

Lucky Foods Expansion

*11847 SW Itel Street
Tualatin, OR*

J.O. SGL 20-025

June 4, 2020

PRELIMINARY STORM REPORT & CALCULATIONS



EXPIRES: 6/30/

SISUL ENGINEERING

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NARRATIVE FOR STORMWATER MANAGEMENT
for the expansion of the
LUCKY FOODS WAREHOUSE
11847 SW Itel Street
Tualatin, OR 97062

Description

Lucky Foods which occupies the warehouse at 11847 SW Itel Street in Tualatin, wishes to enlarge its building's footprint by approximately 5160 SF and to make some minor adjustments to the parking lot and landscape areas. In total, the impacted (redeveloped or modified) area of the site will be less than 6,500 SF.

Stormwater History

The Lucky Foods site is one of two parcels that were partitioned in 2003 and redivided again in 2004. At the time of the original partition a shared stormwater tract to be privately maintained among the parcels was created. This stormwater tract was developed under stormwater standards in place in 2003, and when the building was constructed in 2016-17, that shared stormwater tract was able to be used as the stormwater facility for the improvement.

Since land use approval of the building in 2016, Clean Water Services has twice revised their stormwater manual with the most recent revision being adopted in 2019.

How CWS 2019 Stormwater Standards are applicable to the Lucky Foods Expansion

Chapter 4 of the CWS Stormwater Manual (Runoff Treatment and Control) the following sections are applicable:

4.02 – Water Quantity Control Requirements for Conveyance

4.02-1 – As this is not a new development, but a partial redevelopment, where the amount of impervious will be decrease a few hundred square feet, this is not applicable.

4.02-2 – there is no known downstream deficiency.

4.03.1 – As the redevelopment of the site will exceed 1,000 SF the development is required to implement to reduce impacts to downstream receiving water body.

4.03.2(a) – As the addition or modification of the site will be less than 12,000 SF of impervious area, it meets an exception to the requirement to address Hydromodification Assessment requirement. Therefore, the remainder of Section 4.03 is not applicable to this development.

4.04.1 – As more than 1,000 SF of impervious area will be disturbed water quality will be required.

4.04.2(a) – Water quality shall be implemented on site.¹ As the it neither Item 1 or 2 appears to be applicable to the development, and the City currently does not have a Fee-in-Lieu (as permitted under 4.04.2(b) setup for such requests, thus requirement must be met.

¹While “on site” is not directly defined in the stormwater manual, we have been told that the existing shared stormwater treatment tract created to serve this site in 2003, does qualify as on-site.

4.04.3 – The requirements of Treatment Design and Efficiency is required.

4.05 – LIDA requirements are a potential option for this redevelopment area.

4.05.2 – Appears to require LIDA facilities if possible.

4.05.3(a) – Refers back to facilities noted in 4.04.3(c)1.

4.06 – Summary of Stormwater Management Approaches. Table 4-3 provides some choices for meeting the requirements of Chapter 4.

Of the choices available the following are most potentially suitable for the site:

- LIDA flow through planter
- Proprietary treatment for WQ with a separate detention facility.

4.07.8 – Proprietary treatment systems are allowed if they meet the requirements of 404.3(a) and treat runoff from a single industrial parcel.

4.08.1(d) – As this industrial site will modify more than 1,000 SF of impervious surface, *water quality* must meet the standard of modified impervious area times 3.

4.08.2 – is applicable for the design storm events.

4.08.4(a) – is applicable as each contributing area will be less than 15,000 SF.

4.08.4(b) – is applicable for sizing factor (for water quality) as the infiltration rate will be less than 2 inches per hour.

4.08.4(c) – is applicable for sizing factor for hydromodification and water quality.

4.08.6 – Table 4-6 provides the Peak Flow requirements for the new redeveloped impervious area.

4.09.9(b) – Simplified Sizing of Section 4.08.4 may be used.

Analysis:

Per Section 4.03.1, as the redevelopment area exceeds 1,000 SF the site is required to reduce impacts to downstream receiving water bodies, and to provide water quality. However, per Section 4.03.2(a) as the redevelopment area will be less than 12,000 SF, hydromodification is not required. (As noted above, the site does drain into a shared detention and water quality basin that developed for this parcel and two other adjoining parcels in 2003 era.)

Therefore, water quality must be addressed per new CWS standards but hydromodification does not, but for the redevelopment area only (or an area equal to or larger than) the storm detention is required on site to match the pre-developed 2, 10 and 25 year storm events, per Table 4-6 of Section 4.08.6.

WATER QUALITY

Per Section 4.08.1(d) as more than 1,000 SF of impervious area will be reconstructed the water quality treatment upgrade must equal 3 times the redevelopment area or the entire site, whichever is less. For this redevelopment the new building area will be 5,160 SF and the new reconstructed pavement area is expected to be approximately 1300 SF., or a total of approximately 6500 SF of reconstructed impervious area.

Based on the Section 4.08.4(a) the treatment area can use the simplified area if the contributing area will be less than 15,000 SF. As the treatment area is 6500 SF times 3 the total required treatment area will be 19,500 SF. Therefore, at least 2 facilities will be required to keep each treatment area under 15,000 SF.

- Based on the simplified method for a Flow Through Planter – the new building area will require a flow planter of at least 310 SF ($5,160 \text{ SF} \times 0.06 = 309.6 \text{ SF}$). There is a nearby landscape area to the building that will be used as a flow through planter for the roof area, this landscape area exceeds 310 SF.

For the additional treatment area as required to meet the minimum treatment area threshold (19,500 SF – 5,106 SF = 14,394 SF) as noted above, we are proposing the use of a Contech stormwater filter vault to treat the original building roof area, 13,824 SF and 704 SF of the truck

dock area that drains back to the slotted drain, for a total of 14,528 SF. As the western two thirds of the roof will be replumbed to combine with the trench drain line at the truck dock area, one Contech Stormfilter catchbasin will be installed there and a second one will be installed at the downspout for the eastern 1/3 of the original roof area.

- For the western 2/3rds of roof area and the portion of the truck dock draining back to the slotted drain. (8930 SF + 704 SF= 9634 SF)

Water Quality Volume (WQV):

Per CWS, the water quality storm event is 0.36 inches in 4 hours.

$$WQV = \frac{0.36 \text{ (in.)} \times \text{Area (s.f.)}}{12 \text{ (in/ft)}} = \frac{0.36 \text{ (in.)} \times 9634 \text{ (s.f.)}}{12 \text{ (in/ft)}} = 289 \text{ cu. ft.}$$

Water Quality Flow (WQF):

$$WQF = \frac{WQV \text{ (cu. ft.)}}{4 \text{ (hours)}} = \frac{289 \text{ (cu. ft.)}}{14,400 \text{ (s)}} = 0.020 \text{ cfs}$$

Stormfilter or equivalent 18" tall filters can treat 12.53 gpm or 0.027 cfs. We will divide our required WQF flow rate by cartridge rate to determine how many cartridges we need.

$$\text{Number of Cartridges} = 0.020 \text{ cfs} / 0.027 \text{ cfs} = 0.74 \text{ cartridges} = 1 \text{ cartridge}$$

Therefore, an 18 inch stormfilter system with 1 cartridge can be used to meet CWS water quality requirements, for this area.

- For the eastern 1/3rds of roof area 4894 SF

Water Quality Volume (WQV):

Per CWS, the water quality storm event is 0.36 inches in 4 hours.

$$WQV = \frac{0.36 \text{ (in.)} \times \text{Area (s.f.)}}{12 \text{ (in/ft)}} = \frac{0.36 \text{ (in.)} \times 4894 \text{ (s.f.)}}{12 \text{ (in/ft)}} = 146 \text{ cu. ft.}$$

Water Quality Flow (WQF):

$$WQF = \frac{WQV \text{ (cu. ft.)}}{4 \text{ (hours)}} = \frac{146 \text{ (cu. ft.)}}{14,400 \text{ (s)}} = 0.010 \text{ cfs}$$

Stormfilter or equivalent 12" tall filters can treat 8.35 gpm or 0.018 cfs. We will divide our required WQF flow rate by cartridge rate to determine how many cartridges we need.

$$\text{Number of Cartridges} = 0.010 \text{ cfs} / 0.018 \text{ cfs} = 0.55 \text{ cartridges} = 1 \text{ cartridge}$$

Therefore, a 12 inch stormfilter system with 1 cartridge can be used to meet CWS water quality requirements, for this area.

Summary:

Thus, it is proposed that 19,634 SF of roof and pavement area will be treated, with 310 SF+, Flow through Planter for the new roof area, an 18 inch filter height Contech Stormfilter catchbasin for the western 2/3rds of the existing roof area and a portion of the truck dock area, and a 12 inch filter height Contech Stormfilter catchbasin for the eastern 1/3rd of the existing roof area.

WATER QUANTITY

The requirement is address, onsite an area equal to or exceeding the redevelopment area. The redevelopment area is less than 6500 SF. The proposed area of stormwater detainage will be from an existing parking areas and areas draining into those parking areas totaling 14,596 SF. The pre-developed condition is assumed to be grass areas, which is as it existed prior to the construction of the original building in 2016-17. The existing improved condition is currently, and will remain unchanged, 10,009 SF of impervious area and 4,587 SF of pervious landscape area. We note that there will be a net detention benefit of approximately 3500 SF of impervious area being detained, over the minimum required (10,009 SF – 6,500 SF) = 3,500 SF.

We will begin by determining the sites pre-and post-developed flow rate for a 2, 10 and 25-year storm event.

Area:

Existing Area Breakdown:

Pervious area	= 14,596 SF = 0.34 acres
Impervious area	= <u>0,000 SF = 0.00 acres</u>
Total area	= 14,596 SF = 0.34 acres

Post Developed Area Breakdown:

Pervious area	= 4,587 SF = 0.11 acres
Impervious area	= <u>10,009 SF = 0.23 acres</u>
Total area	= 14,596 SF = 0.34 acres

Runoff Curve Numbers:

NRCS soils indicates our site is mostly comprised of Quatama loam. Per the NRCS datum Quatama loam falls in Hydrologic Soil group 'C'.

Impervious Surfaces	Hydrologic Group 'C' => 98
Pervious Surface grass	Hydrologic Group 'C' => 86

Rainfall Distribution: (Per CWS Table 4-4)

2 yr, 24-hour storm event	Total depth = 2.50 inches
10 yr, 24-hour storm event	Total depth = 3.45 inches
25 yr, 24-hour storm event	Total depth = 3.90 inches

Pre-developed Time of Concentration:

Because of the small area, the site's original natural slope, a $T_c = 5.0$ minutes was used.

Post-developed Time of Concentration:

$T_c = \underline{5.0 \text{ min}}$

Hydrographs:

The predeveloped and post development hydrographs were developed based on the 2, 10 and 25 year storm events.

Pre-Developed Rates

2-Year → 0.30 cfs
10-Year → 0.51 cfs
25-Year^b → 0.62 cfs

A 30 inch Detention Pipe, 80 feet long will be used as the detention system to control release rates from the detention basin.

Design: 30" Detention Pipe

Flow Control:

Bottom Orifice → 3.3" diameter at 0.00'
Second Orifice → 3.0" diameter at 1.10'
Overflow → 12" Riser at 2.25'

Based on the results of the modeling the release flow rates for the 2, 10 and 25 year events are noted below:

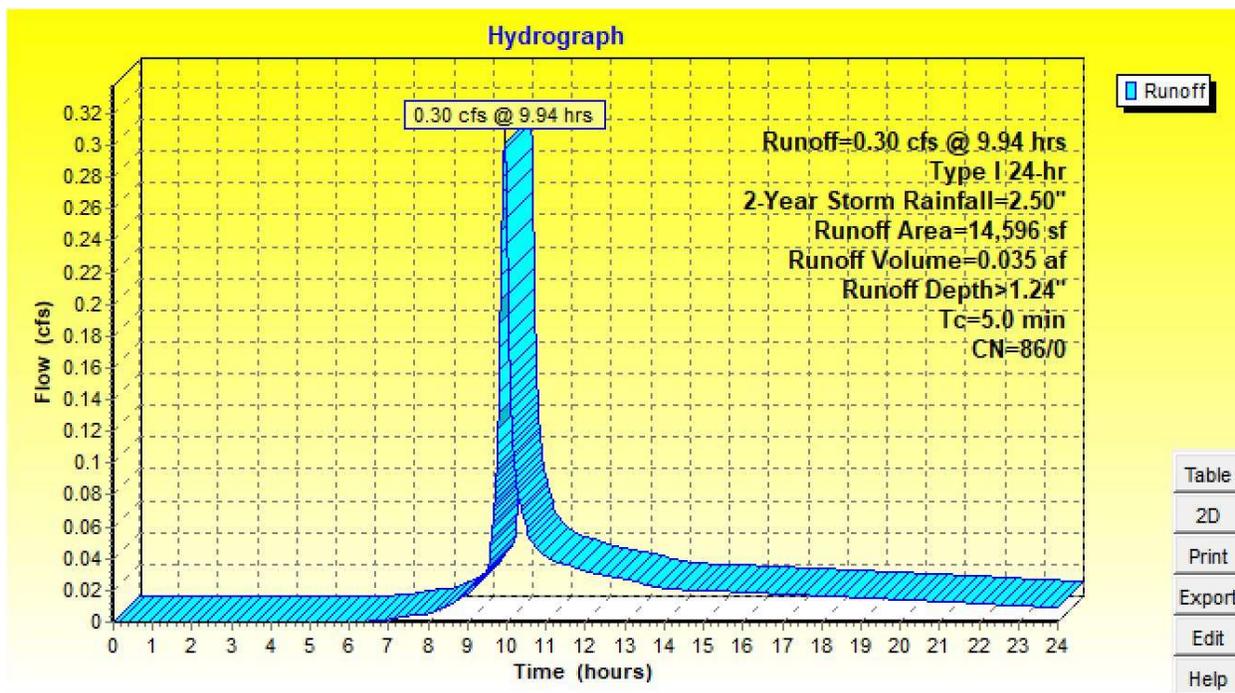
Post-Developed Rates

2-Year → 0.30 cfs
10-Year → 0.50 cfs
25-Year → 0.56 cfs

The peak flow rates meet the requirements of the matching or being less than the design

Below are the Hydrographs, Summary and Tables for the Pre-developed 2 year, 10 year and 25 year events on the detention basin that will drain to the detention system. (Note, in this case the pre-developed condition is that condition that existed prior to 2016).

2 year graph and summary



Runoff = 0.30 cfs @ 9.94 hrs, Volume= 0.035 af, Depth> 1.24"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
 Type I 24-hr 2-Year Storm Rainfall=2.50"

Area (sf)	CN	Description
* 14,596	86	Pasture
14,596	86	100.00% Pervious Area

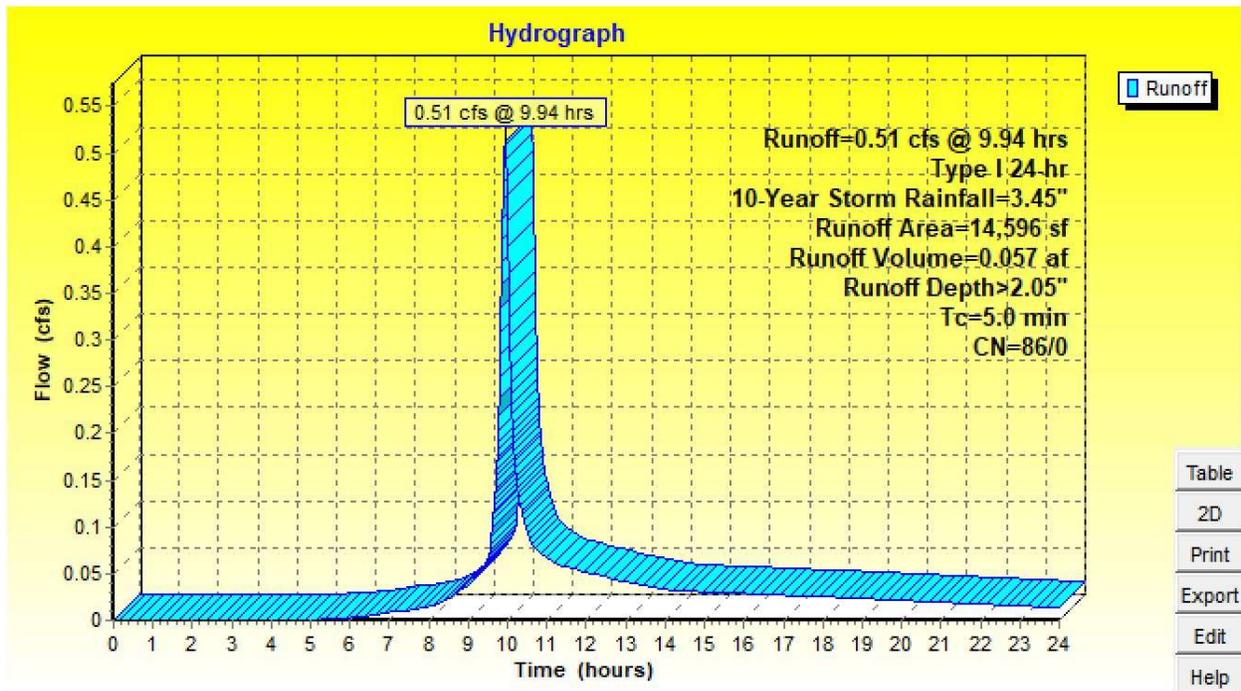
Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					Direct Entry, Time of Concentration

2 year tabular print out

Hydrograph for Pond 3P: Scenario 1 - 30" Detention Pipe

Time (hours)	Inflow (cfs)	Storage (cubic-feet)	Elevation (feet)	Primary (cfs)
0.00	0.00	0	0.00	0.00
0.50	0.00	0	0.00	0.00
1.00	0.00	0	0.00	0.00
1.50	0.00	0	0.02	0.00
2.00	0.00	1	0.03	0.00
2.50	0.00	1	0.03	0.00
3.00	0.01	1	0.04	0.01
3.50	0.01	2	0.04	0.01
4.00	0.01	2	0.05	0.01
4.50	0.01	2	0.05	0.01
5.00	0.01	2	0.05	0.01
5.50	0.01	2	0.05	0.01
6.00	0.01	2	0.06	0.01
6.50	0.01	3	0.06	0.01
7.00	0.02	3	0.07	0.02
7.50	0.02	3	0.07	0.02
8.00	0.02	4	0.08	0.02
8.50	0.03	5	0.09	0.03
9.00	0.05	6	0.11	0.05
9.50	0.07	8	0.13	0.07
10.00	0.38	154	1.04	0.29
10.50	0.08	13	0.19	0.12
11.00	0.05	7	0.12	0.06
11.50	0.05	6	0.11	0.05
12.00	0.04	6	0.10	0.04
12.50	0.04	5	0.10	0.04
13.00	0.03	5	0.09	0.03
13.50	0.03	4	0.09	0.03
14.00	0.03	4	0.08	0.03
14.50	0.02	4	0.08	0.02
15.00	0.02	4	0.08	0.02
15.50	0.02	4	0.08	0.02
16.00	0.02	4	0.08	0.02
16.50	0.02	4	0.08	0.02
17.00	0.02	3	0.08	0.02
17.50	0.02	3	0.07	0.02
18.00	0.02	3	0.07	0.02
18.50	0.02	3	0.07	0.02
19.00	0.02	3	0.07	0.02
19.50	0.02	3	0.07	0.02
20.00	0.02	3	0.07	0.02
20.50	0.02	3	0.06	0.02
21.00	0.02	3	0.06	0.02
21.50	0.01	3	0.06	0.01
22.00	0.01	2	0.06	0.01
22.50	0.01	2	0.06	0.01
23.00	0.01	2	0.06	0.01
23.50	0.01	2	0.05	0.01
24.00	0.01	2	0.05	0.01

10 year graph and summary



Runoff = 0.51 cfs @ 9.94 hrs, Volume= 0.057 af, Depth> 2.05"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
 Type I 24-hr 10-Year Storm Rainfall=3.45"

Area (sf)	CN	Description
* 14,596	86	Pasture
14,596	86	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					Direct Entry, Time of Concentration

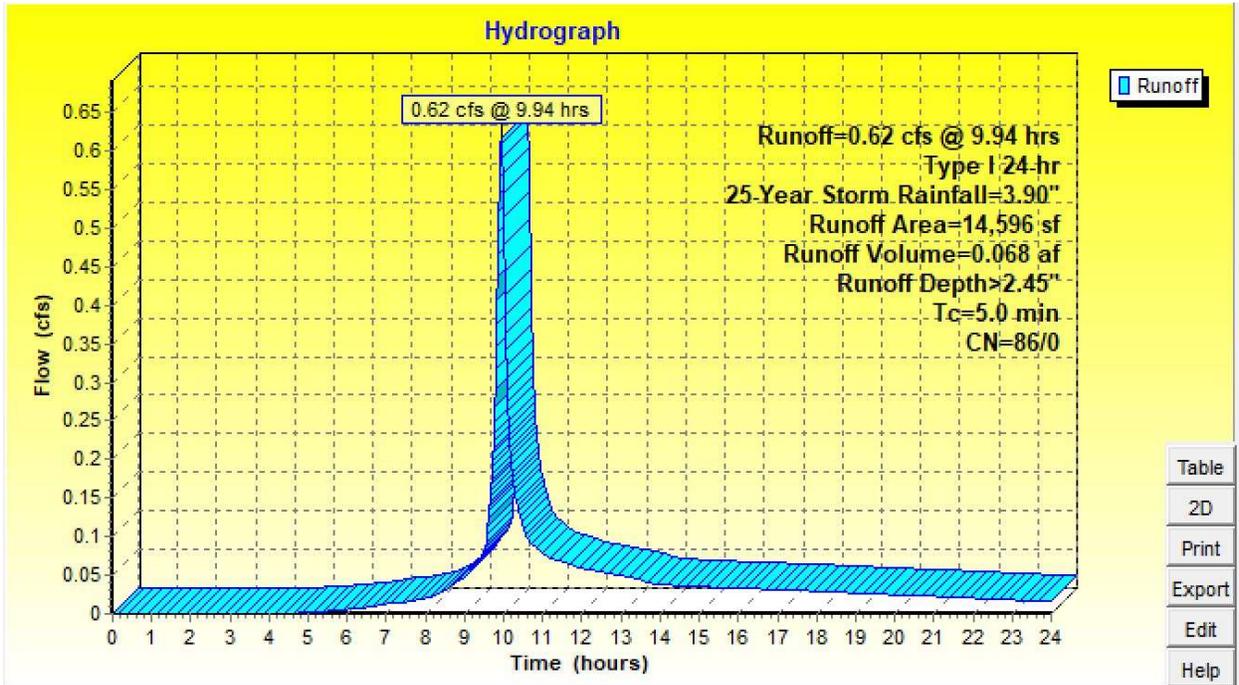
Prelim.

10 year tabular print out

Hydrograph for Subcatchment 1S: Pre-Developed Area

Time (hours)	Precip. (inches)	Perv.Excess (inches)	Imp.Excess (inches)	Runoff (cfs)
0.00	0.00	0.00	0.00	0.00
0.50	0.03	0.00	0.00	0.00
1.00	0.06	0.00	0.00	0.00
1.50	0.09	0.00	0.00	0.00
2.00	0.12	0.00	0.00	0.00
2.50	0.15	0.00	0.00	0.00
3.00	0.19	0.00	0.00	0.00
3.50	0.22	0.00	0.00	0.00
4.00	0.26	0.00	0.00	0.00
4.50	0.30	0.00	0.00	0.00
5.00	0.34	0.00	0.00	0.00
5.50	0.39	0.00	0.00	0.00
6.00	0.43	0.01	0.00	0.00
6.50	0.48	0.01	0.00	0.01
7.00	0.54	0.02	0.00	0.01
7.50	0.60	0.04	0.00	0.01
8.00	0.67	0.06	0.00	0.01
8.50	0.76	0.09	0.00	0.02
9.00	0.88	0.14	0.00	0.04
9.50	1.05	0.22	0.00	0.06
10.00	1.78	0.68	0.00	0.43
10.50	2.01	0.86	0.00	0.09
11.00	2.15	0.96	0.00	0.07
11.50	2.26	1.05	0.00	0.06
12.00	2.36	1.13	0.00	0.05
12.50	2.45	1.20	0.00	0.05
13.00	2.53	1.26	0.00	0.04
13.50	2.60	1.32	0.00	0.04
14.00	2.66	1.37	0.00	0.03
14.50	2.71	1.42	0.00	0.03
15.00	2.77	1.46	0.00	0.03
15.50	2.82	1.51	0.00	0.03
16.00	2.87	1.55	0.00	0.03
16.50	2.92	1.59	0.00	0.03
17.00	2.97	1.63	0.00	0.03
17.50	3.01	1.67	0.00	0.03
18.00	3.06	1.71	0.00	0.03
18.50	3.10	1.75	0.00	0.02
19.00	3.14	1.78	0.00	0.02
19.50	3.18	1.82	0.00	0.02
20.00	3.22	1.85	0.00	0.02
20.50	3.25	1.88	0.00	0.02
21.00	3.28	1.91	0.00	0.02
21.50	3.32	1.94	0.00	0.02
22.00	3.35	1.96	0.00	0.02
22.50	3.37	1.99	0.00	0.02
23.00	3.40	2.01	0.00	0.02
23.50	3.43	2.03	0.00	0.01
24.00	3.45	2.05	0.00	0.01

25 year graph and summary



Runoff = 0.62 cfs @ 9.94 hrs, Volume= 0.068 af, Depth> 2.45"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
 Type I 24-hr 25-Year Storm Rainfall=3.90"

Area (sf)	CN	Description
* 14,596	86	Pasture
14,596	86	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					Direct Entry, Time of Concentration

Prelim

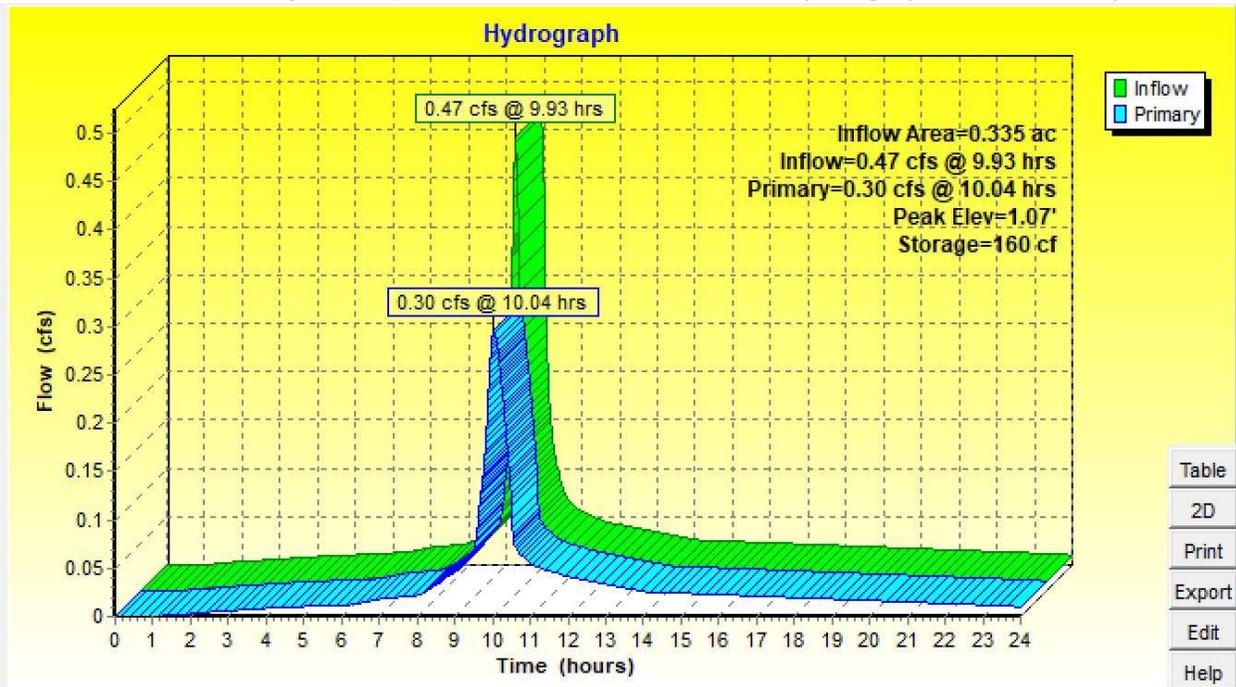
25 year Tabular print out

Hydrograph for Pond 3P: Scenario 1 - 30" Detention Pipe

Time (hours)	Inflow (cfs)	Storage (cubic-feet)	Elevation (feet)	Primary (cfs)
0.00	0.00	0	0.00	0.00
0.50	0.00	0	0.00	0.00
1.00	0.00	1	0.03	0.00
1.50	0.01	1	0.04	0.01
2.00	0.01	2	0.05	0.01
2.50	0.01	2	0.05	0.01
3.00	0.01	2	0.06	0.01
3.50	0.01	3	0.06	0.01
4.00	0.02	3	0.07	0.02
4.50	0.02	3	0.07	0.02
5.00	0.02	3	0.07	0.02
5.50	0.02	3	0.07	0.02
6.00	0.02	4	0.08	0.02
6.50	0.03	4	0.08	0.03
7.00	0.03	5	0.09	0.03
7.50	0.04	5	0.10	0.04
8.00	0.04	5	0.10	0.04
8.50	0.06	7	0.12	0.06
9.00	0.08	9	0.15	0.08
9.50	0.12	13	0.18	0.12
10.00	0.64	287	1.72	0.56
10.50	0.13	76	0.62	0.23
11.00	0.09	10	0.15	0.09
11.50	0.08	9	0.14	0.08
12.00	0.07	8	0.13	0.07
12.50	0.06	8	0.13	0.06
13.00	0.05	7	0.12	0.06
13.50	0.05	6	0.11	0.05
14.00	0.04	6	0.11	0.04
14.50	0.04	6	0.10	0.04
15.00	0.04	5	0.10	0.04
15.50	0.04	5	0.10	0.04
16.00	0.04	5	0.10	0.04
16.50	0.04	5	0.10	0.04
17.00	0.03	5	0.09	0.03
17.50	0.03	5	0.09	0.03
18.00	0.03	5	0.09	0.03
18.50	0.03	4	0.09	0.03
19.00	0.03	4	0.09	0.03
19.50	0.03	4	0.09	0.03
20.00	0.03	4	0.08	0.03
20.50	0.03	4	0.08	0.03
21.00	0.02	4	0.08	0.02
21.50	0.02	4	0.08	0.02
22.00	0.02	4	0.08	0.02
22.50	0.02	3	0.07	0.02
23.00	0.02	3	0.07	0.02
23.50	0.02	3	0.07	0.02
24.00	0.02	3	0.07	0.02

Calculations

Below are the Hydrographs, Summary and Tables the 2, 10 and 25 year post development (of the detention basin) area. (Note post-development in this case is the existing improvements as noted in the basin map above) Below the 2 year graph and summary



- Table
- 2D
- Print
- Export
- Edit
- Help

Inflow Area = 0.335 ac, 68.51% Impervious, Inflow Depth > 1.94" for 2-Year Storm event
 Inflow = 0.47 cfs @ 9.93 hrs, Volume= 0.054 af
 Outflow = 0.30 cfs @ 10.04 hrs, Volume= 0.054 af, Atten= 37%, Lag= 6.2 min
 Primary = 0.30 cfs @ 10.04 hrs, Volume= 0.054 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
 Peak Elev= 1.07' @ 10.04 hrs Surf.Area= 198 sf Storage= 160 cf

Plug-Flow detention time= 3.5 min calculated for 0.054 af (100% of inflow)
 Center-of-Mass det. time= 2.9 min (732.5 - 729.6)

Volume	Invert	Avail.Storage	Storage Description
#1	0.00'	393 cf	30.0" Round CMP_Round 30" L= 80.0'

Device	Routing	Invert	Outlet Devices
#1	Primary	0.00'	12.0" Round Culvert L= 10.0' RCP, groove end projecting, Ke= 0.200 Inlet / Outlet Invert= 0.00' / -0.10' S= 0.0100 /' Cc= 0.900 n= 0.013, Flow Area= 0.79 sf
#2	Device 1	0.00'	3.3" Horiz. Orifice/Grate C= 0.600 Limited to weir flow at low heads
#3	Device 1	1.10'	3.0" Horiz. Orifice/Grate C= 0.600 Limited to weir flow at low heads
#4	Device 1	2.25'	37.1' long 12" Overflow 2 End Contraction(s)

Primary OutFlow Max=0.30 cfs @ 10.04 hrs HW=1.07' (Free Discharge)

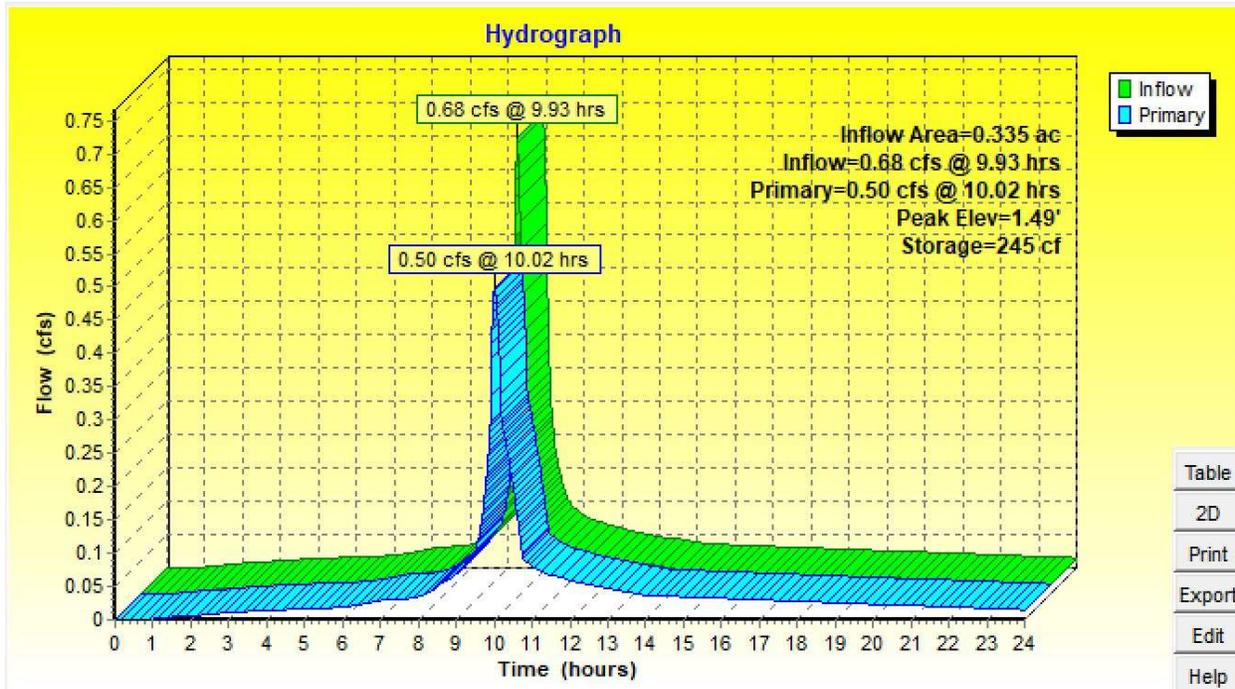
- ↑ 1=Culvert (Passes 0.30 cfs of 2.72 cfs potential flow)
- ↑ 2=Orifice/Grate (Orifice Controls 0.30 cfs @ 4.97 fps)
- ↑ 3=Orifice/Grate (Controls 0.00 cfs)
- ↑ 4=12" Overflow (Controls 0.00 cfs)

2 year tabular print out

Hydrograph for Pond 3P: Scenario 1 - 30" Detention Pipe

Time (hours)	Inflow (cfs)	Storage (cubic-feet)	Elevation (feet)	Primary (cfs)
0.00	0.00	0	0.00	0.00
0.50	0.00	0	0.00	0.00
1.00	0.00	0	0.00	0.00
1.50	0.00	0	0.02	0.00
2.00	0.00	1	0.03	0.00
2.50	0.00	1	0.03	0.00
3.00	0.01	1	0.04	0.01
3.50	0.01	2	0.04	0.01
4.00	0.01	2	0.05	0.01
4.50	0.01	2	0.05	0.01
5.00	0.01	2	0.05	0.01
5.50	0.01	2	0.05	0.01
6.00	0.01	2	0.06	0.01
6.50	0.01	3	0.06	0.01
7.00	0.02	3	0.07	0.02
7.50	0.02	3	0.07	0.02
8.00	0.02	4	0.08	0.02
8.50	0.03	5	0.09	0.03
9.00	0.05	6	0.11	0.05
9.50	0.07	8	0.13	0.07
10.00	0.38	154	1.04	0.29
10.50	0.08	13	0.19	0.12
11.00	0.05	7	0.12	0.06
11.50	0.05	6	0.11	0.05
12.00	0.04	6	0.10	0.04
12.50	0.04	5	0.10	0.04
13.00	0.03	5	0.09	0.03
13.50	0.03	4	0.09	0.03
14.00	0.03	4	0.08	0.03
14.50	0.02	4	0.08	0.02
15.00	0.02	4	0.08	0.02
15.50	0.02	4	0.08	0.02
16.00	0.02	4	0.08	0.02
16.50	0.02	4	0.08	0.02
17.00	0.02	3	0.08	0.02
17.50	0.02	3	0.07	0.02
18.00	0.02	3	0.07	0.02
18.50	0.02	3	0.07	0.02
19.00	0.02	3	0.07	0.02
19.50	0.02	3	0.07	0.02
20.00	0.02	3	0.07	0.02
20.50	0.02	3	0.06	0.02
21.00	0.02	3	0.06	0.02
21.50	0.01	3	0.06	0.01
22.00	0.01	2	0.06	0.01
22.50	0.01	2	0.06	0.01
23.00	0.01	2	0.06	0.01
23.50	0.01	2	0.05	0.01
24.00	0.01	2	0.05	0.01

10 year graph and summary



Inflow Area = 0.335 ac, 68.51% Impervious, Inflow Depth > 2.85" for 10-Year Storm event
 Inflow = 0.68 cfs @ 9.93 hrs, Volume= 0.079 af
 Outflow = 0.50 cfs @ 10.02 hrs, Volume= 0.079 af, Atten= 27%, Lag= 5.0 min
 Primary = 0.50 cfs @ 10.02 hrs, Volume= 0.079 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
 Peak Elev= 1.49' @ 10.02 hrs Surf.Area= 196 sf Storage= 245 cf

Plug-Flow detention time= 3.7 min calculated for 0.079 af (100% of inflow)
 Center-of-Mass det. time= 3.2 min (723.7 - 720.6)

Volume	Invert	Avail.Storage	Storage Description
#1	0.00'	393 cf	30.0" Round CMP_Round 30" L= 80.0'

Device	Routing	Invert	Outlet Devices
#1	Primary	0.00'	12.0" Round Culvert L= 10.0' RCP, groove end projecting, Ke= 0.200 Inlet / Outlet Invert= 0.00' / -0.10' S= 0.0100 /' Cc= 0.900 n= 0.013, Flow Area= 0.79 sf
#2	Device 1	0.00'	3.3" Horiz. Orifice/Grate C= 0.600 Limited to weir flow at low heads
#3	Device 1	1.10'	3.0" Horiz. Orifice/Grate C= 0.600 Limited to weir flow at low heads
#4	Device 1	2.25'	37.1' long 12" Overflow 2 End Contraction(s)

Primary OutFlow Max=0.50 cfs @ 10.02 hrs HW=1.49' (Free Discharge)

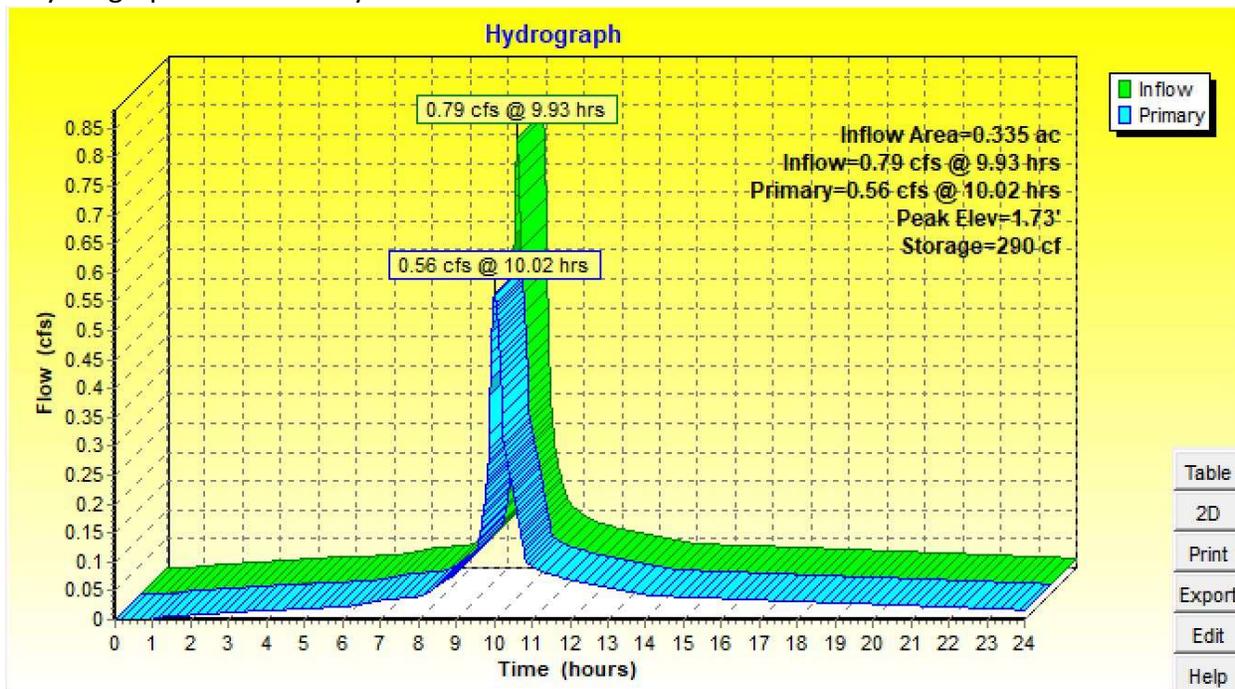
- 1=Culvert (Passes 0.50 cfs of 3.95 cfs potential flow)
- 2=Orifice/Grate (Orifice Controls 0.35 cfs @ 5.89 fps)
- 3=Orifice/Grate (Orifice Controls 0.15 cfs @ 3.02 fps)
- 4=12" Overflow (Controls 0.00 cfs)

10 year tabular print out

Hydrograph for Pond 3P: Scenario 1 - 30" Detention Pipe

Time (hours)	Inflow (cfs)	Storage (cubic-feet)	Elevation (feet)	Primary (cfs)
0.00	0.00	0	0.00	0.00
0.50	0.00	0	0.00	0.00
1.00	0.00	0	0.00	0.00
1.50	0.00	0	0.02	0.00
2.00	0.00	1	0.03	0.00
2.50	0.00	1	0.03	0.00
3.00	0.01	1	0.04	0.01
3.50	0.01	2	0.04	0.01
4.00	0.01	2	0.05	0.01
4.50	0.01	2	0.05	0.01
5.00	0.01	2	0.05	0.01
5.50	0.01	2	0.05	0.01
6.00	0.01	2	0.06	0.01
6.50	0.01	3	0.06	0.01
7.00	0.02	3	0.07	0.02
7.50	0.02	3	0.07	0.02
8.00	0.02	4	0.08	0.02
8.50	0.03	5	0.09	0.03
9.00	0.05	6	0.11	0.05
9.50	0.07	8	0.13	0.07
10.00	0.38	154	1.04	0.29
10.50	0.08	13	0.19	0.12
11.00	0.05	7	0.12	0.06
11.50	0.05	6	0.11	0.05
12.00	0.04	6	0.10	0.04
12.50	0.04	5	0.10	0.04
13.00	0.03	5	0.09	0.03
13.50	0.03	4	0.09	0.03
14.00	0.03	4	0.08	0.03
14.50	0.02	4	0.08	0.02
15.00	0.02	4	0.08	0.02
15.50	0.02	4	0.08	0.02
16.00	0.02	4	0.08	0.02
16.50	0.02	4	0.08	0.02
17.00	0.02	3	0.08	0.02
17.50	0.02	3	0.07	0.02
18.00	0.02	3	0.07	0.02
18.50	0.02	3	0.07	0.02
19.00	0.02	3	0.07	0.02
19.50	0.02	3	0.07	0.02
20.00	0.02	3	0.07	0.02
20.50	0.02	3	0.06	0.02
21.00	0.02	3	0.06	0.02
21.50	0.01	3	0.06	0.01
22.00	0.01	2	0.06	0.01
22.50	0.01	2	0.06	0.01
23.00	0.01	2	0.06	0.01
23.50	0.01	2	0.05	0.01
24.00	0.01	2	0.05	0.01

25 year graph and summary



Inflow Area = 0.335 ac, 68.51% Impervious, Inflow Depth > 3.28" for 25-Year Storm event
 Inflow = 0.79 cfs @ 9.93 hrs, Volume= 0.092 af
 Outflow = 0.56 cfs @ 10.02 hrs, Volume= 0.092 af, Atten= 28%, Lag= 5.1 min
 Primary = 0.56 cfs @ 10.02 hrs, Volume= 0.092 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
 Peak Elev= 1.73' @ 10.02 hrs Surf.Area= 185 sf Storage= 290 cf

Plug-Flow detention time= 3.8 min calculated for 0.091 af (100% of inflow)
 Center-of-Mass det. time= 3.3 min (720.6 - 717.4)

Volume	Invert	Avail.Storage	Storage Description
#1	0.00'	393 cf	30.0" Round CMP_Round 30" L= 80.0'

Device	Routing	Invert	Outlet Devices
#1	Primary	0.00'	12.0" Round Culvert L= 10.0' RCP, groove end projecting, Ke= 0.200 Inlet / Outlet Invert= 0.00' / -0.10' S= 0.0100' / Cc= 0.900 n= 0.013, Flow Area= 0.79 sf
#2	Device 1	0.00'	3.3" Horiz. Orifice/Grate C= 0.600 Limited to weir flow at low heads
#3	Device 1	1.10'	3.0" Horiz. Orifice/Grate C= 0.600 Limited to weir flow at low heads
#4	Device 1	2.25'	37.1' long 12" Overflow 2 End Contraction(s)

Primary OutFlow Max=0.56 cfs @ 10.02 hrs HW=1.73' (Free Discharge)

- ← 1=Culvert (Passes 0.56 cfs of 4.67 cfs potential flow)
- ← 2=Orifice/Grate (Orifice Controls 0.38 cfs @ 6.33 fps)
- ← 3=Orifice/Grate (Orifice Controls 0.19 cfs @ 3.82 fps)
- ← 4=12" Overflow (Controls 0.00 cfs)

25 year tabular print out

Hydrograph for Pond 3P: Scenario 1 - 30" Detention Pipe

Time (hours)	Inflow (cfs)	Storage (cubic-feet)	Elevation (feet)	Primary (cfs)
0.00	0.00	0	0.00	0.00
0.50	0.00	0	0.00	0.00
1.00	0.00	1	0.03	0.00
1.50	0.01	1	0.04	0.01
2.00	0.01	2	0.05	0.01
2.50	0.01	2	0.05	0.01
3.00	0.01	2	0.06	0.01
3.50	0.01	3	0.06	0.01
4.00	0.02	3	0.07	0.02
4.50	0.02	3	0.07	0.02
5.00	0.02	3	0.07	0.02
5.50	0.02	3	0.07	0.02
6.00	0.02	4	0.08	0.02
6.50	0.03	4	0.08	0.03
7.00	0.03	5	0.09	0.03
7.50	0.04	5	0.10	0.04
8.00	0.04	5	0.10	0.04
8.50	0.06	7	0.12	0.06
9.00	0.08	9	0.15	0.08
9.50	0.12	13	0.18	0.12
10.00	0.64	287	1.72	0.56
10.50	0.13	76	0.62	0.23
11.00	0.09	10	0.15	0.09
11.50	0.08	9	0.14	0.08
12.00	0.07	8	0.13	0.07
12.50	0.06	8	0.13	0.06
13.00	0.05	7	0.12	0.06
13.50	0.05	6	0.11	0.05
14.00	0.04	6	0.11	0.04
14.50	0.04	6	0.10	0.04
15.00	0.04	5	0.10	0.04
15.50	0.04	5	0.10	0.04
16.00	0.04	5	0.10	0.04
16.50	0.04	5	0.10	0.04
17.00	0.03	5	0.09	0.03
17.50	0.03	5	0.09	0.03
18.00	0.03	5	0.09	0.03
18.50	0.03	4	0.09	0.03
19.00	0.03	4	0.09	0.03
19.50	0.03	4	0.09	0.03
20.00	0.03	4	0.08	0.03
20.50	0.03	4	0.08	0.03
21.00	0.02	4	0.08	0.02
21.50	0.02	4	0.08	0.02
22.00	0.02	4	0.08	0.02
22.50	0.02	3	0.07	0.02
23.00	0.02	3	0.07	0.02
23.50	0.02	3	0.07	0.02
24.00	0.02	3	0.07	0.02

Summary:

A 30 inch diameter detention pipe, 80 feet long, as measured between the center of the manholes, with orifice controls of a 3.3 inch diameter orifice at the base and a 3 inch orifice at 1.1 feet above the base of the orifice control structure will meet the requirements. This structure will be placed along the west side of the building in a proposed landscape area.

Flow Control manhole lids will be raised sufficiently to allow the overflow riser within the structure to be at 2.5 feet above the outlet elevation.

Preliminary Storm Calculations