1. Call Meeting To Order
2. Roll Call
3. Pledge Of Allegiance
4. Approval Of Meeting Minutes
   4.I. Planning Commission Meeting Minutes_2023-12-14

Documents:
   2023 12 14_DRAFT MINUTES.PDF

5. Public Hearing: Harvest 47 Final Plat
   To consider a request for a Final Plat known as Harvest 47 located south of
   Mountain Avenue on the southern half of property located at 735 State Highway
   56 (Parcel 94-24-009702) near the intersection of Dorothy Drive and Remuda
   Road

Documents:
   HARVEST 47 INFORMATION SHEET AND STAFF REPORT.PDF
   HARVEST 47 FINAL PLAT ATTACHMENTS.PDF

6. Report By Staff
7. Adjourn

Join Zoom Meeting https://us02web.zoom.us/j/86049631362 Meeting ID: 860 4963 1362
One tap mobile +17193594580,,86049631362#US

Individuals needing special accommodation may request assistance by contacting the
Town Clerk at 807 Mountain Avenue, Berthoud, Colorado 80513, 970-532-2643 at least 24
hours in advance.
Planning Commission Minutes – December 14, 2023, at 6:00 p.m.

1. **Call to Order** – The Planning Commission convened a regular meeting on. Commissioner Anderson called the meeting to order at 6:00 p.m.

2. **Pledge of Allegiance**

3. **Roll Call** – Members present: Karen Anderson (Chairperson)  
   Jon Van Benthem (Secretary)  
   Abigail Smith (Vice Chairperson)  
   Brett Wing (Commissioner)  
   Nick Semedalas (Commissioner)  
   Joe Donnelly (Commissioner)  
   Staff present: Anne Johnson (Community Development Director)  
   Tawn Hillenbrand (Senior Planner)  
   Teri Reger (Planning Technician)  
   Erin Smith (Town Attorney via Zoom)

4. **Approval of Minutes** – Minutes from October 26, 2023, Planning Commission Meeting.  
   **MOTION** made by Commissioner Wing to APPROVE the Minutes for October 26, 2023.  
   **SECONDED** by Commissioner Semedalas.  
   With those all in favor, THE MOTION CARRIED.

5. **Public Hearing:** Community Development Director introduced a recommendation to amend the following section of Chapter 30 of the Berthoud Municipal Code, specifically to amend the definition section regarding marijuana businesses (also Sections 30-3-113, 30-3-112, 30-1-117, 30-3-104, and Table 3.10); and clarifying land use application processing requirements throughout Chapter 30 via Ordinance.  
   **MOTION** made by Commission Wing to make a recommendation of approval to the Town Board of Trustees for the proposed Code amendments to Chapter 30 of the Berthoud Municipal Code as attached in the Draft Ordinance and attachment for the reason outlined in the staff report.  
   **SECONDED** by Vice Chair Smith. Commissioner Van Benthem abstained. Five Commissioners voted in the affirmative, THE MOTION CARRIED.

6. **Reports by Staff**
   - Wave 3 of the Code changes went before the Town Board of Trustees on November 28, 2023, and passed.  
   - The Board of Trustees have asked that more time be given to exploring the use of Storage Containers.  
   - The current Sign Code is currently under review.  
   - There will be some Land Use items coming to the Commission in January, possibly including a Final Plat.  
   - There are approximately 20 Land Use items in process currently.  
   - Staff will coordinate tours of downtowns and residential projects for Planning Commissioners to take in 2024.
7. **Adjournment** –

The meeting was adjourned at 6:55 p.m.

_________________________  ________________________
CHAIRPERSON                  SECRETARY
Meeting Date: January 11, 2024

Agenda Title/Subject: Public Hearing to consider a request for a Final Plat known as Harvest 47 located south of Mountain Avenue on the southern half of property located at 735 State Highway 56 (Parcel 94-24-009702) near the intersection of Dorothy Drive and Remuda Road

Type of Item: Public Hearing

Purpose: Request for approval of a Final Plat for Harvest 47

Presented by: Anne Johnson, Community Development Director
Lauren Richardson, Planner, Baseline Engineering

ATTACHMENTS:
- Staff Report
- Application materials
- Public Notification

BACKGROUND:
In July 2022, Planning Commission and the Town Trustees approved the applicant’s request for a Neighborhood Master Plan, Rezoning and Minor Subdivision on the 5.98-acre parcel. The rezoning changed the classification of this property from PUD to Urban Residential (UR) consistent with the 2021 Comprehensive Plan update. The Planning Commission and the Town Board of Trustees approved the Preliminary Plat in May 2023.

UPDATE/NEXT STEPS:
After the Planning Commission public hearing, the applicant will need to enter into a Development Agreement to cover public improvements and landscaping. This Agreement is standard for all development in the Town and shall be entered into between the Town and the applicant. The Planning Commission is the final public hearing for a Final Plat. If approved as presented, any Conditions of Approval will need to be met before the Final Plat materials will be recorded with the Larimer County Clerk and Recorder.

FISCAL IMPACT AND FUND SOURCE:
There is no negative impact to the Town in consideration of this request.

COMMUNITY TOUCHSTONES:
Consideration of this request does not negatively impact community touchstones. The property includes 9 lots for Habitat for Humanity and offers a range of single-family housing options to diversity housing availability in Berthoud.

RECOMMENDED ACTION(S):
Staff recommends approval of the request. See suggested motions in the Staff Report.
STAFF REPORT: HARVEST 47 FINAL PLAT

DATE: January 11, 2023

GENERAL INFORMATION

<table>
<thead>
<tr>
<th>Applicant</th>
<th>Larry Bebo</th>
<th>Size: 5.98 acres</th>
</tr>
</thead>
</table>

Site Location     The property is located near the intersection of Dorothy Drive and Remuda Road. This project is located on the southern portion of the property at 735 State Highway 56 (Parcel 94-24-009702)

Applicant's Request The Applicant is requesting a final plat to subdivide the subject property into 29 lots intended for single family residential.

Current Zoning    UR – Urban Residential

UR ZONING DISTRICT INFORMATION

<table>
<thead>
<tr>
<th>Max Density</th>
<th>N/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Min. Lot Area</td>
<td>2,500 sq.ft.</td>
</tr>
<tr>
<td>Min. Lot Width</td>
<td>25’</td>
</tr>
<tr>
<td>Front Setback</td>
<td>10’</td>
</tr>
<tr>
<td>Side Setback</td>
<td>5’</td>
</tr>
<tr>
<td>Rear Setback</td>
<td>5-8’</td>
</tr>
<tr>
<td>Building Height</td>
<td>30’</td>
</tr>
</tbody>
</table>

SURROUNDING ZONING, LAND USE, AND REQUIRED BUFFERS

<table>
<thead>
<tr>
<th>Adjacent Zoning</th>
<th>Adjacent Land Use</th>
<th>Setbacks for Adjacent Zoning/Buffer required if rezoned</th>
</tr>
</thead>
<tbody>
<tr>
<td>North</td>
<td>PUD</td>
<td>Garden Center</td>
</tr>
<tr>
<td>South</td>
<td>UR</td>
<td>Future Single-Family</td>
</tr>
<tr>
<td>East</td>
<td>UR</td>
<td>Multi-Family</td>
</tr>
<tr>
<td>West</td>
<td>R1</td>
<td>Single-Family</td>
</tr>
</tbody>
</table>
The project site is illustrated below. In an earlier stage of the process the southern portion of the property was subdivided from the garden center and is where the residential development is proposed. The source of this image is the Larimer County Land Information Locator/GIS.
Proposal
The applicant proposes to subdivide the existing 5.98-acre parcel into 29 lots for single-family residential purposes. The final plat, if approved, would subdivide the lots and allow the applicant to begin work on public improvements.

Background
In July 2022, a Neighborhood Master Plan, Rezoning, and Minor Subdivision were approved by Planning Commission and the Board of Trustees for this property. The minor subdivision split this lot from the neighboring garden center to the north, and the Rezoning changed this parcel from Planned Unit Development (PUD) to Urban Residential (UR). Additionally, on May 09, 2023, the Town Board approved a preliminary plat for the project that was identical to the proposed final plat.

Final Plat Review Criteria
In addition to all provisions of the Code, the Town shall use the following criteria to evaluate the applicant’s request:

<table>
<thead>
<tr>
<th>30-6-108(C) Review Criteria</th>
<th>Finding</th>
<th>Rationale</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. The Final Plat is in substantial conformance with the approved Preliminary Plat. For the purposes of this Code, “Substantial conformance.” Includes design adjustments made to meet any conditions of preliminary plat approval, and is determined as follows:</td>
<td>Yes</td>
<td>The final plat is identical to what was proposed during the preliminary plat phase.</td>
</tr>
<tr>
<td>a. Does not change any land use of the proposed plat.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>b. Does not change the number of lots or residential density by more than 5%.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>c. Does not contain changes which would render the final plat in nonconformance with requirements of this Code.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>d. Does not contain significant changes in street alignment and/or access points, or other public elements such as drainage improvements, utility lines or facilities.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>e. Does not change any measurable standard (other than above) by more than 15 percent.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. The development complies with this Code, the Comprehensive Plan and the PORT Plan.</td>
<td>Yes</td>
<td>The land use mix is consistent with the current UR zone district. The future land use map lists this property as urban residential, which focuses on human-scale and new urbanism design. This project will utilize alley loaded garages to create a more walkable neighborhood. The project will also extend existing roadways and sidewalk connectivity. During the Neighborhood Master Plan phase of the project open space/parks requirements were waived. This was due to the 9 lots that are being dedicated to Habitat for Humanity.</td>
</tr>
<tr>
<td>3. All applicable technical standards including the provision of water in sufficient amount and quality have been met.</td>
<td>Yes</td>
<td>Plans were reviewed by Town Staff as well as outside referral agencies. The applicant has provided adequate plans for utilities and transportation systems.</td>
</tr>
</tbody>
</table>
PUBLIC NOTICE AND COMMENT

Notice of the Planning Commission Public Hearing has been mailed to property owners within 500 feet of the subject property on December 27, 2023, a legal ad published December 27, 2023, and the property has been posted since the Preliminary Plan submitted prior to March 16 as required by the Development Code. In addition, when the project was submitted, the application was sent out to all property owners within 500 feet, with an invitation to comment on the request within three weeks of receipt. No comments were received during this initial notice period.

FINDINGS AND RECOMMENDATIONS

- Staff recommends that Planning Commission find the application meets the intent of the Master Plans affecting the project, the Comprehensive Plan and Future Land Use Map, and the Land Use Code.

- Two suggested motions are below:
  - **Approval**: I move to approve the Harvest 47 Final Plat, subject to the following conditions:
    - The applicant shall finalize, with Town staff, a development agreement.
    - The applicant shall add an additional signature block onto the Final Plat for the Planning Commission Chairperson.
    - The applicant shall provide a finalized and executed agreement between The Farmstead and Harvest 47 for the construction and maintenance of the southern alley shared between the two projects.
  - **Denial**: I move to deny the Harvest 47 Preliminary Plat for the following reasons _______
    __________________________________________________________.

Attachments

1. Application Form
2. Cover Letter
3. Final Plat
4. Construction Drawings
5. Traffic Letter
6. Drainage Report
7. Outstanding Staff Comments
8. Presentation from Staff
DEVELOPMENT REVIEW APPLICATION

All required information must be provided before submittal will be accepted and deemed complete.
To be complete, the application must include all items identified on the submittal checklist.
Please complete both sides of application form.

<table>
<thead>
<tr>
<th>Parcel Number(s):</th>
<th>9424138003</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site Address:</td>
<td>TBD</td>
</tr>
<tr>
<td>Project Name:</td>
<td>Harvest 47</td>
</tr>
<tr>
<td>Brief description of project:</td>
<td>Small residential development</td>
</tr>
</tbody>
</table>

APPLICATION TYPE (Check as appropriate):

- [ ] Annexation
- [ ] Preliminary Subdivision Plat
- [ ] Final Site Plan
- [ ] Rezoning
- [ ] Final Subdivision Plat
- [ ] PUD Amendment
- [ ] Concept Plan
- [ ] Plat Amendment
- [ ] PUD Preliminary Development Plan
- [ ] Minor Subdivision
- [ ] Oil and Gas
- [ ] PUD Final Development Plan
- [ ] Special Use Review
- [ ] ROW Vacation
- [ ] Other __________

APPLICANT

Name: Larry Bebbo
E-mail: mbebo@lmenterprisesinc.com
Phone: 970-532-3706
Mailing Address: 735 E. Hwy 56
City/State/Zip: Berthoud CO 80513

CONTACT PERSON (will receive correspondence from Town Staff/Referral Agencies)

Name: Michael T. Cook P.E.
E-mail: mtcookpe@msn.com
Phone: (970) 310-9332
Mailing Address: 970 East CR. 8
City/State/Zip: Berthoud CO 80513

OWNER(S) (if different than applicant)

Name: 
E-mail: 
Phone: 
Mailing Address: 
City/State/Zip: 

CONSULTANT (Engineer, Surveyor, or Planner)

Name: Troy Cambel
E-mail: troy@l2-consultnts.com
Phone: (970) 217-9148
Mailing Address: 16911 Pots Place
City/State/Zip: Mead CO 80542
LAND USE INFORMATION
Existing Use: Commercial / Agricultural
Proposed Use: Residential
Existing Zoning: R-2 urban residential
Proposed Zoning: (if applicable):
Number of acres: 5.98
Proposed Access: Dorothy Drive

Adjacent zoning / land use:
<table>
<thead>
<tr>
<th>East Side</th>
<th>North Side</th>
</tr>
</thead>
<tbody>
<tr>
<td>R-3</td>
<td>PUD</td>
</tr>
<tr>
<td>West Side</td>
<td>South Side</td>
</tr>
<tr>
<td>R-1</td>
<td>R-2</td>
</tr>
</tbody>
</table>

UTILITY SERVICE INFORMATION
Water: TOB
Sewer: TOB

PROJECT INFORMATION
Number of proposed units: 29
Number of phases: 1
Number of Units per phase: 29
Number of lots proposed: 29
Lot size minimum: 4,212.75 S.F. lot 3, Block 1
Lot size maximum: 9,458.80 S.F. lot 6, block2
Lot size average: 6,519.43 S.F.
Gross density (units/acre): 4.85
Net density (units/acre): 6.94
Area and percent open space: 0.0%

Non-Residential Building Area (Sq. Ft.) Proposed: 0.0
Non-Residential Construction Floor Area Ratio Proposed:
Total Number of Parking Spaces:
Acreage of Site:
a. Gross: 5.98
b. Right-of-Way: 1.74

Type of Housing Proposed (please check):
- Future Single Family
- Townhouse
- Duplex
- Multi-family
- Condominium

( # of units: 29 )

Signatures are required for ALL Property Owners and the Applicant
I hereby certify that I am the lawful owner of the parcel(s) of land that this application concerns and consent to the action. I hereby permit Town of Berthoud staff to enter upon the property for the purposes of inspection relating to the application. Building Permits will not be accepted while this application is in process.

Property Owner(s): [Signature] Date: 7-6-23

Property Owner(s): 

In submitting the application materials and signing this application agreement, I acknowledge and agree that the application is subject to the applicable processing and public hearing requirements set forth in the Development Code.

Applicant: [Signature] Date: 7-6-23

FOR OFFICE USE ONLY
Received By: 
Date:

Town of Berthoud • 807 Mountain Ave. • P.O. Box 1229 • Berthoud, CO 80513 • 970.532.2643
July 24th, 2023

Michael T. Cook P.E.
Construction Superintendent
Berthoud Habitat for Humanity
970 East County Road 8
Berthoud, CO  80513
(970) 310-9332
mtcookpe@msn.com

Anne Best Johnson, AICP MBA
Community Development Director
Community Development Director
Town of Berthoud
P.O. Box 1229
Berthoud, CO 80513

RE:  Harvest 47 Subdivision final plat submittal:

Dear Anne:

Attached is our submittal for the Final Plat for the Harvest 47 subdivision.

Attached you will find:

1.0  Harvest 47 cover letter (this document).
2.0  T.O.B. Final Plat check list.
4.0  T.O.B. Harvest 47 project fees tabulation.
5.0  Receipt showing payment of BFPD review fees.
6.0  Completed T.O.B. Memorandum of Understanding.
7.0  Harvest 47 project title commitment.
8.0  Harvest 47 project narrative.
9.0  Harvest 47 project vicinity map.
10.0 Harvest 47 Final Plat survey information.
11.0 Harvest 47 final plat and construction Documents. (Follow link)
12.0 Harvest 47 traffic letter.
13.0 Harvest 47 preliminary drainage and erosion control report.
14.0 Preliminary soils report.
15.0 Affidavit of ownership of oil and gas.
16.0 Proposed HOA formation document
17.0 Proposed Farmstead HOA MOU.
18.0 Harvest 47 final drainage report (Follow link)

Thank you for your patience and help to bring this unique opportunity for development of affordable housing to Berthoud. We look forward to working with the Town of Berthoud on moving this project forward to construction.

Michael T. Cook P.E.
Berthoud Habitat for Humanity
PRELIMINARY
NOT FOR CONSTRUCTION
11/30/2023

HARVEST 47 SUBDIVISION
CONSTRUCTION DOCUMENTS
TOWN OF BERTHOUD, COUNTY OF LARIMER, STATE OF COLORADO
LOCATED IN THE NE 1/4, SECTION 24, TOWNSHIP 4 NORTH, RANGE 69 WEST

Know what's below. Before you dig. Call R before you dig.

C-19 SHEET OF SHEETS

SC-6 Inlet Protection (IP)

Concrete Washout Area (CWA)

SC-2 Sediment Control Log (SCL)

Temporary Outlet Protection (TOP)

EC-8

MM-1

Sediment Control Log (SCL)

SC-6 Inlet Protection (IP)
100-Year Overflow Spillway

4' Wide Berm Minimum

Emergency overflow weir - Credit Inv: 4990.50

Proposed top of point

Concrete weir centered in berm

High water during overflow of entire 100-year peak runoff.

Elev: 4991.00

3" Min. Clearance

2 - #5 Bars

8" Min. Thickness

(See Note)

4' Wide Berm Minimum

Emergency overflow weir - Credit Inv: 4990.50

Proposed top of point

Concrete weir centered in berm

High water during overflow of entire 100-year peak runoff.

Elev: 4991.00

3" Min. Clearance

2 - #5 Bars

8" Min. Thickness

(See Note)

Concrete weir structure centered in berm

Emergency overflow weir - Credit Inv: 4990.50

Proposed top of point

Concrete weir centered in berm

High water during overflow of entire 100-year peak runoff.

Elev: 4991.00

3" Min. Clearance

2 - #5 Bars

8" Min. Thickness

(See Note)

Concrete weir structure centered in berm

Emergency overflow weir - Credit Inv: 4990.50

Proposed top of point

Concrete weir centered in berm

High water during overflow of entire 100-year peak runoff.

Elev: 4991.00

3" Min. Clearance

2 - #5 Bars

8" Min. Thickness

(See Note)

Concrete weir structure centered in berm

Emergency overflow weir - Credit Inv: 4990.50

Proposed top of point

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High water during overflow of entire 100-year peak runoff.

Elev: 4991.00

3" Min. Clearance

2 - #5 Bars

8" Min. Thickness

(See Note)

Concrete weir structure centered in berm

Emergency overflow weir - Credit Inv: 4990.50

Proposed top of point

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High water during overflow of entire 100-year peak runoff.

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3" Min. Clearance

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8" Min. Thickness

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8" Min. Thickness

(See Note)

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Proposed top of point

Concrete weir centered in berm

High water during overflow of entire 100-year peak runoff.

Elev: 4991.00

3" Min. Clearance

2 - #5 Bars

8" Min. Thickness

(See Note)
Harvest 47
735 E. Highway 56, Berthoud, CO

Traffic Letter
KE Job #2021-056

Prepared for:
i2 Consultants
16911 Potts Place
Mead, CO

Prepared by:

skellar@kellarengineering.com
970.219.1602 phone

December 3, 2021
Sean K. Kellar, PE, PTOE

This document, together with the concepts and recommendations presented herein, as an instrument of service, is intended only for the specific purpose and client for which it was prepared. Reuse of and improper reliance on this document without written authorization from Kellar Engineering LLC shall be without liability to Kellar Engineering LLC.
1.0 Introduction

The purpose of this Traffic Generation Letter (Traffic Letter) is to evaluate the traffic generated by the proposed project located at 735 E. Highway 56 in Berthoud, CO.

2.0 Proposed Development

The proposed project consists of 28 single-family homes. See Table 1: Trip Generation and Figure 2: Site Plan.

3.0 Trip Generation

Site generated traffic estimates are determined through a process known as trip generation. Rates and equations are applied to the proposed land use to estimate traffic generated by the development during a specific time interval. The acknowledged source for trip generation rates is the *Trip Generation Report* published by the Institute of Transportation Engineers (ITE). ITE has established trip generation rates in nationwide studies of similar land uses. For this study, Kellar Engineering LLC (KE) used the *ITE 10th Edition Trip Generation Report* average trip rates. Per the ITE, the proposed project is anticipated to generate approximately 264 daily trips, 21 AM total peak hour trips, and 28 PM total peak hour trips. See Table 1: Trip Generation.
Figure 1: Vicinity Map
Figure 2: Site Plan
Table 1: Trip Generation (ITE Trip Generation, 10th Edition)

<table>
<thead>
<tr>
<th>ITE Code</th>
<th>Land Use</th>
<th>Average Daily Trips</th>
<th>AM Peak Hour Trips</th>
<th>PM Peak Hour Trips</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Size</td>
<td>Rate</td>
<td>Total</td>
</tr>
<tr>
<td>210</td>
<td>Single Family</td>
<td>28 DU</td>
<td>9.44</td>
<td>264</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td>264</td>
</tr>
</tbody>
</table>

DU = Dwelling Units
4.0 Appropriateness

Access to the project site is proposed from a local street internal to a subdivision and not from an arterial roadway. Site access should be taken, when available, on the road of lower classification as proposed with the current project. Therefore, the access to the project site is appropriate based upon the existing road network and location of the project site. The proposed project consists of 28 single-family homes. The adjacent neighborhood also consists of single-family residential homes. The project’s site generated traffic is low and the existing transportation network is appropriate to accommodate the proposed project’s traffic.

5.0 Conclusions

Based upon the review of the project’s low trip generation and location, it can be determined that the proposed use is appropriate from a traffic engineering perspective. The trip generation, site location, land use, and size is appropriate from a traffic engineering perspective.

- Per the ITE, the proposed project generates 264 daily trips, 21 AM total peak hour trips, and 28 PM total peak hour trips. See Table 1: Trip Generation.
- The project’s proposed access is appropriate from a traffic engineering standpoint.
- The existing roadway improvements are appropriate to accommodate the proposed project’s traffic.
Single-Family Detached Housing (210)

Vehicle Trip Ends vs: Dwelling Units
On a: Weekday

Setting/Location: General Urban/Suburban
Number of Studies: 159
Avg. Num. of Dwelling Units: 264
Directional Distribution: 50% entering, 50% exiting

Vehicle Trip Generation per Dwelling Unit

<table>
<thead>
<tr>
<th>Average Rate</th>
<th>Range of Rates</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>9.44</td>
<td>4.81 - 19.39</td>
<td>2.10</td>
</tr>
</tbody>
</table>

Data Plot and Equation

Fitted Curve Equation: \( \ln(T) = 0.92 \ln(X) + 2.71 \)

\( R^2 = 0.95 \)
Single-Family Detached Housing
(210)

Vehicle Trip Ends vs: Dwelling Units
On a: Weekday,
Peak Hour of Adjacent Street Traffic,
One Hour Between 7 and 9 a.m.

Setting/Location: General Urban/Suburban
Number of Studies: 173
Avg. Num. of Dwelling Units: 219
Directional Distribution: 25% entering, 75% exiting

Vehicle Trip Generation per Dwelling Unit

<table>
<thead>
<tr>
<th>Average Rate</th>
<th>Range of Rates</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.74</td>
<td>0.33 - 2.27</td>
<td>0.27</td>
</tr>
</tbody>
</table>

Data Plot and Equation

![Data Plot](image)

Fitted Curve Equation: \( T = 0.71X + 4.83 \)

\( R^2 = 0.89 \)
Single-Family Detached Housing
(210)

Vehicle Trip Ends vs: Dwelling Units
On a: Weekday.
Peak Hour of Adjacent Street Traffic,
One Hour Between 4 and 6 p.m.
Setting/Location: General Urban/Suburban
Number of Studies: 190
Avg. Num. of Dwelling Units: 242
Directional Distribution: 63% entering, 37% exiting

Vehicle Trip Generation per Dwelling Unit

<table>
<thead>
<tr>
<th>Average Rate</th>
<th>Range of Rates</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.99</td>
<td>0.44 - 2.98</td>
<td>0.31</td>
</tr>
</tbody>
</table>

Data Plot and Equation

Fitted Curve Equation: \( \ln(T) = 0.96 \ln(X) + 0.20 \)

\( R^2 = 0.92 \)
Sean Kellar, PE, PTOE
Principal Engineer

Education
B.S., Civil Engineering, Arizona State University – Tempe, AZ

Registration
Colorado, Professional Engineer (PE)
Wyoming, Professional Engineer (PE)
Arizona, Professional Engineer (PE)
Kansas, Professional Engineer (PE)
Missouri, Professional Engineer (PE)
Professional Traffic Operations Engineer (PTOE)

Professional Memberships
Institute of Transportation Engineers (ITE)

Industry Tenure
22 Years

Sean’s wide range of expertise includes: transportation planning, traffic modeling, roadway design, bike and pedestrian facilities, traffic impact studies, traffic signal warrant analysis, parking studies, corridor planning and access management. Sean’s experience in both the private and public sectors; passion for safety and excellence; and strong communication and collaboration skills can bring great value to any project. Prior to starting Kellar Engineering, Sean was employed at the Missouri Department of Transportation (MoDOT) as the District Traffic Engineer for the Kansas City District. Sean also worked for the City of Loveland, CO for over 10 years as a Senior Civil Engineer supervising a division of transportation/traffic engineers. While at the City of Loveland, Sean managed several capital improvement projects, presented several projects to the City Council and Planning Commission in public hearings, and managed the revisions to the City’s Street Standards. Sean is also proficient in Highway Capacity Software, Synchro, PT Vissim, Rodel, GIS, and AutoCAD.

WORK EXPERIENCE:

Kellar Engineering, Principal Engineer/President – January 2016 – Present

Missouri Department of Transportation, District Traffic Engineer, Kansas City District – June 2015 – January 2016

City of Loveland, Colorado, Senior Civil Engineer, Public Works Department – February 2005 – June 2015

Kirkham Michael Consulting Engineers, Project Manager - February 2004 – February 2005

Dibble and Associates Consulting Engineers, Project Engineer – August 1999 – February 2004
DRAINAGE & EROSION CONTROL REPORT

HARVEST 47 SUBDIVISION
Berthoud, CO

November 30, 2023

Prepared for:

L & J Bebo
PO Box W
Berthoud, CO  80513

Prepared by:

i2 Consultants, Inc.
16911 Potts Place
Mead, CO  80542
Phone: 970.217.9148

Project Number: 1053-1
November 30, 2023

Mr. Noah Nemmers, PE
Baseline Engineering Corporation
112 N. Rubey Drive, #210
Golden, CO  80403
c/o Town of Berthoud

RE:  Drainage & Erosion Control Report for Harvest 47 Subdivision
Berthoud, CO

Dear Mr. Nemmers:

We are pleased to present this Drainage & Erosion Control Report for Harvest 47 Subdivision for your review and approval. This report has been prepared in general accordance with the Town of Berthoud Engineering and Infrastructure Design Standards and Construction Specifications, dated October 2021 (Design Standards) and Larimer County Storm Drainage Standards.

We look forward to your favorable review of this project and report. Please do not hesitate to contact our office if you have any questions.

Sincerely,

i2 Consultants, Inc.

Troy W. Campbell, PE
Senior Project Engineer
RESPONSIBLE PARTY CERTIFICATION

L. & J. Bebo, hereby certifies that the drainage facilities for Harvest 47 Subdivision, Berthoud, CO will be constructed according to the design presented in this report. I understand that the Town of Berthoud does not and shall not assume liability for the drainage facilities designed and/or certified by my engineer. I understand that the Town of Berthoud reviews drainage plans but cannot, on behalf of Harvest 47 Subdivision, Berthoud, CO, guarantee that the final drainage design review will absolve L. & J. Bebo and/or their successors and/or assigns of future liability for improper design. I further understand that approval of the Plat and/or Development Permit does not imply approval of my engineer’s drainage design.

Attest:

_________________________
L. Bebo

Authorized Signature

ENGINEER’S CERTIFICATION

I, Troy W. Campbell, hereby certify that this report (plan) for the drainage design of Harvest 47 Subdivision, Berthoud, CO was prepared by me (or under my direct supervision) in accordance with the provisions of the Town of Berthoud Standards and Specifications for the Design and Construction of Public and Private Improvements for the Responsible Parties thereof. I understand that the Town of Berthoud does not and shall not assume liability for drainage facilities designed by others.

Registered Professional Engineer
State of Colorado No. 41159
(Seal)
Drainage & Erosion Control Report
Harvest 47 Subdivision
Located within the Northeast Quarter of Section 24,
Township 4 North, Range 69 West of the 6th P.M.
Town of Berthoud, County of Larimer, State of Colorado

TABLE OF CONTENTS

I. GENERAL LOCATION AND DESCRIPTION 4
   A. Site Location
   B. Description of Property
   C. Proposed Project Description
   D. Flood Hazard and Relevant Drainage Studies

II. DRAINAGE BASIN 5
    A. Overall Drainage Basin
    B. Sub-basin and Site Drainage

III. DRAINAGE DESIGN CRITERIA 5
     A. Regulations
     B. Development Criteria Reference and Constraints
     C. Hydrological Criteria
     D. Hydraulic Criteria
     E. Variances from Criteria

IV. DRAINAGE FACILITY DESIGN 7
    A. General Concept
    B. Specific Details
    C. Open Channel Flow
    D. Storm Drainage Pipes
    E. Sediment and Erosion Control
    F. Maintenance of Drainage Facilities

V. CONCLUSIONS 10
   A. Compliance with Standards
   B. Drainage Concept

VI. REFERENCES 11

VII. APPENDICIES 12
I. GENERAL LOCATION AND DESCRIPTION

A. Site Location:

The subject site is located in the northeast quarter of Section 24, Township 4 North, Range 69 West, of the 6th Principal Meridian, Town of Berthoud, County of Larimer, State of Colorado. Furthermore, the project is located south of Highway 56, east of Dorothy Drive and west of County Line Road.

B. Site Description:

The subject site is roughly 6.0 acres and is currently undeveloped.

The proposed development will consist of single-family lots, roadway, alleys, sidewalks and landscaping.

Detention and water quality for the subject site will be to the northeast of the subject site.

The site to the west has been developed and contains single family lots. The area to the south and east is currently being developed as multi-family and single-family lots.

According to the Natural Resources Conversation Service (NRCS) Web Soil Survey, the native soils in this area are:

- Nunn Clay Loam, 0 to 1 percent slopes (Map Unit Symbol #73), which is a Type C soil.
- Wiley Silt Loam, 1 to 3 percent slopes (Map Unit Symbol #118), which is a Type B soil.

Please refer to the NRCS soils information in the Appendix.

There are no irrigation facilities within the subject property boundary. An abandoned irrigation ditch has been removed from the property.

C. Proposed Project Description:

The subject site consists of roughly 6.0 acres and the subject development will be constructed in one phase. The subject project will consist of single-family lots, roadway section, alley and landscaping.
D. Flood Hazard and Relevant Drainage Studies:

The site is shown on FEMA panel 08069C1391H, effective 01/15/2021. The subject site is located with Zone X of the FEMA panel.

Relevant drainage studies for this area include the Drainage Investigation for L&M Enterprises – MRD, prepared by Messner Engineering Associates, dated October 11, 1990, as well as the Preliminary Drainage Report for The Farmstead Third Filing, prepared by Northern Engineering, dated August 10, 2022.

II. DRAINAGE BASIN

A. Overall Drainage Basin:

Related documents for the subject site are provided below:

• Drainage Investigation for L&M Enterprises – MRD, prepared by Messner Engineering Associates, dated October 11, 1990;

B. Sub-basin and Site Drainage:

The proposed site is currently undeveloped and the site runoff currently flows from west to northeast and west to southeast.

The subject site has previously been studied in the report prepared by Messner Engineering Associates and has also been included in previous drainage reports for The Farmstead development.

There is runoff from the property to the west of the detention pond that flows into the proposed detention pond. This runoff will be pass-through flow in the detention pond. Please refer to the Appendix for calculations regarding runoff from this basin.

III. DRAINAGE DESIGN CRITERIA

A. Regulations:

This report has been prepared in general accordance with the Town of Berthoud Design Standards, Larimer County Storm Drainage Standards, the Mile High Flood Control District/Urban Storm Drainage Criteria Manual (USDCM) and the Drainage Investigation for L&M Enterprises – MRD, prepared by Messner Engineering Associates, dated October 11, 1990.
B. Development Criteria Reference and Constraints:

The study area is currently undeveloped and vacant land.

The increase in runoff from the proposed development will be routed through the proposed detention facility northeast of the site as well as the proposed detention pond to be installed with the Farmstead development.

C. Hydrological Criteria:

Drainage design is in accordance with the Town of Berthoud Design Standards, Larimer County Stormwater Design Standards criteria, as well as the USDCM.

The design storms for this project are the 2-year and the 100-year recurrence intervals. Runoff is calculated using the Rational Method since all basins are smaller than 160 acres. The Rational Method calculations are computed by the following:

\[ Q = ciA \]

where:
- \( Q \) = Runoff in cubic feet per second
- \( c \) = Calculated runoff coefficient for design event
- \( i \) = Storm intensity in inches/hour
- \( A \) = Basin area in acres

Rational calculations were prepared using *Peak Runoff Prediction by the Rational Method, Version 2.00*, released May 2017, Urban Drainage and Flood Control District.

D. Hydraulic Criteria:

Proposed hydraulic calculations were prepared using *Hydraflow Express Extension for AutoDesk Civil 3D* as well as the *Detention Basin Volume Estimating Workbook, Version 2.35, Released January 2015*, by Urban Drainage and Flood Control District. Refer to the Appendix, Hydraulic Calculations for additional information as well as the Drainage Plan.

E. Variances from Criteria:

No variances are requested with the subject development.
IV. DRAINAGE FACILITY DESIGN

A. General Concept:
The drainage patterns associated with the proposed improvements are generally consistent, to the extent practical and reasonable, with the existing topography, adjacent development and previous drainage investigation for the subject property.

The estimated runoff for the site was determined using the Rational Method, as detailed above. Based on the direction of flow and existing drainage features the subject site has been divided into six (6) onsite drainage basins.

B. Specific Details:
The drainage analysis for the subject area and the layout of the basins corresponds with the proposed drainage conditions to the extent practical. Due to the proposed development, there are some differences between the previously designed basins and proposed basins due to the required layout, surrounding development and grading of the site.

Basin A
Basin A is the western portion of the site and will contain the front portion of residential lots. The proposed drainage pattern for this basin is generally from east to west and then south along Dorothy Drive. Runoff will be conveyed via curb & gutter to the south in Dorothy Drive.

Basin B
Basin B is in the southern portion of the site and will contain the rear/back portion of residential lots. The proposed drainage pattern for this basin is generally from north to south and then east in the alley along the common lot line for Harvest 47 and The Farmstead. Runoff will be conveyed to The Farmstead storm system and will be detained off-site.

Basin C
Basin C contains the majority of the residential lots south of Remuda Road. Runoff will drain from the south to north and west to east in Remuda Road to a proposed 10’ Type R inlet (in sump). Runoff will be conveyed in the proposed storm system to the proposed detention pond.

Basin D
Basin D contains the majority of the residential lots north of Remuda Road. Runoff will drain from the north to south and west to east in Remuda Road to a proposed 10’ Type R inlet (in sump). Runoff will be conveyed in the proposed storm system to the proposed detention pond.
Basin E
Basin E contains a portion of the residential lots north of Remuda Road (and south of the northernmost alley). Runoff will drain from the south to north and west to east and be conveyed in the proposed alley to the proposed detention pond.

Basin F
Basin F contains the proposed detention pond. Runoff in this basin will flow directly into the detention pond.

Basin G
Basin G contains a small portion of the eastern alley as well as a portion of a residential lot. The basin generally flows from north to south to a proposed inlet. Runoff will be conveyed via storm pipe to the proposed detention pond.

Basin H
Basin H is an off-site basin located west of the proposed detention pond. This basin generally drains from west to east and will reach the proposed detention pond. Runoff from this basin will be pass-through flow through the proposed detention pond.

The proposed drainage from the subject site is not anticipated to have a negative impact on existing or proposed downstream facilities. Detention and water quality for Basins C-G will be provided in the proposed detention pond.

Basins C-G will be detained in the proposed detention pond and will be released to The Farmstead storm system at a 100-year flow of roughly 6 cfs. The release rate was previously determined in the Drainage Investigation for L&M Enterprises – MRD, prepared by Messner Engineering Associates, dated October 11, 1990. The required 100-year detention volume is roughly 0.59 ac-ft; water quality of 0.10 ac-ft is included within this 100-year volume. The volume provided is 0.73 ac-ft, which is the maximum volume stored in the pond. The detention pond includes an emergency overflow weir on the east side of the pond. The emergency overflow spillway will be graded to convey flows to the east towards The Farmstead development. The spillway will be protected with Type H riprap through the spillway.

The proposed pond invert is roughly 4986.5, 100-year WSEL is 4989.4 and pond top is 4992.0. The provided detention volume is 0.73 ac-ft up to elevation 4989.4. The bottom of the emergency spillway will be at elevation 4990.5. The emergency overflow weir will be +/-20’ wide and have a depth of roughly 0.5’.

C. Open Channel Flow

Common lot line swales between the single family lots will be necessary to convey developed runoff from the lots. Runoff will also be conveyed in curb & gutter as well as pans within the alleys.

i2 Consultants, Inc.
D. Storm Drainage Pipes

Storm drainage pipes will be utilized to convey runoff from the subject site to the proposed detention pond. The pipes have been sized to convey the 100-year event.

E. Sediment and Erosion Control

Several sediment and erosion control measures will be incorporated into the construction. The initial sediment and erosion control measures to be installed shall include silt fence, as well as vehicle tracking control. After the initial grading operations, sediment control logs shall be installed in onsite swales and rock socks within the curb and gutter adjacent to the subject site.

As construction progresses, there will be a location designated for a concrete washout area. After the onsite roadway has final surface stabilization, rock socks shall be installed along onsite the curb and gutter and remain until final overall development landscaping has been completed.

Inlet protection shall be installed around any onsite inlets and inlets immediately downstream of the subject site.

Additionally, any area that has been disturbed by construction activities and left exposed for more than fourteen (14) days, shall receive drilled seeding and straw mulch at 2 tons/acre, until permanent landscaping or ground cover has been provided.

All stormwater quality and sediment/erosion control measures shall be regularly inspected and maintained during and after the completion of construction. Furthermore, sufficient care shall be taken by the contractor with materials handling and storage.

The proposed measures for sediment and erosion control shall be updated as necessary during construction, as warranted by site conditions.

F. Maintenance of Drainage Facilities

The onsite drainage facilities shall be regularly inspected and maintained by the property owner or homeowner’s association. The inspections should include a log for the date, items inspected, maintenance actions and any updates to the drainage system.

The facilities shall be maintained at any time that erosion occurs in order to mitigate possible future erosion and to mitigate material leaving the subject site.
Furthermore, items such as onsite culverts and chases shall be cleaned and inspected on a regular basis.

Onsite vegetation shall be maintained and replanted if necessary to establish vegetated groundcover.

V. CONCLUSIONS

A. Compliance with Standards:

The drainage design is in general compliance with the Town of Berthoud Design Standards, Larimer County Storm Drainage Standards, the Mile High Flood Control District/Urban Storm Drainage Criteria Manual (USDCM) and the Drainage Investigation for L&M Enterprises – MRD, prepared by Messner Engineering Associates, dated October 11, 1990.

B. Drainage Concept:

The drainage patterns associated with the proposed improvements are generally consistent, to the extent practical and reasonable, with the design in the Drainage Investigation for L&M Enterprises – MRD, prepared by Messner Engineering Associates, dated October 11, 1990.

The drainage design for this project should not negatively impact improvements downstream or the existing storm system.
VI. REFERENCES


2. Larimer County Stormwater Design Standards (Addendum to the Urban Storm Drainage Criteria Manuals – Volumes 1, 2 and 3), adopted June 20, 2005.


VII. APPENDICIES

- Vicinity Map
- FEMA & Existing Geotechnical Information
- Hydrologic Calculations
- Hydraulic Calculations
- Excerpts from Previous Report
- Charts and Figures
Vicinity Map
FEMA & Existing Geotechnical Information
This map complies with FEMA’s standards for the use of digital flood maps if it is not void as described below. The basemap shown complies with FEMA’s basemap accuracy standards.

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 12/18/2022 at 1:11 PM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

This map image is void if the one or more of the following map elements do not appear: basemap imagery, flood zone labels, legend, scale bar, map creation date, community identifiers, FIRM panel number, and FIRM effective date. Map images for unmapped and unmodernized areas cannot be used for regulatory purposes.
### MAP LEGEND

- **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
- **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 17, Sep 7, 2022

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

**Date(s) aerial images were photographed:** Jul 2, 2021—Aug 25, 2021

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

<table>
<thead>
<tr>
<th>Map Unit Symbol</th>
<th>Map Unit Name</th>
<th>Acres in AOI</th>
<th>Percent of AOI</th>
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</thead>
<tbody>
<tr>
<td>73</td>
<td>Nunn clay loam, 0 to 1 percent slopes</td>
<td>8.5</td>
<td>93.6%</td>
</tr>
<tr>
<td>118</td>
<td>Wiley silt loam, 1 to 3 percent slopes</td>
<td>0.6</td>
<td>6.4%</td>
</tr>
<tr>
<td><strong>Totals for Area of Interest</strong></td>
<td></td>
<td><strong>9.1</strong></td>
<td><strong>100.0%</strong></td>
</tr>
</tbody>
</table>
Hydrologic Soil Group—Larimer County Area, Colorado
(Harvest 47)

Natural Resources Conservation Service
Web Soil Survey
National Cooperative Soil Survey

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

Map Scale: 1:1,420 if printed on A landscape (11" x 8.5") sheet.

N

0 50 100 200 300

0 20 40 80 120

Feet

Meters

Soil Map may not be valid at this scale.
The soil surveys that comprise your AOI were mapped at 1:24,000.

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Hydrologic Soil Group

<table>
<thead>
<tr>
<th>Map unit symbol</th>
<th>Map unit name</th>
<th>Rating</th>
<th>Acres in AOI</th>
<th>Percent of AOI</th>
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<tbody>
<tr>
<td>73</td>
<td>Nunn clay loam, 0 to 1 percent slopes</td>
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<td>8.5</td>
<td>93.6%</td>
</tr>
<tr>
<td>118</td>
<td>Wiley silt loam, 1 to 3 percent slopes</td>
<td>B</td>
<td>0.6</td>
<td>6.4%</td>
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<tr>
<td><strong>Totals for Area of Interest</strong></td>
<td></td>
<td></td>
<td><strong>9.1</strong></td>
<td><strong>100.0%</strong></td>
</tr>
</tbody>
</table>

Description

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

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

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

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

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

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

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

Rating Options

*Aggregation Method: Dominant Condition*
Component Percent Cutoff: None Specified
Tie-break Rule: Higher
Hydrologic Calculations
### Calculation of Peak Runoff using Rational Method

| Subcatchment | Area (ac) | NRCS Hydrologic Soil Group | Percent Impervious | 2-yr | 5-yr | 10-yr | 25-yr | 50-yr | 100-yr | 500-yr | 2-yr | 5-yr | 10-yr | 25-yr | 50-yr | 100-yr | 500-yr | 2-yr | 5-yr | 10-yr | 25-yr | 50-yr | 100-yr | 500-yr |
|--------------|-----------|----------------------------|------------------|------|-----|------|------|------|-------|-------|------|-----|------|------|------|-------|-------|------|-----|------|------|------|-------|-------|------|
| A            | 0.23      | C                           | 45.0             | 0.23 | 0.31 | 0.46 | 0.57 | 0.62 | 0.67 | 0.73 | 5.01 | 7.10 | 7.10 | 2.60 | 3.40 | 4.28 | 5.88 | 7.28 | 8.84 | 13.22 |
| B            | 0.30      | C                           | 45.0             | 0.30 | 0.38 | 0.46 | 0.57 | 0.62 | 0.67 | 0.73 | 5.01 | 7.10 | 7.10 | 2.60 | 3.40 | 4.28 | 5.88 | 7.28 | 8.84 | 13.22 |
| C            | 0.35      | C                           | 45.0             | 0.35 | 0.40 | 0.46 | 0.57 | 0.62 | 0.67 | 0.73 | 5.01 | 7.10 | 7.10 | 2.60 | 3.40 | 4.28 | 5.88 | 7.28 | 8.84 | 13.22 |
| D            | 0.40      | C                           | 45.0             | 0.40 | 0.46 | 0.57 | 0.62 | 0.67 | 0.73 | 5.01 | 7.10 | 7.10 | 2.60 | 3.40 | 4.28 | 5.88 | 7.28 | 8.84 | 13.22 |
| E            | 0.45      | C                           | 45.0             | 0.45 | 0.46 | 0.57 | 0.62 | 0.67 | 0.73 | 5.01 | 7.10 | 7.10 | 2.60 | 3.40 | 4.28 | 5.88 | 7.28 | 8.84 | 13.22 |

**Rainfall Intensity Equation Coefficients**

\[
I = a \times P + t
\]

- **I**: Rainfall intensity (in/hr)
- **a**: Coefficient
- **P**: Rainfall depth (in)
- **t**: Computed time of concentration (min)

**Selected Coefficients**

- **a**: 0.34
- **b**: 0.58
- **t**: 0.20

**Calculation of Peak Runoff using Rational Method**

1. **Overland Flow Length**
   - \( L_i \) (ft)
2. **Overland Flow Time**
   - \( t_i \) (min)
3. **Channelized Flow Length**
   - \( L_t \) (ft)
4. **Channelized Flow Time**
   - \( t_t \) (min)
5. **NRCS Conveyance Factor**
   - \( K \)
6. **NRCS Conveyance Velocity**
   - \( V \) (ft/sec)

**Equations**

- For Overland Flow:
  - \( t_i = \frac{L_i}{S_i} \)
  - \( L_i = \frac{K_i \times Q_i}{V_i} \)
  - \( S_i = \frac{K_i \times Q_i}{V_i} \)

- For Channelized Flow:
  - \( t_t = \frac{L_t}{S_t} \)

**Table Data**

- **Cells of this color are for calculated results based on overrides**
- **Cells of this color are for required user-input**
- **Cells of this color are for optional override values**

**Additional Information**

- Calculations based on Rational Method
- Rainfall Intensity, \( I = a \times P + t \)
- Time of Concentration, \( t_c = 0.395 \times (1 - C) \)

**Notes**

- *CLOCK: 10/4/2023*
Hydraulic Calculations
### INLET MANAGEMENT

<table>
<thead>
<tr>
<th>INLET NAME</th>
<th>Site Q</th>
<th>Site T</th>
<th>Site I</th>
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<tr>
<td>Inlet Type (Urban or Rural)</td>
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<td>URBAN</td>
<td>URBAN</td>
</tr>
<tr>
<td>Inlet Application (Street or Area)</td>
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<td>CDOT Type R Curb Opening</td>
<td>CDOT Type R Curb Opening</td>
<td>CDOT Type R Curb Opening</td>
</tr>
</tbody>
</table>

#### USER-DEFINED INPUT

<table>
<thead>
<tr>
<th>User-Defined Design Flows</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minor ( Q_{b} ) (cfs)</td>
</tr>
<tr>
<td>Major ( Q_{b} ) (cfs)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Bypass (Carry-Over) Flow from Upstream</th>
</tr>
</thead>
<tbody>
<tr>
<td>Receive Bypass Flow from:</td>
</tr>
<tr>
<td>Minor Bypass Flow ( Q_{b} ) (cfs)</td>
</tr>
<tr>
<td>Major Bypass Flow ( Q_{b} ) (cfs)</td>
</tr>
</tbody>
</table>

#### Watershed Characteristics

<table>
<thead>
<tr>
<th>Overland Length (ft)</th>
<th>In Sump</th>
<th>In Sump</th>
<th>In Sump</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minor Flow ( Q_{b} ) (cfs)</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Major Flow ( Q_{b} ) (cfs)</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
</tbody>
</table>

#### Minor Storm Rainfall Input

<table>
<thead>
<tr>
<th>Design Storm Return Period, ( T ) (years)</th>
<th>One-Hour Precipitation, ( P_{1} ) (inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minor Total Design Peak Flow, ( Q ) (cfs)</td>
<td>0.1</td>
</tr>
<tr>
<td>Major Total Design Peak Flow, ( Q ) (cfs)</td>
<td>0.6</td>
</tr>
<tr>
<td>Minor Flow Bypassed Upstream, ( Q_{b} ) (cfs)</td>
<td>0.0</td>
</tr>
<tr>
<td>Major Flow Bypassed Upstream, ( Q_{b} ) (cfs)</td>
<td>0.0</td>
</tr>
</tbody>
</table>

#### Calculated Output

<table>
<thead>
<tr>
<th>Minor Storm (Calculated) Analysis of Flow Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>( T_{c} )</td>
</tr>
<tr>
<td>C</td>
</tr>
<tr>
<td>( t_{r} )</td>
</tr>
<tr>
<td>Overland Flow Velocity, ( V_{o} )</td>
</tr>
<tr>
<td>Channel Flow Velocity, ( V_{c} )</td>
</tr>
<tr>
<td>Overland Flow Time, ( t_{o} )</td>
</tr>
<tr>
<td>Calculated Time of Concentration, ( t_{c} )</td>
</tr>
<tr>
<td>Regional ( T_{r} )</td>
</tr>
<tr>
<td>( t_{r} ) selected by User</td>
</tr>
<tr>
<td>Design Rainfall Intensity, ( I )</td>
</tr>
<tr>
<td>Calculated Local Peak Flow, ( Q_{p} )</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Major Storm (Calculated) Analysis of Flow Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>( T_{c} )</td>
</tr>
<tr>
<td>C</td>
</tr>
<tr>
<td>( t_{r} )</td>
</tr>
<tr>
<td>Overland Flow Velocity, ( V_{o} )</td>
</tr>
<tr>
<td>Channel Flow Velocity, ( V_{c} )</td>
</tr>
<tr>
<td>Overland Flow Time, ( t_{o} )</td>
</tr>
<tr>
<td>Calculated Time of Concentration, ( t_{c} )</td>
</tr>
<tr>
<td>Regional ( T_{r} )</td>
</tr>
<tr>
<td>( t_{r} ) selected by User</td>
</tr>
<tr>
<td>Design Rainfall Intensity, ( I )</td>
</tr>
<tr>
<td>Calculated Local Peak Flow, ( Q_{p} )</td>
</tr>
</tbody>
</table>
### Gutter Geometry (Enter data in the blue cells)

- **Maximum Allowable Width for Spread Behind Curb**: $T_{MAX} = 5.0$ ft
- **Side Slope Behind Curb** (leave blank for no conveyance credit behind curb): $S_{BACK} = 0.020$ ft/ft
- **Manning's Roughness Behind Curb** (typically between 0.012 and 0.020): $n_{BACK} = 0.020$
- **Height of Curb at Gutter Flow Line**: $H_{CURB} = 6.00$ inches
- **Distance from Curb Face to Street Crown**: $T_{CROWN} = 10.0$ ft
- **Gutter Width**: $W = 1.00$ ft
- **Street Transverse Slope**: $S_{X} = 0.020$ ft/ft
- **Gutter Cross Slope** (typically 2 inches over 24 inches or 0.083 ft/ft): $S_{W} = 0.083$ ft/ft
- **Street Longitudinal Slope** - Enter 0 for sump condition: $S_{O} = 0.010$ ft/ft
- **Manning's Roughness for Street Section** (typically between 0.012 and 0.020): $n_{STREET} = 0.020$
- **Min. Allowable Spread for Minor & Major Storm**: $T_{MAX} = 10.0$ ft
- **Max. Allowable Depth at Gutter Flowline for Minor & Major Storm**: $d_{MAX} = 4.0$ inches
- **Allow Flow Depth at Street Crown** (leave blank for no check): yes

### Allowable Capacity for One-Half of Street (Minor & Major Storm)

<table>
<thead>
<tr>
<th></th>
<th>Minor Storm</th>
<th>Major Storm</th>
</tr>
</thead>
<tbody>
<tr>
<td>$Q_{allow}$</td>
<td>2.1 cfs</td>
<td>2.1 cfs</td>
</tr>
</tbody>
</table>

**Minor Storm Allowable Capacity** is based on Spread Criterion

**Major Storm Allowable Capacity** is based on Spread Criterion

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'
### Design Information (Input)

<table>
<thead>
<tr>
<th>MINOR</th>
<th>MAJOR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type of Inlet:</td>
<td>CDOT Type R Curb Opening</td>
</tr>
<tr>
<td>Local Depression (additional to continuous gutter depression ( 'a' ))</td>
<td>( a )</td>
</tr>
<tr>
<td>Total Number of Units in the Inlet (Grate or Curb Opening)</td>
<td>( N_o )</td>
</tr>
<tr>
<td>Length of a Single Unit Inlet (Grate or Curb Opening)</td>
<td>( L_i )</td>
</tr>
<tr>
<td>Width of a Unit Grate (cannot be greater than ( W_i ), Gutter Width)</td>
<td>( W_i )</td>
</tr>
<tr>
<td>Clogging Factor for a Single Unit Grate (typical min. value = 0.5)</td>
<td>( C_{GC} )</td>
</tr>
<tr>
<td>Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)</td>
<td>( C_{GC} )</td>
</tr>
</tbody>
</table>

### Effect Hydraulics: OK \( Q < \) Allowable Street Capacity

<table>
<thead>
<tr>
<th>MINOR</th>
<th>MAJOR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design Discharge for Half of Street (from Sheet Inlet Management)</td>
<td>( Q_o )</td>
</tr>
<tr>
<td>Water Spread Width</td>
<td>( T )</td>
</tr>
<tr>
<td>Water Depth at Flowline (outside of local depression)</td>
<td>( d )</td>
</tr>
<tr>
<td>Water Depth at Street Crown (or at ( T_{MAX} ))</td>
<td>( d_{CROWN} )</td>
</tr>
<tr>
<td>Ratio of Gutter Flow to Design Flow</td>
<td>( E_o )</td>
</tr>
<tr>
<td>Discharge within the Gutter Section W</td>
<td>( Q_w )</td>
</tr>
<tr>
<td>Discharge Behind the Curb Face</td>
<td>( Q_{BACK} )</td>
</tr>
<tr>
<td>Flow Area within the Gutter Section W</td>
<td>( A_o )</td>
</tr>
<tr>
<td>Velocity within the Gutter Section W</td>
<td>( V_w )</td>
</tr>
<tr>
<td>Water Depth for Design Condition</td>
<td>( d_{LOCAL} )</td>
</tr>
</tbody>
</table>

### Grate Analysis (Calculated)

<table>
<thead>
<tr>
<th>MINOR</th>
<th>MAJOR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Length of Inlet Grate Opening</td>
<td>( L )</td>
</tr>
<tr>
<td>Ratio of Grate Flow to Design Flow</td>
<td>( E_{GRATE} )</td>
</tr>
<tr>
<td>Under No-Clogging Condition</td>
<td></td>
</tr>
<tr>
<td>Minimum Velocity Where Grate Splash-Over Begins</td>
<td>( V_s )</td>
</tr>
<tr>
<td>Interception Rate of Frontal Flow</td>
<td>( R_s )</td>
</tr>
<tr>
<td>Interception Rate of Side Flow</td>
<td>( R_x )</td>
</tr>
<tr>
<td>Interception Capacity</td>
<td>( Q_i )</td>
</tr>
<tr>
<td>Under Clogging Condition</td>
<td></td>
</tr>
<tr>
<td>Clogging Coefficient for Multiple-unit Grate Inlet</td>
<td>( GrateCoef )</td>
</tr>
<tr>
<td>Clogging Factor for Multiple-unit Grate Inlet</td>
<td>( GrateClog )</td>
</tr>
<tr>
<td>Effective (unclogged) Length of Multiple-unit Grate Inlet</td>
<td>( L_{E} )</td>
</tr>
<tr>
<td>Minimum Velocity Where Grate Splash-Over Begins</td>
<td>( V_s )</td>
</tr>
<tr>
<td>Interception Rate of Frontal Flow</td>
<td>( R_s )</td>
</tr>
<tr>
<td>Interception Rate of Side Flow</td>
<td>( R_x )</td>
</tr>
<tr>
<td>Actual Interception Capacity</td>
<td>( Q_a )</td>
</tr>
<tr>
<td>Carry-Over Flow ( = Q_o - Q_a ) (to be applied to curb opening or next d/s inlet)</td>
<td>( Q_b )</td>
</tr>
</tbody>
</table>

### Curb or Slotted Inlet Opening Analysis (Calculated)

<table>
<thead>
<tr>
<th>MINOR</th>
<th>MAJOR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Equivalent Slope ( S_e ) (based on grate carry-over)</td>
<td>( S_e )</td>
</tr>
<tr>
<td>Required Length ( L_1 ) to Have 100% Interception</td>
<td>( L_1 )</td>
</tr>
<tr>
<td>Under No-Clogging Condition</td>
<td></td>
</tr>
<tr>
<td>Effective Length of Curb Opening or Slotted Inlet (minimum of ( L, L_1 ))</td>
<td>( L )</td>
</tr>
<tr>
<td>Interception Capacity</td>
<td>( Q_i )</td>
</tr>
<tr>
<td>Under Clogging Condition</td>
<td></td>
</tr>
<tr>
<td>Clogging Coefficient</td>
<td>( CurbCoef )</td>
</tr>
<tr>
<td>Clogging Factor for Multiple-unit Curb Opening or Slotted Inlet</td>
<td>( CurbClog )</td>
</tr>
<tr>
<td>Effective (Unclogged) Length</td>
<td>( L_{E} )</td>
</tr>
<tr>
<td>Actual Interception Capacity</td>
<td>( Q_a )</td>
</tr>
<tr>
<td>Carry-Over Flow ( = Q_{BACK} + Q_b )</td>
<td>( Q_b )</td>
</tr>
</tbody>
</table>

### Summary

<table>
<thead>
<tr>
<th>MINOR</th>
<th>MAJOR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Inlet Interception Capacity</td>
<td>( Q )</td>
</tr>
<tr>
<td>Total Inlet Carry-Over Flow (flow bypassing inlet)</td>
<td>( Q_b )</td>
</tr>
<tr>
<td>Capture Percentage ( = Q/Q_o )</td>
<td>( C% )</td>
</tr>
</tbody>
</table>
Gutter Geometry (Enter data in the blue cells)

- Maximum Allowable Width for Spread Behind Curb
- Side Slope Behind Curb (leave blank for no conveyance credit behind curb)
- Manning's Roughness Behind Curb (typically between 0.012 and 0.020)
- Height of Curb at Gutter Flow Line
- Distance from Curb Face to Street Crown
- Gutter Width
- Street Transverse Slope
- Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)
- Street Longitudinal Slope - Enter 0 for sump condition
- Manning's Roughness for Street Section (typically between 0.012 and 0.020)

- Max. Allowable Spread for Minor & Major Storm
- Max. Allowable Depth at Gutter Flowline for Minor & Major Storm
- Check boxes are not applicable in SUMP conditions

MINOR STORM Allowable Capacity is based on Depth Criterion
MAJOR STORM Allowable Capacity is based on Depth Criterion

Q_{allow} = [SUMP] [SUMP] cfs
### Design Information (Input)

<table>
<thead>
<tr>
<th>MINOR</th>
<th>MAJOR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type of Inlet</td>
<td>CDOT Type R Curb Opening</td>
</tr>
<tr>
<td>Local Depression (additional to continuous gutter depression 'a' from above)</td>
<td></td>
</tr>
<tr>
<td>Number of Unit Inlets (Grate or Curb Opening)</td>
<td></td>
</tr>
<tr>
<td>Water Depth at Flowline (outside of local depression)</td>
<td></td>
</tr>
<tr>
<td>Grate Information</td>
<td></td>
</tr>
<tr>
<td>Length of a Unit Grate</td>
<td></td>
</tr>
<tr>
<td>Width of a Unit Grate</td>
<td></td>
</tr>
<tr>
<td>Area Opening Ratio for a Grate (typical values 0.15-0.90)</td>
<td></td>
</tr>
<tr>
<td>Grate Weir Coefficient (typical value 2.15 - 3.60)</td>
<td></td>
</tr>
<tr>
<td>Grate Orifice Coefficient (typical value 0.60 - 0.80)</td>
<td></td>
</tr>
<tr>
<td>Curb Opening Information</td>
<td></td>
</tr>
<tr>
<td>Length of a Unit Curb Opening</td>
<td></td>
</tr>
<tr>
<td>Height of Vertical Curb Opening in Inches</td>
<td></td>
</tr>
<tr>
<td>Height of Curb Orifice Throat in Inches</td>
<td></td>
</tr>
<tr>
<td>Angle of Throat (see USDCM Figure ST-5)</td>
<td></td>
</tr>
<tr>
<td>Side Width for Depression Pan (typically the gutter width of 2 feet)</td>
<td></td>
</tr>
<tr>
<td>Clogging Factor for a Single Curb Opening (typical value 0.10)</td>
<td></td>
</tr>
<tr>
<td>Curb Opening Weir Coefficient (typical value 2.3-3.7)</td>
<td></td>
</tr>
<tr>
<td>Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)</td>
<td></td>
</tr>
<tr>
<td>Low Head Performance Reduction (Calculated)</td>
<td></td>
</tr>
<tr>
<td>Depth for Grate Midwidth</td>
<td></td>
</tr>
<tr>
<td>Depth for Curb Opening Weir Equation</td>
<td></td>
</tr>
<tr>
<td>Combination Inlet Performance Reduction Factor for Long Inlets</td>
<td></td>
</tr>
<tr>
<td>Grated Inlet Performance Reduction Factor for Long Inlets</td>
<td></td>
</tr>
<tr>
<td>Total Inlet Interception Capacity (assumes clogged condition)</td>
<td></td>
</tr>
</tbody>
</table>

### Override Depths

<table>
<thead>
<tr>
<th>MINOR</th>
<th>MAJOR</th>
</tr>
</thead>
<tbody>
<tr>
<td>No</td>
<td>1</td>
</tr>
<tr>
<td>Ponding Depth</td>
<td>4.8 7.0</td>
</tr>
</tbody>
</table>

### Override Depths

<table>
<thead>
<tr>
<th>MINOR</th>
<th>MAJOR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lo (G)</td>
<td>N/A</td>
</tr>
<tr>
<td>Wo</td>
<td>N/A</td>
</tr>
<tr>
<td>Hvert</td>
<td>6.00</td>
</tr>
<tr>
<td>Hthroat</td>
<td>6.00</td>
</tr>
<tr>
<td>Theta</td>
<td>63.40</td>
</tr>
<tr>
<td>Wp</td>
<td>1.00</td>
</tr>
<tr>
<td>C1 (C)</td>
<td>0.10</td>
</tr>
<tr>
<td>C2 (C)</td>
<td>0.67</td>
</tr>
</tbody>
</table>

### Low Head Performance Reduction (Calculated)

<table>
<thead>
<tr>
<th>MINOR</th>
<th>MAJOR</th>
</tr>
</thead>
<tbody>
<tr>
<td>dGrate</td>
<td>N/A</td>
</tr>
<tr>
<td>dCurb</td>
<td>N/A</td>
</tr>
<tr>
<td>RFGrate</td>
<td>0.32</td>
</tr>
<tr>
<td>RFcurb</td>
<td>0.46</td>
</tr>
<tr>
<td>RFGrate</td>
<td>0.66</td>
</tr>
</tbody>
</table>

### Total Inlet Interception Capacity (assumes clogged condition)

<table>
<thead>
<tr>
<th>MINOR</th>
<th>MAJOR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Qa</td>
<td>6.2</td>
</tr>
<tr>
<td>Qpeak</td>
<td>2.0</td>
</tr>
</tbody>
</table>

*Inlet Capacity IS GOOD for Minor and Major Storms (>Q PEAK)*
Gutter Geometry (Enter data in the blue cells)

- Maximum Allowable Width for Spread Behind Curb
- Side Slope Behind Curb (leave blank for no conveyance credit behind curb)
- Manning's Roughness Behind Curb (typically between 0.012 and 0.020)
- Height of Curb at Gutter Flow Line
- Distance from Curb Face to Street Crown
- Gutter Width
- Street Transverse Slope
- Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)
- Street Longitudinal Slope - Enter 0 for sump condition
- Manning's Roughness for Street Section (typically between 0.012 and 0.020)

- Max. Allowable Spread for Minor & Major Storm
- Max. Allowable Depth at Gutter Flowline for Minor & Major Storm
- Check boxes are not applicable in SUMP conditions

MINOR STORM Allowable Capacity is based on Depth Criterion
MAJOR STORM Allowable Capacity is based on Depth Criterion
### Design Information (Input)

<table>
<thead>
<tr>
<th>Type of Inlet</th>
<th>CDOT Type R Curb Opening</th>
</tr>
</thead>
<tbody>
<tr>
<td>Local Depression (additional to continuous gutter depression 'a' from above)</td>
<td>3.00</td>
</tr>
<tr>
<td>Number of Unit Inlets (Grate or Curb Opening)</td>
<td>1</td>
</tr>
<tr>
<td>Water Depth at Flowline (outside of local depression)</td>
<td>4.8</td>
</tr>
</tbody>
</table>

### Grate Information

| Length of a Unit Grate | N/A |
| Width of a Unit Grate | N/A |
| Area Opening Ratio for a Grate (typical values 0.15-0.90) | N/A |
| Grate Weir Coefficient (typical value 2.15 - 3.60) | N/A |
| Grate Orifice Coefficient (typical value 0.60 - 0.80) | N/A |

### Curb Opening Information

| Length of a Unit Curb Opening | 10.00 |
| Height of Vertical Curb Opening in Inches | 6.00 |
| Height of Curb Orifice Throat in Inches | 6.00 |
| Angle of Throat (see USDCM Figure ST-5) | 63.40 |
| Side Width for Depression Pan (typically the gutter width of 2 feet) | 1.00 |
| Clogging Factor for a Single Curb Opening (typical value 0.10) | 0.10 |
| Curb Opening Weir Coefficient (typical value 2.3-3.7) | 3.60 |
| Curb Opening Orifice Coefficient (typical value 0.60 - 0.70) | 0.67 |

### Low Head Performance Reduction (Calculated)

| Depth for Grate Midwidth | N/A |
| Depth for Curb Opening Weir Equation | 0.32 |
| Combination Inlet Performance Reduction Factor for Long Inlets | 0.46 |
| Grated Inlet Performance Reduction Factor for Long Inlets | N/A |

### Total Inlet Interception Capacity (assumes clogged condition)

<table>
<thead>
<tr>
<th>Qa</th>
<th>MINOR</th>
<th>MAJOR</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.2</td>
<td>10.0</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Q_{PEAK}</th>
<th>MINOR</th>
<th>MAJOR</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.3</td>
<td>2.5</td>
<td></td>
</tr>
</tbody>
</table>
### Watershed Information

- **Selected BMP Type:** EDB
- **Watershed Area:** 6.16 acres
- **Watershed Length:** 700 ft
- **Watershed Length to Centroid:** 300 ft
- **Watershed Slope:** 0.015
- **Watershed Imperviousness:** 45.00% percent
- **Percentage Hydrologic Soil Group A:** 6.4% percent
- **Percentage Hydrologic Soil Groups C/D:** 93.6% percent
- **Target WQCV Drain Time:** 40.0 hours
- **Location for 1-hr Rainfall Depths:** User Input

### Optional User Overrides

### Watershed Area = 6.16 acres

<table>
<thead>
<tr>
<th>Stage Storage Description</th>
<th>Stage (ft)</th>
<th>Optional Override Stage (ft)</th>
<th>Length (ft)</th>
<th>Width (ft)</th>
<th>Area (ft²)</th>
<th>Optional Override Area (ft²)</th>
<th>Volume (ft³)</th>
<th>Volume (ac-ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Top of Micropipet</td>
<td>4,986.60</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>97</td>
<td>0.002</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>4,986.70</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>399</td>
<td>0.009</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>4,986.80</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>961</td>
<td>0.022</td>
<td>98</td>
</tr>
<tr>
<td></td>
<td>4,986.90</td>
<td>--</td>
<td>--</td>
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<td>0.235</td>
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<td>11,448</td>
<td>0.263</td>
<td>5,154</td>
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<tr>
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<td>4,987.90</td>
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<td>--</td>
<td>12,424</td>
<td>0.285</td>
<td>6,347</td>
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</table>

### Optional User Overrides

- **Water Quality Capture Volume (WQCV):** 0.099 acre-feet
- **Excess Urban Runoff Volume (EURV):** 0.362 acre-feet
- **2-yr Runoff Volume (PI = 0.81 in.):** 0.160 acre-feet
- **5-yr Runoff Volume (PI = 1.08 in.):** 0.246 acre-feet
- **10-yr Runoff Volume (PI = 1.38 in.):** 0.377 acre-feet
- **25-yr Runoff Volume (PI = 1.87 in.):** 0.441 acre-feet
- **50-yr Runoff Volume (PI = 2.32 in.):** 0.874 acre-feet
- **100-yr Runoff Volume (PI = 2.84 in.):** 1.165 acre-feet
- **500-yr Runoff Volume (PI = 4.32 in.):** 1.959 acre-feet
- **Approximate 2-yr Detention Volume:** 0.155 acre-feet
- **Approximate 5-yr Detention Volume:** 0.248 acre-feet
- **Approximate 10-yr Detention Volume:** 0.313 acre-feet
- **Approximate 25-yr Detention Volume:** 0.405 acre-feet
- **Approximate 50-yr Detention Volume:** 0.464 acre-feet
- **Approximate 100-yr Detention Volume:** 0.586 acre-feet

### Define Zones and Basin Geometry

- **Zone 1 Volume (WQCV):** 0.099 acre-feet
- **Zone 2 Volume (2-yr - Zone 1):** 0.056 acre-feet
- **Zone 3 Volume (100-yr - Zones 1 & 2):** 0.431 acre-feet
- **Total Detention Basin Volume:** 0.586 acre-feet
- **Initial Surchage Volume (ISV):** user ft
- **Initial Surchage Depth (ISD):** user ft
- **Total Available Detention Depth (Hₜₐₚₜ):** user ft
- **Depth of Trickle Channel (Hₜₐₜ):** user ft
- **Slope of Trickle Channel (Sₜₐₜ):** user ft
- **Slopes of Main Basin Sides (Sₐₚₜ):** user H/V
- **Basin Length-to-Width Ratio (Rₜₚₜ):** user
- **Initial Surchage Area (Aₛₚₜ):** user ft²
- **Surchage Volume Length (Lₛₚₜ):** user ft
- **Surchage Volume Width (Wₛₚₜ):** user ft
- **Depth of Basin Floor (Hₘₚₜ):** user ft
- **Length of Basin Floor (Lₘₚₜ):** user ft
- **Width of Basin Floor (Wₘₚₜ):** user ft
- **Volume of Basin Floor (Vₘₚₜ):** user acre-ft
- **Depth of Main Basin (Hₐₚₜ):** user ft
- **Length of Main Basin (Lₐₚₜ):** user ft
- **Width of Main Basin (Wₐₚₜ):** user ft
- **Area of Main Basin (Aₐₚₜ):** user ft²
- **Volume of Main Basin (Vₐₚₜ):** user acre-ft
- **Calculated Total Basin Volume (Vₜₚₜ):** user acre-ft

---

MHFD-Detention_v4-06, Basin

9/20/2023, 10:21 AM
### DETENTION BASIN OUTLET STRUCTURE DESIGN

**Project:** Harvest 47 Subdivision  
**Basin ID:** Site

#### Example Zone Configuration (Retention Pond)

<table>
<thead>
<tr>
<th>Zone</th>
<th>(WQCV)</th>
<th>Volume</th>
<th>Outlet Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1.13</td>
<td>0.099</td>
<td>Orifice Plate</td>
</tr>
<tr>
<td>2</td>
<td>1.34</td>
<td>0.056</td>
<td>Circular Orifice</td>
</tr>
<tr>
<td>3</td>
<td>2.56</td>
<td>0.431</td>
<td>Weir &amp; Pipe (Restrict)</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>0.586</td>
<td></td>
</tr>
</tbody>
</table>

**User Input:**  
- Orifice at Underdrain Outlet (typically used to drain WQCV in a Filtration BMP)  
- Orifice Plate with one or more orifices or Elliptical Slot Weir (typically used to drain WQCV and/or EURV in a sedimentation BMP)  
- Orifice at Underdrain Outlet (typically used to drain WQCV in a Filtration BMP)  
- Vertical Orifice (Circular or Rectangular)

#### Calculated Parameters for Underdrain

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Underdrain Orifice Invert Depth</td>
<td></td>
</tr>
<tr>
<td>Underdrain Orifice Diameter</td>
<td></td>
</tr>
<tr>
<td>Underdrain Orifice Height Above Pipe</td>
<td></td>
</tr>
</tbody>
</table>

#### Calculated Parameters for Plate

- **Centroid of Lowest Orifice:**
  - Depth (relative to basin bottom at Stage = 0 ft)  
  - Orifice Area per Row |

#### Calculated Parameters for Overflow Weir

- **Overflow Weir Front Edge Height, H0:**
  - Height of Grate Upper Edge, H |

**Calculations for Various Structures:**

- **Vertical Orifice**
- **Overflow Weir** (Dropbox with Flat or Slotted Grate and Outlet Pipe OR Rectangular Trapezoidal Weir and No Outlet Pipe)
- **Outlet Pipe w/ Flow Restriction Plate (Circular Orifice, Restrictor Plate, or Rectangular Orifice)**
- **Emergency Spillway (Rectangular or Trapezoidal)**

#### Spillway Design Flow Depth

- **Spillway Invert Stage:** 4.00 ft (relative to basin bottom at Stage = 0 ft)  
- **Spillway Crest Length:** 20.00 feet  
- **Spillway End Slopes:** 4.00 H:V

<table>
<thead>
<tr>
<th>Structure Controlling Flow</th>
<th>Max Velocity through Grate</th>
<th>Maximum Ponds per (ft)</th>
<th>Maximum Ponding Depth (ft)</th>
<th>Maximum Ponding Depth (acres)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vertical Orifice (V)</td>
<td>Vertical Orifice (V)</td>
<td>Vertical Orifice (V)</td>
<td>Vertical Orifice (V)</td>
<td>Vertical Orifice (V)</td>
</tr>
<tr>
<td>Vertical Orifice (V)</td>
<td>Vertical Orifice (V)</td>
<td>Vertical Orifice (V)</td>
<td>Vertical Orifice (V)</td>
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</tr>
<tr>
<td>Vertical Orifice (V)</td>
<td>Vertical Orifice (V)</td>
<td>Vertical Orifice (V)</td>
<td>Vertical Orifice (V)</td>
<td>Vertical Orifice (V)</td>
</tr>
</tbody>
</table>

#### Inflow Hydrographs

**MHFD-Detention, Version 4.06 (July 2022)**

- **Estimated Stage (ft) | Estimated Volume (ac-ft) | Outlet Type**
## DETENTION BASIN OUTLET STRUCTURE DESIGN

### Inflow Hydrographs

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

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<tr>
<th>SOURCE</th>
<th>CUHP</th>
<th>CUHP</th>
<th>CUHP</th>
<th>CUHP</th>
<th>CUHP</th>
<th>CUHP</th>
<th>CUHP</th>
<th>CUHP</th>
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<td>0:00</td>
<td>0:00</td>
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<td>0:00</td>
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</tr>
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<td>0:15</td>
<td>0:20</td>
<td>0:25</td>
<td>0:30</td>
<td>0:35</td>
<td>0:40</td>
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</tr>
<tr>
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<td>0:10</td>
<td>0:10</td>
<td>0:10</td>
<td>0:10</td>
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<td>0:10</td>
</tr>
<tr>
<td>TIME</td>
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<td>1:00</td>
<td>1:10</td>
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<td>1:20</td>
<td>1:25</td>
<td>1:30</td>
<td>1:35</td>
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<td>3:45</td>
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<td>4:45</td>
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<td>0:50</td>
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</tbody>
</table>
RIPRAP APRON CALCULATION

End of Culvert into Pond

Outlet Variables

<table>
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<th>Quantity</th>
<th>Value</th>
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<tbody>
<tr>
<td>Pond</td>
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<tr>
<td>Number of Culverts</td>
<td>1</td>
</tr>
<tr>
<td>Pipe diameter, Do</td>
<td>30 in</td>
</tr>
<tr>
<td>Total Discharge, Q</td>
<td>17.5 cfs</td>
</tr>
<tr>
<td>Discharge, Qo</td>
<td>17.5 cfs</td>
</tr>
<tr>
<td>Allowable Velocity, V</td>
<td>5 fps for erosive soils and 7 fps for erosion resistant soils.</td>
</tr>
<tr>
<td>Is tailwater elevation known?</td>
<td>yes</td>
</tr>
<tr>
<td>Depth of tailwater</td>
<td>1.58 ft</td>
</tr>
</tbody>
</table>

Riprap Length and Size Calculations

Step 1:

\[ Y_t = \frac{Q}{V} = \frac{17.5}{5} = 3.5 \text{ ft} \]

\[ \frac{Y_t}{D} = \frac{0.6}{30} = 0.02 \]

\[ \frac{Q}{D^{1.5}} = \frac{17.5}{30^{1.5}} = 1.8 \]

Step 2:

From Figure MD-23, expansion factor, \( \frac{1}{2 \tan X} \) = 6.66

Step 3:

Length of Protection, \( L_p \) = 7.50 ft

Note: The length calculated was less than 15, so 15 was used.

Step 4:

If single conduit, use \( \frac{Q}{D^{1.5}} = 4.4 \)

If multiple conduit, use \( Q/W_i H_i^{1.5} \)

\[ \frac{Y_t}{D} = \frac{0.6}{30} = 0.02 \]

\[ \frac{Q}{W H^{0.5}} = \frac{17.5}{30^{0.5}} = 1.8 \]

From Figure MD-21, Riprap size, \( D_{50} \) = 9 in

Type: L

Recommendations?

9 in


Hydraulic Analysis

Chapter 9

Figures 9.96: Riprap apron detail for conduits in line with the channel

TABLE NO.7

<table>
<thead>
<tr>
<th>Material Type</th>
<th>% Density</th>
<th>Unit Weight</th>
<th>Volume Factor</th>
<th>D50</th>
<th>D60</th>
<th>D75</th>
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</thead>
<tbody>
<tr>
<td>Type I</td>
<td>0.88</td>
<td>120 lb/cu ft</td>
<td>0.95</td>
<td>2.5</td>
<td>1.8</td>
<td>1.5</td>
</tr>
<tr>
<td>Type II</td>
<td>0.90</td>
<td>120 lb/cu ft</td>
<td>0.92</td>
<td>2.7</td>
<td>2.0</td>
<td>1.6</td>
</tr>
<tr>
<td>Type III</td>
<td>0.88</td>
<td>120 lb/cu ft</td>
<td>0.94</td>
<td>1.8</td>
<td>1.3</td>
<td>1.0</td>
</tr>
<tr>
<td>Type IV</td>
<td>0.88</td>
<td>120 lb/cu ft</td>
<td>0.94</td>
<td>1.6</td>
<td>1.2</td>
<td>0.8</td>
</tr>
<tr>
<td>Type V</td>
<td>0.88</td>
<td>120 lb/cu ft</td>
<td>0.94</td>
<td>1.5</td>
<td>1.2</td>
<td>0.8</td>
</tr>
<tr>
<td>Type VI</td>
<td>0.88</td>
<td>120 lb/cu ft</td>
<td>0.94</td>
<td>1.4</td>
<td>1.2</td>
<td>0.8</td>
</tr>
</tbody>
</table>
**RIPRAP APRON CALCULATION - Overflow Spillway**

**Outlet Variables**
- Number of Culverts: 1
- Pipe diameter, Do: 30 inches
- Total Discharge, Q: 29.67 cfs
- Discharge, Qo: 29.67 cfs
- Allowable Velocity, V: 5 fps for erosive soils and 7 for erosion resistant soils.
- Is tailwater elevation known? No
- Depth of tailwater: 0 ft

**Riprap Length and Size Calculations**

**Step 1:**
- Yt = Tw, or 0.4 = 0.4 ft
- At = Qo/V = 5.934 ft
- Yt/Do = 0.2
- Q/Do^2.5 = 3.0

**Step 2:**
- From Figure MD-23, expansion factor, 1/(2*tan X) = 2

**Step 3:**
- Length of Protection, Lp = 24.67 ft
- If single conduit, use Qo/Do^1.5 = 7.5
- If multiple conduit, use Q/Wi*Hi^1.5
  - Yt/Do = 0.2
  - Q/WH^0.5
- From Figure MD-21, Riprap size, D50 = 18 in Type H

**Step 4:**
- Recommendations: 18 in Type H
- Reference Chapter 9 - Drainage Criteria Manual, Volume 1, Urban Drainage and Flood Control District.

**Step 5:** Compute width, T
- Lp = 24.67 ft
- X = 0.24 rad
- W = 2.5 ft
- tan(X) = 0.25
- T = 15 ft per culvert
- Total = 15 ft

---

**TABLE NO.7**

<table>
<thead>
<tr>
<th>Material Code</th>
<th>% Debris</th>
<th>Weight Percent</th>
<th>Maximum % Debris</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type I</td>
<td>10%</td>
<td>10%</td>
<td>10%</td>
</tr>
<tr>
<td>Type II</td>
<td>10%</td>
<td>20%</td>
<td>10%</td>
</tr>
<tr>
<td>Type III</td>
<td>10%</td>
<td>30%</td>
<td>10%</td>
</tr>
<tr>
<td>Type IV</td>
<td>10%</td>
<td>40%</td>
<td>10%</td>
</tr>
</tbody>
</table>

*a = 0.3, b = 0.6, c = 0.3*100, remains (depending on void) by weight
*b = 0.3, b = 0.6, c = 0.3*100, remains (depending on void) by weight

---

*Figure 9.14: Riprap apron detail for conduits to flow with the channel

9/06
Urban Drainage and Flood Control District
Urban Drainage and Flood Control District, Volume 1
September 2007
Excerpts from Previous Report
DRAINAGE INVESTIGATION
FOR
L & M ENTERPRISES - M.R.D.
LARIMER, COUNTY, COLORADO

Prepared for
L & M Enterprises, Inc.
835 East Highway No. 56
Berthoud, Colorado 80513

October 11, 1990
Project No. PLA-017-89

CONSULTING ENGINEER
MESSNER Engineering Associates
150 East 29th Street, Suite 225
Loveland, Colorado 80538
Civil and Environmental Engineering Consultants
Mr. Larry Bebo
L & M Enterprises, Inc.
835 E. Hwy. 56
Berthoud, Colorado 80513

Dear Mr. Bebo,

The enclosed report represents the results of a drainage investigation for the L & M ENTERPRISES - M.R.D. as applies to the proposed and existing accesses to L & M Enterprises, Inc. and the L & M Greenhouse located in Larimer County, Colorado.

This investigation was based upon the M.R.D. site development plan; on-site observations; and available topographic information. The investigation was performed in accordance with the criteria established in the Larimer County - "Storm Drainage Criteria Manual".

Enclosed you will find the results of this investigation. If you should have any questions or desire additional information, please feel free to contact this office.

Respectfully,

[Signature]

Devin R. Messner, P.E.
DRM/Inc.

Enclosure
TABLE OF CONTENTS

Letter of Transmittal i
Table of Contents ii
Scope 1
Site Description 1
Existing Conditions 1
Proposed Development 2
Conclusions and Recommendations 2

EXHIBITS

Vicinity Map Exhibit A
Calculations Exhibit B
Drainage Details Exhibit C
SCOPE

The following report represents the results of a drainage investigation for existing and future development to be known as the L & M ENTERPRISES - M.R.D., Larimer County, Colorado. The investigation was performed for L & M Enterprises, Inc. The purpose of this investigation is to determine the effects of the development on the areas existing drainage conditions and to determine the improvements, if any, and the appropriate sizing for proposed improvements so that it may be incorporated with the construction of access drives for the project. The conclusions and recommendations presented in this report are based upon the M.R.D. site development plan; proposed access construction plans; on-site observations; and the available topographic information. The analysis was performed in accordance with the Larimer County "Storm Drainage Criteria Manual".

SITE DESCRIPTION

The site is generally rectangular in shape and is 77.6± acres in area. The sites East-West dimension is approximately 1,329 feet and its North-South dimension varies from approximately 2,583 feet at the westerly boundary to approximately 2,527 feet at the easterly boundary. The site is situated approximately one-half mile east of the Town of Berthoud and abuts the southerly right-of-way of Colorado Highway 56. The site is not located within a designated floodway.

EXISTING CONDITIONS

The site is presently comprised of four distinct uses. A contracting business, L & M Enterprises, Inc., is situated on the 5± acre tract located at the northeast corner of the site. This tract is identified as Lot 3 on the attached exhibits. The existing retail greenhouse and landscaping materials business, L & M Greenhouse, is located on the 7.5± acre tract located immediately west of the contracting business. The greenhouse and associated landscaping materials business is located on Lot 4. Lot 2 is the largest of the parcels and comprises approximately 62.7 acres. This tract is currently being used for agricultural purposes. It is expected to be developed into service related retail uses along the Highway frontage with single-family residential to be situated on the balance of the tract. No near term development of this tract is anticipated. Lot 1 is a single-family residential lot with the existing Bebo residence. Lot 1 contains approximately 2.3 acres.

The site does not receive runoff from any other properties. The irrigation ditch which forms the southerly boundaries of Lots 3 and 4 is situated along the crest of a ridge traversing the site from west to east. The natural slope away from this ridge crest is 1% to 1.5%. The direction of fall away from the crest is towards the south and the north. The portion of the properties located to the west of the site on the northerly side of the ditch drain toward the north and eventually into the curb and gutter section of Highway 56. The runoff flows easterly along the gutter until the curb and gutter ends at a point on the easterly boundary of Lot 1. The runoff is then carried easterly in a roadside drainage swale. The swale is discharged into a inlet that is situated over the outlet pipe from Bacon Lake. This ultimately discharges into the little Thompson River.
PROPOSED DEVELOPMENT

The proposed construction is to consist of a new access to serve the existing greenhouse and landscaping business located on Lot 4 as well as the future development that is anticipated for Lot 2. The access is to be a dedicated public street. The existing accesses serving Lot 1 and Lot 3 are to remain.

The drainage considerations made for the existing and proposed accesses are:
1.) Only the area situated to the north of the existing irrigation ditch has been considered.
2.) The existing usage and development on Lot 3 has been considered in order to determine the volume of detention and rate of release to conform with the existing access permit requirements.
3.) Additional consideration was made for the ultimate paving of the greenhouse parking lot located on Lot 4 in order to determine the volume of detention and rate of release.
4.) No determination was made for the volume of detention and rate of release to be established on Lot 2. Due to the unknown nature of development that may occur on this lot, it is not possible to adequately project these requirements. The design and construction of these drainage improvements will be performed at the time that the property is considered for development.

CONCLUSIONS AND RECOMMENDATIONS

1. The construction as proposed will improve the existing drainage pattern to the benefit of the existing development in the vicinity.

2. Onsite detention of storm water is required by the Colorado State Department of Highways in order to discharge runoff from the site onto the existing Highway right-of-way.

3. All construction is recommended to be performed in accordance with the State of Colorado State Department of Highways-Standards and Specifications.

4. The site is not located within the designated floodway or flood plain.
Calculations for Drainage Investigation for L & M Enterprises - M.R.D.

Total Area = 77.6 acres ±
Area Considered = 26.75 acres ±

NOTE, only the area of the site that is situated north of the irrigation ditch traversing the site is considered to drain toward Highway 56.

Area "A" - located at the Northwest portion of the site that includes all of Lot 1 and all of Lot 2 that lies North of the irrigation ditch. No change from the existing conditions anticipated at this time.

Area = 15.3 acres ±

C₁₀ = 0.20  C₁₀₀ = 0.35

Tₑ = 25 minutes ±

Rainfall Intensities:
I₁₀ @ 25 min. = 2.85 in./hr  I₁₀₀ @ 25 min. = 4.6 in./hr.

Runoff, Q = CIA
Therefore, the Estimated Drainage Flow from the site concentrating at Point "A"
Q₁₀ = 8.7 c.f.s.  Q₁₀₀ = 24.6 c.f.s.

Area "B" - includes existing greenhouse and approximately one-half of the L & M Enterprises building and surrounding concrete pavement.

Area = 5.25 acres ±

Area of Impervious Coverage (Building and Concrete Pavement) = 2.15 acres ±
Therefore, Impervious Coverage = 41%
C₁₀ = 0.26  C₁₀₀ = 0.40

Tₑ = 15 minutes

Rainfall Intensities:
I₁₀ @ 15 min. = 3.65 in./hr  I₁₀₀ @ 15 min. = 6.0 in./hr.

Therefore, the Estimated Drainage Flow Concentrating at "B"
Q₁₀ = 8.6 c.f.s.  Q₁₀₀ = 17.3 c.f.s.

Area "C" - includes approximately one-half of the L & M Enterprises building and surrounding concrete pavement and the undeveloped portion to the South and West.

Area = 6.2 acres ±

Area of Impervious Coverage (Building and Concrete Pavement) = 1.4 acres ±
Therefore, Impervious Coverage = 23%
C₁₀ = 0.30  C₁₀₀ = 0.45
(Area "C" calculations cont.)

\[ T_c = 20 \text{ minutes} \]

Rainfall Intensities:
\[ I_{10} \text{ @ 20 min.} = 3.25 \text{ in./hr} \quad I_{100} \text{ @ 20 min.} = 5.2 \text{ in./hr}. \]

Therefore, the Estimated Drainage Flow Concentrating at "C"
\[ Q_{10} = 6.05 \text{ c.f.s.} \quad Q_{100} = 14.5 \text{ c.f.s.} \]

Total Area draining to Northeast corner of site.

Area = 26.75 acres ±

Area of Impervious Coverage (Building and Concrete Pavement) = 3.55 acres ±
Therefore, Impervious Coverage = 15%
\[ C_{10} = 0.27 \quad C_{100} = 0.41 \]

\[ T_c = 30 \text{ minutes} \]

Rainfall Intensities:
\[ I_{10} \text{ @ 30 min.} = 2.55 \text{ in./hr} \quad I_{100} \text{ @ 30 min.} = 4.2 \text{ in./hr}. \]

Therefore, the Estimated Drainage Flow Concentrating at the Northeast Corner
\[ Q_{10} = 18.4 \text{ c.f.s.} \quad Q_{100} = 46.1 \text{ c.f.s.} \]

DETENTION SIZING

Onsite Detention is to be required by the Colorado State Department of Highways.

The Urban Drainage and Flood Control District's criteria has been used. This is an imperical formula method, where:

\[ V = K A \]

\[ K_{100} = (1.78 \times I - 0.002 \times I^2 - 3.56) / 1000 \]
\[ K_{10} = (0.95 \times I - 1.90) / 1000 \]

\[ I = \text{Developed Basin imperviousness (\%) } \]
\[ A = \text{Basin Area (Acres)} \]
\[ V = \text{Volume (Acre-Feet)} \]

\[ Q_{100} = 1.00 \times A \]
\[ Q_{10} = 0.24 \times A \]

\[ Q = \text{Release Rate (Cubic-Feet-Per-Second)} \]
Area "B"
Detention Sizing

\[ I = 41\% \quad \text{Area} = 5.25 \text{ Acres} \]

\[ K_{10} = \frac{(0.95 \times 41 - 1.90)}{1000} = 0.037 \]
\[ K_{100} = \frac{(1.78 \times 41 - 0.002 \times 41^2 - 3.56)}{1000} = 0.066 \]

\[ V_{10} = K_{10} \times A = 0.037 \times 5.25 = 0.195 \text{ Ac-Ft} = 8,473 \text{ cu. ft.} \]
\[ V_{100} = K_{100} \times A = 0.066 \times 5.25 = 0.347 \text{ Ac-Ft} = 15,107 \text{ cu. ft.} \]

\[ Q_{10} = 0.24 \times 5.25 = 1.26 \text{ c.f.s.} \]
\[ Q_{100} = 1.00 \times 5.25 = 5.25 \text{ c.f.s.} \]

Outlet Sizing
Weir Equation \( Q = CLH^{3/2} \)

\[ Q = \text{Discharge (c.f.s.)} \]
\[ C = \text{Weir Coefficient} \]
\[ L = \text{Length (feet)} \]
\[ H = \text{Total Energy Head (feet)} \]

\[ L = \frac{Q}{CH^{3/2}} \]
\[ L_{10} = \frac{1.26}{(2.85 \times 0.50)^{3/2}} = 1.25 \text{ ft.} = 1\text{ ft.} - 3\text{ in.} \]
\[ L_{100} = \frac{5.25}{(2.85 \times 0.22)^{3/2}} = 17.85 \text{ ft.} = 17\text{ ft.} - 10\text{ -1/4 in.} \]

Area "C"
Detention Sizing

\[ I = 23\% \quad \text{Area} = 6.2 \text{ Acres} \]

\[ K_{10} = \frac{(0.95 \times 23 - 1.90)}{1000} = 0.02 \]
\[ K_{100} = \frac{(1.78 \times 23 - 0.002 \times 23^2 - 3.56)}{1000} = 0.04 \]

\[ V_{10} = K_{10} \times A = 0.02 \times 6.2 = 0.124 \text{ Ac-Ft} = 5,388 \text{ cu. ft.} \]
\[ V_{100} = K_{100} \times A = 0.04 \times 6.2 = 0.225 \text{ Ac-Ft} = 9,809 \text{ cu. ft.} \]

\[ Q_{10} = 0.24 \times 6.2 = 1.5 \text{ c.f.s.} \]
\[ Q_{100} = 1.00 \times 6.2 = 6.2 \text{ c.f.s.} \]

Outlet Sizing
\( L = \frac{Q}{CH^{3/2}} \)

\[ L_{10} = \frac{1.5}{(2.85 \times 1.00)^{3/2}} = 0.53 \text{ ft.} = 0\text{ ft.} - 6\text{ -5/16 in.} \]
\[ L_{100} = \frac{6.2}{(2.85 \times 0.5)^{3/2}} = 6.15 \text{ ft.} = 6 \text{ ft.} - 1\text{ -13/16 in.} \]
Curb @ Pt. "B" w/ Outlet Control
OPENING(S)

40' ±
17'-10½"

Top of Curb Level @ 99.05

Ft of Exist Drain-Pan = 98.33

Curb Minimum of 6" wide & 18" high

Concrete Control Str. @ Pt. "C"

2'
6'-1¾" 2'

0'-6½"

Weir Crest = 97.75

Outlet F = 96.75

Concrete to be minimum of 6" thick.

10-7-90.

L&M Enterprises
# HYD-017-89

DRAINAGE DETAILS
SHEET 1 OF 1
Extend Top of Berm Level at Elev. 99.05 to Point of Match

20' - 0"

17' - 10-1/4"

1' - 3"

Top of Curb Elev. = 99.05

Weir Crest Elev. = 98.83

Flowline Elevation of Existing
Concrete Pan = 98.33

CONCRETE CURB / CONTROL OPENING

6" Minimum

Height Varies 18" Maximum
to 8-5/8" Minimum

SECTION THRU CONCRETE CURB

Extend Top of Berm Level at Elev. 99.05 to Point of Match

3' Min.

Height Varies

SECTION A - A
( Earth Berm )

Note that berm may be widened and side
slopes flattened to match existing conditions

Revised: Sept. 24, 1991
By: DRM

L & M ENTERPRISES, INC.
# HYD - 017 - 89

DRAINAGE DETAIL
SHEET 1 of 2
DISCHARGE CONTROL OPENING @ DESIGN PT. "C"

Extend Top of Berm Level at Elev. 98.00 to Point of Match

9' - 0"

6' - 1-3/16"

0' - 6-5/16"

Top of Curb Elev. = 98.00
Weir Crest Elev. = 97.75
Flowline Elevation of Existing Concrete Pan = 96.75

CONCRETE CURB / CONTROL OPENING

6" Minimum

Height Varies 24" Maximum to 9" Minimum

SECTION THRU CONCRETE CURB

Extend Top of Berm Level at Elev. 98.00 to Point of Match

3' Min.

Height Varies

SECTION A - A
( Earth Berm )

Note that berm may be widened and side slopes flattened to match existing conditions

Revised: Sept. 24, 1991
By: DRM

L & M ENTERPRISES, INC.
# HYD - 017 - 89

DRAINAGE DETAIL
SHEET 2 of 2
1. Drainage designs for areas in and around the Town of Berthoud should use the depth-duration frequency information provided in the Precipitation-Frequency Atlas of the Western United States (Volume 2 - Colorado), published by NOAA. The NOAA Atlas can be accessed on the NOAA website.

Table 600-1, shall be used but may be superseded if more recent NOAA data is published for the Town. The table below is based on NOAA Atlas 14, Volume 8, Version 2 for Berthoud, Colorado.

Table 600- 1: Point Precipitation Frequency Estimates in Inches

<table>
<thead>
<tr>
<th>Estimated Rainfall Depth in Inches</th>
<th>Average Return Interval (ARI) (Years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duration</td>
<td>1</td>
</tr>
<tr>
<td>5-minutes</td>
<td>0.233</td>
</tr>
<tr>
<td>10-minutes</td>
<td>0.341</td>
</tr>
<tr>
<td>15-minutes</td>
<td>0.416</td>
</tr>
<tr>
<td>30-minutes</td>
<td>0.553</td>
</tr>
<tr>
<td>60-minutes</td>
<td>0.684</td>
</tr>
<tr>
<td>2-hours</td>
<td>0.816</td>
</tr>
<tr>
<td>3-hours</td>
<td>0.899</td>
</tr>
<tr>
<td>6-hours</td>
<td>1.07</td>
</tr>
<tr>
<td>24-hours</td>
<td>1.56</td>
</tr>
</tbody>
</table>

C. The Rational Method

1. The Rational Method is one method for determining runoff from a proposed development or road construction project. Note that it should not be used for basins greater than 160 acres. The MHFD spreadsheets can also be used for basins that are no greater than 160 acres. Refer to the rainfall chapter of the MHFD USDCM for more information regarding the rainfall parameters required to use the Rational Method.

D. Larger Basin Rainfall Methods (Basins sizes 160 acres and greater)

1. As noted above, the Rational Method should not be used to determine runoff for basins larger than 160 acres. Where areas are larger than 160 acres that have drainage characteristics similar to an urban area, the Colorado Urban Hydrograph Procedure (CUHP) is an acceptable model for determining runoff amounts. The CUHP model can be used for basins from 0 to 3,000 acres. The parameter adjustments provided in the runoff chapter of the MHFD USDCM Manual (Volume 1) should be used when dealing with basins that are larger than 160 acres.

2. The CUHP model is not applicable in non-urban areas, including those areas in Larimer County that are outside of the Denver metropolitan area. The U.S. Army Corps of Engineers (USACE) HEC-HMS model is more applicable for mixed suburban-agricultural areas. The HEC-HMS model can be used on watersheds and drainage basins larger than 160 acres provided the modeling follows the parameters in the HEC- HMS User’s Manual, the HEC-HMS Technical Reference Manual, the HEC-HMS Application’s Guide.
D. Differences between the Town of Berthoud and the MHFD

1. The Town of Berthoud will allow the use of other modeling methodologies on a case-by-case basis when complete documentation of all assumptions is provided. The Town of Berthoud reserves the right to review alternative methods and compare with other commonly used approaches, including those discussed in the MHFD USDCM Manual.

Table 600-2: Recommended Percentage Imperviousness Values

<table>
<thead>
<tr>
<th>Land Use or Surface Characteristics</th>
<th>Percentage of Imperviousness</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Business:</strong></td>
<td></td>
</tr>
<tr>
<td>Commercial Areas</td>
<td>95</td>
</tr>
<tr>
<td>Neighborhood Area</td>
<td>85</td>
</tr>
<tr>
<td><strong>Residential Lots:</strong> (lot area only)</td>
<td></td>
</tr>
<tr>
<td>Single-Family, 0.25 acres or less</td>
<td>45</td>
</tr>
<tr>
<td>Single-Family, 0.25 - 0.75 acres</td>
<td>30</td>
</tr>
<tr>
<td>Single Family, 0.75 acres or larger</td>
<td>20</td>
</tr>
<tr>
<td>Multi-Family (attached)</td>
<td>60</td>
</tr>
<tr>
<td>Multi-Family (detached)</td>
<td>75</td>
</tr>
<tr>
<td>Apartments</td>
<td>80</td>
</tr>
<tr>
<td><strong>Industrial:</strong></td>
<td></td>
</tr>
<tr>
<td>Light Areas</td>
<td>80</td>
</tr>
<tr>
<td>Heavy Areas</td>
<td>90</td>
</tr>
<tr>
<td>Parks and Cemeteries</td>
<td>10</td>
</tr>
<tr>
<td>Playgrounds</td>
<td>25</td>
</tr>
<tr>
<td>Schools</td>
<td>55</td>
</tr>
<tr>
<td>Railroad Yard Areas</td>
<td>50</td>
</tr>
<tr>
<td><strong>Undeveloped Areas:</strong></td>
<td></td>
</tr>
<tr>
<td>Historic Flow Analysis</td>
<td>2</td>
</tr>
<tr>
<td>Greenbelts, Agricultural</td>
<td>2</td>
</tr>
<tr>
<td>Off-site flow analysis (when land use not defined)</td>
<td>45</td>
</tr>
<tr>
<td><strong>Streets:</strong></td>
<td></td>
</tr>
<tr>
<td>Paved</td>
<td>100</td>
</tr>
<tr>
<td>Gravel (packed)</td>
<td>40</td>
</tr>
<tr>
<td>Drive and Walks</td>
<td>90</td>
</tr>
<tr>
<td>Roofs</td>
<td>90</td>
</tr>
<tr>
<td>Lawns, sandy soil</td>
<td>2</td>
</tr>
<tr>
<td>Lawns, clayey soil</td>
<td>2</td>
</tr>
</tbody>
</table>

602.4 Roadway and Street Drainage

A. General Criteria

1. When runoff in the street exceeds allowable limits, a storm sewer system or open channel is required to convey the excess flows.

2. Design Criteria Based on Frequency and Magnitude: The design criteria for the collection and conveyance of storm water runoff on public streets are based on an allowable frequency and magnitude of traffic interference. The primary design objective shall be to keep the depth and spread (encroachment) of stormwater on the street below an acceptable value for a given storm event.
CONSTRUCTION PHASES

1. PHASE 1: Site Development Construction Phase including perimeter controls and the preliminary erosion control plan. Site development construction phase includes temporary water control measures and the preliminary erosion control plan.

2. PHASE 2: Final Construction Phase

3. PHASE 3: Site Development Construction Phase

4. PHASE 4: Site Development Construction Phase

5. PHASE 5: Site Development Construction Phase

NOTES

1.b. Temporary Site Development Controls shall be designed, installed, and maintained by the contractor during the site development phase of construction.

2. Site development controls shall be designed and maintained by the contractor during the site development phase of construction.

3. Site development controls shall be designed, installed, and maintained by the contractor during the site development phase of construction.

4. Site development controls shall be designed, installed, and maintained by the contractor during the site development phase of construction.

5. Site development controls shall be designed, installed, and maintained by the contractor during the site development phase of construction.

6. Site development controls shall be designed, installed, and maintained by the contractor during the site development phase of construction.

7. Site development controls shall be designed, installed, and maintained by the contractor during the site development phase of construction.

8. Site development controls shall be designed, installed, and maintained by the contractor during the site development phase of construction.

9. Site development controls shall be designed, installed, and maintained by the contractor during the site development phase of construction.

10. Site development controls shall be designed, installed, and maintained by the contractor during the site development phase of construction.

11. Site development controls shall be designed, installed, and maintained by the contractor during the site development phase of construction.

12. Site development controls shall be designed, installed, and maintained by the contractor during the site development phase of construction.

13. Site development controls shall be designed, installed, and maintained by the contractor during the site development phase of construction.

14. Site development controls shall be designed, installed, and maintained by the contractor during the site development phase of construction.

15. Site development controls shall be designed, installed, and maintained by the contractor during the site development phase of construction.

16. Site development controls shall be designed, installed, and maintained by the contractor during the site development phase of construction.

17. Site development controls shall be designed, installed, and maintained by the contractor during the site development phase of construction.

18. Site development controls shall be designed, installed, and maintained by the contractor during the site development phase of construction.

19. Site development controls shall be designed, installed, and maintained by the contractor during the site development phase of construction.

20. Site development controls shall be designed, installed, and maintained by the contractor during the site development phase of construction.
DETAIL SHEET 7
C-19
SHEET OF SHEETS
HARVEST 47 SUBDIVISION
CONSTRUCTION DOCUMENTS
TOWN OF BERTHOUD, COUNTY OF LARIMER, STATE OF COLORADO
LOCATED IN THE NE 1/4, SECTION 24, TOWNSHIP 4 NORTH, RANGE 69 WEST
PRELIMINARY
NOT FOR CONSTRUCTION
11/30/2023
Know what's below. Before you dig. Call R
C:\Users\troy\Dropbox\I2\Projects\1053-1 Harvest47\DWG\Sheets\HarvestCD_DT.dwg, 11/29/2023 7:26:52 PM, _AutoCAD PDF (General Documentation).pc3
100-Year Overflow Spillway

**Concrete weir structure centered in berm.**

1. High water during overflow of entire 100-year peak runoff.
   - Elev: 4991.00

2. **Emergency overflow weir**
   - Crest Inv: 4990.50
   - Proposed Type H Riprap
   - Extend to bottom of slope
   - Top of Pond
     - Elev: 4992.00

3. **Proposed top of pond**
   - Crest Inv: 4992.00

4. **Concrete weir structure centered in berm.**

5. **Concrete footing**

6. **2' X 12' X 3/4' STONE CAP**

7. **8" X 8" X 8" STONE CAP**

8. **CONCRETE FOUNDATION**

9. **CONCRETE FOUNDATION**

**Water Quality Holes**

<table>
<thead>
<tr>
<th>Hole Diameter</th>
<th>Number of Holes</th>
<th>Number of Columns</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Restrictor Plate**

- 4" TYP
- 0.50'
- 0.50'
- 0.25'

**Steel Flow control plate**

- Water quality (WQ) hole
- Stainless steel anchor bolt (typ.)

**NOT FOR CONSTRUCTION**

11/30/2023

Know what's below. before you dig.

Call 811.
REVIEW COMMENTS

DATE: November 1, 2023

Project Name: Harvest 47
Project Type: Final Plat
Location: Lot 2, O’Malley Glen Minor Subdivision
Project Applicant: Larry Bebbo

It has been approximately four weeks since your submittal. As promised, the Town of Berthoud is providing comments to you at this time to advance the development review process.

THE FOLLOWING AGENCIES RECEIVED OR WERE MAILED THIS SUBMITTAL AND THEIR RESPONSES ARE PROVIDED ON THE FOLLOWING PAGES:

TOWN OF BERTHOUD
☐ Engineer/Public Works Director
☐ Project Planner
☐ Town Attorney
☐ Town Arborist
☐ Traffic Consultant

OTHER AGENCIES
☐ Berthoud Fire Protection District
☐ Little Thompson Water District
☐ Ditch Companies
☐ CDOT
☐ Larimer County Engineering
☐ Larimer County Health Dept.
☐ Larimer County Planning

Specific and complete comments are provided under each individual agency’s section. Please read the entire report and address each comment. If you have any questions or concerns regarding any comment, contact the Planning Department or the individual agency to clarify the statement and reach an understanding. It is in your interest to do so in order to streamline the review process.

“NO RESPONSE” indicates an agency has not sent any comments to the project planner before the writing of this summary.

If you have any questions concerning comments on your project or the development review process, please feel free to contact the Planning Department at 281.352.2709.
Project Name: Harvest 47

PLANNING
Community Development Department
Will Charles will.charles@baselinecorp.com

Response received: 12/20/2023

1. The final plat has progressed enough to move forward for hearings. This project will be scheduled for the January 11 hearing.
2. Add a signature block for Planning Commission Chairperson. The Larimer County signature block can be removed if space is needed (they no longer sign these).
3. An approved DA will be required.
4. A signed and finalized agreement between Farmstead and Harvest 47 for the southern alley will be required.
PUBLIC NOTICE IS HEREBY GIVEN of a public hearing before the Berthoud Planning Commission on Thursday, January 11, 2024 at 6:00 p.m. to consider the applicant’s request for the Harvest 47 Subdivision Final Plat. The request is for the platting of 29 residential lots on 5.98 acres located at 735 Mountain Avenue. The public hearing will be held at Town Hall, 807 Mountain Avenue, Berthoud 80513.

For additional information, please contact the Community Development Department at 970-532-2643.

Given and posted this _____ day of __________, 202__.
Published: Loveland Reporter Herald _________________________