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December 9, 2011

Dorene Bolze
Executive Director
Harpeth River Watershed Association
P.O. Box 1127
Franklin, TN 37065

Re.: **Pervious Pavement Parking Lot Design**

Dear Ms. Bolze:

This letter serves as a report on the stormwater treatment capacity of the pervious pavement parking lot that will be constructed as part of the Harpeth River Restoration Project. This report will include all of the site parameters, design assumptions and results of the analysis.

The site was designed using steps 1 through 4 as recommended in the Post Construction Water Quality Policies and Procedure manual. The steps are as follows:

1. Impact reducing site design
2. Integrated Stormwater Sizing
3. Stormwater Credits
4. Selection of Structural Stormwater Controls

Step 1: Impact Reducing Site Design

The Harpeth River Restoration Project includes removal of the low head dam, excavation of a floodplain bench, construction of a hydraulic grade control structure in the river to reduce bank erosion, aquatic habitat features and riparian plantings. A parking area is needed to allow for a low level of use for the public to fish and enjoy the natural setting. The parking area will be sited immediately off of Highway 431 and outside of the required 60 foot stream buffer as shown on Sheet 3 of the design drawings. The parking lot will also be screened with evergreen shrubs as required in the City Zoning Ordinance.

Step 2: Design using integrated stormwater sizing criteria

Sizing structures to accommodate stormwater is necessary for removing pollutants and improving water quality, reducing downstream overbank flooding and passing or reducing flooding from extreme storm events. The purpose of the permeable pavement is to capture stormwater and allow it to infiltrate into the underlying soils. This will reduce runoff that leaves the site by a proportional amount. Calculations were performed to determine the water quality volume that needs to be addressed using equation 1 in the Post Construction Water Quality Procedures Manual.

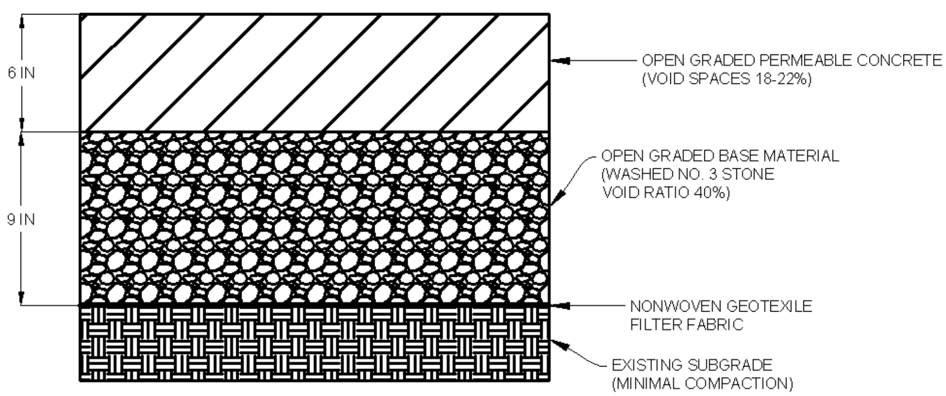
Equation 1 is shown as:

$$WQ_v = \frac{PR_v A}{12} \qquad \textbf{(Equation 1)}$$

$$R_v = 0.015 + 0.0092 I \qquad \textbf{(Equation 2)}$$

where:
- **WQ_v** = water quality treatment volume (acre-feet)
- **P** = rainfall depth for the 85% storm event (1.1 inches)
- **R_v** = runoff coefficient (see Equation 2)
- **A** = drainage area (acres)
- **I** = percent of impervious cover in drainage area - 50% would be 50 not 0.50

Rv for a 100 percent impervious area is 0.93. For this parking lot the value of 1 was used for Rv to give a conservative estimate of volume. A is equal to the parking lot area. The area is 5,170 square feet of parking lot and 500 square feet of the adjacent highway 431 area that will directly runoff onto the parking lot. The total area is 5,670 square feet. The total water quality volume (WQv) is 520 cubic feet of water in a 24 hour time period. The volume of storage capacity within the parking lot area is 1,870 cubic feet. Therefore, the water quality volume will be fully captured during the rain event.



PARKING LOT PAVEMENT SECTION
NOT TO SCALE

Calculations for the pervious pavement design were performed using software provided by the North Carolina Ready Mixed Concrete Association for permeable pavement calculations. The precipitation hydrographs were generated using the SCS Type II storm distribution. For this pavement design assume 20 percent voids in the concrete and 40 percent voids in the base material. Also, a soil infiltration rate of 0.5 was assumed for the soil. The soil rate was determined from the NRCS soil classification for the loamy soils that exist in the area.

Overbank flooding considerations were made for the 50 year design storm of 7.01 inches, the entire volume of that storm (3,244 cubic feet) that falls on the pavement or that runs on to the parking lot from the adjacent highway will be captured within a 24 hour period. This volume will also be exfiltrated within a 24-hour period of time. The results of the calculations are presented on the following pages. From this analysis, it can be shown that lesser storms will also be captured as well. The application of this parking lot design will encourage infiltration and reduce the total amount of runoff and will also reduce the overbank flood protection volume by a proportional amount.

Steps 3: Stormwater site Design Credits

The parking lot is located next to a riparian buffer that will also slow down and treat any runoff that may be generated from storms larger than the 50 year storm. This would reduce the volume of water that would need to be treated for water quality purposes. This BMP treats the entire volume of water and the credit is therefore not necessary.

Step 4: Choose appropriate structural stormwater BMP's

This BMP will be adequate to allow for parking without causing any adverse flooding or addition to run off from the site. The calculations show that the BMP will capture and infiltrate all of the water for the 50-year design storm.

Summary:

This report shows that the parking lot will provide the site with adequate low use parking while capturing and infiltrating most of the stormwater that comes in contact with the pavement. This will reduce the volume of runoff that leaves the site and enters the buffer prior to entering the Harpeth River. All requirements for flood reduction and water quality are met with the proposed design.

If there are any questions regarding this report please feel free to contact me.

Sincerely,

Case Davis, P.E.
President
Beaver Creek Hydrology, LLC

case@beavercreekhydrology.com

Results Sheet

Project:	**Harpeth River Restoration Project**
Designer:	**John C Davis**

Values shown in blue are user inputs.
Values shown in red are computed results.
See caution note below.

Run date	12/08/11

Configuration

Pervious concrete		
Thickness	6	in
Surface area	5,170	sq ft
Porosity	20	%
Gravel base		
Thickness	9	in
Porosity	35	%
Ponding limit	0	in
Exfiltration rate	0.500	in/hr
Impervious surface		
Surface area	0	sq ft
Off-site drainage		
Area	525	sq ft
CN	75	

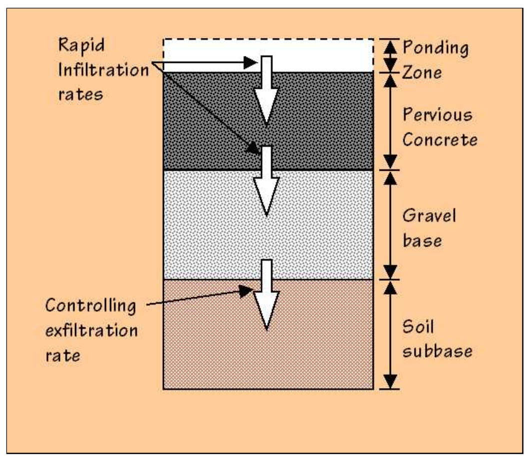
24-hr Precipitation	7.1	in
Location	Franklin, TN	
Return period	50	yr

Design aim

Target CN	79	
Allowable runoff	4.68	in

Summary of results

Effective CN	22	
Estimated runoff (5 days)	0.00	in
Available storage used	71	%
Number of hours of ponding	0	
Max ponding depth	-6.1	in
Available storage after 24 hr	100	%
Available storage after 5 days	100	%
Stage after 5 days	0.0	in
Additional time to drain completely	0	hr



Intermediate results

Total drained surface area	5,695	sqft
Storage capacity, pervious concrete	517	cuft
Storage capacity, gravel base	1,357	cuft
Storage capacity, ponding	0	cuft
Total stormwater storage	1,874	cuft
Total precip volume	3,244	cuft
5-day exfiltration volume	3,244	cuft
Total runoff (overflow)	0	cuft
Water stored after 5-days	0	cuft
Water balance error	0.0	cuft

Caution: This spreadsheet is intended for study purposes to illustrate expected hydrologic behavior of pervious concrete. Designers must verify results for specific sites by independent means.

Simulation Sheet

Total volume in (cuft)	Total exfiltration	Total runoff vol (cuft)	Storage at end (cuft)	Error
3244	3244	0	0	0.00

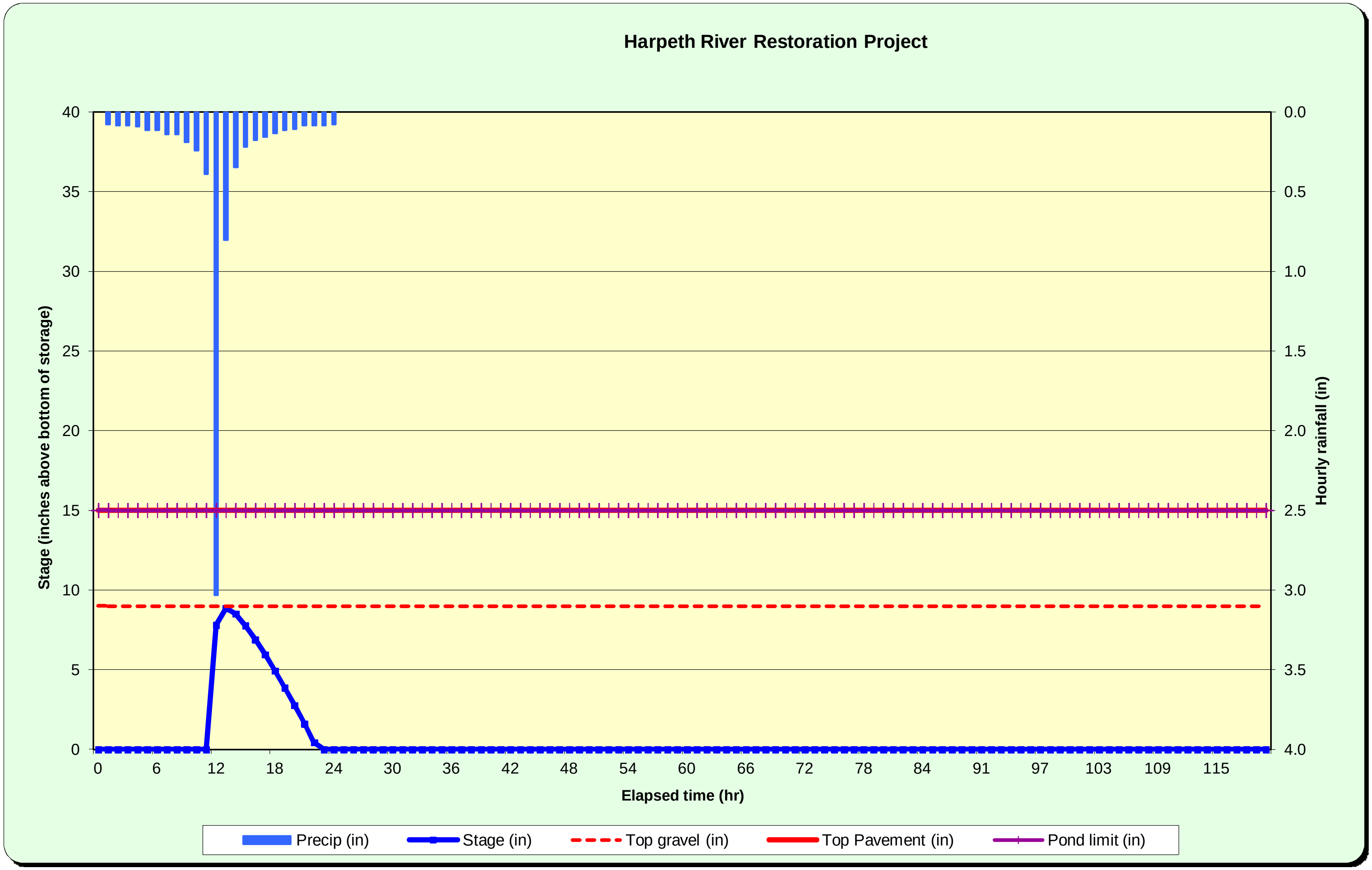
24-hr precip (in)	7.1
Location	Franklin, TN
Return period (yr)	50.0

Incr Volume in	Incr Volume out exfiltrated	Storage Available (cuft)
		1874

Pond limit stage (in)	Top Stage (in)
15.0	15.0

T (hr)	Precip (in)	V perv (cuft)	V imperv (cuft)	V offsite (cuft)	Sum incr V in (cuft)	Max Incr V exfil (cu ft)	Storage state (cuft)	Incr vol runoff (cuft)	% Storage used	Limited stage (in)
0	0.00			0			0	0	0	0.0
1	0.08	34	0	0	34	34	0	0	0	0.0
2	0.09	37	0	0	37	37	0	0	0	0.0
3	0.09	37	0	0	37	37	0	0	0	0.0
4	0.09	40	0	0	40	40	0	0	0	0.0
5	0.11	49	0	0	49	49	0	0	0	0.0
6	0.11	49	0	0	49	49	0	0	0	0.0
7	0.14	61	0	0	61	61	0	0	0	0.0
8	0.14	61	0	0	62	62	0	0	0	0.0
9	0.19	83	0	1	84	84	0	0	0	0.0
10	0.24	104	0	3	107	107	0	0	0	0.0
11	0.39	168	0	6	174	174	0	0	0	0.0
12	3.03	1306	0	87	1393	215	1177	0	63	7.8
13	0.80	346	0	29	374	215	1336	0	71	8.9
14	0.35	150	0	13	163	215	1283	0	68	8.5
15	0.22	95	0	8	103	215	1171	0	62	7.8
16	0.18	76	0	7	83	215	1039	0	55	6.9
17	0.16	67	0	6	73	215	897	0	48	5.9
18	0.13	58	0	5	63	215	744	0	40	4.9
19	0.11	49	0	4	53	215	582	0	31	3.9
20	0.11	46	0	4	50	215	417	0	22	2.8
21	0.09	37	0	3	40	215	241	0	13	1.6
22	0.09	37	0	3	40	215	66	0	4	0.4
23	0.09	37	0	3	40	106	0	0	0	0.0
24	0.08	34	0	3	37	37	0	0	0	0.0
25	0.00	0	0	0	0	0	0	0	0	0.0
26	0.00	0	0	0	0	0	0	0	0	0.0
27	0.00	0	0	0	0	0	0	0	0	0.0
28	0.00	0	0	0	0	0	0	0	0	0.0
29	0.00	0	0	0	0	0	0	0	0	0.0
30	0.00	0	0	0	0	0	0	0	0	0.0
31	0.00	0	0	0	0	0	0	0	0	0.0
32	0.00	0	0	0	0	0	0	0	0	0.0
33	0.00	0	0	0	0	0	0	0	0	0.0
34	0.00	0	0	0	0	0	0	0	0	0.0
35	0.00	0	0	0	0	0	0	0	0	0.0
36	0.00	0	0	0	0	0	0	0	0	0.0
37	0.00	0	0	0	0	0	0	0	0	0.0
38	0.00	0	0	0	0	0	0	0	0	0.0
39	0.00	0	0	0	0	0	0	0	0	0.0
40	0.00	0	0	0	0	0	0	0	0	0.0
41	0.00	0	0	0	0	0	0	0	0	0.0
42	0.00	0	0	0	0	0	0	0	0	0.0
43	0.00	0	0	0	0	0	0	0	0	0.0
44	0.00	0	0	0	0	0	0	0	0	0.0
45	0.00	0	0	0	0	0	0	0	0	0.0
46	0.00	0	0	0	0	0	0	0	0	0.0
47	0.00	0	0	0	0	0	0	0	0	0.0
48	0.00	0	0	0	0	0	0	0	0	0.0
49	0.00	0	0	0	0	0	0	0	0	0.0
50	0.00	0	0	0	0	0	0	0	0	0.0

Graph Sheet


Harpeth River Restoration Project
Stage (inches above bottom of storage)
40
35
30
25
20
15
10
5
0
Hourly rainfall (in)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
0 6 12 18 24 30 36 42 48 54 60 66 72 78 84 91 97 103 109 115
Elapsed time (hr)
Precip (in)
Stage (in)
Top gravel (in)
Top Pavement (in)
Pond limit (in)