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For this submittal, this level of drainage report is sufficient. Note that at site development plan, a final drainage report will be required.




# K. Preliminary Drainage Report

# For

# Williams Creek Generating Station

EPC Project # AASI261

**PROJECT NAME:** Willams Creek Generating Station

**PROJECT NUMBER:** 20070510

**CALCULATION NUMBER:** 20070510-CAL-CW-001

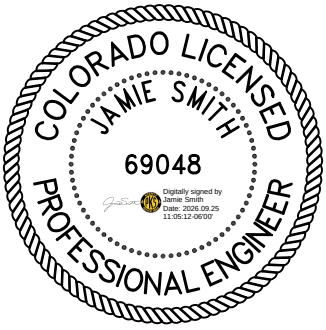
**CALCULATION TITLE:** Preliminary Drainage Report

## ASSUMPTIONS:

| Description | Verified By | Date |
|---|---|---|
| 1) NRCS Curve Number hydrology with DCM rainfall depths.<br>2) SCS Type II 24-hr distribution applied to all storm events | Johnson Rowland | 8/31/26 |

## REFERENCES:

1) El Paso County Drainage Criteria Manual (DCM)
2) El Paso County Engineering Criteria Manual (ECM)
3) Mile High Flood District
4) NOAA Atlas 14
5) NRCS Soil Survey
6) FEMA FIRM 08041C0970G (eff. 12/7/2018)




## DESIGN BASIS:

1) SSA using NRCS TR-55 hydrograph and routing methods
2) Detention designed per MHFD Full Spectrum criteria.

| Rev. | Prepared by, Date | Checked by, Date | Approved by, Date |
|---|---|---|---|
| A | Brent Juenemann 8/28/26 | Johnson Rowland 9/2/26 | Johnson Rowland 9/2/26 |
| B | Brent Juenemann 9/25/26 | Johnson Rowland 9/25/26 | Jamie Smith 9/25/26 |
| | | | |
| | | | |



Provide county standard signature blocks for Owner, Design Engineer & County Engineer. Signature blocks can be found on County website

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**PROJECT NAME: WILLIAMS CREEK GENERATING STATION**
**KIEWIT PROJECT 20070510**

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**KIEWIT PROJECT 20070510**

# REVISION HISTORY

| REVISION | REVISION DESCRIPTION |
|---|---|
| A | ISSUED FOR REVIEW |
| 0 | ISSUED FOR PERMITTING |
| | |
| | |
| | |



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# EXECUTIVE SUMMARY

This Preliminary Drainage Report evaluates existing and proposed drainage conditions for the Williams Creek Generating Station Project for a 1041 Permit. The project is located within the Lower Williams Creek Drainage Basin in El Paso County, Colorado. The project encompasses approximately 96 acres and drains to an unnamed tributary of Williams Creek.

Existing drainage consists of a 467-acre subbasin, producing peak discharges of $Q_5$ = 320 cfs and $Q_{100}$ = 805 cfs at the primary design point.

The proposed development modifies on-site drainage patterns through open channels, storm sewers, and swales, while preserving off-site tributary flows. Proposed hydrology results are mitigated through full-spectrum detention basins designed to meet ECM historic release requirements. Water quality requirements are satisfied in accordance with DCM Volume 2. Detention storage and outlet structures have been sized to meet ECM Chapter 3 criteria.

Based on the preliminary drainage analysis, no adverse downstream impacts are anticipated. Review of available El Paso County drainage planning information and preliminary coordination did not identify an applicable Drainage Basin Planning Study for the project area. Applicability of drainage basin and bridge fees, drainage planning studies, and project-specific downstream outfall criteria will be confirmed with El Paso County and documented in the Final Drainage Report. Any resulting requirements affecting the preliminary drainage concept will be incorporated into the design.

Jurisdictional determinations associated with onsite drainage features are currently under evaluation. Applicable findings and permitting requirements will be incorporated into the final drainage design and supporting permitting documentation.



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**PROJECT NAME: WILLIAMS CREEK GENERATING STATION**
**KIEWIT PROJECT 20070510**

# PROJECT OVERVIEW

The Williams Creek Generating Station project is located within El Paso County, Colorado, on property owned by the City of Colorado Springs. The development area encompasses approximately 96 acres situated near the central-western portion of a larger ~3,655-acre parcel currently used as a 175-megawatt photovoltaic solar facility. Solar arrays are distributed throughout the broader property, while the proposed generating station occupies a distinct portion of the site.

The project involves the construction and installation of ten (10) new natural-gas combustion turbine generators, along with the associated civil, mechanical, and electrical infrastructure required for operation. Supporting facilities within the 96-acre development footprint include two brine solar ponds, an equalization/reverse-osmosis (EQ/RO) reject pond, a zero-liquid-discharge (ZLD) process area, a water storage tank, a control building, gas gate stations, paved parking areas, engineered bypass channels, and a private storm sewer network. These facilities collectively support the generating station's operational, water-management, and utility needs.

Is this what the traffic study referred to as Williams Creek Drive? Please use same name on documents

Please label roads on basin maps

The project area is bordered by a 1,024-acre Woodmoor Water & Sanitation parcel to the west, Substation Drive to the east, Irradiance Road to the south, and an existing solar substation to the north. The larger parcel spans multiple sections within Township 16 South, Ranges 64 and 65 West of the 6th Principal Meridian, including Sections 1, 11, 12, 13, 14, 23, 24, 25, 26, 35, and 36 in Range 65 West, and Sections 6, 7, 18, 30, and 31 in Range 64 West. The generating station site specifically lies within the northeast quarter of Section 26, Township 16 South, Range 65 West.

Existing vegetation within the development area consists of approximately 50% cover, based on field observations and aerial imagery. Vegetation primarily includes native grasses, weeds, and low shrubs typical of the region.

Major drainageways, irrigation ditches where identified, existing utilities, and other known encumbrances are presented on the drainage maps in Appendix A. These features are shown based on the best available survey, mapping, and project information at the time of preparation of this Preliminary Drainage Report.



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# EXISTING CONDITIONS

The project site is located in Zone X, Area of Minimal Flood Hazard per FEMA floodplain panels 08041C0970G; see Appendix C NFHL FIRMette. No regulatory floodway or special flood hazard area affects the project. The site contains mainly Midway clay loam and some Manzanola silty clay loam soils with Hydrologic Soil Group C and D classifications; see Appendix B Hydrologic Soils Map and Legend. These soils exhibit relatively low infiltration rates and contribute to higher runoff potential during storm events.

The project area consists of gently rolling terrain typical of the region, with ground elevations generally sloping from the northern portion of the site toward the south and southeast. Surface runoff is conveyed primarily as shallow overland flow before concentrating within the unnamed tributary channel. The broader 3,655-acre parcel contains solar array fields, access roads, and ancillary facilities, while the 96-acre generating station footprint remains largely undeveloped.

Vegetation within the project area consists of approximately 50 percent cover, including native grasses, weeds, and low shrubs. For hydrologic modeling, these areas were classified as pasture, grassland, or range in fair hydrologic condition, with Curve Numbers of 79 and 84 for Hydrologic Soil Groups C and D, respectively.

**Table 1: Soils Data**

| SOIL MAP UNIT | MAP UNIT NAME | SOIL GROUP | PERCENT ON SITE |
|---|---|---|---|
| 33 | Heldt clay loam, 0 to 3 percent slopes | C | 22.0% |
| 126 | Midway clay loam, dry, 1 to 15 percent slopes | D | 74.1% |
| MzA | Manzanola silty clay loam, saline, 0 to 2 percent slopes | C | 3.9% |

Runoff generated within the larger watershed flows across natural terrain and concentrates within the unnamed tributary that crosses the project site. This tributary conveys flows south towards Williams Creek. The existing drainage system consists entirely of natural conveyance features; no public storm sewer infrastructure is present within the project limits. The existing drainage area is approximately 467 acres and produces peak discharges and volumes as shown below in Table 2.



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**Table 2: Existing Conditions**

| Drainage Area | Area (AC) | Weighted Curve Number | $Q_5$ (cfs) | $Volume_5$ (ac-ft) | $Q_{100}$ (cfs) | $Volume_{100}$ (ac-ft) |
|---|---|---|---|---|---|---|
| 1 | 266.9 | 82.2 | 185 | 25.4 | 450 | 60.3 |
| 2 | 101.9 | 83.5 | 111 | 10.4 | 259 | 24.1 |
| 3 | 98.5 | 83.2 | 107 | 10.0 | 250 | 23.1 |
| Peak at Design Point | 467.3 | 82.7 | 320 | 45.4 | 805 | 106.7 |

# PROPOSED CONDITIONS

The Williams Creek Generating Station development will modify existing drainage patterns through the construction of new facilities, grading, and stormwater conveyance improvements. Proposed conditions reflect the installation of ten natural-gas combustion turbine generators and associated infrastructure, including access roads, equipment pads, process ponds, utility structures, and stormwater management facilities. The drainage design has been developed in accordance with the El Paso County Engineering Criteria Manual (ECM), the Drainage Criteria Manual (DCM) Volumes 1 and 2, and Mile High Flood District (MHFD) criteria.

The project improvements will increase imperviousness within the development area. Impervious surfaces within developed drainage areas were assigned a Curve Number of 98 in accordance with NRCS methodology. Composite subbasin curve numbers were developed based on the proportional distribution of impervious and pervious land cover within each drainage area. Increased imperviousness will reduce infiltration and accelerate runoff concentration. The proposed drainage system is designed to mitigate these effects through engineered conveyance and detention facilities.

Under proposed conditions, stormwater runoff will be conveyed through a combination of overland flow, engineered channels, storm sewer systems, and a full-spectrum detention facility. The proposed drainage patterns include:

- Bypass Channels: Engineered channels will intercept and convey offsite flows and the existing intermittent tributary through the site. These channels maintain historic flow paths while preventing uncontrolled erosion and minimizing impacts to generating station infrastructure.

Note:
With FDR submittal channels will need to be looked at further in meeting criteria for things such as velocity, depth, shear stress, Fr #, etc.



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- Storm Sewer Network: A private storm sewer system will collect runoff from paved surfaces, equipment areas, and structures. The storm sewer network will route flows to the detention facility and designated outfall locations.
- Detention Facilities: Two full-spectrum detention basins will provide Water Quality Capture Volume (WQCV), Excess Urban Runoff Volume (EURV), and 100-year peak flow attenuation. Outlet structures will be designed using MHFD's Detention Basin Design Workbook and routed using CUHP/SWMM hydrographs. Indicate that these will also be private facilities
- Defined Outfall: All flows will be discharged to the existing tributary channel in a controlled manner that meets ECM historic release requirements.

The proposed drainage system maintains the general north-to-south flow direction while improving conveyance reliability and reducing downstream peak discharges. The developed site has been divided into 7 subbasins, shown in Appendix A, based on grading, drainage divides, and the facility layout. The brine ponds and EQ/RO reject ponds are process-water, non-discharge facilities and are excluded from the stormwater hydrologic routing model. These facilities are hydraulically isolated from the proposed stormwater conveyance system. Site grading and conveyance facilities direct stormwater around the pond embankments. Process-water containment, overflow, and permitting requirements are addressed separately from this Preliminary Drainage Report. Peak discharges and volumes for the 5-year and 100-year, 24-hr storms under proposed conditions are shown below in Table 3.

**Table 3: Proposed Conditions**

| Drainage Area | Area (AC) | Weighted Curve Number | $Q_5$ (cfs) | $Volume_5$ (ac-ft) | $Q_{100}$ (cfs) | $Volume_{100}$ (ac-ft) |
|---|---|---|---|---|---|---|
| 1 | 266.9 | 82.2 | 185 | 25.4 | 450 | 60.3 |
| 2 | 75.0 | 83.9 | 87 | 7.8 | 201 | 18.0 |
| 3 | 17.6 | 83.9 | 29 | 1.8 | 66 | 4.2 |
| 4 | 10.3 | 84.0 | 18 | 1.1 | 41 | 2.5 |
| 5 | 4.5 | 98.0 | 14 | 0.9 | 25 | 1.6 |
| 6 | 34.3 | 82.0 | 46 | 3.3 | 110 | 7.8 |
| 7 | 44.2 | 92.5 | 84 | 7.0 | 160 | 13.8 |
| Peak at Design Point* | 452.8 | 83.7 | 255 | 43.6 | 696 | 103.9 |

**Total Study Drainage Area reduced by 14.5 acres to account for zero liquid discharge process ponds.*

Each detention basin was sized to meet all applicable water quality and peak flow attenuation criteria. The Power Block basin, Pond A, provides 1.144 acre-feet of WQCV, 3.333 acre-feet of cumulative EURV storage, and 6.061 acre-feet of total target detention storage.



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The incremental Zone 2 and Zone 3 storage volumes are 2.189 and 2.728 acre-feet, respectively. The WC Gate Station basin, Pond B, provides 0.151 acre-feet of WQCV, 0.402 acre-feet of cumulative EURV storage, and 0.709 acre-feet of total target detention storage. The incremental Zone 2 and Zone 3 storage volumes are 0.251 and 0.307 acre-feet, respectively. All basins include multi-stage outlet structures, emergency spillways sized for uncontrolled 100-year flow, and a minimum freeboard of two feet.

Conveyance improvements include storm sewer pipes sized at 18 inches or larger, engineered channels designed for stability under major storm events, culverts sized at 18 inches or larger at roadway crossings, and riprap energy dissipation at outfalls and transitions.

Overall, the proposed drainage system safely conveys onsite and offsite flows through the development, reduces peak discharges to levels at or below existing conditions, provides required water quality treatment, and meets all applicable ECM, DCM, and MHFD routing criteria. These improvements support the construction and operation of the Williams Creek Generating Station while ensuring long-term stormwater performance and regulatory compliance.

# DESIGN CRITERIA

Hydrologic calculations follow the NRCS Curve Number method and TR-55 unit hydrograph procedures. Rainfall depths for the 24-hour design storms were taken directly from the DCM, attached in Appendix D. The SCS Type II rainfall distribution was applied to all hydrologic modeling and detention routing. SSA's NRCS hydrology engine was used to compute rainfall excess, generate hydrographs, and route flows through the proposed drainage system.

Hydraulic design for storm sewer and channel conveyance followed ECM Chapter 3. Storm sewer pipes must be a minimum of 18 inches in diameter, and all pipes must convey the 5-year minor storm without surcharging. Velocities within storm sewer pipes must remain between 3 fps and 12 fps to prevent sediment deposition and avoid excessive scour. Open channel design followed Manning's equation, and culvert performance will be assessed in the FDR.

Detention and water quality design followed MHFD Full Spectrum Detention (FSD) methodology and DCM Volume 2 requirements. The project includes two full-spectrum detention basins: one serving the power block and one serving the WC meter station. Each basin was sized to provide Water Quality Capture Volume (WQCV), Excess Urban Runoff Volume (EURV), and 100-year peak flow attenuation. WQCV must drain down over a period of



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40 hours, and EURV storage must be released over a 52- to 72-hour period. All basins provide a minimum of two feet of freeboard above the 100-year water surface elevation.

Each detention basin includes a micropool to maintain outlet submergence and improve long-term basin performance. The micropool must be at least 2.5 feet deep, with a footprint sized to maintain stable geometry around the outlet structure. The micropool volume is not intended to provide significant detention storage; instead, it serves as a permanent pool that improves sediment capture and outlet stability.

Outlet structures were designed using the MHFD Detention Basin Design Workbook. Each outlet structure includes a low-flow orifice for WQCV release, an intermediate outlet for EURV release, and an emergency spillway sized to pass the 100-year storm while meeting ECM historic release requirements. Emergency spillways were evaluated to safely convey uncontrolled 100-year flows without overtopping basin embankments.

Downstream impacts were evaluated by comparing existing and proposed peak flows at the project outfall. ECM requires that proposed peak discharges do not exceed existing peak discharges for the 5-year and 100-year storms.

Note:
With FDR explain how flows will enter into existing channel (pipes, rundown, top or middle of bank, extra stabilization needed, etc)

# METHOD OF ANALYSIS

The following section goes into detail on the design of the stormwater system. This section includes information on the software used, soil types, groundwater, curve numbers, time of concentration, rainfall data, drainage design points and materials.

## Software

All hydrologic and hydraulic modeling for the Williams Creek Generating Station was performed using Autodesk Storm and Sanitary Analysis (SSA) with the NRCS SCS TR-55 hydrology engine. SSA was used to generate rainfall-excess hydrographs using the Curve Number method, apply the SCS Type II rainfall distribution, and route flows through the proposed storm sewer network and the two full-spectrum detention basins. AutoCAD Civil 3D was used to design the site layout and grading.

Detention storage and outlet sizing were established using the MHFD Detention Basin Design Workbook in accordance with County requirements. The SSA model was subsequently utilized as a secondary evaluation tool to assess drainage system performance and detention basin operation under the project hydrologic model assumptions.



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Soils

The Web Soil Survey, attached as Appendix B, indicates the hydrologic soil group for on-site areas as predominantly type D, soils with a low infiltration rate.

Curve Number

Curve Number (CN) was determined according to the NRCS Runoff Curve Numbers Table (Appendix E). All proposed areas with pavement, foundations, buildings, or stone surfacing were assigned a CN of 98. Undisturbed areas with Grass Cover (Fair, HSG C/D) were assigned a CN of 79 and 84, respectively.

**Table 4 - Curve Numbers**

| Category | HSG | CN |
|---|---|---|
| Grass Cover (Fair) | C | 79 |
| Grass Cover (Fair) | D | 84 |
| Stone surfacing | D | 98 |
| Impervious Areas – Paved parking lots, roads, laydowns | D | 98 |

Time of Concentration

The TR-55 method was used to determine time of concentration (TOCs) for each individual drainage area, with a minimum TOC of 6 minutes.

Rainfall Data

The rainfall design depths used in this analysis were pulled from El Paso County's Drainage Criteria Manual Table 6-2, found in Appendix D. The 5-year and 100-year, 24-hour storm events of 2.70 and 4.60 inches, respectively, were used as the design rainfall depth for sizing the new stormwater collection system. The rainfall distribution is SCS Type II.

Materials

HDPE corrugated drainage pipe with a smooth interior wall was selected for use in the storm drain system based on local regulations and contractual requirements. Flared end sections are required where no headwalls are provided. Riprap will be placed at the end of every flared end section. Sizing for riprap beds will be calculated in the FDR.



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# FOUR-STEP PROCESS

In accordance with the Engineering Criteria Manual I.7.2.A and DCM V2, this site has implemented the Four-Step Process to minimize adverse impacts of urbanization. The Four-Step Process includes reducing runoff volumes, stabilizing drainageways, treating the water quality capture volume, and considering the need for Industrial/Commercial BMPs.

Step 1 – Runoff Reduction: Proposed development minimizes directly connected impervious area where practicable through preservation of existing pervious areas and routing of developed drainage areas to the planned stormwater facilities. Impervious surfaces were assigned a Curve Number of 98 in accordance with NRCS methodology; composite drainage-area curve numbers reflect the proportional distribution of impervious and pervious land cover. Final evaluation of applicable Undeveloped Impervious Area (UIA) and Runoff Reduction Practices (RPA) will be completed during Final Drainage Report design.

Step 2 – Stabilize Drainageways: The existing unnamed tributary drainageway has been assessed for stormwater runoff capacity and velocity. Vegetation and/or matting will be selected to stabilize the drainageways by reducing the velocity of flows and decreasing any scour. These improvements help stabilize drainageways and minimize erosion and sediment runoff. Other on-site drainageways are to be sized and stabilized with permanent erosion control mitigation measures.

Step 3 – Detention and Water Quality: Runoff from this development is treated through capture and slow release of the WQCV via full-spectrum detention ponds that are designed per current El Paso County DCM V2 and the MHFD. Proposed Pond A and Pond B provide WQCV, EURV, and 100-year detention for the respective tributary basins.

Step 4 – Industrial and Commercial BMPs: Long-term source-control BMPs will be incorporated into the generating station design and operating procedures to minimize exposure of stormwater to industrial pollutants. Applicable measures will include covered or otherwise protected material storage and handling areas, appropriate secondary containment for oil- and chemical-containing equipment and storage areas, secured waste storage, routine inspection and housekeeping, and spill prevention and response procedures. Site-specific measures will be coordinated with the responsible design disciplines and Owner and documented in the final design and applicable facility operating and maintenance plans. Construction-phase erosion, sediment, and pollutant controls will be addressed separately in the site-specific Stormwater Management Plan (SWMP) and Grading & Erosion Control (GEC) Plan prepared prior to construction.



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# RESULTS AND CONCLUSIONS

The hydrologic and hydraulic analysis for the Williams Creek Generating Station demonstrates that the proposed drainage improvements have been developed to comply with applicable ECM, DCM, and MHFD criteria and will be finalized through the Final Drainage Report and construction document phase.

At the primary downstream design point, the modeled 5-year peak discharge decreases from 320 cfs under existing conditions to 255 cfs under proposed conditions, a reduction of approximately 20.3 percent. The modeled 100-year peak discharge decreases from 805 cfs to 696 cfs, a reduction of approximately 13.5 percent. Proposed peak discharges therefore remain below existing-condition peak discharges for both evaluated storms. The corresponding 5-year runoff volume decreases from 45.4 acre-feet to 43.6 acre-feet, a reduction of 1.8 acre-feet, or approximately 4.0 percent. The 100-year runoff volume decreases from 106.7 acre-feet to 103.9 acre-feet, a reduction of 2.8 acre-feet, or approximately 2.6 percent.

All detention basins were sized to provide the required Water Quality Capture Volume (WQCV), Excess Urban Runoff Volume (EURV), and 100-year storage. Each basin meets the 40-hour WQCV drain-down requirement, provides a minimum of two feet of freeboard, and includes a micropool designed in accordance with MHFD criteria. Results of the SSA modeling are shown in Appendix H and I. Operation and maintenance responsibilities for Pond A, Pond B, outlet structures, emergency spillways, and associated conveyance facilities are provided in the project-specific Operations and Maintenance Plan accompanying this report.

**Next Steps**

The preliminary drainage design will be refined during final design and documented in the Final Drainage Report. This work will include confirmation of drainage areas and hydrologic assumptions based on final grading; verification of storm sewer, culvert, and channel capacity; and refinement of detention basin geometry, outlet structures, emergency spillways, tailwater conditions, and hydraulic grade lines. Downstream conveyance, erosion protection, maintenance access, and utility conflicts will also be evaluated.

Coordination with El Paso County will confirm applicable drainage fees, planning requirements, and downstream outfall criteria. Relevant jurisdictional findings and coordination with the mechanical team regarding process-water pond drainage interfaces will be incorporated as applicable. Final documentation will address construction-phase stormwater controls and long-term inspection and maintenance requirements.

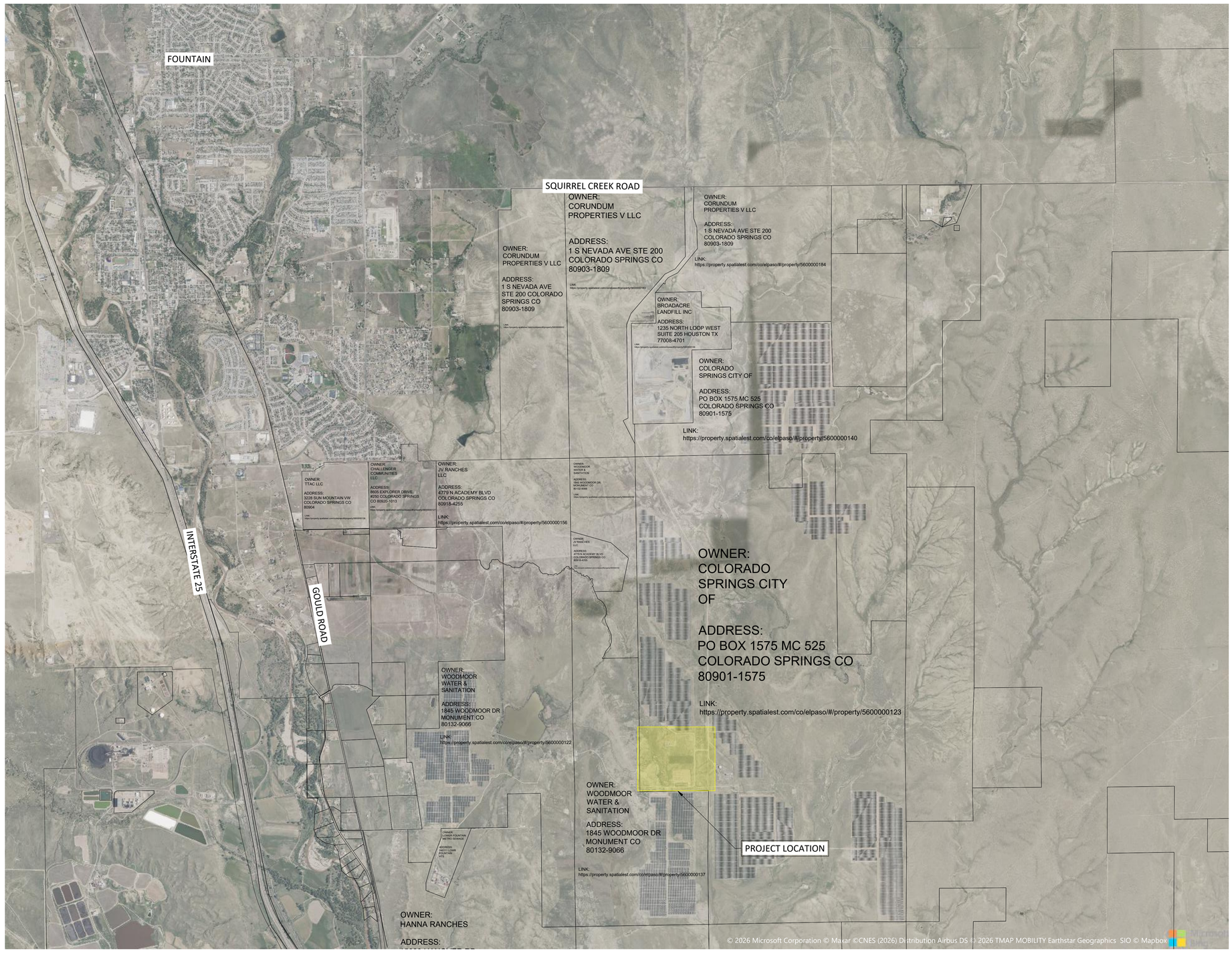


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# APPENDIX A – VICINITY AND DRAINAGE MAPS



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VICINITY MAP

SCALE: 1" = 2000'

N

- PRELIMINARY -
NOT FOR CONSTRUCTION

| | | | |
|---|---|---|---|
| OPEN | CONCEPTUAL EXHIBIT | | |
| | R. GROTANS | J. ROWLAND | 09-25-26 |
| REV | DESIGN BY | CHECKED BY | DATE |

COLORADO SPRINGS UTILITIES
WILLIAMS CREEK GENERATING STATION

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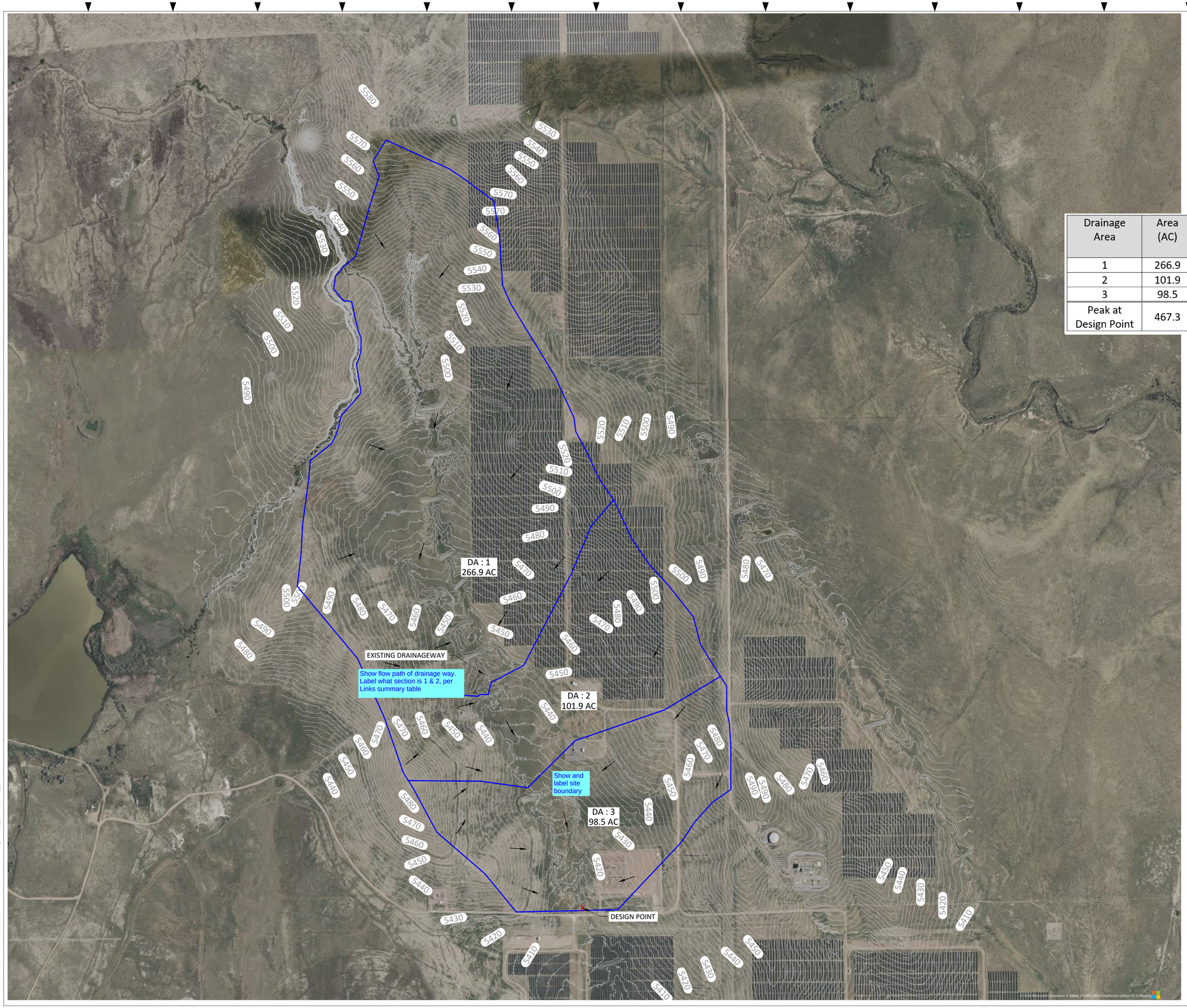
VICINITY MAP

| | |
|---|---|
| ENGINEER/DESIGN ORIGINATOR | R. GROTANS |
| LEAD ENG | J. ROWLAND |
| ENG MGR | D. DUBOSE |
| PROJ MGR | T. ROARK |

DRAWING NUMBER

EXH-CIV-VICINITY_MAP-001

DRAWING NAME: V:\KIWE\Projects\20070510-Williams_Creek_Generating_Station\Civ\CIV-Cover_Sheet-Maps-Notes_&_Legends\EXH-CIV-VICINITY_MAP-001.dwg




## LEGEND

- EXISTING MAJOR CONTOUR
- EXISTING MINOR CONTOUR
- DRAINAGE FLOW PATH
- DRAINAGE AREA BOUNDARY

| Drainage Area | Area (AC) | Weighted Curve Number | $Q_5$ (cfs) | $Volume_5$ (ac-ft) | $Q_{100}$ (cfs) | $Volume_{100}$ (ac-ft) |
|---|---|---|---|---|---|---|
| 1 | 266.9 | 82.2 | 185 | 25.4 | 450 | 60.3 |
| 2 | 101.9 | 83.5 | 111 | 10.4 | 259 | 24.1 |
| 3 | 98.5 | 83.2 | 107 | 10.0 | 250 | 23.1 |
| Peak at Design Point | 467.3 | - | 320 | 45.4 | 805 | 106.7 |

Please move drainage maps to back of report.

Ensure easements are shown and labeled on basin maps

SCALE: 1" = 500'

- PRELIMINARY -
NOT FOR CONSTRUCTION

| | | | |
|---|---|---|---|
| OPEN | CONCEPTUAL EXHIBIT | | |
| | B. JUENEMANN | J. ROWLAND | 09-25-26 |
| REV | DESIGN BY | CHECKED BY | DATE |

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WILLIAMS CREEK GENERATING STATION

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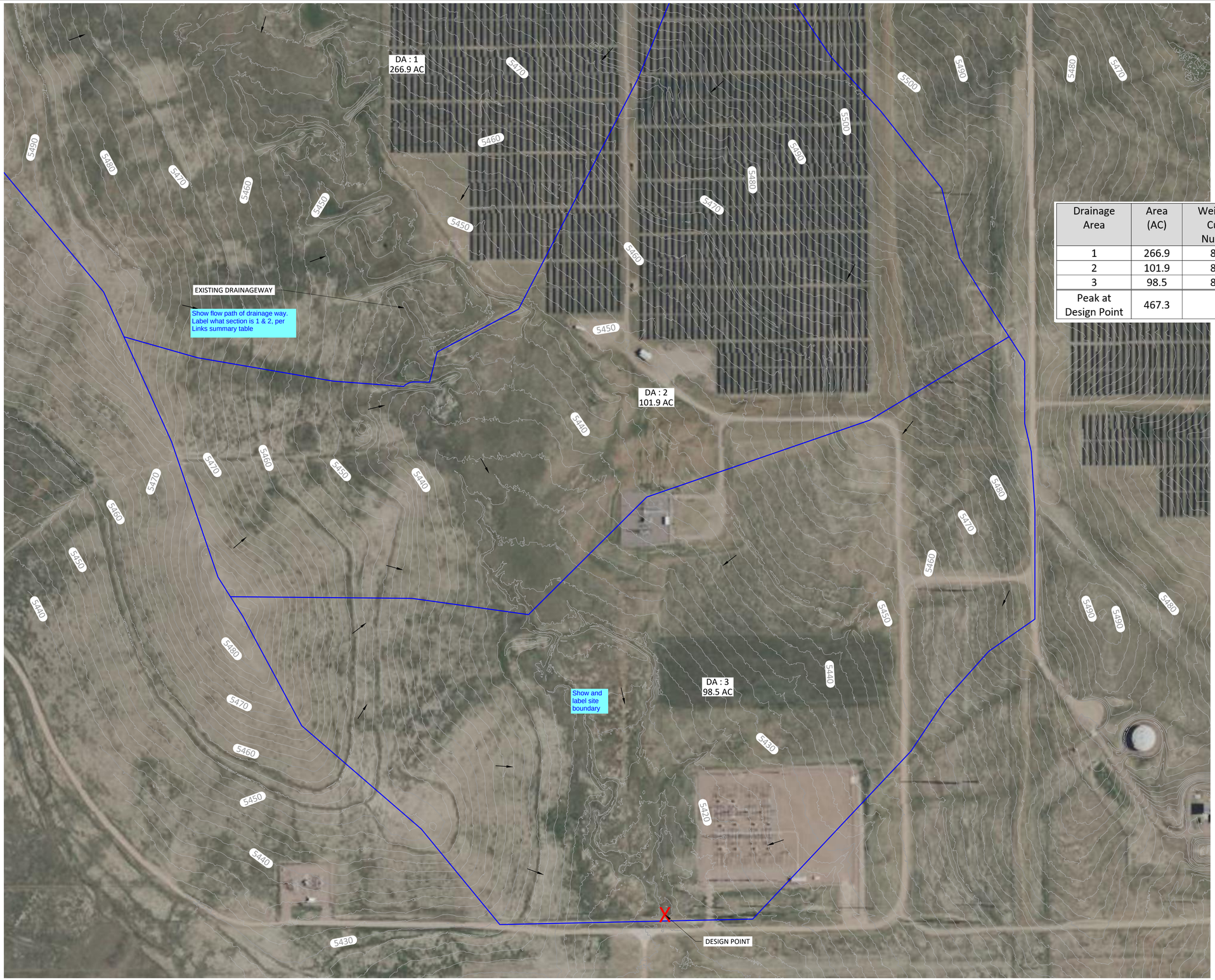
PRE CONSTRUCTION - DRAINAGE AREAS

| | |
|---|---|
| ENGINEER/DESIGN ORIGINATOR | B. JUENEMANN |
| LEAD ENG | J. ROWLAND |
| ENG MGR | D. DUBOSE |
| PROJ MGR | T. ROARK |

DRAWING NUMBER

EXH-CIV-STORM-001

DRAWING NAME: V:\KIWE\Projects\20070510-Williams_Creek_Generating_Station\Civ\TEMP\BA\Stormwater\ExistingDrainageAreas.dwg




## LEGEND

- EXISTING MAJOR CONTOUR
- EXISTING MINOR CONTOUR
- DRAINAGE FLOW PATH
- DRAINAGE AREA BOUNDARY

| Drainage Area | Area (AC) | Weighted Curve Number | $Q_5$ (cfs) | $Volume_5$ (ac-ft) | $Q_{100}$ (cfs) | $Volume_{100}$ (ac-ft) |
|---|---|---|---|---|---|---|
| 1 | 266.9 | 82.2 | 185 | 25.4 | 450 | 60.3 |
| 2 | 101.9 | 83.5 | 111 | 10.4 | 259 | 24.1 |
| 3 | 98.5 | 83.2 | 107 | 10.0 | 250 | 23.1 |
| Peak at Design Point | 467.3 | - | 320 | 45.4 | 805 | 106.7 |

SCALE: 1" = 200'

- PRELIMINARY -
NOT FOR CONSTRUCTION

| | | | |
|---|---|---|---|
| OPEN | CONCEPTUAL EXHIBIT | | |
| | B. JUENEMANN | J. ROWLAND | 09-25-26 |
| REV | DESIGN BY | CHECKED BY | DATE |

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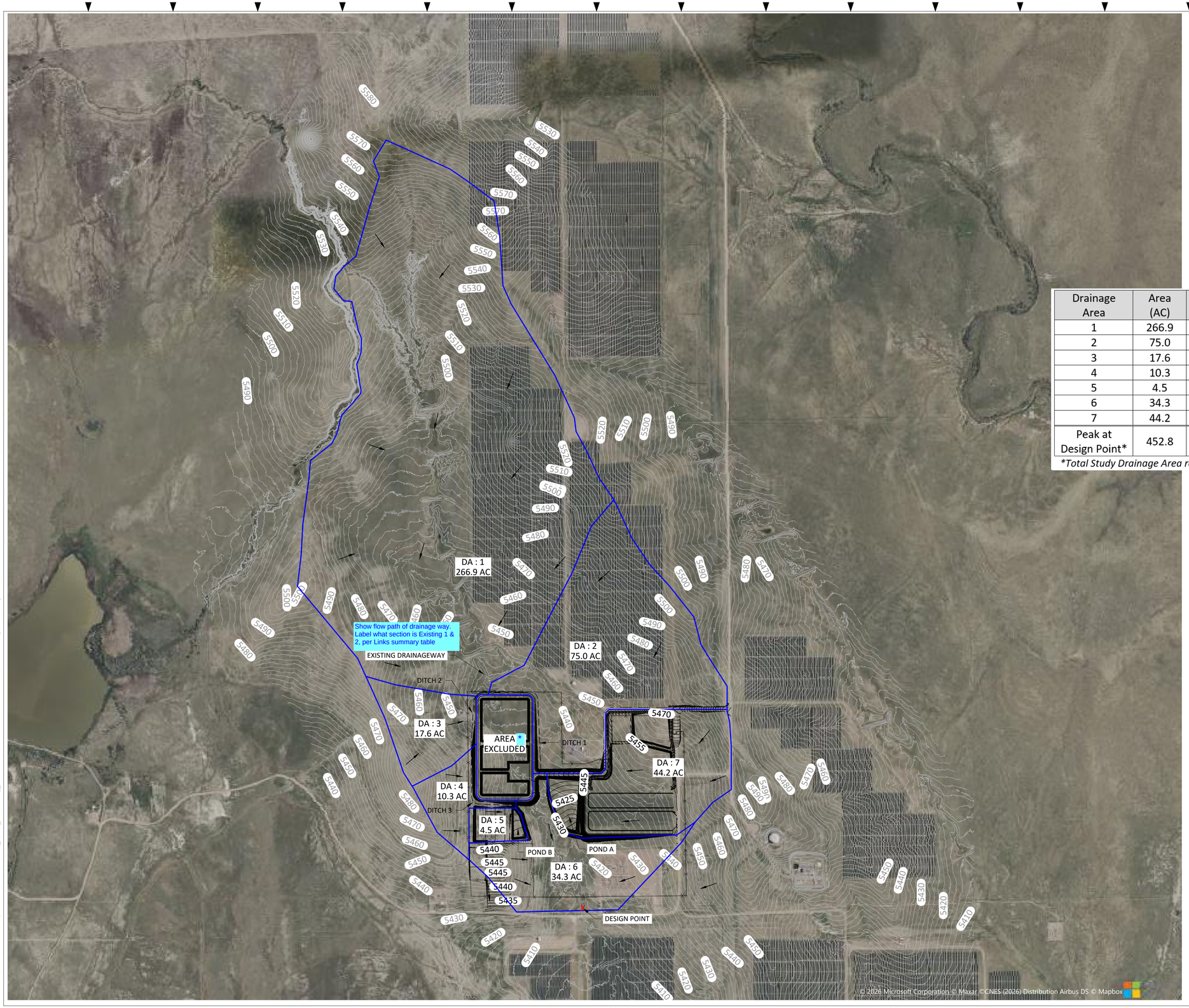
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PRE CONSTRUCTION - DRAINAGE AREAS

| | |
|---|---|
| ENGINEER/DESIGN ORIGINATOR | B. JUENEMANN |
| LEAD ENG | J. ROWLAND |
| ENG MGR | D. DUBOSE |
| PROJ MGR | T. ROARK |

DRAWING NUMBER
EXH-CIV-STORM-002

DRAWING NAME: V:\KIWE\Projects\20070510-Williams_Creek_Generating_Station\Civ\TEMPLBAI\Stormwater\ExistingDrainageAreas.dwg




## LEGEND

- EXISTING MAJOR CONTOUR
- EXISTING MINOR CONTOUR
- PROPOSED MAJOR CONTOUR
- PROPOSED MINOR CONTOUR
- DRAINAGE FLOW PATH
- DRAINAGE AREA BOUNDARY
- PROPOSED DITCH LOCATION

| Drainage Area | Area (AC) | Weighted Curve Number | $Q_5$ (cfs) | $Volume_5$ (ac-ft) | $Q_{100}$ (cfs) | $Volume_{100}$ (ac-ft) |
|---|---|---|---|---|---|---|
| 1 | 266.9 | 82.2 | 185 | 25.4 | 450 | 60.3 |
| 2 | 75.0 | 83.9 | 87 | 7.8 | 201 | 18.0 |
| 3 | 17.6 | 83.9 | 29 | 1.8 | 66 | 4.2 |
| 4 | 10.3 | 84.0 | 18 | 1.1 | 41 | 2.5 |
| 5 | 4.5 | 98.0 | 14 | 0.9 | 25 | 1.6 |
| 6 | 34.3 | 82.0 | 46 | 3.3 | 110 | 7.8 |
| 7 | 44.2 | 92.5 | 84 | 7.0 | 160 | 13.8 |
| Peak at Design Point* | 452.8 | - | 255 | 43.6 | 696 | 103.9 |

**Total Study Drainage Area reduced by 14.5 acres to account for zero liquid discharge process ponds.*

*Areas outside of the drainage boundary will need to be finalized in the final report

SCALE: 1" = 500'

- PRELIMINARY -
NOT FOR CONSTRUCTION

| | | | |
|---|---|---|---|
| OPEN | CONCEPTUAL EXHIBIT | | |
| REV | B. JUENEMANN<br>DESIGN BY | J. ROWLAND<br>CHECKED BY | 09-25-26<br>DATE |

COLORADO SPRINGS UTILITIES
WILLIAMS CREEK GENERATING STATION

Colorado Springs Utilities
it's how we're all connected

Kiewit

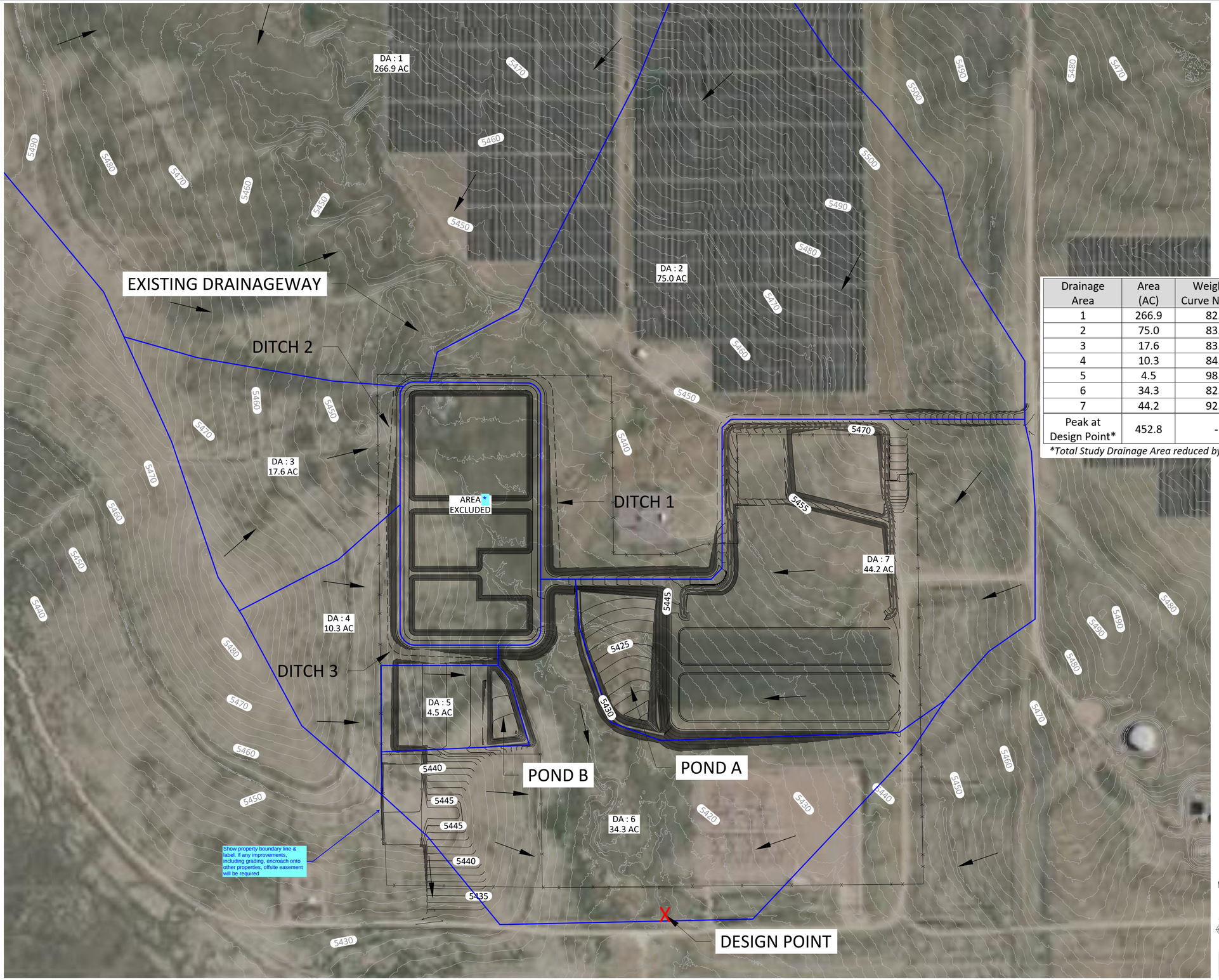
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POST CONSTRUCTION - DRAINAGE AREAS

| | |
|---|---|
| ENGINEER/DESIGN ORIGINATOR | B. JUENEMANN |
| LEAD ENG | J. ROWLAND |
| ENG MGR | D. DUBOSE |
| PROJ MGR | T. ROARK |

DRAWING NUMBER
EXH-CIV-STORM-003

DRAWING NAME: V:\KIWE\Projects\20070510-Williams_Creek_Generating_Station\Civ\TEMP\BA\Stormwater\ProposedDrainageAreas.dwg




## LEGEND

- EXISTING MAJOR CONTOUR
- EXISTING MINOR CONTOUR
- PROPOSED MAJOR CONTOUR
- PROPOSED MINOR CONTOUR
- DRAINAGE FLOW PATH
- DRAINAGE AREA BOUNDARY
- PROPOSED DITCH LOCATION

| Drainage Area | Area (AC) | Weighted Curve Number | $Q_5$ (cfs) | $Volume_5$ (ac-ft) | $Q_{100}$ (cfs) | $Volume_{100}$ (ac-ft) |
|---|---|---|---|---|---|---|
| 1 | 266.9 | 82.2 | 185 | 25.4 | 450 | 60.3 |
| 2 | 75.0 | 83.9 | 87 | 7.8 | 201 | 18.0 |
| 3 | 17.6 | 83.9 | 29 | 1.8 | 66 | 4.2 |
| 4 | 10.3 | 84.0 | 18 | 1.1 | 41 | 2.5 |
| 5 | 4.5 | 98.0 | 14 | 0.9 | 25 | 1.6 |
| 6 | 34.3 | 82.0 | 46 | 3.3 | 110 | 7.8 |
| 7 | 44.2 | 92.5 | 84 | 7.0 | 160 | 13.8 |
| Peak at Design Point* | 452.8 | - | 255 | 43.6 | 696 | 103.9 |

**Total Study Drainage Area reduced by 14.5 acres to account for zero liquid discharge process ponds.*

- PRELIMINARY -
NOT FOR CONSTRUCTION

| | | | |
|---|---|---|---|
| OPEN | CONCEPTUAL EXHIBIT | | |
| | B. JUENEMANN | J. ROWLAND | 09-25-26 |
| REV | DESIGN BY | CHECKED BY | DATE |

COLORADO SPRINGS UTILITIES
WILLIAMS CREEK GENERATING STATION

Colorado Springs Utilities
It's how we're all connected

Kiewit

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POST CONSTRUCTION - DRAINAGE AREAS

| | |
|---|---|
| ENGINEER/DESIGN ORIGINATOR | B. JUENEMANN |
| LEAD ENG | J. ROWLAND |
| ENG MGR | D. DUBOSE |
| PROJ MGR | T. ROARK |

DRAWING NUMBER
EXH-CIV-STORM-004

SCALE: 1" = 200'

DRAWING NAME: V:\KIWE\Projects\20070510-Williams_Creek_Generating_Station\Civ\TEMP\BAI\Stormwater\ProposedDrainageAreas.dwg

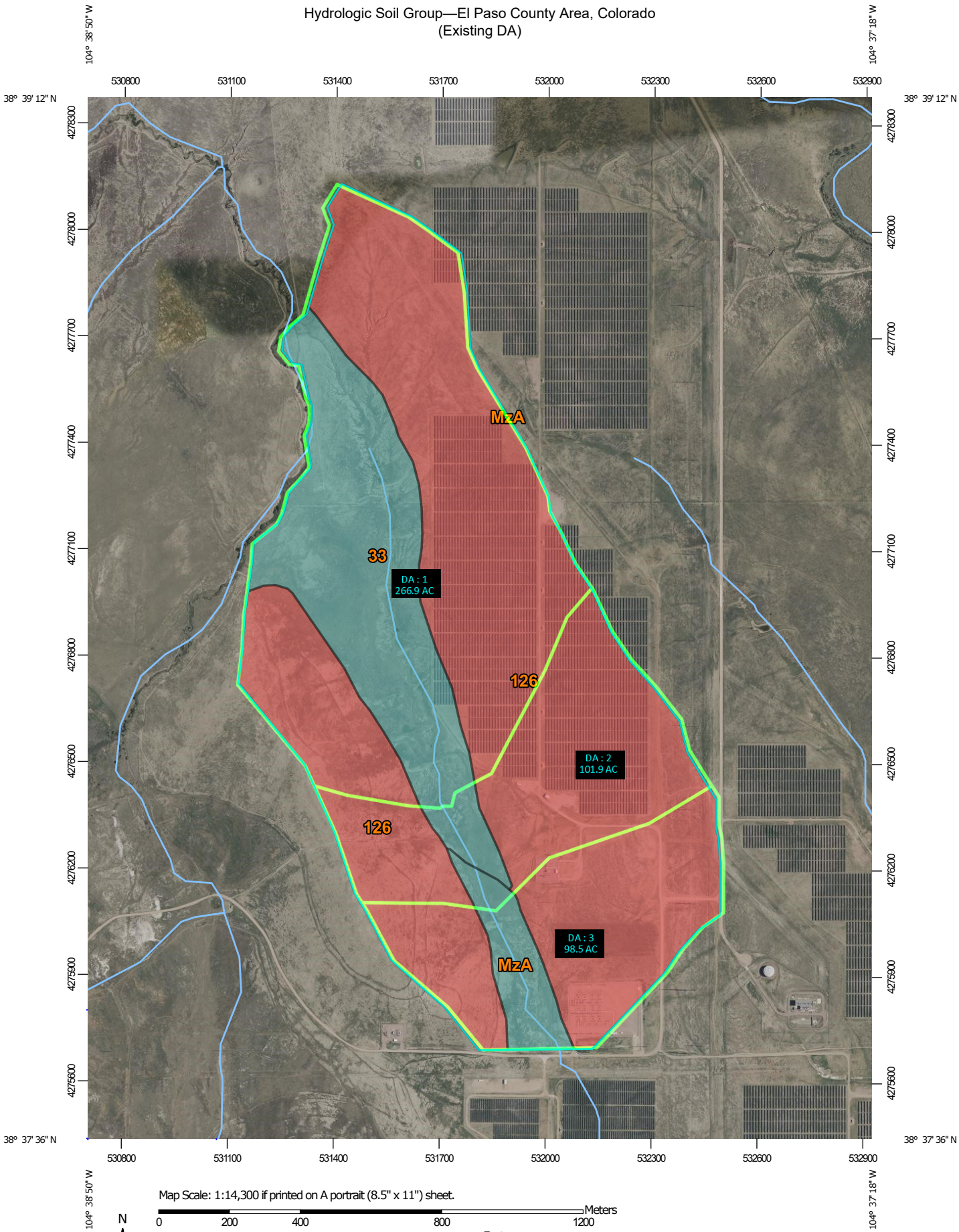
*Areas outside of the drainage boundary will need to be finalized in the final report

# APPENDIX B – WEB SOIL SURVEY



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Hydrologic Soil Group—El Paso County Area, Colorado
(Existing DA)



## MAP LEGEND

**Area of Interest (AOI)**

Area of Interest (AOI)

**Soils**

**Soil Rating Polygons**

A
A/D
B
B/D
C
C/D
D
Not rated or not available

**Soil Rating Lines**

A
A/D
B
B/D
C
C/D
D
Not rated or not available

**Soil Rating Points**

A
A/D
B
B/D
C
C/D
D
Not rated or not available

**Water Features**

Streams and Canals

**Transportation**

Rails
Interstate Highways
US Routes
Major Roads
Local Roads

**Background**

Aerial Photography

## MAP INFORMATION

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

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

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

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

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

Soil Survey Area: El Paso County Area, Colorado
Survey Area Data: Version 23, Aug 29, 2025

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

Date(s) aerial images were photographed: Apr 12, 2017—Aug 4, 2024

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

| Map unit symbol | Map unit name | Rating | Acres in AOI | Percent of AOI |
|---|---|---|---|---|
| 33 | Heldt clay loam, 0 to 3 percent slopes | C | 102.7 | 22.0% |
| 126 | Midway clay loam, dry, 1 to 15 percent slopes | D | 346.4 | 74.1% |
| MzA | Manzanola silty clay loam, saline, 0 to 2 percent slopes | C | 18.3 | 3.9% |
| **Totals for Area of Interest** | | | **467.3** | **100.0%** |

## Description

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

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

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

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

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

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

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

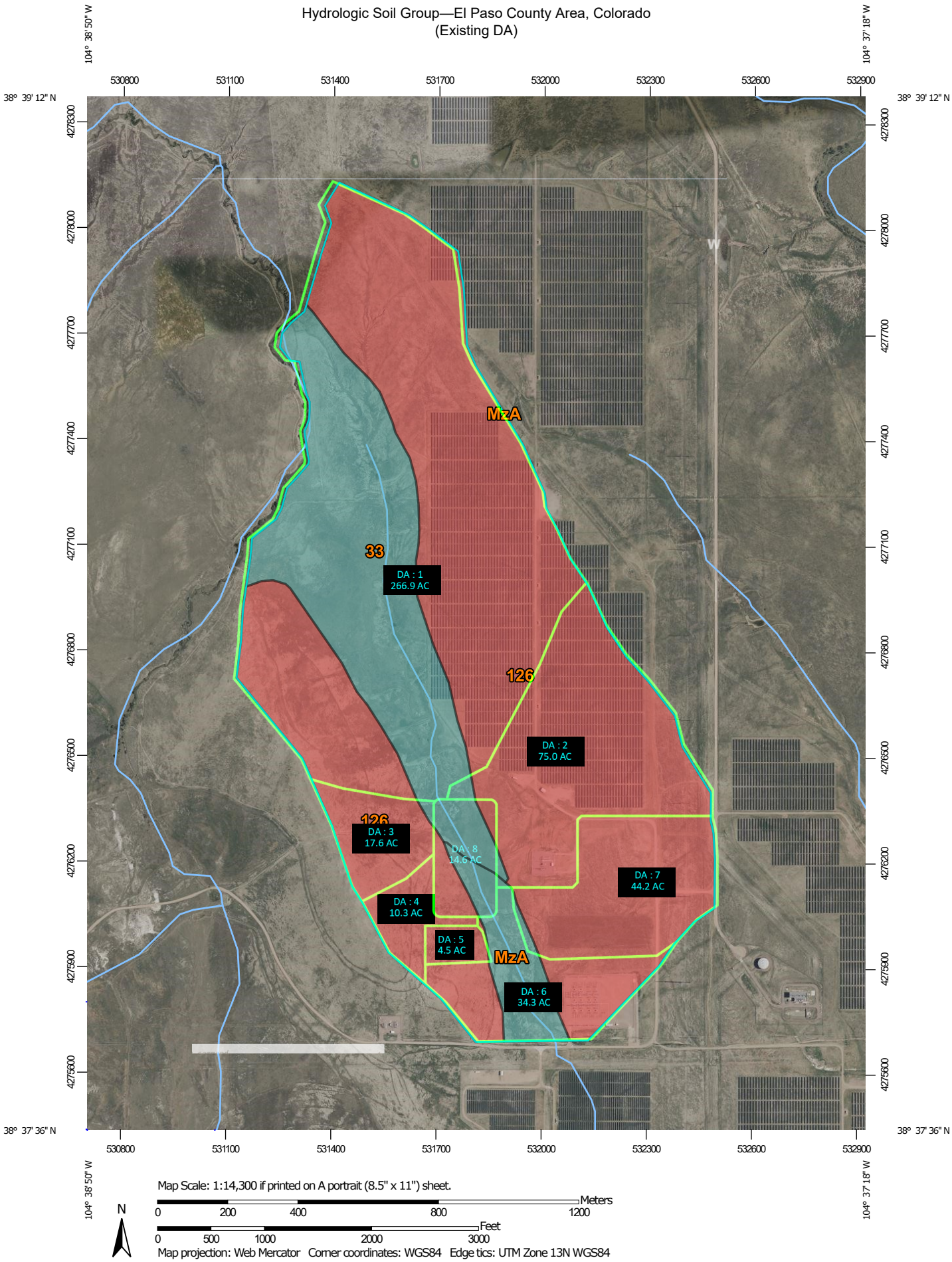
## Rating Options

*Aggregation Method:* Dominant Condition

*Component Percent Cutoff: None Specified*

*Tie-break Rule:* Higher

Hydrologic Soil Group—El Paso County Area, Colorado
(Existing DA)



## MAP LEGEND

**Area of Interest (AOI)**

Area of Interest (AOI)

**Soils**

**Soil Rating Polygons**

A
A/D
B
B/D
C
C/D
D
Not rated or not available

**Soil Rating Lines**

A
A/D
B
B/D
C
C/D
D
Not rated or not available

**Soil Rating Points**

A
A/D
B
B/D
C
C/D
D
Not rated or not available

**Water Features**

Streams and Canals

**Transportation**

Rails
Interstate Highways
US Routes
Major Roads
Local Roads

**Background**

Aerial Photography

## MAP INFORMATION

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

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

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

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

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

Soil Survey Area: El Paso County Area, Colorado
Survey Area Data: Version 23, Aug 29, 2025

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

Date(s) aerial images were photographed: Apr 12, 2017—Aug 4, 2024

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

| Map unit symbol | Map unit name | Rating | Acres in AOI | Percent of AOI |
|---|---|---|---|---|
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| 126 | Midway clay loam, dry, 1 to 15 percent slopes | D | 346.4 | 74.1% |
| MzA | Manzanola silty clay loam, saline, 0 to 2 percent slopes | C | 18.3 | 3.9% |
| **Totals for Area of Interest** | | | **467.3** | **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:

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

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

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

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

## Rating Options

*Aggregation Method:* Dominant Condition

*Component Percent Cutoff: None Specified*

*Tie-break Rule:* Higher

# APPENDIX C – FEMA FLOOD MAP



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# NOTES TO USERS

This map is for use in administering the National Flood Insurance Program. It does not necessarily identify all areas subject to flooding, particularly from local drainage sources of small size. The **community map repository** should be consulted for possible updated or additional flood hazard information.

To obtain more detailed information in areas where **Base Flood Elevations** (BFEs) and/or **floodways** have been determined, users are encouraged to consult the Flood Profiles and Floodway Data and/or Summary of Stillwater Elevations tables contained within the Flood Insurance Study (FIS) report that accompanies this FIRM. Users should be aware that BFEs shown on the FIRM represent rounded whole-foot elevations. These BFEs are intended for flood insurance rating purposes only and should not be used as the sole source of flood elevation information. Accordingly, flood elevation data presented in the FIS report should be utilized in conjunction with the FIRM for purposes of construction and/or floodplain management.

**Coastal Base Flood Elevations** shown on this map apply only landward of 0.0' North American Vertical Datum of 1988 (NAVD88). Users of this FIRM should be aware that coastal flood elevations are also provided in the Summary of Stillwater Elevations table in the Flood Insurance Study report for this jurisdiction. Elevations shown in the Summary of Stillwater Elevations table should be used for construction and/or floodplain management purposes when they are higher than the elevations shown on this FIRM.

Boundaries of the **floodways** were computed at cross sections and interpolated between cross sections. The floodways were based on hydraulic considerations with regard to requirements of the National Flood Insurance Program. Floodway widths and other pertinent floodway data are provided in the Flood Insurance Study report for this jurisdiction.

Certain areas not in Special Flood Hazard Areas may be protected by **flood control structures**. Refer to section 2.4 "Flood Protection Measures" of the Flood Insurance Study report for information on flood control structures for this jurisdiction.

The **projection** used in the preparation of this map was Universal Transverse Mercator (UTM) zone 13. The **horizontal datum** was NAD83, GRS80 spheroid. Differences in datum, spheroid, projection or UTM zones zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of this FIRM.

Flood elevations on this map are referenced to the **North American Vertical Datum of 1988 (NAVD88)**. These flood elevations must be compared to structure and ground elevations referenced to the same **vertical datum**. For information regarding conversion between the National Geodetic Vertical Datum of 1929 and the North American Vertical Datum of 1988, visit the National Geodetic Survey website at http://www.ngs.noaa.gov/ or contact the National Geodetic Survey at the following address:

NGS Information Services
NOAA, N/NGS12
National Geodetic Survey
SSMC-3, #9202
1315 East-West Highway
Silver Spring, MD 20910-3282

To obtain current elevation, description, and/or location information for **bench marks** shown on this map, please contact the Information Services Branch of the National Geodetic Survey at (301) 713-3242 or visit its website at http://www.ngs.noaa.gov/.

**Base Map** information shown on this FIRM was provided in digital format by El Paso County, Colorado Springs Utilities, and Anderson Consulting Engineers, Inc. These data are current as of 2008.

This map reflects more detailed and up-to-date **stream channel configurations and floodplain delineations** than those shown on the previous FIRM for this jurisdiction. The floodplains and floodways that were transferred from the previous FIRM may have been adjusted to conform to these new stream channel configurations. As a result, the Flood Profiles and Floodway Data tables in the Flood Insurance Study Report (which contains authoritative hydraulic data) may reflect stream channel distances that differ from what is shown on this map. The profile baselines depicted on this map represent the hydraulic modeling baselines that match the flood profiles and Floodway Data Tables if applicable, in the FIS report. As a result, the profile baselines may deviate significantly from the new base map channel representation and may appear outside of the floodplain.

**Corporate limits** shown on this map are based on the best data available at the time of publication. Because changes due to annexations or de-annexations may have occurred after this map was published, map users should contact appropriate community officials to verify current corporate limit locations.

Please refer to the separately printed **Map Index** for an overview map of the county showing the layout of map panels; community map repository addresses; and a Listing of Communities table containing National Flood Insurance Program dates for each community as well as a listing of the panels on which each community is located.

Contact **FEMA Map Service Center** (MSC) via the FEMA Map Information eXchange (FMIX) 1-877-336-2627 for information on available products associated with this FIRM. Available products may include previously issued Letters of Map Change, a Flood Insurance Study Report, and/or digital versions of this map. The MSC may also be reached by Fax at 1-800-358-9620 and its website at http://www.msc.fema.gov/.

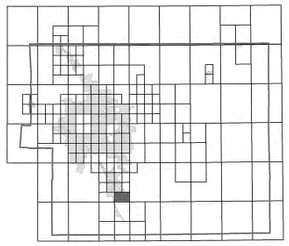
If you have **questions about this map** or questions concerning the National Flood Insurance Program in general, please call **1-877-FEMA MAP** (1-877-336-2627) or visit the FEMA website at http://www.fema.gov/business/nfip.

**El Paso County Vertical Datum Offset Table**

| Flooding Source | Vertical Datum Offset (ft) |
|---|---|

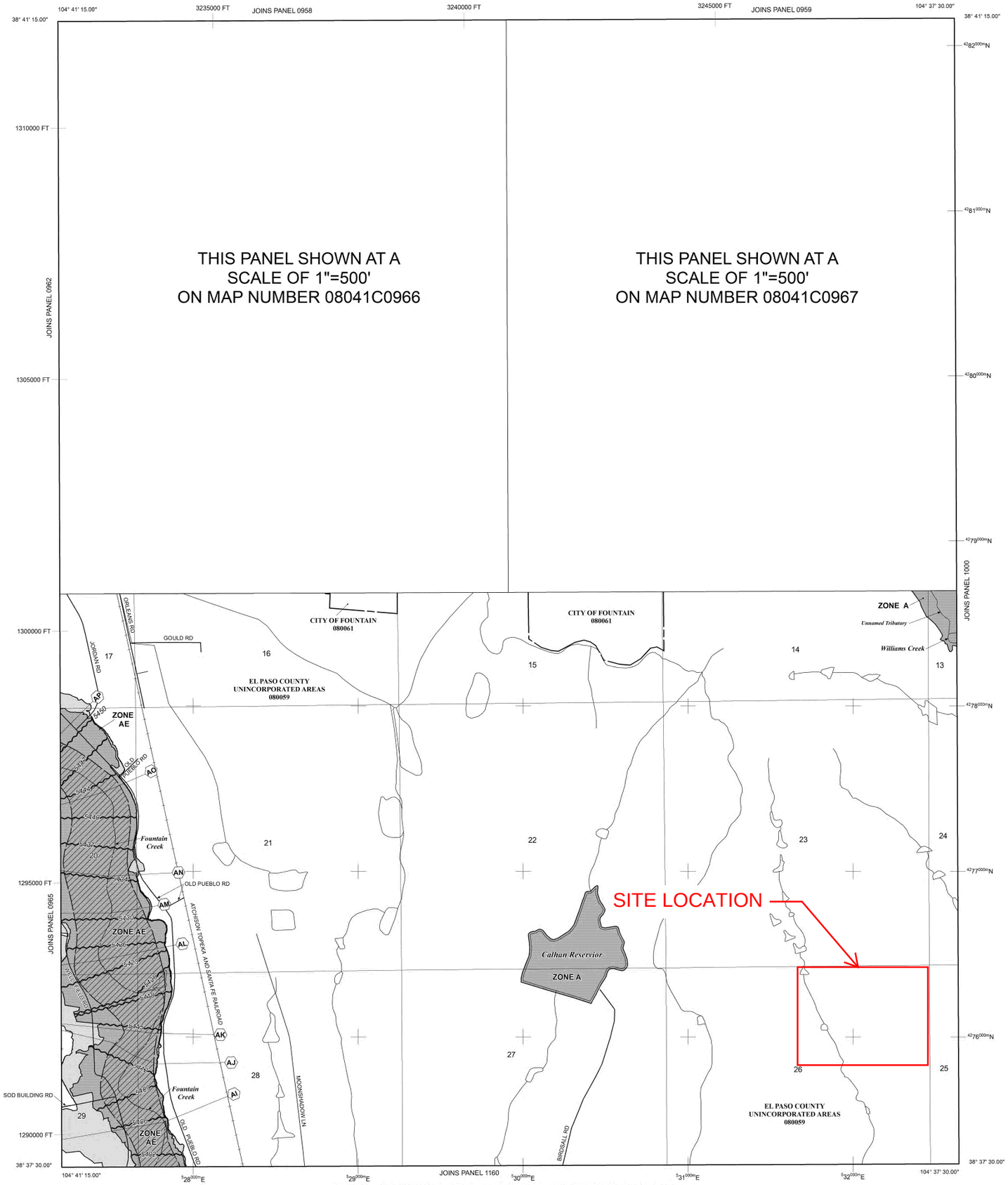
REFER TO SECTION 3.3 OF THE EL PASO COUNTY FLOOD INSURANCE STUDY FOR STREAM BY STREAM VERTICAL DATUM CONVERSION INFORMATION

**Panel Location Map**



This Digital Flood Insurance Rate Map (DFIRM) was produced through a Cooperating Technical Partner (CTP) agreement between the State of Colorado Water Conservation Board (CWCB) and the Federal Emergency Management Agency (FEMA).

Additional Flood Hazard information and resources are available from local communities and the Colorado Water Conservation Board.




# LEGEND

SPECIAL FLOOD HAZARD AREAS (SFHAS) SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

The 1% annual chance flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, A99, V, and VE. The Base Flood Elevation is the water-surface elevation of the 1% annual chance flood.

**ZONE A** No Base Flood Elevations determined.
**ZONE AE** Base Flood Elevations determined.
**ZONE AH** Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.
**ZONE AO** Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.
**ZONE AR** Special Flood Hazard Area Formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.
**ZONE A99** Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.
**ZONE V** Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.
**ZONE VE** Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

OTHER FLOOD AREAS

**ZONE X** Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

OTHER AREAS

**ZONE X** Areas determined to be outside the 0.2% annual chance floodplain.
**ZONE D** Areas in which flood hazards are undetermined, but possible.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

Floodplain boundary
Floodway boundary
Zone D Boundary
CBRS and OPA boundary
Boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or flood velocities.
513 — Base Flood Elevation line and value; elevation in feet*
(EL 987) — Base Flood Elevation value where uniform within zone; elevation in feet*

* Referenced to the North American Vertical Datum of 1988 (NAVD 88)

A — A — Cross section line
23 — 23 — Transect line
97° 07' 30.00" / 32° 22' 30.00" — Geographic coordinates referenced to the North American Datum of 1983 (NAD 83)
4275000mN — 1000-meter Universal Transverse Mercator grid ticks, zone 13
6000000 FT — 5000-foot grid ticks: Colorado State Plane coordinate system, central zone (FIPSZONE 0502), Lambert Conformal Conic Projection
DX5510 — Bench mark (see explanation in Notes to Users section of this FIRM panel)
M1.5 — River Mile

MAP REPOSITORIES
Refer to Map Repositories list on Map Index

EFFECTIVE DATE OF COUNTYWIDE FLOOD INSURANCE RATE MAP
**MARCH 17, 1997**

EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL
**DECEMBER 7, 2018** - to update corporate limits, to change Base Flood Elevations and Special Flood Hazard Areas, to update map format, to add roads and road names, and to incorporate previously issued Letters of Map Revision.

For community map revision history prior to countywide mapping, refer to the Community Map History Table located in the Flood Insurance Study report for this jurisdiction.

To determine if flood insurance is available in this community, contact your insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

**MAP SCALE 1" = 1000'**
500 0 1000 2000 FEET
300 0 300 600 METERS

NFIP

**PANEL 0970G**

MAP REVISED DECEMBER 7, 2018

# FIRM

## FLOOD INSURANCE RATE MAP

## EL PASO COUNTY, COLORADO AND INCORPORATED AREAS

**PANEL 970 OF 1300**

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

| COMMUNITY | NUMBER | PANEL | SUFFIX |
|---|---|---|---|
| EL PASO COUNTY | 080059 | 0970 | G |
| FOUNTAIN, CITY OF | 080061 | 0970 | G |

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

**MAP NUMBER 08041C0970G**

**MAP REVISED DECEMBER 7, 2018**

**Federal Emergency Management Agency**

# APPENDIX D – RAINFALL DEPTHS



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# DRAINAGE CRITERIA MANUAL COUNTY OF EL PASO, COLORADO

## VOLUME 1 UPDATE

### CHAPTER 6 - HYDROLOGY

2.1. - Rainfall Depths

Highlight 24 hour depths since that is the storm used.

Table 6-2. Rainfall Depths for Colorado Springs

| Return Period | 1-Hour Depth | 6-Hour Depth | 24-Hour Depth |
|---|---|---|---|
| 2 | 1.19 | 1.70 | 2.10 |
| 5 | 1.50 | 2.10 | 2.70 |
| 10 | 1.75 | 2.40 | 3.20 |
| 25 | 2.00 | 2.90 | 3.60 |
| 50 | 2.25 | 3.20 | 4.20 |
| 100 | 2.52 | 3.50 | 4.60 |
| Where Z = 6,840 ft/100 | | | |

# APPENDIX E – NRCS CURVE NUMBERS



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# CN Tables

The four pages in this section are reproduced from the SCS (now NRCS) report Urban hydrology for small watersheds. This report is commonly known as TR-55. The tables provide estimates of the curve number (CN) as a function of hydrologic soil group (HSG), cover type, treatment, hydrologic condition, antecedent runoff condition (ARC), and impervious area in the catchment.
TR-55 provides the following guidance for use of these tables:

- Soils are classified into four HSG's (A, B, C, and D) according to their minimum infiltration rate, which is obtained for bare soil after prolonged wetting. Appendix A \[of TR-55\] defines the four groups and provides a list of most of the soils in the United States and their group classification. The soils in the area of interest may be identified from a soil survey report, which can be obtained from local SCS offices or soil and water conservation district offices.
- There are a number of methods for determining cover type. The most common are field reconnaissance, aerial photographs, and land use maps.
- Treatment is a cover type modifier (used only in Table 2-2b) to describe the management of cultivated agricultural lands. It includes mechanical practices, such as contouring and terracing, and management practices, such as crop rotations and reduced or no tillage.
- Hydrologic condition indicates the effects of cover type and treatment on infiltration and runoff and is generally estimated from density of plant and residue cover on sample areas. Good hydrologic condition indicates that the soil usually has a low runoff potential for that specific hydrologic soil group, cover type and treatment. Some factors to consider in estimating the effect of cover on infiltration and runoff are: (a) canopy or density of lawns, crops, or other vegetative areas; (b) amount of year-round cover; (c) amount of grass or close-seeded legumes in rotations; (d) percent of residue cover; and (e) degree of surface roughness.
- The index of runoff potential before a storm event is the antecedent runoff condition (ARC). The CN for the average ARC at a site is the median value as taken from sample rainfall and runoff data. The curve numbers in table 2-2 are for the average ARC, which is used primarily for design applications.
- The percentage of impervious area and the means of conveying runoff from impervious areas to the drainage systems should be considered in computing CN for urban areas. An impervious area is considered connected if runoff from it flows directly into the drainage systems. It is also considered connected if runoff from it occurs as shallow concentrated shallow flow that runs over a pervious area and then into a drainage system. Runoff from unconnected impervious areas is spread over a pervious area as sheet flow.

**SCS TR-55 Table 2-2a – Runoff curve numbers for urban areas[1]**

| Cover description | | Curve numbers for hydrologic soil group | | | |
|---|---|---|---|---|---|
| **Cover type and hydrologic condition** | **Average percent impervious area[2]** | **A** | **B** | **C** | **D** |
| *Fully developed urban areas* | | | | | |
| Open space (lawns, parks, golf courses, cemeteries, etc.)[3]: | | | | | |
| Poor condition (grass cover < 50%) . . . . . | | 68 | 79 | 86 | 89 |
| Fair condition (grass cover 50% to 75%) . . . . . | | 49 | 69 | 79 | 84 |
| Good condition (grass cover > 75%) . . . . . | | 39 | 61 | 74 | 80 |
| Impervious areas: | | | | | |
| Paved parking lots, roofs, driveways, etc. (excluding right-of-way) . . . . . | | 98 | 98 | 98 | 98 |
| Streets and roads: | | | | | |
| Paved; curbs and storm sewers (excluding right-of-way) . . . . . | | 98 | 98 | 98 | 98 |
| Paved; open ditches (including right-of-way) . . . . | | 83 | 89 | 92 | 93 |
| Gravel (including right-of-way) . . . . . | | 76 | 85 | 89 | 91 |
| Dirt (including right-of-way) . . . . . | | 72 | 82 | 87 | 89 |
| Western desert urban areas: | | | | | |

| Cover description | | Curve numbers for hydrologic soil group | | | |
|---|---|---|---|---|---|
| **Cover type and hydrologic condition** | **Average percent impervious area[2]** | **A** | **B** | **C** | **D** |
| Natural desert landscaping (pervious areas only)[4] . . | | 63 | 77 | 85 | 88 |
| Artificial desert landscaping (impervious weed barrier, desert shrub with 1- to 2-inch sand or gravel mulch and basin borders) . . . . . | | 96 | 96 | 96 | 96 |
| Urban districts: | | | | | |
| Commercial and business . . . . . | 85 | 89 | 92 | 94 | 95 |
| Industrial . . . . . | 72 | 81 | 88 | 91 | 93 |
| Residential districts by average lot size | | | | | |
| 1/8 acre or less (town houses) . . . . . | 65 | 77 | 85 | 90 | 92 |
| 1/4 acre . . . . . | 38 | 61 | 75 | 83 | 87 |
| 1/3 acre . . . . . | 30 | 57 | 72 | 81 | 86 |
| 1/2 acre . . . . . | 25 | 54 | 70 | 80 | 85 |
| 1 acre . . . . . | 20 | 51 | 68 | 79 | 84 |
| 2 acre . . . . . | 12 | 46 | 65 | 77 | 82 |

| Cover description | | Curve numbers for hydrologic soil group | | | |
|---|---|---|---|---|---|
| **Cover type and hydrologic condition** | **Average percent impervious area[2]** | **A** | **B** | **C** | **D** |
| *Developing urban areas* | | | | | |
| Newly graded areas (pervious areas only, no vegetation)[5] . . . . . | | 77 | 86 | 91 | 94 |
| Idle lands (CN's are determined using cover types similar to those in table 2-2c | | | | | |

[1] Average runoff condition, and $I_a$ = 0.2S.

[2] The average percent impervious area shown was used to develop the composite CN's. Other assumptions are as follows: impervious areas are directly connected to the drainage system, impervious areas have a CN of 98, and pervious areas are considered equivalent to open space in good hydrologic condition. CN's for other combinations of conditions may be computed using figure 2-3 or 2-4.

[3] CN's shown are equivalent to those of pasture. Composite CN's may be computed for other combinations of open space cover type.

[4] Composite CN's for natural desert landscaping should be computed using figures 2-3 or 2-4 based on the impervious area percentage (CN = 98) and the pervious area CN. The pervious area CN's are assumed equivalent to desert shrub in poor hydrologic condition.

[5] Composite CN's to use for the design of temporary measures during grading and construction should be computed using figure 2-3 or 2-4, based on the degree of development (imperviousness area percentage) and the CN's for the newly graded pervious areas.

**SCS TR-55 Table 2-2b – Runoff curve numbers for cultivated agricultural lands[1]**

| Cover description | | | Curve numbers for hydrologic soil group | | | |
|---|---|---|---|---|---|---|
| Cover type | Treatment[2] | Hydrologic condition[3] | A | B | C | D |
| Fallow | Bare soil | - | 77 | 86 | 91 | 94 |
| | Crop residue cover (CR) | Poor | 76 | 85 | 90 | 93 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | Good | 74 | 83 | 88 | 90 |
| Row crops | Straight row (SR) | Poor | 72 | 81 | 88 | 91 |
| | | Good | 67 | 78 | 85 | 89 |
| | SR + CR | Poor | 71 | 80 | 87 | 90 |
| | | Good | 64 | 75 | 82 | 85 |
| | Contoured (C) | Poor | 70 | 79 | 84 | 88 |
| | | Good | 65 | 75 | 82 | 86 |
| | C + CR | Poor | 69 | 78 | 83 | 87 |
| | | Good | 64 | 74 | 81 | 85 |
| | Contoured & terraced (C & T) | Poor | 66 | 74 | 80 | 82 |
| | | Good | 62 | 71 | 78 | 81 |
| | C & T + CR | Poor | 65 | 73 | 79 | 81 |
| | | Good | 61 | 70 | 77 | 80 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Small grain | SR | Poor | 65 | 76 | 84 | 88 |
| | | Good | 63 | 75 | 83 | 87 |
| | SR + CR | Poor | 64 | 75 | 83 | 86 |
| | | Good | 60 | 72 | 80 | 84 |
| | C | Poor | 63 | 74 | 82 | 85 |
| | | Good | 61 | 73 | 81 | 84 |
| | C + CR | Poor | 62 | 73 | 81 | 84 |
| | | Good | 60 | 72 | 80 | 83 |
| | C & T | Poor | 61 | 72 | 79 | 82 |
| | | Good | 59 | 70 | 78 | 81 |
| | C & T + CR | Poor | 60 | 71 | 78 | 81 |
| | | Good | 58 | 69 | 77 | 80 |
| Close-seeded or broadcast legumes or rotation meadow | SR | Poor | 66 | 77 | 85 | 89 |
| | | Good | 58 | 72 | 81 | 85 |
| | C | Poor | 64 | 75 | 83 | 85 |
| | | Good | 55 | 69 | 78 | 83 |
| | C & T | Poor | 63 | 73 | 80 | 83 |
| | | Good | 51 | 67 | 76 | 80 |

[1] Average runoff condition, and Ia = 0.2S.

[2] *Crop residue cover* applies only if residue is on at least 5% of the surface throughout the

year.
[3] Hydrologic condition is based on combination of factors that affect infiltration and runoff, including (a) density and canopy of vegetative areas, (b) amount of year-round cover, (c) amount of grass or close-seeded legumes in rotations, (d) percent of residue cover on the land surface (good ≥ 20%), and (e) degree of surface roughness.
*Poor: Factors impair infiltration and tend to increase runoff.*

*Good:* Factors encourage average and better than average infiltration and tend to decrease runoff.

**SCS TR-55 Table 2-2c – Runoff curve numbers for other agricultural lands[1]**

| Cover description | | | Curve numbers for hydrologic soil group | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Cover type and hydrologic condition | Hydrologic condition | | A | | B | | C | | D | |
| Pasture, grassland, or range – continuous | Poor | | 68 | 79 | | 86 | | 89 | | |
| forage for graving.[2] | Fair | | 49 | 69 | | 79 | | 84 | | |
| | Good | | 39 | 61 | | 74 | | 80 | | |
| | | | | | | | | | | |
| Meadow – continuous grass, protected from | | | 30 | 58 | | 71 | | 78 | | |
| grazing and generally mowed for hay. | | | | | | | | | | |
| | | | | | | | | | | |
| Brush – brush-weed mixture with brush | Poor | | 48 | 67 | | 77 | | 83 | | |
| the major element.[3] | Fair | | 35 | 56 | | 70 | | 77 | | |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Good | | 30[4] | 48 | | 65 | | 73 | | |
| | | | | | | | | | | |
| Woods – grass combination (orchard | Poor | | 57 | 73 | | 82 | | 86 | | |
| or tree farm).[5] | Fair | | 43 | 65 | | 76 | | 82 | | |
| | Good | | 32 | 58 | | 72 | | 79 | | |
| | | | | | | | | | | |
| Woods.[6] | Poor | | 45 | 66 | | 77 | | 83 | | |
| | Fair | | 36 | 60 | | 73 | | 79 | | |
| | Good | | 30[4] | 55 | | 70 | | 77 | | |
| | | | | | | | | | | |
| Farmsteads – buildings, lanes, driveways, | □ | | 59 | 74 | | 82 | | 86 | | |
| and surrounding lots. | | | | | | | | | | |

[1] Average runoff condition, and $I_a$ = 0.2S.

[2] *Poor:* <50% ground cover or heavily grazed with no mulch.
*Fair:* 50 to 75% ground cover and not heavily grazed.
*Good:* >75% ground cover and lightly or only occasionally grazed.

[3] *Poor:* <50% ground cover.
*Fair:* 50 to 75% ground cover.
*Good:* >75% ground cover.

[4] Actual curve number is less than 30; use CN=30 for runoff computations.

[5] CN's shown were computed for areas with 50% woods and 50% grass (pasture) cover.

Other combinations of conditions may be computed from the CN's for woods and pasture.
6 *Poor:* Forest litter, small trees, and brush are destroyed by heavy grazing or regular burning.
*Fair:* Woods are grazed but not burned, and some forest litter covers the soil.
*Good:* Woods are protected from grazing, and litter and brush adequately cover the soil.

**SCS TR-55 Table 2-2d – Runoff curve numbers for arid and semiarid rangelands[1]**

| Cover description | | Curve numbers for hydrologic soil group | | | |
|---|---|---|---|---|---|
| Cover type | Hydrologic condition[2] | A[3] | B | C | D |
| Herbaceous – mixture of grass, weeds, and low-growing brush, with brush the minor element. | Poor | | 80 | 87 | 93 |
| | Fair | | 71 | 81 | 89 |
| | Good | | 62 | 74 | 85 |
| Oak-aspen – mountain brush mixture of oak brush, aspen, mountain mahogany, bitter brush, maple, and other brush | Poor | | 66 | 74 | 79 |
| | Fair | | 48 | 57 | 63 |
| | Good | | 30 | 41 | 48 |
| Pinyon-juniper – pinyon, juniper, or both; grass understory. | Poor | | 75 | 85 | 89 |
| | Fair | | 58 | 73 | 80 |
| | Good | | 41 | 61 | 71 |
| Sagebrush with grass understory. | Poor | | 67 | 80 | 85 |
| | Fair | | 51 | 63 | 70 |
| | Good | | 35 | 47 | 55 |
| Desert shrub – major plants include saltbrush, greasewood, creosotebush, blackbrush, bursage, palo verde, mesquite, and cactus. | Poor | 63 | 77 | 85 | 88 |
| | Fair | 55 | 72 | 81 | 86 |

| | | | | | |
|---|---|---|---|---|---|
| | Good | 49 | 68 | 79 | 84 |

[1] Average runoff condition, and $I_a$ = 0.2S.

[2] *Poor:* <30% ground cover (litter, grass, and brush overstory).
*Fair:* 30 to 70% ground cover.
*Good:* >70% ground cover.

[3] Curve numbers for group A have been developed only for desert shrub.

# APPENDIX F – HYDRAULIC CALCULATIONS



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# Channel Report

Channel input table shows a channel width of 52 ft. If that's top width, please include that in the channel input table somewhere. If it's not, please verify correct bottom width and revise documents as necessary. This comment is for all 3 proposed channels.



## DITCH-01 - 5 YR CROSS SECTION

**Trapezoidal**

| | |
|---|---|
| Bottom Width (ft) | = 20.00 |
| Side Slopes (z:1) | = 4.00, 4.00 |
| Total Depth (ft) | = 3.00 |
| Invert Elev (ft) | = 1.00 |
| Slope (%) | = 0.65 |
| N-Value | = 0.030 |

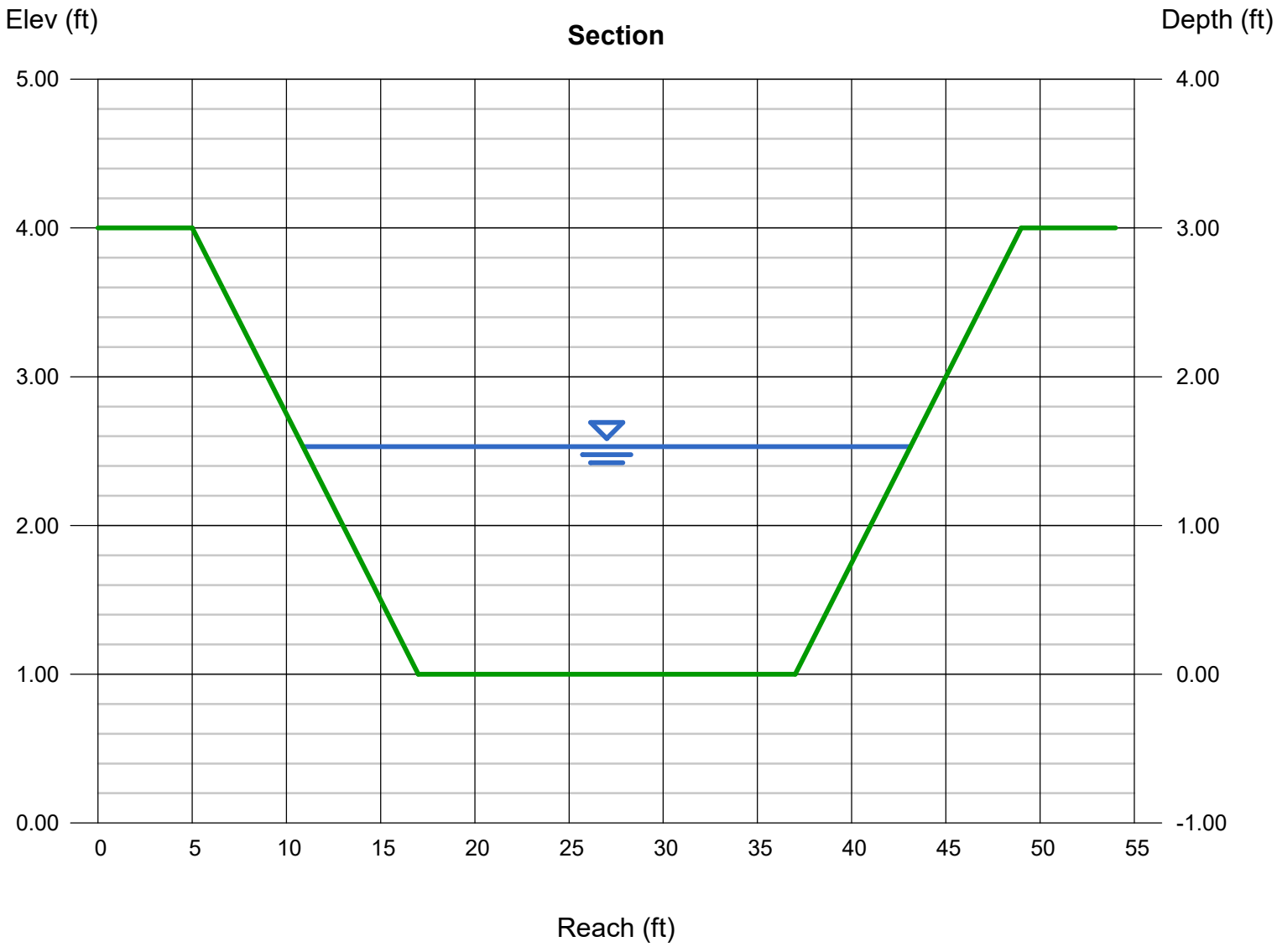
**Highlighted**

| | |
|---|---|
| Depth (ft) | = 1.53 |
| Q (cfs) | = 182.00 |
| Area (sqft) | = 39.96 |
| Velocity (ft/s) | = 4.55 |
| Wetted Perim (ft) | = 32.62 |
| Crit Depth, Yc (ft) | = 1.26 |
| Top Width (ft) | = 32.24 |
| EGL (ft) | = 1.85 |

**Calculations**

| | |
|---|---|
| Compute by: | Known Q |
| Known Q (cfs) | = 182.00 |

Flow doesn't match with summary table. Revise as needed



# Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Tuesday, Aug 25 2026

Flow exceeds max allowed of 5 ft/sec. Provide recommendations. (Actual recommendations/design can hold til FDR, just include a statement that design will be finalized at that stage)

## DITCH-01 - 100 YR CROSS SECTION

**Trapezoidal**

| | |
|---|---|
| Bottom Width (ft) | = 20.00 |
| Side Slopes (z:1) | = 4.00, 4.00 |
| Total Depth (ft) | = 3.00 |
| Invert Elev (ft) | = 1.00 |
| Slope (%) | = 0.65 |
| N-Value | = 0.030 |

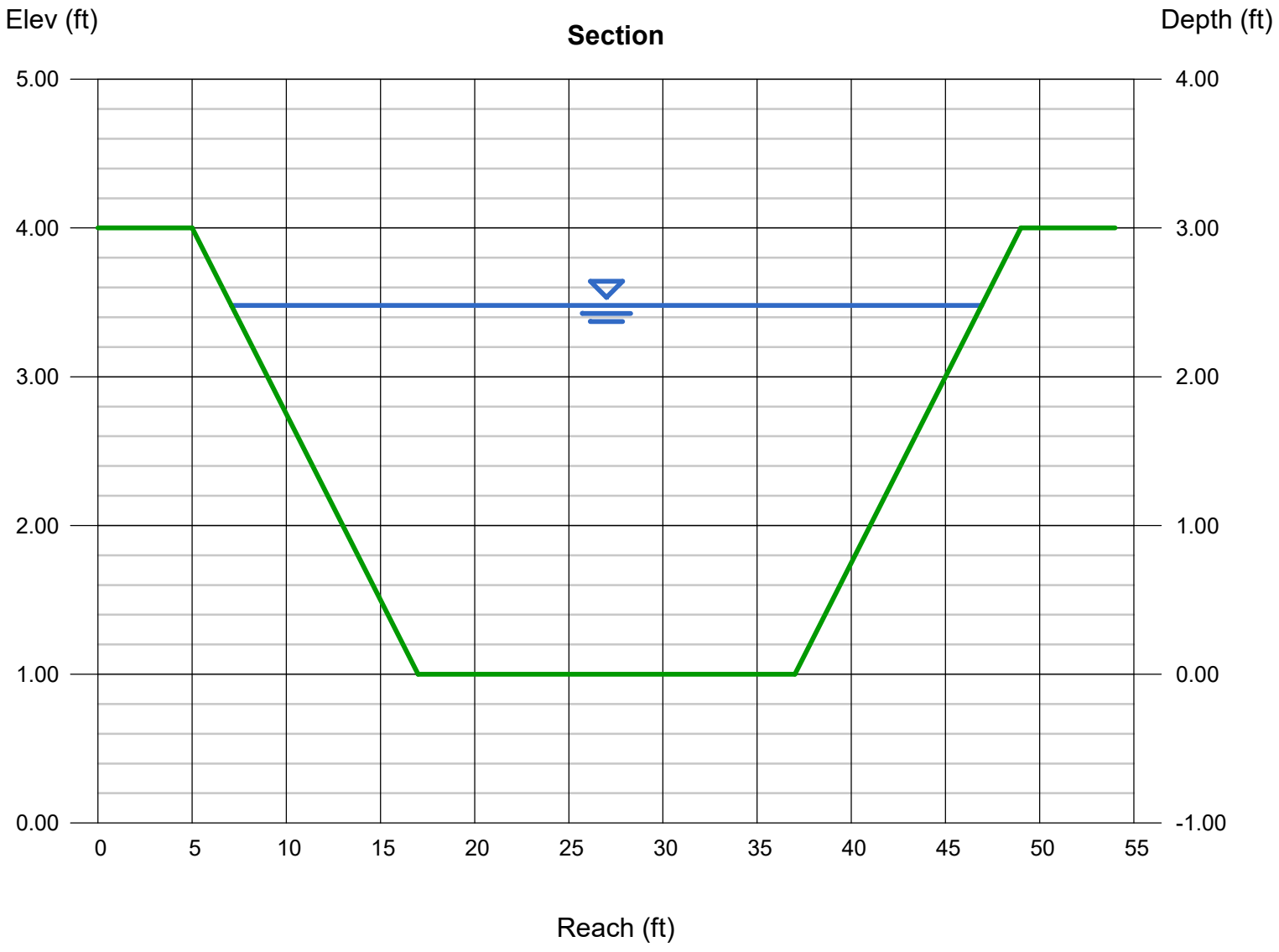
**Highlighted**

| | |
|---|---|
| Depth (ft) | = 2.48 |
| Q (cfs) | = 442.00 |
| Area (sqft) | = 74.20 |
| Velocity (ft/s) | = 5.96 |
| Wetted Perim (ft) | = 40.45 |
| Crit Depth, Yc (ft) | = 2.14 |
| Top Width (ft) | = 39.84 |
| EGL (ft) | = 3.03 |

**Calculations**

| | |
|---|---|
| Compute by: | Known Q |
| Known Q (cfs) | = 442.00 |

Flow doesn't match with summary table. Revise as needed



# Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Tuesday, Aug 25 2026

## DITCH-02 - 5 YR CROSS SECTION

**Trapezoidal**

| | |
|---|---|
| Bottom Width (ft) | = 10.00 |
| Side Slopes (z:1) | = 4.00, 4.00 |
| Total Depth (ft) | = 2.00 |
| Invert Elev (ft) | = 1.00 |
| Slope (%) | = 1.05 |
| N-Value | = 0.030 |

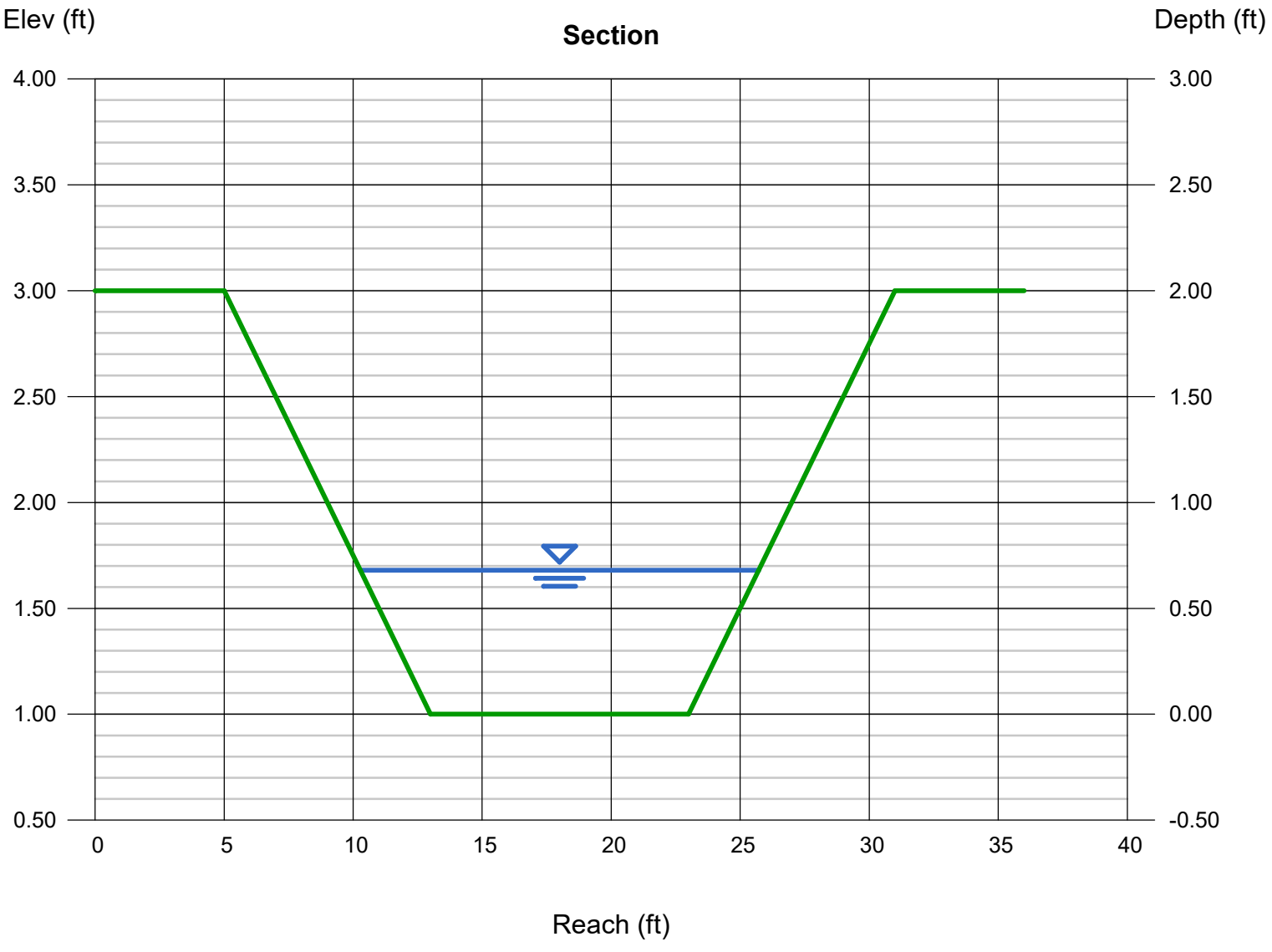
**Highlighted**

| | |
|---|---|
| Depth (ft) | = 0.68 |
| Q (cfs) | = 29.00 |
| Area (sqft) | = 8.65 |
| Velocity (ft/s) | = 3.35 |
| Wetted Perim (ft) | = 15.61 |
| Crit Depth, Yc (ft) | = 0.59 |
| Top Width (ft) | = 15.44 |
| EGL (ft) | = 0.85 |

**Calculations**

| | |
|---|---|
| Compute by: | Known Q |
| Known Q (cfs) | = 29.00 |

Flow doesn't match with summary table. Revise as needed



# Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Tuesday, Aug 25 2026

## DITCH-02 - 100 YR CROSS SECTION

**Trapezoidal**

| | |
|---|---|
| Bottom Width (ft) | = 10.00 |
| Side Slopes (z:1) | = 4.00, 4.00 |
| Total Depth (ft) | = 2.00 |
| Invert Elev (ft) | = 1.00 |
| Slope (%) | = 1.05 |
| N-Value | = 0.030 |

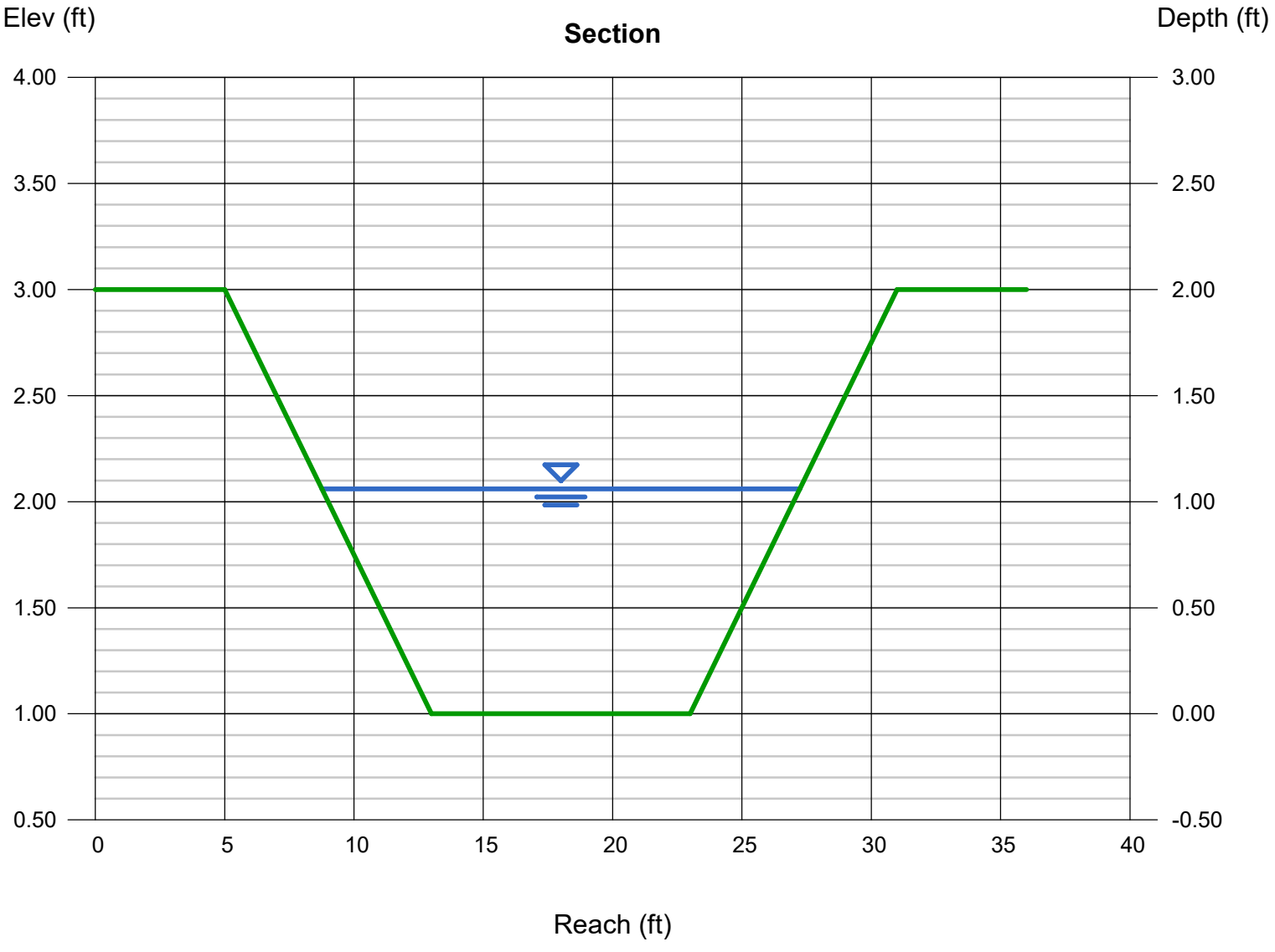
**Highlighted**

| | |
|---|---|
| Depth (ft) | = 1.06 |
| Q (cfs) | = 66.00 |
| Area (sqft) | = 15.09 |
| Velocity (ft/s) | = 4.37 |
| Wetted Perim (ft) | = 18.74 |
| Crit Depth, Yc (ft) | = 0.97 |
| Top Width (ft) | = 18.48 |
| EGL (ft) | = 1.36 |

**Calculations**

| | |
|---|---|
| Compute by: | Known Q |
| Known Q (cfs) | = 66.00 |

Flow doesn't match with summary table. Revise as needed



# Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Tuesday, Aug 25 2026

## DITCH-03 - 5 YR CROSS SECTION

**Trapezoidal**

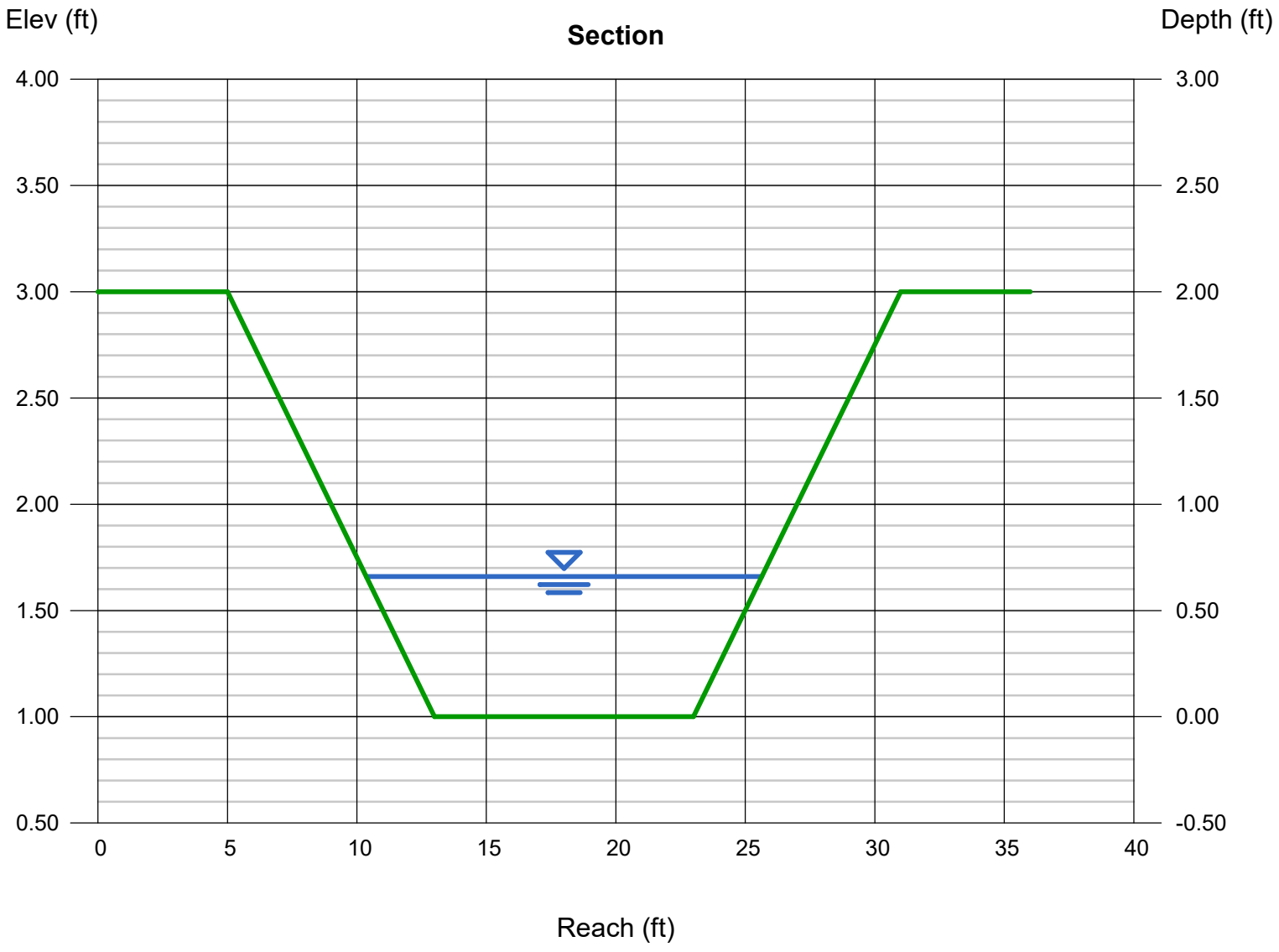
| | |
|---|---|
| Bottom Width (ft) | = 10.00 |
| Side Slopes (z:1) | = 4.00, 4.00 |
| Total Depth (ft) | = 2.00 |
| Invert Elev (ft) | = 1.00 |
| Slope (%) | = 2.44 |
| N-Value | = 0.030 |

**Calculations**

| | |
|---|---|
| Compute by: | Known Q |
| Known Q (cfs) | = 42.00 |

**Highlighted**

| | |
|---|---|
| Depth (ft) | = 0.66 |
| Q (cfs) | = 42.00 |
| Area (sqft) | = 8.34 |
| Velocity (ft/s) | = 5.03 |
| Wetted Perim (ft) | = 15.44 |
| Crit Depth, Yc (ft) | = 0.74 |
| Top Width (ft) | = 15.28 |
| EGL (ft) | = 1.05 |



# Channel Report

Flow exceeds max allowed of 5 ft/sec. Provide recommendations. (Actual recommendations/design can hold til FDR, just include a statement that design will be finalized at that stage)

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Tuesday, Aug 25 2026

## DITCH-03 - 100 YR CROSS SECTION

**Trapezoidal**

| | |
|---|---|
| Bottom Width (ft) | = 10.00 |
| Side Slopes (z:1) | = 4.00, 4.00 |
| Total Depth (ft) | = 2.00 |
| Invert Elev (ft) | = 1.00 |
| Slope (%) | = 2.44 |
| N-Value | = 0.030 |

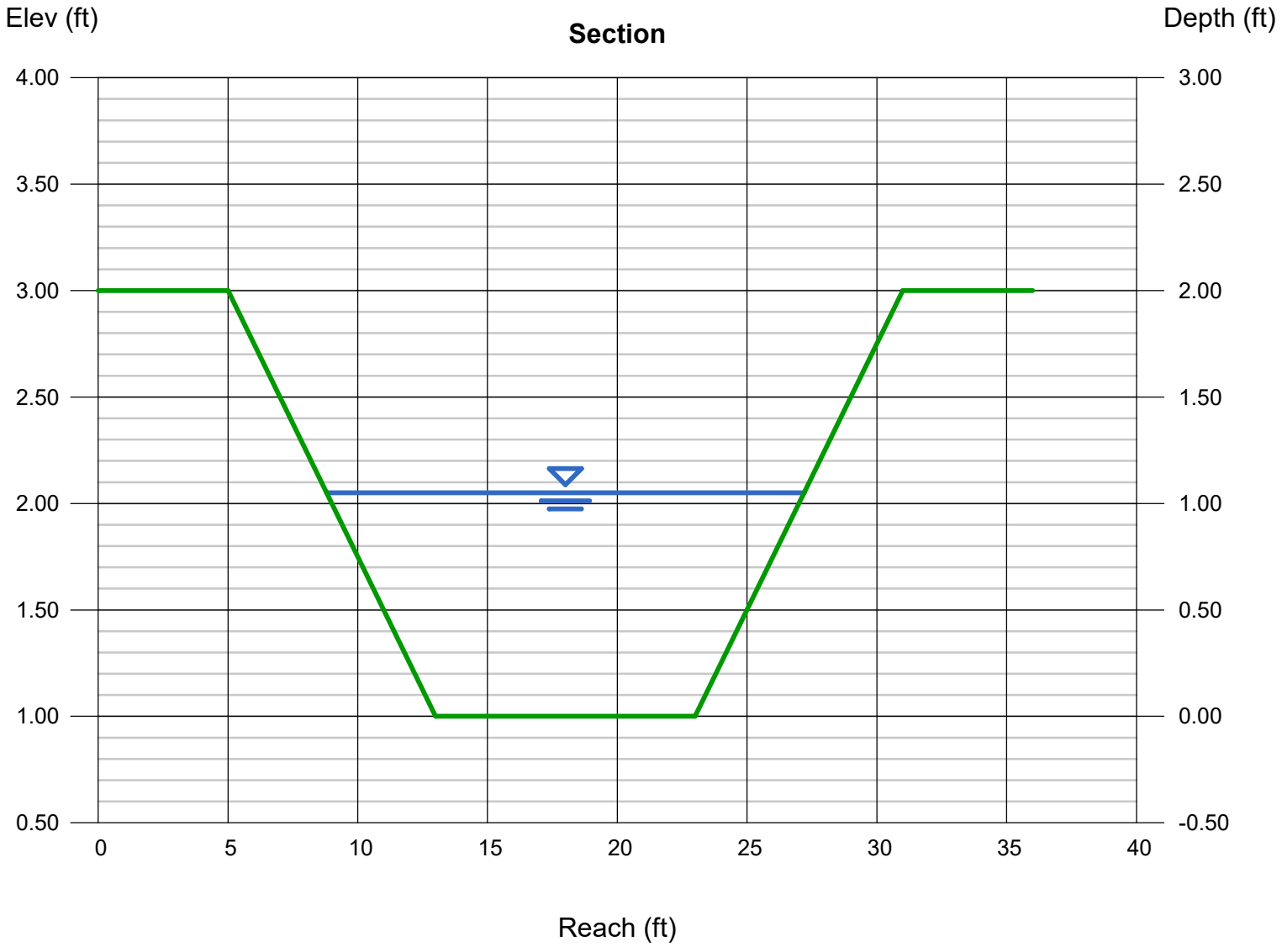
**Highlighted**

| | |
|---|---|
| Depth (ft) | = 1.05 |
| Q (cfs) | = 99.00 |
| Area (sqft) | = 14.91 |
| Velocity (ft/s) | = 6.64 |
| Wetted Perim (ft) | = 18.66 |
| Crit Depth, Yc (ft) | = 1.23 |
| Top Width (ft) | = 18.40 |
| EGL (ft) | = 1.74 |

**Calculations**

| | |
|---|---|
| Compute by: | Known Q |
| Known Q (cfs) | = 99.00 |

Flow doesn't match with summary table. Revise as needed



# APPENDIX G – WATER QUALITY AND DETENTION

Note:
For FDR, design calculations will need to be provided for all pond elements, such as trickle channel, sizing of riprap for spillway, forebays, etc.

Also, calculations will need to be provided for any culvert outlet protection.



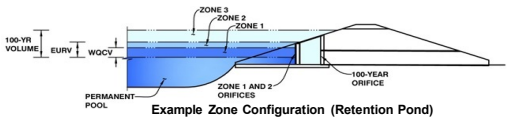
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# DETENTION BASIN STAGE-STORAGE TABLE BUILDER

*MHFD-Detention, Version 4.08 (April 2026)*

**Project:** Williams Creek Generating Station

**Basin ID:** Pond A




**Example Zone Configuration (Retention Pond)**

## Watershed Information

| | | |
|---|---|---|
| Selected SCM Type = | **EDB** | |
| Watershed Area = | 44.20 | acres |
| Watershed Length = | 2,035 | ft |
| Watershed Length to Centroid = | 1,000 | ft |
| Watershed Slope = | 0.022 | ft/ft |
| Watershed Imperviousness = | 77.00% | percent |
| Percentage Hydrologic Soil Group A = | 0.0% | percent |
| Percentage Hydrologic Soil Group B = | 0.0% | percent |
| Percentage Hydrologic Soil Groups C/D = | 100.0% | percent |
| Target WQCV Drain Time = | 40.0 | hours |
| Location for 1-hr Rainfall Depths = | User Input | |

After providing required inputs above including 1-hour rainfall depths, click 'Run CUHP' to generate runoff hydrographs using the embedded Colorado Urban Hydrograph Procedure.

| | | | Optional User Overrides | |
|---|---|---|---|---|
| Water Quality Capture Volume (WQCV) = | 1.144 | acre-feet | | acre-feet |
| Excess Urban Runoff Volume (EURV) = | 3.333 | acre-feet | | acre-feet |
| 2-yr Runoff Volume (P1 = 1.19 in.) = | 3.476 | acre-feet | 1.19 | inches |
| 5-yr Runoff Volume (P1 = 1.5 in.) = | 4.640 | acre-feet | 1.50 | inches |
| 10-yr Runoff Volume (P1 = 1.75 in.) = | 5.599 | acre-feet | 1.75 | inches |
| 25-yr Runoff Volume (P1 = 2 in.) = | 6.618 | acre-feet | 2.00 | inches |
| 50-yr Runoff Volume (P1 = 2.25 in.) = | 7.597 | acre-feet | 2.25 | inches |
| 100-yr Runoff Volume (P1 = 2.52 in.) = | 8.710 | acre-feet | 2.52 | inches |
| 500-yr Runoff Volume (P1 = 3.9 in.) = | 14.167 | acre-feet | 3.90 | inches |
| Approximate 2-yr Detention Volume = | 3.011 | acre-feet | | |
| Approximate 5-yr Detention Volume = | 4.129 | acre-feet | | |
| Approximate 10-yr Detention Volume = | 4.749 | acre-feet | | |
| Approximate 25-yr Detention Volume = | 5.037 | acre-feet | | |
| Approximate 50-yr Detention Volume = | 5.162 | acre-feet | | |
| Approximate 100-yr Detention Volume = | 5.490 | acre-feet | | |

## Define Zones and Basin Geometry

| | | |
|---|---|---|
| Zone 1 Volume (WQCV) = | 1.144 | acre-feet |
| Zone 2 Volume (EURV - Zone 1) = | 2.189 | acre-feet |
| Zone 3 (100yr + 1 / 2 WQCV - Zones 1 & 2) = | 2.728 | acre-feet |
| Total Detention Basin Volume = | 6.061 | acre-feet |
| Initial Surcharge Volume (ISV) = | user | $ft^3$ |
| Initial Surcharge Depth (ISD) = | user | ft |
| Total Available Detention Depth ($H_{total}$) = | user | ft |
| Depth of Trickle Channel ($H_{TC}$) = | user | ft |
| Slope of Trickle Channel ($S_{TC}$) = | user | ft/ft |
| Slopes of Main Basin Sides ($S_{main}$) = | user | H:V |
| Basin Length-to-Width Ratio ($R_{L/W}$) = | user | |

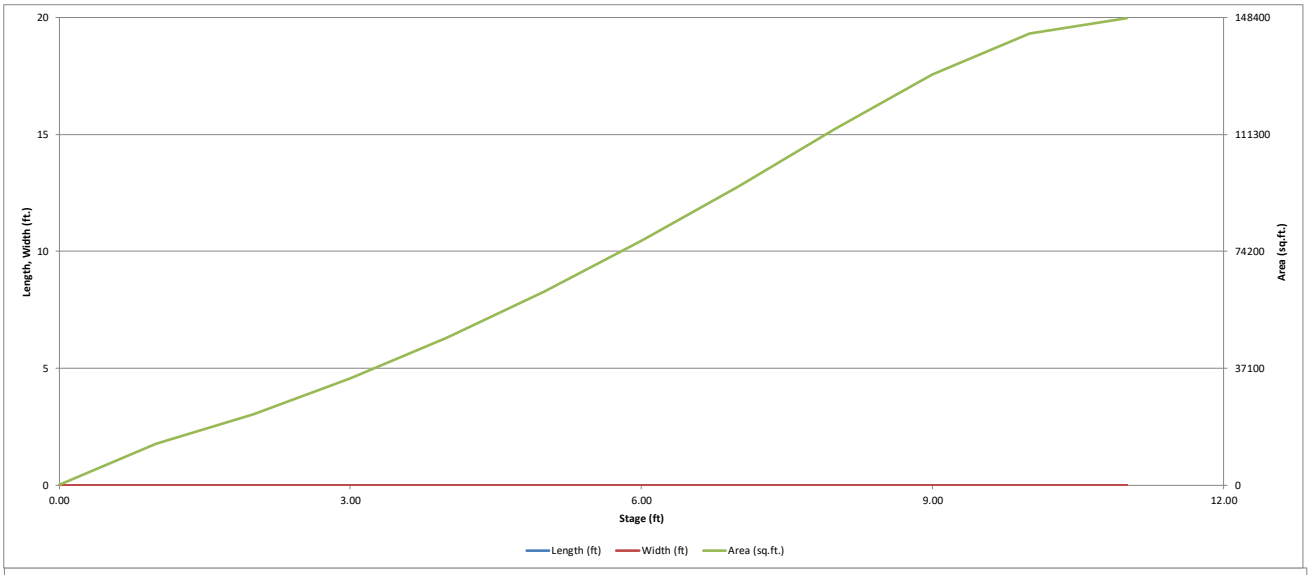
| | | |
|---|---|---|
| Initial Surcharge Area ($A_{ISV}$) = | user | $ft^2$ |
| Surcharge Volume Length ($L_{ISV}$) = | user | ft |
| Surcharge Volume Width ($W_{ISV}$) = | user | ft |
| Depth of Basin Floor ($H_{FLOOR}$) = | user | ft |
| Length of Basin Floor ($L_{FLOOR}$) = | user | ft |
| Width of Basin Floor ($W_{FLOOR}$) = | user | ft |
| Area of Basin Floor ($A_{FLOOR}$) = | user | $ft^2$ |
| Volume of Basin Floor ($V_{FLOOR}$) = | user | $ft^3$ |
| Depth of Main Basin ($H_{MAIN}$) = | user | ft |
| Length of Main Basin ($L_{MAIN}$) = | user | ft |
| Width of Main Basin ($W_{MAIN}$) = | user | ft |
| Area of Main Basin ($A_{MAIN}$) = | user | $ft^2$ |
| Volume of Main Basin ($V_{MAIN}$) = | user | $ft^3$ |
| Calculated Total Basin Volume ($V_{total}$) = | **user** | acre-feet |

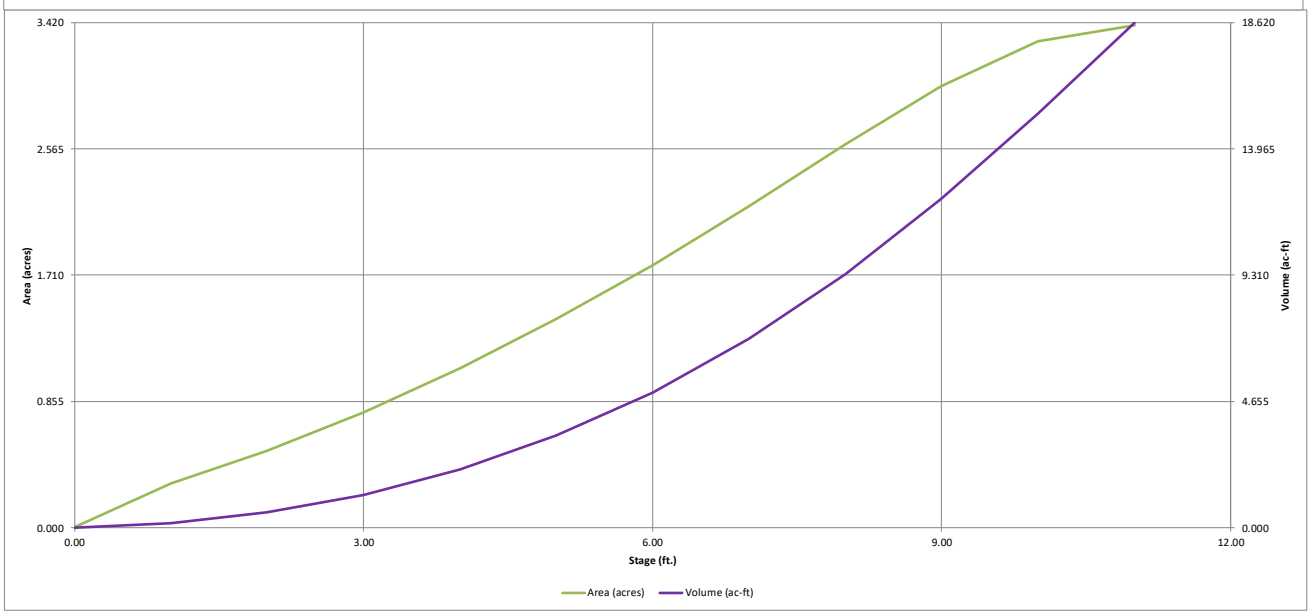
Depth Increment = ft

| Stage - Storage Description | Stage (ft) | Optional Override Stage (ft) | Length (ft) | Width (ft) | Area ($ft^2$) | Optional Override Area ($ft^2$) | Area (acre) | Volume ($ft^3$) | Volume (ac-ft) |
|---|---|---|---|---|---|---|---|---|---|
| **Top of Micropool** | -- | 0.00 | -- | -- | -- | 300 | 0.007 | | |
| **5421** | -- | 1.00 | -- | -- | -- | 13,044 | 0.299 | 6,672 | 0.153 |
| **5422** | -- | 2.00 | -- | -- | -- | 22,565 | 0.518 | 24,476 | 0.562 |
| **5423** | -- | 3.00 | -- | -- | -- | 33,934 | 0.779 | 52,726 | 1.210 |
| **5424** | -- | 4.00 | -- | -- | -- | 46,922 | 1.077 | 93,154 | 2.139 |
| **5425** | -- | 5.00 | -- | -- | -- | 61,435 | 1.410 | 147,332 | 3.382 |
| **5426** | -- | 6.00 | -- | -- | -- | 77,447 | 1.778 | 216,773 | 4.976 |
| **5427** | -- | 7.00 | -- | -- | -- | 94,723 | 2.175 | 302,858 | 6.953 |
| **5428** | -- | 8.00 | -- | -- | -- | 113,114 | 2.597 | 406,777 | 9.338 |
| **5429** | -- | 9.00 | -- | -- | -- | 130,230 | 2.990 | 528,449 | 12.132 |
| **5430** | -- | 10.00 | -- | -- | -- | 143,348 | 3.291 | 665,238 | 15.272 |
| **5431** | -- | 11.00 | -- | -- | -- | 148,268 | 3.404 | 811,046 | 18.619 |

# DETENTION BASIN STAGE-STORAGE TABLE BUILDER

*MHFD-Detention, Version 4.08 (April 2026)*



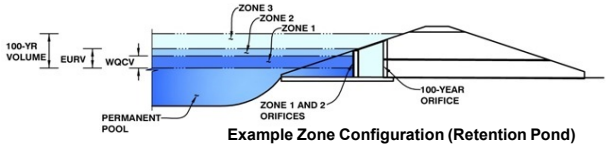



# DETENTION BASIN OUTLET STRUCTURE DESIGN

*MHFD-Detention, Version 4.08 (April 2026)*

**Project: Williams Creek Generating Station**

**Basin ID: Pond A**




**Example Zone Configuration (Retention Pond)**

| | Estimated Stage (ft) | Estimated Volume (ac-ft) | Outlet Type |
|---|---|---|---|
| Zone 1 (WQCV) | 2.92 | 1.144 | Orifice Plate |
| Zone 2 (EURV) | 4.97 | 2.189 | Orifice Plate |
| Z3 (100+1/2WQCV) | 6.58 | 2.728 | Weir&Pipe (Restrict) |
| Total (all zones) | | 6.061 | |

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

| | | | | | |
|---|---|---|---|---|---|
| Underdrain Orifice Invert Depth = | | ft (distance below the filtration media surface) | Underdrain Orifice Area = | | $ft^2$ |
| Underdrain Orifice Diameter = | | inches | Underdrain Orifice Centroid = | | feet |

Calculated Parameters for Underdrain

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

| | | | | | |
|---|---|---|---|---|---|
| Centroid of Lowest Orifice = | 0.00 | ft (relative to basin bottom at Stage = 0 ft) | Row = | 4.569E-02 | $ft^2$ |
| Depth at top of Zone using Orifice Plate = | 4.97 | ft (relative to basin bottom at Stage = 0 ft) | Width = | N/A | feet |
| Orifice Plate: Orifice Vertical Spacing = | 19.88 | inches | troid = | N/A | feet |
| Orifice Plate: Orifice Area per Row = | 6.58 | sq. inches (use rectangular openings) | Area = | N/A | $ft^2$ |

Calculated Parameters for Plate

Pond A summary sheet shows WQCV as rectangular holes 3" x 6.58" and did not seem to account for multiple rows. Verify dimensions of orifices and revise documents as needed. Or provide explanation how the 2 documents look at the outlets.

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

| | Row 1 (required) | Row 2 (optional) | Row 3 (optional) | | | tional) | Row 7 (optional) | Row 8 (optional) |
|---|---|---|---|---|---|---|---|---|
| Stage of Orifice Centroid (ft) | 0.00 | 1.70 | 3.40 | | | | | |
| Orifice Area (sq. inches) | 6.58 | 6.58 | 6.58 | | | | | |

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

User Input: Vertical Orifice (Circular or Rectangular)

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

Calculated Parameters for Vertical Orif

User Input: Overflow Weir (Dropbox with Flat or Sloped Grate and Outlet Pipe OR Rectangular/Trapezoidal Weir and No Outlet Pipe)

| | Zone 3 Weir | Not Selected | | | Zone 3 Weir | Not Selected |
|---|---|---|---|---|---|---|
| Overflow Weir Front Edge Height, Ho = | 4.97 | N/A | ft (relative to basin bottom at Stage = 0 ft) | Height of Grate Upper Edge, $H_t$ = | 4.97 | N/A |
| Overflow Weir Front Edge Length = | 7.00 | N/A | feet | Overflow Weir Slope Length = | 7.00 | N/A |
| Overflow Weir Grate Slope = | 0.00 | N/A | H:V | Grate Open Area / 100-yr Orifice Area = | 7.89 | N/A |
| Horiz. Length of Weir Sides = | 7.00 | N/A | feet | Overflow Grate Open Area w/o Debris = | 34.10 | N/A |
| Overflow Grate Type = | Type C Grate | N/A | | Overflow Grate Open Area w/ Debris = | 17.05 | N/A |
| Debris Clogging % = | 50% | N/A | % | | | |

Calculated Parameters for Overflow W

Pond A summary sheet shows length & width as 4 feet. Verify dimensions and revise documents as needed.

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

| | Zone 3 Restrictor | Not Selected | | | Zone 3 Restrictor | Not Selected |
|---|---|---|---|---|---|---|
| Depth to Invert of Outlet Pipe = | 2.00 | N/A | ft (distance be | t Orifice Area = | 4.32 | N/A |
| Outlet Pipe Diameter = | 30.00 | N/A | inches | Outlet Orifice Centroid = | 1.12 | N/A |
| Restrictor Plate Height Above Pipe Invert = | 24.70 | | inches | Half-Central Angle of Restrictor Plate on Pipe = | 2.27 | N/A |

ated Parameters for Outlet Pipe w/ Flow Restriction Pla

User Input: Emergency Spillway (Rectangular or Trapezoidal)

| | | | | | |
|---|---|---|---|---|---|
| Spillway Invert Stage= | 7.00 | ft (relative to basin bottom at Stage = 0 ft) | Spillway Design Flow Depth= | 0.96 | feet |
| Spillway Crest Length = | 52.00 | feet | Stage at Top of Freeboard = | 9.96 | feet |
| Spillway End Slopes = | 4.00 | H:V | Basin Area at Top of Freeboard = | 3.28 | acres |
| Freeboard above Max Water Surface = | 2.00 | feet | Basin Volume at Top of Freeboard = | 15.14 | acre-ft |

Calculated Parameters for Spillway

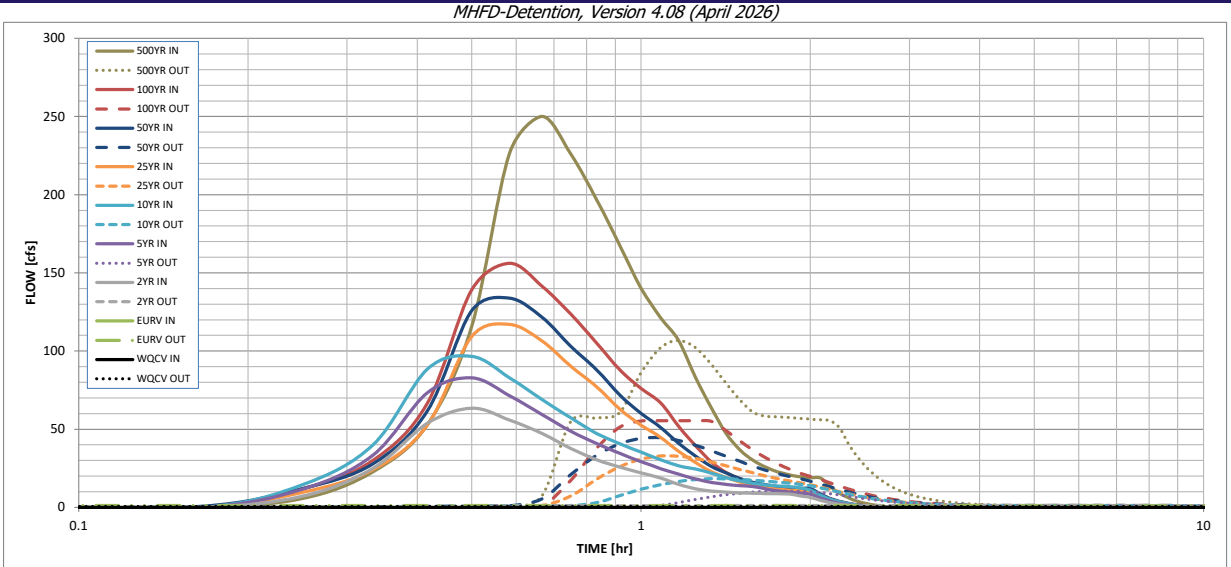
Routed Hydrograph Results

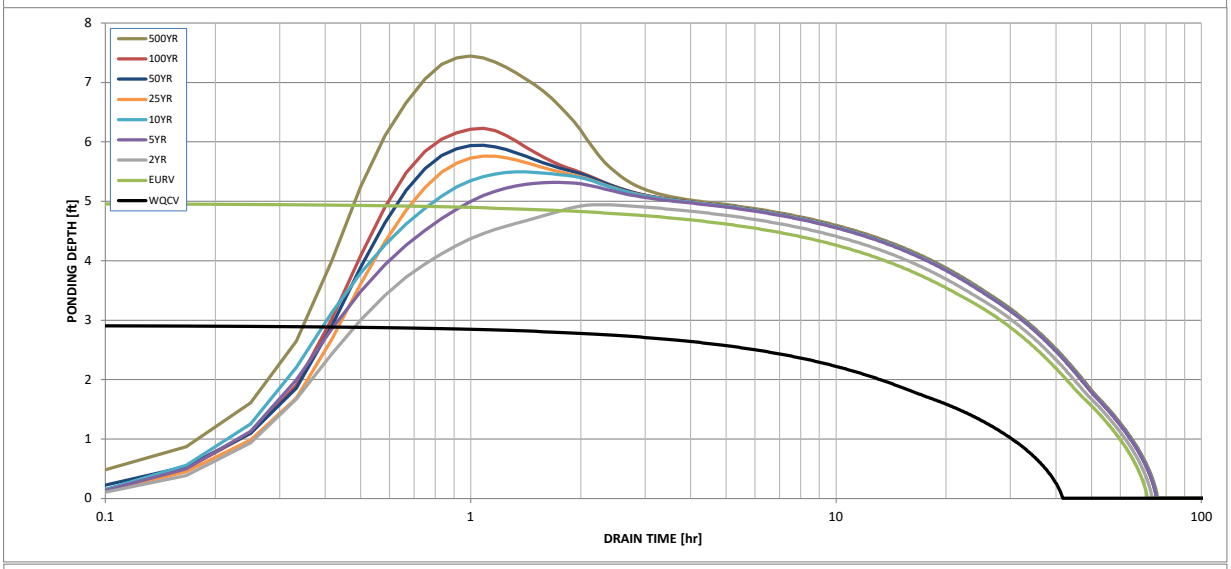
*The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AI*

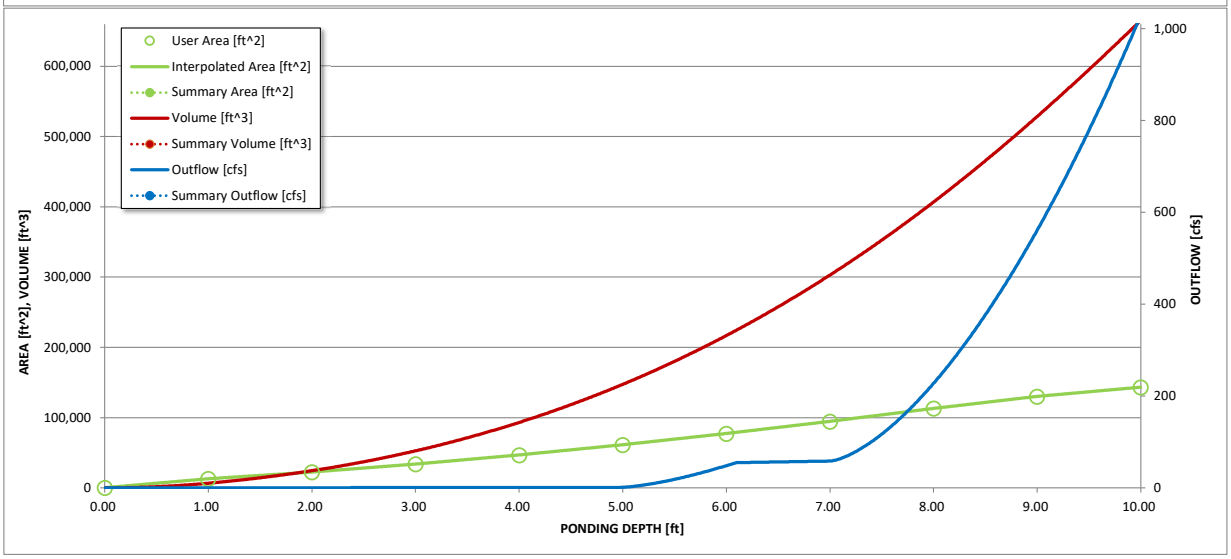
| Design Storm Return Period = | WQCV | EURV | 2 Year | 5 Year | 10 Year | 25 Year | 50 Year | 100 Year |
|---|---|---|---|---|---|---|---|---|
| One-Hour Rainfall Depth (in) = | N/A | N/A | 1.19 | 1.50 | 1.75 | 2.00 | 2.25 | 2.52 |
| CUHP Runoff Volume (acre-ft) = | 1.144 | 3.333 | 3.476 | 4.640 | 5.599 | 6.618 | 7.597 | 8.710 |
| Inflow Hydrograph Volume (acre-ft) = | N/A | N/A | 3.476 | 4.640 | 5.599 | 6.618 | 7.597 | 8.710 |
| CUHP Predevelopment Peak Q (cfs) = | N/A | N/A | 10.1 | 19.7 | 26.8 | 41.3 | 50.6 | 63.0 |
| OPTIONAL Override Predevelopment Peak Q (cfs) = | N/A | N/A | | | | | | |
| Predevelopment Unit Peak Flow, q (cfs/acre) = | N/A | N/A | 0.23 | 0.45 | 0.61 | 0.93 | 1.15 | 1.43 |
| Peak Inflow Q (cfs) = | N/A | N/A | 63.4 | 82.8 | 96.6 | 117.0 | 133.8 | 156.1 |
| Peak Outflow Q (cfs) = | 0.6 | 1.2 | 1.2 | 10.4 | 18.3 | 32.9 | 44.6 | 55.5 |
| Ratio Peak Outflow to Predevelopment Q = | N/A | N/A | N/A | 0.5 | 0.7 | 0.8 | 0.9 | 0.9 |
| Structure Controlling Flow = | Plate | Overflow Weir 1 | Plate | Overflow Weir 1 | Overflow Weir 1 | Overflow Weir 1 | Overflow Weir 1 | Outlet Plate 1 |
| Max Velocity through Grate 1 (fps) = | N/A | N/A | N/A | 0.3 | 0.5 | 0.9 | 1.3 | 1.6 |
| Max Velocity through Grate 2 (fps) = | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Time to Drain 97% of Inflow Volume (hours) = | 38 | 63 | 65 | 65 | 63 | 62 | 60 | 59 |
| Time to Drain 99% of Inflow Volume (hours) = | **40** | 68 | 70 | 71 | 70 | 69 | 69 | 68 |
| Maximum Ponding Depth (ft) = | 2.92 | 4.97 | 4.94 | 5.32 | 5.49 | 5.76 | 5.94 | 6.22 |
| Area at Maximum Ponding Depth (acres) = | 0.76 | 1.40 | 1.39 | 1.52 | 1.59 | 1.69 | 1.76 | 1.87 |
| Maximum Volume Stored (acre-ft) = | 1.149 | 3.340 | 3.284 | 3.837 | 4.117 | 4.543 | 4.870 | 5.377 |

# DETENTION BASIN OUTLET STRUCTURE DESIGN

*MHFD-Detention, Version 4.08 (April 2026)*



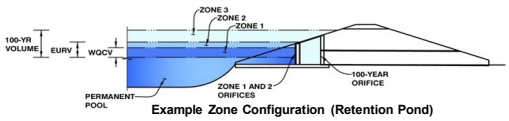

| S-A-V-D Chart Axis Override | X-axis | Left Y-Axis | Right Y-Axis |
|---|---|---|---|
| minimum bound | | | |
| maximum bound | | | |

# DETENTION BASIN STAGE-STORAGE TABLE BUILDER

*MHFD-Detention, Version 4.08 (April 2026)*

**Project:** Williams Creek Generating Station

**Basin ID:** Pond B




**Example Zone Configuration (Retention Pond)**

## Watershed Information

| | | |
|---|---|---|
| Selected SCM Type = | **EDB** | |
| Watershed Area = | 4.50 | acres |
| Watershed Length = | 445 | ft |
| Watershed Length to Centroid = | 200 | ft |
| Watershed Slope = | 0.033 | ft/ft |
| Watershed Imperviousness = | 90.00% | percent |
| Percentage Hydrologic Soil Group A = | 0.0% | percent |
| Percentage Hydrologic Soil Group B = | 0.0% | percent |
| Percentage Hydrologic Soil Groups C/D = | 100.0% | percent |
| Target WQCV Drain Time = | 40.0 | hours |
| Location for 1-hr Rainfall Depths = | User Input | |

After providing required inputs above including 1-hour rainfall depths, click 'Run CUHP' to generate runoff hydrographs using the embedded Colorado Urban Hydrograph Procedure.

| | | | Optional User Overrides | |
|---|---|---|---|---|
| Water Quality Capture Volume (WQCV) = | 0.151 | acre-feet | | acre-feet |
| Excess Urban Runoff Volume (EURV) = | 0.402 | acre-feet | | acre-feet |
| 2-yr Runoff Volume (P1 = 1.19 in.) = | 0.361 | acre-feet | 1.19 | inches |
| 5-yr Runoff Volume (P1 = 1.5 in.) = | 0.470 | acre-feet | 1.50 | inches |
| 10-yr Runoff Volume (P1 = 1.75 in.) = | 0.558 | acre-feet | 1.75 | inches |
| 25-yr Runoff Volume (P1 = 2 in.) = | 0.649 | acre-feet | 2.00 | inches |
| 50-yr Runoff Volume (P1 = 2.25 in.) = | 0.738 | acre-feet | 2.25 | inches |
| 100-yr Runoff Volume (P1 = 2.52 in.) = | 0.837 | acre-feet | 2.52 | inches |
| 500-yr Runoff Volume (P1 = 3.9 in.) = | 1.332 | acre-feet | 3.90 | inches |
| Approximate 2-yr Detention Volume = | 0.366 | acre-feet | | |
| Approximate 5-yr Detention Volume = | 0.488 | acre-feet | | |
| Approximate 10-yr Detention Volume = | 0.566 | acre-feet | | |
| Approximate 25-yr Detention Volume = | 0.598 | acre-feet | | |
| Approximate 50-yr Detention Volume = | 0.611 | acre-feet | | |
| Approximate 100-yr Detention Volume = | 0.633 | acre-feet | | |

## Define Zones and Basin Geometry

| | | |
|---|---|---|
| Zone 1 Volume (WQCV) = | 0.151 | acre-feet |
| Zone 2 Volume (EURV - Zone 1) = | 0.251 | acre-feet |
| Zone 3 (100yr + 1 / 2 WQCV - Zones 1 & 2) = | 0.307 | acre-feet |
| Total Detention Basin Volume = | 0.709 | acre-feet |
| Initial Surcharge Volume (ISV) = | user | $ft^3$ |
| Initial Surcharge Depth (ISD) = | user | ft |
| Total Available Detention Depth ($H_{total}$) = | user | ft |
| Depth of Trickle Channel ($H_{TC}$) = | user | ft |
| Slope of Trickle Channel ($S_{TC}$) = | user | ft/ft |
| Slopes of Main Basin Sides ($S_{main}$) = | user | H:V |
| Basin Length-to-Width Ratio ($R_{L/W}$) = | user | |

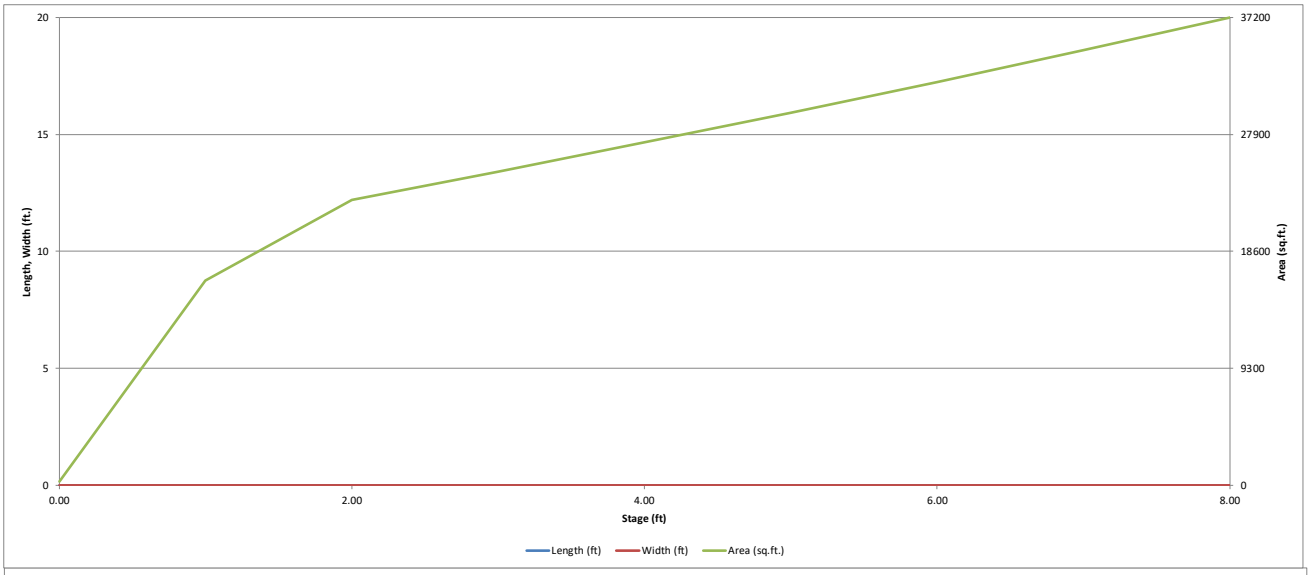
| | | |
|---|---|---|
| Initial Surcharge Area ($A_{ISV}$) = | user | $ft^2$ |
| Surcharge Volume Length ($L_{ISV}$) = | user | ft |
| Surcharge Volume Width ($W_{ISV}$) = | user | ft |
| Depth of Basin Floor ($H_{FLOOR}$) = | user | ft |
| Length of Basin Floor ($L_{FLOOR}$) = | user | ft |
| Width of Basin Floor ($W_{FLOOR}$) = | user | ft |
| Area of Basin Floor ($A_{FLOOR}$) = | user | $ft^2$ |
| Volume of Basin Floor ($V_{FLOOR}$) = | user | $ft^3$ |
| Depth of Main Basin ($H_{MAIN}$) = | user | ft |
| Length of Main Basin ($L_{MAIN}$) = | user | ft |
| Width of Main Basin ($W_{MAIN}$) = | user | ft |
| Area of Main Basin ($A_{MAIN}$) = | user | $ft^2$ |
| Volume of Main Basin ($V_{MAIN}$) = | user | $ft^3$ |
| Calculated Total Basin Volume ($V_{total}$) = | **user** | acre-feet |

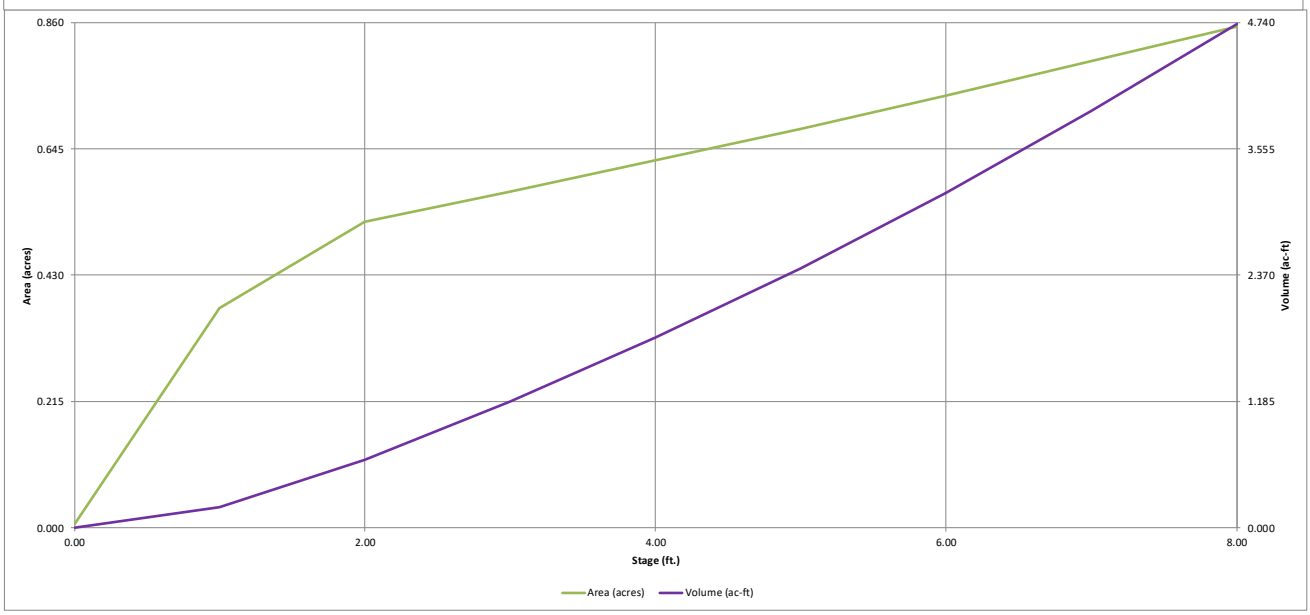
Depth Increment = ft

| Stage - Storage Description | Stage (ft) | Optional Override Stage (ft) | Length (ft) | Width (ft) | Area ($ft^2$) | Optional Override Area ($ft^2$) | Area (acre) | Volume ($ft^3$) | Volume (ac-ft) |
|---|---|---|---|---|---|---|---|---|---|
| **Top of Micropool** | -- | 0.00 | -- | -- | -- | 300 | 0.007 | | |
| **5427** | -- | 1.00 | -- | -- | -- | 16,257 | 0.373 | 8,278 | 0.190 |
| **5428** | -- | 2.00 | -- | -- | -- | 22,675 | 0.521 | 27,744 | 0.637 |
| **5429** | -- | 3.00 | -- | -- | -- | 24,922 | 0.572 | 51,543 | 1.183 |
| **5430** | -- | 4.00 | -- | -- | -- | 27,243 | 0.625 | 77,625 | 1.782 |
| **5431** | -- | 5.00 | -- | -- | -- | 29,585 | 0.679 | 106,039 | 2.434 |
| **5432** | -- | 6.00 | -- | -- | -- | 32,047 | 0.736 | 136,855 | 3.142 |
| **5433** | -- | 7.00 | -- | -- | -- | 34,583 | 0.794 | 170,170 | 3.907 |
| **5434** | -- | 8.00 | -- | -- | -- | 37,192 | 0.854 | 206,058 | 4.730 |

# DETENTION BASIN STAGE-STORAGE TABLE BUILDER

*MHFD-Detention, Version 4.08 (April 2026)*



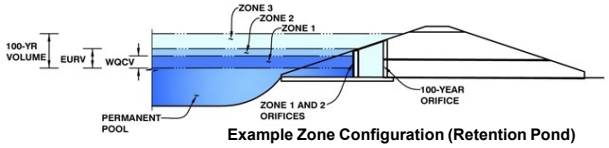



# DETENTION BASIN OUTLET STRUCTURE DESIGN

*MHFD-Detention, Version 4.08 (April 2026)*

**Project: Williams Creek Generating Station**

**Basin ID: Pond B**




**Example Zone Configuration (Retention Pond)**

| | Estimated Stage (ft) | Estimated Volume (ac-ft) | Outlet Type |
|---|---|---|---|
| Zone 1 (WQCV) | 0.89 | 0.151 | Orifice Plate |
| Zone 2 (EURV) | 1.52 | 0.251 | Orifice Plate |
| Z3 (100+1/2WQCV) | 2.14 | 0.307 | Weir&Pipe (Restrict) |
| Total (all zones) | | 0.709 | |

Pond B summary sheet shows WQCV as holes 6.16 sq in and did not seem to account for multiple rows. Verify dimensions of orifices and revise documents as needed. Or provide explanation how the 2 documents look at the outlets.

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

| | | | Calculated Parameters for Underdrain | |
|---|---|---|---|---|
| Underdrain Orifice Invert Depth = | N/A | ft (distance below the filtration media surface) | N/A | $ft^2$ |
| Underdrain Orifice Diameter = | N/A | inches | N/A | feet |

**User Input: Orifice Plate with one or more orifices or Elliptical Slot Weir (typically used to drain WQCV and/or EUR**

| | | | Calculated Parameters for Plate | |
|---|---|---|---|---|
| Centroid of Lowest Orifice = | 0.00 | ft (relative to basin bottom at Stage = 0 ft) | 1.069E-02 | $ft^2$ |
| Depth at top of Zone using Orifice Plate = | 1.52 | ft (relative to basin bottom at Stage = 0 ft) | N/A | feet |
| Orifice Plate: Orifice Vertical Spacing = | 6.08 | inches | N/A | feet |
| Orifice Plate: Orifice Area per Row = | 1.54 | sq. inches (diameter = 1-3/8 inches) | N/A | $ft^2$ |

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

| | Row 1 (required) | Row 2 (optional) | Row 3 (optional) | Row 4 (optional) | Row 5 (optional) | Row 6 (optional) | Row 7 (optional) | Row 8 (optional) |
|---|---|---|---|---|---|---|---|---|
| Stage of Orifice Centroid (ft) | 0.00 | 0.50 | 1.00 | 1.50 | | | | |
| Orifice Area (sq. inches) | 1.54 | 1.54 | 1.54 | 1.54 | | | | |

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

**User Input: Vertical Orifice (Circular or Rectangular)**

| | Not Selected | Not Selected | | | Calculated Parameters for Vertical Orif | |
|---|---|---|---|---|---|---|
| Invert of Vertical Orifice = | N/A | N/A | ft (relative to basin bottom at Stage = 0 ft) | Vertical Orifice Area = | N/A | N/A |
| Depth at top of Zone using Vertical Orifice = | N/A | N/A | ft (relative to basin bottom at Stage = 0 ft) | Vertical Orifice Centroid = | N/A | N/A |
| Vertical Orifice Diameter = | N/A | N/A | inches | | | |

**User Input: Overflow Weir (Dropbox with Flat or Sloped Grate and Outlet Pipe OR Rectangular/Trapezoidal Weir and No Outlet Pipe)**

| | Zone 3 Weir | Not Selected | | | Calculated Parameters for Overflow W | |
|---|---|---|---|---|---|---|
| Overflow Weir Front Edge Height, Ho = | 1.52 | N/A | ft (relative to basin bottom at Stage = 0 ft) | Height of Grate Upper Edge, $H_t$ = | 1.52 | N/A |
| Overflow Weir Front Edge Length = | 14.00 | N/A | feet | Overflow Weir Slope Length = | 14.00 | N/A |
| Overflow Weir Grate Slope = | 0.00 | N/A | H:V | Grate Open Area / 100-yr Orifice Area = | 142.32 | N/A |
| Horiz. Length of Weir Sides = | 14.00 | N/A | feet | Overflow Grate Open Area w/o Debris = | 136.42 | N/A |
| Overflow Grate Type = | Type C Grate | N/A | | w/ Debris = | 68.21 | N/A |
| Debris Clogging % = | 50% | N/A | % | | | |

Pond B summary sheet shows length & width as 4 feet. Verify dimensions and revise documents as needed.

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

| | Zone 3 Restrictor | Not Selected | | | d Parameters for Outlet Pipe w/ Flow Restriction Pla | |
|---|---|---|---|---|---|---|
| Depth to Invert of Outlet Pipe = | 2.00 | N/A | ft (distance below basin bottom at Stage = 0 ft) | Outlet Orifice Area = | 0.96 | N/A |
| Outlet Pipe Diameter = | 18.00 | N/A | inches | Outlet Orifice Centroid = | 0.46 | N/A |
| Restrictor Plate Height Above Pipe Invert = | 9.60 | | inches | Half-Central Angle of Restrictor Plate on Pipe = | 1.64 | N/A |

**User Input: Emergency Spillway (Rectangular or Trapezoidal)**

| | | | | Calculated Parameters for Spillway | |
|---|---|---|---|---|---|
| Spillway Invert Stage= | 5.00 | ft (relative to basin bottom at Stage = 0 ft) | Spillway Design Flow Depth= | 0.79 | feet |
| Spillway Crest Length = | 7.00 | feet | Stage at Top of Freeboard = | 7.79 | feet |
| Spillway End Slopes = | 4.00 | H:V | Basin Area at Top of Freeboard = | 0.84 | acres |
| Freeboard above Max Water Surface = | 2.00 | feet | Basin Volume at Top of Freeboard = | 4.55 | acre-ft |

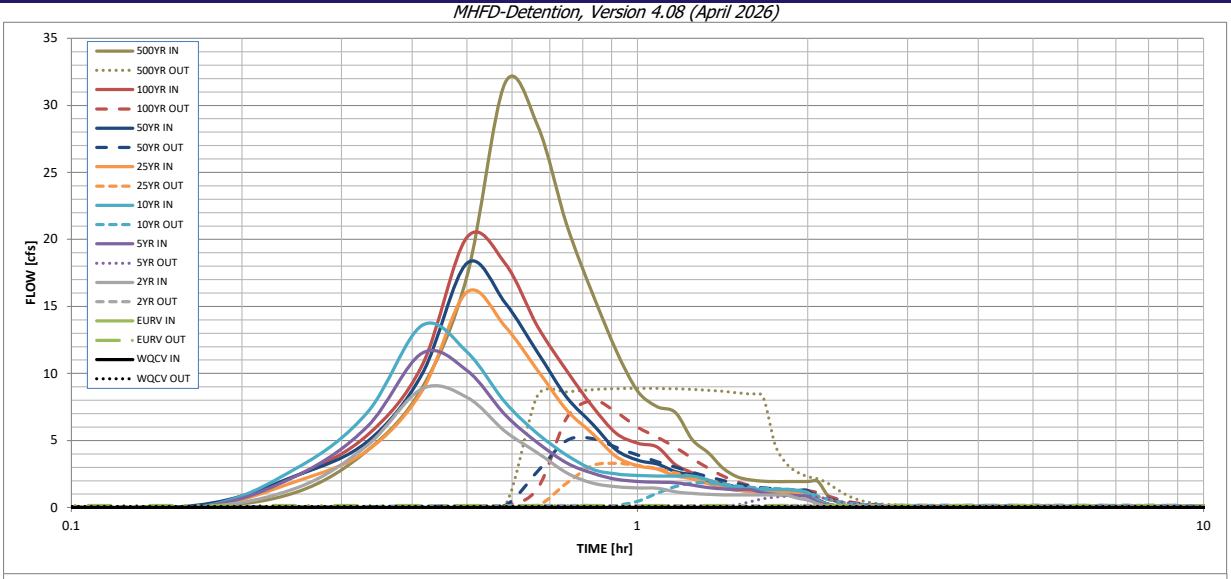
**Routed Hydrograph Results**

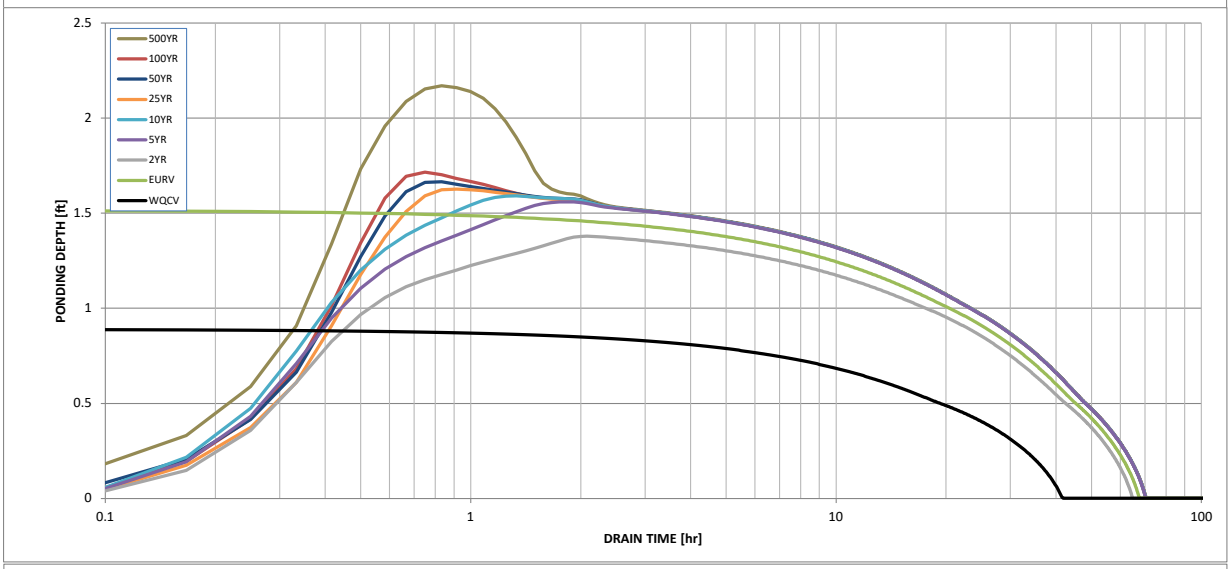
*The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AI*

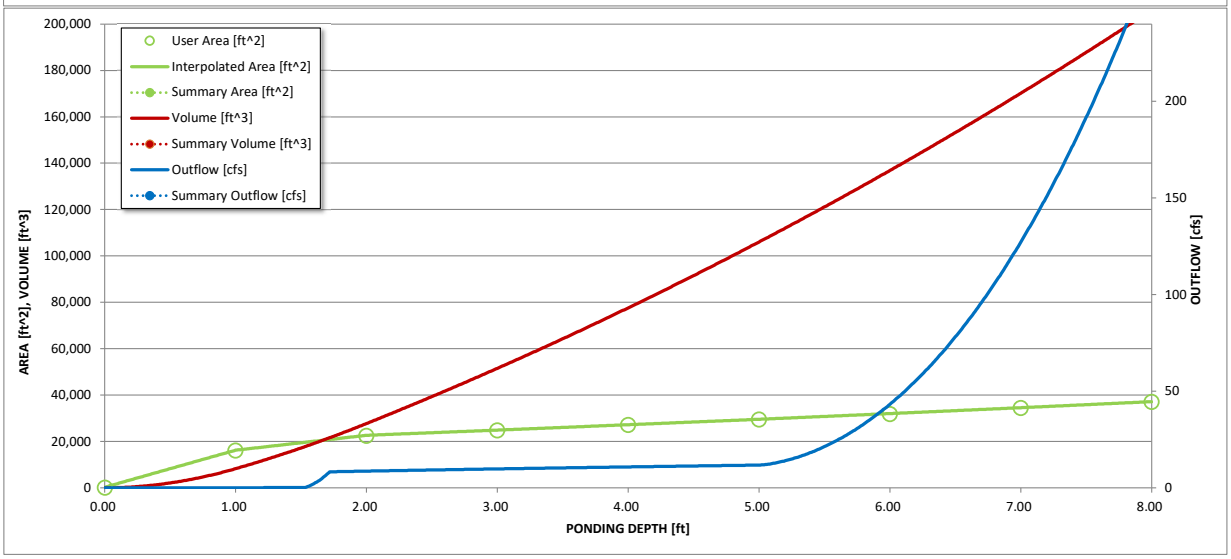
| Design Storm Return Period = | WQCV | EURV | 2 Year | 5 Year | 10 Year | 25 Year | 50 Year | 100 Year |
|---|---|---|---|---|---|---|---|---|
| One-Hour Rainfall Depth (in) = | N/A | N/A | 1.19 | 1.50 | 1.75 | 2.00 | 2.25 | 2.52 |
| CUHP Runoff Volume (acre-ft) = | 0.151 | 0.402 | 0.361 | 0.470 | 0.558 | 0.649 | 0.738 | 0.837 |
| Inflow Hydrograph Volume (acre-ft) = | N/A | N/A | 0.361 | 0.470 | 0.558 | 0.649 | 0.738 | 0.837 |
| CUHP Predevelopment Peak Q (cfs) = | N/A | N/A | 1.5 | 3.0 | 4.1 | 6.1 | 7.4 | 9.0 |
| OPTIONAL Override Predevelopment Peak Q (cfs) = | N/A | N/A | | | | | | |
| Predevelopment Unit Peak Flow, q (cfs/acre) = | N/A | N/A | 0.34 | 0.67 | 0.92 | 1.35 | 1.64 | 2.01 |
| Peak Inflow Q (cfs) = | N/A | N/A | 8.9 | 11.5 | 13.6 | 16.1 | 18.2 | 20.2 |
| Peak Outflow Q (cfs) = | 0.1 | 0.2 | 0.1 | 0.9 | 1.8 | 3.3 | 5.1 | 8.0 |
| Ratio Peak Outflow to Predevelopment Q = | N/A | N/A | N/A | 0.3 | 0.4 | 0.5 | 0.7 | 0.9 |
| Structure Controlling Flow = | Plate | Overflow Weir 1 | Plate | Overflow Weir 1 | Overflow Weir 1 | Overflow Weir 1 | Overflow Weir 1 | Outlet Plate 1 |
| Max Velocity through Grate 1 (fps) = | N/A | N/A | N/A | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 |
| Max Velocity through Grate 2 (fps) = | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Time to Drain 97% of Inflow Volume (hours) = | 38 | 60 | 57 | 62 | 60 | 59 | 58 | 57 |
| Time to Drain 99% of Inflow Volume (hours) = | **40** | 64 | 62 | 66 | 66 | 65 | 65 | 64 |
| Maximum Ponding Depth (ft) = | 0.89 | 1.52 | 1.38 | 1.56 | 1.59 | 1.63 | 1.66 | 1.72 |
| Area at Maximum Ponding Depth (acres) = | 0.33 | 0.45 | 0.43 | 0.45 | 0.46 | 0.46 | 0.47 | 0.48 |
| Maximum Volume Stored (acre-ft) = | 0.151 | 0.404 | 0.338 | 0.418 | 0.431 | 0.450 | 0.468 | 0.492 |

# DETENTION BASIN OUTLET STRUCTURE DESIGN

*MHFD-Detention, Version 4.08 (April 2026)*




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

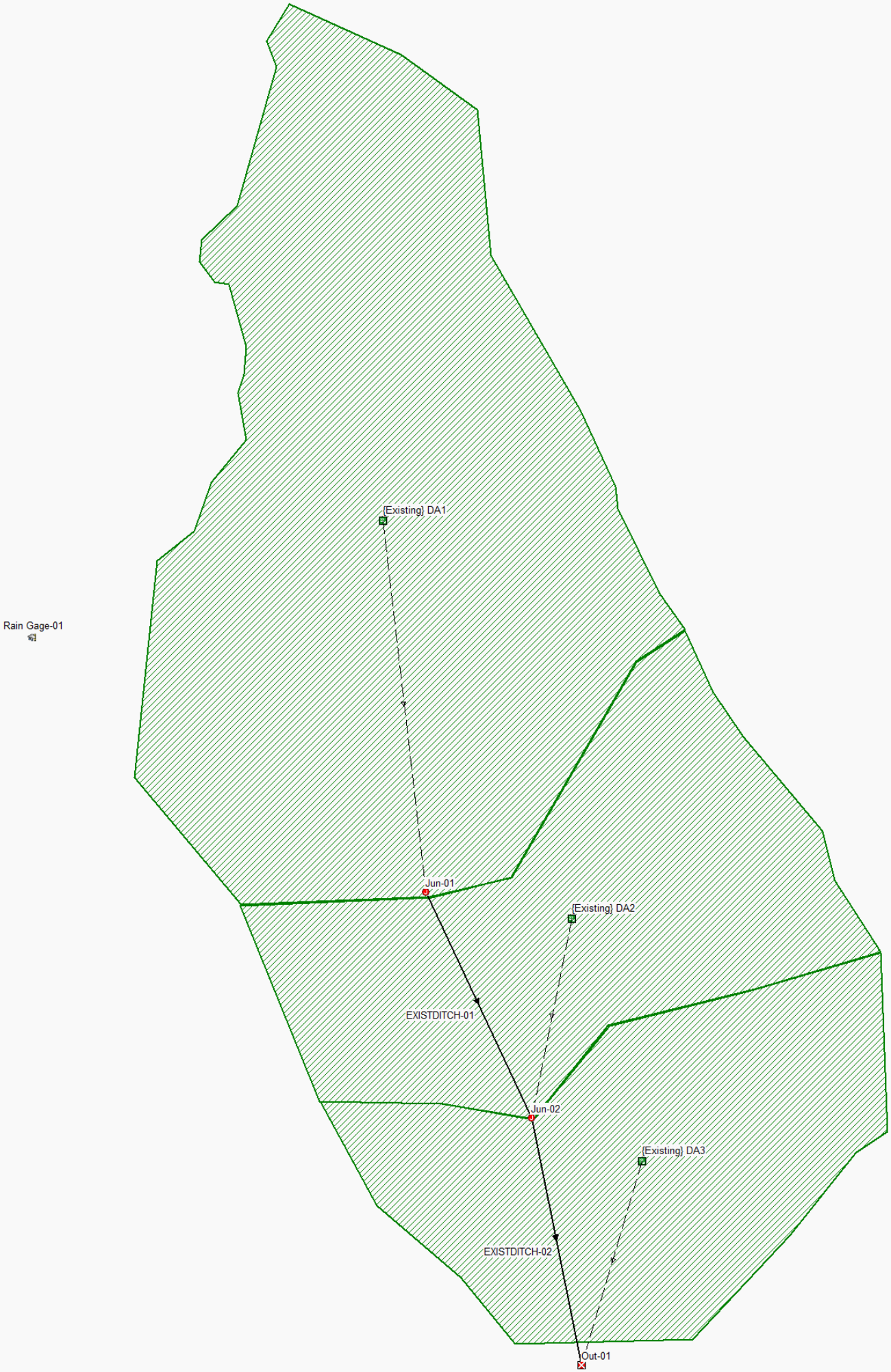
# APPENDIX H – STORM AND SANITARY ANALYSIS KEY PLAN

Delete

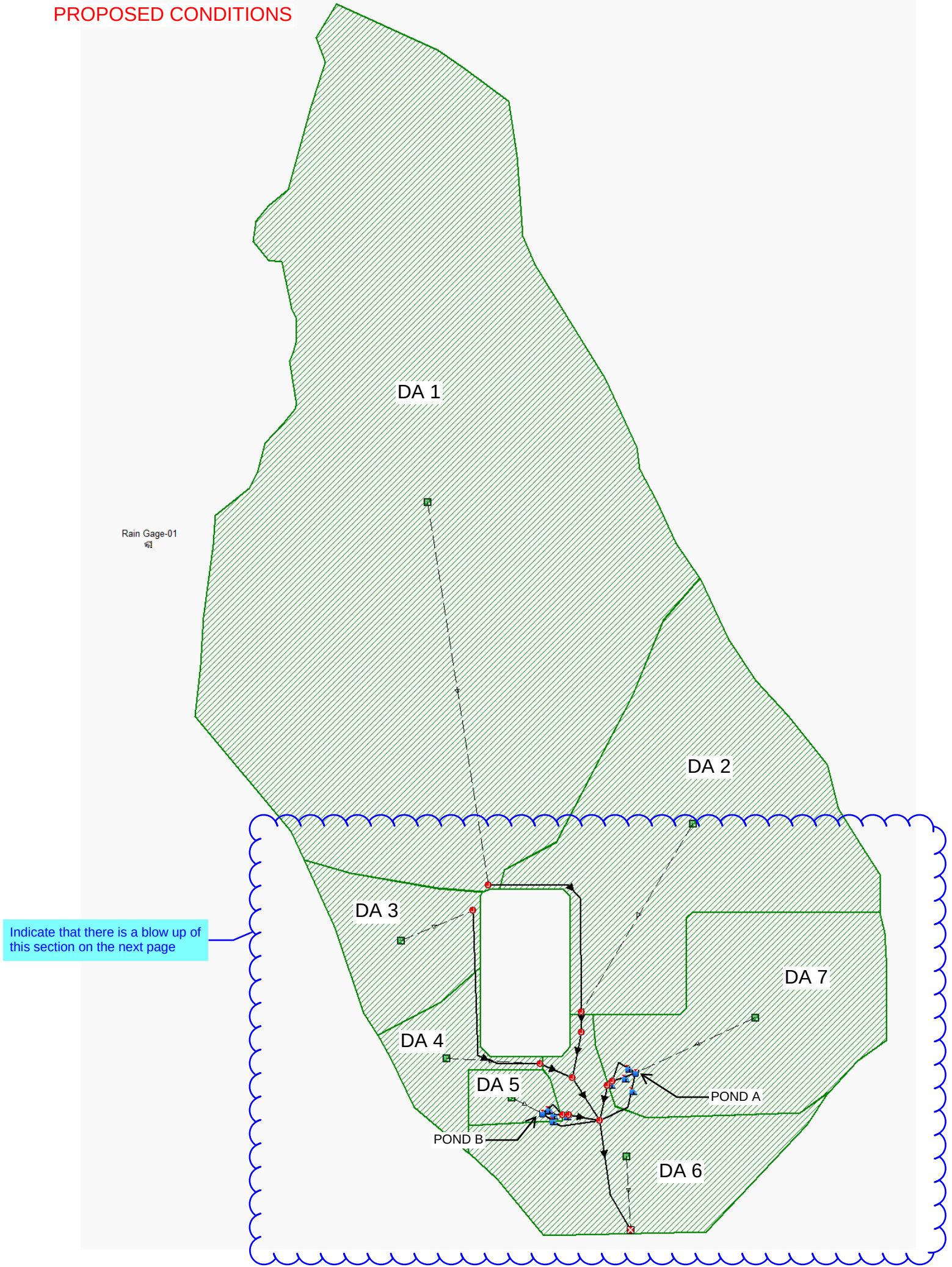


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# EXISTING CONDITIONS

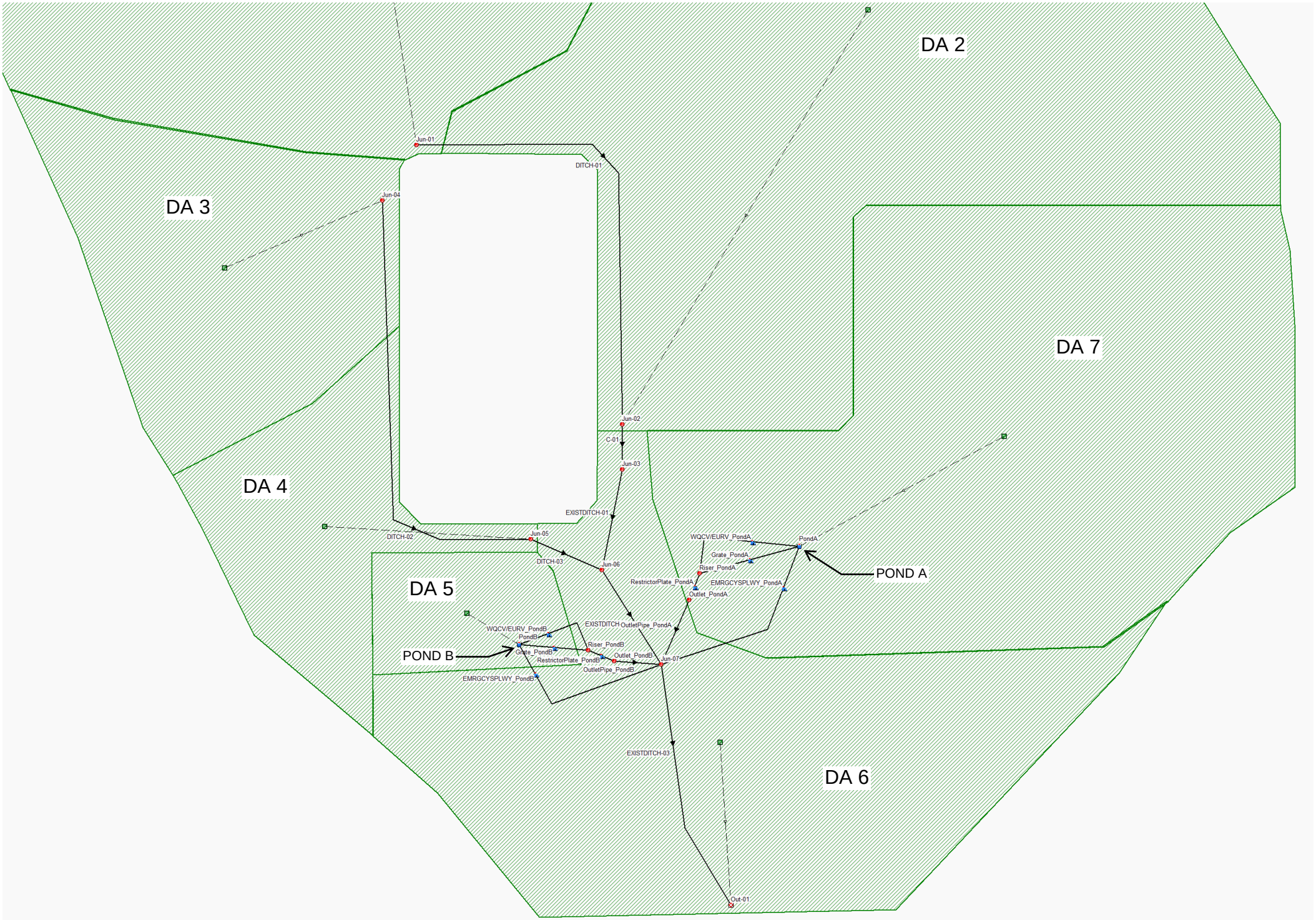


PROPOSED CONDITIONS




Indicate that there is a blow up of this section on the next page

PROPOSED CONDITIONS



# APPENDIX I – STORM AND SANITARY ANALYSIS CALCULATIONS

Delete



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## Project Description

| | |
|---|---|
| File Name | Existing Conditions.SPF |
| Description | |
| | Existing Conditions 5-yr Storm |

## Project Options

| | |
|---|---|
| Flow Units | CFS |
| Elevation Type | Elevation |
| Hydrology Method | SCS TR-55 |
| Time of Concentration (TOC) Method | SCS TR-55 |
| Link Routing Method | Hydrodynamic |
| Enable Overflow Ponding at Nodes | YES |
| Skip Steady State Analysis Time Periods | NO |

## Analysis Options

| | | |
|---|---|---|
| Start Analysis On | 00:00:00 | 0:00:00 |
| End Analysis On | 00:00:00 | 0:00:00 |
| Start Reporting On | 00:00:00 | 0:00:00 |
| 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 | 1 |
| Subbasins | 3 |
| Nodes | 3 |
| *Junctions* | 2 |
| *Outfalls* | 1 |
| *Flow Diversions* | 0 |
| *Inlets* | 0 |
| *Storage Nodes* | 0 |
| Links | 2 |
| *Channels* | 2 |
| *Pipes* | 0 |
| *Pumps* | 0 |
| *Orifices* | 0 |
| *Weirs* | 0 |
| *Outlets* | 0 |
| Pollutants | 0 |
| Land Uses | 0 |

## Rainfall Details

| SN | Rain Gage ID | Data Source | Data Source ID | Rainfall Type | Rain Units | State | County | Return Period (years) | Rainfall Depth (inches) | Rainfall Distribution |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Rain Gage-01 | Time Series | 5-yr | Cumulative | inches | Colorado | El Paso | 5.00 | 2.70 | SCS Type II 24-hr |

## Subbasin Summary

For each table/summary please add if it's existing or proposed and 5 or 100 year scenario in title

| SN | Subbasin ID | Area (ac) | Peak Rate Factor | Weighted Curve Number | Total Rainfall (in) | Total Runoff (in) | Total Runoff Volume (ac-in) | Peak Runoff (cfs) | Time of Concentration (days hh:mm:ss) |
|---|---|---|---|---|---|---|---|---|---|
| 1 | {Existing} DA1 | 266.90 | 484.00 | 82.22 | 2.70 | 1.16 | 309.87 | 185.43 | 0 00:51:56 |
| 2 | {Existing} DA2 | 101.90 | 484.00 | 83.47 | 2.70 | 1.24 | 126.25 | 110.89 | 0 00:29:41 |
| 3 | {Existing} DA3 | 98.50 | 484.00 | 83.24 | 2.70 | 1.22 | 120.56 | 106.82 | 0 00:29:15 |

## Node Summary

| SN | Element ID | Element Type | Invert Elevation (ft) | Ground/Rim (Max) Elevation (ft) | Initial Water Elevation (ft) | Surcharge Elevation (ft) | Ponded Area ($ft^2$) | Peak Inflow (cfs) | Max HGL Elevation Attained (ft) | Max Surcharge Depth Attained (ft) | Min Freeboard Attained (ft) | Time of Peak Flooding Occurrence (days hh:mm) | Total Flooded Volume (ac-in) | Total Time Flooded (min) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1-Jun | Junction | 5437.80 | 6.00 | 0.00 | 0.00 | 0.00 | 185.25 | 5438.52 | 0.00 | 4.28 | 0 00:00 | 0.00 | 0.00 |
| 2 | 2-Jun | Junction | 5424.00 | 6.00 | 0.00 | 0.00 | 0.00 | 257.70 | 5424.95 | 0.00 | 4.05 | 0 00:00 | 0.00 | 0.00 |
| 3 | Out-01 | Outfall | 5409.00 | | | | | 319.56 | 5409.94 | | | | | |

## Link Summary

| SN | Element ID | Element Type | From (Inlet) Node | To (Outlet) Node | Length | Inlet Invert Elevation | Outlet Invert Elevation | Average Slope | Diameter or Height | Manning's Roughness | Peak Flow | Design Flow Capacity | Peak Flow/ Design Flow Ratio | Peak Flow Velocity | Peak Flow Depth | Peak Flow Depth/ Total Depth Ratio | Total Time Surcharged | Reported Condition |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | (ft) | (ft) | (ft) | (%) | (in) | | (cfs) | (cfs) | | (ft/sec) | (ft) | | (min) | |
| 1 | EXISTDITCH-01 | Channel | 1-Jun | 2-Jun | 1241.00 | 5437.80 | 5424.00 | 1.1100 | 60.000 | 0.0400 | 183.59 | 5037.56 | 0.04 | 2.65 | 0.83 | 0.17 | 0.00 | |
| 2 | EXISTDITCH-02 | Channel | 2-Jun | Out-01 | 1796.00 | 5424.00 | 5409.00 | 0.8400 | 60.000 | 0.0400 | 248.73 | 4365.75 | 0.06 | 3.15 | 0.94 | 0.19 | 0.00 | |

# Subbasin Hydrology

## Subbasin : {Existing} DA1

### Input Data

| | |
|---|---|
| Area (ac) | 266.9 |
| Peak Rate Factor | 484 |
| Weighted Curve Number | 82.22 |
| Rain Gage ID | Rain Gage-01 |

### Composite Curve Number

| 32 | Area | Soil | Curve |
|---|---|---|---|
| Soil/Surface Description | (acres) | Group | Number |
| Pasture, grassland, or range, Fair | 95.02 | C | 79 |
| Pasture, grassland, or range, Fair | 171.88 | D | 84 |
| Composite Area & Weighted CN | 266.9 | | 82.22 |

### Time of Concentration

TOC Method : SCS TR-55

Sheet Flow Equation :

Tc = (0.007 * ((n * Lf)^0.8)) / ((P^0.5) * (Sf^0.4))

Where :

Tc = Time of Concentration (hr)
n = Manning's roughness
Lf = Flow Length (ft)
P = 2 yr, 24 hr Rainfall (inches)
Sf = Slope (ft/ft)

Shallow Concentrated Flow Equation :

V = 16.1345 * (Sf^0.5) (unpaved surface)
V = 20.3282 * (Sf^0.5) (paved surface)
V = 15.0 * (Sf^0.5) (grassed waterway surface)
V = 10.0 * (Sf^0.5) (nearly bare & untilled surface)
V = 9.0 * (Sf^0.5) (cultivated straight rows surface)
V = 7.0 * (Sf^0.5) (short grass pasture surface)
V = 5.0 * (Sf^0.5) (woodland surface)
V = 2.5 * (Sf^0.5) (forest w/heavy litter surface)
Tc = (Lf / V) / (3600 sec/hr)

Where:

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)

Channel Flow Equation :

V = (1.49 * (R^(2/3)) * (Sf^0.5)) / n
R = Aq / Wp
Tc = (Lf / V) / (3600 sec/hr)

Where :

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
R = Hydraulic Radius (ft)
Aq = Flow Area ($ft^2$)
Wp = Wetted Perimeter (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)
n = Manning's roughness

| Sheet Flow Computations | Subarea A | Subarea B | Subarea C |
|---|---|---|---|
| Manning's Roughness : | 0.13 | 0 | 0 |
| Flow Length (ft) : | 100 | 0 | 0 |
| Slope (%) : | 1.51 | 0 | 0 |
| 2 yr, 24 hr Rainfall (in) : | 2.1 | 0 | 0 |
| Velocity (ft/sec) : | 0.14 | 0 | 0 |
| Computed Flow Time (min) : | 12.07 | 0 | 0 |

| Shallow Concentrated Flow Computations | Subarea A | Subarea B | Subarea C |
|---|---|---|---|
| Flow Length (ft) : | 5861 | 0 | 0 |
| Slope (%) : | 2.3 | 0 | 0 |
| Surface Type : | Unpaved | Unpaved | Unpaved |
| Velocity (ft/sec) : | 2.45 | 0 | 0 |
| Computed Flow Time (min) : | 39.87 | 0 | 0 |

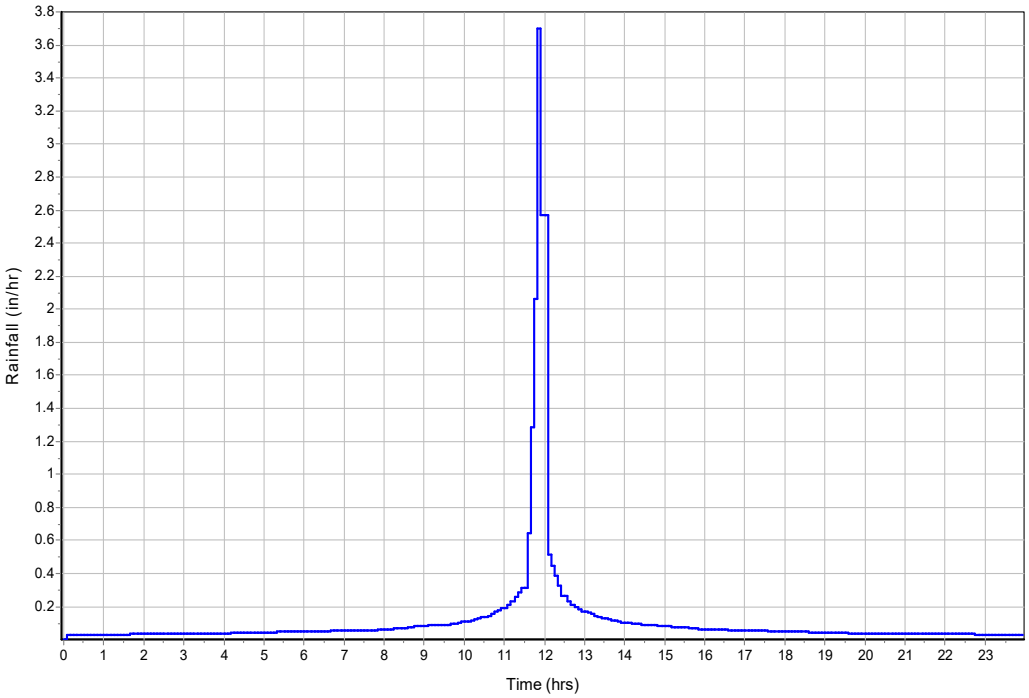
Total TOC (min) .....51.94

**Subbasin Runoff Results**

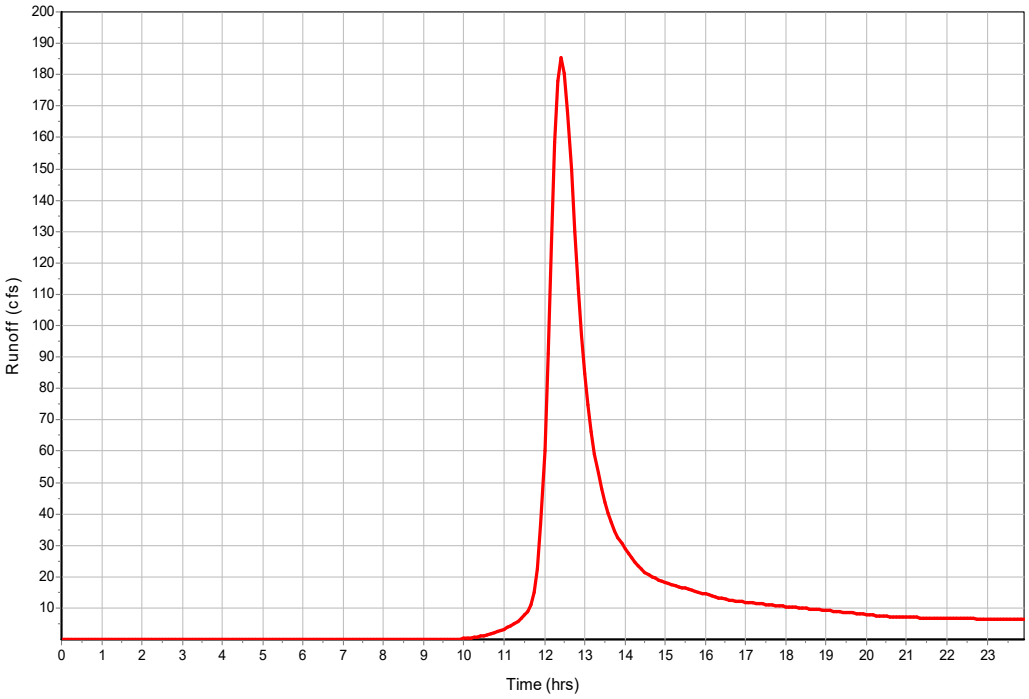
| | |
|---|---|
| Total Rainfall (in) | 2.7 |
| Total Runoff (in) | 1.16 |
| Peak Runoff (cfs) | 185.43 |
| Weighted Curve Number | 82.22 |
| Time of Concentration (days hh:mm:ss) | 0 00:51:56 |

**Subbasin : {Existing} DA1**

**Rainfall Intensity Graph**




**Runoff Hydrograph**



## Subbasin : {Existing} DA2

### Input Data

| | |
|---|---|
| Area (ac) | 101.9 |
| Peak Rate Factor | 484 |
| Weighted Curve Number | 83.47 |
| Rain Gage ID | Rain Gage-01 |

### Composite Curve Number

| 32 | Area | Soil | Curve |
|---|---|---|---|
| Soil/Surface Description | (acres) | Group | Number |
| Pasture, grassland, or range, Fair | 10.9 | C | 79 |
| Pasture, grassland, or range, Fair | 91 | D | 84 |
| Composite Area & Weighted CN | 101.9 | | 83.47 |

### Time of Concentration

| | Subarea | Subarea | Subarea |
|---|---|---|---|
| Sheet Flow Computations | A | B | C |
| Manning's Roughness : | 0.13 | 0 | 0 |
| Flow Length (ft) : | 100 | 0 | 0 |
| Slope (%) : | 2.84 | 0 | 0 |
| 2 yr, 24 hr Rainfall (in) : | 2.1 | 0 | 0 |
| Velocity (ft/sec) : | 0.18 | 0 | 0 |
| Computed Flow Time (min) : | 9.37 | 0 | 0 |

| | Subarea | Subarea | Subarea |
|---|---|---|---|
| Shallow Concentrated Flow Computations | A | B | C |
| Flow Length (ft) : | 1836 | 1298 | 0 |
| Slope (%) : | 4.14 | 1.49 | 0 |
| Surface Type : | Unpaved | Unpaved | Unpaved |
| Velocity (ft/sec) : | 3.28 | 1.97 | 0 |
| Computed Flow Time (min) : | 9.33 | 10.98 | 0 |

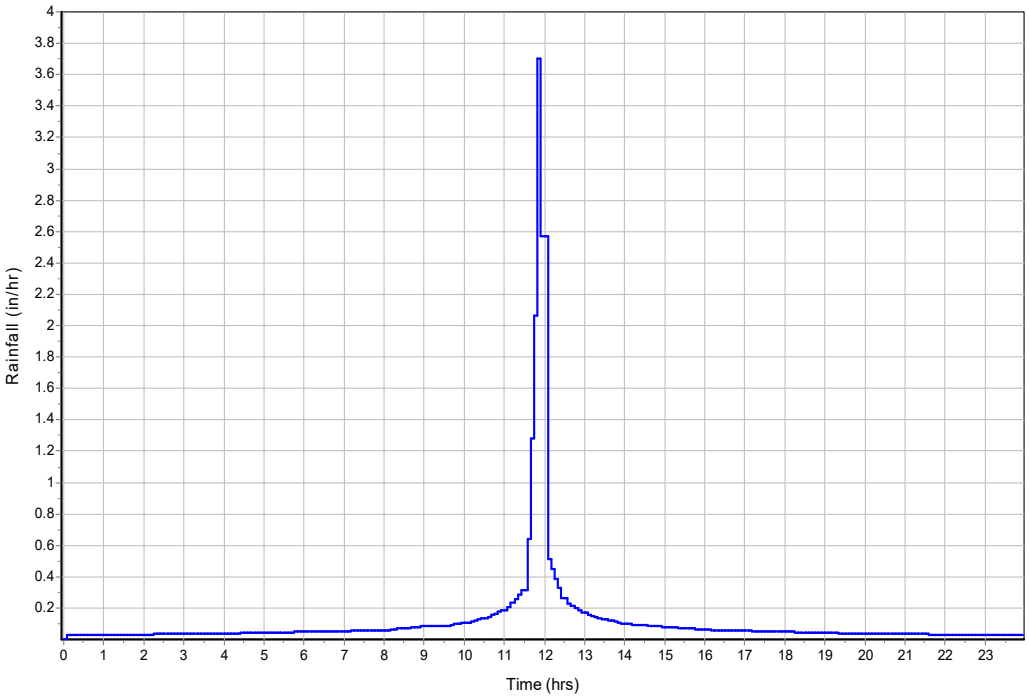
Total TOC (min) .....29.69

### Subbasin Runoff Results

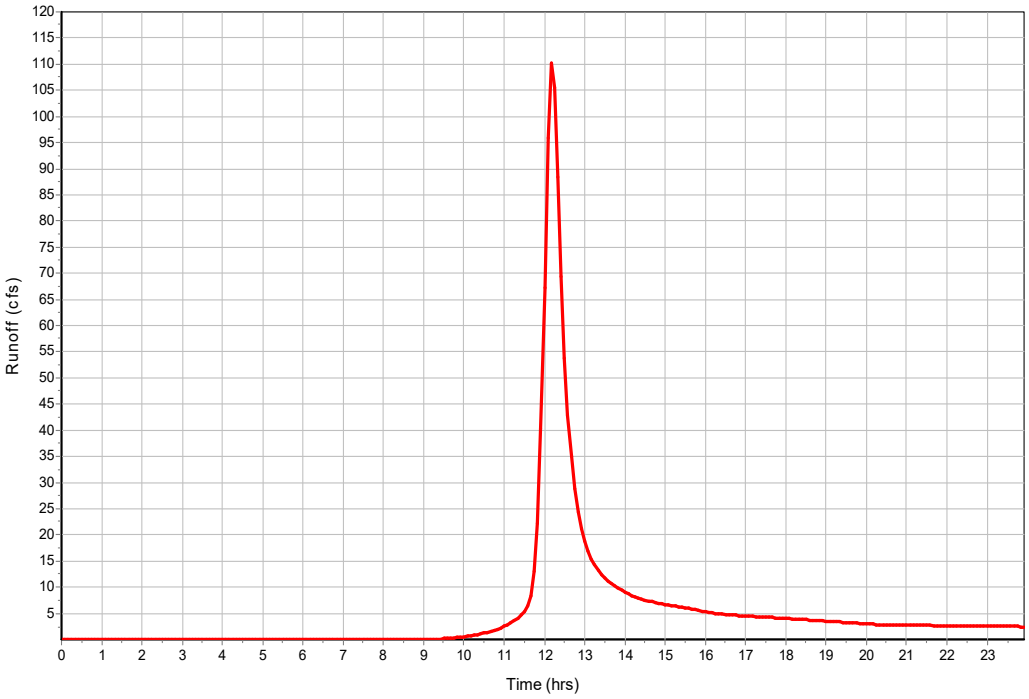
| | |
|---|---|
| Total Rainfall (in) | 2.7 |
| Total Runoff (in) | 1.24 |
| Peak Runoff (cfs) | 110.89 |
| Weighted Curve Number | 83.47 |
| Time of Concentration (days hh:mm:ss) | 0 00:29:41 |

**Subbasin : {Existing} DA2**

**Rainfall Intensity Graph**




**Runoff Hydrograph**



## Subbasin : {Existing} DA3

### Input Data

| | |
|---|---|
| Area (ac) | 98.5 |
| Peak Rate Factor | 484 |
| Weighted Curve Number | 83.24 |
| Rain Gage ID | Rain Gage-01 |

### Composite Curve Number

| 32 | Area | Soil | Curve |
|---|---|---|---|
| Soil/Surface Description | (acres) | Group | Number |
| Pasture, grassland, or range, Fair | 15.07 | C | 79 |
| Pasture, grassland, or range, Fair | 83.43 | D | 84 |
| Composite Area & Weighted CN | 98.5 | | 83.24 |

### Time of Concentration

| | Subarea | Subarea | Subarea |
|---|---|---|---|
| Sheet Flow Computations | A | B | C |
| Manning's Roughness : | 0.13 | 0 | 0 |
| Flow Length (ft) : | 100 | 0 | 0 |
| Slope (%) : | 1.91 | 0 | 0 |
| 2 yr, 24 hr Rainfall (in) : | 2.1 | 0 | 0 |
| Velocity (ft/sec) : | 0.15 | 0 | 0 |
| Computed Flow Time (min) : | 10.99 | 0 | 0 |

| | Subarea | Subarea | Subarea |
|---|---|---|---|
| Shallow Concentrated Flow Computations | A | B | C |
| Flow Length (ft) : | 2316 | 583 | 0 |
| Slope (%) : | 3.26 | 1.44 | 0 |
| Surface Type : | Unpaved | Unpaved | Unpaved |
| Velocity (ft/sec) : | 2.91 | 1.94 | 0 |
| Computed Flow Time (min) : | 13.26 | 5.01 | 0 |

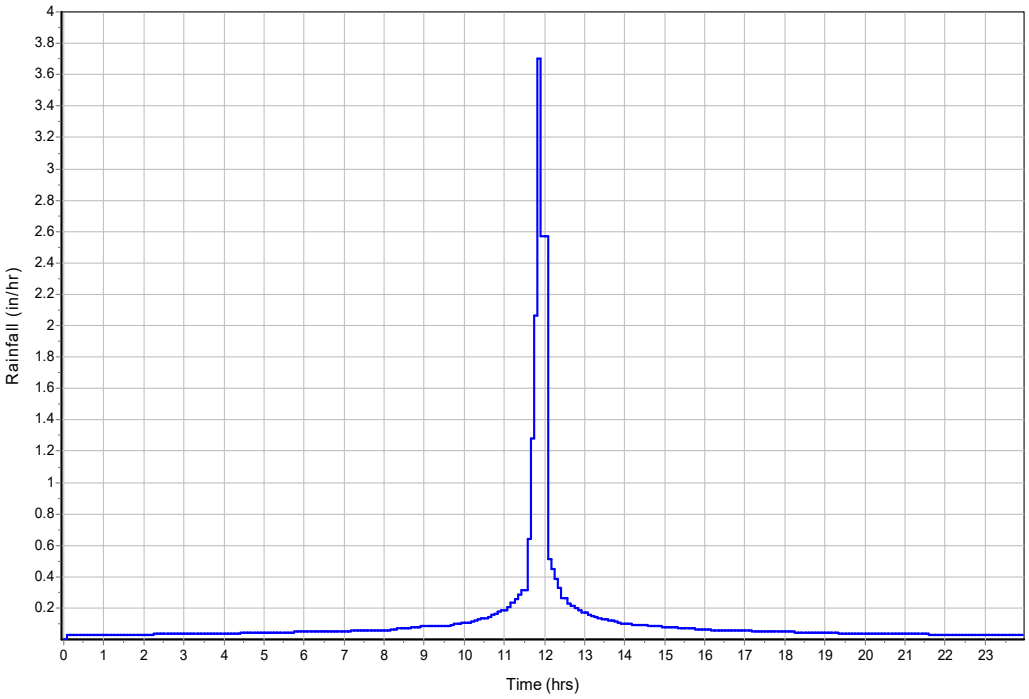
Total TOC (min) .....29.26

### Subbasin Runoff Results

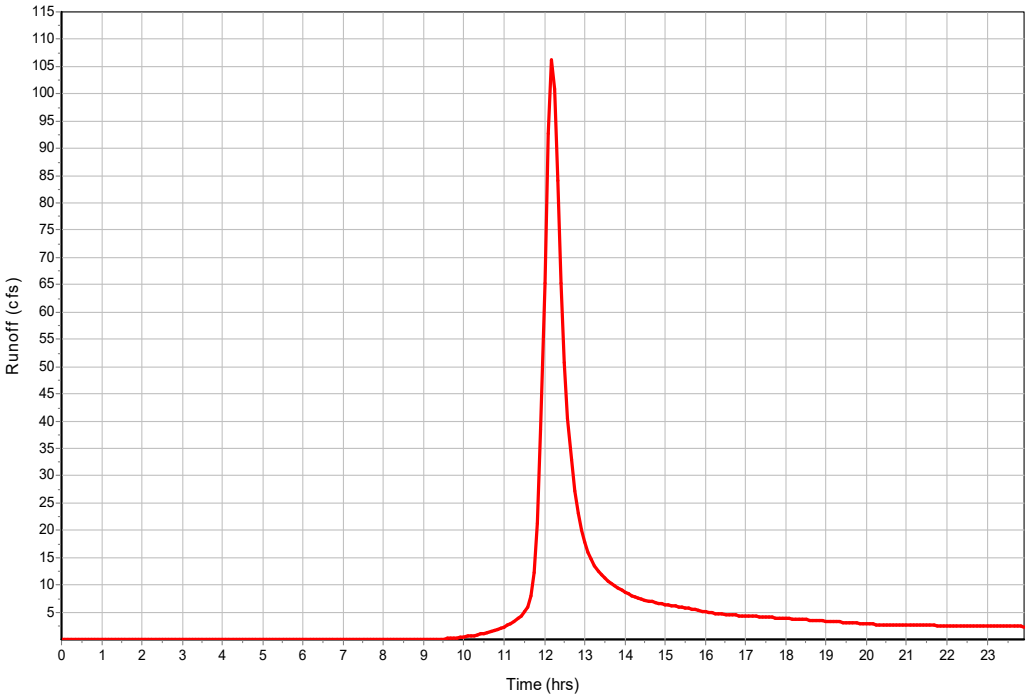
| | |
|---|---|
| Total Rainfall (in) | 2.7 |
| Total Runoff (in) | 1.22 |
| Peak Runoff (cfs) | 106.82 |
| Weighted Curve Number | 83.24 |
| Time of Concentration (days hh:mm:ss) | 0 00:29:16 |

**Subbasin : {Existing} DA3**

**Rainfall Intensity Graph**




**Runoff Hydrograph**



## Junction Input

| SN | 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 ($ft^2$) | Minimum Pipe Cover (in) |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1-Jun | 5437.80 | 6.00 | -5431.80 | 0.00 | -5437.80 | 0.00 | -6.00 | 0.00 | 0.00 |
| 2 | 2-Jun | 5424.00 | 6.00 | -5418.00 | 0.00 | -5424.00 | 0.00 | -6.00 | 0.00 | 0.00 |

## Junction Results

| SN | 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) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1-Jun | 185.25 | 185.25 | 5438.52 | 0.72 | 0.00 | 4.28 | 5437.90 | 0.10 | 0 12:32 | 0 00:00 | 0.00 | 0.00 |
| 2 | 2-Jun | 257.70 | 110.13 | 5424.95 | 0.95 | 0.00 | 4.05 | 5424.13 | 0.13 | 0 12:31 | 0 00:00 | 0.00 | 0.00 |

## Channel Input

| SN | Element ID | Length (ft) | Inlet Invert Elevation (ft) | Inlet Invert Offset (ft) | Outlet Invert Elevation (ft) | Outlet Invert Offset (ft) | Total Drop (ft) | Average Slope (%) | Shape | Height (ft) | Width (ft) | Manning's Roughness | Entrance Losses | Exit/Bend Losses | Additional Losses | Initial Flow (cfs) | Flap Gate |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | EXISTDITCH-01 | 1241.00 | 5437.80 | 0.00 | 5424.00 | 0.00 | 13.80 | 1.1100 | Trapezoidal | 5.000 | 120.000 | 0.0400 | 0.5000 | 0.5000 | 0.0000 | 0.00 | No |
| 2 | EXISTDITCH-02 | 1796.00 | 5424.00 | 0.00 | 5409.00 | 0.00 | 15.00 | 0.8400 | Trapezoidal | 5.000 | 120.000 | 0.0400 | 0.5000 | 0.5000 | 0.0000 | 0.00 | No |

## 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 | EXISTDITCH-01 | 183.59 | 0 12:32 | 5037.56 | 0.04 | 2.65 | 7.81 | 0.83 | 0.17 | 0.00 | | |
| 2 | EXISTDITCH-02 | 248.73 | 0 12:31 | 4365.75 | 0.06 | 3.15 | 9.50 | 0.94 | 0.19 | 0.00 | | |

## Project Description

| | |
|---|---|
| File Name | Existing Conditions.SPF |
| Description | |
| | Existing Conditions 100-yr Storm |

## Project Options

| | |
|---|---|
| Flow Units | CFS |
| Elevation Type | Elevation |
| Hydrology Method | SCS TR-55 |
| Time of Concentration (TOC) Method | SCS TR-55 |
| Link Routing Method | Hydrodynamic |
| Enable Overflow Ponding at Nodes | YES |
| Skip Steady State Analysis Time Periods | NO |

## Analysis Options

| | | |
|---|---|---|
| Start Analysis On | 00:00:00 | 0:00:00 |
| End Analysis On | 00:00:00 | 0:00:00 |
| Start Reporting On | 00:00:00 | 0:00:00 |
| 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 | 1 |
| Subbasins | 3 |
| Nodes | 3 |
| *Junctions* | 2 |
| *Outfalls* | 1 |
| *Flow Diversions* | 0 |
| *Inlets* | 0 |
| *Storage Nodes* | 0 |
| Links | 2 |
| *Channels* | 2 |
| *Pipes* | 0 |
| *Pumps* | 0 |
| *Orifices* | 0 |
| *Weirs* | 0 |
| *Outlets* | 0 |
| Pollutants | 0 |
| Land Uses | 0 |

## Rainfall Details

| SN | Rain Gage ID | Data Source | Data Source ID | Rainfall Type | Rain Units | State | County | Return Period (years) | Rainfall Depth (inches) | Rainfall Distribution |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Rain Gage-01 | Time Series | 100-yr | Cumulative | inches | Colorado | El Paso | 100.00 | 4.60 | SCS Type II 24-hr |

## Subbasin Summary

| SN | Subbasin ID | Area (ac) | Peak Rate Factor | Weighted Curve Number | Total Rainfall (in) | Total Runoff (in) | Total Runoff Volume (ac-in) | Peak Runoff (cfs) | Time of Concentration (days hh:mm:ss) |
|---|---|---|---|---|---|---|---|---|---|
| 1 | {Existing} DA1 | 266.90 | 484.00 | 82.22 | 4.60 | 2.74 | 732.37 | 450.39 | 0 00:51:56 |
| 2 | {Existing} DA2 | 101.90 | 484.00 | 83.47 | 4.60 | 2.86 | 291.23 | 258.93 | 0 00:29:41 |
| 3 | {Existing} DA3 | 98.50 | 484.00 | 83.24 | 4.60 | 2.84 | 279.44 | 250.63 | 0 00:29:15 |

## Node Summary

| SN | Element ID | Element Type | Invert Elevation (ft) | Ground/Rim (Max) Elevation (ft) | Initial Water Elevation (ft) | Surcharge Elevation (ft) | Ponded Area ($ft^2$) | Peak Inflow (cfs) | Max HGL Elevation Attained (ft) | Max Surcharge Depth Attained (ft) | Min Freeboard Attained (ft) | Time of Peak Flooding Occurrence (days hh:mm) | Total Flooded Volume (ac-in) | Total Time Flooded (min) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1-Jun | Junction | 5437.80 | 6.00 | 0.00 | 0.00 | 0.00 | 449.45 | 5439.02 | 0.00 | 3.78 | 0 00:00 | 0.00 | 0.00 |
| 2 | 2-Jun | Junction | 5424.00 | 6.00 | 0.00 | 0.00 | 0.00 | 627.82 | 5425.63 | 0.00 | 3.37 | 0 00:00 | 0.00 | 0.00 |
| 3 | Out-01 | Outfall | 5409.00 | | | | | 804.64 | 5410.61 | | | | | |

## Link Summary

| SN | Element ID | Element Type | From (Inlet) Node | To (Outlet) Node | Length | Inlet Invert Elevation | Outlet Invert Elevation | Average Slope | Diameter or Height | Manning's Roughness | Peak Flow | Design Flow Capacity | Peak Flow/ Design Flow Ratio | Peak Flow Velocity | Peak Flow Depth | Peak Flow Depth/ Total Depth Ratio | Total Time Surcharged | Reported Condition |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | (ft) | (ft) | (ft) | (%) | (in) | | (cfs) | (cfs) | | (ft/sec) | (ft) | | (min) | |
| 1 | EXISTDITCH-01 | Channel | 1-Jun | 2-Jun | 1241.00 | 5437.80 | 5424.00 | 1.1100 | 60.000 | 0.0400 | 447.69 | 5037.56 | 0.09 | 3.69 | 1.42 | 0.28 | 0.00 | |
| 2 | EXISTDITCH-02 | Channel | 2-Jun | Out-01 | 1796.00 | 5424.00 | 5409.00 | 0.8400 | 60.000 | 0.0400 | 617.94 | 4365.75 | 0.14 | 4.41 | 1.61 | 0.32 | 0.00 | |

# Subbasin Hydrology

## Subbasin : {Existing} DA1

### Input Data

| | |
|---|---|
| Area (ac) | 266.9 |
| Peak Rate Factor | 484 |
| Weighted Curve Number | 82.22 |
| Rain Gage ID | Rain Gage-01 |

### Composite Curve Number

| 32 | Area | Soil | Curve |
|---|---|---|---|
| Soil/Surface Description | (acres) | Group | Number |
| Pasture, grassland, or range, Fair | 95.02 | C | 79 |
| Pasture, grassland, or range, Fair | 171.88 | D | 84 |
| Composite Area & Weighted CN | 266.9 | | 82.22 |

### Time of Concentration

TOC Method : SCS TR-55

Sheet Flow Equation :

Tc = (0.007 * ((n * Lf)^0.8)) / ((P^0.5) * (Sf^0.4))

Where :

Tc = Time of Concentration (hr)
n = Manning's roughness
Lf = Flow Length (ft)
P = 2 yr, 24 hr Rainfall (inches)
Sf = Slope (ft/ft)

Shallow Concentrated Flow Equation :

V = 16.1345 * (Sf^0.5) (unpaved surface)
V = 20.3282 * (Sf^0.5) (paved surface)
V = 15.0 * (Sf^0.5) (grassed waterway surface)
V = 10.0 * (Sf^0.5) (nearly bare & untilled surface)
V = 9.0 * (Sf^0.5) (cultivated straight rows surface)
V = 7.0 * (Sf^0.5) (short grass pasture surface)
V = 5.0 * (Sf^0.5) (woodland surface)
V = 2.5 * (Sf^0.5) (forest w/heavy litter surface)
Tc = (Lf / V) / (3600 sec/hr)

Where:

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)

Channel Flow Equation :

V = (1.49 * (R^(2/3)) * (Sf^0.5)) / n
R = Aq / Wp
Tc = (Lf / V) / (3600 sec/hr)

Where :

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
R = Hydraulic Radius (ft)
Aq = Flow Area ($ft^2$)
Wp = Wetted Perimeter (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)
n = Manning's roughness

| Sheet Flow Computations | Subarea A | Subarea B | Subarea C |
|---|---|---|---|
| Manning's Roughness : | 0.13 | 0 | 0 |
| Flow Length (ft) : | 100 | 0 | 0 |
| Slope (%) : | 1.51 | 0 | 0 |
| 2 yr, 24 hr Rainfall (in) : | 2.1 | 0 | 0 |
| Velocity (ft/sec) : | 0.14 | 0 | 0 |
| Computed Flow Time (min) : | 12.07 | 0 | 0 |

| Shallow Concentrated Flow Computations | Subarea A | Subarea B | Subarea C |
|---|---|---|---|
| Flow Length (ft) : | 5861 | 0 | 0 |
| Slope (%) : | 2.3 | 0 | 0 |
| Surface Type : | Unpaved | Unpaved | Unpaved |
| Velocity (ft/sec) : | 2.45 | 0 | 0 |
| Computed Flow Time (min) : | 39.87 | 0 | 0 |

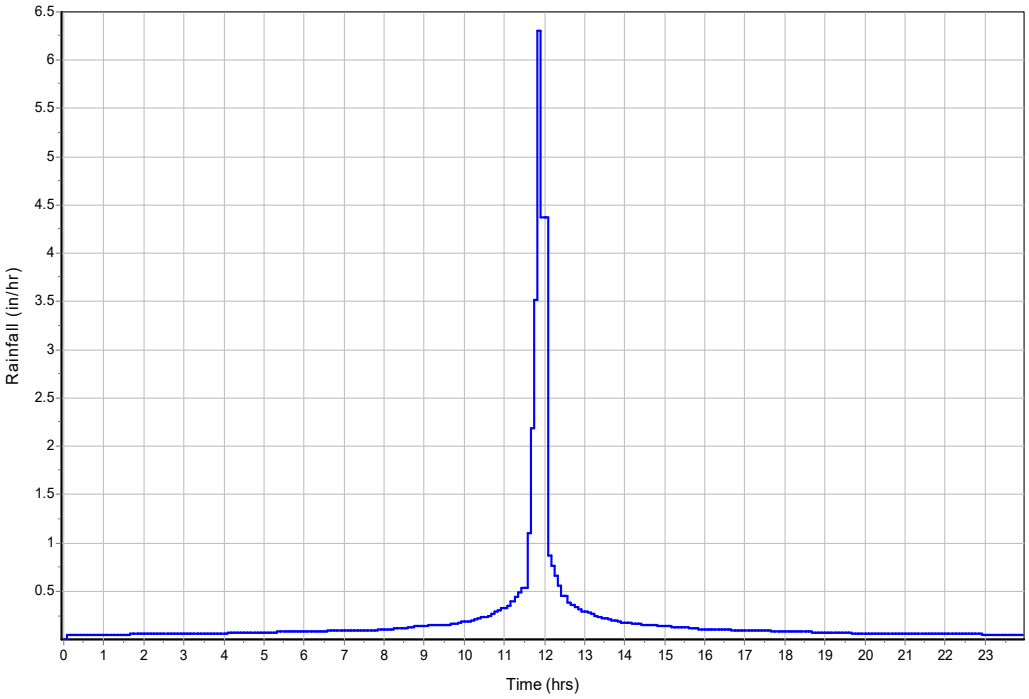
Total TOC (min) .....51.94

**Subbasin Runoff Results**

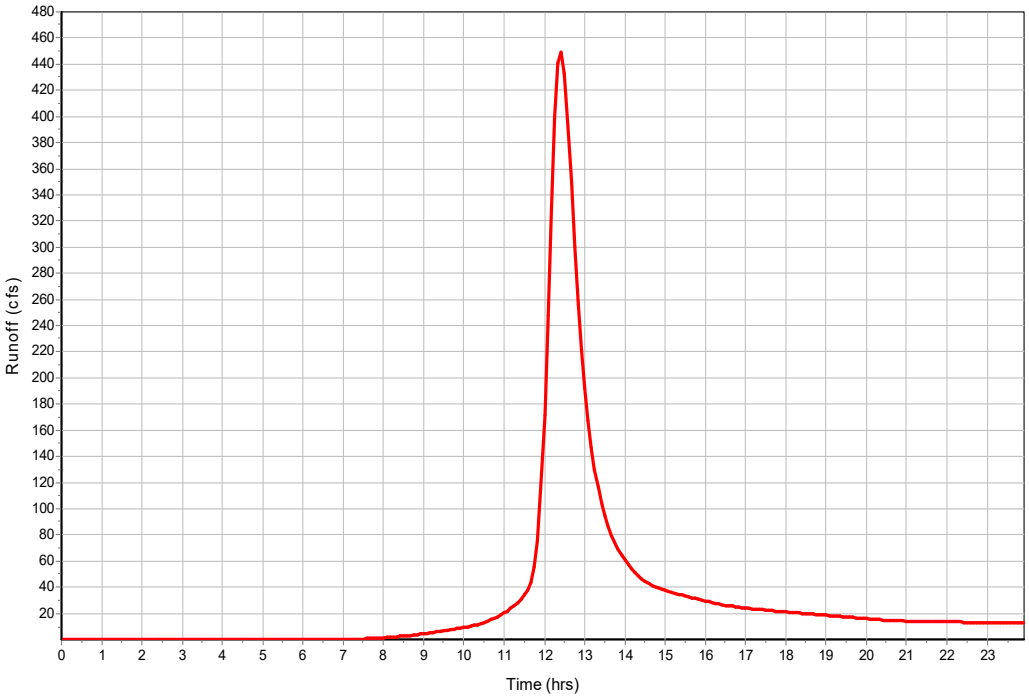
| | |
|---|---|
| Total Rainfall (in) | 4.6 |
| Total Runoff (in) | 2.74 |
| Peak Runoff (cfs) | 450.39 |
| Weighted Curve Number | 82.22 |
| Time of Concentration (days hh:mm:ss) | 0 00:51:56 |

**Subbasin : {Existing} DA1**

**Rainfall Intensity Graph**




**Runoff Hydrograph**



## Subbasin : {Existing} DA2

### Input Data

| | |
|---|---|
| Area (ac) | 101.9 |
| Peak Rate Factor | 484 |
| Weighted Curve Number | 83.47 |
| Rain Gage ID | Rain Gage-01 |

### Composite Curve Number

| 32 | Area | Soil | Curve |
|---|---|---|---|
| Soil/Surface Description | (acres) | Group | Number |
| Pasture, grassland, or range, Fair | 10.9 | C | 79 |
| Pasture, grassland, or range, Fair | 91 | D | 84 |
| Composite Area & Weighted CN | 101.9 | | 83.47 |

### Time of Concentration

| | Subarea | Subarea | Subarea |
|---|---|---|---|
| Sheet Flow Computations | A | B | C |
| Manning's Roughness : | 0.13 | 0 | 0 |
| Flow Length (ft) : | 100 | 0 | 0 |
| Slope (%) : | 2.84 | 0 | 0 |
| 2 yr, 24 hr Rainfall (in) : | 2.1 | 0 | 0 |
| Velocity (ft/sec) : | 0.18 | 0 | 0 |
| Computed Flow Time (min) : | 9.37 | 0 | 0 |

| | Subarea | Subarea | Subarea |
|---|---|---|---|
| Shallow Concentrated Flow Computations | A | B | C |
| Flow Length (ft) : | 1836 | 1298 | 0 |
| Slope (%) : | 4.14 | 1.49 | 0 |
| Surface Type : | Unpaved | Unpaved | Unpaved |
| Velocity (ft/sec) : | 3.28 | 1.97 | 0 |
| Computed Flow Time (min) : | 9.33 | 10.98 | 0 |

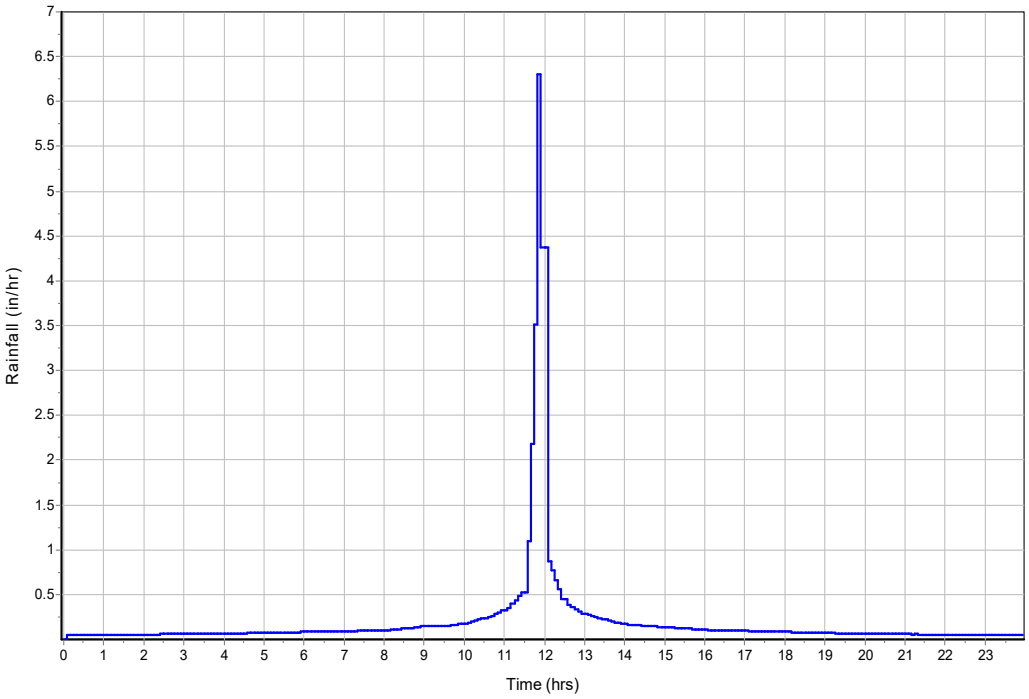
Total TOC (min) .....29.69

### Subbasin Runoff Results

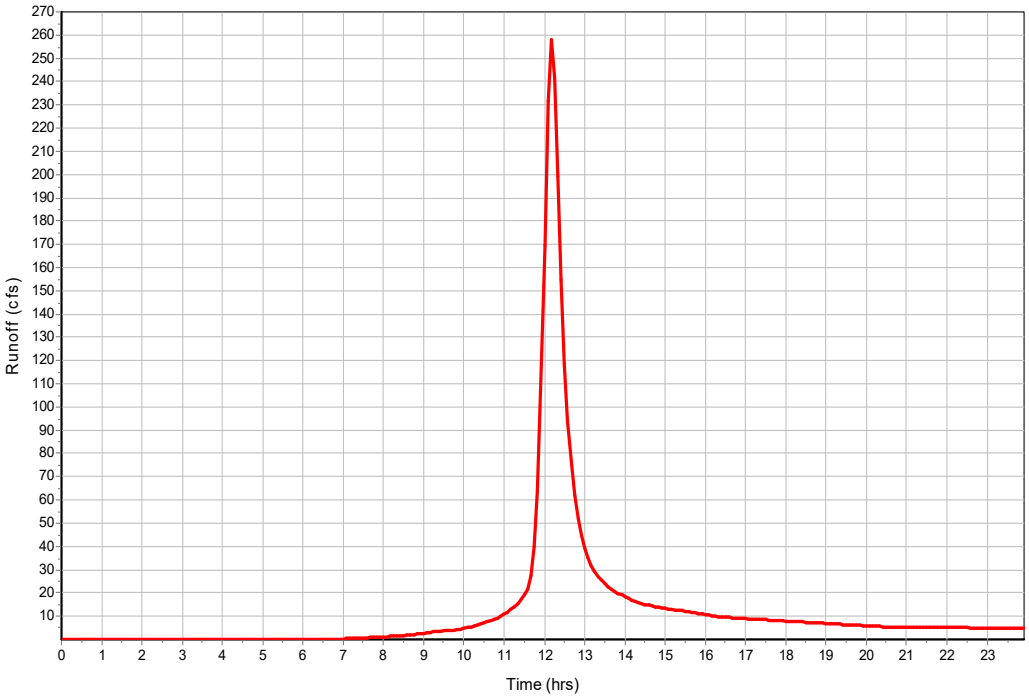
| | |
|---|---|
| Total Rainfall (in) | 4.6 |
| Total Runoff (in) | 2.86 |
| Peak Runoff (cfs) | 258.93 |
| Weighted Curve Number | 83.47 |
| Time of Concentration (days hh:mm:ss) | 0 00:29:41 |

**Subbasin : {Existing} DA2**

## Rainfall Intensity Graph




## Runoff Hydrograph



## Subbasin : {Existing} DA3

### Input Data

| | |
|---|---|
| Area (ac) | 98.5 |
| Peak Rate Factor | 484 |
| Weighted Curve Number | 83.24 |
| Rain Gage ID | Rain Gage-01 |

### Composite Curve Number

| 32 | Area | Soil | Curve |
|---|---|---|---|
| Soil/Surface Description | (acres) | Group | Number |
| Pasture, grassland, or range, Fair | 15.07 | C | 79 |
| Pasture, grassland, or range, Fair | 83.43 | D | 84 |
| Composite Area & Weighted CN | 98.5 | | 83.24 |

### Time of Concentration

| | Subarea | Subarea | Subarea |
|---|---|---|---|
| Sheet Flow Computations | A | B | C |
| Manning's Roughness : | 0.13 | 0 | 0 |
| Flow Length (ft) : | 100 | 0 | 0 |
| Slope (%) : | 1.91 | 0 | 0 |
| 2 yr, 24 hr Rainfall (in) : | 2.1 | 0 | 0 |
| Velocity (ft/sec) : | 0.15 | 0 | 0 |
| Computed Flow Time (min) : | 10.99 | 0 | 0 |

| | Subarea | Subarea | Subarea |
|---|---|---|---|
| Shallow Concentrated Flow Computations | A | B | C |
| Flow Length (ft) : | 2316 | 583 | 0 |
| Slope (%) : | 3.26 | 1.44 | 0 |
| Surface Type : | Unpaved | Unpaved | Unpaved |
| Velocity (ft/sec) : | 2.91 | 1.94 | 0 |
| Computed Flow Time (min) : | 13.26 | 5.01 | 0 |

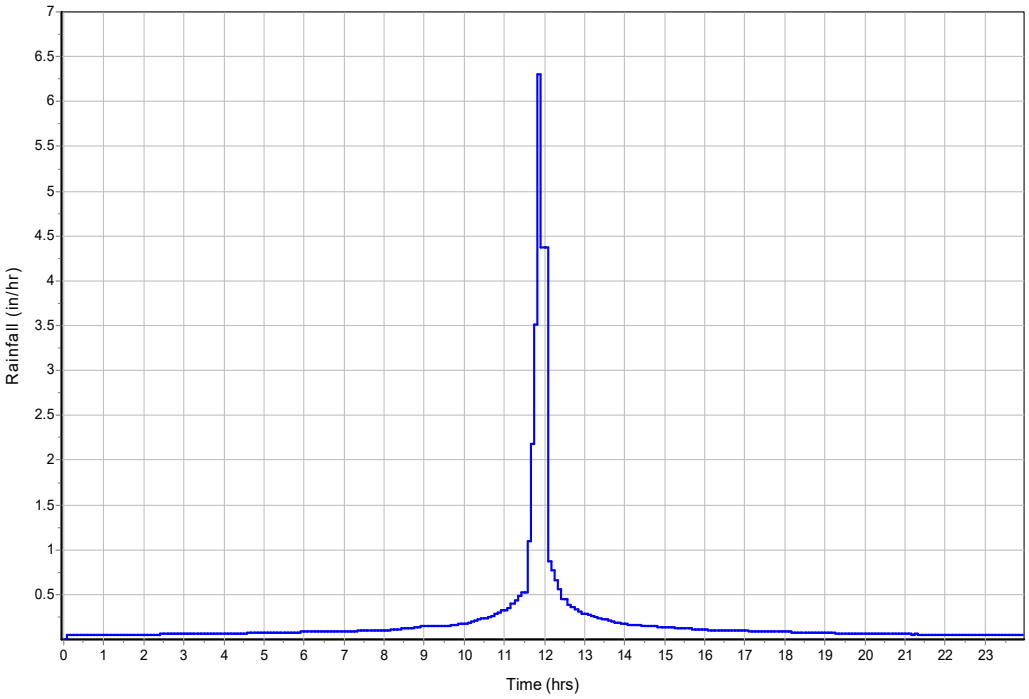
Total TOC (min) .....29.26

### Subbasin Runoff Results

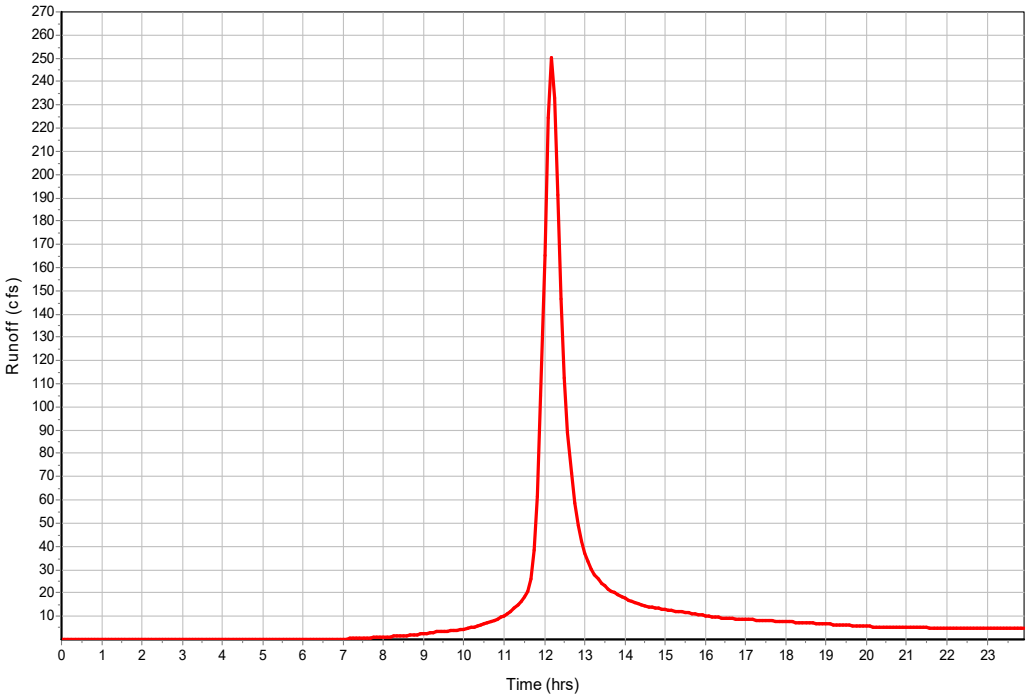
| | |
|---|---|
| Total Rainfall (in) | 4.6 |
| Total Runoff (in) | 2.84 |
| Peak Runoff (cfs) | 250.63 |
| Weighted Curve Number | 83.24 |
| Time of Concentration (days hh:mm:ss) | 0 00:29:16 |

**Subbasin : {Existing} DA3**

## Rainfall Intensity Graph




## Runoff Hydrograph



## Junction Input

| SN | 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 ($ft^2$) | Minimum Pipe Cover (in) |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1-Jun | 5437.80 | 6.00 | -5431.80 | 0.00 | -5437.80 | 0.00 | -6.00 | 0.00 | 0.00 |
| 2 | 2-Jun | 5424.00 | 6.00 | -5418.00 | 0.00 | -5424.00 | 0.00 | -6.00 | 0.00 | 0.00 |

## Junction Results

| SN | 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) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1-Jun | 449.45 | 449.45 | 5439.02 | 1.22 | 0.00 | 3.78 | 5437.97 | 0.17 | 0 12:30 | 0 00:00 | 0.00 | 0.00 |
| 2 | 2-Jun | 627.82 | 258.01 | 5425.63 | 1.63 | 0.00 | 3.37 | 5424.23 | 0.23 | 0 12:27 | 0 00:00 | 0.00 | 0.00 |

## Channel Input

| SN | Element ID | Length (ft) | Inlet Invert Elevation (ft) | Inlet Invert Offset (ft) | Outlet Invert Elevation (ft) | Outlet Invert Offset (ft) | Total Drop (ft) | Average Slope (%) | Shape | Height (ft) | Width (ft) | Manning's Roughness | Entrance Losses | Exit/Bend Losses | Additional Losses | Initial Flow (cfs) | Flap Gate |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | EXISTDITCH-01 | 1241.00 | 5437.80 | 0.00 | 5424.00 | 0.00 | 13.80 | 1.1100 | Trapezoidal | 5.000 | 120.000 | 0.0400 | 0.5000 | 0.5000 | 0.0000 | 0.00 | No |
| 2 | EXISTDITCH-02 | 1796.00 | 5424.00 | 0.00 | 5409.00 | 0.00 | 15.00 | 0.8400 | Trapezoidal | 5.000 | 120.000 | 0.0400 | 0.5000 | 0.5000 | 0.0000 | 0.00 | No |

## 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 | EXISTDITCH-01 | 447.69 | 0 12:31 | 5037.56 | 0.09 | 3.69 | 5.61 | 1.42 | 0.28 | 0.00 | | |
| 2 | EXISTDITCH-02 | 617.94 | 0 12:28 | 4365.75 | 0.14 | 4.41 | 6.79 | 1.61 | 0.32 | 0.00 | | |

## Project Description

| | |
|---|---|
| File Name | Proposed Conditions.SPF |
| Description | |
| | Proposed Conditions 5-yr storm |

## Project Options

| | |
|---|---|
| Flow Units | CFS |
| Elevation Type | Depth |
| Hydrology Method | SCS TR-55 |
| Time of Concentration (TOC) Method | SCS TR-55 |
| Link Routing Method | Hydrodynamic |
| Enable Overflow Ponding at Nodes | YES |
| Skip Steady State Analysis Time Periods | NO |

## Analysis Options

| | | |
|---|---|---|
| Start Analysis On | 00:00:00 | 0:00:00 |
| End Analysis On | 00:00:00 | 0:00:00 |
| Start Reporting On | 00:00:00 | 0:00:00 |
| 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 | 1 |
| Subbasins | 7 |
| Nodes | 14 |
| *Junctions* | 11 |
| *Outfalls* | 1 |
| *Flow Diversions* | 0 |
| *Inlets* | 0 |
| *Storage Nodes* | 2 |
| Links | 17 |
| *Channels* | 6 |
| *Pipes* | 3 |
| *Pumps* | 0 |
| *Orifices* | 6 |
| *Weirs* | 2 |
| *Outlets* | 0 |
| Pollutants | 0 |
| Land Uses | 0 |

## Rainfall Details

| SN | Rain Gage ID | Data Source | Data Source ID | Rainfall Type | Rain Units | State | County | Return Period (years) | Rainfall Depth (inches) | Rainfall Distribution |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Rain Gage-01 | Time Series | 5-yr | Cumulative | inches | Colorado | El Paso | 5.00 | 2.70 | SCS Type II 24-hr |

## Subbasin Summary

| SN | Subbasin ID | Area (ac) | Peak Rate Factor | Weighted Curve Number | Total Rainfall (in) | Total Runoff (in) | Total Runoff Volume (ac-in) | Peak Runoff (cfs) | Time of Concentration (days hh:mm:ss) |
|---|---|---|---|---|---|---|---|---|---|
| 1 | {Proposed}.DA : 1 | 266.90 | 484.00 | 82.22 | 2.70 | 1.16 | 309.87 | 185.43 | 0 00:51:56 |
| 2 | {Proposed}.DA : 2 | 75.00 | 484.00 | 83.89 | 2.70 | 1.27 | 94.95 | 87.26 | 0 00:27:41 |
| 3 | {Proposed}.DA : 3 | 17.60 | 484.00 | 83.87 | 2.70 | 1.27 | 22.26 | 28.96 | 0 00:13:00 |
| 4 | {Proposed}.DA : 4 | 10.30 | 484.00 | 84.00 | 2.70 | 1.27 | 13.11 | 17.92 | 0 00:10:42 |
| 5 | {Proposed}.DA : 5 | 4.50 | 484.00 | 98.00 | 2.70 | 2.47 | 11.12 | 14.24 | 0 00:08:43 |
| 6 | {Proposed}.DA : 6 | 34.30 | 484.00 | 82.04 | 2.70 | 1.15 | 39.45 | 46.24 | 0 00:17:07 |
| 7 | {Proposed}.DA : 7 | 44.20 | 484.00 | 92.51 | 2.70 | 1.92 | 85.04 | 84.41 | 0 00:23:51 |

## Node Summary

| SN | Element ID | Element Type | Invert Elevation (ft) | Ground/Rim (Max) Elevation (ft) | Initial Water Elevation (ft) | Surcharge Elevation (ft) | Ponded Area ($ft^2$) | Peak Inflow (cfs) | Max HGL Elevation Attained (ft) | Max Surcharge Depth Attained (ft) | Min Freeboard Attained (ft) | Time of Peak Flooding Occurrence (days hh:mm) | Total Flooded Volume (ac-in) | Total Time Flooded (min) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1-Jun | Junction | 5437.80 | 5441.80 | 5437.80 | 5445.80 | 0.00 | 185.21 | 5439.33 | 0.00 | 2.47 | 0 00:00 | 0.00 | 0.00 |
| 2 | 2-Jun | Junction | 5428.92 | 5440.40 | 5428.92 | 5451.88 | 0.00 | 234.21 | 5432.15 | 0.00 | 8.25 | 0 00:00 | 0.00 | 0.00 |
| 3 | 3-Jun | Junction | 5427.02 | 5427.02 | 5427.02 | 5427.02 | 0.00 | 228.14 | 5427.74 | 0.00 | 4.28 | 0 00:00 | 0.00 | 0.00 |
| 4 | 4-Jun | Junction | 5441.72 | 5443.72 | 5441.72 | 5445.72 | 0.00 | 28.15 | 5442.36 | 0.00 | 1.36 | 0 00:00 | 0.00 | 0.00 |
| 5 | 5-Jun | Junction | 5426.06 | 5428.06 | 5426.06 | 5430.06 | 0.00 | 42.38 | 5426.85 | 0.00 | 1.21 | 0 00:00 | 0.00 | 0.00 |
| 6 | 6-Jun | Junction | 5421.00 | 5426.00 | 5421.00 | 5431.00 | 0.00 | 238.79 | 5421.88 | 0.00 | 4.12 | 0 00:00 | 0.00 | 0.00 |
| 7 | 7-Jun | Junction | 5417.00 | 5422.00 | 5417.00 | 5427.00 | 0.00 | 247.15 | 5417.99 | 0.00 | 10.01 | 0 00:00 | 0.00 | 0.00 |
| 8 | Outlet_PondA | Junction | 5418.00 | 5420.50 | 5418.00 | 5423.00 | 0.00 | 13.81 | 5419.27 | 0.00 | 1.23 | 0 00:00 | 0.00 | 0.00 |
| 9 | Outlet_PondB | Junction | 5424.00 | 5425.50 | 5424.00 | 5427.00 | 0.00 | 1.65 | 5424.35 | 0.00 | 1.15 | 0 00:00 | 0.00 | 0.00 |
| 10 | Riser_PondA | Junction | 5418.00 | 5424.97 | 5418.00 | 5431.94 | 0.00 | 13.82 | 5419.73 | 0.00 | 5.24 | 0 00:00 | 0.00 | 0.00 |
| 11 | Riser_PondB | Junction | 5424.00 | 5427.52 | 5424.00 | 5431.04 | 0.00 | 1.65 | 5424.55 | 0.00 | 2.97 | 0 00:00 | 0.00 | 0.00 |
| 12 | Out-01 | Outfall | 5409.60 | | | | | 255.01 | 5410.58 | | | | | |
| 13 | PondA | Storage Node | 5420.00 | 5431.00 | 5420.00 | | 0.00 | 82.65 | 5425.35 | | | | 0.00 | 0.00 |
| 14 | PondB | Storage Node | 5426.00 | 5434.00 | 5426.00 | | 0.00 | 13.40 | 5427.56 | | | | 0.00 | 0.00 |

## Link Summary

| SN | Element ID | Element Type | From (Inlet) Node | To (Outlet) Node | Length | Inlet Invert Elevation | Outlet Invert Elevation | Average Slope | Diameter or Height | Manning's Roughness | Peak Flow | Design Flow Capacity | Peak Flow/ Design Flow Ratio | Peak Flow Velocity | Peak Flow Depth | Peak Flow Depth/ Total Depth Ratio | Total Time Surcharged | Reported Condition |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | (ft) | (ft) | (ft) | (%) | (in) | | (cfs) | (cfs) | | (ft/sec) | (ft) | | (min) | |
| 1 | C-01 | Pipe | 2-Jun | 3-Jun | 120.00 | 5428.92 | 5427.02 | 1.5800 | 48.000 | 0.0120 | 228.14 | 1002.95 | 0.23 | 7.71 | 1.97 | 0.49 | 0.00 | Calculated |
| 2 | OutletPipe_PondA | Pipe | Outlet_PondA | 7-Jun | 166.00 | 5418.00 | 5417.00 | 0.6000 | 30.000 | 0.0120 | 13.81 | 34.49 | 0.40 | 7.18 | 1.10 | 0.44 | 0.00 | Calculated |
| 3 | OutletPipe_PondB | Pipe | Outlet_PondB | 7-Jun | 303.00 | 5424.00 | 5417.00 | 2.3100 | 18.000 | 0.0150 | 1.64 | 13.84 | 0.12 | 5.30 | 0.67 | 0.44 | 0.00 | Calculated |
| 4 | DITCH-01 | Channel | 1-Jun | 2-Jun | 1367.00 | 5437.80 | 5428.92 | 0.6500 | 48.000 | 0.0300 | 183.51 | 1119.58 | 0.16 | 2.61 | 2.37 | 0.59 | 0.00 | |
| 5 | DITCH-02 | Channel | 4-Jun | 5-Jun | 1487.80 | 5441.72 | 5426.06 | 1.0500 | 24.000 | 0.0300 | 26.59 | 224.45 | 0.12 | 2.89 | 0.72 | 0.36 | 0.00 | |
| 6 | DITCH-03 | Channel | 5-Jun | 6-Jun | 207.00 | 5426.06 | 5421.00 | 2.4400 | 24.000 | 0.0400 | 41.61 | 256.53 | 0.16 | 4.55 | 0.73 | 0.37 | 0.00 | |
| 7 | EXISTDITCH-01 | Channel | 3-Jun | 6-Jun | 352.00 | 5427.02 | 5421.00 | 1.7100 | 60.000 | 0.0400 | 228.10 | 6247.31 | 0.04 | 3.43 | 0.80 | 0.16 | 0.00 | |
| 8 | EXISTDITCH-02 | Channel | 6-Jun | 7-Jun | 415.00 | 5421.00 | 5417.00 | 0.9600 | 60.000 | 0.0400 | 238.52 | 4689.99 | 0.05 | 3.09 | 0.93 | 0.19 | 0.00 | |
| 9 | EXISTDITCH-03 | Channel | 7-Jun | Out-01 | 1033.00 | 5417.00 | 5409.60 | 0.7200 | 60.000 | 0.0400 | 246.01 | 4043.26 | 0.06 | 2.98 | 0.98 | 0.20 | 0.00 | |
| 10 | Grate_PondA | Orifice | PondA | Riser_PondA | | 5420.00 | 5418.00 | | 48.000 | | 12.25 | | | | | | | |
| 11 | Grate_PondB | Orifice | PondB | Riser_PondB | | 5426.00 | 5424.00 | | 48.000 | | 0.48 | | | | | | | |
| 12 | RestrictorPlate_PondA | Orifice | Riser_PondA | Outlet_PondA | | 5418.00 | 5418.00 | | 24.700 | | 13.81 | | | | | | | |
| 13 | RestrictorPlate_PondB | Orifice | Riser_PondB | Outlet_PondB | | 5424.00 | 5424.00 | | 9.600 | | 1.65 | | | | | | | |
| 14 | WQCV/EURV_PondA | Orifice | PondA | Riser_PondA | | 5420.00 | 5418.00 | | 3.000 | | 1.57 | | | | | | | |
| 15 | WQCV/EURV_PondB | Orifice | PondB | Riser_PondB | | 5426.00 | 5424.00 | | 6.160 | | 1.17 | | | | | | | |
| 16 | EMRGCYSPLWY_PondA | Weir | PondA | 7-Jun | | 5420.00 | 5417.00 | | | | 0.00 | | | | | | | |
| 17 | EMRGCYSPLWY_PondB | Weir | PondB | 7-Jun | | 5426.00 | 5417.00 | | | | 0.00 | | | | | | | |

# Subbasin Hydrology

## Subbasin : {Proposed}.DA : 1

### Input Data

| | |
|---|---|
| Area (ac) | 266.9 |
| Peak Rate Factor | 484 |
| Weighted Curve Number | 82.22 |
| Rain Gage ID | Rain Gage-01 |

### Composite Curve Number

| 32 | Area | Soil | Curve |
|---|---|---|---|
| Soil/Surface Description | (acres) | Group | Number |
| Pasture, grassland, or range, Fair | 171.88 | D | 84 |
| Pasture, grassland, or range, Fair | 95.02 | C | 79 |
| Composite Area & Weighted CN | 266.9 | | 82.22 |

### Time of Concentration

TOC Method : SCS TR-55

Sheet Flow Equation :

Tc = (0.007 * ((n * Lf)^0.8)) / ((P^0.5) * (Sf^0.4))

Where :

Tc = Time of Concentration (hr)
n = Manning's roughness
Lf = Flow Length (ft)
P = 2 yr, 24 hr Rainfall (inches)
Sf = Slope (ft/ft)

Shallow Concentrated Flow Equation :

V = 16.1345 * (Sf^0.5) (unpaved surface)
V = 20.3282 * (Sf^0.5) (paved surface)
V = 15.0 * (Sf^0.5) (grassed waterway surface)
V = 10.0 * (Sf^0.5) (nearly bare & untilled surface)
V = 9.0 * (Sf^0.5) (cultivated straight rows surface)
V = 7.0 * (Sf^0.5) (short grass pasture surface)
V = 5.0 * (Sf^0.5) (woodland surface)
V = 2.5 * (Sf^0.5) (forest w/heavy litter surface)
Tc = (Lf / V) / (3600 sec/hr)

Where:

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)

Channel Flow Equation :

V = (1.49 * (R^(2/3)) * (Sf^0.5)) / n
R = Aq / Wp
Tc = (Lf / V) / (3600 sec/hr)

Where :

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
R = Hydraulic Radius (ft)
Aq = Flow Area ($ft^2$)
Wp = Wetted Perimeter (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)
n = Manning's roughness

| Sheet Flow Computations | Subarea A | Subarea B | Subarea C |
|---|---|---|---|
| Manning's Roughness : | 0.13 | 0 | 0 |
| Flow Length (ft) : | 100 | 0 | 0 |
| Slope (%) : | 1.51 | 0 | 0 |
| 2 yr, 24 hr Rainfall (in) : | 2.1 | 0 | 0 |
| Velocity (ft/sec) : | 0.14 | 0 | 0 |
| Computed Flow Time (min) : | 12.07 | 0 | 0 |

| Shallow Concentrated Flow Computations | Subarea A | Subarea B | Subarea C |
|---|---|---|---|
| Flow Length (ft) : | 5861 | 0 | 0 |
| Slope (%) : | 2.3 | 0 | 0 |
| Surface Type : | Unpaved | Unpaved | Unpaved |
| Velocity (ft/sec) : | 2.45 | 0 | 0 |
| Computed Flow Time (min) : | 39.87 | 0 | 0 |

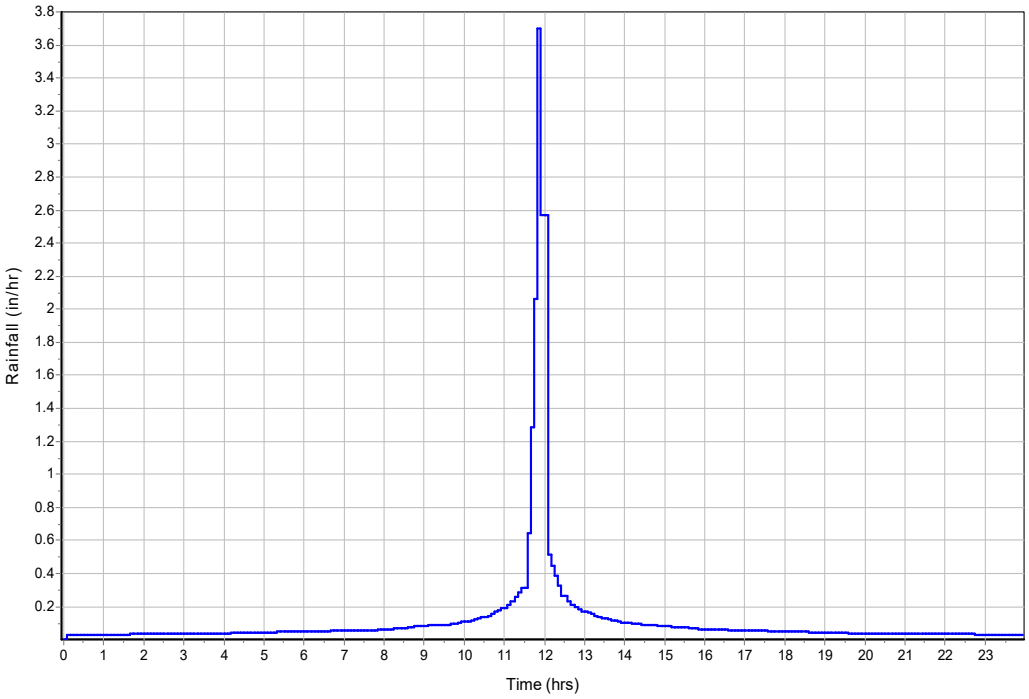
Total TOC (min) .....51.94

**Subbasin Runoff Results**

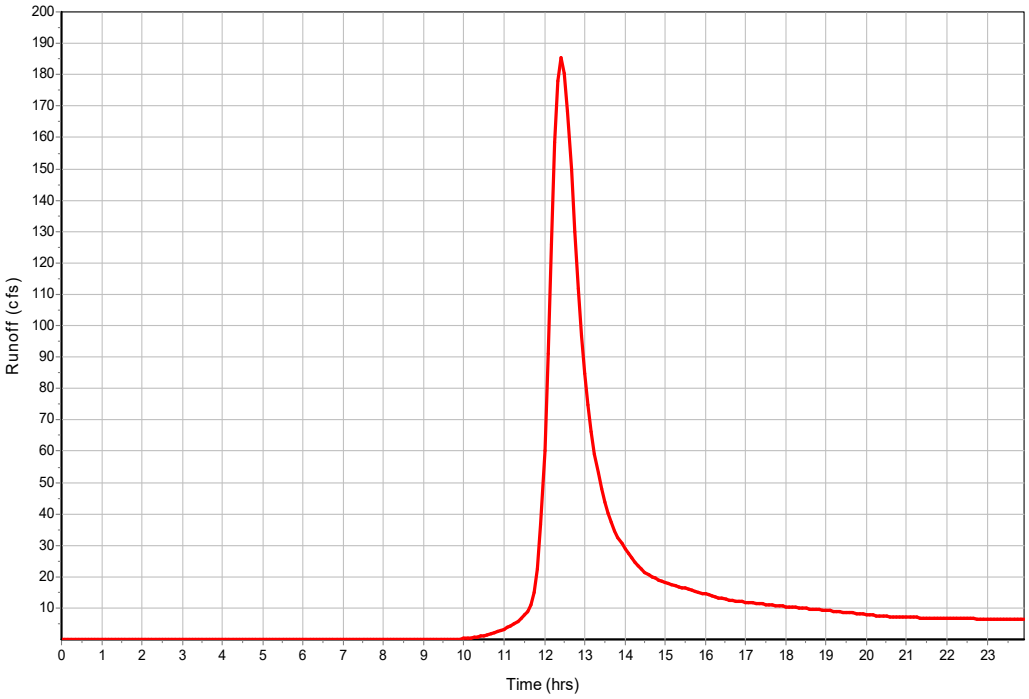
| | |
|---|---|
| Total Rainfall (in) | 2.7 |
| Total Runoff (in) | 1.16 |
| Peak Runoff (cfs) | 185.43 |
| Weighted Curve Number | 82.22 |
| Time of Concentration (days hh:mm:ss) | 0 00:51:56 |

**Subbasin : {Proposed}.DA : 1**

## Rainfall Intensity Graph




## Runoff Hydrograph



## Subbasin : {Proposed}.DA : 2

### Input Data

| | |
|---|---|
| Area (ac) | 75 |
| Peak Rate Factor | 484 |
| Weighted Curve Number | 83.89 |
| Rain Gage ID | Rain Gage-01 |

### Composite Curve Number

| 32<br>Soil/Surface Description | Area<br>(acres) | Soil<br>Group | Curve<br>Number |
|---|---|---|---|
| Pasture, grassland, or range, Fair | 73.35 | D | 84 |
| Pasture, grassland, or range, Fair | 1.65 | C | 79 |
| Composite Area & Weighted CN | 75 | | 83.89 |

### Time of Concentration

| Sheet Flow Computations | Subarea<br>A | Subarea<br>B | Subarea<br>C |
|---|---|---|---|
| Manning's Roughness : | 0.13 | 0 | 0 |
| Flow Length (ft) : | 100 | 0 | 0 |
| Slope (%) : | 2.84 | 0 | 0 |
| 2 yr, 24 hr Rainfall (in) : | 2.1 | 0 | 0 |
| Velocity (ft/sec) : | 0.18 | 0 | 0 |
| Computed Flow Time (min) : | 9.37 | 0 | 0 |

| Shallow Concentrated Flow Computations | Subarea<br>A | Subarea<br>B | Subarea<br>C |
|---|---|---|---|
| Flow Length (ft) : | 3055 | 0 | 0 |
| Slope (%) : | 2.96 | 0 | 0 |
| Surface Type : | Unpaved | Unpaved | Unpaved |
| Velocity (ft/sec) : | 2.78 | 0 | 0 |
| Computed Flow Time (min) : | 18.32 | 0 | 0 |

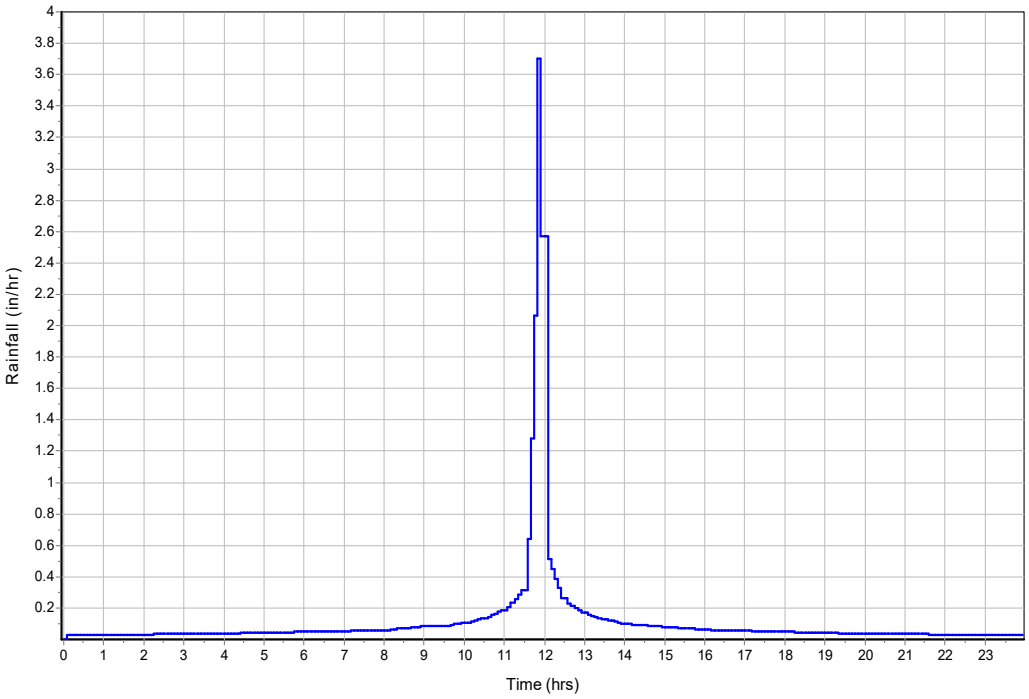
Total TOC (min) .....27.69

### Subbasin Runoff Results

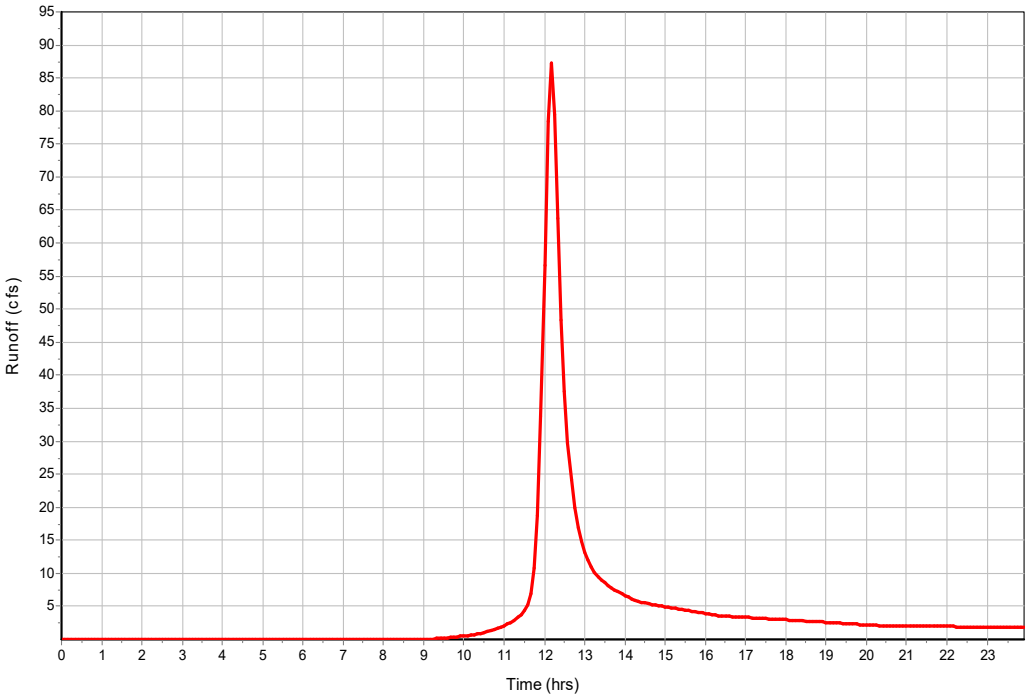
| | |
|---|---|
| Total Rainfall (in) | 2.7 |
| Total Runoff (in) | 1.27 |
| Peak Runoff (cfs) | 87.26 |
| Weighted Curve Number | 83.89 |
| Time of Concentration (days hh:mm:ss) | 0 00:27:41 |

**Subbasin : {Proposed}.DA : 2**

## Rainfall Intensity Graph




## Runoff Hydrograph



## Subbasin : {Proposed}.DA : 3

### Input Data

| | |
|---|---|
| Area (ac) | 17.6 |
| Peak Rate Factor | 484 |
| Weighted Curve Number | 83.87 |
| Rain Gage ID | Rain Gage-01 |

### Composite Curve Number

| 32 | Area | Soil | Curve |
|---|---|---|---|
| Soil/Surface Description | (acres) | Group | Number |
| Pasture, grassland, or range, Fair | 17.16 | D | 84 |
| Pasture, grassland, or range, Fair | 0.44 | C | 79 |
| Composite Area & Weighted CN | 17.6 | | 83.87 |

### Time of Concentration

| | Subarea | Subarea | Subarea |
|---|---|---|---|
| Sheet Flow Computations | A | B | C |
| Manning's Roughness : | 0.13 | 0 | 0 |
| Flow Length (ft) : | 100 | 0 | 0 |
| Slope (%) : | 5.13 | 0 | 0 |
| 2 yr, 24 hr Rainfall (in) : | 2.1 | 0 | 0 |
| Velocity (ft/sec) : | 0.23 | 0 | 0 |
| Computed Flow Time (min) : | 7.4 | 0 | 0 |

| | Subarea | Subarea | Subarea |
|---|---|---|---|
| Shallow Concentrated Flow Computations | A | B | C |
| Flow Length (ft) : | 1052 | 0 | 0 |
| Slope (%) : | 3.77 | 0 | 0 |
| Surface Type : | Unpaved | Unpaved | Unpaved |
| Velocity (ft/sec) : | 3.13 | 0 | 0 |
| Computed Flow Time (min) : | 5.6 | 0 | 0 |

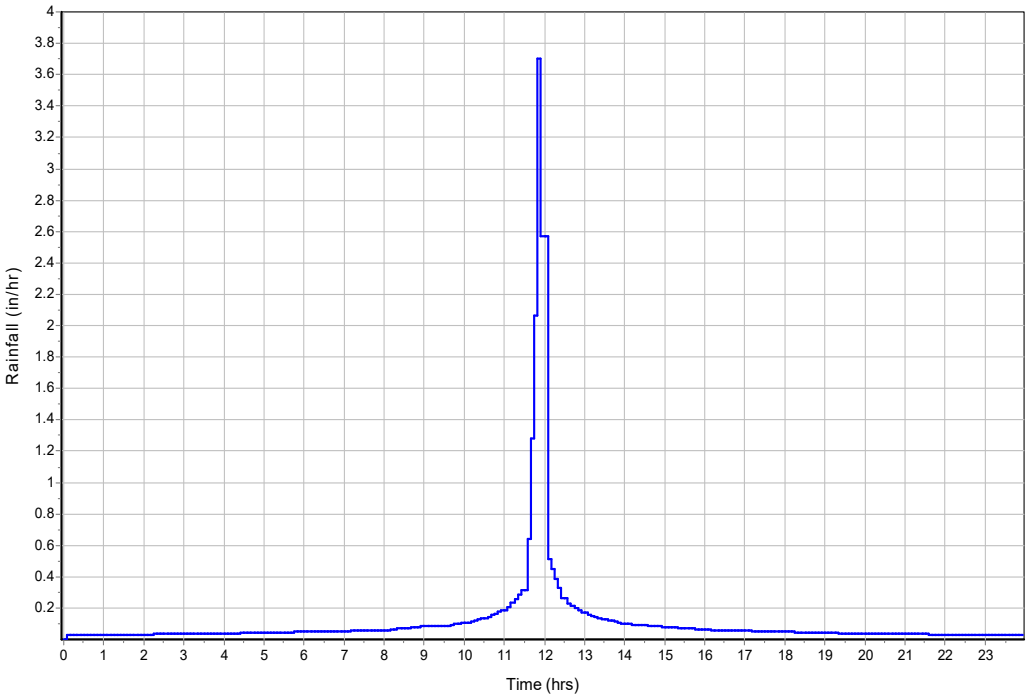
Total TOC (min) .....13.00

### Subbasin Runoff Results

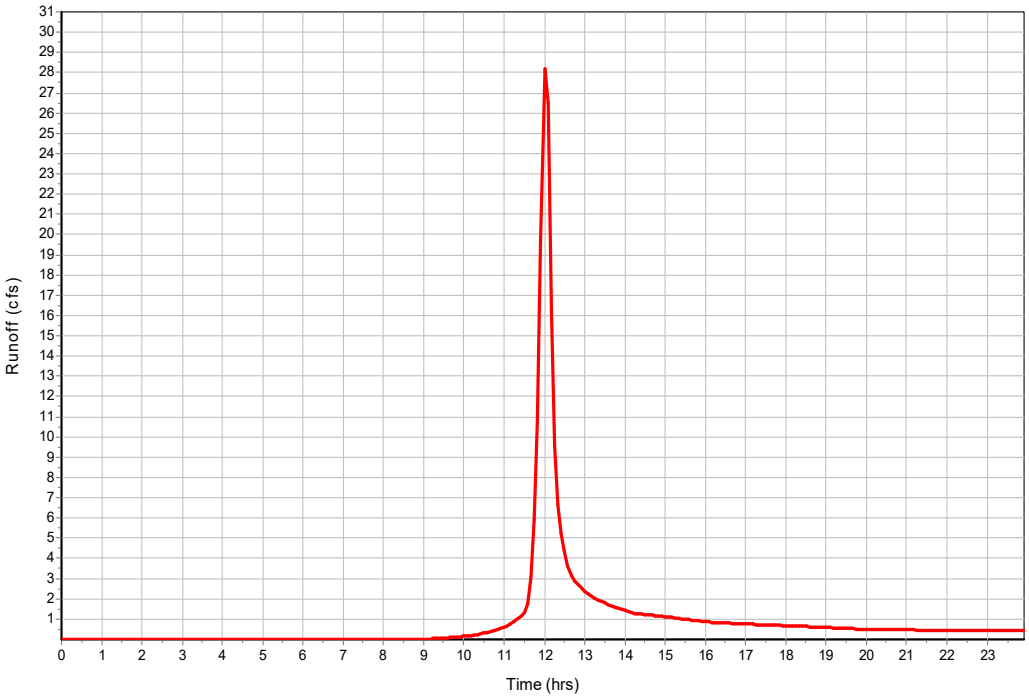
| | |
|---|---|
| Total Rainfall (in) | 2.7 |
| Total Runoff (in) | 1.27 |
| Peak Runoff (cfs) | 28.96 |
| Weighted Curve Number | 83.87 |
| Time of Concentration (days hh:mm:ss) | 0 00:13:00 |

**Subbasin : {Proposed}.DA : 3**

## Rainfall Intensity Graph




## Runoff Hydrograph



## Subbasin : {Proposed}.DA : 4

### Input Data

| | |
|---|---|
| Area (ac) | 10.3 |
| Peak Rate Factor | 484 |
| Weighted Curve Number | 84 |
| Rain Gage ID | Rain Gage-01 |

### Composite Curve Number

| 32 | Area | Soil | Curve |
|---|---|---|---|
| Soil/Surface Description | (acres) | Group | Number |
| Pasture, grassland, or range, Fair | 10.3 | D | 84 |
| Composite Area & Weighted CN | 10.3 | | 84 |

### Time of Concentration

| | Subarea | Subarea | Subarea |
|---|---|---|---|
| Sheet Flow Computations | A | B | C |
| Manning's Roughness : | 0.13 | 0 | 0 |
| Flow Length (ft) : | 100 | 0 | 0 |
| Slope (%) : | 7.32 | 0 | 0 |
| 2 yr, 24 hr Rainfall (in) : | 2.1 | 0 | 0 |
| Velocity (ft/sec) : | 0.26 | 0 | 0 |
| Computed Flow Time (min) : | 6.42 | 0 | 0 |

| | Subarea | Subarea | Subarea |
|---|---|---|---|
| Shallow Concentrated Flow Computations | A | B | C |
| Flow Length (ft) : | 974 | 0 | 0 |
| Slope (%) : | 5.52 | 0 | 0 |
| Surface Type : | Unpaved | Unpaved | Unpaved |
| Velocity (ft/sec) : | 3.79 | 0 | 0 |
| Computed Flow Time (min) : | 4.28 | 0 | 0 |

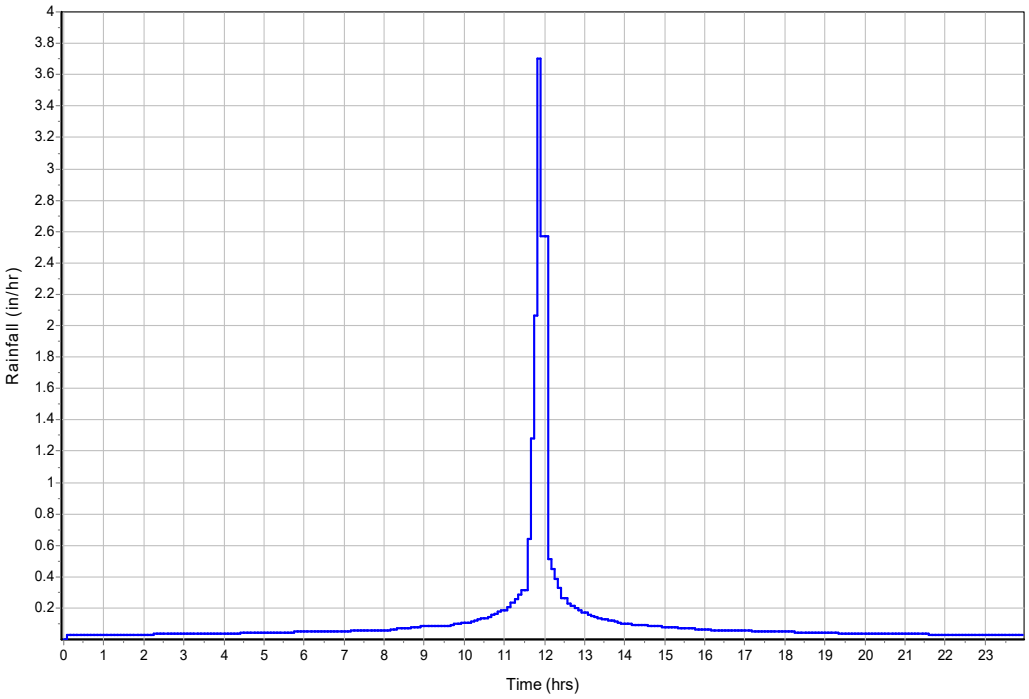
Total TOC (min) .....10.70

### Subbasin Runoff Results

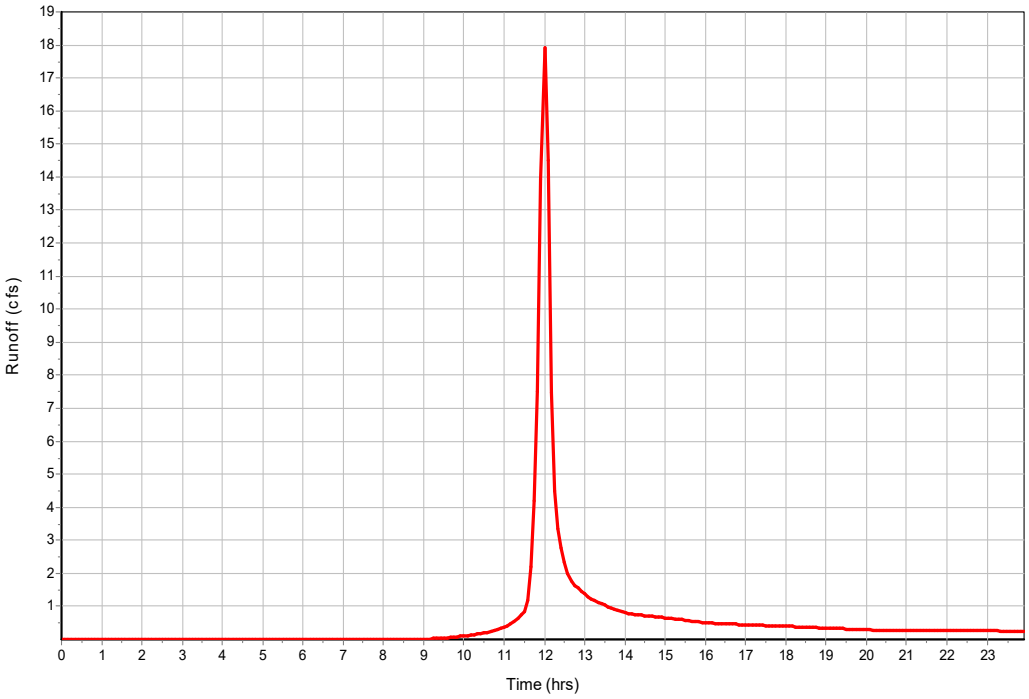
| | |
|---|---|
| Total Rainfall (in) | 2.7 |
| Total Runoff (in) | 1.27 |
| Peak Runoff (cfs) | 17.92 |
| Weighted Curve Number | 84 |
| Time of Concentration (days hh:mm:ss) | 0 00:10:42 |

**Subbasin : {Proposed}.DA : 4**

## Rainfall Intensity Graph




## Runoff Hydrograph



## Subbasin : {Proposed}.DA : 5

### Input Data

| | |
|---|---|
| Area (ac) | 4.5 |
| Peak Rate Factor | 484 |
| Weighted Curve Number | 98 |
| Rain Gage ID | Rain Gage-01 |

### Composite Curve Number

| 32 | Area | Soil | Curve |
|---|---|---|---|
| Soil/Surface Description | (acres) | Group | Number |
| Paved parking & roofs | 4.5 | D | 98 |
| Composite Area & Weighted CN | 4.5 | | 98 |

### Time of Concentration

| | Subarea | Subarea | Subarea |
|---|---|---|---|
| Sheet Flow Computations | A | B | C |
| Manning's Roughness : | 0.11 | 0 | 0 |
| Flow Length (ft) : | 100 | 0 | 0 |
| Slope (%) : | 5.38 | 0 | 0 |
| 2 yr, 24 hr Rainfall (in) : | 2.1 | 0 | 0 |
| Velocity (ft/sec) : | 0.26 | 0 | 0 |
| Computed Flow Time (min) : | 6.35 | 0 | 0 |

| | Subarea | Subarea | Subarea |
|---|---|---|---|
| Shallow Concentrated Flow Computations | A | B | C |
| Flow Length (ft) : | 306 | 0 | 0 |
| Slope (%) : | 1.12 | 0 | 0 |
| Surface Type : | Paved | Unpaved | Unpaved |
| Velocity (ft/sec) : | 2.15 | 0 | 0 |
| Computed Flow Time (min) : | 2.37 | 0 | 0 |

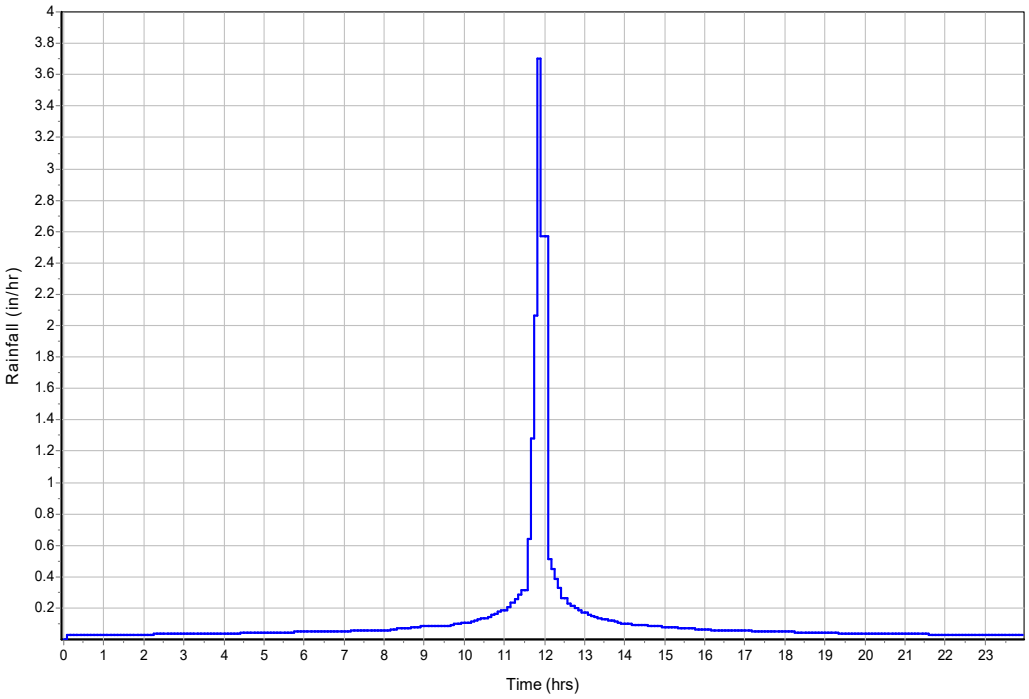
Total TOC (min) .....8.72

### Subbasin Runoff Results

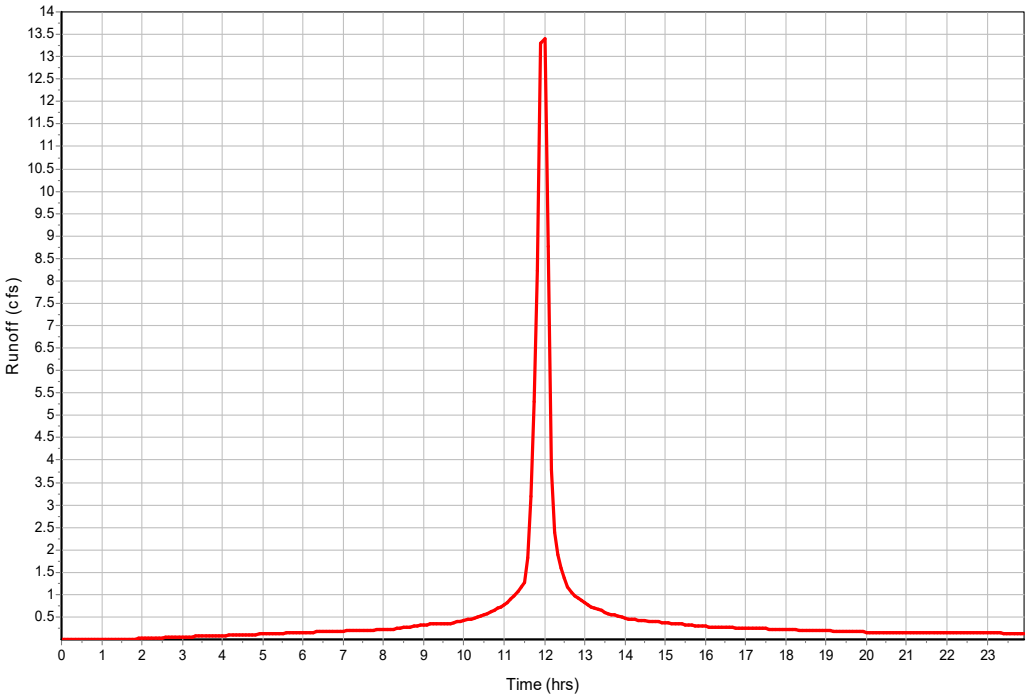
| | |
|---|---|
| Total Rainfall (in) | 2.7 |
| Total Runoff (in) | 2.47 |
| Peak Runoff (cfs) | 14.24 |
| Weighted Curve Number | 98 |
| Time of Concentration (days hh:mm:ss) | 0 00:08:43 |

**Subbasin : {Proposed}.DA : 5**

## Rainfall Intensity Graph




## Runoff Hydrograph



## Subbasin : {Proposed}.DA : 6

### Input Data

| | |
|---|---|
| Area (ac) | 34.3 |
| Peak Rate Factor | 484 |
| Weighted Curve Number | 82.04 |
| Rain Gage ID | Rain Gage-01 |

### Composite Curve Number

| 32 | Area | Soil | Curve |
|---|---|---|---|
| Soil/Surface Description | (acres) | Group | Number |
| Pasture, grassland, or range, Fair | 20.85 | D | 84 |
| Pasture, grassland, or range, Fair | 13.45 | C | 79 |
| Composite Area & Weighted CN | 34.3 | | 82.04 |

### Time of Concentration

| | Subarea | Subarea | Subarea |
|---|---|---|---|
| Sheet Flow Computations | A | B | C |
| Manning's Roughness : | 0.13 | 0 | 0 |
| Flow Length (ft) : | 100 | 0 | 0 |
| Slope (%) : | 3.66 | 0 | 0 |
| 2 yr, 24 hr Rainfall (in) : | 2.1 | 0 | 0 |
| Velocity (ft/sec) : | 0.2 | 0 | 0 |
| Computed Flow Time (min) : | 8.47 | 0 | 0 |

| | Subarea | Subarea | Subarea |
|---|---|---|---|
| Shallow Concentrated Flow Computations | A | B | C |
| Flow Length (ft) : | 1440 | 0 | 0 |
| Slope (%) : | 2.94 | 0 | 0 |
| Surface Type : | Unpaved | Unpaved | Unpaved |
| Velocity (ft/sec) : | 2.77 | 0 | 0 |
| Computed Flow Time (min) : | 8.66 | 0 | 0 |

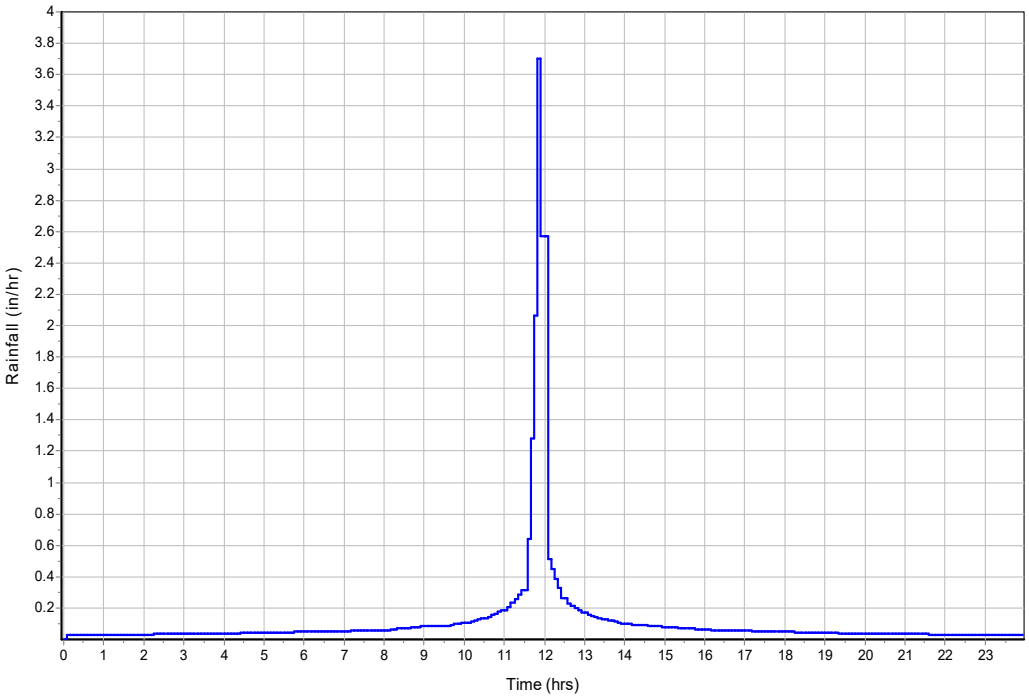
Total TOC (min) .....17.13

### Subbasin Runoff Results

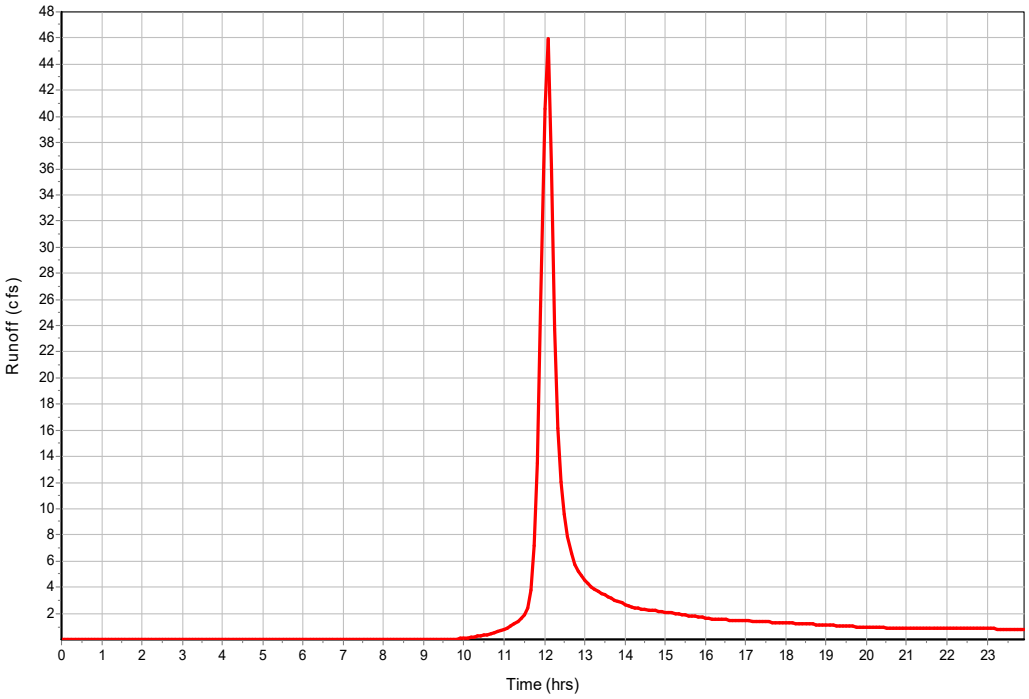
| | |
|---|---|
| Total Rainfall (in) | 2.7 |
| Total Runoff (in) | 1.15 |
| Peak Runoff (cfs) | 46.24 |
| Weighted Curve Number | 82.04 |
| Time of Concentration (days hh:mm:ss) | 0 00:17:08 |

**Subbasin : {Proposed}.DA : 6**

## Rainfall Intensity Graph




## Runoff Hydrograph



## Subbasin : {Proposed}.DA : 7

### Input Data

| | |
|---|---|
| Area (ac) | 44.2 |
| Peak Rate Factor | 484 |
| Weighted Curve Number | 92.51 |
| Rain Gage ID | Rain Gage-01 |

### Composite Curve Number

| 32<br>Soil/Surface Description | Area<br>(acres) | Soil<br>Group | Curve<br>Number |
|---|---|---|---|
| Paved parking & roofs | 26.88 | D | 98 |
| Pasture, grassland, or range, Fair | 17.32 | D | 84 |
| Composite Area & Weighted CN | 44.2 | | 92.51 |

### Time of Concentration

| Sheet Flow Computations | Subarea<br>A | Subarea<br>B | Subarea<br>C |
|---|---|---|---|
| Manning's Roughness : | 0.13 | 0 | 0 |
| Flow Length (ft) : | 100 | 0 | 0 |
| Slope (%) : | 4.83 | 0 | 0 |
| 2 yr, 24 hr Rainfall (in) : | 2.1 | 0 | 0 |
| Velocity (ft/sec) : | 0.22 | 0 | 0 |
| Computed Flow Time (min) : | 7.58 | 0 | 0 |

| Shallow Concentrated Flow Computations | Subarea<br>A | Subarea<br>B | Subarea<br>C |
|---|---|---|---|
| Flow Length (ft) : | 992 | 943 | 0 |
| Slope (%) : | 3.66 | 0.5 | 0 |
| Surface Type : | Unpaved | Paved | Unpaved |
| Velocity (ft/sec) : | 3.09 | 1.44 | 0 |
| Computed Flow Time (min) : | 5.35 | 10.91 | 0 |

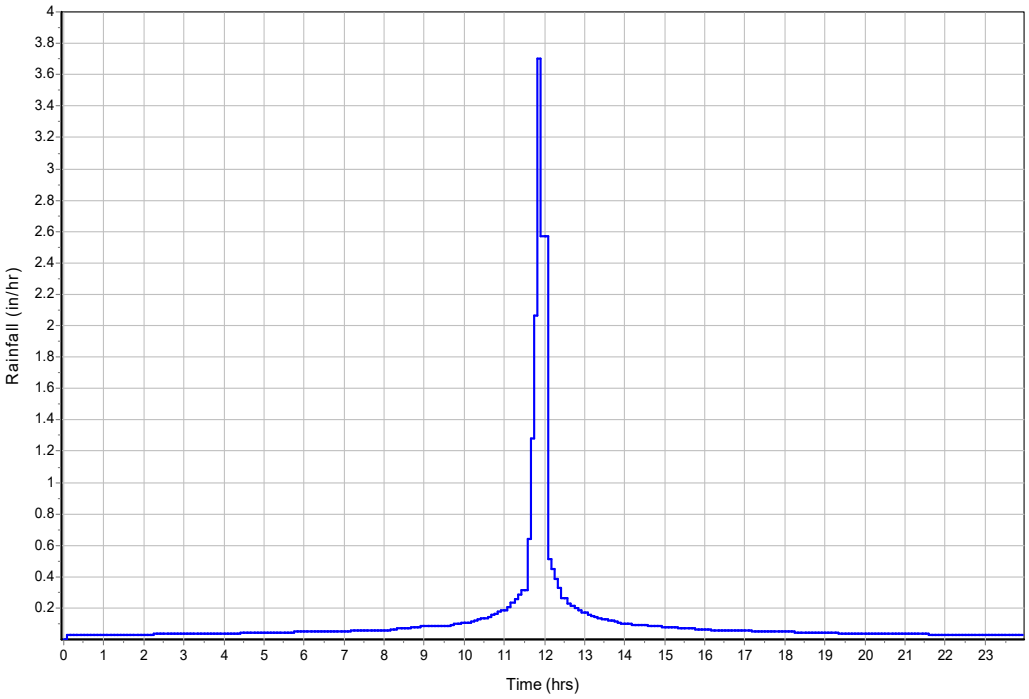
Total TOC (min) .....23.85

### Subbasin Runoff Results

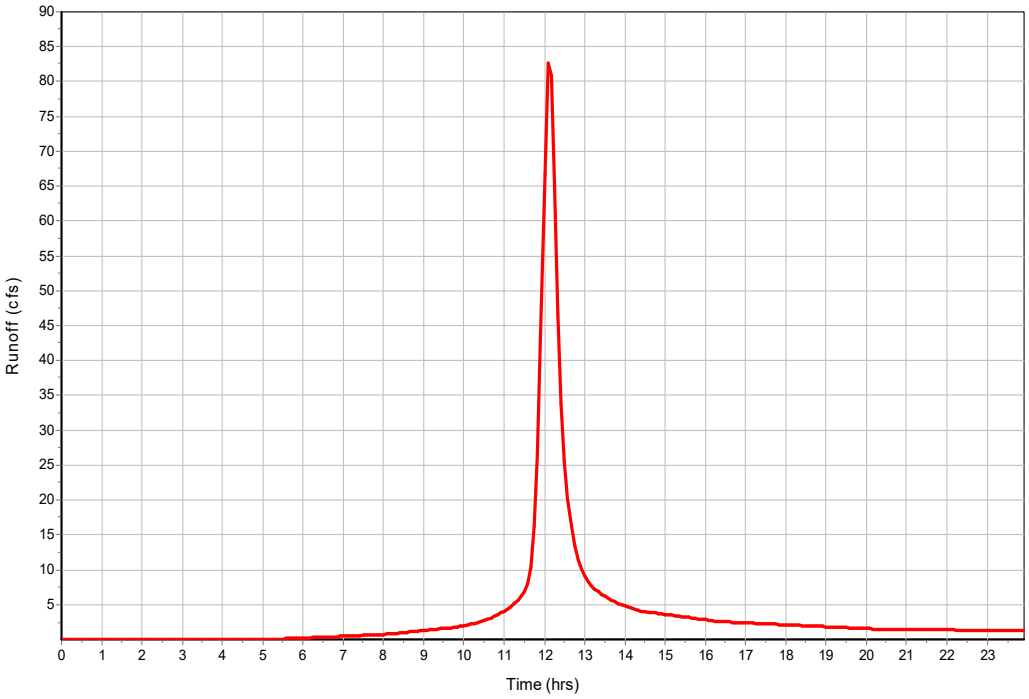
| | |
|---|---|
| Total Rainfall (in) | 2.7 |
| Total Runoff (in) | 1.92 |
| Peak Runoff (cfs) | 84.41 |
| Weighted Curve Number | 92.51 |
| Time of Concentration (days hh:mm:ss) | 0 00:23:51 |

**Subbasin : {Proposed}.DA : 7**

## Rainfall Intensity Graph




## Runoff Hydrograph



## Junction Input

| SN | 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 ($ft^2$) | Minimum Pipe Cover (in) |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1-Jun | 5437.80 | 5441.80 | 4.00 | 5437.80 | 0.00 | 5445.80 | 4.00 | 0.00 | 0.00 |
| 2 | 2-Jun | 5428.92 | 5440.40 | 11.48 | 5428.92 | 0.00 | 5451.88 | 11.48 | 0.00 | 0.00 |
| 3 | 3-Jun | 5427.02 | 5427.02 | 0.00 | 5427.02 | 0.00 | 5427.02 | 0.00 | 0.00 | 0.00 |
| 4 | 4-Jun | 5441.72 | 5443.72 | 2.00 | 5441.72 | 0.00 | 5445.72 | 2.00 | 0.00 | 0.00 |
| 5 | 5-Jun | 5426.06 | 5428.06 | 2.00 | 5426.06 | 0.00 | 5430.06 | 2.00 | 0.00 | 0.00 |
| 6 | 6-Jun | 5421.00 | 5426.00 | 5.00 | 5421.00 | 0.00 | 5431.00 | 5.00 | 0.00 | 0.00 |
| 7 | 7-Jun | 5417.00 | 5422.00 | 5.00 | 5417.00 | 0.00 | 5427.00 | 5.00 | 0.00 | 0.00 |
| 8 | Outlet_PondA | 5418.00 | 5420.50 | 2.50 | 5418.00 | 0.00 | 5423.00 | 2.50 | 0.00 | 0.00 |
| 9 | Outlet_PondB | 5424.00 | 5425.50 | 1.50 | 5424.00 | 0.00 | 5427.00 | 1.50 | 0.00 | 0.00 |
| 10 | Riser_PondA | 5418.00 | 5424.97 | 6.97 | 5418.00 | 0.00 | 5431.94 | 6.97 | 0.00 | 0.00 |
| 11 | Riser_PondB | 5424.00 | 5427.52 | 3.52 | 5424.00 | 0.00 | 5431.04 | 3.52 | 0.00 | 0.00 |

## Junction Results

| SN | 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) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1-Jun | 185.21 | 185.21 | 5439.33 | 1.53 | 0.00 | 2.47 | 5438.19 | 0.39 | 0 12:31 | 0 00:00 | 0.00 | 0.00 |
| 2 | 2-Jun | 234.21 | 87.13 | 5432.15 | 3.23 | 0.00 | 8.25 | 5429.67 | 0.75 | 0 12:31 | 0 00:00 | 0.00 | 0.00 |
| 3 | 3-Jun | 228.14 | 0.00 | 5427.74 | 0.72 | 0.00 | 4.28 | 5427.20 | 0.18 | 0 12:32 | 0 00:00 | 0.00 | 0.00 |
| 4 | 4-Jun | 28.15 | 28.15 | 5442.36 | 0.64 | 0.00 | 1.36 | 5441.82 | 0.10 | 0 12:09 | 0 00:00 | 0.00 | 0.00 |
| 5 | 5-Jun | 42.38 | 17.85 | 5426.85 | 0.79 | 0.00 | 1.21 | 5426.18 | 0.12 | 0 12:09 | 0 00:00 | 0.00 | 0.00 |
| 6 | 6-Jun | 238.79 | 0.00 | 5421.88 | 0.88 | 0.00 | 4.12 | 5421.23 | 0.23 | 0 12:32 | 0 00:00 | 0.00 | 0.00 |
| 7 | 7-Jun | 247.15 | 0.00 | 5417.99 | 0.99 | 0.00 | 10.01 | 5417.27 | 0.27 | 0 12:36 | 0 00:00 | 0.00 | 0.00 |
| 8 | Outlet_PondA | 13.81 | 0.00 | 5419.27 | 1.27 | 0.00 | 1.23 | 5418.49 | 0.49 | 0 12:50 | 0 00:00 | 0.00 | 0.00 |
| 9 | Outlet_PondB | 1.65 | 0.00 | 5424.35 | 0.35 | 0.00 | 1.15 | 5424.21 | 0.21 | 0 12:30 | 0 00:00 | 0.00 | 0.00 |
| 10 | Riser_PondA | 13.82 | 0.00 | 5419.73 | 1.73 | 0.00 | 5.24 | 5418.61 | 0.61 | 0 12:50 | 0 00:00 | 0.00 | 0.00 |
| 11 | Riser_PondB | 1.65 | 0.00 | 5424.55 | 0.55 | 0.00 | 2.97 | 5424.30 | 0.30 | 0 12:30 | 0 00:00 | 0.00 | 0.00 |

## Channel Input

| SN | Element ID | Length (ft) | Inlet Invert Elevation (ft) | Inlet Invert Offset (ft) | Outlet Invert Elevation (ft) | Outlet Invert Offset (ft) | Total Drop (ft) | Average Slope (%) | Shape | Height (ft) | Width (ft) | Manning's Roughness | Entrance Losses | Exit/Bend Losses | Additional Losses | Initial Flow (cfs) | Flap Gate |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | DITCH-01 | 1367.00 | 5437.80 | 0.00 | 5428.92 | 0.00 | 8.88 | 0.6500 | Trapezoidal | 4.000 | 52.000 | 0.0300 | 0.5000 | 0.5000 | 0.0000 | 0.00 | No |
| 2 | DITCH-02 | 1487.80 | 5441.72 | 0.00 | 5426.06 | 0.00 | 15.66 | 1.0500 | Trapezoidal | 2.000 | 26.000 | 0.0300 | 0.5000 | 0.5000 | 0.0000 | 0.00 | No |
| 3 | DITCH-03 | 207.00 | 5426.06 | 0.00 | 5421.00 | 0.00 | 5.06 | 2.4400 | Trapezoidal | 2.000 | 26.000 | 0.0400 | 0.5000 | 0.5000 | 0.0000 | 0.00 | No |
| 4 | EXISTDITCH-01 | 352.00 | 5427.02 | 0.00 | 5421.00 | 0.00 | 6.02 | 1.7100 | Trapezoidal | 5.000 | 120.000 | 0.0400 | 0.5000 | 0.5000 | 0.0000 | 0.00 | No |
| 5 | EXISTDITCH-02 | 415.00 | 5421.00 | 0.00 | 5417.00 | 0.00 | 4.00 | 0.9600 | Trapezoidal | 5.000 | 120.000 | 0.0400 | 0.5000 | 0.5000 | 0.0000 | 0.00 | No |
| 6 | EXISTDITCH-03 | 1033.00 | 5417.00 | 0.00 | 5409.60 | 0.00 | 7.40 | 0.7200 | Trapezoidal | 5.000 | 120.000 | 0.0400 | 0.5000 | 0.5000 | 0.0000 | 0.00 | No |

## 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 | DITCH-01 | 183.51 | 0 12:31 | 1119.58 | 0.16 | 2.61 | 8.73 | 2.37 | 0.59 | 0.00 | | |
| 2 | DITCH-02 | 26.59 | 0 12:09 | 224.45 | 0.12 | 2.89 | 8.58 | 0.72 | 0.36 | 0.00 | | |
| 3 | DITCH-03 | 41.61 | 0 12:10 | 256.53 | 0.16 | 4.55 | 0.76 | 0.73 | 0.37 | 0.00 | | |
| 4 | EXISTDITCH-01 | 228.10 | 0 12:32 | 6247.31 | 0.04 | 3.43 | 1.71 | 0.80 | 0.16 | 0.00 | | |
| 5 | EXISTDITCH-02 | 238.52 | 0 12:32 | 4689.99 | 0.05 | 3.09 | 2.24 | 0.93 | 0.19 | 0.00 | | |
| 6 | EXISTDITCH-03 | 246.01 | 0 12:37 | 4043.26 | 0.06 | 2.98 | 5.78 | 0.98 | 0.20 | 0.00 | | |

## Pipe Input

| SN | Element ID | Length (ft) | Inlet Invert Elevation (ft) | Inlet Invert Offset (ft) | Outlet Invert Elevation (ft) | Outlet Invert Offset (ft) | Total Drop (ft) | Average Slope (%) | Pipe Shape | Pipe Diameter or Height (in) | Pipe Width (in) | Manning's Roughness | Entrance Losses | Exit/Bend Losses | Additional Losses | Initial Flow (cfs) | Flap Gate | No. of Barrels |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | C-01 | 120.00 | 5428.92 | 0.00 | 5427.02 | 0.00 | 1.90 | 1.5800 | Rectangular | 48.000 | 60.000 | 0.0120 | 0.5000 | 0.5000 | 0.0000 | 0.00 | No | 3 |
| 2 | OutletPipe_PondA | 166.00 | 5418.00 | 0.00 | 5417.00 | 0.00 | 1.00 | 0.6000 | CIRCULAR | 30.000 | 30.000 | 0.0120 | 0.5000 | 0.5000 | 0.0000 | 0.00 | No | 1 |
| 3 | OutletPipe_PondB | 303.00 | 5424.00 | 0.00 | 5417.00 | 0.00 | 7.00 | 2.3100 | CIRCULAR | 18.000 | 18.000 | 0.0150 | 0.5000 | 0.5000 | 0.0000 | 0.00 | No | 1 |

## Pipe 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 | C-01 | 228.14 | 0 12:31 | 1002.95 | 0.23 | 7.71 | 0.26 | 1.97 | 0.49 | 0.00 | | Calculated |
| 2 | OutletPipe_PondA | 13.81 | 0 12:50 | 34.49 | 0.40 | 7.18 | 0.39 | 1.10 | 0.44 | 0.00 | | Calculated |
| 3 | OutletPipe_PondB | 1.64 | 0 12:31 | 13.84 | 0.12 | 5.30 | 0.95 | 0.67 | 0.44 | 0.00 | | Calculated |

# Storage Nodes

## Storage Node : PondA

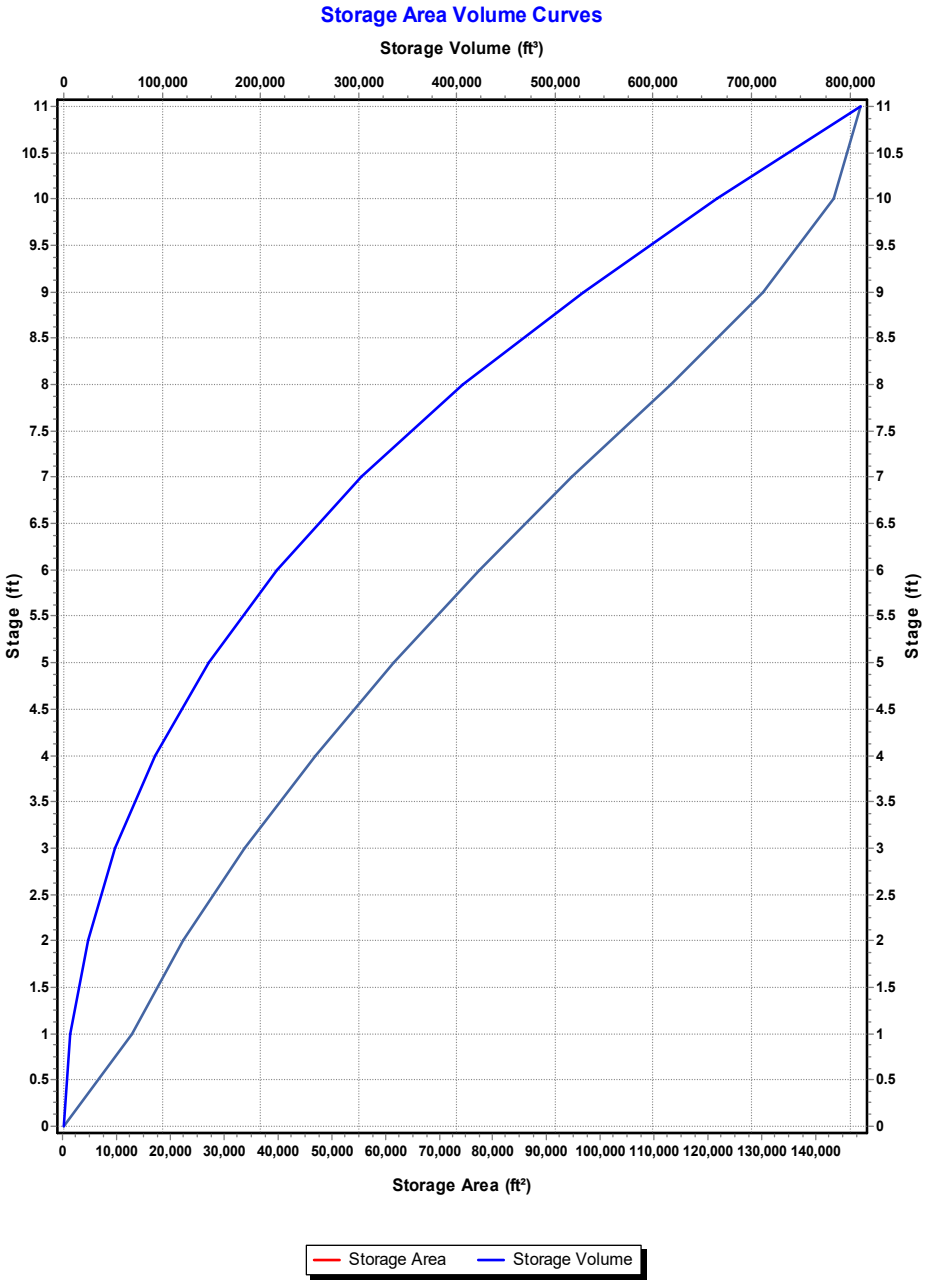
### Input Data

| | |
|---|---|
| Invert Elevation (ft) | 5420.00 |
| Max (Rim) Elevation (ft) | 5431.00 |
| Max (Rim) Offset (ft) | 11.00 |
| Initial Water Elevation (ft) | 5420.00 |
| Initial Water Depth (ft) | 0.00 |
| Ponded Area ($ft^2$) | 0.00 |
| Evaporation Loss | 0.00 |

### Storage Area Volume Curves

Storage Curve : Pond A

| Stage (ft) | Storage Area ($ft^2$) | Storage Volume ($ft^3$) |
|---|---|---|
| 0 | 300 | 0 |
| 1 | 13044 | 6672 |
| 2 | 22565 | 24476.5 |
| 3 | 33934 | 52726 |
| 4 | 46922 | 93154 |
| 5 | 61435 | 147332.5 |
| 6 | 77447 | 216773.5 |
| 7 | 94723 | 302858.5 |
| 8 | 113114 | 406777 |
| 9 | 130230 | 528449 |
| 10 | 143348 | 665238 |
| 11 | 148268 | 811046 |


Storage Area Volume Curves
Storage Volume (ft³)
0
100,000
200,000
300,000
400,000
500,000
600,000
700,000
800,000
Stage (ft)
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
5.5
6
6.5
7
7.5
8
8.5
9
9.5
10
10.5
11
Stage (ft)
0
10,000
20,000
30,000
40,000
50,000
60,000
70,000
80,000
90,000
100,000
110,000
120,000
130,000
140,000
Storage Area (ft²)
Storage Area
Storage Volume

## Storage Node : PondA (continued)

### Outflow Weirs

| SN | Element ID | Weir Type | Flap Gate | Crest Elevation (ft) | Crest Offset (ft) | Length (ft) | Weir Total Height (ft) | Discharge Coefficient |
|---|---|---|---|---|---|---|---|---|
| 1 | EMRGCYSPLWY_PondA | Trapezoidal | No | 5427.00 | 7.00 | 52.00 | 4.00 | 3.33 |

MHFD Detention spreadsheet shows length & width as 7 feet. Verify dimensions and revise documents as needed.

### Outflow Orifices

| SN | Element ID | Orifice Type | Orifice Shape | Flap Gate | Circular Orifice Diameter (in) | Rectangular Orifice Height (in) | Rectangular Orifice Width (in) | Orifice Invert Elevation (ft) | Orifice Coefficient |
|---|---|---|---|---|---|---|---|---|---|
| 1 | Grate_PondA | Bottom | Rectangular | No | | 48.00 | 48.00 | 5424.97 | 0.63 |
| 2 | WQCV/EURV_PondA | Side | Rectangular | No | | 3.00 | 6.58 | 5420.00 | 0.63 |

MHFD spreadsheet shows WQCV as 6.58 sq. inches with 3 rows. Verify dimensions of orifices and revise documents as needed. Or provide explanation how the 2 documents look at the outlets.

### Output Summary Results

| | |
|---|---|
| Peak Inflow (cfs) | 82.65 |
| Peak Lateral Inflow (cfs) | 82.65 |
| Peak Outflow (cfs) | 13.82 |
| Peak Exfiltration Flow Rate (cfm) | 0 |
| Max HGL Elevation Attained (ft) | 5425.35 |
| Max HGL Depth Attained (ft) | 5.35 |
| Average HGL Elevation Attained (ft) | 5423.53 |
| Average HGL Depth Attained (ft) | 3.53 |
| Time of Max HGL Occurrence (days hh:mm) | 0 12:49 |
| Total Exfiltration Volume (1000-ft$^3$) | 0 |
| Total Flooded Volume (ac-in) | 0 |
| Total Time Flooded (min) | 0 |
| Total Retention Time (sec) | 0 |

## Storage Node : PondB

### Input Data

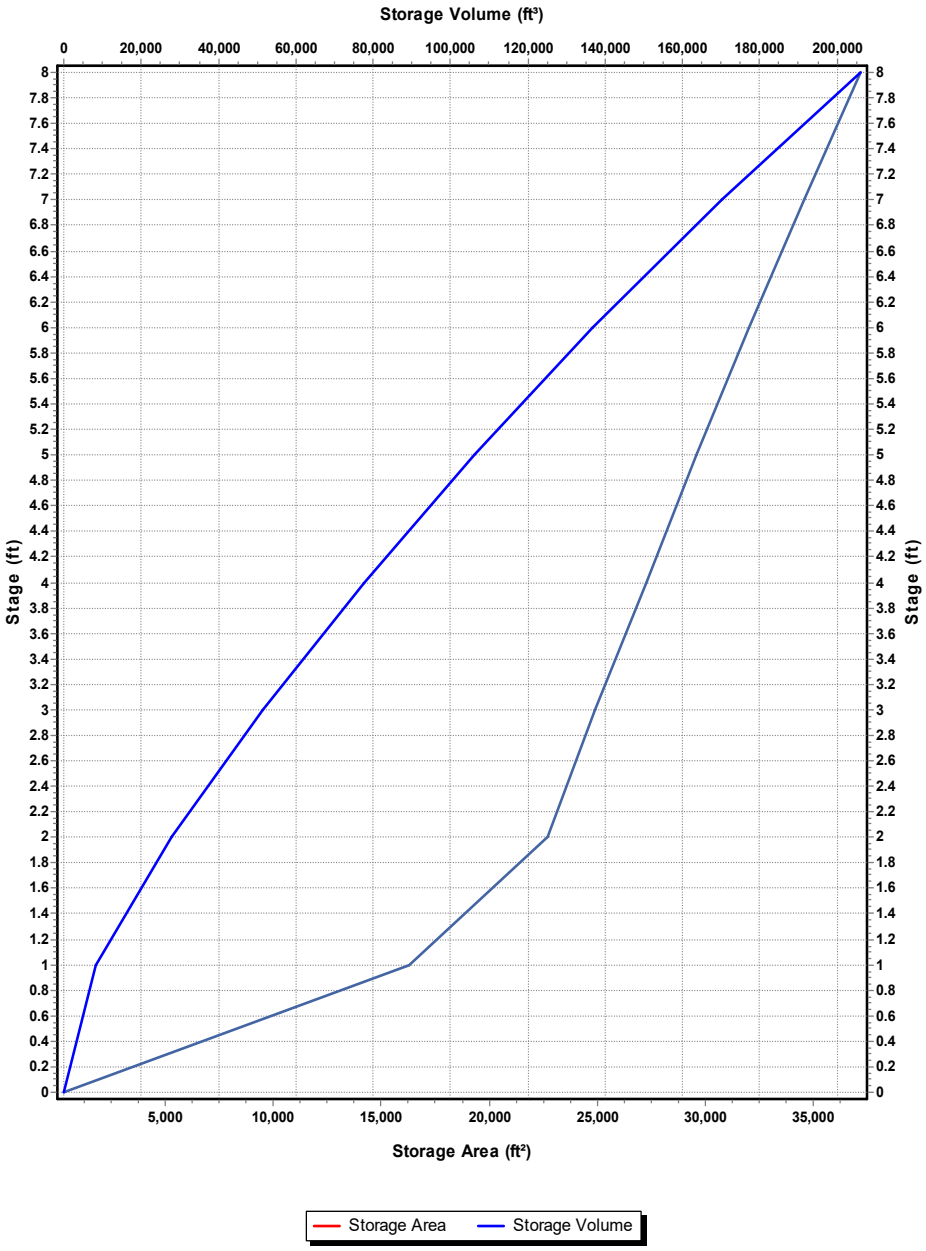
| | |
|---|---|
| Invert Elevation (ft) | 5426.00 |
| Max (Rim) Elevation (ft) | 5434.00 |
| Max (Rim) Offset (ft) | 8.00 |
| Initial Water Elevation (ft) | 5426.00 |
| Initial Water Depth (ft) | 0.00 |
| Ponded Area ($ft^2$) | 0.00 |
| Evaporation Loss | 0.00 |

### Storage Area Volume Curves

Storage Curve : Pond B

| Stage (ft) | Storage Area ($ft^2$) | Storage Volume ($ft^3$) |
|---|---|---|
| 0 | 300 | 0 |
| 1 | 16257 | 8278.5 |
| 2 | 22675 | 27744.5 |
| 3 | 24922 | 51543 |
| 4 | 27243 | 77625.5 |
| 5 | 29585 | 106039.5 |
| 6 | 32047 | 136855.5 |
| 7 | 34583 | 170170.5 |
| 8 | 37192 | 206058 |

## Storage Area Volume Curves



## Storage Node : PondB (continued)

### Outflow Weirs

| SN | Element ID | Weir Type | Flap Gate | Crest Elevation (ft) | Crest Offset (ft) | Length (ft) | Weir Total Height (ft) | Discharge Coefficient |
|---|---|---|---|---|---|---|---|---|
| 1 | EMRGCYSPLWY_PondB | Trapezoidal | No | 5431.00 | 5.00 | 7.00 | 3.00 | 3.33 |

MHFD Detention spreadsheet shows length & width as 14 feet. Verify dimensions and revise documents as needed.

### Outflow Orifices

| SN | Element ID | Orifice Type | Orifice Shape | Flap Gate | Circular Orifice Diameter (in) | Rectangular Orifice Height (in) | Rectangular Orifice Width (in) | Orifice Invert Elevation (ft) | Orifice Coefficient |
|---|---|---|---|---|---|---|---|---|---|
| 1 | Grate_PondB | Bottom | Rectangular | No | | 48.00 | 48.00 | 5427.52 | 0.63 |
| 2 | WQCV/EURV_PondB | Side | CIRCULAR | No | 6.16 | | | 5426.00 | 0.61 |

MHFD spreadsheet shows WQCV as 1.54sq. inches with 4 rows. Verify dimensions of orifices and revise documents as needed. Or provide explanation how the 2 documents look at the outlets.

### Output Summary Results

| | |
|---|---|
| Peak Inflow (cfs) | 13.4 |
| Peak Lateral Inflow (cfs) | 13.4 |
| Peak Outflow (cfs) | 1.65 |
| Peak Exfiltration Flow Rate (cfm) | 0 |
| Max HGL Elevation Attained (ft) | 5427.56 |
| Max HGL Depth Attained (ft) | 1.56 |
| Average HGL Elevation Attained (ft) | 5426.8 |
| Average HGL Depth Attained (ft) | 0.8 |
| Time of Max HGL Occurrence (days hh:mm) | 0 12:29 |
| Total Exfiltration Volume (1000-ft$^3$) | 0 |
| Total Flooded Volume (ac-in) | 0 |
| Total Time Flooded (min) | 0 |
| Total Retention Time (sec) | 0 |

## Project Description

| | |
|---|---|
| File Name | Proposed Conditions.SPF |
| Description | |
| | Proposed Conditions 100-yr storm |

## Project Options

| | |
|---|---|
| Flow Units | CFS |
| Elevation Type | Depth |
| Hydrology Method | SCS TR-55 |
| Time of Concentration (TOC) Method | SCS TR-55 |
| Link Routing Method | Hydrodynamic |
| Enable Overflow Ponding at Nodes | YES |
| Skip Steady State Analysis Time Periods | NO |

## Analysis Options

| | | |
|---|---|---|
| Start Analysis On | 00:00:00 | 0:00:00 |
| End Analysis On | 00:00:00 | 0:00:00 |
| Start Reporting On | 00:00:00 | 0:00:00 |
| 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 | 1 |
| Subbasins | 7 |
| Nodes | 14 |
| *Junctions* | 11 |
| *Outfalls* | 1 |
| *Flow Diversions* | 0 |
| *Inlets* | 0 |
| *Storage Nodes* | 2 |
| Links | 17 |
| *Channels* | 6 |
| *Pipes* | 3 |
| *Pumps* | 0 |
| *Orifices* | 6 |
| *Weirs* | 2 |
| *Outlets* | 0 |
| Pollutants | 0 |
| Land Uses | 0 |

## Rainfall Details

| SN | Rain Gage ID | Data Source | Data Source ID | Rainfall Type | Rain Units | State | County | Return Period (years) | Rainfall Depth (inches) | Rainfall Distribution |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Rain Gage-01 | Time Series | 100-yr | Cumulative | inches | Colorado | El Paso | 100.00 | 4.60 | SCS Type II 24-hr |

## Subbasin Summary

| SN | Subbasin ID | Area (ac) | Peak Rate Factor | Weighted Curve Number | Total Rainfall (in) | Total Runoff (in) | Total Runoff Volume (ac-in) | Peak Runoff (cfs) | Time of Concentration (days hh:mm:ss) |
|---|---|---|---|---|---|---|---|---|---|
| 1 | {Proposed}.DA : 1 | 266.90 | 484.00 | 82.22 | 4.60 | 2.74 | 732.37 | 450.39 | 0 00:51:56 |
| 2 | {Proposed}.DA : 2 | 75.00 | 484.00 | 83.89 | 4.60 | 2.90 | 217.28 | 200.73 | 0 00:27:41 |
| 3 | {Proposed}.DA : 3 | 17.60 | 484.00 | 83.87 | 4.60 | 2.90 | 50.95 | 65.72 | 0 00:13:00 |
| 4 | {Proposed}.DA : 4 | 10.30 | 484.00 | 84.00 | 4.60 | 2.91 | 29.94 | 40.50 | 0 00:10:42 |
| 5 | {Proposed}.DA : 5 | 4.50 | 484.00 | 98.00 | 4.60 | 4.36 | 19.64 | 24.55 | 0 00:08:43 |
| 6 | {Proposed}.DA : 6 | 34.30 | 484.00 | 82.04 | 4.60 | 2.73 | 93.57 | 110.09 | 0 00:17:07 |
| 7 | {Proposed}.DA : 7 | 44.20 | 484.00 | 92.51 | 4.60 | 3.75 | 165.88 | 159.88 | 0 00:23:51 |

## Node Summary

| SN | Element ID | Element Type | Invert Elevation (ft) | Ground/Rim (Max) Elevation (ft) | Initial Water Elevation (ft) | Surcharge Elevation (ft) | Ponded Area ($ft^2$) | Peak Inflow (cfs) | Max HGL Elevation Attained (ft) | Max Surcharge Depth Attained (ft) | Min Freeboard Attained (ft) | Time of Peak Flooding Occurrence (days hh:mm) | Total Flooded Volume (ac-in) | Total Time Flooded (min) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1-Jun | Junction | 5437.80 | 5441.80 | 5437.80 | 5445.80 | 0.00 | 449.45 | 5440.29 | 0.00 | 1.51 | 0 00:00 | 0.00 | 0.00 |
| 2 | 2-Jun | Junction | 5428.92 | 5440.40 | 5428.92 | 5451.88 | 0.00 | 570.49 | 5435.27 | 0.00 | 5.13 | 0 00:00 | 0.00 | 0.00 |
| 3 | 3-Jun | Junction | 5427.02 | 5427.02 | 5427.02 | 5427.02 | 0.00 | 570.45 | 5428.26 | 0.00 | 3.76 | 0 00:00 | 0.00 | 0.00 |
| 4 | 4-Jun | Junction | 5441.72 | 5443.72 | 5441.72 | 5445.72 | 0.00 | 64.87 | 5442.74 | 0.00 | 0.98 | 0 00:00 | 0.00 | 0.00 |
| 5 | 5-Jun | Junction | 5426.06 | 5428.06 | 5426.06 | 5430.06 | 0.00 | 98.80 | 5427.32 | 0.00 | 0.74 | 0 00:00 | 0.00 | 0.00 |
| 6 | 6-Jun | Junction | 5421.00 | 5426.00 | 5421.00 | 5431.00 | 0.00 | 603.61 | 5422.52 | 0.00 | 3.48 | 0 00:00 | 0.00 | 0.00 |
| 7 | 7-Jun | Junction | 5417.00 | 5422.00 | 5417.00 | 5427.00 | 0.00 | 658.99 | 5418.78 | 0.00 | 9.22 | 0 00:00 | 0.00 | 0.00 |
| 8 | Outlet_PondA | Junction | 5418.00 | 5420.50 | 5418.00 | 5423.00 | 0.00 | 46.89 | 5422.45 | 1.95 | 0.00 | 0 00:00 | 0.00 | 0.00 |
| 9 | Outlet_PondB | Junction | 5424.00 | 5425.50 | 5424.00 | 5427.00 | 0.00 | 9.87 | 5424.96 | 0.00 | 0.54 | 0 00:00 | 0.00 | 0.00 |
| 10 | Riser_PondA | Junction | 5418.00 | 5424.97 | 5418.00 | 5431.94 | 0.00 | 59.28 | 5425.74 | 0.77 | 0.00 | 0 00:00 | 0.00 | 0.00 |
| 11 | Riser_PondB | Junction | 5424.00 | 5427.52 | 5424.00 | 5431.04 | 0.00 | 11.81 | 5427.62 | 0.10 | 0.00 | 0 00:00 | 0.00 | 0.00 |
| 12 | Out-01 | Outfall | 5409.60 | | | | | 695.98 | 5411.35 | | | | | |
| 13 | PondA | Storage Node | 5420.00 | 5431.00 | 5420.00 | | 0.00 | 157.28 | 5426.73 | | | | 0.00 | 0.00 |
| 14 | PondB | Storage Node | 5426.00 | 5434.00 | 5426.00 | | 0.00 | 23.03 | 5427.94 | | | | 0.00 | 0.00 |

## Link Summary

| SN | Element ID | Element Type | From (Inlet) Node | To (Outlet) Node | Length | Inlet Invert Elevation | Outlet Invert Elevation | Average Slope | Diameter or Height | Manning's Roughness | Peak Flow | Design Flow Capacity | Peak Flow/ Design Flow Ratio | Peak Flow Velocity | Peak Flow Depth | Peak Flow Depth/ Total Depth Ratio | Total Time Surcharged | Reported Condition |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | (ft) | (ft) | (ft) | (%) | (in) | | (cfs) | (cfs) | | (ft/sec) | (ft) | | (min) | |
| 1 | C-01 | Pipe | 2-Jun | 3-Jun | 120.00 | 5428.92 | 5427.02 | 1.5800 | 48.000 | 0.0120 | 570.45 | 1002.95 | 0.57 | 14.51 | 2.62 | 0.66 | 0.00 | Calculated |
| 2 | OutletPipe_PondA | Pipe | Outlet_PondA | 7-Jun | 166.00 | 5418.00 | 5417.00 | 0.6000 | 30.000 | 0.0120 | 46.89 | 34.49 | 1.36 | 11.84 | 2.14 | 0.86 | 0.00 | > CAPACITY |
| 3 | OutletPipe_PondB | Pipe | Outlet_PondB | 7-Jun | 303.00 | 5424.00 | 5417.00 | 2.3100 | 18.000 | 0.0150 | 9.92 | 13.84 | 0.72 | 7.51 | 1.22 | 0.81 | 0.00 | Calculated |
| 4 | DITCH-01 | Channel | 1-Jun | 2-Jun | 1367.00 | 5437.80 | 5428.92 | 0.6500 | 48.000 | 0.0300 | 447.32 | 1119.58 | 0.40 | 4.18 | 3.24 | 0.81 | 0.00 | |
| 5 | DITCH-02 | Channel | 4-Jun | 5-Jun | 1487.80 | 5441.72 | 5426.06 | 1.0500 | 24.000 | 0.0300 | 61.49 | 224.45 | 0.27 | 3.72 | 1.12 | 0.57 | 0.00 | |
| 6 | DITCH-03 | Channel | 5-Jun | 6-Jun | 207.00 | 5426.06 | 5421.00 | 2.4400 | 24.000 | 0.0400 | 96.80 | 256.53 | 0.38 | 5.68 | 1.25 | 0.64 | 0.00 | |
| 7 | EXISTDITCH-01 | Channel | 3-Jun | 6-Jun | 352.00 | 5427.02 | 5421.00 | 1.7100 | 60.000 | 0.0400 | 570.23 | 6247.31 | 0.09 | 4.83 | 1.38 | 0.28 | 0.00 | |
| 8 | EXISTDITCH-02 | Channel | 6-Jun | 7-Jun | 415.00 | 5421.00 | 5417.00 | 0.9600 | 60.000 | 0.0400 | 602.93 | 4689.99 | 0.13 | 4.29 | 1.65 | 0.33 | 0.00 | |
| 9 | EXISTDITCH-03 | Channel | 7-Jun | Out-01 | 1033.00 | 5417.00 | 5409.60 | 0.7200 | 60.000 | 0.0400 | 656.72 | 4043.26 | 0.16 | 4.28 | 1.76 | 0.35 | 0.00 | |
| 10 | Grate_PondA | Orifice | PondA | Riser_PondA | | 5420.00 | 5418.00 | | 48.000 | | 58.54 | | | | | | | |
| 11 | Grate_PondB | Orifice | PondB | Riser_PondB | | 5426.00 | 5424.00 | | 48.000 | | 11.17 | | | | | | | |
| 12 | RestrictorPlate_PondA | Orifice | Riser_PondA | Outlet_PondA | | 5418.00 | 5418.00 | | 24.700 | | 46.89 | | | | | | | |
| 13 | RestrictorPlate_PondB | Orifice | Riser_PondB | Outlet_PondB | | 5424.00 | 5424.00 | | 9.600 | | 9.87 | | | | | | | |
| 14 | WQCV/EURV_PondA | Orifice | PondA | Riser_PondA | | 5420.00 | 5418.00 | | 3.000 | | 1.61 | | | | | | | |
| 15 | WQCV/EURV_PondB | Orifice | PondB | Riser_PondB | | 5426.00 | 5424.00 | | 6.160 | | 1.27 | | | | | | | |
| 16 | EMRGCYSPLWY_PondA | Weir | PondA | 7-Jun | | 5420.00 | 5417.00 | | | | 0.00 | | | | | | | |
| 17 | EMRGCYSPLWY_PondB | Weir | PondB | 7-Jun | | 5426.00 | 5417.00 | | | | 0.00 | | | | | | | |

# Subbasin Hydrology

## Subbasin : {Proposed}.DA : 1

### Input Data

| | |
|---|---|
| Area (ac) | 266.9 |
| Peak Rate Factor | 484 |
| Weighted Curve Number | 82.22 |
| Rain Gage ID | Rain Gage-01 |

### Composite Curve Number

| 32 | Area | Soil | Curve |
|---|---|---|---|
| Soil/Surface Description | (acres) | Group | Number |
| Pasture, grassland, or range, Fair | 171.88 | D | 84 |
| Pasture, grassland, or range, Fair | 95.02 | C | 79 |
| Composite Area & Weighted CN | 266.9 | | 82.22 |

### Time of Concentration

TOC Method : SCS TR-55

Sheet Flow Equation :

Tc = (0.007 * ((n * Lf)^0.8)) / ((P^0.5) * (Sf^0.4))

Where :

Tc = Time of Concentration (hr)
n = Manning's roughness
Lf = Flow Length (ft)
P = 2 yr, 24 hr Rainfall (inches)
Sf = Slope (ft/ft)

Shallow Concentrated Flow Equation :

V = 16.1345 * (Sf^0.5) (unpaved surface)
V = 20.3282 * (Sf^0.5) (paved surface)
V = 15.0 * (Sf^0.5) (grassed waterway surface)
V = 10.0 * (Sf^0.5) (nearly bare & untilled surface)
V = 9.0 * (Sf^0.5) (cultivated straight rows surface)
V = 7.0 * (Sf^0.5) (short grass pasture surface)
V = 5.0 * (Sf^0.5) (woodland surface)
V = 2.5 * (Sf^0.5) (forest w/heavy litter surface)
Tc = (Lf / V) / (3600 sec/hr)

Where:

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)

Channel Flow Equation :

V = (1.49 * (R^(2/3)) * (Sf^0.5)) / n
R = Aq / Wp
Tc = (Lf / V) / (3600 sec/hr)

Where :

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
R = Hydraulic Radius (ft)
Aq = Flow Area ($ft^2$)
Wp = Wetted Perimeter (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)
n = Manning's roughness

| Sheet Flow Computations | Subarea A | Subarea B | Subarea C |
|---|---|---|---|
| Manning's Roughness : | 0.13 | 0 | 0 |
| Flow Length (ft) : | 100 | 0 | 0 |
| Slope (%) : | 1.51 | 0 | 0 |
| 2 yr, 24 hr Rainfall (in) : | 2.1 | 0 | 0 |
| Velocity (ft/sec) : | 0.14 | 0 | 0 |
| Computed Flow Time (min) : | 12.07 | 0 | 0 |

| Shallow Concentrated Flow Computations | Subarea A | Subarea B | Subarea C |
|---|---|---|---|
| Flow Length (ft) : | 5861 | 0 | 0 |
| Slope (%) : | 2.3 | 0 | 0 |
| Surface Type : | Unpaved | Unpaved | Unpaved |
| Velocity (ft/sec) : | 2.45 | 0 | 0 |
| Computed Flow Time (min) : | 39.87 | 0 | 0 |

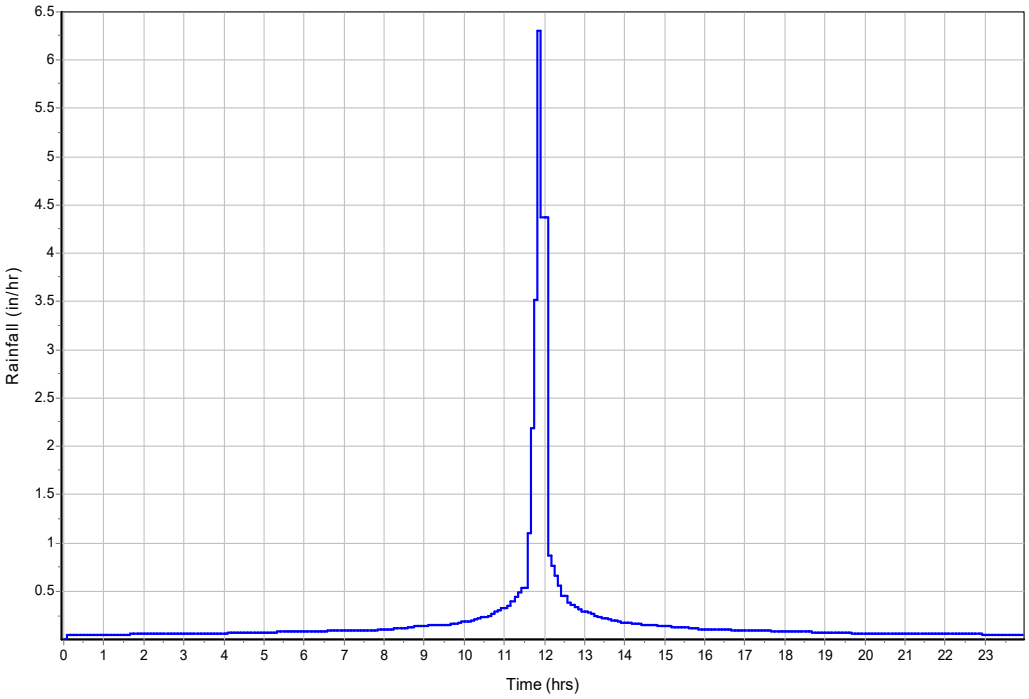
Total TOC (min) .....51.94

**Subbasin Runoff Results**

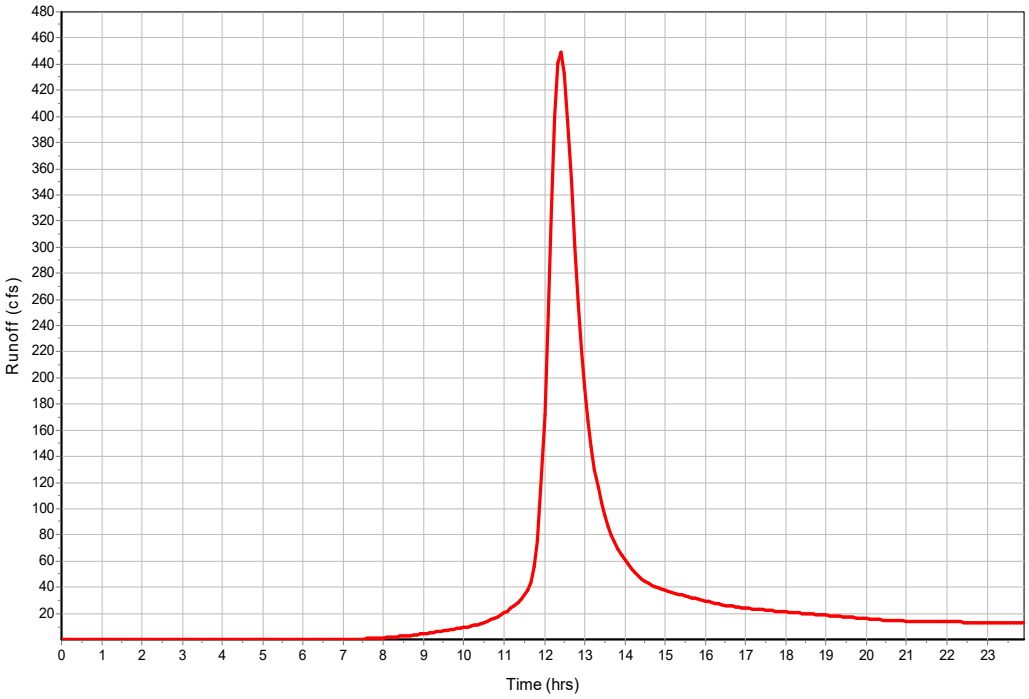
| | |
|---|---|
| Total Rainfall (in) | 4.6 |
| Total Runoff (in) | 2.74 |
| Peak Runoff (cfs) | 450.39 |
| Weighted Curve Number | 82.22 |
| Time of Concentration (days hh:mm:ss) | 0 00:51:56 |

**Subbasin : {Proposed}.DA : 1**

## Rainfall Intensity Graph




## Runoff Hydrograph



## Subbasin : {Proposed}.DA : 2

### Input Data

| | |
|---|---|
| Area (ac) | 75 |
| Peak Rate Factor | 484 |
| Weighted Curve Number | 83.89 |
| Rain Gage ID | Rain Gage-01 |

### Composite Curve Number

| 32<br>Soil/Surface Description | Area<br>(acres) | Soil<br>Group | Curve<br>Number |
|---|---|---|---|
| Pasture, grassland, or range, Fair | 73.35 | D | 84 |
| Pasture, grassland, or range, Fair | 1.65 | C | 79 |
| Composite Area & Weighted CN | 75 | | 83.89 |

### Time of Concentration

| Sheet Flow Computations | Subarea<br>A | Subarea<br>B | Subarea<br>C |
|---|---|---|---|
| Manning's Roughness : | 0.13 | 0 | 0 |
| Flow Length (ft) : | 100 | 0 | 0 |
| Slope (%) : | 2.84 | 0 | 0 |
| 2 yr, 24 hr Rainfall (in) : | 2.1 | 0 | 0 |
| Velocity (ft/sec) : | 0.18 | 0 | 0 |
| Computed Flow Time (min) : | 9.37 | 0 | 0 |

| Shallow Concentrated Flow Computations | Subarea<br>A | Subarea<br>B | Subarea<br>C |
|---|---|---|---|
| Flow Length (ft) : | 3055 | 0 | 0 |
| Slope (%) : | 2.96 | 0 | 0 |
| Surface Type : | Unpaved | Unpaved | Unpaved |
| Velocity (ft/sec) : | 2.78 | 0 | 0 |
| Computed Flow Time (min) : | 18.32 | 0 | 0 |

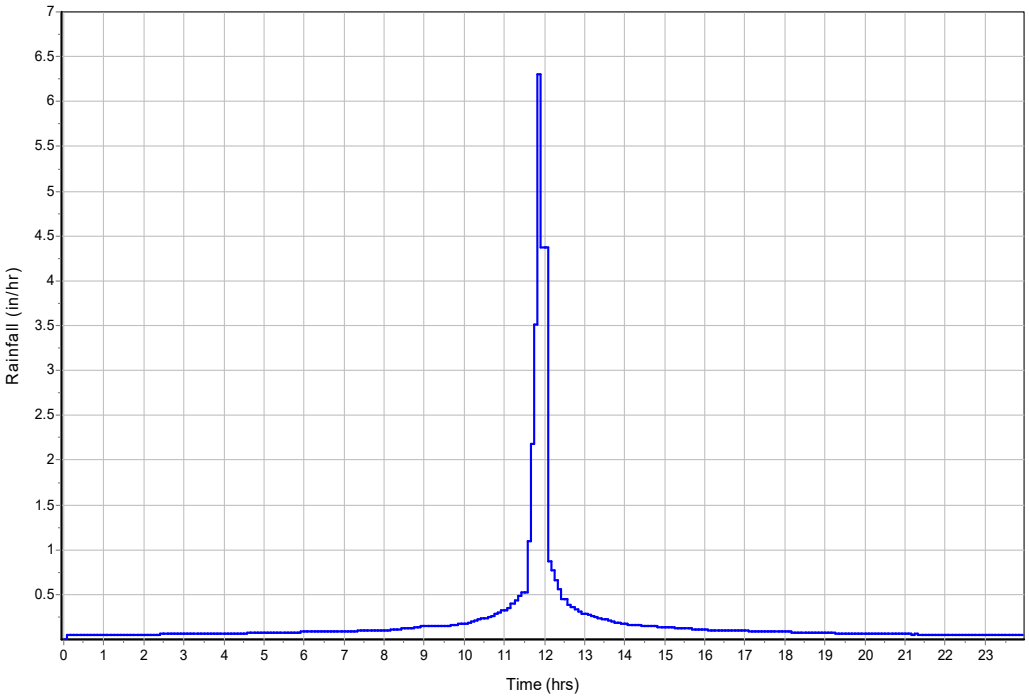
Total TOC (min) .....27.69

### Subbasin Runoff Results

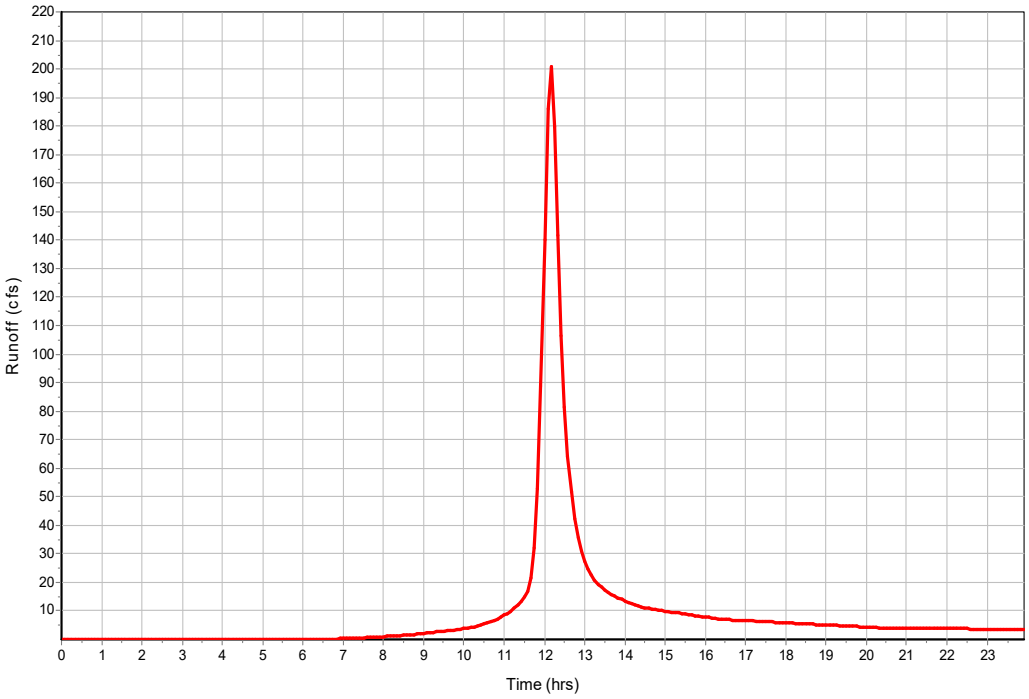
| | |
|---|---|
| Total Rainfall (in) | 4.6 |
| Total Runoff (in) | 2.9 |
| Peak Runoff (cfs) | 200.73 |
| Weighted Curve Number | 83.89 |
| Time of Concentration (days hh:mm:ss) | 0 00:27:41 |

**Subbasin : {Proposed}.DA : 2**

## Rainfall Intensity Graph




## Runoff Hydrograph



## Subbasin : {Proposed}.DA : 3

### Input Data

| | |
|---|---|
| Area (ac) | 17.6 |
| Peak Rate Factor | 484 |
| Weighted Curve Number | 83.87 |
| Rain Gage ID | Rain Gage-01 |

### Composite Curve Number

| 32 | Area | Soil | Curve |
|---|---|---|---|
| Soil/Surface Description | (acres) | Group | Number |
| Pasture, grassland, or range, Fair | 17.16 | D | 84 |
| Pasture, grassland, or range, Fair | 0.44 | C | 79 |
| Composite Area & Weighted CN | 17.6 | | 83.87 |

### Time of Concentration

| | Subarea | Subarea | Subarea |
|---|---|---|---|
| Sheet Flow Computations | A | B | C |
| Manning's Roughness : | 0.13 | 0 | 0 |
| Flow Length (ft) : | 100 | 0 | 0 |
| Slope (%) : | 5.13 | 0 | 0 |
| 2 yr, 24 hr Rainfall (in) : | 2.1 | 0 | 0 |
| Velocity (ft/sec) : | 0.23 | 0 | 0 |
| Computed Flow Time (min) : | 7.4 | 0 | 0 |

| | Subarea | Subarea | Subarea |
|---|---|---|---|
| Shallow Concentrated Flow Computations | A | B | C |
| Flow Length (ft) : | 1052 | 0 | 0 |
| Slope (%) : | 3.77 | 0 | 0 |
| Surface Type : | Unpaved | Unpaved | Unpaved |
| Velocity (ft/sec) : | 3.13 | 0 | 0 |
| Computed Flow Time (min) : | 5.6 | 0 | 0 |

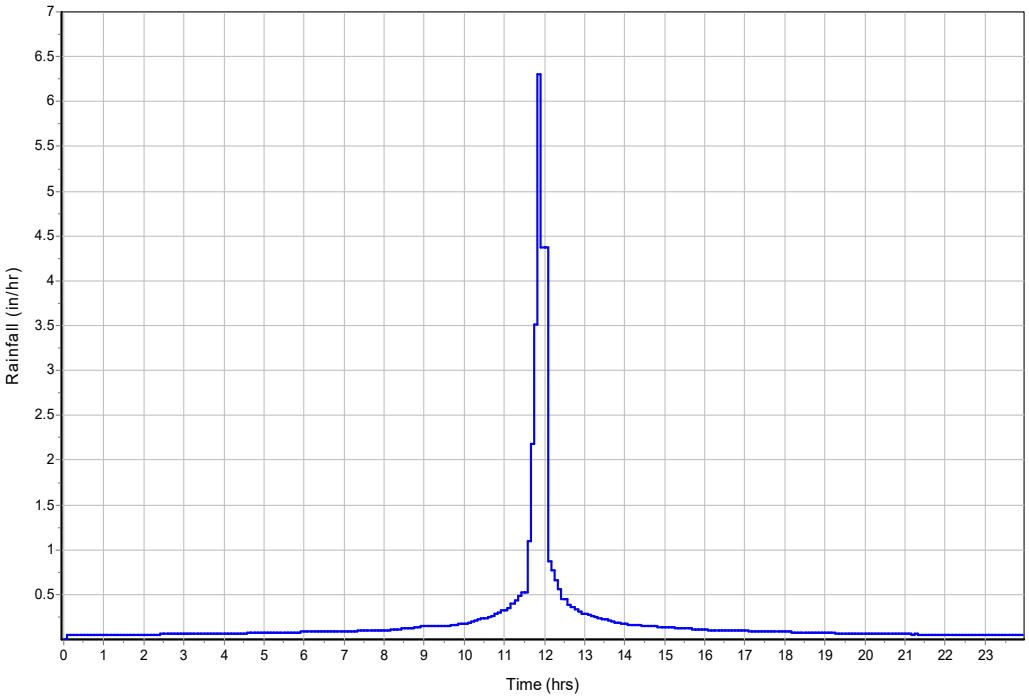
Total TOC (min) .....13.00

### Subbasin Runoff Results

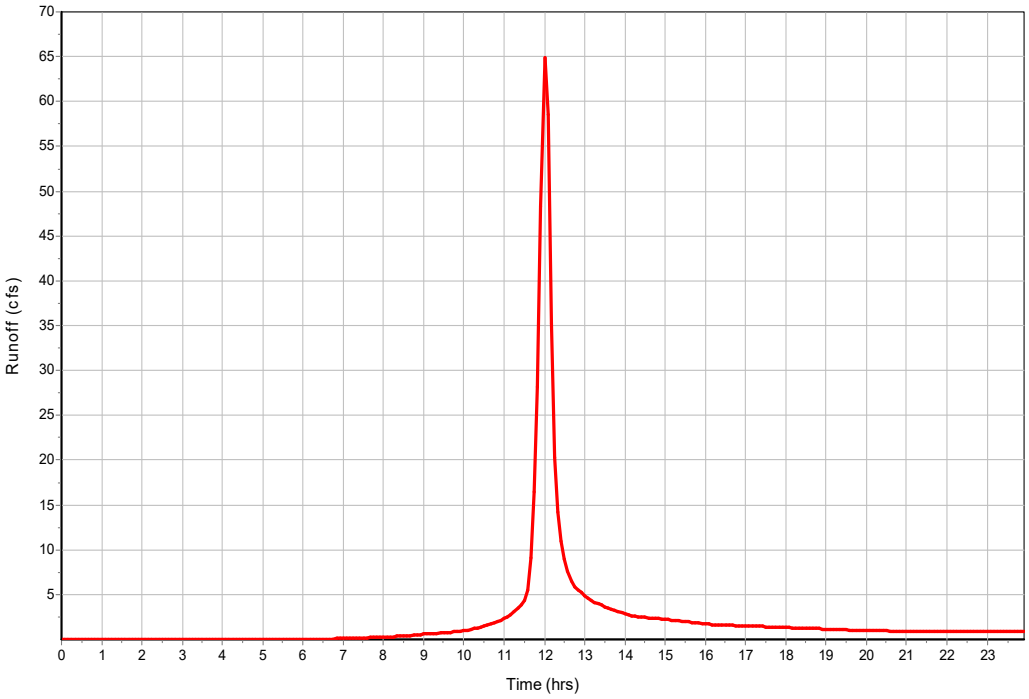
| | |
|---|---|
| Total Rainfall (in) | 4.6 |
| Total Runoff (in) | 2.9 |
| Peak Runoff (cfs) | 65.72 |
| Weighted Curve Number | 83.87 |
| Time of Concentration (days hh:mm:ss) | 0 00:13:00 |

**Subbasin : {Proposed}.DA : 3**

## Rainfall Intensity Graph




## Runoff Hydrograph



## Subbasin : {Proposed}.DA : 4

### Input Data

| | |
|---|---|
| Area (ac) | 10.3 |
| Peak Rate Factor | 484 |
| Weighted Curve Number | 84 |
| Rain Gage ID | Rain Gage-01 |

### Composite Curve Number

| 32 | Area | Soil | Curve |
|---|---|---|---|
| Soil/Surface Description | (acres) | Group | Number |
| Pasture, grassland, or range, Fair | 10.3 | D | 84 |
| Composite Area & Weighted CN | 10.3 | | 84 |

### Time of Concentration

| | Subarea | Subarea | Subarea |
|---|---|---|---|
| Sheet Flow Computations | A | B | C |
| Manning's Roughness : | 0.13 | 0 | 0 |
| Flow Length (ft) : | 100 | 0 | 0 |
| Slope (%) : | 7.32 | 0 | 0 |
| 2 yr, 24 hr Rainfall (in) : | 2.1 | 0 | 0 |
| Velocity (ft/sec) : | 0.26 | 0 | 0 |
| Computed Flow Time (min) : | 6.42 | 0 | 0 |

| | Subarea | Subarea | Subarea |
|---|---|---|---|
| Shallow Concentrated Flow Computations | A | B | C |
| Flow Length (ft) : | 974 | 0 | 0 |
| Slope (%) : | 5.52 | 0 | 0 |
| Surface Type : | Unpaved | Unpaved | Unpaved |
| Velocity (ft/sec) : | 3.79 | 0 | 0 |
| Computed Flow Time (min) : | 4.28 | 0 | 0 |

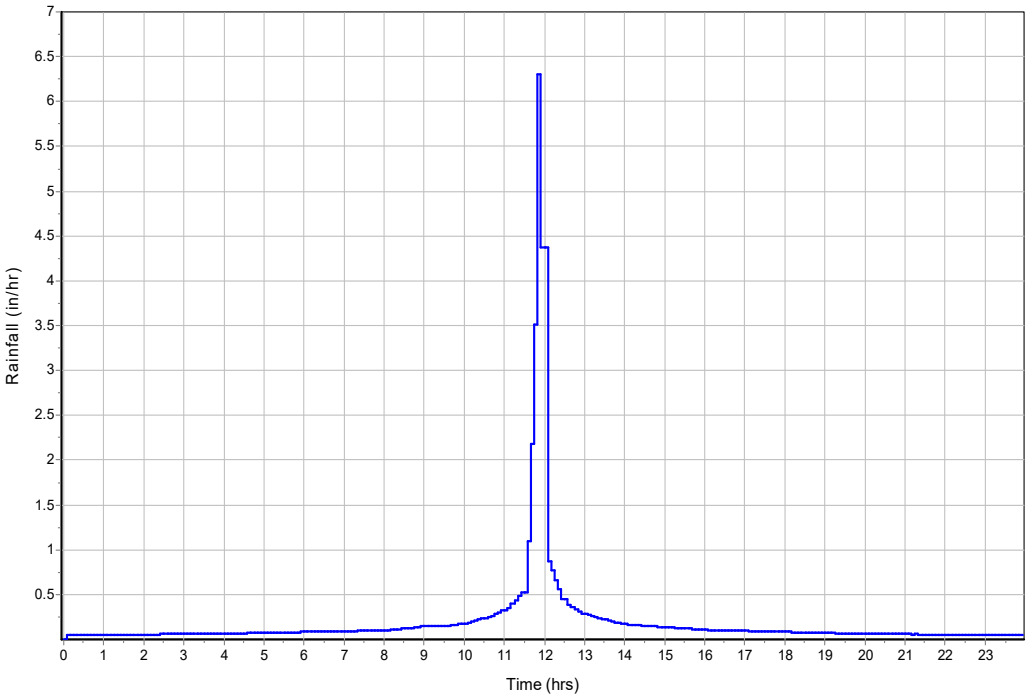
Total TOC (min) .....10.70

### Subbasin Runoff Results

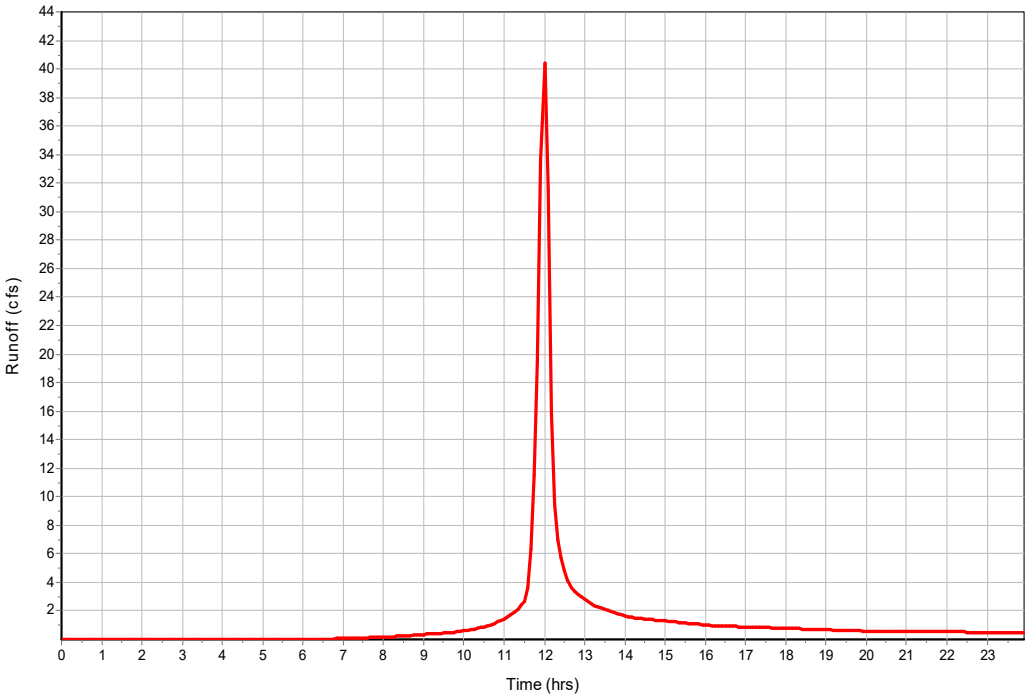
| | |
|---|---|
| Total Rainfall (in) | 4.6 |
| Total Runoff (in) | 2.91 |
| Peak Runoff (cfs) | 40.5 |
| Weighted Curve Number | 84 |
| Time of Concentration (days hh:mm:ss) | 0 00:10:42 |

**Subbasin : {Proposed}.DA : 4**

**Rainfall Intensity Graph**




**Runoff Hydrograph**



## Subbasin : {Proposed}.DA : 5

### Input Data

| | |
|---|---|
| Area (ac) | 4.5 |
| Peak Rate Factor | 484 |
| Weighted Curve Number | 98 |
| Rain Gage ID | Rain Gage-01 |

### Composite Curve Number

| 32 | Area | Soil | Curve |
|---|---|---|---|
| Soil/Surface Description | (acres) | Group | Number |
| Paved parking & roofs | 4.5 | D | 98 |
| Composite Area & Weighted CN | 4.5 | | 98 |

### Time of Concentration

| | Subarea | Subarea | Subarea |
|---|---|---|---|
| Sheet Flow Computations | A | B | C |
| Manning's Roughness : | 0.11 | 0 | 0 |
| Flow Length (ft) : | 100 | 0 | 0 |
| Slope (%) : | 5.38 | 0 | 0 |
| 2 yr, 24 hr Rainfall (in) : | 2.1 | 0 | 0 |
| Velocity (ft/sec) : | 0.26 | 0 | 0 |
| Computed Flow Time (min) : | 6.35 | 0 | 0 |

| | Subarea | Subarea | Subarea |
|---|---|---|---|
| Shallow Concentrated Flow Computations | A | B | C |
| Flow Length (ft) : | 306 | 0 | 0 |
| Slope (%) : | 1.12 | 0 | 0 |
| Surface Type : | Paved | Unpaved | Unpaved |
| Velocity (ft/sec) : | 2.15 | 0 | 0 |
| Computed Flow Time (min) : | 2.37 | 0 | 0 |

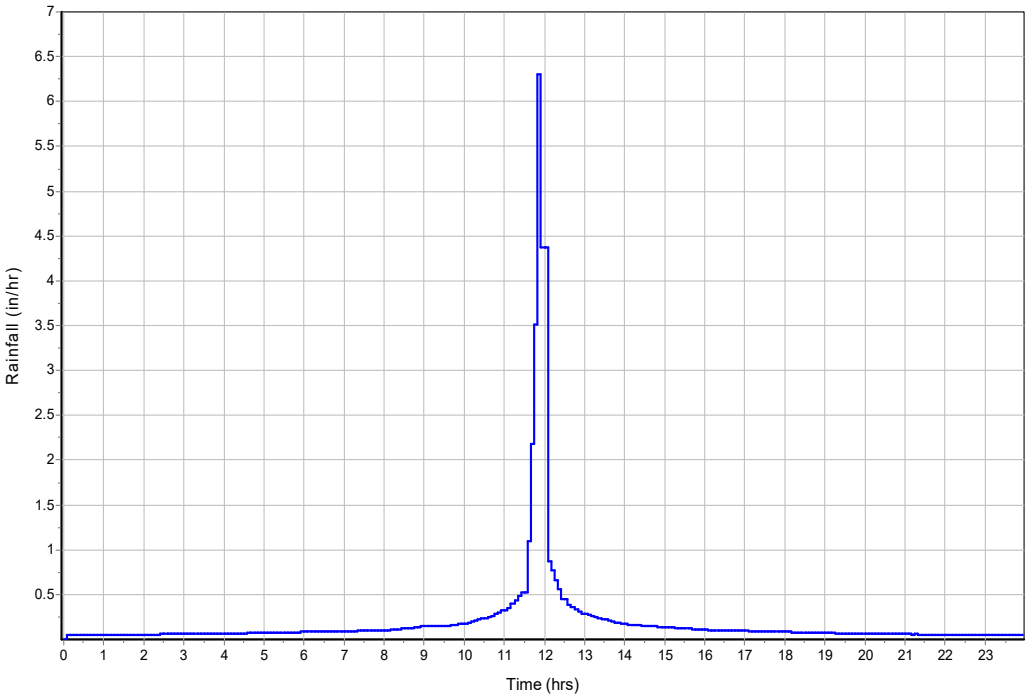
Total TOC (min) .....8.72

### Subbasin Runoff Results

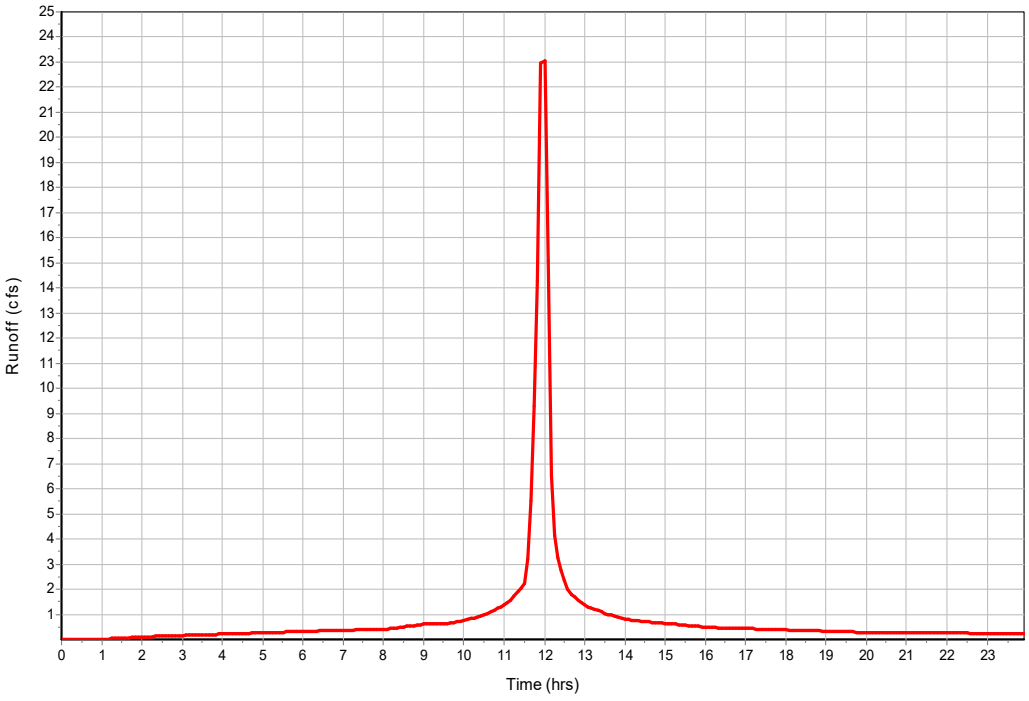
| | |
|---|---|
| Total Rainfall (in) | 4.6 |
| Total Runoff (in) | 4.36 |
| Peak Runoff (cfs) | 24.55 |
| Weighted Curve Number | 98 |
| Time of Concentration (days hh:mm:ss) | 0 00:08:43 |

**Subbasin : {Proposed}.DA : 5**

## Rainfall Intensity Graph




## Runoff Hydrograph



## Subbasin : {Proposed}.DA : 6

### Input Data

| | |
|---|---|
| Area (ac) | 34.3 |
| Peak Rate Factor | 484 |
| Weighted Curve Number | 82.04 |
| Rain Gage ID | Rain Gage-01 |

### Composite Curve Number

| 32 | Area | Soil | Curve |
|---|---|---|---|
| Soil/Surface Description | (acres) | Group | Number |
| Pasture, grassland, or range, Fair | 20.85 | D | 84 |
| Pasture, grassland, or range, Fair | 13.45 | C | 79 |
| Composite Area & Weighted CN | 34.3 | | 82.04 |

### Time of Concentration

| | Subarea | Subarea | Subarea |
|---|---|---|---|
| Sheet Flow Computations | A | B | C |
| Manning's Roughness : | 0.13 | 0 | 0 |
| Flow Length (ft) : | 100 | 0 | 0 |
| Slope (%) : | 3.66 | 0 | 0 |
| 2 yr, 24 hr Rainfall (in) : | 2.1 | 0 | 0 |
| Velocity (ft/sec) : | 0.2 | 0 | 0 |
| Computed Flow Time (min) : | 8.47 | 0 | 0 |

| | Subarea | Subarea | Subarea |
|---|---|---|---|
| Shallow Concentrated Flow Computations | A | B | C |
| Flow Length (ft) : | 1440 | 0 | 0 |
| Slope (%) : | 2.94 | 0 | 0 |
| Surface Type : | Unpaved | Unpaved | Unpaved |
| Velocity (ft/sec) : | 2.77 | 0 | 0 |
| Computed Flow Time (min) : | 8.66 | 0 | 0 |

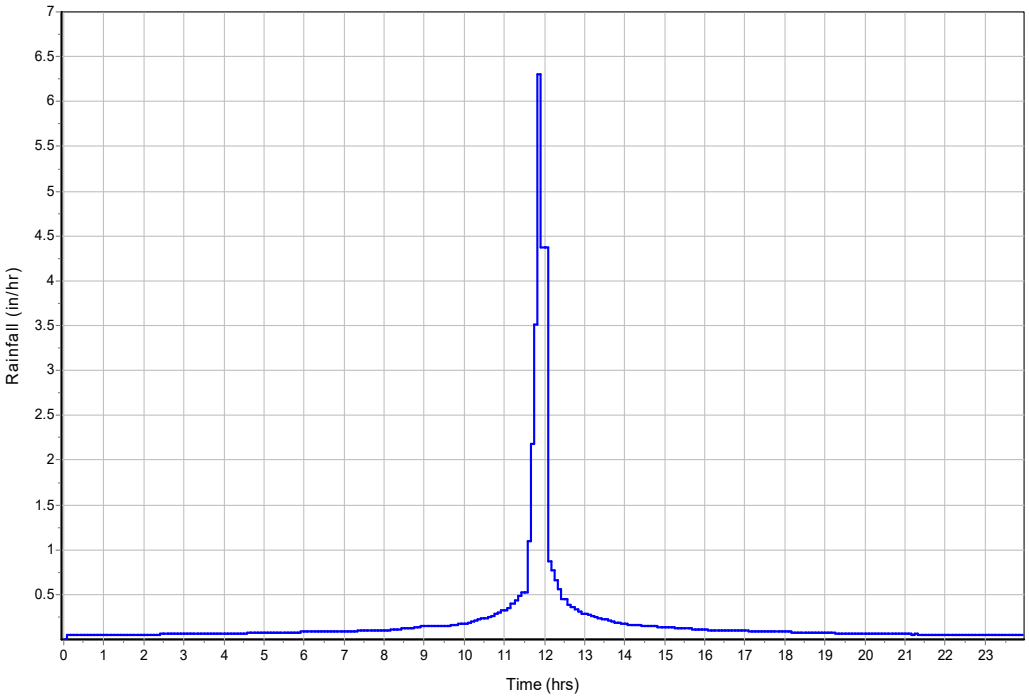
Total TOC (min) .....17.13

### Subbasin Runoff Results

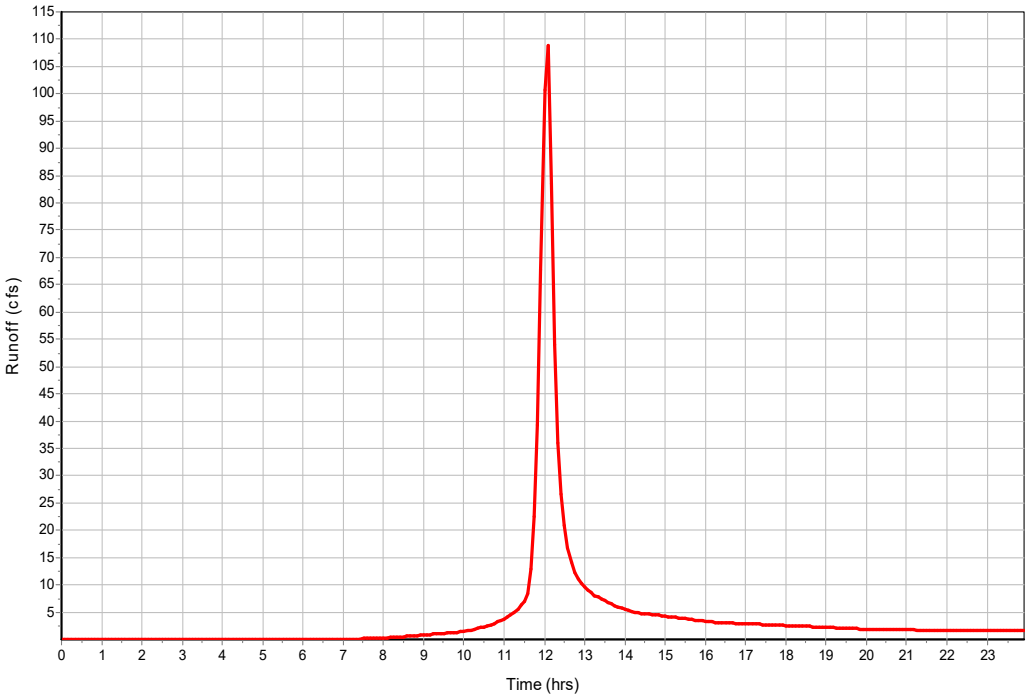
| | |
|---|---|
| Total Rainfall (in) | 4.6 |
| Total Runoff (in) | 2.73 |
| Peak Runoff (cfs) | 110.09 |
| Weighted Curve Number | 82.04 |
| Time of Concentration (days hh:mm:ss) | 0 00:17:08 |

**Subbasin : {Proposed}.DA : 6**

## Rainfall Intensity Graph




## Runoff Hydrograph



## Subbasin : {Proposed}.DA : 7

### Input Data

| | |
|---|---|
| Area (ac) | 44.2 |
| Peak Rate Factor | 484 |
| Weighted Curve Number | 92.51 |
| Rain Gage ID | Rain Gage-01 |

### Composite Curve Number

| 32 | Area | Soil | Curve |
|---|---|---|---|
| Soil/Surface Description | (acres) | Group | Number |
| Paved parking & roofs | 26.88 | D | 98 |
| Pasture, grassland, or range, Fair | 17.32 | D | 84 |
| Composite Area & Weighted CN | 44.2 | | 92.51 |

### Time of Concentration

| | Subarea | Subarea | Subarea |
|---|---|---|---|
| Sheet Flow Computations | A | B | C |
| Manning's Roughness : | 0.13 | 0 | 0 |
| Flow Length (ft) : | 100 | 0 | 0 |
| Slope (%) : | 4.83 | 0 | 0 |
| 2 yr, 24 hr Rainfall (in) : | 2.1 | 0 | 0 |
| Velocity (ft/sec) : | 0.22 | 0 | 0 |
| Computed Flow Time (min) : | 7.58 | 0 | 0 |

| | Subarea | Subarea | Subarea |
|---|---|---|---|
| Shallow Concentrated Flow Computations | A | B | C |
| Flow Length (ft) : | 992 | 943 | 0 |
| Slope (%) : | 3.66 | 0.5 | 0 |
| Surface Type : | Unpaved | Paved | Unpaved |
| Velocity (ft/sec) : | 3.09 | 1.44 | 0 |
| Computed Flow Time (min) : | 5.35 | 10.91 | 0 |

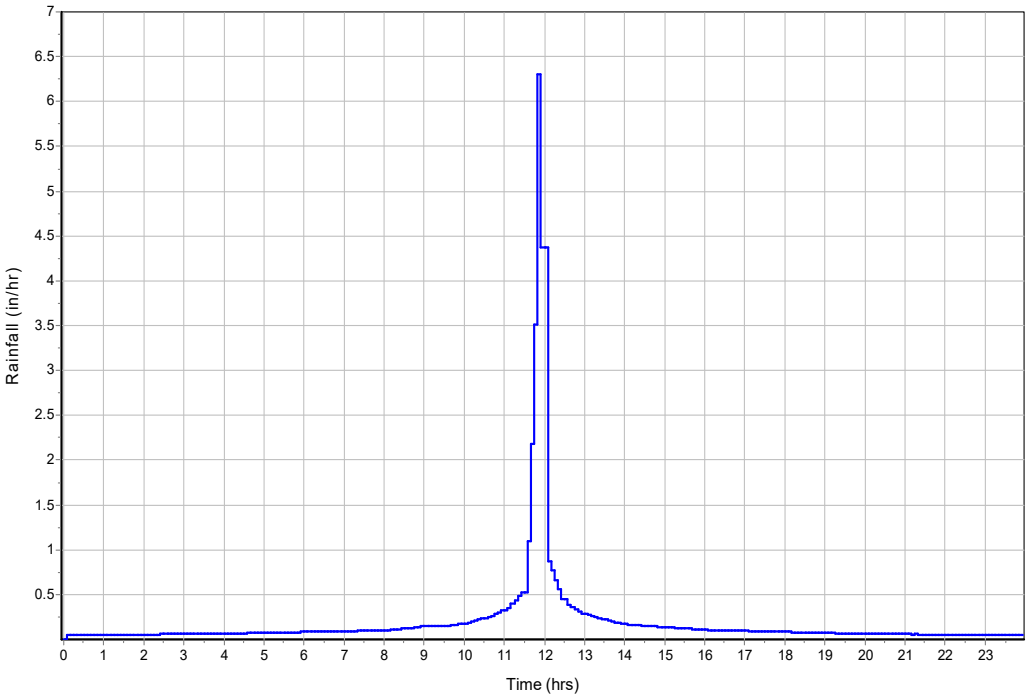
Total TOC (min) .....23.85

### Subbasin Runoff Results

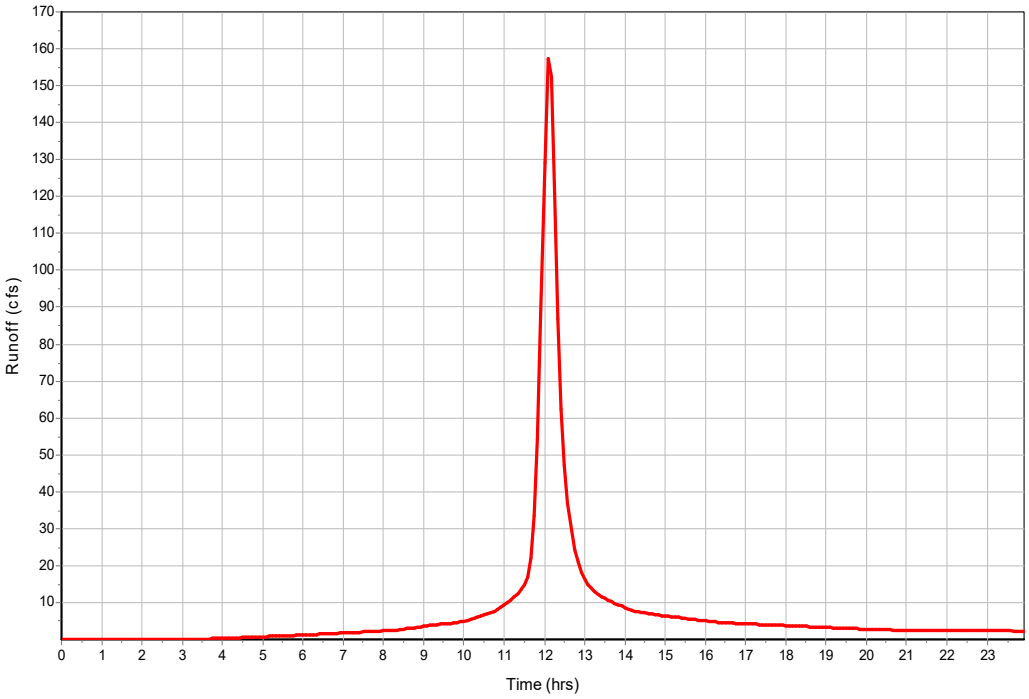
| | |
|---|---|
| Total Rainfall (in) | 4.6 |
| Total Runoff (in) | 3.75 |
| Peak Runoff (cfs) | 159.88 |
| Weighted Curve Number | 92.51 |
| Time of Concentration (days hh:mm:ss) | 0 00:23:51 |

**Subbasin : {Proposed}.DA : 7**

## Rainfall Intensity Graph




## Runoff Hydrograph



## Junction Input

| SN | 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 ($ft^2$) | Minimum Pipe Cover (in) |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1-Jun | 5437.80 | 5441.80 | 4.00 | 5437.80 | 0.00 | 5445.80 | 4.00 | 0.00 | 0.00 |
| 2 | 2-Jun | 5428.92 | 5440.40 | 11.48 | 5428.92 | 0.00 | 5451.88 | 11.48 | 0.00 | 0.00 |
| 3 | 3-Jun | 5427.02 | 5427.02 | 0.00 | 5427.02 | 0.00 | 5427.02 | 0.00 | 0.00 | 0.00 |
| 4 | 4-Jun | 5441.72 | 5443.72 | 2.00 | 5441.72 | 0.00 | 5445.72 | 2.00 | 0.00 | 0.00 |
| 5 | 5-Jun | 5426.06 | 5428.06 | 2.00 | 5426.06 | 0.00 | 5430.06 | 2.00 | 0.00 | 0.00 |
| 6 | 6-Jun | 5421.00 | 5426.00 | 5.00 | 5421.00 | 0.00 | 5431.00 | 5.00 | 0.00 | 0.00 |
| 7 | 7-Jun | 5417.00 | 5422.00 | 5.00 | 5417.00 | 0.00 | 5427.00 | 5.00 | 0.00 | 0.00 |
| 8 | Outlet_PondA | 5418.00 | 5420.50 | 2.50 | 5418.00 | 0.00 | 5423.00 | 2.50 | 0.00 | 0.00 |
| 9 | Outlet_PondB | 5424.00 | 5425.50 | 1.50 | 5424.00 | 0.00 | 5427.00 | 1.50 | 0.00 | 0.00 |
| 10 | Riser_PondA | 5418.00 | 5424.97 | 6.97 | 5418.00 | 0.00 | 5431.94 | 6.97 | 0.00 | 0.00 |
| 11 | Riser_PondB | 5424.00 | 5427.52 | 3.52 | 5424.00 | 0.00 | 5431.04 | 3.52 | 0.00 | 0.00 |

## Junction Results

| SN | 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) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1-Jun | 449.45 | 449.45 | 5440.29 | 2.49 | 0.00 | 1.51 | 5438.49 | 0.69 | 0 12:30 | 0 00:00 | 0.00 | 0.00 |
| 2 | 2-Jun | 570.49 | 200.70 | 5435.27 | 6.35 | 0.00 | 5.13 | 5430.41 | 1.49 | 0 12:25 | 0 00:00 | 0.00 | 0.00 |
| 3 | 3-Jun | 570.45 | 0.00 | 5428.26 | 1.24 | 0.00 | 3.76 | 5427.35 | 0.33 | 0 12:25 | 0 00:00 | 0.00 | 0.00 |
| 4 | 4-Jun | 64.87 | 64.87 | 5442.74 | 1.02 | 0.00 | 0.98 | 5441.89 | 0.17 | 0 12:07 | 0 00:00 | 0.00 | 0.00 |
| 5 | 5-Jun | 98.80 | 40.40 | 5427.32 | 1.26 | 0.00 | 0.74 | 5426.27 | 0.21 | 0 12:07 | 0 00:00 | 0.00 | 0.00 |
| 6 | 6-Jun | 603.61 | 0.00 | 5422.52 | 1.52 | 0.00 | 3.48 | 5421.42 | 0.42 | 0 12:22 | 0 00:00 | 0.00 | 0.00 |
| 7 | 7-Jun | 658.99 | 0.00 | 5418.78 | 1.78 | 0.00 | 9.22 | 5417.50 | 0.50 | 0 12:25 | 0 00:00 | 0.00 | 0.00 |
| 8 | Outlet_PondA | 46.89 | 0.00 | 5422.45 | 4.45 | 1.95 | 0.00 | 5419.30 | 1.30 | 0 12:36 | 0 00:00 | 0.00 | 0.00 |
| 9 | Outlet_PondB | 9.87 | 0.00 | 5424.96 | 0.96 | 0.00 | 0.54 | 5424.30 | 0.30 | 0 12:08 | 0 00:00 | 0.00 | 0.00 |
| 10 | Riser_PondA | 59.28 | 0.00 | 5425.74 | 7.74 | 0.77 | 0.00 | 5420.00 | 2.00 | 0 12:35 | 0 00:00 | 0.00 | 0.00 |
| 11 | Riser_PondB | 11.81 | 0.00 | 5427.62 | 3.62 | 0.10 | 0.00 | 5424.58 | 0.58 | 0 12:13 | 0 00:00 | 0.00 | 0.00 |

## Channel Input

| SN | Element ID | Length (ft) | Inlet Invert Elevation (ft) | Inlet Invert Offset (ft) | Outlet Invert Elevation (ft) | Outlet Invert Offset (ft) | Total Drop (ft) | Average Slope (%) | Shape | Height (ft) | Width (ft) | Manning's Roughness | Entrance Losses | Exit/Bend Losses | Additional Losses | Initial Flow (cfs) | Flap Gate |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | DITCH-01 | 1367.00 | 5437.80 | 0.00 | 5428.92 | 0.00 | 8.88 | 0.6500 | Trapezoidal | 4.000 | 52.000 | 0.0300 | 0.5000 | 0.5000 | 0.0000 | 0.00 | No |
| 2 | DITCH-02 | 1487.80 | 5441.72 | 0.00 | 5426.06 | 0.00 | 15.66 | 1.0500 | Trapezoidal | 2.000 | 26.000 | 0.0300 | 0.5000 | 0.5000 | 0.0000 | 0.00 | No |
| 3 | DITCH-03 | 207.00 | 5426.06 | 0.00 | 5421.00 | 0.00 | 5.06 | 2.4400 | Trapezoidal | 2.000 | 26.000 | 0.0400 | 0.5000 | 0.5000 | 0.0000 | 0.00 | No |
| 4 | EXISTDITCH-01 | 352.00 | 5427.02 | 0.00 | 5421.00 | 0.00 | 6.02 | 1.7100 | Trapezoidal | 5.000 | 120.000 | 0.0400 | 0.5000 | 0.5000 | 0.0000 | 0.00 | No |
| 5 | EXISTDITCH-02 | 415.00 | 5421.00 | 0.00 | 5417.00 | 0.00 | 4.00 | 0.9600 | Trapezoidal | 5.000 | 120.000 | 0.0400 | 0.5000 | 0.5000 | 0.0000 | 0.00 | No |
| 6 | EXISTDITCH-03 | 1033.00 | 5417.00 | 0.00 | 5409.60 | 0.00 | 7.40 | 0.7200 | Trapezoidal | 5.000 | 120.000 | 0.0400 | 0.5000 | 0.5000 | 0.0000 | 0.00 | No |

## 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 | DITCH-01 | 447.32 | 0 12:30 | 1119.58 | 0.40 | 4.18 | 5.45 | 3.24 | 0.81 | 0.00 | | |
| 2 | DITCH-02 | 61.49 | 0 12:07 | 224.45 | 0.27 | 3.72 | 6.67 | 1.12 | 0.57 | 0.00 | | |
| 3 | DITCH-03 | 96.80 | 0 12:08 | 256.53 | 0.38 | 5.68 | 0.61 | 1.25 | 0.64 | 0.00 | | |
| 4 | EXISTDITCH-01 | 570.23 | 0 12:25 | 6247.31 | 0.09 | 4.83 | 1.21 | 1.38 | 0.28 | 0.00 | | |
| 5 | EXISTDITCH-02 | 602.93 | 0 12:22 | 4689.99 | 0.13 | 4.29 | 1.61 | 1.65 | 0.33 | 0.00 | | |
| 6 | EXISTDITCH-03 | 656.72 | 0 12:25 | 4043.26 | 0.16 | 4.28 | 4.02 | 1.76 | 0.35 | 0.00 | | |

## Pipe Input

| SN | Element ID | Length (ft) | Inlet Invert Elevation (ft) | Inlet Invert Offset (ft) | Outlet Invert Elevation (ft) | Outlet Invert Offset (ft) | Total Drop (ft) | Average Slope (%) | Pipe Shape | Pipe Diameter or Height (in) | Pipe Width (in) | Manning's Roughness | Entrance Losses | Exit/Bend Losses | Additional Losses | Initial Flow (cfs) | Flap Gate | No. of Barrels |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | C-01 | 120.00 | 5428.92 | 0.00 | 5427.02 | 0.00 | 1.90 | 1.5800 | Rectangular | 48.000 | 60.000 | 0.0120 | 0.5000 | 0.5000 | 0.0000 | 0.00 | No | 3 |
| 2 | OutletPipe_PondA | 166.00 | 5418.00 | 0.00 | 5417.00 | 0.00 | 1.00 | 0.6000 | CIRCULAR | 30.000 | 30.000 | 0.0120 | 0.5000 | 0.5000 | 0.0000 | 0.00 | No | 1 |
| 3 | OutletPipe_PondB | 303.00 | 5424.00 | 0.00 | 5417.00 | 0.00 | 7.00 | 2.3100 | CIRCULAR | 18.000 | 18.000 | 0.0150 | 0.5000 | 0.5000 | 0.0000 | 0.00 | No | 1 |

## Pipe 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 | C-01 | 570.45 | 0 12:25 | 1002.95 | 0.57 | 14.51 | 0.14 | 2.62 | 0.66 | 0.00 | | Calculated |
| 2 | OutletPipe_PondA | 46.89 | 0 12:35 | 34.49 | 1.36 | 11.84 | 0.23 | 2.14 | 0.86 | 0.00 | | > CAPACITY |
| 3 | OutletPipe_PondB | 9.92 | 0 12:12 | 13.84 | 0.72 | 7.51 | 0.67 | 1.22 | 0.81 | 0.00 | | Calculated |

# Storage Nodes

## Storage Node : PondA

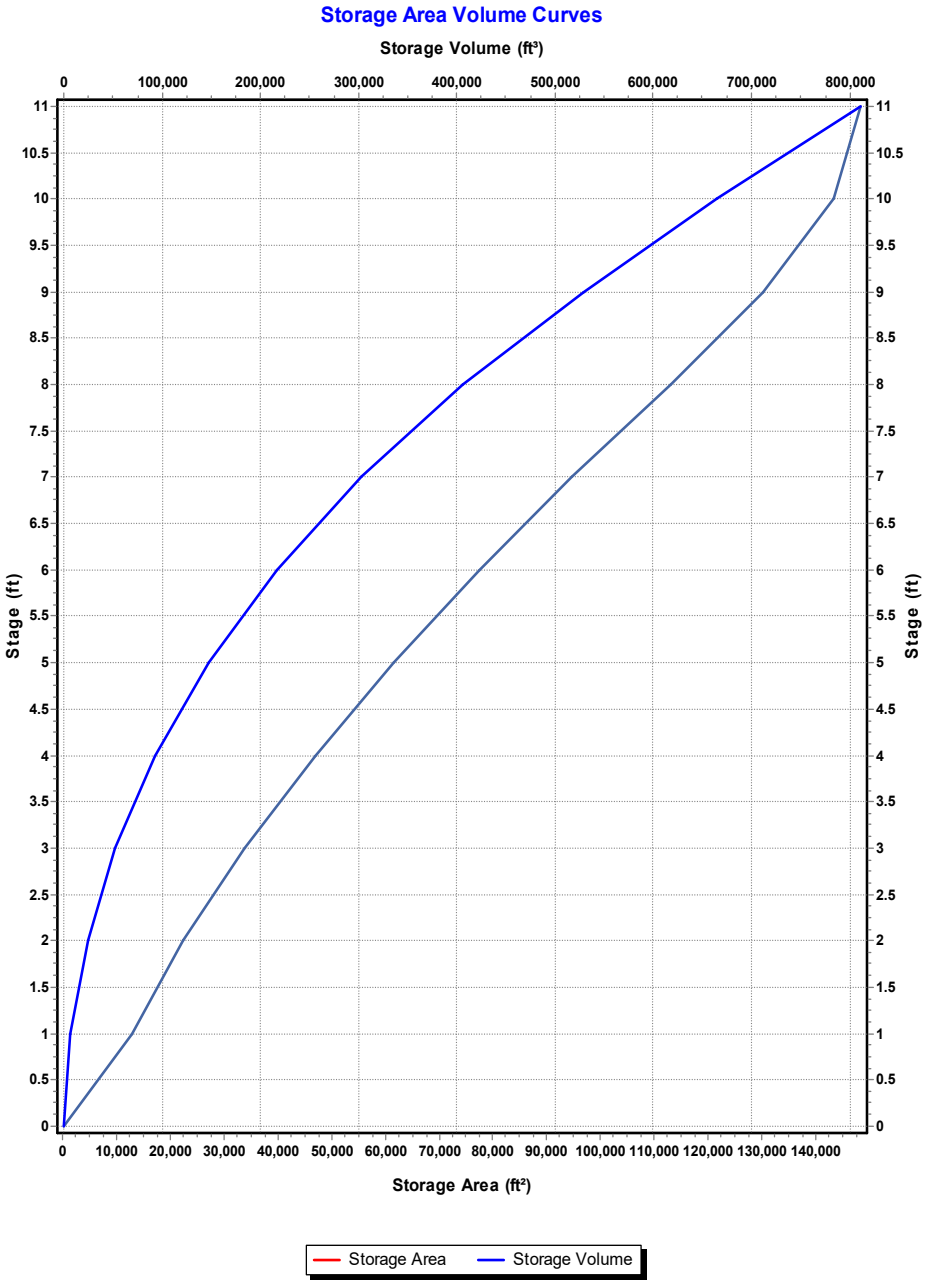
### Input Data

| | |
|---|---|
| Invert Elevation (ft) | 5420.00 |
| Max (Rim) Elevation (ft) | 5431.00 |
| Max (Rim) Offset (ft) | 11.00 |
| Initial Water Elevation (ft) | 5420.00 |
| Initial Water Depth (ft) | 0.00 |
| Ponded Area ($ft^2$) | 0.00 |
| Evaporation Loss | 0.00 |

### Storage Area Volume Curves

Storage Curve : Pond A

| Stage (ft) | Storage Area ($ft^2$) | Storage Volume ($ft^3$) |
|---|---|---|
| 0 | 300 | 0 |
| 1 | 13044 | 6672 |
| 2 | 22565 | 24476.5 |
| 3 | 33934 | 52726 |
| 4 | 46922 | 93154 |
| 5 | 61435 | 147332.5 |
| 6 | 77447 | 216773.5 |
| 7 | 94723 | 302858.5 |
| 8 | 113114 | 406777 |
| 9 | 130230 | 528449 |
| 10 | 143348 | 665238 |
| 11 | 148268 | 811046 |


Storage Area Volume Curves
Storage Volume (ft³)
0
100,000
200,000
300,000
400,000
500,000
600,000
700,000
800,000
Stage (ft)
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
5.5
6
6.5
7
7.5
8
8.5
9
9.5
10
10.5
11
Stage (ft)
0
10,000
20,000
30,000
40,000
50,000
60,000
70,000
80,000
90,000
100,000
110,000
120,000
130,000
140,000
Storage Area (ft²)
Storage Area
Storage Volume

## Storage Node : PondA (continued)

### Outflow Weirs

| SN | Element ID | Weir Type | Flap Gate | Crest Elevation (ft) | Crest Offset (ft) | Length (ft) | Weir Total Height (ft) | Discharge Coefficient |
|---|---|---|---|---|---|---|---|---|
| 1 | EMRGCYSPLWY_PondA | Trapezoidal | No | 5427.00 | 7.00 | 52.00 | 4.00 | 3.33 |

### Outflow Orifices

| SN | Element ID | Orifice Type | Orifice Shape | Flap Gate | Circular Orifice Diameter (in) | Rectangular Orifice Height (in) | Rectangular Orifice Width (in) | Orifice Invert Elevation (ft) | Orifice Coefficient |
|---|---|---|---|---|---|---|---|---|---|
| 1 | Grate_PondA | Bottom | Rectangular | No | | 48.00 | 48.00 | 5424.97 | 0.63 |
| 2 | WQCV/EURV_PondA | Side | Rectangular | No | | 3.00 | 6.58 | 5420.00 | 0.63 |

### Output Summary Results

| | |
|---|---|
| Peak Inflow (cfs) | 157.28 |
| Peak Lateral Inflow (cfs) | 157.28 |
| Peak Outflow (cfs) | 59.28 |
| Peak Exfiltration Flow Rate (cfm) | 0 |
| Max HGL Elevation Attained (ft) | 5426.73 |
| Max HGL Depth Attained (ft) | 6.73 |
| Average HGL Elevation Attained (ft) | 5424.29 |
| Average HGL Depth Attained (ft) | 4.29 |
| Time of Max HGL Occurrence (days hh:mm) | 0 12:35 |
| Total Exfiltration Volume (1000-ft$^3$) | 0 |
| Total Flooded Volume (ac-in) | 0 |
| Total Time Flooded (min) | 0 |
| Total Retention Time (sec) | 0 |

## Storage Node : PondB

### Input Data

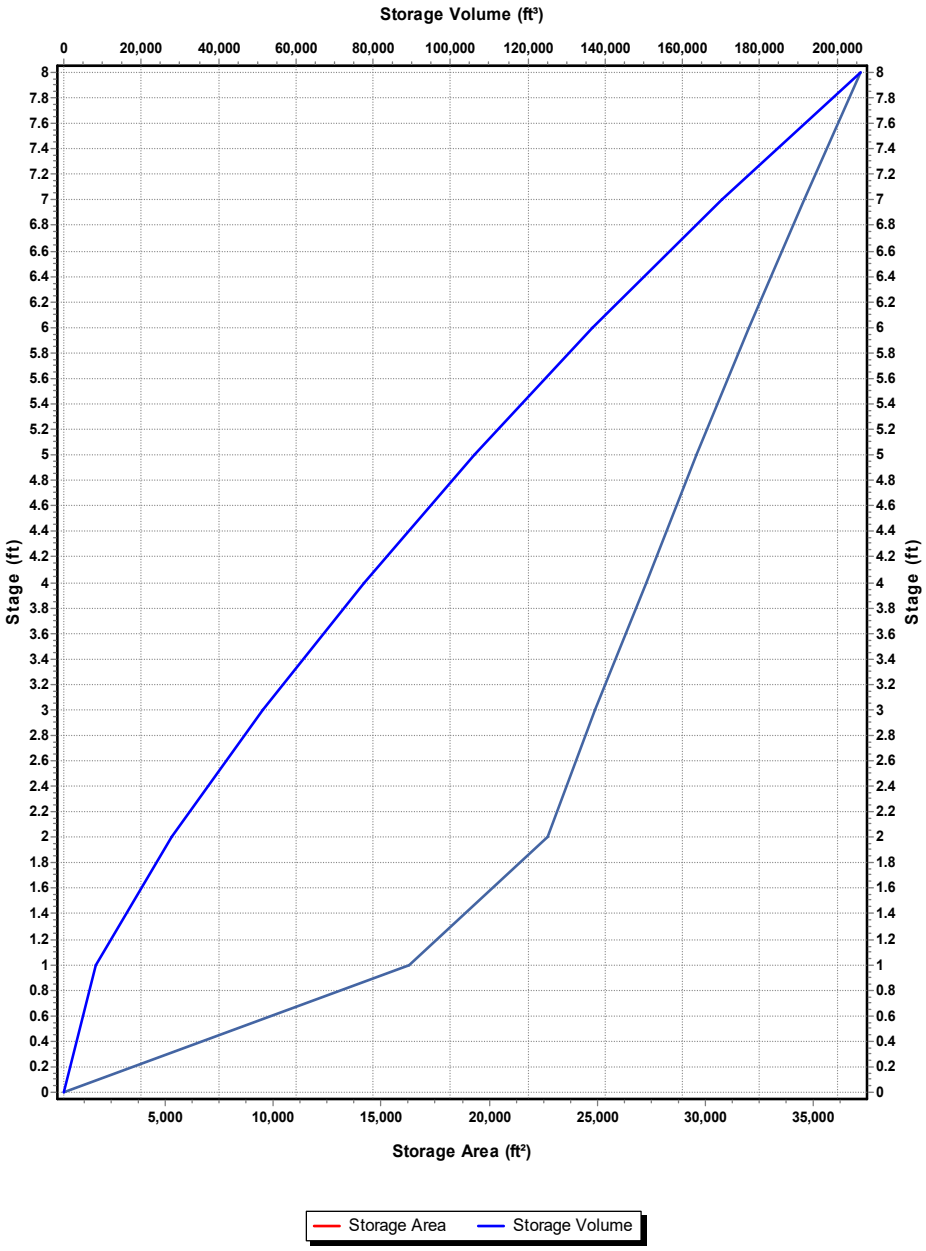
| | |
|---|---|
| Invert Elevation (ft) | 5426.00 |
| Max (Rim) Elevation (ft) | 5434.00 |
| Max (Rim) Offset (ft) | 8.00 |
| Initial Water Elevation (ft) | 5426.00 |
| Initial Water Depth (ft) | 0.00 |
| Ponded Area ($ft^2$) | 0.00 |
| Evaporation Loss | 0.00 |

### Storage Area Volume Curves

Storage Curve : Pond B

| Stage (ft) | Storage Area ($ft^2$) | Storage Volume ($ft^3$) |
|---|---|---|
| 0 | 300 | 0 |
| 1 | 16257 | 8278.5 |
| 2 | 22675 | 27744.5 |
| 3 | 24922 | 51543 |
| 4 | 27243 | 77625.5 |
| 5 | 29585 | 106039.5 |
| 6 | 32047 | 136855.5 |
| 7 | 34583 | 170170.5 |
| 8 | 37192 | 206058 |

## Storage Area Volume Curves



## Storage Node : PondB (continued)

### Outflow Weirs

| SN | Element ID | Weir Type | Flap Gate | Crest Elevation (ft) | Crest Offset (ft) | Length (ft) | Weir Total Height (ft) | Discharge Coefficient |
|---|---|---|---|---|---|---|---|---|
| 1 | EMRGCYSPLWY_PondB | Trapezoidal | No | 5431.00 | 5.00 | 7.00 | 3.00 | 3.33 |

### Outflow Orifices

| SN | Element ID | Orifice Type | Orifice Shape | Flap Gate | Circular Orifice Diameter (in) | Rectangular Orifice Height (in) | Rectangular Orifice Width (in) | Orifice Invert Elevation (ft) | Orifice Coefficient |
|---|---|---|---|---|---|---|---|---|---|
| 1 | Grate_PondB | Bottom | Rectangular | No | | 48.00 | 48.00 | 5427.52 | 0.63 |
| 2 | WQCV/EURV_PondB | Side | CIRCULAR | No | 6.16 | | | 5426.00 | 0.61 |

### Output Summary Results

| | |
|---|---|
| Peak Inflow (cfs) | 23.03 |
| Peak Lateral Inflow (cfs) | 23.03 |
| Peak Outflow (cfs) | 11.81 |
| Peak Exfiltration Flow Rate (cfm) | 0 |
| Max HGL Elevation Attained (ft) | 5427.94 |
| Max HGL Depth Attained (ft) | 1.94 |
| Average HGL Elevation Attained (ft) | 5427.01 |
| Average HGL Depth Attained (ft) | 1.01 |
| Time of Max HGL Occurrence (days hh:mm) | 0 12:13 |
| Total Exfiltration Volume (1000-ft$^3$) | 0 |
| Total Flooded Volume (ac-in) | 0 |
| Total Time Flooded (min) | 0 |
| Total Retention Time (sec) | 0 |

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**EL PASO COUNTY PLANNING AND COMMUNITY DEVELOPMENT DEPARTMENT**

# PRELIMINARY DRAINAGE REPORT (PDR) CHECKLIST

Revised: January 2022

**Preliminary Drainage Report**

The purpose of the Preliminary Drainage Report is to identify specific solutions to problems onsite and offsite resulting from proposed land development, including issues existing prior to development. The PDR shall generally conform to the following outline format and major headings, and contain the applicable information listed.

| | | Applicant | PCD |
|---|---|---|---|
| | **Please confirm each item below has been included by placing a check mark in the "Applicant" column. See right for an example. The "PCD" column is for office use only.** | ✓ | Office use only |
| | **Report Contents** | | |
| 1 | Table of contents, pages numbered | ✓ p. 1 | |
| 2 | Existing/Historic and Developed Conditions Plans at the end of the report | ✓ App. A | |
| | **General Location** | | |
| 1 | City and County, and local streets within and adjacent to the subdivision. | ✓ p. 4; A | |
| 2 | Township, Range, section, 1/4 section. | ✓ p. 4 | |
| 3 | Major drainage ways and existing facilities. | ✓ p. 4 | |
| 4 | Names of surrounding platted developments. | ✓ App. A | |
| | **Description of Property** | | |
| 1 | Area in acres | ✓ p. 4 | |
| 2 | Ground cover, (type of trees, shrubs, vegetation) | ✓ p. 4 | |
| 3 | General topography | ✓ p. 5 | |
| 4 | General soil conditions | ✓ p. 5 | |
| 5 | Major drainageways | ✓ p. 5 | |
| 6 | Irrigation facilities | ✓ N/A | |
| 7 | Utilities and other encumbrances | ✓ p. 4; A | |
| | **Major Basin Descriptions** | | |
| 1 | Reference should be made to major drainageway planning studies; Such as Drainage Basin Planning Studies; Flood Hazard delineation reports, and flood insurance studies or maps if available. | ✓ p. 3; C | |
| 2 | A floodplain statement shall be provided indicating whether any portion of the development is in a designated floodplain as delineated on the current FEMA mapping. | ✓ p. 5; C | |
| 3 | Major basin drainage characteristics. | ✓ p. 3 | |
| 4 | Identification of all nearby irrigation facilities and other obstructions which could influence or be influenced by local drainage. | ✓ N/A | |
| | **Sub-Basin Descriptions** | | |
| 1 | Discussion of historic drainage patterns of the property in question | ✓ p. 5; A | |
| 2 | Discussion of offsite drainage flow patterns and their impact on the development | ✓ p. 5-7 | |

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**EL PASO COUNTY PLANNING AND COMMUNITY DEVELOPMENT DEPARTMENT**

# PRELIMINARY DRAINAGE REPORT (PDR) CHECKLIST

Revised: January 2022

| | | | |
|---|---|---|---|
| | **Drainage Design Criteria** | | |
| 1 | Reference all criteria, master plans, and technical information used for report preparation and design; any deviation from such material must be discussed and justified. | ✓ p. 8-10 | |
| 2 | Discussion of previous drainage studies (i.e. PDR, drainage basin planning studies, master plans, flood insurance studies) for the site in question that influence or are influenced by the drainage design and how the studies affect drainage design for the site | ✓ p. 3 | |
| | **Four-Step Process** | | |
| 1 | Runoff reduction proposed. | ✓ p. 11 | |
| 2 | Stabilization of drainage ways proposed/discussed. | ✓ p. 11 | |
| 3 | Proposed Stormwater Quality Capture Volume (WQCV) proposed. | ✓ p. 11 | |
| 4 | Identify Best Management Practices (BMP's) to be used to control industrial and commercial pollutants. | ✓ p. 11 | |
| | **Hydrologic Criteria** | | |
| 1 | Identify design rainfall. | ✓ p. 10; D | |
| 2 | Identify runoff calculation method. | ✓ p. 8-10 | |
| 3 | Identify design storm recurrence intervals | ✓ p. 7, 10 | |
| 4 | Identify detention discharge and storage calculation method. | ✓ p. 8; G | |
| 5 | Note ECM Appendix I Full Spectrum Detention (FSD) requirement. | ✓ p. 8 | |
| | **Drainage Facility Design - General Concept** | | |
| 1 | Discussion of compliance with offsite runoff considerations. | ✓ p. 5-7 | |
| 2 | Discussion of anticipated and proposed drainage patterns. | ✓ p. 6-8 | |
| 3 | Discussion of the content of tables, charts, figures, plates or drawings presented in the report. | ✓ p. 5-10 | |
| | **Drainage Facility Design - Specific Details** | | |
| 1 | Presentation of existing and proposed hydrologic conditions including approximate flow rates entering and exiting the subdivision with all necessary calculations. | ✓ p. 6-7 | |
| 2 | Presentation of approach to accommodate drainage impacts on existing or proposed improvements and facilities. | ✓ p. 6-7 | |
| 3 | Presentation of proposed facilities with respect to alignment, material and structure type. | ✓ p. 10 | |
| 4 | Discussion of drainage impact of site constraints such as streets, utilities, existing and proposed structures. | ✓ N/A | |
| 5 | Environmental features and issues shall be presented if applicable. | ✓ p. 5 | |
| 6 | Discussion of maintenance access and aspects of the preliminary design. | ✓ p. 12 | |
| 7 | Discussion and analysis of existing and proposed downstream drainage facilities and their ability to convey developed runoff from the proposed development. | ✓ p. 9, 12 | |
| | **Drawing Contents** | | |
| 1 | General Location Map: A map shall be provided in sufficient detail to identify drainage flows entering and leaving the development and general drainage patterns. The map should be at a scale of 1"=50' to 1"=2000'. The map shall identify any major construction (i.e. development, irrigation ditches, existing detention facilities, culverts, storm sewers, etc.) that shall influence or be influenced by the subdivision. | ✓ App. A | |
| 2 | Drainage Plan: Map (s) of the proposed development at a scale of 1"=20' to 1"=200' shall be included to identify existing and proposed conditions on or adjacent to the site in question. | ✓ App. A | |
| 3 | The drainage plan shall delineate all sub-basins and proposed initial and major facilities as well as provide a summary of all initial and major flow rates at design points. All floodplains affecting the site shall be shown. | ✓ App. A | |

At SDP, this will be a stand alone document and will not be located in the drainage report.

# Standard Operation Procedures

for

# Inspection and Maintenance

of

# Extended Detention Basin(s)

# Williams Creek Generating Station

DRAFT

Owner:
Colorado Spring Utilities

111 S. Cascade Avenue
Colorado Springs, CO 80903
www.csu.org
(719) 448-4800

## Introduction

This Operation and Maintenance (O&M) Manual addresses the inspection, operation, and maintenance requirements for the Extended Dry Detention Basins (EDBs) and associated stormwater quality facilities to be constructed as part of the Williams Creek Generating Station project located in El Paso County, Colorado.

The stormwater management facilities are intended to provide water quality treatment, sediment control, and temporary detention of stormwater runoff generated from developed areas of the site. The facilities have been designed to collect, store, and gradually release stormwater runoff through controlled outlet structures while reducing pollutant loading and minimizing downstream impacts associated with post-development runoff conditions.

## Background

The State of Colorado Department of Public Health and Environment, Water Quality Control Division (CDPHE), has implemented federal regulations within the State of Colorado through permitting, and has included El Paso County as one of numerous Municipal Separate Storm Sewer Systems (MS4s) required to be permitted in compliance with National Pollutant Discharge Elimination System (NPDES) Phase 2 Regulations, as defined within Colorado's Phase 2 Municipal Guidance.

NPDES Phase 2 MS4s stormwater discharges are covered under a general permit under the Colorado Discharge Permit System (CDPS) under Regulation 61, and as a minimum require the MS4's operator (e.g., El Paso County) to develop, implement, and enforce a stormwater management program to reduce the discharge of pollutants to the maximum extent practicable to protect water quality requirements of the Colorado Water Quality Control Act, Colorado Code of Regulations [CCR] 61.8(11)(a)(i)).

This Stormwater Facilities Operation and Maintenance (O&M) Plan has been prepared for the Extended Dry Detention Basin (EDB) and associated stormwater management facilities constructed as part of the Williams Creek Generating Station project located in El Paso County, Colorado. The purpose of this manual is to establish procedures for inspection, operation, maintenance, and documentation necessary to preserve the long-term functionality of the stormwater facilities and maintain their intended water quality and runoff detention performance.

## Funding for and Organization of Facility Operation and Maintenance

Colorado Springs Utilities (CSU), or its designated representative, shall be responsible for the operation, inspection, maintenance, repair, and long-term management of the Extended Dry Detention Basins (EDBs) and associated stormwater management facilities upon acceptance of the facilities.

## Site and Facilities Description

The Williams Creek Generating Station project is located in El Paso County, Colorado. The project includes Extended Dry Detention Basins (EDBs) and associated stormwater management facilities designed to provide stormwater quality treatment and runoff detention for developed portions of the site. The detention facilities are located within designated stormwater management areas of the project site and are intended to collect, temporarily store, and gradually release stormwater runoff through controlled outlet structures.

Access to the detention facilities is provided through internal site access roads and maintenance routes as shown on the approved construction plans and site development drawings. Maintenance personnel shall

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have access to all stormwater facility components for inspection and maintenance activities.

Emergency spillways are incorporated into the detention basin design to safely convey runoff in excess of the design storage capacity. The final location, dimensions, and discharge routing of emergency spillways will be documented in the final construction plans.

The stormwater management facilities generally consist of stormwater inflow structures, drainage swales and conveyance channels, forebays (if provided), detention storage areas, outlet control structures, emergency spillways, erosion protection measures, and associated stormwater conveyance systems.

Final drainage areas, storage volumes, outlet structure details, spillway elevations, and facility identification numbers will be incorporated into this manual following completion of final drainage design and preparation of record drawings.

**Extended Detention Basin (EDB) Description**

The subsections below describe general EDB operations and maintenance.

## EDB-1 GENERAL EDB CONCEPT

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

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

## EDB-2 INSPECTING EXTENDED DETENTION BASINS (EDBs)

### EDB-2.1 Access and Easements

Inspection and maintenance personnel may utilize the attached stormwater facility map containing the location(s) of the access points and maintenance easements of the EDB(s) within this development.

### EDB-2.2 Stormwater Management Facilities Locations

Inspection and maintenance personnel may utilize the attached stormwater facility map located in containing the location(s) of the EDB(s) within this development.

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## EDB-2.3 Extended Detention Basin (EDB) Features

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

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

**Table EDB-1: Typical Inspection & Maintenance Requirements Matrix**

| EDB Features | Sediment Removal | Mowing/ Weed Control | Trash & Debris Removal | Erosion | Over- grown Vegetation Removal | Standing Water (mosquito/ algae control) | Structure Repair |
|---|---|---|---|---|---|---|---|
| Inflow Points (outfalls) | X | | X | X | | | X |
| Forebays | X | | X | | | | X |
| Low-Flow Channel | X | | X | X | X | | X |
| Bottom Stage | X | X | X | X | X | X | |
| Micropool | X | | X | | X | X | X |
| Outlet Works | X | | X | | | | X |
| Emergency Spillway | | | X | X | X | | X |
| Upper Stage | | | X | X | | | |
| Embankment | | X | | X | X | | |

### EDB-2.3.1 Inflow Points

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

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

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

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

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

c. Sediment Accumulation – Because of the turbulence in the water created by the energy dissipater, sediment often deposits immediately downstream of the inflow point. To prevent a loss in hydraulic performance of the upstream infrastructure, sediment that accumulates in this area must be removed in a timely manner.
d. Structural Damage – Structural damage can occur at any time during the life of the facility. Typically, for an inflow, the structural damage occurs to the pipe flared end section (concrete or steel). Structural damage can lead to additional operating problems with the facility, including loss of hydraulic performance.
e. Woody Growth/Weeds Present – Undesirable vegetation can grow in and around
f. the inflow area to an EDB that can significantly affect the performance of the drainage facilities discharging into the facility. This type of vegetation includes trees (typically cottonwoods) and dense areas of shrubs (willows). If woody vegetation is not routinely mowed/removed, the growth can cause debris/sediment to accumulate, resulting in blockage of the discharge. Also, tree roots can cause damage to the structural components of the inflow. Routine maintenance is essential for trees (removing a small tree/sapling is much cheaper and "quieter" than a mature tree). In addition, noxious weeds growing in the facility can result in the loss of desirable native vegetation and impact adjacent open spaces/land.

### EDB-2.3.2 Forebay

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

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

a. Sediment/Debris Accumulation – Because this feature of the EDB is designed to provide the initial sedimentation, debris and sediment frequently accumulate in this area. If the sediment and debris is not removed from the forebay on a regular basis, it can significantly affect the function of other features within the EDB. Routine sediment removal from the forebay can significantly reduce the need for dredging of the main portion of the EDB using specialized equipment (long reach excavators). Routine removal of sediment from the forebay can substantially decrease the long-term sediment removal costs of an EDB.
b. Concrete Cracking/Failing – The forebay is primarily constructed of concrete, which cracks, spalls, and settles. Damage to the forebay can result in deceased performance and impact maintenance efforts.
c. Drain Pipe/Weir Clogged – Many times the drainpipe or weir can be clogged with debris, and prevent the forebay from draining properly. If standing water is present in the forebay (and there is not a base flow), the forebay is most likely not draining properly. This can result in a decrease in performance and create potential nuisances with stagnant water (mosquitoes).
d. Weir/Drain Pipe Damaged – Routine maintenance activities, vandalism, or age may cause the weir or drain pipe in the forebay to become damaged. Weirs are typically constructed of concrete, which cracks and spalls. The drainpipe is typically constructed with plastic, which can fracture.

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### EDB-2.3.3 Trickle Channel (Low-Flow)

The trickle channel conveys stormwater from the forebay to the micro- pool of the EDB. The trickle channel is typically made of concrete.

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

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

*a.* Sediment/Debris Accumulation – Trickle channels are typically designed with a relatively flat slope that can promote sedimentation and the collection of debris. Also, if a trickle channel is grass lined it can accumulate sediment and debris at a much quicker rate. Routine removal of accumulated sediment and debris is essential in preventing flows from circumventing the trickle channel and affecting the dry storage portion of the pond.
*b.* Concrete/Riprap Damage – Concrete can crack, spall, and settle and must be repaired to ensure proper function of the trickle channel. Riprap can also shift over time and must be replaced/repaired as necessary.
*c.* Woody Growth/Weeds Present – Because of the constant moisture in the area surrounding the trickle channel, woody growth (cottonwoods/willows) can become a problem. Trees and dense shrub type vegetation can affect the capacity of the trickle channel and can allow flows to circumvent the feature.
*d.* Erosion Outside of Channel – In larger precipitation events, the trickle channel capacity will likely be exceeded. This can result in erosion immediately adjacent to the trickle channel and must be repaired to prevent further damage to the structural components of the EDB.

### EDB-2.3.4 Bottom Stage (Initial Surcharge)

The bottom stage is at least 4 inches deeper than the upper stage and is located directly in front of the outlet works structure, and typically above the permanent water surface of the micropool and the invert of the trickle channel. The bottom stage is designed to store the smaller runoff events, assists in keeping the majority of the basin bottom dry resulting in easier maintenance operations, and enhances the facility's pollutant removal capabilities. This area of the EDB may develop wetland vegetation.

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

*a.* Sediment/Debris Accumulation – The micropool can frequently accumulate sediment and debris. This material must be removed to maintain pond volume and proper function of the outlet structure.
*b.* Woody Growth/Weeds Present – Because of the constant moisture in the soil surrounding the micropool, woody growth (cottonwoods/willows) can create operational problems for the EDB. If woody vegetation is not routinely mowed/removed, the growth can cause debris/sediment to accumulate outside of the micropool, which can cause problems with other EDB features. Also, tree roots can cause damage to the structural components of the outlet works. Routine management is essential for trees (removing a small tree/sapling is much cheaper and less disruptive than removing a mature tree).
*c.* Bank Erosion – The micropool is usually a couple feet deeper than the other areas of the ponds. Erosion can be caused by water dropping into the micropool if
*d.* adequate protection/armor is not present. Erosion in this area must be mitigated to prevent

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sediment transport and other EDB feature damage.

e. Mosquitoes/Algae Treatment – Nuisance created by stagnant water can result from improper maintenance/treatment of the micropool. Mosquito larvae can be laid by adult mosquitoes within the permanent pool. Also, aquatic vegetation that grows in shallow pools of water can decompose causing foul odors. Chemical/mechanical treatment of the micropool may be necessary to reduce these impacts to adjacent homeowners.
f. Petroleum/Chemical Sheen – Many indicators of illicit discharges into the storm sewer systems will be present in the micropool area of the EDB. These indicators can include sheens, odors, discolored soil, and dead vegetation. If it is suspected that an illicit discharge has occurred, contact County Stormwater immediately. Proper removal/mitigation of contaminated soils and water in the EDB is necessary to minimize any environmental impacts downstream.

### EDB-2.3.5 Micropool

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

**The typical maintenance items that are found with micropools are as follows:**

a. Sediment/Debris Accumulation – The micropool can frequently accumulate sediment and debris. This material must be removed to maintain pond volume and proper function of the outlet structure.
b. Woody Growth/Weeds Present – Because of the constant moisture in the soil surrounding the micropool, woody growth (cottonwoods/willows) can create operational problems for the EDB. If woody vegetation is not routinely mowed/removed, the growth can cause debris/sediment to accumulate outside of the micropool, which can cause problems with other EDB features. Also, tree roots can cause damage to the structural components of the outlet works. Routine management is essential for trees (removing a small tree/sapling is much cheaper and less disruptive than removing a mature tree).
c. Mosquitoes/Algae Treatment – Nuisance created by stagnant water can result from improper maintenance/treatment of the micropool. Mosquito larvae can be laid by adult mosquitoes within the permanent pool. Also, aquatic vegetation that grows in shallow pools of water can decompose causing foul odors. Chemical/mechanical treatment of the micropool may be necessary to reduce these impacts to adjacent homeowners.
d. Petroleum/Chemical Sheen – Many indicators of illicit discharges into the storm sewer systems will be present in the micropool area of the EDB. These indicators can include sheens, odors, discolored soil, and dead vegetation. If it is suspected that an illicit discharge has occurred, contact the supervisor immediately. Proper removal of contaminated soils and water in the EDB is necessary to minimize any environmental impacts downstream.

### EDB-2.3.6 Outlet Works

The outlet works is the feature that drains the EDB in specified release rates and periods of time. The outlet works is typically constructed of reinforced concrete into the embankment of the EDB. The concrete structure typically has steel orifice plates anchored/embedded into it to control stormwater release rates.

The larger openings for flood control on the outlet structure typically have trash racks over them to prevent clogging. The water quality orifice plate with small diameter holes will typically have a well screen covering it to prevent smaller materials from clogging it. The outlet structure is the single-most important feature in the EDB operation. Proper inspection and maintenance of the outlet works is essential in ensuring the long-term operation of the EDB.

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

*a.* Trash Rack/Well Screen Clogged – Floatable material that enters the EDB will most likely make its way to the outlet structure. This material is trapped against the trash racks and well screens on the outlet structure (which is why they are there). This material must be removed on a routine basis to ensure the outlet structure drains in the specified design period.
*b.* Structural Damage – The outlet structure is primarily constructed of concrete, which can crack, spall, and settle. The steel trash racks and well screens are also susceptible to damage.
*c.* Orifice Plate Missing/Not Secure – Many times residents, property owners, or maintenance personnel will remove or loosen orifice plates if they believe the pond is not draining properly. Any modification to the orifice plate(s) will significantly affect the designed discharge rates for water quality and/or flood control. Modification of the orifice plates is not allowed without EPC approval.
*d.* Manhole Access – Access to the outlet structure is necessary to properly inspect and maintain the facility. If access is difficult or not available to inspect the structure, chances are it will be difficult to maintain as well.
*e.* Woody Growth/Weeds Present – Because of the constant moisture in the soil surrounding the outlet works, woody growth (cottonwoods/willows) can create operational problems for the EDB. If woody vegetation is not routinely mowed/removed, the growth can cause debris/sediment to accumulate around the outlet works, which can cause problems with other EDB features. Also, tree roots can cause damage to the structural components of the outlet works. Routine management is essential for trees (removing a small tree/sapling is much cheaper and less disruptive than removing a mature tree).

### EDB-2.3.7 Emergency Spillway

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

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

*a.* Riprap Displaced – As mentioned before, the emergency spillway is typically armored with riprap to provide erosion protection. Over the life of an EDB, the riprap may shift or dislodge due to flow.
*b.* Erosion Present – Although the spillway is typically armored, stormwater flowing through the spillway can cause erosion damage. Erosion must be repaired to ensure the integrity of the basin embankment, and proper function of the spillway.
*c.* Woody Growth/Weeds Present – Management of woody vegetation is essential in the proper

long-term function of the spillway. Larger trees or dense shrubs can capture larger debris entering the EDB and reduce the capacity of the spillway.

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

### EDB-2.3.8 Upper Stage (Dry Storage)

The upper stage of the EDB provides the majority of the water quality flood detention volume. This area of the EDB is higher than the micro- pool and typically stays dry, except during storm events. The upper stage is the largest feature/area of the basin. Sometimes, the upper stage can be utilized for park space and other uses in larger EDBs.

With proper maintenance of the micropool and forebay(s), the upper stage should not experience much sedimentation; however, bottom elevations should be monitored to ensure adequate volume.

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

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

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

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

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

*e.* Below is a list of indicators:

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

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

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

*h.* Maintenance Access – Most EDBs typically have a gravel/concrete maintenance access path to

either the upper stage, outlet works, and/or forebay. This access path should be inspected to ensure the surface is still drivable. Some of the smaller EDBs may not have maintenance access paths; however, the inspector should verify that access is available from adjacent properties.

### EDB-2.3.9 Miscellaneous

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

*a.* Encroachment in Easement Area – Private lots/property can sometimes be located very close to the EDBs, even though they are required to be located in tracts with drainage easements. Property owners may place landscaping, trash, fencing, or other items within the easement area that may affect maintenance or the operation of the facility.
*b.* Graffiti/Vandalism – Damage to the EDB infrastructure can be caused by vandals. If criminal mischief is evident, the inspector should forward this information to the local Sheriff's Office.
*c.* Public Hazards – Public hazards include items such as vertical drops of greater than 4-feet, containers of unknown/suspicious substances, exposed metal/jagged concrete on structures. If any hazard is found within the facility area that poses an immediate threat to public safety, contact the Sheriff at 911 immediately!
*d.* Burrowing Animals/Pests – Prairie dogs and other burrowing rodents may cause damage to the EDB features and negatively affect the vegetation within the EDB. Consult EPC Environmental Division if this becomes an issue.
*e.* Other – Any miscellaneous inspection/maintenance items not contained on the form should be entered here.

## EDB-3 MAINTAINING EXTENDED DETENTION BASINS (EDBS)

### EDB-3.1 Maintenance Personnel

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

### EDB-3.2 Equipment

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

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

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

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

**EDB-3.3 Safety**

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

**EDB-3.4 Maintenance Categories and Activities**

A typical EDB Maintenance Program will consist of three broad categories of work: routine, minor, and major maintenance activities. Within each category of work, a variety of maintenance activities can be performed on an EDB. A maintenance activity can be specific to each feature within the EDB, or general to the overall facility. A variety of maintenance activities are typical of EDBs. The maintenance activities range in magnitude from routine trash pickup to the reconstruction of drainage infrastructure. The following three sub-sections (3.5, 3.6, and 3.7) explain each of the categories and briefly describes the typical maintenance activities for an EDB, including the objectives and frequency of actions.

**EDB-3.5 Routine Maintenance Activities**

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

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

**TABLE – EDB-2 Summary of Routine Maintenance Activities**

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

### EDB-3.5.1 Mowing

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

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

### EDB-3.5.2 Trash/Debris Removal

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

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

### EDB-3.5.3 Outlet Works Cleaning

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

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

### EDB-3.5.4 Weed Control

Noxious weeds and other unwanted vegetation must be treated as needed throughout the EDB. This activity can be performed either through mechanical means (mowing/pulling) or with herbicide. Consultation with the Environmental Division at 719-520-7878 is highly recommended prior to the use of herbicide.

Frequency – Routine – As needed based on inspections.

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### EDB-3.5.5 Mosquito/Algae Treatment

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

Frequency – As needed.

### EDB- 3.6 Minor Maintenance Activities

This work consists of a variety of isolated or small-scale maintenance or operational problems. Most of this work can be completed by a small crew, tools, and small equipment. These items may require prior correspondence with EPC Stormwater and require completed inspection and maintenance forms to be submitted to EPC upon request for each inspection and maintenance activity.

**Table – EDB-3 Summary of Minor Maintenance Activities**

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

### EDB-3.6.1 Sediment Removal

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

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

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

### EDB-3.6.2 Erosion Repair

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

Frequency – Nonroutine – As necessary based upon inspections.

### EDB-3.6.3 Vegetation Removal/Tree Thinning

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

Frequency – Nonroutine – As necessary based upon inspections.

### EDB-3.6.4 Clearing Drains/Jet-Vac

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

Frequency – Nonroutine – As necessary based upon inspections.

## EDB-3.7 Major Maintenance Activities

This work consists of larger maintenance/operational problems and failures within the stormwater management facilities. All of this work requires consultation with EPC Stormwater Staff to ensure the proper maintenance is performed. This work requires that the staff review the original design and construction drawings to assess the situation and assign the necessary maintenance. An ESQCP permit may be required for major maintenance activities. This work may also require more specialized maintenance equipment, design/details, surveying, or assistance through private contractors and consultants.

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**Table – EDB-4 Summary of Major Maintenance Activities**

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

### EDB-3.7.1 Major Sediment Removal

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

Frequency – Nonroutine – Repair as needed based upon inspections.

### EDB-3.7.2 Major Erosion Repair

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

Frequency – Nonroutine – Repair as needed based upon inspections.

### EDB-3.7.3 Structural Repair

An EDB includes a variety of structures that can deteriorate or be damaged during the course of routine maintenance. These structures are constructed of steel and concrete that can degrade or be damaged and may need to be repaired or re-constructed from time to time.

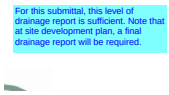
These structures include items like outlet works, trickle channels, forebays, inflows, and other features. In-house operations staff can perform some of the minor structural repairs. Major repairs to structures may require input from a structural engineer and specialized contractors. Consultation with EPC Stormwater Staff should take place prior to all structural repairs.

Frequency – Nonroutine – Repair as needed based upon inspections.

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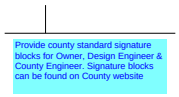
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EPC Project # AASI261

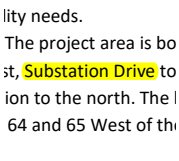
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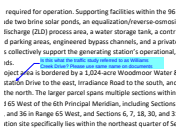
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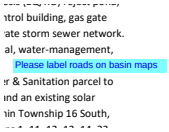
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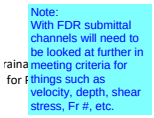
Is this what the traffic study referred to as Williams Creek Drive? Please use same name on documents

---




**Subject:** Text Box
**Page Label:** 6
**Author:** CDurham
**Date:** 11/6/2026 12:12:27 PM
**Status:**
**Color:**
**Layer:**
**Space:**

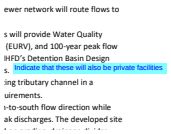
Please label roads on basin maps




**Subject:** Text Box
**Page Label:** 8
**Author:** CDurham
**Date:** 11/6/2026 12:16:09 PM
**Status:**
**Color:**
**Layer:**
**Space:**

Note:
With FDR submittal channels will need to be looked at further in meeting criteria for things such as velocity, depth, shear stress, Fr #, etc.

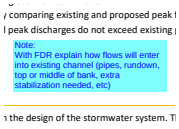
---




**Subject:** Text Box
**Page Label:** 9
**Author:** CDurham
**Date:** 11/6/2026 12:17:45 PM
**Status:**
**Color:**
**Layer:**
**Space:**

Indicate that these will also be private facilities

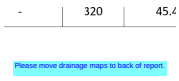
---




**Subject:** Text Box
**Page Label:** 11
**Author:** CDurham
**Date:** 11/6/2026 12:20:25 PM
**Status:**
**Color:**
**Layer:**
**Space:**

Note:
With FDR explain how flows will enter into existing channel (pipes, rundown, top or middle of bank, extra stabilization needed, etc)

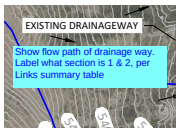
---




**Subject:** Text Box
**Page Label:** 17
**Author:** CDurham
**Date:** 11/6/2026 10:47:30 AM
**Status:**
**Color:**
**Layer:**
**Space:**

Please move drainage maps to back of report.

---




**Subject:** Text Box
**Page Label:** 17
**Author:** CDurham
**Date:** 11/6/2026 11:10:35 AM
**Status:**
**Color:**
**Layer:**
**Space:**

Show flow path of drainage way. Label what section is 1 & 2, per Links summary table

---




**Subject:** Text Box
**Page Label:** 17
**Author:** CDurham
**Date:** 11/6/2026 11:14:50 AM
**Status:**
**Color:**
**Layer:**
**Space:**

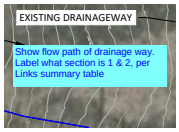
Show and label site boundary




**Subject:** Text Box
**Page Label:** 17
**Author:** CDurham
**Date:** 11/6/2026 12:25:30 PM
**Status:**
**Color:**
**Layer:**
**Space:**

Ensure easements are shown and labeled on basin maps

---




**Subject:** Text Box
**Page Label:** 18
**Author:** CDurham
**Date:** 11/6/2026 11:11:03 AM
**Status:**
**Color:**
**Layer:**
**Space:**

Show flow path of drainage way. Label what section is 1 & 2, per Links summary table

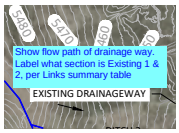
---




**Subject:** Text Box
**Page Label:** 18
**Author:** CDurham
**Date:** 11/6/2026 11:15:02 AM
**Status:**
**Color:**
**Layer:**
**Space:**

Show and label site boundary

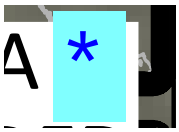
---




**Subject:** Text Box
**Page Label:** 19
**Author:** CDurham
**Date:** 11/6/2026 11:11:41 AM
**Status:**
**Color:**
**Layer:**
**Space:**

Show flow path of drainage way. Label what section is Existing 1 & 2, per Links summary table

---




**Subject:** Text Box
**Page Label:** 19
**Author:** CDurham
**Date:** 11/6/2026 11:13:05 AM
**Status:**
**Color:**
**Layer:**
**Space:**

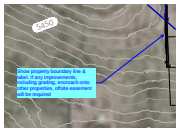
*

---




**Subject:** Text Box
**Page Label:** 20
**Author:** CDurham
**Date:** 11/6/2026 11:13:14 AM
**Status:**
**Color:**
**Layer:**
**Space:**

*




**Subject:** Callout
**Page Label:** 20
**Author:** CDurham
**Date:** 11/6/2026 11:31:08 AM
**Status:**
**Color:**
**Layer:**
**Space:**

Show property boundary line & label. If any improvements, including grading, encroach onto other properties, offsite easement will be required

---

Highlight 24 hour depths since that is the storm used.

**Subject:** Text Box
**Page Label:** 33
**Author:** CDurham
**Date:** 11/6/2026 11:08:28 AM
**Status:**
**Color:**
**Layer:**
**Space:**

Highlight 24 hour depths since that is the storm used.

---

**Subject:** Highlight
**Page Label:** 46
**Author:** CDurham
**Date:** 11/6/2026 11:33:45 AM
**Status:**
**Color:**
**Layer:**
**Space:**

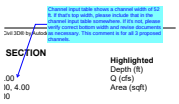
82.00

---

**Subject:** Highlight
**Page Label:** 46
**Author:** CDurham
**Date:** 11/6/2026 11:33:48 AM
**Status:**
**Color:**
**Layer:**
**Space:**

20.00

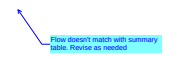
---




**Subject:** Callout
**Page Label:** 46
**Author:** CDurham
**Date:** 11/6/2026 11:38:42 AM
**Status:**
**Color:**
**Layer:**
**Space:**

Channel input table shows a channel width of 52 ft. If that's top width, please include that in the channel input table somewhere. If it's not, please verify correct bottom width and revise documents as necessary. This comment is for all 3 proposed channels.

---



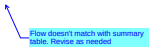

**Subject:** Callout
**Page Label:** 46
**Author:** CDurham
**Date:** 11/6/2026 11:37:41 AM
**Status:**
**Color:**
**Layer:**
**Space:**

Flow doesn't match with summary table. Revise as needed

**Subject:** Highlight
**Page Label:** 47
**Author:** CDurham
**Date:** 11/6/2026 11:37:06 AM
**Status:**
**Color:**
**Layer:**
**Space:**

442.00

---




**Subject:** Callout
**Page Label:** 47
**Author:** CDurham
**Date:** 11/6/2026 11:37:51 AM
**Status:**
**Color:**
**Layer:**
**Space:**

Flow doesn't match with summary table. Revise as needed

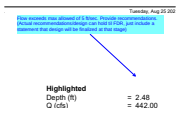
---



**Subject:** Highlight
**Page Label:** 47
**Author:** CDurham
**Date:** 11/6/2026 11:42:30 AM
**Status:**
**Color:**
**Layer:**
**Space:**

5.96

---




**Subject:** Callout
**Page Label:** 47
**Author:** CDurham
**Date:** 11/6/2026 11:42:51 AM
**Status:**
**Color:**
**Layer:**
**Space:**

Flow exceeds max allowed of 5 ft/sec. Provide recommendations. (Actual recommendations/design can hold til FDR, just include a statement that design will be finalized at that stage)

---




**Subject:** Callout
**Page Label:** 48
**Author:** CDurham
**Date:** 11/6/2026 11:38:13 AM
**Status:**
**Color:**
**Layer:**
**Space:**

Flow doesn't match with summary table. Revise as needed

---



**Subject:** Highlight
**Page Label:** 48
**Author:** CDurham
**Date:** 11/6/2026 11:38:18 AM
**Status:**
**Color:**
**Layer:**
**Space:**

29.00




**Subject:** Callout
**Page Label:** 49
**Author:** CDurham
**Date:** 11/6/2026 11:39:15 AM
**Status:**
**Color:**
**Layer:**
**Space:**

Flow doesn't match with summary table. Revise as needed

---



**Subject:** Highlight
**Page Label:** 49
**Author:** CDurham
**Date:** 11/6/2026 11:39:20 AM
**Status:**
**Color:**
**Layer:**
**Space:**

66.00

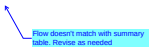
---



**Subject:** Highlight
**Page Label:** 51
**Author:** CDurham
**Date:** 11/6/2026 11:39:53 AM
**Status:**
**Color:**
**Layer:**
**Space:**

99.00

---




**Subject:** Callout
**Page Label:** 51
**Author:** CDurham
**Date:** 11/6/2026 11:40:03 AM
**Status:**
**Color:**
**Layer:**
**Space:**

Flow doesn't match with summary table. Revise as needed

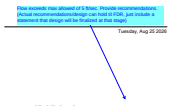
---



**Subject:** Highlight
**Page Label:** 51
**Author:** CDurham
**Date:** 11/6/2026 11:40:08 AM
**Status:**
**Color:**
**Layer:**
**Space:**

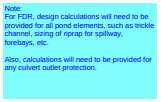
6.64

---




**Subject:** Callout
**Page Label:** 51
**Author:** CDurham
**Date:** 11/6/2026 11:41:42 AM
**Status:**
**Color:**
**Layer:**
**Space:**

Flow exceeds max allowed of 5 ft/sec. Provide recommendations. (Actual recommendations/design can hold til FDR, just include a statement that design will be finalized at that stage)

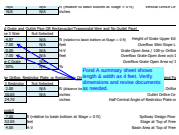



**Subject:** Text Box
**Page Label:** 52
**Author:** CDurham
**Date:** 11/6/2026 12:05:16 PM
**Status:**
**Color:**
**Layer:**
**Space:**

Note:
For FDR, design calculations will need to be provided for all pond elements, such as trickle channel, sizing of riprap for spillway, forebays, etc.

Also, calculations will need to be provided for any culvert outlet protection.

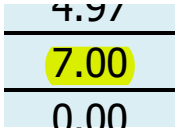
---




**Subject:** Callout
**Page Label:** 55
**Author:** CDurham
**Date:** 11/6/2026 11:50:01 AM
**Status:**
**Color:**
**Layer:**
**Space:**

Pond A summary sheet shows length & width as 4 feet. Verify dimensions and revise documents as needed.

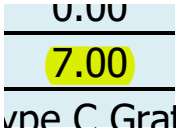
---




**Subject:** Highlight
**Page Label:** 55
**Author:** CDurham
**Date:** 11/6/2026 11:49:28 AM
**Status:**
**Color:**
**Layer:**
**Space:**

7.00

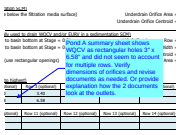
---




**Subject:** Highlight
**Page Label:** 55
**Author:** CDurham
**Date:** 11/6/2026 11:49:36 AM
**Status:**
**Color:**
**Layer:**
**Space:**

7.00

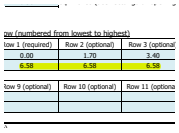
---




**Subject:** Callout
**Page Label:** 55
**Author:** CDurham
**Date:** 11/6/2026 11:59:29 AM
**Status:**
**Color:**
**Layer:**
**Space:**

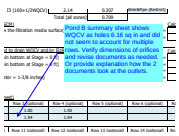
Pond A summary sheet shows WQCV as rectangular holes 3" x 6.58" and did not seem to account for multiple rows. Verify dimensions of orifices and revise documents as needed. Or provide explanation how the 2 documents look at the outlets.

---




**Subject:** Highlight
**Page Label:** 55
**Author:** CDurham
**Date:** 11/6/2026 11:56:18 AM
**Status:**
**Color:**
**Layer:**
**Space:**

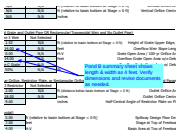
6.58 6.58 6.58




**Subject:** Callout
**Page Label:** 59
**Author:** CDurham
**Date:** 11/6/2026 12:03:07 PM
**Status:**
**Color:**
**Layer:**
**Space:**

Pond B summary sheet shows WQCV as holes 6.16 sq in and did not seem to account for multiple rows. Verify dimensions of orifices and revise documents as needed. Or provide explanation how the 2 documents look at the outlets.

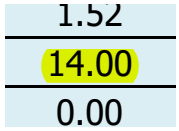
---




**Subject:** Callout
**Page Label:** 59
**Author:** CDurham
**Date:** 11/6/2026 12:02:02 PM
**Status:**
**Color:**
**Layer:**
**Space:**

Pond B summary sheet shows length & width as 4 feet. Verify dimensions and revise documents as needed.

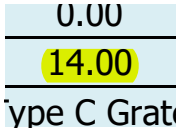
---




**Subject:** Highlight
**Page Label:** 59
**Author:** CDurham
**Date:** 11/6/2026 12:02:08 PM
**Status:**
**Color:**
**Layer:**
**Space:**

14.00

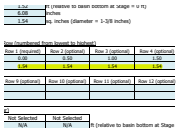
---




**Subject:** Highlight
**Page Label:** 59
**Author:** CDurham
**Date:** 11/6/2026 12:02:15 PM
**Status:**
**Color:**
**Layer:**
**Space:**

14.00

---



**Subject:** Highlight
**Page Label:** 59
**Author:** CDurham
**Date:** 11/6/2026 12:02:25 PM
**Status:**
**Color:**
**Layer:**
**Space:**

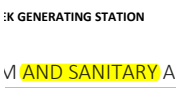
1.54 1.54 1.54 1.54

---




**Subject:** Callout
**Page Label:** 61
**Author:** CDurham
**Date:** 11/6/2026 10:40:32 AM
**Status:**
**Color:**
**Layer:**
**Space:**

Delete




**Subject:** Highlight
**Page Label:** 61
**Author:** CDurham
**Date:** 11/6/2026 10:40:28 AM
**Status:**
**Color:**
**Layer:**
**Space:**

AND SANITARY

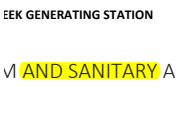
---



**Subject:** Cloud+
**Page Label:** 63
**Author:** CDurham
**Date:** 11/5/2026 3:54:16 PM
**Status:**
**Color:**
**Layer:**
**Space:**

Indicate that there is a blow up of this section on the next page

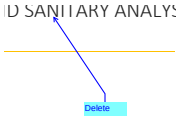
---




**Subject:** Highlight
**Page Label:** 65
**Author:** CDurham
**Date:** 11/6/2026 10:39:37 AM
**Status:**
**Color:**
**Layer:**
**Space:**

AND SANITARY

---




**Subject:** Callout
**Page Label:** 65
**Author:** CDurham
**Date:** 11/6/2026 10:39:57 AM
**Status:**
**Color:**
**Layer:**
**Space:**

Delete

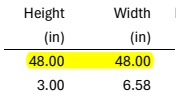
---




**Subject:** Text Box
**Page Label:** 67
**Author:** CDurham
**Date:** 11/6/2026 10:44:06 AM
**Status:**
**Color:**
**Layer:**
**Space:**

For each table/summary please add if it's existing or proposed and 5 or 100 year scenario in title

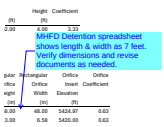
---



| Height (in) | Width (in) |
|---|---|
| 48.00 | 48.00 |
| 3.00 | 6.58 |

**Subject:** Highlight
**Page Label:** 123
**Author:** CDurham
**Date:** 11/6/2026 11:47:47 AM
**Status:**
**Color:**
**Layer:**
**Space:**

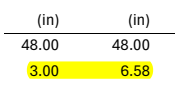
48.00 48.00




**Subject:** Callout
**Page Label:** 123
**Author:** CDurham
**Date:** 11/6/2026 11:53:40 AM
**Status:**
**Color:**
**Layer:**
**Space:**

MHFD Detention spreadsheet shows length & width as 7 feet. Verify dimensions and revise documents as needed.

---

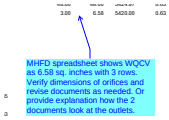


| (in) | (in) |
|---|---|
| 48.00 | 48.00 |
| 3.00 | 6.58 |

**Subject:** Highlight
**Page Label:** 123
**Author:** CDurham
**Date:** 11/6/2026 11:53:32 AM
**Status:**
**Color:**
**Layer:**
**Space:**

3.00 6.58

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**Subject:** Callout
**Page Label:** 123
**Author:** CDurham
**Date:** 11/6/2026 11:59:02 AM
**Status:**
**Color:**
**Layer:**
**Space:**

MHFD spreadsheet shows WQCV as 6.58 sq. inches with 3 rows. Verify dimensions of orifices and revise documents as needed. Or provide explanation how the 2 documents look at the outlets.

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**Subject:** Callout
**Page Label:** 126
**Author:** CDurham
**Date:** 11/6/2026 12:00:17 PM
**Status:**
**Color:**
**Layer:**
**Space:**

MHFD Detention spreadsheet shows length & width as 14 feet. Verify dimensions and revise documents as needed.

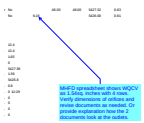
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| Height (in) | Width (in) |
|---|---|
| 48.00 | 48.00 |

**Subject:** Highlight
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**Author:** CDurham
**Date:** 11/6/2026 11:52:26 AM
**Status:**
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**Layer:**
**Space:**

8.00 48.00

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**Subject:** Callout
**Page Label:** 126
**Author:** CDurham
**Date:** 11/6/2026 12:00:49 PM
**Status:**
**Color:**
**Layer:**
**Space:**

MHFD spreadsheet shows WQCV as 1.54sq. inches with 4 rows. Verify dimensions of orifices and revise documents as needed. Or provide explanation how the 2 documents look at the outlets.

At SDP, this will be a stand alone document and will not be located in the drainage report.

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**Subject:** Text Box
**Page Label:** 160
**Author:** CDurham
**Date:** 11/6/2026 10:00:55 AM
**Status:**
**Color:**
**Layer:**
**Space:**

At SDP, this will be a stand alone document and will not be located in the drainage report.