# STORMWATER MANAGEMENT PLAN

**Kwik Trip Convenience Store 1203**
US Highway 71 & County Road 1
Redwood Falls, Minnesota
*Project #9721-00*

Prepared for:

Kwik Trip, Inc.
P.O. Box 2107
1626 Oak Street
LaCrosse, WI 54602-2107

January 3, 2022
Revised: February 4, 2022

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ENGINEERING \ LAND SURVEYING \ ENVIRONMENTAL

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# 1.0 INTRODUCTION

This document provides detailed information on the proposed surface water management system for the development of property located in the southeast quadrant of the intersection of US Highway 71 and County Road 1 in Redwood Falls, Redwood County, Minnesota. Kwik Trip, Inc. plans on developing the site into a convenience store with a single bay carwash and side diesel. Included in this document are peak elevations for the onsite basins, a runoff control analysis, water quality analysis, and storm sewer design. See Figure 1 for a site location map.

## 1.1 Existing Conditions

The site is located in the southeast quadrant of the intersection of US Highway 71 and County Road 1 in Redwood Falls, Redwood County, Minnesota. The site is bounded on the north by Highway 71, on the west by County Road 1, on the south by undeveloped grasslands, and on the east by commercial property. The site is currently abandoned commercial property.

The proposed site boundary consists of 6.710 acres. A drainage boundary of 15.274 acres will be considered for this analysis, which includes runon from the right-of-way area outside the site boundary and from the property to the east. The existing drainage boundary currently has 5.369 acres of impervious surface onsite.

The site has a generally flat topography generally sloping from the west to east, with slopes generally ranging from 0.5% to 2% over the developed area. Elevations at the site range from 1013 in the northwest corner of the site, up to about 1020 in the southwest corner of the site and along the adjacent roads. Stormwater from the site either drains overland to the northwest corner of the site to a culvert that outlets north across US Highway 71 or to the center southern edge of the site, where stormwater is collected by a 14-inch concrete draintile that traverses the site from northwest to southeast. This draintile is part of the public drainage system, identified as County Ditch 48, and outlets to County Ditch 52. Stormwater ultimately flows to Crow Creek and then the Minnesota River. Stormwater from the northwest culvert ultimately flows to the Minnesota River. See Figure 2 for an existing conditions drainage map.

County Ditch 52, located approximately 0.3 miles south of the site and is an impaired water. There are no known wetlands onsite.

## 1.2 Proposed Conditions

Kwik Trip, Inc. plans on developing the site into a convenience store with a single bay carwash, side diesel, and associated parking and drive areas. During construction, approximately 5.9 acres will be disturbed. After the site is constructed, the drainage boundary will contain approximately 6.771 acres of impervious surface, which is an increase of 1.402 acres.

Stormwater from the developed portion of the site, including all fueling areas, will be collected in storm sewer and routed to one of two proposed filtration basins, located in the eastern and western

portions of the site, respectively. Both basins will discharge to the County Ditch 48 draintile, running through the site, which outlets to County Ditch 52. All drainage that isn't collected in storm sewer will either flow directly to the culvert in the northwest corner of the site or to the draintile inlets located south of the site. As part of the project, the County Ditch 48 draintile will be partially realigned around the proposed site improvements. See Figure 3 for proposed conditions drainage map.

### 1.3 Soil Information

In June of 2021, Braun Intertec drilled nine soil borings to approximate near surface soils. The borings indicate that near surface soils consist primarily of clayey sand, sandy lean clay, and silty sand materials. These soils generally fall within the Hydrologic Soil Group (HSG) "D".

Groundwater was found to be present in seven of the borings, and was generally at an elevation of 996 to 1008.5.

See Appendix D for soil information.

### 1.4 Curve Numbers

Curve Numbers (CN) were selected based on the Soil Conservation Service (SCS) Technical Release 55 last revised in 1986.

The existing and proposed site is mainly a combination of bituminous, concrete, rooftops, agricultural land, and grassland. A CN of 98 was selected for all bituminous, gravel, and concrete surfaces and a CN of 80 was selected for any grassy pervious areas, which is consistent with grassy areas in the HSG "D".

### 1.5 Time of Concentration

The times of concentration were calculated using a combination of sheet flow and shallow concentrated flow. These methods require the length, slope of the water course and the water course characteristics for calculating the time of concentration, which were measured from the existing and proposed topography. Per the SCS Technical Release 55, a minimum time of concentration of 6 minutes was used for the analysis. See HydroCAD models in Appendix A and B.

## 2.0 STORMWATER ANALYSIS

The surface water analysis was completed using HydroCAD software, based on the SCS methodologies with Atlas 14 storms. The peak elevations and runoff rates were modeled for the 2-year (2.66"), 10-year (3.84") and 100-year (6.40") events. See Appendix A and B for HydroCAD models.

### 2.1 Peak Elevations

For the proposed filtration basins, the 2-year, 10-year and 100-year high water levels have been calculated. See Table 1.

**Table 1**
**High Water Elevations**
Kwik Trip Convenience Store 1203
Redwood Falls, Minnesota

| Basin | Bottom | 2y HWL | 10y HWL | 100y HWL |
|---|---|---|---|---|
| Filtration Basin 10 | 1012.0 | 1013.0 | 1013.7 | 1015.0 |
| Filtration Basin 20 | 1012.0 | 1013.0 | 1013.8 | 1015.1 |

### 2.2 Runoff Control Analysis

All stormwater from the site either discharges to the culvert in the northwest corner of the site or to he draintile system. As such, runoff rates are compared for both areas.

**Table 2**
**Runoff Comparison 1**
Kwik Trip Convenience Store 1203
Redwood Falls, Minnesota

| | Runoff to NW culvert | | |
|---|---|---|---|
| **Condition** | **2y Storm (cfs)** | **10y Storm (cfs)** | **100y Storm (cfs)** |
| Existing (2P) | 4.8 | 8.0 | 14.1 |
| Proposed (3P) | 2.4 | 4.1 | 7.9 |

**Table 3**
**Runoff Comparison 1**
Kwik Trip Convenience Store 1203
Redwood Falls, Minnesota

| | Runoff to Draintile | | |
|---|---|---|---|
| **Condition** | **2y Storm (cfs)** | **10y Storm (cfs)** | **100y Storm (cfs)** |
| Existing (1P) | 9.1 | 11.3 | 17.9 |
| Proposed (X) | 8.7 | 11.3 | 15.0 |

Note that for all events, the proposed runoff rates are reduced from or equal to existing. Volumes were reduced as much as possible, however since infiltration is not allowed for runoff from fueling areas, volumes were not reduced from existing.

## 2.3 Water Quality Analysis

The MPCA Construction Stormwater Permit requires sites to provide a water quality volume of 1-inch of runoff from newly created impervious surfaces. The proposed site will create approximately 1.402 acres of impervious surface. The water quality requirement for the impervious surface area is 0.117 acre-feet. The onsite filtration basins provide a water quality volume of 0.506 acre-feet and 0.286 acre-feet. The total water quality treatment volume is 0.792 acre-feet. The proposed basins meet and exceed the MPCA Construction Stormwater Permit. See Appendix C for design calculations.

Pretreatment for the stormwater treatment facilities will be provided by sump manholes equipped with SNOUT oil/water/debris separators.

## 2.4 Public Ditch Realignment

Public Ditch 48 traverses the site from northwest to southeast as a 14-inch concrete draintile. As part of the project, approximately 430' of the 14-inch draintile will be removed and replaced with approximately 538' of 15-inch reinforced concrete pipe. The public ditch will be realigned to allow for development of the site.

It is understood that a petition to the public ditch authority to realign Public Ditch 48 will be required per MN Statute 103E. This petition will be submitted upon review and approval of the proposed site construction plans.

## 2.5 Storm Sewer Design

All storm sewers have been designed to accommodate the 10-year storm. The HydroCAD model was used to model the pond outlets, and a rational method spreadsheet was used to design the storm sewer serving the site. See Appendix C for rational method spreadsheet.

## 2.6 Conclusion

Water quality treatment for the site is provided by the onsite filtration basins. Proposed runoff rates have been decreased for all design events and volumes have been reduced as much as possible. All storm sewers have been sized to accommodate the 10-year storm, at a minimum. Sump manholes equipped with SNOUTs will be used to prevent floatables, trash, and sediment from being conveyed downstream.

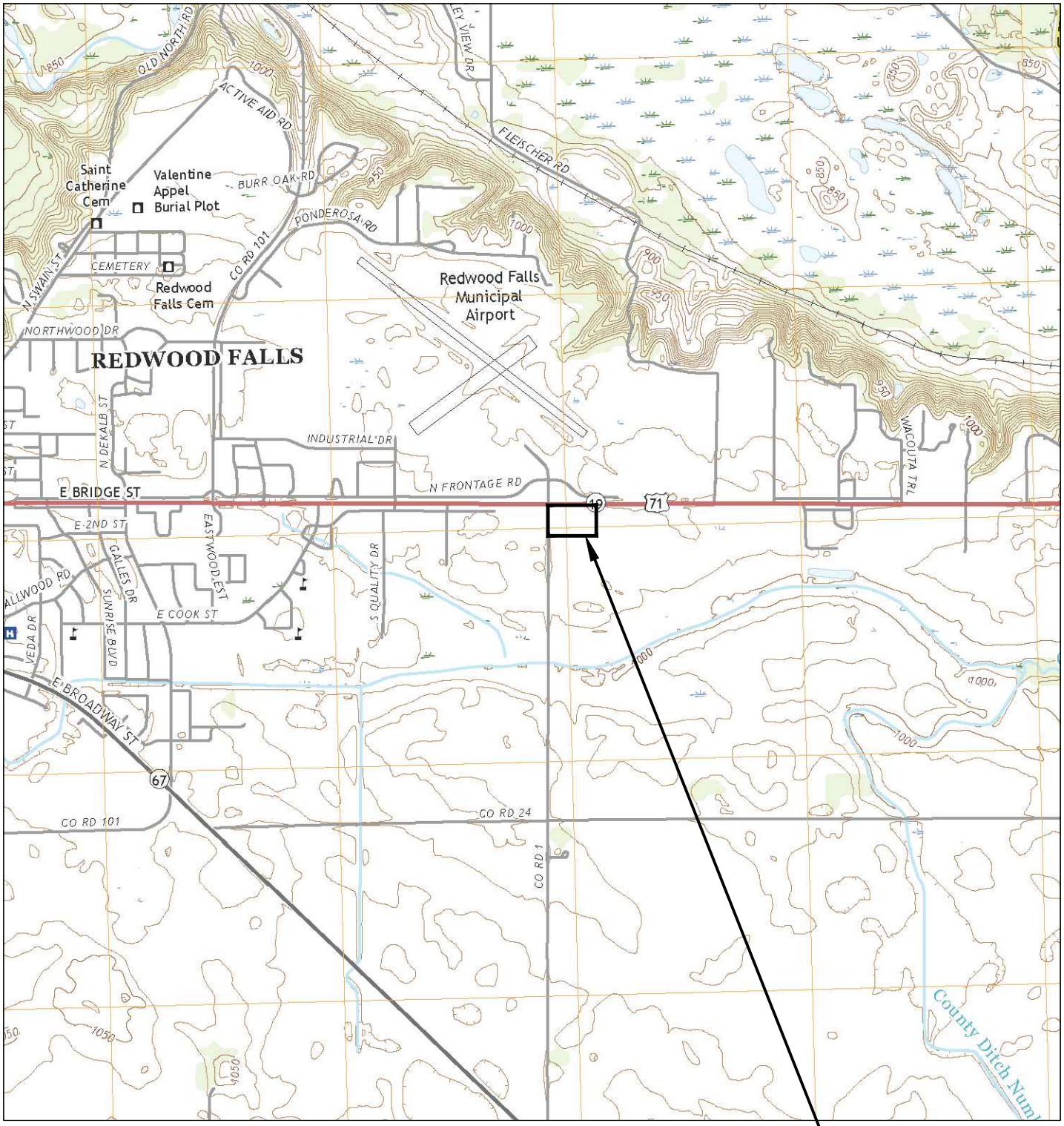
## 3.0 CERTIFICATION

I hereby certify that this plan, specification or report was prepared by me or under my direct supervision and that I am a duly Licensed Professional Engineer under the laws of the State of Minnesota.

This Stormwater Management Plan was prepared by:

| | |
|---|---|
| Joseph T. Radach, P.E.<br>License #: 45889 | 1/3/22<br>Date |

# FIGURES




N

0 500 1000 2000

SOURCE: USGS REDWOOD FALLS 7.5 MIN. QUADRANGLE

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**KWIK TRIP STORE 1203**
**W/1-BAY CARWASH &**
**SIDE DIESEL**
Redwood Falls, Minnesota

**FIGURE 1**
**SITE LOCATION MAP**

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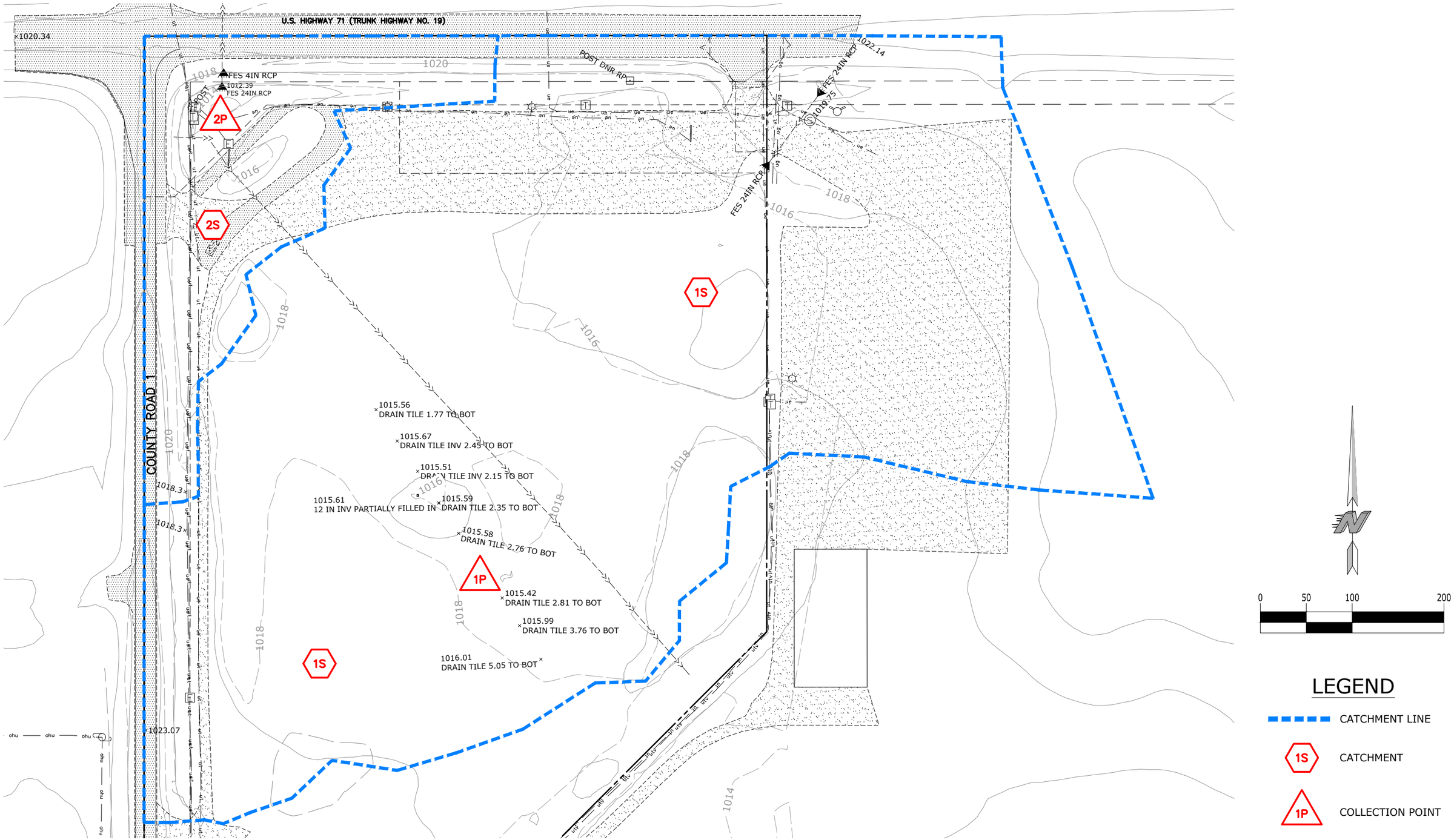


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Notes:

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La Crosse, WI 54602

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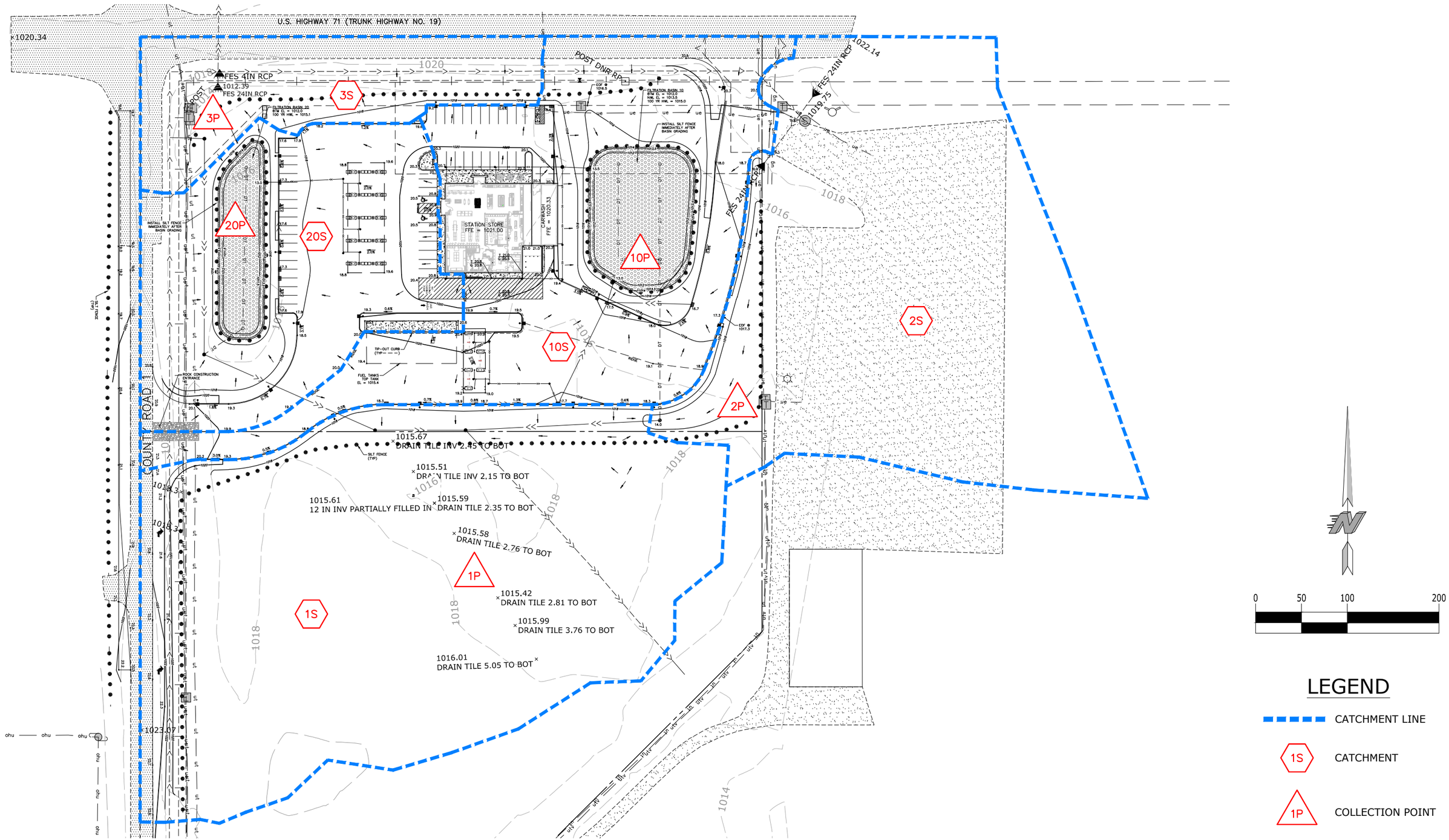
**W/1-BAY CARWASH & SIDE DIESEL**
Redwood Falls, Minnesota

**FIGURE 2**
**EXISTING CONDITIONS DRAINAGE MAP**

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Redwood Falls, Minnesota

**FIGURE 3**
**PROPOSED CONDITIONS DRAINAGE MAP**

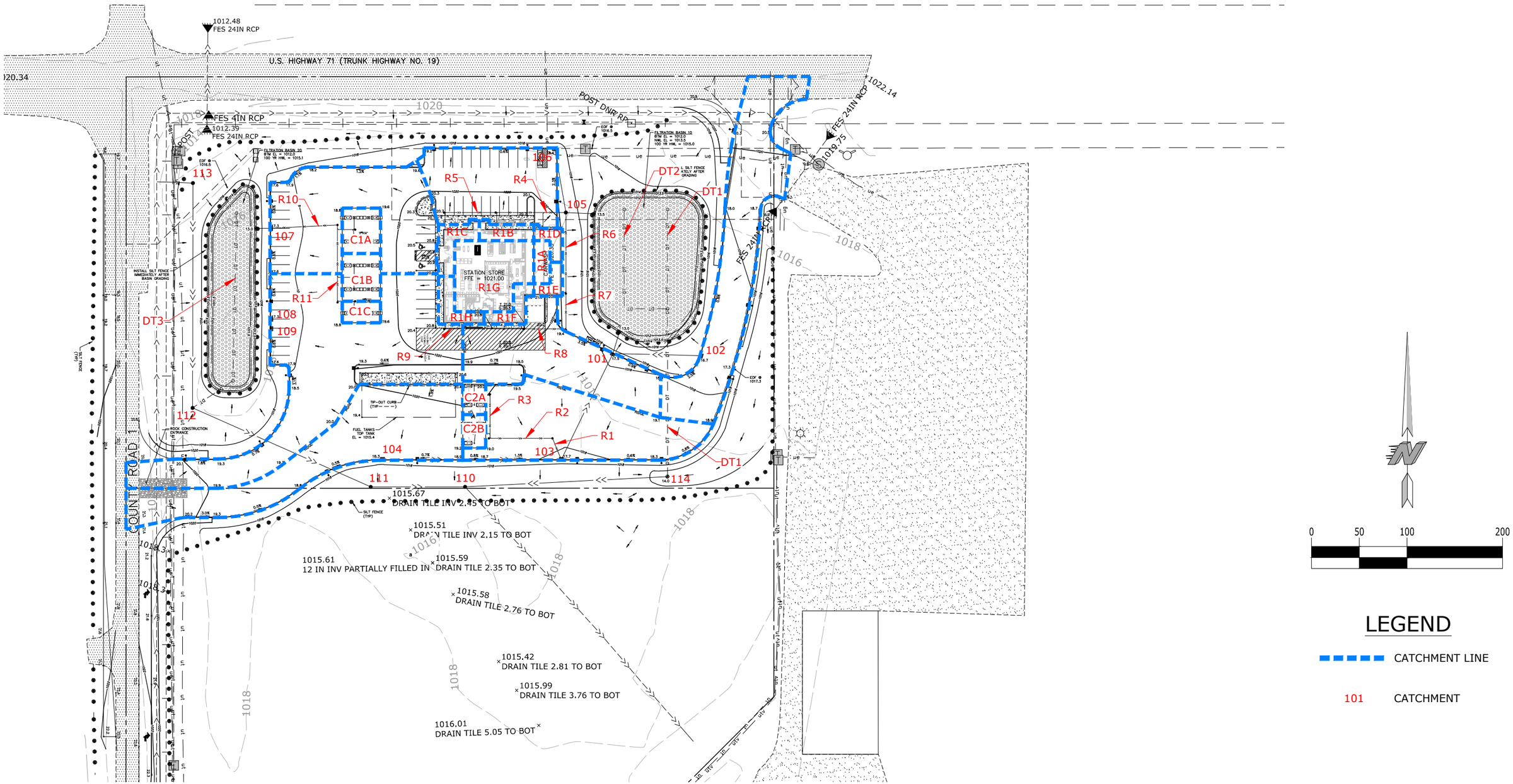


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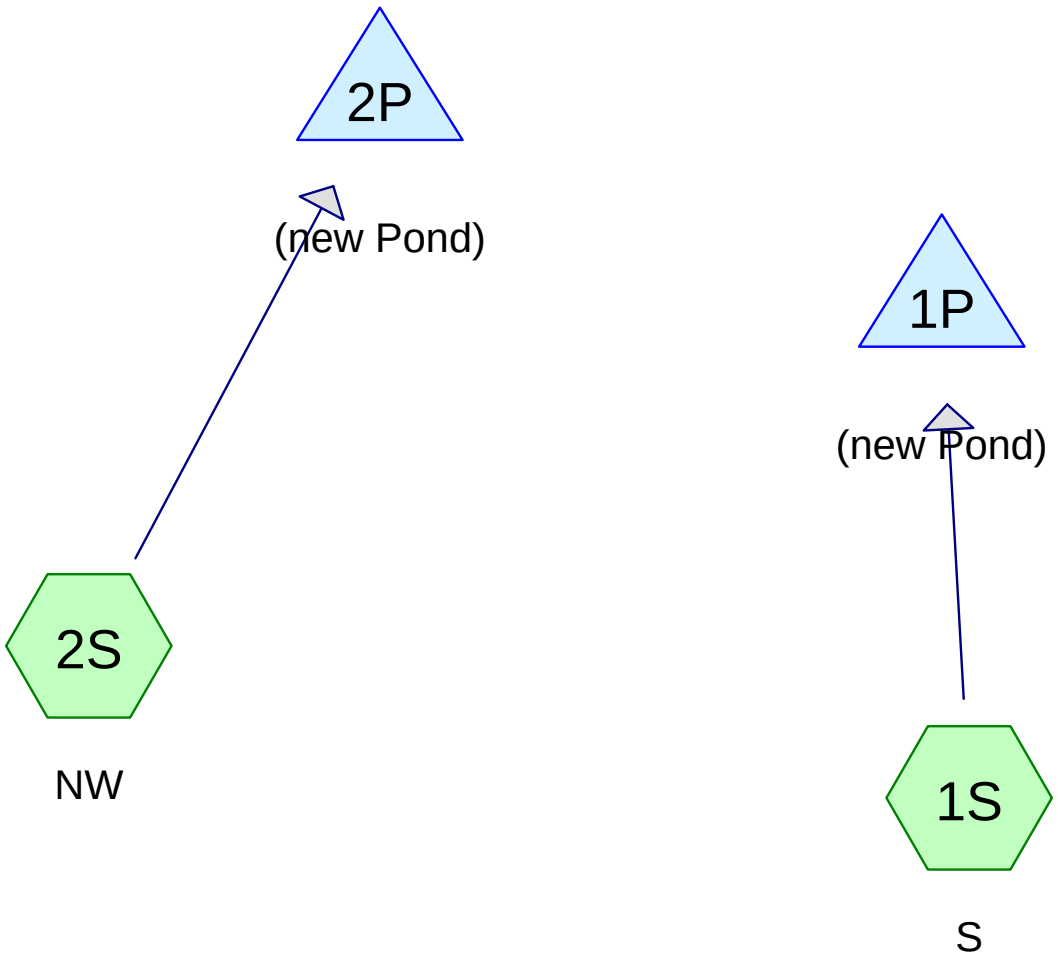
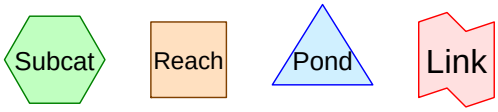
**FIGURE 4**
**STORM SEWER DRAINAGE MAP**

# APPENDIX A




**Routing Diagram for 9721_ex**
Prepared by wilk0260, Printed 12/15/2021
HydroCAD® 10.00-26 s/n 02263 © 2020 HydroCAD Software Solutions LLC

## Area Listing (selected nodes)

| Area (acres) | CN | Description (subcatchment-numbers) |
|---|---|---|
| 9.905 | 80 | >75% Grass cover, Good, HSG D (1S, 2S) |
| 5.369 | 98 | Paved parking, HSG D (1S, 2S) |
| **15.274** | **86** | **TOTAL AREA** |

Time span=5.00-20.00 hrs, dt=0.05 hrs, 301 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

**Subcatchment 1S: S** Runoff Area=13.349 ac 34.11% Impervious Runoff Depth>1.31"
Flow Length=317' Tc=19.1 min CN=86 Runoff=20.95 cfs 1.459 af

**Subcatchment 2S: NW** Runoff Area=1.925 ac 42.34% Impervious Runoff Depth>1.46"
Flow Length=375' Tc=6.0 min CN=88 Runoff=5.20 cfs 0.234 af

**Pond 1P: (new Pond)** Peak Elev=1,016.64' Storage=0.353 af Inflow=20.95 cfs 1.459 af
Outflow=9.10 cfs 1.458 af

**Pond 2P: (new Pond)** Peak Elev=1,013.35' Storage=0.013 af Inflow=5.20 cfs 0.234 af
Outflow=4.84 cfs 0.233 af

**Total Runoff Area = 15.274 ac Runoff Volume = 1.693 af Average Runoff Depth = 1.33"**
**64.85% Pervious = 9.905 ac 35.15% Impervious = 5.369 ac**

## Summary for Subcatchment 1S: S

Runoff = 20.95 cfs @ 12.29 hrs, Volume= 1.459 af, Depth> 1.31"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
MSE 24-hr 3 2-yr Rainfall=2.66"

| Area (ac) | CN | Description |
|---|---|---|
| 8.795 | 80 | >75% Grass cover, Good, HSG D |
| 4.554 | 98 | Paved parking, HSG D |
| 13.349 | 86 | Weighted Average |
| 8.795 | | 65.89% Pervious Area |
| 4.554 | | 34.11% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 14.8 | 100 | 0.0090 | 0.11 | | **Sheet Flow,** Grass: Short n= 0.150 P2= 2.66" |
| 4.3 | 217 | 0.0143 | 0.84 | | **Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps |
| 19.1 | 317 | Total | | | |

## Summary for Subcatchment 2S: NW

Runoff = 5.20 cfs @ 12.13 hrs, Volume= 0.234 af, Depth> 1.46"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
MSE 24-hr 3 2-yr Rainfall=2.66"

| Area (ac) | CN | Description |
|---|---|---|
| 0.815 | 98 | Paved parking, HSG D |
| 1.110 | 80 | >75% Grass cover, Good, HSG D |
| 1.925 | 88 | Weighted Average |
| 1.110 | | 57.66% Pervious Area |
| 0.815 | | 42.34% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 1.8 | 23 | 0.0870 | 0.21 | | **Sheet Flow,** Grass: Short n= 0.150 P2= 2.66" |
| 4.2 | 352 | 0.0085 | 1.38 | | **Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps |
| 6.0 | 375 | Total | | | |

## Summary for Pond 1P: (new Pond)

Inflow Area = 13.349 ac, 34.11% Impervious, Inflow Depth > 1.31" for 2-yr event
Inflow = 20.95 cfs @ 12.29 hrs, Volume= 1.459 af
Outflow = 9.10 cfs @ 12.59 hrs, Volume= 1.458 af, Atten= 57%, Lag= 18.3 min
Primary = 9.10 cfs @ 12.59 hrs, Volume= 1.458 af

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 1,016.64' @ 12.59 hrs Surf.Area= 0.587 ac Storage= 0.353 af

Plug-Flow detention time= 13.9 min calculated for 1.453 af (100% of inflow)
Center-of-Mass det. time= 13.5 min ( 807.9 - 794.4 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 1,015.50' | 2.143 af | **Custom Stage Data (Prismatic)**Listed below (Recalc) |

| Elevation (feet) | Surf.Area (acres) | Inc.Store (acre-feet) | Cum.Store (acre-feet) |
|---|---|---|---|
| 1,015.50 | 0.025 | 0.000 | 0.000 |
| 1,016.00 | 0.276 | 0.075 | 0.075 |
| 1,017.00 | 0.759 | 0.517 | 0.593 |
| 1,018.00 | 2.342 | 1.550 | 2.143 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 1,015.50' | **6.0" Horiz. Orifice/Grate X 9.00** C= 0.600<br>Limited to weir flow at low heads |

**Primary OutFlow** Max=9.09 cfs @ 12.59 hrs HW=1,016.64' (Free Discharge)
└**1=Orifice/Grate** (Orifice Controls 9.09 cfs @ 5.15 fps)

## Summary for Pond 2P: (new Pond)

Inflow Area = 1.925 ac, 42.34% Impervious, Inflow Depth > 1.46" for 2-yr event
Inflow = 5.20 cfs @ 12.13 hrs, Volume= 0.234 af
Outflow = 4.84 cfs @ 12.16 hrs, Volume= 0.233 af, Atten= 7%, Lag= 1.4 min
Primary = 4.84 cfs @ 12.16 hrs, Volume= 0.233 af

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 1,013.35' @ 12.16 hrs Surf.Area= 0.023 ac Storage= 0.013 af

Plug-Flow detention time= 3.3 min calculated for 0.233 af (100% of inflow)
Center-of-Mass det. time= 2.4 min ( 781.6 - 779.2 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 1,012.40' | 0.534 af | **Custom Stage Data (Prismatic)**Listed below (Recalc) |

| Elevation (feet) | Surf.Area (acres) | Inc.Store (acre-feet) | Cum.Store (acre-feet) |
|---|---|---|---|
| 1,012.40 | 0.005 | 0.000 | 0.000 |
| 1,014.00 | 0.035 | 0.032 | 0.032 |
| 1,016.00 | 0.191 | 0.226 | 0.258 |
| 1,017.00 | 0.360 | 0.275 | 0.534 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 1,012.40' | **24.0" Vert. Orifice/Grate** C= 0.600 |

**Primary OutFlow** Max=4.75 cfs @ 12.16 hrs HW=1,013.34' (Free Discharge)
└─**1=Orifice/Grate** (Orifice Controls 4.75 cfs @ 3.29 fps)

Time span=5.00-20.00 hrs, dt=0.05 hrs, 301 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

**Subcatchment 1S: S** Runoff Area=13.349 ac 34.11% Impervious Runoff Depth>2.30"
Flow Length=317' Tc=19.1 min CN=86 Runoff=36.45 cfs 2.561 af

**Subcatchment 2S: NW** Runoff Area=1.925 ac 42.34% Impervious Runoff Depth>2.49"
Flow Length=375' Tc=6.0 min CN=88 Runoff=8.63 cfs 0.399 af

**Pond 1P: (new Pond)** Peak Elev=1,017.25' Storage=0.829 af Inflow=36.45 cfs 2.561 af
Outflow=11.25 cfs 2.559 af

**Pond 2P: (new Pond)** Peak Elev=1,013.66' Storage=0.021 af Inflow=8.63 cfs 0.399 af
Outflow=8.02 cfs 0.398 af

**Total Runoff Area = 15.274 ac Runoff Volume = 2.959 af Average Runoff Depth = 2.33"**
**64.85% Pervious = 9.905 ac 35.15% Impervious = 5.369 ac**

## Summary for Subcatchment 1S: S

Runoff = 36.45 cfs @ 12.28 hrs, Volume= 2.561 af, Depth> 2.30"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
MSE 24-hr 3 10-yr Rainfall=3.84"

| Area (ac) | CN | Description |
|---|---|---|
| 8.795 | 80 | >75% Grass cover, Good, HSG D |
| 4.554 | 98 | Paved parking, HSG D |
| 13.349 | 86 | Weighted Average |
| 8.795 | | 65.89% Pervious Area |
| 4.554 | | 34.11% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 14.8 | 100 | 0.0090 | 0.11 | | **Sheet Flow,** Grass: Short n= 0.150 P2= 2.66" |
| 4.3 | 217 | 0.0143 | 0.84 | | **Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps |
| 19.1 | 317 | Total | | | |

## Summary for Subcatchment 2S: NW

Runoff = 8.63 cfs @ 12.13 hrs, Volume= 0.399 af, Depth> 2.49"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
MSE 24-hr 3 10-yr Rainfall=3.84"

| Area (ac) | CN | Description |
|---|---|---|
| 0.815 | 98 | Paved parking, HSG D |
| 1.110 | 80 | >75% Grass cover, Good, HSG D |
| 1.925 | 88 | Weighted Average |
| 1.110 | | 57.66% Pervious Area |
| 0.815 | | 42.34% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 1.8 | 23 | 0.0870 | 0.21 | | **Sheet Flow,** Grass: Short n= 0.150 P2= 2.66" |
| 4.2 | 352 | 0.0085 | 1.38 | | **Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps |
| 6.0 | 375 | Total | | | |

## Summary for Pond 1P: (new Pond)

Inflow Area = 13.349 ac, 34.11% Impervious, Inflow Depth > 2.30" for 10-yr event
Inflow = 36.45 cfs @ 12.28 hrs, Volume= 2.561 af
Outflow = 11.25 cfs @ 12.69 hrs, Volume= 2.559 af, Atten= 69%, Lag= 24.1 min
Primary = 11.25 cfs @ 12.69 hrs, Volume= 2.559 af

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 1,017.25' @ 12.69 hrs Surf.Area= 1.151 ac Storage= 0.829 af

Plug-Flow detention time= 27.1 min calculated for 2.550 af (100% of inflow)
Center-of-Mass det. time= 26.7 min ( 811.9 - 785.2 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 1,015.50' | 2.143 af | **Custom Stage Data (Prismatic)**Listed below (Recalc) |

| Elevation (feet) | Surf.Area (acres) | Inc.Store (acre-feet) | Cum.Store (acre-feet) |
|---|---|---|---|
| 1,015.50 | 0.025 | 0.000 | 0.000 |
| 1,016.00 | 0.276 | 0.075 | 0.075 |
| 1,017.00 | 0.759 | 0.517 | 0.593 |
| 1,018.00 | 2.342 | 1.550 | 2.143 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 1,015.50' | **6.0" Horiz. Orifice/Grate X 9.00** C= 0.600<br>Limited to weir flow at low heads |

**Primary OutFlow** Max=11.25 cfs @ 12.69 hrs HW=1,017.25' (Free Discharge)
└**1=Orifice/Grate** (Orifice Controls 11.25 cfs @ 6.36 fps)

## Summary for Pond 2P: (new Pond)

Inflow Area = 1.925 ac, 42.34% Impervious, Inflow Depth > 2.49" for 10-yr event
Inflow = 8.63 cfs @ 12.13 hrs, Volume= 0.399 af
Outflow = 8.02 cfs @ 12.16 hrs, Volume= 0.398 af, Atten= 7%, Lag= 1.5 min
Primary = 8.02 cfs @ 12.16 hrs, Volume= 0.398 af

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 1,013.66' @ 12.16 hrs Surf.Area= 0.029 ac Storage= 0.021 af

Plug-Flow detention time= 2.9 min calculated for 0.398 af (100% of inflow)
Center-of-Mass det. time= 2.3 min ( 772.5 - 770.2 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 1,012.40' | 0.534 af | **Custom Stage Data (Prismatic)**Listed below (Recalc) |

| Elevation (feet) | Surf.Area (acres) | Inc.Store (acre-feet) | Cum.Store (acre-feet) |
|---|---|---|---|
| 1,012.40 | 0.005 | 0.000 | 0.000 |
| 1,014.00 | 0.035 | 0.032 | 0.032 |
| 1,016.00 | 0.191 | 0.226 | 0.258 |
| 1,017.00 | 0.360 | 0.275 | 0.534 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 1,012.40' | **24.0" Vert. Orifice/Grate** C= 0.600 |

**Primary OutFlow** Max=7.89 cfs @ 12.16 hrs HW=1,013.65' (Free Discharge)
└─**1=Orifice/Grate** (Orifice Controls 7.89 cfs @ 3.81 fps)

Time span=5.00-20.00 hrs, dt=0.05 hrs, 301 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

**Subcatchment 1S: S** Runoff Area=13.349 ac 34.11% Impervious Runoff Depth>4.61"
Flow Length=317' Tc=19.1 min CN=86 Runoff=71.04 cfs 5.132 af

**Subcatchment 2S: NW** Runoff Area=1.925 ac 42.34% Impervious Runoff Depth>4.85"
Flow Length=375' Tc=6.0 min CN=88 Runoff=16.12 cfs 0.777 af

**Pond 1P: (new Pond)** Peak Elev=1,019.93' Storage=2.143 af Inflow=71.04 cfs 5.132 af
Outflow=17.91 cfs 5.129 af

**Pond 2P: (new Pond)** Peak Elev=1,014.26' Storage=0.044 af Inflow=16.12 cfs 0.777 af
Outflow=14.14 cfs 0.777 af

**Total Runoff Area = 15.274 ac Runoff Volume = 5.910 af Average Runoff Depth = 4.64"**
**64.85% Pervious = 9.905 ac 35.15% Impervious = 5.369 ac**

## Summary for Subcatchment 1S: S

Runoff = 71.04 cfs @ 12.28 hrs, Volume= 5.132 af, Depth> 4.61"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
MSE 24-hr 3 100-yr Rainfall=6.40"

| Area (ac) | CN | Description |
|---|---|---|
| 8.795 | 80 | >75% Grass cover, Good, HSG D |
| 4.554 | 98 | Paved parking, HSG D |
| 13.349 | 86 | Weighted Average |
| 8.795 | | 65.89% Pervious Area |
| 4.554 | | 34.11% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 14.8 | 100 | 0.0090 | 0.11 | | **Sheet Flow,** Grass: Short n= 0.150 P2= 2.66" |
| 4.3 | 217 | 0.0143 | 0.84 | | **Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps |
| 19.1 | 317 | Total | | | |

## Summary for Subcatchment 2S: NW

Runoff = 16.12 cfs @ 12.13 hrs, Volume= 0.777 af, Depth> 4.85"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
MSE 24-hr 3 100-yr Rainfall=6.40"

| Area (ac) | CN | Description |
|---|---|---|
| 0.815 | 98 | Paved parking, HSG D |
| 1.110 | 80 | >75% Grass cover, Good, HSG D |
| 1.925 | 88 | Weighted Average |
| 1.110 | | 57.66% Pervious Area |
| 0.815 | | 42.34% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 1.8 | 23 | 0.0870 | 0.21 | | **Sheet Flow,** Grass: Short n= 0.150 P2= 2.66" |
| 4.2 | 352 | 0.0085 | 1.38 | | **Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps |
| 6.0 | 375 | Total | | | |

## Summary for Pond 1P: (new Pond)

Inflow Area = 13.349 ac, 34.11% Impervious, Inflow Depth > 4.61" for 100-yr event
Inflow = 71.04 cfs @ 12.28 hrs, Volume= 5.132 af
Outflow = 17.91 cfs @ 12.80 hrs, Volume= 5.129 af, Atten= 75%, Lag= 31.3 min
Primary = 17.91 cfs @ 12.80 hrs, Volume= 5.129 af

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 1,019.93' @ 12.80 hrs Surf.Area= 2.342 ac Storage= 2.143 af

Plug-Flow detention time= 60.1 min calculated for 5.112 af (100% of inflow)
Center-of-Mass det. time= 59.7 min ( 833.1 - 773.4 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 1,015.50' | 2.143 af | **Custom Stage Data (Prismatic)**Listed below (Recalc) |

| Elevation (feet) | Surf.Area (acres) | Inc.Store (acre-feet) | Cum.Store (acre-feet) |
|---|---|---|---|
| 1,015.50 | 0.025 | 0.000 | 0.000 |
| 1,016.00 | 0.276 | 0.075 | 0.075 |
| 1,017.00 | 0.759 | 0.517 | 0.593 |
| 1,018.00 | 2.342 | 1.550 | 2.143 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 1,015.50' | **6.0" Horiz. Orifice/Grate X 9.00** C= 0.600<br>Limited to weir flow at low heads |

**Primary OutFlow** Max=17.87 cfs @ 12.80 hrs HW=1,019.91' (Free Discharge)
└**1=Orifice/Grate** (Orifice Controls 17.87 cfs @ 10.11 fps)

## Summary for Pond 2P: (new Pond)

Inflow Area = 1.925 ac, 42.34% Impervious, Inflow Depth > 4.85" for 100-yr event
Inflow = 16.12 cfs @ 12.13 hrs, Volume= 0.777 af
Outflow = 14.14 cfs @ 12.16 hrs, Volume= 0.777 af, Atten= 12%, Lag= 2.1 min
Primary = 14.14 cfs @ 12.16 hrs, Volume= 0.777 af

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 1,014.26' @ 12.16 hrs Surf.Area= 0.055 ac Storage= 0.044 af

Plug-Flow detention time= 2.6 min calculated for 0.777 af (100% of inflow)
Center-of-Mass det. time= 2.1 min ( 760.8 - 758.7 )

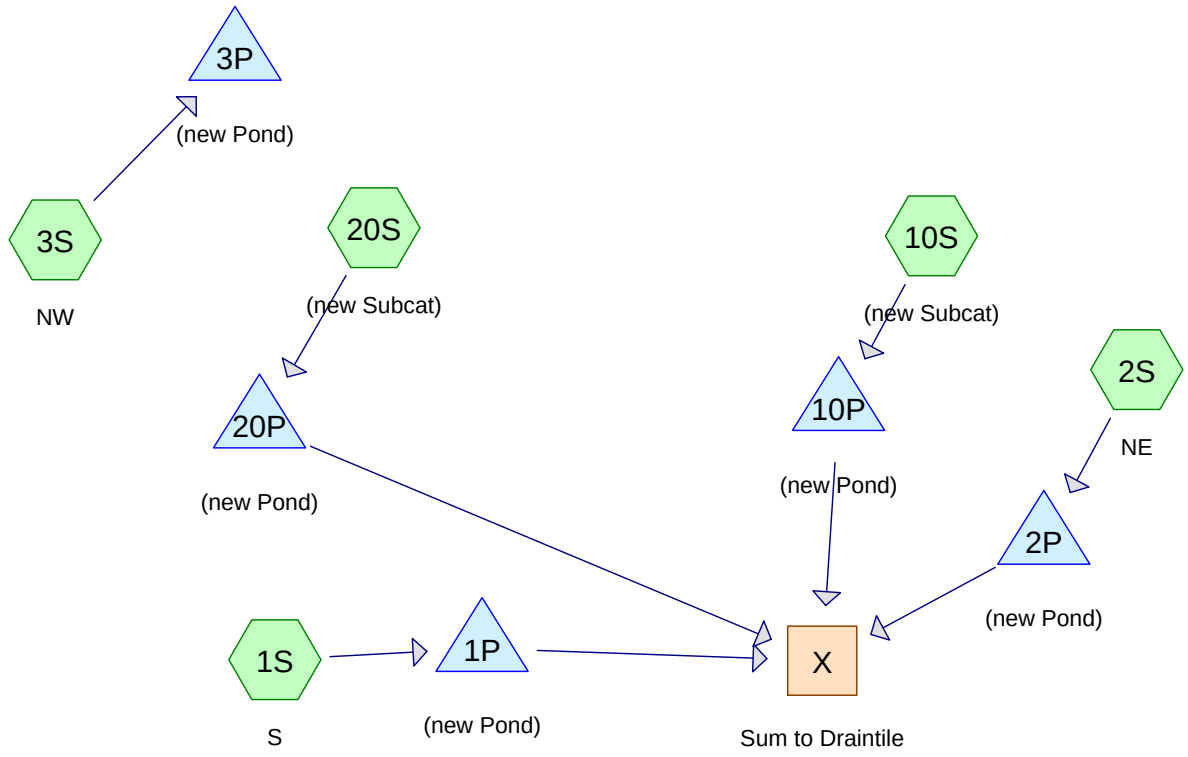
| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 1,012.40' | 0.534 af | **Custom Stage Data (Prismatic)**Listed below (Recalc) |

| Elevation (feet) | Surf.Area (acres) | Inc.Store (acre-feet) | Cum.Store (acre-feet) |
|---|---|---|---|
| 1,012.40 | 0.005 | 0.000 | 0.000 |
| 1,014.00 | 0.035 | 0.032 | 0.032 |
| 1,016.00 | 0.191 | 0.226 | 0.258 |
| 1,017.00 | 0.360 | 0.275 | 0.534 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 1,012.40' | **24.0" Vert. Orifice/Grate** C= 0.600 |

**Primary OutFlow** Max=13.89 cfs @ 12.16 hrs HW=1,014.23' (Free Discharge)
└─**1=Orifice/Grate** (Orifice Controls 13.89 cfs @ 4.61 fps)

# APPENDIX B




Subcat Reach Pond Link

**Routing Diagram for 9721_pr**
Prepared by wilk0260, Printed 1/4/2022
HydroCAD® 10.00-26 s/n 02263 © 2020 HydroCAD Software Solutions LLC

## Area Listing (selected nodes)

| Area (acres) | CN | Description (subcatchment-numbers) |
|---|---|---|
| 8.503 | 80 | >75% Grass cover, Good, HSG D (1S, 2S, 3S, 10S, 20S) |
| 6.771 | 98 | Paved parking, HSG D (1S, 2S, 3S, 10S, 20S) |
| **15.274** | **88** | **TOTAL AREA** |

Time span=5.00-20.00 hrs, dt=0.05 hrs, 301 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

**Subcatchment 1S: S** Runoff Area=5.015 ac 4.59% Impervious Runoff Depth>1.00"
Flow Length=317' Tc=19.1 min CN=81 Runoff=5.96 cfs 0.419 af

**Subcatchment 2S: NE** Runoff Area=3.943 ac 73.57% Impervious Runoff Depth>1.86"
Flow Length=318' Tc=21.0 min CN=93 Runoff=8.13 cfs 0.610 af

**Subcatchment 3S: NW** Runoff Area=1.046 ac 31.45% Impervious Runoff Depth>1.32"
Flow Length=375' Tc=6.0 min CN=86 Runoff=2.57 cfs 0.115 af

**Subcatchment 10S: (new Subcat)** Runoff Area=3.206 ac 65.81% Impervious Runoff Depth>1.78"
Tc=6.0 min CN=92 Runoff=10.20 cfs 0.474 af

**Subcatchment 20S: (new Subcat)** Runoff Area=2.064 ac 58.19% Impervious Runoff Depth>1.61"
Tc=6.0 min CN=90 Runoff=6.07 cfs 0.277 af

**Reach X: Sum to Draintile** Inflow=8.67 cfs 1.364 af
Outflow=8.67 cfs 1.364 af

**Pond 1P: (new Pond)** Peak Elev=1,015.85' Storage=0.040 af Inflow=5.96 cfs 0.419 af
Outflow=4.50 cfs 0.418 af

**Pond 2P: (new Pond)** Peak Elev=1,015.52' Storage=0.139 af Inflow=8.13 cfs 0.610 af
Outflow=3.82 cfs 0.609 af

**Pond 3P: (new Pond)** Peak Elev=1,013.04' Storage=0.007 af Inflow=2.57 cfs 0.115 af
Outflow=2.39 cfs 0.114 af

**Pond 10P: (new Pond)** Peak Elev=1,012.97' Storage=0.320 af Inflow=10.20 cfs 0.474 af
Outflow=0.28 cfs 0.217 af

**Pond 20P: (new Pond)** Peak Elev=1,013.00' Storage=0.191 af Inflow=6.07 cfs 0.277 af
Outflow=0.16 cfs 0.120 af

**Total Runoff Area = 15.274 ac Runoff Volume = 1.895 af Average Runoff Depth = 1.49"**
**55.67% Pervious = 8.503 ac 44.33% Impervious = 6.771 ac**

## Summary for Subcatchment 1S: S

Runoff = 5.96 cfs @ 12.30 hrs, Volume= 0.419 af, Depth> 1.00"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
MSE 24-hr 3 2-yr Rainfall=2.66"

| Area (ac) | CN | Description |
|---|---|---|
| 4.785 | 80 | >75% Grass cover, Good, HSG D |
| 0.230 | 98 | Paved parking, HSG D |
| 5.015 | 81 | Weighted Average |
| 4.785 | | 95.41% Pervious Area |
| 0.230 | | 4.59% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 14.8 | 100 | 0.0090 | 0.11 | | **Sheet Flow,** Grass: Short n= 0.150 P2= 2.66" |
| 4.3 | 217 | 0.0143 | 0.84 | | **Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps |
| 19.1 | 317 | Total | | | |

## Summary for Subcatchment 2S: NE

Runoff = 8.13 cfs @ 12.30 hrs, Volume= 0.610 af, Depth> 1.86"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
MSE 24-hr 3 2-yr Rainfall=2.66"

| Area (ac) | CN | Description |
|---|---|---|
| 2.901 | 98 | Paved parking, HSG D |
| 1.042 | 80 | >75% Grass cover, Good, HSG D |
| 3.943 | 93 | Weighted Average |
| 1.042 | | 26.43% Pervious Area |
| 2.901 | | 73.57% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 14.8 | 100 | 0.0090 | 0.11 | | **Sheet Flow,** Grass: Short n= 0.150 P2= 2.66" |
| 6.2 | 218 | 0.0069 | 0.58 | | **Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps |
| 21.0 | 318 | Total | | | |

## Summary for Subcatchment 3S: NW

Runoff = 2.57 cfs @ 12.13 hrs, Volume= 0.115 af, Depth> 1.32"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
MSE 24-hr 3 2-yr Rainfall=2.66"

| Area (ac) | CN | Description |
|---|---|---|
| 0.329 | 98 | Paved parking, HSG D |
| 0.717 | 80 | >75% Grass cover, Good, HSG D |
| 1.046 | 86 | Weighted Average |
| 0.717 | | 68.55% Pervious Area |
| 0.329 | | 31.45% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 1.8 | 23 | 0.0870 | 0.21 | | **Sheet Flow,** Grass: Short n= 0.150 P2= 2.66" |
| 4.2 | 352 | 0.0085 | 1.38 | | **Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps |
| 6.0 | 375 | Total | | | |

## Summary for Subcatchment 10S: (new Subcat)

Runoff = 10.20 cfs @ 12.13 hrs, Volume= 0.474 af, Depth> 1.78"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
MSE 24-hr 3 2-yr Rainfall=2.66"

| Area (ac) | CN | Description |
|---|---|---|
| 2.110 | 98 | Paved parking, HSG D |
| 1.096 | 80 | >75% Grass cover, Good, HSG D |
| 3.206 | 92 | Weighted Average |
| 1.096 | | 34.19% Pervious Area |
| 2.110 | | 65.81% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 6.0 | | | | | **Direct Entry, min Tc** |

## Summary for Subcatchment 20S: (new Subcat)

Runoff = 6.07 cfs @ 12.13 hrs, Volume= 0.277 af, Depth> 1.61"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
MSE 24-hr 3 2-yr Rainfall=2.66"

| Area (ac) | CN | Description |
|---|---|---|
| 1.201 | 98 | Paved parking, HSG D |
| 0.863 | 80 | >75% Grass cover, Good, HSG D |
| 2.064 | 90 | Weighted Average |
| 0.863 | | 41.81% Pervious Area |
| 1.201 | | 58.19% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 6.0 | | | | | **Direct Entry, min Tc** |

## Summary for Reach X: Sum to Draintile

Inflow Area = 14.228 ac, 45.28% Impervious, Inflow Depth > 1.15" for 2-yr event
Inflow = 8.67 cfs @ 12.47 hrs, Volume= 1.364 af
Outflow = 8.67 cfs @ 12.47 hrs, Volume= 1.364 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

## Summary for Pond 1P: (new Pond)

Inflow Area = 5.015 ac, 4.59% Impervious, Inflow Depth > 1.00" for 2-yr event
Inflow = 5.96 cfs @ 12.30 hrs, Volume= 0.419 af
Outflow = 4.50 cfs @ 12.44 hrs, Volume= 0.418 af, Atten= 24%, Lag= 8.2 min
Primary = 4.50 cfs @ 12.44 hrs, Volume= 0.418 af

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 1,015.85' @ 12.44 hrs Surf.Area= 0.203 ac Storage= 0.040 af

Plug-Flow detention time= 4.0 min calculated for 0.417 af (100% of inflow)
Center-of-Mass det. time= 3.5 min ( 808.1 - 804.6 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 1,015.50' | 1.934 af | **Custom Stage Data (Prismatic)**Listed below (Recalc) |

| Elevation (feet) | Surf.Area (acres) | Inc.Store (acre-feet) | Cum.Store (acre-feet) |
|---|---|---|---|
| 1,015.50 | 0.025 | 0.000 | 0.000 |
| 1,016.00 | 0.276 | 0.075 | 0.075 |
| 1,017.00 | 0.680 | 0.478 | 0.553 |
| 1,018.00 | 2.081 | 1.380 | 1.934 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 1,015.50' | **6.0" Horiz. Orifice/Grate X 8.00** C= 0.600<br>Limited to weir flow at low heads |

**Primary OutFlow** Max=4.49 cfs @ 12.44 hrs HW=1,015.85' (Free Discharge)
└**1=Orifice/Grate** (Orifice Controls 4.49 cfs @ 2.86 fps)

## Summary for Pond 2P: (new Pond)

Inflow Area = 3.943 ac, 73.57% Impervious, Inflow Depth > 1.86" for 2-yr event
Inflow = 8.13 cfs @ 12.30 hrs, Volume= 0.610 af
Outflow = 3.82 cfs @ 12.59 hrs, Volume= 0.609 af, Atten= 53%, Lag= 17.2 min
Primary = 3.82 cfs @ 12.59 hrs, Volume= 0.609 af

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

Peak Elev= 1,015.52' @ 12.59 hrs Surf.Area= 0.263 ac Storage= 0.139 af

Plug-Flow detention time= 13.7 min calculated for 0.607 af (100% of inflow)
Center-of-Mass det. time= 13.1 min ( 790.5 - 777.4 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 1,014.50' | 0.830 af | **Custom Stage Data (Prismatic)**Listed below (Recalc) |

| Elevation (feet) | Surf.Area (acres) | Inc.Store (acre-feet) | Cum.Store (acre-feet) |
|---|---|---|---|
| 1,014.50 | 0.010 | 0.000 | 0.000 |
| 1,016.00 | 0.381 | 0.293 | 0.293 |
| 1,017.00 | 0.692 | 0.537 | 0.830 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 1,014.50' | **12.0" Horiz. Orifice/Grate** C= 0.600<br>Limited to weir flow at low heads |

**Primary OutFlow** Max=3.82 cfs @ 12.59 hrs HW=1,015.52' (Free Discharge)
└**1=Orifice/Grate** (Orifice Controls 3.82 cfs @ 4.87 fps)

## Summary for Pond 3P: (new Pond)

Inflow Area = 1.046 ac, 31.45% Impervious, Inflow Depth > 1.32" for 2-yr event
Inflow = 2.57 cfs @ 12.13 hrs, Volume= 0.115 af
Outflow = 2.39 cfs @ 12.16 hrs, Volume= 0.114 af, Atten= 7%, Lag= 1.5 min
Primary = 2.39 cfs @ 12.16 hrs, Volume= 0.114 af

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 1,013.04' @ 12.16 hrs Surf.Area= 0.017 ac Storage= 0.007 af

Plug-Flow detention time= 4.0 min calculated for 0.114 af (99% of inflow)
Center-of-Mass det. time= 2.9 min ( 786.6 - 783.7 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 1,012.40' | 0.534 af | **Custom Stage Data (Prismatic)**Listed below (Recalc) |

| Elevation (feet) | Surf.Area (acres) | Inc.Store (acre-feet) | Cum.Store (acre-feet) |
|---|---|---|---|
| 1,012.40 | 0.005 | 0.000 | 0.000 |
| 1,014.00 | 0.035 | 0.032 | 0.032 |
| 1,016.00 | 0.191 | 0.226 | 0.258 |
| 1,017.00 | 0.360 | 0.275 | 0.534 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 1,012.40' | **24.0" Vert. Orifice/Grate** C= 0.600 |

**Primary OutFlow** Max=2.34 cfs @ 12.16 hrs HW=1,013.04' (Free Discharge)
└**1=Orifice/Grate** (Orifice Controls 2.34 cfs @ 2.72 fps)

## Summary for Pond 10P: (new Pond)

Inflow Area = 3.206 ac, 65.81% Impervious, Inflow Depth > 1.78" for 2-yr event
Inflow = 10.20 cfs @ 12.13 hrs, Volume= 0.474 af
Outflow = 0.28 cfs @ 14.40 hrs, Volume= 0.217 af, Atten= 97%, Lag= 136.4 min
Primary = 0.28 cfs @ 14.40 hrs, Volume= 0.217 af

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 1,012.97' @ 14.40 hrs Surf.Area= 0.344 ac Storage= 0.320 af

Plug-Flow detention time= 208.6 min calculated for 0.216 af (46% of inflow)
Center-of-Mass det. time= 144.6 min ( 912.9 - 768.3 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 1,012.00' | 1.541 af | **Custom Stage Data (Prismatic)**Listed below (Recalc) |

| Elevation (feet) | Surf.Area (acres) | Inc.Store (acre-feet) | Cum.Store (acre-feet) |
|---|---|---|---|
| 1,012.00 | 0.314 | 0.000 | 0.000 |
| 1,013.50 | 0.361 | 0.506 | 0.506 |
| 1,014.00 | 0.377 | 0.184 | 0.691 |
| 1,016.00 | 0.473 | 0.850 | 1.541 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 1,012.00' | **0.800 in/hr Exfiltration over Surface area** |

**Primary OutFlow** Max=0.28 cfs @ 14.40 hrs HW=1,012.97' (Free Discharge)
└**1=Exfiltration** (Exfiltration Controls 0.28 cfs)

## Summary for Pond 20P: (new Pond)

Inflow Area = 2.064 ac, 58.19% Impervious, Inflow Depth > 1.61" for 2-yr event
Inflow = 6.07 cfs @ 12.13 hrs, Volume= 0.277 af
Outflow = 0.16 cfs @ 14.95 hrs, Volume= 0.120 af, Atten= 97%, Lag= 169.2 min
Primary = 0.16 cfs @ 14.95 hrs, Volume= 0.120 af

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 1,013.00' @ 14.95 hrs Surf.Area= 0.199 ac Storage= 0.191 af

Plug-Flow detention time= 215.2 min calculated for 0.119 af (43% of inflow)
Center-of-Mass det. time= 150.3 min ( 924.4 - 774.1 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 1,012.00' | 0.929 af | **Custom Stage Data (Prismatic)**Listed below |

| Elevation (feet) | Surf.Area (acres) | Inc.Store (acre-feet) | Cum.Store (acre-feet) |
|---|---|---|---|
| 1,012.00 | 0.166 | 0.000 | 0.000 |
| 1,013.50 | 0.215 | 0.286 | 0.286 |
| 1,014.00 | 0.231 | 0.112 | 0.397 |
| 1,016.00 | 0.301 | 0.532 | 0.929 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 1,012.00' | **0.800 in/hr Exfiltration over Surface area** |

**Primary OutFlow** Max=0.16 cfs @ 14.95 hrs HW=1,013.00' (Free Discharge)
└─**1=Exfiltration** (Exfiltration Controls 0.16 cfs)

Time span=5.00-20.00 hrs, dt=0.05 hrs, 301 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

**Subcatchment 1S: S** Runoff Area=5.015 ac 4.59% Impervious Runoff Depth>1.90"
Flow Length=317' Tc=19.1 min CN=81 Runoff=11.38 cfs 0.792 af

**Subcatchment 2S: NE** Runoff Area=3.943 ac 73.57% Impervious Runoff Depth>2.96"
Flow Length=318' Tc=21.0 min CN=93 Runoff=12.63 cfs 0.971 af

**Subcatchment 3S: NW** Runoff Area=1.046 ac 31.45% Impervious Runoff Depth>2.31"
Flow Length=375' Tc=6.0 min CN=86 Runoff=4.42 cfs 0.201 af

**Subcatchment 10S: (new Subcat)** Runoff Area=3.206 ac 65.81% Impervious Runoff Depth>2.86"
Tc=6.0 min CN=92 Runoff=15.95 cfs 0.765 af

**Subcatchment 20S: (new Subcat)** Runoff Area=2.064 ac 58.19% Impervious Runoff Depth>2.67"
Tc=6.0 min CN=90 Runoff=9.78 cfs 0.459 af

**Reach X: Sum to Draintile** Inflow=11.33 cfs 2.156 af
Outflow=11.33 cfs 2.156 af

**Pond 1P: (new Pond)** Peak Elev=1,016.21' Storage=0.140 af Inflow=11.38 cfs 0.792 af
Outflow=6.35 cfs 0.791 af

**Pond 2P: (new Pond)** Peak Elev=1,015.96' Storage=0.279 af Inflow=12.63 cfs 0.971 af
Outflow=4.57 cfs 0.970 af

**Pond 3P: (new Pond)** Peak Elev=1,013.27' Storage=0.011 af Inflow=4.42 cfs 0.201 af
Outflow=4.13 cfs 0.201 af

**Pond 10P: (new Pond)** Peak Elev=1,013.65' Storage=0.559 af Inflow=15.95 cfs 0.765 af
Outflow=0.29 cfs 0.251 af

**Pond 20P: (new Pond)** Peak Elev=1,013.75' Storage=0.341 af Inflow=9.78 cfs 0.459 af
Outflow=0.18 cfs 0.144 af

**Total Runoff Area = 15.274 ac Runoff Volume = 3.189 af Average Runoff Depth = 2.51"**
**55.67% Pervious = 8.503 ac 44.33% Impervious = 6.771 ac**

## Summary for Subcatchment 1S: S

Runoff = 11.38 cfs @ 12.29 hrs, Volume= 0.792 af, Depth> 1.90"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
MSE 24-hr 3 10-yr Rainfall=3.84"

| Area (ac) | CN | Description |
|---|---|---|
| 4.785 | 80 | >75% Grass cover, Good, HSG D |
| 0.230 | 98 | Paved parking, HSG D |
| 5.015 | 81 | Weighted Average |
| 4.785 | | 95.41% Pervious Area |
| 0.230 | | 4.59% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 14.8 | 100 | 0.0090 | 0.11 | | **Sheet Flow,** Grass: Short n= 0.150 P2= 2.66" |
| 4.3 | 217 | 0.0143 | 0.84 | | **Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps |
| 19.1 | 317 | Total | | | |

## Summary for Subcatchment 2S: NE

Runoff = 12.63 cfs @ 12.30 hrs, Volume= 0.971 af, Depth> 2.96"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
MSE 24-hr 3 10-yr Rainfall=3.84"

| Area (ac) | CN | Description |
|---|---|---|
| 2.901 | 98 | Paved parking, HSG D |
| 1.042 | 80 | >75% Grass cover, Good, HSG D |
| 3.943 | 93 | Weighted Average |
| 1.042 | | 26.43% Pervious Area |
| 2.901 | | 73.57% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 14.8 | 100 | 0.0090 | 0.11 | | **Sheet Flow,** Grass: Short n= 0.150 P2= 2.66" |
| 6.2 | 218 | 0.0069 | 0.58 | | **Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps |
| 21.0 | 318 | Total | | | |

## Summary for Subcatchment 3S: NW

Runoff = 4.42 cfs @ 12.13 hrs, Volume= 0.201 af, Depth> 2.31"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
MSE 24-hr 3 10-yr Rainfall=3.84"

| Area (ac) | CN | Description |
|---|---|---|
| 0.329 | 98 | Paved parking, HSG D |
| 0.717 | 80 | >75% Grass cover, Good, HSG D |
| 1.046 | 86 | Weighted Average |
| 0.717 | | 68.55% Pervious Area |
| 0.329 | | 31.45% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 1.8 | 23 | 0.0870 | 0.21 | | **Sheet Flow,** Grass: Short n= 0.150 P2= 2.66" |
| 4.2 | 352 | 0.0085 | 1.38 | | **Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps |
| 6.0 | 375 | Total | | | |

## Summary for Subcatchment 10S: (new Subcat)

Runoff = 15.95 cfs @ 12.13 hrs, Volume= 0.765 af, Depth> 2.86"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
MSE 24-hr 3 10-yr Rainfall=3.84"

| Area (ac) | CN | Description |
|---|---|---|
| 2.110 | 98 | Paved parking, HSG D |
| 1.096 | 80 | >75% Grass cover, Good, HSG D |
| 3.206 | 92 | Weighted Average |
| 1.096 | | 34.19% Pervious Area |
| 2.110 | | 65.81% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 6.0 | | | | | **Direct Entry, min Tc** |

## Summary for Subcatchment 20S: (new Subcat)

Runoff = 9.78 cfs @ 12.13 hrs, Volume= 0.459 af, Depth> 2.67"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
MSE 24-hr 3 10-yr Rainfall=3.84"

| Area (ac) | CN | Description |
|---|---|---|
| 1.201 | 98 | Paved parking, HSG D |
| 0.863 | 80 | >75% Grass cover, Good, HSG D |
| 2.064 | 90 | Weighted Average |
| 0.863 | | 41.81% Pervious Area |
| 1.201 | | 58.19% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 6.0 | | | | | **Direct Entry, min Tc** |

## Summary for Reach X: Sum to Draintile

Inflow Area = 14.228 ac, 45.28% Impervious, Inflow Depth > 1.82" for 10-yr event
Inflow = 11.33 cfs @ 12.55 hrs, Volume= 2.156 af
Outflow = 11.33 cfs @ 12.55 hrs, Volume= 2.156 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

## Summary for Pond 1P: (new Pond)

Inflow Area = 5.015 ac, 4.59% Impervious, Inflow Depth > 1.90" for 10-yr event
Inflow = 11.38 cfs @ 12.29 hrs, Volume= 0.792 af
Outflow = 6.35 cfs @ 12.52 hrs, Volume= 0.791 af, Atten= 44%, Lag= 13.6 min
Primary = 6.35 cfs @ 12.52 hrs, Volume= 0.791 af

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 1,016.21' @ 12.52 hrs Surf.Area= 0.359 ac Storage= 0.140 af

Plug-Flow detention time= 8.0 min calculated for 0.789 af (100% of inflow)
Center-of-Mass det. time= 7.6 min ( 801.9 - 794.3 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 1,015.50' | 1.934 af | **Custom Stage Data (Prismatic)**Listed below (Recalc) |

| Elevation (feet) | Surf.Area (acres) | Inc.Store (acre-feet) | Cum.Store (acre-feet) |
|---|---|---|---|
| 1,015.50 | 0.025 | 0.000 | 0.000 |
| 1,016.00 | 0.276 | 0.075 | 0.075 |
| 1,017.00 | 0.680 | 0.478 | 0.553 |
| 1,018.00 | 2.081 | 1.380 | 1.934 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 1,015.50' | **6.0" Horiz. Orifice/Grate X 8.00** C= 0.600<br>Limited to weir flow at low heads |

**Primary OutFlow** Max=6.34 cfs @ 12.52 hrs HW=1,016.20' (Free Discharge)
└─**1=Orifice/Grate** (Orifice Controls 6.34 cfs @ 4.04 fps)

## Summary for Pond 2P: (new Pond)

Inflow Area = 3.943 ac, 73.57% Impervious, Inflow Depth > 2.96" for 10-yr event
Inflow = 12.63 cfs @ 12.30 hrs, Volume= 0.971 af
Outflow = 4.57 cfs @ 12.67 hrs, Volume= 0.970 af, Atten= 64%, Lag= 21.8 min
Primary = 4.57 cfs @ 12.67 hrs, Volume= 0.970 af

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

Peak Elev= 1,015.96' @ 12.67 hrs Surf.Area= 0.372 ac Storage= 0.279 af

Plug-Flow detention time= 22.1 min calculated for 0.970 af (100% of inflow)
Center-of-Mass det. time= 21.6 min ( 791.0 - 769.4 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 1,014.50' | 0.830 af | **Custom Stage Data (Prismatic)**Listed below (Recalc) |

| Elevation (feet) | Surf.Area (acres) | Inc.Store (acre-feet) | Cum.Store (acre-feet) |
|---|---|---|---|
| 1,014.50 | 0.010 | 0.000 | 0.000 |
| 1,016.00 | 0.381 | 0.293 | 0.293 |
| 1,017.00 | 0.692 | 0.537 | 0.830 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 1,014.50' | **12.0" Horiz. Orifice/Grate** C= 0.600<br>Limited to weir flow at low heads |

**Primary OutFlow** Max=4.57 cfs @ 12.67 hrs HW=1,015.96' (Free Discharge)
└**1=Orifice/Grate** (Orifice Controls 4.57 cfs @ 5.82 fps)

## Summary for Pond 3P: (new Pond)

Inflow Area = 1.046 ac, 31.45% Impervious, Inflow Depth > 2.31" for 10-yr event
Inflow = 4.42 cfs @ 12.13 hrs, Volume= 0.201 af
Outflow = 4.13 cfs @ 12.16 hrs, Volume= 0.201 af, Atten= 7%, Lag= 1.4 min
Primary = 4.13 cfs @ 12.16 hrs, Volume= 0.201 af

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 1,013.27' @ 12.16 hrs Surf.Area= 0.021 ac Storage= 0.011 af

Plug-Flow detention time= 3.5 min calculated for 0.200 af (99% of inflow)
Center-of-Mass det. time= 2.6 min ( 777.1 - 774.5 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 1,012.40' | 0.534 af | **Custom Stage Data (Prismatic)**Listed below (Recalc) |

| Elevation (feet) | Surf.Area (acres) | Inc.Store (acre-feet) | Cum.Store (acre-feet) |
|---|---|---|---|
| 1,012.40 | 0.005 | 0.000 | 0.000 |
| 1,014.00 | 0.035 | 0.032 | 0.032 |
| 1,016.00 | 0.191 | 0.226 | 0.258 |
| 1,017.00 | 0.360 | 0.275 | 0.534 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 1,012.40' | **24.0" Vert. Orifice/Grate** C= 0.600 |

**Primary OutFlow** Max=4.06 cfs @ 12.16 hrs HW=1,013.26' (Free Discharge)
└**1=Orifice/Grate** (Orifice Controls 4.06 cfs @ 3.15 fps)

## Summary for Pond 10P: (new Pond)

Inflow Area = 3.206 ac, 65.81% Impervious, Inflow Depth > 2.86" for 10-yr event
Inflow = 15.95 cfs @ 12.13 hrs, Volume= 0.765 af
Outflow = 0.29 cfs @ 15.10 hrs, Volume= 0.251 af, Atten= 98%, Lag= 178.6 min
Primary = 0.29 cfs @ 15.10 hrs, Volume= 0.251 af

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 1,013.65' @ 15.10 hrs Surf.Area= 0.366 ac Storage= 0.559 af

Plug-Flow detention time= 205.1 min calculated for 0.251 af (33% of inflow)
Center-of-Mass det. time= 125.2 min ( 885.2 - 760.0 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 1,012.00' | 1.541 af | **Custom Stage Data (Prismatic)**Listed below (Recalc) |

| Elevation (feet) | Surf.Area (acres) | Inc.Store (acre-feet) | Cum.Store (acre-feet) |
|---|---|---|---|
| 1,012.00 | 0.314 | 0.000 | 0.000 |
| 1,013.50 | 0.361 | 0.506 | 0.506 |
| 1,014.00 | 0.377 | 0.184 | 0.691 |
| 1,016.00 | 0.473 | 0.850 | 1.541 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 1,012.00' | **0.800 in/hr Exfiltration over Surface area** |

**Primary OutFlow** Max=0.29 cfs @ 15.10 hrs HW=1,013.65' (Free Discharge)
└**1=Exfiltration** (Exfiltration Controls 0.29 cfs)

## Summary for Pond 20P: (new Pond)

Inflow Area = 2.064 ac, 58.19% Impervious, Inflow Depth > 2.67" for 10-yr event
Inflow = 9.78 cfs @ 12.13 hrs, Volume= 0.459 af
Outflow = 0.18 cfs @ 15.11 hrs, Volume= 0.144 af, Atten= 98%, Lag= 179.0 min
Primary = 0.18 cfs @ 15.11 hrs, Volume= 0.144 af

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 1,013.75' @ 15.11 hrs Surf.Area= 0.223 ac Storage= 0.341 af

Plug-Flow detention time= 214.6 min calculated for 0.144 af (31% of inflow)
Center-of-Mass det. time= 137.2 min ( 902.7 - 765.5 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 1,012.00' | 0.929 af | **Custom Stage Data (Prismatic)**Listed below |

| Elevation (feet) | Surf.Area (acres) | Inc.Store (acre-feet) | Cum.Store (acre-feet) |
|---|---|---|---|
| 1,012.00 | 0.166 | 0.000 | 0.000 |
| 1,013.50 | 0.215 | 0.286 | 0.286 |
| 1,014.00 | 0.231 | 0.112 | 0.397 |
| 1,016.00 | 0.301 | 0.532 | 0.929 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 1,012.00' | **0.800 in/hr Exfiltration over Surface area** |

**Primary OutFlow** Max=0.18 cfs @ 15.11 hrs HW=1,013.75' (Free Discharge)
└─**1=Exfiltration** (Exfiltration Controls 0.18 cfs)

Time span=5.00-20.00 hrs, dt=0.05 hrs, 301 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

**Subcatchment 1S: S** Runoff Area=5.015 ac 4.59% Impervious Runoff Depth>4.08"
Flow Length=317' Tc=19.1 min CN=81 Runoff=24.11 cfs 1.705 af

**Subcatchment 2S: NE** Runoff Area=3.943 ac 73.57% Impervious Runoff Depth>5.39"
Flow Length=318' Tc=21.0 min CN=93 Runoff=22.26 cfs 1.770 af

**Subcatchment 3S: NW** Runoff Area=1.046 ac 31.45% Impervious Runoff Depth>4.63"
Flow Length=375' Tc=6.0 min CN=86 Runoff=8.49 cfs 0.403 af

**Subcatchment 10S: (new Subcat)** Runoff Area=3.206 ac 65.81% Impervious Runoff Depth>5.29"
Tc=6.0 min CN=92 Runoff=28.25 cfs 1.413 af

**Subcatchment 20S: (new Subcat)** Runoff Area=2.064 ac 58.19% Impervious Runoff Depth>5.07"
Tc=6.0 min CN=90 Runoff=17.76 cfs 0.872 af

**Reach X: Sum to Draintile** Inflow=15.04 cfs 3.985 af
Outflow=15.04 cfs 3.985 af

**Pond 1P: (new Pond)** Peak Elev=1,016.89' Storage=0.482 af Inflow=24.11 cfs 1.705 af
Outflow=8.92 cfs 1.704 af

**Pond 2P: (new Pond)** Peak Elev=1,016.70' Storage=0.639 af Inflow=22.26 cfs 1.770 af
Outflow=5.62 cfs 1.768 af

**Pond 3P: (new Pond)** Peak Elev=1,013.65' Storage=0.021 af Inflow=8.49 cfs 0.403 af
Outflow=7.91 cfs 0.403 af

**Pond 10P: (new Pond)** Peak Elev=1,015.04' Storage=1.108 af Inflow=28.25 cfs 1.413 af
Outflow=0.34 cfs 0.322 af

**Pond 20P: (new Pond)** Peak Elev=1,015.11' Storage=0.691 af Inflow=17.76 cfs 0.872 af
Outflow=0.22 cfs 0.191 af

**Total Runoff Area = 15.274 ac Runoff Volume = 6.164 af Average Runoff Depth = 4.84"**
**55.67% Pervious = 8.503 ac 44.33% Impervious = 6.771 ac**

## Summary for Subcatchment 1S: S

Runoff = 24.11 cfs @ 12.28 hrs, Volume= 1.705 af, Depth> 4.08"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
MSE 24-hr 3 100-yr Rainfall=6.40"

| Area (ac) | CN | Description |
|---|---|---|
| 4.785 | 80 | >75% Grass cover, Good, HSG D |
| 0.230 | 98 | Paved parking, HSG D |
| 5.015 | 81 | Weighted Average |
| 4.785 | | 95.41% Pervious Area |
| 0.230 | | 4.59% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 14.8 | 100 | 0.0090 | 0.11 | | **Sheet Flow,** Grass: Short n= 0.150 P2= 2.66" |
| 4.3 | 217 | 0.0143 | 0.84 | | **Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps |
| 19.1 | 317 | Total | | | |

## Summary for Subcatchment 2S: NE

Runoff = 22.26 cfs @ 12.30 hrs, Volume= 1.770 af, Depth> 5.39"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
MSE 24-hr 3 100-yr Rainfall=6.40"

| Area (ac) | CN | Description |
|---|---|---|
| 2.901 | 98 | Paved parking, HSG D |
| 1.042 | 80 | >75% Grass cover, Good, HSG D |
| 3.943 | 93 | Weighted Average |
| 1.042 | | 26.43% Pervious Area |
| 2.901 | | 73.57% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 14.8 | 100 | 0.0090 | 0.11 | | **Sheet Flow,** Grass: Short n= 0.150 P2= 2.66" |
| 6.2 | 218 | 0.0069 | 0.58 | | **Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps |
| 21.0 | 318 | Total | | | |

## Summary for Subcatchment 3S: NW

Runoff = 8.49 cfs @ 12.13 hrs, Volume= 0.403 af, Depth> 4.63"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
MSE 24-hr 3 100-yr Rainfall=6.40"

| Area (ac) | CN | Description |
|---|---|---|
| 0.329 | 98 | Paved parking, HSG D |
| 0.717 | 80 | >75% Grass cover, Good, HSG D |
| 1.046 | 86 | Weighted Average |
| 0.717 | | 68.55% Pervious Area |
| 0.329 | | 31.45% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 1.8 | 23 | 0.0870 | 0.21 | | **Sheet Flow,** Grass: Short n= 0.150 P2= 2.66" |
| 4.2 | 352 | 0.0085 | 1.38 | | **Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps |
| 6.0 | 375 | Total | | | |

## Summary for Subcatchment 10S: (new Subcat)

Runoff = 28.25 cfs @ 12.13 hrs, Volume= 1.413 af, Depth> 5.29"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
MSE 24-hr 3 100-yr Rainfall=6.40"

| Area (ac) | CN | Description |
|---|---|---|
| 2.110 | 98 | Paved parking, HSG D |
| 1.096 | 80 | >75% Grass cover, Good, HSG D |
| 3.206 | 92 | Weighted Average |
| 1.096 | | 34.19% Pervious Area |
| 2.110 | | 65.81% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 6.0 | | | | | **Direct Entry, min Tc** |

## Summary for Subcatchment 20S: (new Subcat)

Runoff = 17.76 cfs @ 12.13 hrs, Volume= 0.872 af, Depth> 5.07"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
MSE 24-hr 3 100-yr Rainfall=6.40"

| Area (ac) | CN | Description |
|---|---|---|
| 1.201 | 98 | Paved parking, HSG D |
| 0.863 | 80 | >75% Grass cover, Good, HSG D |
| 2.064 | 90 | Weighted Average |
| 0.863 | | 41.81% Pervious Area |
| 1.201 | | 58.19% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 6.0 | | | | | **Direct Entry, min Tc** |

## Summary for Reach X: Sum to Draintile

Inflow Area = 14.228 ac, 45.28% Impervious, Inflow Depth > 3.36" for 100-yr event
Inflow = 15.04 cfs @ 12.66 hrs, Volume= 3.985 af
Outflow = 15.04 cfs @ 12.66 hrs, Volume= 3.985 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

## Summary for Pond 1P: (new Pond)

Inflow Area = 5.015 ac, 4.59% Impervious, Inflow Depth > 4.08" for 100-yr event
Inflow = 24.11 cfs @ 12.28 hrs, Volume= 1.705 af
Outflow = 8.92 cfs @ 12.62 hrs, Volume= 1.704 af, Atten= 63%, Lag= 20.5 min
Primary = 8.92 cfs @ 12.62 hrs, Volume= 1.704 af

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 1,016.89' @ 12.62 hrs Surf.Area= 0.636 ac Storage= 0.482 af

Plug-Flow detention time= 19.4 min calculated for 1.704 af (100% of inflow)
Center-of-Mass det. time= 19.1 min ( 800.9 - 781.8 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 1,015.50' | 1.934 af | **Custom Stage Data (Prismatic)**Listed below (Recalc) |

| Elevation (feet) | Surf.Area (acres) | Inc.Store (acre-feet) | Cum.Store (acre-feet) |
|---|---|---|---|
| 1,015.50 | 0.025 | 0.000 | 0.000 |
| 1,016.00 | 0.276 | 0.075 | 0.075 |
| 1,017.00 | 0.680 | 0.478 | 0.553 |
| 1,018.00 | 2.081 | 1.380 | 1.934 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 1,015.50' | **6.0" Horiz. Orifice/Grate X 8.00** C= 0.600<br>Limited to weir flow at low heads |

**Primary OutFlow** Max=8.92 cfs @ 12.62 hrs HW=1,016.89' (Free Discharge)
└─**1=Orifice/Grate** (Orifice Controls 8.92 cfs @ 5.68 fps)

## Summary for Pond 2P: (new Pond)

Inflow Area = 3.943 ac, 73.57% Impervious, Inflow Depth > 5.39" for 100-yr event
Inflow = 22.26 cfs @ 12.30 hrs, Volume= 1.770 af
Outflow = 5.62 cfs @ 12.77 hrs, Volume= 1.768 af, Atten= 75%, Lag= 28.5 min
Primary = 5.62 cfs @ 12.77 hrs, Volume= 1.768 af

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

Peak Elev= 1,016.70' @ 12.77 hrs Surf.Area= 0.600 ac Storage= 0.639 af

Plug-Flow detention time= 41.4 min calculated for 1.762 af (100% of inflow)
Center-of-Mass det. time= 40.7 min ( 800.2 - 759.4 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 1,014.50' | 0.830 af | **Custom Stage Data (Prismatic)**Listed below (Recalc) |

| Elevation (feet) | Surf.Area (acres) | Inc.Store (acre-feet) | Cum.Store (acre-feet) |
|---|---|---|---|
| 1,014.50 | 0.010 | 0.000 | 0.000 |
| 1,016.00 | 0.381 | 0.293 | 0.293 |
| 1,017.00 | 0.692 | 0.537 | 0.830 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 1,014.50' | **12.0" Horiz. Orifice/Grate** C= 0.600<br>Limited to weir flow at low heads |

**Primary OutFlow** Max=5.61 cfs @ 12.77 hrs HW=1,016.70' (Free Discharge)
└**1=Orifice/Grate** (Orifice Controls 5.61 cfs @ 7.15 fps)

## Summary for Pond 3P: (new Pond)

Inflow Area = 1.046 ac, 31.45% Impervious, Inflow Depth > 4.63" for 100-yr event
Inflow = 8.49 cfs @ 12.13 hrs, Volume= 0.403 af
Outflow = 7.91 cfs @ 12.15 hrs, Volume= 0.403 af, Atten= 7%, Lag= 1.5 min
Primary = 7.91 cfs @ 12.15 hrs, Volume= 0.403 af

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 1,013.65' @ 12.15 hrs Surf.Area= 0.029 ac Storage= 0.021 af

Plug-Flow detention time= 3.0 min calculated for 0.403 af (100% of inflow)
Center-of-Mass det. time= 2.3 min ( 764.9 - 762.6 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 1,012.40' | 0.534 af | **Custom Stage Data (Prismatic)**Listed below (Recalc) |

| Elevation (feet) | Surf.Area (acres) | Inc.Store (acre-feet) | Cum.Store (acre-feet) |
|---|---|---|---|
| 1,012.40 | 0.005 | 0.000 | 0.000 |
| 1,014.00 | 0.035 | 0.032 | 0.032 |
| 1,016.00 | 0.191 | 0.226 | 0.258 |
| 1,017.00 | 0.360 | 0.275 | 0.534 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 1,012.40' | **24.0" Vert. Orifice/Grate** C= 0.600 |

**Primary OutFlow** Max=7.82 cfs @ 12.15 hrs HW=1,013.65' (Free Discharge)
└**1=Orifice/Grate** (Orifice Controls 7.82 cfs @ 3.80 fps)

## Summary for Pond 10P: (new Pond)

Inflow Area = 3.206 ac, 65.81% Impervious, Inflow Depth > 5.29" for 100-yr event
Inflow = 28.25 cfs @ 12.13 hrs, Volume= 1.413 af
Outflow = 0.34 cfs @ 16.83 hrs, Volume= 0.322 af, Atten= 99%, Lag= 281.9 min
Primary = 0.34 cfs @ 16.83 hrs, Volume= 0.322 af

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 1,015.04' @ 16.83 hrs Surf.Area= 0.427 ac Storage= 1.108 af

Plug-Flow detention time= 211.1 min calculated for 0.322 af (23% of inflow)
Center-of-Mass det. time= 96.2 min ( 845.7 - 749.6 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 1,012.00' | 1.541 af | **Custom Stage Data (Prismatic)**Listed below (Recalc) |

| Elevation (feet) | Surf.Area (acres) | Inc.Store (acre-feet) | Cum.Store (acre-feet) |
|---|---|---|---|
| 1,012.00 | 0.314 | 0.000 | 0.000 |
| 1,013.50 | 0.361 | 0.506 | 0.506 |
| 1,014.00 | 0.377 | 0.184 | 0.691 |
| 1,016.00 | 0.473 | 0.850 | 1.541 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 1,012.00' | **0.800 in/hr Exfiltration over Surface area** |

**Primary OutFlow** Max=0.34 cfs @ 16.83 hrs HW=1,015.04' (Free Discharge)
└**1=Exfiltration** (Exfiltration Controls 0.34 cfs)

## Summary for Pond 20P: (new Pond)

Inflow Area = 2.064 ac, 58.19% Impervious, Inflow Depth > 5.07" for 100-yr event
Inflow = 17.76 cfs @ 12.13 hrs, Volume= 0.872 af
Outflow = 0.22 cfs @ 16.90 hrs, Volume= 0.191 af, Atten= 99%, Lag= 286.4 min
Primary = 0.22 cfs @ 16.90 hrs, Volume= 0.191 af

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 1,015.11' @ 16.90 hrs Surf.Area= 0.270 ac Storage= 0.691 af

Plug-Flow detention time= 222.1 min calculated for 0.191 af (22% of inflow)
Center-of-Mass det. time= 112.8 min ( 867.1 - 754.3 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 1,012.00' | 0.929 af | **Custom Stage Data (Prismatic)**Listed below |

| Elevation (feet) | Surf.Area (acres) | Inc.Store (acre-feet) | Cum.Store (acre-feet) |
|---|---|---|---|
| 1,012.00 | 0.166 | 0.000 | 0.000 |
| 1,013.50 | 0.215 | 0.286 | 0.286 |
| 1,014.00 | 0.231 | 0.112 | 0.397 |
| 1,016.00 | 0.301 | 0.532 | 0.929 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 1,012.00' | **0.800 in/hr Exfiltration over Surface area** |

**Primary OutFlow** Max=0.22 cfs @ 16.90 hrs HW=1,015.11' (Free Discharge)
└─**1=Exfiltration** (Exfiltration Controls 0.22 cfs)

# APPENDIX C

PROJECT NAME: Kwik Trip Convenience Store 1203
PROJECT LOCATION: Redwood Falls, MN
CARLSON PROJECT NO.: 9721-00
DATE: 2/4/22
BY: JTR

| DESIGN CRITERIA | |
|---|---|
| Storm Frequency | 10 year |
| Manning's "n" | 0.013 |
| "C" coefficient | varies |

CARLSON McCAIN

## PROPOSED CONDITIONS STORM SEWER DESIGN

| LOCATION | | MH SIZE | AREA | | | "C" COEFFICIENT | | | GENERAL | | DESIGN | | | | | | PROFILE INFORMATION | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CBMH (from) | CBMH (to) | Diameter (in) | Impervious (sf) | Pervious (sf) | Total Area (ac) | Inc. "C" | Inc. CA | Cum. CA | T (min) | I (in/hr) | Q = CAI (cfs) | D (in) | % Grade | $Q_{full}$ (cfs) | $V_{full}$ (fps) | L (ft) | Invert (in) | Invert (out) | Rim El. | Build (ft) |
| DT3 | DT2 | na | 0 | 0 | 0.00 | 0.00 | 0.00 | 0.00 | 10 | 5.8 | 0.00 | 6 | 0.50% | 0.40 | 2.02 | 150 | 1010.51 | 1009.76 | 1012.00 | 1.50 |
| DT2 | 114 | na | 0 | 0 | 0.00 | 0.00 | 0.00 | 0.00 | 10 | 5.8 | 0.00 | 6 | 0.50% | 0.40 | 2.02 | 280 | 1010.30 | 1008.90 | 1012.00 | 1.70 |
| DT1 | 112 | na | 0 | 0 | 0.00 | 0.00 | 0.00 | 0.00 | 10 | 5.8 | 0.00 | 6 | 0.50% | 0.40 | 2.02 | 226 | 1008.73 | 1007.60 | 1012.00 | 3.27 |
| 114 | 110 | 48 | 0 | 0 | 0.00 | 0.00 | 0.00 | 0.00 | 10 | 5.8 | 0.00 | 12 | 0.50% | 2.52 | 3.21 | 212 | 1008.50 | 1007.44 | 1017.50 | 9.00 |
| 113 | 112 | 48 | 0 | 0 | 0.00 | 0.00 | 0.00 | 0.00 | 10 | 5.8 | 0.00 | 15 | 0.10% | 2.04 | 1.66 | 235 | 1007.54 | 1007.30 | 1014.50 | 6.96 |
| 112 | 111 | 48 | 0 | 0 | 0.00 | 0.00 | 0.00 | 0.00 | 10 | 5.8 | 0.00 | 15 | 0.10% | 2.04 | 1.66 | 204 | 1007.30 | 1007.10 | 1017.50 | 10.20 |
| 111 | 110 | 48 | 0 | 0 | 0.00 | 0.00 | 0.00 | 0.00 | 10 | 5.8 | 0.00 | 15 | 0.10% | 2.04 | 1.66 | 99 | 1007.10 | 1007.00 | 1017.00 | 9.90 |
| 110 | ex | 48 | 0 | 0 | 0.00 | 0.00 | 0.00 | 0.00 | 10 | 5.8 | 0.00 | 14 | 0.67% | 4.39 | 4.11 | 359 | 1007.00 | 1004.60 | 1016.50 | 9.50 |
| | | | | | | | | | | | | | | | | | | | | |
| C1C | R11 | na | 900 | 0 | 0.02 | 0.90 | 0.02 | 0.02 | 10 | 5.8 | 0.11 | 4 | 2.00% | 0.27 | 3.08 | 32 | 1015.30 | 1014.66 | 1019.07 | 3.77 |
| C1B | R11 | na | 2000 | 0 | 0.05 | 0.90 | 0.04 | 0.04 | 10 | 5.8 | 0.24 | 4 | 2.00% | 0.27 | 3.08 | 32 | 1015.14 | 1014.50 | 1019.07 | 3.93 |
| C1A | R11 | na | 1900 | 0 | 0.04 | 0.90 | 0.04 | 0.04 | 10 | 5.8 | 0.23 | 4 | 2.00% | 0.27 | 3.08 | 32 | 1014.84 | 1014.20 | 1019.07 | 4.23 |
| R11 | R10 | na | 0 | 0 | 0.00 | 0.00 | 0.00 | 0.10 | 10 | 5.8 | 0.58 | 10 | 0.60% | 1.70 | 3.11 | 81 | 1014.41 | 1013.92 | 1018.70 | 4.29 |
| R10 | 107 | na | 0 | 0 | 0.00 | 0.00 | 0.00 | 0.10 | 10 | 5.8 | 0.58 | 10 | 0.60% | 1.70 | 3.11 | 70 | 1013.92 | 1013.50 | 1018.70 | 4.78 |
| 109 | 108 | 24 x 36 | 13743 | 525 | 0.33 | 0.87 | 0.29 | 0.29 | 10 | 5.8 | 1.66 | 12 | 2.00% | 5.03 | 6.41 | 10 | 1013.76 | 1013.56 | 1017.19 | 3.43 |
| 108 | 107 | 48 | 13742 | 524 | 0.33 | 0.87 | 0.29 | 0.57 | 10 | 5.8 | 3.32 | 15 | 0.35% | 3.82 | 3.11 | 95 | 1013.39 | 1013.06 | 1017.13 | 3.74 |
| 107 | fes | 48 | 15952 | 48 | 0.37 | 0.90 | 0.33 | 1.00 | 10 | 5.8 | 5.81 | 18 | 0.35% | 6.21 | 3.51 | 17 | 1013.06 | 1013.00 | 1017.13 | 4.07 |
| | | | | | | | | | | | | | | | | | | | | |
| R1H | R9 | na | 1253 | 0 | 0.03 | 0.90 | 0.03 | 0.03 | 10 | 5.8 | 0.00 | 6 | 2.00% | 0.79 | 4.04 | 7 | 1016.23 | 1016.09 | 1021.00 | 4.77 |
| R1G | R9 | na | 5542 | 0 | 0.13 | 0.90 | 0.11 | 0.11 | 10 | 5.8 | 0.00 | 6 | 2.00% | 0.79 | 4.04 | 7 | 1015.93 | 1015.79 | 1021.00 | 5.07 |
| R1F | R8 | na | 1060 | 0 | 0.02 | 0.90 | 0.02 | 0.02 | 10 | 5.8 | 0.13 | 6 | 2.00% | 0.79 | 4.04 | 9 | 1015.77 | 1015.59 | 1021.00 | 5.23 |
| R1E | R6 | na | 681 | 0 | 0.02 | 0.90 | 0.01 | 0.01 | 10 | 5.8 | 0.00 | 6 | 2.00% | 0.79 | 4.04 | 5 | 1015.04 | 1014.94 | 1020.33 | 5.29 |
| R1D | R6 | na | 703 | 0 | 0.02 | 0.90 | 0.01 | 0.01 | 10 | 5.8 | 0.08 | 6 | 2.00% | 0.79 | 4.04 | 5 | 1014.42 | 1014.32 | 1020.33 | 5.91 |
| R1C | R5 | na | 1459 | 0 | 0.03 | 0.90 | 0.03 | 0.03 | 10 | 5.8 | 0.17 | 6 | 2.00% | 0.79 | 4.04 | 18 | 1015.73 | 1015.37 | 1021.00 | 5.27 |
| R1B | R4 | na | 1022 | 0 | 0.02 | 0.90 | 0.02 | 0.02 | 10 | 5.8 | 0.12 | 6 | 2.00% | 0.79 | 4.04 | 18 | 1015.19 | 1014.83 | 1021.00 | 5.81 |
| R1A | R4 | na | 760 | 0 | 0.02 | 0.90 | 0.02 | 0.02 | 10 | 5.8 | 0.00 | 6 | 2.00% | 0.79 | 4.04 | 18 | 1014.68 | 1014.32 | 1020.33 | 5.65 |
| R9 | R8 | na | 0 | 0 | 0.00 | 0.00 | 0.00 | 0.14 | 10 | 5.8 | 0.81 | 10 | 0.60% | 1.70 | 3.11 | 83 | 1015.92 | 1015.42 | 1020.80 | 4.88 |
| R8 | R7 | na | 0 | 0 | 0.00 | 0.00 | 0.00 | 0.16 | 10 | 5.8 | 0.94 | 10 | 0.60% | 1.70 | 3.11 | 45 | 1015.42 | 1015.15 | 1020.30 | 4.88 |
| R7 | R6 | na | 0 | 0 | 0.00 | 0.00 | 0.00 | 0.16 | 10 | 5.8 | 0.94 | 10 | 1.00% | 2.19 | 4.01 | 38 | 1015.15 | 1014.77 | 1019.90 | 4.75 |
| R6 | 105 | na | 0 | 0 | 0.00 | 0.00 | 0.00 | 0.19 | 10 | 5.8 | 1.11 | 10 | 1.00% | 2.19 | 4.01 | 85 | 1014.77 | 1013.92 | 1019.80 | 5.03 |
| R5 | R4 | na | 0 | 0 | 0.00 | 0.00 | 0.00 | 0.03 | 10 | 5.8 | 0.17 | 10 | 1.00% | 2.19 | 4.01 | 54 | 1015.20 | 1014.66 | 1020.60 | 5.40 |
| R4 | 105 | na | 0 | 0 | 0.00 | 0.00 | 0.00 | 0.07 | 10 | 5.8 | 0.39 | 10 | 1.00% | 2.19 | 4.01 | 74 | 1014.66 | 1013.92 | 1020.60 | 5.94 |
| 106 | 105 | 24 x 36 | 10658 | 188 | 0.25 | 0.89 | 0.22 | 0.48 | 10 | 5.8 | 2.78 | 12 | 0.50% | 2.52 | 3.21 | 68 | 1014.73 | 1014.39 | 1018.23 | 3.50 |
| 105 | fes | 48 | 0 | 0 | 0.00 | 0.00 | 0.00 | 0.48 | 10 | 5.8 | 2.78 | 12 | 1.00% | 3.56 | 4.53 | 31 | 1013.81 | 1013.50 | 1019.50 | 5.69 |
| | | | | | | | | | | | | | | | | | | | | |
| C2B | R3 | na | 840 | 0 | 0.02 | 0.90 | 0.02 | 0.02 | 10 | 5.8 | 0.10 | 4 | 2.00% | 0.27 | 3.08 | 28 | 1015.59 | 1015.03 | 1020.10 | 4.51 |
| C2A | R3 | na | 840 | 0 | 0.02 | 0.90 | 0.02 | 0.02 | 10 | 5.8 | 0.10 | 4 | 2.00% | 0.27 | 3.08 | 28 | 1015.34 | 1014.78 | 1019.40 | 4.06 |
| R3 | R2 | na | 0 | 0 | 0.00 | 0.00 | 0.00 | 0.03 | 10 | 5.8 | 0.20 | 10 | 0.60% | 1.70 | 3.11 | 47 | 1014.78 | 1014.50 | 1020.00 | 5.22 |
| R2 | R3 | na | 0 | 0 | 0.00 | 0.00 | 0.00 | 0.03 | 10 | 5.8 | 0.20 | 10 | 0.60% | 1.70 | 3.11 | 67 | 1014.50 | 1014.09 | 1019.20 | 4.70 |
| R1 | 103 | na | 0 | 0 | 0.00 | 0.00 | 0.00 | 0.03 | 10 | 5.8 | 0.20 | 10 | 0.60% | 1.70 | 3.11 | 24 | 1014.09 | 1013.95 | 1018.42 | 4.33 |
| 104 | 103 | 24 x 36 | 18069 | 0 | 0.41 | 0.90 | 0.37 | 0.37 | 10 | 5.8 | 2.17 | 12 | 0.45% | 2.39 | 3.04 | 187 | 1014.68 | 1013.84 | 1018.13 | 3.45 |
| 103 | 101 | 72 | 14793 | 0 | 0.34 | 0.90 | 0.31 | 0.71 | 10 | 5.8 | 4.14 | 18 | 0.30% | 5.75 | 3.25 | 123 | 1013.51 | 1013.14 | 1017.53 | 4.02 |
| 102 | 101 | 24 x 36 | 17217 | 0 | 0.40 | 0.90 | 0.36 | 0.36 | 10 | 5.8 | 2.06 | 12 | 0.45% | 2.39 | 3.04 | 92 | 1013.55 | 1013.14 | 1016.53 | 2.98 |
| 101 | fes | 48 | 11436 | 1191 | 0.29 | 0.83 | 0.24 | 1.31 | 10 | 5.8 | 7.60 | 18 | 0.55% | 7.78 | 4.40 | 25 | 1013.14 | 1013.00 | 1017.33 | 4.19 |

PROJECT NAME: Kwik Trip 1203
PROJECT LOCATION: Redwood Falls, MN
CARLSON MCCAIN PROJECT NO.: 9721
DATE: 1/3/22
BY: JTR

## POND DESIGN - POND 10 - FILTRATION BASIN

| COVER DESCRIPTION | CN | AREA | Product of CN & AREA |
|---|---|---|---|
| Impervious | 98 | 2.110 | 206.78 |
| Pervious - Grass | 39 | 1.096 | 42.74 |
| | Totals | 3.206 | 249.52 |
| Weighted CN | 78 | | |

REQUIRED POND TREATMENT VOLUME

Water Quality Volume (1" Runoff - Impervious Area) **0.176** acre-feet

ACTUAL POND TREATMENT VOLUME

Filtration Volume

| | Elevation | Area (ac.) | Volume (af) | |
|---|---|---|---|---|
| | 1013.5 | 0.361 | 0.506 | |
| Invert | 1012 | 0.314 | | |
| | | Total | **0.506** | acre-feet |

PROJECT NAME: Kwik Trip 1203
PROJECT LOCATION: Redwood Falls, MN
CARLSON MCCAIN PROJECT NO.: 9721
DATE: 1/3/22
BY: JTR

## POND DESIGN - POND 20 - FILTRATION BASIN

| COVER DESCRIPTION | CN | AREA | Product of CN & AREA |
|---|---|---|---|
| Impervious | 98 | 1.201 | 117.70 |
| Pervious - Grass | 39 | 0.863 | 33.66 |
| | Totals | 2.064 | 151.36 |
| Weighted CN | 73 | | |

REQUIRED POND TREATMENT VOLUME

Water Quality Volume (1" Runoff - Impervious Area) **0.100** acre-feet

ACTUAL POND TREATMENT VOLUME

Filtration Volume

| | Elevation | Area (ac.) | Volume (af) | |
|---|---|---|---|---|
| | 1013.5 | 0.215 | 0.286 | |
| Invert | 1012 | 0.166 | | |
| | | Total | **0.286** | acre-feet |

# APPENDIX D


**DENOTES APPROXIMATE LOCATION OF STANDARD PENETRATION TEST BORING**

75' 0 150'

SCALE: 1" = 150'

BRAUN INTERTEC
The Science You Build On.
11001 Hampshire Avenue S
Minneapolis, MN 55438
952.995.2000
braunintertec.com

Drawing Information

| | |
|---|---|
| Project No: | B2104135 |
| Drawing No: | B2104135 |
| Drawn By: | BJB |
| Date Drawn: | 6/7/21 |
| Checked By: | NR |
| Last Modified: | 6/29/21 |

Project Information

Proposed Kwik Trip #1203

SE Corner of Hwy 1 & East Bridge Street

Redwood Falls, Minnesota

**Soil Boring Location Sketch**

F:\2021\B2104135\CAD\B2104135.dwg,Geo,6/29/2021 4:26:07 PM

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# LOG OF BORING

See Descriptive Terminology sheet for explanation of abbreviations

**Project Number B2104135**
**Geotechnical & Environmental Evaluation**
**Proposed Kwik Trip #1203**
**Southeast corner of E. Bridge Street & Hwy 1**
**Redwood Falls, Minnesota**

BORING: **ST-1**
LOCATION: See attached sketch

| | | | |
|---|---|---|---|
| NORTHING: | 226247 | EASTING: | 540789 |
| DRILLER: J. Tatro | LOGGED BY: R. Jett | START DATE: 06/20/21 | END DATE: 06/20/21 |
| SURFACE ELEVATION: 1016.7 ft | RIG: 7507 | METHOD: 3 1/4" HSA | SURFACING: Gravel |
| WEATHER: 68°, sunny | | | |

| Elev./ Depth ft | Water Level | Description of Materials (Soil-ASTM D2488 or 2487; Rock-USACE EM 1110-1-2908) | Sample | Blows (N-Value) Recovery | PID ppm | MC % | Tests or Remarks |
|---|---|---|---|---|---|---|---|
| 1016.1 | | APPARENT AGGREGATE BASE | | | | | |
| 0.6 | | SANDY LEAN CLAY (CL), organic, black, moist (BURIED TOPSOIL) | | | | | |
| | | | | 2-4-3 (7) 16" | 0.3 | | Soil sample (2.5'-5') at 12:45 collected for analytical testing |
| 1013.2 | | | | | | | |
| 3.5 | | CLAYEY SAND (SC), gray and dark brown, moist, stiff (GLACIOFLUVIUM) | | | | | |
| | | 5 | | 3-4-5 (9) 16" | 0.4 | | |
| 1010.2 | | | | | | | |
| 6.5 | | SILTY SAND (SM), fine to coarse-grained, dark brown, moist to wet, loose (GLACIAL OUTWASH) | | 2-3-5 (8) 16" | 0.4 | 19 | |
| | | 10 | | 3-3-3 (6) 16" | 0.3 | | |
| | | | | 2-4-2 (6) 16" | 0.4 | | Water sample at 13:10 collected for analytical testing |
| 1002.7 | | | | | | | |
| 14.0 | | POORLY GRADED SAND with SILT (SP-SM), fine to coarse-grained, gray, wet, loose (GLACIAL OUTWASH) | | | | | |
| | | 15 | | 4-3-4 (7) 16" | 0.3 | | Temporary well installed with screen set from 15 to 20 feet |
| | | 20 | | 2-1-7 (8) 18" | 0.2 | | |
| 995.7 | | | | | | | |
| 21.0 | | END OF BORING | | | | | Water observed at 10.0 feet while drilling. |
| | | Boring then backfilled with bentonite grout | | | | | Water observed at 16.9 feet at end of drilling. |
| | | 25 | | | | | Water measured at a depth of 16.70 feet in temporary well. |
| | | 30 | | | | | Boring elevations and surface elevations were measured by Braun Intertec using GPS technology |

BRAUN INTERTEC
The Science You Build On.

# LOG OF BORING

See Descriptive Terminology sheet for explanation of abbreviations

**Project Number B2104135**
**Geotechnical & Environmental Evaluation**
**Proposed Kwik Trip #1203**
**Southeast corner of E. Bridge Street & Hwy 1**
**Redwood Falls, Minnesota**

BORING: **ST-2**
LOCATION: See attached sketch

| | | | |
|---|---|---|---|
| NORTHING: | 226194 | EASTING: | 540881 |
| DRILLER: J. Tatro | LOGGED BY: R. Jett | START DATE: 06/20/21 | END DATE: 06/20/21 |
| SURFACE ELEVATION: 1015.9 ft | RIG: 7507 | METHOD: 3 1/4" HSA | SURFACING: Grass/Gravel |
| WEATHER: 68°, sunny | | | |

| Elev./ Depth ft | Water Level | Description of Materials (Soil-ASTM D2488 or 2487; Rock-USACE EM 1110-1-2908) | Sample | Blows (N-Value) Recovery | PID ppm | MC % | Tests or Remarks |
|---|---|---|---|---|---|---|---|
| 1015.5 / 0.4 | | APPARENT AGGREGATE BASE, AND TOPSOIL FILL | | | | | |
| 1013.9 / 2.0 | | SILTY SAND (SM), fine to medium-grained, little Gravel, trace roots, dark brown, moist (BURIED TOPSOIL) | | | | | |
| 1011.4 / 4.5 | | POORLY GRADED SAND with SILT (SP-SM), fine to medium-grained, trace Gravel, gray, moist, loose (GLACIAL OUTWASH) | | | | | |
| | | SANDY LEAN CLAY (CL), contains seams of Silt, trace Gravel, gray to brown, moist, medium to stiff (GLACIAL TILL) | | | | | |
| 1004.4 / 11.5 | | SANDY LEAN CLAY (CL), trace Gravel, dark gray, moist, medium (GLACIAL TILL) | | | | | |
| 994.9 / 21.0 | | END OF BORING<br>Boring then backfilled with bentonite grout | | | | | |

| Sample | Blows (N-Value) Recovery | PID ppm | MC % | Tests or Remarks |
|---|---|---|---|---|
| | 3-4-5 (9) 16" | 1.1 | | Soil sample (2.5'-5') at 13:40 collected for analytical testing |
| 5 | 5-3-3 (6) 16" | 0.6 | 23 | P200=52% |
| | 4-7-7 (14) 16" | 0.5 | | |
| 10 | 2-4-6 (10) 16" | 0.5 | | |
| | 2-2-5 (7) 16" | 0.4 | | Water sample at 16:55 collected for analytical testing |
| 15 | 2-2-3 (5) 16" | 0.1 | | Temporary well installed with screen set from 15 to 20 feet |
| 20 | 2-3-4 (7) 16" | 0.1 | 15 | Water measured at a depth of 19.9 feet in temporary well<br>Water observed at 19.0 feet while drilling.<br>Water measured at a depth of 14.90 feet in temporary well when rechecked 3 hours after installation. |
| 25 | | | | |
| 30 | | | | |

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# LOG OF BORING

See Descriptive Terminology sheet for explanation of abbreviations

**Project Number B2104135**
**Geotechnical & Environmental Evaluation**
**Proposed Kwik Trip #1203**
**Southeast corner of E. Bridge Street & Hwy 1**
**Redwood Falls, Minnesota**

BORING: **ST-3**
LOCATION: See attached sketch

| | | | |
|---|---|---|---|
| NORTHING: | 226273 | EASTING: | 540975 |
| DRILLER: J. Tatro | LOGGED BY: R. Jett | START DATE: 06/20/21 | END DATE: 06/20/21 |
| SURFACE ELEVATION: 1015.9 ft | RIG: 7507 | METHOD: 3 1/4" HSA | SURFACING: Gravel |
| WEATHER: 68°, sunny | | | |

| Elev./ Depth ft | Water Level | Description of Materials (Soil-ASTM D2488 or 2487; Rock-USACE EM 1110-1-2908) | Sample | Blows (N-Value) Recovery | PID ppm | MC % | Tests or Remarks |
|---|---|---|---|---|---|---|---|
| 1015.5 | | APPARENT AGGREGATE BASE | | | | | |
| 0.4 / 1013.9 | | FILL: POORLY GRADED SAND with SILT (SP-SM), fine to coarse-grained, trace Gravel, dark brown, moist | | | | | |
| 2.0 / 1011.4 | | FILL: CLAYEY SAND (SC), trace Gravel, trace organic, black, moist | X | 2-4-6 (10) 16" | 0.4 | 25 | Soil sample (2.5'-5') at 14:25 collected for analytical testing OC=5% |
| 4.5 / 1009.4 | | SILTY SAND (SM), fine to medium-grained, trace Gravel, brown, moist, loose (GLACIOFLUVIUM) | X | 2-3-5 (8) 16" | 0.7 | | |
| 6.5 / 1004.4 | ▽ | SILTY SAND (SM), fine to coarse-grained, dark brown, wet, very loose to loose (GLACIOFLUVIUM) | X | 1-2-2 (4) 16" | 0.6 | | Temporary well installed with screen set from 7 to 12 feet |
| | | | X | 2-2-4 (6) 16" | 0.8 | | |
| 11.5 / 1001.9 | | POORLY GRADED SAND (SP), fine to coarse-grained, trace Gravel, brown, wet, loose (GLACIAL OUTWASH) | X | 6-4-4 (8) 16" | 0.2 | | Water sample at 14:40 collected for analytical testing |
| 14.0 / 994.9 | | SANDY LEAN CLAY (CL), contains seams of Poorly Graded Sand, trace Gravel, dark gray, wet, medium (GLACIAL TILL) | X | 6-4-2 (6) 16" | 0.3 | | |
| | | | X | 2-2-3 (5) 16" | 0.3 | | |
| 21.0 | | END OF BORING<br>Boring then backfilled with bentonite grout | | | | | Water observed at 7.5 feet while drilling.<br>Water measured at a depth of 7.40 feet in temporary well. |

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# LOG OF BORING

See Descriptive Terminology sheet for explanation of abbreviations

**Project Number B2104135**
**Geotechnical & Environmental Evaluation**
**Proposed Kwik Trip #1203**
**Southeast corner of E. Bridge Street & Hwy 1**
**Redwood Falls, Minnesota**

BORING: **ST-4**
LOCATION: See attached sketch

| | | | |
|---|---|---|---|
| NORTHING: | 226263 | EASTING: | 541083 |
| DRILLER: J. Tatro | LOGGED BY: R. Jett | START DATE: 06/20/21 | END DATE: 06/20/21 |
| SURFACE ELEVATION: 1015.5 ft | RIG: 7507 | METHOD: 3 1/4" HSA | SURFACING: Gravel |
| WEATHER: 68°, sunny | | | |

| Elev./ Depth ft | Water Level | Description of Materials (Soil-ASTM D2488 or 2487; Rock-USACE EM 1110-1-2908) | Sample | Blows (N-Value) Recovery | PID ppm | MC % | Tests or Remarks |
|---|---|---|---|---|---|---|---|
| 1014.8 | | APPARENT AGGREGATE BASE | | | | | |
| 0.8 | | FILL: CLAYEY SAND (SC), trace Gravel, brown to light brown, moist<br>*With a dark brown to black layer* | | 1-1-3-4 (4) 12" | 0.2 | | Soil sample (2.5'-5') at 15:25 collected for analytical testing |
| 1011.5 | | | | 2-3-2-3 (5) 16" | 0.2 | 23 | |
| 4.0 | | SANDY LEAN CLAY (CL), trace Gravel, gray, moist, medium to stiff (GLACIAL TILL) | | 4-5-7-7 (12) 16" | 1.4 | | |
| 1007.5 | | | | 4-5-7-7 (12) 18" | 0.7 | | $q_p$=2.5 tsf |
| 8.0 | | SANDY LEAN CLAY (CL), trace Gravel, brown, moist, stiff (GLACIAL TILL) | | 4-4-6-7 (10) 18" | 0.6 | | |
| 1005.5 | | | | 6-6-7-6 (13) 18" | 0.1 | | |
| 10.0 | | SANDY LEAN CLAY (CL), trace Gravel, dark gray, moist, stiff to medium (GLACIAL TILL) | | 3-4-4-5 (8) 18" | 0.3 | | |
| | | | | 5-5-6-7 (11) 18" | 0.4 | | |
| | | | | 4-4-6-7 (10) 18" | 0.2 | | |
| 995.5 | | | | | | | |
| 20.0 | | END OF BORING<br>Boring then backfilled with bentonite grout | | | | | Water not observed while drilling. |

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# LOG OF BORING

See Descriptive Terminology sheet for explanation of abbreviations

**Project Number B2104135**
**Geotechnical & Environmental Evaluation**
**Proposed Kwik Trip #1203**
**Southeast corner of E. Bridge Street & Hwy 1**
**Redwood Falls, Minnesota**

BORING: **ST-5**

LOCATION: See attached sketch

| | | | |
|---|---|---|---|
| NORTHING: | 226109 | EASTING: | 540851 |
| DRILLER: J. Tatro | LOGGED BY: R. Jett | START DATE: 06/20/21 | END DATE: 06/20/21 |
| SURFACE ELEVATION: 1016.1 ft | RIG: 7507 | METHOD: 3 1/4" HSA | SURFACING: Grass/Gravel |
| WEATHER: 68°, sunny | | | |

| Elev./ Depth ft | Water Level | Description of Materials (Soil-ASTM D2488 or 2487; Rock-USACE EM 1110-1-2908) | Sample | Blows (N-Value) Recovery | PID ppm | MC % | Tests or Remarks |
|---|---|---|---|---|---|---|---|
| 1014.5 | | APPARENT AGGREGATE BASE, AND TOPSOIL FILL | | | | | |
| 1.7 / 1013.6 | | FILL: SILTY SAND (SM), fine to medium-grained, trace Gravel, trace organic, black, moist | | 4-5-6 (11) 16" | 0.8 | | Soil sample (2.5'-5') at 16:05 collected for analytical testing |
| 2.5 / 1011.6 | | FILL: SILTY SAND (SM), fine to medium-grained, light brown to gray, moist | | | | | |
| 4.5 / 1009.1 | | POORLY GRADED SAND (SP), fine to medium-grained, trace Gravel, light brown, moist, loose (GLACIOFLUVIUM) | 5 | 3-4-4 (8) 16" | 1.3 | | |
| 7.0 / 1006.6 | ▽ | SILTY SAND (SM), fine to medium-grained, trace Gravel, gray, wet, loose (GLACIOFLUVIUM) | | 3-4-3 (7) 16" | 0.5 | 36 | |
| 9.5 / 1002.1 | | SANDY LEAN CLAY (CL), trace Gravel, gray to brown, moist, medium to stiff (GLACIAL TILL) | 10 | 3-4-4 (8) 16" | 0.6 | | Temporary well installed with screen set from 10 to 20 feet |
| | | | | 2-3-6 (9) 16" | 0.4 | | Water sample at 16:45 collected for analytical testing |
| 14.0 / 995.1 | | SANDY LEAN CLAY (CL), trace Gravel, dark gray, moist, stiff to medium (GLACIAL TILL) | 15 | 3-4-5 (9) 16" | 0.8 | | |
| | | | 20 | 2-2-6 (8) 16" | 1.0 | 12 | |
| 21.0 | | END OF BORING<br>Boring then backfilled with bentonite grout | 25<br>30 | | | | Water observed at 7.5 feet while drilling.<br>Water measured at a depth of 7.40 feet in temporary well. |

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# LOG OF BORING

See Descriptive Terminology sheet for explanation of abbreviations

**Project Number B2104135**
**Geotechnical & Environmental Evaluation**
**Proposed Kwik Trip #1203**
**Southeast corner of E. Bridge Street & Hwy 1**
**Redwood Falls, Minnesota**

BORING: **ST-6**
LOCATION: See attached sketch

| | | | |
|---|---|---|---|
| NORTHING: | 226091 | EASTING: | 540926 |
| DRILLER: J. Tatro | LOGGED BY: R. Jett | START DATE: 06/20/21 | END DATE: 06/20/21 |
| SURFACE ELEVATION: 1015.9 ft | RIG: 7507 | METHOD: 3 1/4" HSA | SURFACING: Grass/Gravel |
| WEATHER: 68°, sunny | | | |

| Elev./ Depth ft | Water Level | Description of Materials (Soil-ASTM D2488 or 2487; Rock-USACE EM 1110-1-2908) | Sample | Blows (N-Value) Recovery | PID ppm | MC % | Tests or Remarks |
|---|---|---|---|---|---|---|---|
| 1015.3 / 0.6 | | APPARENT AGGREGATE BASE, AND TOPSOIL FILL | | | | | |
| 1013.9 / 2.0 | | FILL: CLAYEY SAND (SC), trace Gravel, trace organic, black to gray, moist | | | | | |
| 1011.4 / 4.5 | | SILTY SAND (SM), fine to medium-grained, trace Gravel, light brown, moist, loose (GLACIAL OUTWASH) | | 2-4-6 (10) 14" | 0.5 | | Soil sample (2.5'-5') at 08:30 collected for analytical testing |
| 1008.9 / 7.0 | | SILTY SAND (SM), fine to medium-grained, trace Gravel, gray to brown, moist, medium dense (GLACIAL OUTWASH) | 5 | 10-8-10 (18) 14" | 1.1 | | |
| 1004.4 / 11.5 | | POORLY GRADED SAND with SILT (SP-SM), fine to coarse-grained, trace Gravel, brown, wet, medium dense to loose (GLACIAL OUTWASH) | | 8-6-8 (14) 14" | 0.7 | 24 | Temporary well installed with screen set from 7 to 12 feet P200=7% |
| | | | 10 | 3-4-3 (7) 14" | 0.7 | | |
| 997.9 / 18.0 | | SILTY SAND (SM), fine to coarse-grained, trace Gravel, gray, wet, loose (GLACIAL OUTWASH) | | 4-4-4 (8) 14" | 0.3 | | Water sample at 08:55 collected for analytical testing |
| | | | 15 | 2-3-2 (5) 14" | 0.4 | | |
| 994.9 / 21.0 | | SANDY LEAN CLAY (CL), contains seams of Silt, gray, medium (GLACIAL TILL) | 20 | 2-2-3 (5) 14" | 0.4 | | |
| | | END OF BORING<br>Boring then backfilled with bentonite grout | 25<br>30 | | | | Water observed at 7.5 feet while drilling.<br>Water measured at a depth of 7.60 feet in temporary well. |

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# LOG OF BORING

See Descriptive Terminology sheet for explanation of abbreviations

**Project Number B2104135**
**Geotechnical & Environmental Evaluation**
**Proposed Kwik Trip #1203**
**Southeast corner of E. Bridge Street & Hwy 1**
**Redwood Falls, Minnesota**

BORING: **ST-7**
LOCATION: See attached sketch

| | | | |
|---|---|---|---|
| NORTHING: | 225832 | EASTING: | 540742 |
| DRILLER: J. Tatro | LOGGED BY: R. Jett | START DATE: 06/20/21 | END DATE: 06/20/21 |
| SURFACE ELEVATION: 1018.6 ft | RIG: 7507 | METHOD: 3 1/4" HSA | SURFACING: Grass/Gravel |
| WEATHER: 68°, sunny | | | |

| Elev./ Depth ft | Water Level | Description of Materials (Soil-ASTM D2488 or 2487; Rock-USACE EM 1110-1-2908) | Sample | Blows (N-Value) Recovery | PID ppm | MC % | Tests or Remarks |
|---|---|---|---|---|---|---|---|
| 1017.6 | | APPARENT AGGREGATE BASE, AND TOPSOIL FILL | | | | | |
| 1.0 | | FILL: CLAYEY SAND (SC), fine to medium-grained, trace roots, brown, moist to dry | | 6-9-7 (16) 16" | 0.6 | | Soil sample (2.5'-5') at 09:35 collected for analytical testing |
| 1014.6 | | | | | | | |
| 4.0 | | POORLY GRADED SAND with SILT (SP-SM), fine to medium-grained, trace Gravel, light brown, moist, medium dense (GLACIAL OUTWASH) | 5 | 8-7-7 (14) 16" | 0.4 | 9 | |
| 1012.1 | | | | | | | |
| 6.5 | | CLAYEY SAND (SC), trace Gravel, gray to brown, moist, stiff to very stiff (GLACIAL TILL) | | 10-4-6 (10) 16" | 0.5 | | Water sample at 10:20 collected for analytical testing |
| | ▼ | | 10 | 6-7-11 (18) 16" | 0.5 | | Temporary well installed with screen set from 10 to 15 feet |
| | | | | 4-7-10 (17) 16" | 0.4 | | |
| 1004.6 | | | | | | | |
| 14.0 | ▽ | SILTY SAND (SM), fine to coarse-grained, trace Gravel, dark gray, wet, medium dense (GLACIAL TILL) | 15 | 6-7-10 (17) 16" | 0.4 | | |
| 1000.6 | | | | | | | |
| 18.0 | | SANDY LEAN CLAY (CL), trace Gravel, dark gray, wet, stiff (GLACIAL TILL) | 20 | 3-5-5 (10) 16" | 0.3 | | |
| 997.6 | | | | | | | |
| 21.0 | | END OF BORING<br>Boring then backfilled with bentonite grout | 25<br>30 | | | | Water observed at 15.0 feet while drilling.<br>Water measured at a depth of 10.00 feet in temporary well. |

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# LOG OF BORING

See Descriptive Terminology sheet for explanation of abbreviations

**Project Number B2104135**
**Geotechnical & Environmental Evaluation**
**Proposed Kwik Trip #1203**
**Southeast corner of E. Bridge Street & Hwy 1**
**Redwood Falls, Minnesota**

BORING: **ST-8**
LOCATION: See attached sketch

| | | | |
|---|---|---|---|
| NORTHING: | 225648 | EASTING: | 540715 |
| DRILLER: J. Tatro | LOGGED BY: R. Jett | START DATE: 06/20/21 | END DATE: 06/20/21 |
| SURFACE ELEVATION: 1019.9 ft | RIG: 7507 | METHOD: 3 1/4" HSA | SURFACING: Grass/Gravel |
| WEATHER: 68°, sunny | | | |

| Elev./ Depth ft | Water Level | Description of Materials (Soil-ASTM D2488 or 2487; Rock-USACE EM 1110-1-2908) | Sample | Blows (N-Value) Recovery | PID ppm | MC % | Tests or Remarks |
|---|---|---|---|---|---|---|---|
| 1018.4 | | APPARENT AGGREGATE BASE, AND TOPSOIL FILL | | | | | |
| 1.5 | | FILL: CLAYEY SAND (SC), trace Gravel, brown, moist | | 4-7-7 (14) 14" | 0.2 | | Soil sample (2.5'-5') at 10:45 collected for analytical testing |
| 1015.4 | | | | | | | |
| 4.5 | | POORLY GRADED SAND with SILT (SP-SM), fine to medium-grained, trace Gravel, brown, moist, medium dense (GLACIAL OUTWASH) | 5 | 5-7-7 (14) 14" | 0.6 | | |
| 1013.4 | | | | | | | |
| 6.5 | | CLAYEY SAND (SC), trace Gravel, brown, moist, stiff to very stiff (GLACIAL TILL) | | 4-5-6 (11) 14" | 0.2 | 22 | Water sample at 12:45 collected for analytical testing |
| | | | 10 | 5-7-7 (14) 14" | 0.2 | | |
| | | | | 3-5-7 (12) 18" | 0.1 | | Temporary well installed with screen set from 15 to 20 feet |
| | | | 15 | 5-7-7 (14) 18" | 0.3 | | |
| 1001.9 | ▼ | | | | | | |
| 18.0 | ▽ | SANDY LEAN CLAY (CL), trace Gravel, dark gray, moist, stiff (GLACIAL TILL) | | | | | Water measured at a depth of 19.1 feet in temporary well |
| | | | 20 | 5-5-7 (12) 18" | 0.1 | | |
| 998.9 | | | | | | | |
| 21.0 | | END OF BORING | | | | | Water observed at 19.0 feet while drilling. |
| | | Boring then backfilled with bentonite grout | | | | | Water measured at a depth of 17.10 feet in temporary well when rechecked 1 hour after installation. |
| | | | 25 | | | | |
| | | | 30 | | | | |

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# LOG OF BORING

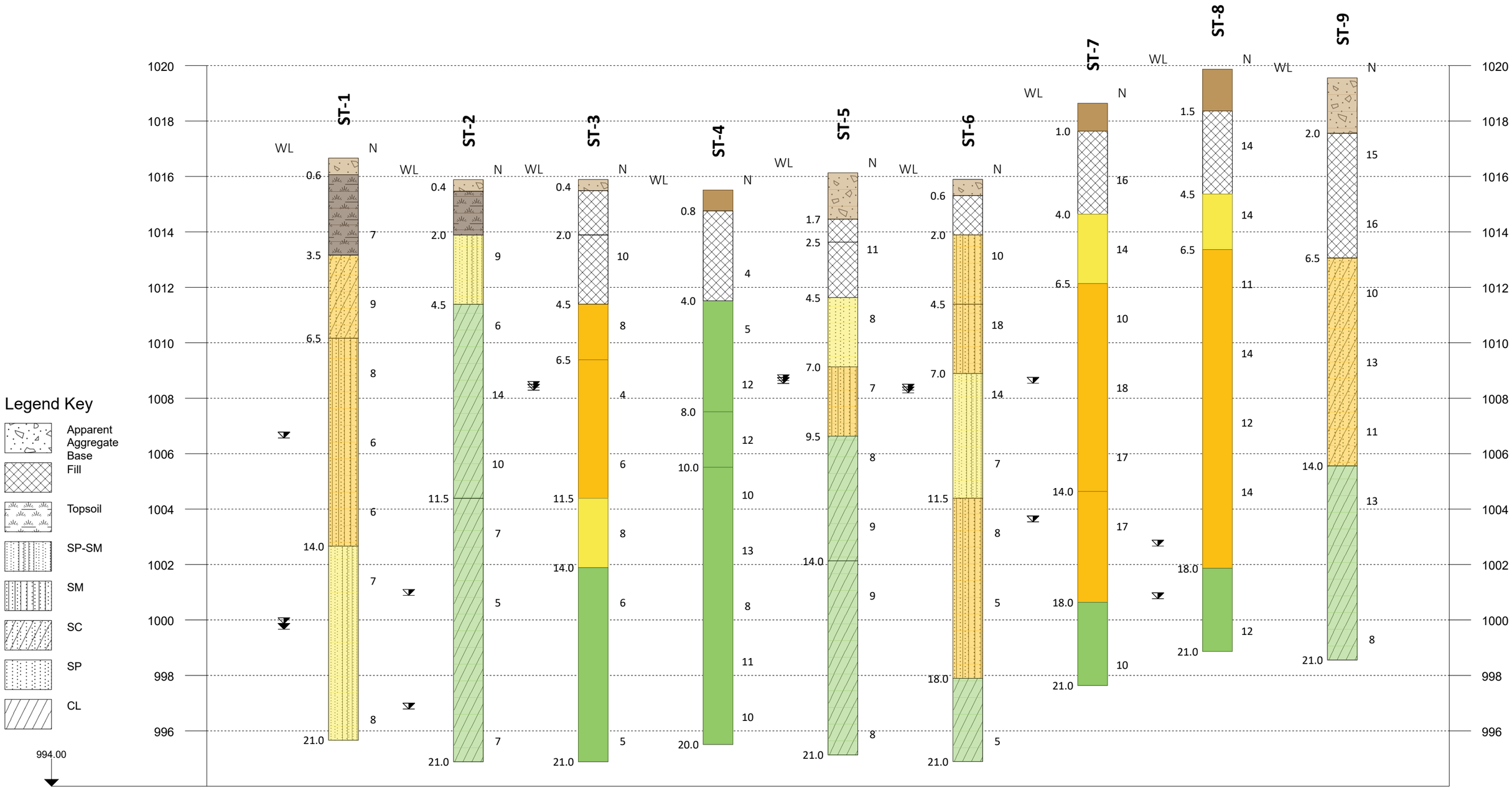
See Descriptive Terminology sheet for explanation of abbreviations

**Project Number B2104135**
**Geotechnical & Environmental Evaluation**
**Proposed Kwik Trip #1203**
**Southeast corner of E. Bridge Street & Hwy 1**
**Redwood Falls, Minnesota**

BORING: **ST-9**
LOCATION: See attached sketch
NORTHING: 225652 | EASTING: 540889

| | | | |
|---|---|---|---|
| DRILLER: J. Tatro | LOGGED BY: R. Jett | START DATE: 06/20/21 | END DATE: 06/20/21 |
| SURFACE ELEVATION: 1019.6 ft | RIG: 7507 | METHOD: 3 1/4" HSA | SURFACING: Grass/Gravel | WEATHER: 68°, sunny |

| Elev./ Depth ft | Water Level | Description of Materials (Soil-ASTM D2488 or 2487; Rock-USACE EM 1110-1-2908) | Sample | Blows (N-Value) Recovery | PID ppm | MC % | Tests or Remarks |
|---|---|---|---|---|---|---|---|
| 1017.6 | | APPARENT AGGREGATE BASE, AND TOPSOIL FILL | | | | | |
| 2.0 | | FILL: SILTY SAND (SM), fine to medium-grained, trace Gravel, trace organic, black, moist | | 6-8-7 (15) 16" | 0.2 | | Soil sample (2.5'-5') at 11:46 collected for analytical testing |
| | | | 5 | 6-9-7 (16) 0" | 0.4 | | |
| 1013.1 | | | | | | | |
| 6.5 | | CLAYEY SAND (SC), trace Gravel, gray to brown, moist, stiff (GLACIAL TILL) | | 4-4-6 (10) 16" | 0.4 | 22 | |
| | | | 10 | 5-6-7 (13) 16" | 0.3 | | |
| | | | | 3-5-6 (11) 16" | 0.2 | | |
| 1005.6 | | | | | | | |
| 14.0 | | SANDY LEAN CLAY (CL), trace Gravel, dark gray, moist, medium to stiff (GLACIAL TILL) | 15 | 8-6-7 (13) 16" | 0.1 | | |
| | | | 20 | 4-4-4 (8) 16" | 0.2 | | |
| 998.6 | | | | | | | |
| 21.0 | | END OF BORING<br>Boring then backfilled with bentonite grout | | | | | Water not observed while drilling.<br>Water not present in temporary well. |
| | | | 25 | | | | |
| | | | 30 | | | | |




Project ID: B2104135
Vert. Scale: 1"=
Hor. Scale: NTS
Date: 07/15/2021

Fence Diagram
Geotechnical & Environmental Evaluation
Proposed Kwik Trip #1203
Southeast corner of E. Bridge Street & Hwy 1
Redwood Falls, Minnesota

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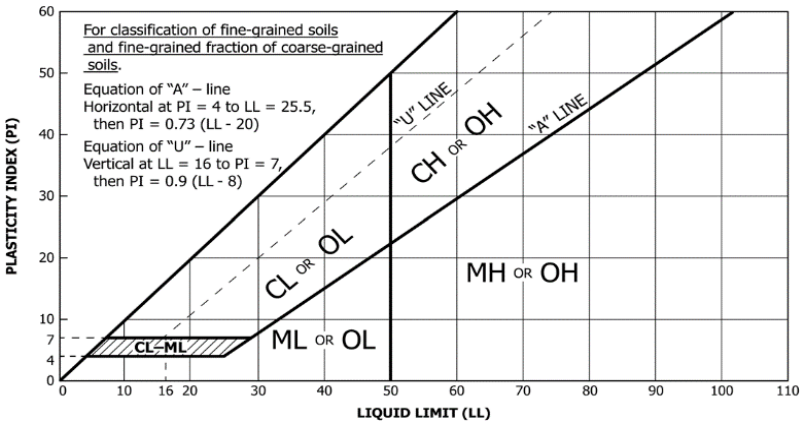
# Descriptive Terminology of Soil

Based on Standards ASTM D2487/2488
(Unified Soil Classification System)

| Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests[A] | | | | Soil Classification | |
|---|---|---|---|---|---|
| | | | | Group Symbol | Group Name[B] |
| Coarse-grained Soils (more than 50% retained on No. 200 sieve) | Gravels (More than 50% of coarse fraction retained on No. 4 sieve) | Clean Gravels (Less than 5% fines[C]) | $C_u \geq 4$ and $1 \leq C_c \leq 3$[D] | GW | Well-graded gravel[E] |
| | | | $C_u < 4$ and/or ($C_c < 1$ or $C_c > 3$)[D] | GP | Poorly graded gravel[E] |
| | | Gravels with Fines (More than 12% fines[C]) | Fines classify as ML or MH | GM | Silty gravel[E F G] |
| | | | Fines Classify as CL or CH | GC | Clayey gravel[E F G] |
| | Sands (50% or more coarse fraction passes No. 4 sieve) | Clean Sands (Less than 5% fines[H]) | $C_u \geq 6$ and $1 \leq C_c \leq 3$[D] | SW | Well-graded sand[I] |
| | | | $C_u < 6$ and/or ($C_c < 1$ or $C_c > 3$)[D] | SP | Poorly graded sand[I] |
| | | Sands with Fines (More than 12% fines[H]) | Fines classify as ML or MH | SM | Silty sand[F G I] |
| | | | Fines classify as CL or CH | SC | Clayey sand[F G I] |
| Fine-grained Soils (50% or more passes the No. 200 sieve) | Silts and Clays (Liquid limit less than 50) | Inorganic | PI > 7 and plots on or above "A" line[J] | CL | Lean clay[K L M] |
| | | | PI < 4 or plots below "A" line[J] | ML | Silt[K L M] |
| | | Organic | Liquid Limit – oven dried / Liquid Limit – not dried <0.75 | OL | Organic clay[K L M N] / Organic silt[K L M O] |
| | Silts and Clays (Liquid limit 50 or more) | Inorganic | PI plots on or above "A" line | CH | Fat clay[K L M] |
| | | | PI plots below "A" line | MH | Elastic silt[K L M] |
| | | Organic | Liquid Limit – oven dried / Liquid Limit – not dried <0.75 | OH | Organic clay[K L M P] / Organic silt[K L M Q] |
| Highly Organic Soils | | Primarily organic matter, dark in color, and organic odor | | PT | Peat |

A. Based on the material passing the 3-inch (75-mm) sieve.
B. If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.
C. Gravels with 5 to 12% fines require dual symbols:
   GW-GM well-graded gravel with silt
   GW-GC well-graded gravel with clay
   GP-GM poorly graded gravel with silt
   GP-GC poorly graded gravel with clay
D. $C_u = D_{60} / D_{10}$ $C_c = (D_{30})^2 / (D_{10} \times D_{60})$
E. If soil contains ≥ 15% sand, add "with sand" to group name.
F. If fines classify as CL-ML, use dual symbol GC-GM or SC-SM.
G. If fines are organic, add "with organic fines" to group name.
H. Sands with 5 to 12% fines require dual symbols:
   SW-SM well-graded sand with silt
   SW-SC well-graded sand with clay
   SP-SM poorly graded sand with silt
   SP-SC poorly graded sand with clay
I. If soil contains ≥ 15% gravel, add "with gravel" to group name.
J. If Atterberg limits plot in hatched area, soil is CL-ML, silty clay.
K. If soil contains 15 to < 30% plus No. 200, add "with sand" or "with gravel", whichever is predominant.
L. If soil contains ≥ 30% plus No. 200, predominantly sand, add "sandy" to group name.
M. If soil contains ≥ 30% plus No. 200 predominantly gravel, add "gravelly" to group name.
N. PI ≥ 4 and plots on or above "A" line.
O. PI < 4 or plots below "A" line.
P. PI plots on or above "A" line.
Q. PI plots below "A" line.




### Laboratory Tests

| | | | |
|---|---|---|---|
| **DD** | Dry density, pcf | **$q_p$** | Pocket penetrometer strength, tsf |
| **WD** | Wet density, pcf | **$q_U$** | Unconfined compression test, tsf |
| **P200** | % Passing #200 sieve | **LL** | Liquid limit |
| **MC** | Moisture content, % | **PL** | Plastic limit |
| **OC** | Organic content, % | **PI** | Plasticity index |

### Particle Size Identification

Boulders..... over 12"
Cobbles..... 3" to 12"
Gravel
   Coarse..... 3/4" to 3" (19.00 mm to 75.00 mm)
   Fine..... No. 4 to 3/4" (4.75 mm to 19.00 mm)
Sand
   Coarse..... No. 10 to No. 4 (2.00 mm to 4.75 mm)
   Medium..... No. 40 to No. 10 (0.425 mm to 2.00 mm)
   Fine..... No. 200 to No. 40 (0.075 mm to 0.425 mm)
Silt..... No. 200 (0.075 mm) to .005 mm
Clay..... < .005 mm

### Relative Proportions[L, M]

trace..... 0 to 5%
little..... 6 to 14%
with..... ≥ 15%

### Inclusion Thicknesses

lens..... 0 to 1/8"
seam..... 1/8" to 1"
layer..... over 1"

### Apparent Relative Density of Cohesionless Soils

Very loose ..... 0 to 4 BPF
Loose ..... 5 to 10 BPF
Medium dense..... 11 to 30 BPF
Dense..... 31 to 50 BPF
Very dense..... over 50 BPF

| Consistency of Cohesive Soils | Blows Per Foot | Approximate Unconfined Compressive Strength |
|---|---|---|
| Very soft | 0 to 1 BPF | < 0.25 tsf |
| Soft | 2 to 4 BPF | 0.25 to 0.5 tsf |
| Medium | 5 to 8 BPF | 0.5 to 1 tsf |
| Stiff | 9 to 15 BPF | 1 to 2 tsf |
| Very Stiff | 16 to 30 BPF | 2 to 4 tsf |
| Hard | over 30 BPF | > 4 tsf |

### Moisture Content:

**Dry:** Absence of moisture, dusty, dry to the touch.
**Moist:** Damp but no visible water.
**Wet:** Visible free water, usually soil is below water table.

### Drilling Notes:

**Blows/N-value:** Blows indicate the driving resistance recorded for each 6-inch interval. The reported N-value is the blows per foot recorded by summing the second and third interval in accordance with the Standard Penetration Test, ASTM D1586.

**Partial Penetration:** If the sampler could not be driven through a full 6-inch interval, the number of blows for that partial penetration is shown as #/x" (i.e. 50/2"). The N-value is reported as "REF" indicating refusal.

**Recovery:** Indicates the inches of sample recovered from the sampled interval. For a standard penetration test, full recovery is 18", and is 24" for a thinwall/shelby tube sample.

**WOH:** Indicates the sampler penetrated soil under weight of hammer and rods alone; driving not required.

**WOR:** Indicates the sampler penetrated soil under weight of rods alone; hammer weight and driving not required.

**Water Level:** Indicates the water level measured by the drillers either while drilling ( ▽ ), at the end of drilling ( ▼ ), or at some time after drilling ( ▼ ).

### Sample Symbols

Standard Penetration Test
Rock Core
Modified California (MC)
Thinwall (TW)/Shelby Tube (SH)
Auger
Texas Cone Penetrometer
Grab Sample
Dynamic Cone Penetrometer