

STORMWATER MANAGEMENT PLAN

Kwik Trip Convenience Store 1782

Bunker Lake Boulevard & Armstrong Boulevard NW
Ramsey, Minnesota

Project #11224-00

Prepared for:

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

January 30, 2025

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3890 PHEASANT RIDGE DRIVE NE, SUITE 100
BLAINE, MN 55449

TEL 763.489.7900
FAX 763.489.7959

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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 southwest quadrant of the intersection of Bunker Lake Boulevard and Armstrong Boulevard NW in Ramsey, Anoka County, Minnesota. Kwik Trip, Inc. plans on developing the site into a convenience store with a single bay carwash and associated parking and driveways. 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 southwest quadrant of the intersection of Bunker Lake Boulevard and Armstrong Boulevard NW in Ramsey, Anoka County, Minnesota. The site is bounded on the north by Bunker Lake Boulevard, on the west by Ferret Street NW, on the south by undeveloped grassland, and on the east by Armstrong Boulevard NW. The site is currently undeveloped grassland with trees along the south property line.

The proposed site boundary consists of 3.350 acres. A drainage boundary of 3.474 acres will be considered for this analysis, which includes run-on from the right-of-way. The existing drainage boundary currently has 0.020 acres of impervious surface onsite.

The site has a generally flat topography generally sloping towards the northwest or southeast, with slopes generally ranging from 0.5% to 2% over the developed area. Elevations at the site range from 870 in the center of the western edge of the site, down to about 867 in the northwest and southeast corners of the site. Stormwater from the site flows to the culvert in the northwest corner of the site, or to a ditch along the south side of the site that flows east. Any stormwater leaving the site ultimately flows to the property east of the site, across Armstrong Boulevard. See Figure 2 for an existing conditions drainage map.

The Mississippi River is located approximately 0.9 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 and associated parking and drive areas. During construction, approximately 3.3 acres will be disturbed. After the site is constructed, the drainage boundary will contain approximately 1.832 acres of impervious surface, which is an increase of 1.812 acres.

Stormwater from the area west of the west front of the station store will be collected in storm sewer and will be directed to a stormwater pond. The pond will outlet to the catch basin located east of the site basins on Armstrong Boulevard NW. This catch basin flows to the Ramsey Trunk Sewer System. All other developed portions of the site, will be collected in storm sewer and routed to an infiltration basin, located in the southeastern portion of the site. The infiltration basin will outlet to the same

location as the stormwater pond. A one-way check valve will be placed on the outlet of the infiltration basin to prevent outflow from the stormwater pond from flowing into the infiltration basin. The use of separate basins for stormwater control is necessary due to restrictions on infiltrating runoff from fueling areas. Infiltration is the preferred method for managing water quality and volume control, therefore the maximum practical amount of runoff has been directed to the infiltration basin, while runoff that cannot be infiltrated is directed to the stormwater pond. While a filtration basin would provide better water quality than a NURP pond, the outlet elevation for the site of 863.0' is too high to allow for the outletting of a filtration basin drain tile, so a NURP pond was used instead. See Figure 3 for proposed conditions drainage map.

1.3 Soil Information

In October of 2024, Braun Intertec drilled ten soil borings to approximate near surface soils. The borings indicate that near surface soils consist primarily of poorly graded sand and silty sand. These soils generally fall within the Hydrologic Soil Group (HSG) "B".

Groundwater was found to be present in all of the borings, and was generally at an elevation of 858 to 860. An infiltration rate of 0.8 in/hr was used for the infiltration basin, which is consistent for poorly graded sands. The basin will be excavated to the poorly graded sand horizon shown on boring ST-1 in Appendix D, and refilled with poorly graded sand to assure an infiltration rate of 0.8 in/hr.

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 and grassland. A CN of 98 was selected for all bituminous, gravel, and concrete surfaces and a CN of 61 was selected for any grassy pervious areas, which is consistent with grassy areas in the HSG "B".

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 (2.86"), 10-year (4.26"), 100-year (7.11"), and 10-day snow melt (7.20") events. See Appendix A and B for HydroCAD models.

2.1 Peak Elevations

For the proposed infiltration basin and stormwater pond, the 2-year, 10-year, 100-year, and 10-day high water levels have been calculated. See Table 1.

Table 1
High Water Elevations
Kwik Trip Convenience Store 1782
Ramsey, Minnesota

Basin	Bottom	Outlet	2y HWL	10y HWL	100y HWL	10-day Snow
Infiltration Basin 10	862.20	864.00	863.0	863.6	864.5	864.4
Stormwater Pond 20	858.00	863.50	864.1	864.6	865.4	864.1

2.2 Runoff Control Analysis

Any stormwater leaving the site ultimately flows to the property east of the site, across Armstrong Boulevard. As such, runoff rates are compared for the entire site. Rates are also shown for drainage to the northwest culvert only and the ditch at the southeast corner of the site only, for reference.

Table 2
Runoff Comparison 1
Kwik Trip Convenience Store 1782
Ramsey, Minnesota

Sum of Site				
Condition	2y Storm (cfs)	10y Storm (cfs)	100y Storm (cfs)	10 Day Snow (cfs)
Existing (X)	0.8	3.3	11.0	1.6
Proposed (X)	0.6	1.4	5.7	1.2

Table 3
Runoff Comparison 2
Kwik Trip Convenience Store 1782
Ramsey, Minnesota

To NW Culvert				
Condition	2y Storm (cfs)	10y Storm (cfs)	100y Storm (cfs)	10 Day Snow (cfs)
Existing (2S)	0.1	0.3	1.0	0.2
Proposed (2S)	0.1	0.3	0.8	0.1

Table 4
Runoff Comparison 3
 Kwik Trip Convenience Store 1782
 Ramsey, Minnesota

Condition	To SE Corner Ditch			
	2y Storm (cfs)	10y Storm (cfs)	100y Storm (cfs)	10 Day Snow (cfs)
Existing (1S)	0.7	3.0	10.0	1.5
Proposed (1S)	0.1	0.5	1.6	0.2

Note that for all events, the proposed runoff rates are less than or equal to existing rates.

2.3 Volume Control Analysis

The City of Ramsey requires sites to provide a volume control of 1-inch of runoff from newly created impervious surfaces. The proposed site will create approximately 1.812 acres of impervious surface. The volume control requirement for the impervious surface area is 0.151 acre-feet. The onsite infiltration basin provides volume control of 0.309 acre-feet.

The Lower Rum River Watershed Management Organization (LRRWMO) requires that a volume equal to one inch of runoff from all impervious surfaces on the site shall be infiltrated on-site. The proposed site will create approximately 1.812 acres of impervious surface. The volume control requirement for the impervious surface area is 0.151 acre-feet. The onsite infiltration basin provides volume control of 0.309 acre-feet.

See Appendix C for design calculations.

2.4 Water Quality Analysis

The City of Ramsey requires that new construction shall have a no net increase in TSS and TP concentrations. A MIDS Model was prepared to determine existing and proposed Total Suspended Solids (TSS) and Total Phosphorus (TP) loading. The Event Mean Concentration (EMC) for TP in the existing condition is 0.19 mg/L, which is the value for “open space” recommended by the Minnesota Stormwater Manual. The EMC for TP in the proposed condition is 0.20 mg/L, which is the value for “commercial” recommended by the Minnesota Stormwater Manual. The MIDS model predicts that the existing conditions will produce TSS and TP values of 238.3 lbs and 0.831 lbs, respectively. The MIDS model predicts that the proposed stormwater system will produce TSS and TP values of 114.4 lbs and 0.774 lbs, respectively. TP and TSS values for the proposed system meets and exceeds the City of Ramsey requirements for TSS and TP.

The LRRWMO requires that stormwater treatment facilities shall provide at least an annual removal efficiency of 60% TP and at least an annual removal efficiency of 90% TSS. A MIDS model was performed for the runoff to the proposed basins in the proposed condition. Runoff that bypasses the basins were excluded, since those areas cannot be directed towards the basins and therefore skew the

removal efficiency of the basins. The MIDS model indicates that the removal efficiency for the basins is 75% for TP and 90% for TSS, which meets or exceeds the LRRWMO requirement.

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

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 infiltration basin and stormwater pond. Proposed runoff rates have been decreased for all design events. Volume control has been provided far more than is required. 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:

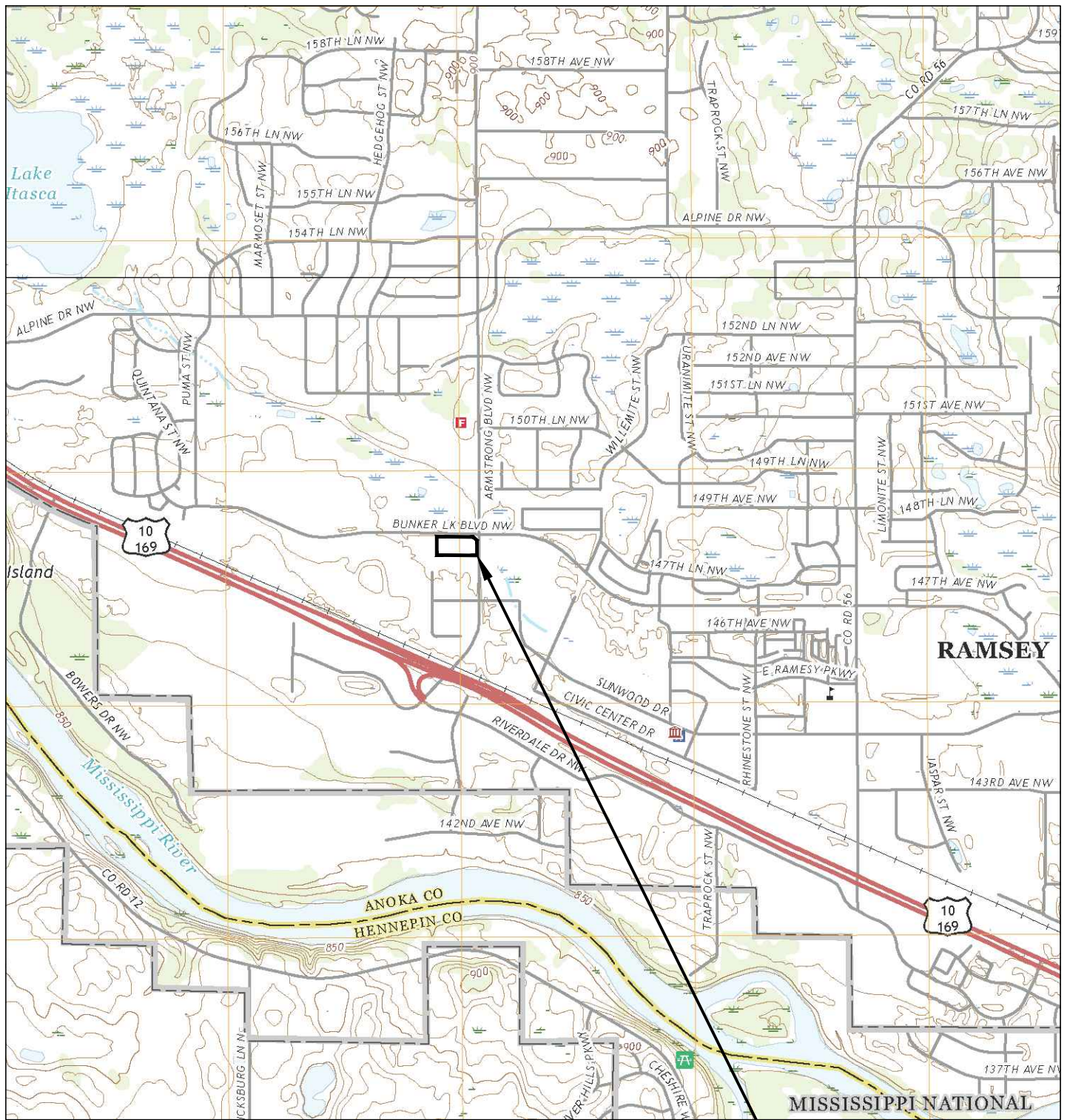


Daniel J. Wilke, P.E.
License #: 53182

7/30/25

Date

FIGURES



SITE LOCATION



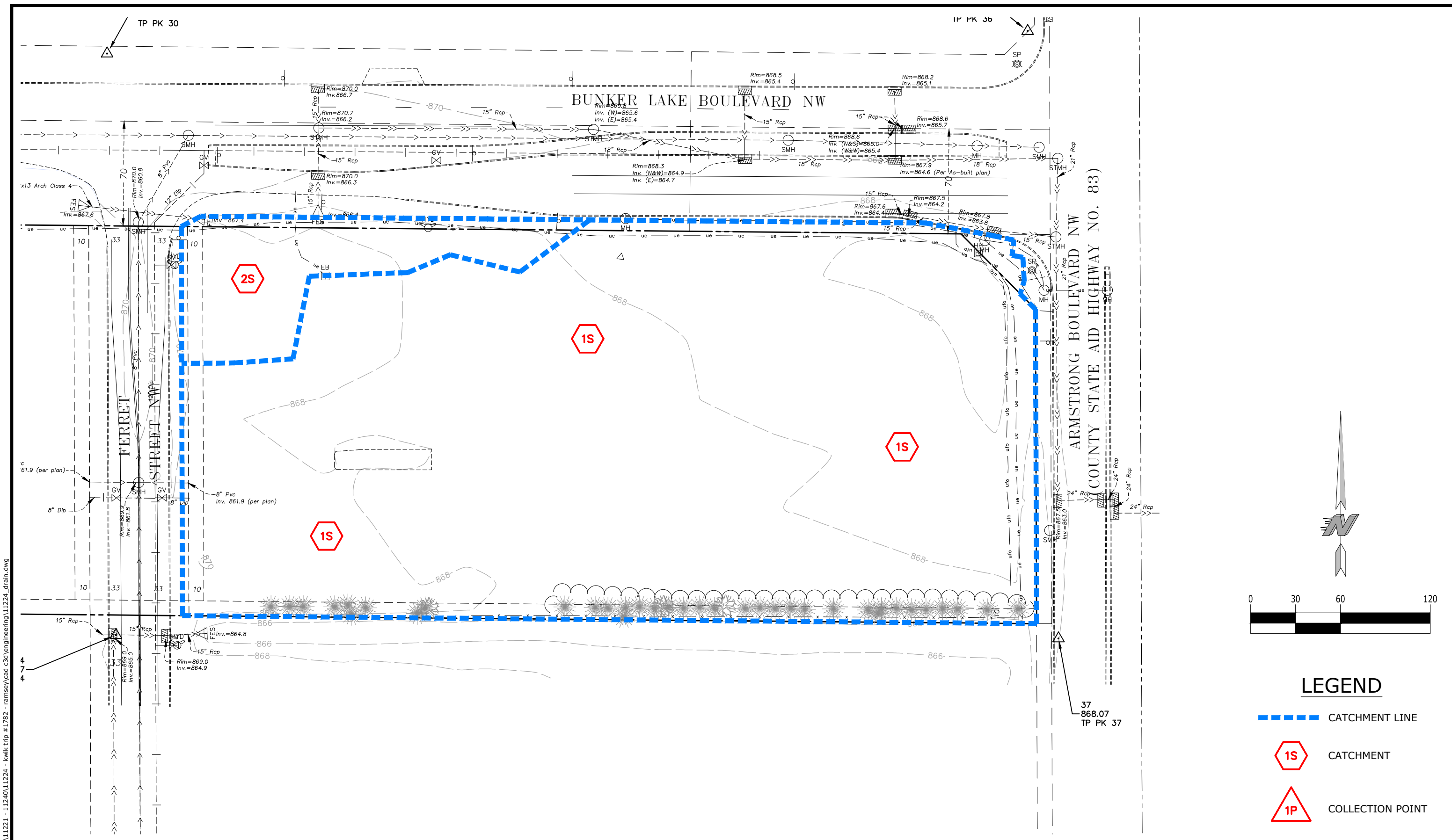
0 500 1000 2000

SOURCE: USGS ANOKA & NOWTHEN 7.5 MIN. QUADRANGLE



KWIK TRIP STORE 1782
W/1-BAY CARWASH
 Ramsey, Minnesota

FIGURE 1
SITE LOCATION MAP



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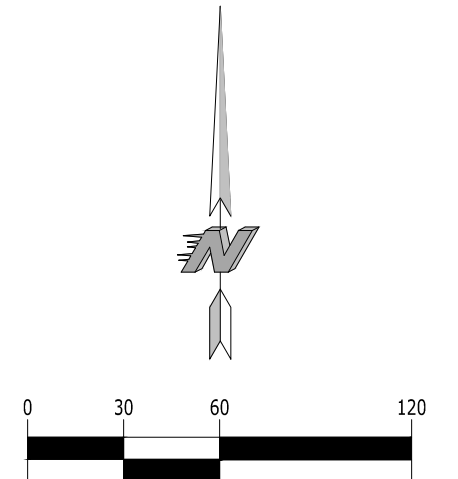
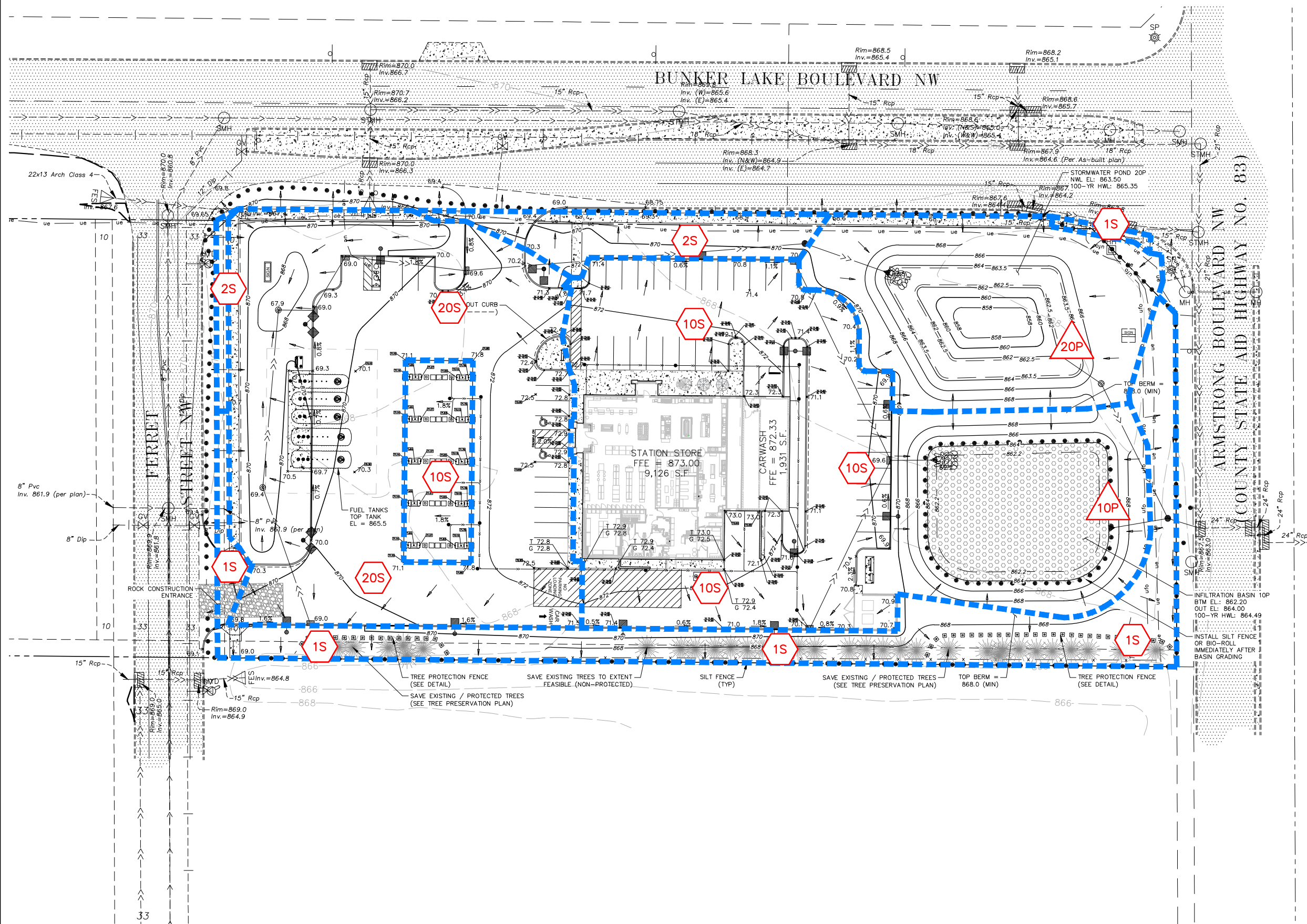
3890 PHEASANT RIDGE DR NE
SUITE 100
BLAINE, MN 55449
TEL 763.489.7900
FAX 763.489.7959
CARLSON-ENGINEERING.COM

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1626 Oak Street
La Crosse, WI 54602

KWIK TRIP STORE 1782
W/1-BAY CARWASH
Ramsey, Minnesota

FIGURE 2
EXISTING CONDITIONS
DRAINAGE MAP

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LEGEND

-  CATCHMENT LINE
-  CATCHMENT
-  COLLECTION POINT

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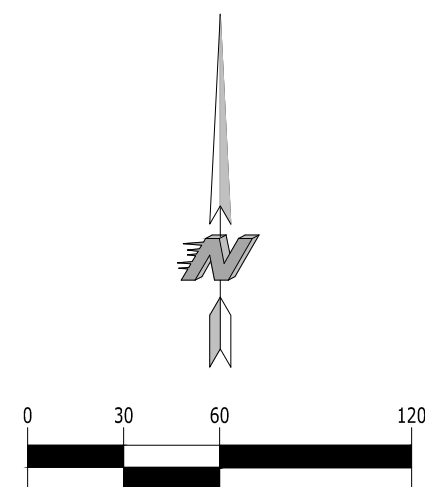
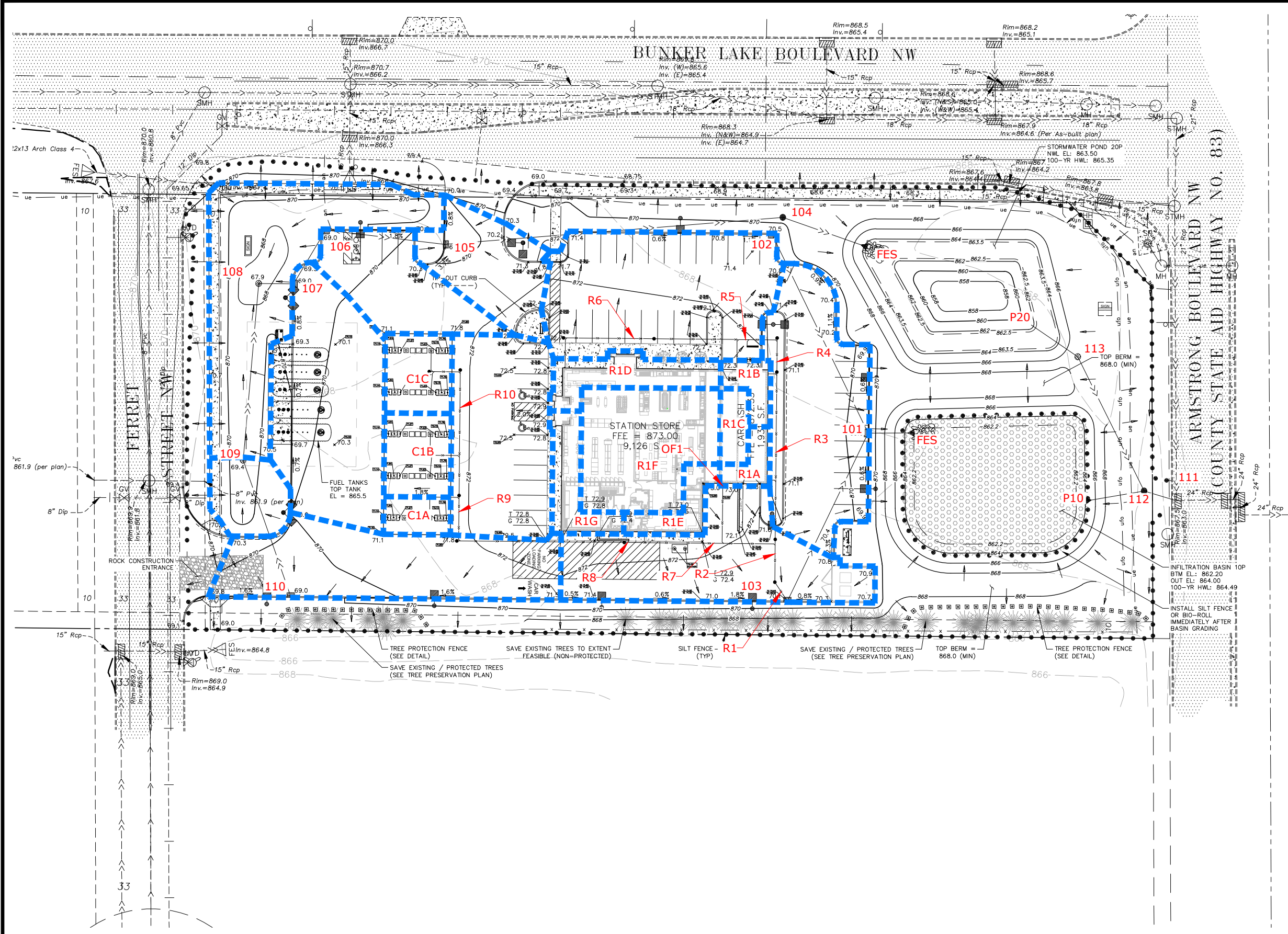
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SUITE 100
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TEL 763.489.7900
FAX 763.489.7959
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Ramsey, Minnesota

FIGURE 3
PROPOSED CONDITIONS
DRAINAGE MAP

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LEGEND

- CATCHMENT LINE
- 101 CATCHMENT



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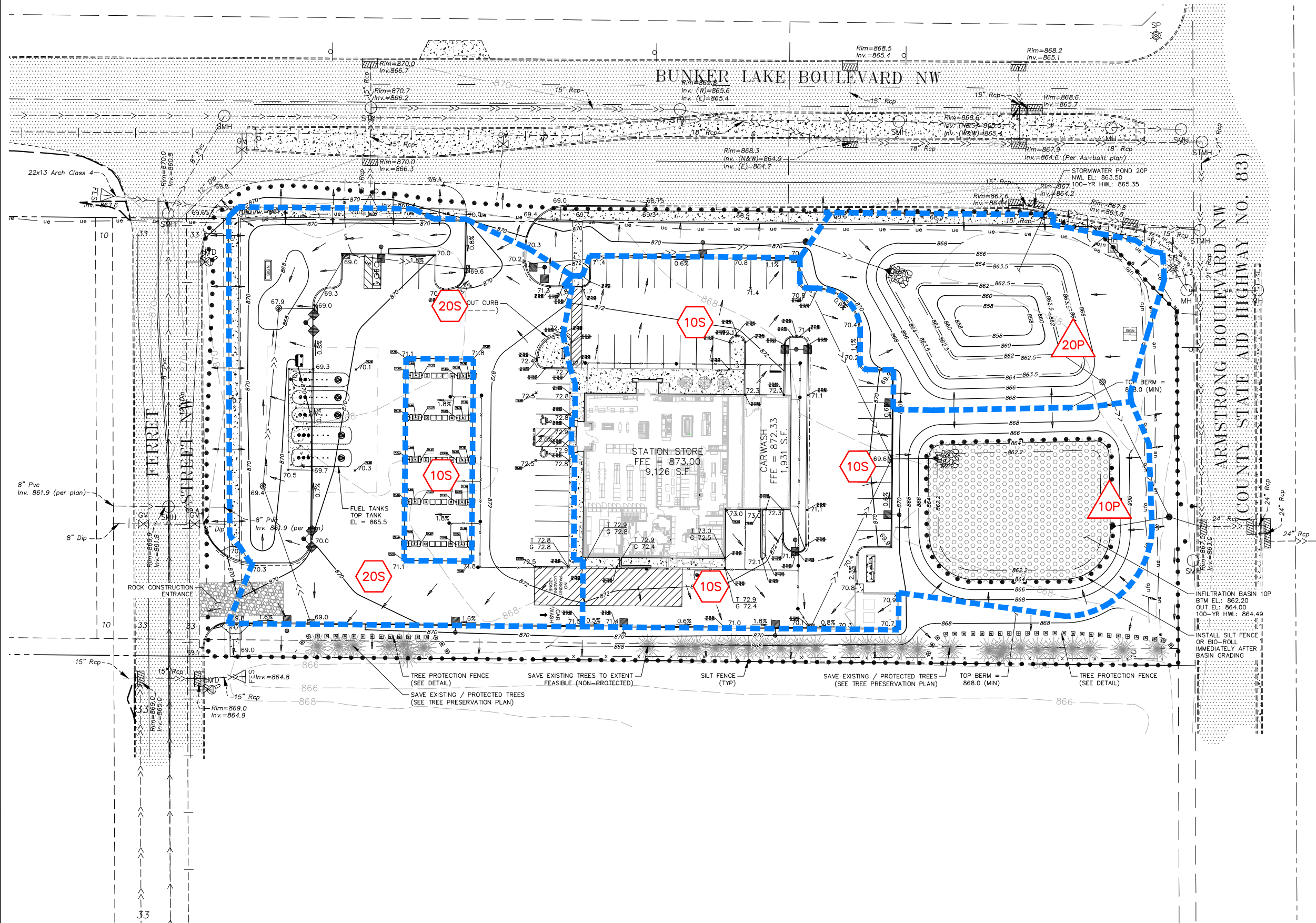
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SUITE 100
BLAINE, MN 55449
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FAX 763.489.7959
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1626 Oak Street
La Crosse, WI 54602

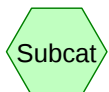
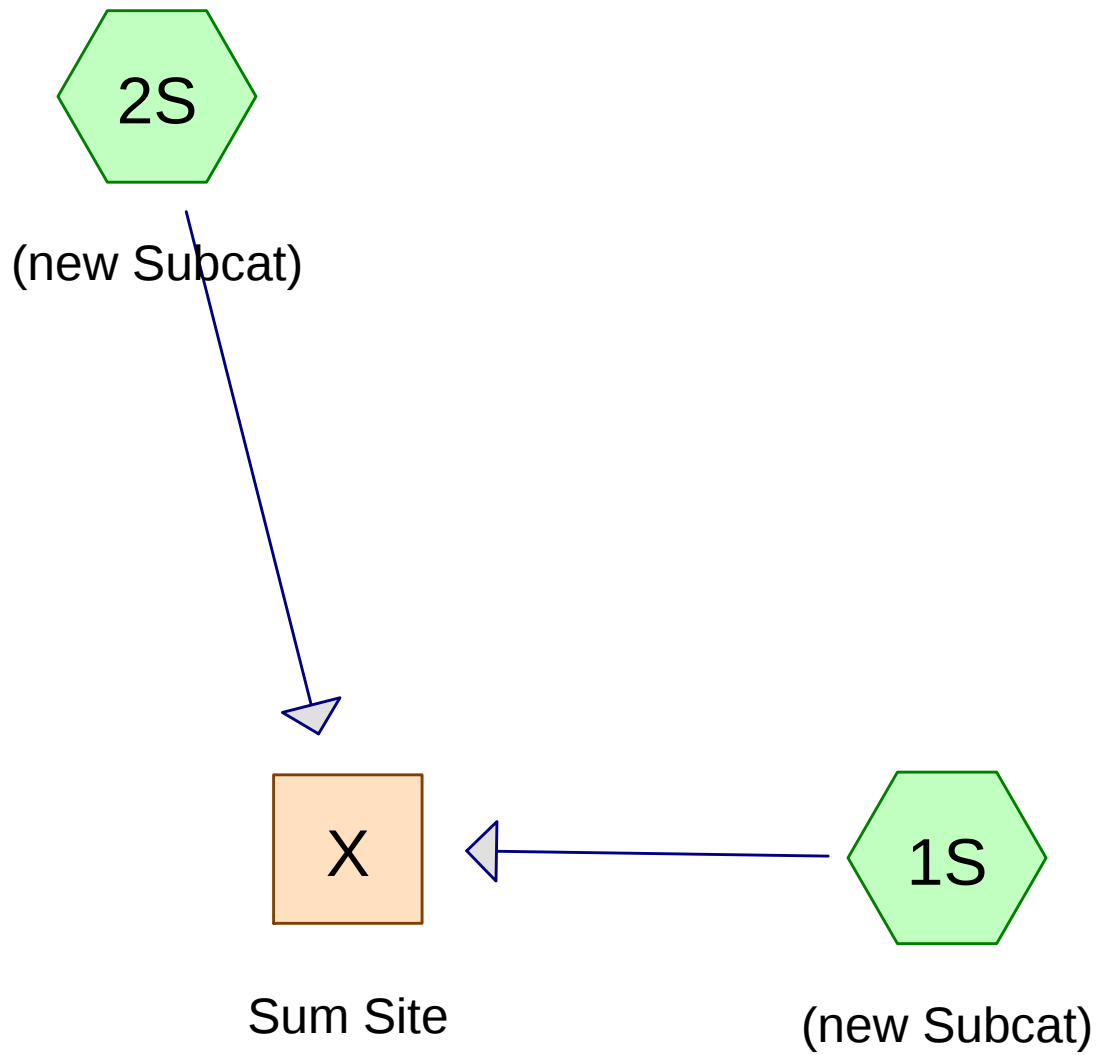
KWIK TRIP STORE 1782
W/1-BAY CARWASH
Ramsey, Minnesota

FIGURE 4
STORM SEWER
DRAINAGE MAP

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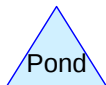
APPENDIX A



Subcat



Reach



Pond



Link

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Page 2

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
3.454	61	>75% Grass cover, Good, HSG B (1S, 2S)
0.020	98	Paved parking, HSG B (1S)
3.474	61	TOTAL AREA

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MSE 24-hr 3 2-yr Rainfall=2.86"

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Page 3

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

Subcatchment1S: (new Subcat)

Runoff Area=3.165 ac 0.63% Impervious Runoff Depth>0.28"
Flow Length=282' Tc=18.5 min CN=61 Runoff=0.69 cfs 0.075 af

Subcatchment2S: (new Subcat)

Runoff Area=0.309 ac 0.00% Impervious Runoff Depth>0.28"
Flow Length=166' Tc=19.1 min CN=61 Runoff=0.07 cfs 0.007 af

Reach X: Sum Site

Inflow=0.75 cfs 0.082 af
Outflow=0.75 cfs 0.082 af

Total Runoff Area = 3.474 ac Runoff Volume = 0.082 af Average Runoff Depth = 0.28"
99.42% Pervious = 3.454 ac 0.58% Impervious = 0.020 ac

Summary for Subcatchment 1S: (new Subcat)

Runoff = 0.69 cfs @ 12.37 hrs, Volume= 0.075 af, Depth> 0.28"

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=2.86"

Area (ac)	CN	Description
3.145	61	>75% Grass cover, Good, HSG B
0.020	98	Paved parking, HSG B
3.165	61	Weighted Average
3.145		99.37% Pervious Area
0.020		0.63% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
13.7	100	0.0100	0.12		Sheet Flow, Grass: Short n= 0.150 P2= 2.86"
4.8	182	0.0080	0.63		Shallow Concentrated Flow, Short Grass Pasture Kv= 7.0 fps
18.5	282	Total			

Summary for Subcatchment 2S: (new Subcat)

Runoff = 0.07 cfs @ 12.39 hrs, Volume= 0.007 af, Depth> 0.28"

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=2.86"

Area (ac)	CN	Description
0.309	61	>75% Grass cover, Good, HSG B
0.309		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
18.0	100	0.0050	0.09		Sheet Flow, Grass: Short n= 0.150 P2= 2.86"
1.1	66	0.0200	0.99		Shallow Concentrated Flow, Short Grass Pasture Kv= 7.0 fps
19.1	166	Total			

Summary for Reach X: Sum Site

Inflow Area = 3.474 ac, 0.58% Impervious, Inflow Depth > 0.28" for 2-yr event
Inflow = 0.75 cfs @ 12.38 hrs, Volume= 0.082 af
Outflow = 0.75 cfs @ 12.38 hrs, Volume= 0.082 af, Atten= 0%, Lag= 0.0 min

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MSE 24-hr 3 2-yr Rainfall=2.86"

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

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MSE 24-hr 3 10-yr Rainfall=4.26"

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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

Subcatchment1S: (new Subcat)

Runoff Area=3.165 ac 0.63% Impervious Runoff Depth>0.88"
Flow Length=282' Tc=18.5 min CN=61 Runoff=3.03 cfs 0.233 af

Subcatchment2S: (new Subcat)

Runoff Area=0.309 ac 0.00% Impervious Runoff Depth>0.88"
Flow Length=166' Tc=19.1 min CN=61 Runoff=0.29 cfs 0.023 af

Reach X: Sum Site

Inflow=3.32 cfs 0.256 af
Outflow=3.32 cfs 0.256 af

Total Runoff Area = 3.474 ac Runoff Volume = 0.256 af Average Runoff Depth = 0.88"
99.42% Pervious = 3.454 ac 0.58% Impervious = 0.020 ac

Summary for Subcatchment 1S: (new Subcat)

Runoff = 3.03 cfs @ 12.32 hrs, Volume= 0.233 af, Depth> 0.88"

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=4.26"

Area (ac)	CN	Description
3.145	61	>75% Grass cover, Good, HSG B
0.020	98	Paved parking, HSG B
3.165	61	Weighted Average
3.145		99.37% Pervious Area
0.020		0.63% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
13.7	100	0.0100	0.12		Sheet Flow, Grass: Short n= 0.150 P2= 2.86"
4.8	182	0.0080	0.63		Shallow Concentrated Flow, Short Grass Pasture Kv= 7.0 fps
18.5	282	Total			

Summary for Subcatchment 2S: (new Subcat)

Runoff = 0.29 cfs @ 12.32 hrs, Volume= 0.023 af, Depth> 0.88"

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=4.26"

Area (ac)	CN	Description
0.309	61	>75% Grass cover, Good, HSG B
0.309		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
18.0	100	0.0050	0.09		Sheet Flow, Grass: Short n= 0.150 P2= 2.86"
1.1	66	0.0200	0.99		Shallow Concentrated Flow, Short Grass Pasture Kv= 7.0 fps
19.1	166	Total			

Summary for Reach X: Sum Site

Inflow Area = 3.474 ac, 0.58% Impervious, Inflow Depth > 0.88" for 10-yr event
Inflow = 3.32 cfs @ 12.32 hrs, Volume= 0.256 af
Outflow = 3.32 cfs @ 12.32 hrs, Volume= 0.256 af, Atten= 0%, Lag= 0.0 min

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MSE 24-hr 3 10-yr Rainfall=4.26"

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Page 8

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

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MSE 24-hr 3 100-yr Rainfall=7.11"

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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

Subcatchment1S: (new Subcat)

Runoff Area=3.165 ac 0.63% Impervious Runoff Depth>2.63"
Flow Length=282' Tc=18.5 min CN=61 Runoff=10.01 cfs 0.695 af

Subcatchment2S: (new Subcat)

Runoff Area=0.309 ac 0.00% Impervious Runoff Depth>2.63"
Flow Length=166' Tc=19.1 min CN=61 Runoff=0.96 cfs 0.068 af

Reach X: Sum Site

Inflow=10.97 cfs 0.762 af
Outflow=10.97 cfs 0.762 af

Total Runoff Area = 3.474 ac Runoff Volume = 0.762 af Average Runoff Depth = 2.63"
99.42% Pervious = 3.454 ac 0.58% Impervious = 0.020 ac

Summary for Subcatchment 1S: (new Subcat)

Runoff = 10.01 cfs @ 12.29 hrs, Volume= 0.695 af, Depth> 2.63"

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=7.11"

Area (ac)	CN	Description
3.145	61	>75% Grass cover, Good, HSG B
0.020	98	Paved parking, HSG B
3.165	61	Weighted Average
3.145		99.37% Pervious Area
0.020		0.63% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
13.7	100	0.0100	0.12		Sheet Flow, Grass: Short n= 0.150 P2= 2.86"
4.8	182	0.0080	0.63		Shallow Concentrated Flow, Short Grass Pasture Kv= 7.0 fps
18.5	282	Total			

Summary for Subcatchment 2S: (new Subcat)

Runoff = 0.96 cfs @ 12.30 hrs, Volume= 0.068 af, Depth> 2.63"

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=7.11"

Area (ac)	CN	Description
0.309	61	>75% Grass cover, Good, HSG B
0.309		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
18.0	100	0.0050	0.09		Sheet Flow, Grass: Short n= 0.150 P2= 2.86"
1.1	66	0.0200	0.99		Shallow Concentrated Flow, Short Grass Pasture Kv= 7.0 fps
19.1	166	Total			

Summary for Reach X: Sum Site

Inflow Area = 3.474 ac, 0.58% Impervious, Inflow Depth > 2.63" for 100-yr event
Inflow = 10.97 cfs @ 12.29 hrs, Volume= 0.762 af
Outflow = 10.97 cfs @ 12.29 hrs, Volume= 0.762 af, Atten= 0%, Lag= 0.0 min

11224_ex

MSE 24-hr 3 100-yr Rainfall=7.11"

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

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
3.454	61	>75% Grass cover, Good, HSG B (1S, 2S)
0.020	98	Paved parking, HSG B (1S)
3.474	61	TOTAL AREA

11224_ex-10day*Spillway 1-day 10-day _10-day Rainfall=7.20", AMC=4*

Prepared by wilk0260

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Time span=0.00-300.00 hrs, dt=0.01 hrs, 30001 points

Runoff by SCS TR-20 method, UH=SCS, Weighted-Q

Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment1S: (new Subcat)

Runoff Area=3.165 ac 0.63% Impervious Runoff Depth=6.96"

Flow Length=282' Tc=18.5 min AMC Adjusted CN=WQ Runoff=1.49 cfs 1.836 af

Subcatchment2S: (new Subcat)

Runoff Area=0.309 ac 0.00% Impervious Runoff Depth=6.96"

Flow Length=166' Tc=19.2 min AMC Adjusted CN=98 Runoff=0.15 cfs 0.179 af

Reach X: Sum Site

Inflow=1.63 cfs 2.015 af

Outflow=1.63 cfs 2.015 af

Total Runoff Area = 3.474 ac Runoff Volume = 2.015 af Average Runoff Depth = 6.96"
99.42% Pervious = 3.454 ac 0.58% Impervious = 0.020 ac

Summary for Subcatchment 1S: (new Subcat)

Runoff = 1.49 cfs @ 121.50 hrs, Volume= 1.836 af, Depth= 6.96"

Runoff by SCS TR-20 method, UH=SCS, Weighted-Q, Time Span= 0.00-300.00 hrs, dt= 0.01 hrs
Spillway 1-day 10-day _10-day Rainfall=7.20", AMC=4

Area (ac)	CN	Adj	Description
3.145	61	98	>75% Grass cover, Good, HSG B
0.020	98	98	Paved parking, HSG B
3.165			Weighted Average
3.145			99.37% Pervious Area
0.020			0.63% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
13.7	100	0.0100	0.12		Sheet Flow, Grass: Short n= 0.150 P2= 2.84"
4.8	182	0.0080	0.63		Shallow Concentrated Flow, Short Grass Pasture Kv= 7.0 fps
18.5	282	Total			

Summary for Subcatchment 2S: (new Subcat)

Runoff = 0.15 cfs @ 121.49 hrs, Volume= 0.179 af, Depth= 6.96"

Runoff by SCS TR-20 method, UH=SCS, Weighted-Q, Time Span= 0.00-300.00 hrs, dt= 0.01 hrs
Spillway 1-day 10-day _10-day Rainfall=7.20", AMC=4

Area (ac)	CN	Adj	Description
0.309	61	98	>75% Grass cover, Good, HSG B
0.309			Weighted Average
0.309			100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
18.1	100	0.0050	0.09		Sheet Flow, Grass: Short n= 0.150 P2= 2.84"
1.1	66	0.0200	0.99		Shallow Concentrated Flow, Short Grass Pasture Kv= 7.0 fps
19.2	166	Total			

Summary for Reach X: Sum Site

Inflow Area = 3.474 ac, 0.58% Impervious, Inflow Depth = 6.96" for _10-day event
Inflow = 1.63 cfs @ 121.50 hrs, Volume= 2.015 af
Outflow = 1.63 cfs @ 121.50 hrs, Volume= 2.015 af, Atten= 0%, Lag= 0.0 min

11224_ex-10day

Spillway 1-day 10-day _10-day Rainfall=7.20", AMC=4

Prepared by wilk0260

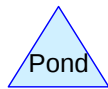
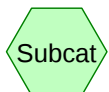
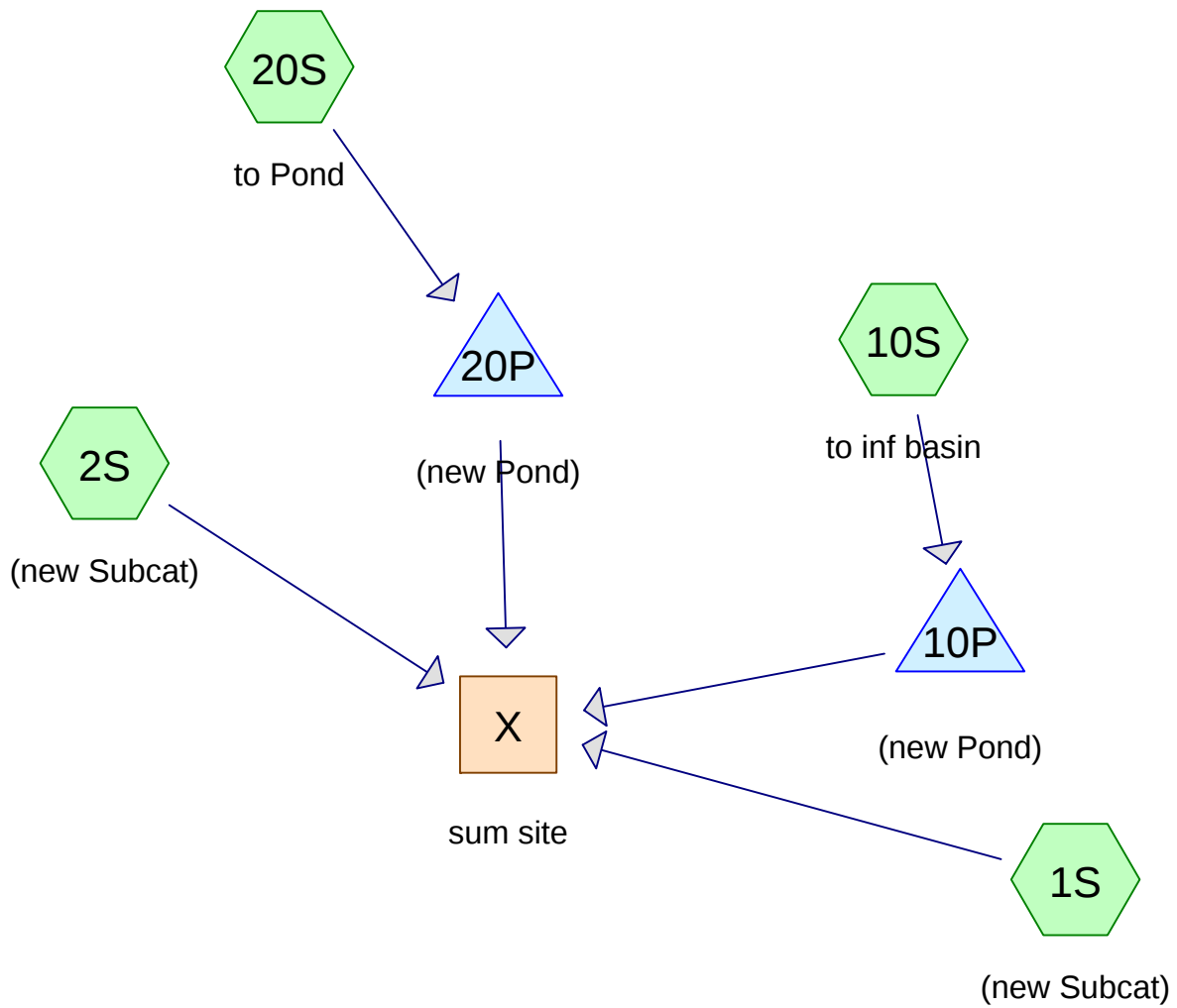
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Routing by Stor-Ind+Trans method, Time Span= 0.00-300.00 hrs, dt= 0.01 hrs

APPENDIX B



Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
1.502	61	>75% Grass cover, Good, HSG B (1S, 2S, 10S, 20S)
1.832	98	Paved parking, HSG B (1S, 2S, 10S, 20S)
0.140	98	Water Surface, 0% imp, HSG B (20S)
3.474	82	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

Subcatchment1S: (new Subcat) Runoff Area=0.436 ac 6.42% Impervious Runoff Depth>0.34"
 Flow Length=227' Slope=0.0100 '/' Tc=16.7 min CN=63 Runoff=0.14 cfs 0.012 af

Subcatchment2S: (new Subcat) Runoff Area=0.145 ac 31.03% Impervious Runoff Depth>0.68"
 Flow Length=213' Tc=12.1 min CN=72 Runoff=0.14 cfs 0.008 af

Subcatchment10S: to inf basin Runoff Area=1.423 ac 69.01% Impervious Runoff Depth>1.55"
 Tc=6.0 min CN=87 Runoff=4.09 cfs 0.184 af

Subcatchment20S: to Pond Runoff Area=1.470 ac 52.86% Impervious Runoff Depth>1.34"
 Tc=6.0 min CN=84 Runoff=3.70 cfs 0.164 af

Reach X: sum site Inflow=0.62 cfs 0.163 af
 Outflow=0.62 cfs 0.163 af

Pond 10P: (new Pond) Peak Elev=862.96' Storage=0.121 af Inflow=4.09 cfs 0.184 af
 Discarded=0.14 cfs 0.097 af Primary=0.00 cfs 0.000 af Outflow=0.14 cfs 0.097 af

Pond 20P: (new Pond) Peak Elev=864.10' Storage=0.088 af Inflow=3.70 cfs 0.164 af
 Outflow=0.41 cfs 0.142 af

Total Runoff Area = 3.474 ac Runoff Volume = 0.369 af Average Runoff Depth = 1.27"
47.27% Pervious = 1.642 ac 52.73% Impervious = 1.832 ac

Summary for Subcatchment 1S: (new Subcat)

Runoff = 0.14 cfs @ 12.32 hrs, Volume= 0.012 af, Depth> 0.34"

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=2.86"

Area (ac)	CN	Description
0.408	61	>75% Grass cover, Good, HSG B
0.028	98	Paved parking, HSG B
0.436	63	Weighted Average
0.408		93.58% Pervious Area
0.028		6.42% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
13.7	100	0.0100	0.12		Sheet Flow, Grass: Short n= 0.150 P2= 2.86"
3.0	127	0.0100	0.70		Shallow Concentrated Flow, Short Grass Pasture Kv= 7.0 fps
16.7	227	Total			

Summary for Subcatchment 2S: (new Subcat)

Runoff = 0.14 cfs @ 12.22 hrs, Volume= 0.008 af, Depth> 0.68"

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=2.86"

Area (ac)	CN	Description
0.100	61	>75% Grass cover, Good, HSG B
0.045	98	Paved parking, HSG B
0.145	72	Weighted Average
0.100		68.97% Pervious Area
0.045		31.03% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.6	50	0.0080	0.10		Sheet Flow, Grass: Short n= 0.150 P2= 2.86"
3.5	163	0.0120	0.77		Shallow Concentrated Flow, Short Grass Pasture Kv= 7.0 fps
12.1	213	Total			

Summary for Subcatchment 10S: to inf basin

Runoff = 4.09 cfs @ 12.13 hrs, Volume= 0.184 af, Depth> 1.55"

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=2.86"

Area (ac)	CN	Description
0.441	61	>75% Grass cover, Good, HSG B
0.982	98	Paved parking, HSG B
1.423	87	Weighted Average
0.441		30.99% Pervious Area
0.982		69.01% 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: to Pond

Runoff = 3.70 cfs @ 12.13 hrs, Volume= 0.164 af, Depth> 1.34"

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=2.86"

Area (ac)	CN	Description
0.553	61	>75% Grass cover, Good, HSG B
0.777	98	Paved parking, HSG B
0.140	98	Water Surface, 0% imp, HSG B
1.470	84	Weighted Average
0.693		47.14% Pervious Area
0.777		52.86% 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 site

Inflow Area = 3.474 ac, 52.73% Impervious, Inflow Depth > 0.56" for 2-yr event
Inflow = 0.62 cfs @ 12.30 hrs, Volume= 0.163 af
Outflow = 0.62 cfs @ 12.30 hrs, Volume= 0.163 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 10P: (new Pond)

Inflow Area = 1.423 ac, 69.01% Impervious, Inflow Depth > 1.55" for 2-yr event
Inflow = 4.09 cfs @ 12.13 hrs, Volume= 0.184 af
Outflow = 0.14 cfs @ 13.68 hrs, Volume= 0.097 af, Atten= 97%, Lag= 92.6 min
Discarded = 0.14 cfs @ 13.68 hrs, Volume= 0.097 af
Primary = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 862.96' @ 13.68 hrs Surf.Area= 0.168 ac Storage= 0.121 af

Plug-Flow detention time= 219.6 min calculated for 0.097 af (53% of inflow)

Center-of-Mass det. time= 157.7 min (937.4 - 779.6)

Volume	Invert	Avail.Storage	Storage Description
#1	862.20'	1.283 af	Custom Stage Data (Prismatic) Listed below (Recalc)

Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
862.20	0.151	0.000	0.000
864.00	0.192	0.309	0.309
866.00	0.242	0.434	0.743
868.00	0.298	0.540	1.283

Device	Routing	Invert	Outlet Devices
#1	Primary	864.00'	12.0" Round Culvert L= 25.0' RCP, sq.cut end projecting, Ke= 0.500 Inlet / Outlet Invert= 864.00' / 863.50' S= 0.0200 ' S= 0.0200 ' Cc= 0.900 n= 0.013 Concrete pipe, bends & connections, Flow Area= 0.79 sf
#2	Discarded	862.20'	0.800 in/hr Exfiltration over Surface area

Discarded OutFlow Max=0.14 cfs @ 13.68 hrs HW=862.96' (Free Discharge)

↑**2=Exfiltration** (Exfiltration Controls 0.14 cfs)

Primary OutFlow Max=0.00 cfs @ 5.00 hrs HW=862.20' (Free Discharge)

↑**1=Culvert** (Controls 0.00 cfs)

Summary for Pond 20P: (new Pond)

Inflow Area = 1.470 ac, 52.86% Impervious, Inflow Depth > 1.34" for 2-yr event
 Inflow = 3.70 cfs @ 12.13 hrs, Volume= 0.164 af
 Outflow = 0.41 cfs @ 12.66 hrs, Volume= 0.142 af, Atten= 89%, Lag= 31.4 min
 Primary = 0.41 cfs @ 12.66 hrs, Volume= 0.142 af

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
 Peak Elev= 864.10' @ 12.66 hrs Surf.Area= 0.153 ac Storage= 0.088 af

Plug-Flow detention time= 138.9 min calculated for 0.142 af (86% of inflow)

Center-of-Mass det. time= 100.3 min (886.3 - 786.0)

Volume	Invert	Avail.Storage	Storage Description
#1	863.50'	0.870 af	Custom Stage Data (Prismatic) Listed below (Recalc)

Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
863.50	0.140	0.000	0.000
864.00	0.151	0.073	0.073
866.00	0.198	0.349	0.422
868.00	0.250	0.448	0.870

Device	Routing	Invert	Outlet Devices
#1	Primary	863.50'	12.0" Round Culvert L= 110.0' RCP, sq.cut end projecting, Ke= 0.500 Inlet / Outlet Invert= 863.50' / 863.00' S= 0.0045 '/' Cc= 0.900 n= 0.013 Concrete pipe, bends & connections, Flow Area= 0.79 sf
#2	Device 1	863.50'	5.0" Vert. Orifice/Grate C= 0.600
#3	Device 1	864.70'	4.0' long Sharp-Crested Rectangular Weir 2 End Contraction(s)

Primary OutFlow Max=0.41 cfs @ 12.66 hrs HW=864.10' (Free Discharge)

- ↑ **1=Culvert** (Passes 0.41 cfs of 0.96 cfs potential flow)
- ↑ **2=Orifice/Grate** (Orifice Controls 0.41 cfs @ 3.00 fps)
- ↑ **3=Sharp-Crested Rectangular Weir** (Controls 0.00 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

Subcatchment1S: (new Subcat)	Runoff Area=0.436 ac 6.42% Impervious Runoff Depth>0.99" Flow Length=227' Slope=0.0100 '/' Tc=16.7 min CN=63 Runoff=0.51 cfs 0.036 af
Subcatchment2S: (new Subcat)	Runoff Area=0.145 ac 31.03% Impervious Runoff Depth>1.56" Flow Length=213' Tc=12.1 min CN=72 Runoff=0.34 cfs 0.019 af
Subcatchment10S: to inf basin	Runoff Area=1.423 ac 69.01% Impervious Runoff Depth>2.77" Tc=6.0 min CN=87 Runoff=7.11 cfs 0.329 af
Subcatchment20S: to Pond	Runoff Area=1.470 ac 52.86% Impervious Runoff Depth>2.50" Tc=6.0 min CN=84 Runoff=6.75 cfs 0.306 af
Reach X: sum site	Inflow=1.39 cfs 0.328 af Outflow=1.39 cfs 0.328 af
Pond 10P: (new Pond)	Peak Elev=863.63' Storage=0.239 af Inflow=7.11 cfs 0.329 af Discarded=0.15 cfs 0.114 af Primary=0.00 cfs 0.000 af Outflow=0.15 cfs 0.114 af
Pond 20P: (new Pond)	Peak Elev=864.64' Storage=0.174 af Inflow=6.75 cfs 0.306 af Outflow=0.63 cfs 0.273 af

Total Runoff Area = 3.474 ac Runoff Volume = 0.690 af Average Runoff Depth = 2.38"
47.27% Pervious = 1.642 ac 52.73% Impervious = 1.832 ac

Summary for Subcatchment 1S: (new Subcat)

Runoff = 0.51 cfs @ 12.28 hrs, Volume= 0.036 af, Depth> 0.99"

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=4.26"

Area (ac)	CN	Description
0.408	61	>75% Grass cover, Good, HSG B
0.028	98	Paved parking, HSG B
0.436	63	Weighted Average
0.408		93.58% Pervious Area
0.028		6.42% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
13.7	100	0.0100	0.12		Sheet Flow, Grass: Short n= 0.150 P2= 2.86"
3.0	127	0.0100	0.70		Shallow Concentrated Flow, Short Grass Pasture Kv= 7.0 fps
16.7	227	Total			

Summary for Subcatchment 2S: (new Subcat)

Runoff = 0.34 cfs @ 12.21 hrs, Volume= 0.019 af, Depth> 1.56"

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=4.26"

Area (ac)	CN	Description
0.100	61	>75% Grass cover, Good, HSG B
0.045	98	Paved parking, HSG B
0.145	72	Weighted Average
0.100		68.97% Pervious Area
0.045		31.03% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.6	50	0.0080	0.10		Sheet Flow, Grass: Short n= 0.150 P2= 2.86"
3.5	163	0.0120	0.77		Shallow Concentrated Flow, Short Grass Pasture Kv= 7.0 fps
12.1	213	Total			

Summary for Subcatchment 10S: to inf basin

Runoff = 7.11 cfs @ 12.13 hrs, Volume= 0.329 af, Depth> 2.77"

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=4.26"

Area (ac)	CN	Description
0.441	61	>75% Grass cover, Good, HSG B
0.982	98	Paved parking, HSG B
1.423	87	Weighted Average
0.441		30.99% Pervious Area
0.982		69.01% 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: to Pond

Runoff = 6.75 cfs @ 12.13 hrs, Volume= 0.306 af, Depth> 2.50"

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=4.26"

Area (ac)	CN	Description
0.553	61	>75% Grass cover, Good, HSG B
0.777	98	Paved parking, HSG B
0.140	98	Water Surface, 0% imp, HSG B
1.470	84	Weighted Average
0.693		47.14% Pervious Area
0.777		52.86% 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 site

Inflow Area = 3.474 ac, 52.73% Impervious, Inflow Depth > 1.13" for 10-yr event
Inflow = 1.39 cfs @ 12.26 hrs, Volume= 0.328 af
Outflow = 1.39 cfs @ 12.26 hrs, Volume= 0.328 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 10P: (new Pond)

Inflow Area = 1.423 ac, 69.01% Impervious, Inflow Depth > 2.77" for 10-yr event
Inflow = 7.11 cfs @ 12.13 hrs, Volume= 0.329 af
Outflow = 0.15 cfs @ 15.09 hrs, Volume= 0.114 af, Atten= 98%, Lag= 177.3 min
Discarded = 0.15 cfs @ 15.09 hrs, Volume= 0.114 af
Primary = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 863.63' @ 15.09 hrs Surf.Area= 0.184 ac Storage= 0.239 af

Plug-Flow detention time= 217.3 min calculated for 0.114 af (35% of inflow)

Center-of-Mass det. time= 145.6 min (915.5 - 770.0)

Volume	Invert	Avail.Storage	Storage Description
#1	862.20'	1.283 af	Custom Stage Data (Prismatic) Listed below (Recalc)

Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
862.20	0.151	0.000	0.000
864.00	0.192	0.309	0.309
866.00	0.242	0.434	0.743
868.00	0.298	0.540	1.283

Device	Routing	Invert	Outlet Devices
#1	Primary	864.00'	12.0" Round Culvert L= 25.0' RCP, sq.cut end projecting, Ke= 0.500 Inlet / Outlet Invert= 864.00' / 863.50' S= 0.0200 ' S= 0.0200 ' Cc= 0.900 n= 0.013 Concrete pipe, bends & connections, Flow Area= 0.79 sf
#2	Discarded	862.20'	0.800 in/hr Exfiltration over Surface area

Discarded OutFlow Max=0.15 cfs @ 15.09 hrs HW=863.63' (Free Discharge)

↑**2=Exfiltration** (Exfiltration Controls 0.15 cfs)

Primary OutFlow Max=0.00 cfs @ 5.00 hrs HW=862.20' (Free Discharge)

↑**1=Culvert** (Controls 0.00 cfs)

Summary for Pond 20P: (new Pond)

Inflow Area = 1.470 ac, 52.86% Impervious, Inflow Depth > 2.50" for 10-yr event
 Inflow = 6.75 cfs @ 12.13 hrs, Volume= 0.306 af
 Outflow = 0.63 cfs @ 12.74 hrs, Volume= 0.273 af, Atten= 91%, Lag= 36.5 min
 Primary = 0.63 cfs @ 12.74 hrs, Volume= 0.273 af

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
 Peak Elev= 864.64' @ 12.74 hrs Surf.Area= 0.166 ac Storage= 0.174 af

Plug-Flow detention time= 157.2 min calculated for 0.273 af (89% of inflow)

Center-of-Mass det. time= 125.2 min (901.0 - 775.8)

Volume	Invert	Avail.Storage	Storage Description
#1	863.50'	0.870 af	Custom Stage Data (Prismatic) Listed below (Recalc)

Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
863.50	0.140	0.000	0.000
864.00	0.151	0.073	0.073
866.00	0.198	0.349	0.422
868.00	0.250	0.448	0.870

Device	Routing	Invert	Outlet Devices
#1	Primary	863.50'	12.0" Round Culvert L= 110.0' RCP, sq.cut end projecting, Ke= 0.500 Inlet / Outlet Invert= 863.50' / 863.00' S= 0.0045 '/' Cc= 0.900 n= 0.013 Concrete pipe, bends & connections, Flow Area= 0.79 sf
#2	Device 1	863.50'	5.0" Vert. Orifice/Grate C= 0.600
#3	Device 1	864.70'	4.0' long Sharp-Crested Rectangular Weir 2 End Contraction(s)

Primary OutFlow Max=0.63 cfs @ 12.74 hrs HW=864.64' (Free Discharge)

- ↑ **1=Culvert** (Passes 0.63 cfs of 2.49 cfs potential flow)
- ↑ **2=Orifice/Grate** (Orifice Controls 0.63 cfs @ 4.64 fps)
- ↑ **3=Sharp-Crested Rectangular Weir** (Controls 0.00 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

Subcatchment1S: (new Subcat) Runoff Area=0.436 ac 6.42% Impervious Runoff Depth>2.83"
 Flow Length=227' Slope=0.0100 '/' Tc=16.7 min CN=63 Runoff=1.58 cfs 0.103 af

Subcatchment2S: (new Subcat) Runoff Area=0.145 ac 31.03% Impervious Runoff Depth>3.75"
 Flow Length=213' Tc=12.1 min CN=72 Runoff=0.81 cfs 0.045 af

Subcatchment10S: to inf basin Runoff Area=1.423 ac 69.01% Impervious Runoff Depth>5.40"
 Tc=6.0 min CN=87 Runoff=13.26 cfs 0.641 af

Subcatchment20S: to Pond Runoff Area=1.470 ac 52.86% Impervious Runoff Depth>5.06"
 Tc=6.0 min CN=84 Runoff=13.12 cfs 0.620 af

Reach X: sum site Inflow=5.68 cfs 0.899 af
 Outflow=5.68 cfs 0.899 af

Pond 10P: (new Pond) Peak Elev=864.49' Storage=0.405 af Inflow=13.26 cfs 0.641 af
 Discarded=0.16 cfs 0.141 af Primary=0.90 cfs 0.180 af Outflow=1.06 cfs 0.321 af

Pond 20P: (new Pond) Peak Elev=865.35' Storage=0.298 af Inflow=13.12 cfs 0.620 af
 Outflow=3.29 cfs 0.571 af

Total Runoff Area = 3.474 ac Runoff Volume = 1.409 af Average Runoff Depth = 4.87"
47.27% Pervious = 1.642 ac 52.73% Impervious = 1.832 ac

Summary for Subcatchment 1S: (new Subcat)

Runoff = 1.58 cfs @ 12.26 hrs, Volume= 0.103 af, Depth> 2.83"

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=7.11"

Area (ac)	CN	Description
0.408	61	>75% Grass cover, Good, HSG B
0.028	98	Paved parking, HSG B
0.436	63	Weighted Average
0.408		93.58% Pervious Area
0.028		6.42% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
13.7	100	0.0100	0.12		Sheet Flow, Grass: Short n= 0.150 P2= 2.86"
3.0	127	0.0100	0.70		Shallow Concentrated Flow, Short Grass Pasture Kv= 7.0 fps
16.7	227	Total			

Summary for Subcatchment 2S: (new Subcat)

Runoff = 0.81 cfs @ 12.20 hrs, Volume= 0.045 af, Depth> 3.75"

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=7.11"

Area (ac)	CN	Description
0.100	61	>75% Grass cover, Good, HSG B
0.045	98	Paved parking, HSG B
0.145	72	Weighted Average
0.100		68.97% Pervious Area
0.045		31.03% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.6	50	0.0080	0.10		Sheet Flow, Grass: Short n= 0.150 P2= 2.86"
3.5	163	0.0120	0.77		Shallow Concentrated Flow, Short Grass Pasture Kv= 7.0 fps
12.1	213	Total			

Summary for Subcatchment 10S: to inf basin

Runoff = 13.26 cfs @ 12.13 hrs, Volume= 0.641 af, Depth> 5.40"

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=7.11"

Area (ac)	CN	Description
0.441	61	>75% Grass cover, Good, HSG B
0.982	98	Paved parking, HSG B
1.423	87	Weighted Average
0.441		30.99% Pervious Area
0.982		69.01% 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: to Pond

Runoff = 13.12 cfs @ 12.13 hrs, Volume= 0.620 af, Depth> 5.06"

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=7.11"

Area (ac)	CN	Description
0.553	61	>75% Grass cover, Good, HSG B
0.777	98	Paved parking, HSG B
0.140	98	Water Surface, 0% imp, HSG B
1.470	84	Weighted Average
0.693		47.14% Pervious Area
0.777		52.86% 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 site

Inflow Area = 3.474 ac, 52.73% Impervious, Inflow Depth > 3.11" for 100-yr event
Inflow = 5.68 cfs @ 12.28 hrs, Volume= 0.899 af
Outflow = 5.68 cfs @ 12.28 hrs, Volume= 0.899 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 10P: (new Pond)

Inflow Area = 1.423 ac, 69.01% Impervious, Inflow Depth > 5.40" for 100-yr event
Inflow = 13.26 cfs @ 12.13 hrs, Volume= 0.641 af
Outflow = 1.06 cfs @ 12.86 hrs, Volume= 0.321 af, Atten= 92%, Lag= 43.7 min
Discarded = 0.16 cfs @ 12.86 hrs, Volume= 0.141 af
Primary = 0.90 cfs @ 12.86 hrs, Volume= 0.180 af

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 864.49' @ 12.86 hrs Surf.Area= 0.204 ac Storage= 0.405 af

Plug-Flow detention time= 163.7 min calculated for 0.321 af (50% of inflow)

Center-of-Mass det. time= 99.6 min (857.9 - 758.4)

Volume	Invert	Avail.Storage	Storage Description
#1	862.20'	1.283 af	Custom Stage Data (Prismatic) Listed below (Recalc)

Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
862.20	0.151	0.000	0.000
864.00	0.192	0.309	0.309
866.00	0.242	0.434	0.743
868.00	0.298	0.540	1.283

Device	Routing	Invert	Outlet Devices
#1	Primary	864.00'	12.0" Round Culvert L= 25.0' RCP, sq.cut end projecting, Ke= 0.500 Inlet / Outlet Invert= 864.00' / 863.50' S= 0.0200 ' S= 0.0200 ' Cc= 0.900 n= 0.013 Concrete pipe, bends & connections, Flow Area= 0.79 sf
#2	Discarded	862.20'	0.800 in/hr Exfiltration over Surface area

Discarded OutFlow Max=0.16 cfs @ 12.86 hrs HW=864.49' (Free Discharge)

↑**2=Exfiltration** (Exfiltration Controls 0.16 cfs)

Primary OutFlow Max=0.90 cfs @ 12.86 hrs HW=864.49' (Free Discharge)

↑**1=Culvert** (Inlet Controls 0.90 cfs @ 2.37 fps)

Summary for Pond 20P: (new Pond)

Inflow Area = 1.470 ac, 52.86% Impervious, Inflow Depth > 5.06" for 100-yr event
 Inflow = 13.12 cfs @ 12.13 hrs, Volume= 0.620 af
 Outflow = 3.29 cfs @ 12.36 hrs, Volume= 0.571 af, Atten= 75%, Lag= 13.6 min
 Primary = 3.29 cfs @ 12.36 hrs, Volume= 0.571 af

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
 Peak Elev= 865.35' @ 12.36 hrs Surf.Area= 0.183 ac Storage= 0.298 af

Plug-Flow detention time= 114.4 min calculated for 0.571 af (92% of inflow)

Center-of-Mass det. time= 88.3 min (852.0 - 763.7)

Volume	Invert	Avail.Storage	Storage Description
#1	863.50'	0.870 af	Custom Stage Data (Prismatic) Listed below (Recalc)

Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
863.50	0.140	0.000	0.000
864.00	0.151	0.073	0.073
866.00	0.198	0.349	0.422
868.00	0.250	0.448	0.870

Device	Routing	Invert	Outlet Devices
#1	Primary	863.50'	12.0" Round Culvert L= 110.0' RCP, sq.cut end projecting, Ke= 0.500 Inlet / Outlet Invert= 863.50' / 863.00' S= 0.0045 '/' Cc= 0.900 n= 0.013 Concrete pipe, bends & connections, Flow Area= 0.79 sf
#2	Device 1	863.50'	5.0" Vert. Orifice/Grate C= 0.600
#3	Device 1	864.70'	4.0' long Sharp-Crested Rectangular Weir 2 End Contraction(s)

Primary OutFlow Max=3.29 cfs @ 12.36 hrs HW=865.35' (Free Discharge)

↑ **1=Culvert** (Barrel Controls 3.29 cfs @ 4.18 fps)

↑ **2=Orifice/Grate** (Passes < 0.84 cfs potential flow)

↑ **3=Sharp-Crested Rectangular Weir** (Passes < 6.59 cfs potential flow)

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
1.502	61	>75% Grass cover, Good, HSG B (1S, 2S, 10S, 20S)
1.832	98	Paved parking, HSG B (1S, 2S, 10S, 20S)
0.140	98	Water Surface, 0% imp, HSG B (20S)
3.474	82	TOTAL AREA

Time span=0.00-300.00 hrs, dt=0.01 hrs, 30001 points

Runoff by SCS TR-20 method, UH=SCS, Weighted-Q

Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment1S: (new Subcat)Runoff Area=0.436 ac 6.42% Impervious Runoff Depth=6.96"
Flow Length=227' Slope=0.0100 '/' Tc=16.7 min AMC Adjusted CN=WQ Runoff=0.21 cfs 0.253 af**Subcatchment2S: (new Subcat)**Runoff Area=0.145 ac 31.03% Impervious Runoff Depth=6.96"
Flow Length=213' Tc=12.1 min AMC Adjusted CN=WQ Runoff=0.07 cfs 0.084 af**Subcatchment10S: to inf basin**Runoff Area=1.423 ac 69.01% Impervious Runoff Depth=6.96"
Tc=6.0 min AMC Adjusted CN=WQ Runoff=0.68 cfs 0.825 af**Subcatchment20S: to Pond**Runoff Area=1.470 ac 52.86% Impervious Runoff Depth=6.96"
Tc=6.0 min AMC Adjusted CN=WQ Runoff=0.71 cfs 0.853 af**Reach X: sum site**Inflow=1.16 cfs 1.706 af
Outflow=1.16 cfs 1.706 af**Pond 10P: (new Pond)**Peak Elev=864.35' Storage=0.378 af Inflow=0.68 cfs 0.825 af
12.0" Round Culvert n=0.013 L=25.0' S=0.0200 '/' Outflow=0.51 cfs 0.517 af**Pond 20P: (new Pond)**Peak Elev=864.14' Storage=0.094 af Inflow=0.71 cfs 0.853 af
Outflow=0.43 cfs 0.853 af**Total Runoff Area = 3.474 ac Runoff Volume = 2.015 af Average Runoff Depth = 6.96"**
47.27% Pervious = 1.642 ac 52.73% Impervious = 1.832 ac

Summary for Subcatchment 1S: (new Subcat)

Runoff = 0.21 cfs @ 121.45 hrs, Volume= 0.253 af, Depth= 6.96"

Runoff by SCS TR-20 method, UH=SCS, Weighted-Q, Time Span= 0.00-300.00 hrs, dt= 0.01 hrs
Spillway 1-day 10-day _10-day Rainfall=7.20", AMC=4

Area (ac)	CN	Adj	Description
0.408	61	98	>75% Grass cover, Good, HSG B
0.028	98	98	Paved parking, HSG B
0.436			Weighted Average
0.408			93.58% Pervious Area
0.028			6.42% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
13.7	100	0.0100	0.12		Sheet Flow, Grass: Short n= 0.150 P2= 2.84"
3.0	127	0.0100	0.70		Shallow Concentrated Flow, Short Grass Pasture Kv= 7.0 fps
16.7	227	Total			

Summary for Subcatchment 2S: (new Subcat)

Runoff = 0.07 cfs @ 121.39 hrs, Volume= 0.084 af, Depth= 6.96"

Runoff by SCS TR-20 method, UH=SCS, Weighted-Q, Time Span= 0.00-300.00 hrs, dt= 0.01 hrs
Spillway 1-day 10-day _10-day Rainfall=7.20", AMC=4

Area (ac)	CN	Adj	Description
0.100	61	98	>75% Grass cover, Good, HSG B
0.045	98	98	Paved parking, HSG B
0.145			Weighted Average
0.100			68.97% Pervious Area
0.045			31.03% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.6	50	0.0080	0.10		Sheet Flow, Grass: Short n= 0.150 P2= 2.84"
3.5	163	0.0120	0.77		Shallow Concentrated Flow, Short Grass Pasture Kv= 7.0 fps
12.1	213	Total			

Summary for Subcatchment 10S: to inf basin

Runoff = 0.68 cfs @ 121.30 hrs, Volume= 0.825 af, Depth= 6.96"

Runoff by SCS TR-20 method, UH=SCS, Weighted-Q, Time Span= 0.00-300.00 hrs, dt= 0.01 hrs
Spillway 1-day 10-day _10-day Rainfall=7.20", AMC=4

Area (ac)	CN	Adj	Description
0.441	61	98	>75% Grass cover, Good, HSG B
0.982	98	98	Paved parking, HSG B
1.423			Weighted Average
0.441			30.99% Pervious Area
0.982			69.01% 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: to Pond

Runoff = 0.71 cfs @ 121.30 hrs, Volume= 0.853 af, Depth= 6.96"

Runoff by SCS TR-20 method, UH=SCS, Weighted-Q, Time Span= 0.00-300.00 hrs, dt= 0.01 hrs
Spillway 1-day 10-day _10-day Rainfall=7.20", AMC=4

Area (ac)	CN	Adj	Description
0.553	61	98	>75% Grass cover, Good, HSG B
0.777	98	98	Paved parking, HSG B
0.140	98	98	Water Surface, 0% imp, HSG B
1.470			Weighted Average
0.693			47.14% Pervious Area
0.777			52.86% 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 site

Inflow Area = 3.474 ac, 52.73% Impervious, Inflow Depth > 5.89" for _10-day event
Inflow = 1.16 cfs @ 122.08 hrs, Volume= 1.706 af
Outflow = 1.16 cfs @ 122.08 hrs, Volume= 1.706 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-300.00 hrs, dt= 0.01 hrs

Summary for Pond 10P: (new Pond)

Inflow Area = 1.423 ac, 69.01% Impervious, Inflow Depth = 6.96" for _10-day event
Inflow = 0.68 cfs @ 121.30 hrs, Volume= 0.825 af
Outflow = 0.51 cfs @ 122.25 hrs, Volume= 0.517 af, Atten= 26%, Lag= 56.8 min
Primary = 0.51 cfs @ 122.25 hrs, Volume= 0.517 af

Routing by Stor-Ind method, Time Span= 0.00-300.00 hrs, dt= 0.01 hrs
Peak Elev= 864.35' @ 122.25 hrs Surf.Area= 0.201 ac Storage= 0.378 af

Plug-Flow detention time= 3,227.2 min calculated for 0.517 af (63% of inflow)
Center-of-Mass det. time= 1,725.4 min (9,135.3 - 7,409.9)

11224_pr-10day

Prepared by wilk0260

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Spillway 1-day 10-day _10-day Rainfall=7.20", AMC=4

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Volume	Invert	Avail.Storage	Storage Description
#1	862.20'	1.283 af	Custom Stage Data (Prismatic) Listed below (Recalc)

Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
862.20	0.151	0.000	0.000
864.00	0.192	0.309	0.309
866.00	0.242	0.434	0.743
868.00	0.298	0.540	1.283

Device	Routing	Invert	Outlet Devices
#1	Primary	864.00'	12.0" Round Culvert L= 25.0' RCP, sq.cut end projecting, Ke= 0.500 Inlet / Outlet Invert= 864.00' / 863.50' S= 0.0200 ' /' Cc= 0.900 n= 0.013 Concrete pipe, bends & connections, Flow Area= 0.79 sf

Primary OutFlow Max=0.51 cfs @ 122.25 hrs HW=864.35' (Free Discharge)↑**1=Culvert** (Inlet Controls 0.51 cfs @ 2.03 fps)**Summary for Pond 20P: (new Pond)**

Inflow Area = 1.470 ac, 52.86% Impervious, Inflow Depth = 6.96" for _10-day event
 Inflow = 0.71 cfs @ 121.30 hrs, Volume= 0.853 af
 Outflow = 0.43 cfs @ 122.71 hrs, Volume= 0.853 af, Atten= 39%, Lag= 84.8 min
 Primary = 0.43 cfs @ 122.71 hrs, Volume= 0.853 af

Routing by Stor-Ind method, Time Span= 0.00-300.00 hrs, dt= 0.01 hrs
 Peak Elev= 864.14' @ 122.71 hrs Surf.Area= 0.154 ac Storage= 0.094 af

Plug-Flow detention time= 282.2 min calculated for 0.853 af (100% of inflow)
 Center-of-Mass det. time= 281.1 min (7,691.0 - 7,409.9)

Volume	Invert	Avail.Storage	Storage Description
#1	863.50'	0.870 af	Custom Stage Data (Prismatic) Listed below (Recalc)

Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
863.50	0.140	0.000	0.000
864.00	0.151	0.073	0.073
866.00	0.198	0.349	0.422
868.00	0.250	0.448	0.870

Device	Routing	Invert	Outlet Devices
#1	Primary	863.50'	12.0" Round Culvert L= 110.0' RCP, sq.cut end projecting, Ke= 0.500 Inlet / Outlet Invert= 863.50' / 863.00' S= 0.0045 ' /' Cc= 0.900 n= 0.013 Concrete pipe, bends & connections, Flow Area= 0.79 sf
#2	Device 1	863.50'	5.0" Vert. Orifice/Grate C= 0.600
#3	Device 1	864.70'	4.0' long Sharp-Crested Rectangular Weir 2 End Contraction(s)

Primary OutFlow Max=0.43 cfs @ 122.71 hrs HW=864.14' (Free Discharge)

└─**1=Culvert** (Passes 0.43 cfs of 1.07 cfs potential flow)

└─**2=Orifice/Grate** (Orifice Controls 0.43 cfs @ 3.16 fps)

└─**3=Sharp-Crested Rectangular Weir** (Controls 0.00 cfs)

APPENDIX C

PROJECT NAME: Kwik Trip Convenience Store 1782

PROJECT LOCATION: Ramsey, MN

CARLSON PROJECT NO.: 11224

DATE: 7/30/25

BY: DJW

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



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)
P10	112	48	0	0	0.00	0.00	0.00	0.00	10	5.8	0.00	12	0.45%	2.39	3.04	36	864.00	863.84	864.00	0.00
P20	113	48	0	0	0.00	0.00	0.00	0.00	10	5.8	0.00	12	5.88%	8.63	10.99	34	861.50	863.50	861.50	0.00
	113	48	0	0	0.00	0.00	0.00	0.00	10	5.8	0.00	12	0.45%	2.40	3.05	89	863.50	863.09	867.50	4.00
	112	48	0	0	0.00	0.00	0.00	0.00	10	5.8	0.00	12	0.45%	2.40	3.05	20	863.09	863.00	868.00	4.91
110	109	24 x 36	8026	0	0.18	0.90	0.17	0.17	10	5.8	0.96	12	0.45%	2.39	3.04	87	865.62	865.22	868.83	3.21
109	108	48	204	1783	0.05	0.27	0.01	0.18	10	5.8	1.03	12	0.45%	2.39	3.04	106	865.22	864.75	869.40	4.18
108	107	48	1627	8171	0.22	0.32	0.07	0.25	10	5.8	1.45	12	0.45%	2.39	3.04	21	864.75	864.65	867.80	3.05
107	106	48	15651	251	0.37	0.89	0.32	0.57	10	5.8	3.33	15	0.35%	3.82	3.11	37	864.65	864.52	868.83	4.18
106	105	48	4155	0	0.10	0.90	0.09	0.66	10	5.8	3.83	15	0.35%	3.84	3.13	72	864.52	864.27	868.83	4.31
105	104	48	3307	655	0.09	0.78	0.07	0.73	10	5.8	4.24	18	0.30%	5.75	3.25	203	864.27	863.66	869.43	5.16
104	fes	48	0	0	0.00	0.00	0.00	0.73	10	5.8	4.24	18	0.30%	5.75	3.25	53	863.66	863.50	869.80	6.14
C1C	R10	na	1900	0	0.04	0.90	0.04	0.04	10	5.8	0.23	4	2.00%	0.27	3.08	32	868.25	867.61	871.56	3.31
C1B	R10	na	2000	0	0.05	0.90	0.04	0.04	10	5.8	0.24	4	2.00%	0.27	3.08	32	867.94	867.30	871.56	3.62
C1A	R9	na	900	0	0.02	0.90	0.02	0.02	10	5.8	0.11	4	2.00%	0.27	3.08	32	867.80	867.16	871.56	3.76
R1G	R8	na	1603	0	0.04	0.90	0.03	0.03	10	5.8	0.19	6	2.00%	0.79	4.04	7	866.67	866.53	873.00	6.33
R1F	R7	na	5542	0	0.13	0.90	0.11	0.11	10	5.8	0.66	6	2.00%	0.79	4.04	7	866.38	866.24	873.00	6.62
R1E	R7	na	1123	0	0.03	0.90	0.02	0.02	10	5.8	0.13	6	2.00%	0.79	4.04	9	866.20	866.02	873.00	6.80
R1D	R6	na	2068	0	0.05	0.90	0.04	0.04	10	5.8	0.25	6	2.00%	0.79	4.04	18	867.64	867.28	873.00	5.36
R1C	R5	na	760	0	0.02	0.90	0.02	0.02	10	5.8	0.09	6	2.00%	0.79	4.04	18	867.01	866.65	872.33	5.32
R1B	R3	na	801	0	0.02	0.90	0.02	0.02	10	5.8	0.10	6	2.00%	0.79	4.04	5	866.50	866.40	872.33	5.83
R1A	R3	na	681	0	0.02	0.90	0.01	0.01	10	5.8	0.08	6	2.00%	0.79	4.04	5	866.11	866.01	872.33	6.22
OF1	R7	na	0	0	0.00	0.00	0.00	0.00	10	5.8	0.00	6	2.00%	0.79	4.04	37	866.69	865.95	872.33	5.64
R10	R9	na	0	0	0.00	0.00	0.00	0.08	10	5.8	0.47	10	0.60%	1.70	3.11	75	867.36	866.91	871.90	4.54
R9	R8	na	0	0	0.00	0.00	0.00	0.10	10	5.8	0.58	10	0.60%	1.70	3.11	27	866.91	866.75	871.90	4.99
R8	R7	na	0	0	0.00	0.00	0.00	0.13	10	5.8	0.77	10	0.60%	1.70	3.11	100	866.75	866.15	871.90	5.15
R7	R2	na	0	0	0.00	0.00	0.00	0.27	10	5.8	1.57	10	0.60%	1.70	3.11	91	866.15	865.60	872.40	6.25
R6	R5	na	0	0	0.00	0.00	0.00	0.04	10	5.8	0.25	10	0.60%	1.70	3.11	54	867.11	866.79	872.70	5.59
R5	R4	na	0	0	0.00	0.00	0.00	0.06	10	5.8	0.34	10	0.60%	1.70	3.11	73	866.79	866.35	872.70	5.91
R4	R3	na	0	0	0.00	0.00	0.00	0.06	10	5.8	0.34	10	0.60%	1.70	3.11	20	866.35	866.23	871.70	5.35
R3	R2	na	0	0	0.00	0.00	0.00	0.09	10	5.8	0.52	10	0.60%	1.70	3.11	100	866.23	865.63	871.70	5.47
R2	R1	na	0	0	0.00	0.00	0.00	0.36	10	5.8	2.08	10	1.00%	2.19	4.01	26	865.63	865.37	871.40	5.77
R1	103	na	0	0	0.00	0.00	0.00	0.36	10	5.8	2.08	10	1.00%	2.19	4.01	14	865.37	865.23	871.10	5.73
103	101	48	7925	135	0.19	0.89	0.16	0.52	10	5.8	3.04	12	1.00%	3.56	4.53	112	865.12	864.00	869.93	4.81
102	101	24 x 36	10000	33	0.23	0.90	0.21	0.21	10	5.8	1.20	12	1.00%	3.56	4.53	136	866.86	865.50	870.33	3.47
101	fes	48	7372	1110	0.19	0.81	0.16	0.89	10	5.8	5.15	18	0.30%	5.75	3.25	27	862.28	862.20	869.43	7.15



PROJECT NAME: Kwik Trip 1782
PROJECT LOCATION: Ramsey, MN
CARLSON MCCAIN PROJECT NO.: 11224-00
DATE: 7/30/25
BY: DJW

POND DESIGN - POND 10 - INFILTRATION BASIN

COVER DESCRIPTION	CN	AREA	Product of CN & AREA
Impervious	98	0.982	96.24
Impervious - not to pond	98	0.073	7.15
Pervious - Grass	61	0.441	26.90
	Totals	1.496	130.29
Weighted CN	87		

REQUIRED POND TREATMENT VOLUME

Water Quality Volume (1" Runoff - Impervious Area) **0.088** acre-feet

ACTUAL POND TREATMENT VOLUME

		<u>Infiltration Volume</u>	
	Elevation	Area (ac.)	Volume (af)
	864	0.192	0.309
Invert	862.2	0.151	
		Total	0.309
			acre-feet



PROJECT NAME: Kwik Trip 1782
 PROJECT LOCATION: Ramsey, MN
 CARLSON MCCAIN PROJECT NO.: 11224-00
 DATE: 7/30/25
 BY: DJW

POND DESIGN - POND 20

COVER DESCRIPTION	CN	AREA	Product of CN & AREA
Impervious	98	0.777	76.15
Pervious	61	0.553	33.73
Water Surface	98	0.140	13.72
Totals		1.470	123.60

Weighted CN	84
2.5" Total Runoff	1.116

REQUIRED POND TREATMENT VOLUME

Permanent Pool Volume (2.5" Runoff - Total Area)	0.137	acre-feet
Water Quality Volume (1" Runoff - Impervious Area)	0.065	acre-feet

ACTUAL POND TREATMENT VOLUME

Permanent Pool Volume

	Elevation	Area (ac.)	Volume (af)	
NWL	863.5	0.140	0.107	
	862.5	0.074	0.035	
	862	0.067	0.105	
	860	0.038	0.055	
Invert	858	0.017		
Total			0.302	acre-feet

Live Storage Volume

	Elevation	Area (ac.)	Volume (af)	
Overflow	868	0.250	0.448	
	866	0.198	0.349	
	864	0.151	0.073	
NWL	863.5	0.140		
Total			0.869	acre-feet

Water Level at Water Quality Volume:	864	feet
Surface Area at Water Quality Volume:	0.151	acre
Allowable Discharge at Water Quality Volume (5.66 cfs/ac)	0.85	cfs
Actual Discharge at Water Quality Volume	0.35	cfs

Project Information

Calculator Version: Version 4: July 2020
Project Name: KT 1782 Ramsey
User Name / Company Name:
Date:
Project Description:
Construction Permit?: Yes

Site Information

Retention Requirement (inches): 1.1
Site's Zip Code: 55303
Annual Rainfall (inches): 30.2
Phosphorus EMC (mg/l): 0.19
TSS EMC (mg/l): 54.5

Total Site Area

Land Cover	A Soils (acres)	B Soils (acres)	C Soils (acres)	D Soils (acres)	Total (acres)
Forest/Open Space - Undisturbed, protected forest/open space or reforested land					0
Managed Turf - disturbed, graded for yards or other turf to be mowed/managed		3.454			3.454
			Impervious Area (acres)		0.02
			Total Area (acres)		3.474

Site Areas Routed to BMPs

Land Cover	A Soils (acres)	B Soils (acres)	C Soils (acres)	D Soils (acres)	Total (acres)
Forest/Open Space - Undisturbed, protected forest/open space or reforested land					0
Managed Turf - disturbed, graded for yards or other turf to be mowed/managed					0
			Impervious Area (acres)		
			Total Area (acres)		0

Summary Information

Performance Goal Requirement

Performance goal volume retention requirement: 80 ft³
Volume removed by BMPs towards performance goal: ft³
Percent volume removed towards performance goal %

Annual Volume and Pollutant Load Reductions

Post development annual runoff volume 1.6077 acre-ft
Annual runoff volume removed by BMPs: acre-ft
Percent annual runoff volume removed: %

Post development annual particulate P load: 0.457 lbs
Annual particulate P removed by BMPs: lbs
Post development annual dissolved P load: 0.374 lbs
Annual dissolved P removed by BMPs: 0 lbs
Total P removed by BMPs 0 lbs
Percent annual total phosphorus removed: %

Post development annual TSS load: 238.3 lbs
Annual TSS removed by BMPs: lbs
Percent annual TSS removed: %

BMP Summary

Performance Goal Summary

BMP Name	BMP Volume Capacity (ft ³)	Volume Recieved (ft ³)	Volume Retained (ft ³)	Volume Outflow (ft ³)	Percent Retained (%)

Annual Volume Summary

BMP Name	Volume From Direct Watershed (acre-ft)	Volume From Upstream BMPs (acre-ft)	Volume Retained (acre-ft)	Volume outflow (acre-ft)	Percent Retained (%)

Particulate Phosphorus Summary

BMP Name	Load From Direct Watershed (lbs)	Load From Upstream BMPs (lbs)	Load Retained (lbs)	Outflow Load (lbs)	Percent Retained (%)

Dissolved Phosphorus Summary

BMP Name	Load From Direct Watershed (lbs)	Load From Upstream BMPs (lbs)	Load Retained (lbs)	Outflow Load (lbs)	Percent Retained (%)
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Total Phosphorus Summary

BMP Name	Load From Direct Watershed (lbs)	Load From Upstream BMPs (lbs)	Load Retained (lbs)	Outflow Load (lbs)	Percent Retained (%)
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TSS Summary

BMP Name	Load From Direct Watershed (lbs)	Load From Upstream BMPs (lbs)	Load Retained (lbs)	Outflow Load (lbs)	Percent Retained (%)
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BMP Schematic

Project Information

Calculator Version: Version 4: July 2020
Project Name: KT 1782 Ramsey
User Name / Company Name:
Date:
Project Description:
Construction Permit?: Yes

Site Information

Retention Requirement (inches): 1.1
Site's Zip Code: 55303
Annual Rainfall (inches): 30.2
Phosphorus EMC (mg/l): 0.2
TSS EMC (mg/l): 54.5

Total Site Area

Land Cover	A Soils (acres)	B Soils (acres)	C Soils (acres)	D Soils (acres)	Total (acres)
Forest/Open Space - Undisturbed, protected forest/open space or reforested land					0
Managed Turf - disturbed, graded for yards or other turf to be mowed/managed		1.642			1.642
			Impervious Area (acres)		1.832
			Total Area (acres)		3.474

Site Areas Routed to BMPs

Land Cover	A Soils (acres)	B Soils (acres)	C Soils (acres)	D Soils (acres)	Total (acres)
Forest/Open Space - Undisturbed, protected forest/open space or reforested land					0
Managed Turf - disturbed, graded for yards or other turf to be mowed/managed		1.134			1.134
			Impervious Area (acres)		1.759
			Total Area (acres)		2.893

Summary Information

Performance Goal Requirement

Performance goal volume retention requirement:	7315	ft ³
Volume removed by BMPs towards performance goal:	3921	ft ³
Percent volume removed towards performance goal	54	%

Annual Volume and Pollutant Load Reductions

Post development annual runoff volume	4.6858	acre-ft
Annual runoff volume removed by BMPs:	2.3128	acre-ft
Percent annual runoff volume removed:	49	%

Post development annual particulate P load:	1.402	lbs
Annual particulate P removed by BMPs:	1.171	lbs
Post development annual dissolved P load:	1.147	lbs
Annual dissolved P removed by BMPs:	0.604	lbs
Total P removed by BMPs	1.775	lbs
Percent annual total phosphorus removed:	70	%

Post development annual TSS load:	694.6	lbs
Annual TSS removed by BMPs:	580.2	lbs
Percent annual TSS removed:	84	%

BMP Summary

Performance Goal Summary

BMP Name	BMP Volume Capacity (ft ³)	Volume Recieved (ft ³)	Volume Retained (ft ³)	Volume Outflow (ft ³)	Percent Retained (%)
10P - Infiltration basin/Infiltration trench (2	13441	3921	3921	0	100
20P - Constructed stormwater pond	0	3103	0	3103	0

Annual Volume Summary

BMP Name	Volume From Direct Watershed (acre-ft)	Volume From Upstream BMPs (acre-ft)	Volume Retained (acre-ft)	Volume outflow (acre-ft)	Percent Retained (%)
10P - Infiltration basin/Infiltration trench (2	2.3128	0	2.3128	0	100
20P - Constructed stormwater pond	1.9858	0	0	1.9858	0

Particulate Phosphorus Summary

BMP Name	Load From Direct Watershed (lbs)	Load From Upstream BMPs (lbs)	Load Retained (lbs)	Outflow Load (lbs)	Percent Retained (%)
10P - Infiltration basin/Infiltration trench (a)	0.692	0	0.692	0	100
20P - Constructed stormwater pond	0.5942	0	0.4792	0.115	81

Dissolved Phosphorus Summary

BMP Name	Load From Direct Watershed (lbs)	Load From Upstream BMPs (lbs)	Load Retained (lbs)	Outflow Load (lbs)	Percent Retained (%)
10P - Infiltration basin/Infiltration trench (a)	0.5662	0	0.5662	0	100
20P - Constructed stormwater pond	0.4861	0	0.0373	0.4488	8

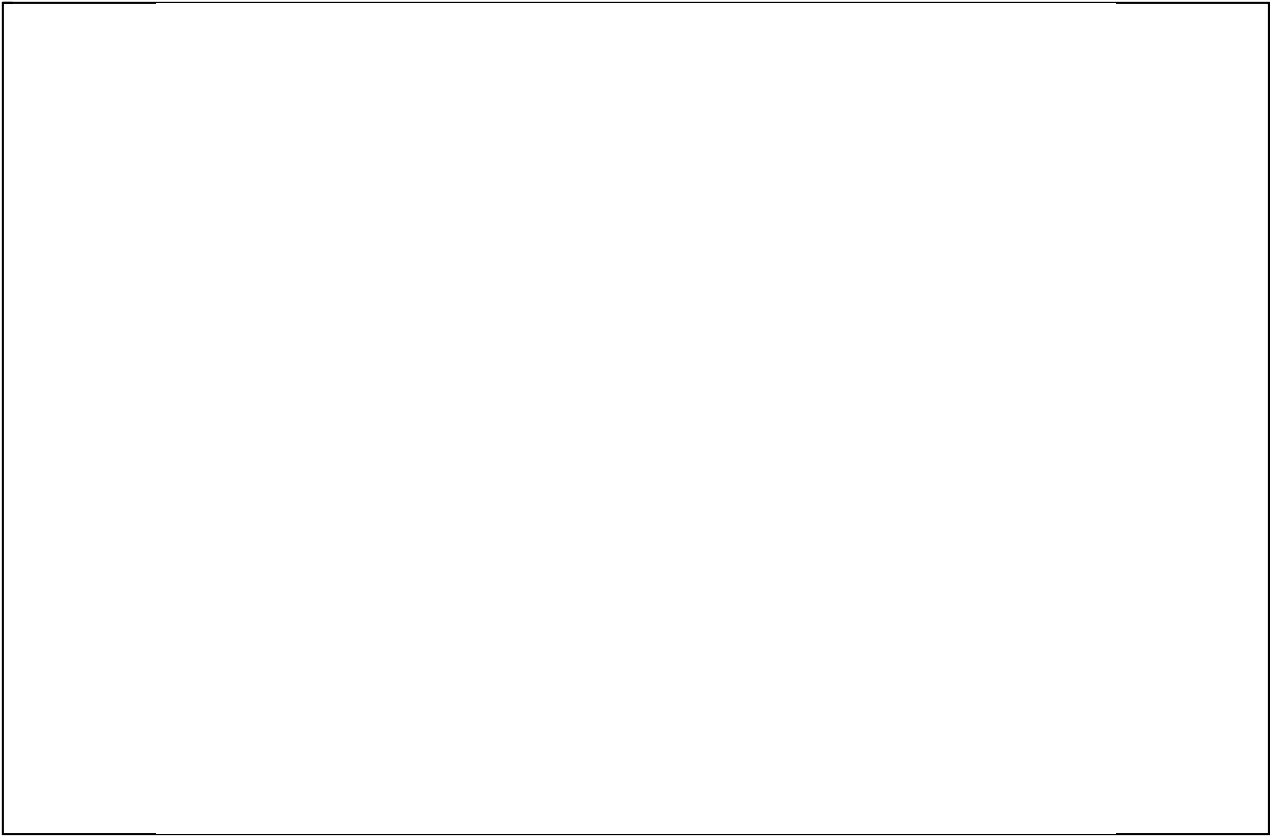
Total Phosphorus Summary

BMP Name	Load From Direct Watershed (lbs)	Load From Upstream BMPs (lbs)	Load Retained (lbs)	Outflow Load (lbs)	Percent Retained (%)
10P - Infiltration basin/Infiltration trench (a)	1.2582	0	1.2582	0	100
20P - Constructed stormwater pond	1.0803	0	0.5165	0.5638	44

TSS Summary

BMP Name	Load From Direct Watershed (lbs)	Load From Upstream BMPs (lbs)	Load Retained (lbs)	Outflow Load (lbs)	Percent Retained (%)
10P - Infiltration basin/Infiltration trench (a)	342.85	0	342.85	0	100
20P - Constructed stormwater pond	294.38	0	237.39	56.99	81

BMP Schematic



Project Information

Calculator Version: Version 4: July 2020
Project Name: KT 1782 Ramsey
User Name / Company Name:
Date:
Project Description:
Construction Permit?: Yes

Site Information

Retention Requirement (inches): 1.1
Site's Zip Code: 55303
Annual Rainfall (inches): 30.2
Phosphorus EMC (mg/l): 0.2
TSS EMC (mg/l): 54.5

Total Site Area

Land Cover	A Soils (acres)	B Soils (acres)	C Soils (acres)	D Soils (acres)	Total (acres)
Forest/Open Space - Undisturbed, protected forest/open space or reforested land					0
Managed Turf - disturbed, graded for yards or other turf to be mowed/managed		1.134			1.134
			Impervious Area (acres)		1.759
			Total Area (acres)		2.893

Site Areas Routed to BMPs

Land Cover	A Soils (acres)	B Soils (acres)	C Soils (acres)	D Soils (acres)	Total (acres)
Forest/Open Space - Undisturbed, protected forest/open space or reforested land					0
Managed Turf - disturbed, graded for yards or other turf to be mowed/managed		1.134			1.134
			Impervious Area (acres)		1.759
			Total Area (acres)		2.893

Summary Information

Performance Goal Requirement

Performance goal volume retention requirement:	7024	ft ³
Volume removed by BMPs towards performance goal:	3921	ft ³
Percent volume removed towards performance goal	56	%

Annual Volume and Pollutant Load Reductions

Post development annual runoff volume	4.2986	acre-ft
Annual runoff volume removed by BMPs:	2.3128	acre-ft
Percent annual runoff volume removed:	54	%

Post development annual particulate P load:	1.2862	lbs
Annual particulate P removed by BMPs:	1.156	lbs
Post development annual dissolved P load:	1.052	lbs
Annual dissolved P removed by BMPs:	0.602	lbs
Total P removed by BMPs	1.758	lbs
Percent annual total phosphorus removed:	75	%

Post development annual TSS load:	637.2	lbs
Annual TSS removed by BMPs:	572.8	lbs
Percent annual TSS removed:	90	%

BMP Summary

Performance Goal Summary

BMP Name	BMP Volume Capacity (ft ³)	Volume Recieved (ft ³)	Volume Retained (ft ³)	Volume Outflow (ft ³)	Percent Retained (%)
10P - Infiltration basin/Infiltration trench (2	13441	3921	3921	0	100
20P - Constructed stormwater pond	0	3103	0	3103	0

Annual Volume Summary

BMP Name	Volume From Direct Watershed (acre-ft)	Volume From Upstream BMPs (acre-ft)	Volume Retained (acre-ft)	Volume outflow (acre-ft)	Percent Retained (%)
10P - Infiltration basin/Infiltration trench (2	2.3128	0	2.3128	0	100
20P - Constructed stormwater pond	1.9858	0	0	1.9858	0

Particulate Phosphorus Summary

BMP Name	Load From Direct Watershed (lbs)	Load From Upstream BMPs (lbs)	Load Retained (lbs)	Outflow Load (lbs)	Percent Retained (%)
10P - Infiltration basin/Infiltration trench (a)	0.692	0	0.692	0	100
20P - Constructed stormwater pond	0.5942	0	0.4642	0.13	78

Dissolved Phosphorus Summary

BMP Name	Load From Direct Watershed (lbs)	Load From Upstream BMPs (lbs)	Load Retained (lbs)	Outflow Load (lbs)	Percent Retained (%)
10P - Infiltration basin/Infiltration trench (a)	0.5662	0	0.5662	0	100
20P - Constructed stormwater pond	0.4861	0	0.0362	0.4499	7

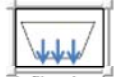
Total Phosphorus Summary

BMP Name	Load From Direct Watershed (lbs)	Load From Upstream BMPs (lbs)	Load Retained (lbs)	Outflow Load (lbs)	Percent Retained (%)
10P - Infiltration basin/Infiltration trench (a)	1.2582	0	1.2582	0	100
20P - Constructed stormwater pond	1.0803	0	0.5004	0.5799	42

TSS Summary

BMP Name	Load From Direct Watershed (lbs)	Load From Upstream BMPs (lbs)	Load Retained (lbs)	Outflow Load (lbs)	Percent Retained (%)
10P - Infiltration basin/Infiltration trench (a)	342.85	0	342.85	0	100
20P - Constructed stormwater pond	294.38	0	229.97	64.41	78

BMP Schematic



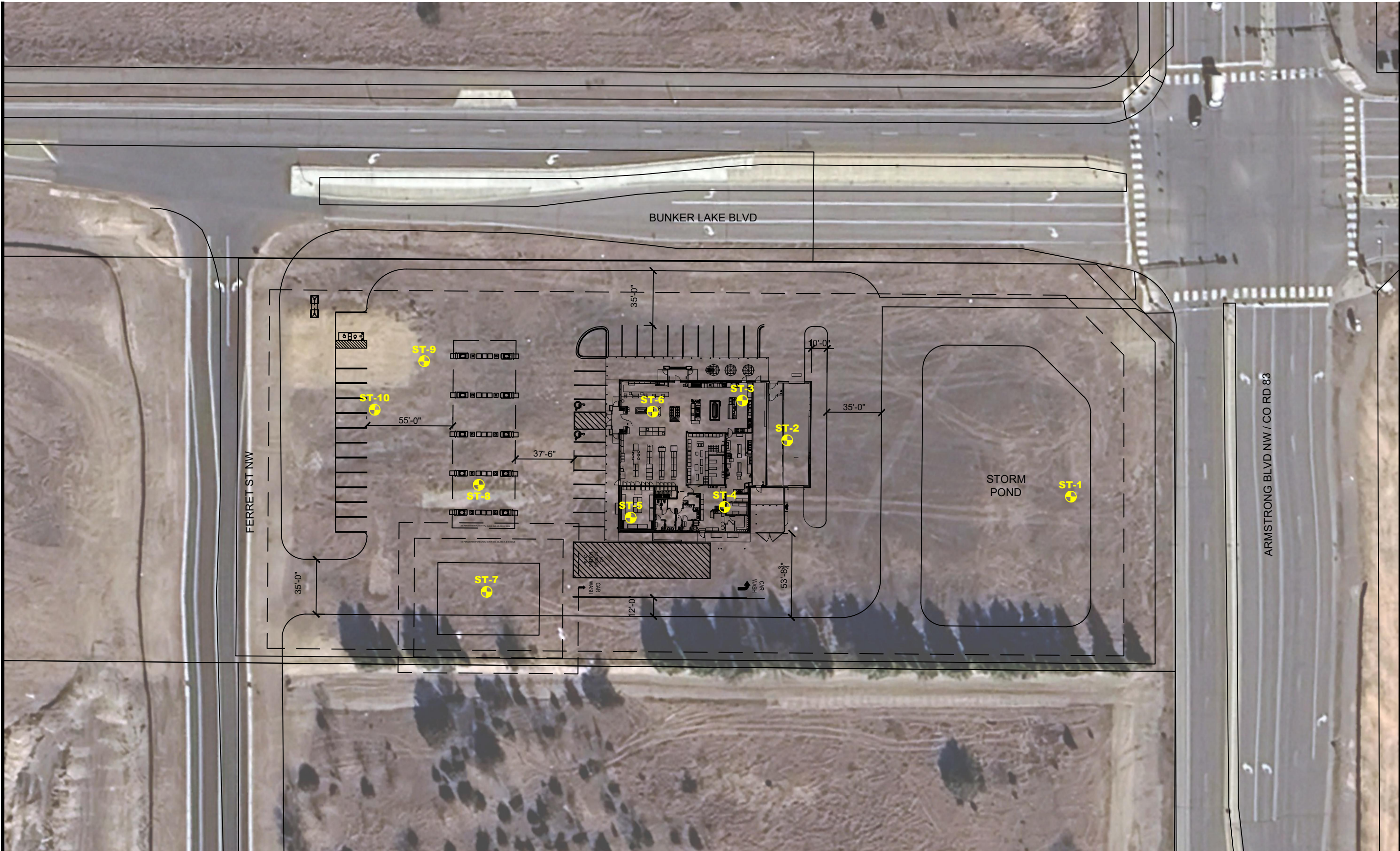
10P - Infiltration basin/
Infiltration trench



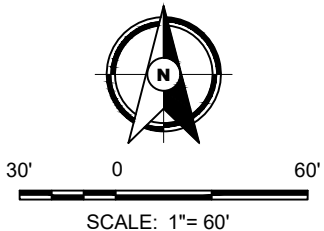
20P - Constructed
stormwater pond

APPENDIX D

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 DENOTES APPROXIMATE LOCATION OF STANDARD PENETRATION TEST BORING



Drawing Information

Project No:
B2408814

Drawing No:
B2408814

Drawn By: JAG
Date Drawn: 9/25/24
Checked By: NMR
Last Modified: 10/10/24

Project Information

Proposed Kwik Trip
#1782

14816 Armstrong
Boulevard NW

Ramsey, Minnesota

**Soil Boring
Location Sketch**

Project Number B2408814 Geotechnical & Environmental Evaluation Proposed Kwik Trip #1782 14816 Armstrong Boulevard Northwest Ramsey, Minnesota					BORING: ST-1					
					LOCATION: Captured with RTK GPS.					
					DATUM: NAD 1983 HARN Adj MN Anoka (US Feet)					
					NORTHING: 174522.1		EASTING: 447396.9			
DRILLER: B. Kammermeier		LOGGED BY: C. Kehl		START DATE: 10/03/24	END DATE: 10/03/24					
SURFACE ELEVATION: 868.0 ft		RIG: 7506	METHOD: 3 1/4" HSA	SURFACING: Grass		WEATHER: 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		
866.8	Water Level ▼ ⚡		SILTY SAND (SM), fine-grained, trace roots, dark brown, moist (TOPSOIL FILL)		9-9-10-13 (19)	0.4	7	Soil sample ST-1 (2'-4') @ 13:40 collected for analytical testing		
1.2			FILL: POORLY GRADED SAND with SILT (SP-SM), fine to coarse-grained, brown, moist		3-3-5-4 (8)	0.2				
866.0			FILL: SILTY SAND (SM), fine-grained, dark brown, moist		3-4-3-4 (7)	0.5				
2.0			POORLY GRADED SAND (SP), fine to coarse-grained, with Gravel, tan to gray, moist to wet, loose to medium dense (ALLUVIUM)	5	4-5-5-5 (10)	0.3				
864.0					5-5-6-6 (11)	0.2		P200=4%		
4.0					5-4-4-3 (8)	0.4				
					3-3-3-4 (6)	0.4				
					2-2-3-3 (5)	0.2				
					3-3-4-5 (7)	0.2				
					4-5-6-7 (11)	0.1				
									Water observed at 10.0 feet while drilling.	
848.0				END OF BORING	20					Water observed at 9.0 feet immediately after withdrawal of auger.
20.0				Boring then grouted						
						Groundwater sampled at 14:05 for analytical testing				

Project Number B2408814 Geotechnical & Environmental Evaluation Proposed Kwik Trip #1782 14816 Armstrong Boulevard Northwest Ramsey, Minnesota					BORING: ST-2		
					LOCATION: Captured with RTK GPS.		
					DATUM: NAD 1983 HARN Adj MN Anoka (US Feet)		
					NORTHING: 174558.2	EASTING: 447215.6	
DRILLER: B. Kammermeier	LOGGED BY: C. Kehl		START DATE: 10/03/24	END DATE: 10/03/24			
SURFACE ELEVATION: 867.5 ft	RIG: 7506	METHOD: 3 1/4" HSA	SURFACING: Grass	WEATHER: 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
866.6		SILTY SAND (SM), fine-grained, trace roots, black, dry (TOPSOIL FILL)					
0.9		FILL: POORLY GRADED SAND with SILT (SP- SM), fine-grained, brown, moist		4-5-5 (10) 12"	1.5	5	P200=5%
863.5		FILL: POORLY GRADED SAND with SILT (SP- SM), fine to medium-grained, tan and black, moist	5	2-3-4 (7) 16"	1.7	15	OC=1%
4.0							
861.0		POORLY GRADED SAND with SILT (SP-SM), fine to medium-grained, brown, moist to wet, loose (ALLUVIUM)		4-5-5 (10) 16"	1.8		Soil sample ST-2 (4.5-6') @ 15:13 collected for analytical testing
6.5							
			10	3-3-3 (6) 14"	1.4		Temporary well installed with screen set from 5 to 10 feet
				2-3-4 (7) 12"	0.1		
853.5		POORLY GRADED SAND (SP), fine-grained, gray, wet, loose (ALLUVIUM)	15	1-3-3 (6) 14"	0.8		
14.0							
846.5		With Gravel at 20 feet	20	1-2-3 (5) 18"	0.5		
21.0		END OF BORING					Water observed at 9.0 feet while drilling.
		Boring then grouted					Water observed at 9.0 feet immediately after withdrawal of auger.
			25				Groundwater sampled @ 14:55 collected for analytical testing
			30				

See Descriptive Terminology sheet for explanation of abbreviations

Project Number B2408814 Geotechnical & Environmental Evaluation Proposed Kwik Trip #1782 14816 Armstrong Boulevard Northwest Ramsey, Minnesota					BORING: ST-3		
					LOCATION: Captured with RTK GPS.		
					DATUM: NAD 1983 HARN Adj MN Anoka (US Feet)		
					NORTHING: 174583.5	EASTING: 447186.9	
DRILLER: B. Kammermeier	LOGGED BY: C. Kehl		START DATE: 10/04/24	END DATE: 10/04/24			
SURFACE ELEVATION: 867.4 ft	RIG: 7506	METHOD: 3 1/4" HSA	SURFACING: Grass	WEATHER: 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
866.3		SILTY SAND (SM), fine-grained, trace roots, dark brown, dry (TOPSOIL FILL)					
1.1		FILL: POORLY GRADED SAND with SILT (SP-SM), fine to medium-grained, brown, moist		3-3-4 (7) 14"	0.3		Soil sample ST-3 (2-3.5') @ 9:10 collected for analytical testing
863.4		POORLY GRADED SAND (SP), fine to medium-grained, tan, moist to wet, loose (ALLUVIUM)	5	3-3-3 (6) 14"	0.5	12	P200=4%
4.0		POORLY GRADED SAND with SILT (SP-SM), fine to medium-grained, tan, moist to wet, loose (ALLUVIUM)		4-4-3 (7) 16"	0.3	25	P200=5%
860.9		POORLY GRADED SAND (SP), fine-grained, tan, wet, medium dense to loose (ALLUVIUM)	10	4-4-7 (11) 16"	0.5		Temporary well installed with screen set from 5 to 10 feet
6.5				4-4-5 (9) 18"	0.4		
858.4		POORLY GRADED SAND (SP), fine to medium-grained, Gravelly, gray, wet, medium dense to very loose (ALLUVIUM)	15	7-9-8 (17) 18"	0.3		
9.0				2-2-2 (4) 18"	0.5		
853.4		END OF BORING					Water observed at 7.5 feet while drilling.
14.0		Boring then grouted					Water observed at 8.5 feet immediately after withdrawal of auger.
846.4			25				Groundwater sampled @ 9:00 collected for analytical testing
21.0			30				

Project Number B2408814 Geotechnical & Environmental Evaluation Proposed Kwik Trip #1782 14816 Armstrong Boulevard Northwest Ramsey, Minnesota					BORING: ST-4		
					LOCATION: Captured with RTK GPS.		
					DATUM: NAD 1983 HARN Adj MN Anoka (US Feet)		
					NORTHING: 174515.5	EASTING: 447175.6	
DRILLER: B. Kammermeier	LOGGED BY: C. Kehl		START DATE: 10/04/24	END DATE: 10/04/24			
SURFACE ELEVATION: 867.4 ft	RIG: 7506	METHOD: 3 1/4" HSA	SURFACING: Grass	WEATHER: 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
866.5 0.9		SILTY SAND (SM), fine-grained, trace roots, dark brown, dry (TOPSOIL FILL)		4-7-5 (12) 16"	1.8		Soil sample ST-4 (2-3.5') @ 11:30 collected for analytical testing
		FILL: POORLY GRADED SAND with SILT (SP-SM), fine-grained, brown, moist		4-3-4 (7) 14"	2.3		
861.9 5.5		POORLY GRADED SAND (SP), fine to medium-grained, light brown to gray, moist to wet, loose (ALLUVIUM)	5	4-4-5 (9) 16"	9.5	21	Temporary well installed with screen set from 5 to 10 feet P200=3%
				4-3-5 (8) 16"	3.4		
				3-4-6 (10) 16"	2.4		
			15	4-2-5 (7) 16"	4.2		
			20	2-2-3 (5) 18"	0.7		
846.4 21.0		END OF BORING					Water observed at 9.0 feet while drilling. Water observed at 9.0 feet immediately after withdrawal of auger. Groundwater sampled @ 11:15 collected for analytical testing
		Boring then grouted					
			25				
			30				

B2408814 Braun Intertec Corporation Print Date:10/22/2024 ST-5 page 1 of 1

Project Number B2408814 Geotechnical & Environmental Evaluation Proposed Kwik Trip #1782 14816 Armstrong Boulevard Northwest Ramsey, Minnesota					BORING: ST-6					
					LOCATION: Captured with RTK GPS.					
					DATUM: NAD 1983 HARN Adj MN Anoka (US Feet)					
					NORTHING: 174576.4		EASTING: 447129.6			
DRILLER: B. Kammermeier		LOGGED BY: C. Kehl		START DATE: 10/04/24		END DATE: 10/04/24				
SURFACE ELEVATION: 867.4 ft		RIG: 7506	METHOD: 3 1/4" HSA		SURFACING: Grass		WEATHER: 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	
866.4		SILTY SAND (SM), fine-grained, trace roots, dark brown, dry (TOPSOIL)								Soil sample ST-6 (2-3.5') @ 10:00 collected for analytical testing
1.0		POORLY GRADED SAND with SILT (SP-SM), fine to medium-grained, light brown, moist, medium dense to loose (ALLUVIUM)				4-5-6 (11) 14"	0.6			
					5	3-4-4 (8) 14"	0.4		Temporary well installed with screen set from 5 to 10 feet	
860.9		POORLY GRADED SAND (SP), fine to coarse-grained, little Gravel, brown, moist to wet, loose (ALLUVIUM)				4-5-4 (9) 16"	0.7			
6.5					10	3-3-3 (6) 16"	1.3	23	P200=1%	
855.9		POORLY GRADED SAND (SP), fine to medium-grained, gray, wet, loose (ALLUVIUM)				2-3-3 (6) 16"	0.9			
11.5					15	3-3-5 (8) 16"	0.6			
849.4		POORLY GRADED SAND (SP), fine to coarse-grained, with Gravel, gray, wet, loose (ALLUVIUM)			20	3-4-4 (8) 18"	0.9		Water observed at 8.0 feet while drilling.	
18.0										
846.4									Water observed at 9.0 feet immediately after withdrawal of auger.	
21.0										
	END OF BORING							Groundwater sampled @ 9:45 collected for analytical testing		
	Boring then grouted									
				25						

Project Number B2408814 Geotechnical & Environmental Evaluation Proposed Kwik Trip #1782 14816 Armstrong Boulevard Northwest Ramsey, Minnesota					BORING: ST-7		
					LOCATION: Captured with RTK GPS.		
					DATUM: NAD 1983 HARN Adj MN Anoka (US Feet)		
					NORTHING: 174461.2	EASTING: 447023.5	
DRILLER: B. Kammermeier	LOGGED BY: C. Kehl		START DATE: 10/03/24	END DATE: 10/03/24			
SURFACE ELEVATION: 867.8 ft	RIG: 7506	METHOD: 3 1/4" HSA	SURFACING: Grass	WEATHER: 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	
867.0 0.8		SILTY SAND (SM), fine-grained, trace roots, black, moist (TOPSOIL)					Soil sample ST-7 (2-3.5') @ 12:40 collected for analytical testing	
		POORLY GRADED SAND with SILT (SP-SM), fine to medium-grained, orangish brown, moist, medium dense (ALLUVIUM)	5	4-5-7 (12) 16"	1.0			
863.8 4.0		POORLY GRADED SAND with SILT (SP-SM), fine to coarse-grained, brown, moist, loose (ALLUVIUM)	5	4-4-5 (9) 16"	0.8			
861.3 6.5			POORLY GRADED SAND (SP), fine to coarse-grained, with Gravel, gray, moist to wet, loose to medium dense (ALLUVIUM)		3-4-4 (8) 14"	1.1		Temporary well installed with screen set from 5 to 10 feet
				10	3-4-4 (8) 16"	2.0		
					3-5-6 (11) 18"	1.2		
				15	4-3-6 (9) 18"	1.0	18	
							P200=1%	
846.8 21.0		END OF BORING	20	3-3-4 (7) 14"	0.8		Water observed at 9.0 feet while drilling.	
		Boring then grouted					Water observed at 9.0 feet immediately after withdrawal of auger.	
			25				Groundwater sampled @ 13:00 collected for analytical testing	
			30					

See Descriptive Terminology sheet for explanation of abbreviations

Project Number B2408814 Geotechnical & Environmental Evaluation Proposed Kwik Trip #1782 14816 Armstrong Boulevard Northwest Ramsey, Minnesota					BORING: ST-8		
					LOCATION: Captured with RTK GPS.		
					DATUM: NAD 1983 HARN Adj MN Anoka (US Feet)		
					NORTHING: 174529.7	EASTING: 447018.5	
DRILLER: B. Kammermeier	LOGGED BY: C. Kehl		START DATE: 10/03/24	END DATE: 10/03/24			
SURFACE ELEVATION: 867.8 ft	RIG: 7506	METHOD: 3 1/4" HSA	SURFACING: Grass	WEATHER: Sunny			

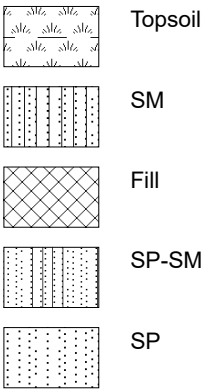
Elev./ Depth ft	Water Level	Description of Materials (Soil-ASTM D2488 or 2487; Rock-USACE EM 1110-1-2908)	Sample	Blows (N-Value) Recovery	PID ppm	MC %	Tests or Remarks
866.9 0.9		SILTY SAND (SM), fine to medium-grained, with Gravel, trace roots, dark brown, dry (TOPSOIL FILL)		4-5-7 (12) 16"	0.1		Soil sample ST-8 (2-3.5') @ 11:40 collected for analytical testing
863.8 4.0		FILL: POORLY GRADED SAND with SILT (SP-SM), fine to medium-grained, brown, moist		7-4-5 (9) 16"	0.1	5	
861.3 6.5		POORLY GRADED SAND with SILT (SP-SM), fine to medium-grained, light brown, moist, loose (ALLUVIUM)	5	4-3-3 (6) 14"	0.1		
		POORLY GRADED SAND (SP), fine to coarse-grained, with Gravel, brown, moist to wet, loose to medium dense (ALLUVIUM)	10	6-6-5 (11) 14"	0.1	20	P200=3%
			15	5-6-7 (13) 16"	1.5		Temporary well installed with screen set from 5 to 10 feet
			15	5-6-7 (13) 16"	1.4		
846.8 21.0		END OF BORING	20	3-5-5 (10) 18"	1.0		Water observed at 9.0 feet while drilling.
		Boring then grouted	25				Water observed at 9.0 feet immediately after withdrawal of auger.
			30				Groundwater sampled @ 12:00 collected for analytical testing

Project Number B2408814 Geotechnical & Environmental Evaluation Proposed Kwik Trip #1782 14816 Armstrong Boulevard Northwest Ramsey, Minnesota					BORING: ST-9	
					LOCATION: Captured with RTK GPS.	
					DATUM: NAD 1983 HARN Adj MN Anoka (US Feet)	
					NORTHING: 174608.7	EASTING: 446983.6
DRILLER: B. Kammermeier	LOGGED BY: C. Kehl		START DATE: 10/03/24	END DATE: 10/03/24		
SURFACE ELEVATION: 868.1 ft	RIG: 7506	METHOD: 3 1/4" HSA	SURFACING: Grass	WEATHER: Sunny		

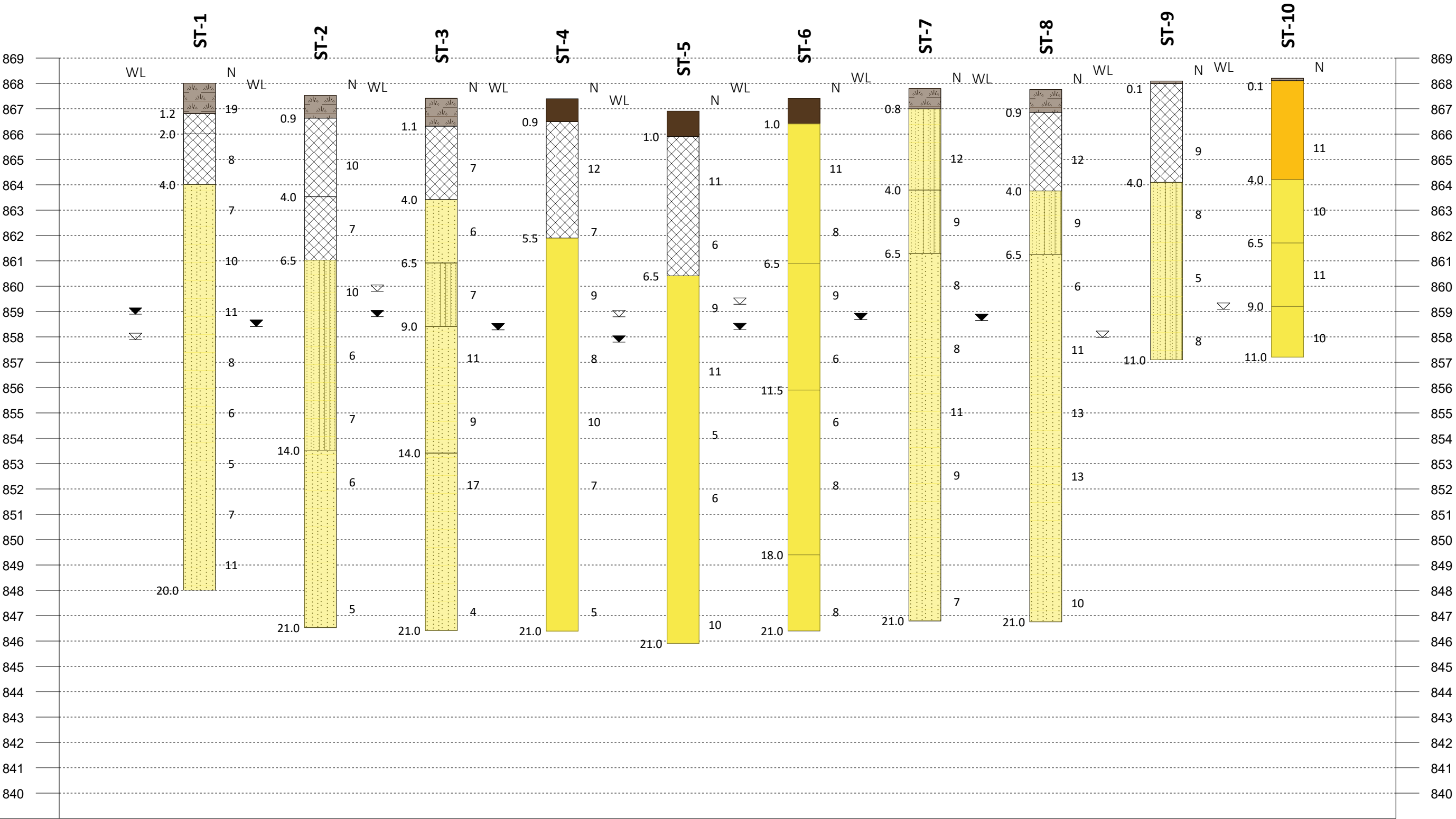
Elev./Depth ft	Water Level	Description of Materials (Soil-ASTM D2488 or 2487; Rock-USACE EM 1110-1-2908)	Sample	Blows (N-Value) Recovery	PID ppm	MC %	Tests or Remarks
868.0 0.1		SILTY SAND (SM), fine to medium-grained, trace roots, brown, moist (TOPSOIL FILL) FILL: POORLY GRADED SAND with SILT (SP-SM), fine to medium-grained, brown and dark brown, moist	X	2-3-6 (9) 14"	0.2	7	Soil sample ST-9 (2-3.5') @ 10:52 collected for analytical testing P200=8%
864.1 4.0			X	5-4-4 (8) 16"	0.1	Temporary well installed with screen set from 5 to 10 feet	
			X	3-2-3 (5) 16"	1.1		
857.1 11.0			X	4-4-4 (8) 18"	0.8		
		END OF BORING Boring then backfilled with auger cuttings					Water observed at 10.0 feet while drilling. Groundwater sampled @ 10:44 collected for analytical testing

Project Number B2408814 Geotechnical & Environmental Evaluation Proposed Kwik Trip #1782 14816 Armstrong Boulevard Northwest Ramsey, Minnesota					BORING: ST-10		
					LOCATION: Captured with RTK GPS.		
					DATUM: NAD 1983 HARN Adj MN Anoka (US Feet)		
					NORTHING: 174577.6	EASTING: 446952.0	
DRILLER: B. Kammermeier		LOGGED BY: C. Kehl		START DATE: 10/03/24		END DATE: 10/03/24	
SURFACE ELEVATION: 868.2 ft		RIG: 7506		METHOD: 3 1/4" HSA		SURFACING: Grass WEATHER: 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
868.1 0.1		SILTY SAND (SM), fine to medium-grained, trace roots, brown, dry (TOPSOIL FILL) SILTY SAND (SM), fine-grained, dark brown, moist, medium dense (ALLUVIUM)		4-5-6 (11) 18"	0.6	6	Soil sample ST-10 (2-3.5') @ 11:37 collected for analytical testing P200=12%
864.2 4.0		POORLY GRADED SAND with SILT (SP-SM), fine to medium-grained, brown, moist, loose (ALLUVIUM)		4-5-5 (10) 18"	1.7		Temporary well installed with screen set from 5 to 10 feet
861.7 6.5		POORLY GRADED SAND (SP), fine to coarse-grained, with Gravel, light brown, moist, medium dense (ALLUVIUM)		4-5-6 (11) 14"	1.3		
859.2 9.0		POORLY GRADED SAND (SP), fine-grained, gray, wet, loose (ALLUVIUM)		4-5-5 (10) 16"	1.0		
857.2 11.0		END OF BORING Boring then backfilled with auger cuttings					
			15				
			20				
			25				
			30				

Legend Key



839.00

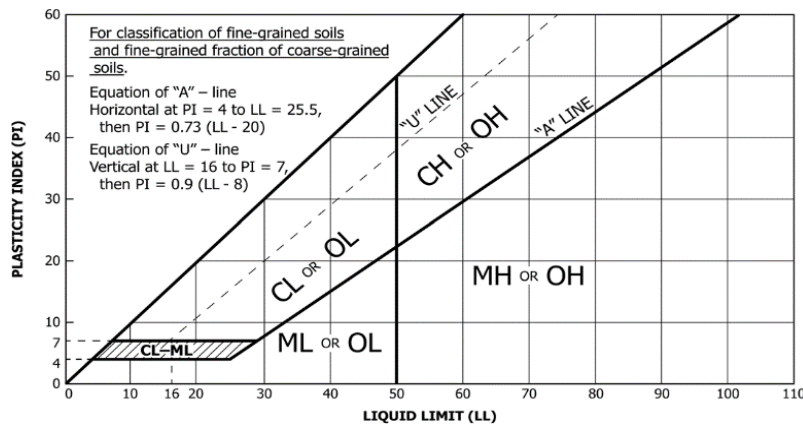


Project ID: B2408814
Vert. Scale: 1"= 4'
Hor. Scale: NTS
Date: 10/22/2024

Fence Diagram
Geotechnical & Environmental Evaluation
Proposed Kwik Trip #1782
14816 Armstrong Boulevard Northwest
Ramsey, Minnesota

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests ^A				Group Symbol	Soil Classification
					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 ^{EFG}
			Fines Classify as CL or CH	GC	Clayey gravel ^{EFG}
	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 ^{FGI}
			Fines classify as CL or CH	SC	Clayey sand ^{FGI}
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 ^{KLM}
			PI < 4 or plots below "A" line ^J	ML	Silt ^{KLM}
		Organic	Liquid Limit – oven dried Liquid Limit – not dried <0.75	OL	Organic clay ^{KLMN} Organic silt ^{KLMQ}
			PI plots on or above "A" line	CH	Fat clay ^{KLM}
	Silts and Clays (Liquid limit 50 or more)	Inorganic	PI plots below "A" line	MH	Elastic silt ^{KLM}
			Liquid Limit – oven dried Liquid Limit – not dried <0.75	OH	Organic clay ^{KLMP} Organic silt ^{KLMQ}
		Organic	Liquid Limit – oven dried Liquid Limit – not dried <0.75	OH	Organic clay ^{KLMP} Organic silt ^{KLMQ}
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 $\geq 15\%$ 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 $\geq 15\%$ 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 $\geq 30\%$ plus No. 200, predominantly sand, add "sandy" to group name.
M. If soil contains $\geq 30\%$ 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.



DD Dry density, pcf
WD Wet density, pcf
P200 % Passing #200 sieve
MC Moisture content, %
OC Organic content, %

Laboratory Tests

q_p Pocket penetrometer strength, tsf
q_u Unconfined compression test, tsf
LL Liquid limit
PL Plastic limit
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..... $\geq 15\%$

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

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

2309 Palace Street
La Crosse, WI 54603
Phone: 608-781-7277

Client:
Kwik Trip, Incorporated
1626 Oak Street
Lacrosse, WI 54603

Project:
B2408814
Proposed Kwik Trip #1782
14816 Armstrong Blvd NW
Ramsey, MN 55303

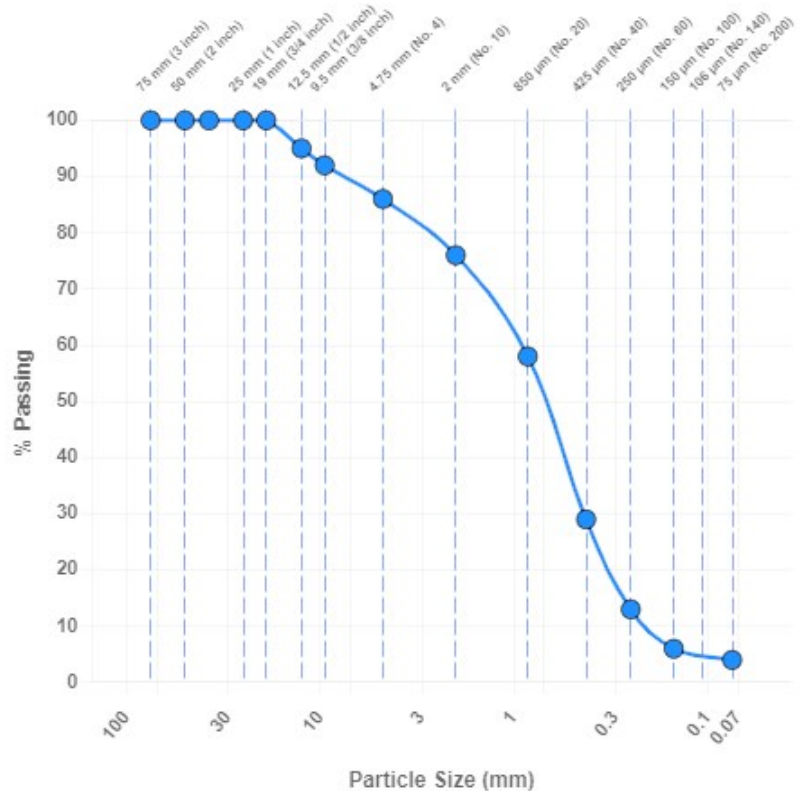
Sample Information

Sample Number: 624917 **Depth (ft):** 9
Sampling Method: Penetration Boring ASTM D1586 **Sampled By:** Drill Crew
Boring Number: ST-1
Location: In-place
Sample Date: 10/03/2024
Received Date: 10/04/2024 **Lab:** 11001 Hampshire Ave S, Bloomington, MN
Tested Date: 10/14/2024 **Tested By:** Streier, Jim

Laboratory Data

Sieve Size	Passing (%)	Specification
19 mm (3/4 inch)	100	
12.5 mm (1/2 inch)	95	
9.5 mm (3/8 inch)	92	
4.75 mm (No. 4)	86	
2 mm (No. 10)	76	
850 µm (No. 20)	58	
425 µm (No. 40)	29	
250 µm (No. 60)	13	
150 µm (No. 100)	6	
75 µm (No. 200)	4	

Gravel (%) 14.0	Sand (%) 82.0	Silt & Clay (%) 4.0
D10 0.207	D30 0.440	D60 0.978
C_u 4.72	C_c 0.96	



Classification: SP Poorly graded sand

General

Results: The test is for informational purposes.

2309 Palace Street
La Crosse, WI 54603
Phone: 608-781-7277

Client:
Kwik Trip, Incorporated
1626 Oak Street
Lacrosse, WI 54603

Project:
B2408814
Proposed Kwik Trip #1782
14816 Armstrong Blvd NW
Ramsey, MN 55303

Sample Information

Sample Number: 624919 **Depth (ft):** 7.5
Sampling Method: Penetration Boring ASTM D1586 **Sampled By:** Drill Crew
Boring Number: ST-3
Location: In-place
Sample Date: 10/03/2024
Received Date: 10/04/2024 **Lab:** 11001 Hampshire Ave S, Bloomington, MN
Tested Date: 10/14/2024 **Tested By:** Streier, Jim

Laboratory Data

Sieve Size	Passing (%)	Specification
9.5 mm (3/8 inch)	100	
4.75 mm (No. 4)	99	
2 mm (No. 10)	96	
850 µm (No. 20)	89	
425 µm (No. 40)	58	
250 µm (No. 60)	24	
150 µm (No. 100)	7	
75 µm (No. 200)	5	

Gravel (%)

1.0

D10

0.168

C_U

2.69

Sand (%)

94.0

D30

0.281

C_C

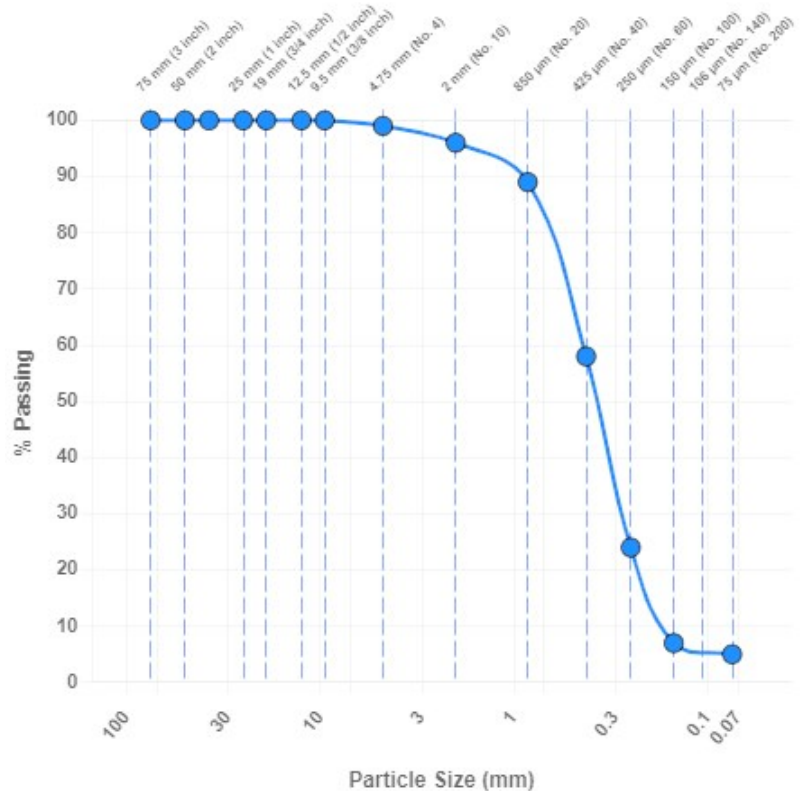
1.04

Silt & Clay (%)

5.0

D60

0.452



Classification: SP-SM Poorly graded sand with silt

General

Results: The test is for informational purposes.

2309 Palace Street
La Crosse, WI 54603
Phone: 608-781-7277

Client:
Kwik Trip, Incorporated
1626 Oak Street
Lacrosse, WI 54603

Project:
B2408814
Proposed Kwik Trip #1782
14816 Armstrong Blvd NW
Ramsey, MN 55303

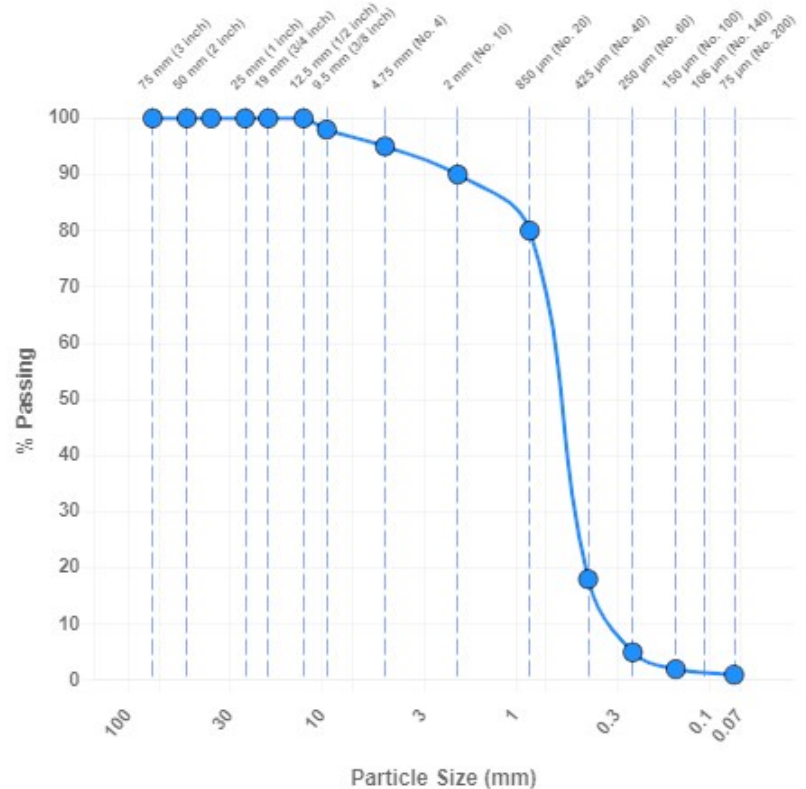
Sample Information

Sample Number: 624920 **Depth (ft):** 15
Sampling Method: Penetration Boring ASTM D1586 **Sampled By:** Drill Crew
Boring Number: ST-7
Location: In-place
Sample Date: 10/03/2024
Received Date: 10/04/2024 **Lab:** 11001 Hampshire Ave S, Bloomington, MN
Tested Date: 10/14/2024 **Tested By:** Streier, Jim

Laboratory Data

Sieve Size	Passing (%)	Specification
12.5 mm (1/2 inch)	100	
9.5 mm (3/8 inch)	98	
4.75 mm (No. 4)	95	
2 mm (No. 10)	90	
850 µm (No. 20)	80	
425 µm (No. 40)	18	
250 µm (No. 60)	5	
150 µm (No. 100)	2	
75 µm (No. 200)	1	

Gravel (%) 5.0	Sand (%) 94.0	Silt & Clay (%) 1.0
D10 0.317	D30 0.507	D60 0.713
C_u 2.25	C_c 1.14	



Classification: SP Poorly graded sand

General

Results: The test is for informational purposes.

2309 Palace Street
La Crosse, WI 54603
Phone: 608-781-7277

Client:
Kwik Trip, Incorporated
1626 Oak Street
Lacrosse, WI 54603

Project:
B2408814
Proposed Kwik Trip #1782
14816 Armstrong Blvd NW
Ramsey, MN 55303

Sample Information

Sample Number: 624921 **Depth (ft):** 10
Sampling Method: Penetration Boring ASTM D1586 **Sampled By:** Drill Crew
Boring Number: ST-8
Location: In-place
Sample Date: 10/03/2024
Received Date: 10/04/2024 **Lab:** 11001 Hampshire Ave S, Bloomington, MN
Tested Date: 10/14/2024 **Tested By:** Streier, Jim

Laboratory Data

Sieve Size	Passing (%)	Specification
9.5 mm (3/8 inch)	100	
4.75 mm (No. 4)	99	
2 mm (No. 10)	96	
850 µm (No. 20)	80	
425 µm (No. 40)	47	
250 µm (No. 60)	21	
150 µm (No. 100)	6	
75 µm (No. 200)	3	

Gravel (%)

1.0

Sand (%)

96.0

Silt & Clay (%)

3.0

D10

0.177

D30

0.311

D60

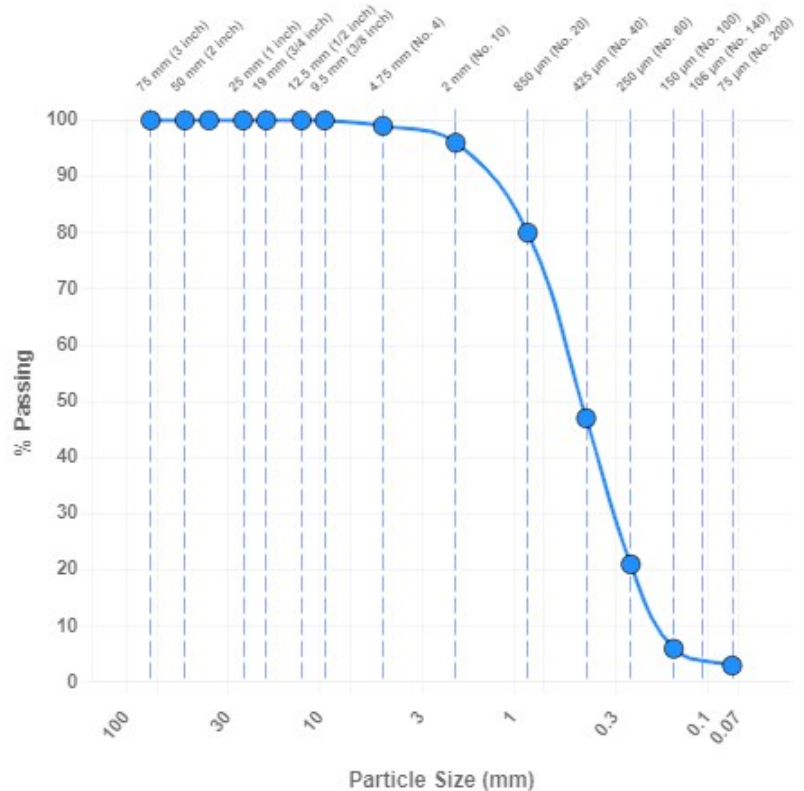
0.592

C_U

3.34

C_C

0.92



Classification: SP Poorly graded sand

General

Results: The test is for informational purposes.