PRELIMINARY STORM WATER REPORT

For

BOULDER CREEK COMMONS SUBDIVISION

5399 Kewanee Drive &
5697 S. Boulder Road
County of Boulder, Colorado

November 2012

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Unincorporated Boulder County, Colorado

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1.0 INTRODUCTION

This **Preliminary Storm Water Report** [Report] is prepared on behalf of BCC, LLC, the developer of the proposed **Boulder Creek Commons Subdivision.** The purpose of this report is to address the City of Boulder's [City] requirements for a "Preliminary Storm Water Report and Plan" as outlined in Chapter 7 "Storm Water Design", "*Design and Construction Standards*" [1]. This Report documents the existing drainage conditions present at the site and provides an analysis of the drainage conditions, storm infrastructure, detention pond facility and water quality measures proposed for the **Boulder Creek Commons Subdivision** development. In addition to addressing the City's general requirements, this Report discusses existing storm drainage issues that occur on and adjacent to the project site as identified by City Staff and reported by neighbors.

2.0 EXISTING SITE CONDITIONS

The proposed **Boulder Creek Commons Subdivision** project site is located in the a Southeast quarter of Section 4, Township 1 South, Range 70 West of the 6th P.M., County of Boulder, State of Colorado. The property is located north of the intersection of S. Boulder Road and 55th Street. Keewaydin Meadows Subdivision (single-family residential) abuts the property to the west, East Boulder Recreation and Senior Center and surrounding East Boulder Community Park to the north, City of Boulder Open Space to the east, and two single-family homes in unincorporated Boulder County to the south. The home west of 55th Street is located on the Bodam Property. The home to the east is located on the Kent Property. Greenbelt Meadows Subdivision (single-family residential) is located to the south of these two homes.

Of the 22.17-acre property, 19.44-acres are located west of 55th Street and are commonly referred to as the West Parcel. The East Parcel is the remaining 2.73-acres that are located east of 55th Street. The Property is in agricultural use and supports livestock grazing for primarily horses. The West Parcel is improved with a gravel access drive from 55th Street, out buildings, corral fencing and light poles. The East Parcel is unimproved and designated for environmental preservation.

As shown on the "*Existing Storm Water Plan"* included in the back pocket of this report, the existing site topography on the West Parcel is at a lower elevation than the developed properties the north (East Boulder Recreation Center and Park), west (Keewaydin Meadows Subdivision), south (Bodam Property) and the adjacent 55th Street. The Property generally slopes downward from the

southeast property corner at 55th Street to the northwest corner of the property north of Kewanee Drive. The terrain has an average 0.9% grade across the West Parcel.

On the East Parcel, the existing site topography is at a lower elevation than 55th Street, but is at a similar elevation as the unimproved City of Boulder Open Space to the east and the modest single-family home located to the south. This portion of the Property generally slopes downward from the southwest property corner at 55th Street to the north and east property lines. The terrain is relatively flat.

Irrigation ditches and laterals are located on and adjacent to the Property. Dry Creek Ditch No. 2 flows across the site from the southwest property corner to the northwest property corner and parallels the west property line. Dry Creek Ditch No. 2 will be piped within the property as part of the Boulder Creek Commons development. The Bodam Lateral straddles the south property line on the West Parcel. This lateral supplies irrigation water from Dry Creek Ditch No. 2 to the Bodam and Boulder Creek Commons properties. The Howard-Superphostical Ditch is a lateral from the Howard Ditch. The Howard-Superphostical Ditch bisects the East Parcel, crosses the northeast and northwest corners of the West Parcel.

USDA Natural Resources Conservation Services classified the soils on the property as predominantly Niwot Soils with a Group C hydrological soil rating [2]. Group C soils are characterized by slow infiltration rates when saturated. The existing pasture vegetation is sparse and dominated by noxious weeds.

Wetlands have formed within and adjacent to Dry Creek Ditch No. 2 and the Howard-Superphostical Ditch. Additional wetland areas have formed down gradient from Dry Creek Ditch No. 2, the Bodam Lateral and adjacent to the Howard-Superphostical Ditch. The locations and extents of the wetland areas are shown on the "*Existing Storm Water Plan".* Refer to the Wetlands Impact section of this report for a detailed discussion of the existing wetlands.

The groundwater is shallow within this area of the South Boulder Creek watershed. The seasonal high ground water occurs in May and June and ground water surface elevations can be within 2 to 3

feet of the ground surface. Refer to the Ground Water section of this report for a detailed discussion of the existing ground water conditions on the site.

Portions of the property are impacted by flood plains. Zone AE 100-year flood plains are located on the west side of the West Parcel on the east side of the East Parcel. The flood plain on the West Parcel generally follows the Dry Creek Ditch No. 2 corridor. The South Boulder Creek Conveyance Zone crosses the north property line on the East Parcel. A High Hazard Zone is defined along the Dry Creek Ditch No. 2 corridor. Zone X 500-year flood plains impact both the East and West Parcel. The flood plain extents are shown on the *"Existing Storm Water Plan".* Refer to the Flood Plain Mitigation section of this report for a detailed discussion of the existing flood plains on the site.

The area surrounding and including the project site lacks underground storm sewer facilities. Frequent localized flooding of storm drainage from the Keewaydin Meadows Subdivision occurs at the eastern dead-end of Kewanee Drive (where Kewanee Drive ends at the site's western boundary). Storm drainage from the Boulder Creek Commons property [Property] does not contribute to the Kewanee Drive flooding. However, the proposed development provides an opportunity to alleviate the localized flooding at Kewanee Drive.

3.0 PROPOSED DEVELOPEMENT

The proposed **Boulder Creek Commons Subdivision** includes the development of 65 single-family homes, 3 duplexes and 50-unit senior housing building on the West Parcel. Kewanee Drive will be extended from the West property line through to 55th Street. The East parcel will remain undeveloped. The proposed development layout, as well as proposed grading and storm system infrastructure, is shown on the "*Preliminary Storm Water Plan"* included in the back pocket of this report.

4.0 DESIGN CRITERIA

This Report was prepared using the criteria outlined the City of Boulder "*Design and Construction Standards*", Chapter 7 "Storm Water Design" [Criteria] [1] and the Urban Drainage and Flood Control District "*Urban Storm Drainage Criteria Manual, Volume 3 – Best Management Practices*" [3].

5.0 CONFORMANCE WITH STORMWATER MASTER PLANS

A review of the City records found two drainage reports relevant to this project:

1. "*Conceptual Storm Water and Floodplain Mitigation Report for Hogan-Pancost Property*" dated May 2010 [4]. This report documents the existing drainage conditions including offsite drainage basins, flow rates and volumes tributary to Boulder Creek Commons property (also referred to as the Hogan-Pancost Property).
2. "*Final Drainage Report for East Boulder Community Park Phase III*" dated May 2009 [5] documents offsite flow tributary to the Boulder Creek Commons property from the recent development of the artificial turf fields and dog park at the East Boulder Community Park.

6.0 HYDROLOGY

The rational method was used to calculate runoff for 10-year and 100-year storm events. Runoff from the 10-year and 100-year storm events were used to size the detention ponds and calculate allowable release rates for the detention ponds.

Existing Conditions

The existing drainage basins were delineated and discussed at length in the "*Conceptual Storm Water and Floodplain Mitigation Report for Hogan-Pancost Property*" [Conceptual Drainage Report, CDR] [4]. The "*Existing Conditions Drainage Exhibit*" Sheets DR-1 and DR-2 from this report are provided in Appendix A and provide existing off-site basin delineations, basin characteristics, flow rates and schematic routing diagrams. These basin delineations were visually confirmed during site visits in April and early May 2012.

The CDR used the rational method and hydrograph routing to determine existing storm water runoff values for each basin and flow rates at each design point. The existing basin data and routing information from the CDR was input into Autodesk's hydrograph routing software "*Storm and Sanitary Analysis Stand-Alone 2012*" [6] to duplicate the routing model. The software uses the Rational Method to calculate subbasin hydrographs. The kinematic wave method is used to route the hydrographs through each storm system. The duplicate effective routing models were developed for existing conditions using the CDR report for the 10-year and 100-year design storms. The duplicate effective routing model resulted in existing storm water runoff values for each basin and flow rates at each design point that were within 1% of the values presented in the CDR. The 10-year and 100-year duplicate effective routing models are provided in Appendix A.

The Property was resurveyed in April 2011. The topography information presented in this report is on the NAVD 88 datum. The CDR was prepared using topography on the City of Boulder vertical datum. Add 3.45-ft to convert elevations from the CDR to the NAVD 88 datum.

Existing on-site basin delineations presented in the CDR were updated to topographic conditions surveyed in April 2011. The existing site is divided into five basins labeled Ax, Bx, Cx, Dx and Ex where the "x" denotes existing conditions. As documented in the CDR, the Property has three existing drainage outfall points: northwest corner of the West Parcel (Design Point H1), the northeast corner of the West Parcel (Design Point H2) and northeast corner of the East Parcel (Design Point H3) . Basins Ax, Bx and Cx are tributary to existing outfall H1. Basin Dx is tributary to existing outfall H2. Basin Ex is tributary to existing outfall H3. Each existing outfall is considered a separate storm drainage system. The basin boundaries for the existing on-site basins are provided on the *"Existing Storm Water Plan"* SHT DR1 in the back pocket of this report.

Photo 1: Looking south at Design Point H1 existing outfall to Dry Creek Ditch No. 2 and East Boulder Community Park. Where black fencing meets tan fencing is northwest corner of the Boulder Creek Commons property. Dry Creek Ditch No. 2 channel is visible in foreground.

Photo 2: Looking north from Design Point H1 to existing outfall to Dry Creek Ditch No. 2 and East Boulder Community Park. Dry Creek Ditch No. 2 channel is visible in foreground.

The "*Final Drainage Report for East Boulder Community Park Phase III*" [FDR] [5] documents a drainage basin tributary to the Property which was not included in the CDR. The basin is located adjacent to the north property line of the West Parcel and outfalls to Design Point 16. This off-site basin is labeled OS12 on the "*Existing Storm Water Plan*". Relevant portions of FDR are included in Appendix A.

Basin descriptions, imperviousness, weighted runoff coefficients, and time of concentration are provided for each existing on-site drainage basin on worksheets labeled "Input Data for the Rational Method" provided in Appendix A.

Existing conditions routing models were developed from the duplicate effective routing models. Basins Ax, Bx, and Cx were adjusted and Basins Dx, Ex and OS12 were added. Runoff values for each basin and at each design point for the 10-year and 100-year storm event were analyzed using the hydrograph routing software. The existing conditions routing models reports are provided in Appendix A for each storm event. The reports include: basin input data (basin size, time of

concentration, runoff coefficient), physical characteristics and capacity for the routing elements, basin peak runoff, and design point peak runoff.

For ease of reference, an existing conditions storm water routing schematic diagram and peak runoff values are provided on the "*Routing Schematics and Tables*" SHT DR3 in the back pocket of this report. The existing conditions peak runoff values are presented in tabular form by design point and by basin. The existing outfall flows at design points H1, H2 and H3 are shown in bold.

Currently, Kewanee Drive discharges into Dry Creek Ditch No. 2. The Kewanee Drive road surface is less than a 1.0-ft higher than the Dry Creek Ditch No. 2 flowline. The road frequently floods with ditch flows and/or storm flows. Further compounding the flooding problems, the frequent ponding has caused the road to become silted in and well vegetated as shown in the following photos.

Photo 3: Looking east at Kewanee Drive. The barbwire fence is the western property line of the Boulder Creek Commons property.

Photo 4: Looking east at the Kewanee Drive southern curb and gutter at Dry Creek Ditch No. 2. Barbwire fence is approximately the Boulder Creek Commons property's western property line.

Photo 5: Looking south at Dry Creek Ditch No. 2 just east of Kewanee Drive Barbwire fence is approximately the Boulder Creek Commons property's western property line.

Proposed Conditions

The proposed on-site drainage basins are delineated on the "*Preliminary Storm Water Plan*" provided in the back pocket of this report. Like Basin Ax, Basin A is tributary to the outfall at the northwest corner of the West Parcel (design point H1). Basin A is divided into 13 sub-basins: A1 through A13. Three detention ponds control and attenuate developed runoff rates within Basin A: Detention Pond 1 in Outlot E, Detention Pond 2 in Outlot H and Detention Pond 3 in Outlot I. Basins A1, A2 and A3 flow into the proposed bioswale and flood conveyance channel located along the west boundary of the West Parcel. Basins A4 and A8 directly discharge to Detention Pond 1. Basins A5, A6 and A7 discharge to Detention Pond 2. Basins A9, A10, A11 and A12 discharge to Detention Pond 3. Discharge from Detention Pond 2 and Detention Pond 3 is conveyed by storm sewer to Detention Pond 1. Basin A13 is a small basin at the 55th Street entry that flows to the curb and gutter in 55th Street.

Basin Bx is divided into 2 sub-basins: Basins B1 and B2. Like Basin Bx, these developed basins flow along the north property line to the existing outfall at the northwest corner of the West Parcel (design point H1). One detention pond, Detention Pond 4, controls and attenuates developed runoff rates within Basin B. Both Basins B1 and B2 discharge to Detention Pond 4.

Basin Cx is adjusted to proposed conditions and becomes Basin C. Basins Dx and Ex remain undeveloped and unchanged for the purposes of this report.

Basin descriptions, imperviousness, weighted runoff coefficients, and time of concentration are provided for each existing drainage basin on worksheets labeled "Input Data for the Rational Method" provided in Appendix C.

Runoff for the 10-year and 100-year storm event was analyzed using the hydrograph routing software [6]. Proposed conditions routing model reports for each storm event are provided in Appendix C. The reports include: basin input data (basin size, time of concentration, runoff coefficient), physical characteristics and capacity for the routing elements, basin peak runoff, design point peak runoff, and maximum water surface elevation for the detention ponds.

For ease of reference, a proposed conditions storm water routing schematic diagram and peak runoff values are provided on the "*Routing Schematics and Tables*" SHT DR3 in the back pocket of this report. The proposed conditions peak runoff values are presented in tabular form by design point and by basin. The existing outfall flows at design points H1, H2 and H3 are shown in bold.

The bioswale and flood conveyance channel is sized to convey the predicted 100-year South Boulder Creek flood flows plus freeboard. The low flow channel is sized to convey up to the local 10-year storm flow. From the south property line to the Kewanee Drive extension, the low flow channel meanders. At Kewanee Drive, additional 100-year South Boulder Creek flood flows confluence with the flood channel. North of Kewanee Drive the flood channel widens to spread the flood waters out in a similar way that flood waters are predicted to exit the subject property. The proposed culvert under Kewanee Drive is sized to allow the 10-year and 100-year local storm flows to pass without overtopping Kewanee Drive. Typical sections of the flood conveyance channel and supporting calculations are provided in Appendix D.

Cobble channels are provided to convey storm water through the open space areas to the detention ponds. Storm sewer inlets are provided at roadway sumps including several bump-out locations. A concrete crosspan and depressed curb opening are proposed at the existing end of Kewanee Drive to allow the roadway to drain freely into the flood conveyance channel.

7.0 STORMWATER DETENTION

As mentioned in the previous section, four detention ponds are proposed and are dispersed throughout the development. Detention Ponds 1, 2 and 3 are sequential detention ponds that control and attenuate developed runoff rates within Basin A: Detention Pond 1 in Outlot E, Detention Pond 2 in Outlot H and Detention Pond 3 in Outlot I. Detention Pond 1 is located in the western open space area and discharges to the adjacent bioswale and flood conveyance channel. The detention pond outfall is located upstream of Kewanee Drive extension and the existing outfall (design point H1). Detention Pond 2 is located in the western interior open space and discharges to Detention Pond 1 by storm sewer. Detention Pond 3 is located in the eastern interior open space and also discharges to Detention Pond 1 by storm sewer. One detention pond, Detention Pond 4, controls and attenuates developed runoff rates within Basin B. Detention Pond 4 is located near the northwest corner of the property.

Detention Ponds 1 and 4 are three stage detention facilities that are sized for the 10-year and 100-year storm events and provide the water quality capture volumes for Basin A and Basin B, respectively. The Detention Ponds 2 and 3 are a two stage detention facilities sized for the 10-year and 100-year storm events.

For each detention pond, the 10-year and 100-year storage volumes were initially calculated using the modified FAA method as prescribed by the Criteria. These FAA 10-year and 100-year storage volumes were analyzed using the Autodesk's hydrograph routing software to take into account the time delayed response of upstream tributary basins and the existing developed conditions of the project site. The 10-year and 100-year storage volumes provided in Detention Pond 2 and Detention Pond 3 are larger than the minimum prescribed by the modified FAA method. Storm flows were over-detained to further attenuate the release rates which reduced the size of the downstream storm sewer infrastructure.

The 10-year and 100-year storage volumes provided in Detention Pond 1 are also larger than the minimum prescribed by the modified FAA method. Storm flows were over-detained to further attenuate the release rate from the Detention Pond 1 outfall [DP 22] which is located just upstream of the proposed Kewanee Drive culvert [DP 23].

The 10-year and 100-year storage volumes provided in Detention Pond 4 are also slightly larger than the minimum prescribed by the modified FAA method. Storm flows were over-detained to further attenuate the release rate from the Detention Pond 4 outfall [DP 12] which is located just upstream of outfall H1.

Detention Pond 1 and Detention Pond 4 are located at the outfalls for Basin A and Basin B, respectively. Each pond includes an Extended Dry Basin [EDB] to provide the water quality capture volume for each basin. The EDBs were sized in accordance with the "*Urban Storm Drainage Criteria Manual, Volume 3 – Best Management Practices*" [3] and are discussed further in the following section.

Due to existing topography constraints, a portion of the Boulder Creek Commons development will be released without first being routed through one of the four proposed detention ponds. The undetained areas include five undeveloped basins and two developed basins. The undeveloped basins include the bioswale and flood conveyance channel (Basins A1 and A3), the area reserved for the Bodam Lateral (Basin C) and the two existing basins that remain unchanged with development (Basins Dx and Ex).

The two developed basins are Basin A2 and Basin A13. Basin A2 is located just east of the existing Kewanee Drive and includes a portion of the Kewanee Drive extension and the front yards of Lots 53 – 59. Basin A13 is located at the proposed intersection of Kewanee Drive and 55th Street and includes a portion of Kewanee Drive and Outlot B. In each case, the existing elevation of the roadway connection inhibits the ability to route the storm flows through a detention facility. As allowed by the Criteria [1], developed areas may be released undetained if the undetained area is less than 5% of the entire parcel and the developed release rate from the undetained area is less than 25% of the historic (ie. existing) release rate of the entire parcel. The total area of the two developed basins, Basin A2 and Basin A13, is less than the 5% threshold for undetained areas. The developed release rate from these two basins is less than the 25% threshold for undetained areas for both the 10-year and 100-year design storms.

The proposed sequential detention pond system for Basin A provides the required detention storage volume and water quality capture volume for the senior housing development proposed for Lot 69. Supporting calculations for the detention ponds are provided in Appendix B.

The proposed detention pond bottoms are designed to be unlined and are graded above the seasonal high ground water table. The high ground water table is not anticipated to affect the capacity or functionality of the proposed detention ponds. Refer to the Ground Water section of this report for a detailed discussion of post-development ground water recharge rates.

8.0 STORMWATER QUALITY AND EROSION CONTROL

The overall site plan incorporates Low Impact Design [LID] strategies into the site design and storm water quality Best Management Practices [BMPs] are dispersed throughout the project development. Directly connected impervious areas are minimized by routing storm water runoff

from the proposed roadways and residential lots through open space areas with meandering low-flow cobble channels.

Grass Buffer LID elements will be implemented for Basins A5 and A10. These basins include the residential lots that directly discharge to the interior open spaces (Outlot H and Outlot I). Grass buffers will be located within the open space between the rear lot lines and the meandering low-flow cobble channel. The grass buffers will be of sufficient width to provide water quality treatment for these basins prior to discharge into sequential detention pond system for Basin A.

A Wetland Channel LID element is provided within the bioswale and flood conveyance channel to primarily provide water quality treatment for off-site flows entering the Boulder Creek Commons development. Should the required base flow for supporting the constructed wetlands not be available as required by the Criteria [3], a Grass Swale LID element will be used in place of the Wetland Channel. The Wetland Channel LID element will provide water quality treatment for undeveloped Basins A1, A3 and C and for developed Basin A2.

As discussed in the previous section, Detention Ponds 1 and 4 are three stage detention facilities that are sized for the 10-year and 100-year storm events and provide the water quality capture volumes for Basin A and Basin B, respectively. An Extended Dry Basin [EDB] in Detention Pond 1 provides the water quality capture volume for Basins A4, A6, A7, A8, A9, A11 and A12. Note that the water quality treatment for Basins A1, A2 and A3 is provided with the Wetland Channel LID element within the bioswale and flood conveyance channel. The water quality treatment for Basins A5 and A10 is provided with a Grass Buffer LID. Basin A13 releases directly to 55th Street without water quality treatment. An Extended Dry Basin [EDB] in Detention Pond 4 provides the water quality capture volume for Basins B1 and B2. The EDBs were sized in accordance with the "*Urban Storm Drainage Criteria Manual, Volume 3 – Best Management Practices*" [3]. Supporting calculations for the Extended Dry Basins [EDB] within Detention Pond 1 and Detention Pond 4 are provided in Appendix B.

Construction Best Management Practices [BMPs] will be installed prior and during construction, to restrict the amount of sediment transported offsite by either wind or water. Construction BMPs may include vehicle tracking control at construction entries, temporary sediment basins, inlet

protection, silt fencing, temporary seeding, concrete washouts and dust control. An Erosion Control and Stormwater Management Plan will be provided at a later date with the Final Storm Water Report.

9.0 WETLAND IMPACTS

The wetland delineations for the Boulder Creek Commons site were updated in late August 2011. As documented in the October 2011 "*City of Boulder Wetland Delineation Report – Boulder Creek Commons Property*" [7], the existing wetlands are degraded, low value wildlife habitat and are considered low functioning wetlands. In addition, the report states that all of the wetlands on the site have evolved due to alterations of the natural hydrology and are supported by man-induced hydrology; the irrigation ditches, seepage from the irrigation ditches, flood irrigation and inefficient use of irrigation water. The May 2010 "*Groundwater Hydrology Monitoring & Wetland Delineation Report*" [8] determined that without a supporting natural hydrology, these wetland areas would revert to their former upland condition when flood irrigation ceased both on and off-site and when the ditches are permanently lined or piped. The locations of the existing wetlands are shown on the "*Existing Storm Water Plan*" [SHT DR1] provided in the back pocket of this Report.

The Boulder Creek Commons project will consolidate the wetlands along the Dry Creek Ditch No.2 corridor and on the East Parcel. By consolidating the wetlands the property owners can augment and control the necessary water supply by again creating a man-induced hydrology to support high-quality wetland habitats.

The proposed wetland mitigation is discussed in detail in the "*Wetland Mitigation Plan for Boulder Creek Commons Property*" [9]. The wetland mitigation strategy is to create high quality habitats on the property by enhancing some existing wetlands and to create new wetlands adjacent the existing wetlands to further enhance the existing wetlands. Where City regulated wetlands are disturbed for enhancement, the wetlands will be mitigated at a 1:1 ratio. Wetlands that are relocated on the property will be created at a 2:1 ratio. The wetland preservation, enhancement and mitigation areas are shown on the "*Preliminary Storm Water Plan*" [SHT DR2].

10.0 FLOOD PLAIN MITIGATION

The 2008 City of Boulder "*South Boulder Creek Flood Mapping Study*" [10] delineates the South Boulder Creek floodplain and assessed the flood hazard in east Boulder. The new South Boulder Creek flood maps were adopted by the City on 01 January 2008. According to the City's website, "The Federal Emergency Management Agency (FEMA) will officially adopt new Digital Flood Insurance Rate Maps (DFIRMs) for Boulder County, including the City of Boulder, on Dec. 18, 2012."

The revised mapping defines areas that will be inundated when floodwaters spill into the South Boulder Creek West Valley when South Boulder Road, US 36 and Foothills Parkway are breached by flood waters. With the revised mapping, the floodplain delineation on the East Parcel remains comparatively unchanged from the previous flood plain mapping. The East Parcel is adjacent to the main stem of South Boulder Creek. The West Parcel is located in the South Boulder Creek West Valley and a portion of the West Parcel was included in the 100-year (Zone AE) floodplain. The South Boulder Creek Conveyance Zone crosses the north property line on the East Parcel. A High Hazard Zone is defined along the Dry Creek Ditch No. 2 corridor. Areas of 500-year flooding (Zone X) are identified on both the East and West Parcels. The South Boulder Creek flood plain extents are shown on the "*Existing Storm Water Plan*" [SHT DR1] provided in the back pocket of this Report.

During the 100-year event, flooding on the West Parcel is relatively shallow and limited to Dry Creek Ditch No. 2 corridor. The Dry Creek Ditch No. 2 corridor is not a natural floodplain for South Boulder Creek. The existing developments upstream and adjacent to the property have diverted flood flows to Dry Creek Ditch No. 2 which is an irrigation ditch and not a natural flood conveyance.

During the South Boulder Creek remapping project, City of Boulder staff determined that due to the small volume of floodwaters entering site, the Boulder Creek Commons property is not a practical location for regional flood mitigation.

With development of the Boulder Creek Commons property, South Boulder Creek West Valley flood flows will be conveyed through the site in a flood conveyance channel. The bioswale and flood conveyance channel is sized to convey the predicted 100-year South Boulder Creek flood flows plus freeboard. The low flow channel is sized to convey up to the local 10-year storm flow. From the south property line to the Kewanee Drive extension, the low flow channel meanders. At Kewanee

Drive, additional 100-year South Boulder Creek West Valley flood flows confluence with the flood flows within the channel. North of Kewanee Drive the flood channel widens to spread the flood waters out in a similar way that flood waters are predicted to exit the subject property. Typical sections of the flood conveyance channel and supporting calculations are provided in Appendix D.

As part of the on-going South Boulder Creek Flood Mitigation Study, the City of Boulder issued in June 2012 the "*South Boulder Creek Major Drainageway Plan*" [11] which identifies five alternative flood mitigation strategies:

- Status Quo
- High Hazard Zone Mitigation (Figure 8-3, Appendix E [11])
- Regional Detention at US 36 (Figure 8-4, Appendix E [11])
- Distributed Regional Detention (Figure 8-6, Appendix E [11])
- Bear Canyon Creek Pipeline (Figure 8-15, Appendix E [11])

The City has identified potential improvements within the Dry Creek Ditch No. 2 corridor in three of the five flood mitigation strategies. In each of these mitigation strategies, the Dry Creek Ditch No. 2 improvements include constructing storm sewers that range in size from 72" to 90" diameter pipes. Previous versions of the South Boulder Creek Flood Mitigation Study included open channel improvements with a 34' top width for the Dry Creek Ditch No. 2 corridor.

Outlots E and F on the western edge of the project are provided to allow the City adequate width to construct future flood mitigation improvements along the Dry Creek Ditch No. 2 corridor as identified in the *"South Boulder Creek Major Drainageway Plan"* [11]. The proposed bioswale and flood conveyance channel is aligned to be parallel with the west property line and immediately adjacent to the Dry Creek Ditch No. 2 pipe. This alignment will better accommodate future flood mitigation options that the City of Boulder is exploring as part of their on-going flood mitigation study.

The City of Boulder regulates 100-year floodplains and restricts development activities that can occur in the floodplain. Floodplain regulations are covered in Sections 9-3-2 through 9-3-8 of the Boulder Revised Code. While the 100-year floodplain minimally impacts the property, the few residential lots that back to the Dry Creek Ditch No. 2 corridor will be developed in compliance with

these regulations and will be subject to a Floodplain Development Permit. As discussed in both the recent Concept Plan application and the 2010 "*Conceptual Storm Water Management Plan and Flood Mitigation Report*" [4], the proposed residential structures will be constructed in accordance with the requirements prescribed by the City of Boulder Floodplain Regulations (Chapter 9, B.R.C. 1981):

- Flood proofing all proposed residential structures within the 100-year floodplain by raising the finished floor elevations of the homes a minimum of 2.0-ft above the 100-year base flood elevation.
- Limiting floodwater depths within the subdivision's roadways to allow for emergency access during the event of a flood (currently only Kewanee Drive extension is affected by the 100-year floodplain).
- Restricting basement construction within the 100-year floodplain.

The proposed senior housing is located outside the 100-year floodplain and partially within the 500-year floodplain. The 500-year floodplain is broad with shallow flood depths of 0.5-ft or less. At this time, the City of Boulder does not regulate development activities within the 500-year floodplain.

The 500-year flooding was taken into consideration during the design of the Boulder Creek Commons project. The site grading and street layout take allow the street network to collect flood waters at the upstream property line and to pass the flood waters through the site to the existing downstream discharge location at the northwest corner of the property. The senior housing design includes elevating the first finished floor at least 1.0-feet above existing grade to provide both positive drainage away from the building and added flood protection in the event of a 500-year flood.

11.0 GROUND WATER

The existing ground water conditions are documented in the "*Boulder Creek Commons Ground Water Recharge Evaluation*" [Ground Water Study] [12]. The Boulder Creek Commons property has a high ground water table with depths to ground water ranging from 5-ft in the winter to 2-ft in the summer.

The Ground Water Study used a water balance approach to estimate the ground water recharge on the Boulder Creek Commons property for both pre-development and post-development conditions.

The Ground Water Study defined the recharge to the ground water table as the sum of ditch leakage, precipitation and irrigation water, less the evapotranspiration and less the surface water runoff. Two pre-development scenarios were analyzed: with and without flood irrigation. Historically the Boulder Creek Commons has been flood irrigated. In 2008, flood irrigation was ceased on the property. The Ground Water Study estimates pre-development recharge to be 10.2-gpm in the winter and 116.0-gpm for the summer under flood irrigation conditions and 10.2-gpm in the winter and 64.7-gpm in the summer without flood irrigation.

As documented in the Ground Water Study [12, pg. 8] with development of the Boulder Creek Commons property, the following hydrologic changes will occur:

- "Storm water runoff within the Project area will drain to a series of storm water swales
- Flood irrigation will not be reinitiated and would be replaced by efficient lawn watering and low water demand landscaping
- Impermeable surfaces (e.g., houses, driveways, sidewalks) will be added
- Dry Creek Ditch No. 2 will be piped across the Project area."

The Ground Water Study includes a detailed discussion of the storm water swales. The storm water swales include the bioswale and flood conveyance, the four detention pond areas and the cobble channels dispersed throughout the development. The Ground Water Study assumes that the storm water swales are unlined and allowed to recharge the ground water table [12, pg. 9]

> "The stormwater swales are designed to contain all storm runoff within the Project area and prevent surface water flows to adjacent properties except during extreme rainfall events. Therefore, for purposes of this evaluation it was assumed that 100% of the storm water runoff entering the stormwater swales from irrigated, non-irrigated, and impervious areas will percolate downward and provide seepage recharge to ground water. This assumption is conservative (i.e., predicts more recharge) because a portion of the swale influent water flowing will evaporate or be evapotranspired by plants growing in the swales."

The Ground Water Study estimates post-development recharge to be 12.5-gpm in the winter and 13.7-gpm in the summer. "Following development, recharge within the Project area is reduced dramatically during the summer months due to piping of Dry Creek Ditch No. 2." [12, pg. 9].

12.0 CONCLUSIONS

This Report meets the City's requirements for Preliminary Storm Water Report information as outlined in the Criteria. The Report documents the existing drainage conditions present at the site and provides an analysis of the drainage conditions, storm infrastructure, detention pond facility and water quality measures proposed for the Boulder Creek Commons Subdivision development. The proposed development will not adversely affect downstream drainage facilities or properties.

When developed, Boulder Creek Commons will preserve the existing flow patterns and flow rates of surface runoff and South Boulder Creek flood waters. The East Parcel will remain undeveloped and the drainage patterns will not be altered. The West Parcel discharges storm run-off and flood water onto City property at two existing discharge locations: the northwest corner and the southeast corner. These discharge locations will be preserved. The developed storm water flows from the project will be detained to preserve the existing storm water flow rates at these discharge points.

13.0 REFERENCES

[1] "*Design and Construction Standards*", City of Boulder.

[2] Soils Map, "*Web Soil Survey 2.0*" , USDA Natural Resources Conservation Service, May 2012.

[3] "*Urban Storm Drainage Criteria Manual, Volume 3 – Best Management Practices*" Urban Drainage and Flood Control District", November 2010.

[4] "*Conceptual Storm Water and Flood Plain Mitigation Report for Hogan-Pancost Property*", Drexel, Barrell & Co., May 2010.

[5] "*Final Drainage Report for East Boulder Community Park Phase III*", JVA, Inc., 18 May 2009.

[6] "Storm and Sanitary Analysis Stand-Alone 2012", Autodesk, Version 6.4.29.6198.

[7] "*City of Boulder Wetland Delineation Report for Boulder Creek Commons Property*", Western Ecological Resource, Inc., October 2011.

[8] "*Groundwater Hydrology Monitoring & Wetland Delineation Report for Hogan-Pancost Property*", Western Ecological Resource, Inc., 05 May 2010.

[9] "*Wetland Mitigation Plan for Boulder Creek Commons Property*", Western Ecological Resource, Inc., August 2012.

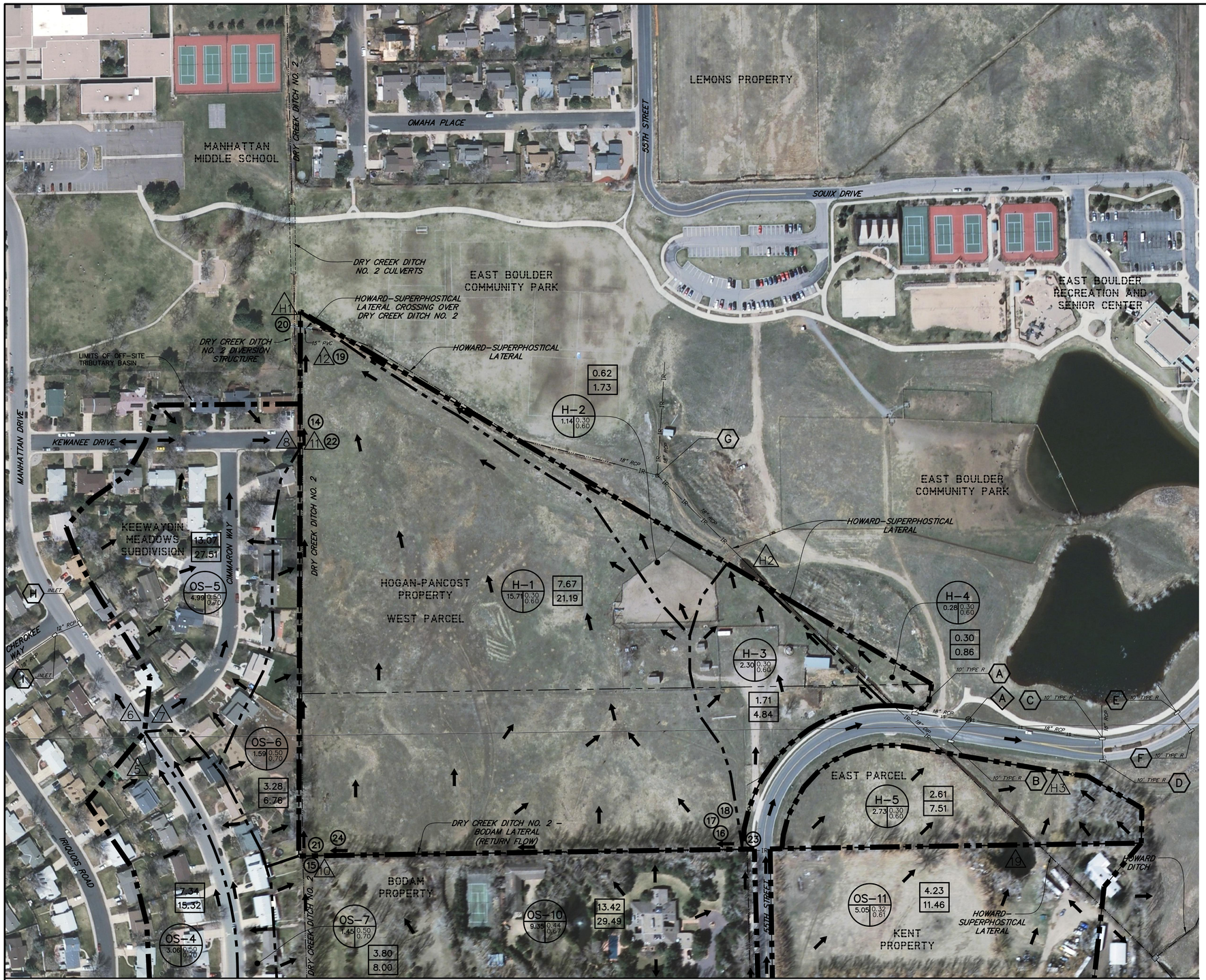
[10] *"South Boulder Creek Flood Mapping Study*", City of Boulder, 2008

[11] "*South Boulder Creek Major Drainageway Plan*", City of Boulder, June 2012

[12] "*Boulder Creek Commons Ground Water Recharge Evaluation*", Telesto Solutions, Inc., June 2012.

APPENDIX A

Existing Conditions Hydrology and Routing Models



N

100 50 0 100 200
SCALE: 1"=100'

LEGEND

- DRAINAGE BASIN BOUNDARY
- DRAINAGE SUB-BASIN BOUNDARY
- DRAINAGE BASIN DESIGN POINT (5)
- 10 YEAR EXISTING FLOW (cfs)
- 100 YEAR EXISTING FLOW (cfs)
- BASIN I.D.
- BASIN AREA (Acres)
- 10 YEAR RUNOFF COEFFICIENT
- 100 YEAR RUNOFF COEFFICIENT
- DIRECTION OF FLOW
- MANHOLE (A)
- WEIR (C)
- INLET (C)
- PHOTO I.D. (X)

C-3 3.45 .45 .90

REFER TO SHEET DR-2 FOR STORM DRAINAGE ROUTING SCHEMATIC.

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OWNER/DEVELOPER:

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CONCEPTUAL STORM WATER AND FLOODPLAIN MITIGATION REPORT FOR:
HOGAN-PANCOST PROPERTY
5399 KEWANEE DR & 5697 SOUTH BOULDER RD
BOULDER COUNTY, COLORADO

ISSUE	DATE
REPORT ISSUE	01/30/09
REPORT ISSUE	05/01/10

DESIGNED BY:	LRE
DRAWN BY:	MLM
CHECKED BY:	
FILE NAME:	54951DR01

COLORADO REGISTERED PROFESSIONAL ENGINEER JAMES BRZOSTOWICZ 40551

NOT VALID WITHOUT ORIGINAL SIGNATURE AND DATE

DRAWING SCALE:
HORIZONTAL: 1" = 100"
VERTICAL:

EXISTING CONDITIONS DRAINAGE EXHIBIT

PROJECT NO.	5495.1
DRAWING NO.	FILE

DR-1

SHEET: 1 OF 3

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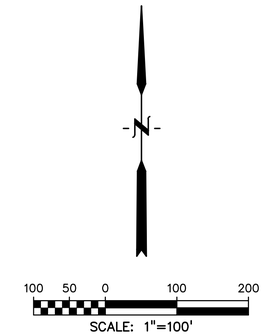

LEGEND

- DRAINAGE BASIN BOUNDARY
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- DRAINAGE BASIN DESIGN POINT
- 10 YEAR EXISTING FLOW (cfs)
- 100 YEAR EXISTING FLOW (cfs)
- BASIN I.D.
- BASIN AREA (Acres)
- 10 YEAR RUNOFF COEFFICIENT
- 100 YEAR RUNOFF COEFFICIENT
- DIRECTION OF FLOW
- MANHOLE
- WEIR
- INLET
- PHOTO I.D.

C-3 3.45 .45 .90

EXISTING CONDITIONS RUNOFF SUMMARY DRY CREEK DITCH NO.2 OPEN CHANNEL

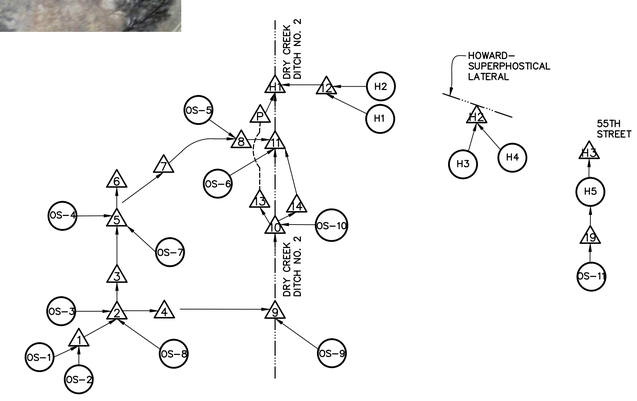
DESIGN POINT	RUNOFF 10 YR (cfs)	RUNOFF 100 YR (cfs)
DP1	41.55	69.65
DP2	40.41	65.57
DP3	20.20	32.78
DP4	20.20	32.78
DP5	20.24	34.72
DP6	10.12	17.36
DP7	10.12	17.36
DP8	17.33	34.67
DP9	28.57	52.44
DP10	38.90	78.93
DP11	49.48	95.55
DP12	8.213	22.70
DP19	4.23	11.46
DPH-1	52.25	103.58
DPH-2	1.84	5.21
DPH-3	2.91	8.09

EXISTING CONDITIONS RUNOFF SUMMARY DRY CREEK DITCH NO.2 PIPED

DESIGN POINT	RUNOFF 10 YR (cfs)	RUNOFF 100 YR (cfs)
DP1	41.55	69.65
DP2	40.41	65.57
DP3	20.20	32.78
DP4	20.20	32.78
DP5	20.24	34.72
DP6	10.12	17.36
DP7	10.12	17.36
DP8	17.33	34.67
DP9	28.57	52.44
DP10	38.90	78.93
DP11	19.45	48.65
DP12	8.21	22.70
DP13	38.90	46.00
DP14	0.004	32.93
DP19	4.23	11.46
DPP	37.32	45.99
DPH-1	53.06	102.44
DPH-2	1.84	5.21
DPH-3	2.91	8.09

DEVELOPED CONDITIONS RUNOFF SUMMARY

DESIGN POINT	DEVELOPED 10 YR (cfs)	DEVELOPED 100 YR IRR=25 (cfs)
DP1	41.55	69.65
DP2	40.41	65.57
DP3	20.20	32.78
DP4	20.20	32.78
DP5	20.24	34.72
DP6	10.12	17.36
DP7	10.12	17.36
DP8	17.33	34.67
DP9	28.57	52.44
DP10	38.90	78.93
DP11	21.86	44.12
DP12	8.13	40.20
DP13	38.90	46.00
DP14	0.004	32.93
DP16	0	20.38
DP17	26.43	54.07
DP18	8.13	40.20
DP19	4.23	11.46
DPP	37.32	45.99
DPH-1	43.33	81.60
DPH-2	0.297	0.86
DPH-3	2.909	8.11



EXISTING CONDITIONS
STORM DRAINAGE ROUTING SCHEMATIC
NOT TO SCALE

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COLORADO REGISTERED PROFESSIONAL ENGINEER JAMES K. BRZOSTOWICZ 40551

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DRAWING SCALE:
HORIZONTAL: 1" = 60"
VERTICAL: 1" = 60"

EXISTING CONDITIONS DRAINAGE EXHIBIT

PROJECT NO.	5495.1
DRAWING NO.	FILE

DR-2

SHEET: 2 OF 3

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Project Description

File Name	1006-HYD-10YR-X-DE.SPF

Project Options

Flow Units	CFS
Elevation Type	Elevation
Hydrology Method	Rational
Time of Concentration (TOC) Method	User-Defined
Link Routing Method	Kinematic Wave
Enable Overflow Ponding at Nodes	YES
Skip Steady State Analysis Time Periods	NO

Analysis Options

Start Analysis On	May 06, 2012	00:00:00
End Analysis On	May 08, 2012	00:00:00
Start Reporting On	May 06, 2012	00:00:00
Antecedent Dry Days	0	days
Runoff (Dry Weather) Time Step	0 01:00:00	days hh:mm:ss
Runoff (Wet Weather) Time Step	0 00:05:00	days hh:mm:ss
Reporting Time Step	0 00:05:00	days hh:mm:ss
Routing Time Step	30	seconds

Number of Elements

	Qty
Rain Gages	0
Subbasins	16
Nodes	23
Junctions	17
Outfalls	4
Flow Diversions	2
Inlets	0
Storage Nodes	0
Links	21
Channels	10
Pipes	11
Pumps	0
Orifices	0
Weirs	0
Outlets	0
Pollutants	0
Land Uses	0

Rainfall Details

Return Period	10 year(s)

Subbasin Summary

Subbasin ID	Area (ac)	Weighted Runoff Coefficient	Total Rainfall (in)	Total Runoff (in)	Total Runoff Volume (ft³)	Peak Runoff (cfs)	Time of Concentration (days hh:mm:ss)
H-1	15.71	0.3000	1.88	0.56	32106.37	7.69	0 01:09:00
H-2	1.14	0.3000	1.79	0.54	2222.21	0.62	0 00:59:00
H-3	2.30	0.3000	1.57	0.47	3932.38	1.71	0 00:38:00
H-4	0.28	0.3000	1.30	0.39	396.40	0.30	0 00:22:00
H-5	2.73	0.3000	1.39	0.42	4122.52	2.62	0 00:26:00
OS-01	7.83	0.7000	0.96	0.67	19071.77	28.68	0 00:11:00
OS-02	3.22	0.8900	0.91	0.81	9502.83	15.71	0 00:10:00
OS-03	0.81	0.5000	1.00	0.50	1476.03	2.03	0 00:12:00
OS-04	3.06	0.5000	1.05	0.52	5809.38	7.38	0 00:13:00
OS-05	4.99	0.5000	0.96	0.48	8694.58	13.05	0 00:11:00
OS-06	1.59	0.5000	1.18	0.59	3405.30	3.31	0 00:17:00
OS-07	1.45	0.5000	0.96	0.48	2526.48	3.79	0 00:11:00
OS-08	1.14	0.5000	0.87	0.43	1791.84	3.29	0 00:09:00
OS-09	9.45	0.4500	1.37	0.61	21062.35	13.93	0 00:25:00
OS-10	9.35	0.4400	1.37	0.60	20398.24	13.48	0 00:25:00
OS-11	5.05	0.3200	1.53	0.49	8982.44	4.24	0 00:35:00

Node Summary

SN	Element ID	Element Type	Initial Water Elevation (ft)	Surcharge Elevation (ft)	Peak Inflow (cfs)	Max HGL Elevation Attained (ft)	Time of Peak Flooding Occurrence (days hh:mm)	Total Time Flooded (min)
1	DP01	Junction	5331.93	5333.93	42.34	5332.74	0 00:00	0.00
2	DP01a	Junction	5332.93	5334.93	28.68	5333.75	0 00:00	0.00
3	DP02	Junction	5330.43	5330.93	46.58	5330.87	0 00:00	0.00
4	DP03	Junction	5330.43	5330.93	23.29	5330.78	0 00:00	0.00
5	DP04	Junction	5330.43	6330.93	23.29	5330.77	0 00:00	0.00
6	DP05	Junction	5323.34	5323.84	31.10	5323.68	0 00:00	0.00
7	DP06	Junction	5323.34	5323.84	15.55	5323.34	0 00:00	0.00
8	DP07	Junction	5323.34	5323.84	15.55	5323.64	0 00:00	0.00
9	DP08	Junction	5316.53	5319.53	21.93	5316.84	0 00:00	0.00
10	DP09	Junction	5328.93	5331.93	30.04	5330.54	0 00:00	0.00
11	DP10	Junction	5324.08	5327.08	36.95	5325.69	0 00:00	0.00
12	DP11	Junction	5315.80	5318.80	52.64	5317.49	0 00:00	0.00
13	DP12	Junction	5315.45	5318.45	8.23	5315.45	0 00:00	0.00
14	DP13	Junction	5324.80	5325.10	4.24	5324.95	0 00:00	0.00
15	DPH1	Junction	5312.38	5315.38	55.11	5314.07	0 00:00	0.00
16	DPH2	Junction	5321.00	5327.00	1.84	5321.00	0 00:00	0.00
17	DPH3	Junction	5322.25	5328.25	6.01	5322.40	0 00:00	0.00
18	Out-DP06	Outfall			15.55	5322.33		
19	Out-DPH1	Outfall			55.11	5312.38		
20	Out-DPH2	Outfall			1.84	5321.00		
21	Out-DPH3	Outfall			6.01	5322.25		
22	DIV01	Flow Diversions	5330.43		46.58	5330.43		0.00
23	DIV02	Flow Diversions	5323.34		31.10	5323.34		0.00

Junction Input

Element ID	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Ground/Rim (Max) Offset (ft)	Initial Water Elevation (ft)	Initial Water Depth (ft)	Surcharge Elevation (ft)	Surcharge Depth (ft)	Ponded Area (ft²)
DP01	5331.93	5333.93	2.00	5331.93	0.00	5333.93	0.00	0.00
DP01a	5332.93	5334.93	2.00	5332.93	0.00	5334.93	0.00	0.00
DP02	5330.43	5330.93	0.50	5330.43	0.00	5330.93	0.00	0.00
DP03	5330.43	5330.93	0.50	5330.43	0.00	5330.93	0.00	0.00
DP04	5330.43	5330.93	0.50	5330.43	0.00	6330.93	1000.00	0.00
DP05	5323.34	5323.84	0.50	5323.34	0.00	5323.84	0.00	0.00
DP06	5323.34	5323.84	0.50	5323.34	0.00	5323.84	0.00	0.00
DP07	5323.34	5323.84	0.50	5323.34	0.00	5323.84	0.00	0.00
DP08	5316.53	5319.53	3.00	5316.53	0.00	5319.53	0.00	0.00
DP09	5328.93	5331.93	3.00	5328.93	0.00	5331.93	0.00	0.00
DP10	5324.08	5327.08	3.00	5324.08	0.00	5327.08	0.00	0.00
DP11	5315.80	5318.80	3.00	5315.80	0.00	5318.80	0.00	0.00
DP12	5315.45	5318.45	3.00	5315.45	0.00	5318.45	0.00	0.00
DP13	5324.80	5325.10	0.30	5324.80	0.00	5325.10	0.00	0.00
DPH1	5312.38	5315.38	3.00	5312.38	0.00	5315.38	0.00	0.00
DPH2	5321.00	5327.00	6.00	5321.00	0.00	5327.00	0.00	0.00
DPH3	5322.25	5328.25	6.00	5322.25	0.00	5328.25	0.00	0.00

Junction Results

Element ID	Peak Inflow (cfs)	Peak Lateral Inflow (cfs)	Max HGL Elevation Attained (ft)	Max HGL Depth Attained (ft)	Max Surcharge Depth Attained (ft)	Min Freeboard Attained (ft)	Average HGL Elevation Attained (ft)	Average HGL Depth Attained (ft)	Time of Max HGL Occurrence (days hh:mm)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded Volume (ac-in)	Total Time Flooded (min)
DP01	42.34	15.70	5332.74	0.81	0.00	1.19	5331.93	0.00	0 00:11	0 00:00	0.00	0.00
DP01a	28.68	28.68	5333.75	0.82	0.00	1.18	5332.93	0.00	0 00:11	0 00:00	0.00	0.00
DP02	46.58	4.81	5330.87	0.44	0.00	0.06	5330.43	0.00	0 00:11	0 00:00	0.00	0.00
DP03	23.29	0.00	5330.78	0.35	0.00	0.15	5330.43	0.00	0 00:11	0 00:00	0.00	0.00
DP04	23.29	0.00	5330.77	0.34	0.00	0.16	5330.43	0.00	0 00:11	0 00:00	0.00	0.00
DP05	31.10	10.61	5323.68	0.34	0.00	0.16	5323.34	0.00	0 00:14	0 00:00	0.00	0.00
DP06	15.55	0.00	5323.34	0.00	0.00	0.50	5323.34	0.00	0 00:00	0 00:00	0.00	0.00
DP07	15.55	0.00	5323.64	0.30	0.00	0.20	5323.34	0.00	0 00:14	0 00:00	0.00	0.00
DP08	21.93	13.05	5316.84	0.31	0.00	2.69	5316.53	0.00	0 00:16	0 00:00	0.00	0.00
DP09	30.04	13.93	5330.54	1.61	0.00	1.39	5328.95	0.02	0 00:12	0 00:00	0.00	0.00
DP10	36.95	13.48	5325.69	1.61	0.00	1.39	5324.10	0.02	0 00:17	0 00:00	0.00	0.00
DP11	52.64	3.31	5317.49	1.69	0.00	1.31	5315.83	0.03	0 00:20	0 00:00	0.00	0.00
DP12	8.23	8.23	5315.45	0.00	0.00	3.00	5315.45	0.00	0 00:00	0 00:00	0.00	0.00
DP13	4.24	4.24	5324.95	0.15	0.00	0.15	5324.80	0.00	0 00:35	0 00:00	0.00	0.00
DPH1	55.11	0.00	5314.07	1.69	0.00	1.31	5312.41	0.03	0 00:21	0 00:00	0.00	0.00
DPH2	1.84	1.84	5321.00	0.00	0.00	6.00	5321.00	0.00	0 00:00	0 00:00	0.00	0.00
DPH3	6.01	2.62	5322.40	0.15	0.00	5.85	5322.25	0.00	0 00:36	0 00:00	0.00	0.00

Channel Input

Element ID	Length (ft)	Inlet Invert Elevation (ft)	Outlet Invert Elevation (ft)	Average Slope (%)	Shape	Height (ft)	Width (ft)	Manning's Roughness
DP01=>DP02	150.00	5331.93	5330.43	1.0000	Trapezoidal	0.500	55.000	0.0160
DP01a=>DP01	200.00	5332.93	5331.93	0.5000	Trapezoidal	2.000	17.000	0.0160
DP03=>DP05	810.00	5330.43	5323.34	0.8800	Trapezoidal	0.500	55.000	0.0160
DP04=>DP09	150.00	5330.43	5328.93	1.0000	Trapezoidal	0.500	55.000	0.0160
DP07=>DP08	780.00	5323.34	5316.53	0.8700	Trapezoidal	0.500	55.000	0.0160
DP08=>DP11	5.00	5316.53	5315.80	14.6000	Trapezoidal	0.500	55.000	0.0500
DP09=>DP10	485.00	5328.93	5324.08	1.0000	Trapezoidal	3.000	23.000	0.0800
DP10=>DP11	865.00	5324.08	5315.80	0.9600	Trapezoidal	3.000	25.000	0.0800
DP11=>DPH1	215.00	5315.80	5312.38	1.5900	Trapezoidal	3.000	25.000	0.0800
DP13=>DPH3	170.00	5324.80	5322.25	1.5000	Trapezoidal	0.300	45.000	0.0350

Channel Results

SN	Element ID	Peak Flow (cfs)	Time of Peak Flow Occurrence (days hh:mm)	Design Flow Capacity (cfs)	Peak Flow/ Design Flow Ratio	Peak Flow Velocity (ft/sec)	Travel Time (min)	Peak Flow Depth (ft)	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged (min)	Froude Number	Reported Condition
1	DP01=>DP02	42.07	0 00:11	58.58	0.72	3.62	0.69	0.44	0.87	0.00		
2	DP01a=>DP01	28.14	0 00:11	167.34	0.17	4.69	0.71	0.81	0.41	0.00		
3	DP03=>DP05	21.35	0 00:14	54.81	0.39	4.02	3.36	0.33	0.67	0.00		
4	DP04=>DP09	23.19	0 00:12	58.58	0.40	3.12	0.80	0.34	0.68	0.00		
5	DP07=>DP08	14.39	0 00:18	54.74	0.26	3.03	4.29	0.28	0.57	0.00		
6	DP08=>DP11	21.93	0 00:16	71.63	0.31	3.54	0.02	0.31	0.61	0.00		
7	DP09=>DP10	28.21	0 00:15	113.38	0.25	2.16	3.74	1.55	0.52	0.00		
8	DP10=>DP11	34.75	0 00:26	131.37	0.26	2.03	7.10	1.55	0.52	0.00		
9	DP11=>DPH1	52.52	0 00:21	169.34	0.31	2.59	1.38	1.69	0.56	0.00		
10	DP13=>DPH3	4.18	0 00:36	16.00	0.26	1.23	2.30	0.15	0.50	0.00		

Pipe Input

Element ID	Length (ft)	Inlet Invert Elevation (ft)	Outlet Invert Elevation (ft)	Total Drop (ft)	Average Slope (%)	Pipe Shape	Pipe Diameter or Height (in)	Pipe Width (in)	Manning's Roughness
DP02=>DIV01	1.00	5330.43	5330.43	0.00	0.0000	Dummy	0.000	0.000	0.0320
DP02=>DP03	1.00	5330.43	5330.43	0.00	0.0000	Dummy	0.000	0.000	0.0150
DP02=>DP04	1.00	5330.43	5330.43	0.00	0.0000	Dummy	0.000	0.000	0.0150
DP05=>DIV02	1.00	5322.33	5322.33	0.00	0.0000	Dummy	0.000	0.000	0.0150
DP05=>DP06	1.00	5322.33	5323.34	-1.01	-101.0000	Dummy	0.000	0.000	0.0150
DP05=>DP07	1.00	5322.33	5322.33	0.00	0.0000	Dummy	0.000	0.000	0.0150
DP06=>Out-H4	1.00	5322.33	5322.33	0.00	0.0000	Dummy	0.000	0.000	0.0320
DP12=>DPH1	1.00	5315.45	5312.38	3.07	307.0000	Dummy	0.000	0.000	0.0320
DP13=>Out-H1	1.00	5312.38	5312.38	0.00	0.0000	Dummy	0.000	0.000	0.0320
DPH2=>Out-DPH2	1.00	5321.00	5321.00	0.00	0.0000	Dummy	0.000	0.000	0.0320
DPH3=>OutDPH3	1.00	5322.25	5322.25	0.00	0.0000	Dummy	0.000	0.000	0.0320

Pipe Results

SN	Element ID	Peak Flow (cfs)	Time of Peak Flow Occurrence (days hh:mm)	Design Flow Capacity (cfs)	Peak Flow Velocity (ft/sec)	Travel Time (min)	Peak Flow Depth (ft)	Total Time Surcharged (min)	Froude Number	Reported Condition
1	DP02=>DIV01	46.58	0 00:11	0.00	0.00		0.81	0.00		Calculated
2	DP02=>DP03	23.29	0 00:11	0.00	0.00		0.81	0.00		Calculated
3	DP02=>DP04	23.29	0 00:11	0.00	0.00		0.81	0.00		Calculated
4	DP05=>DIV02	31.10	0 00:14	0.00	0.00		0.34	0.00		Calculated
5	DP05=>DP06	15.55	0 00:14	0.00	0.00		0.34	0.00		Calculated
6	DP05=>DP07	15.55	0 00:14	0.00	0.00		0.34	0.00		Calculated
7	DP06=>Out-H4	15.55	0 00:14	0.00	0.00		0.34	0.00		Calculated
8	DP12=>DPH1	8.23	0 01:09	0.00	0.00		1.69	0.00		Calculated
9	DP13=>Out-H1	55.11	0 00:21	0.00	0.00		0.15	0.00		Calculated
10	DPH2=>Out-DPH2	1.84	0 00:38	0.00	0.00		0.15	0.00		Calculated
11	DPH3=>OutDPH3	6.01	0 00:35	0.00	0.00		0.15	0.00		Calculated

Project Description

File Name	1006-HYD-100YR-X-DE.SPF

Project Options

Flow Units	CFS
Elevation Type	Elevation
Hydrology Method	Rational
Time of Concentration (TOC) Method	User-Defined
Link Routing Method	Kinematic Wave
Enable Overflow Ponding at Nodes	YES
Skip Steady State Analysis Time Periods	NO

Analysis Options

Start Analysis On	May 06, 2012	00:00:00
End Analysis On	May 08, 2012	00:00:00
Start Reporting On	May 06, 2012	00:00:00
Antecedent Dry Days	0	days
Runoff (Dry Weather) Time Step	0 01:00:00	days hh:mm:ss
Runoff (Wet Weather) Time Step	0 00:05:00	days hh:mm:ss
Reporting Time Step	0 00:05:00	days hh:mm:ss
Routing Time Step	30	seconds

Number of Elements

	Qty
Rain Gages	0
Subbasins	16
Nodes	23
Junctions	17
Outfalls	4
Flow Diversions	2
Inlets	0
Storage Nodes	0
Links	21
Channels	10
Pipes	11
Pumps	0
Orifices	0
Weirs	0
Outlets	0
Pollutants	0
Land Uses	0

Rainfall Details

Return Period	100 year(s)

Subbasin Summary

Subbasin ID	Area (ac)	Weighted Runoff Coefficient	Total Rainfall (in)	Total Runoff (in)	Total Runoff Volume (ft³)	Peak Runoff (cfs)	Time of Concentration (days hh:mm:ss)
H-1	15.71	0.6000	2.60	1.56	88791.51	21.28	0 01:09:00
H-2	1.14	0.6000	2.49	1.49	6178.33	1.73	0 00:59:00
H-3	2.30	0.6000	2.21	1.33	11079.12	4.82	0 00:38:00
H-4	0.28	0.6000	1.89	1.13	1149.55	0.86	0 00:22:00
H-5	2.73	0.6000	1.99	1.19	11802.69	7.50	0 00:26:00
OS-01	7.83	0.8000	1.45	1.16	32856.87	49.36	0 00:11:00
OS-02	3.22	0.9200	1.38	1.27	14844.52	24.54	0 00:10:00
OS-03	0.81	0.7000	1.51	1.05	3099.08	4.27	0 00:12:00
OS-04	3.06	0.7000	1.56	1.10	12163.04	15.47	0 00:13:00
OS-05	4.99	0.7000	1.45	1.01	18312.95	27.52	0 00:11:00
OS-06	1.59	0.7000	1.74	1.22	7035.70	6.84	0 00:17:00
OS-07	1.45	0.7000	1.45	1.01	5321.40	8.00	0 00:11:00
OS-08	1.14	0.7000	1.31	0.92	3803.01	6.98	0 00:09:00
OS-09	9.45	0.6800	1.96	1.33	45760.87	30.25	0 00:25:00
OS-10	9.35	0.6700	1.96	1.31	44597.82	29.49	0 00:25:00
OS-11	5.05	0.6100	2.16	1.32	24179.25	11.42	0 00:35:00

Node Summary

SN	Element ID	Element Type	Initial Water Elevation (ft)	Surcharge Elevation (ft)	Peak Inflow (cfs)	Max HGL Elevation Attained (ft)	Time of Peak Flooding Occurrence (days hh:mm)	Total Time Flooded (min)
1	DP01	Junction	5331.93	5333.93	70.82	5333.01	0 00:00	0.00
2	DP01a	Junction	5332.93	5334.93	49.36	5334.02	0 00:00	0.00
3	DP02	Junction	5330.43	5330.93	79.89	5330.97	0 00:00	0.00
4	DP03	Junction	5330.43	5330.93	39.95	5330.87	0 00:00	0.00
5	DP04	Junction	5330.43	5330.93	39.95	5330.86	0 00:00	0.00
6	DP05	Junction	5323.34	5323.84	58.55	5323.77	0 00:00	0.00
7	DP06	Junction	5323.34	5323.84	29.28	5323.34	0 00:00	0.00
8	DP07	Junction	5323.34	5323.84	29.28	5323.73	0 00:00	0.00
9	DP08	Junction	5316.53	5319.53	45.44	5316.94	0 00:00	0.00
10	DP09	Junction	5328.93	5331.93	54.55	5331.07	0 00:00	0.00
11	DP10	Junction	5324.08	5327.08	70.82	5326.31	0 00:00	0.00
12	DP11	Junction	5315.80	5318.80	106.76	5318.20	0 00:00	0.00
13	DP12	Junction	5315.45	5318.45	22.78	5315.45	0 00:00	0.00
14	DP13	Junction	5324.80	5325.10	11.42	5325.05	0 00:00	0.00
15	DPH1	Junction	5312.38	5315.38	113.22	5314.78	0 00:00	0.00
16	DPH2	Junction	5321.00	5327.00	5.20	5321.00	0 00:00	0.00
17	DPH3	Junction	5322.25	5328.25	16.59	5322.50	0 00:00	0.00
18	Out-DP06	Outfall			29.28	5322.33		
19	Out-DPH1	Outfall			113.22	5312.38		
20	Out-DPH2	Outfall			5.20	5321.00		
21	Out-DPH3	Outfall			16.59	5322.25		
22	DIV01	Flow Diversions	5330.43		79.89	5330.43		0.00
23	DIV02	Flow Diversions	5323.34		58.55	5323.34		0.00

Junction Input

Element ID	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Ground/Rim (Max) Offset (ft)	Initial Water Elevation (ft)	Initial Water Depth (ft)	Surcharge Elevation (ft)	Surcharge Depth (ft)	Ponded Area (ft²)
DP01	5331.93	5333.93	2.00	5331.93	0.00	5333.93	0.00	0.00
DP01a	5332.93	5334.93	2.00	5332.93	0.00	5334.93	0.00	0.00
DP02	5330.43	5330.93	0.50	5330.43	0.00	5330.93	0.00	0.00
DP03	5330.43	5330.93	0.50	5330.43	0.00	5330.93	0.00	0.00
DP04	5330.43	5330.93	0.50	5330.43	0.00	5330.93	0.00	0.00
DP05	5323.34	5323.84	0.50	5323.34	0.00	5323.84	0.00	0.00
DP06	5323.34	5323.84	0.50	5323.34	0.00	5323.84	0.00	0.00
DP07	5323.34	5323.84	0.50	5323.34	0.00	5323.84	0.00	0.00
DP08	5316.53	5319.53	3.00	5316.53	0.00	5319.53	0.00	0.00
DP09	5328.93	5331.93	3.00	5328.93	0.00	5331.93	0.00	0.00
DP10	5324.08	5327.08	3.00	5324.08	0.00	5327.08	0.00	0.00
DP11	5315.80	5318.80	3.00	5315.80	0.00	5318.80	0.00	0.00
DP12	5315.45	5318.45	3.00	5315.45	0.00	5318.45	0.00	0.00
DP13	5324.80	5325.10	0.30	5324.80	0.00	5325.10	0.00	0.00
DPH1	5312.38	5315.38	3.00	5312.38	0.00	5315.38	0.00	0.00
DPH2	5321.00	5327.00	6.00	5321.00	0.00	5327.00	0.00	0.00
DPH3	5322.25	5328.25	6.00	5322.25	0.00	5328.25	0.00	0.00

Junction Results

Element ID	Peak Inflow (cfs)	Peak Lateral Inflow (cfs)	Max HGL Elevation Attained (ft)	Max HGL Depth Attained (ft)	Max Surcharge Depth Attained (ft)	Min Freeboard Attained (ft)	Average HGL Elevation Attained (ft)	Average HGL Depth Attained (ft)	Time of Max HGL Occurrence (days hh:mm)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded Volume (ac-in)	Total Time Flooded (min)
DP01	70.82	24.54	5333.01	1.08	0.00	0.92	5331.94	0.01	0 00:11	0 00:00	0.00	0.00
DP01a	49.36	49.36	5334.02	1.09	0.00	0.91	5332.94	0.01	0 00:11	0 00:00	0.00	0.00
DP02	79.89	10.19	5330.97	0.54	0.00	0.01	5330.43	0.00	0 00:11	0 00:00	0.00	0.00
DP03	39.95	0.00	5330.87	0.44	0.00	0.06	5330.43	0.00	0 00:11	0 00:00	0.00	0.00
DP04	39.95	0.00	5330.86	0.43	0.00	0.07	5330.43	0.00	0 00:11	0 00:00	0.00	0.00
DP05	58.55	22.27	5323.77	0.43	0.00	0.07	5323.34	0.00	0 00:14	0 00:00	0.00	0.00
DP06	29.28	0.00	5323.34	0.00	0.00	0.50	5323.34	0.00	0 00:00	0 00:00	0.00	0.00
DP07	29.28	0.00	5323.73	0.39	0.00	0.11	5323.34	0.00	0 00:13	0 00:00	0.00	0.00
DP08	45.44	27.52	5316.94	0.41	0.00	2.59	5316.53	0.00	0 00:15	0 00:00	0.00	0.00
DP09	54.55	30.25	5331.07	2.14	0.00	0.86	5328.96	0.03	0 00:12	0 00:00	0.00	0.00
DP10	70.82	29.49	5326.31	2.23	0.00	0.77	5324.11	0.03	0 00:17	0 00:00	0.00	0.00
DP11	106.76	6.84	5318.20	2.40	0.00	0.60	5315.84	0.04	0 00:18	0 00:00	0.00	0.00
DP12	22.78	22.78	5315.45	0.00	0.00	3.00	5315.45	0.00	0 00:00	0 00:00	0.00	0.00
DP13	11.42	11.42	5325.05	0.25	0.00	0.05	5324.80	0.00	0 00:35	0 00:00	0.00	0.00
DPH1	113.22	0.00	5314.78	2.40	0.00	0.60	5312.42	0.04	0 00:19	0 00:00	0.00	0.00
DPH2	5.20	5.20	5321.00	0.00	0.00	6.00	5321.00	0.00	0 00:00	0 00:00	0.00	0.00
DPH3	16.59	7.50	5322.50	0.25	0.00	5.75	5322.25	0.00	0 00:36	0 00:00	0.00	0.00

Channel Input

Element ID	Length (ft)	Inlet Invert Elevation (ft)	Outlet Invert Elevation (ft)	Average Slope (%)	Shape	Height (ft)	Width (ft)	Manning's Roughness
DP01=>DP02	150.00	5331.93	5330.43	1.0000	Trapezoidal	0.550	60.000	0.0160
DP01a=>DP01	200.00	5332.93	5331.93	0.5000	Trapezoidal	2.000	17.000	0.0160
DP03=>DP05	810.00	5330.43	5323.34	0.8800	Trapezoidal	0.500	55.000	0.0160
DP04=>DP09	150.00	5330.43	5328.93	1.0000	Trapezoidal	0.500	55.000	0.0160
DP07=>DP08	780.00	5323.34	5316.53	0.8700	Trapezoidal	0.500	55.000	0.0160
DP08=>DP11	5.00	5316.53	5315.80	14.6000	Trapezoidal	0.500	55.000	0.0500
DP09=>DP10	485.00	5328.93	5324.08	1.0000	Trapezoidal	3.000	23.000	0.0800
DP10=>DP11	865.00	5324.08	5315.80	0.9600	Trapezoidal	3.000	25.000	0.0800
DP11=>DPH1	215.00	5315.80	5312.38	1.5900	Trapezoidal	3.000	25.000	0.0800
DP13=>DPH3	170.00	5324.80	5322.25	1.5000	Trapezoidal	0.300	45.000	0.0350

Channel Results

SN	Element ID	Peak Flow (cfs)	Time of Peak Flow Occurrence (days hh:mm)	Design Flow Capacity (cfs)	Peak Flow/ Design Flow Ratio	Peak Flow Velocity (ft/sec)	Travel Time (min)	Peak Flow Depth (ft)	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged (min)	Froude Number	Reported Condition
1	DP01=>DP02	70.34	0 00:11	74.04	0.95	4.12	0.61	0.54	0.98	0.00		
2	DP01a=>DP01	48.53	0 00:11	167.34	0.29	5.48	0.61	1.08	0.54	0.00		
3	DP03=>DP05	37.30	0 00:14	54.81	0.68	4.58	2.95	0.42	0.85	0.00		
4	DP04=>DP09	39.80	0 00:12	58.58	0.68	3.57	0.70	0.43	0.85	0.00		
5	DP07=>DP08	27.44	0 00:17	54.74	0.50	3.48	3.74	0.37	0.75	0.00		
6	DP08=>DP11	45.44	0 00:15	71.63	0.63	4.26	0.02	0.41	0.83	0.00		
7	DP09=>DP10	52.04	0 00:15	113.38	0.46	2.71	2.98	2.08	0.69	0.00		
8	DP10=>DP11	69.01	0 00:26	131.37	0.53	2.42	5.96	2.19	0.73	0.00		
9	DP11=>DPH1	106.59	0 00:19	169.34	0.63	3.13	1.14	2.40	0.80	0.00		
10	DP13=>DPH3	11.29	0 00:36	16.00	0.71	1.63	1.74	0.25	0.84	0.00		

Pipe Input

Element ID	Length (ft)	Inlet Invert Elevation (ft)	Outlet Invert Elevation (ft)	Total Drop (ft)	Average Slope (%)	Pipe Shape	Pipe Diameter or Height (in)	Pipe Width (in)	Manning's Roughness
DP02=>DIV01	1.00	5330.43	5330.43	0.00	0.0000	Dummy	0.000	0.000	0.0320
DP02=>DP03	1.00	5330.43	5330.43	0.00	0.0000	Dummy	0.000	0.000	0.0150
DP02=>DP04	1.00	5330.43	5330.43	0.00	0.0000	Dummy	0.000	0.000	0.0150
DP05=>DIV02	1.00	5322.33	5322.33	0.00	0.0000	Dummy	0.000	0.000	0.0150
DP05=>DP06	1.00	5322.33	5323.34	-1.01	-101.0000	Dummy	0.000	0.000	0.0320
DP05=>DP07	1.00	5322.33	5322.33	0.00	0.0000	Dummy	0.000	0.000	0.0150
DP06=>Out-H4	1.00	5322.33	5322.33	0.00	0.0000	Dummy	0.000	0.000	0.0320
DP12=>DPH1	1.00	5315.45	5312.38	3.07	307.0000	Dummy	0.000	0.000	0.0320
DP13=>Out-H1	1.00	5312.38	5312.38	0.00	0.0000	Dummy	0.000	0.000	0.0320
DPH2=>Out-DPH2	1.00	5321.00	5321.00	0.00	0.0000	Dummy	0.000	0.000	0.0320
DPH3=>OutDPH3	1.00	5322.25	5322.25	0.00	0.0000	Dummy	0.000	0.000	0.0320

Pipe Results

SN	Element ID	Peak Flow (cfs)	Time of Peak Flow Occurrence (days hh:mm)	Design Flow Capacity (cfs)	Peak Flow Velocity (ft/sec)	Travel Time (min)	Peak Flow Depth (ft)	Total Time Surcharged (min)	Froude Number	Reported Condition
1	DP02=>DIV01	79.89	0 00:11	0.00	0.00		1.08	0.00		Calculated
2	DP02=>DP03	39.95	0 00:11	0.00	0.00		1.08	0.00		Calculated
3	DP02=>DP04	39.95	0 00:11	0.00	0.00		1.08	0.00		Calculated
4	DP05=>DIV02	58.55	0 00:13	0.00	0.00		0.43	0.00		Calculated
5	DP05=>DP06	29.28	0 00:13	0.00	0.00		0.43	0.00		Calculated
6	DP05=>DP07	29.28	0 00:13	0.00	0.00		0.43	0.00		Calculated
7	DP06=>Out-H4	29.28	0 00:13	0.00	0.00		0.43	0.00		Calculated
8	DP12=>DPH1	22.78	0 01:09	0.00	0.00		2.40	0.00		Calculated
9	DP13=>Out-H1	113.22	0 00:19	0.00	0.00		0.25	0.00		Calculated
10	DPH2=>Out-DPH2	5.20	0 00:38	0.00	0.00		0.25	0.00		Calculated
11	DPH3=>OutDPH3	16.59	0 00:35	0.00	0.00		0.25	0.00		Calculated

Input Data for Rational Method

Basin Ax

Existing Conditions

Project: Boulder Creek Commons
SG Project I.D.: B1006

Prepared By: LRE
Reviewed By: CCS
Date: 05/08/12
Revised Date:

Basin Description: Located on the western half of the West Parcel, this basin drains towards Dry Creek Ditch No. 2. Flows from this basin are collected in a depression east of the Dry Creek Ditch No. 2 north to Outfall H1.

NRCS Soil Type: Nh - Niwot **NRCS Hydrologic Soil Raiting:** C

Basin Area [acres] = 9.46

Surface Characteristics[1]	Sub-Area [acres]	Imp [%]	Runoff Coefficients			
			C_2	C_5	C_{10}	C_{100}
Undeveloped: Historic Analysis	9.46	2	0.10	0.20	0.30	0.60

[1] *City of Boulder, DCS,* Table 7-2

Weighted Percent Imperviousness [%]: I = 2.00

Weighted Runoff Coefficients:

C_2 = 0.10
C_5 = 0.20
C_{10} = 0.30
C_{100} = 0.60

Time of Concentration:

Sheet Flow:

L_i [ft] = 210
S_i [%] = 2.40
t_i [min] = 17.53

NOTE: non-urbanized basin

Concentrated Flow:

L_{t1} [FT] =	1024	L_{t2} [FT] =	0
S_{t1} [%] =	0.79	S_{t2} [%] =	0.00
V_{t1} [fps][2] =	0.62	V_{t2} [fps] =	0.00
t_{t1} [min] =	27.52	t_{t2} [min] =	0.00

[2] *City of Boulder, DCS,* Figure 7-3

t_i [min] = 17.53

t_t [min] = 27.52

Time of Concentration:

$t_c = t_i + t_t$ [min] = 45.06
t_c=5 min = 5.00

t_c [min] = 45.06

Input Data for Rational Method

Basin Bx

Existing Conditions

Prepared By: LRE
Reviewed By: CCS
Date: 05/08/12
Revised Date:

Project: Boulder Creek Commons
SG Project I.D.: B1006

Basin Description: Located on the eastern portion of the West Parcel, this basin drains toward the north property line. Flows from from this basin are collected in a depression created by the Howard-Superphostical Lateral and conveyed west to Outfall H1.

NRCS Soil Type: Nh - Niwot **NRCS Hydrologic Soil Raiting:** C

Basin Area [acres] = 9.51

Surface Characteristics[1]	Sub-Area [acres]	Imp [%]	Runoff Coefficients			
			C_2	C_5	C_{10}	C_{100}
Undeveloped: Historic Analysis	9.51	2	0.10	0.20	0.30	0.60
Parks / Open Space	0.00	7	0.15	0.25	0.35	0.60
Residential: Single-Family	0.00	40	0.40	0.45	0.50	0.70
Residential: Apartments	0.00	70	0.65	0.70	0.70	0.80
Landscape Areas-clayey soil	0.00	0	0.05	0.10	0.20	0.40

[1] *City of Boulder, DCS,* Table 7-2

Weighted Percent Imperviousness [%]: I = 2.00

Weighted Runoff Coefficients:

C_2 = 0.10
C_5 = 0.20
C_{10} = 0.30
C_{100} = 0.60

Time of Concentration:

Sheet Flow:

L_i [ft] = 273
S_i [%] = 2.00
t_i [min] = 21.26

NOTE: non-urbanized basin

t_i [min] = 21.26

Concentrated Flow:

L_{t1} [FT] =	1281	L_{t2} [FT] =	0
S_{t1} [%] =	0.55	S_{t2} [%] =	0.00
V_{t1} [fps][2] =	0.50	V_{t2} [fps] =	0.00
t_{t1} [min] =	42.70	t_{t2} [min] =	0.00

[2] *City of Boulder, DCS,* Figure 7-3

t_t [min] = 42.70

Time of Concentration:

$t_c = t_i + t_t$ [min] = 63.96
t_c=5 min = 5.00

t_c [min] = 63.96

Input Data for Rational Method

Basin Cx

Existing Conditions

Prepared By: LRE
Project: Boulder Creek Commons
Reviewed By: CCS
SG Project I.D.: B1006
Date: 05/08/12
Revised Date:

Basin Description: Located parallel to the south property line, this basin includes the depression created by the Bodam Lateral. Drainage fromt this basin flows overland towards the Bodam Lateral and is conveyed west to Dry Creek Ditch No. 2.

NRCS Soil Type: Nh - Niwot **NRCS Hydrologic Soil Raiting:** C

Basin Area [acres] = 0.17

Surface Characteristics[1]	Sub-Area [acres]	Imp [%]	Runoff Coefficients			
			C_2	C_5	C_{10}	C_{100}
Undeveloped: Historic Analysis	0.17	2	0.10	0.20	0.30	0.60
Parks / Open Space	0.00	7	0.15	0.25	0.35	0.60
Residential: Single-Family	0.00	40	0.40	0.45	0.50	0.70
Residential: Apartments	0.00	70	0.65	0.70	0.70	0.80
Landscape Areas-clayey soil	0.00	0	0.05	0.10	0.20	0.40

[1] *City of Boulder, DCS,* Table 7-2

Weighted Percent Imperviousness [%]: I = 2.00

Weighted Runoff Coefficients:

C_2 = 0.10
C_5 = 0.20
C_{10} = 0.30
C_{100} = 0.60

Time of Concentration:

Sheet Flow:

L_i [ft] = 8
S_i [%] = 22.50
t_i [min] = 1.62

NOTE: non-urbanized basin

t_i [min] = 1.62

Concentrated Flow:

L_{t1} [FT] =	894	L_{t2} [FT] =	0
S_{t1} [%] =	0.25	S_{t2} [%] =	0.00
V_{t1} [fps][2] =	0.50	V_{t2} [fps] =	0.00
t_{t1} [min] =	29.80	t_{t2} [min] =	0.00

[2] *City of Boulder, DCS,* Figure 7-3

t_t [min] = 29.80

Time of Concentration:

$t_c = t_i + t_t$ [min] = 31.42
t_c=5 min = 5.00

t_c [min] = 31.42

Input Data for Rational Method

Basin Dx

Existing Conditions

Prepared By: LRE
Project: Boulder Creek Commons
Reviewed By: CCS
SG Project I.D.: B1006
Date: 05/08/12
Revised Date:

Basin Description: Located in the northeast corner of the West Parcel, this basin drains away from the Howard-Superphostical Lateral and towards the northeast corner of the property. This basin does not have a defined outfall and ponds at Outfall H2.

NRCS Soil Type: Nh - Niwot **NRCS Hydrologic Soil Raiting:** C

Basin Area [acres] = 0.30

Surface Characteristics[1]	Sub-Area [acres]	Imp [%]	Runoff Coefficients			
			C_2	C_5	C_{10}	C_{100}
Undeveloped: Historic Analysis	0.30	2	0.10	0.20	0.30	0.60
Parks / Open Space	0.00	7	0.15	0.25	0.35	0.60
Residential: Single-Family	0.00	40	0.40	0.45	0.50	0.70
Residential: Apartments	0.00	70	0.65	0.70	0.70	0.80
Landscape Areas-clayey soil	0.00	0	0.05	0.10	0.20	0.40

[1] *City of Boulder, DCS,* Table 7-2

Weighted Percent Imperviousness [%]: I = 2.00

Weighted Runoff Coefficients:

C_2 = 0.10
C_5 = 0.20
C_{10} = 0.30
C_{100} = 0.60

Time of Concentration:

Sheet Flow:

L_i [ft] = 174
S_i [%] = 1.20
t_i [min] = 20.08

NOTE: non-urbanized basin

t_i [min] = 20.08

Concentrated Flow:

L_{t1} [FT] =	0	L_{t2} [FT] =	0
S_{t1} [%] =	0.00	S_{t2} [%] =	0.00
V_{t1} [fps][2] =	0.00	V_{t2} [fps] =	0.00
t_{t1} [min] =	0.00	t_{t2} [min] =	0.00

[2] *City of Boulder, DCS,* Figure 7-3

t_t [min] = 0.00

Time of Concentration:

$t_c = t_i + t_t$ [min] = 20.08
t_c=5 min = 5.00

t_c [min] = 20.08

Input Data for Rational Method

Basin Ex

Existing Conditions

Prepared By: LRE
Project: Boulder Creek Commons
Reviewed By: CCS
SG Project I.D.: B1006
Date: 05/08/12
Revised Date:

Basin Description: This basin includes all of the East Parcel. Drainage from this basin flows northeast to Outfall H3.

NRCS Soil Type: Nh - Niwot

NRCS Hydrologic Soil Raiting: C

Basin Area [acres] = 2.73

Surface Characteristics[1]	Sub-Area [acres]	Imp [%]	Runoff Coefficients			
			C_2	C_5	C_{10}	C_{100}
Undeveloped: Historic Analysis	2.73	2	0.10	0.20	0.30	0.60
Parks / Open Space	0.00	7	0.15	0.25	0.35	0.60
Residential: Single-Family	0.00	40	0.40	0.45	0.50	0.70
Residential: Apartments	0.00	70	0.65	0.70	0.70	0.80
Landscape Areas-clayey soil	0.00	0	0.05	0.10	0.20	0.40

[1] *City of Boulder, DCS,* Table 7-2

Weighted Percent Imperviousness [%]: I = 2.00

Weighted Runoff Coefficients:

C_2 = 0.10
C_5 = 0.20
C_{10} = 0.30
C_{100} = 0.60

Time of Concentration:

Sheet Flow:

L_i [ft] = 602
S_i [%] = 0.83
t_i [min] = 42.29

NOTE: non-urbanized basin

t_i [min] = 42.29

Concentrated Flow:

L_{t1} [FT] =	0	L_{t2} [FT] =	0
S_{t1} [%] =	0.00	S_{t2} [%] =	0.00
V_{t1} [fps][2] =	0.00	V_{t2} [fps] =	0.00
t_{t1} [min] =	0.00	t_{t2} [min] =	0.00

[2] *City of Boulder, DCS,* Figure 7-3

t_t [min] = 0.00

Time of Concentration:

$t_c = t_i + t_t$ [min] = 42.29
t_c=5 min = 5.00

t_c [min] = 42.29

Project Description

File Name	1006-HYD-10YR-X.SPF

Project Options

Flow Units	CFS
Elevation Type	Elevation
Hydrology Method	Rational
Time of Concentration (TOC) Method	User-Defined
Link Routing Method	Kinematic Wave
Enable Overflow Ponding at Nodes	YES
Skip Steady State Analysis Time Periods	NO

Analysis Options

Start Analysis On	May 23, 2012	00:00:00
End Analysis On	May 25, 2012	00:00:00
Start Reporting On	May 23, 2012	00:00:00
Antecedent Dry Days	0	days
Runoff (Dry Weather) Time Step	0 01:00:00	days hh:mm:ss
Runoff (Wet Weather) Time Step	0 00:05:00	days hh:mm:ss
Reporting Time Step	0 00:05:00	days hh:mm:ss
Routing Time Step	30	seconds

Number of Elements

	Qty
Rain Gages	0
Subbasins	17
Nodes	26
Junctions	20
Outfalls	4
Flow Diversions	2
Inlets	0
Storage Nodes	0
Links	24
Channels	12
Pipes	12
Pumps	0
Orifices	0
Weirs	0
Outlets	0
Pollutants	0
Land Uses	0

Rainfall Details

Return Period	10 year(s)

Subbasin Summary

Subbasin ID	Area (ac)	Weighted Runoff Coefficient	Total Rainfall (in)	Total Runoff (in)	Total Runoff Volume (ft³)	Peak Runoff (cfs)	Time of Concentration (days hh:mm:ss)
Ax	9.46	0.3000	1.65	0.50	16998.20	6.24	0 00:45:03
Bx	9.51	0.3000	1.84	0.55	19021.24	4.91	0 01:03:57
Cx	0.17	0.3000	1.49	0.45	275.23	0.14	0 00:31:25
Dx	0.30	0.3000	1.25	0.38	408.38	0.34	0 00:20:04
Ex	2.73	0.3000	1.62	0.49	4826.12	1.88	0 00:42:17
OS-01	7.83	0.7000	0.96	0.67	19071.77	28.68	0 00:11:00
OS-02	3.22	0.8900	0.91	0.81	9502.83	15.71	0 00:10:00
OS-03	0.81	0.5000	1.00	0.50	1476.03	2.03	0 00:12:00
OS-04	3.06	0.5000	1.05	0.52	5809.38	7.38	0 00:13:00
OS-05	4.99	0.5000	0.96	0.48	8694.58	13.05	0 00:11:00
OS-06	1.59	0.5000	1.18	0.59	3405.30	3.31	0 00:17:00
OS-07	1.45	0.5000	0.96	0.48	2526.48	3.79	0 00:11:00
OS-08	1.14	0.5000	0.87	0.43	1791.84	3.29	0 00:09:00
OS-09	9.45	0.4500	1.37	0.61	21062.35	13.93	0 00:25:00
OS-10	9.35	0.4400	1.37	0.60	20398.24	13.48	0 00:25:00
OS-11	5.05	0.3200	1.53	0.49	8982.44	4.24	0 00:35:00
OS-12	2.01	0.3200	0.94	0.30	2203.48	3.41	0 00:10:42

Node Summary

SN	Element ID	Element Type	Initial Water Elevation (ft)	Surcharge Elevation (ft)	Peak Inflow (cfs)	Max HGL Elevation Attained (ft)	Time of Peak Flooding Occurrence (days hh:mm)	Total Time Flooded (min)
1	DP01	Junction	5331.93	5333.93	42.34	5332.74	0 00:00	0.00
2	DP01a	Junction	5332.93	5334.93	28.68	5333.75	0 00:00	0.00
3	DP02	Junction	5330.43	5330.93	46.58	5330.87	0 00:00	0.00
4	DP03	Junction	5330.43	5330.93	23.29	5330.78	0 00:00	0.00
5	DP04	Junction	5330.43	5330.93	23.29	5330.77	0 00:00	0.00
6	DP05	Junction	5323.34	5323.84	31.10	5323.68	0 00:00	0.00
7	DP06	Junction	5323.34	5323.84	15.55	5323.34	0 00:00	0.00
8	DP07	Junction	5323.34	5323.84	15.55	5323.64	0 00:00	0.00
9	DP08	Junction	5316.53	5319.53	21.93	5316.84	0 00:00	0.00
10	DP09	Junction	5328.93	5331.93	30.04	5330.54	0 00:00	0.00
11	DP10	Junction	5324.08	5327.08	36.95	5325.64	0 00:00	0.00
12	DP11	Junction	5315.80	5318.80	52.71	5317.49	0 00:00	0.00
13	DP12	Junction	5315.30	5317.30	4.94	5316.08	0 00:00	0.00
14	DP13	Junction	5315.80	5318.80	3.31	5315.80	0 00:00	0.00
15	DP14	Junction	5324.08	5327.08	37.03	5325.69	0 00:00	0.00
16	DP15	Junction	5324.80	5325.10	4.24	5324.95	0 00:00	0.00
17	DP16	Junction	5319.50	5320.50	3.41	5319.90	0 00:00	0.00
18	DPH1	Junction	5312.38	5315.38	59.42	5314.07	0 00:00	0.00
19	DPH2	Junction	5321.00	5327.00	0.34	5321.00	0 00:00	0.00
20	DPH3	Junction	5322.25	5328.25	5.81	5322.40	0 00:00	0.00
21	Out-DP06	Outfall			15.55	5322.33		
22	Out-DPH1	Outfall			59.42	5312.38		
23	Out-DPH2	Outfall			0.34	5321.00		
24	Out-DPH3	Outfall			5.81	5322.25		
25	DIV01	Flow Diversions	5330.43		46.58	5330.43		0.00
26	DIV02	Flow Diversions	5323.34		31.10	5323.34		0.00

Junction Input

Element ID	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Ground/Rim (Max) Offset (ft)	Initial Water Elevation (ft)	Initial Water Depth (ft)	Surcharge Elevation (ft)	Surcharge Depth (ft)	Ponded Area (ft²)
DP01	5331.93	5333.93	2.00	5331.93	0.00	5333.93	0.00	0.00
DP01a	5332.93	5334.93	2.00	5332.93	0.00	5334.93	0.00	0.00
DP02	5330.43	5330.93	0.50	5330.43	0.00	5330.93	0.00	0.00
DP03	5330.43	5330.93	0.50	5330.43	0.00	5330.93	0.00	0.00
DP04	5330.43	5330.93	0.50	5330.43	0.00	5330.93	0.00	0.00
DP05	5323.34	5323.84	0.50	5323.34	0.00	5323.84	0.00	0.00
DP06	5323.34	5323.84	0.50	5323.34	0.00	5323.84	0.00	0.00
DP07	5323.34	5323.84	0.50	5323.34	0.00	5323.84	0.00	0.00
DP08	5316.53	5319.53	3.00	5316.53	0.00	5319.53	0.00	0.00
DP09	5328.93	5331.93	3.00	5328.93	0.00	5331.93	0.00	0.00
DP10	5324.08	5327.08	3.00	5324.08	0.00	5327.08	0.00	0.00
DP11	5315.80	5318.80	3.00	5315.80	0.00	5318.80	0.00	0.00
DP12	5315.30	5317.30	2.00	5315.30	0.00	5317.30	0.00	0.00
DP13	5315.80	5318.80	3.00	5315.80	0.00	5318.80	0.00	0.00
DP14	5324.08	5327.08	3.00	5324.08	0.00	5327.08	0.00	0.00
DP15	5324.80	5325.10	0.30	5324.80	0.00	5325.10	0.00	0.00
DP16	5319.50	5320.50	1.00	5319.50	0.00	5320.50	0.00	0.00
DPH1	5312.38	5315.38	3.00	5312.38	0.00	5315.38	0.00	0.00
DPH2	5321.00	5327.00	6.00	5321.00	0.00	5327.00	0.00	0.00
DPH3	5322.25	5328.25	6.00	5322.25	0.00	5328.25	0.00	0.00

Junction Results

Element ID	Peak Inflow (cfs)	Peak Lateral Inflow (cfs)	Max HGL Elevation Attained (ft)	Max HGL Depth Attained (ft)	Max Surcharge Depth Attained (ft)	Min Freeboard Attained (ft)	Average HGL Elevation Attained (ft)	Average HGL Depth Attained (ft)	Time of Max HGL Occurrence (days hh:mm)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded Volume (ac-in)	Total Time Flooded (min)
DP01	42.34	15.70	5332.74	0.81	0.00	1.19	5331.93	0.00	0 00:11	0 00:00	0.00	0.00
DP01a	28.68	28.68	5333.75	0.82	0.00	1.18	5332.93	0.00	0 00:11	0 00:00	0.00	0.00
DP02	46.58	4.81	5330.87	0.44	0.00	0.06	5330.43	0.00	0 00:11	0 00:00	0.00	0.00
DP03	23.29	0.00	5330.78	0.35	0.00	0.15	5330.43	0.00	0 00:11	0 00:00	0.00	0.00
DP04	23.29	0.00	5330.77	0.34	0.00	0.16	5330.43	0.00	0 00:11	0 00:00	0.00	0.00
DP05	31.10	10.61	5323.68	0.34	0.00	0.16	5323.34	0.00	0 00:14	0 00:00	0.00	0.00
DP06	15.55	0.00	5323.34	0.00	0.00	0.50	5323.34	0.00	0 00:00	0 00:00	0.00	0.00
DP07	15.55	0.00	5323.64	0.30	0.00	0.20	5323.34	0.00	0 00:14	0 00:00	0.00	0.00
DP08	21.93	13.05	5316.84	0.31	0.00	2.69	5316.53	0.00	0 00:16	0 00:00	0.00	0.00
DP09	30.04	13.93	5330.54	1.61	0.00	1.39	5328.95	0.02	0 00:12	0 00:00	0.00	0.00
DP10	36.95	13.48	5325.64	1.56	0.00	1.44	5324.10	0.02	0 00:15	0 00:00	0.00	0.00
DP11	52.71	0.00	5317.49	1.69	0.00	1.31	5315.83	0.03	0 00:20	0 00:00	0.00	0.00
DP12	4.94	4.91	5316.08	0.78	0.00	1.22	5315.33	0.03	0 01:04	0 00:00	0.00	0.00
DP13	3.31	3.31	5315.80	0.00	0.00	3.00	5315.80	0.00	0 00:00	0 00:00	0.00	0.00
DP14	37.03	0.14	5325.69	1.61	0.00	1.39	5324.10	0.02	0 00:17	0 00:00	0.00	0.00
DP15	4.24	4.24	5324.95	0.15	0.00	0.15	5324.80	0.00	0 00:35	0 00:00	0.00	0.00
DP16	3.41	3.41	5319.90	0.40	0.00	0.60	5319.50	0.00	0 00:10	0 00:00	0.00	0.00
DPH1	59.42	6.24	5314.07	1.69	0.00	1.31	5312.42	0.04	0 00:21	0 00:00	0.00	0.00
DPH2	0.34	0.34	5321.00	0.00	0.00	6.00	5321.00	0.00	0 00:00	0 00:00	0.00	0.00
DPH3	5.81	1.88	5322.40	0.15	0.00	5.85	5322.25	0.00	0 00:36	0 00:00	0.00	0.00

Channel Input

Element ID	Length (ft)	Inlet Invert Elevation (ft)	Outlet Invert Elevation (ft)	Average Slope (%)	Shape	Height (ft)	Width (ft)	Manning's Roughness
DP01=>DP02	150.00	5331.93	5330.43	1.0000	Trapezoidal	0.500	55.000	0.0160
DP01a=>DP01	200.00	5332.93	5331.93	0.5000	Trapezoidal	2.000	17.000	0.0160
DP03=>DP05	810.00	5330.43	5323.34	0.8800	Trapezoidal	0.500	55.000	0.0160
DP04=>DP09	150.00	5330.43	5328.93	1.0000	Trapezoidal	0.500	55.000	0.0160
DP07=>DP08	780.00	5323.34	5316.53	0.8700	Trapezoidal	0.500	55.000	0.0160
DP08=>DP11	5.00	5316.53	5315.80	14.6000	Trapezoidal	0.500	55.000	0.0500
DP09=>DP10	485.00	5328.93	5324.08	1.0000	Trapezoidal	3.000	23.000	0.0800
DP11=>DPH1	215.00	5315.80	5312.38	1.5900	Trapezoidal	3.000	25.000	0.0800
DP12=>DPH1	60.00	5315.30	5312.38	4.8700	Parabolic	1.000	2.000	0.0320
DP14=>DP11	865.00	5324.08	5315.80	0.9600	Trapezoidal	3.000	25.000	0.0800
DP15=>DPH3	170.00	5324.80	5322.25	1.5000	Trapezoidal	0.300	45.000	0.0350
DP16=>DP12	707.00	5319.50	5315.30	0.5900	Parabolic	1.000	15.000	0.0350

Channel Results

SN	Element ID	Peak Flow (cfs)	Time of Peak Flow Occurrence (days hh:mm)	Design Flow Capacity (cfs)	Peak Flow/ Design Flow Ratio	Peak Flow Velocity (ft/sec)	Travel Time (min)	Peak Flow Depth (ft)	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged (min)	Froude Number	Reported Condition
1	DP01=>DP02	42.07	0 00:11	58.58	0.72	3.62	0.69	0.44	0.87	0.00		
2	DP01a=>DP01	28.14	0 00:11	167.34	0.17	4.69	0.71	0.81	0.41	0.00		
3	DP03=>DP05	21.35	0 00:14	54.81	0.39	4.02	3.36	0.33	0.67	0.00		
4	DP04=>DP09	23.19	0 00:12	58.58	0.40	3.12	0.80	0.34	0.68	0.00		
5	DP07=>DP08	14.39	0 00:18	54.74	0.26	3.03	4.29	0.28	0.57	0.00		
6	DP08=>DP11	21.93	0 00:16	71.63	0.31	3.54	0.02	0.31	0.61	0.00		
7	DP09=>DP10	28.21	0 00:15	113.38	0.25	2.16	3.74	1.55	0.52	0.00		
8	DP11=>DPH1	52.60	0 00:21	169.34	0.31	2.59	1.38	1.69	0.56	0.00		
9	DP12=>DPH1	4.93	0 01:04	8.03	0.61	5.33	0.19	0.78	0.78	0.00		
10	DP14=>DP11	34.84	0 00:26	131.37	0.27	2.03	7.10	1.55	0.52	0.00		
11	DP15=>DPH3	4.18	0 00:36	16.00	0.26	1.23	2.30	0.15	0.50	0.00		
12	DP16=>DP12	2.61	0 00:17	24.78	0.11	3.24	3.64	0.34	0.34	0.00		

Pipe Input

Element ID	Length (ft)	Inlet Invert Elevation (ft)	Outlet Invert Elevation (ft)	Total Drop (ft)	Average Slope (%)	Pipe Shape	Pipe Diameter or Height (in)	Pipe Width (in)	Manning's Roughness
DP02=>DIV01	1.00	5330.43	5330.43	0.00	0.0000	Dummy	0.000	0.000	0.0320
DP02=>DP03	1.00	5330.43	5330.43	0.00	0.0000	Dummy	0.000	0.000	0.0320
DP02=>DP04	1.00	5330.43	5330.43	0.00	0.0000	Dummy	0.000	0.000	0.0320
DP05=>DIV02	1.00	5322.33	5322.33	0.00	0.0000	Dummy	0.000	0.000	0.0320
DP05=>DP06	1.00	5322.33	5322.33	0.00	0.0000	Dummy	0.000	0.000	0.0320
DP05=>DP07	1.00	5322.33	5322.33	0.00	0.0000	Dummy	0.000	0.000	0.0320
DP06=>Out-H4	1.00	5322.33	5322.33	0.00	0.0000	Dummy	0.000	0.000	0.0320
DP10=>DP14	0.01	5324.08	5324.08	0.00	0.0000	Dummy	0.000	0.000	0.0320
DP13=>DP11	0.01	5315.80	5315.80	0.00	0.0000	Dummy	0.000	0.000	0.0320
DP13=>Out-H1	1.00	5312.38	5312.38	0.00	0.0000	Dummy	0.000	0.000	0.0320
DPH2=>Out-DPH2	1.00	5321.00	5321.00	0.00	0.0000	Dummy	0.000	0.000	0.0320
DPH3=>OutDPH3	1.00	5322.25	5322.25	0.00	0.0000	Dummy	0.000	0.000	0.0320

Pipe Results

SN	Element ID	Peak Flow (cfs)	Time of Peak Flow Occurrence (days hh:mm)	Design Flow Capacity (cfs)	Peak Flow Velocity (ft/sec)	Travel Time (min)	Peak Flow Depth (ft)	Total Time Surcharged (min)	Froude Number	Reported Condition
1	DP02=>DIV01	46.58	0 00:11	0.00	0.00		0.81	0.00		Calculated
2	DP02=>DP03	23.29	0 00:11	0.00	0.00		0.81	0.00		Calculated
3	DP02=>DP04	23.29	0 00:11	0.00	0.00		0.81	0.00		Calculated
4	DP05=>DIV02	31.10	0 00:14	0.00	0.00		0.34	0.00		Calculated
5	DP05=>DP06	15.55	0 00:14	0.00	0.00		0.34	0.00		Calculated
6	DP05=>DP07	15.55	0 00:14	0.00	0.00		0.34	0.00		Calculated
7	DP06=>Out-H4	15.55	0 00:14	0.00	0.00		0.34	0.00		Calculated
8	DP10=>DP14	36.95	0 00:17	0.00	0.00		1.55	0.00		Calculated
9	DP13=>DP11	3.31	0 00:17	0.00	0.00		0.78	0.00		Calculated
10	DP13=>Out-H1	59.42	0 00:21	0.00	0.00		0.78	0.00		Calculated
11	DPH2=>Out-DPH2	0.34	0 00:20	0.00	0.00		0.34	0.00		Calculated
12	DPH3=>OutDPH3	5.81	0 00:37	0.00	0.00		0.34	0.00		Calculated

Project Description

File Name	1006-HYD-100YR-X.SPF

Project Options

Flow Units	CFS
Elevation Type	Elevation
Hydrology Method	Rational
Time of Concentration (TOC) Method	User-Defined
Link Routing Method	Kinematic Wave
Enable Overflow Ponding at Nodes	YES
Skip Steady State Analysis Time Periods	NO

Analysis Options

Start Analysis On	May 23, 2012	00:00:00
End Analysis On	May 25, 2012	00:00:00
Start Reporting On	May 23, 2012	00:00:00
Antecedent Dry Days	0	days
Runoff (Dry Weather) Time Step	0 01:00:00	days hh:mm:ss
Runoff (Wet Weather) Time Step	0 00:05:00	days hh:mm:ss
Reporting Time Step	0 00:05:00	days hh:mm:ss
Routing Time Step	30	seconds

Number of Elements

	Qty
Rain Gages	0
Subbasins	17
Nodes	26
Junctions	20
Outfalls	4
Flow Diversions	2
Inlets	0
Storage Nodes	0
Links	24
Channels	12
Pipes	12
Pumps	0
Orifices	0
Weirs	0
Outlets	0
Pollutants	0
Land Uses	0

Rainfall Details

Return Period	100 year(s)

Subbasin Summary

Subbasin ID	Area (ac)	Weighted Runoff Coefficient	Total Rainfall (in)	Total Runoff (in)	Total Runoff Volume (ft³)	Peak Runoff (cfs)	Time of Concentration (days hh:mm:ss)
Ax	9.46	0.6000	2.31	1.39	47629.30	17.50	0 00:45:03
Bx	9.51	0.6000	2.55	1.53	52714.03	13.61	0 01:03:57
Cx	0.17	0.6000	2.11	1.26	780.01	0.41	0 00:31:25
Dx	0.28	0.6000	1.83	1.10	1112.96	0.92	0 00:20:04
Ex	2.73	0.6000	2.28	1.37	13546.83	5.29	0 00:42:17
OS-01	7.83	0.8000	1.45	1.16	32856.87	49.36	0 00:11:00
OS-02	3.22	0.9200	1.38	1.27	14844.52	24.54	0 00:10:00
OS-03	0.81	0.7000	1.51	1.05	3099.08	4.27	0 00:12:00
OS-04	3.06	0.7000	1.56	1.10	12163.04	15.47	0 00:13:00
OS-05	4.99	0.7000	1.45	1.01	18312.95	27.52	0 00:11:00
OS-06	1.59	0.7000	1.74	1.22	7035.70	6.84	0 00:17:00
OS-07	1.45	0.7000	1.45	1.01	5321.40	8.00	0 00:11:00
OS-08	1.14	0.7000	1.31	0.92	3803.01	6.98	0 00:09:00
OS-09	9.45	0.6800	1.96	1.33	45760.87	30.25	0 00:25:00
OS-10	9.35	0.6700	1.96	1.31	44597.82	29.49	0 00:25:00
OS-11	5.05	0.6100	2.16	1.32	24179.25	11.42	0 00:35:00
OS-12	2.01	0.5400	1.42	0.77	5596.26	8.68	0 00:10:42

Node Summary

SN	Element ID	Element Type	Initial Water Elevation (ft)	Surcharge Elevation (ft)	Peak Inflow (cfs)	Max HGL Elevation Attained (ft)	Time of Peak Flooding Occurrence (days hh:mm)	Total Time Flooded (min)
1	DP01	Junction	5331.93	5333.93	70.82	5333.01	0 00:00	0.00
2	DP01a	Junction	5332.93	5334.93	49.36	5334.02	0 00:00	0.00
3	DP02	Junction	5330.43	5330.93	79.89	5330.97	0 00:00	0.00
4	DP03	Junction	5330.43	5330.93	39.95	5330.87	0 00:00	0.00
5	DP04	Junction	5330.43	5330.93	39.95	5330.86	0 00:00	0.00
6	DP05	Junction	5323.34	5323.84	58.55	5323.77	0 00:00	0.00
7	DP06	Junction	5323.34	5323.84	29.28	5323.34	0 00:00	0.00
8	DP07	Junction	5323.34	5323.84	29.28	5323.73	0 00:00	0.00
9	DP08	Junction	5316.53	5319.53	45.44	5316.94	0 00:00	0.00
10	DP09	Junction	5328.93	5331.93	54.55	5331.07	0 00:00	0.00
11	DP10	Junction	5324.08	5327.08	70.82	5326.17	0 00:00	0.00
12	DP11	Junction	5315.80	5318.80	106.96	5318.21	0 00:00	0.00
13	DP12	Junction	5315.30	5317.30	13.64	5315.86	0 00:00	0.00
14	DP13	Junction	5315.80	5318.80	6.84	5315.80	0 00:00	0.00
15	DP14	Junction	5324.08	5327.08	71.04	5326.31	0 00:00	0.00
16	DP15	Junction	5324.80	5325.10	11.42	5325.05	0 00:00	0.00
17	DP16	Junction	5319.50	5320.50	8.68	5320.12	0 00:00	0.00
18	DPH1	Junction	5312.38	5315.38	124.53	5314.79	0 00:00	0.00
19	DPH2	Junction	5321.00	5327.00	0.92	5321.00	0 00:00	0.00
20	DPH3	Junction	5322.25	5328.25	15.82	5322.50	0 00:00	0.00
21	Out-DP06	Outfall			29.28	5322.33		
22	Out-DPH1	Outfall			124.53	5312.38		
23	Out-DPH2	Outfall			0.92	5321.00		
24	Out-DPH3	Outfall			15.82	5322.25		
25	DIV01	Flow Diversions	5330.43		79.89	5330.43		0.00
26	DIV02	Flow Diversions	5323.34		58.55	5323.34		0.00

Junction Input

Element ID	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Ground/Rim (Max) Offset (ft)	Initial Water Elevation (ft)	Initial Water Depth (ft)	Surcharge Elevation (ft)	Surcharge Depth (ft)	Ponded Area (ft²)
DP01	5331.93	5333.93	2.00	5331.93	0.00	5333.93	0.00	0.00
DP01a	5332.93	5334.93	2.00	5332.93	0.00	5334.93	0.00	0.00
DP02	5330.43	5330.93	0.50	5330.43	0.00	5330.93	0.00	0.00
DP03	5330.43	5330.93	0.50	5330.43	0.00	5330.93	0.00	0.00
DP04	5330.43	5330.93	0.50	5330.43	0.00	5330.93	0.00	0.00
DP05	5323.34	5323.84	0.50	5323.34	0.00	5323.84	0.00	0.00
DP06	5323.34	5323.84	0.50	5323.34	0.00	5323.84	0.00	0.00
DP07	5323.34	5323.84	0.50	5323.34	0.00	5323.84	0.00	0.00
DP08	5316.53	5319.53	3.00	5316.53	0.00	5319.53	0.00	0.00
DP09	5328.93	5331.93	3.00	5328.93	0.00	5331.93	0.00	0.00
DP10	5324.08	5327.08	3.00	5324.08	0.00	5327.08	0.00	0.00
DP11	5315.80	5318.80	3.00	5315.80	0.00	5318.80	0.00	0.00
DP12	5315.30	5317.30	2.00	5315.30	0.00	5317.30	0.00	0.00
DP13	5315.80	5318.80	3.00	5315.80	0.00	5318.80	0.00	0.00
DP14	5324.08	5327.08	3.00	5324.08	0.00	5327.08	0.00	0.00
DP15	5324.80	5325.10	0.30	5324.80	0.00	5325.10	0.00	0.00
DP16	5319.50	5320.50	1.00	5319.50	0.00	5320.50	0.00	0.00
DPH1	5312.38	5315.38	3.00	5312.38	0.00	5315.38	0.00	0.00
DPH2	5321.00	5327.00	6.00	5321.00	0.00	5327.00	0.00	0.00
DPH3	5322.25	5328.25	6.00	5322.25	0.00	5328.25	0.00	0.00

Junction Results

Element ID	Peak Inflow (cfs)	Peak Lateral Inflow (cfs)	Max HGL Elevation Attained (ft)	Max HGL Depth Attained (ft)	Max Surcharge Depth Attained (ft)	Min Freeboard Attained (ft)	Average HGL Elevation Attained (ft)	Average HGL Depth Attained (ft)	Time of Max HGL Occurrence (days hh:mm)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded Volume (ac-in)	Total Time Flooded (min)
DP01	70.82	24.54	5333.01	1.08	0.00	0.92	5331.94	0.01	0 00:11	0 00:00	0.00	0.00
DP01a	49.36	49.36	5334.02	1.09	0.00	0.91	5332.94	0.01	0 00:11	0 00:00	0.00	0.00
DP02	79.89	10.19	5330.97	0.54	0.00	0.01	5330.43	0.00	0 00:11	0 00:00	0.00	0.00
DP03	39.95	0.00	5330.87	0.44	0.00	0.06	5330.43	0.00	0 00:11	0 00:00	0.00	0.00
DP04	39.95	0.00	5330.86	0.43	0.00	0.07	5330.43	0.00	0 00:11	0 00:00	0.00	0.00
DP05	58.55	22.27	5323.77	0.43	0.00	0.07	5323.34	0.00	0 00:14	0 00:00	0.00	0.00
DP06	29.28	0.00	5323.34	0.00	0.00	0.50	5323.34	0.00	0 00:00	0 00:00	0.00	0.00
DP07	29.28	0.00	5323.73	0.39	0.00	0.11	5323.34	0.00	0 00:13	0 00:00	0.00	0.00
DP08	45.44	27.52	5316.94	0.41	0.00	2.59	5316.53	0.00	0 00:15	0 00:00	0.00	0.00
DP09	54.55	30.25	5331.07	2.14	0.00	0.86	5328.96	0.03	0 00:12	0 00:00	0.00	0.00
DP10	70.82	29.49	5326.17	2.09	0.00	0.91	5324.11	0.03	0 00:15	0 00:00	0.00	0.00
DP11	106.96	0.00	5318.21	2.41	0.00	0.59	5315.84	0.04	0 00:18	0 00:00	0.00	0.00
DP12	13.64	13.61	5315.86	0.56	0.00	1.44	5315.32	0.02	0 00:15	0 00:00	0.00	0.00
DP13	6.84	6.84	5315.80	0.00	0.00	3.00	5315.80	0.00	0 00:00	0 00:00	0.00	0.00
DP14	71.04	0.41	5326.31	2.23	0.00	0.77	5324.11	0.03	0 00:17	0 00:00	0.00	0.00
DP15	11.42	11.42	5325.05	0.25	0.00	0.05	5324.80	0.00	0 00:35	0 00:00	0.00	0.00
DP16	8.68	8.68	5320.12	0.62	0.00	0.38	5319.50	0.00	0 00:10	0 00:00	0.00	0.00
DPH1	124.53	17.49	5314.79	2.41	0.00	0.59	5312.42	0.04	0 00:19	0 00:00	0.00	0.00
DPH2	0.92	0.92	5321.00	0.00	0.00	6.00	5321.00	0.00	0 00:00	0 00:00	0.00	0.00
DPH3	15.82	5.29	5322.50	0.25	0.00	5.75	5322.25	0.00	0 00:36	0 00:00	0.00	0.00

Channel Input

Element ID	Length (ft)	Inlet Invert Elevation (ft)	Outlet Invert Elevation (ft)	Average Slope (%)	Shape	Height (ft)	Width (ft)	Manning's Roughness
DP01=>DP02	150.00	5331.93	5330.43	1.0000	Trapezoidal	0.550	60.000	0.0160
DP01a=>DP01	200.00	5332.93	5331.93	0.5000	Trapezoidal	2.000	17.000	0.0160
DP03=>DP05	810.00	5330.43	5323.34	0.8800	Trapezoidal	0.500	55.000	0.0160
DP04=>DP09	150.00	5330.43	5328.93	1.0000	Trapezoidal	0.500	55.000	0.0160
DP07=>DP08	780.00	5323.34	5316.53	0.8700	Trapezoidal	0.500	55.000	0.0160
DP08=>DP11	5.00	5316.53	5315.80	14.6000	Trapezoidal	0.500	55.000	0.0500
DP09=>DP10	485.00	5328.93	5324.08	1.0000	Trapezoidal	3.000	23.000	0.0800
DP11=>DPH1	215.00	5315.80	5312.38	1.5900	Trapezoidal	3.000	25.000	0.0800
DP12=>DPH1	60.00	5315.30	5312.38	4.8700	Parabolic	1.000	15.000	0.0320
DP14=>DP11	865.00	5324.08	5315.80	0.9600	Trapezoidal	3.000	25.000	0.0800
DP15=>DPH3	170.00	5324.80	5322.25	1.5000	Trapezoidal	0.300	45.000	0.0350
DP16=>DP12	708.00	5319.50	5315.30	0.5900	Parabolic	1.000	15.000	0.0350

Channel Results

SN	Element ID	Peak Flow (cfs)	Time of Peak Flow Occurrence (days hh:mm)	Design Flow Capacity (cfs)	Peak Flow/ Design Flow Ratio	Peak Flow Velocity (ft/sec)	Travel Time (min)	Peak Flow Depth (ft)	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged (min)	Froude Number	Reported Condition
1	DP01=>DP02	70.34	0 00:11	74.04	0.95	4.12	0.61	0.54	0.98	0.00		
2	DP01a=>DP01	48.53	0 00:11	167.34	0.29	5.48	0.61	1.08	0.54	0.00		
3	DP03=>DP05	37.30	0 00:14	54.81	0.68	4.58	2.95	0.42	0.85	0.00		
4	DP04=>DP09	39.80	0 00:12	58.58	0.68	3.57	0.70	0.43	0.85	0.00		
5	DP07=>DP08	27.44	0 00:17	54.74	0.50	3.48	3.74	0.37	0.75	0.00		
6	DP08=>DP11	45.44	0 00:15	71.63	0.63	4.26	0.02	0.41	0.83	0.00		
7	DP09=>DP10	52.04	0 00:15	113.38	0.46	2.71	2.98	2.08	0.69	0.00		
8	DP11=>DPH1	106.79	0 00:19	169.34	0.63	3.13	1.14	2.40	0.80	0.00		
9	DP12=>DPH1	13.63	0 01:04	77.57	0.18	4.56	0.22	0.45	0.45	0.00		
10	DP14=>DP11	69.30	0 00:26	131.37	0.53	2.42	5.96	2.19	0.73	0.00		
11	DP15=>DPH3	11.29	0 00:36	16.00	0.71	1.63	1.74	0.25	0.84	0.00		
12	DP16=>DP12	7.14	0 00:15	24.76	0.29	4.08	2.89	0.55	0.55	0.00		

Pipe Input

Element ID	Length (ft)	Inlet Invert Elevation (ft)	Outlet Invert Elevation (ft)	Total Drop (ft)	Average Slope (%)	Pipe Shape	Pipe Diameter or Height (in)	Pipe Width (in)	Manning's Roughness
DP02=>DIV01	1.00	5330.43	5330.43	0.00	0.0000	Dummy	0.000	0.000	0.0320
DP02=>DP03	1.00	5330.43	5330.43	0.00	0.0000	Dummy	0.000	0.000	0.0150
DP02=>DP04	1.00	5330.43	5330.43	0.00	0.0000	Dummy	0.000	0.000	0.0150
DP05=>DIV02	1.00	5322.33	5322.33	0.00	0.0000	Dummy	0.000	0.000	0.0150
DP05=>DP06	1.00	5322.33	5322.33	0.00	0.0000	Dummy	0.000	0.000	0.0320
DP05=>DP07	1.00	5322.33	5322.33	0.00	0.0000	Dummy	0.000	0.000	0.0150
DP06=>Out-H4	1.00	5322.33	5322.33	0.00	0.0000	Dummy	0.000	0.000	0.0320
DP10=>DP14	0.00	5324.08	5324.08	0.00	0.0000	Dummy	0.000	0.000	0.0320
DP13=>DP11	0.01	5315.80	5315.80	0.00	0.0000	Dummy	0.000	0.000	0.0320
DP13=>Out-H1	1.00	5312.38	5312.38	0.00	0.0000	Dummy	0.000	0.000	0.0320
DPH2=>Out-DPH2	1.00	5321.00	5321.00	0.00	0.0000	Dummy	0.000	0.000	0.0320
DPH3=>OutDPH3	1.00	5322.25	5322.25	0.00	0.0000	Dummy	0.000	0.000	0.0320

Pipe Results

SN	Element ID	Peak Flow (cfs)	Time of Peak Flow Occurrence (days hh:mm)	Design Flow Capacity (cfs)	Peak Flow Velocity (ft/sec)	Travel Time (min)	Peak Flow Depth (ft)	Total Time Surcharged (min)	Froude Number	Reported Condition
1	DP02=>DIV01	79.89	0 00:11	0.00	0.00		1.08	0.00		Calculated
2	DP02=>DP03	39.95	0 00:11	0.00	0.00		1.08	0.00		Calculated
3	DP02=>DP04	39.95	0 00:11	0.00	0.00		1.08	0.00		Calculated
4	DP05=>DIV02	58.55	0 00:13	0.00	0.00		0.43	0.00		Calculated
5	DP05=>DP06	29.28	0 00:13	0.00	0.00		0.43	0.00		Calculated
6	DP05=>DP07	29.28	0 00:13	0.00	0.00		0.43	0.00		Calculated
7	DP06=>Out-H4	29.28	0 00:13	0.00	0.00		0.43	0.00		Calculated
8	DP10=>DP14	70.82	0 00:17	0.00	0.00		2.08	0.00		Calculated
9	DP13=>DP11	6.84	0 00:17	0.00	0.00		0.45	0.00		Calculated
10	DP13=>Out-H1	124.53	0 00:19	0.00	0.00		0.45	0.00		Calculated
11	DPH2=>Out-DPH2	0.92	0 00:20	0.00	0.00		0.55	0.00		Calculated
12	DPH3=>OutDPH3	15.82	0 00:36	0.00	0.00		0.55	0.00		Calculated

FINAL DRAINAGE REPORT

EAST BOULDER COMMUNITY PARK
PHASE III

AT

SIOUX DRIVE AND 55TH STREET

BOULDER, COLORADO 80303

FOR

CITY OF BOULDER PARKS AND RECREATION
3198 BROADWAY
BOULDER, COLORADO 80302

JVA, Inc.
Consulting Engineers
1319 Spruce Street
Boulder, CO 80302
(303) 444-1951
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JVA Project No. 1519c
May 18, 2009

13% impervious area (see the Appendix for calculations). A portion of this sub-basin is located within the 100-yr flood plain limits.

Sub-basin H2, 2.68 acres, is the central portion of the site and consists of grass fields, landscaped areas, concrete walks, and the western portion of the existing parking lot on the north side of the site. The runoff from this basin sheet flows to the north onto Sioux Drive and 55th Street as surface flow, and is ultimately transmitted into South Boulder Creek. Runoffs calculated for this basin are 1.56 cfs for the minor storm and 5.90 cfs for the major storm, with approximately 23% impervious area.

Sub-basin H3, 1.25 acres, consists of grass fields, landscaped areas, concrete walks, gravel walks, and an asphalt basketball court. The runoff from this basin is collected by existing storm inlets and conveyed through a 12-inch diameter RCP, 14-inch diameter RCP, and finally 18-inch diameter RCP into the existing storm sewer system in Sioux Drive and ultimately into South Boulder Creek. Runoffs calculated for this basin are 1.00 cfs for the minor storm and 3.16 cfs for the major storm, with approximately 36% impervious area. (See the Appendix for calculations)

Sub-basin H4, 8.30 acres, is the eastern portion of the site and consists of grass fields, landscaped areas, concrete walks, gravel walks, a small portion of roof area, and a gravel/dirt dog-park area. The runoff from this basin sheet flows to the east into existing ponds where it is used for recreation and irrigation, and is ultimately detained before being transmitted into South Boulder Creek during storm events. Runoffs calculated for this basin are 3.90 cfs for the minor storm and 16.99 cfs for the major storm, with approximately 13% impervious area (see the Appendix for calculations). A portion of this sub-basin is located within the 100-yr flood plain limits.

Sub-basin H5, 1.41 acres, is a small portion of grassy areas, bare ground, and gravel dog park area in the southeastern corner of the site. The runoff from this basin sheet flows to the east into existing ponds where it is used for recreation and irrigation, and is ultimately detained before being transmitted into South Boulder Creek during storm events. Runoffs calculated for this basin are 0.85 cfs for the minor storm and 3.77 cfs for the major storm, with approximately 12% impervious area (see the Appendix for calculations). A portion of this sub-basin is located within the 100-yr flood plain limits.

Sub-basin H6, 2.07 acres, is a narrow southern portion of the site and consists of grass areas, gravel walks, and vegetated ditches. The runoff from this basin sheet flows directly offsite or is collected by the Howard Super-Fossicle Ditch. Runoffs calculated for this basin are 1.43 cfs for the minor storm and 6.69 cfs for the major storm, with approximately 10% impervious area (see the Appendix for calculations). A portion of this sub-basin is located within the 100-yr flood plain limits.

Landscape irrigation infrastructure currently exists on the site but will be replaced as part of the proposed improvements. Delineated wetlands also exist on the site, but will not be impacted as part of the planned improvements.

Proposed (Developed) Drainage

Drainage Design Criteria

The proposed private storm drainage facilities for the project are designed to comply with the "City of Boulder Design and Construction Standards," 2000 Edition, and the Urban Drainage and Flood Control District's (UDFCD) Urban Storm Drainage Criteria Manual (USDCM), June 2005 Edition, as the secondary reference.

Runoff from the western portion of the site currently infiltrates into the soil and sheetflows to the north. This sheet flow is collected by a gentle swale on the north side of the site and is conveyed to Oneida Street in the northwest corner of the site. These flows are eventually collected by existing storm sewer infrastructure and are transmitted to South Boulder Creek. Once developed, runoff from this area will follow the same pattern. Infiltration capacity will be improved by the implementation of a "dry well" infiltration device with grated lid, which will collect runoff via underdrain piping from the western portion of synthetic turf field.

The southern and western edge portions of the site are currently occupied by existing irrigation ditches and infrastructure. Drainage patterns at this infrastructure will not be modified in any way as part of this development, nor will any addition runoff be introduced into this infrastructure as a result of the proposed development. The proposed plans attempt to match the current runoff patterns in this area.

The proposed realignment of Sioux Drive directly north of the existing East Boulder Recreation Center building will not require new storm infrastructure, and runoff from this area will match existing patterns. Though a minor amount of impervious paving area is being added at this location, no detention is required because of the site's proximity to the flood conveyance zone. Water quality mitigation will not be implemented for this area because it is a minor addition to an existing impervious asphalt surface.

PROPOSED SITE BASINS

As shown on the attached Figure 1 – Developed Drainage Plan, the entire 20.91 acre site has been analyzed to determine the proposed runoff from the total developed site area. The site has been divided into six major basins, basins P1-P6; the boundaries of these basins being established based on design points corresponding to locations where runoff leaves the property. The six basins have been delineated to have the approximate size and shape of the historic basins (basins H1-H6) and have been designed to approximately share design point locations to aid in the comparison of discharge quantity between historic and developed conditions.

Basin P1, 4.75 acres, is divided into two minor basins. Basin P1A is 3.5 acres of natural grass, landscaped areas, crusher fines walks, concrete walks, and an irrigation pond and associated pump house. Runoff from this basin is primarily conveyed as sheet flows to the north into the existing swale and ultimately onto Oneida Street, with a portion being infiltrated into the soil. A small portion of potential runoff is collected and retained by the irrigation pond (i.e., rain that falls into the pond and pond perimeter area). Basin P1B is 1.25 acres consisting of the western half of the west synthetic turf field and a portion of the surrounding natural grass and landscaping areas. Runoff from these synthetic turf and landscaped areas is collected in the turf subgrade rock/underdrain system and sump field inlets connected to a perforated underdrain located on the western edge of the west field. The combined runoff is conveyed to a dry well infiltration device near the northwest corner of the west field. An overflow pipe connects the drywell with the existing swale for storm events which can not be entirely mitigated through infiltration. During major storm events, runoff which does not infiltrate via the dry well or directly through the site surface is conveyed to Oneida Street as sheet and channel flows, matching historic drainage patterns.

Pipe sizes and slopes have been designed to the 5-year storm event per calculations included in the Appendix of this report. As shown in these calculations, these pipes have been conservatively designed by determining the percentage of the overall basin runoff which will be discharged at the extreme downstream point of a network and sizing all upstream pipes (excluding underdrain

patterns). Basin P4C is 0.31 acres of rock embankment located adjacent to the north pond. Runoff from this basin sheet flows directly into the north pond. In total, calculated major storm runoff for basin P4 is 20.76 cfs, with approximately 28% impervious area. (see Appendix for calculations)

Basin P5, 2.19 acres, is divided into two minor basins. Basin P5A is 0.88 acres of natural grass area, landscaped area, and concrete walks. Runoff from this basin sheet flows directly into the south pond, and ultimately to South Boulder Creek, matching historic drainage patterns. Basin P5B is 1.31 acres consisting primarily of asphalt parking lot and concrete walks, with some landscaped and natural grass areas. Runoff from this basin sheetflows to the north where it is collected by a sidewalk chase and deposited into a PLD basin (see Appendix for sizing calculations) via a rip rap channel. The runoff is treated for water quality purposes before infiltrating into the soil or being collected and conveyed into the south pond. Calculated major storm runoff for Basin P5 is 9.51 cfs, with approximately 51% impervious area. (see Appendix for calculations)

Basin P6 is 2.01 acres of natural grass area, wetland area, irrigation ditches, and a small portion of gravel walk. This area is similar to the 2.0 acre historic basin H6. Runoff from this basin either sheet flows offsite to the south or is collected by the irrigation ditch and transmitted offsite. This basin will be only mildly affected by development of the site, and proposed drainage patterns will closely match historic. Calculated major storm runoff for basin P6 is 6.06 cfs, with approximately 15% impervious area. (see Appendix for calculations)

Other areas of the site which will be altered by this development but have not been determined to have a significant effect on stormwater quantity, quality, or drainage patterns include: 1) a small area of natural grass, concrete walks, and asphalt driveway at the new parking lot access point on 55th Street on the southern side of the site, 2) a small area of natural grass and concrete walks north of the existing parking lot along Sioux Drive, including a new walk and two new concrete curb ramps, and 3) new asphalt associated with the short realignment of Sioux Drive directly north of the recreation center building.

	Design Storm (cfs)			Design Storm (cfs)	
Basin	5-YR	100-YR	Basin	5-YR	100-YR
H1	4.30	10.36	P1	-	15.78
H2	2.69	5.90	P2	-	18.86
H3	1.61	3.16	P3	-	3.39
H4	7.12	16.99	P4	-	20.76
H5	1.57	3.77	P5	-	9.52
H6	2.72	6.69	P6	-	6.06
Totals	20.01	46.87		-	74.37

WATER QUALITY, DETENTION AND STORMWATER MANAGEMENT PLAN

The City of Boulder has waived the requirement to provide onsite stormwater detention because the project is located immediately adjacent to the South Boulder Creek 100-yr flood plain. Per

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Job Name: East Boulder Community Park Phase III
Job Number: 1535c
Date: 05/18/2009
By: SJD

East Boulder Community Park
Proposed (Developed) Composite Runoff Coefficient & Time of Concentration Calculations

Location: Boulder, Co
Minor Design Storm: 5
Major Design Storm: 100

	%I (per UDFCD)
Landscaping	10
Gravel	40
Asphalt Drives/ Concrete Walks	95
Roofs	95
SOIL TYPE:	C/D

	%I	
Open Space	10	
Gravel	40	UDFCD
Landscaping	10	
Pavements	95	
Roof	95	
Playground	25	
Art. Turf	10 →	
Court	95	

Type of Land Surface	Conveyance Coefficient Cv
Heavy Meadow	2.5
Tillage/field	5
Short Pasture and lawns	7
Nearly bare ground	10
Grassed waterway	15
Paved areas and shallow paved swales	20

Basin Design Data									Runoff Coeff's					Initial Overland Time (t_i) $t_i=0.395(1.1-C_5)L^{1/2}S^{-1/3}$			Travel Time (t_t) t_t=Length/(Velocity x 60)					t_c Computed	t_c Urbanized Check		t_c Final
Basin Design	Design Point	$A_{landscape}$ (sf)	A_{gravel} (sf)	$A_{asphalt\ drives/\ conc\ walks}$ (sf)	A_{roof} (sf)	$A_{artificial\ turf}$ (sf)	A_{Total} (sf)	A_{Total} (ac)	%I	C2	C5	C10	C100	Upper most Length (ft)	Slope (%)	t_i (min)	Length (ft)	Slope (%)	C_v	Velocity (fps)	t_t (min)	Time of Conc $t_i + t_t = t_c$	Total Length (ft)	t_c=(L/180) +10 (min.)	Minimum t_c = 5 min
P1	1	148,200	0	11,844	0	46,719	206,763	4.75	15	0.13	0.23	0.32	0.54	-	-	-	-	-	-	-	-	-	-	-	-
P1A	1	141,119	0	11,347	0	0	152,466	3.50	16	0.15	0.24	0.32	0.54	416	1.70	26.8	0	0.00	0	0.0	0.0	26.8	416	12.3	12.3
P1B	7	7,081	0	497	0	46,719	54,297	1.25	11	0.11	0.21	0.30	0.53	110	5.00	10.0	425	1.00	20	2.0	3.5	13.5	535	13.0	13.0
P2	2	101,276	0	27,050	0	93,438	221,764	5.09	20	0.17	0.26	0.34	0.55	-	-	-	-	-	-	-	-	-	-	-	-
P2A	2	24,811	0	5,363	0	0	30,174	0.69	25	0.20	0.28	0.36	0.56	243	1.90	18.9	0	0.00	0	0.0	0.0	18.9	243	11.4	11.4
P2B	8	3,825	0	12,733	0	0	16,558	0.38	75	0.54	0.58	0.62	0.71	182	2.50	9.5	0	0.00	0	0.0	0.0	9.5	182	11.0	9.5
P2C	9	72,640	0	8,954	0	93,438	175,032	4.02	14	0.13	0.23	0.32	0.54	120	5.00	10.2	390	0.00	0	0.0	0.0	10.2	510	12.8	10.2
P3	3	21,458	0	17,724	0	0	39,182	0.90	48	0.33	0.39	0.45	0.60	219	2.10	15.1	97	4.10	20	4.0	0.4	15.5	316	11.8	11.8
P4	4	106,444	77,651	24,851	4,320	46,719	259,985	5.97	28	0.21	0.29	0.37	0.57	-	-	-	-	-	-	-	-	-	-	-	-
P4A	4	56,805	64,091	14,385	0	46,719	182,000	4.18	27	0.21	0.29	0.37	0.56	432	1.90	25.0	44	0.50	20	1.4	0.5	25.5	476	12.6	12.6
P4B	10	49,639	0	10,466	4,320	0	64,425	1.48	30	0.22	0.30	0.38	0.57	492	1.40	29.2	432	1.90	20	2.8	2.6	31.8	924	15.1	15.1
P4C	11	0	13,560	0	0	0	13,560	0.31	40	0.28	0.35	0.42	0.58	63	12.70	4.7	0	0.00	0	0.0	0.0	4.7	63	10.4	5.0
P5	5	49,079	1,186	45,238	0	0	95,503	2.19	51	0.34	0.40	0.46	0.60	-	-	-	-	-	-	-	-	-	-	-	-
P5A	5	36,232	1,186	1,002	0	0	38,420	0.88	13	0.13	0.23	0.31	0.54	108	8.50	8.1	0	0.00	0	0.0	0.0	8.1	108	10.6	8.1
P5B	12	12,847	0	44,236	0	0	57,083	1.31	76	0.54	0.58	0.62	0.71	187	1.60	11.1	0	0.00	0	0.0	0.0	11.1	187	11.0	11.0
P6	6	82,422	0	5,009	0	0	87,431	2.01	15	0.13	0.23	0.32	0.54	126	2.80	12.6	0	0.00	0	0.0	0.0	12.6	126	10.7	10.7
Total Site		508,879	78,837	131,716	4,320	186,876	910,628	20.91	25	0.20	0.28	0.36	0.56												

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Job Name: East Boulder Community Park Phase III
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Date: 05/18/2009
By: SJD

Developed East Boulder Community Park

Storm Drainage System Design (Rational Method Procedure)

One Hour Point Rainfall 1.35

MAJOR 5 **YEAR**

	Direct Runoff							Pipe			Remarks
Design Point	Subbasin Designation	Area (ac)	Runoff Coefficient	tc (min)	C*A (ac)	I (in/hr)	Q (cfs)	Pipe Size (in)	Slope (%)	Pipe Flow (cfs)	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
ON-SITE											
1	P1A	3.50	0.24	12.3	0.9	3.4	2.86	-	-	-	N/A - No Pipe: proposed pattern = historic pattern
7	P1B	1.25	0.21	13.0	0.26	3.3	0.86	8	1.00	1.75	Pipe Sizing Basin Percentage = 100% → Q_{EQIV} = 0.90 cfs
2	P2A	0.69	0.28	11.4	0.19	3.5	0.67	-	-	-	N/A - No Pipe: proposed pattern = historic pattern
8	P2B	0.38	0.58	9.5	0.22	3.7	0.82	-	-	-	N/A - No Pipe: proposed pattern = historic pattern
9	P2C	4.02	0.23	10.2	0.94	3.6	3.41	12	0.50	3.64	Pipe Sizing Basin Percentage for Dry Well West Inv = 56% → Q_{EQIV} = 2.00 cfs
								8	3.00	3.02	Pipe Sizing Basin Percentage for Dry Well East Inv = 44% → Q_{EQIV} = 1.50 cfs
3	P3	0.90	0.39	11.8	0.35	3.4	1.19	-	-	-	N/A - I% does not increase: proposed pattern = historic pattern
4	P4A	4.18	0.29	12.6	1.20	3.3	3.99	12	0.50	3.64	Pipe Sizing Basin Percentage for Dog Park Inlet West Inv = 55% → Q_{EQIV} = 2.20 cfs
								15	0.50	6.60	Pipe Sizing Basin Percentage for Dog Park Inlet East Inv = 100% → Q_{EQIV} = 4.00 cfs
10	P4B	1.48	0.30	15.1	0.44	3.1	1.34	-	-	-	N/A - No Pipe: proposed pattern = historic pattern
11	P4C	0.31	0.35	5.0	0.11	4.6	0.50	-	-	-	N/A - No Pipe: proposed pattern = historic pattern
5	P5A	0.88	0.23	8.1	0.20	4.0	0.79	-	-	-	N/A - No Pipe: proposed pattern = historic pattern
12	P5B	1.31	0.58	11.0	0.76	3.5	2.67	12.0	0.50	3.64	Pipe Sizing Basin Percentage = 100% → Q_{EQIV} = 2.67 cfs
6	P6	2.01	0.23	10.7	0.47	3.6	1.67	-	-	-	N/A - No Pipe: proposed pattern = historic pattern

Note: This minor storm spreadsheet is intended specifically for pipe sizing purposes. Major Basins P1, P2, P4, and P5 totals are not included in the minor storm spreadsheet because no detention is required and because these basins do not encompass specific sections of pipe, which would require sizing calculations.

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Job Name: East Boulder Community Park Phase III
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By: SJD

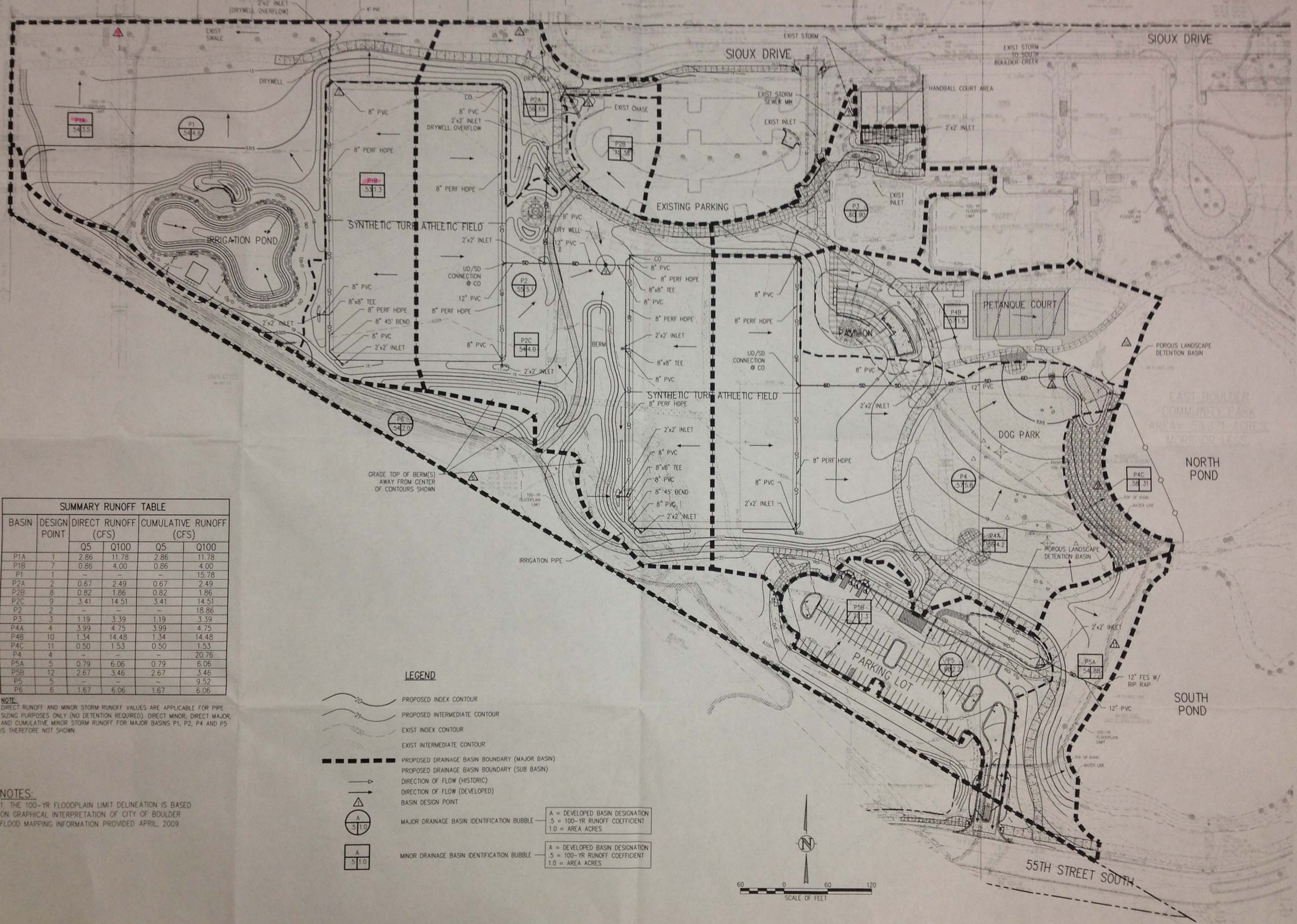
Developed East Boulder Community Park

Storm Drainage System Design (Rational Method Procedure)

One Hour Point Rainfall 2.5

MAJOR 100 **YEAR**

	Direct Runoff							Remarks
Design Point	Subbasin Designation	Area (ac)	Runoff Coefficient	tc (min)	C*A (ac)	I (in/hr)	Q (cfs)	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
ON-SITE								
1	P1A	3.50	0.54	12.30	1.90	6.21	11.78	
7	P1B	1.25	0.53	13.0	0.7	6.1	4.00	
1	P1	4.75	-	-	-	-	15.78	
2	P2A	0.69	0.56	11.4	0.4	6.4	2.49	
8	P2B	0.38	0.71	9.5	0.3	6.9	1.86	
9	P2C	4.02	0.54	10.2	2.2	6.7	14.51	
2	P2	5.09	-	-	-	-	18.86	
3	P3	0.90	0.60	11.8	0.5	6.3	3.39	
4	P4A	1.48	0.57	15.1	0.8	5.7	4.75	
10	P4B	4.18	0.56	12.6	2.4	6.1	14.48	
11	P4C	0.31	0.58	5.0	0.2	8.5	1.53	
4	P4	5.97	-	-	-	-	20.76	
5	P5A	1.31	0.71	11.0	0.9	6.5	6.06	
12	P5B	0.88	0.54	8.1	0.5	7.3	3.46	
5	P5	2.19	-	-	-	-	9.51	
6	P6	1.31	0.71	11.0	0.9	6.5	6.06	



SUMMARY RUNOFF TABLE					
BASIN	DESIGN POINT	DIRECT RUNOFF (CFS)		CUMULATIVE RUNOFF (CFS)	
		Q5	Q100	Q5	Q100
P1A	1	2.86	11.78	2.86	11.78
P1B	7	0.86	4.00	0.86	4.00
P1	1	–	–	–	15.78
P2A	2	0.67	2.49	0.67	2.49
P2B	8	0.82	1.86	0.82	1.86
P2C	9	3.41	14.51	3.41	14.51
P2	2	–	–	–	18.86
P3	3	1.19	3.39	1.19	3.39
P4A	4	3.99	4.75	3.99	4.75
P4B	10	1.34	14.48	1.34	14.48
P4C	11	0.50	1.53	0.50	1.53
P4	4	–	–	–	20.76
P5A	5	0.79	6.06	0.79	6.06
P5B	12	2.67	3.46	2.67	3.46
P5	5	–	–	–	9.52
P6	6	1.67	6.06	1.67	6.06

NOTE:
DIRECT RUNOFF AND MINOR STORM RUNOFF VALUES ARE APPLICABLE FOR PIPE SIZING PURPOSES ONLY (NO DETENTION REQUIRED). DIRECT MINOR, DIRECT MAJOR, AND CUMULATIVE MINOR STORM RUNOFF FOR MAJOR BASINS P1, P2, P4 AND P5 IS THEREFORE NOT SHOWN.

NOTES:
1. THE 100-YR FLOODPLAIN LIMIT DELINEATION IS BASED ON GRAPHICAL INTERPRETATION OF CITY OF BOULDER FLOOD MAPPING INFORMATION PROVIDED APRIL, 2009.

LEGEND

- PROPOSED INDEX CONTOUR
- PROPOSED INTERMEDIATE CONTOUR
- EXIST INDEX CONTOUR
- EXIST INTERMEDIATE CONTOUR
- PROPOSED DRAINAGE BASIN BOUNDARY (MAJOR BASIN)
- PROPOSED DRAINAGE BASIN BOUNDARY (SUB BASIN)
- DIRECTION OF FLOW (HISTORIC)
- DIRECTION OF FLOW (DEVELOPED)
- BASIN DESIGN POINT
- MAJOR DRAINAGE BASIN IDENTIFICATION BUBBLE — A = DEVELOPED BASIN DESIGNATION; .5 = 100-YR RUNOFF COEFFICIENT; 1.0 = AREA ACRES
- MINOR DRAINAGE BASIN IDENTIFICATION BUBBLE — A = DEVELOPED BASIN DESIGNATION; .5 = 100-YR RUNOFF COEFFICIENT; 1.0 = AREA ACRES

DESIGNED BY:	BJD
DRAWN BY:	LAM
CHECKED BY:	CRH
JOB #:	1535c
DATE:	05/18/2009

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EAST BOULDER COMMUNITY PARK
SIOUX DRIVE AND 55TH STREET
BOULDER, CO 80303

PROPOSED DRAINAGE MAP

SHEET NO.
Fig 2

Hydrologic Soil Group—Boulder County Area, Colorado
(B1006 - Boulder Creek Commons)

Map Scale: 1:2,920 if printed on A size (8.5" x 11") sheet.

N

Meters: 0 40 80 160 240

Feet: 0 150 300 600 900

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Map Units

Soil Ratings

A

A/D

B

B/D

C

C/D

D

Not rated or not available

Political Features

Cities

Water Features

Streams and Canals

Transportation

Rails

Interstate Highways

US Routes

Major Roads

Local Roads

MAP INFORMATION

Map Scale: 1:2,920 if printed on A size (8.5" × 11") sheet.

The soil surveys that comprise your AOI were mapped at 1:20,000.

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 accurate map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: UTM Zone 13N NAD83

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

Soil Survey Area: Boulder County Area, Colorado
Survey Area Data: Version 9, May 1, 2009

Date(s) aerial images were photographed: 8/6/2005

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 — Boulder County Area, Colorado (CO643)				
Map unit symbol	**Map unit name**	**Rating**	**Acres in AOI**	**Percent of AOI**
Nh	Niwot soils	C	24.0	100.0%
Totals for Area of Interest			**24.0**	**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

Aggregation is the process by which a set of component attribute values is reduced to a single value that represents the map unit as a whole.

A map unit is typically composed of one or more "components". A component is either some type of soil or some nonsoil entity, e.g., rock outcrop. For the attribute being aggregated, the first step of the aggregation process is to derive one attribute value for each of a map unit's components. From this set of component attributes, the next step of the aggregation process derives a single value that represents the map unit as a whole. Once a single value for each map unit is derived, a thematic map for soil map units can be rendered. Aggregation must be done because, on any soil map, map units are delineated but components are not.

For each of a map unit's components, a corresponding percent composition is recorded. A percent composition of 60 indicates that the corresponding component typically makes up approximately 60% of the map unit. Percent composition is a critical factor in some, but not all, aggregation methods.

The aggregation method "Dominant Condition" first groups like attribute values for the components in a map unit. For each group, percent composition is set to the sum of the percent composition of all components participating in that group. These groups now represent "conditions" rather than components. The attribute value associated with the group with the highest cumulative percent composition is returned. If more than one group shares the highest cumulative percent composition, the corresponding "tie-break" rule determines which value should be returned. The "tie-break" rule indicates whether the lower or higher group value should be returned in the case of a percent composition tie.

The result returned by this aggregation method represents the dominant condition throughout the map unit only when no tie has occurred.

Component Percent Cutoff: None Specified

Components whose percent composition is below the cutoff value will not be considered. If no cutoff value is specified, all components in the database will be considered. The data for some contrasting soils of minor extent may not be in the database, and therefore are not considered.

Tie-break Rule: Higher

The tie-break rule indicates which value should be selected from a set of multiple candidate values, or which value should be selected in the event of a percent composition tie.

APPENDIX B

Detention Pond Calculations

Detention Pond: Stage-Storage

DET01

Proposed Conditions

Project: Boulder Creek Commons
SG Project I.D.: B1006

Prepared By: LRE
Reviewed By: CCS
Date: 06/10/12
Revised Date: 10/08/12

Pond Description: Detention pond located in western open space. Provides detention storage for Basins A4 and A8. Includes EDB water quality BMP for Basins A4, A6, A7, A8, A9, A11 and A12.

Stage [ft]	Elevation [ft]	Contour Area [sf]	Incremental Storage Volume [cf]	Cumulative Storage Volume [cf]	
0.0	5316.5	0	0	0	
0.1	5316.6	374	12	12	
0.2	5316.7	748	55	67	
0.3	5316.8	1121	93	160	
0.4	5316.9	1495	130	291	
0.5	5317.0	1869	168	459	
0.6	5317.1	2418	214	672	
0.7	5317.2	2967	269	941	
0.8	5317.3	3516	324	1265	
0.9	5317.4	4065	379	1644	
1.0	5317.5	4614	434	2077	
1.1	5317.6	5163	489	2566	
1.2	5317.7	5712	544	3109	
1.3	5317.8	6261	598	3708	
1.4	**5317.9**	**6810**	**653**	**4361**	$0.5*V_{WQ}$=4,007-cf
1.5	5318.0	7359	708	5069	
1.6	5318.1	7551	745	5815	
1.7	5318.2	7743	765	6579	
1.8	5318.3	7935	784	7363	
1.9	**5318.4**	**8127**	**803**	**8166**	V_{WQ}=8,015-cf
2.0	5318.5	8319	822	8989	
2.1	5318.6	8511	841	9830	
2.2	5318.7	8703	861	10691	
2.3	5318.8	8895	880	11571	
2.4	5318.9	9087	899	12470	
2.5	5319.0	9279	918	13388	
2.6	5319.1	9436	936	14324	
2.7	5319.2	9592	951	15275	
2.8	5319.3	9749	967	16242	
2.9	5319.4	9905	983	17225	
3.0	5319.5	10062	998	18223	
3.1	**5319.6**	**10218**	**1014**	**19237**	V_{10req}=110%(V_{WQCV}+V_{10})=19,595-cf
3.2	5319.7	10375	1030	20267	
3.3	5319.8	10531	1045	21312	
3.4	**5319.9**	**10688**	**1061**	**22373**	V_{100req}=110%(0.5*V_{WQCV}+V_{100})=21,708-cf
3.5	5320.0	10844	1077	23449	
3.6	5320.1	10999	1092	24542	
3.7	5320.2	11153	1108	25649	
3.8	5320.3	11308	1123	26772	
3.9	5320.4	11462	1138	27911	
4.0	5320.5	11617	1154	29065	
4.1	5320.6	11771	1169	30234	
4.2	5320.7	11926	1185	31419	
4.3	5320.8	12080	1200	32619	
4.4	5320.9	12235	1216	33835	
4.5	**5321.0**	**12389**	**1231**	**35066**	**Top of Pond Embankment**

INITIAL DETENTION POND SIZING

DETØ1 (WESTERN OPEN SPACE)

TRIBUTARY BASINS = A_4 AND A_8 w/ DETØ2 AND DETØ3 PASS THROUGH

FAA INPUT VALUES:

$A_{REA\ DET01} = A_{A4} + A_{A8} = 0.76 + 2.22 = 2.98\ AC$

$Q_{10\ AU} = 0.59\ cfs/AC$
$Q_{100\ AU} = 1.64\ cfs/AC$ } CALC. BASED ON EX. SITE RELEASE RATES

$$I_T = \frac{I_{A4} A_{A4} + I_{A8} A_{A8}}{A_{DET01}} = \frac{26.64(0.76) + 39.69(2.22)}{2.98} = 36.36\%$$

$T_c = T_{cA8} + T_{tA4} = 15.79 + 1.29 = 17.08\ min$

FROM UD_DETENTION_2.2, MODIFIED FAA WORKSHEET:

		FAA		DETØ2		DETØ3	
$V_{10\ FAA} = 2{,}987\text{-cf}$	$Q_{10\ AU} =$	1.76	+	2.74	+	3.69	= 8.19 cfs
$V_{100\ FAA} = 5{,}772\text{-cf}$	$Q_{100\ AU} =$	4.89	+	7.63	+	10.25	= 22.77 cfs

DETØ1 HFS EDB COMPONENT: EDB SIZED FOR BASINS A4, A6, A7, A8, A9 A11 AND A12

$$A_{EDB} = A_{A4} + A_{A6} + A_{A7} + A_{A8} + A_{A9} + A_{A11} + A_{12}$$
$$= 0.76 + 0.66 + 1.64 + 2.22 + 1.33 + 0.80 + 2.50$$
$$= 9.91\ AC$$

$$I_T = \frac{26.64(0.76) + 38.96(0.66) + 40(1.64) + 39.69(2.22) + 40(1.33) + 39.07(0.80) + 53.57(2.50)}{9.91}$$

$I_T = 42.2\%$

FROM UD_BMP V3_01_EDB:

$WQCV = 0.153\ AC\text{-}FT \Rightarrow V_{WQ} = 0.184\ AC\text{-}FT$

$V_{WQ\ DET01} = 8{,}015\ cf$

$V_{10\ ROUTE} = 9{,}799\ cf > V_{10\ FAA} = 2{,}987\ cf$
$V_{100\ ROUTE} = 15{,}727\text{-cf} > V_{100\ FAA} = 5{,}772\text{-cf}$ } USE ROUTING MODEL DETENTION VOLUMES

$V_{10\ DET01} = 110\% (V_{WQ} + V_{10\ ROUTE}) = \underline{\underline{19{,}595\ cf}}$

$V_{100\ DET01} = 110\% (\frac{1}{2} V_{WQ} + V_{100\ ROUTE}) = \underline{\underline{21{,}708\ cf}}$

TOPS 35500

DETENTION VOLUME BY THE MODIFIED FAA METHOD
(See USDCM Volume 2 Storage Chapter for description of method)

Project: Boulder Creek Commons - Preliminary Design

Basin ID: DET01 - Basins A4 and A8

(For catchments less than 160 acres only. For larger catchments, use hydrograph routing method)
(NOTE: for catchments larger than 90 acres, CUHP hydrograph and routing are recommended)

Determination of MINOR Detention Volume Using Modified FAA Method

Design Information (Input):

Catchment Drainage Imperviousness	I_a =	36.36	percent
Catchment Drainage Area	A =	2.980	acres
Predevelopment NRCS Soil Group	Type =	C	A, B, C, or D
Return Period for Detention Control	T =	10	years (2, 5, 10, 25, 50, or 100)
Time of Concentration of Watershed	Tc =	17	minutes
Allowable Unit Release Rate	q =	0.59	cfs/acre
One-hour Precipitation	P_1 =	1.61	inches
Design Rainfall IDF Formula	$i = C_1 * P_1/(C_2+T_c)^{\wedge}C_3$		
Coefficient One	C_1 =	28.50	
Coefficient Two	C_2 =	10	
Coefficient Three	C_3 =	0.789	

Determination of Average Outflow from the Basin (Calculated):

Runoff Coefficient	C =	0.40	
Inflow Peak Runoff	Qp-in =	4.06	cfs
Allowable Peak Outflow Rate	Qp-out =	**1.76**	cfs
Mod. FAA Minor Storage Volume =		2,987	**cubic feet**
Mod. FAA Minor Storage Volume =		**0.069**	**acre-ft**

5 <- Enter Rainfall Duration Incremental Increase Value Here (e.g. 5 for 5-Minutes)

Rainfall Duration minutes (input)	Rainfall Intensity inches / hr (output)	Inflow Volume cubic feet (output)	Adjustment Factor "m" (output)	Average Outflow cfs (output)	Outflow Volume cubic feet (output)	Storage Volume cubic feet (output)
0	0.00	0	0.00	0.00	0	0
5	5.42	1,937	1.00	1.76	527	1,410
10	4.32	3,087	1.00	1.76	1,055	2,032
15	3.62	3,883	1.00	1.76	1,582	2,301
20	3.13	4,484	0.93	1.63	1,952	2,533
25	2.78	4,963	0.84	1.48	2,215	2,748
30	2.50	5,360	0.78	1.38	2,479	2,881
35	2.28	5,699	0.74	1.31	2,743	2,956
40	2.09	5,993	0.71	1.25	3,007	2,987
45	1.94	6,254	0.69	1.21	3,270	2,984
50	1.81	6,488	0.67	1.18	3,534	2,954
55	1.70	6,700	0.65	1.15	3,798	2,902
60	1.61	6,894	0.64	1.13	4,061	2,832
65	1.52	7,073	0.63	1.11	4,325	2,748
70	1.45	7,239	0.62	1.09	4,589	2,650
75	1.38	7,393	0.61	1.08	4,853	2,541
80	1.32	7,539	0.61	1.07	5,116	2,422
85	1.26	7,675	0.60	1.05	5,380	2,295
90	1.21	7,804	0.59	1.05	5,644	2,161
95	1.17	7,927	0.59	1.04	5,908	2,019
100	1.12	8,043	0.59	1.03	6,171	1,872
105	1.09	8,154	0.58	1.02	6,435	1,719
110	1.05	8,261	0.58	1.01	6,699	1,562
115	1.02	8,362	0.57	1.01	6,962	1,400
120	0.99	8,460	0.57	1.00	7,226	1,234
125	0.96	8,554	0.57	1.00	7,490	1,064
130	0.93	8,645	0.57	0.99	7,754	891
135	0.90	8,732	0.56	0.99	8,017	715
140	0.88	8,816	0.56	0.99	8,281	535
145	0.86	8,898	0.56	0.98	8,545	353
150	0.84	8,977	0.56	0.98	8,809	169
155	0.82	9,054	0.55	0.98	9,072	-18
160	0.80	9,128	0.55	0.97	9,336	-208
165	0.78	9,201	0.55	0.97	9,600	-399
170	0.76	9,271	0.55	0.97	9,864	-592
175	0.75	9,340	0.55	0.96	10,127	-787
180	0.73	9,407	0.55	0.96	10,391	-984
185	0.72	9,472	0.55	0.96	10,655	-1,183
190	0.70	9,535	0.54	0.96	10,918	-1,383
195	0.69	9,598	0.54	0.96	11,182	-1,585
200	0.68	9,658	0.54	0.95	11,446	-1,788
205	0.66	9,718	0.54	0.95	11,710	-1,992
210	0.65	9,776	0.54	0.95	11,973	-2,198
215	0.64	9,833	0.54	0.95	12,237	-2,405
220	0.63	9,888	0.54	0.95	12,501	-2,613
225	0.62	9,943	0.54	0.95	12,765	-2,822
230	0.61	9,996	0.54	0.94	13,028	-3,032
235	0.60	10,049	0.54	0.94	13,292	-3,243
240	0.59	10,100	0.54	0.94	13,556	-3,455
245	0.58	10,151	0.53	0.94	13,819	-3,669
250	0.57	10,201	0.53	0.94	14,083	-3,883
255	0.56	10,249	0.53	0.94	14,347	-4,098
260	0.55	10,297	0.53	0.94	14,611	-4,313
265	0.55	10,345	0.53	0.94	14,874	-4,530
270	0.54	10,391	0.53	0.93	15,138	-4,747
275	0.53	10,437	0.53	0.93	15,402	-4,965
280	0.52	10,482	0.53	0.93	15,666	-5,184
285	0.52	10,526	0.53	0.93	15,929	-5,404
290	0.51	10,569	0.53	0.93	16,193	-5,624
295	0.50	10,612	0.53	0.93	16,457	-5,844
300	0.50	10,655	0.53	0.93	16,720	-6,066

Mod. FAA Minor Storage Volume (cubic ft.) = 2,987
Mod. FAA Minor Storage Volume (acre-ft.) = 0.0686

Determination of MAJOR Detention Volume Using Modified FAA Method

Design Information (Input):

Catchment Drainage Imperviousness	I_a =	36.36	percent
Catchment Drainage Area	A =	2.980	acres
Predevelopment NRCS Soil Group	Type =	C	A, B, C, or D
Return Period for Detention Control	T =	100	years (2, 5, 10, 25, 50, or 100)
Time of Concentration of Watershed	Tc =	17	minutes
Allowable Unit Release Rate	q =	1.64	cfs/acre
One-hour Precipitation	P_1 =	2.61	inches
Design Rainfall IDF Formula	$i = C_1 * P_1/(C_2+T_c)^{\wedge}C_3$		
Coefficient One	C_1 =	28.50	
Coefficient Two	C_2 =	10	
Coefficient Three	C_3 =	0.789	

Determination of Average Outflow from the Basin (Calculated):

Runoff Coefficient	C =	0.58	
Inflow Peak Runoff	Qp-in =	9.55	cfs
Allowable Peak Outflow Rate	Qp-out =	**4.89**	cfs
Mod. FAA Major Storage Volume =		5,772	**cubic feet**
Mod. FAA Major Storage Volume =		**0.132**	**acre-ft**

Rainfall Duration minutes (input)	Rainfall Intensity inches / hr (output)	Inflow Volume cubic feet (output)	Adjustment Factor "m" (output)	Average Outflow cfs (output)	Outflow Volume cubic feet (output)	Storage Volume cubic feet (output)
0	0.00	0	0.00	0.00	0	0
5	8.78	4,553	1.00	4.89	1,466	3,087
10	7.00	7,257	1.00	4.89	2,932	4,325
15	5.87	9,128	1.00	4.89	4,398	4,730
20	5.08	10,541	0.93	4.52	5,425	5,116
25	4.50	11,667	0.84	4.11	6,158	5,509
30	4.05	12,600	0.78	3.83	6,891	5,709
35	3.69	13,396	0.74	3.63	7,624	5,772
40	3.40	14,088	0.71	3.48	8,357	5,731
45	3.15	14,701	0.69	3.37	9,090	5,611
50	2.94	15,251	0.67	3.27	9,823	5,427
55	2.76	15,749	0.65	3.20	10,556	5,193
60	2.60	16,205	0.64	3.14	11,289	4,916
65	2.47	16,625	0.63	3.08	12,023	4,603
70	2.34	17,015	0.62	3.04	12,756	4,260
75	2.23	17,379	0.61	3.00	13,489	3,891
80	2.14	17,720	0.61	2.96	14,222	3,499
85	2.05	18,042	0.60	2.93	14,955	3,087
90	1.97	18,345	0.59	2.91	15,688	2,657
95	1.89	18,633	0.59	2.88	16,421	2,212
100	1.82	18,907	0.59	2.86	17,154	1,753
105	1.76	19,168	0.58	2.84	17,887	1,281
110	1.70	19,418	0.58	2.82	18,620	798
115	1.65	19,657	0.57	2.80	19,353	304
120	1.60	19,887	0.57	2.79	20,086	-200
125	1.55	20,107	0.57	2.78	20,819	-712
130	1.51	20,320	0.57	2.76	21,553	-1,232
135	1.47	20,526	0.56	2.75	22,286	-1,760
140	1.43	20,724	0.56	2.74	23,019	-2,295
145	1.39	20,916	0.56	2.73	23,752	-2,836
150	1.36	21,102	0.56	2.72	24,485	-3,383
155	1.32	21,282	0.55	2.71	25,218	-3,936
160	1.29	21,457	0.55	2.70	25,951	-4,494
165	1.26	21,628	0.55	2.70	26,684	-5,057
170	1.24	21,793	0.55	2.69	27,417	-5,624
175	1.21	21,954	0.55	2.68	28,150	-6,196
180	1.18	22,111	0.55	2.67	28,883	-6,772
185	1.16	22,265	0.55	2.67	29,616	-7,352
190	1.14	22,414	0.54	2.66	30,350	-7,935
195	1.12	22,560	0.54	2.66	31,083	-8,522
200	1.09	22,703	0.54	2.65	31,816	-9,113
205	1.07	22,842	0.54	2.65	32,549	-9,706
210	1.06	22,979	0.54	2.64	33,282	-10,303
215	1.04	23,113	0.54	2.64	34,015	-10,902
220	1.02	23,243	0.54	2.63	34,748	-11,505
225	1.00	23,372	0.54	2.63	35,481	-12,109
230	0.99	23,498	0.54	2.62	36,214	-12,717
235	0.97	23,621	0.54	2.62	36,947	-13,326
240	0.95	23,742	0.54	2.62	37,680	-13,938
245	0.94	23,861	0.53	2.61	38,413	-14,552
250	0.92	23,978	0.53	2.61	39,146	-15,169
255	0.91	24,092	0.53	2.61	39,880	-15,787
260	0.90	24,205	0.53	2.60	40,613	-16,407
265	0.88	24,316	0.53	2.60	41,346	-17,030
270	0.87	24,425	0.53	2.60	42,079	-17,654
275	0.86	24,532	0.53	2.59	42,812	-18,279
280	0.85	24,638	0.53	2.59	43,545	-18,907
285	0.84	24,742	0.53	2.59	44,278	-19,536
290	0.83	24,844	0.53	2.59	45,011	-20,167
295	0.82	24,945	0.53	2.58	45,744	-20,799
300	0.81	25,045	0.53	2.58	46,477	-21,432

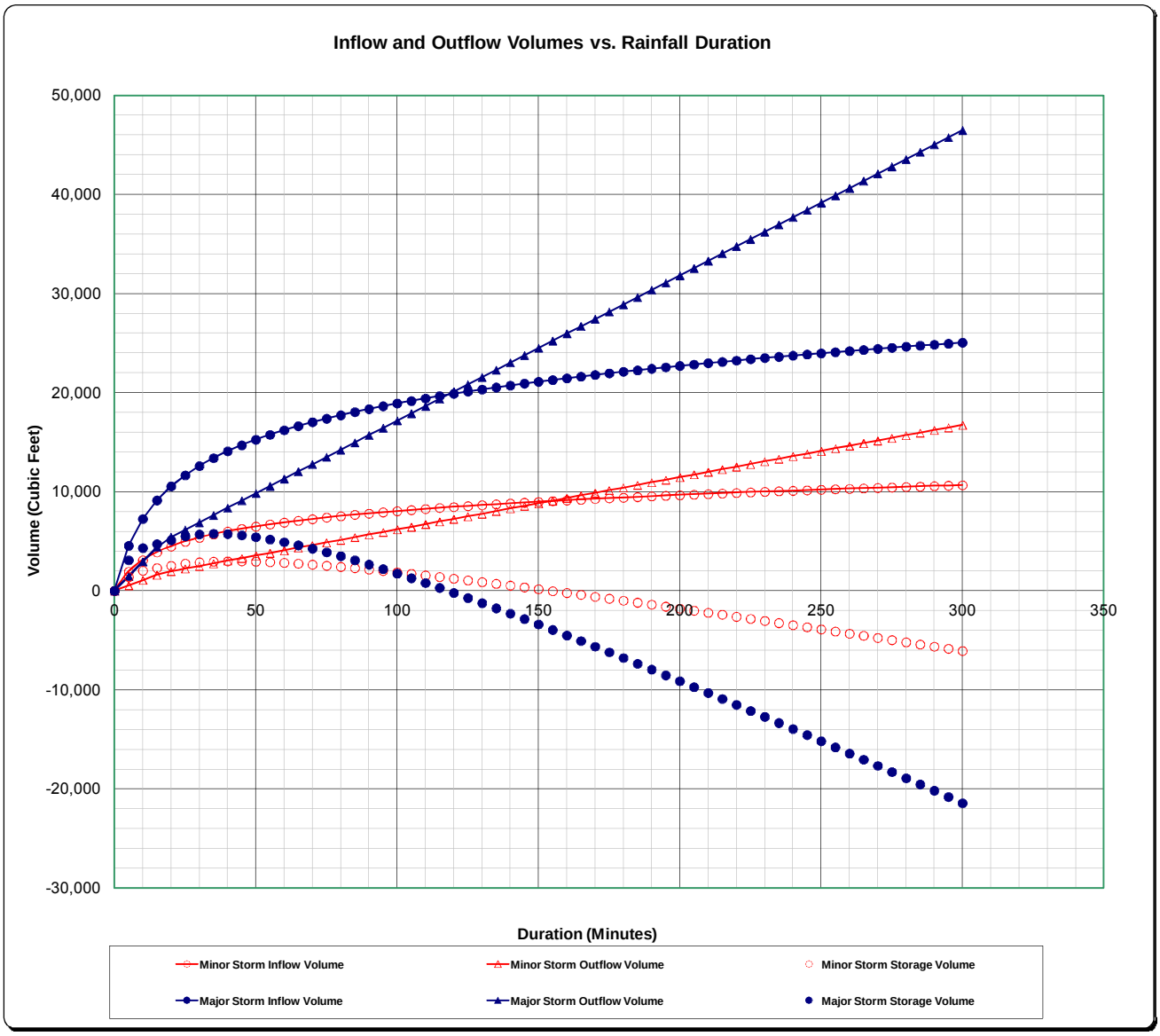
Mod. FAA Major Storage Volume (cubic ft.) = 5,772
Mod. FAA Major Storage Volume (acre-ft.) = 0.1325

UDFCD DETENTION VOLUME ESTIMATING WORKBOOK Version 2.2, Released January 2010

DETENTION VOLUME BY THE MODIFIED FAA METHOD
(See USDCM Volume 2 Storage Chapter for description of method)

Project: Boulder Creek Commons - Preliminary Design

Basin ID: DET01 - Basins A4 and A8



Design Procedure Form: Extended Detention Basin (EDB)

Designer:	**LRE**
Company:	**The Sanitas Group, LLC**
Date:	**September 26, 2012**
Project:	**Boulder Creek Commons - Preliminary Design**
Location:	**Boulder, CO**

1. Basin Storage Volume	
A) Effective Imperviousness of Tributary Area, I_a	I_a = 42.2 %
B) Tributary Area's Imperviousness Ratio ($i = I_a / 100$)	i = 0.422
C) Contributing Watershed Area	Area = 9.910 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 (1.2 WQCV) Based on 40-hour Drain Time (V_{DESIGN} = (1.0 * (0.91 * i^3 - 1.19 * i^2 + 0.78 * i) / 12 * Area * 1.2)	V_{DESIGN}= 0.184 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: EURVA = (0.1878i - 0.0104)*Area For HSG B: $EURV_B$ = (0.1178i - 0.0042)*Area For HSG C/D: $EURV_{C/D}$ = (0.1043i - 0.0031)*Area	EURV = ____ 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:	

Design Procedure Form: Extended Detention Basin (EDB)

Designer: LRE
Company: The Sanitas Group, LLC
Date: September 26, 2012
Project: Boulder Creek Commons - Preliminary Design
Location: Boulder, CO

5. Forebay	
A) Minimum Forebay Volume (V_{FMIN} = _____ of the WQCV)	V_{FMIN} = 0.003 ac-ft
B) Actual Forebay Volume	V_F = _____ ac-ft
C) Forebay Depth (D_F = _____ inch maximum)	D_F = _____ in
D) Forebay Discharge	
i) Undetained 100-year Peak Discharge	Q_{100} = _____ cfs
ii) Forebay Discharge Design Flow ($Q_F = 0.02 * Q_{100}$)	Q_F = _____ 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 = _____ in
6. Trickle Channel	
A) Type of Trickle Channel	Choose One: ○ Concrete ○ Soft Bottom
F) Slope of Trickle Channel	S = _____ ft / ft
7. Micropool and Outlet Structure	
A) Depth of Micropool (2.5-feet minimum)	D_M = _____ ft
B) Surface Area of Micropool (10 ft^2 minimum)	A_M = _____ sq ft
C) Outlet Type	Choose One: ○ Orifice Plate ○ Other (Describe):
D) Depth of Design Volume (EURV or 1.2 WQCV) Based on the Design Concept Chosen Under 1.E.	H = _____ feet
E) Volume to Drain Over Prescribed Time	WQCV = 0.153 ac-ft
F) Drain Time (Min T_D for WQCV= 40 hours; Max T_D for EURV= 72 hours)	T_D = _____ hours
G) Recommended Maximum Outlet Area per Row, (A_o)	A_o = _____ square inches
H) Orifice Dimensions: i) Circular Orifice Diameter or	$D_{orifice}$ = _____ inches
ii) Width of 2" High Rectangular Orifice	$W_{orifice}$ = _____ inches
I) Number of Columns	n_c = _____ number
J) Actual Design Outlet Area per Row (A_o)	A_o = _____ square inches
K) Number of Rows (nr)	n_r = _____ number
L) Total Outlet Area (A_{ot})	A_{ot} = _____ square inches
M) Depth of WQCV (H_{WQCV}) (Estimate using actual stage-area-volume relationship and V_{WQCV})	H_{WQCV} = _____ feet
N) Ensure Minimum 40 Hour Drain Time for WQCV	$T_{D\ WQCV}$ = _____ hours

Detention Pond: Stage-Storage

DET02

Proposed Conditions

Project: Boulder Creek Commons
SG Project I.D.: B1006

Prepared By: LRE
Reviewed By: CCS
Date: 09/24/12
Revised Date: 10/08/12

Pond Description: Detention pond located in western interior open space. Provides detention storage for Basins A5, A6 and A7.

Stage [ft]	Elevation [ft]	Contour Area [sf]	Incremental Storage Volume [cf]	Cumulative Storage Volume [cf]	
0.0	5317.4	0	0	0	
1.1	5318.5	0	0	0	
1.2	5318.6	317	123	123	
1.3	5318.7	634	47	169	
1.4	5318.8	952	79	248	
1.5	5318.9	1269	111	359	
1.6	5319.0	1586	142	501	
1.7	5319.1	2096	184	685	
1.8	5319.2	2606	235	919	
1.9	5319.3	3116	286	1205	
2.0	5319.4	3626	337	1542	
2.1	5319.5	4136	388	1930	
2.2	5319.6	4646	439	2368	
2.3	5319.7	5155	490	2858	
2.4	5319.8	5665	541	3399	
2.5	5319.9	6175	592	3991	
2.6	5320.0	6685	643	4634	
2.7	**5320.1**	**7190**	**694**	**5327**	**V_{10req}=110%*V_{10}=5,055-cf**
2.8	5320.2	7694	744	6071	
2.9	5320.3	8199	794	6866	
3.0	5320.4	8703	845	7711	
3.1	5320.5	9207	895	8606	
3.2	5320.6	9712	946	9552	
3.3	5320.7	10216	996	10548	
3.4	5320.8	10721	1047	11595	
3.5	5320.9	11225	1097	12692	
3.6	**5321.0**	**11730**	**1148**	**13840**	**V_{100req}=110%*V_{100}=13,892-cf**
3.7	5321.1	12473	1210	15050	
3.8	5321.2	13216	1284	16334	
3.9	5321.3	13959	1359	17693	
4.0	5321.4	14702	1433	19126	
4.1	5321.5	15445	1507	20633	
4.2	5321.6	16188	1582	22214	
4.3	5321.7	16931	1656	23870	
4.4	5321.8	17674	1730	25600	
4.5	5321.9	18417	1804	27405	
4.6	**5322.0**	**19160**	**1879**	**29284**	**Top of Pond Embankment**

INITIAL DETENTION POND SIZING

DETØ2 (WESTERN OPEN SPACE)

TRIBUTARY BASINS: A5, A6 AND A7

FAA INPUT VALUES:

$A_{DETØ2} = A_{A5} + A_{A6} + A_{A7} = 2.35 + 0.66 + 1.64 = 4.65$

$Q_{10_{ALL}} = 0.59\ cfs/AC$

$Q_{100_{ALL}} = 1.64\ cfs/AC$

PER EX. SITE RELEASE RATES

$$I_{T_{DETØ2}} = \frac{I_{A5}A_{A5} + I_{A6}A_{A6} + I_{A7}A_{A7}}{A_{DETØ2}} =$$

$$I_{T_{DETØ2}} = \frac{28.73(2.35) + 38.96(0.66) + 40(1.64)}{4.65}$$

$I_{T_{DETØ2}} = 34.16\%$

$T_{C_{DETØ2}} = T_{C_{A6}} + T_{t_{A5}} = 10.66 + 7.13 = 17.79\ min$

FROM UD-DETENTION_2.2, MODIFIED FAA WORKSHEET:

$V_{10\ FAA} = 4{,}595\ cf$ $\qquad Q_{10_{ALL}} = 2.74\ cfs$

$V_{100\ FAA} = 8{,}463\ cf$ $\qquad Q_{100_{ALL}} = 7.63\ cfs$

DETØ2 PROVIDES DETENTION STORAGE ONLY. WQ PROVIDED IN DETØ1.

$V_{10\ ROUTE} = 4{,}595\ cf = V_{10\ FAA}$

$V_{100\ ROUTE} = 12{,}629\ cf > V_{100\ FAA}$ } USE ROUTING MODEL DETENTION VOLUME

OVERDETAIN TO REDUCE DOWNSTREAM PIPE SIZES

$V_{10_{DETØ2}} = 110\%\ V_{10_{ROUTE}} = 5{,}055\text{-}cf$

$V_{100\ DETØ2} = 110\%\ V_{100_{ROUTE}} = 13{,}892\text{-}cf$

DETENTION VOLUME BY THE MODIFIED FAA METHOD
(See USDCM Volume 2 Storage Chapter for description of method)

Project: Boulder Creek Commons - Preliminary Design

Basin ID: DET02 - Basins A5, A6 and A7

(For catchments less than 160 acres only. For larger catchments, use hydrograph routing method)
(NOTE: for catchments larger than 90 acres, CUHP hydrograph and routing are recommended)

Determination of MINOR Detention Volume Using Modified FAA Method

Design Information (Input):

Catchment Drainage Imperviousness	I_a =	34.16	percent
Catchment Drainage Area	A =	4.650	acres
Predevelopment NRCS Soil Group	Type =	C	A, B, C, or D
Return Period for Detention Control	T =	10	years (2, 5, 10, 25, 50, or 100)
Time of Concentration of Watershed	Tc =	18	minutes
Allowable Unit Release Rate	q =	0.59	cfs/acre
One-hour Precipitation	P_1 =	1.61	inches
Design Rainfall IDF Formula	$i = C_1 * P_1/(C_2+T_c)^{\wedge}C_3$		
Coefficient One	C_1 =	28.50	
Coefficient Two	C_2 =	10	
Coefficient Three	C_3 =	0.789	

Determination of Average Outflow from the Basin (Calculated):

Runoff Coefficient	C =	0.40	
Inflow Peak Runoff	Qp-in =	6.19	cfs
Allowable Peak Outflow Rate	Qp-out =	**2.74**	cfs
Mod. FAA Minor Storage Volume =		4,595	**cubic feet**
Mod. FAA Minor Storage Volume =		**0.105**	**acre-ft**

5 <- Enter Rainfall Duration Incremental Increase Value Here (e.g. 5 for 5-Minutes)

Rainfall Duration minutes (input)	Rainfall Intensity inches / hr (output)	Inflow Volume cubic feet (output)	Adjustment Factor "m" (output)	Average Outflow cfs (output)	Outflow Volume cubic feet (output)	Storage Volume cubic feet (output)
0	0.00	0	0.00	0.00	0	0
5	5.42	3,023	1.00	2.74	823	2,199
10	4.32	4,818	1.00	2.74	1,646	3,171
15	3.62	6,060	1.00	2.74	2,469	3,591
20	3.13	6,997	0.95	2.59	3,111	3,886
25	2.78	7,745	0.86	2.35	3,523	4,222
30	2.50	8,364	0.80	2.19	3,934	4,430
35	2.28	8,892	0.75	2.07	4,346	4,547
40	2.09	9,352	0.72	1.98	4,757	4,595
45	1.94	9,759	0.70	1.91	5,169	4,590
50	1.81	10,124	0.68	1.86	5,580	4,544
55	1.70	10,455	0.66	1.82	5,992	4,463
60	1.61	10,757	0.65	1.78	6,403	4,354
65	1.52	11,036	0.64	1.75	6,815	4,221
70	1.45	11,295	0.63	1.72	7,226	4,069
75	1.38	11,537	0.62	1.70	7,638	3,899
80	1.32	11,763	0.61	1.68	8,049	3,714
85	1.26	11,977	0.60	1.66	8,461	3,516
90	1.21	12,178	0.60	1.64	8,872	3,306
95	1.17	12,369	0.59	1.63	9,284	3,085
100	1.12	12,551	0.59	1.62	9,696	2,855
105	1.09	12,724	0.58	1.60	10,107	2,617
110	1.05	12,890	0.58	1.59	10,519	2,371
115	1.02	13,049	0.58	1.58	10,930	2,119
120	0.99	13,201	0.57	1.58	11,342	1,860
125	0.96	13,348	0.57	1.57	11,753	1,595
130	0.93	13,489	0.57	1.56	12,165	1,324
135	0.90	13,625	0.57	1.55	12,576	1,049
140	0.88	13,757	0.56	1.55	12,988	769
145	0.86	13,885	0.56	1.54	13,399	485
150	0.84	14,008	0.56	1.53	13,811	197
155	0.82	14,128	0.56	1.53	14,222	-95
160	0.80	14,244	0.56	1.52	14,634	-390
165	0.78	14,357	0.55	1.52	15,045	-688
170	0.76	14,467	0.55	1.52	15,457	-990
175	0.75	14,574	0.55	1.51	15,868	-1,295
180	0.73	14,678	0.55	1.51	16,280	-1,602
185	0.72	14,780	0.55	1.50	16,691	-1,912
190	0.70	14,879	0.55	1.50	17,103	-2,224
195	0.69	14,976	0.55	1.50	17,515	-2,539
200	0.68	15,071	0.54	1.49	17,926	-2,855
205	0.66	15,163	0.54	1.49	18,338	-3,174
210	0.65	15,254	0.54	1.49	18,749	-3,495
215	0.64	15,343	0.54	1.49	19,161	-3,818
220	0.63	15,430	0.54	1.48	19,572	-4,143
225	0.62	15,515	0.54	1.48	19,984	-4,469
230	0.61	15,598	0.54	1.48	20,395	-4,797
235	0.60	15,680	0.54	1.48	20,807	-5,127
240	0.59	15,761	0.54	1.47	21,218	-5,458
245	0.58	15,839	0.54	1.47	21,630	-5,790
250	0.57	15,917	0.54	1.47	22,041	-6,124
255	0.56	15,993	0.53	1.47	22,453	-6,460
260	0.55	16,068	0.53	1.47	22,864	-6,796
265	0.55	16,142	0.53	1.46	23,276	-7,134
270	0.54	16,214	0.53	1.46	23,687	-7,473
275	0.53	16,285	0.53	1.46	24,099	-7,814
280	0.52	16,355	0.53	1.46	24,510	-8,155
285	0.52	16,424	0.53	1.46	24,922	-8,498
290	0.51	16,492	0.53	1.46	25,333	-8,841
295	0.50	16,559	0.53	1.45	25,745	-9,186
300	0.50	16,625	0.53	1.45	26,157	-9,531

Mod. FAA Minor Storage Volume (cubic ft.) = 4,595
Mod. FAA Minor Storage Volume (acre-ft.) = 0.1055

Determination of MAJOR Detention Volume Using Modified FAA Method

Design Information (Input):

Catchment Drainage Imperviousness	I_a =	34.16	percent
Catchment Drainage Area	A =	4.650	acres
Predevelopment NRCS Soil Group	Type =	C	A, B, C, or D
Return Period for Detention Control	T =	100	years (2, 5, 10, 25, 50, or 100)
Time of Concentration of Watershed	Tc =	18	minutes
Allowable Unit Release Rate	q =	1.64	cfs/acre
One-hour Precipitation	P_1 =	2.61	inches
Design Rainfall IDF Formula	$i = C_1 * P_1/(C_2+T_c)^{\wedge}C_3$		
Coefficient One	C_1 =	28.50	
Coefficient Two	C_2 =	10	
Coefficient Three	C_3 =	0.789	

Determination of Average Outflow from the Basin (Calculated):

Runoff Coefficient	C =	0.57	
Inflow Peak Runoff	Qp-in =	14.30	cfs
Allowable Peak Outflow Rate	Qp-out =	**7.63**	cfs
Mod. FAA Major Storage Volume =		8,463	**cubic feet**
Mod. FAA Major Storage Volume =		**0.194**	**acre-ft**

Rainfall Duration minutes (input)	Rainfall Intensity inches / hr (output)	Inflow Volume cubic feet (output)	Adjustment Factor "m" (output)	Average Outflow cfs (output)	Outflow Volume cubic feet (output)	Storage Volume cubic feet (output)
0	0.00	0	0.00	0.00	0	0
5	8.78	6,982	1.00	7.63	2,288	4,694
10	7.00	11,129	1.00	7.63	4,576	6,553
15	5.87	13,998	1.00	7.63	6,863	7,135
20	5.08	16,164	0.95	7.21	8,648	7,516
25	4.50	17,891	0.86	6.53	9,792	8,099
30	4.05	19,322	0.80	6.08	10,936	8,387
35	3.69	20,542	0.75	5.75	12,080	8,463
40	3.40	21,604	0.72	5.51	13,223	8,381
45	3.15	22,544	0.70	5.32	14,367	8,177
50	2.94	23,387	0.68	5.17	15,511	7,876
55	2.76	24,151	0.66	5.05	16,655	7,496
60	2.60	24,850	0.65	4.94	17,799	7,051
65	2.47	25,495	0.64	4.86	18,943	6,552
70	2.34	26,093	0.63	4.78	20,087	6,006
75	2.23	26,651	0.62	4.72	21,231	5,420
80	2.14	27,174	0.61	4.66	22,375	4,800
85	2.05	27,667	0.60	4.61	23,519	4,148
90	1.97	28,132	0.60	4.57	24,662	3,470
95	1.89	28,574	0.59	4.53	25,806	2,768
100	1.82	28,994	0.59	4.49	26,950	2,044
105	1.76	29,394	0.58	4.46	28,094	1,300
110	1.70	29,777	0.58	4.43	29,238	539
115	1.65	30,144	0.58	4.40	30,382	-238
120	1.60	30,496	0.57	4.38	31,526	-1,030
125	1.55	30,835	0.57	4.36	32,670	-1,835
130	1.51	31,161	0.57	4.34	33,814	-2,653
135	1.47	31,476	0.57	4.32	34,958	-3,482
140	1.43	31,780	0.56	4.30	36,101	-4,321
145	1.39	32,075	0.56	4.28	37,245	-5,171
150	1.36	32,360	0.56	4.27	38,389	-6,030
155	1.32	32,636	0.56	4.25	39,533	-6,897
160	1.29	32,905	0.56	4.24	40,677	-7,772
165	1.26	33,166	0.55	4.22	41,821	-8,655
170	1.24	33,420	0.55	4.21	42,965	-9,545
175	1.21	33,667	0.55	4.20	44,109	-10,442
180	1.18	33,908	0.55	4.19	45,253	-11,345
185	1.16	34,143	0.55	4.18	46,397	-12,254
190	1.14	34,372	0.55	4.17	47,540	-13,168
195	1.12	34,596	0.55	4.16	48,684	-14,088
200	1.09	34,815	0.54	4.15	49,828	-15,014
205	1.07	35,029	0.54	4.14	50,972	-15,943
210	1.06	35,238	0.54	4.14	52,116	-16,878
215	1.04	35,443	0.54	4.13	53,260	-17,817
220	1.02	35,644	0.54	4.12	54,404	-18,760
225	1.00	35,841	0.54	4.11	55,548	-19,707
230	0.99	36,033	0.54	4.11	56,692	-20,658
235	0.97	36,223	0.54	4.10	57,836	-21,613
240	0.95	36,408	0.54	4.10	58,979	-22,571
245	0.94	36,591	0.54	4.09	60,123	-23,533
250	0.92	36,770	0.54	4.08	61,267	-24,498
255	0.91	36,946	0.53	4.08	62,411	-25,466
260	0.90	37,119	0.53	4.07	63,555	-26,436
265	0.88	37,289	0.53	4.07	64,699	-27,410
270	0.87	37,456	0.53	4.06	65,843	-28,387
275	0.86	37,620	0.53	4.06	66,987	-29,366
280	0.85	37,782	0.53	4.06	68,131	-30,348
285	0.84	37,942	0.53	4.05	69,275	-31,333
290	0.83	38,099	0.53	4.05	70,418	-32,319
295	0.82	38,254	0.53	4.04	71,562	-33,309
300	0.81	38,406	0.53	4.04	72,706	-34,300

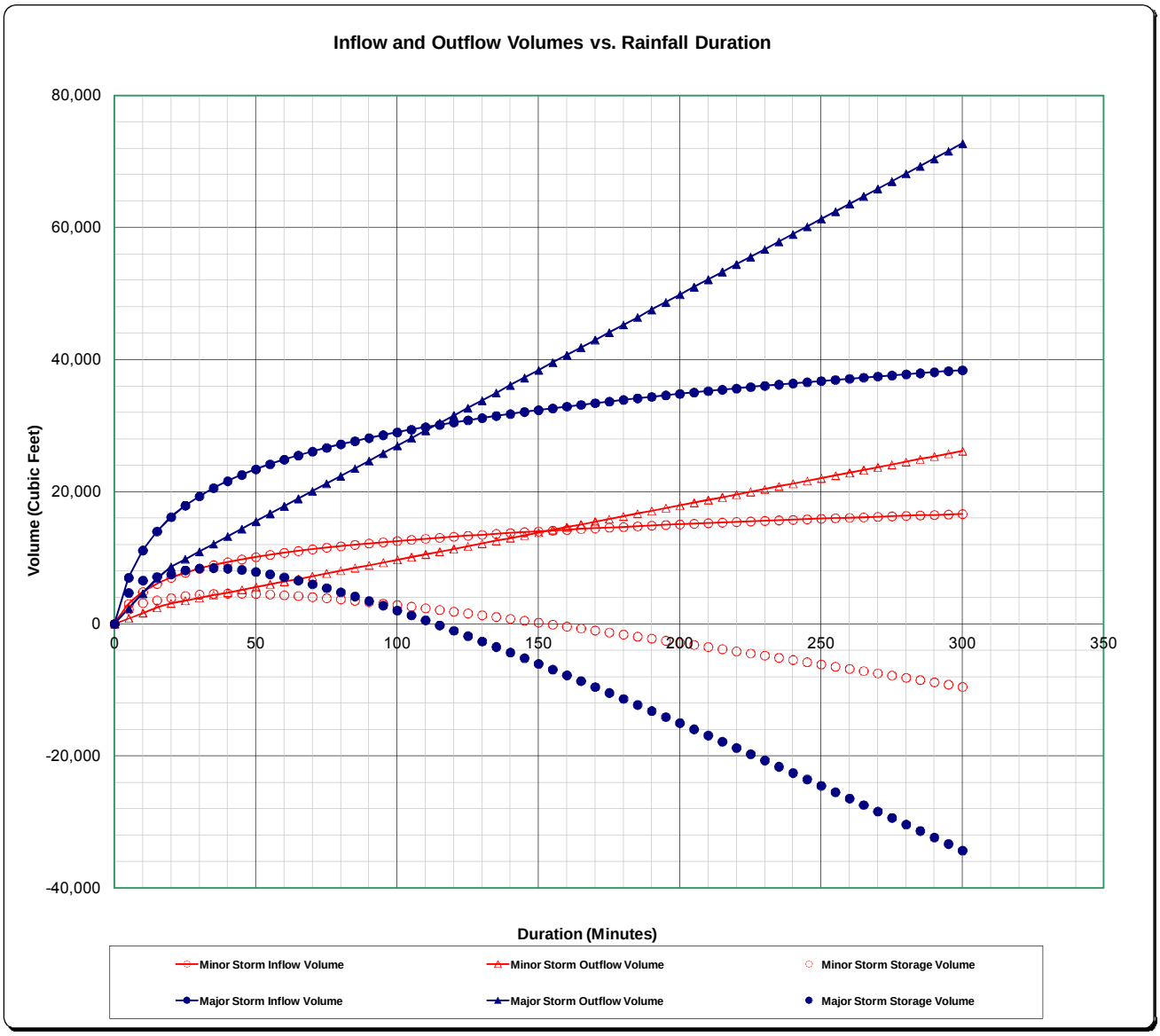
Mod. FAA Major Storage Volume (cubic ft.) = 8,463
Mod. FAA Major Storage Volume (acre-ft.) = 0.1943

UDFCD DETENTION VOLUME ESTIMATING WORKBOOK Version 2.2, Released January 2010

DETENTION VOLUME BY THE MODIFIED FAA METHOD
(See USDCM Volume 2 Storage Chapter for description of method)

Project: Boulder Creek Commons - Preliminary Design

Basin ID: DET02 - Basins A5, A6 and A7



Detention Pond: Stage-Storage

DET03

Proposed Conditions

Project: Boulder Creek Commons
SG Project I.D.: B1006

Prepared By: LRE
Reviewed By: CCS
Date: 06/10/12
Revised Date: 10/08/12

Pond Description: Detention pond located in eastern open space. Provides detention storage for Basins A9, A10, A11 and A12.

Stage [ft]	Elevation [ft]	Contour Area [sf]	Incremental Storage Volume [cf]	Cumulative Storage Volume [cf]	
0.0	5320.5	0	0	0	
0.1	5320.6	58	2	2	
0.2	5320.7	116	9	10	
0.3	5320.8	173	14	25	
0.4	5320.9	231	20	45	
0.5	5321.0	289	26	71	
0.6	5321.1	622	45	115	
0.7	5321.2	955	78	194	
0.8	5321.3	1288	112	305	
0.9	5321.4	1621	145	451	
1.0	5321.5	1954	178	629	
1.1	5321.6	2287	212	841	
1.2	5321.7	2620	245	1086	
1.3	5321.8	2953	278	1364	
1.4	5321.9	3286	312	1676	
1.5	5322.0	3619	345	2021	
1.6	5322.1	4211	391	2412	
1.7	5322.2	4804	450	2863	
1.8	5322.3	5397	510	3373	
1.9	5322.4	5989	569	3942	
2.0	5322.5	6582	628	4570	
2.1	5322.6	7175	688	5258	
2.2	5322.7	7767	747	6004	
2.3	5322.8	8360	806	6811	
2.4	5322.9	8953	865	7676	
2.5	**5323.0**	**9546**	**925**	**8601**	V_{10req}=110%*V_{10}=8,784-cf
2.6	5323.1	10169	986	9586	
2.7	5323.2	10793	1048	10634	
2.8	5323.3	11417	1110	11745	
2.9	5323.4	12041	1173	12918	
3.0	5323.5	12665	1235	14153	
3.1	5323.6	13289	1298	15450	
3.2	5323.7	13913	1360	16810	
3.3	5323.8	14536	1422	18233	
3.4	5323.9	15160	1485	19717	
3.5	**5324.0**	**15784**	**1547**	**21264**	V_{100req}=110%*V_{100}=21,281-cf
3.6	5324.1	16751	1627	22891	
3.7	5324.2	17718	1723	24614	
3.8	5324.3	18685	1820	26434	
3.9	5324.4	19652	1917	28351	
4.0	5324.5	20619	2013	30364	
4.1	5324.6	21587	2110	32474	
4.2	5324.7	22554	2207	34681	
4.3	5324.8	23521	2304	36985	
4.4	5324.9	24488	2400	39385	
4.5	**5325.0**	**25455**	**2497**	**41882**	**Top of Pond Embankment**

INITIAL DETENTION POND SIZING

DET Ø3 (EASTERN OPEN SPACE)

TRIBUTARY BASINS = A9, A10, A11 AND A12

FAA INPUT VALUES:

$A_{DET\emptyset 3} = A_{A9} + A_{A10} + A_{A11} + A_{A12} = 1.33 + 1.62 + 0.80 + 2.50 = 6.25 AC$

$Q_{10\,ALL} = 0.59$ cfs/AC
$Q_{100\,ALL} = 1.64$ cfs/AC
} PER EX. SITE RELEASE RATES

$$I_{T_{DET\emptyset 3}} = \frac{I_{A9} A_{A9} + I_{A10} A_{A10} + I_{A11} A_{A11} + I_{A12} A_{A12}}{A_{DET\emptyset 3}}$$

$$I_{T_{DET\emptyset 3}} = \frac{40(1.33) + 29(1.62) + 39.07(0.80) + 53.57(2.50)}{6.25}$$

$I_{T_{DET\emptyset 3}} = 42.46\%$

$Tc_{DET\emptyset 3} = Tc_{A9} + Tc_{A10} = 14.42 + 5.60 = 20.0$ min

FROM UD-DETENTION_2.2, MODIFIED FAA WORKSHEET:

$V_{10\,FAA} = 6,910$ cf $\qquad Q_{10_{ALL}} = 3.69$ cfs

$V_{100\,FAA} = 11,667$ cf $\qquad Q_{100_{ALL}} = 10.25$ cfs

DET Ø3 PROVIDES DETENTION STORAGE ONLY. WQ PROVIDED IN DET Ø1.

$V_{10\,ROUTE} = 7,985$ cf $> V_{10\,FAA}$
$V_{100\,ROUTE} = 19,346$ cf $> V_{100\,FAA}$
} USE ROUTING MODEL DETENTION VOLUME

OVER DETAIN TO REDUCE DOWNSTREAM PIPE SIZES

$V_{10\,DET\emptyset 3} = 110\%\ V_{10\,ROUTE} = \underline{8,784\text{-cf}}$

$V_{100\,DET\emptyset 3} = 110\%\ V_{100\,ROUTE} = \underline{21,281\text{-cf}}$

DETENTION VOLUME BY THE MODIFIED FAA METHOD
(See USDCM Volume 2 Storage Chapter for description of method)

Project: Boulder Creek Commons - Preliminary Design

Basin ID: DET03 - Basins A9, A10, A11 and A12

(For catchments less than 160 acres only. For larger catchments, use hydrograph routing method)
(NOTE: for catchments larger than 90 acres, CUHP hydrograph and routing are recommended)

Determination of MINOR Detention Volume Using Modified FAA Method

Design Information (Input):

Catchment Drainage Imperviousness	I_a =	42.46	percent
Catchment Drainage Area	A =	6.250	acres
Predevelopment NRCS Soil Group	Type =	C	A, B, C, or D
Return Period for Detention Control	T =	10	years (2, 5, 10, 25, 50, or 100)
Time of Concentration of Watershed	Tc =	20	minutes
Allowable Unit Release Rate	q =	0.59	cfs/acre
One-hour Precipitation	P_1 =	1.61	inches
Design Rainfall IDF Formula	$i = C_1 * P_1/(C_2+T_c)^{C_3}$		
Coefficient One	C_1 =	28.50	
Coefficient Two	C_2 =	10	
Coefficient Three	C_3 =	0.789	

Determination of Average Outflow from the Basin (Calculated):

Runoff Coefficient	C =	0.43	
Inflow Peak Runoff	Qp-in =	8.43	cfs
Allowable Peak Outflow Rate	Qp-out =	**3.69**	cfs
Mod. FAA Minor Storage Volume =		6,910	**cubic feet**
Mod. FAA Minor Storage Volume =		**0.159**	**acre-ft**

5 <- Enter Rainfall Duration Incremental Increase Value Here (e.g. 5 for 5-Minutes)

Rainfall Duration minutes (input)	Rainfall Intensity inches / hr (output)	Inflow Volume cubic feet (output)	Adjustment Factor "m" (output)	Average Outflow cfs (output)	Outflow Volume cubic feet (output)	Storage Volume cubic feet (output)
0	0.00	0	0.00	0.00	0	0
5	5.42	4,367	1.00	3.69	1,106	3,261
10	4.32	6,961	1.00	3.69	2,213	4,748
15	3.62	8,756	1.00	3.69	3,319	5,437
20	3.13	10,110	1.00	3.69	4,425	5,685
25	2.78	11,190	0.90	3.32	4,978	6,212
30	2.50	12,086	0.83	3.07	5,531	6,554
35	2.28	12,849	0.79	2.90	6,084	6,764
40	2.09	13,513	0.75	2.77	6,638	6,875
45	1.94	14,101	0.72	2.66	7,191	6,910
50	1.81	14,628	0.70	2.58	7,744	6,884
55	1.70	15,106	0.68	2.51	8,297	6,809
60	1.61	15,543	0.67	2.46	8,850	6,693
65	1.52	15,946	0.65	2.41	9,403	6,543
70	1.45	16,320	0.64	2.37	9,956	6,364
75	1.38	16,669	0.63	2.34	10,509	6,160
80	1.32	16,997	0.63	2.30	11,063	5,934
85	1.26	17,305	0.62	2.28	11,616	5,689
90	1.21	17,596	0.61	2.25	12,169	5,427
95	1.17	17,872	0.61	2.23	12,722	5,150
100	1.12	18,135	0.60	2.21	13,275	4,860
105	1.09	18,385	0.60	2.19	13,828	4,557
110	1.05	18,625	0.59	2.18	14,381	4,243
115	1.02	18,854	0.59	2.16	14,934	3,920
120	0.99	19,074	0.58	2.15	15,488	3,587
125	0.96	19,286	0.58	2.14	16,041	3,246
130	0.93	19,490	0.58	2.13	16,594	2,897
135	0.90	19,687	0.57	2.12	17,147	2,540
140	0.88	19,878	0.57	2.11	17,700	2,178
145	0.86	20,062	0.57	2.10	18,253	1,809
150	0.84	20,240	0.57	2.09	18,806	1,434
155	0.82	20,413	0.56	2.08	19,359	1,054
160	0.80	20,581	0.56	2.07	19,913	668
165	0.78	20,744	0.56	2.07	20,466	279
170	0.76	20,903	0.56	2.06	21,019	-116
175	0.75	21,058	0.56	2.05	21,572	-514
180	0.73	21,208	0.56	2.05	22,125	-917
185	0.72	21,355	0.55	2.04	22,678	-1,323
190	0.70	21,499	0.55	2.04	23,231	-1,733
195	0.69	21,639	0.55	2.03	23,784	-2,146
200	0.68	21,776	0.55	2.03	24,338	-2,562
205	0.66	21,909	0.55	2.02	24,891	-2,981
210	0.65	22,040	0.55	2.02	25,444	-3,403
215	0.64	22,169	0.55	2.02	25,997	-3,828
220	0.63	22,294	0.55	2.01	26,550	-4,256
225	0.62	22,417	0.54	2.01	27,103	-4,686
230	0.61	22,538	0.54	2.00	27,656	-5,118
235	0.60	22,656	0.54	2.00	28,209	-5,553
240	0.59	22,772	0.54	2.00	28,763	-5,990
245	0.58	22,886	0.54	1.99	29,316	-6,429
250	0.57	22,998	0.54	1.99	29,869	-6,870
255	0.56	23,108	0.54	1.99	30,422	-7,313
260	0.55	23,217	0.54	1.99	30,975	-7,758
265	0.55	23,323	0.54	1.98	31,528	-8,205
270	0.54	23,428	0.54	1.98	32,081	-8,654
275	0.53	23,530	0.54	1.98	32,634	-9,104
280	0.52	23,632	0.54	1.98	33,188	-9,556
285	0.52	23,732	0.54	1.97	33,741	-10,009
290	0.51	23,830	0.53	1.97	34,294	-10,464
295	0.50	23,927	0.53	1.97	34,847	-10,920
300	0.50	24,022	0.53	1.97	35,400	-11,378

Mod. FAA Minor Storage Volume (cubic ft.) = 6,910
Mod. FAA Minor Storage Volume (acre-ft.) = 0.1586

Determination of MAJOR Detention Volume Using Modified FAA Method

Design Information (Input):

Catchment Drainage Imperviousness	I_a =	42.46	percent
Catchment Drainage Area	A =	6.250	acres
Predevelopment NRCS Soil Group	Type =	C	A, B, C, or D
Return Period for Detention Control	T =	100	years (2, 5, 10, 25, 50, or 100)
Time of Concentration of Watershed	Tc =	20	minutes
Allowable Unit Release Rate	q =	1.64	cfs/acre
One-hour Precipitation	P_1 =	2.61	inches
Design Rainfall IDF Formula	$i = C_1 * P_1/(C_2+T_c)^{C_3}$		
Coefficient One	C_1 =	28.50	
Coefficient Two	C_2 =	10	
Coefficient Three	C_3 =	0.789	

Determination of Average Outflow from the Basin (Calculated):

Runoff Coefficient	C =	0.59	
Inflow Peak Runoff	Qp-in =	18.74	cfs
Allowable Peak Outflow Rate	Qp-out =	**10.25**	cfs
Mod. FAA Major Storage Volume =		11,667	**cubic feet**
Mod. FAA Major Storage Volume =		**0.268**	**acre-ft**

Rainfall Duration minutes (input)	Rainfall Intensity inches / hr (output)	Inflow Volume cubic feet (output)	Adjustment Factor "m" (output)	Average Outflow cfs (output)	Outflow Volume cubic feet (output)	Storage Volume cubic feet (output)
0	0.00	0	0.00	0.00	0	0
5	8.78	9,714	1.00	10.25	3,075	6,639
10	7.00	15,483	1.00	10.25	6,150	9,333
15	5.87	19,475	1.00	10.25	9,225	10,250
20	5.08	22,488	1.00	10.25	12,300	10,188
25	4.50	24,891	0.90	9.23	13,838	11,053
30	4.05	26,882	0.83	8.54	15,375	11,507
35	3.69	28,579	0.79	8.05	16,913	11,667
40	3.40	30,057	0.75	7.69	18,450	11,607
45	3.15	31,364	0.72	7.40	19,988	11,377
50	2.94	32,537	0.70	7.18	21,525	11,012
55	2.76	33,600	0.68	6.99	23,063	10,538
60	2.60	34,573	0.67	6.83	24,600	9,973
65	2.47	35,470	0.65	6.70	26,138	9,332
70	2.34	36,302	0.64	6.59	27,675	8,627
75	2.23	37,078	0.63	6.49	29,213	7,866
80	2.14	37,806	0.63	6.41	30,750	7,056
85	2.05	38,491	0.62	6.33	32,288	6,204
90	1.97	39,139	0.61	6.26	33,825	5,314
95	1.89	39,753	0.61	6.20	35,363	4,391
100	1.82	40,338	0.60	6.15	36,900	3,438
105	1.76	40,895	0.60	6.10	38,438	2,457
110	1.70	41,427	0.59	6.06	39,975	1,452
115	1.65	41,938	0.59	6.02	41,513	425
120	1.60	42,428	0.58	5.98	43,050	-622
125	1.55	42,899	0.58	5.95	44,588	-1,689
130	1.51	43,353	0.58	5.91	46,125	-2,772
135	1.47	43,791	0.57	5.88	47,663	-3,872
140	1.43	44,214	0.57	5.86	49,200	-4,986
145	1.39	44,624	0.57	5.83	50,738	-6,114
150	1.36	45,020	0.57	5.81	52,275	-7,255
155	1.32	45,405	0.56	5.79	53,813	-8,407
160	1.29	45,779	0.56	5.77	55,350	-9,571
165	1.26	46,142	0.56	5.75	56,888	-10,746
170	1.24	46,495	0.56	5.73	58,425	-11,930
175	1.21	46,839	0.56	5.71	59,963	-13,123
180	1.18	47,174	0.56	5.69	61,500	-14,326
185	1.16	47,501	0.55	5.68	63,038	-15,536
190	1.14	47,820	0.55	5.66	64,575	-16,755
195	1.12	48,132	0.55	5.65	66,113	-17,981
200	1.09	48,436	0.55	5.64	67,650	-19,214
205	1.07	48,734	0.55	5.63	69,188	-20,454
210	1.06	49,025	0.55	5.61	70,725	-21,700
215	1.04	49,310	0.55	5.60	72,263	-22,952
220	1.02	49,589	0.55	5.59	73,800	-24,211
225	1.00	49,863	0.54	5.58	75,338	-25,474
230	0.99	50,131	0.54	5.57	76,875	-26,744
235	0.97	50,395	0.54	5.56	78,413	-28,018
240	0.95	50,653	0.54	5.55	79,950	-29,297
245	0.94	50,907	0.54	5.54	81,488	-30,581
250	0.92	51,156	0.54	5.54	83,025	-31,869
255	0.91	51,401	0.54	5.53	84,563	-33,162
260	0.90	51,641	0.54	5.52	86,100	-34,459
265	0.88	51,878	0.54	5.51	87,638	-35,760
270	0.87	52,110	0.54	5.50	89,175	-37,065
275	0.86	52,339	0.54	5.50	90,713	-38,373
280	0.85	52,565	0.54	5.49	92,250	-39,685
285	0.84	52,787	0.54	5.48	93,788	-41,001
290	0.83	53,005	0.53	5.48	95,325	-42,320
295	0.82	53,220	0.53	5.47	96,863	-43,642
300	0.81	53,433	0.53	5.47	98,400	-44,967

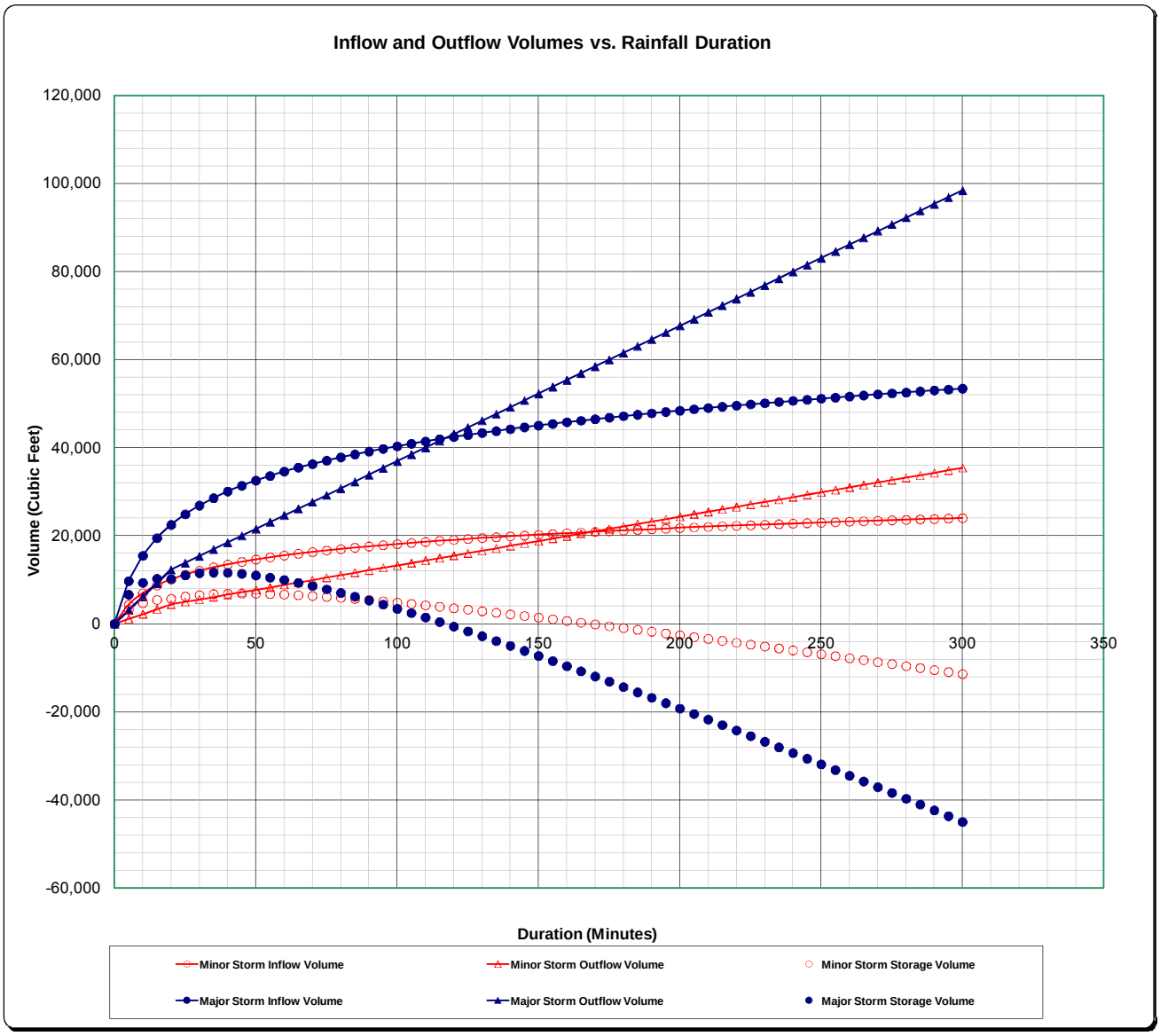
Mod. FAA Major Storage Volume (cubic ft.) = 11,667
Mod. FAA Major Storage Volume (acre-ft.) = 0.2678

UDFCD DETENTION VOLUME ESTIMATING WORKBOOK Version 2.2, Released January 2010

DETENTION VOLUME BY THE MODIFIED FAA METHOD
(See USDCM Volume 2 Storage Chapter for description of method)

Project: Boulder Creek Commons - Preliminary Design

Basin ID: DET03 - Basins A9, A10, A11 and A12



Detention Pond: Stage-Storage

DET04

Proposed Conditions

		Prepared By:	LRE
Project:	Boulder Creek Commons	Reviewed By:	CCS
SG Project I.D.:	B1006	Date:	09/24/12
		Revised Date:	10/08/12

Pond Description: Detention pond located in the northwest corner of the West Parcel. Provides detention storage for Basins B1 and B2. Includes EDB water quality BMP for Basins B1 and B2.

Stage [ft]	Elevation [ft]	Contour Area [sf]	Incremental Storage Volume [cf]	Cumulative Storage Volume [cf]	
0.0	5315.7	0	0	0	
0.1	5315.8	432	14	14	
0.2	5315.9	864	64	78	
0.3	5316.0	2161	146	224	
0.4	5316.1	2444	230	454	
0.5	**5316.2**	**2728**	**258**	**713**	**$0.5*V_{WQ}$=636-cf**
0.6	5316.3	3011	287	1000	
0.7	**5316.4**	**3295**	**315**	**1315**	**V_{WQ}=1,307-cf**
0.8	5316.5	3578	344	1658	
0.9	5316.6	3862	372	2030	
1.0	5316.7	4145	400	2431	
1.1	5316.8	4429	429	2859	
1.2	5316.9	4712	457	3316	
1.3	**5317.0**	**4996**	**485**	**3801**	**V_{10req}=110%(V_{WQCV}+V_{10j})=3,681-cf**
1.4	5317.1	5255	512	4314	
1.5	5317.2	5514	538	4852	
1.6	**5317.3**	**5774**	**564**	**5417**	**V_{100req}=110%(0.5*V_{WQCV}+V_{100j})=5,466-cf**

INITIAL DETENTION POND SIZING

DET Ø4 (NW OPEN SPACE)

TRIBUTARY BASINS = B1 & B2 w/ OS12 PASS THROUGH

FAA INPUT VALUES:

$A_{REA\ DET04} = A_{B1} + A_{B2} = 1.19 + 0.93 = 2.12$

$Q_{10\ ALL} = 0.51\ cfs/ac$
$Q_{100\ ALL} = 1.64\ cfs/ac$ } CALC BASED ON EX. SITE RELEASE RATES

$$I_T = \frac{I_{B1} \times A_{B1} + I_{S2} A_{B2}}{A_{DET\emptyset 3}} = \frac{34.37 \times 1.19 + 15.95 \cdot 0.93}{2.12} \Rightarrow 26.28\%$$

$T_{C_{B1+B2}} = T_{C_{B2}} + T_{T_{B1}} = 16.77\ min + 8.07\ min = 24.84\ min$

FROM UD-DETENTION_22, MODIFIED FAA WORKSHEET:

	FAA	OS-12 PASS THRU	By FAA	EX. ROUTING MODELS @ DP12
$V_{10\ FAA} = 1,505\ cf$	$Q_{10\ ALL} = 1.25\ cfs$	+ 3.41 =	4.66 cfs	4.94
$V_{100\ FAA} = 3,141\ cf$	$Q_{100\ ALL} = 3.48\ cfs$	+ 8.68 =	12.16 cfs	13.64

ACTUAL POND RELEASE RATES w/I RANGE

DETØ5 HAS EDB COMPONENT:

FROM UD_BMP_V3_Ø1-EDB:

WQCV = 0.025 AC-FT ⇒ V_{WQ} = 0.030 AC-FT

* NO FREEBAY REQ'D.

$V_{WQ\ DET04} = 1,306.81\ cf$

$V_{10\ ROUTE} = 2,039\ cf > V_{10\ FAA}$
$V_{100\ ROUTE} = 4,316\ cf > V_{100\ FAA}$ } USE ROUTING MODEL DETENTION VOLUME

$V_{10\ DET\emptyset 4} = 110\% (V_{WQ} + V_{10\ ROUTE}) = \underline{3,681\ cf}$

$V_{100\ DET\emptyset 4} = 110\% (\frac{1}{2} V_{WQ} + V_{100\ ROUTE}) = \underline{5,466\ cf}$

TOPS 35500

DETENTION VOLUME BY THE MODIFIED FAA METHOD
(See USDCM Volume 2 Storage Chapter for description of method)

Project: Boulder Creek Commons - Preliminary Design

Basin ID: DET04 - Basins B1 and B2

(For catchments less than 160 acres only. For larger catchments, use hydrograph routing method)
(NOTE: for catchments larger than 90 acres, CUHP hydrograph and routing are recommended)

Determination of MINOR Detention Volume Using Modified FAA Method

Design Information (Input):

Catchment Drainage Imperviousness	I_a =	26.28	percent
Catchment Drainage Area	A =	2.120	acres
Predevelopment NRCS Soil Group	Type =	C	A, B, C, or D
Return Period for Detention Control	T =	10	years (2, 5, 10, 25, 50, or 100)
Time of Concentration of Watershed	Tc =	25	minutes
Allowable Unit Release Rate	q =	0.59	cfs/acre
One-hour Precipitation	P_1 =	1.61	inches
Design Rainfall IDF Formula	$i = C_1 * P_1/(C_2+T_c)^{\wedge}C_3$		
Coefficient One	C_1 =	28.50	
Coefficient Two	C_2 =	10	
Coefficient Three	C_3 =	0.789	

Determination of Average Outflow from the Basin (Calculated):

Runoff Coefficient	C =	0.37	
Inflow Peak Runoff	Qp-in =	2.18	cfs
Allowable Peak Outflow Rate	Qp-out =	**1.25**	cfs
Mod. FAA Minor Storage Volume =		1,505	**cubic feet**
Mod. FAA Minor Storage Volume =		**0.035**	**acre-ft**

5 <- Enter Rainfall Duration Incremental Increase Value Here (e.g. 5 for 5-Minutes)

Rainfall Duration minutes (input)	Rainfall Intensity inches / hr (output)	Inflow Volume cubic feet (output)	Adjustment Factor "m" (output)	Average Outflow cfs (output)	Outflow Volume cubic feet (output)	Storage Volume cubic feet (output)
0	0.00	0	0.00	0.00	0	0
5	5.42	1,275	1.00	1.25	375	899
10	4.32	2,032	1.00	1.25	750	1,281
15	3.62	2,556	1.00	1.25	1,126	1,430
20	3.13	2,951	1.00	1.25	1,501	1,450
25	2.78	3,266	1.00	1.25	1,876	1,390
30	2.50	3,527	0.92	1.15	2,064	1,464
35	2.28	3,750	0.86	1.07	2,251	1,499
40	2.09	3,944	0.81	1.02	2,439	1,505
45	1.94	4,116	0.78	0.97	2,627	1,489
50	1.81	4,269	0.75	0.94	2,814	1,455
55	1.70	4,409	0.73	0.91	3,002	1,407
60	1.61	4,537	0.71	0.89	3,190	1,347
65	1.52	4,654	0.69	0.87	3,377	1,277
70	1.45	4,763	0.68	0.85	3,565	1,199
75	1.38	4,865	0.67	0.83	3,752	1,113
80	1.32	4,961	0.66	0.82	3,940	1,021
85	1.26	5,051	0.65	0.81	4,128	923
90	1.21	5,136	0.64	0.80	4,315	820
95	1.17	5,216	0.63	0.79	4,503	713
100	1.12	5,293	0.63	0.78	4,691	602
105	1.09	5,366	0.62	0.77	4,878	488
110	1.05	5,436	0.61	0.77	5,066	370
115	1.02	5,503	0.61	0.76	5,253	250
120	0.99	5,567	0.60	0.76	5,441	126
125	0.96	5,629	0.60	0.75	5,629	0
130	0.93	5,689	0.60	0.75	5,816	-128
135	0.90	5,746	0.59	0.74	6,004	-258
140	0.88	5,802	0.59	0.74	6,191	-390
145	0.86	5,855	0.59	0.73	6,379	-524
150	0.84	5,907	0.58	0.73	6,567	-659
155	0.82	5,958	0.58	0.73	6,754	-796
160	0.80	6,007	0.58	0.72	6,942	-935
165	0.78	6,055	0.58	0.72	7,130	-1,075
170	0.76	6,101	0.57	0.72	7,317	-1,216
175	0.75	6,146	0.57	0.71	7,505	-1,359
180	0.73	6,190	0.57	0.71	7,692	-1,502
185	0.72	6,233	0.57	0.71	7,880	-1,647
190	0.70	6,275	0.57	0.71	8,068	-1,793
195	0.69	6,316	0.56	0.71	8,255	-1,940
200	0.68	6,356	0.56	0.70	8,443	-2,087
205	0.66	6,395	0.56	0.70	8,631	-2,236
210	0.65	6,433	0.56	0.70	8,818	-2,385
215	0.64	6,470	0.56	0.70	9,006	-2,535
220	0.63	6,507	0.56	0.70	9,193	-2,686
225	0.62	6,543	0.56	0.69	9,381	-2,838
230	0.61	6,578	0.55	0.69	9,569	-2,991
235	0.60	6,613	0.55	0.69	9,756	-3,144
240	0.59	6,647	0.55	0.69	9,944	-3,297
245	0.58	6,680	0.55	0.69	10,131	-3,452
250	0.57	6,713	0.55	0.69	10,319	-3,607
255	0.56	6,745	0.55	0.69	10,507	-3,762
260	0.55	6,776	0.55	0.69	10,694	-3,918
265	0.55	6,807	0.55	0.68	10,882	-4,075
270	0.54	6,838	0.55	0.68	11,070	-4,232
275	0.53	6,868	0.55	0.68	11,257	-4,389
280	0.52	6,897	0.54	0.68	11,445	-4,547
285	0.52	6,927	0.54	0.68	11,632	-4,706
290	0.51	6,955	0.54	0.68	11,820	-4,865
295	0.50	6,983	0.54	0.68	12,008	-5,024
300	0.50	7,011	0.54	0.68	12,195	-5,184

Mod. FAA Minor Storage Volume (cubic ft.) = 1,505
Mod. FAA Minor Storage Volume (acre-ft.) = 0.0345

Determination of MAJOR Detention Volume Using Modified FAA Method

Design Information (Input):

Catchment Drainage Imperviousness	I_a =	26.28	percent
Catchment Drainage Area	A =	2.120	acres
Predevelopment NRCS Soil Group	Type =	C	A, B, C, or D
Return Period for Detention Control	T =	100	years (2, 5, 10, 25, 50, or 100)
Time of Concentration of Watershed	Tc =	25	minutes
Allowable Unit Release Rate	q =	1.64	cfs/acre
One-hour Precipitation	P_1 =	2.61	inches
Design Rainfall IDF Formula	$i = C_1 * P_1/(C_2+T_c)^{\wedge}C_3$		
Coefficient One	C_1 =	28.50	
Coefficient Two	C_2 =	10	
Coefficient Three	C_3 =	0.789	

Determination of Average Outflow from the Basin (Calculated):

Runoff Coefficient	C =	0.56	
Inflow Peak Runoff	Qp-in =	5.34	cfs
Allowable Peak Outflow Rate	Qp-out =	**3.48**	cfs
Mod. FAA Major Storage Volume =		3,141	**cubic feet**
Mod. FAA Major Storage Volume =		**0.072**	**acre-ft**

Rainfall Duration minutes (input)	Rainfall Intensity inches / hr (output)	Inflow Volume cubic feet (output)	Adjustment Factor "m" (output)	Average Outflow cfs (output)	Outflow Volume cubic feet (output)	Storage Volume cubic feet (output)
0	0.00	0	0.00	0.00	0	0
5	8.78	3,127	1.00	3.48	1,043	2,084
10	7.00	4,985	1.00	3.48	2,086	2,899
15	5.87	6,270	1.00	3.48	3,129	3,141
20	5.08	7,240	1.00	3.48	4,172	3,068
25	4.50	8,014	1.00	3.48	5,215	2,798
30	4.05	8,655	0.92	3.19	5,737	2,918
35	3.69	9,201	0.86	2.98	6,258	2,943
40	3.40	9,677	0.81	2.82	6,780	2,897
45	3.15	10,098	0.78	2.70	7,301	2,797
50	2.94	10,475	0.75	2.61	7,823	2,653
55	2.76	10,818	0.73	2.53	8,344	2,473
60	2.60	11,131	0.71	2.46	8,866	2,265
65	2.47	11,420	0.69	2.41	9,387	2,032
70	2.34	11,687	0.68	2.36	9,909	1,779
75	2.23	11,937	0.67	2.32	10,430	1,507
80	2.14	12,172	0.66	2.28	10,952	1,220
85	2.05	12,392	0.65	2.25	11,473	919
90	1.97	12,601	0.64	2.22	11,995	606
95	1.89	12,799	0.63	2.20	12,516	282
100	1.82	12,987	0.63	2.17	13,038	-51
105	1.76	13,166	0.62	2.15	13,560	-393
110	1.70	13,338	0.61	2.13	14,081	-743
115	1.65	13,502	0.61	2.12	14,603	-1,101
120	1.60	13,660	0.60	2.10	15,124	-1,464
125	1.55	13,811	0.60	2.09	15,646	-1,834
130	1.51	13,958	0.60	2.07	16,167	-2,210
135	1.47	14,099	0.59	2.06	16,689	-2,590
140	1.43	14,235	0.59	2.05	17,210	-2,975
145	1.39	14,367	0.59	2.04	17,732	-3,365
150	1.36	14,494	0.58	2.03	18,253	-3,759
155	1.32	14,618	0.58	2.02	18,775	-4,156
160	1.29	14,739	0.58	2.01	19,296	-4,558
165	1.26	14,856	0.58	2.00	19,818	-4,962
170	1.24	14,969	0.57	1.99	20,339	-5,370
175	1.21	15,080	0.57	1.99	20,861	-5,781
180	1.18	15,188	0.57	1.98	21,382	-6,194
185	1.16	15,293	0.57	1.97	21,904	-6,611
190	1.14	15,396	0.57	1.97	22,425	-7,030
195	1.12	15,496	0.56	1.96	22,947	-7,451
200	1.09	15,594	0.56	1.96	23,468	-7,874
205	1.07	15,690	0.56	1.95	23,990	-8,300
210	1.06	15,784	0.56	1.95	24,511	-8,728
215	1.04	15,875	0.56	1.94	25,033	-9,157
220	1.02	15,965	0.56	1.94	25,554	-9,589
225	1.00	16,054	0.56	1.93	26,076	-10,022
230	0.99	16,140	0.55	1.93	26,598	-10,458
235	0.97	16,225	0.55	1.92	27,119	-10,894
240	0.95	16,308	0.55	1.92	27,641	-11,333
245	0.94	16,390	0.55	1.92	28,162	-11,773
250	0.92	16,470	0.55	1.91	28,684	-12,214
255	0.91	16,549	0.55	1.91	29,205	-12,657
260	0.90	16,626	0.55	1.91	29,727	-13,101
265	0.88	16,702	0.55	1.90	30,248	-13,546
270	0.87	16,777	0.55	1.90	30,770	-13,993
275	0.86	16,851	0.55	1.90	31,291	-14,440
280	0.85	16,923	0.54	1.89	31,813	-14,889
285	0.84	16,995	0.54	1.89	32,334	-15,339
290	0.83	17,065	0.54	1.89	32,856	-15,791
295	0.82	17,134	0.54	1.89	33,377	-16,243
300	0.81	17,203	0.54	1.88	33,899	-16,696

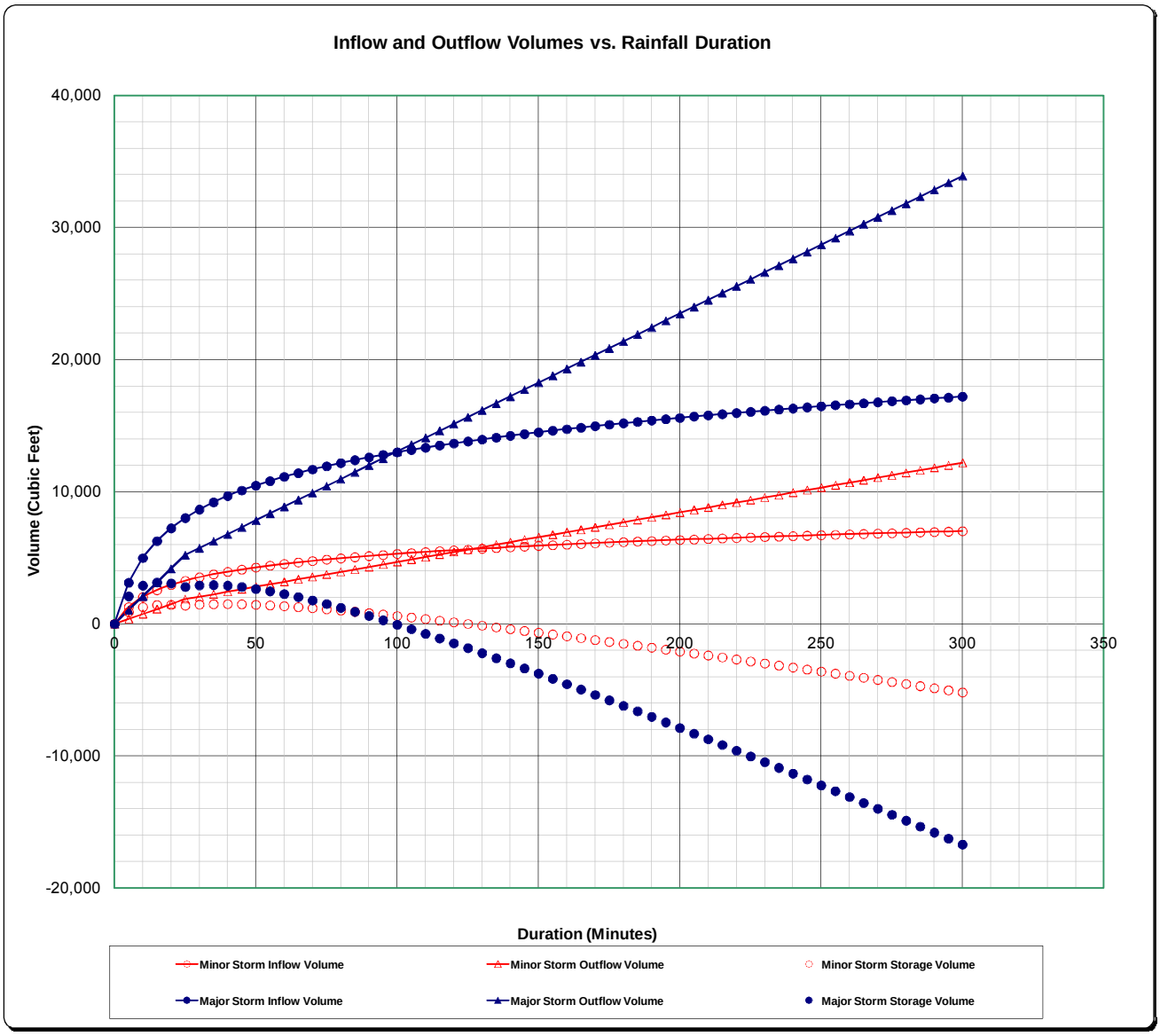
Mod. FAA Major Storage Volume (cubic ft.) = 3,141
Mod. FAA Major Storage Volume (acre-ft.) = 0.0721

UDFCD DETENTION VOLUME ESTIMATING WORKBOOK Version 2.2, Released January 2010

DETENTION VOLUME BY THE MODIFIED FAA METHOD
(See USDCM Volume 2 Storage Chapter for description of method)

Project: Boulder Creek Commons - Preliminary Design

Basin ID: DET04 - Basins B1 and B2



Design Procedure Form: Extended Detention Basin (EDB)

Designer:	**LRE**
Company:	**The Sanitas Group, LLC**
Date:	**September 26, 2012**
Project:	**Boulder Creek Commons - Preliminary Design**
Location:	**Boulder, CO**

1. Basin Storage Volume	
A) Effective Imperviousness of Tributary Area, I_a	I_a = 26.3 %
B) Tributary Area's Imperviousness Ratio ($i = I_a / 100$)	i = 0.263
C) Contributing Watershed Area	Area = 2.120 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 (1.2 WQCV) Based on 40-hour Drain Time (V_{DESIGN} = (1.0 * (0.91 * i^3 - 1.19 * i^2 + 0.78 * i) / 12 * Area * 1.2)	V_{DESIGN}= 0.030 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: EURVA = (0.1878i - 0.0104)*Area For HSG B: $EURV_B$ = (0.1178i - 0.0042)*Area For HSG C/D: $EURV_{C/D}$ = (0.1043i - 0.0031)*Area	EURV = ____ 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:	

Design Procedure Form: Extended Detention Basin (EDB)

Designer:	**LRE**
Company:	**The Sanitas Group, LLC**
Date:	**September 26, 2012**
Project:	**Boulder Creek Commons - Preliminary Design**
Location:	**Boulder, CO**

5. Forebay	
A) Minimum Forebay Volume (V_{FMIN} = _____ of the WQCV)	V_{FMIN} = 0.000 ac-ft — A FOREBAY MAY NOT BE NECESSARY FOR THIS SIZE SITE
B) Actual Forebay Volume	V_F = 0.000 ac-ft
C) Forebay Depth (D_F = _____ inch maximum)	D_F = 0.0 in
D) Forebay Discharge	
i) Undetained 100-year Peak Discharge	Q_{100} = _____ cfs
ii) Forebay Discharge Design Flow ($Q_F = 0.02 * Q_{100}$)	Q_F = _____ 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 = _____ in
6. Trickle Channel	
A) Type of Trickle Channel	Choose One: ○ Concrete ○ Soft Bottom
F) Slope of Trickle Channel	S = _____ ft / ft
7. Micropool and Outlet Structure	
A) Depth of Micropool (2.5-feet minimum)	D_M = _____ ft
B) Surface Area of Micropool (10 ft^2 minimum)	A_M = _____ sq ft
C) Outlet Type	Choose One: ○ Orifice Plate ○ Other (Describe):
D) Depth of Design Volume (EURV or 1.2 WQCV) Based on the Design Concept Chosen Under 1.E.	H = _____ feet
E) Volume to Drain Over Prescribed Time	WQCV = 0.025 ac-ft
F) Drain Time (Min T_D for WQCV= 40 hours; Max T_D for EURV= 72 hours)	T_D = _____ hours
G) Recommended Maximum Outlet Area per Row, (A_o)	A_o = _____ square inches
H) Orifice Dimensions: i) Circular Orifice Diameter or	$D_{orifice}$ = _____ inches
ii) Width of 2" High Rectangular Orifice	$W_{orifice}$ = _____ inches
I) Number of Columns	n_c = _____ number
J) Actual Design Outlet Area per Row (A_o)	A_o = _____ square inches
K) Number of Rows (nr)	n_r = _____ number
L) Total Outlet Area (A_{ot})	A_{ot} = _____ square inches
M) Depth of WQCV (H_{WQCV}) (Estimate using actual stage-area-volume relationship and V_{WQCV})	H_{WQCV} = _____ feet
N) Ensure Minimum 40 Hour Drain Time for WQCV	$T_{D\ WQCV}$ = _____ hours

FAA ALLOWABLE RELEASE RATES

FAA METHOD FOR INITIAL DETENTION POND SIZE REQ. FINAL POND SIZE TO BE DETERMINED BY ROUTING MODEL RESULTS.

ALLOWABLE RELEASE RATES FOR INPUT INTO FAA WORKSHEETS.

$A = A_{Ax} + A_{Bx} = 9.46_{AC} + 9.51_{AC} = 18.97$

$Q_{10} = Q_{10_{Ax}} + Q_{10_{Bx}} = 6.24_{cfs} + 4.91_{cfs} = 11.15_{cfs}$

$Q_{100} = Q_{100_{Ax}} + Q_{100_{Bx}} = 17.50_{cfs} + 13.61_{cfs} = 31.11_{cfs}$

(BASIN Dx NOT TRIBUTARY TO H, Cx EXCLUDED AND WILL NOT BE DEV.)

$$Q_{10_{ALL}} = \frac{Q_{10}}{A} = 0.59\ cfs/AC$$

$$Q_{100_{ALL}} = \frac{Q_{100}}{A} = 1.64\ cfs/AC$$

UNDETAINED SITE RELEASES

WESTERN PARCEL
$A = 19.44 AC$

AREA TRIBUTARY TO H1

$A_{H1} = A - A_{Dx} = 19.44 - 0.30$

$A_{H1} = 19.14$

UNDETAINED BASINS:
UNDEVELOPED ⇒ A1, A3, C EXEMPT

$A_{UND} = A_{A1} + A_{A3} + A_C = 0.28 + 1.86 + 0.33 = 2.47 AC$

$A_{H1_{DEV}} \Rightarrow A_{H1} - A_{UND}$

$A_{H1\,DEV} = 19.14 - 2.47 AC$

$A_{H1\,DEV} = 16.67 AC$

DEVELOPED UNDETAINED BASINS: A2 & A13

$A_{DEV} = 0.53 + 0.17 = 0.7 AC$

$\frac{A_{DEV}}{A_{H1\,DEV}} = \frac{0.7 AC}{16.67 AC} \Rightarrow \underline{\underline{4.2\%}} < 5.0\%_{MAX} \therefore OK$

$Q_{H1} = Q_{Ax} + Q_{Bx} + Q_{Cx}$

$Q_{H1\,10} = 6.24 + 4.91 + 0.14 = 11.29 cfs$

$Q_{H1\,100} = 17.50 + 13.61 + 0.41 = 31.52 cfs$

DEVELOPED UNDETAINED FLOWS:

$Q_{DEV} = Q_{A2} + Q_{A13}$

$Q_{10\,DEV} = 1.61 + 0.43 = 2.04 cfs$ $\quad \frac{Q_{10\,DEV}}{Q_{H1\,10}} = \frac{2.04}{11.29} \Rightarrow \underline{18.1\%} < 25\% \therefore OK$

$Q_{100\,DEV} = 3.42 + 1.00 = 4.42 cfs$ $\quad \frac{Q_{100\,DEV}}{Q_{H1,100}} = \frac{4.42}{31.52} \Rightarrow \underline{14.0\%} < 25\% \therefore OK$

TOPS 35500

APPENDIX C

Proposed Conditions Hydrology and Routing Models

Input Data for Rational Method

Basin A1

Proposed Conditions

Project:	Boulder Creek Commons	Prepared By:	LRE
SG Project I.D.:	B1006	Reviewed By:	CCS
		Date:	06/10/12
		Revised Date:	09/25/12

Basin Description: Located in the northwest corner of West Parcel, this basin includes the flood conveyance channel from Kewanee Drive to north property line.

NRCS Soil Type: Nh - Niwot **NRCS Hydrologic Soil Raiting:** C

Basin Area [acres] = 0.28

Surface Characteristics[1]	Sub-Area [acres]	Imp [%]	Runoff Coefficients			
			C_2	C_5	C_{10}	C_{100}
Parks / Open Space	0.28	7	0.15	0.25	0.35	0.60
Residential: Single-Family	0.00	40	0.40	0.45	0.50	0.70
Streets: Paved (Parking Lot)	0.00	100	0.87	0.88	0.90	0.93
Drives and Walks	0.00	96	0.85	0.87	0.90	0.92
Roofs	0.00	90	0.80	0.85	0.90	0.90
Landscape Areas-clayey soil	0.00	0	0.05	0.10	0.20	0.40

[1] *City of Boulder, DCS,* Table 7-2

Weighted Percent Imperviousness [%]: I = 7.08

Weighted Runoff Coefficients:

C_2 = 0.15
C_5 = 0.25
C_{10} = 0.35
C_{100} = 0.60

Time of Concentration:

Sheet Flow:

L_i [ft] =	45
S_i [%] =	3.80
t_i [min] =	6.56

Check for Urbanized Basins:

t_i=(L_i/180+10) [min] =	10.25
t_i [min] =	6.56

Concentrated Flow:

L_{t1} [FT] =	184	L_{t2} [FT] =	0
S_{t1} [%] =	0.25	S_{t2} [%] =	0.00
V_{t1} [fps][2]=	1.10	V_{t2} [fps] =	0.00
t_{t1} [min] =	2.79	t_{t2} [min] =	0.00

[2] *City of Boulder, DCS,* Figure 7-3

t_t [min] = 2.79

Time of Concentration:

t_c=t_i+t_t [min] =	9.35
t_c=5 min =	5.00

t_c [min] = 9.35

Input Data for Rational Method

Basin A2

Proposed Conditions

		Prepared By:	LRE
Project:	Boulder Creek Commons	Reviewed By:	CCS
SG Project I.D.:	B1006	Date:	06/10/12
		Revised Date:	09/25/12

Basin Description: Located in the northwestern area of the West Parcel, this basin includes the Kewanee Drive extension from the west. Drainage from this basin flows west to the proposed concrete crosspan and into the flood conveyance channel.

NRCS Soil Type: Nh - Niwot **NRCS Hydrologic Soil Raiting:** C

Basin Area [acres] = 0.53

Surface Characteristics[1]	Sub-Area [acres]	Imp [%]	Runoff Coefficients			
			C_2	C_5	C_{10}	C_{100}
Parks / Open Space	0.00	7	0.15	0.25	0.35	0.60
Residential: Single-Family	0.53	40	0.40	0.45	0.50	0.70
Streets: Paved (Parking Lot)	0.00	100	0.87	0.88	0.90	0.93
Drives and Walks	0.00	96	0.85	0.87	0.90	0.92
Roofs	0.00	90	0.80	0.85	0.90	0.90
Landscape Areas-clayey soil	0.00	0	0.05	0.10	0.20	0.40

[1] *City of Boulder, DCS,* Table 7-2

Weighted Percent Imperviousness [%]: I = 40.00

Weighted Runoff Coefficients:

C_2 = 0.40
C_5 = 0.45
C_{10} = 0.50
C_{100} = 0.70

Time of Concentration:

Sheet Flow:

L_i [ft] =	44
S_i [%] =	1.75
t_i [min] =	6.46

Check for Urbanized Basins:

t_i=(L_i/180+10) [min] =	10.25
t_i [min] =	6.46

Concentrated Flow:

L_{t1} [FT] =	252	L_{t2} [FT] =	0
S_{t1} [%] =	1.78	S_{t2} [%] =	0.00
V_{t1} [fps][2]=	2.50	V_{t2} [fps] =	0.00
t_{t1} [min] =	1.68	t_{t2} [min] =	0.00

[2] *City of Boulder, DCS,* Figure 7-3

t_t [min] = 1.68

Time of Concentration:

t_c=t_i+t_t [min] =	8.14
t_c=5 min =	5.00

t_c [min] = **8.14**

Input Data for Rational Method

Basin A3

Proposed Conditions

		Prepared By:	LRE
Project:	Boulder Creek Commons	Reviewed By:	CCS
SG Project I.D.:	B1006	Date:	06/10/12
		Revised Date:	09/25/12

Basin Description: This basin parallels the western property line of the west parcel. Drainage from this basin flows into the flood conveyance channel and is conveyed north to the culvert under Kewanee Drive.

NRCS Soil Type: Nh - Niwot **NRCS Hydrologic Soil Raiting:** C

Basin Area [acres] = 1.86

Surface Characteristics[1]	Sub-Area [acres]	Imp [%]	Runoff Coefficients			
			C_2	C_5	C_{10}	C_{100}
Parks / Open Space	1.86	7	0.15	0.25	0.35	0.60
Residential: Single-Family	0.00	40	0.40	0.45	0.50	0.70
Streets: Paved (Parking Lot)	0.00	100	0.87	0.88	0.90	0.93
Drives and Walks	0.00	96	0.85	0.87	0.90	0.92
Roofs	0.00	90	0.80	0.85	0.90	0.90
Landscape Areas-clayey soil	0.00	0	0.05	0.10	0.20	0.40

[1] *City of Boulder, DCS,* Table 7-2

Weighted Percent Imperviousness [%]: I = 7.00

Weighted Runoff Coefficients:

C_2 = 0.15
C_5 = 0.25
C_{10} = 0.35
C_{100} = 0.60

Time of Concentration:

Sheet Flow:

L_i [ft] =	172
S_i [%] =	1.58
t_i [min] =	17.23

NOTE: non-urbanized basin

t_i [min] = 17 23

Concentrated Flow:

L_{t1} [FT] =	846	L_{t2} [FT] =	0
S_{t1} [%] =	0.77	S_{t2} [%] =	0.00
V_{t1} [fps][2]=	1.10	V_{t2} [fps] =	0.00
t_{t1} [min] =	12.82	t_{t2} [min] =	0.00

[2] *City of Boulder, DCS,* Figure 7-3

t_t [min] = 12.82

Time of Concentration:

$t_c=t_i+t_t$ [min] =	30.05
t_c=5 min =	5.00

t_c [min] = 30.05

Input Data for Rational Method

Basin A4

Proposed Conditions

		Prepared By:	LRE
Project:	Boulder Creek Commons	Reviewed By:	CCS
SG Project I.D.:	B1006	Date:	06/10/12
		Revised Date:	09/25/12

Basin Description: Located east of Basin A3, this basin includes rear yards and Detention Pond 1. Drainage from this basin is conveyed by grass swales to Detention Pond 1.

NRCS Soil Type: Nh - Niwot **NRCS Hydrologic Soil Ralting:** C

Basin Area [acres] = 0.76

Surface Characteristics[1]	Sub-Area [acres]	Imp [%]	Runoff Coefficients			
			C_2	C_5	C_{10}	C_{100}
Parks / Open Space	0.31	7	0.15	0.25	0.35	0.60
Residential: Single-Family	0.45	40	0.40	0.45	0.50	0.70
Streets: Paved (Parking Lot)	0.00	100	0.87	0.88	0.90	0.93
Drives and Walks	0.00	96	0.85	0.87	0.90	0.92
Roofs	0.00	90	0.80	0.85	0.90	0.90
Landscape Areas-clayey soil	0.00	0	0.05	0.10	0.20	0.40

[1] *City of Boulder, DCS,* Table 7-2

Weighted Percent Imperviousness [%]: I = 26.64

Weighted Runoff Coefficients:

C_2 = 0.30
C_5 = 0.37
C_{10} = 0.44
C_{100} = 0.66

Time of Concentration:

Sheet Flow:

L_i [ft] =	56
S_i [%] =	2.00
t_i [min] =	7.78

Check for Urbanized Basins:

t_i=(L_i/180+10) [min] =	10.31
t_i [min] =	7.78

Concentrated Flow:

L_{t1} [FT] =	194	L_{t2} [FT] =	0
S_{t1} [%] =	3.10	S_{t2} [%] =	0.00
V_{t1} [fps][2]=	2.50	V_{t2} [fps] =	0.00
t_{t1} [min] =	1.29	t_{t2} [min] =	0.00

[2] *City of Boulder, DCS,* Figure 7-3

t_t [min] = 1.29

Time of Concentration:

t_c=t_i+t_t [min] =	9.07
t_c=5 min =	5.00
t_c [min] =	9.07

Input Data for Rational Method

Basin A5

Proposed Conditions

		Prepared By:	LRE
Project:	Boulder Creek Commons	Reviewed By:	CCS
SG Project I.D.:	B1006	Date:	06/10/12
		Revised Date:	09/25/12

Basin Description: Located on the west half of the West Parcel, this basin includes the western open space, Detention Pond 2 and residential lots. Drainage from this basin is conveyed north through the open space to Detention Pond 2.

NRCS Soil Type: Nh - Niwot **NRCS Hydrologic Soil Raiting:** C

Basin Area [acres] = 2.35

Surface Characteristics[1]	Sub-Area [acres]	Imp [%]	Runoff Coefficients			
			C_2	C_5	C_{10}	C_{100}
Parks / Open Space	0.80	7	0.15	0.25	0.35	0.60
Residential: Single-Family	1.55	40	0.40	0.45	0.50	0.70
Streets: Paved (Parking Lot)	0.00	100	0.87	0.88	0.90	0.93
Drives and Walks	0.00	96	0.85	0.87	0.90	0.92
Roofs	0.00	90	0.80	0.85	0.90	0.90
Landscape Areas-clayey soil	0.00	0	0.05	0.10	0.20	0.40

[1] *City of Boulder, DCS,* Table 7-2

Weighted Percent Imperviousness [%]: I = 28.73

Weighted Runoff Coefficients:

C_2 = 0.31
C_5 = 0.38
C_{10} = 0.45
C_{100} = 0.67

Time of Concentration:

Sheet Flow:

L_i [ft] =	105
S_i [%] =	3.00
t_i [min] =	9.19

Check for Urbanized Basins:

t_i=(L_i/180+10) [min] =	10.58
t_i [min] =	9.19

Concentrated Flow:

L_{t1} [FT] =	535	L_{t2} [FT] =	0
S_{t1} [%] =	0.61	S_{t2} [%] =	0.00
V_{t1} [fps][2] =	1.25	V_{t2} [fps] =	0.00
t_{t1} [min] =	7.13	t_{t2} [min] =	0.00

[2] *City of Boulder, DCS,* Figure 7-3

t_t [min] = 7.13

Time of Concentration:

t_c=t_i+t_t [min] =	16.32
t_c=5 min =	5.00

t_c [min] = 16.32

Input Data for Rational Method

Basin A6

Proposed Conditions

		Prepared By:	LRE
Project:	Boulder Creek Commons	Reviewed By:	CCS
SG Project I.D.:	B1006	Date:	09/25/12
		Revised Date:	

Basin Description: Located on the southern half of the West Parcel, this basin includes proposed residential lots proposed roadways. Drainage from this basin flows by storm sewer to Detention Pond 2.

NRCS Soil Type: Nh - Niwot **NRCS Hydrologic Soil Raiting:** C

Basin Area [acres] = 0.66

Surface Characteristics[1]	Sub-Area [acres]	Imp [%]	Runoff Coefficients			
			C_2	C_5	C_{10}	C_{100}
Parks / Open Space	0.02	7	0.15	0.25	0.35	0.60
Residential: Single-Family	0.64	40	0.40	0.45	0.50	0.70
Streets: Paved (Parking Lot)	0.00	100	0.87	0.88	0.90	0.93
Drives and Walks	0.00	96	0.85	0.87	0.90	0.92
Roofs	0.00	90	0.80	0.85	0.90	0.90
Landscape Areas-clayey soil	0.00	0	0.05	0.10	0.20	0.40

[1] *City of Boulder, DCS,* Table 7-2

Weighted Percent Imperviousness [%]: I = 38.96

Weighted Runoff Coefficients:

C_2 = 0.39
C_5 = 0.44
C_{10} = 0.50
C_{100} = 0.70

Time of Concentration:

Sheet Flow:

L_i [ft] = 83
S_i [%] = 2.30
t_i [min] = 8.13

Check for Urbanized Basins:

t_i=(L_i/180+10) [min] = 10.46

t_i [min] = 8.13

Concentrated Flow:

L_{t1} [FT] =	266	L_{t2} [FT] =	0
S_{t1} [%] =	0.70	S_{t2} [%] =	0.00
V_{t1} [fps][2]=	1.75	V_{t2} [fps] =	0.00
t_{t1} [min] =	2.53	t_{t2} [min] =	0.00

[2] *City of Boulder, DCS,* Figure 7-3

t_t [min] = 2.53

Time of Concentration:

t_c=t_i+t_t [min] = 10.66
t_c=5 min = 5.00

t_c [min] = 10.66

Input Data for Rational Method

Basin A7

Proposed Conditions

		Prepared By:	LRE
Project:	Boulder Creek Commons	Reviewed By:	CCS
SG Project I.D.:	B1006	Date:	06/10/12
		Revised Date:	08/20/12

Basin Description: Located in the western half of the West Parcel, this basin includes proposed roadways and residential lots. Drainage from this basin is conveyed by roadways and storm sewer to the western open space and Detention Pond 2.

NRCS Soil Type: Nh - Niwot **NRCS Hydrologic Soil Raiting:** C

Basin Area [acres] = 1.64

Surface Characteristics[1]	Sub-Area [acres]	Imp [%]	Runoff Coefficients			
			C_2	C_5	C_{10}	C_{100}
Parks / Open Space	0.00	7	0.15	0.25	0.35	0.60
Residential: Single-Family	1.64	40	0.40	0.45	0.50	0.70
Streets: Paved (Parking Lot)	0.00	100	0.87	0.88	0.90	0.93
Drives and Walks	0.00	96	0.85	0.87	0.90	0.92
Roofs	0.00	90	0.80	0.85	0.90	0.90
Landscape Areas-clayey soil	0.00	0	0.05	0.10	0.20	0.40

[1] *City of Boulder, DCS,* Table 7-2

Weighted Percent Imperviousness [%]: I = 40.00

Weighted Runoff Coefficients:

C_2 = 0.40
C_5 = 0.45
C_{10} = 0.50
C_{100} = 0.70

Time of Concentration:

Sheet Flow:

L_i [ft] =	85
S_i [%] =	1.45
t_i [min] =	9.53

Check for Urbanized Basins:

t_i=(L_i/180+10) [min] =	10.47
t_i [min] =	9.53

Concentrated Flow:

L_{t1} [FT] =	492	L_{t2} [FT] =	0
S_{t1} [%] =	0.61	S_{t2} [%] =	0.00
V_{t1} [fps][2] =	1.60	V_{t2} [fps] =	0.00
t_{t1} [min] =	5.13	t_{t2} [min] =	0.00

[2] *City of Boulder, DCS,* Figure 7-3

t_t [min] = 5.13

Time of Concentration:

t_c=t_i+t_t [min] =	14.66
t_c=5 min =	5.00

t_c [min] = **14.66**

Input Data for Rational Method

Basin A8

Proposed Conditions

		Prepared By:	LRE
Project:	Boulder Creek Commons	Reviewed By:	CCS
SG Project I.D.:	B1006	Date:	09/25/12
		Revised Date:	

Basin Description: Located on the middle of the West Parcel, this basin includes proposed residential lots proposed roadways. Drainage from this basin flows by storm sewer to Detention Pond 1.

NRCS Soil Type: Nh - Niwot **NRCS Hydrologic Soil Raiting:** C

Basin Area [acres] = 2.22

Surface Characteristics[1]	Sub-Area [acres]	Imp [%]	Runoff Coefficients			
			C_2	C_5	C_{10}	C_{100}
Parks / Open Space	0.02	7	0.15	0.25	0.35	0.60
Residential: Single-Family	2.20	40	0.40	0.45	0.50	0.70
Streets: Paved (Parking Lot)	0.00	100	0.87	0.88	0.90	0.93
Drives and Walks	0.00	96	0.85	0.87	0.90	0.92
Roofs	0.00	90	0.80	0.85	0.90	0.90
Landscape Areas-clayey soil	0.00	0	0.05	0.10	0.20	0.40

[1] *City of Boulder, DCS,* Table 7-2

Weighted Percent Imperviousness [%]: I = 39.69

Weighted Runoff Coefficients:

C_2 = 0.40
C_5 = 0.45
C_{10} = 0.50
C_{100} = 0.70

Time of Concentration:

Sheet Flow:

L_i [ft] = 31
S_i [%] = 2.00
t_i [min] = 5.18

Check for Urbanized Basins:
t_i=(L/180+10) [min] = 10.17

t_i [min] = 5.18

Concentrated Flow:

L_{t1} [FT] =	796	L_{t2} [FT] =	0
S_{t1} [%] =	0.50	S_{t2} [%] =	0.00
V_{t1} [fps][2] =	1.25	V_{t2} [fps] =	0.00
t_{t1} [min] =	10.61	t_{t2} [min] =	0.00

[2] *City of Boulder, DCS,* Figure 7-3

t_t [min] = 10.61

Time of Concentration:

t_c=t_i+t_t [min] = 15.79
t_c=5 min = 5.00

t_c [min] = 15.79

Input Data for Rational Method

Basin A9

Proposed Conditions

		Prepared By:	LRE
Project:	Boulder Creek Commons	Reviewed By:	CCS
SG Project I.D.:	B1006	Date:	06/10/12
		Revised Date:	09/25/12

Basin Description: Located in the southern portion of the West Parcel, this basin includes proposed roadways and residential lots. Drainage from this basin is conveyed by roadways and storm sewer to the eastern open space and Detention Pond 3.

NRCS Soil Type: Nh - Niwot **NRCS Hydrologic Soil Raiting:** C

Basin Area [acres] = 1.33

Surface Characteristics[1]	Sub-Area [acres]	Imp [%]	Runoff Coefficients			
			C_2	C_5	C_{10}	C_{100}
Parks / Open Space	0.00	7	0.15	0.25	0.35	0.60
Residential: Single-Family	1.33	40	0.40	0.45	0.50	0.70
Streets: Paved (Parking Lot)	0.00	100	0.87	0.88	0.90	0.93
Drives and Walks	0.00	96	0.85	0.87	0.90	0.92
Roofs	0.00	90	0.80	0.85	0.90	0.90
Landscape Areas-clayey soil	0.00	0	0.05	0.10	0.20	0.40

[1] *City of Boulder, DCS,* Table 7-2

Weighted Percent Imperviousness [%]: I = 40.00

Weighted Runoff Coefficients:

C_2 = 0.40
C_5 = 0.45
C_{10} = 0.50
C_{100} = 0.70

Time of Concentration:

Sheet Flow:

L_i [ft] =	133
S_i [%] =	2.10
t_i [min] =	10.52

Check for Urbanized Basins:

t_i=(L_i/180+10) [min] =	10.74

t_i [min] =	10.52

Concentrated Flow:

L_{t1} [FT] =	293	L_{t2} [FT] =	0
S_{t1} [%] =	0.57	S_{t2} [%] =	0.00
V_{t1} [fps][2]=	1.25	V_{t2} [fps] =	0.00
t_{t1} [min] =	3.91	t_{t2} [min] =	0.00

[2] *City of Boulder, DCS,* Figure 7-3

t_t [min] =	3.91

Time of Concentration:

t_c=t_i+t_t [min] =	14.42
t_c=5 min =	5.00

t_c [min] =	**14.42**

Input Data for Rational Method

Basin A10

Proposed Conditions

		Prepared By:	LRE
Project:	Boulder Creek Commons	Reviewed By:	CCS
SG Project I.D.:	B1006	Date:	09/25/12
		Revised Date:	

Basin Description: Located on the east half of the West Parcel, this basin includes proposed residential lots, the eastern open space and Detention Pond 3. Drainage from this basin flows to Detention Pond 3.

NRCS Soil Type: Nh - Niwot **NRCS Hydrologic Soil Ralting:** C

Basin Area [acres] = 1.62

Surface Characteristics[1]	Sub-Area [acres]	Imp [%]	Runoff Coefficients			
			C_2	C_5	C_{10}	C_{100}
Parks / Open Space	0.54	7	0.15	0.25	0.35	0.60
Residential: Single-Family	1.08	40	0.40	0.45	0.50	0.70
Streets: Paved (Parking Lot)	0.00	100	0.87	0.88	0.90	0.93
Drives and Walks	0.00	96	0.85	0.87	0.90	0.92
Roofs	0.00	90	0.80	0.85	0.90	0.90
Landscape Areas-clayey soil	0.00	0	0.05	0.10	0.20	0.40

[1] *City of Boulder, DCS,* Table 7-2

Weighted Percent Imperviousness [%]: I = 29.00

Weighted Runoff Coefficients:

C_2 = 0.32
C_5 = 0.38
C_{10} = 0.45
C_{100} = 0.67

Time of Concentration:

Sheet Flow:

L_i [ft] = 110
S_i [%] = 2.00
t_i [min] = 10.74

Check for Urbanized Basins:

t_i=(L_i/180+10) [min] = 10.61

t_i [min] = 10.61

Concentrated Flow:

L_{t1} [FT] =	420	L_{t2} [FT] =	0
S_{t1} [%] =	0.50	S_{t2} [%] =	0.00
V_{t1} [fps][2]=	1.25	V_{t2} [fps] =	0.00
t_{t1} [min] =	5.60	t_{t2} [min] =	0.00

[2] *City of Boulder, DCS,* Figure 7-3

t_t [min] = 5.60

Time of Concentration:

t_c=t_i+t_t [min] = 16.21
t_c=5 min = 5.00

t_c [min] = 16.21

Input Data for Rational Method

Basin A11

Proposed Conditions

		Prepared By:	LRE
Project:	Boulder Creek Commons	Reviewed By:	CCS
SG Project I.D.:	B1006	Date:	09/25/12
		Revised Date:	

Basin Description: Located in the eastern half of the West Parcel, this basin includes proposed roadways and residential lots. Drainage from this basin is conveyed by roadways and storm sewer to the western open space and Detention Pond 3.

NRCS Soil Type: Nh - Niwot **NRCS Hydrologic Soil Raiting:** C

Basin Area [acres] = 0.80

Surface Characteristics[1]	Sub-Area [acres]	Imp [%]	Runoff Coefficients			
			C_2	C_5	C_{10}	C_{100}
Parks / Open Space	0.02	7	0.15	0.25	0.35	0.60
Residential: Single-Family	0.78	40	0.40	0.45	0.50	0.70
Streets: Paved (Parking Lot)	0.00	100	0.87	0.88	0.90	0.93
Drives and Walks	0.00	96	0.85	0.87	0.90	0.92
Roofs	0.00	90	0.80	0.85	0.90	0.90
Landscape Areas-clayey soil	0.00	0	0.05	0.10	0.20	0.40

[1] *City of Boulder, DCS,* Table 7-2

Weighted Percent Imperviousness [%]: I = 39.07

Weighted Runoff Coefficients:

C_2 = 0.39
C_5 = 0.44
C_{10} = 0.50
C_{100} = 0.70

Time of Concentration:

Sheet Flow:

L_i [ft] =	45
S_i [%] =	2.40
t_i [min] =	5.91

Check for Urbanized Basins:

$t_i=(L_i/180+10)$ [min] =	10.25
t_i [min] =	5.91

Concentrated Flow:

L_{t1} [FT] =	390	L_{t2} [FT] =	0
S_{t1} [%] =	0.50	S_{t2} [%] =	0.00
V_{t1} [fps][2]=	1.25	V_{t2} [fps] =	0.00
t_{t1} [min] =	5.20	t_{t2} [min] =	0.00

[2] *City of Boulder, DCS,* Figure 7-3

t_t [min] = 5.20

Time of Concentration:

$t_c=t_i+t_t$ [min] =	11.11
t_c=5 min =	5.00
t_c [min] =	11.11

Input Data for Rational Method

Basin A12

Proposed Conditions

		Prepared By:	LRE
Project:	Boulder Creek Commons	Reviewed By:	CCS
SG Project I.D.:	B1006	Date:	06/10/12
		Revised Date:	09/25/12

Basin Description: Located in the northeast portion of the West Parcel, this basin includes the senior housing complex and parking lot. Drainage from this basin is conveyed either overland or by private storm sewer to the storm sewer in Kewanee Drive.

NRCS Soil Type: Nh - Niwot NRCS Hydrologic Soil Raiting: C

Basin Area [acres] = 2.50

Surface Characteristics[1]	Sub-Area [acres]	Imp [%]	Runoff Coefficients			
			C_2	C_5	C_{10}	C_{100}
Parks / Open Space	0.00	7	0.15	0.25	0.35	0.60
Residential: Single-Family	0.00	40	0.40	0.45	0.50	0.70
Streets: Paved (Parking Lot)	0.57	100	0.87	0.88	0.90	0.93
Drives and Walks	0.18	96	0.85	0.87	0.90	0.92
Roofs	0.66	90	0.80	0.85	0.90	0.90
Landscape Areas-clayey soil	1.09	0	0.05	0.10	0.20	0.40

[1] *City of Boulder, DCS,* Table 7-2

Weighted Percent Imperviousness [%]: I = 53.57

Weighted Runoff Coefficients:

C_2 = 0.49
C_5 = 0.53
C_{10} = 0.60
C_{100} = 0.69

Time of Concentration:

Sheet Flow:

L_i [ft] = 112
S_i [%] = 2.50
t_i [min] = 7.97

Check for Urbanized Basins:

t_i=(L_i/180+10) [min] = 10.62

t_i [min] = 7.97

Concentrated Flow:

L_{t1} [FT] =	486	L_{t2} [FT] =	0
S_{t1} [%] =	0.50	S_{t2} [%] =	0.00
V_{t1} [fps][2]=	1.25	V_{t2} [fps] =	0.00
t_{t1} [min] =	6.48	t_{t2} [min] =	0.00

[2] *City of Boulder, DCS,* Figure 7-3

t_t [min] = 6.48

Time of Concentration:

t_c=t_i+t_t [min] = 14.45
t_c=5 min = 5.00

t_c [min] = 14.45

Input Data for Rational Method

Basin A13

Proposed Conditions

		Prepared By:	LRE
Project:	Boulder Creek Commons	Reviewed By:	CCS
SG Project I.D.:	B1006	Date:	06/10/12
		Revised Date:	09/25/12

Basin Description: Located at the intersection of Kewanee Drive and 55th Street, this basin includes a small portion of proposed roadway and entry landscaping. Drainage from this basin discharges to the western curb and gutter in 55th Street.

NRCS Soil Type: Nh - Niwot **NRCS Hydrologic Soil Raiting:** C

Basin Area [acres] = 0.17

Surface Characteristics[1]	Sub-Area [acres]	Imp [%]	Runoff Coefficients			
			C_2	C_5	C_{10}	C_{100}
Parks / Open Space	0.09	7	0.15	0.25	0.35	0.60
Residential: Single-Family	0.08	40	0.40	0.45	0.50	0.70
Streets: Paved (Parking Lot)	0.00	100	0.87	0.88	0.90	0.93
Drives and Walks	0.00	96	0.85	0.87	0.90	0.92
Roofs	0.00	90	0.80	0.85	0.90	0.90
Landscape Areas-clayey soil	0.00	0	0.05	0.10	0.20	0.40

[1] *City of Boulder, DCS,* Table 7-2

Weighted Percent Imperviousness [%]: I = 22.39

Weighted Runoff Coefficients:

C_2 = 0.27
C_5 = 0.34
C_{10} = 0.42
C_{100} = 0.65

Time of Concentration:

Sheet Flow:

L_i [ft] =	60
S_i [%] =	2.00
t_i [min] =	8.37

Check for Urbanized Basins:

t_i=(L_i/180+10) [min] =	10.33
t_i [min] =	8.37

Concentrated Flow:

L_{t1} [FT] =	0	L_{t2} [FT] =	0
S_{t1} [%] =	0.00	S_{t2} [%] =	0.00
V_{t1} [fps][2]=	0.00	V_{t2} [fps] =	0.00
t_{t1} [min] =	0.00	t_{t2} [min] =	0.00

[2] *City of Boulder, DCS,* Figure 7-3

t_t [min] = 0.00

Time of Concentration:

t_c=t_i+t_t [min] =	8.37
t_c=5 min =	5.00
t_c [min] =	8.37

Input Data for Rational Method

Basin B1

Proposed Conditions

		Prepared By:	LRE
Project:	Boulder Creek Commons	Reviewed By:	CCS
SG Project I.D.:	B1006	Date:	06/10/12
		Revised Date:	09/25/12

Basin Description: Located on the West Parcel, this basin parallels the north property line and includes residential lots and open space. Drainage from this basin flows overland to a cobble channel and is conveyed to Detention Pond 4.

NRCS Soil Type: Nh - Niwot **NRCS Hydrologic Soil Raiting:** C

Basin Area [acres] = 1.19

Surface Characteristics[1]	Sub-Area [acres]	Imp [%]	Runoff Coefficients			
			C_2	C_5	C_{10}	C_{100}
Parks / Open Space	0.20	7	0.15	0.25	0.35	0.60
Residential: Single-Family	0.99	40	0.40	0.45	0.50	0.70
Streets: Paved (Parking Lot)	0.00	100	0.87	0.88	0.90	0.93
Drives and Walks	0.00	96	0.85	0.87	0.90	0.92
Roofs	0.00	90	0.80	0.85	0.90	0.90
Landscape Areas-clayey soil	0.00	0	0.05	0.10	0.20	0.40

[1] *City of Boulder, DCS,* Table 7-2

Weighted Percent Imperviousness [%]: I = 34.37

Weighted Runoff Coefficients:

C_2 = 0.36
C_5 = 0.42
C_{10} = 0.47
C_{100} = 0.68

Time of Concentration:

Sheet Flow:

L_i [ft] =	65
S_i [%] =	8.50
t_i [min] =	4.86

Check for Urbanized Basins:

t_i=(L_i/180+10) [min] =	10.36
t_i [min] =	4.86

Concentrated Flow:

L_{t1} [FT] =	605	L_{t2} [FT] =	0
S_{t1} [%] =	0.50	S_{t2} [%] =	0.00
V_{t1} [fps][2]=	1.25	V_{t2} [fps] =	0.00
t_{t1} [min] =	8.07	t_{t2} [min] =	0.00

[2] *City of Boulder, DCS,* Figure 7-3

t_t [min] = 8.07

Time of Concentration:

t_c=t_i+t_t [min] =	12.93
t_c=5 min =	5.00
t_c [min] =	12.93

Input Data for Rational Method

Basin B2

Proposed Conditions

		Prepared By:	LRE
Project:	Boulder Creek Commons	Reviewed By:	CCS
SG Project I.D.:	B1006	Date:	06/10/12
		Revised Date:	09/25/12

Basin Description: Located between the senior housing complex and the Howard-Superphostical Lateral, this basin includes landscape area and open space. This basin drains overland and along the lateral to the north property line and Basin B1.

NRCS Soil Type: Nh - Niwot **NRCS Hydrologic Soil Raiting:** C

Basin Area [acres] = 0.93

Surface Characteristics[1]	Sub-Area [acres]	Imp [%]	Runoff Coefficients			
			C_2	C_5	C_{10}	C_{100}
Parks / Open Space	0.68	7	0.15	0.25	0.35	0.60
Residential: Single-Family	0.25	40	0.40	0.45	0.50	0.70
Streets: Paved (Parking Lot)	0.00	100	0.87	0.88	0.90	0.93
Drives and Walks	0.00	96	0.85	0.87	0.90	0.92
Roofs	0.00	90	0.80	0.85	0.90	0.90
Landscape Areas-clayey soil	0.00	0	0.05	0.10	0.20	0.40

[1] *City of Boulder, DCS,* Table 7-2

Weighted Percent Imperviousness [%]: I = 15.95

Weighted Runoff Coefficients:

C_2 = 0.22
C_5 = 0.30
C_{10} = 0.39
C_{100} = 0.63

Time of Concentration:

Sheet Flow:

L_i [ft] = 72
S_i [%] = 5.00
t_i [min] = 7.11

NOTE: non-urbanized basin

t_i [min] = 7.11

Concentrated Flow:

L_{t1} [FT] =	725	L_{t2} [FT] =	0
S_{t1} [%] =	0.50	S_{t2} [%] =	0.00
V_{t1} [fps][2] =	1.25	V_{t2} [fps] =	0.00
t_{t1} [min] =	9.67	t_{t2} [min] =	0.00

[2] *City of Boulder, DCS,* Figure 7-3

t_t [min] = 9.67

Time of Concentration:

$t_c = t_i + t_t$ [min] = 16.77
t_c=5 min = 5.00

t_c [min] = **16.77**

Input Data for Rational Method

Basin C

Proposed Conditions

		Prepared By:	LRE
Project:	Boulder Creek Commons	Reviewed By:	CCS
SG Project I.D.:	B1006	Date:	06/10/12
		Revised Date:	09/25/12

Basin Description: Located parallel to the south property line, this basin includes the Bodam Lateral and rear yards. Drainage from this basin flows overland towards the Bodam Lateral and is conveyed along the lateral west to the flood channel.

NRCS Soil Type: Nh - Niwot **NRCS Hydrologic Soil Raiting:** C

Basin Area [acres] = 0.33

Surface Characteristics[1]	Sub-Area [acres]	Imp [%]	Runoff Coefficients			
			C_2	C_5	C_{10}	C_{100}
Parks / Open Space	0.33	7	0.15	0.25	0.35	0.60
Residential: Single-Family	0.00	40	0.40	0.45	0.50	0.70
Streets: Paved (Parking Lot)	0.00	100	0.87	0.88	0.90	0.93
Drives and Walks	0.00	96	0.85	0.87	0.90	0.92
Roofs	0.00	90	0.80	0.85	0.90	0.90
Landscape Areas-clayey soil	0.00	0	0.05	0.10	0.20	0.40

[1] *City of Boulder, DCS,* Table 7-2

Weighted Percent Imperviousness [%]: I = 7.00

Weighted Runoff Coefficients:

C_2 = 0.15
C_5 = 0.25
C_{10} = 0.35
C_{100} = 0.60

Time of Concentration:

Sheet Flow:

L_i [ft] = 8
S_i [%] = 22.50
t_i [min] = 1.53

NOTE: non-urbanized basin

Concentrated Flow:

L_{t1} [FT] =	895	L_{t2} [FT] =	0
S_{t1} [%] =	0.25	S_{t2} [%] =	0.00
V_{t1} [fps][2] =	0.50	V_{t2} [fps] =	0.00
t_{t1} [min] =	29.83	t_{t2} [min] =	0.00

[2] *City of Boulder, DCS,* Figure 7-3

t_i [min] = 1.53

t_t [min] = 29.83

Time of Concentration:

$t_c = t_i + t_t$ [min] = 31.37
t_c=5 min = 5.00

t_c [min] = 31.37

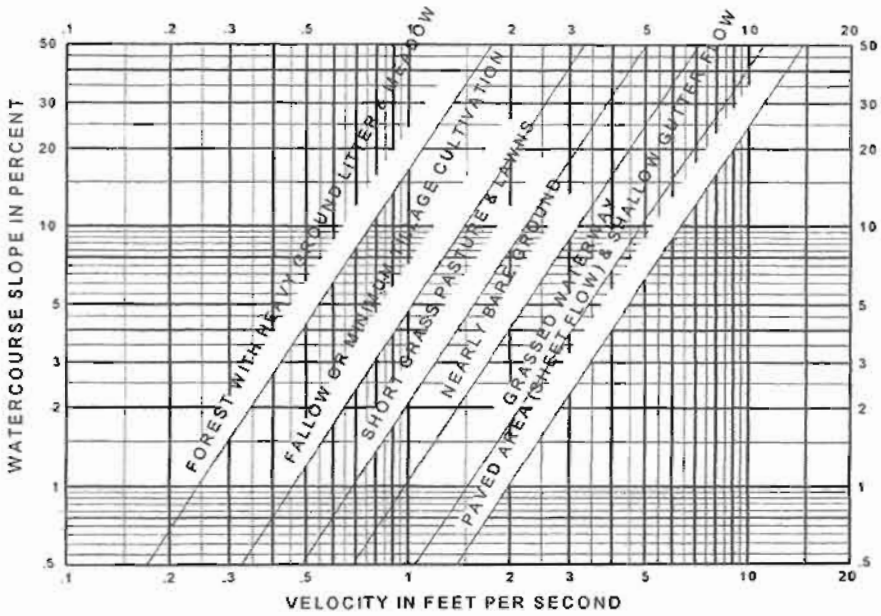
Table 7-2: Runoff Coefficients for the Rational Method

LAND USE OR SURFACE CHARACTERISTICS	PERCENT IMPERVIOUS	STORM FREQUENCY			
		2-Yr	5-Yr	10-Yr	100-Yr
Business:					
Commercial Areas	95	0.87	0.88	0.90	0.93
Neighborhood Areas	65	0.60	0.65	0.70	0.80
Residential:					
Single-Family	40	0.40	0.45	0.50	0.70
Multi-Unit (detached)	50	0.50	0.55	0.60	0.75
Multi-Unit (attached)	70	0.65	0.70	0.70	0.80
½ Acre Lot	30	0.30	0.40	0.45	0.65
Apartments	70	0.65	0.70	0.70	0.80
Industrial:					
Light Areas	80	0.75	0.80	0.80	0.85
Heavy Areas	90	0.80	0.80	0.85	0.90
Parks, Cemeteries:	7	0.15	0.25	0.35	0.60
Playgrounds:	13	0.20	0.30	0.40	0.70
Schools:	50	0.50	0.55	0.60	0.75
Railroad Yard Areas:	40	0.40	0.45	0.50	0.70
Undeveloped Areas:					
Historic Flow Analysis	2	0.10	0.20	0.30	0.60
Greenbelts, Agricultural	-	-	-	-	-
Offsite Flow Analysis (when offsite land use is not defined)	45	0.45	0.50	0.55	0.72
Streets:					
Paved	100	0.87	0.88	0.90	0.93
Gravel	7	0.15	0.25	0.35	0.65
Drives and Walks:	96	0.85	.087	0.90	0.92
Roofs:	90	0.80	0.85	0.90	0.90
Lawns:					
Sandy Soil	0	0.00	0.10	0.20	0.50
Clayey Soil	0	0.10	0.20	0.30	0.60

NOTE: These rational formula coefficients do not apply for larger basins where the time-of-concentration exceeds 60 minutes.

(Source: Urban Drainage and Flood Control District)

FIGURE 7-3: TIME OF TRAVEL



ESTIMATE OF AVERAGE FLOW VELOCITY FOR USE WITH THE RATIONAL METHOD

Project Description

File Name 1006-HYD-10YR-P.SPF

Project Options

Flow Units	CFS
Elevation Type	Elevation
Hydrology Method	Rational
Time of Concentration (TOC) Method	User-Defined
Link Routing Method	Kinematic Wave
Enable Overflow Ponding at Nodes	YES
Skip Steady State Analysis Time Periods	NO

Analysis Options

Start Analysis On	Oct 03, 2012	00:00:00
End Analysis On	Oct 05, 2012	00:00:00
Start Reporting On	Oct 03, 2012	00:00:00
Antecedent Dry Days	0	days
Runoff (Dry Weather) Time Step	0 01:00:00	days hh:mm:ss
Runoff (Wet Weather) Time Step	0 00:05:00	days hh:mm:ss
Reporting Time Step	0 00:05:00	days hh:mm:ss
Routing Time Step	30	seconds

Number of Elements

	Qty
Rain Gages	0
Subbasins	30
Nodes	47
Junctions	35
Outfalls	5
Flow Diversions	2
Inlets	0
Storage Nodes	5
Links	45
Channels	18
Pipes	21
Pumps	0
Orifices	2
Weirs	4
Outlets	0
Pollutants	0
Land Uses	0

Rainfall Details

Return Period..... 10 year(s)

Subbasin Summary

Subbasin ID	Area (ac)	Weighted Runoff Coefficient	Total Rainfall (in)	Total Runoff (in)	Total Runoff Volume (ft³)	Peak Runoff (cfs)	Time of Concentration (days hh:mm:ss)
A01	0.28	0.3500	0.88	0.31	313.05	0.56	0 00:09:21
A02	0.53	0.5000	0.82	0.41	792.65	1.61	0 00:08:08
A03	1.86	0.3500	1.46	0.51	3450.17	1.90	0 00:30:03
A04	0.76	0.4400	0.86	0.38	1045.59	1.92	0 00:09:04
A05	2.35	0.4500	1.16	0.52	4461.45	4.52	0 00:16:19
A06	0.66	0.5000	0.94	0.47	1130.82	1.75	0 00:10:39
A07	1.64	0.5000	1.11	0.56	3309.98	3.73	0 00:14:39
A08	2.22	0.5000	1.15	0.58	4633.70	4.84	0 00:15:47
A09	1.33	0.5000	1.11	0.55	2674.66	3.05	0 00:14:25
A10	1.62	0.4500	1.17	0.53	3093.20	3.07	0 00:16:41
A11	0.80	0.5000	0.97	0.49	1408.44	2.08	0 00:11:06
A12	2.50	0.6000	1.11	0.66	6025.80	6.87	0 00:14:27
A13	0.17	0.4200	0.83	0.35	215.37	0.43	0 00:08:22
B1	1.19	0.4700	1.05	0.49	2129.61	2.71	0 00:12:55
B2	0.93	0.3900	1.18	0.46	1549.54	1.52	0 00:16:46
C	0.33	0.3500	1.48	0.52	620.51	0.33	0 00:31:22
Dx	0.30	0.3000	1.25	0.38	408.38	0.34	0 00:20:04
Ex	2.73	0.3000	1.62	0.49	4826.12	1.88	0 00:42:17
OS-01	7.83	0.7000	0.96	0.67	19071.77	28.68	0 00:11:00
OS-02	3.22	0.8900	0.91	0.81	9502.83	15.71	0 00:10:00
OS-03	0.81	0.5000	1.00	0.50	1476.03	2.03	0 00:12:00
OS-04	3.06	0.5000	1.05	0.52	5809.38	7.38	0 00:13:00
OS-05	4.99	0.5000	0.96	0.48	8694.58	13.05	0 00:11:00
OS-06	1.59	0.5000	1.18	0.59	3405.30	3.31	0 00:17:00
OS-07	1.45	0.5000	0.96	0.48	2526.48	3.79	0 00:11:00
OS-08	1.14	0.5000	0.87	0.43	1791.84	3.29	0 00:09:00
OS-09	9.45	0.4500	1.37	0.61	21062.35	13.93	0 00:25:00
OS-10	9.35	0.4400	1.37	0.60	20398.24	13.48	0 00:25:00
OS-11	5.05	0.3200	1.53	0.49	8982.44	4.24	0 00:35:00
OS-12	2.01	0.3200	0.94	0.30	2203.48	3.41	0 00:10:42

Node Summary

SN	Element ID	Element Type	Initial Water Elevation (ft)	Surcharge Elevation (ft)	Peak Inflow (cfs)	Max HGL Elevation Attained (ft)	Time of Peak Flooding Occurrence (days hh:mm)	Total Time Flooded (min)
1	DP01	Junction	5331.93	5333.93	42.34	5332.74	0 00:00	0.00
2	DP01a	Junction	5332.93	5334.93	28.68	5333.75	0 00:00	0.00
3	DP02	Junction	5330.43	5330.93	46.58	5330.87	0 00:00	0.00
4	DP03	Junction	5330.43	5330.93	23.29	5330.78	0 00:00	0.00
5	DP04	Junction	5330.43	5330.93	23.29	5330.77	0 00:00	0.00
6	DP05	Junction	5323.34	5323.84	31.10	5323.68	0 00:00	0.00
7	DP06	Junction	5323.34	5323.84	15.55	5323.34	0 00:00	0.00
8	DP07	Junction	5323.34	5323.84	15.55	5323.64	0 00:00	0.00
9	DP09	Junction	5328.93	5331.93	30.04	5330.54	0 00:00	0.00
10	DP10	Junction	5324.08	5327.08	36.95	5325.64	0 00:00	0.00
11	DP11	Junction	5315.50	5318.00	54.55	5317.02	0 00:00	0.00
12	DP11a	Junction	5315.50	5318.00	8.09	5315.50	0 00:00	0.00
13	DP12	Junction	5315.65	5317.30	4.94	5315.93	0 00:00	0.00
14	DP13	Junction	5315.80	5319.00	3.31	5315.80	0 00:00	0.00
15	DP14	Junction	5322.40	5325.40	37.13	5323.86	0 00:00	0.00
16	DP15	Junction	5324.80	5325.10	4.24	5324.95	0 00:00	0.00
17	DP16	Junction	5319.50	5320.50	3.41	5319.80	0 00:00	0.00
18	DP17	Junction	5322.68	5325.00	3.05	5323.03	0 00:00	0.00
19	DP18	Junction	5320.50	5325.00	12.87	5321.51	0 00:00	0.00
20	DP19	Junction	5320.50	5325.00	3.90	5321.32	0 00:00	0.00
21	DP20	Junction	5318.03	5321.88	7.99	5319.10	0 00:00	0.00
22	DP21	Junction	5316.50	5321.00	11.82	5317.56	0 00:00	0.00
23	DP22	Junction	5316.34	5319.00	7.88	5317.06	0 00:00	0.00
24	DP23	Junction	5315.80	5319.00	45.39	5317.24	0 00:00	0.00
25	DP24	Junction	5321.32	5325.11	8.39	5322.33	0 00:00	0.00
26	DP25	Junction	5321.86	5325.60	6.87	5322.87	0 00:00	0.00
27	DP26	Junction	5322.12	5322.12	1.75	5322.39	0 00:00	0.00
28	DP27	Junction	5318.43	5322.00	9.12	5318.81	0 00:00	0.00
29	DP28	Junction	5317.44	5322.00	3.88	5317.83	0 00:00	0.00
30	DP29	Junction	5318.53	5322.00	3.73	5318.91	0 00:00	0.00
31	DP30	Junction	5318.75	5319.75	4.37	5319.37	0 00:00	0.00
32	DP31	Junction	5315.65	5317.25	6.16	5316.23	0 00:00	0.00
33	DPH1	Junction	5315.00	5317.75	57.80	5316.49	0 00:00	0.00
34	DPH2	Junction	5321.00	5327.00	0.34	5321.00	0 00:00	0.00
35	DPH3	Junction	5322.25	5328.25	5.81	5322.40	0 00:00	0.00
36	DP32	Outfall			0.43	0.00		
37	Out-DP06	Outfall			15.55	5322.33		
38	Out-DPH1	Outfall			57.80	5315.00		
39	Out-DPH2	Outfall			0.34	5321.00		
40	Out-DPH3	Outfall			5.81	5322.25		
41	DIV01	Flow Diversions	5330.43		46.58	5330.43		0.00
42	DIV02	Flow Diversions	5323.34		31.10	5323.34		0.00
43	DET01	Storage Node	5318.40		11.82	5319.63		0.00
44	DET02	Storage Node	5318.50		9.12	5319.94		0.00
45	DET03	Storage Node	5320.50		12.87	5323.02		0.00
46	DET04	Storage Node	5316.40		6.16	5316.94		0.00
47	DP08	Storage Node	5316.53		22.34	5317.25		0.00

Junction Input

Element ID	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Ground/Rim (Max) Offset (ft)	Initial Water Elevation (ft)	Initial Water Depth (ft)	Surcharge Elevation (ft)	Surcharge Depth (ft)	Ponded Area (ft²)
DP01	5331.93	5333.93	2.00	5331.93	0.00	5333.93	0.00	0.00
DP01a	5332.93	5334.93	2.00	5332.93	0.00	5334.93	0.00	0.00
DP02	5330.43	5330.93	0.50	5330.43	0.00	5330.93	0.00	0.00
DP03	5330.43	5330.93	0.50	5330.43	0.00	5330.93	0.00	0.00
DP04	5330.43	5330.93	0.50	5330.43	0.00	5330.93	0.00	0.00
DP05	5323.34	5323.84	0.50	5323.34	0.00	5323.84	0.00	0.00
DP06	5323.34	5323.84	0.50	5323.34	0.00	5323.84	0.00	0.00
DP07	5323.34	5323.84	0.50	5323.34	0.00	5323.84	0.00	0.00
DP09	5328.93	5331.93	3.00	5328.93	0.00	5331.93	0.00	0.00
DP10	5324.08	5327.08	3.00	5324.08	0.00	5327.08	0.00	0.00
DP11	5315.50	5318.00	2.50	5315.50	0.00	5318.00	0.00	0.00
DP11a	5315.50	5318.00	2.50	5315.50	0.00	5318.00	0.00	0.00
DP12	5315.65	5317.30	1.65	5315.65	0.00	5317.30	0.00	0.00
DP13	5315.80	5319.00	3.20	5315.80	0.00	5319.00	0.00	0.00
DP14	5322.40	5325.40	3.00	5322.40	0.00	5325.40	0.00	0.00
DP15	5324.80	5325.10	0.30	5324.80	0.00	5325.10	0.00	0.00
DP16	5319.50	5320.50	1.00	5319.50	0.00	5320.50	0.00	0.00
DP17	5322.68	5325.00	2.32	5322.68	0.00	5325.00	0.00	0.00
DP18	5320.50	5325.00	4.50	5320.50	0.00	5325.00	0.00	0.00
DP19	5320.50	5325.00	4.50	5320.50	0.00	5325.00	0.00	0.00
DP20	5318.03	5321.88	3.85	5318.03	0.00	5321.88	0.00	0.00
DP21	5316.50	5321.00	4.50	5316.50	0.00	5321.00	0.00	0.00
DP22	5316.34	5319.00	2.66	5316.34	0.00	5319.00	0.00	0.00
DP23	5315.80	5319.00	3.20	5315.80	0.00	5319.00	0.00	0.00
DP24	5321.32	5325.11	3.79	5321.32	0.00	5325.11	0.00	0.00
DP25	5321.86	5325.60	3.74	5321.86	0.00	5325.60	0.00	0.00
DP26	5322.12	5323.12	1.00	5322.12	0.00	5322.12	-1.00	0.00
DP27	5318.43	5322.00	3.57	5318.43	0.00	5322.00	0.00	0.00
DP28	5317.44	5322.00	4.56	5317.44	0.00	5322.00	0.00	0.00
DP29	5318.53	5322.00	3.47	5318.53	0.00	5322.00	0.00	0.00
DP30	5318.75	5319.75	1.00	5318.75	0.00	5319.75	0.00	0.00
DP31	5315.65	5317.25	1.60	5315.65	0.00	5317.25	0.00	0.00
DPH1	5315.00	5317.75	2.75	5315.00	0.00	5317.75	0.00	0.00
DPH2	5321.00	5327.00	6.00	5321.00	0.00	5327.00	0.00	0.00
DPH3	5322.25	5328.25	6.00	5322.25	0.00	5328.25	0.00	0.00

Junction Results

Element ID	Peak Inflow (cfs)	Peak Lateral Inflow (cfs)	Max HGL Elevation Attained (ft)	Max HGL Depth Attained (ft)	Max Surcharge Depth Attained (ft)	Min Freeboard Attained (ft)	Average HGL Elevation Attained (ft)	Average HGL Depth Attained (ft)	Time of Max HGL Occurrence (days hh:mm)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded Volume (ac-in)	Total Time Flooded (min)
DP01	42.34	15.70	5332.74	0.81	0.00	1.19	5331.93	0.00	0 00:11	0 00:00	0.00	0.00
DP01a	28.68	28.68	5333.75	0.82	0.00	1.18	5332.93	0.00	0 00:11	0 00:00	0.00	0.00
DP02	46.58	4.81	5330.87	0.44	0.00	0.11	5330.43	0.00	0 00:11	0 00:00	0.00	0.00
DP03	23.29	0.00	5330.78	0.35	0.00	0.15	5330.43	0.00	0 00:11	0 00:00	0.00	0.00
DP04	23.29	0.00	5330.77	0.34	0.00	0.16	5330.43	0.00	0 00:11	0 00:00	0.00	0.00
DP05	31.10	10.61	5323.68	0.34	0.00	0.16	5323.34	0.00	0 00:14	0 00:00	0.00	0.00
DP06	15.55	0.00	5323.34	0.00	0.00	0.50	5323.34	0.00	0 00:00	0 00:00	0.00	0.00
DP07	15.55	0.00	5323.64	0.30	0.00	0.20	5323.34	0.00	0 00:14	0 00:00	0.00	0.00
DP09	30.04	13.93	5330.54	1.61	0.00	1.39	5328.95	0.02	0 00:12	0 00:00	0.00	0.00
DP10	36.95	13.48	5325.64	1.56	0.00	1.44	5324.10	0.02	0 00:15	0 00:00	0.00	0.00
DP11	54.55	0.00	5317.02	1.52	0.00	1.23	5315.54	0.04	0 00:19	0 00:00	0.00	0.00
DP11a	8.09	0.00	5315.50	0.00	0.00	2.50	5315.50	0.00	0 00:00	0 00:00	0.00	0.00
DP12	4.94	0.00	5315.93	0.28	0.00	2.47	5315.65	0.00	0 00:20	0 00:00	0.00	0.00
DP13	3.31	3.31	5315.80	0.00	0.00	3.20	5315.80	0.00	0 00:00	0 00:00	0.00	0.00
DP14	37.13	0.33	5323.86	1.46	0.00	1.54	5322.42	0.02	0 00:17	0 00:00	0.00	0.00
DP15	4.24	4.24	5324.95	0.15	0.00	0.15	5324.80	0.00	0 00:35	0 00:00	0.00	0.00
DP16	3.41	3.41	5319.80	0.30	0.00	0.70	5319.50	0.00	0 00:10	0 00:00	0.00	0.00
DP17	3.05	3.05	5323.03	0.35	0.00	1.97	5322.68	0.00	0 00:14	0 00:00	0.00	0.00
DP18	12.87	3.07	5321.51	1.01	0.00	3.49	5320.76	0.26	0 00:15	0 00:00	0.00	0.00
DP19	3.90	0.00	5321.32	0.82	0.00	3.68	5320.52	0.02	0 00:31	0 00:00	0.00	0.00
DP20	7.99	4.84	5319.10	1.07	0.00	2.78	5318.05	0.02	0 00:16	0 00:00	0.00	0.00
DP21	11.82	1.92	5317.56	1.06	0.00	3.44	5316.96	0.46	0 00:17	0 00:00	0.00	0.00
DP22	7.88	0.00	5317.06	0.72	0.00	3.78	5316.37	0.03	0 00:36	0 00:00	0.00	0.00
DP23	45.39	1.90	5317.24	1.44	0.00	1.76	5315.89	0.09	0 00:33	0 00:00	0.00	0.00
DP24	8.39	2.08	5322.33	1.01	0.00	2.78	5321.33	0.01	0 00:14	0 00:00	0.00	0.00
DP25	6.87	6.87	5322.87	1.01	0.00	2.73	5321.87	0.01	0 00:14	0 00:00	0.00	0.00
DP26	1.75	1.75	5322.39	0.27	0.00	0.75	5322.12	0.00	0 00:10	0 00:00	0.00	0.00
DP27	9.12	4.52	5318.81	0.38	0.00	3.19	5318.43	0.00	0 00:15	0 00:00	0.00	0.00
DP28	3.88	0.00	5317.83	0.39	0.00	4.17	5317.45	0.01	0 00:28	0 00:00	0.00	0.00
DP29	3.73	3.73	5318.91	0.38	0.00	3.09	5318.53	0.00	0 00:14	0 00:00	0.00	0.00
DP30	4.37	1.52	5319.37	0.62	0.00	0.40	5318.75	0.00	0 00:10	0 00:00	0.00	0.00
DP31	6.16	2.71	5316.23	0.58	0.00	1.02	5315.66	0.01	0 00:17	0 00:00	0.00	0.00
DPH1	57.80	0.55	5316.49	1.49	0.00	1.26	5315.04	0.04	0 00:20	0 00:00	0.00	0.00
DPH2	0.34	0.34	5321.00	0.00	0.00	6.00	5321.00	0.00	0 00:00	0 00:00	0.00	0.00
DPH3	5.81	1.88	5322.40	0.15	0.00	5.85	5322.25	0.00	0 00:36	0 00:00	0.00	0.00

Channel Input

Element ID	Length (ft)	Inlet Invert Elevation (ft)	Outlet Invert Elevation (ft)	Average Slope (%)	Shape	Height (ft)	Width (ft)	Manning's Roughness
DP01=>DP02	150.00	5331.93	5330.43	1.0000	Trapezoidal	0.550	60.000	0.0160
DP01a=>DP01	200.00	5332.93	5331.93	0.5000	Trapezoidal	2.000	17.000	0.0160
DP03=>DP05	810.00	5330.43	5323.34	0.8800	Trapezoidal	0.500	55.000	0.0160
DP04=>DP09	150.00	5330.43	5328.93	1.0000	Trapezoidal	0.500	55.000	0.0160
DP07=>DP08	780.00	5323.34	5316.53	0.8700	Trapezoidal	0.500	55.000	0.0160
DP09=>DP10	485.00	5328.93	5324.08	1.0000	Trapezoidal	3.000	23.000	0.0800
DP10=>DP14	45.00	5324.08	5322.40	3.7300	Parabolic	1.500	25.000	0.0320
DP11=>DPH1	196.00	5315.50	5315.00	0.2600	Trapezoidal	2.750	45.000	0.0700
DP12=>DPH1	95.00	5315.65	5315.00	0.6800	Trapezoidal	2.750	45.000	0.0700
DP14=>DP23	865.00	5322.40	5315.80	0.7600	User-Defined	2.750	41.000	0.0800
DP15=>DPH3	170.00	5324.80	5322.25	1.5000	Trapezoidal	0.300	45.000	0.0350
DP16=>DP30	5.00	5319.50	5318.75	15.0000	Parabolic	1.000	5.000	0.0320
DP17=>DP18	435.00	5322.68	5320.50	0.5000	User-Defined	1.020	56.000	0.0400
DP22=>DP23	124.00	5316.34	5315.85	0.4000	User-Defined	2.750	41.000	0.0320
DP26=>DP27	580.00	5322.12	5318.43	0.6400	User-Defined	1.020	56.000	0.0320
DP28=>DP21	190.00	5317.44	5316.50	0.4900	User-Defined	1.020	56.000	0.0320
DP29=>DP27	20.00	5318.53	5318.43	0.5000	User-Defined	1.020	56.000	0.0320
DP30=>DP31	610.00	5318.75	5315.65	0.5100	User-Defined	1.020	10.000	0.0320

Channel Results

SN	Element ID	Peak Flow (cfs)	Time of Peak Flow Occurrence (days hh:mm)	Design Flow Capacity (cfs)	Peak Flow/ Design Flow Ratio	Peak Flow Velocity (ft/sec)	Travel Time (min)	Peak Flow Depth (ft)	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged (min)	Froude Number	Reported Condition
1	DP01=>DP02	42.07	0 00:11	74.04	0.57	3.62	0.69	0.44	0.79	0.00		
2	DP01a=>DP01	28.14	0 00:11	167.34	0.17	4.69	0.71	0.81	0.41	0.00		
3	DP03=>DP05	21.35	0 00:14	54.81	0.39	4.02	3.36	0.33	0.67	0.00		
4	DP04=>DP09	23.19	0 00:12	58.58	0.40	3.12	0.80	0.34	0.68	0.00		
5	DP07=>DP08	14.39	0 00:18	54.74	0.26	3.03	4.29	0.28	0.57	0.00		
6	DP09=>DP10	28.21	0 00:15	113.38	0.25	2.16	3.74	1.55	0.52	0.00		
7	DP10=>DP14	36.95	0 00:17	222.90	0.17	5.14	0.15	0.65	0.44	0.00		
8	DP11=>DPH1	52.95	0 00:20	161.62	0.33	1.25	2.61	1.48	0.54	0.00		
9	DP12=>DPH1	4.92	0 00:22	264.69	0.02	0.73	2.17	0.28	0.10	0.00		
10	DP14=>DP23	35.26	0 00:33	182.91	0.19	2.06	7.00	1.40	0.51	0.00		
11	DP15=>DPH3	4.18	0 00:36	16.00	0.26	1.23	2.30	0.15	0.50	0.00		
12	DP16=>DP30	3.41	0 00:10	42.98	0.08	6.08	0.01	0.30	0.30	0.00		
13	DP17=>DP18	2.53	0 00:20	49.03	0.05	2.51	2.89	0.32	0.31	0.00		
14	DP22=>DP23	7.87	0 00:38	131.64	0.06	0.92	2.25	0.72	0.26	0.00		
15	DP26=>DP27	1.25	0 00:19	55.24	0.02	2.58	3.75	0.22	0.22	0.00		
16	DP28=>DP21	4.58	0 00:53	48.71	0.09	3.35	0.95	0.38	0.38	0.00		
17	DP29=>DP27	3.71	0 00:15	48.97	0.08	1.28	0.26	0.38	0.37	0.00		
18	DP30=>DP31	3.81	0 00:17	13.52	0.28	2.39	4.25	0.58	0.56	0.00		

Pipe Input

Element ID	Length (ft)	Inlet Invert Elevation (ft)	Outlet Invert Elevation (ft)	Total Drop (ft)	Average Slope (%)	Pipe Shape	Pipe Diameter or Height (in)	Pipe Width (in)	Manning's Roughness
DP02=>DIV01	1.00	5330.43	5330.43	0.00	0.0000	Dummy	0.000	0.000	0.0320
DP02=>DP03	1.00	5330.43	5330.43	0.00	0.0000	Dummy	0.000	0.000	0.0150
DP02=>DP04	1.00	5330.43	5330.43	0.00	0.0000	Dummy	0.000	0.000	0.0150
DP05=>DIV02	1.00	5322.33	5322.33	0.00	0.0000	Dummy	0.000	0.000	0.0150
DP05=>DP06	1.00	5322.33	5322.33	0.00	0.0000	Dummy	0.000	0.000	0.0320
DP05=>DP07	1.00	5322.33	5322.33	0.00	0.0000	Dummy	0.000	0.000	0.0150
DP06=>Out-H4	1.00	5322.33	5322.33	0.00	0.0000	Dummy	0.000	0.000	0.0320
DP11a=>DP11	0.00	5315.50	5315.50	0.00	0.0000	Dummy	0.000	0.000	0.0320
DP13=>DP23	0.00	5315.80	5315.80	0.00	0.0000	Dummy	0.000	0.000	0.0150
DP13=>Out-H1	1.00	5312.38	5312.38	0.00	0.0000	Dummy	0.000	0.000	0.0320
DP18=>DET03	0.00	5320.76	5320.76	0.00	0.0000	Dummy	0.000	0.000	0.0320
DP19=>DP20	450.00	5320.50	5318.03	2.47	0.5500	CIRCULAR	18.000	18.000	0.0150
DP20=>DP21	290.00	5318.03	5316.50	1.53	0.5300	CIRCULAR	24.000	24.000	0.0150
DP21=>DET01	1.00	5316.95	5316.50	0.45	45.0000	Dummy	0.000	0.000	0.0150
DP23=>DP11	60.00	5315.80	5315.50	0.30	0.5000	Rectangular	18.000	120.000	0.0150
DP24=>DP18	116.00	5321.32	5320.50	0.82	0.7100	CIRCULAR	24.000	24.000	0.0150
DP25a=>DP24	112.00	5321.86	5321.32	0.54	0.4800	CIRCULAR	24.000	24.000	0.0150
DP27=>DET02	0.00	5318.43	5318.43	0.00	0.0000	Dummy	0.000	0.000	0.0150
DP31=>DET04	0.00	5315.65	5315.65	0.00	0.0000	Dummy	0.000	0.000	0.0150
DPH2=>Out-DPH2	1.00	5321.00	5321.00	0.00	0.0000	Dummy	0.000	0.000	0.0320
DPH3=>OutDPH3	1.00	5322.25	5322.25	0.00	0.0000	Dummy	0.000	0.000	0.0320

Pipe Results

SN	Element ID	Peak Flow (cfs)	Time of Peak Flow Occurrence (days hh:mm)	Design Flow Capacity (cfs)	Peak Flow Velocity (ft/sec)	Travel Time (min)	Peak Flow Depth (ft)	Total Time Surcharged (min)	Froude Number	Reported Condition
1	DP02=>DIV01	46.58	0 00:11	0.00	0.00		0.81	0.00		Calculated
2	DP02=>DP03	23.29	0 00:11	0.00	0.00		0.81	0.00		Calculated
3	DP02=>DP04	23.29	0 00:11	0.00	0.00		0.81	0.00		Calculated
4	DP05=>DIV02	31.10	0 00:14	0.00	0.00		0.34	0.00		Calculated
5	DP05=>DP06	15.55	0 00:14	0.00	0.00		0.34	0.00		Calculated
6	DP05=>DP07	15.55	0 00:14	0.00	0.00		0.34	0.00		Calculated
7	DP06=>Out-H4	15.55	0 00:14	0.00	0.00		0.34	0.00		Calculated
8	DP11a=>DP11	8.09	0 00:17	0.00	0.00		1.48	0.00		Calculated
9	DP13=>DP23	3.31	0 00:17	0.00	0.00		0.28	0.00		Calculated
10	DP13=>Out-H1	57.80	0 00:20	0.00	0.00		0.28	0.00		Calculated
11	DP18=>DET03	12.87	0 00:16	0.00	0.00		0.32	0.00		Calculated
12	DP19=>DP20	3.90	0 00:32	6.74	3.95	1.90	0.82	0.00		Calculated
13	DP20=>DP21	7.88	0 00:17	14.24	4.66	1.04	1.06	0.00		Calculated
14	DP21=>DET01	11.82	0 00:16	0.00	0.00		1.06	0.00		Calculated
15	DP23=>DP11	44.90	0 00:33	158.04	4.28	0.23	0.53	0.00		Calculated
16	DP24=>DP18	8.36	0 00:15	16.48	5.29	0.37	1.01	0.00		Calculated
17	DP25a=>DP24	6.81	0 00:15	13.61	4.96	0.38	1.00	0.00		Calculated
18	DP27=>DET02	9.12	0 00:16	0.00	0.00		0.22	0.00		Calculated
19	DP31=>DET04	6.16	0 00:14	0.00	0.00		0.58	0.00		Calculated
20	DPH2=>Out-DPH2	0.34	0 00:20	0.00	0.00		0.58	0.00		Calculated
21	DPH3=>OutDPH3	5.81	0 00:37	0.00	0.00		0.58	0.00		Calculated

Storage Nodes

Storage Node : DET01

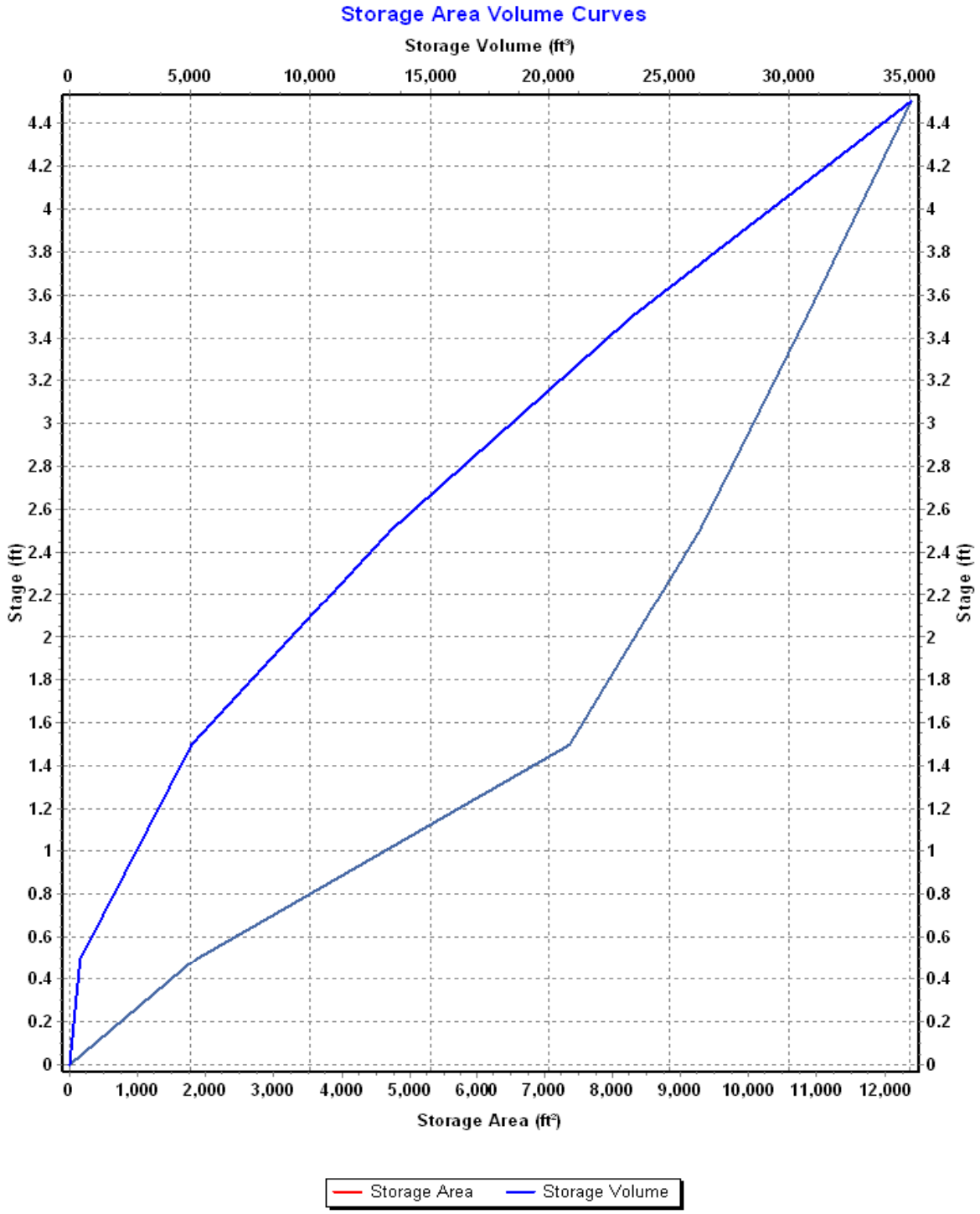
Input Data

Invert Elevation (ft) 5316.50
Max (Rim) Elevation (ft) 5321.00
Max (Rim) Offset (ft) 4.50
Initial Water Elevation (ft) 5318.40
Initial Water Depth (ft) 1.90
Ponded Area (ft²) 0.00
Evaporation Loss 0.00

Storage Area Volume Curves

Storage Curve : DET01

Stage (ft)	Storage Area (ft²)	Storage Volume (ft³)
0	0	0.000
0.5	1869	467.25
1.5	7359	5081.25
2.5	9279	13400.25
3.5	10844	23461.75
4.5	12389	35078.25


Storage Area Volume Curves
Storage Volume (ft³)
0
5,000
10,000
15,000
20,000
25,000
30,000
35,000
Stage (ft)
4.4
4.2
4
3.8
3.6
3.4
3.2
3
2.8
2.6
2.4
2.2
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
1,000
2,000
3,000
4,000
5,000
6,000
7,000
8,000
9,000
10,000
11,000
12,000
Storage Area (ft²)
Storage Area
Storage Volume

Storage Node : DET01 (continued)

Outflow Weirs

Element ID	Weir Type	Crest Elevation (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
DET01	V-Notch	5318.50	12.00	2.50	2.40

Output Summary Results

Peak Inflow (cfs)	11.82
Peak Lateral Inflow (cfs)	0.00
Peak Outflow (cfs)	7.88
Peak Exfiltration Flow Rate (cfm)	0.00
Max HGL Elevation Attained (ft)	5319.63
Max HGL Depth Attained (ft)	3.13
Average HGL Elevation Attained (ft)	5318.60
Average HGL Depth Attained (ft)	2.1
Time of Max HGL Occurrence (days hh:mm)	0 00:36
Total Exfiltration Volume (1000-ft³)	0.000
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0.00

Storage Node : DET02

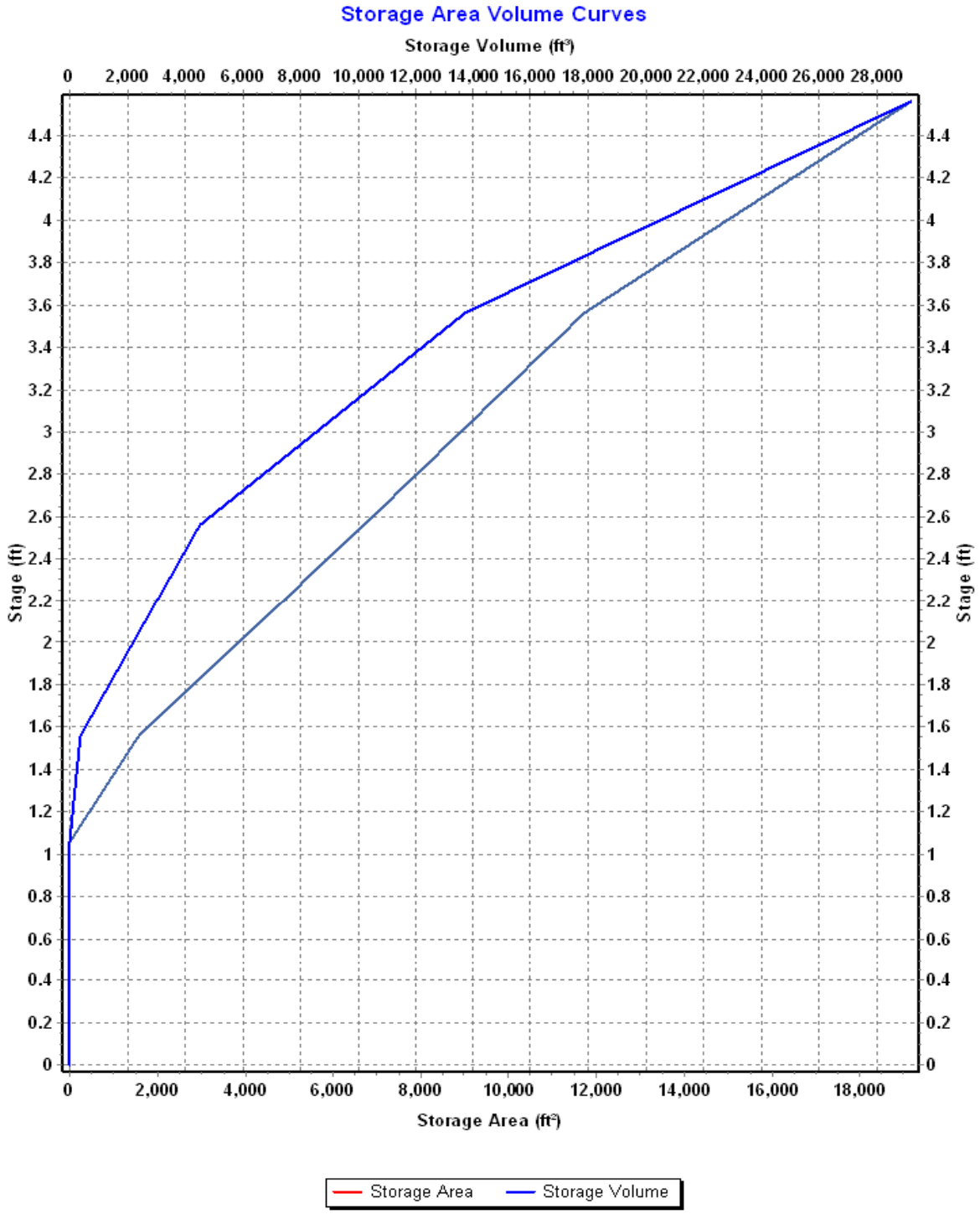
Input Data

Invert Elevation (ft)	5317.44
Max (Rim) Elevation (ft)	5322.00
Max (Rim) Offset (ft)	4.56
Initial Water Elevation (ft)	5318.50
Initial Water Depth (ft)	1.06
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : DET02

Stage (ft)	Storage Area (ft²)	Storage Volume (ft³)
0	0	0.000
0.06	0	0.00
1.06	0	0.00
1.56	1586	396.50
2.56	6685	4532.00
3.56	11730	13739.50
4.56	19160	29184.50


Storage Area Volume Curves
Storage Volume (ft³)
0 2,000 4,000 6,000 8,000 10,000 12,000 14,000 16,000 18,000 20,000 22,000 24,000 26,000 28,000
Stage (ft)
0 0.2 0.4 0.6 0.8 1 1.2 1.4 1.6 1.8 2 2.2 2.4 2.6 2.8 3 3.2 3.4 3.6 3.8 4 4.2 4.4
0 2,000 4,000 6,000 8,000 10,000 12,000 14,000 16,000 18,000
Storage Area (ft²)
Storage Area
Storage Volume

Storage Node : DET02 (continued)

Outflow Orifices

Element ID	Orifice Type	Orifice Shape	Circular Orifice Diameter (in)	Rectangular Orifice Height (in)	Rectangular Orifice Width (in)	Orifice Invert Elevation (ft)	Orifice Coefficient
DET02	Side	CIRCULAR	10.00			5317.44	0.61

Output Summary Results

Peak Inflow (cfs) 9.12
Peak Lateral Inflow (cfs) 0.00
Peak Outflow (cfs) 3.88
Peak Exfiltration Flow Rate (cfm) 0.00
Max HGL Elevation Attained (ft) 5319.94
Max HGL Depth Attained (ft) 2.5
Average HGL Elevation Attained (ft) 5317.53
Average HGL Depth Attained (ft) 0.0899999999999999
Time of Max HGL Occurrence (days hh:mm) 0 00:28
Total Exfiltration Volume (1000-ft³) 0.000
Total Flooded Volume (ac-in) 0
Total Time Flooded (min) 0
Total Retention Time (sec) 0.00

Storage Node : DET03

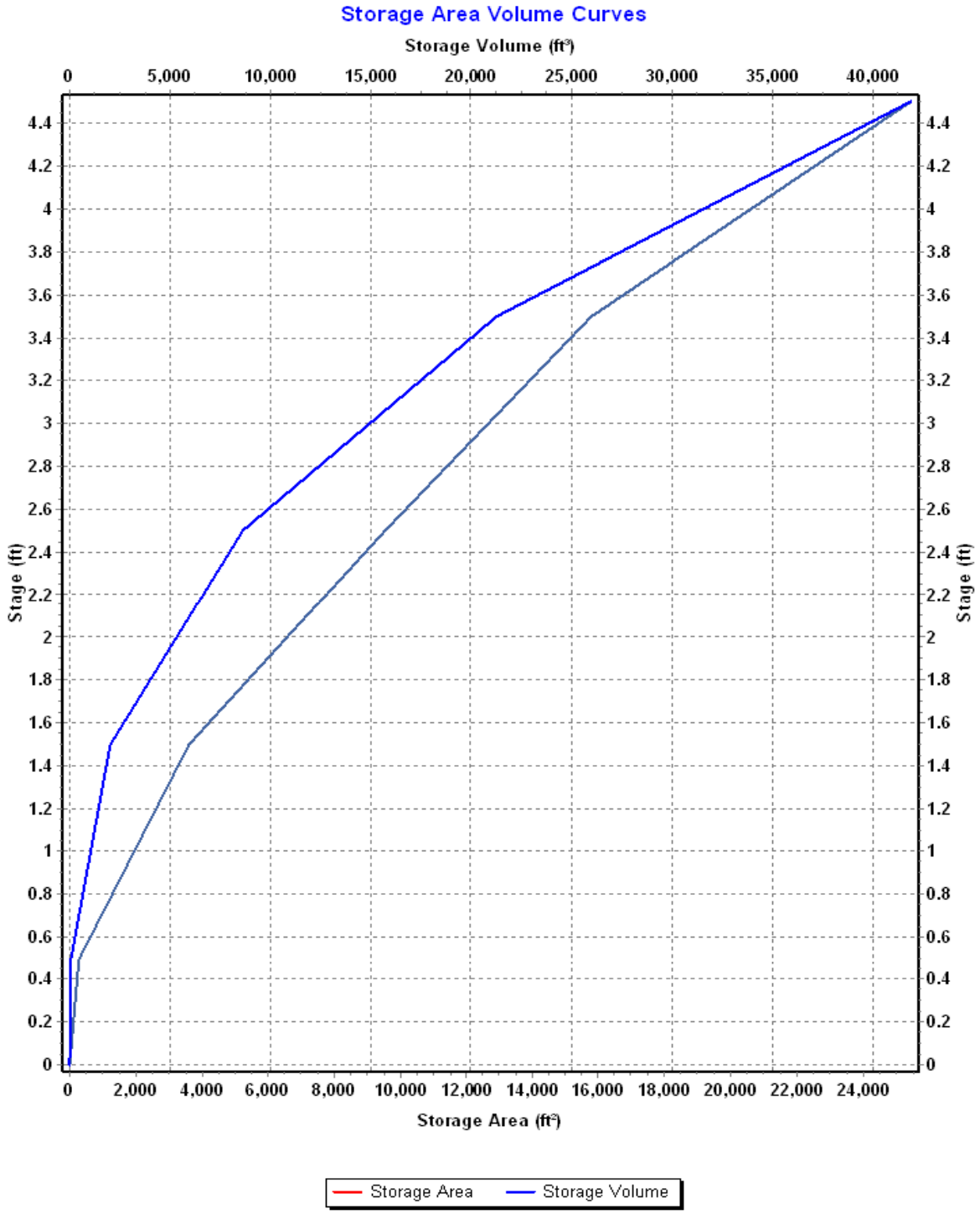
Input Data

Invert Elevation (ft)	5320.50
Max (Rim) Elevation (ft)	5325.00
Max (Rim) Offset (ft)	4.50
Initial Water Elevation (ft)	5320.50
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : DET03

Stage (ft)	Storage Area (ft²)	Storage Volume (ft³)
0	0	0.000
0.5	289	72.25
1.5	3619	2026.25
2.5	9546	8608.75
3.5	15784	21273.75
4.5	25455	41893.25


Storage Area Volume Curves
Storage Volume (ft³)
0
5,000
10,000
15,000
20,000
25,000
30,000
35,000
40,000
Stage (ft)
4.4
4.2
4
3.8
3.6
3.4
3.2
3
2.8
2.6
2.4
2.2
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
2,000
4,000
6,000
8,000
10,000
12,000
14,000
16,000
18,000
20,000
22,000
24,000
Storage Area (ft²)
Storage Area
Storage Volume

Storage Node : DET03 (continued)

Outflow Orifices

Element ID	Orifice Type	Orifice Shape	Circular Orifice Diameter (in)	Rectangular Orifice Height (in)	Rectangular Orifice Width (in)	Orifice Invert Elevation (ft)	Orifice Coefficient
DET03	Side	CIRCULAR	10.00			5320.50	0.61

Output Summary Results

Peak Inflow (cfs)	12.87
Peak Lateral Inflow (cfs)	0.00
Peak Outflow (cfs)	3.90
Peak Exfiltration Flow Rate (cfm)	0.00
Max HGL Elevation Attained (ft)	5323.02
Max HGL Depth Attained (ft)	2.52
Average HGL Elevation Attained (ft)	5320.55
Average HGL Depth Attained (ft)	0.0499999999999998
Time of Max HGL Occurrence (days hh:mm)	0 00:31
Total Exfiltration Volume (1000-ft³)	0.000
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0.00

Storage Node : DET04

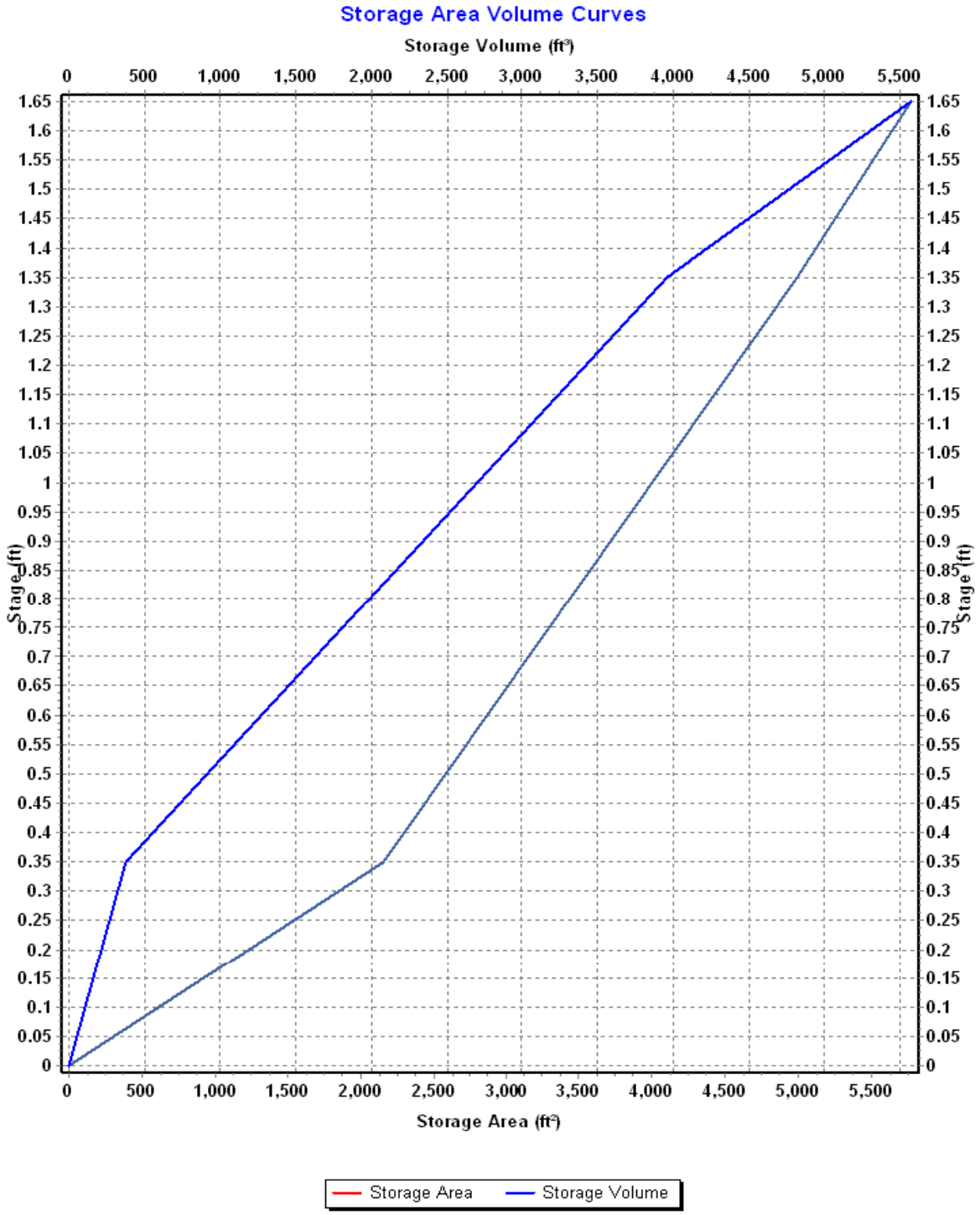
Input Data

Invert Elevation (ft)	5315.65
Max (Rim) Elevation (ft)	5317.30
Max (Rim) Offset (ft)	1.65
Initial Water Elevation (ft)	5316.40
Initial Water Depth (ft)	0.75
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : DET04

Stage (ft)	Storage Area (ft²)	Storage Volume (ft³)
0	0	0.000
0.35	2161	378.17
1.35	4996	3956.67
1.65	5774	5572.17


Storage Area Volume Curves
Storage Volume (ft³)
0
500
1,000
1,500
2,000
2,500
3,000
3,500
4,000
4,500
5,000
5,500
Stage (ft)
1.65
1.6
1.55
1.5
1.45
1.4
1.35
1.3
1.25
1.2
1.15
1.1
1.05
1
0.95
0.9
0.85
0.8
0.75
0.7
0.65
0.6
0.55
0.5
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
Storage Area (ft²)
Storage Area
Storage Volume

Storage Node : DET04 (continued)

Outflow Weirs

Element ID	Weir Type	Crest Elevation (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
DET04	Trapezoidal	5316.40	2.00	0.90	3.33

Output Summary Results

Peak Inflow (cfs)	6.16
Peak Lateral Inflow (cfs)	0.00
Peak Outflow (cfs)	4.94
Peak Exfiltration Flow Rate (cfm)	0.00
Max HGL Elevation Attained (ft)	5316.94
Max HGL Depth Attained (ft)	1.29
Average HGL Elevation Attained (ft)	5316.41
Average HGL Depth Attained (ft)	0.76
Time of Max HGL Occurrence (days hh:mm)	0 00:20
Total Exfiltration Volume (1000-ft³)	0.000
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0.00

Storage Node : DP08

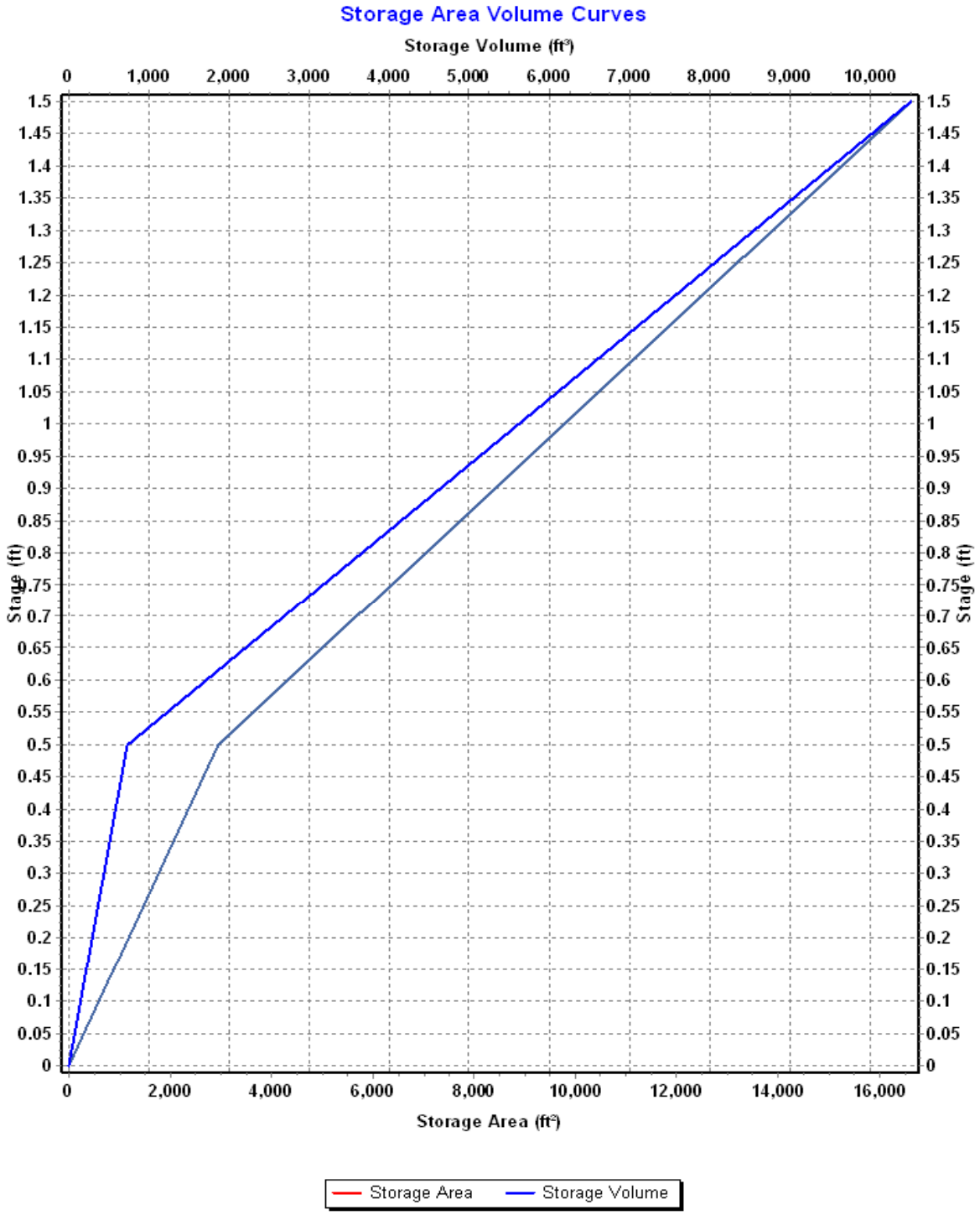
Input Data

Invert Elevation (ft)	5316.53
Max (Rim) Elevation (ft)	5318.00
Max (Rim) Offset (ft)	1.47
Initial Water Elevation (ft)	5316.53
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : DP8-Storage

Stage (ft)	Storage Area (ft²)	Storage Volume (ft³)
0	0	0.000
.5	2936	734.00
1.5	16617	10510.50


Storage Area Volume Curves
Storage Volume (ft³)
0
1,000
2,000
3,000
4,000
5,000
6,000
7,000
8,000
9,000
10,000
Stage (ft)
1.5
1.45
1.4
1.35
1.3
1.25
1.2
1.15
1.1
1.05
1
0.95
0.9
0.85
0.8
0.75
0.7
0.65
0.6
0.55
0.5
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
2,000
4,000
6,000
8,000
10,000
12,000
14,000
16,000
Storage Area (ft²)
Storage Area
Storage Volume

Storage Node : DP08 (continued)

Outflow Weirs

Element ID	Weir Type	Crest Elevation (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
DP08=>DP11	Trapezoidal	5316.53	4.00	0.50	3.33
DP08=>DP11a	Trapezoidal	5317.03	20.00	1.00	3.33

Output Summary Results

Peak Inflow (cfs)	22.34
Peak Lateral Inflow (cfs)	14.21
Peak Outflow (cfs)	22.05
Peak Exfiltration Flow Rate (cfm)	0.00
Max HGL Elevation Attained (ft)	5317.25
Max HGL Depth Attained (ft)	0.72
Average HGL Elevation Attained (ft)	5316.54
Average HGL Depth Attained (ft)	0.0100000000000002
Time of Max HGL Occurrence (days hh:mm)	0 00:17
Total Exfiltration Volume (1000-ft³)	0.000
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0.00

Project Description

File Name	1006-HYD-100YR-P.SPF

Project Options

Flow Units	CFS
Elevation Type	Elevation
Hydrology Method	Rational
Time of Concentration (TOC) Method	User-Defined
Link Routing Method	Kinematic Wave
Enable Overflow Ponding at Nodes	YES
Skip Steady State Analysis Time Periods	NO

Analysis Options

Start Analysis On	Oct 03, 2012	00:00:00
End Analysis On	Oct 05, 2012	00:00:00
Start Reporting On	Oct 03, 2012	00:00:00
Antecedent Dry Days	0	days
Runoff (Dry Weather) Time Step	0 01:00:00	days hh:mm:ss
Runoff (Wet Weather) Time Step	0 00:05:00	days hh:mm:ss
Reporting Time Step	0 00:05:00	days hh:mm:ss
Routing Time Step	30	seconds

Number of Elements

	Qty
Rain Gages	0
Subbasins	30
Nodes	47
Junctions	35
Outfalls	5
Flow Diversions	2
Inlets	0
Storage Nodes	5
Links	45
Channels	18
Pipes	21
Pumps	0
Orifices	2
Weirs	4
Outlets	0
Pollutants	0
Land Uses	0

Rainfall Details

Return Period	100 year(s)

Subbasin Summary

Subbasin ID	Area (ac)	Weighted Runoff Coefficient	Total Rainfall (in)	Total Runoff (in)	Total Runoff Volume (ft³)	Peak Runoff (cfs)	Time of Concentration (days hh:mm:ss)
A01	0.28	0.6000	1.33	0.80	814.14	1.44	0 00:09:21
A02	0.53	0.7000	1.26	0.88	1691.11	3.42	0 00:08:08
A03	1.86	0.6000	2.07	1.24	8392.49	4.63	0 00:30:03
A04	0.76	0.6600	1.31	0.86	2380.84	4.37	0 00:09:04
A05	2.35	0.6700	1.72	1.15	9835.67	9.95	0 00:16:19
A06	0.66	0.7000	1.42	1.00	2388.61	3.70	0 00:10:39
A07	1.64	0.7000	1.66	1.16	6905.71	7.78	0 00:14:39
A08	2.22	0.7000	1.71	1.20	9630.03	10.05	0 00:15:47
A09	1.33	0.7000	1.65	1.16	5585.88	6.37	0 00:14:25
A10	1.62	0.6700	1.73	1.16	6809.74	6.76	0 00:16:41
A11	0.80	0.7000	1.46	1.02	2964.98	4.39	0 00:11:06
A12	2.50	0.6900	1.65	1.14	10336.43	11.79	0 00:14:27
A13	0.17	0.6500	1.26	0.82	506.64	1.00	0 00:08:22
B1	1.19	0.6800	1.57	1.07	4609.12	5.86	0 00:12:55
B2	0.93	0.6300	1.74	1.10	3699.99	3.63	0 00:16:46
C	0.33	0.6000	2.10	1.26	1508.16	0.80	0 00:31:22
Dx	0.30	0.6000	1.83	1.10	1192.46	0.99	0 00:20:04
Ex	2.73	0.6000	2.28	1.37	13546.83	5.29	0 00:42:17
OS-01	7.83	0.8000	1.45	1.16	32856.87	49.36	0 00:11:00
OS-02	3.22	0.9200	1.38	1.27	14844.52	24.54	0 00:10:00
OS-03	0.81	0.7000	1.51	1.05	3099.08	4.27	0 00:12:00
OS-04	3.06	0.7000	1.56	1.10	12163.04	15.47	0 00:13:00
OS-05	4.99	0.7000	1.45	1.01	18312.95	27.52	0 00:11:00
OS-06	1.59	0.7000	1.74	1.22	7035.70	6.84	0 00:17:00
OS-07	1.45	0.7000	1.45	1.01	5321.40	8.00	0 00:11:00
OS-08	1.14	0.7000	1.31	0.92	3803.01	6.98	0 00:09:00
OS-09	9.45	0.6800	1.96	1.33	45760.87	30.25	0 00:25:00
OS-10	9.35	0.6700	1.96	1.31	44597.82	29.49	0 00:25:00
OS-11	5.05	0.6100	2.16	1.32	24179.25	11.42	0 00:35:00
OS-12	2.01	0.5400	1.42	0.77	5596.26	8.68	0 00:10:42

Node Summary

SN	Element ID	Element Type	Initial Water Elevation (ft)	Surcharge Elevation (ft)	Peak Inflow (cfs)	Max HGL Elevation Attained (ft)	Time of Peak Flooding Occurrence (days hh:mm)	Total Time Flooded (min)
1	DP01	Junction	5331.93	5333.93	70.82	5333.01	0 00:00	0.00
2	DP01a	Junction	5332.93	5334.93	49.36	5334.02	0 00:00	0.00
3	DP02	Junction	5330.43	5330.93	79.89	5330.97	0 00:00	0.00
4	DP03	Junction	5330.43	5330.93	39.95	5330.87	0 00:00	0.00
5	DP04	Junction	5330.43	5330.93	39.95	5330.86	0 00:00	0.00
6	DP05	Junction	5323.34	5323.84	58.55	5323.77	0 00:00	0.00
7	DP06	Junction	5323.34	5323.84	29.28	5323.34	0 00:00	0.00
8	DP07	Junction	5323.34	5323.84	29.28	5323.73	0 00:00	0.00
9	DP09	Junction	5328.93	5331.93	54.55	5331.07	0 00:00	0.00
10	DP10	Junction	5324.08	5327.08	70.82	5326.17	0 00:00	0.00
11	DP11	Junction	5315.50	5318.00	112.27	5317.76	0 00:00	0.00
12	DP11a	Junction	5315.50	5318.00	29.00	5315.50	0 00:00	0.00
13	DP12	Junction	5315.65	5317.30	13.10	5316.15	0 00:00	0.00
14	DP13	Junction	5315.80	5319.00	6.84	5315.80	0 00:00	0.00
15	DP14	Junction	5322.40	5325.40	71.25	5324.26	0 00:00	0.00
16	DP15	Junction	5324.80	5325.10	11.42	5325.05	0 00:00	0.00
17	DP16	Junction	5319.50	5320.50	8.68	5319.97	0 00:00	0.00
18	DP17	Junction	5322.68	5325.00	6.37	5323.15	0 00:00	0.00
19	DP18	Junction	5320.50	5325.00	25.37	5322.00	0 00:00	0.00
20	DP19	Junction	5320.50	5325.00	4.72	5321.42	0 00:00	0.00
21	DP20	Junction	5318.03	5321.88	13.86	5319.62	0 00:00	0.00
22	DP21	Junction	5316.50	5321.00	19.11	5318.07	0 00:00	0.00
23	DP22	Junction	5316.34	5319.00	11.89	5317.24	0 00:00	0.00
24	DP23	Junction	5315.80	5319.00	87.56	5317.64	0 00:00	0.00
25	DP24	Junction	5321.32	5325.11	15.01	5322.82	0 00:00	0.00
26	DP25	Junction	5321.86	5325.60	11.79	5323.30	0 00:00	0.00
27	DP26	Junction	5322.12	5322.12	3.70	5322.48	0 00:00	0.00
28	DP27	Junction	5318.43	5322.00	19.81	5318.93	0 00:00	0.00
29	DP28	Junction	5317.44	5322.00	4.77	5317.86	0 00:00	0.00
30	DP29	Junction	5318.53	5322.00	7.78	5319.03	0 00:00	0.00
31	DP30	Junction	5318.75	5319.75	10.97	5319.68	0 00:00	0.00
32	DP31	Junction	5315.65	5317.25	15.30	5316.54	0 00:00	0.00
33	DPH1	Junction	5315.00	5317.75	124.28	5317.26	0 00:00	0.00
34	DPH2	Junction	5321.00	5327.00	0.99	5321.00	0 00:00	0.00
35	DPH3	Junction	5322.25	5328.25	15.82	5322.50	0 00:00	0.00
36	DP32	Outfall			1.00	0.00		
37	Out-DP06	Outfall			29.28	5322.33		
38	Out-DPH1	Outfall			124.28	5315.00		
39	Out-DPH2	Outfall			0.99	5321.00		
40	Out-DPH3	Outfall			15.82	5322.25		
41	DIV01	Flow Diversions	5330.43		79.89	5330.43		0.00
42	DIV02	Flow Diversions	5323.34		58.55	5323.34		0.00
43	DET01	Storage Node	5317.90		19.11	5319.84		0.00
44	DET02	Storage Node	5318.50		19.81	5321.01		0.00
45	DET03	Storage Node	5320.50		25.37	5324.00		0.00
46	DET04	Storage Node	5316.20		15.30	5317.28		0.00
47	DP08	Storage Node	5316.53		46.65	5317.48		0.00

Junction Input

Element ID	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Ground/Rim (Max) Offset (ft)	Initial Water Elevation (ft)	Initial Water Depth (ft)	Surcharge Elevation (ft)	Surcharge Depth (ft)	Ponded Area (ft²)
DP01	5331.93	5333.93	2.00	5331.93	0.00	5333.93	0.00	0.00
DP01a	5332.93	5334.93	2.00	5332.93	0.00	5334.93	0.00	0.00
DP02	5330.43	5330.93	0.50	5330.43	0.00	5330.93	0.00	0.00
DP03	5330.43	5330.93	0.50	5330.43	0.00	5330.93	0.00	0.00
DP04	5330.43	5330.93	0.50	5330.43	0.00	5330.93	0.00	0.00
DP05	5323.34	5323.84	0.50	5323.34	0.00	5323.84	0.00	0.00
DP06	5323.34	5323.84	0.50	5323.34	0.00	5323.84	0.00	0.00
DP07	5323.34	5323.84	0.50	5323.34	0.00	5323.84	0.00	0.00
DP09	5328.93	5331.93	3.00	5328.93	0.00	5331.93	0.00	0.00
DP10	5324.08	5327.08	3.00	5324.08	0.00	5327.08	0.00	0.00
DP11	5315.50	5318.00	2.50	5315.50	0.00	5318.00	0.00	0.00
DP11a	5315.50	5318.00	2.50	5315.50	0.00	5318.00	0.00	0.00
DP12	5315.65	5317.30	1.65	5315.65	0.00	5317.30	0.00	0.00
DP13	5315.80	5319.00	3.20	5315.80	0.00	5319.00	0.00	0.00
DP14	5322.40	5325.40	3.00	5322.40	0.00	5325.40	0.00	0.00
DP15	5324.80	5325.10	0.30	5324.80	0.00	5325.10	0.00	0.00
DP16	5319.50	5320.50	1.00	5319.50	0.00	5320.50	0.00	0.00
DP17	5322.68	5325.00	2.32	5322.68	0.00	5325.00	0.00	0.00
DP18	5320.50	5325.00	4.50	5320.50	0.00	5325.00	0.00	0.00
DP19	5320.50	5325.00	4.50	5320.50	0.00	5325.00	0.00	0.00
DP20	5318.03	5321.88	3.85	5318.03	0.00	5321.88	0.00	0.00
DP21	5316.50	5321.00	4.50	5316.50	0.00	5321.00	0.00	0.00
DP22	5316.34	5319.00	2.66	5316.34	0.00	5319.00	0.00	0.00
DP23	5315.80	5319.00	3.20	5315.80	0.00	5319.00	0.00	0.00
DP24	5321.32	5325.11	3.79	5321.32	0.00	5325.11	0.00	0.00
DP25	5321.86	5325.60	3.74	5321.86	0.00	5325.60	0.00	0.00
DP26	5322.12	5323.12	1.00	5322.12	0.00	5322.12	-1.00	0.00
DP27	5318.43	5322.00	3.57	5318.43	0.00	5322.00	0.00	0.00
DP28	5317.44	5322.00	4.56	5317.44	0.00	5322.00	0.00	0.00
DP29	5318.53	5322.00	3.47	5318.53	0.00	5322.00	0.00	0.00
DP30	5318.75	5319.75	1.00	5318.75	0.00	5319.75	0.00	0.00
DP31	5315.65	5317.25	1.60	5315.65	0.00	5317.25	0.00	0.00
DPH1	5315.00	5317.75	2.75	5315.00	0.00	5317.75	0.00	0.00
DPH2	5321.00	5327.00	6.00	5321.00	0.00	5327.00	0.00	0.00
DPH3	5322.25	5328.25	6.00	5322.25	0.00	5328.25	0.00	0.00

Junction Results

Element ID	Peak Inflow (cfs)	Peak Lateral Inflow (cfs)	Max HGL Elevation Attained (ft)	Max HGL Depth Attained (ft)	Max Surcharge Depth Attained (ft)	Min Freeboard Attained (ft)	Average HGL Elevation Attained (ft)	Average HGL Depth Attained (ft)	Time of Max HGL Occurrence (days hh:mm)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded Volume (ac-in)	Total Time Flooded (min)
DP01	70.82	24.54	5333.01	1.08	0.00	0.92	5331.94	0.01	0 00:11	0 00:00	0.00	0.00
DP01a	49.36	49.36	5334.02	1.09	0.00	0.91	5332.94	0.01	0 00:11	0 00:00	0.00	0.00
DP02	79.89	10.19	5330.97	0.54	0.00	0.01	5330.43	0.00	0 00:11	0 00:00	0.00	0.00
DP03	39.95	0.00	5330.87	0.44	0.00	0.06	5330.43	0.00	0 00:11	0 00:00	0.00	0.00
DP04	39.95	0.00	5330.86	0.43	0.00	0.07	5330.43	0.00	0 00:11	0 00:00	0.00	0.00
DP05	58.55	22.27	5323.77	0.43	0.00	0.07	5323.34	0.00	0 00:14	0 00:00	0.00	0.00
DP06	29.28	0.00	5323.34	0.00	0.00	0.50	5323.34	0.00	0 00:00	0 00:00	0.00	0.00
DP07	29.28	0.00	5323.73	0.39	0.00	0.11	5323.34	0.00	0 00:13	0 00:00	0.00	0.00
DP09	54.55	30.25	5331.07	2.14	0.00	0.86	5328.96	0.03	0 00:12	0 00:00	0.00	0.00
DP10	70.82	29.49	5326.17	2.09	0.00	0.91	5324.11	0.03	0 00:15	0 00:00	0.00	0.00
DP11	112.27	0.00	5317.76	2.26	0.00	0.49	5315.56	0.06	0 00:21	0 00:00	0.00	0.00
DP11a	29.00	0.00	5315.50	0.00	0.00	2.50	5315.50	0.00	0 00:00	0 00:00	0.00	0.00
DP12	13.10	0.00	5316.15	0.50	0.00	2.25	5315.66	0.01	0 00:18	0 00:00	0.00	0.00
DP13	6.84	6.84	5315.80	0.00	0.00	3.20	5315.80	0.00	0 00:00	0 00:00	0.00	0.00
DP14	71.25	0.80	5324.26	1.86	0.00	1.14	5322.43	0.03	0 00:17	0 00:00	0.00	0.00
DP15	11.42	11.42	5325.05	0.25	0.00	0.05	5324.80	0.00	0 00:35	0 00:00	0.00	0.00
DP16	8.68	8.68	5319.97	0.47	0.00	0.53	5319.50	0.00	0 00:10	0 00:00	0.00	0.00
DP17	6.37	6.37	5323.15	0.47	0.00	1.85	5322.68	0.00	0 00:14	0 00:00	0.00	0.00
DP18	25.37	6.75	5322.00	1.50	0.00	3.00	5320.77	0.27	0 00:15	0 00:00	0.00	0.00
DP19	4.72	0.00	5321.42	0.92	0.00	3.58	5320.54	0.04	0 00:33	0 00:00	0.00	0.00
DP20	13.86	10.05	5319.62	1.59	0.00	2.26	5318.07	0.04	0 00:16	0 00:00	0.00	0.00
DP21	19.11	4.37	5318.07	1.57	0.00	2.93	5316.97	0.47	0 00:16	0 00:00	0.00	0.00
DP22	11.89	0.00	5317.24	0.90	0.00	3.60	5316.39	0.05	0 00:32	0 00:00	0.00	0.00
DP23	87.56	4.63	5317.64	1.84	0.00	1.36	5315.91	0.11	0 00:27	0 00:00	0.00	0.00
DP24	15.01	4.39	5322.82	1.50	0.00	2.29	5321.33	0.01	0 00:14	0 00:00	0.00	0.00
DP25	11.79	11.79	5323.30	1.44	0.00	2.30	5321.87	0.01	0 00:14	0 00:00	0.00	0.00
DP26	3.70	3.70	5322.48	0.36	0.00	0.66	5322.12	0.00	0 00:10	0 00:00	0.00	0.00
DP27	19.81	9.95	5318.93	0.50	0.00	3.07	5318.44	0.01	0 00:15	0 00:00	0.00	0.00
DP28	4.77	0.00	5317.86	0.42	0.00	4.14	5317.45	0.01	0 00:31	0 00:00	0.00	0.00
DP29	7.78	7.78	5319.03	0.50	0.00	2.97	5318.53	0.00	0 00:14	0 00:00	0.00	0.00
DP30	10.97	3.63	5319.68	0.93	0.00	0.09	5318.76	0.01	0 00:10	0 00:00	0.00	0.00
DP31	15.30	5.86	5316.54	0.89	0.00	0.71	5315.66	0.01	0 00:15	0 00:00	0.00	0.00
DPH1	124.28	1.44	5317.26	2.26	0.00	0.49	5315.06	0.06	0 00:22	0 00:00	0.00	0.00
DPH2	0.99	0.99	5321.00	0.00	0.00	6.00	5321.00	0.00	0 00:00	0 00:00	0.00	0.00
DPH3	15.82	5.29	5322.50	0.25	0.00	5.75	5322.25	0.00	0 00:36	0 00:00	0.00	0.00

Channel Input

Element ID	Length (ft)	Inlet Invert Elevation (ft)	Outlet Invert Elevation (ft)	Average Slope (%)	Shape	Height (ft)	Width (ft)	Manning's Roughness
DP01=>DP02	150.00	5331.93	5330.43	1.0000	Trapezoidal	0.550	60.000	0.0160
DP01a=>DP01	200.00	5332.93	5331.93	0.5000	Trapezoidal	2.000	17.000	0.0160
DP03=>DP05	810.00	5330.43	5323.34	0.8800	Trapezoidal	0.500	55.000	0.0160
DP04=>DP09	150.00	5330.43	5328.93	1.0000	Trapezoidal	0.500	55.000	0.0160
DP07=>DP08	780.00	5323.34	5316.53	0.8700	Trapezoidal	0.500	55.000	0.0160
DP09=>DP10	485.00	5328.93	5324.08	1.0000	Trapezoidal	3.000	23.000	0.0800
DP10=>DP14	45.00	5324.08	5322.40	3.7300	Parabolic	1.500	25.000	0.0320
DP11=>DPH1	196.00	5315.50	5315.00	0.2600	Trapezoidal	2.750	45.000	0.0700
DP12=>DPH1	95.00	5315.65	5315.00	0.6800	Trapezoidal	2.750	45.000	0.0700
DP14=>DP23	865.00	5322.40	5315.80	0.7600	User-Defined	2.750	41.000	0.0800
DP15=>DPH3	170.00	5324.80	5322.25	1.5000	Trapezoidal	0.300	45.000	0.0350
DP16=>DP30	5.00	5319.50	5318.75	15.0000	Parabolic	1.000	5.000	0.0320
DP17=>DP18	435.00	5322.68	5320.50	0.5000	User-Defined	1.020	56.000	0.0400
DP22=>DP23	124.00	5316.34	5315.85	0.4000	User-Defined	2.750	41.000	0.0320
DP26=>DP27	580.00	5322.12	5318.43	0.6400	User-Defined	1.020	56.000	0.0320
DP28=>DP21	190.00	5317.44	5316.50	0.4900	User-Defined	1.020	56.000	0.0320
DP29=>DP27	20.00	5318.53	5318.43	0.5000	User-Defined	1.020	56.000	0.0320
DP30=>DP31	610.00	5318.75	5315.65	0.5100	User-Defined	1.020	10.000	0.0320

Channel Results

SN	Element ID	Peak Flow (cfs)	Time of Peak Flow Occurrence (days hh:mm)	Design Flow Capacity (cfs)	Peak Flow/ Design Flow Ratio	Peak Flow Velocity (ft/sec)	Travel Time (min)	Peak Flow Depth (ft)	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged (min)	Froude Number	Reported Condition
1	DP01=>DP02	70.34	0 00:11	74.04	0.95	4.12	0.61	0.54	0.98	0.00		
2	DP01a=>DP01	48.53	0 00:11	167.34	0.29	5.48	0.61	1.08	0.54	0.00		
3	DP03=>DP05	37.30	0 00:14	54.81	0.68	4.58	2.95	0.42	0.85	0.00		
4	DP04=>DP09	39.80	0 00:12	58.58	0.68	3.57	0.70	0.43	0.85	0.00		
5	DP07=>DP08	27.44	0 00:17	54.74	0.50	3.48	3.74	0.37	0.75	0.00		
6	DP09=>DP10	52.04	0 00:15	113.38	0.46	2.71	2.98	2.08	0.69	0.00		
7	DP10=>DP14	70.82	0 00:17	222.90	0.32	6.28	0.12	0.88	0.59	0.00		
8	DP11=>DPH1	111.95	0 00:22	161.62	0.69	1.56	2.09	2.25	0.82	0.00		
9	DP12=>DPH1	13.07	0 00:19	264.69	0.05	1.05	1.51	0.50	0.18	0.00		
10	DP14=>DP23	69.30	0 00:27	182.91	0.38	2.38	6.06	1.83	0.67	0.00		
11	DP15=>DPH3	11.29	0 00:36	16.00	0.71	1.63	1.74	0.25	0.84	0.00		
12	DP16=>DP30	8.67	0 00:10	42.98	0.20	8.05	0.01	0.47	0.47	0.00		
13	DP17=>DP18	5.47	0 00:19	49.03	0.11	2.97	2.44	0.43	0.43	0.00		
14	DP22=>DP23	11.88	0 00:33	131.64	0.09	1.04	1.99	0.90	0.33	0.00		
15	DP26=>DP27	2.74	0 00:18	55.24	0.05	3.12	3.10	0.31	0.31	0.00		
16	DP28=>DP21	4.77	0 00:34	48.71	0.10	3.36	0.94	0.42	0.41	0.00		
17	DP29=>DP27	7.74	0 00:15	48.97	0.16	1.54	0.22	0.50	0.49	0.00		
18	DP30=>DP31	9.85	0 00:15	13.52	0.73	3.02	3.37	0.88	0.87	0.00		

Pipe Input

Element ID	Length (ft)	Inlet Invert Elevation (ft)	Outlet Invert Elevation (ft)	Total Drop (ft)	Average Slope (%)	Pipe Shape	Pipe Diameter or Height (in)	Pipe Width (in)	Manning's Roughness
DP02=>DIV01	1.00	5330.43	5330.43	0.00	0.0000	Dummy	0.000	0.000	0.0320
DP02=>DP03	1.00	5330.43	5330.43	0.00	0.0000	Dummy	0.000	0.000	0.0150
DP02=>DP04	1.00	5330.43	5330.43	0.00	0.0000	Dummy	0.000	0.000	0.0150
DP05=>DIV02	1.00	5322.33	5322.33	0.00	0.0000	Dummy	0.000	0.000	0.0150
DP05=>DP06	1.00	5322.33	5322.33	0.00	0.0000	Dummy	0.000	0.000	0.0320
DP05=>DP07	1.00	5322.33	5322.33	0.00	0.0000	Dummy	0.000	0.000	0.0150
DP06=>Out-H4	1.00	5322.33	5322.33	0.00	0.0000	Dummy	0.000	0.000	0.0320
DP11a=>DP11	0.00	5315.50	5315.50	0.00	0.0000	Dummy	0.000	0.000	0.0320
DP13=>DP23	0.00	5315.80	5315.80	0.00	0.0000	Dummy	0.000	0.000	0.0150
DP13=>Out-H1	1.00	5312.38	5312.38	0.00	0.0000	Dummy	0.000	0.000	0.0320
DP18=>DET03	0.00	5320.76	5320.76	0.00	0.0000	Dummy	0.000	0.000	0.0320
DP19=>DP20	450.00	5320.50	5318.03	2.47	0.5500	CIRCULAR	18.000	18.000	0.0150
DP20=>DP21	290.00	5318.03	5316.50	1.53	0.5300	CIRCULAR	24.000	24.000	0.0150
DP21=>DET01	1.00	5316.95	5316.50	0.45	45.0000	Dummy	0.000	0.000	0.0150
DP23=>DP11	60.00	5315.80	5315.50	0.30	0.5000	Rectangular	18.000	120.000	0.0150
DP24=>DP18	116.00	5321.32	5320.50	0.82	0.7100	CIRCULAR	24.000	24.000	0.0150
DP25a=>DP24	112.00	5321.86	5321.32	0.54	0.4800	CIRCULAR	24.000	24.000	0.0150
DP27=>DET02	0.00	5318.43	5318.43	0.00	0.0000	Dummy	0.000	0.000	0.0150
DP31=>DET04	0.00	5315.65	5315.65	0.00	0.0000	Dummy	0.000	0.000	0.0150
DPH2=>Out-DPH2	1.00	5321.00	5321.00	0.00	0.0000	Dummy	0.000	0.000	0.0320
DPH3=>OutDPH3	1.00	5322.25	5322.25	0.00	0.0000	Dummy	0.000	0.000	0.0320

Pipe Results

SN	Element ID	Peak Flow (cfs)	Time of Peak Flow Occurrence (days hh:mm)	Design Flow Capacity (cfs)	Peak Flow Velocity (ft/sec)	Travel Time (min)	Peak Flow Depth (ft)	Total Time Surcharged (min)	Froude Number	Reported Condition
1	DP02=>DIV01	79.89	0 00:11	0.00	0.00		1.08	0.00		Calculated
2	DP02=>DP03	39.95	0 00:11	0.00	0.00		1.08	0.00		Calculated
3	DP02=>DP04	39.95	0 00:11	0.00	0.00		1.08	0.00		Calculated
4	DP05=>DIV02	58.55	0 00:13	0.00	0.00		0.43	0.00		Calculated
5	DP05=>DP06	29.28	0 00:13	0.00	0.00		0.43	0.00		Calculated
6	DP05=>DP07	29.28	0 00:13	0.00	0.00		0.43	0.00		Calculated
7	DP06=>Out-H4	29.28	0 00:13	0.00	0.00		0.43	0.00		Calculated
8	DP11a=>DP11	29.00	0 00:16	0.00	0.00		2.25	0.00		Calculated
9	DP13=>DP23	6.84	0 00:17	0.00	0.00		0.50	0.00		Calculated
10	DP13=>Out-H1	124.28	0 00:22	0.00	0.00		0.50	0.00		Calculated
11	DP18=>DET03	25.37	0 00:16	0.00	0.00		0.43	0.00		Calculated
12	DP19=>DP20	4.72	0 00:35	6.74	4.26	1.76	0.92	0.00		Calculated
13	DP20=>DP21	13.64	0 00:16	14.24	5.21	0.93	1.57	0.00		Calculated
14	DP21=>DET01	19.11	0 00:16	0.00	0.00		1.57	0.00		Calculated
15	DP23=>DP11	87.56	0 00:28	158.04	5.47	0.18	0.80	0.00		Calculated
16	DP24=>DP18	14.96	0 00:15	16.48	5.97	0.32	1.49	0.00		Calculated
17	DP25a=>DP24	11.69	0 00:15	13.61	5.62	0.33	1.43	0.00		Calculated
18	DP27=>DET02	19.81	0 00:16	0.00	0.00		0.31	0.00		Calculated
19	DP31=>DET04	15.30	0 00:13	0.00	0.00		0.88	0.00		Calculated
20	DPH2=>Out-DPH2	0.99	0 00:20	0.00	0.00		0.88	0.00		Calculated
21	DPH3=>OutDPH3	15.82	0 00:36	0.00	0.00		0.88	0.00		Calculated

Storage Nodes

Storage Node : DET01

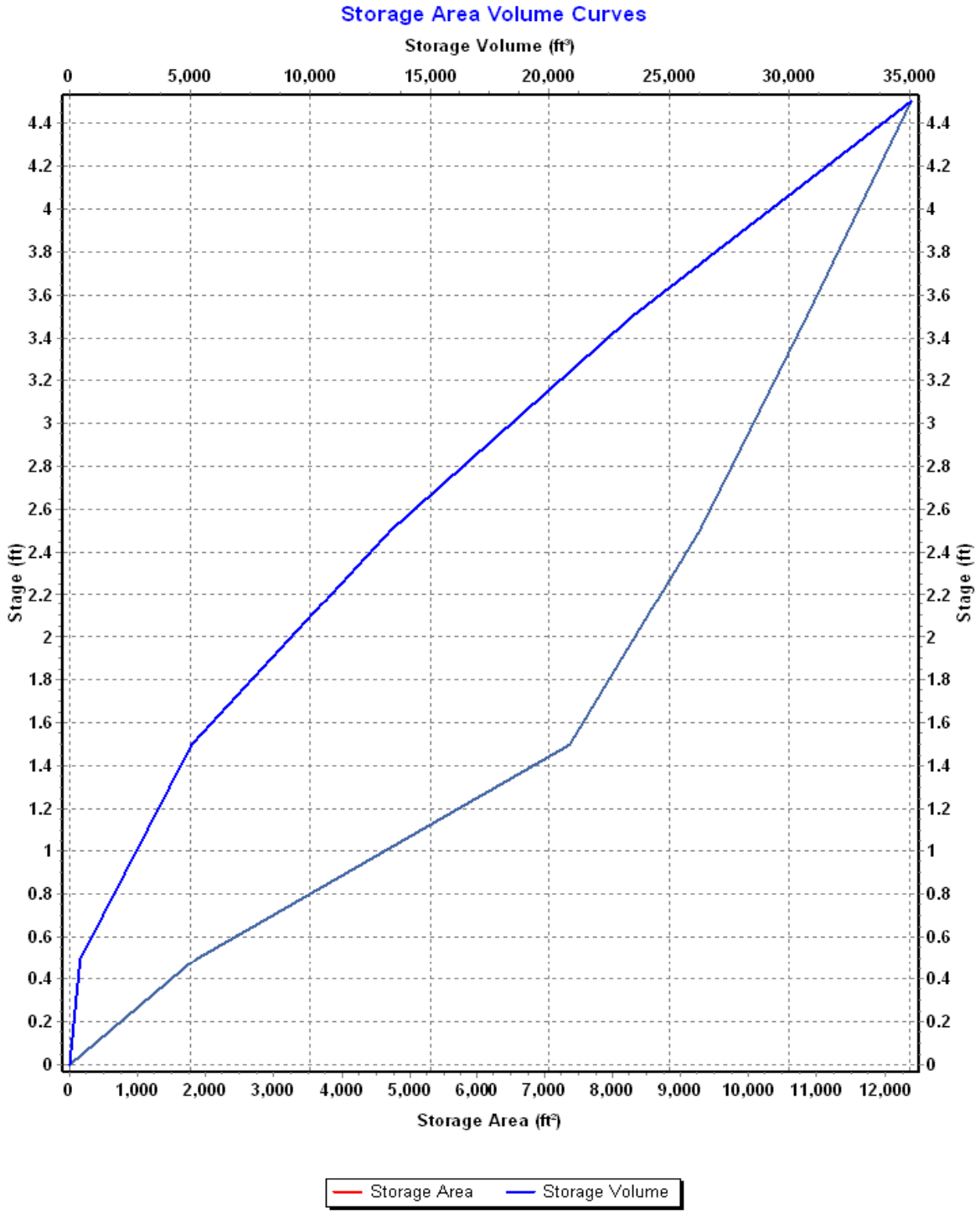
Input Data

Invert Elevation (ft) 5316.50
Max (Rim) Elevation (ft) 5321.00
Max (Rim) Offset (ft) 4.50
Initial Water Elevation (ft) 5317.90
Initial Water Depth (ft) 1.40
Ponded Area (ft²) 0.00
Evaporation Loss 0.00

Storage Area Volume Curves

Storage Curve : DET01

Stage (ft)	Storage Area (ft²)	Storage Volume (ft³)
0	0	0.000
0.5	1869	467.25
1.5	7359	5081.25
2.5	9279	13400.25
3.5	10844	23461.75
4.5	12389	35078.25


Storage Area Volume Curves
Storage Volume (ft³)
0
5,000
10,000
15,000
20,000
25,000
30,000
35,000
Stage (ft)
4.4
4.2
4
3.8
3.6
3.4
3.2
3
2.8
2.6
2.4
2.2
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
1,000
2,000
3,000
4,000
5,000
6,000
7,000
8,000
9,000
10,000
11,000
12,000
Storage Area (ft²)
Storage Area
Storage Volume

Storage Node : DET01 (continued)

Outflow Weirs

Element ID	Weir Type	Crest Elevation (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
DET01	V-Notch	5318.50	12.00	2.50	2.40

Output Summary Results

Peak Inflow (cfs)	19.11
Peak Lateral Inflow (cfs)	0.00
Peak Outflow (cfs)	11.89
Peak Exfiltration Flow Rate (cfm)	0.00
Max HGL Elevation Attained (ft)	5319.84
Max HGL Depth Attained (ft)	3.34
Average HGL Elevation Attained (ft)	5318.62
Average HGL Depth Attained (ft)	2.12
Time of Max HGL Occurrence (days hh:mm)	0 00:32
Total Exfiltration Volume (1000-ft³)	0.000
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0.00

Storage Node : DET02

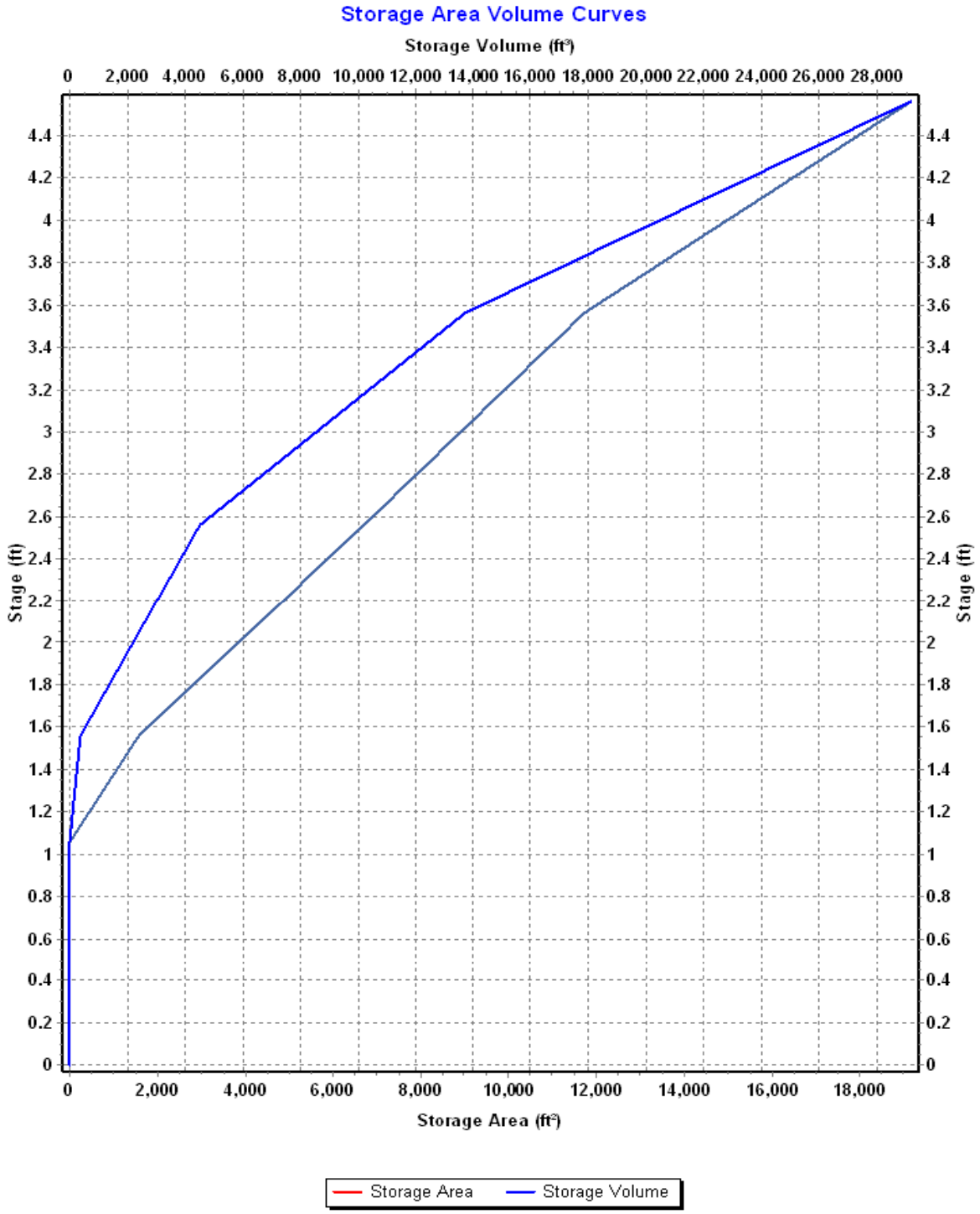
Input Data

Invert Elevation (ft)	5317.44
Max (Rim) Elevation (ft)	5322.00
Max (Rim) Offset (ft)	4.56
Initial Water Elevation (ft)	5318.50
Initial Water Depth (ft)	1.06
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : DET02

Stage (ft)	Storage Area (ft²)	Storage Volume (ft³)
0	0	0.000
0.06	0	0.00
1.06	0	0.00
1.56	1586	396.50
2.56	6685	4532.00
3.56	11730	13739.50
4.56	19160	29184.50


Storage Area Volume Curves
Storage Volume (ft³)
0 2,000 4,000 6,000 8,000 10,000 12,000 14,000 16,000 18,000 20,000 22,000 24,000 26,000 28,000
Stage (ft)
0 0.2 0.4 0.6 0.8 1 1.2 1.4 1.6 1.8 2 2.2 2.4 2.6 2.8 3 3.2 3.4 3.6 3.8 4 4.2 4.4
0 2,000 4,000 6,000 8,000 10,000 12,000 14,000 16,000 18,000
Storage Area (ft²)
Storage Area
Storage Volume

Storage Node : DET02 (continued)

Outflow Orifices

Element ID	Orifice Type	Orifice Shape	Circular Orifice Diameter (in)	Rectangular Orifice Height (in)	Rectangular Orifice Width (in)	Orifice Invert Elevation (ft)	Orifice Coefficient
DET02	Side	CIRCULAR	10.00			5317.44	0.61

Output Summary Results

Peak Inflow (cfs)	19.81
Peak Lateral Inflow (cfs)	0.00
Peak Outflow (cfs)	4.77
Peak Exfiltration Flow Rate (cfm)	0.00
Max HGL Elevation Attained (ft)	5321.01
Max HGL Depth Attained (ft)	3.57
Average HGL Elevation Attained (ft)	5317.57
Average HGL Depth Attained (ft)	0.13
Time of Max HGL Occurrence (days hh:mm)	0 00:31
Total Exfiltration Volume (1000-ft³)	0.000
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0.00

Storage Node : DET03

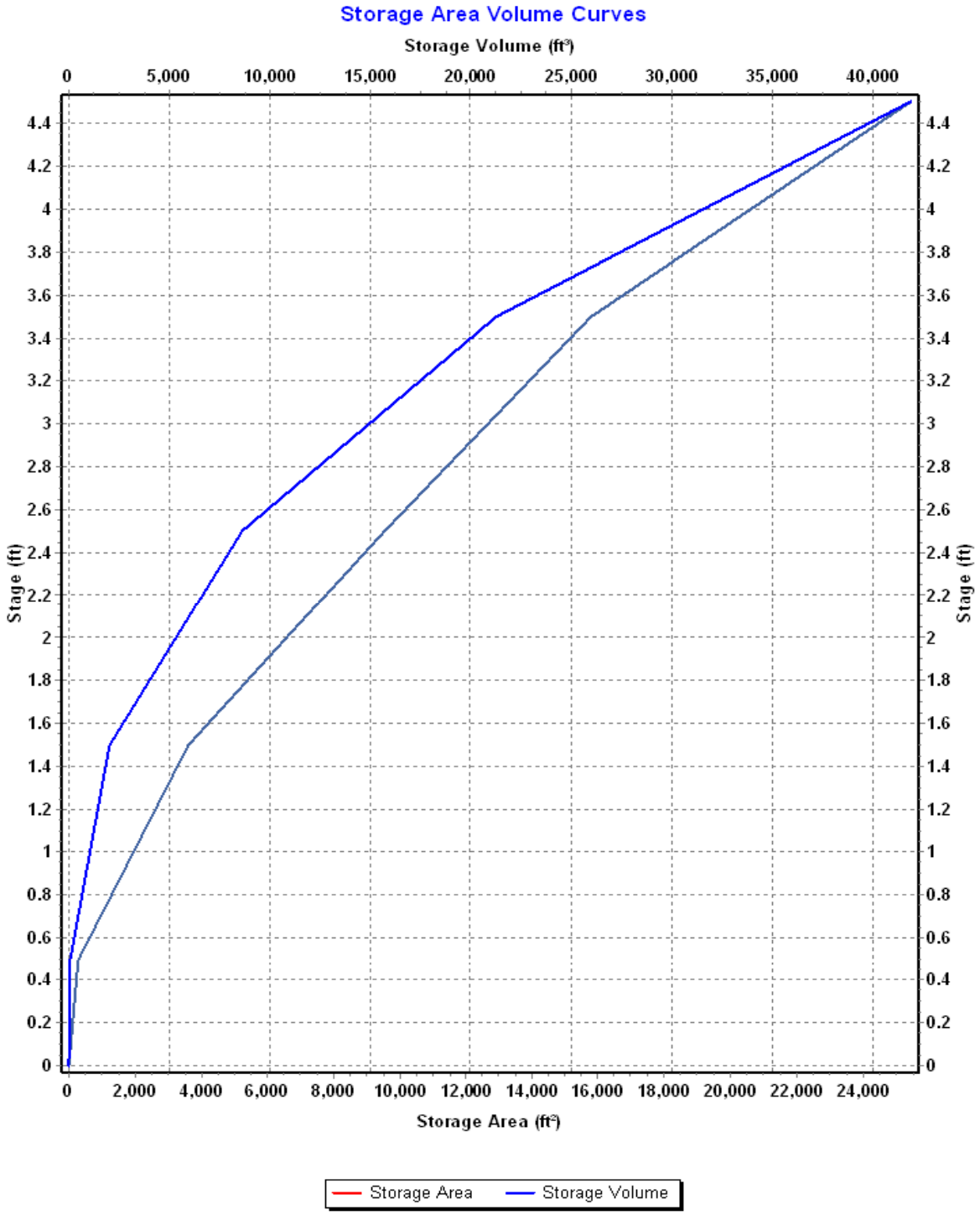
Input Data

Invert Elevation (ft)	5320.50
Max (Rim) Elevation (ft)	5325.00
Max (Rim) Offset (ft)	4.50
Initial Water Elevation (ft)	5320.50
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : DET03

Stage (ft)	Storage Area (ft²)	Storage Volume (ft³)
0	0	0.000
0.5	289	72.25
1.5	3619	2026.25
2.5	9546	8608.75
3.5	15784	21273.75
4.5	25455	41893.25


Storage Area Volume Curves
Storage Volume (ft³)
0
5,000
10,000
15,000
20,000
25,000
30,000
35,000
40,000
Stage (ft)
4.4
4.2
4
3.8
3.6
3.4
3.2
3
2.8
2.6
2.4
2.2
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
2,000
4,000
6,000
8,000
10,000
12,000
14,000
16,000
18,000
20,000
22,000
24,000
Storage Area (ft²)
Storage Area
Storage Volume

Storage Node : DET03 (continued)

Outflow Orifices

Element ID	Orifice Type	Orifice Shape	Circular Orifice Diameter (in)	Rectangular Orifice Height (in)	Rectangular Orifice Width (in)	Orifice Invert Elevation (ft)	Orifice Coefficient
DET03	Side	CIRCULAR	10.00			5320.50	0.61

Output Summary Results

Peak Inflow (cfs)	25.37
Peak Lateral Inflow (cfs)	0.00
Peak Outflow (cfs)	4.72
Peak Exfiltration Flow Rate (cfm)	0.00
Max HGL Elevation Attained (ft)	5324.00
Max HGL Depth Attained (ft)	3.5
Average HGL Elevation Attained (ft)	5320.61
Average HGL Depth Attained (ft)	0.11
Time of Max HGL Occurrence (days hh:mm)	0 00:33
Total Exfiltration Volume (1000-ft³)	0.000
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0.00

Storage Node : DET04

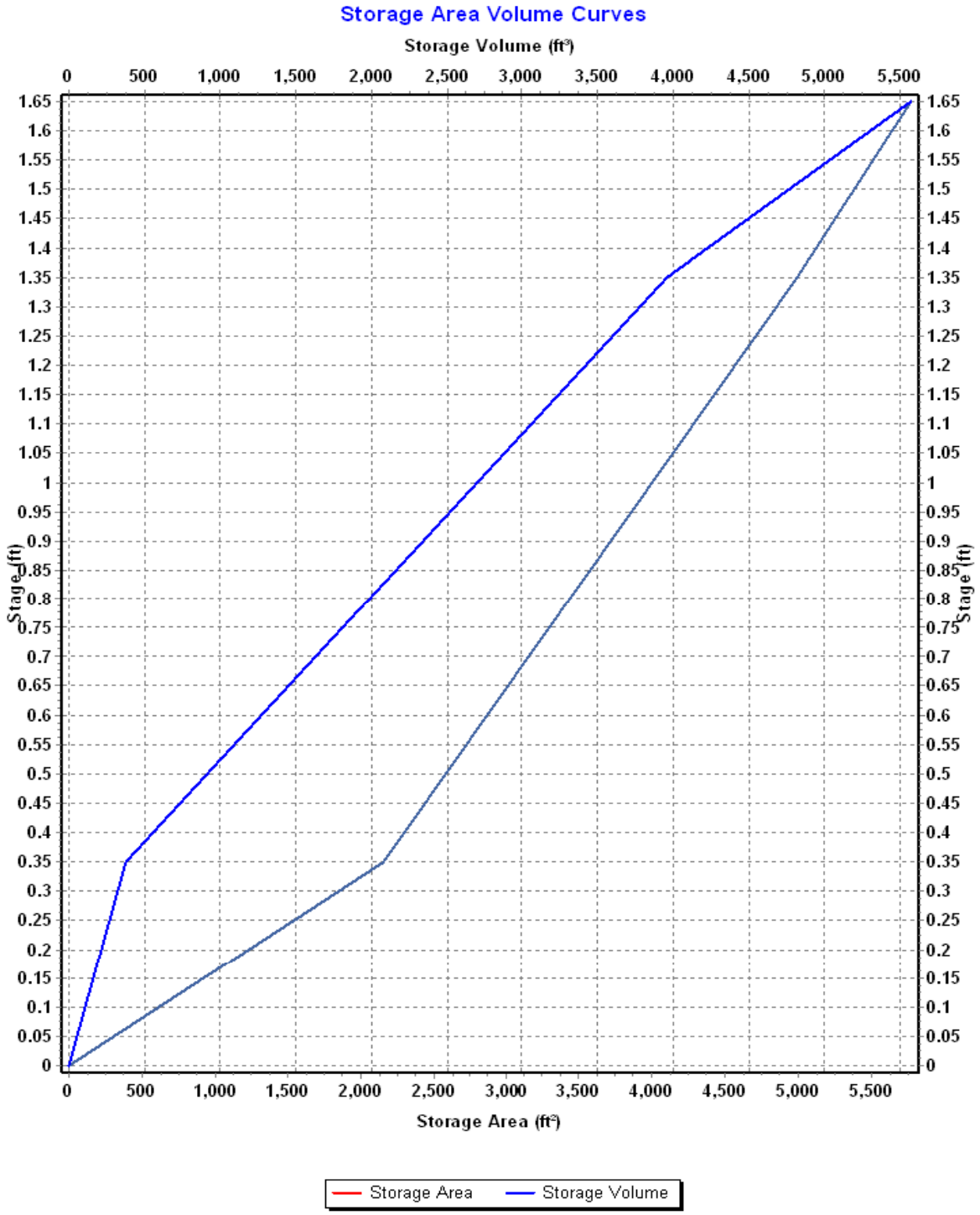
Input Data

Invert Elevation (ft)	5315.65
Max (Rim) Elevation (ft)	5317.30
Max (Rim) Offset (ft)	1.65
Initial Water Elevation (ft)	5316.20
Initial Water Depth (ft)	0.55
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : DET04

Stage (ft)	Storage Area (ft²)	Storage Volume (ft³)
0	0	0.000
0.35	2161	378.17
1.35	4996	3956.67
1.65	5774	5572.17


Storage Area Volume Curves
Storage Volume (ft³)
0
500
1,000
1,500
2,000
2,500
3,000
3,500
4,000
4,500
5,000
5,500
Stage (ft)
1.65
1.6
1.55
1.5
1.45
1.4
1.35
1.3
1.25
1.2
1.15
1.1
1.05
1
0.95
0.9
0.85
0.8
0.75
0.7
0.65
0.6
0.55
0.5
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
Storage Area (ft²)
Storage Area
Storage Volume

Storage Node : DET04 (continued)

Outflow Weirs

Element ID	Weir Type	Crest Elevation (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
DET04	Trapezoidal	5316.40	2.00	0.90	3.33

Output Summary Results

Peak Inflow (cfs)	15.30
Peak Lateral Inflow (cfs)	0.00
Peak Outflow (cfs)	13.10
Peak Exfiltration Flow Rate (cfm)	0.00
Max HGL Elevation Attained (ft)	5317.28
Max HGL Depth Attained (ft)	1.63
Average HGL Elevation Attained (ft)	5316.41
Average HGL Depth Attained (ft)	0.76
Time of Max HGL Occurrence (days hh:mm)	0 00:18
Total Exfiltration Volume (1000-ft³)	0.000
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0.00

Storage Node : DP08

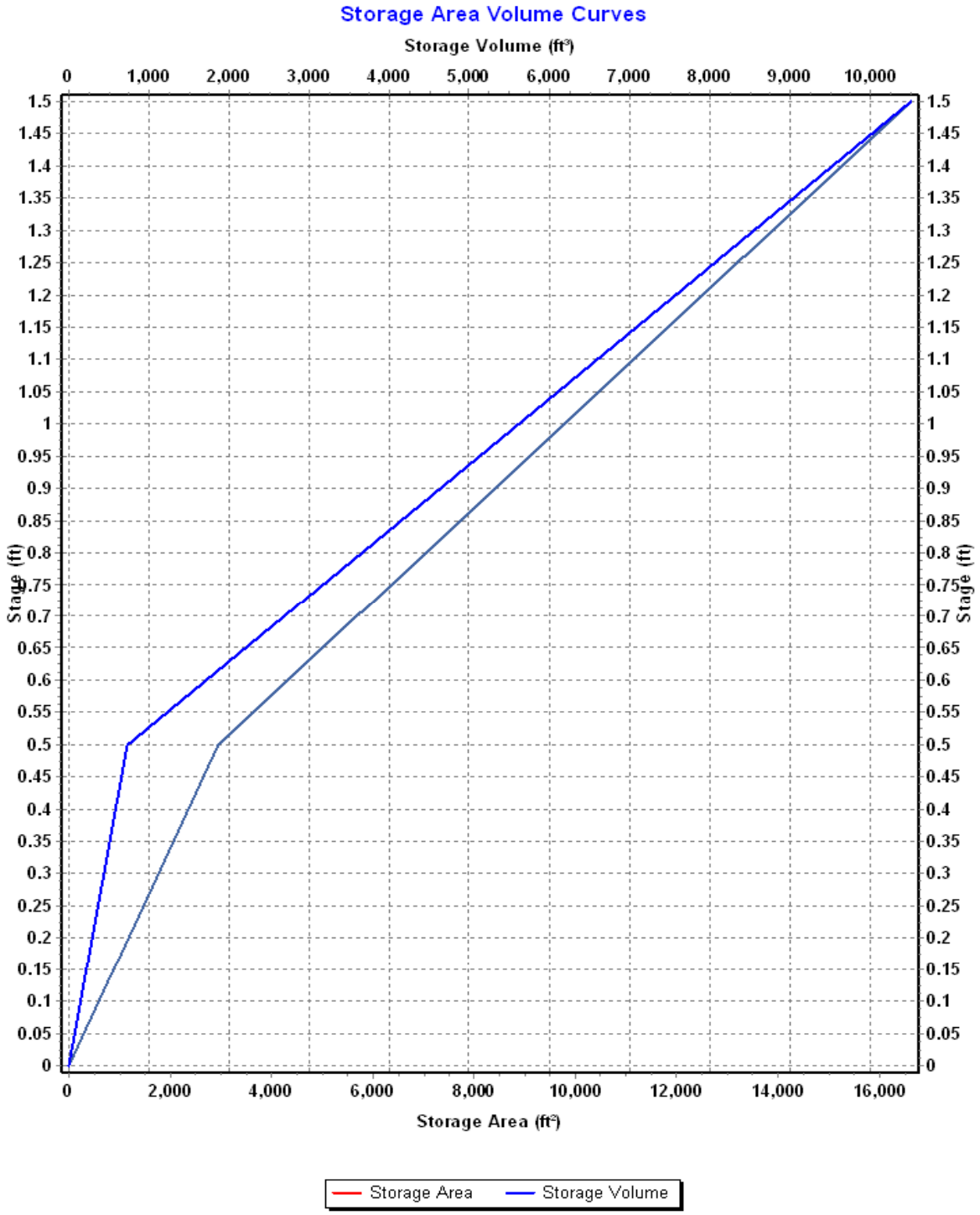
Input Data

Invert Elevation (ft)	5316.53
Max (Rim) Elevation (ft)	5318.00
Max (Rim) Offset (ft)	1.47
Initial Water Elevation (ft)	5316.53
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : DP8-Storage

Stage (ft)	Storage Area (ft²)	Storage Volume (ft³)
0	0	0.000
.5	2936	734.00
1.5	16617	10510.50


Storage Area Volume Curves
Storage Volume (ft³)
0
1,000
2,000
3,000
4,000
5,000
6,000
7,000
8,000
9,000
10,000
Stage (ft)
1.5
1.45
1.4
1.35
1.3
1.25
1.2
1.15
1.1
1.05
1
0.95
0.9
0.85
0.8
0.75
0.7
0.65
0.6
0.55
0.5
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
2,000
4,000
6,000
8,000
10,000
12,000
14,000
16,000
Storage Area (ft²)
Storage Area
Storage Volume

Storage Node : DP08 (continued)

Outflow Weirs

Element ID	Weir Type	Crest Elevation (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
DP08=>DP11	Trapezoidal	5316.53	4.00	0.50	3.33
DP08=>DP11a	Trapezoidal	5317.03	20.00	1.00	3.33

Output Summary Results

Peak Inflow (cfs)	46.65
Peak Lateral Inflow (cfs)	29.99
Peak Outflow (cfs)	46.12
Peak Exfiltration Flow Rate (cfm)	0.00
Max HGL Elevation Attained (ft)	5317.48
Max HGL Depth Attained (ft)	0.95
Average HGL Elevation Attained (ft)	5316.54
Average HGL Depth Attained (ft)	0.0100000000000002
Time of Max HGL Occurrence (days hh:mm)	0 00:16
Total Exfiltration Volume (1000-ft³)	0.000
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0.00

APPENDIX D

Flood Conveyance Channel Supporting Calculations

CITY OF BOULDER
Planning and Development Services

1739 Broadway, Third Floor • P.O. Box 791, Boulder, Colorado 80306-0791
phone 303-441-1880 • fax 303-441-3241 • email plandevelop@bouldercolorado.gov
www.boulderplandevelop.net

March 21, 2011

Leslie Ewy
The Sanitas Group, LLC
1022 Willow Place
Louisville, Colorado 80027

RE: Hogan Pancost Flood Flows

Dear Leslie;

In accordance with your request, the City of Boulder is providing 100-year flood flow rate information for the Hogan Pancost property located at 5399 Kewanee Drive. This flow rate information was prepared by CH2M Hill on March 16, 2011, for the preferred transect locations that you requested on March 9, 2011. The flow rate information was developed from the current regulatory MIKE FLOOD floodplain analysis for South Boulder Creek and is shown in the table below:

100-Year Flood Flow Information

Section	1D Peak Flow (cfs)	2D Peak Flow (cfs)	Combined Peak Flow (cfs)
DCD1	106.10	12.86	117.91
DCD2	92.03	44.11	135.35
DCD3	56.06	74.96	130.54
DCD4	84.19	48.30	131.68
DCD5	87.04	43.81	130.12
DCD6	175.12	3.86	177.50
HP1	0.00	8.55	8.55
HP2	0.00	9.27	9.27
HP3	0.00	8.22	8.22
HP4	0.00	0.00	0.00
HP5	0.00	0.00	0.00
KEW1	0.00	48.15	48.15

The MIKE FLOOD floodplain analysis and associated floodplain mapping for South Boulder Creek was adopted by the City of Boulder for regulatory purposes, effective January 1, 2009. The study has not

CITY OF BOULDER
Planning and Development Services

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www.boulderplandevelop.net

been officially adopted by the Federal Emergency Management Association (FEMA) at this time and is subject to change. A Letter of Map Revision (LOMR) request was sent to FEMA on December 30, 2008. On March 25, 2009, FEMA notified the City of Boulder that they intend to adopt the revised floodplain mapping. Recently, the City of Boulder was informed by FEMA that they will not officially adopt the new floodplain maps until late 2011 when the digital flood insurance rate maps are adopted for Boulder County.

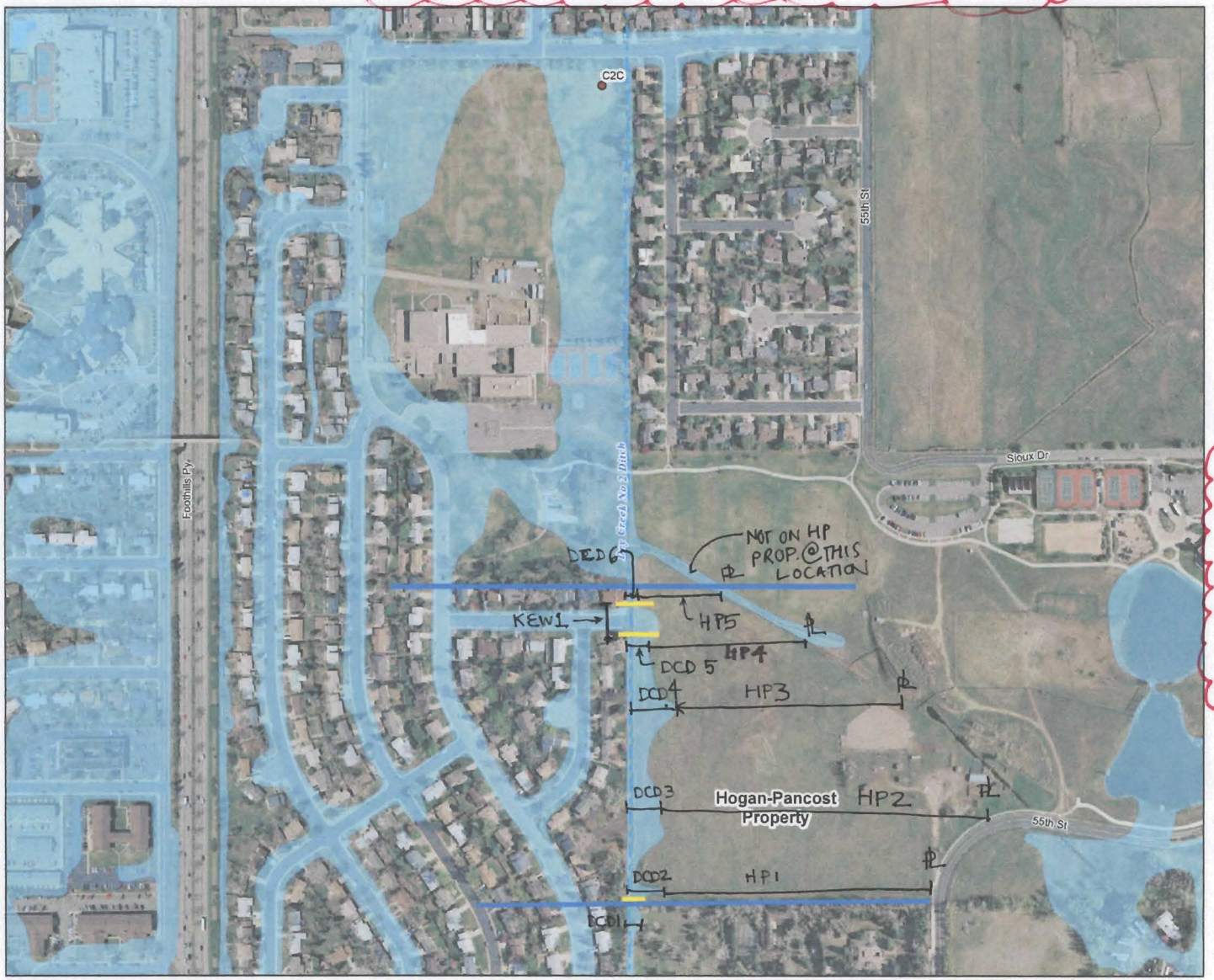
As you are aware, all floodplain information is subject to change. Floodwater depths, flow velocities and floodplain boundaries can all change based on revised topography, better surveying techniques, new floodplain analyses, updated hydrology, and construction activities. The construction at the Hogan Pancost site will be subject to the mapping and regulations in place at the time of building permit application.

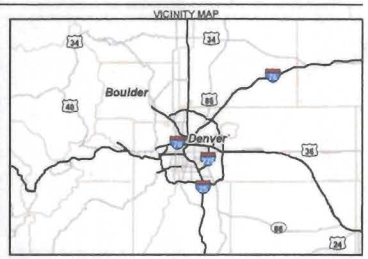
Please let me know if you have any questions.

Sincerely,

Katie Knapp, P.E., CFM
City of Boulder
Public Works
Floodplain and Wetland Administrator

PREFERRED TRANSECT LOCATIONS





LEGEND

Transect Date

- 2/16/2011
- 2/23/2011
- C2 Loadpoint
- Streams, Creeks and Ditches
- Zone AE

ALL DCD Transects are to limits of mapped flood flows.
DCD1....Locate S. of HP PL to determine DCD2 flows before confluence with DCD2-return flow lateral
DCD2....Locate N. of HP PL and confluence of DCD2-return flow lateral
DCD3.....Locate generally as shown.
DCD4.....Locate generally as shown.
DCD5....Locate S. of Kewanee Dr. confluence
DCD6....Locate N. of Kewanne Dr. confluence
ALL HP Transects are from limits of mapped flooding on west to HP property line on east.
PURPOSE: Isolate DCD2 conveyed flood flows from overland flood flows.

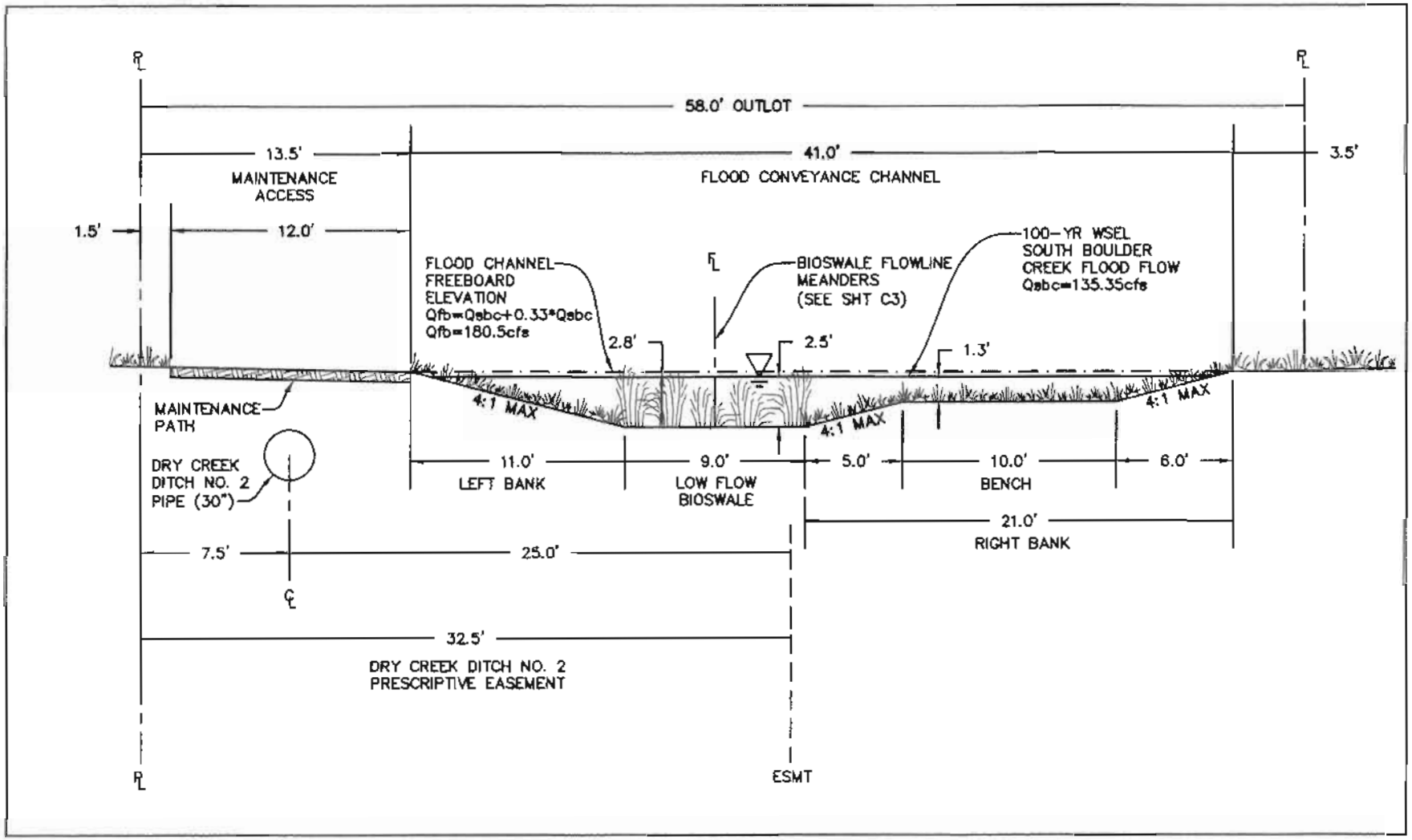
N
W E
S

The Sanitas Group
03/09/11 LRE

0 150 300 600 900 Feet

SOUTH BOULDER CREEK
FLOOD MITIGATION STUDY
Dry Creek Ditch No. 2
at Hogan Pancost Property

CH2MHILL



BIOSWALE AND FLOOD CONVEYANCE CHANNEL TYPICAL SECTION

SOUTH PROPERTY LINE TO KEWANEE DRIVE EXTENSION

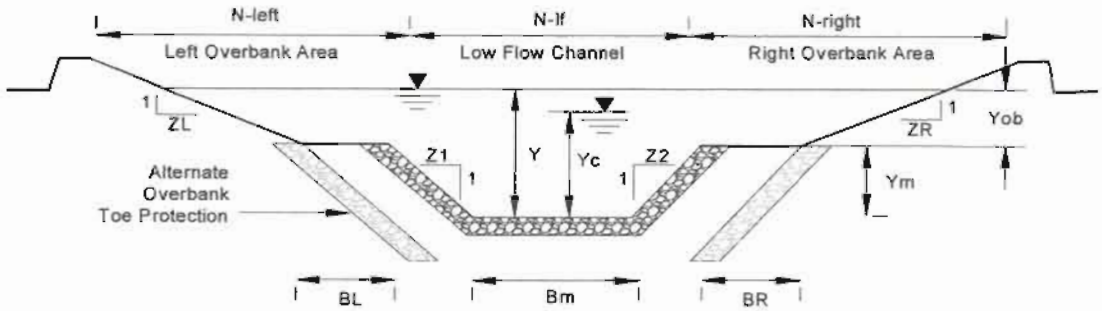
(58.0' OUTLOT WIDTH)

NO SCALE

Capacity Analysis of Composite Channel

Project: Hogan-Pancost Project

Channel ID: DCD1 w/SBC Flood Flows + Freeboard Determination (1/3 SBC Flood Flow)



Design Information (Input)					
Channel Invert Slope	So =	0.00400 ft/ft	Left Overbank Bottom Width	BL =	0.00 ft
			Left Overbank Side Slope	ZL =	4.00 ft/ft
Low Flow Channel Bottom Width	Bm =	9.00 ft	Left Overbank Manning's n	n-left =	0.0350
Low Flow Channel Left Side Slope	Z1 =	4.00 ft/ft	Right Overbank Bottom Width	BR =	10.00 ft
Low Flow Channel Right Side Slope	Z2 =	4.00 ft/ft	Right Overbank Side Slope	ZR =	4.00 ft/ft
Low Flow Channel Manning's Nn for Qd	n-lf =	0.0864	Right Overbank Manning's n	n-right =	0.0350
Low Flow Channel Manning's Nn for Q100	n-m-Q100 =	0.0692			
(See USDCM Vol. II, n vs. Depth Graph)					
Low Flow Channel Bank-full depth	**Ym =**	**1.25 ft**	**Overbank Flow Depth Yob (Y - Ym)**	**Yob =**	**1.50 ft**

Low Flow Channel Condition for Qd			Low Flow Channel Flow Condition for Q100		
Top width	Tlf =	19.0 ft	Top width	Tm =	19.0 ft
Flow area	Alf =	17.5 sq ft	Flow area	Am =	46.0 sq ft
Wetted perimeter	Plf =	19.3 ft	Wetted perimeter	Pm =	19.3 ft
Discharge (Calculated)	**Qlf =**	**17.9 cfs**	**Discharge**	**Qm =**	**111.8 cfs**
Velocity	**Vlf=**	**1.0 fps**	**Velocity**	**Vm =**	**2.4 fps**
Froude number	**Fr-lf =**	**0.19**	**Froude number**	**Frm =**	**0.28**
Qd Critical Velocity	Vlfc =	3.57 fps	100-Yr. Critical Velocity	Vmc =	5.8 fps
Qd Critical Depth	Ylfc =	0.46 ft	100-Yr. Critical Depth	Ymc =	1.4 ft
Left Overbank Flow Condition for Q100			**Right Overbank Flow Condition for Q100**		
Top width	TL =	6.0 ft	Top width	TR =	16.0 ft
Flow area	AL =	4.5000 sq ft	Flow area	AR =	19.5000 sq ft
Wetted perimeter	PL =	6.1800 ft	Wetted perimeter	PR =	16.1800 ft
Discharge	**QL =**	**9.8 cfs**	**Discharge**	**QR =**	**59.5 cfs**
Velocity	**VL =**	**2.2 fps**	**Velocity**	**VR =**	**3.1 fps**
Froude number	**FrL =**	**0.44**	**Froude number**	**FrR =**	**0.49**
100-Yr. Critical Velocity	VLc =	4.2 fps	100-Yr. Critical Velocity	VRc =	5.2 fps
100-Yr. Critical Depth in Overbanks	YLc =	1.1 ft	100-Yr. Critical Depth in Overbanks	YRc =	1.0 ft

Composite Cross-Section Flow Condition for Q100

Top width	**T =**	**41.0 ft**	**Discharge**	**Q =**	**181.0 cfs**
Channel Depth Y	**Y =**	**2.75 ft**	**Velocity**	**V =**	**2.6 fps**
Flow area	A =	70.0 sq ft	**Froude number**	**Fr =**	**0.35**
Wetted perimeter	P =	41.7 ft	100-Yr. Critical Velocity	Vc =	5.6 fps
Cross-Sectional Manning's n (Calculated)	n =	0.0515	100-Yr. Critical Depth in Overbanks	Yc =	0.47 ft

DCD1 DESIGN FLOWS

$Q_{LF} = Q_2 = 17.0$ cfs ± (DETERMINE @ PRELIMINARY DESIGN)

$Q_{100} = 78.93$ cfs

$Q_{SBC} = 135.35$ cfs

$Q_{FB} = Q_{SBC} + \frac{1}{3} Q_{SBC} =$ ~~175.96~~ cfs 180.47cfs < 181.0cfs ✓ AC 09/27/12

MINIMUM EASEMENT WIDTH

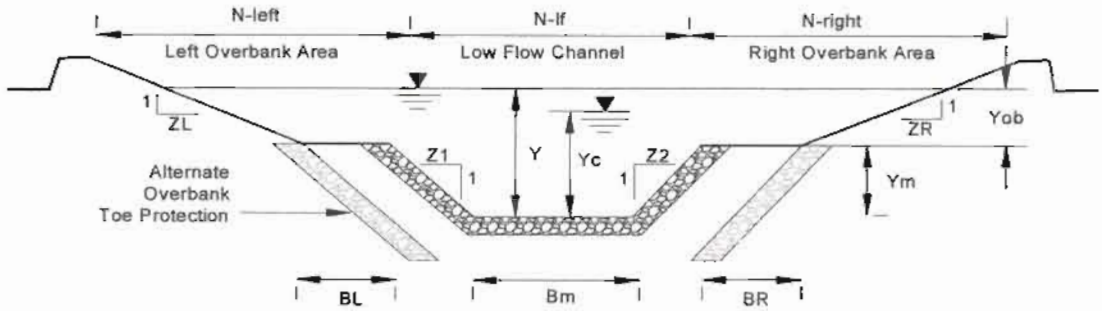
W_{EASE} = 1.5FT (CLEAR FROM PNC) + 12FT (MAINTENANCE RD) + 41FT (CHANNEL TOP WIDTH)

W_{EASE} = 54.5 FT ⇒ ~~60~~FT SHOWN ON PLAN & PROVIDED TO DTJ 07/27/11
58FT 09/20/12

Capacity Analysis of Composite Channel

Project: Hogan-Pancost Project

Channel ID: DCD1 Wetland LF Channel = Q2yr; with SBC Flood Flows



Design Information (Input)

Channel Invert Slope	So =	0.00400 ft/ft	Left Overbank Bottom Width	BL =	0.00 ft
			Left Overbank Side Slope	ZL =	4.00 ft/ft
Low Flow Channel Bottom Width	Bm =	9.00 ft	Left Overbank Manning's n	n-left =	0.0350
Low Flow Channel Left Side Slope	Z1 =	4.00 ft/ft	Right Overbank Bottom Width	BR =	10.00 ft
Low Flow Channel Right Side Slope	Z2 =	4.00 ft/ft	Right Overbank Side Slope	ZR =	4.00 ft/ft
Low Flow Channel Manning's Nn for Qd	n-lf =	0.0837	Right Overbank Manning's n	n-right =	0.0350
Low Flow Channel Manning's Nn for Q100	n-m-Q100 =	0.0650			
(See USDCM Vol. II, n vs. Depth Graph)					
Low Flow Channel Bank-full depth	**Ym =**	**1.25 ft**	**Overbank Flow Depth Yob (Y - Ym)**	**Yob =**	**1.25 ft**

Low Flow Channel Condition for Qd			**Low Flow Channel Flow Condition for Q100**		
Top width	Tlf =	19.0 ft	Top width	Tm =	19.0 ft
Flow area	Alf =	17.5 sq ft	Flow area	Am =	41.3 sq ft
Wetted perimeter	Plf =	19.3 ft	Wetted perimeter	Pm =	19.3 ft
Discharge (Calculated)	**Qlf =**	**18.5 cfs**	**Discharge**	**Qm =**	**99.2 cfs**
Velocity	**Vlf=**	**1.1 fps**	**Velocity**	**Vm =**	**2.4 fps**
Froude number	**Fr-lf =**	**0.19**	**Froude number**	**Frm =**	**0.29**
Qd Critical Velocity	Vlfc =	3.60 fps	100-Yr. Critical Velocity	Vmc =	5.6 fps
Qd Critical Depth	Ylfc =	0.47 ft	100-Yr. Critical Depth	Ymc =	1.3 ft
Left Overbank Flow Condition for Q100			**Right Overbank Flow Condition for Q100**		
Top width	TL =	5.0 ft	Top width	TR =	15.0 ft
Flow area	AL =	3.1300 sq ft	Flow area	AR =	15.6300 sq ft
Wetted perimeter	PL =	5.1500 ft	Wetted perimeter	PR =	15.1500 ft
Discharge	**QL =**	**6.0 cfs**	**Discharge**	**QR =**	**42.9 cfs**
Velocity	**VL =**	**1.9 fps**	**Velocity**	**VR =**	**2.8 fps**
Froude number	**FrL =**	**0.43**	**Froude number**	**FrR =**	**0.47**
100-Yr. Critical Velocity	VLc =	3.8 fps	100-Yr. Critical Velocity	VRc =	4.7 fps
100-Yr. Critical Depth in Overbanks	YLc =	0.9 ft	100-Yr. Critical Depth in Overbanks	YRc =	0.8 ft

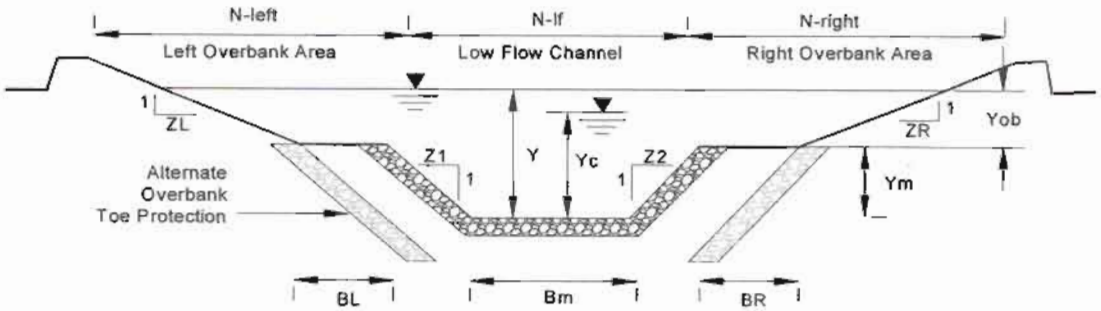
Composite Cross-Section Flow Condition for Q100

Top width	**T =**	**39.0 ft**	**Discharge**	**Q =**	**148.2 cfs**
Channel Depth Y	**Y =**	**2.50 ft**	**Velocity**	**V =**	**2.5 fps**
Flow area	A =	60.0 sq ft	**Froude number**	**Fr =**	**0.35**
Wetted perimeter	P =	39.6 ft	100-Yr. Critical Velocity	Vc =	5.3 fps
Cross-Sectional Manning's n (Calculated)	n =	0.0503	100-Yr. Critical Depth in Overbanks	Yc =	0.34 ft

Capacity Analysis of Composite Channel

Project: Hogan-Pancost Project

Channel ID: DCD1 Wetland LF Channel = Q2yr



Design Information (Input)

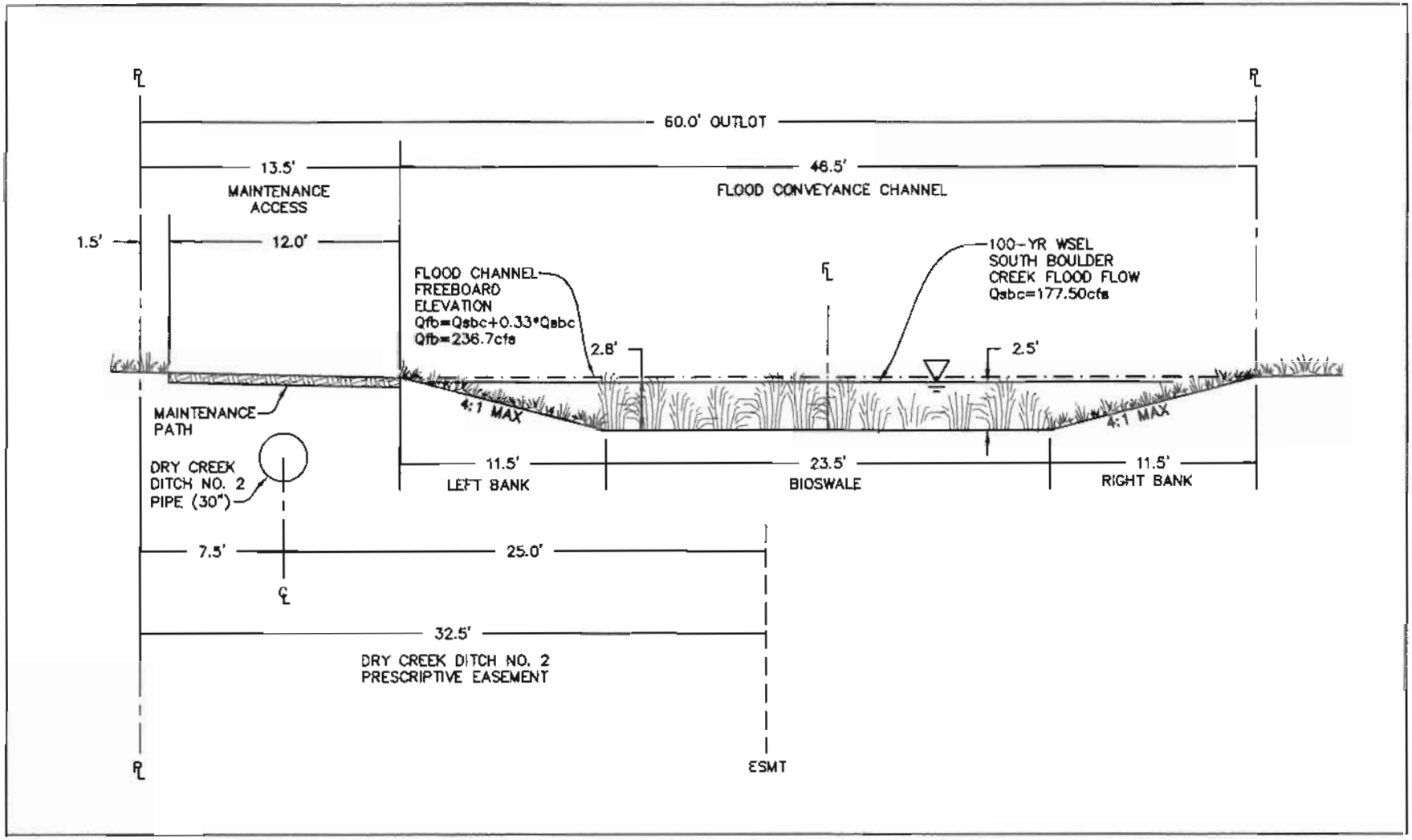
Channel Invert Slope	So =	0.00400 ft/ft	Left Overbank Bottom Width	BL =	0.00 ft
			Left Overbank Side Slope	ZL =	4.00 ft/ft
Low Flow Channel Bottom Width	Bm =	9.00 ft	Left Overbank Manning's n	n-left =	0.0350
Low Flow Channel Left Side Slope	Z1 =	4.00 ft/ft	Right Overbank Bottom Width	BR =	10.00 ft
Low Flow Channel Right Side Slope	Z2 =	4.00 ft/ft	Right Overbank Side Slope	ZR =	4.00 ft/ft
Low Flow Channel Manning's Nn for Qd	n-lf =	0.0837	Right Overbank Manning's n	n-right =	0.0350
Low Flow Channel Manning's Nn for Q100	n-m-Q100 =	0.0650			
(See USDCM Vol. II, n vs. Depth Graph)					
Low Flow Channel Bank-full depth	**Ym =**	**1.25 ft**	**Overbank Flow Depth Yob (Y - Ym)**	**Yob =**	**0.75 ft**

Low Flow Channel Condition for Qd			**Low Flow Channel Flow Condition for Q100**		
Top width	Tlf =	19.0 ft	Top width	Tm =	19.0 ft
Flow area	Alf =	17.5 sq ft	Flow area	Am =	31.8 sq ft
Wetted perimeter	Plf =	19.3 ft	Wetted perimeter	Pm =	19.3 ft
Discharge (Calculated)	**Qlf =**	**18.5 cfs**	**Discharge**	**Qm =**	**64.1 cfs**
Velocity	**Vlf=**	**1.1 fps**	**Velocity**	**Vm =**	**2.0 fps**
Froude number	**Fr-lf =**	**0.19**	**Froude number**	**Frm =**	**0.28**
Qd Critical Velocity	Vlfc =	3.60 fps	100-Yr. Critical Velocity	Vmc =	5.0 fps
Qd Critical Depth	Ylfc =	0.47 ft	100-Yr. Critical Depth	Ymc =	1.0 ft

Left Overbank Flow Condition for Q100			**Right Overbank Flow Condition for Q100**		
Top width	TL =	3.0 ft	Top width	TR =	13.0 ft
Flow area	AL =	1.1300 sq ft	Flow area	AR =	8.6300 sq ft
Wetted perimeter	PL =	3.0900 ft	Wetted perimeter	PR =	13.0900 ft
Discharge	**QL =**	**1.5 cfs**	**Discharge**	**QR =**	**17.6 cfs**
Velocity	**VL =**	**1.4 fps**	**Velocity**	**VR =**	**2.0 fps**
Froude number	**FrL =**	**0.39**	**Froude number**	**FrR =**	**0.44**
100-Yr. Critical Velocity	VLc =	2.9 fps	100-Yr. Critical Velocity	VRc =	3.6 fps
100-Yr. Critical Depth in Overbanks	YLc =	0.5 ft	100-Yr. Critical Depth in Overbanks	YRc =	0.4 ft

Composite Cross-Section Flow Condition for Q100

Top width	**T =**	**35.0 ft**	**Discharge**	**Q =**	**83.3 cfs**
Channel Depth Y	**Y =**	**2.00 ft**	**Velocity**	**V =**	**2.0 fps**
Flow area	A =	41.5 sq ft	**Froude number**	**Fr =**	**0.32**
Wetted perimeter	P =	35.5 ft	100-Yr. Critical Velocity	Vc =	4.5 fps
Cross-Sectional Manning's n (Calculated)	n =	0.0521	100-Yr. Critical Depth in Overbanks	Yc =	0.08 ft



BIOSWALE AND FLOOD CONVEYANCE CHANNEL TYPICAL SECTION

KEWANEE DRIVE EXTENSION TO NORTH PROPERTY LINE

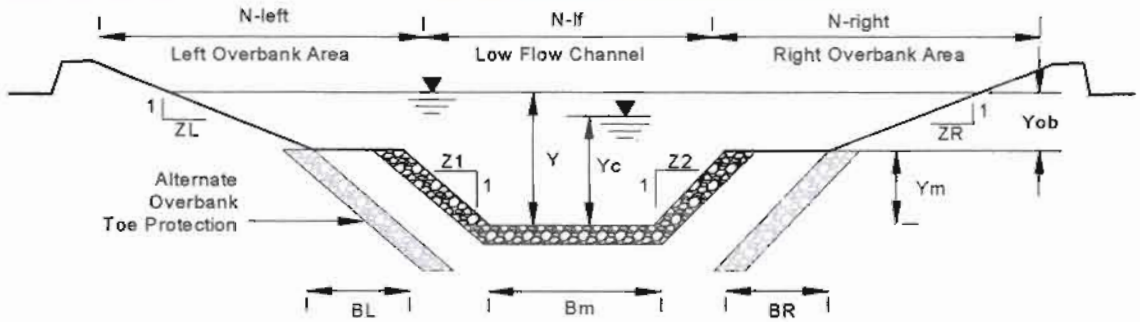
(60.0' OUTLOT WIDTH)

NO SCALE

Capacity Analysis of Composite Channel

Project: B1006 Boulder Creek Commons

Channel ID: DCD2 Channel; with SBC Flood Flows + Freeboard Determination



Design Information (Input)					
Channel Invert Slope	So =	0.00400 ft/ft	Left Overbank Bottom Width	BL =	0.00 ft
			Left Overbank Side Slope	ZL =	4.00 ft/ft
Low Flow Channel Bottom Width	Bm =	23.50 ft	Left Overbank Manning's n	n-left =	0.0350
Low Flow Channel Left Side Slope	Z1 =	4.00 ft/ft	Right Overbank Bottom Width	BR =	0.00 ft
Low Flow Channel Right Side Slope	Z2 =	4.00 ft/ft	Right Overbank Side Slope	ZR =	4.00 ft/ft
Low Flow Channel Manning's Nn for Qd	n-lf =	0.0864	Right Overbank Manning's n	n-right =	0.0350
Low Flow Channel Manning's Nn for Q100	n-m-Q100 =	0.0692			
(See USDCM Vol. II, n vs. Depth Graph)					
Low Flow Channel Bank-full depth	**Ym =**	**1.25 ft**	**Overbank Flow Depth Yob (Y - Ym)**	**Yob =**	**1.50 ft**
Low Flow Channel Condition for Qd			**Low Flow Channel Flow Condition for Q100**		
Top width	Tlf =	33.5 ft	Top width	Tm =	33.5 ft
Flow area	Alf =	35.6 sq ft	Flow area	Am =	85.9 sq ft
Wetted perimeter	Plf =	33.8 ft	Wetted perimeter	Pm =	33.8 ft
Discharge (Calculated)	**Qlf =**	**40.3 cfs**	**Discharge**	**Qm =**	**217.8 cfs**
Velocity	**Vlf=**	**1.1 fps**	**Velocity**	**Vm =**	**2.5 fps**
Froude number	**Fr-lf =**	**0.19**	**Froude number**	**Frm =**	**0.28**
Qd Critical Velocity	Vlfc =	3.64 fps	100-Yr. Critical Velocity	Vmc =	6.0 fps
Qd Critical Depth	Ylfc =	0.44 ft	100-Yr. Critical Depth	Ymc =	1.3 ft
Left Overbank Flow Condition for Q100			**Right Overbank Flow Condition for Q100**		
Top width	TL =	6.0 ft	Top width	TR =	6.0 ft
Flow area	AL =	4.5000 sq ft	Flow area	AR =	4.5000 sq ft
Wetted perimeter	PL =	6.1800 ft	Wetted perimeter	PR =	6.1800 ft
Discharge	**QL =**	**9.8 cfs**	**Discharge**	**QR =**	**9.8 cfs**
Velocity	**VL =**	**2.2 fps**	**Velocity**	**VR =**	**2.2 fps**
Froude number	**FrL =**	**0.44**	**Froude number**	**FrR =**	**0.44**
100-Yr. Critical Velocity	VLc =	4.2 fps	100-Yr. Critical Velocity	VRc =	4.2 fps
100-Yr. Critical Depth in Overbanks	YLc =	1.1 ft	100-Yr. Critical Depth in Overbanks	YRc =	1.1 ft
			Composite Cross-Section Flow Condition for Q100		
Top width	**T =**	**45.5 ft**	**Discharge**	**Q =**	**237.4 cfs**
Channel Depth Y	**Y =**	**2.75 ft**	**Velocity**	**V =**	**2.5 fps**
Flow area	A =	94.9 sq ft	**Froude number**	**Fr =**	**0.31**
Wetted perimeter	P =	46.2 ft	100-Yr. Critical Velocity	Vc =	6.1 fps
Cross-Sectional Manning's n (Calculated)	n =	0.0609	100-Yr. Critical Depth in Overbanks	Yc =	0.10 ft

DCD 2 DESIGN FLOWS

$Q_L = Q_2 = 21.0$ cfs ?

$Q_{100} = 106.96$ (DP 11)

$Q_{SBC} = 177.50$ cfs

$Q_{FB} = Q_{SBC} + \frac{1}{3} Q_{SBC} = 236.7$ cfs (USE FOR FREEBOARD DETERMINATION)

MINIMUM OUTLOT WIDTH

$W_{air} = 1.5$ FT (CLEAR FROM FENCE) + 12 FT (MAINTENANCE RD) + 45.5 FT (CHANNEL TOP WIDTH)

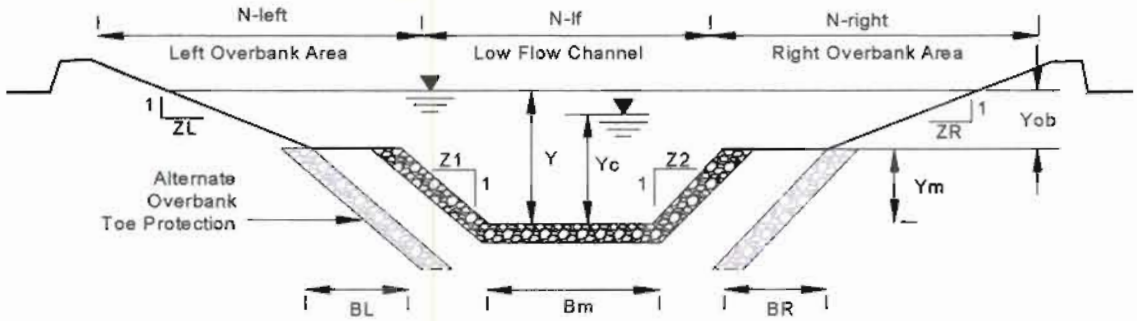
$W_{OUT} = 59.0$ FT ⇒ 60.0 FT PROVIDED

09/27/12

Capacity Analysis of Composite Channel

Project: B1006 Boulder Creek Commons

Channel ID: DCD2 Channel; with SBC Flood Flows



Design Information (Input)					
Channel Invert Slope	So =	0.00400 ft/ft	Left Overbank Bottom Width	BL =	0.00 ft
			Left Overbank Side Slope	ZL =	4.00 ft/ft
Low Flow Channel Bottom Width	Bm =	23.50 ft	Left Overbank Manning's n	n-left =	0.0350
Low Flow Channel Left Side Slope	Z1 =	4.00 ft/ft	Right Overbank Bottom Width	BR =	0.00 ft
Low Flow Channel Right Side Slope	Z2 =	4.00 ft/ft	Right Overbank Side Slope	ZR =	4.00 ft/ft
Low Flow Channel Manning's Nn for Qd	n-lf =	0.0864	Right Overbank Manning's n	n-right =	0.0350
Low Flow Channel Manning's Nn for Q100	n-m-Q100 =	0.0692			
(See USDCM Vol. II, n vs. Depth Graph)					
Low Flow Channel Bank-full depth	**Ym =**	**1.25 ft**	**Overbank Flow Depth Yob (Y - Ym)**	**Yob =**	**1.15 ft**

Low Flow Channel Condition for Qd			**Low Flow Channel Flow Condition for Q100**		
Top width	Tlf =	33.5 ft	Top width	Tm =	33.5 ft
Flow area	Alf =	35.6 sq ft	Flow area	Am =	74.2 sq ft
Wetted perimeter	Plf =	33.8 ft	Wetted perimeter	Pm =	33.8 ft
Discharge (Calculated)	**Qlf =**	**40.3 cfs**	**Discharge**	**Qm =**	**170.5 cfs**
Velocity	**Vlf=**	**1.1 fps**	**Velocity**	**Vm =**	**2.3 fps**
Froude number	**Fr-lf =**	**0.19**	**Froude number**	**Frm =**	**0.27**
Qd Critical Velocity	Vlfc =	3.64 fps	100-Yr. Critical Velocity	Vmc =	5.6 fps
Qd Critical Depth	Ylfc =	0.44 ft	100-Yr. Critical Depth	Ymc =	1.1 ft
Left Overbank Flow Condition for Q100			**Right Overbank Flow Condition for Q100**		
Top width	TL =	4.6 ft	Top width	TR =	4.6 ft
Flow area	AL =	2.6500 sq ft	Flow area	AR =	2.6500 sq ft
Wetted perimeter	PL =	4.7400 ft	Wetted perimeter	PR =	4.7400 ft
Discharge	**QL =**	**4.8 cfs**	**Discharge**	**QR =**	**4.8 cfs**
Velocity	**VL =**	**1.8 fps**	**Velocity**	**VR =**	**1.8 fps**
Froude number	**FrL =**	**0.42**	**Froude number**	**FrR =**	**0.42**
100-Yr. Critical Velocity	VLc =	3.6 fps	100-Yr. Critical Velocity	VRc =	3.6 fps
100-Yr. Critical Depth in Overbanks	YLc =	0.8 ft	100-Yr. Critical Depth in Overbanks	YRc =	0.8 ft

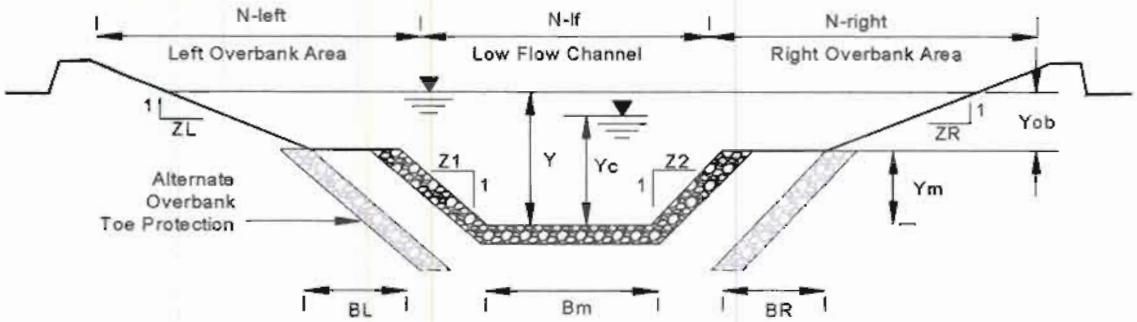
Composite Cross-Section Flow Condition for Q100

Top width	**T =**	**42.7 ft**	**Discharge**	**Q =**	**180.2 cfs**
Channel Depth Y	**Y =**	**2.40 ft**	**Velocity**	**V =**	**2.3 fps**
Flow area	A =	79.4 sq ft	**Froude number**	**Fr =**	**0.29**
Wetted perimeter	P =	43.3 ft	100-Yr. Critical Velocity	Vc =	5.6 fps
Cross-Sectional Manning's n (Calculated)	n =	0.0623	100-Yr. Critical Depth in Overbanks	Yc =	-0.09 ft

Capacity Analysis of Composite Channel

Project: B1006 Boulder Creek Commons

Channel ID: DCD2 Channel



Design Information (Input)

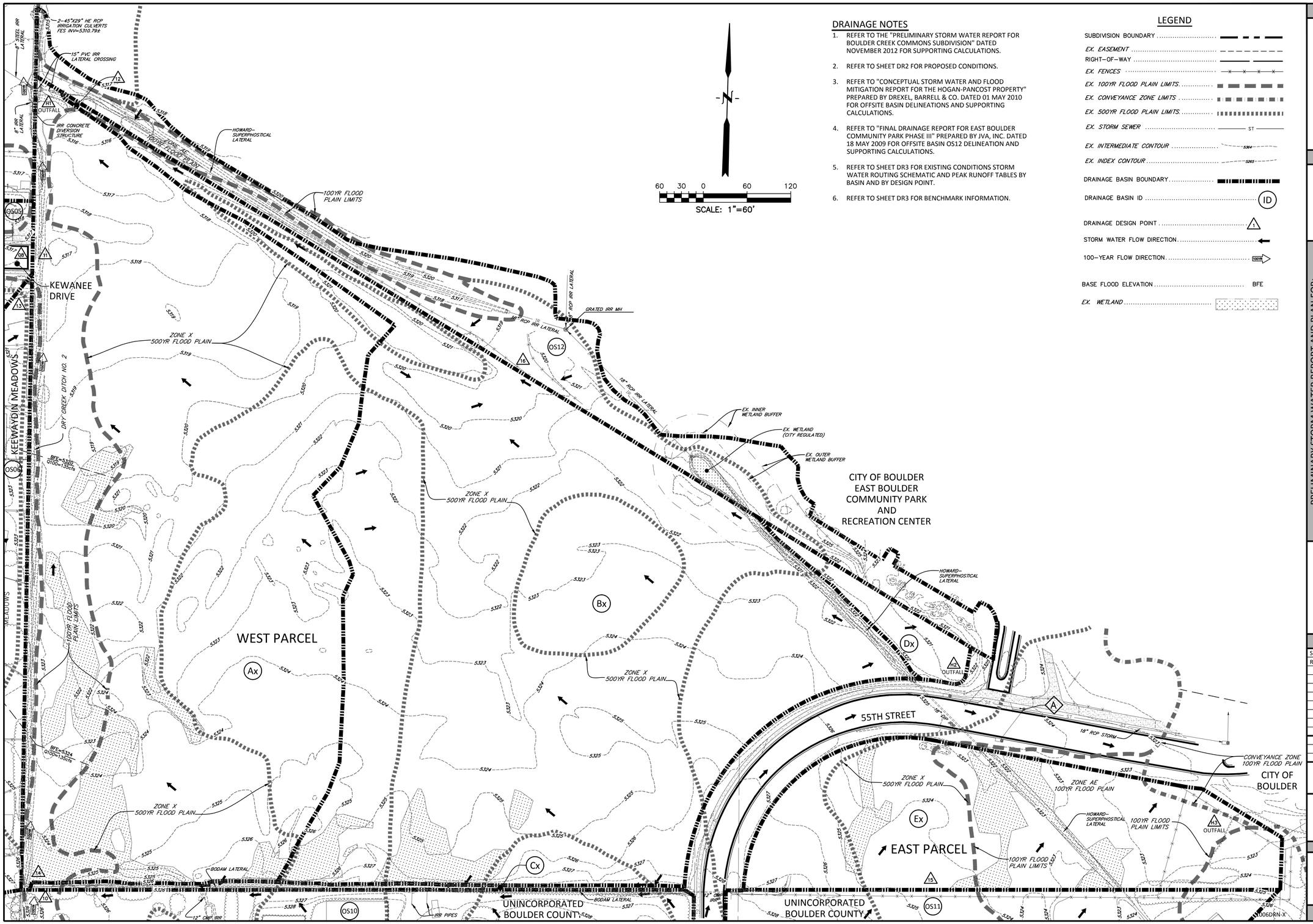
Channel Invert Slope	So =	0.00400 ft/ft	Left Overbank Bottom Width	BL =	0.00 ft
			Left Overbank Side Slope	ZL =	4.00 ft/ft
Low Flow Channel Bottom Width	Bm =	23.50 ft	Left Overbank Manning's n	n-left =	0.0350
Low Flow Channel Left Side Slope	Z1 =	4.00 ft/ft	Right Overbank Bottom Width	BR =	0.00 ft
Low Flow Channel Right Side Slope	Z2 =	4.00 ft/ft	Right Overbank Side Slope	ZR =	4.00 ft/ft
Low Flow Channel Manning's Nn for Qd	n-lf =	0.0864	Right Overbank Manning's n	n-right =	0.0350
Low Flow Channel Manning's Nn for Q100	n-m-Q100 =	0.0692			
(See USDCM Vol. II, n vs. Depth Graph)					
Low Flow Channel Bank-full depth	**Ym =**	**1.25 ft**	**Overbank Flow Depth Yob (Y - Ym)**	**Yob =**	**0.60 ft**

Low Flow Channel Condition for Qd			**Low Flow Channel Flow Condition for Q100**		
Top width	Tlf =	33.5 ft	Top width	Tm =	33.5 ft
Flow area	Alf =	35.6 sq ft	Flow area	Am =	55.7 sq ft
Wetted perimeter	Plf =	33.6 ft	Wetted perimeter	Pm =	33.6 ft
Discharge (Calculated)	**Qlf =**	**40.3 cfs**	**Discharge**	**Qm =**	**105.9 cfs**
Velocity	**Vlf=**	**1.1 fps**	**Velocity**	**Vm =**	**1.9 fps**
Froude number	**Fr-lf =**	**0.19**	**Froude number**	**Frm =**	**0.26**
Qd Critical Velocity	Vlfc =	3.64 fps	100-Yr. Critical Velocity	Vmc =	4.9 fps
Qd Critical Depth	Ylfc =	0.44 ft	100-Yr. Critical Depth	Ymc =	0.8 ft

Left Overbank Flow Condition for Q100			**Right Overbank Flow Condition for Q100**		
Top width	TL =	2.4 ft	Top width	TR =	2.4 ft
Flow area	AL =	0.7200 sq ft	Flow area	AR =	0.7200 sq ft
Wetted perimeter	PL =	2.4700 ft	Wetted perimeter	PR =	2.4700 ft
Discharge	**QL =**	**0.9 cfs**	**Discharge**	**QR =**	**0.9 cfs**
Velocity	**VL =**	**1.2 fps**	**Velocity**	**VR =**	**1.2 fps**
Froude number	**FrL =**	**0.38**	**Froude number**	**FrR =**	**0.38**
100-Yr. Critical Velocity	VLc =	2.6 fps	100-Yr. Critical Velocity	VRc =	2.6 fps
100-Yr. Critical Depth in Overbanks	YLc =	0.4 ft	100-Yr. Critical Depth in Overbanks	YRc =	0.4 ft

Composite Cross-Section Flow Condition for Q100

Top width	**T =**	**38.3 ft**	**Discharge**	**Q =**	**107.6 cfs**
Channel Depth Y	**Y =**	**1.85 ft**	**Velocity**	**V =**	**1.9 fps**
Flow area	A =	57.2 sq ft	**Froude number**	**Fr =**	**0.27**
Wetted perimeter	P =	38.8 ft	100-Yr. Critical Velocity	Vc =	4.9 fps
Cross-Sectional Manning's n (Calculated)	n =	0.0649	100-Yr. Critical Depth in Overbanks	Yc =	-0.40 ft



SCALE: 1"=60'

DRAINAGE NOTES

1. REFER TO THE "PRELIMINARY STORM WATER REPORT FOR BOULDER CREEK COMMONS SUBDIVISION" DATED NOVEMBER 2012 FOR SUPPORTING CALCULATIONS.
2. REFER TO SHEET DR2 FOR PROPOSED CONDITIONS.
3. REFER TO "CONCEPTUAL STORM WATER AND FLOOD MITIGATION REPORT FOR THE HOGAN-PANCOST PROPERTY" PREPARED BY DREXEL, BARRELL & CO. DATED 01 MAY 2010 FOR OFFSITE BASIN DELINEATIONS AND SUPPORTING CALCULATIONS.
4. REFER TO "FINAL DRAINAGE REPORT FOR EAST BOULDER COMMUNITY PARK PHASE III" PREPARED BY JVA, INC. DATED 18 MAY 2009 FOR OFFSITE BASIN OS12 DELINEATION AND SUPPORTING CALCULATIONS.
5. REFER TO SHEET DR3 FOR EXISTING CONDITIONS STORM WATER ROUTING SCHEMATIC AND PEAK RUNOFF TABLES BY BASIN AND BY DESIGN POINT.
6. REFER TO SHEET DR3 FOR BENCHMARK INFORMATION.

LEGEND

SUBDIVISION BOUNDARY
EX. EASEMENT
RIGHT-OF-WAY
EX. FENCES
EX. 100YR FLOOD PLAIN LIMITS
EX. CONVEYANCE ZONE LIMITS
EX. 500YR FLOOD PLAIN LIMITS
EX. STORM SEWER — ST —
EX. INTERMEDIATE CONTOUR — 5364 —
EX. INDEX CONTOUR — 5365 —
DRAINAGE BASIN BOUNDARY
DRAINAGE BASIN ID — ID
DRAINAGE DESIGN POINT — 1
STORM WATER FLOW DIRECTION
100-YEAR FLOW DIRECTION — 100YR
BASE FLOOD ELEVATION — BFE
EX. WETLAND

PREPARED BY:

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1022 WILLOW PLACE
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303.981.9238
PROJECT CONTACT:
LESLIE R. EWY, PE

OWNER / DEVELOPER:

BCC, LLC
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SUITE 260
BOULDER, CO 80302
CONTACT:
MICHAEL BOYERS
303.949.1322

PRELIMINARY STORM WATER REPORT AND PLAN FOR:

BOULDER CREEK COMMONS

5399 KEWANEE DRIVE AND 5697 S. BOULDER ROAD
LOCATED IN THE SW¼ OF SECTION 3 AND THE SE¼ OF SECTION 4,
T1S, R70W, 6TH P.M., COUNTY OF BOULDER, STATE OF COLORADO

ISSUE	DATE
SITE REVIEW	06/18/12
RESUBMITTAL	11/02/12

DESIGNED BY:	LRE
DRAWN BY:	LRE
CHECKED BY:	TSG

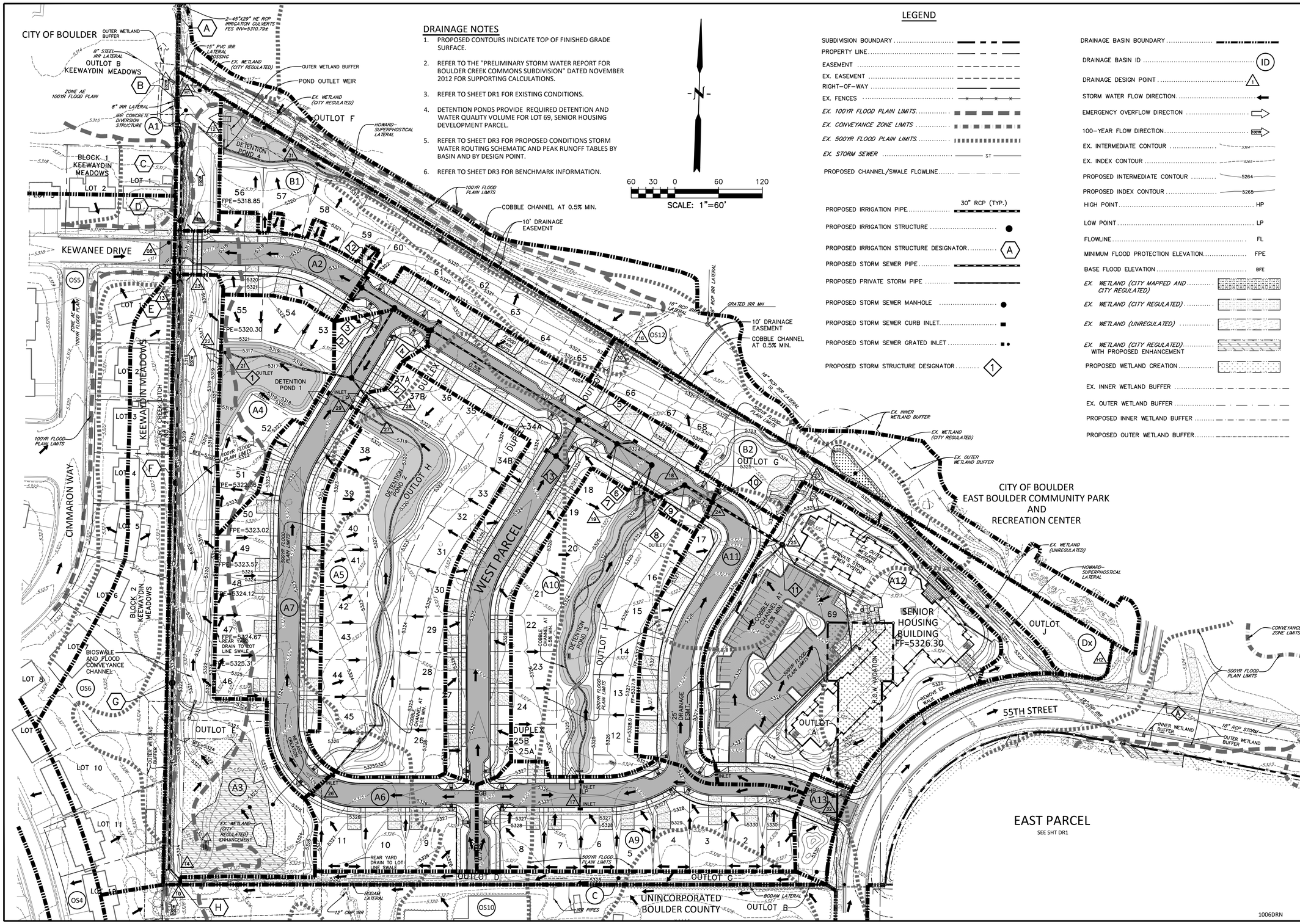
DRAWING SCALE:
HORIZONTAL: 1" = 60'
VERTICAL: NONE

EXISTING STORM WATER PLAN

PROJECT NO. B1006

DR1

SHEET: 1 OF 3



DRAINAGE NOTES

1. PROPOSED CONTOURS INDICATE TOP OF FINISHED GRADE SURFACE.
2. REFER TO THE "PRELIMINARY STORM WATER REPORT FOR BOULDER CREEK COMMONS SUBDIVISION" DATED NOVEMBER 2012 FOR SUPPORTING CALCULATIONS.
3. REFER TO SHEET DR1 FOR EXISTING CONDITIONS.
4. DETENTION PONDS PROVIDE REQUIRED DETENTION AND WATER QUALITY VOLUME FOR LOT 69, SENIOR HOUSING DEVELOPMENT PARCEL.
5. REFER TO SHEET DR3 FOR PROPOSED CONDITIONS STORM WATER ROUTING SCHEMATIC AND PEAK RUNOFF TABLES BY BASIN AND BY DESIGN POINT.
6. REFER TO SHEET DR3 FOR BENCHMARK INFORMATION.

N

60 30 0 60 120

SCALE: 1"=60'

LEGEND

SUBDIVISION BOUNDARY
PROPERTY LINE
EASEMENT
EX. EASEMENT
RIGHT-OF-WAY
EX. FENCES
EX. 100YR FLOOD PLAIN LIMITS
EX. CONVEYANCE ZONE LIMITS
EX. 500YR FLOOD PLAIN LIMITS
EX. STORM SEWER — ST
PROPOSED CHANNEL/SWALE FLOWLINE
PROPOSED IRRIGATION PIPE — 30" RCP (TYP.)
PROPOSED IRRIGATION STRUCTURE
PROPOSED IRRIGATION STRUCTURE DESIGNATOR — A
PROPOSED STORM SEWER PIPE
PROPOSED PRIVATE STORM PIPE
PROPOSED STORM SEWER MANHOLE
PROPOSED STORM SEWER CURB INLET
PROPOSED STORM SEWER GRATED INLET
PROPOSED STORM STRUCTURE DESIGNATOR — 1
DRAINAGE BASIN BOUNDARY
DRAINAGE BASIN ID — ID
DRAINAGE DESIGN POINT — 1
STORM WATER FLOW DIRECTION
EMERGENCY OVERFLOW DIRECTION
100-YEAR FLOW DIRECTION — 100YR
EX. INTERMEDIATE CONTOUR — 5364
EX. INDEX CONTOUR — 5365
PROPOSED INTERMEDIATE CONTOUR — 5264
PROPOSED INDEX CONTOUR — 5265
HIGH POINT — HP
LOW POINT — LP
FLOWLINE — FL
MINIMUM FLOOD PROTECTION ELEVATION — FPE
BASE FLOOD ELEVATION — BFE
EX. WETLAND (CITY MAPPED AND CITY REGULATED)
EX. WETLAND (CITY REGULATED)
EX. WETLAND (UNREGULATED)
EX. WETLAND (CITY REGULATED) WITH PROPOSED ENHANCEMENT
PROPOSED WETLAND CREATION
EX. INNER WETLAND BUFFER
EX. OUTER WETLAND BUFFER
PROPOSED INNER WETLAND BUFFER
PROPOSED OUTER WETLAND BUFFER

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ISSUE	DATE
SITE REVIEW	06/18/12
RESUBMITTAL	11/02/12

DESIGNED BY:	LRE
DRAWN BY:	LRE
CHECKED BY:	TSG

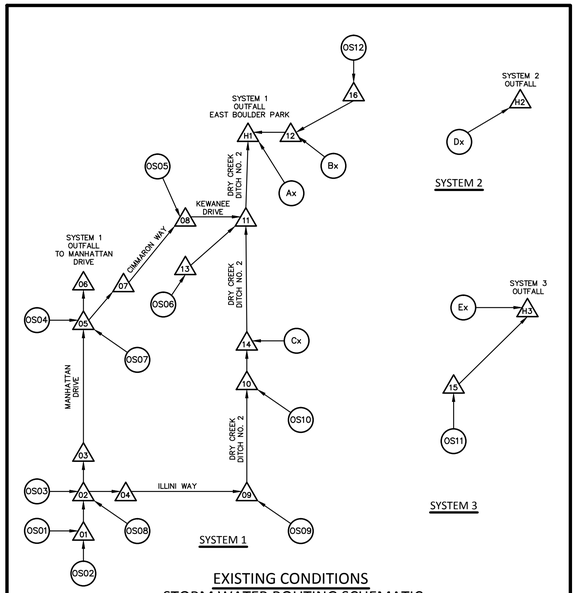
DRAWING SCALE:
HORIZONTAL: 1" = 60'
VERTICAL: NONE

PRELIMINARY STORM WATER PLAN

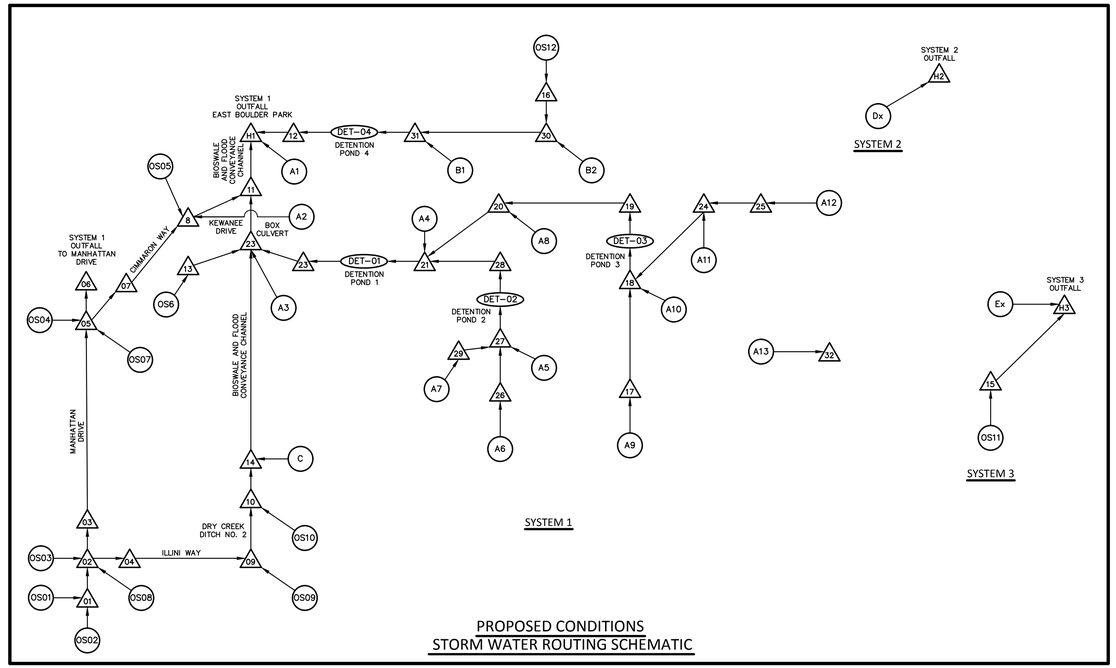
PROJECT NO. B1006

DR2

SHEET: 2 OF 3



EXISTING CONDITIONS
STORM WATER ROUTING SCHEMATIC



PROPOSED CONDITIONS
STORM WATER ROUTING SCHEMATIC

BENCHMARK NOTES

1. EXISTING TOPOGRAPHIC INFORMATION IS FROM FIELD SURVEY PREPARED BY FLAGSTAFF SURVEYING, INC. DATED 20 APRIL 2011.

2. BENCHMARK: FOUND CUT BOX AT SOUTHEAST CORNER OF CATCH BASIN SLAB ON THE WEST SIDE OF 55TH STREET NEAR THE SOUTHEAST CORNER OF THE PROPERTY AT 5692 55TH STREET.

   CITY OF BOULDER BENCHMARK ID V3-2-1
   ELEVATION = 5331.87
   NAVD 88 DATUM.

   INFORMATION FOR BENCHMARK CONVERSION:
   PREVIOUS SURVEY WORK ON THE BOULDER CREEK COMMONS SITE WAS PREPARED USING THE CITY OF BOULDER DATUM.
   CITY BOULDER BENCHMARK ID V3-2-1
   CITY OF BOULDER DATUM ELEVATION = 5328.42
   NGVD 1929 DATUM ELEVATION = 5328.82

   TO CONVERT ELEVATIONS ON CITY OF BOULDER DATUM TO NAVD 88 DATUM,
   ADD 3.45-FT.

EXISTING CONDITIONS PEAK RUNOFF BY BASIN

BASIN ID	BASIN AREA A [acre]	RUNOFF COEFFICIENT C10	RUNOFF COEFFICIENT C100	TIME OF CONCENTRATION Tc [min]	PEAK RUNOFF 10 YR [cfs]	PEAK RUNOFF 100 YR [cfs]
Ax	9.46	0.30	0.60	45	6.24	17.50
Bx	9.51	0.30	0.60	64	4.91	13.61
Cx	0.17	0.30	0.60	31	0.14	0.41
Dx	0.30	0.30	0.60	20	0.34	0.99
Ex	2.73	0.30	0.60	42	1.88	5.29
OS01	7.83	0.70	0.80	11	28.68	49.36
OS02	3.22	0.89	0.92	10	15.71	24.54
OS03	0.81	0.50	0.70	12	2.03	4.27
OS04	3.06	0.50	0.70	13	7.38	15.47
OS05	4.99	0.50	0.70	11	13.05	27.52
OS06	1.59	0.50	0.70	17	3.31	6.84
OS07	1.45	0.50	0.70	11	3.79	8.00
OS08	1.14	0.50	0.70	9	3.29	6.98
OS09	9.45	0.45	0.68	25	13.93	30.25
OS10	9.35	0.44	0.67	25	13.48	29.49
OS11	5.05	0.32	0.61	35	4.24	11.42
OS12	2.01	0.32	0.54	11	3.41	8.68

PROPOSED CONDITIONS PEAK RUNOFF BY BASIN

BASIN ID	BASIN AREA A [acre]	RUNOFF COEFFICIENT C10	RUNOFF COEFFICIENT C100	TIME OF CONCENTRATION Tc [min]	PEAK RUNOFF 10 YR [cfs]	PEAK RUNOFF 100 YR [cfs]
A01	0.28	0.35	0.60	9	0.56	1.44
A02	0.53	0.50	0.70	8	1.61	3.42
A03	1.86	0.35	0.60	30	1.90	4.63
A04	0.76	0.44	0.66	9	1.92	4.37
A05	2.35	0.45	0.67	16	4.52	9.95
A06	0.66	0.50	0.70	11	1.75	3.70
A07	1.64	0.50	0.70	15	3.73	7.78
A08	2.22	0.50	0.70	16	4.84	10.05
A09	1.33	0.50	0.70	14	3.05	6.37
A10	1.62	0.45	0.67	17	3.07	6.76
A11	0.80	0.50	0.70	11	2.08	4.39
A12	2.50	0.60	0.69	14	6.87	11.79
A13	0.17	0.42	0.65	8	0.43	1.00
B01	1.19	0.47	0.68	13	2.71	5.86
B02	0.93	0.39	0.63	17	1.52	3.63
C	0.33	0.35	0.60	31	0.33	0.80
Dx	0.30	0.30	0.60	20	0.34	0.99
Ex	2.73	0.30	0.60	42	1.88	5.29

EXISTING CONDITIONS PEAK RUNOFF BY DESIGN POINT

Design Point ID	PEAK RUNOFF 10 YR [cfs]	PEAK RUNOFF 100 YR [cfs]
01	42.34	70.82
02	46.58	79.89
03	23.29	39.95
04	23.29	39.95
05	31.10	58.55
06	15.55	29.28
07	15.55	29.28
08	21.93	45.44
09	30.04	54.55
10	36.95	70.82
11	52.71	106.96
12	4.94	13.64
13	3.31	6.84
14	37.03	71.04
15	4.24	11.42
16	3.41	8.68
H1	**59.42**	**124.53**
H2	**0.34**	**0.99**
H3	**5.81**	**15.82**

PROPOSED CONDITIONS PEAK RUNOFF BY DESIGN POINT

Design Point ID	PEAK RUNOFF 10 YR [cfs]	PEAK RUNOFF 100 YR [cfs]
01	42.34	70.82
02	46.58	79.89
03	23.29	39.95
04	23.29	39.95
05	31.10	58.55
06	15.55	29.28
07	15.55	29.28
08	22.34	46.65
09	30.04	54.55
10	36.95	70.82
11	54.55	112.27
12	4.94	13.10
13	3.31	6.84
14	37.13	71.25
15	4.24	11.42
16	3.41	8.68
17	3.05	6.37
18	12.87	25.37
19	3.90	4.72
20	7.99	13.86
21	11.82	19.11
22	7.88	11.89
23	45.39	87.56
24	8.39	15.01
25	6.87	11.79
26	1.75	3.70
27	9.12	19.81
28	3.88	4.77
29	3.73	7.78
30	4.37	10.97
31	6.16	15.30
H1	**57.80**	**124.28**
H2	**0.34**	**0.99**
H3	**5.81**	**15.82**

DETENTION POND SUMMARY

	Detention Pond 1	Detention Pond 4
Water Quality Capture Volume [cf]	8,015	1,307
Water Quality Water Surface Elevation	5318.4	5316.4
10-YR Detention Storage Volume [cf]	9,799	2,039
110% * (10-YR Detention + Water Quality) Storage Volume [cf]	19,595	3,681
110% * (10-YR Detention + Water Quality) Water Surface Elevation	5319.6	5317.0
10-YR Release Rate [cfs]	7.88	4.94
100-YR Detention Storage Volume [cf]	15,727	4,316
110% * (100-YR Detention + 0.5*Water Quality) Storage Volume [cf]	21,708	5,466
110% * (100-YR Detention + 0.5*Water Quality) Water Surface Elevation	5319.9	5317.3
100-YR Release Rate [cfs]	11.89	13.10
Detention Pond Invert Elevation	5316.5	5315.7
Emergency Overflow Weir Elevation	5320.5	5317.3
Top of Pond Embankment Elevation	5321.0	5317.3

	Detention Pond 2	Detention Pond 3
10-YR Detention Storage Volume [cf]	4,595	7,985
110% * (10-YR Detention) Storage Volume [cf]	5,055	8,784
110% * (10-YR Detention) Water Surface Elevation	5320.1	5323.0
10-YR Release Rate [cfs]	3.88	3.90
100-YR Detention Storage Volume [cf]	12,629	19,346
110% * (100-YR Detention) Storage Volume [cf]	13,892	21,281
110% * (100-YR Detention) Water Surface Elevation	5321.0	5324.0
100-YR Release Rate [cfs]	4.77	4.72
Detention Pond Invert Elevation	5318.5	5320.5
Emergency Overflow Weir Elevation	5321.7	5324.8
Top of Pond Embankment Elevation	5322.0	5325.0

1006DRN

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1526 SPRUCE STREET
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PRELIMINARY STORM WATER REPORT AND PLAN FOR:

BOULDER CREEK COMMONS

5399 KEWANEE DRIVE AND 5697 S. BOULDER ROAD
LOCATED IN THE SW¼ OF SECTION 3 AND THE SE¼ OF SECTION 4,
T1S, R70W, 6TH P.M., COUNTY OF BOULDER, STATE OF COLORADO

ISSUE	DATE
SITE REVIEW	06/18/12
RESUBMITTAL	11/02/12

DESIGNED BY:	LRE
DRAWN BY:	LRE
CHECKED BY:	TSG

DRAWING SCALE:
HORIZONTAL: 1" = 60'
VERTICAL: NONE

ROUTING SCHEMATICS AND TABLES

PROJECT NO. B1006

DR3

SHEET: 3 OF 3