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POST CONSTRUCTION STORMWATER MANAGEMENT REPORT
120 VERANDA STREET
PORTLAND, MAINE
February 22, 2012 (Revised May 5th, 2014)

INTRODUCTION

The subject property (the Site) is located at 120 Veranda Street in Portland, Maine. The stormwater runoff from this project discharges via overland sheet flow to the northwest of the property where it drains along the abutting property line, eventually draining to the enclosed drainage system with Hodgins Street.

The original site was approximately 18,094 ± square feet with a two-story, single family structure featuring associated driveway and walks. The owner has subdivided the property into three separate, single-family lots; one with the existing single-family home and the remaining two will have single-family structures constructed with associated driveways and site features. This report discusses the Site's hydrological conditions and compares stormwater runoff between existing and proposed conditions.

DATA COLLECTION AND ASSUMPTIONS

Site Data was gathered from an on Site survey performed by Nadeau Land Surveys in March, 2011, as well as utility information on record at the City of Portland. Additionally, site visits to confirm existing conditions were performed in February and December, 2013. This data was used to create a HydroCAD stormwater model, which is based on the United States Department of Agriculture's (USDA) Technical Release 20 (TR-20) and Technical Release 55 (TR-55) hydraulic programs.

Curve numbers (CN's) assigned to differing land cover and soil types were taken from tables within the HydroCAD software, which are from the SCS TR-55 manual, revised 1986. Twenty-four-hour rainfall depths were taken from *Stormwater Management for Maine: Volume III BMP's Technical Design Manual, January 2006*. Time of concentrations were calculated with the HydroCAD software using the TR-55 methodologies including direct entry.

780 Broadway
South Portland, ME · 04106
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The existing and proposed watershed subcatchments for this analysis are shown on attached Drawing, D-100, entitled "Pre and Post Development Drainage". The attached HydroCAD output summarizes modeling assumptions for both the pre-development and post-development conditions.

EXISTING SITE CONDITIONS

Land cover at the Site has been modeled as grass/open space and impervious. We have classified the existing structures and driveways as impervious area. For existing conditions, the total Site impervious area is 2,385 ± square feet.

Site topography generally slopes towards the northwest corner of the property. Slopes are generally mild to moderate. Stormwater runoff from the Site travels via overland flow from southeast to northwest.

According to the United States Department of Agriculture and Soil Conservation Service Soil Survey for Cumberland County, on Site soils are reported as "Elmwood", which has a "C" Hydrological Soil Grouping (HSG) classification. "Elmwood" soils are moderately to poorly draining, with a moderate to high rate of stormwater run-off.

PROPOSED SITE CONDITIONS

The proposed improvements include the creation of two new single family lots with construction of two residences with associated driveway and two small grass underdrainded soil filters to mitigate stormwater impacts. Land cover changes include converting grass areas to impervious areas. The proposed improvements will result in 6,427 ± square feet of impervious area, an increase of 4,042 ± square feet from pre-development conditions. Refer to the aforementioned Drawing and HydroCAD model for details of proposed Site improvements.

Two underdrained soil filter beds are proposed, one for each new lot, to mitigate stormwater quality. These ponds have the storage capacity to retain and treat a combination of 4,062 square feet of new impervious area (see calculations and Drawing D-1). The filter beds have been designed per the guidelines as issued by the Maine Department of Environmental Protection in the most recently updated BMP manual (update as of December, 2012).

WATER QUALITY

The two small underdrained soil filter beds have been designed to attenuate stormwater flows from the proposed increase in impervious areas for the two added single-family lots. They have been sized to detain and treat the "first flush", or 1" of stormwater run-off. For general hydrologic modeling purposes, we have included an analysis for the 1" and 2-year storm events. The grading and design for the filter basins has been indicated on the attached Drawing D-100.

WATER QUANTITY

We have provided the hydrologic modeling for the 2, 10 and 25-year storm events. The points of analysis from pre-development to post-development have been altered due to the collection of treated stormwater near Veranda Street (Lot A). In the pre-development conditions, All on-site stormwater runoff drains to POA#1 in Hodgins Street. For the post-development conditions, POA#10 sees decreased flows for the 2, 10 and 25-year storms. POA#11 represents the flows from Lot A which drain via stormdrain to Veranda street. Due to the creation of the new analysis point in the post-development conditions, a waiver for an increase in peak flow stormwater runoff into the City of Portland Stormdrain System will be required. Considering the flow increases are small, and that the stormdrain is separated from the sewer, there will be no significant downstream effects. See Sheet D-100 for graphic representation.

A summary of peak flow analysis is below:

Table 1: Summary of Peak Flows

	Pre-Development			Post-Development		
Point of Analysis	**2-Year (cfs)**	**10-Year (cfs)**	**25-Year (cfs)**	**2-Year (cfs)**	**10-Year (cfs)**	**25-Year (cfs)**
POA1/10	0.45	0.97	1.23	0.45	0.86	1.06
POA11	n/a	n/a	n/a	0.04	0.15	0.24

CONCLUSIONS

The proposed stormwater design will use low impact development features, or Stormwater Best Management Practices (BMPs) such as the underdrained soil filters to receive and treat the initial 1", or "first flush", of stormwater runoff. These filter beds, as well as long-term and short-term erosion control measures, will mitigate stormwater runoff to the maximum extent practicable.

Stormwater related calculations and computer modeling are also included with this report.

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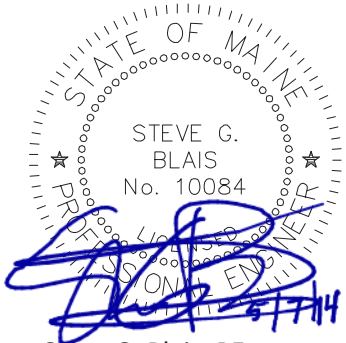
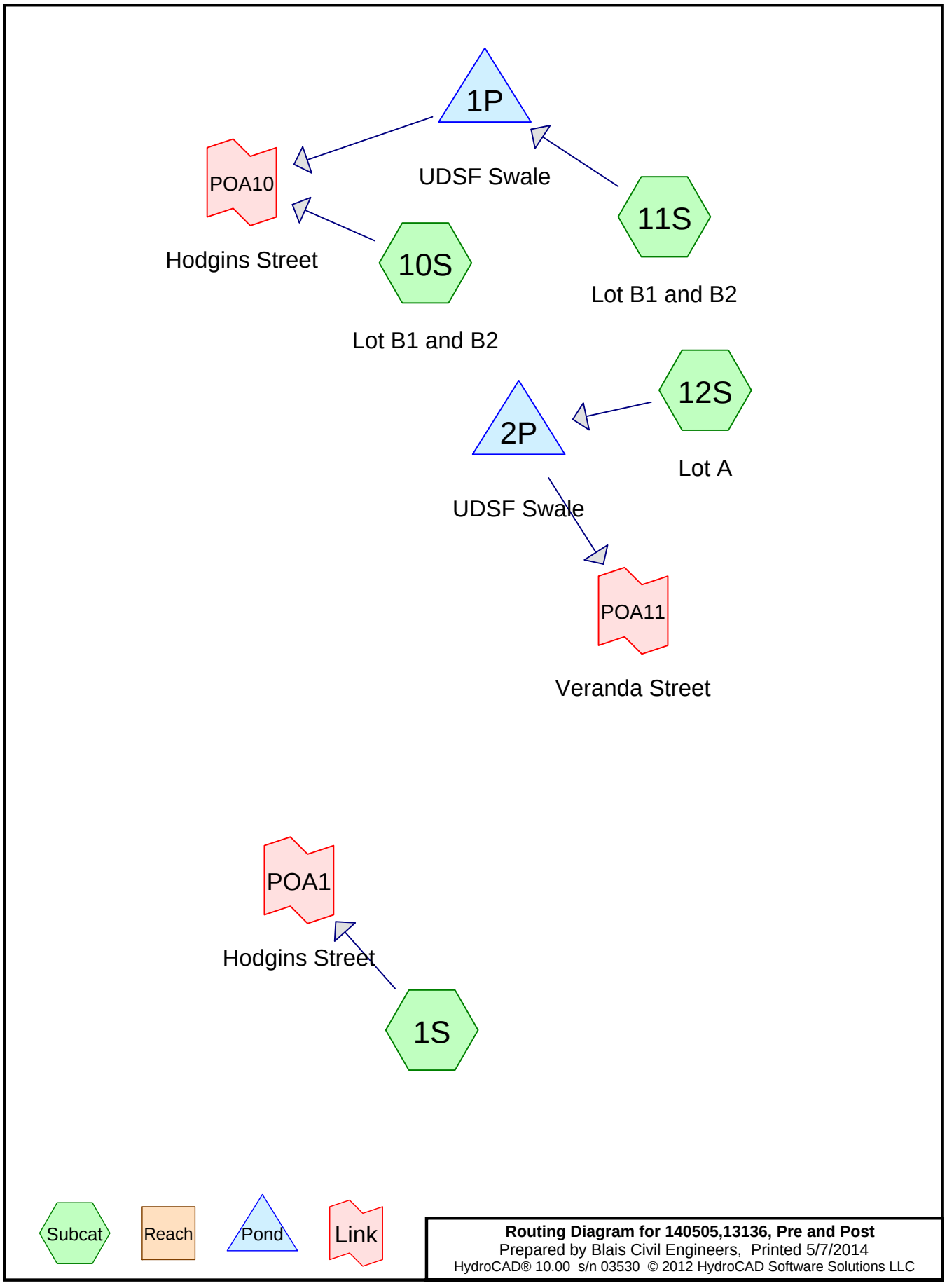


Steve G. Blais, PE
President



Routing Diagram for 140505,13136, Pre and Post
Prepared by Blais Civil Engineers, Printed 5/7/2014

Time span=0.00-30.00 hrs, dt=0.05 hrs, 601 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: Runoff Area=14,090 sf 22.96% Impervious Runoff Depth=1.25"
Flow Length=115' Slope=0.0200 '/' Tc=6.3 min CN=80 Runoff=0.45 cfs 0.034 af

Subcatchment 10S: Lot B1 and B2 Runoff Area=2,078 sf 45.72% Impervious Runoff Depth=1.59"
Tc=5.0 min CN=85 Runoff=0.09 cfs 0.006 af

Subcatchment 11S: Lot B1 and B2 Runoff Area=8,578 sf 47.85% Impervious Runoff Depth=1.59"
Tc=5.0 min CN=85 Runoff=0.37 cfs 0.026 af

Subcatchment 12S: Lot A Runoff Area=2,746 sf 68.32% Impervious Runoff Depth=1.98"
Tc=5.0 min CN=90 Runoff=0.15 cfs 0.010 af

Pond 1P: UDSF Swale Peak Elev=16.56' Storage=211 cf Inflow=0.37 cfs 0.026 af
Outflow=0.37 cfs 0.021 af

Pond 2P: UDSF Swale Peak Elev=18.31' Storage=120 cf Inflow=0.15 cfs 0.010 af
Outflow=0.04 cfs 0.010 af

Link POA1: Hodgins Street Inflow=0.45 cfs 0.034 af
Primary=0.45 cfs 0.034 af

Link POA10: Hodgins Street Inflow=0.45 cfs 0.027 af
Primary=0.45 cfs 0.027 af

Link POA11: Veranda Street Inflow=0.04 cfs 0.010 af
Primary=0.04 cfs 0.010 af

Total Runoff Area = 0.631 ac Runoff Volume = 0.076 af Average Runoff Depth = 1.45"
63.02% Pervious = 0.398 ac 36.98% Impervious = 0.233 ac

Summary for Subcatchment 1S:

Runoff = 0.45 cfs @ 12.10 hrs, Volume= 0.034 af, Depth= 1.25"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Yr Rainfall=3.00"

	Area (sf)	CN	Description
	10,855	74	>75% Grass cover, Good, HSG C
*	2,835	98	Roof and Driveway
*	400	98	Off-Site Impervious
	14,090	80	Weighted Average
	10,855		77.04% Pervious Area
	3,235		22.96% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.8	50	0.0200	0.14		**Sheet Flow, A to B** Grass: Short n= 0.150 P2= 3.00"
0.5	65	0.0200	2.12		**Shallow Concentrated Flow, B to C** Grassed Waterway Kv= 15.0 fps
6.3	115	Total			

Summary for Subcatchment 10S: Lot B1 and B2

Runoff = 0.09 cfs @ 12.08 hrs, Volume= 0.006 af, Depth= 1.59"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Yr Rainfall=3.00"

	Area (sf)	CN	Description
	1,128	74	>75% Grass cover, Good, HSG C
*	950	98	Walkway and Drive
	2,078	85	Weighted Average
	1,128		54.28% Pervious Area
	950		45.72% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry, Minimum**

Summary for Subcatchment 11S: Lot B1 and B2

Runoff = 0.37 cfs @ 12.08 hrs, Volume= 0.026 af, Depth= 1.59"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Yr Rainfall=3.00"

	Area (sf)	CN	Description
	4,473	74	>75% Grass cover, Good, HSG C
*	1,830	98	Rooftop
*	1,875	98	Drive and Walkway
*	400	98	Off-Site Roof
	8,578	85	Weighted Average
	4,473		52.15% Pervious Area
	4,105		47.85% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry, Minimum**

Summary for Subcatchment 12S: Lot A

Runoff = 0.15 cfs @ 12.07 hrs, Volume= 0.010 af, Depth= 1.98"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Yr Rainfall=3.00"

	Area (sf)	CN	Description
	870	74	>75% Grass cover, Good, HSG C
*	1,876	98	Roof & drive
	2,746	90	Weighted Average
	870		31.68% Pervious Area
	1,876		68.32% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry, Minimum**

Summary for Pond 1P: UDSF Swale

Inflow Area = 0.197 ac, 47.85% Impervious, Inflow Depth = 1.59" for 2-Yr event
Inflow = 0.37 cfs @ 12.08 hrs, Volume= 0.026 af
Outflow = 0.37 cfs @ 12.12 hrs, Volume= 0.021 af, Atten= 0%, Lag= 2.3 min
Primary = 0.37 cfs @ 12.12 hrs, Volume= 0.021 af

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs / 2
Peak Elev= 16.56' @ 12.12 hrs Surf.Area= 445 sf Storage= 211 cf

Plug-Flow detention time= 58.6 min calculated for 0.021 af (80% of inflow)
Center-of-Mass det. time= (not calculated: outflow precedes inflow)

Volume	Invert	Avail.Storage	Storage Description
#1	13.99'	478 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Voids (%)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
13.99	185	0.0	0	0
14.00	185	40.0	1	1
14.49	185	40.0	36	37
14.50	185	0.0	0	37
15.99	185	0.0	0	37
16.00	185	100.0	2	39
16.50	395	100.0	145	184
17.00	780	100.0	294	478

Device	Routing	Invert	Outlet Devices
#1	Primary	14.00'	**6.0" Round Culvert** L= 45.0' CMP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 14.00' / 13.50' S= 0.0111 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.20 sf
#2	Device 1	15.00'	**1.0" Vert. Orifice/Grate** C= 0.600
#3	Device 1	16.50'	**24.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=0.32 cfs @ 12.12 hrs HW=16.56' (Free Discharge)
└**1=Culvert** (Passes 0.32 cfs of 1.08 cfs potential flow)
└**2=Orifice/Grate** (Orifice Controls 0.03 cfs @ 5.93 fps)
└**3=Orifice/Grate** (Weir Controls 0.29 cfs @ 0.79 fps)

Summary for Pond 2P: UDSF Swale

Inflow Area = 0.063 ac, 68.32% Impervious, Inflow Depth = 1.98" for 2-Yr event
Inflow = 0.15 cfs @ 12.07 hrs, Volume= 0.010 af
Outflow = 0.04 cfs @ 12.43 hrs, Volume= 0.010 af, Atten= 72%, Lag= 21.2 min
Primary = 0.04 cfs @ 12.43 hrs, Volume= 0.010 af

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs / 2
Peak Elev= 18.31' @ 12.43 hrs Surf.Area= 229 sf Storage= 120 cf

Plug-Flow detention time= 28.4 min calculated for 0.010 af (100% of inflow)
Center-of-Mass det. time= 27.3 min (835.8 - 808.5)

Volume	Invert	Avail.Storage	Storage Description
#1	15.89'	207 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Voids (%)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
15.89	170	0.0	0	0
15.90	170	40.0	1	1
16.49	170	40.0	40	41
16.50	170	0.0	0	41
17.90	170	0.0	0	41
18.00	170	100.0	17	58
18.50	265	100.0	109	167
18.65	275	100.0	40	207

Device	Routing	Invert	Outlet Devices
#1	Primary	15.90'	**6.0" Round Culvert** L= 25.0' CMP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 15.90' / 15.70' S= 0.0080 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.20 sf
#2	Device 1	15.80'	**1.0" Vert. Orifice/Grate** C= 0.600
#3	Device 1	18.60'	**24.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=0.04 cfs @ 12.43 hrs HW=18.31' (Free Discharge)
└─**1=Culvert** (Passes 0.04 cfs of 1.10 cfs potential flow)
  ├─**2=Orifice/Grate** (Orifice Controls 0.04 cfs @ 7.48 fps)
  └─**3=Orifice/Grate** (Controls 0.00 cfs)

Summary for Link POA1: Hodgins Street

Inflow Area = 0.323 ac, 22.96% Impervious, Inflow Depth = 1.25" for 2-Yr event
Inflow = 0.45 cfs @ 12.10 hrs, Volume= 0.034 af
Primary = 0.45 cfs @ 12.10 hrs, Volume= 0.034 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs

Summary for Link POA10: Hodgins Street

Inflow Area = 0.245 ac, 47.44% Impervious, Inflow Depth = 1.33" for 2-Yr event
Inflow = 0.45 cfs @ 12.11 hrs, Volume= 0.027 af
Primary = 0.45 cfs @ 12.11 hrs, Volume= 0.027 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs

Summary for Link POA11: Veranda Street

Inflow Area = 0.063 ac, 68.32% Impervious, Inflow Depth = 1.98" for 2-Yr event
Inflow = 0.04 cfs @ 12.43 hrs, Volume= 0.010 af
Primary = 0.04 cfs @ 12.43 hrs, Volume= 0.010 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs

Time span=0.00-30.00 hrs, dt=0.05 hrs, 601 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: Runoff Area=14,090 sf 22.96% Impervious Runoff Depth=2.63"
Flow Length=115' Slope=0.0200 '/' Tc=6.3 min CN=80 Runoff=0.97 cfs 0.071 af

Subcatchment 10S: Lot B1 and B2 Runoff Area=2,078 sf 45.72% Impervious Runoff Depth=3.09"
Tc=5.0 min CN=85 Runoff=0.17 cfs 0.012 af

Subcatchment 11S: Lot B1 and B2 Runoff Area=8,578 sf 47.85% Impervious Runoff Depth=3.09"
Tc=5.0 min CN=85 Runoff=0.71 cfs 0.051 af

Subcatchment 12S: Lot A Runoff Area=2,746 sf 68.32% Impervious Runoff Depth=3.59"
Tc=5.0 min CN=90 Runoff=0.26 cfs 0.019 af

Pond 1P: UDSF Swale Peak Elev=16.60' Storage=227 cf Inflow=0.71 cfs 0.051 af
Outflow=0.69 cfs 0.049 af

Pond 2P: UDSF Swale Peak Elev=18.63' Storage=201 cf Inflow=0.26 cfs 0.019 af
Outflow=0.15 cfs 0.019 af

Link POA1: Hodgins Street Inflow=0.97 cfs 0.071 af
Primary=0.97 cfs 0.071 af

Link POA10: Hodgins Street Inflow=0.86 cfs 0.062 af
Primary=0.86 cfs 0.062 af

Link POA11: Veranda Street Inflow=0.15 cfs 0.019 af
Primary=0.15 cfs 0.019 af

Total Runoff Area = 0.631 ac Runoff Volume = 0.153 af Average Runoff Depth = 2.91"
63.02% Pervious = 0.398 ac 36.98% Impervious = 0.233 ac

Summary for Subcatchment 1S:

Runoff = 0.97 cfs @ 12.10 hrs, Volume= 0.071 af, Depth= 2.63"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Yr Rainfall=4.70"

	Area (sf)	CN	Description
	10,855	74	>75% Grass cover, Good, HSG C
*	2,835	98	Roof and Driveway
*	400	98	Off-Site Impervious
	14,090	80	Weighted Average
	10,855		77.04% Pervious Area
	3,235		22.96% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.8	50	0.0200	0.14		**Sheet Flow, A to B** Grass: Short n= 0.150 P2= 3.00"
0.5	65	0.0200	2.12		**Shallow Concentrated Flow, B to C** Grassed Waterway Kv= 15.0 fps
6.3	115	Total			

Summary for Subcatchment 10S: Lot B1 and B2

Runoff = 0.17 cfs @ 12.07 hrs, Volume= 0.012 af, Depth= 3.09"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Yr Rainfall=4.70"

	Area (sf)	CN	Description
	1,128	74	>75% Grass cover, Good, HSG C
*	950	98	Walkway and Drive
	2,078	85	Weighted Average
	1,128		54.28% Pervious Area
	950		45.72% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry, Minimum**

Summary for Subcatchment 11S: Lot B1 and B2

Runoff = 0.71 cfs @ 12.07 hrs, Volume= 0.051 af, Depth= 3.09"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Yr Rainfall=4.70"

	Area (sf)	CN	Description
	4,473	74	>75% Grass cover, Good, HSG C
*	1,830	98	Rooftop
*	1,875	98	Drive and Walkway
*	400	98	Off-Site Roof
	8,578	85	Weighted Average
	4,473		52.15% Pervious Area
	4,105		47.85% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry, Minimum**

Summary for Subcatchment 12S: Lot A

Runoff = 0.26 cfs @ 12.07 hrs, Volume= 0.019 af, Depth= 3.59"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Yr Rainfall=4.70"

	Area (sf)	CN	Description
	870	74	>75% Grass cover, Good, HSG C
*	1,876	98	Roof & drive
	2,746	90	Weighted Average
	870		31.68% Pervious Area
	1,876		68.32% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry, Minimum**

Summary for Pond 1P: UDSF Swale

Inflow Area = 0.197 ac, 47.85% Impervious, Inflow Depth = 3.09" for 10-Yr event
Inflow = 0.71 cfs @ 12.07 hrs, Volume= 0.051 af
Outflow = 0.69 cfs @ 12.09 hrs, Volume= 0.049 af, Atten= 3%, Lag= 0.9 min
Primary = 0.69 cfs @ 12.09 hrs, Volume= 0.049 af

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs / 2
Peak Elev= 16.60' @ 12.09 hrs Surf.Area= 472 sf Storage= 227 cf

Plug-Flow detention time= 42.8 min calculated for 0.049 af (97% of inflow)
Center-of-Mass det. time= 27.9 min (837.0 - 809.0)

Volume	Invert	Avail.Storage	Storage Description
#1	13.99'	478 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Voids (%)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
13.99	185	0.0	0	0
14.00	185	40.0	1	1
14.49	185	40.0	36	37
14.50	185	0.0	0	37
15.99	185	0.0	0	37
16.00	185	100.0	2	39
16.50	395	100.0	145	184
17.00	780	100.0	294	478

Device	Routing	Invert	Outlet Devices
#1	Primary	14.00'	**6.0" Round Culvert** L= 45.0' CMP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 14.00' / 13.50' S= 0.0111 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.20 sf
#2	Device 1	15.00'	**1.0" Vert. Orifice/Grate** C= 0.600
#3	Device 1	16.50'	**24.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=0.67 cfs @ 12.09 hrs HW=16.60' (Free Discharge)
└**1=Culvert** (Passes 0.67 cfs of 1.09 cfs potential flow)
  └**2=Orifice/Grate** (Orifice Controls 0.03 cfs @ 6.01 fps)
  └**3=Orifice/Grate** (Weir Controls 0.64 cfs @ 1.03 fps)

Summary for Pond 2P: UDSF Swale

Inflow Area = 0.063 ac, 68.32% Impervious, Inflow Depth = 3.59" for 10-Yr event
Inflow = 0.26 cfs @ 12.07 hrs, Volume= 0.019 af
Outflow = 0.15 cfs @ 12.21 hrs, Volume= 0.019 af, Atten= 43%, Lag= 8.3 min
Primary = 0.15 cfs @ 12.21 hrs, Volume= 0.019 af

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs / 2
Peak Elev= 18.63' @ 12.21 hrs Surf.Area= 274 sf Storage= 201 cf

Plug-Flow detention time= 36.3 min calculated for 0.019 af (100% of inflow)
Center-of-Mass det. time= 34.4 min (826.3 - 791.9)

Volume	Invert	Avail.Storage	Storage Description
#1	15.89'	207 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Voids (%)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
15.89	170	0.0	0	0
15.90	170	40.0	1	1
16.49	170	40.0	40	41
16.50	170	0.0	0	41
17.90	170	0.0	0	41
18.00	170	100.0	17	58
18.50	265	100.0	109	167
18.65	275	100.0	40	207

Device	Routing	Invert	Outlet Devices
#1	Primary	15.90'	**6.0" Round Culvert** L= 25.0' CMP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 15.90' / 15.70' S= 0.0080 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.20 sf
#2	Device 1	15.80'	**1.0" Vert. Orifice/Grate** C= 0.600
#3	Device 1	18.60'	**24.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=0.14 cfs @ 12.21 hrs HW=18.63' (Free Discharge)
└─**1=Culvert** (Passes 0.14 cfs of 1.17 cfs potential flow)
  ├─**2=Orifice/Grate** (Orifice Controls 0.04 cfs @ 7.95 fps)
  └─**3=Orifice/Grate** (Weir Controls 0.09 cfs @ 0.54 fps)

Summary for Link POA1: Hodgins Street

Inflow Area = 0.323 ac, 22.96% Impervious, Inflow Depth = 2.63" for 10-Yr event
Inflow = 0.97 cfs @ 12.10 hrs, Volume= 0.071 af
Primary = 0.97 cfs @ 12.10 hrs, Volume= 0.071 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs

Summary for Link POA10: Hodgins Street

Inflow Area = 0.245 ac, 47.44% Impervious, Inflow Depth = 3.03" for 10-Yr event
Inflow = 0.86 cfs @ 12.09 hrs, Volume= 0.062 af
Primary = 0.86 cfs @ 12.09 hrs, Volume= 0.062 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs

Summary for Link POA11: Veranda Street

Inflow Area = 0.063 ac, 68.32% Impervious, Inflow Depth = 3.58" for 10-Yr event
Inflow = 0.15 cfs @ 12.21 hrs, Volume= 0.019 af
Primary = 0.15 cfs @ 12.21 hrs, Volume= 0.019 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs

Time span=0.00-30.00 hrs, dt=0.05 hrs, 601 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: Runoff Area=14,090 sf 22.96% Impervious Runoff Depth=3.33"
Flow Length=115' Slope=0.0200 '/' Tc=6.3 min CN=80 Runoff=1.23 cfs 0.090 af

Subcatchment 10S: Lot B1 and B2 Runoff Area=2,078 sf 45.72% Impervious Runoff Depth=3.83"
Tc=5.0 min CN=85 Runoff=0.21 cfs 0.015 af

Subcatchment 11S: Lot B1 and B2 Runoff Area=8,578 sf 47.85% Impervious Runoff Depth=3.83"
Tc=5.0 min CN=85 Runoff=0.88 cfs 0.063 af

Subcatchment 12S: Lot A Runoff Area=2,746 sf 68.32% Impervious Runoff Depth=4.36"
Tc=5.0 min CN=90 Runoff=0.31 cfs 0.023 af

Pond 1P: UDSF Swale Peak Elev=16.62' Storage=235 cf Inflow=0.88 cfs 0.063 af
Outflow=0.85 cfs 0.066 af

Pond 2P: UDSF Swale Peak Elev=18.64' Storage=206 cf Inflow=0.31 cfs 0.023 af
Outflow=0.24 cfs 0.023 af

Link POA1: Hodgins Street Inflow=1.23 cfs 0.090 af
Primary=1.23 cfs 0.090 af

Link POA10: Hodgins Street Inflow=1.06 cfs 0.081 af
Primary=1.06 cfs 0.081 af

Link POA11: Veranda Street Inflow=0.24 cfs 0.023 af
Primary=0.24 cfs 0.023 af

Total Runoff Area = 0.631 ac Runoff Volume = 0.191 af Average Runoff Depth = 3.63"
63.02% Pervious = 0.398 ac 36.98% Impervious = 0.233 ac

Summary for Subcatchment 1S:

Runoff = 1.23 cfs @ 12.10 hrs, Volume= 0.090 af, Depth= 3.33"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-Yr Rainfall=5.50"

	Area (sf)	CN	Description
	10,855	74	>75% Grass cover, Good, HSG C
*	2,835	98	Roof and Driveway
*	400	98	Off-Site Impervious
	14,090	80	Weighted Average
	10,855		77.04% Pervious Area
	3,235		22.96% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.8	50	0.0200	0.14		**Sheet Flow, A to B** Grass: Short n= 0.150 P2= 3.00"
0.5	65	0.0200	2.12		**Shallow Concentrated Flow, B to C** Grassed Waterway Kv= 15.0 fps
6.3	115	Total			

Summary for Subcatchment 10S: Lot B1 and B2

Runoff = 0.21 cfs @ 12.07 hrs, Volume= 0.015 af, Depth= 3.83"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-Yr Rainfall=5.50"

	Area (sf)	CN	Description
	1,128	74	>75% Grass cover, Good, HSG C
*	950	98	Walkway and Drive
	2,078	85	Weighted Average
	1,128		54.28% Pervious Area
	950		45.72% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry, Minimum**

Summary for Subcatchment 11S: Lot B1 and B2

Runoff = 0.88 cfs @ 12.07 hrs, Volume= 0.063 af, Depth= 3.83"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-Yr Rainfall=5.50"

	Area (sf)	CN	Description
	4,473	74	>75% Grass cover, Good, HSG C
*	1,830	98	Rooftop
*	1,875	98	Drive and Walkway
*	400	98	Off-Site Roof
	8,578	85	Weighted Average
	4,473		52.15% Pervious Area
	4,105		47.85% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry, Minimum**

Summary for Subcatchment 12S: Lot A

Runoff = 0.31 cfs @ 12.07 hrs, Volume= 0.023 af, Depth= 4.36"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-Yr Rainfall=5.50"

	Area (sf)	CN	Description
	870	74	>75% Grass cover, Good, HSG C
*	1,876	98	Roof & drive
	2,746	90	Weighted Average
	870		31.68% Pervious Area
	1,876		68.32% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry, Minimum**

Summary for Pond 1P: UDSF Swale

Inflow Area = 0.197 ac, 47.85% Impervious, Inflow Depth = 3.83" for 25-Yr event
Inflow = 0.88 cfs @ 12.07 hrs, Volume= 0.063 af
Outflow = 0.85 cfs @ 12.09 hrs, Volume= 0.066 af, Atten= 3%, Lag= 0.9 min
Primary = 0.85 cfs @ 12.09 hrs, Volume= 0.066 af

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs / 2
Peak Elev= 16.62' @ 12.09 hrs Surf.Area= 484 sf Storage= 235 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 50.7 min (853.6 - 803.0)

Volume	Invert	Avail.Storage	Storage Description
#1	13.99'	478 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Voids (%)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
13.99	185	0.0	0	0
14.00	185	40.0	1	1
14.49	185	40.0	36	37
14.50	185	0.0	0	37
15.99	185	0.0	0	37
16.00	185	100.0	2	39
16.50	395	100.0	145	184
17.00	780	100.0	294	478

Device	Routing	Invert	Outlet Devices
#1	Primary	14.00'	**6.0" Round Culvert** L= 45.0' CMP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 14.00' / 13.50' S= 0.0111 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.20 sf
#2	Device 1	15.00'	**1.0" Vert. Orifice/Grate** C= 0.600
#3	Device 1	16.50'	**24.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=0.83 cfs @ 12.09 hrs HW=16.61' (Free Discharge)
└**1=Culvert** (Passes 0.83 cfs of 1.09 cfs potential flow)
  └**2=Orifice/Grate** (Orifice Controls 0.03 cfs @ 6.04 fps)
  └**3=Orifice/Grate** (Weir Controls 0.79 cfs @ 1.11 fps)

Summary for Pond 2P: UDSF Swale

Inflow Area = 0.063 ac, 68.32% Impervious, Inflow Depth = 4.36" for 25-Yr event
Inflow = 0.31 cfs @ 12.07 hrs, Volume= 0.023 af
Outflow = 0.24 cfs @ 12.13 hrs, Volume= 0.023 af, Atten= 23%, Lag= 3.5 min
Primary = 0.24 cfs @ 12.13 hrs, Volume= 0.023 af

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs / 2
Peak Elev= 18.64' @ 12.13 hrs Surf.Area= 275 sf Storage= 206 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 32.0 min (818.6 - 786.6)

Volume	Invert	Avail.Storage	Storage Description
#1	15.89'	207 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Voids (%)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
15.89	170	0.0	0	0
15.90	170	40.0	1	1
16.49	170	40.0	40	41
16.50	170	0.0	0	41
17.90	170	0.0	0	41
18.00	170	100.0	17	58
18.50	265	100.0	109	167
18.65	275	100.0	40	207

Device	Routing	Invert	Outlet Devices
#1	Primary	15.90'	**6.0" Round Culvert** L= 25.0' CMP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 15.90' / 15.70' S= 0.0080 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.20 sf
#2	Device 1	15.80'	**1.0" Vert. Orifice/Grate** C= 0.600
#3	Device 1	18.60'	**24.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=0.23 cfs @ 12.13 hrs HW=18.64' (Free Discharge)
└─**1=Culvert** (Passes 0.23 cfs of 1.18 cfs potential flow)
  ├─**2=Orifice/Grate** (Orifice Controls 0.04 cfs @ 7.97 fps)
  └─**3=Orifice/Grate** (Weir Controls 0.18 cfs @ 0.68 fps)

Summary for Link POA1: Hodgins Street

Inflow Area = 0.323 ac, 22.96% Impervious, Inflow Depth = 3.33" for 25-Yr event
Inflow = 1.23 cfs @ 12.10 hrs, Volume= 0.090 af
Primary = 1.23 cfs @ 12.10 hrs, Volume= 0.090 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs

Summary for Link POA10: Hodgins Street

Inflow Area = 0.245 ac, 47.44% Impervious, Inflow Depth = 3.97" for 25-Yr event
Inflow = 1.06 cfs @ 12.09 hrs, Volume= 0.081 af
Primary = 1.06 cfs @ 12.09 hrs, Volume= 0.081 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs

Summary for Link POA11: Veranda Street

Inflow Area = 0.063 ac, 68.32% Impervious, Inflow Depth = 4.38" for 25-Yr event
Inflow = 0.24 cfs @ 12.13 hrs, Volume= 0.023 af
Primary = 0.24 cfs @ 12.13 hrs, Volume= 0.023 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs

Blais
civil engineers

Veranda Street

BMP Sizing Calculations

BCE #:	13136
Date:	5/5/14
Calcs by:	JL

Underdrain Bioretention Cell

From Chapter 7.1 Grassed Underdrain Soil Filter, DEP BMP Technical Design Manual

	Rain Garden		*(from Treatment*	Treatment Volume Req'd	Treatment Volume Provided
Roof + Drive	Impervious Area:	0.0833 ft (1")	1876 sf	156.3 cf	207.0 cf
Front Lawn	Landscaped Area:	0.0333 ft (0.4")	870 sf	29.0 cf	
				185.3 cf	207.0 cf

	Surface Area Req'd	Surface Area Provided
5% of impv area =	93.8 sf	150.0 sf
2% of landscape area =	17.4 sf	
	111.2 sf	150.0 sf