FINAL DRAINAGE REPORT
FOR
ELLICOTT TOWN CENTER – FILING NO. 1

Prepared for:

Colorado Springs Mayberry, LLC
32823 Temecula Parkway
Temecula, CA 92592

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Prepared by:

JPS ENGINEERING

19 East Willamette Avenue
Colorado Springs, CO 80903
(719)-477-9429
www.jpsengr.com

JPS Project No. 030502

SF-18-025

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EXECUTIVE SUMMARY

A. Background

- Ellicott Town Center is a proposed mixed-use development consisting of 1,048 residential units, 32-acres of commercial space, and associated land uses. The project is located on a 550.6-acre parcel on the south side of State Highway 94 approximately 2 miles west of Ellicott Highway.
- The proposed Ellicott Town Center Filing No. 1 subdivision consists of 98 single-family residential units on 64.2 acres at the north end of the development.
- The Ellicott Town Center Filing No. 1 site is located entirely within the Ellicott Consolidated Drainage Basin, which comprises about 13 square miles, or 8,320 acres. The Ellicott Town Center development area represents approximately 7 percent of the total area of the Ellicott Consolidated Basin.

B. General Drainage Concept

- Historic drainage from off-site areas upstream of the site will be conveyed through the development within grass-lined drainage swales and channels meandering through dedicated open space areas. These drainage channels will serve as "greenways," with trails along the drainage channels linked to a network of trails running throughout the development.
- Developed drainage within the site will be conveyed through paved streets with curb and gutter and storm sewers, as well as grass-lined channels and drainage swales through open space areas.

C. Drainage Impacts

- Developed flows from Ellicott Town Center Filing No. 1 will be detained to historic levels through an on-site detention pond.
- Drainage facilities within public roads will be designed and constructed to El Paso County standards, and dedicated to the County for maintenance.
- Drainage facilities such as channels running through private open space areas and detention ponds will be owned and maintained by the Ellicott Town Center Homeowners Association or Metropolitan District.

DRAINAGE STATEMENT

Engineer's Statement:

The attached drainage plan and report were prepared under my direction and supervision and are correct to the best of my knowledge and belief. Said drainage report has been prepared according to the criteria established by the County for drainage reports and said report is in conformity with the master plan of the drainage basin. I accept responsibility for liability caused by negligent acts, errors or omissions on my part in preparing this report.

____

John P. Schwab, P.E. #29891

Developer's Statement:

I, the developer have read and will comply with all of the requirements specified in this drainage report and plan.

By:

____

Printed Name: Randy Goodson, Manager Date

Colorado Springs Mayberry LLC

32823 Temecula Parkway, Temecula, CA 92592

El Paso County's Statement

Filed in accordance with the requirements of the El Paso County Land Development Code, Drainage Criteria Manual, Volumes 1 and 2, and Engineering Criteria Manual as amended.

____

Jennifer Irvine, P.E. Date

County Engineer / ECM Administrator

Conditions:

FLOODPLAIN STATEMENT

To the best of my knowledge and belief, no parts of the Ellicott Town Center Subdivision are located in a FEMA designated floodplain, as shown on FIRM panel No. 08041C0825F, dated March 17, 1997.

John P. Schwab, P.E. #29891

I. GENERAL LOCATION AND DESCRIPTION

A. Background

Ellicott Town Center is a proposed subdivision located west of Ellicott, Colorado in El Paso County. The development is located on the south side of State Highway 94, approximately 1-1/2 miles west of Ellicott Highway, as shown in Figure A1 (Appendix F). The approved Ellicott Town Center Sketch Plan includes a total of 1,048 single-family dwelling units and 32 acres of commercial space. Ellicott Town Center Filing No. 1 consists of 98 single-family residential units on 64.2-acres near the north boundary of the project. Colorado Springs Mayberry, LLC is moving forward with development of Ellicott Town Center Filing No. 1, which was approved by the Board of County Commissioners on April 12, 2007 (Resolution No. 07-132).

B. Scope

This report is provided in support of recording of the "Ellicott Town Center Filing No. 1 Final Plat." The report is intended to fulfill the El Paso County requirements for a Final Drainage Report (FDR). The report will provide a summary of site drainage issues impacting the proposed development, including analysis of impacts from upstream drainage patterns, site-specific developed drainage patterns, and impacts on downstream facilities. This FDR report was prepared based on the guidelines and criteria presented in the El Paso County Drainage Criteria Manual, providing final design of required drainage facilities for this phase of the project.

C. Site Location and Description

The Ellicott Town Center parcel comprises the west half of Section 14 along with the contiguous east quarter of Section 15, as well the west half of the northeast quarter of Section 14, Township 14 South, Range 63 West of the 6th Principal Meridian. The site is located at an elevation of approximately 6,060 feet above mean sea level. The 550.6-acre site is currently undeveloped, with the exception of the existing Viewpoint Water Tank site at the northwest corner of the parcel. Filing No. 1 comprises 62.4-acres at the north end of the Ellicott Town Center development.

State Highway 94 borders the parcel to the north, and unplatted agricultural properties (zoned A35) border this parcel on the east and south sides. Unplatted property zoned RR3 borders this parcel to the west. The existing 2-1/2-acre lot Viewpoint Estates subdivision (72 lots on 236 acres) is located immediately northwest of this parcel, across State Highway 94. The 5-acre lot Antelope Park Ranchettes subdivision (44 lots on 240 acres) borders Viewpoint Estates to the northwest.

The Ellicott Town Center development will include 1,048 residential lots, along with associated commercial / mixed-use development and an elementary school. Filing No. 1 includes 98 single-family residential lots at the north end of the development. Site improvements will include overlot grading and curb, gutter, and asphalt paving of the roads within the site.

The primary access to Ellicott Town Center will be provided by construction of the newly aligned Log Road, which will run through the site from north to south as a minor arterial roadway (120' right-of-way). Log Road will ultimately intersect with a new extension of Handle Road at the southerly site boundary, which will extend east to the existing "Old" Log Road. Primary access to Filing No. 1 will be provided through construction of the new Log Road intersection at SH94. Secondary access will be provided through an existing approved access point east of New Log Road along the frontage of the old "Springs East Village" parcel. The secondary access will consist of gravel road extensions of Village Main Street and Springs East Road with Filing No. 1. The secondary access road extensions will be paved with Filing No. 2.

The intermittent streams throughout this area drain into the Black Squirrel Creek Basin which ultimately outfalls into the Arkansas River. The entire Filing No. 1 site is located within the Ellicott Consolidated Drainage Basin (CHBS1200). This basin conveys surface drainage to the West Fork of Black Squirrel Creek, which is located east of this parcel between the site and Ellicott Highway.

The terrain is generally flat with gentle northwest to southeast slopes ranging from one to two percent. Historic drainage patterns from the site are conveyed overland to the south and east boundaries of the site. The entire site is covered with native grasses, except for the existing water tank site at the northwest corner of the parcel.

D. General Soil Conditions

According to the Soil Survey of El Paso County prepared by the Soil Conservation Service, on-site soils are comprised primarily of "Blakeland series (type 8)" soils (see Figure A2). The Blakeland soils are characterized as well-drained loamy sand with rapid permeability, slow surface runoff rates, and moderate hazard of erosion. These soils are classified as hydrologic soils group "A" for drainage analysis purposes.

E. References

City of Colorado Springs & El Paso County "Drainage Criteria Manual," revised October 12, 1994.

CDOT, "CDOT Drainage Design Manual," July, 1995.

David R. Sellon & Associates Inc., "Antelope Park Ranchettes Interior Drainage Plan," March, 1972.

El Paso County Planning Department, "Ellicott Valley Comprehensive Plan," March, 1989.

El Paso County "Engineering Criteria Manual," January 9, 2006.

FEMA, Flood Insurance Rate Map (FIRM) Number 08041C1025-F, March 17, 1997.

Add reference to EPC Board Resolution No. 15-042 (El Paso County adoption of Chapter 6 and Section 3.2.1 Chapter 13 of the City of Colorado Springs Drainage Criteria Manual dated May 2014, hydrology and full-spectrum detention).

JPS Engineering, "Master Development Drainage Plan for Ellicott Town Center," November 22, 2005 (Approved by El Paso County 11/28/05).

JPS Engineering, "Master Development Drainage Plan and Preliminary Drainage Report for Springs East Village," March 21, 2002 (Approved by El Paso County 10/23/02).

JPS Engineering, "Master Development Drainage Plan and Preliminary Drainage Report for Viewpoint Village," January 28, 2002 (Approved by El Paso County 9/11/02).

JPS Engineering, "Preliminary Drainage Report for Ellicott Town Center - Phase 1," January 15, 2007.

Not approved?

Leigh Whitehead & Associates, Inc., "Master Development Drainage Plan for Sunset Village," May, 2000 (Approved by El Paso County 8/31/00).

Pacific Summits Engineering, "Final Drainage Report for Viewpoint Estates," January 6, 1998 (Approved by El Paso County 10/6/99).

United Planning and Engineering, "Preliminary Drainage Plan & Report for Springs East," November 19, 1999.

United Planning and Engineering, "Drainage Plan & Report for Viewpoint Subdivision," May, 2000.

USDA/NRCS, "Soil Survey of El Paso County Area, Colorado," June, 1981.

II. DRAINAGE BASINS AND SUB-BASINS

A. Major Basin Description

The proposed development lies primarily within the Ellicott Consolidated Drainage Basin (CHBS1200) as classified by El Paso County. This basin is comprised of the area tributary to the West Fork of Black Squirrel Creek, with the majority of the basin bounded by SH94 to the north and Ellicott Highway to the east. No drainage planning study has been completed for the Ellicott Consolidated Drainage Basin or any adjacent drainage basins. El Paso County has approved the "Sunset Village Master Development Drainage Plan (MDDP)," prepared by Leigh Whitehead. This MDDP covers the adjacent Telephone Exchange Drainage Basin, which borders the Ellicott Town Center parcel to the west. Based on the Drainage Report for Viewpoint Estates, stormwater detention ponds were constructed to maintain historic flows leaving the upstream developed areas. As such, the drainage analysis for major basins impacting the site will assume that historic flows enter this parcel from upstream.

The major drainage basins lying in and around the proposed development are depicted in Figure EX1. Ellicott Town Center is located primarily within the Ellicott Consolidated Drainage Basin, which comprises a tributary area of about 13 square miles, or 8,320 acres. The proposed Ellicott Town Center subdivision represents a total of 551 acres of development, or 7 percent of the total basin area. An "on-site" drainage planning approach has been proposed based on the relatively small developed area in comparison to the remaining undeveloped basin area, which is primarily agricultural land.

The existing site topography has several off-site drainage basins that enter the north and west boundaries of the Ellicott Town Center parcel. Triple 30-inch CMP culverts cross SH94 at several locations along the north boundary of the site. These off-site basins combine with on-site flows, following existing grass-lined swales southeasterly through the site. The site historically consists of five major basins conveying flows towards the south and eastern boundaries of the site, as shown in Figure EX2. Flows from the majority of the site (Basins B-E) combine with the tributary areas downstream of the site, flowing southeasterly to an existing natural channel towards Black Squirrel Creek. This minor western tributary downstream of the Ellicott Town Center parcel overtops Ellicott Highway at a low point 2-1/2 miles south of SH94, and combines with the West Fork of Black Squirrel Creek on the east side of Ellicott Highway.

Is a culvert needed?

Flows from the southwest corner of the site (Basins A and BB) combine with the tributary area in the Telephone Exchange Basin identified as Basin A32 (2.89 sm; Q_5 = 92 cfs, Q_{100} = 438 cfs) in the Sunset Village MDDP. This basin flows southeasterly and ultimately crosses Enoch Road and Ellicott Highway at the northeast corner of the Sunset Village Development.

B. Floodplain Impacts

Ellicott Town Center is located approximately one mile southwest of the 100-year floodplain limits for the West Fork of Black Squirrel Creek, as delineated by the Federal Emergency Management Agency (FEMA). The floodplain limits in the vicinity of the site are shown in Flood Insurance Rate Map (FIRM) Number 08041C0825-F, dated March 17, 1997 (see Figure A3).

C. Sub-Basin Description

The developed drainage basins lying within the proposed development are depicted in Figure D1. The interior site layout has been delineated into several drainage basins (A-E) based on the proposed interior road layout and grading scheme. The natural drainage patterns will be impacted through development by site grading and concentration of runoff in subdivision street gutters, storm drains, and channels. The majority of sub-basins drain to the southeast, collecting in the interior roads and drainage channels. On-site flows will be diverted to proposed detention ponds located at the south and east boundaries of the site, and detained runoff flows will discharge to the southeast, following historic drainage paths.

III. DRAINAGE DESIGN CRITERIA

A. Development Criteria Reference

The Ellicott Consolidated Drainage Basin has not had a Drainage Basin Planning Study performed for the basin. The majority of areas within the basin are comprised of agricultural lands and rural residential uses.

A "Master Development Drainage Plan (MDDP)" for Ellicott Town Center was approved concurrent with the Amended Sketch Plan submittal, and a Preliminary Drainage Report for Phase One was approved with the Phase One PUD and Preliminary Plan. This Final Drainage Report fully conforms to the previously approved MDDP and Preliminary Drainage Report.

B. Hydrologic Criteria

SCS procedures were utilized for analysis of major basin flows impacting the site. In accordance with El Paso County drainage criteria, SCS hydrologic calculations were based on the following assumptions:

• Design storm (minor)	5-year
• Design storm (major)	100-year
• Storm distribution	SCS Type IIA (eastern Colorado)
• 100-year, 24-hour rainfall	4.4 inches per hour (NOAA isopluvial map)
• 5-year, 24-hour rainfall	2.6 inches per hour (NOAA isopluvial map)
• Hydrologic soil type	B
• SCS curve number - undeveloped conditions	61 (pasture / range)
• SCS curve number - developed conditions	80 (1/8-1/4 acre lots)
• SCS curve number - developed conditions	92 (commercial areas)

Rational method procedures were utilized for calculation of peak flows within the on-site drainage basins. Rational method hydrologic calculations were based on the following assumptions:

• Design storm (minor)	5-year	
• Design storm (major)	100-year	
• Rainfall Intensities	El Paso County I-D-F Curve	
• Hydrologic soil type	A	
	<u>C5</u>	<u>C100</u>
• Runoff Coefficients - undeveloped:		
Existing pasture/range areas	0.25	0.35
• Runoff Coefficients - developed:		
Proposed Residential (1/8-1/4 acre lots)	0.375	0.545
Proposed Neighborhood Commercial	0.49	0.62

Composite runoff coefficients for the developed residential areas have been calculated based on average lot sizes between 1/8-acre and 1/4-acre. Hydrologic calculations are enclosed in Appendix B, and peak design flows are identified on the drainage basin drawings. While the hydrologic modeling spreadsheets in Appendix B provide comprehensive preliminary information for the overall Ellicott Town Center project, only the design points associated with Basin C are applicable to this Final Drainage Report.

IV. DRAINAGE PLANNING FOUR STEP PROCESS

El Paso County Drainage Criteria require drainage planning to include a Four Step Process for receiving water protection that focuses on reducing runoff volumes, treating the water quality capture volume (WQCV), stabilizing drainageways, and implementing long-term source controls.

As stated in DCM Volume 2, the Four Step Process is applicable to all new and re-development projects with construction activities that disturb 1 acre or greater or that disturb less than 1 acre but are part of a larger common plan of development. The Four Step Process has been implemented as follows in the planning of this project:

Step 1: Employ Runoff Reduction Practices

- Minimize Impacts: The approved Planned Unit Development includes significant open space, play areas, and parks, resulting in a moderate level of impervious site development.
- Minimize Directly Connected Impervious Areas (MDCIA): The proposed development will include landscaped areas adjoining the proposed building and parking lots, providing for impervious areas to drain across pervious areas where feasible.
- Grass Swales: The proposed drainage plan incorporates grass-lined swales in selected locations to encourage stormwater infiltration while providing positive drainage through the site.

Step 2: Stabilize Drainageways

- Proper erosion control measures will be implemented along the grass-lined drainage channels to provide stabilized drainageways within the site.

Step 3: Provide Water Quality Capture Volume (WQCV)

- EDB: The developed areas of the site will drain through proposed Extended Detention Basins (EDB) southeast of the developed areas. Site drainage will be routed through the extended detention basins, which will capture and slowly release the WQCV over an extended release period.

Step 4: Consider Need for Industrial and Commercial BMPs

- No industrial or commercial land uses are proposed as part of the Filing No. 1 development.

full-spectrum

V. DRAINAGE FACILITY DESIGN

A. General Concept

Consistent with generally accepted practices in eastern El Paso County, the general concept for management of stormwater from development of Ellicott Town Center will be to construct a number of stormwater detention ponds along the south and east boundaries of the site to mitigate the impacts of developed runoff flows from the site.

Development of the Ellicott Town Center project will require site grading and paving, resulting in additional impervious areas across the site. The general drainage pattern will consist of grading away from home sites to swales and gutters along the internal roads within the subdivision, conveying runoff flows through the site. Runoff from the site will flow by street gutters to curb inlets at low points and road intersections, thence by storm drains and drainage channels to the proposed detention ponds. The storm inlets and storm sewer system within the development will be designed as the “minor” drainage system, sized for 5-year developed peak flows. The internal road system, drainage channels, and detention ponds will be designed as the “major” drainage system, sized for 100-year peak flows. Street flows within subdivision streets will be maintained below allowable levels in accordance with El Paso County drainage criteria.

B. Specific Details

1. Existing Drainage Conditions

Historic drainage conditions are depicted in Figure EX2. The site has been divided into six major basins (A, B, BB, C, D, and E). The undeveloped site currently has no drainage facilities within the parcel. The existing off-site drainage basins northwest of the site generally combine with on-site basins as shown on Figure EX2, flowing southeasterly through the site within existing grass-lined drainage swales and channels.

The Viewpoint Estates subdivision northwest of this site included two stormwater detention ponds on the north side of State Highway 94. As detailed in Appendix B1, rational method drainage calculations for upstream off-site Basins OA2 and EC12 have been calculated based on equivalent areas to reflect the design pond discharge rates as presented in the approved drainage report for Viewpoint Estates.

The site is impacted by several large off-site drainage areas within the Ellicott Consolidated Drainage Basin. Off-site flows from Basin EC11 north of this property cross State Highway 94 in a triple 30-inch CMP culvert crossing, and continue flowing southeasterly through an existing grass-lined swale across Basin D to Design Point #5, with historic peak flows of Q_5 = 14.6 cfs and Q_{100} = 97.5 cfs (SCS Method).

Off-site flows from Basin EC10 north of this property cross State Highway 94 in another triple 30-inch CMP culvert crossing near the northeast corner of this site. These flows drain through an existing grass-lined swale across Basin E to Design Point #6, with historic peak flows of Q_5 = 5.3 cfs and Q_{100} = 37.1 cfs (SCS Method). As shown on Sheet EX2, two existing driveway culverts on the south side of SH94 convey flows from the roadside ditch on the south side of SH94 easterly to converge with the existing swale on the downstream side of the triple 30-inch CMP culverts, combining with Basin EC10. These flows continue southeasterly in the existing swale within Basin E.

Drainage from Basins A-C continues flowing southeasterly off-site within existing broad natural channels through the adjoining properties to the south and east. The downstream drainage continues southeast to a more defined natural channel, forming the West Tributary to the Middle Fork of Black Squirrel Creek. Historic drainage from Basins D and E flows southeast to the westerly ditch along "Old" Log Road, then turns east and follows the southerly ditch of Handle Road to its confluence with the main channel of the Middle Fork of Black Squirrel Creek.

2. Developed Drainage Conditions

The developed drainage basins and projected flows are shown in Figures D1, D1.01, and D1.11 (Appendix F). The developed site has been divided into five major basins (A-E) and six major design points (DP1-DP6), as shown on the enclosed Drainage Plan. Hydrologic flow schematics and calculations are enclosed in Appendix B. The development of Ellicott Town Center Phase One lies within Basins C, D, and E, and developed flows from the initial phase of the project impact Design Points #5 and #6.

Off-site Basin EC11 will combine with flows from on-site Basins C and D at Design Point #5, with undetained developed peak flows of Q_5 = 45.6 cfs and Q_{100} = 188.5 cfs. Developed flows at this location will be detained to historic levels by routing flows through the proposed Detention Ponds C1, C3, and D prior to discharging at the easterly site boundary. Detention Pond C1 will be located at the southeast corner of the Filing No. 1 development area, and this pond will be constructed with the initial phase of development.

Off-site flows from Basin EC11 will be conveyed southerly through Channel C1 along the east side of Filing No. 1. Culverts C1.1, C1.6, and C1.9. will convey the flows from Basin EC11 across the Phase 1 subdivision streets.

Storm sewer C1.2 consists of a 30"-36" RCP system extending east on Village Main Street from Market Place Drive to connect with Storm Sewer C1.6 at the east boundary of Filing No. 1. Flows from Basins C1.2, C1.3, C1.4, C1.5, and C1.6 will be intercepted by storm inlets discharging into this system.

Storm sewer C1.8 consists of a 24-inch RCP storm sewer extending east on Ellicott Town Center Boulevard from Garden Park Avenue to connect with Storm Sewer C1.9 at the east boundary of Filing No. 1.

Combined Filing No. 1 flows from Basins C1.1-C1.9 will drain to Detention Pond C1 at the southeast corner of Filing No. 1. Developed peak flows entering Detention Pond C1 at Design Point #C1.9B are calculated as Q_5 = 37.8 cfs and Q_{100} = 92.1 cfs (Rational Method).

Future Detention Ponds C3 and D will mitigate developed drainage impacts from the development areas south and east of Filing No. 1, and the net discharge downstream of Design Point #5 will remain at historic levels.

C. Comparison of Developed to Historic Discharges

Based on the hydrologic calculations in Appendix B, the total developed flows from the site will exceed historic flows from the parcel. Due to the increased impervious areas in the developed site, the total undetained flow from the site would be significantly higher than the historic flow. The increase in developed flows will be mitigated by on-site stormwater detention ponds. The comparison of developed to historic discharges at key design points is summarized as follows:

Design Point	Historic Flow			Developed Flow			Comparison of Developed to Historic Flow (Q_5%/Q_{100}%)
	Area (ac)	Q_5 (cfs)	Q_{100} (cfs)	Area (ac)	Q_5 (cfs)	Q_{100} (cfs)	
5	450.8	14.6	97.5	526.5	45.6	188.5	312% / 193% (increase)*
6	151.1	5.3	37.1	146.8	5.4	36.9	102% / 99% (decrease)

* Developed flows to be detained to historic levels

0.23 cfs/ac. seems low. Discuss comparison to Historic plan EX1 values.

D. Detention Ponds

The total developed storm runoff downstream of the Filing No. 1 site will be maintained at historic levels by routing flows through the proposed Detention Pond C1 located southeast of the Filing No. 1 development area. The proposed detention facility will be sized to attenuate peak flows through the pond, based on the difference between outflow and inflow hydrographs.

Final pond sizing was performed based on a pond routing analysis utilizing the "UD-Detention" software package (see Appendix C), resulting in the following pond sizing parameters:

Pond	Inflow (cfs)	Outflow (cfs)	Volume (ac-ft)
C1	60.2	11.6	4.9

Future Detention Ponds C3 and D will mitigate developed drainage impacts from the development south and east of Filing No. 1.

The proposed detention ponds will be privately owned and maintained by the Ellicott Town Center Homeowners Association or Metropolitan District, under the terms of a "Private Detention Basin Maintenance Agreement" that will be recorded during final platting. Gravel maintenance access roads will be provided around the perimeter of detention pond to facilitate maintenance access.

The pond outlet structures will be designed to release historic flows southeast of the site towards the existing natural swale downstream. Based on the proposed approach of reducing developed flows to historic levels at the site boundaries, no significant downstream drainage impacts are anticipated, and no downstream drainage improvements are proposed.

E. On-Site Drainage Facility Design

Developed sub-basins and proposed drainage improvements are depicted in the enclosed Drainage Plan (Figure D1, D1.01, and D1.11). Hydraulic calculations for sizing of on-site drainage facilities are enclosed in Appendix D, and summarized as follows:

1. Street / Curb & Gutter Capacity

The interior roads on this relatively flat parcel will be graded with a minimum longitudinal slope of 1.0 percent. In accordance with Colorado Springs and El Paso County Drainage Criteria, the allowable minor storm street capacity for residential streets at minimum slope is approximately 12 cfs per side. Storm inlets will be installed at low points and intersections, and other locations where allowable street capacities are exceeded.

Discuss where street flows are conveyed to at each design point.

2. Storm Sewer System

CDOT Type R curb-opening inlets will be specified where required along the interior streets. These inlets will convey runoff to a storm sewer system consisting of reinforced concrete pipe (RCP) pipe, with a minimum pipe diameter of 18-inches. Inlet sizes have been determined based on a maximum allowable ponding depth of 12 inches for the major (100-year) storm, including a 20 percent clogging factor. Storm sewer sizing has been developed assuming full flow conditions with minor storm flows at the proposed minimum slope for each pipe segment. Storm sewer pipe slopes were set based on proposed street grades and detention pond bottom elevations at the storm sewer system outfall.

Riprap outlet protection sized for the 100-year storm event will be provided for erosion control at culvert and storm sewer pipe outlets. Sizing parameters for the proposed storm sewer system are tabulated in Appendix D1.

3. Open Channels

Major drainage channels running through the proposed open space areas to the detention ponds at the site boundaries. These channels will generally be designed as stable grass-lined channels with subcritical flow regimes. Drainage channels will be designed to convey 100-year flows, with trapezoidal cross-sections, side slopes of 4:1, and minimum freeboard of 1-foot. Drop structures will be installed as necessary to minimize channel slopes and velocities, utilizing a minimum longitudinal slope of 0.5 percent. The proposed channels will be seeded with native grasses for erosion control. Hydraulic calculations for sizing the open channels are enclosed in Appendix D2, assuming a Manning's "n" value of 0.030 for non-irrigated native grass channels.

F. Analysis of Existing and Proposed Downstream Facilities

The general concept of the proposed drainage plan is to attenuate peak flows from the developed site by routing flows through the proposed on-site detention ponds.

Combined flows from the Ellicott Town Center site flow southeasterly towards the existing Middle Fork of Black Squirrel Creek. The existing channel downstream of the site consists of a broad grass-lined swale with no signs of active erosion. Based on the on-site stormwater detention concept, no downstream drainage improvements are proposed.

G. Anticipated Drainage Problems and Solutions

The proposed stormwater detention ponds are designed to mitigate the impacts of developed drainage from this project. The overall drainage plan for the subdivision includes a system of improved public streets with curb and gutter, storm inlets, and storm sewers conveying developed flows to improved drainage channels running through the site. The primary drainage problems anticipated within this development will consist of maintenance of these storm sewer systems, culverts, drainage channels, and detention pond facilities. Care will need to be taken to implement proper erosion control measures in the proposed channels and swales, which will be designed to meet allowable velocity criteria.

A trail system will be constructed along the major drainage channels to provide maintenance access to the drainage facilities throughout the development. Proper construction and maintenance of the proposed detention facilities will minimize downstream drainage impacts. The proposed public streets will be owned and maintained by El Paso County. The proposed detention ponds and channels running through open space tracts will be owned and maintained by the homeowners association.

VI. EROSION CONTROL

The Contractor will be required to implement best management practices (BMP's) for erosion control during construction. The proposed erosion control plan for Ellicott Town Center Filing No. 1 is included in the Grading & Erosion Control (GEC) Plans submitted with the subdivision construction drawings. Erosion control measures will include installation of silt fence at the toe of disturbed slopes and hay bales protecting drainage ditches. Cut and fill slopes will be stabilized during excavation if necessary and vegetation will be established for stabilization of the disturbed areas. All ditches will be designed to meet El Paso County criteria for slope and velocity. Additionally, gravel vehicle tracking pads will be installed at construction access points and inlet protection will be provided to minimize conveyance of sediment into storm inlets.

Construction of the proposed stormwater detention pond will be phased at the beginning of overlot grading work to serve as a temporary sediment pond during the construction phase. Accumulated sediment will have to be removed from the pond prior to completion of sitework to restore design capacity of the detention pond.

VII. COST ESTIMATE AND DRAINAGE FEES

The developer will pay all capital costs for Filing No. 1 roadway and drainage improvements. The engineer's cost estimate for proposed drainage improvements is approximately $447,450, as detailed in Appendix E.

The Ellicott Town Center Filing No. 1 parcel is located entirely within the Ellicott Consolidated Drainage Basin, which currently does not have a drainage or bridge fee requirement. As such, no basin fees are applicable.

VIII. MAINTENANCE

All proposed road and drainage construction within Ellicott Town Center will be performed to El Paso County Standards. Interior roads will be dedicated as public right-of-way. Roads and drainage facilities within the public right-of-way will be maintained by El Paso County upon final acceptance of these facilities after the warranty period. The Ellicott Town Center Homeowners Association or Metropolitan District will maintain drainage channels and stormwater detention ponds within the proposed open space areas.

IX. SUMMARY

Ellicott Town Center Filing No. 1 consists of 98 residential lots at the north end of the development, with access connections to State Highway 94 at New Log Road and Springs East Road. The Ellicott Town Center development will generate an increase in undetained developed runoff from the site, which will be mitigated through on-site stormwater detention facilities.

The proposed drainage patterns will remain consistent with historic conditions, and new drainage facilities constructed to El Paso County standards will safely convey runoff to adequate outfalls. Construction of the proposed Detention Pond C1 southeast of the Filing No. 1 development area will ensure that developed flows from Ellicott Town Center Filing No. 1 remain below historic levels. Construction and proper maintenance of the proposed drainage and erosion control facilities will ensure that this subdivision has no significant adverse drainage impacts on downstream or surrounding areas.

APPENDIX A

SCS SOILS INFORMATION

is severely eroded and blowouts have developed, the new seeding should be fertilized.

Windbreaks and environmental plantings are generally suited to this soil. Soil blowing is the main limitation for the establishment of trees and shrubs. This limitation can be overcome by cultivating only in the tree rows and leaving a strip of vegetation between the rows. Supplemental irrigation may be necessary when planting and during dry periods. Trees that are best suited and have good survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine, Siberian elm, Russian-olive, and hackberry. Shrubs that are best suited are skunkbush sumac, lilac, and Siberian peashrub.

This soil is suited to wildlife habitat. It is best suited to habitat for openland and rangeland wildlife. In cropland areas, habitat favorable for ring-necked pheasant, mourning dove, and many nongame species can be developed by establishing areas for nesting and escape cover. For pheasant, the provision of undisturbed nesting cover is vital and should be included in plans for habitat development. Rangeland wildlife, such as pronghorn antelope, can be encouraged by developing livestock watering facilities, properly managing livestock grazing, and reseeding range where needed.

This soil has good potential for use as homesites. Shallow excavation is severely limited because cut banks cave in. This sandy soil requires special management practices to reduce water erosion and soil blowing. Capability subclasses IIIe, irrigated, and IVe, nonirrigated.

7—Bijou sandy loam, 3 to 8 percent slopes. This deep, well drained soil is on flood plains, terraces, and uplands. It formed in sandy alluvium and eolian material derived from arkose deposits. Elevation ranges from 5,400 to 6,200 feet. The average annual precipitation is about 13 inches, the average annual air temperature is about 49 degrees F, and the average frost-free period is about 145 days.

Typically, the surface layer is brown sandy loam about 4 inches thick. The subsoil is brown or grayish brown sandy loam about 24 inches thick. The substratum is pale brown loamy coarse sand.

Included with this soil in mapping are small areas of Olney sandy loam, 3 to 5 percent slopes; Valent sand, 1 to 9 percent slopes; Vona sandy loam, 3 to 9 percent slopes; and Wigton loamy sand, 1 to 8 percent slopes.

Permeability of this Bijou soil is rapid. Effective rooting depth is 60 inches or more. Available water capacity is moderate. Organic matter content of the surface layer is low. Surface runoff is slow, and the hazards of erosion and soil blowing are moderate.

Almost all areas of this soil are used for range.

This soil is suited to the production of native vegetation suitable for grazing. Because of the hazards of water erosion and soil blowing, the soil is not suited to nonirrigated crops.

Native vegetation is dominantly blue grama, sand dropseed, needleandthread, side-oats grama, and buckwheat.

Seeding is a suitable practice if the range has deteriorated. Seeding the native grasses is a good practice. If the range is severely eroded and blowouts have developed, the new seeding should be fertilized. Brush control and grazing management may be needed to improve the depleted range. Grazing should be managed so that enough forage is left standing to protect the soil from blowing, to increase infiltration of water, and to catch and hold snow.

Windbreaks and environmental plantings are generally suited to this soil. Soil blowing is the main limitation for the establishment of trees and shrubs. This limitation can be overcome by cultivating only in the tree rows and leaving a strip of vegetation between the rows. Supplemental irrigation may be needed when planting and during dry periods. Trees that are best suited and have good survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine, Siberian elm, Russian-olive, and hackberry. Shrubs that are best suited are skunkbush sumac, lilac, and Siberian peashrub.

This soil is suited to wildlife habitat. It is best suited to habitat for openland and rangeland wildlife. Rangeland wildlife, such as pronghorn antelope, can be encouraged by developing livestock watering facilities, by properly managing livestock grazing, and by reseeding range where needed.

This soil has good potential for use as homesites. Shallow excavation is severely limited because cut banks cave in. This soil requires special management practices to reduce water erosion and soil blowing. Capability subclass VIe.

8—Blakeland loamy sand, 1 to 9 percent slopes. This deep, somewhat excessively drained soil formed in alluvial and eolian material derived from arkosic sedimentary rock on uplands. The average annual precipitation is about 15 inches, the average annual air temperature is about 47 degrees F, and the average frost-free period is about 135 days.

Typically, the surface layer is dark grayish brown loamy sand about 11 inches thick. The substratum, to a depth of 27 inches, is brown loamy sand; it grades to pale brown sand that extends to a depth of 60 inches.

Included with this soil in mapping are small areas of Bresser sandy loam, 0 to 3 percent slopes; Bresser sandy loam, 3 to 5 percent slopes; Truckton sandy loam, 0 to 3 percent slopes; Truckton sandy loam, 3 to 9 percent slopes; and Stapleton sandy loam, 3 to 8 percent slopes. In some areas, mainly north of Colorado Springs in the Cottonwood Creek area, arkosic beds of sandstone and shale are at a depth of 0 to 40 inches.

Permeability of this Blakeland soil is rapid. Effective rooting depth is 60 inches or more. Available water capacity is low to moderate. Organic matter content of the surface layer is medium. Surface runoff is slow, the hazard of erosion is moderate, and the hazard of soil blowing is severe.

Most areas of this soil are used for range, homesites, and wildlife habitat.

Native vegetation is dominantly western wheatgrass, side-oats grama, and needleandthread. This soil is best suited to deep-rooted grasses.

Proper range management is necessary to prevent excessive removal of plant cover from the soil. Interseeding improves the existing vegetation. Deferment of grazing in spring increases plant vigor and soil stability. Proper location of livestock watering facilities helps to control grazing.

Windbreaks and environmental plantings are fairly well suited to this soil. Blowing sand and low available water capacity are the main limitations for the establishment of trees and shrubs. The soil is so loose that trees need to be planted in shallow furrows and plant cover needs to be maintained between the rows. Supplemental irrigation may be needed to insure survival. Trees that are best suited and have good survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine, and Siberian elm. Shrubs that are best suited are skunkbush sumac, lilac, and Siberian peashrub.

This soil is suited to wildlife habitat. It is best suited to habitat for openland and rangeland wildlife. Rangeland wildlife, such as pronghorn antelope, can be encouraged by developing livestock watering facilities, properly managing livestock grazing, and reseeding range where needed.

This soil has good potential for urban development. Soil blowing is a hazard if protective vegetation is removed. Special erosion control practices must be provided to minimize soil losses. Capability subclass VIe.

9—Blakeland complex, 1 to 9 percent slopes. This complex is on uplands, mostly in the Falcon area. The average annual precipitation is about 15 inches, the average annual air temperature is about 47 degrees F, and the frost-free period is about 135 days.

This complex is about 60 percent Blakeland loamy sand, about 30 percent Fluvaquentic Haplaquolls, and 10 percent other soils.

Included with these soils in mapping are areas of Columbine gravelly sandy loam, 0 to 3 percent slopes, Ellicott loamy coarse sand, 0 to 5 percent slopes, and Ustic Torrifluvents, loamy.

The Blakeland soil is in the more sloping areas. It is deep and somewhat excessively drained. It formed in sandy alluvium and eolian material derived from arkosic sedimentary rock. Typically, the surface layer is dark grayish brown loamy sand about 11 inches thick. The substratum, to a depth of 27 inches, is brown loamy sand; it grades to pale brown sand that extends to a depth of 60 inches or more.

Permeability of the Blakeland soil is rapid. The effective rooting depth is more than 60 inches. The available water capacity is moderate to low. Surface runoff is slow, and the hazard of erosion is moderate.

The Fluvaquentic Haplaquolls are in swale areas. They are deep, poorly drained soils. They formed in alluvium derived from arkosic sedimentary rock. Typically, the surface layer is brown. The texture is variable throughout. The water table is at a depth of 0 to 3 feet.

The Blakeland soil is well suited to deep-rooted grasses. Native vegetation is dominantly western wheatgrass, side-oats grama, and needleandthread. Rangeland vegetation on the Fluvaquentic Haplaquolls is dominantly tall grasses, including sand bluestem, switchgrass, prairie cordgrass, little bluestem, and sand reedgrass. Cattails and bulrushes are common in the swampy areas.

Proper range management is needed to prevent excess removal of plant cover from these soils. It is also needed to maintain the productive grasses. Interseeding improves the existing vegetation. Deferment of grazing during the growing season increases plant vigor and soil stability, and it helps to maintain and improve range condition. Proper location of livestock watering facilities helps to control grazing of animals.

Windbreaks and environmental plantings are fairly well suited to these soils. Blowing sand and low available water capacity are the main limitations to the establishment of trees and shrubs. The soils are so loose that trees need to be planted in shallow furrows and plant cover needs to be maintained between the rows. Supplemental irrigation may be needed to insure survival. Trees that are best suited and have good survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine, and Siberian elm. Shrubs that are best suited are skunkbush sumac, lilac, and Siberian peashrub.

The Blakeland soil is well suited to wildlife habitat. It is best suited to habitat for openland and rangeland wildlife. Rangeland wildlife, such as pronghorn antelope, can be encouraged by developing livestock watering facilities, properly managing livestock grazing, and reseeding range where needed. Wetland wildlife can be attracted to the Fluvaquentic Haplaquolls and the wetland habitat can be enhanced by several means. Shallow water developments can be created by digging or by blasting potholes to create open-water areas. Fencing to control livestock grazing is beneficial, and it allows wetland plants such as cattails, reed canarygrass, and rushes to grow. Control of unplanned burning and prevention of drainage that would remove water from the wetlands are good practices. Openland wildlife use the vegetation on these soils for nesting and escape cover. These shallow marsh areas are especially important for winter cover if natural vegetation is allowed to grow.

The Blakeland soil has good potential for homesites, roads, and streets. It needs to be protected from erosion when vegetation has been removed from building sites. The Fluvaquentic Haplaquolls have poor potential for homesites. Their main limitations for this use are the high water table and the hazard of flooding. Capability subclass VIe.

10—Blendon sandy loam, 0 to 3 percent slopes. This deep, well drained soil formed in sandy arkosic alluvium on alluvial fans and terraces. The average annual precipitation is about 15 inches, the mean annual air temperature is about 47 degrees F, and the average frost-free period is about 135 days.

Permeability of the Crowfoot soil is moderate. Effective rooting depth is 60 inches or more. Available water capacity is moderate. Surface runoff is medium, and the hazard of erosion is moderate. Some gullies are present in some drainageways and along stock trails.

The soils in this complex are used as rangeland, for recreation and wildlife habitat, and as homesites.

Native vegetation is mainly mountain muhly, bluestem, mountain brome, needleandthread, and blue grama. These soils are subject to invasion by Kentucky bluegrass and Gambel oak. Noticeable forbs are hairy goldenrod, geranium, milkvetch, low larkspur, fringed sage, and buckwheat.

Proper location of livestock watering facilities helps to control grazing. Timely deferment of grazing is needed to protect the plant cover.

Windbreaks and environmental plantings are fairly well suited to these soils. Blowing sand and moderate available water capacity are the main limitations for the establishment of trees and shrubs. The soils are so loose that trees need to be planted in shallow furrows and plant cover needs to be maintained between the rows. Supplemental irrigation may be needed to insure survival. Trees that are best suited and have good survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine, and Siberian elm. Shrubs that are best suited are skunkbush sumac, lilac, and Siberian peashrub.

These soils are best suited to habitat for openland wildlife species, such as pronghorn antelope and sharp-tailed grouse. Although sharp-tailed grouse are not plentiful, they could be encouraged on these soils, especially where brush species are interspersed with grasses and forbs. If these soils are used as rangeland, wildlife production can be increased by managing livestock grazing to preclude overuse of the more desirable grass species and depletion of the various brush species.

The main limitations for urban uses are frost-action potential and slope on the Crowfoot soil and slope on the Tomah soil. Buildings and roads must be designed to overcome these limitations. Access roads must have adequate cut-slope grade and be provided with drains to control surface runoff. Maintaining the existing vegetation on building sites during construction helps to control erosion. Capability subclass VIe.

94—Travessilla-Rock outcrop complex, 8 to 90 percent slopes. This moderately sloping to extremely steep complex is mostly on rocky uplands (fig. 5). Elevation ranges from 6,200 to 6,700 feet. The average annual precipitation is about 15 inches, the average annual air temperature is about 47 degrees F, and the average frost-free period is about 140 days.

The Travessilla soil makes up about 45 percent of the complex, Rock outcrop about 30 percent, and included areas about 25 percent.

Included with this complex in mapping are areas of Bresser sandy loam, 5 to 9 percent slopes, Elbeth sandy loam, 8 to 15 percent slopes, Kettle gravelly loamy sand, 8 to 40 percent slopes, and Louviers silty clay loam, 3 to 18 percent slopes. The Elbeth and Kettle soils commonly are on the north-facing slopes.

The Travessilla soil is shallow and well drained. It formed in residuum derived from sandstone. Typically, the surface layer is light brownish gray sandy loam about 3 inches thick. The underlying material is pale brown sandy loam about 8 inches thick. Hard arkosic sandstone that has some fractures is at a depth of about 11 inches.

Permeability of the Travessilla soil is moderately rapid. Effective rooting depth is 6 to 20 inches. Available water capacity is low. Surface runoff is medium to rapid, and the hazard of erosion is high. Gullies are common along drainageways and trails.

Rock outcrop occurs mostly as ledges on cliffs.

This complex is used for urban development, as homesites, and for recreation and wildlife habitat.

This complex is suited to the production of ponderosa pine. The main limitations are the presence of stones and rock outcrop on the surface and a high hazard of erosion. Stones on the surface can hinder felling, yarding, and other operations involving the use of equipment. Practices must be used to minimize soil erosion when harvesting timber. The low available water capacity can influence seedling survival.

Wildlife on these soils is limited mostly to small animals such as cottontail, squirrel, and birds because of the extent of urban development. Ponderosa pine, mountain-mahogany, Gambel oak, and various grasses provide food, cover, and nesting areas.

This complex is extensively used for urban development and as homesites (fig. 6). The main limitations for these uses are depth to bedrock, rock outcrop, and steep slopes. Septic tank absorption fields do not function properly because of the depth to bedrock. Special designs for buildings and roads and streets are needed to overcome the limitations. Plans for homesite development should provide for the preservation of as many trees as possible because of their esthetic value. Capability subclass VIIe.

95—Truckton loamy sand, 1 to 9 percent slopes. This deep, well drained soil formed in alluvium and residuum derived from arkosic sedimentary rock on uplands. Elevation ranges from 6,000 to 7,000 feet. The average annual precipitation is about 15 inches, the average annual air temperature is about 47 degrees F, and the average frost-free period is about 135 days.

Typically, the surface layer is grayish brown loamy sand about 8 inches thick. The subsoil is brown sandy loam about 18 inches thick. The substratum is light yellowish brown coarse sandy loam to a depth of 60 inches or more.

Included with this soil in mapping are small areas of Blakeland loamy sand, 1 to 9 percent slopes; Bresser sandy loam, 3 to 5 percent sloeps; Bresser sandy loam, 5 to 9 percent slopes; Truckton sandy loam, 0 to 3 percent slopes; and Truckton sandy loam, 3 to 9 percent slopes.

Permeability of this Truckton soil is moderately rapid. Effective rooting depth is 60 inches or more. Available water capacity is moderate. Surface runoff is slow, and the hazard of erosion is moderate to high.

Almost all areas of this soil are used as rangeland. A few areas of crops such as alfalfa and corn are grown under sprinkler irrigation.

This soil is well suited to the production of native vegetation suitable for grazing. It is best suited to deep-rooted grasses. The native vegetation is mainly cool- and warm-season grasses such as western wheatgrass, side-oats grama, and needleandthread.

Proper range management is needed to prevent excessive removal of the plant cover. Interseeding is used to improve the existing vegetation. Deferment of grazing in spring increases plant vigor and soil stability. Properly locating livestock watering facilities helps to control grazing.

Windbreaks and environmental plantings are fairly well suited to this soil. Blowing sand is the main limitation for the establishment of trees and shrubs. The soil is so loose that trees need to be planted in shallow furrows and plant cover needs to be maintained between the rows. Supplemental irrigation may be needed to insure survival. Trees that are best suited and have good survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine, and Siberian elm. Shrubs that are best suited are skunkbush sumac, lilac, and Siberian peashrub.

This soil is suited to wildlife habitat. It is best suited to openland and rangeland wildlife habitat. Rangeland wildlife, such as pronghorn antelope, can be encouraged by developing livestock watering facilities, properly managing livestock grazing, and reseeding range where needed.

This soil has good potential for use as homesites. The main limitation of this soil for roads and streets is frost action potential. Special designs for roads are needed to minimize this limitation. Practices are needed to control soil blowing and water erosion on construction sites where the plant cover has been removed. Capability subclass VIe, nonirrigated.

96—Truckton sandy loam, 0 to 3 percent slopes. This deep, well drained soil formed in alluvium and residuum derived from arkosic sedimentary rock on uplands. Elevation ranges from 6,000 to 7,000 feet. The average annual precipitation is about 15 inches, the average annual air temperatue is about 47 degrees F, and the average frost-free period is about 135 days.

Typically, the surface layer is grayish brown sandy loam about 5 inches thick. The next layer is dark grayish brown sandy loam about 3 inches thick. The subsoil is brown sandy loam about 16 inches thick. The substratum is light yellowish brown coarse sandy loam to a depth of 60 inches or more.

Included with this soil in mapping are small areas of Blakeland loamy sand, 1 to 9 percent slopes; Bresser sandy loam, 0 to 3 percent slopes; Ellicott loamy coarse sand, 0 to 5 percent slopes; and Ustic Torrifluvents, loamy.

Permeability of this Truckton soil is moderately rapid. Effective rooting depth is 60 inches or more. Available water capacity is moderate. Surface runoff is slow, and the hazards of erosion and soil blowing are moderate.

This soil is used mainly for cultivated crops. It is also used for livestock grazing, for wildlife habitat, and as homesites.

Crops are commonly grown in combination with summer fallow because moisture is insufficient for annual cropping. Alfalfa can also be grown on this soil. When this soil is used as cropland, crop residue management and minimum tillage are necessary conservation practices.

This soil is well suited to the production of native vegetation suitable for grazing (fig. 7). It favors deep-rooted grasses. The native vegetation is mainly cool- and warm-season grasses such as western wheatgrass, side-oats grama, and needleandthread.

Proper range management is needed to prevent excessive removal of the plant cover. Interseeding is used to improve the existing vegetation. Deferment of grazing in spring increases plant vigor and soil stability. Properly locating livestock watering facilities helps to control grazing.

Windbreaks and environmental plantings generally are suited to this soil. Soil blowing is the main limitation to the establishment of trees and shrubs. This limitation can be overcome by cultivating only in the tree rows and leaving a strip of vegetation between the rows. Supplemental irrigation may be needed when planting and during dry periods. Trees that are best suited and have good survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine, Siberian elm, Russian-olive, and hackberry. Shrubs that are best suited are skunkbush sumac, lilac, and Siberian peashrub.

This soil is suited to wildlife habitat. It is best suited to habitat for openland and rangeland wildlife. In cropland areas, habitat favorable for ring-necked pheasant, mourning dove, and many nongame species can be developed by establishing areas for nesting and escape cover. For pheasant, undisturbed nesting cover is vital and should be provided in plans for habitat development. This is especially true in areas of intensive farming. Rangeland wildlife, such as pronghorn antelope, can be encouraged by developing livestock watering facilities, properly managing livestock grazing, and reseeding range where needed.

This soil has good potential for use as homesites. The main limitation of this soil for roads and streets is frost-action potential. Special designs for roads are needed to overcome this limitation. Capability subclasses IIIe, nonirrigated, and IIe, irrigated.

97—Truckton sandy loam, 3 to 9 percent slopes. This deep, well drained soil formed in alluvium and residuum derived from arkosic sedimentary rock on uplands. Elevation ranges from 6,000 to 7,000 feet. The average annual precipitation is about 15 inches, the average annual air temperature is about 47 degrees F, and the average frost-free period is about 135 days.

Typically, the surface layer is grayish brown sandy loam about 5 inches thick. The next layer is dark grayish brown sandy loam about 3 inches thick. The subsoil is brown sandy loam about 16 inches thick. The substratum is light yellowish brown coarse sandy loam to a depth of 60 inches or more.

TABLE 16.--SOIL AND WATER FEATURES

[Absence of an entry indicates the feature is not a concern. See "flooding" in Glossary for definition of terms as "rare," "brief," and "very brief." The symbol > means greater than]

Soil name and map symbol	Hydro-logic group	Flooding			Bedrock		Potential frost action
		Frequency	Duration	Months	Depth	Hardness	
					In		
Alamosa:							
1	C	Frequent	Brief	May-Jun	>60	---	High.
Ascalon:							
2, 3	B	None	---	---	>60	---	Moderate.
Badland:							
4	D	---	---	---	---	---	---
Bijou:							
5, 6, 7	B	None	---	---	>60	---	Low.
Blakeland:							
8	A	None	---	---	>60	---	Low.
[1]9:							
Blakeland part	A	None	---	---	>60	---	Low.
Fluvaquentic Haplaquolls part	D	Common	Very brief	Mar-Aug	>60	---	High.
Blendon:							
10	B	None	---	---	>60	---	Moderate.
Bresser:							
11, 12, 13	B	None	---	---	>60	---	Low.
Brussett:							
14, 15	B	None	---	---	>60	---	Moderate.
Chaseville:							
16, 17	A	None	---	---	>60	---	Low.
[1]18:							
Chaseville part	A	None	---	---	>60	---	Low.
Midway part	D	None	---	---	10-20	Rippable	Moderate.
Columbine:							
19	A	None to rare	---	---	>60	---	Low.
Connerton:							
[1]20:							
Connerton part	B	None	---	---	>60	---	High.
Rock outcrop part	D	---	---	---	---	---	---
Cruckton:							
21	B	None	---	---	>60	---	Moderate.
Cushman:							
22, 23	C	None	---	---	20-40	Rippable	Moderate.
[1]24:							
Cushman part	C	None	---	---	20-40	Rippable	Moderate.
Kutch part	C	None	---	---	20-40	Rippable	Moderate.
Elbeth:							
25, 26	B	None	---	---	>60	---	Moderate.
[1]27:							
Elbeth part	B	None	---	---	>60	---	Moderate.

[1] See footnote at end of table.

TABLE 16.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydro-logic group	Flooding			Bedrock		Potential frost action
		Frequency	Duration	Months	Depth	Hardness	
					In		
Tomah:							
[1]92, [1]93:							
Tomah part-----	B	None----------	---	---	>60	---	Moderate.
Crowfoot part--	B	None----------	---	---	>60	---	Moderate.
Travessilla:							
[1]94:							
Travessilla part----------	D	None----------	---	---	6-20	Hard	Low.
Rock outcrop part----------	D	---	---	---	---	---	---
Truckton: 95, 96, 97--------	B	None----------	---	---	>60	---	Moderate.
[1]98:							
Truckton part--	B	None----------	---	---	>60	---	Moderate.
Blakeland part-	A	None----------	---	---	>60	---	Low.
[1]99, [1]100:							
Truckton part--	B	None----------	---	---	>60	---	Moderate.
Bresser part---	B	None----------	---	---	>60	---	Low.
Ustic Torrifluvents: 101--------------	B	Occasional----	Very brief----	Mar-Aug	>60	---	Moderate.
Valent: 102, 103---------	A	None----------	---	---	>60	---	Low.
Vona: 104, 105---------	B	None----------	---	---	>60	---	Moderate.
Wigton: 106--------------	A	None----------	---	---	>60	---	Low.
Wiley: 107, 108---------	B	None----------	---	---	>60	---	Low.
Yoder: 109, 110---------	B	None----------	---	---	>60	---	Low.

[1]This map unit is made up of two or more dominant kinds of soil. See map unit description for the composition and behavior characteristics of the map unit.

APPENDIX B1

HYDROLOGIC CALCULATIONS (RATIONAL METHOD)

Table 6-6. Runoff Coefficients for Rational Method
(Source: UDFCD 2001)

Land Use or Surface Characteristics	Percent Impervious	Runoff Coefficients											
		2-year		5-year		10-year		25-year		50-year		100-year	
		HSG A&B	HSG C&D	HSG A&B	HSG C&D	HSG A&B	HSG C&D	HSG A&B	HSG C&D	HSG A&B	HSG C&D	HSG A&B	HSG C&D
Business													
Commercial Areas	95	0.79	0.80	0.81	0.82	0.83	0.84	0.85	0.87	0.87	0.88	0.88	0.89
Neighborhood Areas	70	0.45	0.49	0.49	0.53	0.53	0.57	0.58	0.62	0.60	0.65	0.62	0.68
Residential													
1/8 Acre or less	65	0.41	0.45	0.45	0.49	0.49	0.54	0.54	0.59	0.57	0.62	0.59	0.65
1/4 Acre	40	0.23	0.28	0.30	0.35	0.36	0.42	0.42	0.50	0.46	0.54	0.50	0.58
1/3 Acre	30	0.18	0.22	0.25	0.30	0.32	0.38	0.39	0.47	0.43	0.52	0.47	0.57
1/2 Acre	25	0.15	0.20	0.22	0.28	0.30	0.36	0.37	0.46	0.41	0.51	0.46	0.56
1 Acre	20	0.12	0.17	0.20	0.26	0.27	0.34	0.35	0.44	0.40	0.50	0.44	0.55
Industrial													
Light Areas	80	0.57	0.60	0.59	0.63	0.63	0.66	0.66	0.70	0.68	0.72	0.70	0.74
Heavy Areas	90	0.71	0.73	0.73	0.75	0.75	0.77	0.78	0.80	0.80	0.82	0.81	0.83
Parks and Cemeteries	7	0.05	0.09	0.12	0.19	0.20	0.29	0.30	0.40	0.34	0.46	0.39	0.52
Playgrounds	13	0.07	0.13	0.16	0.23	0.24	0.31	0.32	0.42	0.37	0.48	0.41	0.54
Railroad Yard Areas	40	0.23	0.28	0.30	0.35	0.36	0.42	0.42	0.50	0.46	0.54	0.50	0.58
Undeveloped Areas													
Historic Flow Analysis--Greenbelts, Agriculture	2	0.03	0.05	0.09	0.16	0.17	0.26	0.26	0.38	0.31	0.45	0.36	0.51
Pasture/Meadow	0	0.02	0.04	0.08	0.15	0.15	0.25	0.25	0.37	0.30	0.44	0.35	0.50
Forest	0	0.02	0.04	0.08	0.15	0.15	0.25	0.25	0.37	0.30	0.44	0.35	0.50
Exposed Rock	100	0.89	0.89	0.90	0.90	0.92	0.92	0.94	0.94	0.95	0.95	0.96	0.96
Offsite Flow Analysis (when landuse is undefined)	45	0.26	0.31	0.32	0.37	0.38	0.44	0.44	0.51	0.48	0.55	0.51	0.59
Streets													
Paved	100	0.89	0.89	0.90	0.90	0.92	0.92	0.94	0.94	0.95	0.95	0.96	0.96
Gravel	80	0.57	0.60	0.59	0.63	0.63	0.66	0.66	0.70	0.68	0.72	0.70	0.74
Drive and Walks	100	0.89	0.89	0.90	0.90	0.92	0.92	0.94	0.94	0.95	0.95	0.96	0.96
Roofs	90	0.71	0.73	0.73	0.75	0.75	0.77	0.78	0.80	0.80	0.82	0.81	0.83
Lawns	0	0.02	0.04	0.08	0.15	0.15	0.25	0.25	0.37	0.30	0.44	0.35	0.50

3.2 Time of Concentration

One of the basic assumptions underlying the Rational Method is that runoff is a function of the average rainfall rate during the time required for water to flow from the hydraulically most remote part of the drainage area under consideration to the design point. However, in practice, the time of concentration can be an empirical value that results in reasonable and acceptable peak flow calculations.

For urban areas, the time of concentration (t_c) consists of an initial time or overland flow time (t_i) plus the travel time (t_t) in the storm sewer, paved gutter, roadside drainage ditch, or drainage channel. For non-urban areas, the time of concentration consists of an overland flow time (t_i) plus the time of travel in a concentrated form, such as a swale or drainageway. The travel portion (t_t) of the time of concentration can be estimated from the hydraulic properties of the storm sewer, gutter, swale, ditch, or drainageway. Initial time, on the other hand, will vary with surface slope, depression storage, surface cover, antecedent rainfall, and infiltration capacity of the soil, as well as distance of surface flow. The time of concentration is represented by Equation 6-7 for both urban and non-urban areas.

$$t_c = t_i + t_t$$ (Eq. 6-7)

Where:

t_c = time of concentration (min)

t_i = overland (initial) flow time (min)

t_t = travel time in the ditch, channel, gutter, storm sewer, etc. (min)

3.2.1 Overland (Initial) Flow Time

The overland flow time, t_i, may be calculated using Equation 6-8.

$$t_i = \frac{0.395(1.1 - C_5)\sqrt{L}}{S^{0.33}}$$ (Eq. 6-8)

Where:

t_i = overland (initial) flow time (min)
C_5 = runoff coefficient for 5-year frequency (see Table 6-6)
L = length of overland flow (300 ft maximum for non-urban land uses, 100 ft maximum for urban land uses)
S = average basin slope (ft/ft)

Note that in some urban watersheds, the overland flow time may be very small because flows quickly concentrate and channelize.

3.2.2 Travel Time

For catchments with overland and channelized flow, the time of concentration needs to be considered in combination with the travel time, t_t, which is calculated using the hydraulic properties of the swale, ditch, or channel. For preliminary work, the overland travel time, t_t, can be estimated with the help of Figure 6-25 or Equation 6-9 (Guo 1999).

$$V = C_v S_w^{0.5}$$ (Eq. 6-9)

Where:

V = velocity (ft/s)

C_v = conveyance coefficient (from Table 6-7)

S_w = watercourse slope (ft/ft)

Table 6-7. Conveyance Coefficient, C_v

Type of Land Surface	C_v
Heavy meadow	2.5
Tillage/field	5
Riprap (not buried)*	6.5
Short pasture and lawns	7
Nearly bare ground	10
Grassed waterway	15
Paved areas and shallow paved swales	20

* For buried riprap, select C_v value based on type of vegetative cover.

The travel time is calculated by dividing the flow distance (in feet) by the velocity calculated using Equation 6-9 and converting units to minutes.

The time of concentration (t_c) is then the sum of the overland flow time (t_i) and the travel time (t_t) per Equation 6-7.

3.2.3 First Design Point Time of Concentration in Urban Catchments

Using this procedure, the time of concentration at the first design point (typically the first inlet in the system) in an urbanized catchment should not exceed the time of concentration calculated using Equation 6-10. The first design point is defined as the point where runoff first enters the storm sewer system.

$$t_c = \frac{L}{180} + 10 \qquad \text{(Eq. 6-10)}$$

Where:

t_c = maximum time of concentration at the first design point in an urban watershed (min)

L = waterway length (ft)

Equation 6-10 was developed using the rainfall-runoff data collected in the Denver region and, in essence, represents regional “calibration” of the Rational Method. Normally, Equation 6-10 will result in a lesser time of concentration at the first design point and will govern in an urbanized watershed. For subsequent design points, the time of concentration is calculated by accumulating the travel times in downstream drainageway reaches.

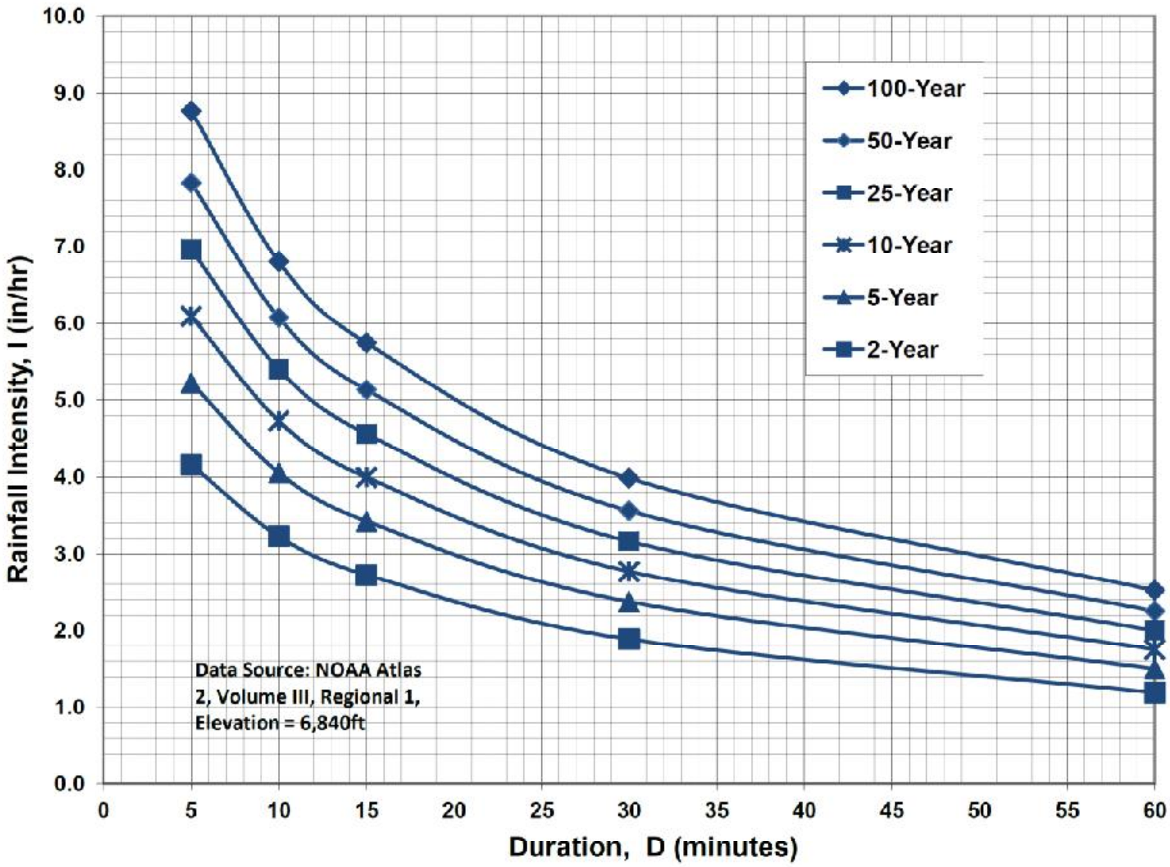
3.2.4 Minimum Time of Concentration

If the calculations result in a t_c of less than 10 minutes for undeveloped conditions, it is recommended that a minimum value of 10 minutes be used. The minimum t_c for urbanized areas is 5 minutes.

3.2.5 Post-Development Time of Concentration

As Equation 6-8 indicates, the time of concentration is a function of the 5-year runoff coefficient for a drainage basin. Typically, higher levels of imperviousness (higher 5-year runoff coefficients) correspond to shorter times of concentration, and lower levels of imperviousness correspond to longer times of

Figure 6-5. Colorado Springs Rainfall Intensity Duration Frequency



IDF Equations

$$I_{100} = -2.52 \ln(D) + 12.735$$

$$I_{50} = -2.25 \ln(D) + 11.375$$

$$I_{25} = -2.00 \ln(D) + 10.111$$

$$I_{10} = -1.75 \ln(D) + 8.847$$

$$I_{5} = -1.50 \ln(D) + 7.583$$

$$I_{2} = -1.19 \ln(D) + 6.035$$

Note: Values calculated by equations may not precisely duplicate values read from figure.

ELLICOTT TOWN CENTER
RATIONAL METHOD
HISTORIC FLOWS

BASIN	DESIGN POINT	AREA (AC)	C 5-YEAR(7)	C 100-YEAR (7)	OVERLAND LENGTH (FT)	SLOPE (%)	Tco (1) (MIN)	CHANNEL LENGTH (FT)	CONVEYANCE COEFFICIENT K	SLOPE (%)	SCS (2) VELOCITY (FT/S)	Tt (3) (MIN)	TOTAL Tc (4) (MIN)	INTENSITY (5) 5-YR (IN/HR)	INTENSITY (5) 100-YR (IN/HR)	PEAK FLOW Q5 (6) (CFS)	PEAK FLOW Q100 (6) (CFS)
OA2		15.1	0.25	0.35									26.5	2.50	4.50	9.44	23.78
OA1		66.8	0.25	0.35	1000	0.5	60.9	2300	1.50	0.9	1.42	26.9	87.9	1.50	2.65	25.05	61.96
A		58.2	0.25	0.35			0.0	2800	1.50	1.0	1.50	31.1	31.1				
OA2,OA1, A	1	140.1	0.25	0.35									145.5	1.50	2.65	52.54	129.94
EC12		30.3	0.25	0.35									33.0	2.20	3.80	16.67	40.30
OB1		33.7	0.25	0.35	700	1.4	36.2	0				0.0	36.2	2.10	3.70	17.69	43.64
B		183.8	0.25	0.35			0.0	6700	1.50	1.0	1.50	74.4	74.4	1.50	2.65	68.93	170.47
EC12,OB1,B	3	247.8	0.25	0.35									143.6	1.50	2.65	92.93	229.83
BB	2	22.5	0.25	0.35	1000	2.8	34.3	300	1.50	1.0	1.50	3.3	37.7	2.00	3.55	11.25	27.96
C	4	123.0	0.25	0.35	1000	1.7	40.5	4800	1.50	1.1	1.57	50.9	91.4	1.50	2.65	46.13	114.08
EC11		296	0.25	0.35	1000	1.0	48.4	6135	1.50	1.3	1.71	59.8	108.2	1.50	2.65	111.00	274.54
D		154.8	0.25	0.35			0.0	3800	1.50	0.9	1.42	44.5	44.5	1.50	2.65	58.05	143.58
EC11,D	5	450.8	0.25	0.35									152.7	1.50	2.65	169.05	418.12
EC10		142.7	0.25	0.35	1000	1.0	48.4	6300	1.50	1.1	1.57	66.7	115.1	1.50	2.65	53.51	132.35
E		8.4	0.25	0.35			0.0	1300	1.50	0.9	1.39	15.6	15.6	1.50	2.65	3.16	7.81
EC10,E	6	151.1	0.25	0.35									130.7	1.50	2.65	56.67	140.16

1) OVERLAND FLOW Tco = (1.87*(1.1-RUNOFF COEFFICIENT)*(OVERLAND FLOW LENGTH^(0.5)/(SLOPE^(0.333))
2) SCS VELOCITY = K * ((SLOPE(%))^0.5)
K = 0.25 FOR MEADOW
K = 1.0 FOR BARE SOIL
K = 1.5 FOR GRASS CHANNEL
K = 2.0 FOR PAVEMENT
3) CHANNEL / SWALE / GUTTER FLOW, Tt = (CHANNEL LENGTH/ SCS VELOCITY) / 60 SEC
4) Tc = Tco + Tt
*** IF TOTAL TIME OF CONCENTRATION IS LESS THAN 5 MINUTES, THEN 5 MINUTES IS USED
5) INTENSITY BASED ON I-D-F CURVE IN EL PASO COUNTY DRAINAGE CRITERIA MANUAL
6) Q = CiA
7) WEIGHTED AVERAGE C VALUES FOR COMBINED BASINS

ELLICOTT TOWN CENTER
COMPOSITE RUNOFF COEFFICIENTS

DEVELOPED CONDITIONS
5-YEAR C VALUES

BASIN	TOTAL AREA (AC)	(AC)	SUB-AREA 1 DEVELOPMENT/ COVER	C	AREA (AC)	SUB-AREA 2 DEVELOPMENT/ COVER	C	(AC)	SUB-AREA 3 DEVELOPMENT/ COVER	C	WEIGHTED C VALUE
FILING NO. 1											
A1A	2.80	0.9	ROADWAY	0.9	1.9	GRASS	0.08				0.355
C1.2	7.97	8.0	COMMERCIAL	0.49							0.490
C1.7A	0.58	0.6	SF LOTS (1/6-AC)	0.375							0.375
C1.7B	4.34	4.3	COMMERCIAL	0.49							0.490
C1.7A,C1.7B	4.92										0.476
C1.2,C1.7	12.89										0.485
C1.3	3.02	3.0	SF LOTS (1/6-AC)	0.375							0.375
C1.2,C1.3,C1.7	15.91										0.464
C1.4	3.23	3.2	SF LOTS (1/6-AC)	0.375							0.375
C1.2-C1.4,C1.7	19.14										0.449
C1.5	3.18	3.2	SF LOTS (1/6-AC)	0.375							0.375
C1.2-C1.5,C1.7	22.32										0.438
C1.1	9.38	3.0	RESIDENTIAL	0.375	1.2	COMMERCIAL	0.49	5.2	OPEN SPACE	0.08	0.226
C1.6	1.98	2.0	SF LOTS (1/6-AC)	0.375							0.375
C1.1,C1.6	11.36										0.252
C1.1-C1.7	33.68										0.376
C1.8	3.89	3.9	SF LOTS (1/6-AC)	0.375							0.375
C1.9	3.60	3.6	SF LOTS (1/6-AC)	0.375							0.375
C1.8-C1.9	7.49										0.375
C1.1-C1.9	41.17										0.376

FILING NO. 2											
C2.1	5.59	1.8	RESIDENTIAL	0.375	0.9	COMMERCIAL	0.49	2.9	OPEN SPACE	0.08	0.242
C2.2	4.03	4.0	SF LOTS (1/6-AC)	0.375							0.375
C2.3	2.76	2.8	SF LOTS (1/6-AC)	0.375							0.375
C2.1-C2.3	12.38										0.315
C2.4	4.98	5.0	SF LOTS (1/6-AC)	0.375							0.375
C2.5	4.12	4.1	SF LOTS (1/6-AC)	0.375							0.375
C2.1-C2.5	21.48										0.341
C4	20.40	20.4	PARK / OS	0.08							0.080
C2.1-C2.5,C4	41.88										0.214
C2.6	2.76	2.8	SF LOTS (1/6-AC)	0.375							0.375
C2.7	2.14	2.1	SF LOTS (1/6-AC)	0.375							0.375
C2.8	3.00	3.0	SF LOTS (1/6-AC)	0.375							0.375
C2.6-C2.8	7.90										0.375
D1.2	2.99	3.0	SF LOTS (1/6-AC)	0.375							0.375
C2.6-C2.8,D1.2	10.89										0.375
D1.1	3.02	3.0	SF LOTS (1/6-AC)	0.375							0.375
D1.3	2.87	2.9	SF LOTS (1/6-AC)	0.375							0.375
C2.6-C2.8,D1.1-D1.3	16.78										0.375
D1.4	4.19	4.2	SF LOTS (1/6-AC)	0.375							0.375
D1.5	5.09	5.1	SF LOTS (1/6-AC)	0.375							0.375
D1.6	2.24	2.2	SF LOTS (1/6-AC)	0.375							0.375
C2.6-C2.8,D1.1-D1.6	28.30										0.375
PHASE 2											
D2	44.58	39.5	MDR-RESIDENTIAL	0.375	5.1	LANDSCAPE/OS	0.08				0.341
C2.6-C2.8,D1.1-D1.6,D2	72.88										0.354
C2,C4,D	**114.76**										**0.303**
C3	**74.48**	**74.5**	**SF LOTS (1/6-AC)**	**0.375**							**0.375**
C2,C3,C4,D	189.24										0.331

ELLICOTT TOWN CENTER
COMPOSITE RUNOFF COEFFICIENTS

DEVELOPED CONDITIONS
100-YEAR C VALUES

BASIN	TOTAL AREA (AC)	SUB-AREA 1 (AC)	SUB-AREA 1 DEVELOPMENT/ COVER	C	SUB-AREA 2 AREA (AC)	SUB-AREA 2 DEVELOPMENT/ COVER	C	SUB-AREA 3 (AC)	SUB-AREA 3 DEVELOPMENT/ COVER	C	WEIGHTED C VALUE
FILING NO. 1											
A1A	2.80	0.9	ROADWAY	0.96	1.9	GRASS	0.35				0.555
C1.2	7.97	8.0	COMMERCIAL	0.62							0.620
C1.7A	0.58	0.6	SF LOTS (1/6-AC)	0.545							0.545
C1.7B	4.34	4.3	COMMERCIAL	0.62							0.620
C1.7A,C1.7B	4.92										0.611
C1.2,C1.7	12.89										0.617
C1.3	3.02	3.0	SF LOTS (1/6-AC)	0.545							0.545
C1.2,C1.3,C1.7	15.91										0.603
C1.4	3.23	3.2	SF LOTS (1/6-AC)	0.545							0.545
C1.2-C1.4,C1.7	19.14										0.593
C1.5	3.18	3.2	SF LOTS (1/6-AC)	0.545							0.545
C1.2-C1.5,C1.7	22.32										0.586
C1.1	9.38	3.0	RESIDENTIAL	0.545	1.2	COMMERCIAL	0.62	5.2	OPEN SPACE	0.35	0.447
C1.6	1.98	2.0	SF LOTS (1/6-AC)	0.545							0.545
C1.1,C1.6	11.36										0.464
C1.2-C1.7	33.68										0.545
C1.8	3.89	3.9	SF LOTS (1/6-AC)	0.545							0.545
C1.9	3.60	3.6	SF LOTS (1/6-AC)	0.545							0.545
C1.8-C1.9	7.49										0.545
C1.1-C1.9	41.17										**0.545**

FILING NO. 2											
C2.1	5.59	1.8	RESIDENTIAL	0.545	0.9	COMMERCIAL	0.62	2.9	OPEN SPACE	0.35	0.457
C2.2	4.03	4.0	SF LOTS (1/6-AC)	0.545							0.545
C2.3	2.76	2.8	SF LOTS (1/6-AC)	0.545							0.545
C2.1-C2.3	12.38										0.505
C2.4	4.98	5.0	SF LOTS (1/6-AC)	0.545							0.545
C2.5	4.12	4.1	SF LOTS (1/6-AC)	0.545							0.545
C2.1-C2.5	21.48										0.522
C4	20.40	20.4	PARK / OS	0.35							0.350
C2.1-C2.5,C4	41.88										0.438
C2.6	2.76	2.8	SF LOTS (1/6-AC)	0.545							0.545
C2.7	2.14	2.1	SF LOTS (1/6-AC)	0.545							0.545
C2.8	3.00	3.0	SF LOTS (1/6-AC)	0.545							0.545
C2.6-C2.8	7.90										0.545
D1.2	2.99	3.0	SF LOTS (1/6-AC)	0.545							0.545
C2.6-C2.8,D1.2	10.89										0.545
D1.1	3.02	3.0	SF LOTS (1/6-AC)	0.545							0.545
D1.3	2.87	2.9	SF LOTS (1/6-AC)	0.545							0.545
C2.6-C2.8,D1.1-D1.3	16.78										0.545
D1.4	4.19	4.2	SF LOTS (1/6-AC)	0.545							0.545
D1.5	5.09	5.1	SF LOTS (1/6-AC)	0.545							0.545
D1.6	2.24	2.2	SF LOTS (1/6-AC)	0.545							0.545
C2.6-C2.8,D1.1-D1.6	28.30										0.545
PHASE 2											
D2	44.58	39.5	MDR-RESIDENTIAL	0.545	5.1	LANDSCAPE/OS	0.35				0.523
C2.6-C2.8,D1.1-D1.6,D2	72.88										0.531
C2,C4,D	**114.76**										**0.497**
C3	**74.48**	**74.5**	**SF LOTS (1/6-AC)**	**0.545**							**0.545**
C2,C3,C4,D	189.24										0.516

ELLICOTT TOWN CENTER
RATIONAL METHOD - HYDROLOGIC CALCULATIONS

DEVELOPED FLOWS

BASIN	DESIGN POINT	AREA (AC)	C 5-YEAR	C 100-YEAR	Overland Flow LENGTH (FT)	Overland Flow SLOPE (FT/FT)	Overland Flow Tco (1) (MIN)	Channel flow CHANNEL LENGTH (FT)	Channel flow CONVEYANCE COEFFICIENT C	Channel flow SLOPE (FT/FT)	Channel flow SCS (2) VELOCITY (FT/S)	Channel flow Tt (3) (MIN)	TOTAL Tc (4) (MIN)	TOTAL Tc (4) (MIN)	INTENSITY (5) 5-YR (IN/HR)	INTENSITY (5) 100-YR (IN/HR)	PEAK FLOW Q5 (6) (CFS)	PEAK FLOW Q100 (6) (CFS)
FILING NO. 1																		
A1A	A1A	2.80	0.355	0.555	40	0.020	6.8	2035	15.00	0.011	1.57	21.6	28.4	28.4	2.56	4.30	2.55	6.68
C1.2	C1.2	7.97	0.490	0.620			0.0	1000	20.00	0.009	1.90	8.8	8.8	8.8	4.32	7.26	16.88	35.87
C1.7A	C1.7A	0.58	0.375	0.545			0.0	680	20.00	0.013	2.28	5.0	5.0	5.0	5.17	8.68	1.12	2.74
C1.7B	C1.7B	4.34	0.490	0.620	100	0.020	8.9	400	20.00	0.01	2.00	3.3	12.2	12.2	3.83	6.43	8.15	17.31
C1.7A,C1.7B	C1.7B1	4.92	0.476	0.611									12.2	12.2	3.83	6.43	8.97	19.33
C1.2,C1.7	C1.2D	12.89	0.485	0.617									12.2	12.2	3.83	6.43	23.95	51.15
C1.3		3.02	0.375	0.545			0.0	280	20.00	0.01	2.00	2.3	2.3	5.0	5.17	8.68	5.85	14.29
C1.2,C1.3,C1.7	C1.3A	15.91	0.464	0.603									14.5	14.5	3.57	5.99	26.34	57.47
C1.4		3.23	0.375	0.545			0.0	300	20.00	0.01	2.00	2.5	2.5	5.0	5.17	8.68	6.26	15.28
C1.2-C1.4,C1.7	C1.4A	19.14	0.449	0.593									17.0	17.0	3.33	5.59	28.62	63.45
C1.5		3.18	0.375	0.545			0.0	300	20.00	0.01	2.00	2.5	2.5	5.0	5.17	8.68	6.16	15.04
C1.2-C1.5,C1.7	C1.5A	22.32	0.438	0.586									19.5	19.5	3.12	5.25	30.55	68.61
C1.1	C1.1	9.38	0.226	0.447	100	0.017	13.4	1800	20.00	0.01	2.00	15.0	28.4	28.4	2.56	4.30	5.43	18.04
C1.6		1.98	0.375	0.545			0.0	280	20.00	0.01	2.00	2.3	2.3	5.0	5.17	8.68	3.84	9.37
C1.1,C1.6	C1.6B	11.36	0.252	0.464									30.7	30.7	2.44	4.10	7.00	21.62
C1.1-C1.7	C1.7A	33.68	0.376	0.545									30.7	30.7	2.44	4.10	30.96	75.30
C1.8		3.89	0.375	0.545			0.0	600	20.00	0.016	2.53	4.0	4.0	5.0	5.17	8.68	7.54	18.40
C1.9		3.60	0.375	0.545			0.0	580	20.00	0.012	2.19	4.4	4.4	5.0	5.17	8.68	6.98	17.03
C1.8,C1.9	C1.9A	7.49	0.375	0.545									8.4	8.4	4.40	7.38	12.35	30.14
C1.1-C1.9	**C1.9B**	**41.17**	**0.376**	**0.545**									**30.7**	**30.7**	**2.44**	**4.10**	**37.84**	**92.05**
FILING NO. 2																		
C2.1		5.59	0.242	0.457	100	0.016	13.4	650	20.00	0.01	2.00	5.4	18.8	18.8	3.18	5.34	4.30	13.63
C2.2		4.03	0.375	0.545			0.0	460	20.00	0.01	2.00	3.8	3.8	5.0	5.17	8.68	7.81	19.06
C2.3		2.76	0.375	0.545			0.0	260	20.00	0.01	2.00	2.2	2.2	5.0	5.17	8.68	5.35	13.06
C2.1-C2.3	C2.3A	12.38	0.315	0.505									21.0	21.0	3.02	5.06	11.76	31.64
C2.4		4.98	0.375	0.545			0.0	560	20.00	0.012	2.19	4.3	4.3	5.0	5.17	8.68	9.65	23.56
C2.5		4.12	0.375	0.545			0.0	330	20.00	0.01	2.00	2.8	2.8	5.0	5.17	8.68	7.99	19.49
C2.1-C2.5	C2.5A	21.48	0.341	0.522									23.8	23.8	2.83	4.75	20.73	53.27

BASIN	DESIGN POINT	AREA (AC)	C 5-YEAR	C 100-YEAR	Overland Flow LENGTH (FT)	Overland Flow SLOPE (FT/FT)	Overland Flow Tco [1] (MIN)	Channel flow CHANNEL LENGTH (FT)	Channel flow CONVEYANCE COEFFICIENT C	Channel flow SLOPE (FT/FT)	Channel flow SCS [2] VELOCITY (FT/S)	Channel flow Tt [3] (MIN)	TOTAL Tc [4] (MIN)	TOTAL Tc [4] (MIN)	INTENSITY [5] 5-YR (IN/HR)	INTENSITY [5] 100-YR (IN/HR)	PEAK FLOW Q5 [6] (CFS)	PEAK FLOW Q100 [6] (CFS)
C4		20.40	0.080	0.350			0.0	1050	15.00	0.011	1.57	11.1	11.1	11.1	3.97	6.66	6.48	47.58
Tc C2.5A TO DP-D2B								2450	15.00	0.01	1.50	27.2						
C2.1-C2.5,C4	C4.1	41.88	0.214	0.438									30.7	30.7	2.44	4.10	21.91	75.25
C2.6		2.76	0.375	0.545			0.0	460	20.00	0.01	2.00	3.8	3.8	5.0	5.17	8.68	5.35	13.06
C2.7		2.14	0.375	0.545			0.0	300	20.00	0.01	2.00	2.5	2.5	5.0	5.17	8.68	4.15	10.12
C2.8		3.00	0.375	0.545			0.0	280	20.00	0.01	2.00	2.3	2.3	5.0	5.17	8.68	5.81	14.19
C2.6-C2.8	C2.8A	7.90	0.375	0.545									6.2	6.2	4.85	8.15	14.38	35.09
D1.2		2.99	0.375	0.545			0.0	300	20.00	0.01	2.00	2.5	2.5	5.0	5.17	8.68	5.80	14.14
C2.6-C2.8,D1.2	D1.2A	10.89	0.375	0.545									8.7	8.7	4.34	7.29	17.74	43.28
D1.1	D1.1	3.02	0.375	0.545			0.0	750	20.00	0.011	2.10	6.0	6.0	6.0	4.91	8.24	5.56	13.56
D1.3		2.87	0.375	0.545			0.0	280	20.00	0.01	2.00	2.3	2.3	5.0	5.17	8.68	5.56	13.58
C2.6-C2.8,D1.1-D1.3	D1.3A	16.78	0.375	0.545									11.0	11.0	3.99	6.69	25.08	61.20
D1.4	D1.4	4.19	0.375	0.545			0.0	550	20.00	0.012	2.19	4.2	4.2	5.0	5.17	8.68	8.12	19.82
D1.5		5.09	0.375	0.545			0.0	280	20.00	0.01	2.00	2.3	2.3	5.0	5.17	8.68	9.87	24.08
D1.6		2.24	0.375	0.545			0.0	1060	20.00	0.01	2.00	8.8	8.8	8.8	4.32	7.25	3.62	8.84
C2.6-C2.8,D1.1-D1.6	D1.6A	28.30	0.375	0.545									15.2	15.2	3.50	5.88	37.17	90.69
PHASE 2																		
D2		44.58	0.341	0.523	100	0.020	11.0	1750	20.00	0.011	2.10	13.9	24.9	24.9	2.76	4.63	41.94	107.95
C2.6-C2.8,D1.1-D1.6,D2	D2A	72.88	0.354	0.531									4.3	5.0	5.17	8.68	133.35	335.88
C2,C4,D	**D2B**	**114.76**	**0.303**	**0.497**									**23.8**	**23.8**	**2.83**	**4.75**	**98.43**	**270.99**
C3		**74.48**	**0.375**	**0.545**	**100**	**0.020**	**10.5**	**3000**	**20.00**	**0.011**	**2.10**	**23.8**	**34.4**	**34.4**	**2.28**	**3.82**	**63.60**	**155.10**
C2,C2,C4,D	D2C	189.24	0.331	0.516									51.0	51.0	1.69	2.83	105.59	276.10

1) OVERLAND FLOW Tco = (0.395*(1.1-RUNOFF COEFFICIENT)*(OVERLAND FLOW LENGTH^(0.5)/(SLOPE^(0.333))
2) SCS VELOCITY = C * ((SLOPE(FT/FT)^0.5)
C = 2.5 FOR HEAVY MEADOW
C = 5 FOR TILLAGE/FIELD
C = 7 FOR SHORT PASTURE AND LAWNS
C = 10 FOR NEARLY BARE GROUND
C = 15 FOR GRASSED WATERWAY
C = 20 FOR PAVED AREAS AND SHALLOW PAVED SWALES
3) MANNING'S CHANNEL TRAVEL TIME = L/V (WHEN CHANNEL VELOCITY IS KNOWN)
4) Tc = Tco + Tt
*** IF TOTAL TIME OF CONCENTRATION IS LESS THAN 5 MINUTES, THEN 5 MINUTES IS USED
5) INTENSITY BASED ON I-D-F EQUATIONS IN CITY OF COLORADO SPRINGS DRAINAGE CRITERIA MANUAL
$I_5 = -1.5 * \ln(Tc) + 7.583$
$I_{100} = -2.52 * \ln(Tc) + 12.735$
6) Q = CiA

APPENDIX B2

HYDROLOGIC CALCULATIONS (SCS METHOD)

TABLE 5-4
RUNOFF CURVE NUMBERS FOR HYDROLOGIC SOIL
COVER COMPLEXES - RURAL CONDITIONS
(Antecedent Moisture Condition II, and $I_a = 0.2\ S$)
(From: U.S. Dept. of Agriculture,
Soil Conservation Service, 1977)

Land Use	Cover Treatment or Practice	Hydrologic Condition	Runoff Curve Number by Hydrologic Soil Group A	B	C	D
Fallow	Straight Row	----	77	86	91	94
Row Crops	Straight Row	Poor	72	81	88	91
	Straight Row	Good	67	78	85	89
	Contoured	Poor	70	79	84	88
	Contoured	Good	65	75	82	86
	Cont. & Terraced	Poor	66	74	80	82
	Cont. & Terraced	Good	62	71	78	81
Small Grain	Straight Row	Poor	65	76	84	88
	Straight Row	Good	63	75	83	87
	Contoured	Poor	63	74	82	85
	Contoured	Good	61	73	81	84
	Cont. & Terraced	Poor	61	72	79	82
	Cont. & Terraced	Good	59	70	78	81
Close-seeded legumes 1/ or rotation meadow	Straight Row	Poor	66	77	85	89
	Straight Row	Good	58	72	81	85
	Contoured	Poor	64	75	83	85
	Contoured	Good	55	69	78	83
	Cont. & Terraced	Poor	63	73	80	83
	Cont. & Terraced	Good	51	67	76	80
Pasture or range		Poor	68	79	86	89
		Fair	49	69	79	84
		Good	39	61	74	80
	Contoured	Poor	47	67	81	88
	Contoured	Fair	25	59	75	83
	Contoured	Good	6	35	70	79
Meadow		Good	30	58	71	78
Woods		Poor	45	66	77	83
		Fair	36	60	73	79
		Good	25	55	70	77
Farmsteads		----	59	74	82	86
Roads (dirt) 2/		----	72	82	87	89
(hard surface) 2/		----	74	84	90	92

1/ Close-drilled or broadcast
2/ Including right-of-way

Hydrograph Plot

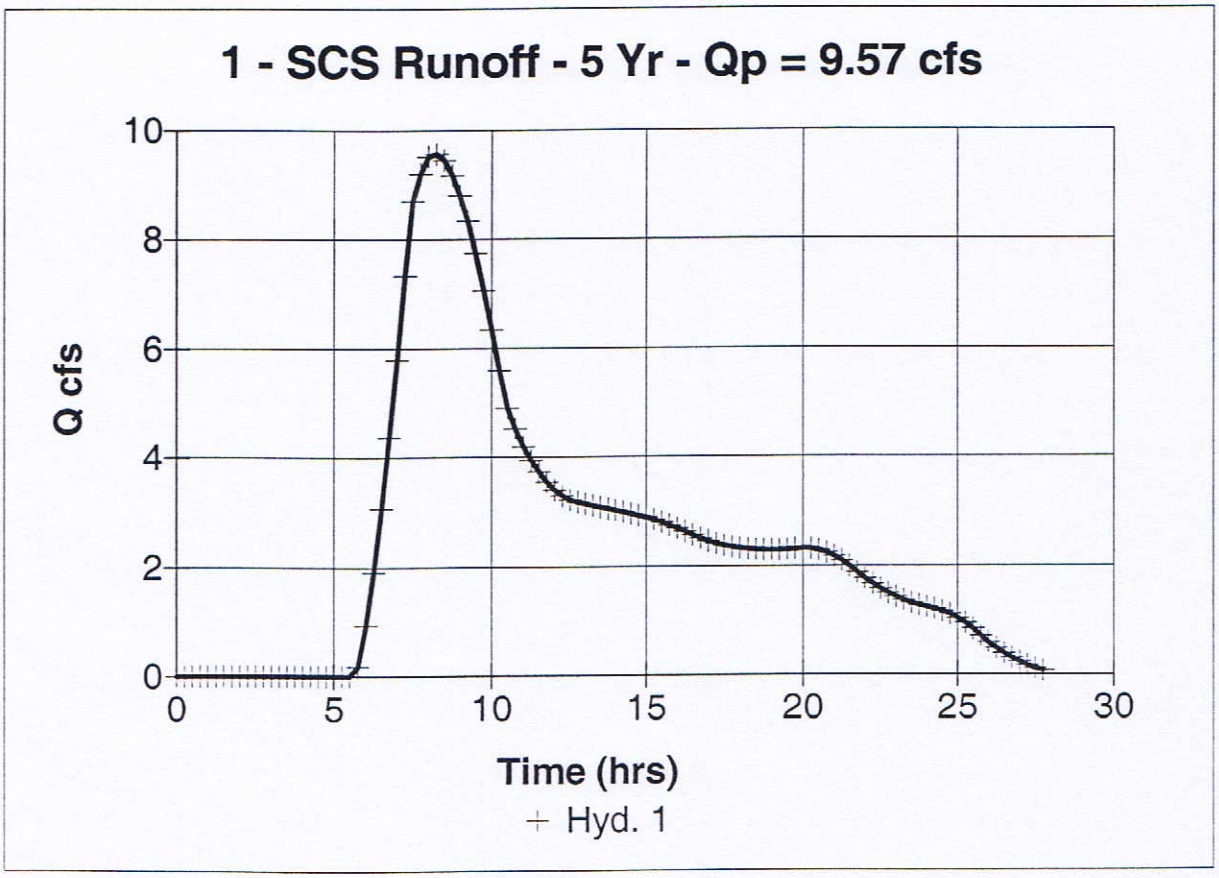
English

Hyd. No. 1

DP-EC11

Hydrograph type	= SCS Runoff	Peak discharge	= 9.57 cfs
Storm frequency	= 5 yrs	Time interval	= 15 min
Drainage area	= 296.00 ac	Curve number	= 61
Basin Slope	= 1.1 %	Hydraulic length	= 10935 ft
Tc method	= USER	Time of conc. (Tc)	= 152.7 min
Total precip.	= 2.60 in	Distribution	= Custom
Storm duration	= TYPE IIA.CDS	Shape factor	= 484

Total Volume = 247,499 cuft



Hydrograph Plot

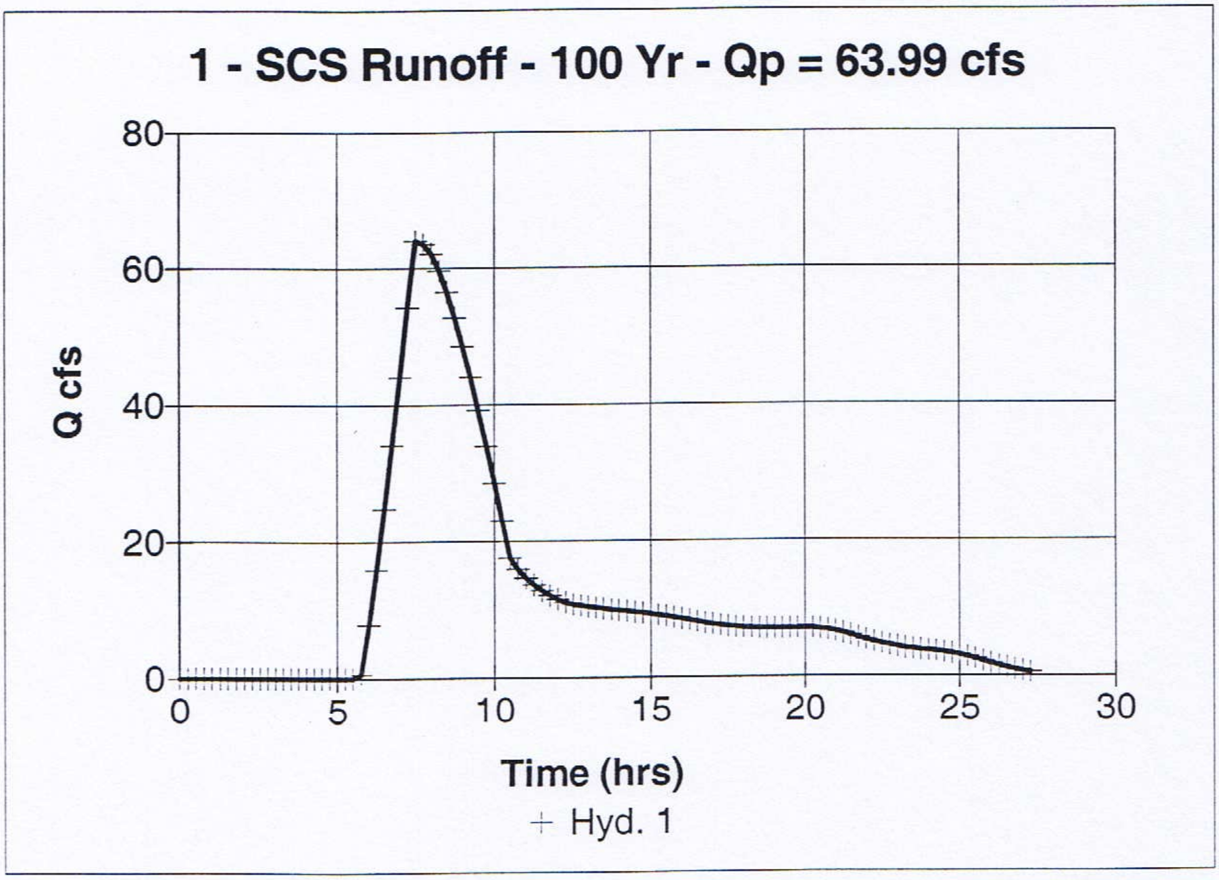
English

Hyd. No. 1

DP-EC11

Hydrograph type	= SCS Runoff	Peak discharge	= 63.99 cfs
Storm frequency	= 100 yrs	Time interval	= 15 min
Drainage area	= 296.00 ac	Curve number	= 61
Basin Slope	= 1.1 %	Hydraulic length	= 10935 ft
Tc method	= USER	Time of conc. (Tc)	= 152.7 min
Total precip.	= 4.40 in	Distribution	= Custom
Storm duration	= TYPE IIA.CDS	Shape factor	= 484

Total Volume = 1,119,855 cuft



Hydrograph Plot

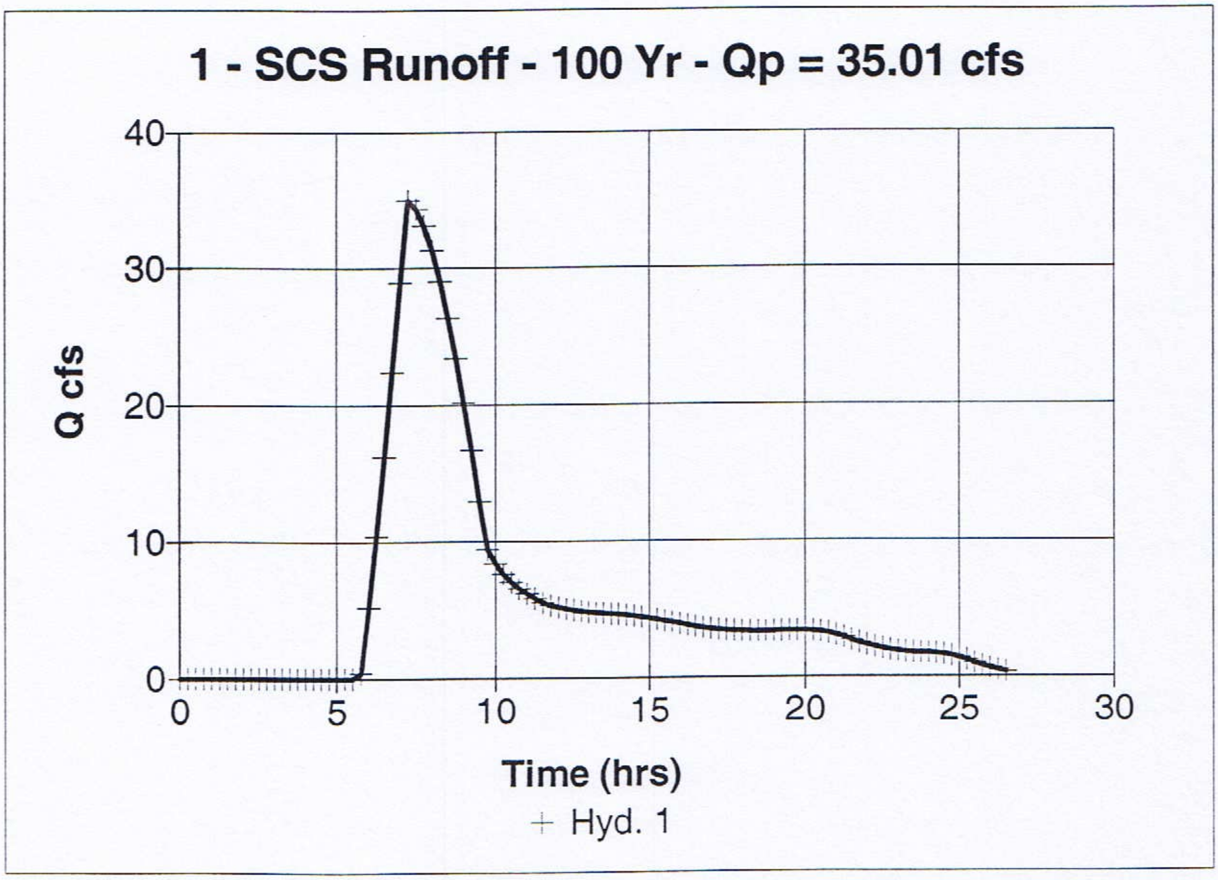
English

Hyd. No. 1

DP-EC10

Hydrograph type	= SCS Runoff	Peak discharge	= 35.01 cfs
Storm frequency	= 100 yrs	Time interval	= 15 min
Drainage area	= 142.70 ac	Curve number	= 61
Basin Slope	= 1.1 %	Hydraulic length	= 8600 ft
Tc method	= USER	Time of conc. (Tc)	= 130.7 min
Total precip.	= 4.40 in	Distribution	= Custom
Storm duration	= TYPE IIA.CDS	Shape factor	= 484

Total Volume = 530,405 cuft



Hydrograph Plot

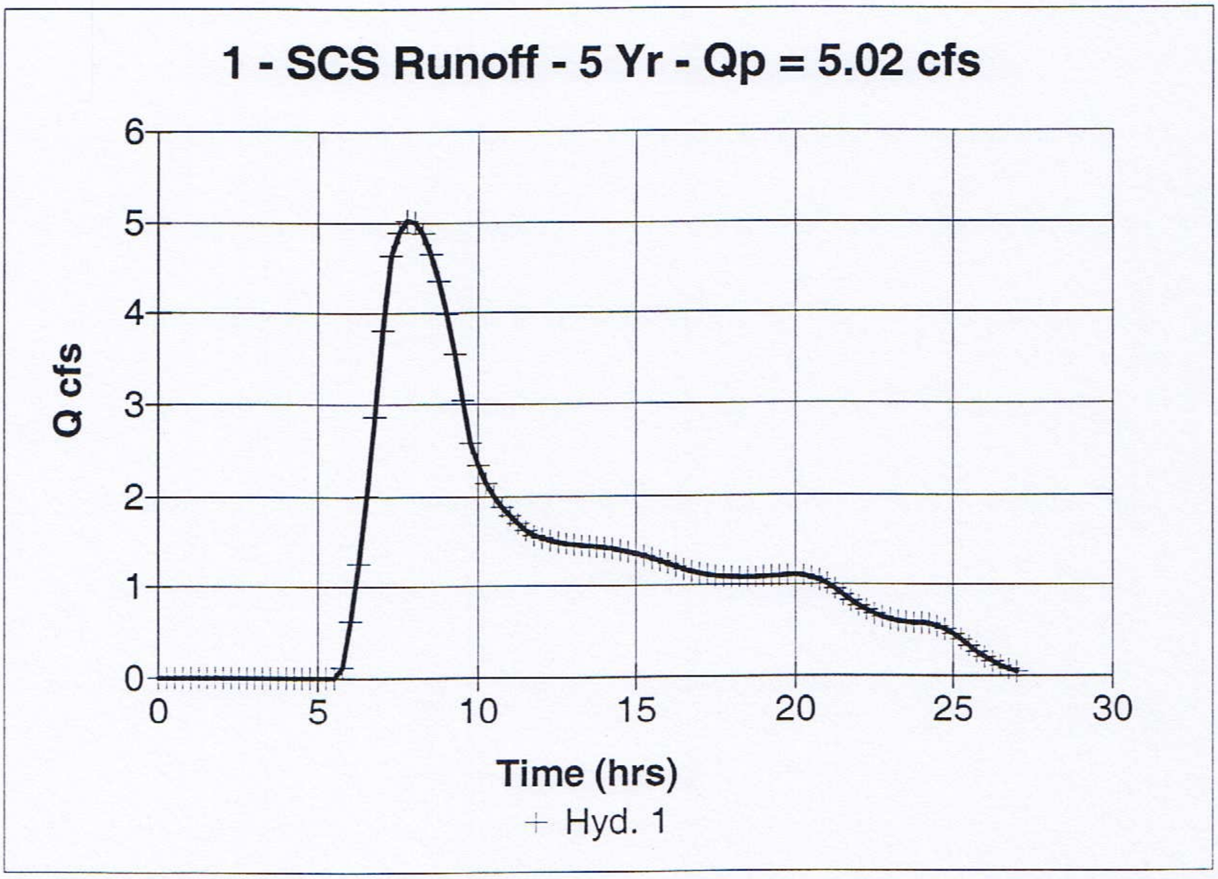
English

Hyd. No. 1

DP-EC10

Hydrograph type	= SCS Runoff	Peak discharge	= 5.02 cfs
Storm frequency	= 5 yrs	Time interval	= 15 min
Drainage area	= 142.70 ac	Curve number	= 61
Basin Slope	= 1.1 %	Hydraulic length	= 8600 ft
Tc method	= USER	Time of conc. (Tc)	= 130.7 min
Total precip.	= 2.60 in	Distribution	= Custom
Storm duration	= TYPE IIA.CDS	Shape factor	= 484

Total Volume = 117,225 cuft



Hydrograph Plot

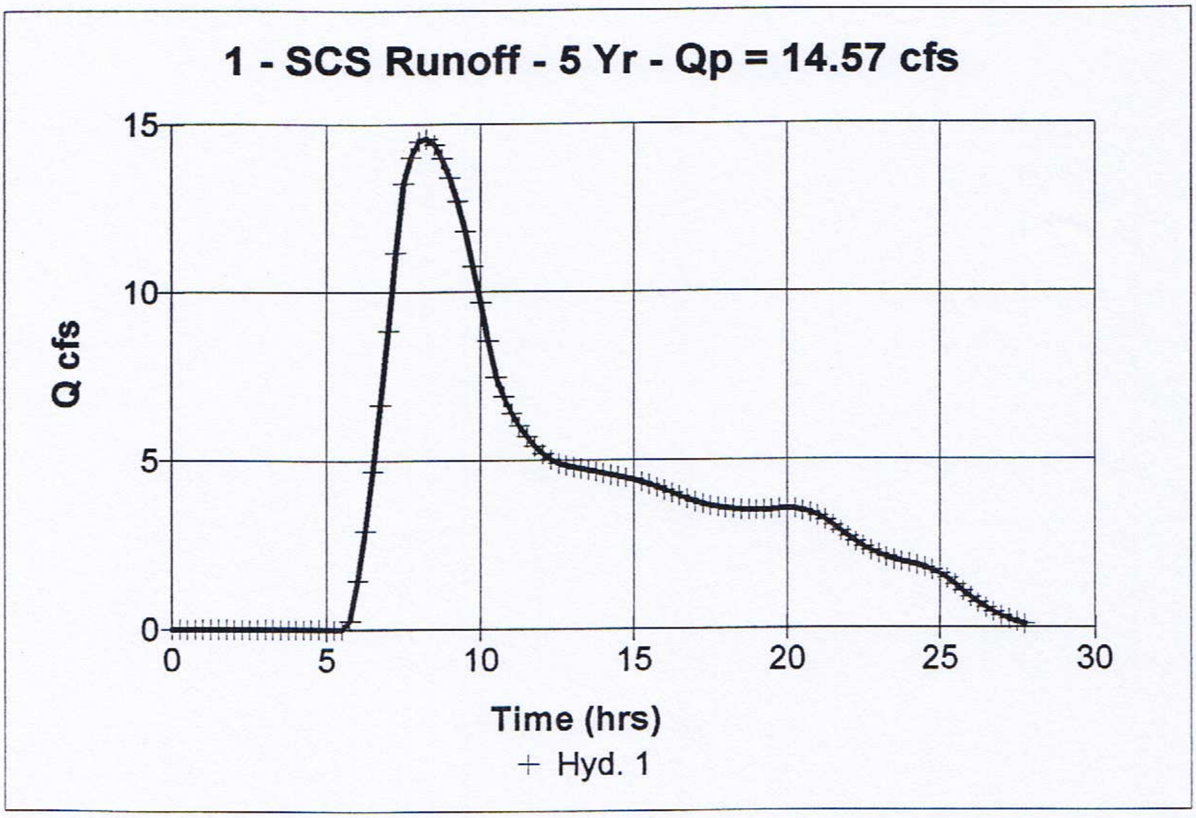
English

Hyd. No. 1

DP5-5YR-HIST

Hydrograph type	= SCS Runoff	Peak discharge	= 14.57 cfs
Storm frequency	= 5 yrs	Time interval	= 15 min
Drainage area	= 450.80 ac	Curve number	= 61
Basin Slope	= 1.1 %	Hydraulic length	= 10935 ft
Tc method	= USER	Time of conc. (Tc)	= 152.7 min
Total precip.	= 2.60 in	Distribution	= Custom
Storm duration	= TYPE IIA.CDS	Shape factor	= 484

Total Volume = 376,934 cuft



Hydrograph Plot

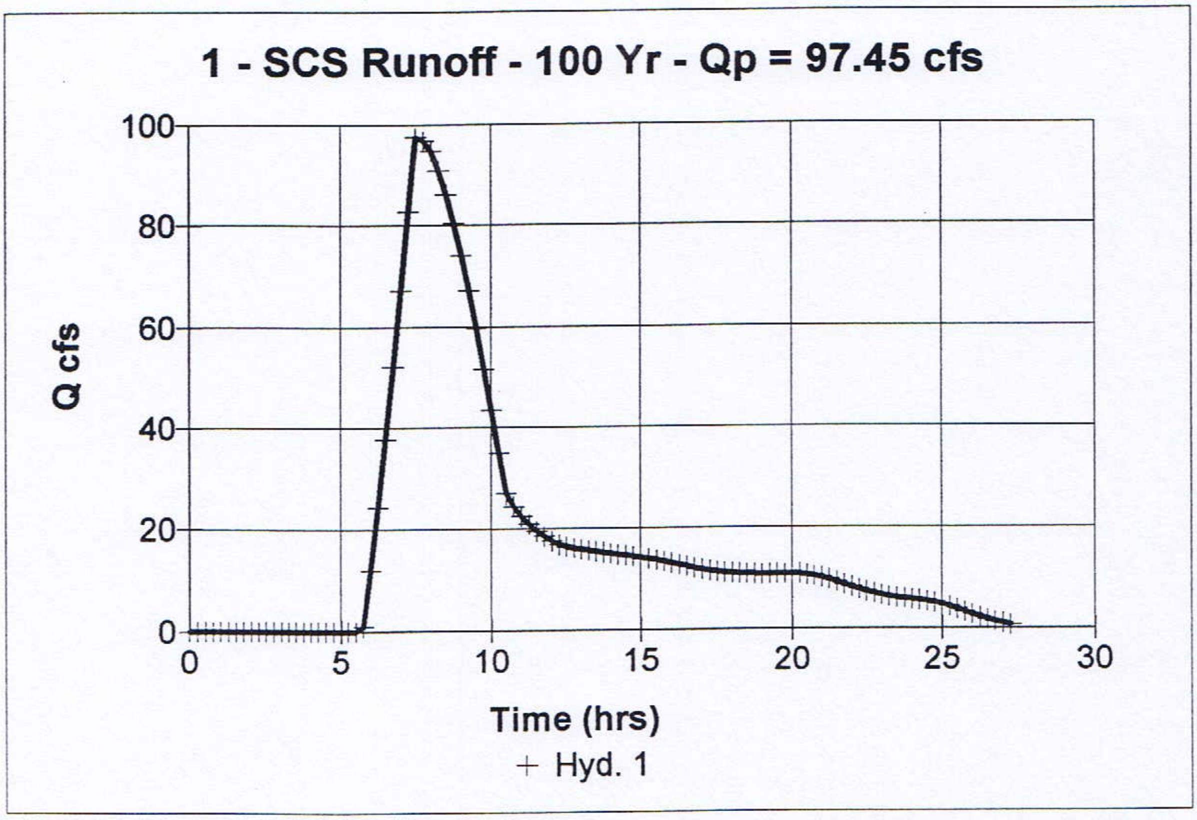
English

Hyd. No. 1

DP5-100YR-HIST

Hydrograph type	= SCS Runoff	Peak discharge	= 97.45 cfs
Storm frequency	= 100 yrs	Time interval	= 15 min
Drainage area	= 450.80 ac	Curve number	= 61
Basin Slope	= 1.1 %	Hydraulic length	= 10935 ft
Tc method	= USER	Time of conc. (Tc)	= 152.7 min
Total precip.	= 4.40 in	Distribution	= Custom
Storm duration	= TYPE IIA.CDS	Shape factor	= 484

Total Volume = 1,705,509 cuft



Hydrograph Plot

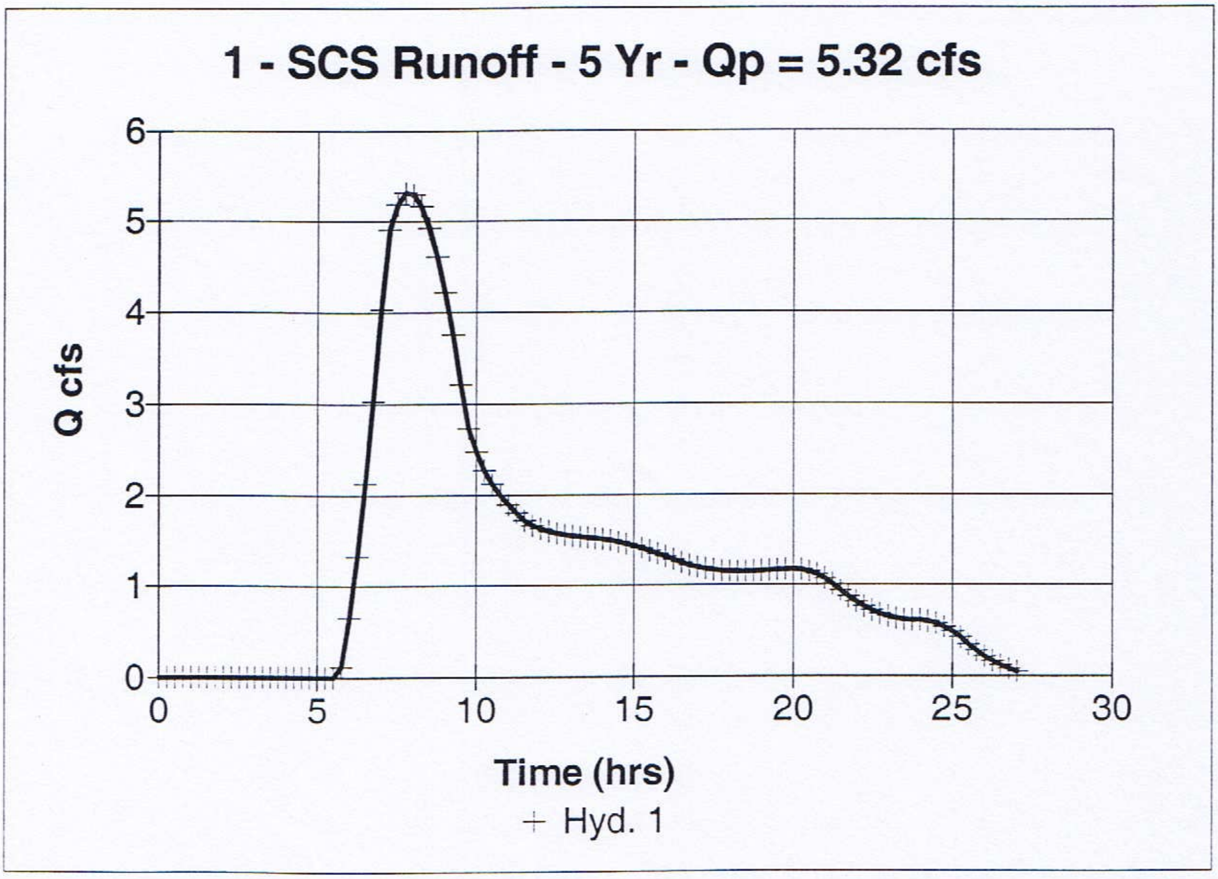
English

Hyd. No. 1

DP6-5YR-HIST

Hydrograph type	= SCS Runoff	Peak discharge	= 5.32 cfs
Storm frequency	= 5 yrs	Time interval	= 15 min
Drainage area	= 151.10 ac	Curve number	= 61
Basin Slope	= 1.1 %	Hydraulic length	= 8600 ft
Tc method	= USER	Time of conc. (Tc)	= 130.7 min
Total precip.	= 2.60 in	Distribution	= Custom
Storm duration	= TYPE IIA.CDS	Shape factor	= 484

Total Volume = 124,125 cuft



Hydrograph Plot

English

Hyd. No. 1

DP6-100YR-HIST

Hydrograph type	= SCS Runoff	Peak discharge	= 37.07 cfs
Storm frequency	= 100 yrs	Time interval	= 15 min
Drainage area	= 151.10 ac	Curve number	= 61
Basin Slope	= 1.1 %	Hydraulic length	= 8600 ft
Tc method	= USER	Time of conc. (Tc)	= 130.7 min
Total precip.	= 4.40 in	Distribution	= Custom
Storm duration	= TYPE IIA.CDS	Shape factor	= 484

Total Volume = 561,627 cuft

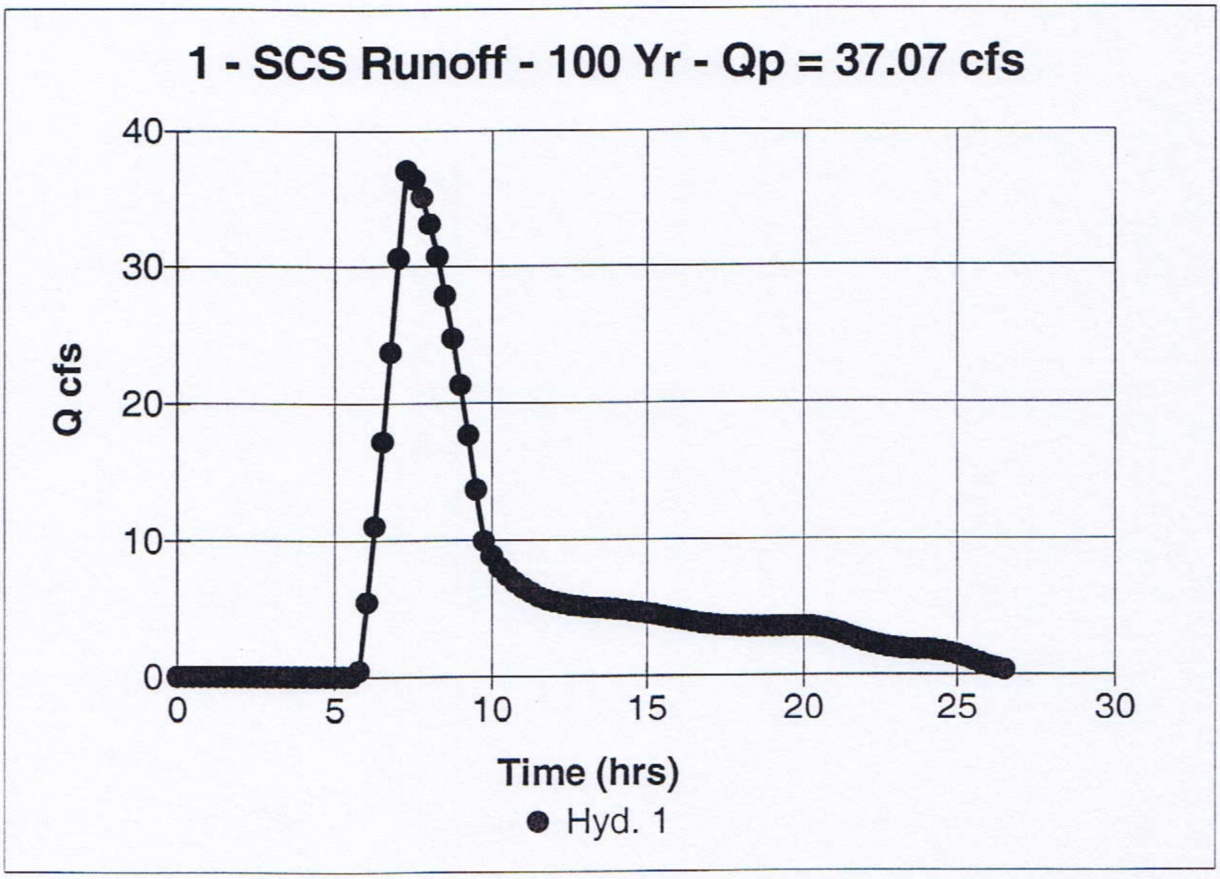


TABLE 5-5
RUNOFF CURVE NUMBERS FOR HYDROLOGIC SOIL COVER COMPLEXES - URBAN AND SUBURBAN CONDITIONS 1/
(Antecedent Moisture Condition II)
(From: U.S. Dept. of Agriculture, Soil Conservation Service, 1977)

Land Use	Average % Impervious 3/	Hydrologic Soil Group A	B	C	D
Open spaces, lawns, parks, golf courses, cemeteries, etc.					
Good condition: grass cover on 75% or more of the area		39*	61	74	80
Fair condition: grass cover on 50% to 75% of the area		49*	69	79	84
Commercial and Business areas (85% Impervious)		89*	92	94	95
Industrial Districts 72% Impervious)		81*	88	91	93
Residential: 2/					
Acres per Dwelling Unit					
1/8 acre or less < 1/4-1/8 ac lots	65	77*	85 < 80	90	92
1/4 acre	38	61*	75	83	87
1/3 acre	30	57*	72	81	86
1/2 acre	25	54*	70	80	85
1 acre	20	51*	68	79	84
Paved parking lots, roofs, driveways, etc.		98	98	98	98
Streets and Roads:					
paved with curbs and storm sewers		98	98	98	98
gravel		76*	85	89	91
dirt		72*	82	87	89

1/ For a more detailed description of agricultural land use curve numbers, refer to the National Engineering Handbook (U.S. Dept. of Agriculture, Soil Conservation Service, 1972).
2/ Curve numbers are computed assuming the runoff from the house and driveway is directed towards the street with a minimum of roof water directed to lawns where additional infiltration could occur.
3/ The remaining pervious areas (lawn) are considered to be in good pasture condition for these curve numbers.

* Not to be used wherever overlot grading or filling is to occur.

ELLICOTT TOWN CENTER
COMPOSITE RUNOFF CURVE NUMBERS

DEVELOPED CONDITIONS
CN-VALUES

BASIN	TOTAL AREA (AC)	(AC)	SUB-AREA 1 DEVELOPMENT/ COVER	CN	AREA (AC)	SUB-AREA 2 DEVELOPMENT/ COVER	CN	(AC)	SUB-AREA 3 DEVELOPMENT/ COVER	CN	WEIGHTED CN-VALUE
OA2	15.1	15.1	MEADOW	61							61.000
OA1	66.8	66.8	MEADOW	61							61.000
A	60.0	43.6	RESIDENTIAL	80	16.4	OPEN SPACE	61				74.805
OA2,OA1, A	141.9										66.836
EC12	30.3	30.3	MEADOW	61							61.000
OB1	33.7	33.7	MEADOW	61							61.000
B1	97.0	67.0	RESIDENTIAL	80	20.0	COMMERCIAL	92	10.0	OPEN SPACE	61	80.516
B2	77.4	69.5	RESIDENTIAL	80	7.9	OPEN SPACE	61				78.061
EC12,OB1,B1,B2	238.4										74.479
BB	20.3	18.3	RESIDENTIAL	80	2.0	OPEN SPACE	61				78.128
B3	59.1	50.7	RESIDENTIAL	80	8.4	OPEN SPACE	61				77.299
EC12,OB1,B1,B2	317.8										75.236
B4	4.5	4.5	RESIDENTIAL	80							80.000
EC11	296	296.0	MEADOW	61							61.000
C1.1	10.2	3.2	RESIDENTIAL	80	1.2	COMMERCIAL	92	5.8	OPEN SPACE	61	70.625
EC11,C1.1	306.2										61.319
C1.2A	1.6	0.9	ROADWAY	92	0.7	PARK/OS	61				77.856
C1..2B	1.6	0.9	ROADWAY	92	0.7	PARK/OS	61				77.962
C1.2A,C1.2B	3.2										77.909
C1.2C	7.1	6.4	COMMERCIAL	92	0.7	LANDSCAPE	61				88.944
C1.2A-C1.2C	10.3										85.523
C1.7A	0.6	0.6	SF LOTS (1/6-AC)	80							80.000
C1.7B	5.1	4.0	COMMERCIAL	92	1.2	LANDSCAPE	61				85.051
C1.7A,C1.7B	5.7										84.538
C1.2,C1.7	16.0										85.171
C1.3	3.0	3.0	SF LOTS (1/6-AC)	80							80.000
C1.2,C1.3,C1.7	19.0										84.350
C1.4	3.2	3.2	SF LOTS (1/6-AC)	80							80.000
C1.2-C1.4,C1.7	22.3										83.719
C1.5	3.2	3.2	SF LOTS (1/6-AC)	80							80.000
C1.2-C1.5,C1.7	25.4										83.254
C1.6	3.0	3.0	SF LOTS (1/6-AC)	80							80.000
C1.2-C1.7	28.4										82.909

EC11,C1.1-C1.7	334.6										63.154
C1.8	3.9	3.9	SF LOTS (1/6-AC)	80							80.000
C1.9	4.4	4.4	SF LOTS (1/6-AC)	80							80.000
C1.8-C1.9	8.3										80.000
EC11,C1.1-C1.9	342.9										63.562
C2.1	4.8	1.8	RESIDENTIAL	80	0.9	COMMERCIAL	92	2.1	OPEN SPACE	61	73.986
C2.2	3.0	3.0	SF LOTS (1/6-AC)	80							80.000
C2.3	2.8	2.8	SF LOTS (1/6-AC)	80							80.000
C2.1-C2.3	10.6										77.259
C2.4	4.1	4.1	SF LOTS (1/6-AC)	80							80.000
C2.5	4.1	4.1	SF LOTS (1/6-AC)	80							80.000
C2.1-C2.5	18.9										78.460
C3	94.1	80.3	MDR-RESIDENTIAL	80	13.8	LANDSCAPE/OS	61				77.214
EC11,C1.1-C2.3,C2.5,C	455.8										66.996
C2.6	2.8	2.8	SF LOTS (1/6-AC)	80							80.000
C2.7	2.1	2.1	SF LOTS (1/6-AC)	80							80.000
C2.8	3.0	3.0	SF LOTS (1/6-AC)	80							80.000
C2.6-C2.8	7.9										80.000
D1.2	3.0	3.0	SF LOTS (1/6-AC)	80							80.000
C2.6-C2.8,D1.2	10.9										80.000
D1.1	3.0	3.0	SF LOTS (1/6-AC)	80							80.000
D1.3	2.9	2.9	SF LOTS (1/6-AC)	80							80.000
C2.6-C2.8,D1.1-D1.3	16.8										80.000
D1.4	4.2	4.2	SF LOTS (1/6-AC)	80							80.000
D1.5	5.1	5.1	SF LOTS (1/6-AC)	80							80.000
D1.6	2.2	2.2	SF LOTS (1/6-AC)	80							80.000
C2.6-C2.8,D1.1-D1.6	28.3										80.000
D2	42.3	37.2	MDR-RESIDENTIAL	80	5.1	LANDSCAPE/OS	61				77.709
C2.6-C2.8,D1.1-D1.6,D	70.6										78.628
EC11,C,D	526.5										68.556
EC10	142.7	142.7	MEADOW	61							61.000
E	4.1	2.0	RESIDENTIAL	80	2.1	OPEN SPACE	61				70.148
EC10,E	146.8										61.252

Hydrograph Plot

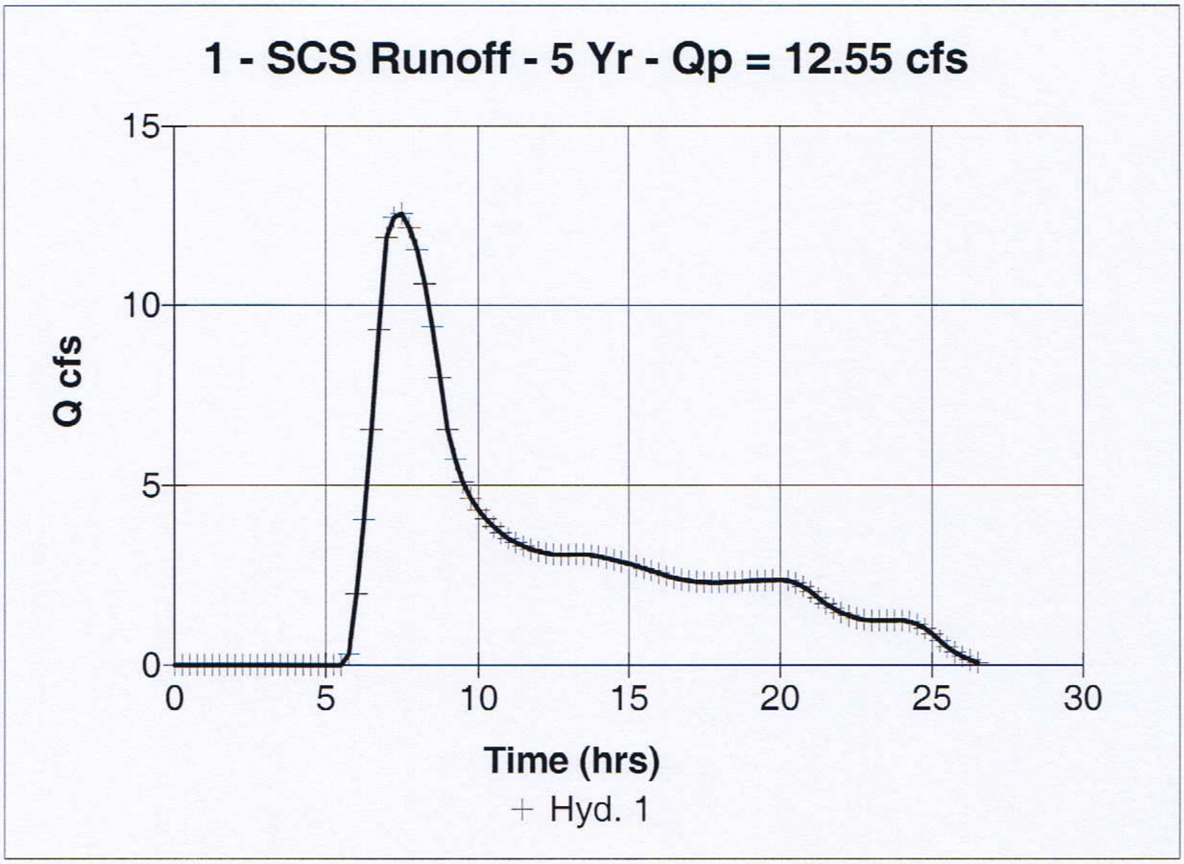
English

Hyd. No. 1

DP-C1.1-DEV

Hydrograph type	= SCS Runoff	Peak discharge	= 12.55 cfs
Storm frequency	= 5 yrs	Time interval	= 15 min
Drainage area	= 306.20 ac	Curve number	= 61.3
Basin Slope	= 1.1 %	Hydraulic length	= 11235 ft
Tc method	= USER	Time of conc. (Tc)	= 112.9 min
Total precip.	= 2.60 in	Distribution	= Custom
Storm duration	= TYPE IIA.CDS	Shape factor	= 484

Total Volume = 253,348 cuft



Hydrograph Plot

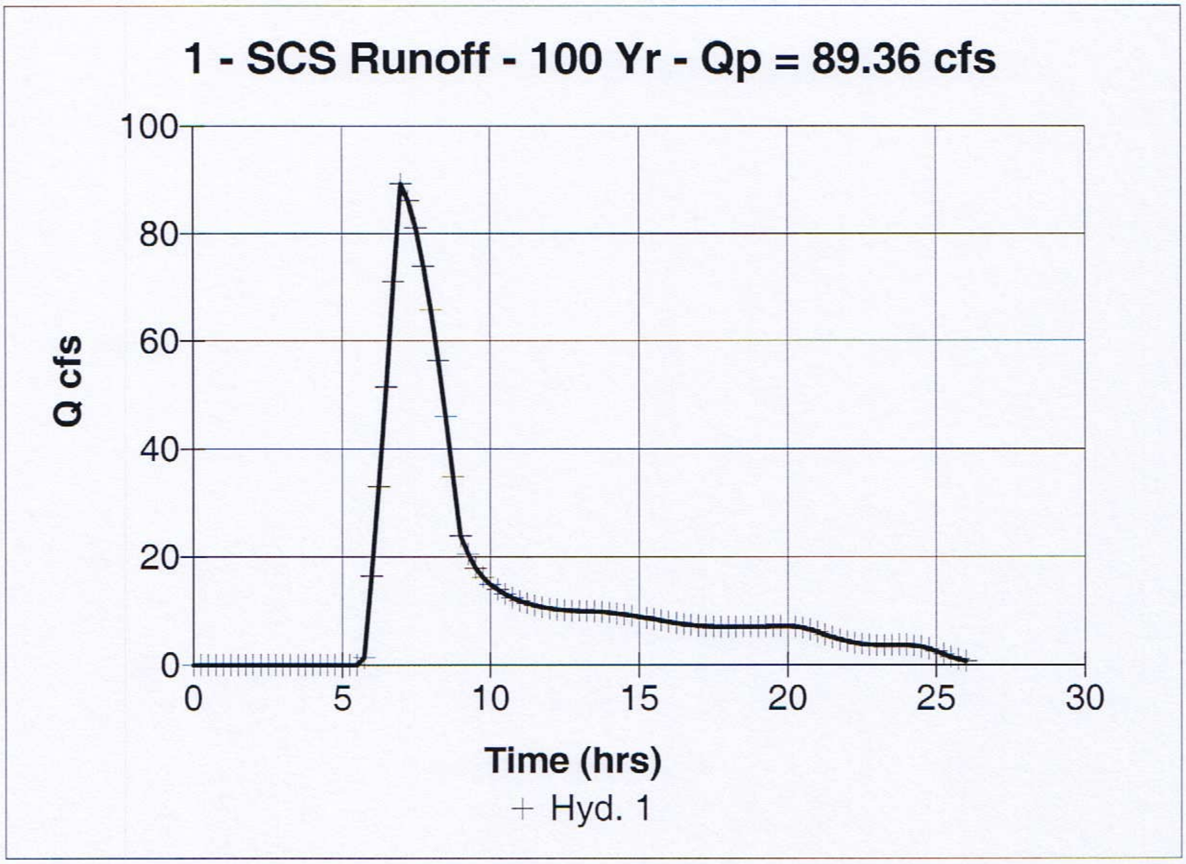
English

Hyd. No. 1

DP-C1.1-DEV

Hydrograph type	= SCS Runoff	Peak discharge	= 89.36 cfs
Storm frequency	= 100 yrs	Time interval	= 15 min
Drainage area	= 306.20 ac	Curve number	= 61.3
Basin Slope	= 1.1 %	Hydraulic length	= 11235 ft
Tc method	= USER	Time of conc. (Tc)	= 112.9 min
Total precip.	= 4.40 in	Distribution	= Custom
Storm duration	= TYPE IIA.CDS	Shape factor	= 484

Total Volume = 1,128,720 cuft



Hydrograph Plot

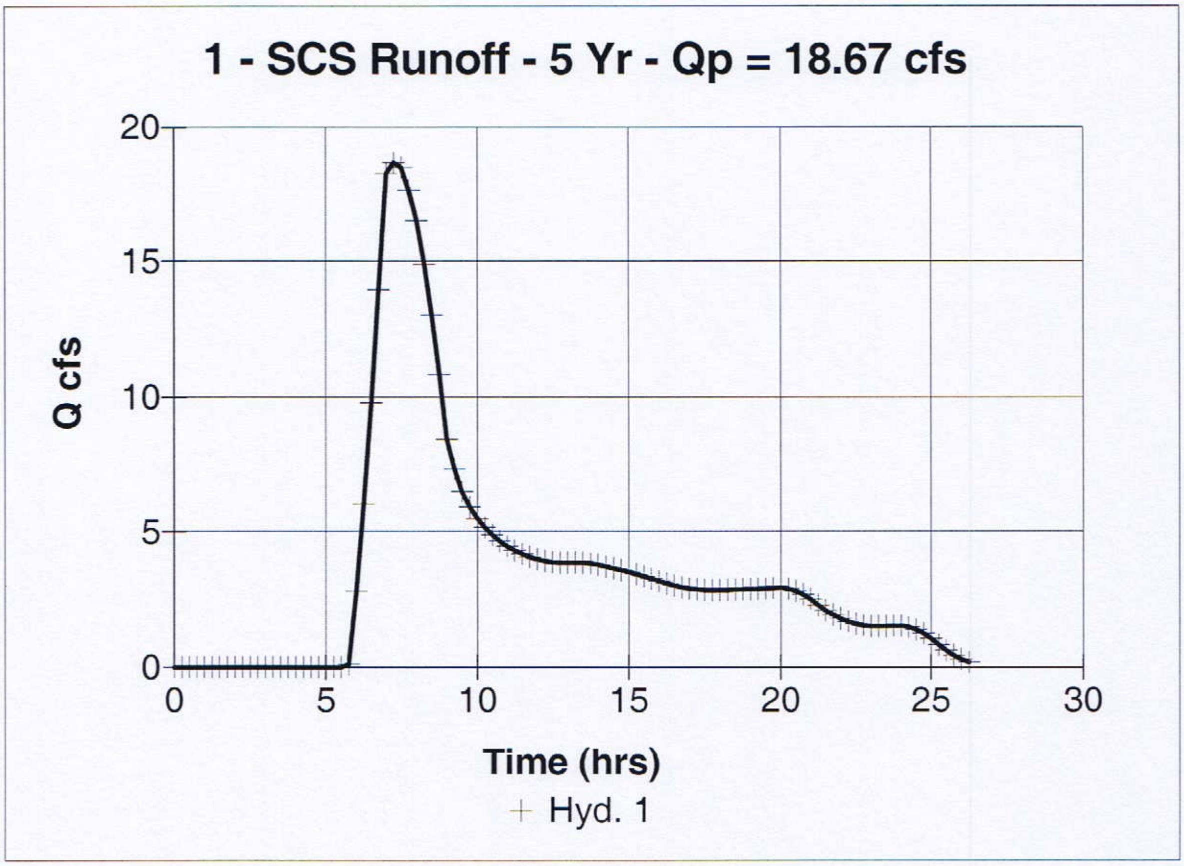
English

Hyd. No. 1

DP-C1.6B-DEV

Hydrograph type	= SCS Runoff	Peak discharge	= 18.67 cfs
Storm frequency	= 5 yrs	Time interval	= 15 min
Drainage area	= 334.60 ac	Curve number	= 63.2
Basin Slope	= 1.1 %	Hydraulic length	= 11710 ft
Tc method	= USER	Time of conc. (Tc)	= 120.3 min
Total precip.	= 2.60 in	Distribution	= Custom
Storm duration	= TYPE IIA.CDS	Shape factor	= 484

Total Volume = 336,185 cuft



Hydrograph Plot

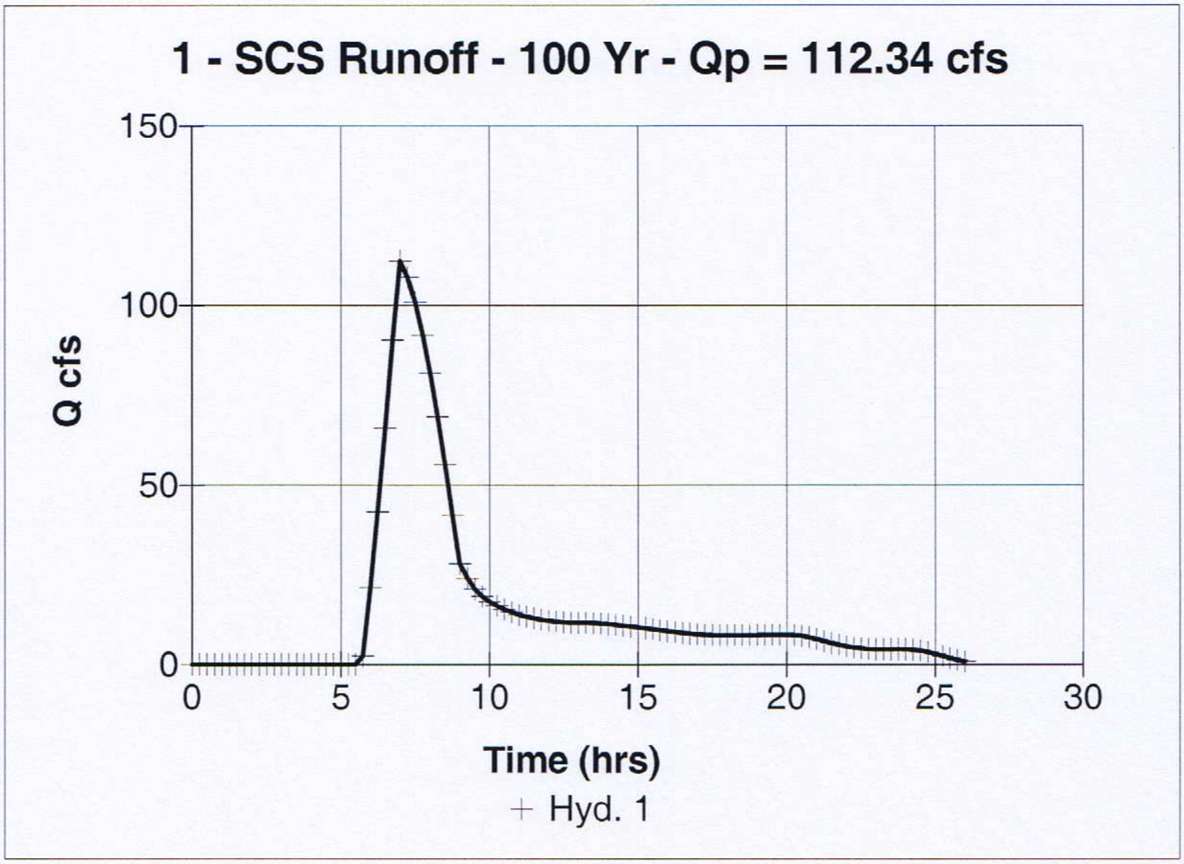
English

Hyd. No. 1

DP-C1.6B-DEV

Hydrograph type	= SCS Runoff	Peak discharge	= 112.34 cfs
Storm frequency	= 100 yrs	Time interval	= 15 min
Drainage area	= 334.60 ac	Curve number	= 63.2
Basin Slope	= 1.1 %	Hydraulic length	= 11710 ft
Tc method	= USER	Time of conc. (Tc)	= 120.3 min
Total precip.	= 4.40 in	Distribution	= Custom
Storm duration	= TYPE IIA.CDS	Shape factor	= 484

Total Volume = 1,368,552 cuft



Hydrograph Plot

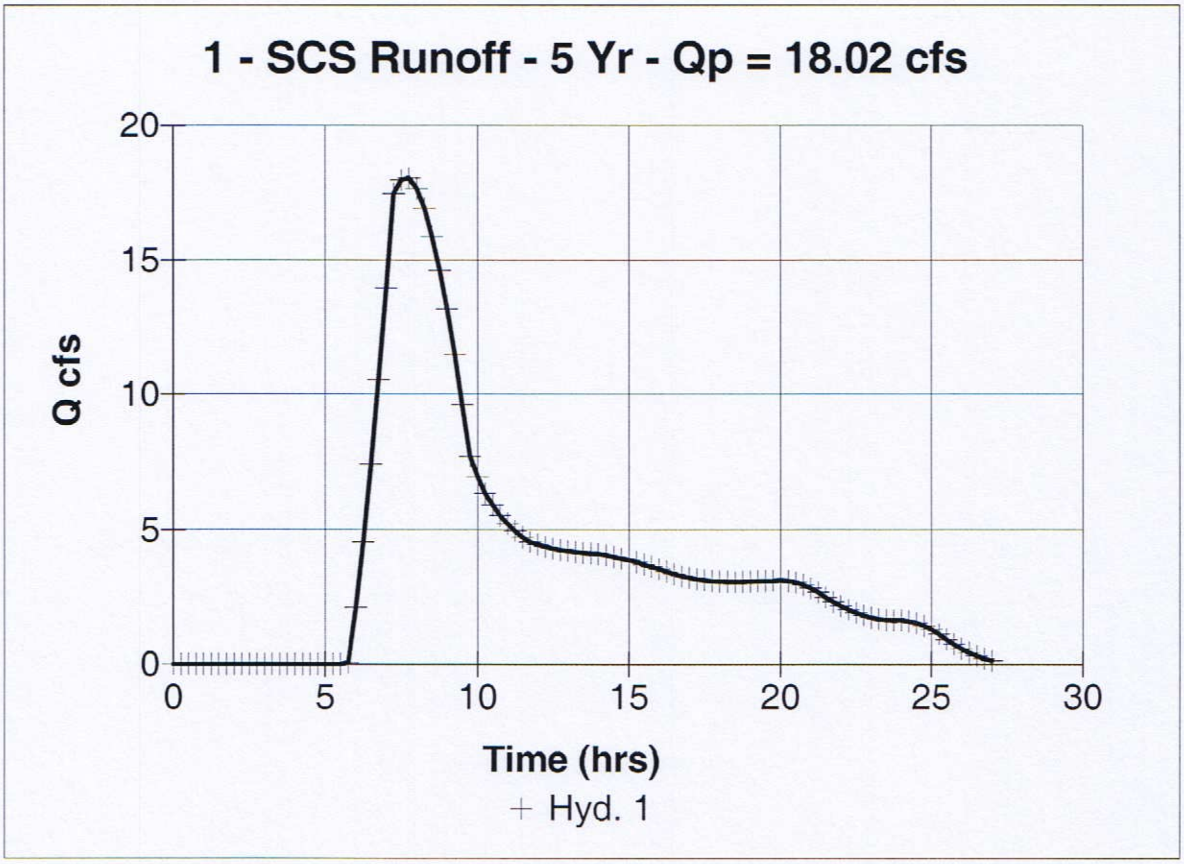
English

Hyd. No. 1

DP-C1.9C-DEV

Hydrograph type	= SCS Runoff	Peak discharge	= 18.02 cfs
Storm frequency	= 5 yrs	Time interval	= 15 min
Drainage area	= 342.90 ac	Curve number	= 63.6
Basin Slope	= 1.1 %	Hydraulic length	= 12035 ft
Tc method	= USER	Time of conc. (Tc)	= 125.5 min
Total precip.	= 2.60 in	Distribution	= Custom
Storm duration	= TYPE IIA.CDS	Shape factor	= 484

Total Volume = 367,253 cuft



Hydrograph Plot

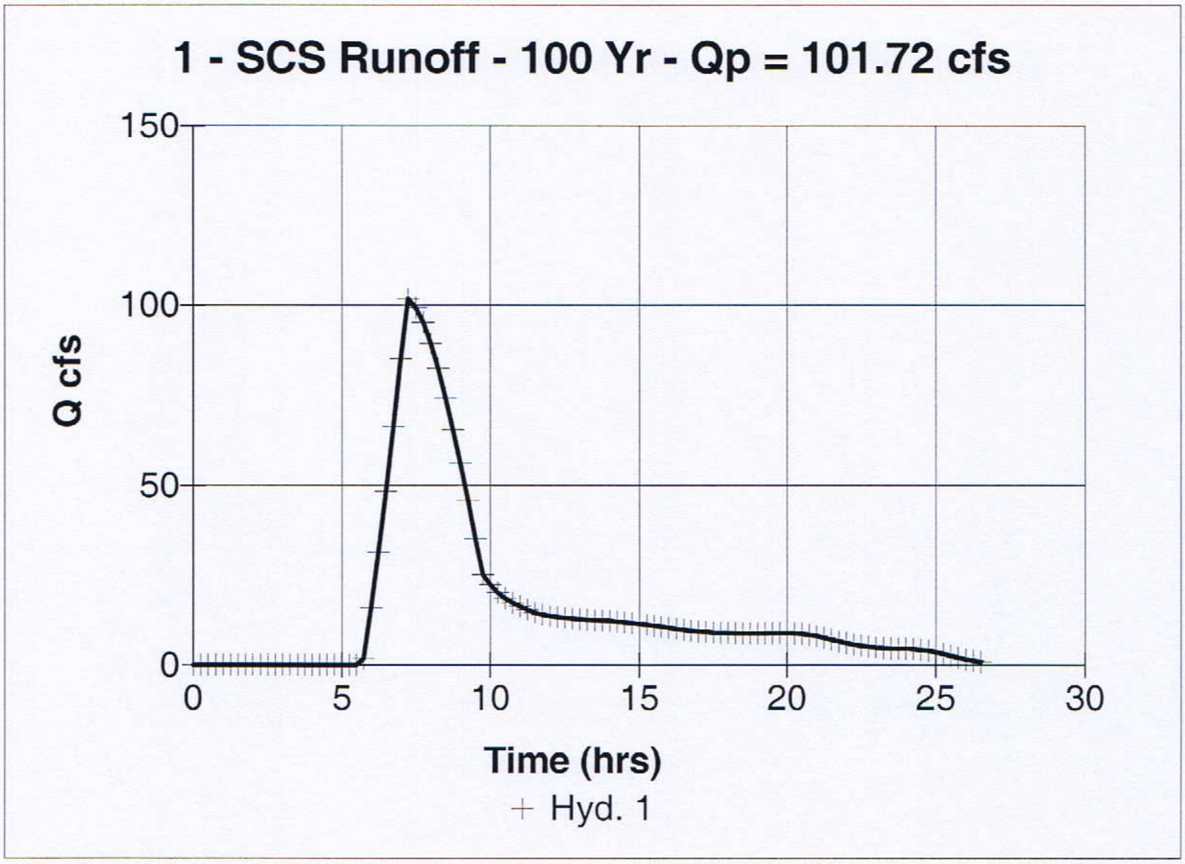
English

Hyd. No. 1

DP-C1.9C-DEV

Hydrograph type	= SCS Runoff	Peak discharge	= 101.72 cfs
Storm frequency	= 100 yrs	Time interval	= 15 min
Drainage area	= 342.90 ac	Curve number	= 63.6
Basin Slope	= 1.1 %	Hydraulic length	= 12035 ft
Tc method	= USER	Time of conc. (Tc)	= 125.5 min
Total precip.	= 4.40 in	Distribution	= Custom
Storm duration	= TYPE IIA.CDS	Shape factor	= 484

Total Volume = 1,469,126 cuft



Hydrograph Plot

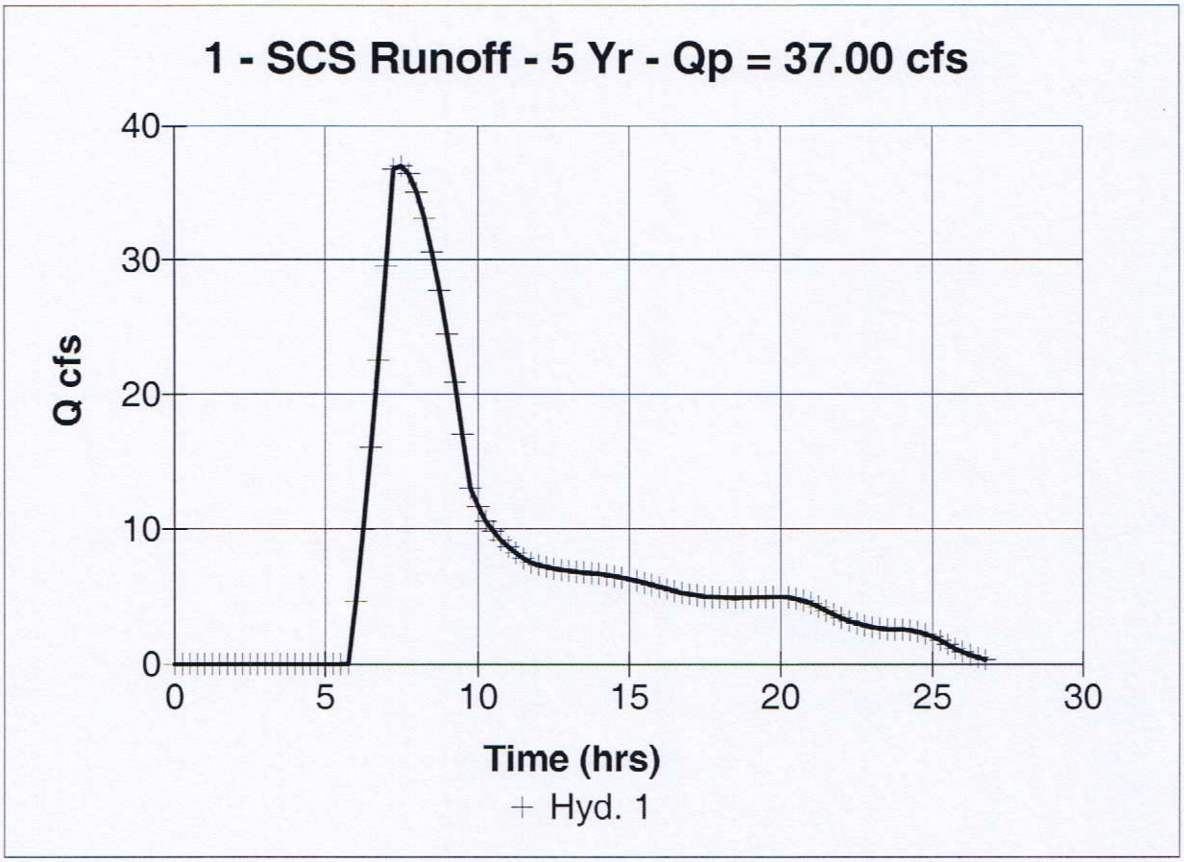
English

Hyd. No. 1

DP-C3A-DEV

Hydrograph type	= SCS Runoff	Peak discharge	= 37.00 cfs
Storm frequency	= 5 yrs	Time interval	= 15 min
Drainage area	= 455.80 ac	Curve number	= 67
Basin Slope	= 1.1 %	Hydraulic length	= 13000 ft
Tc method	= USER	Time of conc. (Tc)	= 137.1 min
Total precip.	= 2.60 in	Distribution	= Custom
Storm duration	= TYPE IIA.CDS	Shape factor	= 484

Total Volume = 659,763 cuft



Hydrograph Plot

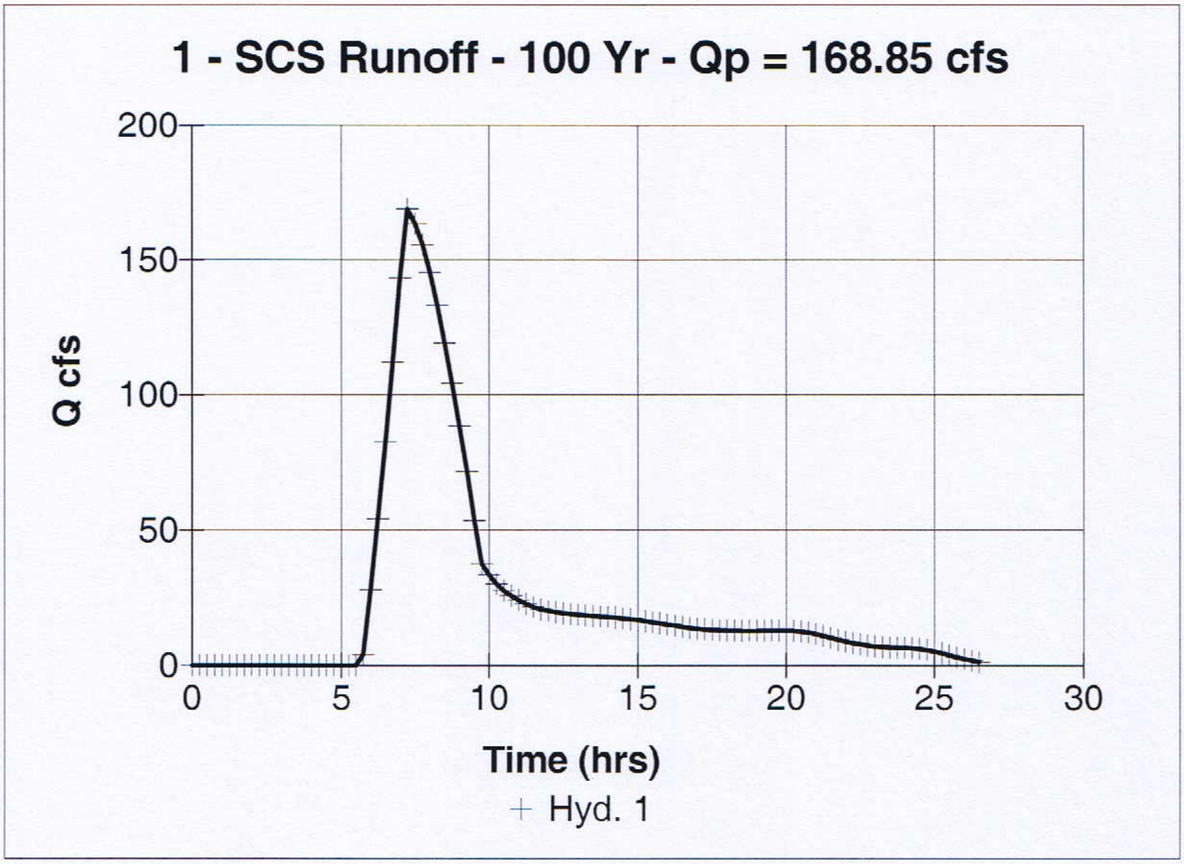
English

Hyd. No. 1

DP-C3A-DEV

Hydrograph type	= SCS Runoff	Peak discharge	= 168.85 cfs
Storm frequency	= 100 yrs	Time interval	= 15 min
Drainage area	= 455.80 ac	Curve number	= 67
Basin Slope	= 1.1 %	Hydraulic length	= 13000 ft
Tc method	= USER	Time of conc. (Tc)	= 137.1 min
Total precip.	= 4.40 in	Distribution	= Custom
Storm duration	= TYPE IIA.CDS	Shape factor	= 484

Total Volume = 2,313,459 cuft



Hydrograph Plot

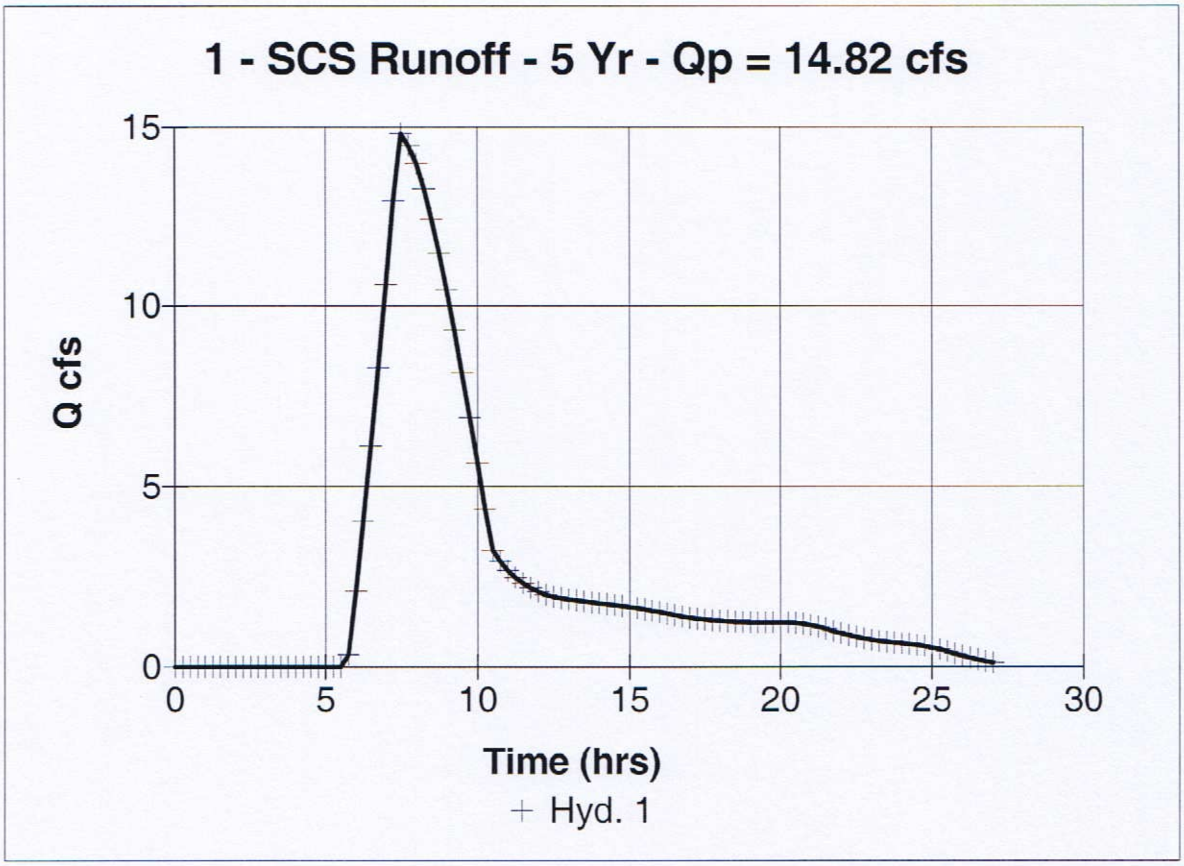
English

Hyd. No. 1

DP-D2A-DEV

Hydrograph type	= SCS Runoff	Peak discharge	= 14.82 cfs
Storm frequency	= 5 yrs	Time interval	= 15 min
Drainage area	= 70.60 ac	Curve number	= 78.6
Basin Slope	= 1.1 %	Hydraulic length	= 3210 ft
Tc method	= USER	Time of conc. (Tc)	= 163.8 min
Total precip.	= 2.60 in	Distribution	= Custom
Storm duration	= TYPE IIA.CDS	Shape factor	= 484

Total Volume = 230,656 cuft



Hydrograph Plot

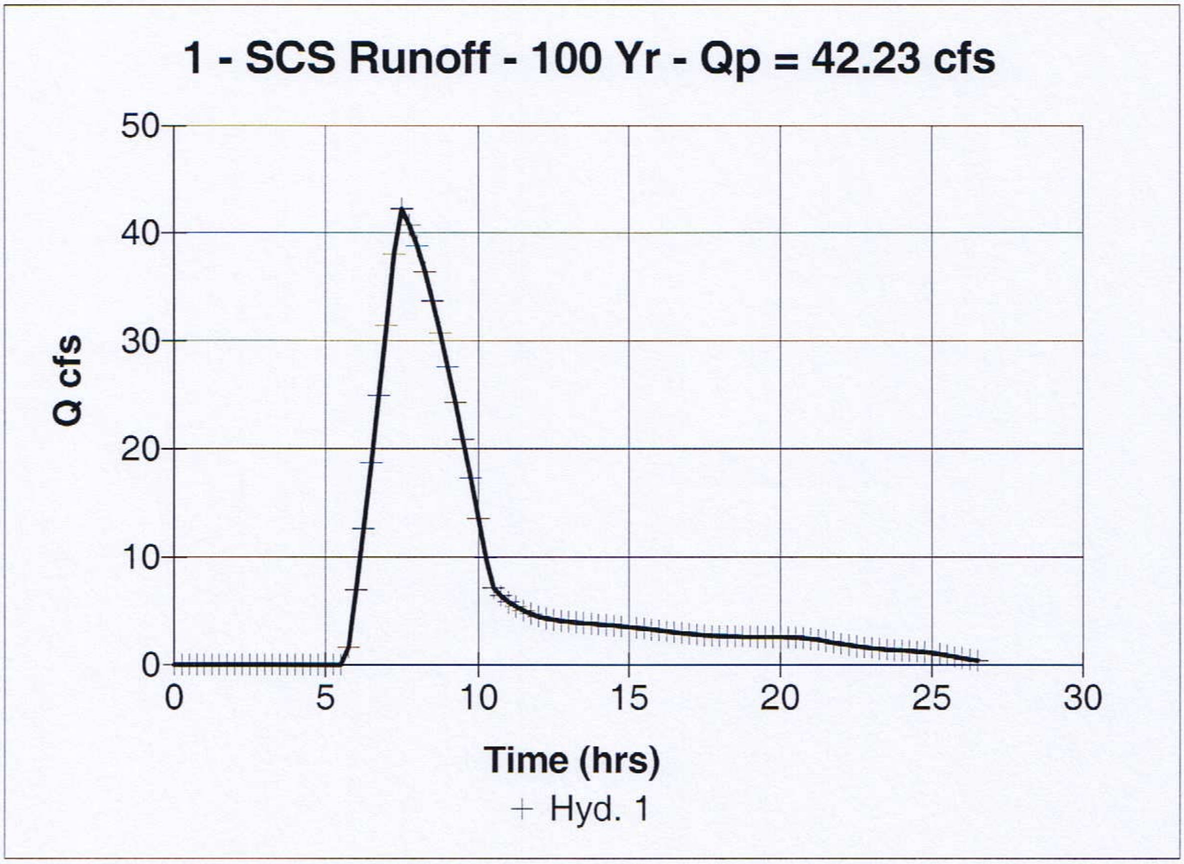
English

Hyd. No. 1

DP-D2A-DEV

Hydrograph type	= SCS Runoff	Peak discharge	= 42.23 cfs
Storm frequency	= 100 yrs	Time interval	= 15 min
Drainage area	= 70.60 ac	Curve number	= 78.6
Basin Slope	= 1.1 %	Hydraulic length	= 3210 ft
Tc method	= USER	Time of conc. (Tc)	= 163.8 min
Total precip.	= 4.40 in	Distribution	= Custom
Storm duration	= TYPE IIA.CDS	Shape factor	= 484

Total Volume = 589,456 cuft



Hydrograph Plot

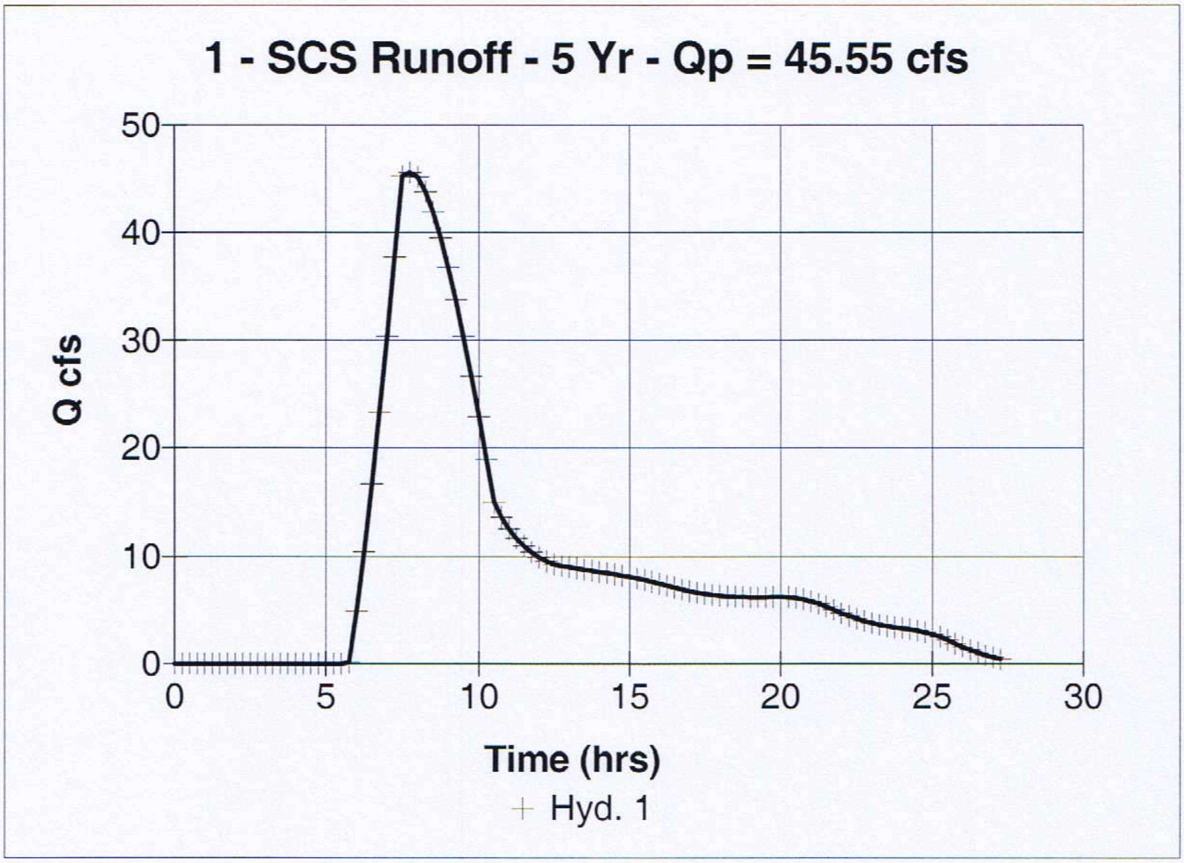
English

Hyd. No. 1

DP-5-DEV

Hydrograph type	= SCS Runoff	Peak discharge	= 45.55 cfs
Storm frequency	= 5 yrs	Time interval	= 15 min
Drainage area	= 526.50 ac	Curve number	= 68.6
Basin Slope	= 1.1 %	Hydraulic length	= 14835 ft
Tc method	= USER	Time of conc. (Tc)	= 163.8 min
Total precip.	= 2.60 in	Distribution	= Custom
Storm duration	= TYPE IIA.CDS	Shape factor	= 484

Total Volume = 881,574 cuft



Hydrograph Plot

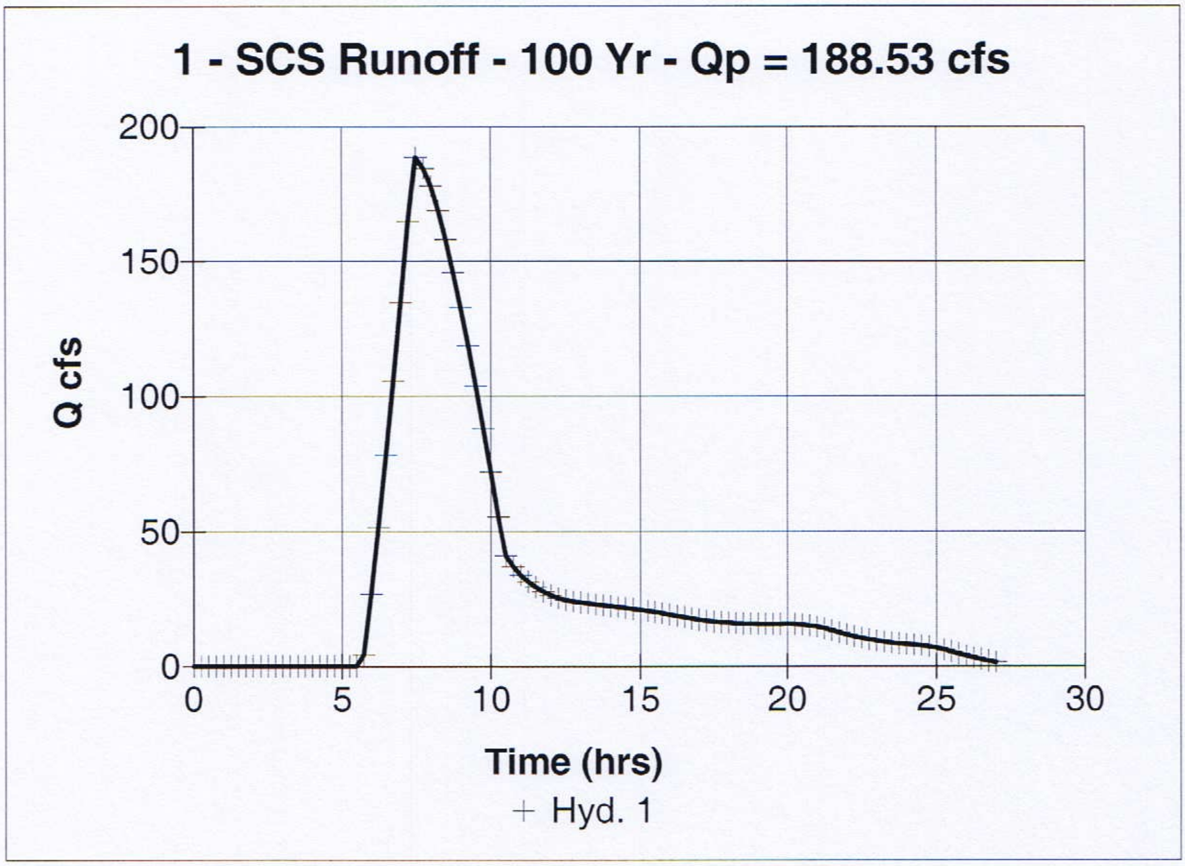
English

Hyd. No. 1

DP-5-DEV

Hydrograph type	= SCS Runoff	Peak discharge	= 188.53 cfs
Storm frequency	= 100 yrs	Time interval	= 15 min
Drainage area	= 526.50 ac	Curve number	= 68.6
Basin Slope	= 1.1 %	Hydraulic length	= 14835 ft
Tc method	= USER	Time of conc. (Tc)	= 163.8 min
Total precip.	= 4.40 in	Distribution	= Custom
Storm duration	= TYPE IIA.CDS	Shape factor	= 484

Total Volume = 2,929,897 cuft



Hydrograph Plot

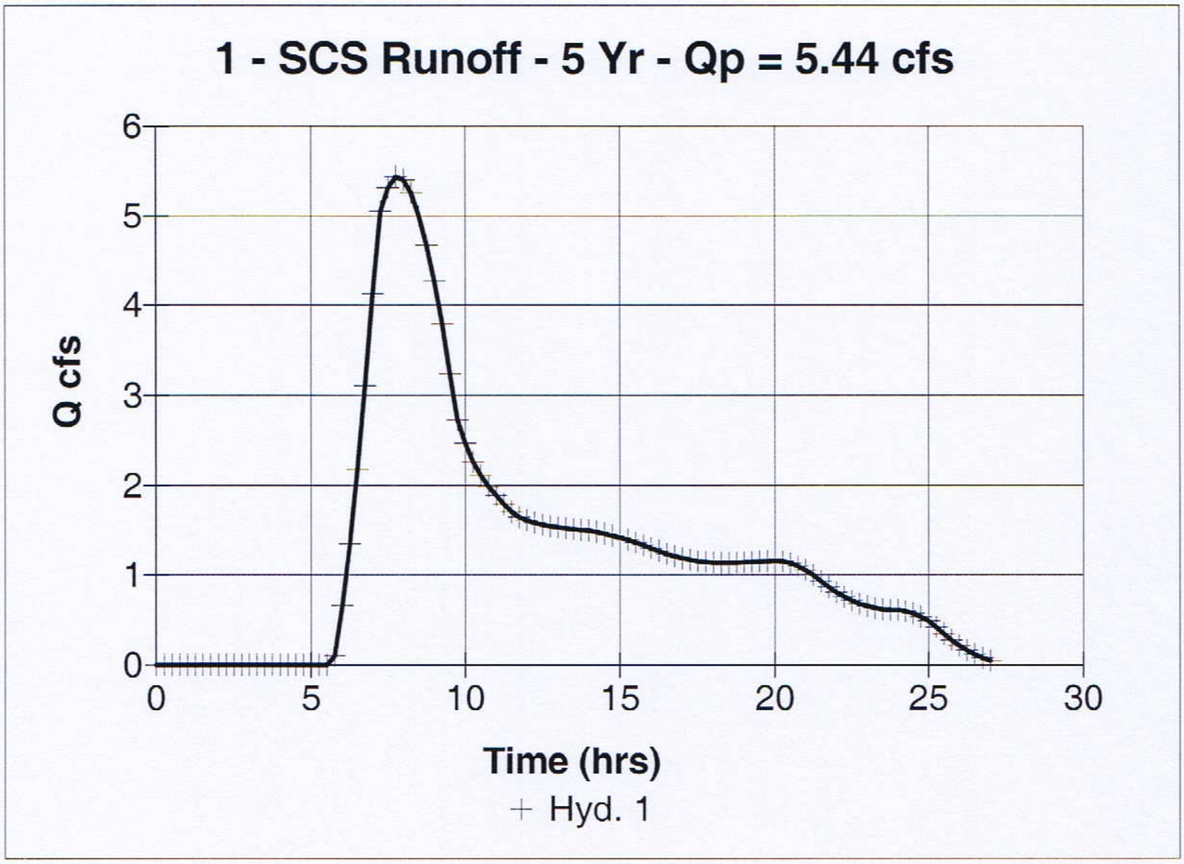
English

Hyd. No. 1

DP-6-DEV

Hydrograph type	= SCS Runoff	Peak discharge	= 5.44 cfs
Storm frequency	= 5 yrs	Time interval	= 15 min
Drainage area	= 146.80 ac	Curve number	= 61.3
Basin Slope	= 1.1 %	Hydraulic length	= 8600 ft
Tc method	= USER	Time of conc. (Tc)	= 132.8 min
Total precip.	= 2.60 in	Distribution	= Custom
Storm duration	= TYPE IIA.CDS	Shape factor	= 484

Total Volume = 124,576 cuft



Hydrograph Plot

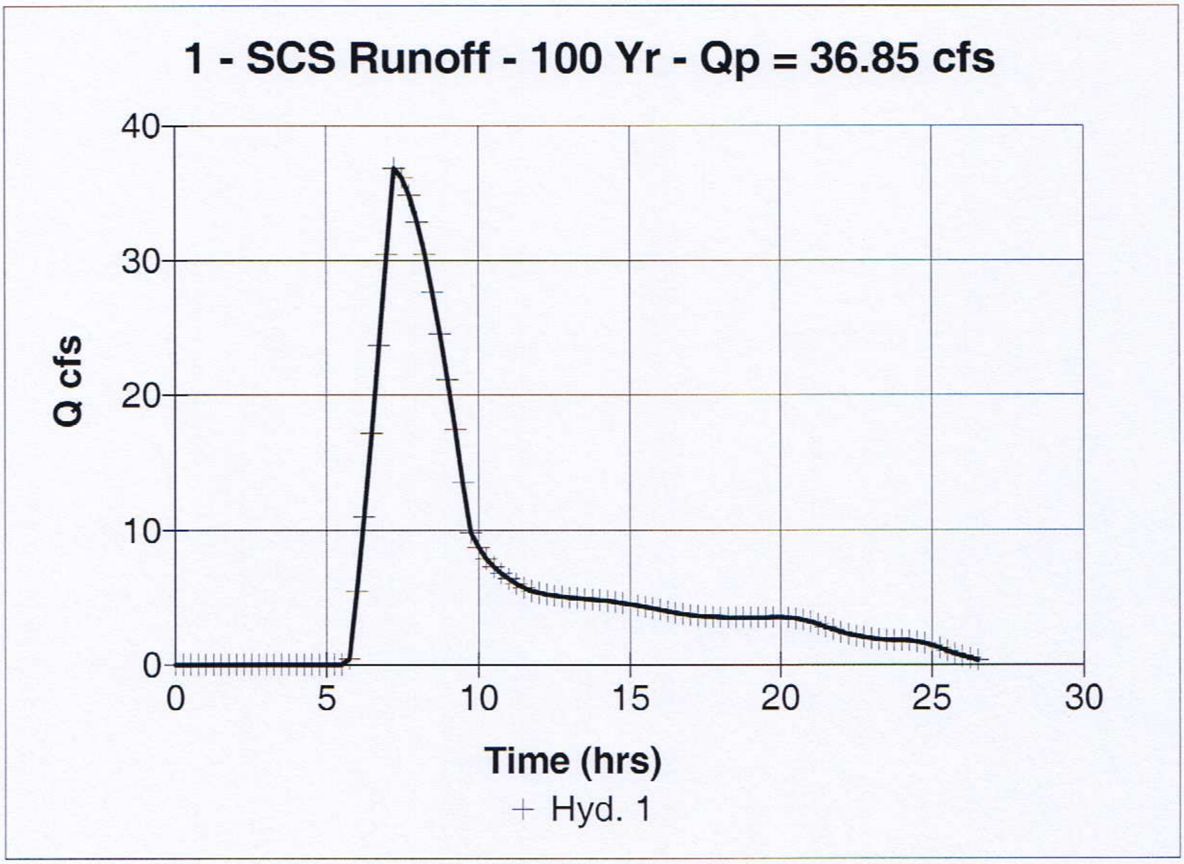
English

Hyd. No. 1

DP-6-DEV

Hydrograph type	= SCS Runoff	Peak discharge	= 36.85 cfs
Storm frequency	= 100 yrs	Time interval	= 15 min
Drainage area	= 146.80 ac	Curve number	= 61.3
Basin Slope	= 1.1 %	Hydraulic length	= 8600 ft
Tc method	= USER	Time of conc. (Tc)	= 132.8 min
Total precip.	= 4.40 in	Distribution	= Custom
Storm duration	= TYPE IIA.CDS	Shape factor	= 484

Total Volume = 555,012 cuft



ELLICOTT TOWN CENTER
SCS METHOD - INPUT/OUTPUT SUMMARY

HISTORIC FLOWS

BASIN	DESIGN POINT	AREA (AC)	AREA (SM)	CURVE NUMBER (CN)	CHANNEL LENGTH (FT)	CHANNEL LENGTH (MI)	SLOPE (%)	Tc (1) (MIN)	PEAK FLOW Q5 (3) (CFS)	Q100 (3) (CFS)
OA2,OA1	OA1	81.9	0.13	61	6100	1.16	0.9%	145.50	2.9	20.1
OA2,OA1,A	1	140.1	0.22	61	6100	1.16	0.9%	145.50	4.9	34.4
EC12,OB1	OB1	64	0.10	61	7400	1.40	1.0%	143.60	2.3	15.7
EC12,OB1,B	3	247.8	0.39	61	7400	1.40	1.0%	143.60	8.7	60.8
C	4	123	0.19	61	5800	1.10	1.2%	91.40	5.5	42.2
EC11	EC11	296	0.46	61	10935	2.07	1.1%	152.70	9.6	64.0
EC11,D	5	450.8	0.70	61	10935	2.07	1.1%	152.70	14.6	97.5
EC10	EC10	142.7	0.22	61	8600	1.63	1.1%	130.70	5.0	35.0
EC10,E	6	151.1	0.24	61	8600	1.63	1.1%	130.70	5.3	37.1

DEVELOPED FLOWS

BASIN	DESIGN POINT	AREA (AC)	AREA (SM)	CURVE NUMBER (CN)	CHANNEL LENGTH (FT)	CHANNEL LENGTH (MI)	SLOPE (%)	Tt (1) (HR)	PEAK FLOW Q5 (3) (CFS)	Q100 (3) (CFS)
OA2,OA1,A	1	141.9	0.22	66.836	6100	1.16	0.9%	141.00	11.3	51.9
EC12,OB1,B1-B3,BB	3	317.8	0.50	75.236	6600	1.25	1.1%	130.60	58.0	184.7
EC11,C1.1	C1.1A	306.2	0.48	61.319	11235	2.13	1.1%	112.90	12.6	89.4
EC11,C1.1-C1.6	C1.6B	334.6	0.52	63.154	11710	2.22	1.1%	120.30	18.7	112.3
EC11,C1.1-C1.9	C1.9C	342.9	0.54	63.562	12035	2.28	1.1%	125.50	18.0	101.7
EC11,C1-C3	C3A	455.8	0.71	66.996	13000	2.46	1.1%	137.10	37.0	168.9
C2.6-2.8,D1.1-D2	D2A	70.6	0.11	78.628	3210	0.61	1.1%	163.80	14.8	42.2
EC11,C,D	5	526.5	0.82	68.556	14835	2.81	1.1%	163.80	45.6	188.5
EC10,E	6	146.8	0.23	61.252	8600	1.63	1.1%	132.80	5.4	36.9

1) DESIGN RAINFALL: 5-YR, 24-HR = 2.6 IN; 100-YR, 24-HR = 4.4 IN
2) Tc FROM RATIONAL METHOD CALCULATION TABLE
3) PEAK FLOWS CALCULATED BY INTELISOLVE "HYDRAFLOW" PROGRAM

APPENDIX C

DETENTION POND CALCULATIONS

ELLICOTT TOWN CENTER
IMPERVIOUS AREA CALCULATIONS

DEVELOPED CONDITIONS

BASIN	TOTAL AREA (AC)	(AC)	SUB-AREA 1 DEVELOPMENT/ COVER	IMP. AREA (%)	AREA (AC)	SUB-AREA 2 DEVELOPMENT/ COVER	IMP. AREA (%)	(AC)	SUB-AREA 3 DEVELOPMENT/ COVER	IMP. AREA (%)	WEIGHTED IMP. AREA (%)
FILING NO. 1											
A1A	2.80	0.9	ROADWAY	100	1.9	GRASS	0				33.571
C1.2	7.97	8.0	COMMERCIAL	70							70.000
C1.7A	0.58	0.6	SF LOTS (1/6-AC)	52.5							52.500
C1.7B	4.34	4.3	COMMERCIAL	70							70.000
C1.7A,C1.7B	4.92										67.937
C1.2,C1.7	12.89										69.213
C1.3	3.02	3.0	SF LOTS (1/6-AC)	52.5							52.500
C1.2,C1.3,C1.7	15.91										66.040
C1.4	3.23	3.2	SF LOTS (1/6-AC)	52.5							52.500
C1.2-C1.4,C1.7	19.14										63.755
C1.5	3.18	3.2	SF LOTS (1/6-AC)	52.5							52.500
C1.2-C1.5,C1.7	22.32										62.152
C1.1	9.38	3.0	RESIDENTIAL	52.5	1.2	COMMERCIAL	70	5.2	OPEN SPACE	0	25.672
C1.6	1.98	2.0	SF LOTS (1/6-AC)	52.5							52.500
C1.1,C1.6	11.36										30.348
C1.1-C1.7	33.68										51.424
C1.8	3.89	3.9	SF LOTS (1/6-AC)	52.5							52.500
C1.9	3.60	3.6	SF LOTS (1/6-AC)	52.5							52.500
C1.8-C1.9	7.49										52.500
C1.1-C1.9	**41.17**										**51.620**

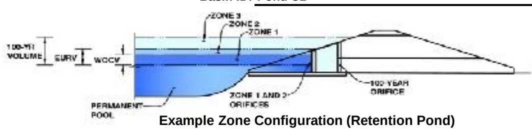
FILING NO. 2											
C2.1	5.59	1.8	SF LOTS (1/6-AC)	52.5	0.9	COMMERCIAL	70	2.9	OPEN SPACE	0	28.426
C2.2	4.03	4.0	SF LOTS (1/6-AC)	52.5							52.500
C2.3	2.76	2.8	SF LOTS (1/6-AC)	52.5							52.500
C2.1-C2.3	12.38										41.630
C2.4	4.98	5.0	SF LOTS (1/6-AC)	52.5							52.500
C2.5	4.12	4.1	SF LOTS (1/6-AC)	52.5							52.500
C2.1-C2.5	21.48										46.235
C4	20.40	20.4	PARK / OS	0							0.000
C2.1-C2.5,C4	41.88										23.714
C2.6	2.76	2.8	SF LOTS (1/6-AC)	52.5							52.500
C2.7	2.14	2.1	SF LOTS (1/6-AC)	52.5							52.500
C2.8	3.00	3.0	SF LOTS (1/6-AC)	52.5							52.500
C2.6-C2.8	7.90										52.500
D1.2	2.99	3.0	SF LOTS (1/6-AC)	52.5							52.500
C2.6-C2.8,D1.2	10.89										52.500
D1.1	3.02	3.0	SF LOTS (1/6-AC)	52.5							52.500
D1.3	2.87	2.9	SF LOTS (1/6-AC)	52.5							52.500
C2.6-C2.8,D1.1-D1.3	16.78										52.500
D1.4	4.19	4.2	SF LOTS (1/6-AC)	52.5							52.500
D1.5	5.09	5.1	SF LOTS (1/6-AC)	52.5							52.500
D1.6	2.24	2.2	SF LOTS (1/6-AC)	52.5							52.500
C2.6-C2.8,D1.1-D1.6	28.30										52.500
PHASE 2											
D2	44.58	39.5	SF LOTS (1/6-AC)	52.5	5.1	LANDSCAPE/OS	0				46.494
C2.6-C2.8,D1.1-D1.6,D2	72.88										48.826
C2,C4,D	**114.76**										**39.662**
C3	**74.48**	**74.5**	**SF LOTS (1/6-AC)**	**52.5**							**52.500**
C2,C3,C4,D	189.24										44.715

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

UD-Detention, Version 3.07 (February 2017)

Project: Ellicott Town Center

Basin ID: Pond C1



Example Zone Configuration (Retention Pond)

Required Volume Calculation

Selected BMP Type =	**EDB**	
Watershed Area =	41.17	acres
Watershed Length =	2,660	ft
Watershed Slope =	0.010	ft/ft
Watershed Imperviousness =	51.62%	percent
Percentage Hydrologic Soil Group A =	100.0%	percent
Percentage Hydrologic Soil Group B =	0.0%	percent
Percentage Hydrologic Soil Groups C/D =	0.0%	percent
Desired WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths =	User Input	

			Optional User Override 1-hr Precipitation	
Water Quality Capture Volume (WQCV) =	0.723	acre-feet		
Excess Urban Runoff Volume (EURV) =	2.472	acre-feet		
2-yr Runoff Volume (P1 = 1.19 in.) =	1.688	acre-feet	1.19	inches
5-yr Runoff Volume (P1 = 1.5 in.) =	2.218	acre-feet	1.50	inches
10-yr Runoff Volume (P1 = 1.75 in.) =	2.727	acre-feet	1.75	inches
25-yr Runoff Volume (P1 = 2 in.) =	3.387	acre-feet	2.00	inches
50-yr Runoff Volume (P1 = 2.25 in.) =	4.202	acre-feet	2.25	inches
100-yr Runoff Volume (P1 = 2.52 in.) =	5.161	acre-feet	2.52	inches
500-yr Runoff Volume (P1 = 3.14 in.) =	7.373	acre-feet	3.14	inches
Approximate 2-yr Detention Volume =	1.592	acre-feet		
Approximate 5-yr Detention Volume =	2.094	acre-feet		
Approximate 10-yr Detention Volume =	2.552	acre-feet		
Approximate 25-yr Detention Volume =	3.115	acre-feet		
Approximate 50-yr Detention Volume =	3.471	acre-feet		
Approximate 100-yr Detention Volume =	3.897	acre-feet		

Stage-Storage Calculation

Zone 1 Volume (WQCV) =	0.723	acre-feet
Zone 2 Volume (EURV - Zone 1) =	1.749	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	1.424	acre-feet
Total Detention Basin Volume =	3.897	acre-feet
Initial Surcharge Volume (ISV) =	user	ft^3
Initial Surcharge Depth (ISD) =	user	ft
Total Available Detention Depth (H_{total}) =	user	ft
Depth of Trickle Channel (H_{TC}) =	user	ft
Slope of Trickle Channel (S_{TC}) =	user	ft/ft
Slopes of Main Basin Sides (S_{main}) =	user	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	user	

Depth Increment = ft

Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	--	0.00	--	--	--	10	0.000		
Bot EL = 6050.0	--	1.00	--	--	--	24,952	0.573	12,232	0.281
	--	3.00	--	--	--	30,324	0.696	67,756	1.555
	--	5.00	--	--	--	36,200	0.831	134,280	3.083
Max WSL = 6056.0	--	7.00	--	--	--	42,486	0.975	212,966	4.889
Top Berm = 6058.0	--	9.00	--	--	--	49,161	1.129	304,613	6.993
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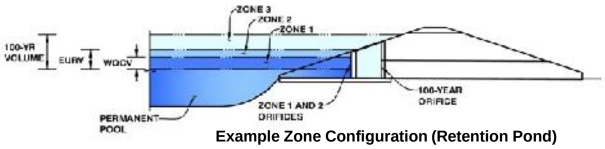
Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)

Project: Ellicott Town Center
Basin ID: Pond C1



Example Zone Configuration (Retention Pond)

	Stage (ft)	Zone Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	1.74	0.723	Orifice Plate
Zone 2 (EURV)	4.25	1.749	Orifice Plate
Zone 3 (100-year)	5.95	1.424	Weir&Pipe (Restrict)
		3.897	Total

User Input: Orifice at Underdrain Outlet (typically used to drain WQCV in a Filtration BMP)

Underdrain Orifice Invert Depth =	N/A	ft (distance below the filtration media surface)
Underdrain Orifice Diameter =	N/A	inches

Calculated Parameters for Underdrain

Underdrain Orifice Area =	N/A	ft^2
Underdrain Orifice Centroid =	N/A	feet

User Input: Orifice Plate with one or more orifices or Elliptical Slot Weir (typically used to drain WQCV and/or EURV in a sedimentation BMP)

Invert of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Orifice Plate =	4.25	ft (relative to basin bottom at Stage = 0 ft)
Orifice Plate: Orifice Vertical Spacing =	17.00	inches
Orifice Plate: Orifice Area per Row =	N/A	inches

Calculated Parameters for Plate

WQ Orifice Area per Row =	N/A	ft^2
Elliptical Half-Width =	N/A	feet
Elliptical Slot Centroid =	N/A	feet
Elliptical Slot Area =	N/A	ft^2

User Input: Stage and Total Area of Each Orifice Row (numbered from lowest to highest)

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	1.42	2.83					
Orifice Area (sq. inches)	6.50	6.50	6.50					

	Row 9 (optional)	Row 10 (optional)	Row 11 (optional)	Row 12 (optional)	Row 13 (optional)	Row 14 (optional)	Row 15 (optional)	Row 16 (optional)
Stage of Orifice Centroid (ft)								
Orifice Area (sq. inches)								

User Input: Vertical Orifice (Circular or Rectangular)

	Not Selected	Not Selected	
Invert of Vertical Orifice =	N/A	N/A	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Vertical Orifice =	N/A	N/A	ft (relative to basin bottom at Stage = 0 ft)
Vertical Orifice Diameter =	N/A	N/A	inches

Calculated Parameters for Vertical Orifice

	Not Selected	Not Selected	
Vertical Orifice Area =	N/A	N/A	ft^2
Vertical Orifice Centroid =	N/A	N/A	feet

User Input: Overflow Weir (Dropbox) and Grate (Flat or Sloped)

	Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	4.25	N/A	ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =	4.00	N/A	feet
Overflow Weir Slope =	0.00	N/A	H:V (enter zero for flat grate)
Horiz. Length of Weir Sides =	2.50	N/A	feet
Overflow Grate Open Area % =	70%	N/A	%, grate open area/total area
Debris Clogging % =	50%	N/A	%

Calculated Parameters for Overflow Weir

	Zone 3 Weir	Not Selected	
Height of Grate Upper Edge, H_t =	4.25	N/A	feet
Over Flow Weir Slope Length =	2.50	N/A	feet
Grate Open Area / 100-yr Orifice Area =	6.78	N/A	should be $\geq$ 4
Overflow Grate Open Area w/o Debris =	7.00	N/A	ft^2
Overflow Grate Open Area w/ Debris =	3.50	N/A	ft^2

User Input: Outlet Pipe w/ Flow Restriction Plate (Circular Orifice, Restrictor Plate, or Rectangular Orifice)

	Zone 3 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	0.00	N/A	ft (distance below basin bottom at Stage = 0 ft)
Outlet Pipe Diameter =	18.00	N/A	inches
Restrictor Plate Height Above Pipe Invert =	10.20		inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Zone 3 Restrictor	Not Selected	
Outlet Orifice Area =	1.03	N/A	ft^2
Outlet Orifice Centroid =	0.48	N/A	feet
Half-Central Angle of Restrictor Plate on Pipe =	1.70	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	6.00	ft (relative to basin bottom at Stage = 0 ft)
Spillway Crest Length =	20.00	feet
Spillway End Slopes =	4.00	H:V
Freeboard above Max Water Surface =	1.00	feet

Calculated Parameters for Spillway

Spillway Design Flow Depth=	0.91	feet
Stage at Top of Freeboard =	7.91	feet
Basin Area at Top of Freeboard =	1.05	acres

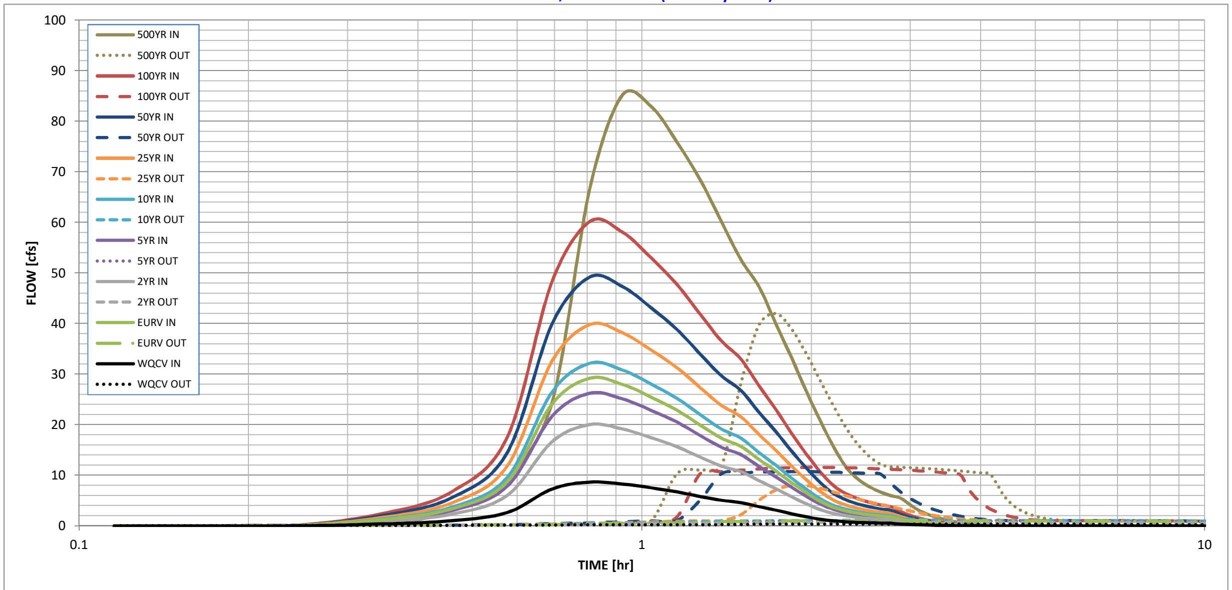
Routed Hydrograph Results

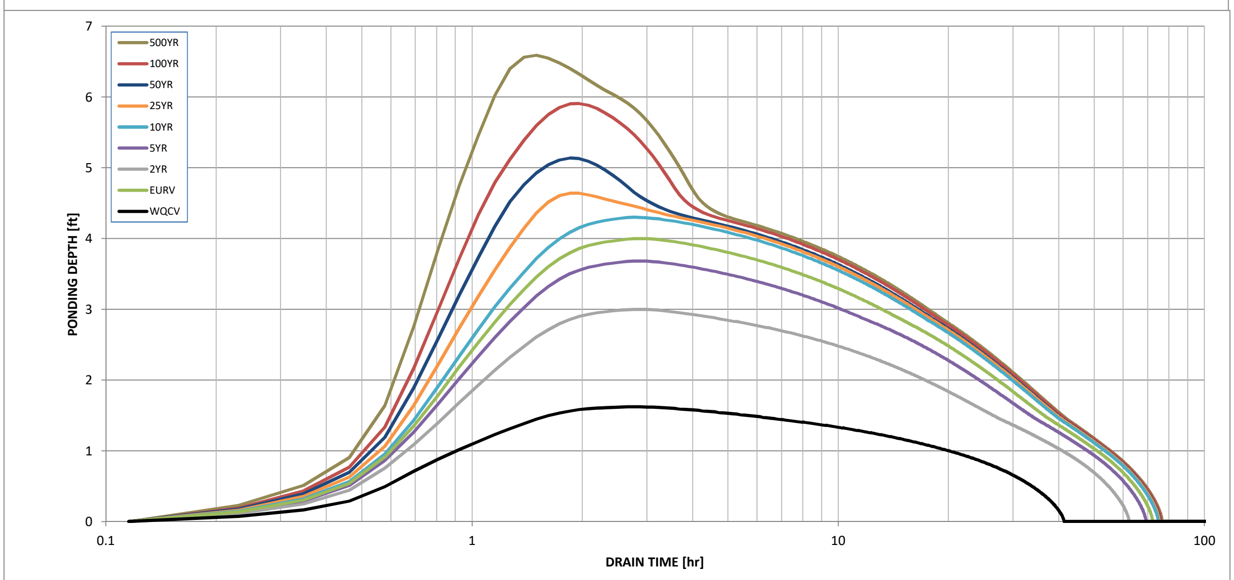
	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	0.53	1.07	1.19	1.50	1.75	2.00	2.25	2.52	3.14
Calculated Runoff Volume (acre-ft) =	0.723	2.472	1.688	2.218	2.727	3.387	4.202	5.161	7.373
OPTIONAL Override Runoff Volume (acre-ft) =									
Inflow Hydrograph Volume (acre-ft) =	0.723	2.473	1.688	2.218	2.728	3.387	4.203	5.163	7.374
Predevelopment Unit Peak Flow, q (cfs/acre) =	0.00	0.00	0.00	0.00	0.01	0.02	0.13	0.31	0.73
Predevelopment Peak Q (cfs) =	0.0	0.0	0.0	0.1	0.3	0.7	5.2	12.8	29.9
Peak Inflow Q (cfs) =	8.7	29.2	20.0	26.2	32.2	39.8	49.2	60.2	85.2
Peak Outflow Q (cfs) =	0.4	1.0	0.7	0.9	1.4	8.0	10.7	11.6	42.0
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	7.0	4.4	11.7	2.1	0.9	1.4
Structure Controlling Flow =	Plate	Plate	Plate	Plate	Overflow Grate 1	Overflow Grate 1	Outlet Plate 1	Outlet Plate 1	Spillway
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	0.0	1.0	1.4	1.5	1.5
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	38	65	57	62	67	66	64	63	59
Time to Drain 99% of Inflow Volume (hours) =	40	69	60	66	71	71	71	71	69
Maximum Ponding Depth (ft) =	1.62	4.00	3.00	3.68	4.30	4.64	5.14	5.91	6.59
Area at Maximum Ponding Depth (acres) =	0.61	0.76	0.70	0.74	0.78	0.81	0.84	0.90	0.95
Maximum Volume Stored (acre-ft) =	0.654	2.278	1.549	2.044	2.510	2.788	3.191	3.860	4.486

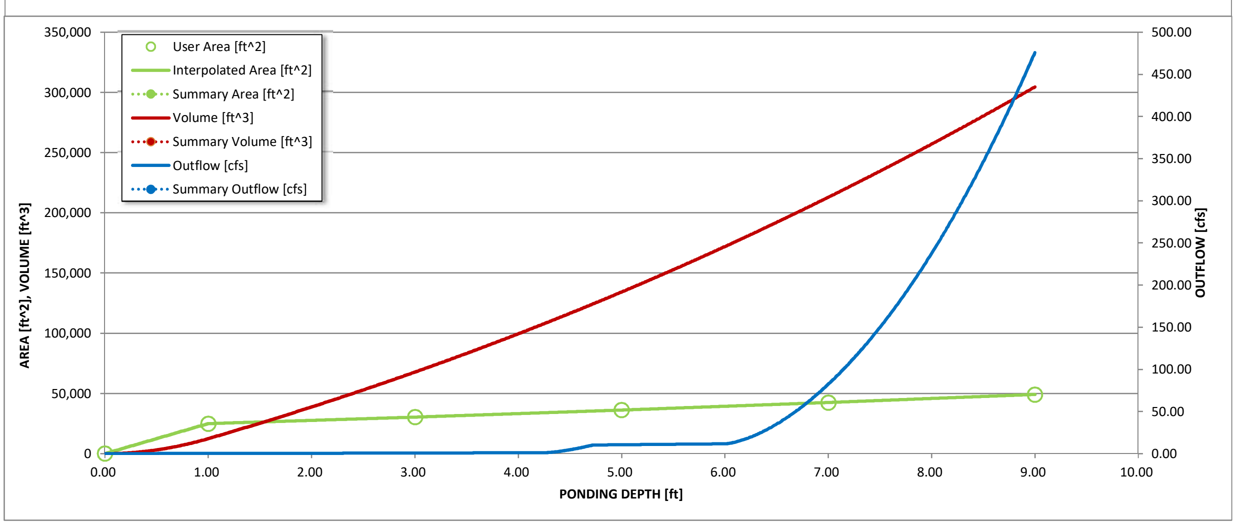
Adjust the outlet
to reduce these.

Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)







S-A-V-D Chart Axis Override	X-axis	Left Y-Axis	Right Y-Axis
minimum bound			
maximum bound			

Detention Basin Outlet Structure Design

Outflow Hydrograph Workbook Filename:

Storm Inflow Hydrographs **UD-Detention, Version 3.07 (February 2017)**

The user can override the calculated inflow hydrographs from this workbook with inflow hydrographs developed in a separate program.

	SOURCE	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK
Time Interval	TIME	WQCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
6.92 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:06:55	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hydrograph	0:13:50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Constant	0:20:46	0.38	1.25	0.87	1.12	1.37	1.68	2.04	2.45	3.30
0.723	0:27:41	1.03	3.42	2.36	3.07	3.76	4.62	5.67	6.86	9.48
	0:34:36	2.65	8.77	6.06	7.89	9.64	11.87	14.56	17.62	24.35
	0:41:31	7.29	24.07	16.63	21.66	26.46	32.57	39.92	48.29	66.63
	0:48:26	8.67	29.19	20.03	26.22	32.15	39.80	49.20	60.17	85.17
	0:55:22	8.27	27.97	19.17	25.12	30.83	38.21	47.34	58.10	82.94
	1:02:17	7.53	25.46	17.45	22.86	28.06	34.77	43.12	53.01	75.92
	1:09:12	6.73	22.88	15.65	20.54	25.23	31.30	38.85	47.77	68.47
	1:16:07	5.81	19.93	13.59	17.87	21.99	27.34	33.99	41.85	60.15
	1:23:02	5.07	17.35	11.81	15.54	19.15	23.84	29.67	36.57	52.63
	1:29:58	4.59	15.71	10.71	14.08	17.33	21.55	26.78	32.96	47.29
	1:36:53	3.79	13.11	8.92	11.75	14.48	18.03	22.45	27.69	39.93
	1:43:48	3.10	10.83	7.35	9.70	11.97	14.92	18.60	22.98	33.18
	1:50:43	2.39	8.52	5.75	7.61	9.43	11.79	14.74	18.27	26.53
	1:57:38	1.78	6.52	4.36	5.81	7.23	9.07	11.39	14.15	20.65
	2:04:34	1.29	4.82	3.20	4.29	5.35	6.75	8.51	10.61	15.57
	2:11:29	1.00	3.64	2.43	3.25	4.04	5.08	6.38	7.93	11.57
	2:18:24	0.82	2.95	1.99	2.64	3.27	4.10	5.13	6.35	9.22
	2:25:19	0.70	2.49	1.68	2.23	2.76	3.45	4.32	5.34	7.73
	2:32:14	0.61	2.18	1.47	1.94	2.41	3.01	3.76	4.64	6.70
	2:39:10	0.55	1.95	1.32	1.74	2.16	2.69	3.36	4.15	5.98
	2:46:05	0.51	1.79	1.21	1.60	1.98	2.47	3.08	3.79	5.46
	2:53:00	0.37	1.32	0.89	1.18	1.46	1.83	2.29	2.85	4.15
	2:59:55	0.27	0.96	0.65	0.86	1.06	1.33	1.66	2.06	2.99
	3:06:50	0.20	0.71	0.48	0.63	0.78	0.98	1.23	1.52	2.22
	3:13:46	0.15	0.53	0.35	0.47	0.58	0.73	0.91	1.13	1.65
	3:20:41	0.11	0.38	0.26	0.34	0.42	0.53	0.67	0.83	1.21
	3:27:36	0.07	0.27	0.18	0.24	0.30	0.38	0.48	0.60	0.88
	3:34:31	0.05	0.20	0.13	0.18	0.22	0.28	0.35	0.43	0.64
	3:41:26	0.04	0.14	0.09	0.12	0.15	0.19	0.24	0.30	0.45
	3:48:22	0.02	0.09	0.06	0.08	0.10	0.12	0.16	0.20	0.30
	3:55:17	0.01	0.05	0.03	0.04	0.05	0.07	0.09	0.11	0.17
	4:02:12	0.00	0.02	0.01	0.02	0.02	0.03	0.04	0.05	0.08
	4:09:07	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.02	0.03
	4:16:02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:22:58	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:29:53	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:36:48	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:43:43	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:50:38	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:57:34	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:04:29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:11:24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:18:19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:25:14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:32:10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:39:05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:46:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:52:55	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:59:50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:06:46	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:13:41	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:20:36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:27:31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:34:26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:41:22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:48:17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:55:12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	7:02:07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	7:09:02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	7:15:58	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	7:22:53	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	7:29:48	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	7:36:43	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	7:43:38	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	7:50:34	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	7:57:29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	8:04:24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	8:11:19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	8:18:14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Design Procedure Form: Extended Detention Basin (EDB)

UD-BMP (Version 3.06, November 2016)

Designer: JPS
Company: JPS
Date: August 23, 2018
Project: Ellicott Town Center
Location: Pond C1

1. Basin Storage Volume	
A) Effective Imperviousness of Tributary Area, I_a	I_a = 51.6 %
B) Tributary Area's Imperviousness Ratio ($i = I_a / 100$)	i = 0.516
C) Contributing Watershed Area	Area = 41.200 ac
D) For Watersheds Outside of the Denver Region, Depth of Average Runoff Producing Storm	d_6 = ____ in
E) Design Concept (Select EURV when also designing for flood control)	Choose One: ○ Water Quality Capture Volume (WQCV) ● Excess Urban Runoff Volume (EURV)
F) Design Volume (WQCV) Based on 40-hour Drain Time ($V_{DESIGN} = (1.0 * (0.91 * i^3 - 1.19 * i^2 + 0.78 * i) / 12 * Area)$)	V_{DESIGN}= 0.723 ac-ft
G) For Watersheds Outside of the Denver Region, Water Quality Capture Volume (WQCV) Design Volume ($V_{WQCV\ OTHER} = (d_6*(V_{DESIGN}/0.43))$)	$V_{DESIGN\ OTHER}$= ____ ac-ft
H) User Input of Water Quality Capture Volume (WQCV) Design Volume (Only if a different WQCV Design Volume is desired)	$V_{DESIGN\ USER}$= ____ ac-ft
I) Predominant Watershed NRCS Soil Group	Choose One: ● A ○ B ○ C / D
J) Excess Urban Runoff Volume (EURV) Design Volume For HSG A: $EURV_A = 1.68 * i^{1.28}$ For HSG B: $EURV_B = 1.36 * i^{1.08}$ For HSG C/D: $EURV_{C/D} = 1.20 * i^{1.08}$	EURV = 2.473 ac-f t
2. Basin Shape: Length to Width Ratio (A basin length to width ratio of at least 2:1 will improve TSS reduction.)	L : W = 2.0 : 1
3. Basin Side Slopes	
A) Basin Maximum Side Slopes (Horizontal distance per unit vertical, 4:1 or flatter preferred)	Z = 3.00 ft / ft **DIFFICULT TO MAINTAIN, INCREASE WHERE POSSIBLE**
4. Inlet	
A) Describe means of providing energy dissipation at concentrated inflow locations:	Concrete Forebay

Design Procedure Form: Extended Detention Basin (EDB)

Designer: JPS
Company: JPS
Date: August 23, 2018
Project: Ellicott Town Center
Location: Pond C1

5. Forebay	
A) Minimum Forebay Volume (V_{FMIN} = 3% of the WQCV)	V_{FMIN} = 0.022 ac-ft
B) Actual Forebay Volume	V_F = 0.025 ac-ft
C) Forebay Depth (D_F = 30 inch maximum)	D_F = 24.0 in
D) Forebay Discharge	
i) Undetained 100-year Peak Discharge	Q_{100} = 92.10 cfs
ii) Forebay Discharge Design Flow ($Q_F = 0.02 * Q_{100}$)	Q_F = 1.84 cfs
E) Forebay Discharge Design	Choose One: ○ Berm With Pipe; ● Wall with Rect. Notch; ○ Wall with V-Notch Weir
F) Discharge Pipe Size (minimum 8-inches)	Calculated D_P = in
G) Rectangular Notch Width	Calculated W_N = 7.1 in
6. Trickle Channel	
A) Type of Trickle Channel	Choose One: ● Concrete; ○ Soft Bottom
F) Slope of Trickle Channel	S = 0.0050 ft / ft
7. Micropool and Outlet Structure	
A) Depth of Micropool (2.5-feet minimum)	D_M = 2.5 ft
B) Surface Area of Micropool (10 ft^2 minimum)	A_M = 10 sq ft
C) Outlet Type	Choose One: ● Orifice Plate; ○ Other (Describe):
D) Smallest Dimension of Orifice Opening Based on Hydrograph Routing (Use UD-Detention)	$D_{orifice}$ = 1.00 inches
E) Total Outlet Area	A_{ot} = 19.50 square inches

Design Procedure Form: Extended Detention Basin (EDB)

Designer: JPS
Company: JPS
Date: August 23, 2018
Project: Ellicott Town Center
Location: Pond C1

8. Initial Surcharge Volume	
A) Depth of Initial Surcharge Volume (Minimum recommended depth is 4 inches)	D_{IS} = 6 in
B) Minimum Initial Surcharge Volume (Minimum volume of 0.3% of the WQCV)	V_{IS} = 94.5 cu ft
C) Initial Surcharge Provided Above Micropool	V_s= 5.0 cu ft
9. Trash Rack	
A) Water Quality Screen Open Area: $A_t = A_{ot} * 38.5*(e^{-0.095D})$	A_t = 683 square inches
B) Type of Screen (If specifying an alternative to the materials recommended in the USDCM, indicate "other" and enter the ratio of the total open are to the total screen are for the material specified.)	*S.S. Well Screen with 60% Open Area*
Other (Y/N): N	
C) Ratio of Total Open Area to Total Area (only for type 'Other')	User Ratio =
D) Total Water Quality Screen Area (based on screen type)	A_{total} = 1138 sq. in.
E) Depth of Design Volume (EURV or WQCV) (Based on design concept chosen under 1E)	H= 4.25 feet
F) Height of Water Quality Screen (H_{TR})	H_{TR}= 79 inches
G) Width of Water Quality Screen Opening ($W_{opening}$) (Minimum of 12 inches is recommended)	$W_{opening}$ = 14.4 inches

Design Procedure Form: Extended Detention Basin (EDB)

Designer: JPS
Company: JPS
Date: August 23, 2018
Project: Ellicott Town Center
Location: Pond C1

10. Overflow Embankment	
A) Describe embankment protection for 100-year and greater overtopping:	Buried Riprap Spillway
B) Slope of Overflow Embankment (Horizontal distance per unit vertical, 4:1 or flatter preferred)	4.00
11. Vegetation	Choose One: ○ Irrigated ◉ Not Irrigated
12. Access	
A) Describe Sediment Removal Procedures	Access Ramp for periodic sediment removal with skid loader as needed

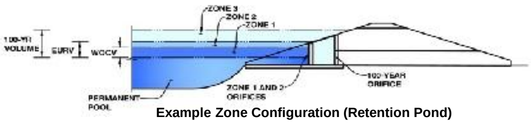
Notes:

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

UD-Detention, Version 3.07 (February 2017)

Project: Ellicott Town Center

Basin ID: Pond C3



Example Zone Configuration (Retention Pond)

Required Volume Calculation

			Optional User Override 1-hr Precipitation	
Selected BMP Type =	**EDB**			
Watershed Area =	74.48	acres		
Watershed Length =	3,100	ft		
Watershed Slope =	0.011	ft/ft		
Watershed Imperviousness =	52.50%	percent		
Percentage Hydrologic Soil Group A =	100.0%	percent		
Percentage Hydrologic Soil Group B =	0.0%	percent		
Percentage Hydrologic Soil Groups C/D =	0.0%	percent		
Desired WQCV Drain Time =	40.0	hours		
Location for 1-hr Rainfall Depths =	User Input			
Water Quality Capture Volume (WQCV) =	1.323	acre-feet		
Excess Urban Runoff Volume (EURV) =	4.571	acre-feet		
2-yr Runoff Volume (P1 = 1.19 in.) =	3.123	acre-feet	1.19	inches
5-yr Runoff Volume (P1 = 1.5 in.) =	4.100	acre-feet	1.50	inches
10-yr Runoff Volume (P1 = 1.75 in.) =	5.038	acre-feet	1.75	inches
25-yr Runoff Volume (P1 = 2 in.) =	6.245	acre-feet	2.00	inches
50-yr Runoff Volume (P1 = 2.25 in.) =	7.725	acre-feet	2.25	inches
100-yr Runoff Volume (P1 = 2.52 in.) =	9.464	acre-feet	2.52	inches
500-yr Runoff Volume (P1 = 3.14 in.) =	13.471	acre-feet	3.14	inches
Approximate 2-yr Detention Volume =	2.946	acre-feet		
Approximate 5-yr Detention Volume =	3.872	acre-feet		
Approximate 10-yr Detention Volume =	4.715	acre-feet		
Approximate 25-yr Detention Volume =	5.750	acre-feet		
Approximate 50-yr Detention Volume =	6.401	acre-feet		
Approximate 100-yr Detention Volume =	7.172	acre-feet		

Stage-Storage Calculation

Zone 1 Volume (WQCV) =	1.323	acre-feet
Zone 2 Volume (EURV - Zone 1) =	3.247	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	2.602	acre-feet
Total Detention Basin Volume =	7.172	acre-feet
Initial Surcharge Volume (ISV) =	173	ft^3
Initial Surcharge Depth (ISD) =	0.50	ft
Total Available Detention Depth (H_{total}) =	7.00	ft
Depth of Trickle Channel (H_{TC}) =	0.50	ft
Slope of Trickle Channel (S_{TC}) =	0.005	ft/ft
Slopes of Main Basin Sides (S_{main}) =	4	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	3	
Initial Surcharge Area (A_{ISV}) =	346	ft^2
Surcharge Volume Length (L_{ISV}) =	18.6	ft
Surcharge Volume Width (W_{ISV}) =	18.6	ft
Depth of Basin Floor (H_{FLOOR}) =	1.86	ft
Length of Basin Floor (L_{FLOOR}) =	398.5	ft
Width of Basin Floor (W_{FLOOR}) =	142.8	ft
Area of Basin Floor (A_{FLOOR}) =	56,898	ft^2
Volume of Basin Floor (V_{FLOOR}) =	38,293	ft^3
Depth of Main Basin (H_{MAIN}) =	4.14	ft
Length of Main Basin (L_{MAIN}) =	431.6	ft
Width of Main Basin (W_{MAIN}) =	175.9	ft
Area of Main Basin (A_{MAIN}) =	75,911	ft^2
Volume of Main Basin (V_{MAIN}) =	273,804	ft^3
Calculated Total Basin Volume (V_{total}) =	**7.173**	acre-feet

Depth Increment = 1 ft

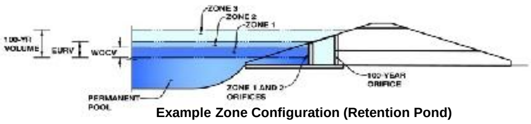
Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	0.00		18.6	18.6	346		0.008		
ISV	0.50		18.6	18.6	346		0.008	169	0.004
	1.00		18.6	18.6	346		0.008	342	0.008
	2.00		220.6	84.6	18,658		0.428	7,553	0.173
Floor	2.86		398.0	142.6	56,759		1.303	38,867	0.892
	3.00		399.6	143.9	57,494		1.320	46,873	1.076
Zone 1 (WQCV)	3.19		401.2	145.4	58,323		1.339	57,876	1.329
	4.00		407.6	151.9	61,906		1.421	106,563	2.446
	5.00		415.6	159.9	66,446		1.525	170,729	3.919
Zone 2 (EURV)	5.43		419.1	163.3	68,438		1.571	199,728	4.585
	6.00		423.6	167.9	71,115		1.633	239,499	5.498
Zone 3 (100-year)	7.00		431.6	175.9	75,911		1.743	313,001	7.186
	8.00		439.6	183.9	80,835		1.856	391,363	8.984
	9.00		447.6	191.9	85,887		1.972	474,713	10.898
	10.00		455.6	199.9	91,067		2.091	563,179	12.929
	11.00		463.6	207.9	96,375		2.212	656,889	15.080
	12.00		471.6	215.9	101,811		2.337	755,971	17.355
	13.00		479.6	223.9	107,375		2.465	860,554	19.756
	14.00		487.6	231.9	113,067		2.596	970,764	22.286
	15.00		495.6	239.9	118,887		2.729	1,086,731	24.948

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

UD-Detention, Version 3.07 (February 2017)

Project: Ellicott Town Center

Basin ID: Pond D



Example Zone Configuration (Retention Pond)

Depth Increment = 1 ft

Required Volume Calculation

Selected BMP Type =	**EDB**			
Watershed Area =	114.76	acres		
Watershed Length =	3,790	ft		
Watershed Slope =	0.010	ft/ft		
Watershed Imperviousness =	39.66%	percent		
Percentage Hydrologic Soil Group A =	100.0%	percent		
Percentage Hydrologic Soil Group B =	0.0%	percent		
Percentage Hydrologic Soil Groups C/D =	0.0%	percent		
Desired WQCV Drain Time =	40.0	hours		
Location for 1-hr Rainfall Depths =	User Input			
Water Quality Capture Volume (WQCV) =	1.711	acre-feet	Optional User Override	
Excess Urban Runoff Volume (EURV) =	4.918	acre-feet	1-hr Precipitation	
2-yr Runoff Volume (P1 = 1.19 in.) =	3.331	acre-feet	1.19	inches
5-yr Runoff Volume (P1 = 1.5 in.) =	4.406	acre-feet	1.50	inches
10-yr Runoff Volume (P1 = 1.75 in.) =	5.481	acre-feet	1.75	inches
25-yr Runoff Volume (P1 = 2 in.) =	7.003	acre-feet	2.00	inches
50-yr Runoff Volume (P1 = 2.25 in.) =	9.119	acre-feet	2.25	inches
100-yr Runoff Volume (P1 = 2.52 in.) =	11.723	acre-feet	2.52	inches
500-yr Runoff Volume (P1 = 3.14 in.) =	17.795	acre-feet	3.14	inches
Approximate 2-yr Detention Volume =	3.131	acre-feet		
Approximate 5-yr Detention Volume =	4.146	acre-feet		
Approximate 10-yr Detention Volume =	5.115	acre-feet		
Approximate 25-yr Detention Volume =	6.350	acre-feet		
Approximate 50-yr Detention Volume =	7.187	acre-feet		
Approximate 100-yr Detention Volume =	8.355	acre-feet		

Stage-Storage Calculation

Zone 1 Volume (WQCV) =	1.711	acre-feet
Zone 2 Volume (EURV - Zone 1) =	3.207	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	3.436	acre-feet
Total Detention Basin Volume =	8.355	acre-feet
Initial Surcharge Volume (ISV) =	224	ft^3
Initial Surcharge Depth (ISD) =	0.50	ft
Total Available Detention Depth (H_{total}) =	7.00	ft
Depth of Trickle Channel (H_{TC}) =	0.50	ft
Slope of Trickle Channel (S_{TC}) =	0.005	ft/ft
Slopes of Main Basin Sides (S_{main}) =	4	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	3	
Initial Surcharge Area (A_{ISV}) =	447	ft^2
Surcharge Volume Length (L_{ISV}) =	21.1	ft
Surcharge Volume Width (W_{ISV}) =	21.1	ft
Depth of Basin Floor (H_{FLOOR}) =	2.05	ft
Length of Basin Floor (L_{FLOOR}) =	439.1	ft
Width of Basin Floor (W_{FLOOR}) =	157.7	ft
Area of Basin Floor (A_{FLOOR}) =	69,262	ft^2
Volume of Basin Floor (V_{FLOOR}) =	51,408	ft^3
Depth of Main Basin (H_{MAIN}) =	3.95	ft
Length of Main Basin (L_{MAIN}) =	470.7	ft
Width of Main Basin (W_{MAIN}) =	189.3	ft
Area of Main Basin (A_{MAIN}) =	89,127	ft^2
Volume of Main Basin (V_{MAIN}) =	312,090	ft^3
Calculated Total Basin Volume (V_{total}) =	**8.355**	acre-feet

Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	0.00		21.1	21.1	447		0.010		
ISV	0.50		21.1	21.1	447		0.010	219	0.005
	1.00		21.1	21.1	447		0.010	443	0.010
	2.00		223.1	87.1	19,444		0.446	8,094	0.186
	3.00		429.1	154.5	66,296		1.522	49,057	1.126
Floor	3.05		437.3	157.1	68,722		1.578	51,757	1.188
Zone 1 (WQCV)	3.37		441.7	160.3	70,802		1.625	74,858	1.718
	4.00		446.7	165.3	73,862		1.696	120,424	2.765
	5.00		454.7	173.3	78,822		1.810	196,755	4.517
Zone 2 (EURV)	5.23		456.6	175.2	79,981		1.836	215,018	4.936
	6.00		462.7	181.3	83,911		1.926	278,111	6.385
Zone 3 (100-year)	7.00		470.7	189.3	89,127		2.046	364,619	8.371
	8.00		478.7	197.3	94,471		2.169	456,408	10.478
	9.00		486.7	205.3	99,944		2.294	553,605	12.709
	10.00		494.7	213.3	105,544		2.423	656,338	15.067
	11.00		502.7	221.3	111,273		2.554	764,736	17.556
	12.00		510.7	229.3	117,129		2.689	878,926	20.177
	13.00		518.7	237.3	123,114		2.826	999,037	22.935
	14.00		526.7	245.3	129,226		2.967	1,125,197	25.831
	15.00		534.7	253.3	135,467		3.110	1,257,532	28.869

APPENDIX D1

STREET CAPACITY & STORM SEWER HYDRAULIC CALCULATIONS

ELLICOTT TOWN CENTER – FILING NO. 1
STREET CAPACITY ANALYSIS

TYPICAL STREET CAPACITY ASSUMPTIONS:

Road Type	Min. Slope	Curb-Curb Width (ft)	Minor Storm Capacity [a] (Q_5, cfs)	Major Storm Capacity [b] (Q_{100}, cfs)
Residential	1.0%	30’	11.3	232.4

[a] Maximum allowable spread at Q_5 is to crown of street.

$Q = 112.6 * S^{(1/2)}$

[b] Maximum allowable flow depth at Q_{100} is 12-inches at flowline.

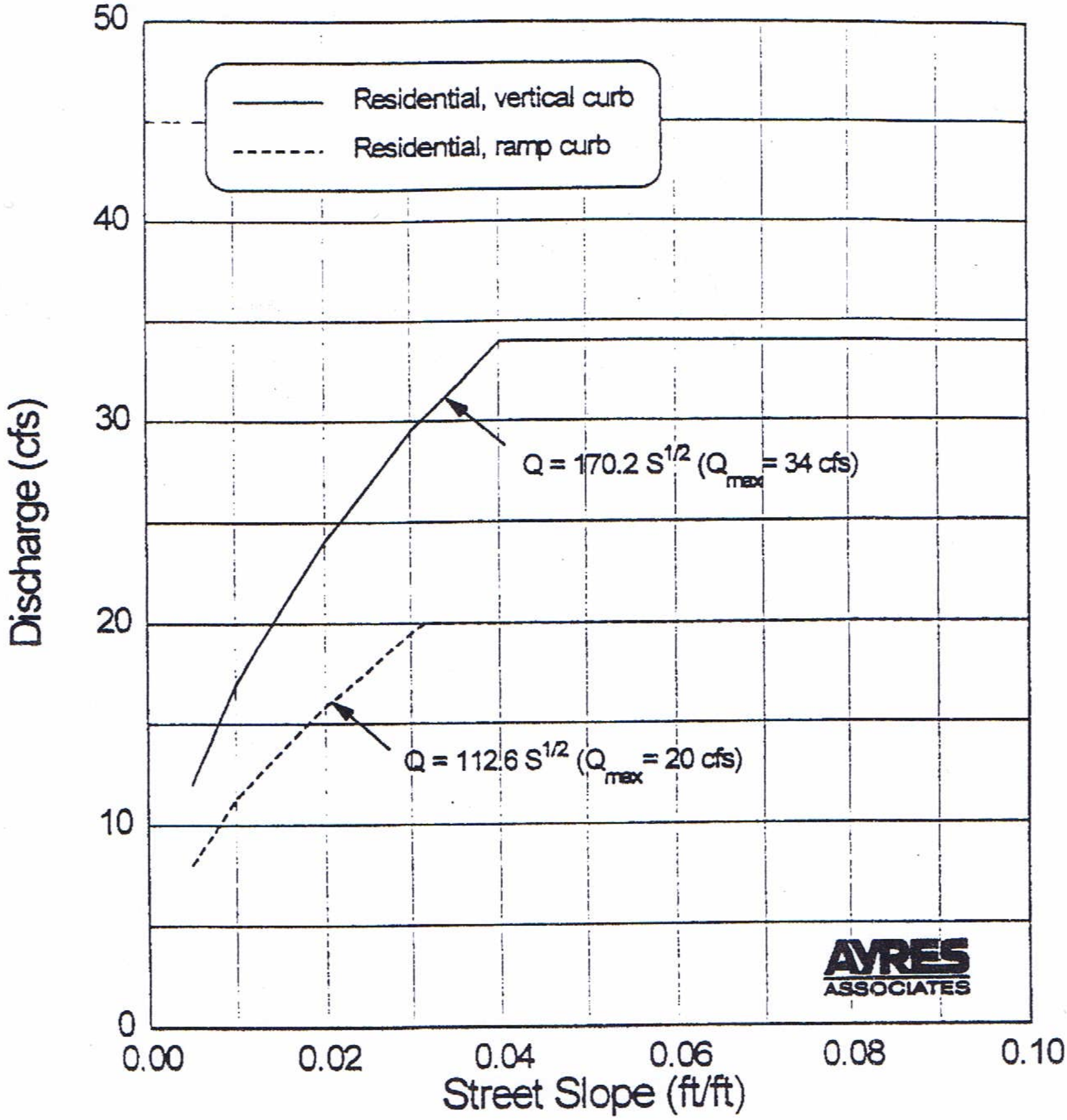
Road (Design Point)	Min. Street Grade	Allowable Minor Storm Capacity (cfs)	Peak Flow (Q_5, cfs)	Inlet Required?
Cattlemen Run (C1.1)	1.0%	11.3	5.4	No
Village Main St. (C1.2)	1.0%	11.3	35.9	Yes
Market Place Dr (C1.7B)	1.0%	11.3	17.3	Yes
ETC Blvd (C1.8)	1.0%	11.3	18.4	Yes

TABLE 6 - 1

Allowable Use of Streets in El Paso County

Street Classification	Use of Streets: Initial Storm	Use of Streets: Major Storm	Cross Flow In Streets: Initial Storm	Cross Flow In Streets: Major Storm
illside Local with Ramp urb & Gutter	Maximum flow spread to crown. Maximum flow rate of 15 cfs per side.	Same as Local Street with Curb & Gutter	Same as Local Street with Curb & Gutter	Same as Local Street with Curb & Gutter
illside Local with 8 in. ertical Curb & Gutter	The depth of flow shall not exceed 6 inches at the gutter flowline. Maximum flow rate of 25 cfs per side.	Same as Local Street with Curb & Gutter	Same as Local Street with Curb & Gutter	Same as Local Street with Curb & Gutter
ocal with Ramp Curb & utter	Maximum flow spread to street crown. Maximum flow rate of 20 cfs per side.	Residential dwellings, public, commercial and industrial buildings shall not be inundated at the ground line. The depth of water at the gutter flowline shall not exceed 12 inches.	Where cross pans are allowed, the depth of flow shall not exceed 6 inches at the flowline.	Where cross pans are allowed, the depth of flow shall not exceed 12 inches at the flowline.
ocal with 8 in. Vertical urb & Gutter	The depth of flow shall not exceed 6 inches at the gutter flowline. Maximum flow rate of 34 cfs per side.	Same as above.	Same as above.	Same as above.
ocal with Roadside Ditch	Flow must not encroach upon road shoulder area.	Residential dwellings, public, commercial and industrial buildings shall not be inundated at the ground line. The depth of water at the edge of road shoulder shall not exceed 6 inches.	Requires culvert. Flow shall not encroach upon the road shoulder.	Requires culvert. Depth of flow shall not exceed 6 inches at the edge of the road shoulder.
ollector with 8 in. Vertical urb & Gutter	Same as Local Streets with 8 in. Vertical Curb & Gutter	Same as Local Streets with Curb & Gutter.	Same as Local Streets with Curb & Gutter.	Same as Local Streets with Curb & Gutter.
ollector with Roadside itch	Same as Local Streets with Roadside Ditch.	Same as Local Streets with Roadside Ditch.	Same as Local Streets with Roadside Ditch.	Same as Local Streets with Roadside Ditch.
rterial with Curb & Gutter	The depth of flow shall not exceed 6 inches at the gutter flowline. Maximum flow rate of 34 cfs per side. One ten foot lane in each direction must remain free of water.	Residential dwellings, public, commercial and industrial buildings shall not be inundated at the ground line. The depth of water at the gutter flowline shall not exceed 8 inches and there shall be no curb overtopping.	No cross flow is allowed on the road surface.	12 in. max. depth at gutter flowline or 4 in. max. depth at crown, whichever is more limiting.
rterial with Roadside Ditch	Flow must not encroach upon road shoulder area.	Residential dwellings, public, commercial and industrial buildings shall not be inundated at the ground line. The depth of water shall not encroach upon the road shoulder.	Requires culvert. Flow shall not encroach upon the road shoulder.	Requires culvert. Flow shall not encroach upon the road shoulder.
ighway / Freeway	No encroachment of water is allowed on any traffic lanes.	No encroachment of water is allowed on any traffic lanes.	No cross flow is allowed on the road surface.	No cross flow is allowed on the road surface.

RESIDENTIAL STREET (34' Flowline to flowline)



Interim Release October 12, 1994
City of Colorado Springs

Use this graph to determine the allowable street capacity per side, initial storm, for the typical street section using a 2% crown.

ELLICOTT TOWN CENTER FILING NO. 1
STORM INLET SIZING SUMMARY

	BASIN FLOW			INLET FLOW					
INLET	DP	Q5 FLOW (CFS) [1]	Q100 FLOW (CFS) [a]	INLET FLOW % OF BASIN	Q5 FLOW (CFS)	Q100 FLOW (CFS)	INLET CONDITION / TYPE	INLET SIZE	INLET CAPACITY (CFS)
C1.2	C1.2	16.9	35.9	100	16.9	35.9	SUMP TYPE R	10.0	25.5 [b]
C1.7A	C1.7A	1.1	2.7	100	1.1	2.7	SUMP TYPE R	5.0	12.3
C1.7B	C1.7B	8.2	17.3	100	8.2	17.3	SUMP TYPE R	10.0	25.5
C1.3	C1.3	5.9	14.3	100	5.9	14.3	SUMP TYPE R	10.0	25.5
C1.4	C1.4	6.3	15.3	100	6.3	15.3	SUMP TYPE R	10.0	25.5
C1.5	C1.5	6.2	15.0	100	6.2	15.0	SUMP TYPE R	10.0	25.5
C1.1	C1.1	5.4	18.0	100	5.4	18.0	SUMP TYPE R	10.0	25.5
C1.6	C1.6	3.8	9.4	100	3.8	9.4	SUMP TYPE R	5.0	12.3
C1.8	C1.8	7.5	18.4	100	7.5	18.4	SUMP TYPE R	10.0	25.5
C1.9	C1.9	7.0	17.0	100	7.0	17.0	SUMP TYPE R	10.0	25.5

[a] REFER TO RATIONAL METOHD HYDROLOGY CALCULATIONS FOR CONTRIBUTING BASINS & DEVELOPED FLOW CALCULATIONS
[b] ADDITIONAL UPSTREAM INLET CAPACITY TO BE PROVIDED WITHIN COMMERCIAL DEVELOPMENT AREA

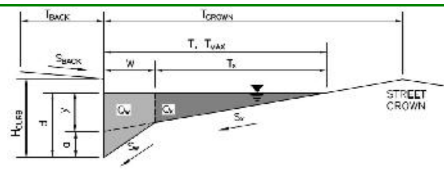
Version 4.05 Released March 2017

ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)

(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project: **Ellicott Town Center - Typical 5' Type R Inlet (Sump Condition)**

Inlet ID:



Gutter Geometry (Enter data in the blue cells)

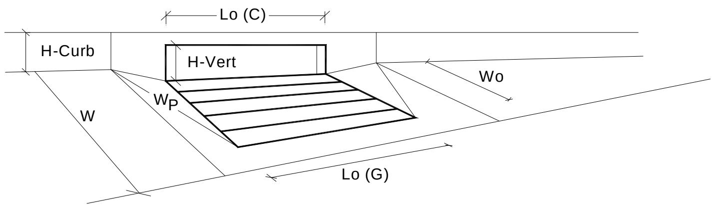
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	12.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.020	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	15.0	ft
Gutter Width	W =	2.00	ft
Street Transverse Slope	S_X =	0.020	ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083	ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.000	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.016	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	15.0	15.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	12.0	inches
Check boxes are not applicable in SUMP conditions		☐	☐	

		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Depth Criterion				
MAJOR STORM Allowable Capacity is based on Depth Criterion	Q_{allow} =	**SUMP**	**SUMP**	**cfs**

INLET IN A SUMP OR SAG LOCATION

Version 4.05 Released March 2017



Design Information (Input)		MINOR	MAJOR	
Type of Inlet — CDOT Type R Curb Opening	Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a' from above)	a_{local} =	3.00	3.00	inches
Number of Unit Inlets (Grate or Curb Opening)	No =	1	1	
Water Depth at Flowline (outside of local depression)	Ponding Depth =	6.0	12.0	inches
Grate Information		MINOR	MAJOR	☑ Override Depths
Length of a Unit Grate	L_o (G) =	N/A	N/A	feet
Width of a Unit Grate	W_o =	N/A	N/A	feet
Area Opening Ratio for a Grate (typical values 0.15-0.90)	A_{ratio} =	N/A	N/A	
Clogging Factor for a Single Grate (typical value 0.50 - 0.70)	C_f (G) =	N/A	N/A	
Grate Weir Coefficient (typical value 2.15 - 3.60)	C_w (G) =	N/A	N/A	
Grate Orifice Coefficient (typical value 0.60 - 0.80)	C_o (G) =	N/A	N/A	
Curb Opening Information		MINOR	MAJOR	
Length of a Unit Curb Opening	L_o (C) =	5.00	5.00	feet
Height of Vertical Curb Opening in Inches	H_{vert} =	6.00	6.00	inches
Height of Curb Orifice Throat in Inches	H_{throat} =	6.00	6.00	inches
Angle of Throat (see USDCM Figure ST-5)	Theta =	63.40	63.40	degrees
Side Width for Depression Pan (typically the gutter width of 2 feet)	W_p =	2.00	2.00	feet
Clogging Factor for a Single Curb Opening (typical value 0.10)	C_f (C) =	0.10	0.10	
Curb Opening Weir Coefficient (typical value 2.3-3.7)	C_w (C) =	3.60	3.60	
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)	C_o (C) =	0.67	0.67	

Low Head Performance Reduction (Calculated)		MINOR	MAJOR	
Depth for Grate Midwidth	d_{Grate} =	N/A	N/A	ft
Depth for Curb Opening Weir Equation	d_{Curb} =	0.33	0.83	ft
Combination Inlet Performance Reduction Factor for Long Inlets	$RF_{Combination}$ =	0.77	1.00	
Curb Opening Performance Reduction Factor for Long Inlets	RF_{Curb} =	1.00	1.00	
Grated Inlet Performance Reduction Factor for Long Inlets	RF_{Grate} =	N/A	N/A	

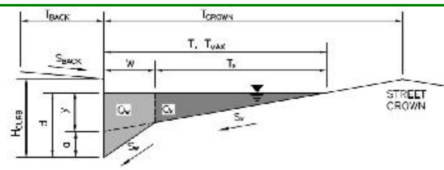
		MINOR	MAJOR	
Total Inlet Interception Capacity (assumes clogged condition)	Q_a =	**5.4**	**12.3**	**cfs**
Inlet Capacity IS GOOD for Minor and Major Storms(>Q PEAK)	$Q_{PEAK\ REQUIRED}$ =	4.0	8.0	cfs

ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)

(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project: Ellicott Town Center - Typical 10' Type R Inlet (Sump Condition)

Inlet ID:



Gutter Geometry (Enter data in the blue cells)

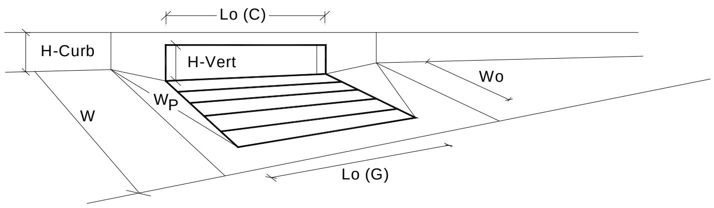
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	12.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.020	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	15.0	ft
Gutter Width	W =	2.00	ft
Street Transverse Slope	S_X =	0.020	ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083	ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.000	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.016	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	15.0	15.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	12.0	inches
Check boxes are not applicable in SUMP conditions		☐	☐	

		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Depth Criterion				
MAJOR STORM Allowable Capacity is based on Depth Criterion	Q_{allow} =	**SUMP**	**SUMP**	**cfs**

INLET IN A SUMP OR SAG LOCATION

Version 4.05 Released March 2017



		MINOR	MAJOR	
Design Information (Input) — CDOT Type R Curb Opening				
Type of Inlet	Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a' from above)	a_{local} =	3.00	3.00	inches
Number of Unit Inlets (Grate or Curb Opening)	No =	1	1	
Water Depth at Flowline (outside of local depression)	Ponding Depth =	6.0	12.0	inches
Grate Information		MINOR	MAJOR	☑ Override Depths
Length of a Unit Grate	L_o (G) =	N/A	N/A	feet
Width of a Unit Grate	W_o =	N/A	N/A	feet
Area Opening Ratio for a Grate (typical values 0.15-0.90)	A_{ratio} =	N/A	N/A	
Clogging Factor for a Single Grate (typical value 0.50 - 0.70)	C_f (G) =	N/A	N/A	
Grate Weir Coefficient (typical value 2.15 - 3.60)	C_w (G) =	N/A	N/A	
Grate Orifice Coefficient (typical value 0.60 - 0.80)	C_o (G) =	N/A	N/A	
Curb Opening Information		MINOR	MAJOR	
Length of a Unit Curb Opening	L_o (C) =	10.00	10.00	feet
Height of Vertical Curb Opening in Inches	H_{vert} =	6.00	6.00	inches
Height of Curb Orifice Throat in Inches	H_{throat} =	6.00	6.00	inches
Angle of Throat (see USDCM Figure ST-5)	Theta =	63.40	63.40	degrees
Side Width for Depression Pan (typically the gutter width of 2 feet)	W_p =	2.00	2.00	feet
Clogging Factor for a Single Curb Opening (typical value 0.10)	C_f (C) =	0.10	0.10	
Curb Opening Weir Coefficient (typical value 2.3-3.7)	C_w (C) =	3.60	3.60	
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)	C_o (C) =	0.67	0.67	
Low Head Performance Reduction (Calculated)		MINOR	MAJOR	
Depth for Grate Midwidth	d_{Grate} =	N/A	N/A	ft
Depth for Curb Opening Weir Equation	d_{Curb} =	0.33	0.83	ft
Combination Inlet Performance Reduction Factor for Long Inlets	$RF_{Combination}$ =	0.57	1.00	
Curb Opening Performance Reduction Factor for Long Inlets	RF_{Curb} =	0.93	1.00	
Grated Inlet Performance Reduction Factor for Long Inlets	RF_{Grate} =	N/A	N/A	
		MINOR	MAJOR	
Total Inlet Interception Capacity (assumes clogged condition)	Q_a =	**8.3**	**25.5**	**cfs**
WARNING: Inlet Capacity less than Q Peak for Minor Storm	$Q_{PEAK\ REQUIRED}$ =	10.0	21.0	cfs

ELLICOTT TOWN CENTER FILING NO. 1
STORM SEWER SIZING SUMMARY

	PIPE FLOW			PIPE CAPACITY		
PIPE	BASINS	Q5 FLOW (CFS)	Q100 FLOW (CFS)	PIPE SIZE	MIN. PIPE SLOPE	FULL PIPE CAPACITY (CFS)
C1.2	C1.2	16.9	35.9	30	1.00%	41.0
C1.7A	C1.7A	1.1	2.7	18	1.0%	10.5
C1.7B	C1.7A,C1.7B	9.3	20.0	24	1.0%	22.6
C1.2A	C1.2,C1.7A-B	26.2	55.9	36	0.89%	62.9
C1.3	C1.3	5.9	14.3	18	1.9%	14.5
C1.3A	C1.2,C1.3,C1.7A-B	32.1	70.2	36	1.41%	79.2
C1.4	C1.4	6.3	15.3	18	2.2%	15.6
C1.4A	C1.2-C1.4,C1.7A-B	38.4	85.5	42	0.85%	92.8
C1.5	C1.5	6.2	15.0	18	2.1%	15.2
C1.5A	C1.2-C1.5,C1.7A-B	44.6	100.5	42	1.0%	100.6
C1.1	C1.1	5.4	18.0	24	1.0%	22.6
C1.6	C1.6	3.8	9.4	18	1.0%	10.5
C1.6A	C1.1,C1.2-C1.6,C1.7A-B	53.8	127.9	48	0.80%	128.5
C1.8	C1.8	7.5	18.4	24	1.36%	26.4
C1.9	C1.9	7.0	17.0	24	1.0%	22.6
C1.9A	C1.1-C1.9	68.3	163.3	48	1.30%	163.7

ASSUMPTIONS:
1. STORM DRAIN PIPE ASSUMED TO BE RCP OR HDPE

Hydraulic Analysis Report

Project Data

Project Title: ETC Filing No. 1 - SD

Designer: JPS

Project Date: Thursday, August 16, 2018

Project Units: U.S. Customary Units

Notes:

Channel Analysis: SD-C1.2

Notes:

Input Parameters

Channel Type: Circular

Pipe Diameter: 2.5000 ft

Longitudinal Slope: 0.0100 ft/ft

Manning's n: 0.0130

Depth: 2.5000 ft

Result Parameters

Flow: 41.0171 cfs

Area of Flow: 4.9087 ft^2

Wetted Perimeter: 7.8540 ft

Hydraulic Radius: 0.6250 ft

Average Velocity: 8.3559 ft/s

Top Width: 0.0000 ft

Froude Number: 0.0000

Critical Depth: 2.1509 ft

Critical Velocity: 9.1300 ft/s

Critical Slope: 0.0093 ft/ft

Critical Top Width: 1.73 ft

Calculated Max Shear Stress: 1.5600 lb/ft^2

Calculated Avg Shear Stress: 0.3900 lb/ft^2

Channel Analysis: SD-C1.7A

Notes:

Input Parameters

Channel Type: Circular

Pipe Diameter: 1.5000 ft

Longitudinal Slope: 0.0100 ft/ft

Manning's n: 0.0130

Depth: 1.5000 ft

Result Parameters

Flow: 10.5043 cfs

Area of Flow: 1.7671 ft^2

Wetted Perimeter: 4.7124 ft

Hydraulic Radius: 0.3750 ft

Average Velocity: 5.9442 ft/s

Top Width: 0.0000 ft

Froude Number: 0.0000

Critical Depth: 1.2451 ft

Critical Velocity: 6.6989 ft/s

Critical Slope: 0.0098 ft/ft

Critical Top Width: 1.13 ft

Calculated Max Shear Stress: 0.9360 lb/ft^2

Calculated Avg Shear Stress: 0.2340 lb/ft^2

Channel Analysis: SD-C1.7B

Notes:

Input Parameters

Channel Type: Circular

Pipe Diameter: 2.0000 ft

Longitudinal Slope: 0.0100 ft/ft

Manning's n: 0.0130

Depth: 2.0000 ft

Result Parameters

Flow: 22.6224 cfs

Area of Flow: 3.1416 ft^2

Wetted Perimeter: 6.2832 ft

Hydraulic Radius: 0.5000 ft

Average Velocity: 7.2009 ft/s

Top Width: 0.0000 ft

Froude Number: 0.0000

Critical Depth: 1.6953 ft

Critical Velocity: 7.9674 ft/s

Critical Slope: 0.0095 ft/ft

Critical Top Width: 1.44 ft

Calculated Max Shear Stress: 1.2480 lb/ft^2

Calculated Avg Shear Stress: 0.3120 lb/ft^2

Channel Analysis: SD-C1.2A

Notes:

Input Parameters

Channel Type: Circular

Pipe Diameter: 3.0000 ft

Longitudinal Slope: 0.0089 ft/ft

Manning's n: 0.0130

Depth: 3.0000 ft

Result Parameters

Flow: 62.9231 cfs

Area of Flow: 7.0686 ft^2

Wetted Perimeter: 9.4248 ft

Hydraulic Radius: 0.7500 ft

Average Velocity: 8.9018 ft/s

Top Width: 0.0000 ft

Froude Number: 0.0000

Critical Depth: 2.5518 ft

Critical Velocity: 9.8203 ft/s

Critical Slope: 0.0084 ft/ft

Critical Top Width: 2.14 ft

Calculated Max Shear Stress: 1.6661 lb/ft^2

Calculated Avg Shear Stress: 0.4165 lb/ft^2

Channel Analysis: SD-C1.3

Notes:

Input Parameters

Channel Type: Circular

Pipe Diameter: 1.5000 ft

Longitudinal Slope: 0.0190 ft/ft

Manning's n: 0.0130

Depth: 1.5000 ft

Result Parameters

Flow: 14.4792 cfs

Area of Flow: 1.7671 ft^2

Wetted Perimeter: 4.7124 ft

Hydraulic Radius: 0.3750 ft

Average Velocity: 8.1936 ft/s

Top Width: 0.0000 ft

Froude Number: 0.0000

Critical Depth: 1.3938 ft

Critical Velocity: 8.4583 ft/s

Critical Slope: 0.0164 ft/ft

Critical Top Width: 0.77 ft

Calculated Max Shear Stress: 1.7784 lb/ft^2

Calculated Avg Shear Stress: 0.4446 lb/ft^2

Channel Analysis: SD-C1.3A

Notes:

Input Parameters

Channel Type: Circular

Pipe Diameter: 3.0000 ft

Longitudinal Slope: 0.0141 ft/ft

Manning's n: 0.0130

Depth: 3.0000 ft

Result Parameters

Flow: 79.2000 cfs

Area of Flow: 7.0686 ft^2

Wetted Perimeter: 9.4248 ft

Hydraulic Radius: 0.7500 ft

Average Velocity: 11.2045 ft/s

Top Width: 0.0000 ft

Froude Number: 0.0000

Critical Depth: 2.7627 ft

Critical Velocity: 11.6333 ft/s

Critical Slope: 0.0122 ft/ft

Critical Top Width: 1.62 ft

Calculated Max Shear Stress: 2.6395 lb/ft^2

Calculated Avg Shear Stress: 0.6599 lb/ft^2

Channel Analysis: SD-C1.4

Notes:

Input Parameters

Channel Type: Circular

Pipe Diameter: 1.5000 ft

Longitudinal Slope: 0.0220 ft/ft

Manning's n: 0.0130

Depth: 1.5000 ft

Result Parameters

Flow: 15.5805 cfs

Area of Flow: 1.7671 ft^2

Wetted Perimeter: 4.7124 ft

Hydraulic Radius: 0.3750 ft

Average Velocity: 8.8167 ft/s

Top Width: 0.0000 ft

Froude Number: 0.0000

Critical Depth: 1.4172 ft

Critical Velocity: 9.0117 ft/s

Critical Slope: 0.0190 ft/ft

Critical Top Width: 0.68 ft

Calculated Max Shear Stress: 2.0592 lb/ft^2

Calculated Avg Shear Stress: 0.5148 lb/ft^2

Channel Analysis: SD-C1.4A

Notes:

Input Parameters

Channel Type: Circular

Pipe Diameter: 3.5000 ft

Longitudinal Slope: 0.0085 ft/ft

Manning's n: 0.0130

Depth: 3.5000 ft

Result Parameters

Flow: 92.7576 cfs

Area of Flow: 9.6211 ft^2

Wetted Perimeter: 10.9956 ft

Hydraulic Radius: 0.8750 ft

Average Velocity: 9.6410 ft/s

Top Width: 0.0000 ft

Froude Number: 0.0000

Critical Depth: 2.9805 ft

Critical Velocity: 10.6254 ft/s

Critical Slope: 0.0080 ft/ft

Critical Top Width: 2.49 ft

Calculated Max Shear Stress: 1.8564 lb/ft^2

Calculated Avg Shear Stress: 0.4641 lb/ft^2

Channel Analysis: SD-C1.5

Notes:

Input Parameters

Channel Type: Circular

Pipe Diameter: 1.5000 ft

Longitudinal Slope: 0.0210 ft/ft

Manning's n: 0.0130

Depth: 1.5000 ft

Result Parameters

Flow: 15.2222 cfs

Area of Flow: 1.7671 ft^2

Wetted Perimeter: 4.7124 ft

Hydraulic Radius: 0.3750 ft

Average Velocity: 8.6140 ft/s

Top Width: 0.0000 ft

Froude Number: 0.0000

Critical Depth: 1.4099 ft

Critical Velocity: 8.8307 ft/s

Critical Slope: 0.0181 ft/ft

Critical Top Width: 0.71 ft

Calculated Max Shear Stress: 1.9656 lb/ft^2

Calculated Avg Shear Stress: 0.4914 lb/ft^2

Channel Analysis: SD-C1.5A

Notes:

Input Parameters

Channel Type: Circular

Pipe Diameter: 3.5000 ft

Longitudinal Slope: 0.0100 ft/ft

Manning's n: 0.0130

Depth: 3.5000 ft

Result Parameters

Flow: 100.6098 cfs

Area of Flow: 9.6211 ft^2

Wetted Perimeter: 10.9956 ft

Hydraulic Radius: 0.8750 ft

Average Velocity: 10.4572 ft/s

Top Width: 0.0000 ft

Froude Number: 0.0000

Critical Depth: 3.0762 ft

Critical Velocity: 11.2307 ft/s

Critical Slope: 0.0090 ft/ft

Critical Top Width: 2.28 ft

Calculated Max Shear Stress: 2.1840 lb/ft^2

Calculated Avg Shear Stress: 0.5460 lb/ft^2

Channel Analysis: SD-C1.1

Notes:

Input Parameters

Channel Type: Circular

Pipe Diameter: 2.0000 ft

Longitudinal Slope: 0.0100 ft/ft

Manning's n: 0.0130

Depth: 2.0000 ft

Result Parameters

Flow: 22.6224 cfs

Area of Flow: 3.1416 ft^2

Wetted Perimeter: 6.2832 ft

Hydraulic Radius: 0.5000 ft

Average Velocity: 7.2009 ft/s

Top Width: 0.0000 ft

Froude Number: 0.0000

Critical Depth: 1.6953 ft

Critical Velocity: 7.9674 ft/s

Critical Slope: 0.0095 ft/ft

Critical Top Width: 1.44 ft

Calculated Max Shear Stress: 1.2480 lb/ft^2

Calculated Avg Shear Stress: 0.3120 lb/ft^2

Channel Analysis: SD-C1.6

Notes:

Input Parameters

Channel Type: Circular

Pipe Diameter: 1.5000 ft

Longitudinal Slope: 0.0100 ft/ft

Manning's n: 0.0130

Depth: 1.5000 ft

Result Parameters

Flow: 10.5043 cfs

Area of Flow: 1.7671 ft^2

Wetted Perimeter: 4.7124 ft

Hydraulic Radius: 0.3750 ft

Average Velocity: 5.9442 ft/s

Top Width: 0.0000 ft

Froude Number: 0.0000

Critical Depth: 1.2451 ft

Critical Velocity: 6.6989 ft/s

Critical Slope: 0.0098 ft/ft

Critical Top Width: 1.13 ft

Calculated Max Shear Stress: 0.9360 lb/ft^2

Calculated Avg Shear Stress: 0.2340 lb/ft^2

Channel Analysis: SD-C1.6A

Notes:

Input Parameters

Channel Type: Circular

Pipe Diameter: 4.0000 ft

Longitudinal Slope: 0.0080 ft/ft

Manning's n: 0.0130

Depth: 4.0000 ft

Result Parameters

Flow: 128.4785 cfs

Area of Flow: 12.5664 ft^2

Wetted Perimeter: 12.5664 ft

Hydraulic Radius: 1.0000 ft

Average Velocity: 10.2240 ft/s

Top Width: 0.0000 ft

Froude Number: 0.0000

Critical Depth: 3.3945 ft

Critical Velocity: 11.3010 ft/s

Critical Slope: 0.0076 ft/ft

Critical Top Width: 2.87 ft

Calculated Max Shear Stress: 1.9968 lb/ft^2

Calculated Avg Shear Stress: 0.4992 lb/ft^2

Channel Analysis: SD-C1.8

Notes:

Input Parameters

Channel Type: Circular

Pipe Diameter: 2.0000 ft

Longitudinal Slope: 0.0136 ft/ft

Manning's n: 0.0130

Depth: 2.0000 ft

Result Parameters

Flow: 26.3820 cfs

Area of Flow: 3.1416 ft^2

Wetted Perimeter: 6.2832 ft

Hydraulic Radius: 0.5000 ft

Average Velocity: 8.3977 ft/s

Top Width: 0.0000 ft

Froude Number: 0.0000

Critical Depth: 1.7949 ft

Critical Velocity: 8.8770 ft/s

Critical Slope: 0.0120 ft/ft

Critical Top Width: 1.21 ft

Calculated Max Shear Stress: 1.6973 lb/ft^2

Calculated Avg Shear Stress: 0.4243 lb/ft^2

Channel Analysis: SD-C1.9

Notes:

Input Parameters

Channel Type: Circular

Pipe Diameter: 2.0000 ft

Longitudinal Slope: 0.0100 ft/ft

Manning's n: 0.0130

Depth: 2.0000 ft

Result Parameters

Flow: 22.6224 cfs

Area of Flow: 3.1416 ft^2

Wetted Perimeter: 6.2832 ft

Hydraulic Radius: 0.5000 ft

Average Velocity: 7.2009 ft/s

Top Width: 0.0000 ft

Froude Number: 0.0000

Critical Depth: 1.6953 ft

Critical Velocity: 7.9674 ft/s

Critical Slope: 0.0095 ft/ft

Critical Top Width: 1.44 ft

Calculated Max Shear Stress: 1.2480 lb/ft^2

Calculated Avg Shear Stress: 0.3120 lb/ft^2

Channel Analysis: SD-C1.9A

Notes:

Input Parameters

Channel Type: Circular

Pipe Diameter: 4.0000 ft

Longitudinal Slope: 0.0130 ft/ft

Manning's n: 0.0130

Depth: 4.0000 ft

Result Parameters

Flow: 163.7785 cfs

Area of Flow: 12.5664 ft^2

Wetted Perimeter: 12.5664 ft

Hydraulic Radius: 1.0000 ft

Average Velocity: 13.0331 ft/s

Top Width: 0.0000 ft

Froude Number: 0.0000

Critical Depth: 3.6914 ft

Critical Velocity: 13.5131 ft/s

Critical Slope: 0.0113 ft/ft

Critical Top Width: 2.13 ft

Calculated Max Shear Stress: 3.2448 lb/ft^2

Calculated Avg Shear Stress: 0.8112 lb/ft^2

ELLICOTT TOWN CENTER FILING NO. 1
CULVERT DESIGN SUMMARY

BASIN	DESIGN POINT	RD CL ELEV	INV IN ELEV	INV OUT ELEV	PIPE LENGTH (FT)	# of CULVERTS	PIPE DIA (FT)	TOTAL Q_5 (CFS)	PER PIPE Q_5 (CFS)	Q_5 MAX ALLOWABLE HEADWATER [1]	CALC Q_5 HW ELEV	TOTAL Q_{100} (CFS)	PER PIPE Q_{100} (CFS)	Q_{100} MAX ALLOWABLE HEADWATER [2]	CALC Q_{100} HW ELEV
C1.6	EC11	6059.69	6055.38	6054.83	110.7	1	**2.5**	9.6	9.6	6057.9	6056.7	64.0	64.0	6060.3	6059.8
C1.9	EC11	6055.41	6049.98	6049.29	138.1	1	**2.5**	9.6	9.6	6052.5	6051.4	64.0	64.0	6055.7	6055.6

[1] Q_5 MAX. ALLOWABLE HEADWATER, HW/D = 1.0

[2] Q_{100} MAX. ALLOWABLE HEADWATER = 12" DEPTH AT GUTTER FLOWLINE (PER DCM TABLE 6-1)

HY-8 Culvert Analysis Report

Crossing Discharge Data – Culvert C1.6

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 5 cfs

Design Flow: 9.6 cfs

Maximum Flow: 64 cfs

Table 1 - Summary of Culvert Flows at Crossing: Crossing C1.6

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert C1.6 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
6056.38	5.00	5.00	0.00	1
6056.82	9.60	9.60	0.00	1
6057.37	16.80	16.80	0.00	1
6057.84	22.70	22.70	0.00	1
6058.24	28.60	28.60	0.00	1
6058.73	34.50	34.50	0.00	1
6059.47	40.40	40.40	0.00	1
6059.74	46.30	42.43	3.69	12
6059.79	52.20	42.72	9.36	5
6059.83	58.10	42.99	14.96	4
6059.86	64.00	43.23	20.67	4
6059.69	42.02	42.02	0.00	Overtopping

Rating Curve Plot for Crossing: Crossing C1.6

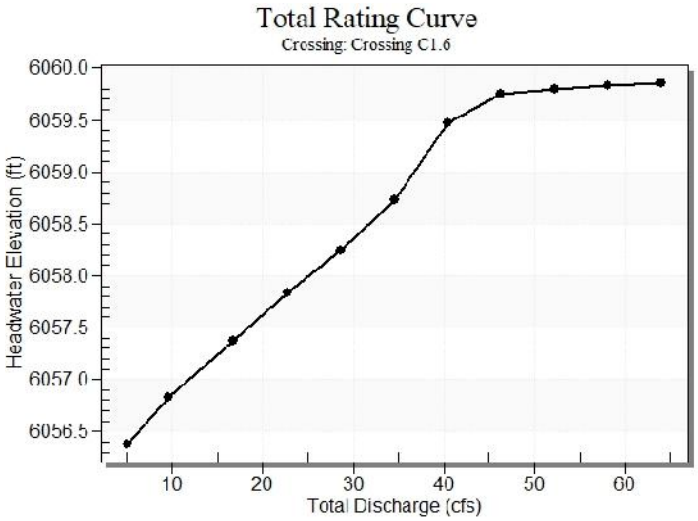


Table 2 - Culvert Summary Table: Culvert C1.6

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
5.00	5.00	6056.38	1.001	0.0*	1-S2n	0.701	0.733	0.704	0.217	4.425	2.596
9.60	9.60	6056.82	1.444	0.0*	1-S2n	0.988	1.031	0.988	0.318	5.317	3.261
16.80	16.80	6057.37	1.994	1.234	1-S2n	1.367	1.381	1.367	0.438	6.119	3.937
22.70	22.70	6057.84	2.386	2.462	2-M2c	1.669	1.618	1.618	0.519	6.756	4.343
28.60	28.60	6058.24	2.801	2.862	7-M2c	2.024	1.821	1.821	0.590	7.465	4.675
34.50	34.50	6058.73	3.282	3.346	7-M2c	2.500	1.994	1.994	0.655	8.220	4.958
40.40	40.40	6059.47	3.856	4.094	7-M2c	2.500	2.137	2.137	0.715	9.043	5.204
46.30	42.43	6059.74	4.077	4.364	7-M2c	2.500	2.178	2.178	0.770	9.347	5.426
52.20	42.72	6059.79	4.111	4.411	7-M2c	2.500	2.184	2.184	0.822	9.393	5.627
58.10	42.99	6059.83	4.141	4.447	7-M2c	2.500	2.189	2.189	0.871	9.434	5.809
64.00	43.23	6059.86	4.168	4.480	7-M2c	2.500	2.194	2.194	0.917	9.471	5.979

* Full Flow Headwater elevation is below inlet invert.

****

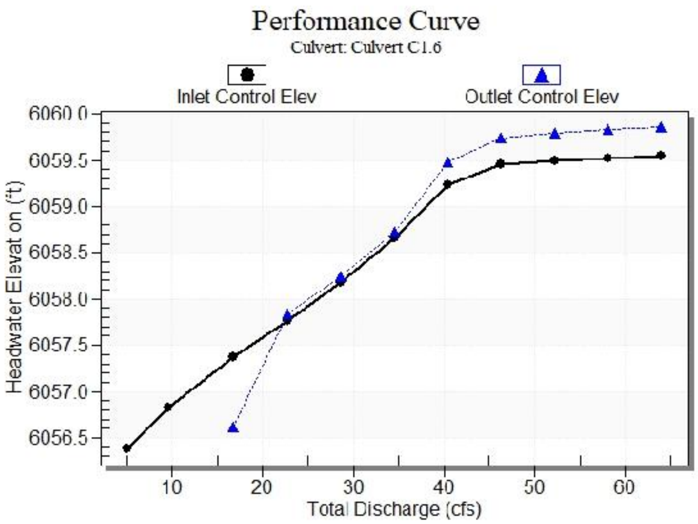
Straight Culvert

Inlet Elevation (invert): 6055.38 ft,   Outlet Elevation (invert): 6054.83 ft

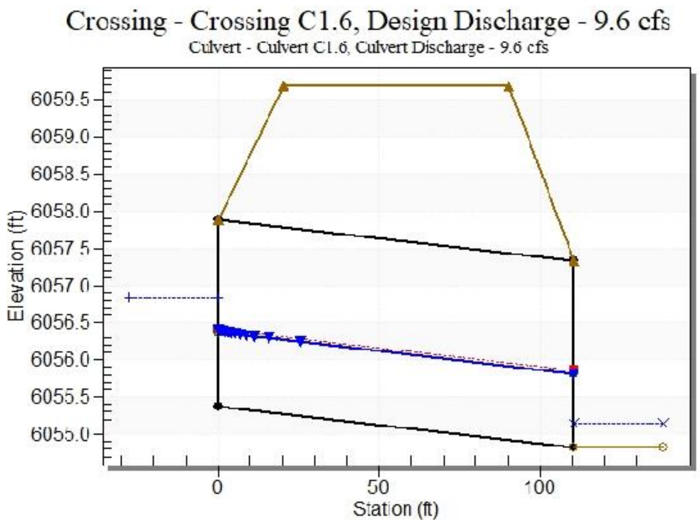
Culvert Length: 110.70 ft,   Culvert Slope: 0.0050

****

Culvert Performance Curve Plot: Culvert C1.6



Water Surface Profile Plot for Culvert: Culvert C1.6



S

Inlet Station: 0.00 ft

Inlet Elevation: 6055.38 ft

Outlet Station: 110.70 ft

Outlet Elevation: 6054.83 ft

Number of Barrels: 1

Culvert Data Summary - Culvert C1.6

Barrel Shape: Circular

Barrel Diameter: 2.50 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0130

Culvert Type: Straight

Inlet Configuration: Grooved End Projecting

Inlet Depression: NONE

Table 3 - Downstream Channel Rating Curve (Crossing: Crossing C1.6)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
5.00	6055.05	0.22	2.60	0.33	1.03
9.60	6055.15	0.32	3.26	0.48	1.09
16.80	6055.27	0.44	3.94	0.66	1.14
22.70	6055.35	0.52	4.34	0.78	1.17
28.60	6055.42	0.59	4.68	0.88	1.19
34.50	6055.49	0.66	4.96	0.98	1.21
40.40	6055.54	0.71	5.20	1.07	1.22
46.30	6055.60	0.77	5.43	1.15	1.23
52.20	6055.65	0.82	5.63	1.23	1.24
58.10	6055.70	0.87	5.81	1.30	1.25
64.00	6055.75	0.92	5.98	1.37	1.26

Tailwater Channel Data - Crossing C1.6

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 8.00 ft

Side Slope (H:V): 4.00 (_:1)

Channel Slope: 0.0240

Channel Manning's n: 0.0300

Channel Invert Elevation: 6054.83 ft

Roadway Data for Crossing: Crossing C1.6

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 100.00 ft

Crest Elevation: 6059.69 ft

Roadway Surface: Paved

Roadway Top Width: 70.00 ft

Crossing Discharge Data – Culvert C1.9

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 5 cfs

Design Flow: 9.6 cfs

Maximum Flow: 64 cfs

Table 4 - Summary of Culvert Flows at Crossing: Crossing C1.9

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert C1.9 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
6050.98	5.00	5.00	0.00	1
6051.42	9.60	9.60	0.00	1
6051.97	16.80	16.80	0.00	1
6052.44	22.70	22.70	0.00	1
6052.84	28.60	28.60	0.00	1
6053.35	34.50	34.50	0.00	1
6054.20	40.40	40.40	0.00	1
6055.08	46.30	46.30	0.00	1
6055.46	52.20	48.64	3.37	15
6055.51	58.10	48.92	9.06	5
6055.55	64.00	49.18	14.72	4
6055.41	48.34	48.34	0.00	Overtopping

Rating Curve Plot for Crossing: Crossing C1.9

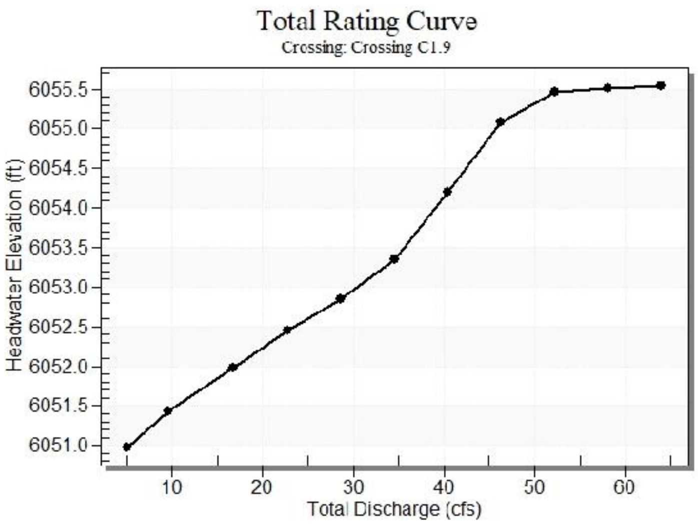


Table 5 - Culvert Summary Table: Culvert C1.9

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
5.00	5.00	6050.98	1.001	0.0*	1-S2n	0.700	0.733	0.700	0.343	4.456	1.557
9.60	9.60	6051.42	1.444	0.488	1-S2n	0.986	1.031	0.991	0.497	5.292	1.934
16.80	16.80	6051.97	1.994	1.139	1-S2n	1.364	1.381	1.364	0.679	6.132	2.309
22.70	22.70	6052.44	2.386	2.462	2-M2c	1.666	1.618	1.618	0.801	6.756	2.531
28.60	28.60	6052.84	2.801	2.862	7-M2c	2.019	1.821	1.821	0.907	7.465	2.712
34.50	34.50	6053.35	3.282	3.375	7-M2c	2.500	1.994	1.994	1.002	8.220	2.866
40.40	40.40	6054.20	3.856	4.218	7-M2c	2.500	2.137	2.137	1.090	9.043	3.000
46.30	46.30	6055.08	4.532	5.105	7-M2c	2.500	2.247	2.247	1.170	9.961	3.120
52.20	48.64	6055.46	4.829	5.483	7-M2c	2.500	2.282	2.282	1.245	10.350	3.229
58.10	48.92	6055.51	4.866	5.528	7-M2c	2.500	2.286	2.286	1.316	10.397	3.328
64.00	49.18	6055.55	4.899	5.564	7-M2c	2.500	2.289	2.289	1.383	10.441	3.419

* Full Flow Headwater elevation is below inlet invert.

****

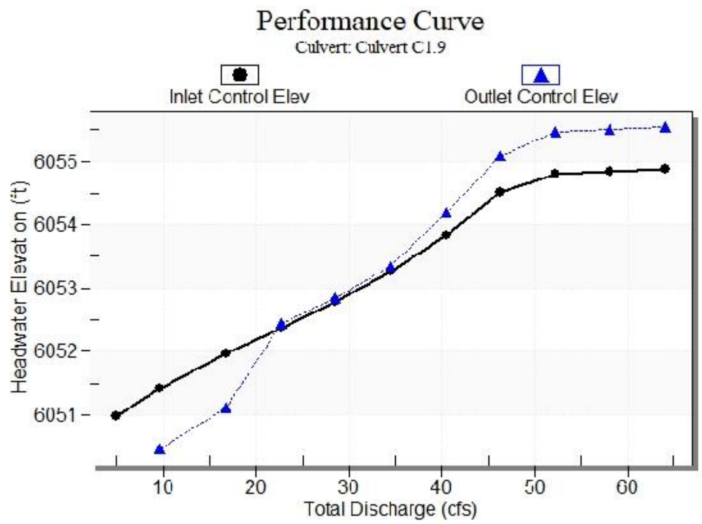
Straight Culvert

Inlet Elevation (invert): 6049.98 ft, Outlet Elevation (invert): 6049.29 ft

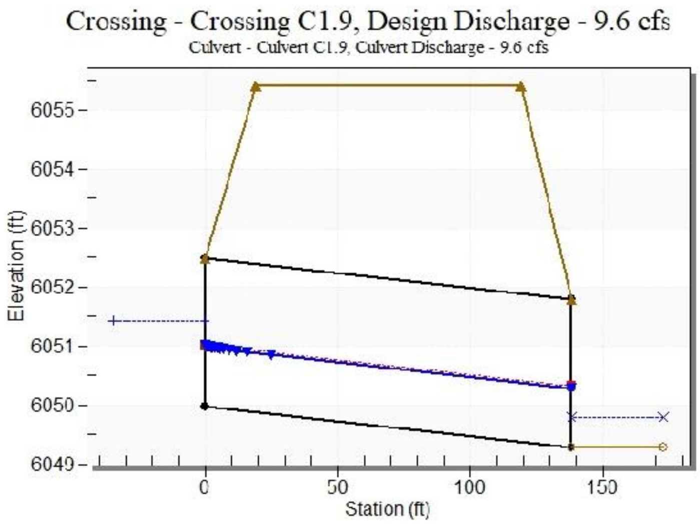
Culvert Length: 138.10 ft, Culvert Slope: 0.0050

****

Culvert Performance Curve Plot: Culvert C1.9



Water Surface Profile Plot for Culvert: Culvert C1.9



S

Inlet Station: 0.00 ft

Inlet Elevation: 6049.98 ft

Outlet Station: 138.10 ft

Outlet Elevation: 6049.29 ft

Number of Barrels: 1

Culvert Data Summary - Culvert C1.9

Barrel Shape: Circular

Barrel Diameter: 2.50 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0130

Culvert Type: Straight

Inlet Configuration: Grooved End Projecting

Inlet Depression: NONE

Table 6 - Downstream Channel Rating Curve (Crossing: Crossing C1.9)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
5.00	6049.63	0.34	1.56	0.11	0.50
9.60	6049.79	0.50	1.93	0.16	0.53
16.80	6049.97	0.68	2.31	0.21	0.55
22.70	6050.09	0.80	2.53	0.25	0.57
28.60	6050.20	0.91	2.71	0.28	0.57
34.50	6050.29	1.00	2.87	0.31	0.58
40.40	6050.38	1.09	3.00	0.34	0.59
46.30	6050.46	1.17	3.12	0.37	0.59
52.20	6050.54	1.25	3.23	0.39	0.60
58.10	6050.61	1.32	3.33	0.41	0.60
64.00	6050.67	1.38	3.42	0.43	0.61

Tailwater Channel Data - Crossing C1.9

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 8.00 ft

Side Slope (H:V): 4.00 (_:1)

Channel Slope: 0.0050

Channel Manning's n: 0.0300

Channel Invert Elevation: 6049.29 ft

Roadway Data for Crossing: Crossing C1.9

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 100.00 ft

Crest Elevation: 6055.41 ft

Roadway Surface: Paved

Roadway Top Width: 100.00 ft

APPENDIX D2

OPEN CHANNEL HYDRAULIC CALCULATIONS

ELLICOTT TOWN CENTER - FILING NO. 1
CHANNEL CALCULATIONS
DEVELOPED FLOWS

PROPOSED CHANNELS

CHANNEL	DESIGN POINT	PROPOSED SLOPE (%)	BOTTOM WIDTH (B, FT)	SIDE SLOPE (Z)	CHANNEL DEPTH (FT)	FRICTION FACTOR (n)	MIN. EASEMENT (FT)	Q100 FLOW (CFS)	Q100 DEPTH (FT)	Q100 VELOCITY (FT/S)	CHANNEL LINING
C1	EC11	1.40	8	4:1	2.0	0.030	40	64.0	1.0	4.9	GRASS
C4	EC11	0.50	8	4:1	2.5	0.030	40	64.0	1.4	3.4	GRASS

1) Channel flow calculations based on Manning's Equation
2) Channel depth includes 1' minimum freeboard
3) n = 0.03 for grass-lined non-irrigated channels (minimum)
4) n = 0.035 for riprap-lined channels
5) Vmax = 5.0 fps for 100-year flows w/ grass-lined channels
6) Vmax = 8.0 fps for 100-year flows w/ Erosion Control Blankets (NAG C150 or equal)

Hydraulic Analysis Report

Project Data

Project Title: ETC-Channels

Designer: JPS

Project Date: Thursday, July 19, 2018

Project Units: U.S. Customary Units

Notes:

Channel Analysis: Channel Analysis-C1

Notes:

Input Parameters

Channel Type: Trapezoidal

Side Slope 1 (Z1): 4.0000 ft/ft

Side Slope 2 (Z2): 4.0000 ft/ft

Channel Width: 8.0000 ft

Longitudinal Slope: 0.0140 ft/ft

Manning's n: 0.0300

Flow: 64.0000 cfs

Result Parameters

Depth: 1.0587 ft

Area of Flow: 12.9533 ft^2

Wetted Perimeter: 16.7304 ft

Hydraulic Radius: 0.7742 ft

Average Velocity: 4.9408 ft/s

Top Width: 16.4697 ft

Froude Number: 0.9818

Critical Depth: 1.0480 ft

Critical Velocity: 5.0090 ft/s

Critical Slope: 0.0145 ft/ft

Critical Top Width: 16.38 ft

Calculated Max Shear Stress: 0.9249 lb/ft^2

Calculated Avg Shear Stress: 0.6764 lb/ft^2

Channel Analysis: Channel Analysis-C4

Notes:

Input Parameters

Channel Type: Trapezoidal

Side Slope 1 (Z1): 4.0000 ft/ft

Side Slope 2 (Z2): 4.0000 ft/ft

Channel Width: 8.0000 ft

Longitudinal Slope: 0.0050 ft/ft

Manning's n: 0.0300

Flow: 64.0000 cfs

Result Parameters

Depth: 1.3832 ft

Area of Flow: 18.7185 ft^2

Wetted Perimeter: 19.4061 ft

Hydraulic Radius: 0.9646 ft

Average Velocity: 3.4191 ft/s

Top Width: 19.0656 ft

Froude Number: 0.6081

Critical Depth: 1.0478 ft

Critical Velocity: 5.0099 ft/s

Critical Slope: 0.0146 ft/ft

Critical Top Width: 16.38 ft

Calculated Max Shear Stress: 0.4316 lb/ft^2

Calculated Avg Shear Stress: 0.3009 lb/ft^2

TABLE 10-2 (Continued)

TYPICAL ROUGHNESS COEFFICIENTS FOR OPEN CHANNELS

Type of Channel and Description	Minimum	Normal	Maximum
c. Concrete bottom float finished with sides of			
1. Dressed stone in mortar	0.015	0.017	0.020
2. Random stone in mortar	0.017	0.020	0.024
3. Cement rubble masonry, plastered	0.016	0.020	0.024
4. Cement rubble masonry	0.020	0.025	0.030
5. Dry rubble or riprap	0.020	0.030	0.035
d. Gravel bottom with sides of			
1. Formed concrete	0.017	0.020	0.025
2. Random stone in mortar	0.020	0.023	0.026
3. Dry rubble or riprap	0.023	0.033	0.036
e. Asphalt			
1. Smooth		0.013	
2. Rough		0.016	
f. Grassed	0.030	0.040	0.050

TABLE 10-3

MAXIMUM PERMISSIBLE DESIGN OPEN CHANNEL FLOW VELOCITIES IN EARTH*

Soil Types	Permissible Mean Channel Velocity (ft/sec)
Fine Sand (noncolloidal)	2.0
Coarse Sand (noncolloidal)	4.0
Sandy Loam (noncolloidal)	2.5
Silt Loam (noncolloidal)	3.0
Ordinary Firm Loam	3.5
Silty Clay	3.5
Fine Gravel	5.0
Stiff Clay (very colloidal)	5.0
Graded, Loam to Cobbles (noncolloidal)	5.0
Graded, Silt to Cobbles (colloidal)	5.5
Alluvial Silts (noncolloidal)	3.5
Alluvial Silts (colloidal)	5.0
Coarse Gravel (noncolloidal)	6.0
Cobbles and Shingles	5.5
Hard Shales and Hard Pans	6.0
Soft Shales	3.5
Soft Sandstone	8.0
Sound rock (usu. igneous or hard metamorphic)	20.0

* These velocities shall be used in conjunction with scour calculations and as approved by City/County.

TABLE 10-4

MAXIMUM PERMISSIBLE VELOCITIES FOR EARTH CHANNELS WITH VARIED GRASS LININGS AND SLOPES

Channel Slope	Lining	Permissible Mean Channel Velocity * (ft/sec)
0 - 5%	Sodded grass	7
	Bermudagrass	6
	Reed canarygrass	5
	Tall fescue	5
	Kentucky bluegrass	5
	Grass-legume mixture	4
	Red fescue	2.5
	Redtop	2.5
	Sericea lespedeza	2.5
	Annual lespedeza	2.5
	Small grains (temporary)	2.5
5 - 10%	Sodded grass	6
	Bermudagrass	5
	Reed canarygrass	4
	Tall fescue	4
	Kentucky bluegrass	4
	Grass-legume mixture	3
Greater than 10%	Sodded grass	5
	Bermudagrass	4
	Reed canarygrass	3
	Tall fescue	3
	Kentucky bluegrass	3

* For highly erodible soils, decrease permissible velocities by 25%.

* Grass lined channels are dependent upon assurances of continuous growth and maintenance of grass.

APPENDIX E

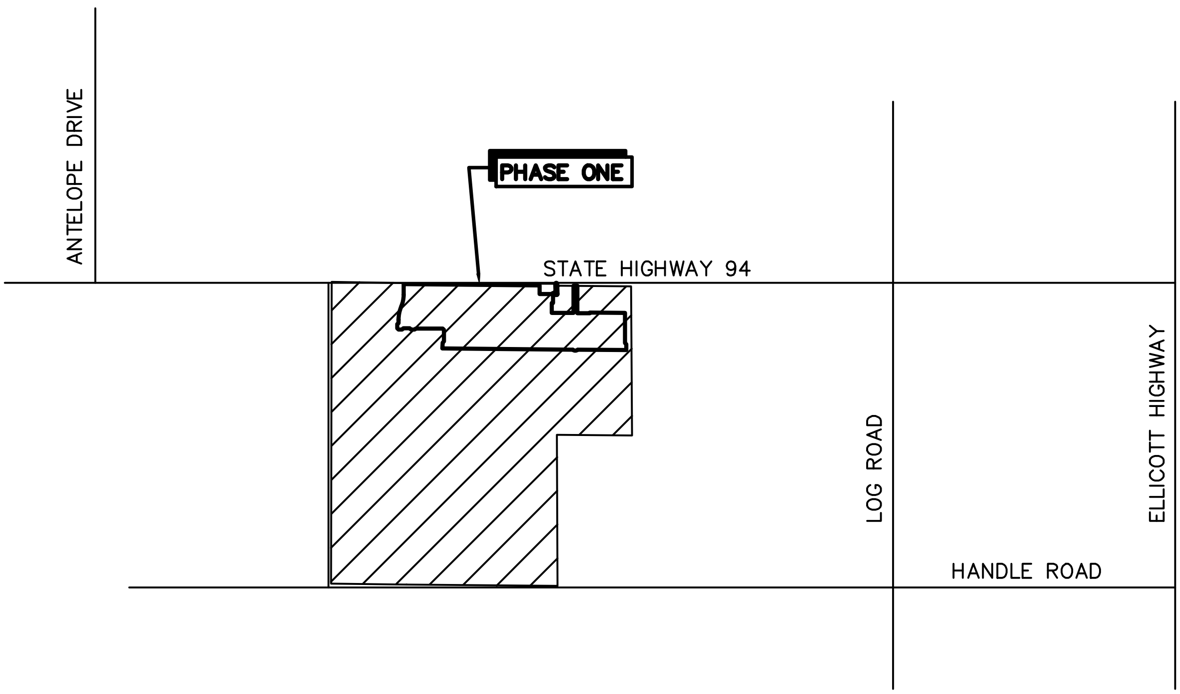
COST ESTIMATE

ELLICOTT TOWN CENTER FILING NO. 1
ENGINEER'S COST ESTIMATE
DRAINAGE IMPROVEMENTS

Item No.	Item	Quantity	Unit	Unit Cost ($$$)	Total Cost ($$$)
506	Riprap (d50 = 12")	15	CY	$98	$1,470
603	18" RCP Storm Sewer	265	LF	$69	$18,285
603	24" RCP Storm Sewer	982	LF	$84	$82,488
603	30" RCP Storm Sewer	278	LF	$94	$26,132
603	36" RCP Storm Sewer	590	LF	$124	$73,160
603	42" RCP Storm Sewer	488	LF	$134	$65,392
603	48" RCP Storm Sewer	428	LF	$178	$76,184
603	18" RCP FES	1	EA	$414	$414
603	30" RCP FES	4	EA	$564	$2,256
604	5' Type R Storm Inlet	3	EA	$3,791	$11,373
604	10' Type R Storm Inlet	7	EA	$5,528	$38,696
604	Storm Manhole	8	EA	$4,575	$36,600
604	Detention Pond Forebay	1	EA	$4,000	$4,000
604	Detention Pond Outlet Structure	1	EA	$8,000	$8,000
604	Detention Pond Spillway	1	EA	$3,000	$3,000
	TOTAL				**$447,450**

APPENDIX F

FIGURES

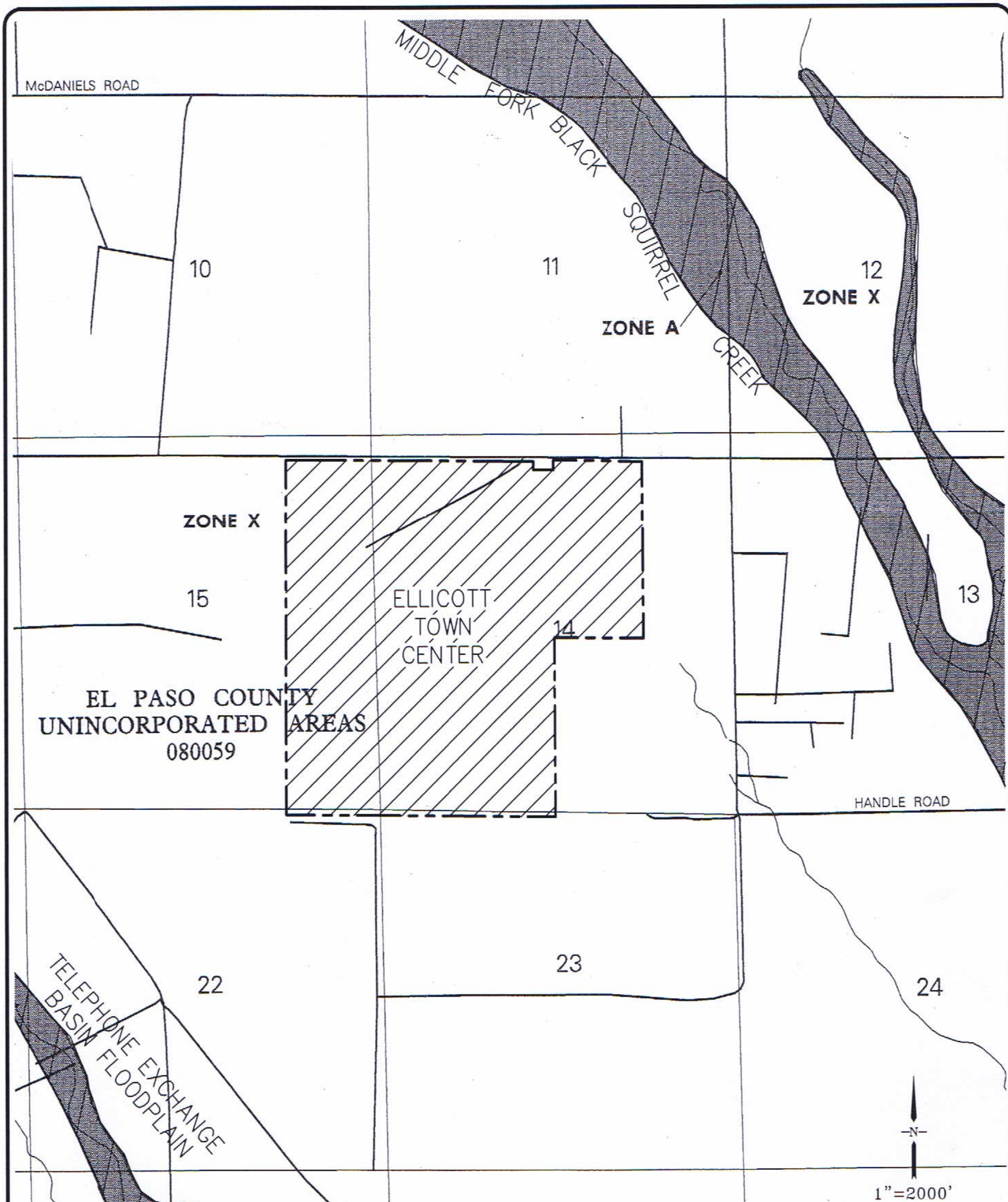


VICINITY MAP

NTS

J:\jpsprojects\090001.EllicottTC\dwg\Civil\A1.dwg Aug 26, 2018 - 2:59pm

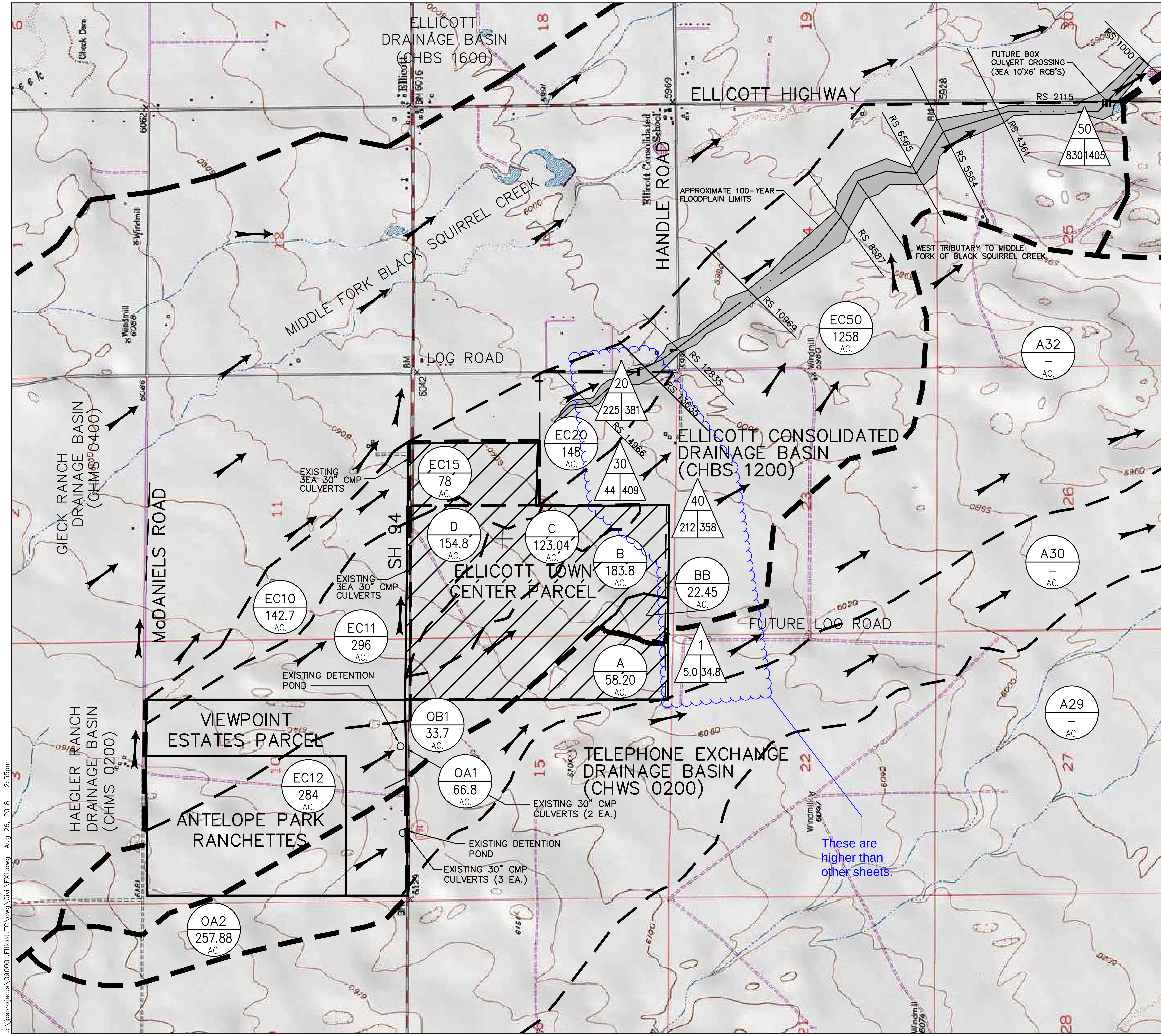
VICINITY MAP	JPS ENGINEERING	**ELLICOTT TOWN CENTER**
		FIGURE A1 **JPS PROJ NO. 090001**



REF: FIRM PANEL 08041C0825, DATED 3/17/97

ELLICOTT TOWN CENTER	JPS ENGINEERING	FLOODPLAIN MAP FIGURE A3 JPS PROJ NO. 090001

J:\jpsprojects\090001.EllicottTC\dwg\Civil\FIG-A3.dwg Feb 17, 2006 - 8:47am



Provide a summary table.

Provide calculations for these flows.

LEGEND

OD1 / 296 / AC.	DRAINAGE BASIN AREA (AC)
2 / 410 694	DESIGN POINT Q5 / Q100 (CFS)
▬ ▬	MAJOR BASIN LINE
— —	BASIN LINE

ORIGINAL SCALE: 1"=1000'

1000 0 1000 2000

JPS ENGINEERING

19 E. Willamette Ave.
Colorado Springs, CO
80903

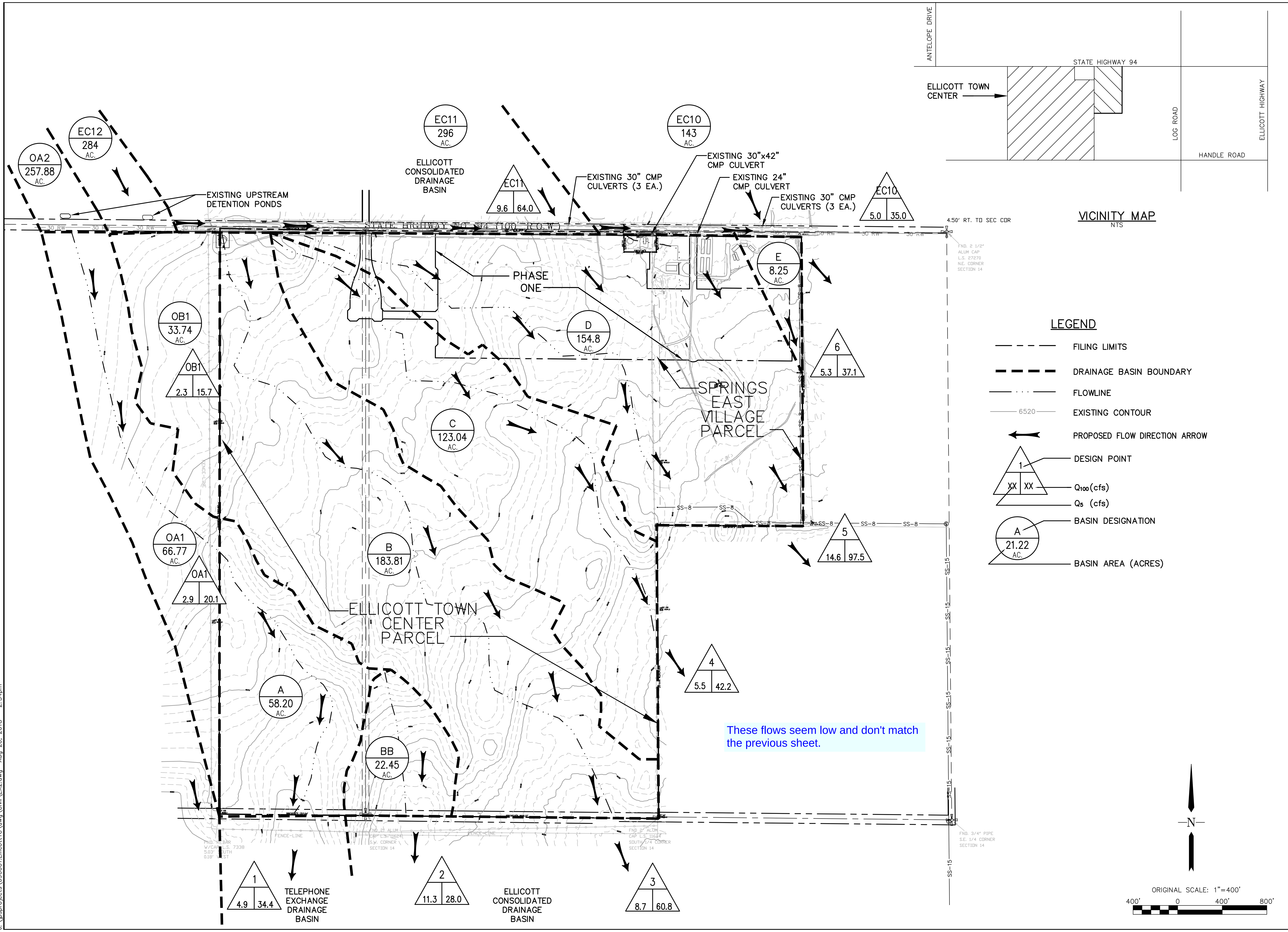
PH: 719-477-9429
FAX: 719-471-0766

ELLICOTT TOWN CENTER

No.	REVISION	BY	DATE

MAJOR BASIN / HISTORIC DRAINAGE PLAN

HORZ. SCALE:	1"=1000'	DRAWN:	MJP
VERT. SCALE:	N/A	DESIGNED:	JPS
SURVEYED:	UP&E	CHECKED:	JPS
CREATED:	12/3/00	LAST MODIFIED:	1/15/07
PROJECT NO:	090001	MODIFIED BY:	MJP
SHEET:	EX1		



JPS ENGINEERING
19 E. Willamette Ave.
Colorado Springs, CO 80903
PH: 719-477-9429
FAX: 719-471-0766

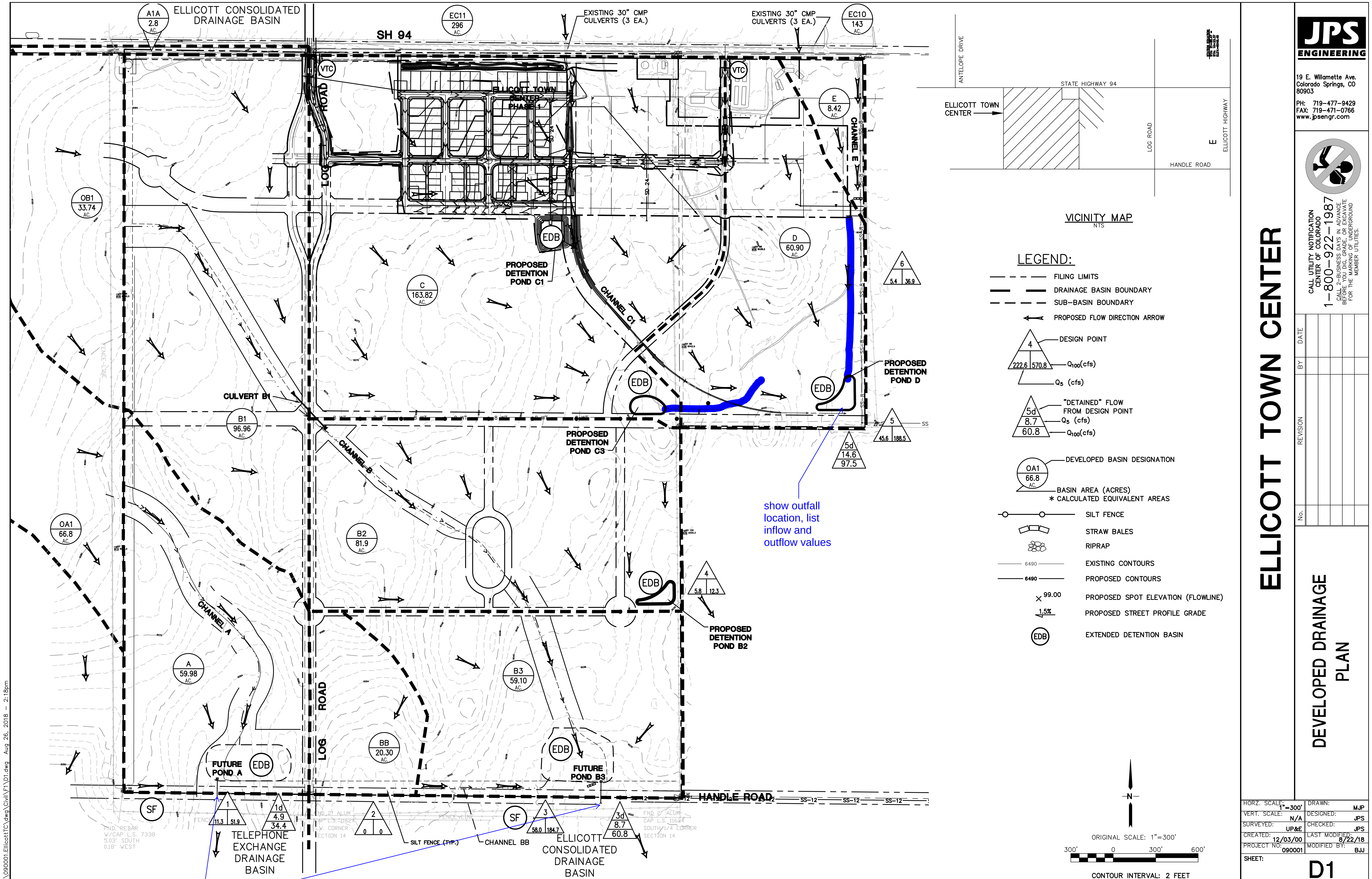
ELLICOTT TOWN CENTER

No.	REVISION	BY	DATE

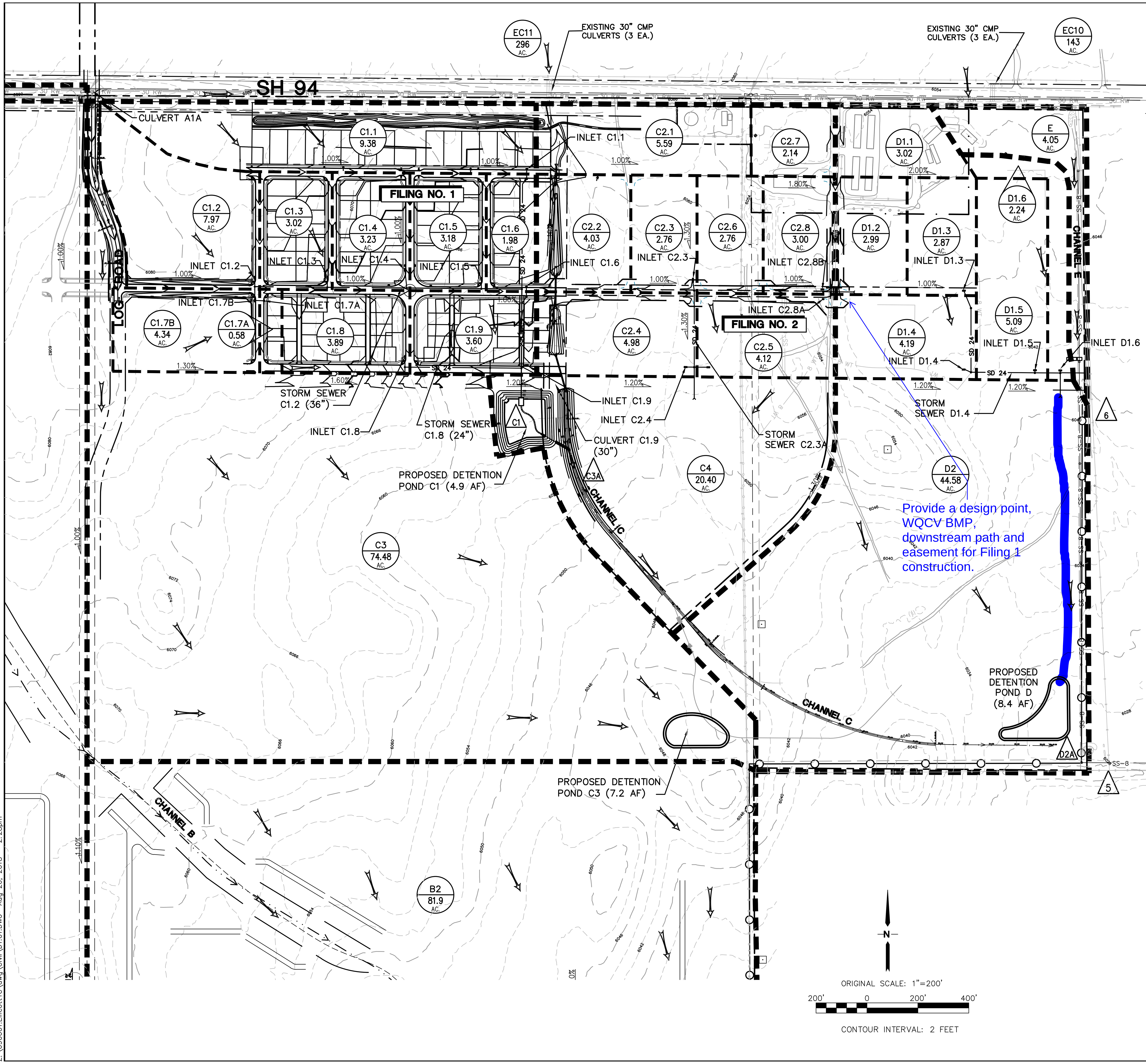
HISTORIC DRAINAGE PLAN

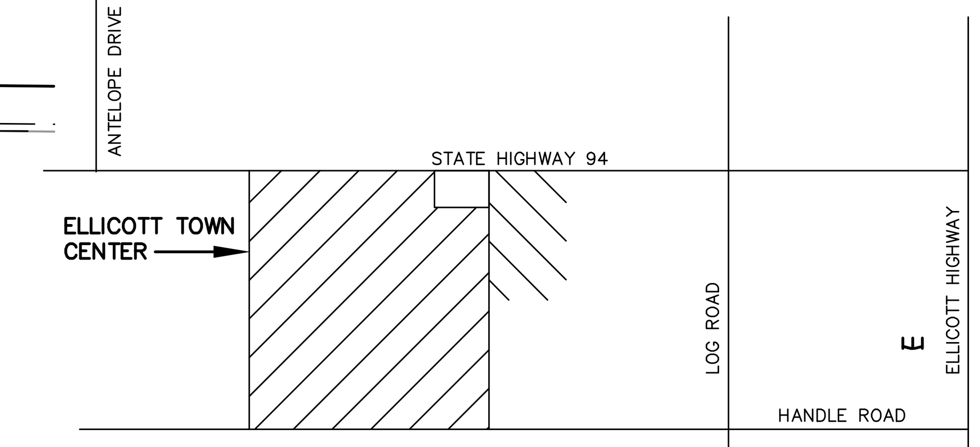
HORZ. SCALE:	1"=400'	DRAWN:	MJP
VERT. SCALE:	N/A	DESIGNED:	JPS
SURVEYED:	UP&E	CHECKED:	JPS
CREATED:	12/03/00	LAST MODIFIED:	1/15/07
PROJECT NO:		MODIFIED BY:	MJP

SHEET: EX2



Label offsite easements required for change in flow onto adjacent properties.





VICINITY MAP
NTS

LEGEND:

- FILING LIMITS
- DRAINAGE BASIN BOUNDARY
- SUB-BASIN BOUNDARY
- PROPOSED FLOW DIRECTION ARROW
- DESIGN POINT
- DEVELOPED BASIN DESIGNATION
- BASIN AREA (ACRES)
- 6490 EXISTING CONTOURS
- 6490 PROPOSED CONTOURS
- 1.5% PROPOSED STREET PROFILE GRADE

HYDROLOGY SUMMARY TABLE

DESIGN POINT	Q_5 (CFS)	Q_{100} (CFS)
C3A	37.0	168.9
D2A	14.8	42.2
5	45.6	188.5
6	5.4	36.9

JPS ENGINEERING

19 E. Willamette Ave.
Colorado Springs, CO 80903
PH: 719-477-9429
FAX: 719-471-0766
www.jpsengr.com

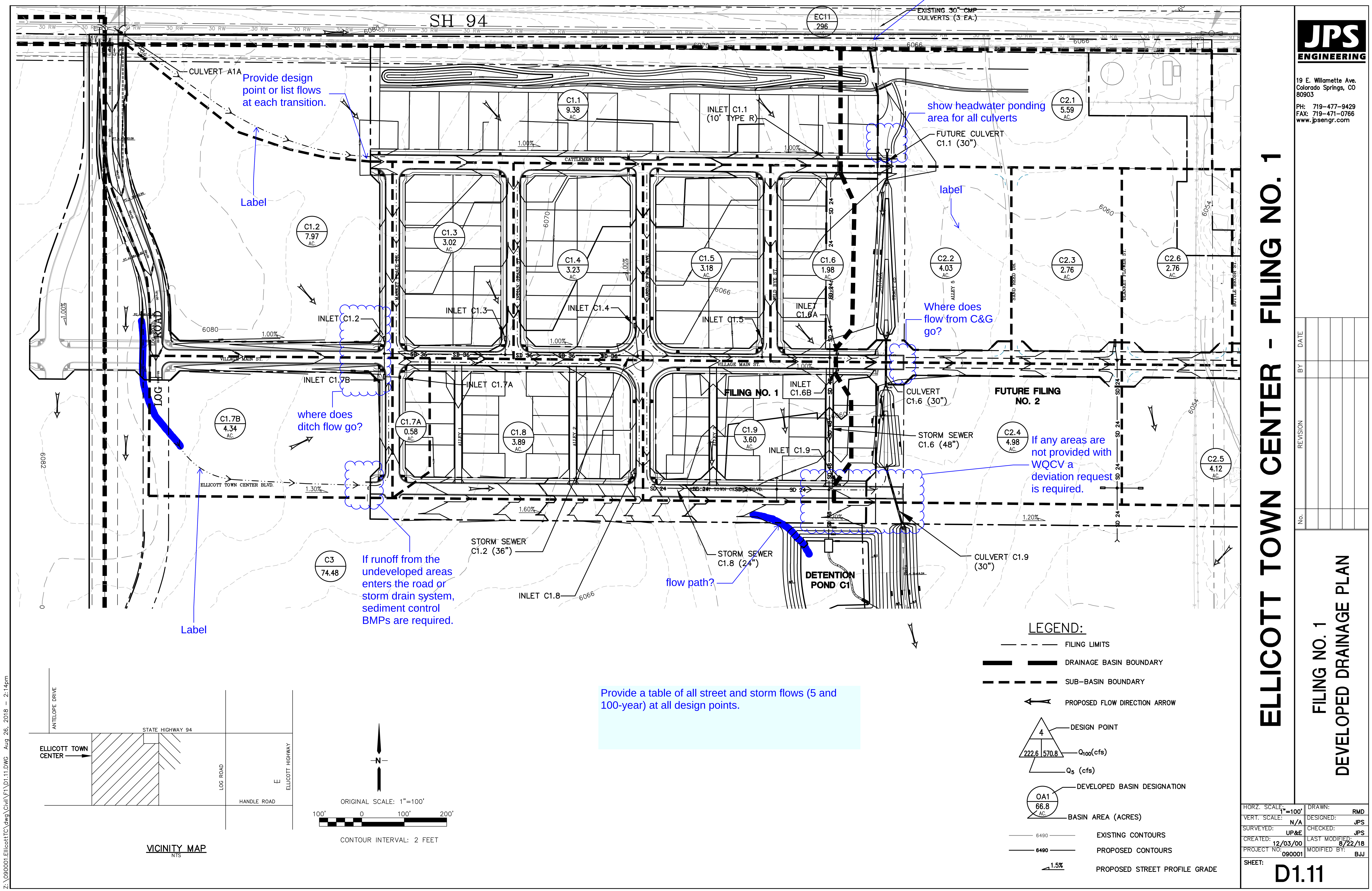
No.	REVISION	BY	DATE

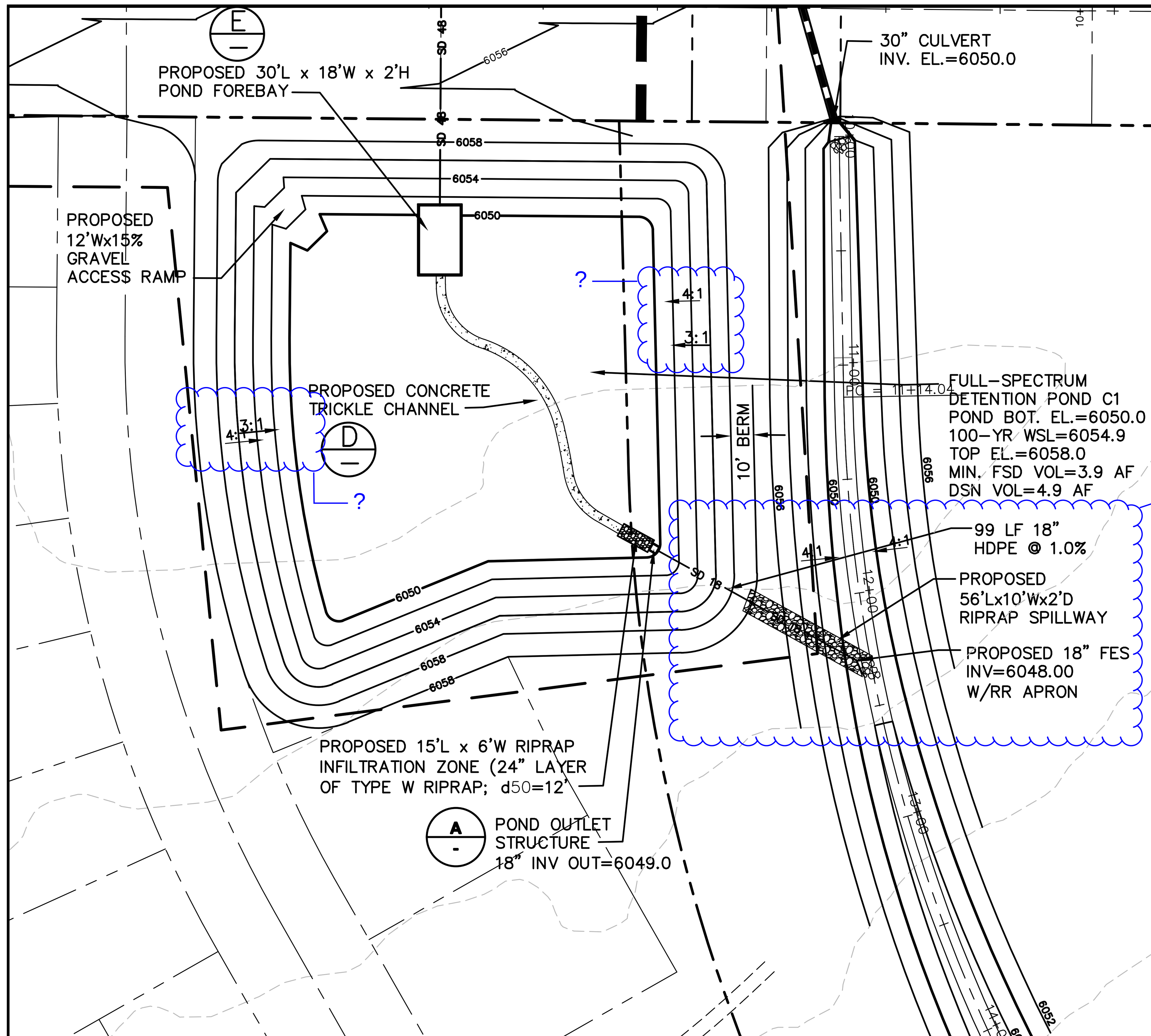
ELLICOTT TOWN CENTER

PHASE 1 DEVELOPED DRAINAGE PLAN

HORZ. SCALE:	1"=200'	DRAWN:	RMD
VERT. SCALE:	N/A	DESIGNED:	JPS
SURVEYED:	UP&E	CHECKED:	JPS
CREATED:	12/03/00	LAST MODIFIED:	8/22/18
PROJECT NO:	090001	MODIFIED BY:	BJJ

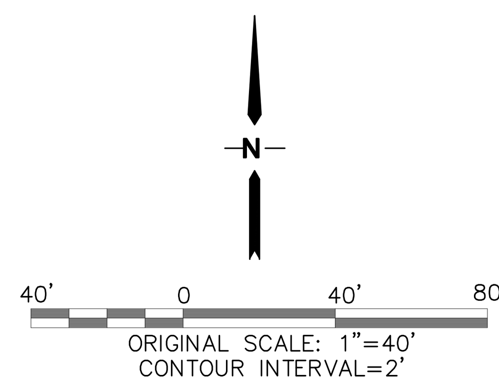
SHEET: D1.01

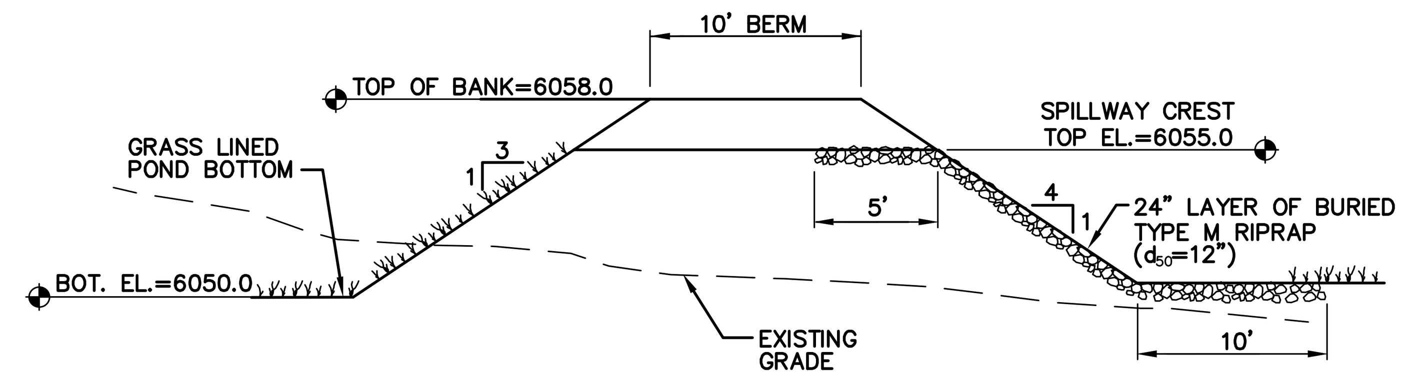

Provide design point at each culvert from here south.
SH 94
EC11
296
EXISTING 30" CMP CULVERTS (3 EA.)
CULVERT A1A
Provide design point or list flows at each transition.
C1.1
9.38 AC.
INLET C1.1 (10' TYPE R)
show headwater ponding area for all culverts
C2.1
5.59 AC.
FUTURE CULVERT C1.1 (30")
CATTLEMEN RUN
Label
label
C1.2
7.97 AC.
C1.3
3.02 AC.
C1.4
3.23 AC.
C1.5
3.18 AC.
C1.6
1.98 AC.
C2.2
4.03 AC.
C2.3
2.76 AC.
C2.6
2.76 AC.
INLET C1.2
INLET C1.3
INLET C1.4
INLET C1.5
INLET C1.6A
Where does flow from C&G go?
LOG ROAD
VILLAGE MAIN ST.
INLET C1.7B
INLET C1.7A
FILING NO. 1
INLET C1.6B
CULVERT C1.6 (30")
FUTURE FILING NO. 2
C1.7B
4.34 AC.
where does ditch flow go?
C1.7A
0.58 AC.
C1.8
3.89 AC.
C1.9
3.60 AC.
INLET C1.9
STORM SEWER C1.6 (48")
C2.4
4.98 AC.
If any areas are not provided with WQCV a deviation request is required.
C2.5
4.12 AC.
ELLICOTT TOWN CENTER BLVD.
C3
74.48
If runoff from the undeveloped areas enters the road or storm drain system, sediment control BMPs are required.
STORM SEWER C1.2 (36")
INLET C1.8
STORM SEWER C1.8 (24")
flow path?
DETENTION POND C1
CULVERT C1.9 (30")
Label
Provide a table of all street and storm flows (5 and 100-year) at all design points.
LEGEND:
FILING LIMITS
DRAINAGE BASIN BOUNDARY
SUB-BASIN BOUNDARY
PROPOSED FLOW DIRECTION ARROW
DESIGN POINT
Q_{100}(cfs)
Q_5 (cfs)
DEVELOPED BASIN DESIGNATION
BASIN AREA (ACRES)
EXISTING CONTOURS
PROPOSED CONTOURS
PROPOSED STREET PROFILE GRADE
VICINITY MAP
NTS
ANTELOPE DRIVE
STATE HIGHWAY 94
ELLICOTT TOWN CENTER
LOG ROAD
HANDLE ROAD
ELLICOTT HIGHWAY
ORIGINAL SCALE: 1"=100'
CONTOUR INTERVAL: 2 FEET
Z:\090001.EllicottTC\dwg\Civil\F1\D1.11.DWG Aug 26, 2018 - 2:14pm
JPS ENGINEERING
19 E. Willamette Ave. Colorado Springs, CO 80903
PH: 719-477-9429
FAX: 719-471-0766
www.jpsengr.com
ELLICOTT TOWN CENTER - FILING NO. 1
FILING NO. 1
DEVELOPED DRAINAGE PLAN
HORZ. SCALE: 1"=100'
VERT. SCALE: N/A
SURVEYED: UP&E
CREATED: 12/03/00
PROJECT NO: 090001
DRAWN: RMD
DESIGNED: JPS
CHECKED: JPS
LAST MODIFIED: 8/22/18
MODIFIED BY: BJJ
SHEET: D1.11



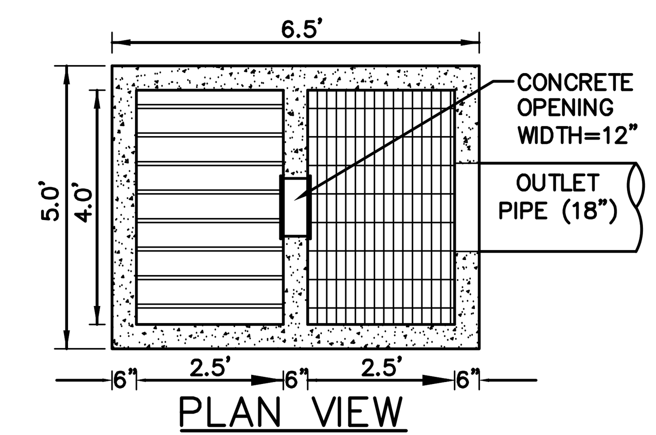
Show maintenance access roads. Access needs to be from the minor road.

Spillway should not be directly over the pipe. Riprap will be sitting on the pipe. Provide profile and detail.

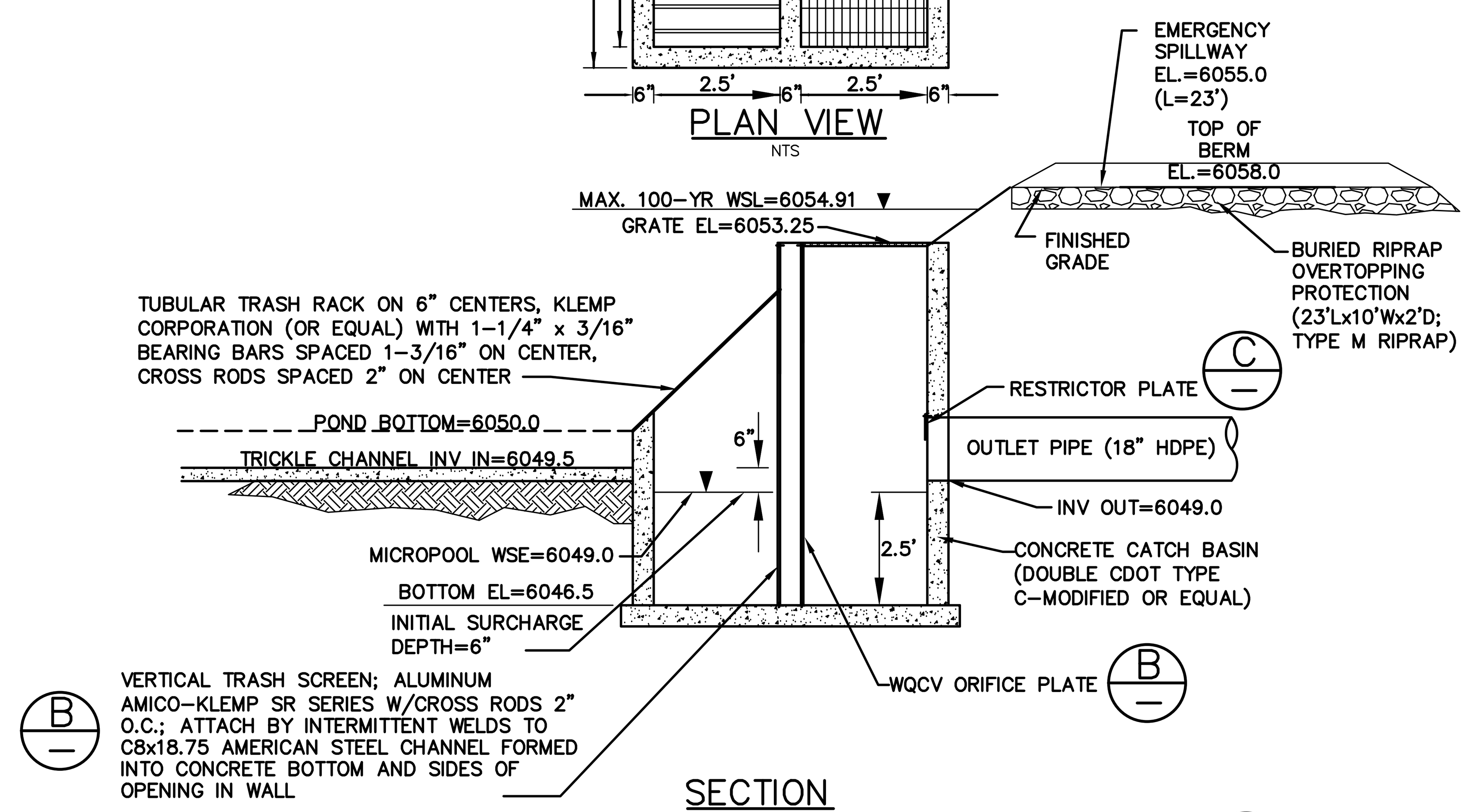




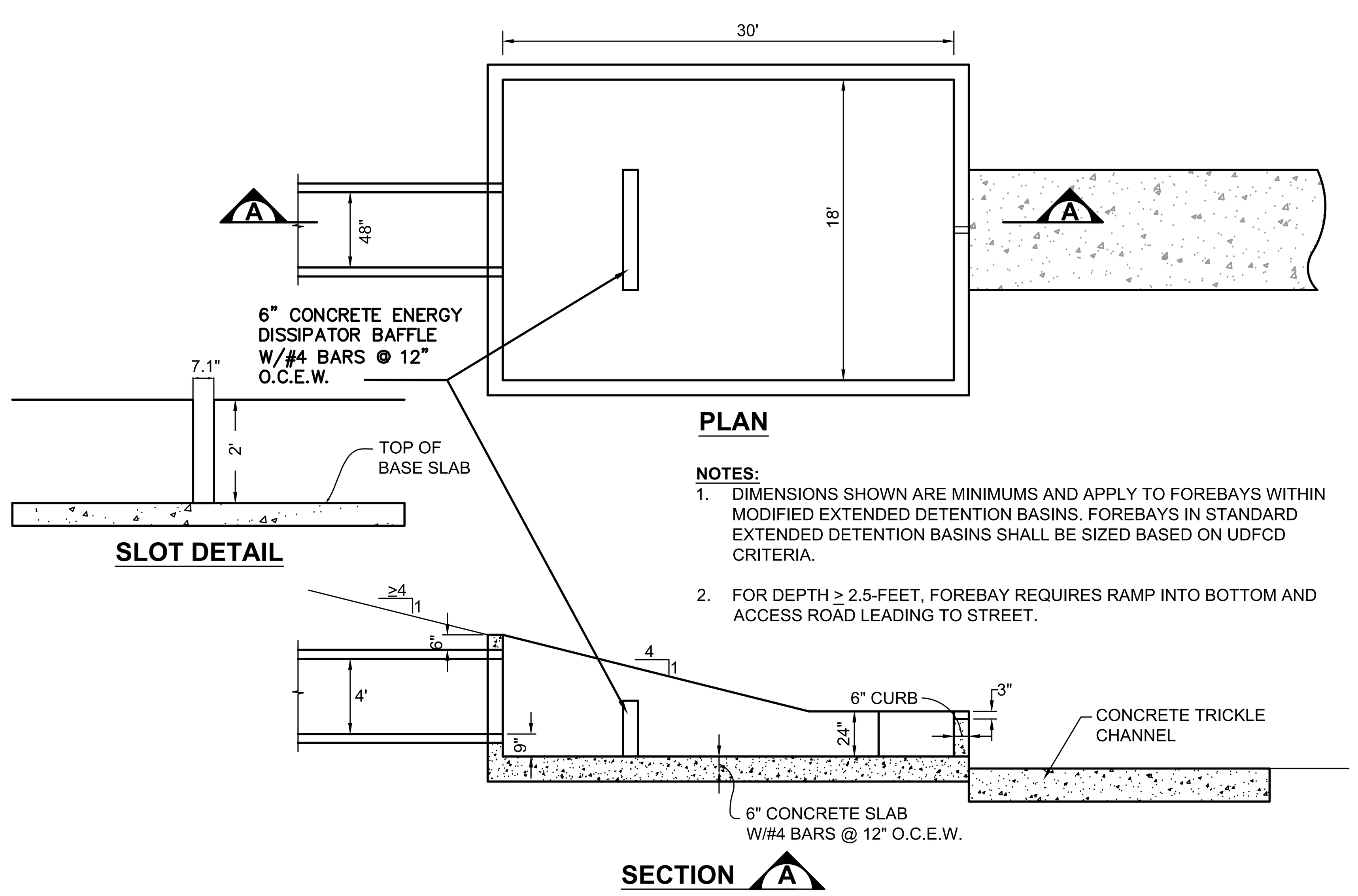
SPILLWAY SECTION (C)
NOT TO SCALE



PLAN VIEW
NTS



SECTION
TYPICAL DETENTION POND OUTLET STRUCTURE (A)
SCALE: NTS



PLAN

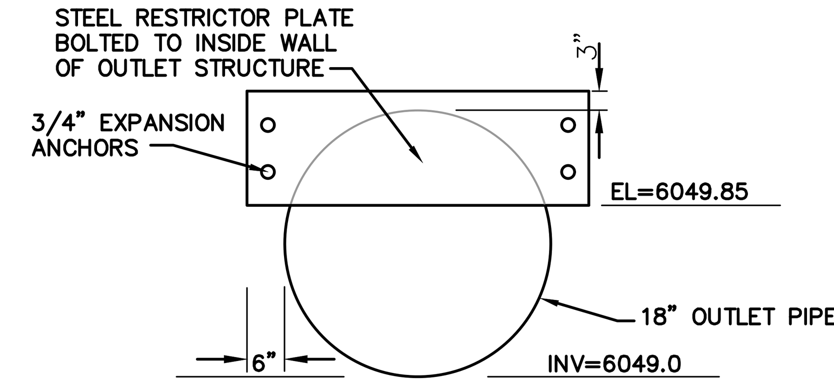
SLOT DETAIL

NOTES:

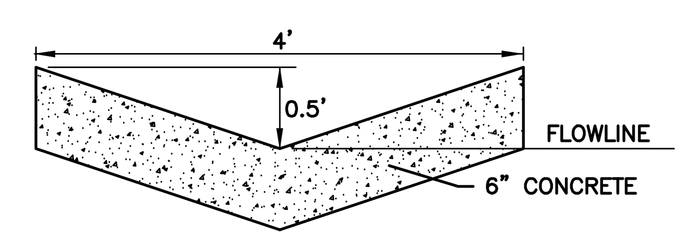
1. DIMENSIONS SHOWN ARE MINIMUMS AND APPLY TO FOREBAYS WITHIN MODIFIED EXTENDED DETENTION BASINS. FOREBAYS IN STANDARD EXTENDED DETENTION BASINS SHALL BE SIZED BASED ON UDFCD CRITERIA.
2. FOR DEPTH ≥ 2.5-FEET, FOREBAY REQUIRES RAMP INTO BOTTOM AND ACCESS ROAD LEADING TO STREET.

SECTION (A)

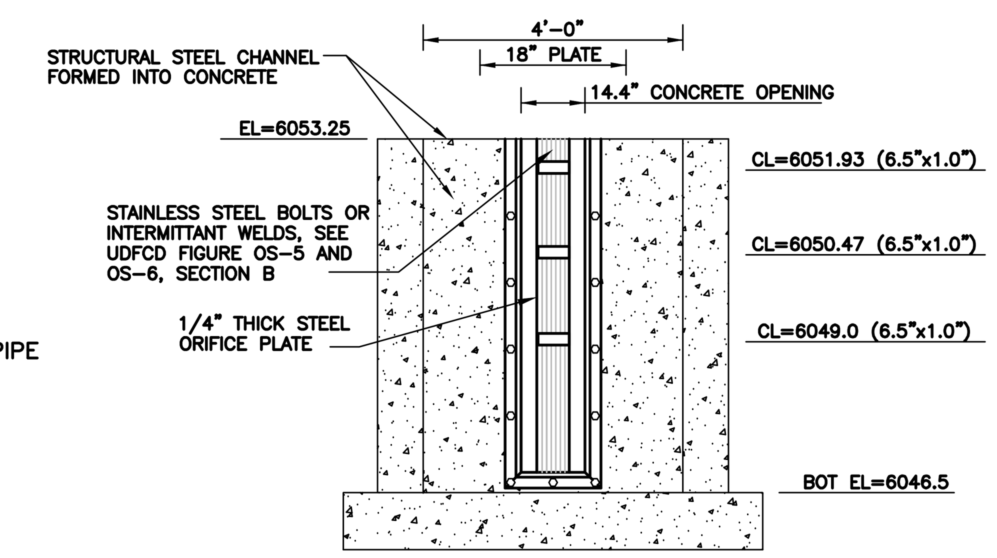
INTEGRAL FOREBAY DETAIL (E)



RESTRICTOR PLATE DETAIL (C)
SCALE: 1"=2'



TYPICAL CONCRETE
TRICKLE CHANNEL (D)
NOT TO SCALE



ELEVATION

ORIFICE PLATE NOTES:

1. MINIMIZE THE NUMBER OF COLUMNS.
2. PROVIDE GASKET MATERIAL BETWEEN THE ORIFICE PLATE AND CONCRETE.
3. BOLT PLATE TO CONCRETE 12" MAX. ON CENTER.

EURV AND WQCV TRASH RACKS:

1. WELL-SCREEN TRASH RACKS (FOR CIRCULAR ORIFICES) SHALL BE STAINLESS STEEL AND SHALL BE ATTACHED BY INTERMITTENT WELDS ALONG THE EDGE OF THE MOUNTING FRAME.
2. STRUCTURAL DESIGN OF TRASH RACKS SHALL BE BASED ON FULL HYDROSTATIC HEAD WITH ZERO HEAD DOWNSTREAM OF THE RACK.

OVERFLOW TRASH RACKS:

1. ALL TRASH RACKS SHALL BE MOUNTED USING STAINLESS STEEL HARDWARE AND PROVIDED WITH HINGED AND LOCKABLE OR BOLTABLE ACCESS PANELS.
2. TRASH RACKS SHALL BE STAINLESS STEEL, ALUMINUM, OR STEEL. STEEL TRASH RACKS SHALL BE HOT DIP GALVANIZED AND MAY BE HOT POWDER COATED AFTER GALVANIZING.
3. TRASH RACKS SHALL BE DESIGNED SUCH THAT THE DIAGONAL DIMENSION OF EACH OPENING IS SMALLER THAN THE DIAMETER OF THE OUTLET PIPE.
4. STRUCTURAL DESIGN OF TRASH RACKS SHALL BE BASED ON FULL HYDROSTATIC HEAD WITH ZERO HEAD DOWNSTREAM OF THE RACK.

ORIFICE PLATE AND TRASH RACK
DETAILS AND NOTES (B)
NTS

JPS ENGINEERING
19 E. Willamette Ave.
Colorado Springs, CO
80903
PH: 719-477-9429
FAX: 719-471-0766
www.jpsengr.com

ELLICOTT TOWN CENTER - FILING NO. 1

No.	REVISION	BY	DATE
A	2018 SUBMITTAL	JPS	8/22/18

POND C1
PLAN & DETAILS

HORZ. SCALE:	1"=50'	DRAWN:	RMD
VERT. SCALE:	N/A	DESIGNED:	JPS
SURVEYED:	UP&E	CHECKED:	JPS
CREATED:	4/4/06	LAST MODIFIED:	8/22/18
PROJECT NO:	090001	MODIFIED BY:	BJJ

SHEET: C1.05

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