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REVISED STORMWATER DISCHARGE EVALUATION FOR VENETA KINGDOM HALL SITE DEVELOPMENT

AMENDED May 20, 2009 FOR 10-YEAR EVENT PER CITY OF EUGENE RAINFALL OF 4.46IN/HR

SUMMARY

Keating Engineering re-evaluated the stormwater system for the Veneta Kingdom Hall project to address issues identified by City of Veneta planners. Staff indicated several potential problems. The first, with the planned use of rip-rap on site, secondly, to be aware of a related on-going study by the city engineers to investigate ways to reduce or eliminate standing water in the vernal pool serving the adjacent Austin Acres subdivision, and third, to seek ways to reduce the impervious surfaces on the proposed site to reduce the runoff rates and quantities.

The original plans for the Austin Acres vernal pool assumed that the Kingdom Hall site would contribute to it, as well as areas from the subdivision site and drainage from the ditches along Hunter. The design of the Austin Acres subdivision therefore included the subject area and allowed for these flows in the design calculations.

The existing *undeveloped* Kingdom Hall site contribution during a design 10-year storm event was shown to amount to a peak flow of 0.33 CFS (cubic feet per second) with a net volume for a 24 hour storm event of 0.283 af (acre-feet) of stormwater. The stormwater modeling for the *developed* Kingdom Hall site needs to respect this identified rate and quantity to avoid further impacts to the Austin Acres vernal pool.

To address the first concerns, staff suggested that it was possible that the formerly proposed rip-rap embankment in the on-site detention basin may present a nuisance where vandals may potentially use them as projectiles, and that standing water in a basin was perceived as an undesirable consequence of above-ground detention that should be reduced when possible. Re-designing the basin to allow for drain-rock infill with a soil covering can accomplish this. This design obviates the need for rip-rap bank protection as well as exposed embankments are eliminated by this new design.

To address the second concerns, eliminating or reducing open water in the proposed detention basin on site, the above solution si further developed using an open graded stony fill with the detention area enlarged to account for the reduction in usable volume presented by the fill. This is to be capped with a filter fabric and planted with turf grasses to conceal the stones and eliminate the temptations they may present to the occasional vandal.

To address the third concerns, the impervious areas might be reduced on the Kingdom Hall site by reducing paving areas or proposing gravel areas where overflow parking was intended. Tthe owner was approached to reduce the on-site parking and subsequent paving areas initially planned.

It was felt that a smaller amount of parking, about 30 to 35 vehicles, would be required for normal present use, based on their experience with a nearby site, and some additional parking must be available to allow for future membership growth. It was also noted that there are usually several events through the year where up to 70 cars may need to be parked. Due to the nature of the group, it is possible that cooperative users may double up on spaces and park in an over-capacity manner without impinging on surface streets but this strategy has obvious limitations. We are therefore proposing that 40 parking stalls be paved to meet the identified needs, and 26 additional "overflow" stalls be graveled, with curbs and paving areas to confine the gravel and keep things neat and tidy. It should be noted that the Veneta Development Code requires 36 paved parking stalls for this use.

The gravel "overflow" areas can also be used to detain some of the site stormwater, and infiltrate some of the stormwater quantities. In the event that the gravel areas become unsightly or difficult to maintain at some point in the future, and the parking areas they represent still be needed, these can be infilled with pervious pavers and still function in some manner.

HYDRAULICS

This stormwater hydrology study analyzes the current peak run-off from the site (identified in the Austin Acres study, with the relevant page attached herein) and compares that to the anticipated run-off from the developed conditions. The increase in peak run-off rate will be detained on-site in piping and several gravel-filled basins. The outlet will only allow water to exit the site in a manner consistent with the present run-off conditions. The site is considered to be a small area, and the Santa Barbara Urban Hydrograph method is used, with Hydrocad software, due to its accuracy and ease of use with computerized models.

HydroCAD is a Computer Aided Design system for modeling the hydrology and hydraulics of stormwater runoff. It is based largely on the hydrology techniques developed by the Soil Conservation Service (SCS/NRCS), combined with other hydrology and hydraulics calculations. For a given rainfall event, these techniques are used to generate hydrographs throughout a watershed. Typically, this allows the engineer to verify that a given drainage system is adequate for the area under consideration, or to predict where flooding or erosion is likely to occur.

The Santa Barbara Urban Hydrograph method (SBUH) was developed by the Santa Barbara County (California) Flood Control and Water Conservation District. The SBUH method has many similarities to the SCS Unit Hydrograph procedure. Both techniques employ the same SCS curve numbers, runoff equation, and rainfall distributions. However, the SBUH method does not utilize a unit hydrograph or the convolution process. (Note that the "UH" stands for Urban Hydrograph, not Unit Hydrograph.)

The basic SBUH runoff procedure is as follows:

1. Compute the instantaneous hydrograph: The storm is divided into equal time increments (dt). At each increment, the SCS Runoff Equation is used to determine the precipitation excess. The difference between the successive values represents the instantaneous runoff at that point in time.
2. Compute the runoff hydrograph: The runoff hydrograph is obtained by routing the instantaneous hydrograph through an imaginary reservoir with a time delay equal to the time of concentration. The following equation is used to estimate the routed flow at each point in time:

$$Q2 = Q1 + w [I1 + I2 - 2 Q1]$$

where $w = dt/(2 Tc + dt)$

Q1, Q2 = Runoff at beginning and end of interval dt [CFS]
I1, I2 = Instantaneous runoff at beginning and end of interval dt [CFS]
dt = Calculation time increment [minutes]
Tc = Time of concentration [minutes]
w = Routing Coefficient

For calculation purposes, each hydrograph consists of flow values (ordinates) that occur at a given time increment throughout a certain time span. Each hydrograph has a peak flow and total volume.

SOIL CLASSIFICATION AND CURVE NUMBERS

Soils are classified into hydrologic soil groups to indicate the minimum rate of infiltration obtained for bare soil after prolonged wetting. The HSG's, which are A, B, C, and D, are one element used in determining runoff curve number.

The infiltration rate is the rate at which water enters the soil at the soil surface. It is controlled by surface conditions. HSG also indicates the transmission rate - the rate at which the water moves through the soil. This rate is controlled by the soil profile. The soil group used for this study is Group D for pre-development in the pasture land, and Group C in the landscaped areas, which are much mope likely to contain amended soils and pervious landscape surfaces. HSG D has very low infiltration rates when thoroughly wetted, and consist chiefly of clay soils with a high swelling potential, soils with a permanent high water table, soils with a claypan or clay layer at or near the surface, and shallow soils over nearly impervious material. These soils have a very low rate of water transmission (0-0.05 in/hr). HSG C soils have low infiltration rates when thoroughly wetted, and consist chiefly of soils with a layer that impedes downward movement of water, and soils with moderately fine to fine texture. These soils have a low rate of water transmission (0.05-0.15 in/hr).

STUDIES

The attached studies include the following:

1. *Pre-development analysis.* This uses the re-print of the discharge from this site as used for the Austin Acres subdivision study and calculates the maximum flow rates for the present undeveloped site, and the maximum flow rate which can be discharged from the site after completion of construction activities.
2. *Post-development 10-yr drainage basin.* This models the design event, and should function without impinging on roadways, or result in long-term standing water

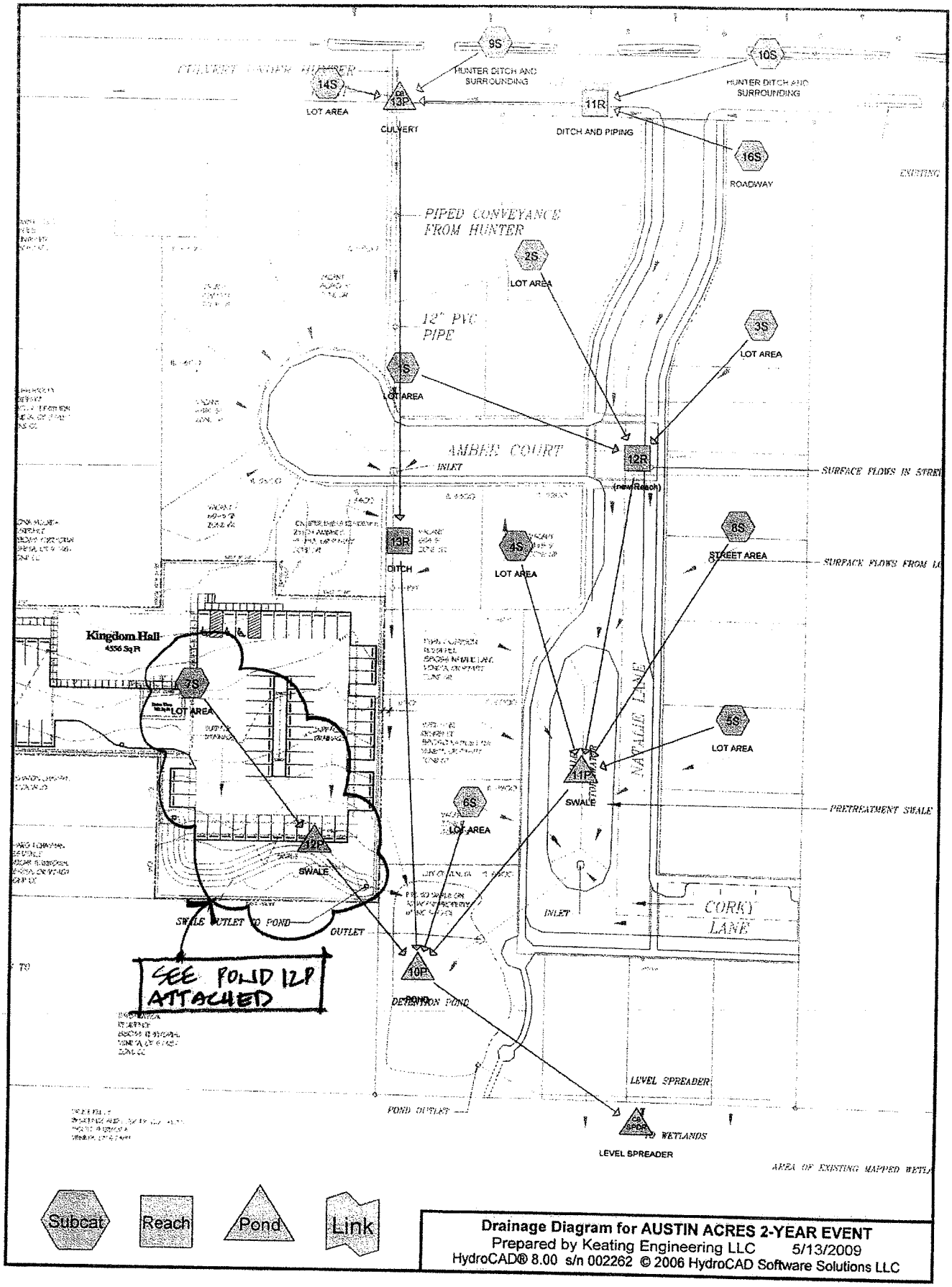
Maps of the basins are included.

CONCLUSIONS

The pre-construction conditions as modeled are compared to the post construction conditions in the table below:

VALUE	DESIGN COND-ITIONS FOR AUSTIN ACRES	POST-CONSTRUCTION CONDITIONS	RESULTS
AREA	0.985 AC	1.292 AC	AREA LARGER THAN PREVIOUSLY MODELED
PEAK FLOW	0.35 CFS	0.34 CFS	EQUIVALENT
PEAK TIME	8.69 HRS	8.42 HRS	EQUIVALENT
VOLUME	0.283AF	0.290 AF	EQUIVALENT RUNOFF

Based on the above, the post-construction design successfully attenuates the peak flow and reduces the impact on the adjacent Austin Acres facility.


9S
HUNTER DITCH AND SURROUNDING
10S
HUNTER DITCH AND SURROUNDING
14S
LOT AREA
13P
CULVERT
11R
DITCH AND PIPING
16S
ROADWAY
EXISTING
PIPED CONVEYANCE FROM HUNTER
2S
LOT AREA
12" PVC PIPE
3S
LOT AREA
1S
LOT AREA
AMBER COURT
INLET
12R
(new Reach)
SURFACE FLOWS IN STREET
13R
DITCH
4S
LOT AREA
8S
STREET AREA
SURFACE FLOWS FROM LOT
Kingdom Hall
4556 SqFt
7S
LOT AREA
NATALIE LANE
5S
LOT AREA
11P
SWALE
PRETREATMENT SWALE
6S
LOT AREA
12P
SWALE
INLET
CORKY LANE
SWALE OUTLET TO POND
OUTLET
SEE POND 12P ATTACHED
10P
POND
DETENTION POND
LEVEL SPREADER
POND OUTLET
WETLANDS
LEVEL SPREADER
AREA OF EXISTING MAPPED WETLA
Subcat
Reach
Pond
Link
Drainage Diagram for AUSTIN ACRES 2-YEAR EVENT
Prepared by Keating Engineering LLC 5/13/2009
HydroCAD® 8.00 s/n 002262 © 2006 HydroCAD Software Solutions LLC

Pond 12P: SWALE

DISCHARGE FROM PRETREATMENT FOREBAY

[82] Warning: Early inflow requires earlier time span
[87] Warning: Oscillations may require Finer Routing or smaller dt

Inflow Area =	0.985 ac,	Inflow Depth >	3.45"	
Inflow =	1.04 cfs @	7.88 hrs, Volume=	0.283 af	
Outflow =	0.36 cfs @	8.69 hrs, Volume=	0.283 af,	Atten= 66%, Lag= 48.6 min
Discarded =	0.00 cfs @	8.69 hrs, Volume=	0.002 af	
Primary =	0.35 cfs @	8.69 hrs, Volume=	0.281 af	

Routing by Dyn-Stor-Ind method, Time Span= 2.00-20.00 hrs, dt= 0.01 hrs / 3
Starting Elev= 412.00' Surf.Area= 0.000 ac Storage= 0.000 af
Peak Elev= 415.68' @ 8.69 hrs Surf.Area= 0.055 ac Storage= 0.031 af
Flood Elev= 416.00' Surf.Area= 0.065 ac Storage= 0.050 af

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 19.2 min (640.2 - 621.0)

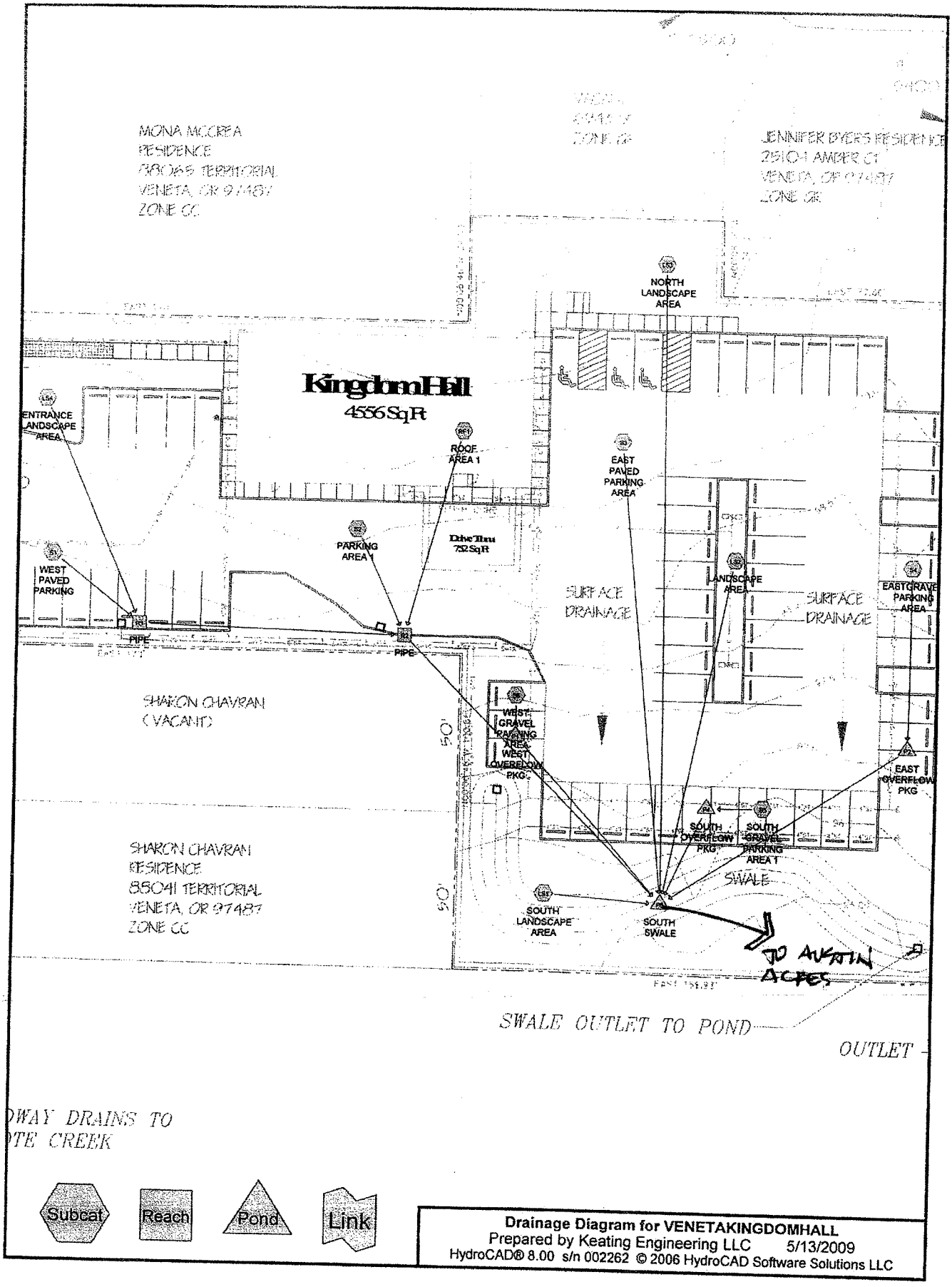
Volume	Invert	Avail.Storage	Storage Description
#1	415.00'	0.157 af	**10.00'W x 150.00'L x 2.25'H Prismatoid Z=4.0**

Device	Routing	Invert	Outlet Devices
#1	Primary	413.00'	**4.0" x 100.0' long Culvert** CMP, square edge headwall, Ke= 0.500 Outlet Invert= 412.50' S= 0.0050 '/' Cc= 0.900 n= 0.011
#2	Discarded	0.00'	**0.050 in/hr Exfiltration over Wetted area**

Discarded OutFlow Max=0.00 cfs @ 8.69 hrs HW=415.68' (Free Discharge)
↑—**2=Exfiltration** (Exfiltration Controls 0.00 cfs)

Primary OutFlow Max=0.35 cfs @ 8.69 hrs HW=415.68' TW=412.01' (Dynamic Tailwater)
↑—**1=Culvert** (Barrel Controls 0.35 cfs @ 4.05 fps)

THIS WAS THE "DESIGN DISCHARGE" USED TO MODEL THE AUSTIN ACRES SUBDIVISION


MONA MCCREA
RESIDENCE
85043 TERRITORIAL
VENETA, OR 97487
ZONE CC
JENNIFER BYERS RESIDENCE
25104 AMBER CT
VENETA, OR 97487
ZONE CC
NORTH LANDSCAPE AREA
Kingdom Hall
4556 SqFt
ENTRANCE LANDSCAPE AREA
ROOF AREA 1
EAST PAVED PARKING AREA
PARKING AREA 1
The Inn
752 SqFt
WEST PAVED PARKING
LANDSCAPE AREA
SURFACE DRAINAGE
SURFACE DRAINAGE
EAST GRAVEL PARKING AREA
PIPE
PIPE
SHARON CHAVRAN
(VACANT)
50'
WEST GRAVEL PARKING AREA
WEST OVERFLOW PKG
EAST OVERFLOW PKG
SOUTH OVERFLOW PKG
SOUTH GRAVEL PARKING AREA 1
SWALE
SHARON CHAVRAN
RESIDENCE
85041 TERRITORIAL
VENETA, OR 97487
ZONE CC
50'
SOUTH LANDSCAPE AREA
SOUTH SWALE
TO AWATIN ACRES
SWALE OUTLET TO POND
OUTLET
DWAY DRAINS TO
TE CREEK
Subcat
Reach
Pond
Link
Drainage Diagram for VENETAKINGDOMHALL
Prepared by Keating Engineering LLC 5/13/2009
HydroCAD® 8.00 s/n 002262 © 2006 HydroCAD Software Solutions LLC

Area Listing (all nodes)

Area (acres)	CN	Description (subcats)
0.380	74	>75% Grass cover, Good, HSG C (LS1,LS2,LS3,LS4)
0.107	89	Gravel roads, HSG C (S4,S5,S6)
0.805	98	Paved parking & roofs (RF1,S1,S2,S3)
1.292		

Time span=0.00-24.00 hrs, dt=0.05 hrs, 481 points
Runoff by SBUH method
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment LS1: SOUTH LANDSCAPE AREA Runoff Area=9,720 sf Runoff Depth>0.72"
Tc=10.0 min Adjusted CN=55 Runoff=0.01 cfs 0.013 af

Subcatchment LS2: LANDSCAPE AREA Runoff Area=720 sf Runoff Depth>0.72"
Tc=10.0 min Adjusted CN=55 Runoff=0.00 cfs 0.001 af

Subcatchment LS3: NORTH LANDSCAPE AREA Runoff Area=3,840 sf Runoff Depth>0.72"
Tc=10.0 min Adjusted CN=55 Runoff=0.01 cfs 0.005 af

Subcatchment LS4: ENTRANCE LANDSCAPE AREA Runoff Area=2,270 sf Runoff Depth>0.72"
Tc=10.0 min Adjusted CN=55 Runoff=0.00 cfs 0.003 af

Subcatchment RF1: ROOF AREA 1 Runoff Area=5,310 sf Runoff Depth>3.76"
Tc=10.0 min Adjusted CN=94 Runoff=0.15 cfs 0.038 af

Subcatchment S1: WEST PAVED PARKING Runoff Area=6,580 sf Runoff Depth>3.76"
Tc=10.0 min Adjusted CN=94 Runoff=0.19 cfs 0.047 af

Subcatchment S2: PARKING AREA 1 Runoff Area=6,580 sf Runoff Depth>3.76"
Tc=10.0 min Adjusted CN=94 Runoff=0.19 cfs 0.047 af

Subcatchment S3: EAST PAVED PARKING AREA Runoff Area=16,600 sf Runoff Depth>3.76"
Tc=10.0 min Adjusted CN=94 Runoff=0.48 cfs 0.119 af

Subcatchment S4: EASTGRAVEL PARKING AREA Runoff Area=2,060 sf Runoff Depth>2.09"
Tc=10.0 min Adjusted CN=76 Runoff=0.03 cfs 0.008 af

Subcatchment S5: SOUTH GRAVEL PARKING AREA 1 Runoff Area=2,115 sf Runoff Depth>2.09"
Tc=10.0 min Adjusted CN=76 Runoff=0.03 cfs 0.008 af

Subcatchment S6: WEST GRAVEL PARKING AREA Runoff Area=490 sf Runoff Depth>2.09"
Tc=10.0 min Adjusted CN=76 Runoff=0.01 cfs 0.002 af

Reach R1: PIPE Avg. Depth=0.15' Max Vel=3.79 fps Inflow=0.19 cfs 0.050 af
D=6.0" n=0.011 L=80.0' S=0.0206 '/' Capacity=0.95 cfs Outflow=0.19 cfs 0.050 af

Reach R2: PIPE Avg. Depth=0.27' Max Vel=4.99 fps Inflow=0.54 cfs 0.136 af
D=6.0" n=0.011 L=80.0' S=0.0206 '/' Capacity=0.95 cfs Outflow=0.54 cfs 0.136 af

Pond P1: WEST OVERFLOW PKG Peak Elev=97.05' Storage=4 cf Inflow=0.01 cfs 0.002 af
Discarded=0.00 cfs 0.000 af Primary=0.01 cfs 0.002 af Outflow=0.01 cfs 0.002 af

Pond P2: EAST OVERFLOW PKG Peak Elev=97.10' Storage=31 cf Inflow=0.03 cfs 0.008 af
Discarded=0.00 cfs 0.000 af Primary=0.02 cfs 0.008 af Outflow=0.02 cfs 0.008 af

Pond P4: SOUTH OVERFLOW PKG Peak Elev=97.00' Storage=0 cf Inflow=0.03 cfs 0.008 af
Discarded=0.00 cfs 0.000 af Primary=0.03 cfs 0.008 af Outflow=0.03 cfs 0.008 af

Pond P6: SOUTH SWALE Peak Elev=96.61' Storage=0.039 af Inflow=1.08 cfs 0.293 af
Discarded=0.00 cfs 0.003 af Primary=0.34 cfs 0.287 af Secondary=0.00 cfs 0.000 af Outflow=0.34 cfs 0.290 af

Total Runoff Area = 1.292 ac Runoff Volume = 0.294 af Average Runoff Depth = 2.73"
37.69% Pervious Area = 0.487 ac 62.31% Impervious Area = 0.805 ac

Subcatchment LS1: SOUTH LANDSCAPE AREA

Runoff = 0.01 cfs @ 14.57 hrs, Volume= 0.013 af, Depth> 0.72"

Runoff by SBUH method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Thurston 24-hr 10-yr Rainfall=4.46" x 2, AMC=1

Area (sf)	CN	Description
9,720	74	>75% Grass cover, Good, HSG C
9,720	74	Weighted Average, Adjusted for AMC to CN = 55
9,720		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry, LANDSCAPE AREA**

Subcatchment LS2: LANDSCAPE AREA

Runoff = 0.00 cfs @ 14.57 hrs, Volume= 0.001 af, Depth> 0.72"

Runoff by SBUH method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Thurston 24-hr 10-yr Rainfall=4.46" x 2, AMC=1

Area (sf)	CN	Description
720	74	>75% Grass cover, Good, HSG C
720	74	Weighted Average, Adjusted for AMC to CN = 55
720		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry, LANDSCAPE AREA**

Subcatchment LS3: NORTH LANDSCAPE AREA

Runoff = 0.01 cfs @ 14.57 hrs, Volume= 0.005 af, Depth> 0.72"

Runoff by SBUH method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Thurston 24-hr 10-yr Rainfall=4.46" x 2, AMC=1

Area (sf)	CN	Description
3,840	74	>75% Grass cover, Good, HSG C
3,840	74	Weighted Average, Adjusted for AMC to CN = 55
3,840		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry, LANDSCAPE AREA**

Subcatchment LS4: ENTRANCE LANDSCAPE AREA

Runoff = 0.00 cfs @ 14.57 hrs, Volume= 0.003 af, Depth> 0.72"

Runoff by SBUH method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Thurston 24-hr 10-yr Rainfall=4.46" x 2, AMC=1

Area (sf)	CN	Description
2,270	74	>75% Grass cover, Good, HSG C
2,270	74	Weighted Average, Adjusted for AMC to CN = 55
2,270		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry, LANDSCAPE AREA**

Subcatchment RF1: ROOF AREA 1

Runoff = 0.15 cfs @ 7.87 hrs, Volume= 0.038 af, Depth> 3.76"

Runoff by SBUH method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Thurston 24-hr 10-yr Rainfall=4.46" x 2, AMC=1

Area (sf)	CN	Description
5,310	98	Paved parking & roofs
5,310	98	Weighted Average, Adjusted for AMC to CN = 94
5,310		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry, ROOF AREAS**

Subcatchment S1: WEST PAVED PARKING

Runoff = 0.19 cfs @ 7.87 hrs, Volume= 0.047 af, Depth> 3.76"

Runoff by SBUH method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Thurston 24-hr 10-yr Rainfall=4.46" x 2, AMC=1

Area (sf)	CN	Description
6,580	98	Paved parking & roofs
6,580	98	Weighted Average, Adjusted for AMC to CN = 94
6,580		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry, PAVING AREAS**

Subcatchment S2: PARKING AREA 1

Runoff = 0.19 cfs @ 7.87 hrs, Volume= 0.047 af, Depth> 3.76"

Runoff by SBUH method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Thurston 24-hr 10-yr Rainfall=4.46" x 2, AMC=1

Area (sf)	CN	Description
6,580	98	Paved parking & roofs
6,580	98	Weighted Average, Adjusted for AMC to CN = 94
6,580		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry, PAVING AREAS**

Subcatchment S3: EAST PAVED PARKING AREA

Runoff = 0.48 cfs @ 7.87 hrs, Volume= 0.119 af, Depth> 3.76"

Runoff by SBUH method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Thurston 24-hr 10-yr Rainfall=4.46" x 2, AMC=1

Area (sf)	CN	Description
16,600	98	Paved parking & roofs
16,600	98	Weighted Average, Adjusted for AMC to CN = 94
16,600		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry, PAVING AREAS**

Subcatchment S4: EASTGRAVEL PARKING AREA

Runoff = 0.03 cfs @ 7.89 hrs, Volume= 0.008 af, Depth> 2.09"

Runoff by SBUH method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Thurston 24-hr 10-yr Rainfall=4.46" x 2, AMC=1

Area (sf)	CN	Description
2,060	89	Gravel roads, HSG C
2,060	89	Weighted Average, Adjusted for AMC to CN = 76
2,060		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry, PAVING AREAS**

Subcatchment S5: SOUTH GRAVEL PARKING AREA 1

Runoff = 0.03 cfs @ 7.89 hrs, Volume= 0.008 af, Depth> 2.09"

Runoff by SBUH method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Thurston 24-hr 10-yr Rainfall=4.46" x 2, AMC=1

Area (sf)	CN	Description
2,115	89	Gravel roads, HSG C
2,115	89	Weighted Average, Adjusted for AMC to CN = 76
2,115		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry, PAVING AREAS**

Subcatchment S6: WEST GRAVEL PARKING AREA

Runoff = 0.01 cfs @ 7.89 hrs, Volume= 0.002 af, Depth> 2.09"

Runoff by SBUH method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Thurston 24-hr 10-yr Rainfall=4.46" x 2, AMC=1

Area (sf)	CN	Description
490	89	Gravel roads, HSG C
490	89	Weighted Average, Adjusted for AMC to CN = 76
490		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry, PAVING AREAS**

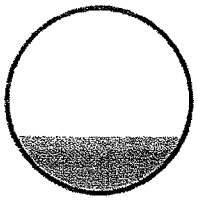
Reach R1: PIPE

Inflow Area = 0.203 ac, Inflow Depth > 2.98"
Inflow = 0.19 cfs @ 7.87 hrs, Volume= 0.050 af
Outflow = 0.19 cfs @ 7.87 hrs, Volume= 0.050 af, Atten= 0%, Lag= 0.2 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Max. Velocity= 3.79 fps, Min. Travel Time= 0.4 min
Avg. Velocity = 2.01 fps, Avg. Travel Time= 0.7 min

Peak Storage= 4 cf @ 7.87 hrs, Average Depth at Peak Storage= 0.15'
Bank-Full Depth= 0.50', Capacity at Bank-Full= 0.95 cfs

6.0" Diameter Pipe, n= 0.011
Length= 80.0' Slope= 0.0206 '/'
Inlet Invert= 99.00', Outlet Invert= 97.35'



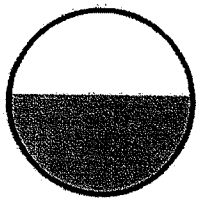
Reach R2: PIPE

Inflow Area =	0.476 ac,	Inflow Depth >	3.43"	
Inflow =	0.54 cfs @	7.87 hrs, Volume=	0.136 af	
Outflow =	0.54 cfs @	7.87 hrs, Volume=	0.136 af,	Atten= 0%, Lag= 0.2 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Max. Velocity= 4.99 fps, Min. Travel Time= 0.3 min
Avg. Velocity = 2.70 fps, Avg. Travel Time= 0.5 min

Peak Storage= 9 cf @ 7.87 hrs, Average Depth at Peak Storage= 0.27'
Bank-Full Depth= 0.50', Capacity at Bank-Full= 0.95 cfs

6.0" Diameter Pipe, n= 0.011
Length= 80.0' Slope= 0.0206 '/'
Inlet Invert= 97.35', Outlet Invert= 95.70'



Pond P1: WEST OVERFLOW PKG

Inflow Area =	0.011 ac,	Inflow Depth >	2.09"	
Inflow =	0.01 cfs @	7.89 hrs, Volume=	0.002 af	
Outflow =	0.01 cfs @	7.97 hrs, Volume=	0.002 af,	Atten= 9%, Lag= 5.2 min
Discarded =	0.00 cfs @	7.97 hrs, Volume=	0.000 af	
Primary =	0.01 cfs @	7.97 hrs, Volume=	0.002 af	

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 97.05' @ 7.97 hrs Surf.Area= 24 sf Storage= 4 cf

Plug-Flow detention time= 20.2 min calculated for 0.002 af (98% of inflow)
Center-of-Mass det. time= 10.5 min (789.3 - 778.8)

Volume	Invert	Avail.Storage	Storage Description
#1	97.00'	74 cf	**Custom Stage Data (Prismatic)** Listed below 245 cf Overall x 30.0% Voids

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
97.00	0	0	0
98.00	490	245	245

Device	Routing	Invert	Outlet Devices
#1	Primary	97.00'	**4.0" x 30.0' long Culvert** CMP, end-section conforming to fill, Ke= 0.500 Outlet Invert= 96.00' S= 0.0333 '/' Cc= 0.900 n= 0.011
#2	Discarded	0.00'	**0.060 in/hr Exfiltration over Horizontal area**

Discarded OutFlow Max=0.00 cfs @ 7.97 hrs HW=97.05' (Free Discharge)
↑—**2=Exfiltration** (Exfiltration Controls 0.00 cfs)

Primary OutFlow Max=0.01 cfs @ 7.97 hrs HW=97.05' TW=96.11' (Dynamic Tailwater)
↑—**1=Culvert** (Inlet Controls 0.01 cfs @ 0.76 fps)

Pond P2: EAST OVERFLOW PKG

Inflow Area =	0.047 ac,	Inflow Depth >	2.09"	
Inflow =	0.03 cfs @	7.89 hrs, Volume=	0.008 af	
Outflow =	0.02 cfs @	8.01 hrs, Volume=	0.008 af,	Atten= 30%, Lag= 7.5 min
Discarded =	0.00 cfs @	8.10 hrs, Volume=	0.000 af	
Primary =	0.02 cfs @	8.01 hrs, Volume=	0.008 af	

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 97.10' @ 8.10 hrs Surf.Area= 209 sf Storage= 31 cf

Plug-Flow detention time= 47.6 min calculated for 0.008 af (97% of inflow)
Center-of-Mass det. time= 25.1 min (803.9 - 778.8)

Volume	Invert	Avail.Storage	Storage Description
#1	97.00'	309 cf	**Custom Stage Data (Prismatic)** Listed below 1,030 cf Overall x 30.0% Voids

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
97.00	0	0	0
98.00	2,060	1,030	1,030

Device	Routing	Invert	Outlet Devices
#1	Primary	97.00'	**4.0" x 150.0' long Culvert** CMP, end-section conforming to fill, Ke= 0.500 Outlet Invert= 96.00' S= 0.0067 '/' Cc= 0.900 n= 0.011
#2	Discarded	0.00'	**0.060 in/hr Exfiltration over Horizontal area**

Discarded OutFlow Max=0.00 cfs @ 8.10 hrs HW=97.10' (Free Discharge)
↑—**2=Exfiltration** (Exfiltration Controls 0.00 cfs)

Primary OutFlow Max=0.02 cfs @ 8.01 hrs HW=97.10' TW=96.23' (Dynamic Tailwater)
↑—**1=Culvert** (Outlet Controls 0.02 cfs @ 1.26 fps)

Pond P4: SOUTH OVERFLOW PKG

Inflow Area =	0.049 ac, Inflow Depth > 2.09"			
Inflow =	0.03 cfs @	7.89 hrs, Volume=	0.008 af	
Outflow =	0.03 cfs @	7.89 hrs, Volume=	0.008 af,	Atten= 0%, Lag= 0.0 min
Discarded =	0.00 cfs @	8.61 hrs, Volume=	0.000 af	
Primary =	0.03 cfs @	7.89 hrs, Volume=	0.008 af	

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 97.00' @ 0.00 hrs Surf.Area= 0 sf Storage= 0 cf

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

Volume	Invert	Avail.Storage	Storage Description
#1	97.00'	317 cf	**Custom Stage Data (Prismatic)** Listed below 1,058 cf Overall x 30.0% Voids

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
97.00	0	0	0
98.00	2,115	1,058	1,058

Device	Routing	Invert	Outlet Devices
#1	Primary	96.50'	**4.0" x 80.0' long Culvert** CMP, end-section conforming to fill, Ke= 0.500 Outlet Invert= 96.00' S= 0.0063 '/' Cc= 0.900 n= 0.011
#2	Discarded	0.00'	**0.060 in/hr Exfiltration over Horizontal area**

Discarded OutFlow Max=0.00 cfs @ 8.61 hrs HW=97.00' (Free Discharge)
↑—**2=Exfiltration** (Controls 0.00 cfs)

Primary OutFlow Max=0.00 cfs @ 7.89 hrs HW=97.00' TW=95.76' (Dynamic Tailwater)
↑—**1=Culvert** (Passes 0.00 cfs of 0.19 cfs potential flow)

Pond P6: SOUTH SWALE

Inflow Area =	1.292 ac, Inflow Depth > 2.72"			
Inflow =	1.08 cfs @	7.87 hrs, Volume=	0.293 af	
Outflow =	0.34 cfs @	8.42 hrs, Volume=	0.290 af,	Atten= 69%, Lag= 32.7 min
Discarded =	0.00 cfs @	8.42 hrs, Volume=	0.003 af	
Primary =	0.34 cfs @	8.42 hrs, Volume=	0.287 af	
Secondary =	0.00 cfs @	0.00 hrs, Volume=	0.000 af	

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 96.61' @ 8.42 hrs Surf.Area= 0.058 ac Storage= 0.039 af

Plug-Flow detention time= 48.2 min calculated for 0.290 af (99% of inflow)
Center-of-Mass det. time= 40.1 min (738.6 - 698.5)

Volume	Invert	Avail.Storage	Storage Description
#1	93.00'	0.070 af	**4.00'W x 160.00'L x 5.00'H Prismatoid Z=1.5** 0.223 af Overall - 0.154 af Embedded = 0.070 af
#2	93.00'	0.046 af	**4.00'W x 160.00'L x 4.00'H Prismatoid Z=1.5** Inside #1 0.154 af Overall x 30.0% Voids
		0.116 af	Total Available Storage

Device	Routing	Invert	Outlet Devices
#1	Discarded	0.00'	**0.060 in/hr Exfiltration over Surface area**
#2	Primary	93.25'	**3.0" x 1.0' long Culvert** CPP, projecting, no headwall, Ke= 0.900 Outlet Invert= 93.00' S= 0.2500 '/' Cc= 0.900 n= 0.011
#3	Secondary	97.00'	**4.0" Horiz. Orifice/Grate X 3.00 columns** X 3 rows Limited to weir flow C= 0.600

Discarded OutFlow Max=0.00 cfs @ 8.42 hrs HW=96.61' (Free Discharge)
↑—**1=Exfiltration** (Exfiltration Controls 0.00 cfs)

Primary OutFlow Max=0.34 cfs @ 8.42 hrs HW=96.61' (Free Discharge)
↑—**2=Culvert** (Inlet Controls 0.34 cfs @ 6.84 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=93.00' (Free Discharge)
↑—**3=Orifice/Grate** (Controls 0.00 cfs)