THE KLEINGERS GROUP

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March 23, 2016

Butler County Engineer's Office
1921 Fairgrove Ave
Hamilton, Ohio 45011-1965

ATTN: Teresa Barnes
Design Engineer

RE: Children's Hospital Expansion
As-built Detention Analysis

Ms. Barnes,

Please see the attached documents for verification that the expanded detention pond at the Children's Hospital Liberty Campus Inpatient Expansion site meets Butler County's requirements for water quality and detention.

As per the Detention Design Report submitted September 2013 and revised November 2013 the critical year storm is the 25-year storm and the allowable discharge for that storm event is 10.01 cfs. The as-built detention pond discharges 8.99 cfs during the 25-year storm event. The required water quality detention volume for the site is 1.74 acre-feet. The as-built detention pond provides this volume at 876.40'. The detention discharge control orifice is installed at 876.49'. Please note that as previously surveyed in 2013 the pond's normal water level appeared to be 875.2 '. Based upon survey shots taken last week the pond's normal water level is 874.80'. It is Kleingers' opinion that the reason for this discrepancy is that the original survey shots were taken in the winter when snow was present. In that condition, snow melt would have likely caused the water surface to remain at an elevated level for longer periods of time.

Sincerely,
THE KLEINGERS GROUP

David V. Wright, PE, LEED AP
Group Leader

cc: FILE

JOB #: 000000.000

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JOB TITLE
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Project Date: 8/13/2013
Project Engineer: cgriebling
Project Title: Proton Liberty Site
Project Comments:

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Det Outlet no 6" Outlet Input Data 5.01

MASTER DESIGN STORM SUMMARY

Network Storm Collection: BUTLER

Return Event	Total Depth in	Rainfall Type	RNF ID
1	2.5000	Synthetic Curve	TypeII 24hr
2	2.9000	Synthetic Curve	TypeII 24hr
5	3.6000	Synthetic Curve	TypeII 24hr
10	4.1000	Synthetic Curve	TypeII 24hr
25	4.7000	Synthetic Curve	TypeII 24hr
50	5.2000	Synthetic Curve	TypeII 24hr
100	5.6000	Synthetic Curve	TypeII 24hr

MASTER NETWORK SUMMARY
SCS Unit Hydrograph Method

(*Node=Outfall; +Node=Diversion;)
(Trun= HYG Truncation: Blank=None; L=Left; R=Rt; LR=Left&Rt)

Node ID	Type	Return Event	HYG Vol ac-ft	Trun	Qpeak hrs	Qpeak cfs	Max WSEL ft	Max Pond Storage ac-ft
BUILDING LOT POS AREA		1	2.664		12.0000	43.03		
BUILDING LOT POS AREA		2	3.315		12.0000	53.22		
BUILDING LOT POS AREA		5	4.487		12.0000	71.22		
BUILDING LOT POS AREA		10	5.343		12.0000	84.11		
BUILDING LOT POS AREA		25	6.384		12.0000	99.57		
BUILDING LOT POS AREA		50	7.260		12.0000	112.43		
BUILDING LOT POS AREA		100	7.965		12.0000	122.69		
PARKING LOT POST AREA		1	1.089		12.0000	17.00		
PARKING LOT POST AREA		2	1.313		12.0000	20.27		
PARKING LOT POST AREA		5	1.709		12.0000	25.96		
PARKING LOT POST AREA		10	1.994		12.0000	30.00		
PARKING LOT POST AREA		25	2.338		12.0000	34.82		
PARKING LOT POST AREA		50	2.625		12.0000	38.83		
PARKING LOT POST AREA		100	2.855		12.0000	42.02		

MASTER NETWORK SUMMARY
SCS Unit Hydrograph Method

(*Node=Outfall; +Node=Diversion;)
(Trun= HYG Truncation: Blank=None; L=Left; R=Rt; LR=Left&Rt)

Node ID	Type	Return Event	HYG Vol ac-ft	Trun	Qpeak hrs	Qpeak cfs	Max WSEL ft	Max Pond Storage ac-ft
POST SITE	JCT	1	3.753		12.0000	60.03		
POST SITE	JCT	2	4.627		12.0000	73.49		
POST SITE	JCT	5	6.196		12.0000	97.18		
POST SITE	JCT	10	7.337		12.0000	114.11		
POST SITE	JCT	25	8.721		12.0000	134.40		
POST SITE	JCT	50	9.885		12.0000	151.25		
POST SITE	JCT	100	10.820		12.0000	164.71		
*PROPOSED OUTFALL	JCT	1	3.113		15.5500	1.71		
*PROPOSED OUTFALL	JCT	2	3.987		13.9500	2.88		
*PROPOSED OUTFALL	JCT	5	5.556		13.1000	5.91		
*PROPOSED OUTFALL	JCT	10	6.697		12.9500	7.50		
*PROPOSED OUTFALL	JCT	25	8.081		12.9000	8.99		
*PROPOSED OUTFALL	JCT	50	9.245		12.7000	12.40		
*PROPOSED OUTFALL	JCT	100	10.180		12.5000	17.66		
PROPOSED PONDIN	POND	1	3.753		12.0000	60.03		
PROPOSED PONDIN	POND	2	4.627		12.0000	73.49		
PROPOSED PONDIN	POND	5	6.196		12.0000	97.18		
PROPOSED PONDIN	POND	10	7.337		12.0000	114.11		
PROPOSED PONDIN	POND	25	8.721		12.0000	134.40		
PROPOSED PONDIN	POND	50	9.885		12.0000	151.25		
PROPOSED PONDIN	POND	100	10.820		12.0000	164.71		
PROPOSED PONDOUT	POND	1	3.113		15.5500	1.71	877.09	2.652
PROPOSED PONDOUT	POND	2	3.987		13.9500	2.88	877.34	3.023
PROPOSED PONDOUT	POND	5	5.556		13.1000	5.91	877.85	3.810
PROPOSED PONDOUT	POND	10	6.697		12.9500	7.50	878.25	4.479
PROPOSED PONDOUT	POND	25	8.081		12.9000	8.99	878.75	5.351
PROPOSED PONDOUT	POND	50	9.245		12.7000	12.40	879.11	6.011
PROPOSED PONDOUT	POND	100	10.180		12.5000	17.66	879.34	6.444

::
TIME OF CONCENTRATION CALCULATOR
::

Segment #1: Tc: User Defined

Segment #1 Time: .1750 hrs

==========
Total Tc: .1750 hrs
==========

Tc Equations used...

==== User Defined ====

Tc = Value entered by user

Where: Tc = Time of concentration

::
TIME OF CONCENTRATION CALCULATOR
::

Segment #1: Tc: User Defined

Segment #1 Time: .1700 hrs

==========
Total Tc: .1700 hrs
==========

Tc Equations used...

==== User Defined ====

Tc = Value entered by user

Where: Tc = Time of concentration

RUNOFF CURVE NUMBER DATA

Soil/Surface Description	CN	Area acres	Impervious Adjustment %C	%UC	Adjusted CN
Existing Site CN from 2006 Report	89	22.000			89.00
COMPOSITE AREA & WEIGHTED CN --->		22.000			89.00 (89)

RUNOFF CURVE NUMBER DATA

Soil/Surface Description	CN	Area acres	Impervious Adjustment %C	%UC	Adjusted CN
Urban Districts - Commercial & Busi	95	5.249			95.00
Urban Districts - Commercial & Busi	92	1.750			92.00
COMPOSITE AREA & WEIGHTED CN --->		6.998			94.25 (94)

Elevation (ft)	Planimeter (sq.in)	Area (acres)	A1+A2+sqr(A1*A2) (acres)	Volume (ac-ft)	Volume Sum (ac-ft)
874.00	-----	.0010	.0000	.000	.000
874.80	-----	.0010	.0030	.001	.001
875.00	-----	1.1020	1.1362	.076	.077
876.00	-----	1.1920	3.4401	1.147	1.223
877.00	-----	1.4180	3.9101	1.303	2.527
878.00	-----	1.6540	4.6035	1.534	4.061
879.00	-----	1.8400	5.2385	1.746	5.807
880.00	-----	2.0230	5.7923	1.931	7.738
881.00	-----	2.2170	6.3578	2.119	9.857
882.00	-----	2.3450	6.8421	2.281	12.138

POND VOLUME EQUATIONS

* Incremental volume computed by the Conic Method for Reservoir Volumes.

Volume = (1/3) * (EL2-EL1) * (Area1 + Area2 + sq.rt.(Area1*Area2))

where: EL1, EL2 = Lower and upper elevations of the increment
Area1,Area2 = Areas computed for EL1, EL2, respectively
Volume = Incremental volume between EL1 and EL2

REQUESTED POND WS ELEVATIONS:

Min. Elev.= 874.00 ft
Increment = .10 ft
Max. Elev.= 882.00 ft

****
OUTLET CONNECTIVITY
****

---> Forward Flow Only (UpStream to DnStream)
<--- Reverse Flow Only (DnStream to UpStream)
<---> Forward and Reverse Both Allowed

Structure	No.		Outfall	E1, ft	E2, ft
Orifice-Circular	O0	--->	O3	876.490	882.000
Inlet Box	R0	--->	O3	878.890	882.000
Orifice-Area	O2	--->	O3	874.730	882.000
Weir-Rectangular	W0	--->	O3	880.500	882.000
Orifice-Circular	O3	--->	TW	874.470	882.000
TW SETUP, DS Channel					

OUTLET STRUCTURE INPUT DATA

Structure ID = O0
Structure Type = Orifice-Circular

# of Openings = 1
Invert Elev. = 876.49 ft
Diameter = 1.3333 ft
Orifice Coeff. = .600

Structure ID = R0
Structure Type = Inlet Box

# of Openings = 1
Invert Elev. = 878.89 ft
Orifice Area = 2.5000 sq.ft
Orifice Coeff. = .610
Weir Length = 6.50 ft
Weir Coeff. = 3.650
K, Reverse = 1.000
Mannings n = .0000
Kev,Charged Riser = .000
Weir Submergence = No

Structure ID = O2
Structure Type = Orifice-Area

# of Openings = 1
Invert Elev. = 874.73 ft
Area = .0625 sq.ft
Top of Orifice = 874.98 ft
Datum Elev. = 874.73 ft
Orifice Coeff. = .600

OUTLET STRUCTURE INPUT DATA

Structure ID = W0
Structure Type = Weir-Rectangular

# of Openings = 1
Crest Elev. = 880.50 ft
Weir Length = 120.00 ft
Weir Coeff. = 3.200000

Weir TW effects (Use adjustment equation)

Structure ID = O3
Structure Type = Orifice-Circular

# of Openings = 1
Invert Elev. = 874.47 ft
Diameter = 3.0000 ft
Orifice Coeff. = .600

Structure ID = TW
Structure Type = TW SETUP, DS Channel

FREE OUTFALL CONDITIONS SPECIFIED

CONVERGENCE TOLERANCES...
Maximum Iterations= 40
Min. TW tolerance = .01 ft
Max. TW tolerance = .01 ft
Min. HW tolerance = .01 ft
Max. HW tolerance = .01 ft
Min. Q tolerance = .00 cfs
Max. Q tolerance = .00 cfs

Index of Starting Page Numbers for ID Names

----- B -----
BUILDING LOT POS... 2.01, 3.01

----- D -----
Det Outlet no 6"... 5.01

----- P -----
PARKING LOT POST... 2.03, 3.02
PROPOSED POND... 4.01

----- W -----
Watershed... 1.01

WATER QUALITY VOLUME

THE KLEINGERS GROUP

PROJECT	Children's Hospital
JOB #	130037.003
DATE	3/23/2016
DESIGN	CJG
CHECK	DVW
	= INPUT FIELDS

Method 1

WQv= C * P * A / 12

C = 0.80
P = 0.75 IN
A = 29 ACRES *

WQv = 1.45 AC FT

RUNOFF COEFFICIENTS

C = 0.8	INDUSTRIAL & COMMERCIAL
C = 0.5	HIGH DENSITY RESIDENTIAL (>8/ACRE)
C = 0.4	MED. DENSITY RESIDENTIAL (<8/ACRE)
C = 0.3	LOW DENSITY RESIDENTIAL (<4 /ACRE)
C = 0.2	OPEN SPACE AND RECREATION

P = Precipitation Depth of 0.75 - inches
***AREA TO INCLUDE OFFSITE DRAINAGE**

Method 2

WQv= C * P * A / 12

C = 0.89
P = 0.75 IN
A = 26.62 ACRES *

WQv = 1.48 AC FT

RUNOFF COEFFICIENT

$C = 0.858i^3 - 0.78i^2 + 0.774i + 0.04$

WHERE: i = IMPERVIOUS RATIO

IMPERVIOUS RATIO, i = IMPER. AREA / TOTAL AREA

IMPERVIOUS AREA =	10.36
TOTAL AREA =	10.36
i =	1.00

P = Precipitation Depth of 0.75 - inches
***AREA TO INCLUDE OFFSITE DRAINAGE**

Req. WQv=	1.45 AC FT	Dry EDv=	1.74 AC FT	Wet EDv=	1.09 AC FT		
Basin Type=	DRY	**Required EDv outside detention or wet pool =**			**1.74 AC FT**	<--- Required Volume	

BASIN STORAGE VOLUME

IF ALL ELEVATIONS NOT RQD, REPEAT TOP OF BASIN INFO

Conical Method Vol = (1/3) * (EL2-EL1) * (AREA1+ AREA2+ SQRT(AREA1 * AREA2)

ELEV.	SQ FT	ACRE	AVG	DELTA	VOL	CUM VOL	ELEV	REQ VOL
882	102152	2.35			2.281	**10.015**	**882**	
			2.28	1				*878.37*
881	96593	2.22			2.120	**7.923**	**881**	
			2.12	1				
880	88127	2.02			1.931	**7.734**	**880**	
			1.93	1				*876.90*
879	80150	1.84			1.746	**5.803**	**879**	
			1.75	1				*876.67*
878	72034	1.65			1.534	**4.057**	**878**	
			1.53	1				*876.49*
877	61758	1.42			1.303	**2.523**	**877**	
			1.30	1				**876.40**
876	51904	1.19			1.146	**1.220**	**876**	
			1.15	1				*876.45*
875	47990	1.10			0.074	**0.074**	**875**	
			0.37	0.2				*879.52*
874.8	1	0.00				0		
		13.79						

REQUIRED STORAGE AVAILABLE AT: 876.40 *DEPTH = 1.60 FT <--- Elevation Volume Provided

SIZE ORIFICE FOR EXTENDED DETENTION VOLUME DRAIN

***** DOUBLE CHECK UNITS *****

METHOD 2: Q(avg) = EDv / Td

Edv = 1.74 AC FT

Td = 48 HOURS
(48 hours for dry/24 for wet)

Q(avg) = 0.4386 CFS

H(avg) = H(max) / 2

H(max) = 1.60 FEET

H(avg) = 0.7995 FEET

A = Q(avg) / C * (2 * g * H(avg))^0.5

A = 0.1019 SQ FT

D = 4.32 IN **Select 3" orifice** <--- Outlet Size

Q(avg) = AVERAGE FLOW RATE THROUGH ORIFICE
H(avg) = AVERAGE HYDRAULIC HEAD
H(max) = MAXIMUM HYDRAULIC HEAD
T_d = EDv DRAIN TIME (24 TO 48 HOURS)
C = 0.6 ORIFICE COEFF.
g = 32.2 ft/ sec^2
A = ORIFICE AREA (ft^2)
*D = ORIFICE DIAMETER (in) = [(4*A/3.14)^0.5] * 12*