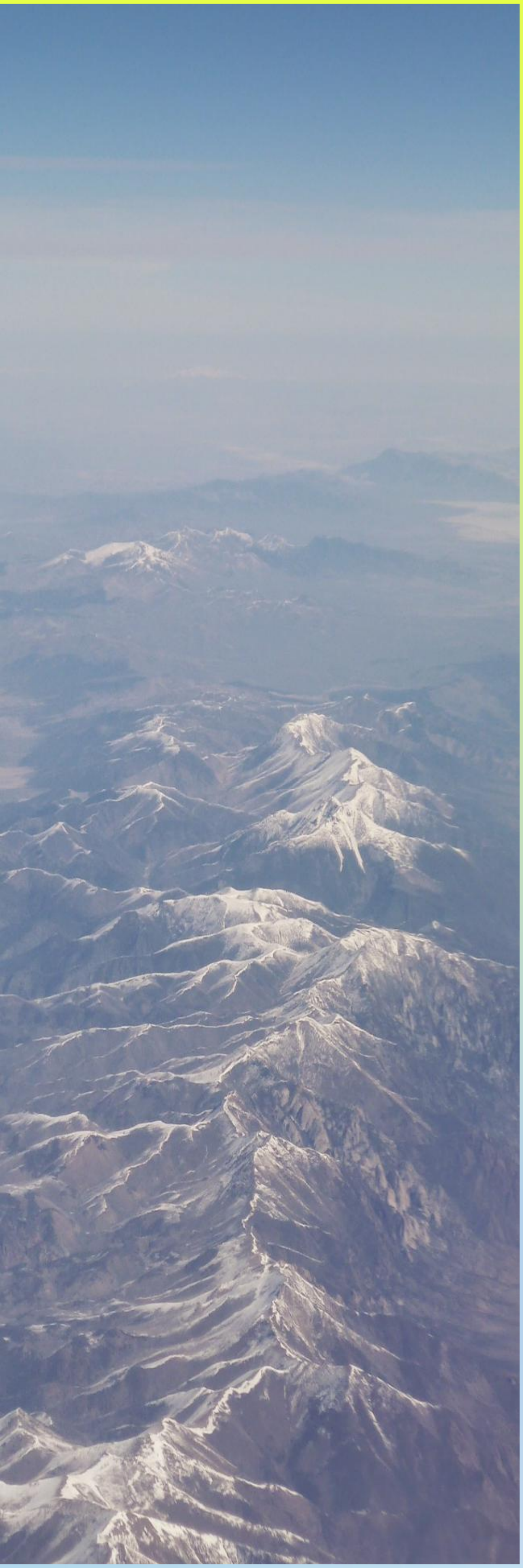
Innovative Land Consultants, Inc.
12071 Tejon Street, Suite 470
Westminster, CO 80234
303.421.4224
www.innovativelandinc.com



Preliminary Drainage Report

Revere North Filing No. 1
Johnstown, Colorado

Project No. 1060-08

Submittal: 1st: April 8, 2022

Prepared For:
Forestar Group Inc.
9555 S. Kingston Court, Suite 200
Englewood, CO 80112

Prepared By:
Innovative Land Consultants, Inc.
12071 Tejon Street, Suite 470
Westminster, CO 80234
(303) 421-4224

CERTIFICATIONS

CERTIFICATION OF ENGINEER

"I hereby certify that this Preliminary Drainage Report for Revere North at Johnstown Filing No. 1 was prepared under my direct supervision in accordance with the provisions of the Town of Johnstown Storm Drainage Criteria for the owners thereof".

____

Teresa Rae Hogan, PE
Registered Professional Engineer
State of Colorado No. 28789
For and on behalf of __________________

____

Prepared by
Alex Asadullaev, PE
Senior Project Engineer

CERTIFICATION OF Owner

Forestar, Inc. hereby certifies the drainage facilities for Revere North at Johnstown Filing No. 1 shall be constructed according to the design presented in this report. We understand that the Town of Johnstown does not and will not assume liability for drainage facilities designed and/or certified by our engineer. We also understand that the Town of Johnstown relies on the representation of others to establish that drainage facilities are designed and constructed in compliance with Town of Johnstown guidelines, standards or specifications. Review by the Town of Johnstown can therefore in no way limit or diminish any liability, which we or any other party may have with respect to the design or construction of such facilities."

Attest:

____

Name of Responsible Party

____

Notary Public

____

Authorized Signature

TABLE OF CONTENTS

APPENDICES

A. Introduction

1. Description of Site

a. Area, Adjacent Streets, Subdivision Name, Lot and Block, Site Plan Name

Revere at Johnstown Filing No. 1 is a proposed single-family residential subdivision located within the Great Plains Village Master Planned community in Johnstown, Colorado. The site is located in the southwest quarter of Section 36, Township 5 North, Range 68 West of the 6th Principal Meridian, Weld County Colorado. The site is located approximately 1.3 miles east of the Interstate Highway 25, and is located adjacent to and north of Larimer Country Road 14 (also known as Weld County Road 50), and approximately 0.6 miles west of the South County Line Road in the Town of Johnstown, Colorado. See the below Vicinity Map for reference.

Vicinity Map

b. Surrounding Developments

Revere North Filing 1 is located within the Great Plains Village Master Planned Community. Undeveloped land currently surrounds the site on the east, north and west side of the site. The site is adjacent to the existing home and farm along the south portion of its western property. The south side of the site is adjacent to the existing East County Road 14 and is also surrounds an existing structures that shall be removed with this project.

The project, inclusive of the proposed major roadways, local roads, single family and multi family housing, a club house and two proposed drainage ponds is approximately 107 acres in size. Currently, the site is used for agricultural farming purposes. The site contains a 24 inch irrigation line bisecting the southeast corner of the site as well as existing irrigation ditch flowing through the northeast corner of the site.

The existing topography of the proposed site consists of slopes varying from 1 to 5% slopes. Majority of the site slopes to the north with a southeastern corner portion of the site sloping to the southeast. Per the NRCS Soils Survey the site consist of Type A, type B , and Type C Hydrologic Soils. The northern portion of the site consists of Ascalon Sandy Loam soils that belong to the Hydrologic Soil Group B and shall be evaluated as such. Wiley Silt Loam soils are present on site in the southern portion of the site, and is also classified as Soil Hydrologic Type B. The area of the site occupied by Hydrologic Soil Type B is approximately 45% of the total project site area.

The predominant type of soil on this site is Weld Silt Loam occupying central portion of the site. These soils belong to Hydrologic Soil Group C. As the present soil type A areas are negligible the 55% of the site area outside of Soil Type B shall be evaluated as Type C soils within this report.

Please reference appendix C for the soil information obtained from the United States Department of Agriculture (USDA) for soil information and map reflecting the soil locations as well as the site soil area tables.

Great Plains Village Master Planned Community is comprised of 15 planning areas in total. Filing 1 North includes the development of parts of PA-4, PA-5, and PA-7 and all of PA-6. These areas have a conceptual layout which includes 244 single-family dwellings, 98 duplex dwellings, public park spaces, sidewalks, two drainage ponds, club house, and public rights-of-ways.

B. Description of Basin and Sub-basins

a. Major Drainageways

There are no major drainageways located on or adjacent to the project site.

The project site is not within a FEMA regulated floodplain. It is located within unshaded Zone X as shown on the FEMA Firm Map 08069C1405g, dated January 15, 2021, included in the Appendix C of this report.

b. Compliance with Storm Water Master Plan for Town of Johnstown

The proposed development is located within the two major basins from the Storm Water Master Plan for the Town of Johnstown, hence forth referred to as Johnstown Master Plan. The two basins containing this property are the Elwell Basin and Twin Mounds Basin of the Johnstown Master Plan with both major basins ultimately discharging into the Big Thompson River. As recommended in the Johnstown Master Plan, on-site ponds are provided for detention and water quality with release rates in accordance with Table IV-1 from the Johnstown Master Plan. Majority of the site is located within the Twin Mounds Basin with a minor portion of the southeastern site corner as part of the Elwell Basin. The proposed development will continue to drain in the pattern of these designated basins with two proposed ponds on site that will continue to release the flows per the Johnstown Master Plan. Please find the relevant references from Johnstown Master Plan included in Appendix C of this report.

c. Nearby Drainage and Irrigation Features

An existing irrigation canal line runs through the northeastern corner of the property and shall remain undisturbed. The existing site was used as the farmland and contains some irrigation pipes that were used for site farm irrigation only. These pipes shall be capped/ abandoned in place during the construction. An existing 24 inch irrigation pipe bisecting the proposed development in south east corner. It shall be realigned with the construction of the project and the realignment plans shall be part of the construction drawings. The representation of the alignment is represented on the Drainage Plan in the back of this report.

d. Historic Drainage Patterns

As previously mentioned, the existing topography of the proposed site consists of slopes between 1% to5%, with the majority of the site sloping to the north of the site. A ridge separating site into two drainage areas is located through the southeast corner of the site and the south east corner drains generally to the southeast. Please reference the Historic Drainage Exhibit located in the back of this report for the onsite drainage pattern representation.

e. Off-Site Drainage Patterns

The east property edge of the site is located at the top of the drainage basins and the offsite flows are not expected to be delivered into this site from the east. The area generally slopes away from the site in current conditions.

An outparcel, as described in Great Planes Village report, located north of the Weld County Road 50 and represented in the Great Planes Village masterplan is located at the southern edge of the site and is surrounded by the site. The flows from this outparcel will be entering the site and shall be accommodated within the drainage. As this outparcel is located at the top of the drainage ridge the flows here are split to the north and to the east. The outparcel is represented by basins OS-1 (Design point 8) and OS-2 (Design Point 10). Please refer to the Drainage Facility design section of this report for the discussion of the drainage capture of this area.

The southern boundary of this site is Weld County Road 50. A portion of the Twin Mounds Basin from the Storm Water Master Plan for the Town of Johnstown topographically is draining north across the Weld County Road 50 at the design point 5. This area is designated as Basin Offsite South (Basin OS-S) on the Twin Mounds Basin exhibit included in the back of this report. The total portion of Twin Mounds Basin coming from the south is approximately 103.5 Acres. Currently this area is undeveloped. Northern portion of the proposed Revere Filing 1 Development lies within this area and upon construction will provide a detention pond (Pond C) that will be detaining the flows to the Johnstown Masterplan criteria. Current historic flows coming across the road at the design point 5 are 37.3 cfs in a 5 year storm and 94.2 cfs in a 100 year storm. With the development of the Revere Filing 1 North project the historic flows from this area shall be accommodated to pass through the site. The storm system will be extended to fully accommodate the 5 year historic flows from this portion of the Twin Mounds Basin. 100 year flows shall be accommodated within the right of way of the proposed streets continuing to the north from WCR 50.

Off-site drainage from the western portion of Great Plains Village basins located north of Weld County Road 50 is partially tributary to the proposed site. The portion of the Twin Mounds basin located to the west and draining toward the proposed site is designated as Basin Offsite West (Basin OS-W) and is represented by Basins OS-W1, OS-W2, and OS-W3 on the Twinn Mounds Drainage exhibit located at the back of this report. This portion of Twin Mounds basin is approximately 405 Acres in size and contributes peak flows of approximately 145.7 cfs in a 5 Year Storm and 368.4 cfs in a 100 Year storm. The low point of this area is designated as Design Point 2 on the Twin Mounds Drainage Exhibit. With the development of the site and the storm infrastructure Basin OS-W shall be subdivided into appropriate areas draining toward the site. Several low points shall be used along the western edge of the site to collect the offsite flows as appropriate to provide the storm path through the system and through the proposed Pond. Temporary swales and area inlets will be provided for the interim condition (final condition of the Phase 1 construction) to capture the undeveloped runoff from these areas along the west side of the proposed road to direct the flows to Design Point 2. Storm system and swales shall be constructed to collect the 5 year storm within the storm system and bypass it through the site. In a 100 year event the storm shall be caried via combination of storm and street capacities to direct the 100 year flows through the proposed site.

While the proposed pond within the site may provide additional storage for some of the area located within the Great Planes village, it shall not be responsible for providing Detention to any portion of Twin Mounds Basin. Any future development of this basin upstream of the site shall provide drainage evaluation to the Town of Johnstown and comply with the original Master Study of releasing no more than 0.91 cfs per acre in a 100 year storm.

Storm infrastructure provided at the western boundary of the proposed site shall be sized for future minor flows from the basins to the west.

The northern boundary of the project is located at the lowest elevation of the site and the topography generally slopes away from the site to the north. No offsite flows are anticipated to enter the site from the north.

C. Drainage Design Criteria

1. Hydrologic Criteria

a. Rainfall Source

Per Mile High Flood District (MHFD, formerly UDFCD) NOAA Atlas 14 was used to obtain the 5-year and 100-year 1-hour point rainfall, respectively. The minor storm is the 5-year event; the major storm is the 100-year event.

5-year P_1 = 1.11 in
100-year P_1 = 2.80 in

The obtained Rainfall Frequency Data is included in Appendix C of this report.

b. Calculation Method

The rational method was utilized to calculate peak runoff values for drainage basins. Impervious coefficients were determined for each basin based on land use. Time of concentrations were calculated by combining the initial time or overland flow time with the travel time in the swale, gutter, and storm sewer. The one-hour rainfall and time of concentrations were used to calculate rainfall intensities. Basin peak runoff calculations can be found in Appendix A of this report.

c. Detention Volume Computation Method

Detention is provided in the proposed full spectrum detention ponds located at the north and southeast corner of the proposed site. The required volumes for the ponds were calculated using the MHFD-Detention Version 4.05 (February 2022). The pond release rates are calculated using Table IV-1 from the Johnstown' Master Plan.

d. Peak Runoff

Peak runoff was calculated for the minor 5-year and major 100-year storm events.

D. Drainage Facility Design

a. Drainage Patterns and Basin Discussion

Per the historic drainage analysis and plan provided in the Preliminary Drainage Report for Great Plains Village, Johnstown Colorado – henceforth referred to as Great Planes Study (please see Appendix C for reference), prepared by Core Consultants, Inc., the site is located within portion of the historic basin EX-3 and entire basin EX-4 (EX-3 sloping to the north and EX-2 sloping to the southeast). The proposed drainage map, prepared by Core Consultants Inc., subdivides the existing basin EX-3 into multiple basins named E through K. Existing basin EX-4 is the proposed Basin L of the that are represented within the study comprise the Southeastern portion of the site located within Elwel Basin. This outparcel is represented by basins OS-1 and OS-2 of the provided Drainage Plan.

As previously mentioned, the existing topography of the site is split with the northern portion of the site sloped to the north This area shall be named Major Basin A within this report. The Major Basin A is a portion of the Historic Basin EX-3 of Great Planes Study. The Major Basin A is also comprised of parts of proposed basins I, J, and K of the Great Planes study. A proposed Pond A shall be provided to collect and detain the flows from this area. It will release the flows to the north in their historic pattern as part of the Twin Mound Basin per the criteria set in the Johnstown Master Plan.

The southeastern corner portion of the site sloped to the southeast and this basin shall be named Major Basin B within this report. Major Basin B is represented in the Great Planes Study as existing basin EX-4 and as Proposed Basin L. The entirety of this proposed Major Basin B will drain and the storm flows be detained in the proposed Pond B. The release flows from this pond will be directed to the east along Weld County Road 50, into the Elwel Basin.

As per the assumption stated in the Great Plains Study each planning area will require on-site detention pond. This will remain true for the Master Basin B. Proposed Pond A shall be providing the detention for the entire Major Basin A. As the proposed site does not match the boundaries of the planning areas used in the Great Planes Study the proposed pond A within the Major Basin A will be providing detention for the parts of Planning Areas 2 through 8 of the Great Planes Study.

The proposed reconfiguration of the drainage basins of the Great Planes Study driven by the development of this site does not alter the standards for storm conveyance and detention set forth in the Johnstown Master Plan and in the Great Planes Study.

Pond A shall be constructed to provide the detention for the entire proposed Filing 1 for Revere North. The outlet structure shall be designed to function for the proposed conditions of the Filing 1 being completely built out. The proposed pond A will have additional built in storage within its volume that will be utilized above the 100 year storm as a temporary emergency volume prior to the emergency spillway. This additional volume will be utilized upon upstream development to the west of Filing 1 (Basin I of the Great Planes Study.) The provision of the additional storage does not exempt the remainder of Basin I of the Great Planes Study from the storm evaluation and original standards set forth in Johnstown Master Plan. Provision of the additional storage may be utilized upon proper evaluation of Pond A, redesign and reconstruction of the outlet structure within Pond A, and storm system extension and evaluation with construction of the upstream projects. With the development of the site in the future, if the provided storage is found insufficient for the land use, an additional detention may be required upstream of this project. The pond volumes and areas discussed below in the Detention section of this report is conditional on the future development, area use, and densities of the remainder of Basin I of the Great Planes Study upon its development.

The proposed drainage concept for Revere North Filing No. 1 maintains the overall concept from the 'Master' Preliminary Drainage Report prepared by Core. The proposed preliminary drainage plan splits basins of the Great Planes Study into onsite and offsite basins for the purposes of this report and site development. An exhibit is provided in Appendix C, representing the information discussing the basins.

Major Basin A is approximately 98.8 acres in size and consists of single-family and single-family duplex units. A storm system is provided from Pond A through the streets at low points and to ensure the minor storm street capacity is not exceeded. Swales are provided along the western boundary to divert flows to area inlets. Storm stubs are provided for the future developments to the west and south to convey the flows of Twin Mound Basin. The flows from a portion of the outparcel of Great Planes Study located at the south end of Major Basin A are expected to be received and conveyed through this Basin.

Major Basin B is approximately 8.2 acres that primarily consists of single-family detached units and Pond B. A storm system within this basin shall drain to Pond B. Pond B shall provide the necessary full spectrum detention for the entire basin and convey offsite flows from the portion of the outparcel of Great Planes Study located west of Major Basin B. Please refer to the Drainage Map located in the back of this report for the Basin location and drainage patterns.

Peak basin runoff calculations are provided in Appendix A. All major basins will be further subdivided in the Final Drainage Report for stormwater routing and hydraulic analysis.

b. Conveyance of Off-Site Drainage

The proposed drainage infrastructure for Revere at Johnstown will be sized to convey the future developed flows from the off-site basins to the west and south as well as the outparcel located adjacent to the southern property line of this site. The proposed drainage plan ensures that all current/undeveloped off-site flows are accounted for and conveyed prior to the developments that will occur in the future. In the interim condition, swales are provided along the west portion of the site to collect the existing storm runoff.

Future development to the west will require on-site detention ponds as per Johnstown Master Plan. Release rates from the future ponds will be analyzed based on Table IV-1 from the Johnstown Master Plan.

c. Preliminary Detention Pond Sizing and Site Outfall Discussion

MHFD detention spreadsheets were used to size the on-site detention ponds. The table below summarizes the volumes required for the on-site ponds based on the proposed site plan.

Preliminary Pond Sizing			
Pond Designation	Proposed Site Area Tributary to the Pond *(Acre)*	Basin Imperviousness *(%)*	Calculated Required Volume *(cu ft)*
Pond A	95.29	46	9.08
Pond B	8.84	54	0.94

To maintain consistency with the existing drainage patterns and Johnstown Master Plan, future off-site ponds from the south, across Weld County Road 50 will be routed through Pond A assumed storm release rates at this point shall be sized per the standards set in the Johnstown Master Plan. The storm shall be sized to convey the current historic flows from the south and the future allowable release rates from the detention pond that will be provided upon the development of this portion of Twin Mound Basin, per the historic drainage analysis provided in the Johnstown Master Plan.

Proposed release rates out of ponds A and B are set based on the criteria set in the Johnstown Drainage Plan. As mentioned previously, Table IV-1(Provided in Appendix C) is used to determine pond release rates for the detention ponds. The table below summarizes the allowable release rates from the proposed ponds.

Preliminary Pond Release Calculations per Johnstown Criteria		
Pond Designation	5 Year Release Rate *(cfs)*	100 Year Release Rate *(cfs)*
Pond A	34.30	86.71
Pond B	2.83	8.22

It should be noted that although the minor storm release rate was calculated per Table IV-1, actual minor storm release rates for each pond will be determined in the final design as this is typically controlled by the Water Quality (WQ) and Excess Urban Runoff Volume (EURV) orifice plates in order to provide the required EURV for the developed site. Final design of Ponds A and B will ensure that minor storm flows to the outfall points do not exceed the historic flows currently seen at these points.

For the major storm event the ponds will be designed to pass the allowable 100-year release rates plus the 100-year allowable release rates from upstream tributary areas. The table below compares the total developed 100-year runoff at the ponds against the historic runoff.

Developed Pond Release Rates			
Pond Designation	100 Year Historic Release *(cfs)*	100 Year Allowable Release *(cfs)*	100 Year Proposed Release *(cfs)*
Pond A	124.60	86.71	85.4
Pond B	13.50	8.22	7.9

Per the table above, total 100-year runoff to each ultimate design point is less than historic.

d. Drainage Impacts to Surrounding Developments

The drainage design of the proposed development is consistent with historic drainage patterns and the Johnstown Master Plan. The proposed onsite detention shall improve the flow patterns in the basins to the proposed conditions of the Master Study and no negative impacts to surrounding and downstream infrastructure are expected.

e. Proposed Drainage Facilities

Drainage facilities proposed with this project include Type C Inlets, Type R Inlets, concrete flared end sections, storm forebays, Type III RCP storm systems, drainage swales, low flow pans, and outlet structures. Inlets are proposed at low points and on-grade where minor storm street capacity is exceeded. Temporary swales are proposed along the western border of the project to collect the offsite storm runoff. Proposed swale shall consists of grass swales sloped at 2% or above and collected into Type C Inlets and the flows will be conveyed to Pond A. As mentioned previously, two on-site detention ponds will be constructed with this development and will provide water quality and storm detention.

All inlets and swales will need to be kept free from debris and trash. The detention pond trash racks, and outlet pipes will also require regular maintenance to ensure proper drainage.

f. Phasing of Construction and Provisions for Drainage

No phasing is proposed for this site construction project.

E. Conclusion

The drainage concept for Revere North Filing No. 1 was derived from the 'Master' Preliminary Drainage Plan for Great Plains Village. The proposed site drainage patterns are in conformance with the existing topography and surrounding developments. There are no expected negative impacts to the surrounding developments or existing streets.

This preliminary drainage report is in conformance with the *Town of Johnstown Storm Drainage Criteria*, the *Storm Water Master Plan for the Town of Johnstown,* and *Mile High Flood District Storm Drainage Criteria Manuals*.

F. List of References

- Town of Johnstown Storm Drainage Criteria
- *Storm Water Master Plan for the Town of Johnstown* as prepared by TEC, Inc., April 2001
- *Preliminary Drainage Report Great Plains Village,* prepared by Core Consultants Inc., November 2019;
- *Mile High Flood District Drainage Criteria Manual* Volumes 1, 2, & 3, current version;
- *Natural Resources Conservation Service Web Soil Survey,* United States Department of Agriculture
- *Federal Emergency Management Agency Flood Insurance Rate Map,* Community-Panel Number 08069C1405F; dated December 19, 2006

APPENDIX A

Hydrologic Computations

Single Family Lots (51' x 110')

03/29/22

Single Lot Area (sf): 5,610.0

Surface	Area (sf)	C_5	C_{100}	Impervious (%)
Lawn	2,330.00	0.05	0.49	2%
Roof	2,740.00	0.77	0.85	90%
Concrete Drive/Walk	540.00	0.77	0.85	90%
Composite Site Values:		0.47	0.70	53%
Composite % Impervious Used:		0.48	0.71	55%

Single Family Lots (61' x 110')

0

03/29/22

Single Lot Area (sf): 6,710.0

Surface	Area (sf)	C_5	C_{100}	Impervious (%)
Lawn	3,430.00	0.05	0.49	2%
Roof	2,740.00	0.77	0.85	90%
Concrete Drive/Walk	540.00	0.77	0.85	90%
Composite Site Values:		0.40	0.67	45%
Composite % Impervious Used:		0.40	0.67	45%

Duplex

03/29/22

Single Lot Area (sf): 2,625.0

Surface	Area (sf)	C_5	C_{100}	Impervious (%)
Lawn	1,002.50	0.05	0.49	2%
Roof	1,420.00	0.77	0.85	90%
Concrete Drive/Walk	202.50	0.77	0.85	90%
Composite Site Values:		0.50	0.72	56%
Composite % Impervious Used:		0.56	0.75	65%

Basin Runoff Calculations - Direct Runoff

Project No.: 0

29-Mar-22

Basin ID	Design Point	Total Area (Ac.)	Imp (%)	Tc (min)	Runoff Coeff.							
					C_2	C_5	C_{100}	I_2	I_5	I_{100}	Q_5	Q_{100}
Developed												
Basin A		95.29	46%	54.58	0.34	0.39	0.66	0.90	1.20	3.01	44.30	189.56
Basin B		8.84	40%	17.89	0.29	0.34	0.63	1.74	2.31	5.83	6.97	32.69

$$\text{Intensity} = \frac{28.5 * P_1}{(10 + T_c)^{0.786}}$$

2 Year P_1 = 0.83

5 Year P_1 = 1.11

100 Year P_1 = 2.80

Time of Concentration

Project No. 1060-02
3/29/22

Basin ID	C_5	Initial/Overland Flow Time T_i Length (ft)	Slope (%)	T_i (min)	Travel Time T_t/ Cocentrated Channel Flow Length (ft)	Slope (%)	Conveyance Element	Conveyance Coefficient (K)	Velocity (fps)	T_t (min)	Total T_c (min)	Tc Check Total Length (ft)	Impervious (i/100)	Slope (ft/ft)	$T_c=(26-17i)+L/(60(14i+9)S^{.5})$ (min)	Final T_c (min)
Pond A	0.39	250	2.00	16.1	4125	0.80	Street	20	1.8	38.4	54.6	4375	0.55	0.008	62.5	54.6
Pond B	0.34	100	2.00	10.9	750	0.80	Street	20	1.8	7.0	17.9	850	0.49	0.008	26.6	17.9

Basin Runoff Calculations - Direct Runoff

Project No.: 0

29-Mar-22

Basin ID	Design Point	Total Area (Ac.)	Imp (%)	Tc (min)	Runoff Coeff. C_2	C_5	C_{100}	I_2	I_5	I_{100}	Q_5	Q_{100}
Developed												
Basin A		95.29	46%	54.58	0.34	0.39	0.66	0.90	1.20	3.01	44.30	189.56
Basin B		8.84	40%	17.89	0.29	0.34	0.63	1.74	2.31	5.83	6.97	32.69

Intensity = $\dfrac{28.5 * P_1}{(10 + T_c)^{0.786}}$

2 Year P_1 = 0.83

5 Year P_1 = 1.11

100 Year P_1 = 2.80

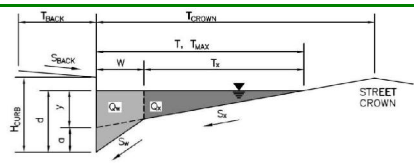
APPENDIX B

Hydraulic and Detention Pond Calculations

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

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

Project: Revere North Filing 1
Inlet ID: Collector Street



Gutter Geometry:

Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	18.0		ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020		ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.020		
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00		inches
Distance from Curb Face to Street Crown	T_{CROWN} =	22.0		ft
Gutter Width	W =	2.00		ft
Street Transverse Slope	S_X =	0.020		ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083		ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.008		ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.016		
		Minor Storm	**Major Storm**	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	14.0	22.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	10.3	inches
Allow Flow Depth at Street Crown (check box for yes, leave blank for no)		☐	☑	

		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Spread Criterion MAJOR STORM Allowable Capacity is based on Depth Criterion	Q_{allow} =	5.9	69.6	cfs

Minor storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'
Major storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'

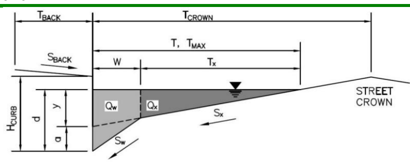
Sized Capacity calclated in this spreadsheet is for one half of the street.

The total street Capacity is 139.2 cfs

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

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

Project: Revere North Filing 1
Inlet ID: Res St w Mountable Curb



Gutter Geometry:

Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	21.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.020	
Height of Curb at Gutter Flow Line	H_{CURB} =	4.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	18.0	ft
Gutter Width	W =	2.00	ft
Street Transverse Slope	S_X =	0.020	ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083	ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.008	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.016	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	18.0	18.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	4.0	6.6	inches
Allow Flow Depth at Street Crown (check box for yes, leave blank for no)		☐	☐	

		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Depth Criterion				
MAJOR STORM Allowable Capacity is based on Spread Criterion	Q_{allow} =	2.9	11.7	cfs

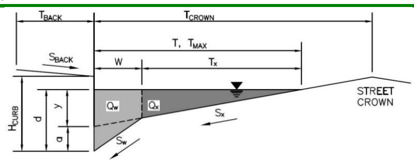
Minor storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'
Major storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'

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

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

Project: Revere North Filing 1

Inlet ID: Res St w Vertical Curb



Gutter Geometry:

Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	21.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.020	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	18.0	ft
Gutter Width	W =	2.00	ft
Street Transverse Slope	S_X =	0.020	ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083	ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.008	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.016	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	18.0	18.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	8.6	inches
Allow Flow Depth at Street Crown (check box for yes, leave blank for no)		☐	☐	

		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Spread Criterion				
MAJOR STORM Allowable Capacity is based on Spread Criterion	Q_{allow} =	10.8	10.8	cfs

Minor storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'

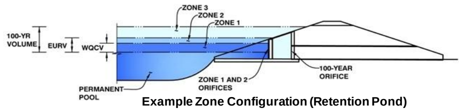
Major storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.05 (January 2022)

Project: Revere North Filing 1

Basin ID: Pond A



Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type =	EDB			
Watershed Area =	95.23	acres		
Watershed Length =	4,375	ft		
Watershed Length to Centroid =	1,200	ft		
Watershed Slope =	0.009	ft/ft		
Watershed Imperviousness =	46.00%	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 =	Denver - Capitol Building			

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) =	1.552	acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	4.117	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 0.83 in.) =	2.723	acre-feet	0.83	inches
5-yr Runoff Volume (P1 = 1.1 in.) =	4.188	acre-feet	1.10	inches
10-yr Runoff Volume (P1 = 1.39 in.) =	6.252	acre-feet	1.39	inches
25-yr Runoff Volume (P1 = 1.87 in.) =	10.434	acre-feet	1.87	inches
50-yr Runoff Volume (P1 = 2.3 in.) =	13.975	acre-feet	2.30	inches
100-yr Runoff Volume (P1 = 2.81 in.) =	18.540	acre-feet	2.81	inches
500-yr Runoff Volume (P1 = 4.23 in.) =	30.753	acre-feet	4.23	inches
Approximate 2-yr Detention Volume =	2.523	acre-feet		
Approximate 5-yr Detention Volume =	4.021	acre-feet		
Approximate 10-yr Detention Volume =	4.969	acre-feet		
Approximate 25-yr Detention Volume =	6.364	acre-feet		
Approximate 50-yr Detention Volume =	7.222	acre-feet		
Approximate 100-yr Detention Volume =	9.076	acre-feet		

Define Zones and Basin Geometry

Zone 1 Volume (WQCV) =	1.552	acre-feet
Zone 2 Volume (EURV - Zone 1) =	2.565	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	4.960	acre-feet
Total Detention Basin Volume =	9.076	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 Increement = 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	--	--	--	200	0.005		
23	--	1.00	--	--	--	15,832	0.363	8,016	0.184
24	--	2.00	--	--	--	80,621	1.851	56,242	1.291
25	--	3.00	--	--	--	173,965	3.994	183,534	4.213
26	--	4.00	--	--	--	258,827	5.942	399,930	9.181
27	--	5.00	--	--	--	322,036	7.393	690,362	15.849
28	--	6.00	--	--	--	360,509	8.276	1,031,634	23.683
29	--	7.00	--	--	--	395,526	9.080	1,409,652	32.361
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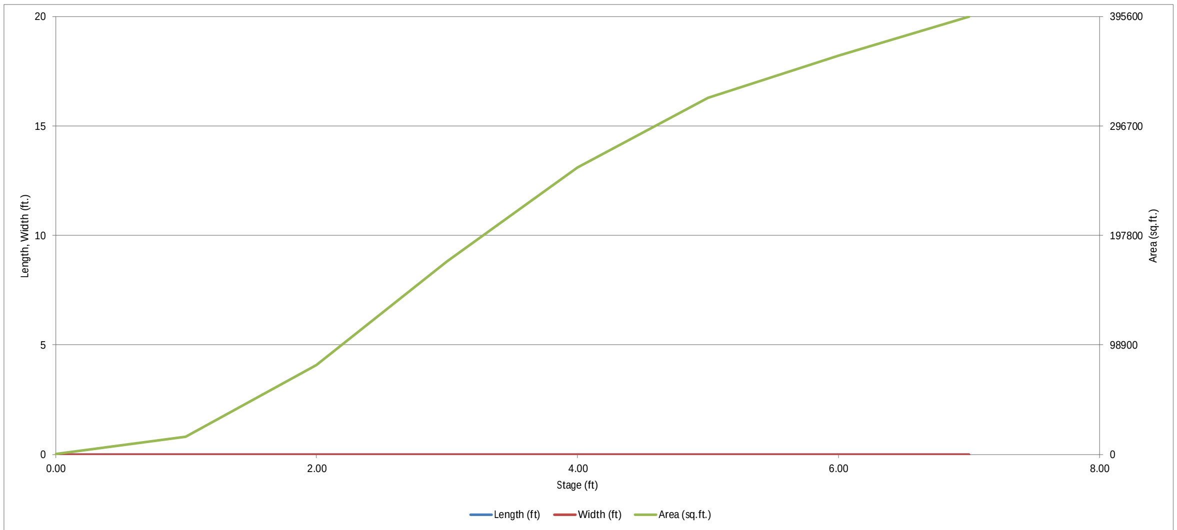
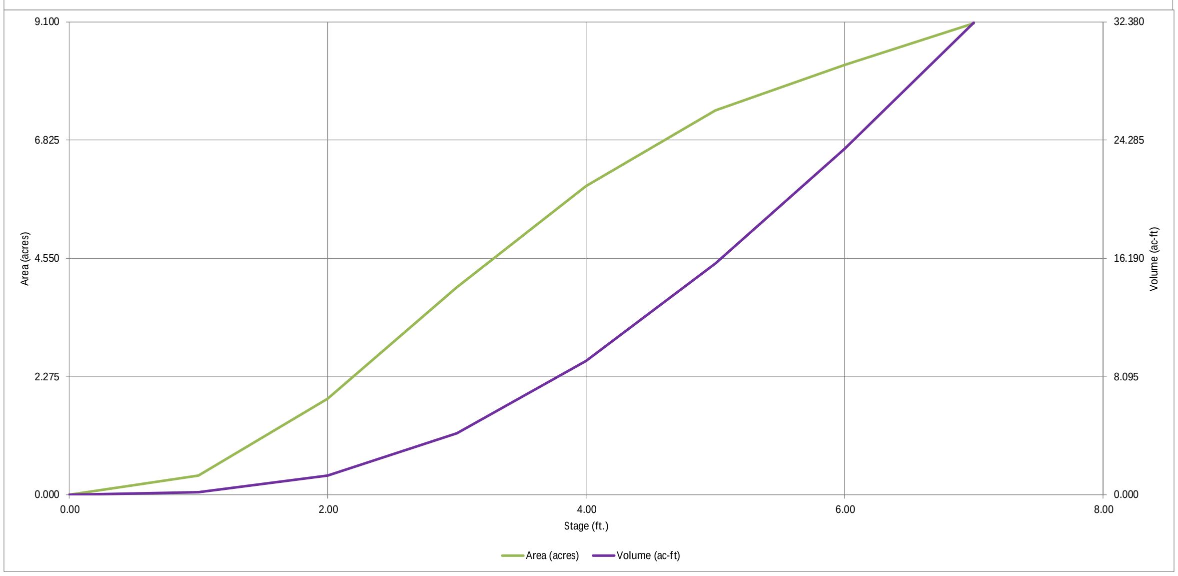

20
15
10
5
0
Length, Width (ft.)
395600
296700
197800
98900
0
Area (sq.ft.)
0.00
2.00
4.00
6.00
8.00
Stage (ft)
Length (ft)
Width (ft)
Area (sq.ft.)

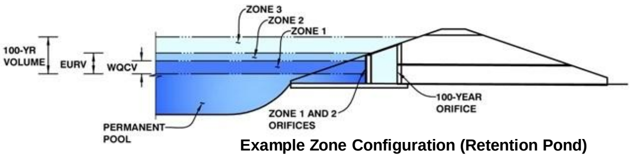

9.100
6.825
4.550
2.275
0.000
Area (acres)
32.380
24.285
16.190
8.095
0.000
Volume (ac-ft)
0.00
2.00
4.00
6.00
8.00
Stage (ft.)
Area (acres)
Volume (ac-ft)

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.05 (January 2022)

Project: Revere North Filing 1

Basin ID: Pond A



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
ıe 1 (WQCV)	2.14	1.552	Orifice Plate
ne 2 (EURV)	2.98	2.565	Orifice Plate
3 (100-year)	3.99	4.960	Weir&Pipe (Restrict)
	Total (all zones)	9.076	

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

Underdrain Orifice Invert Depth =	N/A	ft (distance below the filtration media surface)	Underdrain Orifice Area =	N/A	ft^2
Underdrain Orifice Diameter =	N/A	inches	Underdrain Orifice Centroid =	N/A	feet

Calculated Parameters for Underdrain (right-hand columns above)

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

Calculated Parameters for Plate

Centroid of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)	WQ Orifice Area per Row =	5.424E-02	ft^2
Depth at top of Zone using Orifice Plate =	2.98	ft (relative to basin bottom at Stage = 0 ft)	Elliptical Half-Width =	N/A	feet
Orifice Plate: Orifice Vertical Spacing =	11.90	inches	Elliptical Slot Centroid =	N/A	feet
Orifice Plate: Orifice Area per Row =	7.81	sq. inches (use rectangular openings)	Elliptical Slot Area =	N/A	ft^2

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

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	0.99	1.99					
Orifice Area (sq. inches)	7.81	7.81	7.81					

	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)

Calculated Parameters for Vertical Orifice

	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	ft^2
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	feet
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)

Calculated Parameters for Overflow Weir

	Zone 3 Weir	Not Selected			Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	2.98	N/A	ft (relative to basin bottom at Stage = 0 ft)	Height of Grate Upper Edge, H_t =	2.98	N/A	feet
Overflow Weir Front Edge Length =	16.00	N/A	feet	Overflow Weir Slope Length =	10.00	N/A	feet
Overflow Weir Grate Slope =	0.00	N/A	H:V	Grate Open Area / 100-yr Orifice Area =	11.86	N/A	
Horiz. Length of Weir Sides =	10.00	N/A	feet	Overflow Grate Open Area w/o Debris =	126.56	N/A	ft^2
Overflow Grate Type =	Close Mesh Grate	N/A		Overflow Grate Open Area w/ Debris =	63.28	N/A	ft^2
Debris Clogging % =	50%	N/A	%				

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

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Zone 3 Restrictor	Not Selected			Zone 3 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	0.25	N/A	ft (distance below basin bottom at Stage = 0 ft)	Outlet Orifice Area =	10.67	N/A	ft^2
Outlet Pipe Diameter =	48.00	N/A	inches	Outlet Orifice Centroid =	1.73	N/A	feet
Restrictor Plate Height Above Pipe Invert =	38.00		inches	Half-Central Angle of Restrictor Plate on Pipe =	2.19	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Calculated Parameters for Spillway

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

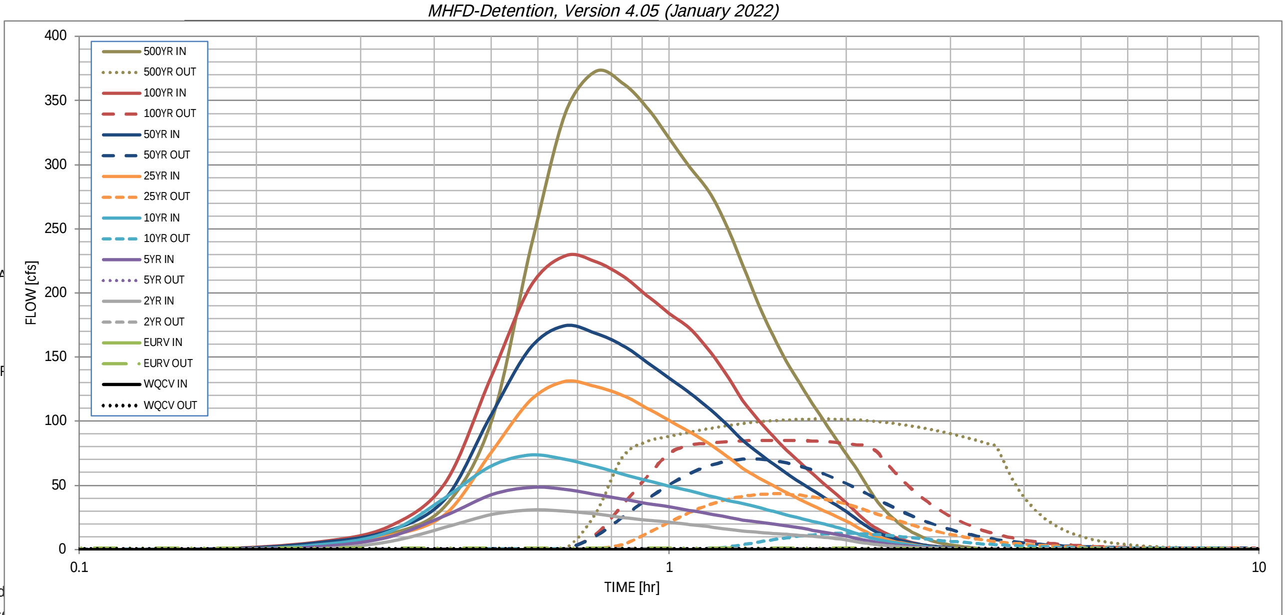
Routed Hydrograph Results

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

Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	N/A	N/A	0.83	1.10	1.39	1.87	2.30	2.81	4.23
CUHP Runoff Volume (acre-ft) =	1.552	4.117	2.723	4.188	6.252	10.434	13.975	18.540	30.753
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	2.723	4.188	6.252	10.434	13.975	18.540	30.753
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	0.7	6.8	21.8	59.8	87.0	124.6	216.6
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.01	0.07	0.23	0.63	0.91	1.31	2.27
Peak Inflow Q (cfs) =	N/A	N/A	30.9	48.6	73.7	131.2	174.7	229.3	373.0
Peak Outflow Q (cfs) =	0.8	1.1	0.9	1.1	12.8	43.6	70.6	85.4	102.0
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.2	0.6	0.7	0.8	0.7	0.5
Structure Controlling Flow =	Plate	Overflow Weir 1	Plate	Plate	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Outlet Plate 1	Outlet Plate 1
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	0.1	0.3	0.5	0.7	0.8
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	38	66	53	68	70	66	63	60	53
Time to Drain 99% of Inflow Volume (hours) =	40	71	56	73	76	74	73	71	68
Maximum Ponding Depth (ft) =	2.14	2.98	2.52	2.94	3.24	3.60	3.84	4.25	5.42
Area at Maximum Ponding Depth (acres) =	2.15	3.95	2.94	3.84	4.46	5.16	5.63	6.29	7.76
Maximum Volume Stored (acre-ft) =	1.571	4.134	2.514	3.939	5.228	6.960	8.255	10.649	19.031

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.05 (January 2022)



COUNTA

WQ P

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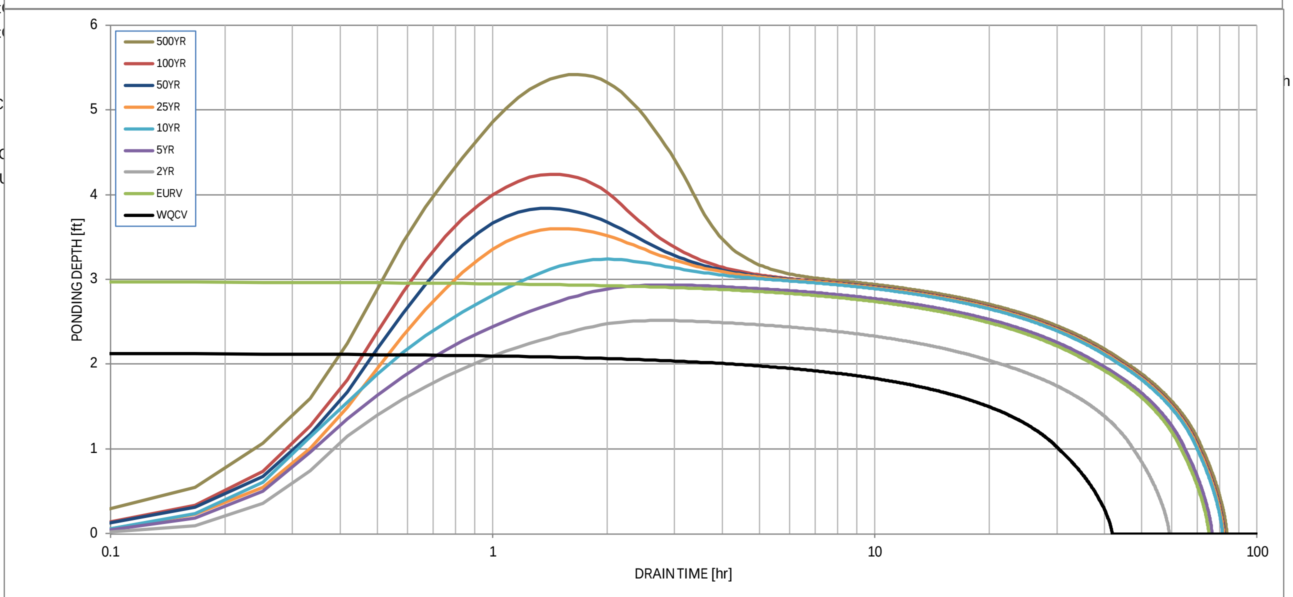

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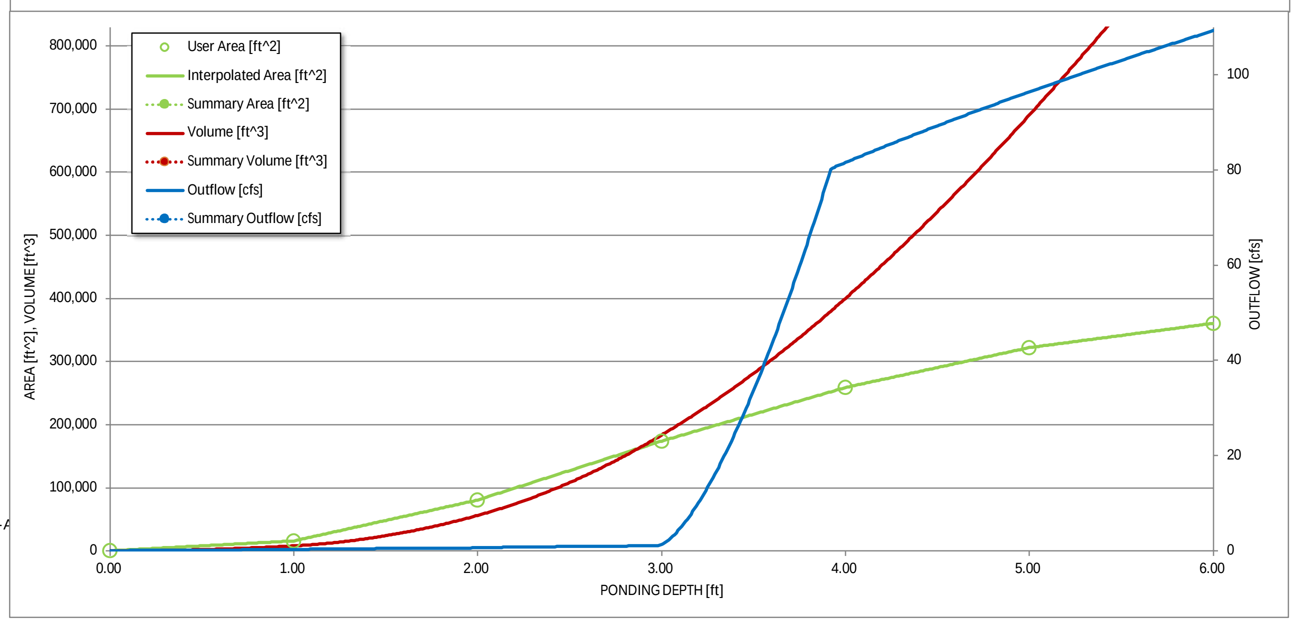


S-A

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

DETENTION BASIN OUTLET STRUCTURE DESIGN

Outflow Hydrograph Workbook Filename:

Inflow Hydrographs

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

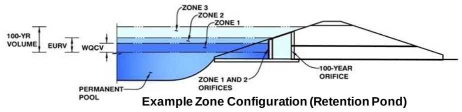
	SOURCE	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP
Time Interval	TIME	WQCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
5.00 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.40	0.48	2.68
	0:15:00	0.00	0.00	0.72	2.19	3.53	3.18	5.03	5.72	11.69
	0:20:00	0.00	0.00	6.06	9.74	13.38	10.64	14.47	17.75	33.94
	0:25:00	0.00	0.00	17.30	26.72	40.56	27.49	39.62	52.07	100.77
	0:30:00	0.00	0.00	27.42	42.84	65.67	76.39	105.98	135.82	235.49
	0:35:00	0.00	0.00	30.94	48.62	73.70	116.71	157.78	205.62	340.32
	0:40:00	0.00	0.00	30.21	46.88	70.27	131.18	174.67	229.31	372.99
	0:45:00	0.00	0.00	27.82	43.08	64.81	127.33	168.62	224.76	364.07
	0:50:00	0.00	0.00	25.24	39.49	59.02	120.56	159.40	213.52	345.03
	0:55:00	0.00	0.00	23.06	36.23	53.89	110.54	146.28	198.39	320.77
	1:00:00	0.00	0.00	21.34	33.37	49.69	100.71	133.62	184.48	298.58
	1:05:00	0.00	0.00	19.76	30.69	45.84	91.96	122.29	172.64	279.48
	1:10:00	0.00	0.00	17.90	28.13	42.13	82.75	110.38	155.92	252.85
	1:15:00	0.00	0.00	16.03	25.52	38.75	73.06	97.82	136.28	222.06
	1:20:00	0.00	0.00	14.56	23.23	35.82	63.46	85.20	116.51	191.42
	1:25:00	0.00	0.00	13.52	21.43	32.81	56.16	75.47	101.00	166.91
	1:30:00	0.00	0.00	12.67	19.92	29.81	49.84	66.92	88.28	146.55
	1:35:00	0.00	0.00	11.92	18.56	27.07	44.28	59.39	77.60	129.38
	1:40:00	0.00	0.00	11.19	16.98	24.58	39.19	52.50	68.05	113.94
	1:45:00	0.00	0.00	10.47	15.28	22.23	34.62	46.30	59.29	99.74
	1:50:00	0.00	0.00	9.74	13.61	19.96	30.26	40.39	51.03	86.36
	1:55:00	0.00	0.00	8.71	12.03	17.64	26.11	34.78	43.31	73.86
	2:00:00	0.00	0.00	7.52	10.50	15.22	22.23	29.56	36.27	62.48
	2:05:00	0.00	0.00	6.17	8.64	12.39	17.67	23.46	28.44	49.64
	2:10:00	0.00	0.00	4.96	6.95	9.97	13.32	17.82	21.42	38.10
	2:15:00	0.00	0.00	4.02	5.63	8.10	10.22	13.76	16.31	29.39
	2:20:00	0.00	0.00	3.29	4.59	6.62	8.00	10.80	12.57	22.90
	2:25:00	0.00	0.00	2.70	3.74	5.39	6.28	8.49	9.64	17.75
	2:30:00	0.00	0.00	2.21	3.04	4.36	4.94	6.67	7.36	13.72
	2:35:00	0.00	0.00	1.79	2.46	3.49	3.88	5.22	5.56	10.48
	2:40:00	0.00	0.00	1.44	1.96	2.75	3.00	4.03	4.15	7.93
	2:45:00	0.00	0.00	1.16	1.54	2.15	2.31	3.09	3.14	6.07
	2:50:00	0.00	0.00	0.93	1.21	1.67	1.80	2.39	2.44	4.73
	2:55:00	0.00	0.00	0.74	0.95	1.31	1.42	1.89	1.95	3.79
	3:00:00	0.00	0.00	0.58	0.74	1.02	1.11	1.47	1.54	2.99
	3:05:00	0.00	0.00	0.44	0.56	0.78	0.85	1.13	1.19	2.28
	3:10:00	0.00	0.00	0.32	0.41	0.57	0.63	0.83	0.87	1.68
	3:15:00	0.00	0.00	0.22	0.28	0.40	0.44	0.58	0.61	1.16
	3:20:00	0.00	0.00	0.14	0.19	0.25	0.29	0.38	0.39	0.74
	3:25:00	0.00	0.00	0.08	0.11	0.14	0.17	0.22	0.22	0.41
	3:30:00	0.00	0.00	0.04	0.05	0.06	0.08	0.10	0.10	0.18
	3:35:00	0.00	0.00	0.01	0.02	0.02	0.02	0.03	0.03	0.04
	3:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.05 (January 2022)

Project: Revere North Filing 1

Basin ID: Pond B



Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type =	EDB			
Watershed Area =	8.84	acres		
Watershed Length =	850	ft		
Watershed Length to Centroid =	380	ft		
Watershed Slope =	0.008	ft/ft		
Watershed Imperviousness =	54.00%	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 =	Denver - Capitol Building			

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) =	0.160	acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	0.454	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 0.83 in.) =	0.296	acre-feet	0.83	inches
5-yr Runoff Volume (P1 = 1.1 in.) =	0.442	acre-feet	1.10	inches
10-yr Runoff Volume (P1 = 1.39 in.) =	0.635	acre-feet	1.39	inches
25-yr Runoff Volume (P1 = 1.87 in.) =	1.014	acre-feet	1.87	inches
50-yr Runoff Volume (P1 = 2.3 in.) =	1.339	acre-feet	2.30	inches
100-yr Runoff Volume (P1 = 2.81 in.) =	1.752	acre-feet	2.81	inches
500-yr Runoff Volume (P1 = 4.23 in.) =	2.862	acre-feet	4.23	inches
Approximate 2-yr Detention Volume =	0.281	acre-feet		
Approximate 5-yr Detention Volume =	0.433	acre-feet		
Approximate 10-yr Detention Volume =	0.535	acre-feet		
Approximate 25-yr Detention Volume =	0.678	acre-feet		
Approximate 50-yr Detention Volume =	0.767	acre-feet		
Approximate 100-yr Detention Volume =	0.941	acre-feet		

Define Zones and Basin Geometry

Zone 1 Volume (WQCV) =	0.160	acre-feet
Zone 2 Volume (EURV - Zone 1) =	0.294	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	0.486	acre-feet
Total Detention Basin Volume =	0.941	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 Increement = 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	--	--	--	200	0.005		
33	--	1.00	--	--	--	12,650	0.290	6,425	0.147
34	--	2.00	--	--	--	25,700	0.590	25,600	0.588
35	--	3.00	--	--	--	31,180	0.716	54,040	1.241
36	--	4.00	--	--	--	36,920	0.848	88,090	2.022
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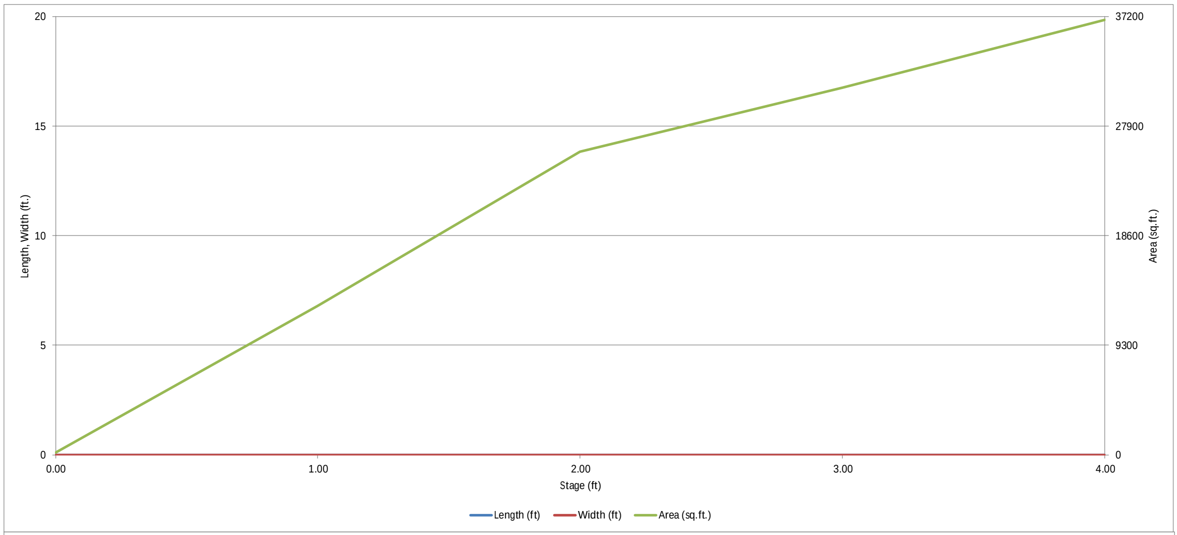
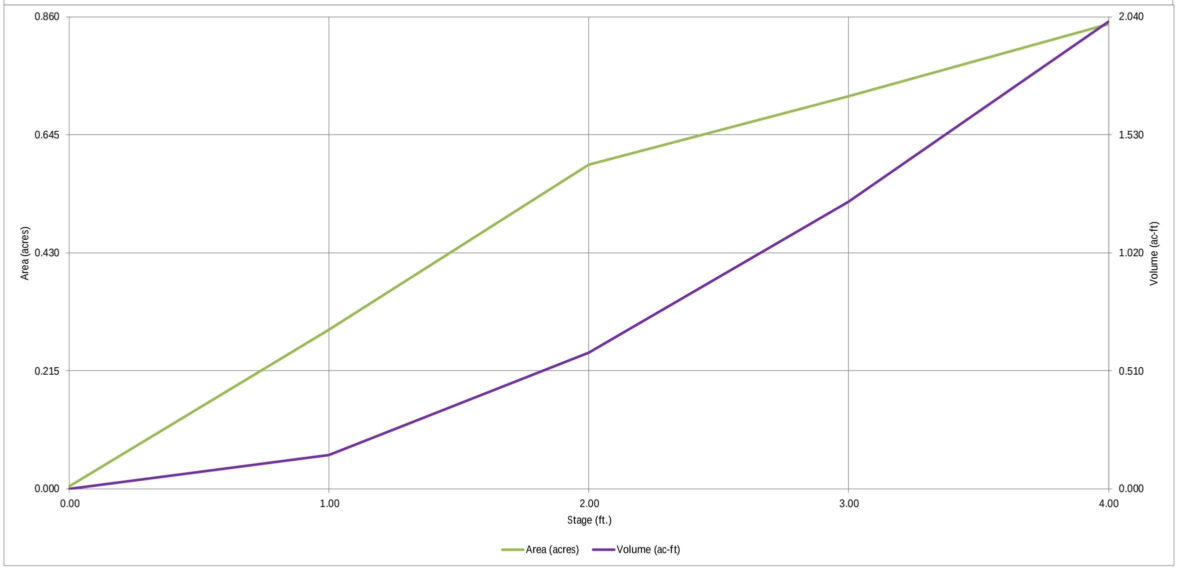

20
15
10
5
0
Length, Width (ft.)
37200
27900
18600
9300
0
Area (sq.ft.)
0.00
1.00
2.00
3.00
4.00
Stage (ft)
Length (ft)
Width (ft)
Area (sq.ft.)

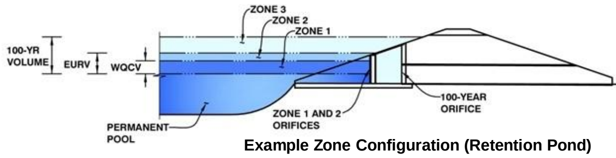

0.860
0.645
0.430
0.215
0.000
Area (acres)
2.040
1.530
1.020
0.510
0.000
Volume (ac-ft)
0.00
1.00
2.00
3.00
4.00
Stage (ft.)
Area (acres)
Volume (ac-ft)

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.05 (January 2022)

Project: Revere North Filing 1

Basin ID: Pond B



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
ne 1 (WQCV)	1.05	0.160	Orifice Plate
one 2 (EURV)	1.76	0.294	Orifice Plate
3 (100-year)	2.57	0.486	Weir&Pipe (Restrict)
Total (all zones)		0.941	

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

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

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

			Calculated Parameters for Plate		
Centroid of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)	WQ Orifice Area per Row =	1.042E-02	ft^2
Depth at top of Zone using Orifice Plate =	1.76	ft (relative to basin bottom at Stage = 0 ft)	Elliptical Half-Width =	N/A	feet
Orifice Plate: Orifice Vertical Spacing =	7.00	inches	Elliptical Slot Centroid =	N/A	feet
Orifice Plate: Orifice Area per Row =	1.50	sq. inches (diameter = 1-3/8 inches)	Elliptical Slot Area =	N/A	ft^2

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

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	0.59	1.17					
Orifice Area (sq. inches)	1.50	1.50	1.50					

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

User Input: Vertical Orifice (Circular or Rectangular)

	Not Selected	Not Selected		Calculated Parameters for Vertical Orifice	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	ft^2
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	feet
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 Weir	Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	1.76	N/A	ft (relative to basin bottom at Stage = 0 ft)	Height of Grate Upper Edge, H_t =	2.76	N/A	feet
Overflow Weir Front Edge Length =	4.00	N/A	feet	Overflow Weir Slope Length =	4.12	N/A	feet
Overflow Weir Grate Slope =	4.00	N/A	H:V	Grate Open Area / 100-yr Orifice Area =	12.94	N/A	
Horiz. Length of Weir Sides =	4.00	N/A	feet	Overflow Grate Open Area w/o Debris =	13.05	N/A	ft^2
Overflow Grate Type =	Close Mesh Grate	N/A		Overflow Grate Open Area w/ Debris =	6.52	N/A	ft^2
Debris Clogging % =	50%	N/A	%				

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

	Zone 3 Restrictor	Not Selected		Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate	Zone 3 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	0.25	N/A	ft (distance below basin bottom at Stage = 0 ft)	Outlet Orifice Area =	1.01	N/A	ft^2
Outlet Pipe Diameter =	18.00	N/A	inches	Outlet Orifice Centroid =	0.48	N/A	feet
Restrictor Plate Height Above Pipe Invert =	10.00		inches	Half-Central Angle of Restrictor Plate on Pipe =	1.68	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

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

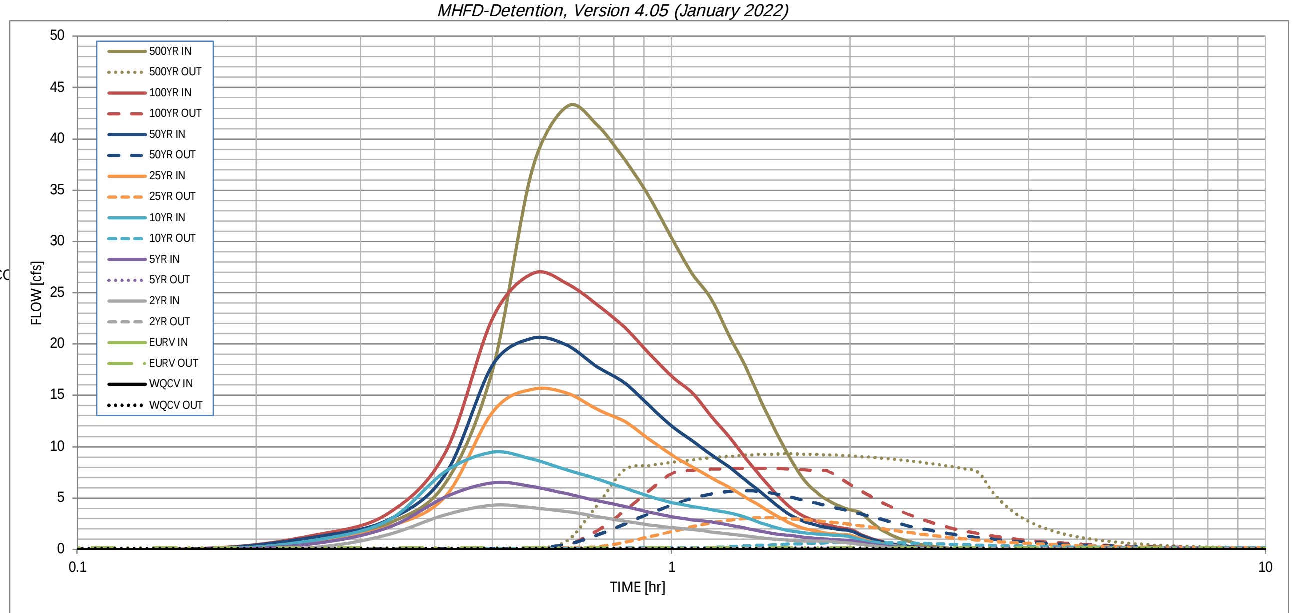
Routed Hydrograph Results

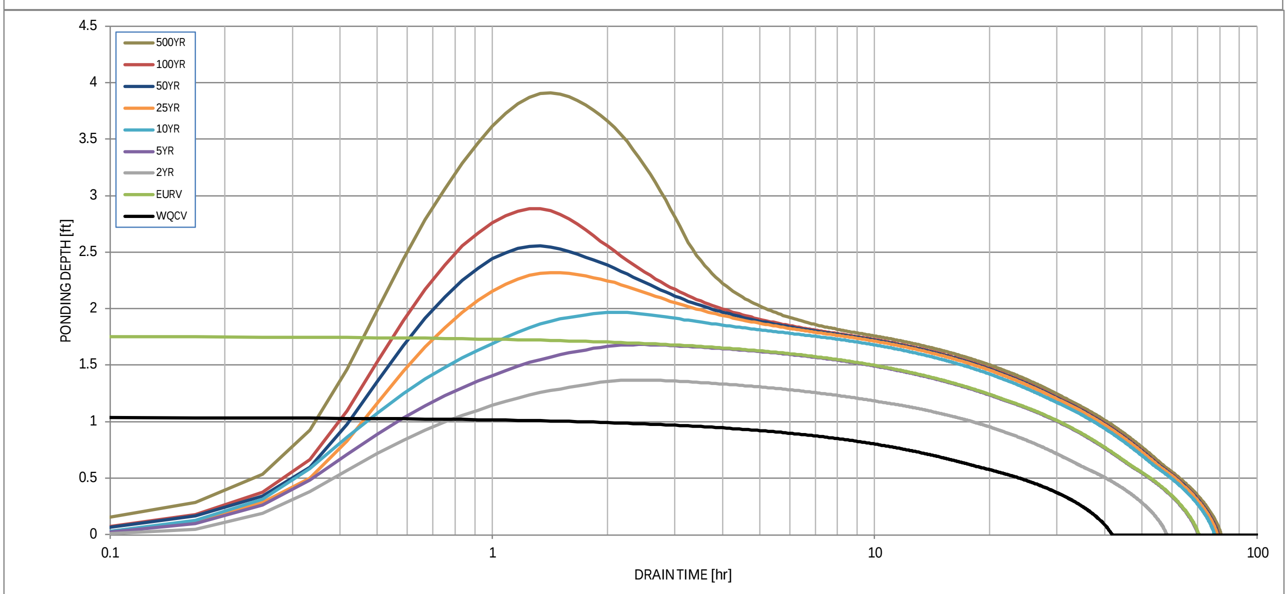
The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).

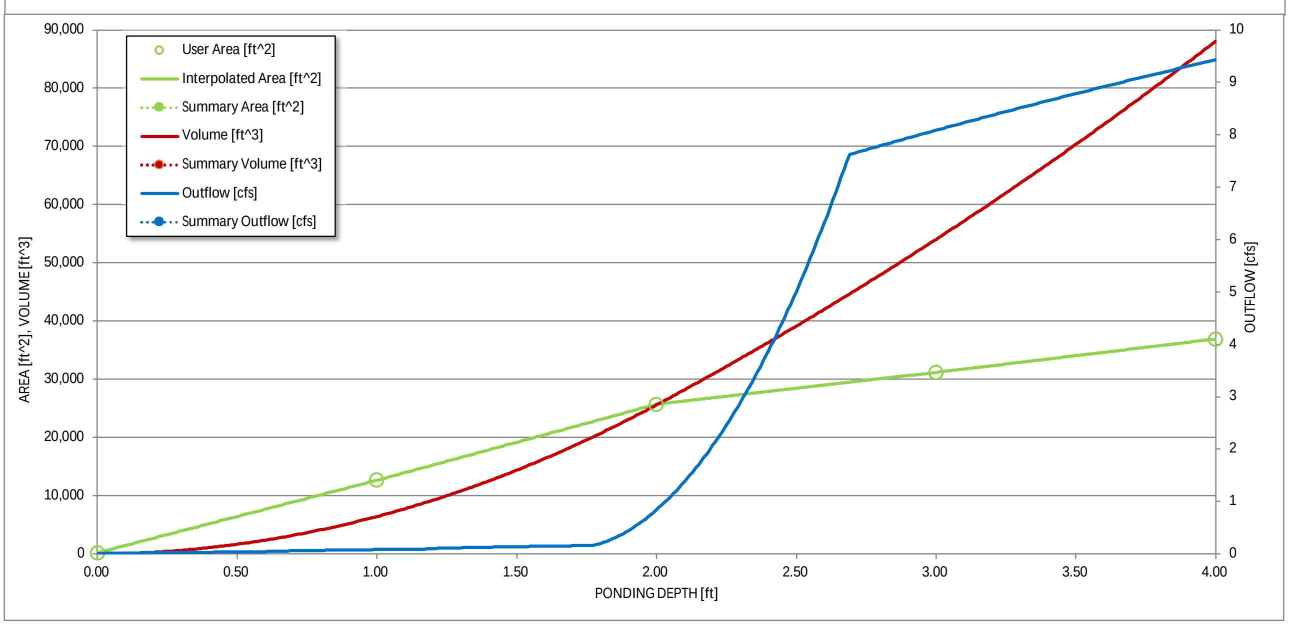
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	N/A	N/A	0.83	1.10	1.39	1.87	2.30	2.81	4.23
CUHP Runoff Volume (acre-ft) =	0.160	0.454	0.296	0.442	0.635	1.014	1.339	1.752	2.862
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	0.296	0.442	0.635	1.014	1.339	1.752	2.862
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	0.1	0.8	2.4	6.5	9.5	13.5	23.4
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.01	0.09	0.27	0.74	1.07	1.53	2.65
Peak Inflow Q (cfs) =	N/A	N/A	4.3	6.5	9.5	15.6	20.6	26.9	43.2
Peak Outflow Q (cfs) =	0.1	0.2	0.1	0.2	0.7	3.1	5.7	7.9	9.3
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.2	0.3	0.5	0.6	0.6	0.4
Structure Controlling Flow =	Plate	Overflow Weir 1	Plate	Plate	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Outlet Plate 1	Outlet Plate 1
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	0.0	0.2	0.4	0.6	0.7
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	38	62	52	62	67	64	61	57	51
Time to Drain 99% of Inflow Volume (hours) =	40	67	55	66	73	72	71	69	66
Maximum Ponding Depth (ft) =	1.05	1.76	1.37	1.68	1.97	2.32	2.56	2.89	3.91
Area at Maximum Ponding Depth (acres) =	0.31	0.52	0.40	0.49	0.58	0.63	0.66	0.70	0.84
Maximum Volume Stored (acre-ft) =	0.162	0.455	0.275	0.414	0.570	0.783	0.931	1.156	1.947

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.05 (January 2022)







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

DETENTION BASIN OUTLET STRUCTURE DESIGN

Outflow Hydrograph Workbook Filename:

Inflow Hydrographs

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

	SOURCE	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP
Time Interval	TIME	WQCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
5.00 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.12	0.69
	0:15:00	0.00	0.00	0.19	0.57	0.91	0.82	1.22	1.38	2.53
	0:20:00	0.00	0.00	1.45	2.14	2.84	2.19	2.88	3.52	6.48
	0:25:00	0.00	0.00	3.41	5.13	7.64	5.21	7.38	9.52	17.61
	0:30:00	0.00	0.00	4.31	6.50	9.47	13.43	18.03	22.61	37.14
	0:35:00	0.00	0.00	4.08	6.13	8.80	15.64	20.58	26.93	43.21
	0:40:00	0.00	0.00	3.70	5.43	7.78	15.25	19.91	25.93	41.36
	0:45:00	0.00	0.00	3.21	4.77	6.89	13.67	17.82	23.85	37.98
	0:50:00	0.00	0.00	2.78	4.22	5.99	12.47	16.25	21.63	34.42
	0:55:00	0.00	0.00	2.42	3.65	5.19	10.76	14.03	19.12	30.40
	1:00:00	0.00	0.00	2.14	3.21	4.58	9.23	12.06	16.90	26.93
	1:05:00	0.00	0.00	1.95	2.91	4.19	8.09	10.61	15.28	24.42
	1:10:00	0.00	0.00	1.73	2.68	3.88	6.99	9.23	12.97	20.85
	1:15:00	0.00	0.00	1.53	2.39	3.59	6.07	8.05	10.99	17.77
	1:20:00	0.00	0.00	1.34	2.07	3.14	5.08	6.73	8.90	14.43
	1:25:00	0.00	0.00	1.16	1.78	2.60	4.21	5.54	7.06	11.50
	1:30:00	0.00	0.00	1.00	1.53	2.13	3.33	4.37	5.46	8.94
	1:35:00	0.00	0.00	0.90	1.36	1.83	2.58	3.39	4.13	6.89
	1:40:00	0.00	0.00	0.85	1.20	1.65	2.09	2.77	3.29	5.61
	1:45:00	0.00	0.00	0.82	1.09	1.53	1.80	2.38	2.77	4.81
	1:50:00	0.00	0.00	0.80	1.00	1.45	1.61	2.13	2.41	4.25
	1:55:00	0.00	0.00	0.71	0.94	1.36	1.47	1.96	2.16	3.86
	2:00:00	0.00	0.00	0.63	0.87	1.24	1.38	1.84	1.98	3.57
	2:05:00	0.00	0.00	0.49	0.68	0.96	1.06	1.41	1.48	2.69
	2:10:00	0.00	0.00	0.38	0.51	0.72	0.79	1.05	1.08	1.98
	2:15:00	0.00	0.00	0.29	0.39	0.54	0.59	0.78	0.80	1.47
	2:20:00	0.00	0.00	0.22	0.29	0.40	0.44	0.58	0.60	1.10
	2:25:00	0.00	0.00	0.16	0.22	0.29	0.33	0.43	0.45	0.82
	2:30:00	0.00	0.00	0.12	0.16	0.22	0.24	0.31	0.33	0.60
	2:35:00	0.00	0.00	0.09	0.11	0.16	0.17	0.23	0.24	0.44
	2:40:00	0.00	0.00	0.06	0.08	0.11	0.13	0.16	0.17	0.32
	2:45:00	0.00	0.00	0.04	0.05	0.08	0.09	0.11	0.12	0.21
	2:50:00	0.00	0.00	0.02	0.03	0.05	0.05	0.07	0.07	0.13
	2:55:00	0.00	0.00	0.01	0.02	0.02	0.03	0.04	0.04	0.07
	3:00:00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.03
	3:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Revere North

Basin Weighted Runoff Coefficient Calculations

Date: 04/05/22

NRCS Soil Group	C		Imperviousness	C_2	C_5	C_{10}	C_{100}
A (Existing Conditions)	Twin Mound Basin Undeveloped Area		2%	0.01	0.05	0.15	0.49

Basin ID	Total Area (Ac.)	A Area (Ac.)	Weighted Imp. I (%)	Weighted Runoff Coefficients C_2	C_5	C_{10}	C_{100}
Historic/Existing							
A	95.29	95.29	2%	0.01	0.05	0.15	0.49
B	8.84	8.84	2%	0.01	0.05	0.15	0.49
OS-1	5.50	5.50	2%	0.01	0.05	0.15	0.49
OS-2	4.50	4.50	2%	0.01	0.05	0.15	0.49
OS-S1	54.02	54.02	2%	0.01	0.05	0.15	0.49
OS-S2	24.78	24.78	2%	0.01	0.05	0.15	0.49
OS-S3	24.73	24.73	2%	0.01	0.05	0.15	0.49
OS-W1	138.20	138.20	2%	0.01	0.05	0.15	0.49
OS-W2	191.64	191.64	2%	0.01	0.05	0.15	0.49
OS-W3	75.00	75.00	2%	0.01	0.05	0.15	0.49

Time of Concentration

Project No.:

Sh. 1 of 3 4/5/22

Basin ID	C_5	Initial Flow Time T_i			Travel Time T_t							Tc Check				Final
		Length (ft)	Slope (%)	T_i (min)	Length (ft)	Slope (%)	Convey. Element	Convey. Coeff. K	Vel. (fps)	T_t (min)	Total T_c (min)	Imp. (dec)	Travel Length (ft)	Avg. Travel Slope (%)	$T_c = 26 - 17i + [L/\{60*(14i+9)*(S^{0.5})\}]$ (min)	T_c (min)
Developed																
A	0.05	500	4.00	26.8	2270	1.40	*Native Grass*	7	0.8	45.7	72.5	0.02	2270	1.4	60.1	60.1
B	0.05	500	2.50	31.3	425	3.00	*Native Grass*	7	1.2	5.8	37.2	0.02	425	3.0	30.1	30.1
OS-1	0.05	500	4.00	26.8	190	5.00	*Native Grass*	7	1.6	2.0	28.9	0.02	190	5.0	27.2	27.2
OS-2	0.05	500	2.00	33.7	260	4.00	*Native Grass*	7	1.4	3.1	36.8	0.02	260	4.0	28.0	28.0
OS-S1	0.05	500	4.00	26.8	2750	0.80	*Native Grass*	7	0.6	73.2	100.0	0.02	2750	0.8	80.9	80.9
OS-S2	0.05	500	1.00	42.4	1100	1.00	*Native Grass*	7	0.7	26.2	68.6	0.02	1100	1.0	45.4	45.4
OS-S3	0.05	500	2.00	33.7	1900	0.90	*Native Grass*	7	0.7	47.7	81.4	0.02	1900	0.9	61.6	61.6
OS-W1	0.05	500	4.00	26.8	3475	3.00	*Native Grass*	7	1.2	47.8	74.6	0.02	3475	3.0	61.7	61.7
OS-W2	0.05	500	2.00	33.7	3175	4.00	*Native Grass*	7	1.4	37.8	71.5	0.02	3175	4.0	54.2	54.2
OS-W3	0.05	500	2.00	33.7	3500	2.00	*Native Grass*	7	1.0	58.9	92.6	0.02	3500	2.0	70.1	70.1

Basin Runoff Calculations - Historic Flows

Project No.: 1060-08

5-Apr-22

Basin ID	Design Point	Total Area (Ac.)	Imp (%)	Tc (min)	Runoff Coeff. C_2	C_5	C_{100}	I_2	I_5	I_{100}	Flow (cfs) Q_5	Q_{100}	Master Basin	Allowable Release (cfs) Q_5	Q_{100}
Existing															
A	1	95.29	2%	60.12	0.01	0.05	0.49	0.84	1.12	2.83	5.34	131.96	*Twin Mounds*	34.3	86.7
B	9	8.84	2%	30.07	0.01	0.05	0.49	1.31	1.74	4.39	0.77	19.00	*Elwel*	2.8	8.2
OS-1	8	5.50	2%	27.19	0.01	0.05	0.49	1.39	1.84	4.65	0.51	12.54	*Twin Mounds*	2.0	5.0
OS-2	10	4.50	2%	27.99	0.01	0.05	0.49	1.36	1.81	4.57	0.41	10.09	*Elwel*	1.4	4.2
OS-S1	5	54.02	2%	80.88	0.01	0.05	0.49	0.69	0.91	2.30	2.47	61.00	*Twin Mounds*	19.4	49.2
OS-S2	6	24.78	2%	45.42	0.01	0.05	0.49	1.01	1.35	3.40	1.67	41.29	*Twin Mounds*	8.9	22.5
OS-S3	7	24.73	2%	61.63	0.01	0.05	0.49	0.83	1.10	2.78	1.36	33.68	*Twin Mounds*	8.9	22.5
OS-W1	2	138.20	2%	61.69	0.01	0.05	0.49	0.83	1.10	2.78	7.61	188.06	*Twin Mounds*	49.8	125.8
OS-W2	3	191.64	2%	54.17	0.01	0.05	0.49	0.90	1.20	3.03	11.51	284.53	*Twin Mounds*	69.0	174.4
OS-W3	4	75.00	2%	70.11	0.01	0.05	0.49	0.76	1.01	2.55	3.78	93.54	*Twin Mounds*	27.0	68.3

Intensity : $\dfrac{28.5 * P_1}{(10 + T_c)^{0.786}}$

2 Year P_1 = 0.83

5 Year P_1 = 1.11

100 Year P_1 = 2.80

APPENDIX C

Referenced Information

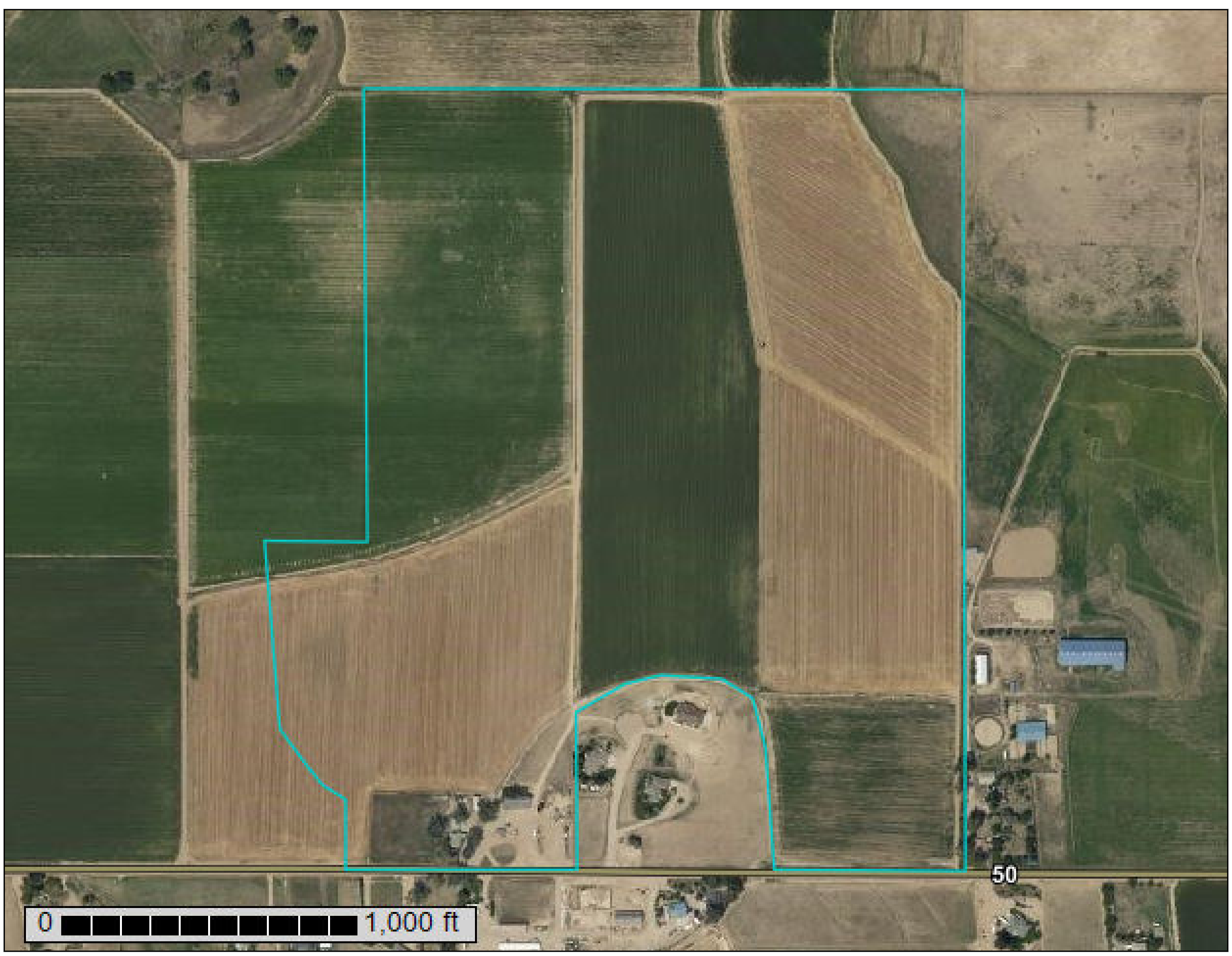
United States Department of Agriculture

NRCS

Natural Resources Conservation Service

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

Custom Soil Resource Report for Larimer County Area, Colorado; and Weld County, Colorado, Southern Part



March 24, 2022

Preface

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

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

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

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

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

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

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Contents

Soil Map

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

Soil Map

Map Scale: 1:5,610 if printed on A portrait (8.5" x 11") sheet.

Meters: 0 50 100 200 300

Feet: 0 250 500 1000 1500

N

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

MAP LEGEND

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

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

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

Water Features
- Streams and Canals

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

Background
- Aerial Photography

MAP INFORMATION

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

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

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

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

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

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

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

Soil Survey Area: Larimer County Area, Colorado
Survey Area Data: Version 16, Sep 2, 2021

Soil Survey Area: Weld County, Colorado, Southern Part
Survey Area Data: Version 20, Aug 31, 2021

Your area of interest (AOI) includes more than one soil survey area. These survey areas may have been mapped at different scales, with a different land use in mind, at different times, or at different levels of detail. This may result in map unit symbols, soil properties, and interpretations that do not completely agree across soil survey area boundaries.

MAP LEGEND	MAP INFORMATION
	Soil map units are labeled (as space allows) for map scales 1:50,000 or larger. Date(s) aerial images were photographed: Aug 11, 2018—Aug 12, 2018 The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
7	Ascalon sandy loam, 0 to 3 percent slopes	23.3	19.4%
8	Ascalon sandy loam, 3 to 5 percent slopes	11.1	9.2%
78	Otero sandy loam, 3 to 5 percent slopes	0.8	0.6%
79	Otero sandy loam, 5 to 9 percent slopes	1.0	0.9%
102	Stoneham loam, 3 to 5 percent slopes	1.6	1.3%
115	Weld silt loam, 0 to 3 percent slopes	61.8	51.5%
119	Wiley silt loam, 3 to 5 percent slopes	19.9	16.6%
Subtotals for Soil Survey Area		**119.5**	**99.6%**
Totals for Area of Interest		**120.0**	**100.0%**

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
79	Weld loam, 1 to 3 percent slopes	0.3	0.3%
83	Wiley-Colby complex, 3 to 5 percent slopes	0.2	0.2%
Subtotals for Soil Survey Area		**0.5**	**0.4%**
Totals for Area of Interest		**120.0**	**100.0%**

Map Unit Descriptions

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

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

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

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

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

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

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

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

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

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

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

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

Larimer County Area, Colorado

7—Ascalon sandy loam, 0 to 3 percent slopes

Map Unit Setting

National map unit symbol: 2swl3
Elevation: 3,870 to 5,960 feet
Mean annual precipitation: 12 to 16 inches
Mean annual air temperature: 46 to 57 degrees F
Frost-free period: 135 to 160 days
Farmland classification: Prime farmland if irrigated

Map Unit Composition

Ascalon and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Ascalon

Setting

Landform: Interfluves
Landform position (two-dimensional): Summit
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Wind-reworked alluvium and/or calcareous sandy eolian deposits

Typical profile

Ap - 0 to 6 inches: sandy loam
Bt1 - 6 to 12 inches: sandy clay loam
Bt2 - 12 to 19 inches: sandy clay loam
Bk - 19 to 35 inches: sandy clay loam
C - 35 to 80 inches: sandy loam

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 10 percent
Maximum salinity: Nonsaline to very slightly saline (0.1 to 2.0 mmhos/cm)
Sodium adsorption ratio, maximum: 1.0
Available water supply, 0 to 60 inches: Moderate (about 7.7 inches)

Interpretive groups

Land capability classification (irrigated): 3e
Land capability classification (nonirrigated): 4c
Hydrologic Soil Group: B
Ecological site: R067BY024CO - Sandy Plains
Hydric soil rating: No

Minor Components

Olnest

Percent of map unit: 10 percent
Landform: Interfluves
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: R067BY024CO - Sandy Plains
Hydric soil rating: No

Vona

Percent of map unit: 5 percent
Landform: Interfluves
Landform position (two-dimensional): Summit
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: R067BY024CO - Sandy Plains
Hydric soil rating: No

8—Ascalon sandy loam, 3 to 5 percent slopes

Map Unit Setting

National map unit symbol: 2tlnt
Elevation: 3,550 to 5,970 feet
Mean annual precipitation: 12 to 16 inches
Mean annual air temperature: 46 to 57 degrees F
Frost-free period: 135 to 160 days
Farmland classification: Prime farmland if irrigated

Map Unit Composition

Ascalon and similar soils: 80 percent
Minor components: 20 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Ascalon

Setting

Landform: Interfluves
Landform position (two-dimensional): Shoulder, summit
Landform position (three-dimensional): Interfluve
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Wind-reworked alluvium and/or calcareous sandy eolian deposits

Typical profile

Ap - 0 to 6 inches: sandy loam
Bt1 - 6 to 12 inches: sandy clay loam
Bt2 - 12 to 19 inches: sandy clay loam

Bk - 19 to 35 inches: sandy clay loam
C - 35 to 80 inches: sandy loam

Properties and qualities

Slope: 3 to 5 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 6.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 10 percent
Maximum salinity: Nonsaline (0.1 to 1.9 mmhos/cm)
Sodium adsorption ratio, maximum: 1.0
Available water supply, 0 to 60 inches: Moderate (about 6.9 inches)

Interpretive groups

Land capability classification (irrigated): 3e
Land capability classification (nonirrigated): 4c
Hydrologic Soil Group: B
Ecological site: R067BY024CO - Sandy Plains, R072XY111KS - Sandy Plains
Hydric soil rating: No

Minor Components

Stoneham

Percent of map unit: 10 percent
Landform: Interfluves
Landform position (two-dimensional): Shoulder, summit
Landform position (three-dimensional): Interfluve
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: R067BY002CO - Loamy Plains, R072XY100KS - Loamy Tableland
Hydric soil rating: No

Vona

Percent of map unit: 8 percent
Landform: Interfluves
Landform position (two-dimensional): Backslope, footslope, shoulder
Landform position (three-dimensional): Interfluve
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: R067BY024CO - Sandy Plains, R072XY111KS - Sandy Plains
Hydric soil rating: No

Platner

Percent of map unit: 2 percent
Landform: Interfluves
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Interfluve
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: R067BY002CO - Loamy Plains, R072XY100KS - Loamy Tableland
Hydric soil rating: No

78—Otero sandy loam, 3 to 5 percent slopes

Map Unit Setting

National map unit symbol: jpxs
Elevation: 4,800 to 5,600 feet
Mean annual precipitation: 13 to 15 inches
Mean annual air temperature: 48 to 50 degrees F
Frost-free period: 135 to 150 days
Farmland classification: Prime farmland if irrigated

Map Unit Composition

Otero and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Otero

Setting

Landform: Fans
Landform position (three-dimensional): Base slope, side slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium and/or eolian deposits

Typical profile

H1 - 0 to 15 inches: sandy loam
H2 - 15 to 60 inches: sandy loam

Properties and qualities

Slope: 3 to 5 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat excessively drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): High (2.00 to 6.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 5 percent
Maximum salinity: Nonsaline to slightly saline (0.0 to 4.0 mmhos/cm)
Available water supply, 0 to 60 inches: Moderate (about 6.3 inches)

Interpretive groups

Land capability classification (irrigated): 3e
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: A
Ecological site: R067BY024CO - Sandy Plains
Hydric soil rating: No

Minor Components

Ascalon

Percent of map unit: 5 percent
Ecological site: R067AY122WY - Loamy (Ly) 12-17" PZ
Hydric soil rating: No

Nelson

Percent of map unit: 5 percent
Ecological site: R067BY024CO - Sandy Plains
Hydric soil rating: No

Kim

Percent of map unit: 5 percent
Ecological site: R067BZ902CO - Loamy Plains
Hydric soil rating: No

79—Otero sandy loam, 5 to 9 percent slopes

Map Unit Setting

National map unit symbol: jpxt
Elevation: 4,800 to 5,600 feet
Mean annual precipitation: 13 to 15 inches
Mean annual air temperature: 48 to 50 degrees F
Frost-free period: 135 to 150 days
Farmland classification: Not prime farmland

Map Unit Composition

Otero and similar soils: 80 percent
Minor components: 20 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Otero

Setting

Landform: Fans
Landform position (three-dimensional): Base slope, side slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium and/or eolian deposits

Typical profile

H1 - 0 to 14 inches: sandy loam
H2 - 14 to 60 inches: sandy loam

Properties and qualities

Slope: 5 to 9 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat excessively drained
Runoff class: Low

Capacity of the most limiting layer to transmit water (Ksat): High (2.00 to 6.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 5 percent
Maximum salinity: Nonsaline to slightly saline (0.0 to 4.0 mmhos/cm)
Available water supply, 0 to 60 inches: Moderate (about 6.3 inches)

Interpretive groups

Land capability classification (irrigated): 4e
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: A
Ecological site: R067BY024CO - Sandy Plains
Hydric soil rating: No

Minor Components

Kim

Percent of map unit: 9 percent
Ecological site: R067BZ902CO - Loamy Plains
Hydric soil rating: No

Nelson

Percent of map unit: 6 percent
Ecological site: R067BY024CO - Sandy Plains
Hydric soil rating: No

Tassel

Percent of map unit: 5 percent
Ecological site: R067BY056CO - Sandstone Breaks
Hydric soil rating: No

102—Stoneham loam, 3 to 5 percent slopes

Map Unit Setting

National map unit symbol: 2x0j1
Elevation: 3,500 to 6,500 feet
Mean annual precipitation: 12 to 18 inches
Mean annual air temperature: 46 to 54 degrees F
Frost-free period: 115 to 155 days
Farmland classification: Prime farmland if irrigated

Map Unit Composition

Stoneham and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Stoneham

Setting

Landform: Interfluves, low hills
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Interfluve
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Mixed alluvial and/or eolian tertiary aged pedisediment

Typical profile

Ap - 0 to 4 inches: loam
Bt - 4 to 9 inches: clay loam
Btk - 9 to 13 inches: clay loam
Bk1 - 13 to 18 inches: loam
Bk2 - 18 to 34 inches: loam
C - 34 to 80 inches: loam

Properties and qualities

Slope: 3 to 5 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.20 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 12 percent
Maximum salinity: Nonsaline to very slightly saline (0.1 to 2.0 mmhos/cm)
Sodium adsorption ratio, maximum: 0.5
Available water supply, 0 to 60 inches: High (about 9.1 inches)

Interpretive groups

Land capability classification (irrigated): 4e
Land capability classification (nonirrigated): 4c
Hydrologic Soil Group: C
Ecological site: R067BY002CO - Loamy Plains
Hydric soil rating: No

Minor Components

Satanta

Percent of map unit: 5 percent
Landform: Interfluves
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Interfluve
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: R067BY002CO - Loamy Plains
Hydric soil rating: No

Weld

Percent of map unit: 5 percent
Landform: Interfluves
Landform position (two-dimensional): Summit

Landform position (three-dimensional): Interfluve
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: R067BY002CO - Loamy Plains
Hydric soil rating: No

Kimst

Percent of map unit: 5 percent
Landform: Low hills, interfluves
Landform position (two-dimensional): Backslope, shoulder
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Convex
Ecological site: R067BY002CO - Loamy Plains
Hydric soil rating: No

115—Weld silt loam, 0 to 3 percent slopes

Map Unit Setting

National map unit symbol: 2x0hx
Elevation: 3,600 to 6,000 feet
Mean annual precipitation: 12 to 18 inches
Mean annual air temperature: 46 to 54 degrees F
Frost-free period: 115 to 155 days
Farmland classification: Prime farmland if irrigated

Map Unit Composition

Weld and similar soils: 80 percent
Minor components: 20 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Weld

Setting

Landform: Interfluves
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Interfluve
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Calcareous loess

Typical profile

Ap - 0 to 3 inches: silt loam
Bt1 - 3 to 11 inches: silty clay
Bt2 - 11 to 15 inches: silty clay
Btk - 15 to 21 inches: silty clay
Bk - 21 to 31 inches: silt loam
C - 31 to 80 inches: silt loam

Properties and qualities

Slope: 0 to 3 percent

Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 14 percent
Maximum salinity: Nonsaline to very slightly saline (0.1 to 2.0 mmhos/cm)
Sodium adsorption ratio, maximum: 5.0
Available water supply, 0 to 60 inches: High (about 11.7 inches)

Interpretive groups

Land capability classification (irrigated): 2e
Land capability classification (nonirrigated): 3c
Hydrologic Soil Group: C
Ecological site: R067BY002CO - Loamy Plains
Hydric soil rating: No

Minor Components

Colby

Percent of map unit: 7 percent
Landform: Hillslopes
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Convex
Ecological site: R067BY002CO - Loamy Plains
Hydric soil rating: No

Keith

Percent of map unit: 5 percent
Landform: Interfluves
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Interfluve
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: R067BY002CO - Loamy Plains
Hydric soil rating: No

Adena

Percent of map unit: 5 percent
Landform: Interfluves
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Interfluve
Down-slope shape: Convex
Across-slope shape: Convex
Ecological site: R067BY002CO - Loamy Plains
Hydric soil rating: No

Rago, rarely flooded

Percent of map unit: 2 percent
Landform: Drainageways
Down-slope shape: Linear
Across-slope shape: Concave

Ecological site: R067BY036CO - Overflow
Hydric soil rating: No

Pleasant, ponded

Percent of map unit: 1 percent
Landform: Playas, closed depressions
Down-slope shape: Concave
Across-slope shape: Concave
Ecological site: R067BY010CO - Closed Upland Depression
Hydric soil rating: Yes

119—Wiley silt loam, 3 to 5 percent slopes

Map Unit Setting

National map unit symbol: jpvf
Elevation: 4,800 to 5,600 feet
Mean annual precipitation: 13 to 15 inches
Mean annual air temperature: 48 to 50 degrees F
Frost-free period: 135 to 150 days
Farmland classification: Prime farmland if irrigated

Map Unit Composition

Wiley and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Wiley

Setting

Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Uniform eolian deposits

Typical profile

H1 - 0 to 6 inches: silt loam
H2 - 6 to 15 inches: silt loam
H3 - 15 to 60 inches: silt loam

Properties and qualities

Slope: 3 to 5 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 15 percent
Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)

Available water supply, 0 to 60 inches: High (about 11.4 inches)

Interpretive groups

Land capability classification (irrigated): 3e
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: B
Ecological site: R067BZ902CO - Loamy Plains
Hydric soil rating: No

Minor Components

Keith

Percent of map unit: 10 percent
Ecological site: R067BZ902CO - Loamy Plains
Hydric soil rating: No

Colby

Percent of map unit: 5 percent
Ecological site: R067BZ008CO - Loamy Slopes
Hydric soil rating: No

Weld County, Colorado, Southern Part

79—Weld loam, 1 to 3 percent slopes

Map Unit Setting

National map unit symbol: 2x0hw
Elevation: 3,600 to 5,750 feet
Mean annual precipitation: 12 to 17 inches
Mean annual air temperature: 46 to 54 degrees F
Frost-free period: 115 to 155 days
Farmland classification: Prime farmland if irrigated

Map Unit Composition

Weld and similar soils: 80 percent
Minor components: 20 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Weld

Setting

Landform: Interfluves
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Interfluve
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Calcareous loess

Typical profile

Ap - 0 to 8 inches: loam
Bt1 - 8 to 12 inches: clay
Bt2 - 12 to 15 inches: clay loam
Btk - 15 to 28 inches: loam
Bk - 28 to 60 inches: silt loam
C - 60 to 80 inches: silt loam

Properties and qualities

Slope: 1 to 3 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 14 percent
Maximum salinity: Nonsaline to very slightly saline (0.1 to 2.0 mmhos/cm)
Sodium adsorption ratio, maximum: 5.0
Available water supply, 0 to 60 inches: High (about 11.3 inches)

Interpretive groups

Land capability classification (irrigated): 2e
Land capability classification (nonirrigated): 3c
Hydrologic Soil Group: C
Ecological site: R067BY002CO - Loamy Plains

Hydric soil rating: No

Minor Components

Adena

Percent of map unit: 8 percent
Landform: Interfluves
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Interfluve
Down-slope shape: Convex
Across-slope shape: Convex
Ecological site: R067BY002CO - Loamy Plains
Hydric soil rating: No

Colby

Percent of map unit: 7 percent
Landform: Hillslopes
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Convex
Ecological site: R067BY002CO - Loamy Plains
Hydric soil rating: No

Keith

Percent of map unit: 3 percent
Landform: Interfluves
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Interfluve
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: R067BY002CO - Loamy Plains
Hydric soil rating: No

Baca

Percent of map unit: 2 percent
Landform: Interfluves
Landform position (two-dimensional): Summit, shoulder
Landform position (three-dimensional): Interfluve
Down-slope shape: Convex, linear
Across-slope shape: Convex, linear
Ecological site: R067BY002CO - Loamy Plains
Hydric soil rating: No

83—Wiley-Colby complex, 3 to 5 percent slopes

Map Unit Setting

National map unit symbol: 3644
Elevation: 4,850 to 5,000 feet
Mean annual precipitation: 12 to 16 inches
Mean annual air temperature: 48 to 54 degrees F

Frost-free period: 135 to 170 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Wiley and similar soils: 55 percent
Colby and similar soils: 30 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Wiley

Setting

Landform: Plains
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Calcareous eolian deposits

Typical profile

H1 - 0 to 11 inches: silt loam
H2 - 11 to 60 inches: silty clay loam
H3 - 60 to 64 inches: silty clay loam

Properties and qualities

Slope: 3 to 5 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 15 percent
Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water supply, 0 to 60 inches: High (about 11.7 inches)

Interpretive groups

Land capability classification (irrigated): 3e
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: B
Ecological site: R067BY002CO - Loamy Plains
Hydric soil rating: No

Description of Colby

Setting

Landform: Plains
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Calcareous eolian deposits

Typical profile

H1 - 0 to 7 inches: loam
H2 - 7 to 60 inches: silt loam

Properties and qualities

Slope: 3 to 5 percent
Depth to restrictive feature: More than 80 inches

Drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 15 percent
Available water supply, 0 to 60 inches: High (about 10.6 inches)

Interpretive groups

Land capability classification (irrigated): 3e
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: B
Ecological site: R067BY002CO - Loamy Plains
Hydric soil rating: No

Minor Components

Heldt

Percent of map unit: 9 percent
Hydric soil rating: No

Weld

Percent of map unit: 6 percent
Hydric soil rating: No

References

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

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

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

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

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

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

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

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

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

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

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

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

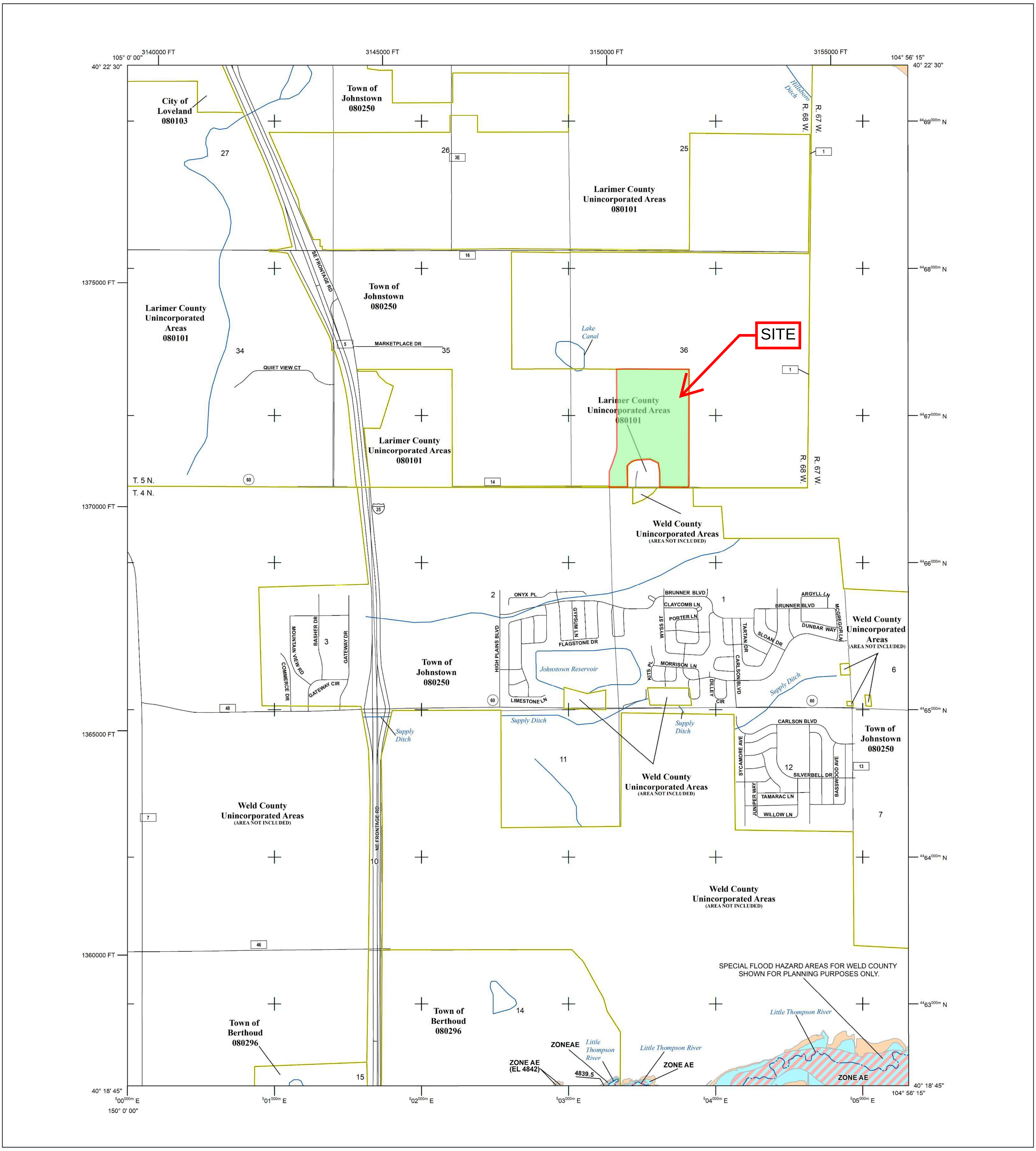
United States Department of Agriculture, Natural Resources Conservation Service. National forestry manual. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/home/?cid=nrcs142p2_053374

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

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

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

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



FLOOD HAZARD INFORMATION

SEE FIS REPORT FOR DETAILED LEGEND AND INDEX MAP FOR FIRM PANEL LAYOUT

THE INFORMATION DEPICTED ON THIS MAP AND SUPPORTING DOCUMENTATION ARE ALSO AVAILABLE IN DIGITAL FORMAT AT

HTTPS://MSC.FEMA.GOV

SPECIAL FLOOD HAZARD AREAS	Without Base Flood Elevation (BFE) *Zone A, V, A99*
	With BFE or Depth *Zone AE, AO, AH, VE, AR*
	Regulatory Floodway
OTHER AREAS OF FLOOD HAZARD	0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile *Zone X*
	Future Conditions 1% Annual Chance Flood Hazard *Zone X*
	Area with Reduced Flood Risk due to Levee See Notes. *Zone X*
	Area with Flood Risk due to Levee *Zone D*
OTHER AREAS	NO SCREEN Area of Minimal Flood Hazard *Zone X*
	Area of Undetermined Flood Hazard *Zone D*
GENERAL STRUCTURES	Channel, Culvert, or Storm Sewer
	Levee, Dike, or Floodwall
OTHER FEATURES	E 18.2 17.5 Cross Sections with 1% Annual Chance Water Surface Elevation
	8 Coastal Transect
	Coastal Transect Baseline
	Profile Baseline
	Hydrographic Feature
	513 Base Flood Elevation Line (BFE)
	Limit of Study
	Jurisdiction Boundary

NOTES TO USERS

For information and questions about this Flood Insurance Rate Map (FIRM), available products associated with this FIRM, including historic versions, the current map date for each FIRM panel, how to order products, or the National Flood Insurance Program (NFIP) in general, please call the FEMA Map Information eXchange at 1-877-FEMA-MAP (1-877-336-2627) or visit the FEMA Flood Map Service Center website at https://msc.fema.gov. Available products may include previously issued Letters of Map Change, a Flood Insurance Study Report, and/or digital versions of this map. Many of these products can be ordered or obtained directly from the website.

Communities annexing land on adjacent FIRM panels must obtain a current copy of the adjacent panel as well as the current FIRM Index. These may be ordered directly from the Flood Map Service Center at the number listed above.

For community and countywide map dates refer to 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.

Base map information shown on this FIRM was derived from the National Flood Hazard Layer (NFHL), dated 2013 and digital data provided by Larimer County GIS Department, dated 2018.

SCALE

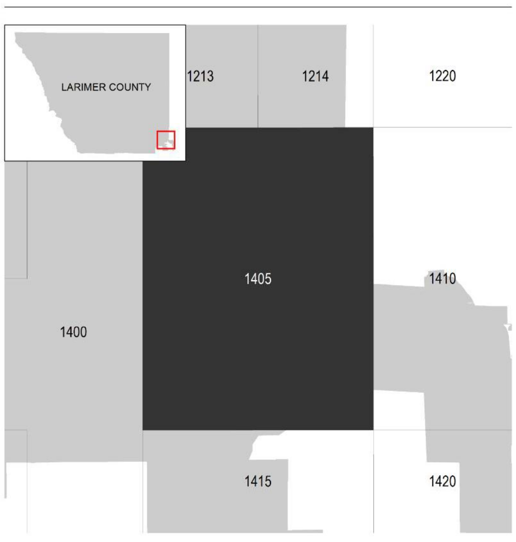
Map Projection:
Universal Transverse Mercator (UTM) Zone 13N; North American Datum 1983; Western Hemisphere; Vertical Datum: NAVD 88

1 inch = 1,000 feet   1:12,000

0 1,000 2,000 4,000 feet

0 250 500 1,000 meters

PANEL LOCATOR



FEMA
National Flood Insurance Program

NATIONAL FLOOD INSURANCE PROGRAM
FLOOD INSURANCE RATE MAP

LARIMER COUNTY, COLORADO
and Incorporated Areas

PANEL **1405** OF **1420**

FEMA

Panel Contains:

COMMUNITY	NUMBER	PANEL	SUFFIX
BERTHOUD, TOWN OF	080296	1405	G
JOHNSTOWN, TOWN OF	080250	1405	G
LOVELAND, CITY OF	080103	1405	G
LARIMER COUNTY	080101	1405	G

VERSION NUMBER
2.5.3.6

MAP NUMBER
08069C1405G

MAP REVISED
JANUARY 15, 2021

NOAA Atlas 14, Volume 8, Version 2
Location name: Johnstown, Colorado, USA*
Latitude: 40.3529°, Longitude: -104.9605°
Elevation: 4936.4 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Deborah Martin, Sandra Pavlovic, Ishani Roy, Michael St. Laurent, Carl Trypaluk, Dale Unruh, Michael Yekta, Geoffrey Bonnin

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.240 (0.186-0.310)	0.287 (0.223-0.371)	0.383 (0.296-0.496)	0.480 (0.370-0.626)	0.642 (0.491-0.904)	0.788 (0.582-1.12)	0.952 (0.678-1.38)	1.14 (0.777-1.70)	1.41 (0.927-2.16)	1.64 (1.04-2.52)
10-min	0.351 (0.273-0.453)	0.420 (0.326-0.543)	0.560 (0.434-0.726)	0.704 (0.541-0.916)	0.940 (0.718-1.32)	1.15 (0.852-1.63)	1.39 (0.993-2.02)	1.67 (1.14-2.49)	2.07 (1.36-3.17)	2.40 (1.52-3.69)
15-min	0.428 (0.333-0.553)	0.512 (0.398-0.662)	0.683 (0.529-0.886)	0.858 (0.660-1.12)	1.15 (0.876-1.62)	1.41 (1.04-1.99)	1.70 (1.21-2.47)	2.03 (1.39-3.03)	2.52 (1.66-3.86)	2.93 (1.86-4.50)
30-min	0.571 (0.444-0.737)	0.681 (0.529-0.880)	0.907 (0.701-1.18)	1.14 (0.875-1.48)	1.52 (1.16-2.14)	1.86 (1.38-2.64)	2.25 (1.61-3.27)	2.69 (1.84-4.01)	3.34 (2.19-5.12)	3.89 (2.46-5.96)
60-min	0.707 (0.550-0.913)	0.834 (0.648-1.08)	1.11 (0.855-1.43)	1.39 (1.07-1.81)	1.87 (1.43-2.64)	2.30 (1.71-3.27)	2.80 (2.00-4.07)	3.37 (2.30-5.03)	4.21 (2.77-6.46)	4.92 (3.12-7.54)
2-hr	0.844 (0.662-1.08)	0.988 (0.774-1.26)	1.30 (1.02-1.67)	1.64 (1.27-2.11)	2.21 (1.72-3.10)	2.74 (2.05-3.86)	3.35 (2.42-4.82)	4.04 (2.80-5.97)	5.08 (3.37-7.70)	5.96 (3.81-9.01)
3-hr	0.928 (0.732-1.18)	1.08 (0.849-1.37)	1.41 (1.11-1.80)	1.78 (1.39-2.27)	2.40 (1.88-3.36)	2.98 (2.25-4.17)	3.65 (2.65-5.23)	4.42 (3.08-6.49)	5.57 (3.72-8.39)	6.54 (4.21-9.82)
6-hr	1.10 (0.874-1.38)	1.27 (1.01-1.60)	1.65 (1.31-2.08)	2.06 (1.62-2.61)	2.75 (2.17-3.79)	3.40 (2.58-4.68)	4.13 (3.03-5.84)	4.98 (3.50-7.21)	6.24 (4.21-9.26)	7.31 (4.75-10.8)
12-hr	1.29 (1.04-1.60)	1.53 (1.23-1.90)	2.00 (1.60-2.49)	2.46 (1.95-3.08)	3.19 (2.51-4.27)	3.84 (2.93-5.18)	4.57 (3.36-6.31)	5.37 (3.80-7.62)	6.55 (4.45-9.55)	7.53 (4.95-11.0)
24-hr	1.55 (1.26-1.91)	1.83 (1.48-2.25)	2.35 (1.89-2.89)	2.84 (2.28-3.52)	3.61 (2.85-4.74)	4.28 (3.28-5.66)	5.01 (3.71-6.80)	5.81 (4.14-8.11)	6.97 (4.78-10.00)	7.93 (5.26-11.4)
2-day	1.80 (1.47-2.18)	2.13 (1.74-2.58)	2.71 (2.21-3.30)	3.25 (2.63-3.97)	4.05 (3.21-5.21)	4.73 (3.65-6.16)	5.46 (4.08-7.28)	6.25 (4.49-8.57)	7.37 (5.10-10.4)	8.28 (5.56-11.8)
3-day	1.96 (1.61-2.36)	2.29 (1.88-2.77)	2.88 (2.36-3.49)	3.42 (2.79-4.16)	4.24 (3.38-5.42)	4.93 (3.83-6.36)	5.67 (4.26-7.50)	6.47 (4.67-8.80)	7.61 (5.29-10.6)	8.53 (5.76-12.0)
4-day	2.09 (1.72-2.50)	2.42 (2.00-2.91)	3.03 (2.49-3.65)	3.58 (2.92-4.33)	4.40 (3.52-5.59)	5.10 (3.97-6.54)	5.84 (4.41-7.69)	6.65 (4.82-8.99)	7.79 (5.44-10.8)	8.71 (5.91-12.2)
7-day	2.36 (1.96-2.81)	2.76 (2.29-3.29)	3.45 (2.85-4.11)	4.05 (3.33-4.85)	4.93 (3.95-6.15)	5.64 (4.42-7.13)	6.39 (4.85-8.28)	7.18 (5.24-9.56)	8.28 (5.82-11.3)	9.15 (6.26-12.7)
10-day	2.61 (2.18-3.08)	3.06 (2.55-3.62)	3.81 (3.17-4.51)	4.45 (3.68-5.30)	5.37 (4.31-6.62)	6.09 (4.79-7.62)	6.84 (5.21-8.78)	7.62 (5.58-10.0)	8.68 (6.13-11.8)	9.51 (6.55-13.1)
20-day	3.34 (2.81-3.90)	3.86 (3.25-4.51)	4.72 (3.96-5.53)	5.44 (4.54-6.40)	6.43 (5.20-7.79)	7.19 (5.70-8.85)	7.96 (6.11-10.0)	8.74 (6.46-11.3)	9.78 (6.97-13.0)	10.6 (7.36-14.3)
30-day	3.92 (3.32-4.54)	4.51 (3.82-5.23)	5.46 (4.61-6.35)	6.24 (5.24-7.30)	7.31 (5.94-8.78)	8.13 (6.47-9.91)	8.94 (6.90-11.2)	9.75 (7.24-12.5)	10.8 (7.75-14.3)	11.6 (8.14-15.6)
45-day	4.61 (3.93-5.31)	5.30 (4.52-6.11)	6.41 (5.44-7.41)	7.31 (6.17-8.48)	8.51 (6.95-10.1)	9.42 (7.54-11.4)	10.3 (7.99-12.7)	11.2 (8.35-14.2)	12.3 (8.87-16.1)	13.1 (9.26-17.5)
60-day	5.17 (4.42-5.92)	5.97 (5.11-6.85)	7.24 (6.17-8.33)	8.26 (7.01-9.54)	9.61 (7.87-11.4)	10.6 (8.52-12.7)	11.6 (9.01-14.2)	12.5 (9.38-15.8)	13.7 (9.91-17.8)	14.6 (10.3-19.3)

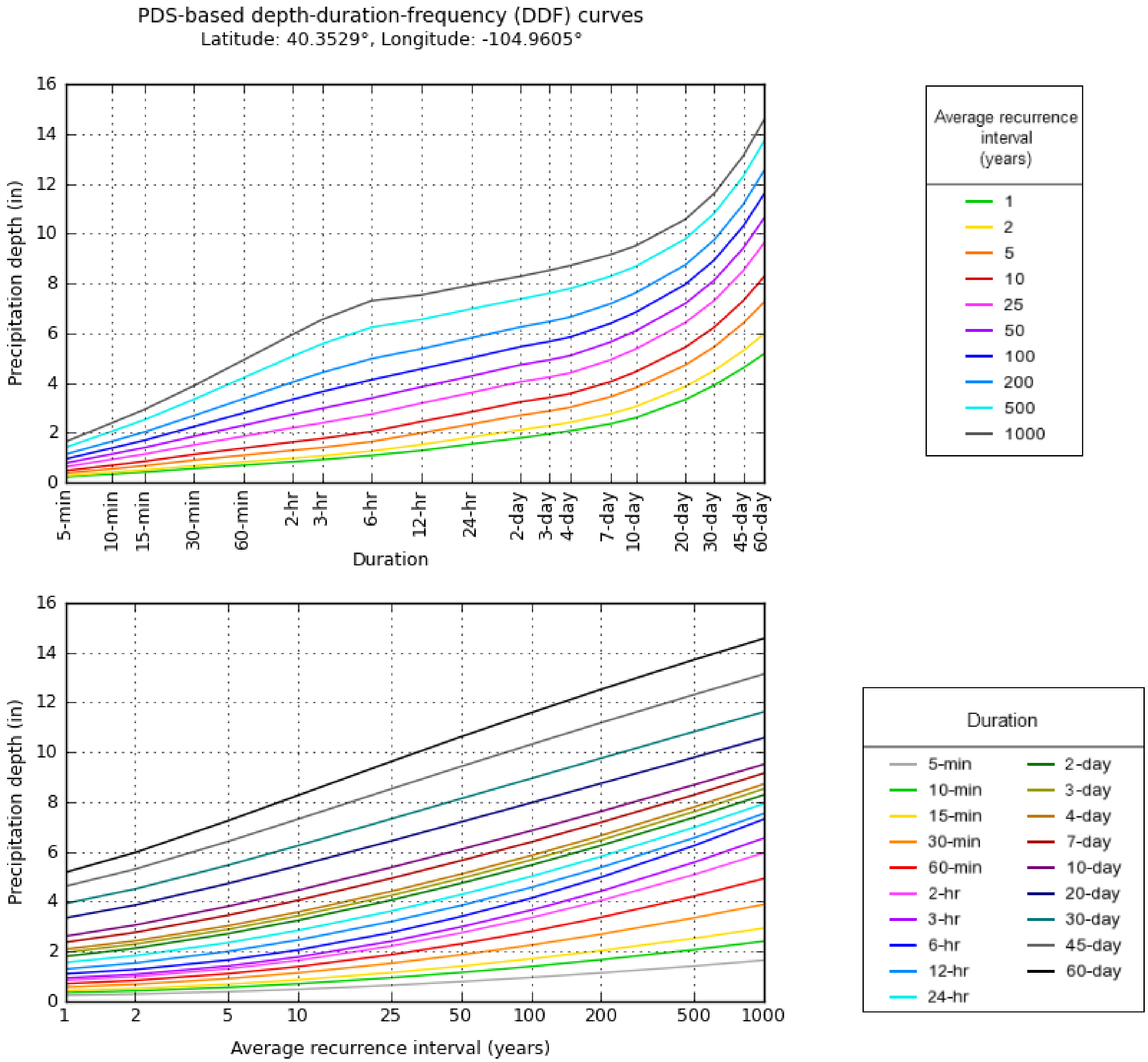
[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

Back to Top

PF graphical

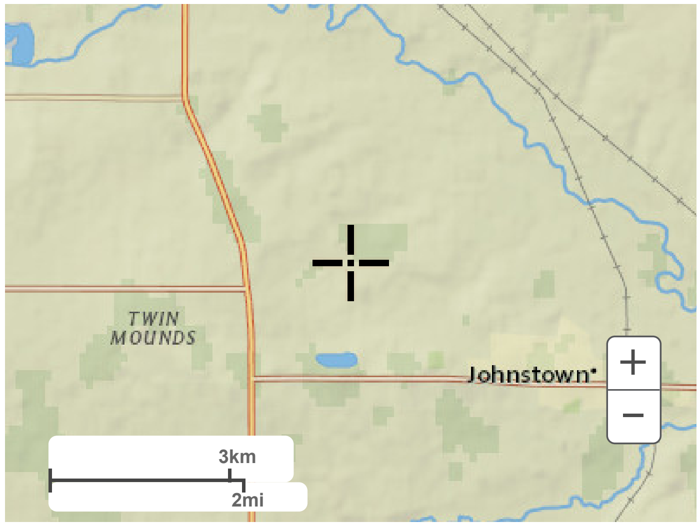


NOAA Atlas 14, Volume 8, Version 2 Created (GMT): Thu Mar 24 21:06:30 2022

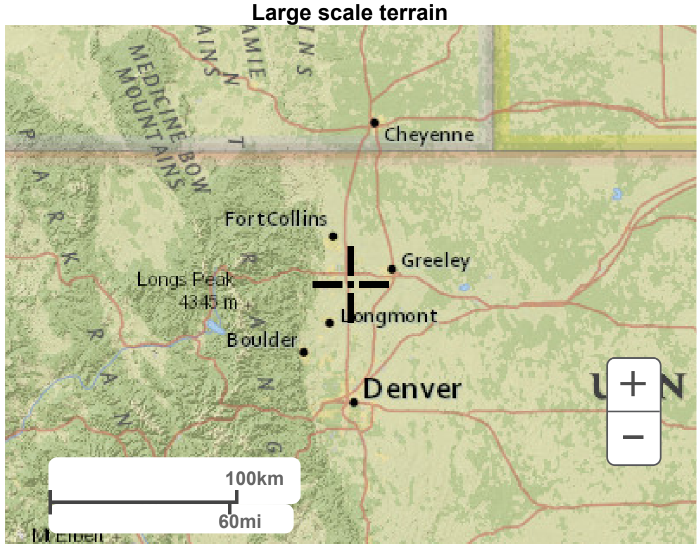
Back to Top

Maps & aerials

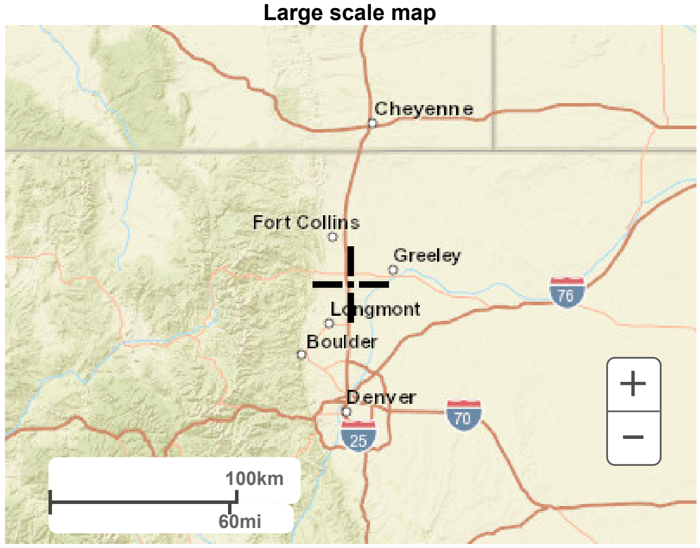
Small scale terrain



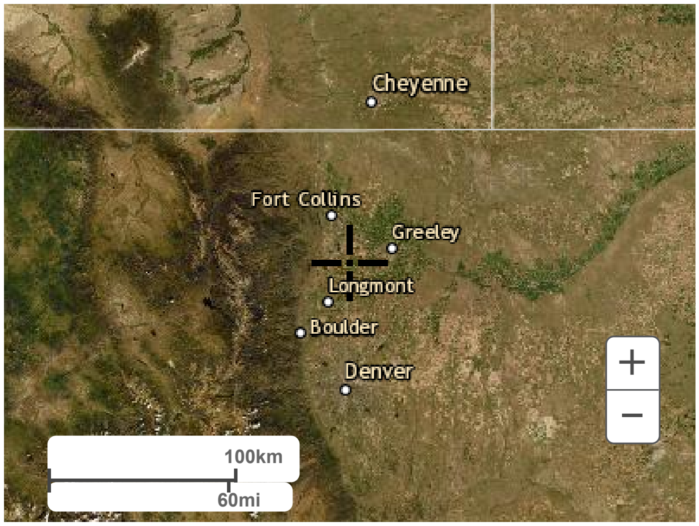
Large scale terrain



Large scale map



Large scale aerial



Back to Top

US Department of Commerce
National Oceanic and Atmospheric Administration
National Weather Service
National Water Center
1325 East West Highway
Silver Spring, MD 20910
Questions?: HDSC.Questions@noaa.gov

PRELIMINARY DRAINAGE REPORT

GREAT PLAINS VILLAGE
JOHNSTOWN, COLORADO

PREPARED FOR:

PLATTE LAND AND WATER, LLC
201 UNIVERSITY BLVD.
CONTACT: TIM WALSH

PREPARED BY:

CORE CONSULTANTS, INC.
1950 W. LITTLETON BOULEVARD, SUITE 109
LITTLETON, CO 80120
PHONE: 303-703-4444
CONTACT: KEVIN ROHRBOUGH
CORE PROJECT NUMBER: 18-156

NOVEMBER, 2019

I. DESCRIPTION OF SITE

This site is approximately +/-502.51-acres and located at the east side of the intersection of the Interstate 25 Frontage Road and Larimer County Road 14 (Weld County Road 50) in Johnstown, Colorado. It is situated in Sections 35 and 36, Township 5 North, Range 68 West of the 6th Principal Meridian, Larimer County, Colorado and Section 2, Township 4 North, Range 68 West of the 6th Principal Meridian, in Larimer and Weld County, Colorado. The site is bound by Interstate 25 to the west and cultivated land to the north, south, and east; and by residential dwellings to the west and south.

The property will be zoned for Residential, Commercial, and Mixed-Use development and is currently undeveloped and used primarily for agricultural purposes with rotating ground cover of crops. This site is proposed to be developed for commercial, residential, retail, light industrial and office purposes. Improvements include buildings, roadways, parking lots, landscaping, and associated utilities. Multiple detention ponds will be provided throughout the site to control water quality and storm water release rates.

The site generally slopes from west to east at an approximate average grade of 2 percent. An array of irrigation swales and structures exist throughout the site and at locations along the site perimeter.

Soils within the site are included in Hydrologic Soil Groups A, B, and C. Soils maps for the site from the Natural Resources Conversation Service can be found in Appendix A.

The site is located outside of any existing FEMA mapped floodplains or floodways, see FIRM map located in Appendix A.

II. DESCRIPTION OF BASINS AND SUB-BASINS

EXISTING DRAINAGE BASINS

Per the *Storm Water Master Plan for the Town of Johnstown, April 2001*, prepared by TEC, the site falls within two (2) major basins, Twin Mounds and Elwell Basins, which both ultimately discharge to the Big Thompson River located north and east of the site. It is anticipated that runoff will be released to the north, following the existing drainage patterns for the site. See Appendix C for the excerpts from the Storm Water Master Plan, and Appendix D for Existing Drainage Map.

PROPOSED DRAINAGE BASIN

Although site planning is in the preliminary stage, 12 regional detention ponds are anticipated throughout the site to manage developed runoff. The ponds will provide full spectrum detention up to the 100-year storm event. These locations are approximate and may be combined or additional ponds required based on final site configurations. Further stormwater infrastructure and detailed detention pond design will be included with each phase of the project.

The proposed detention ponds are anticipated to be connected via storm sewer system and conveyance channels. Flows will be discharged at or below the historical peak runoff to mitigate any impacts to downstream properties. See Appendix B for pond calculations and Appendix D for Proposed Drainage Map.

Offsite flows will continue to be conveyed around the perimeter of the site via existing ditches and/or grass lined swales. These flows will be routed and discharged to maintain historic drainage patterns.

III. Drainage Design Criteria

Rational Method was utilized to determine the peak runoff for the 2-year and 100-year storm events. These calculations and runoff summary table are included in Appendix B. Due to the preliminary nature of this project imperviousness was determined based on anticipated land use. Once site planning has advanced and land uses have been determined a Final Drainage Report will be prepared for the site during the Site Planning phase to provide further detail and accuracy.

Hydrology

Per the Town of Johnstown Storm Drainage Criteria, the Rational Method was utilized for runoff calculations.

$$Q = CIA$$

Q = The peak rate of runoff (cfs)
C = Runoff coefficient
I = Average rainfall intensity (inches/hour)
A = Basin Area (ac)

A minimum time of concentration of 5 minutes is utilized for urbanized watersheds.

IV. Drainage Facility Design

Detention ponds were calculated and sized using the current Urban Drainage UD-Detention spreadsheet. See Appendix B for preliminary Pond Sizing Calculations.

Detailed onsite Stormwater design will be prepared during the Site Planning process of the project.

V. Conclusions

The preliminary design of drainage peak runoff and detention pond calculations has been prepared per the Urban Drainage and the Town of Johnstown Storm Drainage Criteria. All concepts are preliminary and will reduce peak runoff from the development to mitigate impacts to downstream property owners. This report presents general drainage concept for the development and further analysis of the site will be prepared as the land planning process progresses and more detailed land uses are identified.

VI. REFERENCES

1. Town of Johnstown Storm Drainage Criteria, TST.

2. Town of Johnstown Storm Water Master Plan, TEC, April 2001.

3. Drainage Criteria Manual, Volumes 1, 2, & 3, Urban Drainage and Flood Control District, June 2001, Revised 2008.

GREAT PLAINS VILLAGE

CORE Project #: 18-156
Prepared By: DJB

COMPOSITE BASIN - WEIGHTED "C" CALCULATIONS - EXISTING CONDITIONS

	Residential											
	Single Family Detached	Single Family Attached	Multifamily Detached	Multifamily Attached	Commercial/ Mixed Use	Pavement/ Pond Surface	Roof	Concrete Walks/ Drives	Gravel	Landscape/ Historic		
% Imperv.	45.00%	60.00%	55.00%	75.00%	75.00%	100.00%	90.00%	90.00%	40.00%	2.00%		
											Total	Percent
BASIN	Area	Area	Area	Area	Area	Area	Area	Area	Area	Area	Area	Impervious
EX-1										81.00	81.0	2.0%
EX-2										57.60	57.6	2.0%
EX-3										354.90	354.9	2.0%
EX-4										9.00	9.0	2.0%
OS-1							0.35		1.80	3.35	5.5	20.0%
OS-2							0.15		0.60	3.75	4.5	10.0%

GREAT PLAINS VILLAGE

CORE Project #: 18-156
Prepared By: DJB

COMPOSITE DEVELOPED BASIN -WEIGHTED "C" CALCULATIONS - EXISTING CONDITIONS

-REFERENCE UDFCD Vol.1 RUNOFF Table 6-4

i = % imperviousness/100 expressed as a decimal
C_A = Runoff coefficient for NRCS HSG A soils
C_B = Runoff coefficient for NRCS HSG B soils
C_{CD} = Runoff coefficient for NRCS HSG C and D soils.
Natural Resource Conservation Service (NRCS)

Table 6-4. Runoff coefficient equations based on NRCS soil group and storm return period

NRCS Soil Group	Storm Return Period						
	2-Year	5-Year	10-Year	25-Year	50-Year	100-Year	500-Year
A	$C_A = 0.84i^{1.302}$	$C_A = 0.86i^{1.276}$	$C_A = 0.87i^{1.232}$	$C_A = 0.88i^{1.124}$	$C_A = 0.85i + 0.025$	$C_A = 0.78i + 0.110$	$C_A = 0.65i + 0.254$
B	$C_B = 0.84i^{1.169}$	$C_B = 0.86i^{1.088}$	$C_B = 0.81i + 0.057$	$C_B = 0.63i + 0.249$	$C_B = 0.56i + 0.328$	$C_B = 0.47i + 0.426$	$C_B = 0.37i + 0.536$
C/D	$C_{C/D} = 0.83i^{1.122}$	$C_{C/D} = 0.82i + 0.035$	$C_{C/D} = 0.74i + 0.132$	$C_{C/D} = 0.56i + 0.319$	$C_{C/D} = 0.49i + 0.393$	$C_{C/D} = 0.41i + 0.484$	$C_{C/D} = 0.32i + 0.588$

Basin ID	% Imperv.	i	Soil Type	Runoff Coefficients, C				Basin Area	Total Area	Weighted Runoff Coefficients, C			
				2-Year	5-Year	10-Year	100-Year			2-Year	5-Year	10-Year	100-Year
			A	0.01	0.01	0.01	0.13						
EX-1	2.0%	0.02	B	0.01	0.01	0.07	0.44		81.00	0.01	0.05	0.15	0.49
			C or D	0.01	0.05	0.15	0.49	81.00					
			A	0.01	0.01	0.01	0.13						
EX-2	2.0%	0.02	B	0.01	0.01	0.07	0.44		57.60	0.01	0.05	0.15	0.49
			C or D	0.01	0.05	0.15	0.49	57.60					
			A	0.01	0.01	0.01	0.13	8.52					
EX-3	2.0%	0.02	B	0.01	0.01	0.07	0.44	63.88	354.90	0.01	0.04	0.13	0.47
			C or D	0.01	0.05	0.15	0.49	282.50					
			A	0.01	0.01	0.01	0.13						
EX-4	2.0%	0.02	B	0.01	0.01	0.07	0.44	4.05	9.00	0.01	0.03	0.11	0.47
			C or D	0.01	0.05	0.15	0.49	4.95					
			A	0.10	0.11	0.12	0.27						
OS-1	20.0%	0.20	B	0.13	0.15	0.22	0.52	5.50	5.50	0.13	0.15	0.22	0.52
			C or D	0.14	0.20	0.28	0.57						
			A	0.04	0.05	0.05	0.19						
OS-2	10.0%	0.10	B	0.06	0.07	0.14	0.47	4.50	4.50	0.06	0.07	0.14	0.47
			C or D	0.06	0.12	0.21	0.53						

These Calculations have been replaced with the more concervative values for the Filing 1 Sizing

GREAT PLAINS VILLAGE

CORE Project #: 18-156
Prepared By: DJB

TIME OF CONCENTRATION CALCULATIONS - EXISTING CONDITIONS

-REFERENCE UDFCD Vol.1 Section 2.4

NRCS Conveyance factors, K -REFERENCE UDFCD Vol.1 RUNOFF Table 6-2

SF-2

Heavy Meadow	2.50	Short Grass Pasture & Lawns	7.00	Grassed Waterway	15.00
Tillage/field	5.00	Nearly Bare Ground	10.00	Paved Area & Shallow Gutter	20.00

SUB-BASIN DATA			INITIAL / OVERLAND TIME			TRAVEL TIME T(t)						T(c) CHECK (URBANIZED BASINS)		FINAL T(c)
DRAIN BASIN	AREA ac.	C(5)	Length ft.	Slope %	T(i) min	Length ft.	Slope %	Coeff.	Velocity fps	T(t) min.	COMP. T(c)	% IMPER-VIOUS	USDCM Eq . 6-5	min.
EX-1	81.00	0.05	500	1.3	38.8	2630	1.6	7.00	0.9	49.5	88.3	2.0%	63.0	63.0
EX-2	57.60	0.05	500	1.6	36.3	2140	1.5	7.00	0.9	41.6	77.9	2.0%	57.0	57.0
EX-3	354.90	0.04	500	1.2	40.2	6870	1.5	7.00	0.9	133.6	173.7	2.0%	126.4	126.4
EX-4	9.00	0.03	500	2.7	31.0	240	2.5	7.00	1.1	3.6	34.6	2.0%	28.4	28.4
OS-1	5.50	0.15	400	2.0	27.3			7.00			27.3	20.0%		27.3
OS-2	4.50	0.07	460	2.0	31.7			7.00			31.7	10.0%		31.7

GREAT PLAINS VILLAGE

CORE Project #: 18-156
Prepared By: DJB

RATIONAL METHOD PEAK RUNOFF - EXISTING CONDITIONS

5-YR STORM

SF-3 *Rainfall Depth-Duration-Frequency (1-hr) =* **1.1**

-REFERENCE UDFCD Vol.1 EQ 5-1 & EQ 6-1

BASIN INFORMATON				DIRECT RUNOFF				TOTAL RUNOFF				
DESIGN POINT	DRAIN BASIN	AREA ac.	5yr RUNOFF COEFF	T(c) min	C x A	I in/hr	Q cfs	T(c) min	SUM C x A	I in/hr	Q cfs	REMARKS
1	EX-1	81.00	0.05	63.0	4.16	1.08	4.5					
2	EX-2	57.60	0.05	57.0	2.96	1.15	3.4					
3	EX-3	354.90	0.04	126.4	15.35	0.66	10.1					
4	EX-4	9.00	0.03	28.4	0.30	1.78	0.5					
5	OS-1	5.50	0.15	27.3	0.82	1.82	1.5					
6	OS-2	4.50	0.07	31.7	0.32	1.67	0.5					

GREAT PLAINS VILLAGE

CORE Project #: 18-156
Prepared By: DJB

RATIONAL METHOD PEAK RUNOFF - EXISTING CONDITIONS
100-YR STORM

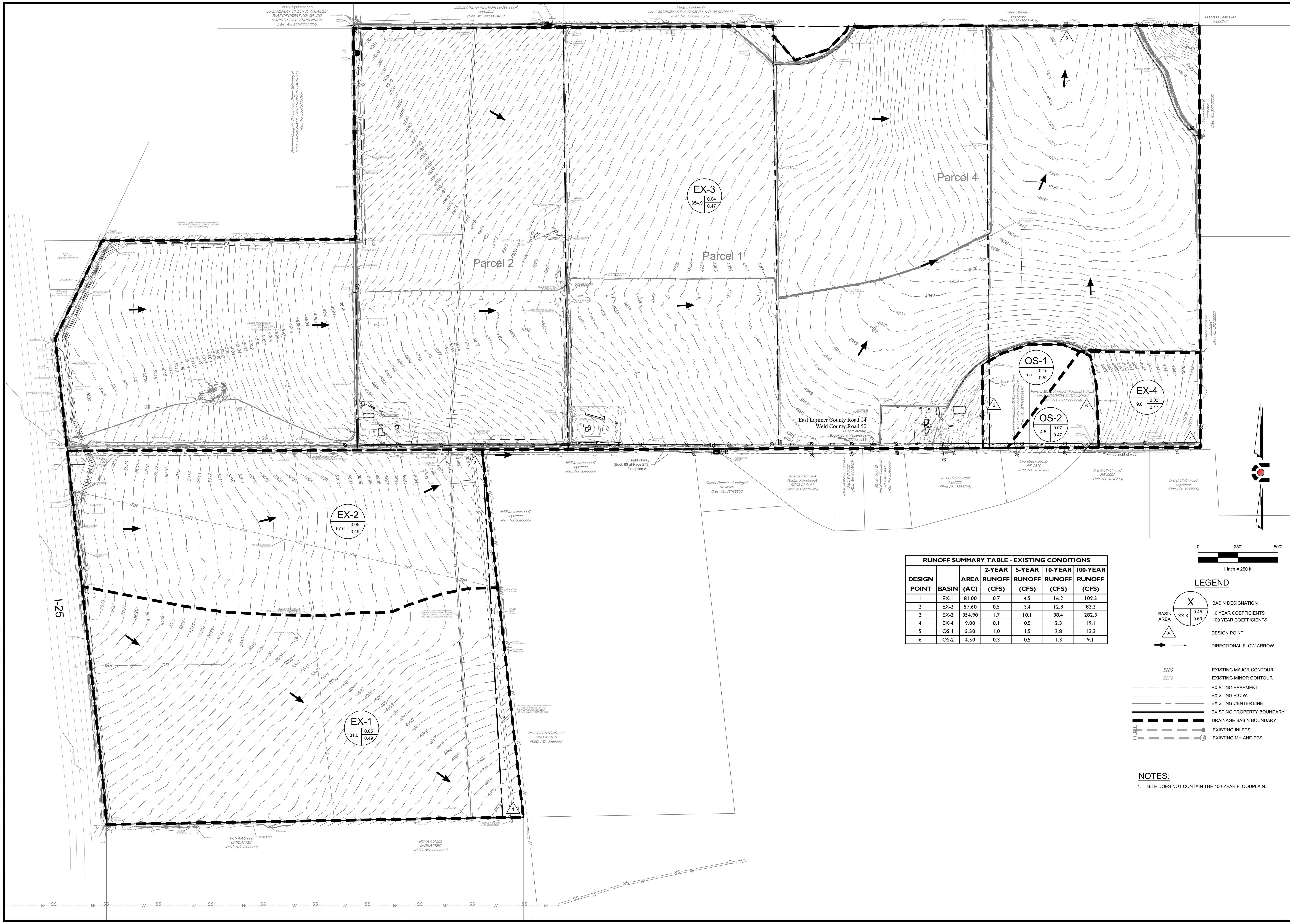
SF-3 *Rainfall Depth-Duration-Frequency (1-hr) =* **2.81**

-REFERENCE UDFCD Vol.1 EQ 5-1 & EQ 6-1

BASIN INFORMATON				DIRECT RUNOFF				TOTAL RUNOFF				
DESIGN POINT	DRAIN BASIN	AREA ac.	100yr RUNOFF COEFF	T(c) min	C x A	I in/hr	Q cfs	T(c) min	SUM C x A	I in/hr	Q cfs	REMARKS
1	EX-1	81.00	0.49	63.0	39.87	2.75	109.5					
2	EX-2	57.60	0.49	57.0	28.35	2.94	83.3					
3	EX-3	354.90	0.47	126.4	167.93	1.68	282.3					
4	EX-4	9.00	0.47	28.4	4.20	4.55	19.1					
5	OS-1	5.50	0.52	27.3	2.86	4.66	13.3					
6	OS-2	4.50	0.47	31.7	2.13	4.27	9.1					

RUNOFF SUMMARY TABLE - EXISTING CONDITIONS						
DESIGN POINT	BASIN	AREA (AC)	2-YEAR RUNOFF (CFS)	5-YEAR RUNOFF (CFS)	10-YEAR RUNOFF (CFS)	100-YEAR RUNOFF (CFS)
1	EX-1	81.00	0.7	4.5	16.2	109.5
2	EX-2	57.60	0.5	3.4	12.3	83.3
3	EX-3	354.90	1.7	10.1	38.4	282.3
4	EX-4	9.00	0.1	0.5	2.3	19.1
5	OS-1	5.50	1.0	1.5	2.8	13.3
6	OS-2	4.50	0.3	0.5	1.3	9.1

Maximum release flow criteria per historic site flows.



RUNOFF SUMMARY TABLE - EXISTING CONDITIONS						
DESIGN POINT	BASIN	AREA (AC)	2-YEAR RUNOFF (CFS)	5-YEAR RUNOFF (CFS)	10-YEAR RUNOFF (CFS)	100-YEAR RUNOFF (CFS)
1	EX-1	81.00	0.7	4.5	16.2	109.5
2	EX-2	57.60	0.5	3.4	12.3	83.3
3	EX-3	354.90	1.7	10.1	38.4	282.3
4	EX-4	9.00	0.1	0.5	2.3	19.1
5	OS-1	5.50	1.0	1.5	2.8	13.3
6	OS-2	4.50	0.3	0.5	1.3	9.1

LEGEND

- X — BASIN DESIGNATION
- BASIN AREA XX.X — 0.45 10 YEAR COEFFICIENTS; 0.60 100 YEAR COEFFICIENTS
- DESIGN POINT
- DIRECTIONAL FLOW ARROW
- 5280 — EXISTING MAJOR CONTOUR
- 5279 — EXISTING MINOR CONTOUR
- EXISTING EASEMENT
- EXISTING R.O.W.
- EXISTING CENTER LINE
- EXISTING PROPERTY BOUNDARY
- DRAINAGE BASIN BOUNDARY
- EXISTING INLETS
- EXISTING MH AND FES

NOTES:

1. SITE DOES NOT CONTAIN THE 100-YEAR FLOODPLAIN.

10/9/2019 2:17 PM , X:\18-156 GREAT PLAINS\CADD\CIVIL\1 - GREAT PLAINS VILLAGE\DRAINAGE MAPS\EXISTING DRAINAGE MAP.DWG,

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303.703.4444
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#	REVISION DESCRIPTION	DATE	BY
A	1ST SUBMISSION	08/05/2019	KR
B	2ND SUBMISSION	10/11/2019	KR
##		##	##

GREAT PLAINS VILLAGE

JOHNSTOWN, CO

PRELIMINARY DRAINAGE REPORT
EXISTING DRAINAGE MAP

DESIGNED BY: DJB
DRAWN BY: DJB
CHECKED BY: KR

JOB NO. 18-156

SHEET 1 OF 2

RUNOFF SUMMARY TABLE - PROPOSED CONDITIONS						
DESIGN POINT	BASIN	AREA (AC)	2-YEAR RUNOFF (CFS)	5-YEAR RUNOFF (CFS)	10-YEAR RUNOFF (CFS)	100-YEAR RUNOFF (CFS)
1	A	45.21	72.4	104.7	140.8	334.7
2	B	52.35	88.3	126.6	169.1	394.4
3	C	18.04	34.2	48.1	63.4	141.7
4	D	23.09	42.8	60.5	80.0	180.0
5	E	36.36	67.3	95.1	125.7	283.1
6	F	24.61	48.3	67.7	88.9	195.9
7	G	15.06	27.2	38.6	51.1	116.2
8	H	68.89	117.7	167.5	223.4	519.9
9	I	100.40	160.9	231.1	310.1	736.8
10	J	42.01	71.7	101.7	135.7	316.5
11	K	67.01	108.9	156.8	210.3	497.2
12	L	9.48	15.1	21.5	28.9	69.5

LEGEND

- BASIN DESIGNATION
- 10 YEAR COEFFICIENTS
- 100 YEAR COEFFICIENTS
- BASIN AREA
- DESIGN POINT
- DIRECTIONAL FLOW ARROW
- EXISTING MAJOR CONTOUR
- EXISTING MINOR CONTOUR
- PROPOSED MAJOR CONTOUR
- PROPOSED MINOR CONTOUR
- EXISTING EASEMENT
- EXISTING R.O.W.
- EXISTING CENTER LINE
- EXISTING PROPERTY BOUNDARY
- PROPOSED EASEMENT
- PROPOSED R.O.W.
- PROPOSED CENTER LINE
- PROPOSED PROPERTY BOUNDARY
- MAJOR BASIN BOUNDARY
- MINOR BASIN BOUNDARY
- 100 YEAR FLOODPLAIN
- PROPOSED INLETS
- PROPOSED MH AND FES
- EXISTING INLETS
- EXISTING MH AND FES
- PROPOSED CHANNEL
- RIPRAP

NOTES:

1. SITE DOES NOT CONTAIN THE 100-YEAR FLOODPLAIN.

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#	REVISION DESCRIPTION	DATE	BY
A	1ST SUBMISSION	08/05/2019	KR
B	2ND SUBMISSION	10/11/2019	KR

GREAT PLAINS VILLAGE

JOHNSTOWN, CO

PRELIMINARY DRAINAGE REPORT
PROPOSED DRAINAGE MAP

DESIGNED BY: DJB
DRAWN BY: DJB
CHECKED BY: KR

JOB NO. 18-156

SHEET 2 OF 2

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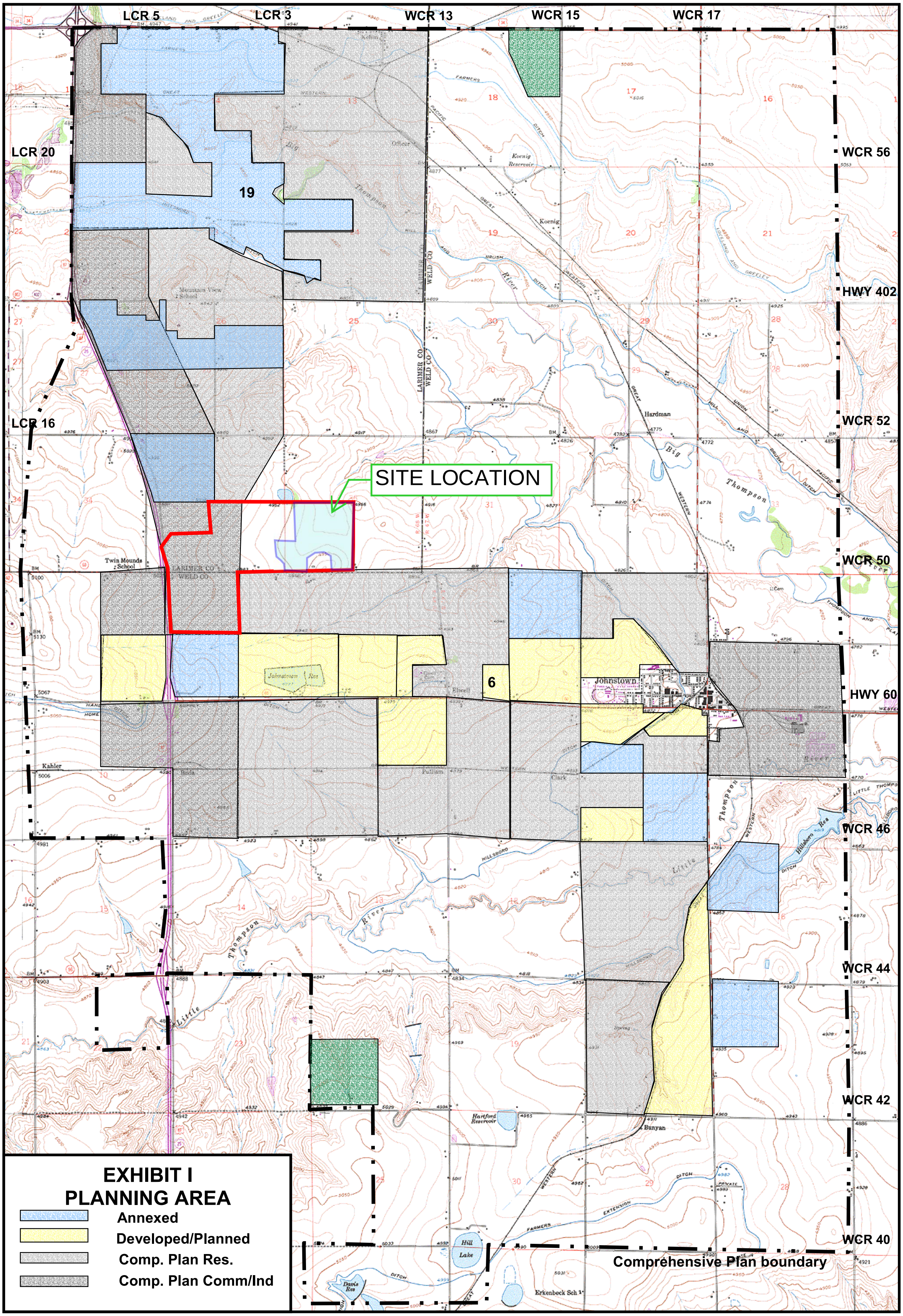
STORM WATER
MASTER PLAN

FOR THE

TOWN OF JOHNSTOWN

APRIL 2001


LCR 5
LCR 3
WCR 13
WCR 15
WCR 17
LCR 20
WCR 56
19
HWY 402
LCR 16
WCR 52
SITE LOCATION
WCR 50
6
Johnstown
HWY 60
WCR 46
WCR 44
WCR 42
WCR 40
Comprehensive Plan boundary
EXHIBIT I
PLANNING AREA
Annexed
Developed/Planned
Comp. Plan Res.
Comp. Plan Comm/Ind

Johnstown to require storm water BMPs (best management practices) in the future in case the EPA regulations become applicable, or the State or county governments require them.

As Johnstown makes the transition from farm community to urban community, inevitably there will be cases where residential developments are built downstream of agricultural operations such as feedlots. Feedlots and other similar operations are regulated by the Environmental Protection Agency, but conflicts may occur.

D. Major Drainage Basins

The study area has been divided into six major drainage basins. Each basin has in turn been divided up into a number of sub-basins. Many of these sub-basins were defined based on drainage reports submitted to the Town by developers. Typically existing geographic features define drainage basins. Where the sub-basins in the drainage reports were based on geography, we incorporated them into the study to allow comparison of results.

Within each major basin, one or more major drainage ways have been defined. The major drainage ways are intended to be corridors into which new development will discharge storm water from their respective detention ponds or other approved facilities. Each drainage way defined in this master plan has associated with it allowable flows, based on the 5-year and 100-year storms. When a parcel of land containing a portion of one of these drainage ways is developed, the developer will be required to set aside an appropriate corridor of right-of-way or easement for the drainage way. In all cases, the major basins are defined based on existing natural topography. In most cases, the drainage ways defined herein are based on existing drainage patterns. Some exceptions have been made where, for example, land planning operations by farmers have obscured natural drainage channels. In such cases, the ultimate alignment of the drainage way may depend in part on land uses proposed by the respective developers. Wherever possible the drainage ways have been aligned on existing sloughs, streambeds, or channels. In those cases where developers wish to redirect flow from one basin to another by grading of the property, they should be required to mitigate the flows to the release rates given in this master plan.

1. Old Town Basin

Of the six major basins, this is the only one that had significant development prior to 1990. Unlike the other basins, the Baseline Model (see Section III, Drainage Model) for this basin is a mix of pre- and post-development conditions. Old Town Basin is 3,509 acres (5.5 square miles) in area. It drains to both the Little and Big Thompson Rivers, and therefore could have been split into two major basins. However, this would have meant splitting the town in two. It is more relevant that the majority of the basin drains first into the Hillsborough Ditch. Most of the recommendations made in this report regarding this basin address how to pass water across the ditch prior to any discharge to a river.

2. Pulliam Basin

Pulliam Basin lies mostly south of Highway 60, and drains southeasterly to the Little Thompson River. It is 1,695 acres (2.6 square miles) in area. Two drainage ways are proposed for this basin. The first would extend from a point along Highway 60 near the west end of Johnstown Reservoir, southeast in an existing slough to the Little Thompson River. The slough becomes very well defined south of the railroad embankment, crossing WCR 46 via a bridge. The slough crosses the Hillsborough Ditch near the river. The ditch has an existing overflow structure very near to this crossing, and therefore an additional structure would likely not be necessary.

The other major drainage way proposed for this basin would closely parallel WCR 15 on the west side. Existing storm water flows appear to run southeast from the intersection of WCRs 15 and 46, but there is not a defined slough. Therefore it may make more sense to follow WCR 15 all the way to the Little Thompson River. Regardless, establishment of a major drainage way will result in drainage reaching the ditch at a point of concentration, where in the past it has likely entered the ditch as a distributed flow. At the point where this major drainage way crosses the ditch, the downstream bank of the ditch should be protected at minimum with a riprap blanket.

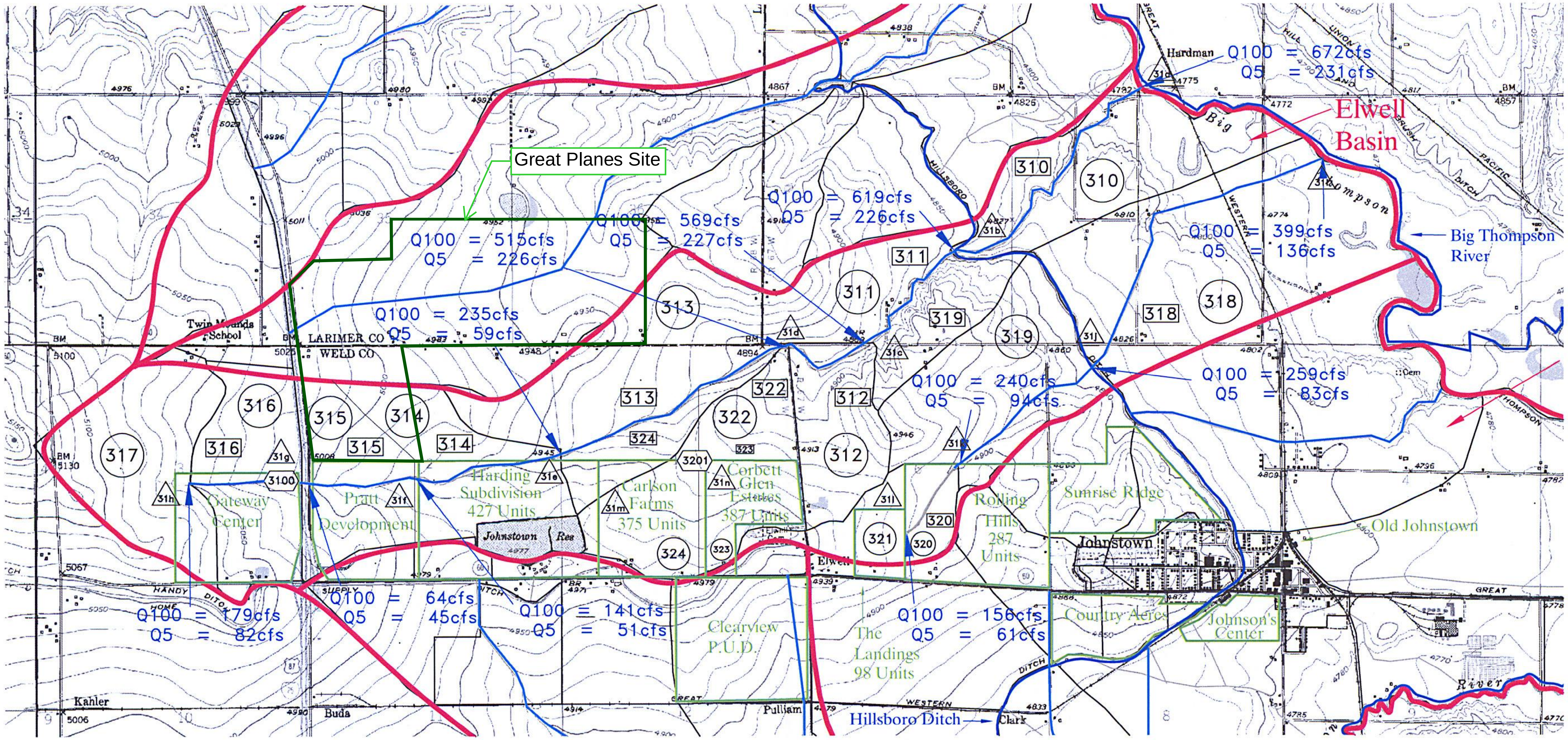
4. Elwell Basin

Elwell Basin begins approximately one mile west of I-25, and extends east and then northeast to the Big Thompson River. It includes many of the existing and proposed developments along the north side of Highway 60. It is 3,140 acres (4.9 acres) in size.

Several detention facilities have been designed for the various subdivisions proposed in this basin. Gateway Center, Carlson Farms, and Potburg Village all contain detention ponds. The pond in Potburg Village appears to outfall to the Rolling Hills subdivision. Rolling Hills has not yet constructed any storm water detention at this time for the portion of the development tributary to this basin (Several small ponds have been constructed for the portion tributary to Old Town Basin). Runoff currently discharges off the end of Rolling Hills Parkway into the adjacent field. Drainage discharged to this field ultimately makes its way to the Big Thompson River, after having crossed the Hillsborough Ditch. There is not a well-defined slough leaving the Rolling Hills property to the north. However, storm water detention should be required for the remainder of Rolling Hills, as it should for all properties lying above the Hillsborough Ditch. For Rolling Hills plans are to construct a basin prior to discharge off-site to the north.

The detention pond in Carlson Farms outfalls into a swale that has been constructed to an existing slough (Thornton Draw), approximately 900 feet north of the property. The slough crosses the Hillsborough Ditch before reaching the Big Thompson River. This slough is the major drainage way for Elwell Basin. The discharge during the 100-year storm from the detention pond in Carlson Farms is well in excess of the capacity of the Hillsborough Ditch. Though the Ditch Company has an turnout structure just

ELWELL BASIN



		Undeveloped		Current	
Node Name	Catchment Area	5yr Peak Flow	100yr Peak Flow	5yr Peak Flow	100 yr Peak Flow
	ac	cfs	cfs	cfs	cfs
31a	279.9	76.02	174.59	76.0	174.6
31b	250.1	73.5	166.4	73.5	166.4
31c	146.97	52.9	123.3	52.9	123.3
31d-1	390.23	134.2	308.4	134.2	308.4
31d-2	84.01	-	-		
31e	234.62	82.6	189.2	82.6	189.2
31f	173.45	63.0	148.5	63.0	148.5
31g	209.06	74.6	172.4	130.2	292.3
31h	261.78	93.0	214.2	93.0	214.2
31i	524.04	126.4	297.7	126.4	297.7
31j	276.05	86.4	194.2	86.4	194.2
31k	49.64	18.2	43.4	61.7	146.2
31l	58.38	22.1	60.1	92.2	207.8
31m	111.44	40.7	97.2	138.3	327.8
31n	90.32	33.8	86.5	33.8	86.5

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Exhibit 6

Legend

- Basin Boundary
- Subdivisions
- Drainageways
- Waterways
- Johnstown Stormwater Basins
- (310) Subcatchment
- [310] Subcatchment Channel
- (3100) Detention Element
- (31g) Concentration Point

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downstream of where the slough crosses the ditch, its capacity is only about 34 cfs. The existing slough can, in the major storm, see a considerable flow of storm water. Weld County has recently constructed two new bridges across this slough, one on WCR 13, and one on WCR 50. The original culvert under WCR 50, and the flows tributary to it, was one of the subjects of the study by Chang and Associates for Weld County. The Chang study calculated a 100-year flow of 1,483 cfs at WCR 50. This is a significantly higher figure than the 534 cfs given in our model. This is due to the application of significantly different methodologies, as well as different goals. Chang used HEC-1 and TR-55, which are programs developed by the U.S. Government to determine maximum flows for the purpose of designing dams and other flood control structures. The Chang study also used a storm duration of 24 hours, with a total storm depth of 5 inches, whereas we have based our analysis on a storm duration of 2 hours, which is the standard for urban drainage design, and a total storm depth of 3.01 inches. Finally, in the method used by Chang the peak rainfall doesn't occur until several hours into the storm, after the ground is saturated. In the two-hour storm typically used in urban drainage design, the peak rainfall occurs early in the storm, when the ground still has significant potential for absorbing water.

5. Twin Mounds Basin

Twin Mounds Basin is almost completely undeveloped at this time. The basin is 1,853 acres (2.9 square miles) in area, and lies almost entirely to the north of WCR 50. The basin extends from a point about one-half mile west of I-25, and drains to the Big Thompson River.

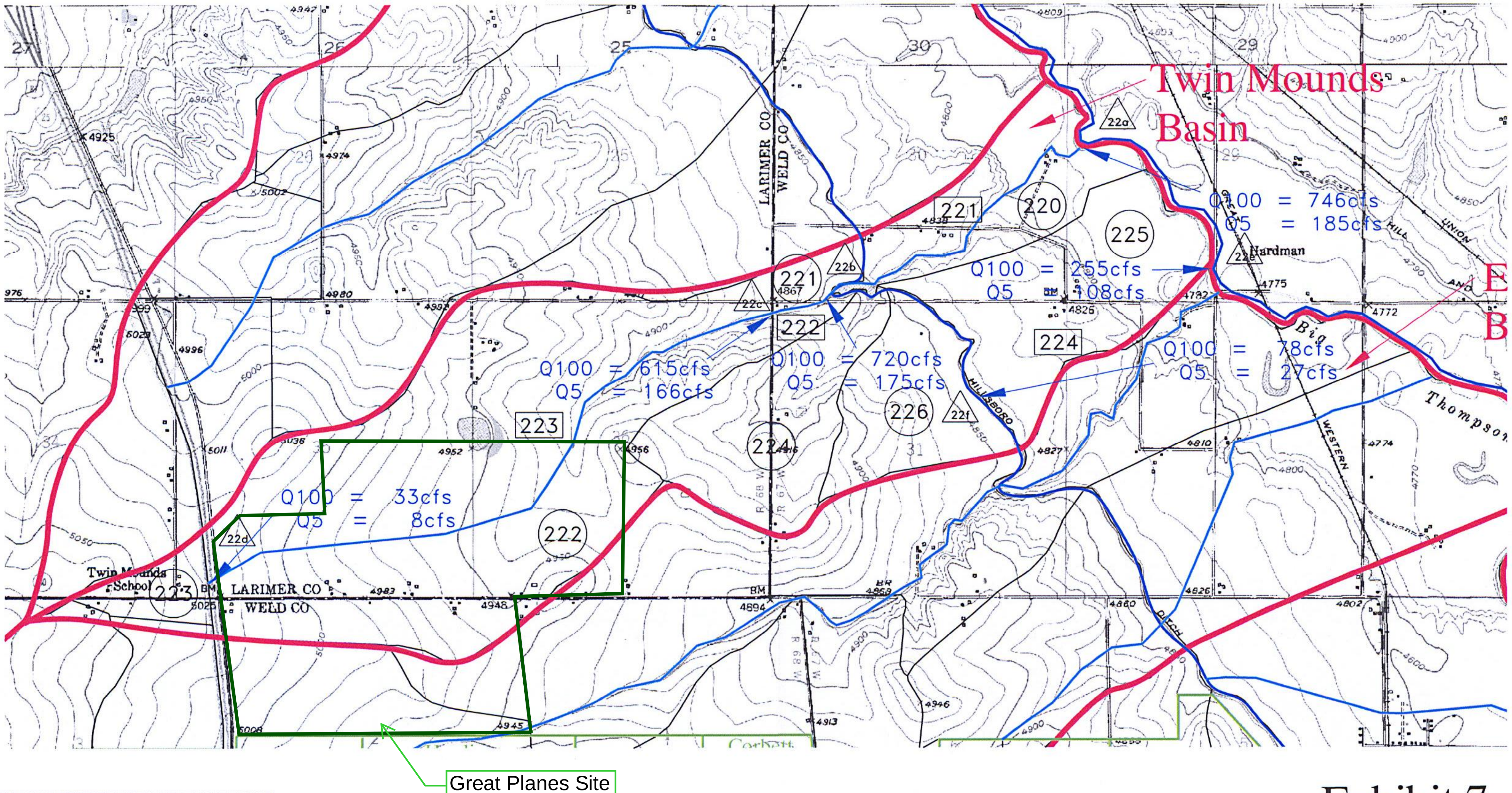
One major drainage way has been defined for this basin. An existing slough becomes well-defined west of WCR 13, and crosses that road and WCR 52 via 48-inch culverts. Just downstream of the point where the slough crosses WCR 52, it crosses the Hillsborough Ditch. There is believed to be a ditch overflow structure near this point. According to the USGS map, there is a pond located near this location on the slough.

6. Johnson's Corner Basin

Johnson's Corner Basin is 2,137 acres (3.3 square miles) in area, and in its upper reach extends nearly one mile southwest of Johnson's Corner, or about one-half mile west of I-25. Like Twin Mounds Basin, this basin is largely undeveloped, and also drains to the Big Thompson River.

One major drainage way has been defined for this basin. Beginning with a 36"x48" culvert under I-25, an existing slough extends northeast to the Big Thompson River. The slough crosses the Hillsborough Ditch at a point just west of WCR 13, and just south of SH 402. The ditch has an overflow structure at this point, which discharges into the slough.

TWIN MOUNDS BASIN



		Undeveloped	
Node Name	Catchment Area ac	5yr Peak Flow cfs	100yr Peak Flow cfs
22a	164.77	66.18	129.8
22b-1	46.63	91.627	212.315
22b-2	219.53	-	-
22c	916.85	330.665	824.095
22d	49.53	19.63	51.768
22e	278.17	90.82	203.85
22f	158	55.317	126.247

Exhibit 7

Legend

- Basin Boundary
- Subdivisions
- Drainageways
- Waterways
- Johnstown Stormwater Basins
- (220) – Subcatchment
- [220] – Subcatchment Channel
- (xxxx) – Detention Element
- △ – Concentration Point

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Bunyan Basin	2,829	acres
Elwell Basin	3,140	acres
Johnson's Corner Basin	2,137	acres
Old Town Basin	3,509	acres
Pulliam Basin	1,695	acres
Twin Mounds Basin	1,853	acres
Total	15,163	acres (23.7 sq. miles)

Table III-1 – Major Basin Areas

The Old Town Basin incorporates the original basin layout described in the M&I report (Basins A-J), but has been expanded to include the area bounded by the two rivers to the north, south and east, and County Road 13 to the west. For the Baseline Model, only the development in and around Old Johnstown that existed prior to 1990 is included. For the rest of the study area, pre-development conditions are assumed.

B. Rainfall Analysis

No two rainstorms are the same. Nevertheless, it is necessary to establish a conceptual "design storm" for which drainage plans and facilities are designed. In Colorado, the type of storm that produces heavy runoff is typically short in duration, with intense rainfall early in the storm. Common practice along the Front Range of Colorado is to use a design storm that is two hours in duration, with the assumed rainfall depth based on a "return period." The return period of a storm refers to the probability that a storm of that magnitude might occur in a given year. For example, a storm with a return period of two years (a 2-year storm) has a probability of 1 in 2 of occurring in any given year. The 100-year storm has a 1 in 100 chance of occurring in any given year. This does not guarantee that two 100-year storms couldn't occur in the same summer. Nature is unpredictable. But the odds are 100 to 1 against it happening in any given year.

The expected rainfall depths for various design storms are based on measurements of actual storms, and statistical analysis of those measurements. This work has been performed by NOAA (National Oceanic and Atmospheric Administration), and compiled in their "Precipitation-Frequency Atlas of the Western U.S., Atlas 2, Vol. 3 – Colorado." The Atlas estimates rainfall depths for storms of six and 24 hours in duration. The Atlas also has formulas for extrapolating rainfall depths for storms of shorter duration. The table below gives the rainfall depths given in the Atlas for the study area, along with the calculated values storms of two hours in duration.

below gives the Horton parameters used for each soil group, along with the other hydrologic parameters used in the model.

Soil Type	Initial Infiltration Rate (in/hr)	Final Infiltration Rate (in/hr)	Decay Rate (1/sec)
A	7.5	0.38	0.00115
B	4.5	0.23	0.00115
C	2	0.1	0.00115
D	2	0.025	0.00115

Table III-3 – Horton Infiltration Parameters

Basin slopes were calculated from USGS topographical maps, as were basin areas and channel lengths. Physical surveys were not conducted as part of this study.

D. Model Calibration

One of the primary purposes of the Baseline Model is to determine allowable release rates from detention ponds constructed in new housing and commercial developments. To ensure that the results generated by the model are reasonable and accurate, some kind of calibration is required. Calibration is, essentially, the practice of comparing model results with some expected results, and adjusting the model accordingly. Our expectation for the Johnstown area is that runoff rates would be low, compared to most urban systems along the Front Range. There are two reasons for this. The first is that the Soil Conservation Service classifies most soil types in the Johnstown area as Group B. As discussed above, Group B soils readily infiltrate, or absorb, water. Soils closer to the foothills typically have a higher clay content, and therefore they generate more runoff.

The other reason for expecting relatively low runoff rates relates to our definition of the historic condition. Virtually all the undeveloped land in the study area is ground that is currently being farmed, or has been farmed in the recent past. Cultivated ground is conditioned by the plow to absorb as much of the natural rainfall as possible. The top few inches of cultivated soil will have much lower compaction than undisturbed grassland. Low compaction results in much greater void space in the soil in which water can be absorbed and stored.

The model has incorporated within it the characteristics of cultivated farmland, in an effort to produce a physically-based model of each basin. These characteristics include infiltration, surface storage, overland flow characteristics, percent impervious, and numerous other criteria. To calibrate the model, several approaches were considered. We compared our results to the results of the study by Combs and Swift. However, they calibrated their model to a discharge of 1.0 to 1.2 cfs per acre, numbers derived from the UDFCD, and we did not feel that such numbers were representative of the Johnstown area for the reasons discussed above. After inputting the same surface detention (0.3”) and percent impervious (40) for Old

Johnstown, our results for that portion of the study area were nearly identical with those in the M&I report. We finally applied the Rational Method to the catchments in the Twin Mounds basin, and compared our results. The Rational Method incorporates soil parameters, runoff slopes, and other basin characteristics, just as SWMM does, but using completely different sets of calculations. It thus represents a method of generating results completely independent of SWMM. Good correlation was found between the two methods. Twin Mounds basin contains soil types A, B and C in the approximate proportions found throughout the study area. We felt it to be the most representative basin, and therefore the entire model was calibrated based on the calibration of the Twin Mounds Basin model to the Rational Method results.

E. Historic Runoff

The calculated historic runoff for the six major basins are given in the exhibits in Section II of this report, for each sub-basin. The peak runoff rates are for "pre-development" conditions as discussed above, except for Old Town where we have assumed an interim condition dating to approximately the same time as the M&I study. Peak runoff rates are for the 5-year and the 100-year storms. The tables printed on the exhibits also show the 5-year and 100-year runoff rates for current conditions.

The Baseline Drainage Model is a tool to establish allowable release rates from previously undeveloped properties. However, the Town has approved several residential and commercial developments within Johnstown in recent years. To gage the effect of these new developments, another version of the drainage model was constructed to analyze the "as is" condition. The purpose was to any identify current drainage problems, and to generate potential solutions. Town staff had identified some existing problems, and this information was compiled and used to verify model output. It was necessary to determine the conditions that exist now (or in the very near future) in order to identify what the most urgent needs are for the Town.

F. Modeling Assumptions

As discussed previously, a variety of methods were applied by various developers' engineers in determining detention storage, release rates, and other design elements for each new subdivision. It would be extremely difficult, if not impossible, to duplicate all these individual analyses in one model. Therefore, we have assumed that residential developments will increase the impervious area from 7.5% (used for undeveloped land) to 40%. Detention ponds known to exist, or that are under construction, have been added to the developed models. The models were then run with the developed conditions, and resultant flows at critical points generated for the 5-year and 100-year storms.

overchutes could also be used. However, they would be considerably more expensive to construct, and they would have to be somehow designed to allow low flows to enter the ditch. In general the principle to follow should be to mitigate the impacts of development only, and not to try and protect the ditch from all acts of nature.

The standard to which downstream improvements should be held would be dependent on whether they lay within the corporate limits of Johnstown, outside the corporate limits but within the urban growth boundary, or within Larimer or Weld County jurisdiction. Within the corporate limits, drainage is typically conveyed by the combination of storm drains, and curb and gutter. Development occurring within the corporate limits might be required to construct off-site road improvements, or at least participate in their cost, to convey drainage. This is likewise true of areas proposed for annexation. Where drainage ways cross roads under county jurisdiction, development need not upgrade the crossing to Johnstown street standards. As long as the county were to maintain the culvert or bridge, their standards would apply. However, in those cases where the road would eventually be transferred to Johnstown's jurisdiction, then Johnstown's street standards would apply.

As we have stated above, development should pay its own way. In the worst case scenario, this policy may require a developer to acquire drainage easements for two or three miles downstream of his/her property, and to improve the ditch bank at the point where drainage crosses the ditch. It is almost certain that the drainage easements will be along a proposed major drainage way, and downstream property owners should be willing to grant easements. They would be motivated to do so if they plan to develop their property in the future. In any case, if it is an existing drainage slough, then it is an existing path of flow. Under this master plan the downstream property owners would know that eventually the easements would be requested. If the developer is unable to get all the required easements, then the Town may wish to become involved in negotiating easements.

Some drainage improvements are proposed in this report to correct existing problems. The Town would construct these capital projects. Nearly all of them are located in the Old Town Basin. Certain other projects may place a disproportionate burden on developers, such as where the required drainage improvements would ultimately serve multiple developments. In this case the Town may choose to participate in the cost of such improvements, with the intention of gaining reimbursements from future developers. Johnstown will need to be flexible in how it approaches raising and spending revenues of its proposed storm water utility. It should also be recognized that even for those developments that have constructed adequate storm water management systems, the Town will be responsible for ongoing operation and maintenance of those systems. Property assessments by the storm water utility must cover the costs not only of capital projects, but operation and maintenance for the entire system.

A. Design Storms

During this study we made a choice to use the 5-year storm as the "minor" storm, and the 100-year storm as the "major" storm. The 100-year storm is the regional standard for urban drainage design. The 100-

year storm represents an event that is unlikely in any given year, but within the realm of possibility. At any given location, the likelihood that the 100-year storm will occur during a 40-year period is one in three.

The definition of the minor storm is not as universal along the Front Range of Colorado. Depending on the jurisdiction, the minor storm may be the 2-, 5- or 10-year storm. Some jurisdictions require the storm water collection system to be designed for the 2-year storm, and storm water detention ponds to be designed for the 10-year storm. UDFCD uses the 2-year storm for residential areas, and the 5-year storm for high-value commercial areas and public buildings.

The major and minor storms relate to the initial and major drainage systems. The initial drainage system is intended to collect storm water from the minor storm. It includes all curbs and gutters, swales, and any storm drains. The initial drainage system should be able to collect and convey storm water, without allowing excessive depth of water in streets, and without causing any property damage. The allowable depth of water in streets during the minor storm may depend on the street. During the 100-year storm, major thoroughfares must still be able to pass traffic each way, whereas local residential streets may need only to allow access to emergency vehicles. During the major storm, all storm drains are likely to be running full or even surcharged, and the major drainage system will need to carry the rest of the storm water. This would likely require greater depth of flow in all streets, but flowing water should still be contained within street rights-of-way. Overflow channels or other conveyances may be needed to route storm water away from private property.

We propose to use the 5-year storm as the minor storm in Johnstown's drainage criteria. This will afford a higher degree of protection than would be provided by using the 2-year storm, with a moderate impact on costs. Most such costs will be borne by developers in the form of slightly larger pipe sizes in on-site storm drain systems, and/or more storm drain piping. For the Town, it will impact certain capital improvement projects slightly. For example, a storm drain serving the downtown area might be six inches larger in diameter than what would be required for a 2-year storm. However, commercial areas are typically designed for the 5-year storm in most jurisdictions.

B. Detention Ponds and Release Rates

In modeling the six major drainage basins, historic release rates were calculated for each basin, sub-basin and catchment, for the entire study area (see appendices). This data was then used to generate a weighted average historic release rate per acre for each basin. For the Old Town Basin, only the undeveloped portions of the basin were used to generate the allowable release rate per acre for that basin. Release rates are by soil type, similar to table 3-2 of the Urban Drainage and Flood Control District Design Criteria Manual. In some basins, not all soil types were found in significant extent. In such cases a weighted average from the other basins with that soil type was used. Developers should be required to provide detention volume sufficient to contain the difference between the storm runoff prior to development, and the developed runoff. The rate of release from all detention ponds should not be allowed to exceed the values given in the table below, either during or immediately after the storm event.

	Soil Group			
Control Frequency	A	B	C	D
5-year				
Bunyan	0.31	0.33	0.34	0.35
Elwell	0.30	0.31	0.32	0.35
Johnson's Corner	0.31	0.33	0.33	0.35
Old Town	0.37	0.37	0.40	0.42
Pulliam	0.35	0.35	0.37	0.42
Twin Mounds	0.36	0.36	0.36	0.37
100-year				
Bunyan	0.7	0.81	0.93	0.97
Elwell	0.7	0.72	0.93	1.00
Johnson's Corner	0.7	0.76	0.77	1.00
Old Town	0.69	0.81	1.20	1.00
Pulliam	0.69	0.79	0.93	1.17
Twin Mounds	0.7	0.77	0.91	1.00

Table IV-1 – Allowable Release Rates, cfs/acre

We recommend that the Town adopt a variable detention policy. Such a policy is based on the principle that if a property is on a major drainage way and close to a major waterway (the Little or Big Thompson Rivers), peak flows in the major drainage way may actually be reduced by allowing discharge of storm water without detention. This is because runoff from catchments high up in the basin may not reach the outfall until long after the peak of the storm. If catchments near the bottom of the basin are allowed to discharge immediately, they will be done discharging before the runoff from the upper basins reaches the outfall. No developments above the Hillsborough Ditch would be qualified for any reduction in required detention.

In general, any development whose storm water discharge enters the Hillsborough Ditch (or any other ditch, for that matter) should be required to detain storm water. An exception could be made if the developer constructs a siphon or overchute to cross the ditch. The developer would then also need to make improvements to the downstream channel to ensure that it could carry the undetained flows, accounting for all other discharges to that channel. Any requests for variances from the Town's storm water detention policy should be considered on a case-by-case basis to ensure that downstream property owners would not be adversely affected, and to ensure adherence to good engineering practice.

All drainage systems and detention ponds should allow for the maintenance of low flows, which are essential to sustain wetlands. Some developers may propose combination detention/retention ponds. In addition to detaining storm water flows, these structures maintain permanent pools. Such facilities may impact downstream water rights. Prior to approval by the Town of any facility that may impound water, the developer should be required to get approval of the facility from the State Engineer's Office.

C. Water Quality

As previously discussed, we recommend that the Town enforce some kind of water quality requirements for storm water runoff from urbanized basins. A variety of methods exist, called BMPs (best management practices), and developers can be given the option to choose among them. Typically the most practical method, especially for smaller (less than 160 acres) developments, is to oversize detention ponds slightly so that they provide extended detention for the "first washoff" of storm water. Outlet structures are designed so that the runoff generated by the average afternoon thunderstorm drains very slowly from the detention pond, allowing pollutants to settle out prior to discharge to the receiving waterway. This practice would also provide an additional buffer to mitigate flooding of the Hillsborough Ditch during the minor storm. Other BMPs include constructed wetlands, which can double as an amenity. We recommend that the Town adopt Volume 3 of the Urban Drainage and Flood Control District Drainage Criteria Manual, which includes detailed descriptions and design procedures for water quality BMPs.

D. Major Drainage Ways

Drainage ways were defined earlier in this report for each Major Basin. Regardless of the policies adopted by the Town, during a major storm the water will flow into existing channels, just as it has always done. By identifying these drainage ways in this master plan, and requiring new developments to incorporate them into their land use plans, the Town ensures that the water will always have a place to go.

The drainage ways also provide the opportunity for development of natural corridors. We propose that the width of these drainage ways be 100 feet at a minimum, and greater if warranted by existing topography, expected storm water flows, or other considerations. They can incorporate trail systems and other amenities, act as wildlife corridors, and in general add to the quality of life in Johnstown. When a parcel of land containing a portion of a drainage way applies for annexation and proposes development, the developer should be required to dedicate the drainage way as permanent easement to the Town.

Developers will likely appreciate this arrangement. The amenity provided by a natural corridor would be a good selling point. Existing Federal law would require any existing wetlands to be preserved in any case. Potential developers would also have more guidance as to where they can discharge drainage.

The proposed major drainage ways in the Bunyan, Johnson's Corner and Twin Mounds basins incorporate existing well-defined channels. Only at the very bottom of each basin, just before the channels reach the Little Thompson River in the case of the Bunyan Basin, and the Big Thompson River for the other two basins, do the established channels lose definition. This is due to farming practices, the effect of the ditch in intercepting low flows, and the natural topography of the river terraces. We have already recommended within this report that a spill structure should be built in Bunyan Basin on the downstream bank of the ditch where the existing channel crosses the ditch. In conjunction with this work, a channel should be established to carry water to the Little Thompson River. Alignment of this channel should be coordinated with the property owner that will be affected, so as not to interfere unduly with agricultural operations. Likewise, as development occurs in the Johnson's Corner and Twin Mounds basins, the developers should be required to construct similar facilities in those basins.

Elwell Basin has two proposed major drainage ways, one of which is an existing channel. The existing channel extends roughly four miles, from Gateway Center down to the Big Thompson River. It is into this channel that we propose to divert flow via a spillway structure. This structure (discussed further in the Recommendations Section) would be located just west of Weld County Road 15, and north of Weld County Road 50. The other major drainage way proposed for this basin is well-defined above the ditch, but not at all defined below the ditch. Without an existing path of flow to the Big Thompson River, could easily be made to follow roadway alignments. The northernmost drainage way for Old Town Basin is also lacking an existing channel, and it would be possible to route the flows from the two drainage ways to a shared channel.

The proposed major drainage way in the northeastern portion of Old Town would primarily serve Sunrise Ridge (including the Knolls), and the eastern two-thirds of Rolling Hills. Given the existing detention pond within Sunrise Ridge, and the proposed ditch spillway structure upstream of this point, a major drainage way may not be required west of Weld County Road 17. East of WCR 17 there appears to be an existing path of flow, but until this land is developed there may not be any need to dedicated a major drainage way.

As discussed previously, of the two major drainage ways proposed for Pulliam Basin, the eastern one is not based on a defined channel, and could therefore be aligned along county roads to minimize impacts on existing land uses.

E. Roadways and Streets

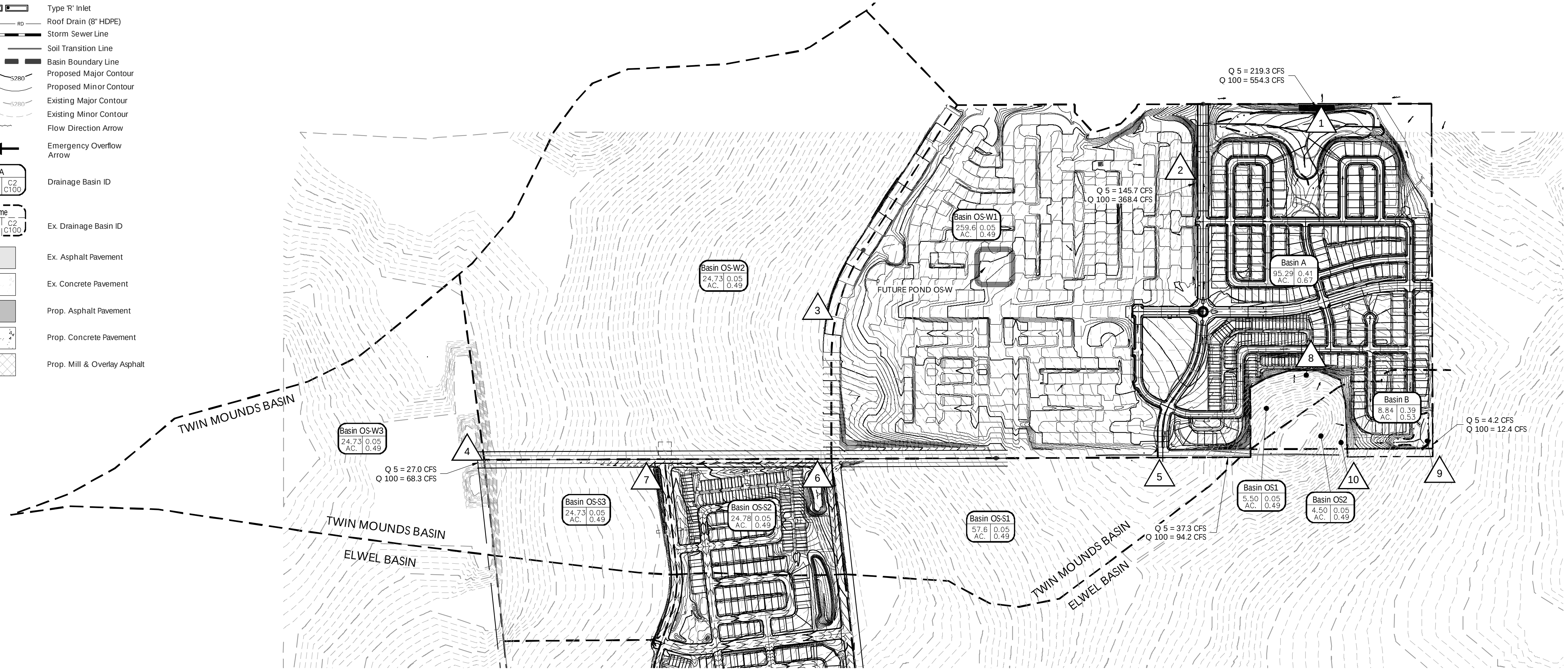
Streets and roadways are an essential element of the storm water collection system. Johnstown currently uses the City of Greeley streets standards for new construction. We recommend that the Town formally adopt these standards for all new construction.

APPENDIX D

Preliminary Drainage Map

LEGEND

- Property Line
- Right of Way Line
- Centerline
- Lot Line
- Easement Line
- Setback Line
- Retaining Wall
- Swale Line
- Storm Manhole
- Roof Drain Cleanout
- Type 'R' Inlet
- Roof Drain (8" HDPE)
- Storm Sewer Line
- Soil Transition Line
- Basin Boundary Line
- Proposed Major Contour
- Proposed Minor Contour
- Existing Major Contour
- Existing Minor Contour
- Flow Direction Arrow
- Emergency Overflow Arrow
- Drainage Basin ID (A / Acre AC. / C2 C100)
- Ex. Drainage Basin ID (Name / Area AC. / C2 C100)
- Ex. Asphalt Pavement
- Ex. Concrete Pavement
- Prop. Asphalt Pavement
- Prop. Concrete Pavement
- Prop. Mill & Overlay Asphalt



Calculated Proposed Runoff Rates

Basin ID	Design Point	Total Area (Ac.)	Tc (min)	Peak Flow (cfs) Q_5	Peak Flow (cfs) Q_{100}
A	1	95.29	60.1	5.34	131.96
B	9	8.84	30.1	0.77	19.00
OS-1	8	5.50	27.2	0.51	12.54
OS-2	10	4.50	28.0	0.41	10.09
OS-S1	5	54.02	80.9	2.47	61.00
OS-S2	6	24.78	45.4	1.67	41.29
OS-S3	7	24.73	61.6	1.36	33.68
OS-W1	2	138.20	61.7	7.61	188.06
OS-W2	3	191.64	54.2	11.51	284.53
OS-W3	4	75.00	70.1	3.78	93.54

SCALE 1 inch = 800 ft.
800 0 400 800

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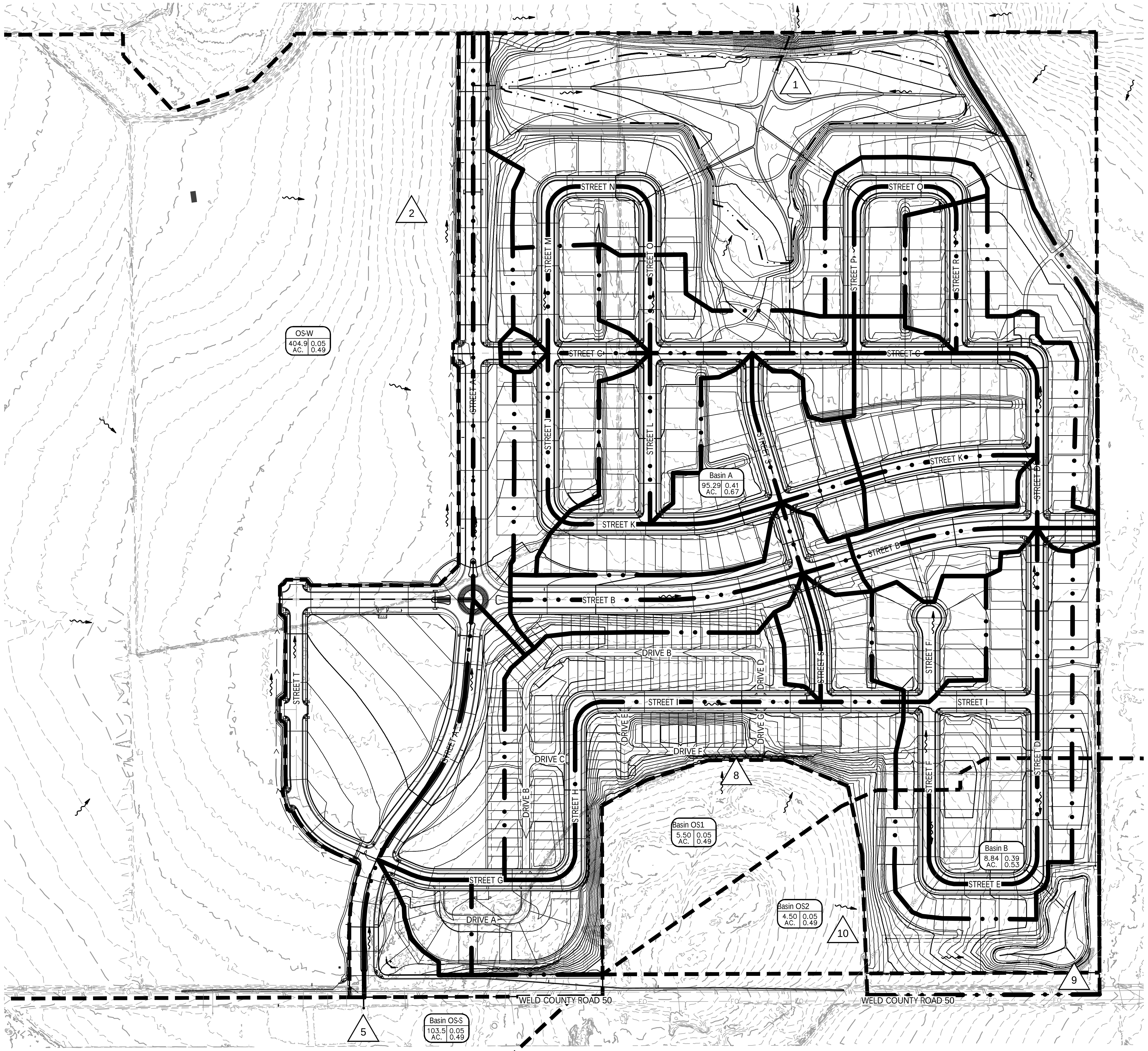
No.	Rev. Date:	Revision Type:
1		
2		
3		
4		
5		
6		

Designed By: RAA
Prepared By: ***ADD***
Approved By: TRH
Date: April 8, 2022
Horiz. Scale: 1" =
Vert. Scale: N/A
Sheet: 1 of 1
Job No.: 1060-08

Proj. Name: Revere North Filing No. 1
Location: Town of Johnstown, Colorado
Plan Set: Engineering Drainage Plans
Sheet Name: Twin Mounds Drainage Exhibit

Sheet: 1

I:\JOB FOLDERS\1060\1060-08\PROD\DRAINAGE_PRELIM\TWIN MOUNDS BASIN -- UPDATED DRAINAGE PLAN PRINTED ON: 4/7/2022 12:30 PM



Detention Pond A Volume Table			
	Requried Vol. (ac-ft.)	Elevation (ft)	Depth (ft)
Bottom of Pond	N/A	4922.00	0.00
WQCV	1.55	4924.14	2.14
EURV	4.12	4924.98	2.98
5-yr	3.94	4924.94	2.94
100-yr	10.65	4926.25	4.25
Emergency Overflow Weir	N/A	4928.1	6.10
Emergency Overflow WSE	N/A	4928.54	6.54
Freeboard / Top of Pond	N/A	4929.25	7.25

Detention Pond B Volume Table			
	Requried Vol. (ac-ft.)	Elevation (ft)	Depth (ft)
Bottom of Pond	N/A	4932.00	0.00
WQCV	0.16	4933.05	1.05
EURV	0.45	4933.76	1.76
5-yr	0.41	4933.68	1.68
100-yr	1.16	4934.89	2.89
Emergency Overflow Weir	N/A	4936.05	3.00
Emergency Overflow WSE	N/A	4937.07	3.31
Freeboard / Top of Pond	N/A	4937.68	4.00

LEGEND

- Property Line
- Right of Way Line
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- Lot Line
- Easement Line
- Setback Line
- Retaining Wall
- Swale Line
- Storm Manhole
- Roof Drain Cleanout
- Type 'R' Inlet
- Roof Drain (8" HDPE)
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- Prop. Concrete Pavement
- Prop. Mill & Overlay Asphalt

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				Q_5	Q_{100}
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B	9	8.84	30.1	0.77	19.00
OS-1	8	5.50	27.2	0.51	12.54
OS-2	10	4.50	28.0	0.41	10.09
OS-S1	5	54.02	80.9	2.47	61.00
OS-S2	6	24.78	45.4	1.67	41.29
OS-S3	7	24.73	61.6	1.36	33.68
OS-W1	2	138.20	61.7	7.61	188.06
OS-W2	3	191.64	54.2	11.51	284.53
OS-W3	4	75.00	70.1	3.78	93.54

SCALE 300 0 150 300
1 inch = 300 ft.

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Westminster, CO 80234
303.421.4224
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Sheet: 1 of 1
Job No.: 1060-08
Revision Type:
No. Rev. Date:
Date: April 8, 2022
Horiz. Scale: 1" =
Vert. Scale: N/A
Designed By: RAA
Prepared By: ***ADD*
Approved By: TRH

Proj. Name: Revere North Filing No. 1
Location: Town of Johnstown, Colorado
Plan Set: Engineering Drainage Plans
Sheet Name: Preliminary Drainage Plan

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Sheet: 1