Permanent Water Quality Facilities Maintenance **Routing #: 19-HA1-XC-00116**
SH 224 & York Street Pedestrian & Drainage Underpass **SAP #: 331001866**
Adams County
Sub account #: 20918
Region 1 – vjm

INTERGOVERNMENTAL AGREEMENT

THIS INTERGOVERNMENTAL AGREEMENT made this ___ day of _____ 2019, and hereinafter referred to as the "Agreement," by and between the State of Colorado for the use and benefit of the COLORADO DEPARTMENT OF TRANSPORTATION ("State" or "CDOT"), and the ADAMS COUNTY, COLORADO, CDOT vendor # 2000055 ("Local Agency"), each of which may also be referred to herein individually, as a "Party" and collectively as the "Parties."

This Agreement shall not be effective or enforceable until it is approved and signed by an authorized signatory of the Local Agency and the Governor of the State of Colorado or the Governor's designee (the "Effective Date").

RECITALS

1. The Local Agency wishes to construct permanent water quality ("PWQ") facilities per the CDOT Multiple Separate Storm Sewer System ("MS4") program within CDOT SH 224 right-of-way (ROW) as part of the SH 224 & York Street Pedestrian Drainage Underpass project ("PWQ Facilities").

2. Required approval, clearance and coordination have been accomplished from and with appropriate agencies.

3. CDOT and the Local Agency desire to enter into this Agreement to delineate each Party's responsibilities for operating and maintaining the PWQ Facilities. CDOT and the Local Agency understand and agree that the Local Agency is to assume all maintenance obligations for all of the PWQ Facilities under this Agreement, pursuant to CRS § 43-2-135.

4. CDOT confirms that it has the authority to enter into this Agreement and that no state or federal laws or regulations have been violated by entering into this Agreement. CDOT's authority to enter into this Agreement exists pursuant to CRS § 43-2-101(4) (c) and CRS § 43-2-104.5. Required approvals, clearance and coordination have been accomplished from and with appropriate agencies.

5. The Local Agency has the resources to perform the desired maintenance on the PWQ Facilities that it is responsible for maintaining under the provisions of this Agreement.

6. These recitals are hereby incorporated into the terms of this Agreement.

DEFINITIONS

1. "MS4": a conveyance or system of conveyances (including roads with drainage systems, municipal streets, catch basins, curbs, gutters, ditches, man-made channels, or storm drains):
   a. owned or operated by a state, city, town, borough, county, parish, district, association, or other public body (created by or pursuant to state law) having jurisdiction over disposal of sewage, industrial wastes, stormwater, or other wastes, including special districts under state law such as a sewer district, flood control district or drainage district, or similar entity, or an Indian tribe or an authorized Indian tribal organization, or a designated and approved management agency under section 208 of the Clean Water Act ("CWA") that discharges to waters of the United States;
   b. designed or used for collecting or conveying stormwater;
   c. which is not a combined sewer; and
   d. which is not part of a Publicly Owned Treatment Works (POTW). See 5 CCR 1002-61.2(62).
2. "Drainage Facilities" refers to the permanent facilities and improvements intended to capture, detain, convey, reduce and/or manage stormwater runoff. Examples include, but are not limited to, stormwater drain inlets and pipes, flood-control-only facilities, water control facilities designed for non-MS4 purposes (whether to meet TMDL/TMAL requirements or that do not meet MS4 design criteria), PWQ Stormwater Conveyance Facilities, and PWQ Facilities. Also referred to as Stormwater Facilities, Storm Drainage Systems or Facilities, or Storm Sewers.

3. "Operation & Maintenance Manual" ("O&M") refers to any owner's manual and/or guide incorporated into **Exhibit A** hereto that addresses how the PWQ Facilities should operate and how to maintain them.

4. "PWQ Stormwater Conveyance Facilities" refers to the collection and conveyance systems, including inlets, catch basins, pipelines, and open channels that are used to transport stormwater to or from PWQ facilities. Any conveyance beyond the PWQ Stormwater Facility outfall (i.e. beyond the outlet structure) is in the PWQ Stormwater Conveyance Facilities.

5. "PWQ Stormwater Access Facilities" consist of the surface improvements such as fencing, security gates, and access roads which are needed to operate and maintain the PWQ facilities.

6. "PWQ Facilities" are stormwater facilities that are intended to provide water quality benefits and are specifically used to meet water quality requirements as outlined in the Colorado Discharge Permit System ("CDPS").

7. The "PWQ Facilities," "PWQ Stormwater Conveyance Facilities," and "PWQ Stormwater Access Facilities" are collectively referred to as "Facilities." This does not include "Drainage Facilities."

8. "Stormwater" shall mean stormwater runoff, snow melt runoff, and surface runoff and drainage. See 5 CCR 1002-61.2(103).

9. "Stormwater Facilities" collectively refers to "drainage facilities" and "permanent water quality facilities".

10. It is the intent of the Parties to this Agreement that all Facilities listed in **Exhibit A** shall be maintained by the Local Agency.

THE PARTIES AGREE THAT:

Section 1. Scope of Work

The Local Agency will maintain the Facilities as set forth and depicted in **Exhibit A**. Such maintenance by the Local Agency shall be conducted in accordance with all applicable statutes, CDOT MS4 requirements, applicable legal requirements, ordinances and regulations, and any O & M, which define the requirements to maintain the Facilities during their useful life. Maintenance shall include upkeep of the Facilities, cleaning, routine landscaping, removal of pollutants (including but not limited to sediment, debris, oil and other chemicals, trash or other solid waste), and minor structural repairs of the Facilities as necessary to meet the requirements of this Agreement. The Local Agency shall make proper provisions for such maintenance obligations each year.

Section 2. CDOT Commitments

CDOT will be responsible for the following:

A. In the event that safety concerns are identified relating to the Facilities, CDOT will partner with the Local Agency and any other affected local jurisdictions to identify the appropriate response to maintain safe and functional Facilities.

B. In the event the Facilities fail due to surpassing their life cycle, the Parties will be responsible for improvements that are not covered by routine operations and maintenance responsibilities of the Local Agency per CDOT Updated Procedural Directive 501.1, Requirements for Storm Drainage Facilities and Municipal Separate Storm Sewer System Facilities (MS4), effective April 22, 2016. Only after funding for the improvement has been identified and obtained may the Parties perform major capital improvement of the Facilities, if necessary, per CDOT

Updated Procedural Directive 501.1, Requirements for Storm Drainage Facilities and Municipal Separate Storm Sewer System Facilities (MS4), effective April 22, 2016.

C. CDOT (and FHWA, if applicable) will make periodic inspection of the Facilities to verify that they are being adequately maintained and will report required and recommended maintenance items to the Local Agency. CDOT may issue a written notice to cure deficiencies in the event the Local Agency fails to inspect, report, or properly maintain the Facilities identified in **Exhibit A**. In the event the deficiencies so noticed to the Local Agency are not remedied within three (3) months after said written notice from CDOT to the Local Agency, CDOT may take whatever steps CDOT deems necessary to maintain the Facilities. The Local Agency shall reimburse CDOT its actual and documented costs for such maintenance and repair work including labor, equipment, supplies and materials. If CDOT repairs any deficiencies, it is under no obligation to maintain or repair in the future.

D. CDOT will require inspection and maintenance documentation from the Local Agency every year of the useful life and operation of the Facilities identified in **Exhibit A** attached hereto.

E. CDOT agrees it will not remove or alter the Facilities in such a way that reduces the documented treatment area as originally constructed. Should CDOT modify the Facilities to add additional treatment area, the changed treatment area shall be documented via a drainage report. CDOT may perform major reconstruction or capital improvement of the Facilities, if necessary, only after funding for the improvement has been identified and obtained per CDOT Updated Procedural Directive 501.1, Requirements for Storm Drainage Facilities and Municipal Separate Storm Sewer System Facilities (MS4), effective April 22, 2016. Prior to commencing any reconstruction activities, CDOT shall coordinate with the Local Agency to minimize impacts to landscaping enhancements that were installed by the Local Agency. CDOT will not be responsible for replacing any enhanced landscaping or irrigation installed by the Local Agency. Any fines levied against CDOT or the Local Agency shall be the responsibility of the Party whose action or inaction is the cause of the fine, regardless of which Party the fine is levied against.

Section 3. Local Agency Commitments

The Local Agency will be responsible for the following:

A. The Local Agency will maintain, inspect and operate the Facilities and associated improvements identified in **Exhibit A** attached hereto to ensure that the Facilities are and remain in proper working condition in accordance with all applicable statutes, the Local Agency's and CDOT's MS4 requirements, applicable legal requirements, ordinances and regulations, and any O&M (for PWQ Facilities only), which define the Local Agency's obligations to maintain such improvements during their useful life. The identified Facilities shall be maintained by the Local Agency at its own expense, unless otherwise agreed to by the Parties in writing. CDOT agrees to grant the Local Agency entrance upon CDOT's right of way ("ROW") for the purpose of performing the maintenance activities provided the Local Agency first obtains an annual special use permit from CDOT. At the time of application for the special use permit, the Local Agency shall submit a Methods of Handling Traffic plan (MHT) to CDOT. The MHT shall adhere to the most current version of the CDOT Standard Plans and Specifications, Miscellaneous Standard Plans ("M&S Standards"), the most current Manual on Uniform Traffic Control Devices ("MUTCD"), and the most current Colorado Supplement to the MUTCD that has been formally adopted by the Colorado Transportation Commission. The Local Agency shall comply with and perform all requirements and provisions of the special use permit and MHT, including but not limited to those relating to access, safety, and traffic control, and shall restrict access to the ROW to only those persons and equipment necessary to perform the work described in this Agreement. Maintenance shall include upkeep of the Facilities, cleaning, routine landscaping, removal of pollutants (including but not limited to sediment, debris, oil and other chemicals, trash or other solid waste), and minor structural repairs of the Facilities as necessary to meet the requirements of this Agreement.

B. The maintenance of the Facilities shall be performed in accordance with any applicable O&M for each specified Facilities.

C. The Local Agency shall inspect the Facilities identified in **Exhibit A** attached hereto at the Local Agency's expense per the recommended frequency in the O&M (if applicable) for the Facilities, but in any case not less than annually. The inspections shall be performed by a person experienced in the inspection of stormwater facilities. Inspections must ensure proper Facilities function and compliance with the most stringent MS4 permit requirements. Inspection and maintenance reports shall be submitted in writing by the Local Agency to the CDOT Permanent Water Quality Manager by December 31st of each year for the Facilities that receive flows from CDOT right of way. Any inspection form may be used if it is acceptable by agreement of the Parties and meets CDOT's MS4 permit requirements. The Local Agency agrees to report maintenance activities to CDOT along with the inspection reports. The State (and FHWA, if applicable,) will make periodic inspections of the Facilities to verify that such improvements are being adequately maintained.

D. The Local Agency shall make, keep, maintain, and allow inspection and monitoring by the State, of a complete file of all records, documents, communications, notes and other written materials, electronic media files, and communications pertaining in any manner to the Facilities. The Local Agency shall maintain such records

permanently, in either paper or electronic form. The Local Agency shall under no circumstances destroy any such records. Upon the expiration or termination of this Agreement, the Local Agency shall return any records provided by the State to the Local Agency as directed by the State. If the Local Agency is prevented by law or regulation from returning any such records provided by the State, the Local Agency warrants it will guarantee the confidentiality of such records.

E. In the event the Local Agency fails to properly inspect, operate, maintain, and/or report regarding the Facilities identified in **Exhibit A**, CDOT may issue a written notice to cure such deficiencies. In the event the deficiencies are not remedied within three (3) months after written notice of such deficiencies from CDOT to the Local Agency, CDOT may take whatever steps CDOT deems necessary to maintain the Facilities. The Local Agency shall reimburse CDOT its actual and documented costs for such maintenance and/or repair work including labor, equipment, supplies and materials. If CDOT remediates any deficiencies, it is under no obligation to maintain or repair in the future. The Local Agency, its successors and assigns shall hold harmless CDOT, its agents and employees from any and all damages, accidents, casualties, occurrences or claims which might be asserted against CDOT arising out of or resulting from the construction, presence, existence, maintenance or use of the Facilities by the Local Agency.

F. The Local Agency agrees it will not remove or alter the Facilities in any way that reduces the documented treatment area as originally constructed. Should the Local Agency modify the Facilities to add additional treatment areas, the changed treatment area shall be documented via a drainage report and as-built plans provided by the Local Agency to CDOT within the calendar year any such modification is completed by the Local Agency. With prior application to CDOT, and prior grant of consent by CDOT, the Local Agency may be permitted to expand or increase the capacity of the Facilities, and to landscape the area as determined by the Local Agency.

G. Any fines levied against CDOT as a result of the Local Agency's failure to comply with the terms of this Agreement shall be the sole and absolute responsibility of the Local Agency or its successors.

Section 4. Term and Termination Provisions

A. This Agreement shall not be effective until executed by both Parties. The maintenance obligations of the Local Agency under this Agreement shall commence on the Effective Date of this Agreement, and will remain in effect until this Agreement is terminated by mutual, written agreement of the Parties hereto or in accordance with the provisions of **Section 4.** B.

B. Termination for Cause. If, through any cause, either Party shall fail to fulfill its obligations under this Agreement, or if either Party shall violate any of the covenants, conditions, provisions, or stipulations of this Agreement, the non-

defaulting Party shall thereupon have the right to terminate this Agreement for cause by giving written notice to the other Party of its intent to terminate and providing at least thirty (30) days from the date of the notice within which to cure the default, unless the other Party can within said thirty (30) days reasonably show cause why termination is not appropriate.

Section 5. Legal Authority

The Parties hereby warrant that each possesses the legal authority to enter into this Agreement and that each has taken all actions required by its respective procedures, rules, regulations, and/or applicable law to exercise that authority, and each has lawfully authorized its undersigned signatories to execute this Agreement and to bind each to its terms. The person(s) executing this Agreement on behalf of each Party warrants that such person(s) has full authority to execute this Agreement. The Local Agency may evidence such authority by an appropriate ordinance/resolution or other authority letter expressly authorizing Local Agency to enter into this Agreement. A copy of any such ordinance/resolution or authority letter is attached hereto as **Exhibit B**.

Section 6. Representatives and Notice

The State will provide a Facilities liaison with the Local Agency through the State's Region Director, Region 1, 2829 W. Howard Place, Denver, Colorado 80204. Said Region Director will also be responsible for coordinating the State's activities under this Agreement. All communications relating to the day-to-day activities for the inspection, maintenance and reporting work shall be exchanged between representatives of the State's Transportation Region 2 and the Local Agency. All communication, notices, and correspondence shall be addressed to the individuals identified below, or as either Party may from time to time designate in writing to the other Party as new or substitute representatives, addresses, telephone numbers and/or email addresses.

If to State:
Gary W. Huber, PE-I
CDOT Region 1 North Area Project Engineer
4670 Holly Street
Denver, Colorado 80216
303-398-6768
gary.huber@state.co.us

with a copy to:
Rachel Hansgen, MPH
CDOT Permanent Water Quality Manager
2829 West Howard Place
Denver, Colorado 80204
303-757-9975
rachel.hansgen@state.co.us

If to the Local Agency:
Rene Valdez, Transportation ~~Infrastructure and Stormwater~~ Manager
Public Works Department
Adams County, Colorado
4430 S. Adams County Parkway
Brighton, Colorado 80601
720-523-6961
rvaldez@adcogov.org

Section 7. Successors

Except as herein otherwise provided, this Agreement shall inure to the benefit of and be binding upon the Parties hereto and their respective successors.

Section 8. Governmental Immunity

Notwithstanding any other provision of this Agreement to the contrary, no term or condition of this Agreement shall be construed or interpreted as a waiver, express or implied, of any of the immunities, rights, benefits, protection, or other provisions of the Colorado Governmental Immunity Act, §24-10-101, *et seq.*, CRS, as now or hereafter amended. The Parties understand and agree that liability for claims for injuries to persons or property arising out of negligence of the State of Colorado, the Local Agency and their respective departments, institutions, agencies, boards, officials and employees is controlled and limited by the provisions of §24-10-101, *et seq*., CRS, as now or hereafter amended, and the risk management statutes, §24-30-1501, *et seq*., CRS, as now or hereafter amended.

Section 9. Severability

To the extent that this Agreement may be executed and performance of the obligations of the Parties may be accomplished within the intent of the Agreement, the terms of this Agreement are severable, and should any term or provision hereof be declared invalid or become inoperative for any reason, such invalidity or failure shall not affect the validity of any other term or provision hereof.

Section 10. Waiver

The waiver of any breach of a term, provision, or requirement of this Agreement shall not be construed or deemed as a waiver of any subsequent breach of such term, provision, or requirement, or of any other term, provision or requirement.

Section 11. Modification and Amendment

A. This Agreement is subject to such modifications as may be required by changes in federal or State law, or their implementing regulations. Any such required modification shall automatically be incorporated into and be part of this Agreement on the effective date of such change as if fully set forth herein. Except as provided above, no modification of this

Agreement shall be effective unless agreed to in writing by both Parties in an amendment to this Agreement that is properly executed and approved in accordance with applicable law.

B. Either Party may suggest renegotiation of the terms of this Agreement, provided that the Agreement shall not be subject to renegotiation more often than annually, and that neither Party shall be required to renegotiate. If the Parties agree to change the provisions of this Agreement, the renegotiated terms shall not be effective until this Agreement is amended/modified accordingly in writing.

Section 12. Disputes

Except as otherwise provided in this Agreement, any dispute concerning a question of fact arising under this Agreement which is not disposed of by agreement of the Parties will be decided by the Chief Engineer of the Colorado Department of Transportation. The decision of the Chief Engineer shall be final and conclusive unless, within 30 calendar days after the date of such written decision, the Local Agency gives notice to the State of its written appeal addressed to the Executive Director of the Colorado Department of Transportation. A copy of the Local Agency's written appeal shall be enclosed with said notice. In connection with any appeal proceeding under this clause, the Local Agency shall be afforded an opportunity to be heard and to offer evidence in support of its appeal. Pending final decision of a dispute hereunder, the Local Agency shall proceed diligently with the performance of the Agreement in accordance with the Chief Engineer's decision. The decision of the Executive Director of the Colorado Department of Transportation or his or her duly authorized representative for the determination of such appeals shall be final and conclusive and serve as final agency action. This dispute clause does not preclude consideration of questions of law in connection with decisions provided for hereunder. Nothing in this Agreement, however, shall be construed as making final the decision of any administrative official, representative, or board on a question of law.

Section 13. Does not supersede other agreements

This Agreement is not intended to supersede or affect in any way any other agreement (if any) that is currently in effect between the State and the Local Agency for other maintenance and operations services on State Highway rights-of-way.

Section 14. Sub-Local Agencies

The Local Agency may subcontract any part of its performance required under this Agreement, subject to reasonable advance written notice to and consent thereto by the State. The State understands that the Local Agency may intend to perform some or all of its obligations under this Agreement through a subcontract. The Local Agency shall not assign any of its obligations of performance under this Agreement without the express written consent of the State, which shall not be unreasonably withheld. Except as herein otherwise provided, this Agreement shall inure to the benefit of and be binding upon the Parties hereto and their respective lawful successors.

THE REMAINDER OF THIS PAGE INTENTIONALLY LEFT BLANK

THE PARTIES HERETO HAVE EXECUTED THIS AGREEMENT

*** Persons signing for the Local Agency hereby swear and affirm that they are authorized to act on the Local Agency's behalf and acknowledge that the State is relying on their representations to that effect.**

THE LOCAL AGENCY **Adams County, Colorado** Print: _____ Name of Authorized Individual Title: _____ Official Title of Authorized Individual _____ *Signature Date: _____	**STATE OF COLORADO** **JARED S. POLIS, GOVERNOR** Colorado Department of Transportation **Shoshana M. Lew, Executive Director** _____ By: **Joshua Laipply, P.E., Chief Engineer** Date: _____
2nd The Local Agency Signature if Needed Print: _____ Name of Authorized Individual Title: _____ Official Title of Authorized Individual _____ *Signature Date: _____	

EXHIBIT A – SCOPE OF WORK

SH 224 and York St. Permanent Water Quality Pond Maintenance
Scope of Work:

PWQ Facilities (permanent water quality pond), and associated engineered features to be designed and constructed by the Local Agency within CDOT SH 224 ROW near and west of York Street as a part of project "SH 224 & York Street Pedestrian & Draingage Underpass", (20805-01BLRT). Refer to Sheets GP01, UD01, and Exhibit 1 within this **Exhibit A**.

Maintenance shall be as delegated below. Maintenance includes upkeep, cleaning, trash removal, sediment and debris removal, repair, and replacement as necessary related to the areas of responsibility as outlined below.

CDOT Responsibilities

1. Normal wear and maintenance of SH 224 roadway pavement.
2. Standard maintenance of the roadway sideslope adjacent to the water quality pond, but not considered part of the pond. Examples include but are not limited to trash removal, necessary regrading, previously existing pipes, and mowing.
3. SH 224 travelled way signage and striping.
4. Roadway delineators not impacted by the water quality pond.
5. Median cover.
6. Signalization and signal device maintenance.

Local Agency Responsibilities

1. PWQ Facilities and associated features.
2. Any abnormal wear or damage to the roadway or adjacent embankment (examples are subsidance, erosion, improper hydraulic flow, cracking, or other damage to the roadway due to the presence of the PWQ Facilities and associated features, structures and water flow.
3. The embankment, riprap, and vegetation within the footprint of the project.
4. PWQ Facilities access road, and associated signs, delineators and features.
5. SH 224 signage, markings, and delineators related to the PWQ Facilities.
6. Sediment removal from the PWQ Facilities and associated features.
7. Mitigation and repair of other issues that may arise as the result of the PWQ Facilities and associated features' proper or improper function. Examples include but are not limited to upstream flooding and erosion, plugged drainage system features, improperly sized or incorrect configuration of system features, wetlands or other vegetation development, roadside ponding, ponding into the roadway, and embankment erosion.
8. Any fencing adjacent to the PWQ Facilities.

SH 224 and York St. Permanent Water Quality Pond Operations Legacy Responsibility

PWQ Facilities and associated engineered features to be designed and constructed by the Local Agency within CDOT SH 224 ROW near SH 224 and West of York Street as a

part of project “SH 224 & York Street Pedestrian & Drainage Underpass”, (20805-01BLRT). Refer to Sheets GP01, UD01, and Exhibit 1 within this **Exhibit A**.

CDOT and the Local Agency hereby agree that the Local Agency shall be solely responsible for the operations and maintenance of the PWQ Facilities and associated features, and any future costs that may arise as a result of the PWQ Facilities and associated features requiring change, reconfiguration, relocation, or any other modification for future widening or modification of SH 224, roadways, structures, or features that may require modification for the benefit of the SH 224 cooridor, and described herein.

CDOT Responsibilities

1. Normal wear of roadway pavement.
2. Travelled way signage and striping.
3. Roadway delineators approaching the pedestrian culvert underpass.
4. Median Cover.
5. Signalization and signal devices at York Street.

Local Agency Responsibilities

1. Complaints, issues, litigation, or other legal actions that may arise as a result of the presence, configuration, functionality, and geometry of the PWQ Facilities and associated features. Examples include but are not limited to: abnormal roadway degradation, channel degradation, ponding, flooding, environmental impacts, icing, bicycle crashes, vehicle crashes, or other unsafe conditions that arise due to the roadway and roadside geometry, design, or maintenance of the PWQ Facilities and associated features.
2. The Local Agency shall contribute to any additional future design, construction, right-of-way, utilities, and permitting costs necessary for CDOT to modify or widen SH 224 due to the presence of the PWQ Facilities and associated features, utilities placed as a result of this project, and associated features. This includes:
    a. Relocating or modification of the PWQ Facilities as necessary, and removal and replacement of any necessary features.
    b. Modification of the PWQ Facilities access road.
    c. Protection and placement of utilities.
    d. Ancillary work necessary to account for the presence of the PWQ Facilities and associated features such as clearing and grubbing, tree removal, seeding, waterway channel work, slope stabilization, scour mitigation, backfill, environmental permitting, floodplain permitting, or any other items necessary to compensate for the presence of the PWQ Facilities to modify SH 224 and the SH 224 corridor (this shall not include any work that would have been necessary to modify SH 224 regardless of the presence of the PWQ Facilities) and associated features.
3. Future maintenance or repair work that may be necessary due to the presence of the impacted water line as shown on sheet WT 01 within this **Exhibit A**, sanitary sewer line as shown on sheets SS01, SS02, Exhibits 2 and 3 within this **Exhibit A**, or any other utilities within the disturbed project footprint.

ADAMS COUNTY, COLORADO

PEDESTRIAN / DRAINAGE CULVERT IMPROVEMENTS

STATE HIGHWAY 224

JANUARY, 2018

VICINITY MAP
NOT TO SCALE

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6–7	DT01–02	DETAILS
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14	RR01	RIPRAP PLAN
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20	UD01	UNDERDRAIN PLAN & PROFILE
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22–29	SWMP01–08	STORM WATER MANAGEMENT PLAN
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32	TC01	TRAFFIC CONTROL PLAN (FUTURE)

OWNER
Adams County
4430 S. ADAMS COUNTY PARKWAY
BRIGHTON, COLORADO 80601
CONTACT: ANNA SPARKS, P.E., C.F.M.
asparks@adcogov.org
(720) 523–6859

CIVIL ENGINEER
Drexel, Barrell & Co.
1800 38th STREET
BOULDER, COLORADO 80301
CONTACT: PAUL MOREAU, P.E.
pmoreau@drexelbarrell.com
(303) 442–4338

Know what's below. Call before you dig.

PREPARED BY:
Drexel, Barrell & Co.
Engineers • Surveyors
1800 38TH STREET
BOULDER, COLORADO 80301
CONTACT: PAUL D. MOREAU, P.E.
(303) 442-4338
BOULDER
COLORADO SPRINGS
GREELEY

OWNER/CLIENT:
ADAMS COUNTY COLORADO
4430 SOUTH ADAMS COUNTY PARKWAY
BRIGHTON, CO 80601
(720) 523-6895
ANNA SPARKS, P.E., C.F.M.

CONSTRUCTION PLANS FOR:
SH 224 & YORK STREET
PEDESTRIAN & DRAINAGE UNDERPASS
ADAMS COUNTY, COLORADO

ISSUE	DATE
PRELIMINARY SET	11/30/16
PROGRESS SET	1/8/18

DESIGNED BY:	PDM
DRAWN BY:	GSG
CHECKED BY:	TDM
FILE NAME:	20805-01_CS01

ORIGINAL DRAWING SCALE:
HORIZONTAL: N/A
VERTICAL: N/A

COVER SHEET

PROJECT:20805-01BLTR
DRAWING NO.
CS01

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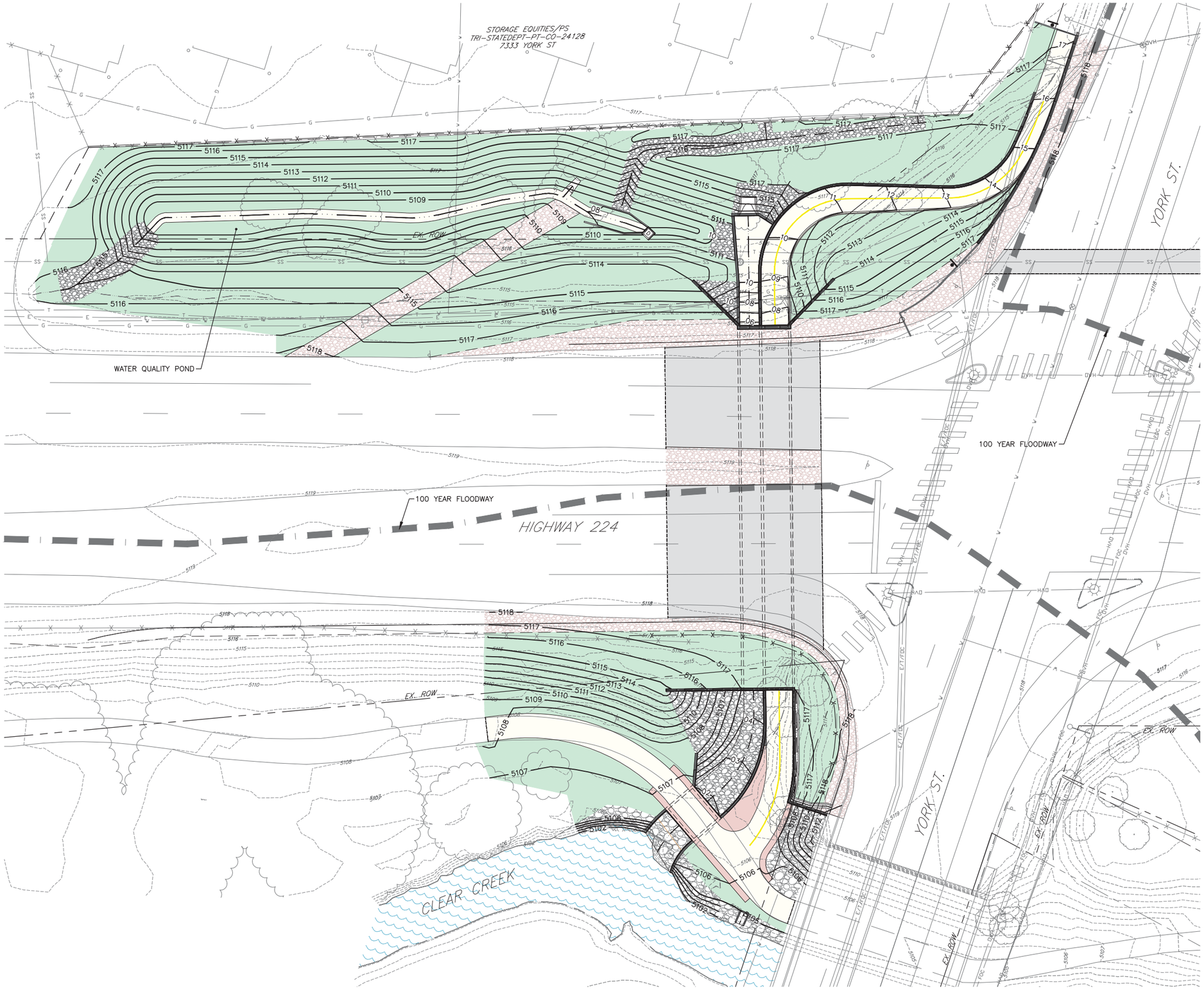

WATER QUALITY POND

TARGET W.Q.C.V.= .136 AC-FT
(FOR YORK ST. NEW IMPERVIOUS AREAS ONLY)

W.Q.C.V. PROVIDED= .136 AC-FT

20 10 0 20 40
SCALE IN FEET

Know what's below. Call before you dig.

PREPARED BY:

DBC Drexel, Barrell & Co.

Drexel, Barrell & Co.
Engineers • Surveyors
1800 38TH STREET
BOULDER, COLORADO 80301
CONTACT: PAUL D. MOREAU, P.E.
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COLORADO SPRINGS
GREELEY

OWNER/CLIENT:

ADAMS COUNTY COLORADO

4430 SOUTH ADAMS COUNTY PARKWAY
BRIGHTON, CO 80601
(720) 523-6895
ANNA SPARKS, P.E., C.F.M.

CONSTRUCTION PLANS FOR:

SH 224 & YORK STREET PEDESTRIAN & DRAINAGE UNDERPASS

ADAMS COUNTY, COLORADO

ISSUE	DATE
PRELIMINARY SET	11/30/16
PROGRESS SET	1/8/18

DESIGNED BY:	PDM
DRAWN BY:	GSG
CHECKED BY:	TDM
FILE NAME:	20805-01_GP01

ORIGINAL DRAWING SCALE:
HORIZONTAL: 1"=20'
VERTICAL: N/A

GRADING PLAN

PROJECT:20805-01BLTR

DRAWING NO.

GP01

SHEET: 13 OF 29

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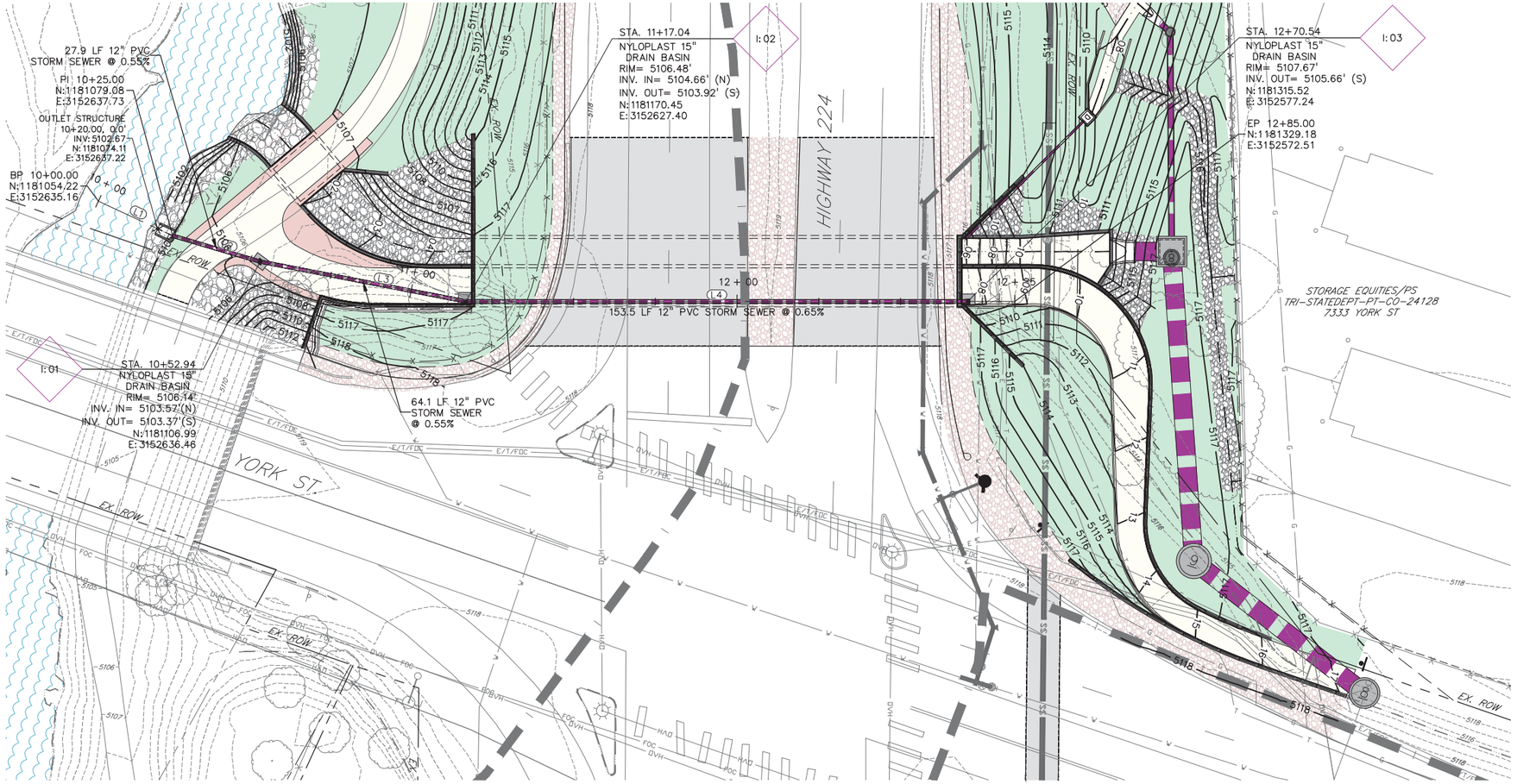
27.9 LF 12" PVC
STORM SEWER @ 0.55%
PI 10+25.00
N:1181079.08
E:3152637.73
OUTLET STRUCTURE
10+20.00, Q0'
INV: 5102.67
N:1181074.11
E:3152637.22
BP 10+00.00
N:1181054.22
E:3152635.16
STA. 11+17.04
NYLOPLAST 15"
DRAIN BASIN
RIM= 5106.48'
INV. IN= 5104.66' (N)
INV. OUT= 5103.92' (S)
N:1181170.45
E:3152627.40
STA. 12+70.54
NYLOPLAST 15"
DRAIN BASIN
RIM= 5107.67'
INV. OUT= 5105.66' (S)
N:1181315.52
E:3152577.24
EP 12+85.00
N:1181329.18
E:3152572.51
HIGHWAY 224
153.5 LF 12" PVC STORM SEWER @ 0.65%
64.1 LF 12" PVC
STORM SEWER
@ 0.55%
STA. 10+52.94
NYLOPLAST 15"
DRAIN BASIN
RIM= 5106.14'
INV. IN= 5103.57' (N)
INV. OUT= 5103.37' (S)
N:1181106.99
E:3152636.46
STORAGE EQUITIES/PS
TRI-STATEDEPT-PT-CO-24128
7333 YORK ST
YORK ST.
EX. ROW
EX. ROW
EX. ROW
EX. ROW
I: 01
I: 02
I: 03
L1
L2
L3
L4
L5
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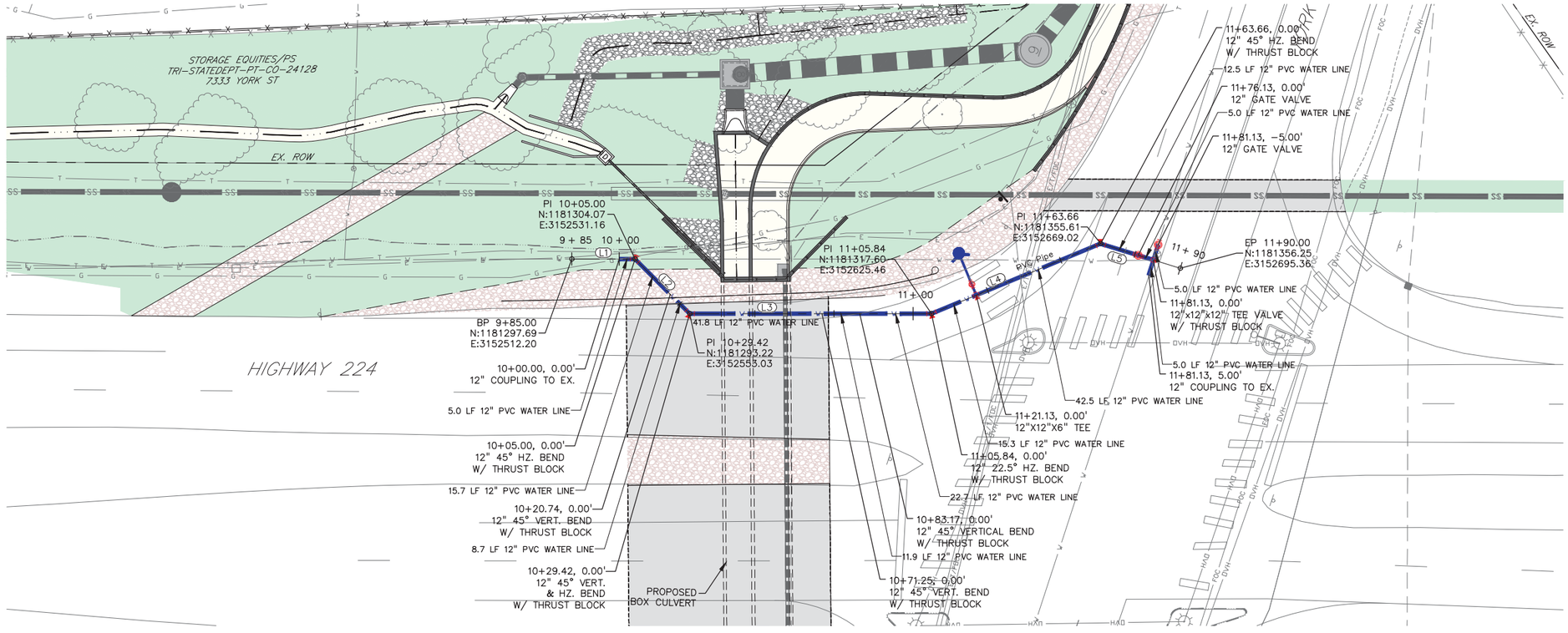

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L4	57.81		N48°53'39"E
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20 10 0 20 40

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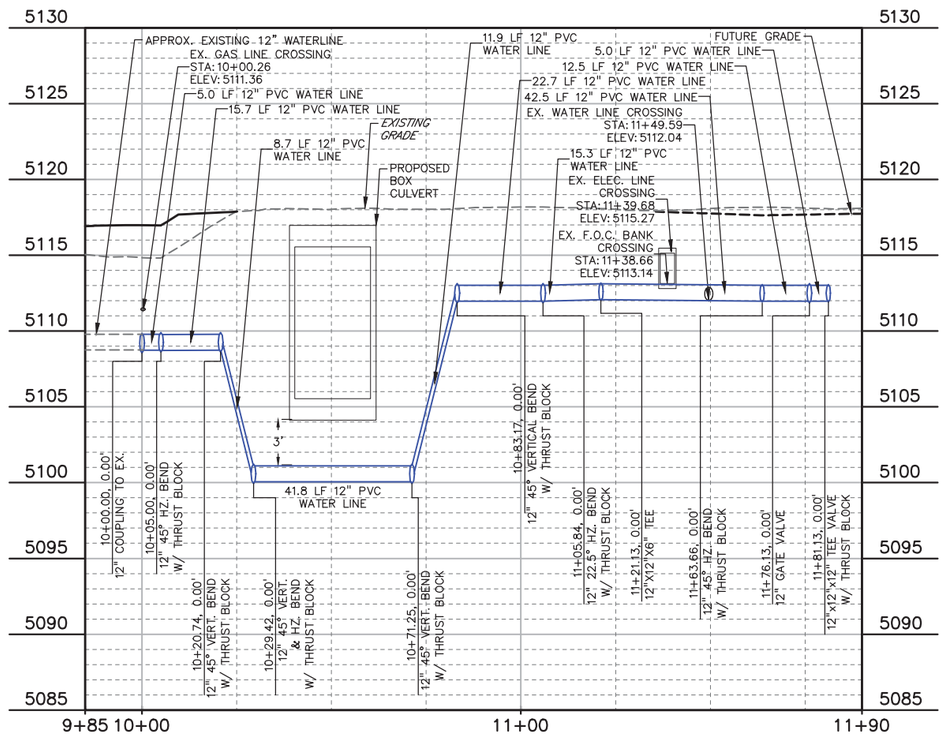

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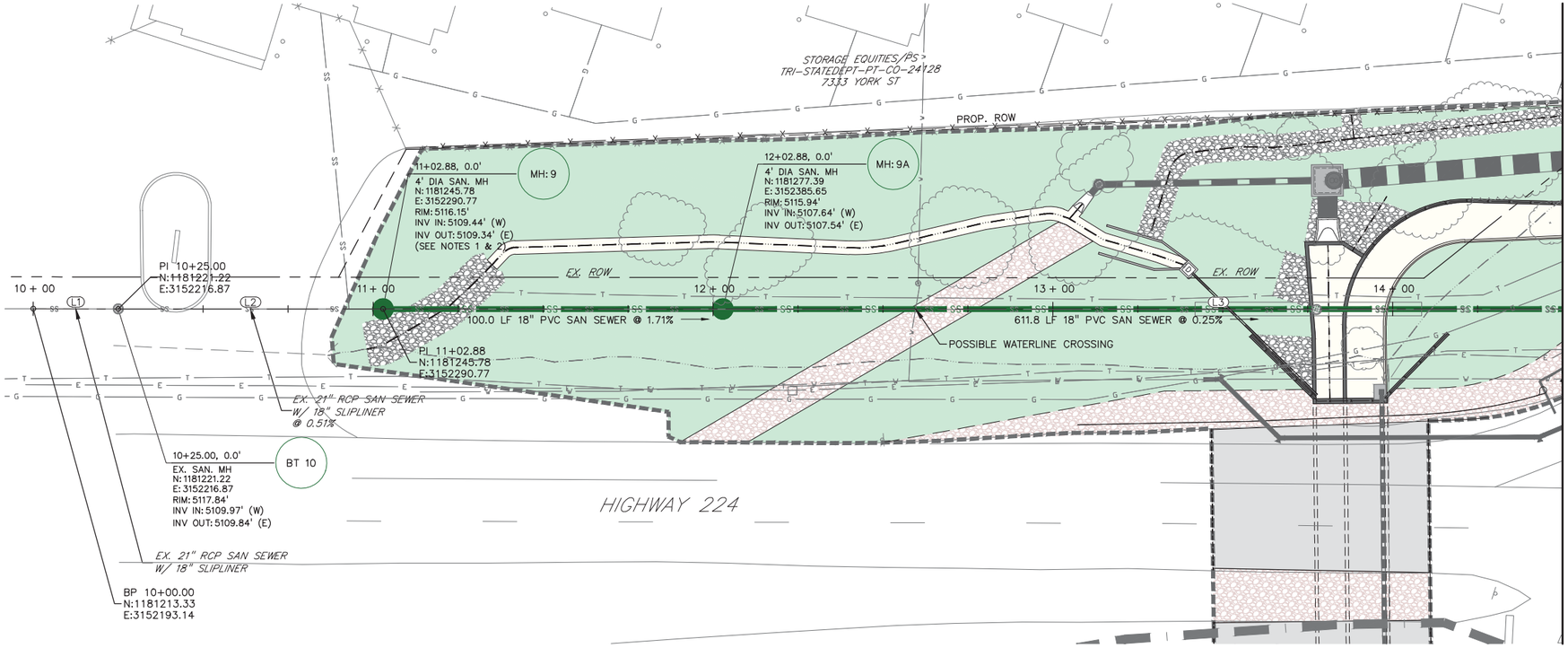

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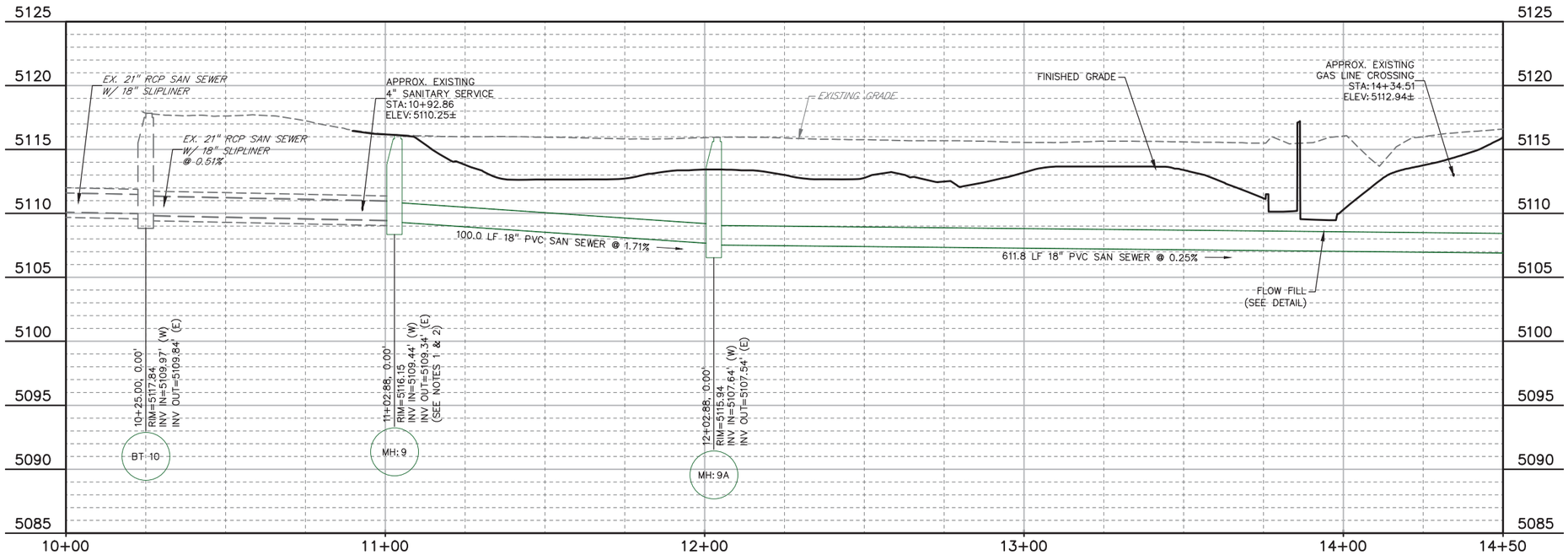

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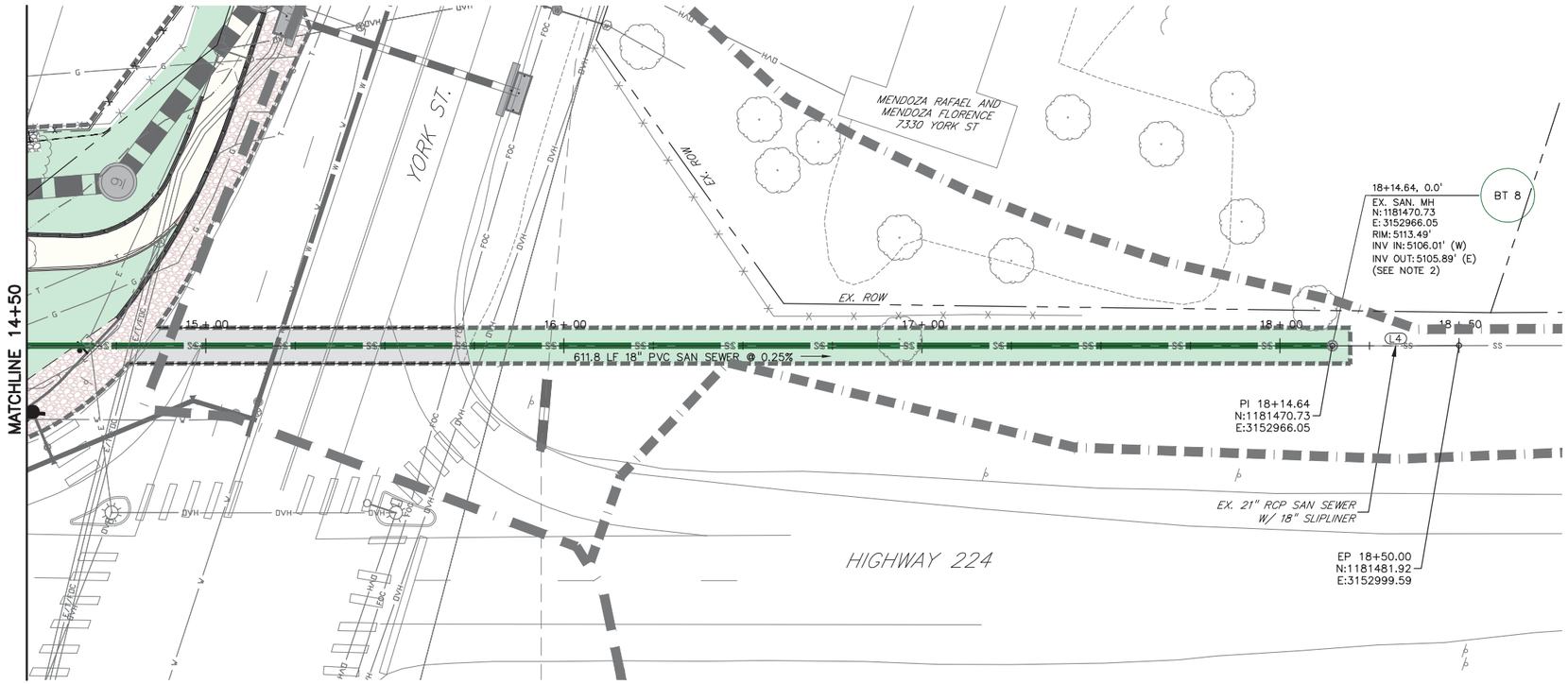

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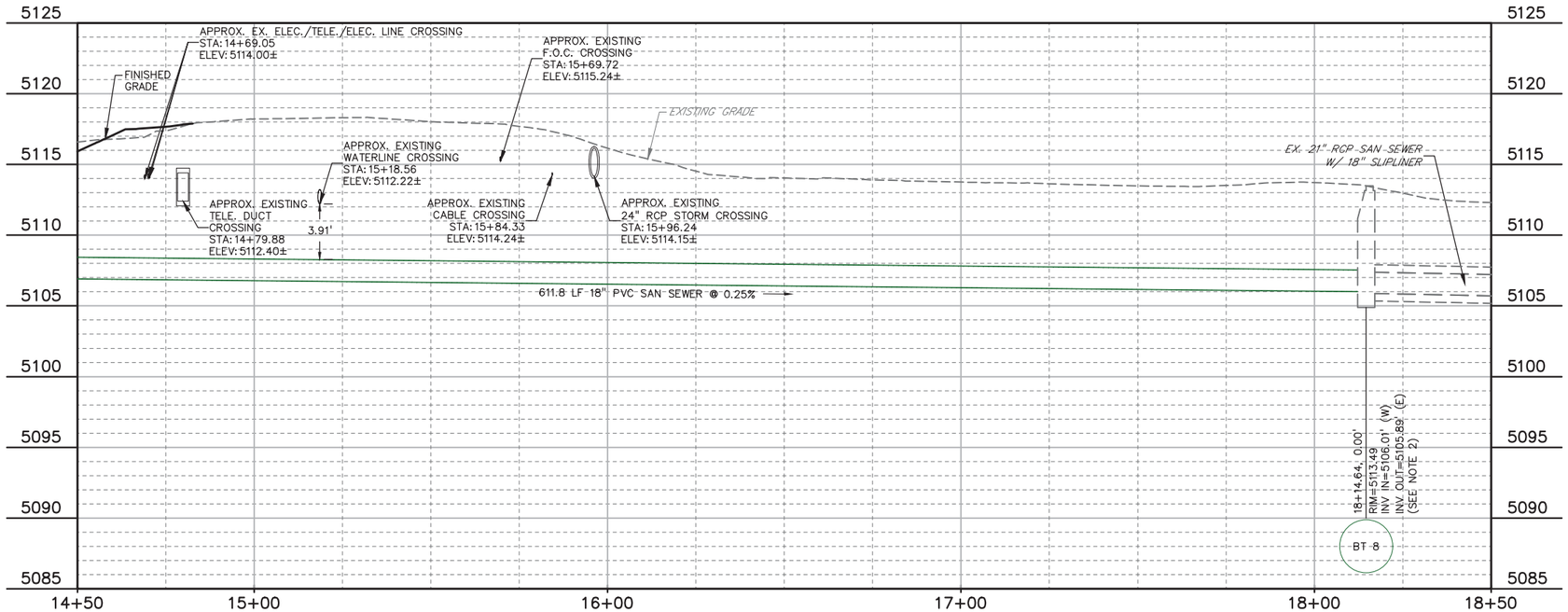

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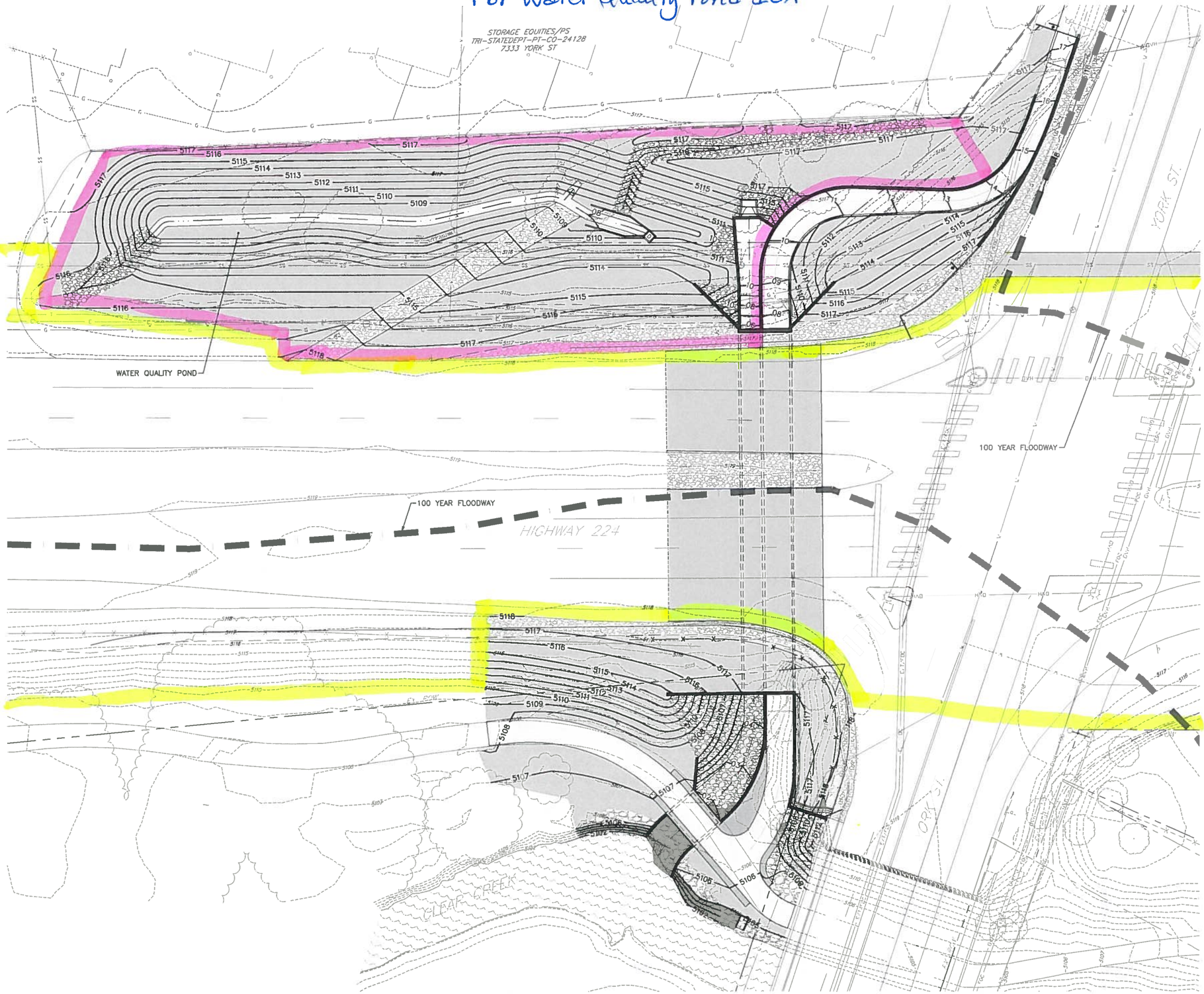
For Water Quality Pond IGA



= Adams County Water Quality Pond - Maintenance by Adams County

= CDOT SH-224 Maintenance by CDOT except where disturbed by Adams County

EXHIBIT 1

WATER QUALITY POND

TARGET W.Q.C.V.= .136 AC-FT
(FOR YORK ST. NEW IMPERVIOUS AREAS ONLY)

W.Q.C.V. PROVIDED= .136 AC-FT

20 10 0 20 40
SCALE IN FEET

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GRADING PLAN

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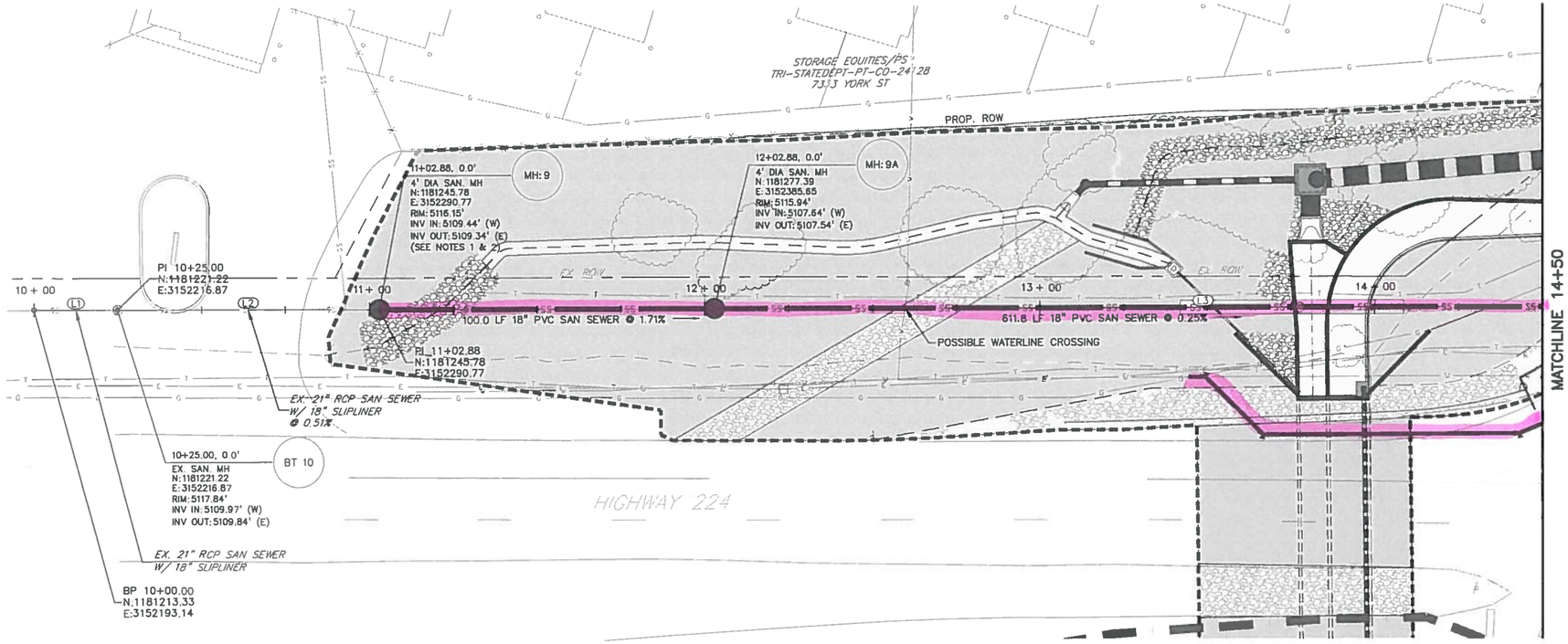

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L4	35.36		N71°33'13"E

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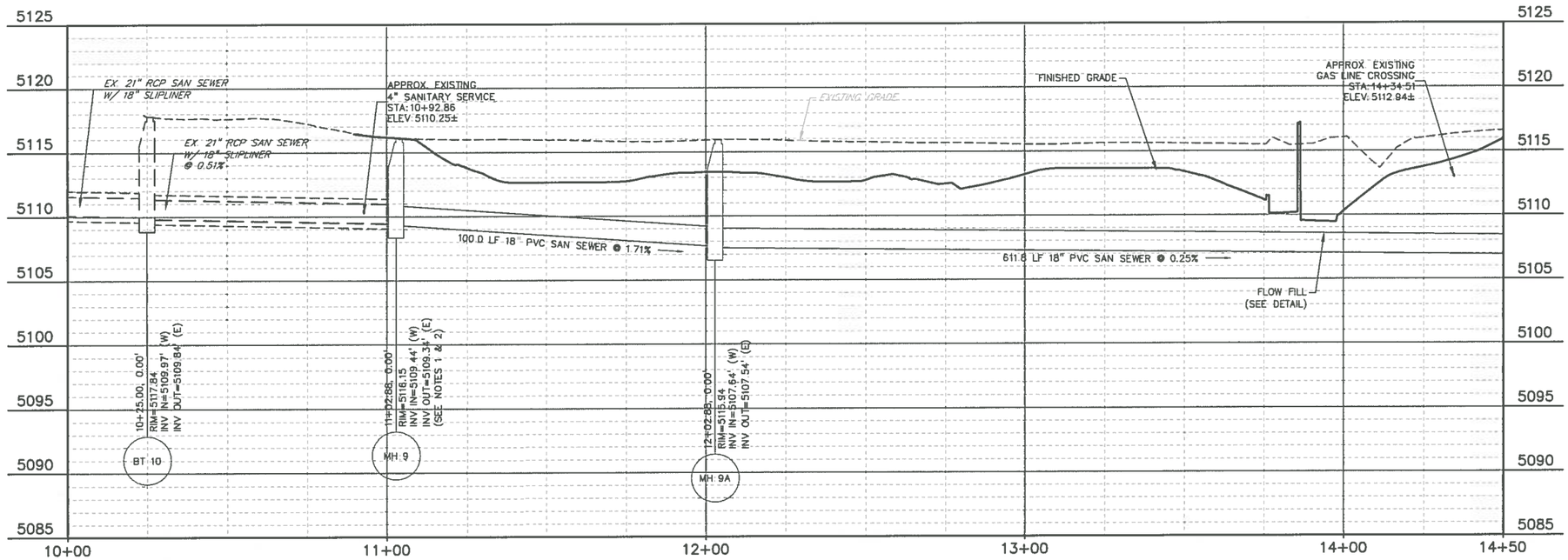
SCALE IN FEET

= Adams County project relocation of utility lines

EXHIBIT 2



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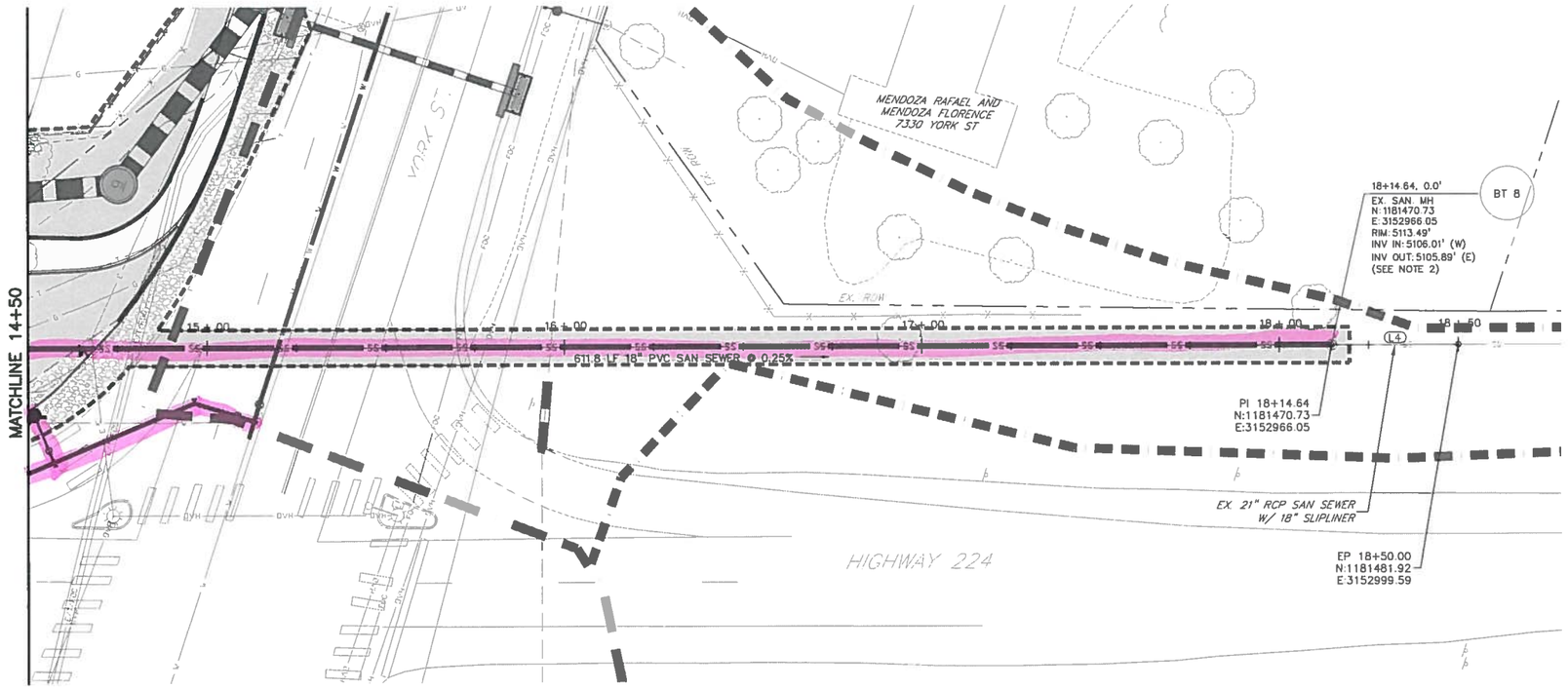

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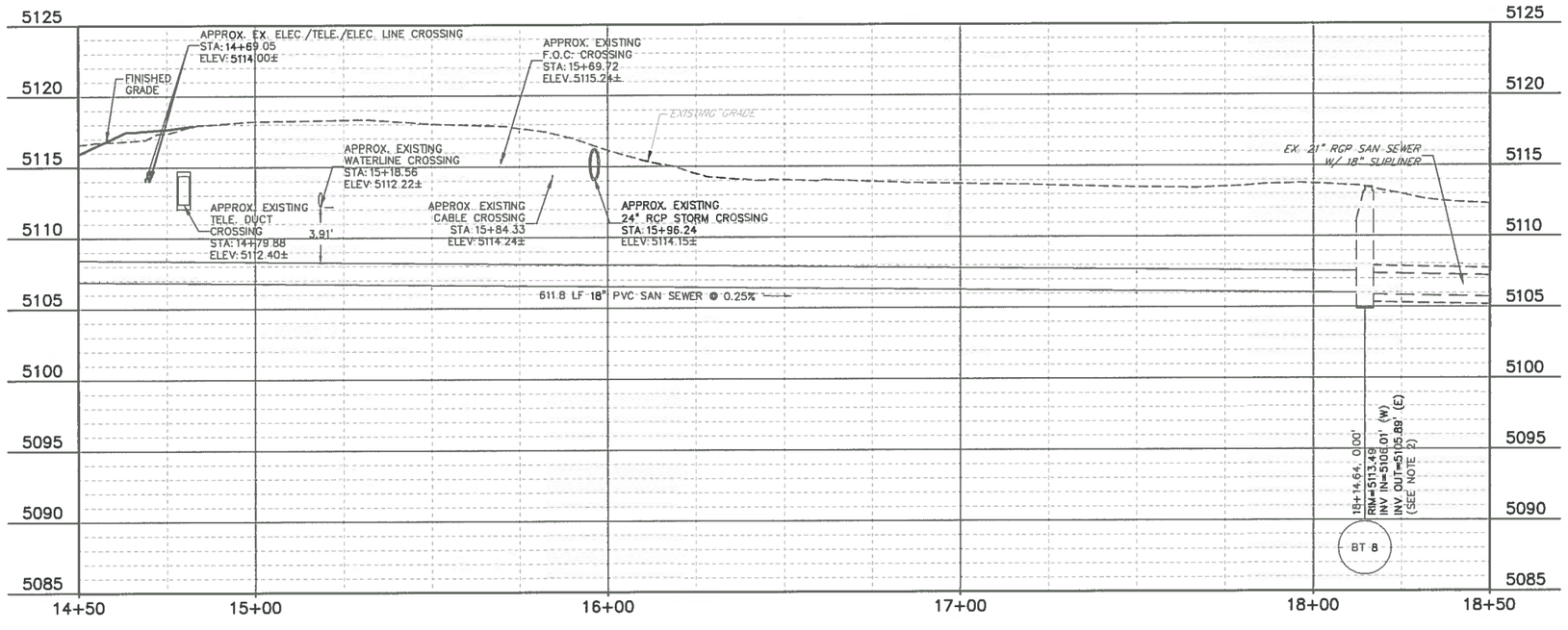
SCALE IN FEET

= Adams Co. project relocation of utility lines

EXHIBIT 3



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Drainage Report
For
York Street Improvements
Adams County, Colorado

July 12, 2016
Revised January 22, 2018
Revised November 20, 2018
Revised December 20, 2018
Revised February 14, 2019

Prepared for:

Adams County, Colorado
4430 South Adams County
Brighton, CO
Contact: René Valdez
(720) 523-6961

Prepared by:

Drexel Barrell & Co.
1800 38th Street
Boulder, Colorado 80301
Contact: Steve Leslie, P.E., C.F.M.
(303) 442-4338

Project Number: 20805-00BLTR

ENGINEER'S CERTIFICATION OF DRAINAGE REPORT:

This statement must be included and signed in all preliminary and final drainage reports by the engineer who prepared or supervised the design.

"I hereby certify that this report (plan) for the final drainage design of the York Street Improvements was prepared by me (or reviewed by me) in accordance with the provisions of Adams County Storm Drainage Design and Technical Criteria for the owners thereof. I understand that Adams County does not and will not assume liability for the facilities designed by others"

For, and on Behalf of, Drexel, Barrell & Co.

Steve Leslie, Colorado P.E. #26096

Final Storm Water Report
York Street Improvements
Adams County, Colorado

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EXISTING STORM SEWER SYSTEMS ..... APPENDIX C
HYDROLOGY CALCULATIONS ..... APPENDIX D
STREET, INLET & PIPE HYDRAULIC CALCULATIONS ..... APPENDIX E
OPEN CHANNEL & BOX CULVERT CALCULATIONS ..... APPENDIX F
WATER QUALITY POND CALCULATIONS ..... APPENDIX G
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DRAINAGE PLANS ..... APPENDIX I
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1.0 INTRODUCTION

This report is prepared in accordance with Adams County Storm Drainage Design and Technical Criteria and is required as part of the proposed York Street Improvements.

York Street Improvements is a roadway improvement project along the York Street corridor within the jurisdiction of Adams County (ADCO). The project will widen York Street from 78th Ave to Highway 224 from two lanes to a 2 lane corridor (2 lanes each direction plus a center shared turn lane), providing curb and gutter, drainage improvements, and sidewalk. This report also includes the Pedestrian and Drainage Culvert Improvements under SH224.

This drainage report, prepared by Drexel Barrell & Co. for the ADCO Public Works Department, summarizes the storm drainage analysis and the recommended storm drainage improvements associated with this roadway improvement project.

2.0 PROJECT LOCATION

The York Street Improvements project is located in Adams County between 78th Ave and Highway 224. The Box Culvert is located below Highway 224, immediately west of SH224. The project location is identified on the Vicinity Map located in Appendix A.

3.0 STORM DRAINAGE DESIGN CRITERIA & METHODOLGIES

This drainage report and the proposed drainage improvements have been completed in accordance with the *Adams County Development Standards & Regulations Manual (2017).*

The design storm return period is 5-yr for the minor storm and 100-yr for the major storm. Storm sewer inlets and piped systems were designed to carry the 5-year storm event.

York Street was classified as an "arterial" street classification. No curb overtopping and two-10-foot travel lanes free of water was used in the 5-year design.

The rational method and Hydraflow computer software program was utilized for hydrological calculations. HY-8, Hydraflow, UDInlet and Flowmaster computer software programs were utilized for the hydraulic, street drainage, inlet sizing, and pipe design calculations.

Storm drainage improvements within the SH224 right-of-way have been completed in accordance with the Drainage Design Manual, Colorado Department of Transportation, 2004.

4.0 PREVIOUS DRAINAGE STUDIES

The project area is located within the planning area of the completed storm drainage master plan study identified below.

A. *Outfall Systems Planning of the Western Hills Area Study (OSP), December 1992* (WRC 1992). This is the most recent Master Plan for the project corridor. Pertinent information from this Master Plan is included in the Appendices C and F. The project corridor is included in OSP Basins 78 and 82 with OSP outfall locations 378 and 382 respectively.

B. Welby Business Park

a. Phase II Site Planset – Civil & Survey, Sorenson Engineering, Inc., 1/19/18.

b. Drainage Report (unavailable for review)

5.0 EXISTING STORM DRAINAGE CONDITIONS

The existing land use tributary to the project area consists of a mixture of residential (Single Family and Multi-Unit attached), commercial and undeveloped land use (Historic). Developed properties that release drainage per Adams County Storm Sewer Criteria, at a historic rate, were deemed historic land use.

NRCS hydrological soil groups within the project area are Type C. Hydrological soil group mapping is included in Appendix B.

The project corridor is located north of Clear Creek. Existing drainage sheet flows or releases to drainage ditches adjacent to each side of York St. Drainage is conveyed via open channel flow and culverts south, ultimately discharging to Clear Creek. Drainage is ultimately conveyed to Clear Creek via two pipes, a 36" storm pipe on the West side of York St. and a 24" pipe on the East side of York St. The capacity of the 36" pipe is approximately 51 cfs and the capacity of the 24" pipe is approximately 27 cfs (see Appendix C for calculations). Additional flows will pond until SH224 is overtopped or flows are conveyed east along the north side of SH224.

The OSP identifies 100-year flows (proposed development with existing drainage facilities) along the York Street, within the project corridor, of 199 cfs and 278 cfs at design points 382 and 378 respectively. The existing road cross section located 100 ft north of 74th Ave can adequately convey approximately 350 cfs (See Appendix C).

6.0 PROPOSED STORM DRAINAGE CONDITIONS

A. Hydrology

1. York Street:

Local storm drainage basins, tributary to the project corridor under proposed conditions, were delineated and are shown in the Drainage Plan on Sheets DR01, DR02 and DR03 located in Appendix I. Hydrologic analysis of these catchments was completed using the Rational Method for the 5-year and 100-year storm events in accordance with ADCO drainage criteria. Basin delineations, areas, runoff coefficients and 5- and 100-year flow rates are shown on Drawings DR01, DR02 and DR03 as well as Table 1. Complete calculations are included in Appendix D. Table 1, shown below, is a summary of the flow for each basin.

Table 1- Discharge Summary, Proposed Conditions, Basin A

Basin and Discharge Summary							
Basin ID	5-Yr Design Point	100-Yr Design Point	Runoff Coefficient		Direct Discharge (cfs)		Comment
			C_5	C_{100}	5-Yr	100-Yr	
A1A	I:21		0.82	0.89	0.2	0.3	Type 13 Combo-On Grade
A1	I:20	W1	0.41	0.64	10.0	30.0	5' Type R-On Grade
A2	I:18	W2	0.50	0.70	6.2	16.4	5' Type R-On Grade
A3	I:19	E1	0.82	0.89	2.6	5.4	5' Type R-On Grade
A4	I:17		0.32	0.60	6.5	22.9	5' Type R-On Grade
A5	I:16	E2	0.82	0.89	1.9	3.9	5' Type R-On Grade
A6	EX:4		0.17	0.51	5.9	33.9	Future Detention pond

Basin and Discharge Summary							
Basin ID	5-Yr Design Point	100-Yr Design Point	Runoff Coefficient		Direct Discharge (cfs)		Comment
			C_5	C_{100}	5-Yr	100-Yr	
A7	I:15	W3	0.73	0.83	3.0	6.5	5' Type R-On Grade
A8	ES:4		0.18	0.52	1.7	9.3	18 Inch RCES
A9	I:13	W4	0.60	0.75	1.7	4.2	5' Type R-On Grade
A10	I:14	E3	0.82	0.89	2.9	5.9	5' Type R-On Grade
A11	I:12		0.82	0.89	2.2	4.6	Type 13 Combo-Sump
A12	EX:3		0.16	0.51	0.8	5.1	Existing Structure
A13	I:10	W5	0.82	0.89	2.1	4.3	5' Type R-On Grade
A14	I:11	E4	0.82	0.89	1.5	3.0	5' Type R-On Grade
A15	EX:2		0.16	0.51	0.6	3.5	Existing Structure
A16	I:9	W6	0.82	0.89	0.8	1.7	5' Type R-On Grade
A17	I:8		0.63	0.78	7.3	17.2	Quad Type 16 Valley- Sump
A18	EX:1		0.16	0.51	0.5	3.1	Existing Detention Pond
A19	ES:3		0.77	0.86	8.1	17.1	18 Inch RCES
A20	I:6	W7	0.82	0.89	1.1	2.3	10' Type R-On Grade
A21	I:7	E5	0.82	0.89	1.7	3.5	5' Type R-On Grade
A22	I:5		0.81	0.88	28.4	59.1	Type C (Triple)-Sump
A23	I:4		0.82	0.89	0.8	1.6	5' Type R-On Grade
A24	I:1	W8	0.67	0.80	3.7	8.4	10' Type R-Sump

Basin and Discharge Summary							
Basin ID	5-Yr Design Point	100-Yr Design Point	Runoff Coefficient		Direct Discharge (cfs)		Comment
			C_5	C_{100}	5-Yr	100-Yr	
A25	I:2	E6	0.82	0.89	3.1	6.5	10' Type R-Sump
A26	W9	W9	0.45	0.67	7.1	20.5	Open Channel

Discharge Summary, Proposed Conditions, Basin B

Basin and Discharge Summary							
Basin ID	5-Yr Design Point	100-Yr Design Point	Runoff Coefficient		Direct Discharge (cfs)		Comment
			C_5	C_{100}	5-Yr	100-Yr	
B1	ES:0	ES:0	0.16	0.51	0.04	0.2	24" RCES

2. <u>Discharge to SH224</u>:

The Western Hills OSP identified drainage master plan improvements tributary to York Street and immediately west of York Street which included: a) the "East 76th Regional Detention Facility" (Outfall System WH-10); b) the "Race Street Channel" (Outfall System WH-7); c) the "York St/SH224 Channel" (Outfall System WH-13); and d) the Lafayette St/SH224 Channel" (Outfall System WH-12) which all discharged to proposed enlarged culverts under SH224, located approximately ¼ mile west of York Street (Race Street Culverts).

Based on discussions with County staff, implementation of the OSP recommended drainage improvements west of York Street, including the Race Street Culverts and the York St/SH224 Channel, is outside the scope of the current York Street project and there are no near term plans to construct the OSP improvements.

The proposed pedestrian underpass, to be installed as part of the York Street project, provided a convenient and cost effective opportunity to outfall storm drainage flows in York Street, under SH224 with discharge to Clear Creek.

Routing drainage through a separate storm sewer culvert under SH224 was investigated but not pursued for final design for the following reasons:

a) A combined pedestrian underpass drainage culvert was more cost effective than constructing a separate storm sewer outfall(s) under SH224.
b) Construction of a single combined pedestrian underpass/drainage culvert would be quicker to construct, with less impact to SH224 traffic than two (or three) separate culverts with separate trenching operations.
c) A combined pedestrian underpass/drainage culvert enhanced pedestrian comfort in the underpass due to the increased open area through the box.
d) A combined pedestrian underpass/drainage culvert allowed for cost effective conveyance of 100-year discharge under SH224. Separate drainage culverts would have to be either sized for the 100-year discharges, or sized for a smaller storm event inundation of the pedestrian underpass during larger events.

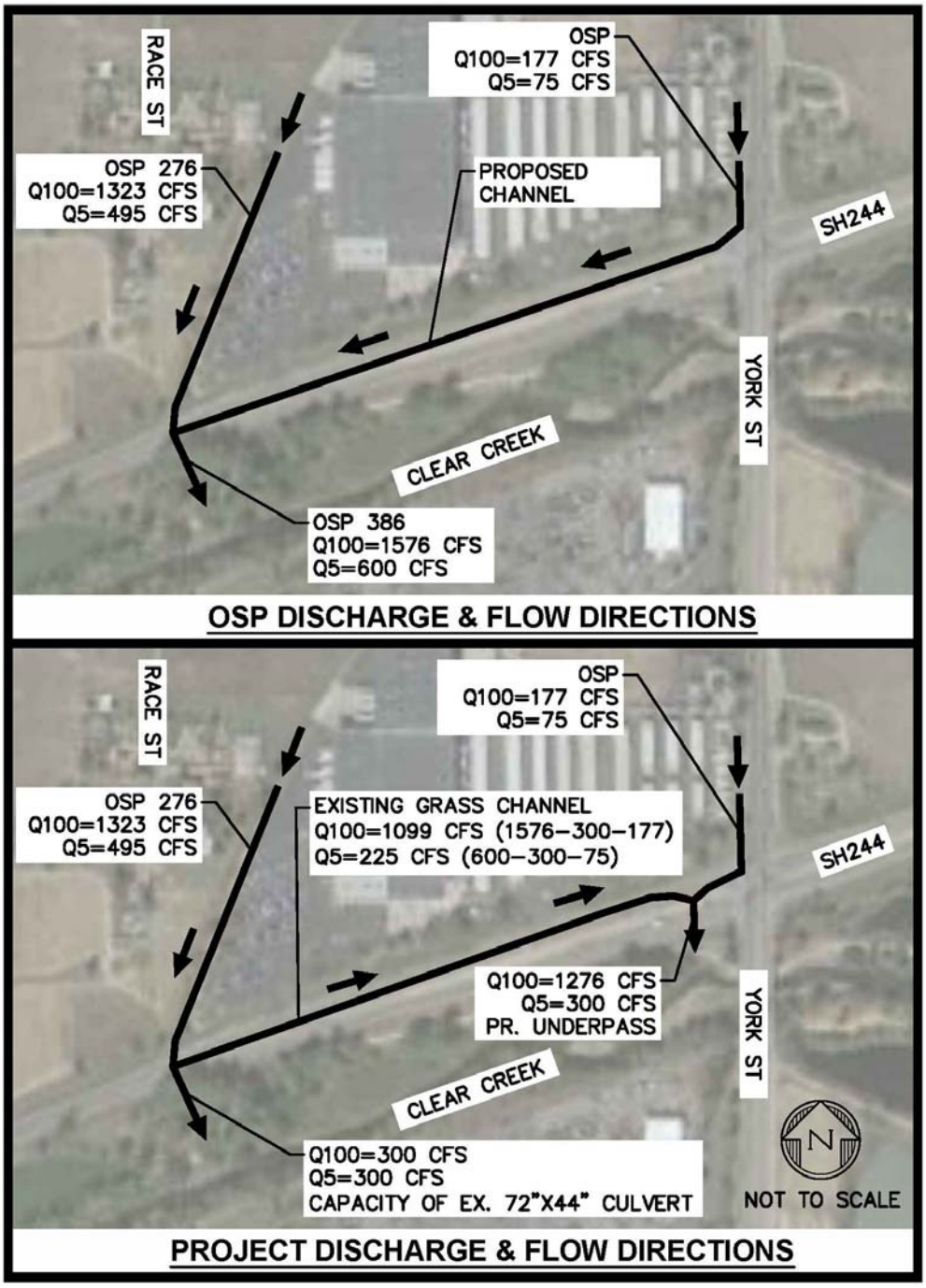
The drainage components of the pedestrian underpass were sized for runoff in York Street as well as offsite runoff originating west of York Street, which under existing conditions, flows east along the north side of SH224.

Because the OSP recommended Regional Detention Facility will not be constructed in the near future, it was assumed the peak flows identified in the OSP Table 5 for "Proposed Development, Existing Drainage Facilities" hydrologic conditions were the appropriate values for the discharge to the Race Street Culverts. OSP Table 5 identifies the 5- and 100-year discharge to the Race Street Culverts as 600 cfs & 1,576 cfs respectively. Because the proposed OSP Race Street Culvert enlargements will not be constructed in the near future, we assumed a flow split will occur at the upstream end of the existing Race Street Culverts. The portion flowing through the existing Race Street Culverts (2 each at 72"x44" CMPA) will be limited to the capacity of the existing culverts, which was estimated to be 300 cfs. The remaining portion will flow east along the north side of SH224, to the proposed SH224 underpass at York Street. The estimated 5-year discharge to the proposed SH224 underpass at York Street SH224 is estimated to

be 300 cfs (600-300 cfs) and the 100-year discharge is estimated to be 1,276 cfs (1576-300 cfs).

A schematic of the OSP and project discharges and flow directions is shown in Figure 1. Select figures from the OSP and existing culvert capacity calculations are included in Appendices C and F.

Figure 1 – OSP & Project Discharges and Flow Directions



B. Proposed Transportation Improvements

York St. will be widened to 5 lanes (2 lanes each direction plus a center shared turn lane) with curb, gutter, median, and detached sidewalk. Existing storm drainage and irrigation facilities will be incorporated in the design. For detailed plans of the proposed roadway and storm sewer improvements reference the *York Street Improvements* construction drawings. Select drawings from this construction drawing set are included in Appendix J.

The project also includes a pedestrian underpass under SH224 located immediately west of the York Street which will connect the York Street sidewalks with an existing trail along the north side of Clear Creek. The underpass will also convey storm drainage from York Street and the north side of SH224, under SH224 and outfall to the north bank of Clear Creek. For detailed plans of the proposed underpass improvements reference the *SH 224 & York Street, Pedestrian & Drainage Underpass* construction drawings. Select drawings from this construction drawing set are included in Appendix J.

C. Drainage Improvements

1. York Street between 78th and SH224:

Along York Street, between 78th and SH224, a series of street inlets and area inlets, located behind the west sidewalk, will intercept the 5-year storm and convey it south in a new piped storm sewer system beneath the northbound lane. The piped storm sewer system varies in size from 18" to 38"x68". The north end of the system was configured and sized to accept a future pipe connection, if the 78th Avenue and York Street intersection is improved in the future. Provisions were made to accept pipe discharges from the Welby Business Park at a manhole located mid block between 76th Avenue and 74th Place. The south end of the sewer system discharges to an open channel and water quality pond located northwest corner of the York Street & SH224 intersection & immediately upstream of the proposed pedestrian underpass/drainage culvert under SH224. The 5-yr discharge from the York Street piped storm sewer system is 73 cfs. Hydraflow hydraulic calculations for the storm inlets on grade and the piped storm sewer system are included in Appendix E. UDInlet hydraulic calculations for

the storm inlets in a sump condition are included in Appendix E. The water quality pond is discussed in more detail below.

2. Open Channel between Storm Sewer and SH224 Underpass:

A short section of open channel will convey storm drainage day lighting from the York Street storm sewer to a proposed 10'x20' RCBC underpass under SH224. The short section of open channel will also collect existing offsite flows from the west, which is conveyed along the north side of SH224 in an existing grass swale. The design 5- and 100-year discharge in this section of open channel is 300 cfs and 1,276 cfs respectively. Flowmaster hydraulic calculations of the open channel are included in Appendix F.

3. SH224 Underpass at York Street:

The design 5- and 100-year discharge through the underpass is 300 cfs and 1,276 cfs respectively.

The underpass will be constructed using a 10'h x 20'w box culvert. The box will be divided into two compartments with a partial height concrete divider wall. Drainage will typically be conveyed in the west compartment and the pedestrian trail will be located in the east compartment. The height of the divider wall was set to keep the pedestrian trail dry up to the 5-year storm event. Flow in excess of the 5-year event will over top the divider wall and be conveyed by both compartments. The 5-year level of protection was selected based on discussions with Adams County and the cost and complexity of keeping the trail dry during a larger storm event.

The west side of the underpass culvert was selected to convey drainage, because the tributary flows from the west were greater than from the east side. Routing all flows to east side of the underpass was problematic due to geometric site constraints.

During design development an alternate was evaluated with two separate (or three) culverts, one for the trail and a second (or third) for drainage. This alternate was no was not pursued for final design for the following reasons.

a) Two culverts would have been more expensive that a single culvert.

b) Construction duration and disruption to traffic would have been greater for separate culverts.

c) A smaller pedestrian only culvert, would be less spacious and use friendly than a combined culvert.

d) It would have been geometrically challenging and expensive to completely separate drainage from trail use due to incoming flows from both the west and north.

e) If the separate drainage culvert(s) were sized for the 5-yr event, a combined pedestrian/drainage culvert would still be required to convey the 100-yr event.

f) If the separate drainage culvert(s) were sized for the 100-yr event, the need for a combined pedestrian/drainage culvert would be eliminated, however the design complexity and costs would increase significantly.

HY-8 hydraulic calculations of the box culvert underpass are included in Appendix F.

5-year runoff leaving the underpass will flow through a short section of open channel, then flow under the Clear Creek trail in a 3'h x 16'w box culvert and then discharge to Clear Creek. 100-year runoff leaving the underpass will overtop the trail and discharge to Clear Creek.

4. York Street, 100-year Conveyance:

The 100-year storm event will be conveyed south along York Street as a combination of pipe flow and as overland flow along the York Street cross section without overtopping onto private property. The 100-year discharge at the south end of York Street is approximately 144 cfs (Design Points W8 + E6). The full flow capacity of the storm sewer at this location is approximately 87 cfs. York Street roadway corridor has a capacity of approximately 86 cfs calculated by cross sectional analysis. A summation of the flow capacity of York Street's storm sewer (87 cfs) plus York Street's roadway corridor capacity (86 cfs) equals a total capacity of 173 cfs, which is greater than the required 100-year flow rate of 144 cfs.

The vertical profile of the York Street roadway is in a sump condition just north of the intersection with SH224. 100-year flows, in excess of the capacity of the piped storm sewer system will pond in York Street at the location of the sump. Once the depth of ponded water in the sump area reaches the level of the top back of sidewalk, water will flow over the sidewalk in two directions.

The easterly flow path was designed to direct flows to an existing 24" culvert, which flows under SH224, immediately east of the York St & SH224 intersection.

The westerly flow path was designed to convey flows down the pedestrian trail and through the proposed SH224 Underpass, located immediately west of the York Street.

7.0 CLEAR CREEK FLOODPLAIN IMPACTS

The effective 100-year and 500-year floodplains and Floodway of Clear Creak inundate the south end of the project corridor as shown on Drainage Plans DR02 and DR03. In accordance with ADCO development regulations, a floodplain development permit will be required for the proposed improvements located within the regulatory floodplain and floodway. The effective floodplain is based on a 2005 Flood Hazard Area Delineation (FHAD).

UDFCD is currently in the process restudying the hydrology and floodplain of Clear Creek. Draft results of the results of the restudy were made available by UDFCD.

Both the effective and restudy floodplains indicate significant flow depths in Clear Creek at York Street, which creates backwater conditions that will inundate the proposed pedestrian underpass and trail approaches during relatively frequent flood events, i.e. less than 10-yr flood event. A comparison of project improvement elevations and Clear Creek water surface elevations for the effective and restudy floodplains are shown in Tables 2A & 2B. Flood warning signage will be installed to warn trail users not to enter the underpass when inundated.

Table 2A – SH224 Underpass & Effective Floodplain Comparison

Improvement Information		Effective Floodplain U/S Face York Street Bridge (FHAD 2005)		
Location	Elevation (ft)	Flood Event	Discharge (cfs)	Water Surface Elevation (ft)
		100-yr	23,100	5118.67
York Street Roadway	5118.0	-	-	-
-	-	25-yr	10,100	5115.99
-	-	10-yr	14,000	5115.39
D/S End Underpass, Top Box	5114.65	-	-	-
-	-	5-yr	8,000	5113.16
-	-	2-yr	5,300	5111.42
D/S End Underpass, Trail	5106.65	-	-	-
D/S End Underpass, Invert	5104.65	-	-	-

Table 2B – SH224 Underpass & Draft FHAD (2017) Floodplain Comparison

Improvement Information		Draft Floodplain U/S Face York Street Bridge (FHAD 2017 - Draft)		
Location	Elevation (ft)	Flood Event	Discharge (cfs)	Water Surface Elevation (ft)
York Street Roadway	5118.0			
		500-yr	22,700	5117.58
		100-yr	14,100	5516.00
D/S End Underpass, Top Box	5114.65	-	-	-
		50-yr	10,400	5113.00
-	-	10-yr	4,900	5111.31
D/S End Underpass, Trail	5106.65	-	-	-
D/S End Underpass, Invert	5104.65	-	-	-

8.0 STORM WATER QUALITY AND EROSION CONTROL MEASURES

Temporary Best Management Practices (BMP) will be implemented during construction activities for the purpose of erosion and sediment control and to minimize negative impacts to storm water quality. Permanent BMP's will included riprap armoring of all culvert entrances and exits and grass channels with steeper longitudinal slopes; and revegetation of all disturbed areas not scheduled for other permanent surface treatments.

Permanent storwmwater quality facilities to be constructed as part of the project include a storm water quality pond at the northwest corner of York St. and SH224 intersection. The water quality capture volume (WQCV) was determined to be 0.136 acre-feet based on the newly created impervious area resulting from the York Street project. Discharge from the water quality pond will occur via a water quality outlet structure and overflow spillway located at east end of the Pond. WQCV, pond sizing, weir/orifice design, and spillway calculations are included in Appendix G.

9.0 CONCLUSION

The proposed York Street and drainage improvements have been designed in accordance with ADCO drainage criteria and Urban Drainage Flood Control District's Storm Drainage Criteria Manuals, Vol. 1, 2 and 3 (USDCM).

5-year runoff, tributary to York Street, will be intercepted and conveyed south in a new piped storm drainage system which will discharge to a new pedestrian underpass/drainage culvert under SH224 which will then discharge to Clear Creek. 100-year runoff, tributary to York Street, will be conveyed south along York Street as a combination of pipe flow and as surface flow along the York Street cross section which will discharge to a new pedestrian underpass/drainage culvert under SH224 which will then discharge to Clear Creek.

The proposed SH224 pedestrian underpass/drainage culvert has been sized to convey 5- and 100-year offsite flows from the west, assuming selected improvements, identified in the Western Hills OSP, will not be constructed in the near future.

Temporary and permanent BMP's will be installed for control erosion and sediment control purposes and a Water Quality Pond will be installed to maintain storm water quality.

The proposed pedestrian underpass/drainage culvert under SH224 will be inundated by backwater from the Clear Creek floodplain during the 2-year and above flood events.

10.0 REFERENCES

[1] "Outfall Systems Planning of the Western Hills Area Study" (OSP), prepared by WCR Engineering Inc., December 1992.

[2] "Construction Plans for: York Street Improvements" (CP), prepared by Drexel Barrell, & Co., 2016.

[3] Adams County Development Standards & Regulations Manual (2005), Adams County.

[4] "Urban Storm Drainage Criteria Manual, Volume 1" prepared by the Urban Drainage and Flood Control District, revised April 2008.

[5] "Urban Storm Drainage Criteria Manual, Volume 2" prepared by the Urban Drainage and Flood Control District, revised April 2008.

[6] "Urban Storm Drainage Criteria Manual, Volume 3-Best Management Practices" prepared by the Urban Drainage and Flood Control District, latest edition.

[7] "Geotechnical Engineering Pavement Thickness Design Report York Street Improvements" prepared by Terracon, dated August 14, 2015.

[8] "Flood Hazard Area Delineation, Clear Creek (Adams County)", prepared by Ayres Associates, December 2005.

[9] "Flood Hazard Area Delineation, Clear Creek (Adams County)", ICON Engineering, Inc, August 2017 - Draft.

[10] FIRM 08001C0604H, FEMA, revised 3/5/2007.

[11] FIS, Adams County, Colorado and Incorporated Areas, FEMA revised 3/5/2007.

APPENDIX A

VICINITY MAP

VICINITY MAP

NOT TO SCALE

YORK STREET IMPROVEMENTS

EAST □8TH AVE TO HI□H□ AY 224
ADAMS COUNTY, COLORADO

Drexel, Barrell & Co.
Engineers • Surveyors

DATE: MAY 2016

JOB NO: 20805-00

DWG. NO. VM

SHEET 1 OF 1

APPENDIX G

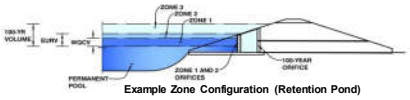
WATER QUALITY POND CALCULATIONS

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

UD-Detention, Version 3.07 (February 2017)

Project: York Street

Basin ID:



Example Zone Configuration (Retention Pond)

Required Volume Calculation

Selected BMP Type =	EDB		
Watershed Area =	3.27	acres	Note: L / W Ratio > 8
Watershed Length =	4,600	ft	L / W Ratio = 148.6
Watershed Slope =	0.010	ft/ft	
Watershed Imperviousness =	100.00%	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	
Desired WQCV Drain Time =	40.0	hours	
Location for 1-hr Rainfall Depths =	Commerce City - Civic Center		
Water Quality Capture Volume (WQCV) =	0.136	acre-feet	Optional User Override 1-hr Precipitation
Excess Urban Runoff Volume (EURV) =	0.327	acre-feet	
2-yr Runoff Volume (P1 = 1 in.) =	0.268	acre-feet	1.00 inches
5-yr Runoff Volume (P1 = 1.42 in.) =	0.395	acre-feet	1.42 inches
10-yr Runoff Volume (P1 = 1.68 in.) =	0.467	acre-feet	1.68 inches
25-yr Runoff Volume (P1 = 1.75 in.) =	0.492	acre-feet	inches
50-yr Runoff Volume (P1 = 2.35 in.) =	0.661	acre-feet	2.35 inches
100-yr Runoff Volume (P1 = 2.71 in.) =	0.771	acre-feet	2.71 inches
500-yr Runoff Volume (P1 = 3.35 in.) =	0.964	acre-feet	inches
Approximate 2-yr Detention Volume =	0.252	acre-feet	
Approximate 5-yr Detention Volume =	0.371	acre-feet	
Approximate 10-yr Detention Volume =	0.439	acre-feet	
Approximate 25-yr Detention Volume =	0.423	acre-feet	
Approximate 50-yr Detention Volume =	0.515	acre-feet	
Approximate 100-yr Detention Volume =	0.541	acre-feet	

Stage-Storage Calculation

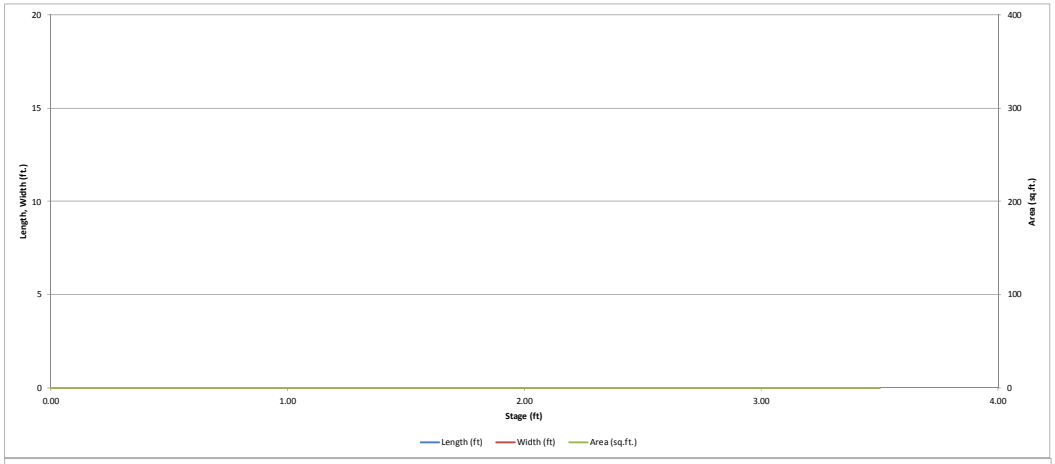
Zone 1 Volume (WQCV) =	0.136	acre-feet	
Select Zone 2 Storage Volume (Optional) =		acre-feet	Total detention volume is less than 100-year volume.
Select Zone 3 Storage Volume (Optional) =		acre-feet	
Total Detention Basin Volume =	0.136	acre-feet	
Initial Surcharge Volume (ISV) =	user	ft^3	
Initial Surcharge Depth (ISD) =	user	ft	
Total Available Detention Depth (H_{total}) =	user	ft	
Depth of Trickle Channel (H_{TC}) =	user	ft	
Slope of Trickle Channel (S_{TC}) =	user	ft/ft	
Slopes of Main Basin Sides (S_{main}) =	user	H:V	
Basin Length-to-Width Ratio ($R_{L/W}$) =	user		
Initial Surcharge Area (A_{ISV}) =	user	ft^2	
Surcharge Volume Length (L_{ISV}) =	user	ft	
Surcharge Volume Width (W_{ISV}) =	user	ft	
Depth of Basin Floor (H_{FLOOR}) =	user	ft	
Length of Basin Floor (L_{FLOOR}) =	user	ft	
Width of Basin Floor (W_{FLOOR}) =	user	ft	
Area of Basin Floor (A_{FLOOR}) =	user	ft^2	
Volume of Basin Floor (V_{FLOOR}) =	user	ft^3	
Depth of Main Basin (H_{MAIN}) =	user	ft	
Length of Main Basin (L_{MAIN}) =	user	ft	
Width of Main Basin (W_{MAIN}) =	user	ft	
Area of Main Basin (A_{MAIN}) =	user	ft^2	
Volume of Main Basin (V_{MAIN}) =	user	ft^3	
Calculated Total Basin Volume (V_{total}) =	user	acre-feet	

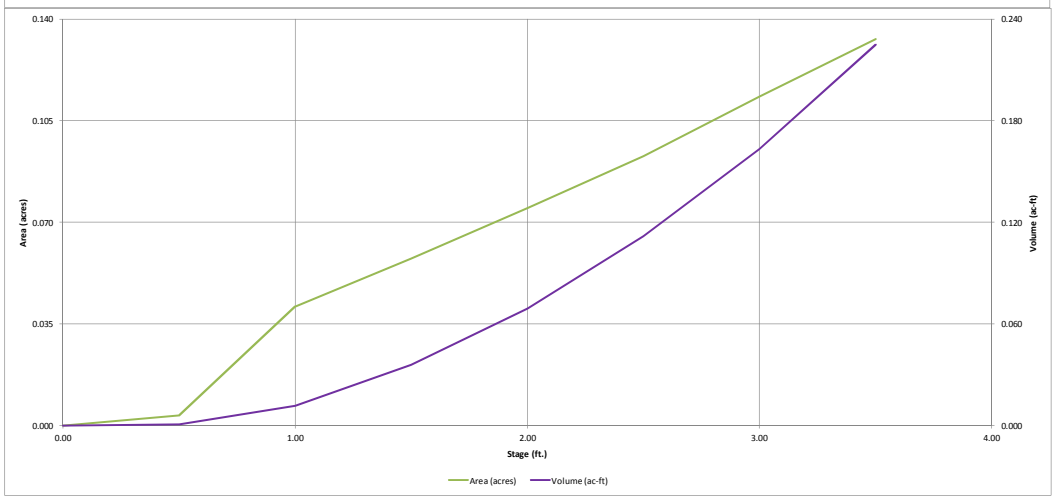
Depth Increment = 0.1 ft

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	--	--	--	0	0.000		
5108	--	0.50	--	--	--	151	0.003	36	0.001
5108.5	--	1.00	--	--	--	1,782	0.041	503	0.012
5109	--	1.50	--	--	--	2,510	0.058	1,569	0.036
5109.5	--	2.00	--	--	--	3,264	0.075	3,005	0.069
5110	--	2.50	--	--	--	4,045	0.093	4,865	0.112
5110.5	--	3.00	--	--	--	4,934	0.113	7,110	0.163
5111	--	3.50	--	--	--	5,798	0.133	9,793	0.225

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

UD-Detention, Version 3.07 (February 2017)



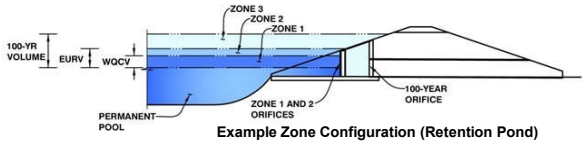


Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)

Project: York Street

Basin ID:



Example Zone Configuration (Retention Pond)

	Stage (ft)	Zone Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	2.76	0.136	Orifice Plate
Zone 2			
Zone 3			
		0.136	Total

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

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

Calculated Parameters for Underdrain

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

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

Invert of Lowest Orifice =	0.50	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Orifice Plate =	3.26	ft (relative to basin bottom at Stage = 0 ft)
Orifice Plate: Orifice Vertical Spacing =	13.00	inches
Orifice Plate: Orifice Area per Row =	0.89	sq. inches (diameter = 1-1/16 inches)

Calculated Parameters for Plate

WQ Orifice Area per Row =	6.181E-03	ft^2
Elliptical Half-Width =	N/A	feet
Elliptical Slot Centroid =	N/A	feet
Elliptical Slot Area =	N/A	ft^2

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

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.50	1.60	2.70					
Orifice Area (sq. inches)	0.89	0.89	0.89					

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

User Input: Vertical Orifice (Circular or Rectangular)

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

Calculated Parameters for Vertical Orifice

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

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

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

Calculated Parameters for Overflow Weir

	Not Selected	Not Selected	
Height of Grate Upper Edge, H_t =			feet
Over Flow Weir Slope Length =			feet
Grate Open Area / 100-yr Orifice Area =			should be ≥ 4
Overflow Grate Open Area w/o Debris =			ft^2
Overflow Grate Open Area w/ Debris =			ft^2

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

	Not Selected	Not Selected	
Depth to Invert of Outlet Pipe =			ft (distance below basin bottom at Stage = 0 ft)
Circular Orifice Diameter =			inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

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

User Input: Emergency Spillway (Rectangular or Trapezoidal)

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

Calculated Parameters for Spillway

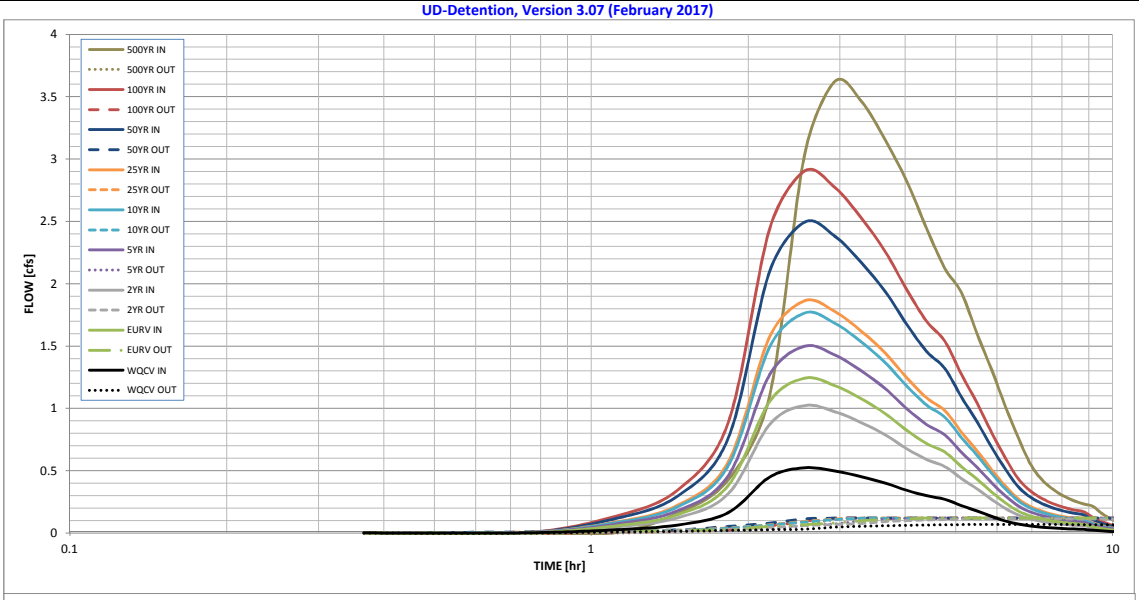
Spillway Design Flow Depth=		feet
Stage at Top of Freeboard =		feet
Basin Area at Top of Freeboard =		acres

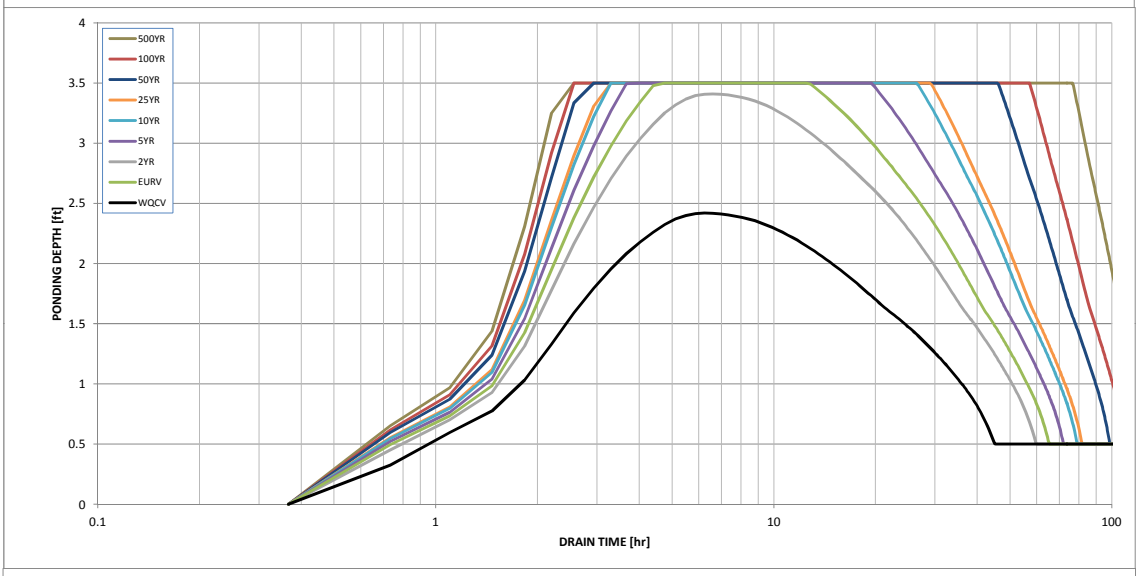
Routed Hydrograph Results

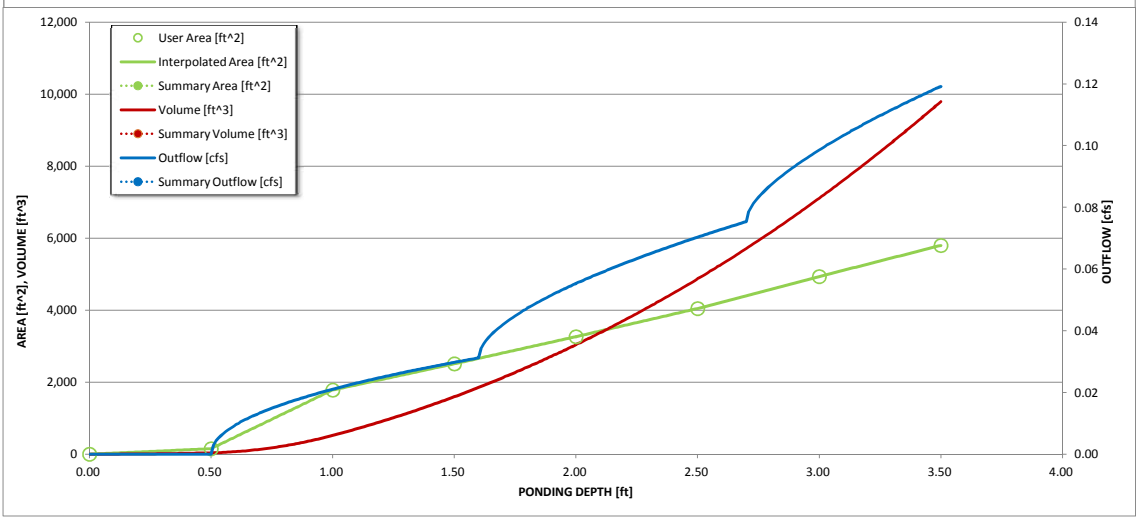
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	0.53	1.07	1.00	1.42	1.68	1.75	2.35	2.71	3.35
Calculated Runoff Volume (acre-ft) =	0.136	0.327	0.268	0.395	0.467	0.492	0.661	0.771	0.964
OPTIONAL Override Runoff Volume (acre-ft) =									
Inflow Hydrograph Volume (acre-ft) =	0.136	0.326	0.268	0.395	0.466	0.492	0.661	0.771	0.964
Predevelopment Unit Peak Flow, q (cfs/acre) =	0.00	0.00	0.01	0.06	0.18	0.41	0.65	0.88	1.28
Predevelopment Peak Q (cfs) =	0.0	0.0	0.0	0.2	0.6	1.3	2.1	2.9	4.2
Peak Inflow Q (cfs) =	0.5	1.2	1.0	1.5	1.8	1.9	2.5	2.9	3.6
Peak Outflow Q (cfs) =	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.6	0.2	0.1	0.1	0.0	0.0
Structure Controlling Flow =	Plate	N/A	Plate	N/A	N/A	N/A	N/A	N/A	N/A
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
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) =	41	58	53	63	69	72	86	95	112
Time to Drain 99% of Inflow Volume (hours) =	**44**	62	58	69	75	77	93	103	122
Maximum Ponding Depth (ft) =	2.42	3.50	3.41	3.50	3.50	3.50	3.50	3.50	3.50
Area at Maximum Ponding Depth (acres) =	0.09	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13
Maximum Volume Stored (acre-ft) =	0.103	0.225	0.213	0.225	0.225	0.225	0.225	0.225	0.225

Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)







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

Detention Basin Outlet Structure Design

Outflow Hydrograph Workbook Filename:

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

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

Time Interval	SOURCE	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK
	TIME	WQCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
21.99 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:21:59	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hydrograph	0:43:59	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Constant	1:05:58	0.02	0.06	0.05	0.07	0.08	0.08	0.11	0.13	0.16
0.227	1:27:58	0.06	0.15	0.12	0.18	0.21	0.22	0.30	0.35	0.43
	1:49:57	0.16	0.38	0.32	0.46	0.54	0.57	0.76	0.89	1.10
	2:11:56	0.45	1.06	0.87	1.27	1.49	1.58	2.10	2.44	3.03
	2:33:56	0.52	1.24	1.02	1.50	1.77	1.86	2.49	2.90	3.62
	2:55:55	0.50	1.18	0.97	1.43	1.68	1.78	2.38	2.77	3.46
	3:17:55	0.45	1.08	0.88	1.30	1.53	1.62	2.17	2.52	3.15
	3:39:54	0.40	0.96	0.79	1.16	1.37	1.44	1.94	2.26	2.82
	4:01:53	0.34	0.82	0.67	1.00	1.18	1.24	1.67	1.95	2.44
	4:23:53	0.30	0.72	0.59	0.87	1.03	1.08	1.46	1.70	2.12
	4:45:52	0.27	0.65	0.53	0.79	0.93	0.98	1.32	1.54	1.93
	5:07:52	0.22	0.53	0.44	0.65	0.76	0.81	1.09	1.27	1.60
	5:29:51	0.18	0.43	0.35	0.53	0.62	0.66	0.89	1.04	1.31
	5:51:50	0.13	0.33	0.27	0.40	0.48	0.50	0.69	0.80	1.01
	6:13:50	0.10	0.24	0.20	0.30	0.35	0.37	0.51	0.60	0.76
	6:35:49	0.07	0.18	0.14	0.22	0.26	0.27	0.37	0.43	0.55
	6:57:49	0.06	0.14	0.11	0.17	0.20	0.21	0.29	0.34	0.42
	7:19:48	0.05	0.11	0.09	0.14	0.16	0.17	0.24	0.28	0.35
	7:41:47	0.04	0.10	0.08	0.12	0.14	0.15	0.20	0.23	0.29
	8:03:47	0.03	0.09	0.07	0.10	0.12	0.13	0.18	0.21	0.26
	8:25:46	0.03	0.08	0.06	0.09	0.11	0.12	0.16	0.18	0.23
	8:47:46	0.03	0.07	0.06	0.09	0.10	0.11	0.15	0.17	0.21
	9:09:45	0.02	0.05	0.04	0.06	0.07	0.08	0.11	0.12	0.16
	9:31:44	0.02	0.04	0.03	0.05	0.05	0.06	0.08	0.09	0.12
	9:53:44	0.01	0.03	0.02	0.03	0.04	0.04	0.06	0.07	0.08
	10:15:43	0.01	0.02	0.02	0.02	0.03	0.03	0.04	0.05	0.06
	10:37:43	0.01	0.01	0.01	0.02	0.02	0.02	0.03	0.04	0.04
	10:59:42	0.00	0.01	0.01	0.01	0.01	0.02	0.02	0.03	0.03
	11:21:41	0.00	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02
	11:43:41	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.02
	12:05:40	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01
	12:27:40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	12:49:39	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	13:11:38	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	13:33:38	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	13:55:37	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	14:17:37	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	14:39:36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	15:01:35	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	15:23:35	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	15:45:34	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	16:07:34	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	16:29:33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	16:51:32	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	17:13:32	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	17:35:31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	17:57:31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	18:19:30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	18:41:29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	19:03:29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	19:25:28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	19:47:28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	20:09:27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	20:31:26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	20:53:26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	21:15:25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	21:37:25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	21:59:24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	22:21:23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	22:43:23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	23:05:22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	23:27:22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	23:49:21	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:11:20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:33:20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:55:19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	1:17:19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	1:39:18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:01:17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:23:17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Safety Grates

Safety grates are intended to keep people and animals from inadvertently entering a storm drain. They are sometimes required even when debris entering a storm drain is not a concern. The grate on top of the outlet drop box is considered a safety grate and should be designed accordingly. The danger associated with outlet structures is the potential associated with pinning a person or animal to unexposed outlet pipe or grate. See the *Culverts and Bridges* chapter of Volume 2 of this manual for design criteria related to safety grates.

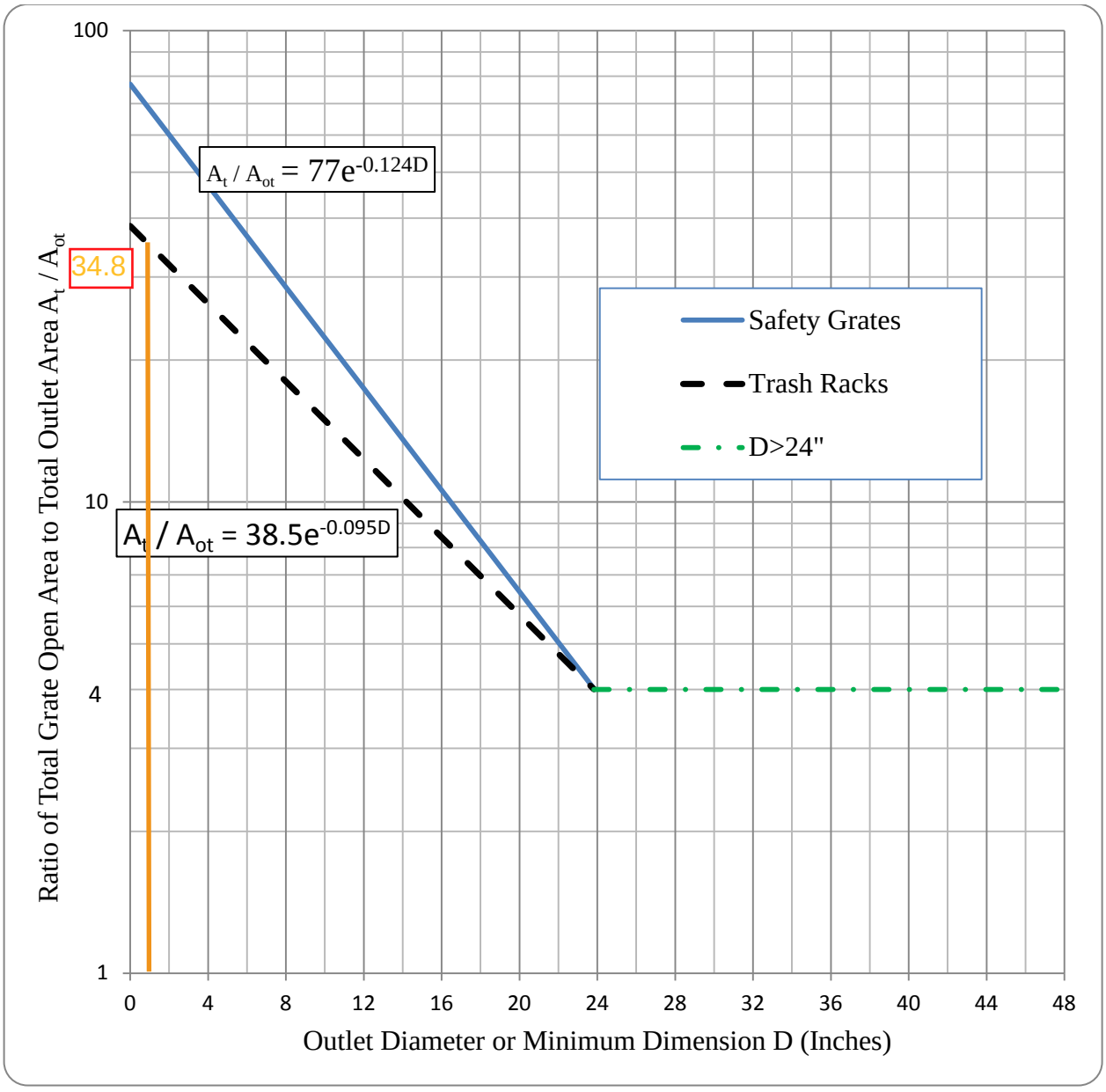


Figure OS-1. Trash Rack Sizing

Table OS-2. Thickness of steel water quality plate

Steel plate thickness (in inches) based on design depth and span of plate										
	Head (feet)									
Span (feet)	3	4	5	6	7	8	9	10	11	12
1	0.1875	0.1875	0.1875	0.1875	0.1875	0.1875	0.1875	0.1875	0.1875	0.1875
2	0.1875	0.2500	0.2500	0.2500	0.2500	0.2500	0.2500	0.2500	0.2500	0.2500
3	0.2500	0.2500	0.3750	0.3750	0.3750	0.3750	0.3750	0.3750	0.3750	0.5000
4	0.2500	0.3750	0.3750	0.3750	0.3750	0.5000	0.5000	0.5000	0.5000	0.5000

Worksheet
Worksheet for Circular Channel

Project Description	
Worksheet	Circular Channel - 1
Flow Element	Circular Channel
Method	Manning's Formula
Solve For	Full Flow Capacity

Input Data		
Mannings Coefficient	0.013	
Slope	0.003000	ft/ft
Diameter	18	in

Results		
Depth	1.50	ft
Discharge	5.75	cfs
Flow Area	1.8	ft²
Wetted Perimeter	4.71	ft
Top Width	0.00	ft
Critical Depth	0.93	ft
Percent Full	100.0	%
Critical Slope	0.006104	ft/ft
Velocity	3.26	ft/s
Velocity Head	0.16	ft
Specific Energy	1.66	ft
Froude Number	0.00	
Maximum Discharg	6.19	cfs
Discharge Full	5.75	cfs
Slope Full	0.003000	ft/ft
Flow Type	N/A	

- If there are threatened and endangered species or habitat in the area.

There are also non-regulatory environmental issues that should be considered. UDFCD recommends early discussions with relevant federal, state and local regulators on these issues. Issues may include the following:

- Potential for encountering contaminated soils during excavation,
- Proper implementation of design elements to mitigate mosquito breeding (i.e., a micropool)
- Concern from area residents regarding the disturbance of existing riparian habitat that may be required for construction of the basin, and
- Colorado water rights issues related to large permanent pools or retention ponds.

5.14 Orifice and Weir Hydraulics

The following discussion regarding weirs and orifices is adapted from *Urban Drainage Design Manual*, Hydraulic Engineering Circular No. 22, Third Edition (Brown et al., 2009).

5.14.1 Orifices

Multiple orifices may be used in a detention facility, and the hydraulics of each can be superimposed to develop the outlet-rating curve. For a single orifice or a group of orifices, orifice flow can be determined using Equation 12-19.

$$Q = C_o A_o (2gH_o)^{0.5}$$

Equation 12-19

Where:

Q = the orifice flow rate through a given orifice (cfs)

C_o = discharge coefficient (0.60 recommended for square-edge orifices)

A_o = area of orifice (ft^2)

H_o = effective head on each orifice opening (ft)

g = gravitational acceleration constant (32.2 ft/sec^2)

If the orifice discharges as a free outfall, the effective head is measured from the centroid of the orifice to the upstream water surface elevation. If the downstream jet of the orifice is submerged, then the effective head is the difference in elevation between the upstream and downstream water surfaces.

5.14.2 Weirs

Flow over a horizontal spillway or drop box crest can be calculated using the following equation for a horizontal broad-crested weir. See Figure 12-20 for a graphical representation of weir flow.

Horizontal Broad-Crested Weir: The equation typically used for a broad-crested weir is:

$$Q = C_{BCW} L H^{1.5}$$

Equation 12-20

Where:

Q = discharge (cfs)

C_{BCW} = broad-crested weir coefficient (This ranges from 2.6 to 3.0. A value of 3.0 is often used in practice.) See Hydraulic Engineering Circular No. 22 for additional information.

L = broad-crested weir length (ft)

H = head above weir crest (ft)

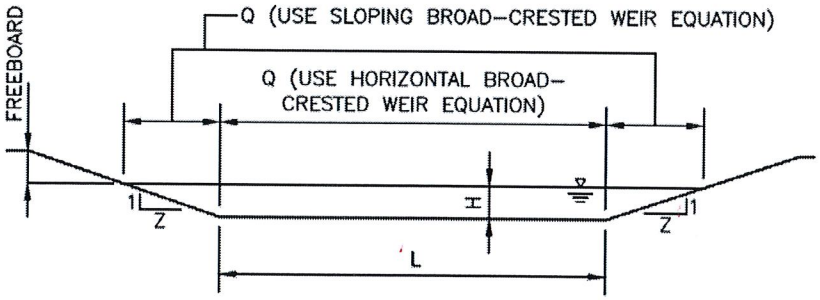


Figure 12-20. Sloping broad-crest weir

Sloping Broad-Crested Weir: Figure 12-20 shows an example of a sloping broad-crested weir. The equation to calculate the flow over the sloping portion of the weir is as follows:

$$Q = \left(\frac{2}{5}\right) C_{BCW} Z H^{2.5} \qquad \text{Equation 12-21}$$

Where:

Q = discharge (cfs)

C_{BCW} = broad-crested weir coefficient (This ranges from 2.6 to 3.0. A value of 3.0 is often used in practice.) See Hydraulic Engineering Circular No. 22 for additional information.

Z = side slope (horizontal: vertical)

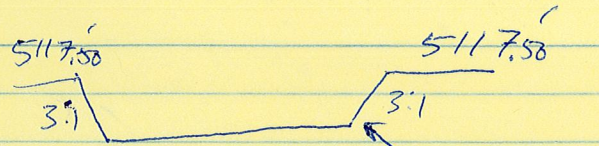
H = head above weir crest (ft)

Note that in order to calculate the total flow over the weir depicted in Figure 12-20, the results from Equation 12-20 must be added to two times the results from Equation 12-21.

CONTOUR TOP ELEVATION = 5117.50'

BOTTOM CONTOUR ELEVATION = 5111.50'

PROPOSED WEIR CALCULATION



$Q = C_{BCW} L H^{1.5}$

$Q = \left(\frac{2}{5}\right) C_{BCW} Z H^{2.5}$

$H = 5117.5 - 5111.50 = 6$

$$Q = \left(\frac{2}{5}\right)(3)(3)(6^{2.5}) = 317.5\ ft^3/s \times 2 = 634.9\ ft^3/s$$

$$Q_{(100)} = 1276\ ft^3/s - 634.9\ ft^3/s = 641.1\ ft^3/s$$

$Q_{(100)} = 641.1$ cfs

$$L_{CALC} = \frac{Q}{C_{BCW} H^{1.5}} = \frac{641.1\ cfs}{(3)(6^{1.5})} = \frac{641.1}{44.09} = 14.54$$

$L_{CALC} = 14.54'$

$L_{CALC} \approx 15$

$L_{CALC} \approx 15 < L_{DESIGN} = 17'$ ✓

EXHIBIT B – LOCAL AGENCY RESOLUTION

LOCAL AGENCY ORDINANCE or RESOLUTION