 11.94 hrs, | Volume= | 0.216 af | |

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Peak Elev= 1,379.05' @ 11.94 hrs
Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 0.0 min ( 808.7 - 808.7 )

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 1,378.00' | **18.0" x 93.0' long Culvert** CMP, projecting, no headwall, Ke= 0.900<br>Outlet Invert= 1,375.50' S= 0.0269 '/' Cc= 0.900<br>n= 0.013 Corrugated PE, smooth interior |

**Primary OutFlow** Max=3.61 cfs @ 11.94 hrs HW=1,379.04' TW=1,376.69' (Dynamic Tailwater)
└**1=Culvert** (Inlet Controls 3.61 cfs @ 2.7 fps)

## Pond 16P: 18"



## Pond 17P: Existing 24" Pipe

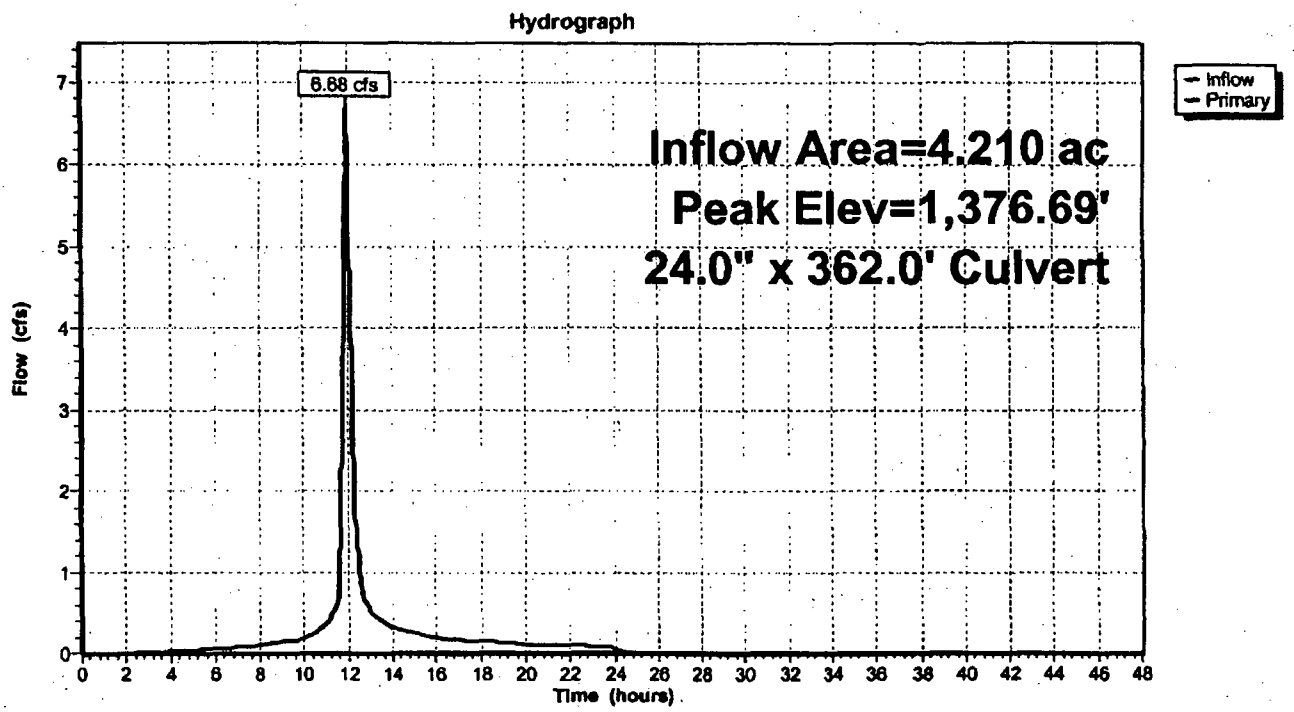
| | | | | | |
|---|---|---|---|---|---|
| Inflow Area = | 4.210 ac, | Inflow Depth = | 1.50" | for | 1 Year Stromm event |
| Inflow = | 6.68 cfs @ | 11.94 hrs, | Volume= | 0.526 af | |
| Outflow = | 6.68 cfs @ | 11.94 hrs, | Volume= | 0.526 af, | Atten= 0%, Lag= 0.0 min |
| Primary = | 6.68 cfs @ | 11.94 hrs, | Volume= | 0.526 af | |

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Peak Elev= 1,376.69' @ 11.94 hrs
Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 0.0 min ( 782.8 - 782.8 )

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 1,375.38' | **24.0" x 362.0' long Culvert** CMP, projecting, no headwall, Ke= 0.900<br>Outlet Invert= 1,366.00' S= 0.0259 '/' Cc= 0.900<br>n= 0.013 Corrugated PE, smooth interior |

**Primary OutFlow** Max=6.68 cfs @ 11.94 hrs HW=1,376.69' TW=1,366.60' (Dynamic Tailwater)
└**1=Culvert** (Inlet Controls 6.68 cfs @ 3.1 fps)

## Pond 17P: Existing 24" Pipe



## Pond 18P: 12"

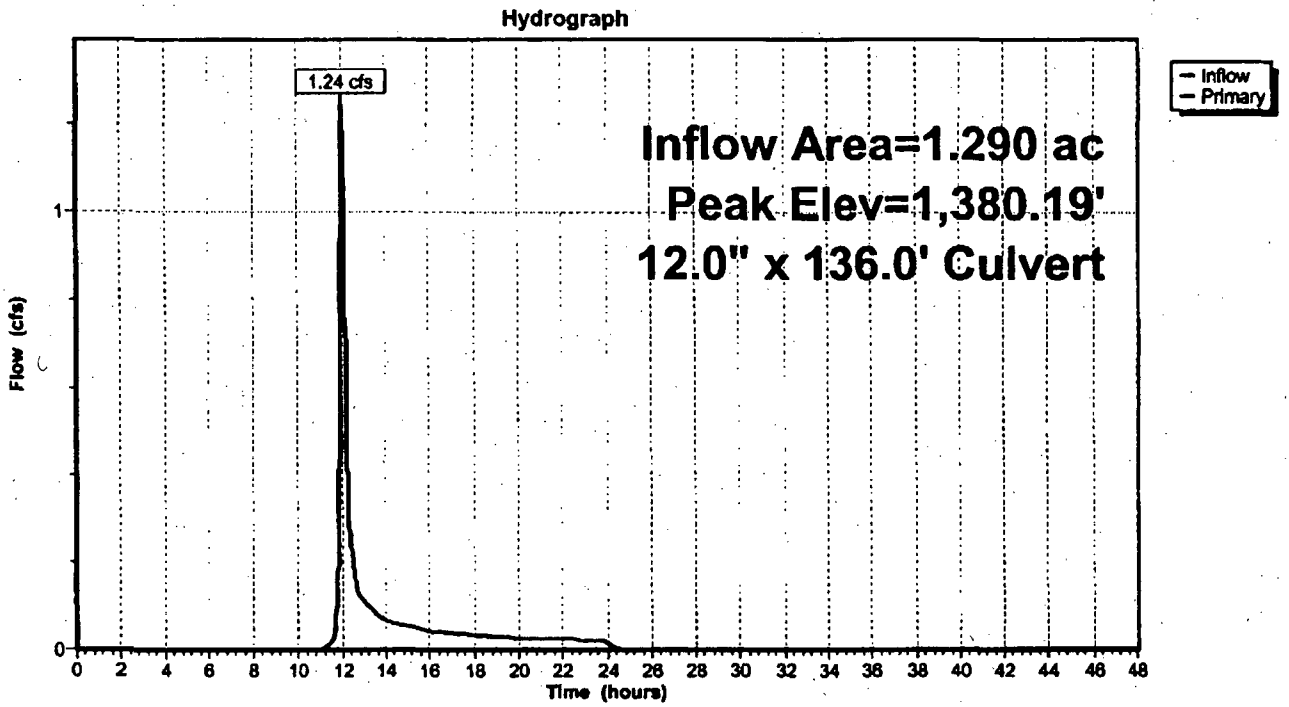
| | | | | | |
|---|---|---|---|---|---|
| Inflow Area = | 1.290 ac, | Inflow Depth = | 0.69" | for | 1 Year Stroom event |
| Inflow = | 1.24 cfs @ | 12.05 hrs, | Volume= | 0.074 af | |
| Outflow = | 1.24 cfs @ | 12.05 hrs, | Volume= | 0.074 af, | Atten= 0%, Lag= 0.0 min |
| Primary = | 1.24 cfs @ | 12.05 hrs, | Volume= | 0.074 af | |

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Peak Elev= 1,380.19' @ 12.05 hrs
Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 0.0 min ( 866.3 - 866.3 )

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 1,379.50' | **12.0" x 136.0' long Culvert** CMP, projecting, no headwall, Ke= 0.900<br>Outlet Invert= 1,378.82' S= 0.0050 '/' Cc= 0.900<br>n= 0.013 Corrugated PE, smooth interior |

**Primary OutFlow** Max=1.24 cfs @ 12.05 hrs HW=1,380.19' TW=1,378.73' (Dynamic Tailwater)
└─**1=Culvert** (Barrel Controls 1.24 cfs @ 3.0 fps)

## Pond 18P: 12"



## Pond 19P: 18"

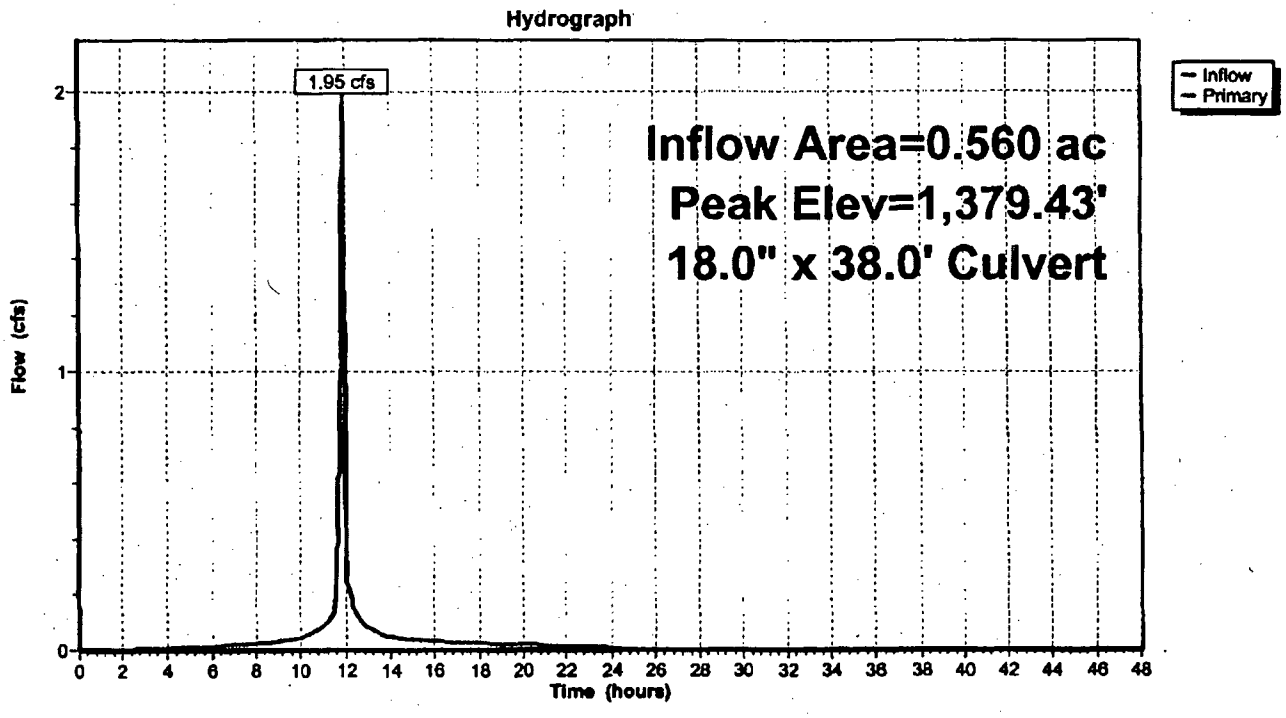
| | | | | | |
|---|---|---|---|---|---|
| Inflow Area = | 0.560 ac, | Inflow Depth = | 1.97" | for | 1 Year Stromm event |
| Inflow = | 1.95 cfs @ | 11.92 hrs, | Volume= | 0.092 af | |
| Outflow = | 1.95 cfs @ | 11.92 hrs, | Volume= | 0.092 af, | Atten= 0%, Lag= 0.0 min |
| Primary = | 1.95 cfs @ | 11.92 hrs, | Volume= | 0.092 af | |

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Peak Elev= 1,379.43' @ 11.93 hrs
Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 0.0 min ( 757.6 - 757.6 )

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 1,378.50' | **18.0" x 38.0' long Culvert** CMP, projecting, no headwall, Ke= 0.900<br>Outlet Invert= 1,378.00' S= 0.0132 '/' Cc= 0.900<br>n= 0.025 Corrugated metal |

**Primary OutFlow** Max=1.88 cfs @ 11.92 hrs HW=1,379.43' TW=1,379.03' (Dynamic Tailwater)
└─**1=Culvert** (Outlet Controls 1.88 cfs @ 2.3 fps)

## Pond 19P: 18"



Time span=0.00-48.00 hrs, dt=0.01 hrs, 4801 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

**Subcatchment 1S: Subarea 1** Runoff Area=2.660 ac Runoff Depth=3.37"
Flow Length=629' Tc=1.6 min CN=98 Runoff=15.55 cfs 0.746 af

**Subcatchment 2S: Subarea #2** Runoff Area=1.890 ac Runoff Depth=3.37"
Flow Length=486' Tc=0.5 min CN=98 Runoff=11.35 cfs 0.530 af

**Subcatchment 3s: Subarea 3** Runoff Area=1.730 ac Runoff Depth=3.37"
Flow Length=473' Tc=3.8 min CN=98 Runoff=9.46 cfs 0.485 af

**Subcatchment 6S: Subarea 6** Runoff Area=0.470 ac Runoff Depth=2.54"
Flow Length=530' Tc=4.6 min CN=90 Runoff=2.14 cfs 0.100 af

**Subcatchment 7S: Subarea 5** Runoff Area=0.560 ac Runoff Depth=3.37"
Flow Length=200' Tc=2.0 min CN=98 Runoff=3.23 cfs 0.157 af

**Subcatchment 8S: Subarea 4** Runoff Area=1.290 ac Runoff Depth=1.72"
Flow Length=394' Tc=11.8 min CN=80 Runoff=3.20 cfs 0.184 af

**Subcatchment 9S: Subarea #7** Runoff Area=0.340 ac Runoff Depth=1.72"
Flow Length=390' Tc=11.5 min CN=80 Runoff=0.85 cfs 0.049 af

**Subcatchment 12S: Subarea #8** Runoff Area=0.032 ac Runoff Depth=1.72"
Flow Length=33' Tc=1.4 min CN=80 Runoff=0.12 cfs 0.005 af

**Subcatchment 13S: Subarea #9** Runoff Area=0.086 ac Runoff Depth=1.72"
Flow Length=50' Tc=2.2 min CN=80 Runoff=0.30 cfs 0.012 af

**Subcatchment 20S: Subarea #10** Runoff Area=1.030 ac Runoff Depth=1.72"
Flow Length=998' Tc=27.4 min CN=80 Runoff=1.62 cfs 0.147 af

**Reach 6R: Erdman Brook** Peak Depth=0.67' Max Vel=10.5 fps Inflow=19.19 cfs 2.416 af
n=0.030 L=5.0' S=0.2000 '/' Capacity=1,024.08 cfs Outflow=19.19 cfs 2.416 af

**Reach 14R: Reach #1** Peak Depth=0.72' Max Vel=5.5 fps Inflow=11.20 cfs 1.020 af
n=0.030 L=30.0' S=0.0500 '/' Capacity=512.04 cfs Outflow=11.20 cfs 1.020 af

**Reach 15R: Reach #2** Peak Depth=0.76' Max Vel=8.1 fps Inflow=18.64 cfs 2.268 af
n=0.030 L=107.0' S=0.1028 '/' Capacity=734.21 cfs Outflow=18.64 cfs 2.268 af

**Pond 3P: Basin #1** Peak Elev=1,379.95' Storage=1,084 cf Inflow=15.55 cfs 0.746 af
Outflow=14.85 cfs 0.746 af

**Pond 4P: Basin #2** Peak Elev=1,379.39' Storage=5,341 cf Inflow=11.35 cfs 0.530 af
Outflow=3.44 cfs 0.530 af

| | | | |
|---|---|---|---|
| **Pond 5P: Basin #3** | Peak Elev=1,378.26' Storage=12,455 cf | Inflow=24.21 cfs | 1.231 af |
| | | Outflow=7.26 cfs | 1.231 af |
| **Pond 16P: 18"** | Peak Elev=1,379.90' | Inflow=7.22 cfs | 0.441 af |
| | 18.0" x 93.0' Culvert | Outflow=7.22 cfs | 0.441 af |
| **Pond 17P: Existing 24" Pipe** | Peak Elev=1,377.16' | Inflow=10.62 cfs | 0.971 af |
| | 24.0" x 362.0' Culvert | Outflow=10.62 cfs | 0.971 af |
| **Pond 18P: 12"** | Peak Elev=1,381.41' | Inflow=3.20 cfs | 0.184 af |
| | 12.0" x 136.0' Culvert | Outflow=3.20 cfs | 0.184 af |
| **Pond 19P: 18"** | Peak Elev=1,380.12' | Inflow=3.23 cfs | 0.157 af |
| | 18.0" x 38.0' Culvert | Outflow=3.23 cfs | 0.157 af |

**Total Runoff Area = 10.088 ac Runoff Volume = 2.416 af Average Runoff Depth = 2.87"**

## Subcatchment 1S: Subarea 1

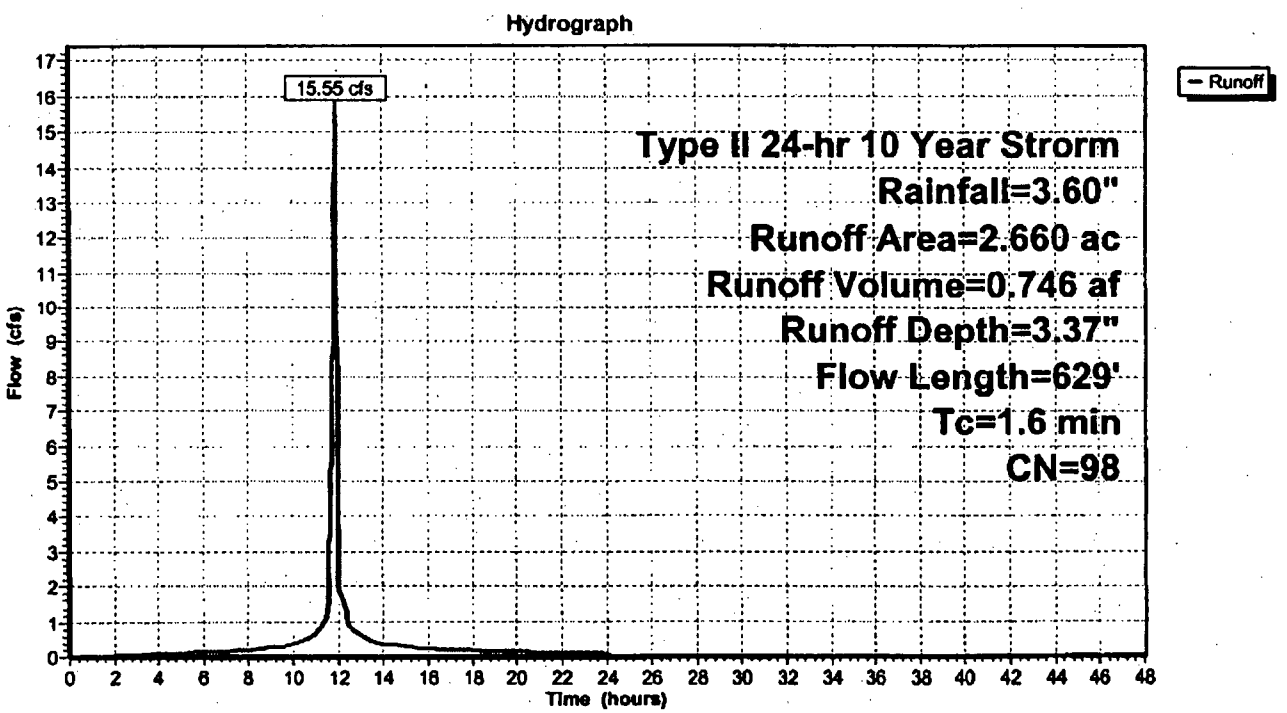
Runoff = 15.55 cfs @ 11.92 hrs, Volume= 0.746 af, Depth= 3.37"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type II 24-hr 10 Year Strorm Rainfall=3.60"

| Area (ac) | CN | Description |
|---|---|---|
| 2.660 | 98 | North and West Sides of Cap |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 0.0 | 2 | 0.1250 | 1.2 | | **Sheet Flow, A to B** Smooth surfaces n= 0.011 P2= 2.50" |
| 0.0 | 37 | 0.0270 | 13.8 | 55.02 | **Channel Flow, B to C** Area= 4.0 sf Perim= 8.2' r= 0.49' n= 0.011 |
| 1.3 | 357 | 0.0028 | 4.5 | 76.40 | **Channel Flow, C to D** Area= 17.0 sf Perim= 34.1' r= 0.50' n= 0.011 |
| 0.2 | 104 | 0.0097 | 8.3 | 70.69 | **Channel Flow, D to E** Area= 8.5 sf Perim= 17.2' r= 0.49' n= 0.011 |
| 0.1 | 129 | 0.0466 | 29.0 | 985.72 | **Channel Flow, E to F** Area= 34.0 sf Perim= 34.3' r= 0.99' n= 0.011 |
| 1.6 | 629 | Total | | | |

## Subcatchment 1S: Subarea 1



## Subcatchment 2S: Subarea #2

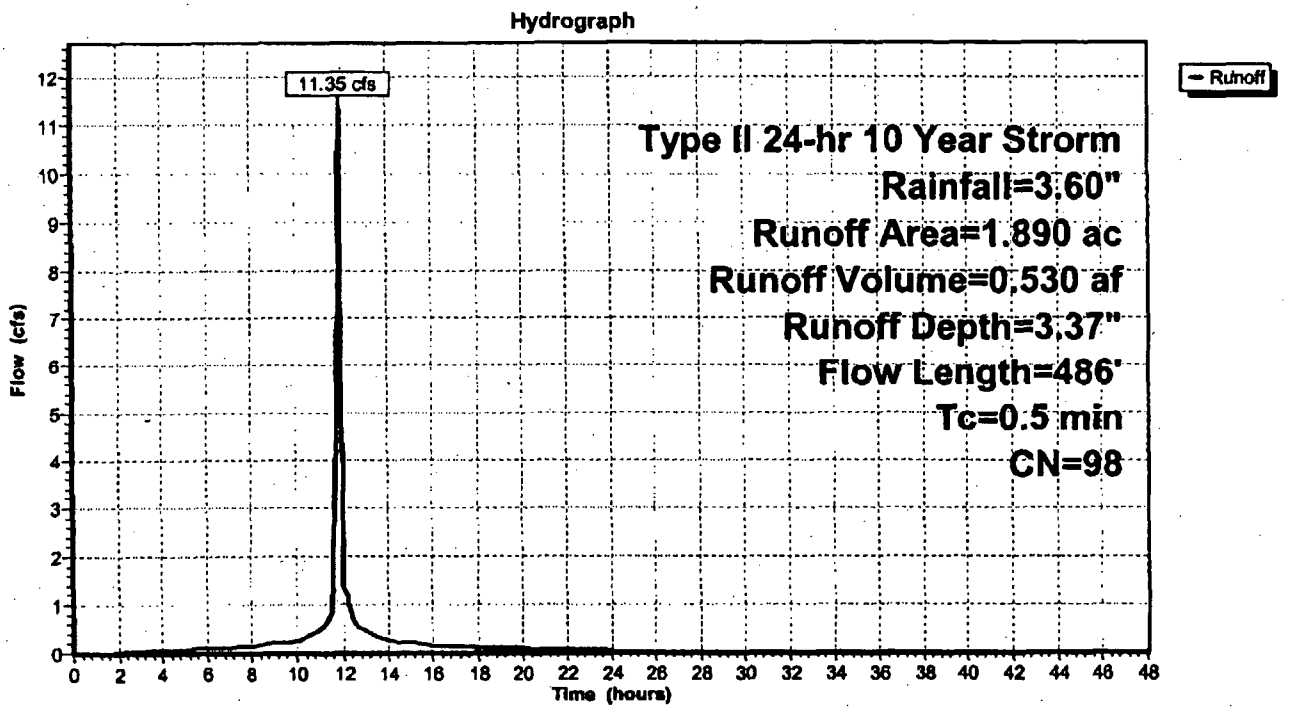
Runoff = 11.35 cfs @ 11.91 hrs, Volume= 0.530 af, Depth= 3.37"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type II 24-hr 10 Year Strorm Rainfall=3.60"

| Area (ac) | CN | Description |
|---|---|---|
| 1.890 | 98 | South Side of Cap |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 0.0 | 2 | 0.1250 | 1.2 | | **Sheet Flow, A to B** Smooth surfaces n= 0.011 P2= 2.50" |
| 0.2 | 102 | 0.0100 | 8.4 | 33.48 | **Channel Flow, B to C** Area= 4.0 sf Perim= 8.2' r= 0.49' n= 0.011 |
| 0.3 | 360 | 0.0250 | 20.9 | 334.82 | **Channel Flow, C to D** Area= 16.0 sf Perim= 16.5' r= 0.97' n= 0.011 |
| 0.0 | 22 | 0.0450 | 28.1 | 449.20 | **Channel Flow, D to E** Area= 16.0 sf Perim= 16.5' r= 0.97' n= 0.011 |
| 0.5 | 486 | Total | | | |

## Subcatchment 2S: Subarea #2



## Subcatchment 3s: Subarea 3

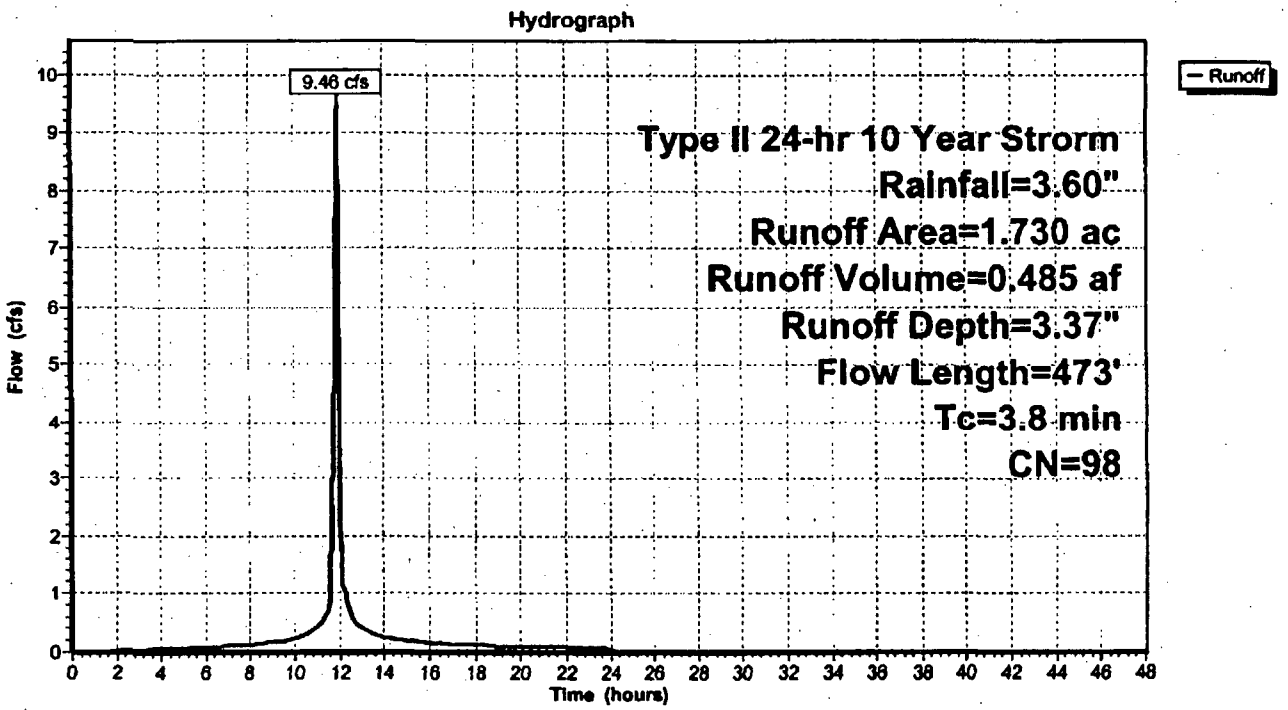
Runoff = 9.46 cfs @ 11.94 hrs, Volume= 0.485 af, Depth= 3.37"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type II 24-hr 10 Year Stroom Rainfall=3.60"

| Area (ac) | CN | Description |
|---|---|---|
| 1.730 | 98 | North and East Sides of Cap |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 1.6 | 100 | 0.0130 | 1.0 | | **Sheet Flow, A to B**<br>Smooth surfaces n= 0.011 P2= 2.50" |
| 1.8 | 243 | 0.0120 | 2.2 | | **Shallow Concentrated Flow, B to C**<br>Paved Kv= 20.3 fps |
| 0.4 | 130 | 0.0850 | 5.9 | | **Shallow Concentrated Flow, C to D**<br>Paved Kv= 20.3 fps |
| 3.8 | 473 | Total | | | |

## Subcatchment 3s: Subarea 3



## Subcatchment 6S: Subarea 6

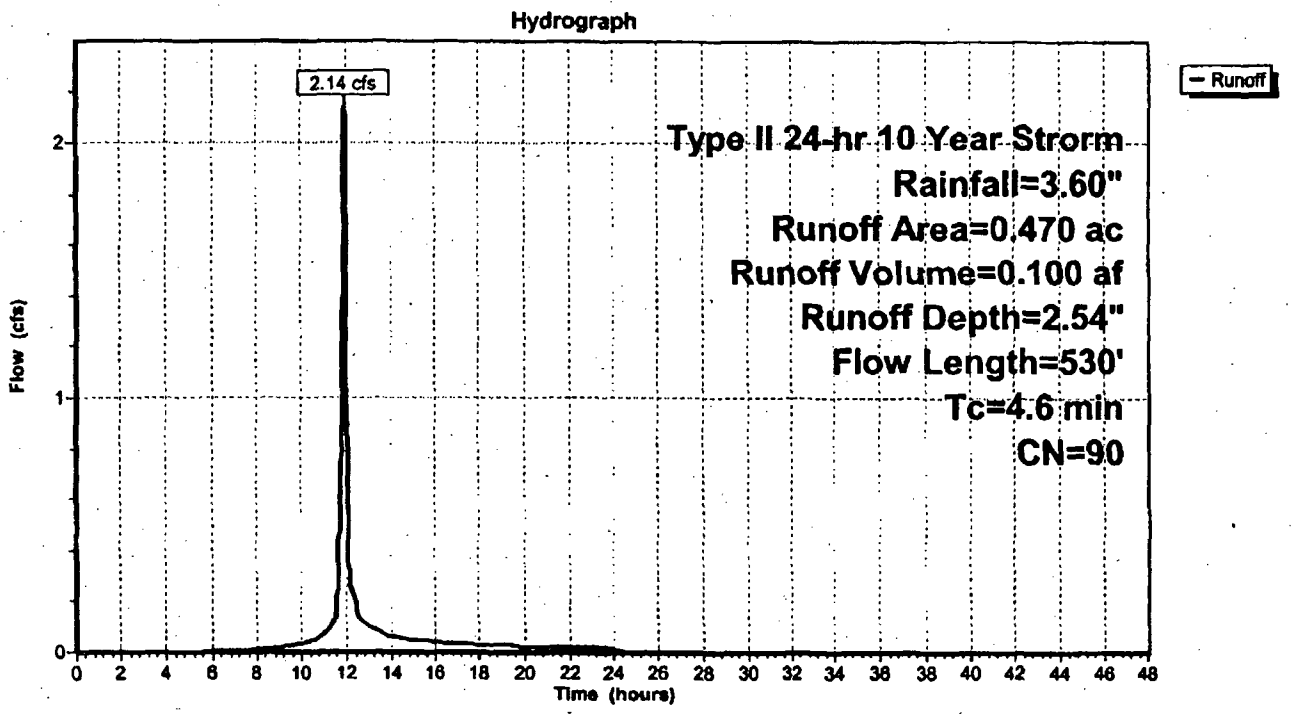
Runoff = 2.14 cfs @ 11.95 hrs, Volume= 0.100 af, Depth= 2.54"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type II 24-hr 10 Year Strorm Rainfall=3.60"

| Area (ac) | CN | Description |
|---|---|---|
| 0.470 | 90 | South area along edge of cap |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 1.2 | 100 | 0.0260 | 1.4 | | **Sheet Flow, A to B** Smooth surfaces n= 0.011 P2= 2.50" |
| 3.4 | 430 | 0.0170 | 2.1 | | **Shallow Concentrated Flow, B to C** Unpaved Kv= 16.1 fps |
| 4.6 | 530 | Total | | | |

## Subcatchment 6S: Subarea 6



## Subcatchment 7S: Subarea 5

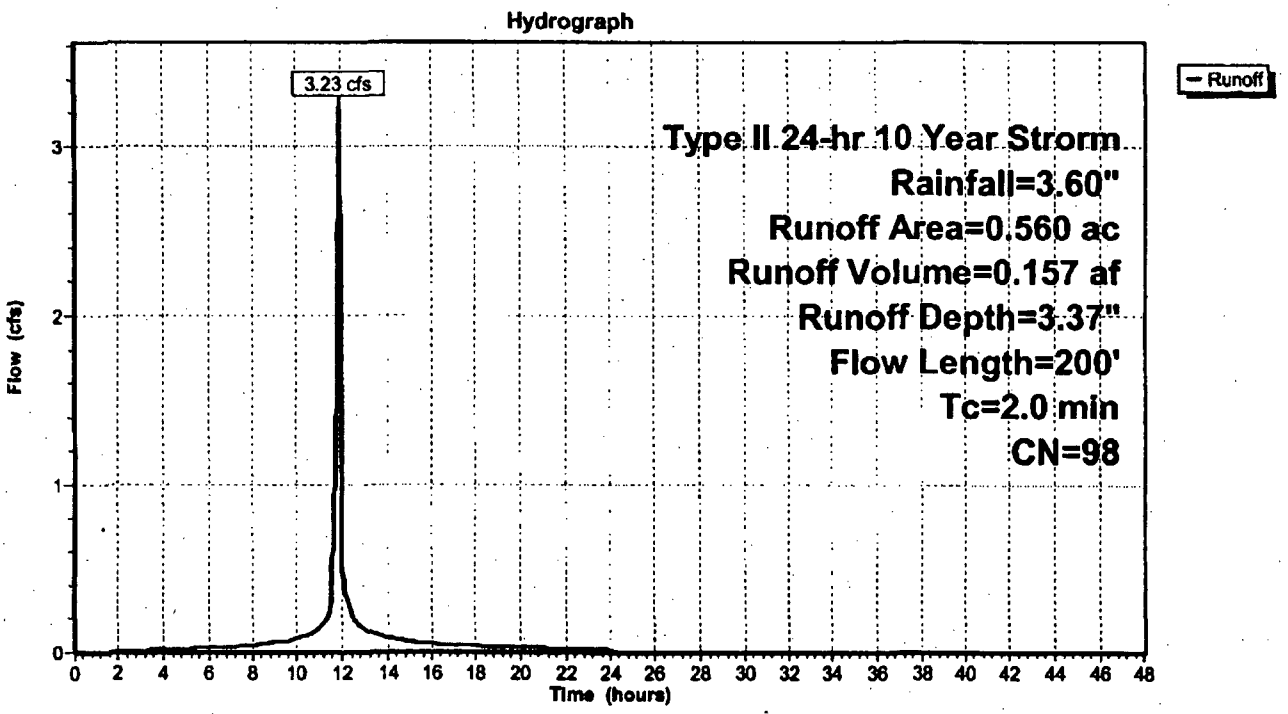
Runoff = 3.23 cfs @ 11.92 hrs, Volume= 0.157 af, Depth= 3.37"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type II 24-hr 10 Year Stroom Rainfall=3.60"

| Area (ac) | CN | Description |
|---|---|---|
| 0.560 | 98 | Area draing from SDA |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 1.4 | 100 | 0.0200 | 1.2 | | **Sheet Flow, A to B** Smooth surfaces n= 0.011 P2= 2.50" |
| 0.6 | 100 | 0.0200 | 2.9 | | **Shallow Concentrated Flow, B to C** Paved Kv= 20.3 fps |
| 2.0 | 200 | Total | | | |

## Subcatchment 7S: Subarea 5



## Subcatchment 8S: Subarea 4

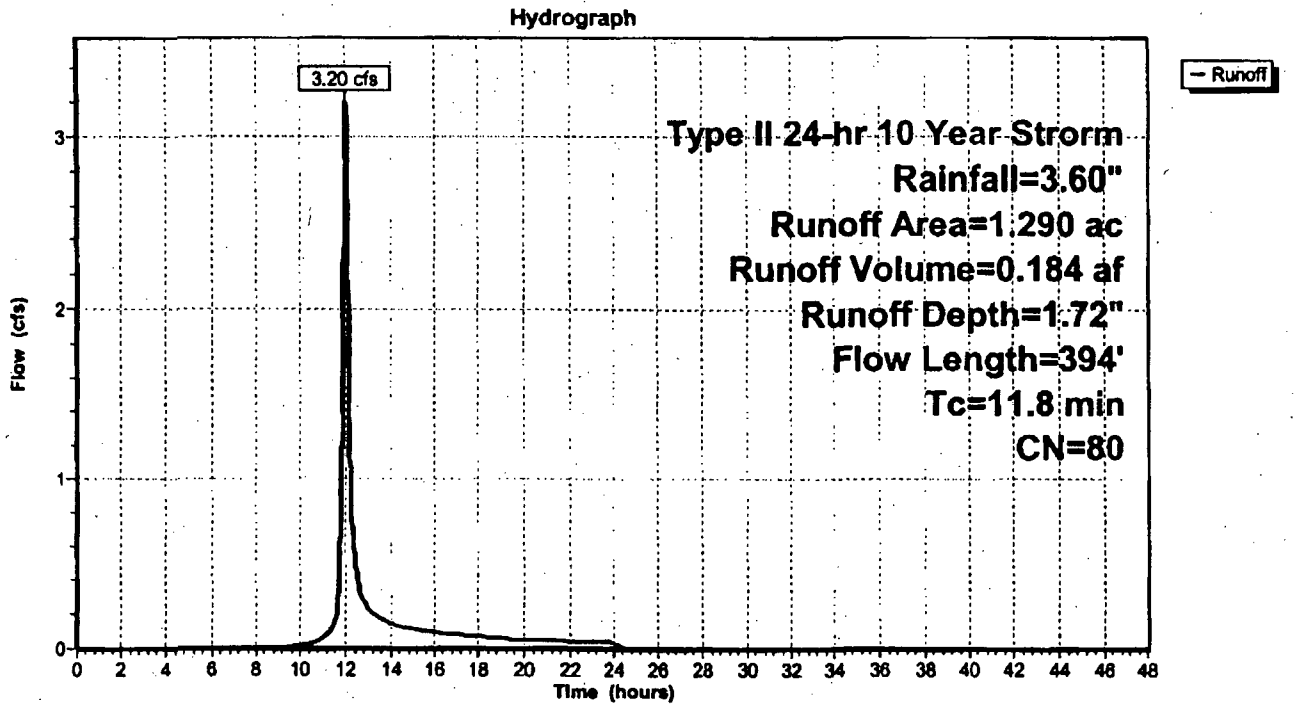
Runoff = 3.20 cfs @ 12.04 hrs, Volume= 0.184 af, Depth= 1.72"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type II 24-hr 10 Year Stroom Rainfall=3.60"

| Area (ac) | CN | Description |
|---|---|---|
| 1.290 | 80 | South area draining to 12" pipe |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 10.1 | 100 | 0.0250 | 0.2 | | **Sheet Flow, A to B**<br>Grass: Short n= 0.150 P2= 2.50" |
| 1.7 | 294 | 0.0310 | 2.8 | | **Shallow Concentrated Flow, B to C**<br>Unpaved Kv= 16.1 fps |
| 11.8 | 394 | Total | | | |

## Subcatchment 8S: Subarea 4



## Subcatchment 9S: Subarea #7

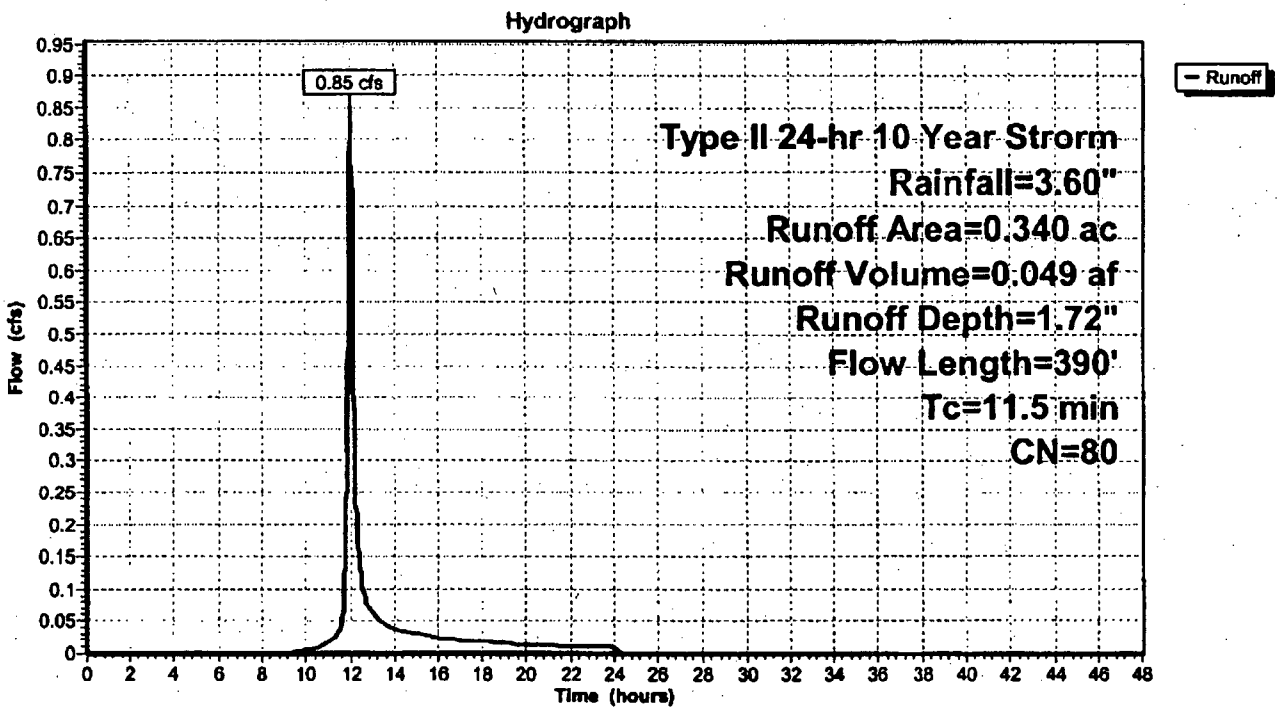
Runoff = 0.85 cfs @ 12.04 hrs, Volume= 0.049 af, Depth= 1.72"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type II 24-hr 10 Year Strorm Rainfall=3.60"

| Area (ac) | CN | Description |
|---|---|---|
| 0.340 | 80 | Exterior east side of cap |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 11.1 | 100 | 0.0200 | 0.2 | | **Sheet Flow, A to B**<br>Grass: Short n= 0.150 P2= 2.50" |
| 0.4 | 290 | 0.0450 | 13.5 | 486.27 | **Channel Flow, B to C**<br>Area= 36.0 sf Perim= 24.7' r= 1.46' n= 0.030 |
| 11.5 | 390 | Total | | | |

## Subcatchment 9S: Subarea #7



## Subcatchment 12S: Subarea #8

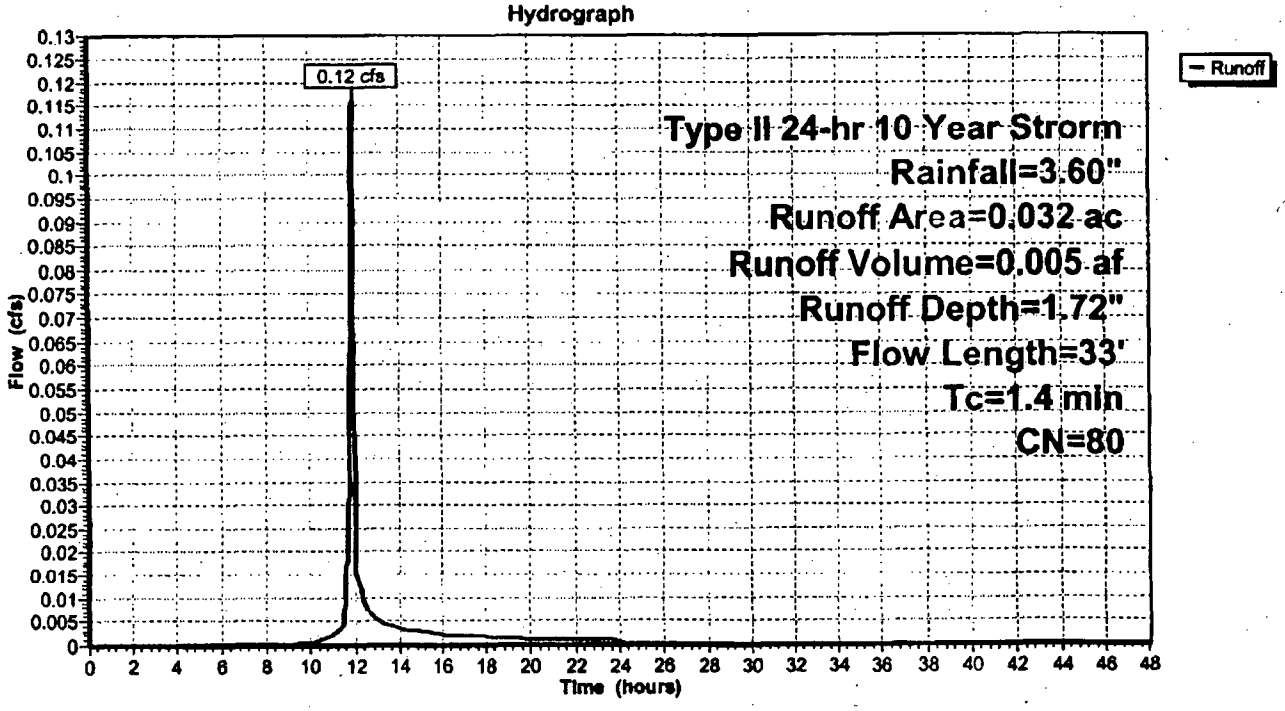
Runoff = 0.12 cfs @ 11.92 hrs, Volume= 0.005 af, Depth= 1.72"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type II 24-hr 10 Year Strorm Rainfall=3.60"

| Area (ac) | CN | Description |
|---|---|---|
| 0.032 | 80 | Northside from 24" to Basin #3 outlet |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 1.4 | 33 | 0.3900 | 0.4 | | **Sheet Flow, A to B**<br>Grass: Short n= 0.150 P2= 2.50" |

## Subcatchment 12S: Subarea #8



## Subcatchment 13S: Subarea #9

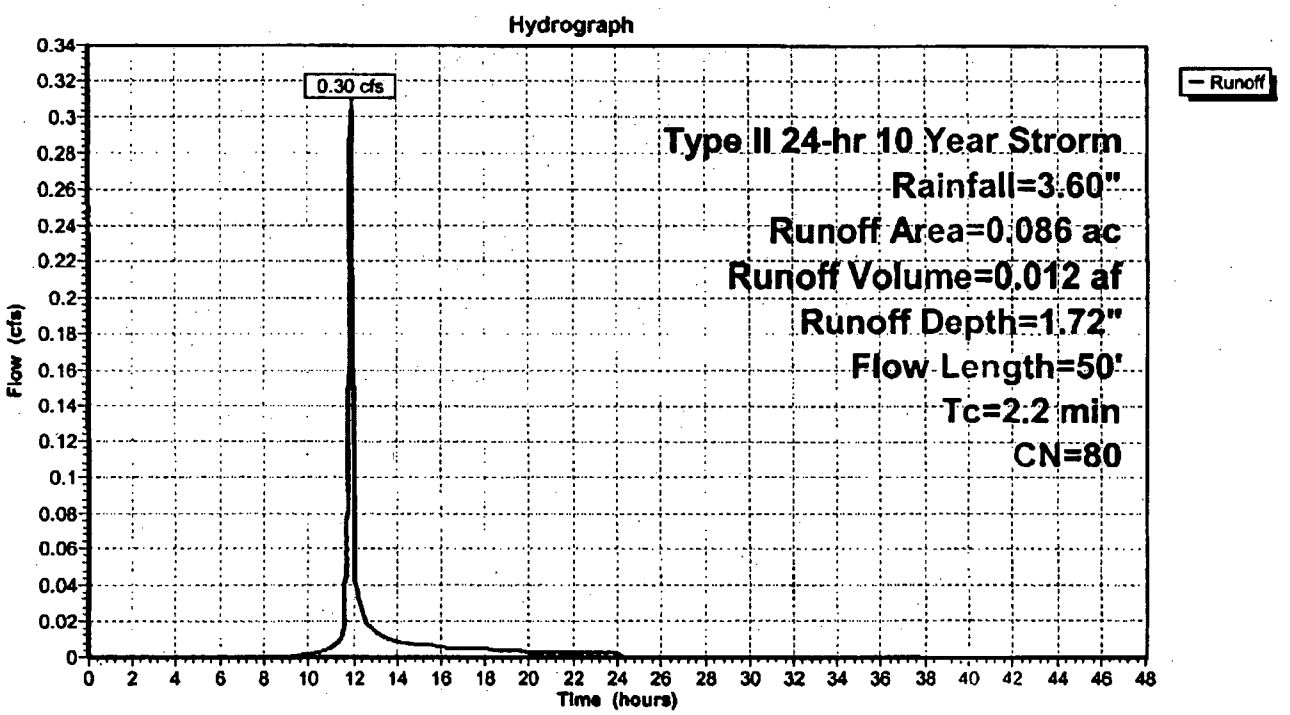
Runoff = 0.30 cfs @ 11.93 hrs, Volume= 0.012 af, Depth= 1.72"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type II 24-hr 10 Year Stroom Rainfall=3.60"

| Area (ac) | CN | Description |
|---|---|---|
| 0.086 | 80 | Northside from Basin #3 outlet to final reach |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 2.2 | 50 | 0.2900 | 0.4 | | **Sheet Flow, A to B**<br>Grass: Short n= 0.150 P2= 2.50" |

## Subcatchment 13S: Subarea #9



## Subcatchment 20S: Subarea #10

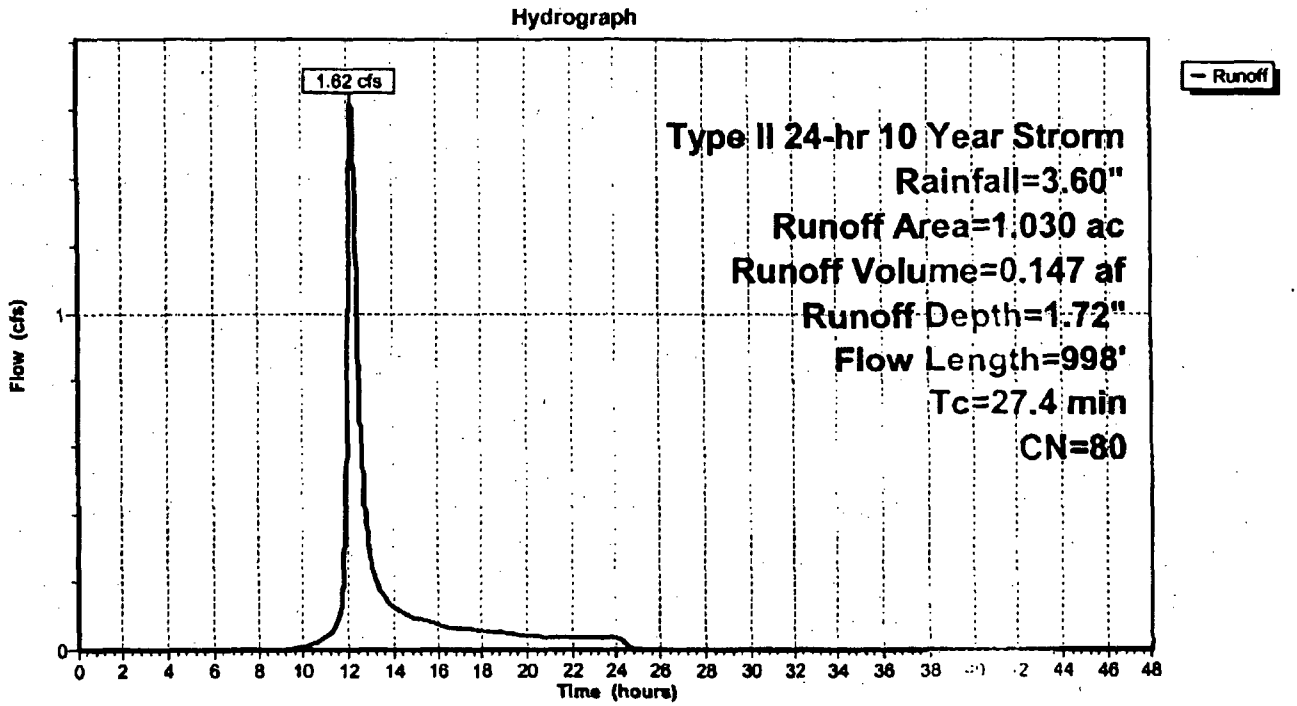
Runoff = 1.62 cfs @ 12.21 hrs, Volume= 0.147 af, Depth= 1.72"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type II 24-hr 10 Year Stroom Rainfall=3.60"

| Area (ac) | CN | Description |
|---|---|---|
| 1.030 | 80 | Northside along edge of cap |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 17.9 | 100 | 0.0060 | 0.1 | | **Sheet Flow, A to B**<br>Grass: Short n= 0.150 P2= 2.50" |
| 7.9 | 417 | 0.0030 | 0.9 | | **Shallow Concentrated Flow, B to C**<br>Unpaved Kv= 16.1 fps |
| 1.4 | 260 | 0.0350 | 3.0 | | **Shallow Concentrated Flow, C to D**<br>Unpaved Kv= 16.1 fps |
| 0.2 | 221 | 0.1150 | 21.6 | 777.35 | **Channel Flow, D to E**<br>Area= 36.0 sf Perim= 24.7' r= 1.46' n= 0.030 |
| 27.4 | 998 | Total | | | |

## Subcatchment 20S: Subarea #10



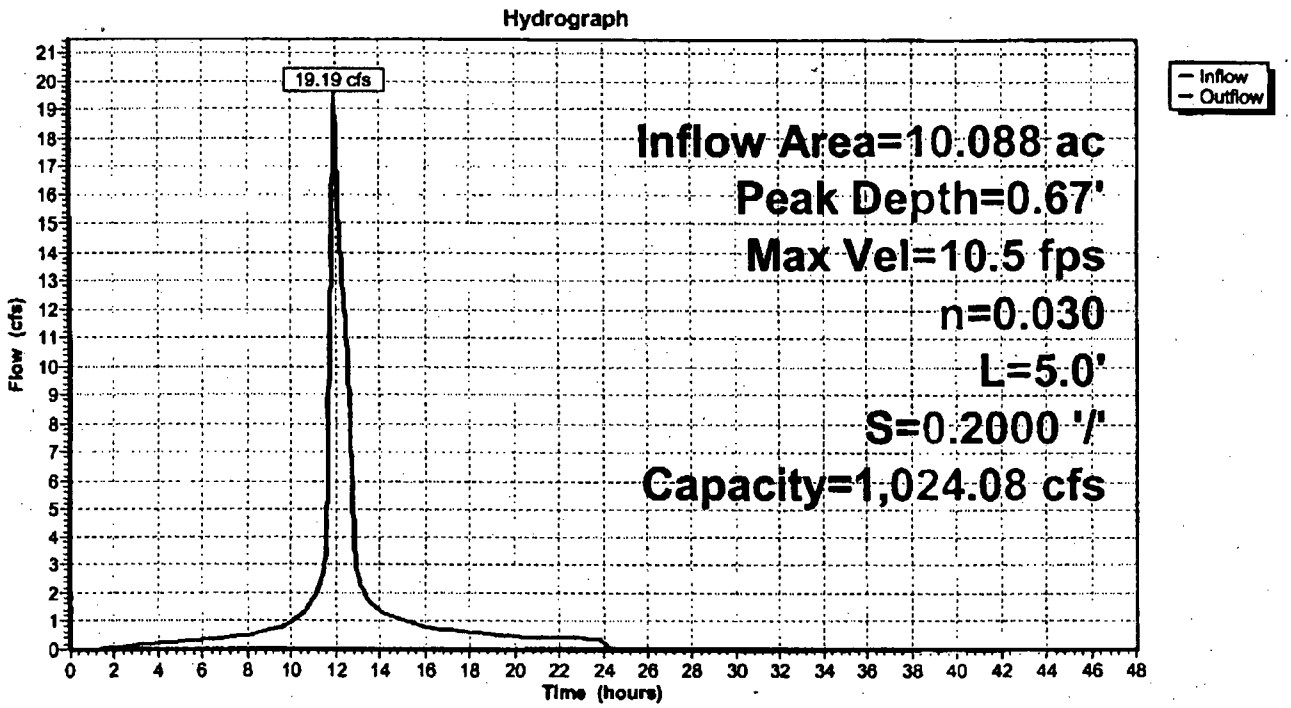
## Reach 6R: Erdman Brook

Inflow Area = 10.088 ac, Inflow Depth = 2.87" for 10 Year Stroom event
Inflow = 19.19 cfs @ 11.96 hrs, Volume= 2.416 af
Outflow = 19.19 cfs @ 11.96 hrs, Volume= 2.416 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Max. Velocity= 10.5 fps, Min. Travel Time= 0.0 min
Avg. Velocity = 4.4 fps, Avg. Travel Time= 0.0 min

Peak Depth= 0.67' @ 11.96 hrs
Capacity at bank full= 1,024.08 cfs
Inlet Invert= 1,353.50', Outlet Invert= 1,352.50'
0.00' x 3.00' deep channel, n= 0.030
Side Slope Z-value= 4.0 '/' Top Width= 24.00'
Length= 5.0' Slope= 0.2000 '/'

## Reach 6R: Erdman Brook



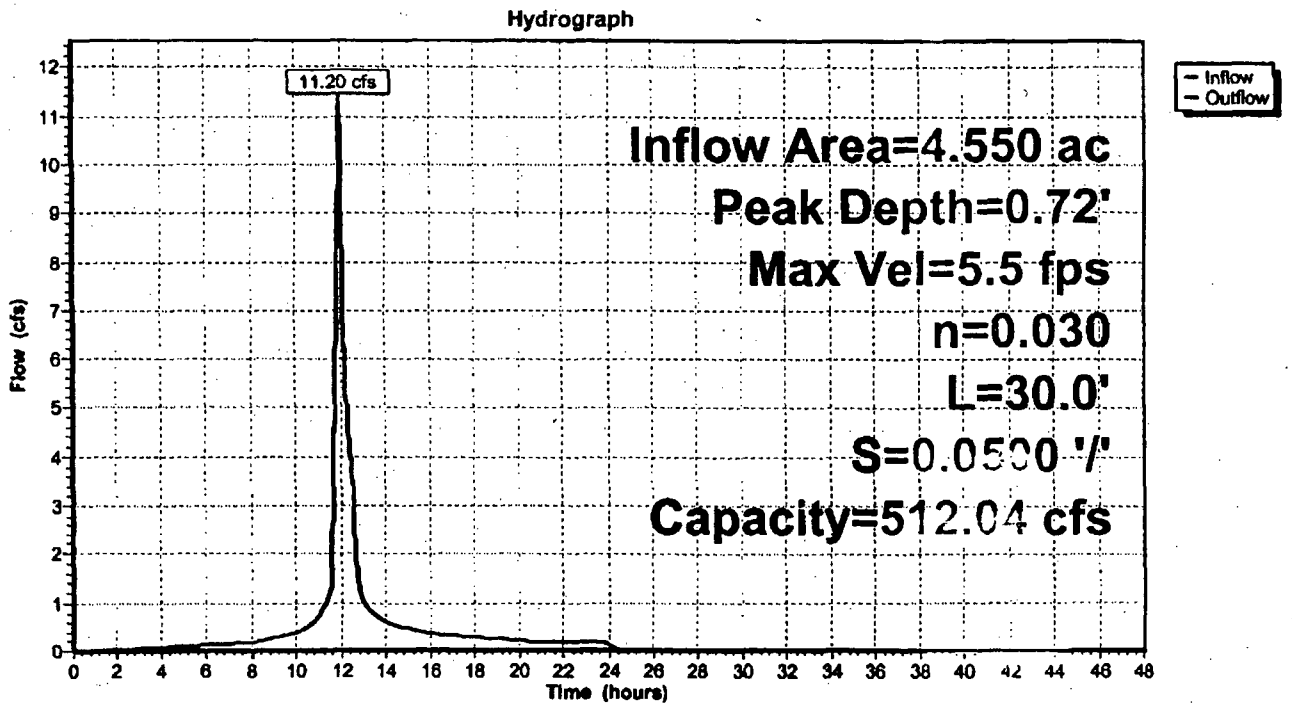
## Reach 14R: Reach #1

Inflow Area = 4.550 ac, Inflow Depth = 2.69" for 10 Year Strorm event
Inflow = 11.20 cfs @ 11.95 hrs, Volume= 1.020 af
Outflow = 11.20 cfs @ 11.95 hrs, Volume= 1.020 af, Atten= 0%, Lag= 0.1 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Max. Velocity= 5.5 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 2.1 fps, Avg. Travel Time= 0.2 min

Peak Depth= 0.72' @ 11.95 hrs
Capacity at bank full= 512.04 cfs
Inlet Invert= 1,366.00', Outlet Invert= 1,364.50'
0.00' x 3.00' deep channel, n= 0.030
Side Slope Z-value= 4.0 '/' Top Width= 24.00'
Length= 30.0' Slope= 0.0500 '/'

## Reach 14R: Reach #1



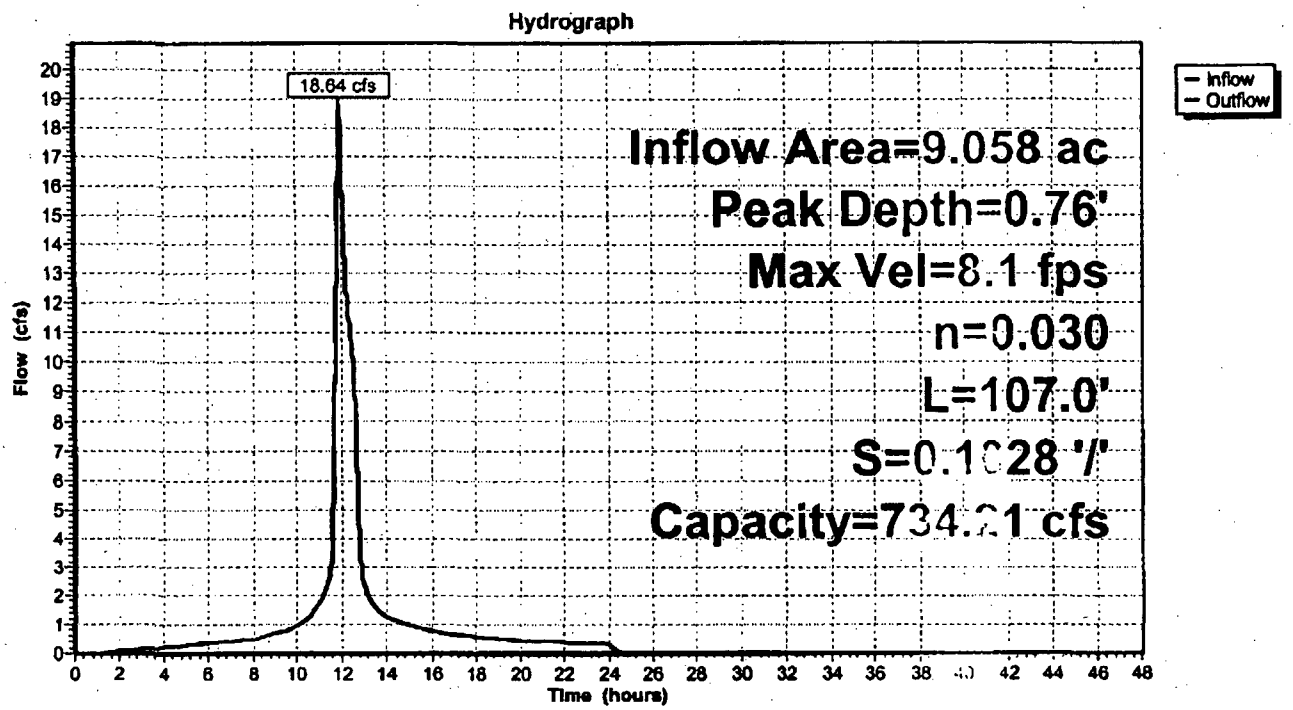
## Reach 15R: Reach #2

Inflow Area = 9.058 ac, Inflow Depth = 3.00" for 10 Year Stroom event
Inflow = 18.64 cfs @ 11.95 hrs, Volume= 2.268 af
Outflow = 18.64 cfs @ 11.95 hrs, Volume= 2.268 af, Atten= 0%, Lag= 0.2 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Max. Velocity= 8.1 fps, Min. Travel Time= 0.2 min
Avg. Velocity = 3.4 fps, Avg. Travel Time= 0.5 min

Peak Depth= 0.76' @ 11.95 hrs
Capacity at bank full= 734.21 cfs
Inlet Invert= 1,364.50', Outlet Invert= 1,353.50'
0.00' x 3.00' deep channel, n= 0.030
Side Slope Z-value= 4.0 '/' Top Width= 24.00'
Length= 107.0' Slope= 0.1028 '/'

## Reach 15R: Reach #2



## Pond 3P: Basin #1

| | | | | | |
|---|---|---|---|---|---|
| Inflow Area = | 2.660 ac, | Inflow Depth = | 3.37" | for | 10 Year Stroom event |
| Inflow = | 15.55 cfs @ | 11.92 hrs, | Volume= | 0.746 af | |
| Outflow = | 14.85 cfs @ | 11.93 hrs, | Volume= | 0.746 af, | Atten= 4%, Lag= 0.8 min |
| Primary = | 14.85 cfs @ | 11.93 hrs, | Volume= | 0.746 af | |

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Peak Elev= 1,379.95' @ 11.93 hrs Surf.Area= 0 sf Storage= 1,084 cf
Plug-Flow detention time= 1.2 min calculated for 0.746 af (100% of inflow)
Center-of-Mass det. time= 1.2 min ( 747.2 - 746.0 )

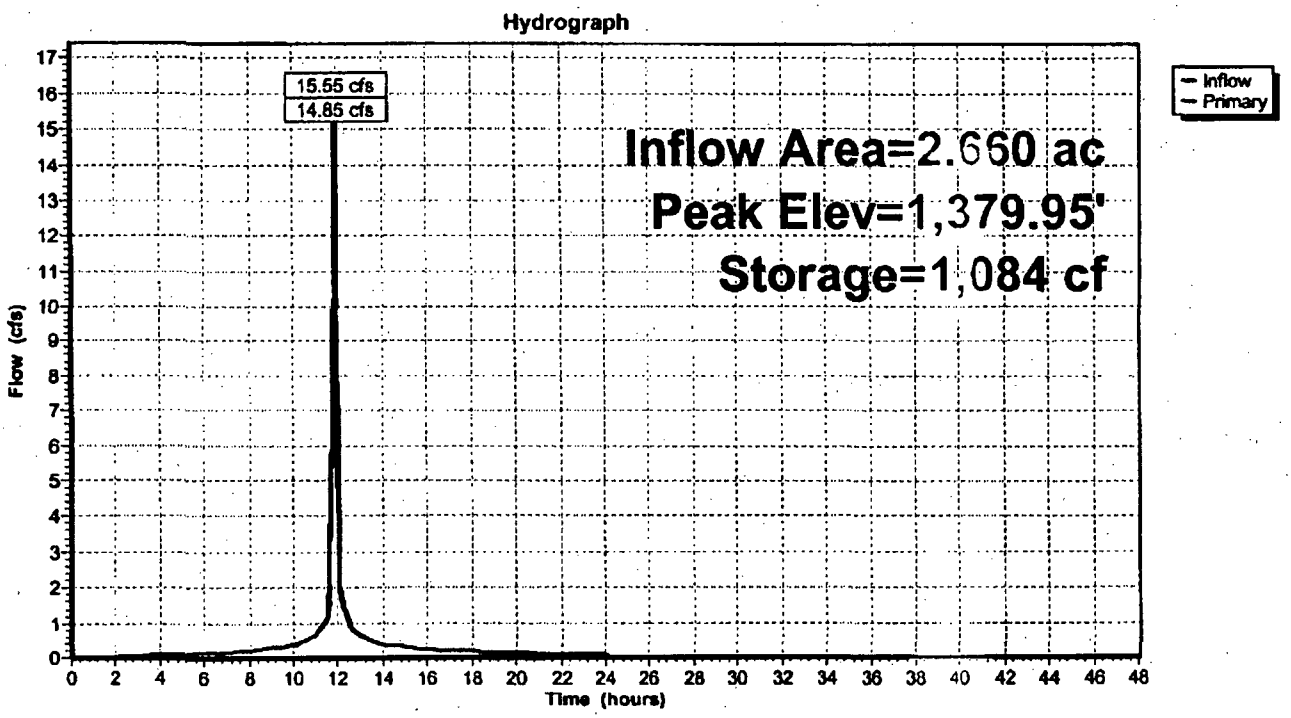
| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 1,379.00' | 8,505 cf | **Custom Stage Data** Listed below |

| Elevation (feet) | Inc.Store (cubic-feet) | Cum.Store (cubic-feet) |
|---|---|---|
| 1,379.00 | 0 | 0 |
| 1,380.00 | 1,145 | 1,145 |
| 1,381.00 | 2,659 | 3,804 |
| 1,382.00 | 4,701 | 8,505 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 0.00' | **Special & User-Defined**<br>Elev. (feet) 1,379.00 1,380.00 1,381.00 1,382.00<br>Disch. (cfs) 0.000 15.680 20.250 23.960 |

**Primary OutFlow** Max=14.83 cfs @ 11.93 hrs HW=1,379.95' TW=1,377.87' (Dynamic Tailwater)
└─**1=Special & User-Defined** (Custom Controls 14.83 cfs)

## Pond 3P: Basin #1



## Pond 4P: Basin #2

Inflow Area = 1.890 ac, Inflow Depth = 3.37" for 10 Year Stroom event
Inflow = 11.35 cfs @ 11.91 hrs, Volume= 0.530 af
Outflow = 3.44 cfs @ 11.99 hrs, Volume= 0.530 af, Atten= 70%, Lag= 4.9 min
Primary = 3.44 cfs @ 11.99 hrs, Volume= 0.530 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Peak Elev= 1,379.39' @ 11.99 hrs Surf.Area= 0 sf Storage= 5,341 cf
Plug-Flow detention time= 11.5 min calculated for 0.530 af (100% of inflow)
Center-of-Mass det. time= 11.5 min ( 756.4 - 744.9 )

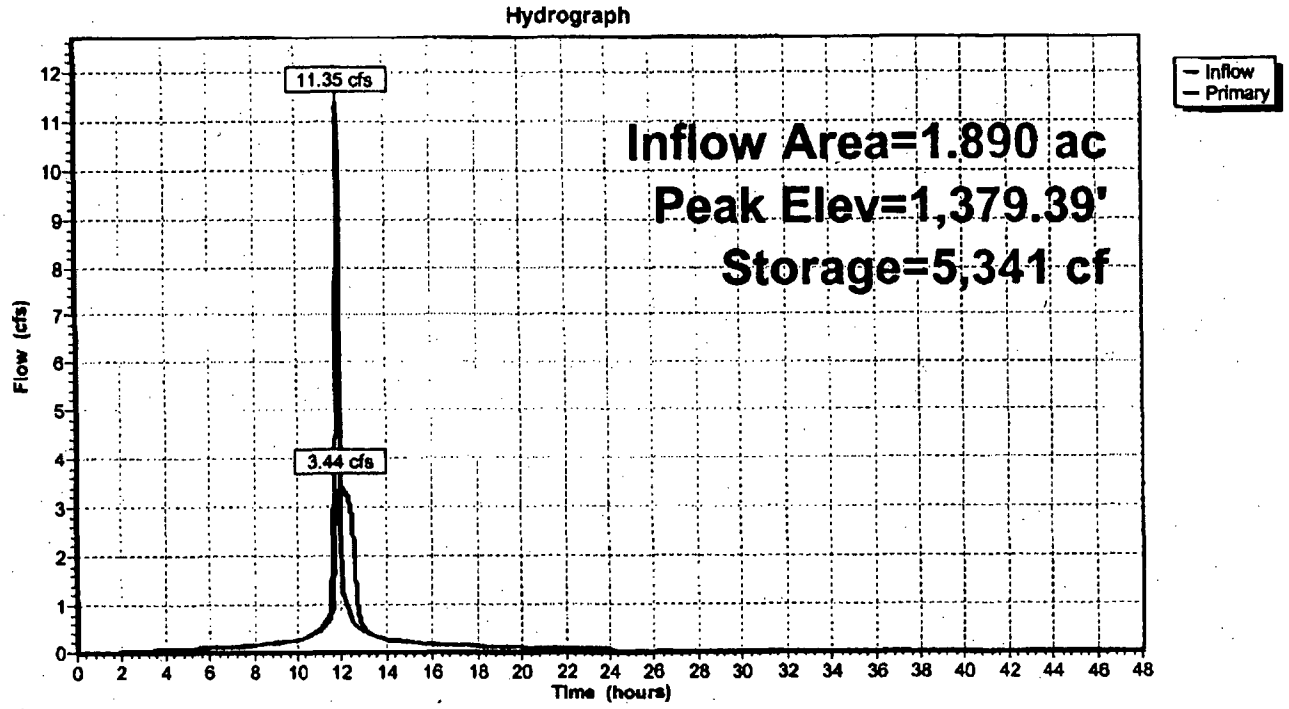
| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 1,377.00' | 8,556 cf | **Custom Stage Data** Listed below |

| Elevation (feet) | Inc.Store (cubic-feet) | Cum.Store (cubic-feet) |
|---|---|---|
| 1,377.00 | 0 | 0 |
| 1,378.00 | 1,300 | 1,300 |
| 1,379.00 | 1,993 | 3,293 |
| 1,380.00 | 5,263 | 8,556 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 0.00' | **Special & User-Defined**<br>Elev. (feet) 1,377.00 1,378.00 1,379.00 1,380.00<br>Disch. (cfs) 0.000 2.780 3.270 3.700 |

**Primary OutFlow** Max=3.44 cfs @ 11.99 hrs HW=1,379.39' TW=1,377.07' (Dynamic Tailwater)
└─**1=Special & User-Defined** (Custom Controls 3.44 cfs)

## Pond 4P: Basin #2



## Pond 5P: Basin #3

| | | | | | |
|---|---|---|---|---|---|
| Inflow Area = | 4.390 ac, | Inflow Depth = | 3.37" | for | 10 Year Stroom event |
| Inflow = | 24.21 cfs @ | 11.94 hrs, | Volume= | 1.231 af | |
| Outflow = | 7.26 cfs @ | 12.04 hrs, | Volume= | 1.231 af, | Atten= 70%, Lag= 6.1 min |
| Primary = | 7.26 cfs @ | 12.04 hrs, | Volume= | 1.231 af | |

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Peak Elev= 1,378.26' @ 12.04 hrs Surf.Area= 0 sf Storage= 12,455 cf
Plug-Flow detention time= 11.8 min calculated for 1.231 af (100% of inflow)
Center-of-Mass det. time= 11.7 min ( 759.2 - 747.5 )

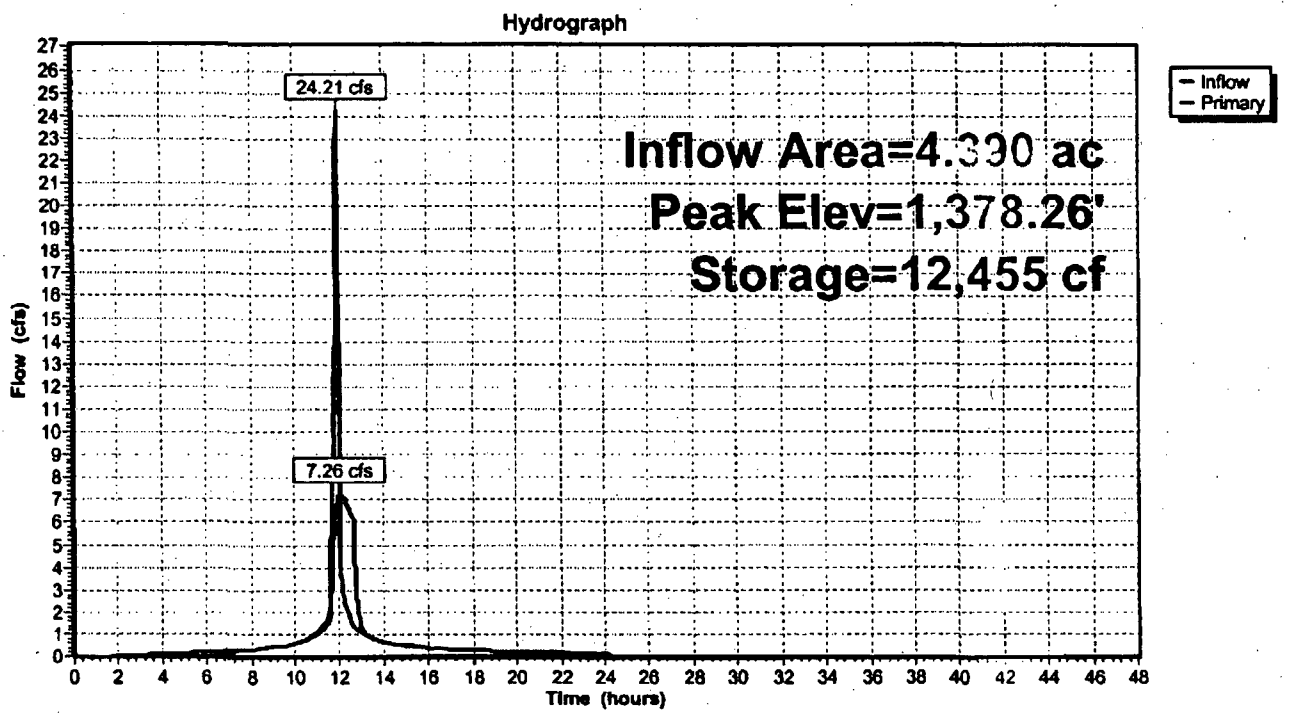
| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 1,376.00' | 21,103 cf | **Custom Stage Data** Listed below |

| Elevation (feet) | Inc.Store (cubic-feet) | Cum.Store (cubic-feet) |
|---|---|---|
| 1,376.00 | 0 | 0 |
| 1,377.00 | 2,549 | 2,549 |
| 1,378.00 | 6,932 | 9,481 |
| 1,379.00 | 11,622 | 21,103 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 0.00' | **Special & User-Defined**<br>Elev. (feet) 1,376.00 1,377.00 1,378.00 1,379.00<br>Disch. (cfs) 0.000 6.110 7.050 7.890 |

**Primary OutFlow** Max=7.26 cfs @ 12.04 hrs HW=1,378.26' TW=1,365.22' (Dynamic Tailwater)
└─**1=Special & User-Defined** (Custom Controls 7.26 cfs)

## Pond 5P: Basin #3



## Pond 16P: 18"

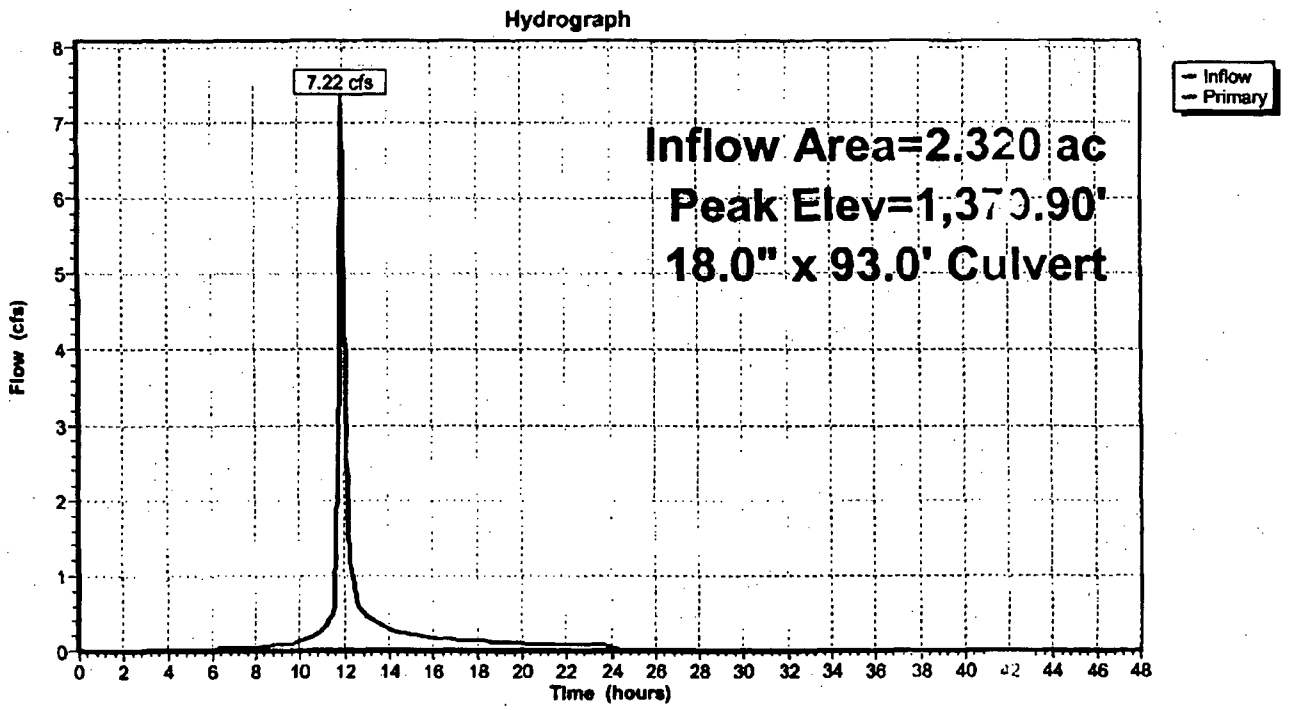
| | | | | | |
|---|---|---|---|---|---|
| Inflow Area = | 2.320 ac, | Inflow Depth = | 2.28" | for | 10 Year Strorm event |
| Inflow = | 7.22 cfs @ | 11.94 hrs, | Volume= | 0.441 af | |
| Outflow = | 7.22 cfs @ | 11.94 hrs, | Volume= | 0.441 af, | Atten= 0%, Lag= 0.0 min |
| Primary = | 7.22 cfs @ | 11.94 hrs, | Volume= | 0.441 af | |

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Peak Elev= 1,379.90' @ 11.94 hrs
Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 0.0 min ( 796.8 - 796.8 )

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 1,378.00' | **18.0" x 93.0' long Culvert** CMP, projecting, no headwall, Ke= 0.900<br>Outlet Invert= 1,375.50' S= 0.0269 '/' Cc= 0.900<br>n= 0.013 Corrugated PE, smooth interior |

**Primary OutFlow** Max=7.21 cfs @ 11.94 hrs HW=1,379.90' TW=1,377.16' (Dynamic Tailwater)
└─**1=Culvert** (Inlet Controls 7.21 cfs @ 4.1 fps)

## Pond 16P: 18"



## Pond 17P: Existing 24" Pipe

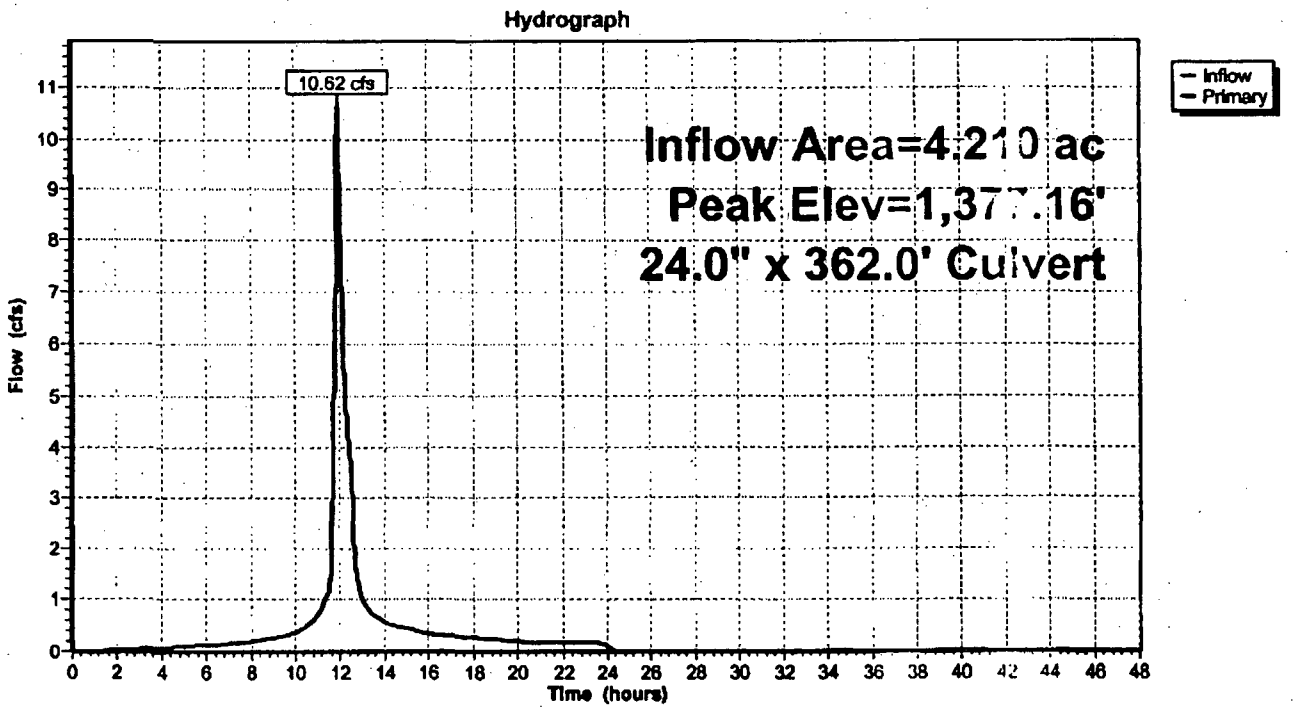
| | | | | | |
|---|---|---|---|---|---|
| Inflow Area = | 4.210 ac, | Inflow Depth = | 2.77" | for | 10 Year Stromm event |
| Inflow = | 10.62 cfs @ | 11.94 hrs, | Volume= | 0.971 af | |
| Outflow = | 10.62 cfs @ | 11.94 hrs, | Volume= | 0.971 af, | Atten= 0%, Lag= 0.0 min |
| Primary = | 10.62 cfs @ | 11.94 hrs, | Volume= | 0.971 af | |

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Peak Elev= 1,377.16' @ 11.94 hrs
Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 0.0 min ( 774.7 - 774.7 )

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 1,375.38' | **24.0" x 362.0' long Culvert** CMP, projecting, no headwall, Ke= 0.900<br>Outlet Invert= 1,366.00' S= 0.0259 '/' Cc= 0.900<br>n= 0.013 Corrugated PE, smooth interior |

**Primary OutFlow** Max=10.61 cfs @ 11.94 hrs HW=1,377.16' TW=1,366.71' (Dynamic Tailwater)
└**1=Culvert** (Inlet Controls 10.61 cfs @ 3.6 fps)

## Pond 17P: Existing 24" Pipe



## Pond 18P: 12"

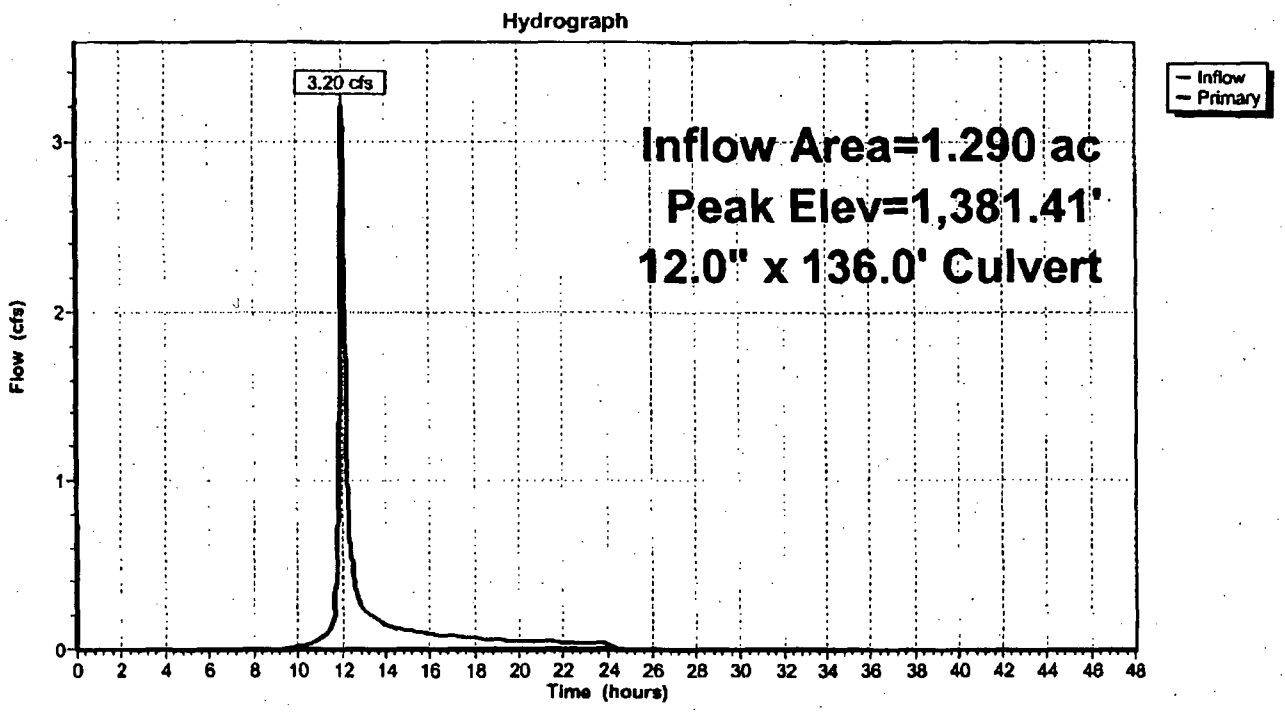
| | | | | | |
|---|---|---|---|---|---|
| Inflow Area = | 1.290 ac, | Inflow Depth = | 1.72" | for | 10 Year Stroom event |
| Inflow = | 3.20 cfs @ | 12.04 hrs, | Volume= | 0.184 af | |
| Outflow = | 3.20 cfs @ | 12.04 hrs, | Volume= | 0.184 af, | Atten= 0%, Lag= 0.0 min |
| Primary = | 3.20 cfs @ | 12.04 hrs, | Volume= | 0.184 af | |

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Peak Elev= 1,381.41' @ 12.04 hrs
Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 0.0 min ( 839.0 - 839.0 )

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 1,379.50' | **12.0" x 136.0' long Culvert**. CMP, projecting, no headwall, Ke= 0.900<br>Outlet Invert= 1,378.82' S= 0.0050 '/' Cc= 0.900<br>n= 0.013 Corrugated PE, smooth interior |

**Primary OutFlow** Max=3.20 cfs @ 12.04 hrs HW=1,381.41' TW=1,379.24' (Dynamic Tailwater)
└**1=Culvert** (Barrel Controls 3.20 cfs @ 4.1 fps)

## Pond 18P: 12"



## Pond 19P: 18"

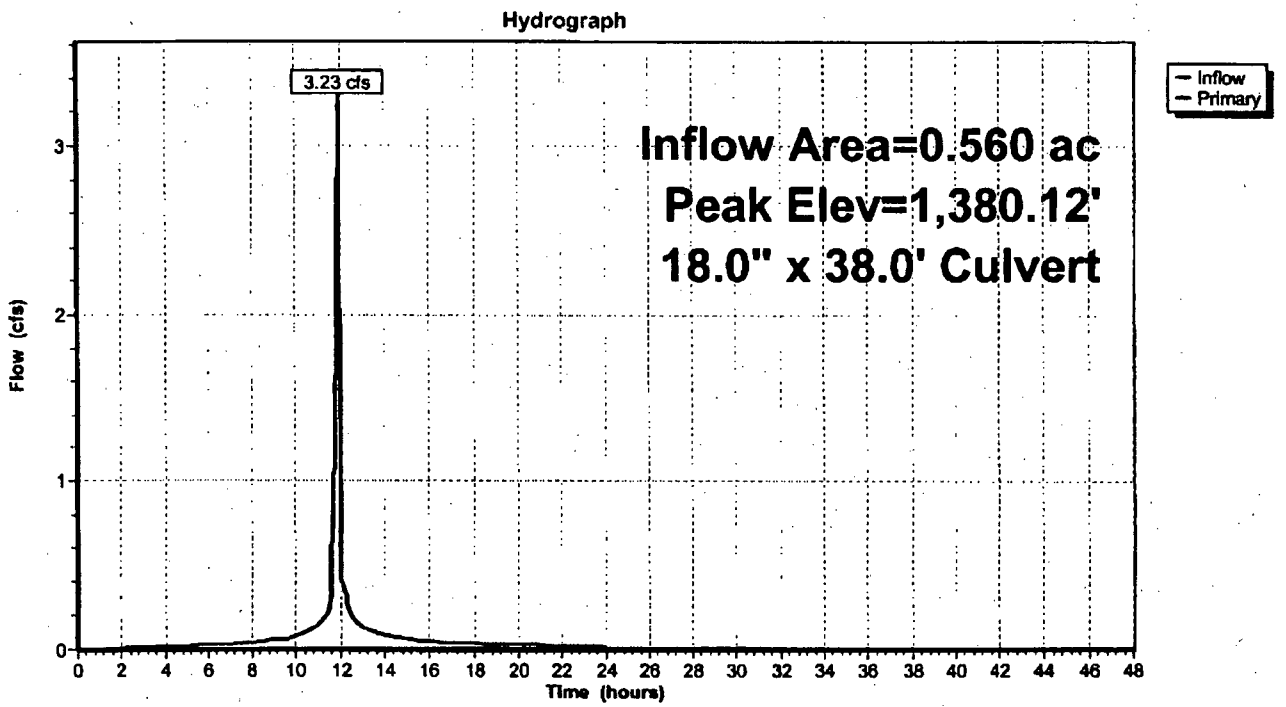
| | | | | | |
|---|---|---|---|---|---|
| Inflow Area = | 0.560 ac, | Inflow Depth = | 3.37" | for | 10 Year Strorm event |
| Inflow = | 3.23 cfs @ | 11.92 hrs, | Volume= | 0.157 af | |
| Outflow = | 3.23 cfs @ | 11.92 hrs, | Volume= | 0.157 af, | Atten= 0%, Lag= 0.0 min |
| Primary = | 3.23 cfs @ | 11.92 hrs, | Volume= | 0.157 af | |

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Peak Elev= 1,380.12' @ 11.94 hrs
Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 0.0 min ( 746.3 - 746.3 )

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 1,378.50' | **18.0" x 38.0' long Culvert** CMP, projecting, no headwall, Ke= 0.900<br>Outlet Invert= 1,378.00' S= 0.0132 '/' Cc= 0.900<br>n= 0.025 Corrugated metal |

**Primary OutFlow** Max=2.69 cfs @ 11.92 hrs HW=1,380.04' TW=1,379.83' (Dynamic Tailwater)
└─**1=Culvert** (Outlet Controls 2.69 cfs @ 1.8 fps)

## Pond 19P: 18"



Time span=0.00-48.00 hrs, dt=0.01 hrs, 4801 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

**Subcatchment 1S: Subarea 1** Runoff Area=2.660 ac Runoff Depth=3.96"
Flow Length=629' Tc=1.6 min CN=98 Runoff=18.18 cfs 0.879 af

**Subcatchment 2S: Subarea #2** Runoff Area=1.890 ac Runoff Depth=3.96"
Flow Length=486' Tc=0.5 min CN=98 Runoff=13.27 cfs 0.624 af

**Subcatchment 3s: Subarea 3** Runoff Area=1.730 ac Runoff Depth=3.96"
Flow Length=473' Tc=3.8 min CN=98 Runoff=11.06 cfs 0.572 af

**Subcatchment 6S: Subarea 6** Runoff Area=0.470 ac Runoff Depth=3.11"
Flow Length=530' Tc=4.6 min CN=90 Runoff=2.59 cfs 0.122 af

**Subcatchment 7S: Subarea 5** Runoff Area=0.560 ac Runoff Depth=3.96"
Flow Length=200' Tc=2.0 min CN=98 Runoff=3.78 cfs 0.185 af

**Subcatchment 8S: Subarea 4** Runoff Area=1.290 ac Runoff Depth=2.21"
Flow Length=394' Tc=11.8 min CN=80 Runoff=4.11 cfs 0.237 af

**Subcatchment 9S: Subarea #7** Runoff Area=0.340 ac Runoff Depth=2.21"
Flow Length=390' Tc=11.5 min CN=80 Runoff=1.10 cfs 0.063 af

**Subcatchment 12S: Subarea #8** Runoff Area=0.032 ac Runoff Depth=2.21"
Flow Length=33' Tc=1.4 min CN=80 Runoff=0.15 cfs 0.006 af

**Subcatchment 13S: Subarea #9** Runoff Area=0.086 ac Runoff Depth=2.21"
Flow Length=50' Tc=2.2 min CN=80 Runoff=0.39 cfs 0.016 af

**Subcatchment 20S: Subarea #10** Runoff Area=1.030 ac Runoff Depth=2.21"
Flow Length=998' Tc=27.4 min CN=80 Runoff=2.09 cfs 0.190 af

**Reach 6R: Erdman Brook** Peak Depth=0.71' Max Vel=10.8 fps Inflow=21.56 cfs 2.893 af
n=0.030 L=5.0' S=0.2000 '/' Capacity=1,024.08 cfs Outflow=21.56 cfs 2.893 af

**Reach 14R: Reach #1** Peak Depth=0.76' Max Vel=5.7 fps Inflow=13.10 cfs 1.231 af
n=0.030 L=30.0' S=0.0500 '/' Capacity=512.04 cfs Outflow=13.10 cfs 1.231 af

**Reach 15R: Reach #2** Peak Depth=0.79' Max Vel=8.4 fps Inflow=20.81 cfs 2.703 af
n=0.030 L=107.0' S=0.1028 '/' Capacity=734.21 cfs Outflow=20.81 cfs 2.703 af

**Pond 3P: Basin #1** Peak Elev=1,380.09' Storage=1,383 cf Inflow=18.18 cfs 0.879 af
Outflow=16.09 cfs 0.879 af

**Pond 4P: Basin #2** Peak Elev=1,379.64' Storage=6,667 cf Inflow=13.27 cfs 0.624 af
Outflow=3.55 cfs 0.624 af

| | | | |
|---|---|---|---|
| **Pond 5P: Basin #3** | Peak Elev=1,378.53' Storage=15,596 cf | Inflow=27.15 cfs | 1.450 af |
| | | Outflow=7.49 cfs | 1.450 af |
| **Pond 16P: 18"** | Peak Elev=1,380.48' | Inflow=8.83 cfs | 0.544 af |
| | 18.0" x 93.0' Culvert | Outflow=8.83 cfs | 0.544 af |
| **Pond 17P: Existing 24" Pipe** | Peak Elev=1,377.45' | Inflow=12.34 cfs | 1.169 af |
| | 24.0" x 362.0' Culvert | Outflow=12.34 cfs | 1.169 af |
| **Pond 18P: 12"** | Peak Elev=1,382.45' | Inflow=4.11 cfs | 0.237 af |
| | 12.0" x 136.0' Culvert | Outflow=4.11 cfs | 0.237 af |
| **Pond 19P: 18"** | Peak Elev=1,380.73' | Inflow=3.78 cfs | 0.185 af |
| | 18.0" x 38.0' Culvert | Outflow=3.78 cfs | 0.185 af |

**Total Runoff Area = 10.088 ac Runoff Volume = 2.893 af Average Runoff Depth = 3.44"**

## Subcatchment 1S: Subarea 1

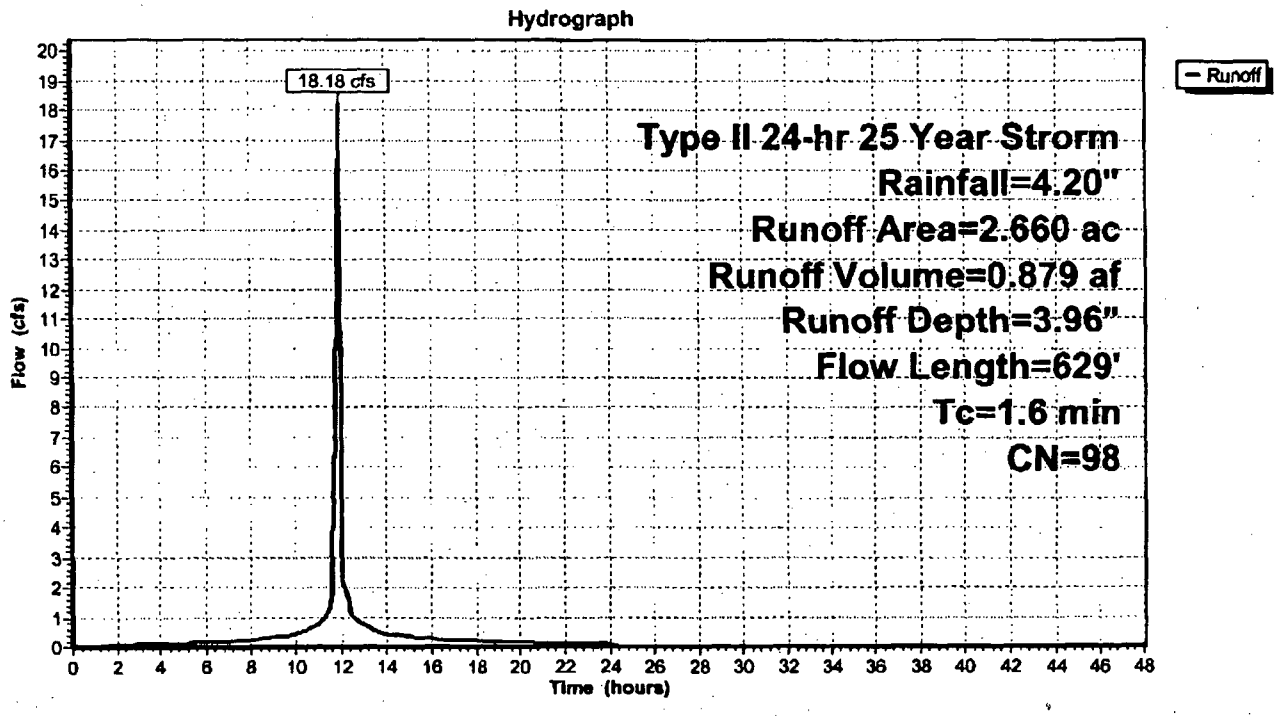
Runoff = 18.18 cfs @ 11.92 hrs, Volume= 0.879 af, Depth= 3.96"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type II 24-hr 25 Year Strorm Rainfall=4.20"

| Area (ac) | CN | Description |
|---|---|---|
| 2.660 | 98 | North and West Sides of Cap |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 0.0 | 2 | 0.1250 | 1.2 | | **Sheet Flow, A to B** Smooth surfaces n= 0.011 P2= 2.50" |
| 0.0 | 37 | 0.0270 | 13.8 | 55.02 | **Channel Flow, B to C** Area= 4.0 sf Perim= 8.2' r= 0.49' n= 0.011 |
| 1.3 | 357 | 0.0028 | 4.5 | 76.40 | **Channel Flow, C to D** Area= 17.0 sf Perim= 34.1' r= 0.50' n= 0.011 |
| 0.2 | 104 | 0.0097 | 8.3 | 70.69 | **Channel Flow, D to E** Area= 8.5 sf Perim= 17.2' r= 0.49' n= 0.011 |
| 0.1 | 129 | 0.0466 | 29.0 | 985.72 | **Channel Flow, E to F** Area= 34.0 sf Perim= 34.3' r= 0.99' n= 0.011 |
| 1.6 | 629 | Total | | | |

## Subcatchment 1S: Subarea 1



## Subcatchment 2S: Subarea #2

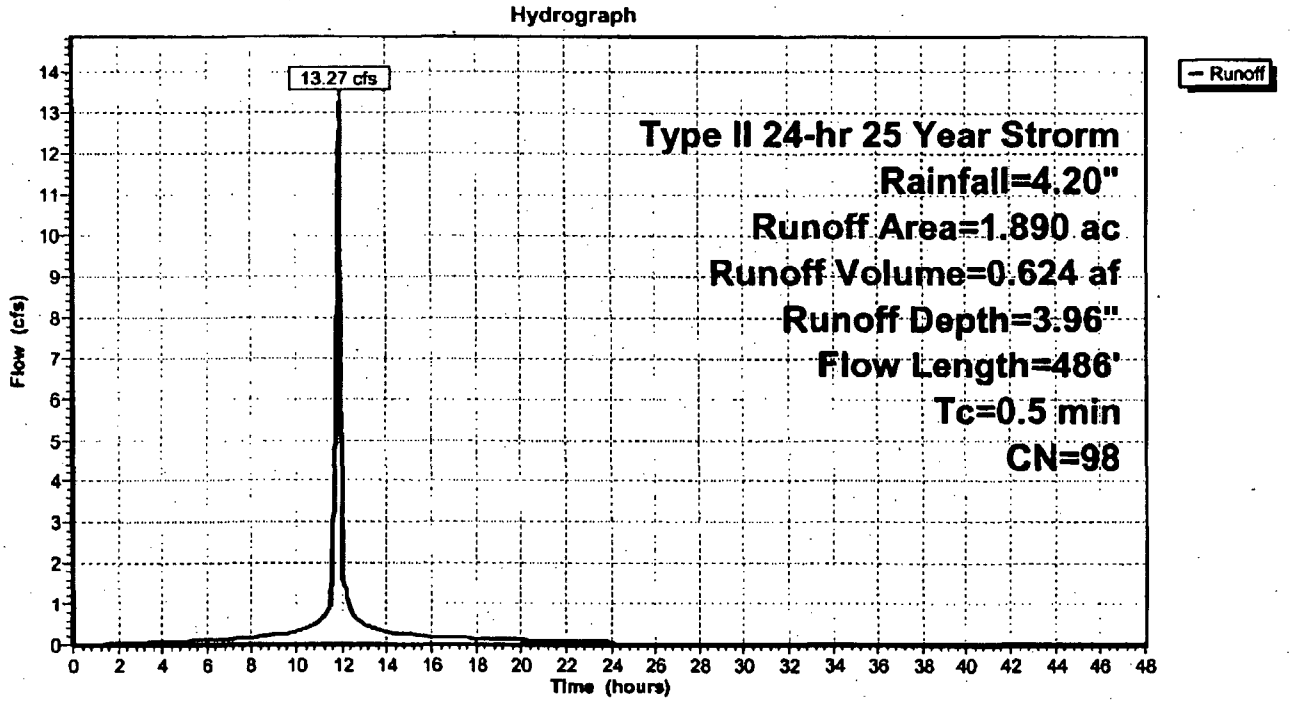
Runoff = 13.27 cfs @ 11.91 hrs, Volume= 0.624 af, Depth= 3.96"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type II 24-hr 25 Year Stroom Rainfall=4.20"

| Area (ac) | CN | Description |
|---|---|---|
| 1.890 | 98 | South Side of Cap |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 0.0 | 2 | 0.1250 | 1.2 | | **Sheet Flow, A to B** Smooth surfaces n= 0.011 P2= 2.50" |
| 0.2 | 102 | 0.0100 | 8.4 | 33.48 | **Channel Flow, B to C** Area= 4.0 sf Perim= 8.2' r= 0.49' n= 0.011 |
| 0.3 | 360 | 0.0250 | 20.9 | 334.82 | **Channel Flow, C to D** Area= 16.0 sf Perim= 16.5' r= 0.97' n= 0.011 |
| 0.0 | 22 | 0.0450 | 28.1 | 449.20 | **Channel Flow, D to E** Area= 16.0 sf Perim= 16.5' r= 0.97' n= 0.011 |
| 0.5 | 486 | Total | | | |

## Subcatchment 2S: Subarea #2



## Subcatchment 3s: Subarea 3

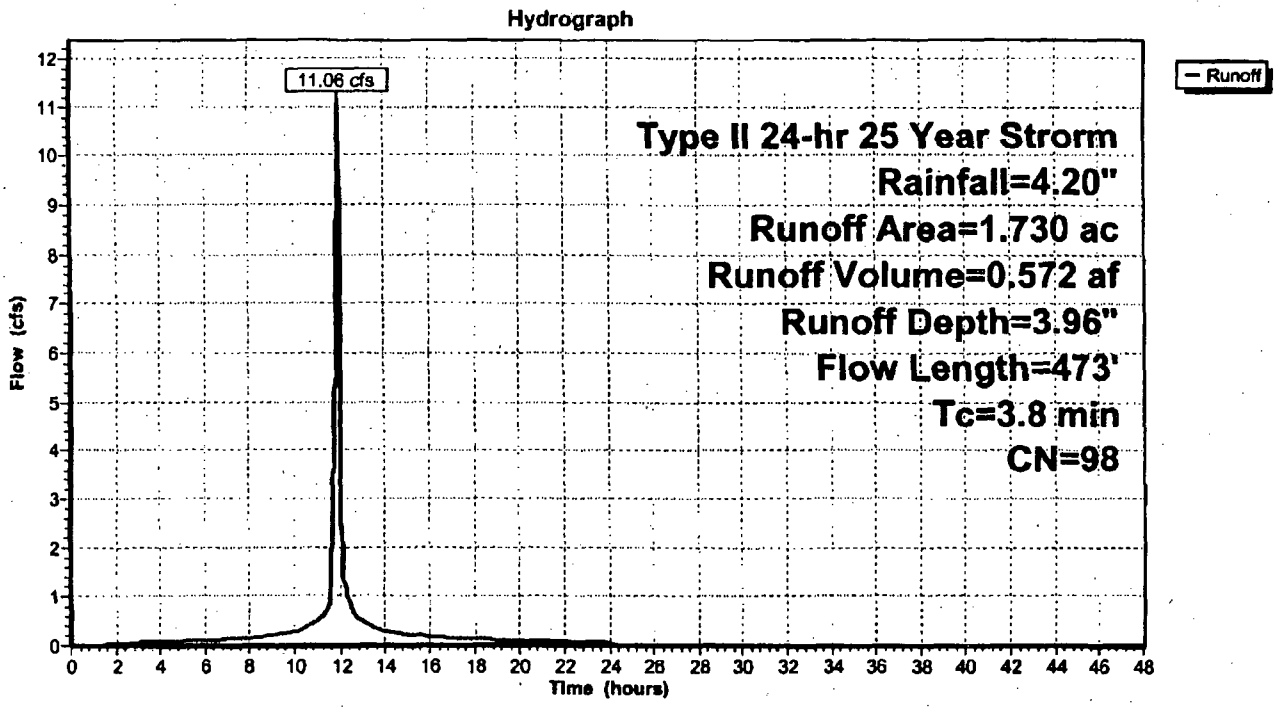
Runoff = 11.06 cfs @ 11.94 hrs, Volume= 0.572 af, Depth= 3.96"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type II 24-hr 25 Year Stroom Rainfall=4.20"

| Area (ac) | CN | Description |
|---|---|---|
| 1.730 | 98 | North and East Sides of Cap |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 1.6 | 100 | 0.0130 | 1.0 | | **Sheet Flow, A to B**<br>Smooth surfaces n= 0.011 P2= 2.50" |
| 1.8 | 243 | 0.0120 | 2.2 | | **Shallow Concentrated Flow, B to C**<br>Paved Kv= 20.3 fps |
| 0.4 | 130 | 0.0850 | 5.9 | | **Shallow Concentrated Flow, C to D**<br>Paved Kv= 20.3 fps |
| 3.8 | 473 | Total | | | |

## Subcatchment 3s: Subarea 3



## Subcatchment 6S: Subarea 6

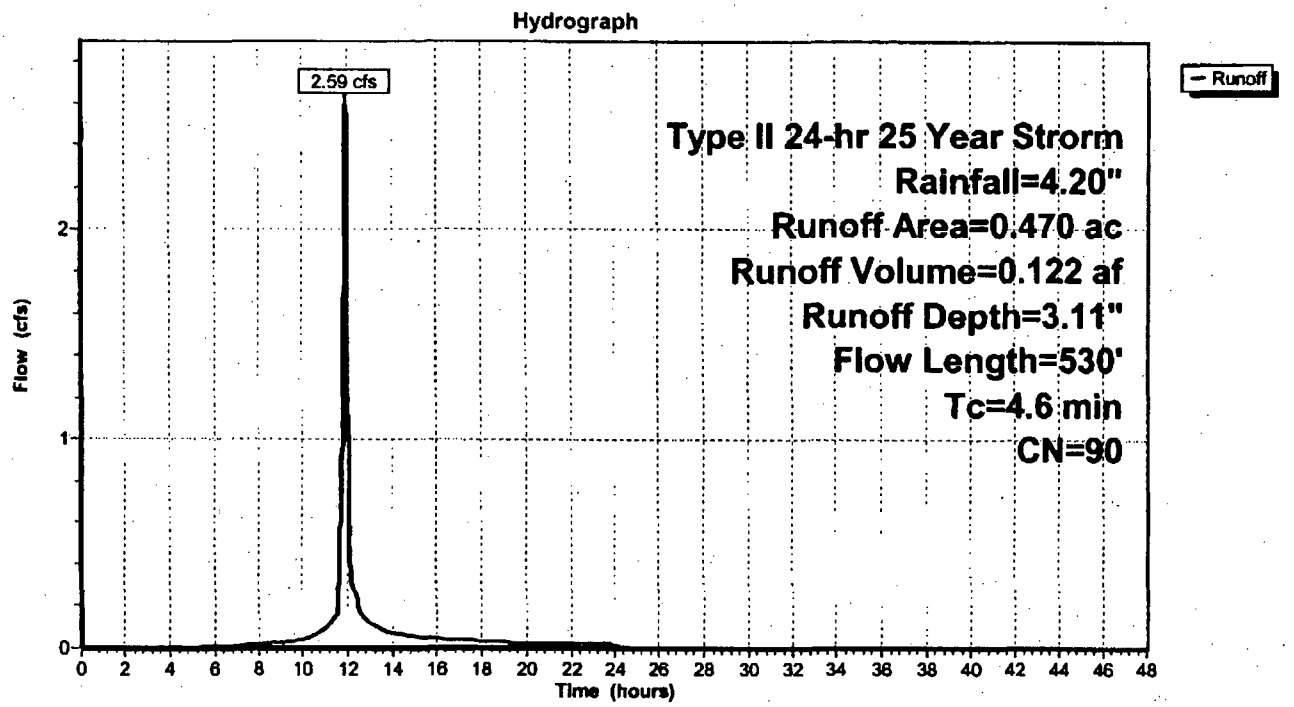
Runoff = 2.59 cfs @ 11.95 hrs, Volume= 0.122 af, Depth= 3.11"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type II 24-hr 25 Year Strorm Rainfall=4.20"

| Area (ac) | CN | Description |
|---|---|---|
| 0.470 | 90 | South area along edge of cap |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 1.2 | 100 | 0.0260 | 1.4 | | **Sheet Flow, A to B**<br>Smooth surfaces n= 0.011 P2= 2.50" |
| 3.4 | 430 | 0.0170 | 2.1 | | **Shallow Concentrated Flow, B to C**<br>Unpaved Kv= 16.1 fps |
| 4.6 | 530 | Total | | | |

## Subcatchment 6S: Subarea 6



## Subcatchment 7S: Subarea 5

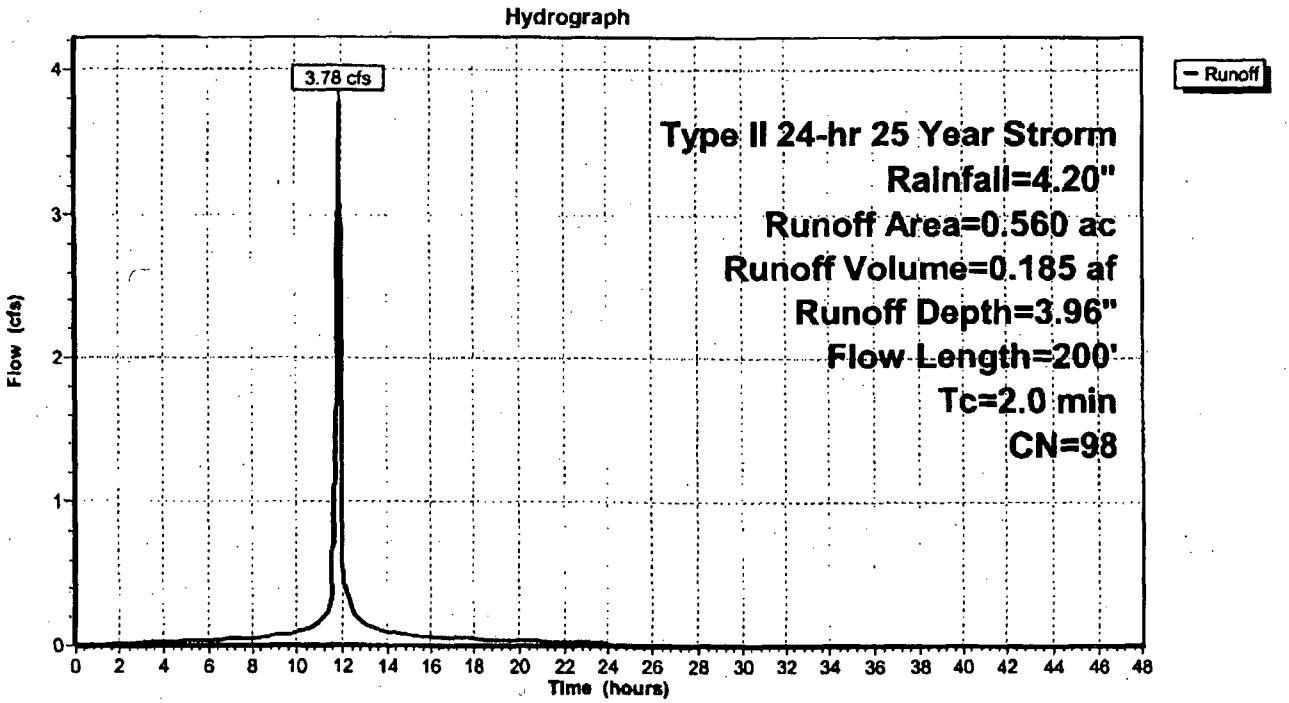
Runoff = 3.78 cfs @ 11.92 hrs, Volume= 0.185 af, Depth= 3.96"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type II 24-hr 25 Year Strorm Rainfall=4.20"

| Area (ac) | CN | Description |
|---|---|---|
| 0.560 | 98 | Area draing from SDA |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 1.4 | 100 | 0.0200 | 1.2 | | **Sheet Flow, A to B**<br>Smooth surfaces n= 0.011 P2= 2.50" |
| 0.6 | 100 | 0.0200 | 2.9 | | **Shallow Concentrated Flow, B to C**<br>Paved Kv= 20.3 fps |
| 2.0 | 200 | Total | | | |

## Subcatchment 7S: Subarea 5



## Subcatchment 8S: Subarea 4

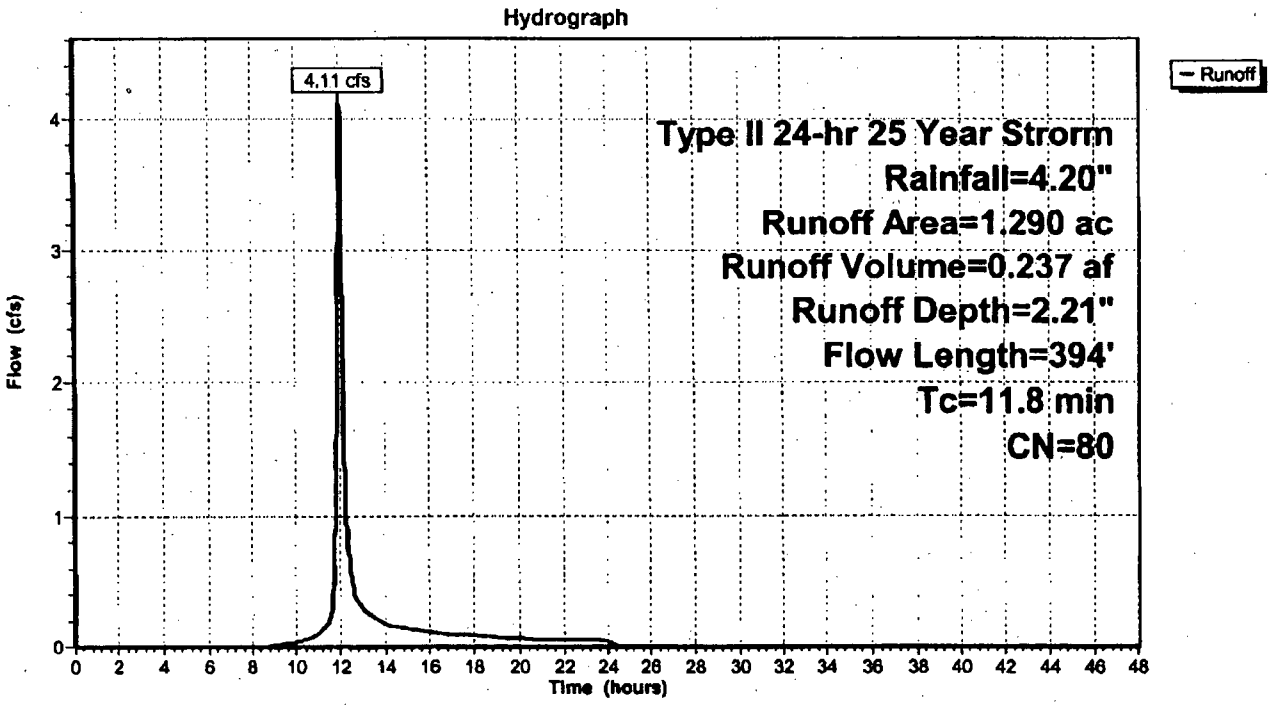
Runoff = 4.11 cfs @ 12.04 hrs, Volume= 0.237 af, Depth= 2.21"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type II 24-hr 25 Year Stroom Rainfall=4.20"

| Area (ac) | CN | Description |
|---|---|---|
| 1.290 | 80 | South area draining to 12" pipe |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 10.1 | 100 | 0.0250 | 0.2 | | **Sheet Flow, A to B**<br>Grass: Short n= 0.150 P2= 2.50" |
| 1.7 | 294 | 0.0310 | 2.8 | | **Shallow Concentrated Flow, B to C**<br>Unpaved Kv= 16.1 fps |
| 11.8 | 394 | Total | | | |

## Subcatchment 8S: Subarea 4



## Subcatchment 9S: Subarea #7

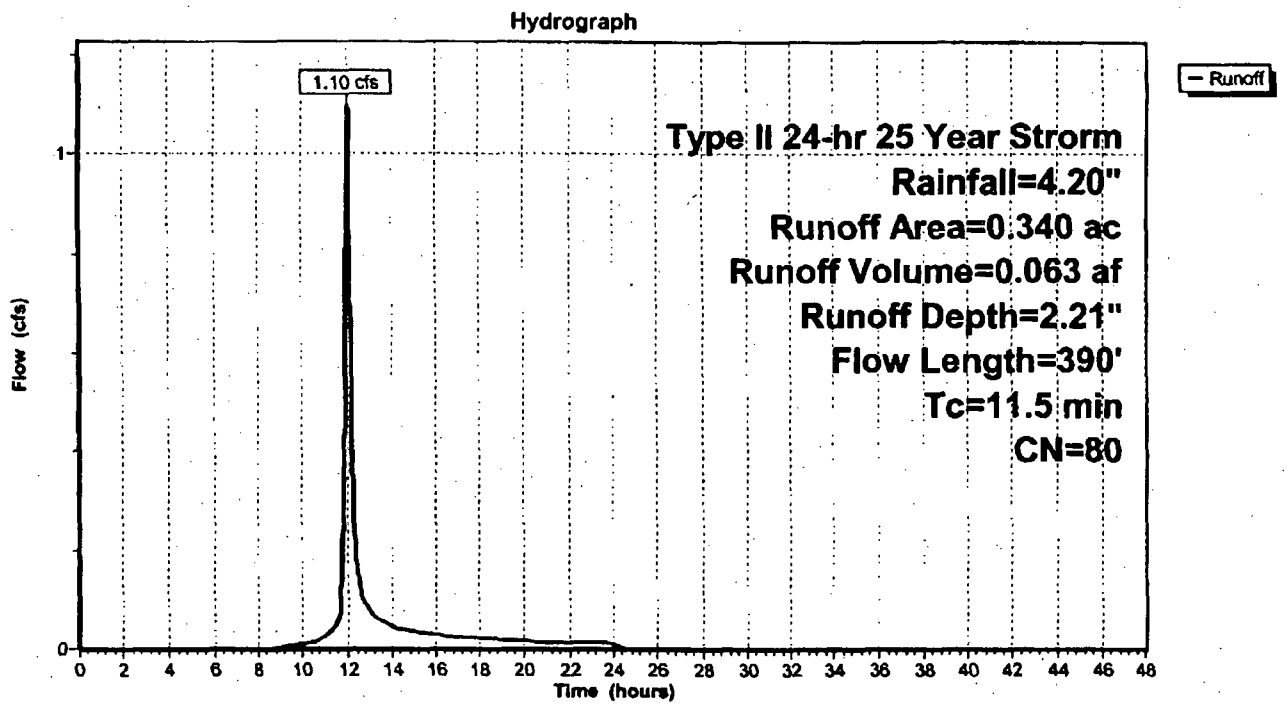
Runoff = 1.10 cfs @ 12.03 hrs, Volume= 0.063 af, Depth= 2.21"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type II 24-hr 25 Year Strorm Rainfall=4.20"

| Area (ac) | CN | Description |
|---|---|---|
| 0.340 | 80 | Exterior east side of cap |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 11.1 | 100 | 0.0200 | 0.2 | | **Sheet Flow, A to B**<br>Grass: Short n= 0.150 P2= 2.50" |
| 0.4 | 290 | 0.0450 | 13.5 | 486.27 | **Channel Flow, B to C**<br>Area= 36.0 sf Perim= 24.7' r= 1.46' n= 0.030 |
| 11.5 | 390 | Total | | | |

## Subcatchment 9S: Subarea #7



## Subcatchment 12S: Subarea #8

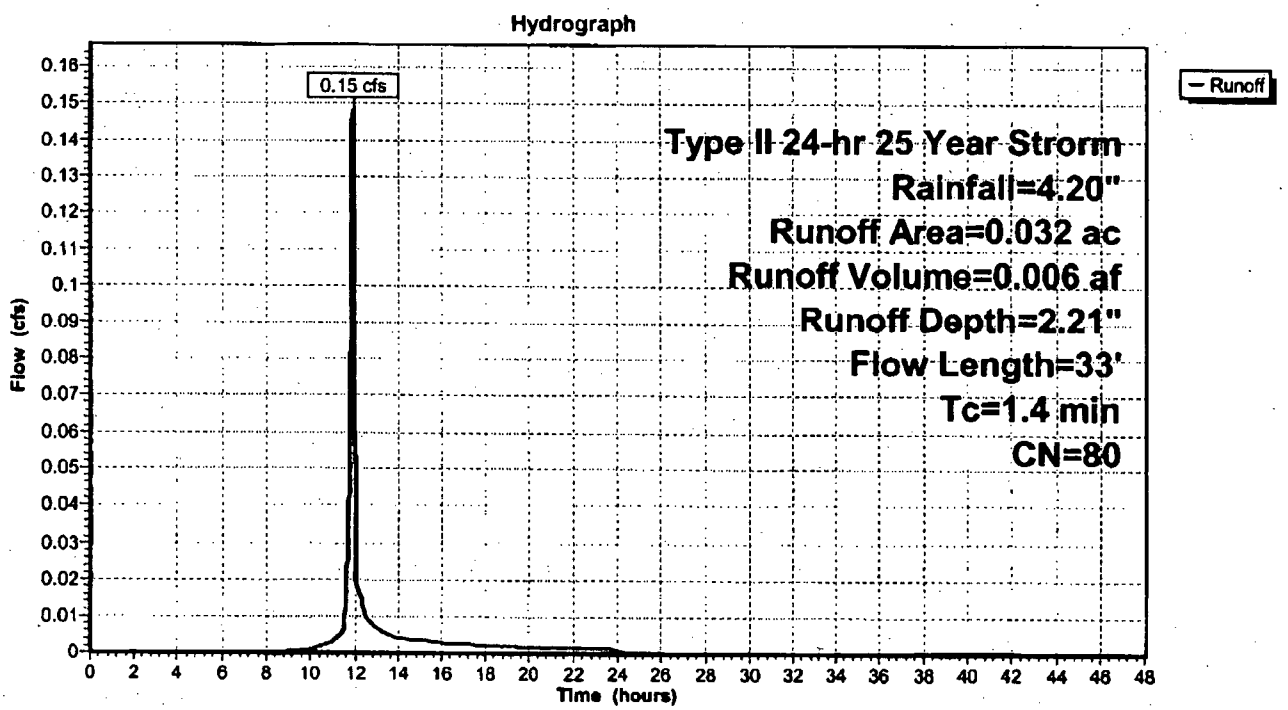
Runoff = 0.15 cfs @ 11.92 hrs, Volume= 0.006 af, Depth= 2.21"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type II 24-hr 25 Year Strorm Rainfall=4.20"

| Area (ac) | CN | Description |
|---|---|---|
| 0.032 | 80 | Northside from 24" to Basin #3 outlet |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 1.4 | 33 | 0.3900 | 0.4 | | **Sheet Flow, A to B**<br>Grass: Short n= 0.150 P2= 2.50" |

## Subcatchment 12S: Subarea #8



## Subcatchment 13S: Subarea #9

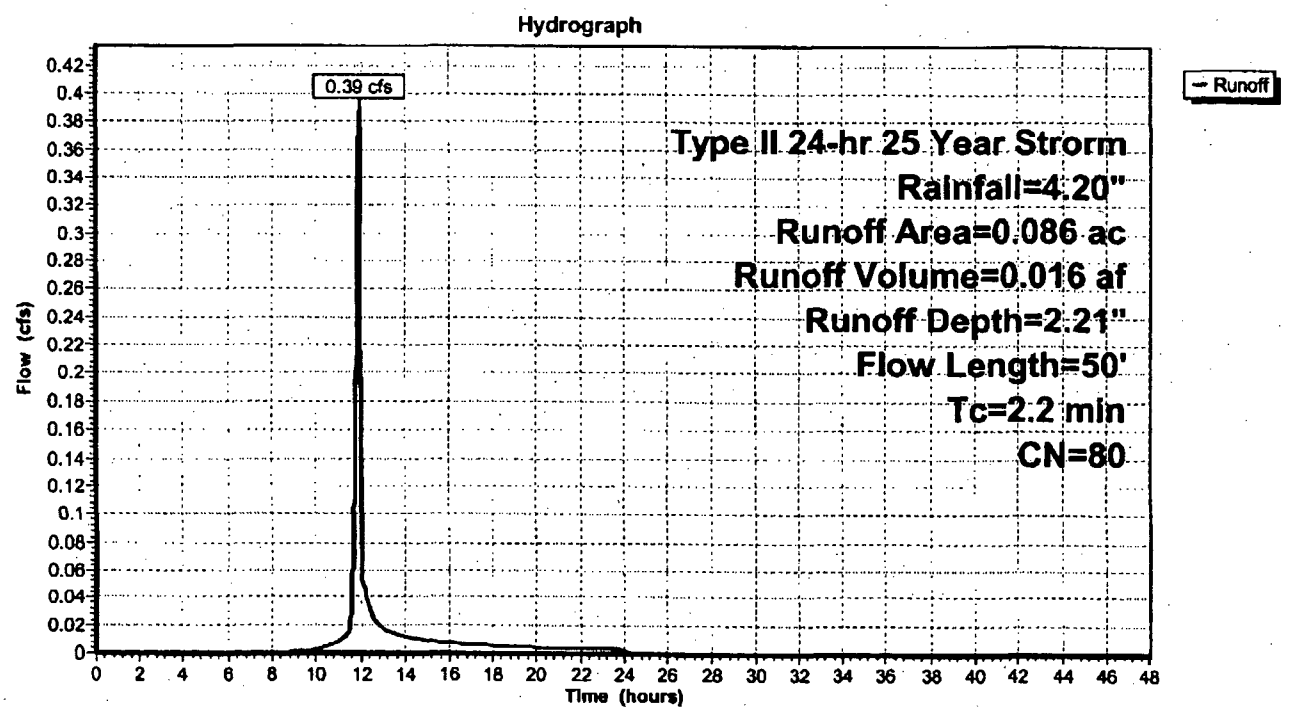
Runoff = 0.39 cfs @ 11.93 hrs, Volume= 0.016 af, Depth= 2.21"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type II 24-hr 25 Year Strorm Rainfall=4.20"

| Area (ac) | CN | Description |
|---|---|---|
| 0.086 | 80 | Northside from Basin #3 outlet to final reach |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 2.2 | 50 | 0.2900 | 0.4 | | **Sheet Flow, A to B**<br>Grass: Short n= 0.150 P2= 2.50" |

## Subcatchment 13S: Subarea #9



## Subcatchment 20S: Subarea #10

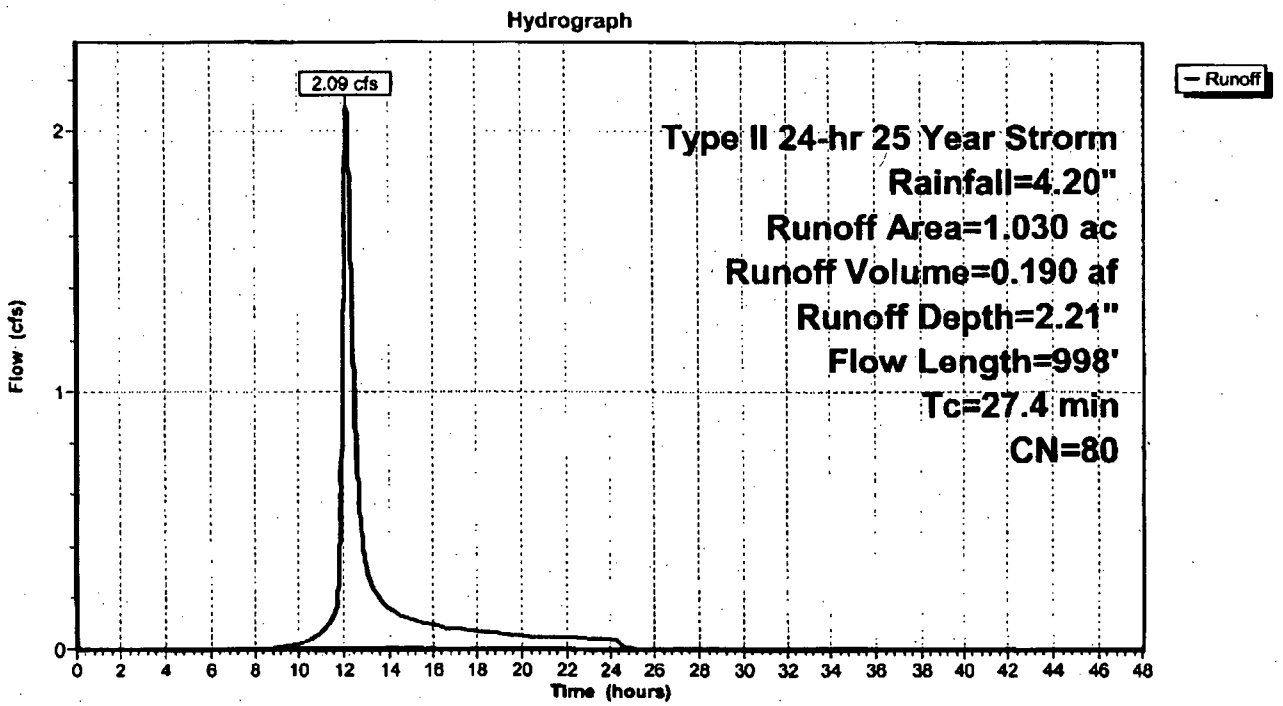
Runoff = 2.09 cfs @ 12.21 hrs, Volume= 0.190 af, Depth= 2.21"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type II 24-hr 25 Year Stroom Rainfall=4.20"

| Area (ac) | CN | Description |
|---|---|---|
| 1.030 | 80 | Northside along edge of cap |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 17.9 | 100 | 0.0060 | 0.1 | | **Sheet Flow, A to B**<br>Grass: Short n= 0.150 P2= 2.50" |
| 7.9 | 417 | 0.0030 | 0.9 | | **Shallow Concentrated Flow, B to C**<br>Unpaved Kv= 16.1 fps |
| 1.4 | 260 | 0.0350 | 3.0 | | **Shallow Concentrated Flow, C to D**<br>Unpaved Kv= 16.1 fps |
| 0.2 | 221 | 0.1150 | 21.6 | 777.35 | **Channel Flow, D to E**<br>Area= 36.0 sf Perim= 24.7' r= 1.46' n= 0.030 |
| 27.4 | 998 | Total | | | |

## Subcatchment 20S: Subarea #10



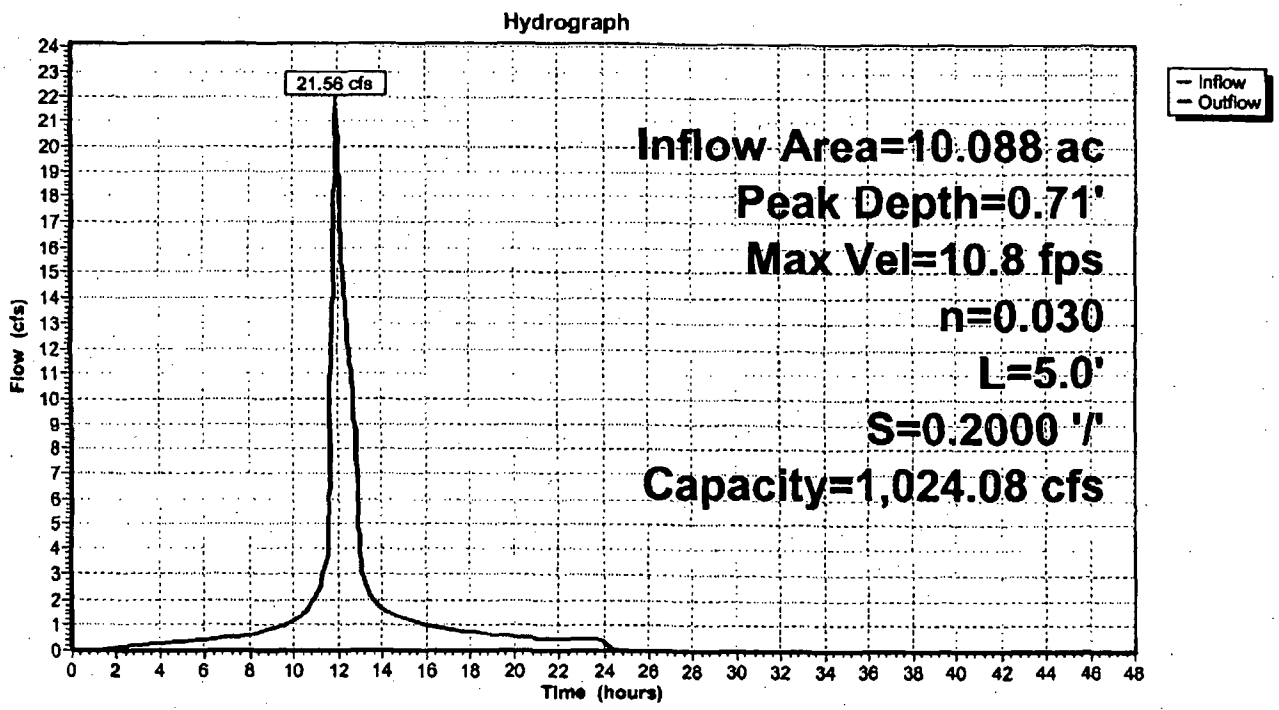
## Reach 6R: Erdman Brook

Inflow Area = 10.088 ac, Inflow Depth = 3.44" for 25 Year Storm event
Inflow = 21.56 cfs @ 11.96 hrs, Volume= 2.893 af
Outflow = 21.56 cfs @ 11.96 hrs, Volume= 2.893 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Max. Velocity= 10.8 fps, Min. Travel Time= 0.0 min
Avg. Velocity = 4.6 fps, Avg. Travel Time= 0.0 min

Peak Depth= 0.71' @ 11.96 hrs
Capacity at bank full= 1,024.08 cfs
Inlet Invert= 1,353.50', Outlet Invert= 1,352.50'
0.00' x 3.00' deep channel, n= 0.030
Side Slope Z-value= 4.0 '/' Top Width= 24.00'
Length= 5.0' Slope= 0.2000 '/'

## Reach 6R: Erdman Brook



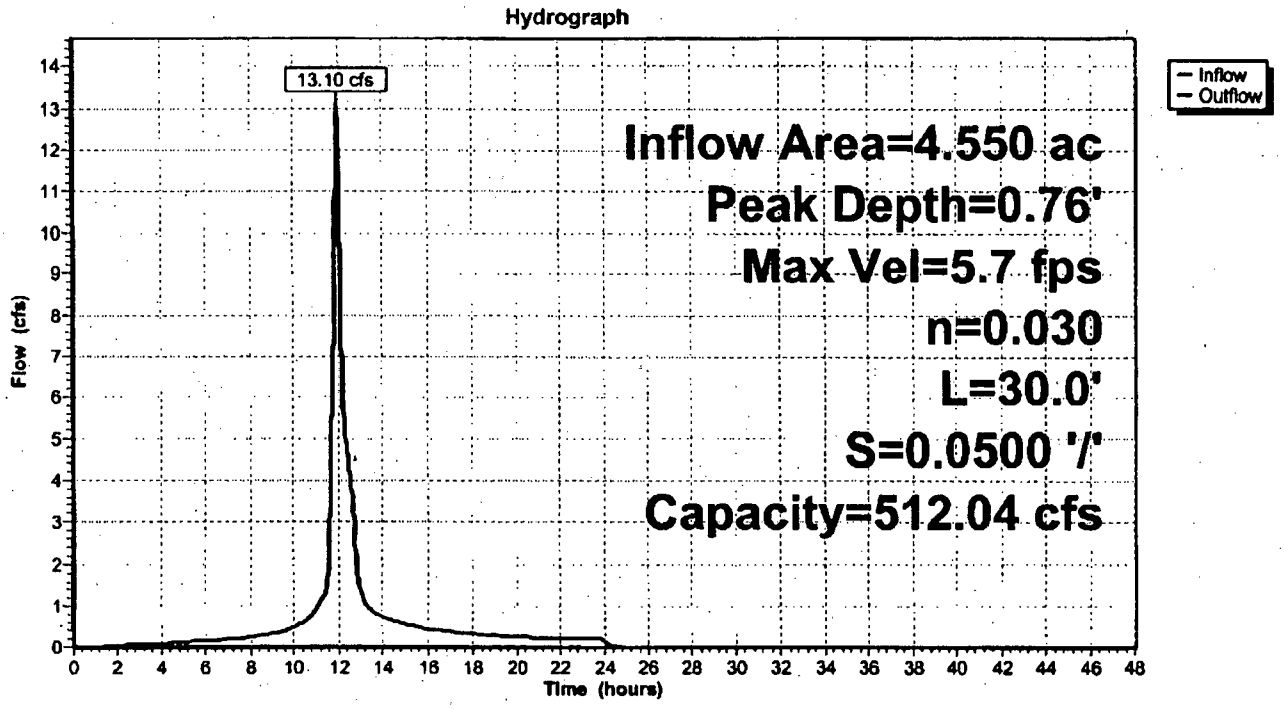
## Reach 14R: Reach #1

Inflow Area = 4.550 ac, Inflow Depth = 3.25" for 25 Year Stroom event
Inflow = 13.10 cfs @ 11.95 hrs, Volume= 1.231 af
Outflow = 13.10 cfs @ 11.95 hrs, Volume= 1.231 af, Atten= 0%, Lag= 0.1 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Max. Velocity= 5.7 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 2.2 fps, Avg. Travel Time= 0.2 min

Peak Depth= 0.76' @ 11.95 hrs
Capacity at bank full= 512.04 cfs
Inlet Invert= 1,366.00', Outlet Invert= 1,364.50'
0.00' x 3.00' deep channel, n= 0.030
Side Slope Z-value= 4.0 '/' Top Width= 24.00'
Length= 30.0' Slope= 0.0500 '/'

## Reach 14R: Reach #1



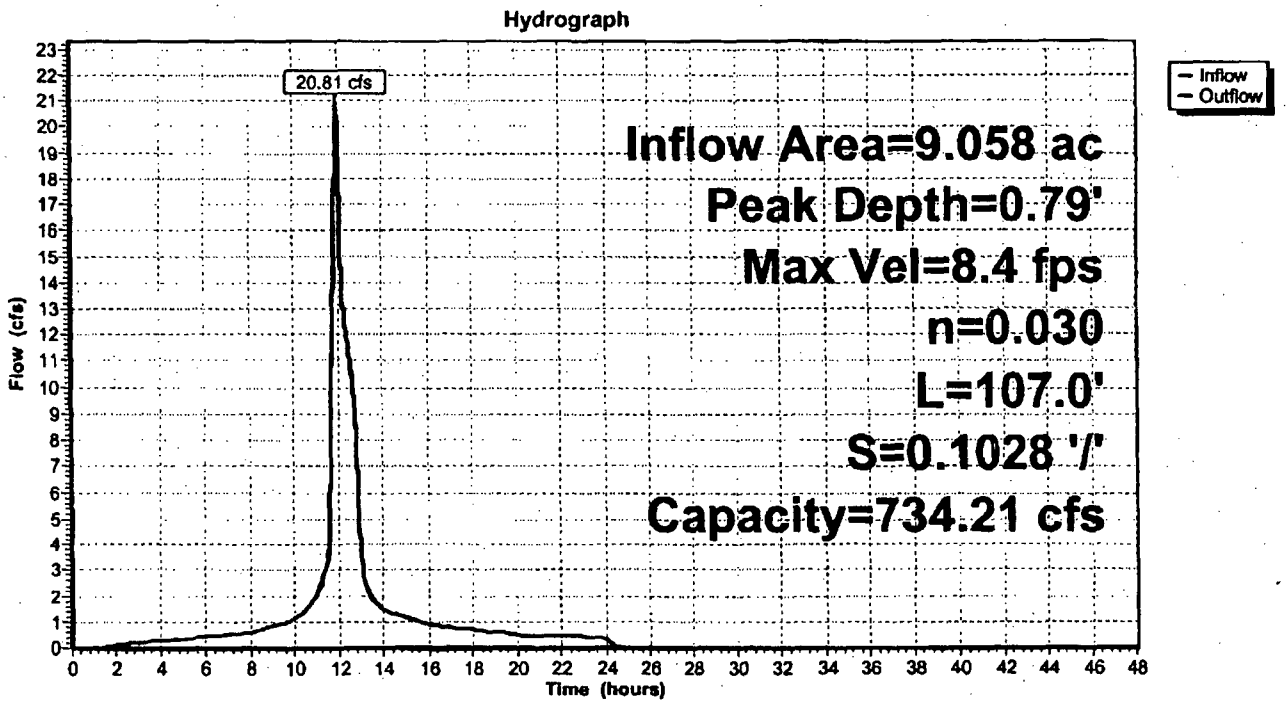
## Reach 15R: Reach #2

Inflow Area = 9.058 ac, Inflow Depth = 3.58" for 25 Year Stromm event
Inflow = 20.81 cfs @ 11.95 hrs, Volume= 2.703 af
Outflow = 20.81 cfs @ 11.95 hrs, Volume= 2.703 af, Atten= 0%, Lag= 0.2 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Max. Velocity= 8.4 fps, Min. Travel Time= 0.2 min
Avg. Velocity = 3.6 fps, Avg. Travel Time= 0.5 min

Peak Depth= 0.79' @ 11.95 hrs
Capacity at bank full= 734.21 cfs
Inlet Invert= 1,364.50', Outlet Invert= 1,353.50'
0.00' x 3.00' deep channel, n= 0.030
Side Slope Z-value= 4.0 '/' Top Width= 24.00'
Length= 107.0' Slope= 0.1028 '/'

## Reach 15R: Reach #2



## Pond 3P: Basin #1

| | | | | | |
|---|---|---|---|---|---|
| Inflow Area = | 2.660 ac, | Inflow Depth = | 3.96" | for | 25 Year Strorm event |
| Inflow = | 18.18 cfs @ | 11.92 hrs, | Volume= | 0.879 af | |
| Outflow = | 16.09 cfs @ | 11.94 hrs, | Volume= | 0.879 af, | Atten= 11%, Lag= 1.4 min |
| Primary = | 16.09 cfs @ | 11.94 hrs, | Volume= | 0.879 af | |

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Peak Elev= 1,380.09' @ 11.94 hrs Surf.Area= 0 sf Storage= 1,383 cf
Plug-Flow detention time= 1.2 min calculated for 0.879 af (100% of inflow)
Center-of-Mass det. time= 1.2 min ( 744.2 - 743.0 )

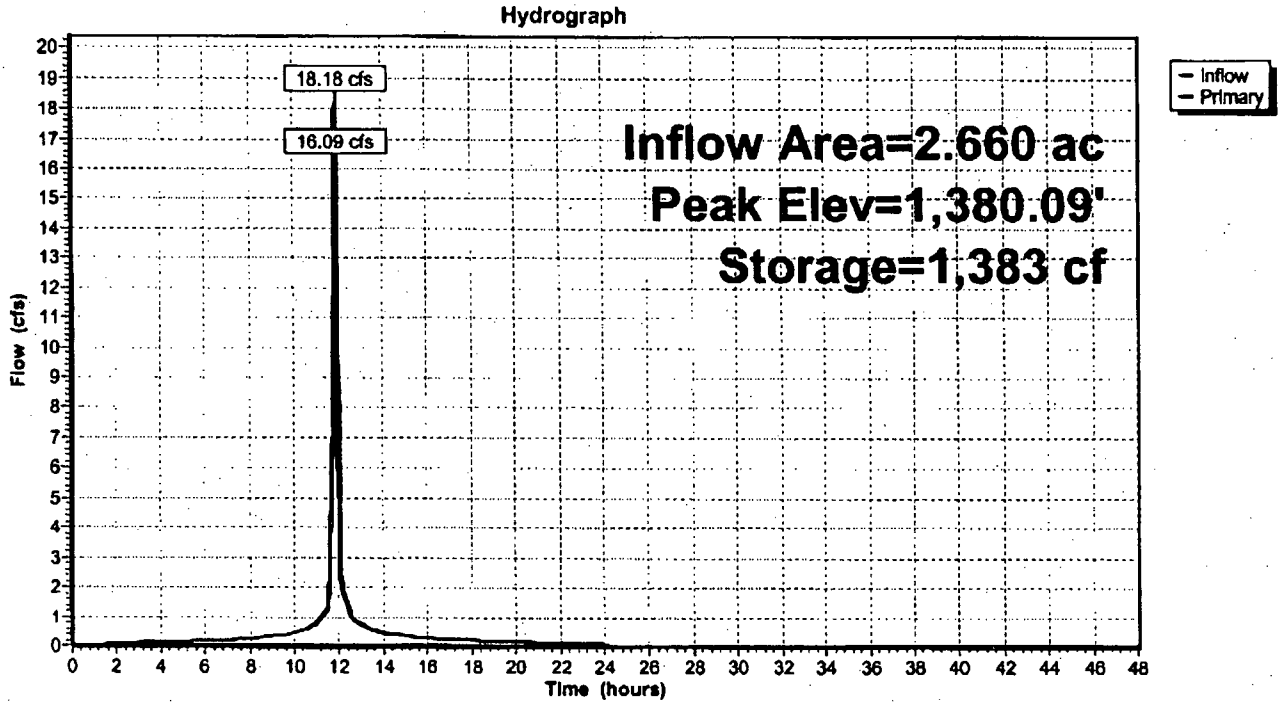
| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 1,379.00' | 8,505 cf | **Custom Stage Data** Listed below |

| Elevation (feet) | Inc.Store (cubic-feet) | Cum.Store (cubic-feet) |
|---|---|---|
| 1,379.00 | 0 | 0 |
| 1,380.00 | 1,145 | 1,145 |
| 1,381.00 | 2,659 | 3,804 |
| 1,382.00 | 4,701 | 8,505 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 0.00' | **Special & User-Defined**<br>Elev. (feet) 1,379.00 1,380.00 1,381.00 1,382.00<br>Disch. (cfs) 0.000 15.680 20.250 23.960 |

**Primary OutFlow** Max=16.09 cfs @ 11.94 hrs HW=1,380.09' TW=1,378.15' (Dynamic Tailwater)
└─**1=Special & User-Defined** (Custom Controls 16.09 cfs)

## Pond 3P: Basin #1



## Pond 4P: Basin #2

| | | | | | |
|---|---|---|---|---|---|
| Inflow Area = | 1.890 ac, | Inflow Depth = | 3.96" | for | 25 Year Stroom event |
| Inflow = | 13.27 cfs @ | 11.91 hrs, | Volume= | 0.624 af | |
| Outflow = | 3.55 cfs @ | 11.99 hrs, | Volume= | 0.624 af, | Atten= 73%, Lag= 5.2 min |
| Primary = | 3.55 cfs @ | 11.99 hrs, | Volume= | 0.624 af | |

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Peak Elev= 1,379.64' @ 11.99 hrs Surf.Area= 0 sf Storage= 6,667 cf
Plug-Flow detention time= 13.0 min calculated for 0.624 af (100% of inflow)
Center-of-Mass det. time= 13.0 min ( 754.9 - 741.9 )

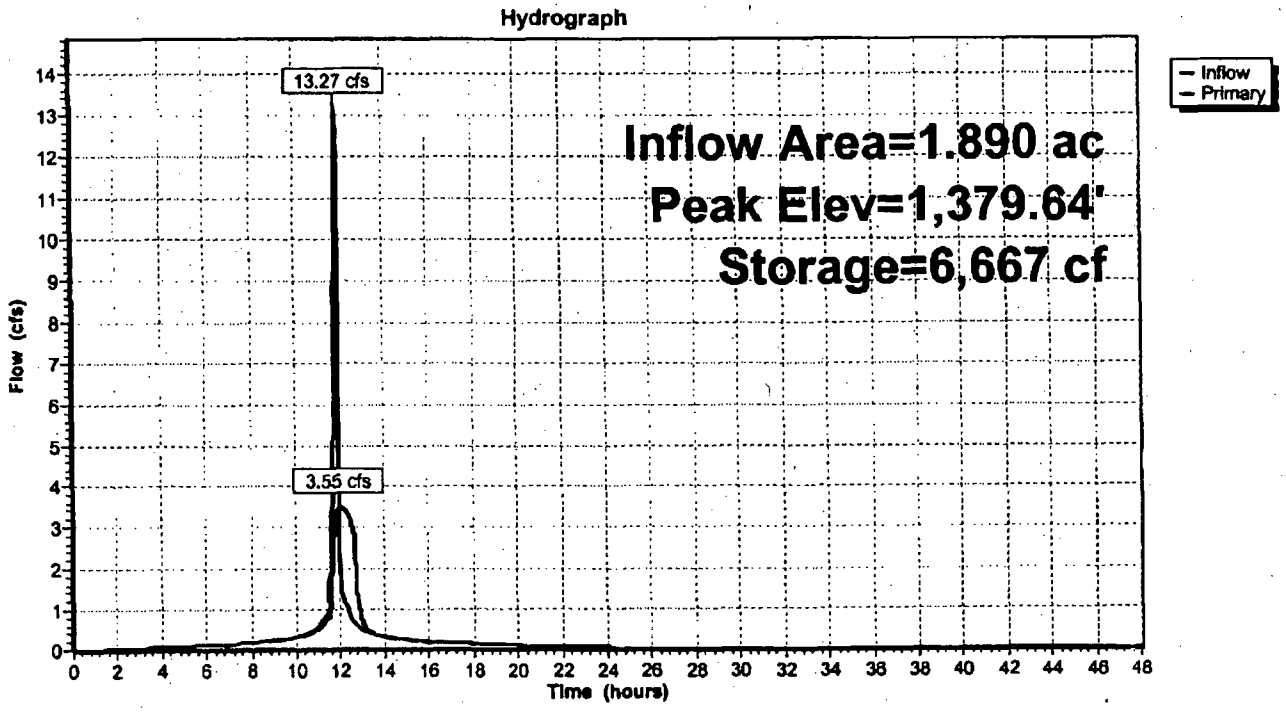
| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 1,377.00' | 8,556 cf | **Custom Stage Data** Listed below |

| Elevation (feet) | Inc.Store (cubic-feet) | Cum.Store (cubic-feet) |
|---|---|---|
| 1,377.00 | 0 | 0 |
| 1,378.00 | 1,300 | 1,300 |
| 1,379.00 | 1,993 | 3,293 |
| 1,380.00 | 5,263 | 8,556 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 0.00' | **Special & User-Defined**<br>Elev. (feet) 1,377.00 1,378.00 1,379.00 1,380.00<br>Disch. (cfs) 0.000 2.780 3.270 3.700 |

**Primary OutFlow** Max=3.55 cfs @ 11.99 hrs HW=1,379.64' TW=1,377.27' (Dynamic Tailwater)
└─**1=Special & User-Defined** (Custom Controls 3.55 cfs)

## Pond 4P: Basin #2



## Pond 5P: Basin #3

| | | | | | |
|---|---|---|---|---|---|
| Inflow Area = | 4.390 ac, | Inflow Depth = | 3.96" | for | 25 Year Strorm event |
| Inflow = | 27.15 cfs @ | 11.94 hrs, | Volume= | 1.450 af | |
| Outflow = | 7.49 cfs @ | 12.04 hrs, | Volume= | 1.450 af, | Atten= 72%, Lag= 6.1 min |
| Primary = | 7.49 cfs @ | 12.04 hrs, | Volume= | 1.450 af | |

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Peak Elev= 1,378.53' @ 12.04 hrs Surf.Area= 0 sf Storage= 15,596 cf
Plug-Flow detention time= 13.6 min calculated for 1.450 af (100% of inflow)
Center-of-Mass det. time= 13.6 min ( 758.1 - 744.5 )

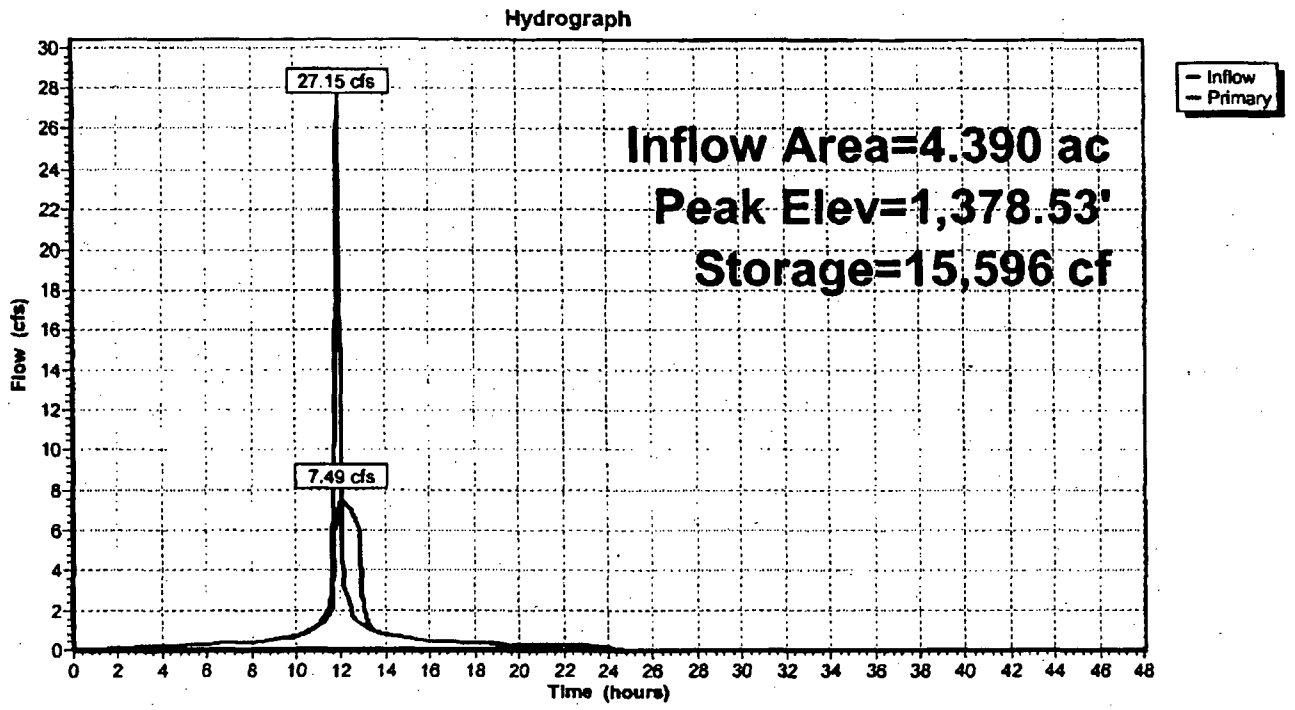
| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 1,376.00' | 21,103 cf | **Custom Stage Data** Listed below |

| Elevation (feet) | Inc.Store (cubic-feet) | Cum.Store (cubic-feet) |
|---|---|---|
| 1,376.00 | 0 | 0 |
| 1,377.00 | 2,549 | 2,549 |
| 1,378.00 | 6,932 | 9,481 |
| 1,379.00 | 11,622 | 21,103 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 0.00' | **Special & User-Defined**<br>Elev. (feet) 1,376.00 1,377.00 1,378.00 1,379.00<br>Disch. (cfs) 0.000 6.110 7.050 7.890 |

**Primary OutFlow** Max=7.49 cfs @ 12.04 hrs HW=1,378.53' TW=1,365.25' (Dynamic Tailwater)
└**1=Special & User-Defined** (Custom Controls 7.49 cfs)

## Pond 5P: Basin #3



## Pond 16P: 18"

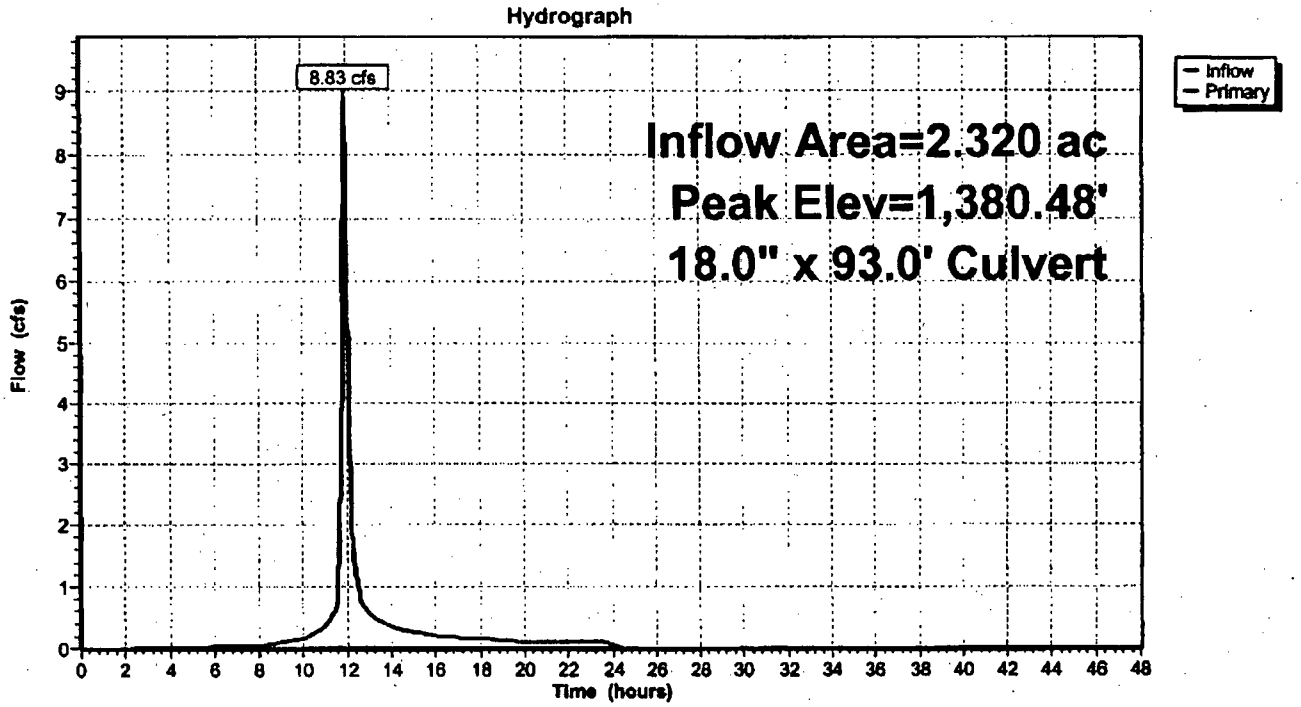
| | | | | | |
|---|---|---|---|---|---|
| Inflow Area = | 2.320 ac, | Inflow Depth = | 2.81" | for | 25 Year Stroom event |
| Inflow = | 8.83 cfs @ | 11.94 hrs, | Volume= | 0.544 af | |
| Outflow = | 8.83 cfs @ | 11.94 hrs, | Volume= | 0.544 af, | Atten= 0%, Lag= 0.0 min |
| Primary = | 8.83 cfs @ | 11.94 hrs, | Volume= | 0.544 af | |

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Peak Elev= 1,380.48' @ 11.94 hrs
Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 0.0 min ( 792.9 - 792.9 )

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 1,378.00' | **18.0" x 93.0' long Culvert** CMP, projecting, no headwall, Ke= 0.900<br>Outlet Invert= 1,375.50' S= 0.0269 '/' Cc= 0.900<br>n= 0.013 Corrugated PE, smooth interior |

**Primary OutFlow** Max=8.82 cfs @ 11.94 hrs HW=1,380.47' TW=1,377.44' (Dynamic Tailwater)
└**1=Culvert** (Inlet Controls 8.82 cfs @ 5.0 fps)

## Pond 16P: 18"



## Pond 17P: Existing 24" Pipe

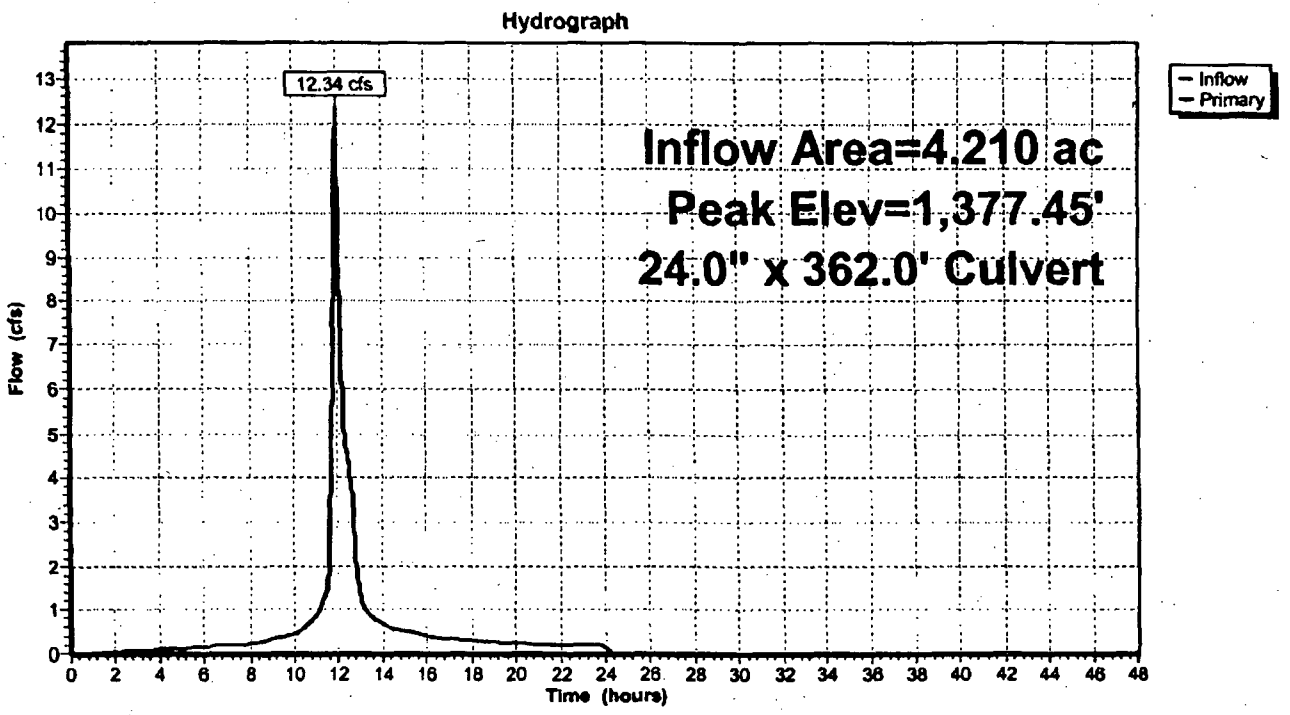
| | | | | | |
|---|---|---|---|---|---|
| Inflow Area = | 4.210 ac, | Inflow Depth = | 3.33" | for | 25 Year Stromm event |
| Inflow = | 12.34 cfs @ | 11.94 hrs, | Volume= | 1.169 af | |
| Outflow = | 12.34 cfs @ | 11.94 hrs, | Volume= | 1.169 af, | Atten= 0%, Lag= 0.0 min |
| Primary = | 12.34 cfs @ | 11.94 hrs, | Volume= | 1.169 af | |

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Peak Elev= 1,377.45' @ 11.94 hrs
Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 0.0 min ( 772.6 - 772.6 )

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 1,375.38' | **24.0" x 362.0' long Culvert** CMP, projecting, no headwall, Ke= 0.900<br>Outlet Invert= 1,366.00' S= 0.0259 '/' Cc= 0.900<br>n= 0.013 Corrugated PE, smooth interior |

**Primary OutFlow** Max=12.32 cfs @ 11.94 hrs HW=1,377.44' TW=1,366.76' (Dynamic Tailwater)
└**1=Culvert** (Inlet Controls 12.32 cfs @ 3.9 fps)

## Pond 17P: Existing 24" Pipe



## Pond 18P: 12"

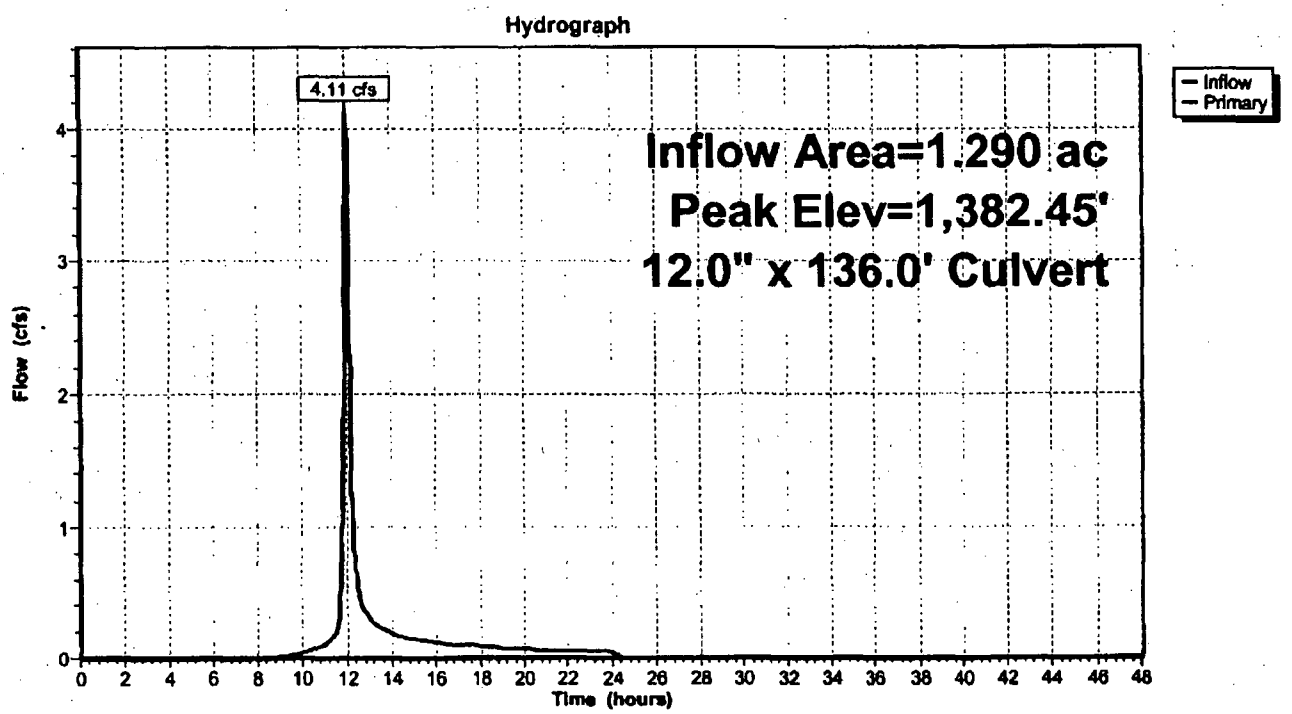
| | | | | | |
|---|---|---|---|---|---|
| Inflow Area = | 1.290 ac, | Inflow Depth = | 2.21" | for | 25 Year Storm event |
| Inflow = | 4.11 cfs @ | 12.04 hrs, | Volume= | 0.237 af | |
| Outflow = | 4.11 cfs @ | 12.04 hrs, | Volume= | 0.237 af, | Atten= 0%, Lag= 0.0 min |
| Primary = | 4.11 cfs @ | 12.04 hrs, | Volume= | 0.237 af | |

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Peak Elev= 1,382.45' @ 12.04 hrs
Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 0.0 min ( 831.8 - 831.8 )

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 1,379.50' | **12.0" x 136.0' long Culvert** CMP, projecting, no headwall, Ke= 0.900<br>Outlet Invert= 1,378.82' S= 0.0050 '/' Cc= 0.900<br>n= 0.013 Corrugated PE, smooth interior |

**Primary OutFlow** Max=4.11 cfs @ 12.04 hrs HW=1,382.44' TW=1,379.54' (Dynamic Tailwater)
└**1=Culvert** (Barrel Controls 4.11 cfs @ 5.2 fps)

**Pond 18P: 12"**



## Pond 19P: 18"

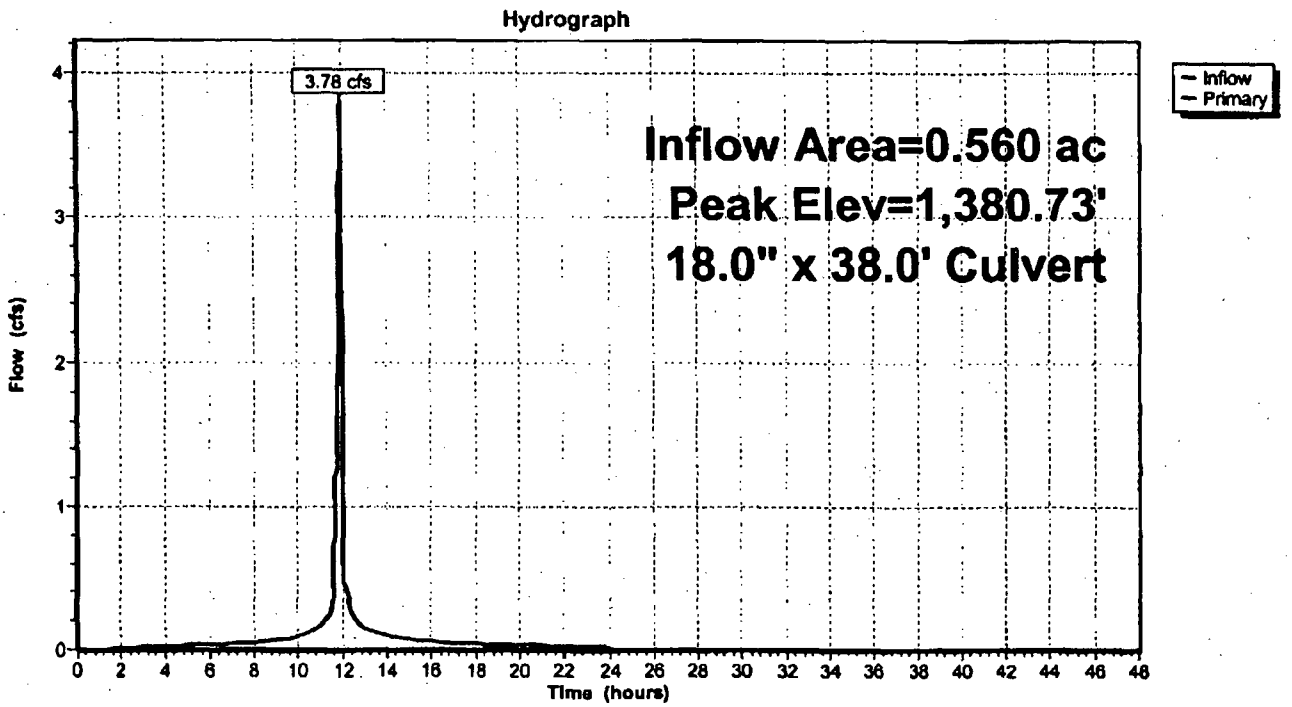
| | | | | | |
|---|---|---|---|---|---|
| Inflow Area = | 0.560 ac, | Inflow Depth = | 3.96" | for | 25 Year Stroom event |
| Inflow = | 3.78 cfs @ | 11.92 hrs, | Volume= | 0.185 af | |
| Outflow = | 3.78 cfs @ | 11.92 hrs, | Volume= | 0.185 af, | Atten= 0%, Lag= 0.0 min |
| Primary = | 3.78 cfs @ | 11.92 hrs, | Volume= | 0.185 af | |

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Peak Elev= 1,380.73' @ 11.94 hrs
Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= (not calculated: outflow precedes inflow)

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 1,378.50' | **18.0" x 38.0' long Culvert** CMP, projecting, no headwall, Ke= 0.900<br>Outlet Invert= 1,378.00' S= 0.0132 '/' Cc= 0.900<br>n= 0.025 Corrugated metal |

**Primary OutFlow** Max=2.86 cfs @ 11.92 hrs HW=1,380.55' TW=1,380.37' (Dynamic Tailwater)
└─**1=Culvert** (Outlet Controls 2.86 cfs @ 1.6 fps)

## Pond 19P: 18"



# BASIN #2 OULET PIPE PROTECTION

**McMahon & Mann**
Consulting Engineers, P.C.

BY ALN DATE 6/5/07 SUBJECT WVNS - NOA SHT. NO. 1 OF 1
CHKD. BY ASK DATE 6/5/07 CAP DESIGN JOB NO. 07-011
POST - CAP STORMWATER ANALYSIS

CHECK OUTLET PROTECTION FOR BASIN #3

- 12" Φ DISCHARGE PIPE

$S = 6.67\%$
$n = 0.013$
$Q = 7.5$ CFS

- USING PARTIALLY FLOWING PIPES, ESTIMATE d AND Q

$$\frac{Qn}{D^{8/3} S^{1/2}} = \frac{(7.5)(0.013)}{(1)^{8/3}(0.0667)^{1/2}} = 0.377$$

- USING ATTACHED CHART

$A/D^2 = 0.5733$ $\quad d/D = 0.685$

$A = 0.5733(1)^2$ $\quad d = 0.685(1)$

$A = 0.5733$ FT$^2$ $\quad d = 0.685$ FT

$V = Q/A = 7.5/0.5733 = 13.08$ FPS (VELOCITY AT OUTLET)

- NOW ADJUST Q

$$Q = VA = 13.08\left(\pi\frac{(0.685)^2}{4}\right) = 4.82 \text{ CFS}$$

ASSUME TW < 1/2 DO USE FIGURE 5B.12 FROM NEW YORK GUIDELINES FOR URBAN EROSION AND SEDIMENT CONTROL

$\therefore D_{50} = 0.25$ FT $\quad L_a = 9$ FT $\quad W = 1 + 9 = 10'$

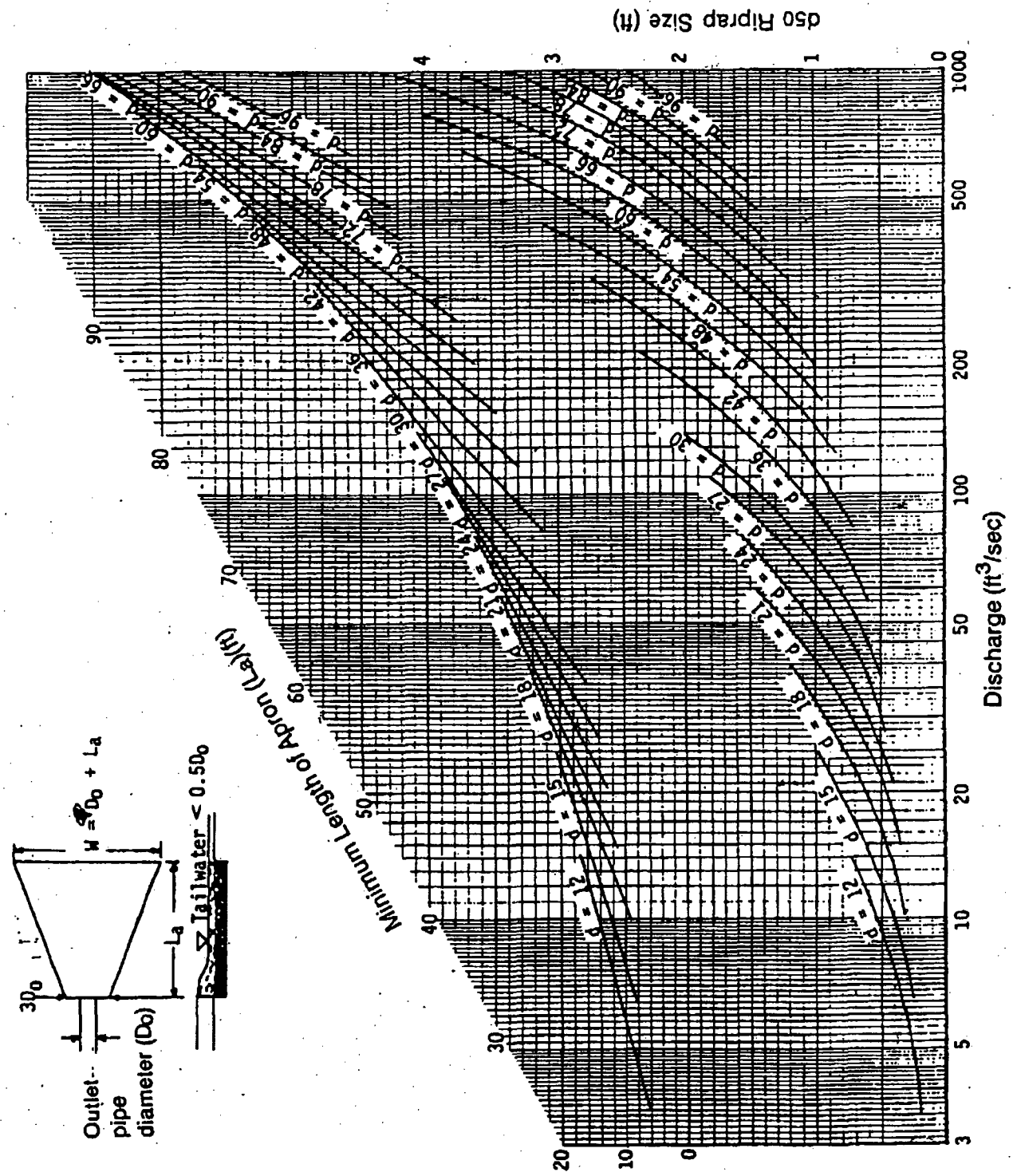
- WE WILL USE $d_{50} = 12"$, WITH THICKNESS OF 27" AND WIDTH OF 12 FT
RIP RAP WILL EXTEND TO THE TOE OF THE REGRADED SLOPE

**Table 4-17. Hydraulic Elements of Pipes (n constant)[23]**

| $\frac{d}{D}$ | $\frac{A}{D^2}$ | $\frac{Qn}{D^{8/3}S^{1/2}}$ | $\frac{Qc}{D^{5/2}}$ | $\frac{d}{D}$ | $\frac{A}{D^2}$ | $\frac{Qn}{D^{8/3}S^{1/2}}$ | $\frac{Qc}{D^{5/2}}$ |
|---|---|---|---|---|---|---|---|
| 0.01 | 0.0013 | 0.00007 | 0.0006 | 0.51 | 0.4027 | 0.239 | 1.4494 |
| 0.02 | 0.0037 | 0.00031 | 0.0025 | 0.52 | 0.4127 | 0.247 | 1.5041 |
| 0.03 | 0.0069 | 0.00074 | 0.0055 | 0.53 | 0.4227 | 0.255 | 1.5598 |
| 0.04 | 0.0105 | 0.00138 | 0.0098 | 0.54 | 0.4327 | 0.263 | 1.6166 |
| 0.05 | 0.0147 | 0.00222 | 0.0153 | 0.55 | 0.4426 | 0.271 | 1.6741 |
| 0.06 | 0.0192 | 0.00328 | 0.0220 | 0.56 | 0.4526 | 0.279 | 1.7328 |
| 0.07 | 0.0242 | 0.00455 | 0.0298 | 0.57 | 0.4625 | 0.287 | 1.7924 |
| 0.08 | 0.0294 | 0.00604 | 0.0389 | 0.58 | 0.4724 | 0.295 | 1.8531 |
| 0.09 | 0.0350 | 0.00775 | 0.0491 | 0.59 | 0.4822 | 0.303 | 1.9147 |
| 0.10 | 0.0409 | 0.00967 | 0.0605 | 0.60 | 0.4920 | 0.311 | 1.9773 |
| 0.11 | 0.0470 | 0.01181 | 0.0731 | 0.61 | 0.5018 | 0.319 | 2.0410 |
| 0.12 | 0.0534 | 0.01417 | 0.0868 | 0.62 | 0.5115 | 0.327 | 2.1058 |
| 0.13 | 0.0600 | 0.01674 | 0.1016 | 0.63 | 0.5212 | 0.335 | 2.1717 |
| 0.14 | 0.0668 | 0.01952 | 0.1176 | 0.64 | 0.5308 | 0.343 | 2.2886 |
| 0.15 | 0.0739 | 0.0225 | 0.1347 | 0.65 | 0.5404 | 0.350 | 2.3068 |
| 0.16 | 0.0811 | 0.0257 | 0.1530 | 0.66 | 0.5499 | 0.358 | 2.3760 |
| 0.17 | 0.0885 | 0.0291 | 0.1724 | 0.67 | 0.5594 | 0.366 | 2.4465 |
| 0.18 | 0.0961 | 0.0327 | 0.1928 | 0.68 | 0.5687 | 0.373 | 2.5182 |
| 0.19 | 0.1039 | 0.0365 | 0.2144 | 0.69 | 0.5780 | 0.380 | 2.5912 |
| 0.20 | 0.1118 | 0.0406 | 0.2371 | 0.70 | 0.5872 | 0.388 | 2.6656 |
| 0.21 | 0.1199 | 0.0448 | 0.2609 | 0.71 | 0.5964 | 0.395 | 2.7416 |
| 0.22 | 0.1281 | 0.0492 | 0.2857 | 0.72 | 0.6054 | 0.402 | 2.8188 |
| 0.23 | 0.1365 | 0.0537 | 0.3116 | 0.73 | 0.6143 | 0.409 | 2.8977 |
| 0.24 | 0.1449 | 0.0585 | 0.3386 | 0.74 | 0.6231 | 0.416 | 2.9783 |
| 0.25 | 0.1535 | 0.0634 | 0.3667 | 0.75 | 0.6319 | 0.422 | 3.0606 |
| 0.26 | 0.1623 | 0.0686 | 0.3957 | 0.76 | 0.6405 | 0.429 | 3.1450 |
| 0.27 | 0.1711 | 0.0739 | 0.4259 | 0.77 | 0.6489 | 0.435 | 3.2314 |
| 0.28 | 0.1800 | 0.0793 | 0.4571 | 0.78 | 0.6573 | 0.441 | 3.3200 |
| 0.29 | 0.1890 | 0.0849 | 0.4893 | 0.79 | 0.6655 | 0.447 | 3.4111 |
| 0.30 | 0.1982 | 0.0907 | 0.5226 | 0.80 | 0.6736 | 0.453 | 3.5051 |
| 0.31 | 0.2074 | 0.0966 | 0.5569 | 0.81 | 0.6815 | 0.458 | 3.6020 |
| 0.32 | 0.2167 | 0.1027 | 0.5921 | 0.82 | 0.6893 | 0.463 | 3.7021 |
| 0.33 | 0.2260 | 0.1089 | 0.6284 | 0.83 | 0.6969 | 0.468 | 3.8062 |
| 0.34 | 0.2355 | 0.1153 | 0.6657 | 0.84 | 0.7043 | 0.473 | 3.9144 |
| 0.35 | 0.2450 | 0.1218 | 0.7040 | 0.85 | 0.7115 | 0.477 | 4.0276 |
| 0.36 | 0.2546 | 0.1284 | 0.7433 | 0.86 | 0.7186 | 0.481 | 4.1466 |
| 0.37 | 0.2642 | 0.1351 | 0.7836 | 0.87 | 0.7254 | 0.485 | 4.2722 |
| 0.38 | 0.2739 | 0.1420 | 0.8249 | 0.88 | 0.7320 | 0.488 | 4.4057 |
| 0.39 | 0.2836 | 0.1490 | 0.8672 | 0.89 | 0.7384 | 0.491 | 4.5486 |
| 0.40 | 0.2934 | 0.1561 | 0.9104 | 0.90 | 0.7445 | 0.494 | 4.7033 |
| 0.41 | 0.3032 | 0.1633 | 0.9546 | 0.91 | 0.7504 | 0.496 | 4.8724 |
| 0.42 | 0.3130 | 0.1705 | 0.9997 | 0.92 | 0.7560 | 0.497 | 5.0602 |
| 0.43 | 0.3229 | 0.1779 | 1.0459 | 0.93 | 0.7612 | 0.498 | 5.2727 |
| 0.44 | 0.3328 | 0.1854 | 1.0929 | 0.94 | 0.7662 | 0.498 | 5.5182 |
| 0.45 | 0.3428 | 0.1929 | 1.1410 | 0.95 | 0.7707 | 0.498 | 5.8119 |
| 0.46 | 0.3527 | 0.201 | 1.1900 | 0.96 | 0.7749 | 0.496 | 6.1785 |
| 0.47 | 0.3627 | 0.208 | 1.2400 | 0.97 | 0.7785 | 0.494 | 6.6695 |
| 0.48 | 0.3727 | 0.216 | 1.2908 | 0.98 | 0.7817 | 0.489 | 7.4063 |
| 0.49 | 0.3827 | 0.224 | 1.3427 | 0.99 | 0.7841 | 0.483 | 8.8261 |
| 0.50 | 0.3927 | 0.232 | 1.3956 | 1.00 | 0.7854 | 0.463 | — |

FROM HANDBOOK OF STEEL DRAINAGE AND
HIGHWAY CONSTRUCTION PRODUCTS

## Figure 5B.12
## Outlet Protection Design - Minimum Tailwater Condition
## (Design of Outlet Protection from a Round Pipe Flowing Full, Minimum Tailwater Condition: $T_W < 0.5D_O$)



**Thickness**

The minimum thickness of the riprap layer shall be 1.5 times the maximum stone diameter for $d_{50}$ of 15 inches or less; and 1.2 times the maximum stone size for $d_{50}$ greater than 15 inches. The following chart lists some examples:

| $D_{50}$ (inches) | $d_{max}$ (inches) | Mimimum Blanket Thickness (inches) |
|---|---|---|
| 4 | 6 | 9 |
| 6 | 9 | 14 |
| 9 | 14 | 20 |
| 12 | 18 | 27 |
| 15 | 22 | 32 |
| 18 | 27 | 32 |
| 21 | 32 | 38 |
| 24 | 36 | 43 |

**Stone Quality**

Stone for riprap shall consist of field stone or rough unhewn quarry stone. The stone shall be hard and angular and of a quality that will not disintegrate on exposure to water or weathering. The specific gravity of the individual stones shall be at least 2.5.

Recycled concrete equivalent may be used provided it has a density of at least 150 pounds per cubic foot, and does not have any exposed steel or reinforcing bars.

**Filter**

A filter is a layer of material placed between the riprap and the underlying soil surface to prevent soil movement into and through the riprap. Riprap shall have a filter placed under it in all cases.

A filter can be of two general forms: A gravel layer or a plastic filter cloth. The plastic filter cloth can be woven or non-woven monofilament yarns, and shall meet these base requirements: thickness 20-60 mils, grab strength 90-120 lbs; and shall conform to ASTM D-1777 and ASTM D-1682.

Gravel filter blanket when used shall be designed by comparing particle sizes of the overlying material and the base material. Design criteria are available in Standard and Specification for Riprap Slope Protection, page 5B.55.

**Gabions**

Gabions shall be made of hexagonal triple twist mesh with heavily galvanized steel wire. The maximum linear dimension of the mesh opening shall not exceed 4 1/2 inches and the area of the mesh opening shall not exceed 10 square inches.

Gabions shall be fabricated in such a manner that the sides, ends, and lid can be assembled at the construction site into a rectangular basket of the specified sizes. Gabions shall be of single unit construction and shall be installed according to manufacturers recommendations.

The area on which the gabion is to be installed shall be graded as shown on the drawings. Foundation conditions shall be the same as for placing rock riprap and filter cloth shall be placed under all gabions. Where required, a key may be needed to prevent undermining of the main gabion structure.

**Maintenance**

Once a riprap outlet has been installed, the maintenance needs are very low. It should be inspected after high flows to see if scour beneath the riprap has occurred, or any stones have been dislodged. Repairs should be made immediately.

## Design Procedure

1. Investigate the downstream channel to assure that non-erosive velocities can be maintained.
2. Determine the tailwater condition at the outlet to establish which curve to use.
3. Enter the appropriate chart with the depth of flow and discharge velocity to determine the riprap size and apron length required. It is noted that references to pipe diameters in the charts are based on full flow. For other than full pipe flow, the parameters of depth of flow and velocity must be used.
4. Calculate apron width at the downstream end if a flared section is to be employed.

**Examples**

Example 1: Pipe Flow (full) with discharge to unconfined section.

Given: A circular conduit flowing full.

Q = 280 cfs, diam. = 66 in., tailwater (surface) is 2 ft. above pipe invert (minimum tailwater condition).

Find: Read $d_{50}$ = 1.2 and apron length ($L_a$) = 38 ft.

Apron width = diam. + $L_a$ = 5B.5 + 38 = 43.5 ft.

Use: $d_{50}$ = 15", $d_{max}$ = 22", blanket thickness = 32"

Example 2: Box Flow (partial) with high tailwater

Given: A box conduit discharging under partial flow conditions. A concrete box 5.5 ft. x 10 ft. flowing 5.0 ft. deep,

Q = 600 cfs and tailwater surface is 5 ft. above invert (max. tailwater condition).

Since this is not full pipe flow and does not directly fit the nomograph assumptions, it is necessary to compute the

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BY _____ DATE _____ SUBJECT _____ SHT. NO. _____ OF ___
CHKD. BY _____ DATE _____ _____ JOB NO. _____

# STORMWATER ANALYSIS
# REFERENCE INFORMATION

**Figure B-3** 2-year, 24-hr rainfall

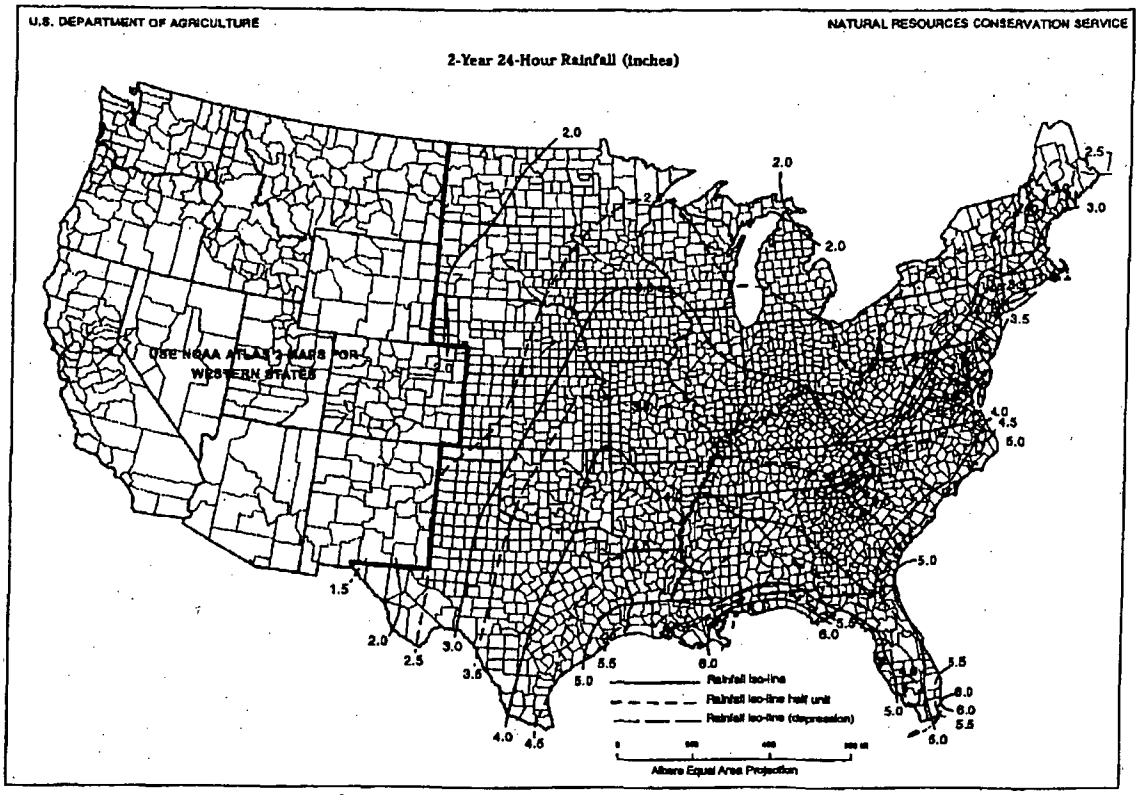



**Figure B-4** 5-year, 24-hour rainfall

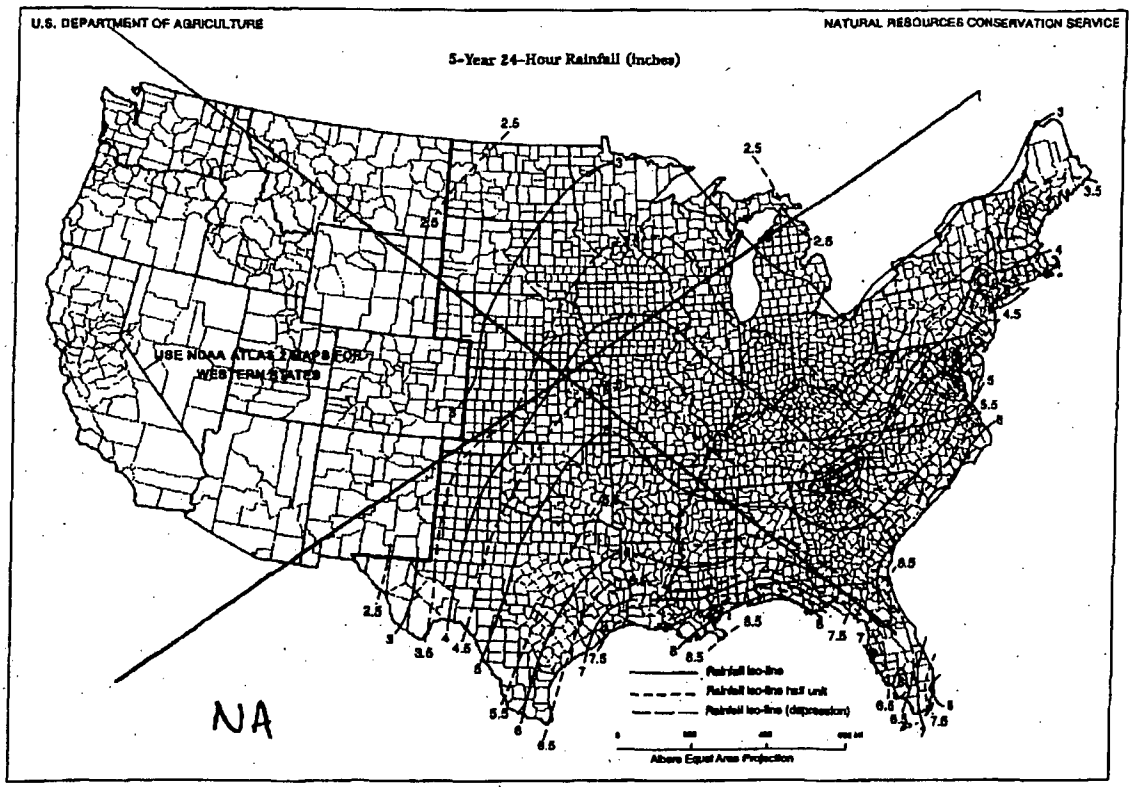


**Figure B-5** 10-year, 24-hour rainfall

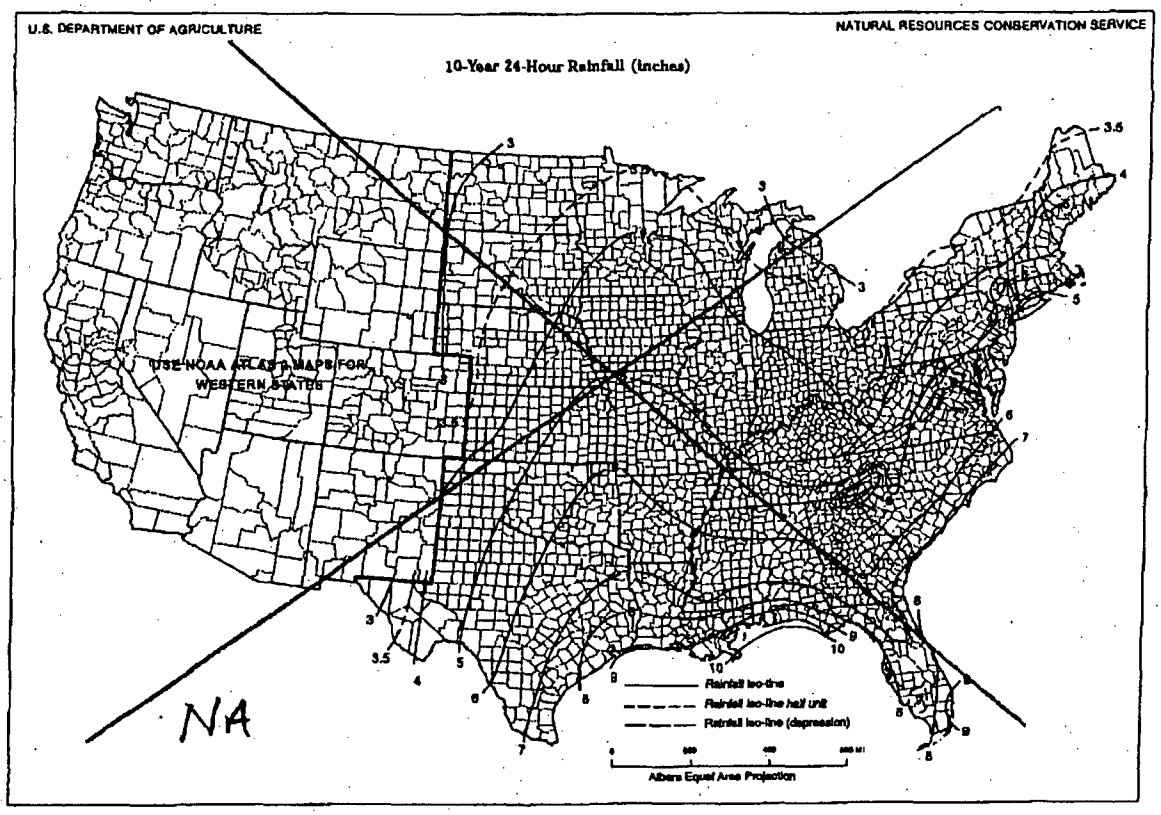
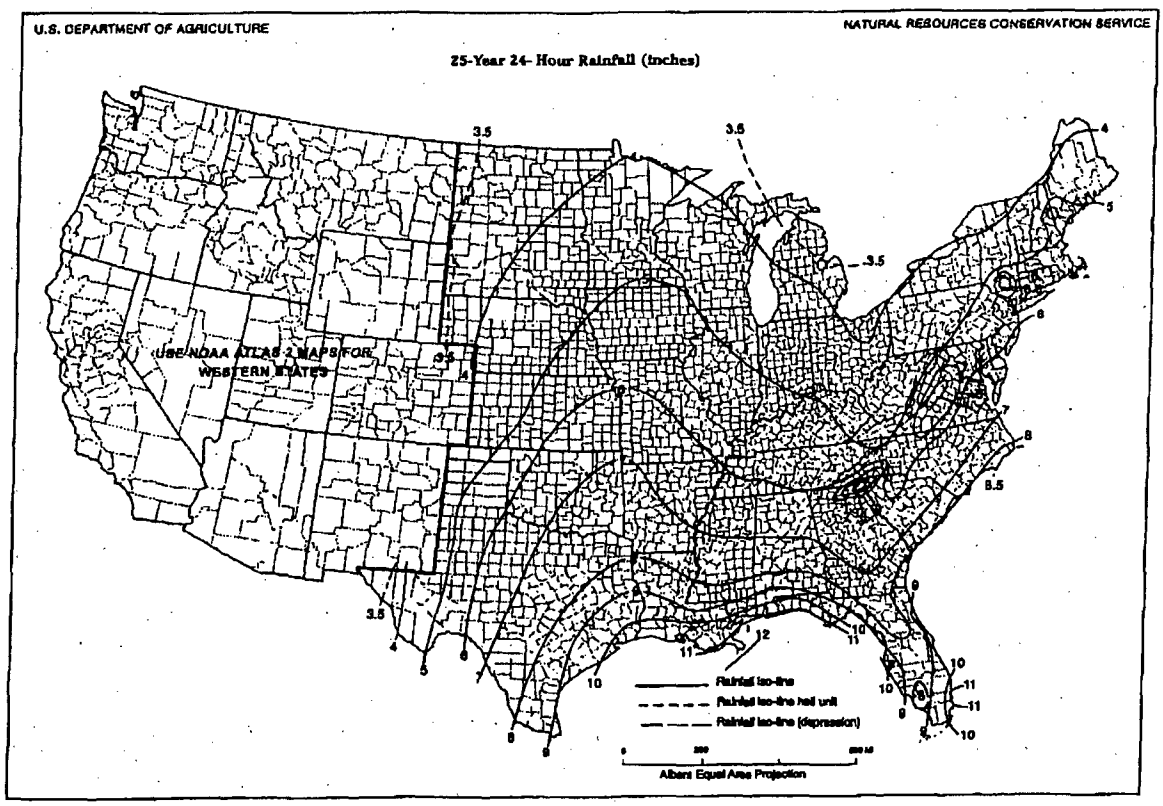



**Figure B-6** 25-year, 24-hour rainfall



# WVDP Annual/Daily Maximum Rain Fall Data
## Period: 1990-2007

| | 1990 (Inches) | 1991 (Inches) | 1992 (Inches) | 1993 (Inches) | 1994 (Inches) | 1995 (Inches) | 1996 (Inches) | 1997 (Inches) | 1998 (Inches) | 1999 (Inches) | 2000 (Inches) | 2001 (Inches) | 2002 (Inches) | 2003 (Inches) | 2004 (Inches) | 2005 (Inches) | 2006 (Inches) | 2007 (Inches) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Yearly Total | 26.64 | 32.76 | 48.63 | 37.35 | 40.13 | 34.17 | 44.89 | 43.23 | 42.76 | 30.97 | 38.05 | 31.02 | 39.96 | 40.99 | 43.21 | 38.52 | 45.06 | 3.55 |
| Daily Maximum | 1.84 | 1.45 | 1.64 | 1.43 | 1.90 | 1.22 | 1.57 | 1.70 | 3.75 | 1.86 | 1.47 | 1.40 | 1.33 | 1.39 | 1.99 | 2.25 | 1.56 | 0.83 |

- USED TO COMPARE TO 2542 STORM RAINFALL AMOUNT

## Don McMahon

**From:** "KK Gupta" <KK.Gupta@wvnsco.com>
**To:** <ckeipper@butlerstc.com>; <dmcmahon@mmce.net>
**Cc:** "Chris Avery" <Chris.Avery@wvnsco.com>
**Sent:** Monday, May 21, 2007 1:59 PM
**Attach:** TA Out Fall W06 Calculations.pdf
**Subject:** SDA Cal for out fall W06

Chuck:

Attached is NYSERDA SPDES outfall W06 Calculations. Use this information for developing bypass line around basin 2. I will issue this information via TA.

K. K. Gupta, Fellow Engineer
WVNSCO

-THIS IS INFORMATION USED FOR SUBAREA #5

**Drainage Area 06 and Outfall WNSTM06**

Drainage Area 06 encompasses 0.56 acres located on the western side of the southern set of SDA trenches. Drainage Area 06 is grass covered with some gravel fill. Snow melt and storm water in Drainage Area 06 is conveyed to the north via sheet flow and a shallow channel which leads to a 12-inch CMP which is used to convey the storm water discharge from the area, under a site roadway, to Outfall WNSTM06 (see Photograph 2-18 and 2-19) in DOE Drainage Area 20. Storm water is not detained prior to discharge to the outfall.

The outfall discharge pipe discharges storm water to a grassed channel into DOE Drainage Area SO-20 (see Photograph 2-20) where it combines with storm water discharges from DOE Outfall SO-18 (upstream). DOE Outfall SO-20 discharges to Erdman Brook.

U.S. EPA Form 2F, Item VII, Part D - Outfall WNSTM06

| 1. Date of Storm Event | 2. Duration of Storm Event (Minutes) | 3. Total Rainfall During The Storm Event(Inches) | 4. Number of Hours between the beginning of the storm and the end of the previous rain event | 5. Maximum Flow Rate During the Storm Event, gallons per minute (gpm) | 6. Total Flow from the Rain Event |
|---|---|---|---|---|---|
| 8/11/95 | 135 minutes | 0.54 inches | 143.25 hours | 16 gpm | 2200 gallons |

**Part D, Item 7 for Outfall WNSTM06:**
**Part D, Items 1, 2, 3, and 4 were obtained from the actual storm event data for a monitoring event at former storm water discharge Outfall SO-19. Item no. 5, maximum flow rate was estimated as follows:**

**Maximum flow rate = (Total flow identified in Part D, Item No. 6)/(Duration identified in Part D. Item No.2)**
**= (2200 gallons)/( 135 minutes)**
**= 16.30gallons per minute (gpm)**

**Rounded to two(2) significant figures = 16 gpm.**

**Item No.6 (i.e., total flow) was estimated as follows:**

**R = (C)(P)**

**P = Precipitation 0.54 in(1 ft/12 in.) 0.045 ft.**

**R = Total rainfall excess, in ft.**

**C = Run-off coefficient estimated as follows:**

**= 0.90 for impervious area (concrete, pavement, etc.)**

**= 0.25 for impervious area (gravel, #3 stone and smaller, and unimproved areas)**

**Rainfall excess:**
**Impervious Area: R = (0.90)(0.045 ft) = 0.0405 ft**

**Pervious Area: R = (0.25)(0.045 ft) = 0.01125 ft**
**From Attachment 2-1 for Outfall WNSTM06,**

**Impervious Area 0.02 acres = 871.2 sq. ft.**

**Pervious Area = 0.56 acres - 0.02 acres = 0.54 acres =23522 sq. ft.**

**Total runoff flow (871.2 sq. ft.)(0.0405 ft.) + (23522.4 sq. ft.)(0.01125 ft.) = 35.28 cu. ft. + 264.63 cu. ft = 299.91 cu. ft. = 2243.63 gallons.**

**Rounding is necessary to correspond to the limiting, two (2) significant figures identified for the run-off coefficients (i.e., C).**

**Therefore, Total flow = 2200 gallons.**

# ATTACHMENT C

## Stormwater Calculations for

## 1/2 Probable Maximum Precipitation

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BY AJN DATE 9/17/07 SUBJECT WVNC - NDA SHT. NO. 1 OF 14
CHKD. BY DRG DATE 9/27/07 CAP DESIGN JOB NO. 07-011
1/2 PMP STORMWATER ANALYSIS

- BASED ON NRC COMMENTS, WE WILL ANALYZE THE 1/2 PMP USING HYDROCAD

- FROM HYDROMETEOROLOGICAL REPORT NO. 51 DATED AUGUST 1980
  - FIGURE 18 PRESENTS THE 6HR PMP FOR DRAINAGE AREAS LESS THAN 10 SQMI.
  - ∴ PMP FOR SITE IS 24.5 IN
  - ∴ 1/2 PMP WOULD BE 12.25 IN

- USE PROCEDURE IN "DESIGN OF SMALL DAMS" UNITED STATES DEPARTMENT OF THE INTERIOR BUREAU OF RECLAMATION DATED 1977.

1) ADJUST THE 6 HOUR 10 SQMILE PMP VALUES (USE FIGURE 16, ZONE 2)

| DURATION | % OF 6 HR VALUE | 1/2 PMP (IN) |
|---|---|---|
| 0 - 6 | 100 | 12.25 |
| 0 - 12 | 108 | 13.23 |
| 0 - 24 | 120 | 14.70 |
| 0 - 48 | 128 | 15.68 |

2) DETERMINE HOURLY AMOUNTS OF PMP WITHIN FIRST 6 HOURS (USE FIGURE 18, ZONE C)

| TIME (HRS) | % OF 6 HR VALUE | ACCUMULATIVE PMP (IN) | INCREMENTAL PMP (IN) |
|---|---|---|---|
| 1 | 49 | 6.0 | 6.0 |
| 2 | 64 | 7.84 | 1.84 |
| 3 | 75 | 9.19 | 1.35 |
| 4 | 84 | 10.29 | 1.1 |
| 5 | 92 | 11.27 | 0.98 |
| 6 | 100 | 12.25 | 0.98 |

3) PMP DESIGN ARRANGEMENT

| TIME (ENDING HOUR) | INCREMENTAL PMP (IN) | ACCUMULATIVE PMP (IN) |
|---|---|---|
| 1 | 0.98 | 0.98 |
| 2 | 1.1 | 2.08 |
| 3 | 1.35 | 3.43 |
| 4 | 6.0 | 9.43 |
| 5 | 1.84 | 11.27 |
| 6 | 0.98 | 12.25 |
| 12 | 0.98 | 13.23 |
| 24 | 1.47 | 14.7 |
| 48 | 0.98 | 15.68 |

**McMahon & Mann**
Consulting Engineers, P.C.

BY AJN DATE 9/17/07 SUBJECT WWNS-NOA SHT. NO. 2 OF 14
CHKD. BY DRG DATE 9/27/07 LAP DESIGN JOB NO. 07-011
1/2 PMP STORMWATER ANALYSIS

4) FOR STORM INPUT INTO HYDROCAD, WE MUST DEVELOPE A DISTRIBUTION OF RAINFALL ON A 1-HOUR BASIS. THIS WILL BE DONE USING THE ABOVE ARRANGEMENT AND INTERPOLATION BETWEEN KNOWN VALUES.

| Duration (hr) | Intensity (in/hr) | Accumulated (in) | Distribution |
|---|---|---|---|
| 0 | 0.0 | 0 | 0 |
| 1 | 1.0 | 0.98 | 0.062 |
| 2 | 1.1 | 2.1 | 0.133 |
| 3 | 1.3 | 3.4 | 0.219 |
| 4 | 6.0 | 9.4 | 0.602 |
| 5 | 1.8 | 11.3 | 0.719 |
| 6 | 1.0 | 12.3 | 0.781 |
| 7 | 0.163 | 12.4 | 0.792 |
| 8 | 0.163 | 12.6 | 0.802 |
| 9 | 0.163 | 12.7 | 0.812 |
| 10 | 0.163 | 12.9 | 0.823 |
| 11 | 0.163 | 13.1 | 0.833 |
| 12 | 0.163 | 13.2 | 0.844 |
| 13 | 0.123 | 13.4 | 0.852 |
| 14 | 0.123 | 13.5 | 0.859 |
| 15 | 0.123 | 13.6 | 0.867 |
| 16 | 0.123 | 13.7 | 0.875 |
| 17 | 0.123 | 13.8 | 0.883 |
| 18 | 0.123 | 14.0 | 0.891 |
| 19 | 0.123 | 14.1 | 0.898 |
| 20 | 0.123 | 14.2 | 0.906 |
| 21 | 0.123 | 14.3 | 0.914 |
| 22 | 0.123 | 14.5 | 0.922 |
| 23 | 0.123 | 14.6 | 0.930 |
| 24 | 0.123 | 14.7 | 0.938 |
| 25 | 0.041 | 14.7 | 0.940 |
| 26 | 0.041 | 14.8 | 0.943 |
| 27 | 0.041 | 14.8 | 0.945 |
| 28 | 0.041 | 14.9 | 0.948 |
| 29 | 0.041 | 14.9 | 0.951 |
| 30 | 0.041 | 14.9 | 0.953 |
| 31 | 0.041 | 15.0 | 0.956 |
| 32 | 0.041 | 15.0 | 0.958 |
| 33 | 0.041 | 15.1 | 0.961 |
| 34 | 0.041 | 15.1 | 0.964 |
| 35 | 0.041 | 15.1 | 0.966 |
| 36 | 0.041 | 15.2 | 0.969 |
| 37 | 0.041 | 15.2 | 0.971 |
| 38 | 0.041 | 15.3 | 0.974 |
| 39 | 0.041 | 15.3 | 0.977 |
| 40 | 0.041 | 15.4 | 0.979 |
| 41 | 0.041 | 15.4 | 0.982 |
| 42 | 0.041 | 15.4 | 0.984 |
| 43 | 0.041 | 15.5 | 0.987 |
| 44 | 0.041 | 15.5 | 0.990 |
| 45 | 0.041 | 15.6 | 0.992 |
| 46 | 0.041 | 15.6 | 0.995 |
| 47 | 0.041 | 15.6 | 0.997 |
| 48 | 0.041 | 15.7 | 1.000 |

**McMahon & Mann**
Consulting Engineers, P.C.

BY AJN DATE 9/27/07 SUBJECT WAWC-NDA SHT. NO. 3 OF 14
CHKD. BY DRG DATE 9/27/07 CAP DESIGN JOB NO. 07-011
1/2 PMP STORMWATER ANALYSIS

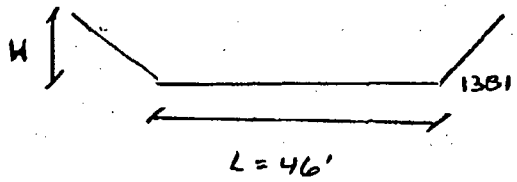
IN ADDITION TO THE RAINFALL DATA, WE MUST REANALYZE THE OUTFLOW STRUCTURES AT BASINS #1, #2 AND #3.

BASIN #1

- OUTLET DEVICE IS AN 18"Φ PIPE, WHEN OUTFLOW EXCEEDS ELEVATION 1381, IT WILL OVERTOP ROADWAY AND FLOW INTO BASIN #3

∴ DEVELOP: A SECONDARY ROUTING USING A BROAD CRESTED WEIR

- THIS IS INPUT DIRECTLY INTO HYDROCAD




b = 15' (BREADTH)

$Q = C_{BRW} L H^{1.5}$

C DEPENDS ON H

*NOTE = IF OUTFLOW EXCEEDS ELEVATION 1382, IT WILL OVERTOP EXTERIOR BERM

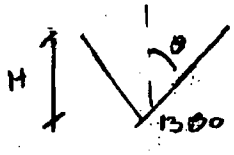
BASIN #2

- OUTLET DEVICE IS AN 8"Φ PIPE DRAINING TO THE EXISTING 24"Φ PIPE
- WHEN OUTFLOW EXCEEDS ELEVATION 1379.75, IT WILL OVERTOP CATCH BASIN AND DRAIN INTO EXISTING 24"Φ PIPE THROUGH BOTH THE 8"Φ PIPE AND TOP OF CATCH BASIN
- WHEN OUTFLOW EXCEEDS ELEVATION 1380, IT WILL FLOW INTO BASIN #3 VIA A NARROW CHANNEL

∴ REDO OUTFLOW ANALYSIS FOR THE PIPE AND DEVELOP A SECONDARY ROUTING USING A V-NOTCH WEIR

- SEE ATTACHED CALCULATIONS FOR OUTLET PIPES
  *NOTE: IF OUTFLOW EXCEEDS ELEVATION 1381, IT WILL OVERTOP EXTERIOR BERM

V-NOTCH WEIR




$Q = K_u \tan(\theta/2)\, H^{2.5}$

$K_u = 2.5$

$\theta = 20°$

WVNS - NDA CAP
Basin #2
07-011

9/26/2007
By: AJN
Chk: PEC

4 of 14

## DETERMINE THE DISCHARGE THROUGH THE DRAIN PIPE

### *1. Estimate the Discharge based on Full Pipe Flow for Basin #2*

Use Bernoulli Equation - See Attached Sheet for Sample Calculation
See Attached Sketch for Layout and Components

g (ft/sec$^2$)= 32.174
$d_{pipe}$ (ft) = 0.630
$A_{pipe}$ (ft$^2$) = 0.31172
Pipe Outlet Ele = 1377.0
Pipe Length (ft) = 5.0
Ke (entrance) = 1.0
f = 0.0145

$\nu$ = 1.41E-05
$\varepsilon$ = 0.000005
$\varepsilon$ / d = 0.000008

| Discharge Elevation (ft) | ΔH (ft) | Q (cfs) | V (fps) | Re |
|---|---|---|---|---|
| 1377.00 | 0.00 | 0.00 | 0.00 | 0 |
| 1377.25 | 0.25 | 0.86 | 2.76 | 123224 |
| 1377.50 | 0.50 | 1.22 | 3.90 | 174265 |
| 1377.75 | 0.75 | 1.49 | 4.78 | 213430 |
| 1378.00 | 1.00 | 1.72 | 5.52 | 246448 |
| 1378.25 | 1.25 | 1.92 | 6.17 | 275537 |
| 1378.50 | 1.50 | 2.11 | 6.76 | 301836 |
| 1378.75 | 1.75 | 2.27 | 7.30 | 326020 |
| 1379.00 | 2.00 | 2.43 | 7.80 | 348530 |
| 1379.25 | 2.25 | 2.58 | 8.27 | 369672 |
| 1379.50 | 2.50 | 2.72 | 8.72 | 389669 |
| 1379.75 | 2.75 | 2.85 | 9.15 | 408688 |
| 1380.00 | 3.00 | 2.98 | 9.55 | 426861 |
| 1380.25 | 3.25 | 3.10 | 9.94 | 444291 |
| 1380.50 | 3.50 | 3.22 | 10.32 | 461062 |
| 1380.75 | 3.75 | 3.33 | 10.68 | 477245 |
| 1381.00 | 4.00 | 3.44 | 11.03 | 492896 |

WVNS - NDA CAP
Basin #2
07-011

9/18/2007
By: AJN
Chk: DRG

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## DETERMINE THE DISCHARGE THROUGH THE OVERFLOW PIPE

The overflow pipe can be governed by either of three flow components

1. Discharge based on orifice control
2. Discharge based on weir control
3. Discharge based on full pipe flow

Reference: Highway Engineering Circular No. 22, Second Edition, "Urban Drainage Design Manual"
Publication No. FHWA-NHI-01-021, August 2001

### *1. Estimate the Discharge based on Circular Orifice Control*

$Q = C_o A_o (2 g H_o)^{0.5}$ (Equation 8-17)

Where:

$Q$ = the orifice flow rate ($ft^3/s$)
$C_o$ = discharge coefficient (0.4 - 0.6)
$A_o$ = area of orifice, ($ft^2$)
$H_o$ = effective head on the orifice measured from the centroid of the opening (ft)
$g$ = gravitational acceleration (32.14 $ft/s^2$)

For Circular orificies with $C_o$ set equal to 0.6

$Q = 0.6 (\Pi D^2/4) (2 g H_o)^{0.5}$

$Q = K_{cr} D^2 H_o^{0.5}$

Where:

$K_{cr}$ = 3.78
$D$ = orifice diameter (ft)

### *2. Estimate the Discharge based on Sharp Crested Weir Control*

$Q = C_{scw} L H^{1.5}$ (Equation 8-19)

Where:

$Q$ = discharge ($ft^3/s$)
$L$ = horizontal weir length (ft)
$H$ = head above weir crest excluding velocity head, (ft)
$C_{scw}$ = $3.27 + 0.4 (H/H_c)$
$H_c$ = height of weir crest above channel bottom (ft)

Weir Crest Elevation = 1379.75
D (ft) = 2
L (ft) = 6.3 (pipe circumference)
Channel Bottom Elevation = 1375.38
$H_c$ (ft) = 4.37

| Discharge Elevation (ft) | Orifice Flow | | Weir Flow | | |
|---|---|---|---|---|---|
| | $H_o$ (ft) | Q (cfs) | H (ft) | $C_{scw}$ | Q (cfs) |
| 1379.75 | 0.00 | 0.00 | 0.00 | 3.27 | 0.00 |
| 1380.00 | 0.25 | 7.56 | 0.25 | 3.29 | 2.59 |
| 1380.25 | 0.50 | 10.69 | 0.50 | 3.32 | 7.37 |
| 1380.50 | 0.75 | 13.09 | 0.75 | 3.34 | 13.63 |
| 1380.75 | 1.00 | 15.12 | 1.00 | 3.36 | 21.12 |
| 1381.00 | 1.25 | 16.90 | 1.25 | 3.38 | 29.72 |

### *3. Estimate the Discharge based on Full Pipe Flow*

Use Bernoulli Equation
See Sketch for Layout and Components

g (ft/sec2)= 32.174
d pipe (ft) = 2.000
A pipe (ft2) = 3.14159
Pipe Outlet Ele = 1366.0
Pipe Length (ft) = 362.0
Ke (entrance) = 1.00
f = 0.0104

v = 1.41E-05
ε = 0.000005
ε / d = 0.000003

| Discharge Elevation (ft) | ΔH (ft) | Q (cfs) | V (fps) | Re |
|---|---|---|---|---|
| 1379.75 | 13.8 | 47.43 | 15.10 | 2141310 |
| 1380.00 | 14.0 | 47.88 | 15.23 | 2160689 |
| 1380.25 | 14.3 | 48.28 | 15.37 | 2179898 |
| 1380.50 | 14.5 | 48.70 | 15.50 | 2198934 |
| 1380.75 | 14.8 | 49.12 | 15.64 | 2217810 |
| 1381.00 | 15.0 | 49.54 | 15.77 | 2236526 |

WVNS - NDA Cap
Basin #2
07-011

9/26/2007
By: AJN
Chk: DDL
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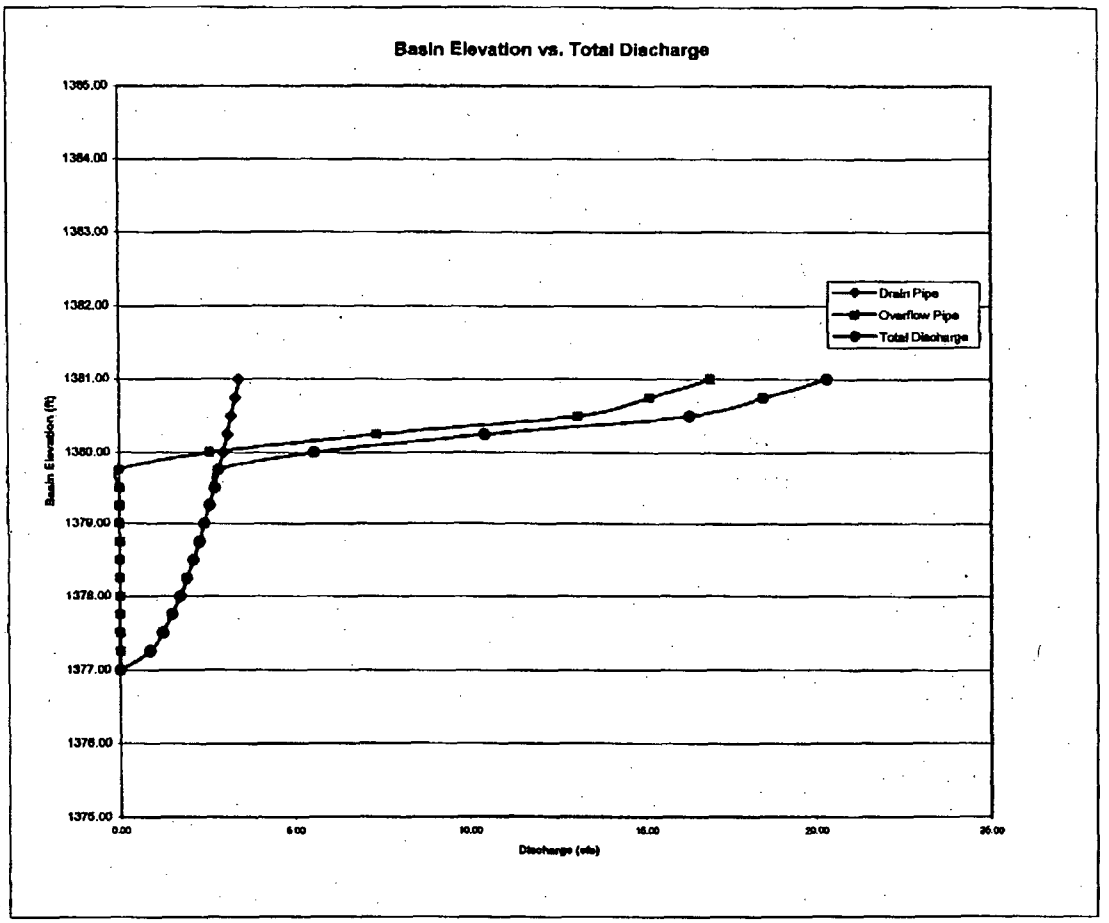
## BASIN #2 DISCHARGE SUMMARY

| Discharge Elevation (ft) | Drain Pipe Discharge | Overflow Pipe Discharge | | | | Total Basin Discharge (cfs) |
|---|---|---|---|---|---|---|
| | | Orifice Flow (cfs) | Weir Flow (cfs) | Full Pipe (cfs) | Controlling Discharge (cfs) | |
| 1377.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 1377.25 | 0.86 | 0.00 | 0.00 | 0.00 | 0.00 | 0.86 |
| 1377.50 | 1.22 | 0.00 | 0.00 | 0.00 | 0.00 | 1.22 |
| 1377.75 | 1.49 | 0.00 | 0.00 | 0.00 | 0.00 | 1.49 |
| 1378.00 | 1.72 | 0.00 | 0.00 | 0.00 | 0.00 | 1.72 |
| 1378.25 | 1.92 | 0.00 | 0.00 | 0.00 | 0.00 | 1.92 |
| 1378.50 | 2.11 | 0.00 | 0.00 | 0.00 | 0.00 | 2.11 |
| 1378.75 | 2.27 | 0.00 | 0.00 | 0.00 | 0.00 | 2.27 |
| 1379.00 | 2.43 | 0.00 | 0.00 | 0.00 | 0.00 | 2.43 |
| 1379.25 | 2.58 | 0.00 | 0.00 | 0.00 | 0.00 | 2.58 |
| 1379.50 | 2.72 | 0.00 | 0.00 | 0.00 | 0.00 | 2.72 |
| 1379.75 | 2.85 | 0.00 | 0.00 | 47.43 | 0.00 | 2.85 |
| 1380.00 | 2.98 | 7.56 | 2.59 | 47.86 | 2.59 | 5.56 |
| 1380.25 | 3.10 | 10.69 | 7.37 | 48.28 | 7.37 | 10.47 |
| 1380.50 | 3.22 | 13.09 | 13.63 | 48.70 | 13.09 | 16.31 |
| 1380.75 | 3.33 | 15.12 | 21.12 | 49.12 | 15.12 | 18.45 |
| 1381.00 | 3.44 | 16.90 | 29.72 | 49.54 | 16.90 | 20.34 |

↑ TOTAL IS LESS THAN FULL PIPE, OK



WVNS - NDA Cap
Basin #2
07-011

9/26/2007
By: AJN
Chk: DEG

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# BASIN #2 SUMMARY OF ELEVATION VS. OUTFLOW AND STORAGE

(to be used as input for HydroCad)

| Elevation (stage) (ft) | Total Discharge (cfs) | Total Cumulative Storage (cf) |
|---|---|---|
| 1377.00 | 0.00 | 0.00 |
| 1377.25 | 0.86 | 324.94 |
| 1377.50 | 1.22 | 649.89 |
| 1377.75 | 1.49 | 974.83 |
| 1378.00 | 1.72 | 1299.77 |
| 1378.25 | 1.92 | 1798.01 |
| 1378.50 | 2.11 | 2296.26 |
| 1378.75 | 2.27 | 2794.50 |
| 1379.00 | 2.43 | 3292.74 |
| 1379.25 | 2.58 | 4608.43 |
| 1379.50 | 2.72 | 5924.12 |
| 1379.75 | 2.85 | 7239.80 |
| 1380.00 | 5.56 | 8555.49 |
| 1380.25 | 10.47 | 10953.08 |
| 1380.50 | 16.31 | 13350.67 |
| 1380.75 | 18.45 | 15748.25 |
| 1381.00 | 20.34 | 18145.84 |

Note: Storage volumes were interpolated between 1 foot elevation increments

**McMahon & Mann**
Consulting Engineers, P.C.

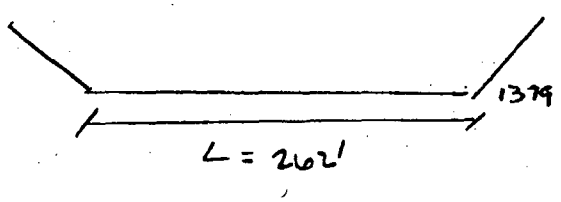
BY AJN DATE 9/18/07 SUBJECT WVNS-NOA SHT. NO. B OF 14
CHKD. BY DRG DATE 9/27/07 CAP DESIGN JOB NO. 07-011
½ PMP STORMWATER ANALYSIS

BASIN #3

- OUTLET DEVICE IS A 12"Ø PIPE DRAINING TO A 24"Ø PIPE
- WHEN OUTFLOW EXCEEDS ELEVATION 1378.75, IT WILL OVERTOP THE CATCH BASIN AND WILL DRAIN INTO THE 24"Ø PIPE THROUGH BOTH THE 12"Ø PIPE AND TOP OF CATCH BASIN.
- WHEN OUTFLOW EXCEEDS ELEVATION 1379, IT WILL FLOW OUT OF BASIN #3 BY OVERTOPPING THE EXTERIOR BERM.

∴ REQD OUTFLOW ANALYSIS FOR THE PIPE AND DEVELOP A SECONDARY ROUTING USING A BROAD CRESTED WEIR
- SEE ATTACHED CALCULATIONS FOR OUTLET PIPES

BROAD CRESTED WEIR CAN BE INPUT DIRECTLY INTO HYDROCAD




$b = 5'$ (BREADTH)

$Q = C_{BCW} L H^{1.5}$
↑ BASED ON H

* NOTE: IF OUTFLOW EXCEEDS ELEVATION 1380, IT WILL OVERTOP BERM OVER A LARGER AREA

WVNS - NDA CAP
Basin #3
07-011

9/26/2007
By: AJN
Chk: DBC
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# DETERMINE THE DISCHARGE THROUGH THE DRAIN PIPE

## *1. Estimate the Discharge based on Full Pipe Flow for Basin #3*

Use Bernoulli Equation - See Attached Sheet for Sample Calculation
See Attached Sketch for Layout and Components

g (ft/sec$^2$)= 32.174
$d_{pipe}$ (ft) = 0.930
$A_{pipe}$ (ft$^2$) = 0.67929
Pipe Outlet Ele = 1376.0
Pipe Length (ft) = 5.0
Ke (entrance) = 1.0
f = 0.132

$\nu$ = 1.41E-05
$\varepsilon$ = 0.000005
$\varepsilon$ / d = 0.000005

| Discharge Elevation (ft) | ΔH (ft) | Q (cfs) | V (fps) | Re |
|---|---|---|---|---|
| 1376.00 | 0.00 | 0.00 | 0.00 | 0 |
| 1376.25 | 0.25 | 1.66 | 2.44 | 160710 |
| 1376.50 | 0.50 | 2.34 | 3.45 | 227278 |
| 1376.75 | 0.75 | 2.87 | 4.22 | 278358 |
| 1377.00 | 1.00 | 3.31 | 4.87 | 321420 |
| 1377.25 | 1.25 | 3.70 | 5.45 | 359358 |
| 1377.50 | 1.50 | 4.05 | 5.97 | 393657 |
| 1377.75 | 1.75 | 4.38 | 6.45 | 425198 |
| 1378.00 | 2.00 | 4.68 | 6.89 | 454556 |
| 1378.25 | 2.25 | 4.97 | 7.31 | 482130 |
| 1378.50 | 2.50 | 5.23 | 7.71 | 508209 |
| 1378.75 | 2.75 | 5.49 | 8.08 | 533014 |
| 1379.00 | 3.00 | 5.73 | 8.44 | 556715 |
| 1379.25 | 3.25 | 5.97 | 8.79 | 579448 |
| 1379.50 | 3.50 | 6.19 | 9.12 | 601321 |
| 1379.75 | 3.75 | 6.41 | 9.44 | 622427 |
| 1380.00 | 4.00 | 6.62 | 9.75 | 642840 |

WVNS - NDA CAP
Basin #3
07-011

9/15/2007
By: AJN
Chk: DBG

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## DETERMINE THE DISCHARGE THROUGH THE OVERFLOW PIPE

The overflow pipe can be governed by either of three flow components

1. Discharge based on orifice control
2. Discharge based on weir control
3. Discharge based on full pipe flow

Reference: Highway Engineering Circular No. 22, Second Edition, "Urban Drainage Design Manual"
Publication No. FHWA-NHI-01-021, August 2001

### *1. Estimate the Discharge based on Circular Orifice Control*

$Q = C_o A_o (2 g H_o)^{0.5}$ (Equation 8-17)

Where:

$Q$ = the orifice flow rate ($ft^3/s$)
$C_o$ = discharge coefficient (0.4 - 0.6)
$A_o$ = area of orifice, ($ft^2$)
$H_o$ = effective head on the orifice measured from the centroid of the opening (ft)
$g$ = gravitational acceleration (32.14 $ft/s^2$)

For Circular orificies with $C_o$ set equal to 0.6

$Q = 0.6 (\Pi D^2/4) (2 g H_o)^{0.5}$

$Q = K_{or} D^2 H_o^{0.5}$

Where:

$K_{or}$ = 3.78
$D$ = orifice diameter (ft)

### *2. Estimate the Discharge based on Sharp Crested Weir Control*

$Q = C_{scw} L H^{1.5}$ (Equation 8-19)

Where:

$Q$ = discharge ($ft^3/s$)
$L$ = horizontal weir length (ft)
$H$ = head above weir crest excluding velocity head, (ft)
$C_{scw}$ = $3.27 + 0.4 (H/H_c)$
$H_c$ = height of weir crest above channel bottom (ft)

| | | |
|---|---|---|
| Weir Crest Elevation = | 1378.75 | |
| D (ft) = | 2 | |
| L (ft) = | 6.3 | (pipe circumference) |
| Channel Bottom Elevation = | 1376 | |
| $H_o$ (ft) = | 2.75 | |

| Discharge Elevation (ft) | Orifice Flow | | Weir Flow | | |
|---|---|---|---|---|---|
| | $H_o$ (ft) | Q (cfs) | H (ft) | $C_{scw}$ | Q (cfs) |
| 1378.75 | 0.00 | 0.00 | 0.00 | 3.27 | 0.00 |
| 1379.00 | 0.25 | 7.56 | 0.25 | 3.31 | 2.60 |
| 1379.25 | 0.50 | 10.69 | 0.50 | 3.34 | 7.43 |
| 1379.50 | 0.75 | 13.09 | 0.75 | 3.38 | 13.79 |
| 1379.75 | 1.00 | 15.12 | 1.00 | 3.42 | 21.46 |
| 1380.00 | 1.25 | 16.90 | 1.25 | 3.45 | 30.31 |

### *3. Estimate the Discharge based on Full Pipe Flow*

Use Bernoulli Equation
*See Sketch for Layout and Components*

| | | | |
|---|---|---|---|
| g (ft/sec2)= | 32.174 | | |
| d pipe (ft) = | 2.000 | | |
| A pipe (ft2) = | 3.14159 | | |
| Pipe Outlet Ele = | 1374.0 | | |
| Pipe Length (ft) = | 25.0 | v = | 1.41E-05 |
| Ke (entrance) = | 1.00 | ε = | 0.000005 |
| f = | 0.0109 | ε / d = | 0.000003 |

| Discharge Elevation (ft) | ΔH (ft) | Q (cfs) | V (fps) | Re |
|---|---|---|---|---|
| 1378.75 | 4.8 | 37.58 | 11.96 | 1696677 |
| 1379.00 | 5.0 | 38.55 | 12.27 | 1740754 |
| 1379.25 | 5.3 | 39.51 | 12.58 | 1783742 |
| 1379.50 | 5.5 | 40.44 | 12.87 | 1825718 |
| 1379.75 | 5.8 | 41.35 | 13.16 | 1866751 |
| 1380.00 | 6.0 | 42.23 | 13.44 | 1906900 |

WVNS - NDA Cap
Basin #3
07-011

9/26/2007
By: AJN
Chk: [illegible]
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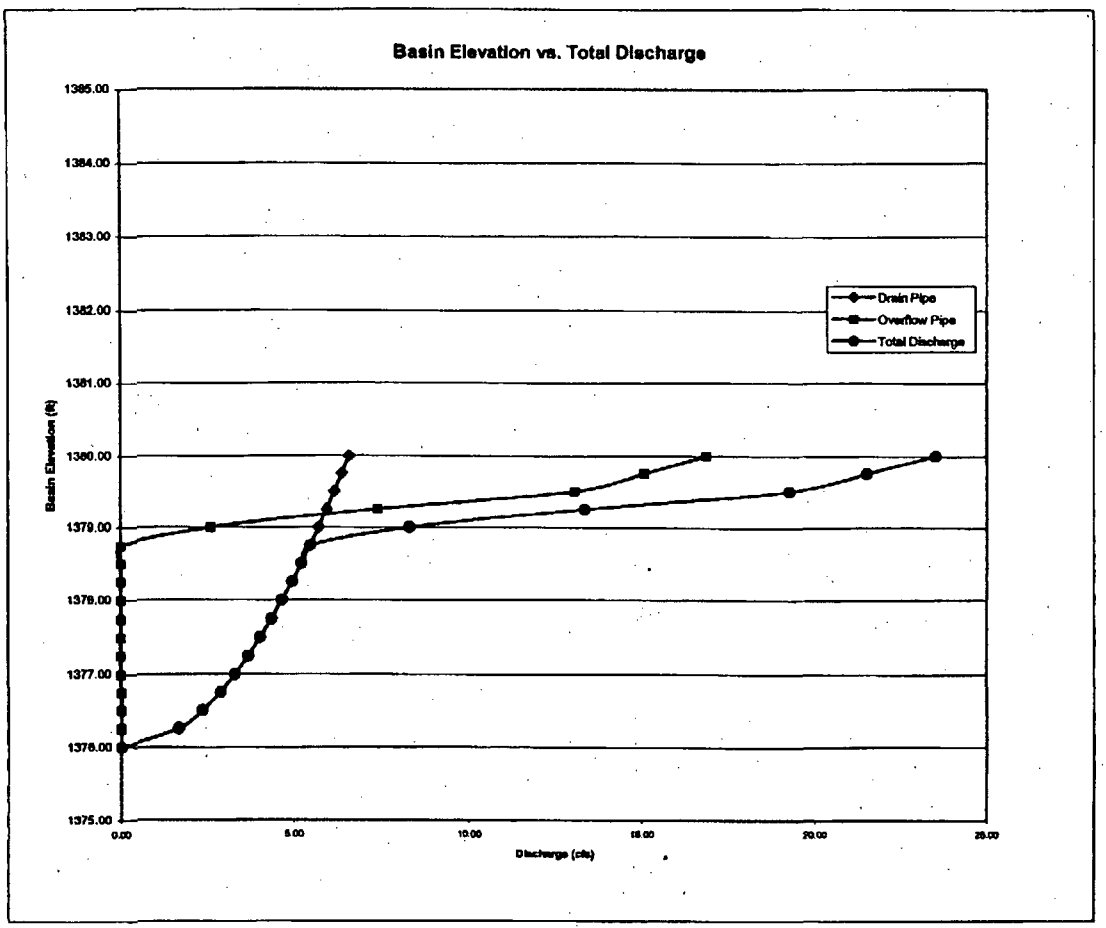
## BASIN #3 DISCHARGE SUMMARY

| Discharge Elevation (ft) | Drain Pipe Discharge | Overflow Pipe Discharge | | | | Total Basin Discharge (cfs) |
|---|---|---|---|---|---|---|
| | | Orifice Flow (cfs) | Weir Flow (cfs) | Full Pipe (cfs) | Controlling Discharge (cfs) | |
| 1376.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 1376.25 | 1.66 | 0.00 | 0.00 | 0.00 | 0.00 | 1.66 |
| 1376.50 | 2.34 | 0.00 | 0.00 | 0.00 | 0.00 | 2.34 |
| 1376.75 | 2.87 | 0.00 | 0.00 | 0.00 | 0.00 | 2.87 |
| 1377.00 | 3.31 | 0.00 | 0.00 | 0.00 | 0.00 | 3.31 |
| 1377.25 | 3.70 | 0.00 | 0.00 | 0.00 | 0.00 | 3.70 |
| 1377.50 | 4.05 | 0.00 | 0.00 | 0.00 | 0.00 | 4.05 |
| 1377.75 | 4.38 | 0.00 | 0.00 | 0.00 | 0.00 | 4.38 |
| 1378.00 | 4.68 | 0.00 | 0.00 | 0.00 | 0.00 | 4.68 |
| 1378.25 | 4.97 | 0.00 | 0.00 | 0.00 | 0.00 | 4.97 |
| 1378.50 | 5.23 | 0.00 | 0.00 | 0.00 | 0.00 | 5.23 |
| 1378.75 | 5.49 | 0.00 | 0.00 | 37.58 | 0.00 | 5.49 |
| 1379.00 | 5.73 | 7.56 | 2.60 | 38.55 | 2.60 | 8.33 |
| 1379.25 | 5.97 | 10.69 | 7.43 | 39.51 | 7.43 | 13.39 |
| 1379.50 | 6.19 | 13.09 | 13.79 | 40.44 | 13.09 | 19.29 |
| 1379.75 | 6.41 | 15.12 | 21.46 | 41.35 | 15.12 | 21.53 |
| 1380.00 | 6.62 | 16.90 | 30.31 | 42.23 | 16.90 | 23.53 |

TOTAL IS LESS THAN FULL PIPE, OK



WVNS - NDA Cap
Basin #3
07-011

9/26/2007
By: AJN
Chk: DRG

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# BASIN #3 SUMMARY OF ELEVATION VS. OUTFLOW AND STORAGE

(to be used as input for HydroCad)

| Elevation (stage) (ft) | Total Discharge (cfs) | Total Cumulative Storage (cf) |
|---|---|---|
| 1376.00 | 0.00 | 0.00 |
| 1376.25 | 1.66 | 637.18 |
| 1376.50 | 2.34 | 1274.37 |
| 1376.75 | 2.87 | 1911.55 |
| 1377.00 | 3.31 | 2548.73 |
| 1377.25 | 3.70 | 4281.69 |
| 1377.50 | 4.05 | 6014.64 |
| 1377.75 | 4.38 | 7747.60 |
| 1378.00 | 4.68 | 9480.55 |
| 1378.25 | 4.97 | 12386.01 |
| 1378.50 | 5.23 | 15291.46 |
| 1378.75 | 5.49 | 18196.92 |
| 1379.00 | 8.33 | 21102.37 |
| 1379.25 | 13.39 | 25037.66 |
| 1379.50 | 19.29 | 28972.95 |
| 1379.75 | 21.53 | 32908.24 |
| 1380.00 | 23.53 | 36843.53 |

Note: Storage volumes were interpolated between 1 foot elevation increments

**McMahon & Mann**
Consulting Engineers, P.C.

BY AJW DATE 9/18/07 SUBJECT W/NS-NOA SHT. NO. 13 OF 14
CHKD. BY DRG DATE 9/27/07 CAD DESIGN JOB NO. 07-011
1/2 PMP STORMWATER ANALYSIS

- PRIOR TO RERUNNING HYDROCAD PROPOSED CONDITIONS WITH THE 1/2 PMP STORM EVENT, REANALYZE THE EXISTING CONDITIONS WITH 1/2 PMP STORM EVENT TO SEE HOW MUCH FLOW WOULD ENTER ERDMAN BROOK

ANALYSIS INDICATES => 49.79 CFS
(SEE ATTACHED HYDROCAD RESULTS)

- NOW CHECK PROPOSED CONDITIONS W/MODIFIED BASIN OUTLETS AS DESCRIBED PREVIOUSLY

BASIN #1 -> OUTFLOW = 15.75 CFS, DOES NOT OVERTOP OUTLET PIPE
∴ SECONDARY ROUTING IS NOT USED

BASIN #2 -> OUTFLOW = 10.63 CFS, WATER REACHES ELEVATION 1380.26
SECONDARY = 0.02 CFS OF TOTAL
∴ PIPE IS OVERTOPPED, SECONDARY ROUTING IS USED BUT REMAINS BELOW ELEVATION 1381, OK

BASIN #3 -> OUTFLOW = 26.96 CFS, WATER REACHES ELEVATION 1379.09
SECONDARY = 15.95 CFS OF TOTAL
∴ PIPE IS OVERTOPPED, SECONDARY ROUTING IS USED BUT REMAINS BELOW ELEVATION 1380, OK

TOTAL FOR ERDMAN BROOK => 55.56 CFS
(SEE ATTACHED HYDROCAD RESULTS)

∴ FLOW WILL NOT INCREASE IN ERDMAN BROOK BY 5.77 CFS

**McMahon & Mann**
Consulting Engineers, P.C.

BY AJN DATE 9/19/07 SUBJECT WINNS - NDA SHT. NO. 14 OF 14
CHKD. BY DJG DATE 9/27/07 CAP DESIGN JOB NO. 07-011
½ PMP STORMWATER ANALYSIS

SINCE BASIN #3 WILL OVERTOP THE BERM, WE NEED TO SIZE RIPRAP TO PROTECT THE SLOPE AND DOWNSTREAM AREAS

- CHECK PROTECTION REQD ON 2:1 SLOPE

$d = 0.10$ FT (1379.09 − 1379 = 0.09 SAY 0.1)

$S = 0.50$ FT/FT

$\tau_d = \gamma d S = (62.4)(0.10)(0.5) = 3.12$ PSF

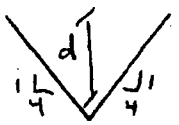
$\tau_p = 4 D_{50} = \tau_d$

$D_{50} = 3.12/4 = 0.78$ FT

∴ USE $D_{50} = 12''$ WITH THICKNESS OF 27"

- FROM 2:1 SLOPE, WATER WILL ENTER EXISTING SWALES (SEE SUBAREA #7 – B TO C, REACH #1 OR REACH #2 (SEE SUBAREA #10 – D TO E)
  - CHECK PROTECTION USING TOTAL FLOW OF 16 CFS (WOULD BE LESS SINCE IT IS SPLIT)

SLOPES OF CHANNELS
B → C → 4.5%
REACH #1 → 5%
REACH #2 → 10.3%
D TO E → 11.5%




ASSUMED SECTION FOR ALL
$n = 0.03$ (FOR R-RAP)

∴ ESTIMATE $d$, USING $Q$

B TO C → 0.83 FT
REACH #1 → 0.81 FT
REACH #2 → 0.71 FT
D TO E → 0.69 FT

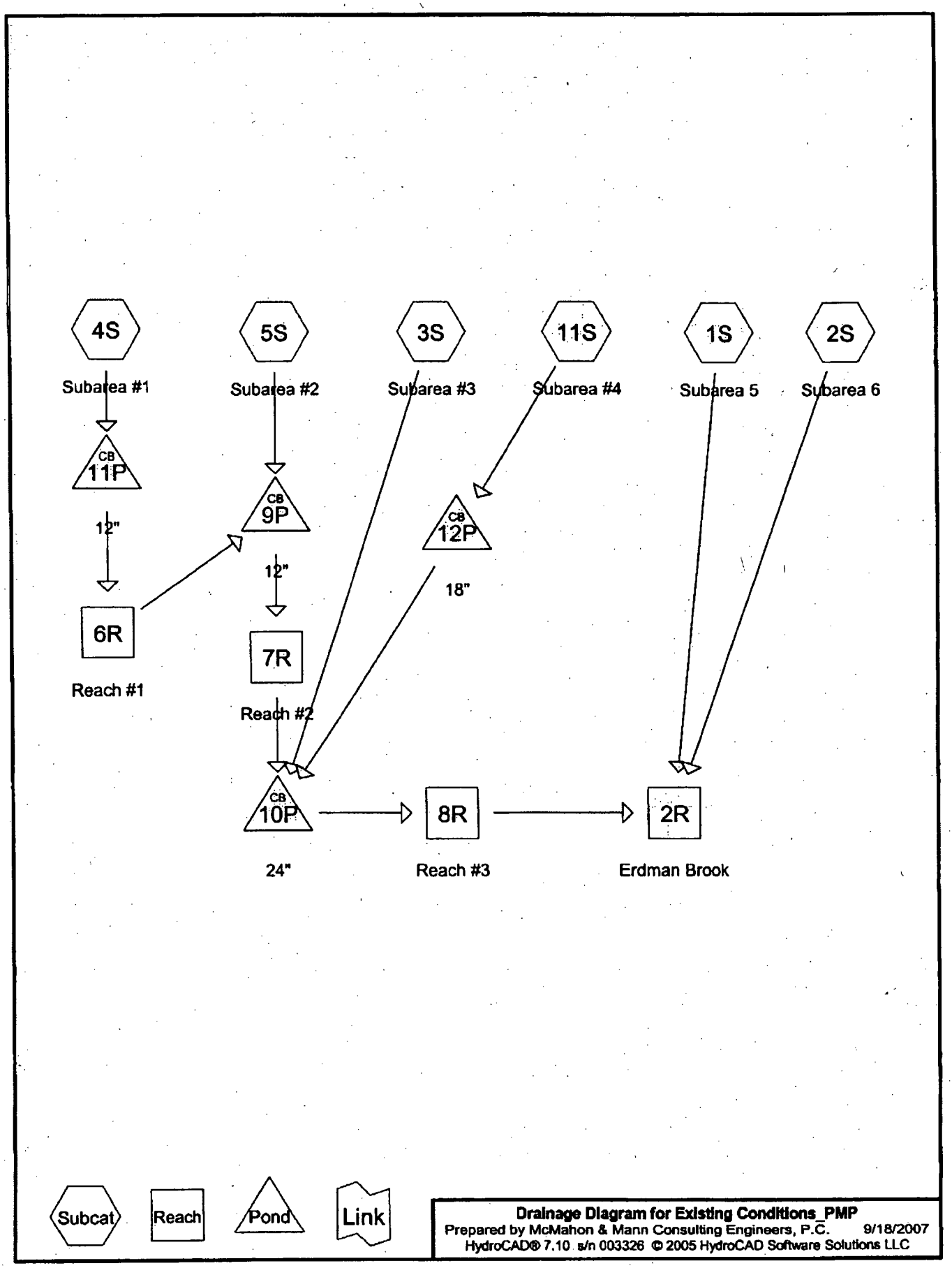
NOW CALCULATE $\tau_d = \gamma d S$

B TO C → 2.33 PSF
REACH #1 → 2.53 PSF
REACH #2 → 4.56 PSF
D TO E → 4.95 PSF ← GOVERNS

$\tau_p = 4 D_{50} = \tau_d$

$D_{50} = 4.95/4 = 1.24''$

∴ USE $D_{50} = 18''$ WITH THICKNESS OF 32"


4S
Subarea #1
5S
Subarea #2
3S
Subarea #3
11S
Subarea #4
1S
Subarea 5
2S
Subarea 6
CB
11P
12"
6R
Reach #1
CB
9P
12"
7R
Reach #2
CB
12P
18"
CB
10P
24"
8R
Reach #3
2R
Erdman Brook
Subcat
Reach
Pond
Link
Drainage Diagram for Existing Conditions_PMP
Prepared by McMahon & Mann Consulting Engineers, P.C. 9/18/2007
HydroCAD® 7.10 s/n 003326 © 2005 HydroCAD Software Solutions LLC

Time span=1.00-48.00 hrs, dt=0.05 hrs, 941 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

**Subcatchment 1S: Subarea 5** Runoff Area=3.330 ac Runoff Depth>13.05"
Flow Length=866' Tc=10.9 min CN=80 Runoff=17.60 cfs 3.620 af

**Subcatchment 2S: Subarea 6** Runoff Area=1.030 ac Runoff Depth>13.05"
Flow Length=657' Tc=9.7 min CN=80 Runoff=5.47 cfs 1.120 af

**Subcatchment 3S: Subarea #3** Runoff Area=2.550 ac Runoff Depth>13.04"
Flow Length=718' Tc=16.7 min CN=80 Runoff=13.14 cfs 2.772 af

**Subcatchment 4S: Subarea #1** Runoff Area=0.730 ac Runoff Depth>13.04"
Flow Length=308' Tc=14.3 min CN=80 Runoff=3.80 cfs 0.794 af

**Subcatchment 5S: Subarea #2** Runoff Area=1.350 ac Runoff Depth>13.05"
Flow Length=394' Tc=11.8 min CN=80 Runoff=7.11 cfs 1.468 af

**Subcatchment 11S: Subarea #4** Runoff Area=0.560 ac Runoff Depth>15.20"
Flow Length=200' Tc=2.0 min CN=98 Runoff=3.35 cfs 0.709 af

**Reach 2R: Erdman Brook** Peak Depth=0.97' Max Vel=13.4 fps Inflow=49.79 cfs 10.481 af
n=0.030 L=5.0' S=0.2000 '/' Capacity=1,024.08 cfs Outflow=49.79 cfs 10.481 af

**Reach 6R: Reach #1** Peak Depth=0.78' Max Vel=2.1 fps Inflow=3.80 cfs 0.794 af
n=0.050 L=275.0' S=0.0185 '/' Capacity=21.73 cfs Outflow=3.79 cfs 0.793 af

**Reach 7R: Reach #2** Peak Depth=1.04' Max Vel=3.3 fps Inflow=10.87 cfs 2.261 af
n=0.050 L=193.0' S=0.0317 '/' Capacity=61.32 cfs Outflow=10.86 cfs 2.261 af

**Reach 8R: Reach #3** Peak Depth=0.89' Max Vel=8.5 fps Inflow=26.88 cfs 5.741 af
n=0.030 L=137.0' S=0.0912 '/' Capacity=691.69 cfs Outflow=26.88 cfs 5.741 af

**Pond 9P: 12"** Peak Elev=1,404.41' Inflow=10.87 cfs 2.261 af
12.0" x 47.0' Culvert Outflow=10.87 cfs 2.261 af

**Pond 10P: 24"** Peak Elev=1,381.44' Inflow=26.88 cfs 5.741 af
24.0" x 362.0' Culvert Outflow=26.88 cfs 5.741 af

**Pond 11P: 12"** Peak Elev=1,388.05' Inflow=3.80 cfs 0.794 af
12.0" x 42.0' Culvert Outflow=3.80 cfs 0.794 af

**Pond 12P: 18"** Peak Elev=1,381.70' Inflow=3.35 cfs 0.709 af
18.0" x 65.0' Culvert Outflow=3.35 cfs 0.709 af

**Total Runoff Area = 9.550 ac Runoff Volume = 10.482 af Average Runoff Depth = 13.17"**

## Subcatchment 1S: Subarea 5

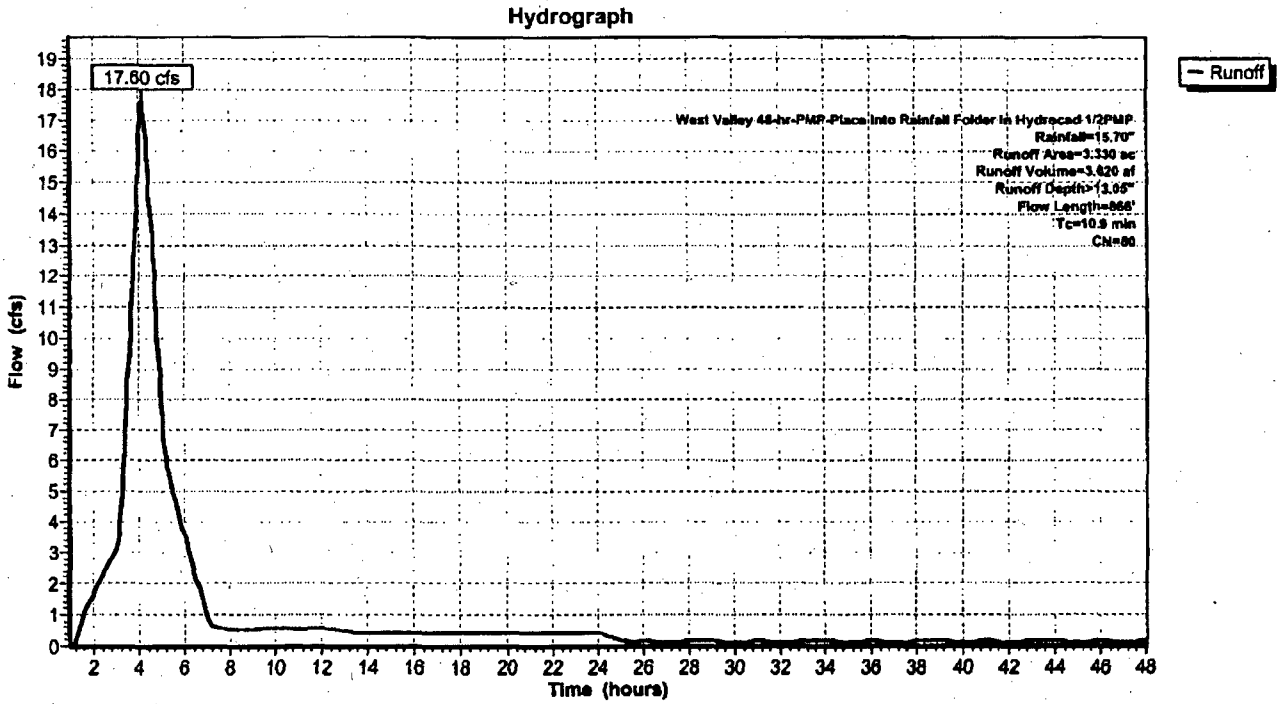
Runoff = 17.60 cfs @ 4.18 hrs, Volume= 3.620 af, Depth>13.05"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-48.00 hrs, dt= 0.05 hrs
West Valley 48-hr-PMP-Place into Rainfall Folder in Hydrocad 1/2PMP Rainfall=15.70"

| Area (ac) | CN | Description |
|---|---|---|
| 3.330 | 80 | North and west side of existing landfill |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 4.2 | 44 | 0.0450 | 0.2 | | **Sheet Flow, A to B**<br>Grass: Short n= 0.150 P2= 2.50" |
| 4.4 | 119 | 0.0042 | 0.5 | | **Shallow Concentrated Flow, B to C**<br>Short Grass Pasture Kv= 7.0 fps |
| 1.9 | 428 | 0.0260 | 3.8 | 25.44 | **Channel Flow, C to D**<br>Area= 6.7 sf Perim= 9.5' r= 0.71' n= 0.050 |
| 0.2 | 71 | 0.0420 | 4.8 | 3.80 | **Circular Channel (pipe), D to E**<br>Diam= 12.0" Area= 0.8 sf Perim= 3.1' r= 0.25'<br>n= 0.025 Corrugated metal |
| 0.2 | 204 | 0.1050 | 20.6 | 742.79 | **Channel Flow, E to F**<br>Area= 36.0 sf Perim= 24.7' r= 1.46' n= 0.030 |
| 10.9 | 866 | Total | | | |

## Subcatchment 1S: Subarea 5



## Subcatchment 2S: Subarea 6

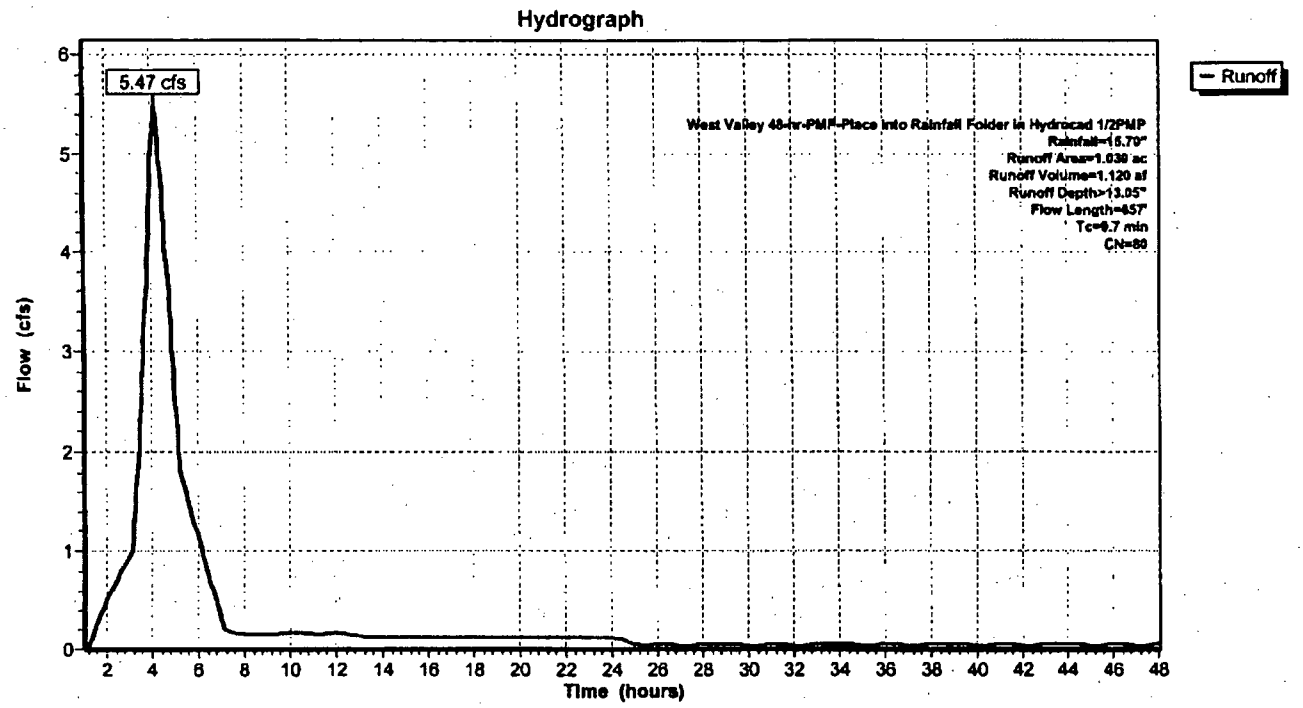
Runoff = 5.47 cfs @ 4.16 hrs, Volume= 1.120 af, Depth>13.05"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-48.00 hrs, dt= 0.05 hrs
West Valley 48-hr-PMP-Place into Rainfall Folder in Hydrocad 1/2PMP Rainfall=15.70"

| Area (ac) | CN | Description |
|---|---|---|
| 1.030 | 80 | West side of exisiting landfill |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 7.7 | 100 | 0.0500 | 0.2 | | **Sheet Flow, A to B**<br>Grass: Short n= 0.150 P2= 2.50" |
| 1.6 | 160 | 0.0560 | 1.7 | | **Shallow Concentrated Flow, B to C**<br>Short Grass Pasture Kv= 7.0 fps |
| 0.4 | 397 | 0.0580 | 15.3 | 552.06 | **Channel Flow, C to D**<br>Area= 36.0 sf Perim= 24.7' r= 1.46' n= 0.030 |
| 9.7 | 657 | Total | | | |

## Subcatchment 2S: Subarea 6



## Subcatchment 3S: Subarea #3

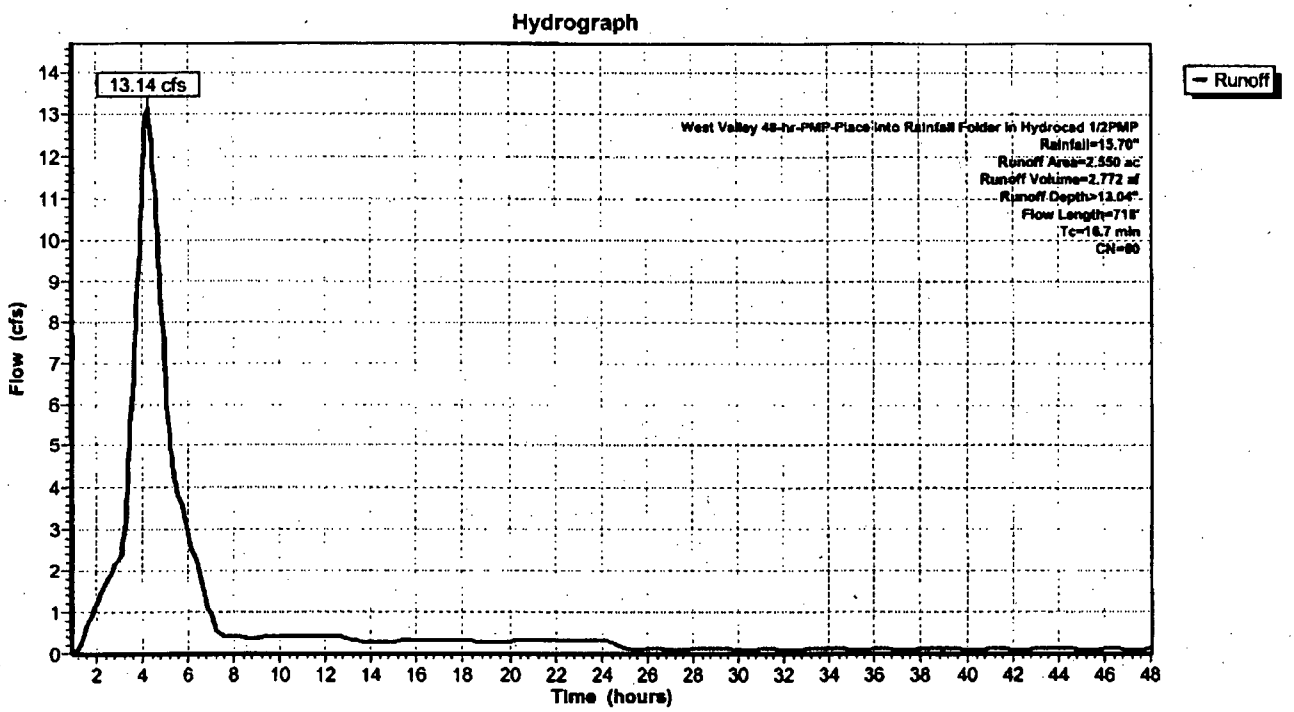
Runoff = 13.14 cfs @ 4.27 hrs, Volume= 2.772 af, Depth>13.04"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-48.00 hrs, dt= 0.05 hrs
West Valley 48-hr-PMP-Place into Rainfall Folder in Hydrocad 1/2PMP Rainfall=15.70"

| Area (ac) | CN | Description |
|---|---|---|
| 2.550 | 80 | Southside of existing landfill |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 12.1 | 100 | 0.0160 | 0.1 | | **Sheet Flow, A to B**<br>Grass: Short n= 0.150 P2= 2.50" |
| 2.4 | 177 | 0.0310 | 1.2 | | **Shallow Concentrated Flow, B to C**<br>Short Grass Pasture Kv= 7.0 fps |
| 0.2 | 71 | 0.0490 | 6.4 | 76.42 | **Channel Flow, C to D**<br>Area= 12.0 sf Perim= 12.6' r= 0.95' n= 0.050 |
| 1.4 | 177 | 0.0085 | 2.2 | 1.71 | **Circular Channel (pipe), D to E**<br>Diam= 12.0" Area= 0.8 sf Perim= 3.1' r= 0.25'<br>n= 0.025 Corrugated metal |
| 0.6 | 193 | 0.0320 | 5.1 | 61.76 | **Channel Flow, E to F**<br>Area= 12.0 sf Perim= 12.6' r= 0.95' n= 0.050 |
| 16.7 | 718 | Total | | | |

## Subcatchment 3S: Subarea #3



## Subcatchment 4S: Subarea #1

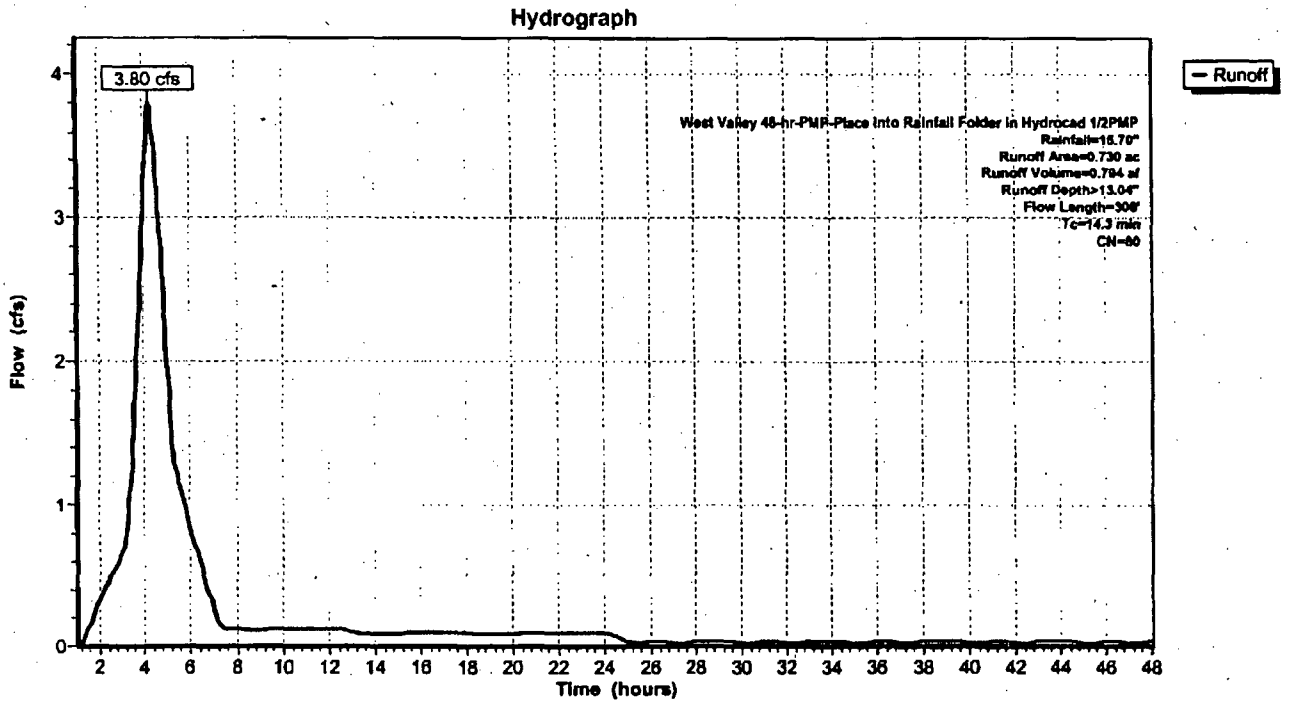
Runoff = 3.80 cfs @ 4.23 hrs, Volume= 0.794 af, Depth>13.04"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-48.00 hrs, dt= 0.05 hrs
West Valley 48-hr-PMP-Place into Rainfall Folder in Hydrocad 1/2PMP Rainfall=15.70"

| Area (ac) | CN | Description |
|---|---|---|
| 0.730 | 80 | Southwest corner of Existing Landfill |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 12.1 | 100 | 0.0160 | 0.1 | | **Sheet Flow, A to B**<br>Grass: Short n= 0.150 P2= 2.50" |
| 2.1 | 165 | 0.0340 | 1.3 | | **Shallow Concentrated Flow, B to C**<br>Short Grass Pasture Kv= 7.0 fps |
| 0.1 | 43 | 0.0290 | 4.9 | 58.79 | **Channel Flow, C to D**<br>Area= 12.0 sf Perim= 12.6' r= 0.95' n= 0.050 |
| 14.3 | 308 | Total | | | |

## Subcatchment 4S: Subarea #1



## Subcatchment 5S: Subarea #2

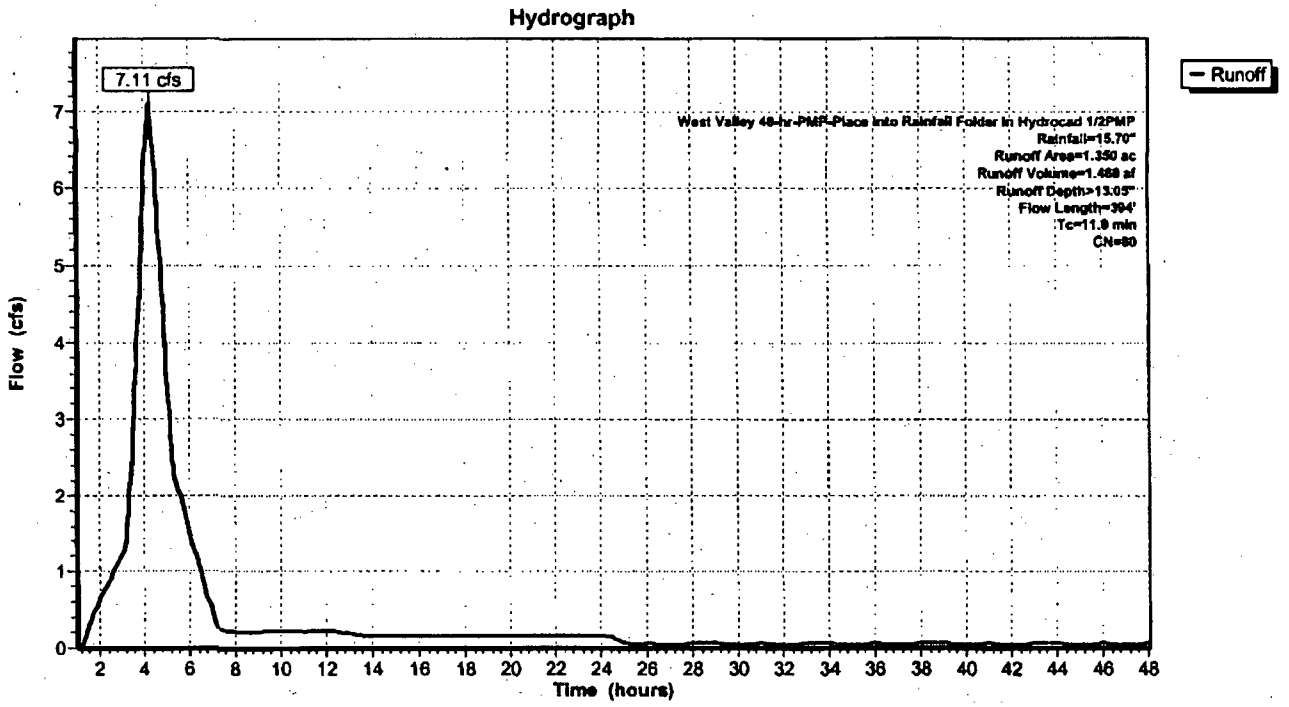
Runoff = 7.11 cfs @ 4.19 hrs, Volume= 1.468 af, Depth>13.05"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-48.00 hrs, dt= 0.05 hrs
West Valley 48-hr-PMP-Place into Rainfall Folder in Hydrocad 1/2PMP Rainfall=15.70"

| Area (ac) | CN | Description |
|---|---|---|
| 1.350 | 80 | Outside south area draing to 12" pipe |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 10.1 | 100 | 0.0250 | 0.2 | | **Sheet Flow, A to B**<br>Grass: Short n= 0.150 P2= 2.50" |
| 1.7 | 294 | 0.0310 | 2.8 | | **Shallow Concentrated Flow, B to C**<br>Unpaved Kv= 16.1 fps |
| 11.8 | 394 | Total | | | |

## Subcatchment 5S: Subarea #2



## Subcatchment 11S: Subarea #4

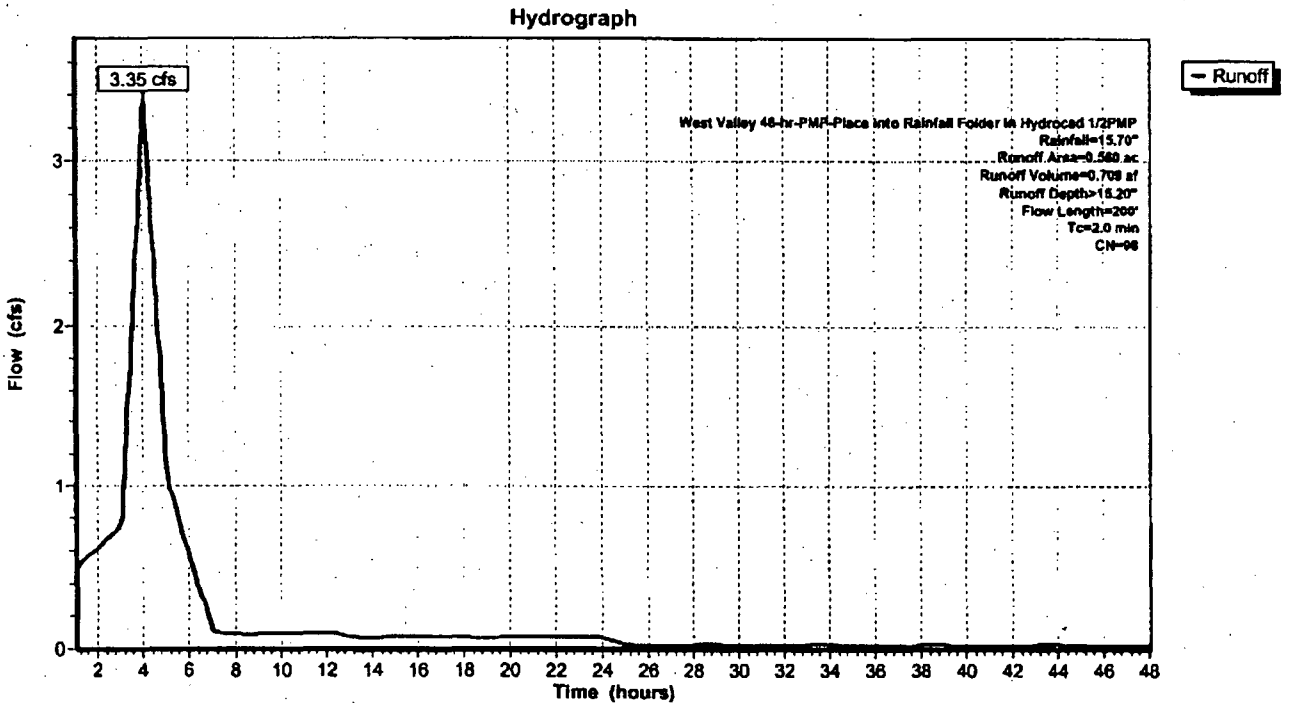
Runoff = 3.35 cfs @ 4.04 hrs, Volume= 0.709 af, Depth>15.20"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-48.00 hrs, dt= 0.05 hrs
West Valley 48-hr-PMP-Place into Rainfall Folder in Hydrocad 1/2PMP Rainfall=15.70"

| Area (ac) | CN | Description |
|---|---|---|
| 0.560 | 98 | From SDA |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 1.4 | 100 | 0.0200 | 1.2 | | **Sheet Flow, A to B**<br>Smooth surfaces n= 0.011 P2= 2.50" |
| 0.6 | 100 | 0.0200 | 2.9 | | **Shallow Concentrated Flow, B to C**<br>Paved Kv= 20.3 fps |
| 2.0 | 200 | Total | | | |

## Subcatchment 11S: Subarea #4



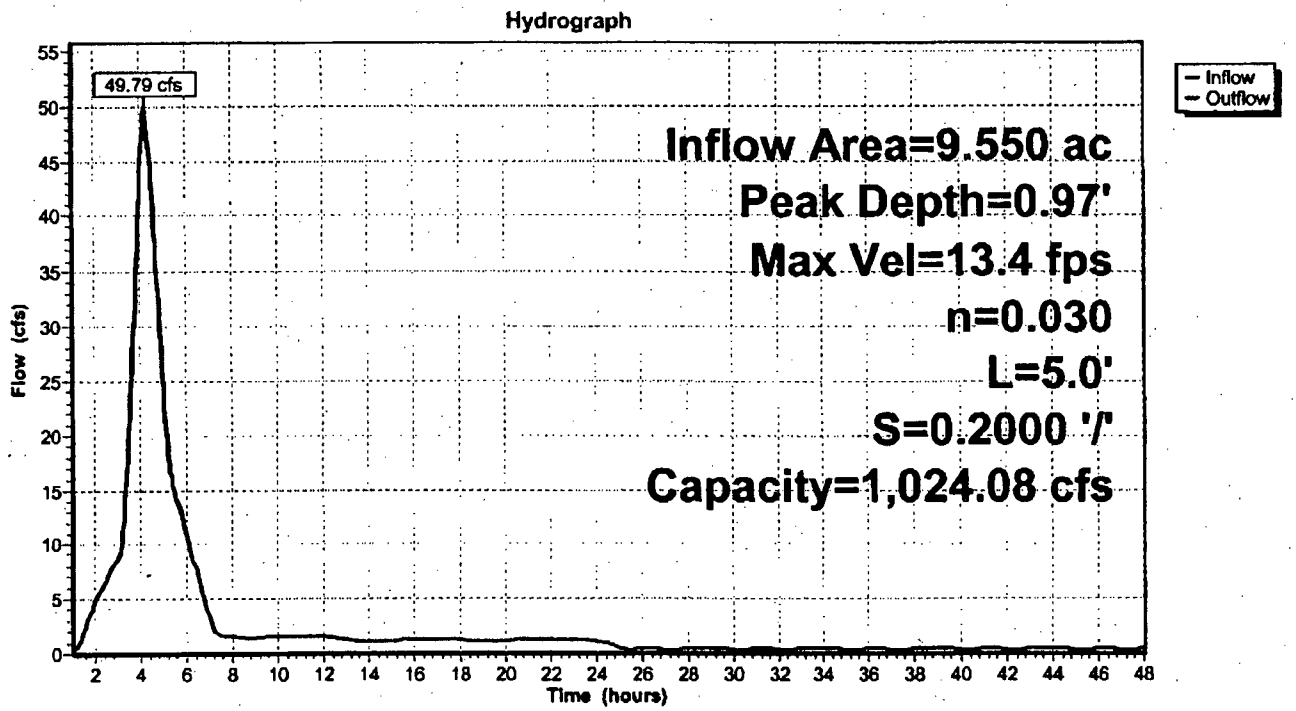
## Reach 2R: Erdman Brook

Inflow Area = 9.550 ac, Inflow Depth > 13.17" for 1/2PMP event
Inflow = 49.79 cfs @ 4.20 hrs, Volume= 10.481 af
Outflow = 49.79 cfs @ 4.20 hrs, Volume= 10.481 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 1.00-48.00 hrs, dt= 0.05 hrs
Max. Velocity= 13.4 fps, Min. Travel Time= 0.0 min
Avg. Velocity = 5.2 fps, Avg. Travel Time= 0.0 min

Peak Depth= 0.97' @ 4.20 hrs
Capacity at bank full= 1,024.08 cfs
Inlet Invert= 1,353.50', Outlet Invert= 1,352.50'
0.00' x 3.00' deep channel, n= 0.030
Side Slope Z-value= 4.0 '/' Top Width= 24.00'
Length= 5.0' Slope= 0.2000 '/'

## Reach 2R: Erdman Brook



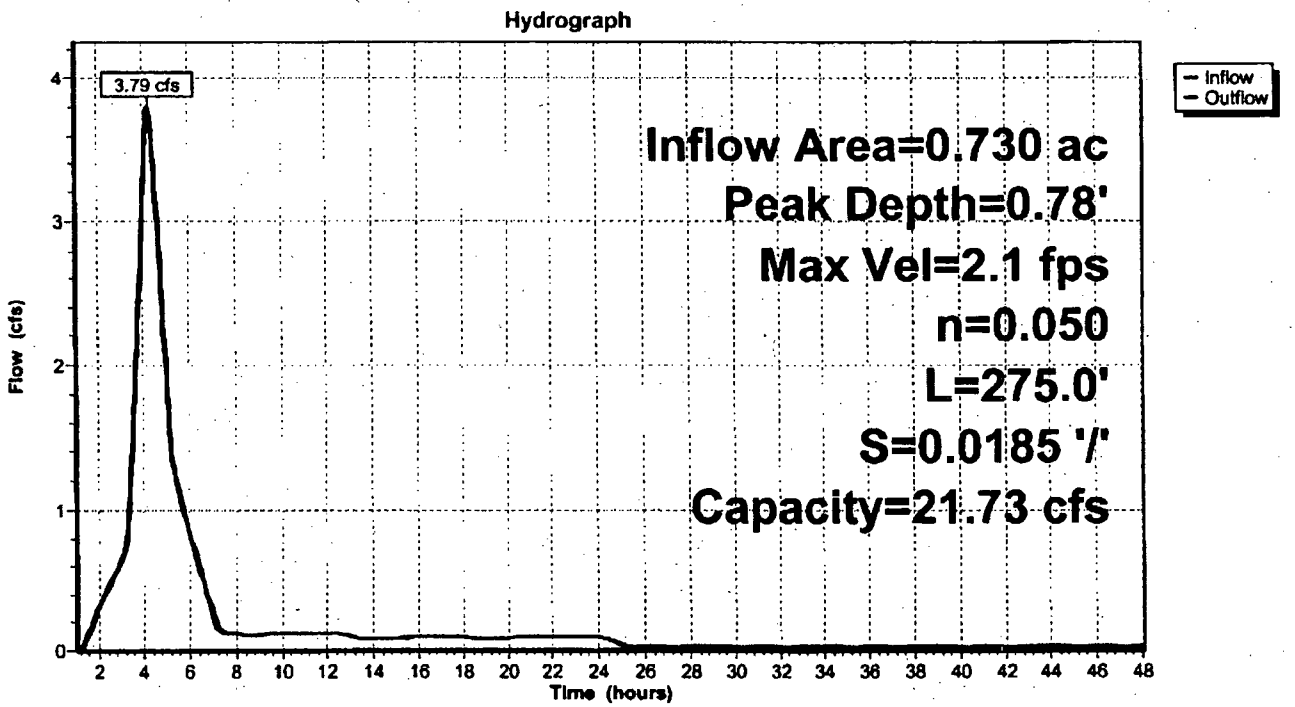
## Reach 6R: Reach #1

Inflow Area = 0.730 ac, Inflow Depth > 13.04" for 1/2PMP event
Inflow = 3.80 cfs @ 4.23 hrs, Volume= 0.794 af
Outflow = 3.79 cfs @ 4.26 hrs, Volume= 0.793 af, Atten= 0%, Lag= 1.8 min

Routing by Dyn-Stor-Ind method, Time Span= 1.00-48.00 hrs, dt= 0.05 hrs
Max. Velocity= 2.1 fps, Min. Travel Time= 2.2 min
Avg. Velocity = 0.8 fps, Avg. Travel Time= 5.7 min

Peak Depth= 0.78' @ 4.26 hrs
Capacity at bank full= 21.73 cfs
Inlet Invert= 1,384.58', Outlet Invert= 1,379.50'
0.00' x 1.50' deep channel, n= 0.050
Side Slope Z-value= 3.0 '/' Top Width= 9.00'
Length= 275.0' Slope= 0.0185 '/'

## Reach 6R: Reach #1



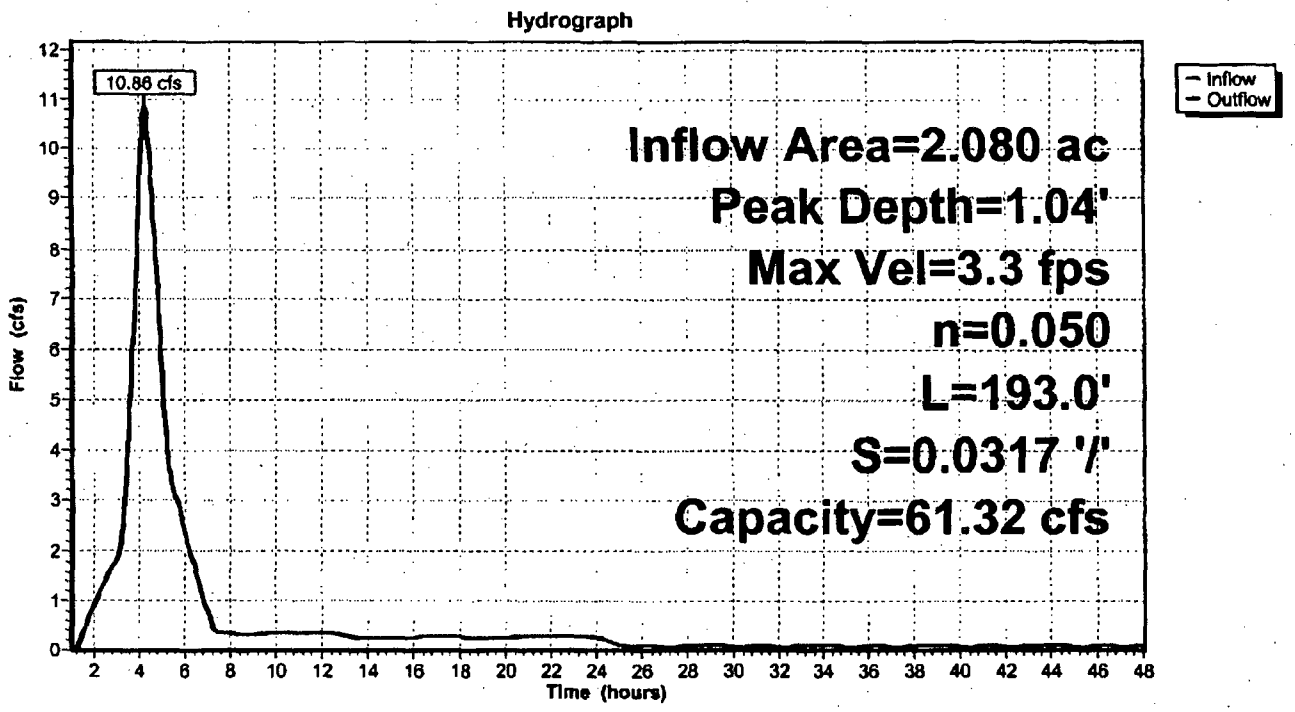
## Reach 7R: Reach #2

Inflow Area = 2.080 ac, Inflow Depth > 13.04" for 1/2PMP event
Inflow = 10.87 cfs @ 4.21 hrs, Volume= 2.261 af
Outflow = 10.86 cfs @ 4.23 hrs, Volume= 2.261 af, Atten= 0%, Lag= 0.7 min

Routing by Dyn-Stor-Ind method, Time Span= 1.00-48.00 hrs, dt= 0.05 hrs
Max. Velocity= 3.3 fps, Min. Travel Time= 1.0 min
Avg. Velocity = 1.3 fps, Avg. Travel Time= 2.5 min

Peak Depth= 1.04' @ 4.23 hrs
Capacity at bank full= 61.32 cfs
Inlet Invert= 1,381.50', Outlet Invert= 1,375.38'
0.00' x 2.00' deep channel, n= 0.050
Side Slope Z-value= 3.0 '/' Top Width= 12.00'
Length= 193.0' Slope= 0.0317 '/'

## Reach 7R: Reach #2



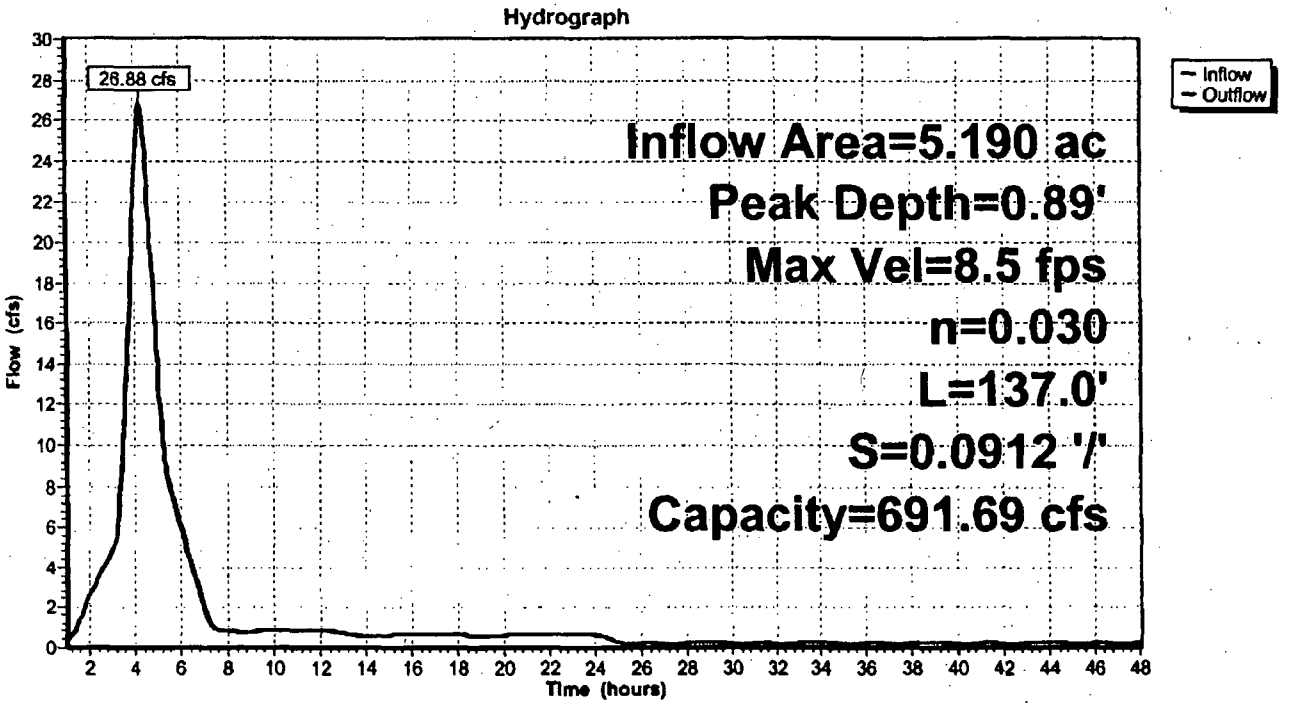
## Reach 8R: Reach #3

Inflow Area = 5.190 ac, Inflow Depth > 13.27" for 1/2PMP event
Inflow = 26.88 cfs @ 4.23 hrs, Volume= 5.741 af
Outflow = 26.88 cfs @ 4.23 hrs, Volume= 5.741 af, Atten= 0%, Lag= 0.2 min

Routing by Dyn-Stor-Ind method, Time Span= 1.00-48.00 hrs, dt= 0.05 hrs
Max. Velocity= 8.5 fps, Min. Travel Time= 0.3 min
Avg. Velocity = 3.3 fps, Avg. Travel Time= 0.7 min

Peak Depth= 0.89' @ 4.23 hrs
Capacity at bank full= 691.69 cfs
Inlet Invert= 1,366.00', Outlet Invert= 1,353.50'
0.00' x 3.00' deep channel, n= 0.030
Side Slope Z-value= 4.0 '/' Top Width= 24.00'
Length= 137.0' Slope= 0.0912 '/'

## Reach 8R: Reach #3



## Pond 9P: 12"

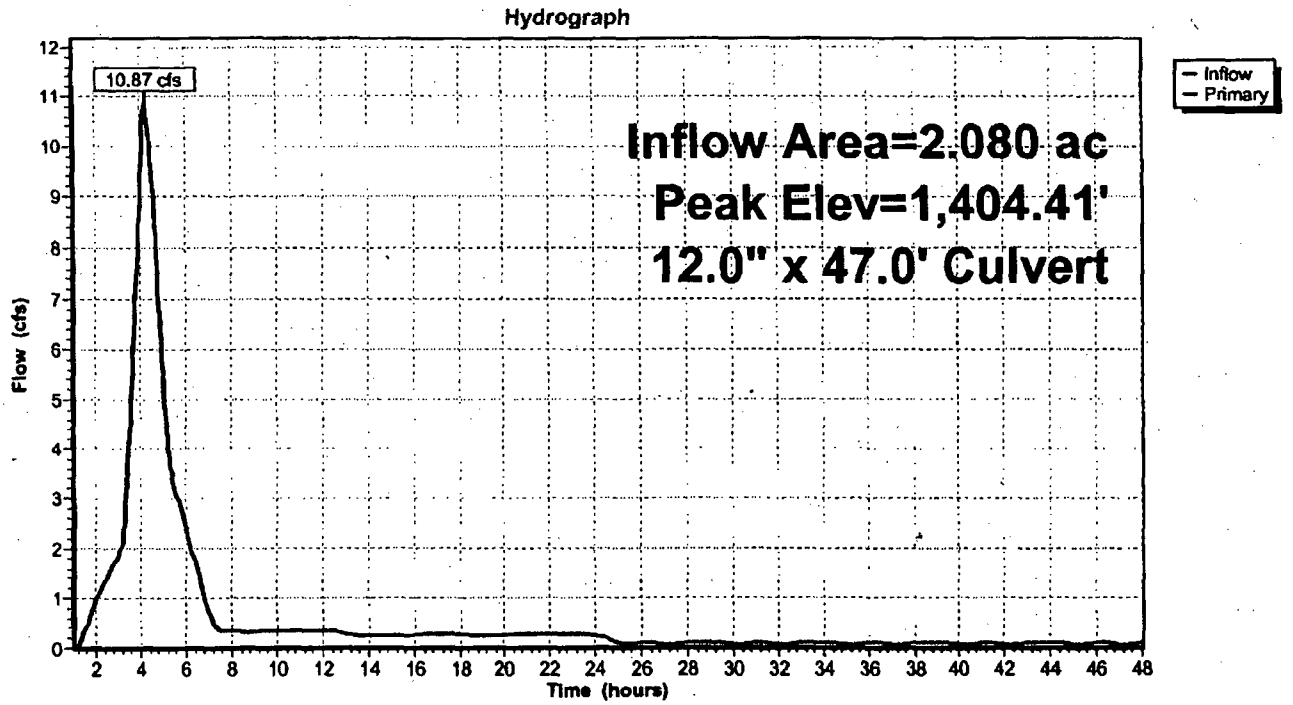
| | | | | | |
|---|---|---|---|---|---|
| Inflow Area = | 2.080 ac, | Inflow Depth > 13.04" | for 1/2PMP event | | |
| Inflow = | 10.87 cfs @ | 4.21 hrs, Volume= | 2.261 af | | |
| Outflow = | 10.87 cfs @ | 4.21 hrs, Volume= | 2.261 af, Atten= 0%, Lag= 0.0 min | | |
| Primary = | 10.87 cfs @ | 4.21 hrs, Volume= | 2.261 af | | |

Routing by Dyn-Stor-Ind method, Time Span= 1.00-48.00 hrs, dt= 0.05 hrs
Peak Elev= 1,404.41' @ 4.21 hrs
Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 0.0 min ( 517.6 - 517.6 )

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 1,379.50' | **12.0" x 47.0' long Culvert** CMP, projecting, no headwall, Ke= 0.900<br>Outlet Invert= 1,379.00' S= 0.0106 '/' Cc= 0.900<br>n= 0.025 Corrugated metal |

**Primary OutFlow** Max=10.85 cfs @ 4.21 hrs HW=1,404.33' TW=1,382.54' (Dynamic Tailwater)
└─**1=Culvert** (Outlet Controls 10.85 cfs @ 13.8 fps)

## Pond 9P: 12"



## Pond 10P: 24"

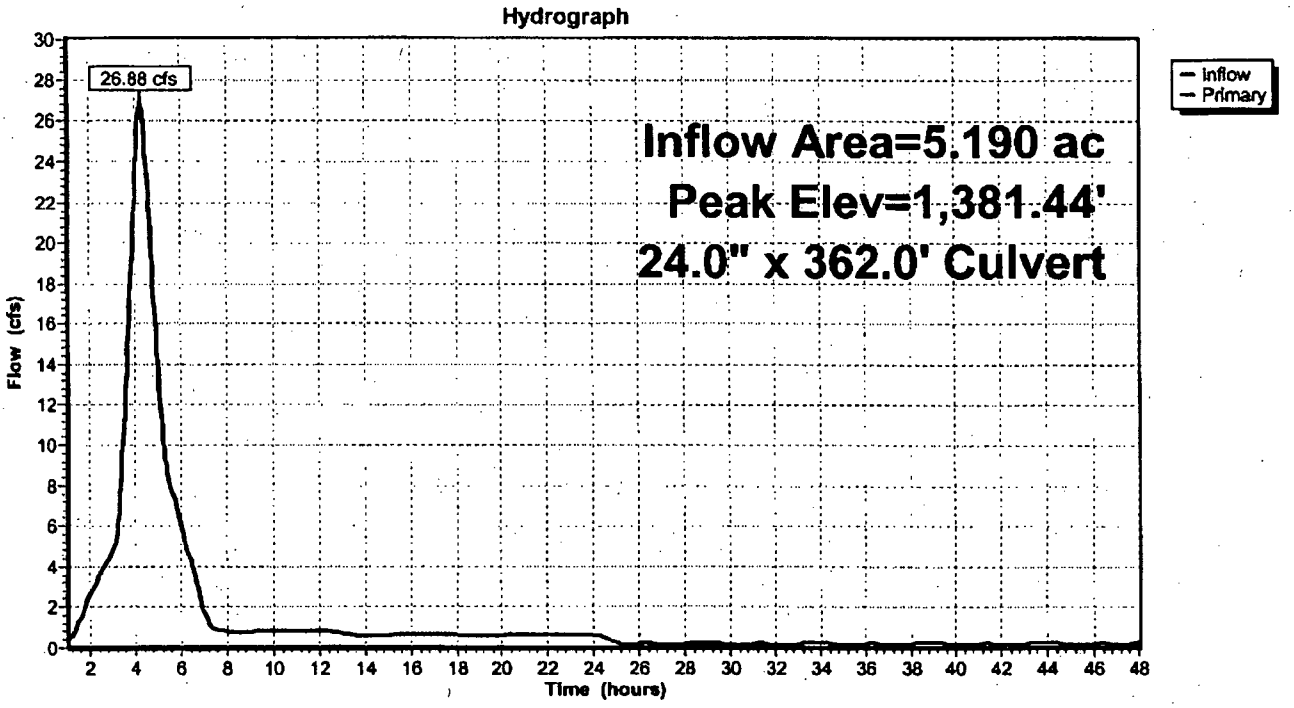
| | | | | | |
|---|---|---|---|---|---|
| Inflow Area = | 5.190 ac, | Inflow Depth > 13.27" | for 1/2PMP event | | |
| Inflow = | 26.88 cfs @ | 4.23 hrs, | Volume= | 5.741 af | |
| Outflow = | 26.88 cfs @ | 4.23 hrs, | Volume= | 5.741 af, | Atten= 0%, Lag= 0.0 min |
| Primary = | 26.88 cfs @ | 4.23 hrs, | Volume= | 5.741 af | |

Routing by Dyn-Stor-Ind method, Time Span= 1.00-48.00 hrs, dt= 0.05 hrs
Peak Elev= 1,381.44' @ 4.23 hrs
Plug-Flow detention time= 0.0 min calculated for 5.741 af (100% of inflow)
Center-of-Mass det. time= (not calculated: outflow precedes inflow)

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 1,375.38' | **24.0" x 362.0' long Culvert** CPP, projecting, no headwall, Ke= 0.900<br>Outlet Invert= 1,366.00' S= 0.0259 '/' Cc= 0.900<br>n= 0.013 Corrugated PE, smooth interior |

**Primary OutFlow** Max=26.84 cfs @ 4.23 hrs HW=1,381.43' TW=1,366.89' (Dynamic Tailwater)
└─**1=Culvert** (Inlet Controls 26.84 cfs @ 8.5 fps)

## Pond 10P: 24"



## Pond 11P: 12"

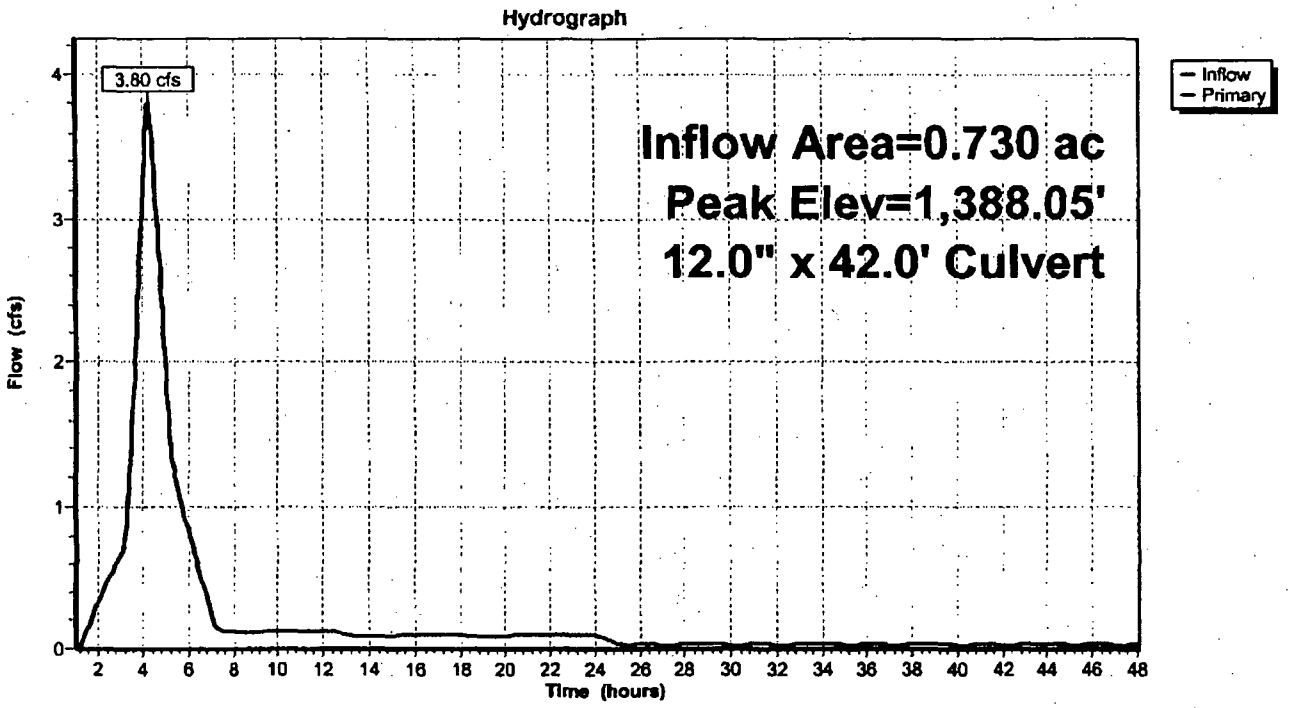
| | | | | | |
|---|---|---|---|---|---|
| Inflow Area = | 0.730 ac, | Inflow Depth > 13.04" | for 1/2PMP event | | |
| Inflow = | 3.80 cfs @ | 4.23 hrs, | Volume= | 0.794 af | |
| Outflow = | 3.80 cfs @ | 4.23 hrs, | Volume= | 0.794 af, | Atten= 0%, Lag= 0.0 min |
| Primary = | 3.80 cfs @ | 4.23 hrs, | Volume= | 0.794 af | |

Routing by Dyn-Stor-Ind method, Time Span= 1.00-48.00 hrs, dt= 0.05 hrs
Peak Elev= 1,388.05' @ 4.23 hrs
Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 0.0 min ( 518.0 - 518.0 )

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 1,385.00' | **12.0" x 42.0' long Culvert** CMP, projecting, no headwall, Ke= 0.900<br>Outlet Invert= 1,384.58' S= 0.0100 '/' Cc= 0.900<br>n= 0.025 Corrugated metal |

**Primary OutFlow** Max=3.80 cfs @ 4.23 hrs HW=1,388.04' TW=1,385.36' (Dynamic Tailwater)
└─**1=Culvert** (Barrel Controls 3.80 cfs @ 4.8 fps)

## Pond 11P: 12"



## Pond 12P: 18"

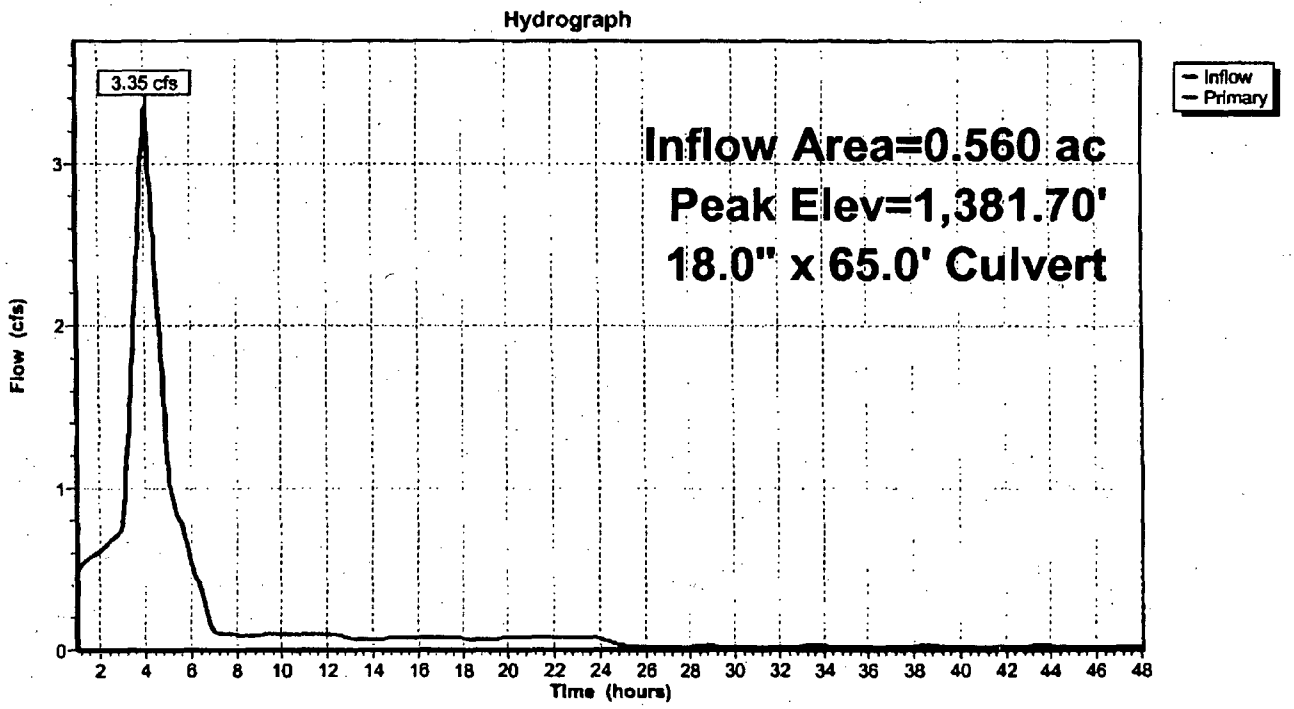
| | | | | | |
|---|---|---|---|---|---|
| Inflow Area = | 0.560 ac, | Inflow Depth > 15.20" | for 1/2PMP event | | |
| Inflow = | 3.35 cfs @ | 4.04 hrs, | Volume= | 0.709 af | |
| Outflow = | 3.35 cfs @ | 4.04 hrs, | Volume= | 0.709 af, | Atten= 0%, Lag= 0.0 min |
| Primary = | 3.35 cfs @ | 4.04 hrs, | Volume= | 0.709 af | |

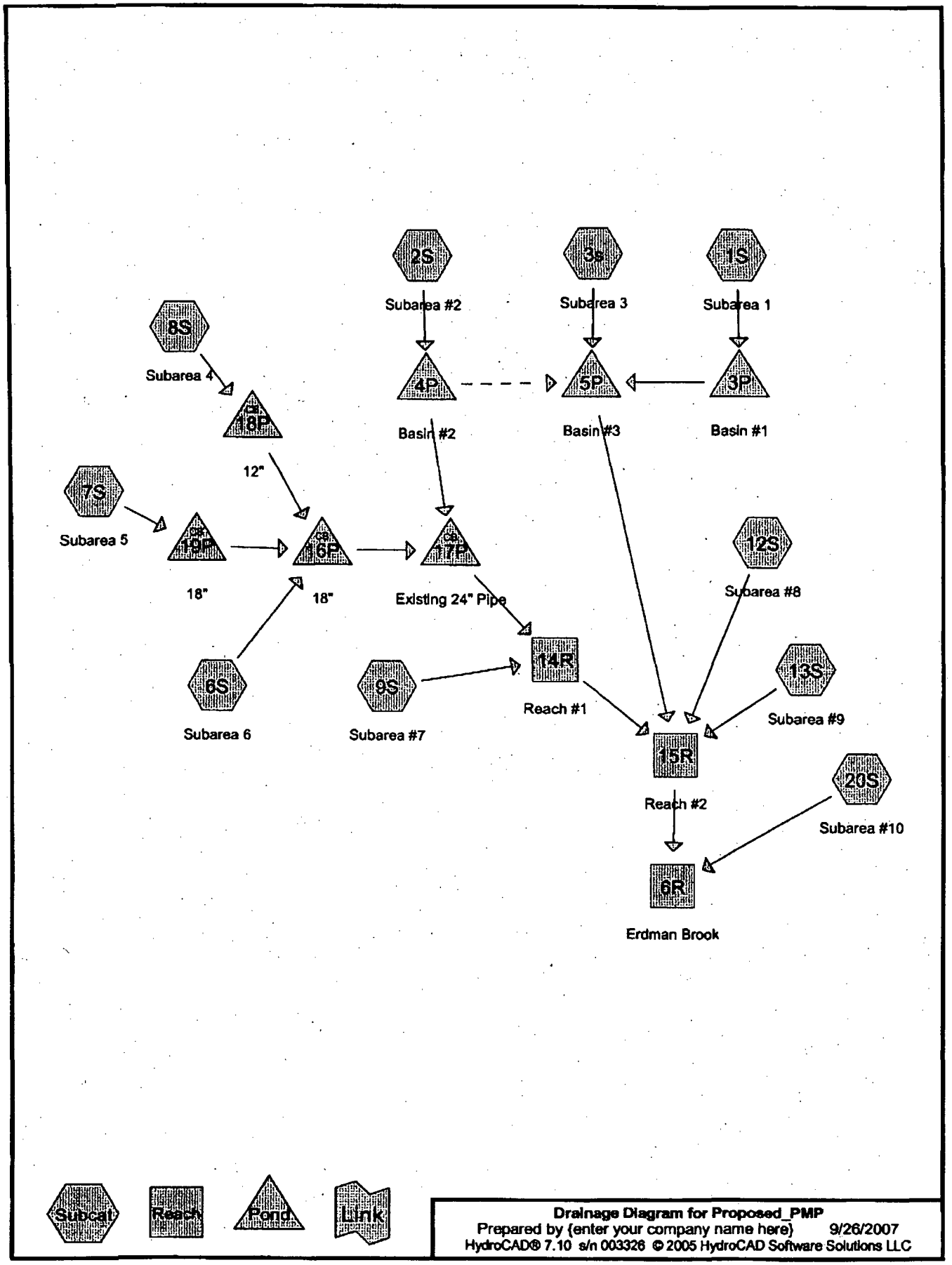
Routing by Dyn-Stor-Ind method, Time Span= 1.00-48.00 hrs, dt= 0.05 hrs
Peak Elev= 1,381.70' @ 4.27 hrs
Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 0.0 min ( 465.0 - 465.0 )

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 1,378.50' | **18.0" x 65.0' long Culvert** CMP, projecting, no headwall, Ke= 0.900<br>Outlet Invert= 1,378.00' S= 0.0077 '/' Cc= 0.900<br>n= 0.025 Corrugated metal |

**Primary OutFlow** Max=0.00 cfs @ 4.04 hrs HW=1,380.45' TW=1,380.50' (Dynamic Tailwater)
└**1=Culvert** ( Controls 0.00 cfs)

## Pond 12P: 18"




2S
Subarea #2
3S
Subarea 3
1S
Subarea 1
8S
Subarea 4
4P
5P
3P
18P
Basin #2
Basin #3
Basin #1
12"
7S
Subarea 5
19P
16P
17P
12S
Subarea #8
18"
18"
Existing 24" Pipe
14R
6S
9S
13S
Reach #1
Subarea 6
Subarea #7
Subarea #9
15R
20S
Reach #2
Subarea #10
6R
Erdman Brook
Subcat
Reach
Pond
Link
Drainage Diagram for Proposed_PMP
Prepared by {enter your company name here} 9/26/2007
HydroCAD® 7.10 s/n 003326 © 2005 HydroCAD Software Solutions LLC

Time span=0.00-48.00 hrs, dt=0.01 hrs, 4801 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

**Subcatchment 1S: Subarea 1** Runoff Area=2.660 ac Runoff Depth>15.46"
Flow Length=629' Tc=1.6 min CN=98 Runoff=16.03 cfs 3.426 af

**Subcatchment 2S: Subarea #2** Runoff Area=1.890 ac Runoff Depth>15.46"
Flow Length=486' Tc=0.5 min CN=98 Runoff=11.43 cfs 2.435 af

**Subcatchment 3s: Subarea 3** Runoff Area=1.730 ac Runoff Depth>15.46"
Flow Length=473' Tc=3.8 min CN=98 Runoff=10.33 cfs 2.228 af

**Subcatchment 6S: Subarea 6** Runoff Area=0.470 ac Runoff Depth>14.44"
Flow Length=530' Tc=4.6 min CN=90 Runoff=2.74 cfs 0.565 af

**Subcatchment 7S: Subarea 5** Runoff Area=0.560 ac Runoff Depth>15.46"
Flow Length=200' Tc=2.0 min CN=98 Runoff=3.37 cfs 0.721 af

**Subcatchment 8S: Subarea 4** Runoff Area=1.290 ac Runoff Depth>13.05"
Flow Length=394' Tc=11.8 min CN=80 Runoff=6.80 cfs 1.402 af

**Subcatchment 9S: Subarea #7** Runoff Area=0.340 ac Runoff Depth>13.05"
Flow Length=390' Tc=11.5 min CN=80 Runoff=1.80 cfs 0.370 af

**Subcatchment 12S: Subarea #8** Runoff Area=0.032 ac Runoff Depth>13.05"
Flow Length=33' Tc=1.4 min CN=80 Runoff=0.18 cfs 0.035 af

**Subcatchment 13S: Subarea #9** Runoff Area=0.086 ac Runoff Depth>13.05"
Flow Length=50' Tc=2.2 min CN=80 Runoff=0.47 cfs 0.094 af

**Subcatchment 20S: Subarea #10** Runoff Area=1.030 ac Runoff Depth>13.04"
Flow Length=998' Tc=27.4 min CN=80 Runoff=5.06 cfs 1.119 af

**Reach 6R: Erdman Brook** Peak Depth=1.01' Max Vel=13.7 fps Inflow=55.56 cfs 12.392 af
n=0.030 L=5.0' S=0.2000 '/' Capacity=1,024.08 cfs Outflow=55.56 cfs 12.392 af

**Reach 14R: Reach #1** Peak Depth=0.97' Max Vel=6.7 fps Inflow=24.92 cfs 5.492 af
n=0.030 L=30.0' S=0.0500 '/' Capacity=512.04 cfs Outflow=24.92 cfs 5.492 af

**Reach 15R: Reach #2** Peak Depth=1.11' Max Vel=10.5 fps Inflow=51.48 cfs 11.273 af
n=0.030 L=107.0' S=0.1028 '/' Capacity=734.21 cfs Outflow=51.48 cfs 11.273 af

**Pond 3P: Basin #1** Peak Elev=1,380.02' Storage=1,184 cf Inflow=16.03 cfs 3.426 af
Primary=15.75 cfs 3.426 af Secondary=0.00 cfs 0.000 af Outflow=15.75 cfs 3.426 af

**Pond 4P: Basin #2** Peak Elev=1,380.26' Storage=11,013 cf Inflow=11.43 cfs 2.435 af
Primary=10.62 cfs 2.433 af Secondary=0.02 cfs 0.001 af Outflow=10.63 cfs 2.434 af

**Pond 5P: Basin #3** Peak Elev=1,379.09' Storage=22,485 cf Inflow=26.10 cfs 5.655 af
Primary=10.11 cfs 4.530 af Secondary=15.95 cfs 1.123 af Outflow=26.06 cfs 5.653 af

**Pond 16P: 18"** Peak Elev=1,383.63' Inflow=12.54 cfs 2.689 af
18.0" x 93.0' Culvert Outflow=12.54 cfs 2.689 af

**Pond 17P: Existing 24" Pipe** Peak Elev=1,380.14' Inflow=23.15 cfs 5.122 af
24.0" x 362.0' Culvert Outflow=23.15 cfs 5.122 af

**Pond 18P: 12"** Peak Elev=1,390.74' Inflow=6.80 cfs 1.402 af
12.0" x 136.0' Culvert Outflow=6.80 cfs 1.402 af

**Pond 19P: 18"** Peak Elev=1,383.85' Inflow=3.37 cfs 0.721 af
18.0" x 38.0' Culvert Outflow=3.37 cfs 0.721 af

**Total Runoff Area = 10.088 ac Runoff Volume = 12.395 af Average Runoff Depth = 14.74"**

## Subcatchment 1S: Subarea 1

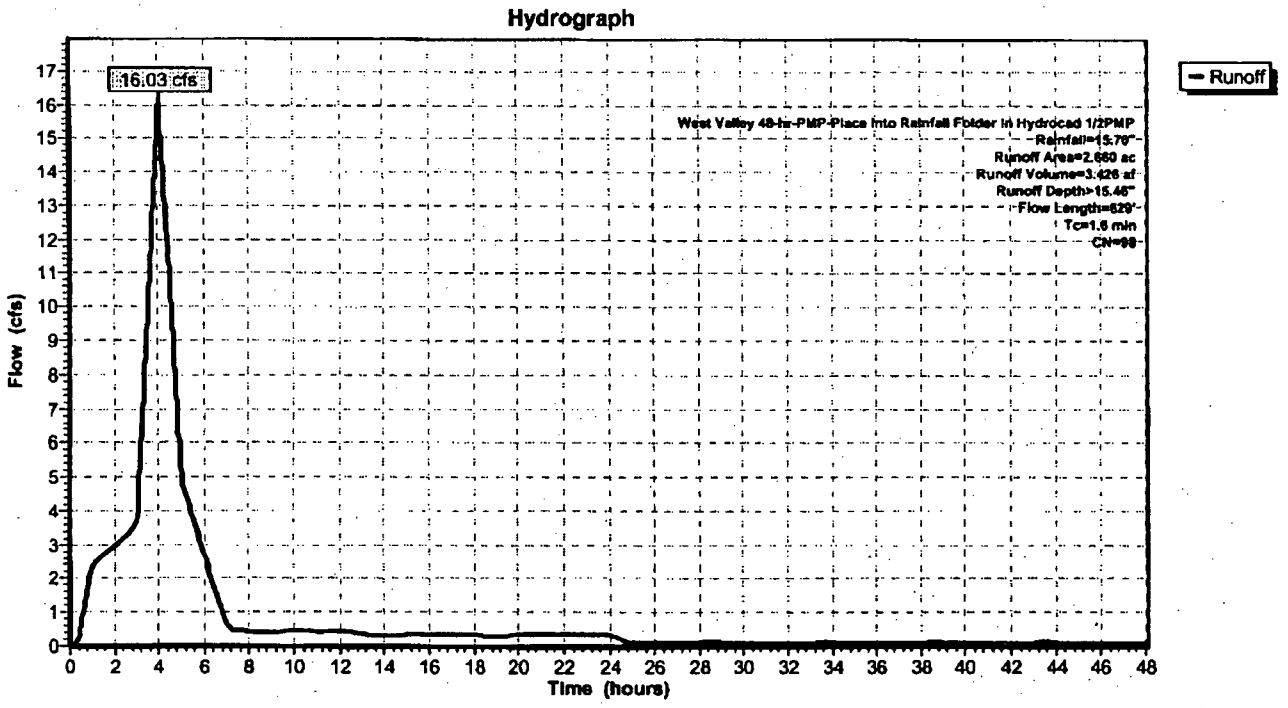
Runoff = 16.03 cfs @ 4.02 hrs, Volume= 3.426 af, Depth>15.46"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
West Valley 48-hr-PMP-Place into Rainfall Folder in Hydrocad 1/2PMP Rainfall=15.70"

| Area (ac) | CN | Description |
|---|---|---|
| 2.660 | 98 | North and West Sides of Cap |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 0.0 | 2 | 0.1250 | 1.2 | | **Sheet Flow, A to B** Smooth surfaces n= 0.011 P2= 2.50" |
| 0.0 | 37 | 0.0270 | 13.8 | 55.02 | **Channel Flow, B to C** Area= 4.0 sf Perim= 8.2' r= 0.49' n= 0.011 |
| 1.3 | 357 | 0.0028 | 4.5 | 76.40 | **Channel Flow, C to D** Area= 17.0 sf Perim= 34.1' r= 0.50' n= 0.011 |
| 0.2 | 104 | 0.0097 | 8.3 | 70.69 | **Channel Flow, D to E** Area= 8.5 sf Perim= 17.2' r= 0.49' n= 0.011 |
| 0.1 | 129 | 0.0466 | 29.0 | 985.72 | **Channel Flow, E to F** Area= 34.0 sf Perim= 34.3' r= 0.99' n= 0.011 |
| 1.6 | 629 | Total | | | |

## Subcatchment 1S: Subarea 1



## Subcatchment 2S: Subarea #2

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

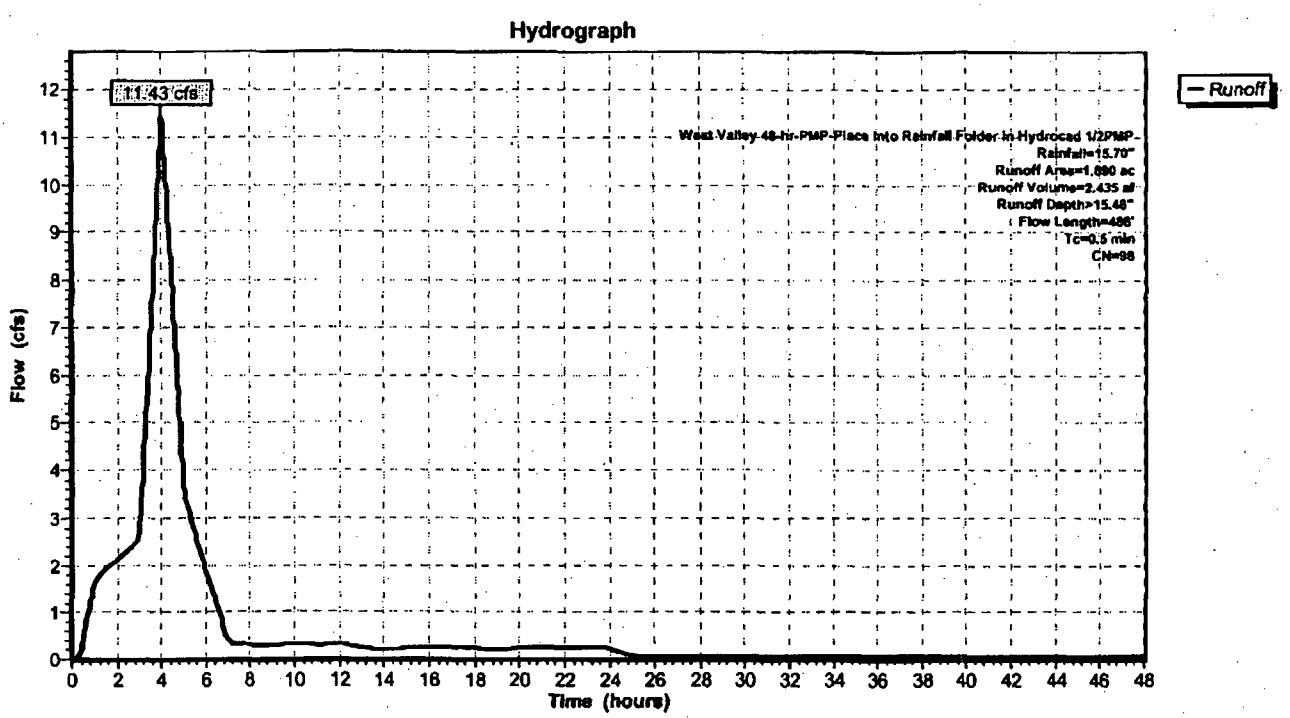
Runoff = 11.43 cfs @ 4.01 hrs, Volume= 2.435 af, Depth>15.46"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
West Valley 48-hr-PMP-Place into Rainfall Folder in Hydrocad 1/2PMP Rainfall=15.70"

| Area (ac) | CN | Description |
|---|---|---|
| 1.890 | 98 | South Side of Cap |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 0.0 | 2 | 0.1250 | 1.2 | | **Sheet Flow, A to B** Smooth surfaces n= 0.011 P2= 2.50" |
| 0.2 | 102 | 0.0100 | 8.4 | 33.48 | **Channel Flow, B to C** Area= 4.0 sf Perim= 8.2' r= 0.49' n= 0.011 |
| 0.3 | 360 | 0.0250 | 20.9 | 334.82 | **Channel Flow, C to D** Area= 16.0 sf Perim= 16.5' r= 0.97' n= 0.011 |
| 0.0 | 22 | 0.0450 | 28.1 | 449.20 | **Channel Flow, D to E** Area= 16.0 sf Perim= 16.5' r= 0.97' n= 0.011 |
| 0.5 | 486 | Total | | | |

## Subcatchment 2S: Subarea #2



## Subcatchment 3s: Subarea 3

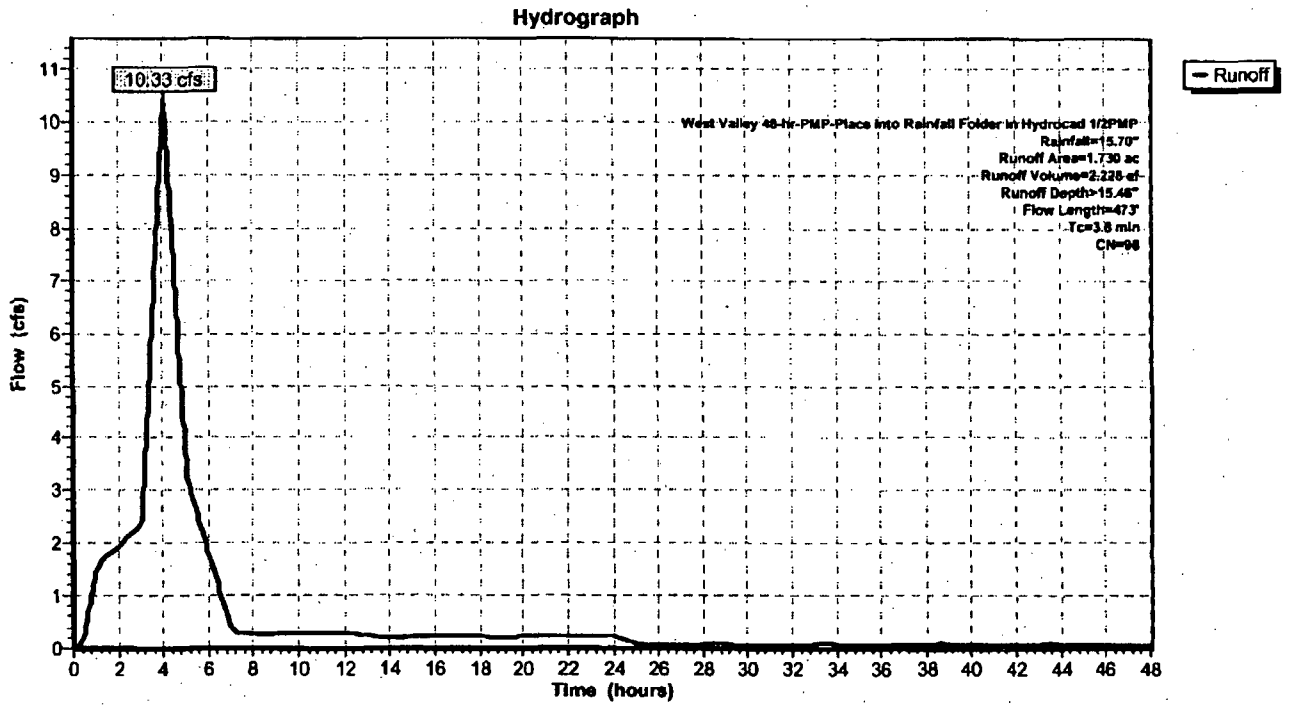
Runoff = 10.33 cfs @ 4.06 hrs, Volume= 2.228 af, Depth>15.46"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
West Valley 48-hr-PMP-Place into Rainfall Folder in Hydrocad 1/2PMP Rainfall=15.70"

| Area (ac) | CN | Description |
|---|---|---|
| 1.730 | 98 | North and East Sides of Cap |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 1.6 | 100 | 0.0130 | 1.0 | | **Sheet Flow, A to B**<br>Smooth surfaces n= 0.011 P2= 2.50" |
| 1.8 | 243 | 0.0120 | 2.2 | | **Shallow Concentrated Flow, B to C**<br>Paved Kv= 20.3 fps |
| 0.4 | 130 | 0.0850 | 5.9 | | **Shallow Concentrated Flow, C to D**<br>Paved Kv= 20.3 fps |
| 3.8 | 473 | Total | | | |

## Subcatchment 3s: Subarea 3



## Subcatchment 6S: Subarea 6

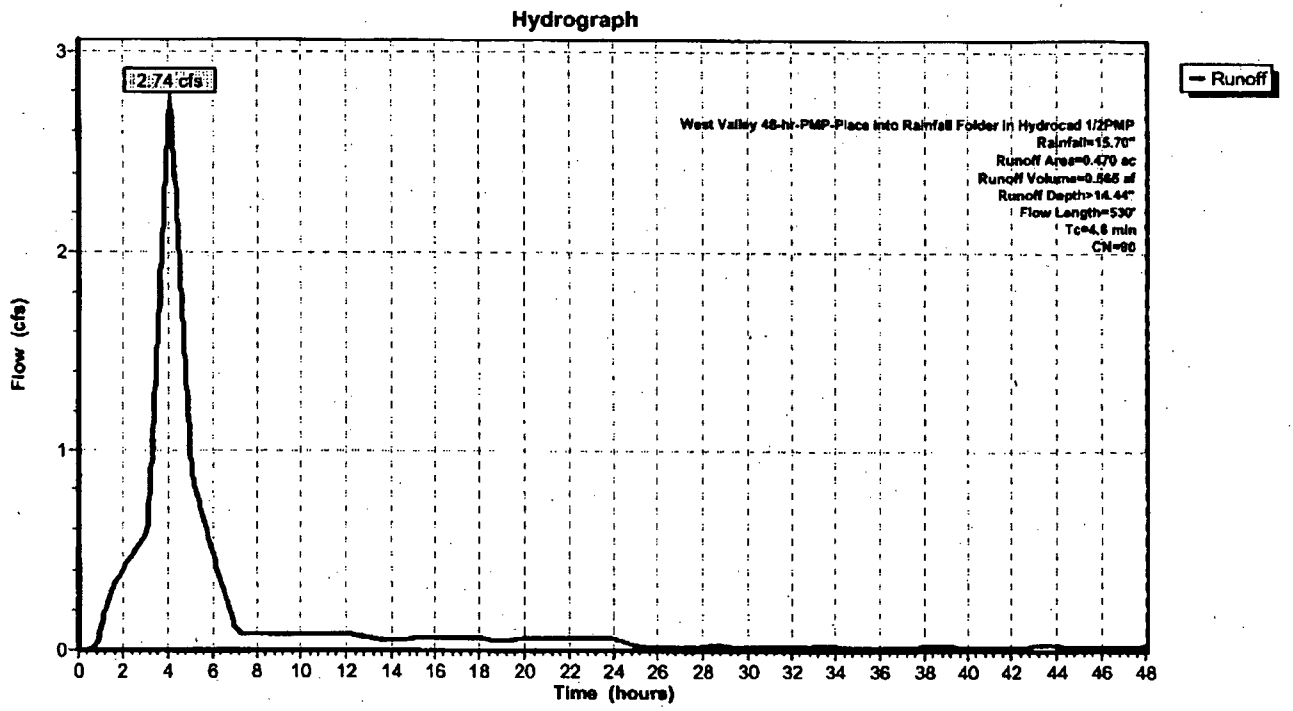
Runoff = 2.74 cfs @ 4.07 hrs, Volume= 0.565 af, Depth>14.44"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
West Valley 48-hr-PMP-Place into Rainfall Folder in Hydrocad 1/2PMP Rainfall=15.70"

| Area (ac) | CN | Description |
|---|---|---|
| 0.470 | 90 | South area along edge of cap |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 1.2 | 100 | 0.0260 | 1.4 | | **Sheet Flow, A to B**<br>Smooth surfaces n= 0.011 P2= 2.50" |
| 3.4 | 430 | 0.0170 | 2.1 | | **Shallow Concentrated Flow, B to C**<br>Unpaved Kv= 16.1 fps |
| 4.6 | 530 | Total | | | |

## Subcatchment 6S: Subarea 6



## Subcatchment 7S: Subarea 5

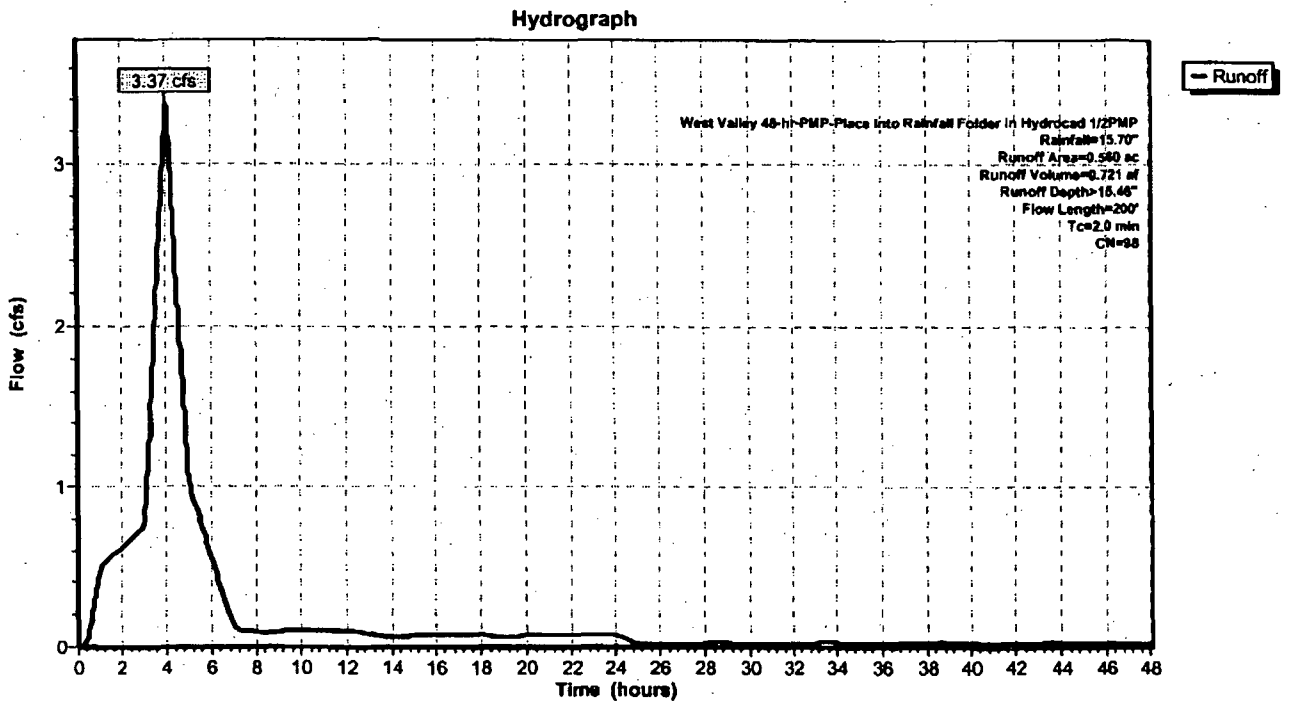
Runoff = 3.37 cfs @ 4.03 hrs, Volume= 0.721 af, Depth>15.46"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
West Valley 48-hr-PMP-Place into Rainfall Folder in Hydrocad 1/2PMP Rainfall=15.70"

| Area (ac) | CN | Description |
|---|---|---|
| 0.560 | 98 | Area draing from SDA |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 1.4 | 100 | 0.0200 | 1.2 | | **Sheet Flow, A to B** Smooth surfaces n= 0.011 P2= 2.50" |
| 0.6 | 100 | 0.0200 | 2.9 | | **Shallow Concentrated Flow, B to C** Paved Kv= 20.3 fps |
| 2.0 | 200 | Total | | | |

## Subcatchment 7S: Subarea 5



## Subcatchment 8S: Subarea 4

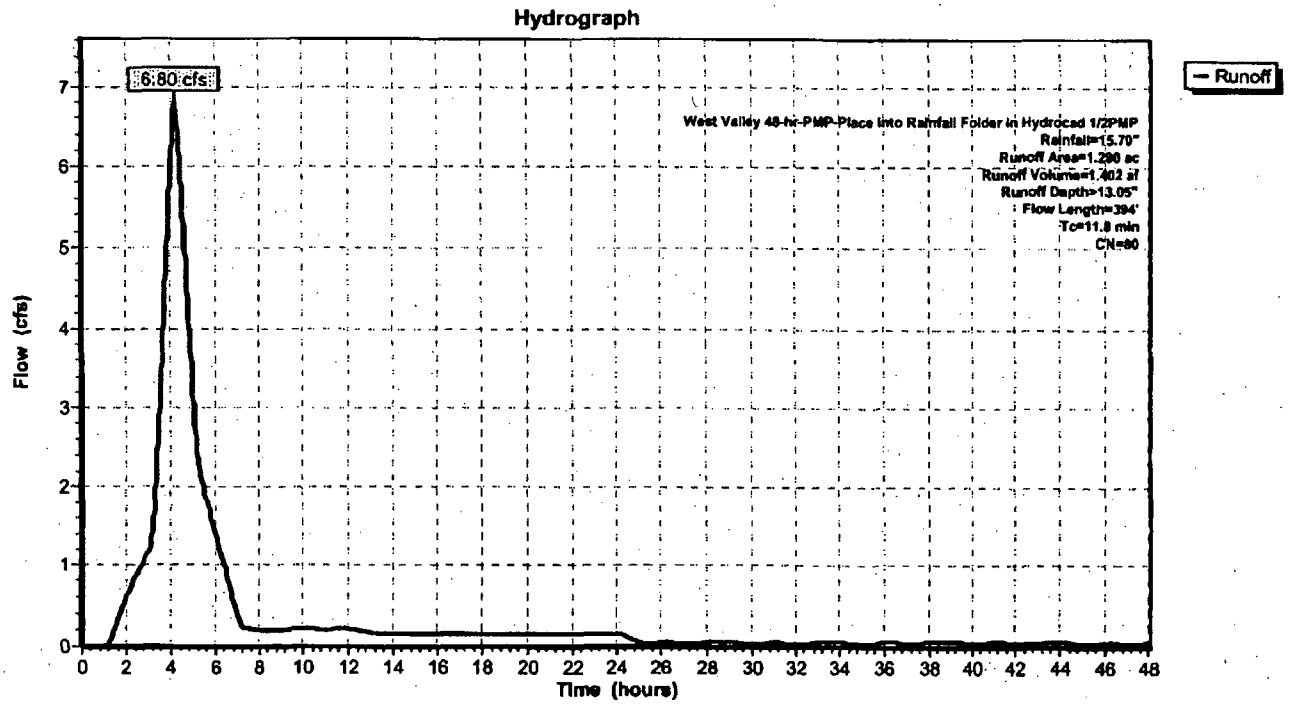
Runoff = 6.80 cfs @ 4.18 hrs, Volume= 1.402 af, Depth>13.05"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
West Valley 48-hr-PMP-Place into Rainfall Folder in Hydrocad 1/2PMP Rainfall=15.70"

| Area (ac) | CN | Description |
|---|---|---|
| 1.290 | 80 | South area draining to 12" pipe |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 10.1 | 100 | 0.0250 | 0.2 | | **Sheet Flow, A to B**<br>Grass: Short n= 0.150 P2= 2.50" |
| 1.7 | 294 | 0.0310 | 2.8 | | **Shallow Concentrated Flow, B to C**<br>Unpaved Kv= 16.1 fps |
| 11.8 | 394 | Total | | | |

## Subcatchment 8S: Subarea 4



## Subcatchment 9S: Subarea #7

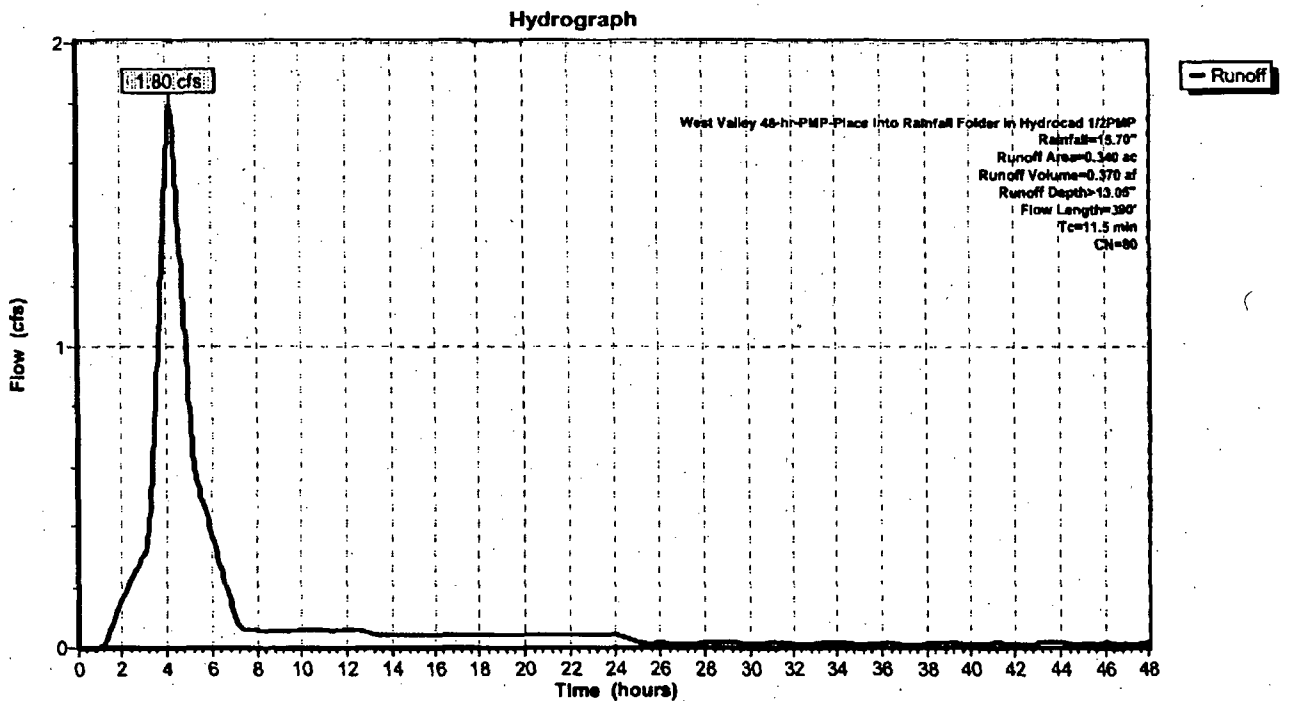
Runoff = 1.80 cfs @ 4.18 hrs, Volume= 0.370 af, Depth>13.05"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
West Valley 48-hr-PMP-Place into Rainfall Folder in Hydrocad 1/2PMP Rainfall=15.70"

| Area (ac) | CN | Description |
|---|---|---|
| 0.340 | 80 | Exterior east side of cap |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 11.1 | 100 | 0.0200 | 0.2 | | **Sheet Flow, A to B**<br>Grass: Short n= 0.150 P2= 2.50" |
| 0.4 | 290 | 0.0450 | 13.5 | 486.27 | **Channel Flow, B to C**<br>Area= 36.0 sf Perim= 24.7' r= 1.46' n= 0.030 |
| 11.5 | 390 | Total | | | |

## Subcatchment 9S: Subarea #7



## Subcatchment 12S: Subarea #8

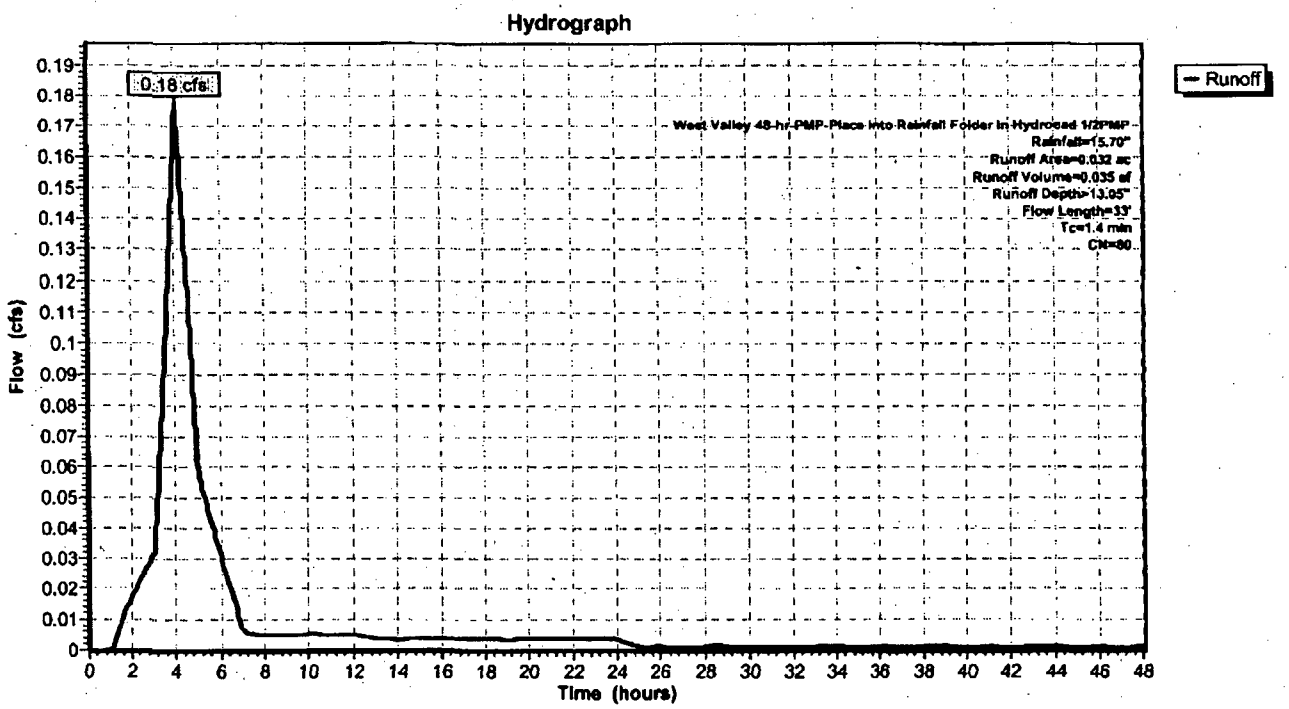
Runoff = 0.18 cfs @ 4.02 hrs, Volume= 0.035 af, Depth>13.05"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
West Valley 48-hr-PMP-Place into Rainfall Folder in Hydrocad 1/2PMP Rainfall=15.70"

| Area (ac) | CN | Description |
|---|---|---|
| 0.032 | 80 | Northside from 24" to Basin #3 outlet |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 1.4 | 33 | 0.3900 | 0.4 | | **Sheet Flow, A to B**<br>Grass: Short n= 0.150 P2= 2.50" |

## Subcatchment 12S: Subarea #8



## Subcatchment 13S: Subarea #9

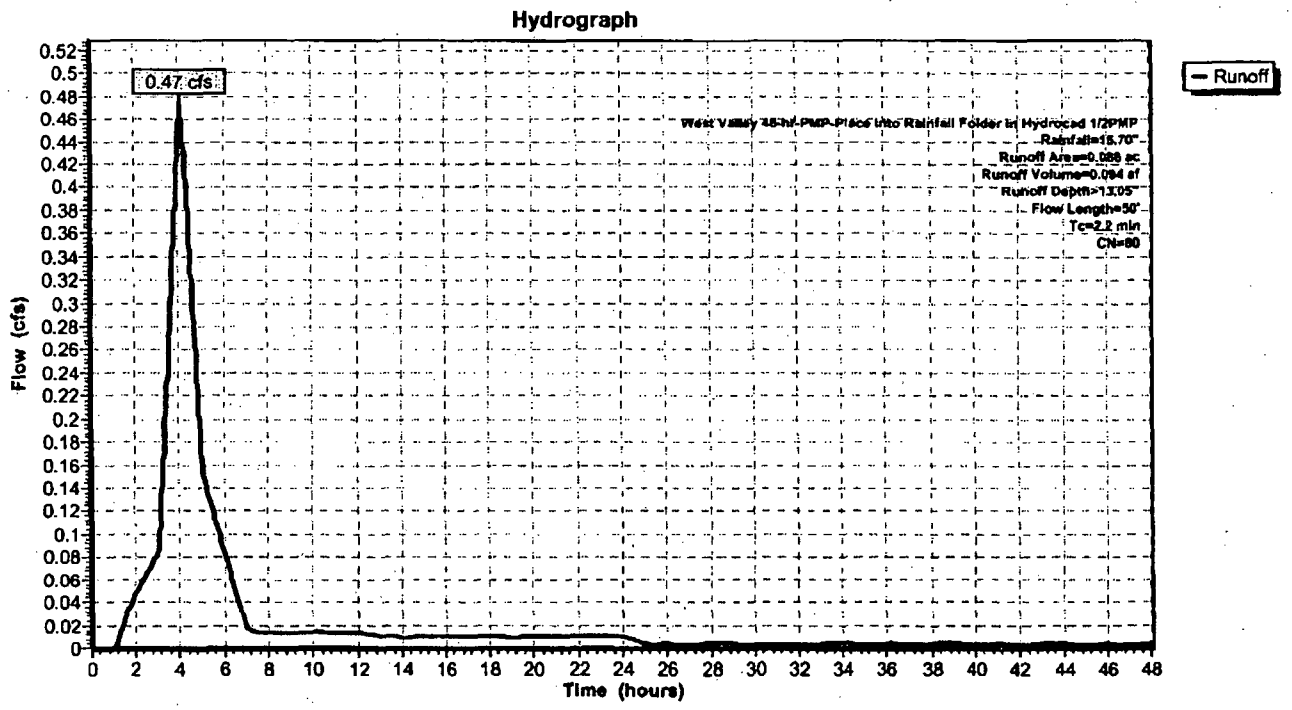
Runoff = 0.47 cfs @ 4.04 hrs, Volume= 0.094 af, Depth>13.05"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
West Valley 48-hr-PMP-Place into Rainfall Folder in Hydrocad 1/2PMP Rainfall=15.70"

| Area (ac) | CN | Description |
|---|---|---|
| 0.086 | 80 | Northside from Basin #3 outlet to final reach |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 2.2 | 50 | 0.2900 | 0.4 | | **Sheet Flow, A to B** Grass: Short n= 0.150 P2= 2.50" |

## Subcatchment 13S: Subarea #9



## Subcatchment 20S: Subarea #10

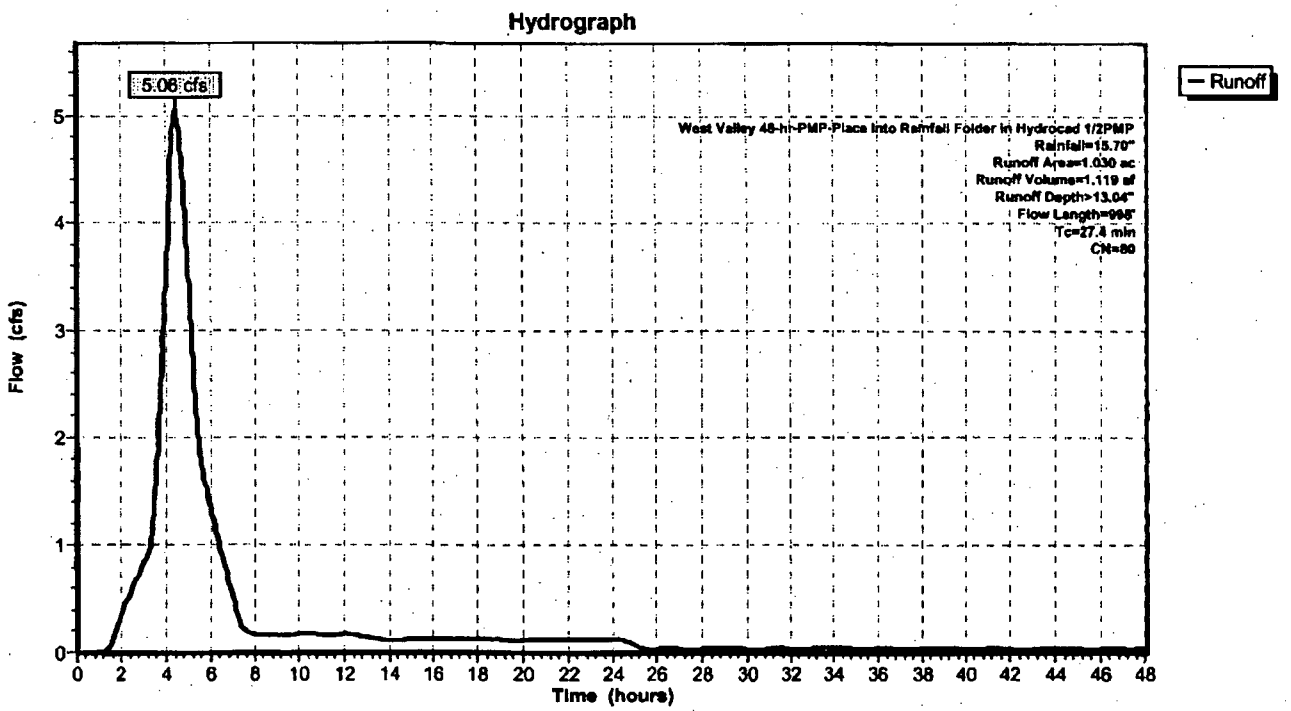
Runoff = 5.06 cfs @ 4.42 hrs, Volume= 1.119 af, Depth>13.04"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
West Valley 48-hr-PMP-Place into Rainfall Folder in Hydrocad 1/2PMP Rainfall=15.70"

| Area (ac) | CN | Description |
|---|---|---|
| 1.030 | 80 | Northside along edge of cap |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 17.9 | 100 | 0.0060 | 0.1 | | **Sheet Flow, A to B**<br>Grass: Short n= 0.150 P2= 2.50" |
| 7.9 | 417 | 0.0030 | 0.9 | | **Shallow Concentrated Flow, B to C**<br>Unpaved Kv= 16.1 fps |
| 1.4 | 260 | 0.0350 | 3.0 | | **Shallow Concentrated Flow, C to D**<br>Unpaved Kv= 16.1 fps |
| 0.2 | 221 | 0.1150 | 21.6 | 777.35 | **Channel Flow, D to E**<br>Area= 36.0 sf Perim= 24.7' r= 1.46' n= 0.030 |
| 27.4 | 998 | Total | | | |

## Subcatchment 20S: Subarea #10



## Reach 6R: Erdman Brook

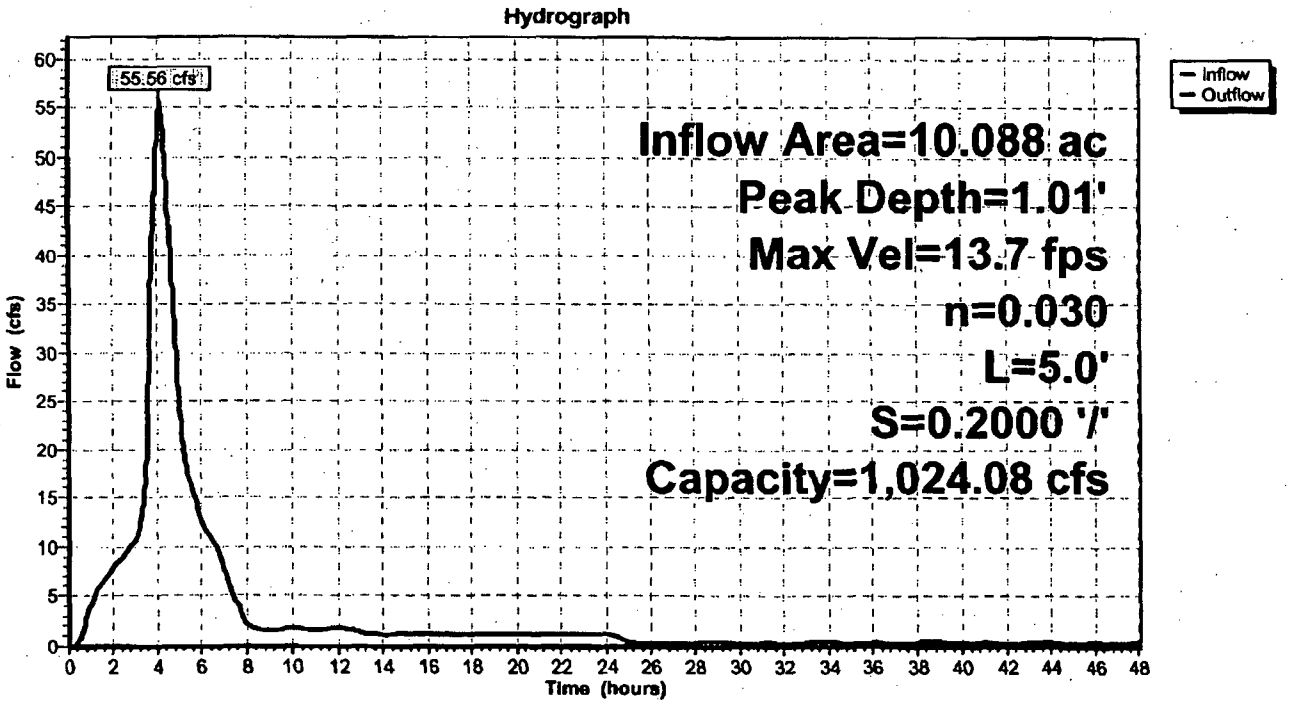
[61] Hint: Submerged 9% of Reach 15R bottom

| | | | | | |
|---|---|---|---|---|---|
| Inflow Area = | 10.088 ac, | Inflow Depth > 14.74" | for 1/2PMP event | | |
| Inflow = | 55.56 cfs @ | 4.11 hrs, Volume= | 12.392 af | | |
| Outflow = | 55.56 cfs @ | 4.11 hrs, Volume= | 12.392 af, | Atten= 0%, | Lag= 0.0 min |

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Max. Velocity= 13.7 fps, Min. Travel Time= 0.0 min
Avg. Velocity = 5.4 fps, Avg. Travel Time= 0.0 min

Peak Depth= 1.01' @ 4.11 hrs
Capacity at bank full= 1,024.08 cfs
Inlet Invert= 1,353.50', Outlet Invert= 1,352.50'
0.00' x 3.00' deep channel, n= 0.030
Side Slope Z-value= 4.0 '/' Top Width= 24.00'
Length= 5.0' Slope= 0.2000 '/'

## Reach 6R: Erdman Brook



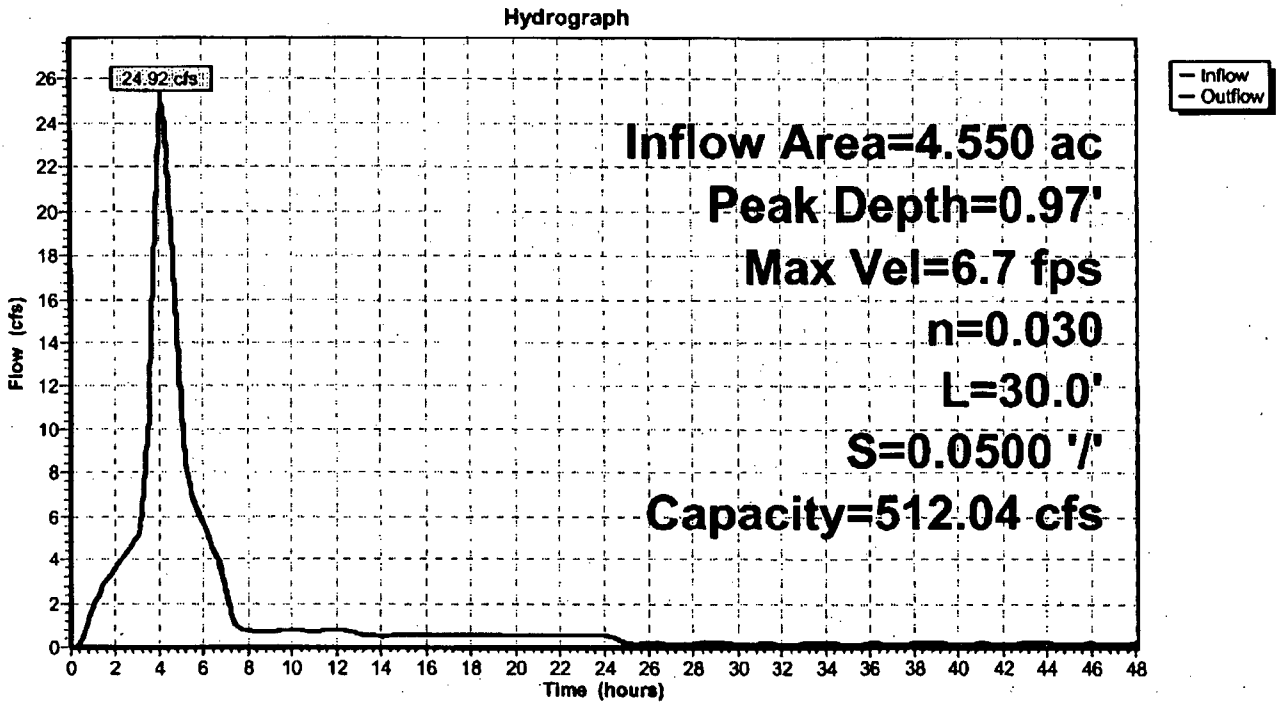
## Reach 14R: Reach #1

Inflow Area = 4.550 ac, Inflow Depth > 14.48" for 1/2PMP event
Inflow = 24.92 cfs @ 4.13 hrs, Volume= 5.492 af
Outflow = 24.92 cfs @ 4.13 hrs, Volume= 5.492 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Max. Velocity= 6.7 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 2.6 fps, Avg. Travel Time= 0.2 min

Peak Depth= 0.97' @ 4.13 hrs
Capacity at bank full= 512.04 cfs
Inlet Invert= 1,366.00', Outlet Invert= 1,364.50'
0.00' x 3.00' deep channel, n= 0.030
Side Slope Z-value= 4.0 '/' Top Width= 24.00'
Length= 30.0' Slope= 0.0500 '/'

## Reach 14R: Reach #1



## Reach 15R: Reach #2

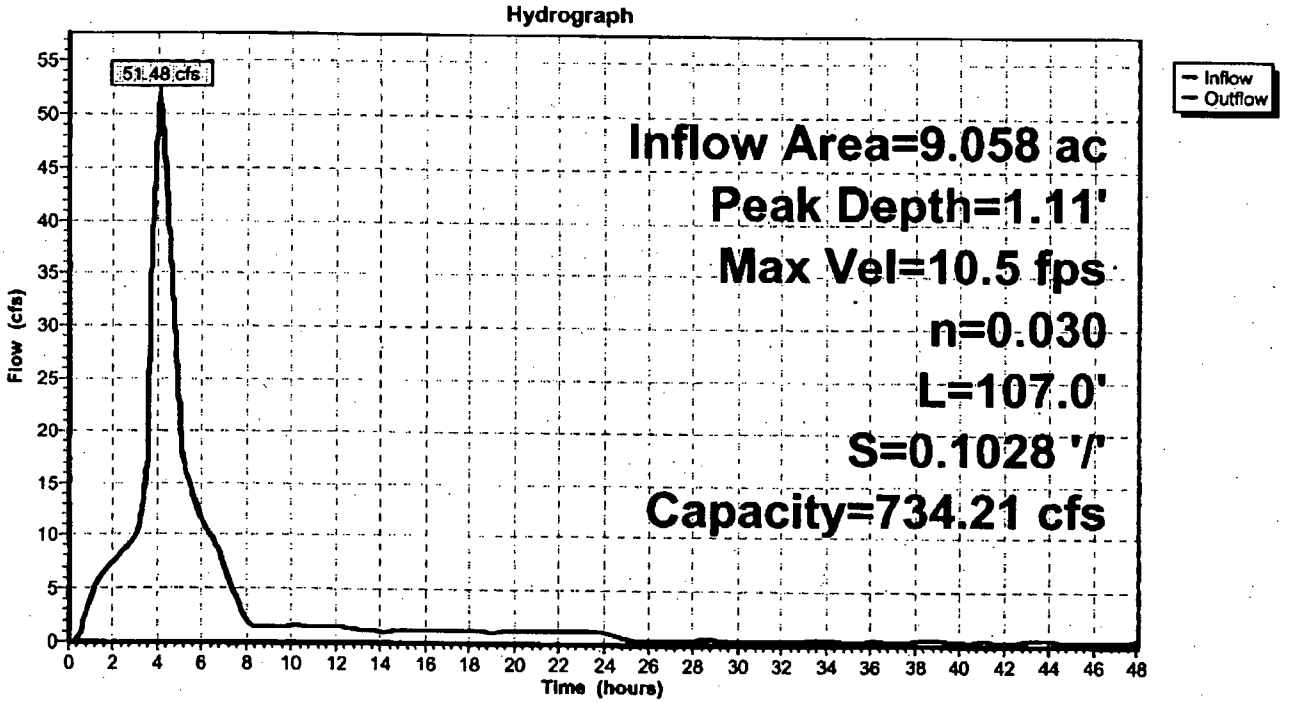
[90] Warning: Qout>Qin may require Finer Routing or smaller dt
[61] Hint: Submerged 74% of Reach 14R bottom

Inflow Area = 9.058 ac, Inflow Depth > 14.93" for 1/2PMP event
Inflow = 51.48 cfs @ 4.09 hrs, Volume= 11.273 af
Outflow = 51.48 cfs @ 4.09 hrs, Volume= 11.273 af, Atten= 0%, Lag= 0.1 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Max. Velocity= 10.5 fps, Min. Travel Time= 0.2 min
Avg. Velocity = 4.1 fps, Avg. Travel Time= 0.4 min

Peak Depth= 1.11' @ 4.09 hrs
Capacity at bank full= 734.21 cfs
Inlet Invert= 1,364.50', Outlet Invert= 1,353.50'
0.00' x 3.00' deep channel, n= 0.030
Side Slope Z-value= 4.0 '/' Top Width= 24.00'
Length= 107.0' Slope= 0.1028 '/'

## Reach 15R: Reach #2



## Pond 3P: Basin #1

| | | | | | |
|---|---|---|---|---|---|
| Inflow Area = | 2.660 ac, | Inflow Depth > 15.46" | for 1/2PMP event | | |
| Inflow = | 16.03 cfs @ | 4.02 hrs, | Volume= | 3.426 af | |
| Outflow = | 15.75 cfs @ | 4.06 hrs, | Volume= | 3.426 af, | Atten= 2%, Lag= 2.1 min |
| Primary = | 15.75 cfs @ | 4.06 hrs, | Volume= | 3.426 af | |
| Secondary = | 0.00 cfs @ | 0.00 hrs, | Volume= | 0.000 af | |

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Peak Elev= 1,380.02' @ 4.06 hrs Surf.Area= 0 sf Storage= 1,184 cf
Plug-Flow detention time= 1.2 min calculated for 3.425 af (100% of inflow)
Center-of-Mass det. time= 1.1 min ( 458.6 - 457.5 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 1,379.00' | 8,415 cf | **Custom Stage Data** Listed below |

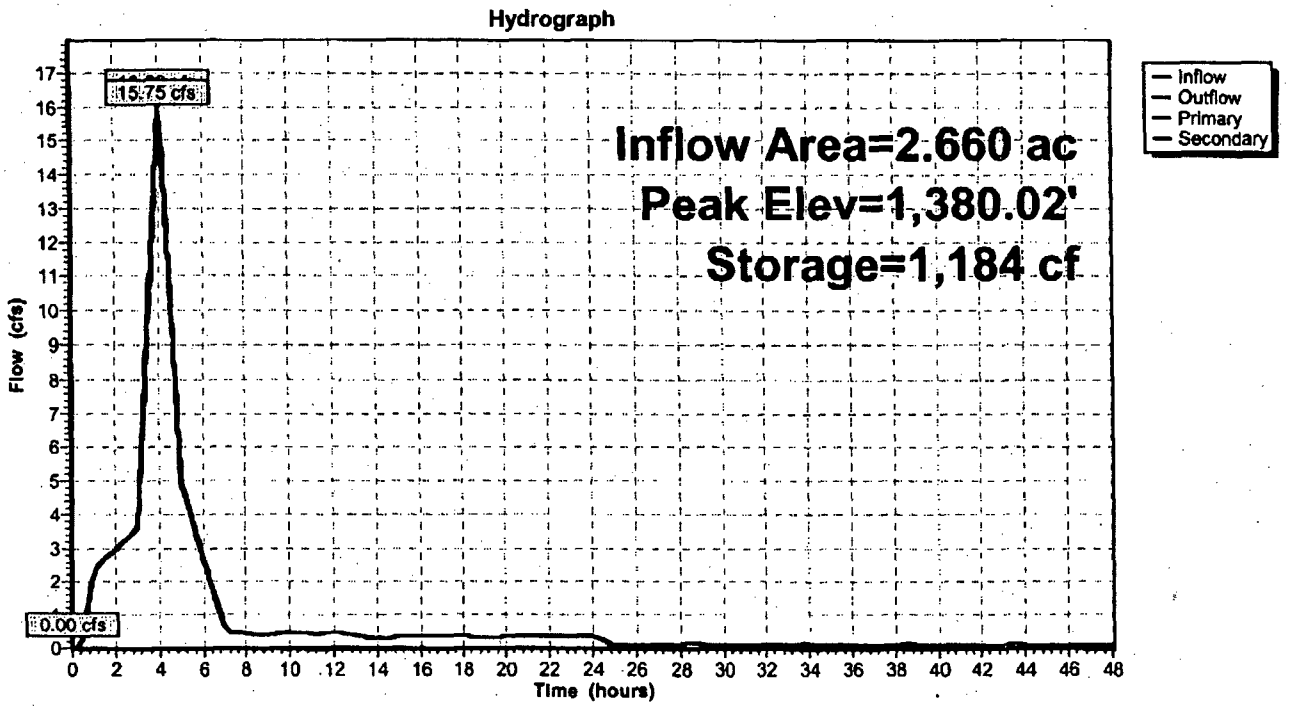
| Elevation (feet) | Inc.Store (cubic-feet) | Cum.Store (cubic-feet) |
|---|---|---|
| 1,379.00 | 0 | 0 |
| 1,380.00 | 1,145 | 1,145 |
| 1,381.00 | 2,569 | 3,714 |
| 1,382.00 | 4,701 | 8,415 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 0.00' | **Special & User-Defined**<br>Elev. (feet) 1,379.00 1,380.00 1,381.00 1,382.00<br>Disch. (cfs) 0.000 15.680 20.250 23.960 |
| #2 | Secondary | 1,381.00' | **46.0' long x 15.0' breadth Broad-Crested Rectangular Weir X 0.00**<br>Head (feet) 0.20 0.40 0.60 0.80 1.00<br>Coef. (English) 2.68 2.70 2.70 2.64 2.63 |

**Primary OutFlow** Max=15.75 cfs @ 4.06 hrs HW=1,380.02' TW=1,379.09' (Dynamic Tailwater)
└─**1=Special & User-Defined** (Custom Controls 15.75 cfs)

**Secondary OutFlow** Max=0.00 cfs @ 0.00 hrs HW=1,379.00' TW=1,376.00' (Dynamic Tailwater)
└─**2=Broad-Crested Rectangular Weir** ( Controls 0.00 cfs)

## Pond 3P: Basin #1



## Pond 4P: Basin #2

| | | | | | |
|---|---|---|---|---|---|
| Inflow Area = | 1.890 ac, | Inflow Depth > 15.46" | for 1/2PMP event | | |
| Inflow = | 11.43 cfs @ | 4.01 hrs, | Volume= | 2.435 af | |
| Outflow = | 10.63 cfs @ | 4.11 hrs, | Volume= | 2.434 af, | Atten= 7%, Lag= 6.3 min |
| Primary = | 10.62 cfs @ | 4.11 hrs, | Volume= | 2.433 af | |
| Secondary = | 0.02 cfs @ | 4.11 hrs, | Volume= | 0.001 af | |

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Peak Elev= 1,380.26' @ 4.11 hrs Surf.Area= 0 sf Storage= 11,013 cf
Plug-Flow detention time= 19.3 min calculated for 2.433 af (100% of inflow)
Center-of-Mass det. time= 18.5 min ( 475.1 - 456.6 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 1,377.00' | 18,146 cf | **Custom Stage Data** Listed below |

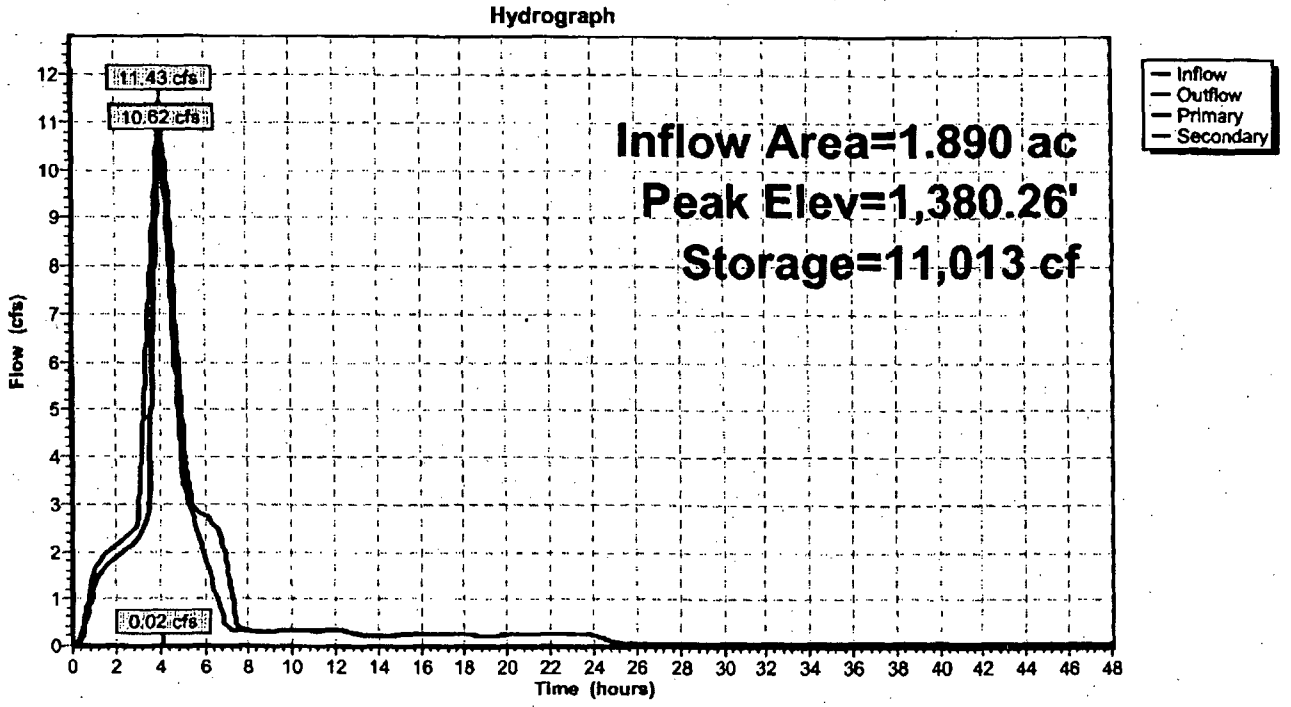
| Elevation (feet) | Inc.Store (cubic-feet) | Cum.Store (cubic-feet) |
|---|---|---|
| 1,377.00 | 0 | 0 |
| 1,378.00 | 1,300 | 1,300 |
| 1,379.00 | 1,993 | 3,293 |
| 1,380.00 | 5,263 | 8,556 |
| 1,381.00 | 9,590 | 18,146 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 0.00' | **Special & User-Defined**<br>Elev. (feet) 1,377.00 1,377.25 1,377.50 1,377.75 1,378.00 1,378.25 1,378.50 1,378.75 1,379.00 1,379.25 1,379.50 1,379.75 1,380.00 1,380.25 1,380.50 1,380.75 1,381.00<br>Disch. (cfs) 0.000 0.860 1.220 1.490 1.720 1.920 2.110 2.270 2.430 2.580 2.720 2.850 5.560 10.470 16.310 18.450 20.340 |
| #2 | Secondary | 1,380.00' | **20.0 deg Sharp-Crested Vee/Trap Weir** C= 2.69 1.00' Rise |

**Primary OutFlow** Max=10.61 cfs @ 4.11 hrs HW=1,380.26' TW=1,380.14' (Dynamic Tailwater)
└**1=Special & User-Defined** (Custom Controls 10.61 cfs)

**Secondary OutFlow** Max=0.02 cfs @ 4.11 hrs HW=1,380.26' TW=1,379.09' (Dynamic Tailwater)
└**2=Sharp-Crested Vee/Trap Weir** (Weir Controls 0.02 cfs @ 1.4 fps)

## Pond 4P: Basin #2



## Pond 5P: Basin #3

[78] Warning: Submerged Pond 3P Primary device # 1 by 0.09'

| | | | | | |
|---|---|---|---|---|---|
| Inflow Area = | 4.390 ac, | Inflow Depth > 15.46" | for 1/2PMP event | | |
| Inflow = | 26.10 cfs @ | 4.06 hrs, | Volume= | 5.655 af | |
| Outflow = | 26.06 cfs @ | 4.07 hrs, | Volume= | 5.653 af, | Atten= 0%, Lag= 0.9 min |
| Primary = | 10.11 cfs @ | 4.07 hrs, | Volume= | 4.530 af | |
| Secondary = | 15.95 cfs @ | 4.07 hrs, | Volume= | 1.123 af | |

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Peak Elev= 1,379.09' @ 4.07 hrs Surf.Area= 0 sf Storage= 22,485 cf
Plug-Flow detention time= 22.8 min calculated for 5.653 af (100% of inflow)
Center-of-Mass det. time= 22.1 min ( 480.9 - 458.8 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 1,376.00' | 36,844 cf | **Custom Stage Data** Listed below |

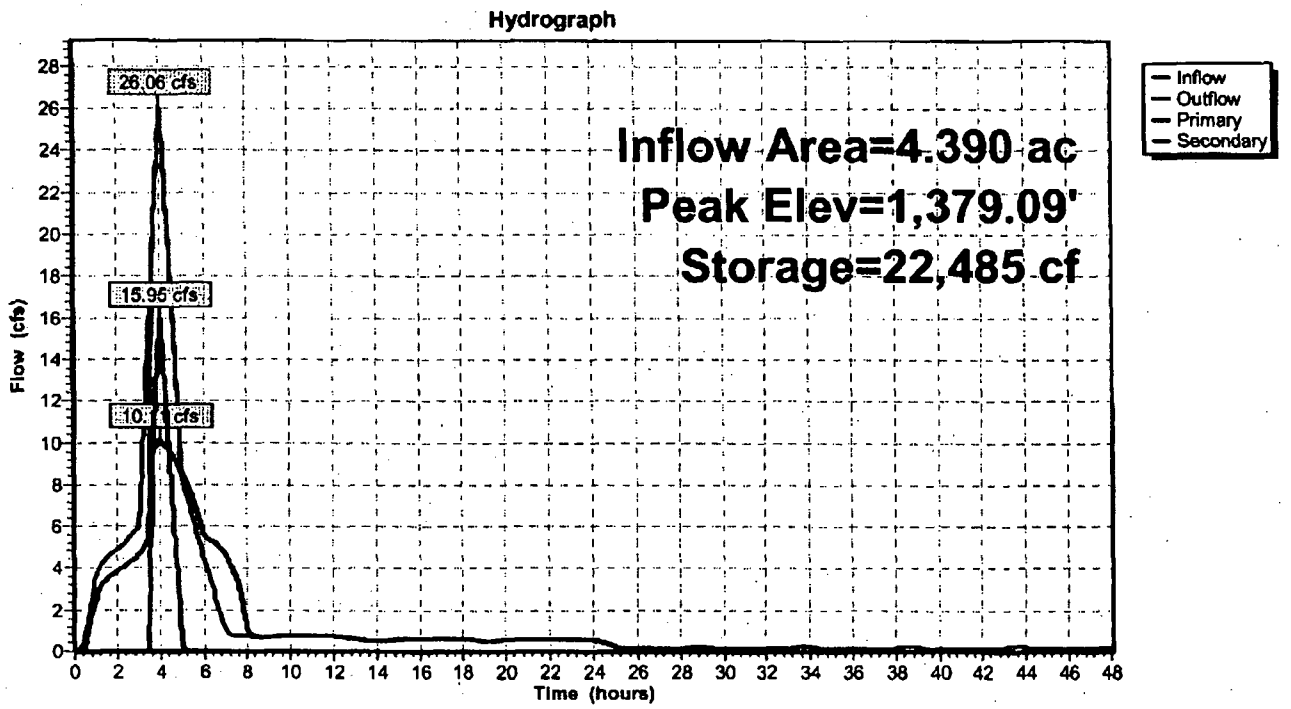
| Elevation (feet) | Inc.Store (cubic-feet) | Cum.Store (cubic-feet) |
|---|---|---|
| 1,376.00 | 0 | 0 |
| 1,377.00 | 2,549 | 2,549 |
| 1,378.00 | 6,932 | 9,481 |
| 1,379.00 | 11,622 | 21,103 |
| 1,380.00 | 15,741 | 36,844 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 0.00' | **Special & User-Defined**<br>Elev. (feet) 1,376.00 1,376.25 1,376.50 1,376.75 1,377.00 1,377.25 1,377.50 1,377.75 1,378.00 1,378.25 1,378.50 1,378.75 1,379.00 1,379.25 1,379.50 1,379.75 1,380.00<br>Disch. (cfs) 0.000 1.660 2.340 2.870 3.310 3.700 4.050 4.380 4.680 4.970 5.230 5.490 8.330 13.390 19.290 21.530 23.530 |
| #2 | Secondary | 1,379.00' | **262.0' long x 5.0' breadth Broad-Crested Rectangular Weir**<br>Head (feet) 0.20 0.40 0.60 0.80 1.00<br>Coef. (English) 2.34 2.50 2.70 2.68 2.68 |

**Primary OutFlow** Max=10.11 cfs @ 4.07 hrs HW=1,379.09' TW=1,365.61' (Dynamic Tailwater)
└─**1=Special & User-Defined** (Custom Controls 10.11 cfs)

**Secondary OutFlow** Max=15.95 cfs @ 4.07 hrs HW=1,379.09' TW=1,365.61' (Dynamic Tailwater)
└─**2=Broad-Crested Rectangular Weir** (Weir Controls 15.95 cfs @ 0.7 fps)

## Pond 5P: Basin #3



## Pond 16P: 18"

[57] Hint: Peaked at 1,383.63' (Flood elevation advised)

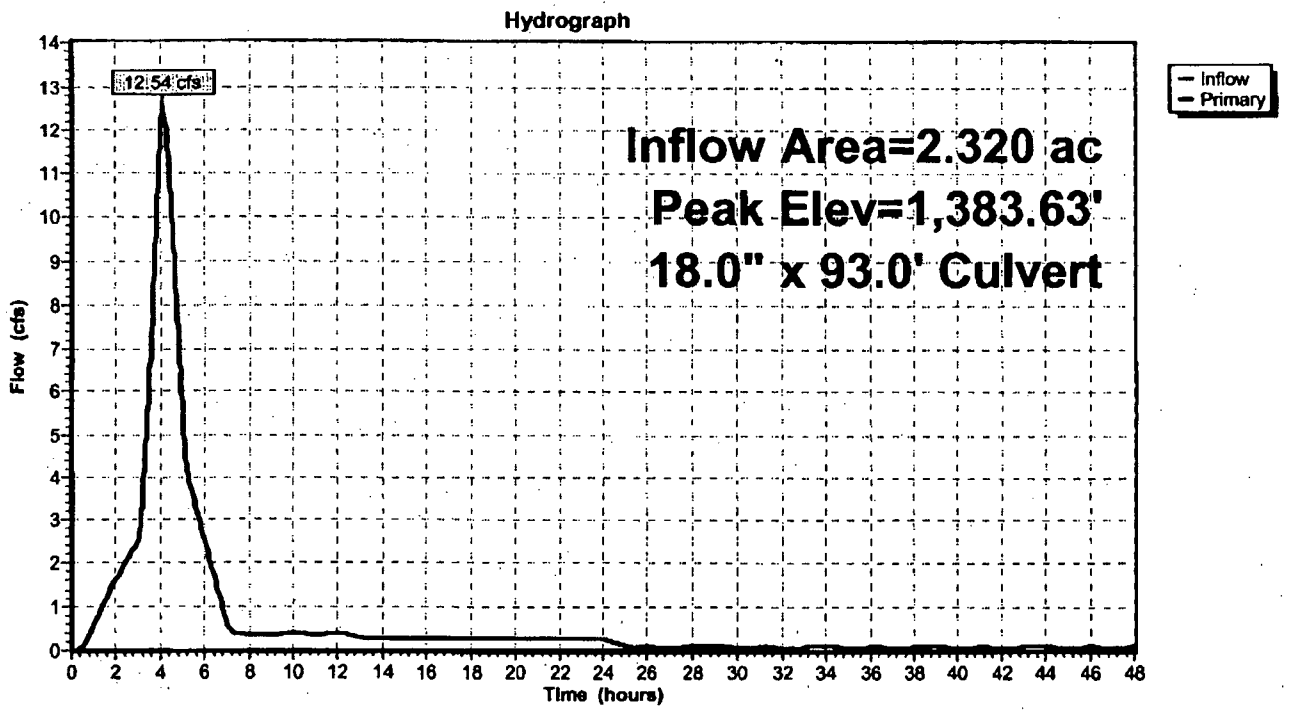
| | | | | | |
|---|---|---|---|---|---|
| Inflow Area = | 2.320 ac, | Inflow Depth > 13.91" | for 1/2PMP event | | |
| Inflow = | 12.54 cfs @ | 4.13 hrs, | Volume= | 2.689 af | |
| Outflow = | 12.54 cfs @ | 4.13 hrs, | Volume= | 2.689 af, | Atten= 0%, Lag= 0.0 min |
| Primary = | 12.54 cfs @ | 4.13 hrs, | Volume= | 2.689 af | |

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Peak Elev= 1,383.63' @ 4.13 hrs
Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= (not calculated: outflow precedes inflow)

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 1,378.00' | **18.0" x 93.0' long Culvert** CMP, projecting, no headwall, Ke= 0.900<br>Outlet Invert= 1,375.50' S= 0.0269 '/' Cc= 0.900<br>n= 0.013 Corrugated PE, smooth interior |

**Primary OutFlow** Max=12.54 cfs @ 4.13 hrs HW=1,383.63' TW=1,380.14' (Dynamic Tailwater)
└**1=Culvert** (Inlet Controls 12.54 cfs @ 7.1 fps)

## Pond 16P: 18"



## Pond 17P: Existing 24" Pipe

[57] Hint: Peaked at 1,380.14' (Flood elevation advised)
[78] Warning: Submerged Pond 4P Primary device # 1 by 3.14'

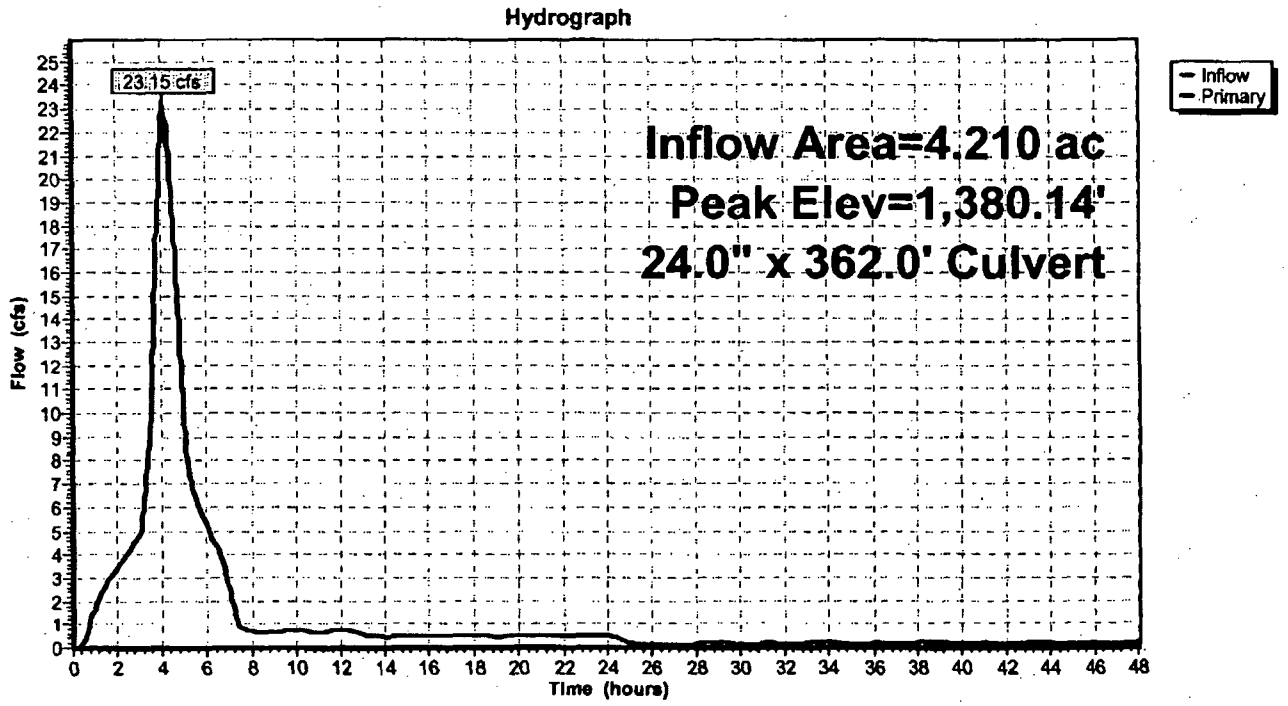
| | | | | | |
|---|---|---|---|---|---|
| Inflow Area = | 4.210 ac, | Inflow Depth > 14.60" | for 1/2PMP event | | |
| Inflow = | 23.15 cfs @ | 4.12 hrs, | Volume= | 5.122 af | |
| Outflow = | 23.15 cfs @ | 4.12 hrs, | Volume= | 5.122 af, | Atten= 0%, Lag= 0.0 min |
| Primary = | 23.15 cfs @ | 4.12 hrs, | Volume= | 5.122 af | |

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Peak Elev= 1,380.14' @ 4.12 hrs
Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= (not calculated: outflow precedes inflow)

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 1,375.38' | **24.0" x 362.0' long Culvert** CMP, projecting, no headwall, Ke= 0.900<br>Outlet Invert= 1,366.00' S= 0.0259 '/' Cc= 0.900<br>n= 0.013 Corrugated PE, smooth interior |

**Primary OutFlow** Max=23.15 cfs @ 4.12 hrs HW=1,380.14' TW=1,366.97' (Dynamic Tailwater)
└─**1=Culvert** (Inlet Controls 23.15 cfs @ 7.4 fps)

## Pond 17P: Existing 24" Pipe



## Pond 18P: 12"

[57] Hint: Peaked at 1,390.74' (Flood elevation advised)

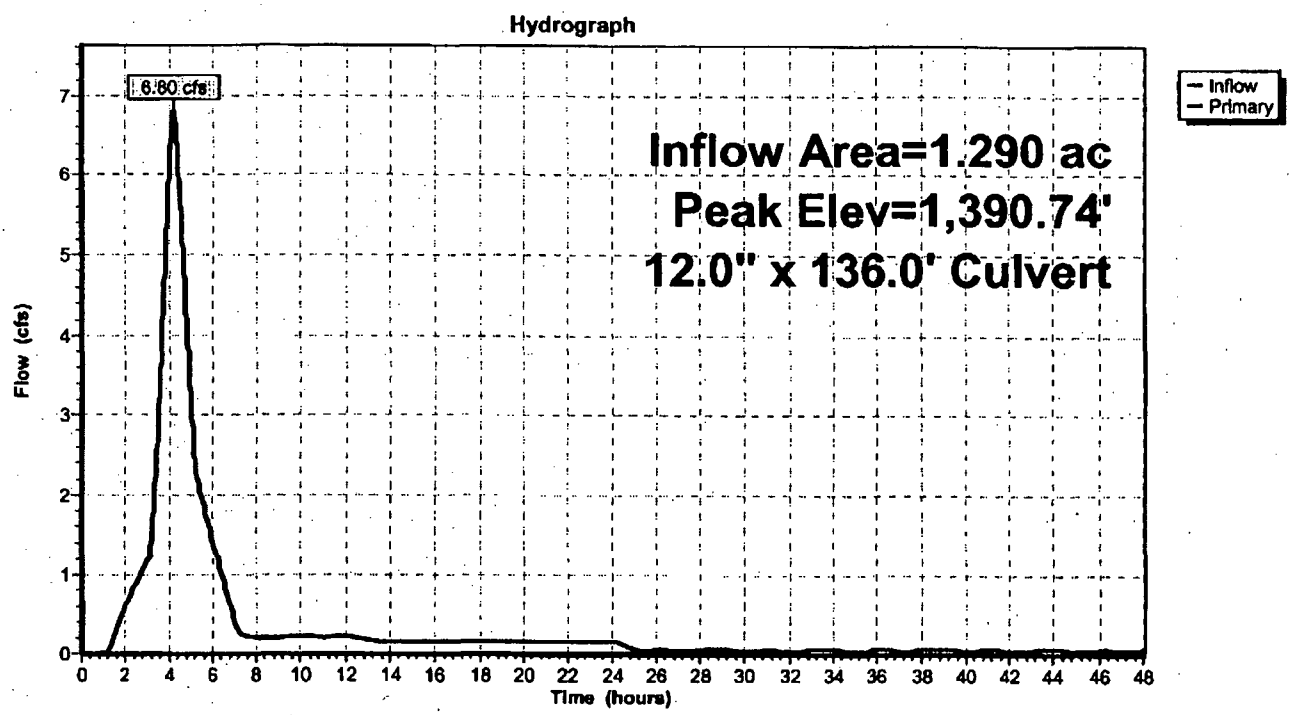
| | | | | | |
|---|---|---|---|---|---|
| Inflow Area = | 1.290 ac, | Inflow Depth > 13.05" | for 1/2PMP event | | |
| Inflow = | 6.80 cfs @ | 4.18 hrs, | Volume= | 1.402 af | |
| Outflow = | 6.80 cfs @ | 4.18 hrs, | Volume= | 1.402 af, | Atten= 0%, Lag= 0.0 min |
| Primary = | 6.80 cfs @ | 4.18 hrs, | Volume= | 1.402 af | |

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Peak Elev= 1,390.74' @ 4.16 hrs
Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 0.0 min ( 515.8 - 515.8 )

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 1,379.50' | **12.0" x 136.0' long Culvert** CMP, projecting, no headwall, Ke= 0.900<br>Outlet Invert= 1,378.82' S= 0.0050 '/' Cc= 0.900<br>n= 0.013 Corrugated PE, smooth interior |

**Primary OutFlow** Max=6.82 cfs @ 4.18 hrs HW=1,390.71' TW=1,383.49' (Dynamic Tailwater)
└─**1=Culvert** (Outlet Controls 6.82 cfs @ 8.7 fps)

## Pond 18P: 12"



## Pond 19P: 18"

[57] Hint: Peaked at 1,383.85' (Flood elevation advised)

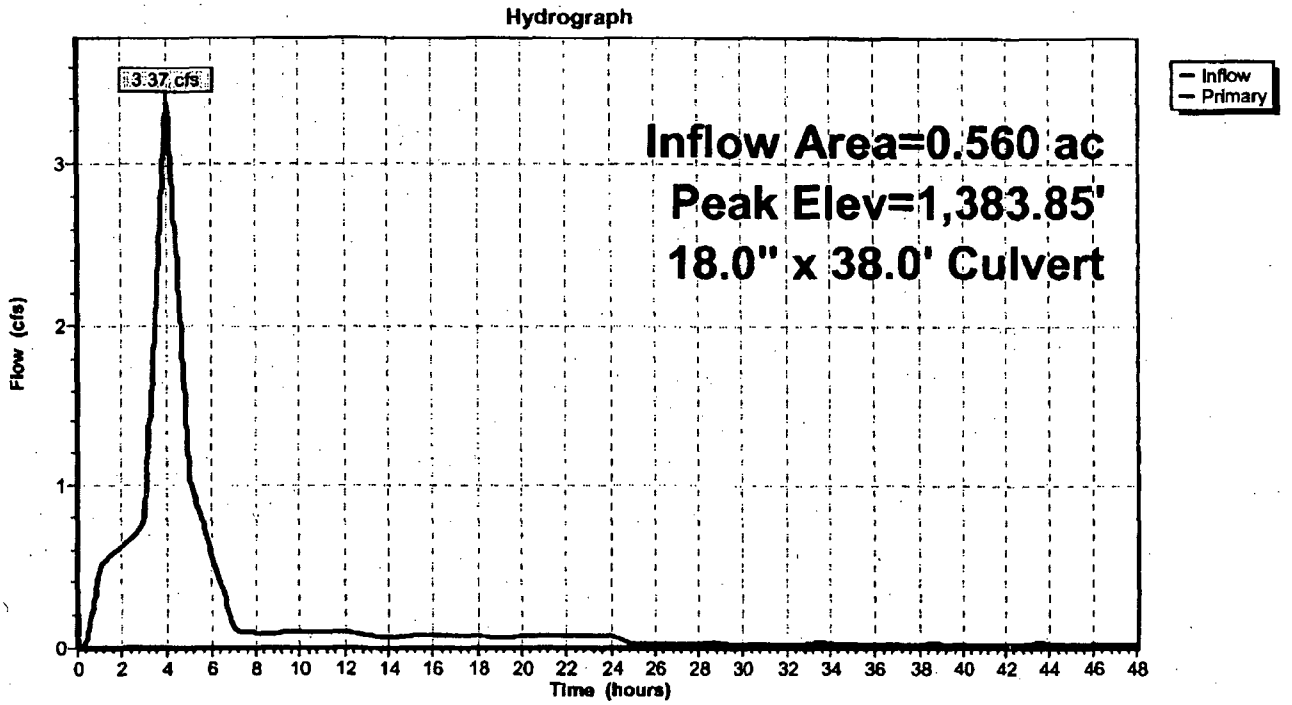
| | | | | | |
|---|---|---|---|---|---|
| Inflow Area = | 0.560 ac, | Inflow Depth > 15.46" | for 1/2PMP event | | |
| Inflow = | 3.37 cfs @ | 4.03 hrs, | Volume= | 0.721 af | |
| Outflow = | 3.37 cfs @ | 4.03 hrs, | Volume= | 0.721 af, | Atten= 0%, Lag= 0.0 min |
| Primary = | 3.37 cfs @ | 4.03 hrs, | Volume= | 0.721 af | |

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Peak Elev= 1,383.85' @ 4.13 hrs
Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= (not calculated: outflow precedes inflow)

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 1,378.50' | **18.0" x 38.0' long Culvert** CMP, projecting, no headwall, Ke= 0.900<br>Outlet Invert= 1,378.00' S= 0.0132 '/' Cc= 0.900<br>n= 0.025 Corrugated metal |

**Primary OutFlow** Max=2.51 cfs @ 4.03 hrs HW=1,383.34' TW=1,383.20' (Dynamic Tailwater)
└─**1=Culvert** (Outlet Controls 2.51 cfs @ 1.4 fps)

## Pond 19P: 18"



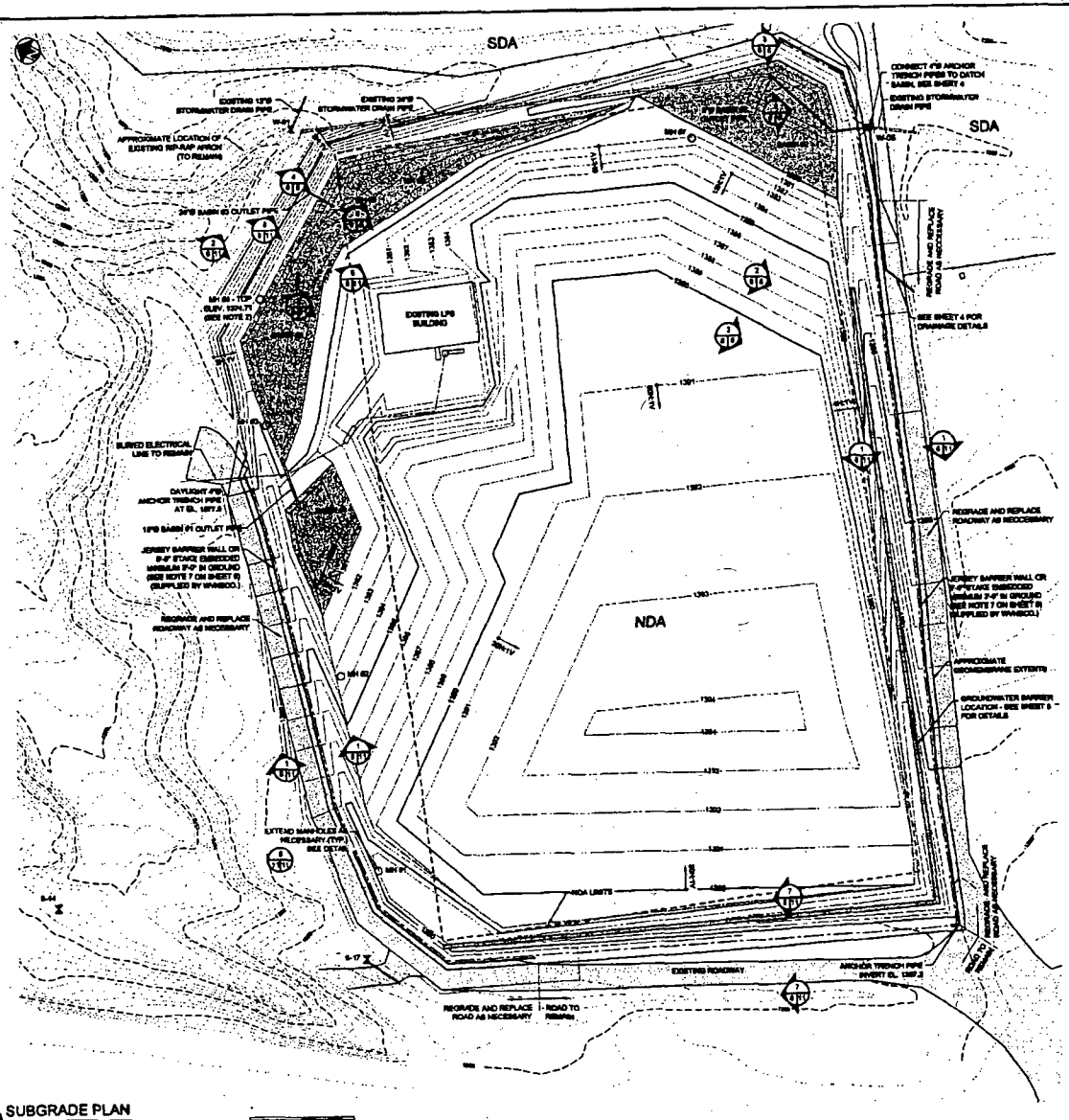
# ATTACHMENT D

## Design Plans, Figures from the SWPPP and

## Sketches of Additional Riprap Protection

# ATTACHMENT D-1

## Design Plan Sheet 8



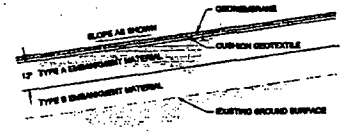

1 8|8 SUBGRADE PLAN
SCALE: 1" = 40'

## LEGEND

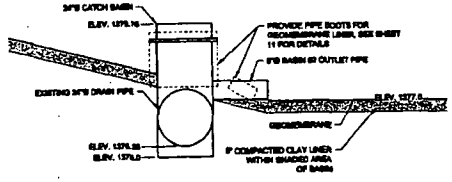
- EXISTING GROUND CONTOURS
- NDA LIMITS
- GEOMEMBRANE EXTENTS
- DRAINAGE SWALE
- JERSEY BARRIER WALL
- EXISTING MANHOLE LOCATION AND DESIGNATION (SEE NOTE 2)
- GROUNDWATER BARRIER
- EXISTING FENCE LINE
- EXISTING BUILDING
- STORMWATER OUTFALL LOCATION AND DESIGNATION

Notes:

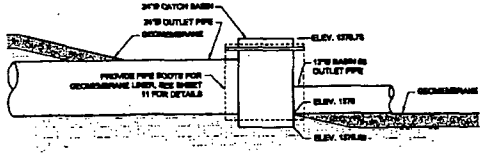
1. Base map adapted from a combination of drawings provided by West Valley Nuclear Services Co., Inc. titled "NYCP Site Map West Lowlands", Dwg. No. 920-D-5020 Rev A dated May 28, 1992 and "NDA Topographic Plot", Sketch # [illegible] Rev A dated February 18, 2007.
2. Locations and elevations of perimeter leachate trench pipe and manholes based on "Batavia Central Project Leachate Trench HPC Limited Disposal Area", drawing numbers [illegible] through [illegible] by Dames & Moore, dated January 28, 1993.




2 8|8 TYPICAL CAP SECTION
SCALE: N.T.S.




3 8|8 BASIN #2 OUTLET PIPE
SCALE: N.T.S.




4 8|8 BASIN #3 OUTLET PIPE
SCALE: N.T.S.

## CULVERT TABLE

| BASIN # | OUTLET PIPE SIZE (IN) | INLET INV. ELEVATION | OUTLET INV. ELEVATION | PIPE LENGTH (FT) |
|---|---|---|---|---|
| 1 | 18 | 1375 | 1375.5 | 43 |
| 2 | 8 | 1377 | — | (SEE NOTE 1) |
| 3 | 12 | 1376 | 1374 | 36 |

NOTE:
1. Stormwater drainage pipe on basin #2 shall be connected to the existing stormwater drain pipe shown on this plan.
2. All outlets shall have a Standard Dimension Ratio (SDR) of 17

NOTE:
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McMahon & Mann Consulting Engineers, P.C.
DESIGN FIRM: [illegible]
SUPPLEMENT FIRM: [illegible]
FAC. ITE [illegible]

REDUCE

| | |
|---|---|
| REV C | 30% SUBMITTAL |
| REV D | |
| REV 0 | |
| REV 1 | |
| REV | |
| REV | |

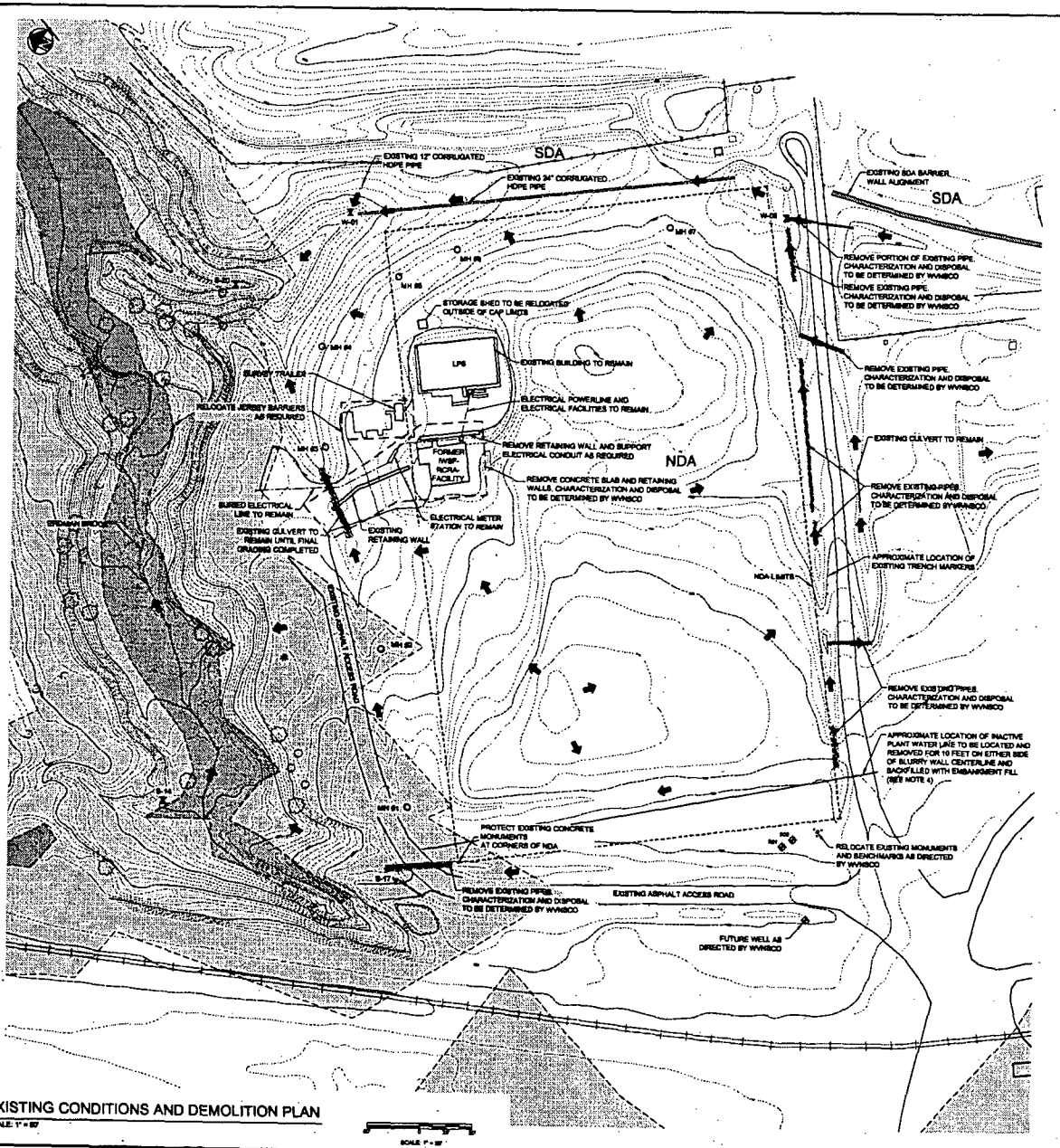
# NDA CAP AND GROUNDWATER BARRIER CONSTRUCTION - SUBGRADE PLAN

WEST VALLEY NEW YORK

| | |
|---|---|
| P.O. 15-[illegible] | |
| DRAWN BY: | C.R.G. |
| CHECKED BY: | D.R.M. |
| SCALE: | 1" = 40' |
| DATE | JUNE 2007 |
| JOB NO. | 07-011 |
| SHEET | 6 OF 12 |
| MMCE DWG. NO. | 07011-001 |
| REVISION NUMBER - 1 | |

# ATTACHMENT D-2

## Figures 2 through 5 from the SWPPP




## EXISTING CONDITIONS AND DEMOLITION PLAN

SCALE: 1" = 50'

SCALE: 1" = 50'

## LEGEND

- EXISTING GROUND CONTOURS
- EXISTING ROAD / ASPHALT
- EXISTING BUILDING
- MH 84 — EXISTING MANHOLE LOCATION AND DESIGNATION
- EXISTING FENCE
- NDA LIMITS
- RGS — WELL LOCATION AND DESIGNATION
- S-14 — STORMWATER OUTFALL LOCATION AND DESIGNATION
- CULVERT TO BE REMOVED
- SURFACE WATER FLOW DIRECTION
- DELINEATED WETLAND
- WETLAND BUFFER ZONE

Note:

1. Base map adapted from a combination of drawings provided by West Valley Nuclear Services Co., Inc. titled "WVDP Site Map Well Locations", Dwg. No. 800-D-8000 Rev A dated May 28, 1992 and "NDA Topographic Plan", Sketch # SKXX02022807 Rev A dated February 19, 2007.
2. Jersey barriers shall be removed and stored for placement at completion of project.
3. Locations of groundwater interceptor trench manholes based on "Solvent Contrd Project Interceptor Trench NRC Licensed Disposal Area", 001 through 008 by Dames & Moore, dated January 28, 1980.
4. Inactive waterline shown based on drawing number 800-E-64874 Rev. 1 titled "NDA (NRC Licensed Disposal Area) Base Map" dated January 28, 1983.
5. Contractor to perform a topographic survey of site and existing facilities including buildings, stockfiled facilities and stormwater drainage structures prior to construction. This information will be used to calculate actual quantities for payment.

## STORMWATER OUTFALLS

| SITE ID | DESCRIPTION | INVERT ELEVATION | OWNER |
|---|---|---|---|
| S-14 | WEIR | 1378.76 | DOE |
| S-17 | 36" CMP | 1370.98 | DOE |
| S-20 | 8" x 8" RECTANGLE | 1368.36 | DOE & HYBERDA |
| W-01 | 12" CORRUGATED HDPE | 1363 | HYBERDA |
| W-06 | 18" CMP | — | HYBERDA |

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Consulting Engineers, P.C.
2495 MAIN STREET, SUITE 432
BUFFALO, NY 14214
FAX: (716) 834-8202

| REV. | |
|---|---|
| 0 | |
| REV | |
| REV | |
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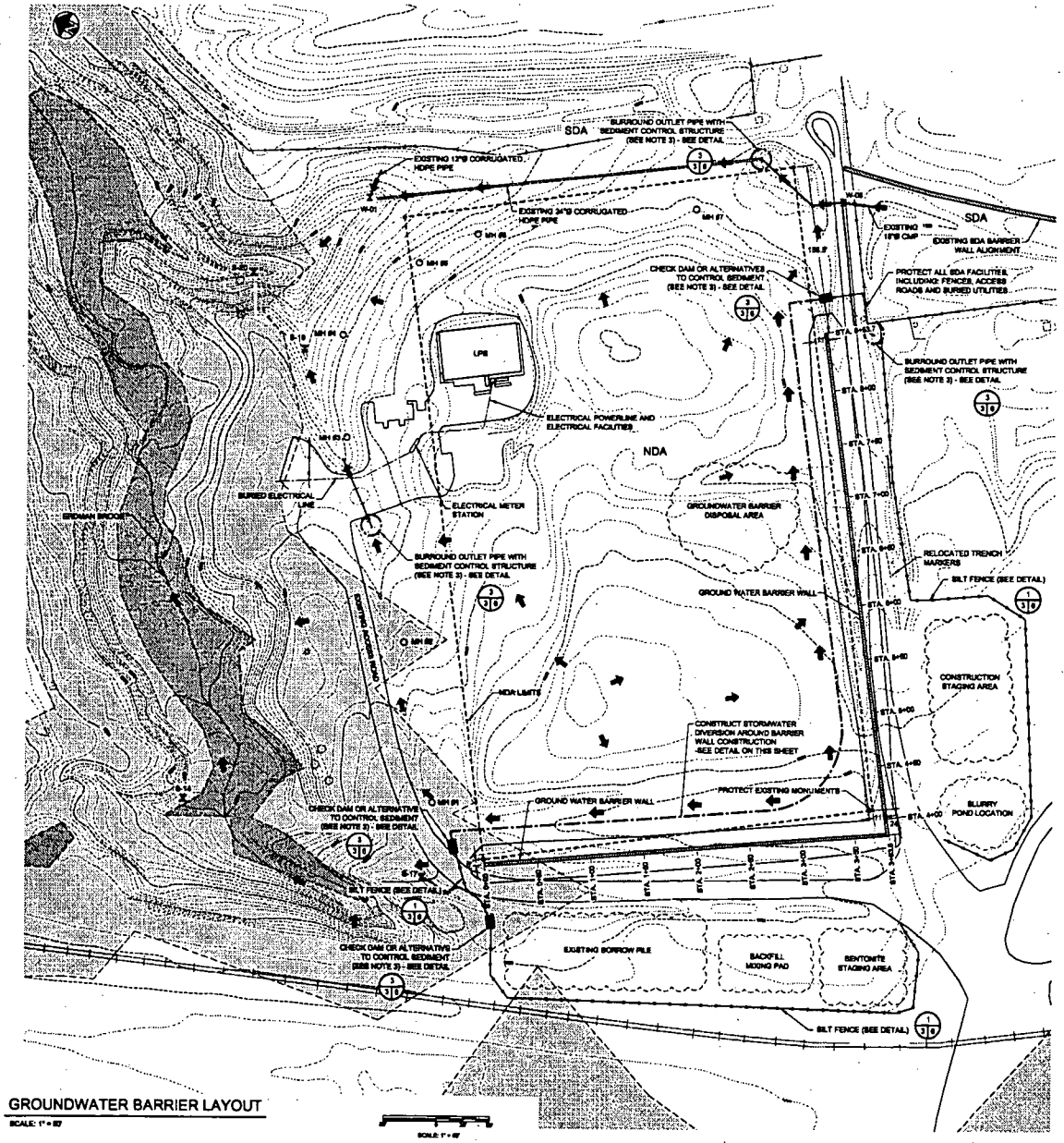
| REV | |
| REV | |

# NDA CAP AND GROUNDWATER BARRIER CONSTRUCTION SWPPP - EXISTING CONDITIONS AND DEMOLITION PLAN

WEST VALLEY NEW YORK

| | |
|---|---|
| P.O. 19-108839-C-CA | |
| DRAWN BY: C.R.G. | |
| CHECKED BY: D.A.M. | |
| SCALE: 1" = 50' | |
| DATE: MAY 2007 | |
| JOB NO. 07-011 | |
| FIGURE 2 | |
| M/M/E DWG. NO. 07011-030 SK | |
| REVISION NUMBER - 0 | |




GROUNDWATER BARRIER LAYOUT

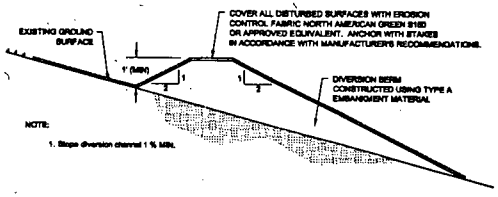
SCALE: 1" = 60'

## LEGEND

- EXISTING GROUND CONTOURS
- NDA LIMITS
- EXISTING ROAD / ASPHALT
- EXISTING FENCE LINE
- EXISTING BUILDING
- MH 04 — EXISTING MANHOLE LOCATION, DESIGNATION
- EXISTING MONUMENT
- S-14 — EXISTING SDA STORMWATER OUTFALL LOCATION AND DESIGNATION
- SEDIMENT CONTROL STRUCTURES
- SILT FENCE / HAYBALE DIKE
- SURFACE WATER FLOW DIRECTION
- CHECK DAM
- DELINEATED WETLAND
- WETLAND BUFFER ZONE

Note:

1. Base map adapted from a combination of drawings provided by West Valley Nuclear Services Co., Inc. titled "WVDP Site Map Well Locations", Dwg. No. 800-O-0000 Rev A dated May 28, 1982 and "NDA Topographic Plan", Sketch # SK00XQ020607 Rev A dated February 18, 2007.
2. All SDA outlets shall be maintained throughout construction.
3. The Contractor is responsible for erosion and sediment control during construction. This plan and other SWPPP drawings show minimum requirements for stormwater diversion and erosion & sediment control during construction. The Contractor shall submit its plan prior to construction providing details for the stormwater diversion, erosion protection and for sediment control structures.




TYPICAL DIVERSION BERM DETAIL

SCALE: NTS

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BUFFALO, NY 14226
PHONE (716) 834-8000
FAX (716) 834-8005

| REV # | DATE | BY | DESCRIPTION |
|---|---|---|---|
| 0 | | | |
| REV | | | |
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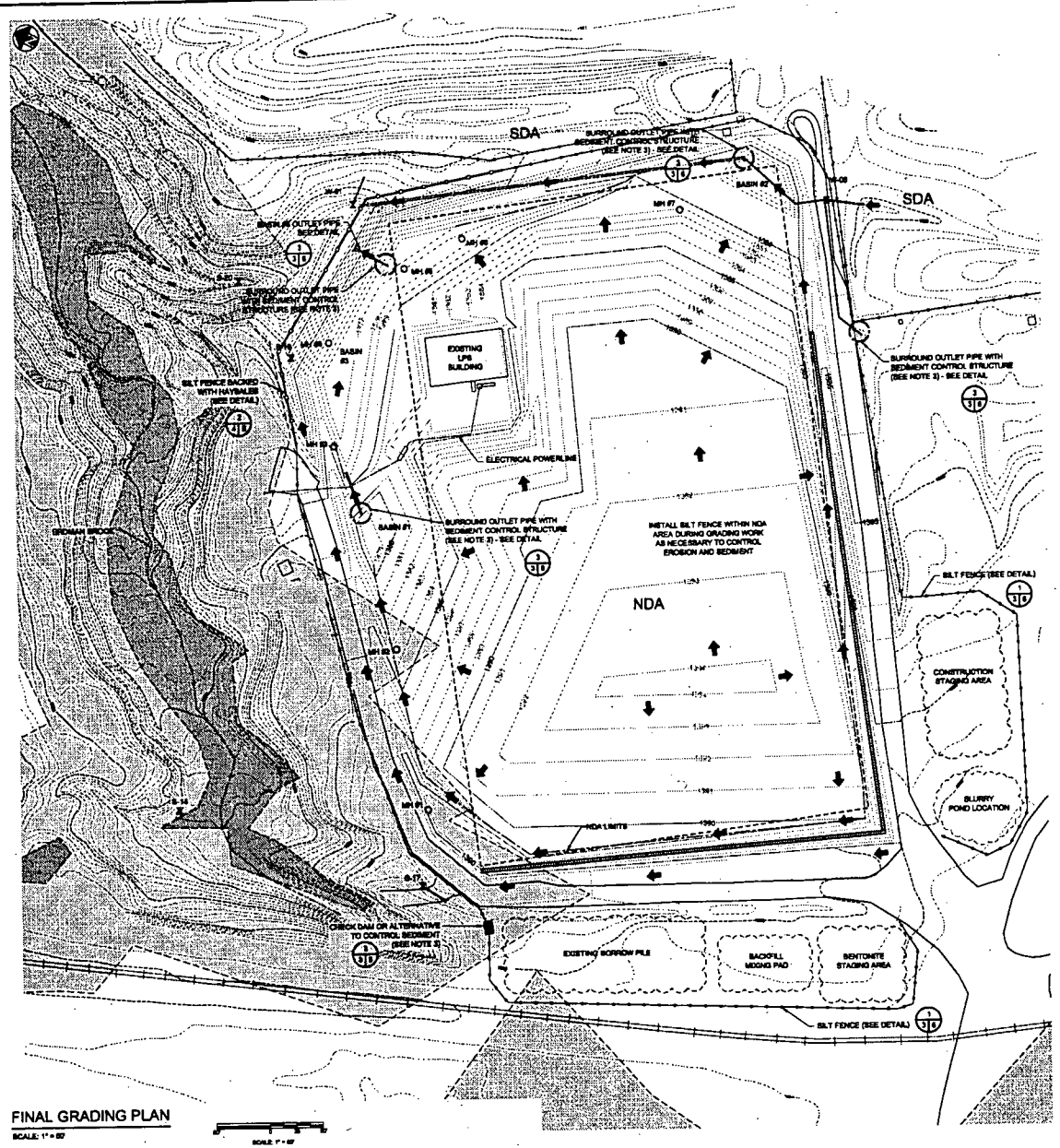
| REV | | | |
| REV | | | |

# NDA CAP AND GROUNDWATER BARRIER CONSTRUCTION SWPPP-GROUNDWATER BARRIER WALL PHASE

WEST VALLEY NEW YORK

| | |
|---|---|
| P.O. 18-108938-C-CA | |
| DRAWN BY: | C.R.G. |
| CHECKED BY: | D.R.M. |
| SCALE: | 1" = 60' |
| DATE: | MAY 2007 |
| JOB NO. | 07-011 |
| FIGURE | 3 |
| MMCE DWG. NO. | 07011-032 BK |
| REVISION NUMBER - 0 | |




FINAL GRADING PLAN

SCALE: 1" = 60'

SCALE: 1" = 60'

## LEGEND

- EXISTING GROUND CONTOURS
- 1390 CAP CONTOURS
- NDA LIMITS
- GEOMEMBRANE LIMITS
- DRAINAGE SWALE
- MH #4 EXISTING MANHOLE LOCATION AND DESIGNATION
- EXISTING FENCE LINE
- EXISTING BUILDING
- JERSEY BARRIER
- SILT FENCE
- SILT FENCE / HAYBALE DIKE
- SEDIMENT CONTROL STRUCTURES
- DELINEATED WETLAND
- WETLAND BUFFER ZONE
- SURFACE WATER FLOW DIRECTION
- S-14 EXISTING SDA STORMWATER OUTFALL LOCATION AND DESIGNATION
- CHECK DAM

Note:

1. Base map adapted from a combination of drawings provided by West Valley Nuclear Services Co., Inc. titled "WVDP Site Map Well 800-D-5000 Rev A dated May 28, 1992 and "NDA Topographic Plan", Station # 590GG0200807 Rev A dated February 19, 2007.
2. All SDA outlets shall be maintained throughout construction.
3. The Contractor is responsible for erosion and sediment control during construction. This plan and other SWPPP drawings show minimum requirements for stormwater diversion and erosion & sediment control during construction. The Contractor shall submit its plan prior to construction providing details for the stormwater diversion, erosion protection and for sediment control structures.
4. All silt fences are to be backed by steel wire mesh as required.

NOTE:
UNAUTHORIZED ALTERATION OR ADDITION TO ANY SURVEY, DRAWING, DESIGN, SPECIFICATION, PLAN, OR REPORT IS A VIOLATION OF SECTION 7209 PROVISION 2 OF THE NEW YORK STATE EDUCATION LAW.

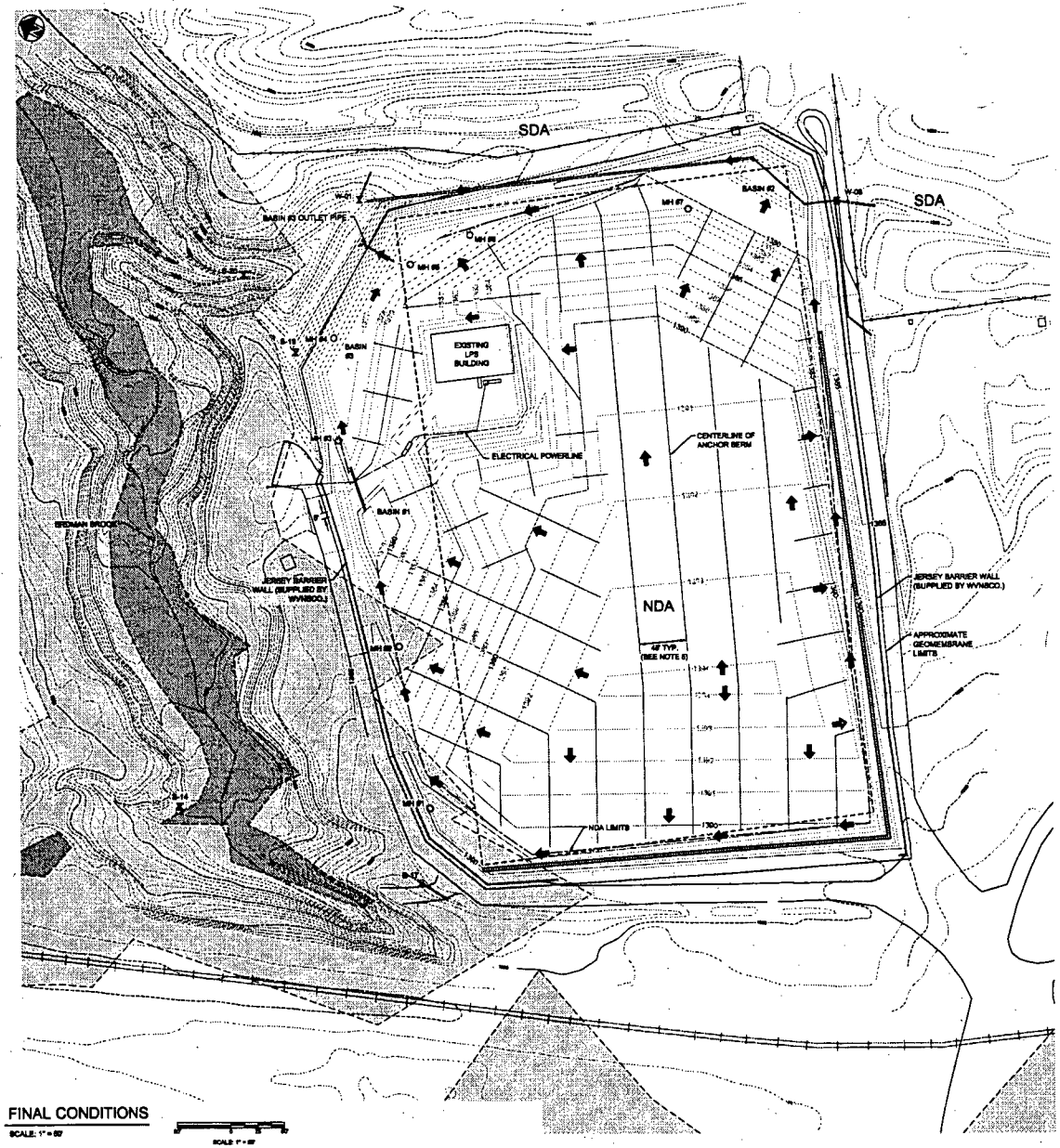
McMahon & Mann
Consulting Engineers, P.C.
3836 MAIN STREET
BUFFALO, NY 14226
PHONE (716) 834-8000
FAX: (716) 834-8004

| REV. 0 | REV | REV | REV | REV | REV | REV |
|---|---|---|---|---|---|---|

# NDA CAP AND GROUNDWATER BARRIER CONSTRUCTION SWPPP - GRADING PHASE

WEST VALLEY NEW YORK

| | |
|---|---|
| P.O. 19-108839-C-CA | |
| DRAWN BY: C.R.G. | |
| CHECKED BY: D.R.M. | |
| SCALE: 1" = 60' | |
| DATE: JUNE 2007 | |
| JOB NO. 07-011 | |
| FIGURE 4 | |
| MMCE DWG. NO. 07011-031 SK | |
| REVISION NUMBER - 0 | |




FINAL CONDITIONS

SCALE: 1" = 50'

SCALE 1" = 50'

## LEGEND

- EXISTING GROUND CONTOURS
- 1320 CAP CONTOURS
- NDA LIMITS
- GEOMEMBRANE LIMITS
- DRAINAGE SWALE
- CENTERLINE OF ANCHOR BERM
- MH #4 EXISTING MANHOLE LOCATION AND DESIGNATION
- EXISTING FENCE LINE
- EXISTING BUILDING
- JERSEY BARRIER
- SURFACE WATER FLOW DIRECTION
- S-14 EXISTING SDA STORMWATER OUTFALL LOCATION AND DESIGNATION
- DELINEATED WETLAND
- WETLAND BUFFER ZONE

Note:

1. Base map adapted from a combination of drawings provided by West Valley Nuclear Services Co., Inc. titled "WVDP Site Map Well 800-D-2000 Rev A dated May 28, 1992 and "NDA Topographic Plan", Sketch # SK00G020807 Rev A dated February 18, 2007.
2. All SDA outfalls shall be maintained throughout construction.

NOTE:
UNAUTHORIZED ALTERATION OR ADDITION TO ANY SURVEY, DRAWING, DESIGN, SPECIFICATION, PLAN, OR REPORT IS A VIOLATION OF SECTION 7209 PROVISION 2 OF THE NEW YORK STATE EDUCATION LAW.

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BUFFALO, NY 14214
(716) 834-8600
FAX: (716) 834-8604

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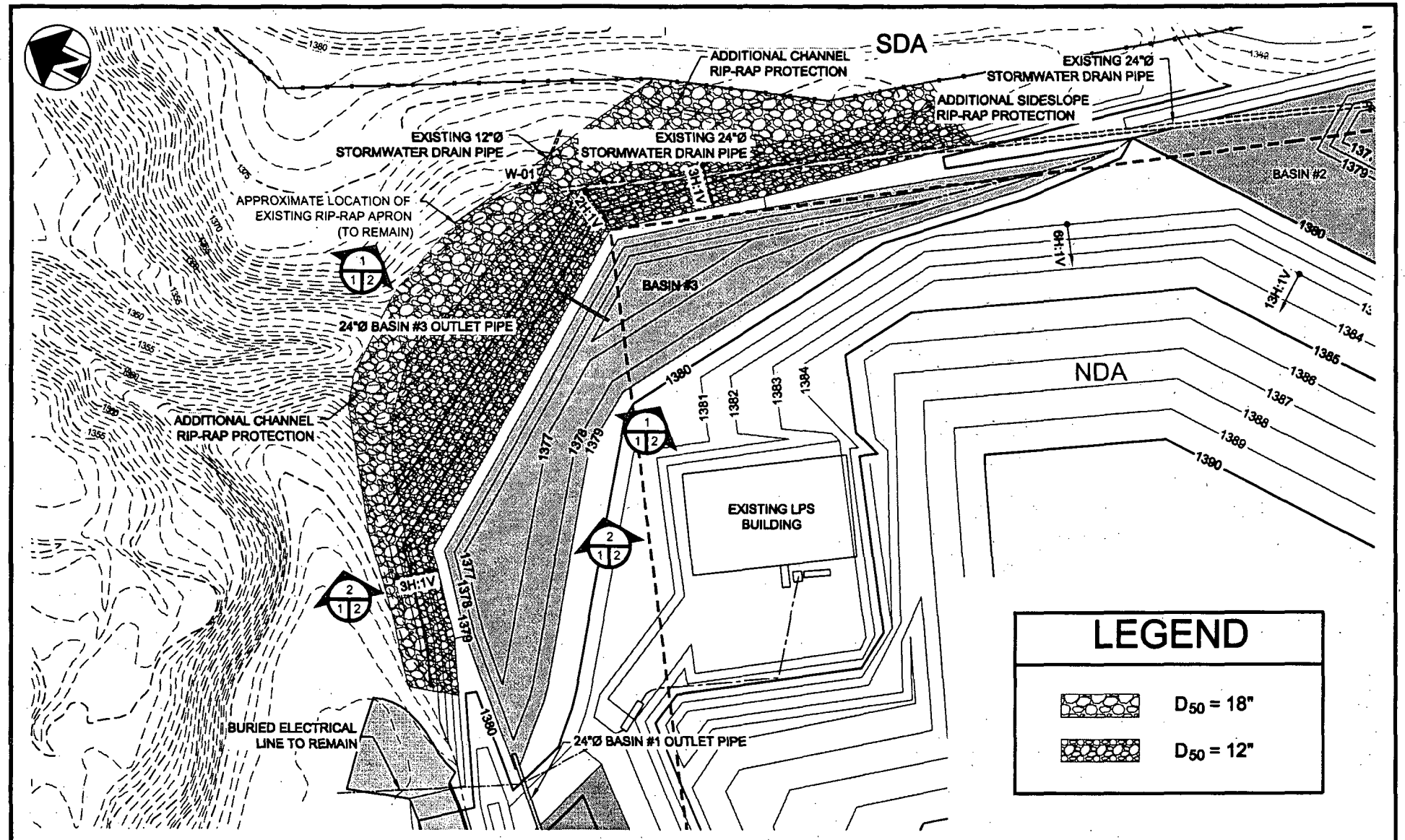
# NDA CAP AND GROUNDWATER BARRIER CONSTRUCTION SWPPP- FINAL CONDITIONS

WEST VALLEY NEW YORK

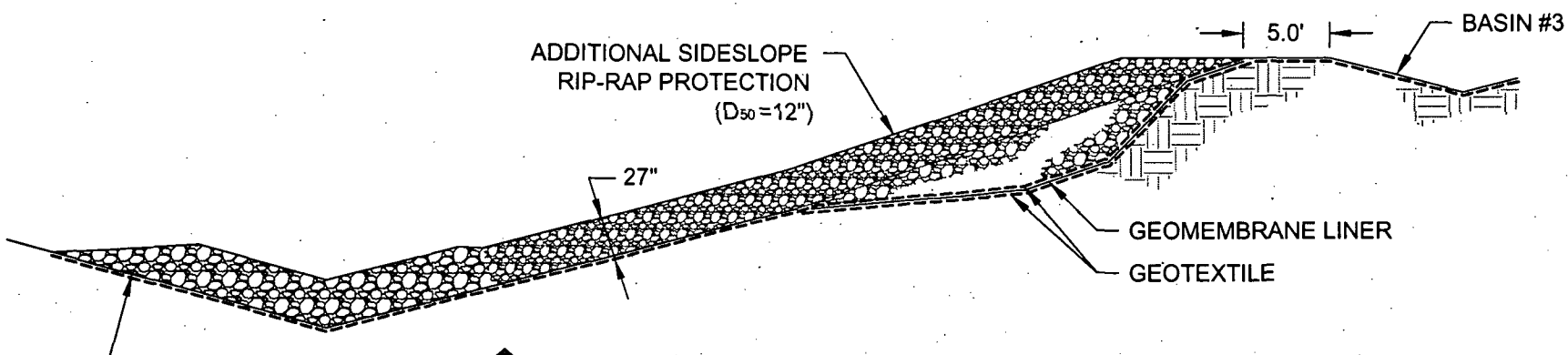
| | |
|---|---|
| P.O. 19-108838-C-CA | |
| DRAWN BY: C.R.G. | |
| CHECKED BY: D.R.M. | |
| SCALE: 1" = 50' | |
| DATE: JUNE 2007 | |
| JOB NO. 07-011 | |
| FIGURE 5 | |
| MMCE DWG. NO. 07011-033 BK | |
| REVISION NUMBER - 0 | |

# ATTACHMENT D-3

## Sketches of Additional Riprap Protection

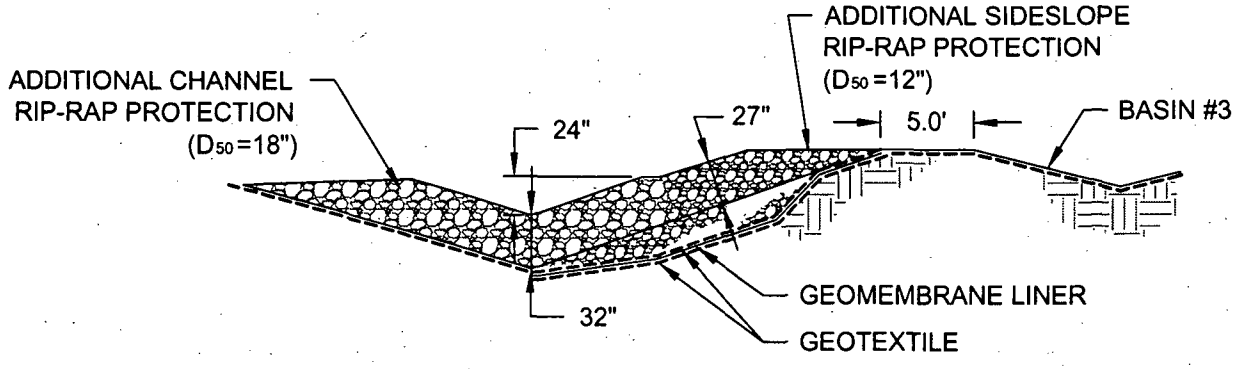



| ADDITIONAL STORMWATER PROTECTION PLAN | NDA CAP AND GROUNDWATER BARRIER CONSTRUCTION | McMahon & Mann Consulting Engineers, P.C. |
|---|---|---|
| DWG. NO.07011-058a | WEST VALLEY NEW YORK | 2495 MAIN STREET, SUITE 432 BUFFALO, NY 14214 (716) 834-8932 FAX: (716) 834-8934 |
| FIGURE 1 | | |




1 / 1 2 TYPICAL SIDESLOPE RIP-RAP PROTECTION

SCALE: 1"=10'




2 / 1 2 TYPICAL CHANNEL RIP-RAP PROTECTION

SCALE: 1"=10'

| | | |
|---|---|---|
| ADDITIONAL STORMWATER PROTECTION SECTIONS | NDA CAP AND GROUNDWATER BARRIER CONSTRUCTION | McMahon & Mann Consulting Engineers, P.C. |
| DWG. NO. 07011-058b | WEST VALLEY •NEW YORK | 2495 MAIN STREET, SUITE 432 BUFFALO, NY 14214 (716) 834-8932 FAX: (716) 834-8934 |
| FIGURE 2 | | |

10' 0 5' 10'

SCALE: 1" = 10'

# REPORT ON GROUNDWATER MODELING

## WEST VALLEY ENVIRONMENTAL SERVICES, LLC
## NUCLEAR REGULATORY COMMISSION LICENSED DISPOSAL AREA CAP AND GROUNDWATER CUTOFF BARRIER PROJECT

**SEPTEMBER 2007**

Prepared for:

West Valley Environmental Services, LLC
10282 Rock Springs Road
West Valley, New York 14171-9799

Prepared by:

McMahon & Mann Consulting Engineers, P.C.
2495 Main Street, Suite 432
Buffalo, NY 14214

## INTRODUCTION

West Valley Environmental Services, LLC (WVES), formerly known as West Valley Nuclear Services Company has engaged Butler Construction Company of WNY, Inc. (Butler) and McMahon & Mann Consulting Engineers, P.C. (MMCE) to design a groundwater barrier wall and a cap to provide interim containment of the Nuclear Regulatory Commission Licensed Disposal Area (NDA) at the West Valley Demonstration Project in West Valley, New York. Figure 1 shows the West Valley site. The NDA is an approximately 7-acre parcel, located near the south end of the West Valley Demonstration Project, see Figure 2

MMCE has modeled groundwater flow as part of our design for the interim containment and has prepared this summary. The purpose of the groundwater barrier wall is to limit the infiltration of groundwater into the NDA from upgradient sources southwest of the NDA. Figure 3 shows the location of the proposed groundwater barrier.

MMCE developed the groundwater model for the NDA site and the area immediately surrounding it to estimate the effect of constructing the NDA barrier wall and geomembrane cover on the groundwater levels within and immediately surrounding the NDA, including the area west of the State Disposal Area (SDA). The model was calibrated using groundwater level data from wells surrounding the NDA and measurements of flow into the NDA interceptor trench (location is shown on Figure 3) collected by WVES and other site features, such as the site topography and surrounding creeks, as described in the following sections.

The results provide an estimate of the long-term steady-state groundwater levels and flow to the interceptor trench after construction of the NDA cap and barrier wall. The groundwater levels are expressed as a potentiometric contour map of the area within the NDA and the surrounding area. The model results also provide an estimate of the flow to the interceptor trench from (1) groundwater upgradient of the NDA and (2) infiltration into the NDA.

The following sections describe a previous groundwater model completed by the USGS in the vicinity of the NDA, calibration of the current model and estimates of steady-state groundwater flow patterns following completion of the barrier wall and cap.

## USGS STUDY

In 1982, the USGS studied groundwater flow within soil deposits in the vicinity of the NDA, which the USGS refers to as the Facility Disposal Area (References 1 and 2). The USGS drilled test borings around the NDA and constructed groundwater monitoring wells with screens placed at various elevations to allow groundwater level measurements and subsequent calculation of vertical and horizontal gradients.

The USGS used a two-dimensional finite element model to evaluate groundwater flow conditions. Figure 4 is a plan view from the USGS report showing the NDA and the State Disposal Area (SDA) and the location of vertical cross sections used in the USGS reports.

Figure 5, taken from Reference 2, is a cross section through the NDA vicinity and shows the geologic conditions and the groundwater level in the uppermost formation, the

weathered Lavery Till, based on measurements made in the monitoring wells. The water level generally mirrors the ground surface topography.

Figure 6 is a cross section, taken from the USGS, showing the geologic formations, the monitoring well screen locations and the nodes used in the USGS groundwater model.

To calibrate the model, the USGS varied the recharge rate and the till's hydraulic conductivity until the model results were in general agreement with groundwater levels measured in the wells. The calibration provides an indication of the area recharge conditions, and the hydraulic conductivity of the weathered and unweathered till, which directly underlies the weathered till. The USGS model results indicate low hydraulic conductivity for the till units and corresponding low lateral groundwater flux through the weathered till zone, about 80 cubic centimeters per day per square meter (0.72 gallons per year per square foot).

The USGS model estimated that about 0.6 to 1.5 inches of precipitation infiltrate into the NDA annually. The model also estimates that groundwater flows laterally through the weathered Lavery Till and vertically through the unweathered Lavery Till. The model estimated the hydraulic conductivity of the weathered Lavery Till as $5x10^{-7}$ centimeters per second (cm/sec) and the unweathered Lavery Till as $5x10^{-8}$ cm/sec.

## METHODOLOGY

MMCE modeled groundwater conditions using ModFlow, a computer program developed at the University of Waterloo. It uses a finite difference technique to solve for unknown heads within the model domain. ModFlow simulates heterogeneous flow in three dimensions. The program uses subroutines that permit examination of specific hydrologic features independently. The subroutine called Visual ModFlow was used to input the data and view the results. The model simulates flow associated with external stresses, such as wells, aerial recharge, drains, and streams.

MMCE developed the site model considering existing geologic data, the site topography, drainage features, rainfall and recharge.

The modeled area (i.e., the area within the model boundaries) extends east from about midway between Rock Springs Road and the railroad embankment, north to Erdman Brook, and south and east to Frank's Creek, covering approximately 50 acres of land. Figure 4 shows these features and Figure 7 shows the model boundaries. This area is within the USGS study boundary.

The weathered Lavery Till was considered to be 16 feet thick and modeled with three layers of elements. Each of the three layers has the same properties, but three layers were used for mesh refinement to model the hydraulic gradient in the vertical direction. The unweathered Lavery Till, at the bottom of the three layers, was considered as an impermeable boundary to simplify the analysis.

Other features added to the model include the barrier wall along the west side of the SDA and the interceptor trench along the north and east sides of the NDA. The SDA barrier wall was simulated by assigning a thickness of 2.5 feet, a hydraulic conductivity

of $1x10^{-7}$ centimeters per second (cm/sec) and a depth extending from the ground surface to the top of the impermeable boundary.

The interceptor trench was simulated by assigning a conductance of approximately 25,000 $ft^2$/sec and invert elevations corresponding to the invert along the alignment of the NDA interceptor trench.

MMCE assigned a constant head boundary at Elevation (El.) 1400 to the elements along the ground contour at El. 1400 between the railroad embankment and Rock Springs Road. This value approximately corresponds to the groundwater levels measured in this area during 2006.

A no flow boundary was assigned along the north, south and east ends of the modeled area corresponding the location of Erdman Brook and Frank's Creek, see Figure 7.

## CALIBRATION

The initial step in the modeling process was to calibrate the groundwater model so that model predictions agree with observations at the site. MMCE varied the hydraulic properties of the weathered Lavery Till and infiltration rates until the model predicted groundwater contours and interceptor trench flow measurements similar to those that have been reported.

The hydraulic conductivity was varied between $1x10^{-4}$ cm/sec and $1x10^{-5}$ cm/sec. The model calibration resulted in a hydraulic conductivity of $1x10^{-5}$ cm/sec for the weathered Lavery Till and $1x10^{-4}$ cm/sec for the fill within the NDA. The weathered till was considered a homogeneous medium, for which Darcy's Law applies.

The weathered Lavery Till is not homogenous. Rather, it is comprised of a series of silt seams that surround blocks of less permeable soil (till). Groundwater flow through this type of soil is considered flow through fractured media. Data regarding the spacing of silt-filled seams in the weathered Lavery Till are not available. Therefore, the hydraulic conductivity used in the model is actually an equivalent hydraulic conductivity.

Using a hydraulic conductivity of $1x10^{-6}$ cm/sec resulted in predicted groundwater levels approximately 20 feet or more above the ground surface. Therefore this hydraulic conductivity was not considered reasonable.

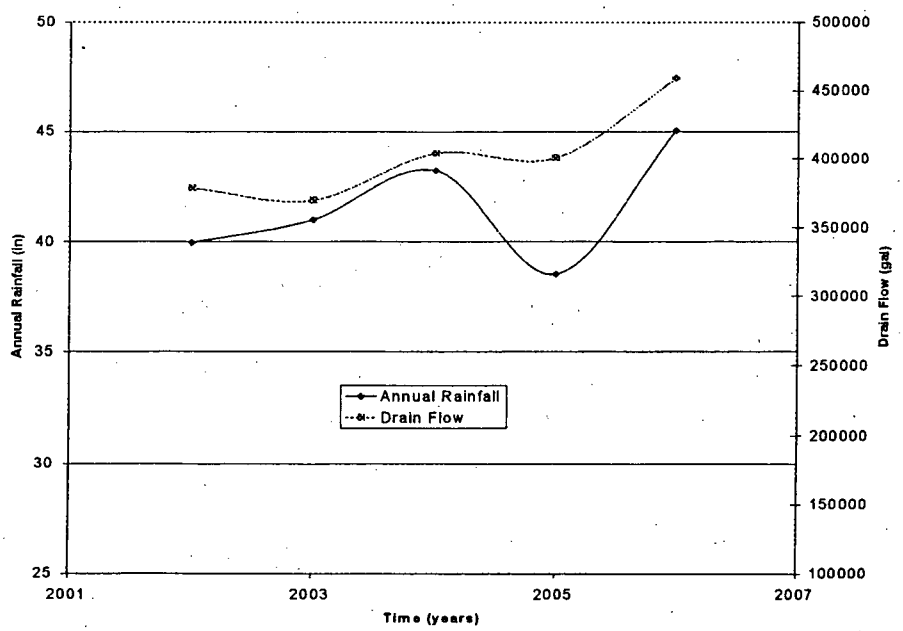
The hydraulic conductivity for the weathered Lavery Till is higher than that used in the USGS study, ($5x10^{-7}$ cm/sec). This could be due to the differences in the model configuration (MMCE's three-dimensional compared with the USGS two-dimensional model) or differences in the boundary conditions. (MMCE considered the top of the unweathered Lavery Till to be impermeable and the USGS considered that it has a low permeability.) The USGS study covered a larger area than the model for the NDA containment design.

We reviewed rainfall data for the site, flow measurement data from the NDA interceptor trench, and recharge values used in the USGS study in calibrating the groundwater flow model. The annual rainfall at the site since 1990 is summarized on the following table.

Also on the table is a summary of the flow collected in the NDA interceptor trench annually since 2002.

| Year | Rainfall (in.) | Year | Rainfall (in.) | Flow Collected in Interceptor Trench (gallons) |
|---|---|---|---|---|
| 1990 | 26.64 | 1999 | 30.97 | |
| 1991 | 32.76 | 2000 | 38.05 | |
| 1992 | 48.63 | 2001 | 31.02 | |
| 1993 | 37.35 | 2002 | 39.96 | 378,471 |
| 1994 | 40.13 | 2003 | 40.99 | 369,680 |
| 1995 | 34.17 | 2004 | 43.21 | 404,166 |
| 1996 | 44.89 | 2005 | 38.52 | 400,907 |
| 1997 | 43.23 | 2006 | 45.06 | 458,911 |
| 1998 | 42.76 | | | |

As indicated on the following chart, the annual rainfall and corresponding annual flow in the interceptor trench follow a similar trend. This suggests that precipitation has a proportionally large contribution to the flow in the interceptor trench.




The recharge rates used in the ModFlow model calibration varied between 0.5 and 3 inches per year. These values are similar to the rates used in the USGS study and resulted in a reasonable prediction of flow collected in the interceptor trench compared with measured values.

The flow in the interceptor trench for the existing conditions was estimated to be 380,000 gallons per year, which compares well with the observations listed in the preceding table.

Figure 7 shows the model boundaries and the predicted groundwater potentiometric contours for the existing conditions. These contours agree reasonably well with the potentiometric maps reviewed for the project, see References 3 and 4.

## EFFECT OF THE PROPOSED NDA CAP AND BARRIER WALL

Once the model was calibrated, the effect of the barrier wall constructed along the west and south sides was considered by assigning a thickness of 3 feet and a hydraulic conductivity of $1 \times 10^{-7}$ cm/sec along the planned alignment for the NDA barrier wall. The barrier wall was extended to the lower boundary condition, i.e., the top of the impermeable, unweathered Lavery Till. We modeled the geomembrane cap by setting the recharge in the NDA area to zero such that no precipitation would infiltrate through the cap within the modeled limits of the NDA.

Figure 8 shows the boundaries used in the model and the potentiometric contours predicted by the model with the barrier wall and geomembrane cap in place under steady state groundwater flow conditions. Appendix A presents the ModFlow input and output for both the calibration (existing) condition and the long-term, steady-state condition.

Comparing Figure 7 (the existing conditions) with Figure 8 shows that the model predicts essentially no change in the groundwater potentiometric contours west and south of the NDA due to installation of the barrier wall and the proposed construction will not affect the adjacent SDA. The groundwater flow in these areas remains toward existing drainage features around the NDA, such as Erdman Brook, Frank's Creek and the drainage swale located southwest of the SDA.

The model predicts a long-term flow to the interceptor trench of approximately 36,000 gallons per year with the cap and barrier wall in place, a reduction of about 344,000 gallons per year. The model shows that the flow into the interceptor trench originates primarily from the area between the north side of the NDA and Erdman Brook. The model predicts the flow into the interceptor trench with only the cap constructed to be about 42,000 gallons per year.

Immediately following construction, no groundwater will flow through the barrier wall because there will be no gradient. However, once the cap is constructed, groundwater levels inside the NDA will decrease until the long-term, steady-state condition develops. During this time, groundwater flow through the barrier wall will increase because the hydraulic gradient across the barrier wall increases. This will continue until the steady-state condition occurs.

## REFERENCES

1. Bergeron, M.P., W. M. Kappel and R. M. Yager, "Geohydrologic Conditions at the Nuclear-Fuels Reprocessing Plant and Waste-management Facilities at the Western New York Nuclear Service Center, Cattaraugus County, New York," U.S. Geological Survey, Ithaca, New York, 1987.

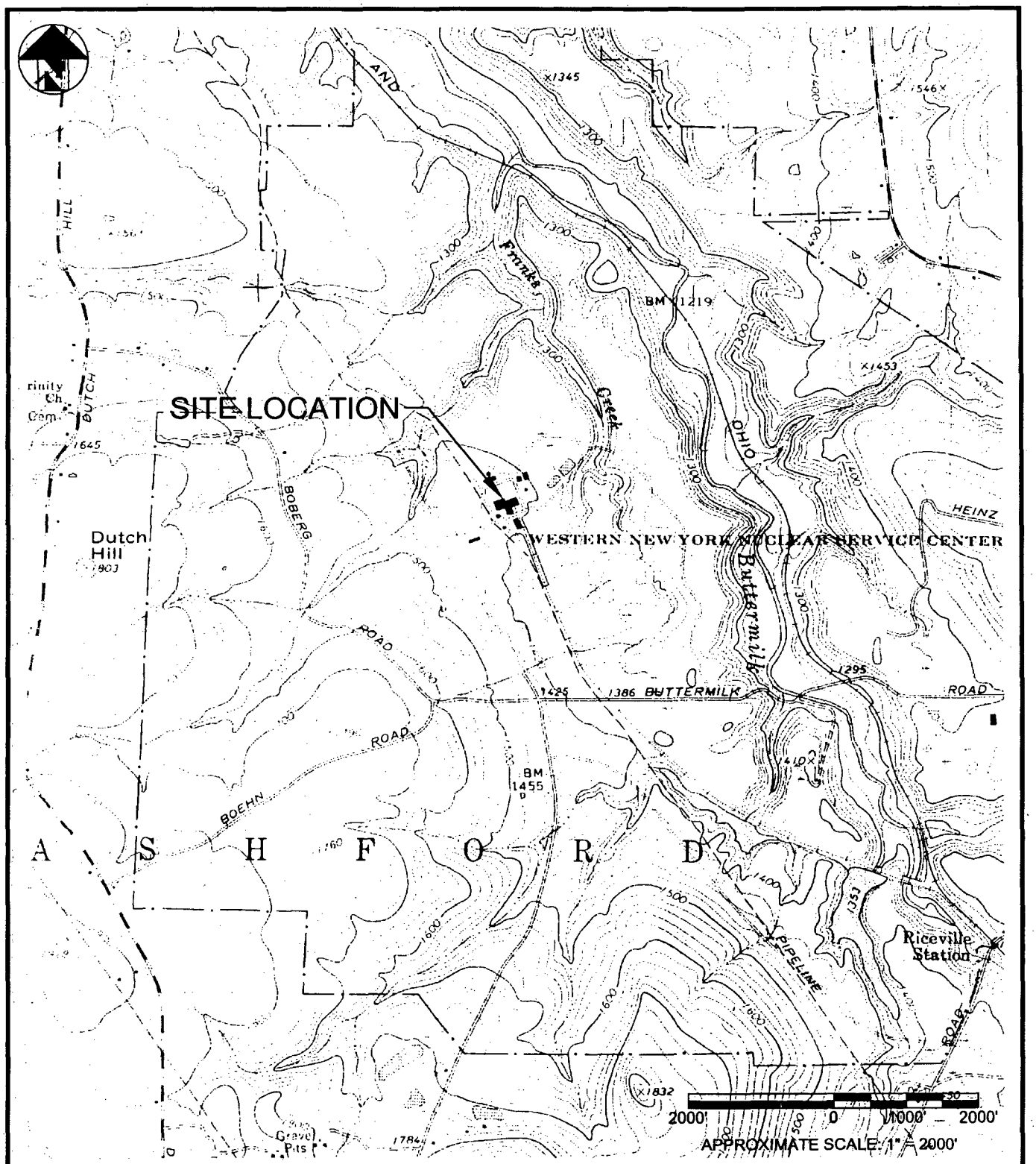
2. Bergeron, M.P., "Ground-Water Flow near Two Radioactive-Waste Disposal Areas as the Western New York Nuclear Service, Cattaraugus County, New York – Results of Flow Simulation," U.S. Geological Survey, Albany, New York, 1988.

3. First Quarter, Second Quarter, Third Quarter and Fourth Quarter 2006 Groundwater Elevation Contours of the Weathered Lavery Till West Valley -Demonstration Project, West Valley, New York.

4. NYSERDA, "State-Licensed Disposal Area (SDA) at West Valley, 2006 Annual Report," March 2007.

# FIGURES

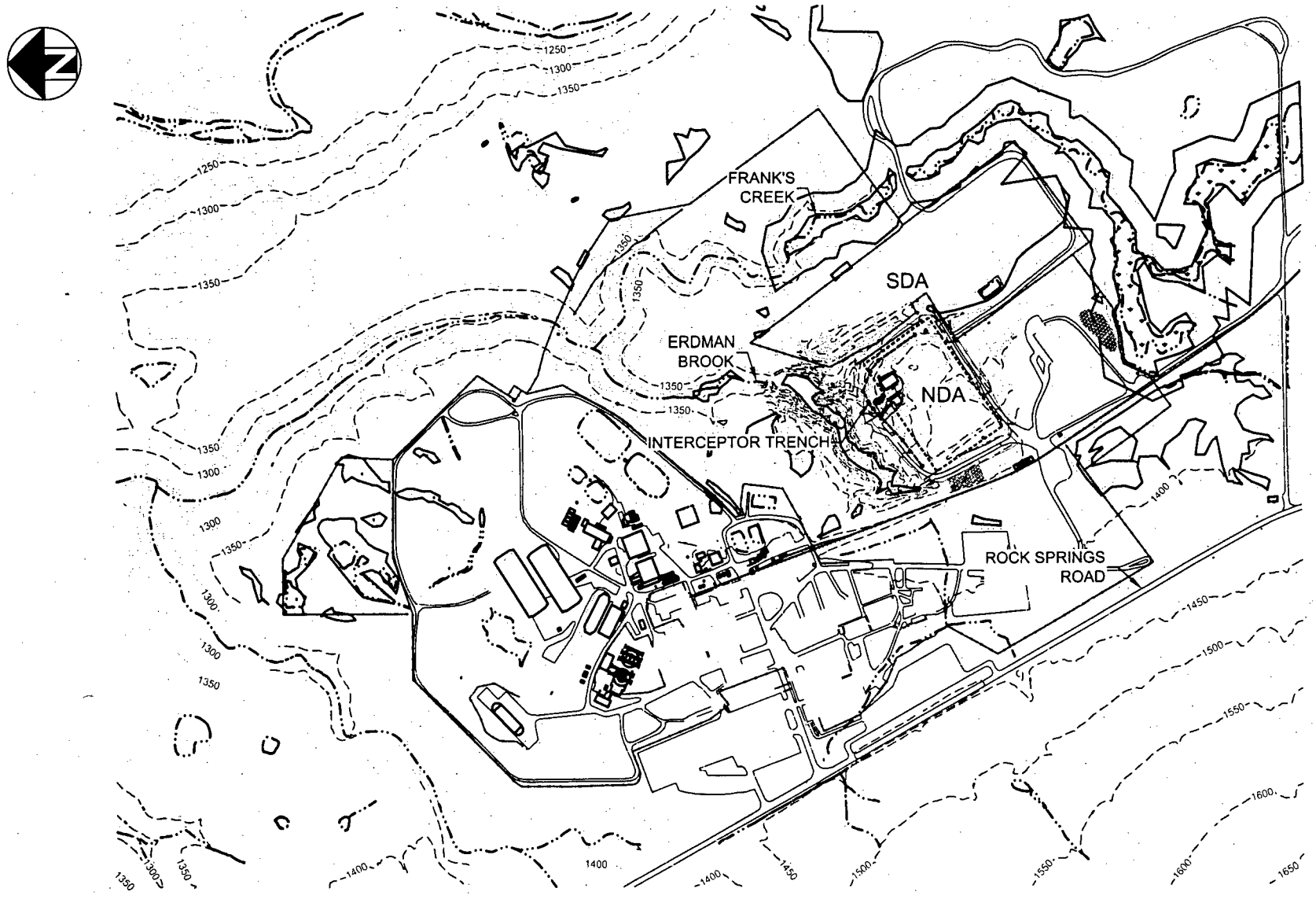
## REPORT ON GROUNDWATER MODELING
## WEST VALLEY ENVIRONMENTAL SERVICES, LLC
## NUCLEAR REGULATORY COMMISSION LICENSED DISPOSAL AREA
## CAP AND GROUNDWATER BARRIER PROJECT




Note:

1. Base map adapted from USGS 7.5 minute series quadrangle map of Ashford Hollow, NY dated 1964.

| | | |
|---|---|---|
| McMahon & Mann Consulting Engineers, P.C. 2495 MAIN STREET, SUITE 432 BUFFALO, NY 14214 (716) 834-8932 FAX: (716) 834-8934 | NDA GROUND WATER FLOW MODEL WEST VALLEY NEW YORK | SITE LOCATION MAP DWG. NO. 07011-010b FIGURE 1 |

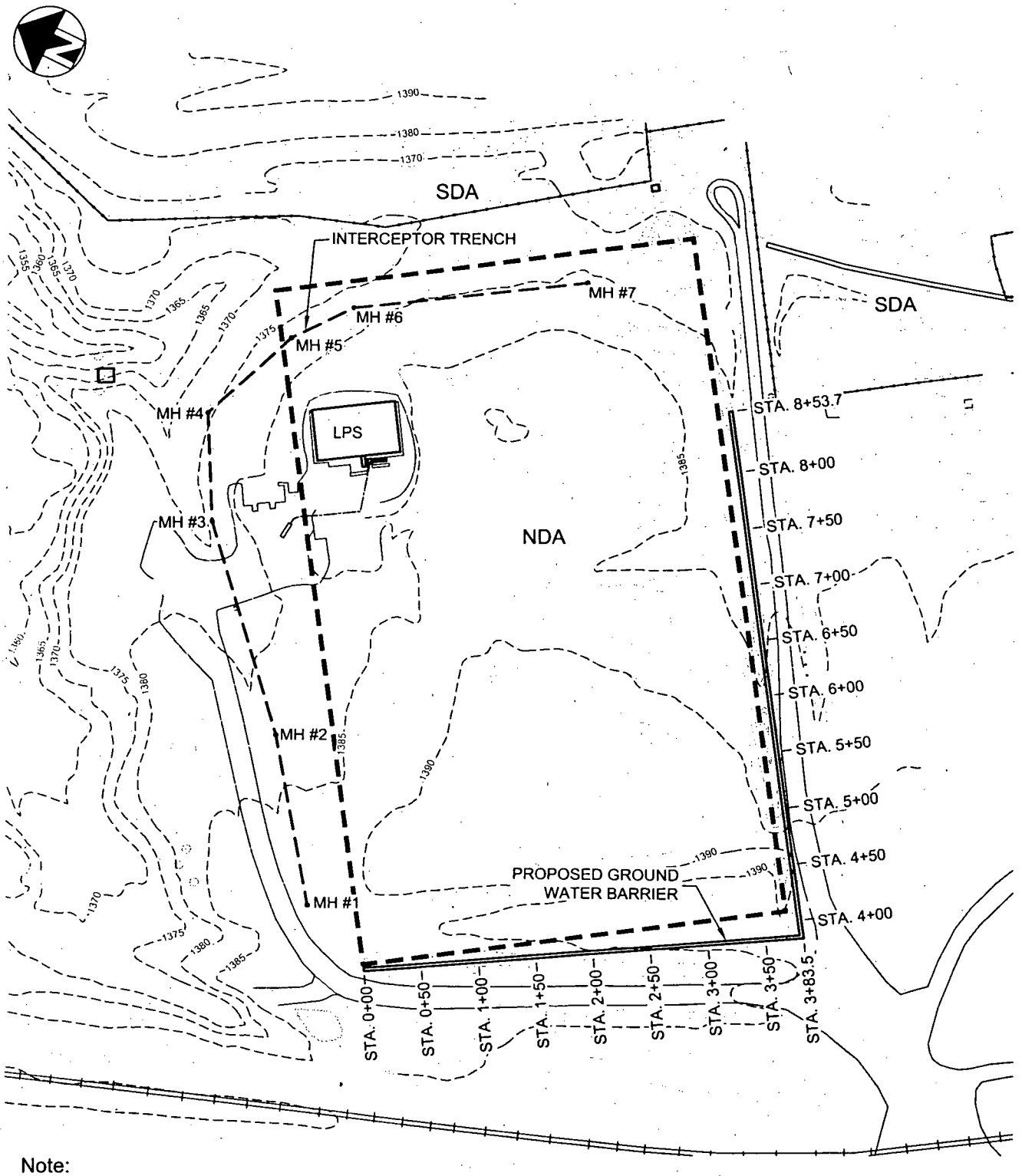



SCALE: N.T.S.

| | | |
|---|---|---|
| SITE PLAN | NDA GROUND WATER FLOW MODEL | McMahon & Mann Consulting Engineers, P.C. |
| DWG. NO. 07011-056 | WEST VALLEY NEW YORK | 2495 MAIN STREET, SUITE 432 BUFFALO, NY 14214 (716) 834-8932 FAX: (716) 834-8934 |
| FIGURE 2 | | |

Note:

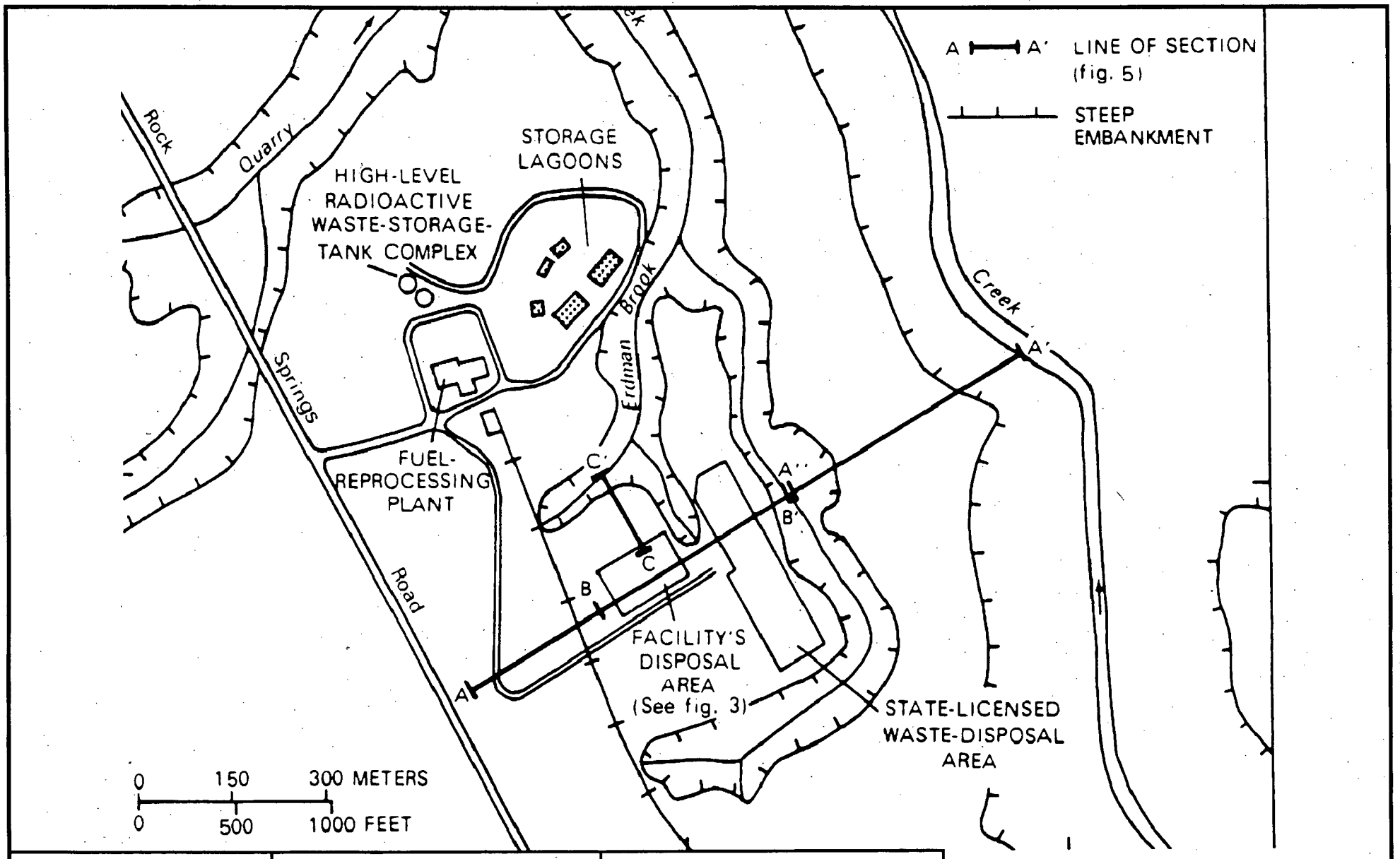
1. Base map adapted from a combination of drawings provided by West Valley Nuclear Services Co., Inc. titled "WVDP Site Map Well Locations", Dwg. No. 900-D-5000 Rev A dated May 26, 1992 and "NDA Topographic Plan", Sketch # SKKKG020607 Rev A dated February 19, 2007.



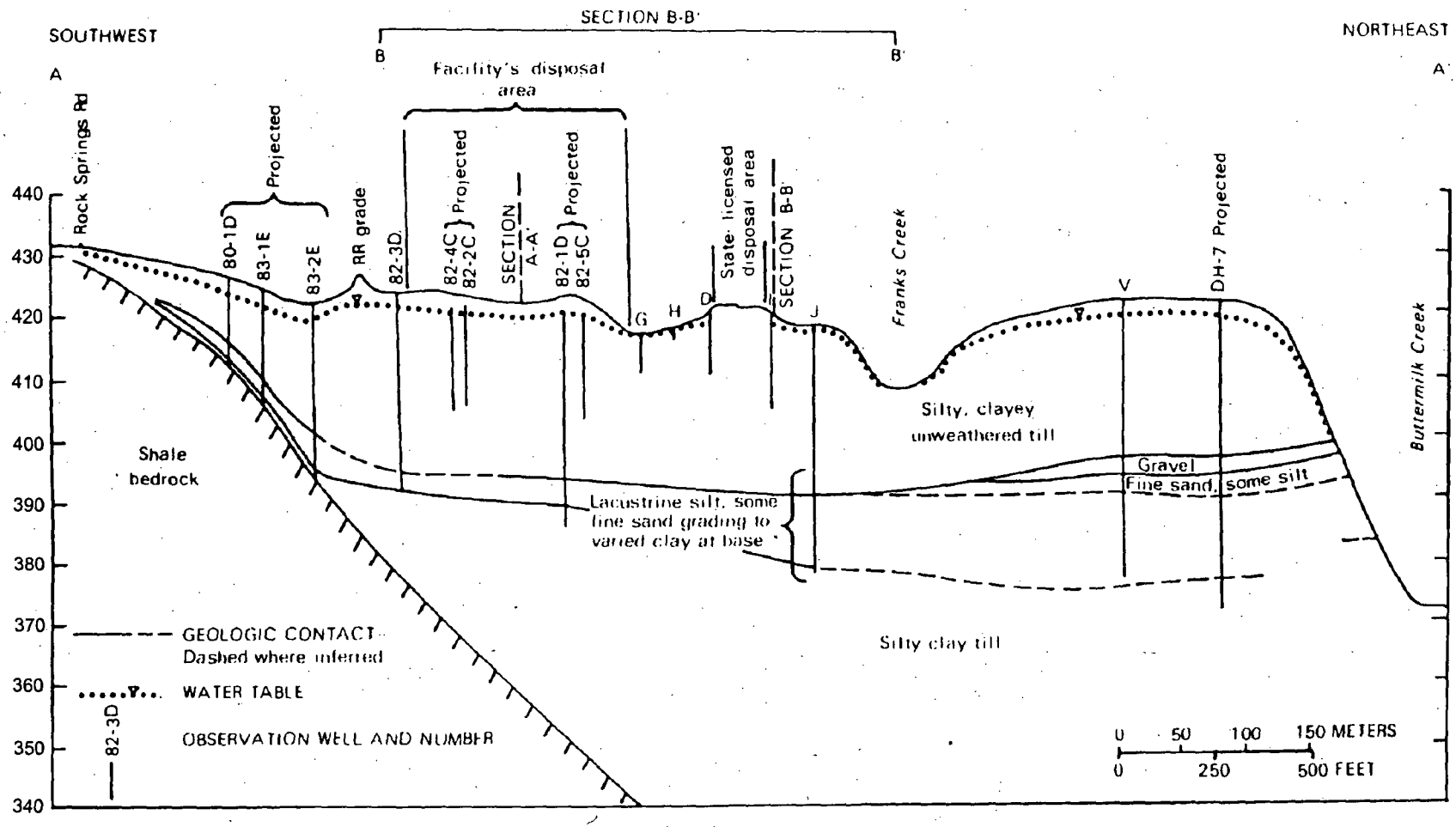

Note:

1. Base map adapted from a combination of drawings provided by West Valley Nuclear Services Co., Inc. titled "WVDP Site Map Well Locations", Dwg. No. 900-D-5000 Rev A dated May 26, 1992 and "NDA Topographic Plan", Sketch # SKKKG020607 Rev A dated February 19, 2007.

| | | |
|---|---|---|
| McMahon & Mann Consulting Engineers, P.C.<br>2495 MAIN STREET, SUITE 432 (716) 834-8932<br>BUFFALO, NY 14214 FAX: (716) 834-8934 | NDA GROUND WATER FLOW MODEL<br>WEST VALLEY NEW YORK | GROUND WATER BARRIER LOCATION<br>DWG. NO. 07011-057<br>FIGURE 3 |

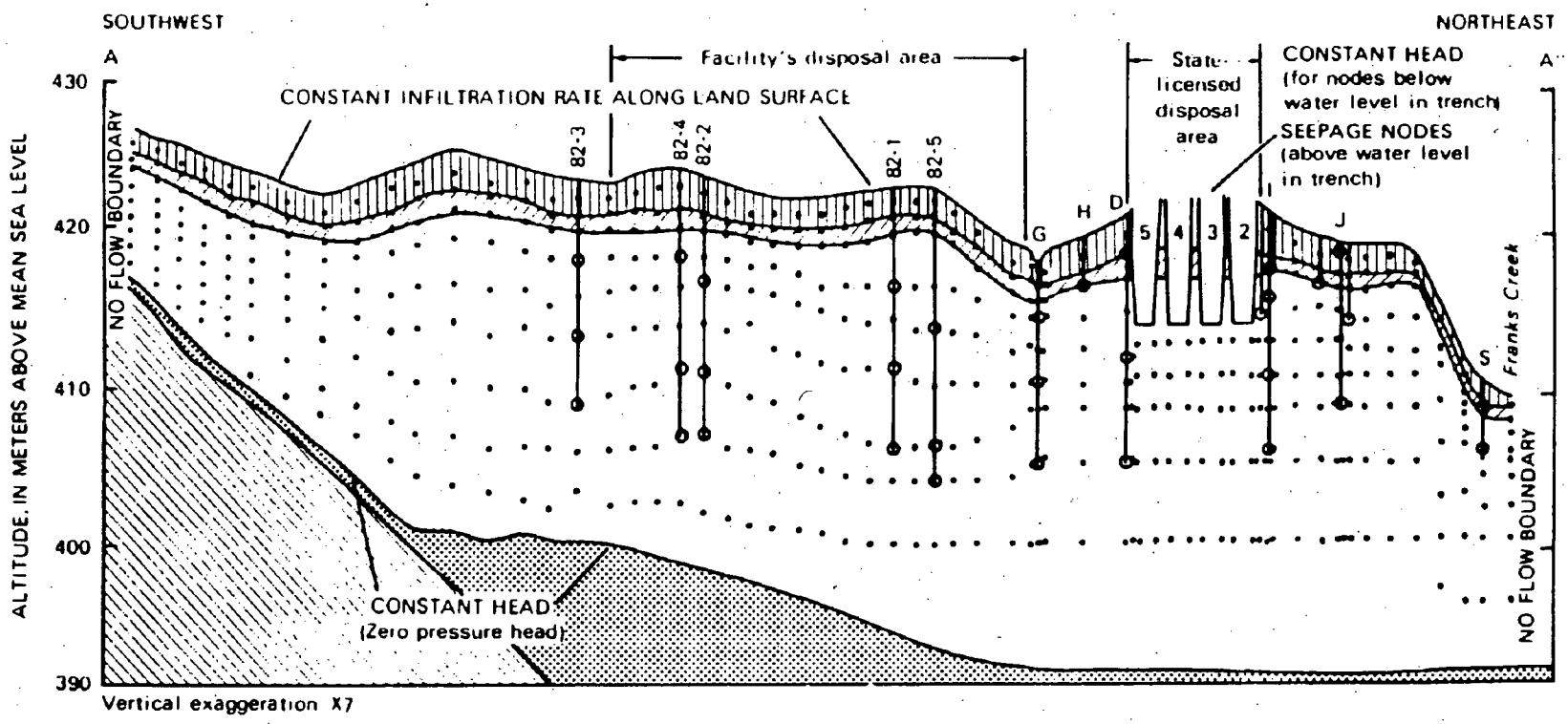



| LOCATION PLAN | NDA GROUND WATER FLOW MODEL | McMahon & Mann Consulting Engineers, P.C. | NOTE: 1. This figure was adapted from Figure 2 presented in Reference 2. |
|---|---|---|---|
| DWG. NO. 07011-055a | WEST VALLEY NEW YORK | 2495 MAIN STREET, SUITE 432 BUFFALO, NY 14214 (716) 834-8932 FAX: (716) 834-8934 | |
| FIGURE 4 | | | |




| GEOLOGIC SECTION | NDA GROUND WATER FLOW MODEL | McMahon & Mann Consulting Engineers, P.C. |
|---|---|---|
| DWG. NO. 07011-055b | WEST VALLEY NEW YORK | 2495 MAIN STREET, SUITE 432 BUFFALO, NY 14214 (716) 834-8932 FAX: (716) 834-8934 |
| FIGURE 5 | | |

NOTE:
1. This figure was adapted from Figure 5 presented in Reference 2.




EXPLANATION

GEOLOGIC UNITS

- Fractured, oxidized, weathered till
- Fractured, oxidized, unweathered till
- Unweathered till
- Lacustrine sandy silt
- Shale bedrock

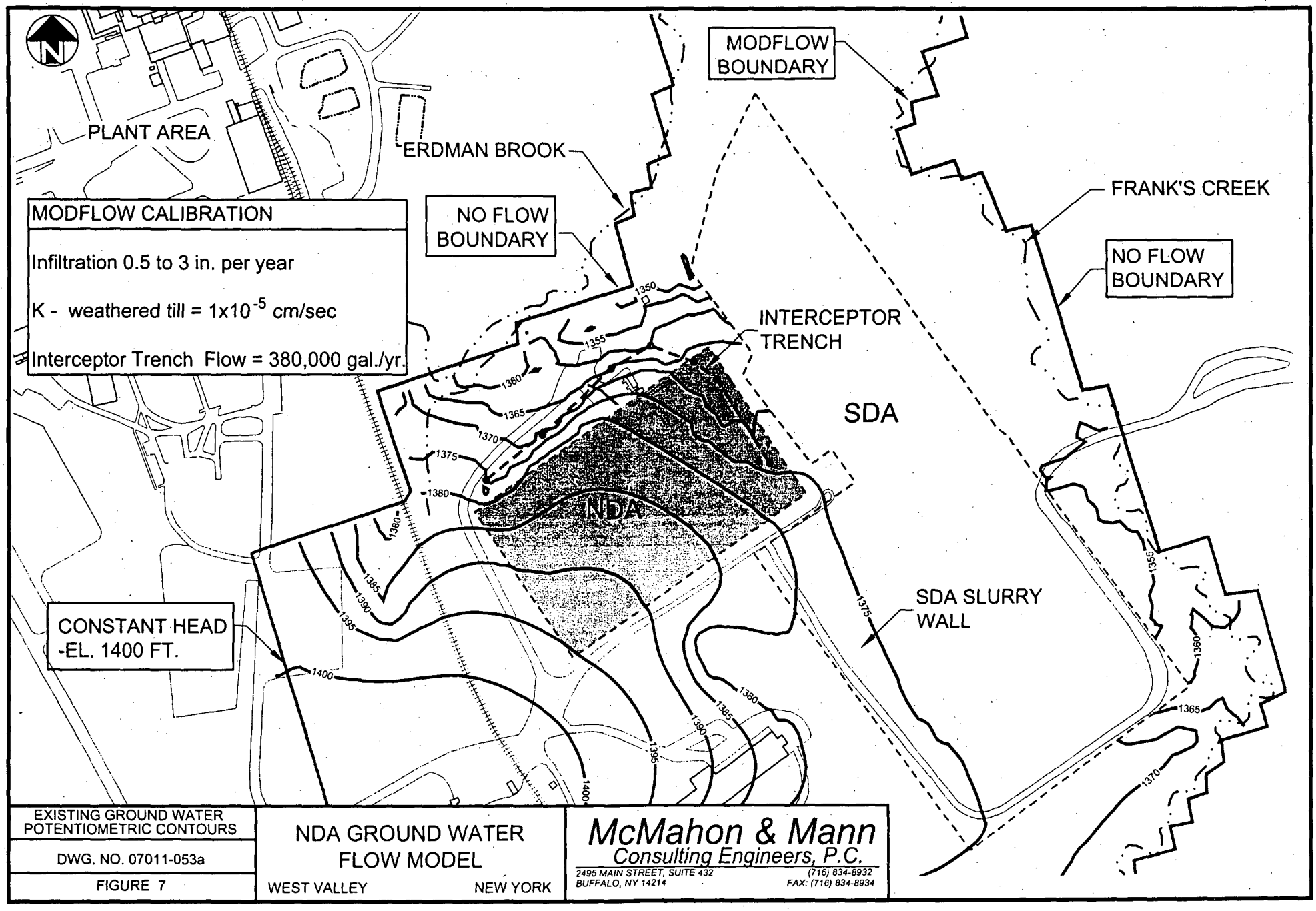
82-1 OBSERVATION WELL WITH PIEZOMETERS, AND NUMBER

• MODEL NODE

o MODEL NODE ASSOCIATED WITH PIEZOMETER

| | | |
|---|---|---|
| FINITE ELEMENT NODES AND BOUNDARIES | NDA GROUND WATER FLOW MODEL | McMahon & Mann Consulting Engineers, P.C. |
| DWG. NO. 07011-055c | WEST VALLEY NEW YORK | 2495 MAIN STREET, SUITE 432 BUFFALO, NY 14214 (716) 834-8932 FAX: (716) 834-8934 |
| FIGURE 6 | | |

NOTE:
1. This figure was adapted from Figure 8 presented in Reference 2.




EXISTING GROUND WATER POTENTIOMETRIC CONTOURS

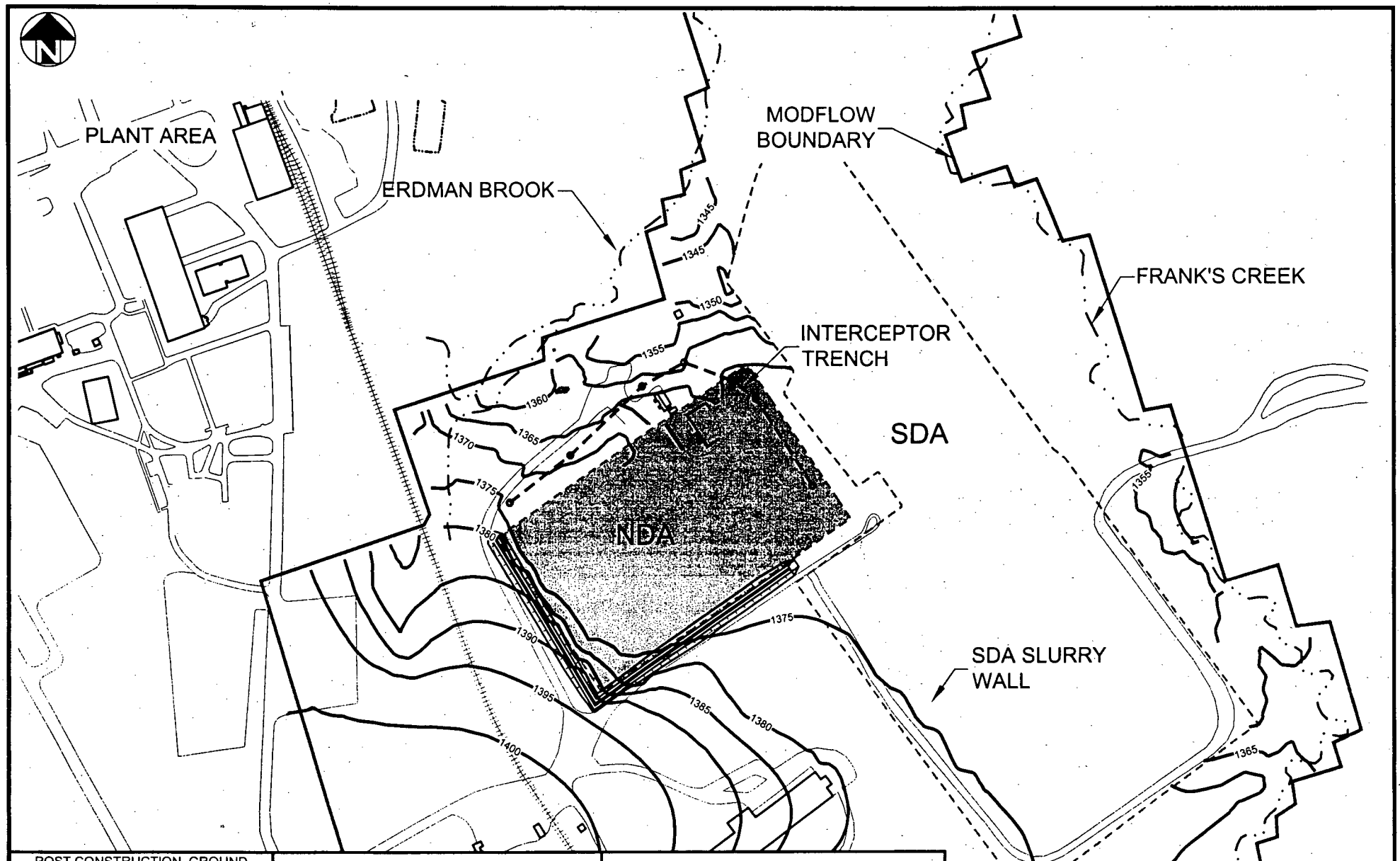
DWG. NO. 07011-053a

FIGURE 7

NDA GROUND WATER FLOW MODEL

WEST VALLEY NEW YORK

McMahon & Mann
Consulting Engineers, P.C.
2495 MAIN STREET, SUITE 432
BUFFALO, NY 14214
(716) 834-8932
FAX: (716) 834-8934




| | | |
|---|---|---|
| POST CONSTRUCTION GROUND WATER POTENTIOMETER CONTOURS | NDA GROUND WATER FLOW MODEL | McMahon & Mann Consulting Engineers, P.C. |
| DWG. NO. 07011-054a | WEST VALLEY NEW YORK | 2495 MAIN STREET, SUITE 432 BUFFALO, NY 14214 (716) 834-8932 FAX: (716) 834-8934 |
| FIGURE 8 | | |

# APPENDIX A

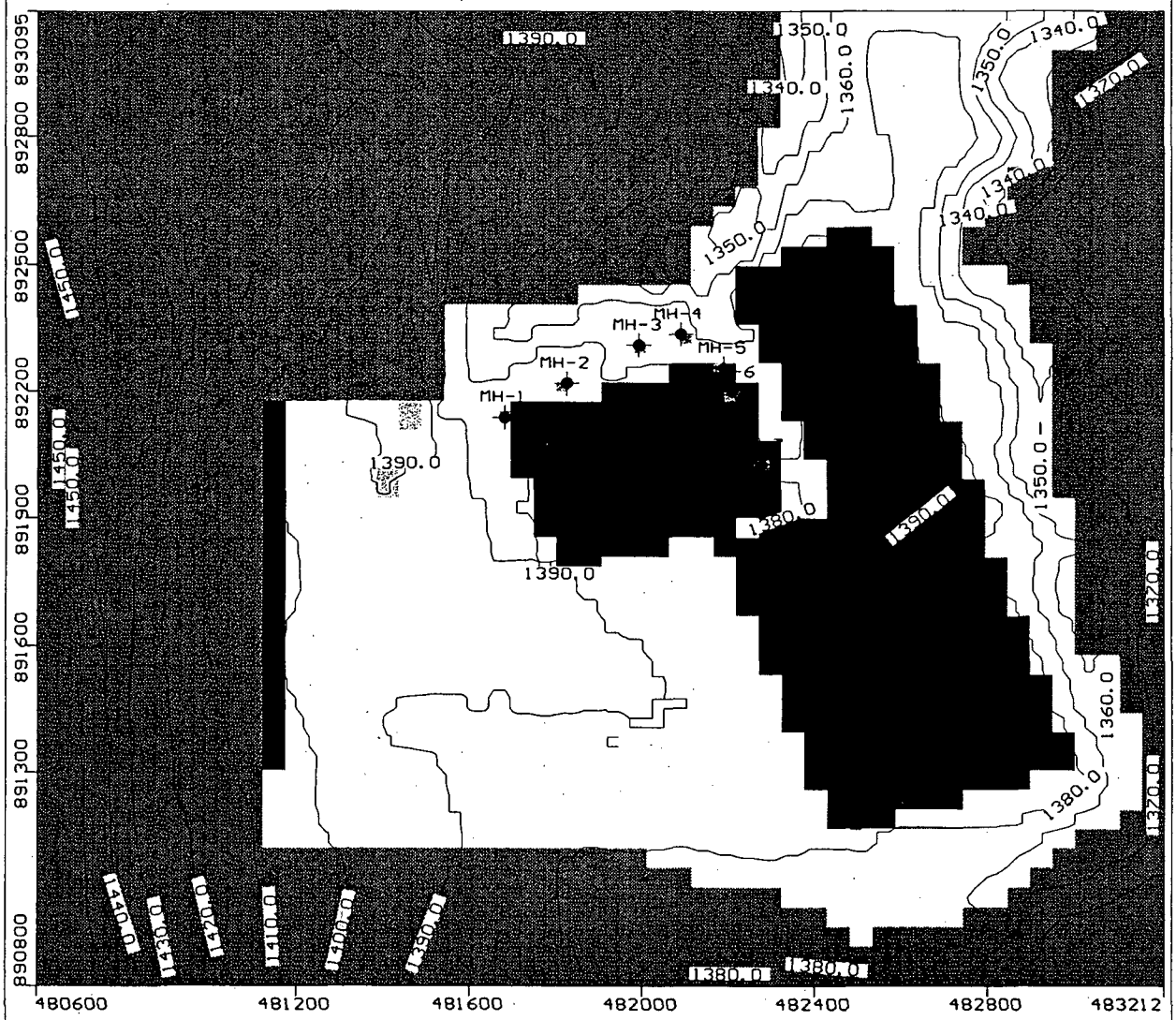
## MODFLOW INPUT AND OUTPUT

## REPORT ON GROUNDWATER MODELING
## WEST VALLEY ENVIRONMENTAL SERVICES, LLC
## NUCLEAR REGULATORY COMMISSION LICENSED DISPOSAL AREA
## CAP AND GROUNDWATER BARRIER PROJECT

# APPENDIX A-1

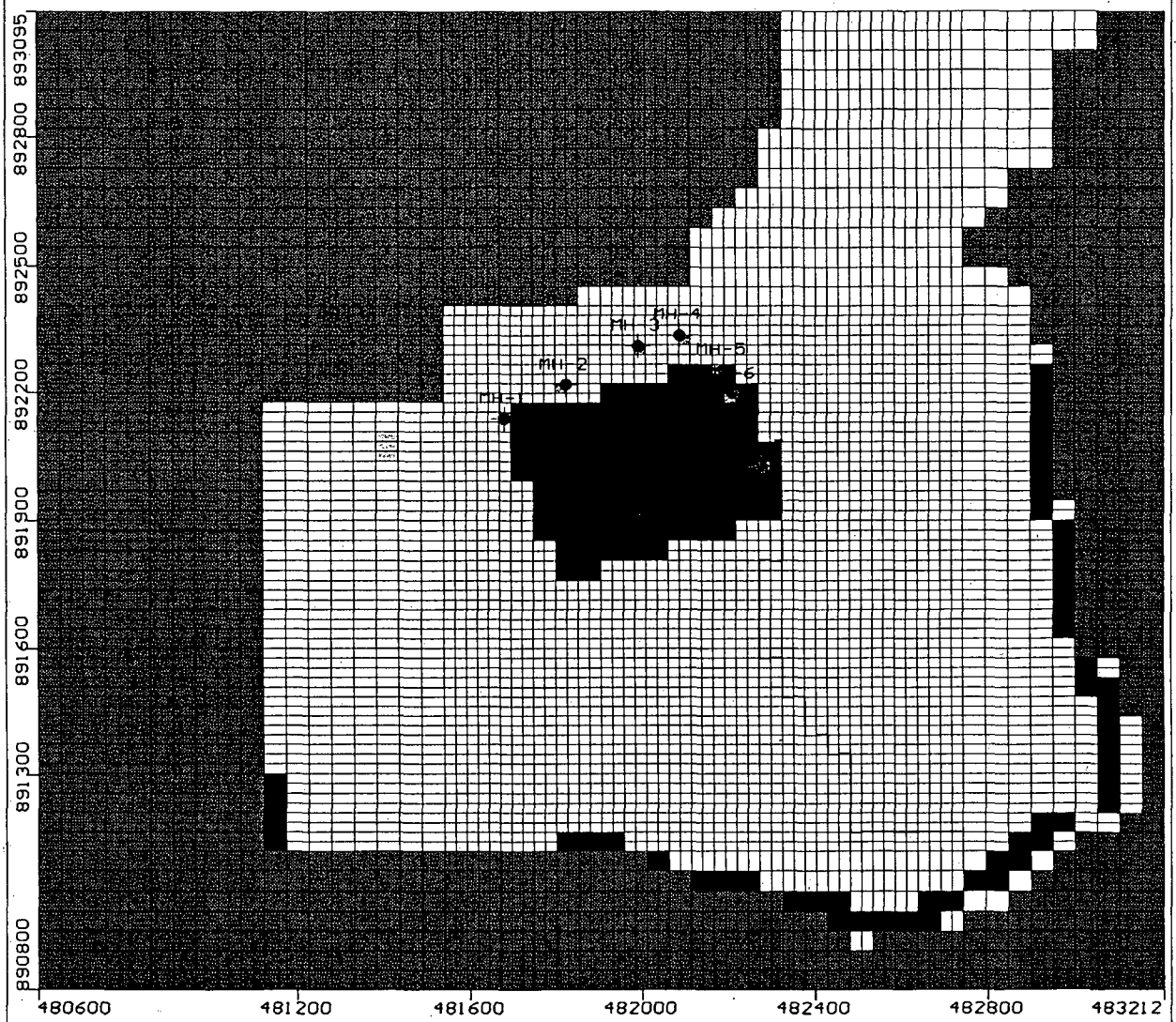
## MODFLOW INPUT

## REPORT ON GROUNDWATER MODELING
## WEST VALLEY ENVIRONMENTAL SERVICES, LLC
## NUCLEAR REGULATORY COMMISSION LICENSED DISPOSAL AREA
## CAP AND GROUNDWATER BARRIER PROJECT



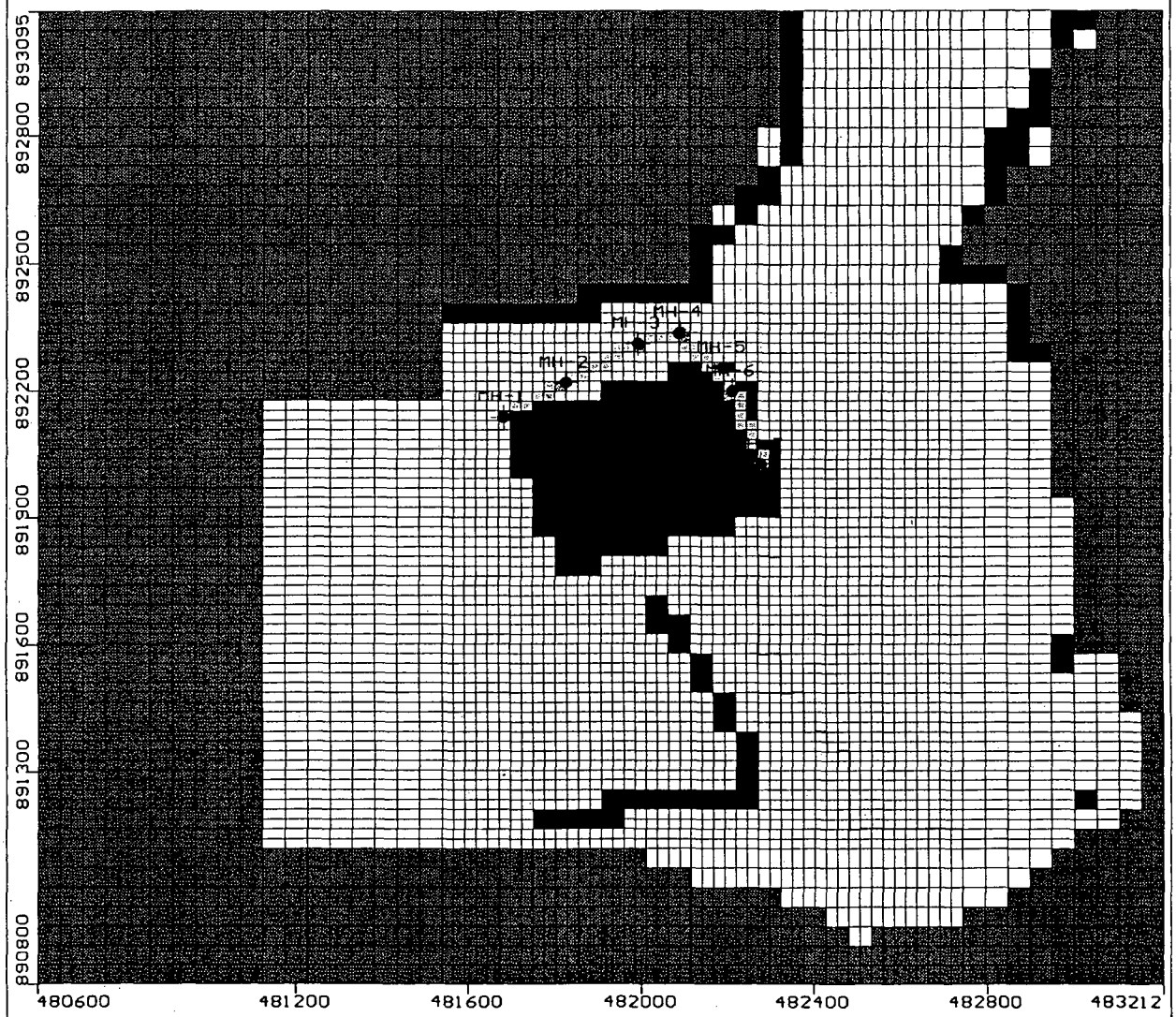

Grid Layer 1

| MMCE | WVNS NDA Existing Conditions |
|---|---|




Grid Layer 2

| | |
|---|---|
| MMCE | WVNS NDA Existing Conditions |




Grid Layer 3

| | |
|---|---|
| MMCE | WVNS NDA Existing Conditions |

```
                                   WVNS-NDA.LST
                                  MODFLOW-2000
     U.S. GEOLOGICAL SURVEY MODULAR FINITE-DIFFERENCE GROUND-WATER FLOW MODEL
                 VERSION 1.15.01 04/05/2005    +OpenMI+SLB

This model run combines GLOBAL and LIST output into this single file.

GLOBAL LISTING FILE: C:\vmodnt\WVNS\WVNS-NDA.LST
                         UNIT    6

OPENING C:\vmodnt\WVNS\WVNS-NDA.WHS
FILE TYPE:WHS   UNIT   53   STATUS:OLD
FORMAT:FORMATTED              ACCESS:SEQUENTIAL

OPENING C:\vmodnt\WVNS\WVNS-NDA.BAS
FILE TYPE:BAS6   UNIT   10   STATUS:OLD
FORMAT:FORMATTED              ACCESS:SEQUENTIAL

OPENING C:\vmodnt\WVNS\WVNS-NDA.BCF
FILE TYPE:BCF6   UNIT   11   STATUS:OLD
FORMAT:FORMATTED              ACCESS:SEQUENTIAL

OPENING C:\vmodnt\WVNS\WVNS-NDA.DRN
FILE TYPE:DRN   UNIT   13   STATUS:OLD
FORMAT:FORMATTED              ACCESS:SEQUENTIAL

OPENING C:\vmodnt\WVNS\WVNS-NDA.RIV
FILE TYPE:RIV   UNIT   14   STATUS:OLD
FORMAT:FORMATTED              ACCESS:SEQUENTIAL

OPENING C:\vmodnt\WVNS\WVNS-NDA.RCH
FILE TYPE:RCH   UNIT   18   STATUS:OLD
FORMAT:FORMATTED              ACCESS:SEQUENTIAL

OPENING C:\vmodnt\WVNS\WVNS-NDA.OC
FILE TYPE:OC   UNIT   22   STATUS:OLD
FORMAT:FORMATTED              ACCESS:SEQUENTIAL

OPENING C:\vmodnt\WVNS\WVNS-NDA.HFB
FILE TYPE:HFB6   UNIT   31   STATUS:OLD
FORMAT:FORMATTED              ACCESS:SEQUENTIAL

OPENING C:\vmodnt\WVNS\WVNS-NDA.DIS
FILE TYPE:DIS   UNIT   34   STATUS:OLD
FORMAT:FORMATTED              ACCESS:SEQUENTIAL

OPENING C:\vmodnt\WVNS\WVNS-NDA.NDC
FILE TYPE:NDC   UNIT   57   STATUS:OLD
FORMAT:FORMATTED              ACCESS:SEQUENTIAL

OPENING C:\vmodnt\WVNS\WVNS-NDA.HDS
FILE TYPE:DATA(BINARY)   UNIT  150   STATUS:UNKNOWN
FORMAT:UNFORMATTED            ACCESS:SEQUENTIAL

OPENING C:\vmodnt\WVNS\WVNS-NDA.DDN
FILE TYPE:DATA(BINARY)   UNIT  151   STATUS:UNKNOWN
FORMAT:UNFORMATTED            ACCESS:SEQUENTIAL

OPENING C:\vmodnt\WVNS\WVNS-NDA.BGT
FILE TYPE:DATA(BINARY)   UNIT  154   STATUS:UNKNOWN
FORMAT:UNFORMATTED            ACCESS:SEQUENTIAL
```

```
                                    WVNS-NDA.LST
DISCRETIZATION INPUT DATA READ FROM UNIT   34
#Discretization Package translator - (c) 2001 Waterloo Hydrogeologic Software
#WVNS-NDA.DIS Wed Jun 27 17:15:39 2007
   3 LAYERS        78 ROWS        73 COLUMNS
   1 STRESS PERIOD(S) IN SIMULATION
MODEL TIME UNIT IS YEARS
MODEL LENGTH UNIT IS FEET
 --- GUI Regime ---
THE GROUND-WATER TRANSPORT PROCESS IS INACTIVE

THE OBSERVATION PROCESS IS INACTIVE
THE SENSITIVITY PROCESS IS INACTIVE
THE PARAMETER-ESTIMATION PROCESS IS INACTIVE

MODE: FORWARD

 Confining bed flag for each layer:
  0   0   0

    153889  ELEMENTS OF GX ARRAY USED OUT OF     153889
     17082  ELEMENTS OF GZ ARRAY USED OUT OF      17082
     17082  ELEMENTS OF IG ARRAY USED OUT OF      17082


                                DELR
READING ON UNIT   34 WITH FORMAT: (10E16.9)


                                DELC
READING ON UNIT   34 WITH FORMAT: (10E16.9)


          TOP ELEVATION OF LAYER 1
READING ON UNIT   34 WITH FORMAT: (10E14.7)


            MODEL LAYER BOTTOM EL. FOR LAYER   1
READING ON UNIT   34 WITH FORMAT: (10E14.7)


            MODEL LAYER BOTTOM EL. FOR LAYER   2
READING ON UNIT   34 WITH FORMAT: (10E14.7)


            MODEL LAYER BOTTOM EL. FOR LAYER   3
READING ON UNIT   34 WITH FORMAT: (10E14.7)

STRESS PERIOD     LENGTH       TIME STEPS     MULTIPLIER FOR DELT    SS FLAG
----------------------------------------------------------------------------
       1         1.000000          1                    1.000         SS

STEADY-STATE SIMULATION


0WHS1  - CGSTAB-P PROCEDURE SOLUTION PACKAGE, VERSION 1, 8/4/95 INPUT READ FROM UNIT
```

```
1
MAXIMUM OF  200 OUTER ITERATIONS ALLOWED FOR CLOSURE
MAXIMUM OF   50 INNER ITERATIONS ALLOWED
    409968 ELEMENTS IN X ARRAY ARE USED BY CGSTAB-P
     34164 ELEMENTS IN Z ARRAY ARE USED BY CGSTAB-P

    409968  ELEMENTS OF X ARRAY USED OUT OF     409968
     34164  ELEMENTS OF Z ARRAY USED OUT OF      34164
         0  ELEMENTS OF IX ARRAY USED OUT OF          1
         0  ELEMENTS OF XHS ARRAY USED OUT OF          1
0


                                                        SOLUTION BY CGSTAB-P

-----------------------------------------
0                                          MAXIMUM ITERATIONS ALLOWED FOR
CLOSURE =      200
0                                          MAXIMUM INNER ITERATIONS ALLOWED =
   50
                                                        DAMPING FACTOR =
1.0000
                                                   HEAD CHANGE CRITERION FOR
CLOSURE =    0.20000E-01
 MAXIMUM RESIDUAL FOR LINEAR ITERATION    0.20000E-01
 MAXIMUM RELATIVE RESIDUAL FOR LINEAR ITERATION    0.00000E+00

 #Basic Package translator - (c) 2001 Waterloo Hydrogeologic Software
 #WVNS-NDA.BAS Wed Jun 27 17:15:38 2007
    3 LAYERS        78 ROWS        73 COLUMNS
    1 STRESS PERIOD(S) IN SIMULATION

 BAS6 -- BASIC PACKAGE, VERSION 6, 1/11/2000 INPUT READ FROM UNIT   10
         15 ELEMENTS IN IR ARRAY ARE USED BY BAS

 BCF6 -- BLOCK-CENTERED FLOW PACKAGE, VERSION 6, 1/11/2000
         INPUT READ FROM UNIT 11
 STEADY-STATE SIMULATION
 CELL-BY-CELL FLOWS WILL BE SAVED ON UNIT154
 HEAD AT CELLS THAT CONVERT TO DRY= -0.10000E+31
 WETTING CAPABILITY IS NOT ACTIVE
      LAYER  LAYER-TYPE CODE     INTERBLOCK T
      ---------------------------------------
         1            1          0 -- HARMONIC
         2            2          0 -- HARMONIC
         3            2          0 -- HARMONIC
      17085 ELEMENTS IN RX ARRAY ARE USED BY BCF

 DRN6 -- DRAIN PACKAGE, VERSION 6, 1/11/2000 INPUT READ FROM UNIT   13
 No named parameters
 MAXIMUM OF     53 ACTIVE DRAINS AT ONE TIME
 CELL-BY-CELL FLOWS WILL BE SAVED ON UNIT  154
        265 ELEMENTS IN RX ARRAY ARE USED BY DRN

 RIV6 -- RIVER PACKAGE, VERSION 6, 1/11/2000 INPUT READ FROM UNIT   14
 No named parameters
 MAXIMUM OF    293 ACTIVE RIVER REACHES AT ONE TIME
 CELL-BY-CELL FLOWS WILL BE SAVED ON UNIT  154
       1758 ELEMENTS IN RX ARRAY ARE USED BY RIV

 RCH6 -- RECHARGE PACKAGE, VERSION 6, 1/11/2000 INPUT READ FROM UNIT   18
 No named parameters
 OPTION 3 -- RECHARGE TO HIGHEST ACTIVE NODE IN EACH VERTICAL COLUMN
```

```
                                    WVNS-NDA.LST
CELL-BY-CELL FLOWS WILL BE SAVED ON UNIT  154
      5694 ELEMENTS IN RX ARRAY ARE USED BY RCH
      5694 ELEMENTS IN IR ARRAY ARE USED BY RCH
HFB6 -- HORIZONTAL FLOW BARRIER PACKAGE, VERSION 6, 1/11/1000.
  INPUT READ FROM UNIT   31
    0 PARAMETERS DEFINE A MAXIMUM OF      0 HORIZONTAL FLOW BARRIERS
   156 HORIZONTAL FLOW BARRIERS NOT DEFINED BY PARAMETERS
      1092 ELEMENTS IN RX ARRAY ARE USED FOR
          HORIZONTAL FLOW BARRIER PACKAGE

     25894  ELEMENTS OF RX ARRAY USED OUT OF      25894
      5709  ELEMENTS OF IR ARRAY USED OUT OF       5709
1
#Basic Package translator - (c) 2001 Waterloo Hydrogeologic Software
#WVNS-NDA.BAS Wed Jun 27 17:15:38 2007


                     BOUNDARY ARRAY FOR LAYER   1
READING ON UNIT   10 WITH FORMAT: (40I2)


                     BOUNDARY ARRAY FOR LAYER   2
READING ON UNIT   10 WITH FORMAT: (40I2)


                     BOUNDARY ARRAY FOR LAYER   3
READING ON UNIT   10 WITH FORMAT: (40I2)

AQUIFER HEAD WILL BE SET TO 1.00000E+30 AT ALL NO-FLOW NODES (IBOUND=0).


                       INITIAL HEAD FOR LAYER   1
READING ON UNIT   10 WITH FORMAT:  (10G12.5)


                       INITIAL HEAD FOR LAYER   2
READING ON UNIT   10 WITH FORMAT:  (10G12.5)


                       INITIAL HEAD FOR LAYER   3
READING ON UNIT   10 WITH FORMAT:  (10G12.5)

OUTPUT CONTROL IS SPECIFIED EVERY TIME STEP
HEAD PRINT FORMAT CODE IS   0    DRAWDOWN PRINT FORMAT CODE IS   0
HEADS WILL BE SAVED ON UNIT  150    DRAWDOWNS WILL BE SAVED ON UNIT  151


          COLUMN TO ROW ANISOTROPY
READING ON UNIT   11 WITH FORMAT: (10G11.4)


             HYD. COND. ALONG ROWS FOR LAYER   1
READING ON UNIT   11 WITH FORMAT:  (10G11.4)
```

```
          VERT HYD COND /THICKNESS FOR LAYER   1
READING ON UNIT   11 WITH FORMAT:  (10G11.4)


              TRANSMIS. ALONG ROWS FOR LAYER   2
READING ON UNIT   11 WITH FORMAT:  (10G11.4)


          VERT HYD COND /THICKNESS FOR LAYER   2
READING ON UNIT   11 WITH FORMAT:  (10G11.4)


              TRANSMIS. ALONG ROWS FOR LAYER   3
READING ON UNIT   11 WITH FORMAT:  (10G11.4)

    0 Drain parameters

    0 River parameters

    0 Recharge parameters

    0 HFB parameters

   156 BARRIERS NOT DEFINED BY PARAMETERS
```

| BARRIER | LAYER | IROW1 | ICOL1 | IROW2 | ICOL2 | HYDCHR |
|---|---|---|---|---|---|---|
| 1 | 1 | 52 | 47 | 51 | 47 | 0.41386E-01 |
| 2 | 1 | 51 | 47 | 51 | 46 | 0.41386E-01 |
| 3 | 1 | 50 | 47 | 50 | 46 | 0.41386E-01 |
| 4 | 1 | 49 | 47 | 49 | 46 | 0.41386E-01 |
| 5 | 1 | 48 | 47 | 48 | 46 | 0.41386E-01 |
| 6 | 1 | 47 | 47 | 47 | 46 | 0.41386E-01 |
| 7 | 1 | 46 | 47 | 46 | 46 | 0.41386E-01 |
| 8 | 1 | 45 | 47 | 45 | 46 | 0.41386E-01 |
| 9 | 1 | 44 | 47 | 44 | 46 | 0.41386E-01 |
| 10 | 1 | 43 | 47 | 43 | 46 | 0.41386E-01 |
| 11 | 1 | 42 | 47 | 42 | 46 | 0.41386E-01 |
| 12 | 1 | 41 | 47 | 42 | 47 | 0.41386E-01 |
| 13 | 1 | 51 | 48 | 52 | 48 | 0.41386E-01 |
| 14 | 1 | 42 | 48 | 41 | 48 | 0.41386E-01 |
| 15 | 1 | 56 | 49 | 55 | 49 | 0.41386E-01 |
| 16 | 1 | 55 | 49 | 55 | 48 | 0.41386E-01 |
| 17 | 1 | 54 | 49 | 54 | 48 | 0.41386E-01 |
| 18 | 1 | 53 | 49 | 53 | 48 | 0.41386E-01 |
| 19 | 1 | 52 | 49 | 52 | 48 | 0.41386E-01 |
| 20 | 1 | 41 | 49 | 41 | 48 | 0.41386E-01 |
| 21 | 1 | 40 | 49 | 40 | 48 | 0.41386E-01 |
| 22 | 1 | 39 | 49 | 39 | 48 | 0.41386E-01 |
| 23 | 1 | 38 | 49 | 38 | 48 | 0.41386E-01 |
| 24 | 1 | 55 | 50 | 56 | 50 | 0.41386E-01 |
| 25 | 1 | 60 | 51 | 59 | 51 | 0.41386E-01 |
| 26 | 1 | 59 | 51 | 59 | 50 | 0.41386E-01 |
| 27 | 1 | 58 | 51 | 58 | 50 | 0.41386E-01 |
| 28 | 1 | 57 | 51 | 57 | 50 | 0.41386E-01 |
| 29 | 1 | 56 | 51 | 56 | 50 | 0.41386E-01 |
| 30 | 1 | 59 | 52 | 60 | 52 | 0.41386E-01 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 31 | 1 | 62 | 53 | 61 | 53 | 0.41386E-01 |
| 32 | 1 | 61 | 53 | 61 | 52 | 0.41386E-01 |
| 33 | 1 | 60 | 53 | 60 | 52 | 0.41386E-01 |
| 34 | 1 | 61 | 54 | 62 | 54 | 0.41386E-01 |
| 35 | 1 | 70 | 55 | 69 | 55 | 0.41386E-01 |
| 36 | 1 | 69 | 55 | 69 | 54 | 0.41386E-01 |
| 37 | 1 | 68 | 55 | 68 | 54 | 0.41386E-01 |
| 38 | 1 | 67 | 55 | 67 | 54 | 0.41386E-01 |
| 39 | 1 | 66 | 55 | 66 | 54 | 0.41386E-01 |
| 40 | 1 | 65 | 55 | 65 | 54 | 0.41386E-01 |
| 41 | 1 | 64 | 55 | 64 | 54 | 0.41386E-01 |
| 42 | 1 | 63 | 55 | 63 | 54 | 0.41386E-01 |
| 43 | 1 | 62 | 55 | 62 | 54 | 0.41386E-01 |
| 44 | 1 | 69 | 56 | 70 | 56 | 0.41386E-01 |
| 45 | 1 | 69 | 57 | 70 | 57 | 0.41386E-01 |
| 46 | 1 | 69 | 58 | 70 | 58 | 0.41386E-01 |
| 47 | 1 | 69 | 59 | 70 | 59 | 0.41386E-01 |
| 48 | 1 | 69 | 60 | 70 | 60 | 0.41386E-01 |
| 49 | 1 | 69 | 61 | 70 | 61 | 0.41386E-01 |
| 50 | 1 | 69 | 62 | 70 | 62 | 0.41386E-01 |
| 51 | 1 | 69 | 63 | 70 | 63 | 0.41386E-01 |
| 52 | 1 | 69 | 64 | 70 | 64 | 0.41386E-01 |
| 53 | 2 | 52 | 47 | 51 | 47 | 0.22058 |
| 54 | 2 | 51 | 47 | 51 | 46 | 0.22059 |
| 55 | 2 | 50 | 47 | 50 | 46 | 0.22059 |
| 56 | 2 | 49 | 47 | 49 | 46 | 0.22059 |
| 57 | 2 | 48 | 47 | 48 | 46 | 0.22059 |
| 58 | 2 | 47 | 47 | 47 | 46 | 0.22058 |
| 59 | 2 | 46 | 47 | 46 | 46 | 0.22058 |
| 60 | 2 | 45 | 47 | 45 | 46 | 0.22059 |
| 61 | 2 | 44 | 47 | 44 | 46 | 0.22059 |
| 62 | 2 | 43 | 47 | 43 | 46 | 0.22059 |
| 63 | 2 | 42 | 47 | 42 | 46 | 0.22059 |
| 64 | 2 | 41 | 47 | 42 | 47 | 0.22058 |
| 65 | 2 | 51 | 48 | 52 | 48 | 0.22059 |
| 66 | 2 | 42 | 48 | 41 | 48 | 0.22059 |
| 67 | 2 | 56 | 49 | 55 | 49 | 0.22100 |
| 68 | 2 | 55 | 49 | 55 | 48 | 0.22058 |
| 69 | 2 | 54 | 49 | 54 | 48 | 0.22058 |
| 70 | 2 | 53 | 49 | 53 | 48 | 0.22058 |
| 71 | 2 | 52 | 49 | 52 | 48 | 0.22058 |
| 72 | 2 | 41 | 49 | 41 | 48 | 0.22059 |
| 73 | 2 | 40 | 49 | 40 | 48 | 0.22059 |
| 74 | 2 | 39 | 49 | 39 | 48 | 0.22059 |
| 75 | 2 | 38 | 49 | 38 | 48 | 0.22059 |
| 76 | 2 | 55 | 50 | 56 | 50 | 0.22058 |
| 77 | 2 | 60 | 51 | 59 | 51 | 0.22058 |
| 78 | 2 | 59 | 51 | 59 | 50 | 0.22058 |
| 79 | 2 | 58 | 51 | 58 | 50 | 0.22058 |
| 80 | 2 | 57 | 51 | 57 | 50 | 0.22059 |
| 81 | 2 | 56 | 51 | 56 | 50 | 0.22059 |
| 82 | 2 | 59 | 52 | 60 | 52 | 0.22058 |
| 83 | 2 | 62 | 53 | 61 | 53 | 0.22100 |
| 84 | 2 | 61 | 53 | 61 | 52 | 0.22058 |
| 85 | 2 | 60 | 53 | 60 | 52 | 0.22058 |
| 86 | 2 | 61 | 54 | 62 | 54 | 0.22058 |
| 87 | 2 | 70 | 55 | 69 | 55 | 0.22058 |
| 88 | 2 | 69 | 55 | 69 | 54 | 0.22058 |
| 89 | 2 | 68 | 55 | 68 | 54 | 0.22058 |
| 90 | 2 | 67 | 55 | 67 | 54 | 0.22058 |
| 91 | 2 | 66 | 55 | 66 | 54 | 0.22058 |
| 92 | 2 | 65 | 55 | 65 | 54 | 0.22058 |
| 93 | 2 | 64 | 55 | 64 | 54 | 0.22058 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 94 | 2 | 63 | 55 | 63 | 54 | 0.22059 |
| 95 | 2 | 62 | 55 | 62 | 54 | 0.22059 |
| 96 | 2 | 69 | 56 | 70 | 56 | 0.22058 |
| 97 | 2 | 69 | 57 | 70 | 57 | 0.22059 |
| 98 | 2 | 69 | 58 | 70 | 58 | 0.22059 |
| 99 | 2 | 69 | 59 | 70 | 59 | 0.22059 |
| 100 | 2 | 69 | 60 | 70 | 60 | 0.22059 |
| 101 | 2 | 69 | 61 | 70 | 61 | 0.22058 |
| 102 | 2 | 69 | 62 | 70 | 62 | 0.22058 |
| 103 | 2 | 69 | 63 | 70 | 63 | 0.22058 |
| 104 | 2 | 69 | 64 | 70 | 64 | 0.22058 |
| 105 | 3 | 52 | 47 | 51 | 47 | 0.22059 |
| 106 | 3 | 51 | 47 | 51 | 46 | 0.22058 |
| 107 | 3 | 50 | 47 | 50 | 46 | 0.22058 |
| 108 | 3 | 49 | 47 | 49 | 46 | 0.22058 |
| 109 | 3 | 48 | 47 | 48 | 46 | 0.22058 |
| 110 | 3 | 47 | 47 | 47 | 46 | 0.22058 |
| 111 | 3 | 46 | 47 | 46 | 46 | 0.22058 |
| 112 | 3 | 45 | 47 | 45 | 46 | 0.22058 |
| 113 | 3 | 44 | 47 | 44 | 46 | 0.22058 |
| 114 | 3 | 43 | 47 | 43 | 46 | 0.22058 |
| 115 | 3 | 42 | 47 | 42 | 46 | 0.22058 |
| 116 | 3 | 41 | 47 | 42 | 47 | 0.22058 |
| 117 | 3 | 51 | 48 | 52 | 48 | 0.22058 |
| 118 | 3 | 42 | 48 | 41 | 48 | 0.22058 |
| 119 | 3 | 56 | 49 | 55 | 49 | 0.22017 |
| 120 | 3 | 55 | 49 | 55 | 48 | 0.22058 |
| 121 | 3 | 54 | 49 | 54 | 48 | 0.22058 |
| 122 | 3 | 53 | 49 | 53 | 48 | 0.22059 |
| 123 | 3 | 52 | 49 | 52 | 48 | 0.22059 |
| 124 | 3 | 41 | 49 | 41 | 48 | 0.22058 |
| 125 | 3 | 40 | 49 | 40 | 48 | 0.22058 |
| 126 | 3 | 39 | 49 | 39 | 48 | 0.22058 |
| 127 | 3 | 38 | 49 | 38 | 48 | 0.22058 |
| 128 | 3 | 55 | 50 | 56 | 50 | 0.22058 |
| 129 | 3 | 60 | 51 | 59 | 51 | 0.22058 |
| 130 | 3 | 59 | 51 | 59 | 50 | 0.22058 |
| 131 | 3 | 58 | 51 | 58 | 50 | 0.22058 |
| 132 | 3 | 57 | 51 | 57 | 50 | 0.22058 |
| 133 | 3 | 56 | 51 | 56 | 50 | 0.22058 |
| 134 | 3 | 59 | 52 | 60 | 52 | 0.22058 |
| 135 | 3 | 62 | 53 | 61 | 53 | 0.22059 |
| 136 | 3 | 61 | 53 | 61 | 52 | 0.22059 |
| 137 | 3 | 60 | 53 | 60 | 52 | 0.22059 |
| 138 | 3 | 61 | 54 | 62 | 54 | 0.22059 |
| 139 | 3 | 70 | 55 | 69 | 55 | 0.22058 |
| 140 | 3 | 69 | 55 | 69 | 54 | 0.22059 |
| 141 | 3 | 68 | 55 | 68 | 54 | 0.22059 |
| 142 | 3 | 67 | 55 | 67 | 54 | 0.22058 |
| 143 | 3 | 66 | 55 | 66 | 54 | 0.22058 |
| 144 | 3 | 65 | 55 | 65 | 54 | 0.22059 |
| 145 | 3 | 64 | 55 | 64 | 54 | 0.22059 |
| 146 | 3 | 63 | 55 | 63 | 54 | 0.22058 |
| 147 | 3 | 62 | 55 | 62 | 54 | 0.22058 |
| 148 | 3 | 69 | 56 | 70 | 56 | 0.22059 |
| 149 | 3 | 69 | 57 | 70 | 57 | 0.22058 |
| 150 | 3 | 69 | 58 | 70 | 58 | 0.22058 |
| 151 | 3 | 69 | 59 | 70 | 59 | 0.22058 |
| 152 | 3 | 69 | 60 | 70 | 60 | 0.22058 |
| 153 | 3 | 69 | 61 | 70 | 61 | 0.22059 |
| 154 | 3 | 69 | 62 | 70 | 62 | 0.22059 |
| 155 | 3 | 69 | 63 | 70 | 63 | 0.22059 |
| 156 | 3 | 69 | 64 | 70 | 64 | 0.22059 |

WVNS-NDA.LST

156 HFB BARRIERS
1

STRESS PERIOD NO. 1, LENGTH = 1.000000

NUMBER OF TIME STEPS = 1

MULTIPLIER FOR DELT = 1.000

INITIAL TIME STEP SIZE = 1.000000

| DRAIN NO. | LAYER | ROW | COL | DRAIN EL. | CONDUCTANCE |
|---|---|---|---|---|---|
| 1 | 3 | 27 | 24 | 1374. | 3711. |
| 2 | 3 | 26 | 25 | 1374. | 0.2168E+05 |
| 3 | 3 | 26 | 26 | 1374. | 0.2672E+05 |
| 4 | 3 | 25 | 27 | 1372. | 0.2967E+05 |
| 5 | 3 | 25 | 28 | 1372. | 0.1578E+05 |
| 6 | 3 | 24 | 28 | 1372. | 0.1389E+05 |
| 7 | 3 | 24 | 29 | 1370. | 0.2970E+05 |
| 8 | 3 | 23 | 30 | 1369. | 0.2566E+05 |
| 9 | 3 | 23 | 31 | 1367. | 0.2032E+05 |
| 10 | 3 | 22 | 31 | 1367. | 9819. |
| 11 | 3 | 22 | 32 | 1367. | 0.3014E+05 |
| 12 | 3 | 22 | 33 | 1365. | 6025. |
| 13 | 3 | 21 | 33 | 1366. | 0.2412E+05 |
| 14 | 3 | 21 | 34 | 1366. | 0.2187E+05 |
| 15 | 3 | 20 | 34 | 1366. | 8273. |
| 16 | 3 | 20 | 35 | 1364. | 0.3014E+05 |
| 17 | 3 | 20 | 36 | 1364. | 7571. |
| 18 | 3 | 19 | 36 | 1365. | 0.2053E+05 |
| 19 | 3 | 19 | 37 | 1362. | 0.2693E+05 |
| 20 | 3 | 19 | 38 | 1362. | 0.2693E+05 |
| 21 | 3 | 19 | 39 | 1359. | 0.1656E+05 |
| 22 | 3 | 18 | 39 | 1359. | 0.1037E+05 |
| 23 | 3 | 20 | 40 | 1364. | 3249. |
| 24 | 3 | 19 | 40 | 1359. | 0.2403E+05 |
| 25 | 3 | 18 | 40 | 1359. | 7042. |
| 26 | 3 | 21 | 41 | 1364. | 7741. |
| 27 | 3 | 20 | 41 | 1363. | 0.2920E+05 |
| 28 | 3 | 22 | 42 | 1368. | 0.1223E+05 |
| 29 | 3 | 21 | 42 | 1364. | 0.2471E+05 |
| 30 | 3 | 23 | 43 | 1366. | 0.2041E+05 |
| 31 | 3 | 22 | 43 | 1366. | 0.2022E+05 |
| 32 | 3 | 25 | 44 | 1369. | 0.1118E+05 |
| 33 | 3 | 24 | 44 | 1369. | 0.2801E+05 |
| 34 | 3 | 23 | 44 | 1366. | 7731. |
| 35 | 3 | 28 | 45 | 1369. | 2529. |
| 36 | 3 | 27 | 45 | 1369. | 0.2493E+05 |
| 37 | 3 | 26 | 45 | 1368. | 0.2493E+05 |
| 38 | 3 | 25 | 45 | 1367. | 0.1451E+05 |
| 39 | 3 | 30 | 46 | 1370. | 0.1956E+05 |
| 40 | 3 | 29 | 46 | 1370. | 0.2493E+05 |
| 41 | 3 | 28 | 46 | 1369. | 0.2240E+05 |
| 42 | 3 | 32 | 47 | 1370. | 0.1404E+05 |
| 43 | 3 | 31 | 47 | 1370. | 0.2493E+05 |
| 44 | 2 | 31 | 16 | 1383. | 0.2368E+07 |
| 45 | 2 | 30 | 16 | 1382. | 0.2368E+07 |
| 46 | 2 | 29 | 16 | 1381. | 0.2292E+07 |
| 47 | 1 | 35 | 16 | 1386. | 0.1753E+07 |
| 48 | 1 | 34 | 16 | 1385. | 0.2368E+07 |
| 49 | 1 | 33 | 16 | 1384. | 0.2368E+07 |

| | | | | | |
|---|---|---|---|---|---|
| 50 | 1 | 32 | 16 | 1384. | 0.2368E+07 |
| 51 | 1 | 28 | 17 | 1379. | 0.2368E+07 |
| 52 | 1 | 27 | 17 | 1378. | 0.2368E+07 |
| 53 | 1 | 26 | 17 | 1377. | 0.2368E+07 |

53 DRAINS

| REACH NO. | LAYER | ROW | COL | STAGE | CONDUCTANCE | BOTTOM EL. |
|---|---|---|---|---|---|---|
| 1 | 3 | 17 | 19 | 1377. | 1000. | 1376. |
| 2 | 3 | 16 | 19 | 1377. | 1000. | 1376. |
| 3 | 3 | 17 | 20 | 1377. | 1000. | 1376. |
| 4 | 3 | 16 | 20 | 1377. | 1000. | 1376. |
| 5 | 3 | 17 | 21 | 1365. | 1000. | 1364. |
| 6 | 3 | 16 | 21 | 1365. | 1000. | 1364. |
| 7 | 3 | 17 | 22 | 1365. | 1000. | 1364. |
| 8 | 3 | 16 | 22 | 1365. | 1000. | 1364. |
| 9 | 3 | 17 | 23 | 1362. | 1000. | 1361. |
| 10 | 3 | 16 | 23 | 1362. | 1000. | 1361. |
| 11 | 3 | 17 | 24 | 1362. | 1000. | 1361. |
| 12 | 3 | 16 | 24 | 1362. | 1000. | 1361. |
| 13 | 3 | 17 | 25 | 1358. | 1000. | 1357. |
| 14 | 3 | 16 | 25 | 1358. | 1000. | 1357. |
| 15 | 3 | 17 | 26 | 1358. | 1000. | 1357. |
| 16 | 3 | 16 | 26 | 1358. | 1000. | 1357. |
| 17 | 3 | 69 | 27 | 1375. | 1000. | 1374. |
| 18 | 3 | 68 | 27 | 1375. | 1000. | 1374. |
| 19 | 3 | 17 | 27 | 1356. | 1000. | 1355. |
| 20 | 3 | 16 | 27 | 1356. | 1000. | 1355. |
| 21 | 3 | 69 | 28 | 1375. | 1000. | 1374. |
| 22 | 3 | 68 | 28 | 1375. | 1000. | 1374. |
| 23 | 3 | 17 | 28 | 1356. | 1000. | 1355. |
| 24 | 3 | 16 | 28 | 1356. | 1000. | 1355. |
| 25 | 3 | 69 | 29 | 1374. | 1000. | 1373. |
| 26 | 3 | 68 | 29 | 1374. | 1000. | 1373. |
| 27 | 3 | 17 | 29 | 1357. | 1000. | 1356. |
| 28 | 3 | 16 | 29 | 1357. | 1000. | 1356. |
| 29 | 3 | 69 | 30 | 1374. | 1000. | 1373. |
| 30 | 3 | 68 | 30 | 1374. | 1000. | 1373. |
| 31 | 3 | 17 | 30 | 1357. | 1000. | 1356. |
| 32 | 3 | 16 | 30 | 1357. | 1000. | 1356. |
| 33 | 3 | 69 | 31 | 1373. | 1000. | 1372. |
| 34 | 3 | 68 | 31 | 1373. | 1000. | 1372. |
| 35 | 3 | 17 | 31 | 1365. | 1000. | 1364. |
| 36 | 3 | 16 | 31 | 1365. | 1000. | 1364. |
| 37 | 3 | 15 | 31 | 1354. | 1000. | 1353. |
| 38 | 3 | 69 | 32 | 1373. | 1000. | 1372. |
| 39 | 3 | 68 | 32 | 1373. | 1000. | 1372. |
| 40 | 3 | 17 | 32 | 1365. | 1000. | 1364. |
| 41 | 3 | 16 | 32 | 1365. | 1000. | 1364. |
| 42 | 3 | 15 | 32 | 1354. | 1000. | 1353. |
| 43 | 3 | 69 | 33 | 1374. | 1000. | 1373. |
| 44 | 3 | 68 | 33 | 1374. | 1000. | 1373. |
| 45 | 3 | 67 | 33 | 1375. | 1000. | 1374. |
| 46 | 3 | 66 | 33 | 1375. | 1000. | 1374. |
| 47 | 3 | 15 | 33 | 1357. | 1000. | 1356. |
| 48 | 3 | 69 | 34 | 1374. | 1000. | 1373. |
| 49 | 3 | 68 | 34 | 1374. | 1000. | 1373. |
| 50 | 3 | 67 | 34 | 1375. | 1000. | 1374. |
| 51 | 3 | 66 | 34 | 1375. | 1000. | 1374. |
| 52 | 3 | 15 | 34 | 1357. | 1000. | 1356. |
| 53 | 3 | 67 | 35 | 1376. | 1000. | 1375. |
| 54 | 3 | 66 | 35 | 1376. | 1000. | 1375. |

| | | | | | | |
|---|---|---|---|---|---|---|
| 55 | 3 | 15 | 35 | 1354. | 1000. | 1353. |
| 56 | 3 | 67 | 36 | 1376. | 1000. | 1375. |
| 57 | 3 | 66 | 36 | 1376. | 1000. | 1375. |
| 58 | 3 | 15 | 36 | 1354. | 1000. | 1353. |
| 59 | 3 | 67 | 37 | 1376. | 1000. | 1375. |
| 60 | 3 | 66 | 37 | 1376. | 1000. | 1375. |
| 61 | 3 | 49 | 37 | 1377. | 1000. | 1376. |
| 62 | 3 | 48 | 37 | 1377. | 1000. | 1376. |
| 63 | 3 | 47 | 37 | 1375. | 1000. | 1374. |
| 64 | 3 | 46 | 37 | 1375. | 1000. | 1374. |
| 65 | 3 | 15 | 37 | 1351. | 1000. | 1350. |
| 66 | 3 | 67 | 38 | 1376. | 1000. | 1375. |
| 67 | 3 | 66 | 38 | 1376. | 1000. | 1375. |
| 68 | 3 | 49 | 38 | 1377. | 1000. | 1376. |
| 69 | 3 | 48 | 38 | 1377. | 1000. | 1376. |
| 70 | 3 | 47 | 38 | 1375. | 1000. | 1374. |
| 71 | 3 | 46 | 38 | 1375. | 1000. | 1374. |
| 72 | 3 | 15 | 38 | 1351. | 1000. | 1350. |
| 73 | 3 | 67 | 39 | 1375. | 1000. | 1374. |
| 74 | 3 | 66 | 39 | 1375. | 1000. | 1374. |
| 75 | 3 | 51 | 39 | 1378. | 1000. | 1377. |
| 76 | 3 | 50 | 39 | 1378. | 1000. | 1377. |
| 77 | 3 | 49 | 39 | 1376. | 1000. | 1375. |
| 78 | 3 | 48 | 39 | 1376. | 1000. | 1375. |
| 79 | 3 | 15 | 39 | 1357. | 1000. | 1356. |
| 80 | 3 | 67 | 40 | 1375. | 1000. | 1374. |
| 81 | 3 | 66 | 40 | 1375. | 1000. | 1374. |
| 82 | 3 | 51 | 40 | 1378. | 1000. | 1377. |
| 83 | 3 | 50 | 40 | 1378. | 1000. | 1377. |
| 84 | 3 | 49 | 40 | 1376. | 1000. | 1375. |
| 85 | 3 | 48 | 40 | 1376. | 1000. | 1375. |
| 86 | 3 | 15 | 40 | 1357. | 1000. | 1356. |
| 87 | 3 | 67 | 41 | 1375. | 1000. | 1374. |
| 88 | 3 | 66 | 41 | 1375. | 1000. | 1374. |
| 89 | 3 | 55 | 41 | 1380. | 1000. | 1379. |
| 90 | 3 | 54 | 41 | 1380. | 1000. | 1379. |
| 91 | 3 | 53 | 41 | 1377. | 1000. | 1376. |
| 92 | 3 | 52 | 41 | 1377. | 1000. | 1376. |
| 93 | 3 | 15 | 41 | 1350. | 1000. | 1349. |
| 94 | 3 | 14 | 41 | 1346. | 1000. | 1345. |
| 95 | 3 | 13 | 41 | 1345. | 1000. | 1344. |
| 96 | 3 | 12 | 41 | 1340. | 1000. | 1339. |
| 97 | 3 | 67 | 42 | 1375. | 1000. | 1374. |
| 98 | 3 | 66 | 42 | 1375. | 1000. | 1374. |
| 99 | 3 | 55 | 42 | 1380. | 1000. | 1379. |
| 100 | 3 | 54 | 42 | 1380. | 1000. | 1379. |
| 101 | 3 | 53 | 42 | 1377. | 1000. | 1376. |
| 102 | 3 | 52 | 42 | 1377. | 1000. | 1376. |
| 103 | 3 | 15 | 42 | 1350. | 1000. | 1349. |
| 104 | 3 | 14 | 42 | 1346. | 1000. | 1345. |
| 105 | 3 | 13 | 42 | 1345. | 1000. | 1344. |
| 106 | 3 | 12 | 42 | 1340. | 1000. | 1339. |
| 107 | 3 | 67 | 43 | 1375. | 1000. | 1374. |
| 108 | 3 | 66 | 43 | 1375. | 1000. | 1374. |
| 109 | 3 | 59 | 43 | 1379. | 1000. | 1378. |
| 110 | 3 | 58 | 43 | 1379. | 1000. | 1378. |
| 111 | 3 | 57 | 43 | 1379. | 1000. | 1378. |
| 112 | 3 | 56 | 43 | 1379. | 1000. | 1378. |
| 113 | 3 | 12 | 43 | 1338. | 1000. | 1337. |
| 114 | 3 | 67 | 44 | 1375. | 1000. | 1374. |
| 115 | 3 | 66 | 44 | 1375. | 1000. | 1374. |
| 116 | 3 | 59 | 44 | 1379. | 1000. | 1378. |
| 117 | 3 | 58 | 44 | 1379. | 1000. | 1378. |

| | | | | | | |
|---|---|---|---|---|---|---|
| 118 | 3 | 57 | 44 | 1379. | 1000. | 1378. |
| 119 | 3 | 56 | 44 | 1379. | 1000. | 1378. |
| 120 | 3 | 12 | 44 | 1338. | 1000. | 1337. |
| 121 | 3 | 67 | 45 | 1375. | 1000. | 1374. |
| 122 | 3 | 66 | 45 | 1375. | 1000. | 1374. |
| 123 | 3 | 65 | 45 | 1375. | 1000. | 1374. |
| 124 | 3 | 64 | 45 | 1375. | 1000. | 1374. |
| 125 | 3 | 63 | 45 | 1376. | 1000. | 1375. |
| 126 | 3 | 62 | 45 | 1376. | 1000. | 1375. |
| 127 | 3 | 61 | 45 | 1375. | 1000. | 1374. |
| 128 | 3 | 60 | 45 | 1375. | 1000. | 1374. |
| 129 | 3 | 11 | 45 | 1336. | 1000. | 1335. |
| 130 | 3 | 10 | 45 | 1337. | 1000. | 1336. |
| 131 | 3 | 67 | 46 | 1375. | 1000. | 1374. |
| 132 | 3 | 66 | 46 | 1375. | 1000. | 1374. |
| 133 | 3 | 65 | 46 | 1375. | 1000. | 1374. |
| 134 | 3 | 64 | 46 | 1375. | 1000. | 1374. |
| 135 | 3 | 63 | 46 | 1376. | 1000. | 1375. |
| 136 | 3 | 62 | 46 | 1376. | 1000. | 1375. |
| 137 | 3 | 61 | 46 | 1375. | 1000. | 1374. |
| 138 | 3 | 60 | 46 | 1375. | 1000. | 1374. |
| 139 | 3 | 11 | 46 | 1336. | 1000. | 1335. |
| 140 | 3 | 10 | 46 | 1337. | 1000. | 1336. |
| 141 | 3 | 10 | 47 | 1350. | 1000. | 1349. |
| 142 | 3 | 9 | 47 | 1349. | 1000. | 1348. |
| 143 | 3 | 10 | 48 | 1350. | 1000. | 1349. |
| 144 | 3 | 9 | 48 | 1349. | 1000. | 1348. |
| 145 | 3 | 8 | 49 | 1350. | 1000. | 1349. |
| 146 | 3 | 7 | 49 | 1344. | 1000. | 1343. |
| 147 | 3 | 6 | 49 | 1341. | 1000. | 1340. |
| 148 | 3 | 5 | 49 | 1341. | 1000. | 1340. |
| 149 | 3 | 4 | 49 | 1338. | 1000. | 1337. |
| 150 | 3 | 3 | 49 | 1335. | 1000. | 1334. |
| 151 | 3 | 2 | 49 | 1332. | 1000. | 1331. |
| 152 | 3 | 1 | 49 | 1347. | 1000. | 1346. |
| 153 | 3 | 8 | 50 | 1350. | 1000. | 1349. |
| 154 | 3 | 7 | 50 | 1344. | 1000. | 1343. |
| 155 | 3 | 6 | 50 | 1341. | 1000. | 1340. |
| 156 | 3 | 5 | 50 | 1341. | 1000. | 1340. |
| 157 | 3 | 4 | 50 | 1338. | 1000. | 1337. |
| 158 | 3 | 3 | 50 | 1335. | 1000. | 1334. |
| 159 | 3 | 2 | 50 | 1332. | 1000. | 1331. |
| 160 | 3 | 1 | 50 | 1347. | 1000. | 1346. |
| 161 | 3 | 14 | 63 | 1348. | 1000. | 1347. |
| 162 | 3 | 13 | 63 | 1349. | 1000. | 1349. |
| 163 | 3 | 14 | 64 | 1348. | 1000. | 1347. |
| 164 | 3 | 13 | 64 | 1349. | 1000. | 1349. |
| 165 | 3 | 14 | 65 | 1342. | 1000. | 1341. |
| 166 | 3 | 11 | 65 | 1338. | 1000. | 1337. |
| 167 | 3 | 14 | 66 | 1341. | 1000. | 1340. |
| 168 | 3 | 10 | 66 | 1334. | 1000. | 1334. |
| 169 | 3 | 9 | 66 | 1342. | 1000. | 1342. |
| 170 | 3 | 8 | 66 | 1357. | 1000. | 1356. |
| 171 | 3 | 7 | 66 | 1363. | 1000. | 1362. |
| 172 | 3 | 21 | 67 | 1341. | 1000. | 1340. |
| 173 | 3 | 20 | 67 | 1341. | 1000. | 1340. |
| 174 | 3 | 19 | 67 | 1338. | 1000. | 1337. |
| 175 | 3 | 18 | 67 | 1338. | 1000. | 1337. |
| 176 | 3 | 17 | 67 | 1335. | 1000. | 1334. |
| 177 | 3 | 16 | 67 | 1335. | 1000. | 1334. |
| 178 | 3 | 15 | 67 | 1336. | 1000. | 1335. |
| 179 | 3 | 8 | 67 | 1342. | 1000. | 1341. |
| 180 | 3 | 7 | 67 | 1347. | 1000. | 1347. |

| | | | | | | |
|---|---|---|---|---|---|---|
| 181 | 3 | 6 | 67 | 1341. | 1000. | 1341. |
| 182 | 3 | 21 | 68 | 1336. | 1000. | 1335. |
| 183 | 3 | 20 | 68 | 1336. | 1000. | 1335. |
| 184 | 3 | 6 | 68 | 1332. | 1000. | 1332. |
| 185 | 3 | 5 | 68 | 1333. | 1000. | 1333. |
| 186 | 3 | 4 | 68 | 1334. | 1000. | 1334. |
| 187 | 3 | 53 | 69 | 1355. | 1000. | 1354. |
| 188 | 3 | 52 | 69 | 1355. | 1000. | 1354. |
| 189 | 3 | 51 | 69 | 1355. | 1000. | 1354. |
| 190 | 3 | 50 | 69 | 1355. | 1000. | 1354. |
| 191 | 3 | 2 | 69 | 1333. | 1000. | 1332. |
| 192 | 3 | 1 | 69 | 1342. | 1000. | 1341. |
| 193 | 3 | 67 | 70 | 1365. | 1000. | 1364. |
| 194 | 3 | 66 | 70 | 1365. | 1000. | 1364. |
| 195 | 3 | 1 | 70 | 1334. | 1000. | 1334. |
| 196 | 2 | 71 | 29 | 1377. | 1000. | 1376. |
| 197 | 2 | 70 | 29 | 1377. | 1000. | 1376. |
| 198 | 2 | 71 | 30 | 1377. | 1000. | 1376. |
| 199 | 2 | 70 | 30 | 1377. | 1000. | 1376. |
| 200 | 2 | 71 | 31 | 1376. | 1000. | 1375. |
| 201 | 2 | 70 | 31 | 1376. | 1000. | 1375. |
| 202 | 2 | 71 | 32 | 1376. | 1000. | 1375. |
| 203 | 2 | 70 | 32 | 1376. | 1000. | 1375. |
| 204 | 2 | 71 | 33 | 1377. | 1000. | 1376. |
| 205 | 2 | 70 | 33 | 1377. | 1000. | 1376. |
| 206 | 2 | 71 | 34 | 1377. | 1000. | 1376. |
| 207 | 2 | 70 | 34 | 1377. | 1000. | 1376. |
| 208 | 2 | 72 | 37 | 1374. | 1000. | 1373. |
| 209 | 2 | 72 | 38 | 1374. | 1000. | 1373. |
| 210 | 2 | 73 | 41 | 1372. | 1000. | 1371. |
| 211 | 2 | 73 | 42 | 1372. | 1000. | 1371. |
| 212 | 2 | 73 | 43 | 1372. | 1000. | 1371. |
| 213 | 2 | 73 | 44 | 1372. | 1000. | 1371. |
| 214 | 2 | 73 | 45 | 1372. | 1000. | 1371. |
| 215 | 2 | 73 | 46 | 1372. | 1000. | 1371. |
| 216 | 2 | 74 | 49 | 1370. | 1000. | 1369. |
| 217 | 2 | 74 | 50 | 1370. | 1000. | 1369. |
| 218 | 2 | 74 | 51 | 1370. | 1000. | 1369. |
| 219 | 2 | 74 | 52 | 1370. | 1000. | 1369. |
| 220 | 2 | 75 | 53 | 1369. | 1000. | 1368. |
| 221 | 2 | 74 | 53 | 1370. | 1000. | 1369. |
| 222 | 2 | 75 | 54 | 1369. | 1000. | 1368. |
| 223 | 2 | 74 | 54 | 1370. | 1000. | 1369. |
| 224 | 2 | 75 | 55 | 1369. | 1000. | 1368. |
| 225 | 2 | 75 | 56 | 1369. | 1000. | 1368. |
| 226 | 2 | 75 | 57 | 1368. | 1000. | 1367. |
| 227 | 2 | 75 | 58 | 1368. | 1000. | 1367. |
| 228 | 2 | 75 | 59 | 1369. | 1000. | 1368. |
| 229 | 2 | 75 | 60 | 1369. | 1000. | 1368. |
| 230 | 2 | 75 | 61 | 1368. | 1000. | 1367. |
| 231 | 2 | 74 | 61 | 1368. | 1000. | 1367. |
| 232 | 2 | 75 | 62 | 1368. | 1000. | 1367. |
| 233 | 2 | 74 | 62 | 1368. | 1000. | 1367. |
| 234 | 2 | 74 | 63 | 1367. | 1000. | 1366. |
| 235 | 2 | 74 | 64 | 1367. | 1000. | 1366. |
| 236 | 2 | 73 | 65 | 1367. | 1000. | 1366. |
| 237 | 2 | 73 | 66 | 1365. | 1000. | 1364. |
| 238 | 2 | 72 | 66 | 1369. | 1000. | 1368. |
| 239 | 2 | 72 | 67 | 1365. | 1000. | 1364. |
| 240 | 2 | 71 | 67 | 1370. | 1000. | 1369. |
| 241 | 2 | 70 | 67 | 1370. | 1000. | 1369. |
| 242 | 2 | 71 | 68 | 1366. | 1000. | 1365. |
| 243 | 2 | 70 | 68 | 1366. | 1000. | 1365. |

| | | | | | | |
|---|---|---|---|---|---|---|
| 244 | 2 | 69 | 68 | 1373. | 1000. | 1372. |
| 245 | 2 | 68 | 68 | 1373. | 1000. | 1372. |
| 246 | 2 | 37 | 68 | 1354. | 1000. | 1353. |
| 247 | 2 | 36 | 68 | 1354. | 1000. | 1353. |
| 248 | 2 | 35 | 68 | 1349. | 1000. | 1348. |
| 249 | 2 | 34 | 68 | 1349. | 1000. | 1348. |
| 250 | 2 | 33 | 68 | 1345. | 1000. | 1344. |
| 251 | 2 | 32 | 68 | 1345. | 1000. | 1344. |
| 252 | 2 | 31 | 68 | 1344. | 1000. | 1343. |
| 253 | 2 | 30 | 68 | 1344. | 1000. | 1343. |
| 254 | 2 | 29 | 68 | 1345. | 1000. | 1344. |
| 255 | 2 | 28 | 68 | 1345. | 1000. | 1344. |
| 256 | 2 | 27 | 68 | 1346. | 1000. | 1345. |
| 257 | 2 | 26 | 68 | 1346. | 1000. | 1345. |
| 258 | 2 | 25 | 68 | 1345. | 1000. | 1344. |
| 259 | 2 | 24 | 68 | 1345. | 1000. | 1344. |
| 260 | 2 | 23 | 68 | 1343. | 1000. | 1342. |
| 261 | 2 | 22 | 68 | 1343. | 1000. | 1342. |
| 262 | 2 | 69 | 69 | 1369. | 1000. | 1368. |
| 263 | 2 | 68 | 69 | 1369. | 1000. | 1368. |
| 264 | 2 | 49 | 69 | 1355. | 1000. | 1354. |
| 265 | 2 | 48 | 69 | 1358. | 1000. | 1357. |
| 266 | 2 | 47 | 69 | 1353. | 1000. | 1352. |
| 267 | 2 | 46 | 69 | 1353. | 1000. | 1352. |
| 268 | 2 | 45 | 69 | 1352. | 1000. | 1351. |
| 269 | 2 | 44 | 69 | 1352. | 1000. | 1351. |
| 270 | 2 | 43 | 69 | 1354. | 1000. | 1353. |
| 271 | 2 | 42 | 69 | 1354. | 1000. | 1353. |
| 272 | 2 | 41 | 69 | 1359. | 1000. | 1358. |
| 273 | 2 | 40 | 69 | 1359. | 1000. | 1358. |
| 274 | 2 | 39 | 69 | 1352. | 1000. | 1351. |
| 275 | 2 | 38 | 69 | 1352. | 1000. | 1351. |
| 276 | 2 | 55 | 70 | 1359. | 1000. | 1358. |
| 277 | 2 | 54 | 70 | 1359. | 1000. | 1358. |
| 278 | 2 | 53 | 70 | 1355. | 1000. | 1354. |
| 279 | 2 | 52 | 70 | 1355. | 1000. | 1354. |
| 280 | 2 | 67 | 71 | 1362. | 1000. | 1361. |
| 281 | 2 | 66 | 71 | 1362. | 1000. | 1361. |
| 282 | 2 | 65 | 71 | 1365. | 1000. | 1364. |
| 283 | 2 | 64 | 71 | 1365. | 1000. | 1364. |
| 284 | 2 | 63 | 71 | 1363. | 1000. | 1362. |
| 285 | 2 | 62 | 71 | 1363. | 1000. | 1362. |
| 286 | 2 | 61 | 71 | 1360. | 1000. | 1359. |
| 287 | 2 | 60 | 71 | 1360. | 1000. | 1359. |
| 288 | 2 | 59 | 71 | 1357. | 1000. | 1356. |
| 289 | 2 | 58 | 71 | 1357. | 1000. | 1356. |
| 290 | 2 | 57 | 71 | 1355. | 1000. | 1354. |
| 291 | 2 | 56 | 71 | 1355. | 1000. | 1354. |
| 292 | 2 | 55 | 71 | 1356. | 1000. | 1355. |
| 293 | 2 | 54 | 71 | 1356. | 1000. | 1355. |

293 RIVER REACHES

RECHARGE
READING ON UNIT 18 WITH FORMAT: (15G11.4)

SOLVING FOR HEAD
0

SOLUTION BY CGSTAB-P

WVNS-NDA.LST

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-------------------------------------------

 CELL CONVERSIONS FOR ITER.=  1  LAYER=  1  STEP=  1  PERIOD=  1   (ROW,COL)
    DRY(  1, 49)   DRY(  1, 50)   DRY(  1, 51)   DRY(  1, 52)   DRY(  1, 53)
    DRY(  1, 70)   DRY(  2, 50)   DRY(  2, 51)   DRY(  2, 53)   DRY(  2, 55)
    DRY(  2, 68)   DRY(  2, 69)   DRY(  2, 70)   DRY(  3, 50)   DRY(  3, 51)
    DRY(  3, 53)   DRY(  3, 67)   DRY(  3, 68)   DRY(  4, 50)   DRY(  4, 51)
    DRY(  4, 53)   DRY(  4, 64)   DRY(  4, 66)   DRY(  4, 67)   DRY(  5, 50)
    DRY(  5, 51)   DRY(  5, 53)   DRY(  5, 55)   DRY(  5, 57)   DRY(  5, 67)
    DRY(  5, 68)   DRY(  6, 50)   DRY(  6, 51)   DRY(  6, 55)   DRY(  6, 66)
    DRY(  6, 68)   DRY(  7, 48)   DRY(  7, 49)   DRY(  7, 51)   DRY(  7, 55)
    DRY(  7, 57)   DRY(  7, 68)   DRY(  8, 48)   DRY(  8, 49)   DRY(  8, 51)
    DRY(  8, 57)   DRY(  8, 68)   DRY(  9, 49)   DRY(  9, 51)   DRY(  9, 57)
    DRY(  9, 64)   DRY(  9, 65)   DRY(  9, 66)   DRY( 10, 47)   DRY( 10, 49)
    DRY( 10, 51)   DRY( 10, 57)   DRY( 10, 62)   DRY( 10, 64)   DRY( 10, 65)
    DRY( 10, 66)   DRY( 11, 47)   DRY( 11, 64)   DRY( 11, 65)   DRY( 12, 64)
    DRY( 13, 64)   DRY( 14, 64)   DRY( 14, 65)   DRY( 15, 64)   DRY( 16, 64)
    DRY( 19, 20)   DRY( 22, 20)   DRY( 23, 20)   DRY( 24, 20)   DRY( 25, 20)
 Outer iteration    1 Inner iteration   1 Max. residual  3.878E+03
 Outer iteration    1 Inner iteration   2 Max. residual  1.539E+03
 Outer iteration    1 Inner iteration   3 Max. residual  8.290E+02
 Outer iteration    1 Inner iteration   4 Max. residual  5.192E+02
 Outer iteration    1 Inner iteration   5 Max. residual  3.675E+02
 Outer iteration    1 Inner iteration   6 Max. residual  2.500E+02
 Outer iteration    1 Inner iteration   7 Max. residual  2.080E+02
 Outer iteration    1 Inner iteration   8 Max. residual  2.434E+02
 Outer iteration    1 Inner iteration   9 Max. residual  1.185E+02
 Outer iteration    1 Inner iteration  10 Max. residual  1.032E+02
 Outer iteration    1 Inner iteration  11 Max. residual -8.868E+01
 Outer iteration    1 Inner iteration  12 Max. residual  6.499E+01
 Outer iteration    1 Inner iteration  13 Max. residual  6.082E+01
 Outer iteration    1 Inner iteration  14 Max. residual  6.189E+01
 Outer iteration    1 Inner iteration  15 Max. residual -7.473E+01
 Outer iteration    1 Inner iteration  16 Max. residual  5.022E+01
 Outer iteration    1 Inner iteration  17 Max. residual  4.353E+01
 Outer iteration    1 Inner iteration  18 Max. residual  4.112E+01
 Outer iteration    1 Inner iteration  19 Max. residual  3.350E+01
 Outer iteration    1 Inner iteration  20 Max. residual  2.521E+01
 Outer iteration    1 Inner iteration  21 Max. residual  3.003E+01
 Outer iteration    1 Inner iteration  22 Max. residual  4.248E+01
 Outer iteration    1 Inner iteration  23 Max. residual  1.433E+01
 Outer iteration    1 Inner iteration  24 Max. residual  3.571E+01
 Outer iteration    1 Inner iteration  25 Max. residual  1.074E+01
 Outer iteration    1 Inner iteration  26 Max. residual  2.532E+01
 Outer iteration    1 Inner iteration  27 Max. residual -6.780E+00
 Outer iteration    1 Inner iteration  28 Max. residual  1.086E+01
 Outer iteration    1 Inner iteration  29 Max. residual -9.662E+00
 Outer iteration    1 Inner iteration  30 Max. residual -5.049E+00
 Outer iteration    1 Inner iteration  31 Max. residual -7.840E+00
 Outer iteration    1 Inner iteration  32 Max. residual  1.338E+00
 Outer iteration    1 Inner iteration  33 Max. residual  6.750E+00
 Outer iteration    1 Inner iteration  34 Max. residual -1.524E+00
 Outer iteration    1 Inner iteration  35 Max. residual  3.334E+00
 Outer iteration    1 Inner iteration  36 Max. residual -1.407E+00
 Outer iteration    1 Inner iteration  37 Max. residual -1.309E+00
 Outer iteration    1 Inner iteration  38 Max. residual -1.295E+00
 Outer iteration    1 Inner iteration  39 Max. residual -4.097E-01
 Outer iteration    1 Inner iteration  40 Max. residual -1.173E+00
 Outer iteration    1 Inner iteration  41 Max. residual -1.324E+00
 Outer iteration    1 Inner iteration  42 Max. residual -8.586E-01
 Outer iteration    1 Inner iteration  43 Max. residual  2.151E+00
 Outer iteration    1 Inner iteration  44 Max. residual -3.460E-01
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Outer iteration    1 Inner iteration  45 Max. residual -1.547E-01
Outer iteration    1 Inner iteration  46 Max. residual -1.194E-01
Outer iteration    1 Inner iteration  47 Max. residual -1.127E-01
Outer iteration    1 Inner iteration  48 Max. residual -1.098E-01
Outer iteration    1 Inner iteration  49 Max. residual -1.158E-01
Outer iteration    1 Inner iteration  50 Max. residual -3.229E-01
0

                                                    SOLUTION BY CGSTAB-P

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CELL CONVERSIONS FOR ITER.=  2  LAYER=  1  STEP=  1  PERIOD=  1   (ROW,COL)
   DRY(  1, 69)   DRY(  4, 68)   DRY(  6, 67)   DRY(  7, 66)   DRY(  7, 67)
   DRY(  8, 66)   DRY(  8, 67)   DRY(  9, 50)   DRY(  9, 52)   DRY(  9, 53)
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DRY( 61, 56)   DRY( 61, 57)   DRY( 61, 58)   DRY( 61, 59)   DRY( 61, 60)
DRY( 61, 61)   DRY( 61, 62)   DRY( 61, 63)   DRY( 61, 64)   DRY( 61, 65)
DRY( 61, 66)   DRY( 61, 67)   DRY( 61, 68)   DRY( 61, 69)   DRY( 61, 70)
DRY( 62, 34)   DRY( 62, 35)   DRY( 62, 36)   DRY( 62, 37)   DRY( 62, 38)
DRY( 62, 39)   DRY( 62, 40)   DRY( 62, 41)   DRY( 62, 42)   DRY( 62, 43)
DRY( 62, 44)   DRY( 62, 45)   DRY( 62, 46)   DRY( 62, 47)   DRY( 62, 48)
DRY( 62, 50)   DRY( 62, 51)   DRY( 62, 52)   DRY( 62, 53)   DRY( 62, 54)
DRY( 62, 55)   DRY( 62, 56)   DRY( 62, 57)   DRY( 62, 58)   DRY( 62, 59)
DRY( 62, 60)   DRY( 62, 61)   DRY( 62, 62)   DRY( 62, 63)   DRY( 62, 64)
DRY( 62, 65)   DRY( 62, 66)   DRY( 62, 67)   DRY( 62, 68)   DRY( 62, 69)
DRY( 62, 70)   DRY( 63, 32)   DRY( 63, 33)   DRY( 63, 34)   DRY( 63, 35)
DRY( 63, 36)   DRY( 63, 37)   DRY( 63, 38)   DRY( 63, 39)   DRY( 63, 40)
DRY( 63, 41)   DRY( 63, 42)   DRY( 63, 43)   DRY( 63, 44)   DRY( 63, 45)
DRY( 63, 46)   DRY( 63, 47)   DRY( 63, 48)   DRY( 63, 50)   DRY( 63, 51)
DRY( 63, 52)   DRY( 63, 53)   DRY( 63, 54)   DRY( 63, 55)   DRY( 63, 56)
DRY( 63, 57)   DRY( 63, 58)   DRY( 63, 59)   DRY( 63, 60)   DRY( 63, 61)
DRY( 63, 62)   DRY( 63, 63)   DRY( 63, 64)   DRY( 63, 65)   DRY( 63, 66)
DRY( 63, 67)   DRY( 63, 68)   DRY( 63, 69)   DRY( 63, 70)   DRY( 64, 33)
DRY( 64, 34)   DRY( 64, 35)   DRY( 64, 36)   DRY( 64, 37)   DRY( 64, 38)
DRY( 64, 39)   DRY( 64, 40)   DRY( 64, 41)   DRY( 64, 42)   DRY( 64, 43)
DRY( 64, 44)   DRY( 64, 45)   DRY( 64, 46)   DRY( 64, 47)   DRY( 64, 48)
DRY( 64, 49)   DRY( 64, 50)   DRY( 64, 51)   DRY( 64, 52)   DRY( 64, 53)
DRY( 64, 54)   DRY( 64, 55)   DRY( 64, 56)   DRY( 64, 57)   DRY( 64, 58)
DRY( 64, 59)   DRY( 64, 60)   DRY( 64, 61)   DRY( 64, 62)   DRY( 64, 63)
DRY( 64, 64)   DRY( 64, 65)   DRY( 64, 66)   DRY( 64, 67)   DRY( 64, 68)
DRY( 64, 69)   DRY( 64, 70)   DRY( 65, 31)   DRY( 65, 32)   DRY( 65, 33)
DRY( 65, 34)   DRY( 65, 35)   DRY( 65, 36)   DRY( 65, 37)   DRY( 65, 38)
DRY( 65, 39)   DRY( 65, 40)   DRY( 65, 41)   DRY( 65, 42)   DRY( 65, 43)
DRY( 65, 44)   DRY( 65, 45)   DRY( 65, 46)   DRY( 65, 47)   DRY( 65, 48)
DRY( 65, 49)   DRY( 65, 50)   DRY( 65, 51)   DRY( 65, 52)   DRY( 65, 53)
DRY( 65, 54)   DRY( 65, 55)   DRY( 65, 56)   DRY( 65, 57)   DRY( 65, 58)
DRY( 65, 59)   DRY( 65, 60)   DRY( 65, 61)   DRY( 65, 62)   DRY( 65, 63)
DRY( 65, 64)   DRY( 65, 65)   DRY( 65, 66)   DRY( 65, 67)   DRY( 65, 68)
DRY( 65, 69)   DRY( 65, 70)   DRY( 66, 31)   DRY( 66, 32)   DRY( 66, 33)
DRY( 66, 34)   DRY( 66, 35)   DRY( 66, 36)   DRY( 66, 37)   DRY( 66, 38)
DRY( 66, 39)   DRY( 66, 40)   DRY( 66, 41)   DRY( 66, 42)   DRY( 66, 43)
DRY( 66, 44)   DRY( 66, 45)   DRY( 66, 46)   DRY( 66, 47)   DRY( 66, 48)
DRY( 66, 49)   DRY( 66, 50)   DRY( 66, 51)   DRY( 66, 52)   DRY( 66, 53)
DRY( 66, 54)   DRY( 66, 55)   DRY( 66, 56)   DRY( 66, 57)   DRY( 66, 58)
DRY( 66, 59)   DRY( 66, 60)   DRY( 66, 61)   DRY( 66, 62)   DRY( 66, 63)
DRY( 66, 64)   DRY( 66, 65)   DRY( 66, 66)   DRY( 66, 67)   DRY( 66, 68)
DRY( 66, 69)   DRY( 66, 70)   DRY( 67, 28)   DRY( 67, 29)   DRY( 67, 30)
DRY( 67, 31)   DRY( 67, 32)   DRY( 67, 33)   DRY( 67, 34)   DRY( 67, 35)
DRY( 67, 36)   DRY( 67, 37)   DRY( 67, 38)   DRY( 67, 39)   DRY( 67, 40)
DRY( 67, 41)   DRY( 67, 42)   DRY( 67, 43)   DRY( 67, 44)   DRY( 67, 45)
DRY( 67, 46)   DRY( 67, 47)   DRY( 67, 48)   DRY( 67, 49)   DRY( 67, 50)
DRY( 67, 51)   DRY( 67, 52)   DRY( 67, 53)   DRY( 67, 54)   DRY( 67, 55)
DRY( 67, 56)   DRY( 67, 57)   DRY( 67, 58)   DRY( 67, 59)   DRY( 67, 60)
DRY( 67, 61)   DRY( 67, 62)   DRY( 67, 63)   DRY( 67, 64)   DRY( 67, 65)
DRY( 67, 66)   DRY( 67, 67)   DRY( 67, 68)   DRY( 67, 69)   DRY( 67, 70)
DRY( 68, 11)   DRY( 68, 27)   DRY( 68, 28)   DRY( 68, 29)   DRY( 68, 30)
DRY( 68, 31)   DRY( 68, 32)   DRY( 68, 33)   DRY( 68, 34)   DRY( 68, 35)
DRY( 68, 36)   DRY( 68, 37)   DRY( 68, 38)   DRY( 68, 39)   DRY( 68, 40)
```

```
   DRY( 68, 41)   DRY( 68, 42)   DRY( 68, 43)   DRY( 68, 44)   DRY( 68, 45)
   DRY( 68, 46)   DRY( 68, 47)   DRY( 68, 48)   DRY( 68, 49)   DRY( 68, 50)
   DRY( 68, 51)   DRY( 68, 52)   DRY( 68, 53)   DRY( 68, 54)   DRY( 68, 55)
   DRY( 68, 56)   DRY( 68, 57)   DRY( 68, 58)   DRY( 68, 59)   DRY( 68, 60)
   DRY( 68, 61)   DRY( 68, 62)   DRY( 68, 63)   DRY( 68, 64)   DRY( 68, 65)
   DRY( 68, 66)   DRY( 68, 67)   DRY( 68, 68)   DRY( 69, 27)   DRY( 69, 28)
   DRY( 69, 29)   DRY( 69, 30)   DRY( 69, 31)   DRY( 69, 32)   DRY( 69, 33)
   DRY( 69, 34)   DRY( 69, 35)   DRY( 69, 36)   DRY( 69, 37)   DRY( 69, 38)
   DRY( 69, 39)   DRY( 69, 40)   DRY( 69, 41)   DRY( 69, 42)   DRY( 69, 43)
   DRY( 69, 44)   DRY( 69, 45)   DRY( 69, 46)   DRY( 69, 47)   DRY( 69, 48)
   DRY( 69, 49)   DRY( 69, 50)   DRY( 69, 51)   DRY( 69, 52)   DRY( 69, 53)
   DRY( 69, 54)   DRY( 69, 55)   DRY( 69, 56)   DRY( 69, 57)   DRY( 69, 58)
   DRY( 69, 59)   DRY( 69, 60)   DRY( 69, 61)   DRY( 69, 62)   DRY( 69, 63)
   DRY( 69, 64)   DRY( 69, 65)   DRY( 69, 66)   DRY( 69, 67)   DRY( 69, 68)
   DRY( 70, 28)   DRY( 70, 35)   DRY( 70, 36)   DRY( 70, 37)   DRY( 70, 38)
   DRY( 70, 41)   DRY( 70, 42)   DRY( 70, 43)   DRY( 70, 44)   DRY( 70, 45)
   DRY( 70, 46)   DRY( 70, 47)   DRY( 70, 48)   DRY( 70, 49)   DRY( 70, 50)
   DRY( 70, 51)   DRY( 70, 52)   DRY( 70, 53)   DRY( 70, 54)   DRY( 70, 55)
   DRY( 70, 56)   DRY( 70, 57)   DRY( 70, 58)   DRY( 70, 59)   DRY( 70, 60)
   DRY( 70, 61)   DRY( 70, 62)   DRY( 70, 63)   DRY( 70, 64)   DRY( 70, 65)
   DRY( 70, 66)   DRY( 71, 35)   DRY( 71, 36)   DRY( 71, 37)   DRY( 71, 38)
   DRY( 71, 39)   DRY( 71, 40)   DRY( 71, 41)   DRY( 71, 42)   DRY( 71, 43)
   DRY( 71, 44)   DRY( 71, 45)   DRY( 71, 46)   DRY( 71, 47)   DRY( 71, 48)
   DRY( 71, 49)   DRY( 71, 50)   DRY( 71, 51)   DRY( 71, 52)   DRY( 71, 53)
   DRY( 71, 54)   DRY( 71, 55)   DRY( 71, 56)   DRY( 71, 57)   DRY( 71, 58)
   DRY( 71, 59)   DRY( 71, 60)   DRY( 71, 61)   DRY( 71, 62)   DRY( 71, 63)
   DRY( 71, 64)   DRY( 71, 65)   DRY( 71, 66)   DRY( 72, 45)   DRY( 72, 46)
   DRY( 72, 47)   DRY( 72, 48)   DRY( 72, 50)   DRY( 72, 53)   DRY( 72, 54)
   DRY( 72, 55)   DRY( 72, 56)   DRY( 72, 57)   DRY( 72, 58)   DRY( 72, 59)
   DRY( 72, 60)   DRY( 72, 61)   DRY( 72, 62)
Outer iteration    2 Inner iteration   1 Max. residual -7.149E+02
Outer iteration    2 Inner iteration   2 Max. residual -2.566E+02
Outer iteration    2 Inner iteration   3 Max. residual -1.539E+02
Outer iteration    2 Inner iteration   4 Max. residual  6.892E+01
Outer iteration    2 Inner iteration   5 Max. residual -7.478E+01
Outer iteration    2 Inner iteration   6 Max. residual -7.985E+01
Outer iteration    2 Inner iteration   7 Max. residual  6.971E+01
Outer iteration    2 Inner iteration   8 Max. residual  1.402E+02
Outer iteration    2 Inner iteration   9 Max. residual  1.641E+02
Outer iteration    2 Inner iteration  10 Max. residual -5.514E+02
Outer iteration    2 Inner iteration  11 Max. residual -1.146E+02
Outer iteration    2 Inner iteration  12 Max. residual -5.635E+01
Outer iteration    2 Inner iteration  13 Max. residual -3.683E+01
Outer iteration    2 Inner iteration  14 Max. residual -4.000E+01
Outer iteration    2 Inner iteration  15 Max. residual -1.759E+01
Outer iteration    2 Inner iteration  16 Max. residual  2.077E+01
Outer iteration    2 Inner iteration  17 Max. residual  7.099E+00
Outer iteration    2 Inner iteration  18 Max. residual  1.102E+01
Outer iteration    2 Inner iteration  19 Max. residual  9.652E+00
Outer iteration    2 Inner iteration  20 Max. residual  5.245E+00
Outer iteration    2 Inner iteration  21 Max. residual  3.512E+00
Outer iteration    2 Inner iteration  22 Max. residual  2.520E+00
Outer iteration    2 Inner iteration  23 Max. residual  2.993E+00
Outer iteration    2 Inner iteration  24 Max. residual  2.693E+00
Outer iteration    2 Inner iteration  25 Max. residual  2.532E+00
Outer iteration    2 Inner iteration  26 Max. residual  2.462E+00
Outer iteration    2 Inner iteration  27 Max. residual -2.564E+00
Outer iteration    2 Inner iteration  28 Max. residual  2.597E+00
Outer iteration    2 Inner iteration  29 Max. residual  1.157E+00
Outer iteration    2 Inner iteration  30 Max. residual  1.849E+01
Outer iteration    2 Inner iteration  31 Max. residual  3.619E+02
Outer iteration    2 Inner iteration  32 Max. residual  2.460E+00
Outer iteration    2 Inner iteration  33 Max. residual  9.979E-01
```

```
Outer iteration    2 Inner iteration  34 Max. residual -5.167E-01
Outer iteration    2 Inner iteration  35 Max. residual -4.473E-01
Outer iteration    2 Inner iteration  36 Max. residual  7.757E-01
Outer iteration    2 Inner iteration  37 Max. residual  4.633E-01
Outer iteration    2 Inner iteration  38 Max. residual -4.349E-01
Outer iteration    2 Inner iteration  39 Max. residual  7.399E-01
Outer iteration    2 Inner iteration  40 Max. residual  4.069E-01
Outer iteration    2 Inner iteration  41 Max. residual  8.316E-01
Outer iteration    2 Inner iteration  42 Max. residual  5.371E-01
Outer iteration    2 Inner iteration  43 Max. residual  6.941E-01
Outer iteration    2 Inner iteration  44 Max. residual  4.245E-01
Outer iteration    2 Inner iteration  45 Max. residual  4.992E-01
Outer iteration    2 Inner iteration  46 Max. residual  4.573E-01
Outer iteration    2 Inner iteration  47 Max. residual -1.691E-01
Outer iteration    2 Inner iteration  48 Max. residual -8.966E-02
Outer iteration    2 Inner iteration  49 Max. residual -1.099E-01
Outer iteration    2 Inner iteration  50 Max. residual -8.162E-02
0

                                                    SOLUTION BY CGSTAB-P

-----------------------------------------

CELL CONVERSIONS FOR ITER.=  3  LAYER=  1  STEP=  1  PERIOD=  1   (ROW,COL)
   DRY(  8, 61)   DRY(  8, 62)   DRY( 13, 63)   DRY( 15, 65)   DRY( 15, 66)
Outer iteration    3 Inner iteration   1 Max. residual -7.240E+01
Outer iteration    3 Inner iteration   2 Max. residual  4.414E+01
Outer iteration    3 Inner iteration   3 Max. residual -1.988E+01
Outer iteration    3 Inner iteration   4 Max. residual  1.434E+01
Outer iteration    3 Inner iteration   5 Max. residual -1.007E+01
Outer iteration    3 Inner iteration   6 Max. residual -1.156E+01
Outer iteration    3 Inner iteration   7 Max. residual -1.062E+01
Outer iteration    3 Inner iteration   8 Max. residual -1.036E+01
Outer iteration    3 Inner iteration   9 Max. residual -1.003E+01
Outer iteration    3 Inner iteration  10 Max. residual -6.098E+00
Outer iteration    3 Inner iteration  11 Max. residual  4.370E+00
Outer iteration    3 Inner iteration  12 Max. residual  4.125E+00
Outer iteration    3 Inner iteration  13 Max. residual  3.797E+00
Outer iteration    3 Inner iteration  14 Max. residual  3.423E+00
Outer iteration    3 Inner iteration  15 Max. residual  3.178E+00
Outer iteration    3 Inner iteration  16 Max. residual -4.114E+00
Outer iteration    3 Inner iteration  17 Max. residual -3.446E+00
Outer iteration    3 Inner iteration  18 Max. residual  2.862E+00
Outer iteration    3 Inner iteration  19 Max. residual  3.096E+00
Outer iteration    3 Inner iteration  20 Max. residual  3.401E+00
Outer iteration    3 Inner iteration  21 Max. residual -7.640E+00
Outer iteration    3 Inner iteration  22 Max. residual  3.541E+00
Outer iteration    3 Inner iteration  23 Max. residual  4.327E+00
Outer iteration    3 Inner iteration  24 Max. residual  7.723E+00
Outer iteration    3 Inner iteration  25 Max. residual  6.906E+00
Outer iteration    3 Inner iteration  26 Max. residual -1.171E+02
Outer iteration    3 Inner iteration  27 Max. residual -4.301E+00
Outer iteration    3 Inner iteration  28 Max. residual -2.040E+00
Outer iteration    3 Inner iteration  29 Max. residual  1.358E+00
Outer iteration    3 Inner iteration  30 Max. residual -9.748E-01
Outer iteration    3 Inner iteration  31 Max. residual -7.473E-01
Outer iteration    3 Inner iteration  32 Max. residual  1.008E+00
Outer iteration    3 Inner iteration  33 Max. residual -4.975E-01
Outer iteration    3 Inner iteration  34 Max. residual -3.775E-01
Outer iteration    3 Inner iteration  35 Max. residual -3.147E-01
Outer iteration    3 Inner iteration  36 Max. residual  3.482E-01
Outer iteration    3 Inner iteration  37 Max. residual -2.213E-01
```

```
 Outer iteration     3 Inner iteration  38 Max. residual -3.120E-01
 Outer iteration     3 Inner iteration  39 Max. residual  2.797E-01
 Outer iteration     3 Inner iteration  40 Max. residual -6.879E-02
 Outer iteration     3 Inner iteration  41 Max. residual  8.836E-02
 Outer iteration     3 Inner iteration  42 Max. residual -3.996E-02
 Outer iteration     3 Inner iteration  43 Max. residual  6.795E-02
 Outer iteration     3 Inner iteration  44 Max. residual -4.034E-02
 Outer iteration     3 Inner iteration  45 Max. residual -3.088E-02
 Outer iteration     3 Inner iteration  46 Max. residual -2.957E-02
 Outer iteration     3 Inner iteration  47 Max. residual -2.877E-02
 Outer iteration     3 Inner iteration  48 Max. residual -2.913E-02
 Outer iteration     3 Inner iteration  49 Max. residual -2.120E-02
 Outer iteration     3 Inner iteration  50 Max. residual -1.038E-02
0

                                                          SOLUTION BY CGSTAB-P

-----------------------------------------
 Outer iteration     4 Inner iteration   1 Max. residual  2.952E+01
 Outer iteration     4 Inner iteration   2 Max. residual -8.007E+00
 Outer iteration     4 Inner iteration   3 Max. residual -3.620E+00
 Outer iteration     4 Inner iteration   4 Max. residual -2.901E+00
 Outer iteration     4 Inner iteration   5 Max. residual  1.884E+00
 Outer iteration     4 Inner iteration   6 Max. residual -1.736E+00
 Outer iteration     4 Inner iteration   7 Max. residual  2.011E+00
 Outer iteration     4 Inner iteration   8 Max. residual -1.505E+00
 Outer iteration     4 Inner iteration   9 Max. residual  1.969E+00
 Outer iteration     4 Inner iteration  10 Max. residual  1.521E+00
 Outer iteration     4 Inner iteration  11 Max. residual  1.264E+00
 Outer iteration     4 Inner iteration  12 Max. residual -8.586E-01
 Outer iteration     4 Inner iteration  13 Max. residual  7.611E-01
 Outer iteration     4 Inner iteration  14 Max. residual -5.786E-01
 Outer iteration     4 Inner iteration  15 Max. residual  5.128E-01
 Outer iteration     4 Inner iteration  16 Max. residual -5.133E-01
 Outer iteration     4 Inner iteration  17 Max. residual -5.099E-01
 Outer iteration     4 Inner iteration  18 Max. residual -4.949E-01
 Outer iteration     4 Inner iteration  19 Max. residual -4.535E-01
 Outer iteration     4 Inner iteration  20 Max. residual -4.112E-01
 Outer iteration     4 Inner iteration  21 Max. residual -3.554E-01
 Outer iteration     4 Inner iteration  22 Max. residual -2.979E-01
 Outer iteration     4 Inner iteration  23 Max. residual  2.232E-01
 Outer iteration     4 Inner iteration  24 Max. residual -3.077E-01
 Outer iteration     4 Inner iteration  25 Max. residual -2.901E-01
 Outer iteration     4 Inner iteration  26 Max. residual -2.351E-01
 Outer iteration     4 Inner iteration  27 Max. residual -2.308E-01
 Outer iteration     4 Inner iteration  28 Max. residual -2.254E-01
 Outer iteration     4 Inner iteration  29 Max. residual -2.170E-01
 Outer iteration     4 Inner iteration  30 Max. residual -2.094E-01
 Outer iteration     4 Inner iteration  31 Max. residual -2.029E-01
 Outer iteration     4 Inner iteration  32 Max. residual -1.953E-01
 Outer iteration     4 Inner iteration  33 Max. residual -1.927E-01
 Outer iteration     4 Inner iteration  34 Max. residual -1.941E-01
 Outer iteration     4 Inner iteration  35 Max. residual -1.596E-01
 Outer iteration     4 Inner iteration  36 Max. residual  1.835E-01
 Outer iteration     4 Inner iteration  37 Max. residual  4.983E-01
 Outer iteration     4 Inner iteration  38 Max. residual -7.318E-02
 Outer iteration     4 Inner iteration  39 Max. residual -4.655E-02
 Outer iteration     4 Inner iteration  40 Max. residual -4.750E-02
 Outer iteration     4 Inner iteration  41 Max. residual -4.189E-02
 Outer iteration     4 Inner iteration  42 Max. residual -4.756E-02
 Outer iteration     4 Inner iteration  43 Max. residual -3.664E-02
 Outer iteration     4 Inner iteration  44 Max. residual -3.642E-02
```

```
 Outer iteration    4 Inner iteration  45 Max. residual -3.718E-02
 Outer iteration    4 Inner iteration  46 Max. residual -4.068E-02
 Outer iteration    4 Inner iteration  47 Max. residual -9.266E-02
 Outer iteration    4 Inner iteration  48 Max. residual -1.206E-02
0

                                                    SOLUTION BY CGSTAB-P

-----------------------------------------
 Outer iteration    5 Inner iteration   1 Max. residual  1.487E+01
 Outer iteration    5 Inner iteration   2 Max. residual -2.272E+00
 Outer iteration    5 Inner iteration   3 Max. residual -7.120E-01
 Outer iteration    5 Inner iteration   4 Max. residual  4.727E-01
 Outer iteration    5 Inner iteration   5 Max. residual  3.234E-01
 Outer iteration    5 Inner iteration   6 Max. residual  2.800E-01
 Outer iteration    5 Inner iteration   7 Max. residual -2.401E-01
 Outer iteration    5 Inner iteration   8 Max. residual -3.143E-01
 Outer iteration    5 Inner iteration   9 Max. residual -2.508E-01
 Outer iteration    5 Inner iteration  10 Max. residual -2.414E-01
 Outer iteration    5 Inner iteration  11 Max. residual -1.783E-01
 Outer iteration    5 Inner iteration  12 Max. residual -1.081E-01
 Outer iteration    5 Inner iteration  13 Max. residual -2.527E-01
 Outer iteration    5 Inner iteration  14 Max. residual -9.544E-02
 Outer iteration    5 Inner iteration  15 Max. residual -1.388E-01
 Outer iteration    5 Inner iteration  16 Max. residual -8.821E-02
 Outer iteration    5 Inner iteration  17 Max. residual -1.384E-01
 Outer iteration    5 Inner iteration  18 Max. residual -6.824E-02
 Outer iteration    5 Inner iteration  19 Max. residual -6.447E-02
 Outer iteration    5 Inner iteration  20 Max. residual -5.006E-02
 Outer iteration    5 Inner iteration  21 Max. residual -4.294E-02
 Outer iteration    5 Inner iteration  22 Max. residual -3.999E-02
 Outer iteration    5 Inner iteration  23 Max. residual -4.147E-02
 Outer iteration    5 Inner iteration  24 Max. residual -2.694E-02
 Outer iteration    5 Inner iteration  25 Max. residual -2.674E-02
 Outer iteration    5 Inner iteration  26 Max. residual -1.947E-02
0

                                                    SOLUTION BY CGSTAB-P

-----------------------------------------
 Outer iteration    6 Inner iteration   1 Max. residual -6.956E+00
 Outer iteration    6 Inner iteration   2 Max. residual -9.669E-01
 Outer iteration    6 Inner iteration   3 Max. residual -3.294E-01
 Outer iteration    6 Inner iteration   4 Max. residual -2.341E-01
 Outer iteration    6 Inner iteration   5 Max. residual  9.877E-02
 Outer iteration    6 Inner iteration   6 Max. residual -8.398E-02
 Outer iteration    6 Inner iteration   7 Max. residual -7.837E-02
 Outer iteration    6 Inner iteration   8 Max. residual  1.118E-01
 Outer iteration    6 Inner iteration   9 Max. residual  4.736E-02
 Outer iteration    6 Inner iteration  10 Max. residual  7.370E-02
 Outer iteration    6 Inner iteration  11 Max. residual  3.991E-02
 Outer iteration    6 Inner iteration  12 Max. residual  4.843E-02
 Outer iteration    6 Inner iteration  13 Max. residual -2.597E-02
 Outer iteration    6 Inner iteration  14 Max. residual  4.056E-02
 Outer iteration    6 Inner iteration  15 Max. residual  2.335E-02
 Outer iteration    6 Inner iteration  16 Max. residual -3.072E-02
 Outer iteration    6 Inner iteration  17 Max. residual  1.507E-02
0

                                                    SOLUTION BY CGSTAB-P
```

```
-------------------------------------------
 Outer iteration    7 Inner iteration   1 Max. residual -3.199E+00
 Outer iteration    7 Inner iteration   2 Max. residual -5.477E-01
 Outer iteration    7 Inner iteration   3 Max. residual -1.539E-01
 Outer iteration    7 Inner iteration   4 Max. residual  6.552E-02
 Outer iteration    7 Inner iteration   5 Max. residual  4.414E-02
 Outer iteration    7 Inner iteration   6 Max. residual  3.425E-02
 Outer iteration    7 Inner iteration   7 Max. residual -3.296E-02
 Outer iteration    7 Inner iteration   8 Max. residual -3.218E-02
 Outer iteration    7 Inner iteration   9 Max. residual  2.013E-02
 Outer iteration    7 Inner iteration  10 Max. residual  2.392E-02
 Outer iteration    7 Inner iteration  11 Max. residual  1.469E-02
0

                                                        SOLUTION BY CGSTAB-P

-------------------------------------------
 Outer iteration    8 Inner iteration   1 Max. residual -1.545E+00
 Outer iteration    8 Inner iteration   2 Max. residual -2.652E-01
 Outer iteration    8 Inner iteration   3 Max. residual -7.164E-02
 Outer iteration    8 Inner iteration   4 Max. residual  4.347E-02
 Outer iteration    8 Inner iteration   5 Max. residual  2.584E-02
 Outer iteration    8 Inner iteration   6 Max. residual  2.368E-02
 Outer iteration    8 Inner iteration   7 Max. residual  1.896E-02
0

                                                        SOLUTION BY CGSTAB-P

-------------------------------------------
 Outer iteration    9 Inner iteration   1 Max. residual -7.438E-01
 Outer iteration    9 Inner iteration   2 Max. residual -1.232E-01
 Outer iteration    9 Inner iteration   3 Max. residual -3.883E-02
 Outer iteration    9 Inner iteration   4 Max. residual  2.624E-02
 Outer iteration    9 Inner iteration   5 Max. residual -2.298E-02
 Outer iteration    9 Inner iteration   6 Max. residual  1.867E-02
0

                                                        SOLUTION BY CGSTAB-P

-------------------------------------------
 Outer iteration   10 Inner iteration   1 Max. residual -3.615E-01
 Outer iteration   10 Inner iteration   2 Max. residual -5.815E-02
 Outer iteration   10 Inner iteration   3 Max. residual -2.044E-02
 Outer iteration   10 Inner iteration   4 Max. residual  1.735E-02
0

                                                        SOLUTION BY CGSTAB-P

-------------------------------------------
 Outer iteration   11 Inner iteration   1 Max. residual -1.698E-01
 Outer iteration   11 Inner iteration   2 Max. residual -2.805E-02
 Outer iteration   11 Inner iteration   3 Max. residual -1.774E-02

 HEAD/DRAWDOWN PRINTOUT FLAG = 1     TOTAL BUDGET PRINTOUT FLAG = 1
 CELL-BY-CELL FLOW TERM FLAG = 1

 OUTPUT FLAGS FOR ALL LAYERS ARE THE SAME:
   HEAD    DRAWDOWN  HEAD  DRAWDOWN
```

WVNS-NDA.LST

```
PRINTOUT  PRINTOUT  SAVE    SAVE
----------------------------------
    0         0       1       1
UBUDSV SAVING "   CONSTANT HEAD" ON UNIT154 AT TIME STEP  1, STRESS PERIOD    1
UBUDSV SAVING "FLOW RIGHT FACE " ON UNIT154 AT TIME STEP  1, STRESS PERIOD    1
UBUDSV SAVING "FLOW FRONT FACE " ON UNIT154 AT TIME STEP  1, STRESS PERIOD    1
UBUDSV SAVING "FLOW LOWER FACE " ON UNIT154 AT TIME STEP  1, STRESS PERIOD    1
UBUDSV SAVING "          DRAINS" ON UNIT154 AT TIME STEP  1, STRESS PERIOD    1
UBUDSV SAVING "   RIVER LEAKAGE" ON UNIT154 AT TIME STEP  1, STRESS PERIOD    1
UBUDSV SAVING "        RECHARGE" ON UNIT154 AT TIME STEP  1, STRESS PERIOD    1

HEAD WILL BE SAVED ON UNIT  150 AT END OF TIME STEP   1, STRESS PERIOD    1

DRAWDOWN WILL BE SAVED ON UNIT  151 AT END OF TIME STEP   1, STRESS PERIOD    1
1
 VOLUMETRIC BUDGET FOR ENTIRE MODEL AT END OF TIME STEP  1 IN STRESS PERIOD   1
 ------------------------------------------------------------------------------

    CUMULATIVE VOLUMES      L**3       RATES FOR THIS TIME STEP      L**3/T
    ------------------                 ------------------------

          IN:                                  IN:
          ---                                  ---
            STORAGE =          0.0000            STORAGE =          0.0000
      CONSTANT HEAD =        783.7897      CONSTANT HEAD =        783.7897
             DRAINS =          0.0000             DRAINS =          0.0000
      RIVER LEAKAGE =      19267.2852      RIVER LEAKAGE =      19267.2852
           RECHARGE =     140214.8906           RECHARGE =     140214.8906

            TOTAL IN =     160265.9688            TOTAL IN =     160265.9688

         OUT:                                 OUT:
         ----                                 ----
            STORAGE =          0.0000            STORAGE =          0.0000
      CONSTANT HEAD =       4932.1763      CONSTANT HEAD =       4932.1763
             DRAINS =      64860.8125             DRAINS =      64860.8125
      RIVER LEAKAGE =      89652.1094      RIVER LEAKAGE =      89652.1094
           RECHARGE =          0.0000           RECHARGE =          0.0000

           TOTAL OUT =     159445.0938           TOTAL OUT =     159445.0938

            IN - OUT =        820.8750            IN - OUT =        820.8750

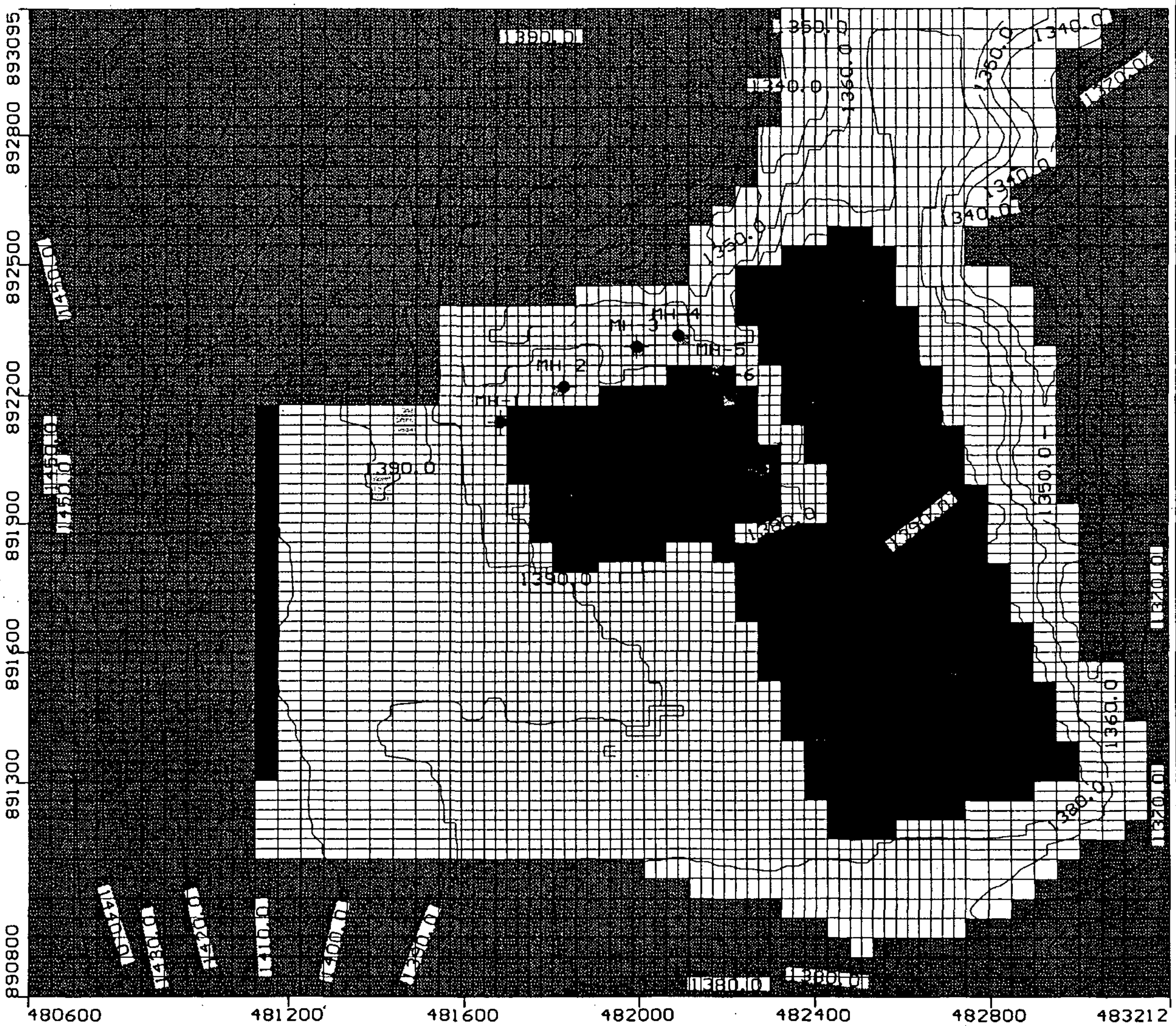
 PERCENT DISCREPANCY =           0.51   PERCENT DISCREPANCY =           0.51


          TIME SUMMARY AT END OF TIME STEP   1 IN STRESS PERIOD    1
                    SECONDS     MINUTES      HOURS       DAYS        YEARS
                    ------------------------------------------------------
   TIME STEP LENGTH 3.15576E+07 5.25960E+05  8766.0      365.25      1.0000
 STRESS PERIOD TIME 3.15576E+07 5.25960E+05  8766.0      365.25      1.0000
         TOTAL TIME 3.15576E+07 5.25960E+05  8766.0      365.25      1.0000
1
```

# APPENDIX A-2

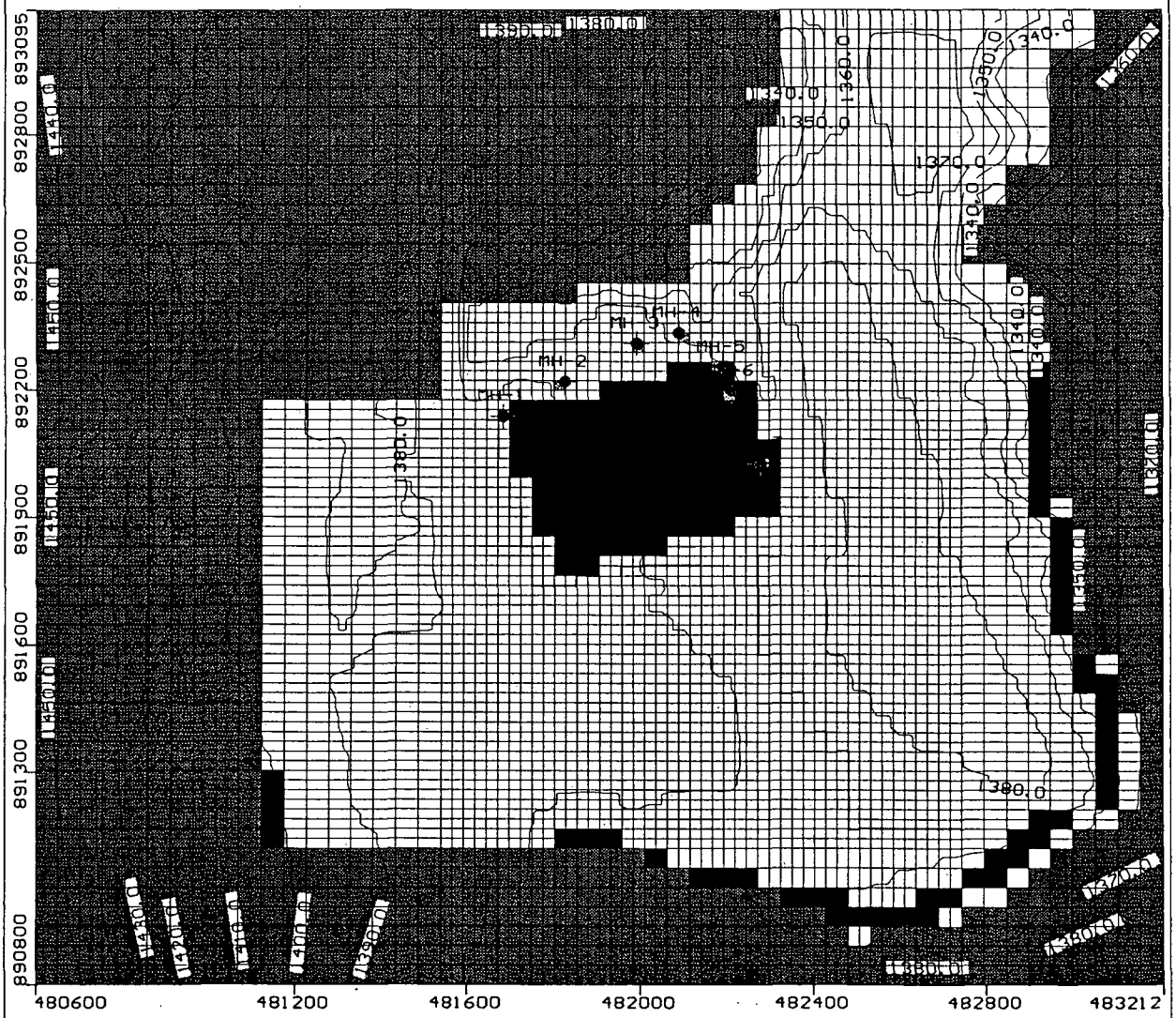
## MODFLOW OUTPUT

## REPORT ON GROUNDWATER MODELING
## WEST VALLEY ENVIRONMENTAL SERVICES, LLC
## NUCLEAR REGULATORY COMMISSION LICENSED DISPOSAL AREA
## CAP AND GROUNDWATER BARRIER PROJECT



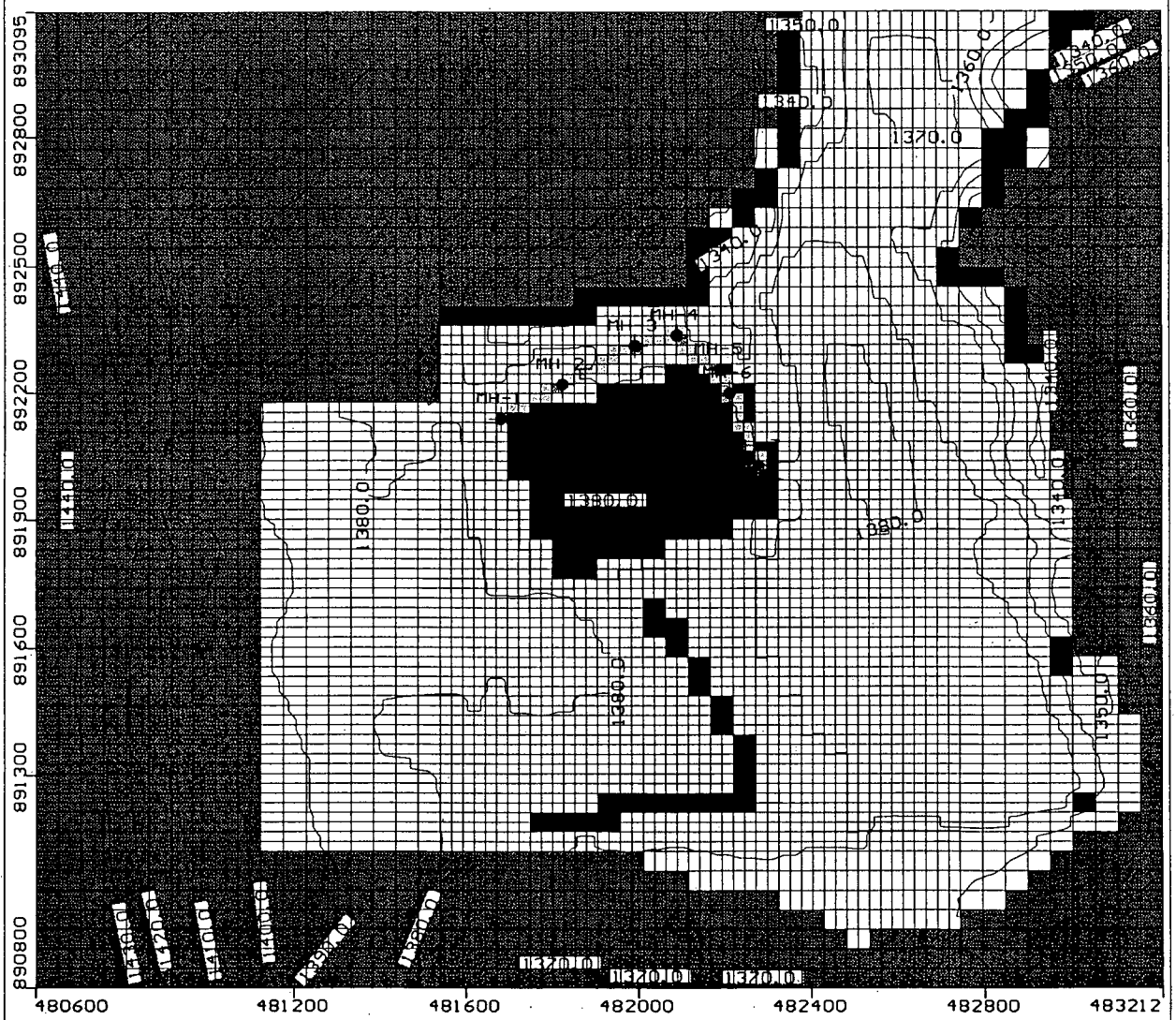

Grid Layer 1

| | |
|---|---|
| MMCE | WVNS NDA Cap and Slurry |




Grid Layer 2

| | |
|---|---|
| MMCE | WVNS NDA Cap and Slurry |




Grid Layer 3

| | |
|---|---|
| MMCE | WVNS NDA Cap and Slurry |

```
                                WVNS-NDA.LST
                              MODFLOW-2000
     U.S. GEOLOGICAL SURVEY MODULAR FINITE-DIFFERENCE GROUND-WATER FLOW MODEL
                 VERSION 1.15.01 04/05/2005    +OpenMI+SLB

This model run combines GLOBAL and LIST output into this single file.

GLOBAL LISTING FILE: C:\vmodnt\WVNS\WVNS-NDA.LST
                         UNIT    6

OPENING C:\vmodnt\WVNS\WVNS-NDA.WHS
FILE TYPE:WHS   UNIT   53   STATUS:OLD
FORMAT:FORMATTED              ACCESS:SEQUENTIAL

OPENING C:\vmodnt\WVNS\WVNS-NDA.BAS
FILE TYPE:BAS6   UNIT   10   STATUS:OLD
FORMAT:FORMATTED              ACCESS:SEQUENTIAL

OPENING C:\vmodnt\WVNS\WVNS-NDA.BCF
FILE TYPE:BCF6   UNIT   11   STATUS:OLD
FORMAT:FORMATTED              ACCESS:SEQUENTIAL

OPENING C:\vmodnt\WVNS\WVNS-NDA.DRN
FILE TYPE:DRN   UNIT   13   STATUS:OLD
FORMAT:FORMATTED              ACCESS:SEQUENTIAL

OPENING C:\vmodnt\WVNS\WVNS-NDA.RIV
FILE TYPE:RIV   UNIT   14   STATUS:OLD
FORMAT:FORMATTED              ACCESS:SEQUENTIAL

OPENING C:\vmodnt\WVNS\WVNS-NDA.RCH
FILE TYPE:RCH   UNIT   18   STATUS:OLD
FORMAT:FORMATTED              ACCESS:SEQUENTIAL

OPENING C:\vmodnt\WVNS\WVNS-NDA.OC
FILE TYPE:OC   UNIT   22   STATUS:OLD
FORMAT:FORMATTED              ACCESS:SEQUENTIAL

OPENING C:\vmodnt\WVNS\WVNS-NDA.HFB
FILE TYPE:HFB6   UNIT   31   STATUS:OLD
FORMAT:FORMATTED              ACCESS:SEQUENTIAL

OPENING C:\vmodnt\WVNS\WVNS-NDA.DIS
FILE TYPE:DIS   UNIT   34   STATUS:OLD
FORMAT:FORMATTED              ACCESS:SEQUENTIAL

OPENING C:\vmodnt\WVNS\WVNS-NDA.NDC
FILE TYPE:NDC   UNIT   57   STATUS:OLD
FORMAT:FORMATTED              ACCESS:SEQUENTIAL

OPENING C:\vmodnt\WVNS\WVNS-NDA.HDS
FILE TYPE:DATA(BINARY)   UNIT  150   STATUS:UNKNOWN
FORMAT:UNFORMATTED            ACCESS:SEQUENTIAL

OPENING C:\vmodnt\WVNS\WVNS-NDA.DDN
FILE TYPE:DATA(BINARY)   UNIT  151   STATUS:UNKNOWN
FORMAT:UNFORMATTED            ACCESS:SEQUENTIAL

OPENING C:\vmodnt\WVNS\WVNS-NDA.BGT
FILE TYPE:DATA(BINARY)   UNIT  154   STATUS:UNKNOWN
FORMAT:UNFORMATTED            ACCESS:SEQUENTIAL
```

```
                                        WVNS-NDA.LST
DISCRETIZATION INPUT DATA READ FROM UNIT   34
#Discretization Package translator - (c) 2001 Waterloo Hydrogeologic Software
#WVNS-NDA.DIS Wed Jun 27 16:46:54 2007
   3 LAYERS        78 ROWS        73 COLUMNS
   1 STRESS PERIOD(S) IN SIMULATION
MODEL TIME UNIT IS YEARS
MODEL LENGTH UNIT IS FEET
 --- GUI Regime ---
THE GROUND-WATER TRANSPORT PROCESS IS INACTIVE

THE OBSERVATION PROCESS IS INACTIVE
THE SENSITIVITY PROCESS IS INACTIVE
THE PARAMETER-ESTIMATION PROCESS IS INACTIVE

MODE: FORWARD

 Confining bed flag for each layer:
  0   0   0

    153889  ELEMENTS OF GX ARRAY USED OUT OF     153889
     17082  ELEMENTS OF GZ ARRAY USED OUT OF      17082
     17082  ELEMENTS OF IG ARRAY USED OUT OF      17082


                                 DELR
READING ON UNIT   34 WITH FORMAT: (10E16.9)


                                 DELC
READING ON UNIT   34 WITH FORMAT: (10E16.9)


          TOP ELEVATION OF LAYER 1
READING ON UNIT   34 WITH FORMAT: (10E14.7)


            MODEL LAYER BOTTOM EL. FOR LAYER   1
READING ON UNIT   34 WITH FORMAT: (10E14.7)


            MODEL LAYER BOTTOM EL. FOR LAYER   2
READING ON UNIT   34 WITH FORMAT: (10E14.7)


            MODEL LAYER BOTTOM EL. FOR LAYER   3
READING ON UNIT   34 WITH FORMAT: (10E14.7)

STRESS PERIOD     LENGTH       TIME STEPS     MULTIPLIER FOR DELT    SS FLAG
----------------------------------------------------------------------------
       1         1.000000          1                    1.000         SS

STEADY-STATE SIMULATION


0WHS1  - CGSTAB-P PROCEDURE SOLUTION PACKAGE, VERSION 1, 8/4/95 INPUT READ FROM UNIT
```

```
1
MAXIMUM OF  200 OUTER ITERATIONS ALLOWED FOR CLOSURE
MAXIMUM OF   50 INNER ITERATIONS ALLOWED
    409968 ELEMENTS IN X ARRAY ARE USED BY CGSTAB-P
     34164 ELEMENTS IN Z ARRAY ARE USED BY CGSTAB-P

    409968  ELEMENTS OF X ARRAY USED OUT OF     409968
     34164  ELEMENTS OF Z ARRAY USED OUT OF      34164
         0  ELEMENTS OF IX ARRAY USED OUT OF          1
         0  ELEMENTS OF XHS ARRAY USED OUT OF          1
0


                                                          SOLUTION BY CGSTAB-P

-------------------------------------------
0                                                MAXIMUM ITERATIONS ALLOWED FOR
CLOSURE =      200
0                                                MAXIMUM INNER ITERATIONS ALLOWED =
   50
                                                                 DAMPING FACTOR =
1.0000
                                                       HEAD CHANGE CRITERION FOR
CLOSURE =    0.20000E-01
 MAXIMUM RESIDUAL FOR LINEAR ITERATION    0.20000E-01
 MAXIMUM RELATIVE RESIDUAL FOR LINEAR ITERATION     0.00000E+00

 #Basic Package translator - (c) 2001 Waterloo Hydrogeologic Software
 #WVNS-NDA.BAS Wed Jun 27 16:46:53 2007
    3 LAYERS        78 ROWS        73 COLUMNS
    1 STRESS PERIOD(S) IN SIMULATION

 BAS6 -- BASIC PACKAGE, VERSION 6, 1/11/2000 INPUT READ FROM UNIT   10
         15 ELEMENTS IN IR ARRAY ARE USED BY BAS

 BCF6 -- BLOCK-CENTERED FLOW PACKAGE, VERSION 6, 1/11/2000
         INPUT READ FROM UNIT 11
 STEADY-STATE SIMULATION
 CELL-BY-CELL FLOWS WILL BE SAVED ON UNIT154
 HEAD AT CELLS THAT CONVERT TO DRY= -0.10000E+31
 WETTING CAPABILITY IS NOT ACTIVE
      LAYER  LAYER-TYPE CODE     INTERBLOCK T
      ---------------------------------------------
         1            1          0 -- HARMONIC
         2            2          0 -- HARMONIC
         3            2          0 -- HARMONIC
      17085 ELEMENTS IN RX ARRAY ARE USED BY BCF

 DRN6 -- DRAIN PACKAGE, VERSION 6, 1/11/2000 INPUT READ FROM UNIT   13
 No named parameters
 MAXIMUM OF     53 ACTIVE DRAINS AT ONE TIME
 CELL-BY-CELL FLOWS WILL BE SAVED ON UNIT  154
        265 ELEMENTS IN RX ARRAY ARE USED BY DRN

 RIV6 -- RIVER PACKAGE, VERSION 6, 1/11/2000 INPUT READ FROM UNIT   14
 No named parameters
 MAXIMUM OF    293 ACTIVE RIVER REACHES AT ONE TIME
 CELL-BY-CELL FLOWS WILL BE SAVED ON UNIT  154
       1758 ELEMENTS IN RX ARRAY ARE USED BY RIV

 RCH6 -- RECHARGE PACKAGE, VERSION 6, 1/11/2000 INPUT READ FROM UNIT   18
 No named parameters
 OPTION 3 -- RECHARGE TO HIGHEST ACTIVE NODE IN EACH VERTICAL COLUMN
```

```
CELL-BY-CELL FLOWS WILL BE SAVED ON UNIT  154
      5694 ELEMENTS IN RX ARRAY ARE USED BY RCH
      5694 ELEMENTS IN IR ARRAY ARE USED BY RCH
HFB6 -- HORIZONTAL FLOW BARRIER PACKAGE, VERSION 6, 1/11/1000.
  INPUT READ FROM UNIT   31
    0 PARAMETERS DEFINE A MAXIMUM OF      0 HORIZONTAL FLOW BARRIERS
   280 HORIZONTAL FLOW BARRIERS NOT DEFINED BY PARAMETERS
      1960 ELEMENTS IN RX ARRAY ARE USED FOR
          HORIZONTAL FLOW BARRIER PACKAGE

     26762  ELEMENTS OF RX ARRAY USED OUT OF      26762
      5709  ELEMENTS OF IR ARRAY USED OUT OF       5709
1
#Basic Package translator - (c) 2001 Waterloo Hydrogeologic Software
#WVNS-NDA.BAS Wed Jun 27 16:46:53 2007


                     BOUNDARY ARRAY FOR LAYER   1
READING ON UNIT   10 WITH FORMAT: (40I2)


                     BOUNDARY ARRAY FOR LAYER   2
READING ON UNIT   10 WITH FORMAT: (40I2)


                     BOUNDARY ARRAY FOR LAYER   3
READING ON UNIT   10 WITH FORMAT: (40I2)

AQUIFER HEAD WILL BE SET TO 1.00000E+30 AT ALL NO-FLOW NODES (IBOUND=0).


                       INITIAL HEAD FOR LAYER   1
READING ON UNIT   10 WITH FORMAT:  (10G12.5)


                       INITIAL HEAD FOR LAYER   2
READING ON UNIT   10 WITH FORMAT:  (10G12.5)


                       INITIAL HEAD FOR LAYER   3
READING ON UNIT   10 WITH FORMAT:  (10G12.5)

OUTPUT CONTROL IS SPECIFIED EVERY TIME STEP
HEAD PRINT FORMAT CODE IS   0    DRAWDOWN PRINT FORMAT CODE IS   0
HEADS WILL BE SAVED ON UNIT  150    DRAWDOWNS WILL BE SAVED ON UNIT  151


          COLUMN TO ROW ANISOTROPY
READING ON UNIT   11 WITH FORMAT: (10G11.4)


             HYD. COND. ALONG ROWS FOR LAYER   1
READING ON UNIT   11 WITH FORMAT:  (10G11.4)
```

```
          VERT HYD COND /THICKNESS FOR LAYER   1
READING ON UNIT   11 WITH FORMAT:  (10G11.4)


              TRANSMIS. ALONG ROWS FOR LAYER   2
READING ON UNIT   11 WITH FORMAT:  (10G11.4)


          VERT HYD COND /THICKNESS FOR LAYER   2
READING ON UNIT   11 WITH FORMAT:  (10G11.4)


              TRANSMIS. ALONG ROWS FOR LAYER   3
READING ON UNIT   11 WITH FORMAT:  (10G11.4)

    0 Drain parameters

    0 River parameters

    0 Recharge parameters

    0 HFB parameters

   280 BARRIERS NOT DEFINED BY PARAMETERS
```

| BARRIER | LAYER | IROW1 | ICOL1 | IROW2 | ICOL2 | HYDCHR |
|---|---|---|---|---|---|---|
| 1 | 1 | 28 | 23 | 27 | 23 | 0.34488E-01 |
| 2 | 1 | 27 | 23 | 27 | 22 | 0.34488E-01 |
| 3 | 1 | 26 | 23 | 26 | 22 | 0.34488E-01 |
| 4 | 1 | 32 | 24 | 31 | 24 | 0.34488E-01 |
| 5 | 1 | 31 | 24 | 31 | 23 | 0.34488E-01 |
| 6 | 1 | 30 | 24 | 30 | 23 | 0.34488E-01 |
| 7 | 1 | 29 | 24 | 29 | 23 | 0.34488E-01 |
| 8 | 1 | 28 | 24 | 28 | 23 | 0.34488E-01 |
| 9 | 1 | 37 | 25 | 36 | 25 | 0.34488E-01 |
| 10 | 1 | 36 | 25 | 36 | 24 | 0.34488E-01 |
| 11 | 1 | 35 | 25 | 35 | 24 | 0.34488E-01 |
| 12 | 1 | 34 | 25 | 34 | 24 | 0.34488E-01 |
| 13 | 1 | 33 | 25 | 33 | 24 | 0.34488E-01 |
| 14 | 1 | 32 | 25 | 32 | 24 | 0.34488E-01 |
| 15 | 1 | 41 | 26 | 40 | 26 | 0.34488E-01 |
| 16 | 1 | 40 | 26 | 40 | 25 | 0.34488E-01 |
| 17 | 1 | 39 | 26 | 39 | 25 | 0.34488E-01 |
| 18 | 1 | 38 | 26 | 38 | 25 | 0.34488E-01 |
| 19 | 1 | 37 | 26 | 37 | 25 | 0.34488E-01 |
| 20 | 1 | 45 | 27 | 44 | 27 | 0.34488E-01 |
| 21 | 1 | 44 | 27 | 44 | 26 | 0.34488E-01 |
| 22 | 1 | 43 | 27 | 43 | 26 | 0.34488E-01 |
| 23 | 1 | 42 | 27 | 42 | 26 | 0.34488E-01 |
| 24 | 1 | 41 | 27 | 41 | 26 | 0.34488E-01 |
| 25 | 1 | 45 | 28 | 44 | 28 | 0.34488E-01 |
| 26 | 1 | 45 | 29 | 44 | 29 | 0.34488E-01 |
| 27 | 1 | 45 | 30 | 44 | 30 | 0.34488E-01 |
| 28 | 1 | 44 | 30 | 44 | 31 | 0.34488E-01 |
| 29 | 1 | 44 | 31 | 43 | 31 | 0.34488E-01 |
| 30 | 1 | 44 | 32 | 43 | 32 | 0.34488E-01 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 31 | 1 | 44 | 33 | 43 | 33 | 0.34488E-01 |
| 32 | 1 | 44 | 34 | 43 | 34 | 0.34488E-01 |
| 33 | 1 | 43 | 34 | 43 | 35 | 0.34488E-01 |
| 34 | 1 | 43 | 35 | 42 | 35 | 0.34488E-01 |
| 35 | 1 | 43 | 36 | 42 | 36 | 0.34488E-01 |
| 36 | 1 | 42 | 36 | 42 | 37 | 0.34488E-01 |
| 37 | 1 | 43 | 37 | 43 | 36 | 0.34488E-01 |
| 38 | 1 | 42 | 37 | 43 | 37 | 0.34488E-01 |
| 39 | 1 | 42 | 38 | 43 | 38 | 0.34488E-01 |
| 40 | 1 | 42 | 39 | 43 | 39 | 0.34488E-01 |
| 41 | 1 | 42 | 40 | 43 | 40 | 0.34488E-01 |
| 42 | 1 | 42 | 41 | 43 | 41 | 0.34488E-01 |
| 43 | 1 | 52 | 47 | 51 | 47 | 0.41386E-01 |
| 44 | 1 | 51 | 47 | 51 | 46 | 0.41386E-01 |
| 45 | 1 | 50 | 47 | 50 | 46 | 0.41386E-01 |
| 46 | 1 | 49 | 47 | 49 | 46 | 0.41386E-01 |
| 47 | 1 | 48 | 47 | 48 | 46 | 0.41386E-01 |
| 48 | 1 | 47 | 47 | 47 | 46 | 0.41386E-01 |
| 49 | 1 | 46 | 47 | 46 | 46 | 0.41386E-01 |
| 50 | 1 | 45 | 47 | 45 | 46 | 0.41386E-01 |
| 51 | 1 | 44 | 47 | 44 | 46 | 0.41386E-01 |
| 52 | 1 | 43 | 47 | 43 | 46 | 0.41386E-01 |
| 53 | 1 | 42 | 47 | 42 | 46 | 0.41386E-01 |
| 54 | 1 | 41 | 47 | 42 | 47 | 0.41386E-01 |
| 55 | 1 | 51 | 48 | 52 | 48 | 0.41386E-01 |
| 56 | 1 | 42 | 48 | 41 | 48 | 0.41386E-01 |
| 57 | 1 | 56 | 49 | 55 | 49 | 0.41386E-01 |
| 58 | 1 | 55 | 49 | 55 | 48 | 0.41386E-01 |
| 59 | 1 | 54 | 49 | 54 | 48 | 0.41386E-01 |
| 60 | 1 | 53 | 49 | 53 | 48 | 0.41386E-01 |
| 61 | 1 | 52 | 49 | 52 | 48 | 0.41386E-01 |
| 62 | 1 | 41 | 49 | 41 | 48 | 0.41386E-01 |
| 63 | 1 | 40 | 49 | 40 | 48 | 0.41386E-01 |
| 64 | 1 | 39 | 49 | 39 | 48 | 0.41386E-01 |
| 65 | 1 | 38 | 49 | 38 | 48 | 0.41386E-01 |
| 66 | 1 | 55 | 50 | 56 | 50 | 0.41386E-01 |
| 67 | 1 | 60 | 51 | 59 | 51 | 0.41386E-01 |
| 68 | 1 | 59 | 51 | 59 | 50 | 0.41386E-01 |
| 69 | 1 | 58 | 51 | 58 | 50 | 0.41386E-01 |
| 70 | 1 | 57 | 51 | 57 | 50 | 0.41386E-01 |
| 71 | 1 | 56 | 51 | 56 | 50 | 0.41386E-01 |
| 72 | 1 | 59 | 52 | 60 | 52 | 0.41386E-01 |
| 73 | 1 | 62 | 53 | 61 | 53 | 0.41386E-01 |
| 74 | 1 | 61 | 53 | 61 | 52 | 0.41386E-01 |
| 75 | 1 | 60 | 53 | 60 | 52 | 0.41386E-01 |
| 76 | 1 | 61 | 54 | 62 | 54 | 0.41386E-01 |
| 77 | 1 | 70 | 55 | 69 | 55 | 0.41386E-01 |
| 78 | 1 | 69 | 55 | 69 | 54 | 0.41386E-01 |
| 79 | 1 | 68 | 55 | 68 | 54 | 0.41386E-01 |
| 80 | 1 | 67 | 55 | 67 | 54 | 0.41386E-01 |
| 81 | 1 | 66 | 55 | 66 | 54 | 0.41386E-01 |
| 82 | 1 | 65 | 55 | 65 | 54 | 0.41386E-01 |
| 83 | 1 | 64 | 55 | 64 | 54 | 0.41386E-01 |
| 84 | 1 | 63 | 55 | 63 | 54 | 0.41386E-01 |
| 85 | 1 | 62 | 55 | 62 | 54 | 0.41386E-01 |
| 86 | 1 | 69 | 56 | 70 | 56 | 0.41386E-01 |
| 87 | 1 | 69 | 57 | 70 | 57 | 0.41386E-01 |
| 88 | 1 | 69 | 58 | 70 | 58 | 0.41386E-01 |
| 89 | 1 | 69 | 59 | 70 | 59 | 0.41386E-01 |
| 90 | 1 | 69 | 60 | 70 | 60 | 0.41386E-01 |
| 91 | 1 | 69 | 61 | 70 | 61 | 0.41386E-01 |
| 92 | 1 | 69 | 62 | 70 | 62 | 0.41386E-01 |
| 93 | 1 | 69 | 63 | 70 | 63 | 0.41386E-01 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 94 | 1 | 69 | 64 | 70 | 64 | 0.41386E-01 |
| 95 | 2 | 28 | 23 | 27 | 23 | 0.18382 |
| 96 | 2 | 27 | 23 | 27 | 22 | 0.18382 |
| 97 | 2 | 26 | 23 | 26 | 22 | 0.18382 |
| 98 | 2 | 32 | 24 | 31 | 24 | 0.18382 |
| 99 | 2 | 31 | 24 | 31 | 23 | 0.18382 |
| 100 | 2 | 30 | 24 | 30 | 23 | 0.18382 |
| 101 | 2 | 29 | 24 | 29 | 23 | 0.18382 |
| 102 | 2 | 28 | 24 | 28 | 23 | 0.18382 |
| 103 | 2 | 37 | 25 | 36 | 25 | 0.18382 |
| 104 | 2 | 36 | 25 | 36 | 24 | 0.18382 |
| 105 | 2 | 35 | 25 | 35 | 24 | 0.18382 |
| 106 | 2 | 34 | 25 | 34 | 24 | 0.18382 |
| 107 | 2 | 33 | 25 | 33 | 24 | 0.18382 |
| 108 | 2 | 32 | 25 | 32 | 24 | 0.18382 |
| 109 | 2 | 41 | 26 | 40 | 26 | 0.18382 |
| 110 | 2 | 40 | 26 | 40 | 25 | 0.18382 |
| 111 | 2 | 39 | 26 | 39 | 25 | 0.18382 |
| 112 | 2 | 38 | 26 | 38 | 25 | 0.18382 |
| 113 | 2 | 37 | 26 | 37 | 25 | 0.18382 |
| 114 | 2 | 45 | 27 | 44 | 27 | 0.18382 |
| 115 | 2 | 44 | 27 | 44 | 26 | 0.18382 |
| 116 | 2 | 43 | 27 | 43 | 26 | 0.18382 |
| 117 | 2 | 42 | 27 | 42 | 26 | 0.18382 |
| 118 | 2 | 41 | 27 | 41 | 26 | 0.18382 |
| 119 | 2 | 45 | 28 | 44 | 28 | 0.18382 |
| 120 | 2 | 45 | 29 | 44 | 29 | 0.18382 |
| 121 | 2 | 45 | 30 | 44 | 30 | 0.18382 |
| 122 | 2 | 44 | 30 | 44 | 31 | 0.18382 |
| 123 | 2 | 44 | 31 | 43 | 31 | 0.18382 |
| 124 | 2 | 44 | 32 | 43 | 32 | 0.18382 |
| 125 | 2 | 44 | 33 | 43 | 33 | 0.18382 |
| 126 | 2 | 44 | 34 | 43 | 34 | 0.18382 |
| 127 | 2 | 43 | 34 | 43 | 35 | 0.18382 |
| 128 | 2 | 43 | 35 | 42 | 35 | 0.18382 |
| 129 | 2 | 43 | 36 | 42 | 36 | 0.18382 |
| 130 | 2 | 42 | 36 | 42 | 37 | 0.18382 |
| 131 | 2 | 43 | 37 | 43 | 36 | 0.18382 |
| 132 | 2 | 42 | 37 | 43 | 37 | 0.18382 |
| 133 | 2 | 42 | 38 | 43 | 38 | 0.18382 |
| 134 | 2 | 42 | 39 | 43 | 39 | 0.18417 |
| 135 | 2 | 42 | 40 | 43 | 40 | 0.18417 |
| 136 | 2 | 42 | 41 | 43 | 41 | 0.18382 |
| 137 | 2 | 52 | 47 | 51 | 47 | 0.22058 |
| 138 | 2 | 51 | 47 | 51 | 46 | 0.22059 |
| 139 | 2 | 50 | 47 | 50 | 46 | 0.22059 |
| 140 | 2 | 49 | 47 | 49 | 46 | 0.22059 |
| 141 | 2 | 48 | 47 | 48 | 46 | 0.22059 |
| 142 | 2 | 47 | 47 | 47 | 46 | 0.22058 |
| 143 | 2 | 46 | 47 | 46 | 46 | 0.22058 |
| 144 | 2 | 45 | 47 | 45 | 46 | 0.22059 |
| 145 | 2 | 44 | 47 | 44 | 46 | 0.22059 |
| 146 | 2 | 43 | 47 | 43 | 46 | 0.22059 |
| 147 | 2 | 42 | 47 | 42 | 46 | 0.22059 |
| 148 | 2 | 41 | 47 | 42 | 47 | 0.22058 |
| 149 | 2 | 51 | 48 | 52 | 48 | 0.22059 |
| 150 | 2 | 42 | 48 | 41 | 48 | 0.22059 |
| 151 | 2 | 56 | 49 | 55 | 49 | 0.22100 |
| 152 | 2 | 55 | 49 | 55 | 48 | 0.22058 |
| 153 | 2 | 54 | 49 | 54 | 48 | 0.22058 |
| 154 | 2 | 53 | 49 | 53 | 48 | 0.22058 |
| 155 | 2 | 52 | 49 | 52 | 48 | 0.22058 |
| 156 | 2 | 41 | 49 | 41 | 48 | 0.22059 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 157 | 2 | 40 | 49 | 40 | 48 | 0.22059 |
| 158 | 2 | 39 | 49 | 39 | 48 | 0.22059 |
| 159 | 2 | 38 | 49 | 38 | 48 | 0.22059 |
| 160 | 2 | 55 | 50 | 56 | 50 | 0.22058 |
| 161 | 2 | 60 | 51 | 59 | 51 | 0.22058 |
| 162 | 2 | 59 | 51 | 59 | 50 | 0.22058 |
| 163 | 2 | 58 | 51 | 58 | 50 | 0.22058 |
| 164 | 2 | 57 | 51 | 57 | 50 | 0.22059 |
| 165 | 2 | 56 | 51 | 56 | 50 | 0.22059 |
| 166 | 2 | 59 | 52 | 60 | 52 | 0.22058 |
| 167 | 2 | 62 | 53 | 61 | 53 | 0.22100 |
| 168 | 2 | 61 | 53 | 61 | 52 | 0.22058 |
| 169 | 2 | 60 | 53 | 60 | 52 | 0.22058 |
| 170 | 2 | 61 | 54 | 62 | 54 | 0.22058 |
| 171 | 2 | 70 | 55 | 69 | 55 | 0.22058 |
| 172 | 2 | 69 | 55 | 69 | 54 | 0.22058 |
| 173 | 2 | 68 | 55 | 68 | 54 | 0.22058 |
| 174 | 2 | 67 | 55 | 67 | 54 | 0.22058 |
| 175 | 2 | 66 | 55 | 66 | 54 | 0.22058 |
| 176 | 2 | 65 | 55 | 65 | 54 | 0.22058 |
| 177 | 2 | 64 | 55 | 64 | 54 | 0.22058 |
| 178 | 2 | 63 | 55 | 63 | 54 | 0.22059 |
| 179 | 2 | 62 | 55 | 62 | 54 | 0.22059 |
| 180 | 2 | 69 | 56 | 70 | 56 | 0.22058 |
| 181 | 2 | 69 | 57 | 70 | 57 | 0.22059 |
| 182 | 2 | 69 | 58 | 70 | 58 | 0.22059 |
| 183 | 2 | 69 | 59 | 70 | 59 | 0.22059 |
| 184 | 2 | 69 | 60 | 70 | 60 | 0.22059 |
| 185 | 2 | 69 | 61 | 70 | 61 | 0.22058 |
| 186 | 2 | 69 | 62 | 70 | 62 | 0.22058 |
| 187 | 2 | 69 | 63 | 70 | 63 | 0.22058 |
| 188 | 2 | 69 | 64 | 70 | 64 | 0.22058 |
| 189 | 3 | 28 | 23 | 27 | 23 | 0.18382 |
| 190 | 3 | 32 | 24 | 31 | 24 | 0.18382 |
| 191 | 3 | 31 | 24 | 31 | 23 | 0.18382 |
| 192 | 3 | 30 | 24 | 30 | 23 | 0.18382 |
| 193 | 3 | 29 | 24 | 29 | 23 | 0.18382 |
| 194 | 3 | 28 | 24 | 28 | 23 | 0.18382 |
| 195 | 3 | 37 | 25 | 36 | 25 | 0.18382 |
| 196 | 3 | 36 | 25 | 36 | 24 | 0.18382 |
| 197 | 3 | 35 | 25 | 35 | 24 | 0.18382 |
| 198 | 3 | 34 | 25 | 34 | 24 | 0.18382 |
| 199 | 3 | 33 | 25 | 33 | 24 | 0.18382 |
| 200 | 3 | 32 | 25 | 32 | 24 | 0.18382 |
| 201 | 3 | 41 | 26 | 40 | 26 | 0.18382 |
| 202 | 3 | 40 | 26 | 40 | 25 | 0.18382 |
| 203 | 3 | 39 | 26 | 39 | 25 | 0.18382 |
| 204 | 3 | 38 | 26 | 38 | 25 | 0.18382 |
| 205 | 3 | 37 | 26 | 37 | 25 | 0.18382 |
| 206 | 3 | 45 | 27 | 44 | 27 | 0.18382 |
| 207 | 3 | 44 | 27 | 44 | 26 | 0.18382 |
| 208 | 3 | 43 | 27 | 43 | 26 | 0.18382 |
| 209 | 3 | 42 | 27 | 42 | 26 | 0.18382 |
| 210 | 3 | 41 | 27 | 41 | 26 | 0.18382 |
| 211 | 3 | 45 | 28 | 44 | 28 | 0.18382 |
| 212 | 3 | 45 | 29 | 44 | 29 | 0.18382 |
| 213 | 3 | 45 | 30 | 44 | 30 | 0.18382 |
| 214 | 3 | 44 | 30 | 44 | 31 | 0.18382 |
| 215 | 3 | 44 | 31 | 43 | 31 | 0.18382 |
| 216 | 3 | 44 | 32 | 43 | 32 | 0.18382 |
| 217 | 3 | 44 | 33 | 43 | 33 | 0.18382 |
| 218 | 3 | 44 | 34 | 43 | 34 | 0.18382 |
| 219 | 3 | 43 | 34 | 43 | 35 | 0.18382 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 220 | 3 | 43 | 35 | 42 | 35 | 0.18382 |
| 221 | 3 | 43 | 36 | 42 | 36 | 0.18382 |
| 222 | 3 | 42 | 36 | 42 | 37 | 0.18382 |
| 223 | 3 | 43 | 37 | 43 | 36 | 0.18382 |
| 224 | 3 | 42 | 37 | 43 | 37 | 0.18382 |
| 225 | 3 | 42 | 38 | 43 | 38 | 0.18382 |
| 226 | 3 | 42 | 39 | 43 | 39 | 0.18348 |
| 227 | 3 | 42 | 40 | 43 | 40 | 0.18348 |
| 228 | 3 | 42 | 41 | 43 | 41 | 0.18382 |
| 229 | 3 | 52 | 47 | 51 | 47 | 0.22059 |
| 230 | 3 | 51 | 47 | 51 | 46 | 0.22058 |
| 231 | 3 | 50 | 47 | 50 | 46 | 0.22058 |
| 232 | 3 | 49 | 47 | 49 | 46 | 0.22058 |
| 233 | 3 | 48 | 47 | 48 | 46 | 0.22058 |
| 234 | 3 | 47 | 47 | 47 | 46 | 0.22058 |
| 235 | 3 | 46 | 47 | 46 | 46 | 0.22058 |
| 236 | 3 | 45 | 47 | 45 | 46 | 0.22058 |
| 237 | 3 | 44 | 47 | 44 | 46 | 0.22058 |
| 238 | 3 | 43 | 47 | 43 | 46 | 0.22058 |
| 239 | 3 | 42 | 47 | 42 | 46 | 0.22058 |
| 240 | 3 | 41 | 47 | 42 | 47 | 0.22058 |
| 241 | 3 | 51 | 48 | 52 | 48 | 0.22058 |
| 242 | 3 | 42 | 48 | 41 | 48 | 0.22058 |
| 243 | 3 | 56 | 49 | 55 | 49 | 0.22017 |
| 244 | 3 | 55 | 49 | 55 | 48 | 0.22058 |
| 245 | 3 | 54 | 49 | 54 | 48 | 0.22058 |
| 246 | 3 | 53 | 49 | 53 | 48 | 0.22059 |
| 247 | 3 | 52 | 49 | 52 | 48 | 0.22059 |
| 248 | 3 | 41 | 49 | 41 | 48 | 0.22058 |
| 249 | 3 | 40 | 49 | 40 | 48 | 0.22058 |
| 250 | 3 | 39 | 49 | 39 | 48 | 0.22058 |
| 251 | 3 | 38 | 49 | 38 | 48 | 0.22058 |
| 252 | 3 | 55 | 50 | 56 | 50 | 0.22058 |
| 253 | 3 | 60 | 51 | 59 | 51 | 0.22058 |
| 254 | 3 | 59 | 51 | 59 | 50 | 0.22058 |
| 255 | 3 | 58 | 51 | 58 | 50 | 0.22058 |
| 256 | 3 | 57 | 51 | 57 | 50 | 0.22058 |
| 257 | 3 | 56 | 51 | 56 | 50 | 0.22058 |
| 258 | 3 | 59 | 52 | 60 | 52 | 0.22058 |
| 259 | 3 | 62 | 53 | 61 | 53 | 0.22059 |
| 260 | 3 | 61 | 53 | 61 | 52 | 0.22059 |
| 261 | 3 | 60 | 53 | 60 | 52 | 0.22059 |
| 262 | 3 | 61 | 54 | 62 | 54 | 0.22059 |
| 263 | 3 | 70 | 55 | 69 | 55 | 0.22058 |
| 264 | 3 | 69 | 55 | 69 | 54 | 0.22059 |
| 265 | 3 | 68 | 55 | 68 | 54 | 0.22059 |
| 266 | 3 | 67 | 55 | 67 | 54 | 0.22058 |
| 267 | 3 | 66 | 55 | 66 | 54 | 0.22058 |
| 268 | 3 | 65 | 55 | 65 | 54 | 0.22059 |
| 269 | 3 | 64 | 55 | 64 | 54 | 0.22059 |
| 270 | 3 | 63 | 55 | 63 | 54 | 0.22058 |
| 271 | 3 | 62 | 55 | 62 | 54 | 0.22058 |
| 272 | 3 | 69 | 56 | 70 | 56 | 0.22059 |
| 273 | 3 | 69 | 57 | 70 | 57 | 0.22058 |
| 274 | 3 | 69 | 58 | 70 | 58 | 0.22058 |
| 275 | 3 | 69 | 59 | 70 | 59 | 0.22058 |
| 276 | 3 | 69 | 60 | 70 | 60 | 0.22058 |
| 277 | 3 | 69 | 61 | 70 | 61 | 0.22059 |
| 278 | 3 | 69 | 62 | 70 | 62 | 0.22059 |
| 279 | 3 | 69 | 63 | 70 | 63 | 0.22059 |
| 280 | 3 | 69 | 64 | 70 | 64 | 0.22059 |

280 HFB BARRIERS

WVNS-NDA.LST

1

STRESS PERIOD NO. 1, LENGTH = 1.000000

NUMBER OF TIME STEPS = 1

MULTIPLIER FOR DELT = 1.000

INITIAL TIME STEP SIZE = 1.000000

| DRAIN NO. | LAYER | ROW | COL | DRAIN EL. | CONDUCTANCE |
|---|---|---|---|---|---|
| 1 | 3 | 27 | 24 | 1374. | 3711. |
| 2 | 3 | 26 | 25 | 1374. | 0.2168E+05 |
| 3 | 3 | 26 | 26 | 1374. | 0.2672E+05 |
| 4 | 3 | 25 | 27 | 1372. | 0.2967E+05 |
| 5 | 3 | 25 | 28 | 1372. | 0.1578E+05 |
| 6 | 3 | 24 | 28 | 1372. | 0.1389E+05 |
| 7 | 3 | 24 | 29 | 1370. | 0.2970E+05 |
| 8 | 3 | 23 | 30 | 1369. | 0.2566E+05 |
| 9 | 3 | 23 | 31 | 1367. | 0.2032E+05 |
| 10 | 3 | 22 | 31 | 1367. | 9819. |
| 11 | 3 | 22 | 32 | 1367. | 0.3014E+05 |
| 12 | 3 | 22 | 33 | 1365. | 6025. |
| 13 | 3 | 21 | 33 | 1366. | 0.2412E+05 |
| 14 | 3 | 21 | 34 | 1366. | 0.2187E+05 |
| 15 | 3 | 20 | 34 | 1366. | 8273. |
| 16 | 3 | 20 | 35 | 1364. | 0.3014E+05 |
| 17 | 3 | 20 | 36 | 1364. | 7571. |
| 18 | 3 | 19 | 36 | 1365. | 0.2053E+05 |
| 19 | 3 | 19 | 37 | 1362. | 0.2693E+05 |
| 20 | 3 | 19 | 38 | 1362. | 0.2693E+05 |
| 21 | 3 | 19 | 39 | 1359. | 0.1656E+05 |
| 22 | 3 | 18 | 39 | 1359. | 0.1037E+05 |
| 23 | 3 | 20 | 40 | 1364. | 3249. |
| 24 | 3 | 19 | 40 | 1359. | 0.2403E+05 |
| 25 | 3 | 18 | 40 | 1359. | 7042. |
| 26 | 3 | 21 | 41 | 1364. | 7741. |
| 27 | 3 | 20 | 41 | 1363. | 0.2920E+05 |
| 28 | 3 | 22 | 42 | 1368. | 0.1223E+05 |
| 29 | 3 | 21 | 42 | 1364. | 0.2471E+05 |
| 30 | 3 | 23 | 43 | 1366. | 0.2041E+05 |
| 31 | 3 | 22 | 43 | 1366. | 0.2022E+05 |
| 32 | 3 | 25 | 44 | 1369. | 0.1118E+05 |
| 33 | 3 | 24 | 44 | 1369. | 0.2801E+05 |
| 34 | 3 | 23 | 44 | 1366. | 7731. |
| 35 | 3 | 28 | 45 | 1369. | 2529. |
| 36 | 3 | 27 | 45 | 1369. | 0.2493E+05 |
| 37 | 3 | 26 | 45 | 1368. | 0.2493E+05 |
| 38 | 3 | 25 | 45 | 1367. | 0.1451E+05 |
| 39 | 3 | 30 | 46 | 1370. | 0.1956E+05 |
| 40 | 3 | 29 | 46 | 1370. | 0.2493E+05 |
| 41 | 3 | 28 | 46 | 1369. | 0.2240E+05 |
| 42 | 3 | 32 | 47 | 1370. | 0.1404E+05 |
| 43 | 3 | 31 | 47 | 1370. | 0.2493E+05 |
| 44 | 2 | 31 | 16 | 1383. | 0.2368E+07 |
| 45 | 2 | 30 | 16 | 1382. | 0.2368E+07 |
| 46 | 2 | 29 | 16 | 1381. | 0.2292E+07 |
| 47 | 1 | 35 | 16 | 1386. | 0.1753E+07 |
| 48 | 1 | 34 | 16 | 1385. | 0.2368E+07 |
| 49 | 1 | 33 | 16 | 1384. | 0.2368E+07 |
| 50 | 1 | 32 | 16 | 1384. | 0.2368E+07 |
| 51 | 1 | 28 | 17 | 1379. | 0.2368E+07 |

| | | | | | |
|---|---|---|---|---|---|
| 52 | 1 | 27 | 17 | 1378. | 0.2368E+07 |
| 53 | 1 | 26 | 17 | 1377. | 0.2368E+07 |

53 DRAINS

| REACH NO. | LAYER | ROW | COL | STAGE | CONDUCTANCE | BOTTOM EL. |
|---|---|---|---|---|---|---|
| 1 | 3 | 17 | 19 | 1377. | 1000. | 1376. |
| 2 | 3 | 16 | 19 | 1377. | 1000. | 1376. |
| 3 | 3 | 17 | 20 | 1377. | 1000. | 1376. |
| 4 | 3 | 16 | 20 | 1377. | 1000. | 1376. |
| 5 | 3 | 17 | 21 | 1365. | 1000. | 1364. |
| 6 | 3 | 16 | 21 | 1365. | 1000. | 1364. |
| 7 | 3 | 17 | 22 | 1365. | 1000. | 1364. |
| 8 | 3 | 16 | 22 | 1365. | 1000. | 1364. |
| 9 | 3 | 17 | 23 | 1362. | 1000. | 1361. |
| 10 | 3 | 16 | 23 | 1362. | 1000. | 1361. |
| 11 | 3 | 17 | 24 | 1362. | 1000. | 1361. |
| 12 | 3 | 16 | 24 | 1362. | 1000. | 1361. |
| 13 | 3 | 17 | 25 | 1358. | 1000. | 1357. |
| 14 | 3 | 16 | 25 | 1358. | 1000. | 1357. |
| 15 | 3 | 17 | 26 | 1358. | 1000. | 1357. |
| 16 | 3 | 16 | 26 | 1358. | 1000. | 1357. |
| 17 | 3 | 69 | 27 | 1375. | 1000. | 1374. |
| 18 | 3 | 68 | 27 | 1375. | 1000. | 1374. |
| 19 | 3 | 17 | 27 | 1356. | 1000. | 1355. |
| 20 | 3 | 16 | 27 | 1356. | 1000. | 1355. |
| 21 | 3 | 69 | 28 | 1375. | 1000. | 1374. |
| 22 | 3 | 68 | 28 | 1375. | 1000. | 1374. |
| 23 | 3 | 17 | 28 | 1356. | 1000. | 1355. |
| 24 | 3 | 16 | 28 | 1356. | 1000. | 1355. |
| 25 | 3 | 69 | 29 | 1374. | 1000. | 1373. |
| 26 | 3 | 68 | 29 | 1374. | 1000. | 1373. |
| 27 | 3 | 17 | 29 | 1357. | 1000. | 1356. |
| 28 | 3 | 16 | 29 | 1357. | 1000. | 1356. |
| 29 | 3 | 69 | 30 | 1374. | 1000. | 1373. |
| 30 | 3 | 68 | 30 | 1374. | 1000. | 1373. |
| 31 | 3 | 17 | 30 | 1357. | 1000. | 1356. |
| 32 | 3 | 16 | 30 | 1357. | 1000. | 1356. |
| 33 | 3 | 69 | 31 | 1373. | 1000. | 1372. |
| 34 | 3 | 68 | 31 | 1373. | 1000. | 1372. |
| 35 | 3 | 17 | 31 | 1365. | 1000. | 1364. |
| 36 | 3 | 16 | 31 | 1365. | 1000. | 1364. |
| 37 | 3 | 15 | 31 | 1354. | 1000. | 1353. |
| 38 | 3 | 69 | 32 | 1373. | 1000. | 1372. |
| 39 | 3 | 68 | 32 | 1373. | 1000. | 1372. |
| 40 | 3 | 17 | 32 | 1365. | 1000. | 1364. |
| 41 | 3 | 16 | 32 | 1365. | 1000. | 1364. |
| 42 | 3 | 15 | 32 | 1354. | 1000. | 1353. |
| 43 | 3 | 69 | 33 | 1374. | 1000. | 1373. |
| 44 | 3 | 68 | 33 | 1374. | 1000. | 1373. |
| 45 | 3 | 67 | 33 | 1375. | 1000. | 1374. |
| 46 | 3 | 66 | 33 | 1375. | 1000. | 1374. |
| 47 | 3 | 15 | 33 | 1357. | 1000. | 1356. |
| 48 | 3 | 69 | 34 | 1374. | 1000. | 1373. |
| 49 | 3 | 68 | 34 | 1374. | 1000. | 1373. |
| 50 | 3 | 67 | 34 | 1375. | 1000. | 1374. |
| 51 | 3 | 66 | 34 | 1375. | 1000. | 1374. |
| 52 | 3 | 15 | 34 | 1357. | 1000. | 1356. |
| 53 | 3 | 67 | 35 | 1376. | 1000. | 1375. |
| 54 | 3 | 66 | 35 | 1376. | 1000. | 1375. |
| 55 | 3 | 15 | 35 | 1354. | 1000. | 1353. |
| 56 | 3 | 67 | 36 | 1376. | 1000. | 1375. |

| | | | | | | |
|---|---|---|---|---|---|---|
| 57 | 3 | 66 | 36 | 1376. | 1000. | 1375. |
| 58 | 3 | 15 | 36 | 1354. | 1000. | 1353. |
| 59 | 3 | 67 | 37 | 1376. | 1000. | 1375. |
| 60 | 3 | 66 | 37 | 1376. | 1000. | 1375. |
| 61 | 3 | 49 | 37 | 1377. | 1000. | 1376. |
| 62 | 3 | 48 | 37 | 1377. | 1000. | 1376. |
| 63 | 3 | 47 | 37 | 1375. | 1000. | 1374. |
| 64 | 3 | 46 | 37 | 1375. | 1000. | 1374. |
| 65 | 3 | 15 | 37 | 1351. | 1000. | 1350. |
| 66 | 3 | 67 | 38 | 1376. | 1000. | 1375. |
| 67 | 3 | 66 | 38 | 1376. | 1000. | 1375. |
| 68 | 3 | 49 | 38 | 1377. | 1000. | 1376. |
| 69 | 3 | 48 | 38 | 1377. | 1000. | 1376. |
| 70 | 3 | 47 | 38 | 1375. | 1000. | 1374. |
| 71 | 3 | 46 | 38 | 1375. | 1000. | 1374. |
| 72 | 3 | 15 | 38 | 1351. | 1000. | 1350. |
| 73 | 3 | 67 | 39 | 1375. | 1000. | 1374. |
| 74 | 3 | 66 | 39 | 1375. | 1000. | 1374. |
| 75 | 3 | 51 | 39 | 1378. | 1000. | 1377. |
| 76 | 3 | 50 | 39 | 1378. | 1000. | 1377. |
| 77 | 3 | 49 | 39 | 1376. | 1000. | 1375. |
| 78 | 3 | 48 | 39 | 1376. | 1000. | 1375. |
| 79 | 3 | 15 | 39 | 1357. | 1000. | 1356. |
| 80 | 3 | 67 | 40 | 1375. | 1000. | 1374. |
| 81 | 3 | 66 | 40 | 1375. | 1000. | 1374. |
| 82 | 3 | 51 | 40 | 1378. | 1000. | 1377. |
| 83 | 3 | 50 | 40 | 1378. | 1000. | 1377. |
| 84 | 3 | 49 | 40 | 1376. | 1000. | 1375. |
| 85 | 3 | 48 | 40 | 1376. | 1000. | 1375. |
| 86 | 3 | 15 | 40 | 1357. | 1000. | 1356. |
| 87 | 3 | 67 | 41 | 1375. | 1000. | 1374. |
| 88 | 3 | 66 | 41 | 1375. | 1000. | 1374. |
| 89 | 3 | 55 | 41 | 1380. | 1000. | 1379. |
| 90 | 3 | 54 | 41 | 1380. | 1000. | 1379. |
| 91 | 3 | 53 | 41 | 1377. | 1000. | 1376. |
| 92 | 3 | 52 | 41 | 1377. | 1000. | 1376. |
| 93 | 3 | 15 | 41 | 1350. | 1000. | 1349. |
| 94 | 3 | 14 | 41 | 1346. | 1000. | 1345. |
| 95 | 3 | 13 | 41 | 1345. | 1000. | 1344. |
| 96 | 3 | 12 | 41 | 1340. | 1000. | 1339. |
| 97 | 3 | 67 | 42 | 1375. | 1000. | 1374. |
| 98 | 3 | 66 | 42 | 1375. | 1000. | 1374. |
| 99 | 3 | 55 | 42 | 1380. | 1000. | 1379. |
| 100 | 3 | 54 | 42 | 1380. | 1000. | 1379. |
| 101 | 3 | 53 | 42 | 1377. | 1000. | 1376. |
| 102 | 3 | 52 | 42 | 1377. | 1000. | 1376. |
| 103 | 3 | 15 | 42 | 1350. | 1000. | 1349. |
| 104 | 3 | 14 | 42 | 1346. | 1000. | 1345. |
| 105 | 3 | 13 | 42 | 1345. | 1000. | 1344. |
| 106 | 3 | 12 | 42 | 1340. | 1000. | 1339. |
| 107 | 3 | 67 | 43 | 1375. | 1000. | 1374. |
| 108 | 3 | 66 | 43 | 1375. | 1000. | 1374. |
| 109 | 3 | 59 | 43 | 1379. | 1000. | 1378. |
| 110 | 3 | 58 | 43 | 1379. | 1000. | 1378. |
| 111 | 3 | 57 | 43 | 1379. | 1000. | 1378. |
| 112 | 3 | 56 | 43 | 1379. | 1000. | 1378. |
| 113 | 3 | 12 | 43 | 1338. | 1000. | 1337. |
| 114 | 3 | 67 | 44 | 1375. | 1000. | 1374. |
| 115 | 3 | 66 | 44 | 1375. | 1000. | 1374. |
| 116 | 3 | 59 | 44 | 1379. | 1000. | 1378. |
| 117 | 3 | 58 | 44 | 1379. | 1000. | 1378. |
| 118 | 3 | 57 | 44 | 1379. | 1000. | 1378. |
| 119 | 3 | 56 | 44 | 1379. | 1000. | 1378. |

| | | | | | | |
|---|---|---|---|---|---|---|
| 120 | 3 | 12 | 44 | 1338. | 1000. | 1337. |
| 121 | 3 | 67 | 45 | 1375. | 1000. | 1374. |
| 122 | 3 | 66 | 45 | 1375. | 1000. | 1374. |
| 123 | 3 | 65 | 45 | 1375. | 1000. | 1374. |
| 124 | 3 | 64 | 45 | 1375. | 1000. | 1374. |
| 125 | 3 | 63 | 45 | 1376. | 1000. | 1375. |
| 126 | 3 | 62 | 45 | 1376. | 1000. | 1375. |
| 127 | 3 | 61 | 45 | 1375. | 1000. | 1374. |
| 128 | 3 | 60 | 45 | 1375. | 1000. | 1374. |
| 129 | 3 | 11 | 45 | 1336. | 1000. | 1335. |
| 130 | 3 | 10 | 45 | 1337. | 1000. | 1336. |
| 131 | 3 | 67 | 46 | 1375. | 1000. | 1374. |
| 132 | 3 | 66 | 46 | 1375. | 1000. | 1374. |
| 133 | 3 | 65 | 46 | 1375. | 1000. | 1374. |
| 134 | 3 | 64 | 46 | 1375. | 1000. | 1374. |
| 135 | 3 | 63 | 46 | 1376. | 1000. | 1375. |
| 136 | 3 | 62 | 46 | 1376. | 1000. | 1375. |
| 137 | 3 | 61 | 46 | 1375. | 1000. | 1374. |
| 138 | 3 | 60 | 46 | 1375. | 1000. | 1374. |
| 139 | 3 | 11 | 46 | 1336. | 1000. | 1335. |
| 140 | 3 | 10 | 46 | 1337. | 1000. | 1336. |
| 141 | 3 | 10 | 47 | 1350. | 1000. | 1349. |
| 142 | 3 | 9 | 47 | 1349. | 1000. | 1348. |
| 143 | 3 | 10 | 48 | 1350. | 1000. | 1349. |
| 144 | 3 | 9 | 48 | 1349. | 1000. | 1348. |
| 145 | 3 | 8 | 49 | 1350. | 1000. | 1349. |
| 146 | 3 | 7 | 49 | 1344. | 1000. | 1343. |
| 147 | 3 | 6 | 49 | 1341. | 1000. | 1340. |
| 148 | 3 | 5 | 49 | 1341. | 1000. | 1340. |
| 149 | 3 | 4 | 49 | 1338. | 1000. | 1337. |
| 150 | 3 | 3 | 49 | 1335. | 1000. | 1334. |
| 151 | 3 | 2 | 49 | 1332. | 1000. | 1331. |
| 152 | 3 | 1 | 49 | 1347. | 1000. | 1346. |
| 153 | 3 | 8 | 50 | 1350. | 1000. | 1349. |
| 154 | 3 | 7 | 50 | 1344. | 1000. | 1343. |
| 155 | 3 | 6 | 50 | 1341. | 1000. | 1340. |
| 156 | 3 | 5 | 50 | 1341. | 1000. | 1340. |
| 157 | 3 | 4 | 50 | 1338. | 1000. | 1337. |
| 158 | 3 | 3 | 50 | 1335. | 1000. | 1334. |
| 159 | 3 | 2 | 50 | 1332. | 1000. | 1331. |
| 160 | 3 | 1 | 50 | 1347. | 1000. | 1346. |
| 161 | 3 | 14 | 63 | 1348. | 1000. | 1347. |
| 162 | 3 | 13 | 63 | 1349. | 1000. | 1349. |
| 163 | 3 | 14 | 64 | 1348. | 1000. | 1347. |
| 164 | 3 | 13 | 64 | 1349. | 1000. | 1349. |
| 165 | 3 | 14 | 65 | 1342. | 1000. | 1341. |
| 166 | 3 | 11 | 65 | 1338. | 1000. | 1337. |
| 167 | 3 | 14 | 66 | 1341. | 1000. | 1340. |
| 168 | 3 | 10 | 66 | 1334. | 1000. | 1334. |
| 169 | 3 | 9 | 66 | 1342. | 1000. | 1342. |
| 170 | 3 | 8 | 66 | 1357. | 1000. | 1356. |
| 171 | 3 | 7 | 66 | 1363. | 1000. | 1362. |
| 172 | 3 | 21 | 67 | 1341. | 1000. | 1340. |
| 173 | 3 | 20 | 67 | 1341. | 1000. | 1340. |
| 174 | 3 | 19 | 67 | 1338. | 1000. | 1337. |
| 175 | 3 | 18 | 67 | 1338. | 1000. | 1337. |
| 176 | 3 | 17 | 67 | 1335. | 1000. | 1334. |
| 177 | 3 | 16 | 67 | 1335. | 1000. | 1334. |
| 178 | 3 | 15 | 67 | 1336. | 1000. | 1335. |
| 179 | 3 | 8 | 67 | 1342. | 1000. | 1341. |
| 180 | 3 | 7 | 67 | 1347. | 1000. | 1347. |
| 181 | 3 | 6 | 67 | 1341. | 1000. | 1341. |
| 182 | 3 | 21 | 68 | 1336. | 1000. | 1335. |

| | | | | | | |
|---|---|---|---|---|---|---|
| 183 | 3 | 20 | 68 | 1336. | 1000. | 1335. |
| 184 | 3 | 6 | 68 | 1332. | 1000. | 1332. |
| 185 | 3 | 5 | 68 | 1333. | 1000. | 1333. |
| 186 | 3 | 4 | 68 | 1334. | 1000. | 1334. |
| 187 | 3 | 53 | 69 | 1355. | 1000. | 1354. |
| 188 | 3 | 52 | 69 | 1355. | 1000. | 1354. |
| 189 | 3 | 51 | 69 | 1355. | 1000. | 1354. |
| 190 | 3 | 50 | 69 | 1355. | 1000. | 1354. |
| 191 | 3 | 2 | 69 | 1333. | 1000. | 1332. |
| 192 | 3 | 1 | 69 | 1342. | 1000. | 1341. |
| 193 | 3 | 67 | 70 | 1365. | 1000. | 1364. |
| 194 | 3 | 66 | 70 | 1365. | 1000. | 1364. |
| 195 | 3 | 1 | 70 | 1334. | 1000. | 1334. |
| 196 | 2 | 71 | 29 | 1377. | 1000. | 1376. |
| 197 | 2 | 70 | 29 | 1377. | 1000. | 1376. |
| 198 | 2 | 71 | 30 | 1377. | 1000. | 1376. |
| 199 | 2 | 70 | 30 | 1377. | 1000. | 1376. |
| 200 | 2 | 71 | 31 | 1376. | 1000. | 1375. |
| 201 | 2 | 70 | 31 | 1376. | 1000. | 1375. |
| 202 | 2 | 71 | 32 | 1376. | 1000. | 1375. |
| 203 | 2 | 70 | 32 | 1376. | 1000. | 1375. |
| 204 | 2 | 71 | 33 | 1377. | 1000. | 1376. |
| 205 | 2 | 70 | 33 | 1377. | 1000. | 1376. |
| 206 | 2 | 71 | 34 | 1377. | 1000. | 1376. |
| 207 | 2 | 70 | 34 | 1377. | 1000. | 1376. |
| 208 | 2 | 72 | 37 | 1374. | 1000. | 1373. |
| 209 | 2 | 72 | 38 | 1374. | 1000. | 1373. |
| 210 | 2 | 73 | 41 | 1372. | 1000. | 1371. |
| 211 | 2 | 73 | 42 | 1372. | 1000. | 1371. |
| 212 | 2 | 73 | 43 | 1372. | 1000. | 1371. |
| 213 | 2 | 73 | 44 | 1372. | 1000. | 1371. |
| 214 | 2 | 73 | 45 | 1372. | 1000. | 1371. |
| 215 | 2 | 73 | 46 | 1372. | 1000. | 1371. |
| 216 | 2 | 74 | 49 | 1370. | 1000. | 1369. |
| 217 | 2 | 74 | 50 | 1370. | 1000. | 1369. |
| 218 | 2 | 74 | 51 | 1370. | 1000. | 1369. |
| 219 | 2 | 74 | 52 | 1370. | 1000. | 1369. |
| 220 | 2 | 75 | 53 | 1369. | 1000. | 1368. |
| 221 | 2 | 74 | 53 | 1370. | 1000. | 1369. |
| 222 | 2 | 75 | 54 | 1369. | 1000. | 1368. |
| 223 | 2 | 74 | 54 | 1370. | 1000. | 1369. |
| 224 | 2 | 75 | 55 | 1369. | 1000. | 1368. |
| 225 | 2 | 75 | 56 | 1369. | 1000. | 1368. |
| 226 | 2 | 75 | 57 | 1368. | 1000. | 1367. |
| 227 | 2 | 75 | 58 | 1368. | 1000. | 1367. |
| 228 | 2 | 75 | 59 | 1369. | 1000. | 1368. |
| 229 | 2 | 75 | 60 | 1369. | 1000. | 1368. |
| 230 | 2 | 75 | 61 | 1368. | 1000. | 1367. |
| 231 | 2 | 74 | 61 | 1368. | 1000. | 1367. |
| 232 | 2 | 75 | 62 | 1368. | 1000. | 1367. |
| 233 | 2 | 74 | 62 | 1368. | 1000. | 1367. |
| 234 | 2 | 74 | 63 | 1367. | 1000. | 1366. |
| 235 | 2 | 74 | 64 | 1367. | 1000. | 1366. |
| 236 | 2 | 73 | 65 | 1367. | 1000. | 1366. |
| 237 | 2 | 73 | 66 | 1365. | 1000. | 1364. |
| 238 | 2 | 72 | 66 | 1369. | 1000. | 1368. |
| 239 | 2 | 72 | 67 | 1365. | 1000. | 1364. |
| 240 | 2 | 71 | 67 | 1370. | 1000. | 1369. |
| 241 | 2 | 70 | 67 | 1370. | 1000. | 1369. |
| 242 | 2 | 71 | 68 | 1366. | 1000. | 1365. |
| 243 | 2 | 70 | 68 | 1366. | 1000. | 1365. |
| 244 | 2 | 69 | 68 | 1373. | 1000. | 1372. |
| 245 | 2 | 68 | 68 | 1373. | 1000. | 1372. |

| | | | | | | |
|---|---|---|---|---|---|---|
| 246 | 2 | 37 | 68 | 1354. | 1000. | 1353. |
| 247 | 2 | 36 | 68 | 1354. | 1000. | 1353. |
| 248 | 2 | 35 | 68 | 1349. | 1000. | 1348. |
| 249 | 2 | 34 | 68 | 1349. | 1000. | 1348. |
| 250 | 2 | 33 | 68 | 1345. | 1000. | 1344. |
| 251 | 2 | 32 | 68 | 1345. | 1000. | 1344. |
| 252 | 2 | 31 | 68 | 1344. | 1000. | 1343. |
| 253 | 2 | 30 | 68 | 1344. | 1000. | 1343. |
| 254 | 2 | 29 | 68 | 1345. | 1000. | 1344. |
| 255 | 2 | 28 | 68 | 1345. | 1000. | 1344. |
| 256 | 2 | 27 | 68 | 1346. | 1000. | 1345. |
| 257 | 2 | 26 | 68 | 1346. | 1000. | 1345. |
| 258 | 2 | 25 | 68 | 1345. | 1000. | 1344. |
| 259 | 2 | 24 | 68 | 1345. | 1000. | 1344. |
| 260 | 2 | 23 | 68 | 1343. | 1000. | 1342. |
| 261 | 2 | 22 | 68 | 1343. | 1000. | 1342. |
| 262 | 2 | 69 | 69 | 1369. | 1000. | 1368. |
| 263 | 2 | 68 | 69 | 1369. | 1000. | 1368. |
| 264 | 2 | 49 | 69 | 1355. | 1000. | 1354. |
| 265 | 2 | 48 | 69 | 1358. | 1000. | 1357. |
| 266 | 2 | 47 | 69 | 1353. | 1000. | 1352. |
| 267 | 2 | 46 | 69 | 1353. | 1000. | 1352. |
| 268 | 2 | 45 | 69 | 1352. | 1000. | 1351. |
| 269 | 2 | 44 | 69 | 1352. | 1000. | 1351. |
| 270 | 2 | 43 | 69 | 1354. | 1000. | 1353. |
| 271 | 2 | 42 | 69 | 1354. | 1000. | 1353. |
| 272 | 2 | 41 | 69 | 1359. | 1000. | 1358. |
| 273 | 2 | 40 | 69 | 1359. | 1000. | 1358. |
| 274 | 2 | 39 | 69 | 1352. | 1000. | 1351. |
| 275 | 2 | 38 | 69 | 1352. | 1000. | 1351. |
| 276 | 2 | 55 | 70 | 1359. | 1000. | 1358. |
| 277 | 2 | 54 | 70 | 1359. | 1000. | 1358. |
| 278 | 2 | 53 | 70 | 1355. | 1000. | 1354. |
| 279 | 2 | 52 | 70 | 1355. | 1000. | 1354. |
| 280 | 2 | 67 | 71 | 1362. | 1000. | 1361. |
| 281 | 2 | 66 | 71 | 1362. | 1000. | 1361. |
| 282 | 2 | 65 | 71 | 1365. | 1000. | 1364. |
| 283 | 2 | 64 | 71 | 1365. | 1000. | 1364. |
| 284 | 2 | 63 | 71 | 1363. | 1000. | 1362. |
| 285 | 2 | 62 | 71 | 1363. | 1000. | 1362. |
| 286 | 2 | 61 | 71 | 1360. | 1000. | 1359. |
| 287 | 2 | 60 | 71 | 1360. | 1000. | 1359. |
| 288 | 2 | 59 | 71 | 1357. | 1000. | 1356. |
| 289 | 2 | 58 | 71 | 1357. | 1000. | 1356. |
| 290 | 2 | 57 | 71 | 1355. | 1000. | 1354. |
| 291 | 2 | 56 | 71 | 1355. | 1000. | 1354. |
| 292 | 2 | 55 | 71 | 1356. | 1000. | 1355. |
| 293 | 2 | 54 | 71 | 1356. | 1000. | 1355. |

293 RIVER REACHES

RECHARGE
READING ON UNIT 18 WITH FORMAT: (15G11.4)

SOLVING FOR HEAD
0

SOLUTION BY CGSTAB-P

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WVNS-NDA.LST

```
CELL CONVERSIONS FOR ITER.=  1  LAYER=  1  STEP=  1  PERIOD=  1   (ROW,COL)
   DRY(  1, 49)   DRY(  1, 50)   DRY(  1, 51)   DRY(  1, 52)   DRY(  1, 53)
   DRY(  1, 70)   DRY(  2, 50)   DRY(  2, 51)   DRY(  2, 53)   DRY(  2, 55)
   DRY(  2, 68)   DRY(  2, 69)   DRY(  2, 70)   DRY(  3, 50)   DRY(  3, 51)
   DRY(  3, 53)   DRY(  3, 67)   DRY(  3, 68)   DRY(  4, 50)   DRY(  4, 51)
   DRY(  4, 53)   DRY(  4, 64)   DRY(  4, 66)   DRY(  4, 67)   DRY(  5, 50)
   DRY(  5, 51)   DRY(  5, 53)   DRY(  5, 55)   DRY(  5, 57)   DRY(  5, 67)
   DRY(  5, 68)   DRY(  6, 50)   DRY(  6, 51)   DRY(  6, 55)   DRY(  6, 66)
   DRY(  6, 68)   DRY(  7, 48)   DRY(  7, 49)   DRY(  7, 51)   DRY(  7, 55)
   DRY(  7, 57)   DRY(  7, 68)   DRY(  8, 48)   DRY(  8, 49)   DRY(  8, 51)
   DRY(  8, 57)   DRY(  8, 68)   DRY(  9, 49)   DRY(  9, 51)   DRY(  9, 57)
   DRY(  9, 64)   DRY(  9, 65)   DRY(  9, 66)   DRY( 10, 47)   DRY( 10, 49)
   DRY( 10, 51)   DRY( 10, 57)   DRY( 10, 62)   DRY( 10, 64)   DRY( 10, 65)
   DRY( 10, 66)   DRY( 11, 47)   DRY( 11, 64)   DRY( 11, 65)   DRY( 12, 64)
   DRY( 13, 64)   DRY( 14, 64)   DRY( 14, 65)   DRY( 15, 64)   DRY( 16, 64)
   DRY( 19, 20)   DRY( 22, 20)   DRY( 23, 20)   DRY( 24, 20)   DRY( 25, 20)
Outer iteration    1 Inner iteration   1 Max. residual  3.931E+03
Outer iteration    1 Inner iteration   2 Max. residual  1.602E+03
Outer iteration    1 Inner iteration   3 Max. residual  8.712E+02
Outer iteration    1 Inner iteration   4 Max. residual  5.652E+02
Outer iteration    1 Inner iteration   5 Max. residual  4.270E+02
Outer iteration    1 Inner iteration   6 Max. residual  3.134E+02
Outer iteration    1 Inner iteration   7 Max. residual  2.768E+02
Outer iteration    1 Inner iteration   8 Max. residual  3.056E+02
Outer iteration    1 Inner iteration   9 Max. residual  1.715E+02
Outer iteration    1 Inner iteration  10 Max. residual  1.499E+02
Outer iteration    1 Inner iteration  11 Max. residual  1.339E+02
Outer iteration    1 Inner iteration  12 Max. residual  1.269E+02
Outer iteration    1 Inner iteration  13 Max. residual  1.232E+02
Outer iteration    1 Inner iteration  14 Max. residual  1.231E+02
Outer iteration    1 Inner iteration  15 Max. residual  1.077E+02
Outer iteration    1 Inner iteration  16 Max. residual  1.009E+02
Outer iteration    1 Inner iteration  17 Max. residual  8.435E+01
Outer iteration    1 Inner iteration  18 Max. residual  7.173E+01
Outer iteration    1 Inner iteration  19 Max. residual  5.072E+01
Outer iteration    1 Inner iteration  20 Max. residual  3.464E+01
Outer iteration    1 Inner iteration  21 Max. residual  4.597E+01
Outer iteration    1 Inner iteration  22 Max. residual  4.173E+01
Outer iteration    1 Inner iteration  23 Max. residual -1.404E+01
Outer iteration    1 Inner iteration  24 Max. residual  2.883E+01
Outer iteration    1 Inner iteration  25 Max. residual -1.181E+01
Outer iteration    1 Inner iteration  26 Max. residual  3.718E+01
Outer iteration    1 Inner iteration  27 Max. residual -8.081E+00
Outer iteration    1 Inner iteration  28 Max. residual -8.738E+00
Outer iteration    1 Inner iteration  29 Max. residual -1.119E+01
Outer iteration    1 Inner iteration  30 Max. residual -7.487E+00
Outer iteration    1 Inner iteration  31 Max. residual  1.364E+01
Outer iteration    1 Inner iteration  32 Max. residual  1.116E+00
Outer iteration    1 Inner iteration  33 Max. residual  3.804E+00
Outer iteration    1 Inner iteration  34 Max. residual -1.480E+00
Outer iteration    1 Inner iteration  35 Max. residual  3.253E+00
Outer iteration    1 Inner iteration  36 Max. residual -1.476E+00
Outer iteration    1 Inner iteration  37 Max. residual -1.574E+00
Outer iteration    1 Inner iteration  38 Max. residual -1.413E+00
Outer iteration    1 Inner iteration  39 Max. residual -1.657E+00
Outer iteration    1 Inner iteration  40 Max. residual -1.265E+00
Outer iteration    1 Inner iteration  41 Max. residual -1.178E+00
Outer iteration    1 Inner iteration  42 Max. residual -1.004E+00
Outer iteration    1 Inner iteration  43 Max. residual -1.514E+00
Outer iteration    1 Inner iteration  44 Max. residual -2.929E+00
Outer iteration    1 Inner iteration  45 Max. residual -6.958E-01
Outer iteration    1 Inner iteration  46 Max. residual -6.867E-01
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 Outer iteration    1 Inner iteration  47 Max. residual -1.229E+00
 Outer iteration    1 Inner iteration  48 Max. residual -1.454E+00
 Outer iteration    1 Inner iteration  49 Max. residual -9.125E-02
 Outer iteration    1 Inner iteration  50 Max. residual  1.737E-01
0


                                                    SOLUTION BY CGSTAB-P

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 CELL CONVERSIONS FOR ITER.=  2  LAYER=  1  STEP=  1  PERIOD=  1   (ROW,COL)
    DRY(  1, 69)   DRY(  4, 68)   DRY(  6, 67)   DRY(  7, 66)   DRY(  7, 67)
    DRY(  8, 62)   DRY(  8, 66)   DRY(  8, 67)   DRY(  9, 50)   DRY(  9, 52)
    DRY(  9, 53)   DRY(  9, 54)   DRY(  9, 59)   DRY(  9, 60)   DRY(  9, 61)
    DRY(  9, 62)   DRY( 10, 45)   DRY( 10, 46)   DRY( 10, 50)   DRY( 10, 52)
    DRY( 10, 53)   DRY( 10, 54)   DRY( 10, 55)   DRY( 10, 56)   DRY( 10, 58)
    DRY( 10, 59)   DRY( 10, 60)   DRY( 10, 61)   DRY( 11, 43)   DRY( 11, 44)
    DRY( 11, 45)   DRY( 11, 46)   DRY( 11, 48)   DRY( 11, 49)   DRY( 11, 50)
    DRY( 11, 51)   DRY( 11, 52)   DRY( 11, 53)   DRY( 11, 54)   DRY( 11, 55)
    DRY( 11, 56)   DRY( 11, 57)   DRY( 11, 58)   DRY( 11, 59)   DRY( 11, 60)
    DRY( 11, 61)   DRY( 11, 62)   DRY( 12, 41)   DRY( 12, 42)   DRY( 12, 43)
    DRY( 12, 44)   DRY( 12, 45)   DRY( 12, 47)   DRY( 12, 48)   DRY( 12, 49)
    DRY( 12, 50)   DRY( 12, 51)   DRY( 12, 52)   DRY( 12, 53)   DRY( 12, 54)
    DRY( 12, 55)   DRY( 12, 56)   DRY( 12, 57)   DRY( 12, 58)   DRY( 12, 59)
    DRY( 12, 60)   DRY( 12, 61)   DRY( 12, 62)   DRY( 13, 41)   DRY( 13, 42)
    DRY( 13, 43)   DRY( 13, 44)   DRY( 13, 45)   DRY( 13, 46)   DRY( 13, 47)
    DRY( 13, 48)   DRY( 13, 49)   DRY( 13, 50)   DRY( 13, 51)   DRY( 13, 52)
    DRY( 13, 53)   DRY( 13, 54)   DRY( 13, 55)   DRY( 13, 56)   DRY( 13, 57)
    DRY( 13, 58)   DRY( 13, 59)   DRY( 13, 60)   DRY( 13, 61)   DRY( 13, 62)
    DRY( 14, 41)   DRY( 14, 42)   DRY( 14, 43)   DRY( 14, 44)   DRY( 14, 45)
    DRY( 14, 46)   DRY( 14, 47)   DRY( 14, 48)   DRY( 14, 49)   DRY( 14, 50)
    DRY( 14, 51)   DRY( 14, 52)   DRY( 14, 53)   DRY( 14, 54)   DRY( 14, 55)
    DRY( 14, 56)   DRY( 14, 57)   DRY( 14, 58)   DRY( 14, 59)   DRY( 14, 60)
    DRY( 14, 61)   DRY( 14, 62)   DRY( 14, 63)   DRY( 15, 31)   DRY( 15, 32)
    DRY( 15, 33)   DRY( 15, 34)   DRY( 15, 35)   DRY( 15, 36)   DRY( 15, 37)
    DRY( 15, 38)   DRY( 15, 39)   DRY( 15, 40)   DRY( 15, 41)   DRY( 15, 42)
    DRY( 15, 43)   DRY( 15, 44)   DRY( 15, 45)   DRY( 15, 46)   DRY( 15, 47)
    DRY( 15, 48)   DRY( 15, 49)   DRY( 15, 50)   DRY( 15, 51)   DRY( 15, 52)
    DRY( 15, 53)   DRY( 15, 54)   DRY( 15, 55)   DRY( 15, 56)   DRY( 15, 57)
    DRY( 15, 58)   DRY( 15, 59)   DRY( 15, 60)   DRY( 15, 61)   DRY( 15, 62)
    DRY( 15, 63)   DRY( 15, 67)   DRY( 16, 19)   DRY( 16, 20)   DRY( 16, 21)
    DRY( 16, 22)   DRY( 16, 23)   DRY( 16, 24)   DRY( 16, 25)   DRY( 16, 26)
    DRY( 16, 27)   DRY( 16, 28)   DRY( 16, 29)   DRY( 16, 30)   DRY( 16, 31)
    DRY( 16, 32)   DRY( 16, 33)   DRY( 16, 34)   DRY( 16, 35)   DRY( 16, 36)
    DRY( 16, 37)   DRY( 16, 38)   DRY( 16, 39)   DRY( 16, 40)   DRY( 16, 41)
    DRY( 16, 42)   DRY( 16, 43)   DRY( 16, 44)   DRY( 16, 45)   DRY( 16, 46)
    DRY( 16, 47)   DRY( 16, 48)   DRY( 16, 49)   DRY( 16, 50)   DRY( 16, 51)
    DRY( 16, 52)   DRY( 16, 53)   DRY( 16, 54)   DRY( 16, 55)   DRY( 16, 56)
    DRY( 16, 57)   DRY( 16, 58)   DRY( 16, 59)   DRY( 16, 60)   DRY( 16, 61)
    DRY( 16, 62)   DRY( 16, 63)   DRY( 16, 65)   DRY( 16, 66)   DRY( 16, 67)
    DRY( 17, 19)   DRY( 17, 20)   DRY( 17, 21)   DRY( 17, 22)   DRY( 17, 23)
    DRY( 17, 24)   DRY( 17, 25)   DRY( 17, 26)   DRY( 17, 27)   DRY( 17, 28)
    DRY( 17, 29)   DRY( 17, 30)   DRY( 17, 31)   DRY( 17, 32)   DRY( 17, 33)
    DRY( 17, 34)   DRY( 17, 35)   DRY( 17, 36)   DRY( 17, 37)   DRY( 17, 38)
    DRY( 17, 39)   DRY( 17, 40)   DRY( 17, 43)   DRY( 17, 44)   DRY( 17, 45)
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    DRY( 17, 51)   DRY( 17, 52)   DRY( 17, 53)   DRY( 17, 54)   DRY( 17, 55)
    DRY( 17, 56)   DRY( 17, 57)   DRY( 17, 58)   DRY( 17, 59)   DRY( 17, 60)
    DRY( 17, 61)   DRY( 17, 62)   DRY( 17, 63)   DRY( 17, 64)   DRY( 17, 65)
    DRY( 17, 66)   DRY( 17, 67)   DRY( 18, 19)   DRY( 18, 20)   DRY( 18, 22)
    DRY( 18, 24)   DRY( 18, 25)   DRY( 18, 26)   DRY( 18, 27)   DRY( 18, 28)
    DRY( 18, 29)   DRY( 18, 30)   DRY( 18, 31)   DRY( 18, 32)   DRY( 18, 33)
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DRY( 18, 34)   DRY( 18, 35)   DRY( 18, 36)   DRY( 18, 37)   DRY( 18, 38)
DRY( 18, 39)   DRY( 18, 40)   DRY( 18, 41)   DRY( 18, 42)   DRY( 18, 43)
DRY( 18, 44)   DRY( 18, 45)   DRY( 18, 46)   DRY( 18, 47)   DRY( 18, 48)
DRY( 18, 49)   DRY( 18, 50)   DRY( 18, 51)   DRY( 18, 52)   DRY( 18, 53)
DRY( 18, 54)   DRY( 18, 55)   DRY( 18, 56)   DRY( 18, 57)   DRY( 18, 58)
DRY( 18, 59)   DRY( 18, 60)   DRY( 18, 61)   DRY( 18, 62)   DRY( 18, 63)
DRY( 18, 64)   DRY( 18, 65)   DRY( 18, 66)   DRY( 18, 67)   DRY( 19, 19)
DRY( 19, 27)   DRY( 19, 28)   DRY( 19, 29)   DRY( 19, 30)   DRY( 19, 31)
DRY( 19, 32)   DRY( 19, 33)   DRY( 19, 34)   DRY( 19, 35)   DRY( 19, 36)
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DRY( 19, 57)   DRY( 19, 58)   DRY( 19, 59)   DRY( 19, 60)   DRY( 19, 61)
DRY( 19, 62)   DRY( 19, 63)   DRY( 19, 64)   DRY( 19, 65)   DRY( 19, 66)
DRY( 19, 67)   DRY( 20, 19)   DRY( 20, 20)   DRY( 20, 25)   DRY( 20, 26)
DRY( 20, 27)   DRY( 20, 28)   DRY( 20, 29)   DRY( 20, 30)   DRY( 20, 31)
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DRY( 20, 42)   DRY( 20, 43)   DRY( 20, 44)   DRY( 20, 45)   DRY( 20, 46)
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DRY( 20, 52)   DRY( 20, 53)   DRY( 20, 54)   DRY( 20, 55)   DRY( 20, 56)
DRY( 20, 57)   DRY( 20, 58)   DRY( 20, 59)   DRY( 20, 60)   DRY( 20, 61)
DRY( 20, 62)   DRY( 20, 63)   DRY( 20, 64)   DRY( 20, 65)   DRY( 20, 66)
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DRY( 21, 31)   DRY( 21, 32)   DRY( 21, 33)   DRY( 21, 34)   DRY( 21, 35)
DRY( 21, 36)   DRY( 21, 37)   DRY( 21, 38)   DRY( 21, 39)   DRY( 21, 40)
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DRY( 21, 66)   DRY( 21, 67)   DRY( 21, 68)   DRY( 22, 19)   DRY( 22, 23)
DRY( 22, 24)   DRY( 22, 25)   DRY( 22, 26)   DRY( 22, 27)   DRY( 22, 28)
DRY( 22, 29)   DRY( 22, 30)   DRY( 22, 31)   DRY( 22, 32)   DRY( 22, 33)
DRY( 22, 34)   DRY( 22, 35)   DRY( 22, 36)   DRY( 22, 37)   DRY( 22, 38)
DRY( 22, 39)   DRY( 22, 40)   DRY( 22, 41)   DRY( 22, 42)   DRY( 22, 43)
DRY( 22, 44)   DRY( 22, 45)   DRY( 22, 46)   DRY( 22, 47)   DRY( 22, 48)
DRY( 22, 49)   DRY( 22, 50)   DRY( 22, 51)   DRY( 22, 52)   DRY( 22, 53)
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DRY( 69, 58)   DRY( 69, 59)   DRY( 69, 60)   DRY( 69, 61)   DRY( 69, 62)
DRY( 69, 63)   DRY( 69, 64)   DRY( 69, 65)   DRY( 69, 66)   DRY( 69, 67)
DRY( 69, 68)   DRY( 70, 28)   DRY( 70, 35)   DRY( 70, 36)   DRY( 70, 37)
DRY( 70, 38)   DRY( 70, 41)   DRY( 70, 42)   DRY( 70, 43)   DRY( 70, 44)
DRY( 70, 45)   DRY( 70, 46)   DRY( 70, 47)   DRY( 70, 48)   DRY( 70, 49)
DRY( 70, 50)   DRY( 70, 51)   DRY( 70, 52)   DRY( 70, 53)   DRY( 70, 54)
DRY( 70, 55)   DRY( 70, 56)   DRY( 70, 57)   DRY( 70, 58)   DRY( 70, 59)
DRY( 70, 60)   DRY( 70, 61)   DRY( 70, 62)   DRY( 70, 63)   DRY( 70, 64)
DRY( 70, 65)   DRY( 70, 66)   DRY( 71, 35)   DRY( 71, 36)   DRY( 71, 37)
DRY( 71, 38)   DRY( 71, 39)   DRY( 71, 40)   DRY( 71, 41)   DRY( 71, 42)
DRY( 71, 43)   DRY( 71, 44)   DRY( 71, 45)   DRY( 71, 46)   DRY( 71, 47)
```

```
   DRY( 71, 48)   DRY( 71, 49)   DRY( 71, 50)   DRY( 71, 51)   DRY( 71, 52)
   DRY( 71, 53)   DRY( 71, 54)   DRY( 71, 55)   DRY( 71, 56)   DRY( 71, 57)
   DRY( 71, 58)   DRY( 71, 59)   DRY( 71, 60)   DRY( 71, 61)   DRY( 71, 62)
   DRY( 71, 63)   DRY( 71, 64)   DRY( 71, 65)   DRY( 71, 66)   DRY( 72, 45)
   DRY( 72, 46)   DRY( 72, 47)   DRY( 72, 48)   DRY( 72, 50)   DRY( 72, 53)
   DRY( 72, 54)   DRY( 72, 55)   DRY( 72, 56)   DRY( 72, 57)   DRY( 72, 58)
   DRY( 72, 59)   DRY( 72, 60)   DRY( 72, 61)   DRY( 72, 62)   DRY( 72, 64)
Outer iteration    2 Inner iteration    1 Max. residual -7.150E+02
Outer iteration    2 Inner iteration    2 Max. residual -2.358E+02
Outer iteration    2 Inner iteration    3 Max. residual -1.100E+02
Outer iteration    2 Inner iteration    4 Max. residual -8.579E+01
Outer iteration    2 Inner iteration    5 Max. residual  5.756E+01
Outer iteration    2 Inner iteration    6 Max. residual  4.948E+01
Outer iteration    2 Inner iteration    7 Max. residual  4.627E+01
Outer iteration    2 Inner iteration    8 Max. residual  2.688E+01
Outer iteration    2 Inner iteration    9 Max. residual  3.025E+01
Outer iteration    2 Inner iteration   10 Max. residual  3.289E+01
Outer iteration    2 Inner iteration   11 Max. residual  3.544E+01
Outer iteration    2 Inner iteration   12 Max. residual  3.960E+01
Outer iteration    2 Inner iteration   13 Max. residual  5.055E+01
Outer iteration    2 Inner iteration   14 Max. residual  9.892E+01
Outer iteration    2 Inner iteration   15 Max. residual -2.038E+02
Outer iteration    2 Inner iteration   16 Max. residual -2.910E+02
Outer iteration    2 Inner iteration   17 Max. residual -2.074E+01
Outer iteration    2 Inner iteration   18 Max. residual -1.877E+01
Outer iteration    2 Inner iteration   19 Max. residual -1.464E+01
Outer iteration    2 Inner iteration   20 Max. residual -9.864E+00
Outer iteration    2 Inner iteration   21 Max. residual -8.732E+00
Outer iteration    2 Inner iteration   22 Max. residual -3.895E+00
Outer iteration    2 Inner iteration   23 Max. residual -3.227E+00
Outer iteration    2 Inner iteration   24 Max. residual -2.886E+00
Outer iteration    2 Inner iteration   25 Max. residual -2.542E+00
Outer iteration    2 Inner iteration   26 Max. residual -2.202E+00
Outer iteration    2 Inner iteration   27 Max. residual -1.946E+00
Outer iteration    2 Inner iteration   28 Max. residual -8.555E-01
Outer iteration    2 Inner iteration   29 Max. residual -1.597E+00
Outer iteration    2 Inner iteration   30 Max. residual -6.064E-01
Outer iteration    2 Inner iteration   31 Max. residual -4.010E-01
Outer iteration    2 Inner iteration   32 Max. residual -4.434E-01
Outer iteration    2 Inner iteration   33 Max. residual -2.920E-01
Outer iteration    2 Inner iteration   34 Max. residual -2.551E-01
Outer iteration    2 Inner iteration   35 Max. residual  1.914E-01
Outer iteration    2 Inner iteration   36 Max. residual -2.464E-01
Outer iteration    2 Inner iteration   37 Max. residual -1.436E-01
Outer iteration    2 Inner iteration   38 Max. residual -1.425E-01
Outer iteration    2 Inner iteration   39 Max. residual -1.377E-01
Outer iteration    2 Inner iteration   40 Max. residual -1.257E-01
Outer iteration    2 Inner iteration   41 Max. residual  2.589E-01
Outer iteration    2 Inner iteration   42 Max. residual -1.868E-01
Outer iteration    2 Inner iteration   43 Max. residual  2.743E-01
Outer iteration    2 Inner iteration   44 Max. residual  4.746E-01
Outer iteration    2 Inner iteration   45 Max. residual  8.099E-01
Outer iteration    2 Inner iteration   46 Max. residual -1.009E+00
Outer iteration    2 Inner iteration   47 Max. residual -1.853E-01
Outer iteration    2 Inner iteration   48 Max. residual -1.047E-01
Outer iteration    2 Inner iteration   49 Max. residual -8.701E-02
Outer iteration    2 Inner iteration   50 Max. residual -6.353E-02
0

                                                    SOLUTION BY CGSTAB-P

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```

WVNS-NDA.LST

```
 CELL CONVERSIONS FOR ITER.=  3  LAYER=  1  STEP=  1  PERIOD=  1   (ROW,COL)
    DRY(  7, 62)   DRY(  8, 61)   DRY( 13, 63)   DRY( 15, 65)   DRY( 15, 66)
 Outer iteration    3 Inner iteration   1 Max. residual  1.084E+02
 Outer iteration    3 Inner iteration   2 Max. residual  5.502E+01
 Outer iteration    3 Inner iteration   3 Max. residual  1.867E+01
 Outer iteration    3 Inner iteration   4 Max. residual  1.733E+01
 Outer iteration    3 Inner iteration   5 Max. residual  1.031E+01
 Outer iteration    3 Inner iteration   6 Max. residual -1.489E+01
 Outer iteration    3 Inner iteration   7 Max. residual -1.378E+01
 Outer iteration    3 Inner iteration   8 Max. residual -1.168E+01
 Outer iteration    3 Inner iteration   9 Max. residual -9.053E+00
 Outer iteration    3 Inner iteration  10 Max. residual -7.739E+00
 Outer iteration    3 Inner iteration  11 Max. residual  3.291E+00
 Outer iteration    3 Inner iteration  12 Max. residual  2.874E+00
 Outer iteration    3 Inner iteration  13 Max. residual  2.607E+00
 Outer iteration    3 Inner iteration  14 Max. residual  2.276E+00
 Outer iteration    3 Inner iteration  15 Max. residual  2.021E+00
 Outer iteration    3 Inner iteration  16 Max. residual -3.006E+00
 Outer iteration    3 Inner iteration  17 Max. residual -2.418E+00
 Outer iteration    3 Inner iteration  18 Max. residual  2.299E+00
 Outer iteration    3 Inner iteration  19 Max. residual  9.500E-01
 Outer iteration    3 Inner iteration  20 Max. residual  8.644E-01
 Outer iteration    3 Inner iteration  21 Max. residual  1.885E+00
 Outer iteration    3 Inner iteration  22 Max. residual  1.428E+00
 Outer iteration    3 Inner iteration  23 Max. residual  2.089E+00
 Outer iteration    3 Inner iteration  24 Max. residual  2.430E+00
 Outer iteration    3 Inner iteration  25 Max. residual  4.577E+00
 Outer iteration    3 Inner iteration  26 Max. residual -2.183E+00
 Outer iteration    3 Inner iteration  27 Max. residual  2.899E+00
 Outer iteration    3 Inner iteration  28 Max. residual  2.163E+00
 Outer iteration    3 Inner iteration  29 Max. residual  2.342E+00
 Outer iteration    3 Inner iteration  30 Max. residual  3.218E+00
 Outer iteration    3 Inner iteration  31 Max. residual  2.797E+00
 Outer iteration    3 Inner iteration  32 Max. residual  2.686E+00
 Outer iteration    3 Inner iteration  33 Max. residual  6.679E+00
 Outer iteration    3 Inner iteration  34 Max. residual -9.214E+00
 Outer iteration    3 Inner iteration  35 Max. residual -1.771E+01
 Outer iteration    3 Inner iteration  36 Max. residual -3.687E+00
 Outer iteration    3 Inner iteration  37 Max. residual -2.771E+00
 Outer iteration    3 Inner iteration  38 Max. residual -5.588E-01
 Outer iteration    3 Inner iteration  39 Max. residual -5.909E-01
 Outer iteration    3 Inner iteration  40 Max. residual -2.580E-01
 Outer iteration    3 Inner iteration  41 Max. residual -2.233E-01
 Outer iteration    3 Inner iteration  42 Max. residual -1.707E-01
 Outer iteration    3 Inner iteration  43 Max. residual -1.524E-01
 Outer iteration    3 Inner iteration  44 Max. residual -1.175E-01
 Outer iteration    3 Inner iteration  45 Max. residual -1.466E-01
 Outer iteration    3 Inner iteration  46 Max. residual -7.250E-02
 Outer iteration    3 Inner iteration  47 Max. residual -6.142E-02
 Outer iteration    3 Inner iteration  48 Max. residual -6.426E-02
 Outer iteration    3 Inner iteration  49 Max. residual  1.294E-02
0

                                                        SOLUTION BY CGSTAB-P

-------------------------------------------
 Outer iteration    4 Inner iteration   1 Max. residual -3.978E+01
 Outer iteration    4 Inner iteration   2 Max. residual  1.039E+01
 Outer iteration    4 Inner iteration   3 Max. residual -7.783E+00
 Outer iteration    4 Inner iteration   4 Max. residual  4.580E+00
 Outer iteration    4 Inner iteration   5 Max. residual  3.405E+00
```

```
 Outer iteration    4 Inner iteration   6 Max. residual  2.517E+00
 Outer iteration    4 Inner iteration   7 Max. residual  4.822E+00
 Outer iteration    4 Inner iteration   8 Max. residual  2.530E+00
 Outer iteration    4 Inner iteration   9 Max. residual  2.124E+00
 Outer iteration    4 Inner iteration  10 Max. residual  1.570E+00
 Outer iteration    4 Inner iteration  11 Max. residual  1.306E+00
 Outer iteration    4 Inner iteration  12 Max. residual -5.246E-01
 Outer iteration    4 Inner iteration  13 Max. residual  4.822E-01
 Outer iteration    4 Inner iteration  14 Max. residual -4.360E-01
 Outer iteration    4 Inner iteration  15 Max. residual  4.558E-01
 Outer iteration    4 Inner iteration  16 Max. residual -4.327E-01
 Outer iteration    4 Inner iteration  17 Max. residual -3.839E-01
 Outer iteration    4 Inner iteration  18 Max. residual -3.211E-01
 Outer iteration    4 Inner iteration  19 Max. residual  3.666E-01
 Outer iteration    4 Inner iteration  20 Max. residual  2.413E-01
 Outer iteration    4 Inner iteration  21 Max. residual  2.181E-01
 Outer iteration    4 Inner iteration  22 Max. residual  1.884E-01
 Outer iteration    4 Inner iteration  23 Max. residual -3.481E-01
 Outer iteration    4 Inner iteration  24 Max. residual -1.090E-01
 Outer iteration    4 Inner iteration  25 Max. residual -2.829E-01
 Outer iteration    4 Inner iteration  26 Max. residual -7.963E-02
 Outer iteration    4 Inner iteration  27 Max. residual -7.560E-02
 Outer iteration    4 Inner iteration  28 Max. residual -1.779E-01
 Outer iteration    4 Inner iteration  29 Max. residual -5.924E-02
 Outer iteration    4 Inner iteration  30 Max. residual -6.020E-02
 Outer iteration    4 Inner iteration  31 Max. residual -6.305E-02
 Outer iteration    4 Inner iteration  32 Max. residual -7.191E-02
 Outer iteration    4 Inner iteration  33 Max. residual -1.258E-01
 Outer iteration    4 Inner iteration  34 Max. residual -1.320E-01
 Outer iteration    4 Inner iteration  35 Max. residual -4.582E-01
 Outer iteration    4 Inner iteration  36 Max. residual -2.814E-01
 Outer iteration    4 Inner iteration  37 Max. residual -9.792E-01
 Outer iteration    4 Inner iteration  38 Max. residual -4.960E-02
 Outer iteration    4 Inner iteration  39 Max. residual -1.154E-01
 Outer iteration    4 Inner iteration  40 Max. residual -2.071E-02
 Outer iteration    4 Inner iteration  41 Max. residual -3.931E-02
 Outer iteration    4 Inner iteration  42 Max. residual -1.343E-02
0

                                                    SOLUTION BY CGSTAB-P

-----------------------------------------
 Outer iteration    5 Inner iteration   1 Max. residual -1.915E+01
 Outer iteration    5 Inner iteration   2 Max. residual  5.143E+00
 Outer iteration    5 Inner iteration   3 Max. residual -2.534E+00
 Outer iteration    5 Inner iteration   4 Max. residual  1.839E+00
 Outer iteration    5 Inner iteration   5 Max. residual  1.265E+00
 Outer iteration    5 Inner iteration   6 Max. residual  1.000E+00
 Outer iteration    5 Inner iteration   7 Max. residual -7.630E-01
 Outer iteration    5 Inner iteration   8 Max. residual -6.450E-01
 Outer iteration    5 Inner iteration   9 Max. residual -4.465E-01
 Outer iteration    5 Inner iteration  10 Max. residual  3.366E-01
 Outer iteration    5 Inner iteration  11 Max. residual  2.579E-01
 Outer iteration    5 Inner iteration  12 Max. residual  2.054E-01
 Outer iteration    5 Inner iteration  13 Max. residual  2.117E-01
 Outer iteration    5 Inner iteration  14 Max. residual -2.385E-01
 Outer iteration    5 Inner iteration  15 Max. residual  6.981E-02
 Outer iteration    5 Inner iteration  16 Max. residual -1.136E-01
 Outer iteration    5 Inner iteration  17 Max. residual -5.231E-02
 Outer iteration    5 Inner iteration  18 Max. residual -1.097E-01
 Outer iteration    5 Inner iteration  19 Max. residual  5.866E-02
 Outer iteration    5 Inner iteration  20 Max. residual  5.701E-02
```

```
 Outer iteration    5 Inner iteration  21 Max. residual  5.145E-02
 Outer iteration    5 Inner iteration  22 Max. residual  5.854E-02
 Outer iteration    5 Inner iteration  23 Max. residual  4.533E-02
 Outer iteration    5 Inner iteration  24 Max. residual -1.644E-02
0

                                                    SOLUTION BY CGSTAB-P

-------------------------------------------
 Outer iteration    6 Inner iteration   1 Max. residual -9.072E+00
 Outer iteration    6 Inner iteration   2 Max. residual  2.556E+00
 Outer iteration    6 Inner iteration   3 Max. residual -1.236E+00
 Outer iteration    6 Inner iteration   4 Max. residual  8.933E-01
 Outer iteration    6 Inner iteration   5 Max. residual  6.156E-01
 Outer iteration    6 Inner iteration   6 Max. residual  4.849E-01
 Outer iteration    6 Inner iteration   7 Max. residual  3.259E-01
 Outer iteration    6 Inner iteration   8 Max. residual  2.649E-01
 Outer iteration    6 Inner iteration   9 Max. residual  1.909E-01
 Outer iteration    6 Inner iteration  10 Max. residual  1.625E-01
 Outer iteration    6 Inner iteration  11 Max. residual  1.234E-01
 Outer iteration    6 Inner iteration  12 Max. residual  9.809E-02
 Outer iteration    6 Inner iteration  13 Max. residual  6.623E-02
 Outer iteration    6 Inner iteration  14 Max. residual  4.687E-02
 Outer iteration    6 Inner iteration  15 Max. residual  5.881E-02
 Outer iteration    6 Inner iteration  16 Max. residual  3.624E-02
 Outer iteration    6 Inner iteration  17 Max. residual -4.890E-02
 Outer iteration    6 Inner iteration  18 Max. residual  4.016E-02
 Outer iteration    6 Inner iteration  19 Max. residual  4.993E-02
 Outer iteration    6 Inner iteration  20 Max. residual  5.310E-02
 Outer iteration    6 Inner iteration  21 Max. residual  4.934E-02
 Outer iteration    6 Inner iteration  22 Max. residual  3.957E-02
 Outer iteration    6 Inner iteration  23 Max. residual  3.346E-02
 Outer iteration    6 Inner iteration  24 Max. residual  2.169E-02
 Outer iteration    6 Inner iteration  25 Max. residual  1.433E-02
0

                                                    SOLUTION BY CGSTAB-P

-------------------------------------------
 Outer iteration    7 Inner iteration   1 Max. residual -4.306E+00
 Outer iteration    7 Inner iteration   2 Max. residual  1.269E+00
 Outer iteration    7 Inner iteration   3 Max. residual -6.069E-01
 Outer iteration    7 Inner iteration   4 Max. residual  4.246E-01
 Outer iteration    7 Inner iteration   5 Max. residual  2.831E-01
 Outer iteration    7 Inner iteration   6 Max. residual  2.304E-01
 Outer iteration    7 Inner iteration   7 Max. residual  1.506E-01
 Outer iteration    7 Inner iteration   8 Max. residual  1.002E-01
 Outer iteration    7 Inner iteration   9 Max. residual  8.750E-02
 Outer iteration    7 Inner iteration  10 Max. residual  7.599E-02
 Outer iteration    7 Inner iteration  11 Max. residual  5.734E-02
 Outer iteration    7 Inner iteration  12 Max. residual  4.678E-02
 Outer iteration    7 Inner iteration  13 Max. residual  3.145E-02
 Outer iteration    7 Inner iteration  14 Max. residual  2.494E-02
 Outer iteration    7 Inner iteration  15 Max. residual  2.616E-02
 Outer iteration    7 Inner iteration  16 Max. residual  2.097E-02
 Outer iteration    7 Inner iteration  17 Max. residual -2.790E-02
 Outer iteration    7 Inner iteration  18 Max. residual  2.379E-02
 Outer iteration    7 Inner iteration  19 Max. residual -3.062E-02
 Outer iteration    7 Inner iteration  20 Max. residual  2.752E-02
 Outer iteration    7 Inner iteration  21 Max. residual  2.401E-02
 Outer iteration    7 Inner iteration  22 Max. residual  2.041E-02
```

```
 Outer iteration    7 Inner iteration  23 Max. residual  1.474E-02
0

                                                        SOLUTION BY CGSTAB-P

-------------------------------------------
 Outer iteration    8 Inner iteration   1 Max. residual -2.049E+00
 Outer iteration    8 Inner iteration   2 Max. residual  6.308E-01
 Outer iteration    8 Inner iteration   3 Max. residual -2.976E-01
 Outer iteration    8 Inner iteration   4 Max. residual  2.201E-01
 Outer iteration    8 Inner iteration   5 Max. residual  1.506E-01
 Outer iteration    8 Inner iteration   6 Max. residual  1.197E-01
 Outer iteration    8 Inner iteration   7 Max. residual  7.959E-02
 Outer iteration    8 Inner iteration   8 Max. residual  6.482E-02
 Outer iteration    8 Inner iteration   9 Max. residual  4.859E-02
 Outer iteration    8 Inner iteration  10 Max. residual  4.193E-02
 Outer iteration    8 Inner iteration  11 Max. residual  3.257E-02
 Outer iteration    8 Inner iteration  12 Max. residual  2.618E-02
 Outer iteration    8 Inner iteration  13 Max. residual  1.831E-02
0

                                                        SOLUTION BY CGSTAB-P

-------------------------------------------
 Outer iteration    9 Inner iteration   1 Max. residual -1.004E+00
 Outer iteration    9 Inner iteration   2 Max. residual  3.155E-01
 Outer iteration    9 Inner iteration   3 Max. residual -1.358E-01
 Outer iteration    9 Inner iteration   4 Max. residual  1.138E-01
 Outer iteration    9 Inner iteration   5 Max. residual  7.751E-02
 Outer iteration    9 Inner iteration   6 Max. residual  6.408E-02
 Outer iteration    9 Inner iteration   7 Max. residual  4.353E-02
 Outer iteration    9 Inner iteration   8 Max. residual -3.340E-02
 Outer iteration    9 Inner iteration   9 Max. residual  2.976E-02
 Outer iteration    9 Inner iteration  10 Max. residual  2.629E-02
 Outer iteration    9 Inner iteration  11 Max. residual  2.011E-02
 Outer iteration    9 Inner iteration  12 Max. residual  1.666E-02
0

                                                        SOLUTION BY CGSTAB-P

-------------------------------------------
 Outer iteration   10 Inner iteration   1 Max. residual -5.097E-01
 Outer iteration   10 Inner iteration   2 Max. residual  1.571E-01
 Outer iteration   10 Inner iteration   3 Max. residual -6.506E-02
 Outer iteration   10 Inner iteration   4 Max. residual  5.806E-02
 Outer iteration   10 Inner iteration   5 Max. residual  3.945E-02
 Outer iteration   10 Inner iteration   6 Max. residual  3.387E-02
 Outer iteration   10 Inner iteration   7 Max. residual  2.299E-02
 Outer iteration   10 Inner iteration   8 Max. residual  1.778E-02
0

                                                        SOLUTION BY CGSTAB-P

-------------------------------------------
 Outer iteration   11 Inner iteration   1 Max. residual -2.676E-01
 Outer iteration   11 Inner iteration   2 Max. residual  7.598E-02
 Outer iteration   11 Inner iteration   3 Max. residual -4.624E-02
 Outer iteration   11 Inner iteration   4 Max. residual  3.973E-02
 Outer iteration   11 Inner iteration   5 Max. residual  3.081E-02
```

```
Outer iteration   11 Inner iteration   6 Max. residual  2.125E-02
Outer iteration   11 Inner iteration   7 Max. residual  2.565E-02
Outer iteration   11 Inner iteration   8 Max. residual  9.756E-03

HEAD/DRAWDOWN PRINTOUT FLAG = 1     TOTAL BUDGET PRINTOUT FLAG = 1
CELL-BY-CELL FLOW TERM FLAG = 1

OUTPUT FLAGS FOR ALL LAYERS ARE THE SAME:
  HEAD    DRAWDOWN  HEAD  DRAWDOWN
PRINTOUT  PRINTOUT  SAVE    SAVE
---------------------------------
    0         0       1       1
UBUDSV SAVING "   CONSTANT HEAD" ON UNIT154 AT TIME STEP  1, STRESS PERIOD    1
UBUDSV SAVING "FLOW RIGHT FACE " ON UNIT154 AT TIME STEP  1, STRESS PERIOD    1
UBUDSV SAVING "FLOW FRONT FACE " ON UNIT154 AT TIME STEP  1, STRESS PERIOD    1
UBUDSV SAVING "FLOW LOWER FACE " ON UNIT154 AT TIME STEP  1, STRESS PERIOD    1
UBUDSV SAVING "          DRAINS" ON UNIT154 AT TIME STEP  1, STRESS PERIOD    1
UBUDSV SAVING "   RIVER LEAKAGE" ON UNIT154 AT TIME STEP  1, STRESS PERIOD    1
UBUDSV SAVING "        RECHARGE" ON UNIT154 AT TIME STEP  1, STRESS PERIOD    1

HEAD WILL BE SAVED ON UNIT  150 AT END OF TIME STEP   1, STRESS PERIOD    1

DRAWDOWN WILL BE SAVED ON UNIT  151 AT END OF TIME STEP   1, STRESS PERIOD    1
1
 VOLUMETRIC BUDGET FOR ENTIRE MODEL AT END OF TIME STEP  1 IN STRESS PERIOD   1
 ------------------------------------------------------------------------------

    CUMULATIVE VOLUMES      L**3       RATES FOR THIS TIME STEP      L**3/T
    ------------------                 ------------------------

          IN:                                   IN:
          ---                                   ---
            STORAGE =          0.0000             STORAGE =          0.0000
      CONSTANT HEAD =        817.3912       CONSTANT HEAD =        817.3912
             DRAINS =          0.0000              DRAINS =          0.0000
      RIVER LEAKAGE =      19717.1543       RIVER LEAKAGE =      19717.1543
           RECHARGE =      83869.4609            RECHARGE =      83869.4609

           TOTAL IN =     104404.0078            TOTAL IN =     104404.0078

         OUT:                                  OUT:
         ----                                  ----
            STORAGE =          0.0000             STORAGE =          0.0000
      CONSTANT HEAD =       4634.5732       CONSTANT HEAD =       4634.5732
             DRAINS =      13476.2295              DRAINS =      13476.2295
      RIVER LEAKAGE =      85466.8125       RIVER LEAKAGE =      85466.8125
           RECHARGE =          0.0000            RECHARGE =          0.0000

          TOTAL OUT =     103577.6172           TOTAL OUT =     103577.6172

           IN - OUT =        826.3906            IN - OUT =        826.3906

PERCENT DISCREPANCY =           0.79     PERCENT DISCREPANCY =           0.79


        TIME SUMMARY AT END OF TIME STEP   1 IN STRESS PERIOD    1
                   SECONDS     MINUTES      HOURS       DAYS        YEARS
                   ---------------------------------------------------------
  TIME STEP LENGTH 3.15576E+07 5.25960E+05  8766.0      365.25      1.0000
```

```
 STRESS PERIOD TIME 3.15576E+07 5.25960E+05  8766.0      365.25      1.0000
         TOTAL TIME 3.15576E+07 5.25960E+05  8766.0      365.25      1.0000
1
```