FEASIBILITY STUDY

REGIONAL STORM WATER MANAGEMENT FACILITY

SOUTH ROANOKE COUNTY HIGH SCHOOL SITE

ROANOKE COUNTY, VIRGINIA

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FINAL DRAFT

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I. Executive Summary

This study was prepared under the direction of the Roanoke County Engineering Department to investigate the feasibility of constructing a regional stormwater management facility on the property of the proposed South Roanoke County High School. This report examines the technical challenges and opportunities of constructing a regional facility, and identifies grant prospects for possible funding sources.

Interest in this facility was realized during the schematic design and special use permitting phase of site development. Roanoke County and School Board staff review of submitted planning documents and community input during the zoning related public hearings for the school, were the catalysts for undertaking the study effort. The regional stormwater management study prepared by Dewberry and Davis, Inc. in 1997, identified the reach of Mud Lick Creek within the boundary limits of the School site, as a potential location for placement of an impoundment. The subject facility is identified as MUD02 in the Dewberry report and is one of several possible facility locations recognized in the region as possessing favorable site characteristics for construction. All the regional impoundments within the Dewberry report were analyzed for their flood reduction potential on downstream properties and are primarily viewed as volume or water *quantity* versus pollutant removing or water *quality* facilities.

This study expands on the Dewberry report to review the inclusion of the *quality* element of design while honoring the intent of reducing downstream volumes during various frequency storm events. The *quality* aspect of a storm water management facility is one of the characteristics that may qualify a particular impoundment for grant funding through various Commonwealth and Federal programs. Three facility options have been studied for favorable *quality* and *quantity* characteristics on the subject property. Each option possesses various *quality* achieving characteristics either through stormwater retention, detention or enhanced-extended detention methods. The intent of this feasibility study is to identify practical stormwater management alternatives that meet grant funding application guidelines. In addition to funding issues, this study will help Roanoke County assess the benefit of implementing a facility design that may be the first in the area to continue regional flood reduction efforts. This facility would be in concert with various local and regional studies previously undertaken to understand the effects and impacts of a regional management program on existing flood control problems.

II. Background

The Mud Lick Creek watershed is a 9.6-square mile drainage basin located in east central Roanoke County and southeast Roanoke City. The watershed is fan shaped and has a length of about 4.5 miles and a maximum width of about 3.5 miles near its headwaters. The Mud Lick Creek basin is located entirely within Roanoke County and the City of Roanoke. Mud Lick Creek originates on Long Ridge, near Poor Mountain, at an elevation of approximately 2300 feet above sea level and flows in a southeasterly direction for about 1.7 miles. The course continues in a northeasterly direction for approximately 4.5 miles until reaching its confluence with the Roanoke River within the City limits. Land along the main stem of Mud Lick Creek is relatively undeveloped until the stream intersects with Farmington Drive where the downstream land use becomes primarily residential with some scattered commercial development. Developed land use is planned to be primarily high-density residential development and rural villages with some commercial and lower density residential development (Dewberry & Davis 1997).

There are two significant streams that drain into the Mud Lick Creek watershed, West Mud Lick Creek and Murdock Creek. West Mud Lick Creek lies entirely within Roanoke County and has a drainage area of 1.0 square miles at its mouth. West Mud Lick Creek is located in the western portion of the Mud Lick Creek watershed. This basin is undeveloped in the upstream portion of its drainage area with mainly residential development in the downstream areas including a commercial development in the center of the watershed just upstream of VA Route 419. Future land use in the West Mud Lick Creek subbasin is planned for high density residential, neighborhood preservation areas and rural villages. Murdock Creek is located mostly in the City of Roanoke with the very upstream area in Roanoke County and has a drainage area of 0.8 square miles at its mouth. Murdock Creek is located in the northwestern portion of the Mud Lick Creek watershed and is mostly developed with residential areas with some commercial areas in the upstream portion of the watershed. Future land use in the Murdock Creek subbasin is planned for essentially the same types of existing uses, as the watershed is mostly developed at this time (Dewberry & Davis 1997).

The Mud Lick Creek Watershed Plan prepared by Dewberry & Davis (1997) notes that the major flooding in this watershed is along South Park Circle in the Southwoods subdivision. Upstream detention was considered as a flood hazard mitigation measure to reduce flooding along Mud Lick Creek at several locations, including at South Park Circle in the Southwoods subdivision. A stormwater management pond site was identified at a location approximately 800 feet upstream of Farmington Drive, however, further analysis determined that a stormwater management facility at this location would not provide enough flood protection to justify the expense and was not recommended for implementation (Dewberry & Davis 1997).

III. Existing Site Conditions

The proposed school property is a largely undeveloped tract of land located west of Brambleton Avenue (Route 221) and Pleasant Hill Drive, and south of Farmington Drive. The site is bounded on all sides by the existing single-family residential developments of Nottingham Hills on the north, Kingston Court on the east, Nichols Estates on the south, and Canterbury Park on the south and west. The initial site is comprised of three parcels of land totaling approximately 69.5 acres with frontage on Farmington Drive. An existing building onsite is presently used as a residence. The main dwelling and ancillary buildings are accessed by means of a paved driveway running along the eastern boundary line, with an entrance onto Farmington Drive. The three individual parcels are currently under the ownership of The Roanoke County School Board.

The site is partially wooded, with the majority of tree cover occurring in the western portion of the property and along the stream valley of Mud Lick Creek. The remainder of the site is open, lying in field or meadow condition. The main topographical feature of the site is Mud Lick Creek and the associated stream valley that runs southwest to northeast through the entire site. Approximately three fifths of the site lies on the western side of Mud Lick, and is typified by gentle to rolling terrain, with elevations falling 130 feet from the western boundary to the creek. On the east side, elevations fall approximately 50 feet from the property boundary to the creek. There is an existing pond, approximately two acres in area, to the west of the residence on the main tract. Mud Lick Creek passes below and immediately to the west of this pond. There is a 100-year flood plain associated with Mud Lick Creek that has been mapped and shown on Panel 61 of 90, Map Number 511610061-D, of the FEMA Flood Insurance Rate map for Roanoke County and is dated October 15, 1993.

IV. Soil Conditions

A subsurface geotechnical report prepared by Environmental Consulting Services, Inc. (ECS) for the Roanoke County School board identifies the majority of onsite soil as cohesive in nature and consisting of Clayey Silt (ML-MH) and Silty Clay (CL-CH). Generally, the onsite soil characteristics would support the construction of the impoundment embankment areas. The extent of excavation required for the construction of the school and associated site amenities could yield a variation of suitable soil types for use in the stormwater management facility. A detailed soil analysis should be undertaken by a geotechnical engineer to verify soil compatability as it relates specifically to the construction of detention and retention basins.

V. Environmental Site Assessment (ESA)

ECS, Inc., under direction of the Roanoke County School Board, has performed a phase I ESA of the subject property. Per their report, the site would generally be considered developable with no major impediments to construction.

VI. Wetlands

ECS, Inc., by direction of the Roanoke County School Board, conducted a site visit with the Army Corps of Engineers to confirm their site assessment of wetland conditions on the property. The Army Corps has agreed that no jurisdictional wetlands are present onsite. Mud Lick Creek and its tributary located near the southern property boundary are regulated waters of the U. S. The pond located east of Mud Lick Creek is not jurisdictional and may be drained to accommodate proposed school athletic fields. Care must be taken during draining operations to minimize impact to the adjacent creek and down stream properties. A nationwide permit, secured through the local Army Corps of Engineers office, will be required for the road and stormwater management embankments crossing Mud Lick Creek.

VII. Proposed Site Development – Basin Extents

The construction of the proposed South County High School will define the limits of area available for stormwater management storage volumes. Extensive earthwork operations will be undertaken to accommodate the entire site program supporting various school site elements. The limits of the embankment area directly adjacent and parallel to Mud Lick Creek to the west will form a uniform 3:1 slope rising an average of 50-feet from the basin floor. The majority of the existing slope along the east will be left in its natural state, with the exception of those areas requiring grading for recreational amenities, and will rise an average of 20-feet from the basin floor. The lowest elevation within the basin area is 1096 and the maximum elevation available for volume consideration is 1120, which yield 24-feet of effective basin area. The northern limits of the stormwater management facility will be limited by the proposed access road crossing that will serve the school building located on the west side of Mud Lick Creek. The low point elevation of the road were it crosses the creek will be approximately 1124. The southern limits of the facility will be limited by Canter Drive, which serves the existing Canterbury Park subdivision. The existing road elevation is above the useable elevation considered for the stormwater management facility. Effective water surface area available for storm routing consideration, based on the constraints of the proposed site improvements, will be approximately 6.0 acres.

VIII. Stormwater Management Options

Overview

A growing body of research continues to show that urbanization in a watershed can have adverse impacts on streams and receiving waters related to flooding, stream-bank erosion and pollutant export. The Virginia Stormwater Management Regulations require that the *first flush* of runoff be captured and treated to remove pollutants. The first flush, or water quality volume (WQV) as its known, is generally defined as the first one-half to one inch of runoff from impervious surfaces. While other methods for defining this first flush have been developed, methodology developed by the Center for Watershed Protection indicates that 90 percent of the annual runoff is generated by storms of one inch of rainfall or less. Therefore, the goal of treating at least 90 percent of the annual runoff results in a treatment volume based on a one-inch rainfall. The control of the first flush of runoff is especially important since the runoff from this type of storm event is considered to contain the highest concentration of pollutants although there is considerable debate over the intensity of rain needed to wash pollutants from the urban landscape (DCR 1999).

Best Management Practices (BMPs) are structural or nonstructural practices, or a combination of practices, that are designed to minimize the impacts of urbanization on surface water quality. BMPs operate by trapping stormwater runoff and detaining it until phosphorus, sediment, heavy metals and other harmful pollutants are allowed to settle out or be filtered through the soil horizon. The basic mechanisms of pollutant removal in BMP systems are gravitational settling of pollutants, infiltration of soluble nutrients through the soil profile, and biological and chemical stabilization of nutrients. Pollutants and sediment trapped by BMPs must be disposed of through periodic maintenance in an environmentally sound manner (NVPDC & ESI 1992).

A number of BMPs have been developed to mitigate the adverse impacts associated with urbanization that target the removal of urban pollutants in runoff. Most of these practices involve extra detention, retention and/or infiltration of urban stormwater runoff to enhance pollutant removal efficiencies and provide additional stormwater management opportunities. Field testing of these practices has shown that an integrated approach to BMP design is needed that seeks not only to maximize pollutant removal but also minimize costs, reduce future maintenance requirements, and blend facilities into the natural and human landscapes. This integrated approach generally requires more thoughtful planning and sophisticated design throughout the BMP formulation process (Schueler 1987).

Basin Selection

The first step in choosing a BMP is the identification of which BMPs are deemed suitable given the physical conditions of the site under study. Generally, the two most important physical factors that must be considered are (1) the total contributing watershed area and (2) the infiltration rate of the soils on the site. Pond BMPs normally require a significant contributing watershed area greater than 10 acres in size to ensure proper operation. In circumstances where the contributing area of a site is either too small to meet minimum ponding requirements or too large to meet spatial requirements of the site, local topography and drainage conditions can often be creatively altered to better accommodate a particular BMP. For instance, additional runoff generated away from the site (i.e., off-site runoff) can be routed to the site under study, thereby increasing the size of the contributing drainage area and making pond options more feasible. Conversely, various portions of the total runoff from the site can be routed to individual BMPs, thereby splitting the contributing drainage area into smaller portions that can effectively be mitigated with infiltration and vegetative BMPs. The use of pond BMPs is generally only restricted in terms of spatial limitations of the site, as other potential constraints such as slope, presence of high water table, proximity to foundations and bedrock, high sediment input and thermal impacts can be overcome through careful site design (Schueler 1987).

Extended Detention Basins (Dry Facility)

Extending the detention time of dry or wet ponds is an effective, low cost means of removing particulate pollutants and controlling increases in downstream bank erosion. Studies show if stormwater runoff is detained for 24 hours or more, as much as 90 percent removal of pollutants is possible (Schueler 1987). While laboratory and field studies indicate that significant settling of urban pollutants occurs in the first 6 to 12 hours of detention, the brim draw down requirement for water quality extended detention design is 24 to 30 hours. A 30-hour draw down allows additional time for ideal settling conditions to develop within the stormwater facility (DCR 1999). While extended detention only slightly reduces levels of soluble phosphorus and nitrogen found in urban runoff, removal of these pollutants can be enhanced if the normally inundated area of the pond is managed as a shallow marsh (i.e., wetland) or permanent pool. Extended detention ponds can significantly reduce the frequency of occurrence of erosive floods downstream, depending on the quantity of stormwater detained and the time over which it is released. Extended detention is extremely cost-effective; with construction costs seldom more than 10 percent above those reported for conventional dry ponds (Schueler 1987).

Positive impacts of extended detention ponds include creation of local wetland and wildlife habitat, limited protection of downstream aquatic habitat and recreational use in the infrequently inundated portion of the pond. Negative impacts include occasional nuisance and aesthetic problems in the inundated portion of the pond (e.g., odor, debris and weeds), moderate to high routine maintenance requirements and the eventual need for costly sediment removal. Extended detention generally can be applied in most new development situations and is an attractive option for retrofitting existing dry and wet ponds in older urbanized areas (Schueler 1987).

Enhanced Extended Detention Basins (Wetland Enhanced)

A variation of the extended detention basin is the *enhanced* extended detention basin that offers higher pollutant removal efficiency through the incorporation of a shallow marsh or wetland in the bottom of the basin. The layer of wetland vegetation provides additional pollutant removal through plant uptake, absorption, physical filtration and decomposition. The addition of wetland vegetation in the bottom of the basin also helps reduce the re-suspension of settled pollutants during runoff events by trapping the settled pollutants within the vegetative cover. BMPs that include plants and grasses display increased pollutant removal efficiency over time as the biomass increases, and as the vegetation thickens, the velocity of the runoff through the BMP is reduced allowing for increased gravitational settling and filtering of pollutants (DCR 1999).

Retention Basins (Permanent Pool)

Retention basins are BMPs that utilize a permanent impoundment or pool of water and therefore are normally wet during non-rainfall periods. Stormwater runoff inflows may then be temporarily stored above this permanent pool elevation. Retention basins that provide flood control are designed with a dry storage area above the permanent pool elevation based upon design storms selected for flood control (i.e., two-year, 10-year frequency, etc.) as specified by state or local ordinances or as necessary to address specific watershed conditions. Storage volume above the permanent pool can also be used to control or reduce channel erosion through reduction of the peak rate of discharge or by controlling the time over which the peak volume of discharge is released, as in extended detention (DCR 1999).

Retention basins provide for long-term water quality enhancement of stormwater runoff and provide a higher removal rate of particulate matter and soluble pollutants (nutrients) through gravitational settling, biological uptake and decomposition. Monitoring studies have shown sediment removal efficiencies range from 50 to 90 percent, total phosphorus removal efficiencies range from 30 to 40 percent and soluble nutrient removal efficiencies range from 40 to 80 percent. An even higher degree of pollutant removal efficiency is possible when the retention basin is enhanced through the use of various modifications relating to the size and design of the permanent pool. Typically, a watershed of at least 10 acres and/or a good source of base-flow should be present for a retention basin to be feasible. Even with 10 acres of contributing watershed, the permanent pool may be susceptible to dry weather drawdowns due to infiltration and evaporation. A retention basin is recommended for use as a regional or watershed-wide stormwater management facility since its cost per acre is inversely proportional to the watershed size (DCR 1999).

A retention basin is typically selected for its water quality enhancement abilities and/or aesthetic value along with its flexibility in providing additional opportunities for channel erosion control, flood control and habitat enhancement. By providing a larger pool and/or adding modifications such as an aquatic bench or a sediment forebay, the retention basin can be designed to provide greater and more consistent pollutant removal benefits. While retention basins are suitable for use in both high- and low-visibility situations, care must be taken on high-visibility sites to avoid aesthetic problems associated with stagnation or excessive infiltration of the permanent pool. Maintenance of the permanent pool is not necessarily critical to the retention basin's ability to remove pollutants, but maintenance is critical to ensure the BMPs acceptance by adjacent landowners (DCR 1999).

Basin Development Considerations

Basins that are accessible to populated areas should include all possible safety precautions including warning signs legible from all adjacent streets, sidewalks and paths strategically placed in clearly visible areas to identify areas of deep water and potential health risks. A notice should be posted that warns site users and adjacent property owners of potential waterborne disease that may be contacted by swimming or diving in these facilities. Basins that exceed a surface area of 20,000 square feet should be designed with an aquatic bench that occupies a 10- to 15-foot wide area that slopes from zero inches at the shoreline to between 12 and 18 inches deep in the basin. This bench will address safety concerns along the edge of the basin, and will serve as a suitable growth area for aquatic plants and emergent vegetation while providing an ideal habitat for wildlife, such as waterfowl and fish, and for predator insects that feed on mosquitoes and other nuisance insects (DCR 1999).

The primary impact of extended detention ponds on the human environment is related to aesthetic value. Survey research has shown that most residents consider existing dry ponds to be fairly unattractive unless they are maintained as lawn. Unlike wet ponds, most residents surveyed felt that dry ponds do not enhance property values, and in the case of poorly maintained ponds, can actually detract from them. While residents in survey indicated that they do not consider dry ponds to be a safety hazard, many voiced concerns about mosquito and other nuisance problems. Survey findings indicated that dry ponds were perceived to have limited recreational, wildlife and aesthetic values, particularly in comparison to wet ponds and urban lake. Landscaping plans prepared for extended detention ponds should utilize native plants and natural landscaping in a two-stage design where the upper stage of the facility is designed for regular mowing or as a site for a wet meadow and the lower stage is designed as a wetland area. It is more likely that citizens will accept a planned marsh or wetland area in their community as opposed to an unplanned swampy area that develops on its own (Schueler 1987).

IX. Funding Sources for Stormwater Management Projects

Federal Emergency Management Agency (FEMA)

Research indicates that FEMA funding for structural solutions to flooding problems has been phased out. The only such projects currently being funded by FEMA are the completion of older projects that were started several years ago.

Virginia Department of Environmental Quality (DEQ)

Research has not resulted in the identification of any DEQ funding sources for stormwater management projects.

Virginia Department of Conservation and Recreation (DCR)

DCR is the most likely source of funding for stormwater management projects through the agency's oversight of two different programs, the Water Quality Improvement Fund and the 319 Program.

The Virginia Water Quality Improvement Act of 1997 created the Water Quality Improvement Fund (WQIF) to provide Water Quality Improvement Grants to local governments, among others, for point and nonpoint source pollution prevention, reduction and control programs. While the Virginia Department of Environmental Quality (DEQ) has responsibilities through the Act related to point source pollution, DCR is responsible for the provision of technical and financial assistance for nonpoint source pollution prevention, reduction and control programs.

The primary objective of the Fund is to reduce the flow of excess nutrients (nitrogen and phosphorus), sediment and suspended solids into the Chesapeake Bay through the implementation of the Tributary Strategies program. An additional goal of the Fund is to improve water quality in the Southern Rivers watersheds, which are watersheds in the Commonwealth outside of the drainage area of the Chesapeake Bay, through nutrient and sediment reductions as well as other source pollutants. In the Southern Rivers watersheds, the goal is to achieve measurable improvements in water quality, which can include nutrient and sediment reductions as well as reduction of other pollutants. As Mud Lick Creek drains into the Roanoke River, which is not a tributary river of the Chesapeake Bay, the funding available for the Southern Rivers watersheds will be the applicable funding mechanism available for this project.

DCR implements the state's stormwater management (SWM) program according to the Virginia Stormwater Management Act and Regulations as mandated by Virginia's General Assembly for implementation by all state agencies. Stormwater management engineers at DCR serve as the review and approval authority for SWM plans for regulated state agency projects, and inspect SWM practices construction and take action to see that agencies comply with approved plans. The regulations ensure that localities, state agencies and federal agencies work together to restore and protect watersheds across political boundaries in an effort to provide consistency for consultants, whose work must comply with SWM ordinances and regulations within these jurisdictions. The Virginia Conservation and Recreation Board has been delegated the authority to promulgate regulations that specify minimum technical criteria and administrative procedures for stormwater management programs in Virginia.

The Clean Water Act of 1987, Section 319, required states to assess their state waters and identify those adversely affected by nonpoint sources of pollution along with state management programs to control nonpoint source pollution. The most recent assessment completed in 1996 ranked the state's 494 watersheds for potential nonpoint source pollution. These rankings will be used to direct the implementation of Virginia's nonpoint source pollution control programs, as well as cost-share and Section 319 funding, to the highest priority watersheds (i.e., watersheds with greatest pollution potential).

DCR administers Environmental Protection Agency (EPA) grant funds to implement Section 319 nonpoint source programs, in coordination with the interagency Nonpoint Source Advisory Committee (NPSAC), to fund watershed projects, demonstration and educational programs, nonpoint source pollution control development, and technical and program staff. The 1999 appropriations bill for EPA provided $200 million for states to implement their nonpoint source management programs under Section 319 providing the opportunity for states to make significant progress in resolving their remaining water quality problems.

These two programs are quite similar, with the WQIF funds provided by the Commonwealth and the 319 funds provided by the federal government. Application packages for both programs will be sent out together around November 11, 1999. The applications will be due around the middle of December 1999. In general, DCR will encourage applicants to apply for one or the other of the two programs.

Both programs are intended to reduce nonpoint source pollution, and applicant's opportunities for funding are enhanced by location on the 303(d) list and for watersheds located in high priority hydrologic unit codes. The hydrologic unit code (HUC) for this basin is L04. L04 is classified as a high priority watershed for urban - nutrients and for urban - erosion. It is classified as a low priority watershed for agricultural and forestry impairments. It overall rating is high.

Our research has not shown Mud Lick Creek to be on the 303(d) impaired segment list. However, the 1998 303(d) list does include 11.72 miles of the Roanoke River within this HUC as being impaired for fecal coliform and general standard benthics. As a tributary to this river, funding opportunities for projects on Mud Lick Creek should be enhanced.

An applicant's scoring will also be enhanced if the project is part of an overall Comprehensive Watershed Plan and by partnerships between governments, agencies and/or citizen groups. However, these partners do not necessarily need to have financial involvement.

The required community match for these funding sources will be 50/50 for WQIA and 60/40 with 40% local match for the 319. These funds can be used for studying or fixing problems. Typical projects for these funds might include:

- retrofit of stormwater management facilities
- development of forebays
- maintenance activities
- CSO separation
- stream bank protection
- riparian quality improvements

For WQIF funding, the draft guidelines indicate that the evaluation criteria for this program will include:

- location in an impaired watershed

- documented water quality improvement
- achievement of water quality improvement greater than required by law
- availability of other funding mechanisms
- In addition to these criteria, applications will be evaluated according to the project area/scope, project coordination and anticipated water quality improvements. Also, the cost-effectiveness of each project in achieving reductions of nonpoint source pollutants will be considered. Information on eligibility criteria and specific criteria used to score the project applications will be included in the application package.

For 319 funding, there is a stronger emphasis on monitoring. Programs that involve pre- and post-condition water quality monitoring programs will have increased chances for funding.

X. Technical Calculations and Data

Overview

The Virginia Stormwater Management Handbook, First Edition 1999, was used as the basis of design for the three options analyzed. While the handbook has yet to be adopted, it reflects consistency between the Virginia SWM Regulations (DCR), The Chesepeake Bay Preservation Act (CBPA) and regulations (CBLAD) and the Virginia Pollution Discharge Elimination System (VPDES) permit (DEQ).

As detailed above, three types of BMP's were identified for study: extended detention, enhanced-extended detention and retention. The first step in the analysis involved designing an impoundment while working with the proposed grades for the planned South Roanoke County High School. Each BMP facility alternative required a forebay for maximum efficiency and therefore was included in each option. The forebay will be a constant in each analysis. The water quality volume (WQV) will also remain constant across the three options and will be based on an anticipated 30% impervious watershed. Facility routing calculations and volume estimates were based on future watershed development estimates in the year 2020. The capacity of the facility, if constructed, will function at a more efficient rate proportional to the year of completion and watershed development.

Forebay

Acceptable forebay design volumes should fall between 0.1" of runoff per impervious acre to 0.25" inches of runoff per impervious acre. The drainage area flowing to the facility is approximately 1,040 acres. The forebay volume designed for each option has a volume of 5.0 acre-feet. The forebay volume equates to 0.2" of runoff per impervious acre, which falls at the upper end of the recommended 0.1" to 0.25" of runoff per impervious acre. The forebay in each analysis is also wetland enhanced allowing for additional pollutant uptake and higher facility efficiency rating. The separation of the forebay from the primary facility can accommodate a pedestrian land bridge that could connect the school on the west side of Mud Lick Creek with the recreational fields on the east side.

Water Quality Volume

As discussed earlier in the document, the water quality volume equates to 1/2" of runoff per impervious acre. Using an anticipated 30% impervious watershed of 1,040 acres, the WQV used in all designs will be 13.0 acre-feet.

Basin Options

Option 1 - Extended Detention Basin

The Extended Detention Basin (EDB) can be used to serve a watershed with 22% to 37% impervious areas. The removal efficiency for an EDB reaches 35% by providing a 30-hour drawdown of 2.0 times the WQV.

The proposed EDB can provide a 30-hour drawdown time for 2.0 times the WQV while also providing stormwater quantity management for the 2-2 and 10-10 storms. The facility will require different outlet structures to manage the 2-2 storm event only versus a multi-stage outlet structure that would manage the 2-2 and the 10-10 storm event. The costs associated with a multi-stage outlet structure could potentially be much greater than a structure that manages the 2-2 storm event only.

Option 2 - Enhanced-Extended Detention Basin

Enhanced-Extended Detention Basin (EEDB) works primarily the same as EDB by relying on the 30-hour drawdown of 2.0 times the WQV. However, EEDB can provide an additional 15% removal efficiency by the addition of a shallow marsh. The shallow marsh design occupies 1.0 times the WQV while the remaining 1.0 times the WQV is provided by extended detention above the shallow marsh.

While the shallow marsh design provides for higher removal efficiencies up to 50%, it also has requirements that restrict pool depths related to plant growth and extended detention above the shallow marsh. EEDB are recommended to provide 20% of the BMP surface area with Deep Water from 1.5' to 4' deep, 40% surface area with Low Marsh 0.5' to 1.5' deep, and the final 40% of surface area with High Marsh 0' to 0.5' deep. For these reasons, the minimum surface area for an EEDB should be approximately 1% of the contributing drainage area or 10 acres in this instance. The physical limitations of the subject site do not allow for a facility to accommodate the WQV's at the depths recommended. The anticipated surface area that can be provided at this site of 6 acres is well short of the minimum 10 acres recommended.

The shallow marsh should not have more than 3.0' of extended detention provided above its water surface, which greatly reduces the volume available for stormwater quantity management. Therefore, this facility will not be able to accommodate stormwater quality or quantity in an acceptable manner.

Option 3 - Retention Basin

The phosphorus removal efficiency for a Retention Basin corresponds with the volume provided in the facility. A Retention Basin that serves a watershed with 22% to 37% impervious is recommended to have 3.0 times the WQV for a removal efficiency of 40%. Therefore, the minimum design for the Retention Basin should provide (3.0) * (13.0 ac-ft)

= 39.0 ac-ft. Other guidelines indicate that the depth of the permanent pool will affect the removal efficiency of the facility. The recommended depths per percentage of BMP surface area are listed below:

1. 0 - 1.5 feet deep — 15% of surface area
2. 1.5 - 2 feet deep — 15% of surface area
3. 2 - 6 feet deep — 70% of surface area

The physical limitations of the proposed site do not lend itself to a Retention Basin facility. While the BMP could provide 39.0 ac-ft of permanent storage recommended for its given removal efficiency, the depth of water to provide this volume would approach 21'. As shown above, the recommended depths for a Retention Basin facility do not reach depths greater than 6 feet.

By providing 3.0 times the WQV, the Retention Basin facility would also not be able to provide any stormwater quantity management. The volume available for stormwater quantity management is entirely above the permanent pool level. Therefore, given the physical constraints at Canter Drive and the proposed access road to the high school, there is not enough storage above the permanent pool to provide stormwater management for even a 2-2 storm event.

XI. Conclusions

The analysis of the three options identifies Option 1 - Extended Detention Basin as the only feasible option that will address stormwater quality and stormwater quantity. A brief list of conclusions for each option is listed below:

1. Option 1 - Extended Detention Basin
   - Can provide minimum 2.0 X WQV
   - Can manage stormwater quantity for 2-2 and 10-10 storm events
   - Can meet 30-hour drawdown requirement
   - Can provide vegetative buffer area

2. Option 2 - Enhanced Extended Detention Basin
   - Can provide minimum 2.0 X WQV
   - Can not meet depth requirements for shallow marsh
   - Can not manage stormwater quantity above shallow marsh at acceptable depth
   - Can provide vegetative buffer area

3. Option 3 - Retention Basin
   - Can provide minimum 3.0 X WQV
   - Can not meet depth requirements
   - Can not manage stormwater quantity at permanent pool associated with minimum 3.0 X WQV
   - Can provide vegetative buffer area

The results of the facility calculations have defined the design requirements of Options 2 and 3 as not feasible. The limiting design factor for Option 2 relates to the geometry of the available basin area. The narrow surface area and excessive depth did not allow for the optimum conditions necessary to support adequate wetland areas and presented negative pollutant re-suspension scenarios. In addition to the limiting factors defined in Option 2, Option 3 could not provide adequate reductions in downstream runoff and could not detain the 2-2 storm volume.

Option 1 will allow for the effective reduction of downstream runoff rates through detainment of the 2-2 and 10-10 storms and can meet the minimum pollutant removal efficiency necessary for funding consideration. The objective of the regional study prepared by Dewberry and Davis, as stated earlier, concentrated on reduction of runoff discharges within the basin downstream of the impoundment area. The routing calculations for Option 1 reflect year 2020 downstream reduction capabilities for the 2, 10, 25 and 100-year storms of approximately 90%, 60%, 28% and 8% respectively. Because of the water quality element of design through extended drawdown of the facility (30 hours or more), the 2 and 10 year storm event reductions downstream are approximately 85% and 40% respectively more effective than the water quantity only projections in the Dewberry study. The benefit realized in downstream runoff reduction of the more frequent storm events, represent a significant bonus related to water quality management provisions. The 100-year storm event is not as effective as the Dewberry study by a 22% margin (Dewberry 30% reduction) due to the maximum water surface elevation limit associated with the available basin area. The embankment placement of this facility, in the available reach length of Mud Lick Creek within the property limits, reduces basin volume possibilities as compared to the Dewberry estimated embankment placement that was closer to Farmington Drive.

The construction of a regional facility at this site, if funding applications are approved, could coincide with site work related to the construction of the proposed high school if time lines correlate. The major cost components for a regional facility (see feasibility cost estimate in the appendix) relate directly to excavation and outlet structure construction. The outlet structure considered for this study combines the use of a stepped embankment that should allow for a significant reduction in wall height and the corresponding structural elements necessary for construction of the principal outlet spillway.

The primary task of the outlet structure will be to provide a minimum 30-hour drawdown of two times the water quality volume. The drawdown will be accomplished with a 12" orifice at the bottom of the facility. Once the facility has provided the 30-hour drawdown for stormwater quality, storm event management must be accommodated. Due to similar volumes required for managing two times the water quality volume and the 2-year storm, the 12" orifice will serve as the outlet for the 2-year storm event. The proposed primary outlet structure (spillway) above the 12" base-flow pipe consists of 160 linear feet of 4' high rock-faced wall on a 100' radius projecting outward from the road embankment. A 35' opening in the midpoint of the wall divides the spillway into two equal 80' length sections. Given the geometry of the structure, the 35' opening will serve as the overflow spillway primarily for the 10-year storm event. The top of the rock-faced wall will serve as the overflow weir for all storm events above the 10-year storm event.

Due to the elevation difference between the 12" orifice at approximately 1096' and the 10-year overflow spillway at 1115', an effort was made to minimize the cost of the structural element of the spillway. The stepped embankment should effectively accomplish that goal and allow for the separation of the principal outlet spillway from the access road embankment. A definable separation of these two elements could help to eliminate VDOT concerns related to maintenance responsibility if the school access road is taken into the State road system. The drainage structure that will be placed for the access road is not a part of the estimate for a regional impoundment as that element is separate from the operation of the stormwater management facility and is necessary for access road construction supporting the school site.

Beyond the overflow spillway (downstream), an exposed rock concrete surface is proposed. The rock-face wall and exposed rock surface will be highly visible from the proposed road accessing the planned high school as well as the recreation areas. The slopes of the stepped bench and other grading proposed for the facility are planned at 3:1 to allow for reasonable maintenance and to provide a means of safety for people walking around the facility. The spillway will have an "overlook" feel and will provide views up the watershed (see attached graphic). No fencing is proposed around the spillway given the mild slopes and unimposing structure.

Revetment matting is proposed downstream of the overflow spillway to protect the backside of the embankment for its entire length and should terminate at a stilling basin located at the bottom of the embankment. The discharge from the 12" orifice will be piped directly to the dissipation structure and all primary spillway overflows should pass through the dissipation structure where velocities will be dropped before releasing into the existing Mud Lick Creek basin.

XII. Recommendations

After reviewing available BMP facility alternatives, funding options, and analyzing the different facilities for the proposed site, the following recommendations are offered:

1. Begin the WQIF and 319 grant application process for funding opportunities outlining existing regional stormwater management study efforts already undertaken.

2. Submit December 1999 grant applications for year 2000 funding consideration.

3. Present the study findings and application process to the Board of Supervisors as update of progress on regional stormwater management effort and solicitation of program support.

4. Begin dialogue with the Roanoke County School Board explaining feasibility study results and benefits of facility construction assuming grant approval.

5. Begin study of maintenance and monitoring programs related to implementing a regional stormwater management program.

6. Begin study related to cost offsets for construction, maintenance and monitoring of the regional program through a development pro-rata-share or similar program.

7. If funding is approved by the State, begin impoundment design development phase.

Should Roanoke County decide to pursue funding opportunities for implementing a regional stormwater management program, the effective presentation of justifications for consideration will be paramount to the effort and overall rating rendered by the reviewing authority. Although the study area is not located in the Chesapeake Bay drainage basin, the need to improve southern rivers water quality is realized as a benefit to statewide pollution reduction initiatives. A portion of the Roanoke River is listed on the 1998 303(d) list and the study basin is classified as a high priority watershed for urban - nutrients and urban - erosion reduction. Favorable review or perhaps approval of the application may be enhanced by the very location of the facility itself. Regional funding applications for impoundments in southwest Virginia are uncommon and may generate a concentrated review effort given the need to begin addressing southern rivers water quality issues.

Beyond funding approval, Roanoke County will need to plan for several long-term issues associated with implementing and operating an impoundment. Liability, maintenance, monitoring and cost sharing programs must be investigated. Research of other programs already in use throughout the Commonwealth will help to identify elements that will ensure an effective regional effort and reveal benefits of its implementation.

COST ESTIMATE

ROANOKE COUNTY REGIONAL STORMWATER MANAGEMENT FACILITY

5/1/2000

Roanoke County
Regional Stormwater Management Facility
Feasibility Cost Estimate

Category	Item	Quantity	Unit	Unit Price	Extension
Site Preparation					
	Erosion & Sediment Control	1	LUMP	$35,000.00	$35,000.00
	Clearing & Grubbing	5	AC	$1,500.00	$7,500.00
	Excavation (95% Compaction)	72,000	CY	$3.75	$270,000.00
	Excavation (Consolidation)	8,000	CY	$3.00	$24,000.00
				Site Preparation Subtotal =	*$336,500.00*
Outlet Structure					
	Drawdown Pipe (12" RCP)	305	LF	$40.00	$12,200.00
	Overflow Weir	45	CY	$375.00	$16,875.00
	Overflow Base	470	CY	$250.00	$117,500.00
	Dissipation Structure	1	LUMP	$40,000.00	$40,000.00
	Embankment Stabilization	600	SY	$50.00	$30,000.00
				Outlet Structure Subtotal =	*$216,575.00*
Miscellaneous					
	Vegetated Buffer & Riparian Plantings	1	LUMP	$60,000.00	$60,000.00
	Monitoring (3 Year Program)	1	LUMP	$12,000.00	$12,000.00
				Miscellaneous Subtotal =	*$72,000.00*
				Subtotal =	**$625,075**
				7% Construction Contingency =	**$43,755**
				Engineering & Construction Administration =	**$85,000**
				Stormwater Facility Total Cost =	**$753,830**

This feasibility estimate represents the anticipated costs for constructing an extended detention facility. The numbers reflect raw construction costs including subcontractor's overhead and profit. Escalation and general contractor markup are not included. The total facility cost represents year 2000 dollars.

APPENDIX A

SUPPORT GRAPHICS

ROANOKE COUNTY REGIONAL STORMWATER MANAGEMENT FACILITY

COUNTY OF ROANOKE VIRGINIA 1838

FEASIBILITY STUDY
REGIONAL STORM WATER MANAGEMENT FACILITY SOUTH ROANOKE COUNTY HIGH SCHOOL SITE

OVERALL HIGH SCHOOL SITE PLAN

100' 0' 100' 200'
SCALE: 1"=100'

November 3, 1999

ENGINEERING CONCEPTS, INC.

COUNTY OF ROANOKE VIRGINIA 1838

FEASIBILITY STUDY

REGIONAL STORM WATER MANAGEMENT FACILITY SOUTH ROANOKE COUNTY HIGH SCHOOL SITE

Option #1 Extended Detention Basin (Dry Basin)

100' 0' 100' 200'

SCALE: 1"=100'

November 3, 1999

COUNTY OF ROANOKE VIRGINIA 1838

FEASIBILITY STUDY
REGIONAL STORM WATER MANAGEMENT FACILITY
SOUTH ROANOKE COUNTY HIGH SCHOOL SITE

OVERALL HIGH SCHOOL SITE PLAN

100' 0' 100' 200'
SCALE: 1"=100'

November 3, 1999

ENGINEERING CONCEPTS, INC.

COUNTY OF ROANOKE VIRGINIA 1838

FEASIBILITY STUDY
REGIONAL STORM WATER MANAGEMENT FACILITY SOUTH ROANOKE COUNTY HIGH SCHOOL SITE

Option #1 Extended Detention Basin (Dry Basin)

100' 0' 100' 200'

SCALE: 1"=100'

November 3, 1999

ENGINEERING CONCEPTS, INC.

COUNTY OF ROANOKE VIRGINIA 1838

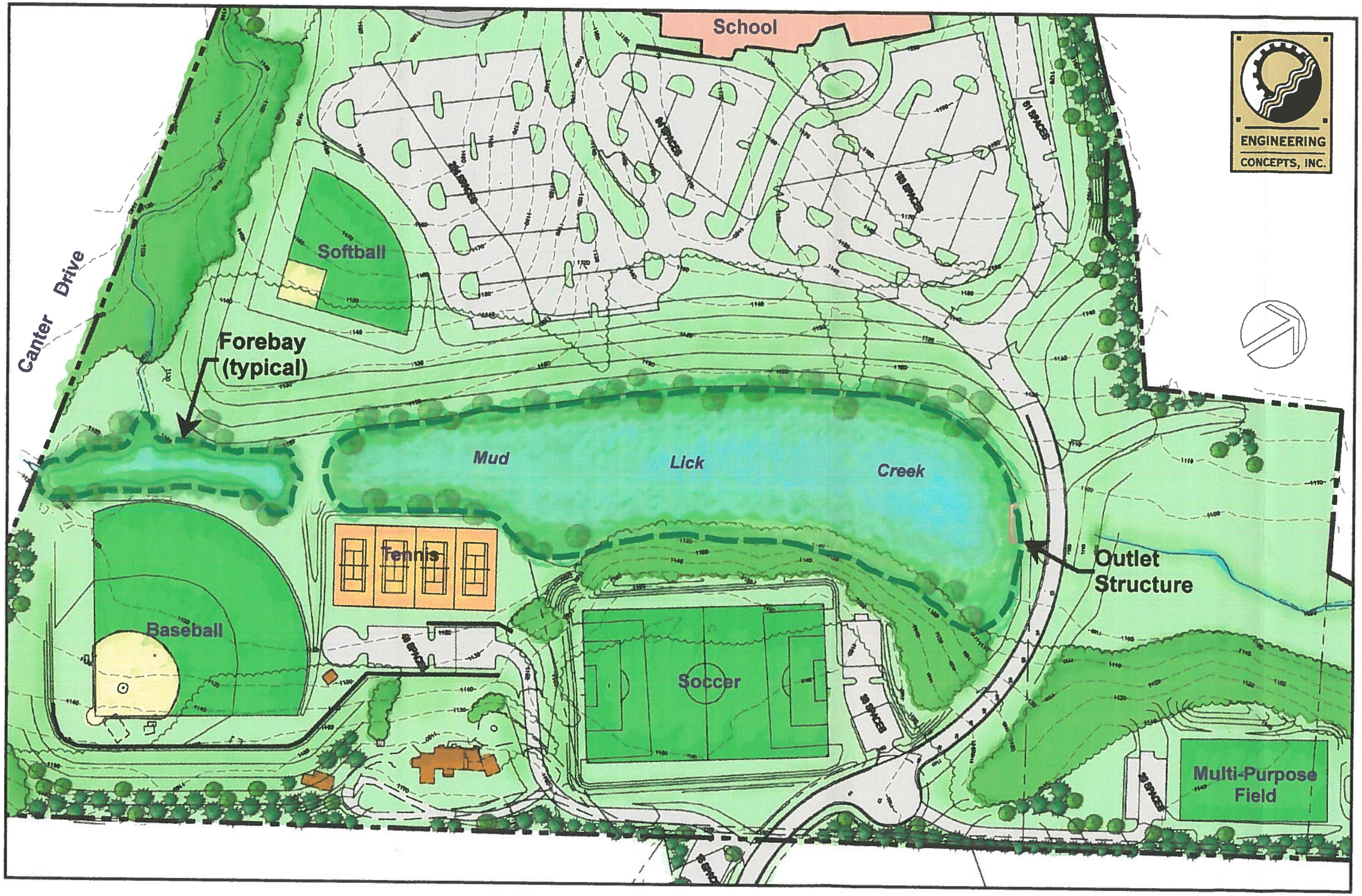
FEASIBILITY STUDY
REGIONAL STORM WATER MANAGEMENT FACILITY SOUTH ROANOKE COUNTY HIGH SCHOOL SITE

Option #2 Enhanced Extended Detention Basin (Wetland Enhanced)

100' 0' 100' 200'

SCALE: 1"=100'

November 3, 1999



ENGINEERING CONCEPTS, INC.

COUNTY OF ROANOKE VIRGINIA 1838

FEASIBILITY STUDY

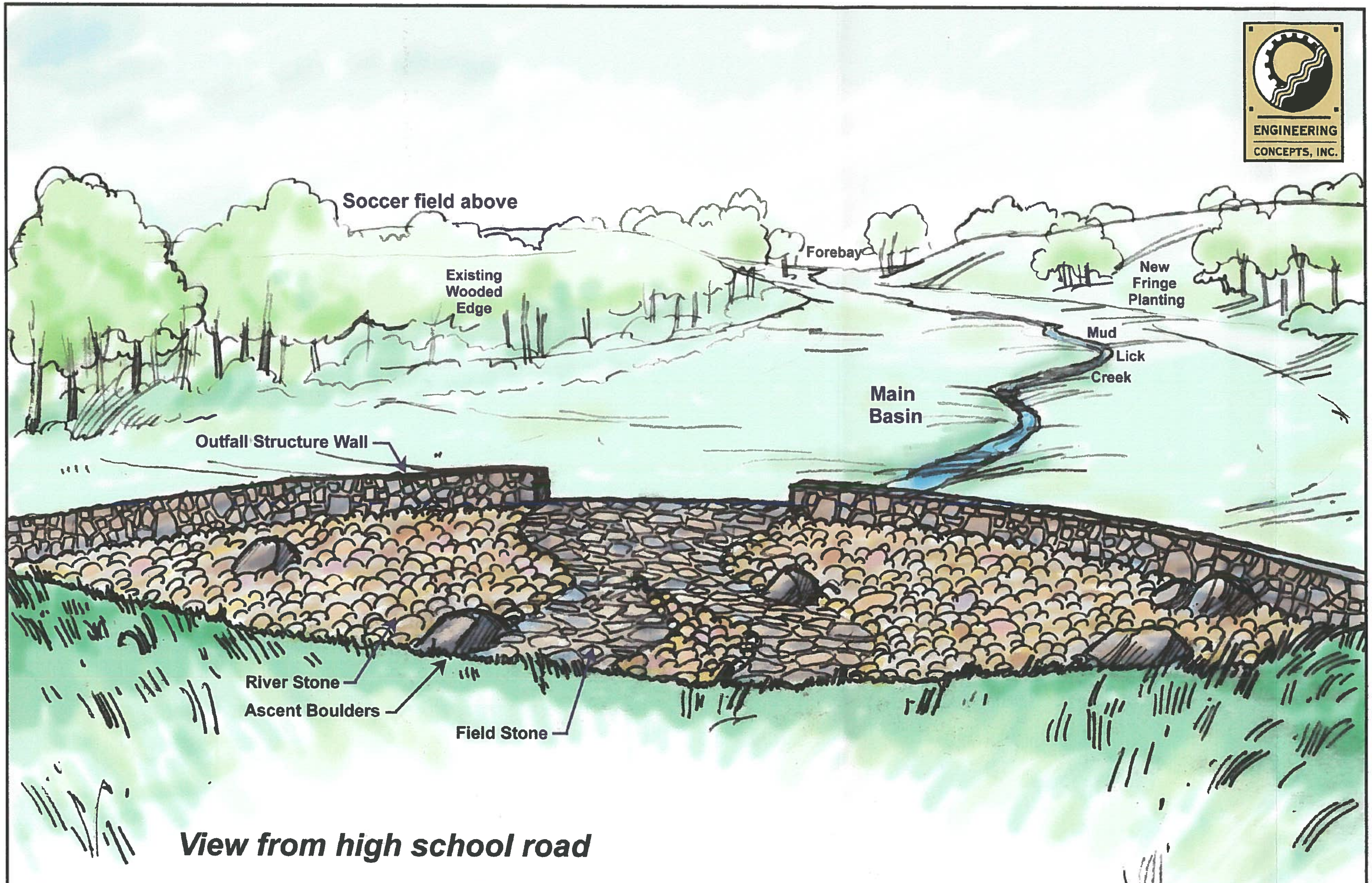
REGIONAL STORM WATER MANAGEMENT FACILITY SOUTH ROANOKE COUNTY HIGH SCHOOL SITE

Option #3 Retention Basin

100' 0' 100' 200'

SCALE: 1"=100'

November 3, 1999



FEASIBILITY STUDY
REGIONAL STORM WATER MANAGEMENT FACILITY SOUTH ROANOKE COUNTY HIGH SCHOOL SITE

Outfall Structure for Option #1 Extended Detention Basin (Dry Basin)

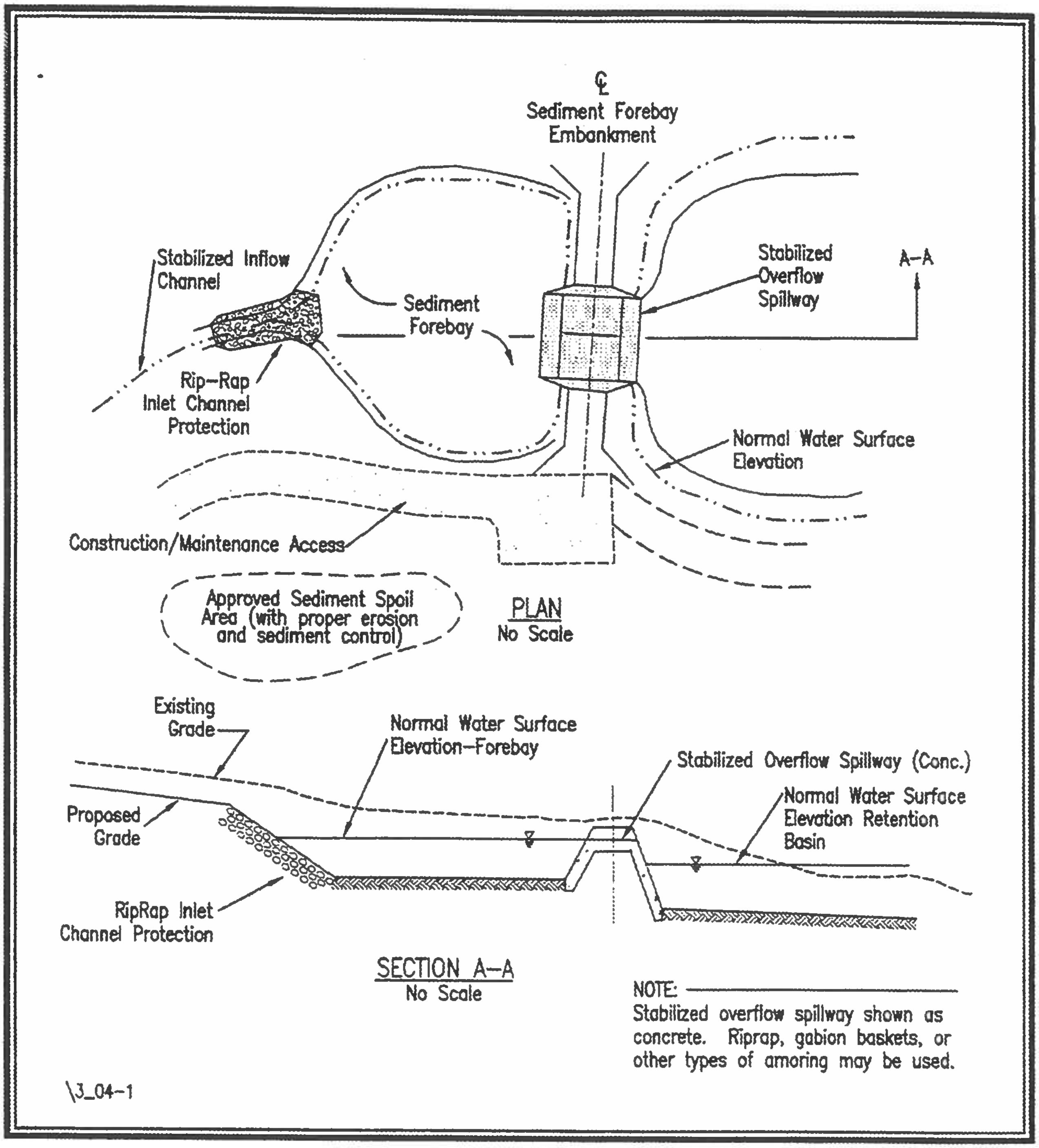
November 3, 1999

APPENDIX B

SUPPLEMENTAL EXHIBITS

ROANOKE COUNTY REGIONAL STORMWATER MANAGEMENT FACILITY

FIGURE 3.04 - 1
Typical Sediment Forebay Plan and Section

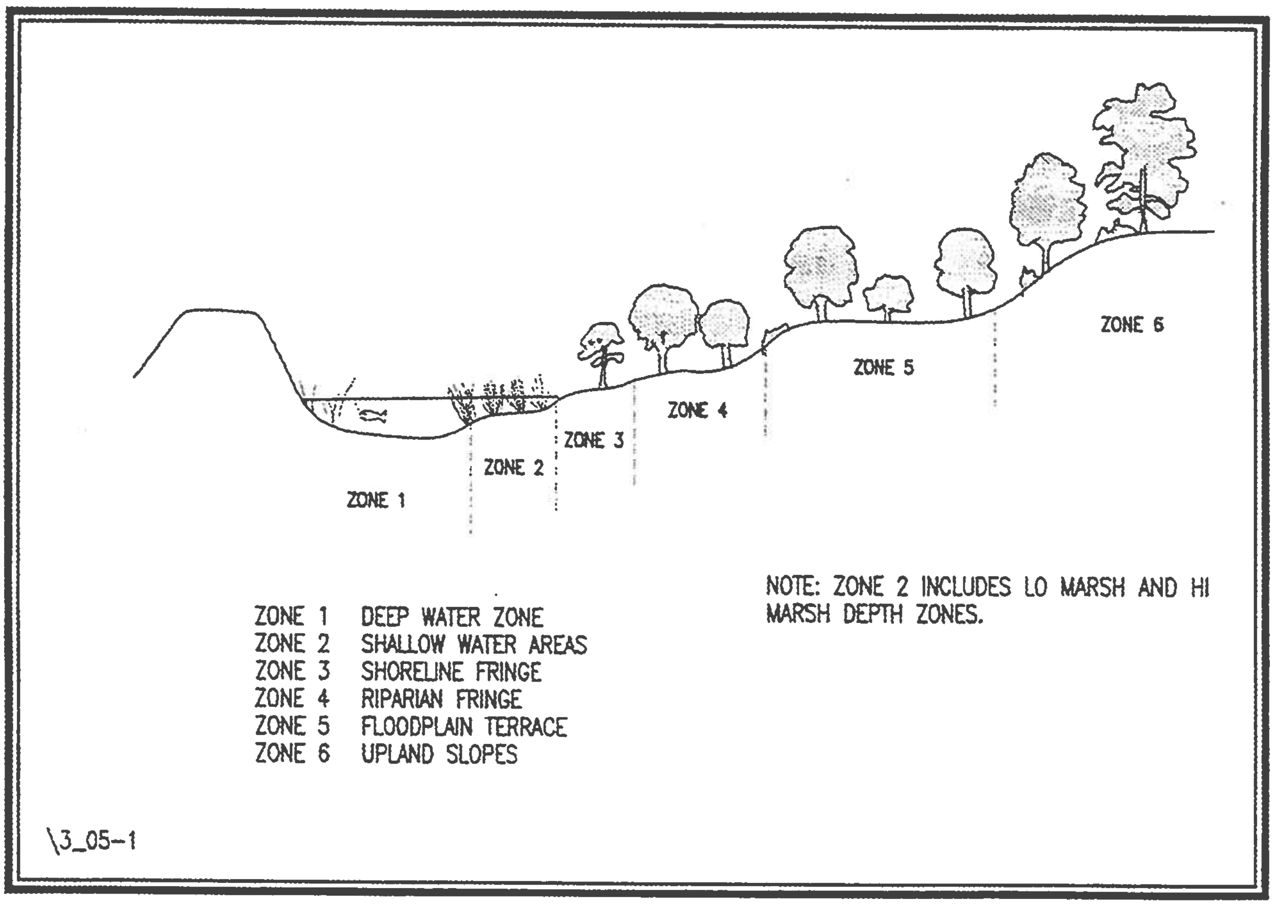


Source: Virginia Stormwater Management Handbook, 1999.

Specific plant communities may require different levels of maintenance. Upland and floodplain terrace areas, grown as meadows or forests, require very little maintenance, while aquatic or emergent vegetation may need periodic thinning or reinforcement plantings. Note that after the first growing season it should be obvious if reinforcement plantings are needed. If they are, they should be installed at the onset of the second growing season after construction.

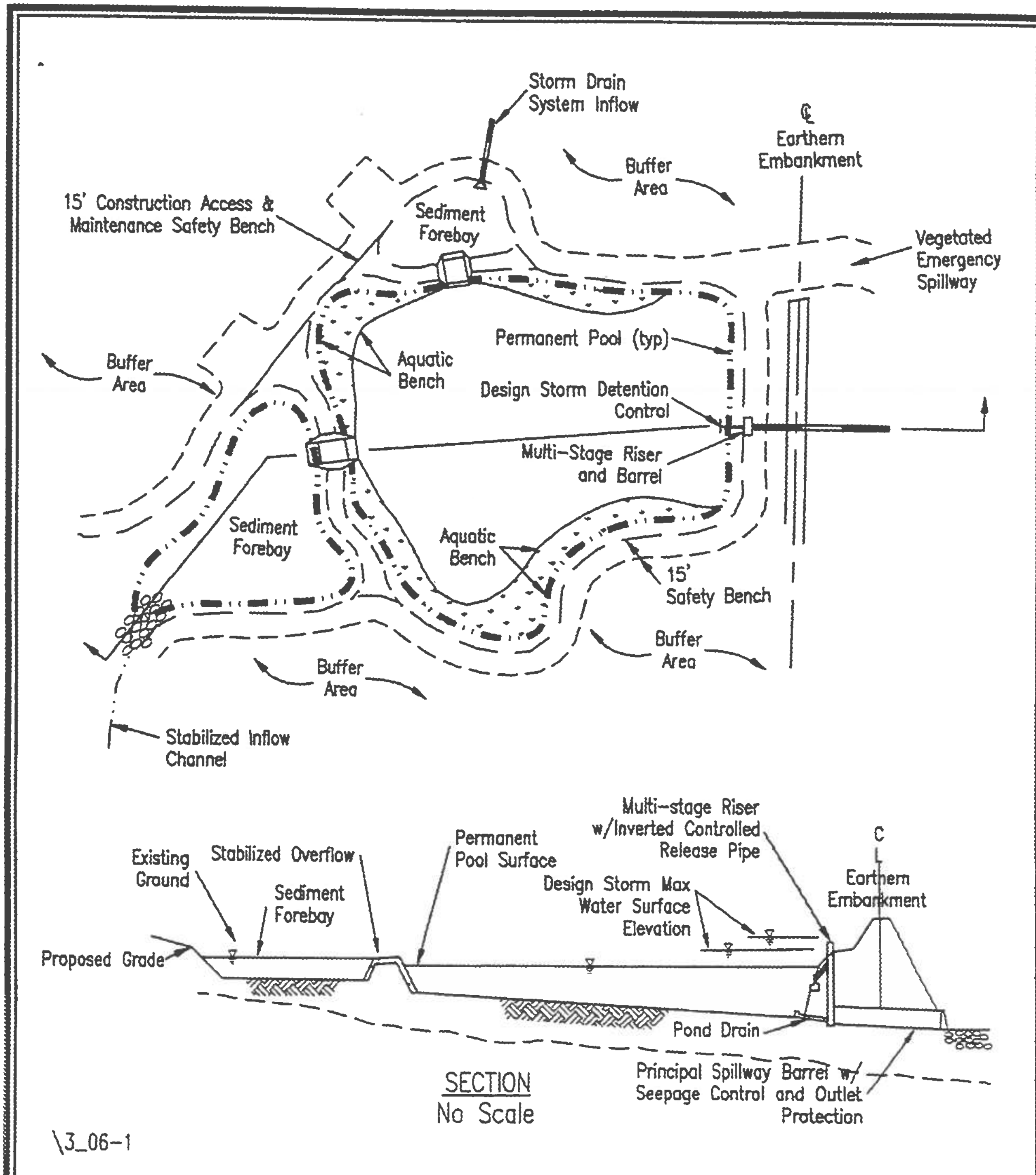
Research indicates that for most aquatic plants the uptake of pollutants are stored in the roots, not the stems and leaves (Lepp 1981). Therefore, aquatic plants should not require harvesting before winter plant die-back. There are still many unanswered questions about the long term pollutant storage capacity of plants. It is possible that aquatic and emergent plant maintenance recommendations may be presented in the future.

FIGURE 3.05 - 1
Planting Zones for Typical Stormwater BMPS



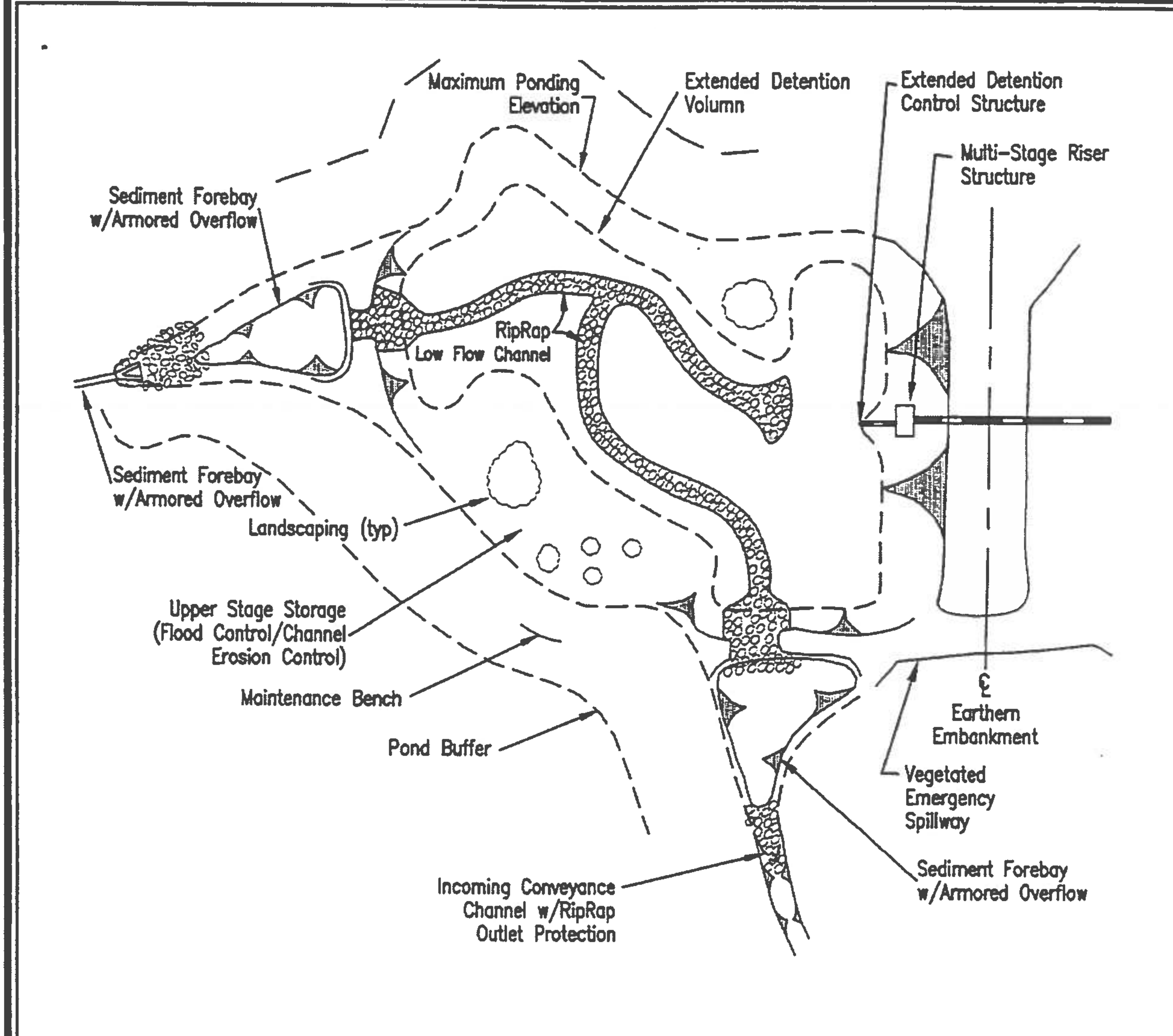
Source: Virginia Stormwater Management Handbook. 1999.

FIGURE 3.06 - 1
Retention Basin - Plan & Section



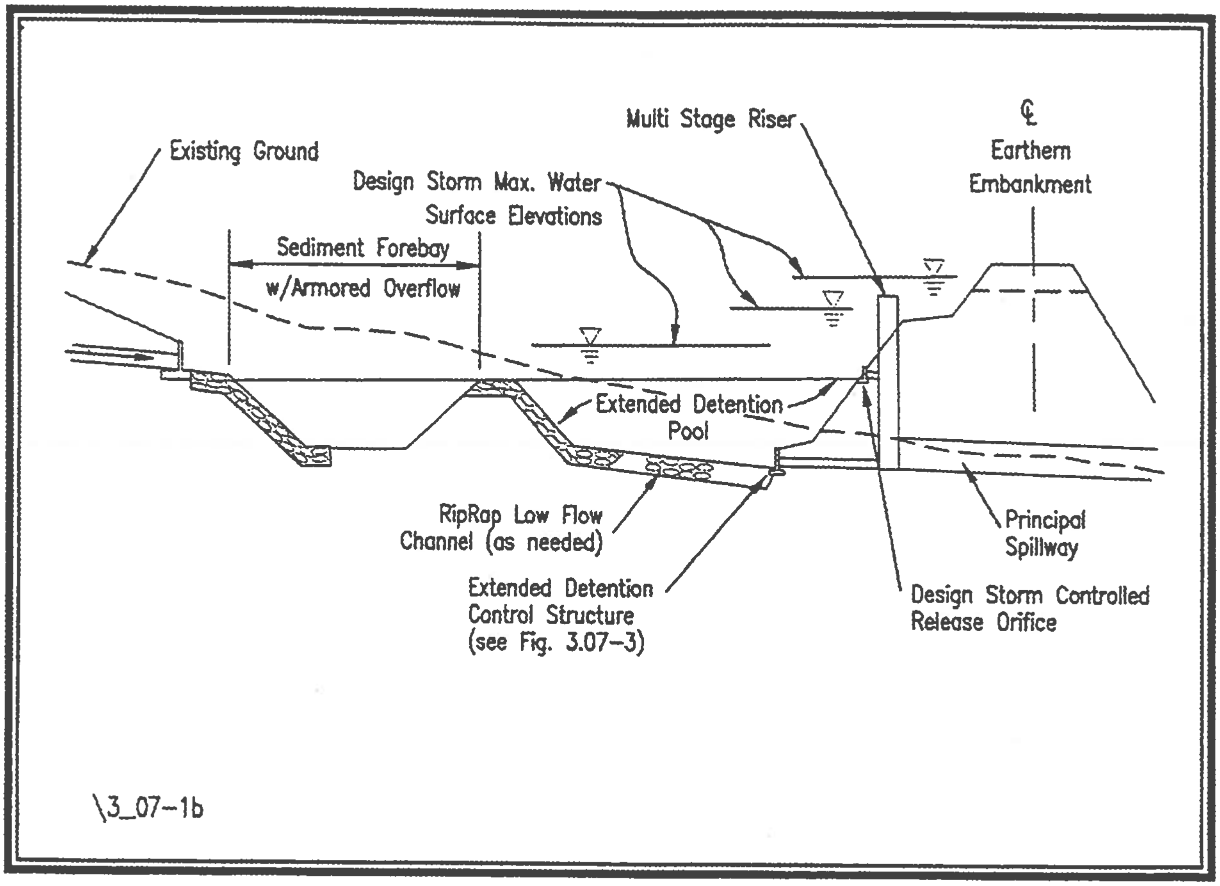
Source: Virginia Stormwater Management Handbook. 1999.

FIGURE 3.07 - 1a
Extended-Detention Basin - Plan



Source: Virginia Stormwater Management Handbook, 1999.

FIGURE 3.07-1b
Extended-Detention Basin - Section



Flood Control

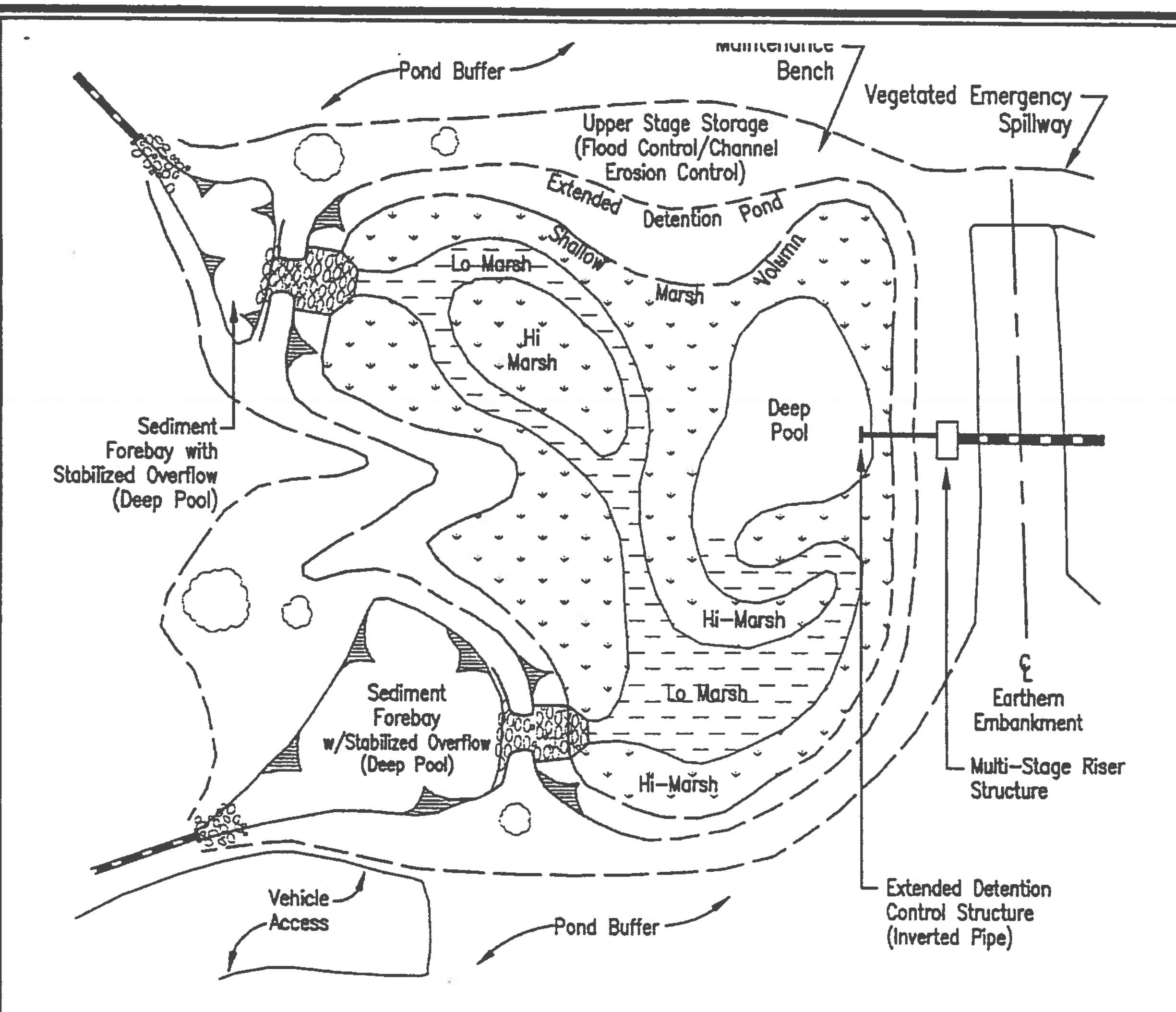
Extended-detention basins can be designed for flood control by providing additional storage above the extended-detention volume, and by reducing the peak rate of runoff from the drainage area. The design storms chosen for flood control are usually specified by ordinance, or are based on specific watershed conditions. By managing multiple storms, such as the 2- and 10-year storms, adequate flood control may be provided for a broad range of storm events.

The additional volume required for storage above the extended-detention volume can be readily determined using the hydrologic methods discussed in **Chapter 4, Hydrologic Methods**. Once this volume is known, a control or spillway structure can be designed and the reservoir routing and channel capacity design techniques discussed in **Chapter 5, Engineering Calculations**.

Source: Virginia Stormwater Management Handbook, 1999.

FIGURE 3.07 - 2a

Enhanced Extended-Detention Basin - Plan



Depth Zone	% of Surface Areas
Deep Pool	20%
Lo Marsh	35%
Hi Marsh	45%

\3_07-2a

Source: Virginia Stormwater Management Handbook, 1999.

FIGURE 3.07 - 2b
Enhanced Extended-Detention Basin - Section

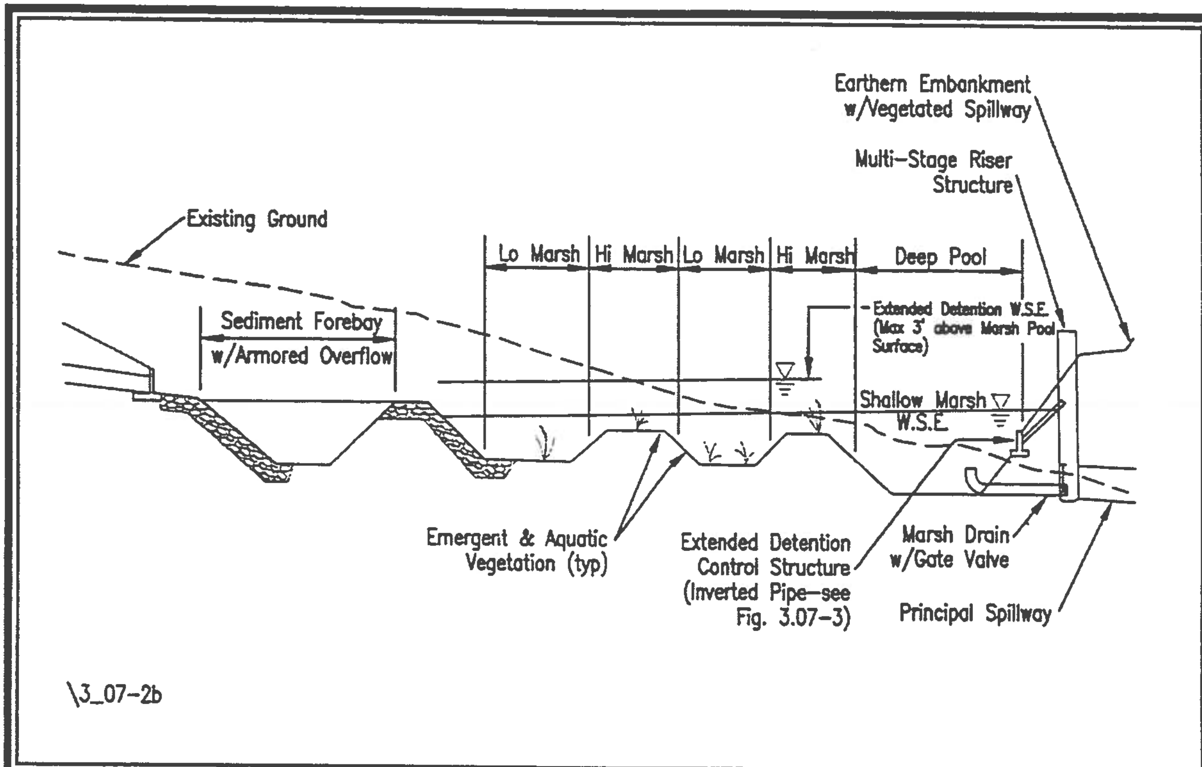


TABLE 3.07 - 1
Pollutant Removal Efficiencies for
Extended-Detention & Enhanced Extended-Detention Basins

Type	Target Phosphorus Removal Efficiency	Impervious Cover
Extended-detention (30 *hr*. Drawdown of 2 × WQ Volume)	35%	22 - 37%
Enhanced extended-detention (30-*hr*. Drawdown of 1 × WQ Volume, and 1 × WQ Volume Shallow Marsh)	50%	38 - 66%

Source: Virginia Stormwater Management Handbook, 1999.

BMP/Design	SUSPENDED SEDIMENT	TOTAL PHOSPHORUS	TOTAL NITROGEN	OXYGEN DEMAND	TRACE METALS	BACTERIA	OVERALL REMOVAL CAPABILITY
EXTENDED DETENTION POND							
DESIGN 1	◕	◔	◔	◔	◑	⊗	MODERATE
DESIGN 2	●	◑	◔	◑	◕	⊗	MODERATE
DESIGN 3	●	◕	◑	◑	◕	⊗	HIGH
WET POND							
DESIGN 4	◕	◑	◔	◔	◔	⊗	MODERATE
DESIGN 5	◕	◑	◔	◔	◕	⊗	MODERATE
DESIGN 6	●	◕	◑	◑	◕	⊗	HIGH
INFILTRATION TRENCH							
DESIGN 7	◕	◑	◑	◕	◕	◕	MODERATE
DESIGN 8	●	◑	◑	◕	●	◕	HIGH
DESIGN 9	●	◕	◕	●	●	●	HIGH
INFILTRATION BASIN							
DESIGN 7	◕	◑	◑	◕	◑	◕	MODERATE
DESIGN 8	●	◑	◑	◕	●	◕	HIGH
DESIGN 9	●	◕	◕	●	●	●	HIGH
POROUS PAVEMENT							
DESIGN 7	◑	◕	◑	◕	◑	◕	MODERATE
DESIGN 8	●	◕	◕	◕	●	●	HIGH
DESIGN 9	●	◕	◕	●	●	●	HIGH
WATER QUALITY INLET							
DESIGN 10	○	⊗	⊗	⊗	⊗	⊗	LOW
FILTER STRIP							
DESIGN 11	◔	○	○	○	◔	⊗	LOW
DESIGN 12	●	◑	◑	◕	●	⊗	MODERATE
GRASSED SWALE							
DESIGN 13	○	○	○	○	○	⊗	LOW
DESIGN 14	◔	◔	◔	◔	○	⊗	LOW

Design 1: First-flush runoff volume detained for 6-12 hours.
Design 2: Runoff volume produced by 1.0 inch, detained 24 hours.
Design 3: As in Design 2, but with shallow marsh in bottom stage.
Design 4: Permanent pool equal to 0.5 inch storage per impervious acre.
Design 5: Permanent pool equal to 2.5 (Vr); where Vr mean storm runoff.
Design 6: Permanent pool equal to 4.0 (Vr); approx. 2 weeks retention.
Design 7: Facility exfiltrates first-flush; 0.5 inch runoff/impervious acre.
Design 8: Facility exfiltrates one inch runoff volume per impervious acre.
Design 9: Facility exfiltrates all runoff up to the 2 year design storm.
Design 10: 400 cubic feet wet storage per impervious acre.
Design 11: 20 foot wide turf strip.
Design 12: 100 foot wide forested strip, with level spreader.
Design 13: High slope swales, with no check dams.
Design 14: Low gradient swales with check dams.

KEY:
- ○ 0 TO 20% REMOVAL
- ◔ 20 TO 40% REMOVAL
- ◑ 40 TO 60% REMOVAL
- ◕ 60 TO 80% REMOVAL
- ● 80 TO 100% REMOVAL
- ⊗ INSUFFICIENT KNOWLEDGE

FIGURE 15.30 Comparative pollutant removal of urban BMP designs. (Courtesy of Galli, John 1982. *Analysis of Urban BMP Performance and Longevity in Prince George's County, Maryland.* Washington, D.C.: Metropolitan Washington Council of Governments, 777 No. Capitol St. NE, Ste 300, Washington, DC 20002-4226. 202/962-3256.)

Source: Land Development Hanbook, Dewberry & Davis. 1996.

APPENDIX C

CALCULATIONS

ROANOKE COUNTY REGIONAL STORMWATER MANAGEMENT FACILITY

Job File: N:\PROJECTS\99\99074\ENGINEER\PONDPACK\PRE-DEVELOPED.PPW
Rain Dir: D:\ENGINEER\HAESTAD\PPKW\RAINFALL\

==========================
JOB TITLE
==========================

Predeveloped Watershed

Table of Contents

******************** RUNOFF HYDROGRAPHS ********************

SCS UNIT HYDROGRAPH METHOD

STORM EVENT: 2 year storm
Duration = 24.0000 hrs Rain Depth = 3.5000 in
Rain Dir = D:\ENGINEER\HAESTAD\PPKW\RAINFALL\
Rain File -ID = SCSTYPES.RNF - TypeII 24hr
Unit Hyd Type = Default Curvilinear
HYG Dir = N:\PROJECTS\99\99074\ENGINEER\PONDPACK\
HYG File - ID = PREDVLPD.HYG - PREDEVELOPED Pre..2
Tc = .5200 hrs
Drainage Area = 1040.000 acres Runoff CN= 53

==
Computational Time Increment = .06933 hrs
Computed Peak Time = 12.3413 hrs
Computed Peak Flow = 99.12 cfs

Time Increment for HYG File = .0500 hrs
Peak Time, Interpolated Output = 12.3500 hrs
Peak Flow, Interpolated Output = 98.92 cfs
==

DRAINAGE AREA

ID:None Selected
CN = 53
Area = 1040.000 acres
S = 8.8679 in
0.2S = 1.7736 in

Cumulative Runoff

.2813 in
24.382 ac-ft

HYG Volume... 24.383 ac-ft (area under HYG curve)

***** UNIT HYDROGRAPH PARAMETERS *****

Time Concentration, Tc = .52000 hrs (ID: None Selected)
Computational Incr, Tm = .06933 hrs = 0.20000 Tp

Unit Hyd. Shape Factor = 483.432 (37.46% under rising limb)
K = 483.43/645.333, K = .7491 (also, K = 2/(1+(Tr/Tp))
Receding/Rising, Tr/Tp = 1.6698 (solved from K = .7491)

Unit peak, qp = 2266.09 cfs
Unit peak time Tp = .34667 hrs
Unit receding limb, Tr = 1.38667 hrs
Total unit time, Tb = 1.73333 hrs

SCS UNIT HYDROGRAPH METHOD

STORM EVENT: 10 year storm
Duration = 24.0000 hrs Rain Depth = 5.0000 in
Rain Dir = D:\ENGINEER\HAESTAD\PPKW\RAINFALL\
Rain File -ID = SCSTYPES.RNF - TypeII 24hr
Unit Hyd Type = Default Curvilinear
HYG Dir = N:\PROJECTS\99\99074\ENGINEER\PONDPACK\
HYG File - ID = PREDVLPD.HYG - PREDEVELOPED Pre.10
Tc = .5200 hrs
Drainage Area = 1040.000 acres Runoff CN= 53

==
Computational Time Increment = .06933 hrs
Computed Peak Time = 12.2720 hrs
Computed Peak Flow = 545.23 cfs

Time Increment for HYG File = .0500 hrs
Peak Time, Interpolated Output = 12.2500 hrs
Peak Flow, Interpolated Output = 539.50 cfs
==

DRAINAGE AREA

ID:None Selected
CN = 53
Area = 1040.000 acres
S = 8.8679 in
0.2S = 1.7736 in

Cumulative Runoff

.8607 in
74.595 ac-ft

HYG Volume... 74.597 ac-ft (area under HYG curve)

***** UNIT HYDROGRAPH PARAMETERS *****

Time Concentration, Tc = .52000 hrs (ID: None Selected)
Computational Incr, Tm = .06933 hrs = 0.20000 Tp

Unit Hyd. Shape Factor = 483.432 (37.46% under rising limb)
K = 483.43/645.333, K = .7491 (also, K = 2/(1+(Tr/Tp))
Receding/Rising, Tr/Tp = 1.6698 (solved from K = .7491)

Unit peak, qp = 2266.09 cfs
Unit peak time Tp = .34667 hrs
Unit receding limb, Tr = 1.38667 hrs
Total unit time, Tb = 1.73333 hrs

SCS UNIT HYDROGRAPH METHOD

STORM EVENT: 25 year storm
Duration = 24.0000 hrs Rain Depth = 6.0000 in
Rain Dir = D:\ENGINEER\HAESTAD\PPKW\RAINFALL\
Rain File -ID = SCSTYPES.RNF - TypeII 24hr
Unit Hyd Type = Default Curvilinear
HYG Dir = N:\PROJECTS\99\99074\ENGINEER\PONDPACK\
HYG File - ID = PREDVLPD.HYG - PREDEVELOPED Pre.25
Tc = .5200 hrs
Drainage Area = 1040.000 acres Runoff CN= 53

==
Computational Time Increment = .06933 hrs
Computed Peak Time = 12.2720 hrs
Computed Peak Flow = 974.76 cfs

Time Increment for HYG File = .0500 hrs
Peak Time, Interpolated Output = 12.2500 hrs
Peak Flow, Interpolated Output = 974.52 cfs
==

DRAINAGE AREA

ID:None Selected
CN = 53
Area = 1040.000 acres
S = 8.8679 in
0.2S = 1.7736 in

Cumulative Runoff

1.3641 in
118.226 ac-ft

HYG Volume... 118.228 ac-ft (area under HYG curve)

***** UNIT HYDROGRAPH PARAMETERS *****

Time Concentration, Tc = .52000 hrs (ID: None Selected)
Computational Incr, Tm = .06933 hrs = 0.20000 Tp

Unit Hyd. Shape Factor = 483.432 (37.46% under rising limb)
K = 483.43/645.333, K = .7491 (also, K = 2/(1+(Tr/Tp))
Receding/Rising, Tr/Tp = 1.6698 (solved from K = .7491)

Unit peak, qp = 2266.09 cfs
Unit peak time Tp = .34667 hrs
Unit receding limb, Tr = 1.38667 hrs
Total unit time, Tb = 1.73333 hrs

SCS UNIT HYDROGRAPH METHOD

STORM EVENT: 100 year storm
Duration = 24.0000 hrs Rain Depth = 7.5000 in
Rain Dir = D:\ENGINEER\HAESTAD\PPKW\RAINFALL\
Rain File -ID = SCSTYPES.RNF - TypeII 24hr
Unit Hyd Type = Default Curvilinear
HYG Dir = N:\PROJECTS\99\99074\ENGINEER\PONDPACK\
HYG File - ID = PREDVLPD.HYG - PREDEVELOPED Pre100
Tc = .5200 hrs
Drainage Area = 1040.000 acres Runoff CN= 53

==
Computational Time Increment = .06933 hrs
Computed Peak Time = 12.2027 hrs
Computed Peak Flow = 1776.03 cfs

Time Increment for HYG File = .0500 hrs
Peak Time, Interpolated Output = 12.2000 hrs
Peak Flow, Interpolated Output = 1770.39 cfs
==

DRAINAGE AREA

ID:None Selected
CN = 53
Area = 1040.000 acres
S = 8.8679 in
0.2S = 1.7736 in

Cumulative Runoff

2.2469 in
194.730 ac-ft

HYG Volume... 194.734 ac-ft (area under HYG curve)

***** UNIT HYDROGRAPH PARAMETERS *****

Time Concentration, Tc = .52000 hrs (ID: None Selected)
Computational Incr, Tm = .06933 hrs = 0.20000 Tp

Unit Hyd. Shape Factor = 483.432 (37.46% under rising limb)
K = 483.43/645.333, K = .7491 (also, K = 2/(1+(Tr/Tp))
Receding/Rising, Tr/Tp = 1.6698 (solved from K = .7491)

Unit peak, qp = 2266.09 cfs
Unit peak time Tp = .34667 hrs
Unit receding limb, Tr = 1.38667 hrs
Total unit time, Tb = 1.73333 hrs

Index of Starting Page Numbers for ID Names

Job File: N:\PROJECTS\99\99074\ENGINEER\PONDPACK\DEVELOPED.PPW
Rain Dir: D:\ENGINEER\HAESTAD\PPKW\RAINFALL\

==========================
JOB TITLE
==========================

Future Developed Watershed based on Dewberry Davis Study

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Table of Contents (continued)

SCS UNIT HYDROGRAPH METHOD

STORM EVENT: 100 year storm
Duration = 24.0000 hrs Rain Depth = 7.5000 in
Rain Dir = D:\ENGINEER\HAESTAD\PPKW\RAINFALL\
Rain File -ID = SCSTYPES.RNF - TypeII 24hr
Unit Hyd Type = Default Curvilinear
HYG Dir = N:\PROJECTS\99\99074\ENGINEER\PONDPACK\
HYG File - ID = ROUTING.HYG - DEVELOPED 100yr
Tc = .4800 hrs
Drainage Area = 1040.000 acres Runoff CN= 64

==
Computational Time Increment = .06400 hrs
Computed Peak Time = 12.1600 hrs
Computed Peak Flow = 3015.98 cfs

Time Increment for HYG File = .0500 hrs
Peak Time, Interpolated Output = 12.2000 hrs
Peak Flow, Interpolated Output = 2978.61 cfs
==

DRAINAGE AREA

ID:None Selected
CN = 64
Area = 1040.000 acres
S = 5.6250 in
0.2S = 1.1250 in

Cumulative Runoff

3.3867 in
293.516 ac-ft

HYG Volume... 293.513 ac-ft (area under HYG curve)

***** UNIT HYDROGRAPH PARAMETERS *****

Time Concentration, Tc = .48000 hrs (ID: None Selected)
Computational Incr, Tm = .06400 hrs = 0.20000 Tp

Unit Hyd. Shape Factor = 483.432 (37.46% under rising limb)
K = 483.43/645.333, K = .7491 (also, K = 2/(1+(Tr/Tp))
Receding/Rising, Tr/Tp = 1.6698 (solved from K = .7491)

Unit peak, qp = 2454.93 cfs
Unit peak time Tp = .32000 hrs
Unit receding limb, Tr = 1.28000 hrs
Total unit time, Tb = 1.60000 hrs

SCS UNIT HYDROGRAPH METHOD

STORM EVENT: 10 year storm
Duration = 24.0000 hrs Rain Depth = 5.0000 in
Rain Dir = D:\ENGINEER\HAESTAD\PPKW\RAINFALL\
Rain File -ID = SCSTYPES.RNF - TypeII 24hr
Unit Hyd Type = Default Curvilinear
HYG Dir = N:\PROJECTS\99\99074\ENGINEER\PONDPACK\
HYG File - ID = ROUTING.HYG - DEVELOPED 10yr
Tc = .4800 hrs
Drainage Area = 1040.000 acres Runoff CN= 64

==
Computational Time Increment = .06400 hrs
Computed Peak Time = 12.2240 hrs
Computed Peak Flow = 1317.76 cfs

Time Increment for HYG File = .0500 hrs
Peak Time, Interpolated Output = 12.2000 hrs
Peak Flow, Interpolated Output = 1316.14 cfs
==

DRAINAGE AREA

ID:None Selected
CN = 64
Area = 1040.000 acres
S = 5.6250 in
0.2S = 1.1250 in

Cumulative Runoff

1.5806 in
136.985 ac-ft

HYG Volume... 136.984 ac-ft (area under HYG curve)

***** UNIT HYDROGRAPH PARAMETERS *****

Time Concentration, Tc = .48000 hrs (ID: None Selected)
Computational Incr, Tm = .06400 hrs = 0.20000 Tp

Unit Hyd. Shape Factor = 483.432 (37.46% under rising limb)
K = 483.43/645.333, K = .7491 (also, K = 2/(1+(Tr/Tp))
Receding/Rising, Tr/Tp = 1.6698 (solved from K = .7491)

Unit peak, qp = 2454.93 cfs
Unit peak time Tp = .32000 hrs
Unit receding limb, Tr = 1.28000 hrs
Total unit time, Tb = 1.60000 hrs

SCS UNIT HYDROGRAPH METHOD

STORM EVENT: 25 year storm
Duration = 24.0000 hrs Rain Depth = 6.0000 in
Rain Dir = D:\ENGINEER\HAESTAD\PPKW\RAINFALL\
Rain File -ID = SCSTYPES.RNF - TypeII 24hr
Unit Hyd Type = Default Curvilinear
HYG Dir = N:\PROJECTS\99\99074\ENGINEER\PONDPACK\
HYG File - ID = ROUTING.HYG - DEVELOPED 25yr
Tc = .4800 hrs
Drainage Area = 1040.000 acres Runoff CN= 64

==
Computational Time Increment = .06400 hrs
Computed Peak Time = 12.1600 hrs
Computed Peak Flow = 1960.01 cfs

Time Increment for HYG File = .0500 hrs
Peak Time, Interpolated Output = 12.2000 hrs
Peak Flow, Interpolated Output = 1948.85 cfs
==

DRAINAGE AREA

ID:None Selected
CN = 64
Area = 1040.000 acres
S = 5.6250 in
0.2S = 1.1250 in

Cumulative Runoff

2.2634 in
196.161 ac-ft

HYG Volume... 196.160 ac-ft (area under HYG curve)

***** UNIT HYDROGRAPH PARAMETERS *****

Time Concentration, Tc = .48000 hrs (ID: None Selected)
Computational Incr, Tm = .06400 hrs = 0.20000 Tp

Unit Hyd. Shape Factor = 483.432 (37.46% under rising limb)
K = 483.43/645.333, K = .7491 (also, K = 2/(1+(Tr/Tp))
Receding/Rising, Tr/Tp = 1.6698 (solved from K = .7491)

Unit peak, qp = 2454.93 cfs
Unit peak time Tp = .32000 hrs
Unit receding limb, Tr = 1.28000 hrs
Total unit time, Tb = 1.60000 hrs

SCS UNIT HYDROGRAPH METHOD

STORM EVENT: 2 year storm
Duration = 24.0000 hrs Rain Depth = 3.5000 in
Rain Dir = D:\ENGINEER\HAESTAD\PPKW\RAINFALL\
Rain File -ID = SCSTYPES.RNF - TypeII 24hr
Unit Hyd Type = Default Curvilinear
HYG Dir = N:\PROJECTS\99\99074\ENGINEER\PONDPACK\
HYG File - ID = ROUTING.HYG - DEVELOPED 2yr
Tc = .4800 hrs
Drainage Area = 1040.000 acres Runoff CN= 64

===
Computational Time Increment = .06400 hrs
Computed Peak Time = 12.2240 hrs
Computed Peak Flow = 509.28 cfs

Time Increment for HYG File = .0500 hrs
Peak Time, Interpolated Output = 12.2000 hrs
Peak Flow, Interpolated Output = 500.01 cfs
WARNING: The difference between calculated peak flow
and interpolated peak flow is greater than 1.50%
===

DRAINAGE AREA

ID:None Selected
CN = 64
Area = 1040.000 acres
S = 5.6250 in
0.2S = 1.1250 in

Cumulative Runoff

.7051 in
61.107 ac-ft

HYG Volume... 61.107 ac-ft (area under HYG curve)

***** UNIT HYDROGRAPH PARAMETERS *****

Time Concentration, Tc = .48000 hrs (ID: None Selected)
Computational Incr, Tm = .06400 hrs = 0.20000 Tp

Unit Hyd. Shape Factor = 483.432 (37.46% under rising limb)
K = 483.43/645.333, K = .7491 (also, K = 2/(1+(Tr/Tp))
Receding/Rising, Tr/Tp = 1.6698 (solved from K = .7491)

Unit peak, qp = 2454.93 cfs
Unit peak time Tp = .32000 hrs
Unit receding limb, Tr = 1.28000 hrs
Total unit time, Tb = 1.60000 hrs

Type.... Vol: Planimeter
Name.... COMBINED

File.... N:\PROJECTS\99\99074\ENGINEER\PONDPACK\DEVELOPED.PPW
Title... Combined Volume of Forebay and BMP2

POND VOLUME CALCULATIONS

Planimeter scale: 1.00 ft/in

Elevation (ft)	Planimeter (sq.in)	Area (acres)	A1+A2+sqr(A1*A2) (acres)	Volume (ac-ft)	Volume Sum (ac-ft)
1096.00	100.000	.0023	.0000	.000	.000
1098.00	3317.900	.0762	.0917	.061	.061
1100.00	19770.800	.4539	.7160	.477	.538
1102.00	36518.500	.8383	1.9091	1.273	1.811
1104.00	50302.700	1.1548	2.9771	1.985	3.796
1106.00	66539.000	1.5275	4.0105	2.674	6.470
1108.00	84398.600	1.9375	5.1854	3.457	9.926
1110.00	103050.600	2.3657	6.4442	4.296	14.223
1112.00	126965.900	2.9147	7.9064	5.271	19.493
1114.00	157524.800	3.6163	9.7776	6.518	26.012
1116.00	185486.300	4.2582	11.7986	7.866	33.878
1118.00	215502.000	4.9472	13.7952	9.197	43.074
1120.00	252308.500	5.7922	16.0925	10.728	53.803
1122.00	273693.900	6.2831	18.1080	12.072	65.875

POND VOLUME EQUATIONS

* Incremental volume computed by the Conic Method for Reservoir Volumes.

Volume = (1/3) * (EL2-EL1) * (Area1 + Area2 + sq.rt.(Area1*Area2))

where: EL1, EL2 = Lower and upper elevations of the increment
Area1,Area2 = Areas computed for EL1, EL2, respectively
Volume = Incremental volume between EL1 and EL2

File.... N:\PROJECTS\99\99074\ENGINEER\PONDPACK\DEVELOPED.PPW
Title... Multi-Stage Outlet for the 2-2, 10-10, and pass the
100 year post

REQUESTED POND WS ELEVATIONS:

Min. Elev.= 1096.00 ft
Increment = .50 ft
Max. Elev.= 1121.50 ft

Spot Elevations, ft
1121.15
1114.60
1119.80

****
OUTLET CONNECTIVITY
****

---> Forward Flow Only (UpStream to DnStream)
<--- Reverse Flow Only (DnStream to UpStream)
<---> Forward and Reverse Both Allowed

Structure	No.		Outfall	E1, ft	E2, ft
Weir-XY Points	wr	--->	TW	1115.000	1121.500
Orifice-Circular	DD	--->	TW	1096.000	1121.500
TW SETUP, DS Channel					

File.... N:\PROJECTS\99\99074\ENGINEER\PONDPACK\DEVELOPED.PPW
Title... Multi-Stage Outlet for the 2-2, 10-10, and pass the
100 year post

OUTLET STRUCTURE INPUT DATA

Structure ID = wr
Structure Type = Weir-XY Points

# of Openings = 1
WEIR X-Y GROUND POINTS

X, ft	Elev, ft
.00	1121.50
1.00	1119.00
79.00	1119.00
80.00	1115.00
100.00	1115.00
101.00	1119.00
179.00	1119.00
180.00	1121.50

Lowest Elev. = 1115.00 ft

Weir Coeff. = 3.330000

Weir TW effects (Use adjustment equation)

Structure ID = DD
Structure Type = Orifice-Circular

# of Openings = 1
Invert Elev. = 1096.00 ft
Diameter = 1.0000 ft
Orifice Coeff. = .600

Structure ID = TW
Structure Type = TW SETUP, DS Channel

FREE OUTFALL CONDITIONS SPECIFIED

CONVERGENCE TOLERANCES...
Maximum Iterations= 30
Min. TW tolerance = .01 ft
Max. TW tolerance = .01 ft
Min. HW tolerance = .01 ft
Max. HW tolerance = .01 ft
Min. Q tolerance = .10 cfs
Max. Q tolerance = .10 cfs

File.... N:\PROJECTS\99\99074\ENGINEER\PONDPACK\DEVELOPED.PPW
Title... Multi-Stage Outlet for the 2-2, 10-10, and pass the
100 year post

***** COMPOSITE OUTFLOW SUMMARY ****

WS Elev, Total Q		Converge		Notes
Elev. ft	Q cfs	TW Elev ft	Error +/-ft	Contributing Structures
1096.00	.00	Free Outfall		None contributing
1096.50	.76	Free Outfall		DD
1097.00	2.67	Free Outfall		DD
1097.50	3.78	Free Outfall		DD
1098.00	4.63	Free Outfall		DD
1098.50	5.35	Free Outfall		DD
1099.00	5.98	Free Outfall		DD
1099.50	6.55	Free Outfall		DD
1100.00	7.07	Free Outfall		DD
1100.50	7.56	Free Outfall		DD
1101.00	8.02	Free Outfall		DD
1101.50	8.45	Free Outfall		DD
1102.00	8.87	Free Outfall		DD
1102.50	9.26	Free Outfall		DD
1103.00	9.64	Free Outfall		DD
1103.50	10.00	Free Outfall		DD
1104.00	10.35	Free Outfall		DD
1104.50	10.69	Free Outfall		DD
1105.00	11.02	Free Outfall		DD
1105.50	11.34	Free Outfall		DD
1106.00	11.65	Free Outfall		DD
1106.50	11.95	Free Outfall		DD
1107.00	12.25	Free Outfall		DD
1107.50	12.54	Free Outfall		DD
1108.00	12.82	Free Outfall		DD
1108.50	13.09	Free Outfall		DD
1109.00	13.36	Free Outfall		DD
1109.50	13.63	Free Outfall		DD
1110.00	13.89	Free Outfall		DD
1110.50	14.14	Free Outfall		DD
1111.00	14.39	Free Outfall		DD
1111.50	14.64	Free Outfall		DD
1112.00	14.88	Free Outfall		DD
1112.50	15.12	Free Outfall		DD
1113.00	15.36	Free Outfall		DD
1113.50	15.59	Free Outfall		DD
1114.00	15.81	Free Outfall		DD
1114.50	16.04	Free Outfall		DD

***** COMPOSITE OUTFLOW SUMMARY ****

WS Elev, Total Q		Converge		Notes
Elev. ft	Q cfs	TW Elev ft	Error +/-ft	Contributing Structures
1114.60	16.08	Free Outfall		DD
1115.00	16.26	Free Outfall		wr +DD
1115.50	40.13	Free Outfall		wr +DD
1116.00	83.88	Free Outfall		wr +DD
1116.50	140.88	Free Outfall		wr +DD
1117.00	208.82	Free Outfall		wr +DD
1117.50	286.40	Free Outfall		wr +DD
1118.00	372.77	Free Outfall		wr +DD
1118.50	467.31	Free Outfall		wr +DD
1119.00	569.57	Free Outfall		wr +DD
1119.50	864.05	Free Outfall		wr +DD
1119.80	1122.13	Free Outfall		wr +DD
1120.00	1317.96	Free Outfall		wr +DD
1120.50	1878.12	Free Outfall		wr +DD
1121.00	2525.45	Free Outfall		wr +DD
1121.15	2734.91	Free Outfall		wr +DD
1121.50	3248.89	Free Outfall		wr +DD

DIVERTED HYDROGRAPH...
HYG file = N:\PROJECTS\99\99074\ENGINEER\PONDPACK\ROUTING.HYG
HYG ID = OUT
HYG Tag = 100yr

Peak Discharge = 2749.06 cfs
Time to Peak = 12.2500 hrs
HYG Volume = 293.513 ac-ft

HYDROGRAPH ORDINATES (cfs)
Output Time increment = .0500 hrs
Time on left represents time for first value in each row.

Time hrs					
9.1000	.00	.00	.02	.06	.16
9.3500	.33	.60	.97	1.44	2.02
9.6000	2.68	2.97	3.39	3.85	4.18
9.8500	4.58	4.85	5.15	5.43	5.64
10.1000	5.90	6.10	6.30	6.52	6.70
10.3500	6.88	7.08	7.25	7.44	7.62
10.6000	7.80	8.00	8.18	8.37	8.55
10.8500	8.74	8.93	9.12	9.32	9.52
11.1000	9.72	9.93	10.13	10.35	10.56
11.3500	10.78	11.01	11.24	11.48	11.72
11.6000	11.98	12.27	12.59	12.98	13.46
11.8500	14.05	14.75	15.54	30.36	246.14
12.1000	593.09	1676.46	2463.46	2749.06	2729.34
12.3500	2545.56	2293.53	2020.47	1770.79	1554.93
12.6000	1363.89	1210.62	1081.92	972.55	873.61
12.8500	806.01	743.97	686.43	634.52	588.55
13.1000	560.90	544.70	527.46	509.71	491.87
13.3500	474.24	457.39	441.26	425.75	410.99
13.6000	397.03	383.84	371.44	360.21	349.51
13.8500	339.33	329.63	320.38	311.56	303.14
14.1000	295.09	287.39	280.43	273.80	267.45
14.3500	261.40	255.64	250.21	245.10	240.29
14.6000	235.79	231.56	227.58	223.85	220.32
14.8500	216.99	213.84	210.83	208.04	205.53
15.1000	203.08	200.70	198.38	196.11	193.88
15.3500	191.70	189.54	187.42	185.32	183.25
15.6000	181.19	179.15	177.13	175.12	173.12
15.8500	171.12	169.14	167.16	165.18	163.21
16.1000	161.25	159.30	157.36	155.45	153.57
16.3500	151.75	150.00	148.30	146.69	145.15
16.6000	143.68	142.29	140.97	139.85	138.78
16.8500	137.75	136.75	135.77	134.83	133.91
17.1000	133.02	132.14	131.29	130.45	129.63

HYDROGRAPH ORDINATES (cfs)
Output Time increment = .0500 hrs
Time on left represents time for first value in each row.

Time hrs					
17.3500	128.82	128.02	127.24	126.47	125.70
17.6000	124.94	124.19	123.45	122.71	121.98
17.8500	121.25	120.53	119.81	119.09	118.37
18.1000	117.65	116.94	116.23	115.52	114.81
18.3500	114.10	113.39	112.69	111.98	111.27
18.6000	110.57	109.86	109.15	108.45	107.74
18.8500	107.03	106.32	105.61	104.90	104.19
19.1000	103.48	102.77	102.06	101.35	100.64
19.3500	99.92	99.21	98.50	97.78	97.07
19.6000	96.35	95.63	94.91	94.19	93.48
19.8500	92.76	92.03	91.31	90.59	89.87
20.1000	89.15	88.43	87.72	87.01	86.33
20.3500	85.66	85.02	84.40	83.83	83.39
20.6000	82.96	82.55	82.15	81.78	81.42
20.8500	81.07	80.75	80.44	80.14	79.85
21.1000	79.58	79.32	79.06	78.82	78.59
21.3500	78.36	78.15	77.94	77.73	77.53
21.6000	77.34	77.15	76.97	76.79	76.61
21.8500	76.44	76.27	76.11	75.94	75.78
22.1000	75.62	75.46	75.31	75.15	75.00
22.3500	74.85	74.70	74.55	74.40	74.26
22.6000	74.11	73.97	73.82	73.68	73.54
22.8500	73.39	73.25	73.11	72.97	72.83
23.1000	72.69	72.55	72.41	72.27	72.13
23.3500	71.99	71.85	71.71	71.57	71.43
23.6000	71.29	71.15	71.01	70.87	70.73
23.8500	70.60	70.46	70.32	70.18	70.01
24.1000	69.72	69.21	68.36	67.02	65.16
24.3500	62.81	60.04	56.96	53.69	50.37
24.6000	47.06	43.83	40.72	38.75	37.07
24.8500	35.43	33.83	32.29	30.80	29.37
25.1000	28.00	26.68	25.42	24.22	23.06
25.3500	21.96	20.91	19.91	18.96	18.05
25.6000	17.18	16.36	16.25	16.24	16.24
25.8500	16.23	16.22	16.21	16.21	16.20
26.1000	16.19	16.18	16.18	16.17	16.16
26.3500	16.15	16.15	16.14	16.13	16.12
26.6000	16.11	16.11	16.10	16.09	16.08
26.8500	16.08	16.07	16.06	16.05	16.05
27.1000	16.04	16.03	16.02	16.01	16.01
27.3500	16.00	15.99	15.98	15.97	15.97
27.6000	15.96	15.95	15.94	15.93	15.93
27.8500	15.92	15.91	15.90	15.89	15.89
28.1000	15.88	15.87	15.86	15.85	15.85
28.3500	15.84	15.83	15.82	15.81	15.81
28.6000	15.80	15.79	15.78	15.77	15.76
28.8500	15.75	15.75	15.74	15.73	15.72

Type.... Diverted Hydrograph Page 4.03
Name.... OUT Event: 100 yr
File.... N:\PROJECTS\99\99074\ENGINEER\PONDPACK\
Storm... TypeII 24hr Tag: 100yr

HYDROGRAPH ORDINATES (cfs)

Output Time increment = .0500 hrs

Time on left represents time for first value in each row.

Time hrs					
29.1000	15.71	15.70	15.70	15.69	15.68
29.3500	15.67	15.66	15.65	15.65	15.64
29.6000	15.63	15.62	15.61	15.60	15.60
29.8500	15.59	15.58	15.57	15.56	15.55
30.1000	15.54	15.53	15.53	15.52	15.51
30.3500	15.50	15.49	15.48	15.47	15.46
30.6000	15.45	15.45	15.44	15.43	15.42
30.8500	15.41	15.40	15.39	15.38	15.38
31.1000	15.37	15.36	15.35	15.34	15.33
31.3500	15.32	15.31	15.30	15.29	15.28
31.6000	15.27	15.26	15.26	15.25	15.24
31.8500	15.23	15.22	15.21	15.20	15.19
32.1000	15.18	15.17	15.16	15.15	15.14
32.3500	15.13	15.13	15.12	15.11	15.10
32.6000	15.09	15.08	15.07	15.06	15.05
32.8500	15.04	15.03	15.02	15.01	15.00
33.1000	14.99	14.98	14.97	14.96	14.95
33.3500	14.94	14.93	14.92	14.91	14.90
33.6000	14.89	14.88	14.87	14.86	14.85
33.8500	14.84	14.83	14.82	14.81	14.80
34.1000	14.79	14.78	14.76	14.75	14.74
34.3500	14.73	14.72	14.71	14.70	14.69
34.6000	14.68	14.67	14.66	14.65	14.64
34.8500	14.63	14.62	14.61	14.60	14.59
35.1000	14.57	14.56	14.55	14.54	14.53
35.3500	14.52	14.51	14.50	14.49	14.48
35.6000	14.47	14.45	14.44	14.43	14.42
35.8500	14.41	14.40	14.39	14.38	14.37
36.1000	14.35	14.34	14.33	14.32	14.31
36.3500	14.30	14.29	14.27	14.26	14.25
36.6000	14.24	14.23	14.22	14.20	14.19
36.8500	14.18	14.17	14.16	14.15	14.14
37.1000	14.12	14.11	14.10	14.09	14.07
37.3500	14.06	14.05	14.04	14.03	14.01
37.6000	14.00	13.99	13.98	13.97	13.95
37.8500	13.94	13.93	13.92	13.90	13.89
38.1000	13.88	13.87	13.85	13.84	13.83
38.3500	13.82	13.80	13.79	13.78	13.76
38.6000	13.75	13.74	13.73	13.71	13.70
38.8500	13.69	13.68	13.66	13.65	13.64
39.1000	13.62	13.61	13.60	13.58	13.57
39.3500	13.56	13.54	13.53	13.52	13.50
39.6000	13.49	13.48	13.46	13.45	13.44
39.8500	13.42	13.41	13.40	13.38	13.37
40.1000	13.36	13.34	13.33	13.31	13.30
40.3500	13.28	13.27	13.26	13.24	13.23
40.6000	13.21	13.20	13.19	13.17	13.16

HYDROGRAPH ORDINATES (cfs)

Output Time increment = .0500 hrs

Time on left represents time for first value in each row.

Time hrs					
40.8500	13.14	13.13	13.12	13.10	13.09
41.1000	13.07	13.06	13.04	13.03	13.01
41.3500	13.00	12.98	12.97	12.95	12.94
41.6000	12.92	12.91	12.89	12.88	12.86
41.8500	12.85	12.83	12.82	12.80	12.79
42.1000	12.77	12.76	12.74	12.73	12.71
42.3500	12.69	12.68	12.66	12.65	12.63
42.6000	12.62	12.60	12.58	12.57	12.55
42.8500	12.54	12.52	12.50	12.49	12.47
43.1000	12.45	12.44	12.42	12.40	12.39
43.3500	12.37	12.35	12.34	12.32	12.30
43.6000	12.29	12.27	12.26	12.24	12.22
43.8500	12.20	12.18	12.17	12.15	12.13
44.1000	12.11	12.10	12.08	12.06	12.04
44.3500	12.03	12.01	11.99	11.97	11.96
44.6000	11.94	11.92	11.90	11.88	11.86
44.8500	11.84	11.82	11.81	11.79	11.77
45.1000	11.75	11.73	11.71	11.69	11.68
45.3500	11.66	11.64	11.62	11.60	11.58
45.6000	11.56	11.54	11.52	11.50	11.48
45.8500	11.46	11.44	11.42	11.40	11.38
46.1000	11.36	11.34	11.32	11.29	11.27
46.3500	11.25	11.23	11.21	11.19	11.17
46.6000	11.14	11.12	11.10	11.08	11.06
46.8500	11.04	11.02	10.99	10.97	10.95
47.1000	10.92	10.90	10.88	10.86	10.83
47.3500	10.81	10.79	10.76	10.74	10.72
47.6000	10.70	10.67	10.65	10.62	10.60
47.8500	10.57	10.55	10.52	10.50	10.47
48.1000	10.45	10.42	10.40	10.38	10.35
48.3500	10.32	10.30	10.27	10.24	10.22
48.6000	10.19	10.16	10.14	10.11	10.09
48.8500	10.06	10.03	10.01	9.98	9.95
49.1000	9.92	9.89	9.86	9.83	9.80
49.3500	9.78	9.75	9.72	9.69	9.66
49.6000	9.63	9.60	9.57	9.54	9.51
49.8500	9.48	9.45	9.42	9.38	9.35
50.1000	9.32	9.29	9.26	9.23	9.19
50.3500	9.16	9.13	9.09	9.06	9.02
50.6000	8.99	8.96	8.92	8.89	8.86
50.8500	8.82	8.78	8.74	8.70	8.67
51.1000	8.63	8.59	8.55	8.52	8.48
51.3500	8.44	8.40	8.35	8.31	8.26
51.6000	8.22	8.18	8.14	8.09	8.05
51.8500	8.00	7.95	7.90	7.85	7.80
52.1000	7.75	7.70	7.65	7.60	7.55
52.3500	7.49	7.43	7.37	7.31	7.25

HYDROGRAPH ORDINATES (cfs)

Time hrs	Output Time increment = .0500 hrs Time on left represents time for first value in each row.				
52.6000	7.19	7.13	7.07	7.00	6.92
52.8500	6.84	6.77	6.69	6.62	6.54
53.1000	6.43	6.32	6.22	6.11	6.01
53.3500	5.86	5.69	5.53	5.37	5.11
53.6000	4.83	4.52	4.03	3.39	2.58
53.8500	1.01	.35	.11	.04	.01
54.1000	.00	.00			

DIVERTED HYDROGRAPH...
HYG file = N:\PROJECTS\99\99074\ENGINEER\PONDPACK\ROUTING.HYG
HYG ID = OUT
HYG Tag = 10yr

Peak Discharge = 518.70 cfs
Time to Peak = 12.6500 hrs
HYG Volume = 136.984 ac-ft

HYDROGRAPH ORDINATES (cfs)

Output Time increment = .0500 hrs
Time on left represents time for first value in each row.

Time hrs					
10.8500	.00	.01	.03	.10	.27
11.1000	.62	1.14	1.92	2.81	3.43
11.3500	4.08	4.70	5.17	5.60	6.02
11.6000	6.40	6.79	7.24	7.78	8.44
11.8500	9.20	10.09	11.11	12.19	13.24
12.1000	14.24	15.11	15.85	36.87	145.91
12.3500	264.68	362.41	434.00	480.39	507.15
12.6000	518.49	518.70	510.76	497.00	479.28
12.8500	459.53	439.11	418.28	397.62	377.51
13.1000	358.93	341.41	324.78	309.06	294.28
13.3500	280.83	268.67	257.22	246.49	236.48
13.6000	227.15	218.48	210.39	203.35	196.84
13.8500	190.68	184.85	179.32	174.08	169.10
14.1000	164.36	159.85	155.55	151.47	147.59
14.3500	143.93	140.53	137.68	134.97	132.40
14.6000	129.96	127.66	125.47	123.40	121.44
14.8500	119.57	117.80	116.10	114.48	112.93
15.1000	111.44	110.00	108.61	107.26	105.96
15.3500	104.69	103.45	102.23	101.05	99.88
15.6000	98.73	97.60	96.48	95.38	94.28
15.8500	93.20	92.12	91.06	89.99	88.94
16.1000	87.89	86.84	85.81	84.79	83.80
16.3500	83.02	82.24	81.48	80.73	80.01
16.6000	79.30	78.62	77.96	77.33	76.71
16.8500	76.12	75.54	74.98	74.44	73.91
17.1000	73.40	72.90	72.41	71.94	71.47
17.3500	71.01	70.56	70.12	69.69	69.27
17.6000	68.84	68.43	68.02	67.61	67.21
17.8500	66.81	66.42	66.02	65.63	65.25
18.1000	64.86	64.48	64.09	63.71	63.33
18.3500	62.95	62.57	62.20	61.82	61.44
18.6000	61.07	60.69	60.32	59.94	59.56
18.8500	59.19	58.81	58.44	58.06	57.68

HYDROGRAPH ORDINATES (cfs)
Output Time increment = .0500 hrs
Time on left represents time for first value in each row.

Time hrs					
19.1000	57.31	56.93	56.55	56.18	55.80
19.3500	55.42	55.04	54.66	54.28	53.90
19.6000	53.52	53.14	52.76	52.38	51.99
19.8500	51.61	51.23	50.84	50.46	50.07
20.1000	49.69	49.30	48.92	48.54	48.17
20.3500	47.81	47.46	47.12	46.80	46.49
20.6000	46.20	45.92	45.65	45.40	45.17
20.8500	44.94	44.73	44.53	44.34	44.16
21.1000	43.99	43.83	43.68	43.53	43.39
21.3500	43.25	43.12	43.00	42.88	42.76
21.6000	42.65	42.55	42.44	42.34	42.24
21.8500	42.15	42.05	41.96	41.87	41.78
22.1000	41.70	41.61	41.53	41.44	41.36
22.3500	41.28	41.20	41.12	41.05	40.97
22.6000	40.89	40.82	40.74	40.67	40.59
22.8500	40.52	40.44	40.37	40.29	40.22
23.1000	40.15	40.10	40.05	40.01	39.96
23.3500	39.92	39.87	39.82	39.77	39.72
23.6000	39.67	39.61	39.56	39.50	39.45
23.8500	39.39	39.33	39.27	39.22	39.15
24.1000	39.04	38.86	38.56	38.10	37.46
24.3500	36.64	35.67	34.57	33.37	32.14
24.6000	30.87	29.61	28.36	27.12	25.92
24.8500	24.76	23.63	22.54	21.49	20.49
25.1000	19.52	18.60	17.72	16.88	16.26
25.3500	16.25	16.24	16.23	16.23	16.22
25.6000	16.21	16.20	16.20	16.19	16.18
25.8500	16.17	16.17	16.16	16.15	16.14
26.1000	16.13	16.13	16.12	16.11	16.10
26.3500	16.10	16.09	16.08	16.07	16.07
26.6000	16.06	16.05	16.04	16.03	16.03
26.8500	16.02	16.01	16.00	15.99	15.99
27.1000	15.98	15.97	15.96	15.95	15.95
27.3500	15.94	15.93	15.92	15.91	15.91
27.6000	15.90	15.89	15.88	15.87	15.87
27.8500	15.86	15.85	15.84	15.83	15.83
28.1000	15.82	15.81	15.80	15.79	15.79
28.3500	15.78	15.77	15.76	15.75	15.74
28.6000	15.74	15.73	15.72	15.71	15.70
28.8500	15.69	15.68	15.68	15.67	15.66
29.1000	15.65	15.64	15.63	15.63	15.62
29.3500	15.61	15.60	15.59	15.58	15.58
29.6000	15.57	15.56	15.55	15.54	15.53
29.8500	15.52	15.51	15.50	15.50	15.49
30.1000	15.48	15.47	15.46	15.45	15.44
30.3500	15.43	15.43	15.42	15.41	15.40
30.6000	15.39	15.38	15.37	15.36	15.36

HYDROGRAPH ORDINATES (cfs)

Output Time increment = .0500 hrs

Time on left represents time for first value in each row.

Time hrs					
30.8500	15.35	15.34	15.33	15.32	15.31
31.1000	15.30	15.29	15.28	15.27	15.26
31.3500	15.25	15.24	15.23	15.22	15.22
31.6000	15.21	15.20	15.19	15.18	15.17
31.8500	15.16	15.15	15.14	15.13	15.12
32.1000	15.11	15.10	15.09	15.08	15.07
32.3500	15.06	15.05	15.04	15.03	15.02
32.6000	15.01	15.00	14.99	14.98	14.97
32.8500	14.96	14.95	14.94	14.93	14.93
33.1000	14.92	14.91	14.90	14.89	14.88
33.3500	14.87	14.85	14.84	14.83	14.82
33.6000	14.81	14.80	14.79	14.78	14.77
33.8500	14.76	14.75	14.74	14.73	14.72
34.1000	14.71	14.70	14.69	14.68	14.67
34.3500	14.66	14.65	14.64	14.63	14.61
34.6000	14.60	14.59	14.58	14.57	14.56
34.8500	14.55	14.54	14.53	14.52	14.51
35.1000	14.49	14.48	14.47	14.46	14.45
35.3500	14.44	14.43	14.42	14.41	14.40
35.6000	14.39	14.37	14.36	14.35	14.34
35.8500	14.33	14.32	14.30	14.29	14.28
36.1000	14.27	14.26	14.25	14.24	14.22
36.3500	14.21	14.20	14.19	14.18	14.17
36.6000	14.15	14.14	14.13	14.12	14.11
36.8500	14.09	14.08	14.07	14.06	14.05
37.1000	14.03	14.02	14.01	14.00	13.99
37.3500	13.97	13.96	13.95	13.94	13.92
37.6000	13.91	13.90	13.89	13.88	13.86
37.8500	13.85	13.84	13.82	13.81	13.80
38.1000	13.79	13.77	13.76	13.75	13.73
38.3500	13.72	13.71	13.70	13.68	13.67
38.6000	13.66	13.65	13.63	13.62	13.61
38.8500	13.59	13.58	13.57	13.55	13.54
39.1000	13.52	13.51	13.50	13.48	13.47
39.3500	13.46	13.44	13.43	13.42	13.40
39.6000	13.39	13.38	13.36	13.35	13.34
39.8500	13.32	13.31	13.29	13.28	13.27
40.1000	13.25	13.24	13.22	13.21	13.19
40.3500	13.18	13.17	13.15	13.14	13.12
40.6000	13.11	13.10	13.08	13.07	13.05
40.8500	13.04	13.02	13.01	12.99	12.98
41.1000	12.96	12.95	12.93	12.92	12.90
41.3500	12.89	12.87	12.86	12.84	12.83
41.6000	12.81	12.80	12.78	12.77	12.75
41.8500	12.74	12.72	12.70	12.69	12.67
42.1000	12.66	12.64	12.63	12.61	12.59
42.3500	12.58	12.56	12.55	12.53	12.52

HYDROGRAPH ORDINATES (cfs)

Output Time increment = .0500 hrs

Time on left represents time for first value in each row.

Time hrs					
42.6000	12.50	12.48	12.46	12.45	12.43
42.8500	12.41	12.40	12.38	12.37	12.35
43.1000	12.33	12.32	12.30	12.28	12.27
43.3500	12.25	12.23	12.21	12.20	12.18
43.6000	12.16	12.14	12.13	12.11	12.09
43.8500	12.07	12.06	12.04	12.02	12.00
44.1000	11.99	11.97	11.95	11.93	11.91
44.3500	11.89	11.87	11.86	11.84	11.82
44.6000	11.80	11.78	11.76	11.74	11.72
44.8500	11.71	11.69	11.67	11.65	11.63
45.1000	11.61	11.59	11.57	11.55	11.53
45.3500	11.51	11.49	11.47	11.45	11.43
45.6000	11.41	11.39	11.37	11.35	11.33
45.8500	11.31	11.29	11.27	11.24	11.22
46.1000	11.20	11.18	11.16	11.14	11.12
46.3500	11.09	11.07	11.05	11.03	11.01
46.6000	10.99	10.96	10.94	10.92	10.89
46.8500	10.87	10.85	10.82	10.80	10.78
47.1000	10.76	10.73	10.71	10.69	10.66
47.3500	10.64	10.61	10.59	10.56	10.54
47.6000	10.51	10.49	10.46	10.44	10.42
47.8500	10.39	10.37	10.34	10.32	10.29
48.1000	10.26	10.23	10.21	10.18	10.16
48.3500	10.13	10.10	10.08	10.05	10.02
48.6000	10.00	9.97	9.94	9.91	9.88
48.8500	9.85	9.82	9.79	9.77	9.74
49.1000	9.71	9.68	9.65	9.62	9.59
49.3500	9.56	9.53	9.50	9.47	9.44
49.6000	9.40	9.37	9.34	9.31	9.28
49.8500	9.25	9.22	9.18	9.15	9.11
50.1000	9.08	9.05	9.01	8.98	8.95
50.3500	8.91	8.88	8.84	8.80	8.77
50.6000	8.73	8.69	8.65	8.62	8.58
50.8500	8.54	8.50	8.47	8.43	8.38
51.1000	8.34	8.29	8.25	8.21	8.16
51.3500	8.12	8.08	8.04	7.99	7.94
51.6000	7.88	7.83	7.78	7.73	7.68
51.8500	7.63	7.58	7.53	7.47	7.41
52.1000	7.35	7.29	7.23	7.17	7.11
52.3500	7.05	6.97	6.89	6.82	6.74
52.6000	6.67	6.59	6.50	6.39	6.29
52.8500	6.18	6.07	5.97	5.80	5.63
53.1000	5.47	5.30	5.01	4.74	4.34
53.3500	3.87	3.11	1.97	.77	.25
53.6000	.08	.03	.01	.00	

DIVERTED HYDROGRAPH...
HYG file = N:\PROJECTS\99\99074\ENGINEER\PONDPACK\ROUTING.HYG
HYG ID = OUT
HYG Tag = 25yr

Peak Discharge = 1399.77 cfs
Time to Peak = 12.4000 hrs
HYG Volume = 196.160 ac-ft

HYDROGRAPH ORDINATES (cfs)

Output Time increment = .0500 hrs

Time on left represents time for first value in each row.

Time hrs					
10.1500	.00	.00	.02	.06	.17
10.4000	.38	.72	1.17	1.80	2.65
10.6500	3.04	3.62	4.09	4.60	4.94
10.9000	5.36	5.63	5.96	6.21	6.49
11.1500	6.73	6.98	7.22	7.46	7.71
11.4000	7.97	8.22	8.49	8.75	9.04
11.6500	9.36	9.72	10.18	10.75	11.43
11.9000	12.24	13.16	14.16	15.14	16.04
12.1500	120.58	346.23	578.65	1072.62	1359.90
12.4000	1399.77	1311.75	1190.78	1065.65	951.74
12.6500	851.68	780.19	709.76	643.71	584.20
12.9000	554.23	532.40	509.61	486.63	464.16
13.1500	443.05	422.71	403.26	384.82	367.66
13.4000	352.03	337.27	323.42	310.48	298.43
13.6500	287.22	277.39	268.17	259.49	251.29
13.9000	243.56	236.24	229.31	222.74	216.49
14.1500	210.56	205.24	200.30	195.57	191.06
14.4000	186.78	182.73	178.92	175.34	171.97
14.6500	168.80	165.82	163.02	160.38	157.88
14.9000	155.51	153.27	151.12	149.08	147.11
15.1500	145.22	143.40	141.64	140.04	138.56
15.4000	137.10	135.65	134.22	132.79	131.37
15.6500	129.96	128.55	127.15	125.76	124.36
15.9000	122.97	121.59	120.20	118.81	117.43
16.1500	116.05	114.69	113.33	112.01	110.71
16.4000	109.45	108.24	107.07	105.96	104.89
16.6500	103.88	102.91	101.98	101.09	100.25
16.9000	99.43	98.65	97.90	97.18	96.48
17.1500	95.80	95.14	94.50	93.88	93.27
17.4000	92.68	92.09	91.52	90.95	90.40
17.6500	89.85	89.31	88.77	88.24	87.71
17.9000	87.18	86.66	86.15	85.63	85.12
18.1500	84.61	84.10	83.64	83.23	82.81

HYDROGRAPH ORDINATES (cfs)

Output Time increment = .0500 hrs

Time on left represents time for first value in each row.

Time hrs					
18.4000	82.38	81.95	81.51	81.07	80.62
18.6500	80.16	79.70	79.24	78.78	78.31
18.9000	77.83	77.36	76.88	76.40	75.91
19.1500	75.43	74.94	74.45	73.96	73.46
19.4000	72.97	72.47	71.97	71.47	70.97
19.6500	70.46	69.96	69.45	68.95	68.44
19.9000	67.93	67.42	66.90	66.39	65.88
20.1500	65.37	64.86	64.36	63.86	63.38
20.4000	62.91	62.46	62.03	61.61	61.22
20.6500	60.85	60.50	60.16	59.84	59.55
20.9000	59.26	58.99	58.74	58.50	58.26
21.1500	58.05	57.84	57.64	57.45	57.26
21.4000	57.09	56.92	56.76	56.60	56.45
21.6500	56.30	56.16	56.02	55.89	55.76
21.9000	55.63	55.50	55.38	55.26	55.14
22.1500	55.03	54.91	54.80	54.69	54.58
22.4000	54.47	54.36	54.25	54.15	54.04
22.6500	53.94	53.83	53.73	53.63	53.53
22.9000	53.43	53.32	53.22	53.12	53.02
23.1500	52.92	52.82	52.72	52.63	52.53
23.4000	52.43	52.33	52.23	52.13	52.03
23.6500	51.93	51.83	51.74	51.64	51.54
23.9000	51.44	51.34	51.24	51.12	50.92
24.1500	50.55	49.92	48.95	47.60	45.88
24.4000	43.86	41.61	39.60	38.18	36.72
24.6500	35.24	33.77	32.32	30.90	29.52
24.9000	28.18	26.89	25.64	24.45	23.30
25.1500	22.20	21.15	20.15	19.19	18.27
25.4000	17.40	16.56	16.25	16.25	16.24
25.6500	16.23	16.22	16.22	16.21	16.20
25.9000	16.19	16.19	16.18	16.17	16.16
26.1500	16.15	16.15	16.14	16.13	16.12
26.4000	16.12	16.11	16.10	16.09	16.09
26.6500	16.08	16.07	16.06	16.06	16.05
26.9000	16.04	16.03	16.02	16.02	16.01
27.1500	16.00	15.99	15.98	15.98	15.97
27.4000	15.96	15.95	15.94	15.94	15.93
27.6500	15.92	15.91	15.90	15.90	15.89
27.9000	15.88	15.87	15.86	15.86	15.85
28.1500	15.84	15.83	15.82	15.82	15.81
28.4000	15.80	15.79	15.78	15.77	15.77
28.6500	15.76	15.75	15.74	15.73	15.72
28.9000	15.72	15.71	15.70	15.69	15.68
29.1500	15.67	15.66	15.66	15.65	15.64
29.4000	15.63	15.62	15.61	15.61	15.60
29.6500	15.59	15.58	15.57	15.56	15.55
29.9000	15.55	15.54	15.53	15.52	15.51

HYDROGRAPH ORDINATES (cfs)

Time hrs	Output Time increment = .0500 hrs. Time on left represents time for first value in each row.				
30.1500	15.50	15.49	15.48	15.47	15.47
30.4000	15.46	15.45	15.44	15.43	15.42
30.6500	15.41	15.40	15.40	15.39	15.38
30.9000	15.37	15.36	15.35	15.34	15.33
31.1500	15.32	15.31	15.30	15.30	15.29
31.4000	15.28	15.27	15.26	15.25	15.24
31.6500	15.23	15.22	15.21	15.20	15.19
31.9000	15.18	15.17	15.16	15.16	15.15
32.1500	15.14	15.13	15.12	15.11	15.10
32.4000	15.09	15.08	15.07	15.06	15.05
32.6500	15.04	15.03	15.02	15.01	15.00
32.9000	14.99	14.98	14.97	14.96	14.95
33.1500	14.94	14.93	14.92	14.91	14.90
33.4000	14.89	14.88	14.87	14.86	14.85
33.6500	14.84	14.83	14.82	14.81	14.80
33.9000	14.79	14.78	14.77	14.76	14.75
34.1500	14.74	14.73	14.72	14.71	14.69
34.4000	14.68	14.67	14.66	14.65	14.64
34.6500	14.63	14.62	14.61	14.60	14.59
34.9000	14.58	14.57	14.56	14.54	14.53
35.1500	14.52	14.51	14.50	14.49	14.48
35.4000	14.47	14.46	14.45	14.44	14.42
35.6500	14.41	14.40	14.39	14.38	14.37
35.9000	14.36	14.35	14.33	14.32	14.31
36.1500	14.30	14.29	14.28	14.26	14.25
36.4000	14.24	14.23	14.22	14.21	14.20
36.6500	14.18	14.17	14.16	14.15	14.14
36.9000	14.13	14.11	14.10	14.09	14.08
37.1500	14.07	14.05	14.04	14.03	14.02
37.4000	14.00	13.99	13.98	13.97	13.96
37.6500	13.94	13.93	13.92	13.91	13.90
37.9000	13.88	13.87	13.86	13.84	13.83
38.1500	13.82	13.81	13.79	13.78	13.77
38.4000	13.75	13.74	13.73	13.72	13.70
38.6500	13.69	13.68	13.67	13.65	13.64
38.9000	13.63	13.61	13.60	13.59	13.57
39.1500	13.56	13.55	13.53	13.52	13.51
39.4000	13.49	13.48	13.47	13.45	13.44
39.6500	13.43	13.41	13.40	13.39	13.37
39.9000	13.36	13.34	13.33	13.32	13.30
40.1500	13.29	13.27	13.26	13.25	13.23
40.4000	13.22	13.20	13.19	13.17	13.16
40.6500	13.15	13.13	13.12	13.10	13.09
40.9000	13.08	13.06	13.05	13.03	13.02
41.1500	13.00	12.99	12.97	12.96	12.94
41.4000	12.93	12.91	12.90	12.88	12.87
41.6500	12.85	12.84	12.82	12.81	12.79

Type.... Diverted Hydrograph Page 4.13
Name.... OUT Event: 25 yr
File.... N:\PROJECTS\99\99074\ENGINEER\PONDPACK\
Storm... TypeII 24hr Tag: 25yr

HYDROGRAPH ORDINATES (cfs)

Output Time increment = .0500 hrs
Time on left represents time for first value in each row.

Time hrs					
41.9000	12.78	12.76	12.74	12.73	12.71
42.1500	12.70	12.68	12.67	12.65	12.64
42.4000	12.62	12.60	12.59	12.57	12.56
42.6500	12.54	12.53	12.51	12.49	12.47
42.9000	12.46	12.44	12.42	12.41	12.39
43.1500	12.38	12.36	12.34	12.33	12.31
43.4000	12.29	12.28	12.26	12.24	12.22
43.6500	12.21	12.19	12.17	12.15	12.14
43.9000	12.12	12.10	12.08	12.07	12.05
44.1500	12.03	12.01	12.00	11.98	11.96
44.4000	11.94	11.92	11.90	11.89	11.87
44.6500	11.85	11.83	11.81	11.79	11.77
44.9000	11.75	11.74	11.72	11.70	11.68
45.1500	11.66	11.64	11.62	11.60	11.58
45.4000	11.56	11.54	11.52	11.50	11.48
45.6500	11.46	11.44	11.42	11.40	11.38
45.9000	11.36	11.34	11.32	11.30	11.28
46.1500	11.26	11.24	11.21	11.19	11.17
46.4000	11.15	11.13	11.11	11.09	11.06
46.6500	11.04	11.02	11.00	10.98	10.95
46.9000	10.93	10.91	10.88	10.86	10.84
47.1500	10.82	10.79	10.77	10.75	10.72
47.4000	10.70	10.68	10.65	10.63	10.60
47.6500	10.58	10.55	10.53	10.50	10.48
47.9000	10.46	10.43	10.41	10.38	10.36
48.1500	10.33	10.30	10.28	10.25	10.22
48.4000	10.20	10.17	10.14	10.12	10.09
48.6500	10.07	10.04	10.01	9.99	9.96
48.9000	9.93	9.90	9.87	9.84	9.81
49.1500	9.78	9.75	9.73	9.70	9.67
49.4000	9.64	9.61	9.58	9.55	9.52
49.6500	9.49	9.45	9.42	9.39	9.36
49.9000	9.33	9.30	9.27	9.24	9.20
50.1500	9.17	9.13	9.10	9.07	9.03
50.4000	9.00	8.97	8.93	8.90	8.87
50.6500	8.83	8.79	8.75	8.71	8.68
50.9000	8.64	8.60	8.56	8.53	8.49
51.1500	8.45	8.41	8.36	8.32	8.28
51.4000	8.23	8.19	8.15	8.10	8.06
51.6500	8.02	7.97	7.91	7.86	7.81
51.9000	7.76	7.71	7.66	7.61	7.56
52.1500	7.50	7.44	7.38	7.32	7.26
52.4000	7.20	7.15	7.09	7.02	6.94
52.6500	6.86	6.79	6.71	6.64	6.56
52.9000	6.46	6.35	6.24	6.14	6.03
53.1500	5.90	5.73	5.57	5.41	5.18
53.4000	4.90	4.64	4.15	3.61	2.81

HYDROGRAPH ORDINATES (cfs)

Output Time increment = .0500 hrs

Time on left represents time for first value in each row.

Time hrs					
53.6500	1.33	.49	.16	.05	.02
53.9000	.01	.00			

DIVERTED HYDROGRAPH...
HYG file = N:\PROJECTS\99\99074\ENGINEER\PONDPACK\ROUTING.HYG
HYG ID = OUT
HYG Tag = 2yr

Peak Discharge = 49.84 cfs
Time to Peak = 15.1500 hrs
HYG Volume = 61.107 ac-ft

HYDROGRAPH ORDINATES (cfs)

Time | Output Time increment = .0500 hrs
hrs | Time on left represents time for first value in each row.

Time hrs					
11.5500	.00	.00	.03	.31	1.67
11.8000	3.83	5.27	6.36	7.39	8.44
12.0500	9.45	10.44	11.34	12.10	12.75
12.3000	13.28	13.72	14.08	14.36	14.60
12.5500	14.79	14.95	15.10	15.22	15.33
12.8000	15.42	15.50	15.58	15.64	15.70
13.0500	15.76	15.82	15.87	15.91	15.95
13.3000	16.00	16.04	16.07	16.11	16.14
13.5500	16.17	16.20	16.23	16.76	19.61
13.8000	22.24	24.67	26.90	28.95	30.83
14.0500	32.55	34.12	35.55	36.85	38.03
14.3000	39.10	40.07	41.56	42.89	44.06
14.5500	45.07	45.95	46.72	47.37	47.93
14.8000	48.40	48.79	49.11	49.37	49.56
15.0500	49.70	49.79	49.84	49.84	49.80
15.3000	49.73	49.63	49.49	49.33	49.14
15.5500	48.92	48.69	48.43	48.15	47.86
15.8000	47.55	47.22	46.88	46.53	46.16
16.0500	45.78	45.39	45.00	44.59	44.18
16.3000	43.78	43.37	42.97	42.58	42.20
16.5500	41.83	41.47	41.13	40.80	40.47
16.8000	40.16	39.98	39.80	39.63	39.46
17.0500	39.28	39.11	38.94	38.76	38.59
17.3000	38.42	38.24	38.07	37.90	37.73
17.5500	37.55	37.38	37.21	37.03	36.86
17.8000	36.68	36.51	36.34	36.16	35.99
18.0500	35.81	35.64	35.46	35.28	35.11
18.3000	34.93	34.75	34.57	34.39	34.22
18.5500	34.04	33.86	33.68	33.49	33.31
18.8000	33.13	32.95	32.77	32.58	32.40
19.0500	32.22	32.03	31.85	31.66	31.47
19.3000	31.29	31.10	30.91	30.72	30.53
19.5500	30.35	30.16	29.96	29.77	29.58

HYDROGRAPH ORDINATES (cfs)

Output Time increment = .0500 hrs

Time on left represents time for first value in each row.

Time hrs					
19.8000	29.39	29.20	29.01	28.81	28.62
20.0500	28.42	28.23	28.03	27.84	27.65
20.3000	27.46	27.27	27.08	26.90	26.72
20.5500	26.55	26.39	26.23	26.07	25.92
20.8000	25.77	25.63	25.50	25.37	25.24
21.0500	25.12	25.00	24.89	24.78	24.68
21.3000	24.57	24.48	24.38	24.29	24.20
21.5500	24.11	24.03	23.95	23.87	23.79
21.8000	23.71	23.64	23.57	23.50	23.43
22.0500	23.37	23.30	23.24	23.18	23.12
22.3000	23.06	23.00	22.95	22.89	22.84
22.5500	22.78	22.73	22.68	22.63	22.58
22.8000	22.53	22.48	22.43	22.39	22.34
23.0500	22.29	22.25	22.20	22.16	22.12
23.3000	22.07	22.03	21.99	21.94	21.90
23.5500	21.86	21.82	21.78	21.74	21.70
23.8000	21.66	21.62	21.58	21.54	21.50
24.0500	21.45	21.39	21.28	21.11	20.86
24.3000	20.50	20.05	19.52	18.91	18.26
24.5500	17.58	16.89	16.26	16.25	16.24
24.8000	16.24	16.23	16.22	16.22	16.21
25.0500	16.20	16.19	16.19	16.18	16.17
25.3000	16.16	16.16	16.15	16.14	16.13
25.5500	16.12	16.12	16.11	16.10	16.09
25.8000	16.09	16.08	16.07	16.06	16.06
26.0500	16.05	16.04	16.03	16.02	16.02
26.3000	16.01	16.00	15.99	15.98	15.98
26.5500	15.97	15.96	15.95	15.94	15.94
26.8000	15.93	15.92	15.91	15.90	15.90
27.0500	15.89	15.88	15.87	15.86	15.86
27.3000	15.85	15.84	15.83	15.82	15.82
27.5500	15.81	15.80	15.79	15.78	15.77
27.8000	15.77	15.76	15.75	15.74	15.73
28.0500	15.72	15.72	15.71	15.70	15.69
28.3000	15.68	15.67	15.67	15.66	15.65
28.5500	15.64	15.63	15.62	15.62	15.61
28.8000	15.60	15.59	15.58	15.57	15.56
29.0500	15.55	15.55	15.54	15.53	15.52
29.3000	15.51	15.50	15.49	15.48	15.48
29.5500	15.47	15.46	15.45	15.44	15.43
29.8000	15.42	15.41	15.40	15.40	15.39
30.0500	15.38	15.37	15.36	15.35	15.34
30.3000	15.33	15.32	15.31	15.30	15.30
30.5500	15.29	15.28	15.27	15.26	15.25
30.8000	15.24	15.23	15.22	15.21	15.20
31.0500	15.19	15.18	15.17	15.17	15.16
31.3000	15.15	15.14	15.13	15.12	15.11

HYDROGRAPH ORDINATES (cfs)

Output Time increment = .0500 hrs

Time on left represents time for first value in each row.

Time hrs					
31.5500	15.10	15.09	15.08	15.07	15.06
31.8000	15.05	15.04	15.03	15.02	15.01
32.0500	15.00	14.99	14.98	14.97	14.96
32.3000	14.95	14.94	14.93	14.92	14.91
32.5500	14.90	14.89	14.88	14.87	14.86
32.8000	14.85	14.84	14.83	14.82	14.81
33.0500	14.80	14.79	14.78	14.77	14.76
33.3000	14.75	14.74	14.73	14.72	14.71
33.5500	14.70	14.68	14.67	14.66	14.65
33.8000	14.64	14.63	14.62	14.61	14.60
34.0500	14.59	14.58	14.57	14.56	14.55
34.3000	14.53	14.52	14.51	14.50	14.49
34.5500	14.48	14.47	14.46	14.45	14.44
34.8000	14.43	14.41	14.40	14.39	14.38
35.0500	14.37	14.36	14.35	14.33	14.32
35.3000	14.31	14.30	14.29	14.28	14.27
35.5500	14.25	14.24	14.23	14.22	14.21
35.8000	14.20	14.19	14.17	14.16	14.15
36.0500	14.14	14.13	14.11	14.10	14.09
36.3000	14.08	14.07	14.05	14.04	14.03
36.5500	14.02	14.00	13.99	13.98	13.97
36.8000	13.96	13.94	13.93	13.92	13.91
37.0500	13.90	13.88	13.87	13.86	13.85
37.3000	13.83	13.82	13.81	13.79	13.78
37.5500	13.77	13.76	13.74	13.73	13.72
37.8000	13.70	13.69	13.68	13.67	13.65
38.0500	13.64	13.63	13.61	13.60	13.59
38.3000	13.57	13.56	13.55	13.53	13.52
38.5500	13.51	13.49	13.48	13.47	13.45
38.8000	13.44	13.43	13.41	13.40	13.39
39.0500	13.37	13.36	13.35	13.33	13.32
39.3000	13.30	13.29	13.27	13.26	13.25
39.5500	13.23	13.22	13.20	13.19	13.18
39.8000	13.16	13.15	13.13	13.12	13.11
40.0500	13.09	13.08	13.06	13.05	13.03
40.3000	13.02	13.00	12.99	12.97	12.96
40.5500	12.94	12.93	12.91	12.90	12.88
40.8000	12.87	12.85	12.84	12.82	12.81
41.0500	12.79	12.78	12.76	12.75	12.73
41.3000	12.71	12.70	12.68	12.67	12.65
41.5500	12.64	12.62	12.60	12.59	12.57
41.8000	12.56	12.54	12.53	12.51	12.49
42.0500	12.48	12.46	12.44	12.43	12.41
42.3000	12.39	12.38	12.36	12.34	12.33
42.5500	12.31	12.29	12.28	12.26	12.24
42.8000	12.23	12.21	12.19	12.17	12.15
43.0500	12.14	12.12	12.10	12.08	12.07

HYDROGRAPH ORDINATES (cfs)
Output Time increment = .0500 hrs
Time on left represents time for first value in each row.

Time hrs					
43.3000	12.05	12.03	12.01	12.00	11.98
43.5500	11.96	11.94	11.92	11.91	11.89
43.8000	11.87	11.85	11.83	11.81	11.79
44.0500	11.77	11.76	11.74	11.72	11.70
44.3000	11.68	11.66	11.64	11.62	11.60
44.5500	11.58	11.56	11.54	11.52	11.50
44.8000	11.48	11.46	11.44	11.42	11.40
45.0500	11.38	11.36	11.34	11.32	11.30
45.3000	11.28	11.26	11.24	11.21	11.19
45.5500	11.17	11.15	11.13	11.11	11.09
45.8000	11.07	11.04	11.02	11.00	10.98
46.0500	10.95	10.93	10.91	10.88	10.86
46.3000	10.84	10.82	10.79	10.77	10.75
46.5500	10.73	10.70	10.68	10.65	10.63
46.8000	10.60	10.58	10.55	10.53	10.51
47.0500	10.48	10.46	10.43	10.41	10.38
47.3000	10.36	10.33	10.31	10.28	10.25
47.5500	10.23	10.20	10.17	10.15	10.12
47.8000	10.09	10.07	10.04	10.01	9.99
48.0500	9.96	9.93	9.90	9.87	9.84
48.3000	9.81	9.78	9.76	9.73	9.70
48.5500	9.67	9.64	9.61	9.58	9.55
48.8000	9.52	9.49	9.46	9.42	9.39
49.0500	9.36	9.33	9.30	9.27	9.24
49.3000	9.20	9.17	9.14	9.10	9.07
49.5500	9.03	9.00	8.97	8.93	8.90
49.8000	8.87	8.83	8.79	8.75	8.71
50.0500	8.68	8.64	8.60	8.56	8.53
50.3000	8.49	8.45	8.41	8.37	8.32
50.5500	8.28	8.23	8.19	8.15	8.10
50.8000	8.06	8.02	7.97	7.92	7.87
51.0500	7.82	7.76	7.71	7.66	7.61
51.3000	7.57	7.51	7.44	7.38	7.32
51.5500	7.27	7.21	7.15	7.09	7.02
51.8000	6.94	6.86	6.79	6.71	6.64
52.0500	6.57	6.46	6.35	6.25	6.14
52.3000	6.04	5.91	5.74	5.58	5.42
52.5500	5.19	4.91	4.65	4.17	3.65
52.8000	2.84	1.40	.52	.17	.05
53.0500	.02	.01	.00		

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