July 25, 2018

PRELIMINARY DRAINAGE AND EROSION CONTROL REPORT FOR
DRAKE REDEVELOPMENT
Fort Collins, Colorado

Prepared for:
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Project Number: 379-072
July 25, 2018

City of Fort Collins
Stormwater Utility
700 Wood Street
Fort Collins, Colorado 80521

RE: Preliminary Drainage and Erosion Control Report for
DRAKE REDEVELOPMENT

Dear Staff:

Northern Engineering is pleased to submit this Preliminary Drainage and Erosion Control Report for your review. This report accompanies the Project Development Plan submittal for the proposed Drake Redevelopment development.

This report has been prepared in accordance to Fort Collins Stormwater Criteria Manual (FCSCM), and serves to document the stormwater impacts associated with the proposed project. We understand that review by the City is to assure general compliance with standardized criteria contained in the FCSCM.

If you should have any questions as you review this report, please feel free to contact us.

Sincerely,

NORTHERN ENGINEERING SERVICES, INC.

Aaron Cvar, PhD, PE
Senior Project Engineer
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MAP POCKET:
Proposed Drainage Exhibit
I. GENERAL LOCATION AND DESCRIPTION

A. Location

1. Vicinity Map

2. The project site is located in the northeast quarter of Section 26, Township 7 North, Range 69 West of the 6th Principal Meridian, City of Fort Collins, County of Larimer, State of Colorado.

3. The project site is located just southwest of the intersection of W. Drake Road and South College Avenue.

4. The project site lies within the Spring Creek Basin. The historic outfall for the site is the existing South College Avenue storm system. This outfall will be utilized by the proposed project as the main point of discharge for the developed site. The proposed site will not be increasing drainage area to the historic South College Avenue outfall and will reduce overall site imperviousness. An exhibit documenting existing and proposed imperviousness for the site has been included in the appendix for reference. Typically, projects are required to detain the difference between the 100-year developed inflow rate and the historic 2-year release rate. Based on discussions with City of Fort Collins Stormwater Utility Staff, since the development of the site will result in a reduction of overall imperviousness detention will not be required.
5. Water quality treatment will be provided in a proposed underground chamber system and will treat site runoff prior to discharge into the existing South College Avenue storm system.

6. No offsite flows enter the site as adjacent Rights of Way of Drake Road, Thunderbird Drive, McClelland Drive, and College Avenue convey offsite flows away from the project site.

B. Description of Property

1. The development area is roughly 7.08 net acres.

2. The subject property is currently an existing car dealership. The ground cover generally consists paved surfaces, rooftops and minimal landscaped area. Existing ground slopes are mild to moderate (i.e., 1 - 3±%) through the interior of the property. General topography slopes from west to east.

4. The proposed project is a redevelopment of the existing car dealership, and will consist of a hotel, commercial buildings and multifamily residential buildings. Associated drives and parking areas, water and sewer lines will be constructed with the development.

5. The proposed land use is mixed-use.
C. Floodplain

1. The project site is not encroached by any City designated or FEMA designated 100-year floodplain.

![Figure 3 – Area Floodplain Mapping]

II. DRAINAGE BASINS AND SUB-BASINS

A. Major Basin Description

1. The historic outfall for the site is the existing South College Avenue storm system. This outfall will be utilized by the proposed project as the main point of discharge for the developed site. The proposed site will not be increasing drainage area to the historic South College Avenue outfall and will reduce overall site imperviousness. An exhibit documenting existing and proposed imperviousness for the site has been included in the appendix for reference. Typically, projects are required to detain the difference between the 100-year developed inflow rate and the historic 2-year release rate. Based on discussions with City of Fort Collins Stormwater Utility Staff, since the development of the site will result in a reduction of overall imperviousness detention will not be required.
Sub-Basin Description

1. The subject property historically drains overland from west to east. Historically, the development site sheet flows into the adjacent Drake Road, Thunderbird Drive, McClelland Drive, and College Avenue rights-of-way. Ultimately, all runoff from the historic site is directed into the existing College Avenue storm line system. The existing site provides no detention or water quality treatment of existing storm runoff prior to entering the College Avenue storm line system.

2. The proposed site will generally maintain historic drainage patterns, with all developed runoff being directed into the existing College Avenue storm line system. However, the proposed site will reduce overall site imperviousness, and will provide water quality treatment in an onsite underground chamber system. A more detailed description of the project drainage patterns is provided below.

III. DRAINAGE DESIGN CRITERIA

A. Regulations

There are no optional provisions outside of the FCSCM proposed with the proposed project.

B. Four Step Process

The overall stormwater management strategy employed with the proposed project utilizes the “Four Step Process” to minimize adverse impacts of urbanization on receiving waters. The following is a description of how the proposed development has incorporated each step.

Step 1 – Employ Runoff Reduction Practices

Several techniques have been utilized with the proposed development to facilitate the reduction of runoff peaks, volumes, and pollutant loads as the site is developed from the current use by implementing multiple Low Impact Development (LID) strategies including:

- Conserving existing amenities in the site including the existing vegetated areas.
- Providing vegetated open areas throughout the site to reduce the overall impervious area and to minimize directly connected impervious areas (MDCIA).
- Routing flows, to the extent feasible, through vegetated swales to increase time of concentration, promote infiltration and provide initial water quality.

Step 2 – Implement BMPs That Provide a Water Quality Capture Volume (WQCV) with Slow Release

The efforts taken in Step 1 will facilitate the reduction of runoff; however, urban development of this intensity will still generate stormwater runoff that will require additional BMPs and water quality. The majority of stormwater runoff from the site will ultimately be intercepted and treated using detention and LID treatment methods prior to exiting the site.

Step 3 – Stabilize Drainageways

There are no major drainageways within the subject property. While this step may not seem applicable to proposed development, the project indirectly helps achieve stabilized drainageways nonetheless. By providing water quality treatment, where none previously existed, sediment with erosion potential is removed from downstream drainageway systems. Furthermore, this project will pay one-time stormwater development fees, as
well as ongoing monthly stormwater utility fees, both of which help achieve City-wide drainageway stability.

**Step 4 – Implement Site Specific and Other Source Control BMPs.**
The proposed project will improve upon site specific source controls compared to historic conditions:
- The proposed development will provide LID and water quality treatment; thus, eliminating sources of potential pollution previously left exposed to weathering and runoff processes.

**C. Development Criteria Reference and Constraints**
The subject property is surrounded by currently developed properties. Thus, several constraints have been identified during the course of this analysis that will impact the proposed drainage system including:
- Existing elevations along the property lines will generally be maintained.
- As previously mentioned, overall drainage patterns of the existing site will be maintained.
- Elevations of existing downstream facilities that the subject property will release to will be maintained.

**D. Hydrological Criteria**
1. The City of Fort Collins Rainfall Intensity-Duration-Frequency Curves, as depicted in Figure RA-16 of the FCSCM, serve as the source for all hydrologic computations associated with the proposed development. Tabulated data contained in Table RA-7 has been utilized for Rational Method runoff calculations.
2. The Rational Method has been employed to compute stormwater runoff utilizing coefficients contained in Tables RO-11 and RO-12 of the FCSCM.
3. Three separate design storms have been utilized to address distinct drainage scenarios. A fourth design storm has also been computed for comparison purposes. The first design storm considered is the 80th percentile rain event, which has been employed to design the project's water quality features. The second event analyzed is the “Minor,” or “Initial” Storm, which has a 2-year recurrence interval. The third event considered is the “Major Storm,” which has a 100-year recurrence interval. The fourth storm computed, for comparison purposes only, is the 10-year event.
4. No other assumptions or calculation methods have been used with this development that are not referenced by current City of Fort Collins criteria.

**E. Hydraulic Criteria**
1. As previously noted, the subject property maintains historic drainage patterns.
2. All drainage facilities proposed with the project are designed in accordance with criteria outlined in the FCSCM and/or the Urban Drainage and Flood Control District (UDFCD) Urban Storm Drainage Criteria Manual.
3. As stated above, the subject property is not located in a City designated floodplain. The proposed project does not propose to modify any natural drainageways.
F. Modifications of Criteria

1. The proposed development is not requesting any modifications to criteria at this time.

IV. DRAINAGE FACILITY DESIGN

A. General Concept

1. The main objectives of the project drainage design are to maintain existing drainage patterns, and to ensure no adverse impacts to any adjacent properties.

2. A list of tables and figures used within this report can be found in the Table of Contents at the front of the document. The tables and figures are located within the sections to which the content best applies.

3. The drainage patterns anticipated for proposed drainage basins are described below.

   Basin 1
   Basin 1 consists of the northern and eastern portions of the project site that drain directly into the adjacent Drake Road and College Avenue rights-of-way. Basin 1 is composed of landscaped areas that cannot be graded to drain inward towards the project site. This basin also includes a portion of the access drive into the site from Drake Road, which for grading purposes was necessary to drain to Drake Road.

   Basin 2
   Basin 2 consists of the western portion of the project site that drains directly into the adjacent McClelland Drive Right of Way. Basin 2 is composed of landscaped areas that cannot be graded to drain inward towards the project site. This basin also includes a portion of the access drive into the site from McClelland Drive, which for grading purposes was necessary to drain to McClelland Drive.

   Basin 3
   Basin 3 consists of the southern portion of the project site that drains directly into the adjacent Thunderbird Drive Right of Way. Basin 3 is composed of landscaped areas that cannot be graded to drain inward towards the project site. This basin also includes a portion of the access drive into the site from Thunderbird Drive, which for grading purposes was necessary to drain to Thunderbird Drive.

   Basin 4 - 10
   Basin 4 through 10 consist of landscaped areas, rooftop areas, drives and parking areas. In general, runoff from these basins will be directed via sheet flow, pans, and curb and gutter into onsite storm inlets and storm lines. The onsite storm line system will direct all developed runoff into a series of underground chambers, which will provide all required water quality treatment for the site as described below. The underground chamber system will outfall to the existing College Avenue storm system, also described further below.

   A full-size copy of the Drainage Exhibit can be found in the Map Pocket at the end of this report.
B. Specific Details

1. LID treatment of the majority of developed onsite runoff involving an underground chamber system will be provided. An interior storm line system has been designed to capture developed onsite storm runoff and convey runoff into the chamber system. In storm events which exceed the water quality design event, excess runoff will bypass the chamber system and be conveyed into the existing College Avenue storm system. As noted above, a portion of the site could not be graded to drain into the proposed chamber system.

2. It is noted that the existing College Avenue storm system is currently undersized for the full 100-year storm event. The design of proposed onsite storm pipes has been done anticipating future improvements to the College Avenue storm system and assume that the full 100-year storm will be adequately conveyed within this system. As such, all onsite storm lines are designed to convey the full 100-year storm event to the existing College Avenue storm system.

3. Please see preliminary LID information and Water Quality Capture Volume (Extended Detention) computations provided in the Appendix.

4. Final design details, and construction documentation shall be provided to the City of Fort Collins for review prior to Final Development Plan approval.

5. Stormwater facility Standard Operating Procedures (SOP) will be provided by the City of Fort Collins in the Development Agreement.

V. CONCLUSIONS

A. Compliance with Standards

1. The drainage design proposed with the proposed project complies with the City of Fort Collins’ Stormwater Criteria Manual.

2. The drainage design proposed with this project complies with requirements for Spring Creek Basin.

3. The drainage plan and stormwater management measures proposed with the proposed development are compliant with all applicable State and Federal regulations governing stormwater discharge.

B. Drainage Concept

1. The drainage design proposed with this project will effectively limit any potential damage associated with its stormwater runoff by providing water quality mitigation features.

2. The drainage concept for the proposed development is consistent with requirements for the Spring Creek Basin.
References


## DEVELOPED COMPOSITE % IMPERVIOUSNESS AND RUNOFF COEFFICIENT CALCULATIONS

**Character of Surface:**

### Streets, Parking Lots, Roofs, Alleys, and Drives:

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<th>Runoff Coefficient</th>
<th>Percentage Impervious</th>
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### Lawns and Landscaping

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2-year $C_r = 1.00$  
10-year $C_r = 1.00$  
100-year $C_r = 1.25$

---

Runoff Coefficients are taken from the City of Fort Collins Storm Drainage Design Criteria and Construction Standards, Table 3-3. % Impervious taken from UDFCD USDCM, Volume I.

### Basin ID | Basin Area (ac) | Area of Asphalt (ac) | Area of Concrete (ac) | Area of Roofs (ac) | Area of Gravel (ac) | Area of Lawns and Landscaping (ac) | 2-year Composite Runoff Coefficient | 10-year Composite Runoff Coefficient | 100-year Composite Runoff Coefficient | Composite % Imperv. |
--- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
1 | 1.01 | 0.09 | 0.38 | 0.00 | 0.00 | 0.00 | 0.55 | 0.57 | 0.57 | 0.71 | 42% |
2 | 0.56 | 0.02 | 0.24 | 0.00 | 0.00 | 0.00 | 0.31 | 0.57 | 0.57 | 0.71 | 42% |
3 | 0.23 | 0.01 | 0.07 | 0.00 | 0.00 | 0.02 | 0.14 | 0.52 | 0.52 | 0.65 | 36% |
4 | 0.29 | 0.07 | 0.04 | 0.00 | 0.00 | 0.02 | 0.16 | 0.52 | 0.52 | 0.66 | 38% |
5 | 1.88 | 0.81 | 0.03 | 0.94 | 0.00 | 0.00 | 0.10 | 0.91 | 0.91 | 1.00 | 89% |
6 | 0.81 | 0.22 | 0.26 | 0.22 | 0.00 | 0.00 | 0.10 | 0.86 | 0.86 | 1.00 | 82% |
7 | 0.77 | 0.22 | 0.23 | 0.20 | 0.00 | 0.02 | 0.09 | 0.85 | 0.85 | 1.00 | 80% |
8 | 0.63 | 0.07 | 0.20 | 0.32 | 0.00 | 0.01 | 0.03 | 0.91 | 0.91 | 1.00 | 86% |
9 | 0.46 | 0.14 | 0.04 | 0.00 | 0.00 | 0.00 | 0.28 | 0.52 | 0.52 | 0.65 | 38% |
10 | 0.45 | 0.23 | 0.10 | 0.05 | 0.00 | 0.00 | 0.07 | 0.84 | 0.84 | 1.00 | 81% |
Total Onsite | 5.28 | 1.76 | 0.90 | 1.74 | 0.00 | 0.05 | 0.84 | 0.83 | 0.83 | 1.00 | 78% |

---

Project: Drake Redevelopment  
Calculations By: A. Reese  
Date: July 25, 2018
Overland Flow, Time of Concentration:

\[ T_i = \frac{1.87(1.1 - C \ast C_f)}{S^{\frac{1}{3}}} \sqrt{L} \]

Gutter/Swale Flow, Time of Concentration:

\[ T_i = \frac{T_c}{60V} \]

\[ T_c = T_i + T_t \]

(Equation RO-2)

Velocity (Gutter Flow), \( V = 20 \cdot S^{\frac{1}{2}} \)

Velocity (Swale Flow), \( V = 15 \cdot S^{\frac{1}{2}} \)

NOTE: C-value for overland flows over grassy surfaces; \( C = 0.25 \)

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## DEVELOPED RUNOFF COMPUTATIONS

**Rational Method Equation:**

\[ Q = C_f \cdot (C_i(A)) \]

From Section 3.2.1 of the CFCSDDC

**Rainfall Intensity:**

Rainfall Intensity taken from the City of Fort Collins Storm Drainage Design Criteria (CFCSDDC), Figure 3.1

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<td>0.53</td>
</tr>
</tbody>
</table>
LID TREATMENT EXHIBIT

DRAKE REDEVELOPMENT ON-SITE LID TREATMENT

Project Summary
- Total Impervious Area: 230,699 sf
- Target Treatment Percentage: 75%
- Minimum Area to be Treated by LID measures: 173,024.27 sf

Chamber Isolator Rows
- Total Chamber Treatment Area: 210,907 sf
- Total Treatment Area: 210,907 sf
- Percent Total Project Area Treated: 91.4%
### Chamber Configuration Summary

<table>
<thead>
<tr>
<th>Vault ID</th>
<th>Total Required WQ Volume (cf)</th>
<th>InFlow, WQ (cfs)</th>
<th>Chamber Type</th>
<th>Individual Chamber Release Rate (^a) (cfs)</th>
<th>Individual Chamber Volume (^b) (cfs)</th>
<th>Individual Installed Chamber Volume (^c) (cfs)</th>
<th>Minimum No. of Chambers (^d)</th>
<th>Minimum Release Rate (^e) (cfs)</th>
<th>Required Chamber Volume by FAA Method (cf)</th>
<th>Provided Number of Chambers</th>
<th>Provided Release Rate (^e) (cfs)</th>
<th>Provided Chamber Volume (^f) (cf)</th>
<th>Total Installed Chamber Volume (^g) (cf)</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>7332</td>
<td>6.3</td>
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<td>2299</td>
<td>101</td>
<td>2.38</td>
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</tbody>
</table>

\(^a\) Release rate per chamber, limited by flow through geotextile with accumulated sediment.

\(^b\) Volume within chamber only, not accounting for void spaces in surrounding aggregate.

\(^c\) Volume includes chamber and void spaces (40%) in surrounding aggregate, per chamber unit.

\(^d\) Number of chambers required to provide full WQCV within total installed system, including aggregate.

\(^e\) Release rate per chamber times number of chambers.

\(^f\) Volume provided in chambers only (no aggregate storage). This number must meet or exceed the required FAA storage volume.

\(^g\) System volume includes total number of chambers, plus surrounding aggregate. This number must meet or exceed the required WQCV.

Note: "Chamber Volume" refers to the open volume within the vaults. "Installed Chamber Volume" refers to the total volume provided, including the surrounding aggregates.
## Chamber Volume Calculation | FAA Method

**Project:** Drake Station  
**Project Location:** Fort Collins, Colorado  
**Calculations By:** A. Reese  
**Date:** July 25, 2018  
**Pond No.:** Overall

### Input Variables
- **Design Point:** 1
- **Design Storm:** WQ
- **Developed "C" =** 1.00
- **Area (A)=** 5.28 acres
- **Max Release Rate =** 2.38 cfs

### Results

<table>
<thead>
<tr>
<th>Time (mins)</th>
<th>Time (secs)</th>
<th>Ft.Collins WQ Intensity</th>
<th>Q₁₀₀</th>
<th>Inflow (Runoff) Volume (ft³)</th>
<th>Outflow (Release) Volume (ft³)</th>
<th>Storage Detention Volume (ft³)</th>
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<tr>
<td>5</td>
<td>300</td>
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### StormTech Chamber Data

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<th>Chamber Dimensions</th>
<th>SC-160LP</th>
<th>SC-310</th>
<th>SC-740</th>
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</thead>
<tbody>
<tr>
<td>Width (in)</td>
<td>25</td>
<td>34.00</td>
<td>51.00</td>
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<td>Length (in)</td>
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<td>85.40</td>
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<td>Height (in)</td>
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<td>16.00</td>
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<td>Floor Area (sf)</td>
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<td>20.16</td>
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<tr>
<td>Chamber Volume (cf)</td>
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<td>14.70</td>
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<td>Chamber/Aggregate Volume (cf)</td>
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### Chamber Flow Rate Conversion (gpm/sf to cfs)

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<th>Flow Rate**</th>
<th>0.35 gpm/sf</th>
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<tr>
<td>1 cf =</td>
<td>7.48052 gal</td>
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<tr>
<td>1 gallon =</td>
<td>0.133681 cf</td>
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<tr>
<td>1 GPM =</td>
<td>0.002228 cfs</td>
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**Flow rate based on 1/2 of Nov 07 Q_MAX in Figure 17 of UNH Testing Report

<table>
<thead>
<tr>
<th>Chamber Flow Rate</th>
<th>SC-160LP</th>
<th>SC-310</th>
<th>SC-740</th>
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<tbody>
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<td>Flow Rate/chamber (cfs)</td>
<td>0.011562</td>
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WATER QUALITY DESIGN CALCULATIONS
STORMTECH CHAMBER SYSTEM

<table>
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<th>Project:</th>
<th>Drake Redevelopment</th>
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<tr>
<td>By:</td>
<td>A. Reese</td>
</tr>
<tr>
<td>Date:</td>
<td>July 25, 2018</td>
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<table>
<thead>
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<th>REQUIRED STORAGE &amp; OUTLET WORKS:</th>
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<tr>
<td>BASIN AREA = 5.28</td>
<td>INPUT from impervious calcs</td>
</tr>
<tr>
<td>BASIN IMPERVIOUSNESS PERCENT = 78.5</td>
<td>INPUT from impervious calcs</td>
</tr>
<tr>
<td>BASIN IMPERVIOUSNESS RATIO = 0.78</td>
<td>CALCULATED</td>
</tr>
<tr>
<td>WQCV (watershed inches) = 0.319</td>
<td>CALCULATED from Figure EDB-2</td>
</tr>
<tr>
<td>WQCV (ac-ft) = 0.168</td>
<td>CALCULATED from UDFCD DCM V.3 Section 6.5</td>
</tr>
<tr>
<td>WQCV (cu-ft) = 7332</td>
<td>CALCULATED from UDFCD DCM V.3 Section 6.5</td>
</tr>
</tbody>
</table>
EROSION CONTROL REPORT

A comprehensive Erosion and Sediment Control Plan (along with associated details) will be included with the final construction drawings. It should be noted, however, that any such Erosion and Sediment Control Plan serves only as a general guide to the Contractor. Staging and/or phasing of the BMPs depicted, and additional or different BMPs from those included may be necessary during construction, or as required by the authorities having jurisdiction.

It shall be the responsibility of the Contractor to ensure erosion control measures are properly maintained and followed. The Erosion and Sediment Control Plan is intended to be a living document, constantly adapting to site conditions and needs. The Contractor shall update the location of BMPs as they are installed, removed or modified in conjunction with construction activities. It is imperative to appropriately reflect the current site conditions at all times.

The Erosion and Sediment Control Plan shall address both temporary measures to be implemented during construction, as well as permanent erosion control protection. Best Management Practices from the Volume 3, Chapter 7 – Construction BMPs will be utilized. Measures may include, but are not limited to, silt fencing along the disturbed perimeter, gutter protection in the adjacent roadways and inlet protection at existing and proposed storm inlets. Vehicle tracking control pads, spill containment and clean-up procedures, designated concrete washout areas, dumpsters, and job site restrooms shall also be provided by the Contractor.

Grading and Erosion Control Notes can be found on the Utility Plans. The Final Plans will contain a full-size Erosion Control sheet as well as a separate sheet dedicated to Erosion Control Details. In addition to this report and the referenced plan sheets, the Contractor shall be aware of, and adhere to, the applicable requirements outlined in the Development Agreement for the development. Also, the Site Contractor for this project will be required to secure a Stormwater Construction General Permit from the Colorado Department of Public Health and Environment (CDPHE), Water Quality Control Division – Stormwater Program, prior to any earth disturbance activities. Prior to securing said permit, the Site Contractor shall develop a comprehensive StormWater Management Plan (SWMP) pursuant to CDPHE requirements and guidelines. The SWMP will further describe and document the ongoing activities, inspections, and maintenance of construction BMP'S.
Custom Soil Resource Report for Larimer County Area, Colorado
Preface

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

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

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

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

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

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

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    73—Nunn clay loam, 0 to 1 percent slopes ............................................................. 13
References ................................................................................................................. 15
How Soil Surveys Are Made

Soil surveys are made to provide information about the soils and miscellaneous areas in a specific area. They include a description of the soils and miscellaneous areas and their location on the landscape and tables that show soil properties and limitations affecting various uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They observed and described many soil profiles. A soil profile is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed or from the surface down to bedrock. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

Currently, soils are mapped according to the boundaries of major land resource areas (MLRAs). MLRAs are geographically associated land resource units that share common characteristics related to physiography, geology, climate, water resources, soils, biological resources, and land uses (USDA, 2006). Soil survey areas typically consist of parts of one or more MLRA.

The soils and miscellaneous areas in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil
scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

The objective of soil mapping is not to delineate pure map unit components; the objective is to separate the landscape into landforms or landform segments that have similar use and management requirements. Each map unit is defined by a unique combination of soil components and/or miscellaneous areas in predictable proportions. Some components may be highly contrasting to the other components of the map unit. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The delineation of such landforms and landform segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

Soil scientists make many field observations in the process of producing a soil map. The frequency of observation is dependent upon several factors, including scale of mapping, intensity of mapping, design of map units, complexity of the landscape, and experience of the soil scientist. Observations are made to test and refine the soil-landscape model and predictions and to verify the classification of the soils at specific locations. Once the soil-landscape model is refined, a significantly smaller number of measurements of individual soil properties are made and recorded. These measurements may include field measurements, such as those for color, depth to bedrock, and texture, and laboratory measurements, such as those for content of sand, silt, clay, salt, and other components. Properties of each soil typically vary from one point to another across the landscape.

Observations for map unit components are aggregated to develop ranges of characteristics for the components. The aggregated values are presented. Direct measurements do not exist for every property presented for every map unit component. Values for some properties are estimated from combinations of other properties.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and
identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.
Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.
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 12, Oct 10, 2017

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

Date(s) aerial images were photographed: Mar 20, 2015—Oct 15, 2016

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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<tr>
<td>73</td>
<td>Nunn clay loam, 0 to 1 percent slopes</td>
<td>8.4</td>
<td>100.0%</td>
</tr>
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</table>

Totals for Area of Interest

8.4

100.0%

Map Unit Descriptions

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

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

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

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.
An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

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

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

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

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

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

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

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

73—Nunn clay loam, 0 to 1 percent slopes

Map Unit Setting
- National map unit symbol: 2tlng
- Elevation: 4,100 to 5,700 feet
- Mean annual precipitation: 14 to 15 inches
- Mean annual air temperature: 48 to 52 degrees F
- Frost-free period: 135 to 152 days
- Farmland classification: Prime farmland if irrigated

Map Unit Composition
- Nunn and similar soils: 85 percent
- Minor components: 15 percent
- Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Nunn

Setting
- Landform: Terraces
- Landform position (three-dimensional): Tread
- Down-slope shape: Linear
- Across-slope shape: Linear
- Parent material: Pleistocene aged alluvium and/or eolian deposits

Typical profile
- Ap - 0 to 6 inches: clay loam
- Bt1 - 6 to 10 inches: clay loam
- Bt2 - 10 to 26 inches: clay loam
- Btk - 26 to 31 inches: clay loam
- Bk1 - 31 to 47 inches: loam
- Bk2 - 47 to 80 inches: loam

Properties and qualities
- Slope: 0 to 1 percent
- Depth to restrictive feature: More than 80 inches
- Natural drainage class: Well drained
- Runoff class: Medium
- Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
- Depth to water table: More than 80 inches
- Frequency of flooding: None
- Frequency of ponding: None
- Calcium carbonate, maximum in profile: 7 percent
- Salinity, maximum in profile: Nonsaline (0.1 to 1.0 mmhos/cm)
- Sodium adsorption ratio, maximum in profile: 0.5
- Available water storage in profile: High (about 9.1 inches)

Interpretive groups
- Land capability classification (irrigated): 3e
- Land capability classification (nonirrigated): 4e
- Hydrologic Soil Group: C
- Ecological site: Clayey Plains (R067BY042CO)
- Hydric soil rating: No
Minor Components

Heldt
Percent of map unit: 10 percent
Landform: Terraces
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: Clayey Plains (R067BY042CO)
Hydric soil rating: No

Wages
Percent of map unit: 5 percent
Landform: Terraces
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: Loamy Plains (R067BY002CO)
Hydric soil rating: No
References


Custom Soil Resource Report


