SR3ENGINEERS

Deanna Bennett – Borough Clerk
Borough of Haddonfield
242 Kings Highway East,
Haddonfield, NJ 08033-0969

September 23, 2019

Re: **Stormwater Investigation – ZBA #2019-14**
138 North Drive
Block 91.10, Lot 11.01
Borough of Haddonfield, Camden County, NJ

Dear Miss Bennett:

Our office has performed the following stormwater investigation for the above referenced Zoning Board application (ZBA #2019-14).

Purpose:

The applicant is proposing the addition of an approximately 430 square foot deck to the rear of their existing residence. The addition of the deck increases the impervious lot coverage percentage to 35.1%, which is over the maximum allowable impervious coverage of 32%, for the R-5A Zoning District (per Borough Code Section 135-30.1). However, the applicant already installed underground storage for stormwater in 2008 when the residence was constructed. The purpose of this stormwater investigation is to determine if this existing underground storage system is able to offset the proposed increase in impervious coverage over the maximum allowable coverage, per the Borough Code.

Hydrologic Methodologies:

Technical Release No. 55 (TR55) was used to calculate the allowable and proposed runoff from the property. The computer program Hydrology Studio has been used to generate hydrographs for the 2, 10 and 100-year frequency storm events utilizing the NRCS New Jersey Region C storm distribution and the 24-hour regional rainfall data for Camden County from the NOAA. Supporting data from the Hydrology Studios model has been attached to the end of this letter for reference.

SR3 Engineers, LLC
100 Essex Avenue, Suite 201
Bellmawr, NJ 08031
856-933-3323

Allowable Condition:

The pre-construction stormwater outflow in the model represents the maximum impervious coverage allowed on-site (32% per ordinance). The existing lot coverage and existing underground stormwater storage was not included in the model for allowable stormwater runoff. The table below lists a summary of the runoff data for the property's allowable stormwater outflow.

ALLOWABLE DRAINAGE SUMMARY ***(Peak Rate and Runoff Volume)***			
Storm Event	2-Year	10-Year	100-Year
Allowable Peak Discharge Rate (cfs)	***0.285***	***0.439***	***0.750***
Allowable Runoff Volume (cuft)	***912***	***1,434***	***2,799***

Underground Storage:

Contractor receipts confirm that the underground storage is comprised of 4 Stormtech SC-740 chambers, equipped with endcaps. The receipts also show that 30 tons (approximately 400 cubic feet) of 1 1/2" stone were used as backfill under and around the storm chambers. Per the construction plans for the residence, all of the home's roof area is routed to this underground storage system. It was confirmed by field investigation that all 4 downspouts on the residence have boots connected to underground conveyance piping and 4" diameter overflow outlets.

This underground storage was modeled in Hydrology Studio using the manufacture's specification for the SC-740 chambers, stone placement to equate to the approximate volume of stone installed, and four 4" orifices to account for the overflows on each downspout. For modelling purposes orifices are shown at the very top of the underground storage cross section as opposed to being above it at surface grade. Additionally, any storage provided by the conveyance piping from each downspout was not included in the model.

Proposed Condition:

The post-construction stormwater outflow represents the total impervious area of the site after the deck has been constructed (35.1% impervious). This is based CAD measurements of the proposed area of the deck and the existing impervious coverage on site. In this model the roof area of the residence is also routed through the existing underground stormwater storage system. A summary of the runoff data for the property's proposed stormwater outflow is listed in the table below.

PROPOSED DRAINAGE SUMMARY ***(Peak Rate and Runoff Volume)***			
Storm Event	2-Year	10-Year	100-Year
Proposed Peak Discharge Rate (cfs)	**0.135**	**0.207**	**0.819**

Proposed Runoff Volume (cuft)	**432**	**1,004**	**2,452**

Conclusion:

As depicted in the below, table the 100-Year storm peak discharge rate is marginally higher than allowable in the proposed condition. However, the peak discharge rates and runoff volumes for the proposed condition are lower than the allowable condition for all other storm events. Therefore, we do not foresee any adverse impacts related to stormwater runoff due to the construction of the proposed deck at this property.

OVERALL DRAINAGE SUMMARY AND COMPARISON			
Storm Event	2-Year	10-Year	100-Year
Allowable Peak Discharge Rate (cfs)	*0.285*	*0.439*	*0.750*
Proposed Peak Discharge Rate (cfs)	0.135	0.207	0.819
Allowable vs Proposed (cfs)	**-0.150**	**-0.232**	**+0.069**
Allowable Runoff Volume (cuft)	*912*	*1,434*	*2,799*
Proposed Runoff Volume (cuft)	432	1,004	2,452
Allowable vs Proposed (cuft)	**-480**	**-430**	**-347**

If you have any questions, comments, or suggestions, then please do not hesitate to contact me (856 933-3323 or srenauro@sr3engineers.com).

Thank You,

Samuel Renauro III, PE

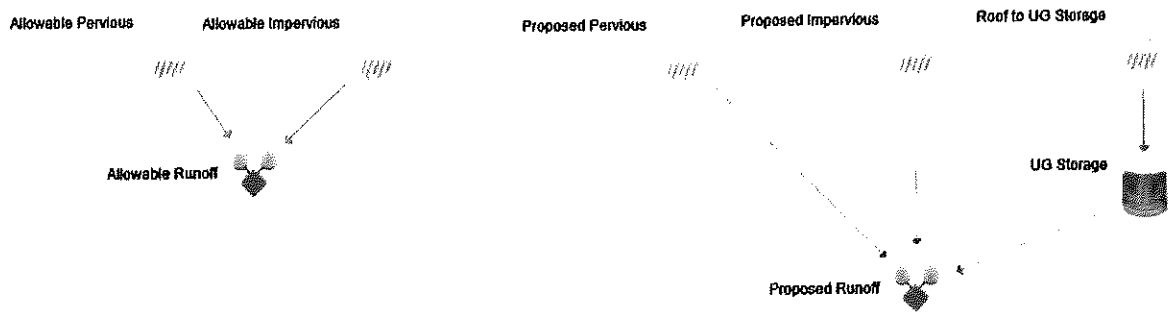
SR3 Engineers, LLC
100 Essex Avenue, Suite 201
Bellmawr, NJ 08031
856-933-3323

Basin Model

Hydrology Studio v 3.0.0.12

Project Name:

09-25-2019



Hydrograph by Return Period

Project Name:

09-25-2019

Hydrology Studio v 3.0.0.12

Hyd. No.	Hydrograph Type	Hydrograph Name	Peak Outflow (cfs)							
			1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr
1	NRCS Runoff	Allowable Pervious		0.000			0.000			0.031
2	**NRCS Runoff**	**Allowable Impervious**		**0.288**			**0.444**			**0.749**
3	Junction	Allowable Runoff		0.288			0.444			0.757
4	**NRCS Runoff**	**Proposed Impervious**		**0.144**			**0.222**			**0.375**
5	NRCS Runoff	Proposed Pervious		0.000			0.000			0.029
6	**NRCS Runoff**	**Roof to UG Storage**		**0.180**			**0.277**			**0.468**
7	Pond Route	UG Storage		0.002			0.065			0.466
8	**Junction**	**Proposed Runoff**		**0.144**			**0.222**			**0.848**

Hydrograph 2-yr Summary

Project Name:

09-25-2019

Hydrology Studio v 3.0.0.12

Hyd. No.	Hydrograph Type	Hydrograph Name	Peak Flow (cfs)	Time to Peak (hrs)	Hydrograph Volume (cuft)	Inflow Hyd(s)	Maximum Elevation (ft)	Maximum Storage (cuft)
1	NRCS Runoff	Allowable Pervious	0.000	0.00	0.000	---		
2	NRCS Runoff	Allowable Impervious	0.288	12.12	922	---		
3	Junction	Allowable Runoff	0.288	12.12	922	1, 2		
4	NRCS Runoff	Proposed Impervious	0.144	12.12	461	---		
5	NRCS Runoff	Proposed Pervious	0.000	0.00	0.000	---		
6	NRCS Runoff	Roof to UG Storage	0.180	12.12	576	---		
7	Pond Route	UG Storage	0.002	24.03	7.19	6	60.68	569
8	Junction	Proposed Runoff	0.144	12.12	468	4, 5, 7		

Hydrograph 10-yr Summary

Project Name:

09-25-2019

Hydrology Studio v 3.0.0.12

Hyd. No.	Hydrograph Type	Hydrograph Name	Peak Flow (cfs)	Time to Peak (hrs)	Hydrograph Volume (cuft)	Inflow Hyd(s)	Maximum Elevation (ft)	Maximum Storage (cuft)
1	NRCS Runoff	Allowable Pervious	0.000	24.00	4.15	---		
2	NRCS Runoff	Allowable Impervious	0.444	12.12	1,444	---		
3	Junction	Allowable Runoff	0.444	12.12	1,449	1, 2		
4	NRCS Runoff	Proposed Impervious	0.222	12.12	722	---		
5	NRCS Runoff	Proposed Pervious	0.000	24.00	3.91	---		
6	NRCS Runoff	Roof to UG Storage	0.277	12.12	903	---		
7	Pond Route	UG Storage	0.065	12.38	334	6	60.75	575
8	Junction	Proposed Runoff	0.222	12.12	1,060	4, 5, 7		

Hydrograph 100-yr Summary

Project Name:

09-25-2019

Hydrology Studio v 3.0.0.12

Hyd. No.	Hydrograph Type	Hydrograph Name	Peak Flow (cfs)	Time to Peak (hrs)	Hydrograph Volume (cuft)	Inflow Hyd(s)	Maximum Elevation (ft)	Maximum Storage (cuft)
1	NRCS Runoff	Allowable Pervious	0.031	12.32	347	---		
2	NRCS Runoff	Allowable Impervious	0.749	12.12	2,480	---		
3	Junction	Allowable Runoff	0.757	12.12	2,827	1, 2		
4	NRCS Runoff	Proposed Impervious	0.375	12.12	1,240	---		
5	NRCS Runoff	Proposed Pervious	0.029	12.32	327	---		
6	NRCS Runoff	Roof to UG Storage	0.468	12.12	1,550	---		
7	Pond Route	UG Storage	0.466	12.12	981	6	60.92	588
8	Junction	Proposed Runoff	0.848	12.12	2,548	4, 5, 7		

Pond Report

Project Name:

Hydrology Studio v 3.0.0.12

09-24-2019

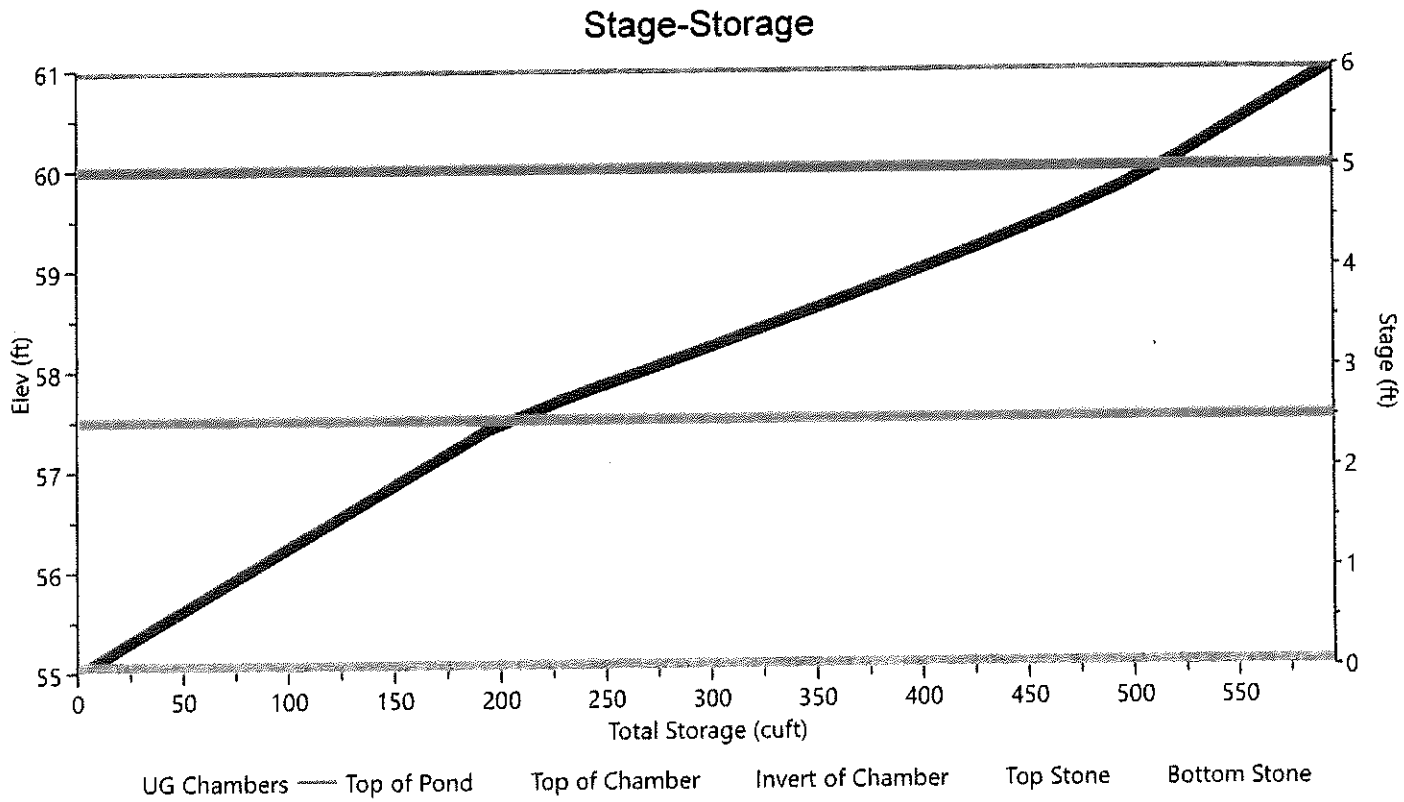
UG Storage 1

Stage-Storage

StormTech® SC-740™ Chamber	
Description	**Input**
Chamber Height, in	30
Chamber Shape	Arch
Chamber Width, in	51
Installed Length, ft	7.12
No. Chambers	4
Bare Chamber Stor, cuft	184
No. Rows	2
Space Between Rows, in	12
Stone Above, in	12
Stone Below, in	30
Stone Sides, in	12
Stone Ends, in	12
Encasement Voids, %	40.00
Encasement Bottom Elevation, ft	55.00

Stage / Storage Table

Stage (in)	Elevation (ft)	Contour Area (sqft)	Incr. Storage (cuft)	Total Storage (cuft)
0.0	55.00	202	0.000	0.000
3.6	55.30	202	24.3	24.3
7.2	55.60	202	24.3	48.5
10.8	55.90	202	24.3	72.8
14.4	56.20	202	24.3	97.0
18.0	56.50	202	24.3	121
21.6	56.80	202	24.3	146
25.2	57.10	202	24.3	170
28.8	57.40	202	24.3	194
32.4	57.70	202	35.3	229
36.0	58.00	202	40.9	270
39.6	58.30	202	40.5	311
43.2	58.60	202	39.8	351
46.8	58.90	202	38.8	389
50.4	59.20	202	37.4	427
54.0	59.50	202	35.5	462
57.6	59.80	202	32.8	495
61.2	60.10	202	27.4	522
64.8	60.40	202	24.3	547
68.4	60.70	202	24.3	571
72.0	61.00	202	24.3	595



Pond Report

Project Name:

Hydrology Studio v 3.0.0.12

09-24-2019

UG Storage 1

Stage-Discharge

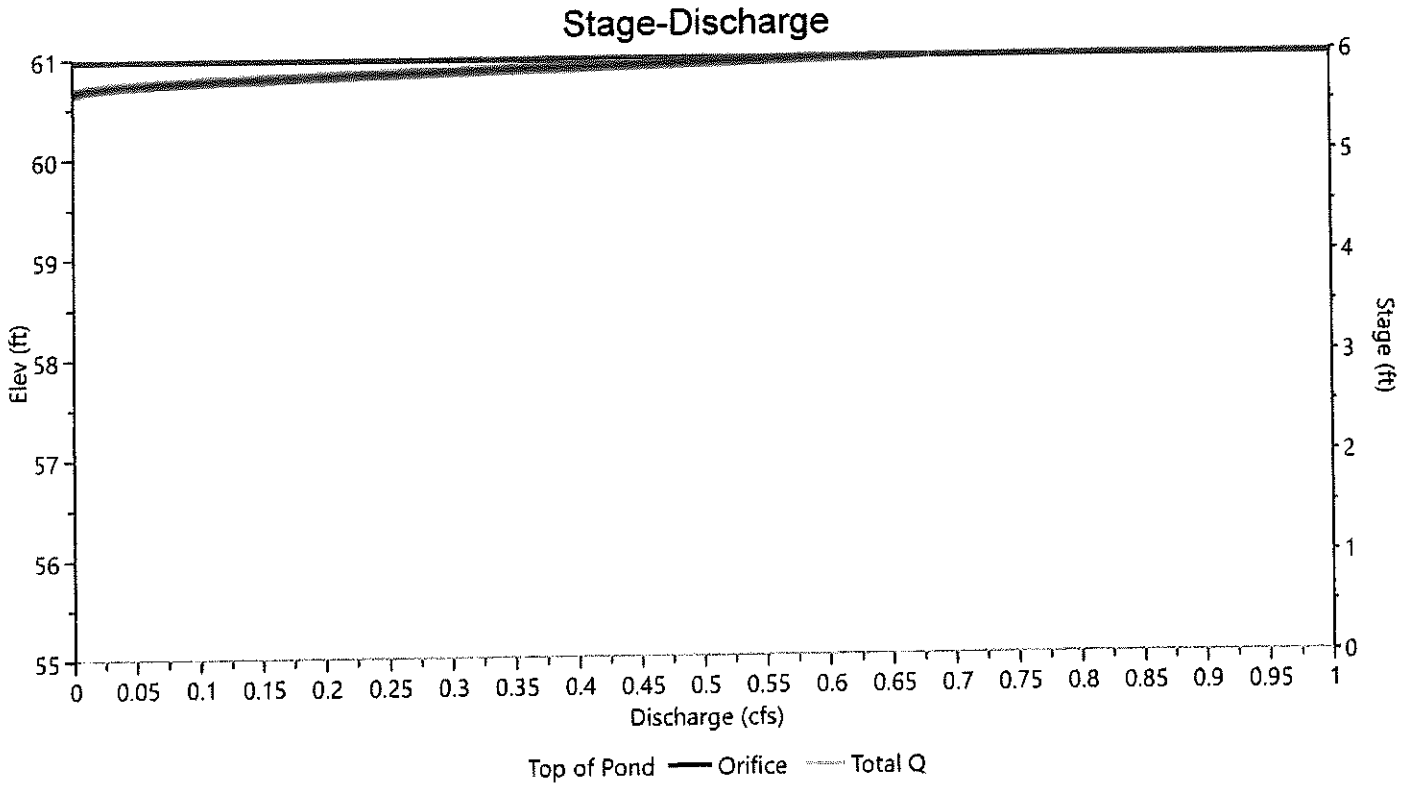
Culvert / Orifices	Culvert	Orifices 1	Orifices 2	Orifices 3
Rise, in		4		
Span, in		4		
No. Barrels		4		
Invert Elevation, ft	0.00	60.67	0.00	0.00
Orifice Coefficient, Co		.6		
Length, ft				
Barrel Slope, %				
N-Value, n	0.000			

Weirs	Riser*	Weirs 1	Weirs 2	Weirs 3
Shape / Type				
Crest Elevation, ft				
Crest Length, ft				
Angle, deg				
Weir Coefficient, Cw				

Perforated Riser
Perf. Rise, in
Perf. Span, in
No. Perforations
Invert Elevation, ft
Height, ft
Orifice Coefficient, Co

Ancillary
Exfiltration, in/hr

*Routes through Culvert.



Project Name:

Pond Report

09-24-2019

Hydrology Studio v 3.0.0.12

UG Storage 1

Stage-Storage-Discharge Summary

Stage (ft)	Elev. (ft)	Storage (cuft)	Culvert (cfs)	Orifices, cfs			Riser (cfs)	Weirs, cfs			Pf Riser (cfs)	Exfil (cfs)	User (cfs)	Total (cfs)
				1	2	3		1	2	3				
0.00	55.00	0.000		0.000				0.000						0.000
0.30	55.30	24.3		0.000				0.000						0.000
0.60	55.60	48.5		0.000				0.000						0.000
0.90	55.90	72.8		0.000				0.000						0.000
1.20	56.20	97.0		0.000				0.000						0.000
1.50	56.50	121		0.000				0.000						0.000
1.80	56.80	146		0.000				0.000						0.000
2.10	57.10	170		0.000				0.000						0.000
2.40	57.40	194		0.000				0.000						0.000
2.70	57.70	229		0.000				0.000						0.000
3.00	58.00	270		0.000				0.000						0.000
3.30	58.30	311		0.000				0.000						0.000
3.60	58.60	351		0.000				0.000						0.000
3.90	58.90	389		0.000				0.000						0.000
4.20	59.20	427		0.000				0.000						0.000
4.50	59.50	462		0.000				0.000						0.000
4.80	59.80	495		0.000				0.000						0.000
5.10	60.10	522		0.000				0.000						0.000
5.40	60.40	547		0.000				0.000						0.000
5.70	60.70	571		0.009				0.000						0.009
6.00	61.00	595		0.682				0.000						0.682

Suffix key: ic = inlet control, oc = outlet control, s = submerged weir

Pond Report

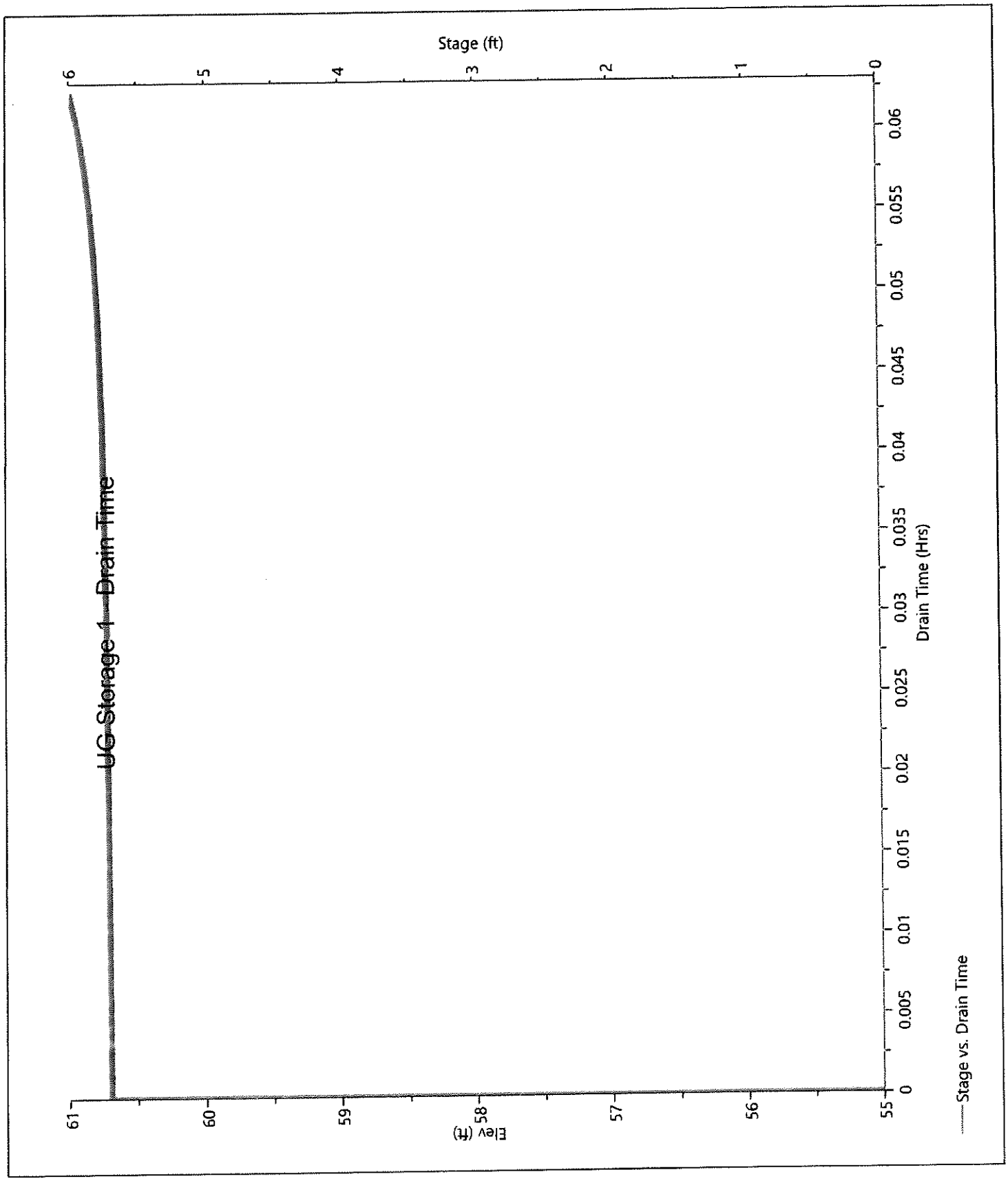
Project Name:

Hydrology Studio v 3.0.0.12

09-24-2019

UG Storage 1

Pond Drawdown



Design Storm Report

Custom Storm filename: NJ Water Quality.cds

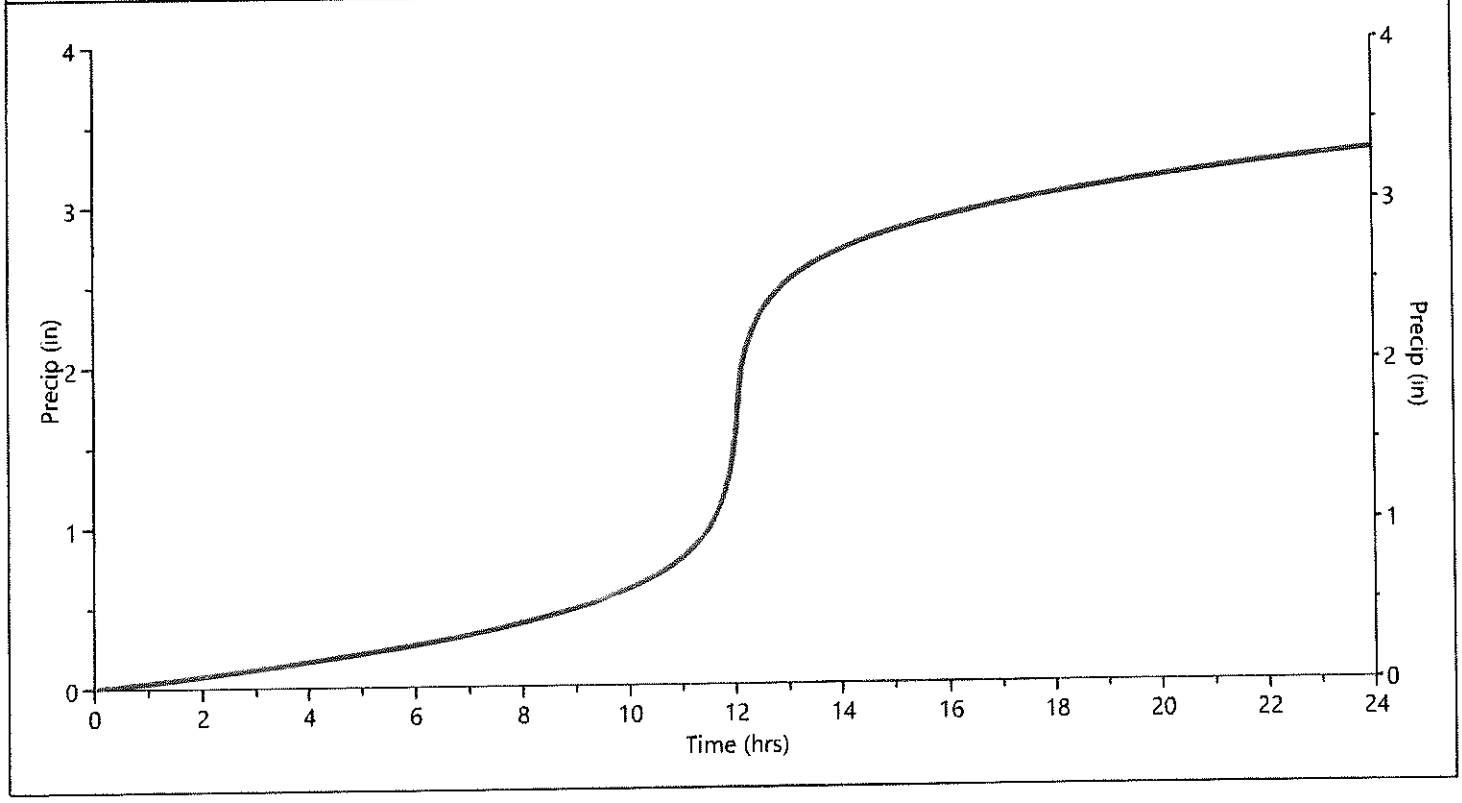
Hydrology Studio v 3.0.0.12

09-25-2019

Storm Distribution: Custom - NJ Region C

Storm Duration	Total Rainfall Volume (in)								
	1-yr	✔ 2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr	
24 hrs	0.00	3.31	0.00	0.00	5.06	6.28	7.34	8.52	

Incremental Rainfall Distribution, 2-yr									
Time (hrs)	Precip (in)	Time (hrs)	Precip (in)	Time (hrs)	Precip (in)	Time (hrs)	Precip (in)	Time (hrs)	Precip (in)
11.55	0.011155	11.73	0.016100	11.92	0.038568	12.10	0.064386	12.28	0.016100
11.57	0.011155	11.75	0.016096	11.93	0.038565	12.12	0.022349	12.30	0.016097
11.58	0.011155	11.77	0.016096	11.95	0.038568	12.13	0.022346	12.32	0.011740
11.60	0.011155	11.78	0.016100	11.97	0.038568	12.15	0.022349	12.33	0.011737
11.62	0.011741	11.80	0.016096	11.98	0.038565	12.17	0.022349	12.35	0.011741
11.63	0.011737	11.82	0.022349	12.00	0.038568	12.18	0.022346	12.37	0.011740
11.65	0.011741	11.83	0.022346	12.02	0.064386	12.20	0.022349	12.38	0.011737
11.67	0.011741	11.85	0.022349	12.03	0.064383	12.22	0.016097	12.40	0.011740
11.68	0.011737	11.87	0.022349	**12.05**	**0.064386**	12.23	0.016100	12.42	0.011155
11.70	0.011741	11.88	0.022346	12.07	0.064386	12.25	0.016097	12.43	0.011155
11.72	0.016096	11.90	0.022349	12.08	0.064383	12.27	0.016096	12.45	0.011155



Design Storm Report

Custom Storm filename: NJ Water Quality.cds

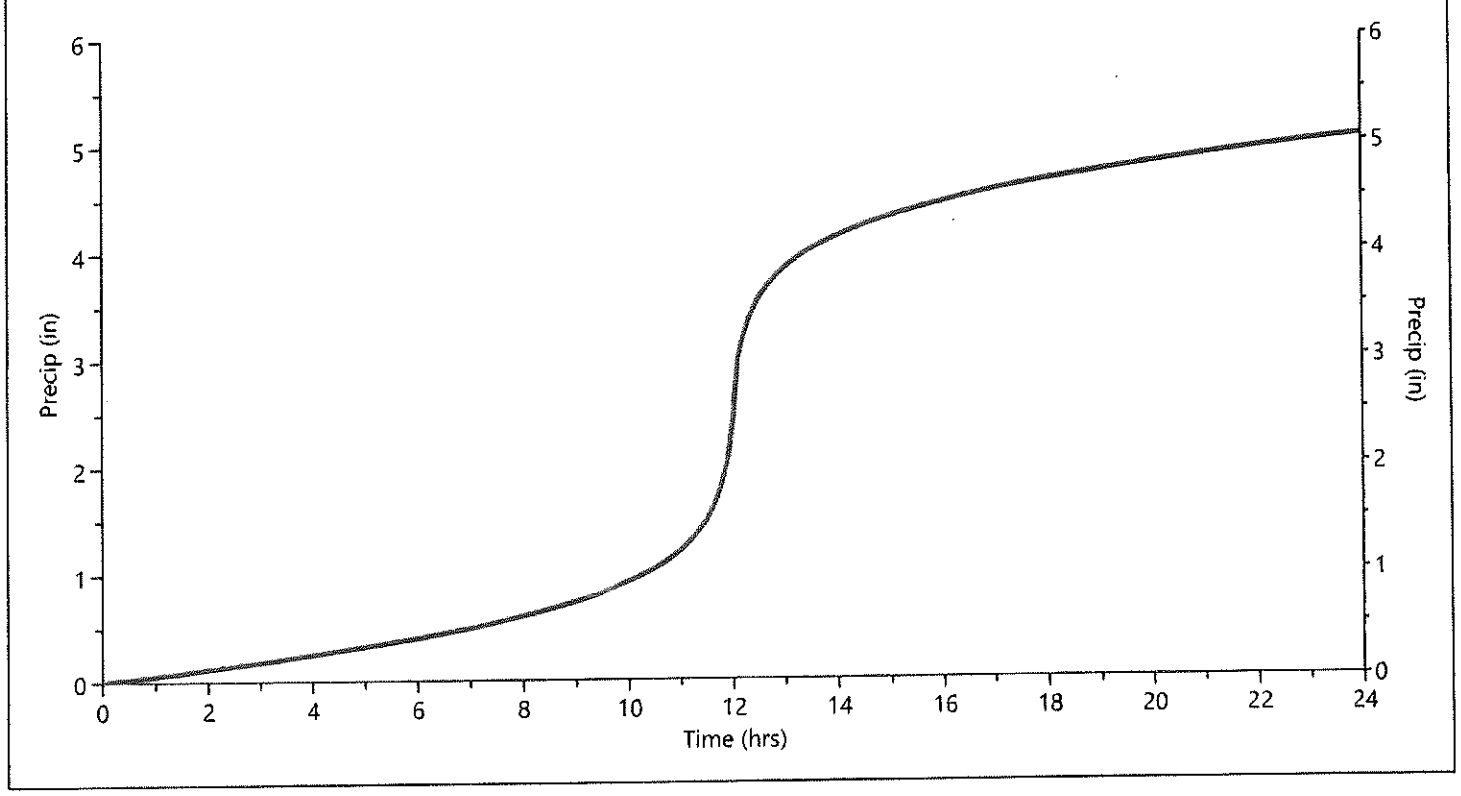
Hydrology Studio v 3.0.0.12

09-25-2019

Storm Distribution: Custom - NJ Region C

Storm Duration	Total Rainfall Volume (in)								
	1-yr	2-yr	3-yr	5-yr	✔ 10-yr	25-yr	50-yr	100-yr	
24 hrs	0.00	3.31	0.00	0.00	5.06	6.28	7.34	8.52	

Incremental Rainfall Distribution, 10-yr									
Time (hrs)	Precip (in)	Time (hrs)	Precip (in)	Time (hrs)	Precip (in)	Time (hrs)	Precip (in)	Time (hrs)	Precip (in)
11.55	0.017052	11.73	0.024612	11.92	0.058959	12.10	0.098427	12.28	0.024612
11.57	0.017052	11.75	0.024607	11.93	0.058954	12.12	0.034165	12.30	0.024607
11.58	0.017052	11.77	0.024607	11.95	0.058959	12.13	0.034160	12.32	0.017948
11.60	0.017052	11.78	0.024612	11.97	0.058959	12.15	0.034165	12.33	0.017943
11.62	0.017948	11.80	0.024607	11.98	0.058954	12.17	0.034165	12.35	0.017948
11.63	0.017943	11.82	0.034165	12.00	0.058959	12.18	0.034160	12.37	0.017948
11.65	0.017948	11.83	0.034160	12.02	0.098427	12.20	0.034165	12.38	0.017943
11.67	0.017948	11.85	0.034165	12.03	0.098422	12.22	0.024607	12.40	0.017948
11.68	0.017943	11.87	0.034165	12.05	0.09 427	12.23	0.024612	12.42	0.017052
11.70	0.017948	11.88	0.034160	12.07	0.098427	12.25	0.024607	12.43	0.017052
11.72	0.024607	11.90	0.034165	12.08	0.098422	12.27	0.024607	12.45	0.017052



Design Storm Report

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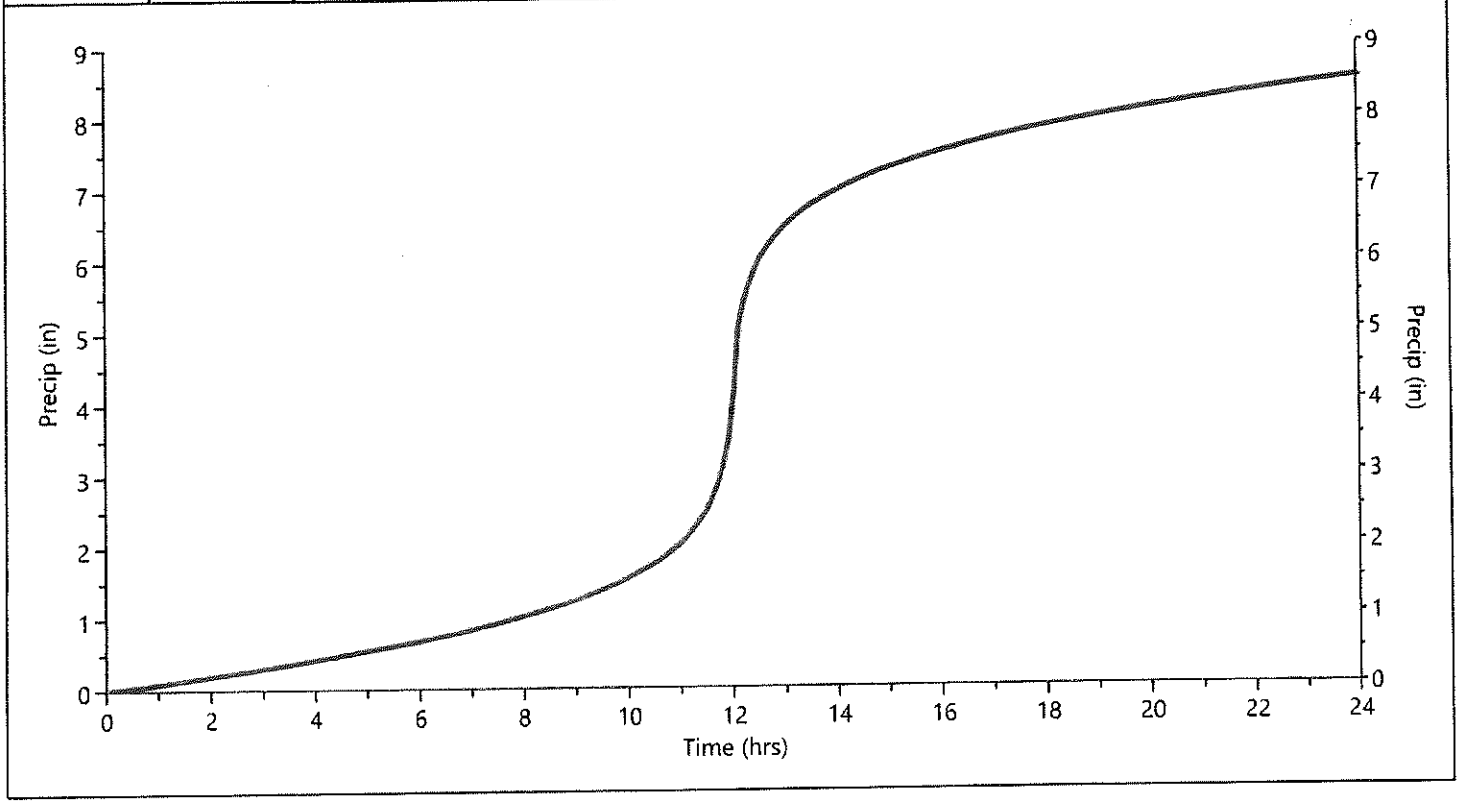
09-25-2019

Storm Distribution: Custom - NJ Region C

Storm Duration	Total Rainfall Volume (in)								
	1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	✔ 100-yr	
24 hrs	0.00	3.31	0.00	0.00	5.06	6.28	7.34	8.52	

Incremental Rainfall Distribution, 100-yr									
Time (hrs)	Precip (in)	Time (hrs)	Precip (in)	Time (hrs)	Precip (in)	Time (hrs)	Precip (in)	Time (hrs)	Precip (in)
11.55	0.028712	11.73	0.041441	11.92	0.099275	12.10	0.165731	12.28	0.041442
11.57	0.028712	11.75	0.041433	11.93	0.099267	12.12	0.057528	12.30	0.041432
11.58	0.028713	11.77	0.041433	11.95	0.099275	12.13	0.057518	12.32	0.030221
11.60	0.028712	11.78	0.041441	11.97	0.099275	12.15	0.057527	12.33	0.030212
11.62	0.030221	11.80	0.041433	11.98	0.099267	12.17	0.057527	12.35	0.030221
11.63	0.030212	11.82	0.057527	12.00	0.099275	12.18	0.057518	12.37	0.030221
11.65	0.030220	11.83	0.057518	12.02	0.165731	12.20	0.057527	12.38	0.030212
11.67	0.030221	11.85	0.057527	12.03	0.165722	12.22	0.041433	12.40	0.030220
11.68	0.030212	11.87	0.057527	**12.05**	**0.165731**	12.23	0.041441	12.42	0.028713
11.70	0.030221	11.88	0.057518	12.07	0.165731	12.25	0.041433	12.43	0.028712
11.72	0.041433	11.90	0.057527	12.08	0.165723	12.27	0.041432	12.45	0.028712