Project Development
Drainage and Erosion Control Report

Center for Advanced Technologies 22nd Filing
"Community Horticultural Center"

January 2003

Prepared for:

City of Fort Collins

Prepared by:

EDAW Inc.
240 East Mountain Avenue
Fort Collins, CO 80524
(970) 484-6073
Job No. 7F082.20
January 10, 2003

Mr. Basil Hamdan
City of Fort Collins
Stormwater Utility
700 Wood Street
Fort Collins, CO 80524

Re: Project Development Drainage and Erosion Control Report for Center for Advanced Technologies 22nd Filing
"Community Horticultural Center"

Dear Basil:

We are pleased to submit for your review and approval this Project Development Drainage and Erosion Control Report for the CAT 22nd Filing "Community Horticultural Center."

We appreciate your consideration in reviewing this submittal. Please call if you have questions.

Best Regards,

[Signature]

[Stamp: Gregory Hurst, P.E.
Principal-in-Charge]

Encl.
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Introduction

This report is submitted as a Project Development Drainage and Erosion Control Report for the Fort Collins Community Horticultural Center, a parcel in a portion of Tract C, Windtrail Townhomes PUD 1st Replat, and in the NE ¼ of Section 23, T7N, R 69 W, Fort Collins, Colorado. The parcel is 18.7 acres, bounded on the east by Center Avenue, on the south by the proposed extension of Rolland Moore Drive, on the west by Hill Pond and on the north by Spring Creek. This north property line defines a 100-foot wide buffer strip on the north bank of Spring Creek. Drainage elements on site interact with Spring Creek, Hill Pond, the Sherwood Ditch Lateral and CSURF property south of the proposed Rolland Moore Drive. The site is located within the Spring Creek Drainage Basin and floodplain, and no detention is required.

The northern portion of the site currently drains at less than 1% to the south, directly into Spring Creek, while the southern portion is interrupted by the Sherwood Ditch Lateral. An existing suspended 12-inch CMP currently appears to convey runoff from CSURF property to the south, across this ditch and towards Spring Creek. The project proposes to maintain these drainage patterns by replacing the suspended CMP with RCP culverts under the Sherwood Ditch.

Portions of the project lie within the 100-year floodplain of Spring Creek. An evaluation of the site was performed to identify the 100-year floodplain on the site at a fully developed condition prior to improvement. It is entitled, *Hydraulic Evaluation of the Community Horticultural Center Fort Collins, Colorado (Based on the City of Fort Collins Fully Developed Condition Hydrology)*, dated December 29, 2000 (revised April 27, 2001), by Anderson Consulting Engineers Incorporated. Minor regrading of the site has increased the flood storage of the Spring Creek channel. An evaluation of the revised site grading is contained in the *Hydraulic Evaluation of the Community Horticultural Center Fort Collins, Colorado (Prepared in Support of a Conditional Letter of Revision for the Community Horticultural Center Project)*, dated December 21, 2000 (Revised April 2, 2001), by Anderson Consulting Engineers, Incorporated. The conditional letter of map revision has been approved. Additional hydraulic analysis and hydraulic design of the Horticultural Center Outfall Channel, by Anderson Consulting Engineers, Incorporated (September 4, 2002), has subsequently been undertaken and is an Addendum to this report.

As part of this project, the intermediate route of the Sherwood Lateral will be shifted to the north, although the endpoints at Spring Creek and at Centre Avenue will remain in their present location.

Although no detention is required on the site, BMP’s will address stormwater quality. They will consist of porous landscape, a wetlands basin and a grassed
swale that will treat low flow, while allowing high flow events to bypass into Spring Creek.

An erosion control plan and report will address erosion potential during construction.

**Proposed Development** - A horticulture garden will be constructed on the site and will include a main building/conservatory in its first phase of construction. This building is being built outside of the floodplain. There will also be minor site furnishings including, three bike racks (not in the floodplain), one bike rack and two benches (in the floodplain). These site furnishings will be installed as part of the first phase of construction; these improvements will be secured to the ground so they will not be allowed to move during a flood. They will be surface mounted using expansion bolts in concrete and vandal proof bolts to resist theft and tampering.

**Historic Off-Site Drainage** – Historic off-site drainage comes from 11.52 acres of CSURF property to the south, as well as from 0.7 acre immediately west of the property. Although a suspended 12-inch CMP appears to convey some amount of water across the Sherwood Lateral and thence to Spring Creek, the Addendum to the Final Drainage Report of the Windtrail PUD Townhomes Site, Lidstone & Anderson, 1995, indicates that off-site flows are diverted to Sherwood Lateral by a berm designed with that report.

**Proposed Off-Site Drainage** – From Spring Creek Basin Master Drainage Plan, Baseline Hydrology, (Anderson Consulting Engineers, Incorporated, November 2001), the subject property is located in SWMM Subbasin 130, which encompasses 90.3 acres. The fully developed percent impervious assumed for the subbasin is 50. The Master Plan SWMM model assumes no on-site detention for the subbasin. Runoff from the subbasin enters Spring Creek via conveyance element 130. From the Master Plan SWMM model, $Q_{100/CE130} = 453$ cfs. This implies the unit runoff from the subbasin is 5.0 cfs/ac. The 100-year runoff from the contributing 11:52 acres is estimated to be 57.6 cfs. $Q_{100/total} = 64.3$ cfs (Anderson Consulting Engineers, Incorporated, September 2002). Those flows, which include those from the west between the Windtrail berm and the west property line of the Horticultural Center, will be routed through a grassed swale and thence to Spring Creek via culverts under the proposed Sherwood Lateral.

**Historic On-Site Drainage** – The northern portion of the site currently drains at less than 1% to the north, directly into Spring Creek, while the southern portion is interrupted by the Sherwood Ditch Lateral. An existing suspended 12-inch CMP currently conveys runoff across this ditch and towards Spring Creek.

**Proposed On-Site Drainage** – Development of the property will cause an increase of discharge into Spring Creek. Approximately 10% of the site will be
impervious, with the remaining portion developed as playgrounds and gardens. No detention is required on the site. However, a combination of culvert and overland flow will convey the developed runoff to Spring Creek. Other that an area immediately adjacent to Sherwood Lateral, no runoff will enter the lateral except during a 100-year event. At such time, the 100-year ponding elevation of 4,997.2 feet will inundate the lateral and the proposed culverts, conveying the developed 100-year runoff into Spring Creek. Although the culverts will be inundated during a 100-year event, they are designed to convey that flow for such time as there is a hydraulic gradient towards Spring Creek. At the time of peak runoff along the Horticultural Center outfall, the peak flow is not occurring along Spring Creek. The 100-year discharge on Spring Creek in the vicinity of the outfall is 3,611 cfs (Conveyance Element 327 from the Master Plan SWMM Model (Anderson Consulting Engineers, Incorporated, November 2001). The peak occurs at time 1:22 from the beginning of the storm. At time 0:37, the time of the peak for the outfall, the 100-year discharge on Spring Creek is 1,108 cfs. At time 1:22, the time of the peak flow on Spring Creek, the 100-year discharge for Conveyance Element 130 is 81 cfs. The associated discharge for the outfall is 17.0 cfs (Anderson Consulting Engineers, Incorporated, September 2002)

During extended periods of low flow events the channel will be kept silt free by the facility maintenance staff to avoid problems during larger events. Care will be taken to perform this channel maintenance on a regular basis at 6 month intervals.

**Drainage Design Criteria** – Drainage criteria are based on the City of Fort Collins Storm Drainage Design Criteria, and calculations use the rational method.

**Best Management Practice for Water Quality** – Best management practices are employed per the criteria of the Denver Urban Storm Drainage Criteria Manual, Vol. 3. On-site and off-site runoff is treated by several methods. The parking lot runoff is conveyed by an adjacent grassed swale to a porous landscape pond underlain by a perforated pipe. Flows in excess of the WQCV will continue down the swale to a wetlands basin. The basin has a permanent pool, but provides freeboard to accept the designated WQCV and a perforated orifice to control the rate of discharge to Spring Creek. Two other basins are also treated with porous landscape ponds. In addition, off-site runoff from CSURF is conveyed to storm drainage culverts via a grassed swale.

**Erosion Control Design** – The Community Horticultural Center site lies within moderate rainfall and wind erodability zones per City of Fort Collins zone maps. Potential for erosion exists as construction commences and until paving and landscaping are completed. The site is required to meet a rainfall erosion performance standard of 79.8 during construction, and a performance standard of 91.8 after construction. Wind erosion is mitigated by the same cover methods that address rainfall erosion.
Overlot grading will begin in the winter of 2001. The northern portion will be reseeded and straw-mulched. Parking lot paving will not be installed until spring of 2002, but the site will over-winter with a combination of covers and sediment traps to control erosion. These include straw mulch, hydromulch and disking, as well as silt fences, straw bale dikes and sediment traps.

Prior to construction, silt fencing will be installed around the entire site. Basins A3a, A3b and A3c will drain to inlets interior to the site. Basin A1 will drain to a water quality pond, which will function as a sediment trap during construction. These facilities will be installed within approximately 8 weeks. During construction, straw bale dikes will protect these inlets. At completion of construction, the entire site will be hard surfaces or landscaped.

**Erosion Control Security**

Temporary erosion control measures:

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Security = $13,079 x 1.5 = $19,618

**Conclusion** – All design and computations will be completed in compliance with the City of Fort Collins Storm Drainage Design Criteria. The site does not substantially change existing drainage patterns. All site drainage will be directed to Spring Creek through existing and new conveyances.

Erosion control measures will protect Spring Creek from excessive wind and water-born sediment. The project will also be scheduled to minimize the time bare ground is exposed to the elements.
Drainage Calculations
Erosion Control Calculations
Water Quality BMP Calculations
Rolland Moore Drive Culvert
Windtrail Townhomes Addendum
Riprap Calculations
Attachment B
Interpretive Plan Historical Inaccuracies: Will Bagley

Historical Errors and Suggested Corrections

Handcarts played a relatively minor role in emigration on the Mormon Trail but had nothing to do with the California Trail. A few crazies set out from the Missouri with wheelbarrows, but only one of them might have made it across the Rockies. Many “Californians” cut down wagons into carts but used draft animals to haul them. A very important mode of travel—“packing,” or using pack trains, almost always employing mules. There are great stories about the difficulties of packing and managing mules, who truly played a colorful and important role in the trail’s history.

Correction: Scrap the handcart, get a mule and pack frame.

Correction: Sierra Nevada Mountains is redundant. It’s Sierra Nevada, singular, PERIOD.

Correction: “The era of the transcontinental train began in the 1870s, and ended the mass migration over the California Trail.” Try: “The transcontinental railroad was completed at Promontory Summit in 1869 and basically ended mass migration over the California Trail.”

Correction: The “Stevens Party” is usually called the “Stephens-Murphy-Townsend Party.” Note correct spelling of “Stephens”

Correction: The Lavinia Porter diary quote is repeated in “Jumping Off” and “The Great Basin.”

Correction: “Do you empty the wagons and put your belongings on a raft?” Never happened. Bridges also began appearing in 1850.

Correction: “Oak trees, cottonwoods, foxglove, wild pea, lupine.” Except on islands, there were practically no trees (and absolutely not a single oak) on the Platte River east of Fort Laramie, hence the use of buffalo chips. One 1847 traveler said he saw no timber between Green River and the Sierra.

Correction: “The time in camp was the time for cooking and leisure, like playing music and games for the children.” There was damn little “leisure” on the trail. There are many accounts of music and dancing, but I don’t recall ever seeing a reference to children playing games. They did chores. Rosemary Gudmundson Palmer’s Children’s Voices from the Trail: Narratives of the Platte River Road (Spokane: The Arthur H. Clark Co., 2002) has no entry for “games” in its index, but dozens for “chores.”

Correction: “The travelers met the tribes that made their homes on the plains: the Caw, Kansa, Pawnee, Shawnee, Delaware, Crow, Cheyenne, Lakota, and Arapaho.” The Caw and Kansa are the same tribe. You really have two cultural groups here: On the frontier, nations such as the Shawnee, Delaware, Saux, Fox, and Pottawattamie were known as
“civilized tribes.” They often lived near missions, farmed, and ran ferries and bridges. Pawnee lived between the civilized tribes and the Plains Indians and were continually at war with them. The Crow, Cheyenne, Lakota, and Arapaho were Plains Indians sometimes encountered on the Platte River hunting buffalo or congregated at Fort Laramie.

**Correction:** “Cathedral Rocks.” Use the modern name (for the NPS site), City of Rocks.

**Correction:** Guides were occasionally available at Fort Hall for the next leg of the journey.

**Correction:** Ice Slough (/Ice Spring) was a flat swamp, not a very striking landscape.

**Correction:** Cut “How do you cross the Humboldt River?” When it flooded, people did drown in the Humboldt, but it was easy to ford.

**Correction:** Virginia Reed writes in 1847: “Don’t take no cut-offs and get where you’re going as fast as you can.” No she didn’t. She wrote,” never take no cutoffs and hury along as fast as you can.”

**Correction:** “California and El Dorado.” California is El Dorado.

**Vocabulary**

Most American Indians now avoid the confusing term “Native Americans.”

Avoid terms like “undisturbed” and “wilderness.” Indians had been transforming the West for about 12,000 years.

*Will Bagley*
Existing and suggested AInterpretive Exhibit Outline@ Organization

This section shows the original structure of the AInterpretive Exhibit Outline, starting on Page 52 of the AAbstract Design of the California National Historic Trail Interpretive Center@ and ending on Page 63. The second section, ASuggested Interpretive Center Exhibits Reorganization@ shows a simplified and resequenced outline. Will Bagley

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Suggested Interpretive Center Exhibits Reorganization

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The West in 1841
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Wall Map: Exploration .......................................................... 5
Why Go West? Video Wall ....................................................... 5
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<td>&quot;A Wall of Granite&quot; The Sierra Nevada</td>
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Drainage Calculations
Fort Collins Horticultural Center
Storm Drainage Report

EDAW Job No. 8F082.20
By: KF/GAH
Date: 9/18/2002
Revised:

Runoff Calculations

**Condition: 100-Year Developed**

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**Condition: 2-Year Developed**

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**Condition: 10-Year Developed**

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<th>Coefficient</th>
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Notes:

The analyzed condition is 100-year developed drainage from the CSURF property (A3c)

This condition is taken from ACE *Hydraulic Analysis of the Horticulture Center Outfall Channel, Sept. 2002*

### Fort Collins Horticultural Center
#### Storm Drainage Report

EDAW Job No. 7F082.20  
By: KF  
Date: 4/17/2001  
Revised:

<table>
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<th>Composite Runoff Coefficients</th>
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#### Runoff Coefficient

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Erosion Control Calculations
Horticultural Center
Storm Drainage Report

EDAW Job No. 7F082.20
By: KF
Date: 4/17/2001
Revised:

Rainfall Performance Standard Evaluation
Standard Form A

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For additional information or an official copy, please contact City of Fort Collins Utilities 700 Wood Street Fort Collins, CO 80524 USA
# Effectiveness Calculations

**Project:** Fort Collins Horticultural Center  
**Completed By:** Key Force - EDAW  
**Date:** 4.17.01

### Erosion Control Method

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<th>P-Factor Value</th>
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### Calculations

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<td>A1</td>
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- **24%** rough ground  
  \[ P = 0.90 \times 1.79 \text{ ac} \]
  \[ 24\% \text{ straw mulch} = C = 0.06 \times 5.62 \text{ ac} \]
  \[ \text{Sed. Trap} = P = 0.50 \]
  \[ \text{Eff}_{A1} = 1 - (1.79 \times 0.90 + 5.62 \times 0.06) \times 0.50 = 87\% \]

| A2          | 6.44   |           |           |              |

- **126 ac**  
  \[ \text{straw mulch} = C = 0.06 \times 0.265 \]  
  \[ \text{Silt Fence} = P = 0.80 \]
  \[ \text{Eff}_{A2} = 1 - (126 \times 0.01 + 6.18 \times 0.06) \times 0.50 = 88\% \]

| B           |        | B         | 1.43      |              |

- **Hyd. Mulch**  
  \[ C = 0.10 \]
  \[ \text{Straw Bales} = P = 0.80 \]
  \[ \text{Eff}_{B} = 1 - (0.10 \times 0.80) = 92\% \]

---

For additional information or an official copy, please contact City of Fort Collins Utilities, 700 Wood Street, Fort Collins, CO 80524 USA.
## Construction Sequence

**Project:** FC Horticultural Center  
2001/2002

**Sequence for 19** only  
**Completed by:** fall 2002  
**Date:** 4.17.01

Indicate by use of a bar line or symbols when erosion control measures will be installed. Major modifications to an approved schedule may require submitting a new schedule for approval by the City Engineer.

<table>
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<th>Year</th>
<th>Month</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sep</td>
<td>Oct</td>
</tr>
<tr>
<td>Nov</td>
<td>Dec</td>
</tr>
<tr>
<td>Jan</td>
<td>Feb</td>
</tr>
<tr>
<td>Mar</td>
<td>Apr</td>
</tr>
<tr>
<td>May</td>
<td>Jun</td>
</tr>
<tr>
<td>Jul</td>
<td>Aug</td>
</tr>
<tr>
<td>Sep</td>
<td>Oct</td>
</tr>
<tr>
<td>Nov</td>
<td>Dec</td>
</tr>
</tbody>
</table>

### Overlot Grading
- Soil Roughening
- Perimeter Barrier
- Additional Barriers
- Vegetative Methods
- Soil Sealant (Mulch)
- Other

### Wind Erosion Control
- Sediment Trap/Basin
- Inlet Filters
- Straw Barriers
- Silt Fence Barriers
- Sand Bags
- Bare Soil Preparation
- Contour Furrows
- Terracing
- Asphalt/Concrete Paving
- Other

### Rainfall Erosion Control
- Structural:
  - Sherwood Ditch
  - Sherwood Ditch

- Vegetative:
  - Permanent Seed Planting
  - Mulching/Sealant
  - Temporary Seed Planting
  - Sod Installation
  - Nettings/Mats/Blankets
  - Other

**Structures:** Installed by **Contractor**  
Maintained by **Contractor**

**Vegetation/Mulching Contractor**

**Date Submitted**

**Approved by City of Fort Collins on**
Horticultural Center
Storm Drainage Report
Porous Landscape Detention, Water Quality Pond

EDAW Job No. 7F082.20
By:  KF/GAH
Date:  9/19/2002
Revised:


### Design Basin Storage Volume

<table>
<thead>
<tr>
<th>Basin</th>
<th>Drain Time (Hr.)</th>
<th>(Ac.)</th>
<th>(S.F.)</th>
<th>(In.)</th>
<th>(C.F.)</th>
<th>WQCV</th>
<th>Design Vol.</th>
</tr>
</thead>
<tbody>
<tr>
<td>A3b</td>
<td>12</td>
<td>1.28</td>
<td>55,757</td>
<td>0.4</td>
<td>0.145</td>
<td>674</td>
<td>Storage Vol.</td>
</tr>
</tbody>
</table>

**Design Surface Area**  (Design Vol./ avg. depth)

<table>
<thead>
<tr>
<th>(C.F.)</th>
<th>(Fl.)</th>
<th>(S.F.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design Vol.</td>
<td>D(avg)</td>
<td>Design Area</td>
</tr>
<tr>
<td>674</td>
<td>0.50</td>
<td>1,347</td>
</tr>
</tbody>
</table>

1,347  Surface Area

### Design Basin Storage Volume

<table>
<thead>
<tr>
<th>Basin</th>
<th>Drain Time (Hr.)</th>
<th>(Ac.)</th>
<th>(S.F.)</th>
<th>(In.)</th>
<th>(C.F.)</th>
<th>WQCV</th>
<th>Design Vol.</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1a</td>
<td>12</td>
<td>2.59</td>
<td>112,820</td>
<td>0.6</td>
<td>0.19</td>
<td>1,786</td>
<td>Storage Vol.</td>
</tr>
</tbody>
</table>

**Design Surface Area**  (Design Vol./ avg. depth)

<table>
<thead>
<tr>
<th>(C.F.)</th>
<th>(Fl.)</th>
<th>(S.F.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design Vol.</td>
<td>D(avg)</td>
<td>Design Area</td>
</tr>
<tr>
<td>1,786</td>
<td>0.50</td>
<td>3,573</td>
</tr>
</tbody>
</table>

3,573  Surface Area

### Design Basin Storage Volume

<table>
<thead>
<tr>
<th>Basin</th>
<th>Drain Time (Hr.)</th>
<th>(Ac.)</th>
<th>(S.F.)</th>
<th>(In.)</th>
<th>(C.F.)</th>
<th>WQCV</th>
<th>Design Vol.</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1b</td>
<td>12</td>
<td>1.81</td>
<td>78,844</td>
<td>0.25</td>
<td>0.11</td>
<td>723</td>
<td>Storage Vol.</td>
</tr>
</tbody>
</table>

**Design Surface Area**  (Design Vol./ avg. depth)

<table>
<thead>
<tr>
<th>(C.F.)</th>
<th>(Fl.)</th>
<th>(S.F.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design Vol.</td>
<td>D(avg)</td>
<td>Design Area</td>
</tr>
<tr>
<td>723</td>
<td>0.58</td>
<td>1,246</td>
</tr>
</tbody>
</table>

1,246  Surface Area

### Design Basin Storage Volume

<table>
<thead>
<tr>
<th>Basin</th>
<th>Drain Time (Hr.)</th>
<th>(Ac.)</th>
<th>(S.F.)</th>
<th>(In.)</th>
<th>(C.F.)</th>
<th>WQCV</th>
<th>Design Vol.</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1</td>
<td>24</td>
<td>4.38</td>
<td>190,793</td>
<td>0.25</td>
<td>0.12</td>
<td>1,908</td>
<td>Storage Vol.</td>
</tr>
</tbody>
</table>

**Design Surface Area**  (Design Vol./ avg. depth)

<table>
<thead>
<tr>
<th>(C.F.)</th>
<th>(Fl.)</th>
<th>(S.F.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design Vol.</td>
<td>D(avg)</td>
<td>Design Area</td>
</tr>
<tr>
<td>1,908</td>
<td>0.23</td>
<td>8,295</td>
</tr>
</tbody>
</table>

8,295  Surface Area

Total  10.06 acres
PROJECT: Fort Collins Horticultural Center
Storm Drainage Report - Water Qual

Prepared by: EDAW inc.
Date: #

Manning's Equation, Pipe & Channel
Grassed Swale A3a (Section B-1)

Q2 = 7.5 cfs
Q100 = 33.7 cfs

CHANNEL AND PIPE DATA

Mannings n = 0.055
Side Slope = 2.00 x 1
Base Width = 5.00 feet
Bottom Slope = 0.000 ft/ft
Flow Depth = 0.600 feet

ADDITIONAL PIPE DATA

Pipe Diam. = 0.00 inches
Percent Full = 0 percent

RESULTS - CHANNEL

Area [sq ft] = 15.24
Hyd. Radius = 15.91
Flow [cfs] = 35.62 33.7 cfs req'd for Q100-hist
Flow [gpm] = 16078
Vel [fps] = 2.34
Width [ft] = 14.40

RESULTS - PIPE

Flow [cfs] = #DIV/0!
Flow [gpm] = #DIV/0!
Vel [fps] = #DIV/0!
Rolland Moore Drive Culvert
## DRAINAGE SUMMARY TABLE

<table>
<thead>
<tr>
<th>Design</th>
<th>Tributary Sub-basin</th>
<th>Area (ac)</th>
<th>C (2)</th>
<th>C (10)</th>
<th>C (100)</th>
<th>tc (2) (min)</th>
<th>tc (10) (min)</th>
<th>tc (100) (min)</th>
<th>Q(2)tot (cfs)</th>
<th>Q(10)tot (cfs)</th>
<th>Q(100)tot (cfs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>101</td>
<td>1.35</td>
<td>0.49</td>
<td>0.49</td>
<td>0.62</td>
<td>9.6</td>
<td>9.6</td>
<td>8.5</td>
<td>1.5</td>
<td>2.58</td>
<td>6.9</td>
</tr>
<tr>
<td>2</td>
<td>102</td>
<td>0.72</td>
<td>0.76</td>
<td>0.76</td>
<td>0.95</td>
<td>7.4</td>
<td>7.4</td>
<td>5.8</td>
<td>1.4</td>
<td>2.33</td>
<td>6.4</td>
</tr>
<tr>
<td>OS-1*</td>
<td></td>
<td>8.93</td>
<td>0.68</td>
<td>0.68</td>
<td>0.85</td>
<td>13.1</td>
<td>13.1</td>
<td>10.7</td>
<td>12.1</td>
<td>20.62</td>
<td>57.6</td>
</tr>
<tr>
<td>OS-2</td>
<td></td>
<td>0.70</td>
<td>0.20</td>
<td>0.20</td>
<td>0.25</td>
<td>12.0</td>
<td>12.0</td>
<td>11.6</td>
<td>0.3</td>
<td>0.49</td>
<td>1.3</td>
</tr>
</tbody>
</table>

*This is based upon this basin being developed.*
RUNOFF COEFFICIENTS & % IMPERVIOUS

LOCATION: Rolland Moore Drive
PROJECT NO: 9023.30
COMPUTATIONS BY: A. Reed (modified OS-1 by D. Mattson)
DATE: 9/20/2002

Recommended Runoff Coefficients from Table 3-3 of City of Fort Collins Design Criteria
Recommended % Impervious from Urban Storm Drainage Criteria Manual

<table>
<thead>
<tr>
<th></th>
<th>Runoff coefficient C</th>
<th>% Impervious</th>
</tr>
</thead>
<tbody>
<tr>
<td>Streets, parking lots (asphalt)</td>
<td>0.95</td>
<td>100</td>
</tr>
<tr>
<td>Sidewalks (concrete)</td>
<td>0.95</td>
<td>96</td>
</tr>
<tr>
<td>Roofs</td>
<td>0.95</td>
<td>90</td>
</tr>
<tr>
<td>Lawns (flat &lt;2%, sandy soil)</td>
<td>0.20</td>
<td>0</td>
</tr>
</tbody>
</table>

SUBBASIN DESIGNATION | TOTAL AREA (ac.) | TOTAL AREA (sq.ft) | ROOF AREA (sq.ft) | PAVED AREA (sq.ft) | SIDEWALK AREA (sq.ft) | LANDSCAPE AREA (sq.ft) | RUNOFF COEFF. (C) | % Impervious |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>101</td>
<td>1.35</td>
<td>58,665</td>
<td>0</td>
<td>18,417</td>
<td>4,655</td>
<td>35,603</td>
<td>0.49</td>
<td>39.01</td>
</tr>
<tr>
<td>102</td>
<td>0.72</td>
<td>31,305</td>
<td>0</td>
<td>18,985</td>
<td>4,498</td>
<td>7,821</td>
<td>0.76</td>
<td>74.44</td>
</tr>
<tr>
<td>OS-1*</td>
<td>8.93</td>
<td>388,961</td>
<td>90,000</td>
<td>125,000</td>
<td>35,000</td>
<td>138,961</td>
<td>0.68</td>
<td>61.60</td>
</tr>
<tr>
<td>OS-2</td>
<td>0.70</td>
<td>30,365</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>30,365</td>
<td>0.20</td>
<td>0.00</td>
</tr>
</tbody>
</table>

*This is based upon this basin being developed.

Equations

- Calculated C coefficients & % Impervious are area weighted
  
  \[ C = \sum (\frac{C_i A_i}{A_t}) \]

  - \( C_i \) = runoff coefficient for specific area, \( A_i \)
  - \( A_i \) = areas of surface with runoff coefficient of \( C_i \)
  - \( n \) = number of different surfaces to consider
  - \( A_t \) = total area over which \( C \) is applicable; the sum of all \( A_i \)'s
### STANDARD FORM SF-2
#### TIME OF CONCENTRATION - 2 YR

**LOCATION:** Rolland Moore Drive

**PROJECT NO:** 9023.30

**COMPUTATIONS BY:** A. Reed (modified OS-1 by D. Mattson)

**DATE:** 09/20/02

2-yr storm \( C_f = 1.00 \)

<table>
<thead>
<tr>
<th>SUB-BASIN</th>
<th>INITIAL/OVERLAND TIME (t)</th>
<th>TRAVEL TIME / GUTTER OR CHANNEL FLOW</th>
<th>TC CHECK (URBANIZED BASIN)</th>
<th>FINAL tc</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>DESIGN PON'T</strong></td>
<td><strong>SUBBASIN(e) Area (ac)</strong></td>
<td><strong>(2)</strong></td>
<td><strong>C</strong></td>
<td><strong>(3)</strong></td>
<td><strong>Length (ft)</strong></td>
</tr>
<tr>
<td>1</td>
<td>101</td>
<td>1.35</td>
<td>0.49</td>
<td>30</td>
<td>2.9</td>
</tr>
<tr>
<td>2</td>
<td>102</td>
<td>0.72</td>
<td>0.76</td>
<td>30</td>
<td>2.9</td>
</tr>
<tr>
<td>OS-1*</td>
<td>8.93</td>
<td>0.68</td>
<td>0.35</td>
<td>2.0</td>
<td>6.0</td>
</tr>
<tr>
<td>OS-2</td>
<td>0.70</td>
<td>0.20</td>
<td>48</td>
<td>4.0</td>
<td>7.3</td>
</tr>
</tbody>
</table>

**EQUATIONS:**

\[ tc = t_i + t_t \]

\[ t_i = \left[1.87 \times (1.1 - CC_t) \times L^{0.5}\right] / S^{1/3} \]

\[ t_t = L / \text{Vel.} \]

Velocity from Manning's Equation with \( R = 0.1 \) (corresponds to Figure 3-3 of City of Fort Collins Design Manual)

**final tc = minimum of \( t_i + t_t \) and urbanized basin check**

\[ \text{min. tc} = 5 \text{ min. due to limits of IDF curves} \]
STANDARD FORM SF-2
TIME OF CONCENTRATION - 10 YR

10-yr storm  $C_f = 1.00$

<table>
<thead>
<tr>
<th>SUB-BASIN DATA</th>
<th>INITIAL / OVERLAND TIME (ti)</th>
<th>TRAVEL TIME / GUTTER OR CHANNEL FLOW</th>
<th>tc CHECK (URBANIZED BASIN)</th>
<th>FINAL tc</th>
</tr>
</thead>
<tbody>
<tr>
<td>DESIGN PONIT</td>
<td>SUBBASIN(s)</td>
<td>Area (ac)</td>
<td>C</td>
<td>Length (ft)</td>
</tr>
<tr>
<td>----------------</td>
<td>------------</td>
<td>-----------</td>
<td>---</td>
<td>-------------</td>
</tr>
<tr>
<td>1</td>
<td>101</td>
<td>1.33</td>
<td>0.49</td>
<td>30</td>
</tr>
<tr>
<td>2</td>
<td>102</td>
<td>0.72</td>
<td>0.76</td>
<td>30</td>
</tr>
<tr>
<td>OS-1*</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OS-2</td>
<td></td>
<td>8.93</td>
<td>0.68</td>
<td>68</td>
</tr>
</tbody>
</table>

EQUATIONS:

$tc = ti + tt$

$ti = \left[ \frac{1.87 \left(1.1 - C_f \right) L^{0.5}}{S^{1/3}} \right]$

$tt = \frac{L}{V}$

Velocity from Manning's Equation with $R=0.1$ (corresponds to Figure 3-3 of City of Fort Collins Design Manual)

final tc = minimum of ti + tt and urbanized basin check

min. tc = 5 min. due to limits of IDF curves
**STANDARD FORM SF-2**

**TIME OF CONCENTRATION - 100 YR**

**LOCATION:** Rolland Moore Drive  
**PROJECT NO.:** 9023.30  
**COMPUTATIONS BY:** A. Reed (modified OS-1 by D. Mattson)  
**DATE:** 09/20/02

100-yr storm  \( C_f = 1.25 \)

<table>
<thead>
<tr>
<th>SUB-BASIN DATA</th>
<th>INITIAL / OVERLAND TIME (( t_i ))</th>
<th>TRAVEL TIME / GUTTER OR CHANNEL FLOW (( t_t ))</th>
<th>tc CHECK (URBANIZED BASIN)</th>
<th>FINAL ( tc )</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>DESIGN POINT</td>
<td>SUBBASIN(( a ))</td>
<td>AREA ( \text{ac} )</td>
<td>( C )</td>
<td>( C_f )</td>
<td>LENGTH (( ft ))</td>
</tr>
<tr>
<td>1</td>
<td>101</td>
<td>1.35</td>
<td>0.49</td>
<td>0.62</td>
<td>30</td>
</tr>
<tr>
<td>2</td>
<td>102</td>
<td>0.72</td>
<td>0.76</td>
<td>0.88</td>
<td>30</td>
</tr>
<tr>
<td>OS-1*</td>
<td>8.93</td>
<td>0.68</td>
<td>0.86</td>
<td>0.95</td>
<td>55</td>
</tr>
<tr>
<td>OS-2</td>
<td>0.70</td>
<td>0.20</td>
<td>0.25</td>
<td>0.48</td>
<td>48</td>
</tr>
</tbody>
</table>

**EQUATIONS:**

\[
\begin{align*}
t_c &= t_i + t_t \\
t_i &= \left[ 1.87 (1.1 - CC_f) \right] / S^{1.5} \\
t_t &= L / \text{Vel.}
\end{align*}
\]

Velocity from Manning's Equation with \( R=0.1 \) (corresponds to Figure 3-3 of City of Fort Collins Design Manual)

final \( tc \) = minimum of \( t_i + t_t \) and urbanized basin check  
min. \( tc = 5 \text{ min.} \) due to limits of IDF curves
# 2-Year Historic Flows

**Location:** Rolland Moore Drive  
**Project No.:** 9023.30  
**Computations By:** A. Reed (modified OS-1 by D. Mattson)  
**Date:** 9/20/2002

Recommended Runoff Coefficient from Table 3-3 of City of Fort Collins Design Criteria  
Recommended % Impervious from Urban Storm Drainage Criteria Manual

<table>
<thead>
<tr>
<th>Runoff Coefficient</th>
<th>% Impervious</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td></td>
</tr>
<tr>
<td>Laws (flat &lt;2%, sandy soil):</td>
<td>0.10</td>
</tr>
<tr>
<td>Laws (average, 2-7%, sandy soil):</td>
<td>0.15</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Design Point</th>
<th>Subbasin Designation</th>
<th>Total Area (ac.)</th>
<th>Total Area (sq.ft)</th>
<th>Length (ft)</th>
<th>Slope (%)</th>
<th>ti (min)</th>
<th>i (in/hr)</th>
<th>Q (cfs)</th>
<th>from Design Point</th>
<th>Q (cfs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>101H</td>
<td>15.03</td>
<td>654,565</td>
<td>1390</td>
<td>0.5</td>
<td>84.5</td>
<td>0.75</td>
<td>1.69</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Equations**

- Calculated C coefficients & % Impervious are area weighted
  \[ C = \sum (C_i A_i) / A_t \]
  
  \[ C_i = \text{runoff coefficient for specific area}, A_i = \text{areas of surface with runoff coefficient of } C_i 
  \]
  
  \[ n = \text{number of different surfaces to consider} \]
  
  \[ A_t = \text{total area over which } C \text{ is applicable; the sum of all } A_i's \]

\[ Q = C_t C i A \]

\[ \text{ti} = [1.87 (1.1 - CC_t) L^{0.5}] / S^{1.3} \]

\[ i = 26 / (10 + b)^{0.764} \]

\[ A = \text{drainage area (acres)} \]
RATIONAL METHOD PEAK RUNOFF
(City of Fort Collins, 2-Yr Storm)

LOCATION: Rolland Moore Drive
PROJECT NO: 9023.30
COMPUTATIONS BY: A. Reed (modified OS-1 by D. Mattson)
DATE: 09/20/02

2 yr storm, Cf = 1.00

<table>
<thead>
<tr>
<th>Design Point</th>
<th>Tributary Sub-basin</th>
<th>A (ac)</th>
<th>C Cf</th>
<th>t0 (min)</th>
<th>i (in/hr)</th>
<th>Q (2) (cfs)</th>
<th>Carry Over</th>
<th>TOTAL</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Q (2) (cfs)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>101</td>
<td>1.35</td>
<td>0.49</td>
<td>9.6</td>
<td>2.27</td>
<td>1.51</td>
<td>1.51</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>102</td>
<td>0.72</td>
<td>0.76</td>
<td>7.4</td>
<td>2.48</td>
<td>1.36</td>
<td>1.36</td>
<td></td>
<td></td>
</tr>
<tr>
<td>OS-1</td>
<td></td>
<td>8.93</td>
<td>0.68</td>
<td>13.1</td>
<td>1.88</td>
<td>12.07</td>
<td>12.07</td>
<td></td>
<td>Developed Conditions</td>
</tr>
<tr>
<td>OS-2</td>
<td></td>
<td>0.70</td>
<td>0.20</td>
<td>12.0</td>
<td>2.07</td>
<td>0.29</td>
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<td></td>
</tr>
</tbody>
</table>

\[ Q = C_r C I A \]

**Q** = peak discharge (cfs)

**C** = runoff coefficient

**C_r** = frequency adjustment factor

**i** = rainfall intensity (in/hr) from City of Fort Collins IDF curve (4/16/69)

\[ i = 24.221 / (10 + 10^{-0.793}) \]
# RATIONAL METHOD PEAK RUNOFF
(City of Fort Collins, 10-Yr Storm)

**LOCATION:** Rolland Moore Drive  
**PROJECT NO:** 9023.30  
**COMPUTATIONS BY:** A. Reed (modified OS-1 by D. Mattson)  
**DATE:** 09/20/02

10 yr storm, \( C_f = 1.00 \)

<table>
<thead>
<tr>
<th>Design Point</th>
<th>Tributary Sub-basin</th>
<th>A (ac)</th>
<th>C Cf</th>
<th>tc (min)</th>
<th>i (in/hr)</th>
<th>Q (10) Design from Design Point (cfs)</th>
<th>Q (10) Total (cfs)</th>
<th>REMARKS</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>101</td>
<td>1.35</td>
<td>0.49</td>
<td>9.6</td>
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<td>2.58</td>
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<tr>
<td>2</td>
<td>102</td>
<td>0.72</td>
<td>0.76</td>
<td>7.4</td>
<td>4.25</td>
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<tr>
<td>OS-1*</td>
<td></td>
<td>8.93</td>
<td>0.68</td>
<td>13.1</td>
<td>3.38</td>
<td>20.62</td>
<td></td>
<td>Developed Conditions</td>
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<tr>
<td>OS-2</td>
<td></td>
<td>0.70</td>
<td>0.20</td>
<td>12.0</td>
<td>3.53</td>
<td>0.49</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\[
Q = C_f C i A \\
Q = \text{peak discharge (cfs)} \\
C = \text{runoff coefficient} \\
C_f = \text{frequency adjustment factor} \\
i = \text{rainfall intensity (in/hr) from City of Fort Collins IDF curve (4/16/99)} \\
A = \text{drainage area (acres)} \\
i = 41.44 / (10 + \text{tc})^{0.5704}
\]
**RATIONAL METHOD PEAK RUNOFF**  
*(City of Fort Collins, 100-Yr Storm)*

**LOCATION:** Rolland Moore Drive  
**PROJECT NO.:** 9023.30  
**COMPUTATIONS BY:** A. Reed (modified OS-1 by D. Mattson)  
**DATE:** 09/20/02

100 yr storm, Cf = 1.25

<table>
<thead>
<tr>
<th>Des.</th>
<th>Area</th>
<th>A</th>
<th>C Cf</th>
<th>tc</th>
<th>i</th>
<th>Q (100)</th>
<th>CARRY OVER</th>
<th>TOTAL</th>
<th>REMARKS</th>
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</thead>
<tbody>
<tr>
<td>Point</td>
<td>Design.</td>
<td>(ac)</td>
<td>(min)</td>
<td>(in/hr)</td>
<td>(cfs)</td>
<td>from Design Point</td>
<td>Q (100)</td>
<td>Q(100)tot</td>
<td></td>
</tr>
<tr>
<td>------</td>
<td>---------</td>
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<tr>
<td>1</td>
<td>101</td>
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<td>0.62</td>
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<td>2</td>
<td>102</td>
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<td>0.95</td>
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<td>9.36</td>
<td>6.41</td>
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<td>0.85</td>
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<tr>
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<td></td>
<td>0.70</td>
<td>0.25</td>
<td>11.6</td>
<td>7.32</td>
<td>1.26</td>
<td>1.3</td>
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<td></td>
</tr>
</tbody>
</table>

Q = C / A

Q = peak discharge (cfs)  
C = runoff coefficient  
i = rainfall intensity (in/hr) from City of Fort Collins IDF curve (4/16/99)  
A = drainage area (acres)  
i = 84.682 / (10 + tc)^0.7975
UDINLET: INLET HYDRAULICS AND SIZING
DEVELOPED BY
CIVIL ENG DEPT. U OF COLORADO AT DENVER
SUPPORTED BY METRO DENVER CITIES/COUNTIES AND UD&FCD

SER:JR ENGINEERS-DENVER CO. ..................................................

ON DATE 01-17-2003 AT TIME 10:03:41

*** PROJECT TITLE: ROLLAND MOORE

*** COMBINATION INLET: GRATE INLET AND CURB OPENING:

*** GRATE INLET HYDRAULICS AND SIZING:

INLET ID NUMBER: 1

INLET HYDRAULICS: IN A SUMP.

GIVEN INLET DESIGN INFORMATION:

INLET GRATE WIDTH (ft) = 1.87
INLET GRATE LENGTH (ft) = 3.25
INLET GRATE TYPE = Type 16 Grate Inlet
NUMBER OF GRATES = 1.00
SUMP DEPTH ON GRATE (ft) = 0.17
GRATE OPENING AREA RATIO (%) = 0.60
IS THE INLET GRATE NEXT TO A CURB? --- YES

Note: Sump is the additional depth to flow depth.

STREET GEOMETRIES:

STREET LONGITUDINAL SLOPE (%) = 0.80
STREET CROSS SLOPE (%) = 2.00
STREET MANNING N = 0.016
GUTTER DEPRESSION (inch) = 2.00
GUTTER WIDTH (ft) = 2.00

STREET FLOW HYDRAULICS:

WATER SPREAD ON STREET (ft) = 14.50
GUTTER FLOW DEPTH (ft) = 0.46
FLOW VELOCITY ON STREET (fps) = 3.02
FLOW CROSS SECTION AREA (sq ft) = 2.27
GRATE CLOGGING FACTOR (%) = 50.00
CURB OPENING CLOGGING FACTOR (%) = 20.00

INLET INTERCEPTION CAPACITY:

FOR 1 GRATE INLETS:
DESIGN DISCHARGE (cfs) = 6.90
IDEAL GRATE INLET CAPACITY (cfs) = 10.40
BY FAA HEC-12 METHOD:
FLOW INTERCEPTED (cfs) = 5.20
BY DENVER UD&FCD METHOD:
FLOW INTERCEPTED (cfs) = 5.20

*** CURB OPENING INLET HYDRAULICS AND SIZING:

INLET ID NUMBER: 1
INLET HYDRAULICS: IN A SUMP.

GIVEN INLET DESIGN INFORMATION:

GIVEN CURB OPENING LENGTH (ft) = 3.30
HEIGHT OF CURB OPENING (in) = 6.00
INCLINED THROAT ANGLE (degree) = 0.00
LATERAL WIDTH OF DEPRESSION (ft) = 2.00
SUMP DEPTH (ft) = 0.17

Note: The sump depth is additional depth to flow depth.

INLET INTERCEPTION CAPACITY:

IDEAL INTERCEPTION CAPACITY (cfs) = 7.87

BY FAA HEC-12 METHOD: DESIGN FLOW (cfs) = 1.70
FLOW INTERCEPTED (cfs) = 1.70
CARRY-OVER FLOW (cfs) = 0.00

BY DENVER UDFCD METHOD: DESIGN FLOW (cfs) = 1.70
FLOW INTERCEPTED (cfs) = 1.70
CARRY-OVER FLOW (cfs) = 0.00

*** SUMMARY FOR THE COMBINATION INLET:

THE TOTAL DESIGN PEAK FLOW RATE (cfs) = 6.90 = Q_{100}

BY FAA HEC-12 METHOD:
FLOW INTERCEPTED BY GRATE INLET (cfs) = 5.20
FLOW INTERCEPTED BY CURB OPENING (cfs) = 1.70
TOTAL FLOW INTERCEPTED (cfs) = 6.90
CARRYOVER FLOW (cfs) = 0.00

BY DENVER UDFCD METHOD:
FLOW INTERCEPTED BY GRATE INLET (cfs) = 5.20
FLOW INTERCEPTED BY CURB OPENING (cfs) = 1.70
TOTAL FLOW INTERCEPTED (cfs) = 6.90
CARRYOVER FLOW (cfs) = 0.00
UDINLET: INLET HYDRAULICS AND SIZING
DEVELOPED BY
CIVIL ENG DEPT. U OF COLORADO AT DENVER
SUPPORTED BY METRO DENVER CITIES/COUNTIES AND UD&FCD

SER:JR ENGINEERS- DENVER CO. ............................................................
ON DATE 01-17-2003 AT TIME 10:04:38

*** PROJECT TITLE: ROLLAND MOORE

*** COMBINATION INLET: GRATE INLET AND CURB OPENING:

*** GRATE INLET HYDRAULICS AND SIZING:

INLET ID NUMBER: 2

INLET HYDRAULICS: IN A SUMP.

GIVEN INLET DESIGN INFORMATION:

INLET GRATE WIDTH (ft) = 1.87
INLET GRATE LENGTH (ft) = 3.25
INLET GRATE TYPE = Type 16 Grate Inlet
NUMBER OF GRATES = 1.00
SUMP DEPTH ON GRATE (ft) = 0.17
GRATE OPENING AREA RATIO (%) = 0.60
IS THE INLET GRATE NEXT TO A CURB? -- YES
Note: Sump is the additional depth to flow depth.

STREET GEOMETRIES:

STREET LONGITUDINAL SLOPE (%) = 0.80
STREET CROSS SLOPE (%) = 2.00
STREET MANNING N = 0.016
GUTTER DEPRESSION (inch) = 2.00
GUTTER WIDTH (ft) = 2.00

STREET FLOW HYDRAULICS:

WATER SPREAD ON STREET (ft) = 14.13
GUTTER FLOW DEPTH (ft) = 0.45
FLOW VELOCITY ON STREET (fps) = 2.98
FLOW CROSS SECTION AREA (sq ft) = 2.16
GRATE CLOGGING FACTOR (%) = 50.00
CURB OPENING CLOGGING FACTOR (%) = 20.00

INLET INTERCEPTION CAPACITY:

FOR 1 GRATE INLETS:
DESIGN DISCHARGE (cfs) = 6.40
IDEAL GRATE INLET CAPACITY (cfs) = 10.22
BY FAA HEC-12 METHOD:
FLOW INTERCEPTED (cfs) = 5.11
BY DENVER UD&FCD METHOD:
FLOW INTERCEPTED (cfs) = 5.11

*** CURB OPENING INLET HYDRAULICS AND SIZING:

INLET ID NUMBER: 2
INLET HYDRAULICS: IN A SUMP.

GIVEN INLET DESIGN INFORMATION:

- GIVEN CURB OPENING LENGTH (ft) = 3.30
- HEIGHT OF CURB OPENING (in) = 6.00
- INCLINED THROAT ANGLE (degree) = 0.00
- LATERAL WIDTH OF DEPRESSION (ft) = 2.00
- SUMP DEPTH (ft) = 0.17

Note: The sump depth is additional depth to flow depth.

INLET INTERCEPTION CAPACITY:
IDEAL INTERCEPTION CAPACITY (cfs) = 7.73
BY FAA HEC-12 METHOD:
- DESIGN FLOW (cfs) = 1.29
- FLOW INTERCEPTED (cfs) = 1.29
- CARRY-OVER FLOW (cfs) = 0.00

BY DENVER UDFCD METHOD:
- DESIGN FLOW (cfs) = 1.29
- FLOW INTERCEPTED (cfs) = 1.29
- CARRY-OVER FLOW (cfs) = 0.00

*** SUMMARY FOR THE COMBINATION INLET:

- THE TOTAL DESIGN PEAK FLOW RATE (cfs) = 6.40 = $Q_{100}$

BY FAA HEC-12 METHOD:
- FLOW INTERCEPTED BY GRATE INLET (cfs) = 5.11
- TOTAL FLOW INTERCEPTED (cfs) = 6.40

BY DENVER UDFCD METHOD:
- FLOW INTERCEPTED BY GRATE INLET (cfs) = 5.11
- TOTAL FLOW INTERCEPTED (cfs) = 6.40
- CARRYOVER FLOW (cfs) = 0.00
DRAINAGE ASSUMPTIONS/NOTES

LOCATION:  Rolland Moore Drive
PROJECT NO:  9023.30
COMPUTATIONS BY:  A. Reed (modified OS-1 by D. Mattson)
DATE:  9/20/2002

1. Due to negotiations with CSU assume land from the south (Basin OS-1) will be fully developed and therefore, pipes under Roland Moore must be capable of carrying fully developed flows.

2. Basin flows and inlet sizing was done assuming that the road was completely constructed (i.e. Final Conditions).

3. Assume no flow from Centre Ave is coming on site.
Windtrail Townhomes Addendum
ADDENDUM TO THE
FINAL DRAINAGE REPORT
FOR THE
WINDTRAIL P.U.D., TOWNHOMES SITE

PREPARED FOR:
City of Fort Collins
Stormwater Utility
235 Mathews
Fort Collins, CO 80524

PREPARED BY:
Lidstone & Anderson, Inc.
736 Whalers Way, F-200
Fort Collins, CO 80525
(LA Project No. COTST18.8)

March 1, 1995
SWALE OVERSIZING

Background

The swale shown on Sheet 2 of the Windtrail Townhomes drainage report [LA, 1994], and repeated on Sheet 2 of the Windtrail on Spring Creek drainage report [LA, 1994], was designed to convey the 100-year developed condition runoff from both the townhomes and single-family sites as well as the 100-year historical runoff from all other areas tributary to the swale. It was previously assumed that detention would be provided in conjunction with future development in the area to reduce 100-year developed condition flows to 100-year historical levels. CSURF has requested that the downstream reach of the swale, from the southeast to northeast corner of the Windtrail single-family homes site, be oversized to minimize potential detention requirements.

Hydrology

CSURF’s engineer, Mr. Patrick Mulhern of Mulhern MRE, Inc., has provided design discharges which he believes will allow developed condition runoff from CSURF’s property to be released undetained to this reach of the swale. A copy of Mr. Mulhern’s letter dated December 1, 1994 is included in Appendix C of this report. It is noted that inclusion of Mr. Mulhern’s letter in this report does not imply concurrence with his discharges or conclusions. Attempting to estimate the required channel design discharge in order to allow undetained runoff associated with developed conditions from a site which has not yet been designed is difficult at best. However, CSURF (through Mr. Mulhern) has indicated that the discharges cited in his letter would be acceptable for designing the swale.

To summarize the information in Mr. Mulhern’s letter, the 100-year discharge from the Spring Creek Trail to the east end of Gilgalad Way would be 216 cfs. The 100-year discharge from Gilgalad Way to the southeast corner of the single-family site would be 188 cfs. In order to meet City of Fort Collins’ freeboard requirements, the swale was designed to convey an additional one-third of these values or 288 and 250 cfs, respectively.

Hydraulic Analysis and Design

The swale grading plan was modified for the reach from DP #8 to DP #5 in order to maximize the channel cross section. The lot layout near the east end of Gilgalad Way, as well as Gilgalad Way itself, were modified in order to accommodate the swale. In addition, the grading plan now includes construction of a berm along the west side of the Spring Creek Trail in order to form the east bank of the swale along this reach. A typical cross section of this reach is given
in schematic form in Figure 1; a summary of swale design parameters are provided in the table on Sheet 1.

Based on the Mulhern discharge at DP #8, an HY-8 analysis was conducted for the previously-designed double box culvert; the results of this analysis are included in Appendix D. It was determined that the previous culvert design will accommodate the increased discharge without modifying the culvert.

Results of the HY-8 analysis were used to define the starting water surface elevation for the HEC-2 analysis of the swale. The revised discharge profile (for oversizing) given in Table 1, which includes Mulhern's discharges in the lower reach and the discharges cited in the previous section for the upper reaches, was incorporated into the HEC-2 model for the proposed swale. Complete HEC-2 output for the modeling of this condition are included in Appendix E; the results are summarized in Table 3. The minimum channel depth for Sections E1-E1 and E2-E2 specified in the table on Sheet 1 is the maximum flow depth within the specified reach associated with 1.55 times the 100-year discharge for the reach.

If you have any comments or questions concerning this study or the information provided herein, please do not hesitate to contact us.

Sincerely,

LIDSTONE & ANDERSON, INC.

[Signature]

Gregory J. Koch, P.E.
Senior Engineer

GJK/tlt

Attachments
December 1, 1994

VIA TELECOPIER - 1-303-223-9115
AND REGULAR MAIL

Mr. Steve Human
TST, Inc.
748 Whalers Way
Fort Collins, Colorado 80522

Re: CSURF/McCoy Land Swap

Dear Steve:

In follow-up to our recent conversation, I have attached my calculations of drainage design flows with allowances for the discharge of fully developed flows from the McCoy swap parcel and portions of CSURF Site J. All my calculations relate to the Overall Drainage Plan map for Windtrail on Spring Creek PUD and the Final Drainage Report for Windtrail PUD, Townhome Site, both prepared by Lidstone and Anderson.

These calculations provide our best estimates of future fully developed flow conditions and the required channel width to discharge that flow across the easement at McCoy single family home sites. We understand that plan approval for the single family home sites will be based upon the estimated discharges contained herein which may vary with actual development. If the actual development creates discharges in excess of these numbers, we understand that detention will be necessary on-site to limit discharges to these peaks.

I hope this information is sufficient to meet your needs. We would appreciate the opportunity to review the final design for the drainage channel across the single family home sites.

In addition to this issue, there are a few others that need to be addressed. First, as we discussed, we need to review the location of the proposed sanitary sewer easement across a portion of CSURF Site J. We would prefer that this easement be located on the edge of the drainageway so that the future roadway location is not constrained by this easement. I understood you to say that the City would not allow this alternative, but with your permission we would like to pursue this option with the City. Secondly, CSURF has agreed to allow for additional detention area on Site J to accommodate spill-over drainage from the CSURF swap...
Mr. Steve Human  
December 1, 1994  
Page 2

parcel. We need to see a document that shows the limits and a plan of the proposed detention, and documentation which identifies this area as a wetland per City criteria.

Finally, we have previously discussed that drainage swales will be constructed on the McCoy swap parcel as part of the requirements for the development of the single family homesites. We would like to provide specific input as to the location of these swales across the swap parcel. If you would provide us with a copy of your design sheet in this area, we will be happy to locate the alignment that we desire.

Thank you for your assistance in all of these matters. We look forward to hearing from you at your earliest convenience.

Sincerely,

MULHERN MRE, INC.

Patrick F. Mulhern, P.E.  
President

PFM/Ihl  
Attachment  
cc: Ms. Kathleen Byington (via telex and regular mail)  
Mr. John McCoy (via regular mail)
ASSUMPTIONS

1. Drainage basin boundaries are the same as contained in the Overall Drainage Plan Map for the Windrail on Spring Creek PUD as prepared by Lidstone and Anderson, Inc., dated 9/6/94.

2. 13 acres on the west side of Basin A is to be detained. This west basin has been renamed A2. The C value for Basin A2 is 0.20. The remaining portion of Basin A is renamed Basin A1.

3. Basins A1, F, and G will be developed in the future with no detention. No plan currently exists. The C value for these basins is assumed at 0.60.

4. Design points evaluated are DP(5) and DP(8) (located upstream of contributions from Basin J.

Since Basin A2 is detained, it seems that the critical time of concentration would be for Basin B, plus channel flow to the design points.

DP(5):
\[ t_c \text{ (Basin B) } = 17.9 \text{ minutes (per Lidstone-Anderson)} \]
\[ t_c \text{ (channel to DP(5)) } = 9.2 \text{ minutes (1,050 feet at 1.9 fps per Lidstone Anderson Design)} \]
\[ t_c \text{ (total to DP5) } = 27 \text{ minutes} \]
\[ i \text{ (27.2 minutes) } = 4.4 \text{ in/hr} \]

C Factor:

<table>
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<tr>
<th>Basin</th>
<th>Area</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1</td>
<td>9.5</td>
<td>0.60</td>
</tr>
<tr>
<td>A2</td>
<td>13.0</td>
<td>0.20</td>
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<tr>
<td>B</td>
<td>12.3</td>
<td>0.60</td>
</tr>
<tr>
<td>C</td>
<td>4.5</td>
<td>0.60</td>
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<td>E</td>
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<td>F</td>
<td>8.2</td>
<td>0.60</td>
</tr>
<tr>
<td>G</td>
<td>10.5</td>
<td>0.60</td>
</tr>
</tbody>
</table>

Total: 65.6
Total Weighted: 0.52
\[ Q_{100} = 1.25 \times 0.52 \times 65.6 \times 4.4 = 187.6 \]

\[ Q_{100} + \text{Freeboard} = 1.3 \times 187.6 = 243.9 \text{ cfs} \]

**Estimate Channel Width from Section E-E in Lidstone Anderson Report**

**Normal Depth** = 1.98 ft  
**Ave Velocity** = 2.19 fps

Flow Per Foot of Width = 4.33 cfs  
**Additional Flow** = 243.9 - 185.9 = 58.0

**Additional Width** = 58.0/4.33 = 13.4 ft

**DP8:**

\[ t_c = t_c (DP(5)) + t_c \text{ (channel)} \]

\[ t_c \text{ (channel)} = 2.65 \text{ minutes} \]

(350 feet at 2.2 fps)  
\[ t_c = 27.1 + 2.65 = 29.7 \text{ minutes} \]

\[ i (29.7 \text{ minutes}) = 4.2 \text{ in/hr} \]

**C Factor:**

<table>
<thead>
<tr>
<th>Basin</th>
<th>Area</th>
<th>C</th>
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<tbody>
<tr>
<td>A-6</td>
<td>65.6</td>
<td>0.52</td>
</tr>
<tr>
<td>H</td>
<td>3.6</td>
<td>0.30</td>
</tr>
<tr>
<td>L</td>
<td>4.7</td>
<td>0.50</td>
</tr>
</tbody>
</table>

**TOTAL**  
**TOTAL WEIGHTED** = 0.51

\[ Q_{100} = 1.25 \times 0.51 \times 73.9 \times 4.2 = 197.9 \]

\[ Q_{100} + \text{Freeboard} = 197.9 \times 1.3 = 257.3 \text{ cfs} \]

**Estimate Channel Width from Section E-E (same as above)**

**Additional Flow** = 257.3 - 185.9 = 71.4

**Additional Width** = 71.4 + 4.33 = 16.5 feet
Basin J then enters channel upstream of the bike trail culvert:

\[ t_c = 29.7 \text{ minutes} \]
\[ i (29.7 \text{ minutes}) = 4.2 \text{ in/hr} \]

**C Factor:**

<table>
<thead>
<tr>
<th>Basin</th>
<th>Area</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>A-I</td>
<td>73.9</td>
<td>0.51</td>
</tr>
<tr>
<td>J</td>
<td>6.8</td>
<td>0.50</td>
</tr>
</tbody>
</table>

**TOTAL**

| TOTAL WEIGHTED | 80.7 | 0.51 |

\[ Q_{100} = 1.25 \times (0.51) \times (80.7) \times (4.2) \]
\[ = 216.1 \text{ cfs} \]
April 5, 1995

Mr. Basil Hamden
City of Fort Collins
Storm Water Utility
P.O. Box 580
Fort Collins, Colorado 80522

Re: Windtrail Park P.U.D.

Dear Mr. Hamden:

I have reviewed the plan for drainage channels across the undeveloped parcels downstream of the Windtrail Park project on behalf of the Colorado State University Research Foundation ("CSURF"). I am satisfied that the channel locations shown on the "Revised Grading and Drainage Plan, Addendum to the Outfall Swale for the Windtrail P.U.D." with revision date of 3/28/95 as prepared by Lidstone and Anderson, Inc. accommodate future development in this area. Therefore, we are in agreement with construction of the channels in these locations.

If you have any questions regarding this letter, please do not hesitate to contact me.

Sincerely,

Patrick F. Mulhern, P.E.
President

cc: Ms. Kathleen Byington, CSURF
Rip Rap Calculations
**Rip rap calculations**

**5-inch pipe:** Assume flowing full

**Velocity (Manostats) = 2.58 ft/s**

Assume slope of channel = 1% (0.01 ft/ft)

\[ V = 0.12 \]

\[ \frac{V^0.7}{S_0^{0.7}} = \frac{2.58^{0.7}}{0.01^{0.7}} = 2.5 \]

\[ 2.58 / 0.01 = 258 / (2.5-1) = 66 \quad 0.902 \rightarrow \text{No rip rap needed} \]

**However, recommend using Class 6**

\[ D_{50} = 6'' \]

---

**15-inch pipe**

**Calculations for pipe flow shown for water quality pond basin A3b**

\[ V = 6.0 \text{ ft/sec} \]

Assume slope of channel = 1%

\[ V = 0.17 / (S_0 - 1)^{0.6} \]

\[ S_0 = 2.5 \]

\[ 6.0 / 0.01 = 600 / (2.5-1) = 2.30 \rightarrow \text{Use Class 6} \]

\[ D_{50} = 6'' \]

---

**3-15-inch pipe**

**Calculations for pipe flow shown for combined basins A3a, b,c**

\[ V = 9.1 \text{ ft/sec} \]

**Slope = 0.7 ft/ft**

\[ V = 0.17 / (S_0 - 1)^{0.6} \]

\[ 9.1 / 0.01 = 910 / (2.5-1) = 2.5 \]

\[ S_0 = 2.5 \]

\[ 2.5 = 2.5 \rightarrow \text{Use Class 6} \]

\[ D_{50} = 6'' \]

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