FINAL DRAINAGE REPORT

for

SETTLERS VIEW SUBDIVISION

Rename to Preliminary Drainage Report.

Prepared for:

Hannigan and Associates, Inc.
19360 Spring Valley Road
Monument, Colorado 80132

February 17, 2017

Prepared by:

JPS ENGINEERING

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1. Use the latest version of UD-Detention (v3.07)

2. The Stormwater Detention and Infiltration (SDI) design data sheet and EPC MS4 post construction form (attached) will be required with the final plat application.

JPS Project No. 111603

Add: PCD File No.: SP-17-006

SETTLERS VIEW SUBDIVISION
FINAL DRAINAGE REPORT
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APPENDICES

Extract the O&M Manual from the drainage report. This item will be a required standalone submittal document with the final plat application.

JPS ENGINEERING

SETTLERS VIEW– FINAL DRAINAGE REPORT
EXECUTIVE SUMMARY

A. Background

- Settlers View is a proposed residential subdivision of a 40-acre parcel located northwest of Hodgen Road and Steppler Road in El Paso County.
- The proposed subdivision consists of 14 rural residential lots with 2.5-acre minimum lot sizes.
- Settlers View is located within the East and West Cherry Creek Drainage Basins, each of which comprise total drainage areas in excess of 30 square miles. The Settlers View property represents less than 0.2 percent of the total basin area.

B. General Drainage Concept

- Developed drainage within the site will be conveyed along paved streets with roadside ditches and culverts, as well as grass-lined channels through drainage easements, following historic drainage patterns.
- Developed flows from the subdivision will be detained to historic levels through an on-site private stormwater detention pond.
- Subdivision drainage improvements will be designed and constructed to meet El Paso County standards,

C. Drainage Impacts

- The proposed detention pond will detain to historic flows at the downstream property boundary, ensuring no significant adverse developed drainage impact on downstream properties.
- Drainage facilities within public road rights-of-way will be dedicated to the County for maintenance. The proposed stormwater detention pond will be maintained by the subdivision HOA.

DRAINAGE STATEMENT

Engineer's Statement:

Remove "City"

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 City/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: Date

Type the name, title, business name and address.

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 Settlers View Subdivision are located in a FEMA designated floodplain, as shown on FIRM panel No. 08041C0325F, dated March 17, 1997.

____

John P. Schwab, P.E. #29891

I. GENERAL LOCATION AND DESCRIPTION

A. Background

Settlers View is a proposed rural residential subdivision located in northeastern El Paso County, Colorado. The Settlers View parcel (El Paso County Assessor's Number 61000-00-463) is located between Grandview Subdivision and Settlers Ranch Subdivision, west of Steppler Road, as shown in Figure A1 (Appendix F). Settlers Ranch Subdivision will consist of 14 low-density residential lots (2.5-acre minimum size) on a 40-acre parcel. The north boundary of this site adjoins the current termination of Silver Nell Drive in Grandview Subdivision.

B. Scope

This report is intended to fulfill the El Paso County requirements for a Preliminary and Final Drainage Report (FDR) for submittal with the Preliminary Plan and Final Plat applications. The report provides a summary of site drainage issues impacting the proposed development, including analysis of impacts from upstream drainage areas, site-specific developed drainage patterns, and impacts on downstream facilities. This FDR report has been prepared based on the guidelines and criteria presented in the El Paso County Drainage Criteria Manual.

C. Site Location and Description

The Settlers View parcel is located in the Northeast Quarter of Section 23, Township 11 South, Range 66 West of the 6th Principal Meridian. The site is currently a vacant meadow tract, with some existing trees at the north end of the property.

The property is currently zoned RR-5 (Rural Residential; 5-acre minimum lots), and the proposed subdivision will include re-zoning the property to RR-2.5 (Rural Residential; 2.5-acre minimum lots). The proposed low-density lots will be served by individual wells and septic systems.

The north boundary of the property borders the existing Grandview Subdivision, and the south boundary of the property adjoins the approved Settlers Ranch Subdivision, both of which consist primarily of 2.5-acre lots. The west boundary of the borders an undeveloped 40-acre ranch property, and the east boundary of the site adjoins a currently vacant 40-acre property which is proposed for development as the Abert Ranch Subdivision, with 2.5-acre minimum lots.

Access through Settlers View Subdivision will be provided by extension of Silver Nell Drive southeasterly through the property, along with construction of the proposed Settlers View Road extending southwest from Silver Nell Drive. Subdivision infrastructure improvements will include paving of new public roadways through the site, as well as grading, drainage, and utility service improvements for the proposed residential lots. Local roads will be classified as rural minor residential roads, with 60-feet rights-of-way and paved widths of 28-feet.

Ground elevations within the parcel range from a low point of approximately 7,570 feet above mean sea level at the west boundary of the parcel, to a high point of 7,650 feet near the north boundary.

This site is located along the ridge between the East and West Cherry Creek drainage basins. Surface drainage from the east edge of the property flows easterly towards tributaries of East Cherry Creek, and surface drainage from the western part of the site flows southwesterly towards tributaries of West Cherry Creek. The terrain is rolling with slopes ranging from 2% to 8%. Existing vegetation is typical eastern Colorado prairie grass.

D. General Soil Conditions

According to the Soil Survey of El Paso County prepared by the Soil Conservation Service, on-site soils are comprised of the following soil types (see Appendix A):

- Type 25 – Elbeth sandy loam: Hydrologic Group B (northwest corner of site)
- Type 67 – Peyton sandy loam: Hydrologic Group B (east side of property)
- Type 92 – Tomah-Crowfoot: Hydrologic Group B (southwest part of property; majority of site)

E. References

City of Colorado Springs & El Paso County "Drainage Criteria Manual, Volumes 1 and 2," revised May, 2014.

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

FEMA, Flood Insurance Rate Map (FIRM) Number 08041C0325-F, March 17, 1997.

JPS Engineering, Inc., "Final Drainage Report for Grandview Subdivision," September 7, 2007 (approved by El Paso County 9/14/07).

JPS Engineering, Inc., "Master Development Drainage Plan (MDDP) and Preliminary Drainage Report for Walden Preserve Subdivision," December 10, 2004 (approved by El Paso County 12/20/04).

JPS Engineering, Inc., "Final Drainage Report for Settlers Ranch Subdivision Filing No. 1," October 18, 2005 (approved by El Paso County 10/19/05).

JPS Engineering, Inc., "Final Drainage Report for Settlers Ranch Subdivision Filing No. 2," May 30, 2008 (approved by El Paso County 3/31/09).

JPS Engineering, Inc., "Final Drainage Report for Walden Pines Subdivision," March 24, 2004.

JPS Engineering, Inc., "Final Drainage Report for Walden Preserve Subdivision Filing No. 1," May 11, 2005.

II. DRAINAGE BASINS AND SUB-BASINS

A. Major Basin Description

The proposed development lies within both the West Cherry Creek Drainage Basin (CYCY 0400) and East Cherry Creek Drainage Basin (CYCY 0200), as classified by El Paso County. Drainage from the west part of the site flows southwesterly to an eastern tributary of West Cherry Creek, which flows to a confluence with the main channel north of Walker Road. Downstream agricultural areas generally drain northerly towards the main channel of West Cherry Creek.

Drainage from the east part of the site flows easterly to a tributary of East Cherry Creek.

No drainage planning study has been completed for this drainage basin or any adjacent drainage basins. In the absence of plans for regional drainage facilities, El Paso County generally requires new developments to provide stormwater detention to maintain historic runoff flows leaving developed areas.

The major drainage basins lying in and around the proposed development are depicted in Figure EX1. The Settlers View parcel is located near the southerly limits of the West Cherry Creek and East Cherry Creek Drainage Basins, each of which comprise total drainage areas in excess of 30 square miles. As such, the proposed 40-acre Settlers View subdivision represents less than 0.2 percent of the total basin area, which is primarily ranch land.

B. Floodplain Impacts

The proposed development area is located beyond the limits of any 100-year floodplain 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) Panel Number 08041C0325-F, dated March 17, 1997, as shown in Figure FIRM (Appendix F).

C. Sub-Basin Description

The existing drainage basins lying in and around the proposed development are depicted in Figure EX1 (Appendix F). The existing on-site topography has been delineated as several sub-basins draining to design points at the east and west boundaries of the site.

The developed drainage basins lying within the proposed development are depicted on Figure D1. The developed site layout has been divided into sub-basins based on the proposed road layout within the site. The natural drainage patterns will be impacted through development by site grading and concentration of runoff in subdivision roadside ditches and channels.

On-site flows will be diverted to the existing natural drainage swales and channels running through the property, following historic drainage paths.

III. DRAINAGE DESIGN CRITERIA

A. Development Criteria Reference

No Drainage Basin Planning Study (DBPS) has been completed for either the West Cherry Creek Drainage Basin or the East Cherry Creek Drainage Basin. Previous drainage reports for completed subdivision filings have proposed to provide on-site detention for mitigation of developed flows.

B. Hydrologic Criteria

In accordance with the El Paso County Drainage Criteria Manual, Rational Method procedures were utilized for hydrologic calculations since the tributary drainage basins are below 100 acres.

Rational Method hydrologic calculations were based on the following assumptions:

• Design storm (minor)	5-year	
• Design storm (major)	100-year	
• Time of Concentration – Overland Flow	"Airport" equation (300' max. developed)	
• Time of Concentration – Gutter/Ditch Flow	"SCS Upland" equation	
• Rainfall Intensities	El Paso County I-D-F Curve	
• Hydrologic soil type	B	
	C5	C100
• Runoff Coefficients - undeveloped:		
Existing pasture/range areas	0.08	0.35
• Runoff Coefficients - developed:		
Proposed lot areas (2.5-acre lots)	0.170	0.417

Hydrologic calculations are enclosed in Appendix A, and peak design flows are identified on the drainage basin drawings.

Update the 4 step process based on the steps identified in Appendix I Section I.7.2 which are different from the city.

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 proposed rural residential subdivision development with 2.5-acre minimum lot sizes provides for inherently minimal drainage impacts based on the limited impervious areas associated with rural residential development.
- Minimize Directly Connected Impervious Areas (MDCIA): The rural residential development will have roadside ditches along all roads, providing for impervious areas to drain across pervious areas. Based on the roadside ditches throughout the subdivision, the subdivision is classified as MDCIA Level One.
- Grass Swales: The proposed roadside ditches will drain to existing and proposed grass-lined drainage swales following historic drainage patterns through the property.

Step 2: Implement BMPs that Provide a Water Quality Capture Volume with Slow Release

- FSD: A Full-Spectrum Detention Pond will be provided at the west boundary of the site. On-site drainage will be routed through the extended detention basin, which will capture and slowly release the WQCV over a 72-hour design release period.

Step 3: Stabilize Drainageways

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

Step 4: Implement Site Specific and Other Source Control BMPs

- No industrial or commercial land uses are proposed within this rural residential subdivision.
- On-site drainage will be routed through the private Full-Spectrum Detention (FSD) basin to minimize introduction of contaminants to the County's public drainage system.

V. DRAINAGE FACILITY DESIGN

A. General Concept

Development of the Settlers View Subdivision 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 roadside ditches along the internal roads within the subdivision, conveying runoff flows through the site. Runoff from the site will flow by roadside ditches to cross culverts at low points in the road profiles, and grass-lined channels connecting to existing natural swales at the site boundaries.

The stormwater management concept for the Settlers View development will be to provide roadside ditches and natural swales as required to convey developed drainage through the site to existing natural outfalls. Individual lot grading will provide positive drainage away from building sites, and direct developed flows into the system of roadside ditches and drainage swales running through the subdivision.

A stormwater detention pond will be constructed at the west boundary of the subdivision to mitigate the impact of developed flows and maintain historic peak flows downstream of the property.

Figure EX1 labels the basin as "S". Revise accordingly.

B. Specific Details

1. Existing Drainage Conditions

Historic drainage conditions within the site are depicted in Figure EX1. Basin A comprises the eastern side of the property, which drains easterly along several existing natural swales. Basin A flows easterly to Design Pont #A, with historic peak flows calculated as Q_5 = 3.0 cfs and Q_{100} = 21.6 cfs.

Basin A discharges to an existing grass-lined drainage swale flowing easterly across the adjoining 40-acre property to an existing stock pond**,** ultimately crossing Steppler Road in an existing 48-inch RCP Culvert.

The west side of the property has been delineated as Basin S1, which flows southwesterly to an existing grass-lined drainage swale at the west boundary of the site. Off-site Basin OS1 comprises a relatively small area within the adjoining Grandview Subdivision, which flows southwesterly into the northwest corner of Basin S1. Additionally, off-site drainage from Basin D9 of the adjoining Settlers Ranch Subdivision flows northwesterly through Basin S1. Flows from Basins OS1, D9, and S1 combine at Design Pont #S1, with historic peak flows calculated as Q_5 = 10.0 cfs and Q_{100} = 73.1 cfs.

Basin S1 discharges to an existing grass-lined drainage swale flowing westerly across the adjoining 40-acre property to the existing downstream drainage channel and series of ponds within the Walden Preserve Subdivision.

2. Developed Drainage Conditions

The developed drainage basins and projected flows are shown in Figure D1, and hydrologic calculations are enclosed in Appendix B.

The east side of the property has been delineated as Basins A, B, and C in the developed condition, and these basins will continue to sheet flow easterly through the proposed Abert Ranch Subdivision.

Basin A flows easterly to Design Point #A, with developed peak flows calculated as Q_5 = 5.5 cfs and Q_{100} = 22.4 cfs. Basin B flows easterly to Design Point #B, with developed peak flows calculated as Q_5 = 1.7 cfs and Q_{100} = 6.8 cfs. Basin C flows easterly to Design Point #C, with developed peak flows calculated as Q_5 = 0.8 cfs and Q_{100} = 3.1 cfs. Combined developed flows from Basins A, B, and C are calculated as Q_5 = 7.6 cfs and Q_{100} = 31.2 cfs (Design Point #A1).

Show on Map.

Development plans for the proposed Abert Ranch Subdivision on the adjoining ranch property to the east include upgrade of an existing stock pond to meet stormwater detention requirements for the Abert Ranch site, including the minimal developed drainage contribution from Settlers View Basins A, B, and C.

The west side of the property has been delineated as Basins S1-S4 based on the developed road configuration, and these basins will continue to flow westerly to the existing drainage swale at the western property boundary.

Inconsistent with the next paragraph. Map indicates OS1 & S4 flows do not combine with Basin D9 and S1-S3 upstream of Pond S3.

Developed Basin S1 will flow southwesterly to the proposed Culvert S1 crossing Silver Nell Drive at Design Point #S1. Culvert S1 fill flow northwesterly through the existing grass-lined drainage swale in Basin S3 to a proposed Full-Spectrum Detention Pond (Pond S3) at the west boundary of the subdivision.

Off-site drainage from Basin D9 of the adjoining Settlers Ranch Subdivision will flow northwesterly through Basin S2 to the proposed Culvert S2 crossing Settlers View Road at Design Point #S2, continuing through a grass-lined channel to Detention Pond S3.

Flows from Basins D9 and S1-S3 combine at Design Point #S3, with developed peak flows of Q_5 = 19.0 cfs and Q_{100} = 78.1 cfs.

Off-site Basin OS1 will continue to flow northwesterly through Basin S4 to the west boundary of the site.

Flows from Basins D9, OS1, and S1-S4 combine at Design Point #S, with developed peak flows of Q_5 = 22.0 cfs and Q_{100} = 90.6 cfs. Developed flow impacts will be mitigated by routing flows through Detention Pond #S3.

Not shown on Figure D1. Is this DP #S3

C. Comparison of Developed to Historic Discharges

Based on the hydrologic calculations in Appendix B, the proposed development will result in developed flows exceeding historic flows from the parcel. The increase in developed flows will be mitigated through on-site stormwater detention facilities.

The comparison of developed to historic discharges at key design points is summarized as follows:

Design Point	Historic Flow Area (ac)	Historic Flow Q_5 (cfs)	Historic Flow Q_{100} (cfs)	Developed Flow Area (ac)	Developed Flow Q_5 (cfs)	Developed Flow Q_{100} (cfs)	Comparison of Developed to Historic Flow (Q_5%/Q_{100}%)
A	15.0	3.0	21.6	15.0	7.6	31.2	253% / 144% (increase)
S	46.8	10.0	73.1	46.8	22.0	90.6	220% / 124% (increase)

D. Detention Ponds

The Developed storm runoff downstream of the proposed subdivision will be maintained at historic levels by routing flows through a proposed detention pond at the west boundary of the property. Pond #S3 will be constructed as a Full-Spectrum Detention (FSD) Pond to mitigate developed flow impacts from the proposed subdivision. The pond outlet structure has been designed with multiple orifice openings to detain the full spectrum of storm events.

Detailed pond routing calculations have been performed utilizing the Denver Urban Drainage "UD-Detention" software package (see Appendix C). The pond outlet structure configuration has been designed to maintain the calculated pond discharge below the target outflow, while maintaining the maximum water surface elevation below the pond spillway. Final detention pond design parameters are summarized as follows:

Pond	Inflow (Q_{100}, cfs)	Outflow (Q_{100}, cfs)	Volume (ac-ft)	Outlet Structure
Pond #S3	78.1	24.2	0.44	24-inch SD w/ multiple orifices

15-foot wide gravel maintenance access roads will be provided for all stormwater detention facilities. The proposed detention ponds will be privately owned and maintained by the subdivision homeowners association (HOA). An Operation & Maintenance (O&M) Manual for the detention pond is enclosed in Appendix D.

E. On-Site Drainage Facility Design

Developed sub-basins and proposed drainage improvements are depicted in the enclosed Drainage Plan (Sheet D1). In accordance with El Paso County standards, new roadways will be graded with a minimum longitudinal slope of 1.0 percent. The typical local road section will consist of a 28-foot paved width with 2-foot gravel shoulders and 4:1 slopes to 2.5-foot ditches.

On-site drainage facilities will consist of roadside ditches, grass-lined channels, and culverts. Hydraulic calculations for preliminary sizing of major on-site drainage facilities are enclosed in Appendix D, and design criteria are summarized as follows:

1. Culverts

The internal road system has been graded to drain roadside ditches to low points along the road profile, where cross-culverts will convey developed flows into grass-lined channels following historic drainage paths. Culvert pipes have been specified as reinforced concrete pipe (RCP) with a minimum diameter of 18-inches. Culvert sizes have been identified based on a maximum headwater-to-depth ratio (HW/D) of 1.0 for the minor (5-year) design storm. Final culvert design calculations were performed utilizing the FHWA HY-8 software package to perform a detailed analysis of inlet and outlet control conditions, meeting El Paso County criteria for allowable overtopping. HY8 calculation results are summarized in the "Culvert Sizing Summary" Table in Appendix B. Riprap outlet protection will be provided at all culverts.

2. Open Channels

Drainage easements will be dedicated along major drainage channels following historic drainage paths through the subdivision. These channels will generally be grass-lined channels designed to convey 100-year flows, with a trapezoidal cross-section, variable bottom width and depth, 4:1 maximum side slopes, 1-foot freeboard, and a minimum slope of 0.5 percent.

The proposed drainage channels have been sized utilizing Manning's equation for open channel flow, assuming a friction factor ("n") of 0.030 for dry-land grass channels. Maximum allowable velocities will be evaluated based on El Paso County drainage criteria, typically allowing for a maximum 100-year velocity of 5 feet per second. Erosion control mats have been specified for channel segments with maximum 100-year velocities up to 8 feet per second. The proposed channels will generally be seeded with native grasses for erosion control. Erosion control mats, ditch checks, and/or riprap channel lining will be provided where required based on erosive velocities. Ditch flows will be diverted to drainage channels at the nearest practical location to minimize excessive roadside ditch sizes. Detailed channel hydraulic calculations are enclosed in Appendix B.

Primary drainage swales crossing proposed lots have been placed in drainage easements, with variable widths based on the required channel sections.

F. Anticipated Drainage Problems and Solutions

The proposed stormwater Detention Pond #S3 has been designed to mitigate the impacts of developed drainage from this project. The overall drainage plan for the subdivision includes a system of roadside ditches, channels, and culverts to convey developed flows through the site. The primary drainage problems anticipated within this development will consist of maintenance of these drainage channels, culverts, and detention pond facilities. Care will need to be taken to implement proper erosion control measures in the proposed roadside ditches, channels, and swales.

Ditches will be designed to meet allowable velocity criteria. Erosion control mats, ditch checks, and riprap channel lining will be installed where necessary to minimize erosion concerns. Proper construction and maintenance of the proposed detention facilities will minimize downstream drainage impacts. Public roadway improvements and ditches within the public right-of-way will be owned and maintained by El Paso County. The proposed stormwater detention pond and drainage channels located within open space tracts will be owned and maintained by the subdivision HOA.

VI. EROSION / SEDIMENT CONTROL

The Contractor will be required to implement Best Management Practices (BMP's) for erosion control through the course of construction. Sediment control measures will include installation of silt fence at the toe of disturbed slopes and hay bales protecting drainage ditches. Cut slopes will be stabilized during excavation as necessary and vegetation will be established for stabilization of disturbed areas as soon as possible. All ditches will be designed to meet El Paso County criteria for slope and velocity. The proposed detention pond will serve as a sediment basin during the construction phase of the project.

VII. COST ESTIMATE AND DRAINAGE FEES

A cost estimate for proposed drainage improvements is enclosed in Appendix E, with a total estimated cost of approximately $42,500 for subdivision drainage improvements. The developer will finance all construction costs for proposed roadway and drainage improvements, and public facilities will be owned and maintained by El Paso County upon final acceptance. Private drainage facilities will be owned and maintained by the subdivision HOA. This parcel is located in the West Cherry Creek and East Cherry Creek Drainage Basins. No drainage and bridge fees will be due at time of recordation of the final plat as the subject site is not located in a fee basin.

VIII. SUMMARY

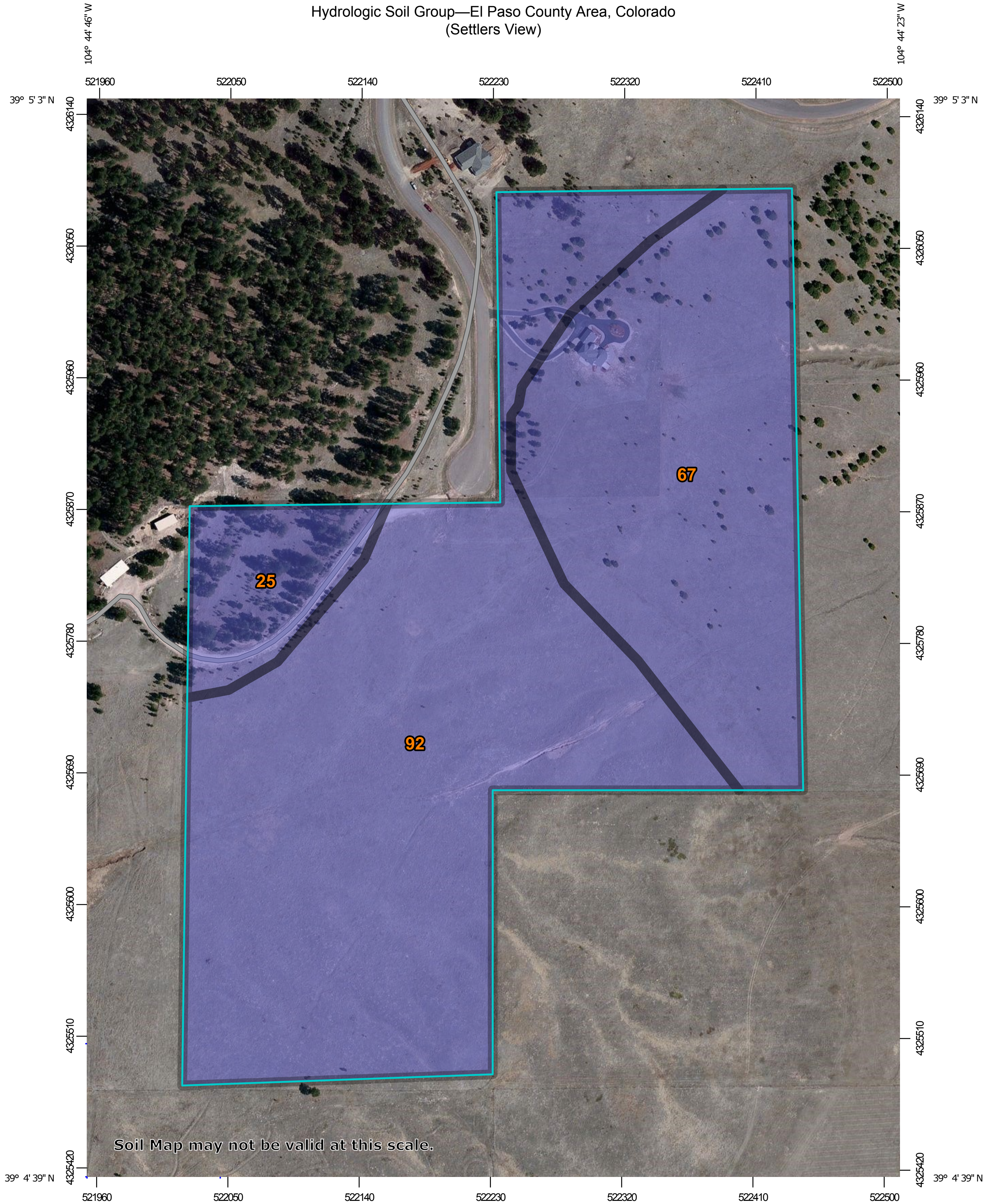
Settlers View is a proposed residential subdivision consisting of 14 lots on a 40-acre parcel located between Grandview Subdivision and Settlers Ranch Subdivision on the west side of Steppler Road in northeastern El Paso County. Development of the proposed Settlers View Subdivision will generate an increase in developed runoff from the site, which will be mitigated through construction of 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 suitable outfalls. Based on the on-site stormwater detention concept, no new downstream drainage facilities are proposed.

The proposed detention pond will ensure that overall developed flows from the Settlers View Subdivision remain consistent with historic levels. Construction and proper maintenance of the proposed drainage and erosion control facilities will ensure that this subdivision has no significant adverse drainage impact on downstream or surrounding areas.

APPENDIX A

HYDROLOGIC CALCULATIONS

Hydrologic Soil Group—El Paso County Area, Colorado
(Settlers View)



Map Scale: 1:3,590 if printed on A portrait (8.5" x 11") sheet.

Meters: 0, 50, 100, 200, 300

Feet: 0, 150, 300, 600, 900

N

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 13N WGS84

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils

Soil Rating Polygons
- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Lines
- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Points
- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: El Paso County Area, Colorado
Survey Area Data: Version 14, Sep 23, 2016

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Apr 15, 2011—Sep 22, 2011

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

Hydrologic Soil Group

Hydrologic Soil Group— Summary by Map Unit — El Paso County Area, Colorado (CO625)				
Map unit symbol	**Map unit name**	**Rating**	**Acres in AOI**	**Percent of AOI**
25	Elbeth sandy loam, 3 to 8 percent slopes	B	3.0	7.2%
67	Peyton sandy loam, 5 to 9 percent slopes	B	14.0	33.6%
92	Tomah-Crowfoot loamy sands, 3 to 8 percent slopes	B	24.6	59.2%
Totals for Area of Interest			**41.6**	**100.0%**

Description

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

United States Department of Agriculture

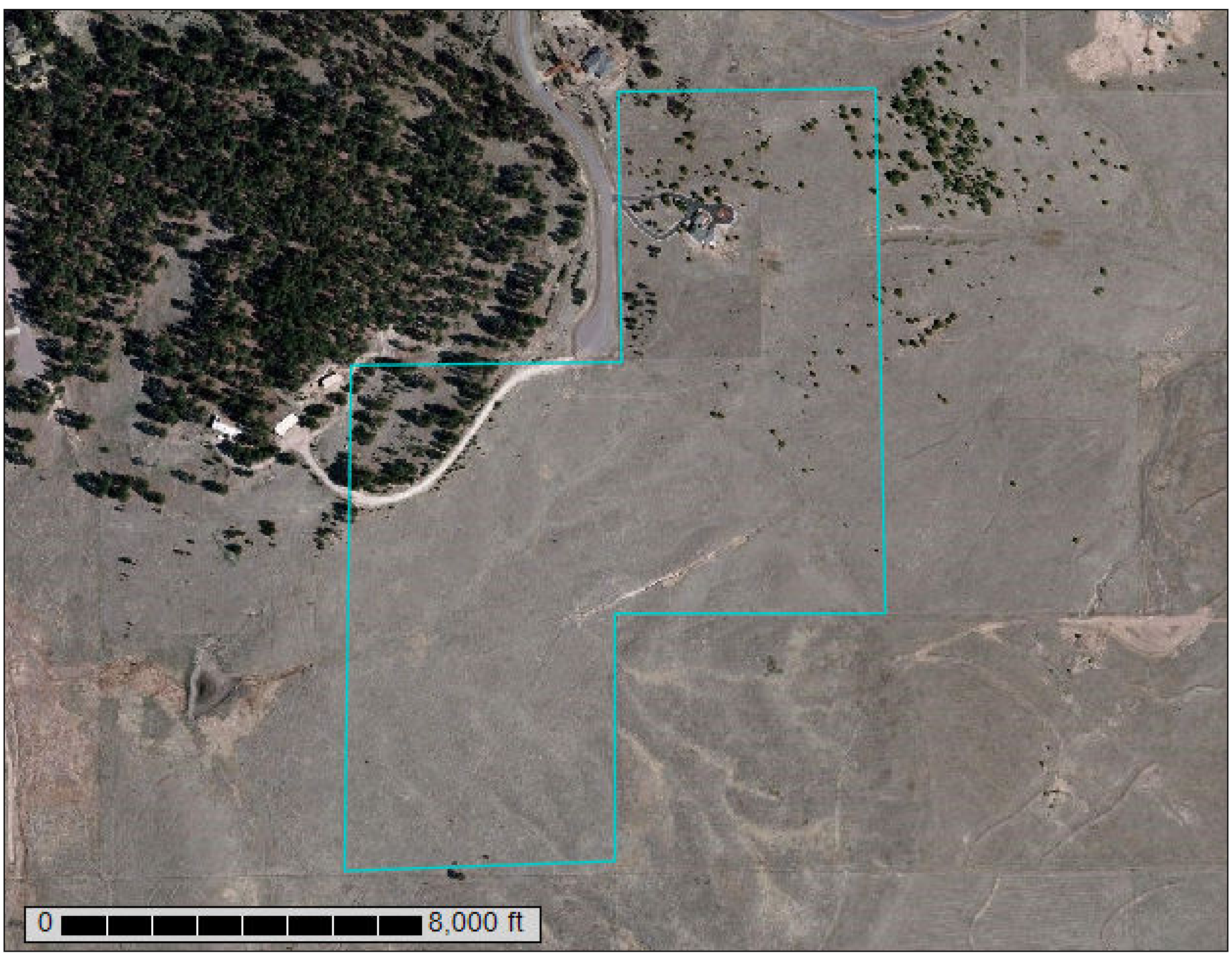
NRCS

Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for

El Paso County Area, Colorado



December 23, 2016

Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (https://offices.sc.egov.usda.gov/locator/app?agency=nrcs) or your NRCS State Soil Scientist (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Web Soil Survey, the site for official soil survey information.

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Contents

How Soil Surveys Are Made

Soil surveys are made to provide information about the soils and miscellaneous areas in a specific area. They include a description of the soils and miscellaneous areas and their location on the landscape and tables that show soil properties and limitations affecting various uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They observed and described many soil profiles. A soil profile is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed or from the surface down to bedrock. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

Currently, soils are mapped according to the boundaries of major land resource areas (MLRAs). MLRAs are geographically associated land resource units that share common characteristics related to physiography, geology, climate, water resources, soils, biological resources, and land uses (USDA, 2006). Soil survey areas typically consist of parts of one or more MLRA.

The soils and miscellaneous areas in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

The objective of soil mapping is not to delineate pure map unit components; the objective is to separate the landscape into landforms or landform segments that have similar use and management requirements. Each map unit is defined by a unique combination of soil components and/or miscellaneous areas in predictable proportions. Some components may be highly contrasting to the other components of the map unit. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The delineation of such landforms and landform segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

Soil scientists make many field observations in the process of producing a soil map. The frequency of observation is dependent upon several factors, including scale of mapping, intensity of mapping, design of map units, complexity of the landscape, and experience of the soil scientist. Observations are made to test and refine the soil-landscape model and predictions and to verify the classification of the soils at specific locations. Once the soil-landscape model is refined, a significantly smaller number of measurements of individual soil properties are made and recorded. These measurements may include field measurements, such as those for color, depth to bedrock, and texture, and laboratory measurements, such as those for content of sand, silt, clay, salt, and other components. Properties of each soil typically vary from one point to another across the landscape.

Observations for map unit components are aggregated to develop ranges of characteristics for the components. The aggregated values are presented. Direct measurements do not exist for every property presented for every map unit component. Values for some properties are estimated from combinations of other properties.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

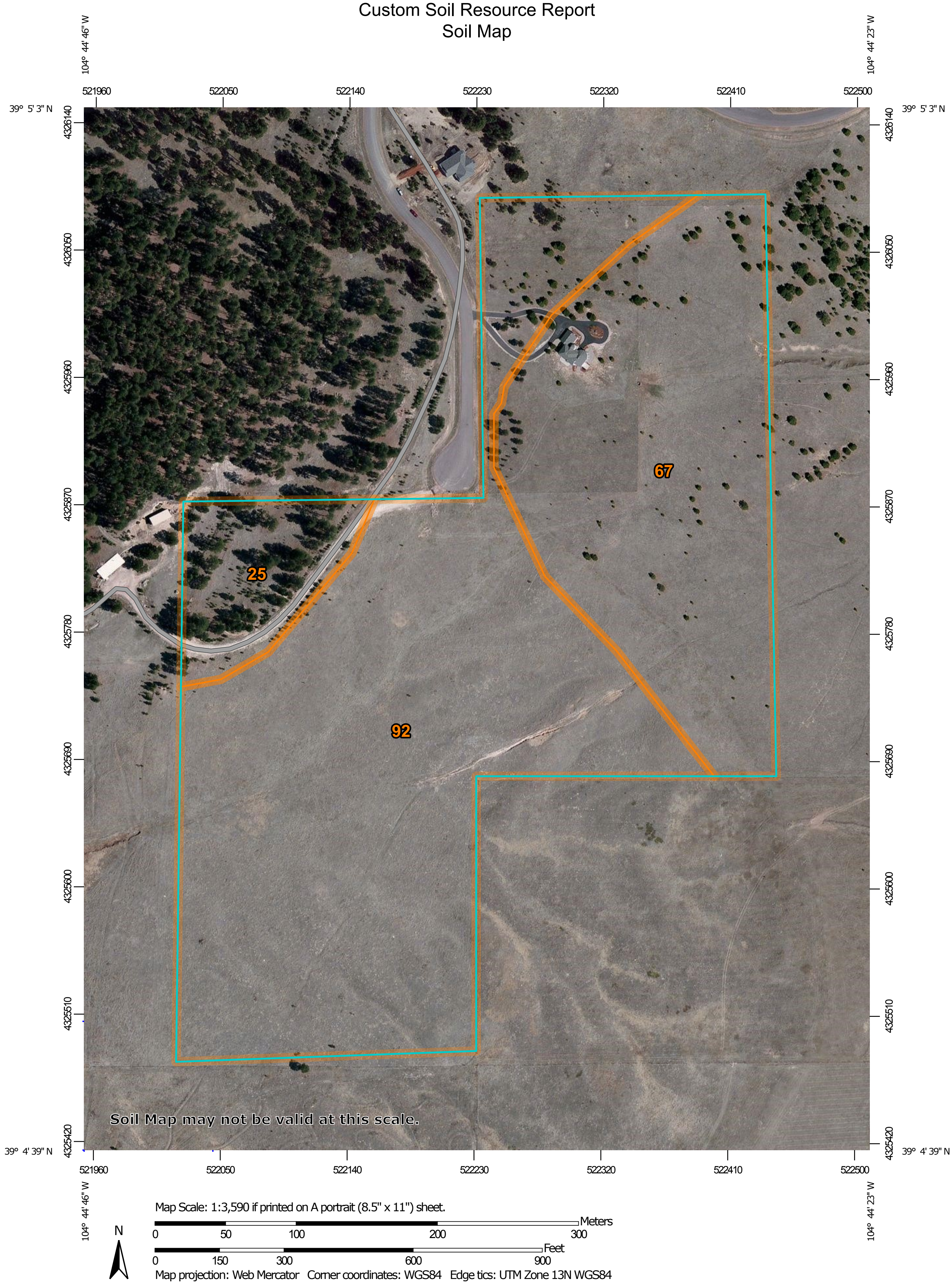
Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

Custom Soil Resource Report
Soil Map



MAP LEGEND

Area of Interest (AOI)

- Area of Interest (AOI)

Soils

- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features

- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features

- Streams and Canals

Transportation

- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background

- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: El Paso County Area, Colorado
Survey Area Data: Version 14, Sep 23, 2016

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Apr 15, 2011—Sep 22, 2011

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

Map Unit Legend

El Paso County Area, Colorado (CO625)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
25	Elbeth sandy loam, 3 to 8 percent slopes	3.0	7.2%
67	Peyton sandy loam, 5 to 9 percent slopes	14.0	33.6%
92	Tomah-Crowfoot loamy sands, 3 to 8 percent slopes	24.6	59.2%
Totals for Area of Interest		**41.6**	**100.0%**

Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

El Paso County Area, Colorado

25—Elbeth sandy loam, 3 to 8 percent slopes

Map Unit Setting

National map unit symbol: 367x
Elevation: 7,300 to 7,600 feet
Farmland classification: Not prime farmland

Map Unit Composition

Elbeth and similar soils: 85 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Elbeth

Setting

Landform: Hills
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium derived from arkose

Typical profile

A - 0 to 3 inches: sandy loam
E - 3 to 23 inches: loamy sand
Bt - 23 to 68 inches: sandy clay loam
C - 68 to 74 inches: sandy clay loam

Properties and qualities

Slope: 3 to 8 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.60 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 7.1 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: B
Hydric soil rating: No

Minor Components

Other soils

Percent of map unit:
Hydric soil rating: No

67—Peyton sandy loam, 5 to 9 percent slopes

Map Unit Setting

National map unit symbol: 369d
Elevation: 6,800 to 7,600 feet
Mean annual air temperature: 43 to 45 degrees F
Frost-free period: 115 to 125 days
Farmland classification: Not prime farmland

Map Unit Composition

Peyton and similar soils: 85 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Peyton

Setting

Landform: Hills
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Arkosic alluvium derived from sedimentary rock and/or arkosic residuum weathered from sedimentary rock

Typical profile

A - 0 to 12 inches: sandy loam
Bt - 12 to 25 inches: sandy clay loam
BC - 25 to 35 inches: sandy loam
C - 35 to 60 inches: sandy loam

Properties and qualities

Slope: 5 to 9 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.60 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 7.3 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: B
Ecological site: Sandy Divide (R049BY216CO)
Hydric soil rating: No

Minor Components

Other soils

Percent of map unit:
Hydric soil rating: No

Pleasant

Percent of map unit:
Landform: Depressions
Hydric soil rating: Yes

92—Tomah-Crowfoot loamy sands, 3 to 8 percent slopes

Map Unit Setting

National map unit symbol: 36b9
Elevation: 7,300 to 7,600 feet
Farmland classification: Not prime farmland

Map Unit Composition

Tomah and similar soils: 50 percent
Crowfoot and similar soils: 30 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Tomah

Setting

Landform: Alluvial fans, hills
Landform position (three-dimensional): Side slope, crest
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium derived from arkose and/or residuum weathered from arkose

Typical profile

A - 0 to 10 inches: loamy sand
E - 10 to 22 inches: coarse sand
C - 48 to 60 inches: coarse sand

Properties and qualities

Slope: 3 to 8 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Very low (about 2.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: B
Ecological site: Sandy Divide (R049BY216CO)
Hydric soil rating: No

Description of Crowfoot

Setting

Landform: Alluvial fans, hills
Landform position (three-dimensional): Side slope, crest
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium

Typical profile

A - 0 to 12 inches: loamy sand
E - 12 to 23 inches: sand
Bt - 23 to 36 inches: sandy clay loam
C - 36 to 60 inches: coarse sand

Properties and qualities

Slope: 3 to 8 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Low (about 4.7 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: B
Ecological site: Sandy Divide (R049BY216CO)
Hydric soil rating: No

Minor Components

Other soils

Percent of map unit:
Hydric soil rating: No

Pleasant

Percent of map unit:
Landform: Depressions
Hydric soil rating: Yes

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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.

$$t_c = t_i + t_t \qquad \text{(Eq. 6-7)}$$

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.

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

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).

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

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.

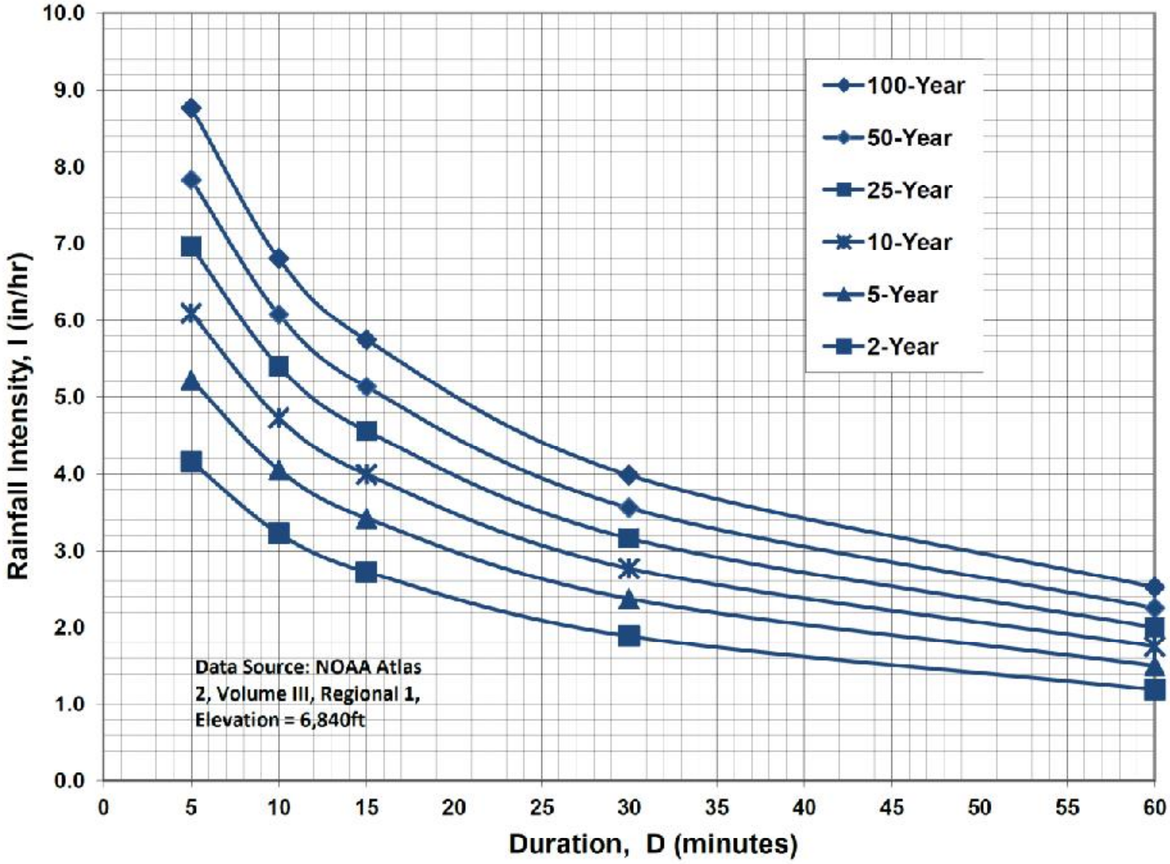
3.2.4 Minimum Time of Concentration

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.

SETTLERS VIEW SUBDIVISION
COMPOSITE RUNOFF COEFFICIENTS - TYPICAL RURAL RESIDENTIAL LOTS

DEVELOPED CONDITIONS

5-YEAR C VALUES

BASIN	TOTAL AREA (AC)	AREA (%)	SUB-AREA 1 DEVELOPMENT/ COVER	C	AREA (%)	SUB-AREA 2 DEVELOPMENT/ COVER	C	AREA (%)	SUB-AREA 3 DEVELOPMENT/ COVER	C	WEIGHTED C VALUE
2.5-ACRE LOTS	2.50	11.00	BUILDING / PAVEMENT	0.90	89.00	LANDSCAPED	0.08				0.170
5-ACRE LOTS	2.50	7.00	BUILDING / PAVEMENT	0.90	93.00	LANDSCAPED	0.08				0.137

100-YEAR C VALUES

BASIN	TOTAL AREA (AC)	AREA (%)	SUB-AREA 1 DEVELOPMENT/ COVER	C	AREA (AC)	SUB-AREA 2 DEVELOPMENT/ COVER	C	AREA (%)	SUB-AREA 3 DEVELOPMENT/ COVER	C	WEIGHTED C VALUE
2.5-ACRE LOTS	2.50	11.00	BUILDING / PAVEMENT	0.96	89.00	LANDSCAPED	0.35				0.417
5-ACRE LOTS	2.50	7.00	BUILDING / PAVEMENT	0.96	93.00	LANDSCAPED	0.35				0.393

IMPERVIOUS AREAS

BASIN	TOTAL AREA (AC)	AREA (%)	SUB-AREA 1 DEVELOPMENT/ COVER	PERCENT IMPERVIOUS	AREA (%)	SUB-AREA 2 DEVELOPMENT/ COVER	PERCENT IMPERVIOUS	AREA (%)	SUB-AREA 3 DEVELOPMENT/ COVER	PERCENT IMPERVIOUS	WEIGHTED % IMP
2.5-ACRE LOTS	2.50	11.00	BUILDING / PAVEMENT	100	89.00	LANDSCAPED	0				11.000
5-ACRE LOTS	2.50	7.00	BUILDING / PAVEMENT	100	93.00	LANDSCAPED	0				7.000

SETTLERS VIEW
RATIONAL METHOD

HISTORIC FLOWS

			C		Overland Flow			Channel flow							INTENSITY (5)		PEAK FLOW	
BASIN	DESIGN POINT	AREA (AC)	5-YEAR (7)	100-YEAR (7)	LENGTH (FT)	SLOPE (FT/FT)	Tco (1) (MIN)	CHANNEL LENGTH (FT)	CONVEYANCE COEFFICIENT C	SLOPE (FT/FT)	SCS (2) VELOCITY (FT/S)	Tt (3) (MIN)	TOTAL Tc (4) (MIN)	TOTAL Tc (4) (MIN)	5-YR (IN/HR)	100-YR (IN/HR)	Q5 (6) (CFS)	Q100 (6) (CFS)
WEST CHERRY CREEK BASIN																		
OS1	OS1	4.01	0.080	0.350	300	0.073	16.7	450	15.00	0.0578	3.61	2.1	18.8	18.8	3.19	5.35	1.02	7.50
D9	D9	14.30	0.080	0.350	250	0.080	14.8	700	15.00	0.074	4.08	2.9	17.6	17.6	3.28	5.50	3.75	27.54
S1		28.47	0.080	0.350	300	0.033	21.7	1000	15.00	0.051	3.39	4.9	26.7	26.7	2.66	4.46	6.06	44.46
OA1,D9,S1	S	46.78	0.080	0.350									26.7	26.7	2.66	4.46	9.95	73.06
EAST CHERRY CREEK BASIN																		
A	A	14.95	0.080	0.350	750	0.048	30.3	0				0.0	30.3	30.3	2.46	4.14	2.95	21.64

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

SETTLERS VIEW
RATIONAL METHOD

OS1

DEVELOPED FLOWS

BASIN	DESIGN POINT	AREA (AC)	C 5-YEAR(7)	C 100-YEAR (7)	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)
WEST CHERRY CREEK BASIN																		
OS1	OS1	4.01	0.170	0.417	300	0.073	15.2	450	15.00	0.058	3.61	2.1	17.3	17.3	3.31	5.55	2.25	9.28
S4		2.46	0.080	0.350			0.0	200	15.00	0.05	3.35	1.0	1.0	5.0	5.17	8.68	1.02	7.47
OA1,S1	S4	6.47	0.136	0.392									18.3	18.3	3.22	5.41	2.83	13.71
S1	S1	4.30	0.170	0.417	300	0.033	19.8	0				0.0	19.8	19.8	3.10	5.21	2.27	9.34
D9	D9	14.30	0.170	0.417	250	0.080	13.5	700	15.00	0.074	4.08	2.9	16.3	16.3	3.39	5.70	8.25	33.97
S2	S2a	9.04	0.170	0.417	300	0.073	15.2	650	15.00	0.049	3.33	3.3	18.4	18.4	3.21	5.39	4.93	20.32
Tc Channel S2							0.0	280	15.00	0.025	2.37	2.0	2.0	5.0				
D9,S2	S2	23.34	0.170	0.417									18.4	18.4	3.21	5.39	12.74	52.46
S3	S3a	12.67	0.170	0.417	300	0.060	16.2	1000	15.00	0.049	3.31	5.0	21.3	21.3	3.00	5.03	6.46	26.58
Tc Channel S3							0.0	1000	15.00	0.050	3.35	5.0	5.0	5.0				
D9,S1-S3	S3	40.31	0.170	0.417									24.8	24.8	2.77	4.65	18.97	78.09
OS1,D9,S1-S4	S	46.78	0.170	0.417									24.8	24.8	2.77	4.65	22.01	90.62
EAST CHERRY CREEK BASIN																		
A	A	10.74	0.170	0.417	300	0.033	19.8	400	15.00	0.075	4.11	1.6	21.4	21.4	2.99	5.01	5.45	22.44
B	B	2.93	0.170	0.417	300	0.050	17.3	0				0.0	17.3	17.3	3.31	5.56	1.65	6.79
C	C	1.28	0.170	0.417	300	0.067	15.7	0				0.0	15.7	15.7	3.45	5.80	0.75	3.10
A,B,C	A1	14.95	0.170	0.417									21.4	21.4	2.99	5.01	7.59	31.24

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

7) WEIGHTED AVERAGE C VALUES FOR COMBINED BASINS

APPENDIX B

HYDRAULIC CALCULATIONS

SETTLERS VIEW
DITCH CALCULATION SUMMARY

PROPOSED ROADSIDE DITCHES

ROADWAY	FROM STA	TO STA	SIDE	PROPOSED SLOPE (%)	SIDE SLOPE (Z)	CHANNEL DEPTH (FT)	FRICTION FACTOR (n)	ROW WIDTH (ft)	BASIN	Q100 FLOW (CFS)	DITCH FLOW % OF BASIN	DITCH FLOW (CFS)	Q100 DEPTH (FT)	Q100 VELOCITY (FT/S)	DITCH LINING
SILVER NELL DRIVE	1425	1629	N	3.76	4:1/3:1	2.5	0.030	60	B	6.8	15	1.0	0.3	2.8	GRASS
SILVER NELL DRIVE	1425	1629	S	3.76	4:1/3:1	2.5	0.030	60	C	3.1	50	1.6	0.4	3.1	GRASS
SILVER NELL DRIVE	1629	2065	N	6.00	4:1/3:1	2.5	0.030	60	S1	9.3	35	3.3	0.5	4.4	GRASS
SILVER NELL DRIVE	1629	2065	S	6.00	4:1/3:1	2.5	0.030	60	S2a	20.3	10	2.0	0.4	3.9	GRASS
SILVER NELL DRIVE	2065	2323	E	6.97	4:1/3:1	2.5	0.030	60	S1	9.3	65	6.1	0.6	5.5	**GRASS / ECB**
SILVER NELL DRIVE	2065	2323	W	6.97	4:1/3:1	2.5	0.030	60	S3a	26.6	5	1.3	0.3	3.7	GRASS
SETTLERS VIEW ROAD	1060	1630	E	7.50	4:1/3:1	2.5	0.030	60	S2a	20.3	70	14.2	0.8	7.0	**GRASS / ECB**
SETTLERS VIEW ROAD	1060	1630	W	7.50	4:1/3:1	2.5	0.030	60	S3a	26.6	20	5.3	0.5	5.4	**GRASS / ECB**
SETTLERS VIEW ROAD	1630	1932	E	3.00	4:1/3:1	2.5	0.030	60	S2a	20.3	30	6.1	0.7	4.0	GRASS
SETTLERS VIEW ROAD	1630	1932	W	3.00	4:1/3:1	2.5	0.030	60	S3	78.1	5	3.9	0.6	3.6	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 = 0.045 for riprap-lined channels
5) Vmax = 5.0 fps per El Paso County criteria (p. 10-13) for fescue (dry land grass) for 100-year flows
6) Vmax = 8.0 fps with Erosion Control Blankets (Tensar Eronet SC150 or equal)

SETTLERS VIEW
CHANNEL CALCULATIONS
DEVELOPED FLOWS

EXISTING / PROPOSED CHANNELS

CHANNEL	DESIGN POINT	EXISTING SLOPE (%)	PROPOSED SLOPE (%)	BOTTOM WIDTH (B, FT)	SIDE SLOPE (Z)	CHANNEL DEPTH (FT)	FRICTION FACTOR (n)	Q100 FLOW (CFS)	Q100 DEPTH (FT)	Q100 VELOCITY (FT/S)	CHANNEL LINING
S2.1	S2	0.025	0.025	4	4:1	2.0	0.030	52.5	1.05	6.10	**GRASS / ECB**
S2.2	S2	0.058	0.058	6	4:1	2.0	0.030	52.5	0.70	8.00	**GRASS / ECB**
S3	S3	0.053	0.053	10	10:1	2.0	0.030	78.1	0.70	7.00	**GRASS / ECB**

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)

The complete line of RollMax™ products offers a variety of options for both short-term and permanent erosion control needs. Reference the RollMax Products Chart below to find the right solution for your next project.

RollMax Product Selection Chart

	TEMPORARY						
	ERONET						BIONET
							
	DS75	DS150	S75	S150	SC150	C125	S75BN
Longevity	45 days	60 days	12 mo.	12 mo.	24 mo.	36 mo.	12 mo.
Applications	Low Flow Channels 4:1-3:1 Slopes	Moderate Flow Channels 3:1-2:1 Slopes	Low Flow Channels 4:1-3:1 Slopes	Moderate Flow Channels 3:1-2:1 Slopes	Medium Flow Channels 2:1-1:1 Slopes	High-Flow Channels 1:1 and Greater Slopes	Low Flow Channels 4:1-3:1 Slopes
Design Permissible Shear Stress lbs/ft² (Pa)	Unvegetated 1.55 (74)	Unvegetated 1.75 (84)	Unvegetated 1.55 (74)	Unvegetated 1.75 (84)	Unvegetated 2.00 (96)	Unvegetated 2.25 (108)	Unvegetated 1.60 (76)
Design Permissible Velocity ft/s (m/s)	Unvegetated 5.00 (1.52)	Unvegetated 6.00 (1.52)	Unvegetated 5.00 (1.2)	Unvegetated 6.00 (1.83)	Unvegetated 8.00 (2.44)	Unvegetated 10.00 (3.05)	Unvegetated 5.00 (1.52)
Top Net	Lightweight accelerated photodegradable polypropylene 1.50 lbs/1000 ft² (0.73 kg/100 m²) approx wt	Lightweight accelerated photodegradable polypropylene 1.50 lbs/1000 ft² (0.73 kg/100 m²) approx wt	Lightweight photodegradable polypropylene 1.50 lbs/1000 ft² (0.73 kg/100 m²) approx wt	Lightweight photodegradable polypropylene 1.50 lbs/1000 ft² (0.73 kg/100 m²) approx wt	Heavyweight UV-stabilized polypropylene 2.9 lbs/1000 ft² (1.47 kg/100 m²) approx wt	Heavyweight UV-stabilized polypropylene 2.9 lbs/1000 ft² (1.47 kg/100 m²) approx wt	Leno woven. 100% biodegradable jute fiber 9.30 lbs/1000 ft² (4.53 kg/100 m²) approx wt
Center Net	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Fiber Matrix	Straw fiber 0.50 lbs/yd² (0.27 kg/m²)	Straw fiber 0.50 lbs/yd² (0.27 kg/m²)	Straw fiber 0.50 lbs/yd² (0.27 kg/m²)	Straw fiber 0.50 lbs/yd² (0.27 kg/m²)	Straw/coconut matrix 70% Straw 0.35 lbs/yd² (0.19 kg/m²) 30% Coconut 0.15 lbs/yd² (0.08 kg/m²)	Coconut fiber 0.50 lbs/yd² (0.27 kg/m²)	Straw fiber 0.50 lbs/yd² (0.27 kg/m²)
Bottom Net	N/A	Lightweight accelerated photodegradable polypropylene 1.50 lbs/1000 ft² (0.73 kg/100 m²) approx wt	N/A	Lightweight photodegradable polypropylene 1.50 lbs/1000 ft² (0.73 kg/100 m²) approx wt	Lightweight photodegradable polypropylene 1.50 lbs/1000 ft² (0.73 kg/100 m²) approx wt	Heavyweight UV-stabilized polypropylene 2.9 lbs/1000 ft² (1.47 kg/100 m²) approx wt	N/A
Thread	Accelerated degradable	Accelerated degradable	Degradable	Degradable	Degradable	UV-stabilized polypropylene	Biodegradable

Hydraulic Analysis Report

Project Data

Project Title: Settlers View

Designer: JPS

Project Date: Friday, February 10, 2017

Project Units: U.S. Customary Units

Notes:

Channel Analysis: Ditch-1425-1629-N

Notes:

Input Parameters

Channel Type: Triangular

Side Slope 1 (Z1): 4.0000 ft/ft

Side Slope 2 (Z2): 3.0000 ft/ft

Longitudinal Slope: 0.0376 ft/ft

Manning's n: 0.0300

Flow: 1.0000 cfs

Result Parameters

Depth: 0.3215 ft

Area of Flow: 0.3617 ft^2

Wetted Perimeter: 2.3420 ft

Hydraulic Radius: 0.1544 ft

Average Velocity: 2.7648 ft/s

Top Width: 2.2503 ft

Froude Number: 1.2153

Critical Depth: 0.3490 ft

Critical Velocity: 2.3460 ft/s

Critical Slope: 0.0243 ft/ft

Critical Top Width: 2.49 ft

Calculated Max Shear Stress: 0.7542 lb/ft^2

Calculated Avg Shear Stress: 0.3623 lb/ft^2

Channel Analysis: Ditch-1425-1629-S

Notes:

Input Parameters

Channel Type: Triangular

Side Slope 1 (Z1): 4.0000 ft/ft

Side Slope 2 (Z2): 3.0000 ft/ft

Longitudinal Slope: 0.0376 ft/ft

Manning's n: 0.0300

Flow: 1.6000 cfs

Result Parameters

Depth: 0.3834 ft

Area of Flow: 0.5146 ft^2

Wetted Perimeter: 2.7934 ft

Hydraulic Radius: 0.1842 ft

Average Velocity: 3.1095 ft/s

Top Width: 2.6840 ft

Froude Number: 1.2515

Critical Depth: 0.4212 ft

Critical Velocity: 2.5773 ft/s

Critical Slope: 0.0228 ft/ft

Critical Top Width: 3.01 ft

Calculated Max Shear Stress: 0.8996 lb/ft^2

Calculated Avg Shear Stress: 0.4322 lb/ft^2

Channel Analysis: Ditch-1629-2065-N

Notes:

Input Parameters

Channel Type: Triangular

Side Slope 1 (Z1): 4.0000 ft/ft

Side Slope 2 (Z2): 3.0000 ft/ft

Longitudinal Slope: 0.0600 ft/ft

Manning's n: 0.0300

Flow: 3.3000 cfs

Result Parameters

Depth: 0.4608 ft

Area of Flow: 0.7432 ft^2

Wetted Perimeter: 3.3572 ft

Hydraulic Radius: 0.2214 ft

Average Velocity: 4.4402 ft/s

Top Width: 3.2257 ft

Froude Number: 1.6301

Critical Depth: 0.5626 ft

Critical Velocity: 2.9788 ft/s

Critical Slope: 0.0207 ft/ft

Critical Top Width: 4.02 ft

Calculated Max Shear Stress: 1.7253 lb/ft^2

Calculated Avg Shear Stress: 0.8288 lb/ft^2

Channel Analysis: Ditch-1629-2065-S

Notes:

Input Parameters

Channel Type: Triangular

Side Slope 1 (Z1): 4.0000 ft/ft

Side Slope 2 (Z2): 3.0000 ft/ft

Longitudinal Slope: 0.0600 ft/ft

Manning's n: 0.0300

Flow: 2.0000 cfs

Result Parameters

Depth: 0.3819 ft

Area of Flow: 0.5105 ft^2

Wetted Perimeter: 2.7824 ft

Hydraulic Radius: 0.1835 ft

Average Velocity: 3.9177 ft/s

Top Width: 2.6734 ft

Froude Number: 1.5799

Critical Depth: 0.4605 ft

Critical Velocity: 2.6949 ft/s

Critical Slope: 0.0221 ft/ft

Critical Top Width: 3.29 ft

Calculated Max Shear Stress: 1.4299 lb/ft^2

Calculated Avg Shear Stress: 0.6869 lb/ft^2

Channel Analysis: Ditch-2065-2323-E

Notes:

Input Parameters

Channel Type: Triangular

Side Slope 1 (Z1): 4.0000 ft/ft

Side Slope 2 (Z2): 3.0000 ft/ft

Longitudinal Slope: 0.0697 ft/ft

Manning's n: 0.0300

Flow: 6.1000 cfs

Result Parameters

Depth: 0.5641 ft

Area of Flow: 1.1138 ft^2

Wetted Perimeter: 4.1099 ft

Hydraulic Radius: 0.2710 ft

Average Velocity: 5.4766 ft/s

Top Width: 3.9489 ft

Froude Number: 1.8172

Critical Depth: 0.7193 ft

Critical Velocity: 3.3682 ft/s

Critical Slope: 0.0191 ft/ft

Critical Top Width: 5.14 ft

Calculated Max Shear Stress: 2.4535 lb/ft^2

Calculated Avg Shear Stress: 1.1787 lb/ft^2

Channel Analysis: Ditch-2065-2323-W

Notes:

Input Parameters

Channel Type: Triangular

Side Slope 1 (Z1): 4.0000 ft/ft

Side Slope 2 (Z2): 3.0000 ft/ft

Longitudinal Slope: 0.0697 ft/ft

Manning's n: 0.0300

Flow: 1.3000 cfs

Result Parameters

Depth: 0.3159 ft

Area of Flow: 0.3494 ft^2

Wetted Perimeter: 2.3018 ft

Hydraulic Radius: 0.1518 ft

Average Velocity: 3.7210 ft/s

Top Width: 2.2116 ft

Froude Number: 1.6499

Critical Depth: 0.3876 ft

Critical Velocity: 2.4724 ft/s

Critical Slope: 0.0234 ft/ft

Critical Top Width: 2.77 ft

Calculated Max Shear Stress: 1.3741 lb/ft^2

Calculated Avg Shear Stress: 0.6601 lb/ft^2

Channel Analysis: Ditch-1060-1630-E

Notes:

Input Parameters

Channel Type: Triangular

Side Slope 1 (Z1): 4.0000 ft/ft

Side Slope 2 (Z2): 3.0000 ft/ft

Longitudinal Slope: 0.0750 ft/ft

Manning's n: 0.0300

Flow: 14.2000 cfs

Result Parameters

Depth: 0.7639 ft

Area of Flow: 2.0422 ft^2

Wetted Perimeter: 5.5651 ft

Hydraulic Radius: 0.3670 ft

Average Velocity: 6.9532 ft/s

Top Width: 5.3471 ft

Froude Number: 1.9827

Critical Depth: 1.0086 ft

Critical Velocity: 3.9883 ft/s

Critical Slope: 0.0170 ft/ft

Critical Top Width: 7.21 ft

Calculated Max Shear Stress: 3.5749 lb/ft^2

Calculated Avg Shear Stress: 1.7174 lb/ft^2

Channel Analysis: Ditch-1060-1630-E

Notes:

Input Parameters

Channel Type: Triangular

Side Slope 1 (Z1): 4.0000 ft/ft

Side Slope 2 (Z2): 3.0000 ft/ft

Longitudinal Slope: 0.0750 ft/ft

Manning's n: 0.0300

Flow: 5.3000 cfs

Result Parameters

Depth: 0.5279 ft

Area of Flow: 0.9752 ft^2

Wetted Perimeter: 3.8456 ft

Hydraulic Radius: 0.2536 ft

Average Velocity: 5.4348 ft/s

Top Width: 3.6950 ft

Froude Number: 1.8643

Critical Depth: 0.6800 ft

Critical Velocity: 3.2748 ft/s

Critical Slope: 0.0194 ft/ft

Critical Top Width: 4.86 ft

Calculated Max Shear Stress: 2.4704 lb/ft^2

Calculated Avg Shear Stress: 1.1868 lb/ft^2

Channel Analysis: Ditch-1630-1932-E

Notes:

Input Parameters

Channel Type: Triangular

Side Slope 1 (Z1): 4.0000 ft/ft

Side Slope 2 (Z2): 3.0000 ft/ft

Longitudinal Slope: 0.0300 ft/ft

Manning's n: 0.0300

Flow: 6.1000 cfs

Result Parameters

Depth: 0.6607 ft

Area of Flow: 1.5280 ft^2

Wetted Perimeter: 4.8137 ft

Hydraulic Radius: 0.3174 ft

Average Velocity: 3.9922 ft/s

Top Width: 4.6251 ft

Froude Number: 1.2240

Critical Depth: 0.7193 ft

Critical Velocity: 3.3682 ft/s

Critical Slope: 0.0191 ft/ft

Critical Top Width: 5.14 ft

Calculated Max Shear Stress: 1.2369 lb/ft^2

Calculated Avg Shear Stress: 0.5942 lb/ft^2

Channel Analysis: Ditch-1630-1932-W

Notes:

Input Parameters

Channel Type: Triangular

Side Slope 1 (Z1): 4.0000 ft/ft

Side Slope 2 (Z2): 3.0000 ft/ft

Longitudinal Slope: 0.0300 ft/ft

Manning's n: 0.0300

Flow: 3.9000 cfs

Result Parameters

Depth: 0.5587 ft

Area of Flow: 1.0925 ft^2

Wetted Perimeter: 4.0703 ft

Hydraulic Radius: 0.2684 ft

Average Velocity: 3.5699 ft/s

Top Width: 3.9108 ft

Froude Number: 1.1903

Critical Depth: 0.6015 ft

Critical Velocity: 3.0800 ft/s

Critical Slope: 0.0202 ft/ft

Critical Top Width: 4.30 ft

Calculated Max Shear Stress: 1.0459 lb/ft^2

Calculated Avg Shear Stress: 0.5025 lb/ft^2

Channel Analysis: Channel-S2.1

Notes:

Input Parameters

Channel Type: Trapezoidal

Side Slope 1 (Z1): 4.0000 ft/ft

Side Slope 2 (Z2): 4.0000 ft/ft

Channel Width: 4.0000 ft

Longitudinal Slope: 0.0250 ft/ft

Manning's n: 0.0300

Flow: 52.5000 cfs

Result Parameters

Depth: 1.0536 ft

Area of Flow: 8.6543 ft^2

Wetted Perimeter: 12.6879 ft

Hydraulic Radius: 0.6821 ft

Average Velocity: 6.0664 ft/s

Top Width: 12.4285 ft

Froude Number: 1.2811

Critical Depth: 1.1965 ft

Critical Velocity: 4.9938 ft/s

Critical Slope: 0.0147 ft/ft

Critical Top Width: 13.57 ft

Calculated Max Shear Stress: 1.6436 lb/ft^2

Calculated Avg Shear Stress: 1.0641 lb/ft^2

Channel Analysis: Channel-S2.2

Notes:

Input Parameters

Channel Type: Trapezoidal

Side Slope 1 (Z1): 4.0000 ft/ft

Side Slope 2 (Z2): 4.0000 ft/ft

Channel Width: 6.0000 ft

Longitudinal Slope: 0.0580 ft/ft

Manning's n: 0.0300

Flow: 52.5000 cfs

Result Parameters

Depth: 0.7366 ft

Area of Flow: 6.5902 ft^2

Wetted Perimeter: 12.0743 ft

Hydraulic Radius: 0.5458 ft

Average Velocity: 7.9664 ft/s

Top Width: 11.8930 ft

Froude Number: 1.8860

Critical Depth: 1.0506 ft

Critical Velocity: 4.8978 ft/s

Critical Slope: 0.0148 ft/ft

Critical Top Width: 14.41 ft

Calculated Max Shear Stress: 2.6660 lb/ft^2

Calculated Avg Shear Stress: 1.9754 lb/ft^2

Channel Analysis: Channel-S3

Notes:

Input Parameters

Channel Type: Trapezoidal

Side Slope 1 (Z1): 10.0000 ft/ft

Side Slope 2 (Z2): 10.0000 ft/ft

Channel Width: 10.0000 ft

Longitudinal Slope: 0.0530 ft/ft

Manning's n: 0.0300

Flow: 78.1000 cfs

Result Parameters

Depth: 0.6711 ft

Area of Flow: 11.2158 ft^2

Wetted Perimeter: 23.4898 ft

Hydraulic Radius: 0.4775 ft

Average Velocity: 6.9634 ft/s

Top Width: 23.4229 ft

Froude Number: 1.7734

Critical Depth: 0.9142 ft

Critical Velocity: 4.4627 ft/s

Critical Slope: 0.0155 ft/ft

Critical Top Width: 28.28 ft

Calculated Max Shear Stress: 2.2196 lb/ft^2

Calculated Avg Shear Stress: 1.5791 lb/ft^2

SETTLERS VIEW
CULVERT DESIGN SUMMARY

BASIN	DESIGN POINT	RD CL ELEV	INV IN ELEV	INV OUT ELEV	PIPE LENGTH (FT)	# of CULVERTS	PIPE DIA (FT)	TOTAL Q5 (CFS)	PER PIPE Q5 (CFS)	MAX ALLOWABLE HEADWATER	CALC HW ELEV	TOTAL Q100 (CFS)	PER PIPE Q100 (CFS)	MAX ALLOWABLE HEADWATER	CALC HW ELEV
S1	S1	7620.23	7617.50	7614.00	64.0	1	1.5	2.3	2.3	7619.00	7618.8	9.34	9.34	7620.9	7619.9
S2	S2	7587.72	7584.14	7583.50	64.0	1	2.0	12.7	12.7	7586.14	7586.0	52.50	52.50	7588.4	7588.0

HY-8 Culvert Analysis Report

Crossing Discharge Data

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

Minimum Flow: 2.3 cfs

Design Flow: 9.34 cfs

Maximum Flow: 15 cfs

Table 1 - Summary of Culvert Flows at Crossing: Crossing S1

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert S1 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
7618.75	2.30	2.30	0.00	1
7618.98	3.57	3.57	0.00	1
7619.18	4.84	4.84	0.00	1
7619.36	6.11	6.11	0.00	1
7619.54	7.38	7.38	0.00	1
7619.75	8.65	8.65	0.00	1
7619.87	9.34	9.34	0.00	1
7620.23	11.19	11.10	0.03	35
7620.27	12.46	11.26	1.17	6
7620.29	13.73	11.36	2.32	4
7620.31	15.00	11.45	3.52	4
7620.23	11.09	11.09	0.00	Overtopping

Table 2 - Culvert Summary Table: Culvert S1

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)
2.30	2.30	7618.75	0.748	0.0*	1-S2n	0.296	0.569	0.296	0.164	9.466	3.021
3.57	3.57	7618.98	0.981	0.0*	1-S2n	0.368	0.721	0.368	0.211	10.516	3.502
4.84	4.84	7619.18	1.176	0.0*	1-S2n	0.433	0.842	0.433	0.250	11.502	3.867
6.11	6.11	7619.36	1.357	0.0*	1-S2n	0.488	0.950	0.488	0.285	12.201	4.167
7.38	7.38	7619.54	1.544	0.0*	5-S2n	0.543	1.049	0.561	0.317	12.242	4.423
8.65	8.65	7619.75	1.750	0.0*	5-S2n	0.590	1.134	0.623	0.346	12.442	4.646
9.34	9.34	7619.87	1.873	0.0*	5-S2n	0.615	1.180	0.644	0.361	12.872	4.758
11.19	11.10	7620.23	2.233	0.0*	5-S2n	0.680	1.274	0.718	0.398	13.307	5.026
12.46	11.26	7620.27	2.269	0.0*	5-S2n	0.685	1.282	0.724	0.422	13.349	5.191
13.73	11.36	7620.29	2.293	0.0*	5-S2n	0.689	1.286	0.728	0.445	13.377	5.344
15.00	11.45	7620.31	2.313	0.0*	5-S2n	0.692	1.290	0.731	0.466	13.401	5.485

* Full Flow Headwater elevation is below inlet invert.

****

Straight Culvert

Inlet Elevation (invert): 7618.00 ft,   Outlet Elevation (invert): 7614.00 ft

Culvert Length: 64.12 ft,   Culvert Slope: 0.0625

****

Site Data - Culvert S1

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 7618.00 ft

Outlet Station: 64.00 ft

Outlet Elevation: 7614.00 ft

Number of Barrels: 1

Culvert Data Summary - Culvert S1

Barrel Shape: Circular

Barrel Diameter: 1.50 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 S1)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
2.30	7614.16	0.16	3.02	0.51	1.41
3.57	7614.21	0.21	3.50	0.66	1.46
4.84	7614.25	0.25	3.87	0.78	1.49
6.11	7614.29	0.29	4.17	0.89	1.52
7.38	7614.32	0.32	4.42	0.99	1.54
8.65	7614.35	0.35	4.65	1.08	1.56
9.34	7614.36	0.36	4.76	1.13	1.57
11.19	7614.40	0.40	5.03	1.24	1.59
12.46	7614.42	0.42	5.19	1.32	1.60
13.73	7614.44	0.44	5.34	1.39	1.62
15.00	7614.47	0.47	5.49	1.45	1.63

Tailwater Channel Data - Crossing S1

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 4.00 ft

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

Channel Slope: 0.0500

Channel Manning's n: 0.0300

Channel Invert Elevation: 7614.00 ft

Roadway Data for Crossing: Crossing S1

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 7620.23 ft

Roadway Surface: Paved

Roadway Top Width: 32.00 ft

Crossing Discharge Data

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

Minimum Flow: 12.7 cfs

Design Flow: 52.5 cfs

Maximum Flow: 60 cfs

Table 4 - Summary of Culvert Flows at Crossing: Crossing S2

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert S2 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
7586.02	12.70	12.70	0.00	1
7586.49	17.43	17.43	0.00	1
7587.08	22.16	22.16	0.00	1
7587.74	26.89	26.39	0.43	27
7587.82	31.62	26.84	4.66	6
7587.88	36.35	27.16	9.12	5
7587.92	41.08	27.42	13.56	4
7587.97	45.81	27.66	18.10	4
7588.00	50.54	27.87	22.52	3
7588.02	52.50	27.96	24.48	3
7588.07	60.00	28.25	31.65	3
7587.72	26.26	26.26	0.00	Overtopping

Table 5 - Culvert Summary Table: Culvert S2

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)
12.70	12.70	7586.02	1.877	0.0*	1-S2n	1.070	1.279	1.083	0.389	7.310	4.327
17.43	17.43	7586.49	2.349	2.063	5-S2n	1.317	1.503	1.328	0.464	7.882	4.784
22.16	22.16	7587.08	2.941	2.737	5-S2n	1.605	1.679	1.605	0.530	8.209	5.155
26.89	26.39	7587.74	3.601	3.412	7-M2c	2.000	1.795	1.795	0.589	8.879	5.467
31.62	26.84	7587.82	3.680	3.503	7-M2c	2.000	1.805	1.805	0.643	8.995	5.740
36.35	27.16	7587.88	3.736	3.570	7-M2c	2.000	1.812	1.812	0.693	9.078	5.983
41.08	27.42	7587.92	3.783	3.621	7-M2c	2.000	1.817	1.817	0.739	9.146	6.202
45.81	27.66	7587.97	3.825	3.662	7-M2c	2.000	1.822	1.822	0.783	9.208	6.401
50.54	27.87	7588.00	3.863	3.703	7-M2c	2.000	1.826	1.826	0.825	9.264	6.587
52.50	27.96	7588.02	3.879	3.719	7-M2c	2.000	1.828	1.828	0.842	9.287	6.660
60.00	28.25	7588.07	3.933	3.781	7-M2c	2.000	1.833	1.833	0.902	9.367	6.919

* Full Flow Headwater elevation is below inlet invert.

****

Straight Culvert

Inlet Elevation (invert): 7584.14 ft,   Outlet Elevation (invert): 7583.50 ft

Culvert Length: 64.00 ft,   Culvert Slope: 0.0100

****

Site Data - Culvert S2

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 7584.14 ft

Outlet Station: 64.00 ft

Outlet Elevation: 7583.50 ft

Number of Barrels: 1

Culvert Data Summary - Culvert S2

Barrel Shape: Circular

Barrel Diameter: 2.00 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 S2)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
12.70	7583.89	0.39	4.33	0.85	1.34
17.43	7583.96	0.46	4.78	1.01	1.38
22.16	7584.03	0.53	5.15	1.16	1.40
26.89	7584.09	0.59	5.47	1.29	1.42
31.62	7584.14	0.64	5.74	1.40	1.44
36.35	7584.19	0.69	5.98	1.51	1.45
41.08	7584.24	0.74	6.20	1.62	1.47
45.81	7584.28	0.78	6.40	1.71	1.48
50.54	7584.33	0.83	6.59	1.80	1.49
52.50	7584.34	0.84	6.66	1.84	1.49
60.00	7584.40	0.90	6.92	1.97	1.51

Tailwater Channel Data - Crossing S2

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 6.00 ft

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

Channel Slope: 0.0350

Channel Manning's n: 0.0300

Channel Invert Elevation: 7583.50 ft

Roadway Data for Crossing: Crossing S2

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 7587.72 ft

Roadway Surface: Paved

Roadway Top Width: 32.00 ft

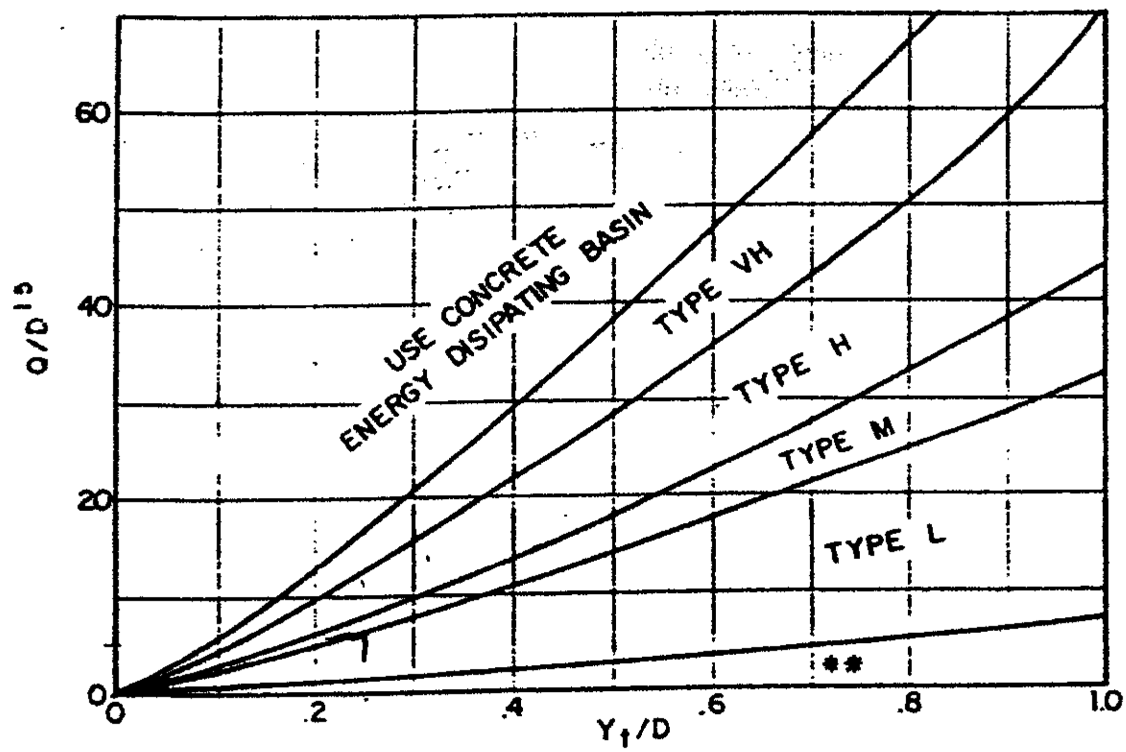
Culvert 51, $\Delta = 1.5'$

$Q_{100} = 9.3$ cfs

$\frac{Q}{\Delta^{1.5}} = \frac{9.3}{(1.5)^{1.5}} = 5.1$

$Y_t = 0.36$

$\frac{Y_t}{\Delta} = \frac{.36}{1.5} = 0.24$



Use D_a instead of D whenever flow is supercritical in the barrel.
** Use Type L for a distance of 3D downstream.

Use Type M Riprap

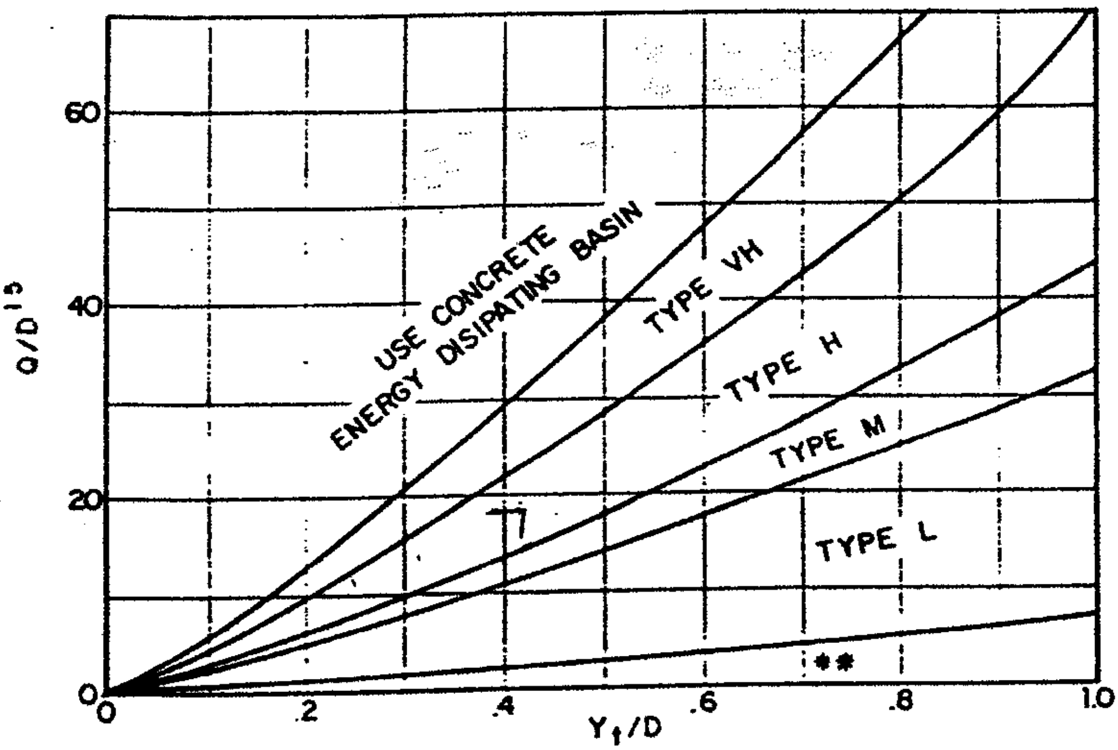
FIGURE 5-7. RIPRAP EROSION PROTECTION AT CIRCULAR CONDUIT OUTLET.

Culvert 52, $\Delta = 2.0'$
$Q_{100} = 52.5$ CFS

$$\frac{Q}{\Delta^{1.5}} = \frac{52.5}{(2)^{1.5}} = 18.6$$

$Y_t = 0.84'$

$$\frac{Y_t}{\Delta} = \frac{0.84}{2.0} = 0.42$$



Use D_a instead of D whenever flow is supercritical in the barrel.
** Use Type L for a distance of 3D downstream.

Use Type H Riprap

FIGURE 5-7. RIPRAP EROSION PROTECTION AT CIRCULAR CONDUIT OUTLET.

APPENDIX C

DETENTION POND CALCULATIONS

Use the latest version of UD-Detention (v3.07)

DETENTION VOLUME BY THE FULL SPECTRUM METHOD

Project: SETTLERS VIEW SUBDIVISION
Basin ID: POND S3

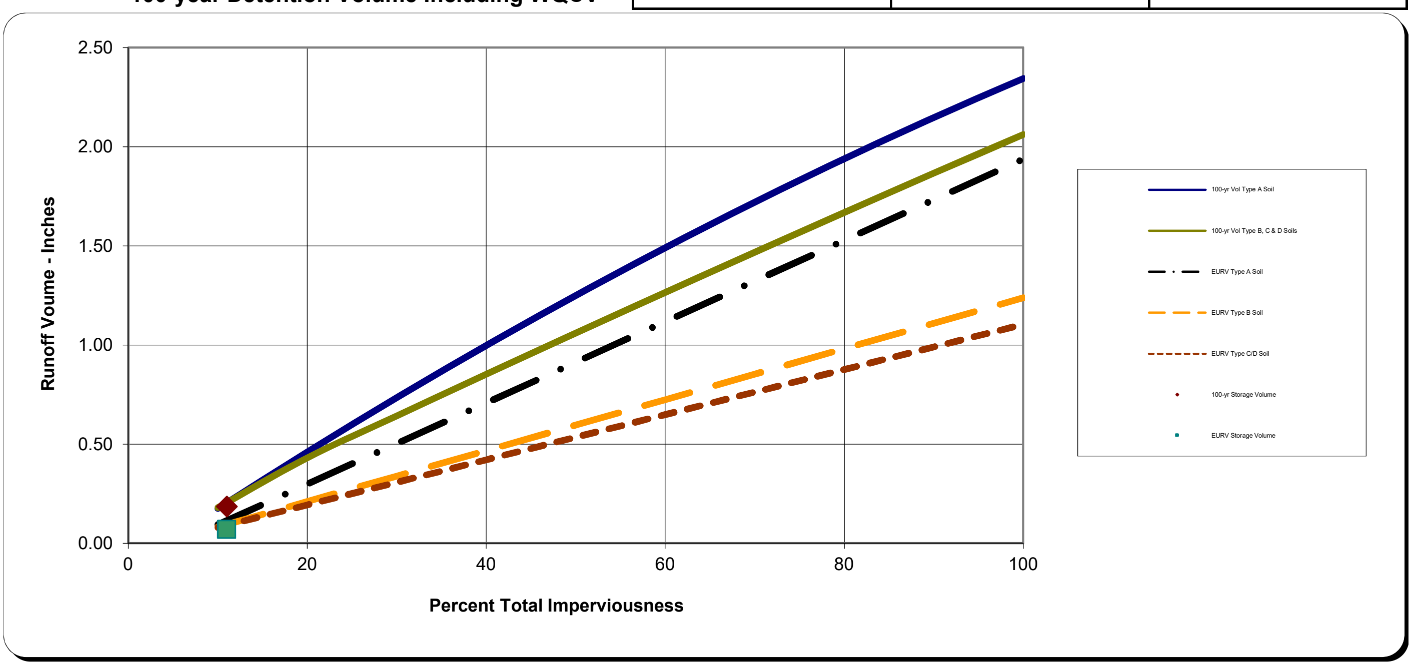
* User input data shown in blue.

Area of Watershed (acres)	28.50	
Subwatershed Imperviousness	11.0%	
Level of Minimizing Directly Connected Impervious Area (MDCIA)	1	1
Effective Imperviousness[1]	8.6%	

Hydrologic Soil Type	Percentage of Area	Area (acres)
Type A		0.0
Type B	100.0%	28.5
Type C or D		0.0

Recommended Horton's Equation Parameters for CUHP		
Infiltration (inches per hour)		Decay Coefficient--α
Initial--f_i	Final--fo	
4.5	0.6	0.0018

	Detention Volumes [2,5] (watershed inches)	(acre-feet)	Maximum Allowable Release Rate, cfs[3]
Excess Urban Runoff Volume[4]	0.07	0.17	Design Oulet to Empty EURV in 72 Hours
100-year Detention Volume Including WQCV [5]	0.19	0.44	24.23



Notes:

1) Effective imperviousness is based on Figure ND-1 of the Urban Storm Drainage Criteria Manual (USDCM).

2) Results shown reflect runoff reduction from Level 1 or 2 MDCIA and are plotted at the watershed's total imperviousness value; the impact of MDCIA is reflected by the results being below the curves.

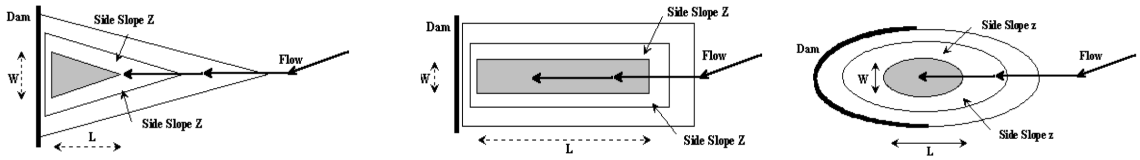
3) Maximum allowable release rates for 100-year event are based on Table SO-1. Outlet for the Excess Urban Runoff Volume (EURV) to be designed to empty out the EURV in 72 hours. Outlet design is similar to one for the WQCV outlet of an extended detention basin (i.e., perforated plate with a micro-pool) and extends to top of EURV water surface elevation.

4) EURV approximates the difference between developed and pre-developed runoff volume.

5) 100-yr detention volume includes EURV. No need to add more volume for WQCV or EURV

STAGE-STORAGE SIZING FOR DETENTION BASINS

Project: SETTLERS VIEW
Basin ID: POND S3



Design Information (Input):

Width of Basin Bottom, W =		ft
Length of Basin Bottom, L =		ft
Dam Side-slope (H:V), Z_d =		ft/ft

Check Basin Shape

Right Triangle		OR…
Isosceles Triangle		OR…
Rectangle		OR…
Circle / Ellipse		OR…
Irregular	X	(Use Overide values in cells G32:G52)

Stage-Storage Relationship:

	MINOR	MAJOR	
Storage Requirement from Sheet 'Modified FAA':			acre-ft.
Storage Requirement from Sheet 'Hydrograph':			acre-ft.
Storage Requirement from Sheet 'Full-Spectrum':	0.17	0.44	acre-ft.

Labels for WQCV, Minor, & Major Storage Stages (input)	Water Surface Elevation ft (input)	Side Slope (H:V) ft/ft Below El. (input)	Basin Width at Stage ft (output)	Basin Length at Stage ft (output)	Surface Area at Stage ft^2 (output)	Surface Area at Stage ft^2 User Overide	Volume Below Stage ft^3 (output)	Surface Area at Stage acres (output)	Volume Below Stage acre-ft (output)	Target Volumes for WQCV, Minor, & Major Storage Volumes (for goal seek)
BOTTOM	7572.00					1,169		0.027	0.000	
	7574.00		0.00	0.00		2,753	3,922	0.063	0.090	
	7576.00		0.00	0.00		4,737	11,412	0.109	0.262	
100-YR WSL	7578.00		0.00	0.00		7,123	23,272	0.164	0.534	
TOP	7580.00		0.00	0.00		10,256	40,651	0.235	0.933	
							#N/A		#N/A	
							#N/A		#N/A	
							#N/A		#N/A	
							#N/A		#N/A	
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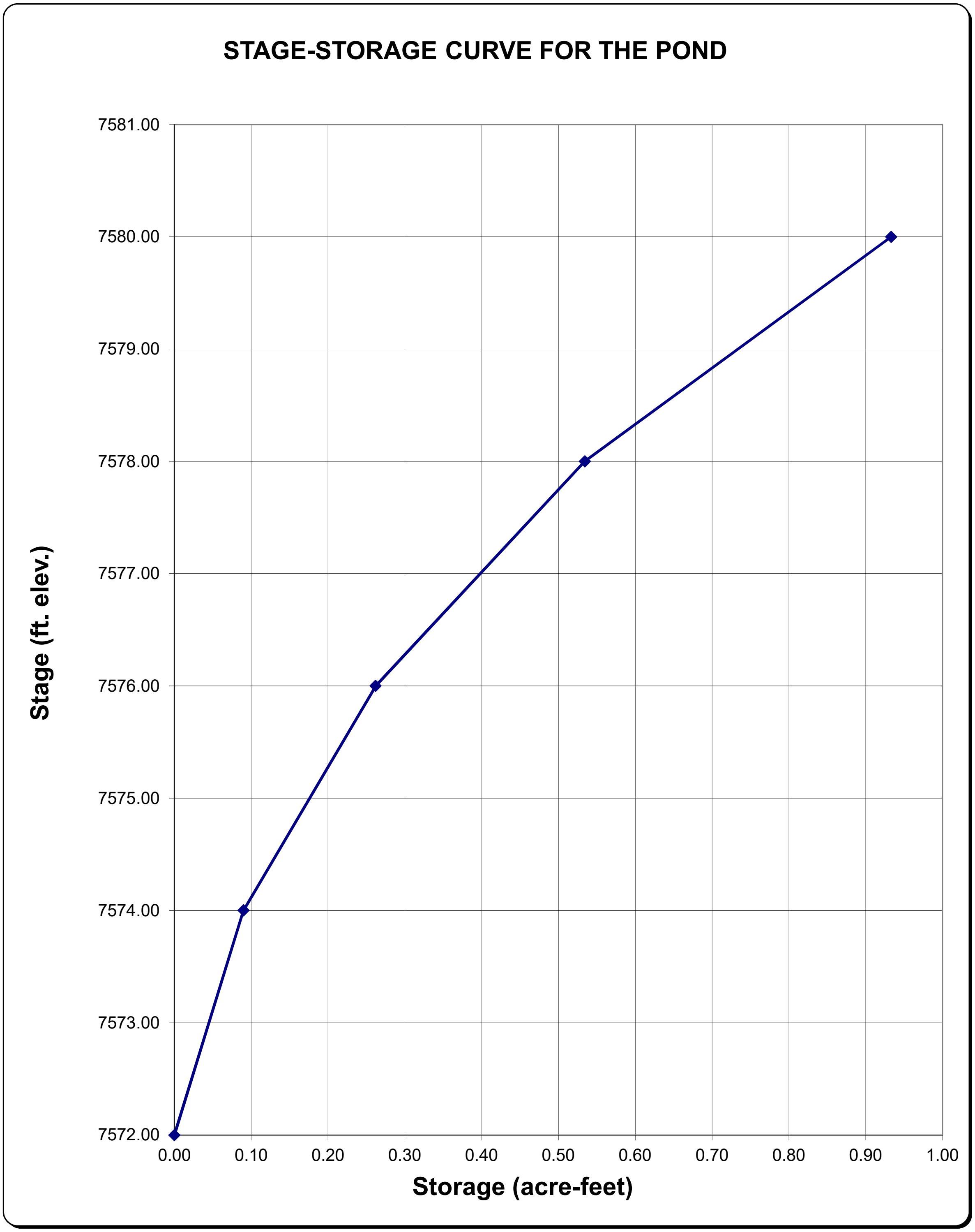
STAGE-STORAGE SIZING FOR DETENTION BASINS

Project:

Basin ID:



STAGE-DISCHARGE SIZING OF THE WATER QUALITY CAPTURE VOLUME (WQCV) OUTLET

Project: SETTLERS VIEW
Basin ID: POND S3

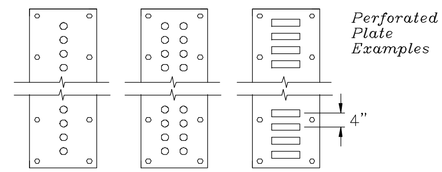
WQCV Design Volume (Input):

Catchment Imperviousness, I_a =	11.0	percent
Catchment Area, A =	28.50	acres
Depth at WQCV outlet above lowest perforation, H =	3	feet
Vertical distance between rows, h =	4.00	inches
Number of rows, NL =	9.00	
Orifice discharge coefficient, C_o =	0.60	
Slope of Basin Trickle Channel, S =	0.005	ft / ft
Time to Drain the Pond =	72	hours

Diameter of holes, D =	0.545	inches
Number of holes per row, N =	1	
OR		
Height of slot, H =		inches
Width of slot, W =		inches

Watershed Design Information (Input):

Percent Soil Type A =		%
Percent Soil Type B =	100	%
Percent Soil Type C/D =		%



Outlet Design Information (Output):

Excess Urban Runoff Volume (From 'Full-Spectrum Sheet')	0.070	watershed inches
	N/A	
Excess Urban Runoff Volume (From 'Full-Spectrum Sheet')	**0.167**	**acre-feet**
Outlet area per row, Ao =	0.23	square inches
Total opening area at each row based on user-input above, Ao =	0.23	square inches
Total opening area at each row based on user-input above, Ao =	0.002	square feet

3

	Central Elevations of Rows of Holes in feet																								
	Row 1	Row 2	Row 3	Row 4	Row 5	Row 6	Row 7	Row 8	Row 9	Row 10	Row 11	Row 12	Row 13	Row 14	Row 15	Row 16	Row 17	Row 18	Row 19	Row 20	Row 21	Row 22	Row 23	Row 23	**Σ Flow**
	7572.00	7572.33	7572.67	7573.00	7573.33	7573.67	7574.00	7574.33	7574.67																
	Collection Capacity for Each Row of Holes in cfs																								
7572.00	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000																**0.00**
7574.00	0.0110	0.0101	0.0090	0.0078	0.0064	0.0045	0.0000	0.0000	0.0000																**0.05**
7576.00	0.0156	0.0149	0.0142	0.0135	0.0127	0.0119	0.0110	0.0101	0.0090																**0.11**
7578.00	0.0191	0.0186	0.0180	0.0174	0.0169	0.0162	0.0156	0.0149	0.0142																**0.15**
7580.00	0.0221	0.0216	0.0211	0.0206	0.0202	0.0196	0.0191	0.0186	0.0180																**0.18**
	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A																**#N/A**
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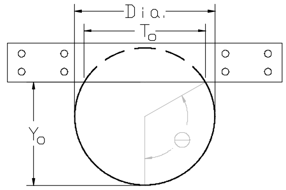
	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A																**#N/A**
	Override Area Row 1	Override Area Row 2	Override Area Row 3	Override Area Row 4	Override Area Row 5	Override Area Row 6	Override Area Row 7	Override Area Row 8	Override Area Row 9	Override Area Row 10	Override Area Row 11	Override Area Row 12	Override Area Row 13	Override Area Row 14	Override Area Row 15	Override Area Row 16	Override Area Row 17	Override Area Row 18	Override Area Row 19	Override Area Row 20	Override Area Row 21	Override Area Row 22	Override Area Row 23	Override Area Row 24	

RESTRICTOR PLATE SIZING FOR CIRCULAR VERTICAL ORIFICES

Project: SETTLERS VIEW
Basin ID: POND S3

X



Sizing the Restrictor Plate for Circular Vertical Orifices or Pipes (Input)

		#1 Vertical Orifice	#2 Vertical Orifice	
Water Surface Elevation at Design Depth	Elev: WS =		7,578.00	feet
Pipe/Vertical Orifice Entrance Invert Elevation	Elev: Invert =		7,572.00	feet
Required Peak Flow through Orifice at Design Depth	Q =		24.00	cfs
Pipe/Vertical Orifice Diameter (inches)	Dia =		24.0	inches
Orifice Coefficient	C_o =		0.60	

Full-flow Capacity (Calculated)

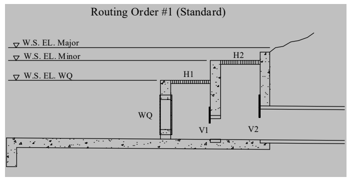
Full-flow area	Af =		3.14	sq ft
Half Central Angle in Radians	Theta =		3.14	rad
Full-flow capacity	Qf =		33.8	cfs
	Percent of Design Flow =		141%	

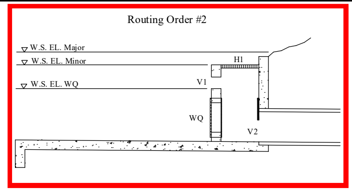
Calculation of Orifice Flow Condition

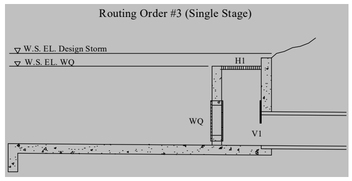
Half Central Angle (0<Theta<3.1416)	Theta =		1.87	rad
Flow area	A_o =		2.16	sq ft
Top width of Orifice (inches)	T_o =		22.92	inches
Height from Invert of Orifice to Bottom of Plate (feet)	Y_o =		1.30	feet
Elevation of Bottom of Plate	Elev Plate Bottom Edge =		7,573.30	feet
Resultant Peak Flow Through Orifice at Design Depth	Q_o =		24.0	cfs
Width of Equivalent Rectangular Vertical Orifice	**Equivalent Width =**		**1.66**	**feet**

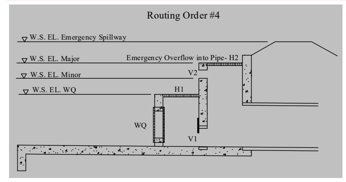
STAGE-DISCHARGE SIZING OF THE WEIRS AND ORIFICES (INLET CONTROL)

Project: SETTLERS VIEW
Basin ID: POND S3









Current Routing Order is #2

Design Information (Input):

			#1 Horiz.	#2 Horiz.	#1 Vert.	#2 Vert.	
Circular Opening:	Diameter in Inches	Dia. =					inches
OR							
Rectangular Opening:	Width in Feet	W =	3.00		1.00	1.66	ft.
	Length (Height for Vertical)	L or H =	3.00		0.50	1.30	ft.
	Percentage of Open Area After Trash Rack Reduction	% open =	50		100	100	%
	Orifice Coefficient	C_o =	0.60		0.60	0.60	
	Weir Coefficient	C_w =	3.00				
	Orifice Elevation (Bottom for Vertical)	E_o =	7576.00		7,575.00	7,572.00	ft.

Calculation of Collection Capacity:

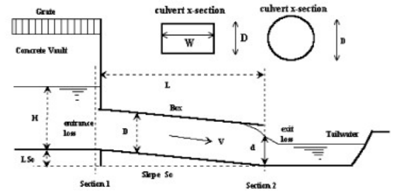
		#1 Horiz.	#2 Horiz.	#1 Vert.	#2 Vert.	
Net Opening Area (after Trash Rack Reduction)	A_o =	4.50		0.50	2.16	sq. ft.
OPTIONAL: User-Overide Net Opening Area	A_o =					sq. ft.
Perimeter as Weir Length	L_w =	9.00		ft.		
OPTIONAL: User-Overide Weir Length	L_w =			ft.		
Top Elevation of Vertical Orifice Opening, Top =				7575.50	7573.30	ft.
Center Elevation of Vertical Orifice Opening, Cen =				7575.25	7572.65	ft.

Routing 2: Water flows through WQCV plate and #1 vertical opening and #1 horizontal opening into #2 vertical opening (#2 horizontal opening is not used).

			Horizontal Orifices				Vertical Orifices			
Labels for WQCV, Minor, & Major Storage W.S. Elevations (input)	Water Surface Elevation ft (linked)	WQCV Plate/Riser Flow cfs (User-linked)	#1 Horiz. Weir Flow cfs (output)	#1 Horiz. Orifice Flow cfs (output)	#2 Horiz. Weir Flow cfs (output)	#2 Horiz. Orifice Flow cfs (output)	#1 Vert. Collection Capacity cfs (output)	#2 Vert. Collection Capacity cfs (output)	**Total Collection Capacity cfs (output)**	Target Volumes for WQCV, Minor, & Major Storage Volumes (link for goal seek)
BOTTOM	7572.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**	
	7574.00	0.05	0.00	0.00	0.00	0.00	0.00	12.08	**0.05**	
	7576.00	0.11	0.00	0.00	0.00	0.00	2.08	19.04	**2.20**	
100-YR WSL	7578.00	0.15	76.37	30.64	0.00	0.00	3.99	24.06	**24.06**	
TOP	7580.00	0.18	216.00	43.33	0.00	0.00	5.25	28.20	**28.20**	
		#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	**#N/A**	
		#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	**#N/A**	
		#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	**#N/A**	

STAGE-DISCHARGE SIZING OF THE OUTLET CULVERT (INLET vs. OUTLET CONTROL WITH TAILWATER EFFECTS)

Project: SETTLERS VIEW
Basin ID: POND S3



Status: Culvert Data is valid!

Design Information (Input):

Circular Culvert: Barrel Diameter in Inches	D =	24	in.
Circular Culvert: Inlet Edge Type (choose from pull-down list)		Grooved End with Headwall	
OR:			
Box Culvert: Barrel Height (Rise) in Feet	Height (Rise) =		ft.
Box Culvert: Barrel Width (Span) in Feet	Width (Span) =		ft.
Box Culvert: Inlet Edge Type (choose from pull-down list)		Square Edge w/ 90-15 deg. Flared Wingwall	
Number of Barrels	No =	1	
Inlet Elevation at Culvert Invert	I_{elev} =	7572.00	ft. elev.
Outlet Elevation at Culvert Invert	O_{elev} =	7571.00	ft. elev.
Culvert Length in Feet	L =	80.0	ft.
Manning's Roughness	n =	0.0130	
Bend Loss Coefficient	K_b =	0.00	
Exit Loss Coefficient	K_x =	1.00	

Design Information (calculated):

Entrance Loss Coefficient	K_e =	0.20
Friction Loss Coefficient	K_f =	0.99
Sum of All Loss Coefficients	K_s =	2.19
Orifice Inlet Condition Coefficient	C_d =	0.99
Minimum Energy Condition Coefficient	KE_{low} =	-0.03

Calculations of Culvert Capacity (output):

Water Surface Elevation From Sheet "Basin" (ft., linked)	Tailwater Surface Elevation ft (input if known)	Culvert Inlet-Control Flowrate cfs (output)	Culvert Outlet-Control Flowrate cfs (output)	Flowrate Into Culvert From Sheet "Outlet" (cfs, linked)	Controlling Culvert Flowrate cfs (output)	Inlet Equation Used (output)
7572.00	0.00	0.00	0.00	**0.00**	**0.00**	No Flow (WS < inlet)
7574.00	0.00	14.20	14.13	**0.05**	**0.05**	Regression Eqn.
7576.00	0.00	29.30	24.46	**2.20**	**2.20**	Regression Eqn.
7578.00	0.00	39.50	31.58	**24.06**	**24.06**	Regression Eqn.
7580.00	0.00	46.80	37.37	**28.20**	**28.20**	Orifice Eqn.
0.00	0.00	0.00	0.00	**#N/A**	**#N/A**	No Flow (WS < inlet)
0.00	0.00	0.00	0.00	**#N/A**	**#N/A**	No Flow (WS < inlet)
0.00	0.00	0.00	0.00	**#N/A**	**#N/A**	No Flow (WS < inlet)
0.00	0.00	0.00	0.00	**#N/A**	**#N/A**	No Flow (WS < inlet)
0.00	0.00	0.00	0.00	**#N/A**	**#N/A**	No Flow (WS < inlet)
0.00	0.00	0.00	0.00	**#N/A**	**#N/A**	No Flow (WS < inlet)
0.00	0.00	0.00	0.00	**#N/A**	**#N/A**	No Flow (WS < inlet)
0.00	0.00	0.00	0.00	**#N/A**	**#N/A**	No Flow (WS < inlet)
0.00	0.00	0.00	0.00	**#N/A**	**#N/A**	No Flow (WS < inlet)
0.00	0.00	0.00	0.00	**#N/A**	**#N/A**	No Flow (WS < inlet)
0.00	0.00	0.00	0.00	**#N/A**	**#N/A**	No Flow (WS < inlet)
0.00	0.00	0.00	0.00	**#N/A**	**#N/A**	No Flow (WS < inlet)
0.00	0.00	0.00	0.00	**#N/A**	**#N/A**	No Flow (WS < inlet)
0.00	0.00	0.00	0.00	**#N/A**	**#N/A**	No Flow (WS < inlet)
0.00	0.00	0.00	0.00	**#N/A**	**#N/A**	No Flow (WS < inlet)
0.00	0.00	0.00	0.00	**#N/A**	**#N/A**	No Flow (WS < inlet)
0.00	0.00	0.00	0.00	**#N/A**	**#N/A**	No Flow (WS < inlet)
0.00	0.00	0.00	0.00	**#N/A**	**#N/A**	No Flow (WS < inlet)
0.00	0.00	0.00	0.00	**#N/A**	**#N/A**	No Flow (WS < inlet)
0.00	0.00	0.00	0.00	**#N/A**	**#N/A**	No Flow (WS < inlet)
0.00	0.00	0.00	0.00	**#N/A**	**#N/A**	No Flow (WS < inlet)
0.00	0.00	0.00	0.00	**#N/A**	**#N/A**	No Flow (WS < inlet)
0.00	0.00	0.00	0.00	**#N/A**	**#N/A**	No Flow (WS < inlet)
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0.00	0.00	0.00	0.00	**#N/A**	**#N/A**	No Flow (WS < inlet)
0.00	0.00	0.00	0.00	**#N/A**	**#N/A**	No Flow (WS < inlet)
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0.00	0.00	0.00	0.00	**#N/A**	**#N/A**	No Flow (WS < inlet)
0.00	0.00	0.00	0.00	**#N/A**	**#N/A**	No Flow (WS < inlet)
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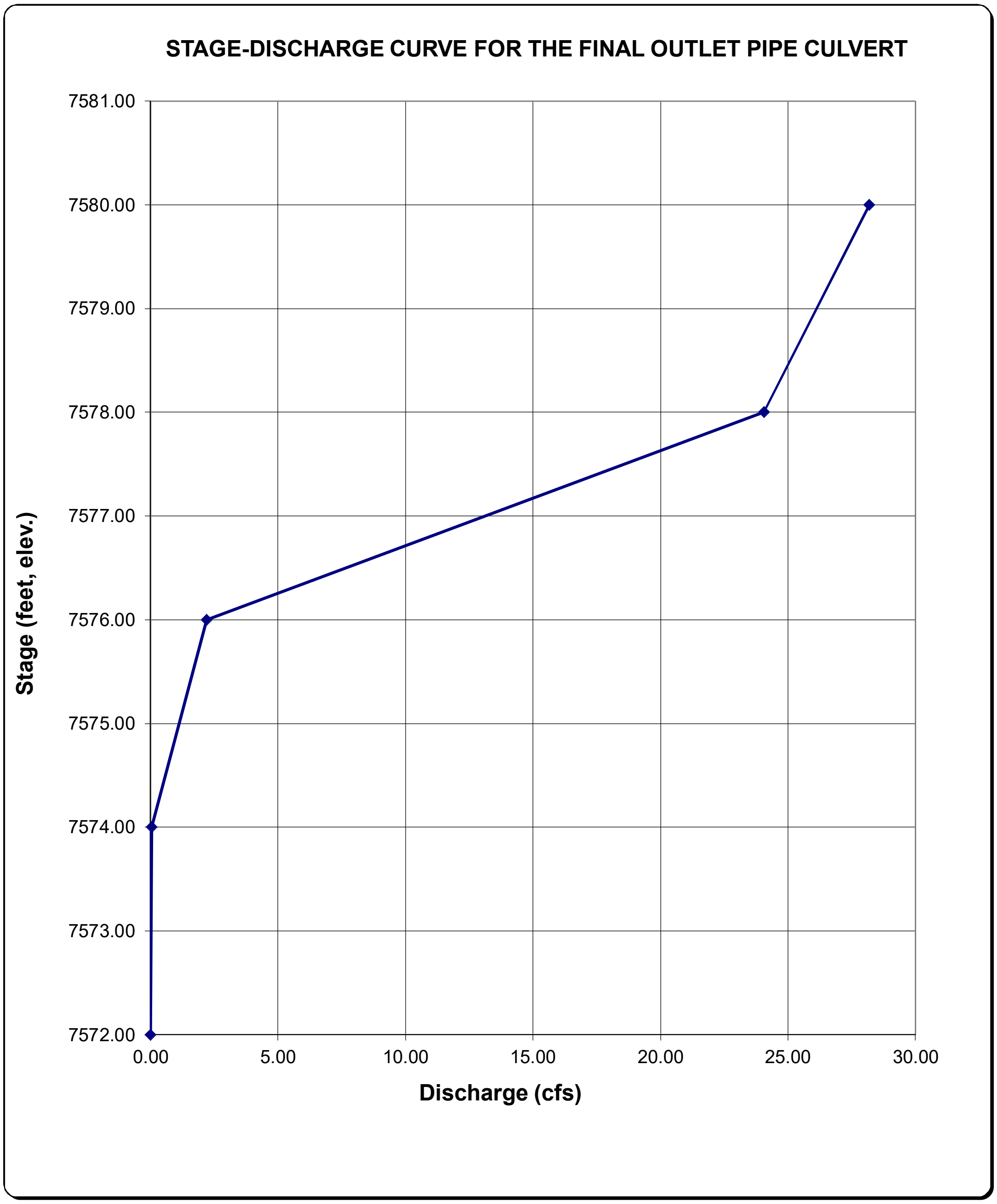
0.00	0.00	0.00	0.00	**#N/A**	**#N/A**	No Flow (WS < inlet)
0.00	0.00	0.00	0.00	**#N/A**	**#N/A**	No Flow (WS < inlet)
0.00	0.00	0.00	0.00	**#N/A**	**#N/A**	No Flow (WS < inlet)
0.00	0.00	0.00	0.00	**#N/A**	**#N/A**	No Flow (WS < inlet)
0.00	0.00	0.00	0.00	**#N/A**	**#N/A**	No Flow (WS < inlet)
0.00	0.00	0.00	0.00	**#N/A**	**#N/A**	No Flow (WS < inlet)
0.00	0.00	0.00	0.00	**#N/A**	**#N/A**	No Flow (WS < inlet)
0.00	0.00	0.00	0.00	**#N/A**	**#N/A**	No Flow (WS < inlet)

STAGE-DISCHARGE SIZING OF THE OUTLET CULVERT (INLET vs. OUTLET CONTROL WITH TAILWATER EFFECTS)

Project: SETTLERS VIEW
Basin ID: POND S3



STAGE-DISCHARGE SIZING OF THE SPILLWAY

Project: SETTLERS VIEW
Basin ID: POND S3

75.96
4.00000

Design Information (input):

Bottom Length of Weir	L =	10.00	feet
Angle of Side Slope Weir	Angle =	75.96	degrees
Elev. for Weir Crest	EL. Crest =	7,578.00	feet
Coef. for Rectangular Weir	C_w =	3.00	
Coef. for Trapezoidal Weir	C_t =	3.00	

Calculation of Spillway Capacity (output):

Water Surface Elevation ft. (linked)	Rect. Weir Flowrate cfs (output)	Triangle Weir Flowrate cfs (output)	Total Spillway Release cfs (output)	Total Pond Release cfs (output)
7572.00	0.00	0.00	0.00	0.00
7574.00	0.00	0.00	0.00	0.05
7576.00	0.00	0.00	0.00	2.20
7578.00	0.00	0.00	0.00	24.06
7580.00	84.85	67.86	152.72	180.92
#N/A	#N/A	#N/A	#N/A	#N/A
#N/A	#N/A	#N/A	#N/A	#N/A
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#N/A	#N/A	#N/A	#N/A	#N/A
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#N/A	#N/A	#N/A	#N/A	#N/A

APPENDIX D

DETENTION POND OPERATION & MAINTENANCE MANUAL

Operation and Maintenance Manual
for

Extended Detention Basins
(EDBs)

June, 2009

TABLE OF CONTENTS

EDB-1 BACKGROUND

Extended Detention Basins (EDBs) are one of the most common types of Stormwater BMPs utilized within the Front Range of Colorado. An EDB is a sedimentation basin designed to “extend” the runoff detention time, but to drain completely dry sometime after stormwater runoff ends. The EDB’s drain time for the water quality portion of the facility is typically 40 hours. The basins are considered to be “dry” because the majority of the basin is designed not to have a significant permanent pool of water remaining between runoff events.

EDBs are an adaptation of a detention basin used for flood control, with the primary difference is the addition of forebays, micropools and a slow release outlet design. Forebays are shallow concrete “pans” located at the inflow point to the basin and are provided to facilitate sediment removal within a contained area prior to releasing into the pond. These forebays collect and briefly hold stormwater runoff resulting in a process called sedimentation, dropping sediment out of the stormwater. The stormwater is then routed from the forebay into the concrete trickle channel and upper basin, the large grassy portion of the basin. The EDB uses a much smaller outlet that extends the emptying time of the more frequently occurring runoff events to facilitate pollutant removal. An EDB should have a small micropool just upstream of the outlet. This micropool is designed to hold a small amount of water to keep sediment and floatables from blocking the outlet orifices.

EDB-2 INSPECTING EXTENDED DETENTION BASINS (EDBs)

EDB-2.1 Access and Easements

Inspection or maintenance personnel may utilize the figures located in the approved Final Drainage Report for the project and recorded subdivision plat containing the location(s) of the access points and potential maintenance easements of the EDB(s) within this development.

EDB-2.2 Stormwater Best Management Practice (BMP) Locations

Inspection or maintenance personnel may utilize the figures located in the approved Final Drainage Report for the project and recorded subdivision plat containing the location(s) of the EDB(s) within this development.

EDB-2.3 Extended Detention Basin (EDB) Features

EDBs have a number of features that are designed to serve a particular function. Many times the proper function of one feature depends on another. For example, if a forebay is not properly maintained, it could negatively affect the performance of a feature downstream (trickle channel, micropool, etc.).

Therefore, it is critical that each feature of the EDB is properly inspected and maintained to ensure that the overall facility functions as it was intended. Below is a list and description of the most common features within an EDB and the corresponding maintenance inspection items that can be anticipated:

Table EDB-1
Typical Inspection & Maintenance Requirements Matrix

EDB Features	Sediment Removal	Mowing/ Weed control	Trash & Debris Removal	Erosion	Overgrown Vegetation Removal	Standing Water (mosquito/ algae control)	Structure Repair
Inflow Points (outfalls)	X		X				X
Forebay	X		X				X
Low-flow channel	X		X	X	X		X
Bottom Stage	X	X	X	X	X	X	
Micropool	X		X		X	X	X
Outlet Works	X		X				X
Emergency Spillway			X	X	X		X
Upper Stage			X	X			
Embankment		X		X	X		

EDB-2.3.1 Inflow Points

Inflow Points or Outfalls into EDBs are the point source of the stormwater discharge into the facility. An inflow point is commonly a storm sewer pipe with a flared end section that discharges into the EDB. In some instances, an inflow point could be a drainage channel or ditch that flows into the facility.

An energy dissipater (riprap or hard armor protection) is typically immediately downstream of the discharge point into the EDB to protect from erosion. In some cases, the storm sewer outfall can have a toe-wall or cut-off wall immediately below the structure to prevent undercutting of the outfall from erosion.

The typical maintenance items that are found with inflow points are as follows:

a. Riprap Displaced – Many times, because the repeated impact/force of water, the riprap can shift and settle. If any portion of the riprap apron appears to have settled, soil is present between the riprap, or the riprap has shifted, maintenance may be required to ensure future erosion is prevented.

b. Erosion Present/Outfall Undercut – In some situations, the energy dissipater may not have been sized, constructed, or maintained appropriately and erosion has occurred. Any erosion within the vicinity of the inflow point will require maintenance to prevent damage to the structure(s) and sediment transport within the facility.

c. Sediment Accumulation – Because of the turbulence in the water created by the energy dissipater, sediment often deposits immediately downstream of the inflow point. To prevent a loss in hydraulic performance of the upstream infrastructure, sediment that accumulates in this area must be removed in a timely manner.

d. Structural Damage – Structural damage can occur at anytime during the life of the facility. Typically, for an inflow, the structural damage occurs to the pipe flared end section (concrete or steel). Structural damage can lead to additional operating problems with the facility, including loss of hydraulic performance.

e. Woody Growth/Weeds Present – Undesirable vegetation can grow in and around the inflow area to an EDB that can significantly affect the performance of the drainage facilities discharging into the facility. This type of vegetation includes trees (typically cottonwoods) and dense areas of shrubs (willows). If woody vegetation is not routinely mowed/removed, the growth can cause debris/sediment to accumulate, resulting in blockage of the discharge. Also, tree roots can cause damage to the structural components of the inflow. Routine maintenance is essential for trees (removing a small tree/sapling is much cheaper and "quieter" than a mature tree). In addition, noxious weeds growing in the facility can result in the loss of desirable native vegetation and impact adjacent open spaces/land.

EDB-2.3.2 Forebay

A forebay is a solid surface (pad), typically constructed of concrete, immediately downstream of the inflow point. The forebay is designed to capture larger particles and trash to prevent them from entering the main portion of the EDB. The solid surface is designed to facilitate mechanical sediment removal (skid steer). The forebay typically includes a small diameter discharge pipe or v-notch weir on the downstream end and designed to drain the forebay in a specified period of time to promote sedimentation. The forebays vary in size and depth depending on the design and site constraints.

The typical maintenance items that are found with forebays are as follows:

a. Sediment/Debris Accumulation – Because this feature of the EDB is designed to provide the initial sedimentation, debris and sediment frequently accumulate in this area. If the sediment and debris is not removed from the forebay on a regular basis, it can significantly affect the function of other features within the EDB. Routine sediment removal from the forebay can **significantly** reduce the need for dredging of the main portion of the EDB using specialized equipment (long reach excavators). Routine removal of sediment from the forebay can **substantially** decrease the long-term sediment removal costs of an EDB.

b. Concrete Cracking/Failing – The forebay is primarily constructed of concrete, which cracks, spalls, and settles. Damage to the forebay can result in deceased performance and impact maintenance efforts.

c. Drain Pipe/Weir Clogged – Many times the drainpipe or weir can be clogged with debris, and prevent the forebay from draining properly. If standing water is present in the forebay (and there is not a base flow), the forebay is most likely not draining properly. This can result in a decrease in performance and create potential nuisances with stagnant water (mosquitoes).

d. Weir/Drain Pipe Damaged – Routine maintenance activities, vandalism, or age may cause the weir or drain pipe in the forebay to become damaged. Weirs are typically constructed of concrete, which cracks and spalls. The drainpipe is typically smaller in diameter and constructed with plastic, which can fracture.

EDB-2.3.3 <u>Trickle Channel (Low-Flow)</u>

The trickle channel conveys stormwater from the forebay to the micro-pool of the EDB. The trickle channel is typically made of concrete. However, grass lined (riprap sides protected) is also common and can provide for an additional means of water quality within the EDB. The trickle channel is typically 6-9 inches in depth and can vary in width.

The typical maintenance items that are found with trickle channels are as follows:

a. Sediment/Debris Accumulation – Trickle channels are typically designed with a relatively flat slope that can promote sedimentation and the collection of debris. Also, if a trickle channel is grass lined it can accumulate sediment and debris at a much quicker rate. Routine removal of accumulated sediment and debris is essential in preventing flows from circumventing the trickle channel and affecting the dry storage portion of the pond.

b. Concrete/Riprap Damage – Concrete can crack, spall, and settle and must be repaired to ensure proper function of the trickle channel. Riprap can also shift over time and must be replaced/repaired as necessary.

c. Woody Growth/Weeds Present – Because of the constant moisture in the area surrounding the trickle channel, woody growth (cottonwoods/willows) can become a problem. Trees and dense shrub type vegetation can affect the capacity of the trickle channel and can allow flows to circumvent the feature.

d. Erosion Outside of Channel – In larger precipitation events, the trickle channel capacity will likely be exceeded. This can result in erosion immediately adjacent to the trickle channel and must be repaired to prevent further damage to the structural components of the EDB.

EDB-2.3.4 Bottom Stage

The bottom stage is at least 1.0 to 2.0 feet deeper than the upper stage and is located in front of the outlet works structure. The bottom stage is designed to store the smaller runoff events, assists in keeping the majority of the basin bottom dry resulting in easier maintenance operations, and enhances the facilities pollutant removal capabilities. This area of the EDB may develop wetland vegetation.

The typical maintenance items that are found with the bottom stage are as follows:

a. Sediment/Debris Accumulation – The micro-pool can frequently accumulate sediment and debris. This material must be removed to maintain pond volume and proper function of the outlet structure.

b. Woody Growth/Weeds Present - Because of the constant moisture in the soil surrounding the micro-pool, woody growth (cottonwoods/willows) can create operational problems for the EDB. If woody vegetation is not routinely mowed/removed, the growth can cause debris/sediment to accumulate outside of the micro-pool, which can cause problems with other EDB features. Also, tree roots can cause damage to the structural components of the outlet works. Routine management is essential for trees (removing a small tree/sapling is much cheaper and “quieter” than a mature tree).

c. Bank Erosion – The micro-pool is usually a couple feet deeper than the other areas of the ponds. Erosion can be caused by water dropping into the micro-pool if adequate protection/armor is not present. Erosion in this area must be mitigated to prevent sediment transport and other EDB feature damage.

d. Mosquitoes/Algae Treatment – Nuisance created by stagnant water can result from improper maintenance/treatment of the micro-pool. Mosquito larvae can be laid by adult mosquitoes within the permanent pool. Also, aquatic vegetation that grows in shallow pools of water can decompose causing foul odors. Chemical/mechanical treatment of the micro-pool may be necessary to reduce these impacts to adjacent homeowners.

e. Petroleum/Chemical Sheen – Many indicators of illicit discharges into the storm sewer systems will be present in the micro-pool area of the EDB. These indicators can include sheens, odors, discolored soil, and dead vegetation. If it is suspected that an illicit discharge has occurred, contact the supervisor immediately. Proper removal/mitigation of contaminated soils and water in the EDB is necessary to minimize any environmental impacts downstream.

EDB-2.3.5 Micro-pool

The micro-pool is a concrete or grouted boulder walled structure directly in front of the outlet works. At a minimum, the micropool is 2.5 feet deep and is designed to hold water. The micro-pool is critical in the proper function of the EDB; it allows suspended sediment to be deposited at the bottom of the micro-pool and prevents these sediments from being deposited in front of the outlet works causing clogging of the outlet structure, which results in marshy areas within the top and bottom stages.

The typical maintenance items that are found with micro-pools are as follows:

a. Sediment/Debris Accumulation – The micro-pool can frequently accumulate sediment and debris. This material must be removed to maintain pond volume and proper function of the outlet structure.

b. Woody Growth/Weeds Present - Because of the constant moisture in the soil surrounding the micro-pool, woody growth (cottonwoods/willows) can create operational problems for the EDB. If woody vegetation is not routinely mowed/removed, the growth can cause debris/sediment to accumulate outside of the micro-pool, which can cause problems with other EDB features. Also, tree roots can cause damage to the structural components of the outlet works. Routine management is essential for trees (removing a small tree/sapling is much cheaper and “quieter” than a mature tree).

c. Mosquitoes/Algae Treatment – Nuisance created by stagnant water can result from improper maintenance/treatment of the micro-pool. Mosquito larvae can be laid by adult mosquitoes within the permanent pool. Also, aquatic vegetation that grows in shallow pools of water can decompose causing foul odors. Chemical/mechanical treatment of the micro-pool may be necessary to reduce these impacts to adjacent homeowners.

d. Petroleum/Chemical Sheen – Many indicators of illicit discharges into the storm sewer systems will be present in the micro-pool area of the EDB. These indicators can include sheens, odors, discolored soil, and dead vegetation. If it is suspected that an illicit discharge has occurred, contact the supervisor immediately. Proper removal/mitigation of contaminated soils and water in the EDB is necessary to minimize any environmental impacts downstream.

EDB-2.3.6 Outlet Works

The outlet works is the feature that drains the EDB in specified quantities and periods of time. The outlet works is typically constructed of reinforced concrete into the embankment of the EDB. The concrete structure typically has steel orifice plates anchored/embedded into it to control stormwater release rates. The larger openings (flood control) on the outlet structure typically have trash racks over them to prevent clogging. The water quality orifice plate (smaller diameter holes) will typically have a well screen covering it to prevent smaller materials from clogging it. The outlet structure is the single most important feature in the EDB operation. Proper inspection and maintenance of the outlet works is essential in ensuring the long-term operation of the EDB.

The typical maintenance items that are found with the outlet works are as follows:

a. Trash Rack/Well Screen Clogged – Floatable material that enters the EDB will most likely make its way to the outlet structure. This material is trapped against the trash racks and well screens on the outlet structure (which is why they are there). This material must be removed on a routine basis to ensure the outlet structure drains in the specified design period.

b. Structural Damage - The outlet structure is primarily constructed of concrete, which can crack, spall, and settle. The steel trash racks and well screens are also susceptible to damage.

c. Orifice Plate Missing/Not Secure – Many times residents, property owners, or maintenance personnel will remove or loosen orifice plates if they believe the pond is not draining properly. Any modification to the orifice plate(s) will significantly affect the designed discharge rates for water quality and/or flood control. Modification of the orifice plates is not allowed without approval from the County.

d. Manhole Access – Access to the outlet structure is necessary to properly inspect and maintain the facility. If access is difficult or not available to inspect the structure, chances are it will be difficult to maintain as well.

e. Woody Growth/Weeds Present - Because of the constant moisture in the soil surrounding the outlet works, woody growth (cottonwoods/willows) can create operational problems for the EDB. If woody vegetation is not routinely mowed/removed, the growth can cause debris/sediment to accumulate around the outlet works, which can cause problems with other EDB features. Also, tree roots can cause damage to the structural components of the outlet works. Routine management is essential for trees (removing a small tree/sapling is much cheaper and “quieter” than a mature tree).

EDB-2.3.7 <u>Emergency Spillway</u>

An emergency spillway is typical of all EDBs and designed to serve as the overflow in the event the volume of the pond is exceeded. The emergency spillway is typically armored with riprap (or other hard armor) and is sometimes buried with soil. The emergency spillway is typically a weir (notch) in the pond embankment. Proper function of the emergency spillway is essential to ensure flooding does not affect adjacent properties.

The typical maintenance items that are found with emergency spillways are as follows:

a. Riprap Displaced – As mentioned before, the emergency spillway is typically armored with riprap to provide erosion protection. Over the life of an EDB, the riprap may shift or dislodge due to flow.

b. Erosion Present – Although the spillway is typically armored, stormwater flowing through the spillway can cause erosion damage.

Erosion must be repaired to ensure the integrity of the basin embankment, and proper function of the spillway.

c. Woody Growth/Weeds Present – Management of woody vegetation is essential in the proper long-term function of the spillway. Larger trees or dense shrubs can capture larger debris entering the EDB and reduce the capacity of the spillway.

d. Obstruction Debris – The spillway must be cleared of any obstruction (man made or natural) to ensure the proper design capacity.

EDB-2.3.8 Upper Stage (Dry Storage)

The upper stage of the EDB provides the majority of the water quality flood detention volume. This area of the EDB is higher than the micro-pool and typically stays dry, except during storm events. The upper stage is the largest feature/area of the basin. Sometimes, the upper stage can be utilized for park space and other uses in larger EDBs. With proper maintenance of the micro-pool and forebay(s), the upper stage should not experience much sedimentation; however, bottom elevations should be monitored to ensure adequate volume.

The typical maintenance items that are found with upper stages are as follows:

a. Vegetation Sparse – The upper basin is the most visible part of the EDB, and therefore aesthetics is important. Adequate and properly maintained vegetation can greatly increase the overall appearance and acceptance of the EDB by the public. In addition, vegetation can reduce the potential for erosion and subsequent sediment transport to the other areas of the pond.

b. Woody Growth/Undesirable Vegetation – Although some trees and woody vegetation may be acceptable in the upper basin, some thinning of cottonwoods and willows may be necessary. Remember, the basin will have to be dredged to ensure volume, and large trees and shrubs will be difficult to protect during that operation.

c. Standing Water/Boggy Areas – Standing water or boggy areas in the upper stage is typically a sign that some other feature in the pond is not functioning properly. Routine maintenance (mowing, trash removal, etc) can be extremely difficult for the upper stage if the ground is saturated. If this inspection item is checked, make sure you have identified the root cause of the problem.

d. Sediment Accumulation – Although other features within the EDB are designed to capture sediment, the upper storage area will collect sediment over time. Excessive amounts of sedimentation will result in a loss of storage volume. It may be more difficult to determine if this area has accumulated sediment without conducting a field survey.

Below is a list of indicators:

1. Ground adjacent to the trickle channel appears to be several inches higher than concrete/riprap
2. Standing water or boggy areas in upper stage
3. Uneven grades or mounds
4. Micro-pool or Forebay has excessive amounts of sediment

e. Erosion (banks and bottom) – The bottom grades of the dry storage are typically flat enough that erosion should not occur. However, inadequate vegetative cover may result in erosion of the upper stage. Erosion that occurs in the upper stage can result in increased dredging/maintenance of the micro-pool.

f. Trash/Debris – Trash and debris can accumulate in the upper area after large events, or from illegal dumping. Over time, this material can accumulate and clog the EDB outlet works.

g. Maintenance Access – Most EDBs typically have a gravel/concrete maintenance access path to either the upper stage or forebay. This access path should be inspected to ensure the surface is still drivable. Some of the smaller EDBs may not have maintenance access paths; however, the inspector should verify that access is available from adjacent properties.

EDB-2.3.9 Miscellaneous

There are a variety of inspection/maintenance issues that may not be attributed to a single feature within the EDB. This category on the inspection form is for maintenance items that are commonly found in the EDB, but may not be attributed to an individual feature.

a. Access – Access needs to be maintained.

b. Graffiti/Vandalism – Damage to the EDB infrastructure can be caused by vandals. If criminal mischief is evident, the inspector should forward this information to the local enforcement agency.

c. Public Hazards – Public hazards include items such as vertical drops of greater than 4-feet, containers of unknown/suspicious substances, exposed metal/jagged concrete on structures. **If any hazard is found within the facility area that poses an immediate threat to public safety, contact the local emergency services at 911 immediately!**

d. Burrowing Animals/Pests – Prairie dogs and other burrowing rodents may cause damage to the EDB features and negatively affect the vegetation within the EDB.

e. Other – Any miscellaneous inspection/maintenance items not contained on the form should be entered here.

EDB-2.4 Inspection Forms

Inspection forms shall be completed by the person(s) conducting the inspection activities. These inspection forms shall be kept a minimum of 5 years and made available to the County upon request.

EDB-3 MAINTAINING EXTENDED DETENTION BASINS (EDBS)

EDB-3.1 Maintenance Personnel

Maintenance personnel must be qualified to properly maintain EDBs. Inadequately trained personnel can cause additional problems resulting in additional maintenance costs.

EDB-3.2 Equipment

It is imperative that the appropriate equipment and tools are taken to the field with the operations crew. The types of equipment/tools will vary depending on the task at hand. Below is a list of tools, equipment, and material(s) that may be necessary to perform maintenance on an EDB:

1.) Loppers/Tree Trimming Tools
2.) Mowing Tractors
3.) Trimmers (extra string)
4.) Shovels
5.) Rakes
6.) All Surface Vehicle (ASVs)
7.) Skid Steer
8.) Back Hoe
9.) Track Hoe/Long Reach Excavator
10.) Dump Truck

11.) Jet-Vac Machine
12.) Engineers Level (laser)
13.) Riprap (Minimum - Type M)
14.) Filter Fabric
15.) Erosion Control Blanket(s)
16.) Seed Mix (Native Mix)
17.) Illicit Discharge Cleanup Kits
18.) Trash Bags
19.) Tools (wrenches, screw drivers, hammers, etc)
20.) Chain Saw
21.) Confined Space Entry Equipment
22.) Approved Inspection and Maintenance Plan

Some of the items identified above may not be needed for every maintenance operation. However, this equipment should be available to the maintenance operations crews should the need arise.

EDB-3.3 Safety

Vertical drops may be encountered in areas located within and around the facility. Avoid walking on top of retaining walls or other structures that have a significant vertical drop. If a vertical drop is identified within the EDB that is greater than 48" in height, make the appropriate note/comment on the maintenance inspection form.

EDB-3.4 Maintenance Forms

An EDB Maintenance Form provides a record of each maintenance operation performed by maintenance contractors. An EBD Maintenance Form shall be filled out in the field after the completion of the maintenance operation.

EDB-3.5 Maintenance Categories and Activities

A typical EDB Maintenance Program will consist of three broad categories of work: Routine, Restoration (minor), and Rehabilitation (major). Within each category of work, a variety of maintenance activities can be performed on an EDB. A maintenance activity can be specific to each feature within the EDB, or general to the overall facility. This section of the SOP explains each of the categories and briefly describes the typical maintenance activities for an EDB.

A variety of maintenance activities are typical of EDBs. The maintenance activities range in magnitude from routine trash pickup to the reconstruction of drainage infrastructure. Below is a description of each maintenance activity, the objectives, and frequency of actions:

EDB-3.6 Routine Maintenance Activities

The majority of this work consists of regularly scheduled mowing and trash and debris pickups for stormwater management facilities during the growing season. This includes items such as the removal of debris/material that may be clogging the outlet structure well screens and trash racks. It also includes activities such as includes weed control, mosquito treatment, and algae treatment. These activities normally will be performed numerous times during the year. These items can be completed without any prior correspondence with the County; however, completed inspection and maintenance forms shall be kept on file.

The Maintenance Activities are summarized below, and further described in the following sections.

TABLE – EDB-2
Summary of Routine Maintenance Activities

MAINTENANCE ACTIVITY	MINIMUM FREQUENCY	LOOK FOR:	MAINTENANCE ACTION
Mowing	Twice annually	Excessive grass height/aesthetics	Mow grass to a height of 4” to 6”
Trash/Debris Removal	Twice annually	Trash & debris in EDB	Remove and dispose of trash and debris
Outlet Works Cleaning	As needed - after significant rain events – twice annually min.	Clogged outlet structure; ponding water	Remove and dispose of debris/trash/sediment to allow outlet to function properly
Weed control	Minimum twice annually	Noxious weeds; Unwanted vegetation	Treat w/ herbicide or hand pull; Consult the local weed specialist
Mosquito Treatment	As needed	Standing water/mosquito habitat	Treat w/ EPA approved chemicals
Algae Treatment	As needed	Standing water/ Algal growth/green color	Treat w/ EPA approved chemicals

EDB-3.6.1 Mowing

Occasional mowing is necessary to limit unwanted vegetation and to improve the overall appearance of the EDB. Native vegetation should be mowed to a height of 4-to-6 inches tall. Grass clippings should be collected and disposed of properly.

Frequency – Routine - Minimum of twice annually or depending on aesthetics.

EDB-3.6.2 Trash/Debris Removal

Trash and debris must be removed from the entire EDB area to minimize outlet clogging and to improve aesthetics. This activity must be performed prior to mowing operations.

Frequency – Routine – Prior to mowing operations and minimum of twice annually.

EDB-3.6.3 Outlet Works Cleaning

Debris and other materials can clog the outlet work's well screen, orifice plate(s) and trash rack. This activity must be performed anytime other maintenance activities are conducted to ensure proper operation.

Frequency - Routine – After significant rainfall event or concurrently with other maintenance activities.

EDB-3.6.4 Weed Control

Noxious weeds and other unwanted vegetation must be treated as needed throughout the EDB. This activity can be performed either through mechanical means (mowing/pulling) or with herbicide. Consultation with the local Weed Inspector is highly recommended prior to the use of herbicide.

Frequency – Routine – As needed based on inspections.

EDB-3.6.5 Mosquito/Algae Treatment

Treatment of permanent pools is necessary to control mosquitoes and undesirable aquatic vegetation that can create nuisances. Only EPA approved chemicals/materials can be used in areas that are warranted.

Frequency – As needed.

EDB- 3.7 Restoration Maintenance Activities

This work consists of a variety of isolated or small-scale maintenance or operational problems. Most of this work can be completed by a small crew, tools, and small equipment. These items do not require prior correspondence with the County require completed inspection and maintenance forms to be kept on file.

Table – EDB-3
Summary of Restoration Maintenance Activities

MAINTENANCE ACTIVITY	MINIMUM FREQUENCY	LOOK FOR:	MAINTENANCE ACTION
Sediment Removal	As needed; typically every 1 –2 years	Sediment build-up; decrease in pond volume	Remove and dispose of sediment
Erosion Repair	As needed, based upon inspection	Rills/gullies forming on side slopes, trickle channel, other areas	Repair eroded areas Revegetate; address source of erosion
Vegetation Removal/Tree Thinning	As needed, based upon inspection	Large trees/wood vegetation in lower chamber of pond	Remove vegetation; restore grade and surface
Drain Cleaning/Jet Vac	As needed, based upon inspection	Sediment build-up /non draining system	Clean drains; Jet Vac if needed

EDB-3.7.1 Sediment Removal

Sediment removal is necessary to maintain the original design volume of the EDB and to ensure proper function of the infrastructure. Regular sediment removal (minor) from the forebay, inflow(s), and trickle channel can significantly reduce the frequency of major sediment removal activities (dredging) in the upper and lower stages. The minor sediment removal activities can typically be addressed with shovels and smaller equipment. Major sediment removal activities will require larger and more specialized equipment. The major sediment activities may also require surveying with an engineer’s level, and consultation with the Consulting Engineer or County staff to ensure design volumes/grades are achieved.

Stormwater sediments removed from EDBs do not meet the criteria of “hazardous waste”. However, these sediments are contaminated with a wide array of organic and inorganic pollutants and handling must be done with care. Sediments from permanent pools must be carefully removed to minimize turbidity, further sedimentation, or other adverse water quality impacts. Sediments should be transported by motor vehicle only after they are dewatered. All sediments must be taken to a landfill for proper disposal. Prompt and thorough cleanup is important should a spill occur during transportation.

Frequency – Nonroutine – As necessary based upon inspections. Sediment removal in the forebay and trickle channel may be necessary as frequently as every 1-2 years.

EDB-3.7.2 Erosion Repair

The repair of eroded areas is necessary to ensure the proper function of the EDB, minimize sediment transport, and to reduce potential impacts to other features. Erosion can vary in magnitude from minor repairs to trickle channels, energy dissipaters, and rilling to major gullies in the embankments and spillways. The repair of eroded areas may require the use of excavators, earthmoving equipment, riprap, concrete, erosion control blankets, and turf reinforcement mats. Major erosion repair to the pond embankments, spillways, and adjacent to structures will require consultation with the Consulting Engineer or County Engineering staff.

Frequency – Nonroutine – As necessary based upon inspections.

EDB-3.7.3 Vegetation Removal/Tree Thinning

Dense stands of woody vegetation (willows, shrubs, etc) or trees can create maintenance problems for the infrastructure within an EDB. Tree roots can damage structures and invade pipes/channels thereby blocking flows. Also, trees growing in the upper and lower stages of the EDB will most likely have to be removed when sediment/dredging operations occur. A small tree is easier to remove than a large tree, therefore, regular removal/thinning is imperative. All trees and woody vegetation that is growing in the bottom of the EDB or near structures (inflows, trickle channels, outlet works, emergency spillways, etc) should be removed. Any trees or woody vegetation in the EDB should be limited to the upper portions of the pond banks.

Frequency – Nonroutine – As necessary based upon inspections.

EDB-3.7.4 Clearing Drains/Jet-Vac

An EDB contains many structures, openings, and pipes that can be frequently clogged with debris. These blockages can result in a decrease of hydraulic capacity and create standing water in areas outside of the micro-pool. Many times the blockage to this infrastructure can be difficult to access and/or clean. Specialized equipment (jet-vac machines) may be necessary to clear debris from these difficult areas.

Frequency – Nonroutine – As necessary based upon inspections.

EDB-3.8 Rehabilitation Maintenance Activities

This work consists of larger maintenance/operational problems and failures within the stormwater management facilities. All of this work requires consultation with the Consulting Engineer or County Engineering staff to ensure the proper maintenance is performed. This work requires that the engineering staff review the original design and construction drawings to access the situation and assign the necessary maintenance. This work may also require more specialized maintenance equipment, design/details, surveying, or assistance through private contractors and consultants. Any proper permits required for this activity must be obtained.

Table – EDB-4
Summary of Rehabilitation Maintenance Activities

MAINTENANCE ACTIVITY	MINIMUM FREQUENCY	LOOK FOR:	MAINTENANCE ACTION
Major Sediment Removal	As needed – based upon scheduled inspections	Large quantities of sediment; reduced pond capacity	Remove and dispose of sediment. Repair vegetation as needed
Major Erosion Repair	As needed – based upon scheduled inspections	Severe erosion including gullies, excessive soil displacement, areas of settlement, holes	Repair erosion – find cause of problem and address to avoid future erosion
Structural Repair	As needed – based upon scheduled inspections	Deterioration and/or damage to structural components – broken concrete, damaged pipes, outlet works	Structural repair to restore the structure to its original design

EDB-3.8.1 Major Sediment Removal

Major sediment removal consists of removal of large quantities of sediment or removal of sediment from vegetated areas. Care shall be given when removing large quantities of sediment and sediment deposited in vegetated areas. Large quantities of sediment need to be carefully removed, transported and disposed of. Vegetated areas need special care to ensure design volumes and grades are preserved.

Frequency – Nonroutine – Repair as needed based upon inspections.

EDB-3.8.2 Major Erosion Repair

Major erosion repair consist of filling and revegetating areas of severe erosion. Determining the cause of the erosion as well as correcting the condition that caused the erosion should also be part of the erosion repair. Care should be given to ensure design grades and volumes are preserved.

Frequency – Nonroutine – Repair as needed based upon inspections.

EDB-3.8.3 Structural Repair

An EDB includes a variety of structures that can deteriorate or be damaged during the course of routine maintenance. These structures are constructed of steel and concrete that can degrade or be damaged and may need to be repaired or re-constructed from time to time. These structures include items like outlet works, trickle channels, forebays, inflows and other features. In-house operations staff can perform some of the minor structural repairs. Major repairs to structures may require input from a structural engineer and specialized contractors. Consultation with the Consulting Engineer or County Engineering staff should take place prior to all structural repairs.

Frequency – Nonroutine – Repair as needed based upon inspections.

Reference:
This Manual is adapted from City of Colorado Springs O&M Procedures, which are adapted from SEMSWA (2007) and from the Town of Parker, Colorado (2004), STORMWATER PERMANENT BEST MANAGEMENT PRACTICES (PBMP) LONG-TERM OPERATION AND MAINTENANCE MANUAL

APPENDIX E

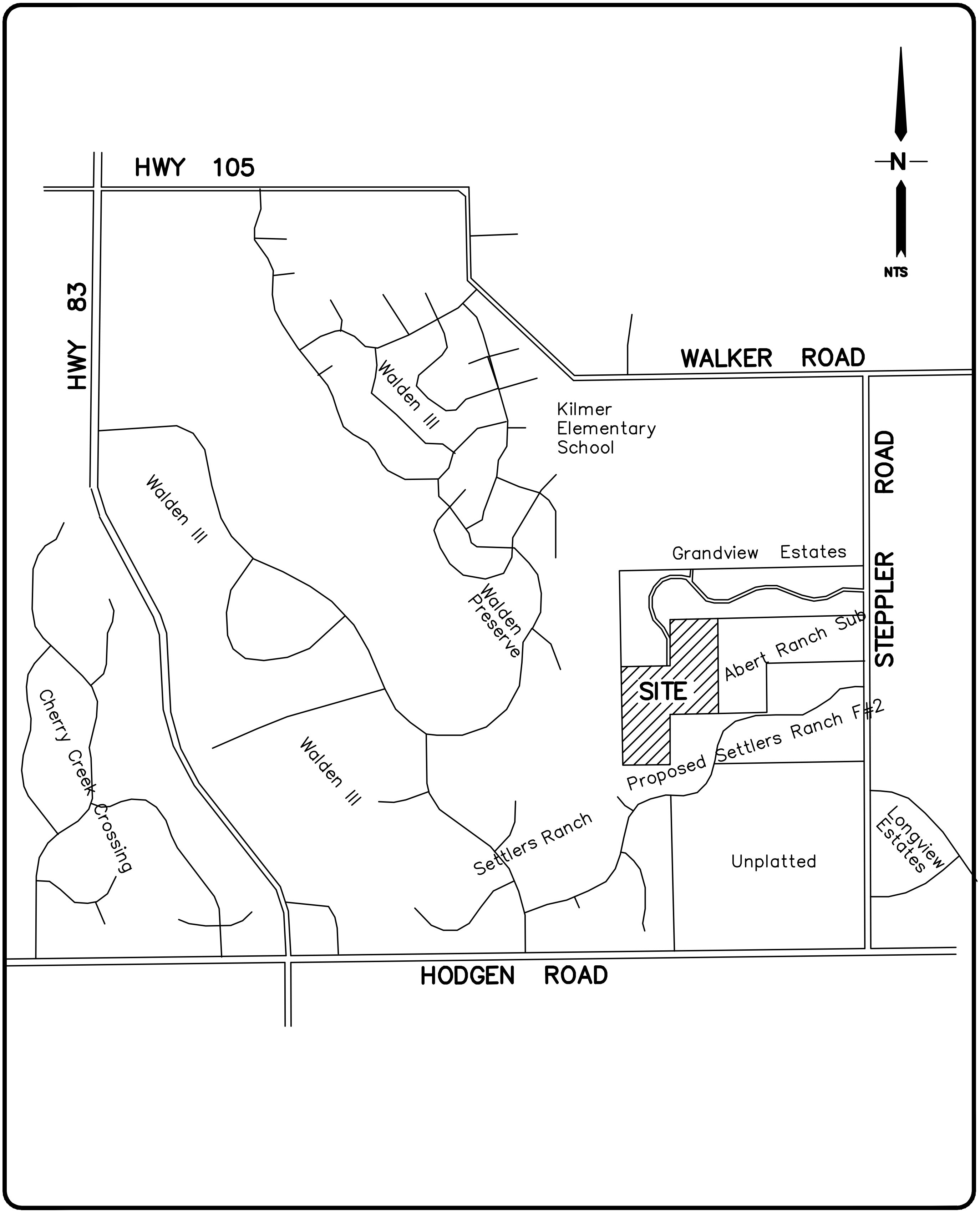
DRAINAGE COST ESTIMATE

SETTLERS VIEW
DRAINAGE IMPROVEMENTS COST ESTIMATE

Item No.	Description	Quantity	Unit	Unit Cost ($$$)	Total Cost ($$$)
	PRIVATE DRAINAGE IMPROVEMENTS				
506	Riprap Aprons (d_{50} = 12")	5	CY	$98	$490
603	24" HDPE Pond Discharge Pipe w/ FES	80	LF	$84	$6,720
604	Detention Pond Grading	1000	CY	$5	$5,000
604	Detention Pond Forebay	1	EA	$3,000	$3,000
604	Detention Pond Outlet Structure	1	LS	$8,000	$8,000
604	Detention Pond Spillway	1	LS	$3,000	$3,000
	SUBTOTAL				**$26,210**
	Contingency @ 15%				$3,932
	TOTAL				**$30,142**
	PUBLIC DRAINAGE IMPROVEMENTS (NON-REIMBURSABLE)				
506	Riprap Culvert Aprons (d_{50} = 12")	10	CY	$98	$980
603	18" RCP Culvert w/ FES	64	LF	$69	$4,416
603	24" RCP Culvert w/ FES	64	LF	$84	$5,376
	SUBTOTAL				**$10,772**
	Contingency @ 15%				$1,616
	TOTAL				**$12,388**
	TOTAL DRAINAGE IMPROVEMENTS				**$42,529**

APPENDIX F

FIGURES



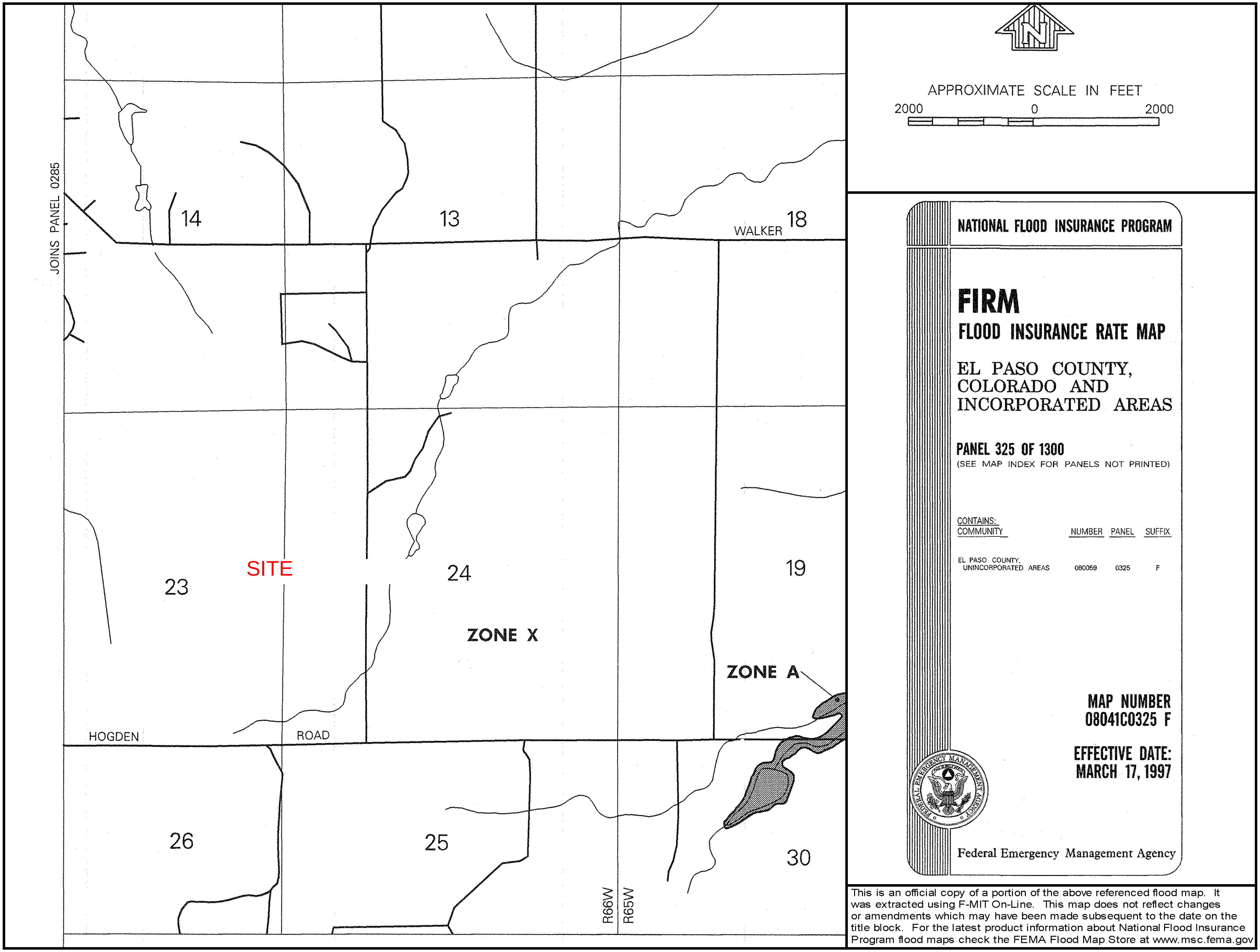
VICINITY MAP

JPS ENGINEERING

SETTLERS VIEW

FIGURE A1

JPS PROJ NO. 111603



NATIONAL FLOOD INSURANCE PROGRAM

FIRM
FLOOD INSURANCE RATE MAP

EL PASO COUNTY,
COLORADO AND
INCORPORATED AREAS

PANEL 325 OF 1300
(SEE MAP INDEX FOR PANELS NOT PRINTED)

CONTAINS: COMMUNITY	NUMBER	PANEL	SUFFIX
EL PASO COUNTY, UNINCORPORATED AREAS	080059	0325	F

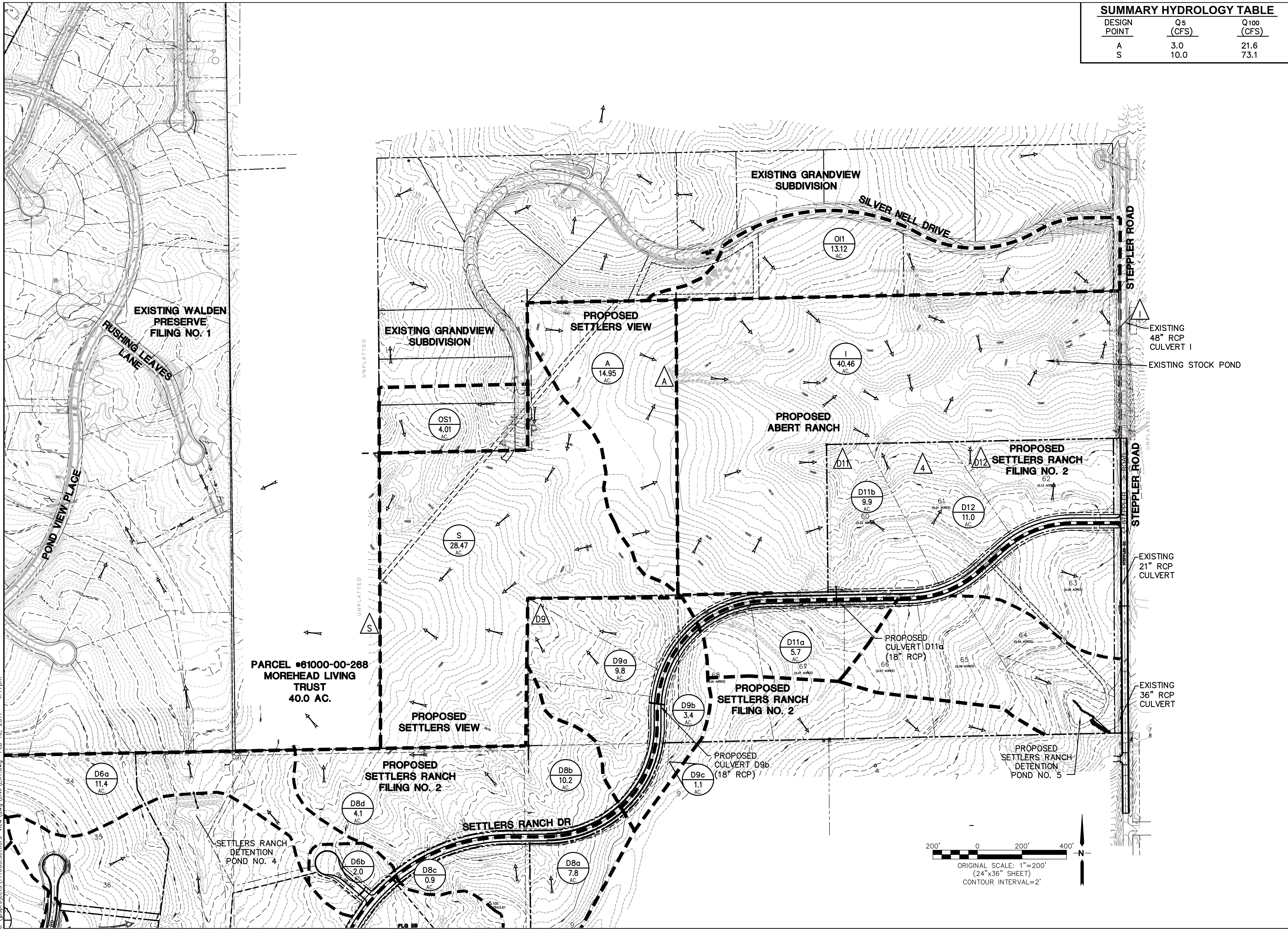
MAP NUMBER
08041C0325 F

EFFECTIVE DATE:
MARCH 17, 1997

Federal Emergency Management Agency

SUMMARY HYDROLOGY TABLE

DESIGN POINT	Q5 (CFS)	Q100 (CFS)
A	3.0	21.6
S	10.0	73.1



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FAX: 719-471-0766
www.jpsengr.com

CALL UTILITY NOTIFICATION CENTER OF COLORADO
1-800-922-1987
CALL 2-BUSINESS DAYS IN ADVANCE BEFORE YOU DIG, GRADE, OR EXCAVATE FOR THE MARKING OF UNDERGROUND MEMBER UTILITIES.

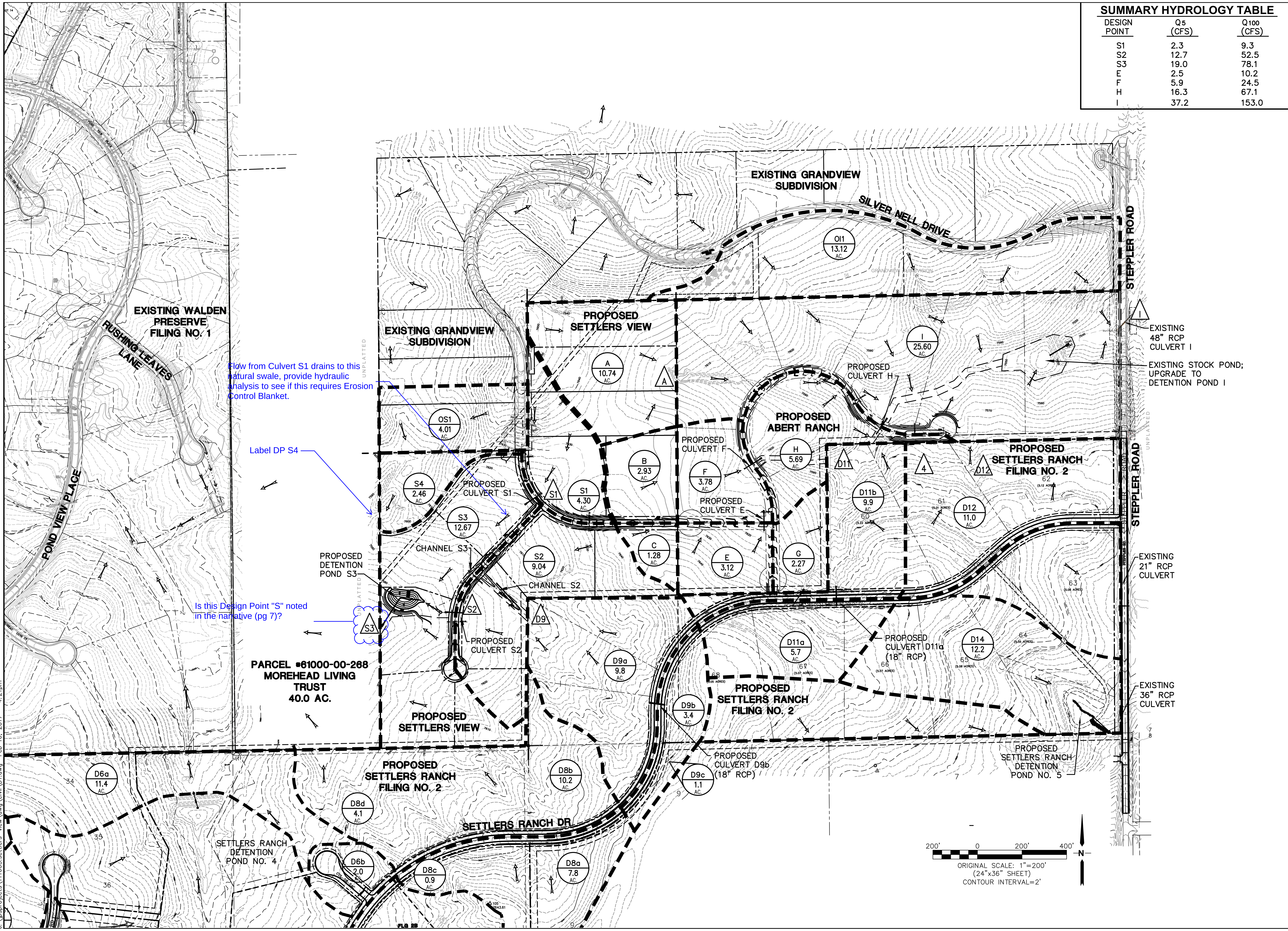
No.	REVISION	BY	DATE

SETTLERS VIEW & ABERT RANCH

HISTORIC DRAINAGE PLAN

HORZ. SCALE: 1"=200'	DRAWN: BJJ
VERT. SCALE: N/A	DESIGNED: JPS
SURVEYED: HANNIGAN	CHECKED: JPS
CREATED: 2/14/17	LAST MODIFIED: 2/16/17
PROJECT NO: 111603	MODIFIED BY: BJJ

SHEET: EX1



SUMMARY HYDROLOGY TABLE

DESIGN POINT	Q_5 (CFS)	Q_{100} (CFS)
S1	2.3	9.3
S2	12.7	52.5
S3	19.0	78.1
E	2.5	10.2
F	5.9	24.5
H	16.3	67.1
I	37.2	153.0

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No.	REVISION	BY	DATE

SETTLERS VIEW & ABERT RANCH

DEVELOPED DRAINAGE PLAN

HORZ. SCALE: 1"=200'	DRAWN: BJJ
VERT. SCALE: N/A	DESIGNED: JPS
SURVEYED: HANNIGAN	CHECKED: JPS
CREATED: 12/26/16	LAST MODIFIED: 2/16/17
PROJECT NO: 111603	MODIFIED BY: BJJ
SHEET:	D1

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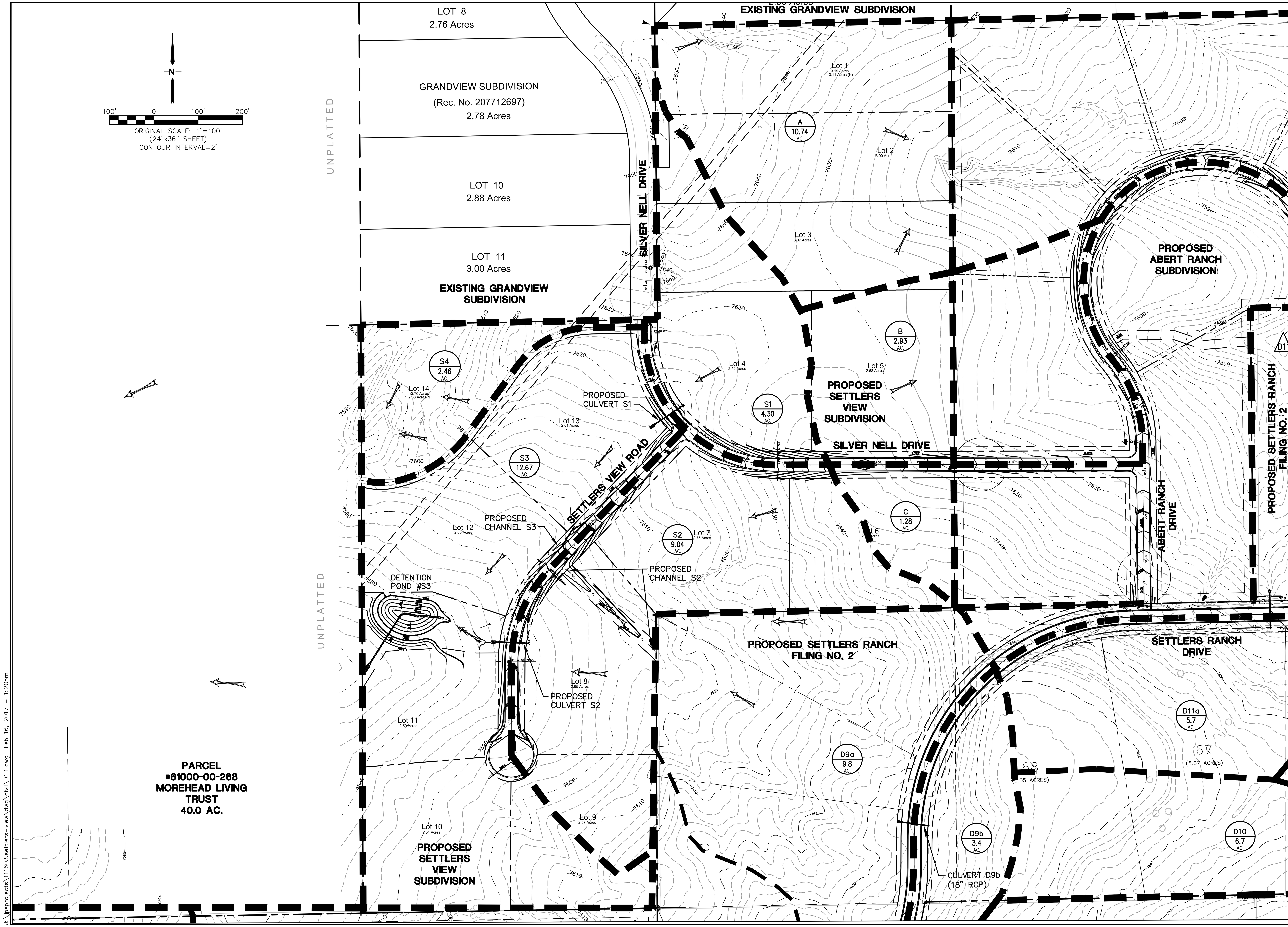

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CALL 2-BUSINESS DAYS IN ADVANCE BEFORE YOU DIG, GRADE, OR EXCAVATE FOR THE MARKING OF UNDERGROUND MEMBER UTILITIES.

No.	REVISION	BY	DATE

SETTLERS VIEW

ENLARGED DEVELOPED DRAINAGE PLAN

HORZ. SCALE:	1"=100'	DRAWN:	BJJ
VERT. SCALE:	N/A	DESIGNED:	JPS
SURVEYED:	HANNIGAN	CHECKED:	JPS
CREATED:	12/26/16	LAST MODIFIED:	2/16/17
PROJECT NO:	111603	MODIFIED BY:	BJJ
SHEET:		D1.1	

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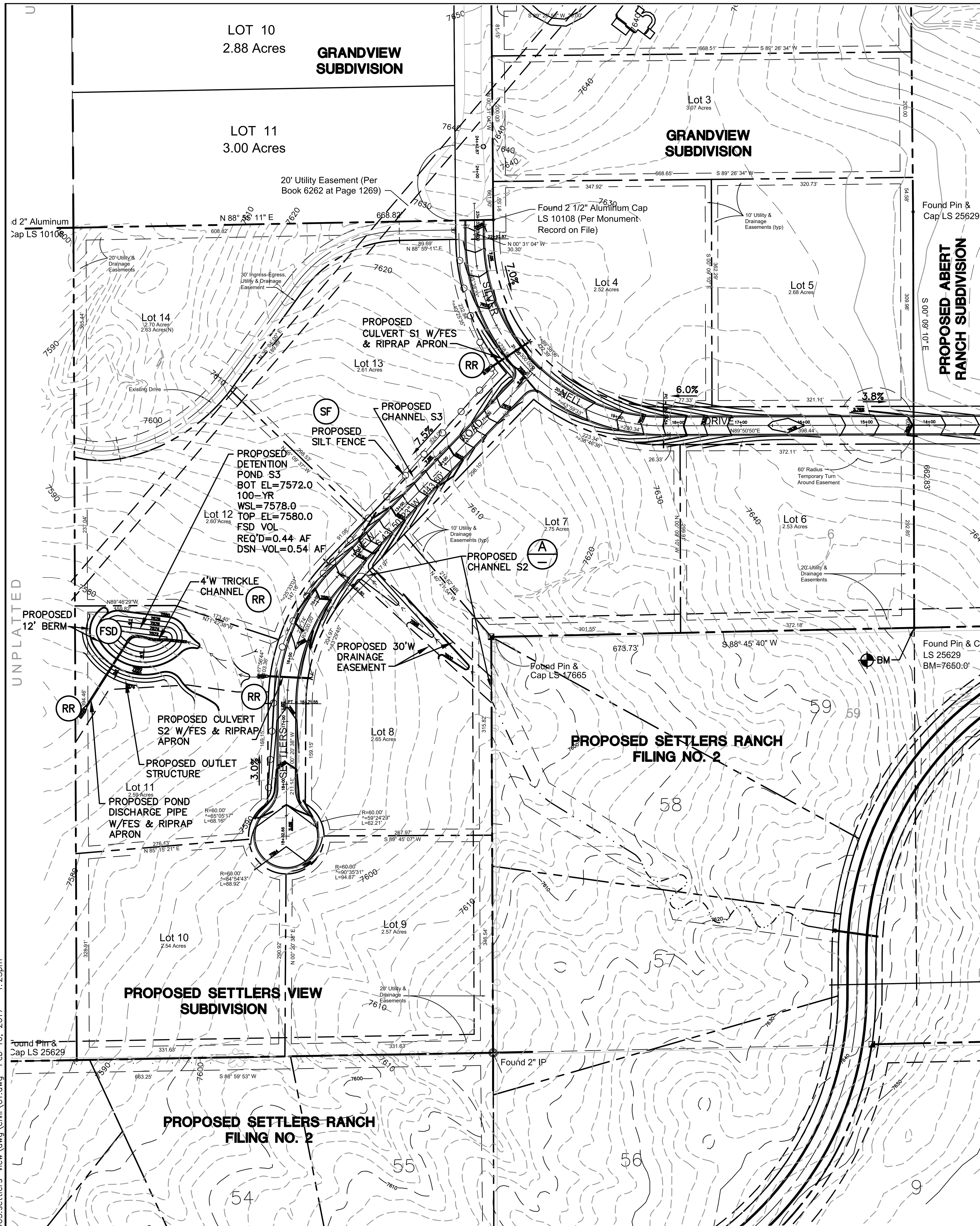


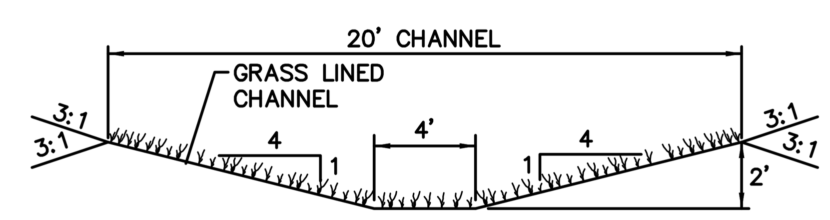
BENCHMARK
THE MONUMENT AT THE SOUTHEAST PROPERTY CORNER, HAVING AN ASSUMED ELEVATION OF 7650.0 DATUM IS NAVD '88.

EROSION CONTROL:

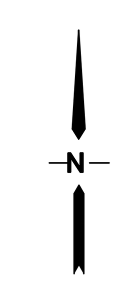
- (RR) RIPRAP
- (VTC) VEHICLE TRACKING PAD
- (SF) SILT FENCE
- (FSD) FULL-SPECTRUM DETENTION BASIN

LEGEND:

NEW/EXISTING
- SECTION LINE – NEW/EXISTING
- EASEMENT LINE – NEW/EXISTING
- 6230 CONTOUR – NEW/EXISTING
- PROPERTY LINE – NEW/EXISTING
- FENCE – NEW/EXISTING
- OHE OVERHEAD ELECTRIC LINE W/ POWER POLE NEW/EXISTING
- UGE UNDERGROUND ELECTRIC LINE NEW/EXISTING
- UGE UNDERGROUND ELECTRIC – NEW/EXISTING
- TEL TELEPHONE – NEW/EXISTING
- GAS GAS – NEW/EXISTING
- WT WATER – NEW/EXISTING
- 1 SECTION NUMBER
- P1 SHEET ON WHICH SECTION IS SHOWN



CHANNEL SECTION S2 (A)
SCALE : NTS



ORIGINAL SCALE: 1"=100'
(24"x36" SHEET)
CONTOUR INTERVAL = 2'

SETTLERS VIEW

PRELIMINARY GRADING & EROSION CONTROL PLAN

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No.	REVISION	BY	DATE

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VERT. SCALE:	N/A	DESIGNED:	JPS
SURVEYED:	HANNIGAN	CHECKED:	JPS
CREATED:	11/23/16	LAST MODIFIED:	2/16/17
PROJECT NO:	111603	MODIFIED BY:	BJJ
SHEET:	C1		

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Markup Summary

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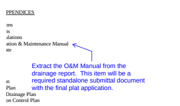

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Status:
Checkmark: Unchecked
Author: dsdlaforce
Date: 8/1/2017 4:51:34 PM
Color:

Extract the O&M Manual from the drainage report. This item will be a required standalone submittal document with the final plat application.

8/1/2017 4:52:31 PM (1)

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Date: 8/1/2017 4:52:31 PM
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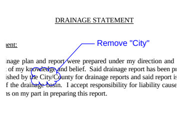

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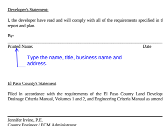

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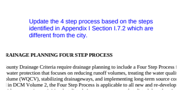

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Update the 4 step process based on the steps identified in Appendix I Section I.7.2 which are different from the city.

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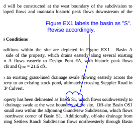

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Date: 8/2/2017 11:51:52 AM
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Figure EX1 labels the basin as "S". Revise accordingly.

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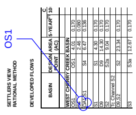

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OS1

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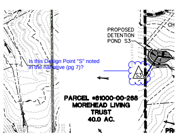

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Is this Design Point "S" noted in the narrative (pg 7)?

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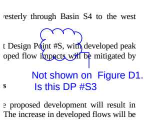

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Not shown on Figure D1. Is this DP #S3

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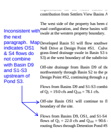

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Author: dsdlaforce
Date: 8/3/2017 8:55:11 AM
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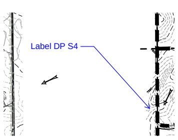
Inconsistent with the next paragraph. Map indicates OS1 & S4 flows do not combine with Basin D9 and S1-S3 upstream of Pond S3.

8/3/2017 8:56:26 AM (1)



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Label DP S4

8/3/2017 9:02:48 AM (1)

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Page Label: 12
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Date: 8/3/2017 9:02:48 AM
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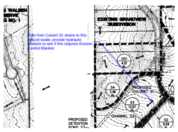
Show on Map.

8/3/2017 9:08:45 AM (1)



Subject: Callout
Page Label: 114
Lock: Unlocked
Status:
Checkmark: Unchecked
Author: dsdlaforce
Date: 8/3/2017 9:08:45 AM
Color:

Flow from Culvert S1 drains to this natural swale, provide hydraulic analysis to see if this requires Erosion Control Blanket.

8/3/2017 9:15:12 AM (1)

Subject: Callout
Page Label: 1
Lock: Unlocked
Status:
Checkmark: Unchecked
Author: dsdlaforce
Date: 8/3/2017 9:15:12 AM
Color:

Rename to Preliminary Drainage Report.

8/3/2017 9:26:29 AM (1)

Subject: Text Box
Page Label: 78
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Status:
Checkmark: Unchecked
Author: dsdlaforce
Date: 8/3/2017 9:26:29 AM
Color:

Use the latest version of UD-Detention (v3.07)

8/3/2017 9:39:35 AM (1)

Subject: Text Box
Page Label: 1
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Status:
Checkmark: Unchecked
Author: dsdlaforce
Date: 8/3/2017 9:39:35 AM
Color:

1. Use the latest version of UD-Detention (v3.07)

2. The Stormwater Detention and Infiltration (SDI) design data sheet and EPC MS4 post construction form (attached) will be required with the final plat application.

8/3/2017 9:40:39 AM (1)

Subject: File Attachment
Page Label: 1
Lock: Unlocked
Status:
Checkmark: Unchecked
Author: dsdlaforce
Date: 8/3/2017 9:40:39 AM
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