

**FINAL
STORM DRAINAGE ANALYSIS**

**LOTS 7, 8, 9A AND 9B
OF
WATERFORD PLACE SUBDIVISION**

*Located on Vogel Road between
The Stockfleith Ditch and Burkhardt Road
Evansville, Indiana*

BLA Project No. 194-0021-0PD

Prepared for:

**East Park Development/Decem Investments
c/o Joseph Ream
10287 Wexford Court
Newburgh, IN 47630**

By:

**Bernardin, Lochmueller & Associates, Inc.
6200 Vogel Road
Evansville, IN 47715-4006
(812) 479-6200**

October 22, 1999

INTRODUCTION

East Park Development and Decem Investments, Inc. own a tract of land which lies along the west side of Burkhardt Road between Vogel Road and Columbia Street known as Waterford Place Subdivision. The Owner/Developer are proposing a five lot replat of Lot 9 of Waterford Place Subdivision. This replat lies next to Lots 7 and 8 of Waterford Place Subdivision. Stephen Libs Candy Company has developed Lot 7 in accordance with a Final Drainage Plan approved in September 1977. Lot 8 which lies south of the Libs property and south and east of the proposed Replat of Lot 9 has not been built on to date, but is comparable to the Stephen Libs' site and will be developed in the same manner. Within the Replat of Lot 9 a retail center, better known as Waterford Commons, is proposed on Lots 9A and 9B of this replat. These lots lie immediately west of the Stephen Libs' site.

The plat of Waterford Place received preliminary drainage approval on June 23, 1997 and the Replat of Lot 9 received preliminary drainage approval on May 24, 1999. According to the approved preliminary drainage plans for both plats, each lot developer is required to submit a final drainage plan for review prior to issuance of a building permit. To date, of the Lots mentioned (7, 8, 9A and 9B), only Lot 7 has drainage approval and building permits. The current owner/developer wishes to construct Waterford commons on Lots 9A and 9B at this time and are hereby submitting this Final Drainage Plan for this proposed development. In order to avoid many small basins which will be difficult to maintain a final drainage plan is being proposed which will entail a single retention facility for all of Lot 7, 8, 9A and 9B. The small basin previously approved for the Libs site (Lot 7) will be enlarged to accommodate the requirements for Lot 7 as previously approved while also satisfying the final drainage requirements for Lots 8, 9A and 9B. This final plan shall be in accordance with the proposed subdivision plat and the Protective Covenants (*Appendix F*) attached thereto and recorded in the office of the Recorder of Vanderburgh County, whereby each lot owner is required to design his respective site to satisfy the drainage/storm water requirements as set forth in the Vanderburgh County Drainage Ordinance.

As previously agreed, if any owner/developer of Lots 9C through 9E of this Replat of Waterford Place fail to fulfill their drainage obligation, East Park Development/Decem Investments will construct a basin on Lot 9E or other suitable location sized to handle the storm water detention

requirements for any lot found to be deficient and/or not in accordance with a particular lot's approved drainage plan. Should the larger Lot 9E be sold and developed prior to development of Lots 9C through 9D, any stormwater facility in place on Lot 9E may be relocated to the location designated and approved by the drainage board. This prime commitment to provide for storm detention on Lots 9C - 9E will further reduce the amount of detention originally planned for Lot 10 in the original drainage report submitted with the original plat of Waterford Place. As previously stated, the same commitments were made within that drainage report and Lot 10 was designated as the lot upon which any unfulfilled storm drainage requirements would be satisfied.

This report will establish the key criteria by which a drainage plan can be implemented to satisfy the final drainage requirements for Lots 7, 8, 9A and 9B of Waterford Place.

METHOD

The Rational Method ($Q = cia$) will form the basis for this analysis. The inflow/outflow analysis will be calculated so as to determine the storage requirements needed to preserve the runoff rate from the existing 10 year storm and store the additional runoff generated by the developed 25 year storm.

At present, a roadside ditch along Vogel Road drains the subject property to the Stockfleith Ditch which lies west of the subject property. Therefore, this proposed Final Drainage Plan will be designed with storm detention that will be routed into a basin along Vogel Road and outlet into a pipe along Vogel Road that will drain to the Stockfleith Ditch. This will account for approximately 1.976 acres of the total 12.22 acres in the Replat of Lot 9 and also Lot 7 (1.007 acres) and Lot 8 (1.008 acres). The remainder will be stored in a retention/detention basin constructed on Lots 9C - 9E at a location near the west property line. This, too, will be conveyed to Stockfleith Ditch.

Because the preliminary drainage plans were approved in a manner that stated that Final Drainage Plans will be approved on a lot by lot basis, the developer is making a strong commitment to see that all drainage from these sites is handled properly and in conformance with this agreement. In order to provide fewer, easier maintained facilities, the owner is grouping several lots into one final plan. As previously stated, the developer has recorded restrictive covenants that require a formal drainage plan be submitted and approved by the developer's

architectural review committee to assure that all development is of the highest quality. In this case, all of Lots 7, 8, 9A and 9B will drain to the Stockfleith Ditch under one final plan.

For this final drainage submittal, the required storage previously committed to for Lot 7 will be preserved. In addition, storm water storage for Lots 8, 9A and 9B will be calculated along with the additional requirement for a small future addition to the Stephen Libs (Lot 7) development will be incorporated and designed into one facility.

A value of 0.2 will be used for the undeveloped runoff coefficient ("c"). This is a value that has been accepted by the local authority to best describe those drainage characteristics for that portion of the east side of Evansville from Green River Road east to the Vanderburgh/Warrick county line and from the Lloyd Expressway north to Morgan Avenue.

The developed runoff coefficient of 0.56 previously utilized for the Lot 7 development will also be used for Lot 8 and the developed runoff coefficient for each area of Lots 9A and 9B (0.68) will be weighted to produce a value of 0.62 representative of all four lots combined.

The existing conditions are so flat that the times of concentration are rather large attributing for very low undeveloped intensities.

- ▶ For the Libs (Lot 7) site previously submitted, an undeveloped intensity of 2.74 was used (see Appendix B). For Lots 9A/9B and 9C/9D a rainfall intensity of 3.147 was calculated and used in the preliminary submittal. The lesser intensity of 2.74 will be utilized in this report which will yield a lesser allowable outflow rate and will yield a more conservative storage requirement.
- ▶ The allowable outflow rate of 2.19 cfs was calculated for the combined basin planned for Lots 7, 8, 9A and 9B.

(Refer to input/output data sheets shown in Appendix C)

RESULTS

- ▶ The required 25 year storage for each of Lots 7, 8, 9A and 9B combined will be 14,490 cubic feet (0.333 acre/feet). This will be stored in a single basin located between the lots.
- ▶ To improve the appearance along Vogel Road, the rather deep roadside ditch will be sewerred. The outlets for the basins located between Lots 9A and 9B and Lots 7 and 8 will be piped into the sewer installed along Vogel Road. The outflow rate from the basin will be controlled by a dual outlet structure. The grass strip between the development and Vogel Road will be slightly depressed and an area inlet will serve to drain this area into the roadside sewer. This will afford additional assurance that Vogel Road will not be flooded in the future.

SUMMARY

The final result will produce a single retention element to satisfy the drainage from four lots combined in a location removed from any right-of-way or peripheral area that would need to be utilized in the future for road widening which was a concern presented at the time of preliminary approval.

In addition, the development for which this plan is being presented does not encroach upon the legal drainage easement for the Stockfleith Ditch which was also a concern of the preliminary approval.

APPENDIX "A"

Proposed Development Grading
and Storm Detention Plan

APPENDIX "B"

Runoff Coefficients

APPENDIX "C"

Times of Concentration
and IDF Curves

APPENDIX "D"

Storage Volume Output Data

APPENDIX "E"

Outlet Control Structure Analysis

APPENDIX "F"

Basin Volume Data

APPENDIX "G"

Protective Covenant

APPENDIX "A"

Proposed Development Grading
and Storm Detention Plan

APPENDIX "B"
Runoff Coefficients

TABLE 803

UNDEVELOPED RUNOFF COEFFICIENTS (Cd)

SURFACE TYPE:

WOODLAND, TURFED MEADOWS
ROUGH PASTURE, FALLOW BRUSH:

SLOPE:

Less than	2%	C = 0.12
2% to	5%	C = 0.24
5 + % to	10%	C = 0.36
Over	10%	C = 0.48

CULTIVATED FIELDS:

Less than	2%	C = 0.20
2% to	5%	C = 0.35
5 + % to	10%	C = 0.50
Over	10%	C = 0.65

TABLE 804

DEVELOPED RUNOFF COEFFICIENTS (Cd)

SURFACE TYPE:

PAVEMENT, ROOFTOP
OTHER IMPERVIOUS SURFACES:

SLOPE

Less than	2%	C = 0.92
2% to	5%	C = 0.94
5 + % to	10%	C = 0.96
Over	10%	C = 0.98

LAWNS WITH TURF

Less than	2%	C = 0.15
2% to	5%	C = 0.25
5 + % to	10%	C = 0.40
Over	10%	C = 0.55

ALL WATER SURFACES
BASINS, PONDS & LAKES

UNDEVELOPED "C" FACTOR = 0.20 (Table 803)

Cultivated Fields (Less than 2%)

LOTS 7, 8, 9A & 9B COMBINED

Weighted Developed "C" Factor

Lot 7	Weighted Vlaue from Libs development	1.007 acre *(0.56)	=	0.5645
Lot 8	Undeveloped (use same value as Libs)	1.008 acre *(0.56)	=	0.5645
Lots 9A/9B	Wtd. Value from Village Commons	<u>1.9760 acre †(0.68)</u>	=	<u>1.3437</u>
		3.9910 acre		2.4727
		2.4727 / 3.9910 =		0.62

* see excerpt from Libs Drainage Report where value of 0.56 was derived (next page)

† see excerpt from Preliminary Drainage Report for replat of Lot 9 where 0.68 was derived (see below) for Lots 9A - 9B combined.

Excerpt from Drainage Report for Lots 9A/9B Combined

UNDEVELOPED "C" FACTOR = 0.20 (Table 803)

Cultivated Fields (Less than 2%)

LOTS 9A - 9B COMBINED AND 9C - 9D COMBINED

Weighted Developed "C" Factor

Building	20,000 SF (0.90)	=	18,000
Paving/Parking	32,400 SF (0.90)	=	29,160
Lawn	36,350 SF (0.30)	=	10,905
Roads	3,262 SF (0.90)	=	2,936
	<hr/>		<hr/>
	88,750 SF/2.03 Ac		61,001
	61,001/88,705	=	0.68

UNDEVELOPED "C" FACTOR = 0.20 (Table 803)
Cultivated Fields (Less than 2%)

Excerpt from Drainage Report for Lots 7 (Stephen Libs)

NOTE: *This is a value used extensively throughout the area that lies between the Lloyd Expressway and Morgan Avenue and between Green River Road & I-164*

DEVELOPED WEIGHTED "C" FACTOR

Building	6,160 SF (0.95)	=	5,852
Pavement	17,124 SF (0.95)	=	16,268
Lawn	22,630 SF (0.15)	=	3,395
	<hr/>		<hr/>
	42,914 SF/1.05 Acres		25,515
	 25,515/45,914	=	 0.56

0.15 - Table 3.2(b) lawns
0.95 - Table 3.2(b) Roofs/Asphalt

TIME OF CONCENTRATION

Use larger Time of Concentration from
Stephen Libs (Lot 7) Report or Lot 9A/9B
Report—each shown below

EXCERPT FROM LOT 7 (STEPHEN LIBS) DRAINAGE REPORT

SHEET FLOW

$$TC = .827 \left[\frac{(N)(L)}{\sqrt{S}} \right]^{.467} \quad (\text{Kerby's Formula})$$

N = 0.4 Coefficient Grass

L = Length

S = Slope

L = 280'

H = 385 - 384.35 = 0.65

S = .0023

$$T_c = .827 \left[\frac{(0.4)(280)}{\sqrt{.0023}} \right]^{.467} = 31 \text{ minutes}$$

INTENSITY

$$i_{10} = \frac{C(T)^\alpha}{(T_c+d)^\beta}$$

Factors for Evansville

C = 1.9533

α = 0.1747

d = 0.522

β = 1.6408

T = duration

T_c = Time of Concentration (10 yr. undeveloped)

$$i_{10} = \frac{1.9533(10)^{0.1747}}{(31.0/60+0.522)^{1.6408}} = \frac{2.9206}{1.0642} = 2.74$$

$$i_{10} = 2.74$$

APPENDIX "C"

Time of Concentration and IDF Curves

TIME OF CONCENTRATION

Use larger of two used from Libs Report or
Lot 9A/9B Report—each shown below

EXCERPT FROM LOT 7 (STEPHEN LIBS) DRAINAGE REPORT

SHEET FLOW

$$TC = .827 \left[\frac{(N)(L)}{\sqrt{S}} \right]^{.467} \quad (\text{Kerby's Formula})$$

N = 0.4 Coefficient Grass

L = Length

S = Slope

L = 280'

H = 385 - 384.35 = 0.65

S = .0023

$$T_c = .827 \left[\frac{(0.4)(280)}{\sqrt{.0023}} \right]^{.467} = 31 \text{ minutes}$$

INTENSITY

$$i_{10} = \frac{C(T)^{\alpha}}{(T_c+d)^{\beta}}$$

Factors for Evansville

C = 1.9533

T = duration

α = 0.1747

T_c = Time of Concentration (10 yr. undeveloped)

d = 0.522

β = 1.6408

$$i_{10} = \frac{1.9533(10)^{0.1747}}{(31.0/60+0.522)^{1.6408}} = \frac{2.9206}{1.0642} = 2.74$$

$$i_{10} = 2.74$$

TIME OF CONCENTRATION

EXCERPT FROM LOT 9A-9B COMBINED DRAINAGE REPORT

LOTS 9A - 9B COMBINED

$$TC = .827 \left[\frac{(N)(L)}{\sqrt{S}} \right] .467$$

(Kerby's Formula)

N = 0.4 Coefficient Grass

L = Length

S = Slope

L = 250

H = 1

S = .004

$$TC = .827 \left[\frac{(0.4)(250)}{\sqrt{0.004}} \right] .467 = 26 \text{ Min.}$$

$$10 = 3.1479$$

APPENDIX "D."
Storage Volume Output Data

100 YEAR STORM

STORM DURATION (HRS)	RAINFALL INTENSITY (INCH/HR)	INFLOW RATE (CFS)	OUTFLOW RATE (CFS)	STORAGE RATE (CFS)	REQUIRED STORAGE (ACRE-FT)
0.08	9.52	23.56	2.19	21.37	0.142
0.17	7.40	18.30	2.19	16.11	0.228
0.25	6.30	15.59	2.19	13.40	0.279
0.33	5.54	13.71	2.19	11.52	0.317
0.42	4.91	12.15	2.19	9.96	0.349
0.50	4.48	11.08	2.19	8.89	0.370
0.58	4.12	10.21	2.19	8.01	0.387
0.67	3.80	9.40	2.19	7.20	0.402
0.75	3.55	8.79	2.19	6.60	0.412
0.83	3.34	8.26	2.19	6.07	0.420
0.92	3.13	7.75	2.19	5.56	0.426
1.00	2.97	7.35	2.08	5.27	0.440
1.25	2.57	6.35	2.08	4.27	0.445
1.50	2.27	5.61	2.08	3.53	0.441
1.75	2.03	5.03	2.08	2.95	0.430
2.00	1.84	4.56	2.08	2.48	0.413
2.50	1.56	3.85	2.08	1.77	0.369
3.00	1.35	3.34	2.08	1.26	0.315
4.00	1.07	2.64	2.08	0.56	0.187
			2.08		

PEAK STORAGE (ACRE/FT): 0.45
 PEAK STORAGE (CUBIC FT): 19385.96

APPENDIX "E"

Outlet Control Structure Analysis

OUTLET CONTROL STRUCTURE

ORIFICE EQUATION

$$\text{(Lots 9A/9B and 9C/9D)} \quad cd = Cc \times Cv = (.62)(.97) = .60$$

$$\text{Allow Outflow } Q = cia = (0.20)(2.74)(3.9910) = 2.18 \text{ CFS}$$

$$c = 0.20$$

$$i = 2.74 / Tc = 31 \text{ minutes}$$

$$a = 3.9910$$

$$\text{Allow HW} = \text{Rim to Invert of Pipe} = 2.0'$$

$$(2.18) = Q = (.60) (A) \sqrt{2(32.2)(2.0)}$$

$$A = \frac{2.18}{6.8094} = \frac{\Pi d^2}{4}$$

$$d = 0.6315 - \text{Use } 8'' \text{ diameter orifice}$$

Note: Culvert analysis which follows suggests pipe outlet control and 10" pipe needed to carry adequate outflow 2.19 cf @ 1.3' HW

APPENDIX "F"
Basin Volume Data

BASIN (Lots 9A-9B)

ELEVATION	SURFACE AREA (square feet)	STAGED VOLUME (cubic feet)	ACCUMULATED VOLUME (cubic feet)
382.00	9214		0
383.00	11,258	10,236	10,236
384.00	14,312	12,785	23,021
384.50	15,796	7,527	30,548

Note: Storage @ elevation 383.00 (10,623 cf) approximates 25 year requirement of 14,490 cf
 Storage @ elevation 384.00 (23,021 cf) exceeds 100year requirement of 19,386

APPENDIX "G"
Protective Covenant

95-24863

Deem Investments, Inc.
East Park Development

DECLARATION OF PROTECTIVE COVENANTS

RECEIVED FOR RECORD Oct 30 1995 3:01 P.
CTRL # 0140 BETTY J. FINE, REGISTER
VALLEYBURGH CO.