FINAL DRAINAGE REPORT

for

LONDONDERRY SCHOOL
TRACT B, PAINT BRUSH HILLS FILING NO. 13A
11243 LONDONDERRY DRIVE

Prepared for:

Falcon School District 49
10850 E. Woodmen Road
Peyton, CO 80831

April 11, 2017
Revised May 3, 2017
Revised May 25, 2017

Prepared by:

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LONDONDERRY SCHOOL
FINAL DRAINAGE REPORT
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DRAINAGE STATEMENT

Engineer's Statement:

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

John P. Schwab, P.E. #29891

COLORADO REGISTERED PROFESSIONAL ENGINEER JOHN P. SCHWAB 29891 5/24/17

Developer's Statement:

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

By: Brett Ridgway 5/18/2017

Brett Ridgway Chief Business Officer
Falcon School District 49
10850 E. Woodmen Road
Peyton, CO 80831

Date

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.
County Engineer / ECM Administrator

Date

Conditions:

I. INTRODUCTION

A. Property Location and Description

Falcon School District 49 (D49) is constructing a new school campus on a 12.5-acre property located southeast of Londonderry Drive and Towner Avenue in the Falcon area of El Paso County, Colorado. The proposed school site is located on a vacant 12.5-acre property (El Paso County Assessor's Parcel No. 52253-01-022). The site is zoned residential (RS-20,000 and RS-6,000), and the proposed school is a permitted use. The property is described as Tract B, Paint Brush Hills Filing No. 13A, and the site is addressed as 11243 Londonderry Drive.

The site adjoins developed residential areas on the north and east sides. An existing water tank parcel owned by Paint Brush Hills Metropolitan District adjoins the northwest corner of the property, and the west boundary of the site adjoins vacant land planned for future commercial and residential development. The south boundary of the site borders the existing Falcon Middle School property. In conjunction with the Site Development Plan for the new elementary school, D49 is processing a Subdivision Exemption to combine the elementary school parcel with the adjoining 39.1-acre Falcon Middle School property (Assessor's Parcel No. 52253-00-002).

The Phase 1 Site Development Plan consists of a proposed 65,570 square-foot two-story elementary school building, along with associated parking and site improvements. The future Phase 2 Site Development Plan will include a 54,800 square-foot two-story building addition to provide expanded facilities and middle school classroom space.

Access will be provided by a new private access drive connection to Londonderry Drive at the northern site boundary, and an additional private access drive connection to Towner Avenue at the southwest corner of the site. A new one-way drive will also be constructed along the east side of the Middle School site to provide for internal circulation between school buildings.

B. Scope

In support of the El Paso County Site Development Plan submittal for this project, this report is intended to meet the requirements of a Final Drainage Report in accordance with El Paso County drainage criteria. This report will provide a summary of site drainage issues impacting the proposed development. The report will analyze impacts from upstream drainage patterns, site-specific developed drainage patterns, and impacts on downstream facilities. This report is based on the guidelines and criteria presented in the City of Colorado Springs and El Paso County "Drainage Criteria Manual."

C. References

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

Classic Consulting Engineers & Surveyors, "Final Drainage Report for Paint Brush Hills Filing No. 13A (Phased Final Plat – Phase 1)," April, 2013 (approved 5/13/13).

Classic Consulting Engineers & Surveyors, "Final Drainage Report for Paint Brush Hills Filing No. 13B (Phased Final Plat – Phase 2)," January, 2014 (approved 4/23/14).

Core Engineering Group, "Final Drainage Report, Scenic View at Paint Brush Hills," July, 2014.

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

FEMA, Flood Insurance Rate Map (FIRM) Number 08041C0575F, March 17, 1997.

KKBNA, Inc., "Drainage Analysis for Paint Brush Hills Filing No. 4," December, 1986.

RG and Associates, LLC, "Preliminary / Final Drainage Report (PDR/FDR) for Paint Brush Hills Metropolitan District Administration Building Site," August, 2016.

USDA/NRCS, "Custom Soil Resource Report for El Paso County Area, Colorado," April 5, 2017.

II. EXISTING DRAINAGE CONDITIONS

The existing site topography generally slopes downward to the south with grades in the range of 2-5 percent. According to the Soil Survey of El Paso County prepared by the Soil Conservation Service (SCS), on-site soils are comprised of Pring coarse sandy loam soils, and these well-drained soils are classified as hydrologic soils group "B" (see Appendix A).

Drainage planning for this site has previously been studied in several subdivision drainage reports for the Paint Brush Hills Subdivision. Most recently, Classic Consulting Engineers & Surveyors (CCES) prepared the "Final Drainage Report for Paint Brush Hills Filing No. 13B (Phased Final Plat – Phase 2)" dated January, 2014. The school site lies within historic drainage basins H-8, H-8, H-10, and H-11 as delineated in the Classic drainage report.

As shown on the enclosed Historic Drainage Plan (Sheet EX1, Appendix E), the site has been delineated as four historic on-site drainage basins. The school site is also impacted by off-site drainage from the existing Paint Brush Hills Metropolitan District parcel (Basin Y) to the northwest.

The south side of the school property has been delineated as Basin W, which corresponds to Basin H-10 in the subdivision drainage report. Historic flows from the undeveloped Basin W drain southerly to Design Point W at the south boundary the property, with historic peak flows calculated as Q_5 = 1.1 cfs and Q_{100} = 7.7 cfs. Hydrologic calculations are enclosed in Appendix B.

Basin X comprises the northwest part of the school property. Flows from Off-site Basin Y combine with Basin X at Design Point #10, with historic peak flows calculated as Q_5 = 1.2 cfs and Q_{100} = 9.0 cfs. An existing 24" RCP culvert crosses Towner Avenue at this location and flows southwesterly to an existing regional detention pond at the northwest corner of Towner Avenue and Londonderry Drive southwest of this site.

The small area at the north boundary of the property has been delineated as Basin Z1, which sheet flows northeasterly into the existing curb and gutter along the souths side of Londonderry Drive, flowing east to the existing downstream drainage system. Historic peak flows at Design Point Z1 are calculated as Q_5 = 0.1 cfs and Q_{100} = 0.5 cfs.

The east side of the school property has been delineated as Basin Z2. The undeveloped Basin Z2 drains southeasterly to Design Point Z2 at the southeast corner of the property, with historic peak flows calculated as Q_5 = 1.2 cfs and Q_{100} = 9.0 cfs.

The subdivision drainage report by CCES has specific notes limiting the developed drainage from the school property flowing to the east, including a note within Basin Z2 stating that "Prior to grading / development of the school site this 3.8 acres will continue to historically sheet flow in an easterly direction." The CCES report further states that "Upon school development, no additional release to the east (Basins Z, AA1, AA2, AA3, & C already account for 30' of school site dev. allowed to release onto the future lots to the east)."

III. PROPOSED DRAINAGE CONDITIONS

As shown on the enclosed Drainage Plan (Figure D1, Appendix E), the school site has been delineated as six on-site drainage basins flowing across the property. Developed flows have been calculated based on the impervious areas associated with the proposed building and parking areas.

The majority of the school site has been delineated as Basins X1 and X2, which drain westerly across the site to a proposed stormwater detention pond at the western boundary of the school property. The proposed school building pad will be graded with protective slopes to provide positive drainage away from the building. A private storm sewer system will be extended around the perimeter of the building parking areas, and site grades around the school campus will slope to storm inlets at selected locations, collecting surface drainage and conveying stormwater to the proposed extended detention basin (EDB) at the west boundary of the site.

Off-site flows from the upstream area at the northwest corner of the property (Basin Y) flow southwesterly onto the site, and these flows will be collected in a drainage swale along the west side of the North Parking Lot. Roof drains from the north side of the building will flow north to a private storm sewer system (Storm Sewer X1), which will also collect surface drainage from the North Parking Lot and future northeast athletic field. Storm Sewer X1 will flow westerly into Extended Detention Basin X1. Developed peak flows at Design Point X1 are calculated as Q_5 = 6.7 cfs and Q_{100} = 17.9 cfs.

Developed flows from Basin X1 will be intercepted by Storm Inlets X1.1-X1.3 along the north side of the school building, and these flows will be conveyed westerly through a 12”-18” private storm sewer system to Detention Basin X1.

Roof drains from the south side of the building will flow south to a private storm sewer system (Storm Sewer X2) along the south side of the building. Storm Sewer X2 will flow northwesterly into Extended Detention Basin X1. Developed peak flows at Design Point X2 are calculated as Q_5 = 4.1 cfs and Q_{100} = 8.0 cfs.

Developed flows from Basin X2 will be intercepted by Storm Inlets X2.1-X2.3 along the south side of the school building, and these flows will be conveyed northwesterly through a 12”-18” private storm sewer system to Detention Basin X1.

According to the “Preliminary / Final Drainage Report (PDR/FDR) for Paint Brush Hills Metropolitan District Administration Building Site” by RG and Associates, LLC, the development plan for the Metropolitan District parcel in Basin Y will include an on-site stormwater quality facility discharging southwesterly onto the school property through a 15” storm drain. A drainage swale will be graded to convey the off-site drainage from Basin Y southwesterly through the school site to the existing culvert crossing Towner Avenue.

Off-site flows from Basin Y combine with on-site flows from Basins X1 and X2 at Design Point #10, with developed peak flows calculated as Q_5 =12.8 cfs and Q_{100} = 30.0 cfs. Stormwater detention and stormwater quality enhancement will be provided by routing developed flows through EDB X1.

The approved subdivision drainage report by CCES states the allowable release at DP-10 (Basin Y and a portion of Basin X) is limited to Q_5 =11 cfs and Q_{100} = 21 cfs. The pond outlet structure for EDB-X1 has been designed to maintain releases below the limits specified in the subdivision drainage report.

Basin Z1 comprises the small area at the north end of the north access drive, which will flow northerly into the existing curb and gutter along the south side of Londonderry Drive. Developed peak flows at Design Point Z1 are calculated as Q_5 = 0.2 cfs and Q_{100} = 0.6 cfs, and these minor flows will have a negligible impact on the existing downstream drainage system to the east in Londonderry Drive.

The east side of the developed school property has been delineated as Basin Z2, and this undeveloped area will continue to flow southeasterly following historic drainage patterns. In accordance with the approved subdivision drainage report, the site grading plan has been designed to limit the developed area flowing easterly to less than 30 feet in width. Developed peak flows at Design Point Z2 are calculated as Q_5 = 0.4 cfs and Q_{100} = 3.2 cfs, and these flows are lower than the calculated historic flows at this design point.

The south end of the elementary school site has been delineated as developed Basins W1 and W2. Basin W1 comprises a small area on the west side of the new school building which will sheet flow southwesterly into the existing curb and gutter on the east side of Towner Avenue. Developed peak flows at Design Point W1 are calculated as Q_5 = 0.9 cfs and Q_{100} = 2.5 cfs, and these minor flows will have a negligible impact on the existing downstream drainage system flowing south in Towner Avenue.

The new South Parking Lot has been delineated as Basin W2, which sheet flows to Inlet W2 on the south side of the parking lot, draining into Rain Garden W2. Developed peak flows at Design Point W2 are calculated as Q_5 = 6.2 cfs and Q_{100} = 13.1 cfs. Stormwater quality mitigation for the South Parking lot will be provided by routing developed flows through RG-W2.

The approved subdivision drainage report by CCES states the allowable release into Towner Avenue (Basin W) is limited to Q_5 =14 cfs and Q_{100} = 27 cfs. The proposed drainage plan for the school site has been designed to maintain releases from Basin W below the limits specified in the subdivision drainage report.

Hydrologic calculations for the school site are detailed in the attached spreadsheets (Appendix B), and peak flows are identified on Figures EX1 and D1 (Appendix E).

The contractor will be required to implement standard best management practices for erosion control during construction. The proposed Site Grading and Erosion Control Plans (Sheets C1.2-C1.5) are enclosed in Appendix E.

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 elementary school development includes significant open space, play areas, and a future athletic field, resulting in a moderate level of impervious site development. The proposed school campus development generates less impervious area and less intensive drainage impacts in comparison to multi-family residential, commercial, or industrial land uses.
- Minimize Directly Connected Impervious Areas (MDCIA): The proposed school site development will have landscaped areas adjoining the proposed building and parking lots, providing for impervious areas to drain across pervious areas in many locations.
- Reduce Pavement Area: The proposed school site layout has been designed to provide pavement areas as required to meet the functional needs of the school campus while minimizing excessive paved areas.
- Grass Swales: The proposed drainage plan incorporates grass-lined swales in selected locations to encourage stormwater infiltration while providing positive drainage through the site.

Step 2: Stabilize Drainageways

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

Step 3: Provide Water Quality Capture Volume (WQCV)

- EDB: The majority of the developed building area will drain through a proposed Extended Detention Basin (EDB) along the west boundary of the site. Site drainage will be routed through the extended detention basin, which will capture and slowly release the WQCV over a 40-hour design release period.
- RG: The new South Parking Lot area will drain through a proposed Rain Garden (RG). Site drainage from the South Parking Lot will be routed through the Rain Garden, which will capture and slowly release the WQCV over a 12-hour design release period.

Step 4: Consider Need for Industrial and Commercial BMPs

- No industrial or commercial land uses are proposed within this school site development.
- On-site drainage will be routed through the private Extended Detention Basin (EDB) and Rain Garden (RG) to minimize introduction of contaminants to the County's public drainage system.

V. FLOODPLAIN IMPACTS

According to FIRM Panel No. 08041C0575 dated March 17, 1997, the proposed school site is not impacted by any delineated 100-year FEMA floodplains (see FIRM exhibit in Appendix E).

VI. STORMWATER DETENTION AND WATER QUALITY

The proposed drainage and grading plan for the school site includes a private Extended Detention Basin (EDB) at the west boundary of the site, and a private Rain Garden (RG) on the south side of the South Parking Lot. These facilities have been designed to provide the required stormwater detention and water quality mitigation for this site in accordance with El Paso County drainage criteria.

In accordance with the subdivision drainage report by CCES, the on-site detention pond at Design Point #10 has been designed for release rates below the specified maximum allowable rates of Q_5 =11 cfs and Q_{100} = 21 cfs to remain within the allowable capacity of the existing downstream drainage system. As detailed in the detention pond hydraulic calculations in Appendix D, the required Water Quality Capture Volume (WQCV) for Design Point #10 has been calculated as 0.16 acre-feet, and the total required Excess Urban Runoff Volume (EURV) is 0.46 acre-feet. The proposed Extended Detention Basin (EDB) X1 has been designed for a storage volume of 0.79 acre-feet, which is well above the minimum storage volume required.

The proposed pond outlet structure has been designed using the UDFCD "UD-Detention" calculation spreadsheets, providing for a 40-hour release of the WQCV, and outlet structure sizing to maintain maximum allowable release rates from the pond. The EDB will have a grass-lined bottom and riprap trickle channel to encourage infiltration of stormwater prior to discharging into the public storm sewer system. As detailed in Appendix D, the EDB-X1 has been designed for an outflow of Q_5 =0.3 cfs and Q_{100} = 13.8 cfs, remaining below the maximum release rates specified in the subdivision drainage report. The pond spillway provides for an emergency overflow path from the southwest corner of the pond to the existing curb and gutter along the east side of Towner Avenue.

The required "Stormwater Detention and Infiltration Design Data Sheet" for the new EDB has been submitted to the County through the Site Development Plan process, along with the El Paso County MS4 Post-Construction form.

The proposed Rain Garden at the south end of the elementary school site has been designed to provide stormwater quality mitigation for the southerly developed areas which will not drain through the detention pond at the west boundary of the property. According to the calculations in Appendix D, the required Water Quality Capture Volume (WQCV) for Basins W1 and W2 is 1,916 cubic feet, and the proposed Rain Garden provides a volume of 2,151 cubic feet.

As shown on the enclosed Developed Drainage Plan, the 18-inch outlet pipe from the Rain Garden will discharge to an existing grass swale flowing south to an existing grated storm inlet on the north side of the Middle School building. The existing grass swale is also the overflow path from the new Rain Garden. An existing 24-inch private storm sewer flows southeasterly around the Middle School building to an existing private detention pond at the south boundary of the Middle School site, ultimately discharging southwesterly into the public storm sewer at the corner of Londonderry Drive and

Towner Avenue (Design Point #20 as identified on the CCES subdivision drainage plan enclosed in Appendix E.

The majority of drainage from both the Londonderry School site and the existing Middle School site ultimately flows to the existing sub-regional Detention Pond B1 southwest of the Middle School (see subdivision drainage plan by CCES in Appendix E).

The proposed stormwater detention facilities will be privately owned and maintained by School District 49, and maintenance access will be provided from the adjacent parking lots and public road. Operations and Maintenance (O&M) Manuals for the Extended Detention Basin (EDB) and Rain Garden (Porous Landscape Detention) have been submitted to the County through the Site Development Plan process.

Construction details for the proposed stormwater detention and stormwater quality facilities are depicted on Sheet C1.5 (Appendix E).

VII. DRAINAGE BASIN FEES

Development of the school site will include construction of a private storm sewer system and private stormwater detention and water quality facilities.

The site lies entirely within the Falcon Drainage Basin, which is tributary to the Black Squirrel Creek Drainage Basin.

Per the El Paso County Land Development Code, drainage and bridge fees are not applicable on a subdivision exemption.

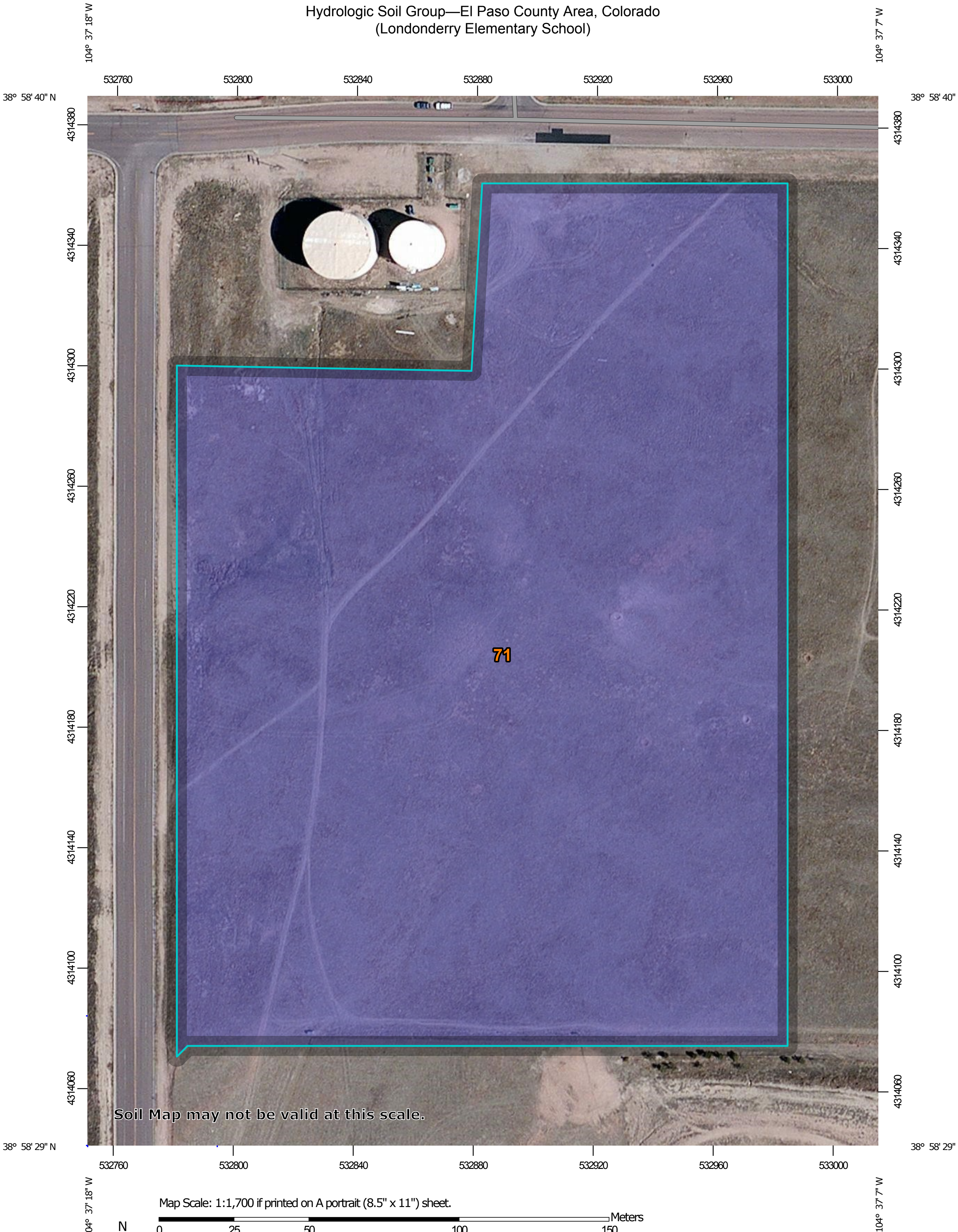
VIII. SUMMARY

The developed drainage patterns associated with the proposed Londonderry Elementary School campus will remain consistent with historic conditions and the overall drainage plan for area. The proposed drainage plan for development of this school site is consistent with the previously approved subdivision drainage report for Paint Brush Hills Filing No. 13A. The majority of developed flows from the site will drain through a proposed stormwater Detention Pond at the west boundary of the property and a proposed Rain Garden at the south boundary of the site, prior to discharging to the existing downstream drainage system.

The proposed stormwater detention and water quality facilities have been designed to mitigate developed flow impacts and meet the County's stormwater quality requirements. Construction and proper maintenance of the proposed Extended Detention Basin and Rain Garden, in conjunction with proper erosion control practices, will ensure that this developed site has no significant adverse drainage impact on downstream or surrounding areas.

APPENDIX A

SOILS INFORMATION



Map Scale: 1:1,700 if printed on A portrait (8.5" x 11") sheet.

Meters: 0, 25, 50, 100, 150

Feet: 0, 50, 100, 200, 300

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**
71	Pring coarse sandy loam, 3 to 8 percent slopes	B	12.9	100.0%
Totals for Area of Interest			**12.9**	**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

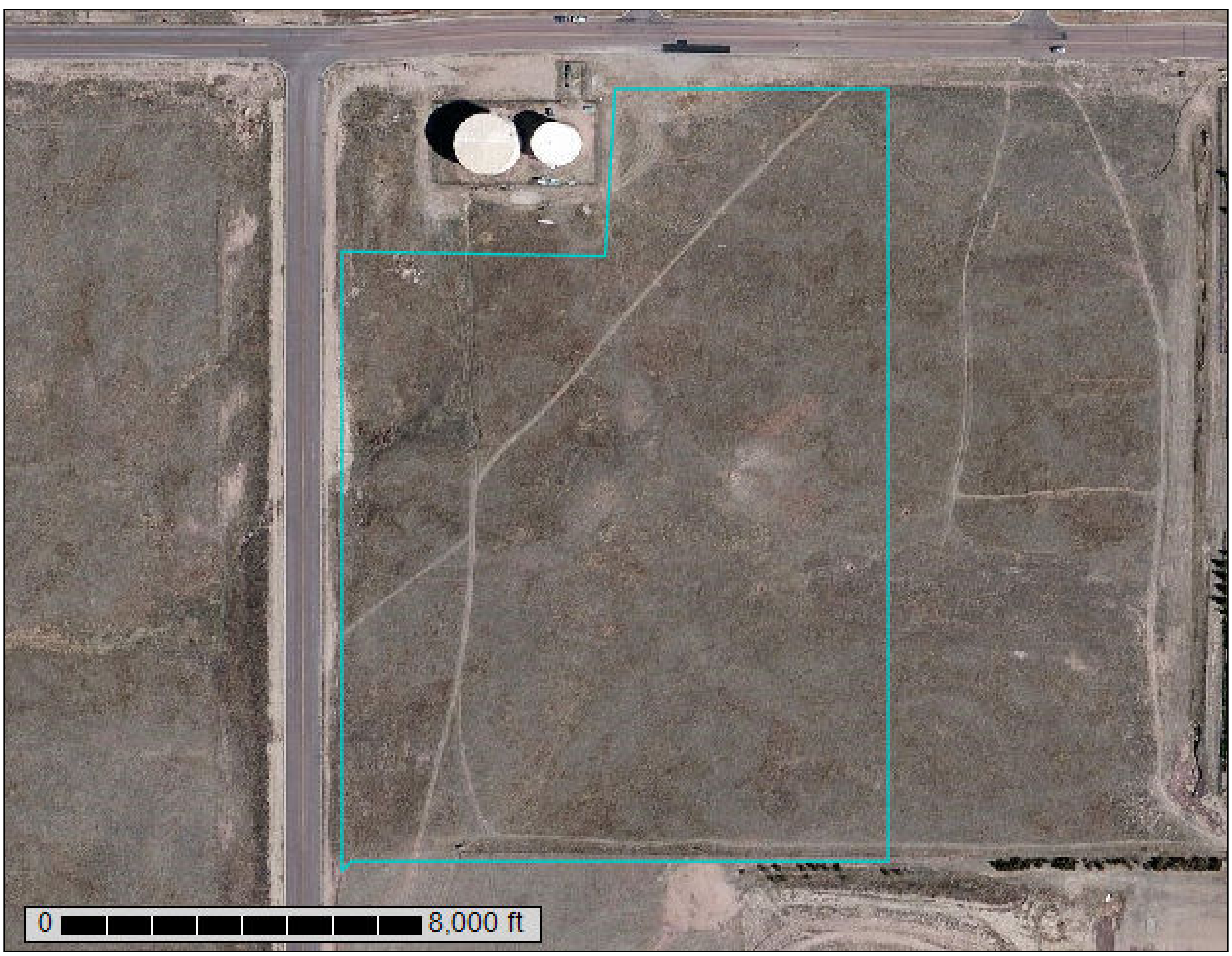
NRCS

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



April 5, 2017

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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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.

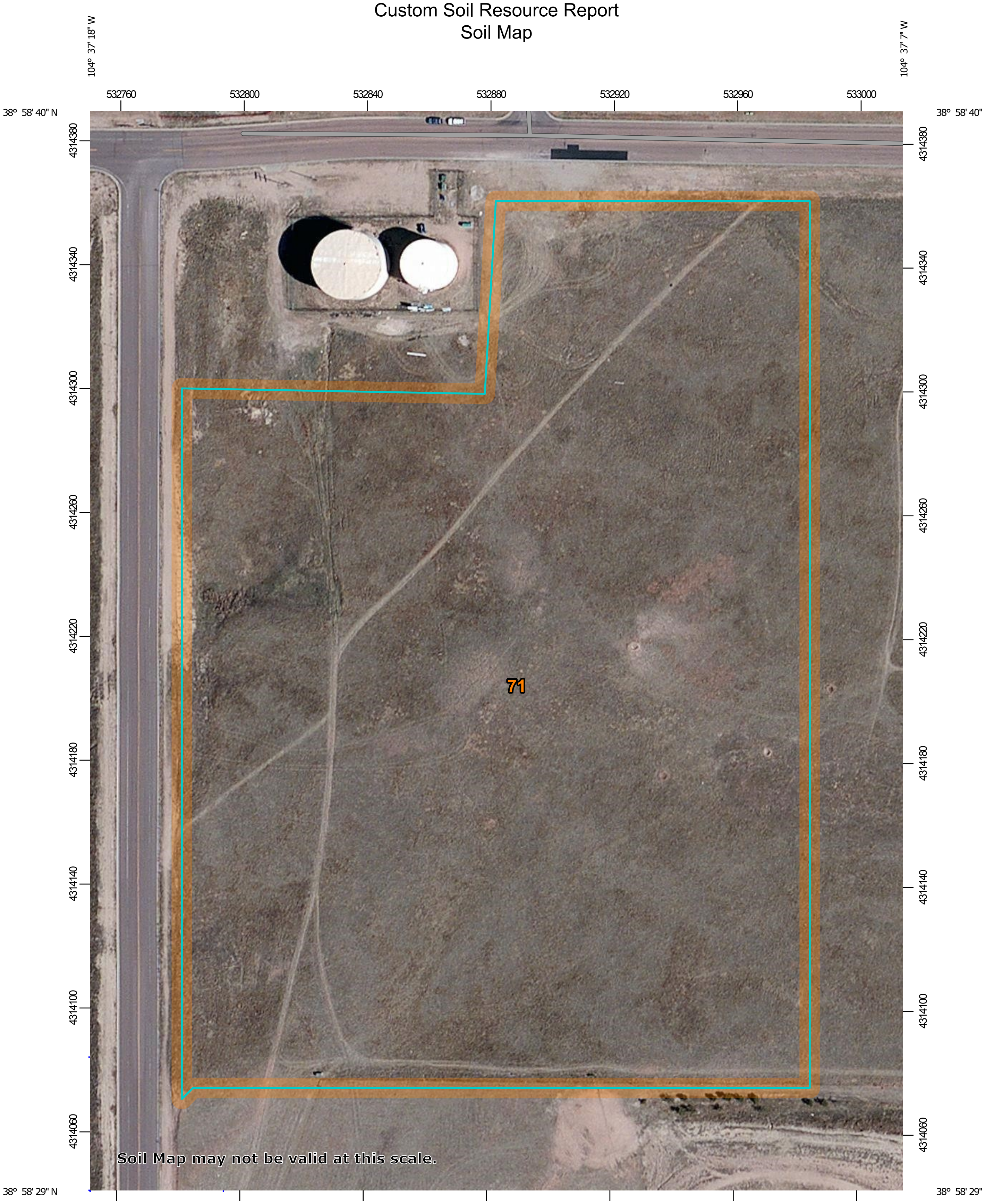
Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree 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.

Soil Map



Map Scale: 1:1,700 if printed on A portrait (8.5" x 11") sheet.

Meters: 0, 25, 50, 100, 150

Feet: 0, 50, 100, 200, 300

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 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**
71	Pring coarse sandy loam, 3 to 8 percent slopes	12.9	100.0%
Totals for Area of Interest		**12.9**	**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

71—Pring coarse sandy loam, 3 to 8 percent slopes

Map Unit Setting

National map unit symbol: 369k
Elevation: 6,800 to 7,600 feet
Farmland classification: Not prime farmland

Map Unit Composition

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

Description of Pring

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

Typical profile

A - 0 to 14 inches: coarse sandy loam
C - 14 to 60 inches: gravelly sandy loam

Properties and qualities

Slope: 3 to 8 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): High (2.00 to 6.00 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 6.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: B
Ecological site: Loamy Park (R048AY222CO)
Hydric soil rating: No

Minor Components

Pleasant

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

Other soils

Percent of map unit:
Hydric soil rating: No

References

American Association of State Highway and Transportation Officials (AASHTO). 2004. Standard specifications for transportation materials and methods of sampling and testing. 24th edition.

American Society for Testing and Materials (ASTM). 2005. Standard classification of soils for engineering purposes. ASTM Standard D2487-00.

Cowardin, L.M., V. Carter, F.C. Golet, and E.T. LaRoe. 1979. Classification of wetlands and deep-water habitats of the United States. U.S. Fish and Wildlife Service FWS/OBS-79/31.

Federal Register. July 13, 1994. Changes in hydric soils of the United States.

Federal Register. September 18, 2002. Hydric soils of the United States.

Hurt, G.W., and L.M. Vasilas, editors. Version 6.0, 2006. Field indicators of hydric soils in the United States.

National Research Council. 1995. Wetlands: Characteristics and boundaries.

Soil Survey Division Staff. 1993. Soil survey manual. Soil Conservation Service. U.S. Department of Agriculture Handbook 18. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_054262

Soil Survey Staff. 1999. Soil taxonomy: A basic system of soil classification for making and interpreting soil surveys. 2nd edition. Natural Resources Conservation Service, U.S. Department of Agriculture Handbook 436. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053577

Soil Survey Staff. 2010. Keys to soil taxonomy. 11th edition. U.S. Department of Agriculture, Natural Resources Conservation Service. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053580

Tiner, R.W., Jr. 1985. Wetlands of Delaware. U.S. Fish and Wildlife Service and Delaware Department of Natural Resources and Environmental Control, Wetlands Section.

United States Army Corps of Engineers, Environmental Laboratory. 1987. Corps of Engineers wetlands delineation manual. Waterways Experiment Station Technical Report Y-87-1.

United States Department of Agriculture, Natural Resources Conservation Service. National forestry manual. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/home/?cid=nrcs142p2_053374

United States Department of Agriculture, Natural Resources Conservation Service. National range and pasture handbook. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/landuse/rangepasture/?cid=stelprdb1043084

United States Department of Agriculture, Natural Resources Conservation Service. National soil survey handbook, title 430-VI. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/scientists/?cid=nrcs142p2_054242

United States Department of Agriculture, Natural Resources Conservation Service. 2006. Land resource regions and major land resource areas of the United States, the Caribbean, and the Pacific Basin. U.S. Department of Agriculture Handbook 296. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053624

United States Department of Agriculture, Soil Conservation Service. 1961. Land capability classification. U.S. Department of Agriculture Handbook 210. http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_052290.pdf

APPENDIX B

HYDROLOGIC CALCULATIONS

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.

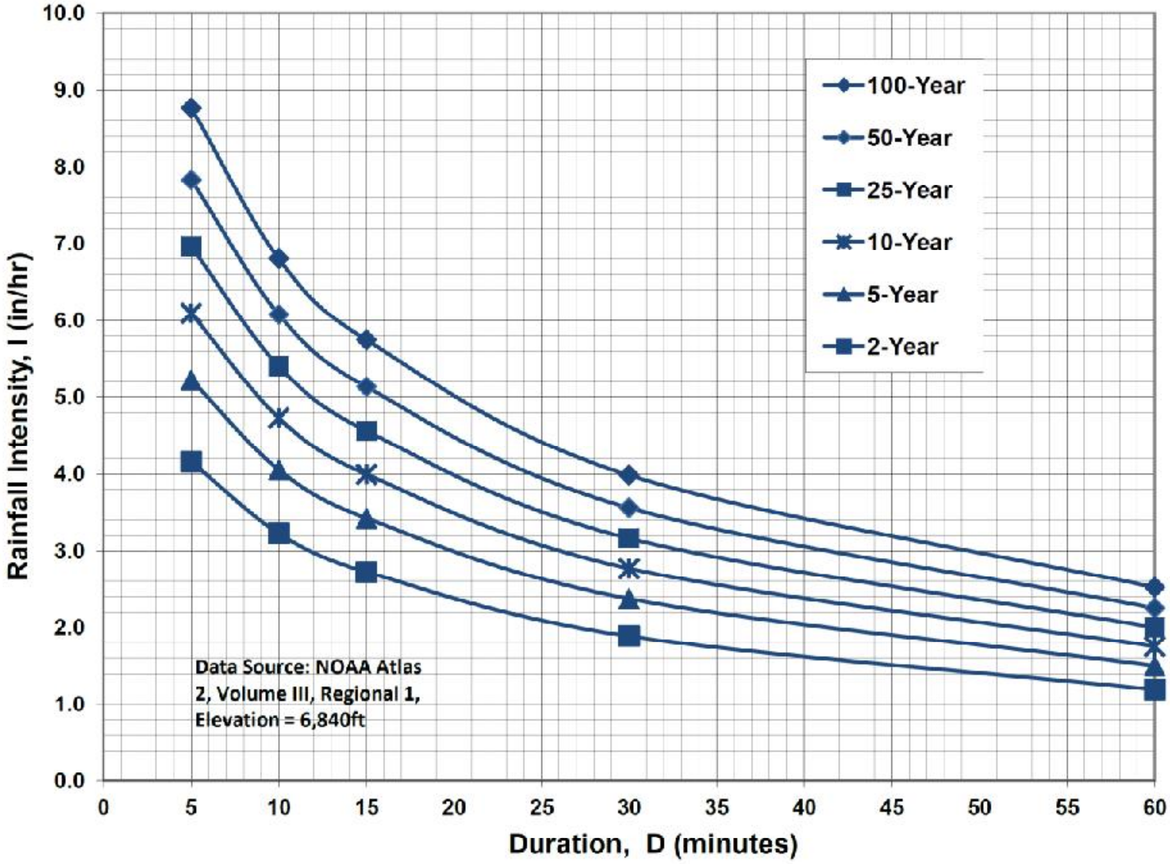
3.2.4 Minimum Time of Concentration

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.

LONDONDERRY ELEMENTARY SCHOOL
RATIONAL METHOD

HISTORIC 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)
W	W	3.96	0.080	0.350	200	0.050	15.5	320	15.00	0.044	3.15	1.7	17.1	17.1	3.32	5.57	1.05	7.73
Y	Y	1.77	0.080	0.350	100	0.020	14.8	400	15.00	0.035	2.81	2.4	17.2	17.2	4.24	8.00	0.60	4.96
X		2.84	0.080	0.350	100	0.030	13.0	240	15.00	0.029	2.55	1.6	14.5	14.5	3.57	5.99	0.81	5.96
Y,X	10	4.61	0.080	0.350									17.2	17.2	3.32	5.57	1.22	8.98
Z1	Z1	0.25	0.080	0.350	120	0.042	12.7	180	15.00	0.0389	2.96	1.0	13.7	13.7	3.65	6.13	0.07	0.54
Z2	Z2	5.09	0.080	0.350	300	0.053	18.6	280	15.00	0.014	1.77	2.6	21.2	21.2	3.00	5.04	1.22	8.98

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

LONDONDERRY ELEMENTARY SCHOOL
COMPOSITE RUNOFF COEFFICIENTS

DEVELOPED CONDITIONS

5-YEAR C VALUES

BASIN	TOTAL AREA (AC)	(AC)	SUB-AREA 1 DEVELOPMENT/ COVER	C	AREA (AC)	SUB-AREA 2 DEVELOPMENT/ COVER	C	(AC)	SUB-AREA 3 DEVELOPMENT/ COVER	C	WEIGHTED C VALUE
W1	0.79	0.21	PAVEMENT	0.9	0.58	LANDSCAPE	0.08				0.298
W2	2.40	1.39	PAVEMENT	0.9	1.01	LANDSCAPE	0.08				0.555
W1,W2	3.19										0.491
Y	1.77	1.10	BUILDING / PAVEMENT	0.9	0.67	LANDSCAPE	0.08				0.590
X1	6.61	2.15	BUILDING / PAVEMENT	0.9	4.46	LANDSCAPE	0.08				0.347
X2	1.48	1.09	BUILDING / PAVEMENT	0.9	0.39	LANDSCAPE	0.08				0.684
Y,X1,X2	9.86										0.441
Z1	0.12	0.04	PAVEMENT	0.9	0.08	LANDSCAPE	0.08				0.353
Z2	1.51	1.51	LANDSCAPE	0.08							0.080

100-YEAR C VALUES

BASIN	TOTAL AREA (AC)	(AC)	SUB-AREA 1 DEVELOPMENT/ COVER	C	AREA (AC)	SUB-AREA 2 DEVELOPMENT/ COVER	C	(AC)	SUB-AREA 3 DEVELOPMENT/ COVER	C	WEIGHTED C VALUE
W1	0.79	0.21	PAVEMENT	0.96	0.58	LANDSCAPE	0.35				0.512
W2	2.40	1.39	PAVEMENT	0.96	1.01	LANDSCAPE	0.35				0.703
W1,W2	3.19										0.656
Y	1.77	1.10	BUILDING / PAVEMENT	0.96	0.67	LANDSCAPE	0.35				0.729
X1	6.61	2.15	BUILDING / PAVEMENT	0.96	4.46	LANDSCAPE	0.35				0.548
X2	1.48	1.09	BUILDING / PAVEMENT	0.96	0.39	LANDSCAPE	0.35				0.799
Y,X1,X2	9.86										0.618
Z1	0.12	0.04	PAVEMENT	0.96	0.08	LANDSCAPE	0.35				0.553
Z2	1.51	1.51	LANDSCAPE	0.35							0.350

LONDONDERRY ELEMENTARY SCHOOL
RATIONAL METHOD

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)
W1	W1	0.79	0.298	0.512	160	0.025	13.7	0				0.0	13.7	13.7	3.66	6.14	0.86	2.48
W2	W2	2.40	0.555	0.703	50	0.040	4.4	400	20.00	0.015	2.45	2.7	7.2	7.2	4.63	7.77	6.17	13.11
W1,W2	W	3.19	0.491	0.656									13.7	13.7	3.66	6.14	5.73	12.85
Y	Y	1.77	0.590	0.729	100	0.020	7.4	400	15.00	0.035	2.81	2.4	9.8	9.8	4.16	6.99	4.35	9.02
X1	X1	6.61	0.347	0.548	200	0.020	15.5	840	20.00	0.011	2.10	6.7	22.2	22.2	2.94	4.93	6.73	17.85
X2	X2	1.48	0.684	0.799	50	0.020	4.3	720	20.00	0.008	1.82	6.6	10.9	10.9	4.01	6.72	4.05	7.95
Y,X1,X2	10	9.86	0.441	0.618									22.2	22.2	2.94	4.93	12.77	30.03
Z1	Z1	0.12	0.353	0.553	15	0.020	4.2	270	20.00	0.030	3.44	1.3	5.5	5.5	5.02	8.43	0.21	0.56
Z2	Z2	1.51	0.080	0.350	140	0.071	11.5	220	15.00	0.009	1.43	2.6	14.1	14.1	3.62	6.07	0.44	3.21

* BASIN Y HYDROLOGY IS FROM "PRELIMINARY/FINAL DRAINAGE REPORT FOR PAINT BRUSH HILLS METROPOLITAN DISTRICT ADMINISTRATION BUILDING SITE" BY RGA DATED 8/16

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 C

HYDRAULIC CALCULATIONS

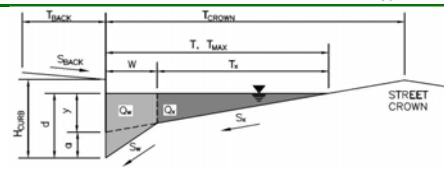
Version 4.04 Released November 2016

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

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

Project: Londonderry ES - Inlet W2

Inlet ID: Inlet W2



Gutter Geometry (Enter data in the blue cells)

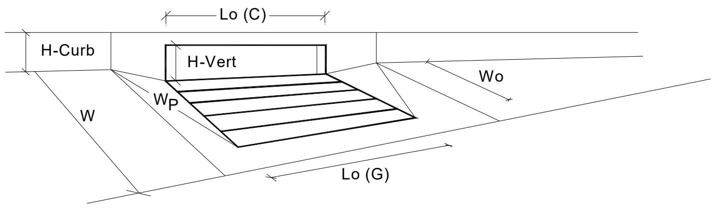
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	6.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.016	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	100.0	ft
Gutter Width	W =	1.00	ft
Street Transverse Slope	S_X =	0.040	ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083	ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.000	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.016	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	100.0	100.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	12.0	inches
Allow Flow Depth at Street Crown (leave blank for no)		☐	☑	check = yes

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

INLEET IN A SUMP OR SAG LOCATION

Version 4.04 Released November 2016



Design Information (Input)	CDOT Type R Curb Opening		MINOR	MAJOR	
Type of Inlet		Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a' from 'Q-Allow')		a_{local} =	3.00	3.00	inches
Number of Unit Inlets (Grate or Curb Opening)		No =	1	1	
Water Depth at Flowline (outside of local depression)		Ponding Depth =	6.0	12.0	inches
Grate Information			MINOR	MAJOR	☐ Override Depths
Length of a Unit Grate		L_o (G) =	N/A	N/A	feet
Width of a Unit Grate		W_o =	N/A	N/A	feet
Area Opening Ratio for a Grate (typical values 0.15-0.90)		A_{ratio} =	N/A	N/A	
Clogging Factor for a Single Grate (typical value 0.50 - 0.70)		C_f (G) =	N/A	N/A	
Grate Weir Coefficient (typical value 2.15 - 3.60)		C_w (G) =	N/A	N/A	
Grate Orifice Coefficient (typical value 0.60 - 0.80)		C_o (G) =	N/A	N/A	
Curb Opening Information			MINOR	MAJOR	
Length of a Unit Curb Opening		L_o (C) =	10.00	10.00	feet
Height of Vertical Curb Opening in Inches		H_{vert} =	6.00	6.00	inches
Height of Curb Orifice Throat in Inches		H_{throat} =	6.00	6.00	inches
Angle of Throat (see USDCM Figure ST-5)		Theta =	63.40	63.40	degrees
Side Width for Depression Pan (typically the gutter width of 2 feet)		W_p =	1.00	1.00	feet
Clogging Factor for a Single Curb Opening (typical value 0.10)		C_f (C) =	0.10	0.10	
Curb Opening Weir Coefficient (typical value 2.3-3.7)		C_w (C) =	3.60	3.60	
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)		C_o (C) =	0.67	0.67	
Low Head Performance Reduction (Calculated)			MINOR	MAJOR	
Depth for Grate Midwidth		d_{Grate} =	N/A	N/A	ft
Depth for Curb Opening Weir Equation		d_{Curb} =	0.42	0.92	ft
Combination Inlet Performance Reduction Factor for Long Inlets		$RF_{Combination}$ =	0.57	1.00	
Curb Opening Performance Reduction Factor for Long Inlets		RF_{Curb} =	0.93	1.00	
Grated Inlet Performance Reduction Factor for Long Inlets		RF_{Grate} =	N/A	N/A	
			MINOR	MAJOR	
Total Inlet Interception Capacity (assumes clogged condition)		Q_a =	**10.0**	**25.5**	**cfs**
Inlet Capacity IS GOOD for Minor and Major Storms(>Q PEAK)		$Q_{PEAK\ REQUIRED}$ =	6.2	13.1	cfs

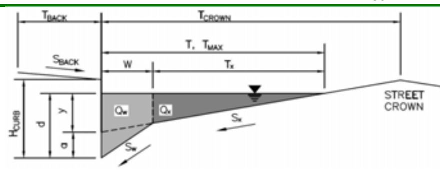
Version 4.04 Released November 2016

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

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

Project: Londonderry ES - Inlet X1.1 (Q = 50% * DP-X1)

Inlet ID: Inlet X1.1



Gutter Geometry (Enter data in the blue cells)

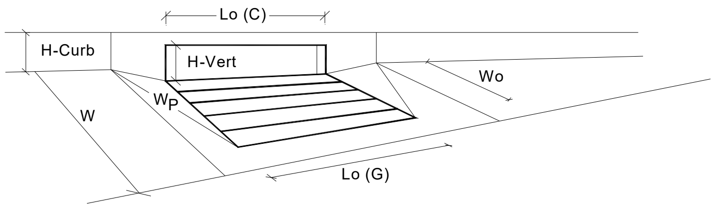
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	20.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.020	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	100.0	ft
Gutter Width	W =	1.00	ft
Street Transverse Slope	S_X =	0.010	ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083	ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.000	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.016	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	100.0	100.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	12.0	inches
Allow Flow Depth at Street Crown (leave blank for no)		☐	☑	check = yes

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

INLET IN A SUMP OR SAG LOCATION

Version 4.04 Released November 2016



Design Information (Input)		MINOR	MAJOR	
Type of Inlet (CDOT Type R Curb Opening)	Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a' from 'Q-Allow')	a_{local} =	3.00	3.00	inches
Number of Unit Inlets (Grate or Curb Opening)	No =	1	1	
Water Depth at Flowline (outside of local depression)	Ponding Depth =	6.0	12.0	inches
Grate Information		MINOR	MAJOR	Override Depths
Length of a Unit Grate	L_o (G) =	N/A	N/A	feet
Width of a Unit Grate	W_o =	N/A	N/A	feet
Area Opening Ratio for a Grate (typical values 0.15-0.90)	A_{ratio} =	N/A	N/A	
Clogging Factor for a Single Grate (typical value 0.50 - 0.70)	C_f (G) =	N/A	N/A	
Grate Weir Coefficient (typical value 2.15 - 3.60)	C_w (G) =	N/A	N/A	
Grate Orifice Coefficient (typical value 0.60 - 0.80)	C_o (G) =	N/A	N/A	
Curb Opening Information		MINOR	MAJOR	
Length of a Unit Curb Opening	L_o (C) =	5.00	5.00	feet
Height of Vertical Curb Opening in Inches	H_{vert} =	6.00	6.00	inches
Height of Curb Orifice Throat in Inches	H_{throat} =	6.00	6.00	inches
Angle of Throat (see USDCM Figure ST-5)	Theta =	63.40	63.40	degrees
Side Width for Depression Pan (typically the gutter width of 2 feet)	W_p =	1.00	1.00	feet
Clogging Factor for a Single Curb Opening (typical value 0.10)	C_f (C) =	0.10	0.10	
Curb Opening Weir Coefficient (typical value 2.3-3.7)	C_w (C) =	3.60	3.60	
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)	C_o (C) =	0.67	0.67	

Low Head Performance Reduction (Calculated)		MINOR	MAJOR	
Depth for Grate Midwidth	d_{Grate} =	N/A	N/A	ft
Depth for Curb Opening Weir Equation	d_{Curb} =	0.42	0.92	ft
Combination Inlet Performance Reduction Factor for Long Inlets	$RF_{Combination}$ =	0.77	1.00	
Curb Opening Performance Reduction Factor for Long Inlets	RF_{Curb} =	1.00	1.00	
Grated Inlet Performance Reduction Factor for Long Inlets	RF_{Grate} =	N/A	N/A	

		MINOR	MAJOR	
Total Inlet Interception Capacity (assumes clogged condition)	Q_a =	**5.9**	**12.3**	**cfs**
Inlet Capacity IS GOOD for Minor and Major Storms(>Q PEAK)	$Q_{PEAK\ REQUIRED}$ =	3.4	8.9	cfs

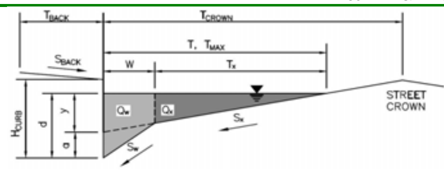
Version 4.04 Released November 2016

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

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

Project: Londonderry ES - Inlet X1.2-X1.3 (Q = 25% * DP-X1)

Inlet ID: Inlet X1.2 & X1.3



Gutter Geometry (Enter data in the blue cells)

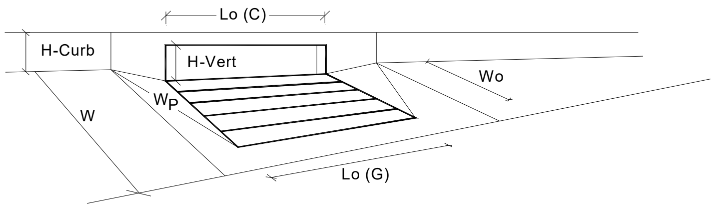
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	20.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.020	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	100.0	ft
Gutter Width	W =	1.00	ft
Street Transverse Slope	S_X =	0.010	ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083	ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.000	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.016	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	100.0	100.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	12.0	inches
Allow Flow Depth at Street Crown (leave blank for no)		☐	☑	check = yes

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

INLET IN A SUMP OR SAG LOCATION

Version 4.04 Released November 2016



Design Information (Input)	CDOT Type R Curb Opening		MINOR	MAJOR	
Type of Inlet		Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a' from 'Q-Allow')		a_{local} =	3.00	3.00	inches
Number of Unit Inlets (Grate or Curb Opening)		No =	1	1	
Water Depth at Flowline (outside of local depression)		Ponding Depth =	6.0	12.0	inches
Grate Information			MINOR	MAJOR	Override Depths
Length of a Unit Grate		L_o (G) =	N/A	N/A	feet
Width of a Unit Grate		W_o =	N/A	N/A	feet
Area Opening Ratio for a Grate (typical values 0.15-0.90)		A_{ratio} =	N/A	N/A	
Clogging Factor for a Single Grate (typical value 0.50 - 0.70)		C_f (G) =	N/A	N/A	
Grate Weir Coefficient (typical value 2.15 - 3.60)		C_w (G) =	N/A	N/A	
Grate Orifice Coefficient (typical value 0.60 - 0.80)		C_o (G) =	N/A	N/A	
Curb Opening Information			MINOR	MAJOR	
Length of a Unit Curb Opening		L_o (C) =	5.00	5.00	feet
Height of Vertical Curb Opening in Inches		H_{vert} =	6.00	6.00	inches
Height of Curb Orifice Throat in Inches		H_{throat} =	6.00	6.00	inches
Angle of Throat (see USDCM Figure ST-5)		Theta =	63.40	63.40	degrees
Side Width for Depression Pan (typically the gutter width of 2 feet)		W_p =	1.00	1.00	feet
Clogging Factor for a Single Curb Opening (typical value 0.10)		C_f (C) =	0.10	0.10	
Curb Opening Weir Coefficient (typical value 2.3-3.7)		C_w (C) =	3.60	3.60	
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)		C_o (C) =	0.67	0.67	

Low Head Performance Reduction (Calculated)		MINOR	MAJOR	
Depth for Grate Midwidth	d_{Grate} =	N/A	N/A	ft
Depth for Curb Opening Weir Equation	d_{Curb} =	0.42	0.92	ft
Combination Inlet Performance Reduction Factor for Long Inlets	$RF_{Combination}$ =	0.77	1.00	
Curb Opening Performance Reduction Factor for Long Inlets	RF_{Curb} =	1.00	1.00	
Grated Inlet Performance Reduction Factor for Long Inlets	RF_{Grate} =	N/A	N/A	

		MINOR	MAJOR	
Total Inlet Interception Capacity (assumes clogged condition)	Q_a =	**5.9**	**12.3**	**cfs**
Inlet Capacity IS GOOD for Minor and Major Storms(>Q PEAK)	$Q_{PEAK\ REQUIRED}$ =	1.7	4.5	cfs

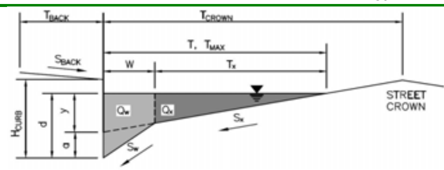
Version 4.04 Released November 2016

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

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

Project: Londonderry ES - Inlet X2.1 (Q = 33% * DP-X2)

Inlet ID: Inlet x2.1



Gutter Geometry (Enter data in the blue cells)

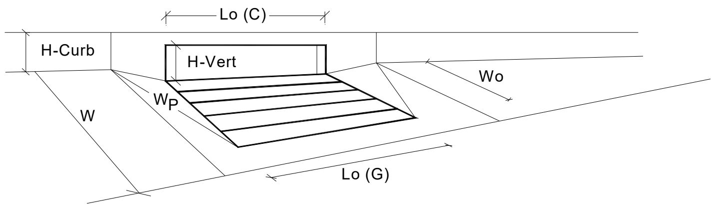
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	5.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.016	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	30.0	ft
Gutter Width	W =	1.00	ft
Street Transverse Slope	S_X =	0.020	ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083	ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.000	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.016	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	30.0	30.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	12.0	inches
Allow Flow Depth at Street Crown (leave blank for no)		☐	☑	check = yes

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

INLET IN A SUMP OR SAG LOCATION

Version 4.04 Released November 2016



Design Information (Input)		MINOR	MAJOR	
Type of Inlet (CDOT Type R Curb Opening)	Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a' from 'Q-Allow')	a_{local} =	3.00	3.00	inches
Number of Unit Inlets (Grate or Curb Opening)	No =	1	1	
Water Depth at Flowline (outside of local depression)	Ponding Depth =	6.0	8.0	inches
Grate Information		MINOR	MAJOR	Override Depths
Length of a Unit Grate	L_o (G) =	N/A	N/A	feet
Width of a Unit Grate	W_o =	N/A	N/A	feet
Area Opening Ratio for a Grate (typical values 0.15-0.90)	A_{ratio} =	N/A	N/A	
Clogging Factor for a Single Grate (typical value 0.50 - 0.70)	C_f (G) =	N/A	N/A	
Grate Weir Coefficient (typical value 2.15 - 3.60)	C_w (G) =	N/A	N/A	
Grate Orifice Coefficient (typical value 0.60 - 0.80)	C_o (G) =	N/A	N/A	
Curb Opening Information		MINOR	MAJOR	
Length of a Unit Curb Opening	L_o (C) =	5.00	5.00	feet
Height of Vertical Curb Opening in Inches	H_{vert} =	6.00	6.00	inches
Height of Curb Orifice Throat in Inches	H_{throat} =	6.00	6.00	inches
Angle of Throat (see USDCM Figure ST-5)	Theta =	63.40	63.40	degrees
Side Width for Depression Pan (typically the gutter width of 2 feet)	W_p =	1.00	1.00	feet
Clogging Factor for a Single Curb Opening (typical value 0.10)	C_f (C) =	0.10	0.10	
Curb Opening Weir Coefficient (typical value 2.3-3.7)	C_w (C) =	3.60	3.60	
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)	C_o (C) =	0.67	0.67	

Low Head Performance Reduction (Calculated)		MINOR	MAJOR	
Depth for Grate Midwidth	d_{Grate} =	N/A	N/A	ft
Depth for Curb Opening Weir Equation	d_{Curb} =	0.42	0.58	ft
Combination Inlet Performance Reduction Factor for Long Inlets	$RF_{Combination}$ =	0.77	1.00	
Curb Opening Performance Reduction Factor for Long Inlets	RF_{Curb} =	1.00	1.00	
Grated Inlet Performance Reduction Factor for Long Inlets	RF_{Grate} =	N/A	N/A	

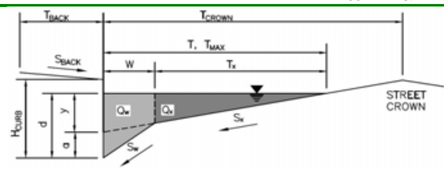
		MINOR	MAJOR	
Total Inlet Interception Capacity (assumes clogged condition)	Q_a =	**5.9**	**9.2**	**cfs**
Inlet Capacity IS GOOD for Minor and Major Storms(>Q PEAK)	$Q_{PEAK\ REQUIRED}$ =	1.4	2.7	cfs

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

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

Project: Londonderry ES - Inlet X2.2 & X2.3 (Q = 33% * DP-X2)

Inlet ID: Inlet X2.2 & X2.3



Gutter Geometry (Enter data in the blue cells)

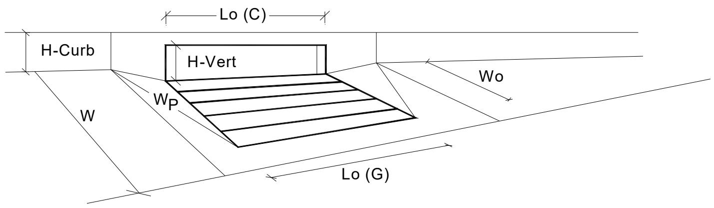
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	20.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.020	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	20.0	ft
Gutter Width	W =	3.00	ft
Street Transverse Slope	S_X =	0.020	ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083	ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.000	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.020	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	20.0	20.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	12.0	inches
Allow Flow Depth at Street Crown (leave blank for no)		☐	☑	check = yes

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

INLEET IN A SUMP OR SAG LOCATION

Version 4.04 Released November 2016



Design Information (Input)		MINOR	MAJOR	
Type of Inlet — CDOT Type C Grate	Type =	CDOT Type C Grate		
Local Depression (additional to continuous gutter depression 'a' from 'Q-Allow')	a_{local} =	0.00	0.00	inches
Number of Unit Inlets (Grate or Curb Opening)	No =	1	1	
Water Depth at Flowline (outside of local depression)	Ponding Depth =	6.0	7.1	inches
Grate Information		MINOR	MAJOR	Override Depths
Length of a Unit Grate	L_o (G) =	2.92	2.92	feet
Width of a Unit Grate	W_o =	2.92	2.92	feet
Area Opening Ratio for a Grate (typical values 0.15-0.90)	A_{ratio} =	0.70	0.70	
Clogging Factor for a Single Grate (typical value 0.50 - 0.70)	C_f (G) =	0.50	0.50	
Grate Weir Coefficient (typical value 2.15 - 3.60)	C_w (G) =	2.41	2.41	
Grate Orifice Coefficient (typical value 0.60 - 0.80)	C_o (G) =	0.67	0.67	
Curb Opening Information		MINOR	MAJOR	
Length of a Unit Curb Opening	L_o (C) =	N/A	N/A	feet
Height of Vertical Curb Opening in Inches	H_{vert} =	N/A	N/A	inches
Height of Curb Orifice Throat in Inches	H_{throat} =	N/A	N/A	inches
Angle of Throat (see USDCM Figure ST-5)	Theta =	N/A	N/A	degrees
Side Width for Depression Pan (typically the gutter width of 2 feet)	W_p =	N/A	N/A	feet
Clogging Factor for a Single Curb Opening (typical value 0.10)	C_f (C) =	N/A	N/A	
Curb Opening Weir Coefficient (typical value 2.3-3.7)	C_w (C) =	N/A	N/A	
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)	C_o (C) =	N/A	N/A	

Low Head Performance Reduction (Calculated)		MINOR	MAJOR	
Depth for Grate Midwidth	d_{Grate} =	0.379	0.468	ft
Depth for Curb Opening Weir Equation	d_{Curb} =	N/A	N/A	ft
Combination Inlet Performance Reduction Factor for Long Inlets	$RF_{Combination}$ =	N/A	N/A	
Curb Opening Performance Reduction Factor for Long Inlets	RF_{Curb} =	N/A	N/A	
Grated Inlet Performance Reduction Factor for Long Inlets	RF_{Grate} =	0.95	1.00	

		MINOR	MAJOR	
Total Inlet Interception Capacity (assumes clogged condition)	Q_a =	**2.0**	**2.8**	**cfs**
Inlet Capacity IS GOOD for Minor and Major Storms(>Q PEAK)	$Q_{PEAK\ REQUIRED}$ =	1.4	2.7	cfs

Hydraulic Analysis Report

Project Data

Project Title: Londonderry ES

Designer: JPS

Project Date: Sunday, April 09, 2017

Project Units: U.S. Customary Units

Notes:

Channel Analysis: Storm-Drain X1.3

Notes: Q5 = 6.7 cfs

Input Parameters

Channel Type: Circular

Pipe Diameter: 1.5000 ft

Longitudinal Slope: 0.0050 ft/ft

Manning's n: 0.0130

Depth: 1.5000 ft

Result Parameters

Flow: 7.4277 cfs

Area of Flow: 1.7671 ft^2

Wetted Perimeter: 4.7124 ft

Hydraulic Radius: 0.3750 ft

Average Velocity: 4.2032 ft/s

Top Width: 0.0000 ft

Froude Number: 0.0000

Critical Depth: 1.0554 ft

Critical Velocity: 5.5902 ft/s

Critical Slope: 0.0070 ft/ft

Critical Top Width: 1.37 ft

Calculated Max Shear Stress: 0.4680 lb/ft^2

Calculated Avg Shear Stress: 0.1170 lb/ft^2

Channel Analysis: Storm-Drain X2.3

Notes: Q5 = 4.1 cfs

Input Parameters

Channel Type: Circular

Pipe Diameter: 1.5000 ft

Longitudinal Slope: 0.0050 ft/ft

Manning's n: 0.0130

Depth: 1.5000 ft

Result Parameters

Flow: 7.4277 cfs

Area of Flow: 1.7671 ft^2

Wetted Perimeter: 4.7124 ft

Hydraulic Radius: 0.3750 ft

Average Velocity: 4.2032 ft/s

Top Width: 0.0000 ft

Froude Number: 0.0000

Critical Depth: 1.0554 ft

Critical Velocity: 5.5902 ft/s

Critical Slope: 0.0070 ft/ft

Critical Top Width: 1.37 ft

Calculated Max Shear Stress: 0.4680 lb/ft^2

Calculated Avg Shear Stress: 0.1170 lb/ft^2

Channel Analysis: Storm-Drain W2

Notes: Q5 = 6.2 cfs

Input Parameters

Channel Type: Circular

Pipe Diameter: 1.5000 ft

Longitudinal Slope: 0.0860 ft/ft

Manning's n: 0.0130

Depth: 1.5000 ft

Result Parameters

Flow: 30.8048 cfs

Area of Flow: 1.7671 ft^2

Wetted Perimeter: 4.7124 ft

Hydraulic Radius: 0.3750 ft

Average Velocity: 17.4319 ft/s

Top Width: 0.0000 ft

Froude Number: 0.0000

Critical Depth: 1.4941 ft

Critical Velocity: 17.4392 ft/s

Critical Slope: 0.0816 ft/ft

Critical Top Width: 0.19 ft

Calculated Max Shear Stress: 8.0496 lb/ft^2

Calculated Avg Shear Stress: 2.0124 lb/ft^2

APPENDIX D

DETENTION POND CALCULATIONS

LONDONDERRY ELEMENTARY SCHOOL
COMPOSITE IMPERVIOUS AREAS

IMPERVIOUS AREAS

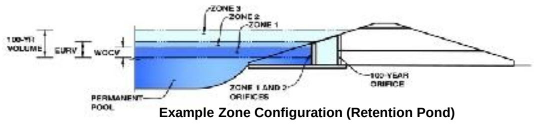
BASIN	TOTAL AREA (AC)	(AC)	SUB-AREA 1 DEVELOPMENT/ COVER	PERCENT IMPERVIOUS	AREA (AC)	SUB-AREA 2 DEVELOPMENT/ COVER	PERCENT IMPERVIOUS	(AC)	SUB-AREA 3 DEVELOPMENT/ COVER	PERCENT IMPERVIOUS	WEIGHTED % IMP
W1	0.79	0.21	PAVEMENT	100	0.58	LANDSCAPE	0				26.582
W2	2.40	1.39	PAVEMENT	100	1.01	LANDSCAPE	0				57.917
W1,W2	3.19										50.157
Y	1.77	1.10	BUILDING / PAVEMENT	100	0.67	LANDSCAPE	0				62.147
X1	6.61	2.15	BUILDING / PAVEMENT	100	4.46	LANDSCAPE	0				32.526
X2	1.48	1.09	BUILDING / PAVEMENT	100	0.39	LANDSCAPE	0				73.649
X1,X2	8.09										40.049
Y,X1,X2	9.86										44.016
Z1	0.12	0.04	PAVEMENT	100	0.08	LANDSCAPE	0				33.333
Z2	1.51	1.51	LANDSCAPE	0							0.000

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

UD-Detention, Version 3.07 (February 2017)

Project: LONDONDERRY SCHOOL

Basin ID: X



Example Zone Configuration (Retention Pond)

Required Volume Calculation

Selected BMP Type =	**EDB**			
Watershed Area =	9.86	acres		
Watershed Length =	1,040	ft		
Watershed Slope =	0.013	ft/ft		
Watershed Imperviousness =	44.00%	percent		
Percentage Hydrologic Soil Group A =	0.0%	percent		
Percentage Hydrologic Soil Group B =	100.0%	percent		
Percentage Hydrologic Soil Groups C/D =	0.0%	percent		
Desired WQCV Drain Time =	40.0	hours		
Location for 1-hr Rainfall Depths =	User Input			
Water Quality Capture Volume (WQCV) =	0.156	acre-feet	Optional User Override 1-hr Precipitation	
Excess Urban Runoff Volume (EURV) =	0.459	acre-feet		
2-yr Runoff Volume (P1 = 1.19 in.) =	0.365	acre-feet	1.19	inches
5-yr Runoff Volume (P1 = 1.5 in.) =	0.504	acre-feet	1.50	inches
10-yr Runoff Volume (P1 = 1.75 in.) =	0.701	acre-feet	1.75	inches
25-yr Runoff Volume (P1 = 2 in.) =	1.020	acre-feet	2.00	inches
50-yr Runoff Volume (P1 = 2.25 in.) =	1.237	acre-feet	2.25	inches
100-yr Runoff Volume (P1 = 2.52 in.) =	1.522	acre-feet	2.52	inches
500-yr Runoff Volume (P1 = 3.14 in.) =	2.100	acre-feet	3.14	inches
Approximate 2-yr Detention Volume =	0.342	acre-feet		
Approximate 5-yr Detention Volume =	0.474	acre-feet		
Approximate 10-yr Detention Volume =	0.641	acre-feet		
Approximate 25-yr Detention Volume =	0.709	acre-feet		
Approximate 50-yr Detention Volume =	0.743	acre-feet		
Approximate 100-yr Detention Volume =	0.842	acre-feet		

Stage-Storage Calculation

Zone 1 Volume (WQCV) =	0.156	acre-feet	
Zone 2 Volume (EURV - Zone 1) =	0.303	acre-feet	**Total detention volume is less than 100-year volume.**
Select Zone 3 Storage Volume (Optional) =		acre-feet	
Total Detention Basin Volume =	0.459	acre-feet	
Initial Surcharge Volume (ISV) =	user	ft^3	
Initial Surcharge Depth (ISD) =	user	ft	
Total Available Detention Depth (H_{total}) =	user	ft	
Depth of Trickle Channel (H_{TC}) =	user	ft	
Slope of Trickle Channel (S_{TC}) =	user	ft/ft	
Slopes of Main Basin Sides (S_{main}) =	user	H:V	
Basin Length-to-Width Ratio ($R_{L/W}$) =	user		
Initial Surcharge Area (A_{ISV}) =	user	ft^2	
Surcharge Volume Length (L_{ISV}) =	user	ft	
Surcharge Volume Width (W_{ISV}) =	user	ft	
Depth of Basin Floor (H_{FLOOR}) =	user	ft	
Length of Basin Floor (L_{FLOOR}) =	user	ft	
Width of Basin Floor (W_{FLOOR}) =	user	ft	
Area of Basin Floor (A_{FLOOR}) =	user	ft^2	
Volume of Basin Floor (V_{FLOOR}) =	user	ft^3	
Depth of Main Basin (H_{MAIN}) =	user	ft	
Length of Main Basin (L_{MAIN}) =	user	ft	
Width of Main Basin (W_{MAIN}) =	user	ft	
Area of Main Basin (A_{MAIN}) =	user	ft^2	
Volume of Main Basin (V_{MAIN}) =	user	ft^3	
Calculated Total Basin Volume (V_{total}) =	**user**	acre-feet	

Depth Increment = ___ ft

Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	--	0.00	--	--	--	5,439	0.125		
	--	1.00	--	--	--	6,897	0.158	6,099	0.140
	--	2.00	--	--	--	8,355	0.192	13,711	0.315
	--	3.00	--	--	--	10,304	0.237	23,123	0.531
MAX WSL = 7215	--	4.00	--	--	--	12,252	0.281	34,401	0.790
TOP EL = 7216	--	5.00	--	--	--	14,200	0.326	47,627	1.093
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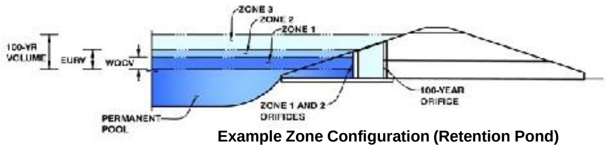
Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)

Project: LONDONDERRY SCHOOL

Basin ID: X



Example Zone Configuration (Retention Pond)

	Stage (ft)	Zone Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	1.10	0.156	Orifice Plate
Zone 2 (EURV)	2.69	0.303	Weir&Pipe (Restrict)
Zone 3			
		0.459	Total

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

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

Calculated Parameters for Underdrain

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

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

Invert of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Orifice Plate =	1.10	ft (relative to basin bottom at Stage = 0 ft)
Orifice Plate: Orifice Vertical Spacing =	4.40	inches
Orifice Plate: Orifice Area per Row =	1.89	sq. inches (diameter = 1-9/16 inches)

Calculated Parameters for Plate

WQ Orifice Area per Row =	1.313E-02	ft^2
Elliptical Half-Width =	N/A	feet
Elliptical Slot Centroid =	N/A	feet
Elliptical Slot Area =	N/A	ft^2

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

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	0.37	0.73					
Orifice Area (sq. inches)	1.89	1.89	1.89					

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

User Input: Vertical Orifice (Circular or Rectangular)

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

Calculated Parameters for Vertical Orifice

	Not Selected	Not Selected	
Vertical Orifice Area =			ft^2
Vertical Orifice Centroid =			feet

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

	Zone 2 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	3.00		ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =	3.00		feet
Overflow Weir Slope =	0.00		H:V (enter zero for flat grate)
Horiz. Length of Weir Sides =	3.00		feet
Overflow Grate Open Area % =	70%		%, grate open area/total area
Debris Clogging % =	50%		%

Calculated Parameters for Overflow Weir

	Zone 2 Weir	Not Selected	
Height of Grate Upper Edge, H_t =	3.00		feet
Over Flow Weir Slope Length =	3.00		feet
Grate Open Area / 100-yr Orifice Area =	2.49		should be $\geq$ 4
Overflow Grate Open Area w/o Debris =	6.30		ft^2
Overflow Grate Open Area w/ Debris =	3.15		ft^2

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

	Zone 2 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	0.00		ft (distance below basin bottom at Stage = 0 ft)
Outlet Pipe Diameter =	24.00		inches
Restrictor Plate Height Above Pipe Invert =	18.00		inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Zone 2 Restrictor	Not Selected	
Outlet Orifice Area =	2.53		ft^2
Outlet Orifice Centroid =	0.83		feet
Half-Central Angle of Restrictor Plate on Pipe =	2.09	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	4.00	ft (relative to basin bottom at Stage = 0 ft)
Spillway Crest Length =	7.00	feet
Spillway End Slopes =	4.00	H:V
Freeboard above Max Water Surface =	1.00	feet

Calculated Parameters for Spillway

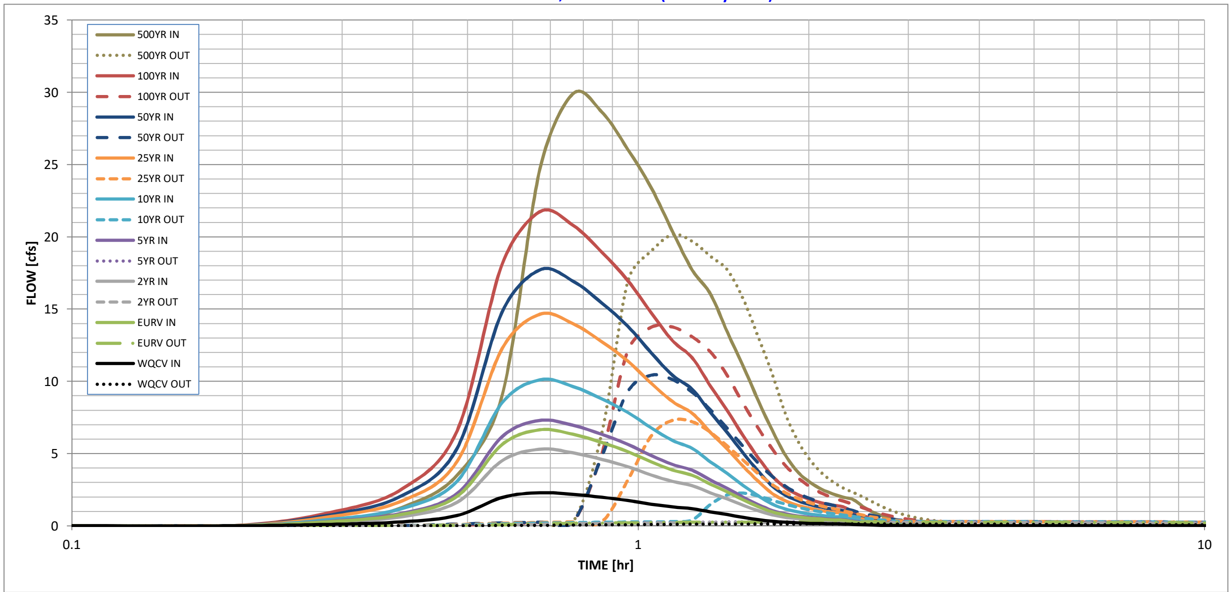
Spillway Design Flow Depth=	0.82	feet
Stage at Top of Freeboard =	5.82	feet
Basin Area at Top of Freeboard =	0.33	acres

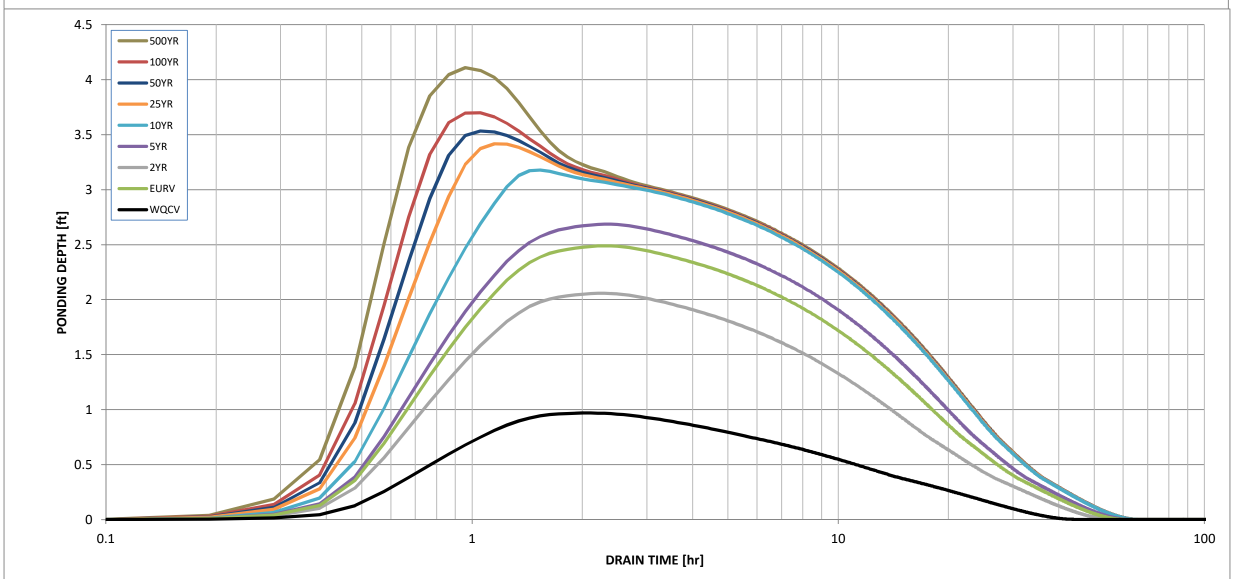
Routed Hydrograph Results

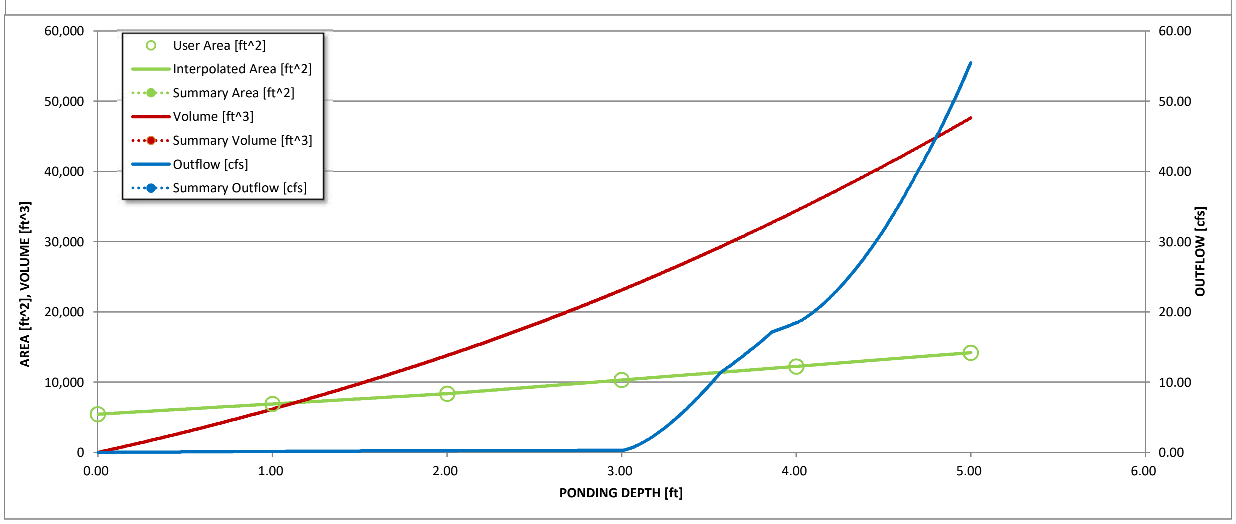
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	0.53	1.07	1.19	1.50	1.75	2.00	2.25	2.52	3.14
Calculated Runoff Volume (acre-ft) =	0.156	0.459	0.365	0.504	0.701	1.020	1.237	1.522	2.100
OPTIONAL Override Runoff Volume (acre-ft) =									
Inflow Hydrograph Volume (acre-ft) =	0.156	0.458	0.365	0.504	0.700	1.019	1.236	1.521	2.100
Predevelopment Unit Peak Flow, q (cfs/acre) =	0.00	0.00	0.01	0.02	0.17	0.57	0.78	1.06	1.57
Predevelopment Peak Q (cfs) =	0.0	0.0	0.1	0.2	1.6	5.6	7.7	10.5	15.5
Peak Inflow Q (cfs) =	2.3	6.6	5.3	7.3	10.1	14.6	17.7	21.7	29.9
Peak Outflow Q (cfs) =	0.1	0.3	0.2	0.3	2.3	7.3	10.4	13.8	20.2
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	1.7	1.4	1.3	1.4	1.3	1.3
Structure Controlling Flow =	Plate	Plate	Plate	Plate	Overflow Grate 1	Overflow Grate 1	Overflow Grate 1	Overflow Grate 1	Spillway
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	0.3	1.1	1.6	2.1	3.0
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	36	45	43	46	47	43	40	38	33
Time to Drain 99% of Inflow Volume (hours) =	40	52	49	54	55	53	52	50	47
Maximum Ponding Depth (ft) =	0.97	2.49	2.06	2.69	3.18	3.42	3.53	3.70	4.11
Area at Maximum Ponding Depth (acres) =	0.16	0.21	0.19	0.22	0.24	0.25	0.26	0.27	0.29
Maximum Volume Stored (acre-ft) =	0.135	0.414	0.326	0.457	0.572	0.632	0.662	0.705	0.818

Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)







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

Detention Basin Outlet Structure Design

Outflow Hydrograph Workbook Filename:

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

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

Time Interval	
5.75 min	
Hydrograph Constant	0.869

SOURCE	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK
TIME	WQCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0:05:45	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0:11:30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0:17:15	0.10	0.30	0.24	0.33	0.45	0.64	0.77	0.94	1.28
0:23:00	0.28	0.80	0.64	0.87	1.20	1.74	2.10	2.56	3.51
0:28:45	0.71	2.05	1.64	2.24	3.09	4.46	5.38	6.59	9.01
0:34:30	1.96	5.62	4.50	6.16	8.50	12.26	14.79	18.09	24.73
0:40:15	2.29	6.64	5.30	7.29	10.11	14.64	17.72	21.75	29.90
0:46:00	2.17	6.33	5.05	6.95	9.65	13.99	16.94	20.81	28.63
0:51:45	1.98	5.76	4.60	6.33	8.78	12.74	15.42	18.94	26.06
0:57:30	1.75	5.14	4.09	5.65	7.85	11.40	13.82	16.99	23.41
1:03:15	1.50	4.43	3.52	4.87	6.78	9.87	11.98	14.74	20.36
1:09:00	1.31	3.86	3.07	4.24	5.90	8.59	10.42	12.81	17.70
1:14:45	1.18	3.50	2.78	3.84	5.35	7.79	9.44	11.62	16.04
1:20:30	0.96	2.88	2.28	3.16	4.42	6.46	7.84	9.66	13.38
1:26:15	0.78	2.34	1.85	2.58	3.61	5.29	6.44	7.95	11.04
1:32:00	0.58	1.79	1.41	1.98	2.78	4.11	5.01	6.21	8.66
1:37:45	0.42	1.33	1.04	1.47	2.08	3.08	3.78	4.71	6.61
1:43:30	0.31	0.97	0.76	1.07	1.50	2.23	2.75	3.44	4.87
1:49:15	0.24	0.75	0.59	0.83	1.16	1.72	2.11	2.63	3.69
1:55:00	0.20	0.62	0.49	0.68	0.96	1.41	1.73	2.14	3.00
2:00:45	0.17	0.53	0.42	0.58	0.81	1.20	1.46	1.81	2.53
2:06:30	0.15	0.46	0.37	0.51	0.71	1.05	1.28	1.59	2.21
2:12:15	0.14	0.42	0.33	0.46	0.64	0.94	1.15	1.42	1.98
2:18:00	0.13	0.38	0.31	0.42	0.59	0.87	1.06	1.31	1.82
2:23:45	0.09	0.28	0.22	0.31	0.43	0.64	0.78	0.96	1.34
2:29:30	0.07	0.21	0.16	0.23	0.32	0.47	0.57	0.70	0.98
2:35:15	0.05	0.15	0.12	0.17	0.23	0.34	0.42	0.52	0.72
2:41:00	0.04	0.11	0.09	0.12	0.17	0.25	0.31	0.38	0.53
2:46:45	0.03	0.08	0.06	0.09	0.12	0.18	0.22	0.28	0.39
2:52:30	0.02	0.06	0.04	0.06	0.09	0.13	0.16	0.20	0.28
2:58:15	0.01	0.04	0.03	0.04	0.06	0.09	0.11	0.14	0.20
3:04:00	0.01	0.03	0.02	0.03	0.04	0.06	0.08	0.10	0.14
3:09:45	0.00	0.02	0.01	0.02	0.02	0.04	0.05	0.06	0.09
3:15:30	0.00	0.01	0.01	0.01	0.01	0.02	0.02	0.03	0.05
3:21:15	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.02
3:27:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3:32:45	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3:38:30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3:44:15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3:55:45	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:01:30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:07:15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:13:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:18:45	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:24:30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:30:15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:36:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:41:45	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:47:30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:53:15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:59:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:04:45	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:10:30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:16:15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:22:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:27:45	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:33:30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:39:15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:50:45	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:56:30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6:02:15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6:08:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6:13:45	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6:19:30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6:25:15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6:31:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6:36:45	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6:42:30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6:48:15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6:54:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Design Procedure Form: Extended Detention Basin (EDB)

UD-BMP (Version 3.06, November 2016)

Designer: JPS
Company: JPS
Date: April 10, 2017
Project: LONDONDERRY ELEMENTARY SCHOOL
Location: EDB-DP-X

1. Basin Storage Volume	
A) Effective Imperviousness of Tributary Area, I_a	I_a = 40.0 %
B) Tributary Area's Imperviousness Ratio ($i = I_a / 100$)	i = 0.400
C) Contributing Watershed Area	Area = 8.090 ac
D) For Watersheds Outside of the Denver Region, Depth of Average Runoff Producing Storm	d_6 = ______ in
E) Design Concept (Select EURV when also designing for flood control)	Choose One: ○ Water Quality Capture Volume (WQCV) ● Excess Urban Runoff Volume (EURV)
F) Design Volume (WQCV) Based on 40-hour Drain Time ($V_{DESIGN} = (1.0 * (0.91 * i^3 - 1.19 * i^2 + 0.78 * i) / 12 * Area)$	V_{DESIGN}= 0.121 ac-ft
G) For Watersheds Outside of the Denver Region, Water Quality Capture Volume (WQCV) Design Volume ($V_{WQCV\ OTHER} = (d_6*(V_{DESIGN}/0.43))$	$V_{DESIGN\ OTHER}$= ______ ac-ft
H) User Input of Water Quality Capture Volume (WQCV) Design Volume (Only if a different WQCV Design Volume is desired)	$V_{DESIGN\ USER}$= ______ ac-ft
I) Predominant Watershed NRCS Soil Group	Choose One: ○ A ● B ○ C / D
J) Excess Urban Runoff Volume (EURV) Design Volume For HSG A: $EURV_A = 1.68 * i^{1.28}$ For HSG B: $EURV_B = 1.36 * i^{1.08}$ For HSG C/D: $EURV_{C/D} = 1.20 * i^{1.08}$	EURV = 0.341 ac-f t
2. Basin Shape: Length to Width Ratio (A basin length to width ratio of at least 2:1 will improve TSS reduction.)	L : W = 3.0 : 1
3. Basin Side Slopes A) Basin Maximum Side Slopes (Horizontal distance per unit vertical, 4:1 or flatter preferred)	Z = 4.00 ft / ft
4. Inlet A) Describe means of providing energy dissipation at concentrated inflow locations:	Concrete Forebays

Design Procedure Form: Extended Detention Basin (EDB)

Designer: JPS
Company: JPS
Date: April 10, 2017
Project: LONDONDERRY ELEMENTARY SCHOOL
Location: EDB-DP-X

5. Forebay

A) Minimum Forebay Volume (V_{FMIN} = 2% of the WQCV) — V_{FMIN} = 0.002 ac-ft

B) Actual Forebay Volume — V_F = 0.009 ac-ft

C) Forebay Depth (D_F = 18 inch maximum) — D_F = 18.0 in

D) Forebay Discharge

i) Undetained 100-year Peak Discharge — Q_{100} = 17.85 cfs

ii) Forebay Discharge Design Flow ($Q_F = 0.02 * Q_{100}$) — Q_F = 0.36 cfs

E) Forebay Discharge Design

Choose One
- ○ Berm With Pipe
- ● Wall with Rect. Notch
- ○ Wall with V-Notch Weir

(flow too small for berm w/ pipe)

F) Discharge Pipe Size (minimum 8-inches) — Calculated D_P = ______ in

G) Rectangular Notch Width — Calculated W_N = 4.3 in

6. Trickle Channel

A) Type of Trickle Channel

Choose One
- ○ Concrete
- ● Soft Bottom

PROVIDE A CONSISTENT LONGITUDINAL SLOPE FROM FOREBAY TO MICROPOOL WITH NO MEANDERING. RIPRAP AND SOIL RIPRAP LINED CHANNELS ARE NOT RECOMMENDED. MINIMUM DEPTH OF 1.5 FEET

F) Slope of Trickle Channel — S = 0.0050 ft / ft

7. Micropool and Outlet Structure

A) Depth of Micropool (2.5-feet minimum) — D_M = 2.5 ft

B) Surface Area of Micropool (10 ft^2 minimum) — A_M = 10 sq ft

C) Outlet Type

Choose One
- ● Orifice Plate
- ○ Other (Describe):

D) Smallest Dimension of Orifice Opening Based on Hydrograph Routing (Use UD-Detention) — $D_{orifice}$ = 1.56 inches

E) Total Outlet Area — A_{ot} = 5.67 square inches

Design Procedure Form: Extended Detention Basin (EDB)

Designer:	**JPS**
Company:	**JPS**
Date:	**April 10, 2017**
Project:	**LONDONDERRY ELEMENTARY SCHOOL**
Location:	**EDB-DP-X**

8. Initial Surcharge Volume	
A) Depth of Initial Surcharge Volume (Minimum recommended depth is 4 inches)	D_{IS} = 4 in
B) Minimum Initial Surcharge Volume (Minimum volume of 0.3% of the WQCV)	V_{IS} = ____ cu ft
C) Initial Surcharge Provided Above Micropool	V_s= 3.3 cu ft
9. Trash Rack	
A) Water Quality Screen Open Area: $A_t = A_{ot} * 38.5*(e^{-0.095D})$	A_t = 188 square inches
B) Type of Screen (If specifying an alternative to the materials recommended in the USDCM, indicate "other" and enter the ratio of the total open are to the total screen are for the material specified.) Other (Y/N): N	*Aluminum Amico-Klemp SR Series with Cross Rods 2" O.C.*
C) Ratio of Total Open Area to Total Area (only for type 'Other')	User Ratio =
D) Total Water Quality Screen Area (based on screen type)	A_{total} = 265 sq. in.
E) Depth of Design Volume (EURV or WQCV) (Based on design concept chosen under 1E)	H= 2 feet
F) Height of Water Quality Screen (H_{TR})	H_{TR}= 52 inches
G) Width of Water Quality Screen Opening ($W_{opening}$) (Minimum of 12 inches is recommended)	$W_{opening}$ = 12.0 inches

Design Procedure Form: Extended Detention Basin (EDB)

Designer:	**JPS**
Company:	**JPS**
Date:	**April 10, 2017**
Project:	**LONDONDERRY ELEMENTARY SCHOOL**
Location:	**EDB-DP-X**

10. Overflow Embankment A) Describe embankment protection for 100-year and greater overtopping:	Buried Riprap
B) Slope of Overflow Embankment (Horizontal distance per unit vertical, 4:1 or flatter preferred)	4.00
11. Vegetation	Choose One ◉ Irrigated ○ Not Irrigated **AVOID PLACING IRRIGATION HEADS IN THE BOTTOM OF THE BASIN**
12. Access A) Describe Sediment Removal Procedures	Periodic inspection and maintenance as required

Notes:

Design Procedure Form: Rain Garden (RG)

Designer: JPS
Company: JPS
Date: April 8, 2017
Project: LONDONDERRY ELEMENTARY SCHOOL
Location: RAIN GARDEN - DP-W2

1. Basin Storage Volume	
A) Effective Imperviousness of Tributary Area, I_a (100% if all paved and roofed areas upstream of rain garden)	I_a = 50.2 %
B) Tributary Area's Imperviousness Ratio ($i = I_a/100$)	i = 0.502
C) Water Quality Capture Volume (WQCV) for a 12-hour Drain Time (WQCV= 0.8 * (0.91* i^3 - 1.19 * i^2 + 0.78 * i)	WQCV = 0.17 watershed inches
D) Contributing Watershed Area (including rain garden area)	Area = 138,956 sq ft
E) Water Quality Capture Volume (WQCV) Design Volume Vol = (WQCV / 12) * Area	V_{WQCV} = 1,916 cu ft
F) For Watersheds Outside of the Denver Region, Depth of Average Runoff Producing Storm	d_6 = ______ in
G) For Watersheds Outside of the Denver Region, Water Quality Capture Volume (WQCV) Design Volume	$V_{WQCV\ OTHER}$ = ______ cu ft
H) User Input of Water Quality Capture Volume (WQCV) Design Volume (Only if a different WQCV Design Volume is desired)	$V_{WQCV\ USER}$ = ______ cu ft
2. Basin Geometry	
A) WQCV Depth (12-inch maximum)	D_{WQCV} = 12 in
B) Rain Garden Side Slopes (Z = 4 min., horiz. dist per unit vertical) (Use "0" if rain garden has vertical walls)	Z = 4.00 ft / ft
C) Mimimum Flat Surface Area	A_{Min} = 1395 sq ft
D) Actual Flat Surface Area	A_{Actual} = 1742 sq ft
E) Area at Design Depth (Top Surface Area)	A_{Top} = 2559 sq ft
F) Rain Garden Total Volume (V_T= ((A_{Top} + A_{Actual}) / 2) * Depth)	V_T= 2,151 cu ft
3. Growing Media	Choose One: (●) 18" Rain Garden Growing Media; ( ) Other (Explain):
4. Underdrain System	
A) Are underdrains provided?	Choose One: (●) YES; ( ) NO
B) Underdrain system orifice diameter for 12 hour drain time	
i) Distance From Lowest Elevation of the Storage Volume to the Center of the Orifice	y = 2.0 ft
ii) Volume to Drain in 12 Hours	Vol_{12} = 1,916 cu ft
iii) Orifice Diameter, 3/8" Minimum	D_O = 1 in

Design Procedure Form: Rain Garden (RG)

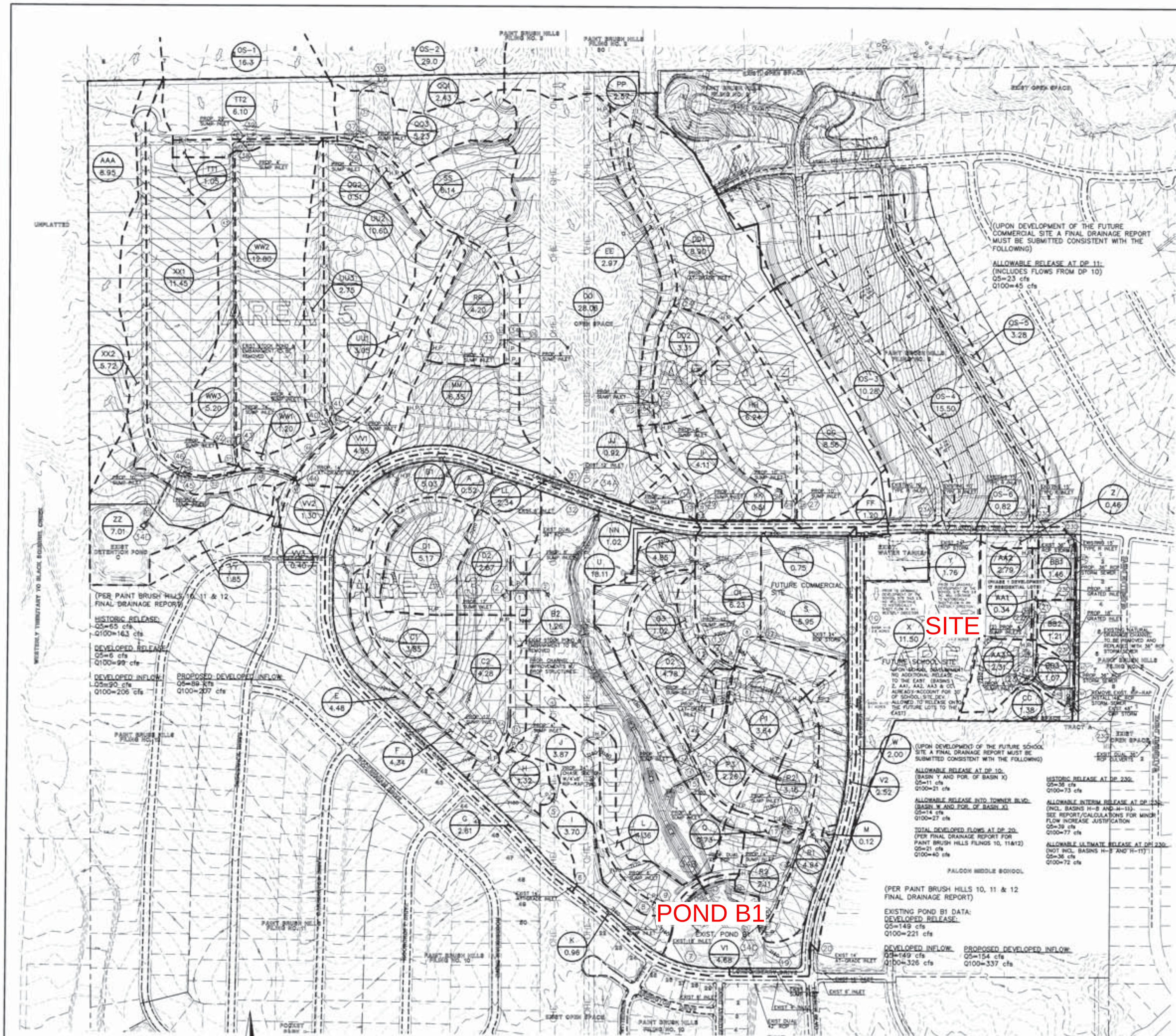
Designer: JPS
Company: JPS
Date: April 8, 2017
Project: LONDONDERRY ELEMENTARY SCHOOL
Location: RAIN GARDEN - DP-W2

5. Impermeable Geomembrane Liner and Geotextile Separator Fabric A) Is an impermeable liner provided due to proximity of structures or groundwater contamination?	Choose One ○ YES ◉ NO
6. Inlet / Outlet Control A) Inlet Control	Choose One ○ Sheet Flow- No Energy Dissipation Required ◉ Concentrated Flow- Energy Dissipation Provided
7. Vegetation	Choose One ◉ Seed (Plan for frequent weed control) ○ Plantings ○ Sand Grown or Other High Infiltration Sod
8. Irrigation A) Will the rain garden be irrigated?	Choose One ○ YES ○ NO

Notes:

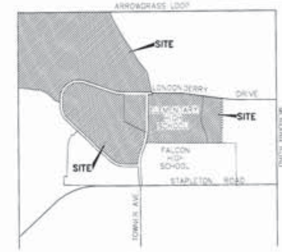
APPENDIX E

FIGURES



LEGEND

DESCRIPTION	SYMBOL
EXISTING GROUND CONTOUR	6810
PROPOSED FINISHED CONTOUR	—— 6810 ——
BASIN BOUNDARY	– – – –
DESIGN POINT	(3)
BASIN IDENTIFIER / AREA IN ACRES	BB / 10.0
EXISTING DIRECTION OF FLOW	⇨
PROPOSED DIRECTION OF FLOW	➡
PROPOSED STORM SEWER	——
PROPOSED STORM SEWER INLETS	▭
STORM PIPE RUN SIZING	(20)
TIME OF CONCENTRATION	



VICINITY MAP
N.T.S.

NOTE: ALL PIPES BASED ON 100 YR. FLOWS AT 1.0% MIN. GRADE)

PIPE RUN	SIZE	PIPE RUN	SIZE	PIPE RUN	SIZE	PIPE RUN	SIZE
1	30" RCP	17	24" RCP	27	36" RCP	42	36" RCP
2	36" RCP	18	18" RCP	28	30" RCP	43	42" RCP
3 3A	30" RCP	19	24" RCP	29	30" RCP	44	18" RCP
4	30" RCP	20	30" RCP	30	36" RCP	45	30" RCP
5	24" RCP	21	30" RCP	31	24" RCP	46	30" RCP
6	30" RCP	22	18" RCP	32	18" RCP	47	18" RCP
7	EXIST. 24" RCP	23	18" RCP	33	30" RCP	48	36" RCP
8	36" RCP	24	24" RCP	34	36" RCP	49	24" RCP
9	30" RCP	24A	18" RCP	35	24" RCP	50	30" RCP
10	18" RCP	24B	24" RCP	36	30" RCP	51	54" RCP
11	30" RCP	24C	36" RCP	37	36" RCP	52	54" RCP
12	36" RCP	24D	36" RCP	38	18" RCP	53	24" RCP
13	18" RCP	24E	36" RCP	39	24" RCP	54	30" RCP
13A	42" RCP	24F	48" RCP	39A	42" RCP	55	54" RCP
14	30" RCP	25	18" RCP	40	42" RCP	56	48" RCP
15	24" RCP	26	30" RCP	41	18" RCP	57	48" RCP
16	42" RCP	26A	30" RCP	41A	42" RCP		

DESIGN POINT	FLOW	INLET SIZE
1	Q5 = 9 CFS Q100 = 20 CFS	8' TYPE R SUMP INLET
2	Q5 = 12 CFS Q100 = 26 CFS	12' TYPE R SUMP INLET
3	Q5 = 2 CFS Q100 = 5 CFS	4' TYPE R SUMP INLET
4	Q5 = 13 CFS Q100 = 27 CFS	12' TYPE R SUMP INLET
5	Q5 = 2 CFS Q100 = 5 CFS	18" CONC. CHASE SECTION
6	Q5 = 19 CFS Q100 = 38 CFS	EXIST. 14' TYPE R AT-GRADE INLET
7	Q5 = 15 CFS Q100 = 37 CFS	EXIST 18' TYPE R SUMP INLET
8	Q5 = 6 CFS Q100 = 12 CFS	4' TYPE R SUMP INLET
9	Q5 = 7 CFS Q100 = 14 CFS	8' TYPE R SUMP INLET
10	Q5 = 11 CFS Q100 = 21 CFS	EXIST 24" RCP STORM
11	Q5 = 23 CFS Q100 = 45 CFS	36" RCP STORM
12	Q5 = 2 CFS Q100 = 5 CFS	4' TYPE R SUMP INLET
13	Q5 = 13 CFS Q100 = 27 CFS	12' TYPE R SUMP INLET
14	Q5 = 12 CFS Q100 = 28 CFS	12' TYPE R SUMP INLET
14A	Q5 = 8 CFS Q100 = 17 CFS	12' TYPE R AT-GRADE INLET
15	Q5 = 8 CFS Q100 = 17 CFS	6' TYPE R SUMP INLET
16	Q5 = 6 CFS Q100 = 12 CFS	4' TYPE R SUMP INLET
17	Q5 = 2 CFS Q100 = 3 CFS	4' TYPE R SUMP INLET
18	Q5 = 12 CFS Q100 = 26 CFS	12' TYPE R SUMP INLET
19	Q5 = 9 CFS Q100 = 17 CFS	EXIST. 8' TYPE R SUMP INLET
20	Q5 = 19 CFS Q100 = 36 CFS	EXIST. 14' TYPE R AT-GRADE INLET
21	Q5 = 1 CFS Q100 = 3 CFS	4' TYPE R SUMP INLET
22	Q5 = 5 CFS Q100 = 11 CFS	4' TYPE R SUMP INLET
23	Q5 = 4 CFS Q100 = 9 CFS	4' TYPE R SUMP INLET
23A	Q5 = 10 CFS Q100 = 22 CFS	EXIST. 10' TYPE R INLETS
23B	Q5 = 14 CFS Q100 = 28 CFS	EXIST. 15' TYPE R INLET
23C	Q5 = 5 CFS Q100 = 10 CFS	EXIST. 15' TYPE R INLET
23D	Q5 = 3 CFS Q100 = 5 CFS	EXIST. 15' TYPE R INLET
23E	Q5 = 2 CFS Q100 = 4 CFS	18" GRATED INLET
23F	Q5 = 2 CFS Q100 = 3 CFS	18" GRATED INLET
23G INTERIM	Q5 = 36 CFS Q100 = 77 CFS	EXIST. 48" CMP / DUAL 36" CULVERT
23G ULTIMATE	Q5 = 36 CFS Q100 = 72 CFS	EXIST. 48" CMP / DUAL 36" CULVERT
24	Q5 = 10 CFS Q100 = 23 CFS	14' TYPE R AT-GRADE INLET
25	Q5 = 9 CFS Q100 = 23 CFS	8' TYPE R SUMP INLET
26	Q5 = 6 CFS Q100 = 12 CFS	4' TYPE R SUMP INLET
27	Q5 = 11 CFS Q100 = 25 CFS	10' TYPE R SUMP INLET
28	Q5 = 10 CFS Q100 = 22 CFS	10' TYPE R SUMP INLET
29	Q5 = 8 CFS Q100 = 17 CFS	6' TYPE R SUMP INLET
30	Q5 = 2 CFS Q100 = 4 CFS	4' TYPE R SUMP INLET
31	Q5 = 15 CFS Q100 = 32 CFS	EXIST 12' TYPE R
32	Q5 = 4 CFS Q100 = 7 CFS	EXIST. 8' TYPE R
33	Q5 = 6 CFS Q100 = 14 CFS	4' TYPE R SUMP INLET
34	Q5 = 7 CFS Q100 = 16 CFS	6' TYPE R SUMP INLET
34A	Q5 = 46 CFS Q100 = 106 CFS	EXIST. DUAL 36" RCP STORM
34B	Q5 = 139 CFS Q100 = 302 CFS	PROP. DUAL 48" RCP STORM
34C	Q5 = 134 CFS Q100 = 337 CFS	EXIST. DUAL 42" RCP STORM
34D	Q5 = 89 CFS Q100 = 207 CFS	EXIST. POND
35	Q5 = 26 CFS Q100 = 62 CFS	PROP. 36" RCP STORM
36	Q5 = 1 CFS Q100 = 2 CFS	4' TYPE R SUMP INLET
37	Q5 = 5 CFS Q100 = 13 CFS	4' TYPE R SUMP INLET
38	Q5 = 1 CFS Q100 = 3 CFS	4' TYPE R SUMP INLET
39	Q5 = 18 CFS Q100 = 42 CFS	20' TYPE R SUMP INLET
40	Q5 = 4 CFS Q100 = 8 CFS	4' TYPE R SUMP INLET
41	Q5 = 14 CFS Q100 = 32 CFS	14' TYPE R SUMP INLET
42	Q5 = 5 CFS Q100 = 12 CFS	4' TYPE R SUMP INLET
43	Q5 = 14 CFS Q100 = 32 CFS	14' TYPE R SUMP INLET
44	Q5 = 8 CFS Q100 = 13 CFS	14' TYPE R AT-GRADE INLET
45	Q5 = 7 CFS Q100 = 16 CFS	6' TYPE R SUMP INLET
46	Q5 = 11 CFS Q100 = 26 CFS	10' TYPE R SUMP INLET

NOTES:
THIS MAP IS FOR DRAINAGE PURPOSES ONLY. SEE GRADING PLAN FOR APPROPRIATE GRADING INFORMATION.

200 100 0 200 400
SCALE: 1" = 200'

FLOOD PLAIN STATEMENT:
NO PORTION OF THIS SITE IS LOCATED WITHIN A FEMA FLOODPLAIN AS DETERMINED BY THE FLOOD INSURANCE RATE MAPS (F.I.R.M.) MAP NUMBERS 08041C 0535F AND 08041C 0575, WITH EFFECTIVE DATES OF MARCH 17, 1997 (SEE APPENDIX).

48 HOURS BEFORE YOU DIG, CALL UTILITY LOCATORS
1-800-922-1987
CITY OF COLORADO SPRINGS DEPT. OF UTILITIES GAS, ELECTRIC, WATER AND WASTEWATER

THE LOCATIONS OF EXISTING UNDERGROUND UTILITIES ARE SHOWN IN AN APPROXIMATE WAY ONLY. THE CONTRACTOR SHALL DETERMINE THE EXACT LOCATION OF ALL EXISTING UTILITIES BEFORE COMMENCING WORK. THE CONTRACTOR SHALL BE FULLY RESPONSIBLE FOR ANY AND ALL DAMAGES WHICH MIGHT BE CAUSED BY HIS FAILURE TO EXACTLY LOCATE AND PRESERVE ANY AND ALL UNDERGROUND UTILITIES.

NO.	REVISION	DATE

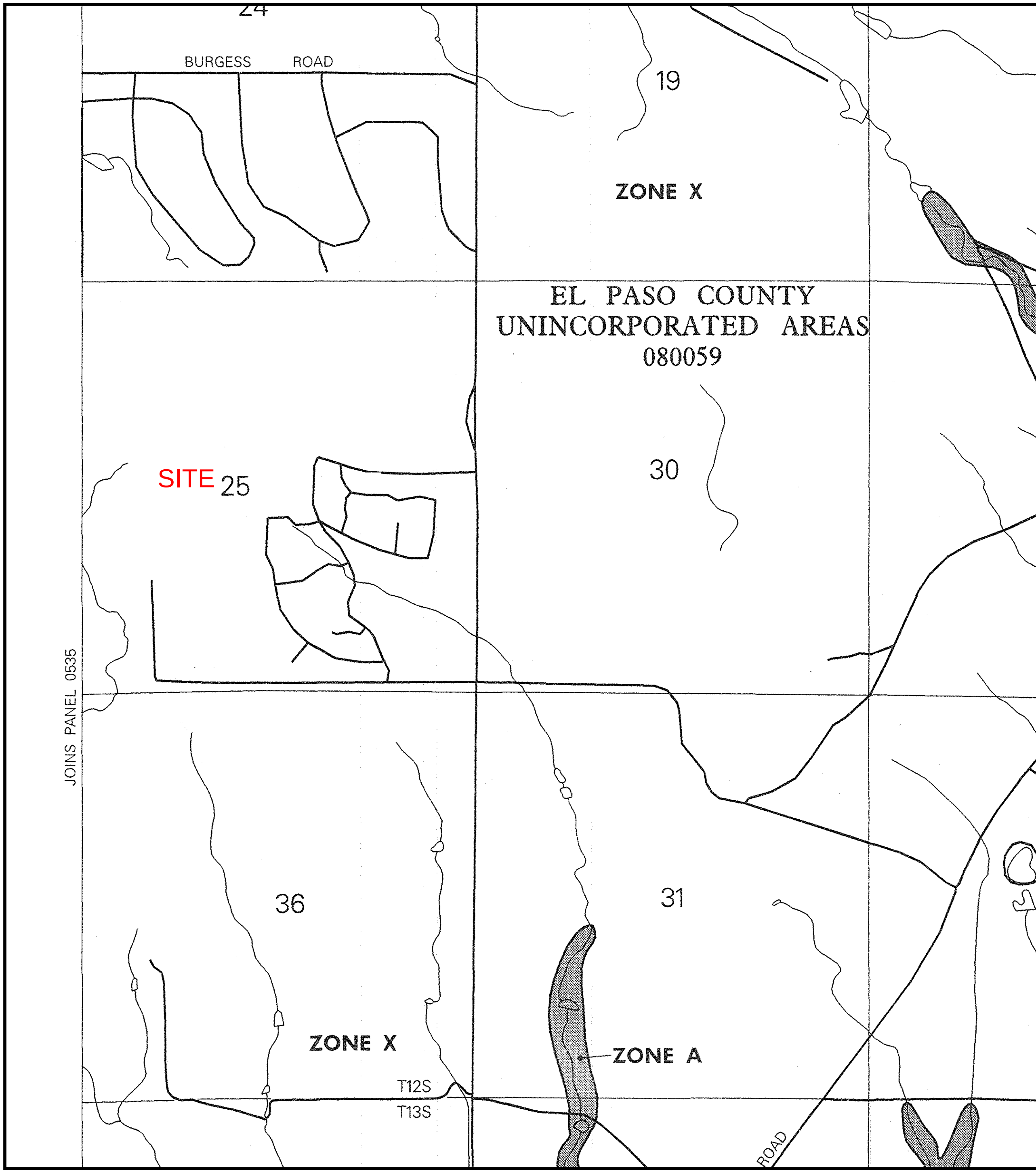
REVIEW:
PREPARED UNDER MY DIRECT SUPERVISION FOR AND ON BEHALF OF CLASSIC CONSULTING ENGINEERS AND SURVEYORS, LLC

MARC A. WHORTON, COLORADO P.E. #37155 DATE

CLASSIC CONSULTING ENGINEERS & SURVEYORS
6385 Corporate Drive, Suite 101 Colorado Springs, Colorado 80919
(719)785-0790 (719)785-0799 (Fax)

PAINT BRUSH HILLS FILING NO. 13A
PHASED FINAL PLAT – PHASE 1
FINAL DRAINAGE REPORT
PROPOSED CONDITIONS DRAINAGE MAP

DESIGNED BY	MAW	SCALE	2-11-13
DRAWN BY	MAW	(H) 1"= 200'	SHEET 2 OF 2
CHECKED BY		(V) 1"= N/A	JOB NO. 2053.24



APPROXIMATE SCALE IN FEET

2000 0 2000

NATIONAL FLOOD INSURANCE PROGRAM

FIRM

FLOOD INSURANCE RATE MAP

EL PASO COUNTY, COLORADO AND INCORPORATED AREAS

PANEL 575 OF 1300

(SEE MAP INDEX FOR PANELS NOT PRINTED)

CONTAINS:

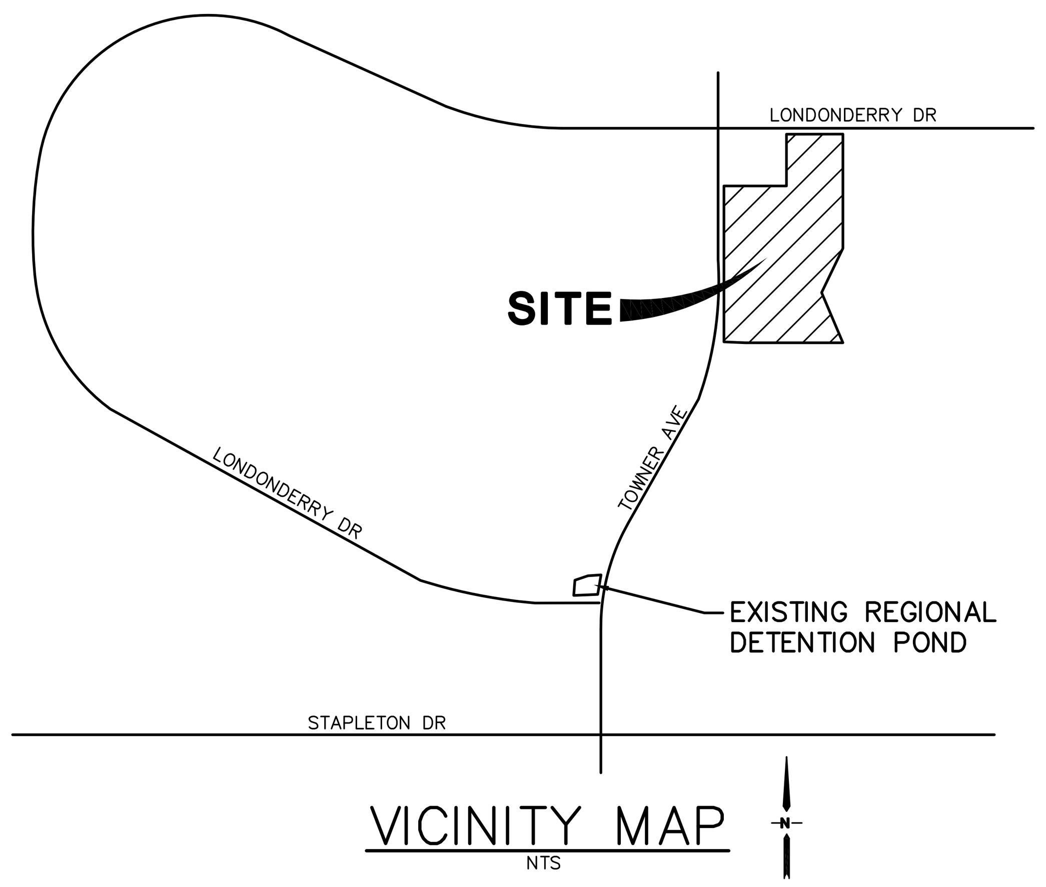
COMMUNITY	NUMBER	PANEL	SUFFIX
COLORADO SPRINGS, CITY OF	080060	0575	F
EL PASO COUNTY, UNINCORPORATED AREAS	080059	0575	F

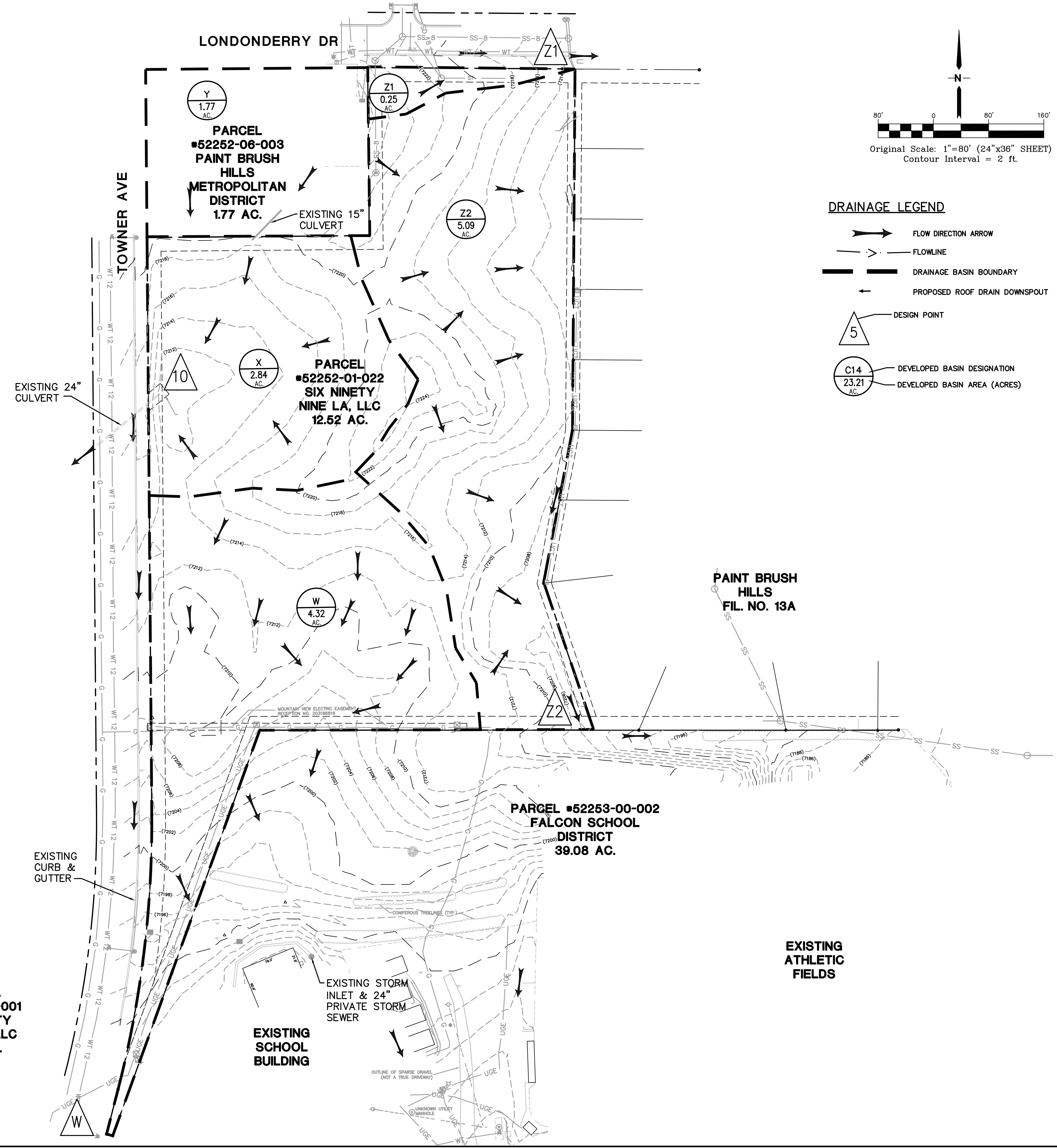
MAP NUMBER
08041C0575 F

EFFECTIVE DATE:
MARCH 17, 1997

Federal Emergency Management Agency

This is an official copy of a portion of the above referenced flood map. It was extracted using F-MIT On-Line. This map does not reflect changes or amendments which may have been made subsequent to the date on the title block. For the latest product information about National Flood Insurance Program flood maps check the FEMA Flood Map Store at www.msc.fema.gov





SUMMARY HYDROLOGY TABLE

DESIGN POINT	Q_5 (CFS)	Q_{100} (CFS)
W	1.1	7.7
10	1.2	9.0
Z1	0.1	0.5
Z2	1.2	9.0

j:\jpsprojects\121605.falcon-elem\dwg\civil\EX1.dwg May 03, 2017 – 4:01pm

LONDONDERRY SCHOOL

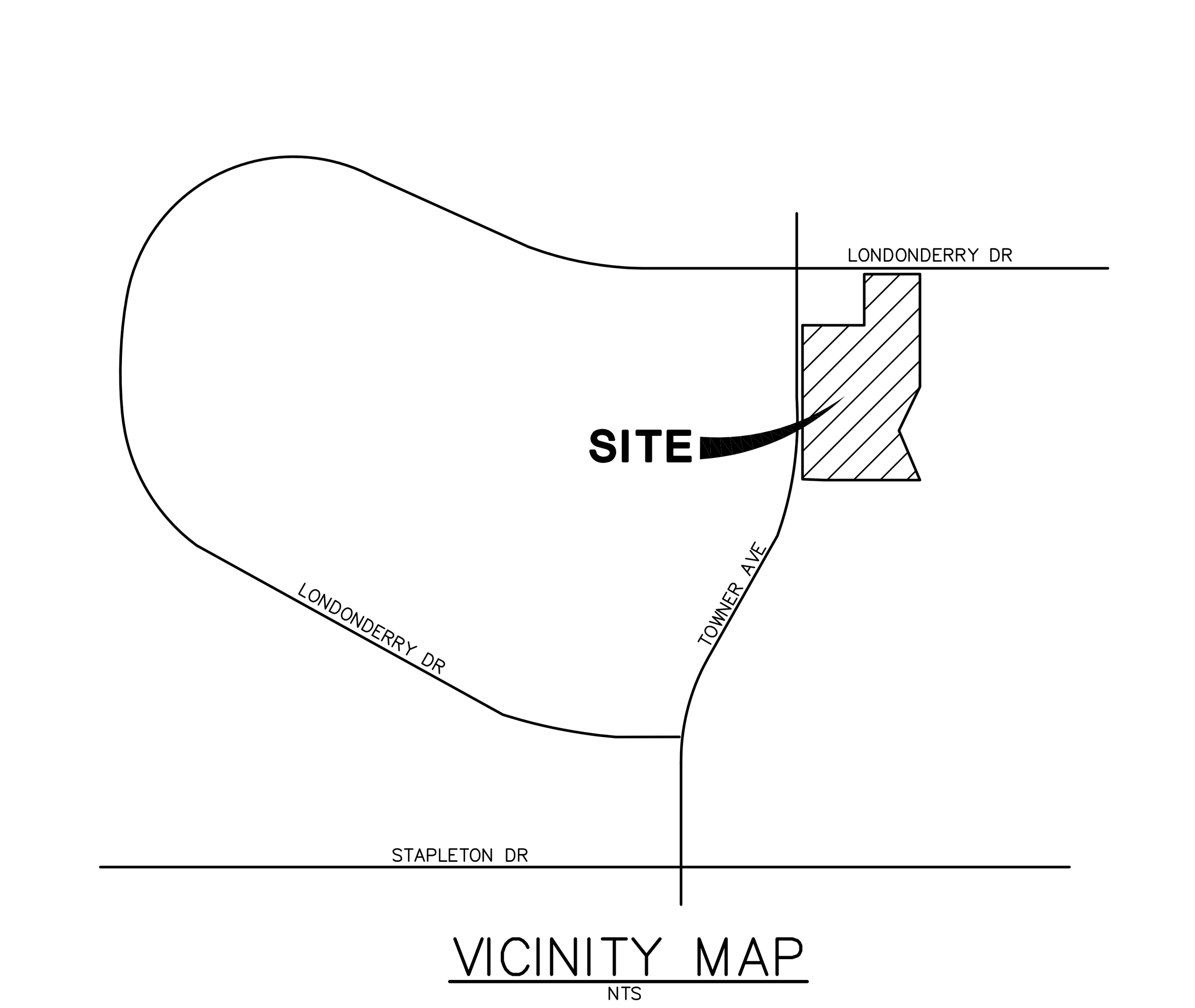
HISTORIC DRAINAGE PLAN

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

HORZ. SCALE: 1"=80'	DRAWN: BJJ
VERT. SCALE: N/A	DESIGNED: JPS
SURVEYED: M&S	CHECKED: JPS
CREATED: 4/06/17	LAST MODIFIED: 4/10/17
PROJECT NO: 121605	MODIFIED BY: BJJ
SHEET: EX1	



VICINITY MAP

NTS

IMPERVIOUS AREAS:

AREA W1 = 0.80 AC.

SURFACE TYPE	AREA
PARKING PAVEMENT	5,320 SF
BUILDING (ULTIMATE)	– SF
SIDEWALK	3,776 SF
TOTAL	9,096 SF
	= 0.21 AC
	= 26% IMPERVIOUS

AREA W2 = 2.40 AC.

SURFACE TYPE	AREA
BUILDING (ULTIMATE)	55,452 SF
SIDEWALK	5,177 SF
TOTAL	60,629 SF
	= 1.39 AC
	= 58% IMPERVIOUS

AREA X1 = 6.61 AC.

SURFACE TYPE	AREA
PARKING PAVEMENT	36,318 SF
BUILDING (ULTIMATE)	47,258 SF
SIDEWALK	10,081 SF
TOTAL	93,657 SF
	= 2.15 AC
	= 33% IMPERVIOUS

AREA X2 = 1.48 AC.

SURFACE TYPE	AREA
PARKING PAVEMENT	16,692 SF
BUILDING (ULTIMATE)	29,206 SF
SIDEWALK	1,762 SF
TOTAL	47,660 SF
	= 1.09 AC
	= 74% IMPERVIOUS

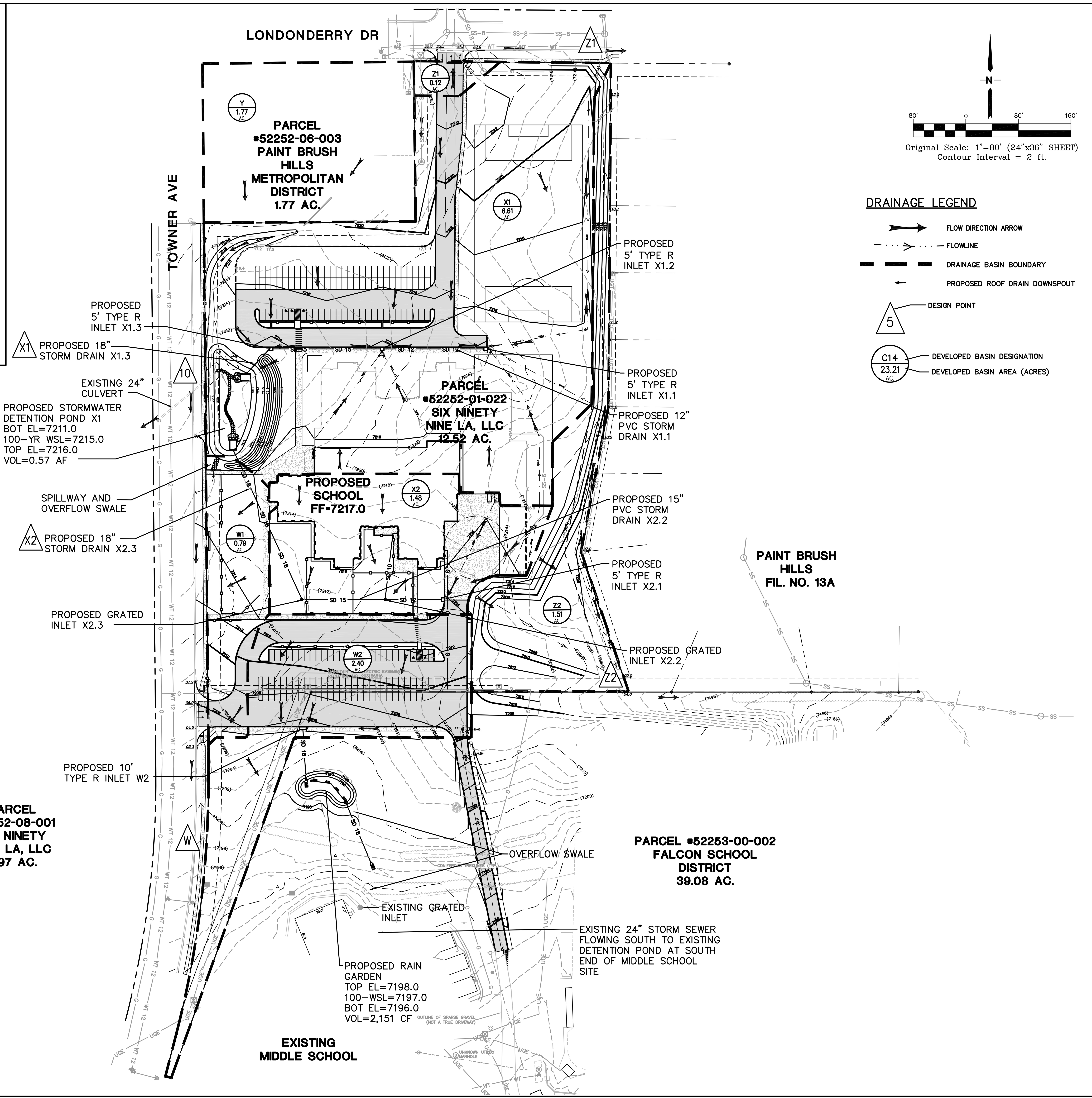
AREA Z1 = 0.12 AC.

SURFACE TYPE	AREA
PARKING PAVEMENT	1,526 SF
SIDEWALK	273 SF
TOTAL	1,799 SF
	= 0.04 AC
	= 34% IMPERVIOUS

SUMMARY HYDROLOGY TABLE

DESIGN POINT	Q_5 (CFS)	Q_{100} (CFS)
W	5.7	12.9
X1	6.7	17.9
X2	4.1	8.0
10	12.8	30.0
Z1	0.2	0.6
Z2	0.4	3.2

j:\jpsprojects\121605.falcon-elem\dwg\civil\D1.dwg May 25, 2017 – 7:59am



JPS ENGINEERING

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Colorado Springs, CO 80903
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FAX: 719-471-0766
www.jpsengr.com

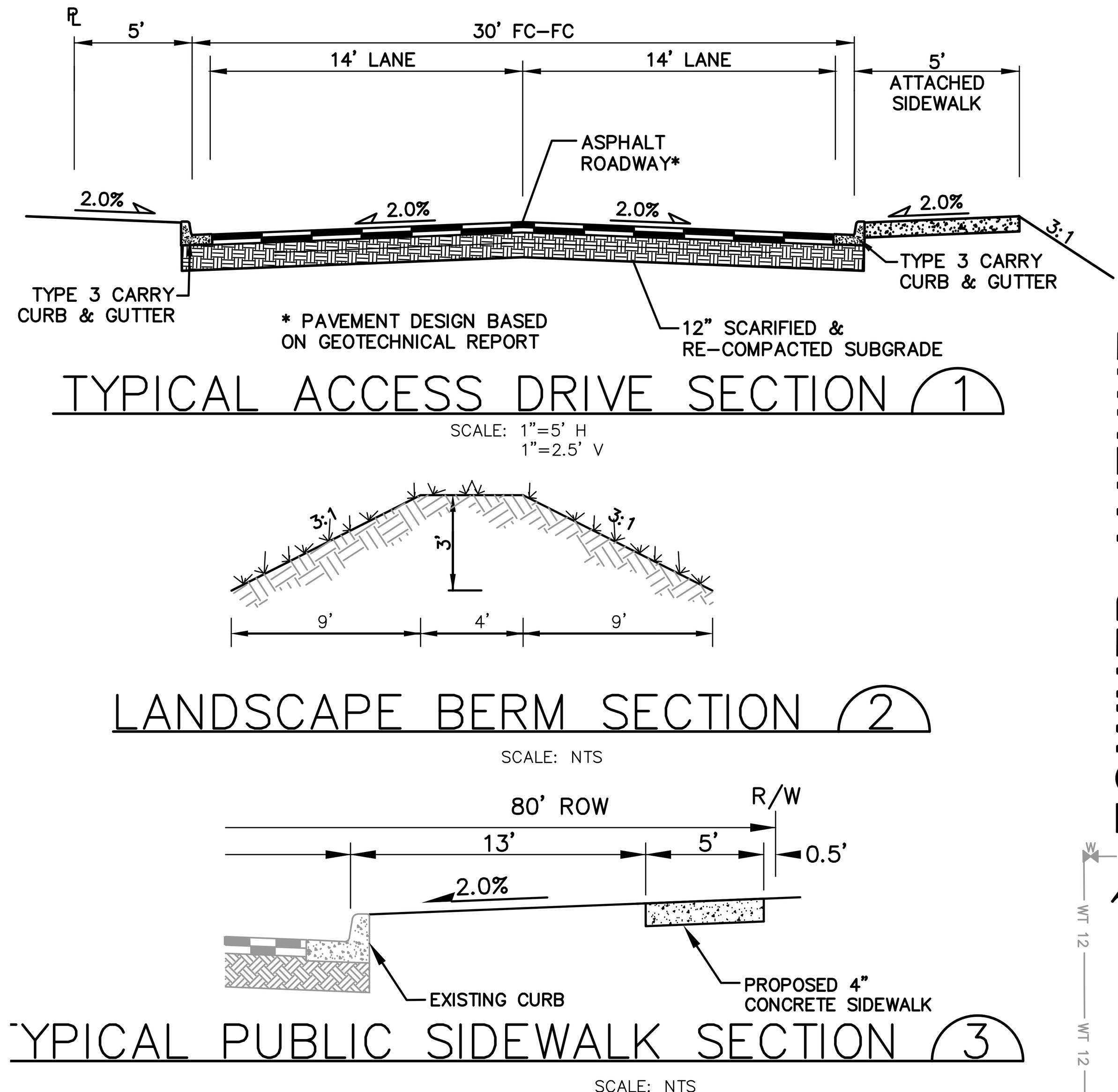
CALL UTILITY NOTIFICATION CENTER OF COLORADO
1-800-922-1987
CALL 2-BUSINESS DAYS IN ADVANCE BEFORE YOU DIG, GRADE, OR EXCAVATE FOR THE MARKING OF UNDERGROUND MEMBER UTILITIES.

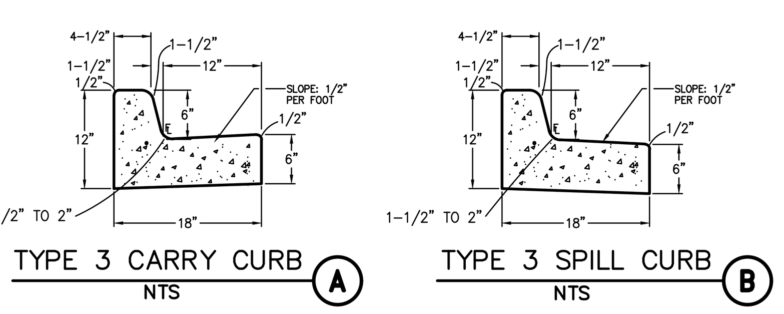
No.	REVISION	BY	DATE

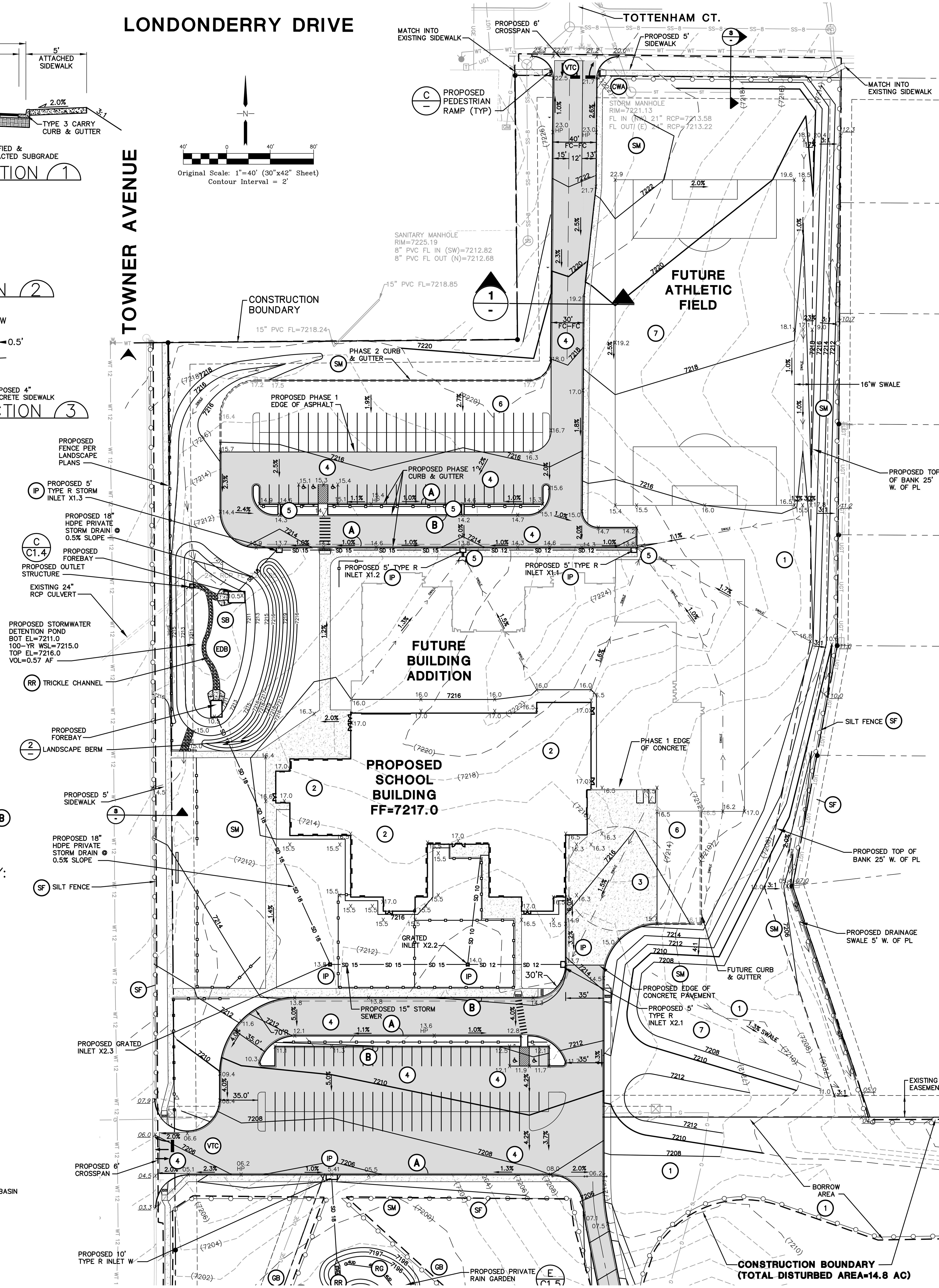
LONDONDERRY SCHOOL

DEVELOPED DRAINAGE PLAN

HORZ. SCALE:	1"=80'	DRAWN:	BJJ
VERT. SCALE:	N/A	DESIGNED:	JPS
SURVEYED:	–	CHECKED:	JPS
CREATED:	1/24/17	LAST MODIFIED:	5/3/17
PROJECT NO:	121605	MODIFIED BY:	BJJ
SHEET:			D1







ESTIMATED EARTHWORK QUANTITY:

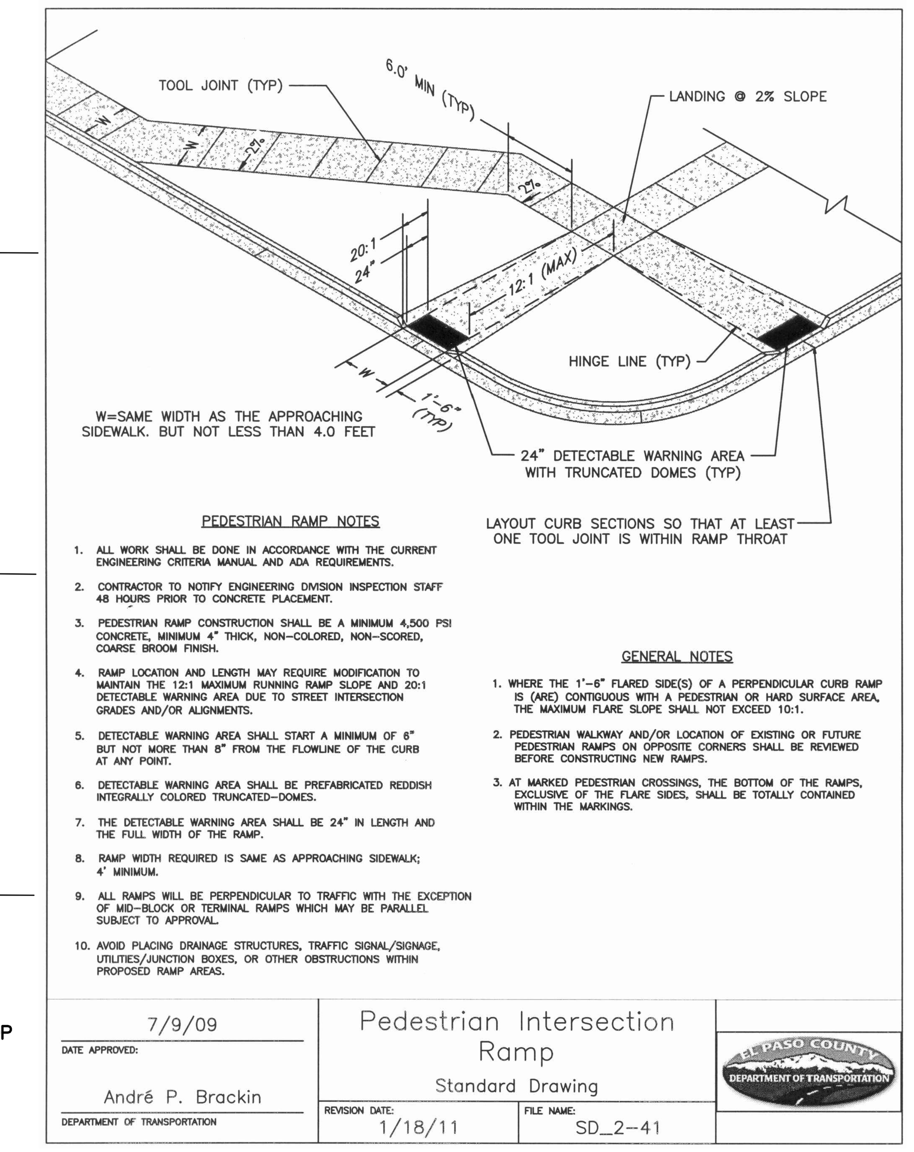
UNCLASSIFIED EXCAVATION (TOTAL CUT) = 16,417 CY
*EMBANKMENT FILL = 37,322 CY
NET (FILL) = 20,905 CY
* (ASSUMES 15% COMPACTION FACTOR)

NOTE: THIS ESTIMATE IS PROVIDED FOR INFORMATION ONLY, REPRESENTING THE CALCULATED BULK EARTHWORK VOLUME TO FINISHED GRADE, EXCLUDING ANY ADJUSTMENT FOR PAVEMENT DEPTHS, ETC. CONTRACTOR SHALL MAKE HIS OWN DETERMINATION OF EARTHWORK QUANTITIES AS BASIS FOR BID PRICING AND NOTIFY ENGINEER OF ANY DISCREPANCIES.

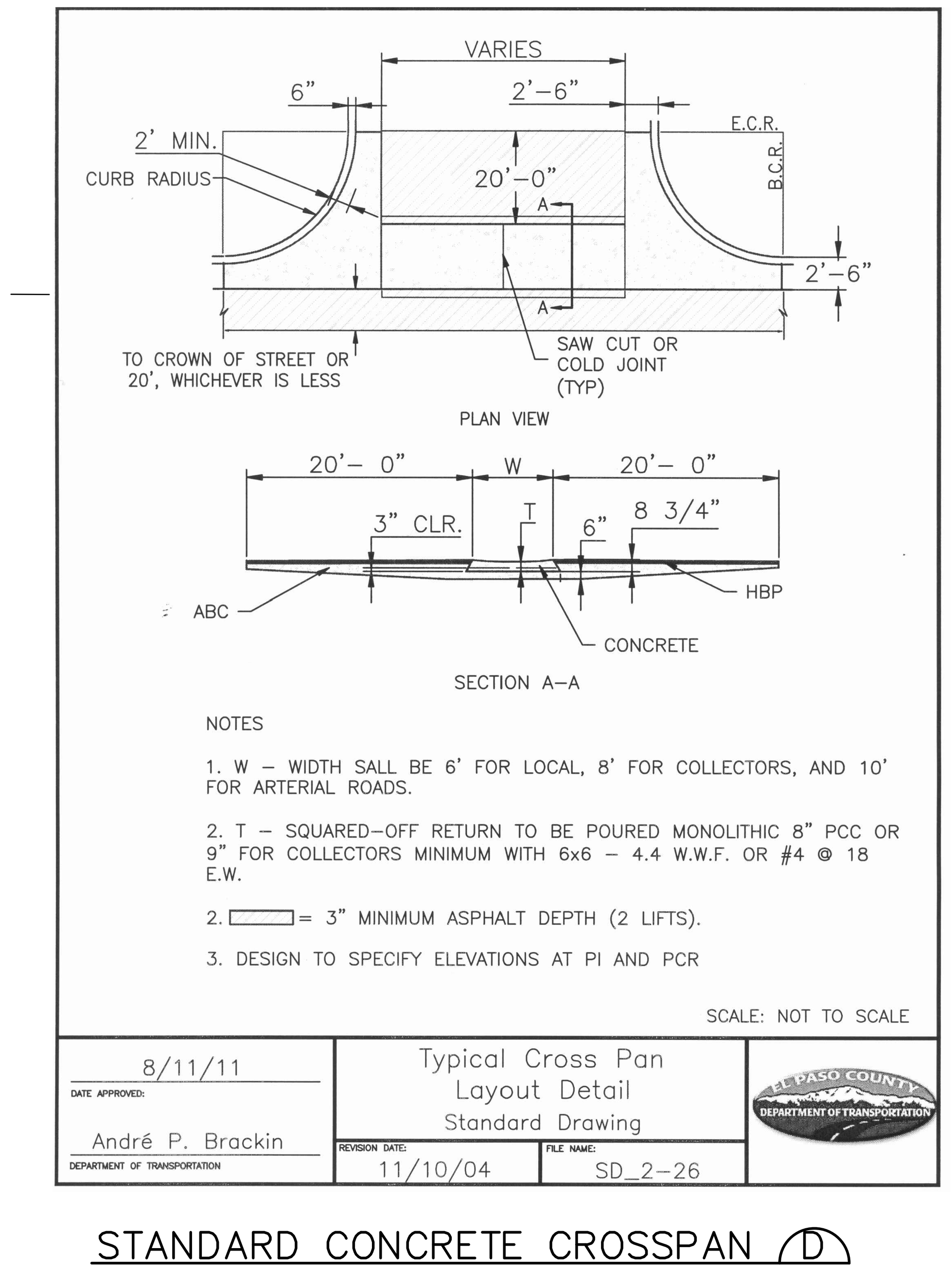
LEGEND

- PROPERTY LINE
- EASEMENT
- 6520 PROPOSED CONTOUR
- 6520 EXISTING CONTOUR
- 99.0 PROPOSED SPOT ELEVATION (FLOWLINE)
- 99.0 EXIST. SPOT ELEVATION
- SF SILT FENCE
- RR RIPRAP PAD
- VTC VEHICLE TRACKING PAD
- SM SEED & MULCH
- IP INLET PROTECTION
- SB SEDIMENT BASIN
- GB GRASS BUFFER
- EDB EXTENDED DETENTION BASIN
- CWA CONCRETE WASHOUT AREA
- RG RAIN GARDEN

NOTES:
1. ALL EROSION CONTROL MEASURES SHALL CONFORM TO CITY OF COLORADO SPRINGS DRAINAGE CRITERIA MANUAL, VOLUME 2 REQUIREMENTS.
2. CONTRACTOR SHALL OBTAIN A "WORK IN THE ROW PERMIT" FOR ALL WORK IN COUNTY RIGHT-OF-WAY.



STANDARD PEDESTRIAN RAMP (C)
NOT TO SCALE



STANDARD CONCRETE CROSSPAN (D)
NOT TO SCALE

KEYED NOTES:

1. CONTRACTOR MAY WASTE EXCESS CUT MATERIAL OR BORROW SUITABLE FILL MATERIAL FROM THIS AREA . MAINTAIN POSITIVE DRAINAGE & MATCH INTO EXISTING GRADES WITH 3:1 MAX. SLOPE.
2. PREPARE AND COMPACT BUILDING FOUNDATION & SLABS PER PROJECT GEOTECHNICAL REPORT
3. HEAVY DUTY PAVEMENT: 5" CONCRETE (REFER TO GEOTECH REPORT)
4. MODERATE DUTY PAVEMENT: 4" HBP OVER 6" ABC (REFER TO GEOTECH REPORT)
5. 2' CURB CHASE
6. BUILDING MATERIAL STORAGE AREA
7. TOPSOIL STOCKPILE AREA

NO.	REVISION	BY	DATE
1	COUNTY COMMENTS	JPS	5/23/17

LONDONDERRY SCHOOL

PHASE 1
NEW CONSTRUCTION
DEVELOPMENT PLAN

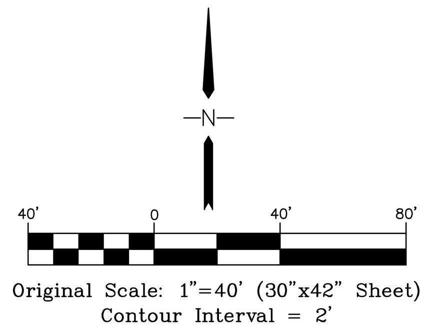
JPS ENGINEERING
19 E. Willamette Ave.
Colorado Springs, CO 80903
PH: 719-477-9429
FAX: 719-471-0766
www.jpsengr.com

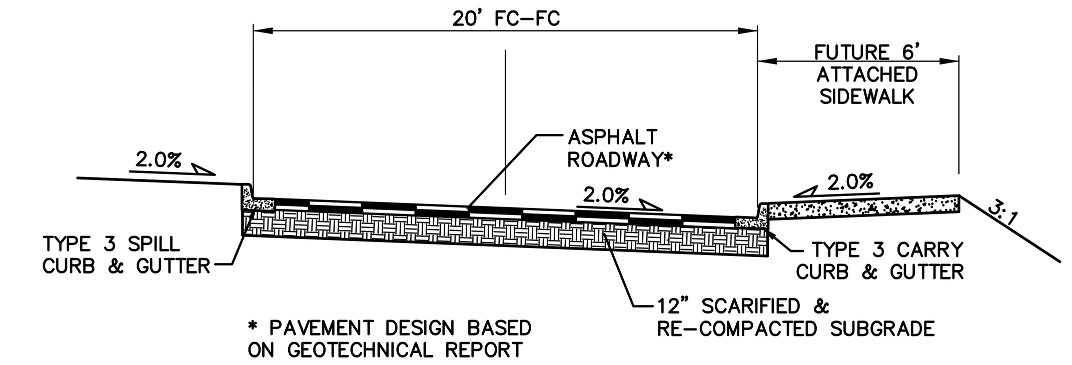
CRP ARCHITECTS AIA
100 E. St. Vrain, Suite 300
Colorado Springs, Colorado 80903

NORTH SITE GRADING & EROSION CONTROL PLAN
SCALE : 1"=40'

DATE: 1/18/17
DRAWN BY: BJJ
CHECKED BY: JPS
REVISED: 5/23/17

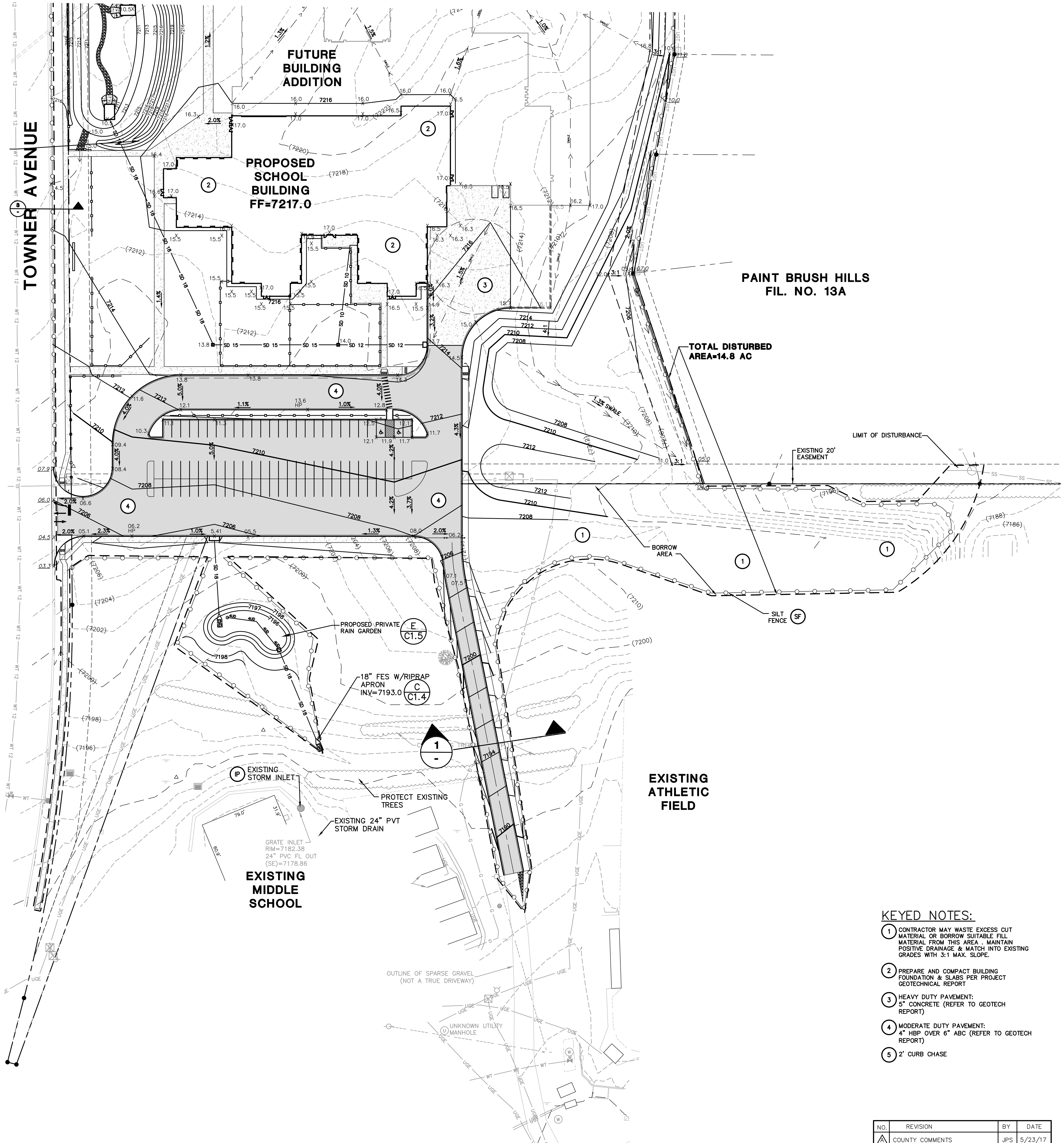
C1.2





TYPICAL ACCESS DRIVE SECTION (1)

SCALE: 1"=5' H
1"=2.5' V



KEYED NOTES:

1. CONTRACTOR MAY WASTE EXCESS CUT MATERIAL OR BORROW SUITABLE FILL MATERIAL FROM THIS AREA . MAINTAIN POSITIVE DRAINAGE & MATCH INTO EXISTING GRADES WITH 3:1 MAX. SLOPE.
2. PREPARE AND COMPACT BUILDING FOUNDATION & SLABS PER PROJECT GEOTECHNICAL REPORT
3. HEAVY DUTY PAVEMENT: 5" CONCRETE (REFER TO GEOTECH REPORT)
4. MODERATE DUTY PAVEMENT: 4" HBP OVER 6" ABC (REFER TO GEOTECH REPORT)
5. 2' CURB CHASE

NO.	REVISION	BY	DATE
1	COUNTY COMMENTS	JPS	5/23/17

LONDONDERRY SCHOOL

PHASE 1

NEW CONSTRUCTION

DEVELOPMENT PLAN

JPS ENGINEERING

19 E. Willamette Ave.
Colorado Springs, CO 80903

PH: 719-477-9429
FAX: 719-471-0766
www.jpsengr.com

CRP ARCHITECTS AIA

100 E. St. Vrain, Suite 300
Colorado Springs, Colorado 80903

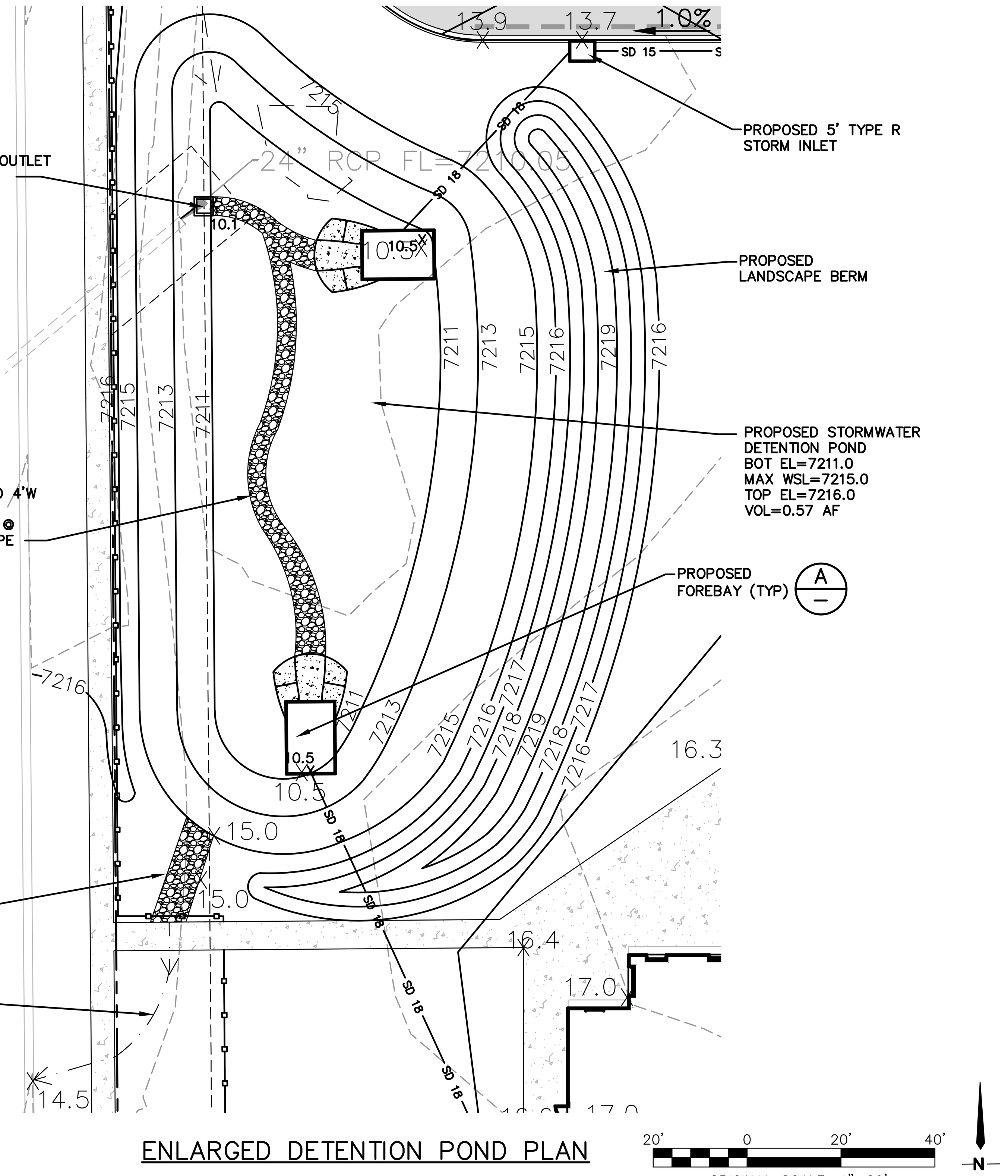
SOUTH SITE GRADING & EROSION CONTROL PLAN

SCALE : 1"=40'

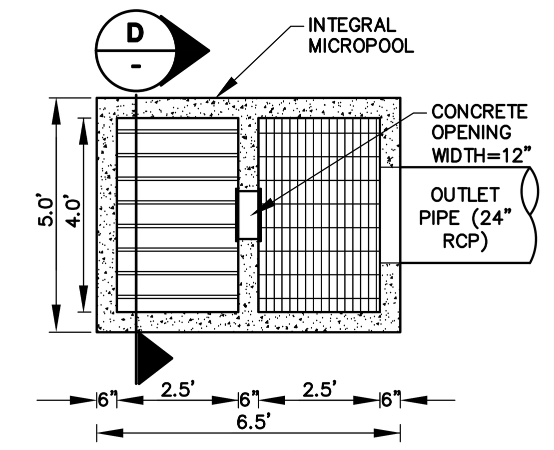
NORTH

DATE: 5/03/17
DRAWN BY: BJJ
CHECKED BY: JPS
REVISED: 5/23/17

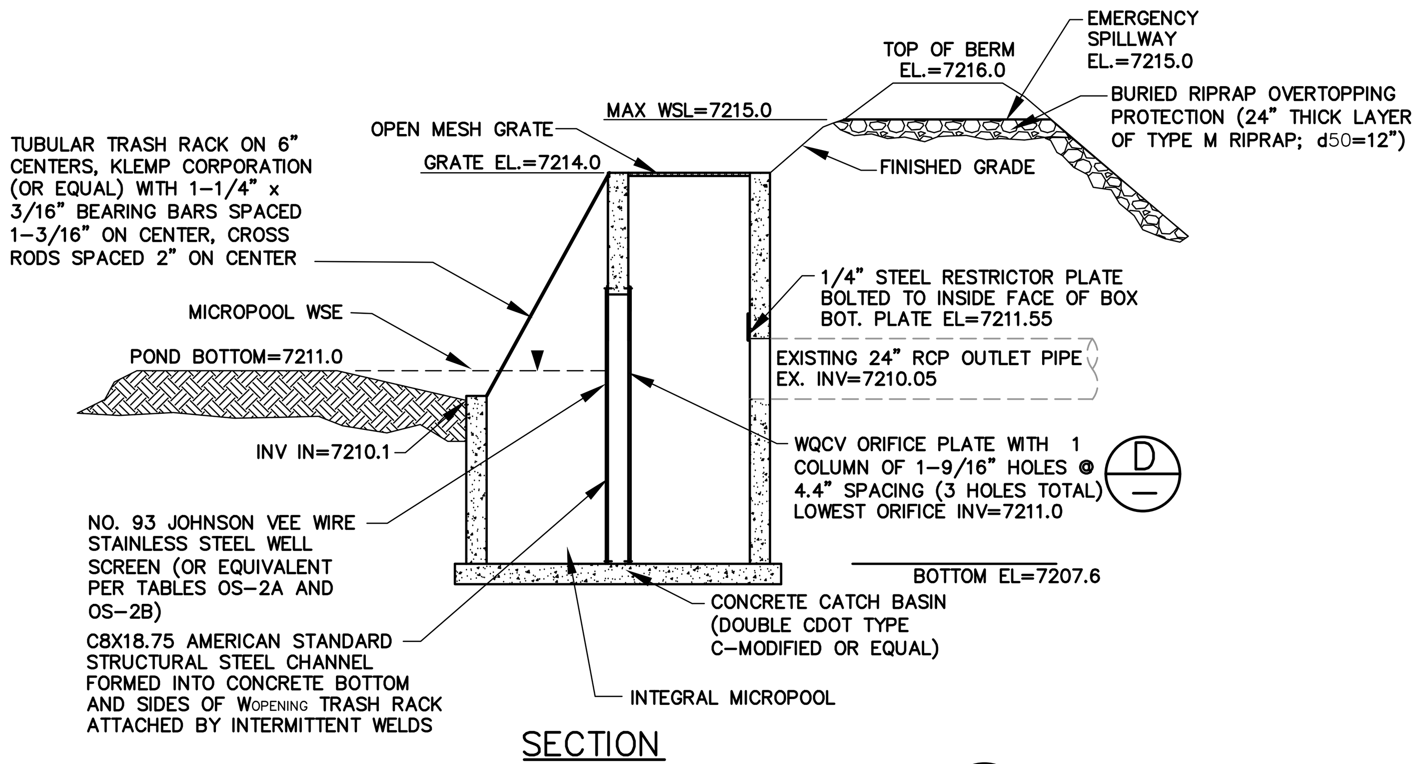
C1.3



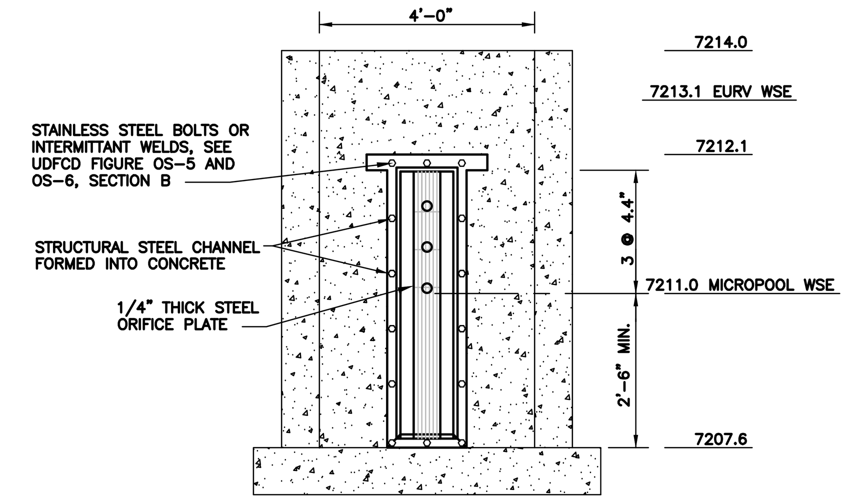
ENLARGED DETENTION POND PLAN



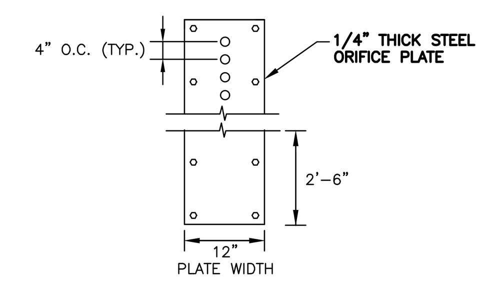
PLAN VIEW
NTS



SECTION
DETENTION POND OUTLET STRUCTURE (C)
SCALE: NTS



ELEVATION



ORIFICE PATTERN

ORIFICE PLATE NOTES:

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

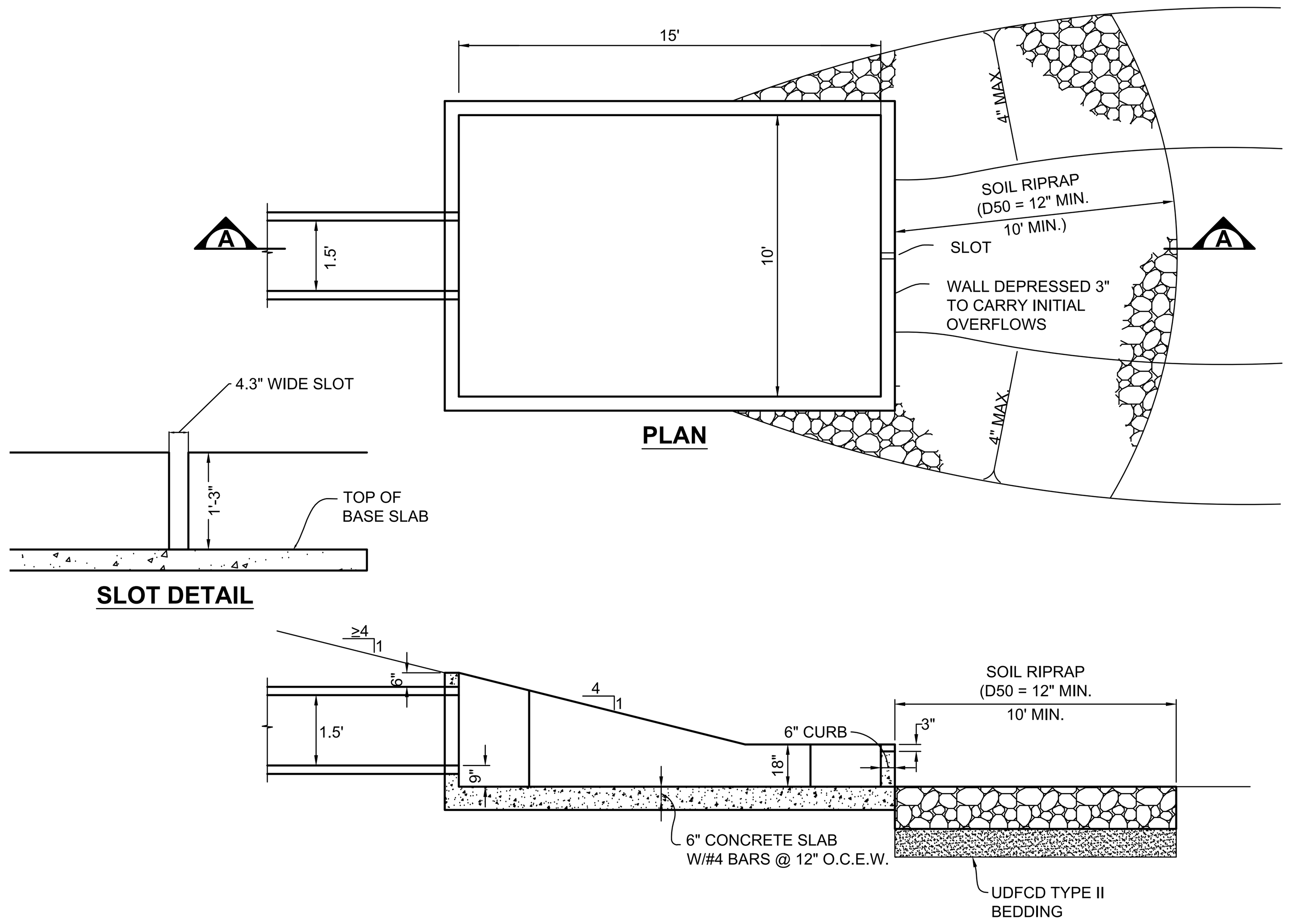
EURV AND WQCV TRASH RACKS:

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

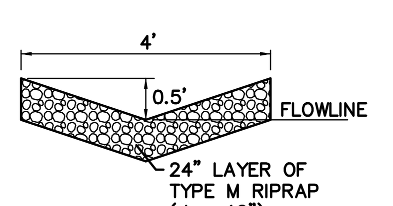
OVERFLOW TRASH RACKS:

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

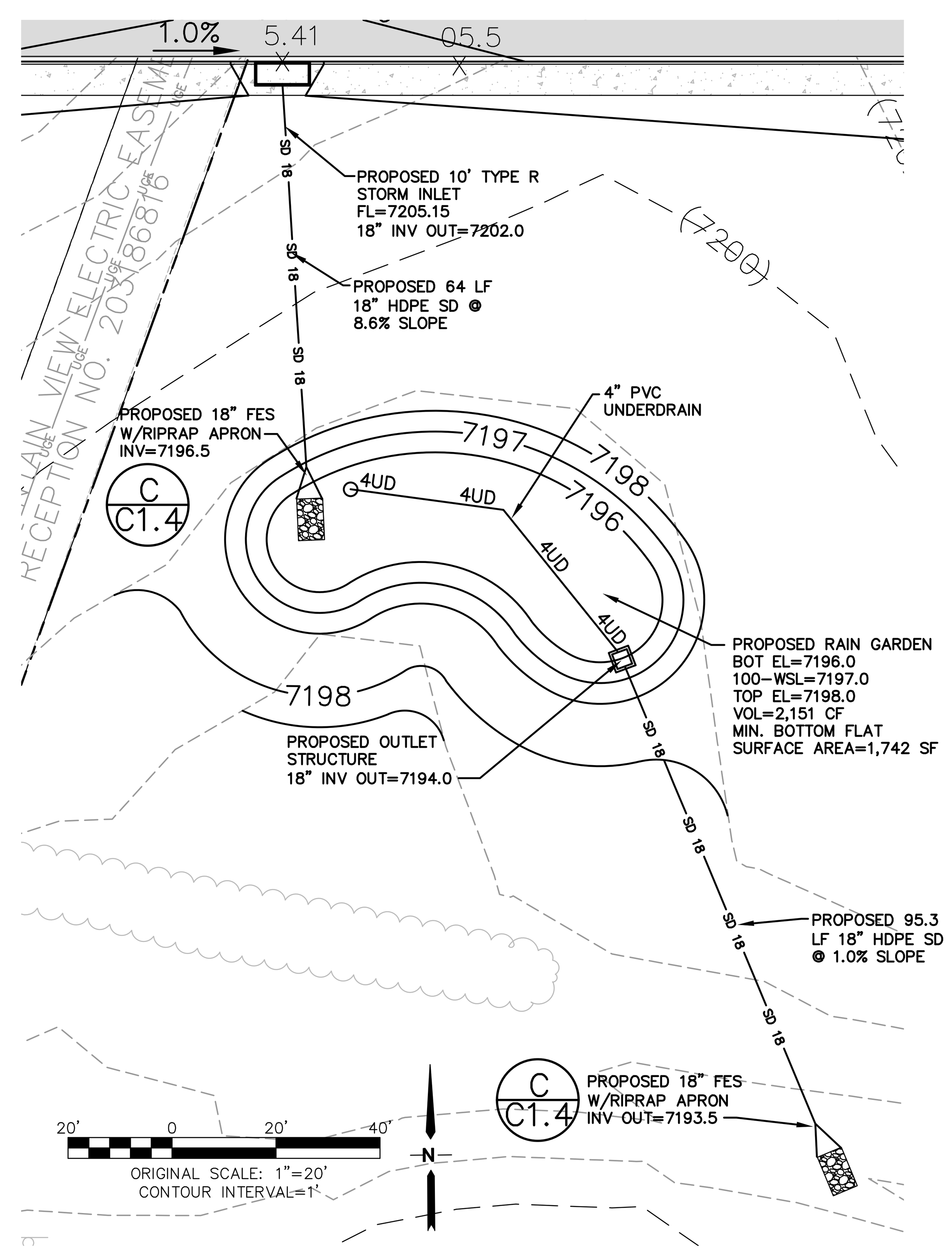
TYPICAL WQCV ORIFICE PLATE DETAIL (D)
SCALE: NTS



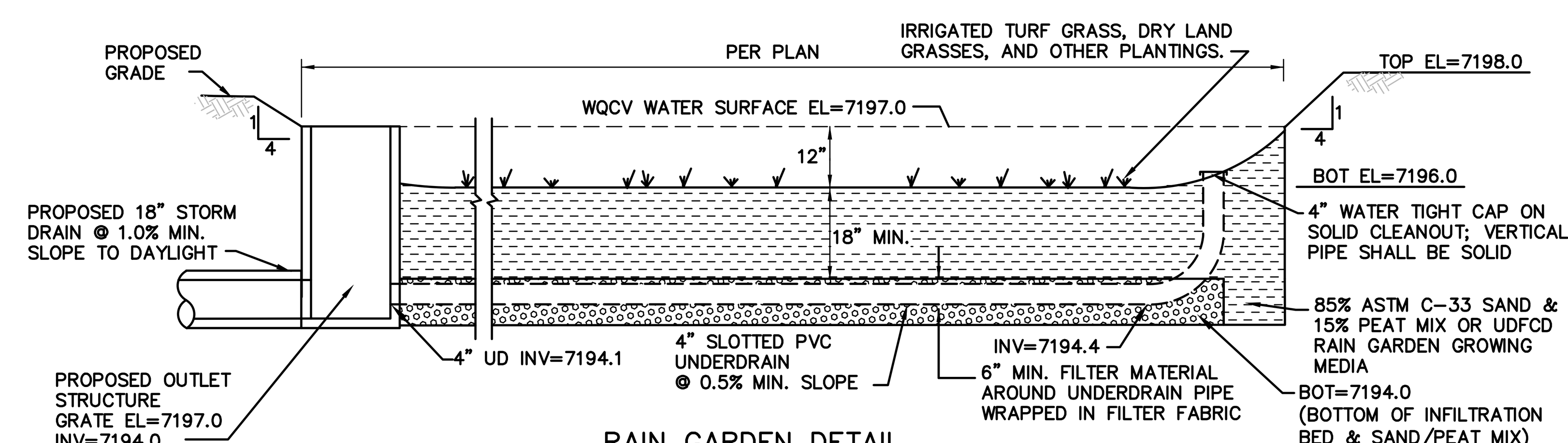
INTEGRAL FOREBAY DETAIL (A)



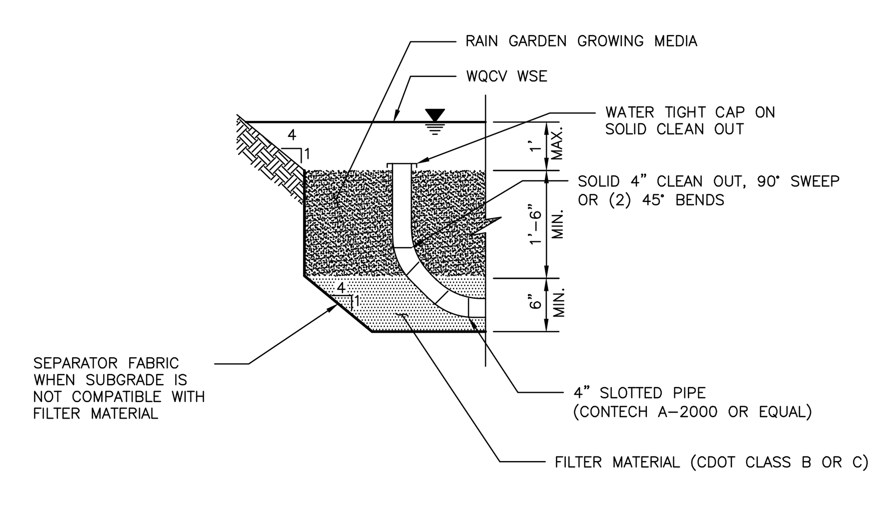
TYPICAL RIPRAP TRICKLE CHANNEL (B)
NOT TO SCALE



ENLARGED RAIN GARDEN PLAN



RAIN GARDEN DETAIL
POROUS LANDSCAPE DETENTION (BIORETENTION) AREA (E)
SCALE: NTS



PARTIAL INFILTRATION SECTION (F)
NTS

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

CRP ARCHITECTS AIA
100 E. St. Vrain, Suite 300
Colorado Springs, Colorado 80903

DETENTION FACILITY PLAN

SCALE : 1"=20'

NORTH

DATE:	5/03/17
DRAWN BY:	BJJ
CHECKED BY:	JPS
REVISED:	5/23/17