Chepachet Village
Groundwater/Stormwater Assessment

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TABLE OF CONTENTS

List of Figures

List of Tables

Appendices

1.0 INTRODUCTION

1.1 EXECUTIVE SUMMARY

This Assessment Study finds that the focus area of Tanyard Lane/Oil Mill Road exhibits an interrelated set of problems including high groundwater table, poor surface and subsurface drainage, and hydrologic soils, all of which may be exacerbated by drainage infiltration from the surrounding area. This combination of factors contributes to basement flooding, poorly functioning septic systems, and possible contamination of groundwater in the area that can pose a threat to potable water supply, as well as to the water quality of the adjacent Chepachet River. Significantly, groundwater is the sole source of potable water in Glocester and deserves utmost protection.

Alternative potential solutions to the problems identified are explored, including options for phasing a combination of remediation actions that include installation of a minimal storm drain system with sub-drain to lower the groundwater level, addressing potential infiltration of stormwater and/or wastewater, enabling improvement in the functioning of area in-ground wastewater treatment options, and "best management" containment and potential treatment of drainage discharges to the Chepachet River as preferred options.

The recommended course of action presents a two-phased option to construct stormwater and groundwater drainage facilities in Tanyard Lane and in Oil Mill Road. Within this recommendation, there is also a potential to coordinate with a future State of R.I. drainage project on Route 44. General cost comparisons, resource availabilities, and implementation options are also set forth for further consideration.

1.2. GENERAL DISCUSSION

Edwards and Kelcey (EK) was retained by the Town of Glocester to prepare a "Ground Water/Stormwater Needs Assessment Study" for the Chepachet Village Area . The purpose of the study was to "investigate sources and/or the cause of the high groundwater table and to develop a conceptual (10 percent) plan/design to address the existing groundwater/stormwater flooding in the project area."[1] As further directed by the Town, this study was to focus more specifically on the stormwater and basement flooding problems in the Tanyard Lane and Oil Mill Lane area.

Our evaluation and study was based in part on review of existing relevant information, data, and reports that were previously developed for the Town (See references in Appendix "A"), and in part on new field investigations, patterned interviews, document research, study, and conceptual designs.

To prepare this study/report, EK has

- Conducted patterned interviews with local and state officials, including RI Department of Environmental Management and RI Department of Transportation.
- Conducted field observations and investigations.
- Monitored four newly installed groundwater observation wells.
- Reviewed pertinent existing studies, reports, official records, and other documents.
- Prepared a conceptual (10%) plan/design for the recommended solution.
- Evaluated potential alternative solutions.
- Evaluated the preferred solution with reference to the Glocester Comprehensive Plan
- Evaluated implementation prospects.

[1] Town of Glocester, Request For Proposals 2004-3, February 11, 2004.

1.3 BACKGROUND

Homes and businesses in the Chepachet Village area have been experiencing significant basement flooding, particularly in the Tanyard Lane and Oil Mill Road area. Some residents have been forced to run sump pumps on a daily basis to curtail infiltration of groundwater and/or surface water into basements. It has been observed that this problem has been exacerbated since the Rhode Island Department of Environmental Management (RIDEM) enforced closure of an illegal and outdated cistern located in the center of the study area, which collected runoff and wastewater from nearby residences. Wastewater effluents had been discharging to the cistern, which then discharged onto the surface of properties and roads, and eventually into the Chepachet River. Although the cistern's sole use was for runoff and wastewater collection (albeit illegal), it did serve to lessen basement flooding in the area. RIDEM forced closure of the cistern because it discharged directly to the river. The estimated annual wastewater generated in the focus area is approximately 917,975 gallons per year.

Closure of the cistern and its contributing sources resulted in an increase of groundwater problems in the immediate vicinity that most likely further contributed to a number of septic failures. As documented in the Town Building Office, a number of these septic problems have been remediated with RIDEM approval, and some through assistance of the URI Cooperative Extension "Innovative Septic Design Program" Program, and "Manage" Program, and associated resources of the URI. However, two problems remain: first, a high groundwater table, particularly after periods of high storm runoff; and second, continued pump-outs of home basements onto the public streets.

The importance of groundwater as a component of the "hydrologic cycle" was recognized by the Town in its Comprehensive Plan (The Plan) with reference to the reality that "100 percent of the potable water supply (in Glocester) is obtained from groundwater sources"[2] "Since groundwater is the exclusive water supply source for Glocester's residents, extreme care must be exercised not to pollute aquifers through inappropriate land-use

[2] Town of Glocester Comprehensive Community Plan, 6.1 Natural Resources P.75

practices"[3] "Pollution sources included those naturally occurring, contaminated surface water runoff and faulty septic systems.

Glocester has no public sewerage collection system or treatment facility. All septic waste is treated through cesspools or on-site-septic systems.[4] "These waste systems are located in the ground and have a potential to contaminate ground and surface water if improperly operated, functionally obsolescent or improperly installed or designed."[5] Regarding surface runoff, The Plan also recognizes that "surface water runoff pollutants can contaminate groundwater and the drainage system," that in this area includes the adjacent Chepachet River.

The Tanyard Lane area is listed in The Plan as one of the numerous "Hydrologically Sensitive" areas of Glocester and is also within a designated "Wellhead Protection Area."[6]

The significance of the above references is that the Town is committed to recognizing the interrelationship of groundwater, surface water, potable water supply, and potential contamination and pollution issues through the policy statements of its adopted Comprehensive Plan

In furthering this commitment, the Town completed a Wastewater Management Facilities Plan in 1997 that comprehensively covers the issue of wastewater management in the Town. This Facilities Plan is also incorporated into The "Plan" by reference.[7] In its submittal report to the Town Council, the Glocester Wastewater Management Commission recognized Chepachet Village as a "focus" area of concern wherein is stated:

WW Fac Plan

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[3] Ibid, p.75

[4] Ibid, P. 75

[5] Ibid, P.85

[6] Ibid, Fig. 14.2, P.76

[7] See Glocester Wastewater Management Study, Fuss & O'Neill Inc., 1997

> *"This is a high density area with commercial as well as residential land use. Some properties (i.e., restaurants) are high volume water users. Soil types are severely restrictive. There have been past reports of failed systems resulting in direct discharges to surface water in the village. As the commercial center of Town, the Commission recognizes the limitations of ISDS to support growth in the section."*[8]

The 1997 Facilities Plan also recognizes the importance of the relationship between protecting the Town's potable water supply and surface water and threats to quality posed by constraints to proper wastewater disposal, evaluated both structural and non-structural alternatives, and recommended a series of actions for the Town to consider. The Town subsequently and in furtherance of the Facilities Plan, adopted an "Ordinance Establishing a "Wastewater Management District" and Wastewater Management District Rules and Regulations" in 2004.

The provisions of these Regulations were approved and recommended by the Glocester Wastewater Management Commission and are subject to implementation and oversight by said Board with staff assistance. The cited "Wastewater Management District Rules and Regulations" contain a comprehensive statement of "Purpose", "Findings", and "Authority" which are referenced herein for convenience, rather than restated as likewise supportive of and also providing a basis for this current study. Section 6.2 of the Glocester Plan is cited in said Regulations as establishing the primary "...goals of conserving, preserving, and enhancing the many natural resources of Glocester with a policy of maximum protection."[9]

This is the 3rd Step

This current study represents a logical further step in implementation of the Facilities Plan as it relates to the Chepachet Village area and in particular the focus of resolving stormwater/groundwater constraints in the vicinity of Old (Oil) Mill Road/Tanyard Lane and the Chepachet River.

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[8] Glocester Wastewater Management Commission, cover letter to the Town Council 11/13/97, P.2

[9] Glocester Wastewater Management District Rules and Regulations, 2004, "Findings" #1.

1.4 APPROACH

Two ongoing problems are addressed by this study:

1. The amelioration and/or improvement of basement flooding in the Tanyard Lane and Oil Mill Road area. To confirm that a high groundwater table most probably caused this, four observation wells would be installed and monitored. It would be confirm the existence of the high groundwater table and determine that the primary source of groundwater in the immediate area is infiltration from stormwater runoff from a relatively small drainage area (approximately 4 acres). It would further confirm the direct correlation between runoff, infiltration, and depth to groundwater in the focus area. It is felt that by controlling the stormwater/infiltration quantities, the groundwater table could be lowered, and resulting problems alleviated.
2. Consideration that existing ISDS systems on private lots may not be functioning properly due in part to high groundwater levels. The lowering of the groundwater table in the area can result in improved performance of ISDS systems. Given a properly constructed drainage system, the result should be observable within approximately one or two years (annual season cycles) after installation of suitable drainage facilities.

As part of this approach, EK is committed to recommending to the Town the most cost-effective solution which conforms to the Town's Comprehensive Plan.

2.0 EXISTING CONDITIONS

2.1 DEMOGRAPHICS

2.1.1 As seen in Figure 1, the study area is located within the Town designated Historic District of Chepachet Village adjacent to Putnam Pike (Route 44) from Tanyard Lane to Oil Mill Road. The area is a small sub-basin with the Chepachet River sub-basin, which is itself a part of the Blackstone River Watershed.

2.1.2 Tanyard Lane and Oil Mill Road are narrow (8 to 10 feet-wide) roads lined with residences that forms a horseshoe shaped loop off Putnam Pike. The study area is densely developed with small residential lots and homes located in close proximity to the two roadways, and to each other leaving little space for ordinary ISDS construction.

2.1.3 Within the immediate study area are approximately 13 buildings of interest containing approximately 30 units of housing in the immediate focus area – by actual count since 2000 Census data appears unreliable for the area. The present zoning is Medium Density Residential with a 1 ¼ acre minimum lot size. The area lots are mostly non-conforming in size as they predate zoning requirements.

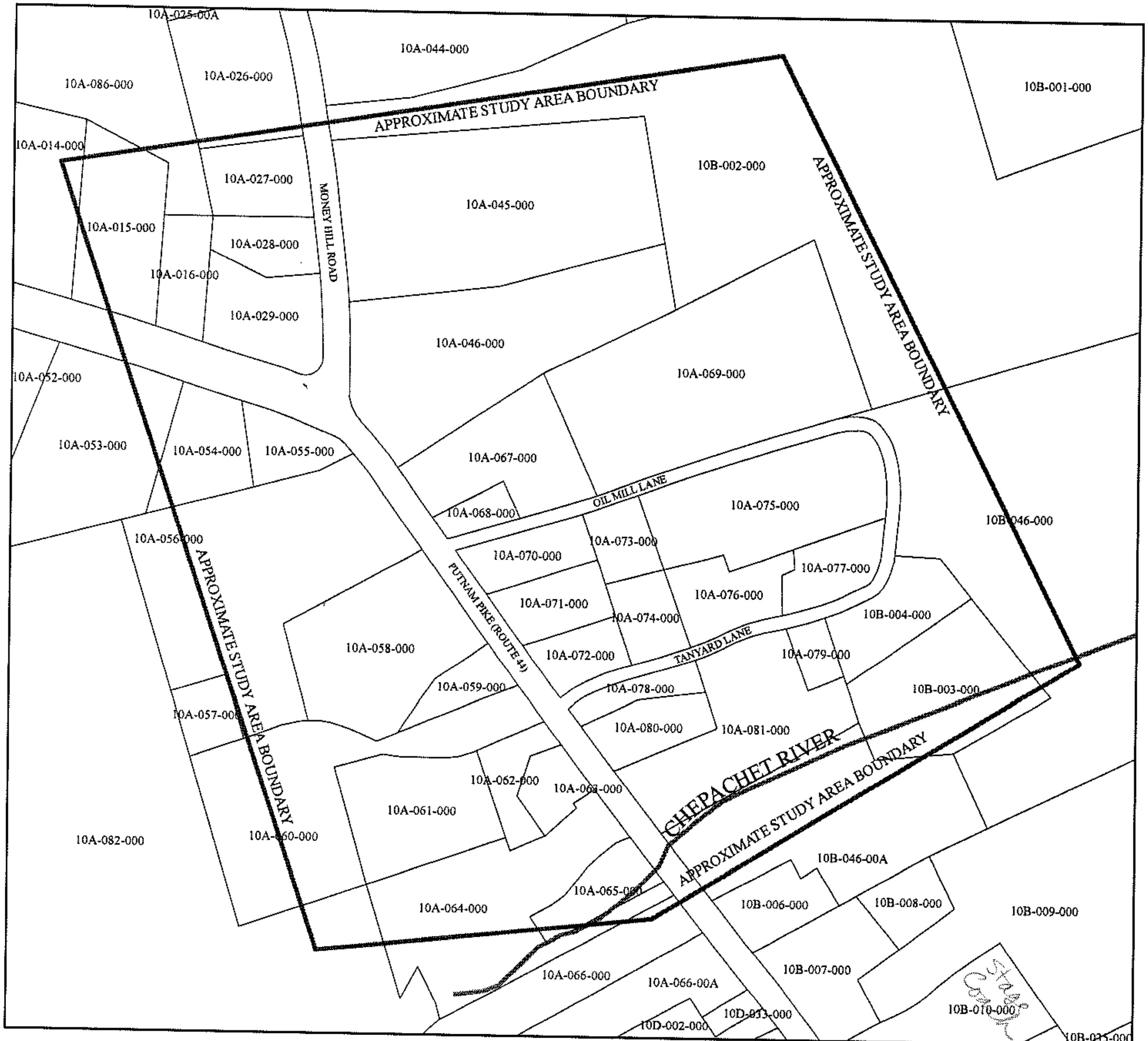
2.1.4 The area is located within a "Water Resource Protection Area" overlay district as set forth in the Town's Wastewater Management Program Regulations

2.2 SOILS

2.2.1 The predominant soils in Glocester are Canton-Charlton, Hinckley, Merrimac, Paxton, Ridgebury-Whitman-Leicester, Sutton, and Woodbridge.[10] The Woodbridge C90 (WoB) contains 1.18 acres and assumes 1/8 acre lots (soil purposes only – not zoning), and the Paxton Urban B85 (PD) contains 1.22 acres and assumes 1/8 acre lots.

2.2.2 These specific soils in the Chepachet Village area have been classified as severely restrictive for absorption fields, primarily because of the shallow depth to water table or bedrock, and/or fine grained, compact, or poorly drained soils. These soils are considered wet and would typically have high soil percolation rates. The surface slope does not contribute to mitigation of these restrictions.

[10] Source: USDA NRCS Soil Survey



*DATA COURTESY OF RIGIS AND TOWN OF GLOCESTER

N

Edwards and Kelcey
ENGINEERS
ARCHITECTS
PLANNERS
CONSTRUCTORS

175 87.5 0 175
Feet

Figure 1

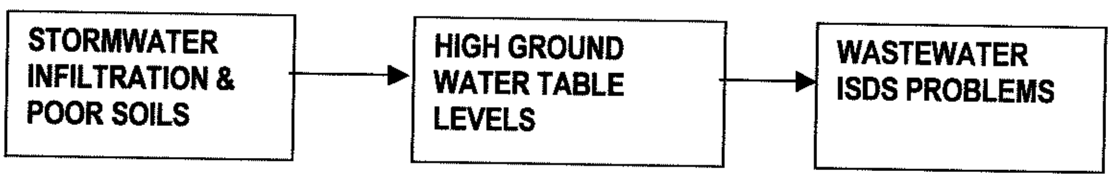
CHEPACHET VILLAGE AREA MAP

2.3 WASTEWATER

2.3.1 It is an established fact that the Town is entirely dependent on groundwater from private wells for its drinking water, and relies entirely upon privately owned on-site ISDS's for wastewater disposal.[11]

As stated earlier, the groundwater source is direct rainfall infiltration and surface runoff from the surrounding area to the south and west. The infiltration portion contributes directly to the groundwater table levels. The runoff affects the treatment and disposal efficiencies of the ISDS in the area. This problem is depicted graphically in Figure 2. It is felt that addressing stormwater conditions first can mitigate wastewater problems.

Figure 2. Problem Depiction



A meeting with EK, Town, and RIDEM personnel was held on August 4, 2004 to discuss our findings to date and to determine the RIDEM position with respect to possible courses of action. The RIDEM is responsible for review and approvals of any physical alteration of drainage into the adjacent Chepachet River as well as remediation of septic problems in the area. RIDEM

As a result of this meeting, RIDEM agreed to the following approach:

1. Lowering the groundwater table first with a storm drain and subdrain system was valid.

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[11] Glocester Wastewater Management Study, page 1-2.

2. A storm drain system with a subdrain on Oil Mill Road would be permissible so long as a minimum distance of 25 feet was maintained from nearby ISDS systems. This would be to ensure that that no leachate would enter the proposed drainage system. Use of a sealed (gasketed) storm drain pipe is preferred to ensure no contaminated groundwater enters the system.
3. Groundwater would be captured in a separate subdrain system and would require treatment similar to an ISDS system.
4. RIDEM would have to approve final design for the system and the Town would be required to maintain such a system in working order.

2.3.2 Existing Wastewater Flows:

As previously discussed, the immediate area of concern is the Tanyard Lane and Oil Mill Road area shown in Figure 3. The failure of existing "conventional" ISDS systems in the focus area is well known and documented[12]. We concur with the findings of the wastewater management study, based on our discussions with Town personnel, RIDEM, and review of available data concerning septic system repairs and failures, lot sizes, soils limitations, and depth to groundwater.

The existing quantity of wastewater flows in the area shown was determined by the following calculations:

- Assessor's information provided by the town provided the number of beds in each building, with 2 persons per bed assumed.
- Multiplying the number of beds by the number of persons per bed generated the number of persons.
- Multiplying the minimum design requirements (75 gal/person/day for single residence)[13].
- This resulted in 2,515 gallons of wastewater generated per day, or 917,975 gallons per year.

[12] Glocester Wastewater Management Study, page 2-10.

[13] Source: RIDEM ISDS Rules and Regulations

Table 1. Focus Area Wastewater Flows

Plat #	Lot #	Flow (gal/day)	Flow (gal/year)
10A	70	900	328,500
10A	71	15	5,475
10A	72	100	36,500
10A	73	900	328,500
10A	75	600	219,000
Total		**2,515**	**917,975**

2.3.2.1 If wastewater problems were to be considered alone (apart from stormwater and groundwater factors), several solutions are available to alleviate the problems associated with onsite wastewater disposal in the study area. Each solution has its own distinctive advantages and disadvantages. Many of these were considered in the Town's Wastewater Management Study[14] and dismissed as not feasible or in the Town's best interest. These are summarized below and will not be elaborated on further here. The ultimate selection of a preferred wastewater solution should not be based solely on cost considerations, but should include consideration of community preferences, community constraints, public acceptance, etc, and is beyond the scope of this study.

[14] Source: Glocester Wastewater Management Study.

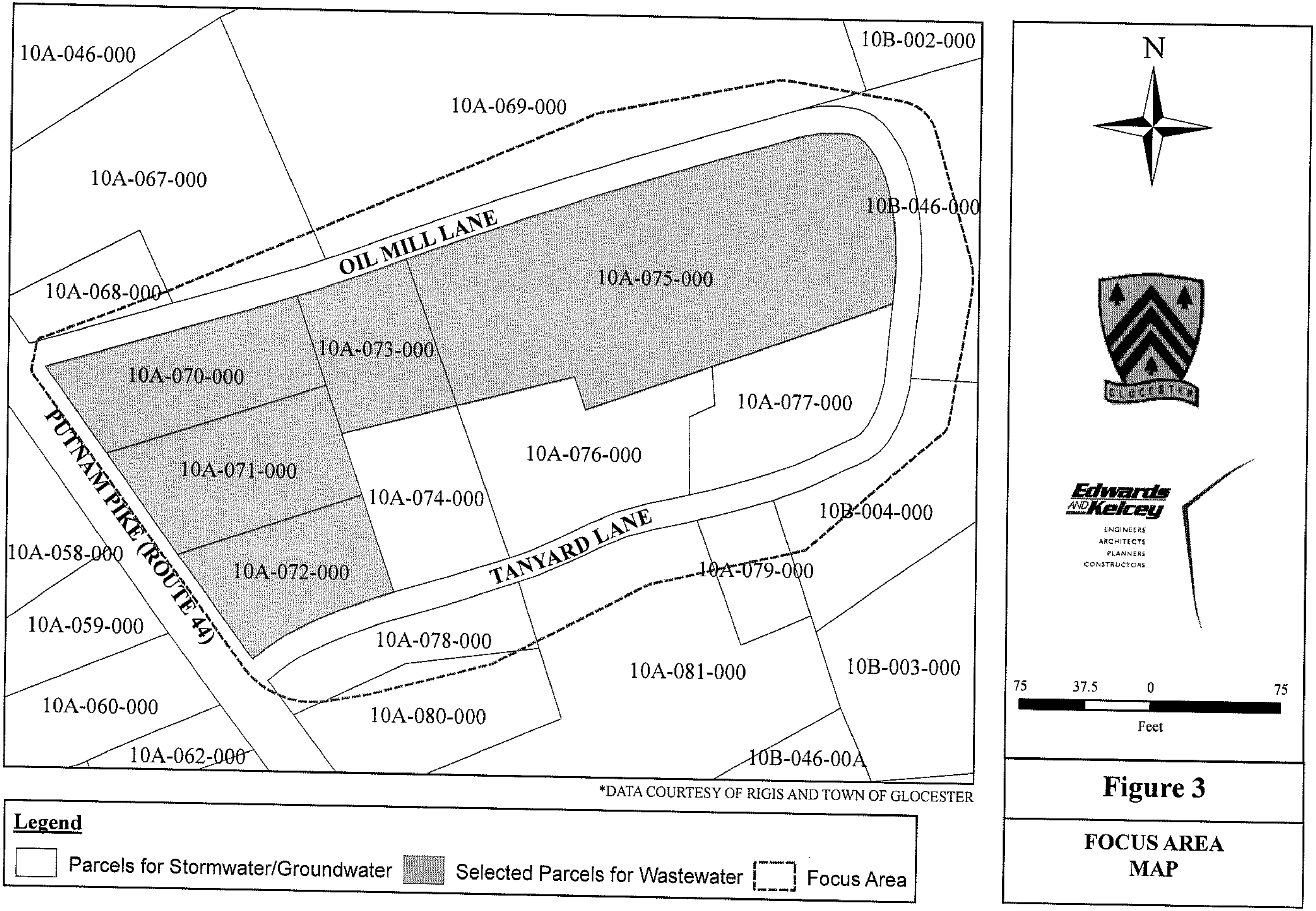


Figure 3

FOCUS AREA MAP

2.3.3 **Wastewater alternatives:** Possible wastewater solutions include:

1. Continue to repair and/or upgrade existing onsite ISDS systems as needed:
    a. Repair substandard systems up to current standards.
    b. Upgrade existing systems using advanced features.
2. Abandon existing onsite ISDS systems by going to a offsite (community, or neighborhood) treatment facility: NO
    a. Connect to existing sewerage system by pumping to Burrillville Wastewater Treatment Plant.
    b. Construct a one or more large capacity community septic system (leaching field) with
        i. Gravity flow from existing septic tanks, or,
        ii. Pumping the flow using individual grinder pumps and low-pressure sewer system.
3. Continue to use existing ISDS systems "as-is", and postpone consideration of onsite and offsite wastewater treatment alternatives. Instead, first address the stormwater problems by intercepting surface runoff and attempting to lower the groundwater table in the focus area. This would enable existing ISDS systems to perform better by reducing surface water infiltration and increasing the depth to the groundwater table. Recommended
    a. Construct new storm drain systems with subdrains for groundwater interception.
        i. Phase 1: Construct a storm drain with subdrain on Oil Mill Road only and observe resulting conditions for a period of approximately two years.
        ii. Phase 2: If necessary, construct a second storm drain with subdrain on Tanyard Lane.

2.3.4 **Evaluation of wastewater alternatives:**

We recommend that the Town proceed with development of stormwater and groundwater solutions (#3 above) for the following reasons:

1. Given the existence of flooding and known high groundwater table in the area, ISDS systems will continue to fail or under perform. This will require repairs and upgrades to conform to current RIDEM ISDS standards.
2. Onsite ISDS repairs can be very expensive to homeowners in areas of high groundwater levels, particularly if "advanced" treatment systems will be required by RIDEM.
3. It is our understanding that the Town is not prepared to proceed with any off-site wastewater plans at this time as preferred options.

2.3.5 Additional wastewater information:

2.3.5.1 EK was notified by RIDEM that certain matching grant monies may be available to the Town for approved projects located in the Blackstone Valley Watershed Area. Although not a part of this study, this information is being presented as an additional alternative in case the Town wishes to pursue additional solutions to the wastewater problems in the focus area.

2.4 GROUNDWATER

2.4.1 **Background.** Groundwater is the sole source for drinking water that the residents obtain from individual and private non-community wells. The groundwater classification in the study area is GAA. Other groundwater resources in the Village area include a groundwater recharge area, non-community wells, and well protection areas[15].

2.4.2 **Existing Groundwater Conditions:** To better determine the existing groundwater level in the area, and as part of this study, the Town DPW installed four observation wells along Oil Mill Rd and Tanyard Lane as shown in Figure 4. EK personnel monitored these wells with summary results shown below in Table 2. Additional data may be found in Appendix F.

Table 2. Monitoring Wells Results

Monitoring Well	Depth to Bottom (ft)	Depth of Water (ft)	Existing Ground Elevation (ft)	Approximate Water Table (ft)
#1	9.3	4.3	421.3	417.0
#2	7.4	4.6	409.4	403.9
#3	12.0	7.3	406.5	398.5
#4	4.6	**2.9**	413.8	410.9

As can be seen, the groundwater table elevation was measured as high as 2.9 feet.

During the course of our groundwater observations, it was observed that the water table in Well #1 rose rather sharply shortly after a heavy rainfall. After considering the evident rise of the water table, EK concluded that there were two contributing causes for this problem, possibly in combination:

[15] Source: RIGIS, 1997 Wastewater Management Study.

1. Possible infiltration of surface runoff or stormwater from the Route 44 drainage area. This could indicate a potential failure of the state drainage system on Route 44.
2. Evidence of Hydrologic soils Group B (Paxton Urban) and Group C (Woodbridge) in the immediate area.

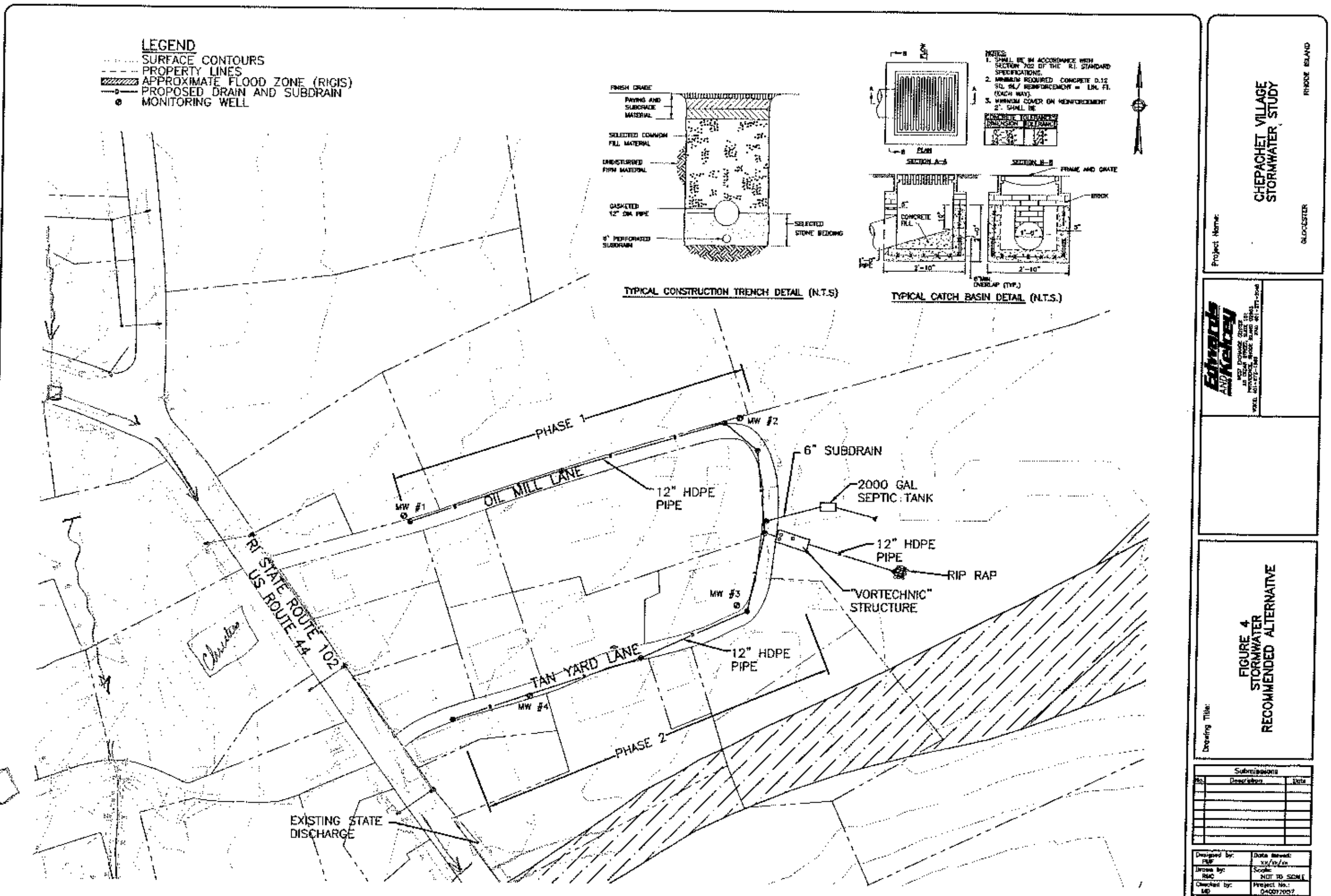
This, in turn, led to further discussions with the Department of Transportation and its consulting engineers to look into the possibility of adjacent and upstream flooding and to examine the Route 44 closed stormwater drainage system more closely.

It was later learned that the RIDOT is planning a stormwater drainage system upgrade on Route 44 immediately adjacent to this study area. At this time, it appears that the RIDOT timetable for construction is still several years away and is cannot be relied upon as a short-term solution to our immediate problem. The RIDOT plan, however, may be a partial solution to longer-term problem of flooding as described further in this study.

2.5 STORMWATER RUNOFF AND INFILTRATION:

2.5.1 Background. The quantity or volume of surface stormwater results directly from rainfall runoff less any amount infiltrated into the ground. The infiltration portion contributes directly to the water table and groundwater levels. The runoff fraction ultimately flows overland to the Chepachet River.

2.5.2 Existing stormwater conditions: As shown in Figure 4, the drainage area for purposes of stormwater drainage design consists of approximately 2.4 acres of primarily 1/8-acre lots that drains southeast and eventually into the Chepachet River. Presently, there are no catch basin inlets or other stormwater collection features within the study vicinity to intercept or control the runoff. It should be noted that in the focus area, stormwater runoff from roofs discharge directly onto the ground adjacent to buildings. All other runoff produced by the remaining drainage area along US Route 44 and RI Route 102 flows into the closed state



LEGEND
SURFACE CONTOURS
PROPERTY LINES
APPROXIMATE FLOOD ZONE (RIGIS)
PROPOSED DRAIN AND SUBDRAIN
MONITORING WELL
TYPICAL CONSTRUCTION TRENCH DETAIL (N.T.S)
TYPICAL CATCH BASIN DETAIL (N.T.S.)
PHASE 1
PHASE 2
MW #1
MW #2
MW #3
MW #4
OIL MILL LANE
TAN YARD LANE
RI STATE ROUTE 102
US ROUTE 44
6" SUBDRAIN
2000 GAL SEPTIC TANK
12" HDPE PIPE
RIP RAP
"VORTECHNIC" STRUCTURE
EXISTING STATE DISCHARGE
CHEPACHET VILLAGE STORMWATER STUDY
GLOCESTER
RHODE ISLAND
FIGURE 4
STORMWATER RECOMMENDED ALTERNATIVE
Submissions
NOT TO SCALE

drainage system that is along Route 44 and continues past Oil Mill Road and Tanyard Lane and discharges directly into the Chepachet River at the Dr. William G. Shancker Jr. Memorial Bridge.

2.5.2.1 With respect to the state drainage system on Route 44, the RIDOT is currently evaluating the entire drainage area and collection system for possible upgrading and/or replacement. That system was originally constructed in the 1920's and is in need of upgrading due to functional obsolescence and age. It is suspected that system failures or blockages on Route 44 may have a direct influence on the groundwater problem in the study focus area. Meetings were held with the RIDOT consultants and RIDOT engineers to discuss discharges directly into the Chepachet River

2.5.2.2 Conclusion: The State improvement plan will proceed under a separate and longer timetable than the Town's plan for Tanyard Lane and Oil Mill Road—perhaps 3 to 5 years. At that time, the RIDOT will have to address new RIDEM requirements for increased treatment of discharges to the Chepachet River at Route 44. It is also believed that RIDOT may have to approach the Town for permission to redirect its storm drain system down Tanyard Lane and install some type of BMP on or near Town property before discharge to the Chepachet River. When and if this occurs, the Town will be in a position to suggest that RIDOT include further drainage improvements on Tanyard Lane in its plans. This could offer significant cost savings to the Town, albeit at a sacrifice of timing. In this study, we refer to this possibility as Alternative 3. It is recommended that the Town follow this RIDOT project closely with the object of potential integration of both plans.

2.5.3 Stormwater Volumes:

2.5.3.1 The stormwater computer model used is the Hydrocad Version 6.0-computer program. This software is based on the SCS TR 55 design criteria. The model has been formulated to directly compare existing and proposed stormwater flows. These flows will then be used to compute the flows for each of the rainfall amounts to be studied. All flow computations and design criteria are included herein at Appendices B through E.

2.5.3.2 EK analyzed the stormwater flow based on the Soil Conservation Service Technical Release 55 *Urban Hydrology for Small Watersheds,* June 1986 utilizing the Type III distribution unit hydrograph. Pre and post development hydrologic conditions were analyzed for the 2, 10, 25 and 100-year storm events. These storm events correspond to 24-hour rainfall depths of 3.3, 4.8, 5.6 and 7.0 inches respectively based on the isohyetal contours for Rhode Island.

2.5.4 Stormwater Recommendations: Since there is no closed drainage system in the focus area, the construction of such a system would greatly reduce the flooding and other problems being experienced in the area. There are several ways to approach this solution.

2.5.4.1 Stormwater Alternative 1: Construct a new storm drain system only on Oil Mill Road. This would consist of approximately 600 linear feet of 12 inch diameter piping, standard catch basins, and a Best Management Practice (BMP) "Vortechnics"[16] type structure before discharge to the Chepachet River. Also to be included in the same trench is 600 linear feet of 6 inch-diameter perforated PVC pipe to function as a subdrain to discharge to a 2,000-gallon septic tank, also acting as a BMP. Construction would include installation of catch basins and trench paving. Construction on this street is recommended as a priority because it is first in line to intercept both surface water runoff and groundwater flows.

2.5.4.2 Stormwater Alternative 2: Construct a new storm drain system on both Oil Mill Road and Tanyard Lane. This would consist of all construction items in Alternative 1 plus an additional 400 linear feet of 12 inch diameter concrete piping, 4 additional standard catch basins, and 400 linear feet of 6 inch diameter PVC subdrain.

2.5.4.3 Stormwater Alternative 3: Wait for the RIDOT system on Route 44 to develop further. Due to the proximity of the state drainage system and the site constraints of the area, it would be ideal for both the Town and RIDOT to combine their construction efforts to save money. The disadvantage here is that the RIDOT timetable is still indeterminate for any construction work. They are presently only in the preliminary design phase of their study.

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[16] "Vortechnics" is the trade name for a commercially manufactured concrete structure that pretreats stormwater prior to discharge to a water body.

2.5.5 Alternative 1 is the initial stormwater solution recommended alternative, with Alternative 2 (Tanyard Lane) as an option to follow—in coordination with the RIDOT Rt. 44 project if at all possible

2.5.6 BMP's (Best Management Practices). BMP's are non-structural and low-structural practices or combinations of practices that are determined to be the most cost-effective, practical means of preventing or reducing pollution inputs from non-point sources (e.g., stormwater runoff). Improving quality and controlling the quantity of runoff to receiving groundwater and surface water is a common purpose for BMP's. BMP's typically include but are not limited to the following:

- Detention and vegetated treatment
- Wet (retention) ponds
- Hooded and deep sump catch basins[17]
- Constructed stormwater wetlands
- Water quality (grassed) swales
- Infiltration trenches
- Infiltration basins
- Dry wells (rooftop infiltration)
- Sand and organic filters
- Sediment traps (forebays)
- Drainage channels
- *Street and parking lot sweeping
- *Catch basin cleaning
- *Local bylaws and regulations
- *Public Education

* indicates non-structural BMP

[17] Hooded and deep sump catch basins are underground retention systems designed to remove trash, debris, and some amount of sediment and oil and grease from stormwater runoff. There are several commercially available treatment units, including the "Vortechnics" unit referred to in this study.

3.0 ALTERNATIVE RECOMMENDATIONS

3.1 DISCUSSION: After meetings with Town of Glocester, RIDEM and RIDOT officials, several alternatives were developed and examined to address the flooding problem related to stormwater and groundwater. The general objectives agreed upon for the focus area were to: (1) lower the groundwater table, (2) control the surface water flow of stormwater, and (3) continue to monitor the RIDOT upgrade plan for Route 44.

3.2 RECOMMENDED PLAN: Several evaluation criteria were used in order to identify the alternative(s) that meet or exceed the Town's needs in the focus area of study. The criteria used were as follows:

- Conformance with Town Comprehensive Plan
- Environmental mitigation
- Public acceptability
- Cost effectiveness
- Ease of implementation

The following describes three alternative recommendations that meet the above criteria and the general objectives:

3.2.1 ALTERNATIVE 1: To accomplish these objectives, EK recommends a "measured step" approach for design and construction of a limited new drainage system in two phases. This "measured step" approach should result in the least cost expense to the Town of Glocester, spreads the cost out over several budget periods, and allows the Town to measure the performance of the improvements before proceeding with further construction. In addition, it allows the Town additional time to monitor the progress of the RIDOT drainage improvement plan on Route 44.

3.2.1.1 Phase 1 would consist of construction of a 12 inch-diameter storm drain system with a 6" diameter subdrain on Oil Mill Road, with discharge to two "BMP" (Best

Management Practice) containment structures and eventual discharge to the Chepachet River, all as illustrated in Figure 4. The stormwater would receive treatment through a "Vortechnics", or equal, structure, while the groundwater would enter a 2,000 gallon septic tank in order to permit observation and testing if necessary.

3.2.1.2 Phase 2 would be to construct a second 12 inch-diameter storm drain on Tanyard Lane with 6 inch-diameter subdrain only after one or two years observation of the Phase 1 work, and then only if needed.

3.2.2 ALTERNATIVE 2: Build the complete system on both streets. If the Town does not wish to proceed with the "measured step" approach of Alternative 1, this alternative would recommend construction of the storm drain and sub drain systems on both Oil Mill Road and Tanyard Lane, with two necessary BMP structures on Town land, all in one phase or contract.

3.2.2.1 For either Alternative 1 or 2, a "Vortechnic" (or equal) BMP structure would collect all the sediment and debris, before discharging into the Chepachet River, and a second detention or retention basin would be required to intercept the subdrain flow for possible treatment if it is found to be contaminated by any wastewater leachate from ISDS systems. While these structures are conceptually proposed in this study, their detailed design is not part of this scope of work.

3.2.3 ALTERNATIVE 3. Similar to Alternative 1. Proceed to construct improvements on Oil Mill Road, but wait to connect Tanyard Lane directly into a new state closed drainage system if and when it is built. Although it is not yet designed, the state system could stop at Oil Mill Road or Tanyard Lane and continue down these streets to the Town-owned land, then into a BMP structure before discharging to the Chepachet River. This could be a combined state and town construction effort and therefore the cost of construction could also be a cooperative effort.

3.2.3.1 This alternative could provide a cost savings potential benefit both to the town and to the state. The Town will be reducing its flooding and high groundwater problems and at the same time provide the State with the necessary area to provide BMP treatment prior to discharge of its runoff. This alternative may not be practical, however, due to timeframe of construction. The Town would prefer to begin construction far sooner than the State would be prepared to begin.

3.2.3.2 There is a potential that the Town could start an "incremental" design that could later be redone by the State at cost savings incentive.

3.3 TIMETABLE: Generally speaking, the sequence for implementation of these recommendations is to (1) prepare more detailed (preliminary) engineering design drawings, (2) submit them to RIDEM for review, comment, and approval, (3) submit application for RIDEM permits, (4) prepare final plans and specifications Contractor bids and estimates, (5) Advertise for bids and award construction contract, (6) Build the project, (7) Operate and maintain the system. An estimated time required for each activity (subject to Town review and modification) is:

3.3.1 Preparation of preliminary engineering design drawings for RIDEM review and approval purposes: 8 to 12 weeks from receipt of notice to proceed. Time Req'd

3.3.2 Review and approval by RIDEM: 4 to 6 weeks.

3.3.3 Preparation of RIDEM Stormwater Permit Application: 2 to 4 weeks, with subsequent review and approval by RIDEM in 4 to 6 weeks.

3.3.4 Preparation of final plans and specifications suitable for competitive bid estimates: 4 to 6 weeks.

3.3.5 Bid and award period: 4 to 8 weeks.

3.3.6 Construction period: 16 to 20 weeks.

It is possible that activity #6 (Construction) can be financed in the next fiscal year (2006) in order to minimize impacts to the Town budget. N.B.

All time would commence from a written "notice to proceed' date from the Town.

3.4 COST ESTIMATES: Approximate construction and installed costs were developed for each of the proposed alternatives as follows:

TABLE 3. COST ESTIMATES WORK DESCRIPTION	ESTIMATED QUANTITY	UNIT COST	ESTIMATED COST
ALTERNATE 1: OIL MILL ROAD ONLY (PHASE 1) AND WAIT FOR PHASE 2.			
Phase 1, 12 inch diameter pipe. <12 feet deep.	600 lf	$95.00	$57,000
Phase 1 Vortechnics type structure	1	$20,000	$20,000
Phase 1 Septic tank	1	$10,000	$10,000
Phase 1, 6 inch diameter PVC perf pipe	600 lf	$60.00	$36,000
Catch basins	4	$1,500	$6,000
Access Manholes	6	$2,500	$15,000
Construction contingencies	Allowance	10%	$14,400
PHASE 1 CONSTRUCTION COST:			**$158,400**
Engineering Fees: Preliminary Design Final Design Contract Administration			 $9,504 $5,702 $3,802
Resident Observation	30 man days		$10,800
Reimbursables: Printing Mileage	 Allowance Allowance		 $500 $250
Outside Services: Survey and mapping Borings	 Allowance Allowance		 $3,000 $2,500
PHASE 1 PROJECT COST:			**$194,458**

Constr. only

Total Project

Continued →

Table 3 (continued)

ALTERNATE 2: INCLUDE PHASE 2: (ADD TANYARD LANE).	**ESTIMATED QUANTITY**	**UNIT COST**	**ESTIMATED COST**
Phase 2, 12 inch diameter concrete pipe	400 lf	$95.00	$38,000
Phase 2, 6 inch diameter PVC perf pipe	400 lf	$60.00	$24,000
Catch basins	2	$1,500	$3,000
Access Manholes	4	$2,500	$10,000
Construction Contingencies	Allowance	10%	$7,500
PHASE 2 CONSTRUCTION COST:			**$82,500**
Engineering Fees: Preliminary Design Final Design Contract Administration			 $4,950 $2,970 $1,980
Resident Observation	20 man days		$7,200
Reimbursables: Printing Mileage	 Allowance Allowance		 $500 $250
Outside Services: Survey and mapping Borings	 Allowance Allowance		 N/A N/A
PHASE 2 PROJECT COST: **TOTAL ALTERNATE 2 COST:** **(Phase 1 plus Phase 2)**			 **$100,350** **$294,808**
ALTERNATE 3: **CONSTRUCT ALL AT ONE TIME:**			**$294,808**
ANNUAL O&M By Town	Allowance		$5,000

Notes:

1. All costs are subject to change depending on final design details, regulatory review, and construction constraints.
2. Permits and application fees not included.

3.5 RECOMMENDED ALTERNATIVE

3.5.1 Due to the proximity of the state drainage system on Route 44 and the site constraints of the study focus area, it would be ideal for both the Town and RIDOT to combine their construction efforts insofar as possible. But, because the State's plans for Route 44 drainage improvements will of necessity lag behind the Town's plans, Alternate 1 would be the preferred alternative to begin with.

The advantages of this alternate are:

- Allows the Town to construct Phase 1 drainage improvements on Oil Mill Road sooner rather than later.
- May spread project costs over 2 budget cycles.
- Allows a period of time to "wait and see" what RIDOT will do with its drainage project on Route 44.

The Town would first construct a storm drain and subdrain system along Oil Mill Lane (Phase 1) to lower the groundwater table. A one to two year period of observation and monitoring (over several seasonal cycles) would ensue. If this does not alleviate the flooding/groundwater problem sufficiently, the Town can continue to Phase 2, Tanyard Lane, with or without the State. At that time, more information should also be available about the State's plans for Route 44. This would provide better information to the Town on which to make a final decision to proceed with or without the State.

3.5.2 In the meantime, the Town should cooperate with the State, allow the State the option to come down Tanyard Lane, and into the BMP structure, and install catch basin inlets along Tanyard Lane. This would help defray the cost on that street and give the state the necessary discharge area and time for construction.

3.6 RELATIONSHIP TO COMPREHENSIVE PLAN

3.6.1 The brief assessment included herein as Appendix "H" provides that the alternative projects outlined by this study for the Tanyard Lane area of Chepachet are supported by and consistent with the Glocester Comprehensive Plan as well as the approved Wastewater Management Plan as it may relate to pollution abatement and protection of groundwater and surface water.

3.6.2 All of these efforts are supported by and designed to carry out certain relevant goals, objectives, and recommendations of the Glocester Plan with respect to a number of Plan Elements. Protection of sole source drinking water supply that in Glocester is groundwater; protection of health, safety and economic welfare threats to groundwater including inadequately treated sanitary waste; protection from contamination of surface waters, and recognizing the integrated relationship of groundwater and surface water are all examples particularly relevant to and also supportive of this current groundwater/stormwater study project.

3.7 PROJECT RESOURCES

3.7.1 To carry out any of the suggested alternatives will require both financial and manpower resource allocations by the Town. Recognizing that the Town administration and the personnel budget do not provide for qualified engineering services, the implementation of this project may logically fall to a coordinated effort by the Town Planner and the Public Works Director with assistance of qualified outside professional engineering help. Both the Town Planner and Public Works Directors are full time/full workload personnel. For these reasons, a budget for implementation should provide for engineering services, not only for project design and plans, but also to include construction bid document preparation, obtaining necessary permit approvals, construction oversight, inspection, reporting and possibly post construction monitoring activities.

3.7.2 Funding could be budgeted by the Town in its Capital Budget as one project, in phases through its Operating Budget, or possibly by borrowing for a capital

Funding

project. The R.I. Clean Water Revolving Fund, to which the Town is eligible, or Town borrowing (bonding) capacity could be sourced.

3.7.3 There are potential outside financial resources that could be relevant to this project as well. As mentioned earlier, a partial funding and/or cost saving might be gained by coordinating with the RIDOT Rt. 44 project. Another resource could have basis in the goals of the "Chepachet Village Historic Preservation" Plan through a new Blackstone Watershed Integrated Water Resource Restoration grant Project through the RIDEM since Glocester is an eligible participatory community within the Blackstone National Heritage Corridor. Such a grant would likely require local share match that could be partly made up with in-kind personnel services and limited budget contribution. Such a contribution could also be partially be used for retaining consultant assistance in developing a proper grant application.

APPENDIX A

REFERENCES

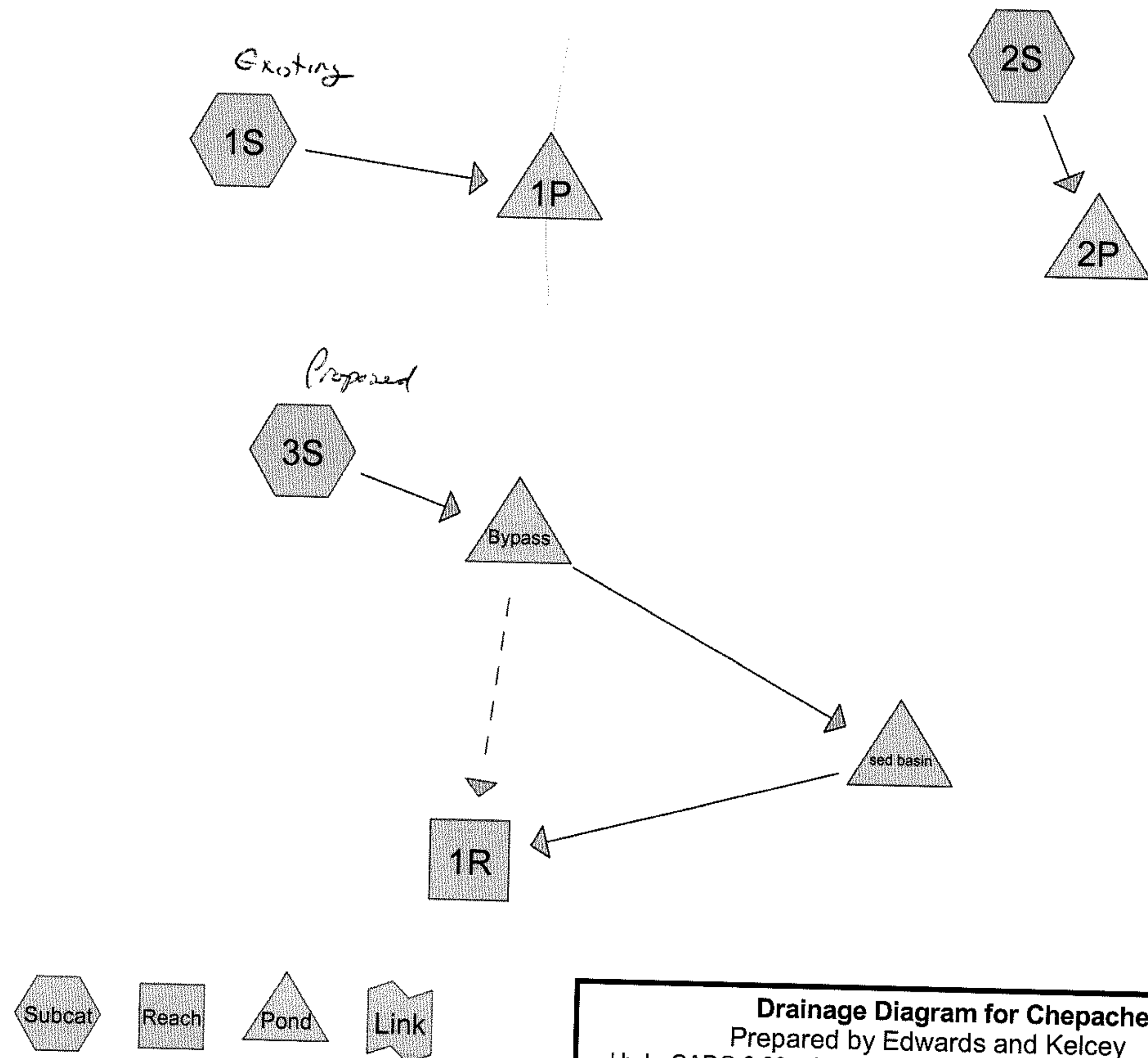
1. Glocester Wastewater Management Commission, *Glocester Wastewater Management Study*, Fuss & O'Neill Consulting Engineers, 1997.
2. Town of Glocester, *Final Report Chepachet Village Planning Project*, Community Planning Studio, University of Rhode Island, 1997.
3. Town of Glocester, *Comprehensive Community Plan, 2001.*
4. Town of Glocester, Zoning Ordinance, 2004____
5. Town of Glocester, Subdivision and Land Development Regulations 2001.
6. State of Rhode Island, *Soils Survey, latest edition.*
7. RIDEM ISDS Regulations
8. Glocester Conservation Commission, Water Quality and Sewage Disposal in Chepachet, 1989
9. Town of Glocester, Wastewater management District Rules and Regulations, 2004
10. University of Rhode Island Cooperative Extension, Water Quality Program (MANAGE Watershed Assessment Method), 2004
11. ASCE-WEF, *Urban Runoff Quality Management*, Manual Of Practice No. 23, 1998.
12. All stormwater runoff calculations were performed using SCS TR-20 method; SCS Unit Hydrograph; Type III 24-hr Rainfall; reach routing by Stor-Ind+Trans Method; pond routing by Stor-Ind Method.

APPENDIX "B"

STORMWATER COMPUTATIONS

for

5 Year Storm Frequency



5 year

Drainage Diagram for Chepachet Village
Prepared by Edwards and Kelcey 8/24/04
HydroCAD® 6.00 s/n 001340 © 1986-2001 Applied Microcomputer Systems

Time span=5.00-20.00 hrs, dt=0.05 hrs, 301 points
Runoff by SCS TR-20 method, UH=SCS, Type III 24-hr Rainfall=3.30"
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: Chepachet Village original
Tc=12.7 min CN=79 Area=2.400 ac Runoff= 3.11 cfs 0.260 af

Subcatchment 2S: 1.5" rainfall
Tc=12.7 min CN=79 Area=2.400 ac Runoff= 3.11 cfs 0.260 af

Subcatchment 3S: with structure
Tc=12.7 min CN=79 Area=2.400 ac Runoff= 3.11 cfs 0.260 af

Reach 1R: (new node)
Inflow= 3.02 cfs 0.246 af
Length= 10.0' Max Vel= 4.1 fps Capacity= 56.51 cfs Outflow= 3.02 cfs 0.246 af

Pond 1P: Dentention Pond
Peak Storage= 0.021 af Inflow= 3.11 cfs 0.260 af
Primary= 2.97 cfs 0.251 af Outflow= 2.97 cfs 0.251 af

Pond 2P: (new node)
Peak Storage= 0.018 af Inflow= 3.11 cfs 0.260 af
Primary= 3.07 cfs 0.251 af Outflow= 3.07 cfs 0.251 af

Pond Bypass: Bypass
Peak Storage= 14 cf Inflow= 3.11 cfs 0.260 af
Primary= 2.71 cfs 0.256 af Secondary= 0.40 cfs 0.004 af Outflow= 3.11 cfs 0.260 af

Pond sed basin: sed basin
Peak Storage= 0.025 af Inflow= 2.71 cfs 0.256 af
Primary= 2.66 cfs 0.242 af Outflow= 2.66 cfs 0.242 af

Runoff Area = 7.200 ac Volume = 0.780 af Average Depth = 1.30"

Subcatchment 1S: Chepachet Village original

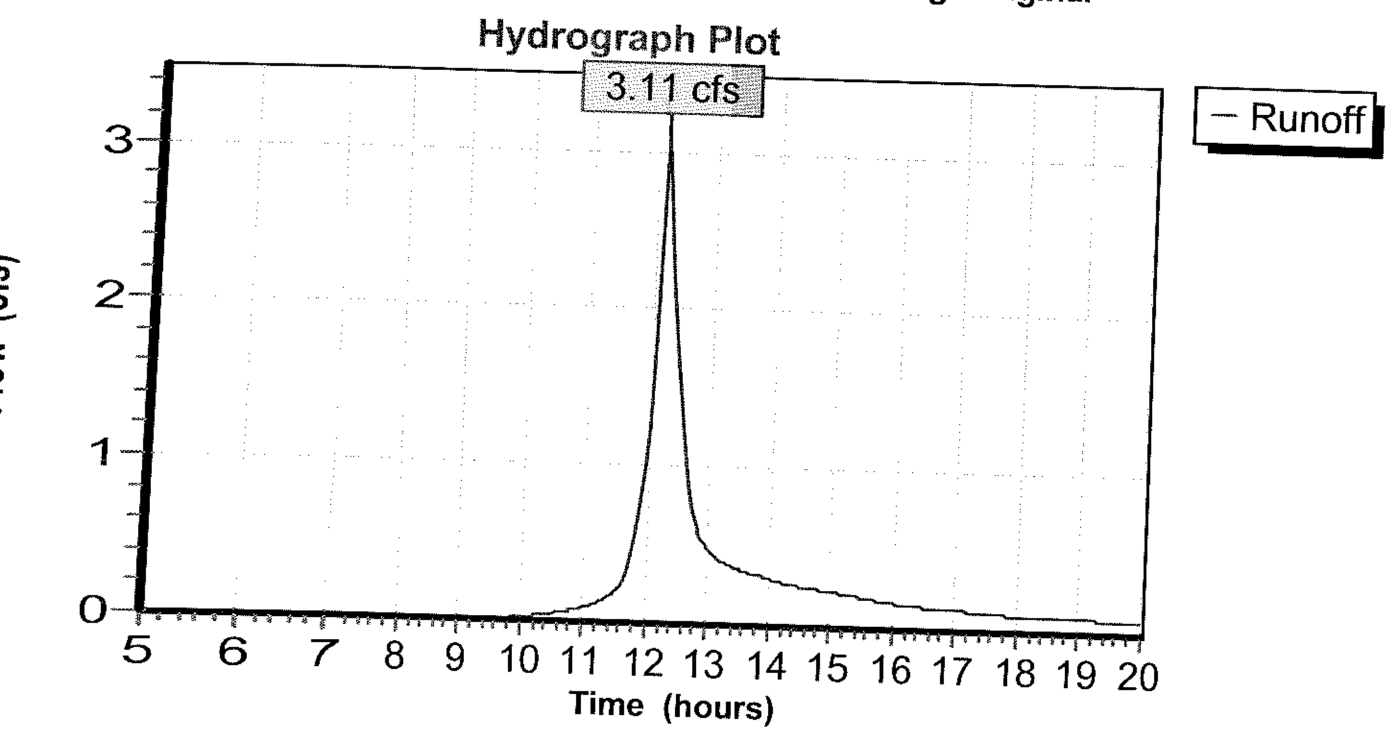
unoff = 3.11 cfs @ 12.18 hrs, Volume= 0.260 af

unoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
pe III 24-hr Rainfall=3.30"

Area (ac)	CN	Description
1.180	83	1/8 acre lots, 65% imp, HSG C
1.220	75	1/8 acre lots, 65% imp, HSG B
2.400	79	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.7	100	0.0100	0.1		**Sheet Flow, Sheet Flow** Grass: Short n= 0.150 P2= 3.30"

Subcatchment 1S: Chepachet Village original



Subcatchment 2S: 1.5" rainfall

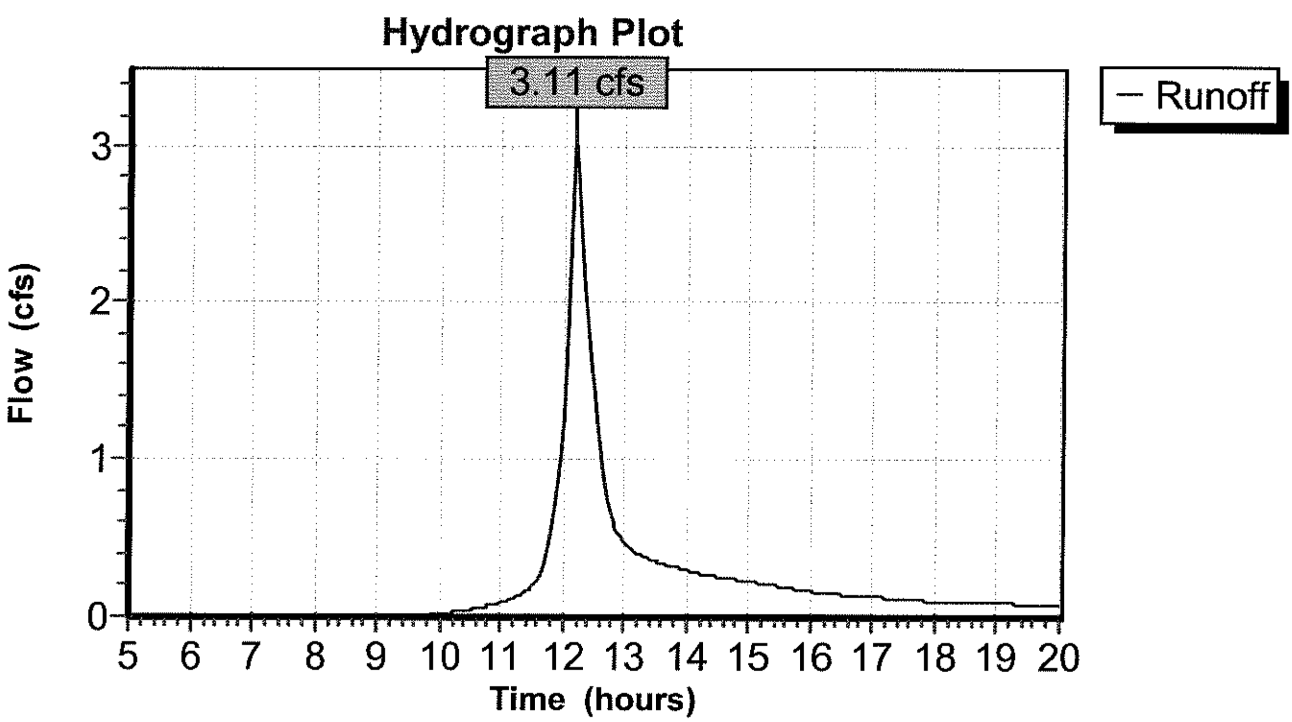
Runoff = 3.11 cfs @ 12.18 hrs, Volume= 0.260 af

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr Rainfall=3.30"

Area (ac)	CN	Description
1.180	83	1/8 acre lots, 65% imp, HSG C
1.220	75	1/8 acre lots, 65% imp, HSG B
2.400	79	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.7	100	0.0100	0.1		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.30"

Subcatchment 2S: 1.5" rainfall



Subcatchment 3S: with structure

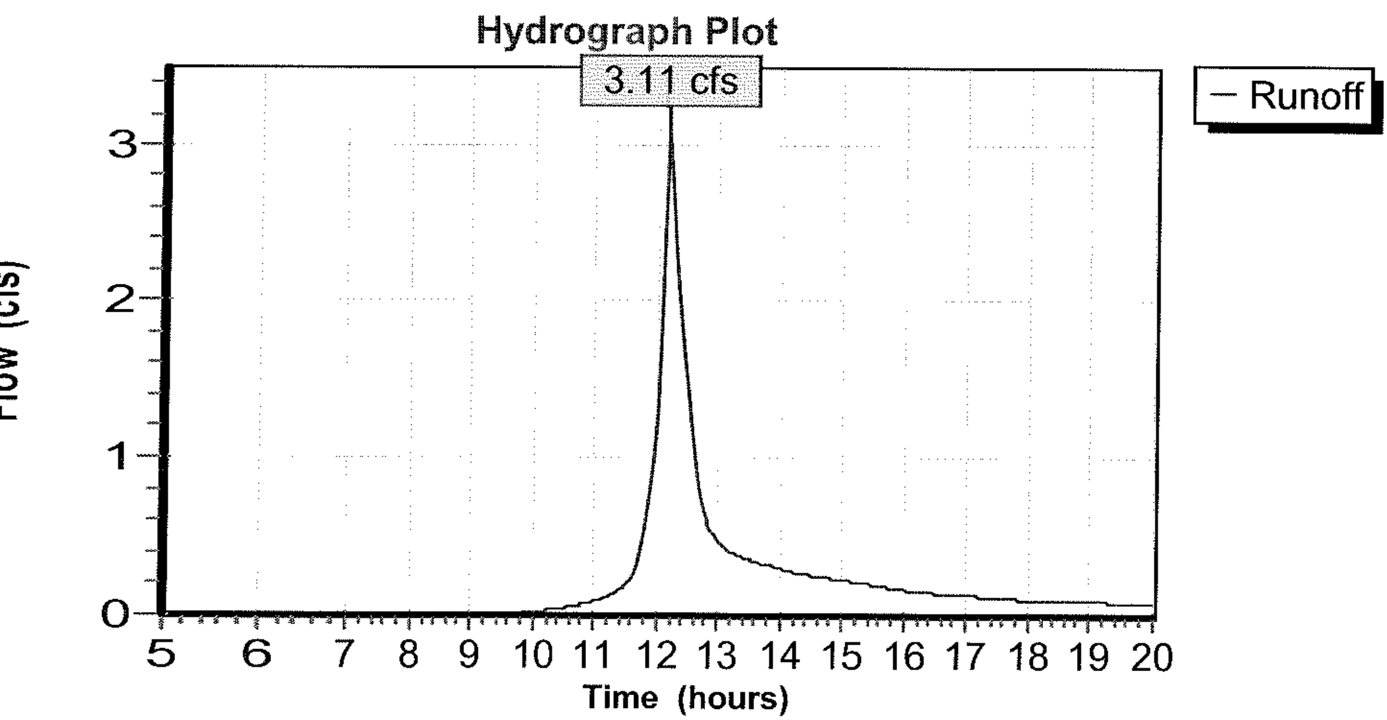
noff = 3.11 cfs @ 12.18 hrs, Volume= 0.260 af

noff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
pe III 24-hr Rainfall=3.30"

Area (ac)	CN	Description
1.180	83	1/8 acre lots, 65% imp, HSG C
1.220	75	1/8 acre lots, 65% imp, HSG B
2.400	79	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.7	100	0.0100	0.1		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.30"

Subcatchment 3S: with structure



Reach 1R: (new node)

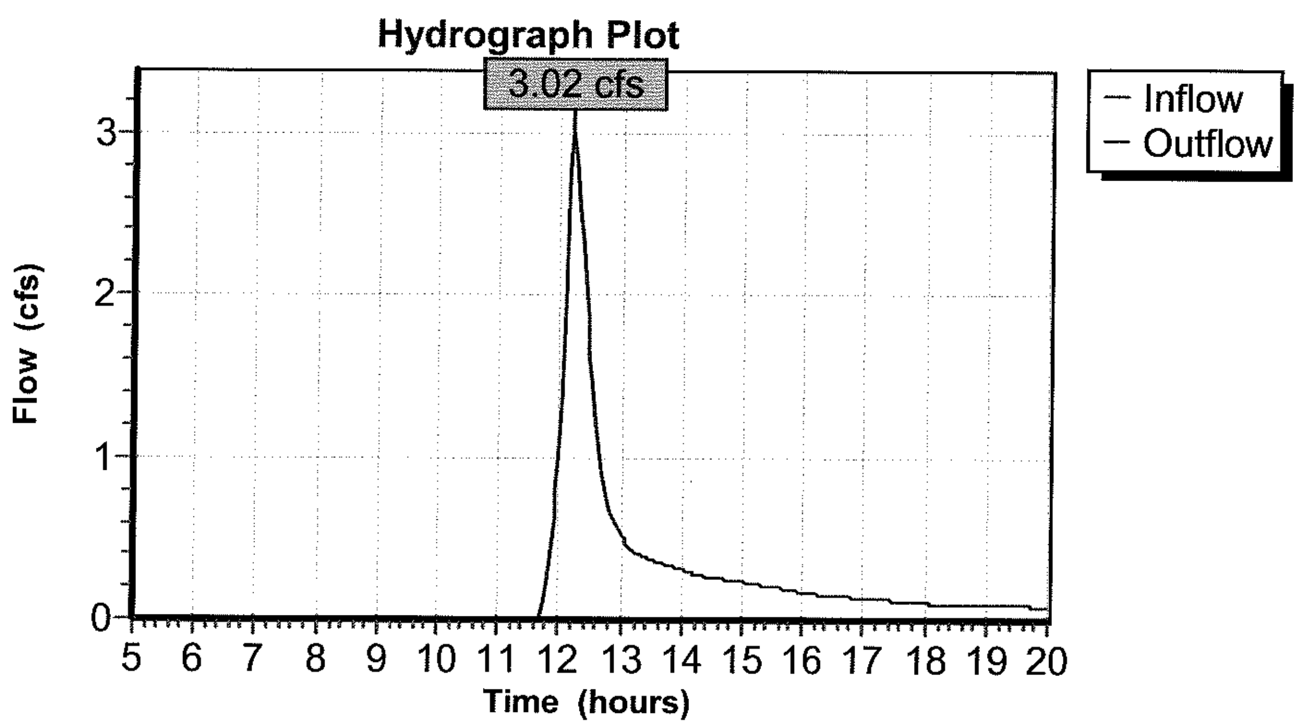
[88] Warning: Qout>Qin may require Finer Routing>1
[80] Warning: Exceeded Pond Bypass by 6.00' @ 5.00 hrs (132.04 cfs)
[79] Warning: Submerged Pond sed basin Primary device # 1 by 0.34'

Inflow	=	3.02 cfs @	12.20 hrs, Volume=	0.246 af
Outflow	=	3.02 cfs @	12.21 hrs, Volume=	0.246 af, Atten= 0%, Lag= 0.1 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 4.1 fps, Min. Travel Time= 0.0 min
Avg. Velocity = 1.7 fps, Avg. Travel Time= 0.1 min

Peak Depth= 0.34'
Capacity at bank full= 56.51 cfs
Inlet Invert= 402.00', Outlet Invert= 401.90'
2.00' x 2.00' deep channel, n= 0.015 Length= 10.0' Slope= 0.0100 '/'
Side Slope Z-value= 0.5 '/'

Reach 1R: (new node)



Pond 1P: Dentention Pond

ow	=	3.11 cfs @	12.18 hrs, Volume=	0.260 af
flow	=	2.97 cfs @	12.23 hrs, Volume=	0.251 af, Atten= 5%, Lag= 2.5 min
nary	=	2.97 cfs @	12.23 hrs, Volume=	0.251 af

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

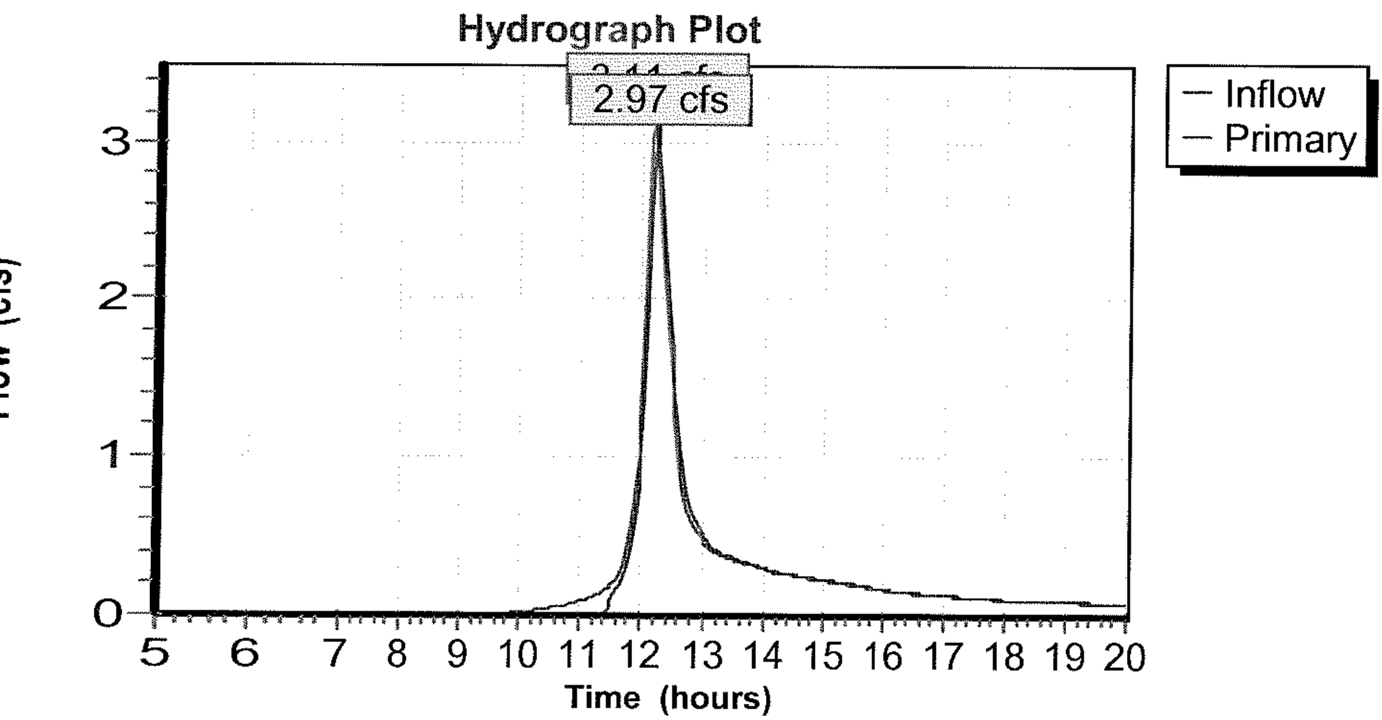
ık Elev= 401.91' Storage= 0.021 af
od Elev= 402.00' Storage= 0.023 af
g-Flow detention time= 21.2 min calculated for 0.250 af (96% of inflow)
rage and wetted areas determined by Prismatic sections

evation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
400.00	0.000	0.000	0.000
401.00	0.014	0.007	0.007
402.00	0.017	0.016	0.023

nary OutFlow (Free Discharge)
=Culvert

Routing	Invert	Outlet Devices
Primary	401.00'	**12.0" x 50.0' long Culvert** Ke= 0.200 Outlet Invert= 400.00' S= 0.0200 '/' n= 0.015 Cc= 0.900

Pond 1P: Dentention Pond



Pond 2P: (new node)

Inflow	=	3.11 cfs @ 12.18 hrs, Volume=	0.260 af	
Outflow	=	3.07 cfs @ 12.21 hrs, Volume=	0.251 af,	Atten= 1%, Lag= 1.7 min
Primary	=	3.07 cfs @ 12.21 hrs, Volume=	0.251 af	

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

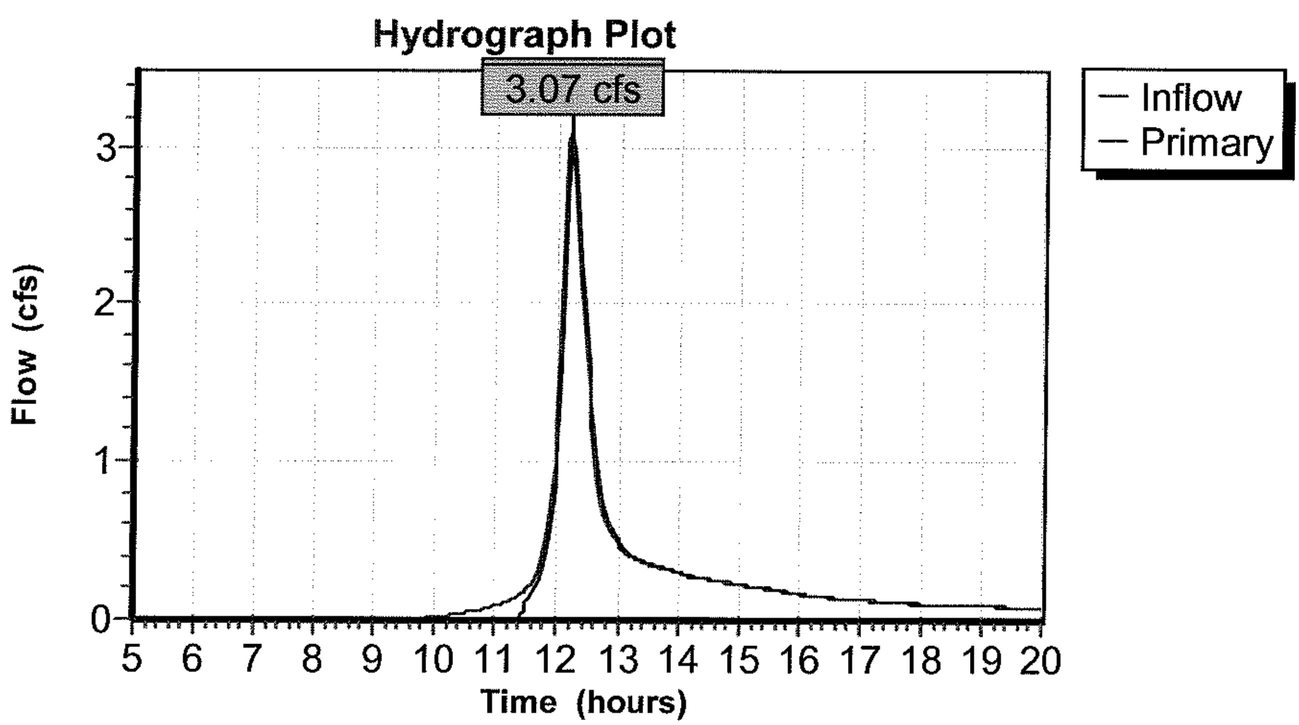
Peak Elev= 401.74' Storage= 0.018 af
Flood Elev= 402.00' Storage= 0.023 af
Plug-Flow detention time= 20.3 min calculated for 0.250 af (96% of inflow)
Storage and wetted areas determined by Prismatic sections

Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
400.00	0.000	0.000	0.000
401.00	0.014	0.007	0.007
402.00	0.017	0.016	0.023

Primary OutFlow (Free Discharge)
└─1=Culvert

#	Routing	Invert	Outlet Devices
1	Primary	401.00'	**18.0" x 50.0' long Culvert** Ke= 0.200 Outlet Invert= 400.00' S= 0.0200 '/' n= 0.015 Cc= 0.900

Pond 2P: (new node)



Pond Bypass: Bypass

ow =	3.11 cfs @	12.18 hrs,	Volume=	0.260 af
flow =	3.11 cfs @	12.18 hrs,	Volume=	0.260 af, Atten= 0%, Lag= 0.0 min
nary =	2.71 cfs @	12.18 hrs,	Volume=	0.256 af
condary =	0.40 cfs @	12.18 hrs,	Volume=	0.004 af

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

k Elev= 397.10' Storage= 14 cf
od Elev= 403.00' Storage= 91 cf
g-Flow detention time= 0.2 min calculated for 0.260 af (100% of inflow)
rage and wetted areas determined by Conic sections

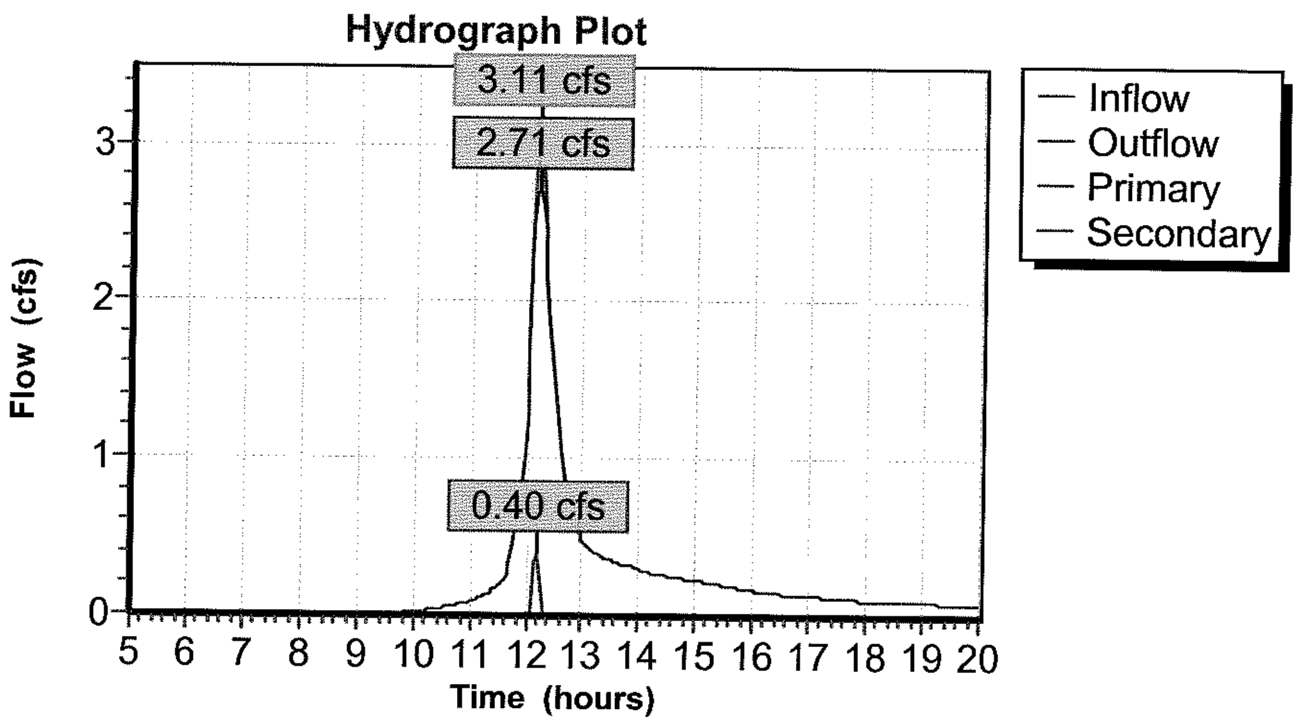
vation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
396.00	13	0	0	13
398.00	13	26	26	39
400.00	13	26	52	64
401.00	13	13	65	77
402.00	13	13	78	90

nary OutFlow (Free Discharge)
=Culvert

condary OutFlow (Free Discharge)
=Sharp-Crested Rectangular Weir

Routing	Invert	Outlet Devices
Secondary	397.00'	**4.0' long x 3.0' high Sharp-Crested Rectangular Weir** 2 End Contraction(s)
Primary	396.00'	**10.0" x 50.0' long Culvert** RCP, groove end projecting, Ke= 0.200 Outlet Invert= 395.00' S= 0.0200 '/' n= 0.012 Cc= 0.900

Pond Bypass: Bypass



Pond sed basin: sed basin

Hint: Peaked 0.82' above defined flood level
Warning: Exceeded Pond Bypass by 6.01' @ 12.70 hrs (6.30 cfs)

ow	=	2.71 cfs @ 12.18 hrs, Volume=	0.256 af
flow	=	2.66 cfs @ 12.24 hrs, Volume=	0.242 af, Atten= 2%, Lag= 3.2 min
nary	=	2.66 cfs @ 12.24 hrs, Volume=	0.242 af

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

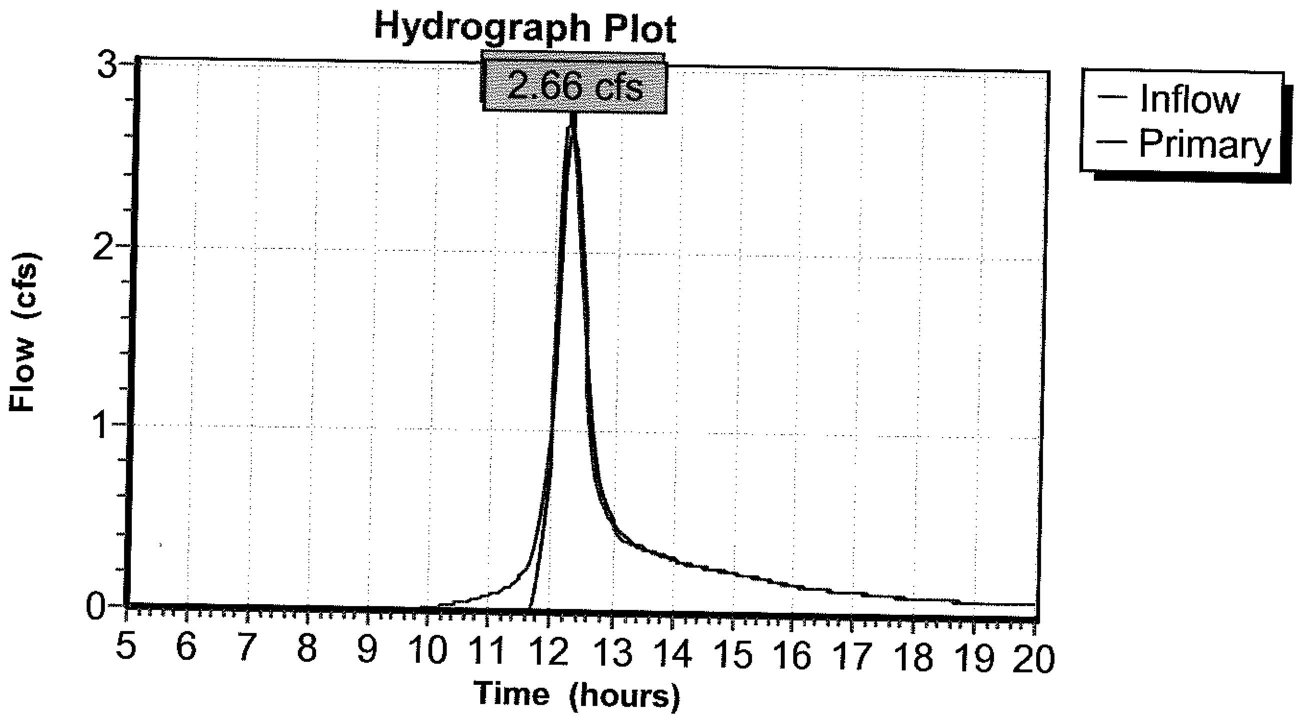
k Elev= 402.82' Storage= 0.025 af
od Elev= 402.00' Storage= 0.012 af
j-Flow detention time= 29.9 min calculated for 0.241 af (94% of inflow)
rage and wetted areas determined by Conic sections

vation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)	Wet.Area (acres)
-01.00	0.010	0.000	0.000	0.010
-02.00	0.014	0.012	0.012	0.014
-03.00	0.017	0.015	0.027	0.018

nary OutFlow (Free Discharge)
=Culvert

Routing	Invert	Outlet Devices
Primary	401.00'	**12.0" x 50.0' long Culvert** Ke= 0.200 Outlet Invert= 402.00' S= -0.0200 '/' n= 0.015 Cc= 0.900

Pond sed basin: sed basin

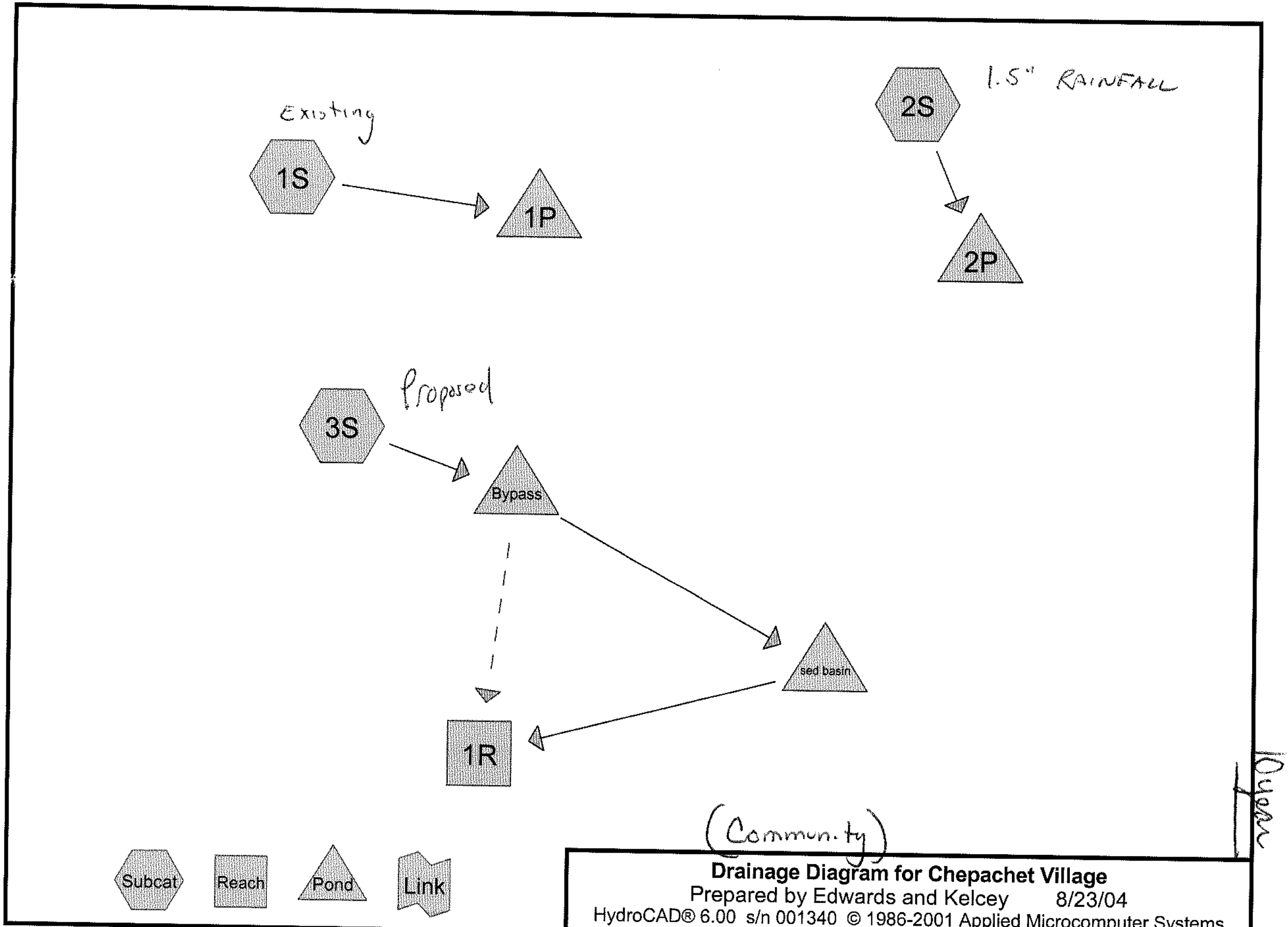


APPENDIX “C”

STORMWATER COMPUTATIONS

for

10 Year Storm Frequency



Drainage Diagram for Chepachet Village
Prepared by Edwards and Kelcey 8/23/04
HydroCAD® 6.00 s/n 001340 © 1986-2001 Applied Microcomputer Systems

Time span=5.00-20.00 hrs, dt=0.05 hrs, 301 points
Runoff by SCS TR-20 method, UH=SCS, Type III 24-hr Rainfall=4.80"
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: Chepachet Village original
Tc=12.7 min CN=79 Area=2.400 ac Runoff= 5.89 cfs 0.489 af

Subcatchment 2S: 1.5" rainfall
Tc=12.7 min CN=79 Area=2.400 ac Runoff= 5.89 cfs 0.489 af

Subcatchment 3S: with structure
Tc=12.7 min CN=79 Area=2.400 ac Runoff= 5.89 cfs 0.489 af

Reach 1R: (new node)
Inflow= 5.81 cfs 0.475 af
Length= 10.0' Max Vel= 5.1 fps Capacity= 56.51 cfs Outflow= 5.81 cfs 0.475 af

Pond 1P: Dentention Pond
Peak Storage= 0.034 af Inflow= 5.89 cfs 0.489 af
Primary= 5.36 cfs 0.480 af Outflow= 5.36 cfs 0.480 af

Pond 2P: (new node)
Peak Storage= 0.024 af Inflow= 5.89 cfs 0.489 af
Primary= 5.82 cfs 0.480 af Outflow= 5.82 cfs 0.480 af

Pond Bypass: Bypass
Peak Storage= 18 cf Inflow= 5.89 cfs 0.489 af
Primary= 3.16 cfs 0.433 af Secondary= 2.72 cfs 0.056 af Outflow= 5.88 cfs 0.489 af

Pond sed basin: sed basin
Peak Storage= 0.026 af Inflow= 3.16 cfs 0.433 af
Primary= 3.12 cfs 0.419 af Outflow= 3.12 cfs 0.419 af

Runoff Area = 7.200 ac Volume = 1.468 af Average Depth = 2.45"

Subcatchment 1S: Chepachet Village original

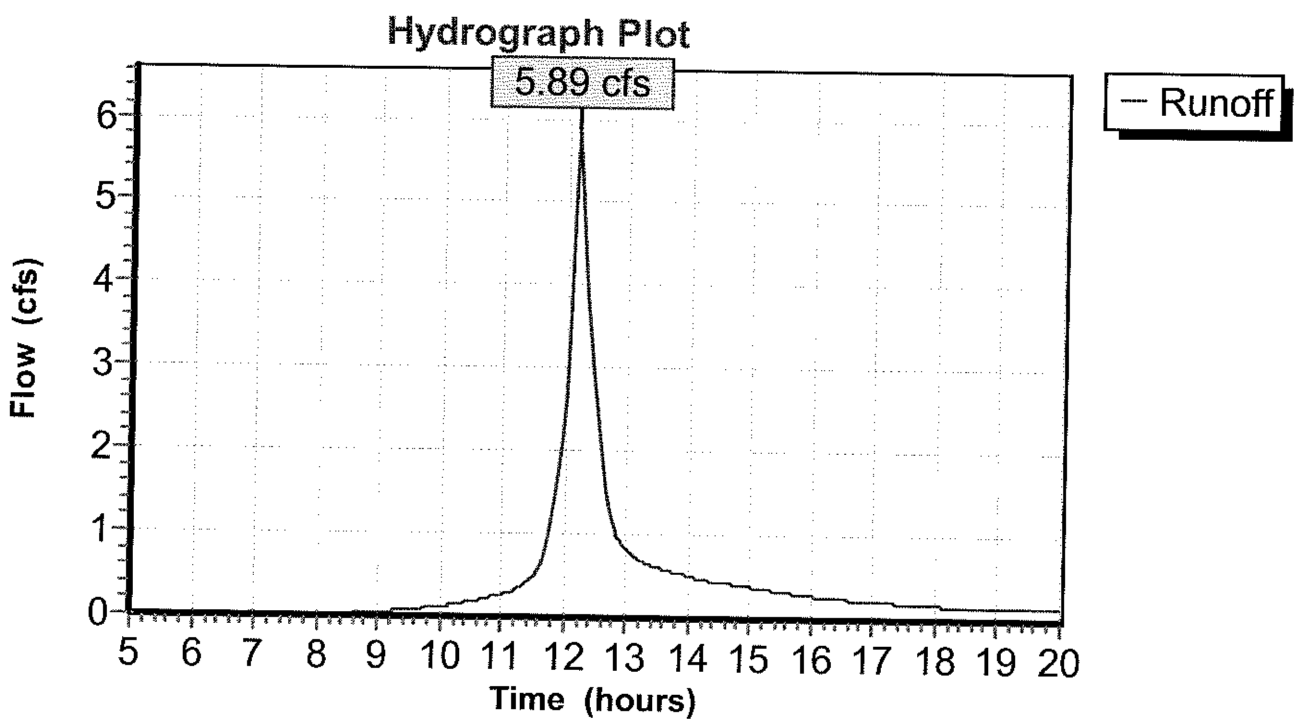
Runoff = 5.89 cfs @ 12.18 hrs, Volume= 0.489 af

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr Rainfall=4.80"

Area (ac)	CN	Description
1.180	83	1/8 acre lots, 65% imp, HSG C
1.220	75	1/8 acre lots, 65% imp, HSG B
2.400	79	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.7	100	0.0100	0.1		**Sheet Flow, Sheet Flow** Grass: Short n= 0.150 P2= 3.30"

Subcatchment 1S: Chepachet Village original



Subcatchment 2S: 1.5" rainfall

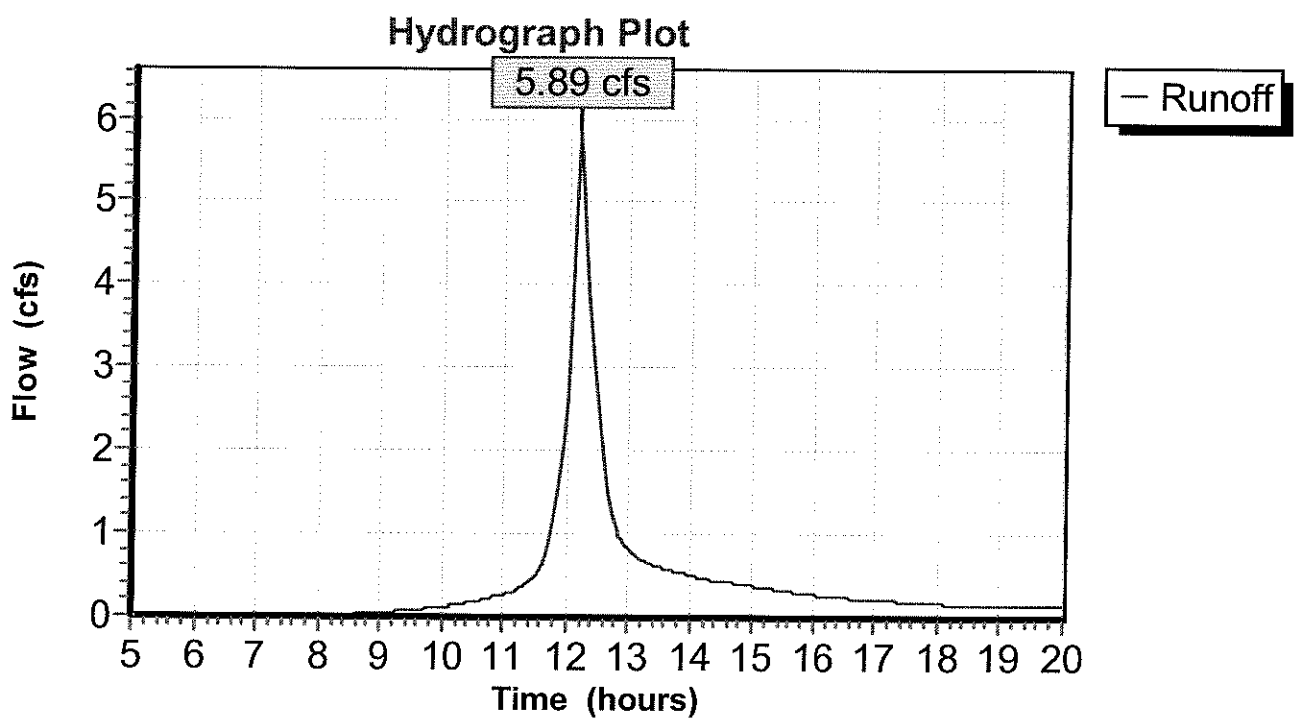
Runoff = 5.89 cfs @ 12.18 hrs, Volume= 0.489 af

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr Rainfall=4.80"

Area (ac)	CN	Description
1.180	83	1/8 acre lots, 65% imp, HSG C
1.220	75	1/8 acre lots, 65% imp, HSG B
2.400	79	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.7	100	0.0100	0.1		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.30"

Subcatchment 2S: 1.5" rainfall



Subcatchment 3S: with structure

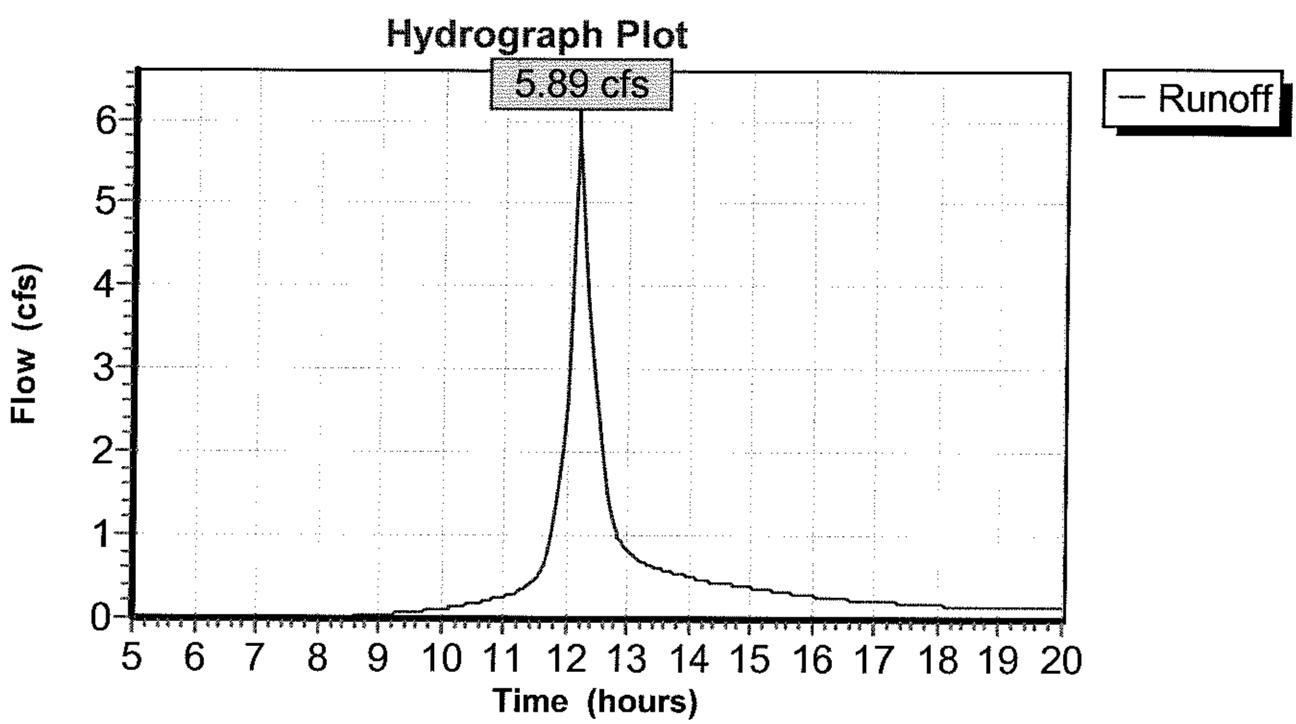
Runoff = 5.89 cfs @ 12.18 hrs, Volume= 0.489 af

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr Rainfall=4.80"

Area (ac)	CN	Description
1.180	83	1/8 acre lots, 65% imp, HSG C
1.220	75	1/8 acre lots, 65% imp, HSG B
2.400	79	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.7	100	0.0100	0.1		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.30"

Subcatchment 3S: with structure



Reach 1R: (new node)

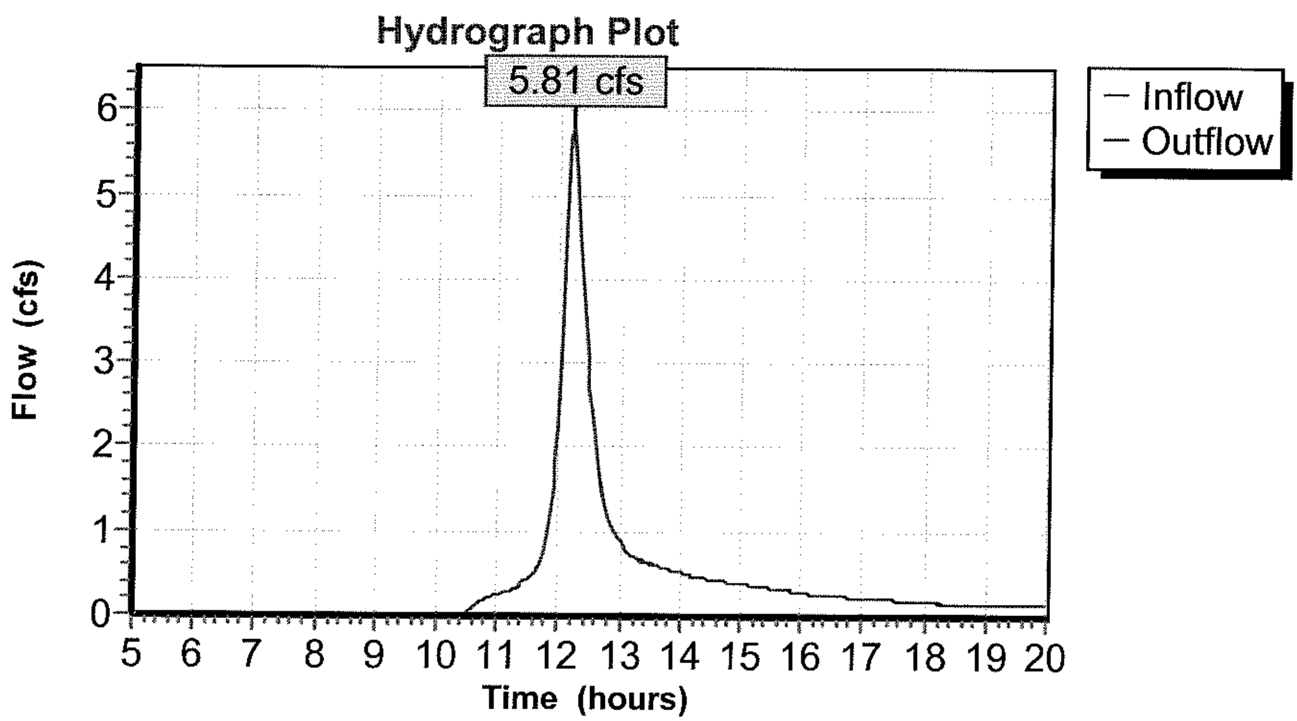
[80] Warning: Exceeded Pond Bypass by 6.00' @ 5.00 hrs (132.04 cfs)
[79] Warning: Submerged Pond sed basin Primary device # 1 by 0.51'

Inflow	=	5.81 cfs @	12.18 hrs, Volume=	0.475 af
Outflow	=	5.81 cfs @	12.19 hrs, Volume=	0.475 af, Atten= 0%, Lag= 0.1 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 5.1 fps, Min. Travel Time= 0.0 min
Avg. Velocity = 2.0 fps, Avg. Travel Time= 0.1 min

Peak Depth= 0.51'
Capacity at bank full= 56.51 cfs
Inlet Invert= 402.00', Outlet Invert= 401.90'
2.00' x 2.00' deep channel, n= 0.015 Length= 10.0' Slope= 0.0100 '/'
Side Slope Z-value= 0.5 '/'

Reach 1R: (new node)



Pond 1P: Dentention Pond

[91] Warning: Storage range exceeded by 0.76'
[58] Hint: Peaked 0.76' above defined flood level

Inflow	=	5.89 cfs @	12.18 hrs,	Volume=	0.489 af
Outflow	=	5.36 cfs @	12.24 hrs,	Volume=	0.480 af, Atten= 9%, Lag= 3.9 min
Primary	=	5.36 cfs @	12.24 hrs,	Volume=	0.480 af

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

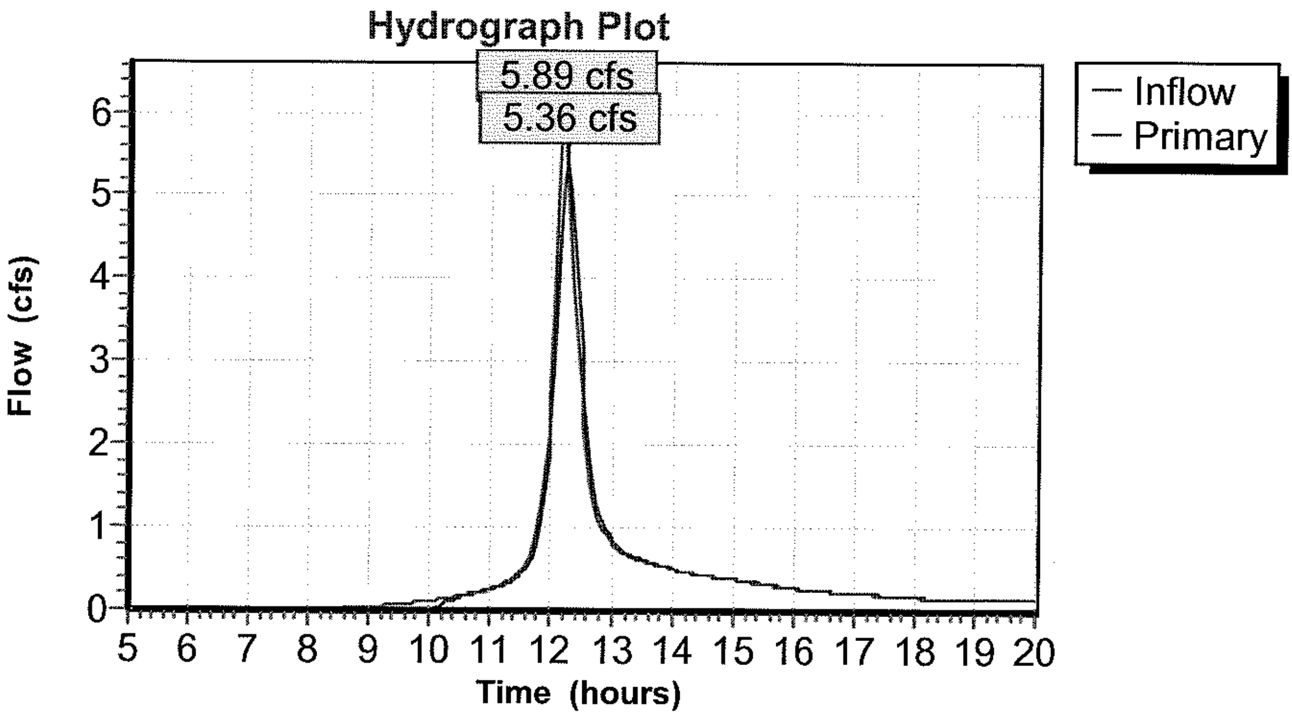
Peak Elev= 402.76' Storage= 0.034 af
Flood Elev= 402.00' Storage= 0.023 af
Plug-Flow detention time= 14.6 min calculated for 0.478 af (98% of inflow)
Storage and wetted areas determined by Prismatic sections

Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
400.00	0.000	0.000	0.000
401.00	0.014	0.007	0.007
402.00	0.017	0.016	0.023

Primary OutFlow (Free Discharge)
└─1=Culvert

#	Routing	Invert	Outlet Devices
1	Primary	401.00'	**12.0" x 50.0' long Culvert** Ke= 0.200 Outlet Invert= 400.00' S= 0.0200 '/' n= 0.015 Cc= 0.900

Pond 1P: Dentention Pond



Pond 2P: (new node)

[91] Warning: Storage range exceeded by 0.09'
[58] Hint: Peaked 0.09' above defined flood level

Inflow	=	5.89 cfs @	12.18 hrs, Volume=	0.489 af
Outflow	=	5.82 cfs @	12.21 hrs, Volume=	0.480 af, Atten= 1%, Lag= 1.6 min
Primary	=	5.82 cfs @	12.21 hrs, Volume=	0.480 af

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

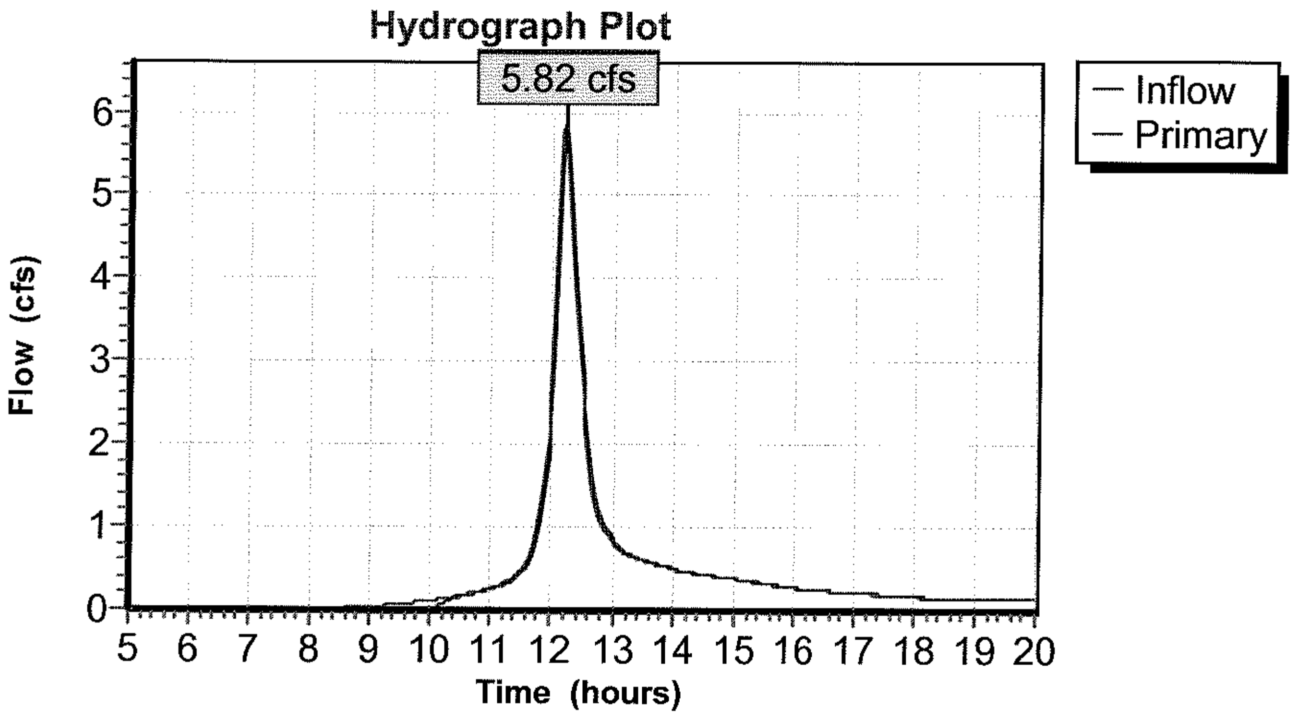
Peak Elev= 402.09' Storage= 0.024 af
Flood Elev= 402.00' Storage= 0.023 af
Plug-Flow detention time= 13.7 min calculated for 0.480 af (98% of inflow)
Storage and wetted areas determined by Prismatic sections

Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
400.00	0.000	0.000	0.000
401.00	0.014	0.007	0.007
402.00	0.017	0.016	0.023

Primary OutFlow (Free Discharge)
↑—1=Culvert

#	Routing	Invert	Outlet Devices
1	Primary	401.00'	**18.0" x 50.0' long Culvert** Ke= 0.200 Outlet Invert= 400.00' S= 0.0200 '/' n= 0.015 Cc= 0.900

Pond 2P: (new node)



Pond Bypass: Bypass

Inflow =	5.89 cfs @	12.18 hrs, Volume=	0.489 af	
Outflow =	5.88 cfs @	12.18 hrs, Volume=	0.489 af,	Atten= 0%, Lag= 0.0 min
Primary =	3.16 cfs @	12.18 hrs, Volume=	0.433 af	
Secondary =	2.72 cfs @	12.18 hrs, Volume=	0.056 af	

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

Peak Elev= 397.35' Storage= 18 cf
Flood Elev= 403.00' Storage= 91 cf
Plug-Flow detention time= 0.1 min calculated for 0.488 af (100% of inflow)
Storage and wetted areas determined by Conic sections

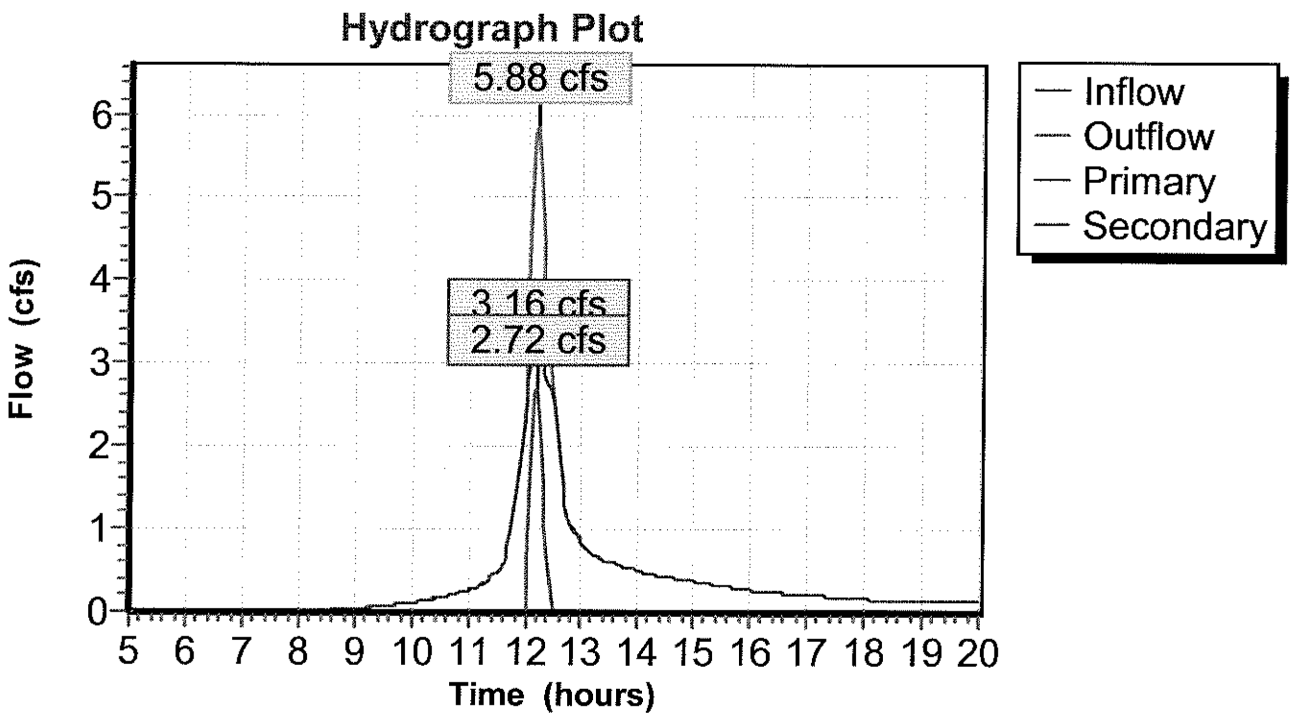
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
396.00	13	0	0	13
398.00	13	26	26	39
400.00	13	26	52	64
401.00	13	13	65	77
402.00	13	13	78	90

Primary OutFlow (Free Discharge)
↑—2=Culvert

Secondary OutFlow (Free Discharge)
↑—1=Sharp-Crested Rectangular Weir

#	Routing	Invert	Outlet Devices
1	Secondary	397.00'	**4.0' long x 3.0' high Sharp-Crested Rectangular Weir** 2 End Contraction(s)
2	Primary	396.00'	**10.0" x 50.0' long Culvert** RCP, groove end projecting, Ke= 0.200 Outlet Invert= 395.00' S= 0.0200 '/' n= 0.012 Cc= 0.900

Pond Bypass: Bypass



Pond sed basin: sed basin

[58] Hint: Peaked 0.93' above defined flood level
[80] Warning: Exceeded Pond Bypass by 6.00' @ 12.70 hrs (6.29 cfs)

Inflow	=	3.16 cfs @	12.18 hrs,	Volume=	0.433 af
Outflow	=	3.12 cfs @	12.23 hrs,	Volume=	0.419 af, Atten= 1%, Lag= 3.1 min
Primary	=	3.12 cfs @	12.23 hrs,	Volume=	0.419 af

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

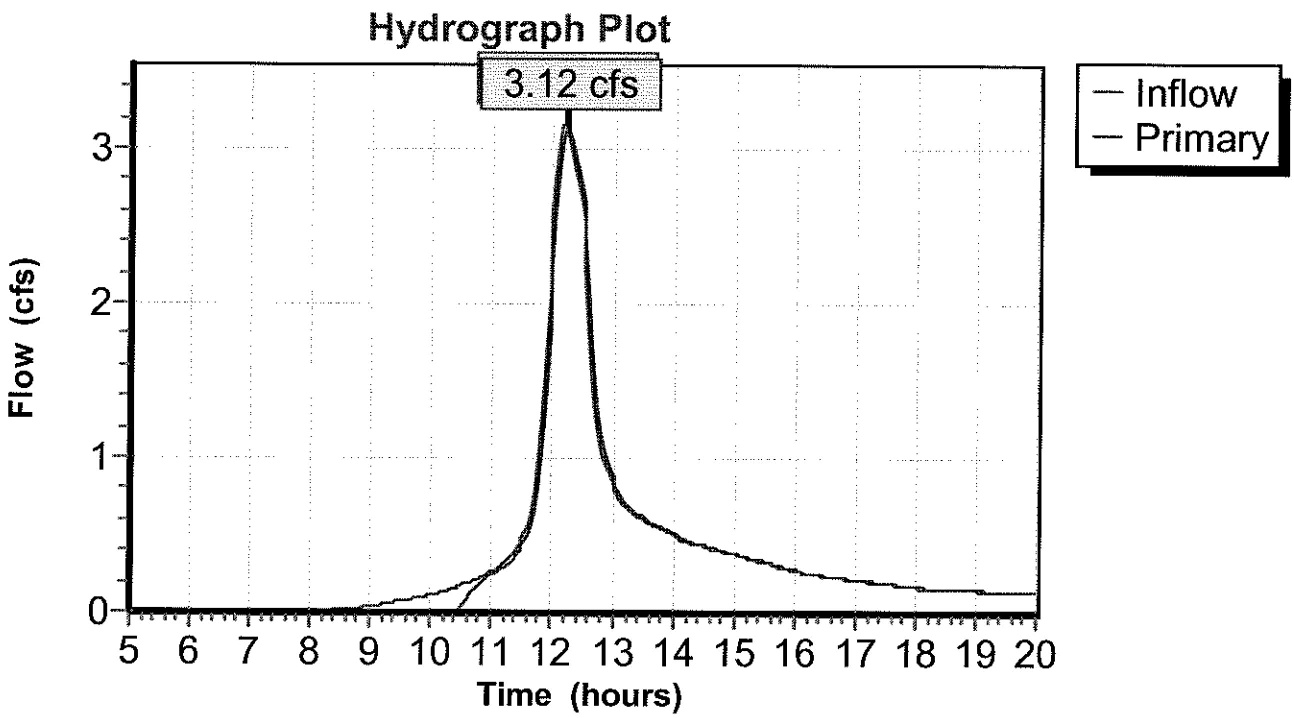
Peak Elev= 402.93' Storage= 0.026 af
Flood Elev= 402.00' Storage= 0.012 af
Plug-Flow detention time= 22.1 min calculated for 0.418 af (96% of inflow)
Storage and wetted areas determined by Conic sections

Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)	Wet.Area (acres)
401.00	0.010	0.000	0.000	0.010
402.00	0.014	0.012	0.012	0.014
403.00	0.017	0.015	0.027	0.018

Primary OutFlow (Free Discharge)
└—1=Culvert

#	Routing	Invert	Outlet Devices
1	Primary	401.00'	**12.0" x 50.0' long Culvert** Ke= 0.200 Outlet Invert= 402.00' S= -0.0200 '/' n= 0.015 Cc= 0.900

Pond sed basin: sed basin



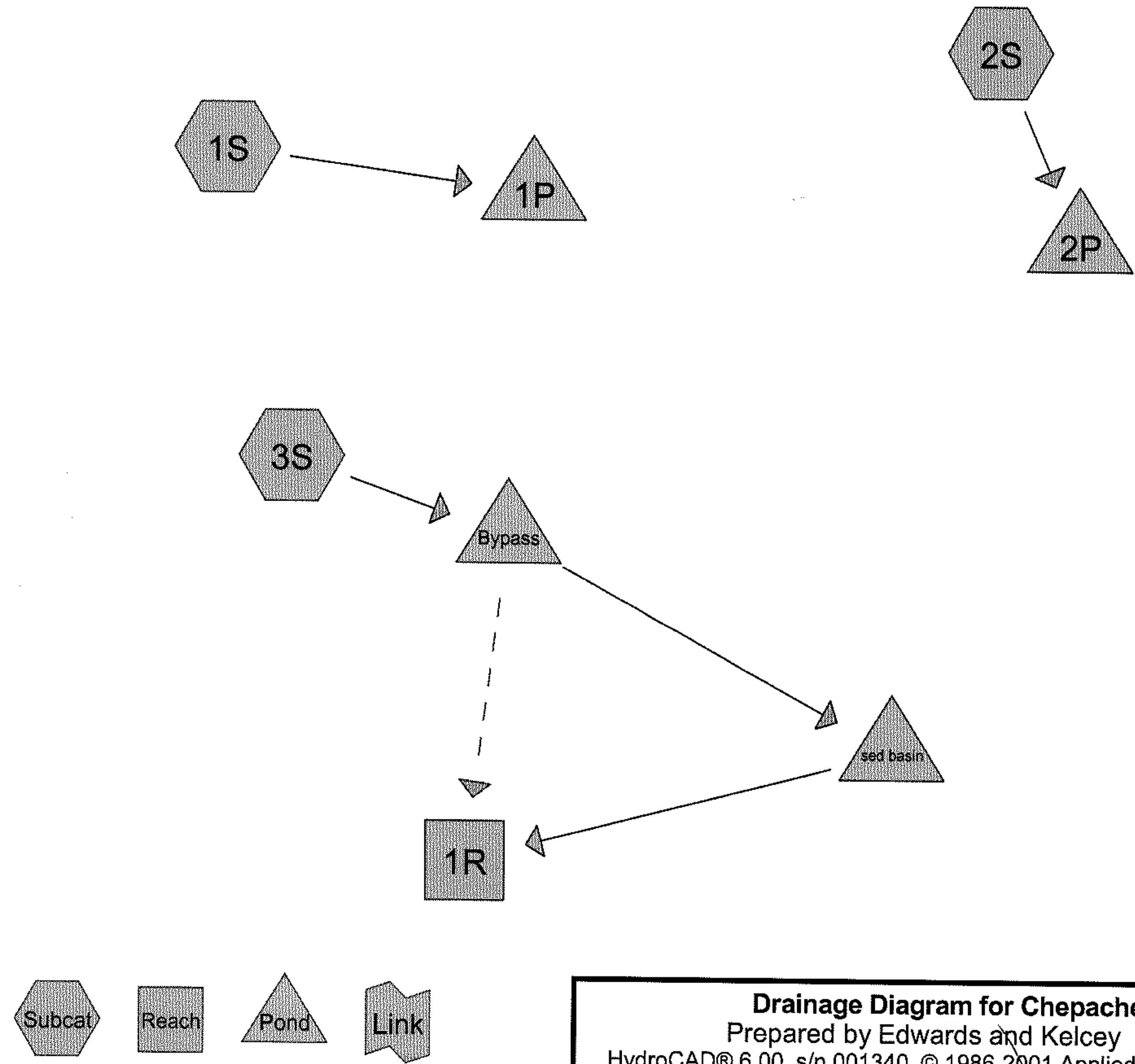
APPENDIX “D”

STORMWATER COMPUTATIONS

for

25 Year Storm Frequency

25 year



Drainage Diagram for Chepachet Village

Prepared by Edwards and Kelcey 8/24/04

Time span=5.00-20.00 hrs, dt=0.05 hrs, 301 points
Runoff by SCS TR-20 method, UH=SCS, Type III 24-hr Rainfall=5.60"
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: Chepachet Village original
Tc=12.7 min CN=79 Area=2.400 ac Runoff= 7.44 cfs 0.620 af

Subcatchment 2S: 1.5" rainfall
Tc=12.7 min CN=79 Area=2.400 ac Runoff= 7.44 cfs 0.620 af

Subcatchment 3S: with structure
Tc=12.7 min CN=79 Area=2.400 ac Runoff= 7.44 cfs 0.620 af

Reach 1R: (new node) Inflow= 7.37 cfs 0.606 af
Length= 10.0' Max Vel= 5.4 fps Capacity= 56.51 cfs Outflow= 7.36 cfs 0.606 af

Pond 1P: Dentention Pond Peak Storage= 0.042 af Inflow= 7.44 cfs 0.620 af
Primary= 6.75 cfs 0.611 af Outflow= 6.75 cfs 0.611 af

Pond 2P: (new node) Peak Storage= 0.027 af Inflow= 7.44 cfs 0.620 af
Primary= 7.36 cfs 0.611 af Outflow= 7.36 cfs 0.611 af

Pond Bypass: Bypass Peak Storage= 19 cf Inflow= 7.44 cfs 0.620 af
Primary= 3.28 cfs 0.522 af Secondary= 4.16 cfs 0.098 af Outflow= 7.44 cfs 0.620 af

Pond sed basin: sed basin Peak Storage= 0.027 af Inflow= 3.28 cfs 0.522 af
Primary= 3.24 cfs 0.508 af Outflow= 3.24 cfs 0.508 af

Runoff Area = 7.200 ac Volume = 1.861 af Average Depth = 3.10"

Subcatchment 1S: Chepachet Village original

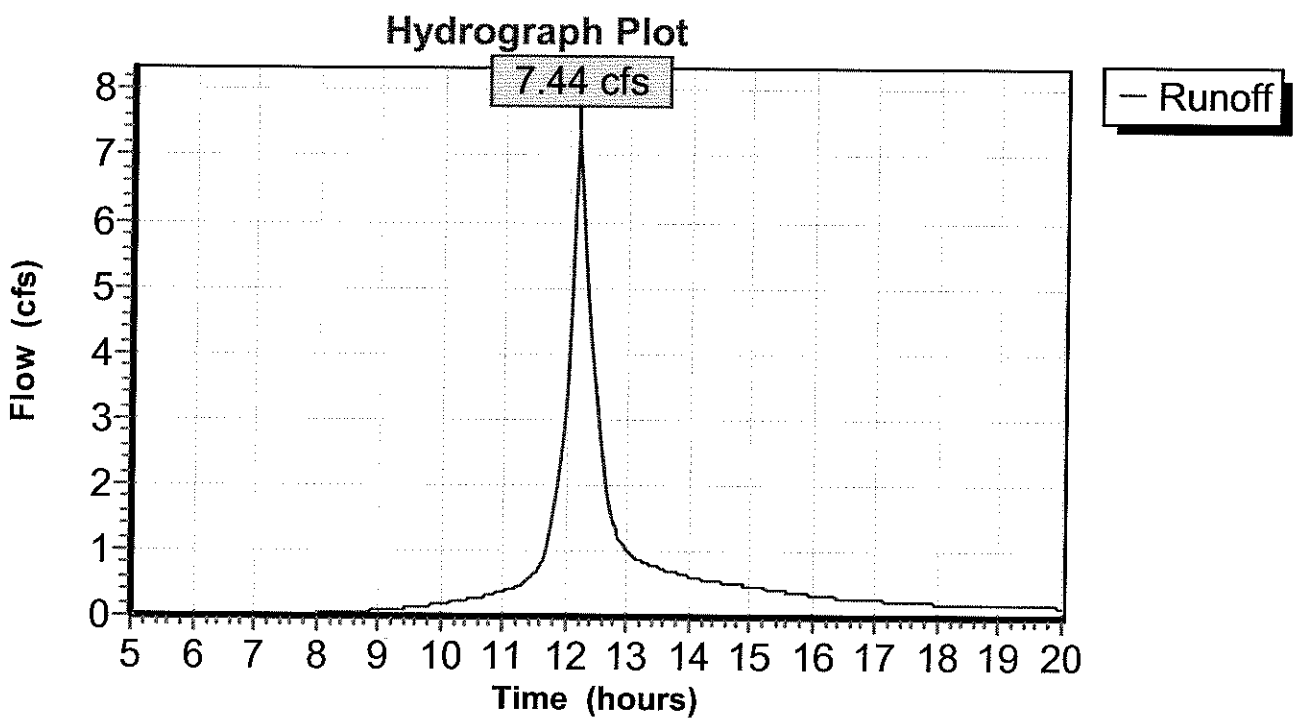
Runoff = 7.44 cfs @ 12.18 hrs, Volume= 0.620 af

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr Rainfall=5.60"

Area (ac)	CN	Description
1.180	83	1/8 acre lots, 65% imp, HSG C
1.220	75	1/8 acre lots, 65% imp, HSG B
2.400	79	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.7	100	0.0100	0.1		**Sheet Flow, Sheet Flow** Grass: Short n= 0.150 P2= 3.30"

Subcatchment 1S: Chepachet Village original



Subcatchment 2S: 1.5" rainfall

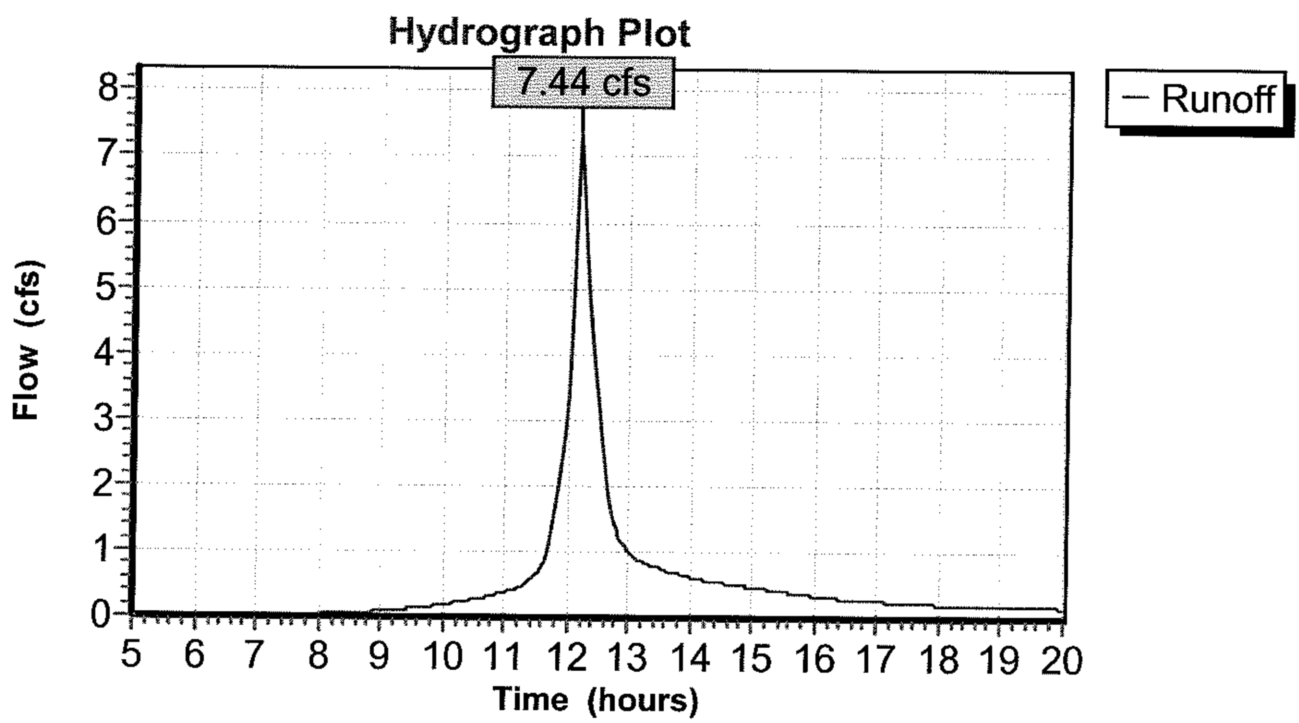
Runoff = 7.44 cfs @ 12.18 hrs, Volume= 0.620 af

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr Rainfall=5.60"

Area (ac)	CN	Description
1.180	83	1/8 acre lots, 65% imp, HSG C
1.220	75	1/8 acre lots, 65% imp, HSG B
2.400	79	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.7	100	0.0100	0.1		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.30"

Subcatchment 2S: 1.5" rainfall



Subcatchment 3S: with structure

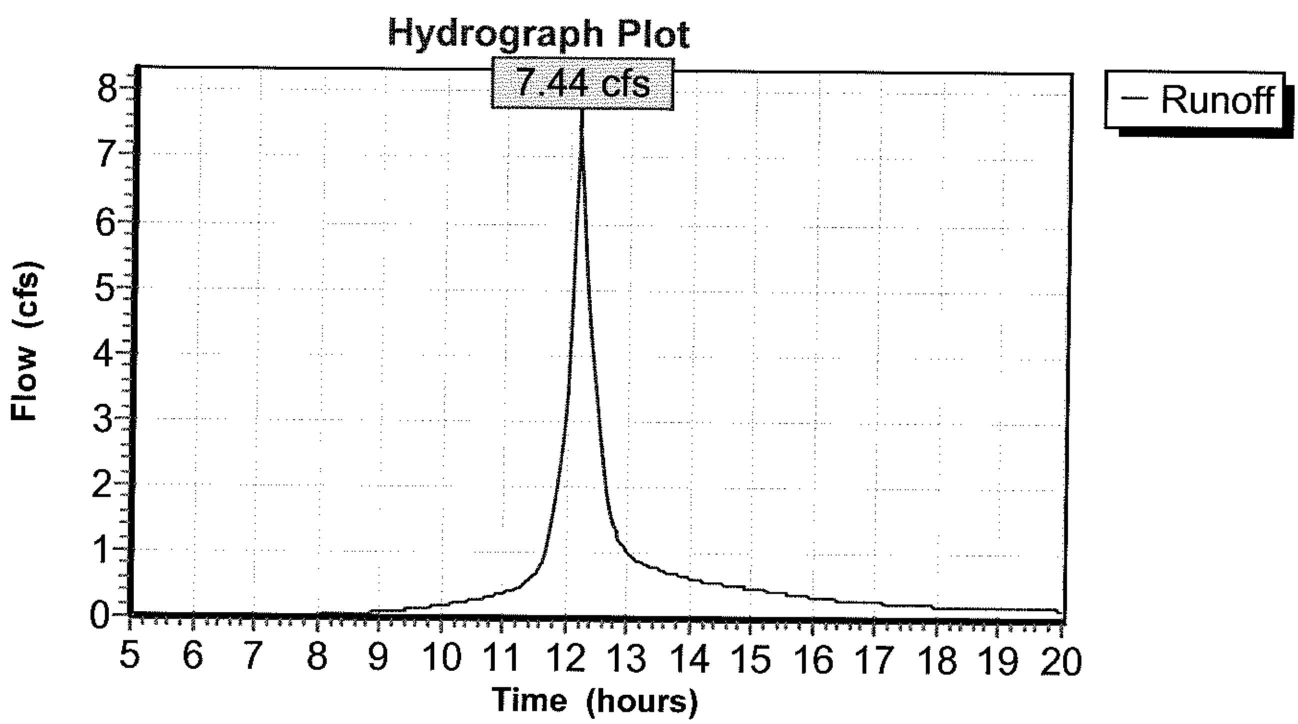
Runoff = 7.44 cfs @ 12.18 hrs, Volume= 0.620 af

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr Rainfall=5.60"

Area (ac)	CN	Description
1.180	83	1/8 acre lots, 65% imp, HSG C
1.220	75	1/8 acre lots, 65% imp, HSG B
2.400	79	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.7	100	0.0100	0.1		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.30"

Subcatchment 3S: with structure



Reach 1R: (new node)

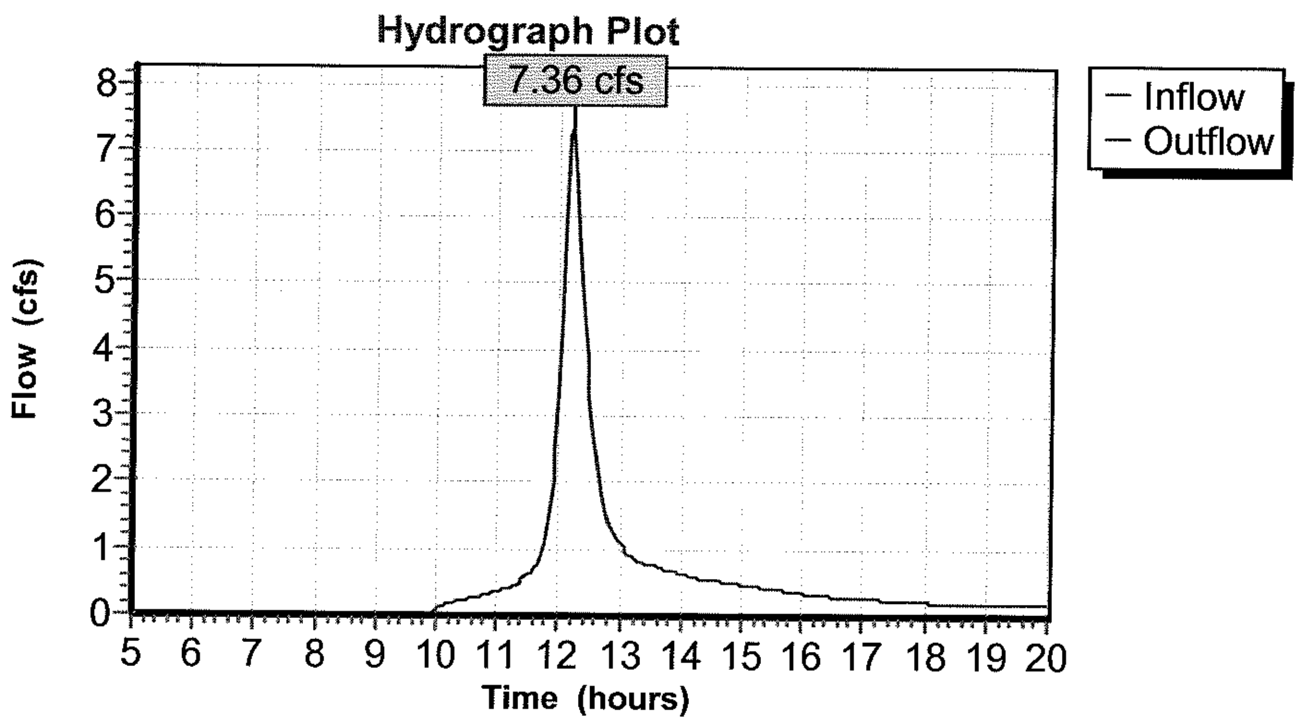
[80] Warning: Exceeded Pond Bypass by 6.00' @ 5.00 hrs (132.04 cfs)
[79] Warning: Submerged Pond sed basin Primary device # 1 by 0.59'

Inflow	=	7.37 cfs @	12.18 hrs, Volume=	0.606 af	
Outflow	=	7.36 cfs @	12.18 hrs, Volume=	0.606 af,	Atten= 0%, Lag= 0.1 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 5.4 fps, Min. Travel Time= 0.0 min
Avg. Velocity = 2.1 fps, Avg. Travel Time= 0.1 min

Peak Depth= 0.59'
Capacity at bank full= 56.51 cfs
Inlet Invert= 402.00', Outlet Invert= 401.90'
2.00' x 2.00' deep channel, n= 0.015 Length= 10.0' Slope= 0.0100 '/'
Side Slope Z-value= 0.5 '/'

Reach 1R: (new node)



Pond 1P: Dentention Pond

[91] Warning: Storage range exceeded by 1.29'
[58] Hint: Peaked 1.29' above defined flood level

Inflow	=	7.44 cfs @	12.18 hrs,	Volume=	0.620 af
Outflow	=	6.75 cfs @	12.24 hrs,	Volume=	0.611 af, Atten= 9%, Lag= 4.0 min
Primary	=	6.75 cfs @	12.24 hrs,	Volume=	0.611 af

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

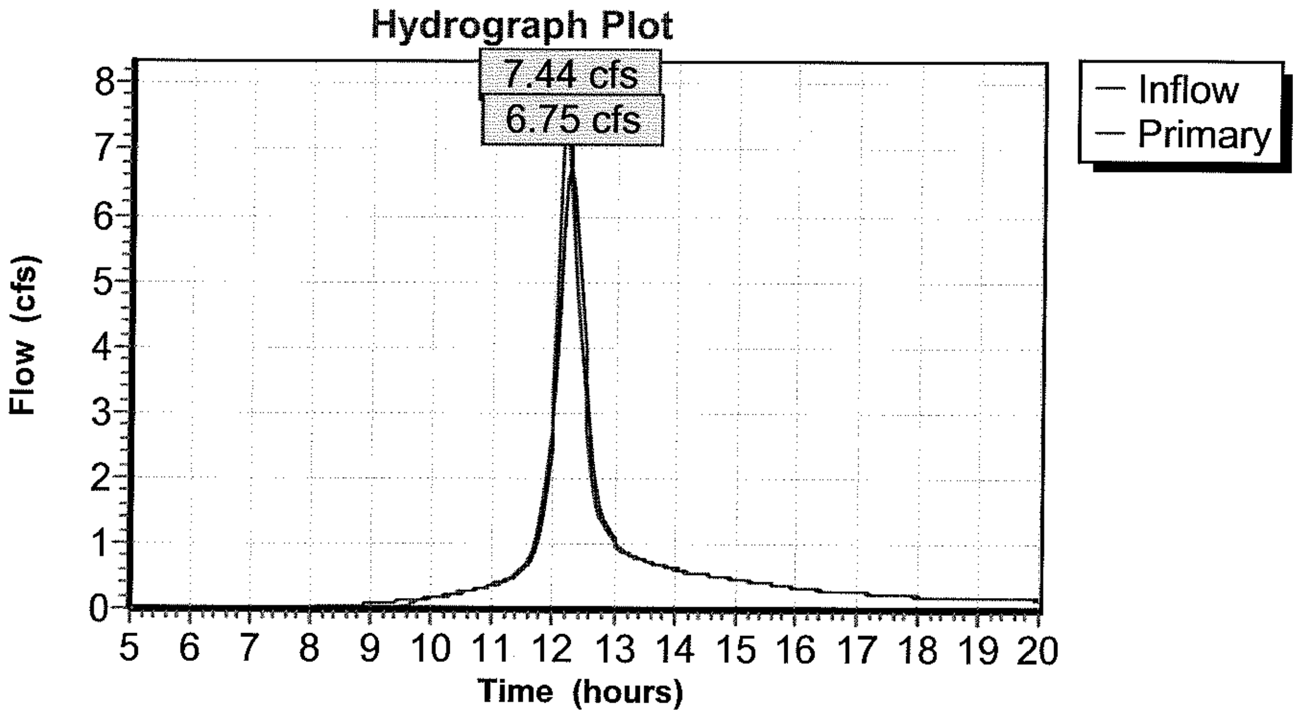
Peak Elev= 403.29' Storage= 0.042 af
Flood Elev= 402.00' Storage= 0.023 af
Plug-Flow detention time= 12.9 min calculated for 0.611 af (98% of inflow)
Storage and wetted areas determined by Prismatic sections

Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
400.00	0.000	0.000	0.000
401.00	0.014	0.007	0.007
402.00	0.017	0.016	0.023

Primary OutFlow (Free Discharge)
↑—1=Culvert

#	Routing	Invert	Outlet Devices
1	Primary	401.00'	**12.0" x 50.0' long Culvert** Ke= 0.200 Outlet Invert= 400.00' S= 0.0200 '/' n= 0.015 Cc= 0.900

Pond 1P: Dentention Pond



Pond 2P: (new node)

[91] Warning: Storage range exceeded by 0.28'
[58] Hint: Peaked 0.28' above defined flood level

Inflow	=	7.44 cfs @	12.18 hrs,	Volume=	0.620 af
Outflow	=	7.36 cfs @	12.20 hrs,	Volume=	0.611 af, Atten= 1%, Lag= 1.6 min
Primary	=	7.36 cfs @	12.20 hrs,	Volume=	0.611 af

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

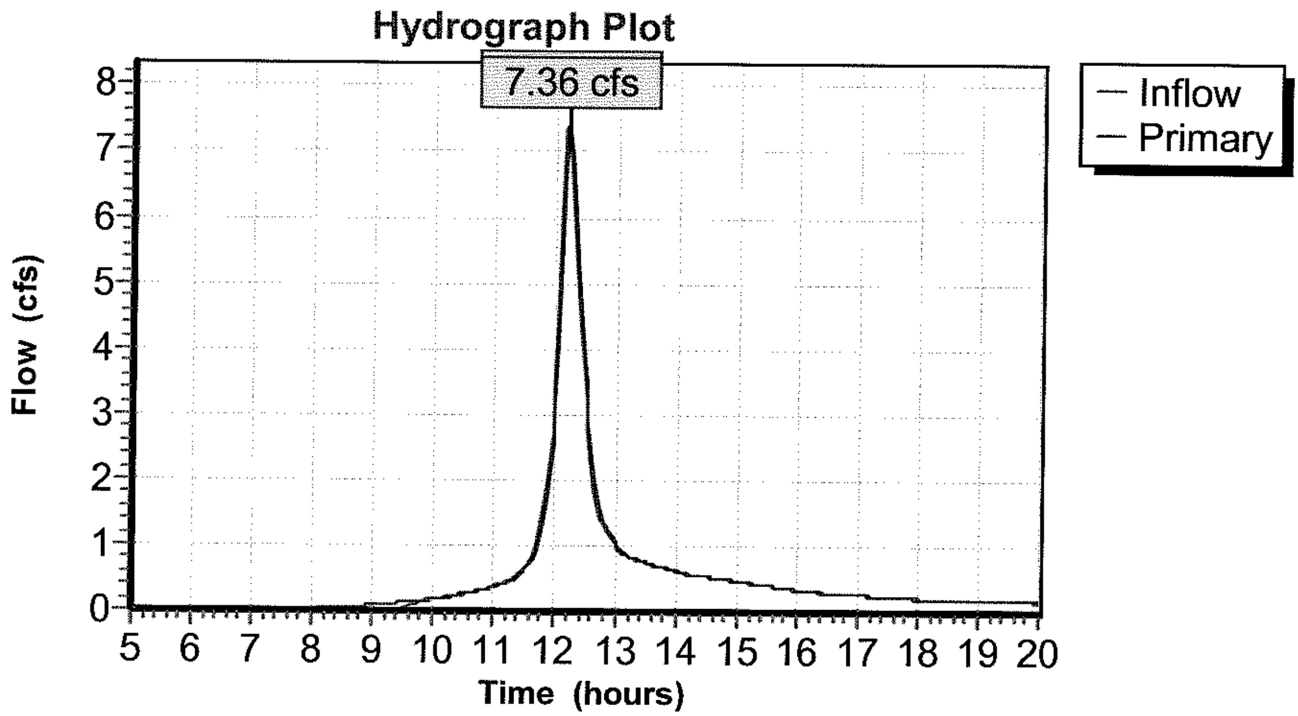
Peak Elev= 402.28' Storage= 0.027 af
Flood Elev= 402.00' Storage= 0.023 af
Plug-Flow detention time= 11.8 min calculated for 0.609 af (98% of inflow)
Storage and wetted areas determined by Prismatic sections

Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
400.00	0.000	0.000	0.000
401.00	0.014	0.007	0.007
402.00	0.017	0.016	0.023

Primary OutFlow (Free Discharge)
└─1=Culvert

#	Routing	Invert	Outlet Devices
1	Primary	401.00'	**18.0" x 50.0' long Culvert** Ke= 0.200 Outlet Invert= 400.00' S= 0.0200 '/' n= 0.015 Cc= 0.900

Pond 2P: (new node)



Pond Bypass: Bypass

[88] Warning: Qout>Qin may require Finer Routing>1

Inflow =	7.44 cfs @	12.18 hrs,	Volume=	0.620 af
Outflow =	7.44 cfs @	12.18 hrs,	Volume=	0.620 af, Atten= 0%, Lag= 0.0 min
Primary =	3.28 cfs @	12.18 hrs,	Volume=	0.522 af
Secondary =	4.16 cfs @	12.18 hrs,	Volume=	0.098 af

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

Peak Elev= 397.47' Storage= 19 cf
Flood Elev= 403.00' Storage= 91 cf
Plug-Flow detention time= 0.1 min calculated for 0.620 af (100% of inflow)
Storage and wetted areas determined by Conic sections

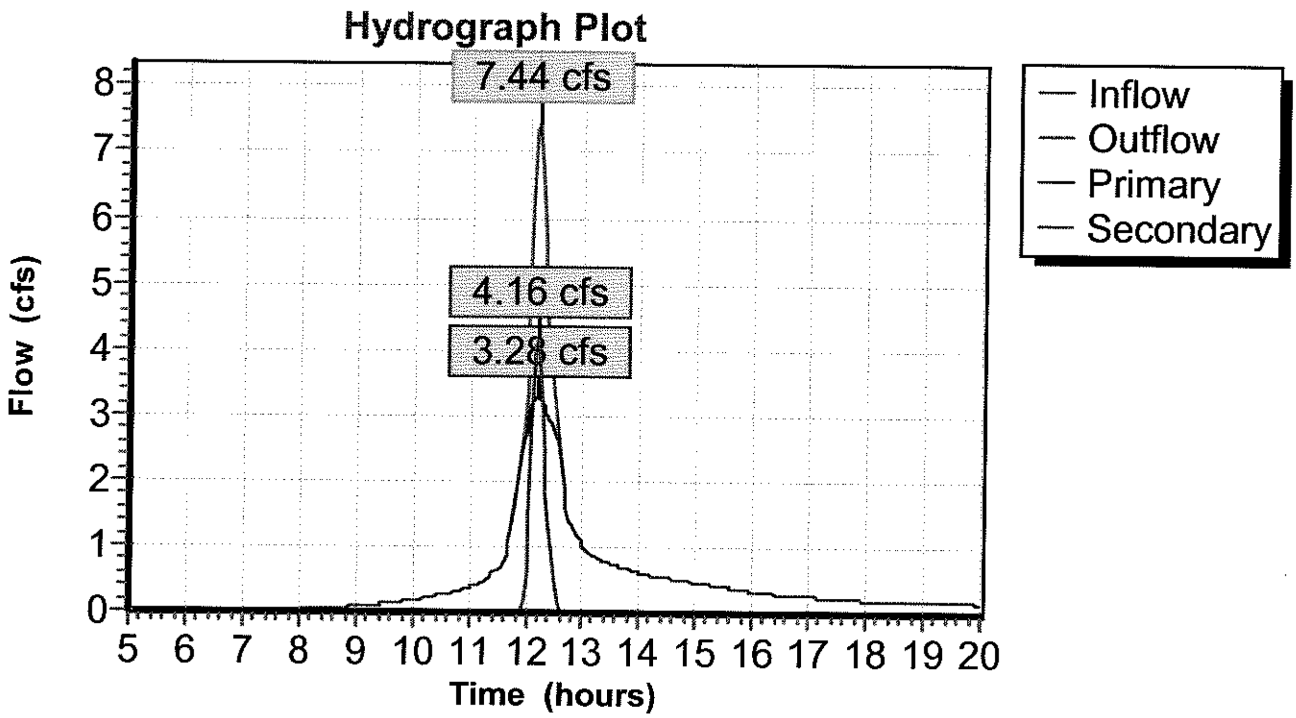
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
396.00	13	0	0	13
398.00	13	26	26	39
400.00	13	26	52	64
401.00	13	13	65	77
402.00	13	13	78	90

Primary OutFlow (Free Discharge)
↑—2=Culvert

Secondary OutFlow (Free Discharge)
↑—1=Sharp-Crested Rectangular Weir

#	Routing	Invert	Outlet Devices
1	Secondary	397.00'	**4.0' long x 3.0' high Sharp-Crested Rectangular Weir** 2 End Contraction(s)
2	Primary	396.00'	**10.0" x 50.0' long Culvert** RCP, groove end projecting, Ke= 0.200 Outlet Invert= 395.00' S= 0.0200 '/' n= 0.012 Cc= 0.900

Pond Bypass: Bypass



Pond sed basin: sed basin

[58] Hint: Peaked 0.96' above defined flood level
[80] Warning: Exceeded Pond Bypass by 5.99' @ 18.10 hrs (6.29 cfs)

Inflow	=	3.28 cfs @	12.18 hrs,	Volume=	0.522 af
Outflow	=	3.24 cfs @	12.23 hrs,	Volume=	0.508 af, Atten= 1%, Lag= 3.4 min
Primary	=	3.24 cfs @	12.23 hrs,	Volume=	0.508 af

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

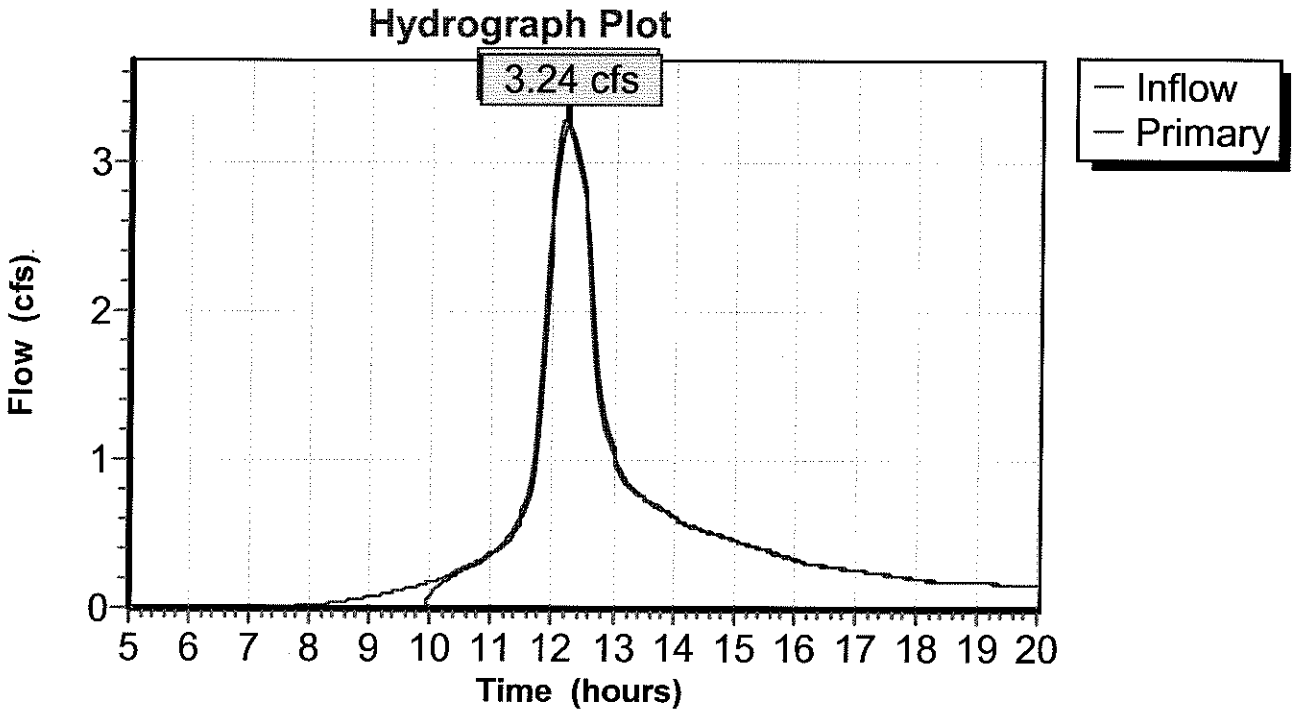
Peak Elev= 402.96' Storage= 0.027 af
Flood Elev= 402.00' Storage= 0.012 af
Plug-Flow detention time= 20.1 min calculated for 0.508 af (97% of inflow)
Storage and wetted areas determined by Conic sections

Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)	Wet.Area (acres)
401.00	0.010	0.000	0.000	0.010
402.00	0.014	0.012	0.012	0.014
403.00	0.017	0.015	0.027	0.018

Primary OutFlow (Free Discharge)
↑—1=Culvert

#	Routing	Invert	Outlet Devices
1	Primary	401.00'	**12.0" x 50.0' long Culvert** Ke= 0.200 Outlet Invert= 402.00' S= -0.0200 '/' n= 0.015 Cc= 0.900

Pond sed basin: sed basin



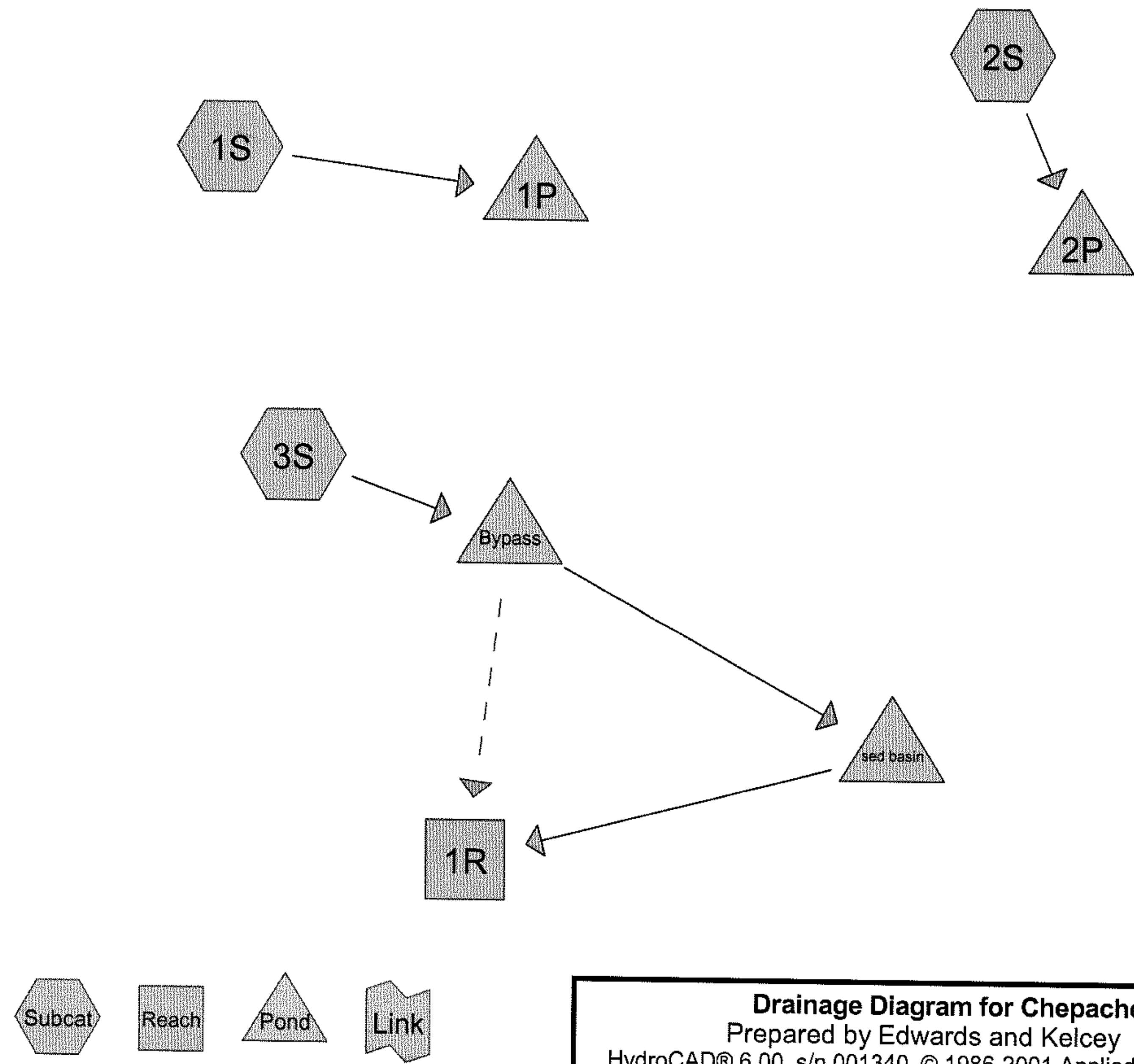
APPENDIX "E"

STORMWATER COMPUTATIONS

for

100 Year Storm Frequency

100 year



Drainage Diagram for Chepachet Village

Prepared by Edwards and Kelcey 8/24/04

Time span=5.00-20.00 hrs, dt=0.05 hrs, 301 points
Runoff by SCS TR-20 method, UH=SCS, Type III 24-hr Rainfall=7.00"
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: Chepachet Village original
Tc=12.7 min CN=79 Area=2.400 ac Runoff= 10.26 cfs 0.859 af

Subcatchment 2S: 1.5" rainfall
Tc=12.7 min CN=79 Area=2.400 ac Runoff= 10.26 cfs 0.859 af

Subcatchment 3S: with structure
Tc=12.7 min CN=79 Area=2.400 ac Runoff= 10.26 cfs 0.859 af

Reach 1R: (new node) Inflow= 10.11 cfs 0.844 af
Length= 10.0' Max Vel= 6.0 fps Capacity= 56.51 cfs Outflow= 10.10 cfs 0.844 af

Pond 1P: Dentention Pond Peak Storage= 0.057 af Inflow= 10.26 cfs 0.859 af
Primary= 9.25 cfs 0.849 af Outflow= 9.25 cfs 0.849 af

Pond 2P: (new node) Peak Storage= 0.032 af Inflow= 10.26 cfs 0.859 af
Primary= 10.09 cfs 0.849 af Outflow= 10.09 cfs 0.849 af

Pond Bypass: Bypass Peak Storage= 21 cf Inflow= 10.26 cfs 0.859 af
Primary= 3.46 cfs 0.672 af Secondary= 6.80 cfs 0.187 af Outflow= 10.26 cfs 0.859 af

Pond sed basin: sed basin Peak Storage= 0.028 af Inflow= 3.46 cfs 0.672 af
Primary= 3.40 cfs 0.657 af Outflow= 3.40 cfs 0.657 af

Runoff Area = 7.200 ac Volume = 2.577 af Average Depth = 4.30"

Subcatchment 1S: Chepachet Village original

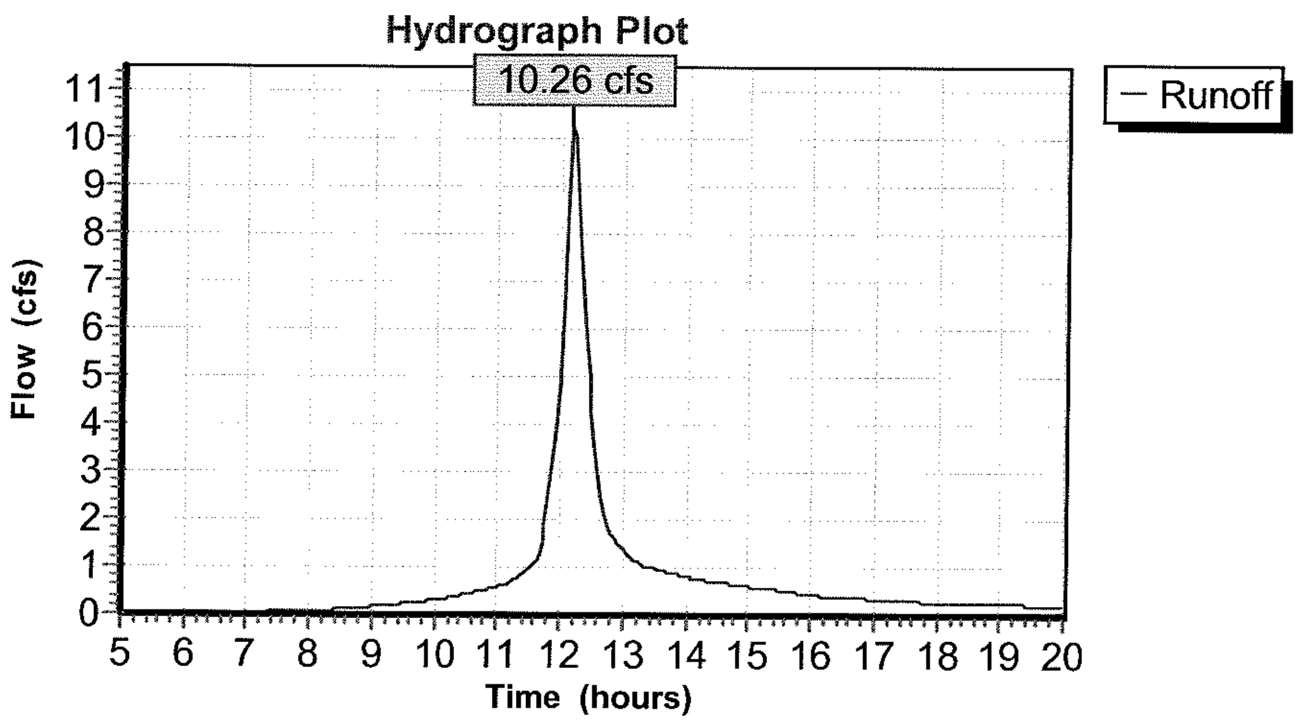
Runoff = 10.26 cfs @ 12.17 hrs, Volume= 0.859 af

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr Rainfall=7.00"

Area (ac)	CN	Description
1.180	83	1/8 acre lots, 65% imp, HSG C
1.220	75	1/8 acre lots, 65% imp, HSG B
2.400	79	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.7	100	0.0100	0.1		**Sheet Flow, Sheet Flow** Grass: Short n= 0.150 P2= 3.30"

Subcatchment 1S: Chepachet Village original



Subcatchment 2S: 1.5" rainfall

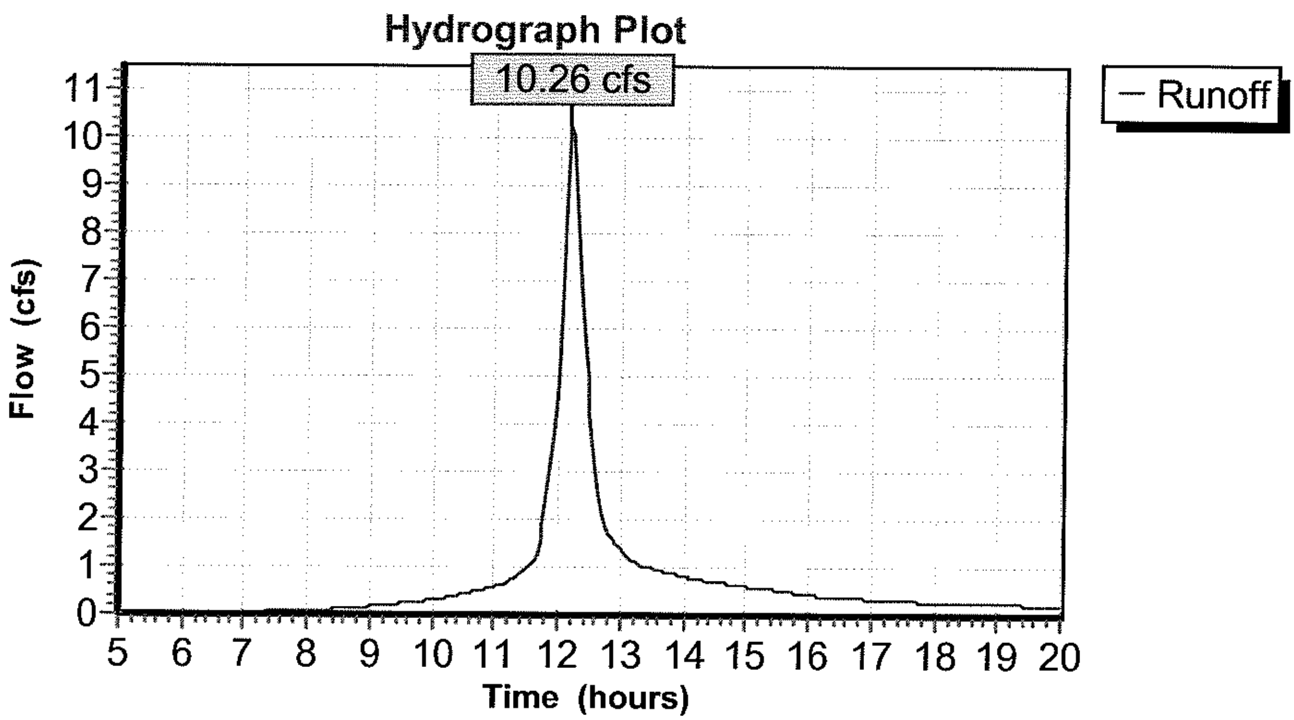
Runoff = 10.26 cfs @ 12.17 hrs, Volume= 0.859 af

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr Rainfall=7.00"

Area (ac)	CN	Description
1.180	83	1/8 acre lots, 65% imp, HSG C
1.220	75	1/8 acre lots, 65% imp, HSG B
2.400	79	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.7	100	0.0100	0.1		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.30"

Subcatchment 2S: 1.5" rainfall



Subcatchment 3S: with structure

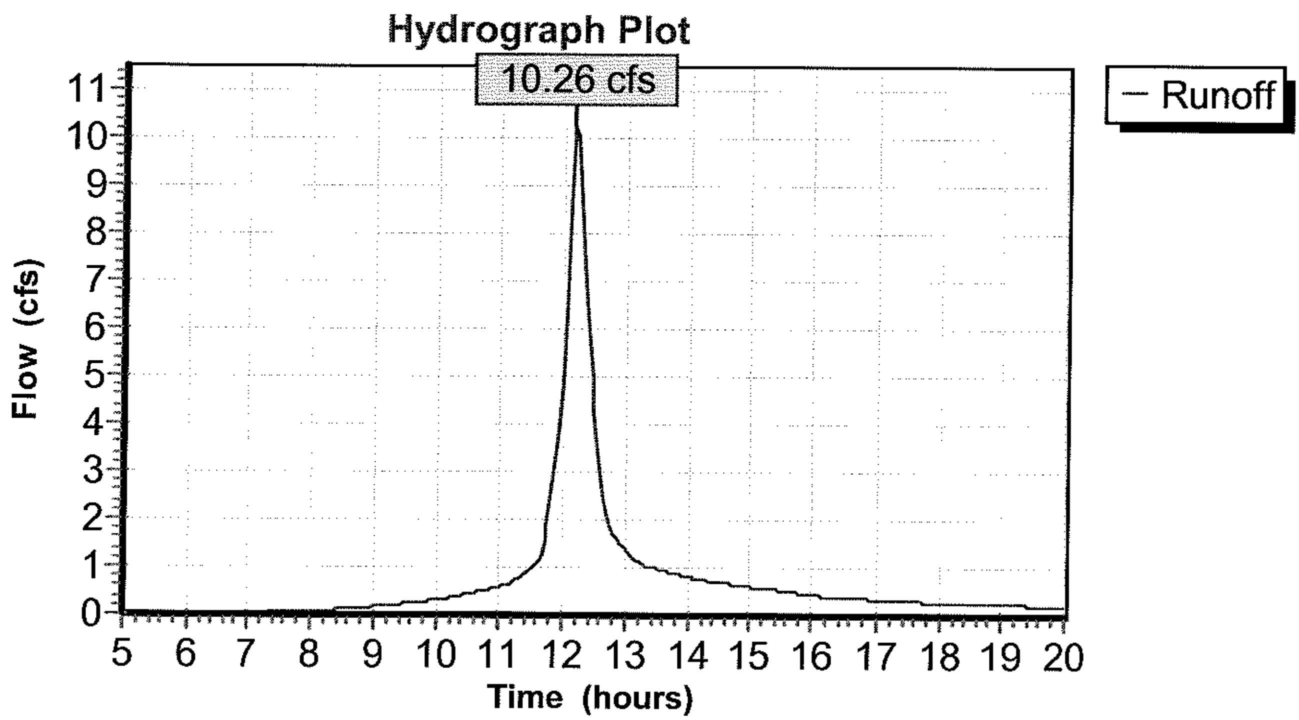
Runoff = 10.26 cfs @ 12.17 hrs, Volume= 0.859 af

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr Rainfall=7.00"

Area (ac)	CN	Description
1.180	83	1/8 acre lots, 65% imp, HSG C
1.220	75	1/8 acre lots, 65% imp, HSG B
2.400	79	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.7	100	0.0100	0.1		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.30"

Subcatchment 3S: with structure



Reach 1R: (new node)

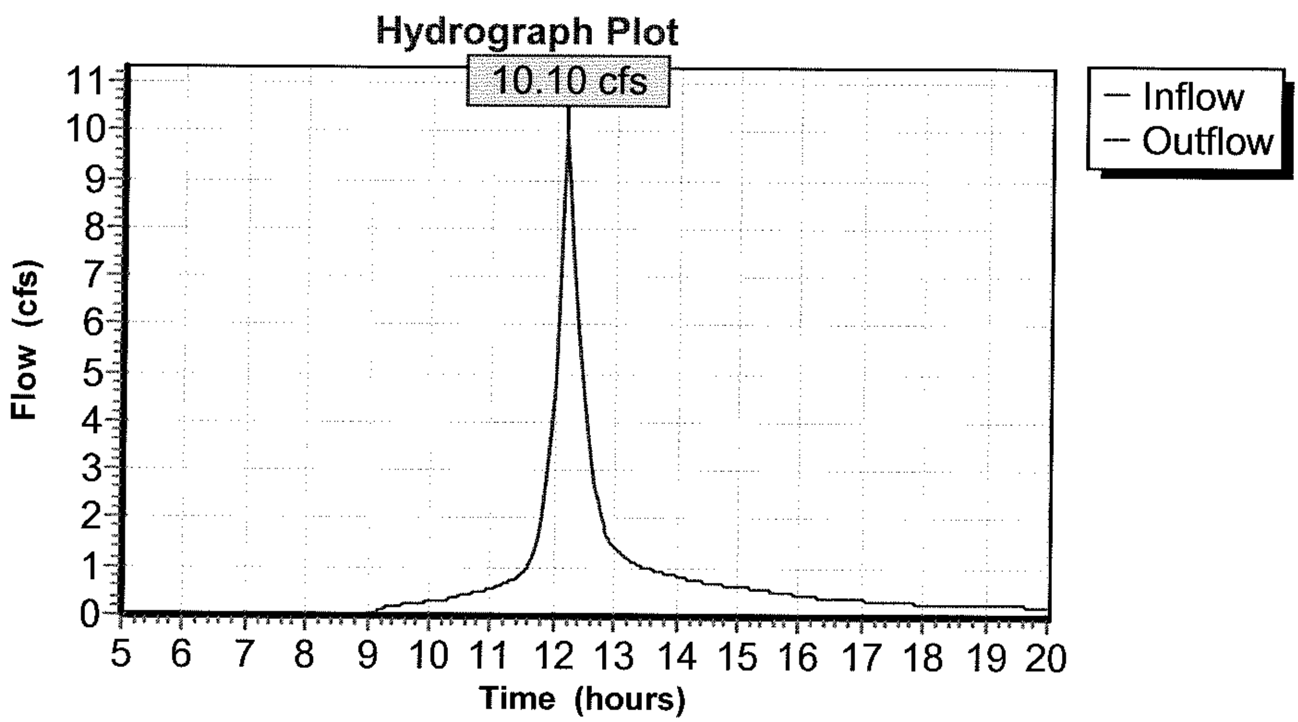
[80] Warning: Exceeded Pond Bypass by 6.00' @ 5.00 hrs (132.04 cfs)
[79] Warning: Submerged Pond sed basin Primary device # 1 by 0.71'

Inflow	=	10.11 cfs @	12.18 hrs, Volume=	0.844 af
Outflow	=	10.10 cfs @	12.18 hrs, Volume=	0.844 af, Atten= 0%, Lag= 0.1 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 6.0 fps, Min. Travel Time= 0.0 min
Avg. Velocity = 2.3 fps, Avg. Travel Time= 0.1 min

Peak Depth= 0.72'
Capacity at bank full= 56.51 cfs
Inlet Invert= 402.00', Outlet Invert= 401.90'
2.00' x 2.00' deep channel, n= 0.015 Length= 10.0' Slope= 0.0100 '/'
Side Slope Z-value= 0.5 '/'

Reach 1R: (new node)



Pond 1P: Dentention Pond

[91] Warning: Storage range exceeded by 2.23'
[58] Hint: Peaked 2.23' above defined flood level

Inflow	=	10.26 cfs @	12.17 hrs,	Volume=	0.859 af
Outflow	=	9.25 cfs @	12.24 hrs,	Volume=	0.849 af, Atten= 10%, Lag= 4.0 min
Primary	=	9.25 cfs @	12.24 hrs,	Volume=	0.849 af

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

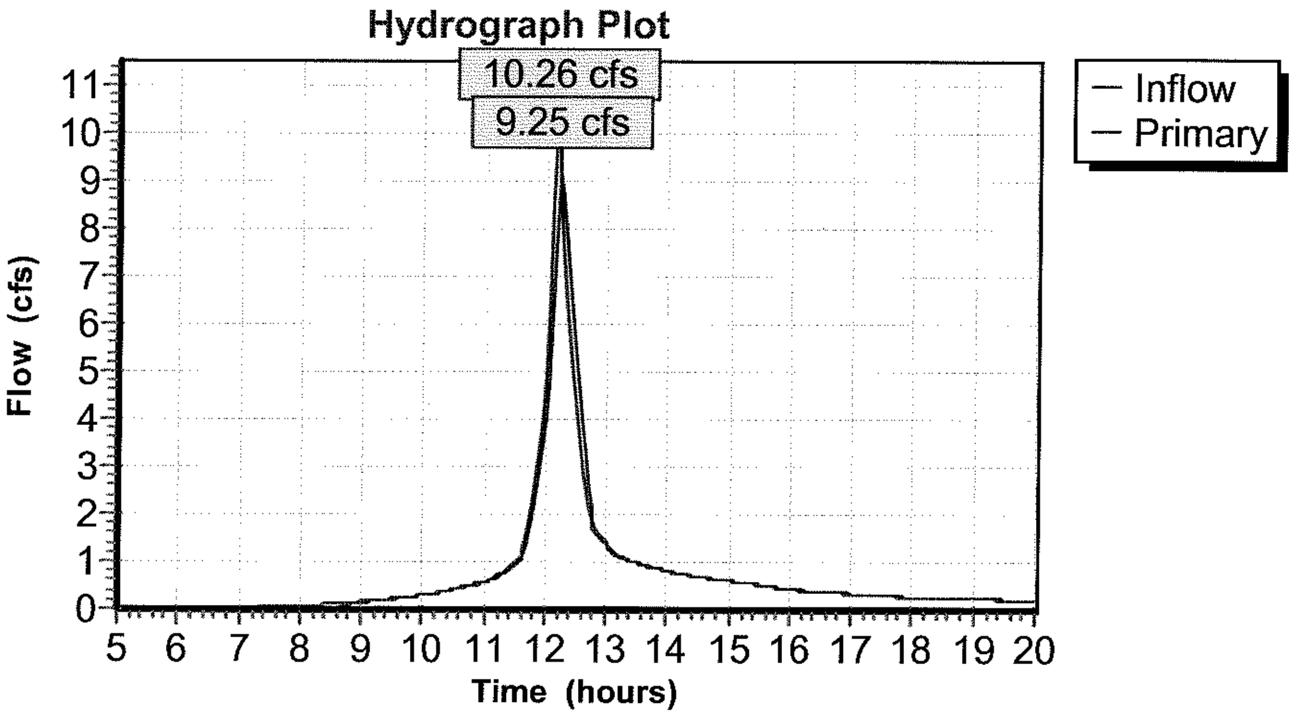
Peak Elev= 404.23' Storage= 0.057 af
Flood Elev= 402.00' Storage= 0.023 af
Plug-Flow detention time= 11.0 min calculated for 0.849 af (99% of inflow)
Storage and wetted areas determined by Prismatic sections

Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
400.00	0.000	0.000	0.000
401.00	0.014	0.007	0.007
402.00	0.017	0.016	0.023

Primary OutFlow (Free Discharge)
↑—1=Culvert

#	Routing	Invert	Outlet Devices
1	Primary	401.00'	**12.0" x 50.0' long Culvert** Ke= 0.200 Outlet Invert= 400.00' S= 0.0200 '/' n= 0.015 Cc= 0.900

Pond 1P: Dentention Pond



Pond 2P: (new node)

[91] Warning: Storage range exceeded by 0.62'
[58] Hint: Peaked 0.62' above defined flood level

Inflow	=	10.26 cfs @	12.17 hrs,	Volume=	0.859 af
Outflow	=	10.09 cfs @	12.20 hrs,	Volume=	0.849 af, Atten= 2%, Lag= 1.6 min
Primary	=	10.09 cfs @	12.20 hrs,	Volume=	0.849 af

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

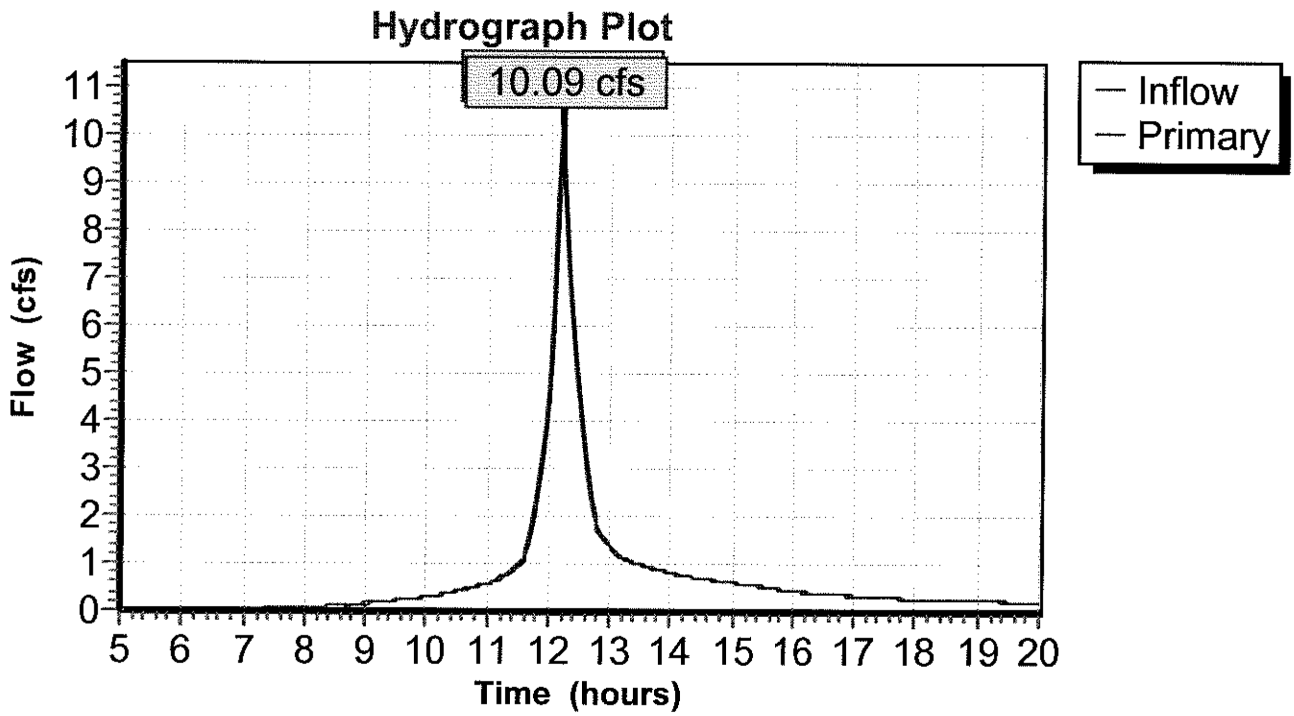
Peak Elev= 402.62' Storage= 0.032 af
Flood Elev= 402.00' Storage= 0.023 af
Plug-Flow detention time= 9.7 min calculated for 0.846 af (99% of inflow)
Storage and wetted areas determined by Prismatic sections

Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
400.00	0.000	0.000	0.000
401.00	0.014	0.007	0.007
402.00	0.017	0.016	0.023

Primary OutFlow (Free Discharge)
↑—1=Culvert

#	Routing	Invert	Outlet Devices
1	Primary	401.00'	**18.0" x 50.0' long Culvert** Ke= 0.200 Outlet Invert= 400.00' S= 0.0200 '/' n= 0.015 Cc= 0.900

Pond 2P: (new node)



Pond Bypass: Bypass

[88] Warning: Qout>Qin may require Finer Routing>1

Inflow	=	10.26 cfs @	12.17 hrs, Volume=	0.859 af	
Outflow	=	10.26 cfs @	12.17 hrs, Volume=	0.859 af,	Atten= 0%, Lag= 0.0 min
Primary	=	3.46 cfs @	12.17 hrs, Volume=	0.672 af	
Secondary	=	6.80 cfs @	12.17 hrs, Volume=	0.187 af	

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

Peak Elev= 397.65' Storage= 21 cf
Flood Elev= 403.00' Storage= 91 cf
Plug-Flow detention time= 0.1 min calculated for 0.859 af (100% of inflow)
Storage and wetted areas determined by Conic sections

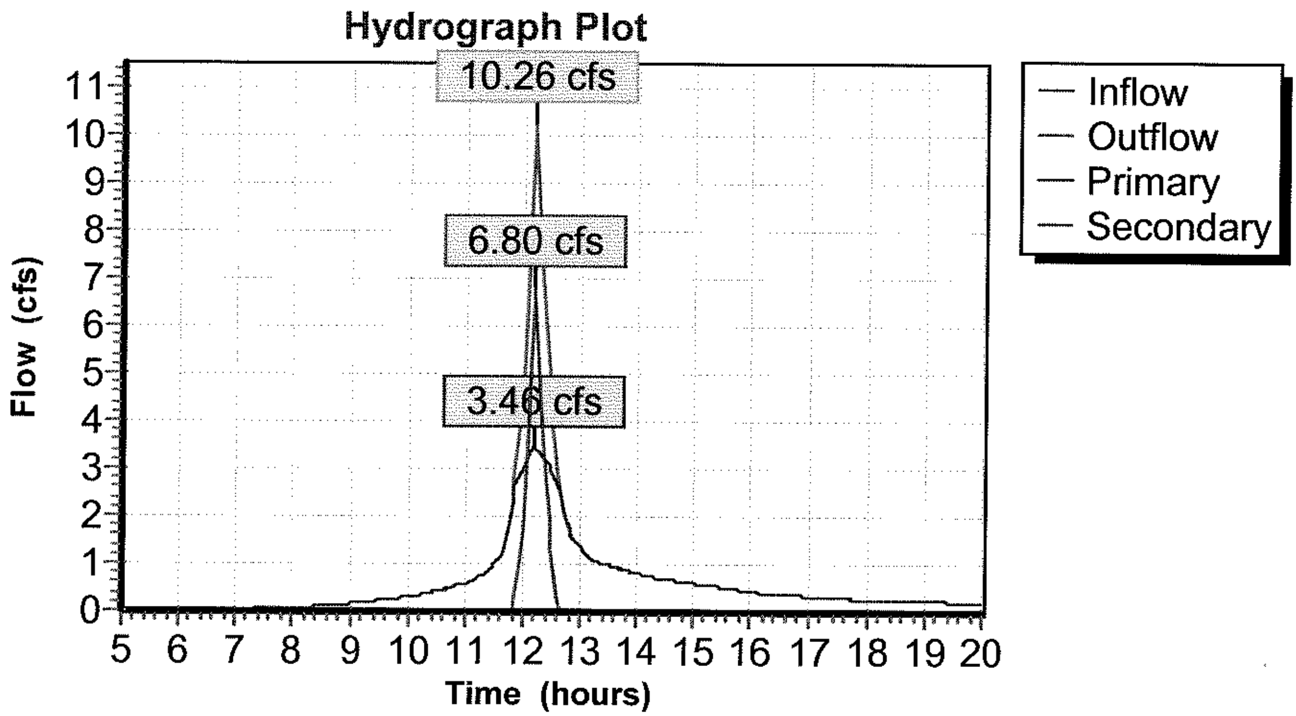
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
396.00	13	0	0	13
398.00	13	26	26	39
400.00	13	26	52	64
401.00	13	13	65	77
402.00	13	13	78	90

Primary OutFlow (Free Discharge)
↑—2=Culvert

Secondary OutFlow (Free Discharge)
↑—1=Sharp-Crested Rectangular Weir

#	Routing	Invert	Outlet Devices
1	Secondary	397.00'	**4.0' long x 3.0' high Sharp-Crested Rectangular Weir** 2 End Contraction(s)
2	Primary	396.00'	**10.0" x 50.0' long Culvert** RCP, groove end projecting, Ke= 0.200 Outlet Invert= 395.00' S= 0.0200 '/' n= 0.012 Cc= 0.900

Pond Bypass: Bypass



Pond sed basin: sed basin

[91] Warning: Storage range exceeded by 0.02'
[58] Hint: Peaked 1.02' above defined flood level
[80] Warning: Exceeded Pond Bypass by 5.99' @ 19.95 hrs (6.29 cfs)

Inflow = 3.46 cfs @ 12.17 hrs, Volume= 0.672 af
Outflow = 3.40 cfs @ 12.24 hrs, Volume= 0.657 af, Atten= 2%, Lag= 4.0 min
Primary = 3.40 cfs @ 12.24 hrs, Volume= 0.657 af

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

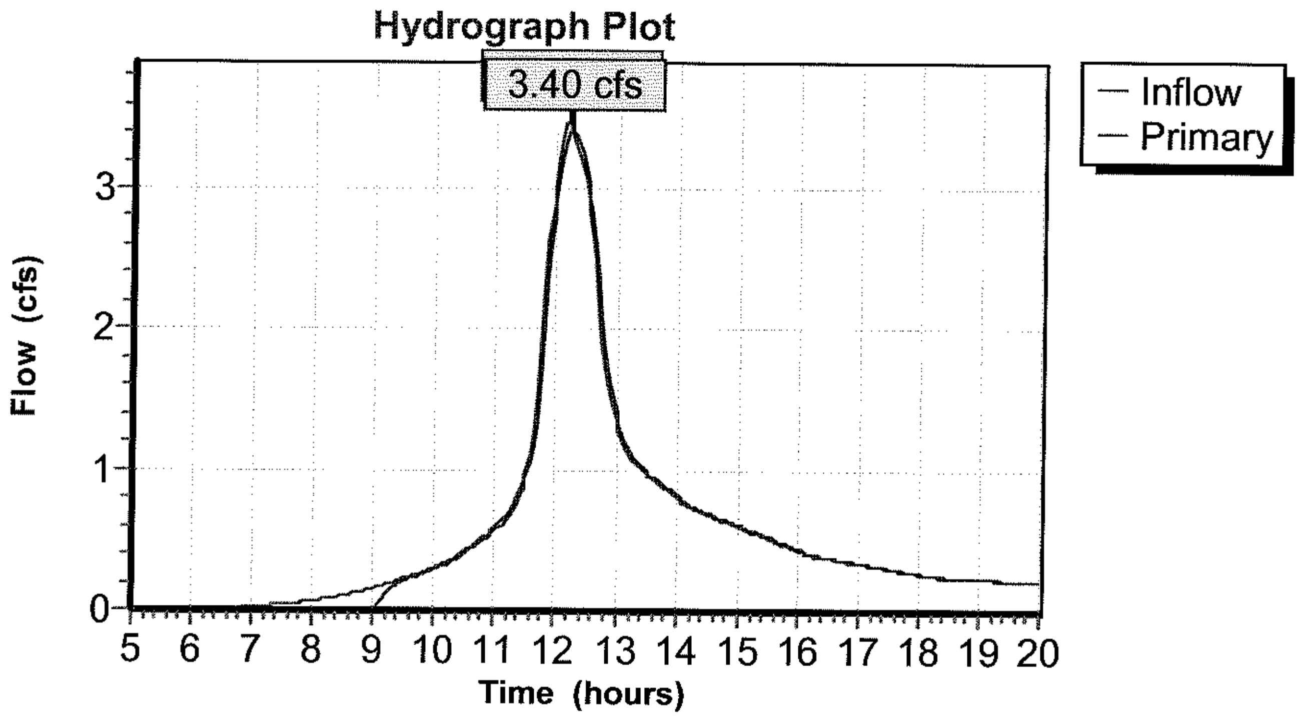
Peak Elev= 403.02' Storage= 0.028 af
Flood Elev= 402.00' Storage= 0.012 af
Plug-Flow detention time= 17.6 min calculated for 0.657 af (98% of inflow)
Storage and wetted areas determined by Conic sections

Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)	Wet.Area (acres)
401.00	0.010	0.000	0.000	0.010
402.00	0.014	0.012	0.012	0.014
403.00	0.017	0.015	0.027	0.018

Primary OutFlow (Free Discharge)
↑—1=Culvert

#	Routing	Invert	Outlet Devices
1	Primary	401.00'	**12.0" x 50.0' long Culvert** Ke= 0.200 Outlet Invert= 402.00' S= -0.0200 '/' n= 0.015 Cc= 0.900

Pond sed basin: sed basin



APPENDIX "F"

ADDITIONAL GROUNDWATER MONITORING DATA

MONITORING WELLS
CHEPACHET VILLAGE STORMWATER STUDY
GLOCESTER, RI

Date	Bottom (ft)	W.L. below surface (ft)	Ex. Ground Elev. (ft)	Water Table (ft)
Monitoring Well #1				
4/28/04	9.30	4.00	421.26	417.26
5/6/04	9.30	4.00	421.26	417.26
5/19/04	9.30	4.42	421.26	416.84
5/26/04	9.30	4.67	421.26	416.59
6/6/04	9.30	4.42	421.26	416.84
Average	9.30	4.30	421.26	416.96
Monitoring Well #2				
4/28/04	7.40	3.67	409.39	405.72
5/6/04	7.40	3.50	409.39	405.89
5/19/04	7.40	6.67	409.39	402.72
5/26/04	7.40	6.67	409.39	402.72
6/6/04	7.40	7.00	409.39	402.39
Average	7.40	4.61	409.39	403.89
Monitoring Well #3				
4/28/04	12.00	7.00	406.45	399.45
5/6/04	12.00	6.50	406.45	399.95
5/19/04	12.00	8.33	406.45	398.12
5/26/04	12.00	8.75	406.45	397.70
6/6/04	12.00	9.00	406.45	397.45
Average	12.00	7.28	406.45	398.53
Monitoring Well #4				
4/28/04	4.50	2.67	413.77	411.10
5/6/04	4.80	2.50	413.77	411.27
5/19/04	4.50	3.08	413.77	410.69
5/26/04	4.50	3.25	413.77	410.52
6/6/04	4.50	3.00	413.77	410.77
Average	4.58	2.90	413.77	410.87

APPENDIX "G"

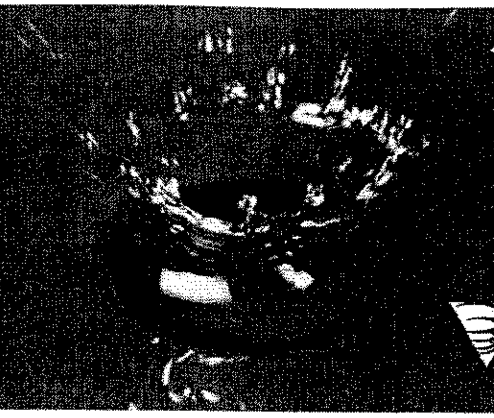
TYPICAL DETAILS

For

"VORTECHNICS" or similar BMP Structure

Vortechs® System

The proven stormwater treatment leader



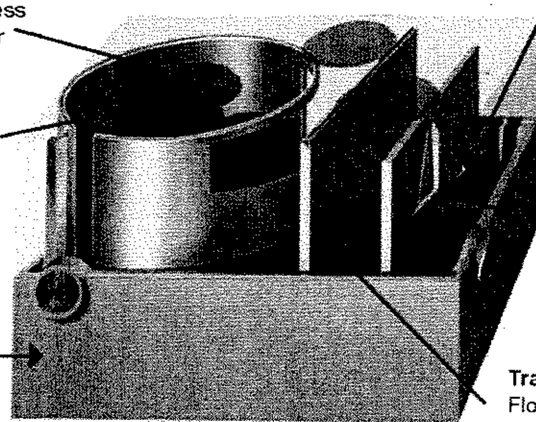
Vortechnics
A CONTECH Company

Get proven, reliable stormwater treatment every time.

The Vortechs® System is the proven stormwater solution chosen by engineers, contractors, regulators, developers and conservation organizations to meet water quality challenges and to ensure that urban runoff is as clean as possible.

The EPA award-winning design efficiently removes contaminated sediment, floating hydrocarbons, and debris from stormwater. The Vortechs® System's swirl-concentrator and flow controls work together to eliminate turbulence and to provide positive removal efficiencies throughout the full range of operation. With the most comprehensive lab, field and third party testing in the industry, the Vortechs® System delivers proven results and site-specific solutions for all applications and rainfall conditions.

Vortechs® System Features and Benefits



Best standalone treatment technology on the market.

The pollutants targeted by most stormwater regulations are sediment, hydrocarbons and debris. While other technologies are useful in removing some of these pollutants, the Vortechs® System is the best standalone solution for addressing all of the target pollutants. Other technologies have inherent design limitations that can compromise treatment efficiency, diminish flow rate capacity and/or obstruct maintenance access. For more than 15 years, Vortechs® Systems have proven their versatility and adaptability on more than 4,500 successful installations.

Advantages of the Vortechs® System

- **Treats Full Range of Flows**
- **Easy Maintenance**
- **Meets Treatment Needs of Commercial, Residential and Municipal Sites**
- **Shallow System Profile**
- **Customizable Design**
- **Optimizes Surface Use of Real Estate on High Value Sites**
- **Easy Installation**
- **20-Year Warranty**
- **Performance Verified Through Lab, Field and Third-Party Testing**

Learn More! Call 877.907.8676 or visit us at www.vortechnics.com

Committed to Clean Water™

Vortechs® System: a System Sized for Every Application

When you specify a Vortechs® System, the Vortechnics team will customize the design to fit your site's unique parameters and provide you with an effective, cost-efficient solution.

Each Vortechs® System is custom designed based on:

- » Removal Efficiency Goals
- » Drainage Area
- » Regional Rainfall Intensity Distribution
- » Design Flow
- » Site Runoff Coefficient and Time of Concentration
- » Anticipated Pollutant Characteristics

Vortechs® System Sizing Methodology: the Rational Rainfall Method™

Differences in local climate and topography make every site unique, so it is important to take these factors into consideration when choosing a stormwater treatment system. Therefore Vortechnics developed the Rational Rainfall Method™ to accurately design each Vortechs® System. The sizing methodology combines site-specific information, including local historical precipitation records, with laboratory-generated performance data corroborated by third party field studies, ensuring accurate long-term performance.

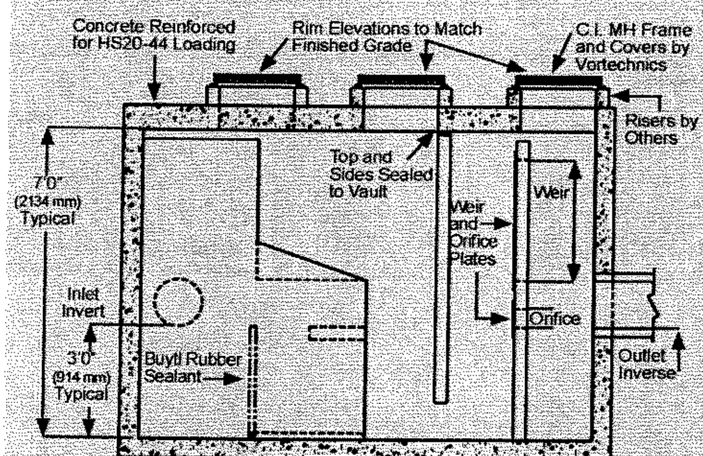
Short duration rain gauge records from across the United States and Canada were analyzed by Vortechnics to determine the percent of the total annual rainfall that fell at a range of intensities. One trend was consistent at all sites: the vast majority of precipitation fell at low intensities and high intensity storms contributed relatively little to the total annual depth.

These intensities, along with the total drainage area and runoff coefficient for a specific site, are translated into flow rates using the Rational Rainfall Method™. Based on the flow rates calculated for each intensity, an operating rate within a proposed Vortechs® System is determined. Finally, a removal efficiency is selected for each operating rate based on anticipated pollutant characteristics and on full-scale laboratory tests. The relative removal efficiencies at each operating rate are summed to produce a net annual pollutant removal efficiency estimate.

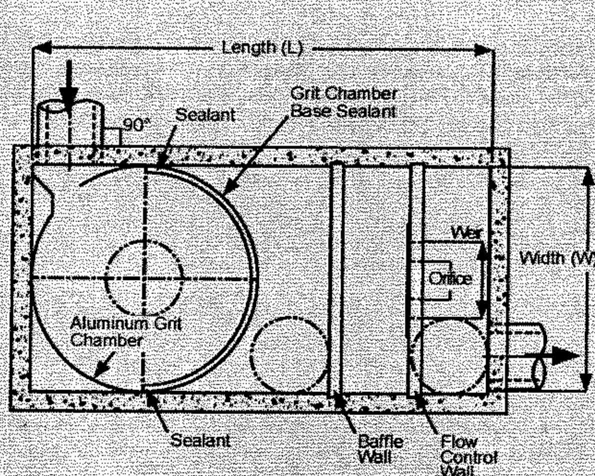
Vortechnics typically selects a system size that will provide an 80 percent annual total suspended solids (TSS) load reduction based on laboratory-generated performance curves for 50-micron sediment particles, however the Rational Rainfall Method™ can accommodate other removal efficiencies or particle sizes. It can also be used to estimate annual hydrocarbon load reductions.

Once a system size is established, the internal elements of the system are designed based on information provided by the site engineer. Flow control sizes and shapes, sump depth, spill storage capacity, sediment storage volume and inlet and outlet orientation are determined for each system. In addition, bypass weir calculations are made for offline systems.

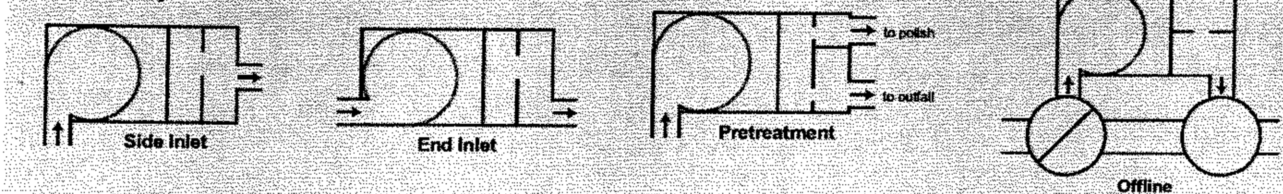
Typical Vortechs® System Elevation View



Typical Vortechs® System Plan View



Vortechs® System Orientations



Specifying a Vortechs® System

Nine precast models are available to treat flow rates from 1.6 cfs to 25 cfs. Sites that generate larger flows can be treated using cast-in-place systems. Vortechs® Systems can be configured in both online and offline orientations depending on water quality objectives and site constraints. They can also be designed to accommodate various inlet and outlet pipe orientations. To provide a tangential inlet to the grit chamber, the inlet pipe must enter at a corner and at a 90 degree angle to the inlet wall. Outlet pipes can exit the end or the side of the system at most angles.

Standard Vortechs® System models, peak treatment flow rates, and dimensions are listed below. For assistance with a detailed design, please fill out our Specifier's Worksheet, which is available online at www.vortechnics.com or by calling 877.907.8676. In most cases a site plan will be required for Vortechnics® to complete the design process.

Vortechs® Model	Grit Chamber Diameter		Peak Treatment Flow		Approximate Size	
	ft	mm	cfs	l/s	ft	mm
1000	3	900	1.6	45	9 x 3	2700 x 900
2000	4	1200	2.8	80	10 x 4	3100 x 1200
3000	5	1500	4.5	130	11 x 5	3400 x 1500
4000	6	1800	6.0	170	12 x 6	3700 x 1800
5000	7	2100	8.5	240	13 x 7	4000 x 2100
7000	8	2400	11	310	14 x 8	4300 x 2400
9000	9	2700	14	400	15 x 9	4600 x 2700
11000	10	3000	17.5	500	16 x 10	4900 x 3000
16000	12	3700	25	710	18 x 12	5500 x 3700

Engineering Notes

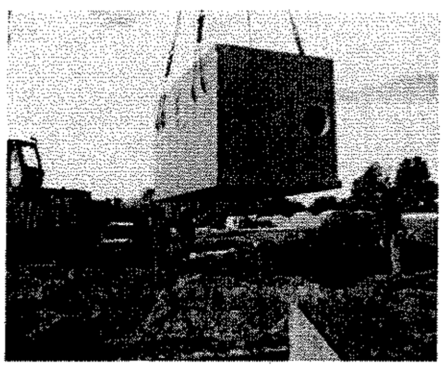
- For online Vortechs® Systems without a bypass, sizing criteria is based on providing one square foot of grit chamber surface area for each 100 gpm of peak treatment storm flow rate. For more details about Vortechnics sizing criteria refer to Vortechnics Technical Bulletin 3 available at www.vortechnics.com.
- The sizing information above is representative of typical Vortechs® Systems. Construction details may vary depending on the specific application. Any alterations to the sizing chart specifications will appear on Vortechnics dimensional and shop drawings. Contact Vortechnics for the weight of a specific Vortechs® System.
- Treatment flow rates greater than 25 cfs can be accommodated using Vortechs® Systems that are constructed on-site using cast-in-place concrete structures. Contact Vortechnics for details.

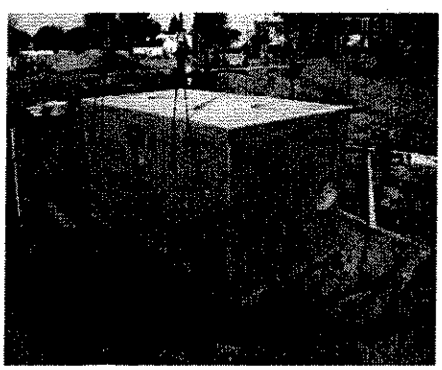
Installing a Vortechs® System

The Vortechnics team's superior technical support and customer service continues throughout the bidding process and installation of every Vortechs® System.

The Vortechs® System is the only hydrodynamic separator in the industry with a horizontal design. This unique shallow profile can greatly reduce overall project costs, saving both time and money during installation. Because the Vortechs® System requires no on-site assembly, and a Vortechnics representative is always on-site during installation, most Vortechs® System installations are completed in under two hours.

Vortechnics has set the industry standard with its emphasis on research and development, customization and ease of installation and maintenance. Vortechnics has installed thousands of systems throughout the U.S. and Canada, ensuring that millions of people are able to enjoy the benefits of cleaner, safer water.





Vortechs® System

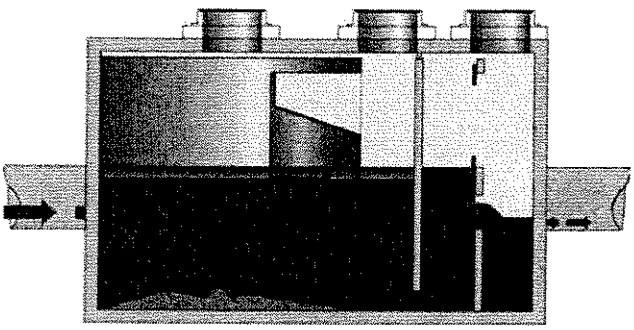
The proven stormwater treatment leader

Vortechnics
A CONTECH Company

Vortechs® System Operation

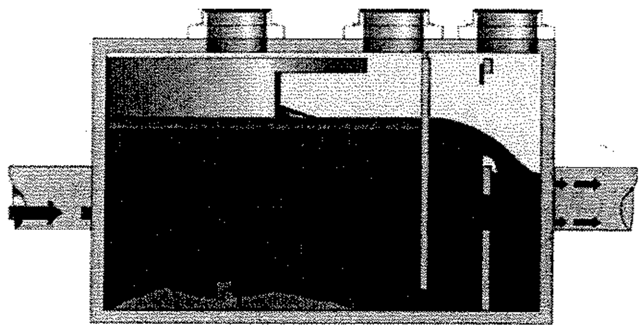
Visit www.vortechnics.com to see an animated Vortechs® System in action!

Low Intensity Storm



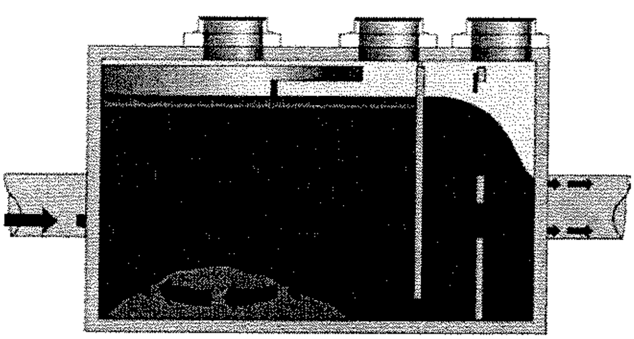
Most storm events (85 percent) do not exceed the two-month storm intensity. During this low intensity storm flow, the water level within the Vortechs® System will rise above the top of the inlet pipe, reducing inflow velocity and turbulence. Oil and fine sediments are usually washed off paved surfaces during these events, and the Vortechs® System treatment efficiencies are in the 80 to 90 percent range for typical urban runoff sediment.

Medium Intensity Storm



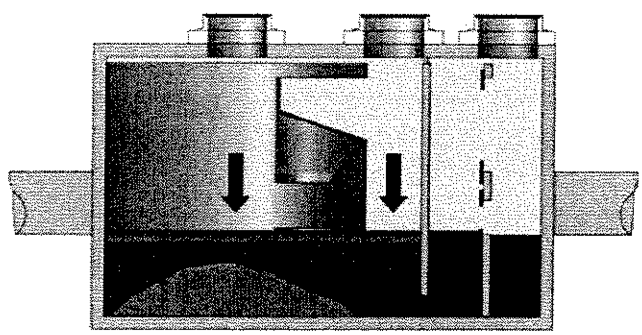
During a medium intensity storm, which occurs with a frequency of one to two years, remaining oil washes off pavement, and larger sediment particles and debris are now transported into the Vortechs® System. As flow increases, the water level rises above the low flow control and the tank begins to fill. With the inlet submerged, the oily layer is above the influent flow path, preventing re-entrainment of floating pollutants. Swirling action increases at this stage, which increases sediment removal rates.

High Intensity Storm



High intensity storms are infrequent, and storm flows have sufficient energy to wash off the largest sediment particles and pieces of debris. When the high flow control approaches full discharge within the Vortechs® System, storm drains are flowing at peak capacity. The Vortechs® System can accommodate flows up to the specified design storm (i.e. 10-year storm). Treatment efficiencies remain constant during this phase.

Storm Subsidence



Treated runoff is decanted out of the Vortechs® System at a controlled rate, restoring the water level to a low, dry-weather volume. This reveals a conical pile of accumulated sediment in the center of the grit chamber. Besides facilitating inspection and cleaning, the low water level significantly reduces maintenance costs by reducing pump-out volume.

Learn More! Call 877.907.8676 or visit us at www.vortechnics.com

Committed to Clean Water™

APPENDIX "H"

RELATION TO COMPREHENSIVE PLAN

APPENDIX "H"
RELATIONSHIP TO COMPREHENSIVE PLAN

H.1 The Town of Glocester Comprehensive Community Plan (The Plan) was originally adopted in 1994, was readopted as amended in 2001, and was approved by the R..I. Dept. of Administration, Division of Planning in December, 2001. The revised Plan also recognizes and incorporates by reference two important planning initiatives that occurred since its initial 1994 adoption: to wit, the "Chepachet Village Planning Project," 1997,and the previously cited "Glocester Wastewater management Study," prepared for the Town in 1997 by Fuss & O'Neill Inc. This latter report serves as the RIDEM approved wastewater "Facility Plan" for the Town of Glocester.

H.2 Among the relevant goals, objectives and recommendations of The Plan that are particularly supportive of and consistent with the current project recommendations are the following:

- Evaluate alternatives and implement the appropriate objectives and recommendations of the Wastewater Facilities Management Plan approved by the R..I. Department of Environmental Management as they relate to natural resource protection (Nat. and Cult. Res. Element 6.4 (2) (A) 8, p.30).
- Develop groundwater and wellhead protection strategies designed to protect the groundwater that is the Town's sole source of water supply (Nat. and Cult. Res. Element 6.3 (9), p.28).
- Evaluate the alternatives and implement the appropriate objectives and recommendations as they relate to land use issues of the "Wastewater Facilities Management Plan" approved by the R.I. Department of Environmental Management (Land Use Element 3.4 (9) p.23).
- Protect potable groundwater and surface water from contamination (Serv. And Facilities Element 7.3 (3), p.32).

APPENDIX "H"

RELATION TO COMPREHENSIVE PLAN

H.3 The Plan supports the objectives of the Wastewater Facilities Management Plan in several areas of concern as noted. Among the recommendations are that "…on-site alternatives should be evaluated for suitability and feasibility, that a wastewater treatment set-aside for Glocester at the Burrillville and Smithfield Wastewater Treatment Facility Village …areas should be performed with consideration of alternative solutions" (Econ .Dev. Element 13.4, p.71). "The Town incorporates the goals and objectives of the Glocester Wastewater Management Study into the Plan by reference. Alternatives to meeting these goals and objectives deserve further evaluation…" (Econ. Dev. Element 13.4, p.71).

H.4 The above quoted recommendations are directly relevant to the Study at hand. Additional research as part of this feasibility review finds that the potential alternative of wastewater treatment for Chepachet Village or a portion thereof at the Burrillville treatment plant is not considered to be a viable alternative at this point in time. Although the Glocester Plan calls for securing a "set-aside" at the Burrillville plant, no official action has been taken to date by the Town to do so. Additionally, the Town of Burrillville has since undertaken and adopted its own Wastewater Facility Plan, also approved by the RIDEM, that does not provide for any such set-aside and alternatively reserves excess capacity for that Town's own anticipated growth.

H.5 On the other hand, mitigation of groundwater problems in the Chepachet area and the provision of wastewater treatment options presented in this current study represent an "alternative solutions" approach to resolving these groundwater and wastewater area problems at least on short-term pollution abatement terms. In fact, the Town Wastewater Facilities Plan calls for and discusses evaluation of sewage disposal alternatives (See Chapter 4, Fuss & O'Neill Report) including enhanced on-site systems, holding tanks, etc., as potential solutions to problem areas. A subsequent ongoing project of the Glocester/URI Cooperative Extension "Manage" program and Innovative Septic Design Program has been to support and assist in the installation of a least (5) advanced design individual on-site systems within Chepachet Village, and to allow for the monitoring of same for performance. These latter programs are an alternative extension of the Wastewater Facilities planning effort by the Town as is this current study and recommendation.