INTRODUCTION:
This Report is for the redevelopment of the Easterly storm pond at the Crest View Estates 1st Addition. The purpose of this drainage report is to identify drainage impacts resulting from the proposed Crest View Estates Short Plat. This drainage report will describe the drainage infrastructure improvements that are necessary to control and treat the stormwater runoff from the project site. The results reported will demonstrate there is no negative impact to the adjacent properties with the proposed redevelopment. The proposed project lies within the City of Spokane and will be designed in accordance with the Spokane Regional Stormwater Manual (SRSMM), and treatment methods will be based on equation 6-1d; \( V=1815A \), as outlined in the SRSMM, and updated soil, and swale amendments per the 2019 Eastern Washington Stormwater Management Manual (EWSMM).

The proposed project is a 2-lot short replat development on an approximately 0.56 +/- acre site located off Tieton Avenue & Ash Street. The site is currently mostly developed with an existing grassed storm swale. The site is located within the City of Spokane and lies in the SE 1/4 of Section 24, T 26 N., R 42 E., W.M.

The proposed 2-lot short replat receives stormwater for the existing Crestview 1st additional subdivision. The proposal will attenuate redirect and consolidate the stormwater from the existing subdivision.

Table 1 - Site Summary

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Description</th>
<th>Volume @ 0.5 ft of depth</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Required treatment volume</td>
<td>3,101 cf <em>Generated by this Project</em></td>
</tr>
<tr>
<td>B</td>
<td>Provided treatment volume</td>
<td>5,408 cf <em>Provided by this Project</em></td>
</tr>
<tr>
<td>C</td>
<td>Extra area if Any (A – B)</td>
<td>2,307 sf/ cf <em>Excess</em></td>
</tr>
</tbody>
</table>
NARRATIVE:

Project Description:
- Parcel # 26241.0410 & 26241.0310
- Property address: 8903 N ASH ST & 8904 N ASH ST
- NE 1/4 of Section 24, T 26 N., R 42 E., W.M.
- Lot size: 24,393 sf or 0.56± ac
- Bio-infiltration swales proposed with 12” treatment depth, & 2.5-foot gravel gallery beneath pond
- See Geotech information below for surface soils
- Existing site is vegetated with, field grass, and weeds.

Geotechnical Information:

4.2 Drainage and Stormwater Infiltration Recommendations

Drainage retention swales may be utilized to treat and retain stormwater. The following recommendations should be used by the civil engineer to retention swales:

- The depth to a restrictive layer is at least three feet below the ground surface based on the shallow bedrock encountered at the site during the exploration.
- Swales should be located 10-feet from the edge of buildings and concrete hardscapes to minimize the effects of retention.
Attention: Bob Frisch

PROJECT: CRESTVIEW ESTATES
Stormwater Facilities
Spokane, WA

SUBJECT: Limited Subsurface Evaluation
For Stormwater Management

In accordance with your request, we have conducted subsurface exploration and testing at specific locations along the Maple Street alignment of the proposed Crestview Estates development to provide recommendations for stormwater handling. The site is located on Five Mile Prairie in the City of Spokane.

Our evaluation has consisted of site reconnaissance, geotechnical drilling, logging (borings and backhoe pits), geophysical testing, sampling, percolation testing, and laboratory testing. Four (4) borings were advanced near the intersections of proposed roads on August 3, 1995, and 2 backhoe pits were logged on September 8, 1995. Boring and test pit logs are provided as Figures 6.2. Infiltrometer test results are provided as Figure 6.2.5. Results of gradation analysis are presented as Figure 7.1.3, with the results summarized in Table 7.0. Two (2) shallow seismic refraction surveys were conducted to evaluate the soundness of rock. Results are presented as Figures 6.7.

(509) 535-8841

F.C. Budinger PE
Stephen D. Burchell PE
Seasonal groundwater flow is believed to follow the surface topography to the south at a gradient of approximately 0.02 (i=0.02). We did not encounter groundwater during our exploration of the site.

A single-ring infiltrometer test was conducted adjacent to Test Pit #5 in accordance with Spokane County specifications to evaluate the permeability of the clean gravel, sand, and cobble deposit. The 10" I.D. steel casing was driven approximately 3" below the excavated surface of the clean sand and gravel. The results were \( k=36 \text{ ft/day} \) (18 in/hr). These results were somewhat lower than Hazen's Approximation of permeability from gradation analysis of a bulk sample of this material, indicating \( k=150 \text{ ft/day} \).

CONCLUSIONS
We conclude that the subsurface conditions are poorly suited for on-site disposal of stormwater by subsurface infiltration throughout most of the site. However, a limited zone of permeable soils appears to be present in the southern area of the site. The majority of the soils offer moderately slow permeability on the order of 1 ft/day (0.5 in/hr). The permeable sand and gravel encountered in the southern portion of the site offers more favorable permeability on the order of 40 ft/day (20 in/hr).

If cuts are required to achieve grade, excavation difficulty may be encountered due to shallow rock.

RECOMMENDATIONS
We recommend that accumulated stormwater be discharged to slowly percolating retention swales utilizing permeability rates of the sod and topsoil or 0.5 in/hr, whichever is slower. Excess stormwater in the southern portion of the site may be discharged to the permeable sand and gravel through an infiltration gallery at a permeability of \( k=30 \text{ ft/day} \) (15 in/hr).
It has been a pleasure to be of service to you on this project. If we may be of further assistance, or if these results require further clarification, please do not hesitate to contact us.

Respectfully Submitted:
BUDINGER & ASSOCIATES

By: John E. Finnegan, EIT
Geotechnical Engineer

Reviewed By: Stephen D. Burchett, PE
PE Expires 9/24/95

JEF/sr
Addressee - 5
Scott Busch - 1
Attachments
PRE-DEVELOPMENT BASIN INFORMATION:
As shown on the Pre-Developed Basin Map and table 1 Below, the site gradually slopes to the south at approximately 1% to 2%. Per the original civil engineering plans in 2003 the stormwater is conveyed to two (2) existing ponds with a gravel galleries and a discharge structures connected to the gravel galleries.

Per the original storm report in 2003 they accounted for 41-acres of undeveloped grass and field runoff to the existing crest view estates subdivision. Since then development has occurred in the 5-mile area and Basin 1 has been developed into an existing subdivision, and Basin 2 has also had portion of it developed. Leaving a 2.5± acres of undeveloped grass field that is being discharged to Crest View Estates 1st Addition, and conveyed along the easter property line in a ditches to ponds A and B per WCE proposed short replat located along Ash Street and Tieton. The table 1 reflect this reduction in runoff compared to the Taylor report, therefore the offsite basin A is smaller

It should be noted that Pre basin A is made up of 18-sub basins with localized roadside swales. This was not a part of the original report but after visiting the site and seeing the curb drop and roadside swales this information has been added to the stormwater report.

<table>
<thead>
<tr>
<th>Pre-Basin</th>
<th>Ponds</th>
<th>Total Basin Area (sf)</th>
<th>Impervious Area (sf)</th>
<th>Pervious Area (sf)</th>
<th>PGIS Area (sf)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre A</td>
<td>N/A</td>
<td>202,690</td>
<td>26,559</td>
<td>176,131</td>
<td>48,099</td>
</tr>
<tr>
<td>Pre B</td>
<td>1-16</td>
<td>107,724</td>
<td>0</td>
<td>107,724</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>-</td>
<td>310,414.00</td>
<td>69,620</td>
<td>240,794</td>
<td>69,620</td>
</tr>
</tbody>
</table>
POST-DEVELOPMENT BASIN INFORMATION:
The Post-Development basins have been divided into 18 sub basin that flows to road side swales and then overflow downstream to the next pond, and eventually to the proposed expanded pond A, see Table 2 and 3.

Per the original report Taylor report in the appendix accounted for 41-acres of undeveloped grass field runoff to the existing crest view estates subdivision. Since then development has occurred in the 5-mile area and Basin 1 has been developed into an existing subdivision, and Basin 2 has also had portion of it developed. Leaving a 2.5-acres of undeveloped grass field that is being discharge to Crest View Estates 1st Addition.

Table 2 – Post-Development Project Site Basin Summary

<table>
<thead>
<tr>
<th>Pre-Basin</th>
<th>Ponds</th>
<th>Total Basin Area (sf)</th>
<th>Impervious Area (sf)</th>
<th>Pervious Area (sf)</th>
<th>PGIS Area (sf)</th>
</tr>
</thead>
<tbody>
<tr>
<td>POST A</td>
<td>A</td>
<td>152,704</td>
<td>67,220</td>
<td>85,484</td>
<td>67,220</td>
</tr>
<tr>
<td>POST B</td>
<td>1-16</td>
<td>49,986</td>
<td>7,200</td>
<td>42,786</td>
<td>7,200</td>
</tr>
<tr>
<td>POST C</td>
<td>N/A</td>
<td>107,724</td>
<td>0</td>
<td>107,724</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>-</td>
<td>310,414.00</td>
<td>74,420</td>
<td>235,994</td>
<td>74,420</td>
</tr>
</tbody>
</table>

Table 3 – Post-Development Project Site Pond Summary

<table>
<thead>
<tr>
<th>Basins</th>
<th>Ponds</th>
<th>(Method 1815A (ac)) Treatment Area/Volume (square feet/cubic feet)</th>
<th>Required</th>
<th>Provided</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td><strong>Pond area</strong></td>
<td><strong>Pond vol.</strong></td>
<td><strong>Pond area</strong></td>
</tr>
<tr>
<td>Basin A</td>
<td>Pond A</td>
<td>5,602 sf</td>
<td>2,801 cf</td>
<td>1,905</td>
</tr>
<tr>
<td>Basin B</td>
<td>Pond A</td>
<td>600 sf</td>
<td>300 cf</td>
<td>8,154 sf</td>
</tr>
<tr>
<td>Basin C</td>
<td>Pond A</td>
<td>0 sf</td>
<td>0 cf</td>
<td>0.00 sf</td>
</tr>
<tr>
<td>TOTAL</td>
<td>-</td>
<td><strong>6,202 sf</strong></td>
<td><strong>3,101 cf</strong></td>
<td><strong>10,059, sf</strong></td>
</tr>
</tbody>
</table>

Refer to basin calculations in Appendix for areas and peak flows for all basins.

Critical Areas:
Based on the Critical Area Maps provided by Spokane County, (DNR Streams, Fish and Wildlife, Wetlands, Geo-hazard Area and Critical Aquifer Resource Area), there does not appear to be any critical areas on site. No inventoried wetlands or federal flood zones are present within the project site.

Down-Gradient Analysis:
The updated Pond A is designed and analyzed to store, treat and discharge the 100-year storm event, therefore, no further downstream flows are anticipated.
Methodology:
As required by the SRSM, and the EWLID the storm drainage facilities proposed for this site have been sized to attenuate the 50- and 100-year storm events using the SCS / TR-55 Method. The SCS / TR-55 Method has been used to calculate peak flows, volumes, and time for storm event interactions for this project as there is one (1) offsite drainage basin (existing field) that discharges to this project and proposed Pond A. The rational method was used onsite to determine localized stormflows, and offsite for the other projects, but when combining all the projects together the rational method is not the best fit. The peak flows and volumes for these storm events are shown in the calculations that are included within the Appendix of this report.

Water Quality Treatment:
The proposed storm drainage pond has been designed to provide treatment volume based on SWMMEW (Stormwater Management Manual for Eastern Washington) chapter 5.4.3, SSC-6 Soil Physical and Chemical Suitability for Treatment, and Equation 6-1d (V=1815A) of the SRSM, and as outlined in Section 6.7.1. see the below description for bio-infiltiration swale.

Results:
Within this report we have provided the required treatment volume for the improvements proposed for the redevelopment. In the below snippet form the Hydro Cad report we show that the updated Pond A can attenuate and infiltrate the 100-year storm event

**3376-STORM**
Prepared by Whipple Consulting Engineers

HydroCAD® 10.20-3c s/n 10129 © 2023 HydroCAD Software Solutions LLC

Type IIA 24-hr 100 year Rainfall=2.60"

Printed 10/19/2023

Page 20

Time span=1.00-48.00 hrs, dt=0.05 hrs, 941 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: Subdivision
   Runoff Area=3.510 ac  30.00% Impervious  Runoff Depth=1.01"
   Flow Length=725'  Tc=1.8 min  CN=81  Runoff=0.77 cfs  0.297 af

Subcatchment 3S: Back Yards
   Runoff Area=1.150 ac  0.00% Impervious  Runoff Depth=0.67"
   Flow Length=649'  Slope=0.0130 '/'  Tc=13.6 min  CN=74  Runoff=0.11 cfs  0.064 af

Subcatchment 4S: Field
   Runoff Area=2.470 ac  0.00% Impervious  Runoff Depth=1.13"
   Flow Length=800'  Slope=0.0150 '/'  Tc=15.6 min  CN=83  Runoff=0.59 cfs  0.233 af

Reach 3R: Gutter
   Avg. Flow Depth=0.12'  Max Vel=2.27 fps  Inflow=1.33 cfs  0.530 af
   n=0.013  L=700.0'  S=0.0130 '/'  Capacity=37.59 cfs  Outflow=1.27 cfs  0.530 af

Reach 4R: Backyard flow
   Avg. Flow Depth=0.02'  Max Vel=0.06 fps  Inflow=0.11 cfs  0.064 af
   n=0.240  L=649.0'  S=0.0130 '/'  Capacity=9.53 cfs  Outflow=0.05 cfs  0.063 af

Pond 2P: POND A
   Peak Elev=1,001.90'  Storage=17,503 cf  Inflow=1.27 cfs  0.593 af
   Outflow=0.13 cfs  0.407 af

Total Runoff Area = 7.130 ac  Runoff Volume = 0.593 af  Average Runoff Depth = 1.00"

85.23% Pervious = 6.077 ac  14.77% Impervious = 1.053 ac
Summary for Pond 2P: POND A

Inflow Area = 7.130 ac, 14.77% Impervious, Inflow Depth > 1.00" for 100 year event
Inflow = 1.27 cfs @ 8.09 hrs, Volume= 0.593 af
Outflow = 0.13 cfs @ 24.33 hrs, Volume= 0.407 af, Atten= 90%, Lag= 974.3 min
Primary = 0.13 cfs @ 24.33 hrs, Volume= 0.407 af

Routing by Stor-Ind method, Time Span= 1.00-48.00 hrs, dl= 0.05 hrs
Peak Elev= 1,001.90' @ 24.33 hrs Surf.Area= 10,328 sf Storage= 17,503 cf

Plug-Flow detention time= 944.9 min calculated for 0.406 af (69% of inflow)
Center-of-Mass det. time= 757.3 min (1,649.1 - 891.8)

<table>
<thead>
<tr>
<th>Volume</th>
<th>Invert</th>
<th>Avail Storage</th>
<th>Storage Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>#1</td>
<td>1,000.00'</td>
<td>18,544 cf</td>
<td>90.23'W x 90.23'L x 2.00'H Prismatoid Z=3.0</td>
</tr>
</tbody>
</table>

Device Routing Invert Outlet Devices
#1 Primary 1,000.00' 0.500 in/hr Exfiltration over Surface area
Conductivity to Groundwater Elevation = 980.00'

Primary OutFlow Max=0.13 cfs @ 24.33 hrs HW=1,001.90' (Free Discharge)
1=Exfiltration (Controls 0.13 cfs)

Pond 2P: POND A

Inflow Area=7.130 ac
Peak Elev=1,001.90'
Storage=17,503 cf
**Operation Characteristics:**

**Bio-infiltration Swale “A”**
The stormwater generated by the existing street, driveways & front roofs will be conveyed in the existing Ash street gutters, to updated pond “A”. This updated include are large pond bottom and addition catch basins and pipes to collect and discharge storm flow in the Ash Street gutter. Once the storm water has been discharged to the existing pond “A” the stormwater will infiltrate through the existing and proposed 12-inches of treatment soil, to the existing gravel gallery. Once the stormwater exceeds the height of 6-inches, excess stormwater will spill into a single depth drywell and be discharged to the existing gravel gallery per the Spokane Regional Stormwater Manual, and the Eastern Washington Low Impact Development Guidance Manual.

**Bio-infiltration Swale “1-16”**
The stormwater generated within the Ash Street sub basin 0-16 will sheet flow across the pavement to the gutter where it will then be detained by the existing bio-infiltration swales 1 through 16. These swales are existing and attenuate the flow to pond A. These ponds do not have drywells or discharge points other than Pond A, so while they will collect and detain/retain stormwater their potential volume has been ignored for this analysis.

The infiltration rate given by Budinger engineers as required per the Spokane Regional Stormwater Manual, and the Eastern Washington Low Impact Development Guidance Manual. Is still valid as no changes to the gallery are proposed.

**Results:**
Refer to Table 1 and Pre & Post basin tables in Appendix for Post-Development storm drainage information.
Perpetual Maintenance of Facilities:
There is an existing homeowner association and the swales within the proposed tracts “A” will be maintained by the existing HOA. The City of Spokane will not be liable for any maintenance or operation of the facilities. A maintenance plan will be provided to the owner if requested.

Offsite Easements:

There are no offsite easements required for this property.

Regional Facilities:

There are no known regional facilities that lie within or are affected by the project site.

CONCLUSION:
As required by the City of Spokane and the Spokane Regional Stormwater Manual, the onsite storm drainage facilities for this project will adequately collect, treat, and discharge stormwater runoff generated by the site during the 50 & 100-year storm event. Also, the storm drainage facilities will contain and discharge the 50 & 100-year storm under non frozen conditions. Therefore, this project will have no adverse impact to adjacent and/or downstream properties.
APPENDIX
VICINITY MAP
BASIN MAPS
### SPOKANE COUNTY - SRSM - GRASSED PERCOLATION METHOD

<table>
<thead>
<tr>
<th>Basin</th>
<th>Total Ac</th>
<th>Total sf</th>
<th>Access/Parking /Street (sf)</th>
<th>Sidewalk</th>
<th>Lot #</th>
<th>DV sf</th>
<th>Buildings sf</th>
<th>Total Impervious sf</th>
<th>Total Pervious sf</th>
<th>Wtd &quot;C&quot;</th>
<th>PGIS sf</th>
<th>Pond Vol (cf)</th>
<th>2 yr Q</th>
<th>10 yr Q</th>
<th>25 yr Q</th>
<th>50 yr Q</th>
<th>100 yr Q</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre A</td>
<td>4.65</td>
<td>202,690</td>
<td>26,420</td>
<td>0</td>
<td>18</td>
<td>21,600</td>
<td>79</td>
<td>48,099</td>
<td>154,591</td>
<td>0</td>
<td>48,099</td>
<td>4,008</td>
<td>2,004</td>
<td>2.16</td>
<td>4.00</td>
<td>5.07</td>
<td>5.86</td>
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<tr>
<td>Pre B</td>
<td>2.47</td>
<td>107,724</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>107,724</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.53</td>
<td>0.97</td>
<td>1.23</td>
<td>1.43</td>
</tr>
<tr>
<td>Total</td>
<td>7.13</td>
<td>310,414</td>
<td>0.00</td>
<td>18.00</td>
<td>21.600</td>
<td>21.600</td>
<td>69,620</td>
<td>240,794</td>
<td>0</td>
<td>69,620</td>
<td>5,802</td>
<td>2,901</td>
<td>3.22</td>
<td>5.94</td>
<td>7.53</td>
<td>8.71</td>
<td>9.93</td>
</tr>
</tbody>
</table>

### PRE SUB BASIN SAMPLE

| SUB 1  | 0.27     | 11,580   | 3,190                       | 0        | 2     | 2,400 | 2,400       | 7,990            | 3,590            | 0.67    | 7,990   | 666       | 333   | 0.25   | 0.46   | 0.59   | 0.68    | 0.78   |
| SUB 2  | 0.25     | 10,750   | 3,190                       | 0        | 2     | 2,400 | 2,400       | 7,990            | 2,760            | 0.71    | 7,990   | 666       | 333   | 0.25   | 0.46   | 0.58   | 0.67    | 0.76   |
| SUB 3  | 0.13     | 5,850    | 1,250                       | 0        | 1     | 1,200 | 1,200       | 3,650            | 2,200            | 0.62    | 3,650   | 304       | 152   | 0.12   | 0.22   | 0.28   | 0.32    | 0.36   |
| SUB 4  | 0.13     | 5,850    | 1,250                       | 0        | 1     | 1,200 | 1,200       | 3,650            | 2,200            | 0.62    | 3,650   | 304       | 152   | 0.12   | 0.22   | 0.28   | 0.32    | 0.36   |
| SUB 5  | 0.13     | 5,880    | 1,250                       | 0        | 1     | 1,200 | 1,200       | 3,650            | 2,200            | 0.62    | 3,650   | 304       | 152   | 0.12   | 0.22   | 0.28   | 0.32    | 0.36   |
| SUB 6  | 0.13     | 5,880    | 1,250                       | 0        | 1     | 1,200 | 1,200       | 3,650            | 2,200            | 0.62    | 3,650   | 304       | 152   | 0.12   | 0.22   | 0.28   | 0.32    | 0.36   |
| SUB 7  | 0.13     | 5,880    | 1,250                       | 0        | 1     | 1,200 | 1,200       | 3,650            | 2,200            | 0.62    | 3,650   | 304       | 152   | 0.12   | 0.22   | 0.28   | 0.32    | 0.36   |
| SUB 8  | 0.13     | 5,880    | 1,250                       | 0        | 1     | 1,200 | 1,200       | 3,650            | 2,200            | 0.62    | 3,650   | 304       | 152   | 0.12   | 0.22   | 0.28   | 0.32    | 0.36   |
| SUB 9  | 0.13     | 5,880    | 1,250                       | 0        | 1     | 1,200 | 1,200       | 3,650            | 2,200            | 0.62    | 3,650   | 304       | 152   | 0.12   | 0.22   | 0.28   | 0.32    | 0.36   |
| SUB 10 | 0.13     | 5,880    | 1,250                       | 0        | 1     | 1,200 | 1,200       | 3,650            | 2,200            | 0.62    | 3,650   | 304       | 152   | 0.12   | 0.22   | 0.28   | 0.32    | 0.36   |
| SUB 11 | 0.13     | 5,880    | 1,250                       | 0        | 1     | 1,200 | 1,200       | 3,650            | 2,200            | 0.62    | 3,650   | 304       | 152   | 0.12   | 0.22   | 0.28   | 0.32    | 0.36   |
| SUB 12 | 0.13     | 5,880    | 1,250                       | 0        | 1     | 1,200 | 1,200       | 3,650            | 2,200            | 0.62    | 3,650   | 304       | 152   | 0.12   | 0.22   | 0.28   | 0.32    | 0.36   |
| SUB 13 | 0.13     | 5,880    | 1,250                       | 0        | 1     | 1,200 | 1,200       | 3,650            | 2,200            | 0.62    | 3,650   | 304       | 152   | 0.12   | 0.22   | 0.28   | 0.32    | 0.36   |
| SUB 14 | 0.13     | 5,880    | 1,250                       | 0        | 1     | 1,200 | 1,200       | 3,650            | 2,200            | 0.62    | 3,650   | 304       | 152   | 0.12   | 0.22   | 0.28   | 0.32    | 0.36   |
| SUB 15 | 1.26     | 54,930   | 2,520                       | 0        | 1     | 1,200 | 1,200       | 4,920            | 50,010           | 0.22    | 4,920   | 410       | 205   | 0.39   | 0.72   | 0.91   | 1.05    | 1.20   |
| SUB 16 | 1.26     | 54,930   | 2,520                       | 0        | 1     | 1,200 | 1,200       | 4,920            | 50,010           | 0.22    | 4,920   | 410       | 205   | 0.39   | 0.72   | 0.91   | 1.05    | 1.20   |
| Total  | 4.65     | 202,690  | 26,420                      | 0        | 18    | 21,600| 21,600      | 69,620           | 133,070          | 0.41    | 69,620  | 5,802     | 2,901 | 2.69   | 4.97   | 6.30   | 7.29    | 8.31   |
**Whipple Consulting Engineers**

**Basin Calculation Worksheet**

<table>
<thead>
<tr>
<th>Date</th>
<th>Project Name</th>
<th>Imp</th>
<th>Per</th>
<th>Intensities from SRSM eqn. 5-13, per Table 5-7, Assumes Tc = 5 min</th>
</tr>
</thead>
<tbody>
<tr>
<td>10/19/2023</td>
<td>Crest View Short Plat</td>
<td>0.9</td>
<td>0.15</td>
<td>1 (2 yr) = 1.418 inches, 1 (10 yr) = 2.619 inches, NOTE: 1 (25 yr) = 3.319 inches, 1 (50 yr) = 3.843 inches</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Post Onsite Flow</th>
<th>fictional area (sq ft)</th>
<th>1,200 sq ft</th>
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<tr>
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<td>3.51 152,704 26,420 0 17 20,400 20,400 67,220 85,484 0.48 67,220 5,602 2,801 2.39 4.41 5.59 6.47 7.37</td>
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<tr>
<td>POST B</td>
<td>1.15 49,986 0 0 3 3,600 3,600 7,200 42,786 0.26 7,200 600 300 0.42 0.78 0.98 1.14 1.30</td>
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<tr>
<td>POST C</td>
<td>2.47 107,724 0 0 0 0 0 107,724 0.15 0 0 0 0.53 0.97 1.23 1.43 1.63</td>
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**POST SUB BASIN SAMPLE**

| SUB 1          | 0.27 11,580 3,190 0 2 2,400 2,400 7,990 3,590 0.67 7,990 666 333 0.25 0.46 0.59 0.68 0.78 |
| SUB 2          | 0.25 10,750 3,190 0 2 2,400 2,400 7,990 2,760 0.71 7,990 666 333 0.25 0.46 0.59 0.68 0.76 |
| SUB 3          | 0.13 5,850 1,250 0 1 1,200 1,200 3,650 2,200 0.62 3,650 304 152 0.12 0.22 0.28 0.32 0.36 |
| SUB 4          | 0.13 5,850 1,250 0 1 1,200 1,200 3,650 2,200 0.62 3,650 304 152 0.12 0.22 0.28 0.32 0.36 |
| SUB 5          | 0.13 5,880 1,250 0 1 1,200 1,200 3,650 2,200 0.62 3,650 304 152 0.12 0.22 0.28 0.32 0.36 |
| SUB 6          | 0.13 5,880 1,250 0 1 1,200 1,200 3,650 2,200 0.62 3,650 304 152 0.12 0.22 0.28 0.32 0.36 |
| SUB 7          | 0.13 5,880 1,250 0 1 1,200 1,200 3,650 2,200 0.62 3,650 304 152 0.12 0.22 0.28 0.32 0.36 |
| SUB 8          | 0.13 5,880 1,250 0 1 1,200 1,200 3,650 2,200 0.62 3,650 304 152 0.12 0.22 0.28 0.32 0.36 |
| SUB 9          | 0.13 5,880 1,250 0 1 1,200 1,200 3,650 2,200 0.62 3,650 304 152 0.12 0.22 0.28 0.32 0.36 |
| SUB 10         | 0.13 5,880 1,250 0 1 1,200 1,200 3,650 2,200 0.62 3,650 304 152 0.12 0.22 0.28 0.32 0.36 |
| SUB 11         | 0.13 5,880 1,250 0 1 1,200 1,200 3,650 2,200 0.62 3,650 304 152 0.12 0.22 0.28 0.32 0.36 |
| SUB 12         | 0.13 5,880 1,250 0 1 1,200 1,200 3,650 2,200 0.62 3,650 304 152 0.12 0.22 0.28 0.32 0.36 |
| SUB 13         | 0.13 5,880 1,250 0 1 1,200 1,200 3,650 2,200 0.62 3,650 304 152 0.12 0.22 0.28 0.32 0.36 |
| SUB 14         | 0.13 5,880 1,250 0 1 1,200 1,200 3,650 2,200 0.62 3,650 304 152 0.12 0.22 0.28 0.32 0.36 |
| SUB 15         | 0.11 4,942 2,520 0 0 0 0 2,520 2,422 0.53 2,520 210 105 0.09 0.16 0.20 0.23 0.26 |
| SUB 16         | 0.31 13,565 2,520 0 0 0 0 2,520 11,045 0.29 2,520 210 105 0.13 0.24 0.30 0.35 0.39 |
| SUB 17         | 0.95 41,367 0 0 1 1,200 1,200 2,400 38,967 0.19 2,400 200 100 0.26 0.48 0.61 0.71 0.81 |
| **Total**      | **3.51 152,704 26,420 0 17 20,400 20,400 67,220 85,484 0.48 67,220 5,602 2,801 2.39 4.41 5.59 6.47 7.37** |
POND VOLUME WORKSHEET
## WHIPPLE CONSULTING ENGINEERS
### POND VOLUME CALC SHEET

**Project:** 22-3376  
**Designer:** TEW  
**Date:** 10/19/2023

**CREST VIEW ESTATS SHORT PLAT**

<table>
<thead>
<tr>
<th>Basins</th>
<th>Ponds/Swales</th>
<th>Bottom Area (sf)</th>
<th>Treatment Area (w/ Side Slopes)</th>
<th>Squared Side (lf)</th>
<th>Pond Bottom Elevation at Drywell</th>
<th>Pond Drywell Elevation</th>
<th>Pond Inlet Elevation (avg)</th>
<th>Conic Volume to Rim (ef)</th>
<th>Side Slope Volume (ef)</th>
<th>Total Volume to Rim (ef)</th>
<th>Conic Volume to Inlet (ef)</th>
<th>Side Slope Volume (ef)</th>
<th>Total Volume to Inlet (ef)</th>
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<td><strong>-</strong></td>
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</tr>
</tbody>
</table>

* LID ponds do not calculate side slopes.
CURB INLET CALCULATIONS
### WEST SIDE OF ASH CURB INLET 1

#### Grate Inlet
<table>
<thead>
<tr>
<th>Location</th>
<th>On grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>Curb Length (ft)</td>
<td>-0-</td>
</tr>
<tr>
<td>Throat Height (in)</td>
<td>-0-</td>
</tr>
<tr>
<td>Grate Area (sqft)</td>
<td>-0-</td>
</tr>
<tr>
<td>Grate Width (ft)</td>
<td>1.61</td>
</tr>
<tr>
<td>Grate Length (ft)</td>
<td>1.61</td>
</tr>
</tbody>
</table>

#### Gutter
| Slope, Sw (ft/ft) | 0.020         |
| Slope, Sx (ft/ft) | 0.020         |
| Local Depr (in)   | -0-           |
| Gutter Width (ft)  | 1.50          |
| Gutter Slope (%)  | 2.00          |
| Gutter n-value    | 0.016         |

#### Calculations
- **Compute by:**
  - **Known Q**
  - **Q (cfs)** = 0.34

#### Highlighted
- **Q Total (cfs)** = 0.34
- **Q Capt (cfs)** = 0.25
- **Q Bypass (cfs)** = 0.09
- **Depth at Inlet (in)** = 1.01
- **Efficiency (%)** = 72
- **Gutter Spread (ft)** = 4.23
- **Gutter Vel (ft/s)** = 1.90
- **Bypass Spread (ft)** = 2.61
- **Bypass Depth (in)** = 0.63

All dimensions in ft.
WEST SIDE OF ASH CURB INLET 2

**Curb Inlet**
- Location = On grade
- Curb Length (ft) = 2.95
- Throat Height (in) = 6.00
- Grate Area (sqft) = -0-
- Grate Width (ft) = -0-
- Grate Length (ft) = -0-

**Calculations**
- Compute by: Known Q
- Q (cfs) = 0.09

**Highlighted**
- Q Total (cfs) = 0.09
- Q Capt (cfs) = 0.05
- Q Bypass (cfs) = 0.04
- Depth at Inlet (in) = 0.62
- Efficiency (%) = 54
- Gutter Spread (ft) = 2.57
- Gutter Vel (ft/s) = 1.36
- Bypass Spread (ft) = 1.92
- Bypass Depth (in) = 0.46

**Gutter**
- Slope, Sw (ft/ft) = 0.020
- Slope, Sx (ft/ft) = 0.020
- Local Depr (in) = -0-
- Gutter Width (ft) = 1.50
- Gutter Slope (%) = 2.00
- Gutter n-value = 0.016
# EAST SIDE OF ASH CATCH BASIN 1

## Grate Inlet
- **Location**: On grade
- **Curb Length (ft)**: -0-
- **Throat Height (in)**: -0-
- **Grate Area (sqft)**: -0-
- **Grate Width (ft)**: 1.61
- **Grate Length (ft)**: 1.61

## Gutter
- **Slope, Sw (ft/ft)**: 0.020
- **Slope, Sx (ft/ft)**: 0.020
- **Local Depr (in)**: -0-
- **Gutter Width (ft)**: 1.50
- **Gutter Slope (%)**: 2.00
- **Gutter n-value**: 0.016

## Calculations
- **Compute by**: Known Q
- **Q (cfs)**: 0.34

## Highlighted
- **Q Total (cfs)**: 0.34
- **Q Capt (cfs)**: 0.25
- **Q Bypass (cfs)**: 0.09
- **Depth at Inlet (in)**: 1.01
- **Efficiency (%)**: 72
- **Gutter Spread (ft)**: 4.23
- **Gutter Vel (ft/s)**: 1.90
- **Bypass Spread (ft)**: 2.61
- **Bypass Depth (in)**: 0.63
# EAST SIDE OF ASH CATCH BASIN 2

## Grate Inlet

<table>
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<th>Parameter</th>
<th>Value</th>
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<tbody>
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<td>On grade</td>
</tr>
<tr>
<td>Curb Length (ft)</td>
<td>-0-</td>
</tr>
<tr>
<td>Throat Height (in)</td>
<td>-0-</td>
</tr>
<tr>
<td>Grate Area (sqft)</td>
<td>-0-</td>
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<tr>
<td>Grate Width (ft)</td>
<td>1.61</td>
</tr>
<tr>
<td>Grate Length (ft)</td>
<td>1.61</td>
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</table>

## Gutter

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
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</thead>
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<tr>
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<tr>
<td>Slope, Sx (ft/ft)</td>
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<tr>
<td>Local Depr (in)</td>
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<td>Gutter Width (ft)</td>
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<tr>
<td>Gutter Slope (%)</td>
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<tr>
<td>Gutter n-value</td>
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## Calculations

<table>
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</thead>
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<td>Q (cfs)</td>
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## Highlighted

<table>
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<td>Gutter Vel (ft/s)</td>
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<td>Bypass Depth (in)</td>
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All dimensions in ft.
HydroCAD
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<th>Curve</th>
<th>Mode</th>
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<th>Depth (inches)</th>
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### Area Listing (all nodes)

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<td>&gt;75% Grass cover, Good, HSG C (3S)</td>
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<td>7.130</td>
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</tbody>
</table>
Subcatchment 1S: Subdivision
Runoff Area = 3.510 ac  30.00% Impervious  Runoff Depth = 0.48"
Flow Length = 725'  Tc = 1.8 min  CN = 81  Runoff = 0.29 cfs  0.141 af

Subcatchment 3S: Back Yards
Runoff Area = 1.150 ac  0.00% Impervious  Runoff Depth = 0.26"
Flow Length = 649'  Slope = 0.0130 '/'  Tc = 13.6 min  CN = 74  Runoff = 0.025 cfs  0.025 af

Subcatchment 4S: Field
Runoff Area = 2.470 ac  0.00% Impervious  Runoff Depth = 0.56"
Flow Length = 800'  Slope = 0.0150 '/'  Tc = 15.6 min  CN = 83  Runoff = 0.24 cfs  0.116 af

Reach 3R: Gutter
Avg. Flow Depth = 0.08'  Max Vel = 1.74 fps  Inflow = 0.50 cfs  0.257 af
n = 0.013  L = 700.0'  S = 0.0130 '/'  Capacity = 37.59 cfs  Outflow = 0.45 cfs  0.257 af

Reach 4R: Backyard flow
Avg. Flow Depth = 0.01'  Max Vel = 0.04 fps  Inflow = 0.02 cfs  0.025 af
n = 0.240  L = 649.0'  S = 0.0130 '/'  Capacity = 9.53 cfs  Outflow = 0.02 cfs  0.025 af

Pond 2P: POND A
Peak Elev = 1,000.66'  Storage = 5,584 cf  Inflow = 0.46 cfs  0.281 af
Outflow = 0.11 cfs  0.281 af

Total Runoff Area = 7.130 ac  Runoff Volume = 0.282 af  Average Runoff Depth = 0.47"
85.23% Pervious = 6.077 ac  14.77% Impervious = 1.053 ac
Summary for Subcatchment 1S: Subdivision

[49] Hint: Tc<2dt may require smaller dt

Runoff = 0.29 cfs @ 7.98 hrs, Volume= 0.141 af, Depth= 0.48"
Routed to Reach 3R: Gutter

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-48.00 hrs, dt= 0.05 hrs
Type IA 24-hr 10 year Rainfall=1.80"

<table>
<thead>
<tr>
<th>Area (ac)</th>
<th>CN</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.510</td>
<td>81</td>
<td>1/3 acre lots, 30% imp, HSG C</td>
</tr>
<tr>
<td>2.457</td>
<td>70.00% Pervious Area</td>
<td></td>
</tr>
<tr>
<td>1.053</td>
<td>30.00% Impervious Area</td>
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<tr>
<th>Tc (min)</th>
<th>Length (feet)</th>
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<td>Unpaved Kv= 16.1 fps</td>
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<td></td>
<td></td>
<td></td>
<td>Area= 0.5 sf Perim= 1.1' r= 0.45'</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>n= 0.013 Concrete, trowel finish</td>
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</tbody>
</table>

1.8 725 Total

Subcatchment 1S: Subdivision

Hydrograph

Type IA 24-hr
10 year Rainfall=1.80"
Runoff Area=3.510 ac
Runoff Volume=0.141 af
Runoff Depth=0.48"
Flow Length=725'
Tc=1.8 min
CN=81
Summary for Subcatchment 3S: Back Yards

Runoff = 0.02 cfs @ 16.93 hrs, Volume= 0.025 af, Depth= 0.26"
Routed to Reach 4R : Backyard flow

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-48.00 hrs, dt= 0.05 hrs
Type IA 24-hr 10 year Rainfall=1.80"

<table>
<thead>
<tr>
<th>Area (ac)</th>
<th>CN</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.150</td>
<td>74</td>
<td>&gt;75% Grass cover, Good, HSG C</td>
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<tr>
<td>1.150</td>
<td>100</td>
<td>100.00% Pervious Area</td>
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<th>Slope (ft/ft)</th>
<th>Velocity (ft/sec)</th>
<th>Capacity (cfs)</th>
<th>Description</th>
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<tbody>
<tr>
<td>13.6</td>
<td>649</td>
<td>0.0130</td>
<td>0.80</td>
<td></td>
<td>Shallow Concentrated Flow, Backyards</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Short Grass Pasture, Kv= 7.0 fps</td>
</tr>
</tbody>
</table>

Subcatchment 3S: Back Yards

Hydrograph

Type IA 24-hr
10 year Rainfall=1.80"
Runoff Area=1.150 ac
Runoff Volume=0.025 af
Runoff Depth=0.26"
Flow Length=649'
Slope=0.0130 '/
Tc=13.6 min
CN=74
Summary for Subcatchment 4S: Field

Runoff = 0.24 cfs @ 8.10 hrs, Volume = 0.116 af, Depth = 0.56"
Routed to Reach 3R: Gutter

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span = 1.00-48.00 hrs, dt = 0.05 hrs
Type IA 24-hr 10 year Rainfall=1.80"

<table>
<thead>
<tr>
<th>Area (ac)</th>
<th>CN</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>2.470</td>
<td>83</td>
<td>Legumes, contoured, Poor, HSG C</td>
</tr>
<tr>
<td>2.470</td>
<td></td>
<td>100.00% Pervious Area</td>
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</table>

<table>
<thead>
<tr>
<th>Tc (min)</th>
<th>Length (feet)</th>
<th>Slope (ft/ft)</th>
<th>Velocity (ft/sec)</th>
<th>Capacity (cfs)</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>15.6</td>
<td>800</td>
<td>0.0150</td>
<td>0.86</td>
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<td>Shallow Concentrated Flow, Field</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>7.0 fps</td>
<td>Short Grass Pasture</td>
</tr>
</tbody>
</table>

Subcatchment 4S: Field

Hydrograph

Type IA 24-hr
10 year Rainfall=1.80"
Runoff Area = 2.470 ac
Runoff Volume = 0.116 ac
Runoff Depth = 0.56"
Flow Length = 800'
Slope = 0.0150 '/'
Tc = 15.6 min
CN = 83
Summary for Reach 3R: Gutter

Inflow Area = 5.980 ac, 17.61% Impervious, Inflow Depth = 0.51" for 10 year event
Inflow = 0.50 cfs @ 7.99 hrs, Volume= 0.257 af
Outflow = 0.46 cfs @ 8.16 hrs, Volume= 0.257 af, Atten= 9%, Lag= 10.6 min
Routed to Pond 2P : POND A

Routing by Stor-Ind+Trans method, Time Span= 1.00-48.00 hrs, dt= 0.05 hrs
Max. Velocity= 1.74 fps, Min. Travel Time= 6.7 min
Avg. Velocity = 1.17 fps, Avg. Travel Time= 9.9 min

Peak Storage= 186 cf @ 8.05 hrs
Average Depth at Peak Storage= 0.08', Surface Width= 5.39'
Bank-Full Depth= 0.50' Flow Area= 7.1 sf, Capacity= 37.59 cfs

1.50' x 0.50' deep channel, n= 0.013 Concrete, trowel finish
Side Slope Z-value= 0.5 50.0 /' Top Width= 28.75'
Length= 700.0' Slope= 0.0130 /'
Inlet Invert= 1,011.10', Outlet Invert= 1,002.00'

Reach 3R: Gutter

Hydrograph

Inflow Area=5.980 ac
Avg. Flow Depth=0.08'
Max Vel=1.74 fps
n=0.013
L=700.0'
S=0.0130 '/'
Capacity=37.59 cfs
Summary for Reach 4R: Backyard flow

Inflow Area = 1.150 ac, 0.00% Impervious, Inflow Depth = 0.26" for 10 year event
Inflow = 0.02 cfs @ 16.93 hrs, Volume = 0.025 af
Outflow = 0.02 cfs @ 24.81 hrs, Volume = 0.025 af, Atten = 6%, Lag = 473.0 min
Routed to Pond 2P: POND A

Routing by Stor-Ind+Trans method, Time Span = 1.00-48.00 hrs, dt = 0.05 hrs
Max. Velocity = 0.04 fps, Min. Travel Time = 256.3 min
Avg. Velocity = 0.03 fps, Avg. Travel Time = 381.9 min

Peak Storage = 299 cf @ 20.54 hrs
Average Depth at Peak Storage = 0.01', Surface Width = 31.50'
Bank-Full Depth = 0.50' Flow Area = 27.5 sf, Capacity = 9.53 cfs

30.00' x 0.50' deep channel, $n = 0.240$ Sheet flow over Dense Grass
Side Slope $Z$-value = 50.0 'r' Top Width = 80.00'
Length = 649.0 ' $S = 0.0130$ 'r'
Inlet Invert = 1,010.44', Outlet Invert = 1,002.00'

---

Reach 4R: Backyard flow

**Hydrograph**

- **Inflow Area = 1.150 ac**
- **Avg. Flow Depth = 0.01'**
- **Max Vel = 0.04 fps**
- **$n = 0.240$**
- **$L = 649.0'$**
- **$S = 0.0130$ 'r'**
- **Capacity = 9.53 cfs**
Summary for Pond 2P: POND A

Inflow Area = 7.130 ac, 14.77% Impervious. Inflow Depth > 0.47" for 10 year event
Inflow = 0.46 cfs @ 8.16 hrs, Volume= 0.281 af
Outflow = 0.11 cfs @ 24.24 hrs, Volume= 0.281 af, Atten= 77%, Lag= 964.6 min
Primary = 0.11 cfs @ 24.24 hrs, Volume= 0.281 af

Routing by Stor-Ind method, Time Span= 1.00-48.00 hrs, dt= 0.05 hrs
Peak Elev= 1,000.66' @ 24.24 hrs Surf.Area= 8,888 sf Storage= 5,584 cf

Plug-Flow detention time= 523.1 min calculated for 0.281 af (100% of inflow)
Center-of-Mass det. time= 522.4 min (1,472.4 - 950.0)

<table>
<thead>
<tr>
<th>Volume</th>
<th>Invert</th>
<th>Avail.Storage</th>
<th>Storage Description</th>
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<tr>
<td>#1</td>
<td>1,000.00'</td>
<td>18,544 cf</td>
<td>90.23'W x 90.23'L x 2.00'H Prismatoid Z=3.0</td>
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</table>

Device Routing Invert Outlet Devices
#1 Primary 1,000.00' 0.500 in/hr Exfiltration over Surface area Conductivity to Groundwater Elevation = 980.00'

Exfiltration Max=0.11 cfs @ 24.24 hrs HW=1,000.66' (Free Discharge)
Exfiltration (Controls 0.11 cfs)

Pond 2P: POND A

Inflow Area=7.130 ac
Peak Elev=1,000.66'
Storage=5,584 cf
Time span = 1.00-48.00 hrs, dt = 0.05 hrs, 941 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

**Subcatchment 1S: Subdivision**

- Runoff Area = 3.510 ac
- Impervious = 30.00%
- Runoff Depth = 0.73"
- Flow Length = 725'
- Tc = 1.8 min
- CN = 81
- Runoff = 0.51 cfs
- 0.215 af

**Subcatchment 3S: Back Yards**

- Runoff Area = 1.150 ac
- Impervious = 0.00%
- Runoff Depth = 0.45"
- Flow Length = 649'
- Slope = 0.0130 '/
- Tc = 13.6 min
- CN = 74
- Runoff = 0.05 cfs
- 0.043 af

**Subcatchment 4S: Field**

- Runoff Area = 2.470 ac
- Impervious = 0.00%
- Runoff Depth = 0.84"
- Flow Length = 800'
- Slope = 0.0150 '/
- Tc = 15.6 min
- CN = 83
- Runoff = 0.41 cfs
- 0.172 af

**Reach 3R: Gutter**

- Avg. Flow Depth = 0.10'
- Max Vel = 2.03 fps
- Inflow = 0.89 cfs
- 0.387 af
- n = 0.013
- L = 700.0'
- S = 0.0130 '/
- Capacity = 37.59 cfs
- Outflow = 0.84 cfs
- 0.387 af

**Reach 4R: Backyard flow**

- Avg. Flow Depth = 0.02'
- Max Vel = 0.05 fps
- Inflow = 0.05 cfs
- 0.043 af
- n = 0.240
- L = 649.0'
- S = 0.0130 '/
- Capacity = 9.53 cfs
- Outflow = 0.03 cfs
- 0.042 af

**Pond 2P: POND A**

- Peak Elev = 1,001.27' Storage = 11,228 cf
- Inflow = 0.84 cfs
- 0.429 af
- Outflow = 0.12 cfs
- 0.367 af

**Total Runoff Area = 7.130 ac**

**Runoff Volume = 0.430 af**

**Average Runoff Depth = 0.72"**

**85.23% Pervious = 6.077 ac**

**14.77% Impervious = 1.053 ac**
Summary for Subcatchment 1S: Subdivision

[49] Hint: Tc<2dt may require smaller dt

Runoff = 0.51 cfs @ 7.95 hrs, Volume = 0.215 af, Depth = 0.73"
Routed to Reach 3R: Gutter

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span = 1.00-48.00 hrs, dt = 0.05 hrs
Type IA 24-hr 25 year Rainfall = 2.20"

<table>
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<tr>
<th>Area (ac)</th>
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<tbody>
<tr>
<td>3.510</td>
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<td>1/3 acre lots, 30% imp., HSG C</td>
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<td>2.457</td>
<td>81</td>
<td>70.00% Pervious Area</td>
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<tr>
<td>1.053</td>
<td>81</td>
<td>30.00% Impervious Area</td>
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<table>
<thead>
<tr>
<th>Tc (min)</th>
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<th>Slope (ft/ft)</th>
<th>Velocity (ft/sec)</th>
<th>Capacity (cfs)</th>
<th>Description</th>
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<tbody>
<tr>
<td>0.4</td>
<td>60</td>
<td>0.0200</td>
<td>2.28</td>
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<td>Shallow Concentrated Flow, Shallow Concentrated Flow</td>
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<tr>
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<td></td>
<td>Unpaved Kv = 16.1 fps</td>
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<tr>
<td>1.4</td>
<td>665</td>
<td>0.0130</td>
<td>7.70</td>
<td>3.85</td>
<td>Channel Flow,</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Area = 0.5 sf, Perim = 1.1', r = 0.45'</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>n = 0.013 Concrete, trowel finish</td>
</tr>
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</table>

| 1.8      | 725           | Total                     |

Subcatchment 1S: Subdivision

Hydrograph

Type IA 24-hr 25 year Rainfall = 2.20"
Runoff Area = 3.510 ac
Runoff Volume = 0.215 af
Runoff Depth = 0.73"
Flow Length = 725'
Tc = 1.8 min
CN = 81
Summary for Subcatchment 3S: Back Yards

Runoff = 0.05 cfs @ 8.14 hrs, Volume= 0.043 af, Depth= 0.45"
Routed to Reach 4R : Backyard flow

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-48.00 hrs, dt= 0.05 hrs
Type IA 24-hr 25 year Rainfall=2.20"

<table>
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<tr>
<th>Area (ac)</th>
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<th>Description</th>
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<tbody>
<tr>
<td>1.150</td>
<td>74</td>
<td>&gt;75% Grass cover, Good, HSG C</td>
</tr>
<tr>
<td>1.150</td>
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<td>100.00% Pervious Area</td>
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<th>Tc (min)</th>
<th>Length (feet)</th>
<th>Slope (ft/ft)</th>
<th>Velocity (ft/sec)</th>
<th>Capacity (cfs)</th>
<th>Description</th>
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<tbody>
<tr>
<td>13.6</td>
<td>649</td>
<td>0.0130</td>
<td>0.80</td>
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<td>Shallow Concentrated Flow, Backyards</td>
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<tr>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>Short Grass Pasture , Kv= 7.0 fps</td>
</tr>
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Subcatchment 3S: Back Yards

Hydrograph

Type IA 24-hr
25 year Rainfall=2.20"
Runoff Area=1.150 ac
Runoff Volume=0.043 af
Runoff Depth=0.45"
Flow Length=649'
Slope=0.0130 '/'
Tc=13.6 min
CN=74
Summary for Subcatchment 4S: Field

Runoff = 0.41 cfs @ 8.09 hrs, Volume= 0.172 af, Depth= 0.84"
Routed to Reach 3R : Gutter

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-48.00 hrs, dt= 0.05 hrs
Type IA 24-hr 25 year Rainfall=2.20"

<table>
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<tr>
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<th>Description</th>
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<td>2.470</td>
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<td>2.470</td>
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<td>100.00% Pervious Area</td>
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<table>
<thead>
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<th>Tc (min)</th>
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<th>Slope (ft/ft)</th>
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<tbody>
<tr>
<td>15.6</td>
<td>800</td>
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<td>0.86</td>
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<td>Shallow Concentrated Flow, Field</td>
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<td></td>
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<td>Short Grass Pasture Kv= 7.0 fps</td>
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Subcatchment 4S: Field

Hydrograph

Type IA 24-hr
25 year Rainfall=2.20"
Runoff Area=2.470 ac
Runoff Volume=0.172 af
Runoff Depth=0.84"
Flow Length=800'
Slope=0.0150 '/'
Tc=15.6 min
CN=83
Summary for Reach 3R: Gutter

Inflow Area = 5.980 ac, 17.61% Impervious, Inflow Depth = 0.78" for 25 year event
Inflow = 0.89 cfs @ 7.98 hrs, Volume = 0.387 af
Outflow = 0.84 cfs @ 8.12 hrs, Volume = 0.387 af, Atten = 6%, Lag = 8.2 min
Routed to Pond 2P: POND A

Routing by Stor-Ind+Trans method, Time Span = 1.00-48.00 hrs, dt = 0.05 hrs
Max. Velocity = 2.03 fps, Min. Travel Time = 5.7 min
Avg. Velocity = 1.29 fps, Avg. Travel Time = 9.1 min

Peak Storage = 290 cf @ 8.02 hrs
Average Depth at Peak Storage = 0.10', Surface Width = 6.64'
Bank-Full Depth = 0.50' Flow Area = 7.1 sf, Capacity = 37.59 cfs

1.50' x 0.50' deep channel, n = 0.013 Concrete, trowel finish
Side Slope Z-value = 0.5 50.0 '/' Top Width = 26.75'
Length = 700.0' Slope = 0.0130 '/'
Inlet Invert = 1,011.10', Outlet Invert = 1,002.00'

Reach 3R: Gutter

Hydrograph

Inflow Area = 5.980 ac
Avg. Flow Depth = 0.10'
Max Vel = 2.03 fps
n = 0.013
L = 700.0'
S = 0.0130 '/'
Capacity = 37.59 cfs
Summary for Reach 4R: Backyard flow

Inflow Area = 1.150 ac, 0.00% Impervious, Inflow Depth = 0.45" for 25 year event
Inflow = 0.05 cfs @ 8.14 hrs, Volume= 0.043 af
Outflow = 0.03 cfs @ 21.74 hrs, Volume= 0.042 af, Atten= 40%, Lag= 815.8 min
Routed to Pond 2P : POND A

Routing by Stor-Ind+Trans method, Time Span= 1.00-48.00 hrs, dt= 0.05 hrs
Max. Velocity= 0.05 fps, Min. Travel Time= 212.6 min
Avg. Velocity = 0.03 fps, Avg. Travel Time= 328.1 min

Peak Storage= 401 cf @ 18.19 hrs
Average Depth at Peak Storage= 0.02', Surface Width= 32.00'
Bank-Full Depth= 0.50' Flow Area= 27.5 sf, Capacity= 9.53 cfs

30.00' x 0.50' deep channel, n= 0.240 Sheet flow over Dense Grass
Side Slope Z-value= 50.0 '/' Top Width= 80.00'
Length= 649.0' Slope= 0.0130 '/'
Inlet Invert= 1,010.44', Outlet Invert= 1,002.00'

Reach 4R: Backyard flow

Flow Area=1.150 ac
Avg. Flow Depth=0.02'
Max Vel=0.05 fps
n=0.240
L=649.0'
S=0.0130 '/'
Capacity=9.53 cfs
Summary for Pond 2P: POND A

Inflow Area = 7.130 ac, 14.77% Impervious, Inflow Depth > 0.72" for 25 year event
Inflow = 0.84 cfs @ 8.12 hrs, Volume = 0.429 af
Outflow = 0.12 cfs @ 24.30 hrs, Volume = 0.367 af, Atten = 86%, Lag = 970.8 min
Primary = 0.12 cfs @ 24.30 hrs, Volume = 0.367 af

Routing by Stor-Ind method, Time Span = 1.00-48.00 hrs, dt = 0.05 hrs
Peak Elev = 1,001.27' @ 24.30 hrs Surf.Area = 9,574 sf Storage = 11,228 cf

Plug-Flow detention time = 830.6 min calculated for 0.367 af (86% of inflow)
Center-of-Mass det. time = 735.6 min \( (1,652.4 - 916.8) \)

<table>
<thead>
<tr>
<th>Volume</th>
<th>Invert</th>
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<th>Storage Description</th>
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<td>#1</td>
<td>1,000.00'</td>
<td>18,544 cf 90.23'W x 90.23'L x 2.00'H Prismatoid Z=3.0</td>
<td></td>
</tr>
</tbody>
</table>

Device Routing Invert Outlet Devices
#1 Primary 1,000.00' 0.500 in/hr Exfiltration over Surface area
Conductivity to Groundwater Elevation = 980.00'

Primary OutFlow Max = 0.12 cfs @ 24.30 hrs HW = 1,001.27' (Free Discharge)
Exfiltration (Controls 0.12 cfs)

Pond 2P: POND A

Inflow Area = 7.130 ac
Peak Elev = 1,001.27'
Storage = 11,228 cf
Time span=1.00-48.00 hrs, dt=0.05 hrs, 941 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: Subdivision**
- Runoff Area=3.510 ac  30.00% Impervious  Runoff Depth=1.01"
- Flow Length=725’  Tc=1.8 min  CN=81  Runoff=0.77 cfs 0.297 af

**Subcatchment3S: Back Yards**
- Runoff Area=1.150 ac  0.00% Impervious  Runoff Depth=0.67"
- Flow Length=649’  Slope=0.0130 ’/’  Tc=13.6 min  CN=74  Runoff=0.11 cfs 0.064 af

**Subcatchment4S: Field**
- Runoff Area=2.470 ac  0.00% Impervious  Runoff Depth=1.13"
- Flow Length=800’  Slope=0.0150 ’/’  Tc=15.6 min  CN=83  Runoff=0.59 cfs 0.233 af

**Reach 3R: Gutter**
- Avg. Flow Depth=0.12’  Max Vel=2.27 fps  Inflow=1.33 cfs 0.530 af
- n=0.013  L=700.0’  S=0.0130 ’/’  Capacity=37.59 cfs  Outflow=1.27 cfs 0.530 af

**Reach 4R: Backyard flow**
- Avg. Flow Depth=0.02’  Max Vel=0.06 fps  Inflow=0.11 cfs 0.064 af
- n=0.240  L=649.0’  S=0.0130 ’/’  Capacity=9.53 cfs  Outflow=0.05 cfs 0.063 af

**Pond 2P: POND A**
- Peak Elev=1,001.90’  Storage=17,503 cf  Inflow=1.27 cfs 0.593 af
- Outflow=0.13 cfs 0.407 af

**Total Runoff Area = 7.130 ac  Runoff Volume = 0.593 af  Average Runoff Depth = 1.00"**
85.23% Pervious = 6.077 ac    14.77% Impervious = 1.053 ac
Summary for Subcatchment 1S: Subdivision

[49] Hint: Tc<2dt may require smaller dt

Runoff = 0.77 cfs @ 7.94 hrs, Volume= 0.297 af, Depth= 1.01"
Routed to Reach 3R: Gutter

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-48.00 hrs, dt= 0.05 hrs
Type IA 24-hr 100 year Rainfall=2.60"

<table>
<thead>
<tr>
<th>Area (ac)</th>
<th>CN</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.510</td>
<td>81</td>
<td>1/3 acre lots, 30% imp. HSG C</td>
</tr>
<tr>
<td>2.457</td>
<td></td>
<td>70.00% Pervious Area</td>
</tr>
<tr>
<td>1.053</td>
<td></td>
<td>30.00% Impervious Area</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Tc (min)</th>
<th>Length (feet)</th>
<th>Slope (ft/ft)</th>
<th>Velocity (ft/sec)</th>
<th>Capacity (cfs)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.4</td>
<td>60</td>
<td>0.0200</td>
<td>2.28</td>
<td></td>
<td>Shallow Concentrated Flow, Shallow Concentrated Flow Unpaved Kv= 16.1 fps</td>
</tr>
<tr>
<td>1.4</td>
<td>665</td>
<td>0.0130</td>
<td>7.70</td>
<td>3.85</td>
<td><strong>Channel Flow</strong>, Area= 0.5 sf Perim= 1.1' r= 0.45' n= 0.013 Concrete, trowel finish</td>
</tr>
</tbody>
</table>

| 1.8      | 725          | Total        |

Subcatchment 1S: Subdivision

Hydrograph

Type IA 24-hr 100 year Rainfall=2.60"
Runoff Area=3.510 ac
Runoff Volume=0.297 ac
Runoff Depth=1.01"
Flow Length=725'
Tc=1.8 min
CN=81
Summary for Subcatchment 3S: Back Yards

Runoff = 0.11 cfs @ 8.10 hrs, Volume= 0.064 ac, Depth= 0.67"  
Routed to Reach 4R: Backyard flow

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-48.00 hrs, dt= 0.05 hrs  
Type IA 24-hr 100 year Rainfall=2.60"

<table>
<thead>
<tr>
<th>Area (ac)</th>
<th>CN</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.150</td>
<td>74</td>
<td>&gt;75% Grass cover, Good, HSG C</td>
</tr>
<tr>
<td>1.150</td>
<td>100.00% Pervious Area</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Tc (min)</th>
<th>Length (feet)</th>
<th>Slope (ft/ft)</th>
<th>Velocity (ft/sec)</th>
<th>Capacity (cfs)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>13.6</td>
<td>649</td>
<td>0.0130</td>
<td>0.80</td>
<td></td>
<td>Shallow Concentrated Flow, Backyards</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Short Grass Pasture, Kv= 7.0 fps</td>
</tr>
</tbody>
</table>

Subcatchment 3S: Back Yards

Hydrograph

Type IA 24-hr  
100 year Rainfall=2.60"  
Runoff Area=1.150 ac  
Runoff Volume=0.064 ac  
Runoff Depth=0.67"  
Flow Length=649'  
Slope=0.0130 '/'  
Tc=13.6 min  
CN=74
Summary for Subcatchment 4S: Field

Runoff = 0.59 cfs @ 8.08 hrs, Volume = 0.233 ac, Depth = 1.13"
Routed to Reach 3R : Gutter

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span = 1.00-48.00 hrs, dt = 0.05 hrs
Type IA 24-hr 100 year Rainfall = 2.60"

<table>
<thead>
<tr>
<th>Area (ac)</th>
<th>CN</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.470</td>
<td>83</td>
<td>Legumes, contoured, Poor, HSG C</td>
</tr>
<tr>
<td>2.470</td>
<td></td>
<td>100.00% Pervious Area</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Tc (min)</th>
<th>Length (feet)</th>
<th>Slope (ft/ft)</th>
<th>Velocity (ft/sec)</th>
<th>Capacity (cfs)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>15.6</td>
<td>800</td>
<td>0.0150</td>
<td>0.86</td>
<td></td>
<td>Shallow Concentrated Flow, Field</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Short Grass Pasture</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Kv = 7.0 fps</td>
</tr>
</tbody>
</table>

Subcatchment 4S: Field

Type IA 24-hr
100 year Rainfall = 2.60"
Runoff Area = 2.470 ac
Runoff Volume = 0.233 ac
Runoff Depth = 1.13"
Flow Length = 800'
Slope = 0.0150 '/'
Tc = 15.6 min
CN = 83
Summary for Reach 3R: Gutter

Inflow Area = 5.980 ac, 17.61% Impervious, Inflow Depth = 1.06" for 100 year event
Inflow = 1.33 cfs @ 7.98 hrs, Volume= 0.530 af
Outflow = 1.27 cfs @ 8.09 hrs, Volume= 0.530 af, Atten= 5%, Lag= 7.0 min
Routed to Pond 2P : POND A

Routing by Stor-Ind+Trans method, Time Span= 1.00-48.00 hrs, dt= 0.05 hrs
Max. Velocity= 2.27 fps, Min. Travel Time= 5.1 min
Avg. Velocity = 1.38 fps, Avg. Travel Time= 8.4 min

Peak Storage= 394 cf @ 8.01 hrs
Average Depth at Peak Storage= 0.12', Surface Width= 7.69'
Bank-Full Depth= 0.50' Flow Area= 7.1 sf, Capacity= 37.59 cfs

1.50' x 0.50' deep channel, n= 0.013 Concrete, trowel finish
Side Slope Z-value= 0.5 50.0 '/' Top Width= 26.75'
Length= 700.0' Slope= 0.0130 '/'
Inlet Invert= 1,011.10', Outlet Invert= 1,002.00'

Reach 3R: Gutter
Hydrograph

Inflow Area=5.980 ac
Avg. Flow Depth=0.12'
Max Vel=2.27 fps
n=0.013
L=700.0'
S=0.0130 '/'
Capacity=37.59 cfs
Summary for Reach 4R: Backyard flow

Inflow Area = 1.150 ac, 0.00% Impervious, Inflow Depth = 0.67" for 100 year event
Inflow = 0.11 cfs @ 8.10 hrs, Volume = 0.064 af
Outflow = 0.05 cfs @ 19.01 hrs, Volume = 0.063 af, Atten= 59%, Lag= 654.8 min
Routed to Pond 2P : POND A

Routing by Stor-Ind+Trans method, Time Span= 1.00-48.00 hrs, dt= 0.05 hrs
Max. Velocity= 0.06 fps, Min. Travel Time= 184.7 min
Avg. Velocity = 0.04 fps, Avg. Travel Time= 293.0 min

Peak Storage= 503 cf @ 15.94 hrs
Average Depth at Peak Storage= 0.02', Surface Width= 32.48'
Bank-Full Depth= 0.50' Flow Area= 27.5 sf, Capacity= 9.53 cfs

30.00' x 0.50' deep channel, n= 0.240 Sheet flow over Dense Grass
Side Slope Z-value= 50.0 '/' Top Width= 80.00'
Length= 649.0' Slope= 0.0130 '/'
Inlet Invert= 1,010.44', Outlet Invert= 1,002.00'

†

Reach 4R: Backyard flow

Hydrograph

Inflow Area=1.150 ac
Avg. Flow Depth=0.02'
Max Vel=0.06 fps
n=0.240
L=649.0'
S=0.0130 '/'
Capacity=9.53 cfs
Summary for Pond 2P: POND A

Inflow Area = 7.130 ac, 14.77% Impervious, Inflow Depth > 1.00" for 100 year event
Inflow = 1.27 cfs @ 8.09 hrs, Volume= 0.593 af
Outflow = 0.13 cfs @ 24.33 hrs, Volume= 0.407 af, Atten= 90%, Lag= 974.3 min
Primary = 0.13 cfs @ 24.33 hrs, Volume= 0.407 af

Routing by Stor-Ind method, Time Span= 1.00-48.00 hrs, dt= 0.05 hrs
Peak Elev= 1,001.90' @ 24.33 hrs Surf.Area= 10,328 sf Storage= 17,503 cf

Plug-Flow detention time= 944.9 min calculated for 0.406 af (69% of inflow)
Center-of-Mass det. time= 757.3 min (1,649.1 - 891.8)

<table>
<thead>
<tr>
<th>Volume</th>
<th>Invert</th>
<th>Avail. Storage</th>
<th>Storage Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>#1</td>
<td>1,000.00'</td>
<td>18,544 cf</td>
<td>90.23'W x 90.23'L x 2.00'H Prismatoid Z=3.0</td>
</tr>
</tbody>
</table>

Device Routing Invert Outlet Devices
#1 Primary 1,000.00' 0.500 in/hr Exfiltration over Surface area
Conductivity to Groundwater Elevation = 980.00'

Primary OutFlow Max=0.13 cfs @ 24.33 hrs HW=1,001.90' (Free Discharge)
= Exfiltration (Controls 0.13 cfs)

Pond 2P: POND A

Hydrograph

Inflow Area=7.130 ac
Peak Elev=1,001.90'
Storage=17,503 cf
GEOTECHNICAL REPORT
Geotechnical Engineering Report
Crestview Estates 1st Addition
Ash Street and Tieton Avenue
Spokane County, Washington

Prepared For:
Austin J Fuller
Whipple Consulting Engineers, Inc.
21 South Pines Road
Spokane Valley, Washington 99206

Prepared By:

Liberty Geotechnical Engineering, Inc.
3012 N Sullivan Rd
Spokane Valley, Washington 99216
(509) 213-0400

Report Date: April 5, 2022
Job Number: 21425
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Appendices
Appendix A: Exploration Site Plan
Appendix B: Subsurface Exploration Logs
Appendix C: Photo Log
1.0 EXECUTIVE SUMMARY

The following geotechnical engineering report has been prepared for Crestview Estates 1st Addition in Ash Street, Spokane County, Washington. The following items have been identified at the project site and proposed construction that should be carefully considered during design and construction:

- Standing water was observed within the existing drywells located at the site. This may be due to fluctuations of groundwater and perching between the topsoil or undocumented fill, and bedrock at the site.
- Swales consisting of single or double-depth drywells were not feasible across the site due to the limiting layer of shallow bedrock. Drainage retention swales are recommended to treat and retain the stormwater.
- The area appears to be a stormwater disposal facility. Drain rock, filter fabric and drywells were observed in the area.
- Undocumented fill was observed in both test pits to a depth of 1 1/2- to 2-feet below the ground surface. Undocumented fill may be reused as Embankment Fill provided it meets the requirements of Table 4.1.2.A of this report.

Liberty Geotech should be involved in the design development and earthwork construction to help ensure that the report recommendations are incorporated into the design and construction. Liberty Geotech is available to discuss these items further in-person or via a conference call.

2.0 PROPOSED CONSTRUCTION

The proposed construction consists of a stormwater drainage facility. Stormwater disposal will consist of swales and typical single or double-depth drywells position within the swale areas. The recommendations included in this report are based on a plat map prepared by Taylor Engineering, Inc. dated October 10, 2003.

3.0 GEOTECHNICAL EXPLORATION

Subsurface exploration was performed by excavating two test pits with a SANY SY26U mini-excavator. Subsurface exploration was performed at the project site on December 2, 2021. The test pits were excavated through the topsoil, undocumented fill, and bedrock and terminated on the rock surface. The contractor or client is recommended to notify Liberty Geotech if the soil conditions are different from those described in the following sections.

Throughout this report, test pits are abbreviated TP and are hyphenated with a numbering system that corresponds to Appendix A: Exploration Site Plan and Appendix B: Subsurface Exploration Results. The test pits depicted in Appendix A were located using the accuracy of a cell phone location system. The locations were not surveyed and the accuracy is expected to be
within 10-feet of the depicted location. Also, the elevation of each test pit was estimated using Google Earth™ mapping service with the GWS84 EGM96 geoid.

3.1 Geology, Topography, and Current Site Use

The Geologic map of the Spokane Northwest 7.5-minute quadrangle, Spokane County, Washington (Derkey, 2004) was reviewed to determine the geologic deposit at the site. The geologic map indicated that the geologic unit was the Priest Rapids Member of the Wanapum Basalt, Columbia River Basalt Group (middle Miocene). In addition, the United States Department of Agriculture (USDA), Natural Resources Conservation Service (NRCS) Web Soil Survey (NRCS, 2021) was reviewed. The soil survey indicates that the soil unit is the Urban land-Seaboldt, warm, disturbed-Brincken, moist, disturbed complex consisting of ashy loam from the ground surface to a depth of 10 inches, loam from 10 inches to 16 inches, sandy loam from 16 inches to 23 inches, extremely gravelly sandy loam from 23 inches to 28 inches, and bedrock from 28 inches to 38 inches. The soil survey describes the soil as loess mixed with minor amounts of volcanic ash over glaciofluvial deposits over residuum from basalt.

The two lots have existing drainage swales and both with a single-depth drywell. According to the historical aerial images, the earthwork construction for the residential development within the site’s vicinity was between 2003 to 2006. The existing swales and drywells appeared to be placed within the site during that time. In addition, based on the topography obtained from Google Earth™, the site is relatively level with approximately five to seven feet of relief across the site.

3.2 Summary of Soil and Rock Encountered During Exploration

The soil encountered during the exploration is generally consistent with the geologic research. However, both test pits observed undocumented fill to depths of 2 ½- to 3-feet below the ground surface. The test pits encountered one foot of topsoil overlying a separation fabric overlying drain rock with a separation fabric overlying bedrock.

3.3 Estimated Groundwater and Bedrock Elevations

Groundwater was not observed in both test pits. However, there was standing water at the drywells during the exploration. This may be due to fluctuations of groundwater and perching between the topsoil and bedrock at the site.

According to the well logs in the vicinity of the site (Ecology), the static water level is approximately 37-feet below the ground surface. Seasonal and annual fluctuations in groundwater levels should be anticipated.

Both test pits met refusal due to basalt bedrock to depths ranging from three to four feet below the ground surface. In TP-2, residual bedrock was observed 2 ½-feet below the ground surface.
4.0 GEOTECHNICAL RECOMMENDATIONS

4.1 Earthwork

The following recommendations should be considered by the general contractors and earthwork subcontractors prior to providing a cost estimate for the earthwork on the project.

4.1.1 Subgrade Preparation

Clear and grub all vegetation, strip all topsoil. Topsoil and undocumented fill removal are estimated to be one to three feet across the site.

Liberty Geotech should be contacted once the subgrade areas have been exposed to review the subgrade conditions.

4.1.2 Earthwork Soil Products, Compaction, and Testing Frequency

Different soil products should be used for different applications. The following table presents recommendations for anticipated earthwork construction:

<table>
<thead>
<tr>
<th>Soil Product</th>
<th>Project Use</th>
<th>Soil Description</th>
</tr>
</thead>
</table>
| Embankment Fill   | • Utility trench backfill | Soil classified as:
|                   |                           |   • GP-GM or GW-GM
|                   |                           |   • GM
|                   |                           |   • SP-SM or SW-SM
|                   |                           |   • SM
|                   |                           |   • ML
|                   |                           | Soil should have less than 6% organic deleterious material, and all material larger than 3-inches in diameter. |

The following table provides compaction recommendations specific to ASTM D1557 Laboratory Compaction Characteristics of Soil Using Modified Effort. All fill products should be compacted in lifts of soil not exceeding 12 inches measured prior to compaction.

<table>
<thead>
<tr>
<th>Project Use</th>
<th>Recommended Compaction</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Exterior wall backfill.</td>
<td>92 percent of the maximum dry density of Modified Proctor.</td>
</tr>
<tr>
<td>• Utility trench backfills.</td>
<td></td>
</tr>
<tr>
<td>• Non-structural fill areas.</td>
<td>80 to 85 percent of the maximum</td>
</tr>
</tbody>
</table>
Vegetated areas. dry density of Modified Proctor.

If more than 30 percent of native or imported Structural Fill material is retained on the ¾” sieve, ASTM D1557 Laboratory Compaction Characteristics of Soil Using Modified Effort is not recommended to be used. In this case, a soil-specific method specification can be developed. A nuclear density gauge can be used during earthwork operations to establish a moisture and compaction method that provides an acceptable maximum dry density. Method specification earthwork operations are recommended to have full-time soil testing to ensure adequate compaction.

The soil products are recommended to have passing compaction testing results at the following frequency to ensure the soil is uniformly meeting compaction requirements. Failing test results should be retested after additional compactive effort and, if necessary, water is added. At least 90% of the compaction testing results must achieve the required maximum dry density.

**Table 4.1.2.C - Testing Frequency.**

<table>
<thead>
<tr>
<th>Project Use</th>
<th>Testing Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Utility trenches for every two vertical feet of trench backfill.</td>
<td>100 lineal feet and a minimum of 2 tests.</td>
</tr>
</tbody>
</table>

The jurisdictional requirements should be conformed to if there is a conflict with the requirements of Table 5.1.2.C. Excavations deeper than four feet must have adequate trenching protection or be sloped back in accordance with state and federal requirements in order to be compaction tested.

### 4.2 Drainage and Stormwater Infiltration Recommendations

Drainage retention swales may be utilized to treat and retain stormwater. The following recommendations should be used by the civil engineer to retention swales:

- The depth to a restrictive layer is at least three feet below the ground surface based on the shallow bedrock encountered at the site during the exploration.
- Swales should be located 10-feet from the edge of buildings and concrete hardscapes to minimize the effects of retention.

### 5.0 DESIGN REVIEW AND CONSTRUCTION OBSERVATIONS

#### 5.1 Geotechnical Consultant versus Geotechnical Inspector

In order to retain Liberty Geotech as the geotechnical engineer of record, the client must contact Liberty Geotech or require their contractor to contact Liberty Geotech to perform the observations and notifications that are recommended within this report. Liberty Geotech is not the engineer of record and has no liability for the construction or design based on this report if
observations and material testing are not performed and meet the recommendations contained within this report. In addition, Liberty Geotech's liability is limited to the authorized proposal dated November 24, 2021.

5.2 Revisions and Transfer of Geotechnical Recommendations

Liberty Geotech should be notified to update recommendations if the proposed development changes or subsurface soil or groundwater conditions vary from those described in this report. This report cannot be relied upon by property owners adjacent to this property without confirmation of their specific site soil conditions. Also, the report recommendations cannot be transferred to other business entities or subsequent property owners without written authorization. No warranty or certification of construction is provided with this report. Liberty Geotech should review the final construction drawings to confirm the incorporation of the recommendations of this report.

7.0 REFERENCES

ACI Committee 302. “Guide for Concrete Floor and Slab Construction.” ACI 302.1R-15. American Concrete Institute, P.O. Box 19150 Redford Station, Detroit, Michigan 48219.


APPENDIX B

Subsurface Exploration Logs
### Unified Soil Classification System

<table>
<thead>
<tr>
<th>MAJOR DIVISIONS</th>
<th>GRAPHIC SYMBOL</th>
<th>USCS GROUP SYMBOL</th>
<th>SOIL DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>CLEAN GRAVEL</td>
<td></td>
<td>GW</td>
<td>WELL-GRADED GRAVEL</td>
</tr>
<tr>
<td></td>
<td></td>
<td>GP</td>
<td>POORLY-GRADED GRAVEL</td>
</tr>
<tr>
<td>GRASS WITH FINES</td>
<td></td>
<td>GM</td>
<td>SILTY GRAVEL</td>
</tr>
<tr>
<td></td>
<td></td>
<td>GC</td>
<td>CLAYEY GRAVEL</td>
</tr>
<tr>
<td>CLEAN SAND</td>
<td></td>
<td>SW</td>
<td>WELL-GRADED SAND</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SP</td>
<td>POORLY-GRADED SAND</td>
</tr>
<tr>
<td>SAND WITH FINES</td>
<td></td>
<td>SM</td>
<td>SILTY SAND</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SC</td>
<td>CLAYEY SAND</td>
</tr>
<tr>
<td>SILT AND CLAY LIQUID LIMIT LESS THAN 50%</td>
<td>ML</td>
<td>INELASTIC SILT</td>
<td></td>
</tr>
<tr>
<td></td>
<td>CL</td>
<td>LEAN CLAY</td>
<td></td>
</tr>
<tr>
<td></td>
<td>OL</td>
<td>ORGANIC SILT</td>
<td></td>
</tr>
<tr>
<td>SILT AND CLAY LIQUID LIMIT GREATER THAN 50%</td>
<td>MH</td>
<td>ELASTIC SILT</td>
<td></td>
</tr>
<tr>
<td></td>
<td>CH</td>
<td>FAT CLAY</td>
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<tr>
<td></td>
<td>OH</td>
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</tr>
<tr>
<td></td>
<td>PT</td>
<td>PEAT</td>
<td></td>
</tr>
</tbody>
</table>

**Abbreviations**
- BGS - BELOW EXISTING GROUND SURFACE
- N.E. - NOT ENCOUNTERED
<table>
<thead>
<tr>
<th>USCS DESCRIPTION</th>
<th>ELEVATION (Ft)</th>
<th>DEPTH (Ft)</th>
<th>LITHOLOGY</th>
<th>SAMPLE INTERVAL</th>
<th>PERCENT PASSING 20MM</th>
<th>DRY DENSITY (pcf)</th>
<th>MOISTURE CONTENT (%)</th>
<th>VOID RATIO (%)</th>
<th>ADDITIONAL NOTES</th>
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<tbody>
<tr>
<td>TOPEOIL - Well-Graded Sand with Silt (SW-SM) Medium Dense, Brown, Moist</td>
<td>2385</td>
<td>-</td>
<td>-</td>
<td>0-3</td>
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<td>-</td>
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<td>-</td>
<td>1-foot treatment soil overlying geo fabric overlying drain rock overlying bedrock.</td>
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<tr>
<td>UNDOCUMENTED FILL - Well-Graded Gravel (GW) Medium Dense, Black, Moist</td>
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<td>3</td>
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<td>Test pit terminated at 3-feet bgs due to bedrock.</td>
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<table>
<thead>
<tr>
<th>USCS DESCRIPTION</th>
<th>ELEVATION (FT)</th>
<th>DEPTH (FT)</th>
<th>SAMPLE INTERVAL</th>
<th>POCKET PEN (TSF)</th>
<th>% PASSING 200 MESH</th>
<th>DRY DENSITY (PCF)</th>
<th>MOISTURE CONTENT (%)</th>
<th>VOID RATIO (%)</th>
<th>ADDITIONAL NOTES</th>
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</thead>
<tbody>
<tr>
<td>TOPSOIL - Well-Graded Sand with Silt (SW-SM) Medium Dense, Brown, Moist</td>
<td>2385</td>
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<td>-</td>
<td>-</td>
<td>1-foot treatment soil overlying geofabric overlying drain rock overlying geofabric overlying bedrock, Drain rock.</td>
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<tr>
<td>BEDROCK - Well-Graded Gravel (GW) Very Dense, Black, Dry</td>
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<td>4</td>
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</table>

Test pit terminated at 4-feet bgs due to bedrock.
APPENDIX C

Photo Log
Appendix C: Photo Log

PHOTO 1: TP-1 LOCATION

PHOTO 2: GEOFABRIC WITHIN TP-1

PHOTO 3: TP-1 EXCAVATED SOILS

PHOTO 4: BOULDERS WITHIN TP-1
Appendix C: Photo Log

PHOTO 5: TP-1 STANDING WATER WITHIN DRYWELL

PHOTO 6: TP-2 LOCATION

PHOTO 7: TP-2 EXCAVATED SOILS AND BOULDERS

PHOTO 8: GEOFABRIC WITHIN TP-2
TAYLOR 1996 STORM REPORT
Underground Injection Control

Non-Municipal Stormwater

For UIC stormwater wells used along roads and in parking lots not owned by a county or city.

Registration Status

Site Number: 38047
Authorization Status: Pending
Comments:

Facility/Site Information

Facility Name: Crestview Homeowners Association
Address: 8205 N Division St
PO Box/Suite/Building:
City: Spokane
State: WA 99208
Phone: 509-458-5542
County: Spokane

Contact Information

Well Owner

Name: Terry Tombari
Organization: Crestview Homeowners Association
Address: 8205 N Division St
PO Box/Suite/Building:
City: SPokane
State: WA 99208
Email: terry@tombariproperties.com
Phone: 509-458-5542

Property Owner

Name: Terry Tombari
Organization: Crestview Homeowners Association
Address: 8205 N Division St
PO Box/Suite/Building:
City: Spokane
State: WA 99208
Email: terry@tombariproperties.com
Phone: 509-458-5542

Technical Contact

Name: Elliott Whipple
Organization: Whipple Consulting Engineers
Address: 21 S Pines Rd
PO Box/Suite/Building:
City: Spokane Valley
State: WA 99206
Email: ewhipple@whipplece.com
Phone: 509-893-2617

Main Well Information

<table>
<thead>
<tr>
<th>Well Name</th>
<th>Right-of-Way Location</th>
<th>Construction Date</th>
<th>EPA Well Type</th>
<th>Status</th>
<th>UIC Construction Type</th>
<th>Depth of UIC Well (ft.)</th>
<th>Latitude</th>
<th>Longitude</th>
<th>Google Map Link</th>
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<tr>
<td>02</td>
<td>Stormwater (residential, paved streets, roofs, parking lots)</td>
<td>6/1/2003</td>
<td>Proposed Manhole with perforated pipe</td>
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<tr>
<td>Well Name</td>
<td>Right-of-way Location</td>
<td>Construction Date</td>
<td>EPA Well Type</td>
<td>Status</td>
<td>UIC Construction Type</td>
<td>Depth of UIC Well (ft.)</td>
<td>Latitude</td>
<td>Longitude</td>
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<tr>
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<td>Stormwater (residential, paved streets, roofs, parking lots)</td>
<td>6/1/2003</td>
<td>Proposed</td>
<td>Manhole with perforated pipe</td>
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<td>47.739003,-117.435650</td>
<td><a href="https://google.com/maps/place/47.739003,-117.435650/@47.739003,-117.435650">https://google.com/maps/place/47.739003,-117.435650/@47.739003,-117.435650</a></td>
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**Main Well Information (cont.)**

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<th>Well Name</th>
<th>IT constructed in accordance with approved stormwater manual?</th>
<th>Within 1000 feet of surface water?</th>
<th>Within 100 feet of a drinking water well or spring?</th>
<th>Is High Susceptible Aquifer?</th>
<th>Is Confining Layer Present?</th>
<th>Zoning</th>
<th>Within a Ground Water Protection Area?</th>
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<td>02</td>
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<td>N</td>
<td>Y</td>
<td>Y</td>
<td>Residential</td>
<td>Critical Aquifer Recharge Area</td>
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<tr>
<td>01</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>Residential</td>
<td>Critical Aquifer Recharge Area</td>
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**Documents**

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<th>Document Type</th>
<th>Document</th>
<th>Uploaded By</th>
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<tr>
<td>Miscellaneous Support Documents</td>
<td>ENG - Street, 2003070, ASH, STRONG, STREET PLAN AND PROFILE.pdf</td>
<td>whipplice on 9/5/2023 11:52:10 AM</td>
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<tr>
<td>UIC Drainage Plans</td>
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UIC Registration Signature Page

Site Number: 38047

I hereby certify that the information contained in the above referenced registration is true and correct to the best of my knowledge.

Elliott Whipple
Name of legally authorized representative

[Signature]
Signature of legally authorized representative

[Signature]
Title

09/05/2023
Date