MID-COUNTY PLAZA
HIGHWAY OCCUPANCY PERMIT

PennDOT EPS #42543

DRAINAGE DESIGN AND DRAINAGE IMPACT REPORT

IN

MARPLE TOWNSHIP
DELAWARE COUNTY

Prepared for

Marple Associates, Inc

November 5, 2013
Revised January 15, 2014

Orth-Rodgers & Associates, Inc.
TRANSPORTATION ENGINEERS AND PLANNERS

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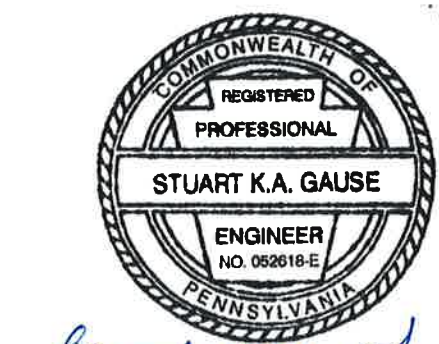


DRAINAGE DESIGN

PROPOSED SITE IMPROVEMENTS

National Realty Corporation proposes a mixed use retail, office, and residential development along Langford Run Road in Marple Township. As part of the development, the intersection of the SR 0476 southbound off-ramp to SR 0003 will be realigned and widened at the signal with SR 0003 while removing the on-ramp to SR 0003 westbound. Langford Run Road will be widened at the intersection with SR 0003 and the raised median of SR 0003 will be reduced in width for proposed left turn lanes.

EXISTING SITE CONDITIONS AND TOPOGRAPHIC FEATURES

SR 0003, West Chester Pike, is a two lane divided highway with a signalized intersection at the on and off ramps to SR 0476, Blue Route, southbound. Ramp S-WC is the SR 0476 southbound off ramp to SR 0003, West Chester Pike on the north leg of the intersection with SR 0003, West Chester Pike.

Langford run road is a local road in the southwest quadrant of the highway interchange.

The site is an urban interchange with an undeveloped parcel that is currently forested in the southwest quadrant.

RECEIVING WATER CLASSIFICATION

The site is located in the valley of Darby Creek and one of its tributaries, Langford Run. Darby Creek is designated a Cold Water Fishery (CWF) and a Migratory Fishery (MF) by PA Code, Title 25, Chapter 93 and Langford Run is designated as a Warm Water Fishery and a Migratory Fishery in the category of Unnamed Tributaries.

Both Darby Creek and Langford Run are not listed by the PA Fish and Boat Commission as Trout Stocked or streams that support trout.

Both Darby Creek and Langford Run are listed in the 2010 Pennsylvania Integrated Water Quality Monitoring and Assessment Report in Category 5, Impaired and Requiring a TMDL for, Aquatic Life from Urban Runoff/Storm Sewers. Darby Creek is also listed in Category 4c, Impaired and Not Requiring a TMDL, for Aquatic Life from Urban Runoff/Storm Sewers.

SUPPLEMENTAL PLANS

This report has been prepared in conjunction with the engineering design plans for the Construction of Mid-County Plaza.

METHODOLOGY

Proposed storm sewer conveyance systems on SR 0003 and the southbound off ramp are designed to convey the 10-year storm event. Storm sewer capacity is computed for the 10-year frequency rainfall events using the Rational Method. Rainfall intensity data

is obtained from PennDOT Pub. 584. Please reference Appendix B for the storm drain design calculations, factors and assumptions.

Proposed inlets are located according to the method in Design Manual 2 and to minimize spread in the travel lanes. Existing inlets and junctions in the storm drain system are maintained. At locations along the median of SR 0003, West Chester Pike, inlets at existing junctions are replaced with inlets that have larger boxes so that the inlets are aligned with the curb and gutter while connecting to the existing pipes.

Where roadways are widened, Type C inlets top units are replaced with manhole opening top slabs to maintain access to the storm drain junctions.

Pipes are replaced with same type pipes along the drainage systems. Under SR 0003, the existing and proposed pipes are RCP. Along Ramp S-WC, the pipes are RCP and CMP. New pipes under Langford Run Road are TP or RCP in coordination with the site development drainage design.

The drainage systems are separated by their points of Interest:

- Point of Interest 1 is the SR 0003 drainage system.
- Point of Interest 2 is the Ramp S-WC drainage system, and
- Point of Interest 3 is the SR 0003 Westbound to I-476 Southbound Loop Ramp drainage area.

A fourth point of Interest is Langford Run Road which is connected into the site development drainage and is not a part of the Highway Occupancy Permit.

The existing drainage system for Point of Interest 1 remains in place with median Type M inlets with standard boxes replaced by Type C inlets with standard and Type 4 boxes to accommodate the addition of an eastbound left turn lane.

The existing system of Ramp S-WC, for Point of Interest 2, is adjusted by capping one inlet and the addition of dikes at inlets in the ditch. 0.52 acres of existing pavement of Ramp S-WC is removed for the development. By capping the inlet, area is transferred from the SR 0003 system to POI 1 to the Ramp S-WC system and POI 2.

The existing drainage for Point of Interest 3 is slightly affected due to widening of Ramp S-WC Spur between stations 10129+25 LT and 10130+75 LT for the proposed conditions shoulder.

DRAINAGE IMPACT

POINTS OF INTEREST

Three points of interest are analyzed at locations where the proposed drainage exits the project:

- Point of Interest 1 – SR 0003 drainage system to the existing 21" pipe outfall at a ditch along the on-ramp to southbound SR 0476.
- Point of Interest 2 – Ramp S-WC drainage system to the connection to the existing 24" RCP at the SR 0476 southbound off-ramp gore.
- Point of Interest 3 – Drainage area to the existing 18" RCP at the loop ramp infield from SR 0003 westbound to SR 0476 southbound.

METHODOLOGY

Comparison of existing peak flows to proposed peak flows is done by the rational method using the actual time of concentration to determine the rainfall intensity. Individual travel times through each pipe in the storm drain systems are determined from the storm drain calculations for the existing and proposed drainage systems. Sheet flow and overland flow are determined by the NRCS segmental method in the TR-55 Urban Hydrology Manual.

Comparison is made for the 10-year design storm. Drainage areas and runoff coefficients are the same as used in the storm drain design.

To mitigate an increase in pavement for the eastbound left turn lane on SR 0003 to POI No.1, an existing inlet, No. EINL 16, off of Ramp S-WC is proposed to be capped so that runoff in the ditch cannot enter the inlet. The ditch and inlet are along side of the ramp that will be removed with the proposed project. Runoff will continue flowing down the ditch to the next inlet, EINL 49, where it will be collected into the storm drain system that runs alongside of Ramp S-WC.

Capping the inlet and allowing the runoff to remain in the ditch removes 0.50 acres from the POI No. 1 watershed area where it mitigates the increase in pavement due to the addition of turn lanes on SR 0003. While it adds 0.50 acres to the watershed of POI No. 2, the addition is offset by the removal of 0.52 acres of pavement which will be planted with grass.

0.02 acre of drainage area to POI is diverted to POI No. 2 by extension of an existing swale along the east side of Ramp S-WC Spur.

RESULTS

Runoff results at each Point of Interest:

POI	Total Area (ac)	Pavement Area (ac)	Runoff Coefficient	Time of Concentration (min)	Rainfall Intensity (in/hr)	Discharge (cfs)
1 Existing	6.67	3.06	0.60	5	6.6	26.41
1 Proposed	6.09	3.26	0.65	5	6.6	26.13
1 Difference	-0.58	+0.20	+0.05	0	0	-0.29
2 Existing	8.05	2.39	0.49	14.6	4.27	16.84
2 Proposed	8.76	2.44	0.48	17.4	4.00	16.82
2 Difference	+0.71	+0.05	-0.01	+2.8	-0.27	-0.02
3 Existing	0.95	0.48	0.62	5	6.6	3.89
3 Proposed	0.93	0.48	0.63	5	6.6	3.87
3 Difference	-0.02	0.00	+0.01	0	0	-0.02
Project	+0.11	+0.25	+0.05	-	-	-

Each Point of Interest has a decrease in peak flow due to the capping of Inlet EINL 16, the removal of the existing pavement of Ramp S-WC, and the swale extension of Ramp S-WC.

Overall project area has an increase due to the widening of Langford Run Road which keeps a portion of the proposed contributing drainage from entering the site development area.

The additions of the through lane and left turn lane on SR 0003, the widening of Langford Run Road, and the widening of Ramp S-WC cause the increase in overall pavement area which is greater than the removal of Ramp S-WC Spur.

Appendix A

Location Map

Appendix B

Storm Drain Design
Rainfall Intensity
Inlet Efficiency
Pipe Design
Channel Design
Drainage Area Maps

Appendix C

Drainage Impact
Points of Interest/Watershed Map
Time of Concentration Calculations
Comparison

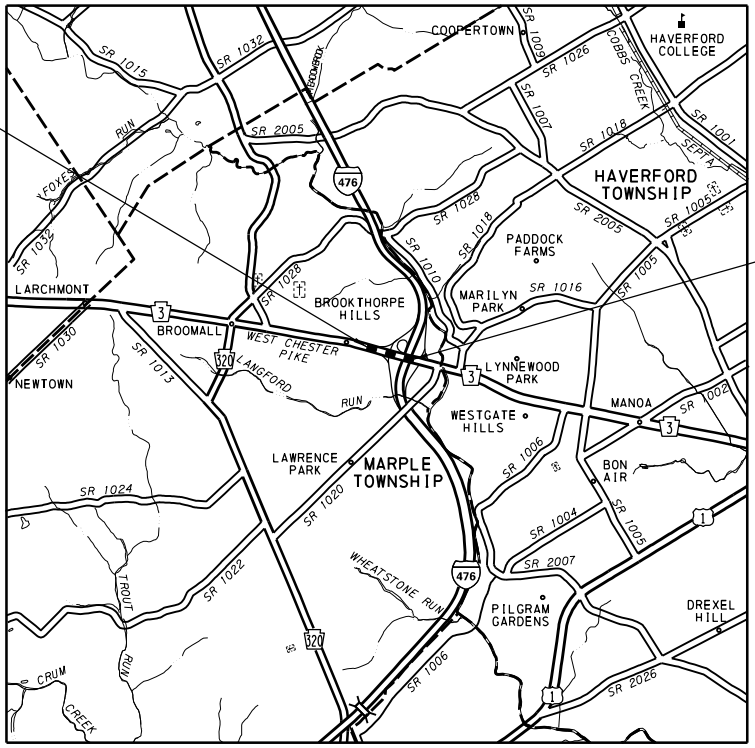
Appendix A

Location Map

DISTRICT	COUNTY	ROUTE	SECTION	SHEET
6-0	DELAWARE	0003		OF
MARPLE TOWNSHIP				

REVISION NUMBER	REVISIONS	DATE	BY

LIMIT OF WORK
STA 339+10.00
SEG 0120 OFF 2141
SEG 0121 OFF 2157
SR 0003
MARPLE TOWNSHIP
DELAWARE COUNTY



LIMIT OF WORK
STA 352+70.00
SEG 0120 OFF 3501
SEG 0121 OFF 3517
SR 0003
MARPLE TOWNSHIP
DELAWARE COUNTY

LEGEND
PROJECT
STATE HIGHWAY

LOCATION MAP
SCALE IN MILES
1/2 0 1/2 1

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Appendix B

Storm Drain Design
Rainfall Intensity
Inlet Efficiency
Pipe Design
Drainage Area Maps

Table 7A.5(a) Five (5) minute through twenty-four (24) hour storm totals for Region 4 (Metric).

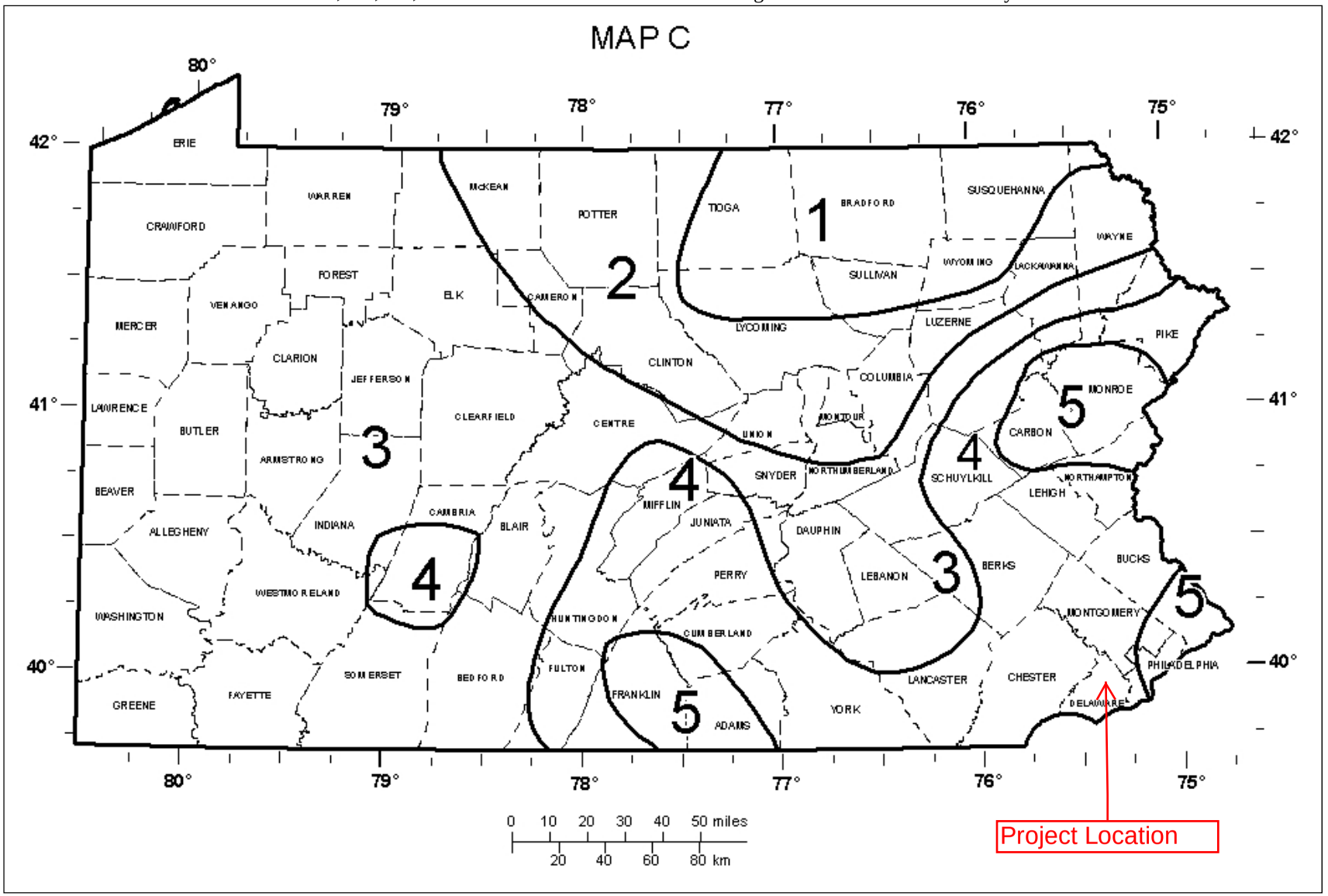
Region 4								
Rainfall Total								
	1-Yr Storm	2-Yr Storm	5-Yr Storm	10-Yr Storm	25-Yr Storm	50-Yr Storm	100-Yr Storm	500-Yr Storm
Duration (Min)	cm	cm	cm	cm	cm	cm	cm	cm
5	0.89	1.06	1.24	1.39	1.61	1.78	1.95	
10	1.38	1.65	1.93	2.16	2.47	2.71	2.95	
15	1.69	2.02	2.38	2.66	3.06	3.36	3.66	
30	2.24	2.71	3.28	3.72	4.34	4.82	5.31	
60	2.76	3.36	4.18	4.82	5.67	6.36	7.12	
120	3.28	3.98	4.99	5.80	6.91	7.85	9.09	
180	3.61	4.36	5.47	6.37	7.64	8.77	10.11	
360	4.50	5.45	6.85	7.99	9.65	10.99	12.43	
720	5.59	6.72	8.37	9.84	12.03	13.88	15.89	
1440	6.69	8.03	9.94	11.61	14.21	16.59	19.38	27.89

Table 7A.5(b). Five (5) minute through twenty-four (24) hour storm totals for Region 4 (U.S. Customary).

Region 4								
Rainfall Total								
	1-Yr Storm	2-Yr Storm	5-Yr Storm	10-Yr Storm	25-Yr Storm	50-Yr Storm	100-Yr Storm	500-Yr Storm
Duration (Min)	in	in	in	in	in	in	in	in
5	0.35	0.42	0.49	0.55	0.63	0.70	0.77	
10	0.54	0.65	0.76	0.85	0.97	1.07	1.16	
15	0.67	0.79	0.94	1.05	1.21	1.32	1.44	
30	0.88	1.07	1.29	1.47	1.71	1.90	2.09	
60	1.09	1.32	1.65	1.90	2.23	2.51	2.80	
120	1.29	1.57	1.96	2.28	2.72	3.09	3.58	
180	1.42	1.72	2.16	2.51	3.01	3.45	3.98	
360	1.77	2.14	2.70	3.15	3.80	4.33	4.89	
720	2.20	2.65	3.29	3.87	4.74	5.46	6.26	
1440	2.64	3.16	3.91	4.57	5.60	6.53	7.63	10.98

Rainfall Intensity = 6.6 in/hr

Figure 7A.3 Map C. 5- and 10-minute durations for storms occurring with an ARI of 1-, 2-, 5-, and 10-years, 10- and 15-minute durations for storms occurring with an ARI of 25-years and 10-, 15-, 30-, 60-minute durations for storms occurring with an ARI of 50- and 100-years.



By:	NRP		Date:	9/10/2013															
Check:	S. Gause		Date:	17-Oct-13				n=	0.013										
STRUCTURE NUMBER	STATION	SIDE	AREA, A	C	INTENSITY, i	AC	Q	LONG SLOPE	CROSS SLOPE	INLET CAPACITY Q	BYPASS FROM ABOVE	TOTAL Q	EFFICIENCY % CAPTURED	FLOW CAPTURED	BYPASS FLOW	BYPASS AC	Spread	Allowable Spread	NOTES
			(Acres)		(in/hr)	(Acres)	(CFS)	(FT/FT)	(FT/FT)	(CFS)	(CFS)	(CFS)	%	(CFS)	(CFS)	(Acres)	(FT)	(FT)	
								0	for a sump inlet with curb										
								999	for a Type M Inlet sump in mountable curb										
EINL 10	340+94.32	RT	0.50	0.62	6.60	0.310	2.05	0.0429	0.03	0.4	0.00	2.05	81%	1.66	0.39	0.059	3.85	8.0	To EINL 48
EINL 48	342+45.44	RT	0.29	0.60	6.60	0.174	1.15	0.0429	0.03	0.4	0.39	1.54	86%	1.32	0.21	0.033	3.53	7.0	To EINL 14
EINL 14	343+44.44	RT	0.20	0.56	6.60	0.112	0.74	0.0429	0.03	0.4	0.21	0.95	93%	0.89	0.07	0.010	3.04	7.0	To EINL 17
INL 112	341+03.77	LT	0.03	0.95	6.60	0.029	0.19	0.0429	0.02	0.4	0.00	0.19	100%	0.19	0.00	0.000	2.19	7.5	To INL 101
INL 115	343+52.92	LT	0.09	0.95	6.60	0.086	0.56	0.0429	0.02	0.4	0.00	0.56	99%	0.56	0.01	0.001	3.30	7.5	To EINL 16
EINL 20	345+94.10	RT	0.30	0.53	6.60	0.159	1.05	0.0429	0.025	0.4	0.00	1.05	92%	0.96	0.09	0.013	3.52	8.0	To EINL 22
EINL 22	347+81.42	RT	0.50	0.55	6.60	0.275	1.82	0.0429	0.025	0.4	0.09	1.90	82%	1.56	0.34	0.052	4.22	8.0	Escapes
INL 121	345+94.10	LT	0.04	0.95	6.60	0.038	0.25	0.0429	0.02	0.4	0.00	0.25	100%	0.25	0.00	0.000	2.44	7.5	To INL 102
INL 102	347+81.42	LT	0.05	0.95	6.60	0.048	0.31	0.0429	0.02	0.4	0.00	0.31	100%	0.31	0.00	0.000	2.66	7.5	Escapes

By:	NRP		Date:	9/12/2013																	
Check:	S. Gause		Date:	17-Sep-13				n=	0.013												
STRUCTURE NUMBER	STATION	SIDE	AREA, A	C	INTENSITY, i	AC	Q	LONG SLOPE	CROSS SLOPE	INLET CAPACITY Q	BYPASS FROM ABOVE	TOTAL Q	EFFICIENCY % CAPTURED	FLOW CAPTURED	BYPASS FLOW	BYPASS AC	Spread	Allowable Spread	NOTES		
			(Acres)		(in/hr)	(Acres)	(CFS)	(FT/FT)	(FT/FT)	(CFS)	(CFS)	(CFS)	%	(CFS)	(CFS)	(Acres)	(FT)	(FT)			
								0	for a sump inlet with curb												
								999	for a Type M Inlet sump in mountable curb												
INL 154	21+50	LT	0.07	0.91	6.60	0.064	0.42	0.0275	0.02	0.6	0.00	0.42	100%	0.42	0.00	0.000	3.22	7	To INL 155		
INL 155	20+74	LT	0.08	0.93	6.60	0.074	0.49	0.0000	0.02	2	0.00	0.49	100%	0.49	0.00	0.000	-	-	Low Point		
EINL 17	20+73.21	RT	0.44	0.46	6.60	0.202	1.34	0.0000	0.055	7.7	0.07	1.41	100%	1.41	0.00	0.000	-	-	Low Point, Bypass from EINL 14		
EINL 36	23+53.85	RT	0.11	0.42	6.60	0.046	0.30	0.0725	0.02	0.5	0.00	0.30	100%	0.30	0.00	0.000	2.38	9	To EINL 38		
EINL 38	26+03.01	RT	0.12	0.95	6.60	0.114	0.75	0.0725	0.02	0.5	0.00	0.75	99%	0.75	0.01	0.001	3.33	9	To Site		
INL 153	23+74	LT	0.07	0.90	6.60	0.063	0.42	0.0725	0.02	0.5	0.00	0.42	100%	0.42	0.00	0.000	2.68	7	To INL 152		
INL 152	25+92.50	LT	0.19	0.92	6.60	0.175	1.15	0.0725	0.02	0.5	0.00	1.15	96%	1.11	0.04	0.007	3.87	7	Escapes		

TABLE 10.3.3 (ENGLISH)
CAPACITY OF TYPE M INLET (MEDIAN) OR TYPE S INLET

SLOPES			INLET CAPACITY WITHOUT DIKE (cfs)	INLET CAPACITY WITH DIKE (ft^3/s)*		
LONGITUDINAL	SWALE	BACK		12 in DEPTH	9 in DEPTH	6 in DEPTH
0.5%	1V:12H	1V:2H	3.1	17.1	13.6	10.1
		1V:4H	3.6	16.7	13.4	10.1
		1V:6H	4.2	16.4	13.4	10.3
		1V:8H	4.4	16.2	13.3	10.3
		1V:12H	4.6	16.9	13.8	10.8
	1V:6H	1V:2H	5.9	16.6	13.9	11.3
		1V:4H	8.4	16.6	14.5	12.5
		1V:6H	9.0	16.6	14.7	12.8
		1V:8H	7.7	16.3	14.2	12.0
		1V:12H	4.2	16.4	13.4	10.3
2.0%	1V:12H	1V:2H	3.5	12.5	10.3	8.0
		1V:4H	3.5	13.1	10.7	8.3
		1V:6H	3.5	15.3	12.5	9.7
		1V:8H	3.6	15.3	12.4	9.5
		1V:12H	3.7	17.6	14.1	10.7
	1V:6H	1V:2H	5.7	16.5	13.8	11.1
		1V:4H	7.7	16.3	14.2	12.0
		1V:6H	9.0	15.9	14.1	12.4
		1V:8H	7.3	16.4	14.1	11.8
		1V:12H	3.5	15.3	12.5	9.7
4.0%	1V:12H	1V:2H	1.6	10.0	7.9	5.8
		1V:4H	2.0	10.8	8.6	6.4
		1V:6H	3.4	13.1	10.7	8.3
		1V:8H	3.2	12.9	10.4	8.0
		1V:12H	3.2	13.4	10.9	8.3
	1V:6H	1V:2H	6.3	11.9	10.5	9.1
		1V:4H	8.0	13.7	12.3	10.8
		1V:6H	8.7	14.7	13.2	11.7
		1V:8H	7.4	14.7	12.9	11.0
		1V:12H	3.4	13.1	10.7	8.3
8.0%	1V:12H	1V:2H	1.5	9.2	7.3	5.4
		1V:4H	2.0	8.8	7.1	5.4
		1V:6H	2.8	9.3	7.7	6.1
		1V:8H	2.7	9.1	7.5	5.9
		1V:12H	2.4	9.5	7.7	5.9
	1V:6H	1V:2H	5.2	12.2	10.5	8.7
		1V:4H	6.2	13.8	11.9	10.0
		1V:6H	6.9	14.1	12.3	10.5
		1V:8H	6.2	13.5	11.7	9.9
		1V:12H	2.8	9.3	7.7	6.1

TYPICAL SWALES WITH DIKES AT INLETS

* Height of dike is dependent on the longitudinal slope, width available and depth of water desired over the inlet grate.

Orth-Rodgers & Associates, Inc.
TRANSPORTATION ENGINEERS and PLANNERS

ΔAC_o = AC (Contrib. Surface Flow Between Inlets)
ΔAC_b = AC (Bypassing Flow From Previous Inlet)
ΔAC_i = AC (Entering Inlet)
C = Runoff Factor

SR 0003 Storm Drains

Storm Event 10 -year

Sheet No. _____Of_____ By NRP Date 9/10/2013
S.R. 0003 Chkd. By SKG Date 10/17/2013

INLET NUMBER	TG	BASELINE	STATION	SIDE	DRAINAGE AREA								TIME		(I)	(Q)	PIPE UPSTREAM INVERT	PIPE DOWNSTREAM INVERT	LENGTH OF PIPE	SLOPE OF PIPE	TYPE OF PIPE	MANNINGS N VALUE	SIZE OF PIPE	MEAN VELOCITY	PIPE CAPACITY FLOWING FULL	REMARKS	TO
					ΔA	C	ΔAC_o	ΔAC_b	$\Delta AC_o + \Delta AC_b$	INLET INTERCEPTION	ΔAC_i	$\sum AC_i$	ΔT	$\sum T$	RAINFALL INTENSITY	DISCHARGE											
----	----	----	----		(Acres)	----	(Acres)	(Acres)	(Acres)	-----	(Acres)	(Acres)	(Min)	(Min)	(In/Hr)	(CFS)	----	----	(Feet)	(Ft/Ft)	----	----	(In)	(FPS)	(CFS)	----	
3	318.27	-	-	-	0.10	0.95	0.10	0.00	0.10	100%	0.10	0.10	5.0	5.0	6.60	0.63	314.60	-	-	0.0035	RCP	0.012	18	2.4	6.7	Unknown Inverts, Assumed Slope	4
																										Assumed connection to inlet 4	
5	315.56	-	-	-	0.27	0.95	0.26	0.00	0.26	100%	0.26	0.26	5.0	5.0	6.60	1.69	311.99	310.38	55	0.0293	RCP	0.012	18	6.7	19.5		4
47	316.8	-	-	-	0.10	0.83	0.08	0.00	0.08	100%	0.08	0.08	5.0	5.0	6.60	0.55	-	-	-	0.0035	RCP	0.012	18	2.3	6.7	Unknown Inverts, Assumed Slope	4
4	316.17	-	-	-	0.15	0.30	0.05	0.00	0.05	100%	0.05	0.48	5.0	5.1	6.60	3.16	310.53	309.98	12	0.0458	RCP	0.012	18	9.4	24.4		6
6	316.12	-	-	-	0.00	0.00	0.00	0.00	0.00	100%	0.00	0.48	5.0	5.2	6.60	3.16	309.88	308.78	57	0.0193	RCP	0.012	18	6.9	15.8		7
7	315.29	-	-	-	0.12	0.95	0.11	0.00	0.11	100%	0.11	0.59	5.0	5.3	6.60	3.92	308.80	305.16	194	0.0188	RCP	0.012	18	7.3	15.6	Inverts and length of pipe measured to inlet 9	8A
8	312.5	-	-	-	0.08	0.95	0.08	0.00	0.08	100%	0.08	0.08	5.0	5.0	6.60	0.50	-	-	-	0.0035	RCP	0.012	18	2.2	6.7	Unknown Inverts, Assumed Slope	8A
8A	-	-	-	-	-	-	-	-	-	-	-	0.67	5.0	5.0	6.60	4.42	-	-	-	0.0035	RCP	0.012	18	4.1	6.7	Unknown Inverts, Assumed Slope	9
																										Assumed Junction	
9	309.73	-	-	-	0.08	0.30	0.02	0.00	0.02	100%	0.02	0.69	5.0	5.7	6.60	4.58	305.02	302.30	97	0.0280	RCP	0.012	18	8.8	19.1		112
10	306.12	-	-	-	0.50	0.62	0.31	0.00	0.31	81%	0.25	0.25	5.0	5.0	6.60	1.66	-	-	46	0.0035	RCP	0.012	18	3.1	6.7	Unknown Inverts, Assumed Slope	112
11	306.64	-	-	-	0.32	0.73	0.23	0.00	0.23	100%	0.23	0.23	5.0	5.0	6.60	1.54	-	-	51	0.0035	RCP	0.012	18	3.1	6.7	Unknown Inverts, Assumed Slope	112
112	306.99	-	-	-	0.03	0.95	0.03	0.00	0.03	100%	0.03	1.21	5.0	5.9	6.60	7.96	302.26	293.16	249	0.0365	RCP	0.012	18	11.3	21.8		115
48	302.14	-	-	-	0.29	0.60	0.17	0.06	0.23	86%	0.20	0.20	5.0	5.0	6.60	1.32	297.41	294.76	99	0.0200	RCP	0.012	18	5.4	16.1		14
13	297.69	-	-	-	0.35	0.74	0.26	0.00	0.26	100%	0.26	0.26	5.0	5.0	6.60	1.71	296.05	293.85	80	0.0275	RCP	0.012	18	6.6	18.9		115
14	298.02	-	-	-	0.20	0.56	0.11	0.03	0.14	93%	0.13	0.33	5.0	5.0	6.60	2.21	294.64	293.16	51	0.0290	RCP	0.012	18	7.2	19.4		115
115	298.01	-	-	-	0.09	0.95	0.09	0.00	0.09	99%	0.08	1.89	5.0	6.3	6.60	12.44	292.92	280.93	249	0.0482	RCP	0.012	18	14.1	25.0		121
20	285.72	-	-	-	0.50	0.64	0.32	0.00	0.32	92%	0.29	0.29	5.0	5.0	6.60	1.94	282.09	281.13	48	0.0200	RCP	0.012	18	6.1	16.1		121

TABLE 2.10.5.7
COMPUTATION TABLE FOR STORM SEWER DESIGN

Orth-Rodgers & Associates, Inc.
TRANSPORTATION ENGINEERS and PLANNERS

ΔAC_o = AC (Contrib. Surface Flow Between Inlets)
ΔAC_b = AC (Bypassing Flow From Previous Inlet)
ΔAC_i = AC (Entering Inlet)
C = Runoff Factor

SR 0003 Storm Drains

Storm Event 10 -year

Sheet No. _____Of_____ By NRP Date 9/10/2013
S.R. 0003 Chkd. By SKG Date 10/17/2013

INLET NUMBER	TG	BASELINE	STATION	SIDE	DRAINAGE AREA								TIME		(I)	(Q)	PIPE UPSTREAM INVERT	PIPE DOWNSTREAM INVERT	LENGTH OF PIPE	SLOPE OF PIPE	TYPE OF PIPE	MANNINGS N VALUE	SIZE OF PIPE	MEAN VELOCITY	PIPE CAPACITY FLOWING FULL	REMARKS	TO
					ΔA	C	ΔAC_o	ΔAC_b	$\Delta AC_o + \Delta AC_b$	INLET INTERCEPTION	ΔAC_i	$\sum AC_i$	ΔT	$\sum T$	RAINFALL INTENSITY	DISCHARGE											
----	----	----	----		(Acres)	----	(Acres)	(Acres)	(Acres)	-----	(Acres)	(Acres)	(Min)	(Min)	(In/Hr)	(CFS)	----	----	(Feet)	(Ft/Ft)	----	----	(In)	(FPS)	(CFS)	----	
121	285.94	-	-	-	0.04	0.95	0.04	0.00	0.04	100%	0.04	2.22	5.0	6.6	6.60	14.64	280.70	274.49	113	0.0550	RCP	0.012	18	15.4	26.7		102
102	280.45	-	-	-	0.05	0.95	0.05	0.00	0.05	100%	0.05	2.27	5.0	6.7	6.60	14.95	274.32	270.22	73	0.0561	RCP	0.012	18	15.6	27.0		123
22	*276.42*	-	-	-	0.50	0.55	0.28	0.03	0.30	82%	0.25	0.25	5.0	5.0	6.60	1.63	270.44	270.22	62	0.0035	RCP	0.012	18	3.1	6.8	Assumed Pipe Upstream Inv	123
123	277.18	-	-	-	0.00	0.00	0.00	0.00	0.00	100%	0.00	2.51	5.0	6.7	6.60	16.58	269.25	260.53	282	0.0309	RCP	0.012	21	12.8	30.2	Existing inlet converted to manhole	*26*
25	*263.31*	-	-	-	0.76	0.68	0.52	0.00	0.52	100%	0.52	0.52	5.0	5.0	6.60	3.41	261.28	260.41	58	0.0150	RCP	0.012	18	6.5	13.9		*26*
26	*265.52*	-	-	-	0.03	0.30	0.01	0.00	0.01	100%	0.01	3.04	5.0	7.1	6.60	20.05	259.10	258.56	59	0.0092	RCP	0.012	21	6.8	16.4		*27*
27	*263.88*	-	-	-	0.21	0.95	0.20	0.00	0.20	100%	0.20	3.24	5.0	7.2	6.60	21.36	258.26	257.65	103	0.0059	RCP	0.012	21	5.5	13.2		*28*
28	*261.55*	-	-	-	0.23	0.38	0.09	0.00	0.09	100%	0.09	3.32	5.0	7.5	6.60	21.94	257.47	256.52	105	0.0090	RCP	0.012	21	6.8	16.3	POI 1	OUT

Orth-Rodgers & Associates, Inc.
TRANSPORTATION ENGINEERS and PLANNERS

ΔAC_o = AC (Contrib. Surface Flow Between Inlets)
ΔAC_b = AC (Bypassing Flow From Previous Inlet)
ΔAC_i = AC (Entering Inlet)
C = Runoff Factor

Ramp S-WC Storm Drains

Storm Event 10 -year

Sheet No. _____Of_____ By NRP Date 9/13/2013
S.R. 0003 Chkd. By SKG Date 10/17/2013

INLET NUMBER	TG	BASELINE	STATION	SIDE	DRAINAGE AREA ΔA	C	ΔAC_o	ΔAC_b	$\Delta AC_o + \Delta AC_b$	INLET INTERCEPTION	ΔAC_i	$\sum AC_i$	TIME ΔT	TIME ∑T	(I) RAINFALL INTENSITY	(Q) DISCHARGE	PIPE UPSTREAM INVERT	PIPE DOWNSTREAM INVERT	LENGTH OF PIPE	SLOPE OF PIPE	TYPE OF PIPE	MANNINGS N VALUE	SIZE OF PIPE	MEAN VELOCITY	PIPE CAPACITY FLOWING FULL	REMARKS	TO
----	----		----		(Acres)	----	(Acres)	(Acres)	(Acres)	-----	(Acres)	(Acres)	(Min)	(Min)	(In/Hr)	(CFS)	----	----	(Feet)	(Ft/Ft)	----	----	(In)	(FPS)	(CFS)	----	
49	*273.83*	-	-	-	1.16	0.60	0.70	0.00	0.70	100%	0.70	0.70	5.0	5.0	6.60	4.59	268.65	249.22	425	0.0457	CMP	0.024	18	6.4	12.2	Existing inlet	*42*
141	253.81	-	-	-	0.84	0.38	0.32	0.00	0.32	100%	0.32	0.32	5.0	5.0	6.60	2.11	249.63	249.38	49	0.0051	RCP	0.012	18	3.8	8.1		*42*
42	*252.42*	-	-	-	0.93	0.30	0.28	0.00	0.28	100%	0.28	1.29	5.0	6.1	6.60	8.54	249.10	241.52	162	0.0468	CMP	0.024	18	7.5	12.3	Existing inlet	*43*
142B	*246.69*	-	-	-	0.44	0.36	0.16	0.00	0.16	100%	0.16	1.45	5.0	5.2	6.60	9.59	241.32	225.46	338	0.0469	CMP	0.024	18	7.7	12.3		
43	*228.99*	-	-	-	0.88	0.41	0.36	0.00	0.36	100%	0.36	1.81	5.0	6.5	6.60	11.97	225.15	224.12	72	0.0143	RCP	0.012	18	8.7	13.6	Existing inlet	*44*
44	*228.47*	-	-	-	1.10	0.50	0.55	0.00	0.55	100%	0.55	2.36	5.0	6.6	6.60	15.60	224.10	210.34	400	0.0344	RCP	0.012	18	13.0	21.1	Existing inlet	*46*
45	*212.26*	-	-	-	1.24	0.49	0.61	0.00	0.61	100%	0.61	0.61	5.0	5.0	6.60	4.01	209.14	209.02	52	0.0023	RCP	0.012	18	3.4	5.5	Existing inlet	*46*
46	*214.04*	-	-	-	2.19	0.57	1.25	0.00	1.25	100%	1.25	4.22	5.0	7.1	6.60	27.85	208.57	-	-	-	RCP	0.012	24	-	-	POI 2	
																										Outlets to existing drainage system	

TABLE 2.10.5.7
COMPUTATION TABLE FOR STORM SEWER DESIGN

Orth-Rodgers & Associates, Inc.
TRANSPORTATION ENGINEERS and PLANNERS

ΔAC_o = AC (Contrib. Surface Flow Between Inlets)
ΔAC_b = AC (Bypassing Flow From Previous Inlet)
ΔAC_i = AC (Entering Inlet)
C = Runoff Factor

Langford Run Road Storm Drains

Storm Event 10 -year

Sheet No. _____Of_____ By NRP Date 9/12/2013
S.R. 0003 Chkd. By SKG Date 10/17/2013

INLET NUMBER	TG	BASELINE	STATION	SIDE	DRAINAGE AREA								TIME		(I)	(Q)	PIPE UPSTREAM INVERT	PIPE DOWNSTREAM INVERT	LENGTH OF PIPE	SLOPE OF PIPE	TYPE OF PIPE	MANNINGS N VALUE	SIZE OF PIPE	MEAN VELOCITY	PIPE CAPACITY FLOWING FULL	REMARKS	TO
					ΔA	C	ΔAC_o	ΔAC_b	$\Delta AC_o + \Delta AC_b$	INLET INTERCEPTION	ΔAC_i	$\sum AC_i$	ΔT	$\sum T$	RAINFALL INTENSITY	DISCHARGE											
----	----	----	----		(Acres)	----	(Acres)	(Acres)	(Acres)	-----	(Acres)	(Acres)	(Min)	(Min)	(In/Hr)	(CFS)	----	----	(Feet)	(Ft/Ft)	----	----	(In)	(FPS)	(CFS)	----	
17	293.01	-	-	-	0.44	0.46	0.20	0.00	0.20	100%	0.20	0.20	5.0	5.0	6.60	1.34	290.44	288.49	22	0.0886	HDPE	0.012	18	9.3	33.9	Beginning of site drainage, existing inlet	118
118	291.97	-	-	-	0.00	0.00	0.00	0.00	0.00	100%	0.00	0.20	5.0	###	6.60	1.34	288.42	288.40	17	0.0012	HDPE	0.012	18	2.0	3.9	Existing inlet converted to manhole	119
155	291.76	-	-	-	0.08	0.93	0.07	0.00	0.07	100%	0.07	0.07	5.0	5.0	6.60	0.49	288.64	288.52	24	0.0050	DIP	0.015	18	2.1	6.4		118
155b	292.3	-	-	-	0.00	0.00	0.00	0.00	0.00	100%	0.00	0.28	5.0	5.0	6.60	1.83	288.40	288.34	51	0.0012	HDPE	0.012	18	2.2	3.9		118
154	293.42	-	-	-	0.07	0.91	0.06	0.00	0.06	100%	0.06	0.06	5.0	5.0	6.60	0.42	289.93	289.71	22	0.0100	RCP	0.012	18	3.0	11.4		119
119	293.89	-	-	-	0.00	0.00	0.00	0.00	0.00	100%	0.00	0.34	5.0	5.2	6.60	2.25	288.27	286.79	126	0.0117	HDPE	0.012	18	5.3	12.3	Existing inlet converted to manhole	*34*
34	*297.99*	-	-	-	0.40	0.68	0.27	0.00	0.27	100%	0.27	0.61	5.0	5.6	6.60	4.04	286.69	284.76	59	0.0327	HDPE	0.012	18	9.0	20.6	Existing manhole	135
153	291.99	-	-	-	0.07	0.90	0.06	0.00	0.06	100%	0.06	0.06	5.0	5.0	6.60	0.42	288.24	287.62	62	0.0100	RCP	0.012	18	3.0	11.4		135
135	295.69	-	-	-	0.00	0.00	0.00	0.00	0.00	100%	0.00	0.68	5.0	5.7	6.60	4.46	284.71	283.27	55	0.0262	HDPE	0.012	18	8.6	18.4	Existing inlet converted to manhole	*36*
36	*293.91*	-	-	-	0.11	0.42	0.05	0.00	0.05	100%	0.05	0.72	5.0	5.8	6.60	4.76	283.16	271.16	257	0.0467	HDPE	0.012	18	10.7	24.6	Existing inlet	*38*
152	276.35	-	-	-	0.19	0.92	0.17	0.00	0.17	96%	0.17	0.17	5.0	5.0	6.60	1.11	272.60	272.43	17	0.0100	RCP	0.012	18	4.1	11.4		137
38	*275.75*	-	-	-	0.12	0.95	0.11	0.00	0.11	99%	0.11	0.11	5.0	6.2	6.60	0.74	271.12	269.77	34	0.0397	HDPE	0.012	18	5.8	22.7	Existing inlet	137
137	275.33	-	-	-	0.00	0.00	0.00	0.00	0.00	100%	0.00	1.00	5.0	6.3	6.60	6.62	269.61	260.70	187	0.0476	HDPE	0.012	18	11.8	24.8	Existing inlet converted to manhole	
																										Connects to site drainage system	

TABLE 2.10.5.7
COMPUTATION TABLE FOR STORM SEWER DESIGN

Orth-Rodgers & Associates, Inc.
TRANSPORTATION ENGINEERS and PLANNERS

SHEET _____ OF _____
MADE BY _____ DATE 12/23/2013
CHECKED BY _____ DATE _____

STANDARD E&S WORKSHEET #11
Channel Design Data

PROJECT NAME: Mid-County HOP
LOCATION: Marple Township
PREPARED BY: S. Gause DATE: 18-Dec-13
CHECKED BY: _____ DATE: _____

CHANNEL OR CHANNEL SECTION		EINL 25	EINL 25	INL141	INL141	INL 142B	INL142B
TEMPORARY OR PERMANENT	(T OR P)	Temp	Perm	Temp	Perm	Temp	Perm
DESIGN STORM	(2,3, OR 10 YR)	2-year	10-year	2-year	10-year	2-year	10-year
ACRES	(AC)			Note A	Note A		
MULTIPLIER	(1.6, 2.25, OR 2.75)[1]	N/A	N/A	N/A	N/A	N/A	N/A
Q_r (REQUIRED CAPACITY)	(CFS)	0.08	0.12	1.58	2.07	0.66	1.03
Q (CALCULATED AT FLOW DEPTH d)	(CFS)	0.07	0.10	1.77	2.53	0.89	1.19
PROTECTIVE LINING[2]		ECMB	Veg-D	ECMB	Veg-D	ECMB	Veg-D
n (MANNING'S COEFFICIENT)[2]		0.065	0.130	0.110	0.095	0.065	0.125
V_a (ALLOWABLE VELOCITY)	(FPS)	-	4.50	-	4.50	-	4.50
V (CALCULATED AT FLOW DEPTH d)	(FPS)	0.34	0.22	0.98	1.20	1.45	0.95
t_a (MAX ALLOWABLE SHEAR STRESS)	(LB/FT^2)	1.60	-	1.60	-	1.60	-
t_d (CALC'D SHEAR STRESS @ FLOW DEPTH d)	(LB/FT^2)	0.06	0.09	1.09	1.18	0.96	1.37
CHANNEL BOTTOM WIDTH	(FT)	0	0	0	0	0	0
CHANNEL SIDE SLOPE-LEFT	(H:V)	4:1	4:1	4:1	4:1	4:1	4:1
CHANNEL SIDE SLOPE-RIGHT	(H:V)	6:1	6:1	6:1	6:1	6:1	6:1
D (TOTAL DEPTH)	(FT)	0.70	0.80	1.10	1.15	0.85	1.00
CHANNEL TOP WIDTH @ D	(FT)	7.00	8.00	11.00	11.50	8.50	10.00
d (CALCULATED FLOW DEPTH)	(FT)	0.20	0.30	0.60	0.65	0.35	0.50
CHANNEL TOP WIDTH @ FLOW DEPTH d	(FT)	2.00	3.00	6.00	6.50	3.50	5.00
BOTTOM WIDTH: FLOW DEPTH RATIO	(12:1 MAX)	:1	:1	:1	:1	:1	:1
d_{50} STONE SIZE	(IN)	N/A	N/A	N/A	N/A	N/A	N/A
A (CROSS-SECTIONAL AREA)	(SQ. FT.)	0.20	0.45	1.80	2.11	0.61	1.25
WETTED PERIMETER	(FT)	2.06	3.13	6.43	7.00	3.67	5.31
R (HYDRAULIC RADIUS)		0.10	0.14	0.28	0.30	0.17	0.24
S (BED SLOPE)[3]	(FT/FT)	0.01	0.01	0.03	0.03	0.04	0.04
S_c (CRITICAL SLOPE)	(FT/FT)	0.14	0.49	0.29	0.21	0.12	0.39
$.7S_c$	(FT/FT)	0.10	0.34	0.20	0.15	0.08	0.27
$1.3S_c$	(FT/FT)	0.18	0.64	0.38	0.27	0.15	0.51
STABLE FLOW?	(Y/N)	Y	Y	Y	Y	Y	Y
FREEBOARD BASED ON UNSTABLE FLOW	(FT)	N/A	N/A	N/A	N/A	N/A	N/A
FREEBOARD BASED ON STABLE FLOW	(FT)	0.05	0.08	0.15	0.16	0.09	0.13
MINIMUM REQUIRED FREEBOARD[4]	(FT)	0.50	0.50	0.50	0.50	0.50	0.50
DESIGN METHOD FOR PROTECTIVE LINING[5] PERMISSIBLE VELOCITY (V) OR SHEAR STRESS (S)		S	V	S	V	S	V

1. Use 1.6 for Temporary Channels; 2.25 for Temporary Channels in Special Protection (HQ or EV) Watersheds; 2.75 for Permanent Channels. For Rational Method, enter "N/A: and attach E&S Worksheets 9 and 10. For TR-55 enter "N/A" and attach appropriate Worksheets
2. Adjust "n" value for changes in channel liner and flow depth. For vegetated channels, provide data for manufactured linings without vegetation and with vegetation in separate columns.
3. Slopes may not be averaged.
4. Minimum Freeboard is 0.5 ft. or 1/4 Total Channel Depth, whichever is greater
5. Permissible velocity lining design method is not acceptable for channels with a bed slope of 10% or greater. Shear stress lining design method is required for channels with a bed slope of 10% or greater. Shear stress lining design method may be used for any channel bed slope.

Note A: Discharges used are the entire drainage area. Proposed swale is a portion of the entire drainage area until 50 feet from the inlet.

Orth-Rodgers & Associates, Inc.
TRANSPORTATION ENGINEERS and PLANNERS

SHEET _____ OF _____
MADE BY _____ DATE 12/23/2013
CHECKED BY _____ DATE _____

STANDARD E&S WORKSHEET #11
Channel Design Data

PROJECT NAME: Mid-County HOP
LOCATION: Marple Township
PREPARED BY: S. Gause DATE: 18-Dec-13
CHECKED BY: _____ DATE: _____

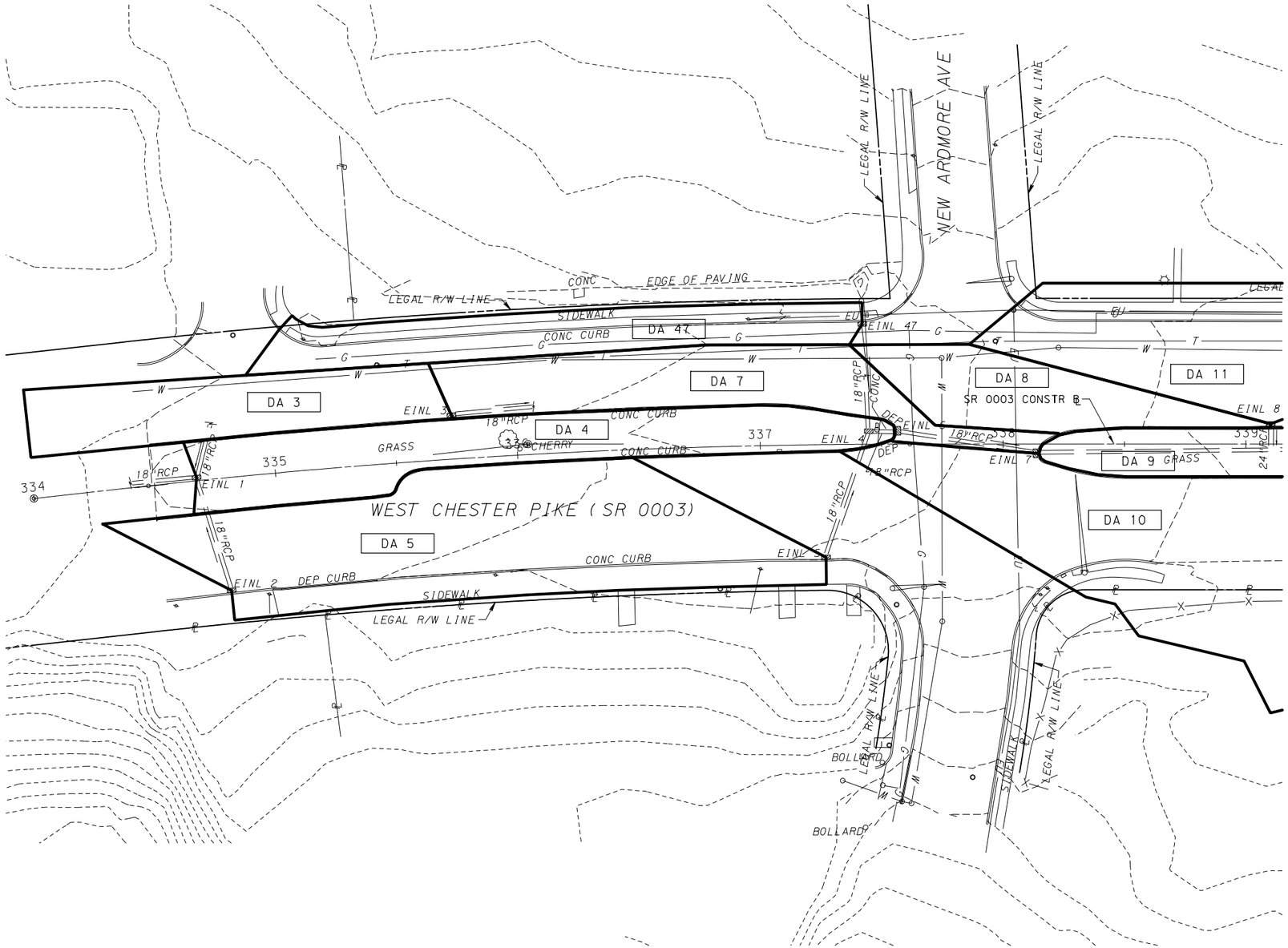
CHANNEL OR CHANNEL SECTION		EINL 43	EINL 43	EINL 44	EINL 44		
TEMPORARY OR PERMANENT	(T OR P)	Temp	Perm	Temp	Perm		
DESIGN STORM	(2,3, OR 10 YR)	2-year	10-year	2-year	10-year		
ACRES	(AC)						
MULTIPLIER	(1.6, 2.25, OR 2.75)[1]	N/A	N/A	N/A	N/A		
Q_r (REQUIRED CAPACITY)	(CFS)	1.53	2.41	2.23	3.51		
Q (CALCULATED AT FLOW DEPTH d)	(CFS)	1.73	2.53	2.04	3.70		
PROTECTIVE LINING[2]		ECMB	Veg-D	ECMB	Veg-D		
n (MANNING'S COEFFICIENT)[2]		0.065	0.095	0.065	0.080		
V_a (ALLOWABLE VELOCITY)	(FPS)	-	4.50	-	4.50		
V (CALCULATED AT FLOW DEPTH d)	(FPS)	1.71	1.40	1.82	1.75		
t_a (MAX ALLOWABLE SHEAR STRESS)	(LB/FT^2)	1.60	-	1.60	-		
t_d (CALC'D SHEAR STRESS @ FLOW DEPTH d)	(LB/FT^2)	1.24	1.65	1.37	1.78		
CHANNEL BOTTOM WIDTH	(FT)	0	0	0	0		
CHANNEL SIDE SLOPE-LEFT	(H:V)	4:1	4:1	3:1	4:1		
CHANNEL SIDE SLOPE-RIGHT	(H:V)	6:1	6:1	6:1	6:1		
D (TOTAL DEPTH)	(FT)	0.95	1.10	1.00	1.15		
CHANNEL TOP WIDTH @ D	(FT)	9.50	11.00	9.00	11.50		
d (CALCULATED FLOW DEPTH)	(FT)	0.45	0.60	0.50	0.65		
CHANNEL TOP WIDTH @ FLOW DEPTH d	(FT)	4.50	6.00	4.50	6.50		
BOTTOM WIDTH: FLOW DEPTH RATIO	(12:1 MAX)	:1	:1	:1	:1		
d_{50} STONE SIZE	(IN)	N/A	N/A	N/A	N/A		
A (CROSS-SECTIONAL AREA)	(SQ. FT.)	1.01	1.80	1.13	2.11		
WETTED PERIMETER	(FT)	4.76	6.43	4.83	7.00		
R (HYDRAULIC RADIUS)		0.21	0.28	0.23	0.30		
S (BED SLOPE)[3]	(FT/FT)	0.04	0.04	0.04	0.04		
S_c (CRITICAL SLOPE)	(FT/FT)	0.11	0.22	0.11	0.15		
$.7S_c$	(FT/FT)	0.08	0.15	0.08	0.10		
$1.3S_c$	(FT/FT)	0.14	0.28	0.14	0.19		
STABLE FLOW?	(Y/N)	Y	Y	Y	Y		
FREEBOARD BASED ON UNSTABLE FLOW	(FT)	N/A	N/A	N/A	N/A		
FREEBOARD BASED ON STABLE FLOW	(FT)	0.11	0.15	0.13	0.16		
MINIMUM REQUIRED FREEBOARD[4]	(FT)	0.50	0.50	0.50	0.50		
DESIGN METHOD FOR PROTECTIVE LINING[5] PERMISSIBLE VELOCITY (V) OR SHEAR STRESS (S)		S	V	S	V		

1. Use 1.6 for Temporary Channels; 2.25 for Temporary Channels in Special Protection (HQ or EV) Watersheds; 2.75 for Permanent Channels. For Rational Method, enter "N/A: and attach E&S Worksheets 9 and 10. For TR-55 enter "N/A" and attach appropriate Worksheets
2. Adjust "n" value for changes in channel liner and flow depth. For vegetated channels, provide data for manufactured linings without vegetation and with vegetation in separate columns.
3. Slopes may not be averaged.
4. Minimum Freeboard is 0.5 ft. or 1/4 Total Channel Depth, whichever is greater
5. Permissible velocity lining design method is not acceptable for channels with a bed slope of 10% or greater. Shear stress lining design method is required for channels with a bed slope of 10% or greater. Shear stress lining design method may be used for any channel bed slope.

PROPOSED DRAINAGE AREAS

DISTRICT	COUNTY	ROUTE	SECTION	SHEET
6-0	DELAWARE	0003		1 OF 6
MARPLE TOWNSHIP				

REVISION NUMBER	REVISIONS	DATE	BY



EINL 1 TG 319.39 INV IN 314.97 (N) INV IN 314.85 (S) INV OUT 314.38	EINL 6 TG 316.12 INV IN 309.98 INV OUT 309.88
EINL 2 TG 318.29 INV OUT 315.48	EINL 7 TG 315.29 INV IN 308.78 INV OUT 308.80
EINL 3 TG 318.27 INV OUT 314.60	EINL 8 TG 312.50 INV OUT 307.79
EINL 4 TG 316.17 INV IN 312.69 (N) INV IN 310.38 (S) INV OUT 310.53	EINL 47 TG 316.80
EINL 5 TG 315.56 INV OUT 311.99	

SCALE

0 25 50 FEET

LEGEND

- LIMIT OF FULL DEPTH PAVEMENT
- PAVEMENT REMOVAL
- MILL AND VARIABLE DEPTH OVERLAY
- VARIABLE DEPTH OVERLAY

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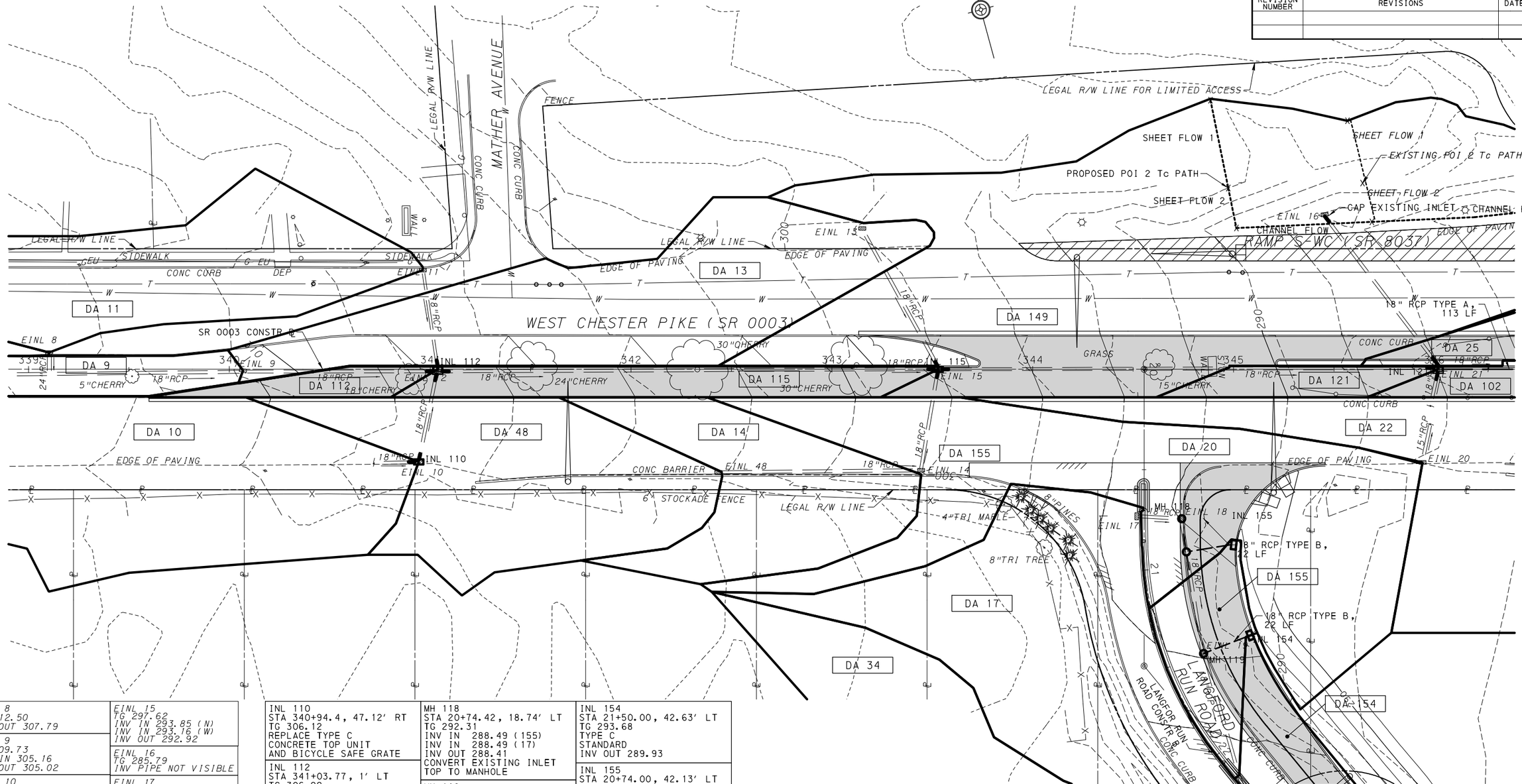
PROPOSED DRAINAGE AREAS

DISTRICT	COUNTY	ROUTE	SECTION	SHEET
6-0	DELAWARE	0003		2 OF 6
MARPLE TOWNSHIP				

REVISION NUMBER	REVISIONS	DATE	BY



EINL 8 TG 312.50 INV OUT 307.79	EINL 15 TG 297.62 INV IN 293.85 (N) INV IN 293.16 (W) INV OUT 292.92	INL 110 STA 340+94.4, 47.12' RT TG 306.12 REPLACE TYPE C CONCRETE TOP UNIT AND BICYCLE SAFE GRATE	MH 118 STA 20+74.42, 18.74' LT TG 292.31 INV IN 288.49 (155) INV IN 288.49 (17) INV OUT 288.41 CONVERT EXISTING INLET TOP TO MANHOLE	INL 154 STA 21+50.00, 42.63' LT TG 293.68 TYPE C STANDARD INV OUT 289.93
EINL 9 TG 309.73 INV IN 305.16 INV OUT 305.02	EINL 16 TG 285.79 INV PIPE NOT VISIBLE	INL 112 STA 341+03.77, 1' LT TG 306.99 TYPE C TYPE 4 INV IN 302.62 (11) INV IN 302.30 (9) INV IN 302.40 (110) INV OUT 302.26 CONNECT TO EXISTING PIPES	MH 119 STA 21+49.97, 19.09' LT TG 294.14 INV IN 289.71 (154) INV IN 288.34 (118) INV OUT 288.27 CONVERT EXISTING INLET TOP TO MANHOLE	INL 155 STA 20+74.00, 42.13' LT TG 291.84 TYPE C STANDARD INV OUT 288.60
EINL 10 TG 306.12 INV IN 303.98 INV OUT FULL OF DEBRIS	EINL 17 TG 293.01 INV OUT 290.44	INL 115 STA 343+52.92, 1' LT TG 298.01 TYPE C STANDARD INV IN 293.85 (13) INV IN 293.16 (112) INV OUT 292.92 CONNECT TO EXISTING PIPES	INL 121 STA 346+01.94, 1' LT TG 284.94 TYPE C MODIFIED TYPE 4 INV IN 281.13 (20) INV IN 280.93 (115) INV OUT 280.70 CONNECT TO EXISTING PIPES	
EINL 11 TG 306.15 INV FILLED W/ DEBRIS	EINL 18 TG 291.93 INV IN 288.49 INV OUT 288.42			
EINL 12 TG 306.64 INV IN 302.62 (N) INV IN 302.30 (W) INV IN 302.40 (S) INV OUT 302.26	EINL 19 TG 293.84 INV IN 288.34 INV OUT 288.27			
EINL 13 TG 297.68 INV OUT 296.05	EINL 20 TG 285.72 INV OUT 282.09			
EINL 14 TG 298.02 INV IN 294.76 INV OUT 294.64	EINL 21 TG 285.28 INV IN 281.13 (S) INV IN 280.93 (W) INV OUT 280.70			
	EINL 48 TG 302.14 INV OUT 297.41			

SCALE

0 25 50 FEET

LEGEND

- LIMIT OF FULL DEPTH PAVEMENT
- PAVEMENT REMOVAL
- MILL AND VARIABLE DEPTH OVERLAY
- VARIABLE DEPTH OVERLAY

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PROPOSED DRAINAGE AREAS

DISTRICT	COUNTY	ROUTE	SECTION	SHEET
6-0	DELAWARE	0003		3 OF 6
MARPLE TOWNSHIP				

REVISION NUMBER	REVISIONS	DATE	BY

PROPOSED/EXISTING POI 2 Tc PATH
PIPE FLOW
CHANNEL FLOW
DA 42
DA 141
DA 49
DA 25
DA 26
DA 27
DA 28
DA 22
DA 50
EINL 49
18"CMP
RAMP S-WC (SR 8037)
RAMP S-WC SPUR (SR 8037)
SR 8037 CONSTR ℄
LEGAL R/W LINE
EDGE OF PAVING
EINL 25
15"RCP
CONC CURB
EINL 26
GUIDE RAIL
CONC
10"CHERRY
12"CHERRY
21"CMP
G R A S S
MH 123
INL 102
347
348
349
350
351
352 CONC CNRB
353
SR 0003 CONSTR ℄
WEST CHESTER PIKE (SR 0003)
CONC MEDIAN
18" RCP TYPE A, 113 LF
18" RCP TYPE A, 73 LF
18"RCP
21"RCP
OVERHEAD SIGNS
EINL 22
CONC CURB
WALL
EINL 24
LEGAL R/W LINE
082
RAMP WC-S1 (SR 8037)
RAMP WC-S1 SPUR (SR 8037)
EINL 27
EINL 30
18"RCP
GUIDE RAIL
LEGAL R/W LINE FOR LIMITED ACCESS
TOP OF CRUSHED CMP - 268.12
EINL 28
EINL 29
18"CMP
RIP-RAP
RW 256.52
POI 1
LEGAL R/W LINE FOR LIMI

EINL 22 TG 276.42 NO PIPE VISIBLE	EINL 27 TG 263.88 INV IN 258.56 INV OUT 258.26	EINL 32 TG 250.45 INV IN 247.30 (S) INV IN 245.39 (W) INV OUT 245.07
EINL 23 TG 276.78 INV IN 270.22 INV OUT 269.25	EINL 28 TG 261.55 INV IN 257.65 INV OUT 257.47	EINL 33 TG 249.53 INV IN 242.58 INV OUT 242.31
EINL 24 TG 276.72 INV GRATE FILLED W/ CONC	EINL 29 TG 259.69 INV IN 257.65	EINL 49 TG 273.83 INV OUT 268.65
EINL 25 TG 263.31 INV OUT 261.28	EINL 30 TG 257.02 INV OUT 253.88	
EINL 26 TG 265.52 INV IN 260.53 (W) INV IN 260.41 (N) INV OUT 259.10	EINL 31 TG 250.35 INV OUT 247.67	

INL 102 STA 347+15.00, 1' LT TG 280.45 TYPE C STANDARD INV IN 274.49 INV OUT 274.32
MH 123 STA 347+87.41, 7.42' LT TG 277.18 INV IN 270.22 (102) INV IN 270.22 (22) INV OUT 269.25 CONVERT EXISTING INLET TOP TO MANHOLE

LEGEND

- LIMIT OF FULL DEPTH PAVEMENT
- PAVEMENT REMOVAL
- MILL AND VARIABLE DEPTH OVERLAY
- VARIABLE DEPTH OVERLAY

SCALE
0 25 50 FEET

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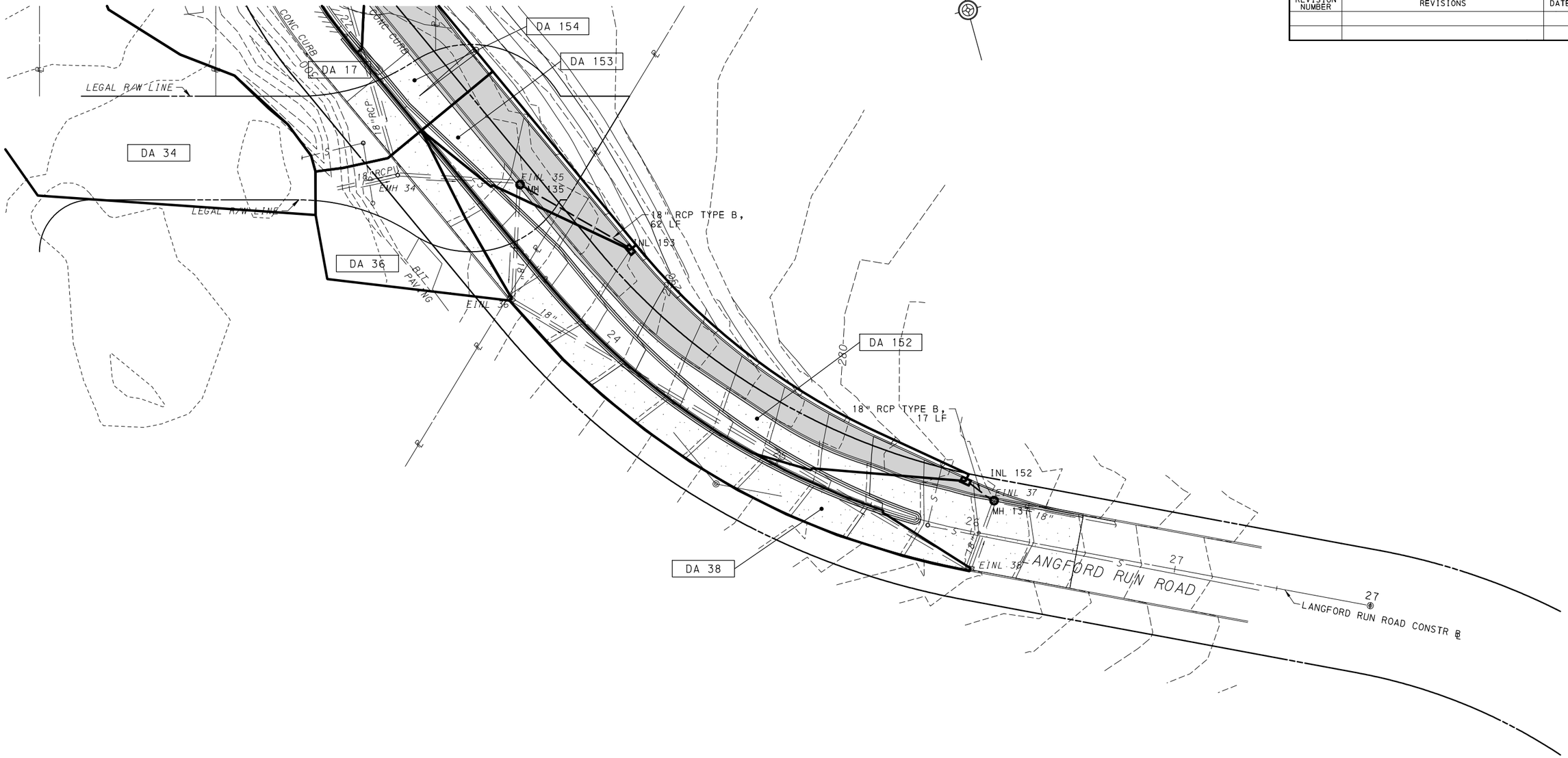
PROPOSED DRAINAGE AREAS

DISTRICT	COUNTY	ROUTE	SECTION	SHEET
6-0	DELAWARE	0003	X	4 OF 6
MARPLE TOWNSHIP				

REVISION NUMBER	REVISIONS	DATE	BY



EMH 34 *RIM 297.99* *INV IN 291.19* *INV IN 286.79* *INV OUT 286.79*
EINL 35 *TG 295.66* *INV IN 284.76* *INV OUT 284.71*
EINL 36 *TG 293.91* *INV IN 283.27* *INV OUT 283.16*
EINL 37 *TG 275.20* *INV IN 269.77* *INV OUT 269.61*
EINL 38 *TG 275.75* *INV IN 271.16* *INV OUT 271.12*

MH 135 STA 23+13.97, 19.05' LT TG 295.69 INV IN 287.62 (153) INV IN 284.76 (34) INV OUT 284.71 CONVERT EXISTING INLET TOP TO MANHOLE	INL 152 STA 25+92.50, 24.14' LT TG 276.35 TYPE C STANDARD INV OUT 272.60
MH 137 STA 26+08.31, 16.60' LT TG 275.33 INV IN 272.43 (152) INV IN 269.77 (38) INV OUT 269.61 CONVERT EXISTING INLET TOP TO MANHOLE	INL 153 STA 23+74.00, 40.62' LT TG 291.99 TYPE C STANDARD INV OUT 288.24

SCALE

0 25 50 FEET

LEGEND

- LIMIT OF FULL DEPTH PAVEMENT
- PAVEMENT REMOVAL
- MILL AND VARIABLE DEPTH OVERLAY
- VARIABLE DEPTH OVERLAY

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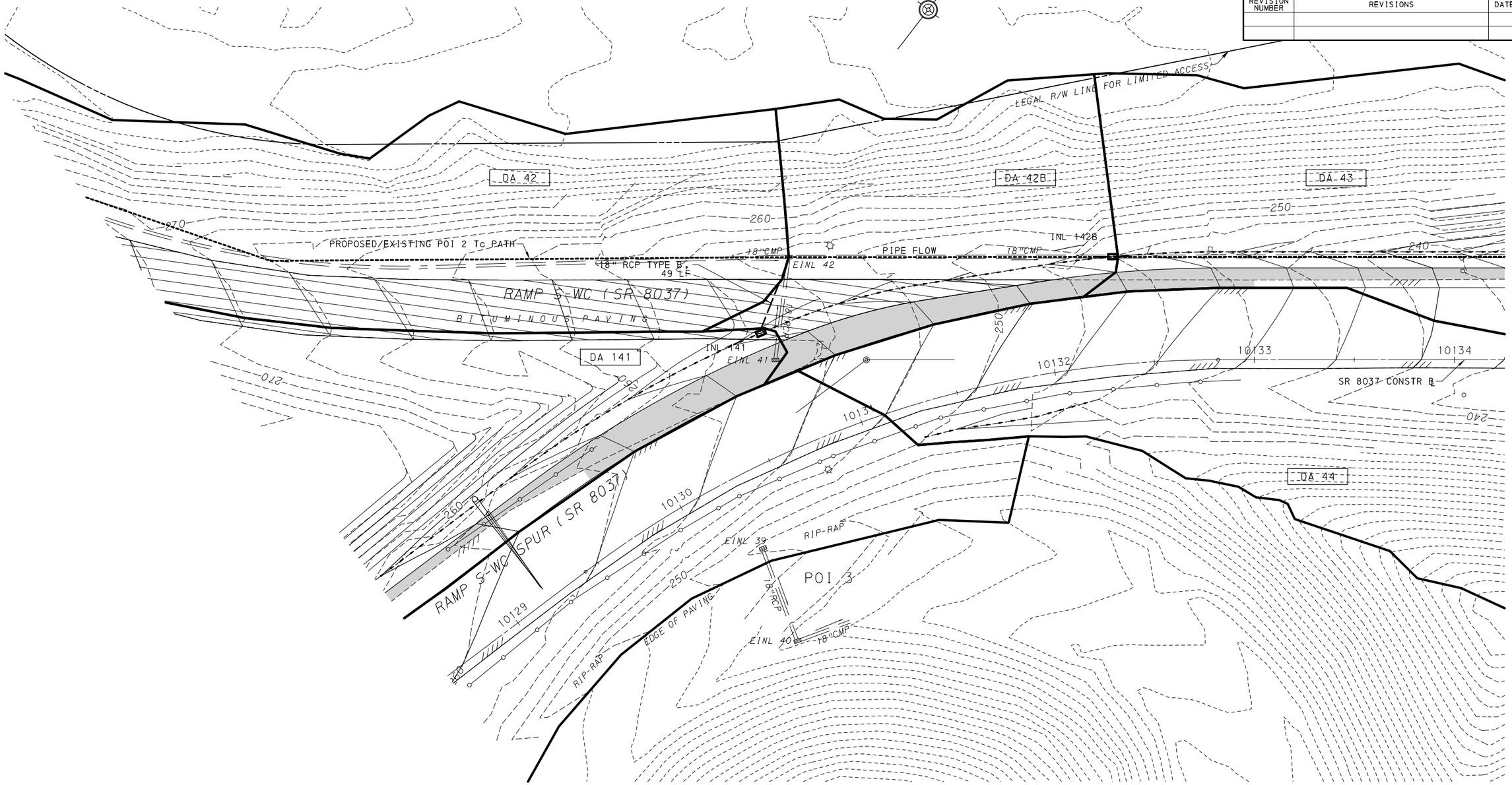
DISTRICT	COUNTY	ROUTE	SECTION	SHEET
6-0	DELAWARE	0003		5 OF 6
MARPLE TOWNSHIP				

REVISION NUMBER	REVISIONS	DATE	BY

PROPOSED DRAINAGE AREAS



EINL 39 TG 245.79 INV OUT 239.85
EINL 40 TG 243.22 INV IN 238.54 INV OUT 237.49
EINL 41 TG 254.32 INV OUT 249.63
EINL 42 TG 252.42 INV IN 249.22 (W) INV IN 249.38 (S) INV OUT 249.10

INL 141 STA 10130+65.00, 54' LT TG 253.81 TYPE M STANDARD INV OUT 249.63

SCALE

0 25 50 FEET

LEGEND

- LIMIT OF FULL DEPTH PAVEMENT
- PAVEMENT REMOVAL
- MILL AND VARIABLE DEPTH OVERLAY
- VARIABLE DEPTH OVERLAY

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PROPOSED DRAINAGE AREAS

DISTRICT	COUNTY	ROUTE	SECTION	SHEET
6-0	DELAWARE	0003		6 OF 6
MARPLE TOWNSHIP				

REVISION NUMBER	REVISIONS	DATE	BY

DA 43

PROPOSED/EXISTING POI 2 Tc PATH

DA 45

DA 44

DA 46

18"CMP

PIPE FLOW

EINL 43

EINL 44

EINL 45

EINL 46

ELEC BOX

ELEC BOX

18"RCP

18"RCP

18"RCP

24"RCP

RAMP S-WC (SR 8037)

SR 8037 CONSTR ℄

34

BITUMINOUS PAVING

240

230

220

10135

10136

10137

10138

10139

10140

10141

EINL 43 TG 228.99 INV IN 225.46 INV OUT 225.15
EINL 44 TG 228.47 INV IN 224.12 INV OUT 224.10
EINL 45 TG 212.26 INV OUT 209.14
EINL 46 TG 214.04 INV IN 210.34 (W) INV IN 209.02 (N) INV OUT 208.57

SCALE

0 25 50 FEET

LEGEND

- LIMIT OF FULL DEPTH PAVEMENT
- PAVEMENT REMOVAL
- MILL AND VARIABLE DEPTH OVERLAY
- VARIABLE DEPTH OVERLAY

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Appendix C

Drainage Impact
Points of Interest/Watershed Map
Time of Concentration Calculations
Comparison

POINTS OF INTEREST

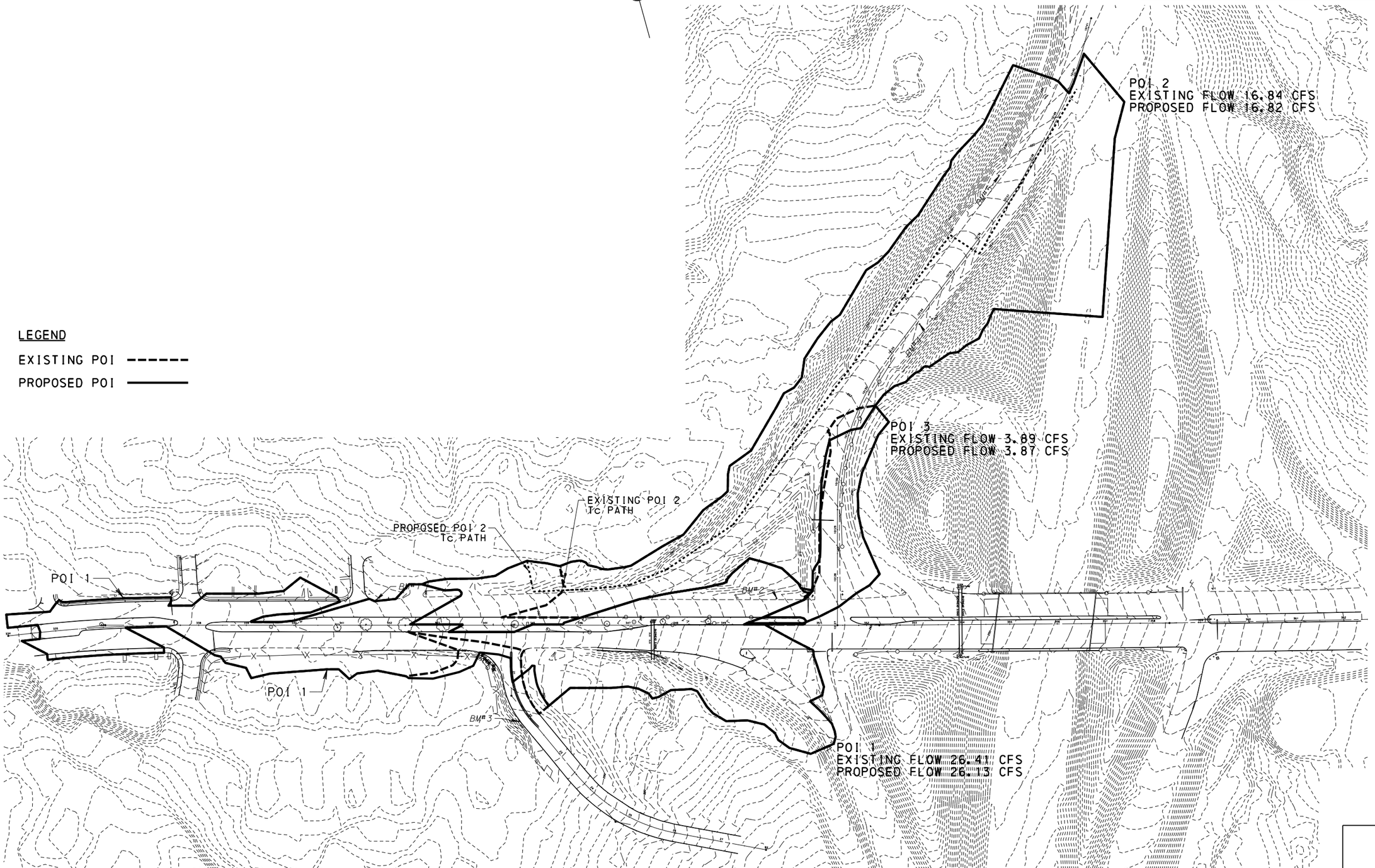
DISTRICT	COUNTY	ROUTE	SECTION	SHEET
6-0	DELAWARE	0003		1 OF 1
MARPLE TOWNSHIP				

REVISION NUMBER	REVISIONS	DATE	BY

LEGEND

EXISTING POI ------

PROPOSED POI ——————



SCALE

0 100 200 FEET

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SOIL CONSERVATION SERVICE
TIME OF CONCENTRATION AND TRAVEL TIME SPREADSHEET

Existing Conditions - Time of Concentration Path
Project: Mid-County HOP
Calc. by: NRP Date: 10/4/2013
Check by: S. Gause Date: 10/9/2013

Sheet Flow (Applicable to Tc only)	Segment ID	**sheet**						
1. Surface description (table 3-1)		Forest	Forest					
2. Manning's roughness coeff., n		0.800	0.800					
3. Flow length, L (total <= 300 ft)	ft	32	20					
4. Two-year 24-hr rainfall, P_2	in	3.16	3.16					
5. Land slope, s	ft/ft	0.1	0.33					
6. $Tt = \{0.007*(nL)^{0.8}\}/\{P_2^{0.5}*s^{0.4}\}$	hr	0.13	0.06					0.19 hr
Shallow Concentrated Flow	Segment ID	**drive**	**lawn**	hill	embank	embank		
7. Surface description (paved or unpaved)								
8. Flow Length, L	ft							
9. Watercourse slope, s	ft/ft							
10. Average Velocity, V	ft/s							
11. Tt = L/(3600*V)	hr							0.00 hr
Channel Flow	Segment ID	**ditch**	**18" RCP**	**18" CMP**	**18" RCP**	**18" RCP**		
12. Cross sectional flow area, a *Full Flow*	ft^2	4.50	1.77	1.77	1.77	1.77		
13. Wetter perimeter, p_w *Assumed*	ft	9.25	4.71	4.71	4.71	4.71		
14. Hydraulic radius, $r = a/p_w$	ft	0.486486	0.375	0.375	0.375	0.375		
15. Channel slope, s	ft/ft	0.05	0.0457	0.0473	0.0143	0.0344		
16. Manning's roughness coeff., n		0.05	0.012	0.024	0.012	0.012		
17. $V = \{1.49r^{2/3}s^{1/2}\}/n$	ft/s	4.12	13.80	7.02	7.72	11.98		
18. Flow Length, L	ft	220	425	500	72	400		
19. Tt = L/(3600V)	hr	0.01	0.01	0.02	0.00	0.01		0.06 hr

Watershed or subarea Tc or Tt **0.24 hr**
14.6 min

SOIL CONSERVATION SERVICE
TIME OF CONCENTRATION AND TRAVEL TIME SPREADSHEET

Proposed Conditions - Time of Concentration Path
Project: Mid-County HOP
Calc. by: NRP Date: 10/4/2013
Check by: S. Gause Date: 10/9/2013

Sheet Flow (Applicable to Tc only)	Segment ID	**sheet**					
1. Surface description (table 3-1)		Forest	Forest				
2. Manning's roughness coeff., n		0.800	0.800				
3. Flow length, L (total <= 300 ft)	ft	45	20				
4. Two-year 24-hr rainfall, P_2	in	3.16	3.16				
5. Land slope, s	ft/ft	0.1	0.33				
6. Tt = $\{0.007*(nL)^{0.8}\}/\{P_2^{0.5}*s^{0.4}\}$	hr	0.17	0.06				0.23 hr

Shallow Concentrated Flow	Segment ID	**drive**	**lawn**	hill	embank	embank		
7. Surface description (paved or unpaved)								
8. Flow Length, L	ft							
9. Watercourse slope, s	ft/ft							
10. Average Velocity, V	ft/s							
11. Tt = L/(3600*V)	hr							0.00 hr

Channel Flow		Segment ID	**ditch**	**18" RCP**	**18" CMP**	**18" RCP**	**18" RCP**		
12. Cross sectional flow area, a	*Full Flow*	ft^2	4.50	1.77	1.77	1.77	1.77		
13. Wetter perimeter, p_w	*Assumed*	ft	9.25	4.71	4.71	4.71	4.71		
14. Hydraulic radius, r = a/p_w		ft	0.486486	0.375	0.375	0.375	0.375		
15. Channel slope, s		ft/ft	0.05	0.0457	0.0473	0.0143	0.0344		
16. Manning's roughness coeff., n			0.05	0.012	0.024	0.012	0.012		
17. V = $\{1.49r^{2/3}s^{1/2}\}/n$		ft/s	4.12	13.80	7.02	7.72	11.98		
18. Flow Length, L		ft	287	425	500	72	400		
19. Tt = L/(3600V)		hr	0.02	0.01	0.02	0.00	0.01		0.06 hr

Watershed or subarea Tc or Tt **0.29 hr**
17.4 min

POI Comparison

Existing						
POI	Drainage Area	Pavement Area	Composite Runoff Coefficient	Tc	Rainfall Intensity (10 yr)	Flow
	(ac)	(ac)		(min)	(in/hr)	(cfs)
1	6.67	3.06	0.60	5.00	6.60	26.41
2	8.05	2.39	0.49	14.60	4.27	16.84
3	0.95	0.46	0.62	5.00	6.60	3.89
Total	15.67					

Proposed						
POI	Drainage Area	Pavement Area	Composite Runoff Coefficient	Tc	Rainfall Intensity (10 yr)	Flow
	(ac)	(ac)		(min)	(in/hr)	(cfs)
1	6.09	3.26	0.65	5.00	6.60	26.13
2	8.76	2.44	0.48	17.40	4.00	16.82
3	0.93	0.48	0.63	5.00	6.60	3.87
Total	15.78					

+0.11 acre into the project

POI	Change in Flow
	(cfs)
1	-0.29
2	-0.02
3	-0.02