City Copy

MASTER STORM WATER PLAN
for
Destin Landing
36th Avenue SE and Post Oak Road
Norman, Oklahoma

January 12, 2015
Revised November 2, 2015

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This site is located in the southeast area of Norman, Oklahoma, see figure 1, location map.

It is proposed to develop 760 acres into a multi-use area, including various densities of single family homes, multifamily homes (including apartments), patio homes and mixed use commercial and open space with equestrian facilities, see Exhibit A.

The historic runoff is calculated based on the current land use which is undeveloped. There will be minor diversion of storm water runoff from basin to basin, using the preliminary layout as shown in Exhibit A, but there will be **NO** increase in the calculated "historic" runoff from each individual basin. ?

The existing land use is meadow. The existing soil types for the area varies between Type B, Type C and Type D soils, see Exhibit B for Soils map. The proposed runoff CN is weighted based on the soil type and proposed land use, see Appendix A.

Hydrologic modeling for the existing and proposed drainage basins was performed using the SCS method.

Hydrologic coefficients were taken from The City of Norman, Engineering Design Criteria manual, Table 5004.1, Total Rainfall Depths. The time of concentration was computed using the TR-55 method.

Part of the project lies within the Stream Planning Corridor as outlined in the City ordinance Sec. 19-210, Sec. 19-303, Sec. 19-411, Sec. 19-514, Sec. 19-601 and Sec. 19-606. The Stream Planning Corridor and WQPZ ordinances will be fully evaluated at the preliminary plat stage of each phase.

Part of the project site is also within FEMA designated flood plains. The flood plain as shown on the effective FEMA maps will be avoided as much as possible to eliminate possible map revisions. Impact to any FEMA designated flood plain will be fully evaluated at the final plat stage of each phase.

No houses or proposed lots will be located within the ~~current~~ effective FEMA designated floodplain. The preliminary plats will show the FEMA designated floodplain to verify no lot encroaches said floodplain. at the time of preliminary and final platting.

HEC-RAS modelling of the creeks running through the property will be used to determine the base flood elevations and set minimum floor elevations. In cases where an on-site dam could or off-site (Cedar Lakes Estates)

(A) Each preliminary and final plat will be subject to the Engineering Design Criteria and Subdivision Regulations in affect at the time of submittal

be considered high hazard and come under the jurisdiction of the OWRB, a dam breach analysis will be used to evaluated the hazard potential to homes and property.

In the master planning concept some areas will bypass proposed detention ponds. In all future construction phases the bypass areas will be accounted for, in some cases temporary detention areas may be used to ensure historic discharge will not be exceeded.

Notification to the USACE will be given for any detention pond or disturbance located within a USGS "blue line". A letter of jurisdictional determination will be obtained prior to any construction taking place.

(A) →

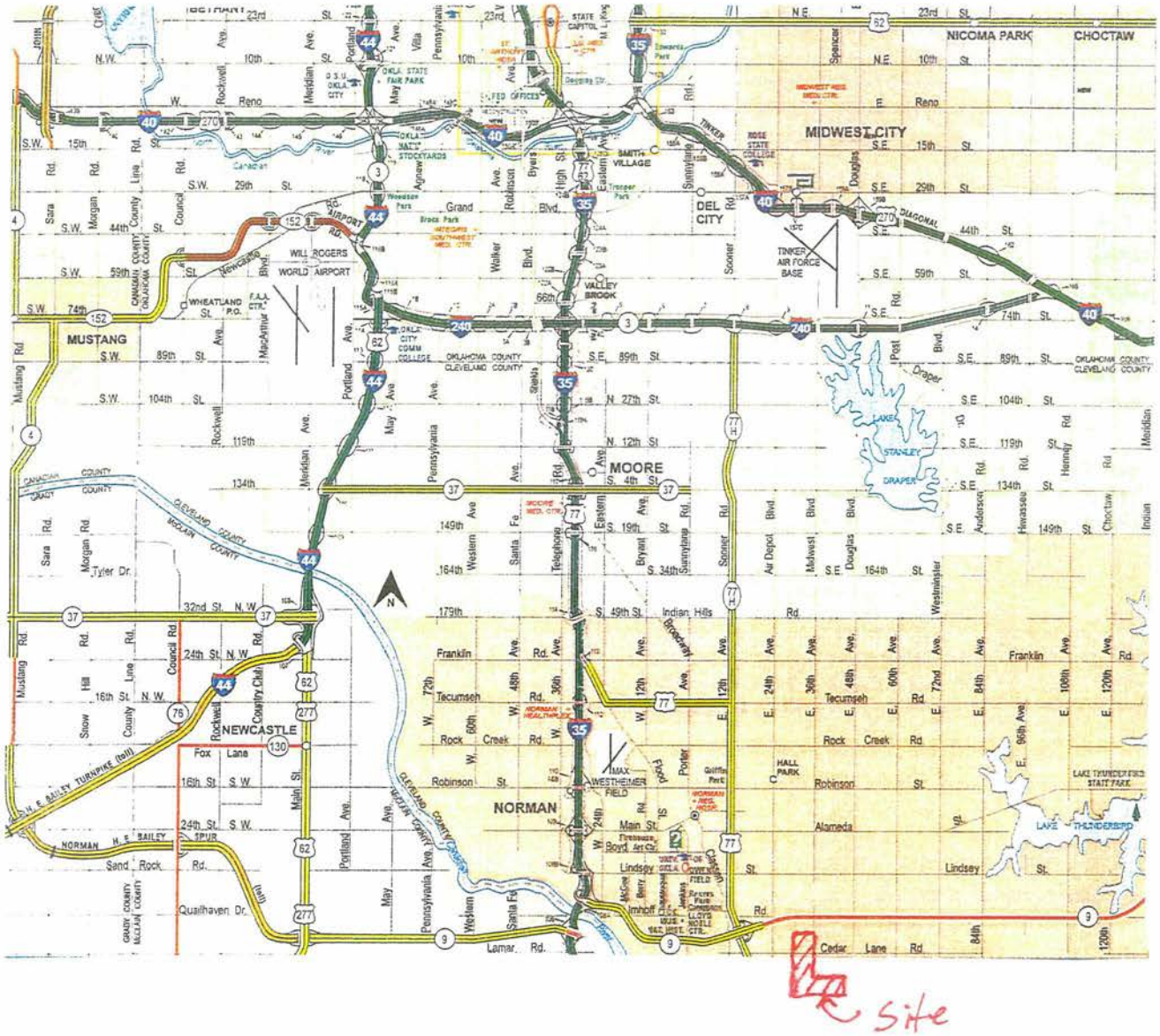


Figure 1, Location map.

Area A:

This area consists of several small drainage basins, including offsite areas. The entire area is considered undeveloped for purposes of this report.

Existing:

D.A. - 312.1 acres

53.4 acres,	CN - 58 Type B soil
205.4 acres,	CN - 71 Type C soil
53.3 acres,	CN - 78 Type D soil

See Appendix A for soil data and Exhibit A for Soil Type map.

Wt. CN - 70

Time of concentration (TR-55) -

Overland (range, meadow) - 300' at 1.17%	Tol- 24.09 min
Swale (grassed waterway) - 370' at 2.30%	Tsw- 2.71 min
Existing creek - 5,650' at 1.24%	Tcr- 36.00 min
	Tc - 62.80 min

Q2 - 163.3 cfs
Q100 - 776.5 cfs

See Appendix B, Area A for historic runoff calculations.

See Exhibit B for Historic Drainage Area map.

Proposed:

The proposed runoff is divided into several smaller drainage basins. See Proposed Drainage Area map, Exhibit C.

Area A.1-

Drainage Basin	A.1									
			Soil Types							
Land use			Type B			Type C			Type D		
			Acres	CN	Ac*CN	Acres	CN	Ac*CN	Acres	CN	Ac*CN
Mixed use	3.57	ac	0.00	92	0	3.57	94	336	0.00	95	0
Single family	6.90	ac	0.00	75	0	2.74	83	227	4.16	87	362
Open Space	1.16	ac	0.00	58	0	1.16	71	82	0.00	78	0
Offsite	11.30	ac	0.00	58	0	8.12	71	577	3.18	78	248
			0.00		0	15.59		1222	7.34		610
			Wt. CN			Wt. CN	78		Wt. CN	83	
							67.99%			32.01%	
Total -	22.93	ac									
Wt. CN -	80										

Time of concentration (TR-55) -

Overland (Bermuda grass) - 100′ at 1.00% Tol- 26.70 min
Street flow - 500′ at 1.50% Tst- 3.35 min
Pipe flow - 560′ at 0.50% Tpi- 1.40 min
Tc - 31.45 min

The proposed pond will be constructed on the north side of the existing creek. The areas and volumes used for this report are based on the pond outline as shown in Exhibit C. The outlet structure is a 42″ RCP with standard headwalls at a flow line of 1130.00 feet.

Table 1
Summary of detention Pond A.1

Storm (yrs)	Proposed Inflow Rate (cfs)	Pond Release Rate (cfs)	Storage Volume (Cu.Ft.)	Water Surface Elevation (ft)
2	30.3	22.1	34,541	1131.77
100	99.1	77.5	88,704	1134.55

The pond and calculations as provided in this report are conceptual in nature and will change when the final plat and construction documents are developed.

Adequate free-board will be provided at the final design stage.

Area A.2-

Drainage Basin	A.2									
			Soil Types							
Land use			Type B			Type C			Type D	
			Acres	CN	Ac*CN	Acres	CN	Ac*CN	Acres	CN	Ac*CN
Single family	27.10	ac	0.00	75	0	25.69	83	2132	1.41	87	123
Open Space	7.02	ac	0.00	58	0	6.79	71	482	0.23	78	18
Offsite	14.88	ac	0.00	58	0	14.63	71	1039	0.25	78	20
			0.00		0	47.11		3653	1.89		160
			Wt. CN			Wt. CN	78		Wt. CN	85	
							96.14%			3.86%	
Total -	49.00	ac									
Wt. CN -	78										

Time of concentration (TR-55) -

Overland (Bermuda grass) - 100' at 1.00% Tol- 26.70 min
Street flow - 270' at 0.75% Tst- 2.56 min
Pipe flow - 1,350 at 0.50% Tpi- 3.37 min
Tc - 32.63 min

The proposed pond will be constructed on the north side of the existing creek. The areas and volumes used for this report are based on the pond outline as shown in Exhibit C. The outlet structure is a 36" RCP with standard headwalls at a flow line of 1133.00 feet.

Table 2
Summary of detention Pond A.2

Storm (yrs)	Proposed Inflow Rate (cfs)	Pond Release Rate (cfs)	Storage Volume (Cu.Ft.)	Water Surface Elevation (ft)
2	58.0	9.8	153,099	1134.20
100	201.3	55.3	529,115	1137.14

The pond and calculations as provided in this report are conceptual in nature and will change when the final plat and construction documents are developed.

Adequate free-board will be provided at the final design stage.

Area A.3-

Drainage Basin	A.3									
			Soil Types							
Land use			Type B			Type C			Type D		
			Acres	CN	Ac*CN	Acres	CN	Ac*CN	Acres	CN	Ac*CN
Single family	14.00	ac	0.00	75	0	14.00	83	1162	0.00	87	0
			0.00		0	14.00		1162	0.00		0
			Wt. CN			Wt. CN	83		Wt. CN		
							100.00%			0.00%	
Total -	14.00	ac									
Wt. CN -	83										

Time of concentration (TR-55) -

Overland (Bermuda grass) - 100′ at 1.00% Tol- 26.70 min
Street flow - 980′ at 0.80% Tst- 9.00 min
Tc - 35.70 min

The proposed pond will be constructed on the north side of the existing creek. The areas and volumes used for this report are based on the pond outline as shown in Exhibit C. The outlet structure is a 30″ RCP with standard headwalls at a flow line of 1140.00 feet.

Table 3
Summary of detention Pond A.3

Storm (yrs)	Proposed Inflow Rate (cfs)	Pond Release Rate (cfs)	Storage Volume (Cu.Ft.)	Water Surface Elevation (ft)
2	19.6	12.8	29,214	1141.50
100	59.9	39.6	79,203	1144.06

The pond and calculations as provided in this report are conceptual in nature and will change when the final plat and construction documents are developed.

Adequate free-board will be provided at the final design stage.

Area A.4-

Drainage Basin	A.4									
			Soil Types							
Land use			Type B			Type C			Type D	
			Acres	CN	Ac*CN	Acres	CN	Ac*CN	Acres	CN	Ac*CN
Multi family	6.40	ac	1.47	75	110	4.93	83	409	0.00	87	0
Open Space	3.17	ac	0.00	58	0	3.17	71	225	0.00	78	0
Offsite	43.37	ac	13.33	58	773	17.31	71	1229	12.73	78	993
			14.80		883	25.41		1863	12.73		993
			Wt. CN	60		Wt. CN	73		Wt. CN	78	
				27.96%			48.00%			24.05%	
Total -	52.94	ac									
Wt. CN -	71										

Time of concentration (TR-55) -

Overland (bermuda) - 300' at 1.00% Tol- 64.29 min
Swale (grassed waterway) - 1,300' at 0.50% Tsw- 20.43 min
Existing creek - 1,100 at 0.50% Tcr- 7.85 min
Tc - 92.57 min

The existing pond will be modified and used for detention purposes. The areas and volumes used for this report are based on the pond outline as shown in Exhibit C. The outlet structure is a 36" RCP with standard headwalls at a flow line of 1138.00 feet.

Table 4
Summary of detention Pond A.4

Storm (yrs)	Proposed Inflow Rate (cfs)	Pond Release Rate (cfs)	Storage Volume (Cu.Ft.)	Water Surface Elevation (ft)
2	22.8	17.1	47,631	1141.50
100	106.1	63.0	250,959	1144.06

The pond and calculations as provided in this report are conceptual in nature and will change when the final plat and construction documents are developed.

Adequate free-board will be provided at the final design stage.

Area A.5-

Drainage Basin	A.5									
			Soil Types							
Land use			Type B			Type C			Type D	
			Acres	CN	Ac*CN	Acres	CN	Ac*CN	Acres	CN	Ac*CN
Multi family	5.00	ac	0.90	75	68	4.10	83	340	0.00	87	0
			0.90		68	4.10		340	0.00		0
			Wt. CN	75		Wt. CN	83		Wt. CN		
				18.00%			82.00%			0.00%	
Total -	5.00	ac									
Wt. CN -	82										

Time of concentration (TR-55) -

Overland (bermuda) - 50' at 1.00% Tol- 15.33 min
Street - 600 at 1.00% Tsw- 4.93 min
Tc - 20.26 min

The proposed pond will be constructed on the west side of the existing creek. The areas and volumes used for this report are based on the pond outline as shown in Exhibit C. The outlet structure is an 18" RCP with standard headwalls at a flow line of 1145.00 feet.

Table 5
Summary of detention Pond A.5

Storm (yrs)	Proposed Inflow Rate (cfs)	Pond Release Rate (cfs)	Storage Volume (Cu.Ft.)	Water Surface Elevation (ft)
2	9.0	2.8	15,261	1145.78
100	27.0	10.7	45,291	1147.32

The pond and calculations as provided in this report are conceptual in nature and will change when the final plat and construction documents are developed.

Adequate free-board will be provided at the final design stage.

Area A.6-

Drainage Basin			A.6								
			Soil Types								
Land use			Type B			Type C			Type D		
			Acres	CN	Ac*CN	Acres	CN	Ac*CN	Acres	CN	Ac*CN
Patio homes	14.24	ac	3.35	85	285	7.30	90	657	3.59	92	330
Single family	24.09	ac	22.11	75	1658	1.51	83	125	0.47	87	41
Commercial	3.49	ac	0.00	92	0	2.57	94	242	0.92	95	87
Multi family	29.87	ac	10.27	75	770	15.64	83	1298	3.96	87	345
Open Space	15.35	ac	1.72	58	100	2.71	71	192	10.92	78	852
			37.45		2813	29.73		2514	19.86		1655
			Wt. CN	75		Wt. CN	85		Wt. CN	83	
				43.03%			34.16%			22.82%	
Total -	87.04	ac									
Wt. CN -	80										

Time of concentration (TR-55) -

Overland (Bermuda grass) - 100' at 1.00% Tol- 26.70 min
Street flow - 810' at 2.00% Tst- 4.70 min
Existing creek - 2,100 at 1.24% Tpi- 13.38 min
Tc - 44.78 min

The existing pond will be modified and used for detention purposes. The areas and volumes used for this report are based on the pond outline as shown in Exhibit C. The outlet structure is a 36" RCP with standard headwalls at a flow line of 1140.00 feet.

Table 6
Summary of detention Pond A.6

Storm (yrs)	Proposed Inflow Rate (cfs)	Pond Release Rate (cfs)	Storage Volume (Cu.Ft.)	Water Surface Elevation (ft)
2	94.5	39.7	210,286	1142.84
100	317.8	85.0	882,104	1147.73

The pond and calculations as provided in this report are conceptual in nature and will change when the final plat and construction documents are developed.

Adequate free-board will be provided at the final design stage.

Area A.7-

Drainage Basin	A.7									
			Soil Types							
Land use			Type B			Type C			Type D		
			Acres	CN	Ac*CN	Acres	CN	Ac*CN	Acres	CN	Ac*CN
Mixed use	5.23	ac	0.00	92	0	3.11	94	292	2.12	95	201
Multi family	8.77	ac	0.00	75	0	6.21	83	515	2.56	87	223
Open Space	0.35	ac	0.00	58	0	0.35	71	25	0.00	78	0
			0.00		0	9.67		833	4.68		424
			Wt. CN			Wt. CN	86		Wt. CN	91	
				0.00%			67.39%			32.61%	
Total -	14.35	ac									
Wt. CN -	88										

Time of concentration (TR-55) -

Overland (bermuda) - 100' at 1.00%
Street - 625 at 2.00%

Tol- 26.70 min
Tsw- 3.63 min
Tc - 30.33 min

The proposed pond will be constructed on the east side of the existing creek. The areas and volumes used for this report are based on the pond outline as shown in Exhibit C. The outlet structure is a 36" RCP with standard headwalls at a flow line of 1145.00 feet.

Table 7
Summary of detention Pond A.7

Storm (yrs)	Proposed Inflow Rate (cfs)	Pond Release Rate (cfs)	Storage Volume (Cu.Ft.)	Water Surface Elevation (ft)
2	26.4	18.3	33,154	1146.70
100	70.5	51.6	74,081	1148.80

The pond and calculations as provided in this report are conceptual in nature and will change when the final plat and construction documents are developed.

Adequate free-board will be provided at the final design stage.

Area A.8-

Drainage Basin	A.8									
			Soil Types							
Land use			Type B			Type C			Type D	
			Acres	CN	Ac*CN	Acres	CN	Ac*CN	Acres	CN	Ac*CN
Single family	19.29	ac	0.00	75	0	19.05	83	1581	0.24	87	21
Open Space	4.59	ac	0.00	58	0	2.86	71	203	1.73	78	135
Offsite	4.59	ac	0.00	58	0	3.43	71	244	1.16	78	90
			0.00		0	25.34		2028	3.13		246
			Wt. CN			Wt. CN	80		Wt. CN	79	
							89.01%			10.99%	
Total -	28.47	ac									
Wt. CN -	80										

Time of concentration (TR-55) -

Overland (bermuda) - 100' at 1.00%
Street - 790 at 2.00%

Tol- 26.70 min
Tsw- 4.59 min
Tc - 31.29 min

The proposed pond will be constructed on the south side of the existing creek. The areas and volumes used for this report are based on the pond outline as shown in Exhibit C. The outlet structure is a 36" RCP with standard headwalls at a flow line of 1125.00 feet.

Table 8
Summary of detention Pond A.8

Storm (yrs)	Proposed Inflow Rate (cfs)	Pond Release Rate (cfs)	Storage Volume (Cu.Ft.)	Water Surface Elevation (ft)
2	37.8	4.4	106,607	1125.78
100	123.5	33.6	338,103	1127.49

The pond and calculations as provided in this report are conceptual in nature and will change when the final plat and construction documents are developed.

Adequate free-board will be provided at the final design stage.

Common Area-

Drainage Basin	Common Area									
			Soil Types							
Land use			Type B			Type C			Type D	
			Acres	CN	Ac*CN	Acres	CN	Ac*CN	Acres	CN	Ac*CN
Common Area	37.18	ac	0.00	58	0	34.06	71	2418	3.12	78	243
			0.00		0	34.06		2418	3.12		243
			Wt. CN			Wt. CN	71		Wt. CN	78	
				0.00%			91.61%			8.39%	
Total -	37.18	ac									
Wt. CN -	72										

Time of concentration (TR-55) -

Overland (short meadow) - 100' at 2.00%
Ex. creek - 3,200 at 1.00%

Tol- 9.05 min
Tsw- 21.16 min
Tc - 30.21 min

Total discharge from post developed Area A-

The discharges from each individual drainage basin are combined to give the total runoff from post development.

Table 9
Summary of runoffs from Area A

Storm (yrs)	*Historic flows (cfs)*	Pond A.1 release (cfs)	Pond A.2 release (cfs)	Pond A.3 release (cfs)	Pond A.4 release (cfs)	Pond A.5 release (cfs)	Pond A.6 release (cfs)	Pond A.7 release (cfs)	Pond A.8 release (cfs)	Pond CA release (cfs)	**Total flow from site (cfs)**
2	*163.3*	22.1	9.8	12.8	17.1	2.8	39.7	18.3	4.4	33.4	**119.8**
100	*776.5*	44.5	55.3	39.6	63.0	10.7	85.0	51.6	33.6	139.9	**454.2**

See Appendix B, Area A for proposed runoff calculations.

See Exhibit C for Proposed Drainage Area map.

Area B:

This area consists of several small drainage basins, including offsite areas. The entire area is considered undeveloped for purposes of this report.

Existing:

D.A. - 122.1 acres

18.6 acres,	CN - 58 Type B soil
57.4 acres,	CN - 71 Type C soil
46.1 acres,	CN - 78 Type D soil

See Appendix A for soil data and Exhibit A for Soil Type map.

Wt. CN - 72

Time of concentration (TR-55) -

Overland (range, meadow) - 300' at 1.00% Tol- 25.65 min
Existing creek - 3,181 at 2.17% Tcr- 15.32 min
Tc - 40.97 min

Q2 - 93.1 cfs
Q100 - 399.2 cfs

See Appendix C for Area B historic runoff calculations.

See Exhibit B for Historic Drainage Area map.

Proposed:

This basin includes an area bypassing the pond. See Proposed Drainage Area map, Exhibit C.

Area B-

Drainage Basin	B									
			Soil Types							
Land use			Type B			Type C			Type D	
			Acres	CN	Ac*CN	Acres	CN	Ac*CN	Acres	CN	Ac*CN
Patio homes	11.68	ac	3.35	85	285	4.52	90	407	3.81	92	351
Single family	23.00	ac	9.40	75	705	6.22	83	516	7.38	87	642
Commercial	4.87	ac	0.00	92	0	3.21	94	302	1.66	95	158
Multi family	10.19	ac	0.00	75	0	7.32	83	608	2.87	87	250
Open Space	29.36	ac	5.55	58	322	18.22	71	1294	5.59	78	436
Offsite	21.29	ac	0.00	58	0	12.19	71	865	9.10	78	710
Service	9.41	ac	0.00	88	0	6.33	91	576	3.08	93	286
			18.30		1312	58.01		4568	33.49		2832
			Wt. CN	72		Wt. CN	79		Wt. CN	85	
				16.67%			52.83%			30.50%	
Total -	109.80	ac									
Wt. CN -	79										

Time of concentration (TR-55) -

Overland (Bermuda grass) - 100' at 1.00% Tol- 26.70 min
Street flow - 200' at 1.00% Tst- 1.81 min
Existing creek - 3,181' at 2.17% Tpi- 15.32 min
Tc - 43.83 min

The existing pond will be modified and used for detention purposes. The areas and volumes used for this report are based on the pond outline as shown in Exhibit C. The outlet structure is a 36" RCP with standard headwalls at a flow line of 1133.00 feet.

Table 10
Summary of detention Pond B

Storm (yrs)	Proposed Inflow Rate (cfs)	Pond Release Rate (cfs)	Storage Volume (Cu.Ft.)	Water Surface Elevation (ft)
2	137.0	37.7	389,237	1135.71
100	425.3	91.9	1,370,720	1141.78

The pond and calculations as provided in this report are conceptual in nature and will change when the final plat and construction documents are developed.

Adequate free-board will be provided at the final design stage.

Bypass (Commercial) -

Commercial not to pond

		Type B			Type C			Type D		
		Acres	CN	Ac*CN	Acres	CN	Ac*CN	Acres	CN	Ac*CN
	12.79 ac	0.00	92	0	12.63	94	1187	0.16	95	15
Total -	12.79 ac									
Wt. CN -	94									

Time of concentration (TR-55) -

Overland (commercial) - Tol- 15.00 min

Tc - 15.00 min

Table 11
Summary of runoffs from Area B

Storm (yrs)	*Historic flows (cfs)*	Pond B release (cfs)	Bypass flow (cfs)	**Total flow from site (cfs)**
2	*93.1*	37.7	40.4	**42.6**
100	*399.2*	91.9	89.2	**123.8**

See Appendix C for Area B and Bypass area proposed runoff calculations.

See Exhibit C for Proposed Drainage Area map.

Area C:

The entire area is considered undeveloped for purposes of this report.

Existing:

D.A. - 51.1 acres

40.8 acres,	CN - 58 Type B soil
10.3 acres,	CN - 71 Type C soil

See Appendix A for soil data and Exhibit A for Soil Type map.

Wt. CN - 61

Time of concentration (TR-55) -

Overland (range, meadow) - 300' at 1.67%	Tol- 20.89 min
Swale flow - 200' at 5.00%	Tst- 2.13 min
Existing creek - 3,181 at 2.17%	Tcr- 11.85 min
	Tc - 34.87 min

Q2 - 18.4 cfs
Q100 - 133.5 cfs

See Appendix D for Area C historic runoff calculations.

See Exhibit B for Historic Drainage Area map.

Proposed:

See Proposed Drainage Area map, Exhibit C.

Area C-

Drainage Basin C

Land use			Soil Types: Type B Acres	Type B CN	Type B Ac*CN	Type C Acres	Type C CN	Type C Ac*CN	Type D Acres	Type D CN	Type D Ac*CN
Single family	39.12	ac	35.27	75	2645	3.85	83	320	0.00	87	0
Open Space	12.00	ac	5.54	58	321	6.46	71	459	0.00	78	0
			40.81		2967	10.31		778	0.00		0
			Wt. CN	73		Wt. CN	75		Wt. CN		
				79.83%			20.17%			0.00%	
Total -	51.12	ac									
Wt. CN -	73										

Time of concentration (TR-55) -

Overland (Bermuda grass) - 100' at 1.00% Tol- 26.70 min
Street flow - 300' at 5.00% Tst- 1.10 min
Existing creek - 1,400' at 3.20% Tpi- 5.55 min
Tc - 33.35 min

The proposed pond will be constructed as part of the existing creek. The areas and volumes used for this report are based on the pond outline as shown in Exhibit C. The outlet structure is a 30" RCP with standard headwalls at a flow line of 1140.00 feet.

Table 12
Summary of detention Pond C

Storm (yrs)	Historic runoff (cfs)	Proposed Inflow Rate (cfs)	Pond Release Rate (cfs)	Storage Volume (Cu.Ft.)	Water Surface Elevation (ft)
2	18.4	46.0	13.6	99,765	1141.55
100	133.5	187.8	45.4	470,559	1144.94

The pond and calculations as provided in this report are conceptual in nature and will change when the final plat and construction documents are developed.

Adequate free-board will be provided at the final design stage.

See Appendix D for Area C proposed runoff calculations.

See Exhibit C for Proposed Drainage Area map.

Area D:

This area consists of several small drainage basins, including offsite areas. The entire area is considered undeveloped for purposes of this report.

Existing:

D.A. - 96.1 acres

37.9 acres,	CN - 58 Type B soil
15.5 acres,	CN - 71 Type C soil
42.7 acres,	CN - 78 Type D soil

See Appendix A for soil data and Exhibit A for Soil Type map.

Wt. CN - 69

Time of concentration (TR-55) -

Overland (range, meadow) - 300' at 2.00%	Tol- 19.44 min
Existing creek - 2,381 at 2.02%	Tcr- 11.89 min
	Tc - 31.33 min

Q2 - 70.3 cfs
Q100 - 331.8 cfs

See Appendix E for Area D historic runoff calculations.

See Exhibit B for Historic Drainage Area map.

Proposed:

The proposed runoff is divided into several smaller drainage basins. See Proposed Drainage Area map, Exhibit C.

Area D.1-

Drainage Basin	D.1									
			Soil Types							
Land use			Type B			Type C			Type D	
			Acres	CN	Ac*CN	Acres	CN	Ac*CN	Acres	CN	Ac*CN
Single family	40.22	ac	28.28	75	2121	0.21	83	17	11.73	87	1021
Open Space	9.70	ac	9.70	58	563	0.00	71	0	0.00	78	0
			37.98		2684	0.21		17	11.73		1021
			Wt. CN	71		Wt. CN	83		Wt. CN	87	
				76.08%			0.42%			23.50%	
Total -	49.92	ac									
Wt. CN -	75										

Time of concentration (TR-55) -

Overland (Bermuda grass) - 100' at 1.00% Tol- 26.70 min
Street flow - 2,100' at 1.00% Tst- 17.24 min
Tc - 43.94 min

The proposed pond will be constructed on the west side of the existing creek. The areas and volumes used for this report are based on the pond outline as shown in Exhibit C. The outlet structure is a 30" RCP with standard headwalls at a flow line of 1155.00 feet.

Table 13
Summary of detention Pond D.1

Storm (yrs)	Proposed Inflow Rate (cfs)	Pond Release Rate (cfs)	Storage Volume (Cu.Ft.)	Water Surface Elevation (ft)
2	43.2	3.1	172,010	1155.69
100	168.6	25.8	612,641	1157.43

The pond and calculations as provided in this report are conceptual in nature and will change when the final plat and construction documents are developed.

Adequate free-board will be provided at the final design stage.

Area D.2-

Drainage Basin	D.2									
			Soil Types							
Land use			Type B			Type C			Type D	
			Acres	CN	Ac*CN	Acres	CN	Ac*CN	Acres	CN	Ac*CN
Patio homes	19.90	ac	0.00	85	0	4.08	90	367	15.82	92	1455
Commercial	5.74	ac	0.00	92	0	1.28	94	120	4.46	95	424
			0.00		0	5.36		488	20.28		1879
			Wt. CN			Wt. CN	91		Wt. CN	93	
				0.00%			20.90%			79.10%	
Total -	25.64	ac									
Wt. CN -	92										

Time of concentration (TR-55) -

Overland (Bermuda grass) - 100′ at 1.00% Tol- 26.70 min
Street flow - 850′ at 2.00% Tst- 4.93 min
Tc - 31.63 min

The proposed pond will be constructed on the east side of the existing creek. The areas and volumes used for this report are based on the pond outline as shown in Exhibit C. The outlet structure is a 30″ RCP with standard headwalls at a flow line of 1160.00 feet.

Table 14
Summary of detention Pond D.2

Storm (yrs)	Proposed Inflow Rate (cfs)	Pond Release Rate (cfs)	Storage Volume (Cu.Ft.)	Water Surface Elevation (ft)
2	52.4	9.0	155,165	1161.22
100	128.6	31.2	388,195	1162.99

The pond and calculations as provided in this report are conceptual in nature and will change when the final plat and construction documents are developed.

Adequate free-board will be provided at the final design stage.

Open space-

Open space not to pond

			Type B			Type C			Type D		
			Acres	CN	Ac*CN	Acres	CN	Ac*CN	Acres	CN	Ac*CN
Open space	16.33	ac	1.02	58	59	9.80	71	696	5.51	78	430
Total -	16.33	ac									
Wt. CN -	69										

Time of concentration (TR-55) -

Overland (Bermuda) - 50′ at 1.00% Tol- 15.33 min
Ex. creek - 2,225 at 1.50% Tsw- 12.01 min
Tc - 27.34 min

Table 15
Summary of runoffs from Area D

Storm (yrs)	*Historic flows (cfs)*	Pond D.1 release (cfs)	Pond D.2 release (cfs)	Open space flow (cfs)	**Total flow from site (cfs)**
2	*70.3*	3.1	9.0	12.8	**16.6**
100	*331.8*	25.1	31.2	59.9	**84.5**

See Appendix E for Area C proposed runoff calculations.

See Exhibit C for Proposed Drainage Area map.

Area E:

The entire area is considered undeveloped for purposes of this report.

Existing:

D.A. - 34.2 acres

14.8 acres,	CN - 71 Type C soil
19.4 acres,	CN - 78 Type D soil

See Appendix A for soil data and Exhibit A for Soil Type map.

Wt. CN - 75

Time of concentration (TR-55) -

Overland (range, meadow) - 300' at 1.67%	Tol- 20.89 min
Swale flow - 150' at 2.67%	Tst- 2.19 min
Existing creek - 880 at 3.41%	Tcr- 3.38 min
	Tc - 26.46 min

Q2 - 38.8 cfs
Q100 - 145.5 cfs

See Appendix F for Area C historic runoff calculations.

See Exhibit B for Historic Drainage Area map.

Proposed:

See Proposed Drainage Area map, Exhibit C.

Area E-

Drainage Basin	E									
			Soil Types							
Land use			Type B			Type C			Type D	
			Acres	CN	Ac*CN	Acres	CN	Ac*CN	Acres	CN	Ac*CN
Commercial	11.00	ac	0.00	92	0	1.21	94	114	9.79	95	930
Multi family	11.82	ac	0.00	75	0	9.45	83	784	2.37	87	206
Open Space	1.72	ac	0.00	58	0	0.34	71	24	1.38	78	108
			0.00		0	11.00		922	13.54		1244
			Wt. CN			Wt. CN	84		Wt. CN	92	
				0.00%			44.82%			55.18%	
Total -	24.54	ac									
Wt. CN -	88										

Time of concentration (TR-55) -

Overland (Bermuda grass) - 50' at 1.00% Tol- 15.33 min
Parking - 725' at 2.00% Tst- 4.21 min
Tc - 19.54 min

The proposed pond will be constructed on the north side of Post Oak Road. The areas and volumes used for this report are based on the pond outline as shown in Exhibit C. The outlet structure is a 30" RCP with standard headwalls at a flow line of 1154.00 feet.

Table 16
Summary of detention Pond E

Storm (yrs)	Historic runoff (cfs)	Proposed Inflow Rate (cfs)	Pond Release Rate (cfs)	Storage Volume (Cu.Ft.)	Water Surface Elevation (ft)
2	38.8	57.0	27.2	69,434	1157.57
100	145.5	146.0	56.4	211,485	1161.94

The pond and calculations as provided in this report are conceptual in nature and will change when the final plat and construction documents are developed.

Adequate free-board will be provided at the final design stage.

See Appendix F for Area E proposed runoff calculations.

See Exhibit C for Proposed Drainage Area map.

Area F:

This area consists of several small drainage basins, including offsite areas. The entire area is considered undeveloped for purposes of this report.

Existing:

D.A. - 215.4 acres

10.5 acres,	CN - 58 Type B soil
156.3 acres,	CN - 71 Type C soil
48.6 acres,	CN - 78 Type D soil

See Appendix A for soil data and Exhibit A for Soil Type map.

Wt. CN - 72

Time of concentration (TR-55) -

Overland (range, meadow) - 300' at 1.67%	Tol- 20.89 min
Swale (pasture, meadow) - 200' at 3.00%	Tsw- 2.75 min
Existing creek - 4,600' at 1.98%	Tcr- 23.19 min
	Tc - 46.83 min

Q2 - 152.4 cfs
Q100 - 659.0 cfs

See Appendix G for Area F historic runoff calculations.

See Exhibit B for Historic Drainage Area map.

Proposed:

The proposed runoff is divided into several smaller drainage basins. See Proposed Drainage Area map, Exhibit C.

Area F.1-

Drainage Basin	F.1									
			Soil Types							
Land use			Type B			Type C			Type D	
			Acres	CN	Ac*CN	Acres	CN	Ac*CN	Acres	CN	Ac*CN
Single family	29.71	ac	0.00	75	0	14.34	83	1190	15.37	87	1337
Multi family	7.38	ac	0.00	75	0	3.19	83	265	4.19	87	365
Open Space	5.42	ac	0.00	58	0	5.20	71	369	0.22	78	17
Offsite	7.72	ac	0.00	58	0	0.00	71	0	7.72	78	602
			0.00		0	22.73		1824	27.50		2321
			Wt. CN			Wt. CN	80		Wt. CN	84	
				0.00%			45.25%			54.75%	
Total -	50.23	ac									
Wt. CN -	83										

Time of concentration (TR-55) -

Overland (Bermuda grass) - 100′ at 1.00% Tol- 26.70 min
Street flow - 850′ at 2.00% Tst- 4.93 min
Tc - 31.63 min

The existing pond will be modified and used for detention purposes. The areas and volumes used for this report are based on the pond outline as shown in Exhibit C. The outlet structure is a 24″ RCP with standard headwalls at a flow line of 1154.00 feet.

Table 17
Summary of detention Pond F.1

Storm (yrs)	Proposed Inflow Rate (cfs)	Pond Release Rate (cfs)	Storage Volume (Cu.Ft.)	Water Surface Elevation (ft)
2	75.2	24.1	148,007	1157.55
100	227.0	44.8	575,473	1163.78

The pond and calculations as provided in this report are conceptual in nature and will change when the final plat and construction documents are developed.

Adequate free-board will be provided at the final design stage.

Area F.2-

Drainage Basin	F.2									
			Soil Types							
Land use			Type B			Type C			Type D	
			Acres	CN	Ac*CN	Acres	CN	Ac*CN	Acres	CN	Ac*CN
Single family	10.49	ac	0.00	75	0	4.16	83	345	6.33	87	551
Multi family	21.66	ac	0.00	75	0	18.49	83	1535	3.17	87	276
Open Space	11.00	ac	0.00	58	0	9.60	71	682	1.40	78	109
			0.00		0	32.25		2562	10.90		936
			Wt. CN			Wt. CN	79		Wt. CN	86	
				0.00%			74.74%			25.26%	
Total -	43.15	ac									
Wt. CN -	81										

Time of concentration (TR-55) -

Overland (Bermuda grass) - 100' at 1.00% Tol- 26.70 min
Street flow - 435' at 2.00% Tst- 2.53 min
Existing creek - 1,115 at 1.50% Tpi- 6.02 min
Tc - 35.25 min

The proposed pond will be constructed as part of the existing creek. The areas and volumes used for this report are based on the pond outline as shown in Exhibit C. The outlet structure is a 36" RCP with standard headwalls at a flow line of 1133.00 feet.

Inflow to Pond F.2 includes the controlled release from Pond F.1.

Table 18
Summary of detention Pond F.2

Storm (yrs)	Proposed Inflow Rate (cfs)	Pond Release Rate (cfs)	Storage Volume (Cu.Ft.)	Water Surface Elevation (ft)
2	75.0	48.6	109,117	1134.20
100	216.3	99.5	416,476	1137.14

The pond and calculations as provided in this report are conceptual in nature and will change when the final plat and construction documents are developed.

Adequate free-board will be provided at the final design stage.

Area F.3-

Drainage Basin	F.3									
			Soil Types							
Land use			Type B			Type C			Type D		
			Acres	CN	Ac*CN	Acres	CN	Ac*CN	Acres	CN	Ac*CN
Single family	43.05	ac	3.13	75	235	39.92	83	3313	0.00	87	0
Open Space	6.10	ac	0.41	58	24	5.69	71	404	0.00	78	0
			3.54		259	45.61		3717	0.00		0
			Wt. CN	73		Wt. CN	82		Wt. CN		
				7.20%			92.80%			0.00%	
Total -	49.15	ac									
Wt. CN -	81										

Time of concentration (TR-55) -

Overland (Bermuda grass) - 50′ at 1.00% Tol- 15.33 min
Existing creek - 1,650′ at 2.50% Tst- 6.90 min
Tc - 22.23 min

The proposed pond will be constructed on the east side of the existing creek. The areas and volumes used for this report are based on the pond outline as shown in Exhibit C. The outlet structure is a 42″ RCP with standard headwalls at a flow line of 1125.00 feet.

Table 19
Summary of detention Pond F.3

Storm (yrs)	Proposed Inflow Rate (cfs)	Pond Release Rate (cfs)	Storage Volume (Cu.Ft.)	Water Surface Elevation (ft)
2	81.7	48.4	86,202	1127.86
100	252.2	117.0	321,854	1133.12

The pond and calculations as provided in this report are conceptual in nature and will change when the final plat and construction documents are developed.

Adequate free-board will be provided at the final design stage.

Area F.4-

Drainage Basin	F.4									
			Soil Types							
Land use			Type B			Type C			Type D	
			Acres	CN	Ac*CN	Acres	CN	Ac*CN	Acres	CN	Ac*CN
Single family	24.64	ac	5.21	75	391	19.43	83	1613	0.00	87	0
Open Space	1.20	ac	0.21	58	12	0.99	71	70	0.00	78	0
			5.42		403	20.42		1683	0.00		0
			Wt. CN	74		Wt. CN	82		Wt. CN		
				20.98%			79.02%			0.00%	
Total -	25.84	ac									
Wt. CN -	81										

Time of concentration (TR-55) -

Overland (bermuda) - 100' at 1.00% Tol- 26.70 min
Street flow - 750 at 2.00% Tsw- 4.35 min
Existing creek - 1,100 at 0.50% Tcr- 7.85 min
Tc - 38.90 min

The existing pond will be modified and used for detention purposes. The areas and volumes used for this report are based on the pond outline as shown in Exhibit C. The outlet structure is an 18" RCP with standard headwalls at a flow line of 1115.00 feet.

Table 20
Summary of detention Pond F.4

Storm (yrs)	Proposed Inflow Rate (cfs)	Pond Release Rate (cfs)	Storage Volume (Cu.Ft.)	Water Surface Elevation (ft)
2	31.8	5.2	95,769	1141.50
100	102.9	14.8	351,007	1144.06

The pond and calculations as provided in this report are conceptual in nature and will change when the final plat and construction documents are developed.

Adequate free-board will be provided at the final design stage.

Area F.5-

Drainage Basin F.5

Land use			Soil Types: Type B Acres	Type B CN	Type B Ac*CN	Type C Acres	Type C CN	Type C Ac*CN	Type D Acres	Type D CN	Type D Ac*CN
Single family	22.60	ac	0.00	75	0	3.97	83	330	18.63	87	1621
			0.00		0	3.97		330	18.63		1621
			Wt. CN			Wt. CN	83		Wt. CN	87	
				0.00%			17.57%			82.43%	
Total -	22.60	ac									
Wt. CN -	86										

Time of concentration (TR-55) -

Overland (bermuda) - 100' at 1.00%
Street - 1,125 at 2.00%

Tol- 26.70 min
Tsw- 6.53 min
Tc - 33.23 min

The proposed pond will be constructed on the west side of the existing creek. The areas and volumes used for this report are based on the pond outline as shown in Exhibit C. The outlet structure is a 30" RCP with standard headwalls at a flow line of 1120.00 feet.

Table 21
Summary of detention Pond F.5

Storm (yrs)	Proposed Inflow Rate (cfs)	Pond Release Rate (cfs)	Storage Volume (Cu.Ft.)	Water Surface Elevation (ft)
2	37.0	3.8	116,269	1120.77
100	104.1	22.1	329,765	1122.12

The pond and calculations as provided in this report are conceptual in nature and will change when the final plat and construction documents are developed.

Adequate free-board will be provided at the final design stage.

Common Area-

Drainage Basin	Common Area									
			Soil Types							
Land use			Type B			Type C			Type D	
			Acres	CN	Ac*CN	Acres	CN	Ac*CN	Acres	CN	Ac*CN
Common Area	38.91	ac	3.38	58	196	31.38	71	2228	4.15	78	324
			3.38		196	31.38		2228	4.15		324
			Wt. CN			Wt. CN	71		Wt. CN	78	
				8.69%			80.65%			10.67%	
Total -	38.91	ac									
Wt. CN -	66										

Time of concentration (TR-55) -

Overland (short meadow) - 100' at 2.00%
Existing creek - 3,175 at 0.75%

Tol- 9.05 min
Tsw- 24.25 min
Tc - 33.30 min

Total discharge from post developed Area F-

The discharges from each individual drainage basin are combined to give the total runoff from post development.

Table 22
Summary of runoffs from Area F

Storm (yrs)	*Historic flows (cfs)*	Pond F.1 release (cfs)	Pond F.2 release (cfs)	Pond F.3 release (cfs)	Pond F.4 release (cfs)	Pond F.5 release (cfs)	Pond CA release (cfs)	**Total flow from site (cfs)**
2	*152.4*	24.1	48.6	48.4	5.2	3.8	33.4	**115.3**
100	*659.0*	44.8	99.5	117.0	14.8	22.1	139.9	**339.3**

See Appendix G for Area F proposed runoff calculations.

See Exhibit C for Proposed Drainage Area map.

Area G:

The entire area is considered undeveloped for purposes of this report.

Existing:

D.A. - 87.5 acres

42.3 acres, CN - 71 Type C soil
45.2 acres, CN - 78 Type D soil

See Appendix A for soil data and Exhibit A for Soil Type map.

Wt. CN - 75

Time of concentration (TR-55) -

Overland (range, meadow) - 300' at 4.67%	Tol- 13.85 min
Swale flow - 255' at 9.40%	Tst- 1.98 min
Existing creek - 2,420 at 1.86%	Tcr- 12.59 min
	Tc - 28.42 min

Q2 - 95.6 cfs
Q100 - 360.5 cfs

See Appendix H for Area G historic runoff calculations.

See Exhibit B for Historic Drainage Area map.

Proposed:

See Proposed Drainage Area map, Exhibit C.

Area G-

Drainage Basin			G								
			Soil Types								
Land use			Type B			Type C			Type D		
			Acres	CN	Ac*CN	Acres	CN	Ac*CN	Acres	CN	Ac*CN
Single family	22.91	ac	0.00	75	0	16.92	83	1404	5.99	87	521
Open Space	7.23	ac	0.00	58	0	0.82	71	58	6.41	78	500
Offsite	57.44	ac	0.00	58	0	24.60	71	1747	32.84	78	2562
			0.00		0	42.34		3209	45.24		3583
			Wt. CN			Wt. CN	76		Wt. CN	79	
				0.00%			48.34%			51.66%	
Total -	87.58	ac									
Wt. CN -	78										

Time of concentration (TR-55) -

Overland (range, meadow) - 300' at 2.00% Tol- 19.44 min
Swale flow - 500 at 2.00% Tsw- 3.66 min
Existing creek - 1,150 at 1.50% Tcr- 6.66 min
Tc - 29.76 min

The proposed pond will be constructed on the north side of Post Oak Road. The areas and volumes used for this report are based on the pond outline as shown in Exhibit C. The outlet structure is a 30" RCP with standard headwalls at a flow line of 1154.00 feet.

Table 23
Summary of detention Pond G

Storm (yrs)	Historic runoff (cfs)	Proposed Inflow Rate (cfs)	Pond Release Rate (cfs)	Storage Volume (Cu.Ft.)	Water Surface Elevation (ft)
2	95.6	109	41.4	203,861	1128.57
100	360.5	375.9	123.0	788,595	1134.80

The pond and calculations as provided in this report are conceptual in nature and will change when the final plat and construction documents are developed.

Adequate free-board will be provided at the final design stage.

See Appendix H for Area G proposed runoff calculations.

See Exhibit C for Proposed Drainage Area map.

WQPZ:

Part of the lies within the Little River drainage basin thus falls under the recently adopted City of Norman Water Quality Protection Zone (WQPZ) ordinance.

As part of the water quality control measures to be used when final plans are developed will be "wet" detention ponds, "dry" extended detention ponds, grassed drainage swales and bio-swales/forebays, just to mention a few.

The target removal rate for Total Suspended Solids (TSS) is 80% (reference the City of Wichita/Sedgwick County Storm Water manual).

When using engineered solution, the target removal rates for Phosphorus (P) is 58% and Nitrogen (N) is 75% (reference the City of Norman WQPZ ordinance).

Pollutant removal:

Pollutants, such as Phosphorus (P), Nitrogen (N) and heavy metals are being reduced by using storm water ponds, grass lined channels and bio-swales/forebays.

Please refer to Appendix I for Pollutant Removal table.

The "example" treatment train will consist of a wet pond, a grass swale, in line bio-swales and forebays discharging to the existing creek.

Controls in series for pollutant removal efficiencies:

$TSS_{AB} = TSS_A + TSS_B - (TSS_A * TSS_B)/100$, where

A - wet pond
B - grass channel

Only two controls in series can be calculated at one time.

Where,

TSS_{AB} = total TSS removal for series (%)

TSS_A = %TSS removal of the wet pond - 80%
TSS_B = %TSS removal of the grass channel - 50%

$TSS_{AB} = 80 + 50 - (80 * 50)/100 = 90.0\%$

Same calculations can be used for Phosphorus (P) and Nitrogen (N)

Phosphorous:

P_{AB} = total P removal for series (%)
P_A = %P removal of the wet pond - 55%
P_B = %P removal of the grass channel - 25%

$P_{AB} = 55 + 25 - (55 * 25)/100 = 66.25\%$

Nitrogen:

N_{AB} = total N removal for series (%)
N_A = %N removal of the wet pond - 30%
N_B = %N removal of the grass channel - 20%

$N_{AB} = 30 + 20 - (30 * 20)/100 = 44.0\%$

First, Second and Third trains in series:

Even though there are several bio-swales and forebays proposed, they will be considered as one in the treatment train.

$TSS_{ABC} = TSS_{AB} + TSS_C - (TSS_{AB} * TSS_C)/100$, where

C - bio-swale/forebay

Where,

TSS_{ABC} = total TSS removal for series (%)

TSS_{AB} = 90%

TSS_C = %TSS removal of bio-swale/forebay - 90%

$TSS_{ABC} = 90 + 90 - (90 * 90)/100 = 99.0\%$

Same calculations can be used for Phosphorus (P) and Nitrogen (N)

Phosphorous:

P_{AB} = 66.25%

P_C = %P removal of bio-swale/forebay - 60%

$P_{ABC} = 66.25 + 60 - (66.25 * 60)/100 = 86.5\%$

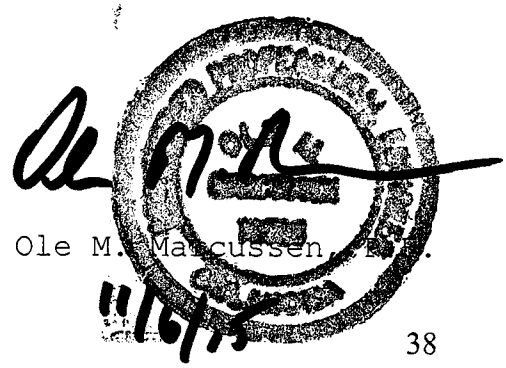
Nitrogen:

N_{AB} = 44%

N_C = %N removal of bio-swale/forebay - 60%

$N_{ABC} = 44 + 60 - (44 * 60)/100 = 77.6\%$

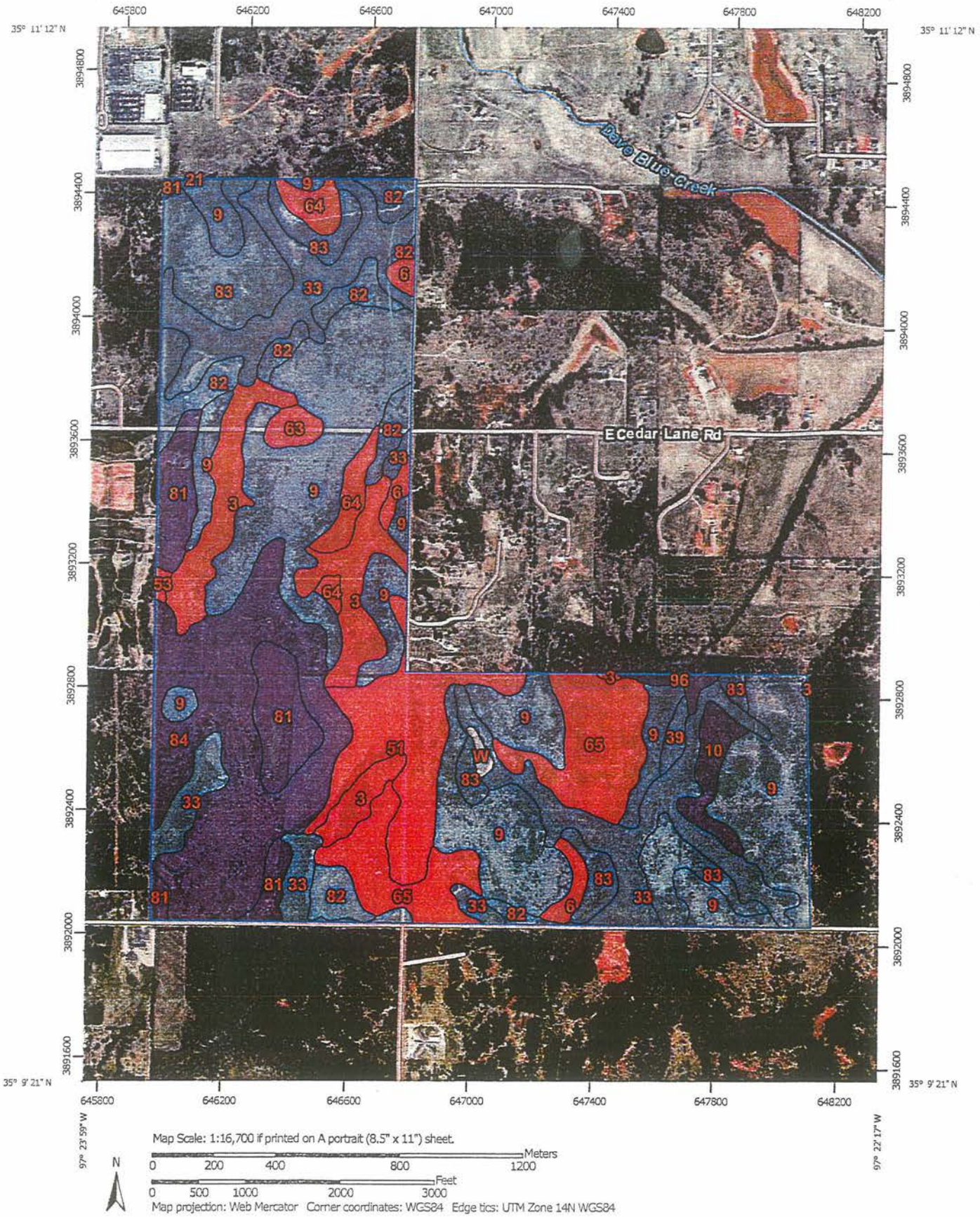
The post-developed runoff from the proposed development will not cause any adverse effects upstream or downstream of the project.



Ole M. Marcussen, P.E.

Appendix A
Soils data

Hydrologic Soil Group—Cleveland County, Oklahoma
(760 Acre site)



MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils

Soil Rating Polygons
- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Lines
- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Points
- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Cleveland County, Oklahoma
Survey Area Data: Version 10, Sep 17, 2014

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Feb 28, 2011—Mar 23, 2011

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Hydrologic Soil Group

Hydrologic Soil Group— Summary by Map Unit — Cleveland County, Oklahoma (OK027)				
Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
3	Grainola-Ashport complex, 0 to 8 percent slopes	D	50.8	6.7%
6	Grainola-Ironmound complex, 5 to 12 percent slopes	D	9.1	1.2%
9	Kingfisher-Ironmound complex, 1 to 5 percent slopes	C	209.7	27.7%
10	Teval silt loam, 3 to 8 percent slopes	B	10.5	1.4%
21	Pits		0.1	0.0%
33	Norge-Ashport complex, 0 to 8 percent slopes	C	106.0	14.0%
39	Asher silt loam, 0 to 1 percent slopes, clayey substratum, rarely flooded	C	3.1	0.4%
51	Kirkland-Pawhuska complex, 0 to 3 percent slopes	D	44.2	5.8%
53	Kirkland-Pawhuska complex, 0 to 3 percent slopes, eroded	D	1.0	0.1%
63	Renfrow silt loam, 3 to 5 percent slopes	D	4.9	0.6%
64	Renfrow silty clay loam, 3 to 5 percent slopes, eroded	D	14.9	2.0%
65	Renfrow-Huska complex, 3 to 5 percent slopes, eroded	D	58.0	7.7%
81	Norge silt loam, 1 to 3 percent slopes	B	38.0	5.0%
82	Norge silt loam, 3 to 5 percent slopes	C	38.9	5.1%
83	Norge silt loam, 5 to 8 percent slopes, eroded	C	61.8	8.2%
84	Grant-Huska complex, 1 to 5 percent slopes	B	100.6	13.3%

Hydrologic Soil Group—Summary by Map Unit — Cleveland County, Oklahoma (OK027)				
Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
96	Ashport silt loam, 0 to 1 percent slopes, occasionally flooded	B	3.4	0.4%
W	Water		1.6	0.2%
Totals for Area of Interest			**756.8**	**100.0%**

Description

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: *None Specified*

Tie-break Rule: Higher

Table 2-2a.—Runoff curve numbers for urban areas[1]

Cover description		Curve numbers for hydrologic soil group—			
Cover type and hydrologic condition	Average percent impervious area[2]	A	B	C	D
Fully developed urban areas (vegetation established)					
Open space (lawns, parks, golf courses, cemeteries, etc.)[3]:					
Poor condition (grass cover < 50%)		68	79	86	89
Fair condition (grass cover 50% to 75%)		49	69	79	84
Good condition (grass cover > 75%)		39	61	74	80
Impervious areas:					
Paved parking lots, roofs, driveways, etc. (excluding right-of-way)		98	98	98	98
Streets and roads:					
Paved; curbs and storm sewers (excluding right-of-way)		98	98	98	98
Paved; open ditches (including right-of-way)		83	89	92	93
Gravel (including right-of-way)		76	85	89	91
Dirt (including right-of-way)		72	82	87	89
Western desert urban areas:					
Natural desert landscaping (pervious areas only)[4]		63	77	85	88
Artificial desert landscaping (impervious weed barrier, desert shrub with 1- to 2-inch sand or gravel mulch and basin borders)		96	96	96	96
Urban districts:					
Commercial and business	85	89	92	94	95
Industrial	72	81	88	91	93
Residential districts by average lot size:					
1/8 acre or less (town houses)	65	77	85	90	92
1/4 acre	38	61	75	83	87
1/3 acre	30	57	72	81	86
1/2 acre	25	54	70	80	85
1 acre	20	51	68	79	84
2 acres	12	46	65	77	82
Developing urban areas					
Newly graded areas (pervious areas only, no vegetation)[5]		77	86	91	94
Idle lands (CN's are determined using cover types similar to those in table 2-2c).					

[1]Average runoff condition, and $I_a = 0.2S$.

[2]The average percent impervious area shown was used to develop the composite CN's. Other assumptions are as follows: impervious areas are directly connected to the drainage system, impervious areas have a CN of 98, and pervious areas are considered equivalent to open space in good hydrologic condition. CN's for other combinations of conditions may be computed using figure 2-3 or 2-4.

[3]CN's shown are equivalent to those of pasture. Composite CN's may be computed for other combinations of open space cover type.

[4]Composite CN's for natural desert landscaping should be computed using figures 2-3 or 2-4 based on the impervious area percentage (CN = 98) and the pervious area CN. The pervious area CN's are assumed equivalent to desert shrub in poor hydrologic condition.

[5]Composite CN's to use for the design of temporary measures during grading and construction should be computed using figure 2-3 or 2-4, based on the degree of development (impervious area percentage) and the CN's for the newly graded pervious areas.

Table 2-2b.—Runoff curve numbers for cultivated agricultural lands[1]

Cover description			Curve numbers for hydrologic soil group—			
Cover type	Treatment[2]	Hydrologic condition[3]	A	B	C	D
Fallow	Bare soil	—	77	86	91	94
	Crop residue cover (CR)	Poor	76	85	90	93
		Good	74	83	88	90
Row crops	Straight row (SR)	Poor	72	81	88	91
		Good	67	78	85	89
	SR + CR	Poor	71	80	87	90
		Good	64	75	82	85
	Contoured (C)	Poor	70	79	84	88
		Good	65	75	82	86
	C + CR	Poor	69	78	83	87
		Good	64	74	81	85
	Contoured & terraced (C&T)	Poor	66	74	80	82
		Good	62	71	78	81
	C&T + CR	Poor	65	73	79	81
		Good	61	70	77	80
Small grain	SR	Poor	65	76	84	88
		Good	63	75	83	87
	SR + CR	Poor	64	75	83	86
		Good	60	72	80	84
	C	Poor	63	74	82	85
		Good	61	73	81	84
	C + CR	Poor	62	73	81	84
		Good	60	72	80	83
	C&T	Poor	61	72	79	82
		Good	59	70	78	81
	C&T + CR	Poor	60	71	78	81
		Good	58	69	77	80
Close-seeded or broadcast legumes or rotation meadow	SR	Poor	66	77	85	89
		Good	58	72	81	85
	C	Poor	64	75	83	85
		Good	55	69	78	83
	C&T	Poor	63	73	80	83
		Good	51	67	76	80

[1]Average runoff condition, and $I_a = 0.2S$.

[2]*Crop residue cover* applies only if residue is on at least 5% of the surface throughout the year.

[3]Hydrologic condition is based on combination of factors that affect infiltration and runoff, including (a) density and canopy of vegetative areas, (b) amount of year-round cover, (c) amount of grass or close-seeded legumes in rotations, (d) percent of residue cover on the land surface (good ≥ 20%), and (e) degree of surface roughness.

Poor: Factors impair infiltration and tend to increase runoff.

Good: Factors encourage average and better than average infiltration and tend to decrease runoff.

Table 2-2c.—Runoff curve numbers for other agricultural lands[1]

Cover description		Curve numbers for hydrologic soil group—			
Cover type	Hydrologic condition	A	B	C	D
Pasture, grassland, or range—continuous forage for grazing.[2]	Poor	68	79	86	89
	Fair	49	69	79	84
	Good	39	61	74	80
Meadow—continuous grass, protected from grazing and generally mowed for hay.	—	30	58	71	78
Brush—brush-weed-grass mixture with brush the major element.[3]	Poor	48	67	77	83
	Fair	35	56	70	77
	Good	[4]30	48	65	73
Woods—grass combination (orchard or tree farm).[5]	Poor	57	73	82	86
	Fair	43	65	76	82
	Good	32	58	72	79
Woods.[6]	Poor	45	66	77	83
	Fair	36	60	73	79
	Good	[4]30	55	70	77
Farmsteads—buildings, lanes, driveways, and surrounding lots.	—	59	74	82	86

[1]Average runoff condition, and $I_a = 0.2S$.

[2]*Poor:* <50% ground cover or heavily grazed with no mulch.
Fair: 50 to 75% ground cover and not heavily grazed.
Good: >75% ground cover and lightly or only occasionally grazed.

[3]*Poor:* <50% ground cover.
Fair: 50 to 75% ground cover.
Good: >75% ground cover.

[4]Actual curve number is less than 30; use CN = 30 for runoff computations.

[5]CN's shown were computed for areas with 50% woods and 50% grass (pasture) cover. Other combinations of conditions may be computed from the CN's for woods and pasture.

[6]*Poor:* Forest litter, small trees, and brush are destroyed by heavy grazing or regular burning.
Fair: Woods are grazed but not burned, and some forest litter covers the soil.
Good: Woods are protected from grazing, and litter and brush adequately cover the soil.

Table 2-2d.—Runoff curve numbers for arid and semiarid rangelands[1]

Cover description		Curve numbers for hydrologic soil group—			
Cover type	Hydrologic condition[2]	A[3]	B	C	D
Herbaceous—mixture of grass, weeds, and low-growing brush, with brush the minor element.	Poor		80	87	93
	Fair		71	81	89
	Good		62	74	85
Oak-aspen—mountain brush mixture of oak brush, aspen, mountain mahogany, bitter brush, maple, and other brush.	Poor		66	74	79
	Fair		48	57	63
	Good		30	41	48
Pinyon-juniper—pinyon, juniper, or both; grass understory.	Poor		75	85	89
	Fair		58	73	80
	Good		41	61	71
Sagebrush with grass understory.	Poor		67	80	85
	Fair		51	63	70
	Good		35	47	55
Desert shrub—major plants include saltbush, greasewood, creosotebush, blackbrush, bursage, palo verde, mesquite, and cactus.	Poor	63	77	85	88
	Fair	55	72	81	86
	Good	49	68	79	84

[1]Average runoff condition, and $I_a = 0.2S$. For range in humid regions, use table 2-2c.

[2]*Poor:* <30% ground cover (litter, grass, and brush overstory).
Fair: 30 to 70% ground cover.
Good: >70% ground cover.

[3]Curve numbers for group A have been developed only for desert shrub.

Chapter 3: Time of concentration and travel time

Travel time (T_t) is the time it takes water to travel from one location to another in a watershed. T_t is a component of time of concentration (T_c), which is the time for runoff to travel from the hydraulically most distant point of the watershed to a point of interest within the watershed. T_c is computed by summing all the travel times for consecutive components of the drainage conveyance system.

T_c influences the shape and peak of the runoff hydrograph. Urbanization usually decreases T_c, thereby increasing the peak discharge. But T_c can be increased as a result of (a) ponding behind small or inadequate drainage systems, including storm drain inlets and road culverts, or (b) reduction of land slope through grading.

Factors affecting time of concentration and travel time

Surface roughness

One of the most significant effects of urban development on flow velocity is less retardance to flow. That is, undeveloped areas with very slow and shallow overland flow through vegetation become modified by urban development: the flow is then delivered to streets, gutters, and storm sewers that transport runoff downstream more rapidly. Travel time through the watershed is generally decreased.

Channel shape and flow patterns

In small non-urban watersheds, much of the travel time results from overland flow in upstream areas. Typically, urbanization reduces overland flow lengths by conveying storm runoff into a channel as soon as possible. Since channel designs have efficient hydraulic characteristics, runoff flow velocity increases and travel time decreases.

Slope

Slopes may be increased or decreased by urbanization, depending on the extent of site grading or the extent to which storm sewers and street ditches are used in the design of the water management system. Slope will tend to increase when channels are straightened and decrease when overland flow is directed through storm sewers, street gutters, and diversions.

Computation of travel time and time of concentration

Water moves through a watershed as sheet flow, shallow concentrated flow, open channel flow, or some combination of these. The type that occurs is a function of the conveyance system and is best determined by field inspection.

Travel time (T_t) is the ratio of flow length to flow velocity:

$$T_t = \frac{L}{3600\ V} \qquad \text{[Eq. 3-1]}$$

where

T_t = travel time (hr),
L = flow length (ft),
V = average velocity (ft/s), and
3600 = conversion factor from seconds to hours.

Time of concentration (T_c) is the sum of T_t values for the various consecutive flow segments:

$$T_c = T_{t_1} + T_{t_2} + \ldots T_{t_m} \qquad \text{[Eq. 3-2]}$$

where

T_c = time of concentration (hr) and
m = number of flow segments.

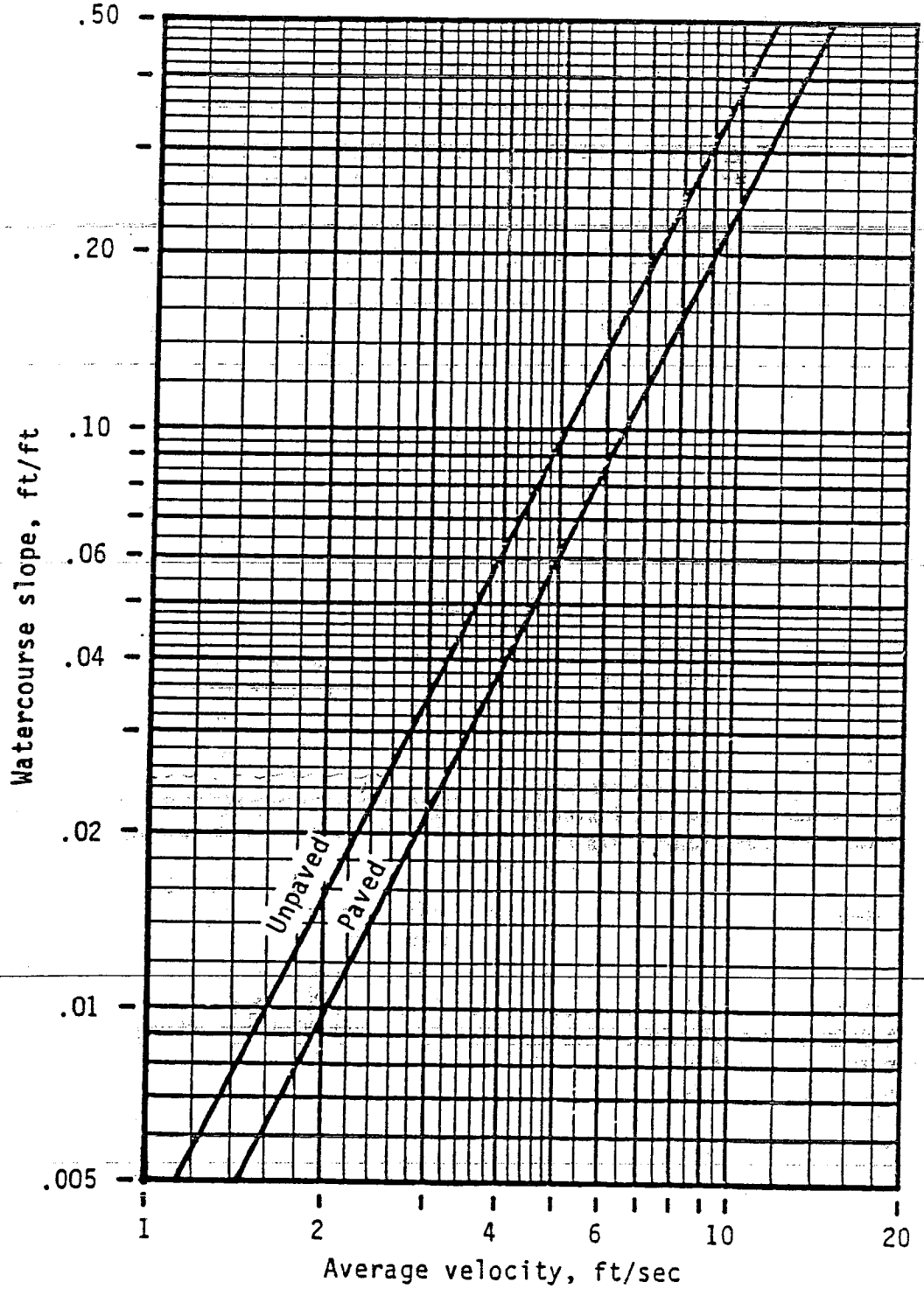


Figure 3-1.—Average velocities for estimating travel time for shallow concentrated flow.

Sheet flow

Sheet flow is flow over plane surfaces. It usually occurs in the headwater of streams. With sheet flow, the friction value (Manning's n) is an effective roughness coefficient that includes the effect of raindrop impact; drag over the plane surface; obstacles such as litter, crop ridges, and rocks; and erosion and transportation of sediment. These n values are for very shallow flow depths of about 0.1 foot or so. Table 3-1 gives Manning's n values for sheet flow for various surface conditions.

For sheet flow of less than 300 feet, use Manning's kinematic solution (Overton and Meadows 1976) to compute T_t:

$$T_t = \frac{0.007\,(nL)^{0.8}}{(P_2)^{0.5}\,s^{0.4}} \qquad \text{[Eq. 3-3]}$$

Table 3-1.—Roughness coefficients (Manning's n) for sheet flow

Surface description	n[1]
Smooth surfaces (concrete, asphalt, gravel, or bare soil)	0.011
Fallow (no residue)	0.05
Cultivated soils:	
Residue cover ≤20%	0.06
Residue cover >20%	0.17
Grass:	
Short grass prairie	0.15
Dense grasses[2]	0.24
Bermudagrass	0.41
Range (natural)	0.13
Woods:[3]	
Light underbrush	0.40
Dense underbrush	0.80

[1]The n values are a composite of information compiled by Engman (1986).
[2]Includes species such as weeping lovegrass, bluegrass, buffalo grass, blue grama grass, and native grass mixtures.
[3]When selecting n, consider cover to a height of about 0.1 ft. This is the only part of the plant cover that will obstruct sheet flow.

where

T_t = travel time (hr),
n = Manning's roughness coefficient (table 3-1),
L = flow length (ft),
P_2 = 2-year, 24-hour rainfall (in), and
s = slope of hydraulic grade line (land slope, ft/ft).

This simplified form of the Manning's kinematic solution is based on the following: (1) shallow steady uniform flow, (2) constant intensity of rainfall excess (that part of a rain available for runoff), (3) rainfall duration of 24 hours, and (4) minor effect of infiltration on travel time. Rainfall depth can be obtained from appendix B.

Shallow concentrated flow

After a maximum of 300 feet, sheet flow usually becomes shallow concentrated flow. The average velocity for this flow can be determined from figure 3-1, in which average velocity is a function of watercourse slope and type of channel. For slopes less than 0.005 ft/ft, use equations given in appendix F for figure 3-1. Tillage can affect the direction of shallow concentrated flow. Flow may not always be directly down the watershed slope if tillage runs across the slope.

After determining average velocity in figure 3-1, use equation 3-1 to estimate travel time for the shallow concentrated flow segment.

Open channels

Open channels are assumed to begin where surveyed cross section information has been obtained, where channels are visible on aerial photographs, or where blue lines (indicating streams) appear on United States Geological Survey (USGS) quadrangle sheets. Manning's equation or water surface profile information can be used to estimate average flow velocity. Average flow velocity is usually determined for bank-full elevation.

Manning's equation is

$$V = \frac{1.49\ r^{2/3}\ s^{1/2}}{n} \qquad \text{[Eq. 3-4]}$$

where

V = average velocity (ft/s),
r = hydraulic radius (ft) and is equal to a/p_w,
a = cross sectional flow area (ft^2),
p_w = wetted perimeter (ft),
s = slope of the hydraulic grade line (channel slope, ft/ft), and
n = Manning's roughness coefficient for open channel flow.

Manning's n values for open channel flow can be obtained from standard textbooks such as Chow (1959) or Linsley et al. (1982). After average velocity is computed using equation 3-4, T_t for the channel segment can be estimated using equation 3-1.

Reservoirs or lakes

Sometimes it is necessary to estimate the velocity of flow through a reservoir or lake at the outlet of a watershed. This travel time is normally very small and can be assumed as zero.

Limitations

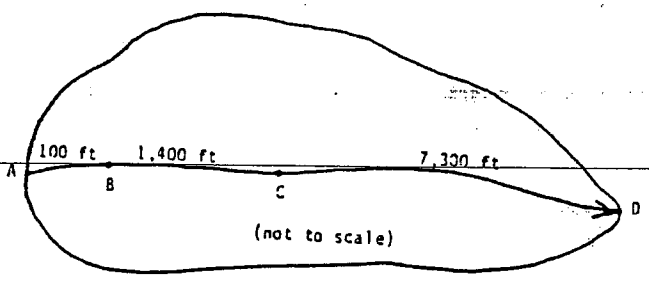
- Manning's kinematic solution should not be used for sheet flow longer than 300 feet. Equation 3-3 was developed for use with the four standard rainfall intensity-duration relationships.
- In watersheds with storm sewers, carefully identify the appropriate hydraulic flow path to estimate T_c. Storm sewers generally handle only a small portion of a large event. The rest of the peak flow travels by streets, lawns, and so on, to the outlet. Consult a standard hydraulics textbook to determine average velocity in pipes for either pressure or nonpressure flow.
- The minimum T_c used in TR-55 is 0.1 hour.
- A culvert or bridge can act as a reservoir outlet if there is significant storage behind it. The procedures in TR-55 can be used to determine the peak flow upstream of the culvert. Detailed storage routing procedures should be used to determine the outflow through the culvert.

Example 3-1

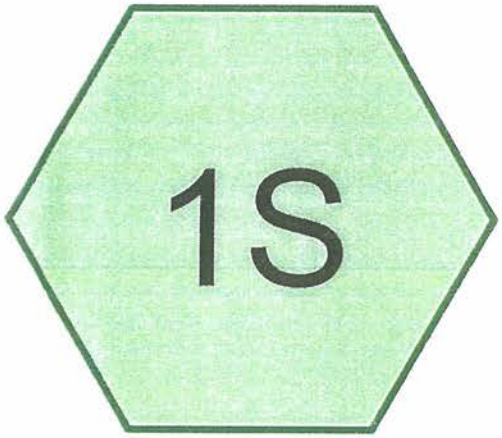
The sketch below shows a watershed in Dyer County, northwestern Tennessee. The problem is to compute T_c at the outlet of the watershed (point D). The 2-year 24-hour rainfall depth is 3.6 inches. All three types of flow occur from the hydraulically most distant point (A) to the point of interest (D). To compute T_c, first determine T_t for each segment from the following information:

Segment AB: Sheet flow; dense grass; slope (s) = 0.01 ft/ft; and length (L) = 100 ft.
Segment BC: Shallow concentrated flow; unpaved; s = 0.01 ft/ft; and L = 1400 ft.
Segment CD: Channel flow; Manning's n = .05; flow area (a) = 27 ft^2; wetted perimeter (p_w) = 28.2 ft; s = 0.005 ft/ft; and L = 7300 ft.

See figure 3-2 for the computations made on worksheet 3.



Appendix B
Drainage Calculations
Area A



Historic Area A

Subcat Reach Pond Link

Routing Diagram for Historic Area A
Prepared by SMC Consulting Engineers, P.C., Printed 1/10/2015

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
53.400	58	Type B soil (1S)
205.400	71	Type C soil (1S)
53.300	78	Type D soil (1S)

Summary for Subcatchment 1S: Historic Area A

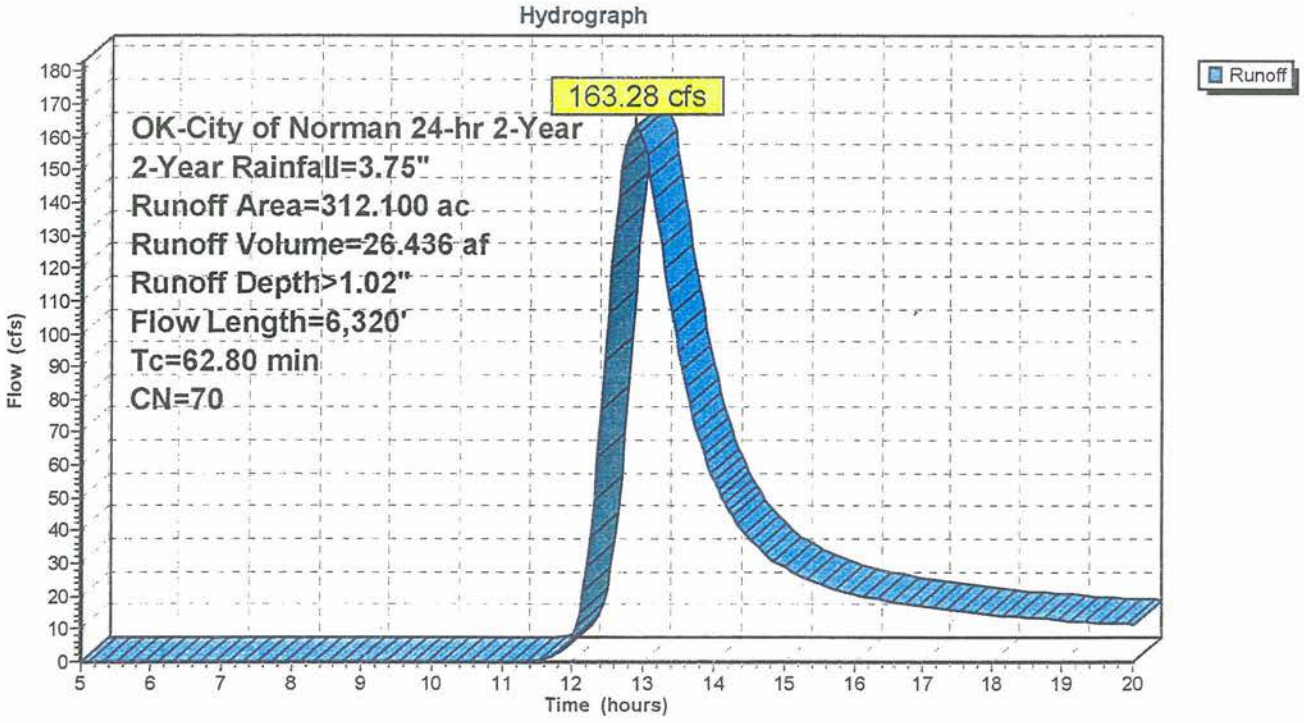
Runoff = 163.28 cfs @ 12.89 hrs, Volume= 26.436 af, Depth> 1.02"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
OK-City of Norman 24-hr 2-Year 2-Year Rainfall=3.75"

	Area (ac)	CN	Description
*	53.400	58	Type B soil
*	205.400	71	Type C soil
*	53.300	78	Type D soil
	312.100	70	Weighted Average
	312.100		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
24.09	300	0.0117	0.21		**Sheet Flow, Overland flow** Range n= 0.130 P2= 3.75"
2.71	370	0.0230	2.27		**Shallow Concentrated Flow, Swale** Grassed Waterway Kv= 15.0 fps
36.00	5,650	0.0124	2.62	39.24	**Channel Flow, Creek** Area= 15.0 sf Perim= 25.0' r= 0.60' n= 0.045
62.80	6,320	Total			

Subcatchment 1S: Historic Area A



Summary for Subcatchment 1S: Historic Area A

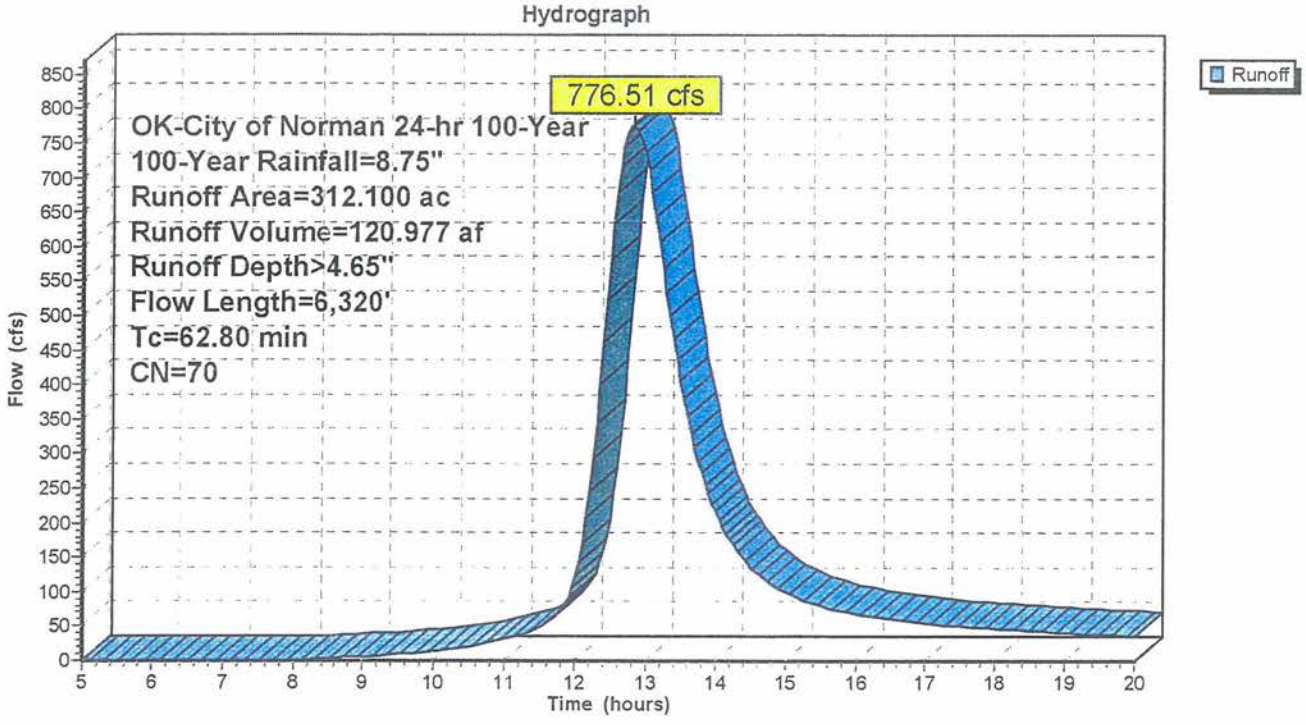
Runoff = 776.51 cfs @ 12.84 hrs, Volume= 120.977 af, Depth> 4.65"

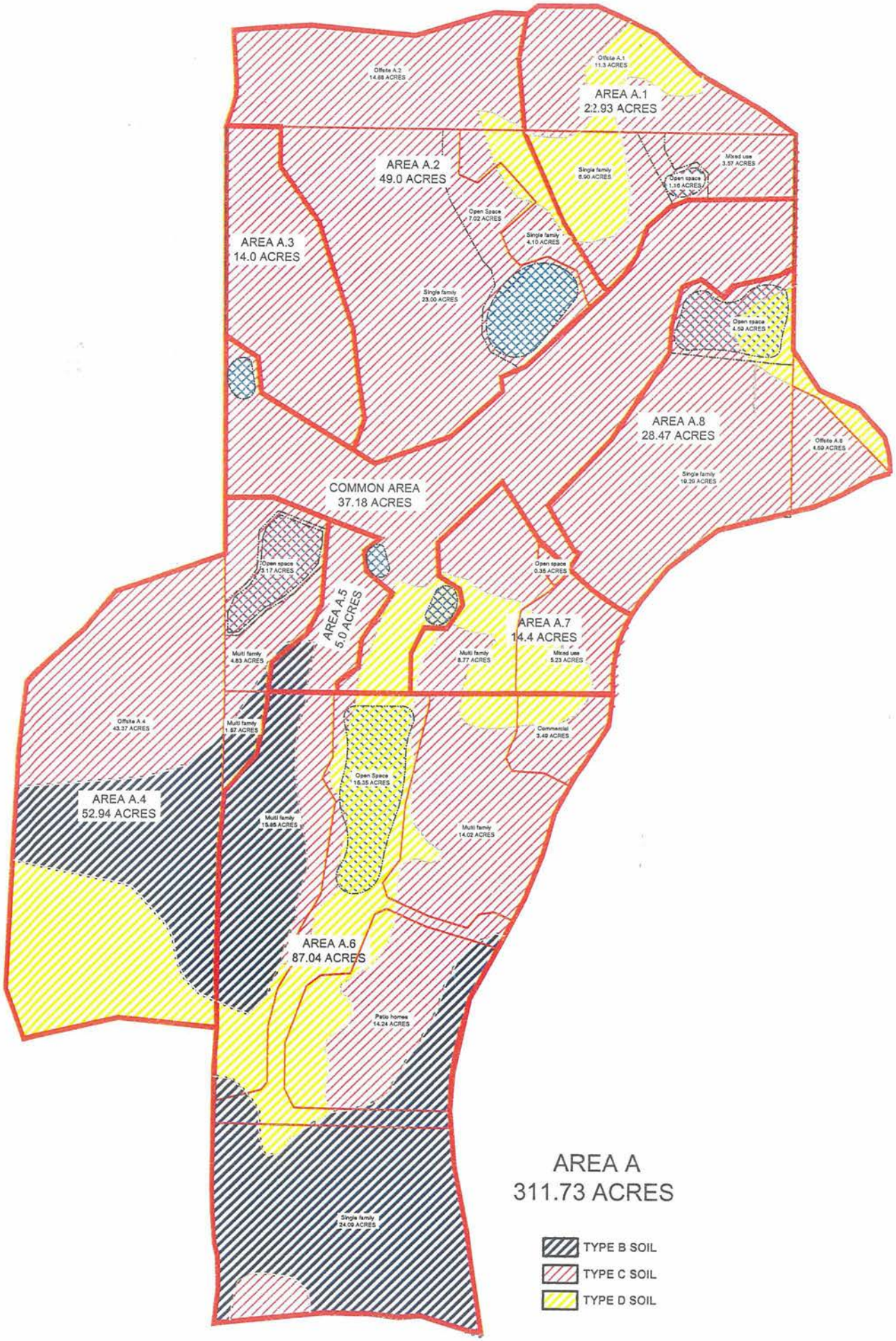
Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
OK-City of Norman 24-hr 100-Year 100-Year Rainfall=8.75"

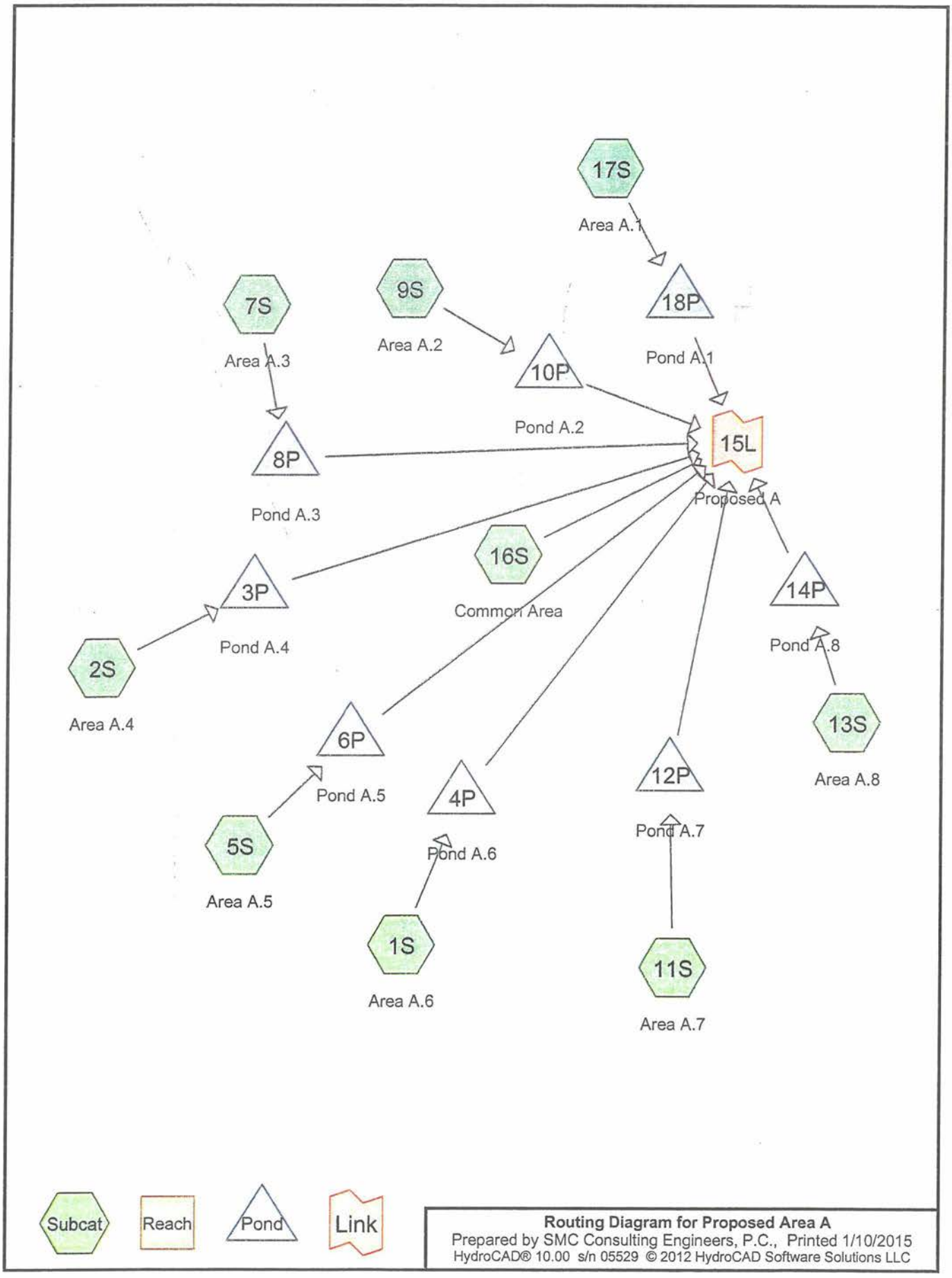
	Area (ac)	CN	Description
*	53.400	58	Type B soil
*	205.400	71	Type C soil
*	53.300	78	Type D soil
	312.100	70	Weighted Average
	312.100		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
24.09	300	0.0117	0.21		**Sheet Flow, Overland flow** Range n= 0.130 P2= 3.75"
2.71	370	0.0230	2.27		**Shallow Concentrated Flow, Swale** Grassed Waterway Kv= 15.0 fps
36.00	5,650	0.0124	2.62	39.24	**Channel Flow, Creek** Area= 15.0 sf Perim= 25.0' r= 0.60' n= 0.045
62.80	6,320	Total			

Subcatchment 1S: Historic Area A




Offsite A.2
14.66 ACRES
Offsite A.1
11.3 ACRES
AREA A.1
22.93 ACRES
AREA A.2
49.0 ACRES
Single family
6.90 ACRES
Mixed use
3.57 ACRES
Open space
1.16 ACRES
Open Space
7.02 ACRES
Single family
4.10 ACRES
AREA A.3
14.0 ACRES
Single family
23.00 ACRES
Open space
4.59 ACRES
AREA A.8
28.47 ACRES
Offsite A.8
4.69 ACRES
Single family
10.29 ACRES
COMMON AREA
37.18 ACRES
Open space
3.17 ACRES
Open space
0.35 ACRES
AREA A.5
5.0 ACRES
AREA A.7
14.4 ACRES
Multi family
4.83 ACRES
Multi family
8.77 ACRES
Mixed use
5.23 ACRES
Offsite A.4
43.37 ACRES
Multi family
1.57 ACRES
Commercial
3.49 ACRES
Open Space
15.35 ACRES
AREA A.4
52.94 ACRES
Multi family
15.85 ACRES
Multi family
14.02 ACRES
AREA A.6
87.04 ACRES
Patio homes
14.24 ACRES
Single family
24.09 ACRES
AREA A
311.73 ACRES
TYPE B SOIL
TYPE C SOIL
TYPE D SOIL



Routing Diagram for Proposed Area A
Prepared by SMC Consulting Engineers, P.C., Printed 1/10/2015
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Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
138.440	80	Developed (1S, 13S, 17S)
5.000	82	Developed (5S)
14.000	83	Developed (7S)
49.000	78	Developed (9S)
14.350	88	Developed (11S)
37.180	72	Developed (16S)
52.940	71	Offsite & developed (2S)

Summary for Subcatchment 1S: Area A.6

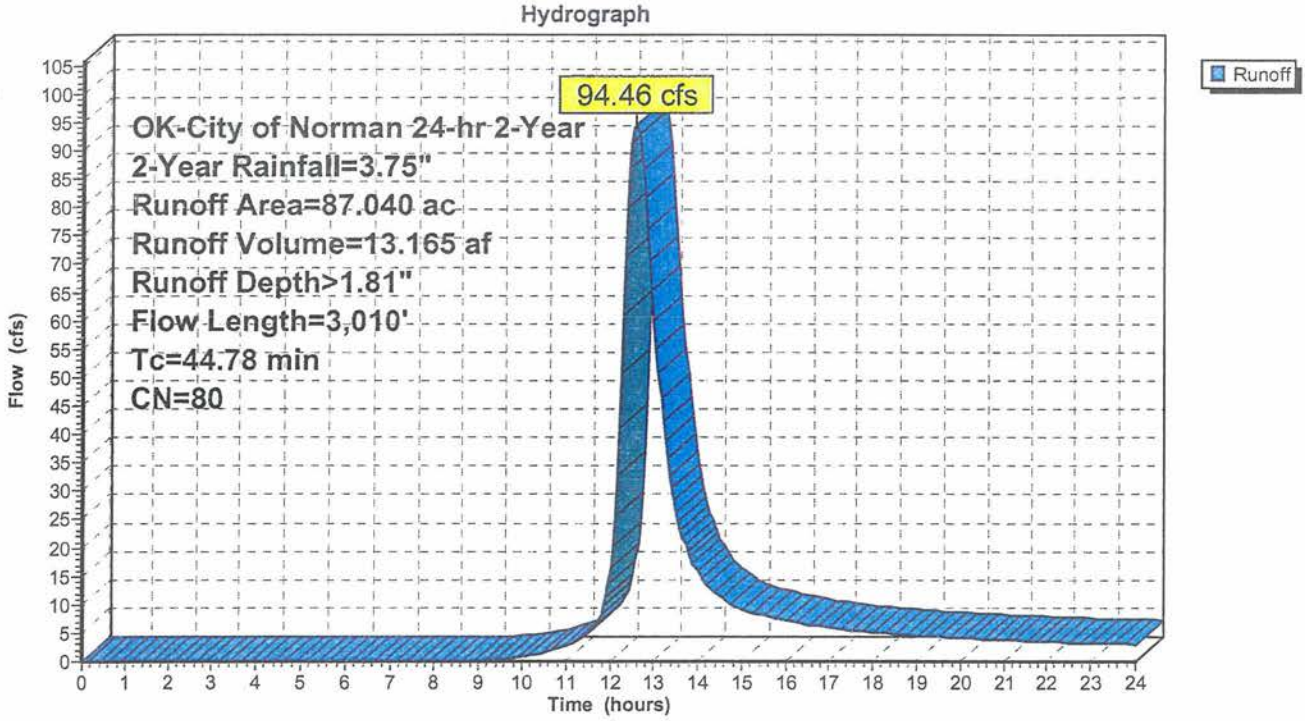
Runoff = 94.46 cfs @ 12.59 hrs, Volume= 13.165 af, Depth> 1.81"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
OK-City of Norman 24-hr 2-Year 2-Year Rainfall=3.75"

	Area (ac)	CN	Description
*	87.040	80	Developed
	87.040		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
26.70	100	0.0100	0.06		**Sheet Flow, Overland flow** Grass: Bermuda n= 0.410 P2= 3.75"
4.70	810	0.0200	2.87		**Shallow Concentrated Flow, Street** Paved Kv= 20.3 fps
13.38	2,100	0.0124	2.62	39.24	**Channel Flow, Creek** Area= 15.0 sf Perim= 25.0' r= 0.60' n= 0.045
44.78	3,010	Total			

Subcatchment 1S: Area A.6



Summary for Subcatchment 2S: Area A.4

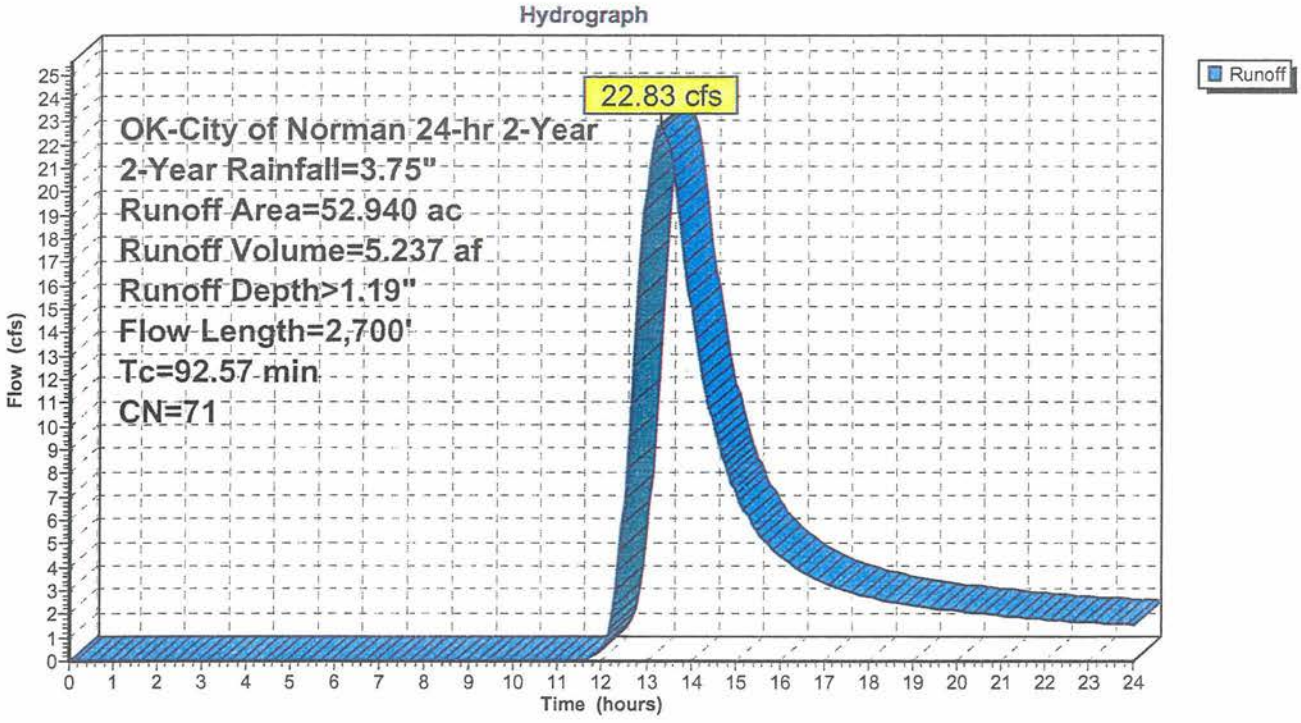
Runoff = 22.83 cfs @ 13.28 hrs, Volume= 5.237 af, Depth> 1.19"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
OK-City of Norman 24-hr 2-Year 2-Year Rainfall=3.75"

	Area (ac)	CN	Description
*	52.940	71	Offsite & developed
	52.940		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
64.29	300	0.0100	0.08		**Sheet Flow, Overland** Grass: Bermuda n= 0.410 P2= 3.75"
20.43	1,300	0.0050	1.06		**Shallow Concentrated Flow, Swale** Grassed Waterway Kv= 15.0 fps
7.85	1,100	0.0050	2.34	23.35	**Channel Flow, Ex. channel** Area= 10.0 sf Perim= 10.0' r= 1.00' n= 0.045
92.57	2,700	Total			

Subcatchment 2S: Area A.4



Summary for Subcatchment 5S: Area A.5

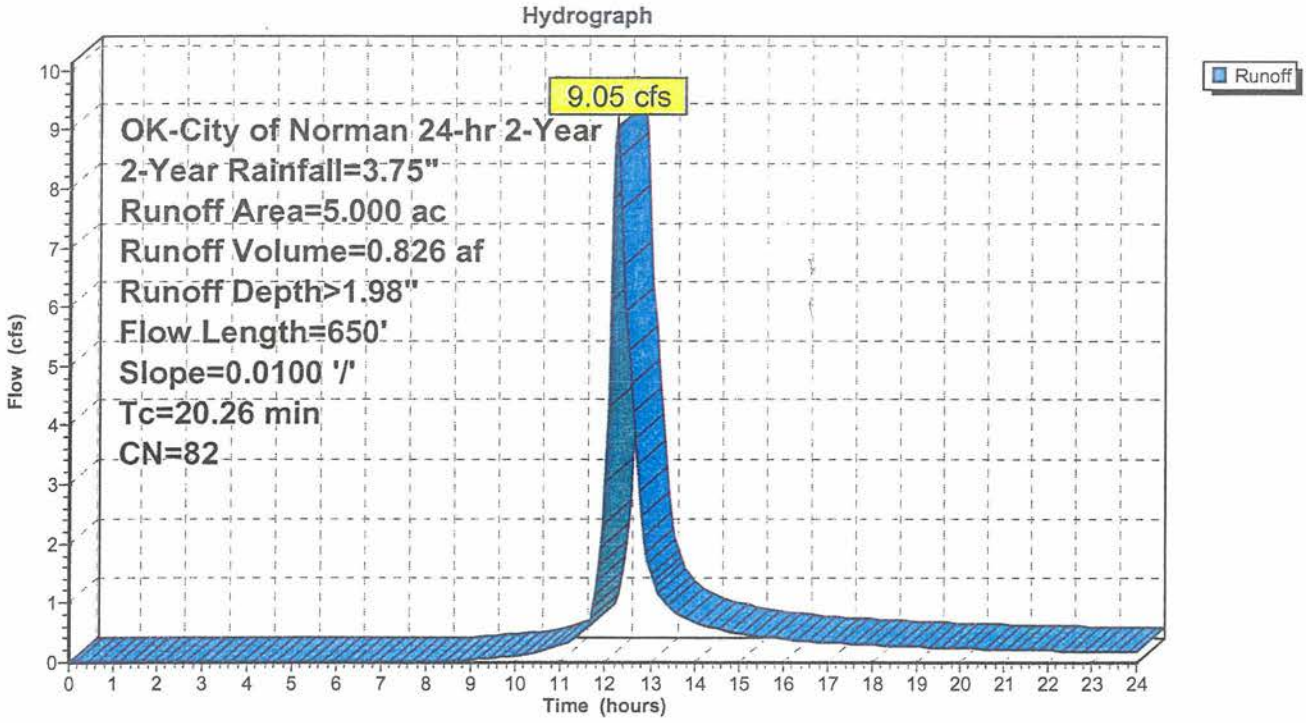
Runoff = 9.05 cfs @ 12.24 hrs, Volume= 0.826 af, Depth> 1.98"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
OK-City of Norman 24-hr 2-Year 2-Year Rainfall=3.75"

	Area (ac)	CN	Description
*	5.000	82	Developed
	5.000		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
15.33	50	0.0100	0.05		**Sheet Flow, Overland** Grass: Bermuda n= 0.410 P2= 3.75"
4.93	600	0.0100	2.03		**Shallow Concentrated Flow, Street** Paved Kv= 20.3 fps
20.26	650	Total			

Subcatchment 5S: Area A.5



Summary for Subcatchment 7S: Area A.3

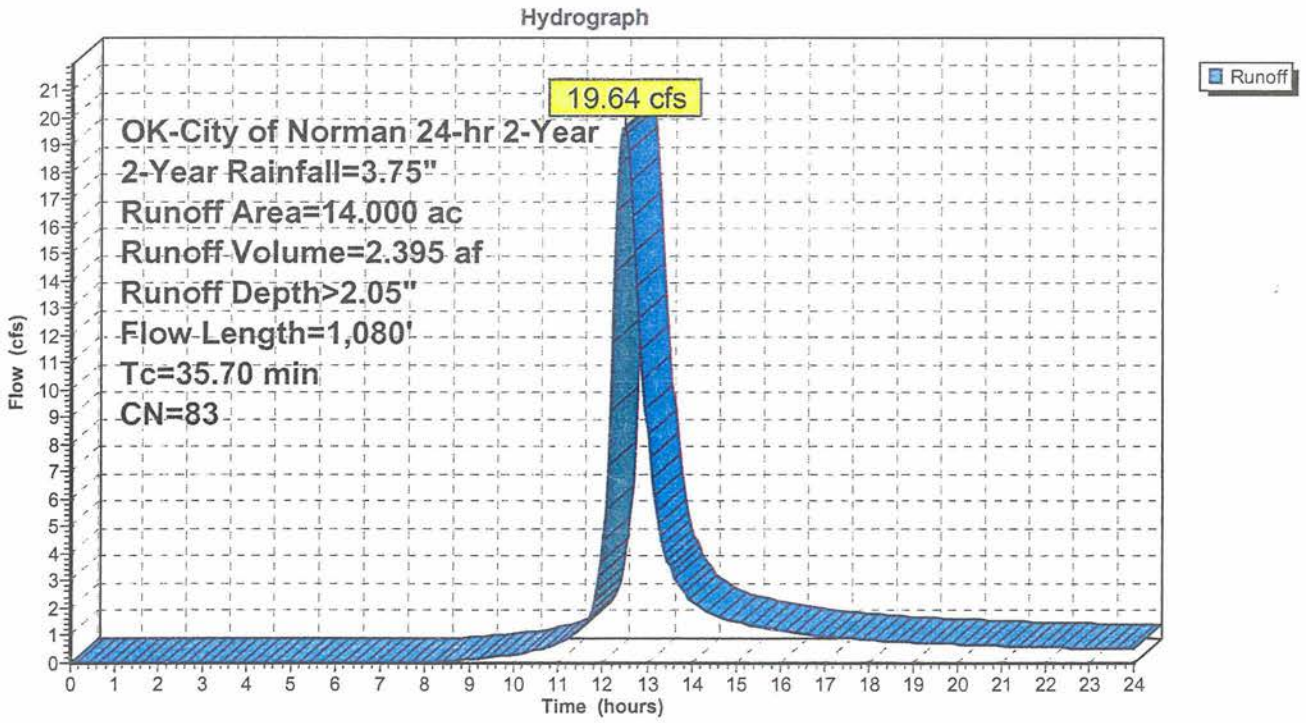
Runoff = 19.64 cfs @ 12.46 hrs, Volume= 2.395 af, Depth> 2.05"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
OK-City of Norman 24-hr 2-Year 2-Year Rainfall=3.75"

	Area (ac)	CN	Description
*	14.000	83	Developed
	14.000		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
26.70	100	0.0100	0.06		**Sheet Flow, Overland** Grass: Bermuda n= 0.410 P2= 3.75"
9.00	980	0.0080	1.82		**Shallow Concentrated Flow, Street** Paved Kv= 20.3 fps
35.70	1,080	Total			

Subcatchment 7S: Area A.3



Summary for Subcatchment 9S: Area A.2

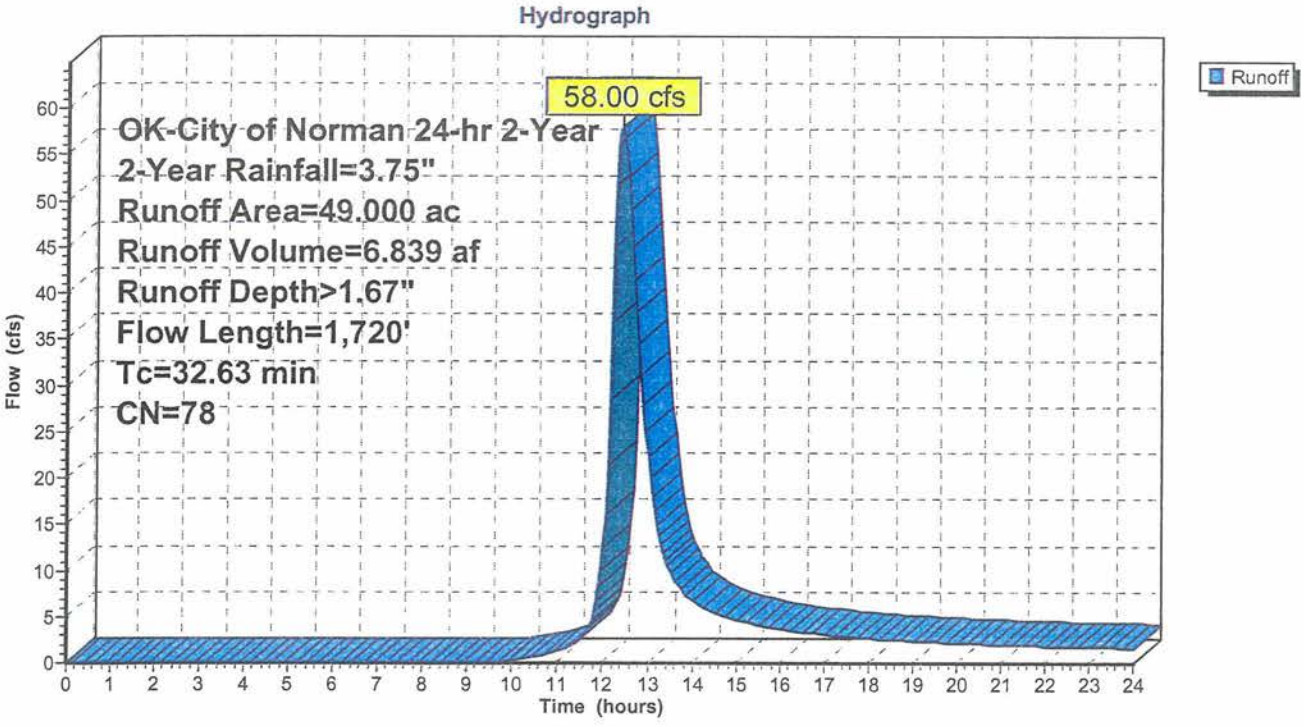
Runoff = 58.00 cfs @ 12.42 hrs, Volume= 6.839 af, Depth> 1.67"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
OK-City of Norman 24-hr 2-Year 2-Year Rainfall=3.75"

	Area (ac)	CN	Description
*	49.000	78	Developed
	49.000		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
26.70	100	0.0100	0.06		**Sheet Flow, Overland** Grass: Bermuda n= 0.410 P2= 3.75"
2.56	270	0.0075	1.76		**Shallow Concentrated Flow, Street** Paved Kv= 20.3 fps
3.37	1,350	0.0050	6.67	47.16	**Pipe Channel, RCP_Round 36"** 36.0" Round Area= 7.1 sf Perim= 9.4' r= 0.75' n= 0.013
32.63	1,720	Total			

Subcatchment 9S: Area A.2



Summary for Subcatchment 11S: Area A.7

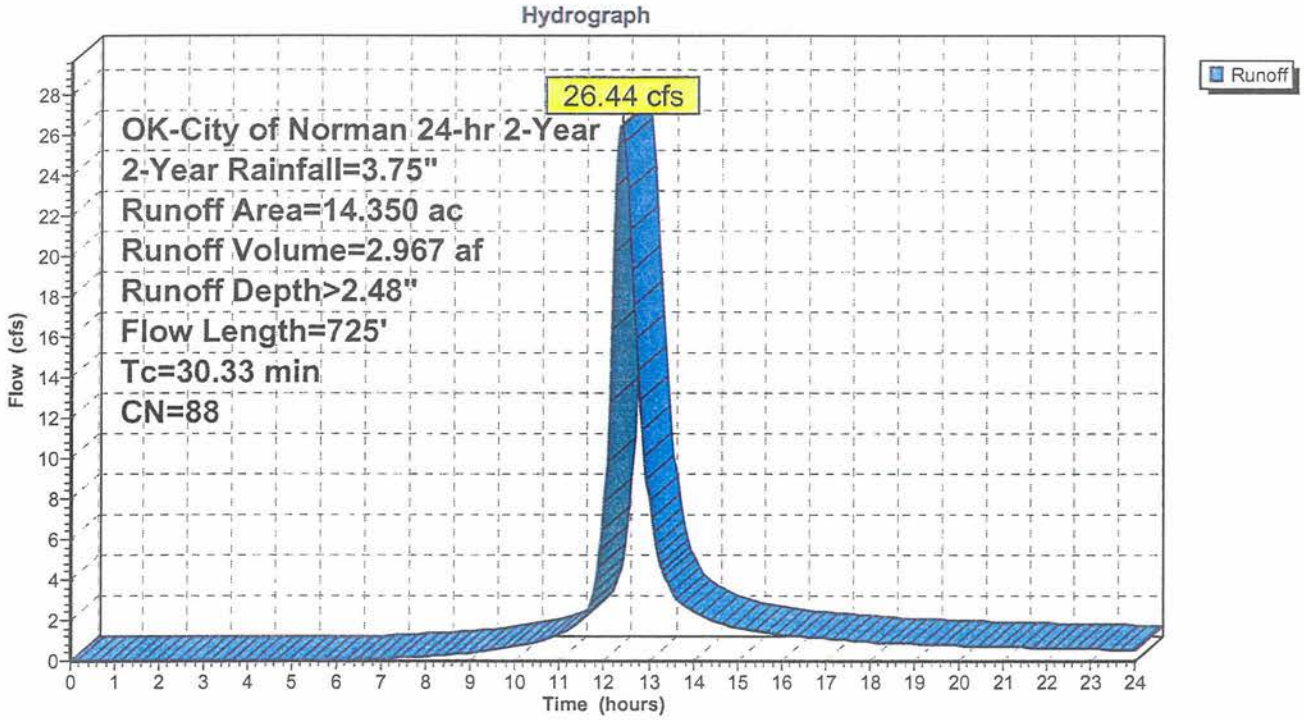
Runoff = 26.44 cfs @ 12.36 hrs, Volume= 2.967 af, Depth> 2.48"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
OK-City of Norman 24-hr 2-Year 2-Year Rainfall=3.75"

	Area (ac)	CN	Description
*	14.350	88	Developed
	14.350		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
26.70	100	0.0100	0.06		**Sheet Flow, Overland** Grass: Bermuda n= 0.410 P2= 3.75"
3.63	625	0.0200	2.87		**Shallow Concentrated Flow, Street** Paved Kv= 20.3 fps
30.33	725	Total			

Subcatchment 11S: Area A.7



Summary for Subcatchment 13S: Area A.8

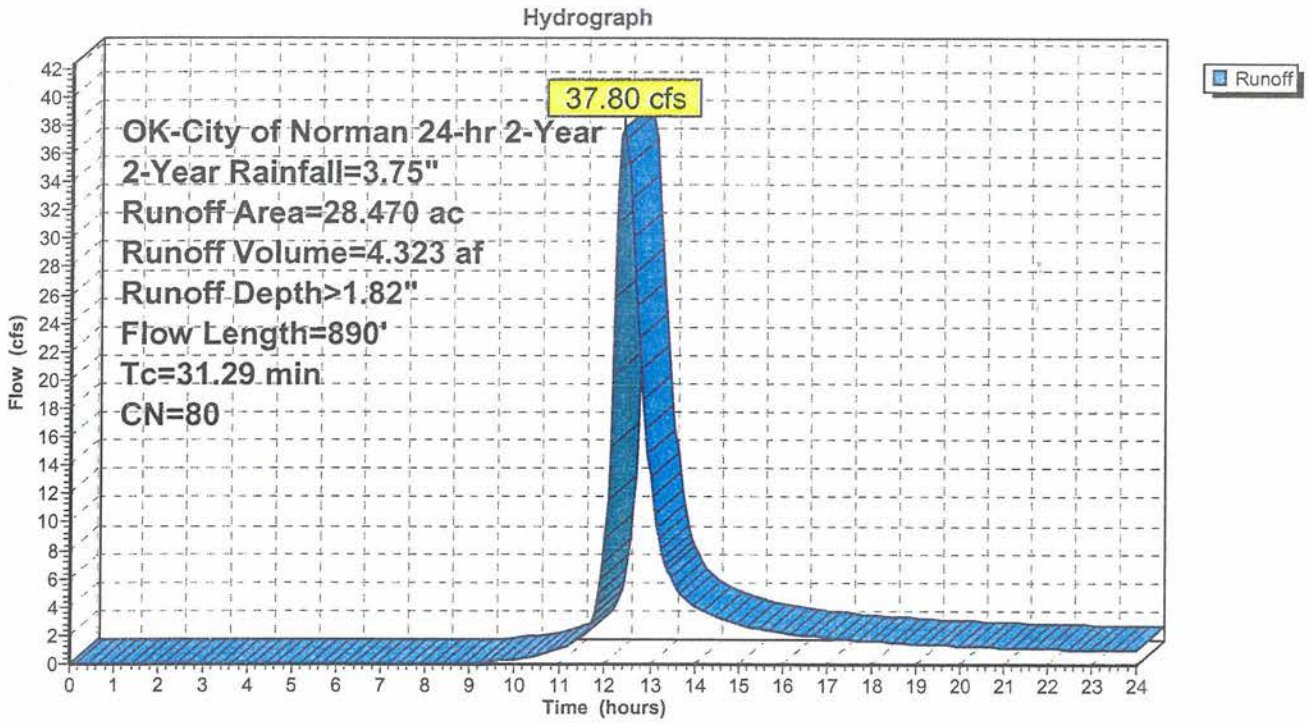
Runoff = 37.80 cfs @ 12.40 hrs, Volume= 4.323 af, Depth> 1.82"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
OK-City of Norman 24-hr 2-Year 2-Year Rainfall=3.75"

	Area (ac)	CN	Description
*	28.470	80	Developed
	28.470		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
26.70	100	0.0100	0.06		**Sheet Flow, Overland** Grass: Bermuda n= 0.410 P2= 3.75"
4.59	790	0.0200	2.87		**Shallow Concentrated Flow, Street** Paved Kv= 20.3 fps
31.29	890	Total			

Subcatchment 13S: Area A.8



Summary for Subcatchment 16S: Common Area

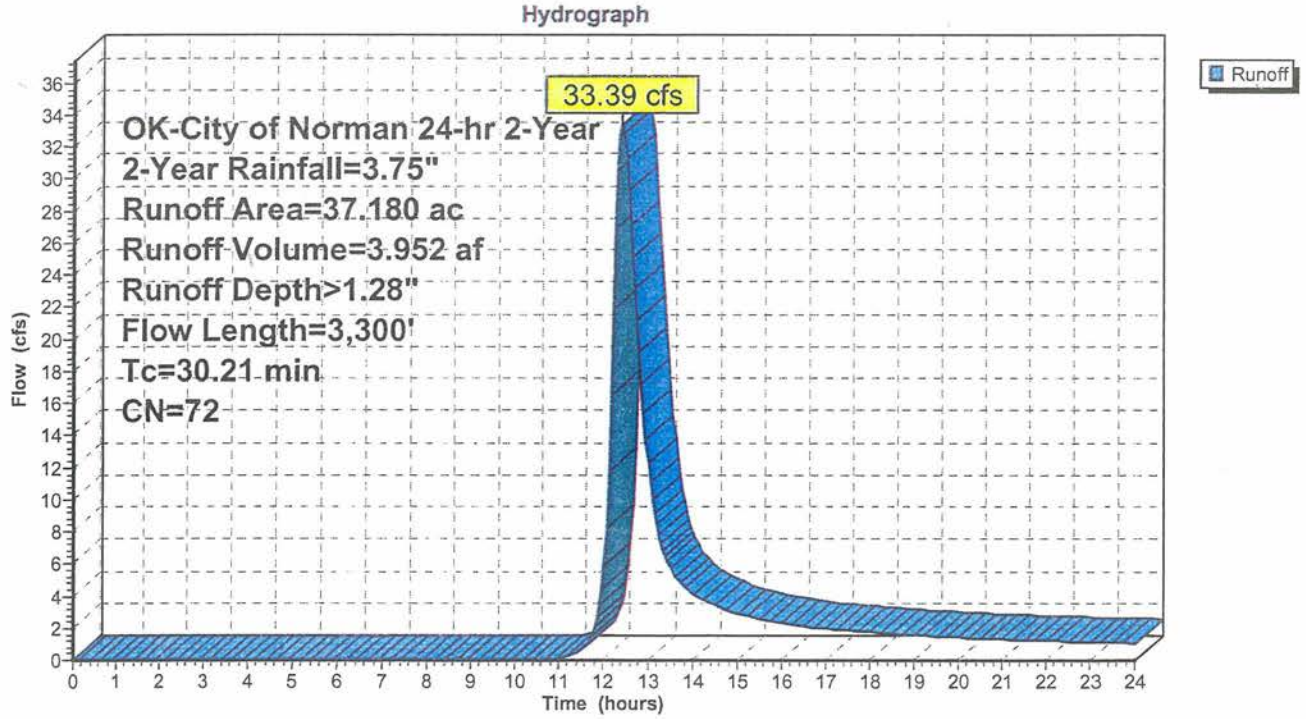
Runoff = 33.39 cfs @ 12.40 hrs, Volume= 3.952 af, Depth> 1.28"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
OK-City of Norman 24-hr 2-Year 2-Year Rainfall=3.75"

	Area (ac)	CN	Description
*	37.180	72	Developed
	37.180		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.05	100	0.0200	0.18		**Sheet Flow, Overland** Grass: Short n= 0.150 P2= 3.75"
21.16	3,200	0.0100	2.52	25.20	**Channel Flow, Ex. channel** Area= 10.0 sf Perim= 15.0' r= 0.67' n= 0.045
30.21	3,300	Total			

Subcatchment 16S: Common Area



Summary for Subcatchment 17S: Area A.1

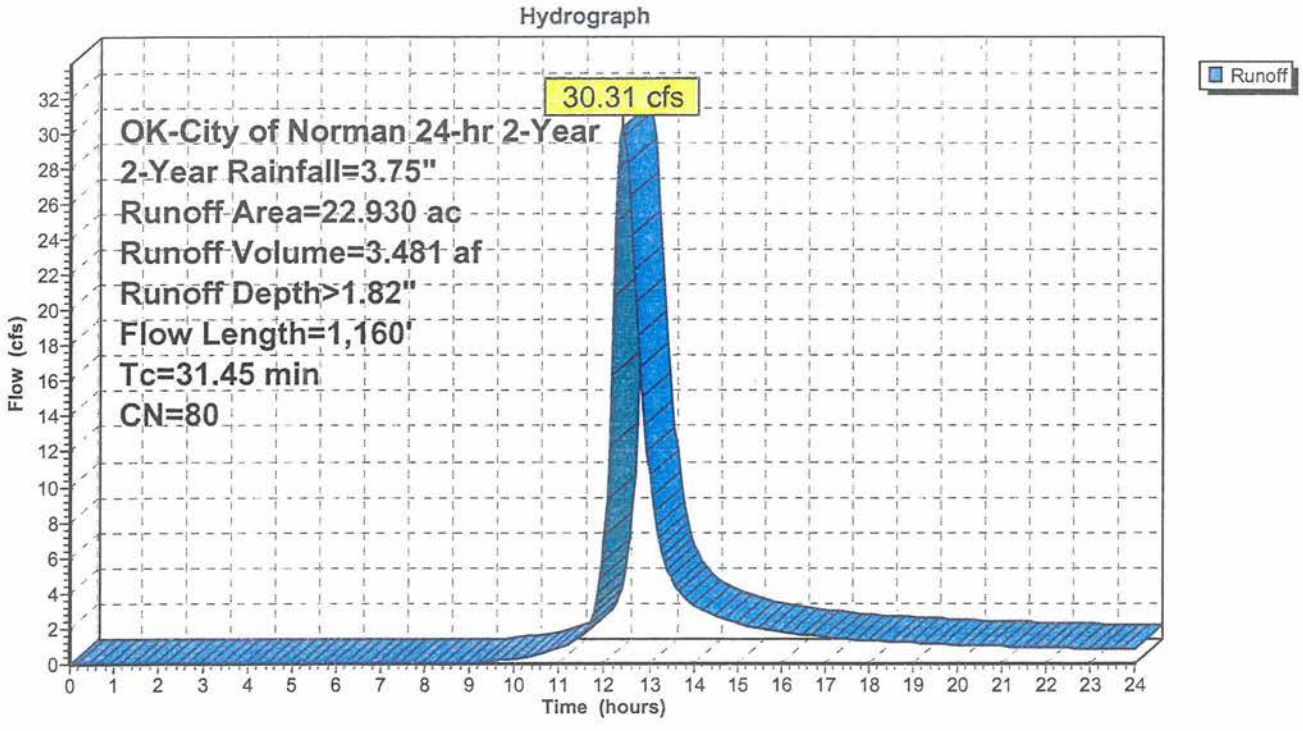
Runoff = 30.31 cfs @ 12.40 hrs, Volume= 3.481 af, Depth> 1.82"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
OK-City of Norman 24-hr 2-Year 2-Year Rainfall=3.75"

	Area (ac)	CN	Description
*	22.930	80	Developed
	22.930		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
26.70	100	0.0100	0.06		**Sheet Flow, Overland** Grass: Bermuda n= 0.410 P2= 3.75"
3.35	500	0.0150	2.49		**Shallow Concentrated Flow, Street** Paved Kv= 20.3 fps
1.40	560	0.0050	6.67	47.16	**Pipe Channel, RCP_Round 36"** 36.0" Round Area= 7.1 sf Perim= 9.4' r= 0.75' n= 0.013
31.45	1,160	Total			

Subcatchment 17S: Area A.1



Summary for Pond 3P: Pond A.4

Inflow Area = 52.940 ac, 0.00% Impervious, Inflow Depth > 1.19" for 2-Year event
Inflow = 22.83 cfs @ 13.28 hrs, Volume= 5.237 af
Outflow = 17.08 cfs @ 13.84 hrs, Volume= 5.007 af, Atten= 25%, Lag= 33.58 min
Primary = 17.08 cfs @ 13.84 hrs, Volume= 5.007 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 1,139.63' @ 13.84 hrs Surf.Area= 40,004 sf Storage= 47,624 cf

Plug-Flow detention time= 60.24 min calculated for 5.007 af (96% of inflow)
Center-of-Mass det. time= 38.98 min (965.20 - 926.22)

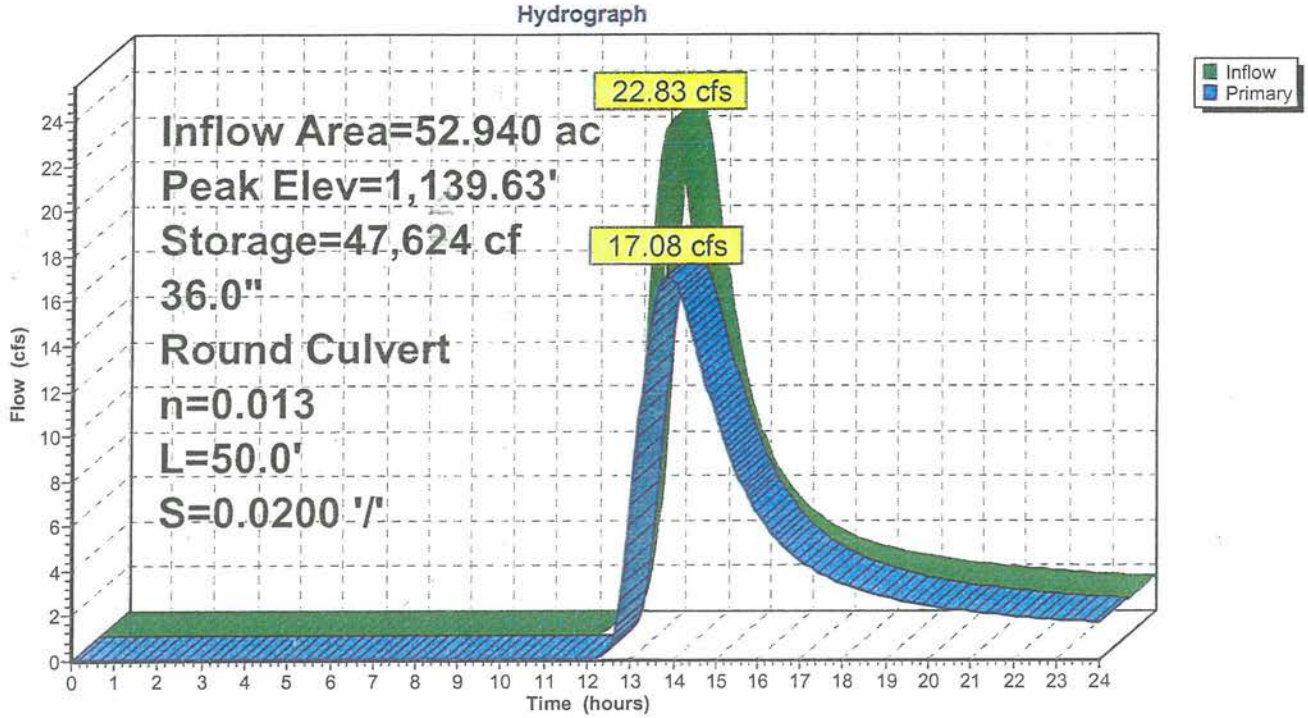
Volume	Invert	Avail.Storage	Storage Description
#1	1,138.00'	453,390 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
1,138.00	18,390	0	0
1,145.00	111,150	453,390	453,390

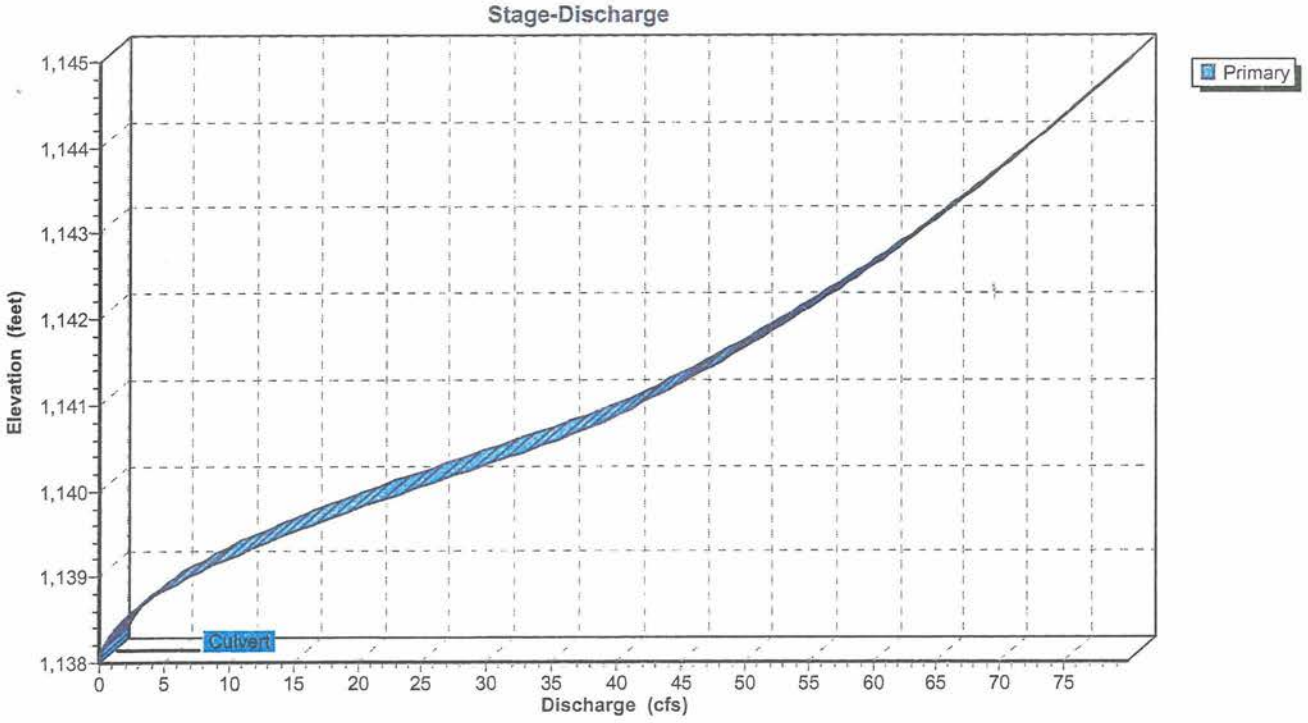
Device	Routing	Invert	Outlet Devices
#1	Primary	1,138.00'	**36.0" Round Culvert** L= 50.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 1,138.00' / 1,137.00' S= 0.0200 '/' Cc= 0.900 n= 0.013, Flow Area= 7.07 sf

Primary OutFlow Max=17.07 cfs @ 13.84 hrs HW=1,139.63' (Free Discharge)
↑—**1=Culvert** (Inlet Controls 17.07 cfs @ 4.35 fps)

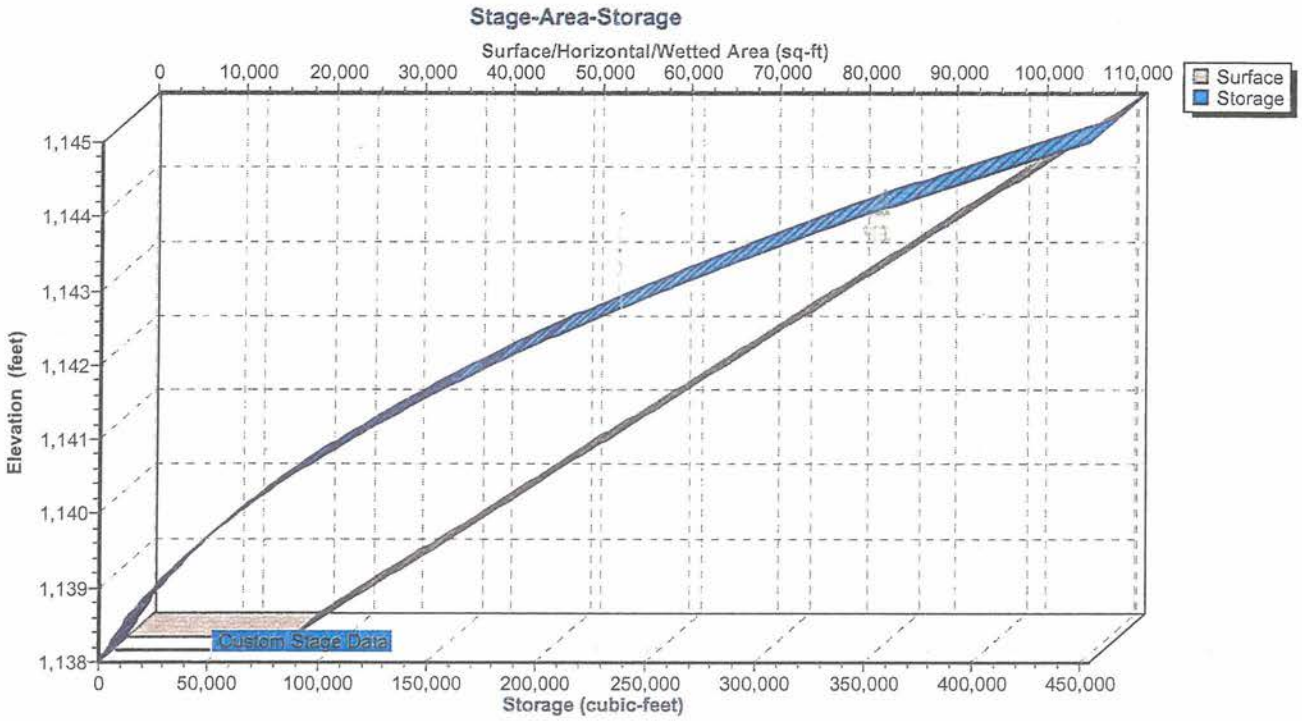
Pond 3P: Pond A.4



Pond 3P: Pond A.4



Pond 3P: Pond A.4



Summary for Pond 4P: Pond A.6

Inflow Area = 87.040 ac, 0.00% Impervious, Inflow Depth > 1.81" for 2-Year event
Inflow = 94.46 cfs @ 12.59 hrs, Volume= 13.165 af
Outflow = 39.65 cfs @ 13.24 hrs, Volume= 12.279 af, Atten= 58%, Lag= 38.67 min
Primary = 39.65 cfs @ 13.24 hrs, Volume= 12.279 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 1,142.84' @ 13.24 hrs Surf.Area= 97,240 sf Storage= 210,267 cf

Plug-Flow detention time= 104.74 min calculated for 12.254 af (93% of inflow)
Center-of-Mass det. time= 70.82 min (936.56 - 865.74)

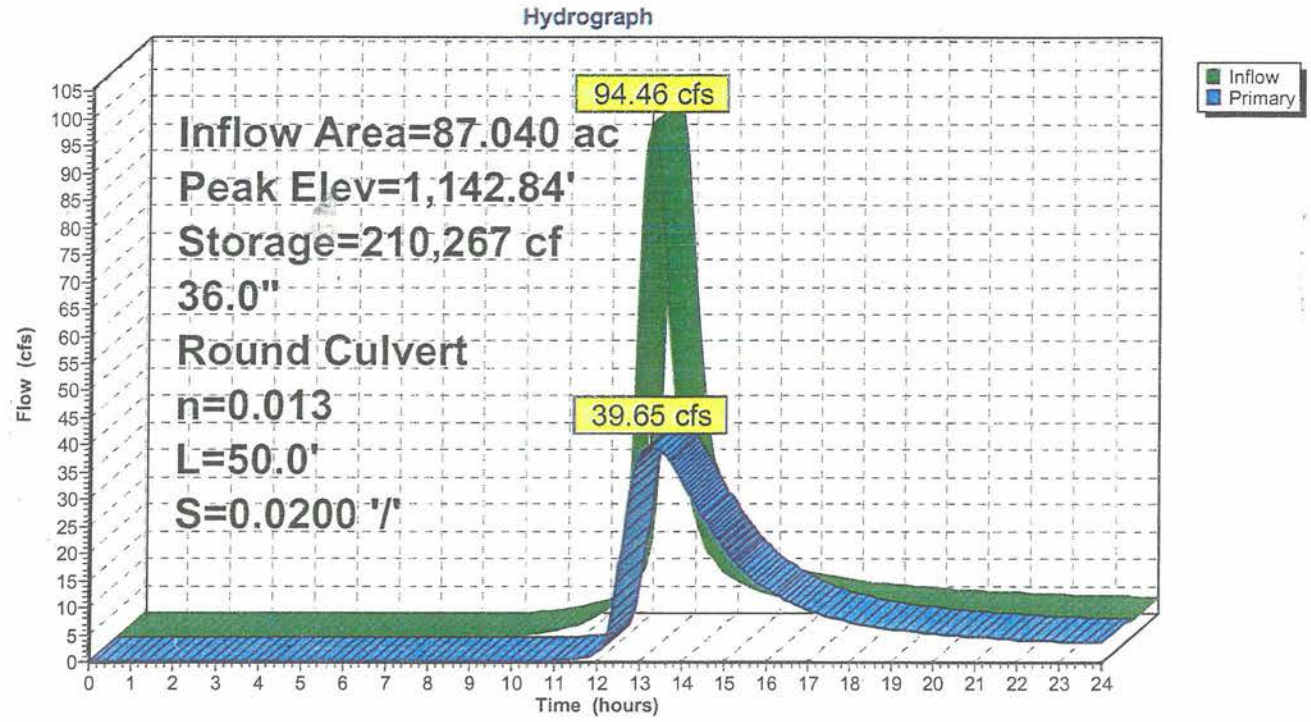
Volume	Invert	Avail.Storage	Storage Description
#1	1,140.00'	1,325,000 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
1,140.00	51,000	0	0
1,150.00	214,000	1,325,000	1,325,000

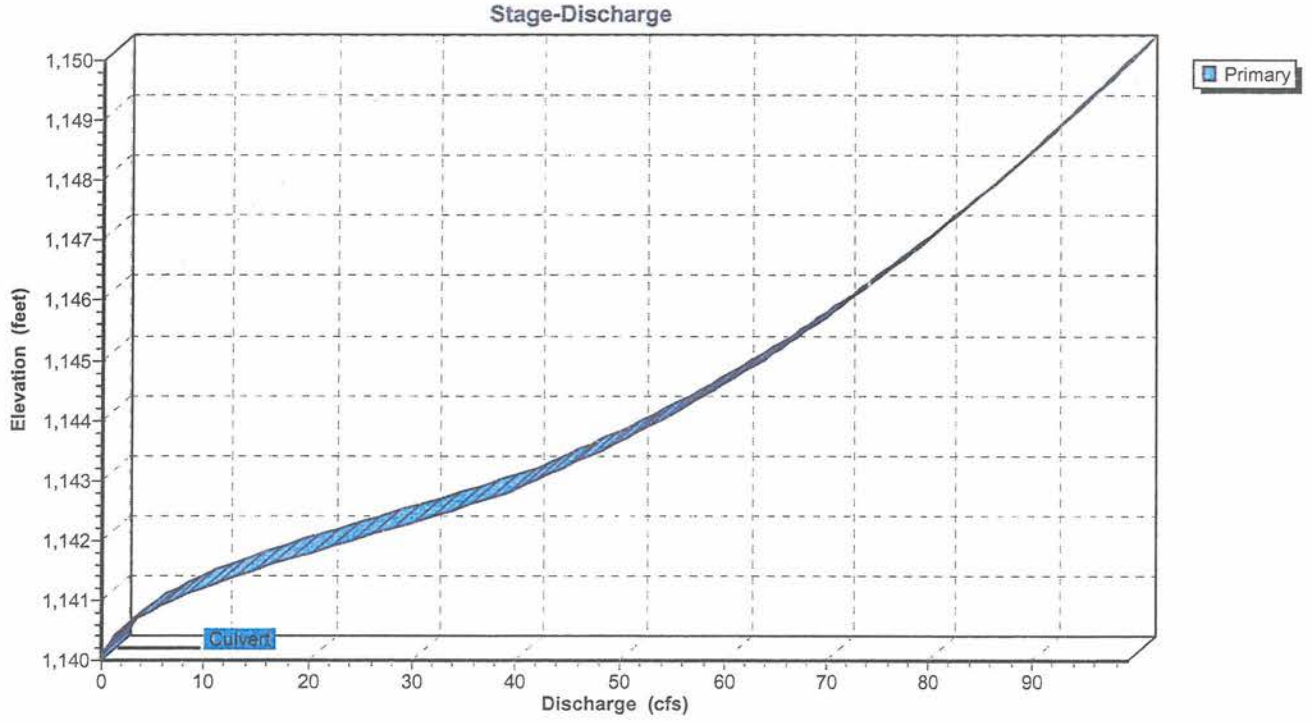
Device	Routing	Invert	Outlet Devices
#1	Primary	1,140.00'	**36.0" Round Culvert** L= 50.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 1,140.00' / 1,139.00' S= 0.0200 '/' Cc= 0.900 n= 0.013, Flow Area= 7.07 sf

Primary OutFlow Max=39.67 cfs @ 13.24 hrs HW=1,142.84' (Free Discharge)
↑—**1=Culvert** (Inlet Controls 39.67 cfs @ 5.73 fps)

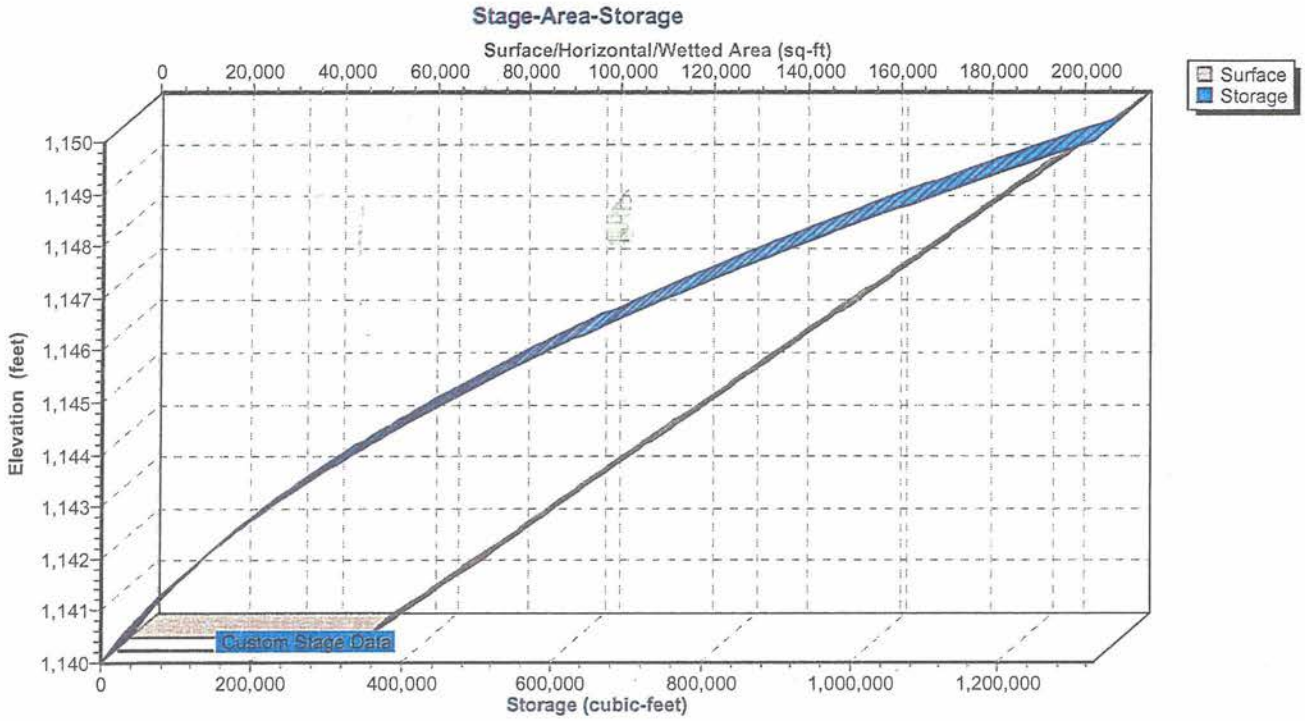
Pond 4P: Pond A.6



Pond 4P: Pond A.6



Pond 4P: Pond A.6



Summary for Pond 6P: Pond A.5

Inflow Area = 5.000 ac, 0.00% Impervious, Inflow Depth > 1.98" for 2-Year event
Inflow = 9.05 cfs @ 12.24 hrs, Volume= 0.826 af
Outflow = 2.81 cfs @ 12.76 hrs, Volume= 0.736 af, Atten= 69%, Lag= 31.26 min
Primary = 2.81 cfs @ 12.76 hrs, Volume= 0.736 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 1,145.78' @ 12.76 hrs Surf.Area= 19,508 sf Storage= 15,261 cf

Plug-Flow detention time= 138.06 min calculated for 0.736 af (89% of inflow)
Center-of-Mass det. time= 85.56 min (926.64 - 841.08)

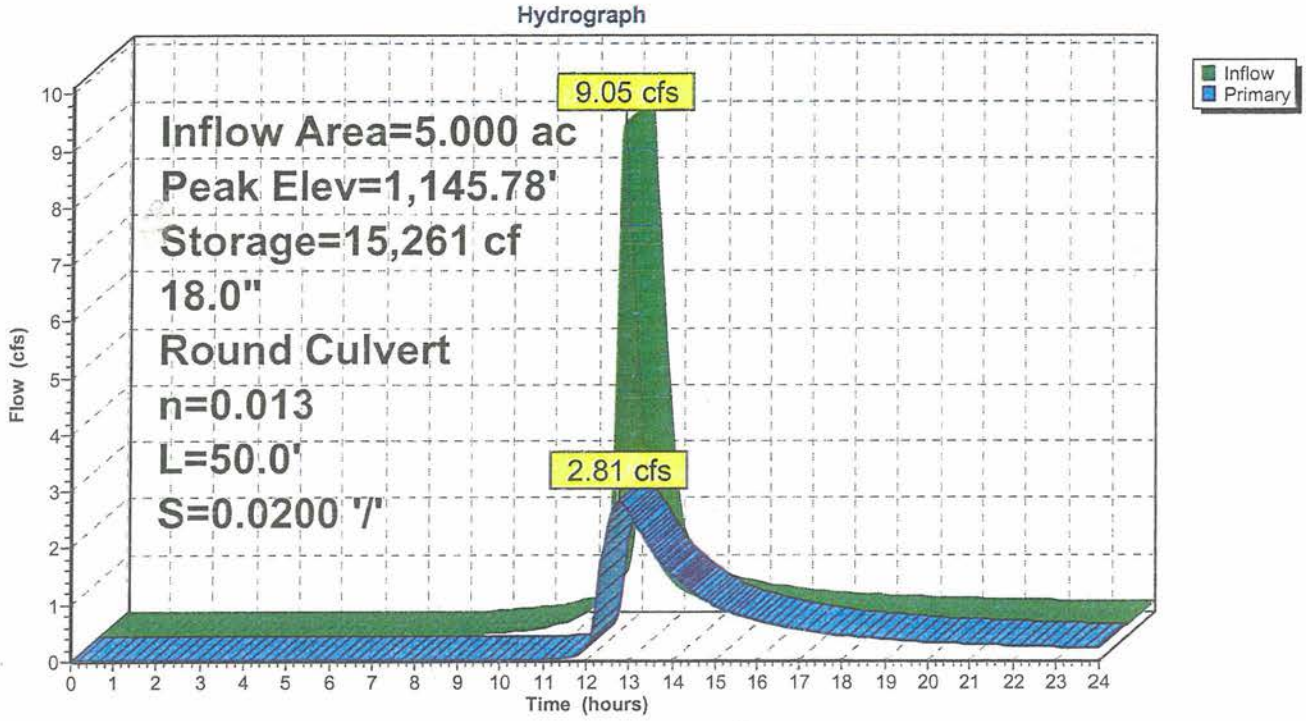
Volume	Invert	Avail.Storage	Storage Description
#1	1,145.00'	97,540 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
1,145.00	19,508	0	0
1,150.00	19,508	97,540	97,540

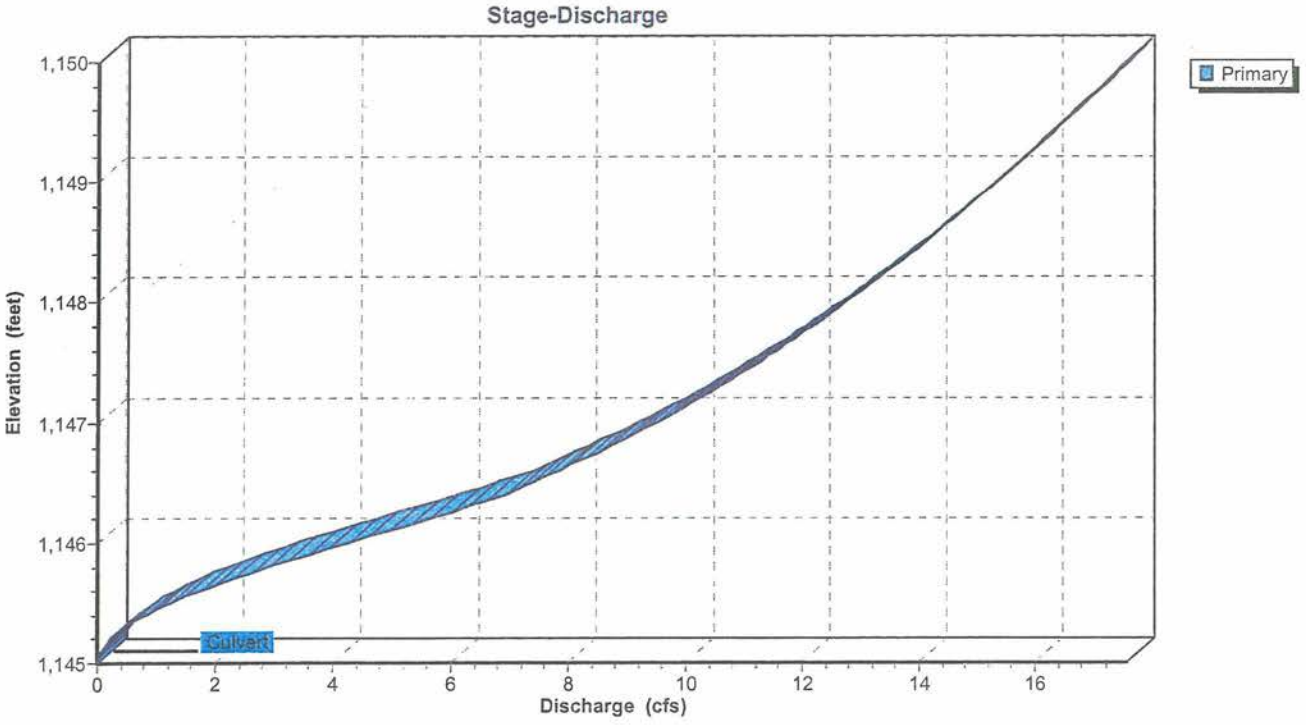
Device	Routing	Invert	Outlet Devices
#1	Primary	1,145.00'	**18.0" Round Culvert** L= 50.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 1,145.00' / 1,144.00' S= 0.0200 '/' Cc= 0.900 n= 0.013, Flow Area= 1.77 sf

Primary OutFlow Max=2.80 cfs @ 12.76 hrs HW=1,145.78' (Free Discharge)
↑**1=Culvert** (Inlet Controls 2.80 cfs @ 3.01 fps)

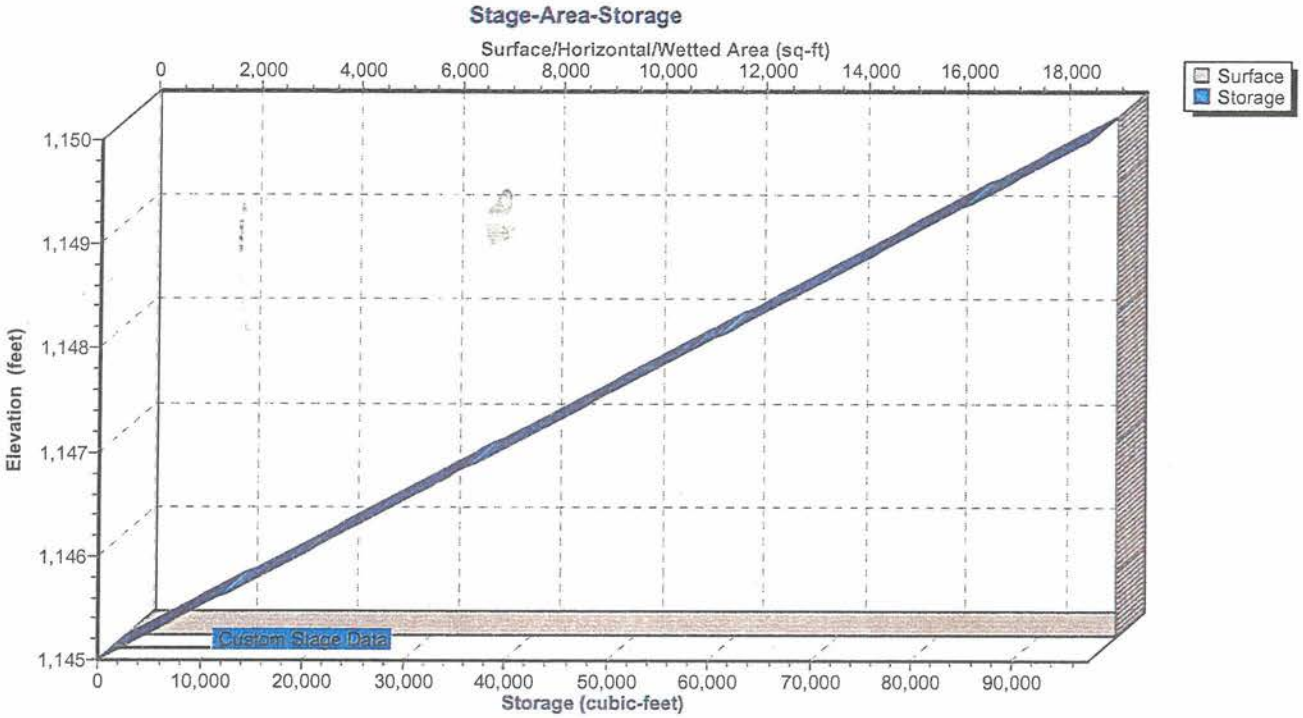
Pond 6P: Pond A.5



Pond 6P: Pond A.5



Pond 6P: Pond A.5



Summary for Pond 8P: Pond A.3

Inflow Area = 14.000 ac, 0.00% Impervious, Inflow Depth > 2.05" for 2-Year event
Inflow = 19.64 cfs @ 12.46 hrs, Volume= 2.395 af
Outflow = 12.79 cfs @ 12.79 hrs, Volume= 2.269 af, Atten= 35%, Lag= 20.33 min
Primary = 12.79 cfs @ 12.79 hrs, Volume= 2.269 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 1,141.50' @ 12.79 hrs Surf.Area= 19,508 sf Storage= 29,214 cf

Plug-Flow detention time= 72.02 min calculated for 2.269 af (95% of inflow)
Center-of-Mass det. time= 44.18 min (894.08 - 849.90)

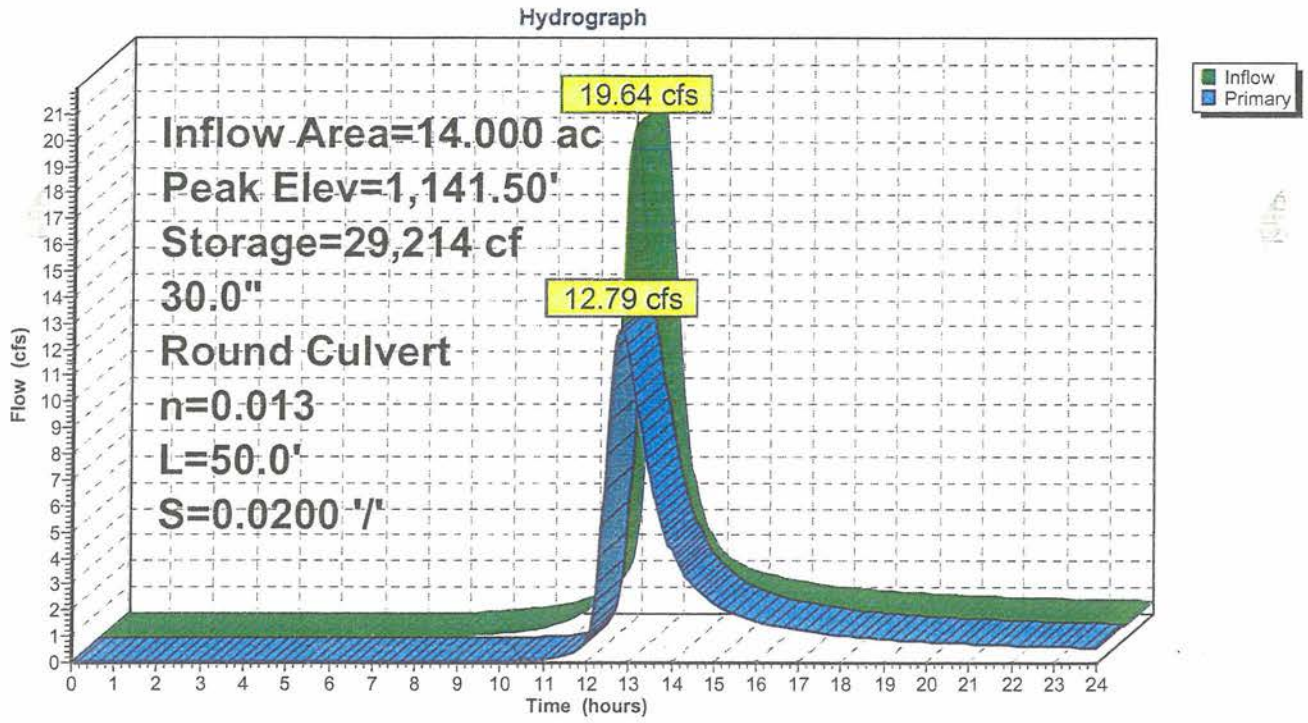
Volume	Invert	Avail.Storage	Storage Description
#1	1,140.00'	97,540 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
1,140.00	19,508	0	0
1,145.00	19,508	97,540	97,540

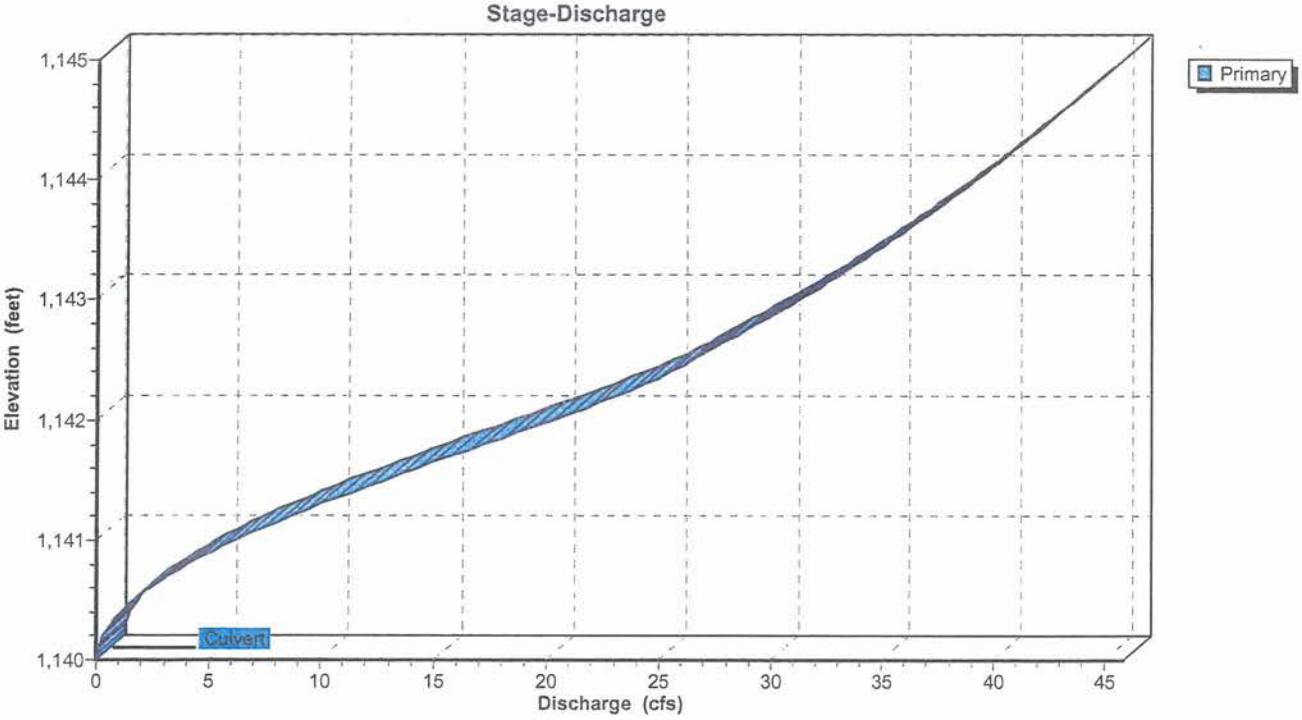
Device	Routing	Invert	Outlet Devices
#1	Primary	1,140.00'	**30.0" Round Culvert** L= 50.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 1,140.00' / 1,139.00' S= 0.0200 '/' Cc= 0.900 n= 0.013, Flow Area= 4.91 sf

Primary OutFlow Max=12.78 cfs @ 12.79 hrs HW=1,141.50' (Free Discharge)
1=Culvert (Inlet Controls 12.78 cfs @ 4.17 fps)

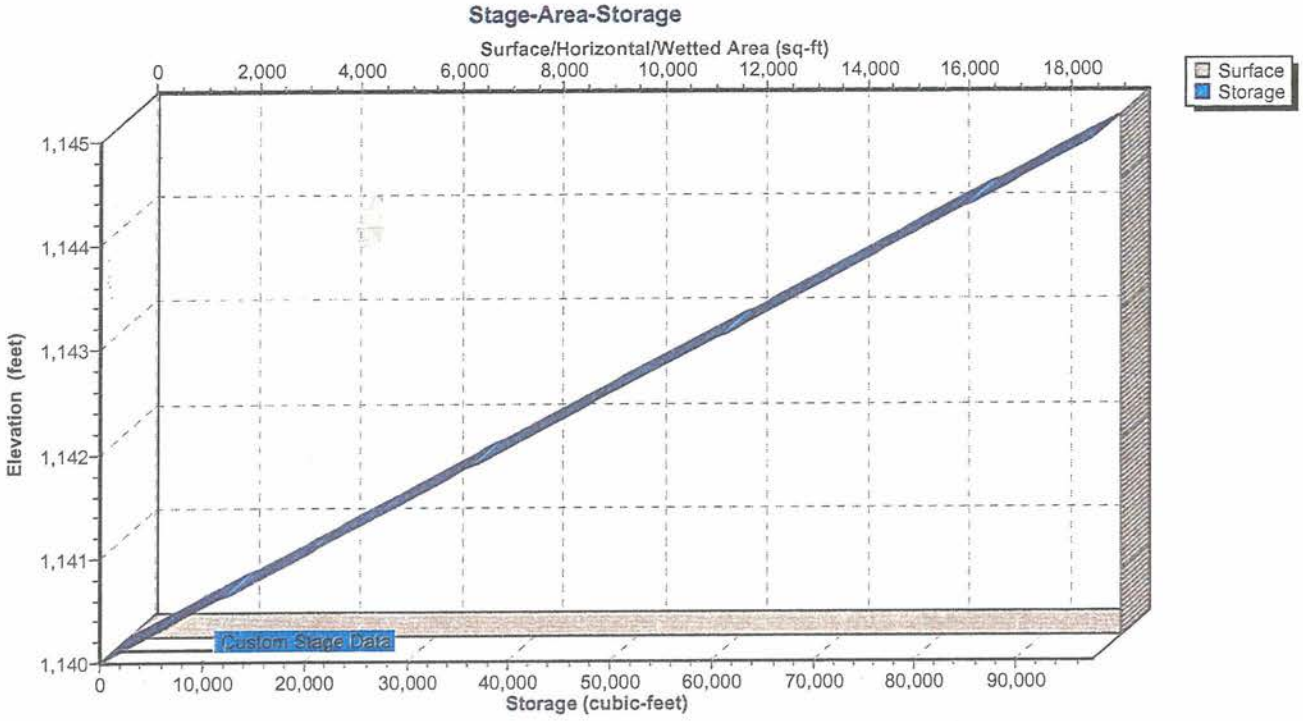
Pond 8P: Pond A.3



Pond 8P: Pond A.3



Pond 8P: Pond A.3



Summary for Pond 10P: Pond A.2

Inflow Area = 49.000 ac, 0.00% Impervious, Inflow Depth > 1.67" for 2-Year event
Inflow = 58.00 cfs @ 12.42 hrs, Volume= 6.839 af
Outflow = 9.81 cfs @ 13.51 hrs, Volume= 5.138 af, Atten= 83%, Lag= 65.11 min
Primary = 9.81 cfs @ 13.51 hrs, Volume= 5.138 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 1,134.20' @ 13.51 hrs Surf.Area= 127,850 sf Storage= 153,099 cf

Plug-Flow detention time= 242.68 min calculated for 5.138 af (75% of inflow)
Center-of-Mass det. time= 150.59 min (1,012.88 - 862.30)

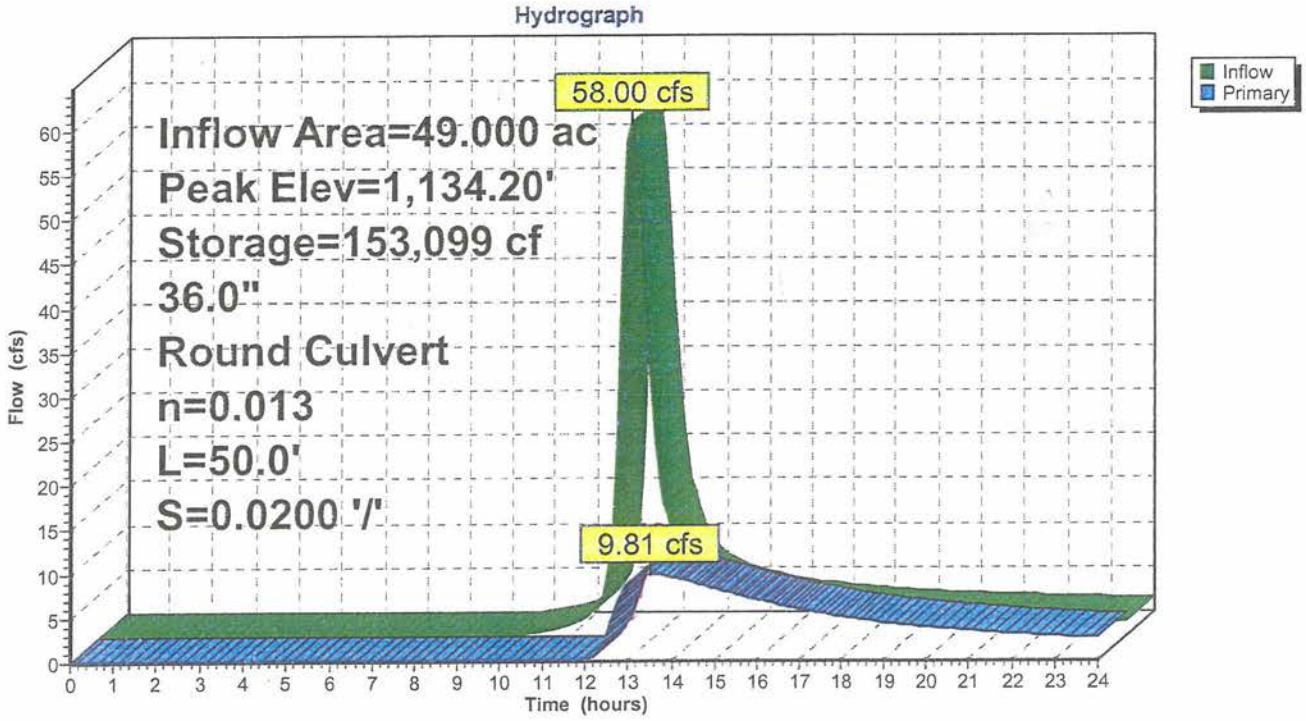
Volume	Invert	Avail.Storage	Storage Description
#1	1,133.00'	894,950 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
1,133.00	127,850	0	0
1,140.00	127,850	894,950	894,950

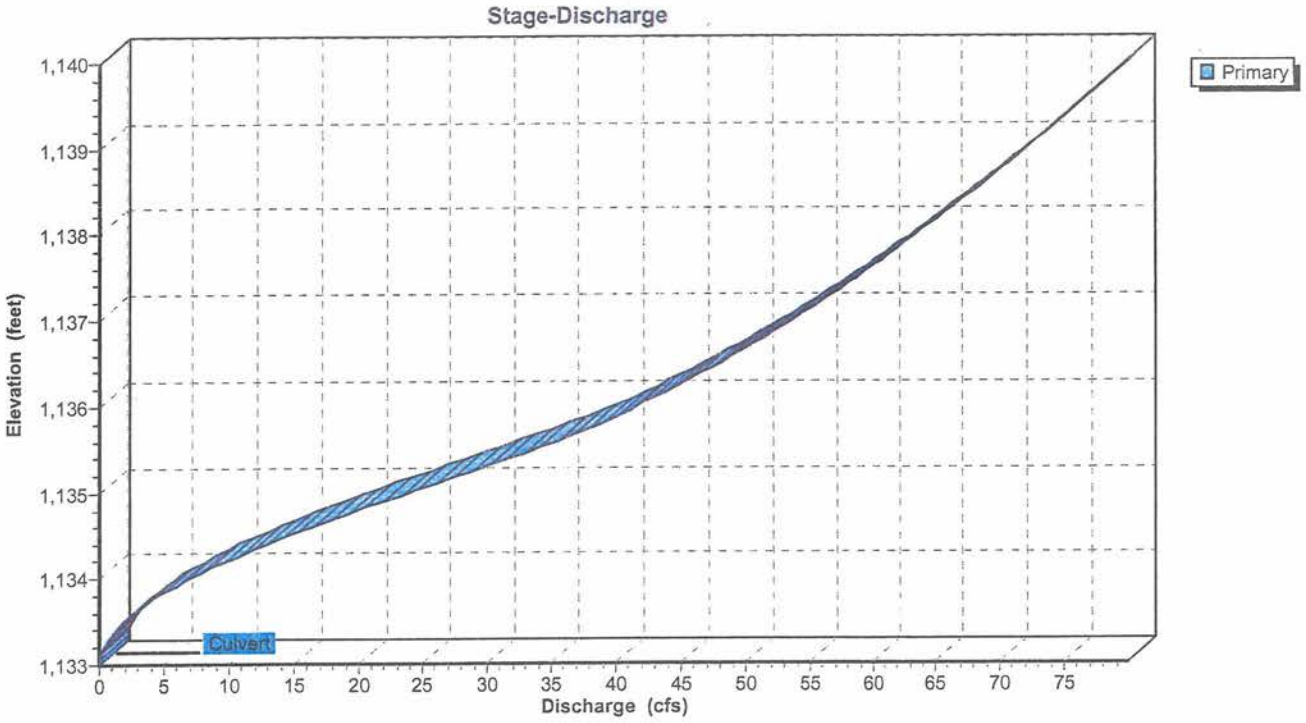
Device	Routing	Invert	Outlet Devices
#1	Primary	1,133.00'	**36.0" Round Culvert** L= 50.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 1,133.00' / 1,132.00' S= 0.0200 '/' Cc= 0.900 n= 0.013, Flow Area= 7.07 sf

Primary OutFlow Max=9.81 cfs @ 13.51 hrs HW=1,134.20' (Free Discharge)
1=Culvert (Inlet Controls 9.81 cfs @ 3.73 fps)

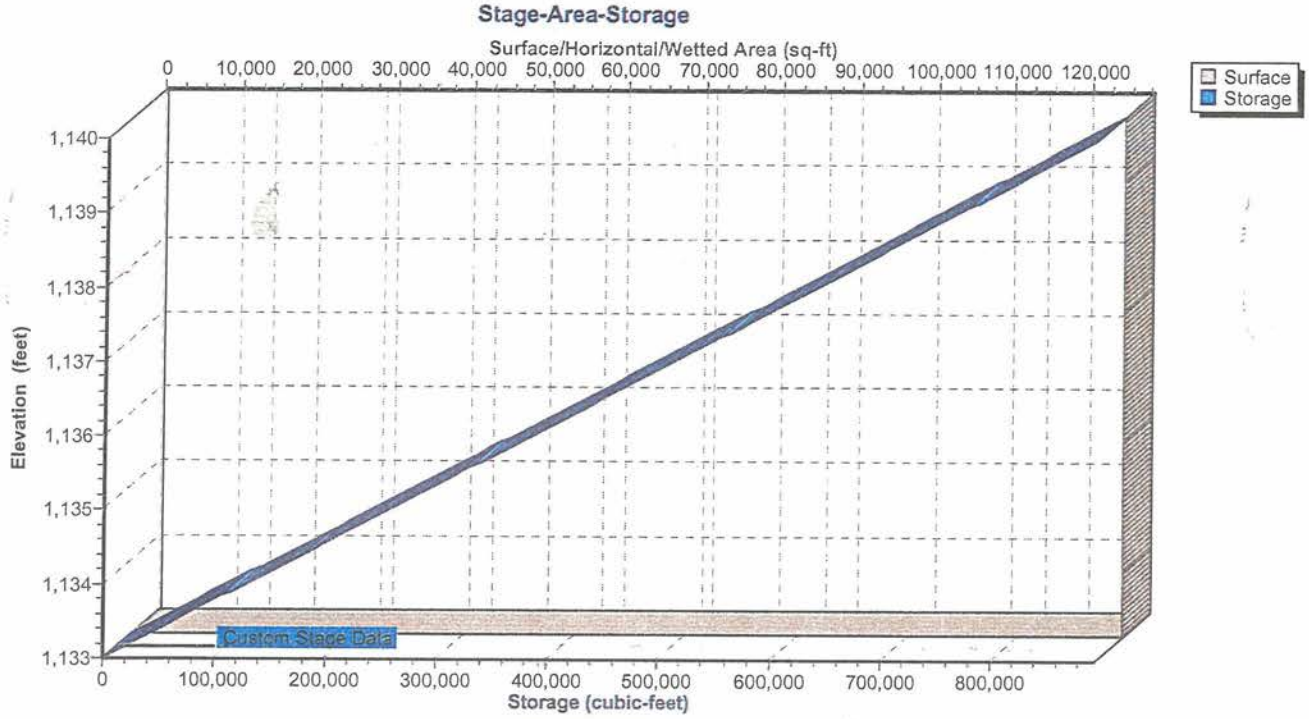
Pond 10P: Pond A.2



Pond 10P: Pond A.2



Pond 10P: Pond A.2



Summary for Pond 12P: Pond A.7

Inflow Area = 14.350 ac, 0.00% Impervious, Inflow Depth > 2.48" for 2-Year event
Inflow = 26.44 cfs @ 12.36 hrs, Volume= 2.967 af
Outflow = 18.34 cfs @ 12.63 hrs, Volume= 2.843 af, Atten= 31%, Lag= 15.88 min
Primary = 18.34 cfs @ 12.63 hrs, Volume= 2.843 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 1,146.70' @ 12.63 hrs Surf.Area= 19,508 sf Storage= 33,154 cf

Plug-Flow detention time= 63.42 min calculated for 2.843 af (96% of inflow)
Center-of-Mass det. time= 40.12 min (868.96 - 828.84)

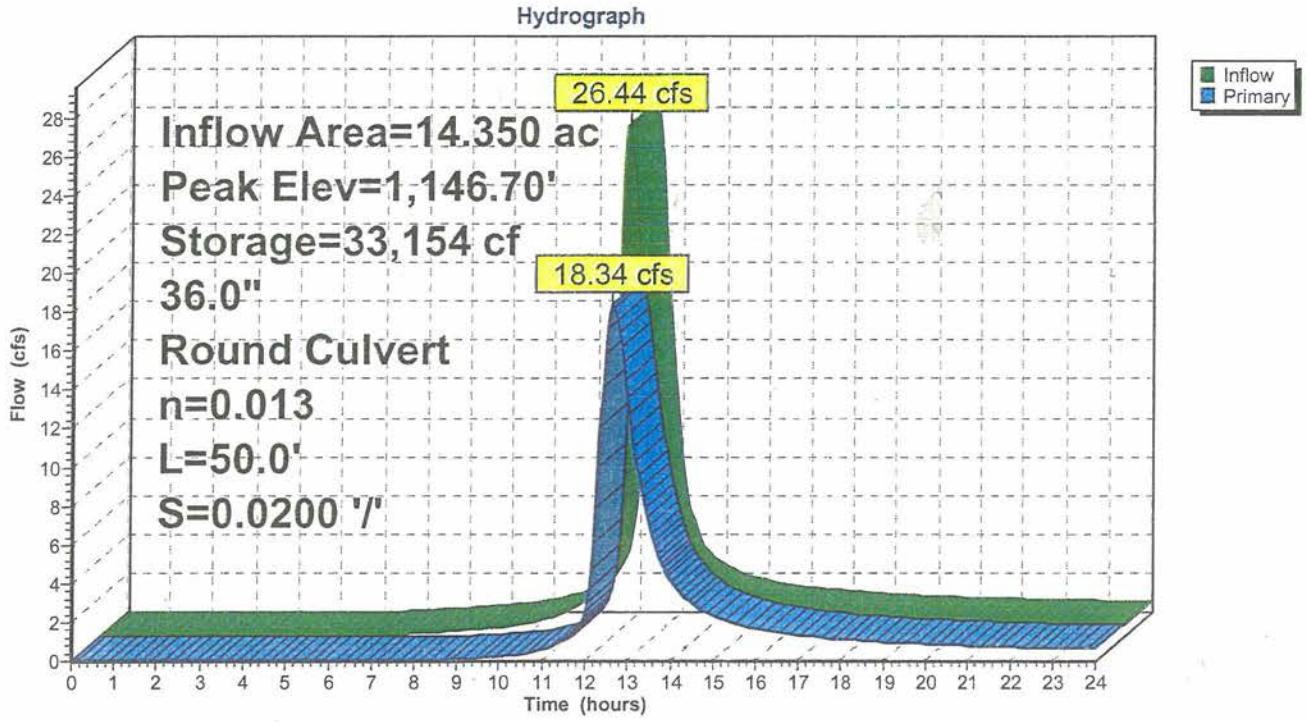
Volume	Invert	Avail.Storage	Storage Description
#1	1,145.00'	97,540 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
1,145.00	19,508	0	0
1,150.00	19,508	97,540	97,540

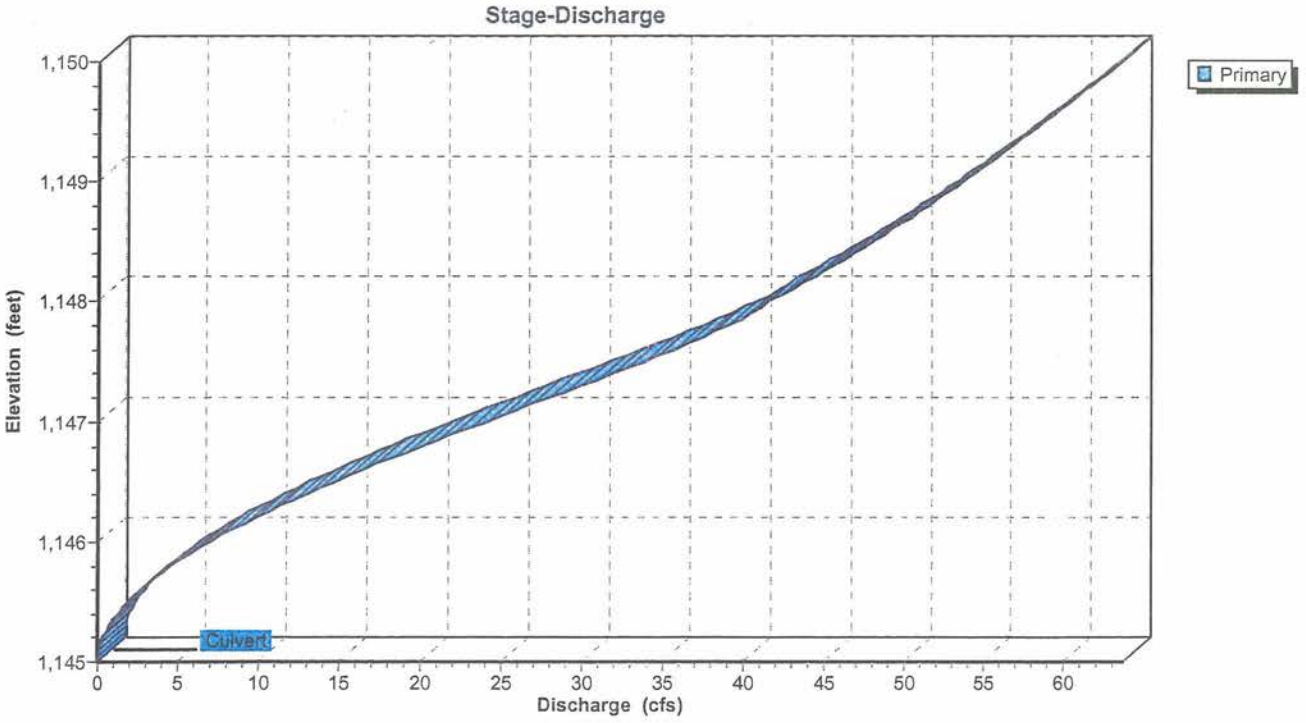
Device	Routing	Invert	Outlet Devices
#1	Primary	1,145.00'	**36.0" Round Culvert** L= 50.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 1,145.00' / 1,144.00' S= 0.0200 '/' Cc= 0.900 n= 0.013, Flow Area= 7.07 sf

Primary OutFlow Max=18.30 cfs @ 12.63 hrs HW=1,146.70' (Free Discharge)
1=Culvert (Inlet Controls 18.30 cfs @ 4.44 fps)

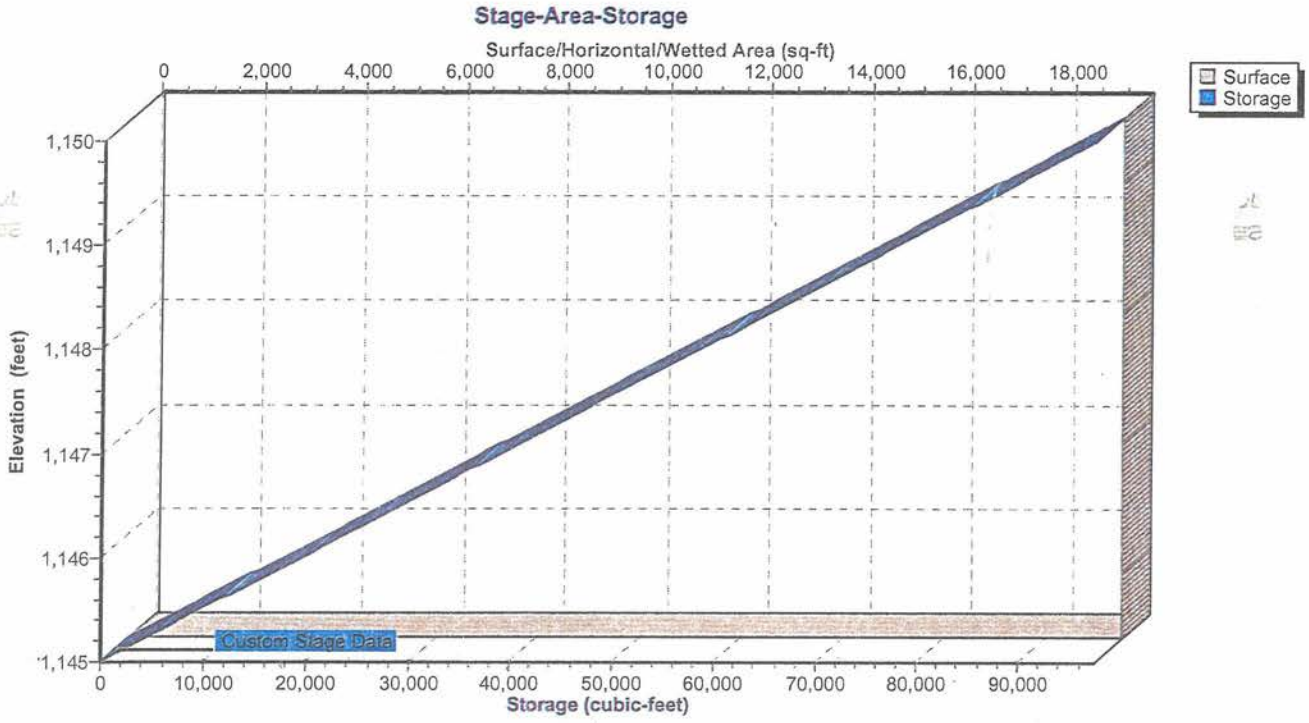
Pond 12P: Pond A.7



Pond 12P: Pond A.7



Pond 12P: Pond A.7



Summary for Pond 14P: Pond A.8

Inflow Area = 28.470 ac, 0.00% Impervious, Inflow Depth > 1.82" for 2-Year event
Inflow = 37.80 cfs @ 12.40 hrs, Volume= 4.323 af
Outflow = 4.44 cfs @ 13.83 hrs, Volume= 2.846 af, Atten= 88%, Lag= 86.26 min
Primary = 4.44 cfs @ 13.83 hrs, Volume= 2.846 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 1,125.78' @ 13.83 hrs Surf.Area= 136,000 sf Storage= 106,607 cf

Plug-Flow detention time= 288.44 min calculated for 2.846 af (66% of inflow)
Center-of-Mass det. time= 183.39 min (1,038.88 - 855.49)

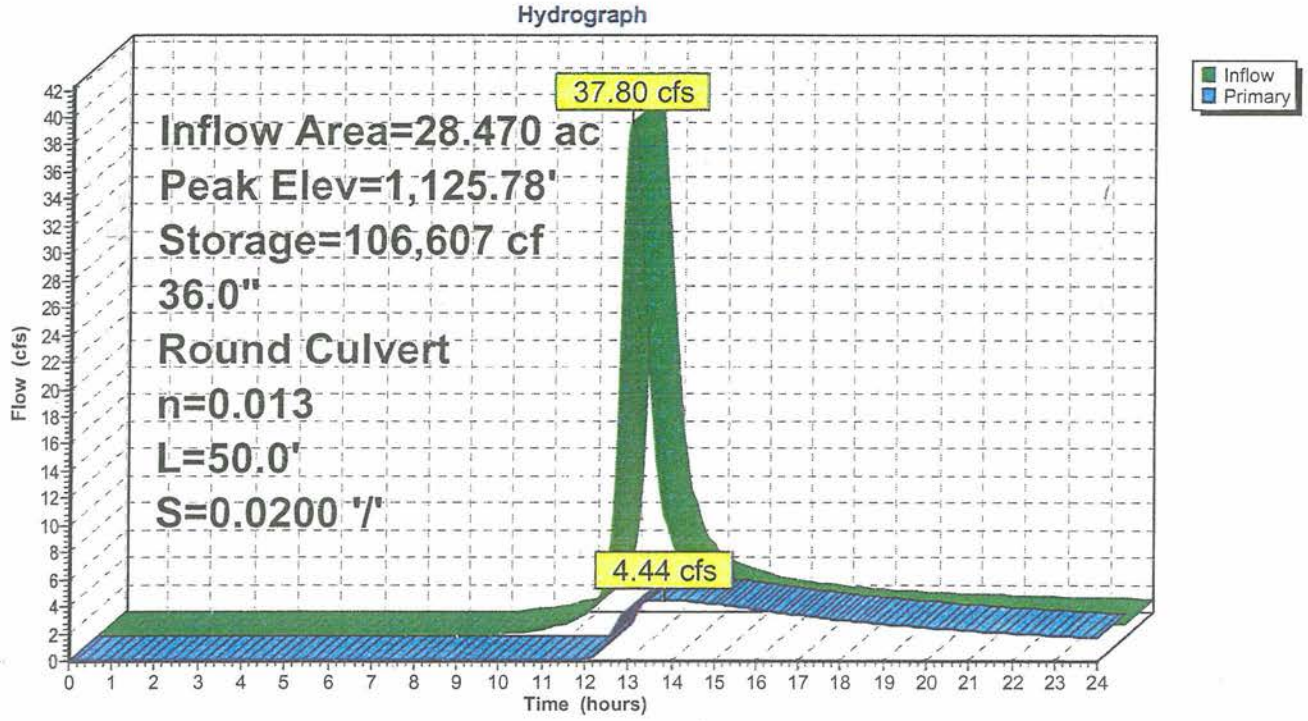
Volume	Invert	Avail.Storage	Storage Description
#1	1,125.00'	1,088,000 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
1,125.00	136,000	0	0
1,133.00	136,000	1,088,000	1,088,000

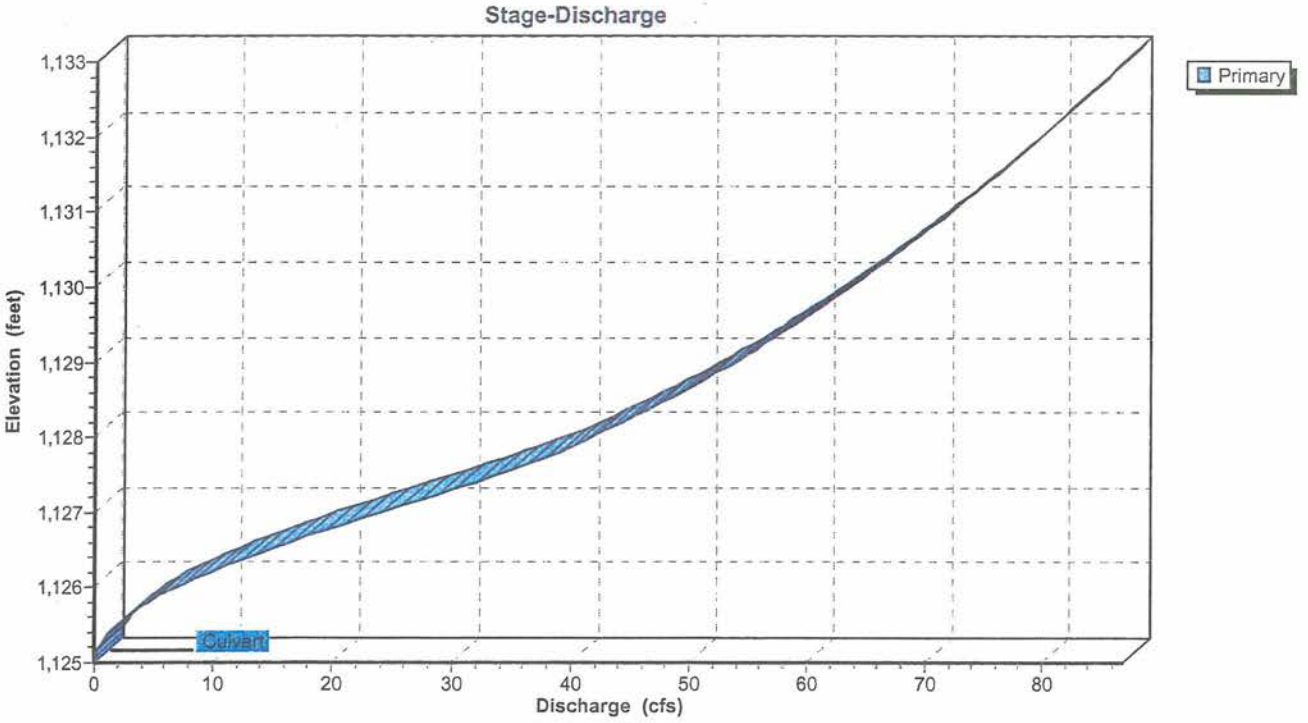
Device	Routing	Invert	Outlet Devices
#1	Primary	1,125.00'	**36.0" Round Culvert** L= 50.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 1,125.00' / 1,124.00' S= 0.0200 '/' Cc= 0.900 n= 0.013, Flow Area= 7.07 sf

Primary OutFlow Max=4.43 cfs @ 13.83 hrs HW=1,125.78' (Free Discharge)
└**1=Culvert** (Inlet Controls 4.43 cfs @ 3.01 fps)

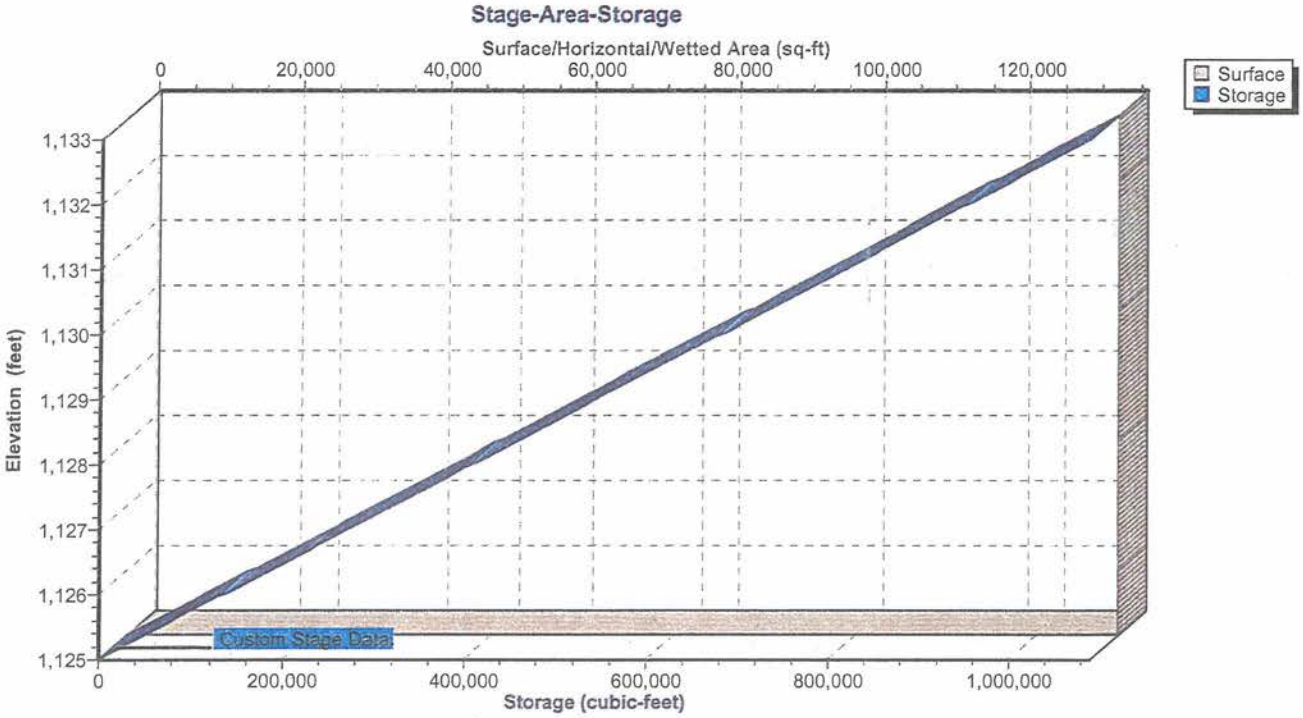
Pond 14P: Pond A.8



Pond 14P: Pond A.8



Pond 14P: Pond A.8



Summary for Pond 18P: Pond A.1

Inflow Area = 22.930 ac, 0.00% Impervious, Inflow Depth > 1.82" for 2-Year event
Inflow = 30.31 cfs @ 12.40 hrs, Volume= 3.481 af
Outflow = 22.12 cfs @ 12.66 hrs, Volume= 3.341 af, Atten= 27%, Lag= 15.43 min
Primary = 22.12 cfs @ 12.66 hrs, Volume= 3.341 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 1,131.77' @ 12.66 hrs Surf.Area= 19,508 sf Storage= 34,541 cf

Plug-Flow detention time= 53.83 min calculated for 3.341 af (96% of inflow)
Center-of-Mass det. time= 31.93 min (887.52 - 855.60)

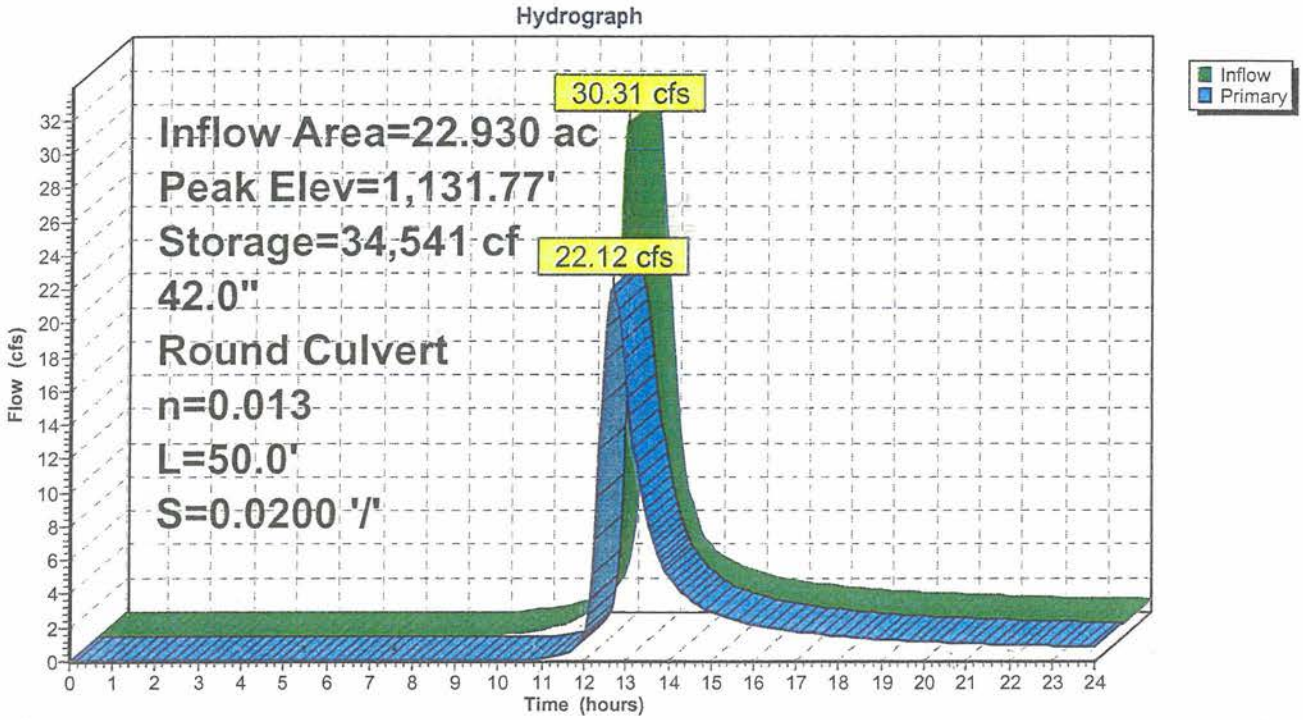
Volume	Invert	Avail.Storage	Storage Description
#1	1,130.00'	97,540 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
1,130.00	19,508	0	0
1,135.00	19,508	97,540	97,540

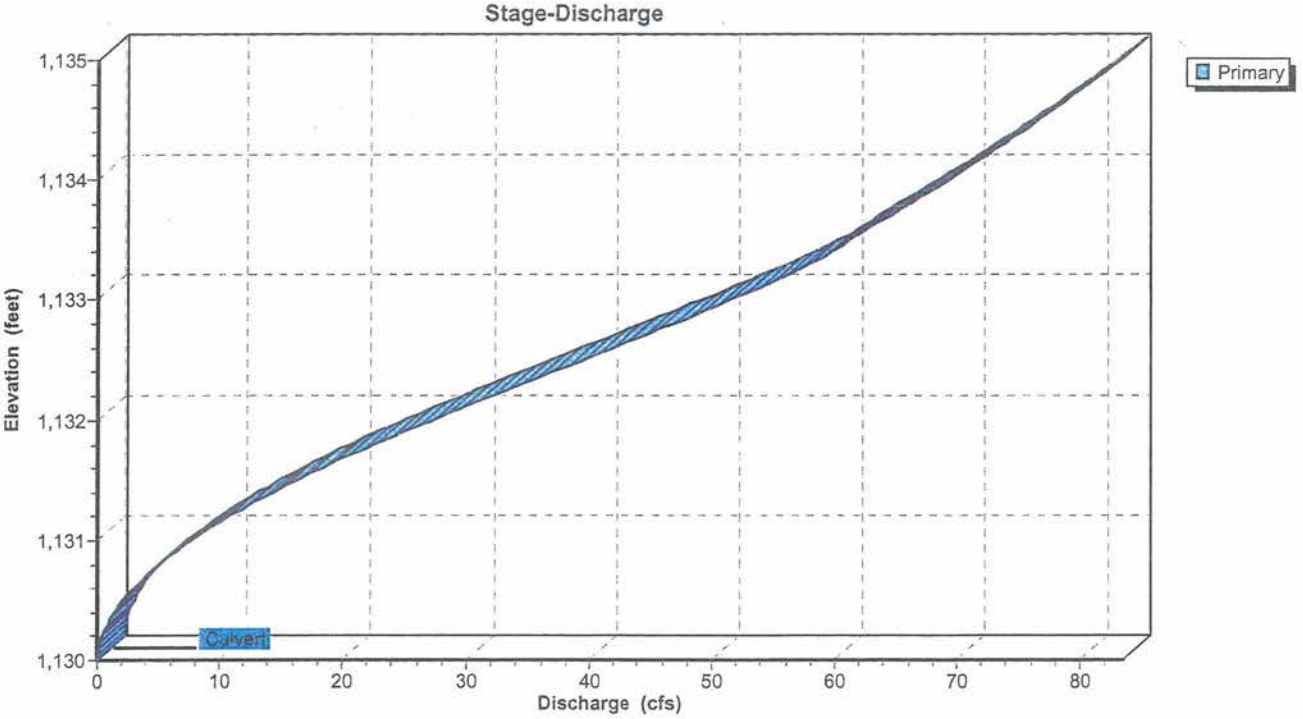
Device	Routing	Invert	Outlet Devices
#1	Primary	1,130.00'	**42.0" Round Culvert** L= 50.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 1,130.00' / 1,129.00' S= 0.0200 '/' Cc= 0.900 n= 0.013, Flow Area= 9.62 sf

Primary OutFlow Max=22.10 cfs @ 12.66 hrs HW=1,131.77' (Free Discharge)
↑**1=Culvert** (Inlet Controls 22.10 cfs @ 4.53 fps)

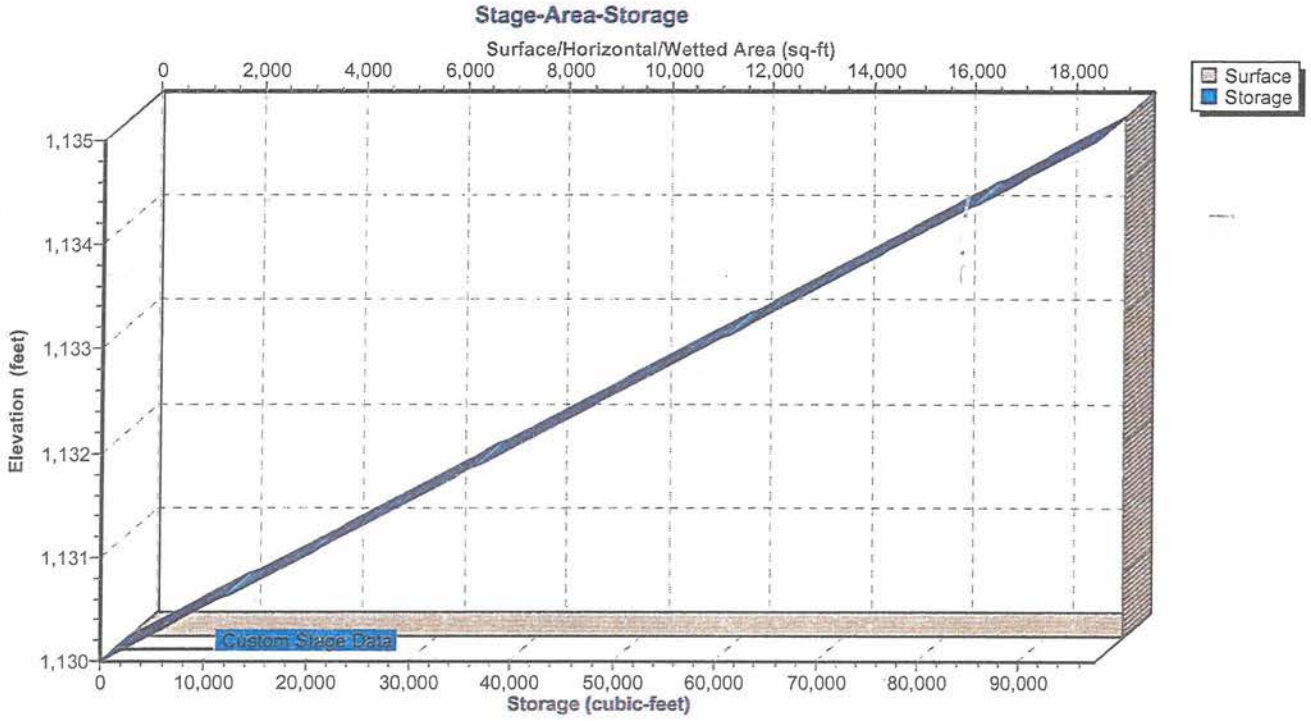
Pond 18P: Pond A.1



Pond 18P: Pond A.1



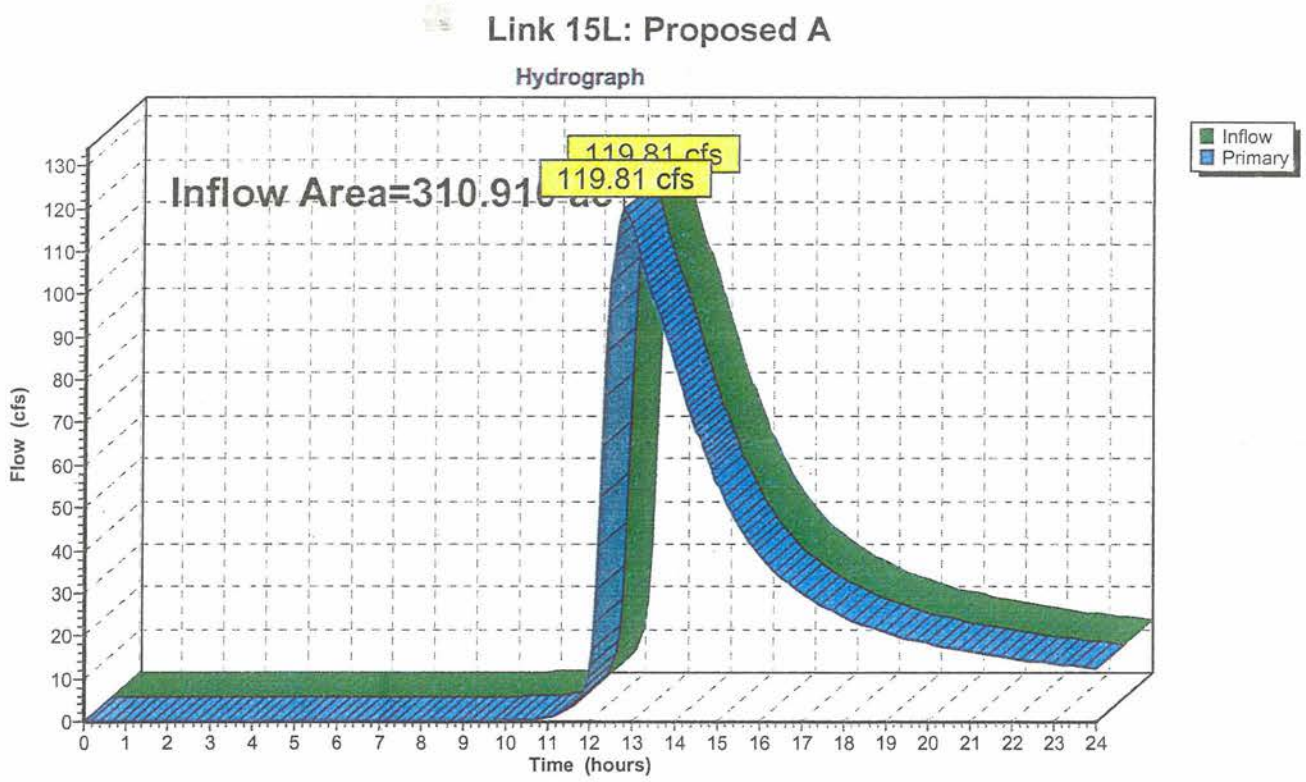
Pond 18P: Pond A.1



Summary for Link 15L: Proposed A

Inflow Area = 310.910 ac, 0.00% Impervious, Inflow Depth > 1.48" for 2-Year event
Inflow = 119.81 cfs @ 12.78 hrs, Volume= 38.410 af
Primary = 119.81 cfs @ 12.78 hrs, Volume= 38.410 af, Atten= 0%, Lag= 0.00 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs



Summary for Subcatchment 1S: Area A.6

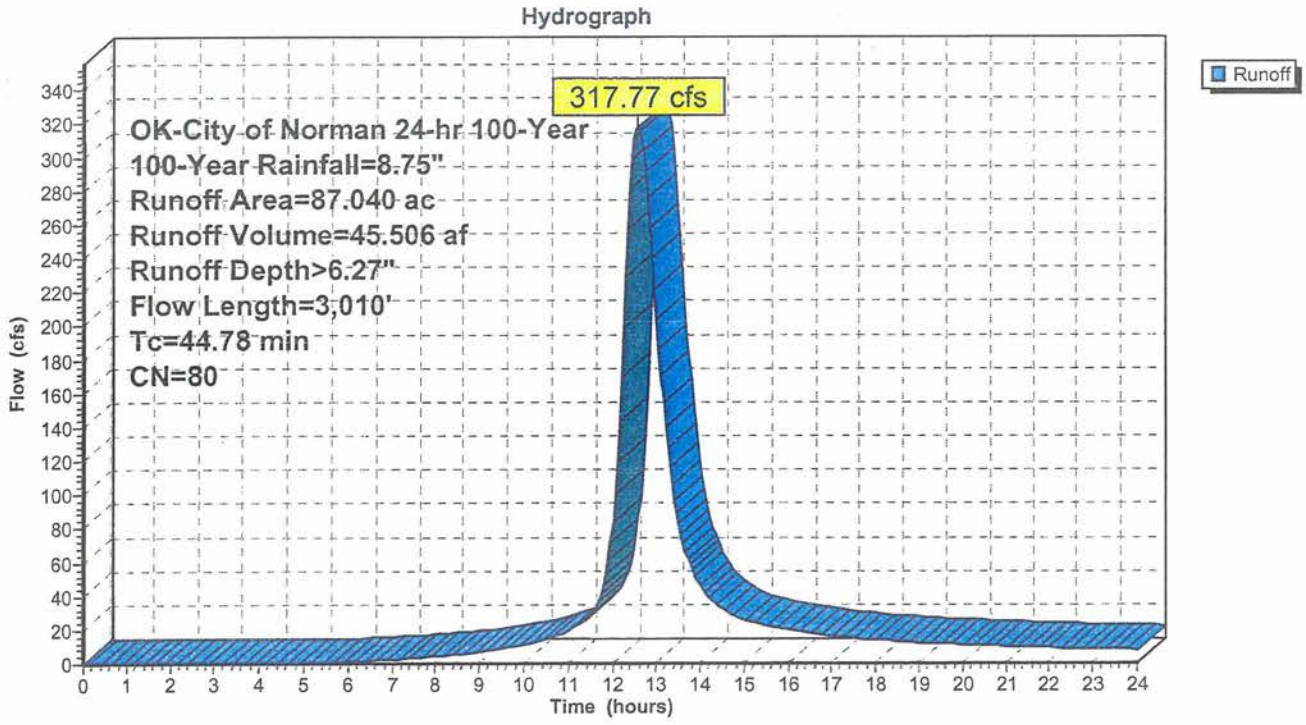
Runoff = 317.77 cfs @ 12.58 hrs, Volume= 45.506 af, Depth> 6.27"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
OK-City of Norman 24-hr 100-Year 100-Year Rainfall=8.75"

	Area (ac)	CN	Description
*	87.040	80	Developed
	87.040		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
26.70	100	0.0100	0.06		**Sheet Flow, Overland flow** Grass: Bermuda n= 0.410 P2= 3.75"
4.70	810	0.0200	2.87		**Shallow Concentrated Flow, Street** Paved Kv= 20.3 fps
13.38	2,100	0.0124	2.62	39.24	**Channel Flow, Creek** Area= 15.0 sf Perim= 25.0' r= 0.60' n= 0.045
44.78	3,010	Total			

Subcatchment 1S: Area A.6



Summary for Subcatchment 2S: Area A.4

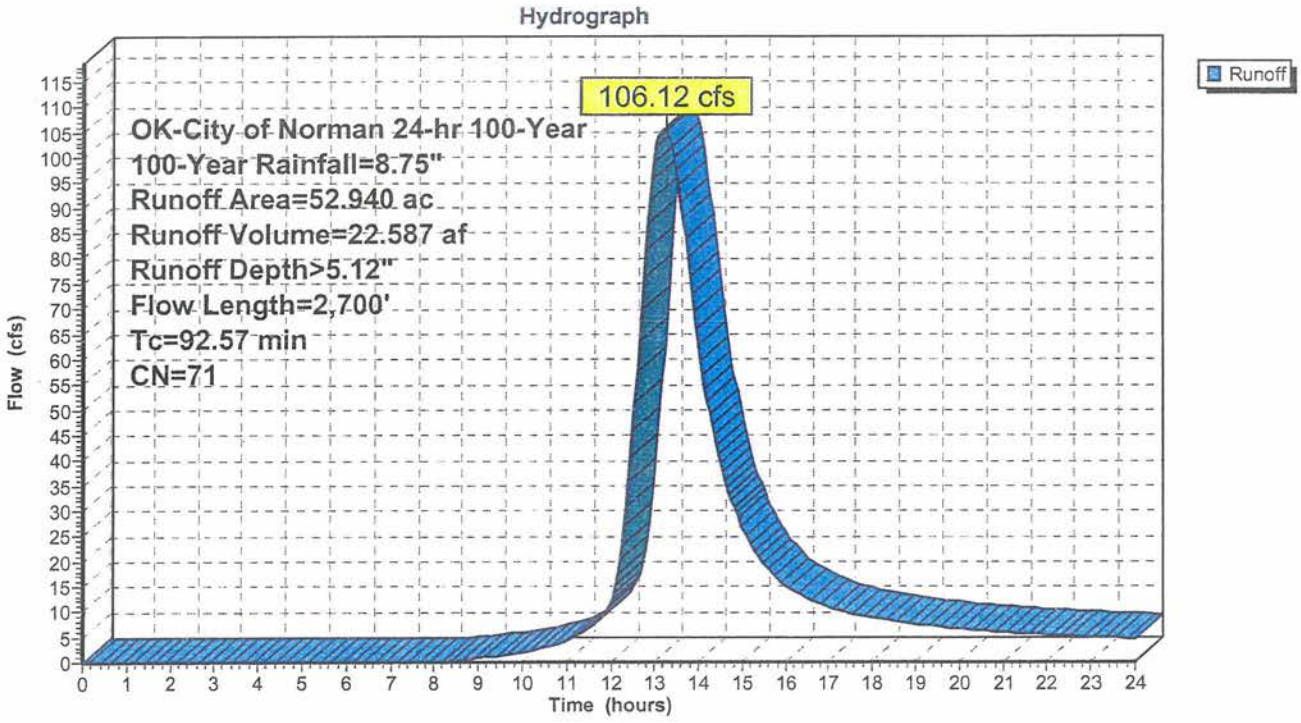
Runoff = 106.12 cfs @ 13.24 hrs, Volume= 22.587 af, Depth> 5.12"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
OK-City of Norman 24-hr 100-Year 100-Year Rainfall=8.75"

	Area (ac)	CN	Description
*	52.940	71	Offsite & developed
	52.940		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
64.29	300	0.0100	0.08		**Sheet Flow, Overland** Grass: Bermuda n= 0.410 P2= 3.75"
20.43	1,300	0.0050	1.06		**Shallow Concentrated Flow, Swale** Grassed Waterway Kv= 15.0 fps
7.85	1,100	0.0050	2.34	23.35	**Channel Flow, Ex. channel** Area= 10.0 sf Perim= 10.0' r= 1.00' n= 0.045
92.57	2,700	Total			

Subcatchment 2S: Area A.4



Summary for Subcatchment 5S: Area A.5

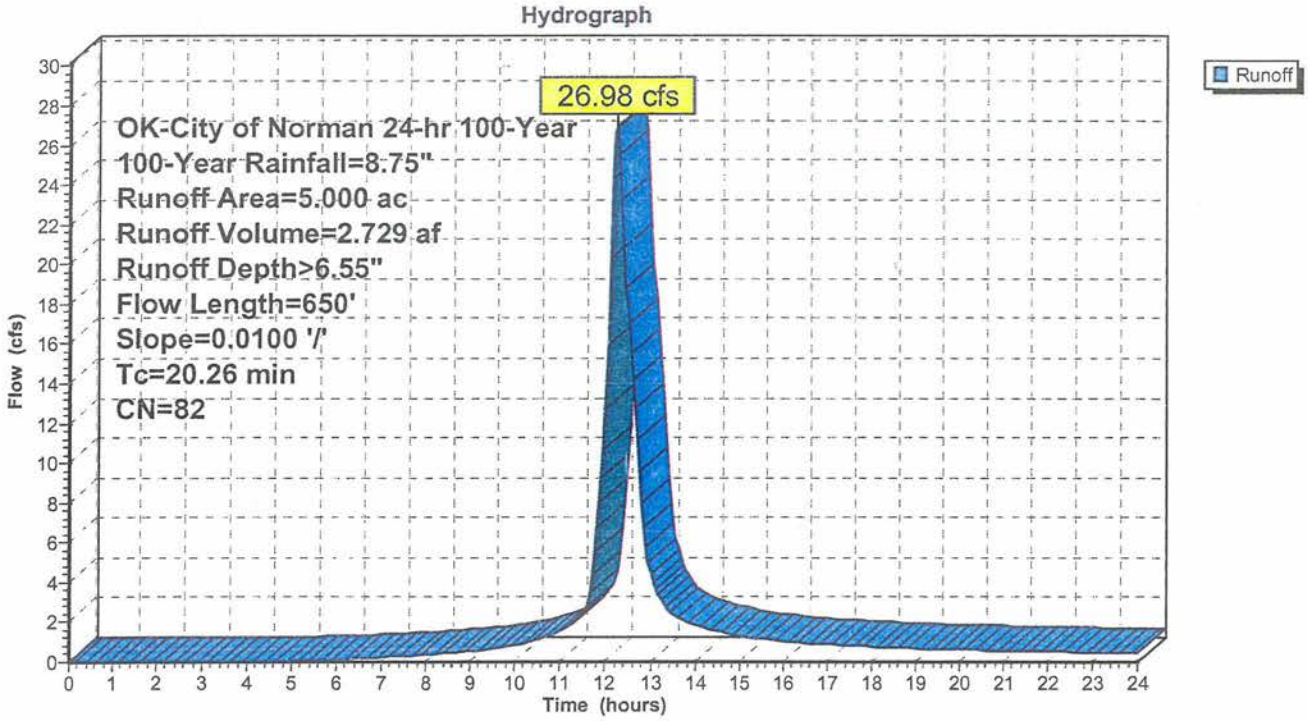
Runoff = 26.98 cfs @ 12.23 hrs, Volume= 2.729 af, Depth> 6.55"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
OK-City of Norman 24-hr 100-Year 100-Year Rainfall=8.75"

	Area (ac)	CN	Description
*	5.000	82	Developed
	5.000		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
15.33	50	0.0100	0.05		**Sheet Flow, Overland** Grass: Bermuda n= 0.410 P2= 3.75"
4.93	600	0.0100	2.03		**Shallow Concentrated Flow, Street** Paved Kv= 20.3 fps
20.26	650	Total			

Subcatchment 5S: Area A.5



Summary for Subcatchment 7S: Area A.3

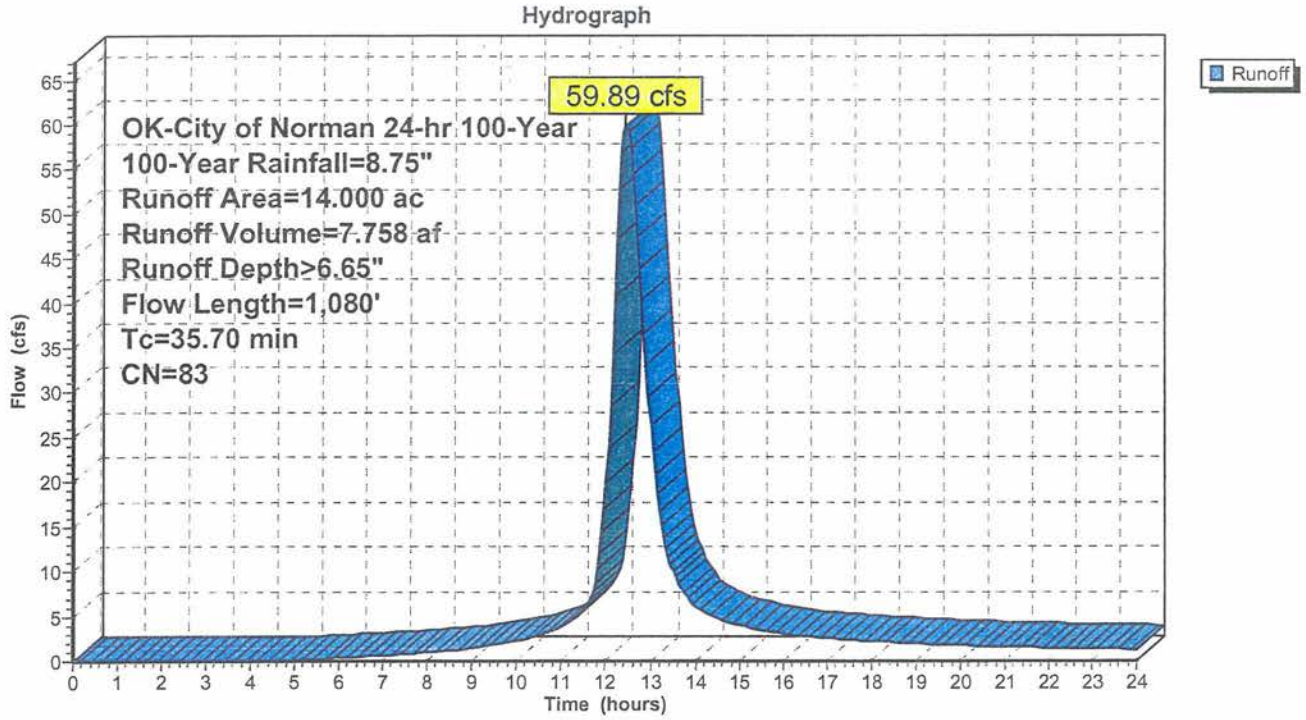
Runoff = 59.89 cfs @ 12.45 hrs, Volume= 7.758 af, Depth> 6.65"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
OK-City of Norman 24-hr 100-Year 100-Year Rainfall=8.75"

	Area (ac)	CN	Description
*	14.000	83	Developed
	14.000		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
26.70	100	0.0100	0.06		**Sheet Flow, Overland** Grass: Bermuda n= 0.410 P2= 3.75"
9.00	980	0.0080	1.82		**Shallow Concentrated Flow, Street** Paved Kv= 20.3 fps
35.70	1,080	Total			

Subcatchment 7S: Area A.3



Summary for Subcatchment 9S: Area A.2

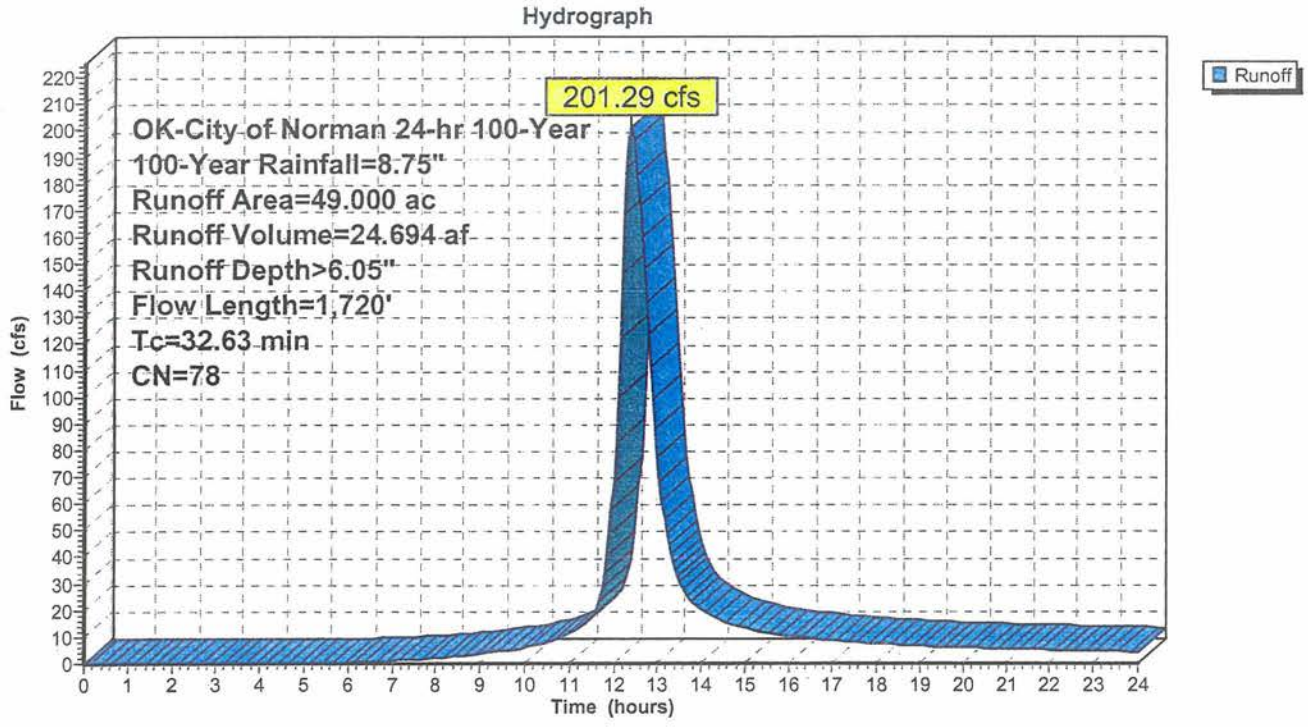
Runoff = 201.29 cfs @ 12.41 hrs, Volume= 24.694 af, Depth> 6.05"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
OK-City of Norman 24-hr 100-Year 100-Year Rainfall=8.75"

	Area (ac)	CN	Description
*	49.000	78	Developed
	49.000		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
26.70	100	0.0100	0.06		**Sheet Flow, Overland** Grass: Bermuda n= 0.410 P2= 3.75"
2.56	270	0.0075	1.76		**Shallow Concentrated Flow, Street** Paved Kv= 20.3 fps
3.37	1,350	0.0050	6.67	47.16	**Pipe Channel, RCP_Round 36"** 36.0" Round Area= 7.1 sf Perim= 9.4' r= 0.75' n= 0.013
32.63	1,720	Total			

Subcatchment 9S: Area A.2



Summary for Subcatchment 11S: Area A.7

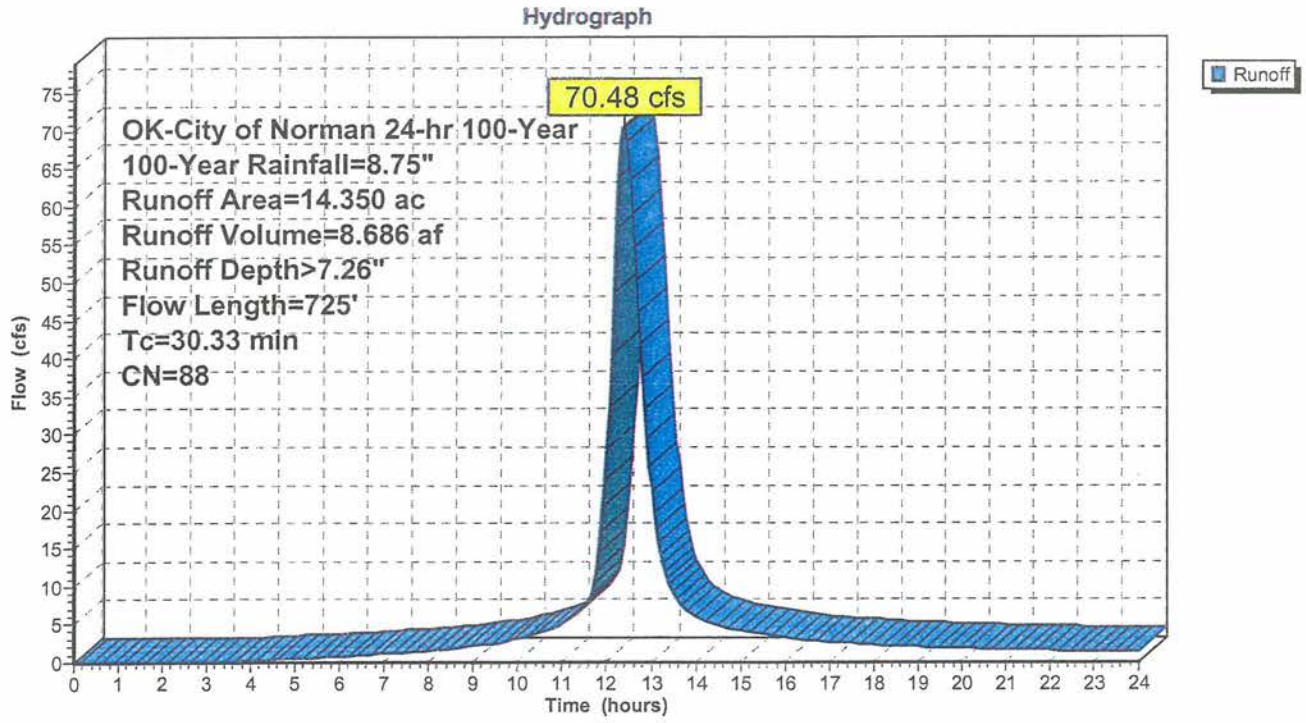
Runoff = 70.48 cfs @ 12.36 hrs, Volume= 8.686 af, Depth> 7.26"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
OK-City of Norman 24-hr 100-Year 100-Year Rainfall=8.75"

	Area (ac)	CN	Description
*	14.350	88	Developed
	14.350		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
26.70	100	0.0100	0.06		**Sheet Flow, Overland** Grass: Bermuda n= 0.410 P2= 3.75"
3.63	625	0.0200	2.87		**Shallow Concentrated Flow, Street** Paved Kv= 20.3 fps
30.33	725	Total			

Subcatchment 11S: Area A.7



Summary for Subcatchment 13S: Area A.8

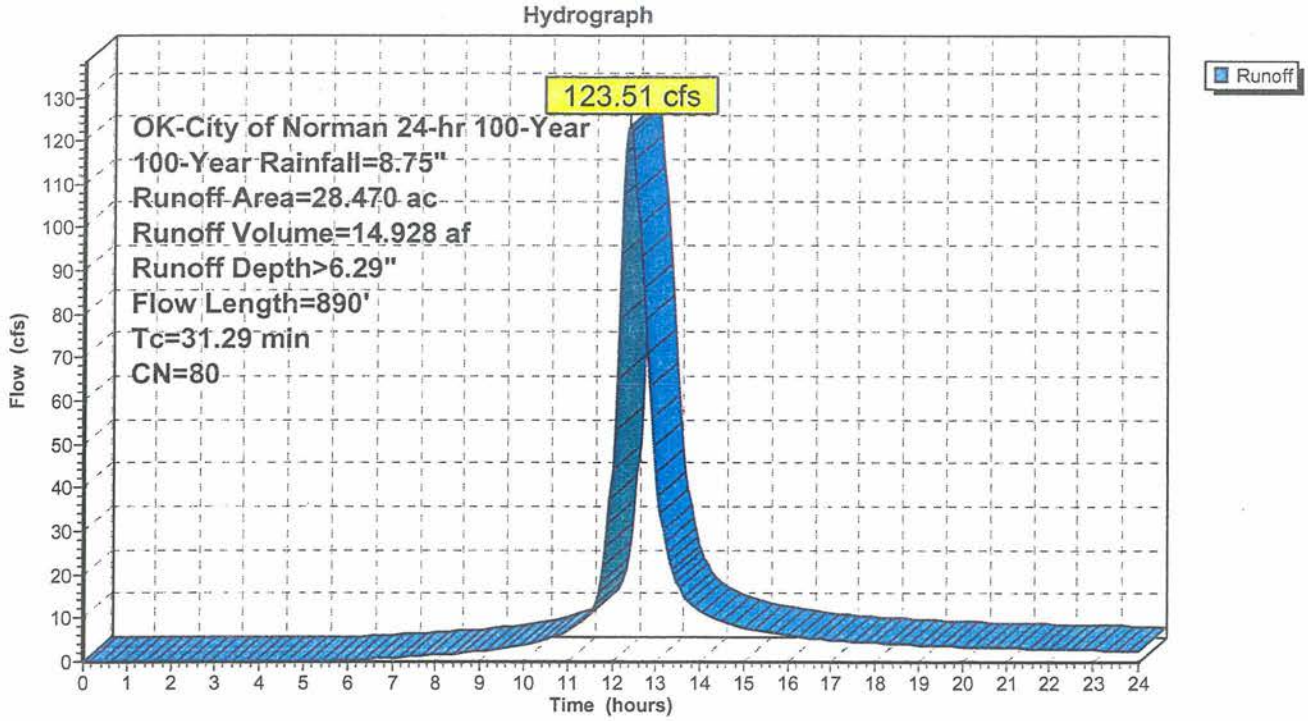
Runoff = 123.51 cfs @ 12.39 hrs, Volume= 14.928 af, Depth> 6.29"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
OK-City of Norman 24-hr 100-Year 100-Year Rainfall=8.75"

	Area (ac)	CN	Description
*	28.470	80	Developed
	28.470		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
26.70	100	0.0100	0.06		**Sheet Flow, Overland** Grass: Bermuda n= 0.410 P2= 3.75"
4.59	790	0.0200	2.87		**Shallow Concentrated Flow, Street** Paved Kv= 20.3 fps
31.29	890	Total			

Subcatchment 13S: Area A.8



Summary for Subcatchment 16S: Common Area

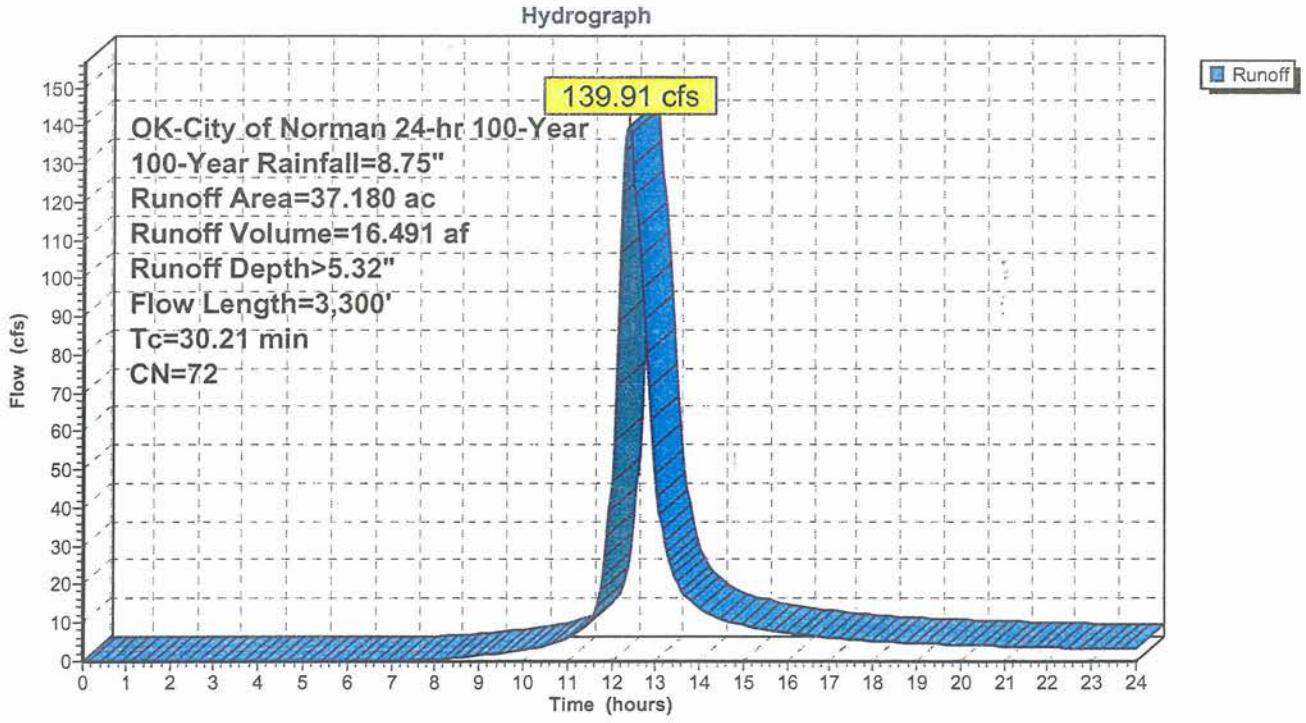
Runoff = 139.91 cfs @ 12.39 hrs, Volume= 16.491 af, Depth> 5.32"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
OK-City of Norman 24-hr 100-Year 100-Year Rainfall=8.75"

	Area (ac)	CN	Description
*	37.180	72	Developed
	37.180		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.05	100	0.0200	0.18		**Sheet Flow, Overland** Grass: Short n= 0.150 P2= 3.75"
21.16	3,200	0.0100	2.52	25.20	**Channel Flow, Ex. channel** Area= 10.0 sf Perim= 15.0' r= 0.67' n= 0.045
30.21	3,300	Total			

Subcatchment 16S: Common Area



Summary for Subcatchment 17S: Area A.1

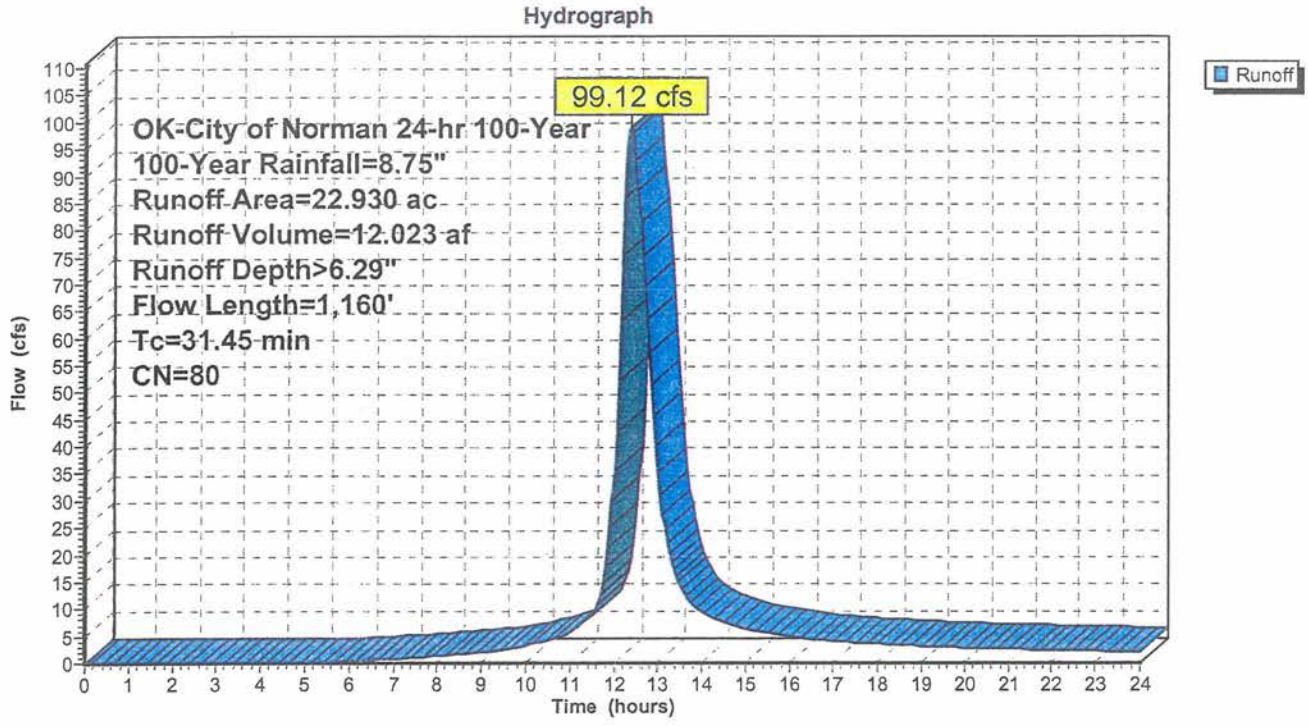
Runoff = 99.12 cfs @ 12.39 hrs, Volume= 12.023 af, Depth> 6.29"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
OK-City of Norman 24-hr 100-Year 100-Year Rainfall=8.75"

	Area (ac)	CN	Description
*	22.930	80	Developed
	22.930		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
26.70	100	0.0100	0.06		**Sheet Flow, Overland** Grass: Bermuda n= 0.410 P2= 3.75"
3.35	500	0.0150	2.49		**Shallow Concentrated Flow, Street** Paved Kv= 20.3 fps
1.40	560	0.0050	6.67	47.16	**Pipe Channel, RCP_Round 36"** 36.0" Round Area= 7.1 sf Perim= 9.4' r= 0.75' n= 0.013
31.45	1,160	Total			

Subcatchment 17S: Area A.1



Summary for Pond 3P: Pond A.4

Inflow Area = 52.940 ac, 0.00% Impervious, Inflow Depth > 5.12" for 100-Year event
Inflow = 106.12 cfs @ 13.24 hrs, Volume= 22.587 af
Outflow = 62.95 cfs @ 14.00 hrs, Volume= 22.136 af, Atten= 41%, Lag= 45.50 min
Primary = 62.95 cfs @ 14.00 hrs, Volume= 22.136 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 1,142.92' @ 14.00 hrs Surf.Area= 83,601 sf Storage= 250,952 cf

Plug-Flow detention time= 55.55 min calculated for 22.089 af (98% of inflow)
Center-of-Mass det. time= 45.02 min (930.54 - 885.51)

Volume	Invert	Avail.Storage	Storage Description
#1	1,138.00'	453,390 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)

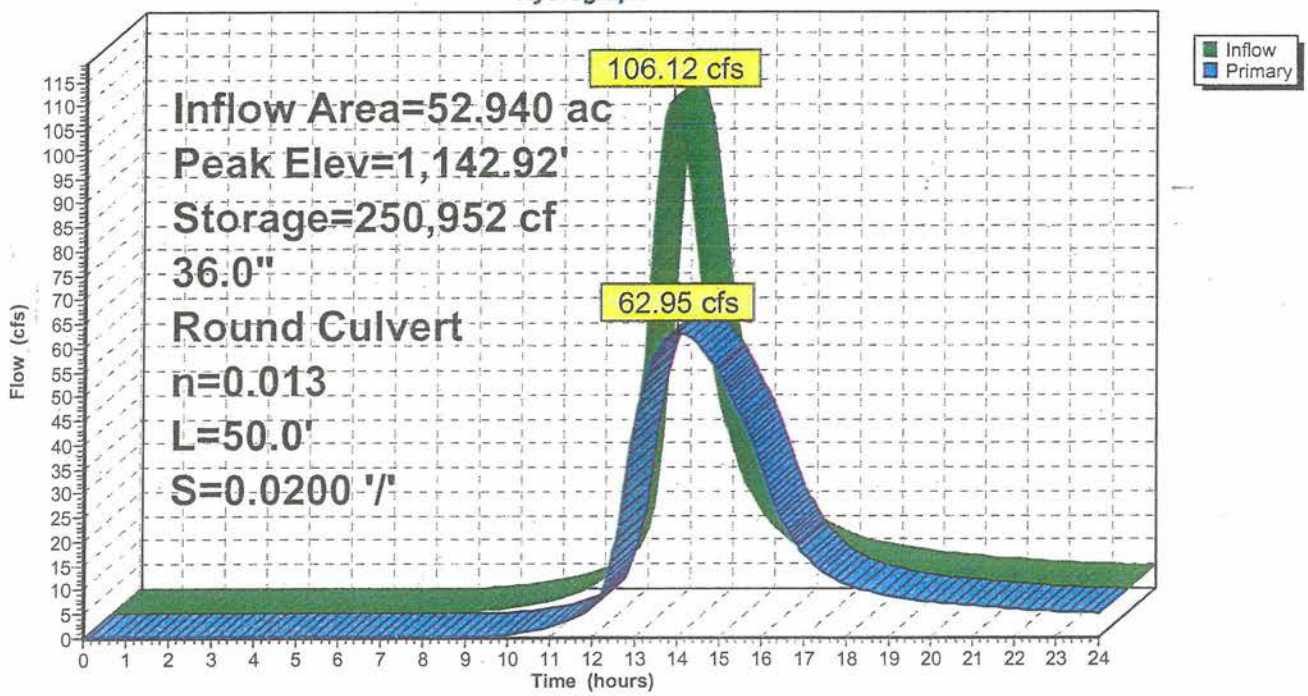
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
1,138.00	18,390	0	0
1,145.00	111,150	453,390	453,390

Device	Routing	Invert	Outlet Devices
#1	Primary	1,138.00'	**36.0" Round Culvert** L= 50.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 1,138.00' / 1,137.00' S= 0.0200 '/' Cc= 0.900 n= 0.013, Flow Area= 7.07 sf

Primary OutFlow Max=62.95 cfs @ 14.00 hrs HW=1,142.92' (Free Discharge)
↑**1=Culvert** (Inlet Controls 62.95 cfs @ 8.91 fps)

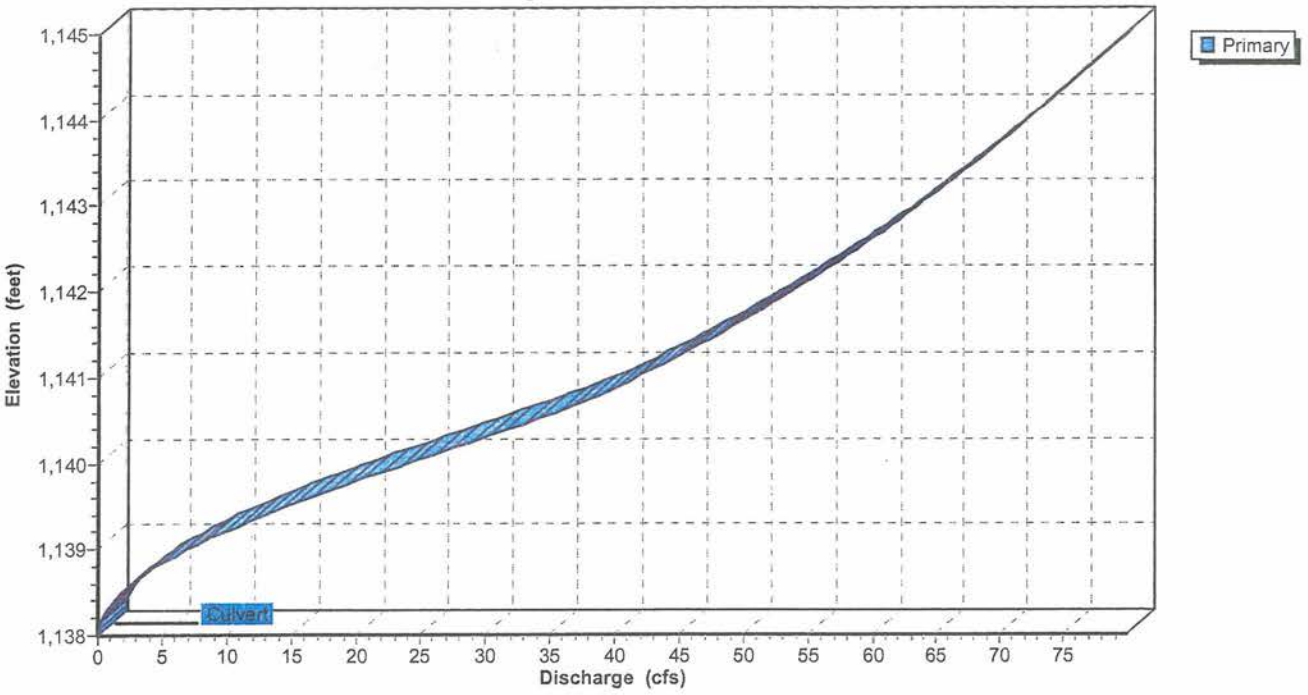
Pond 3P: Pond A.4

Hydrograph

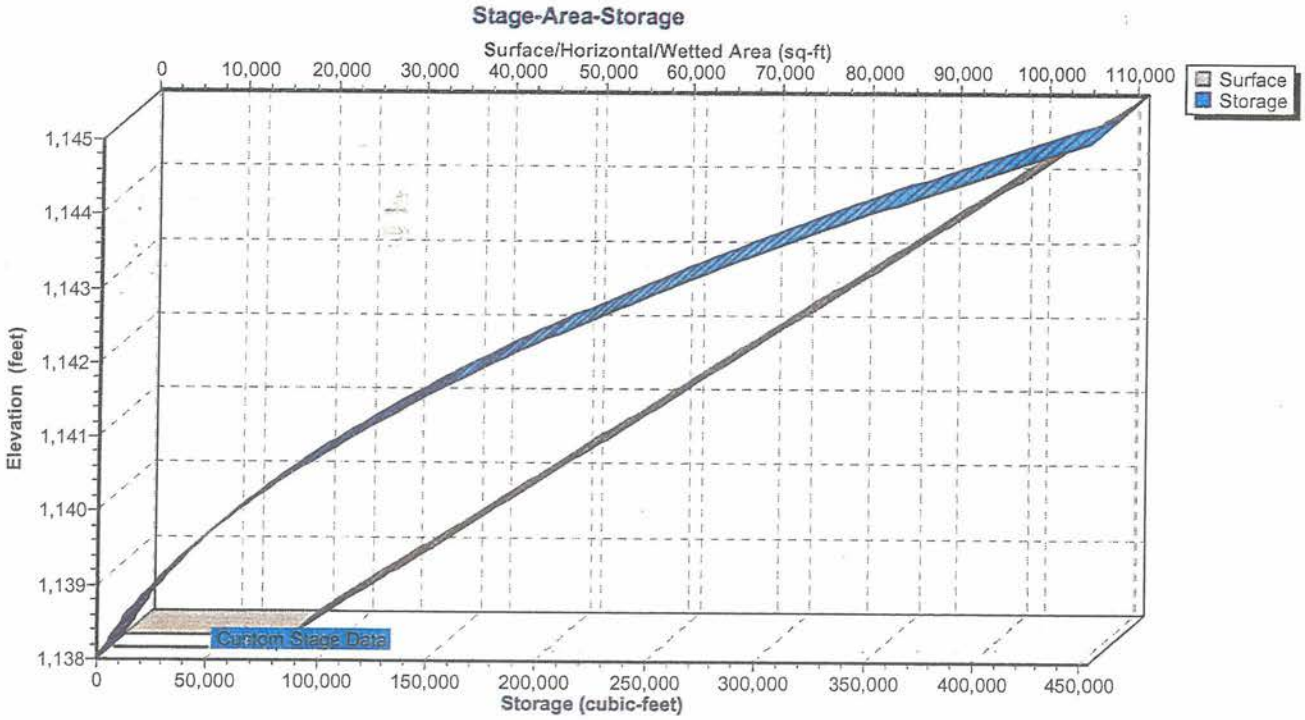


Pond 3P: Pond A.4

Stage-Discharge



Pond 3P: Pond A.4



Summary for Pond 4P: Pond A.6

Inflow Area = 87.040 ac, 0.00% Impervious, Inflow Depth > 6.27" for 100-Year event
Inflow = 317.77 cfs @ 12.58 hrs, Volume= 45.506 af
Outflow = 84.98 cfs @ 13.48 hrs, Volume= 43.950 af, Atten= 73%, Lag= 53.68 min
Primary = 84.98 cfs @ 13.48 hrs, Volume= 43.950 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 1,147.73' @ 13.48 hrs Surf.Area= 177,079 sf Storage= 882,086 cf

Plug-Flow detention time= 128.88 min calculated for 43.950 af (97% of inflow)
Center-of-Mass det. time= 109.79 min (939.61 - 829.82)

Volume	Invert	Avail.Storage	Storage Description
#1	1,140.00'	1,325,000 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)

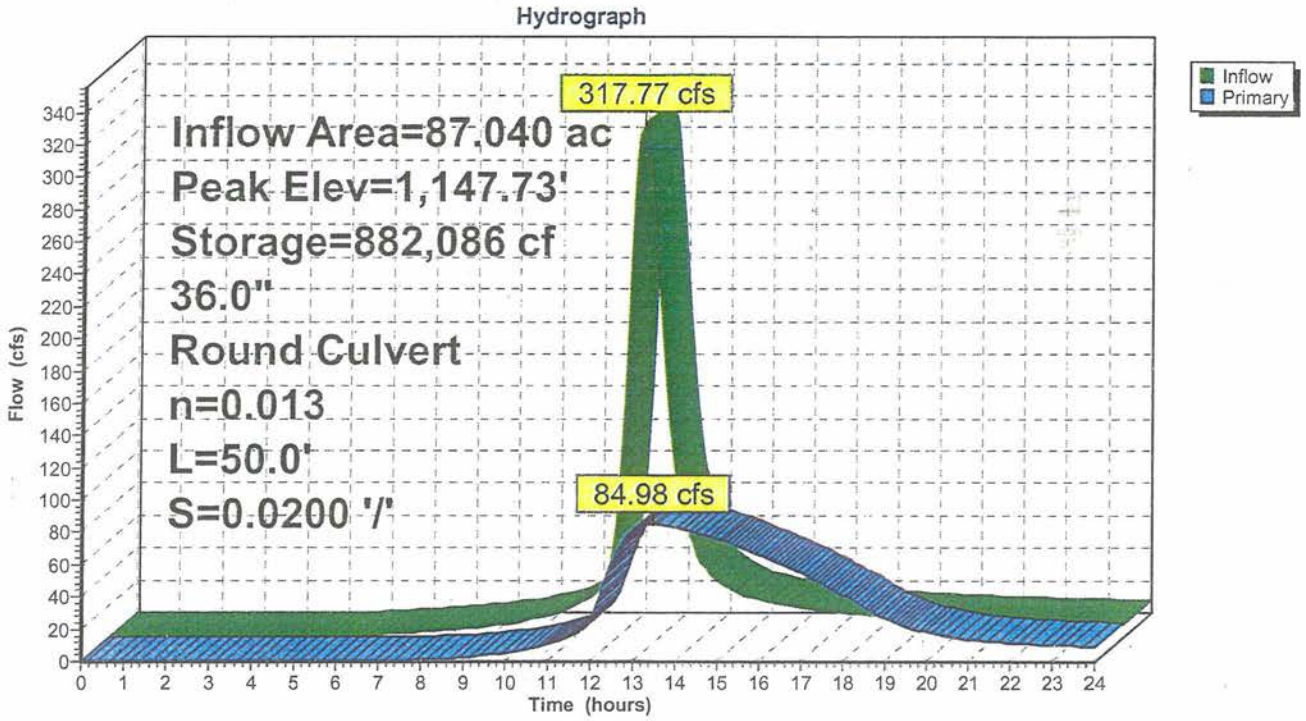
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
1,140.00	51,000	0	0
1,150.00	214,000	1,325,000	1,325,000

Device	Routing	Invert	Outlet Devices
#1	Primary	1,140.00'	**36.0" Round Culvert** L= 50.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 1,140.00' / 1,139.00' S= 0.0200 '/' Cc= 0.900 n= 0.013, Flow Area= 7.07 sf

Primary OutFlow Max=84.98 cfs @ 13.48 hrs HW=1,147.73' (Free Discharge)
↑**1=Culvert** (Inlet Controls 84.98 cfs @ 12.02 fps)

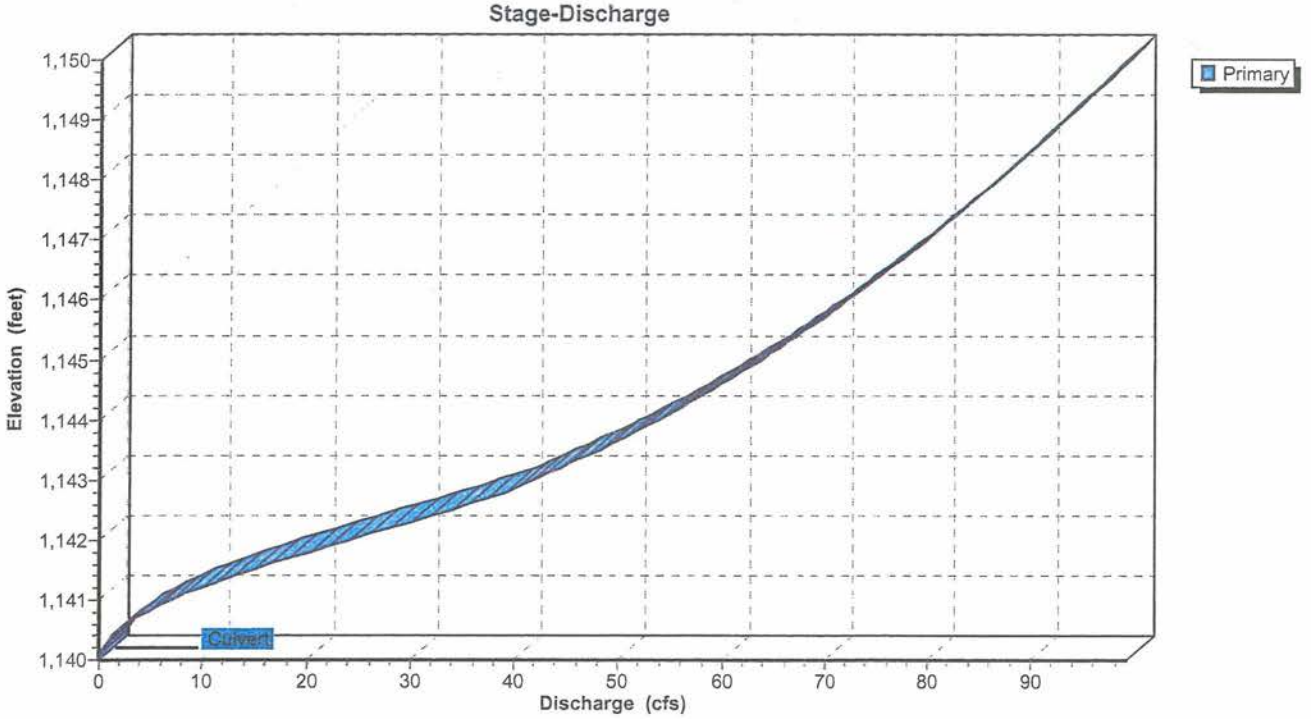
Pond 4P: Pond A.6

Hydrograph

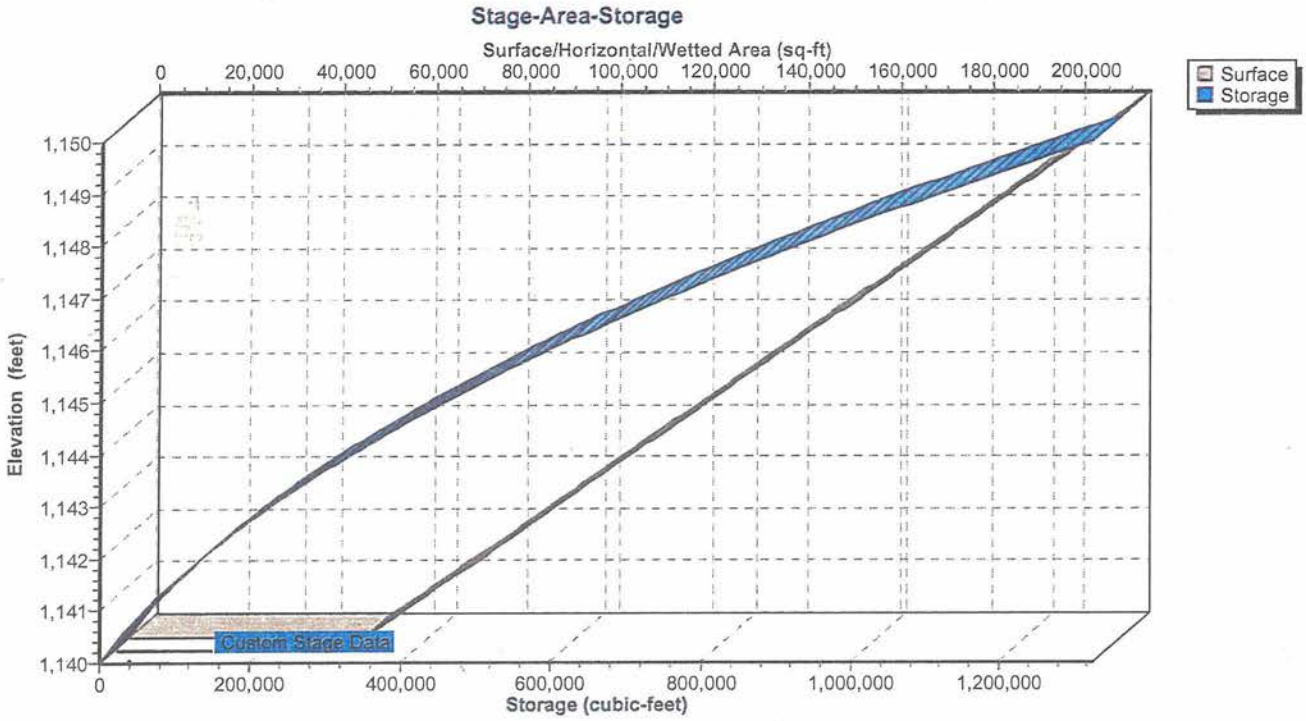


Pond 4P: Pond A.6

Stage-Discharge



Pond 4P: Pond A.6



Summary for Pond 6P: Pond A.5

Inflow Area = 5.000 ac, 0.00% Impervious, Inflow Depth > 6.55" for 100-Year event
Inflow = 26.98 cfs @ 12.23 hrs, Volume= 2.729 af
Outflow = 10.67 cfs @ 12.72 hrs, Volume= 2.590 af, Atten= 60%, Lag= 28.91 min
Primary = 10.67 cfs @ 12.72 hrs, Volume= 2.590 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 1,147.32' @ 12.72 hrs Surf.Area= 19,508 sf Storage= 45,291 cf

Plug-Flow detention time= 92.74 min calculated for 2.585 af (95% of inflow)
Center-of-Mass det. time= 64.76 min (870.55 - 805.78)

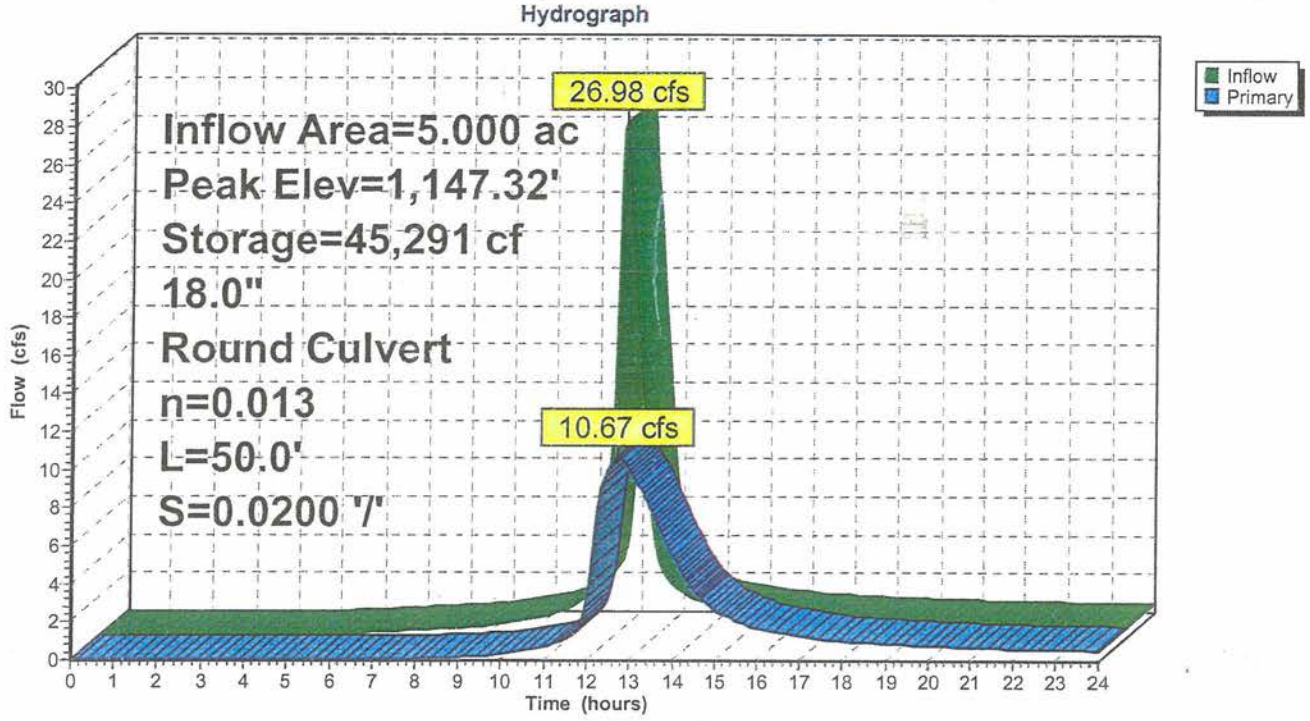
Volume	Invert	Avail.Storage	Storage Description
#1	1,145.00'	97,540 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
1,145.00	19,508	0	0
1,150.00	19,508	97,540	97,540

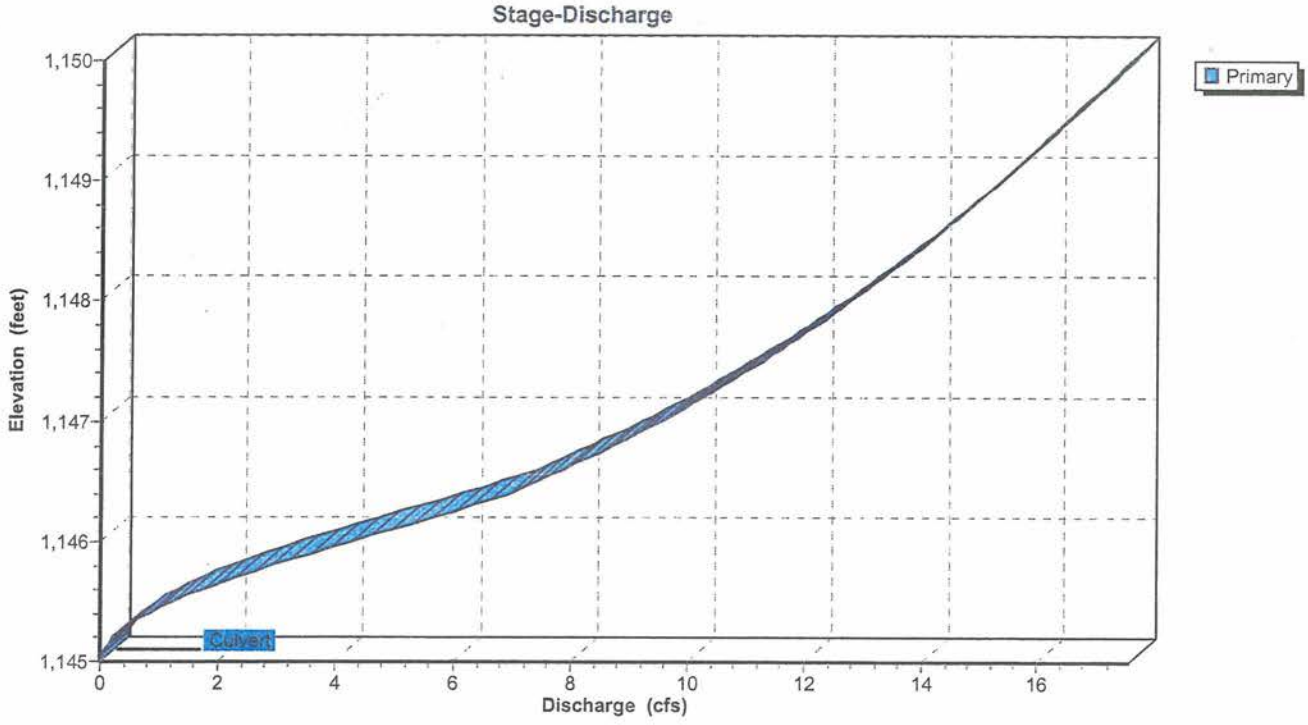
Device	Routing	Invert	Outlet Devices
#1	Primary	1,145.00'	**18.0" Round Culvert** L= 50.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 1,145.00' / 1,144.00' S= 0.0200 '/' Cc= 0.900 n= 0.013, Flow Area= 1.77 sf

Primary OutFlow Max=10.66 cfs @ 12.72 hrs HW=1,147.32' (Free Discharge)
↑**1=Culvert** (Inlet Controls 10.66 cfs @ 6.03 fps)

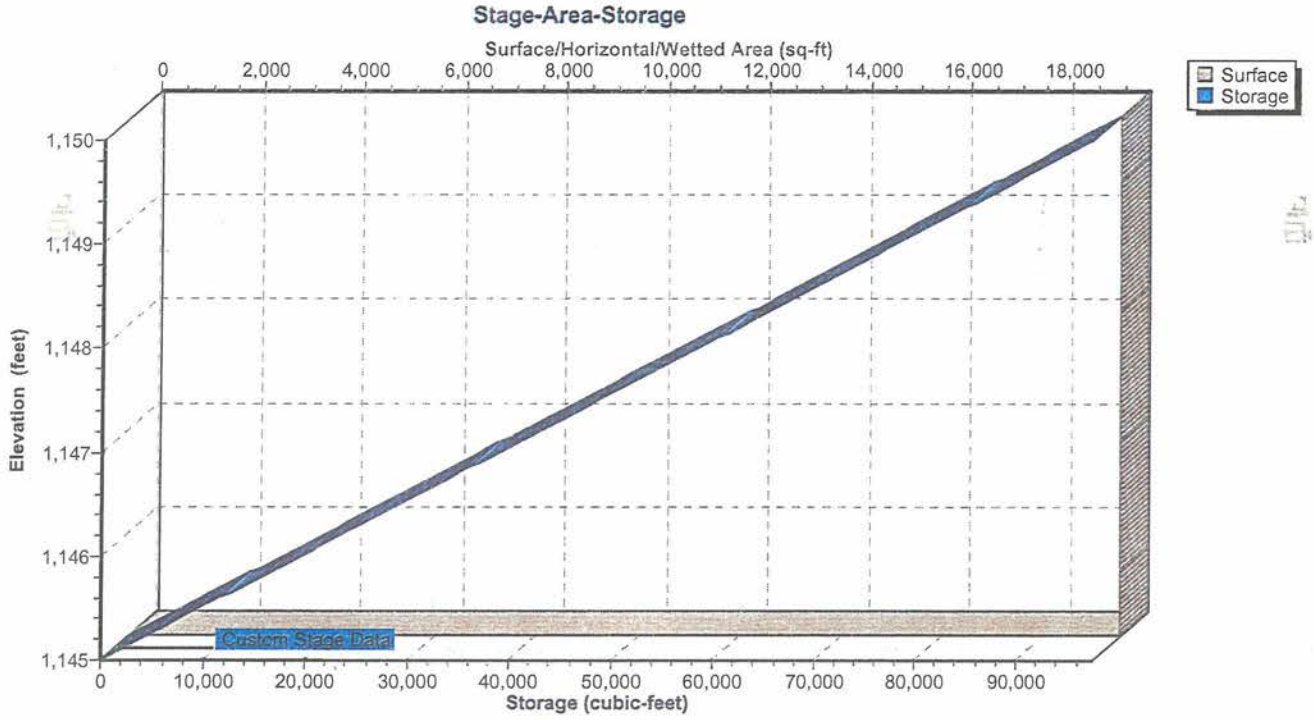
Pond 6P: Pond A.5



Pond 6P: Pond A.5



Pond 6P: Pond A.5



Summary for Pond 8P: Pond A.3

Inflow Area = 14.000 ac, 0.00% Impervious, Inflow Depth > 6.65" for 100-Year event
Inflow = 59.89 cfs @ 12.45 hrs, Volume= 7.758 af
Outflow = 39.62 cfs @ 12.81 hrs, Volume= 7.560 af, Atten= 34%, Lag= 21.61 min
Primary = 39.62 cfs @ 12.81 hrs, Volume= 7.560 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 1,144.06' @ 12.81 hrs Surf.Area= 19,508 sf Storage= 79,203 cf

Plug-Flow detention time= 48.59 min calculated for 7.544 af (97% of inflow)
Center-of-Mass det. time= 33.84 min (849.57 - 815.73)

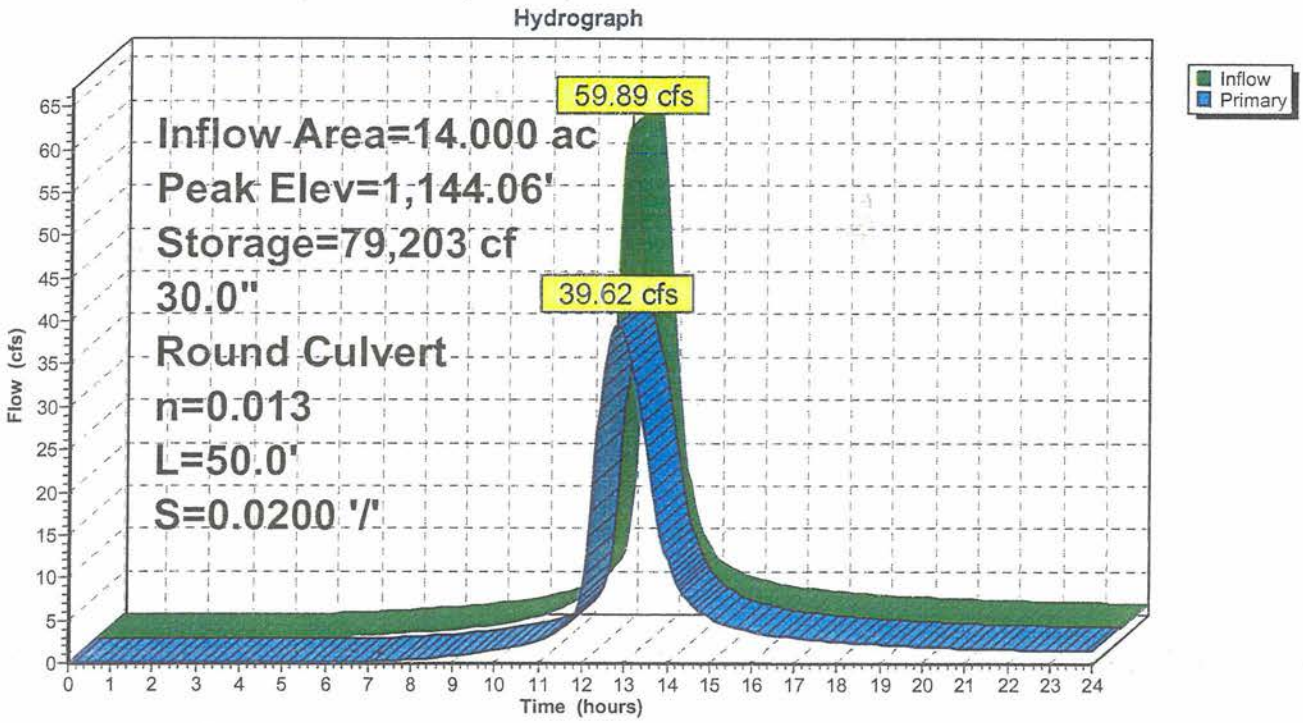
Volume	Invert	Avail.Storage	Storage Description
#1	1,140.00'	97,540 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
1,140.00	19,508	0	0
1,145.00	19,508	97,540	97,540

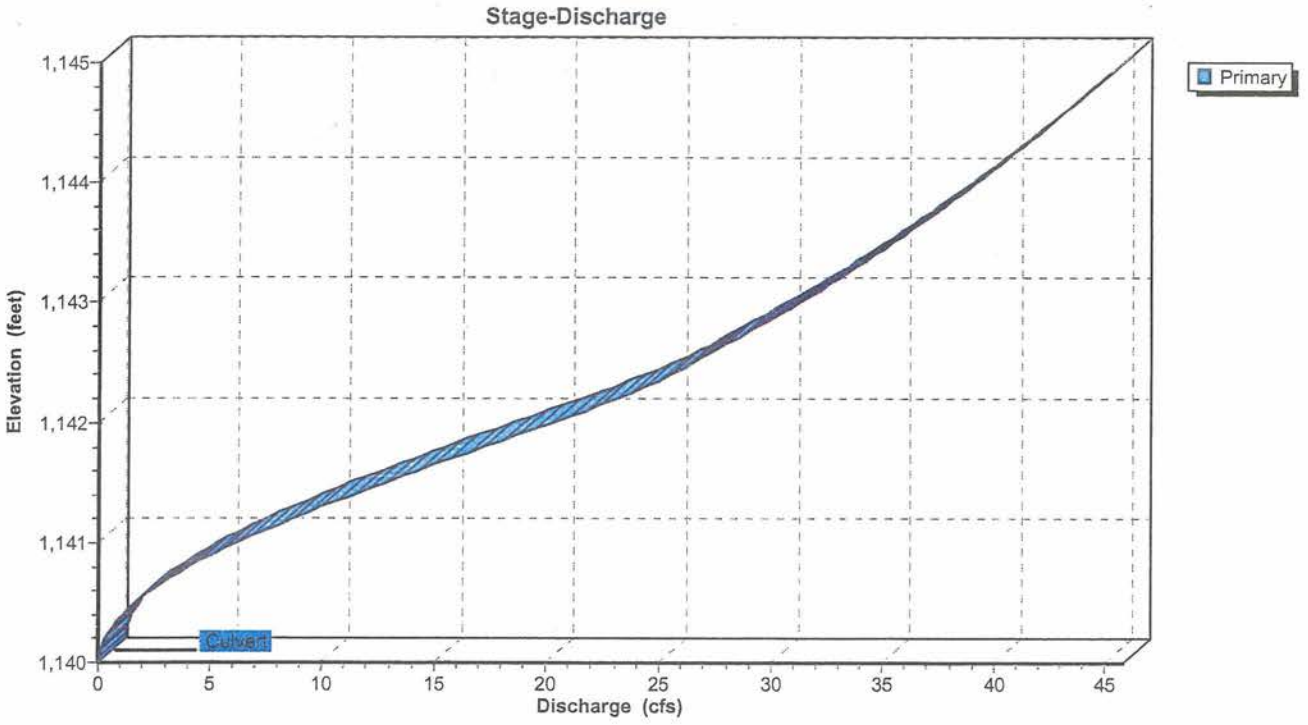
Device	Routing	Invert	Outlet Devices
#1	Primary	1,140.00'	**30.0" Round Culvert** L= 50.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 1,140.00' / 1,139.00' S= 0.0200 '/' Cc= 0.900 n= 0.013, Flow Area= 4.91 sf

Primary OutFlow Max=39.60 cfs @ 12.81 hrs HW=1,144.06' (Free Discharge)
1=Culvert (Inlet Controls 39.60 cfs @ 8.07 fps)

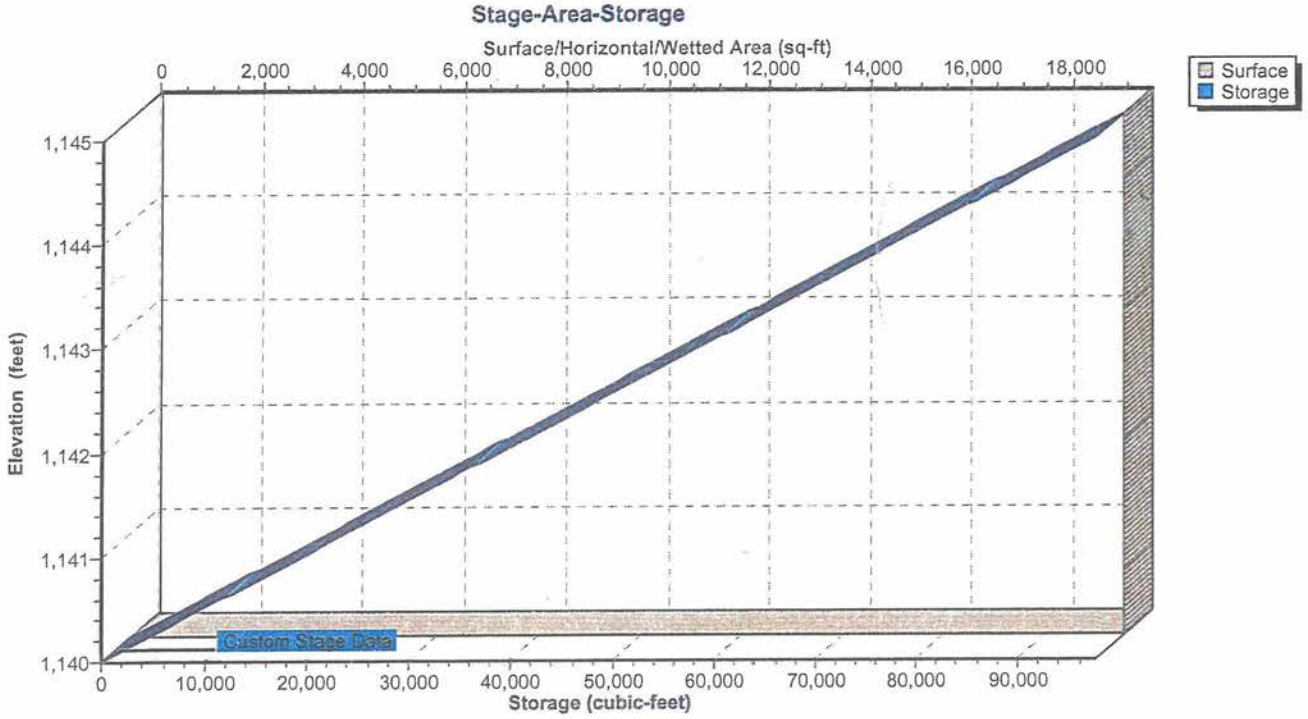
Pond 8P: Pond A.3



Pond 8P: Pond A.3



Pond 8P: Pond A.3



Summary for Pond 10P: Pond A.2

Inflow Area = 49.000 ac, 0.00% Impervious, Inflow Depth > 6.05" for 100-Year event
Inflow = 201.29 cfs @ 12.41 hrs, Volume= 24.694 af
Outflow = 55.28 cfs @ 13.14 hrs, Volume= 22.025 af, Atten= 73%, Lag= 43.92 min
Primary = 55.28 cfs @ 13.14 hrs, Volume= 22.025 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 1,137.14' @ 13.14 hrs Surf.Area= 127,850 sf Storage= 529,115 cf

Plug-Flow detention time= 169.47 min calculated for 22.025 af (89% of inflow)
Center-of-Mass det. time= 118.45 min (943.03 - 824.58)

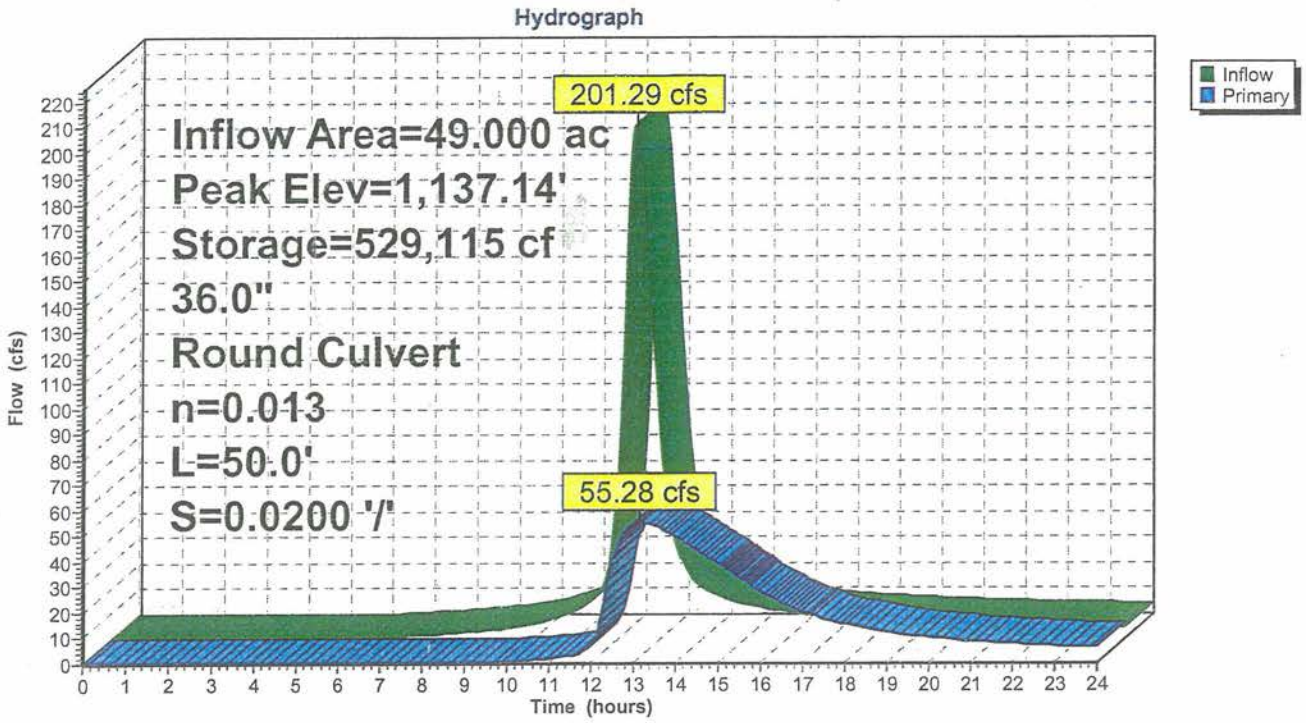
Volume	Invert	Avail.Storage	Storage Description
#1	1,133.00'	894,950 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
1,133.00	127,850	0	0
1,140.00	127,850	894,950	894,950

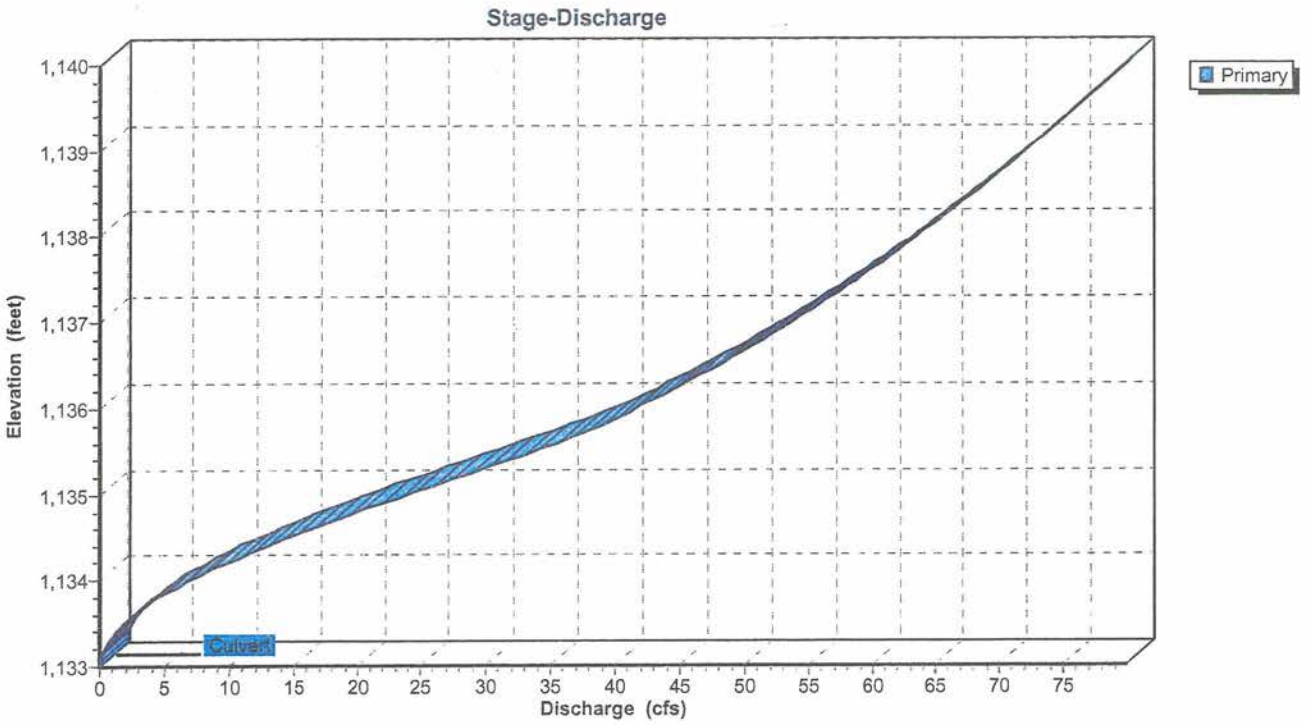
Device	Routing	Invert	Outlet Devices
#1	Primary	1,133.00'	**36.0" Round Culvert** L= 50.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 1,133.00' / 1,132.00' S= 0.0200 '/' Cc= 0.900 n= 0.013, Flow Area= 7.07 sf

Primary OutFlow Max=55.28 cfs @ 13.14 hrs HW=1,137.14' (Free Discharge)
1=Culvert (Inlet Controls 55.28 cfs @ 7.82 fps)

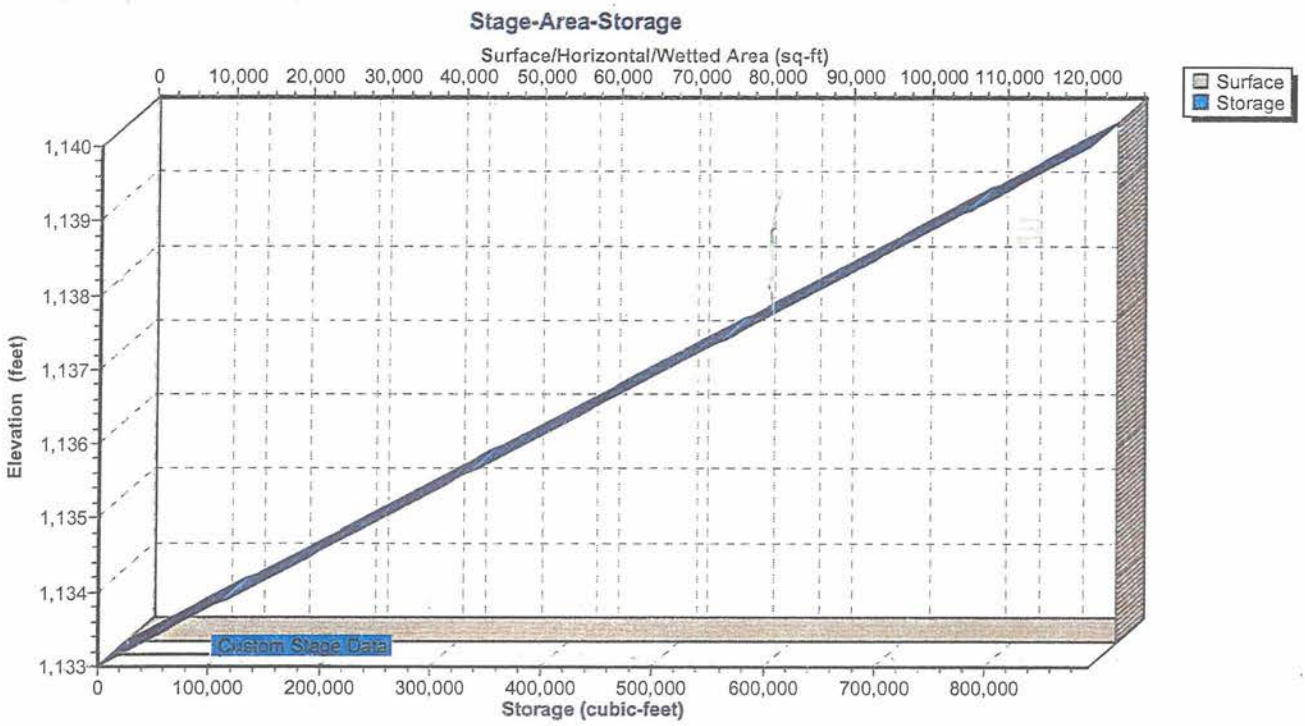
Pond 10P: Pond A.2



Pond 10P: Pond A.2



Pond 10P: Pond A.2



Summary for Pond 12P: Pond A.7

Inflow Area = 14.350 ac, 0.00% Impervious, Inflow Depth > 7.26" for 100-Year event
Inflow = 70.48 cfs @ 12.36 hrs, Volume= 8.686 af
Outflow = 51.59 cfs @ 12.64 hrs, Volume= 8.494 af, Atten= 27%, Lag= 16.34 min
Primary = 51.59 cfs @ 12.64 hrs, Volume= 8.494 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 1,148.80' @ 12.64 hrs Surf.Area= 19,508 sf Storage= 74,081 cf

Plug-Flow detention time= 42.91 min calculated for 8.494 af (98% of inflow)
Center-of-Mass det. time= 29.66 min (827.98 - 798.32)

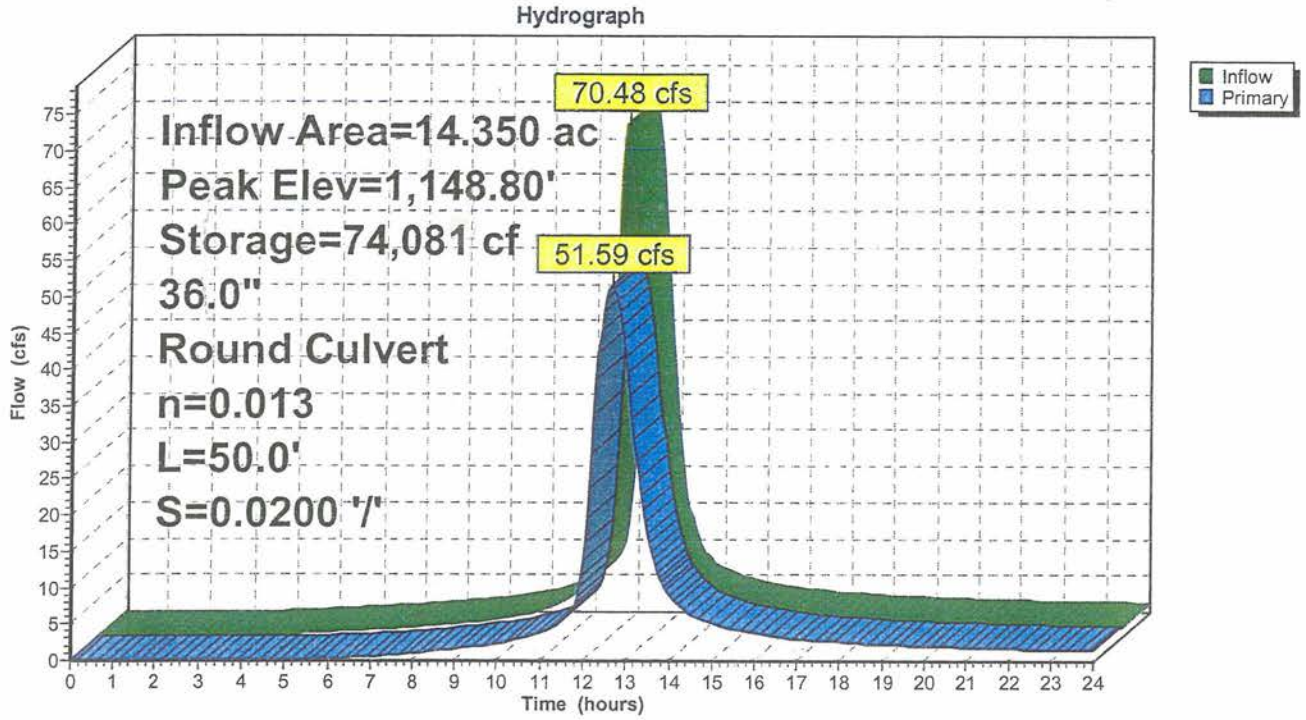
Volume	Invert	Avail.Storage	Storage Description
#1	1,145.00'	97,540 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
1,145.00	19,508	0	0
1,150.00	19,508	97,540	97,540

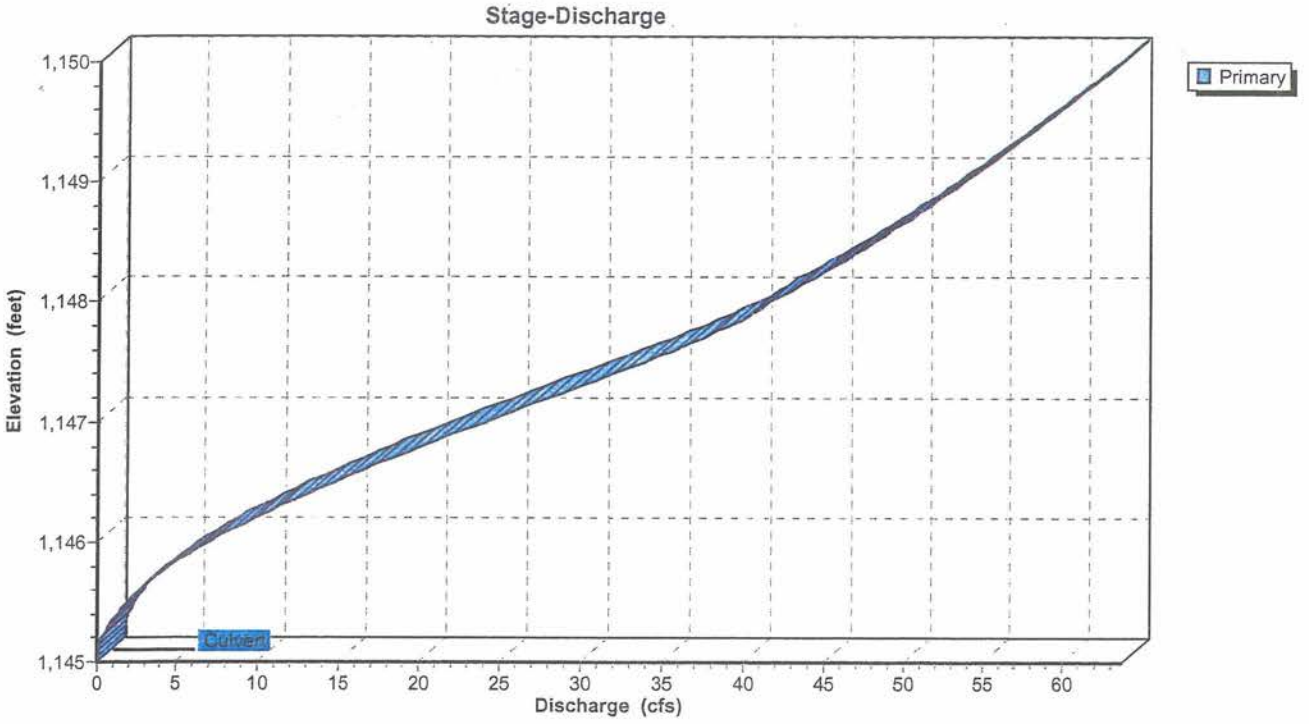
Device	Routing	Invert	Outlet Devices
#1	Primary	1,145.00'	**36.0" Round Culvert** L= 50.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 1,145.00' / 1,144.00' S= 0.0200 '/' Cc= 0.900 n= 0.013, Flow Area= 7.07 sf

Primary OutFlow Max=51.55 cfs @ 12.64 hrs HW=1,148.79' (Free Discharge)
1=Culvert (Inlet Controls 51.55 cfs @ 7.29 fps)

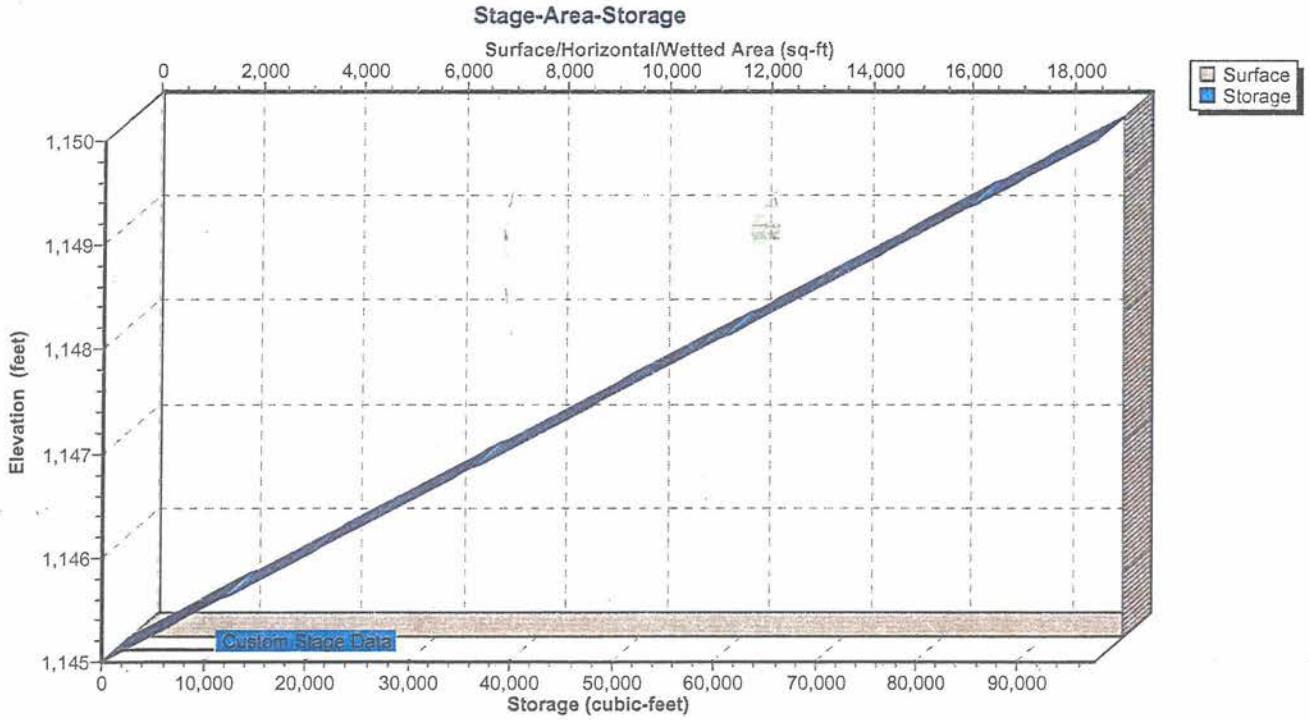
Pond 12P: Pond A.7



Pond 12P: Pond A.7



Pond 12P: Pond A.7



Summary for Pond 14P: Pond A.8

Inflow Area = 28.470 ac, 0.00% Impervious, Inflow Depth > 6.29" for 100-Year event
Inflow = 123.51 cfs @ 12.39 hrs, Volume= 14.928 af
Outflow = 33.62 cfs @ 13.11 hrs, Volume= 12.639 af, Atten= 73%, Lag= 43.12 min
Primary = 33.62 cfs @ 13.11 hrs, Volume= 12.639 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 1,127.49' @ 13.11 hrs Surf.Area= 136,000 sf Storage= 338,103 cf

Plug-Flow detention time= 199.60 min calculated for 12.639 af (85% of inflow)
Center-of-Mass det. time= 134.75 min (953.89 - 819.14)

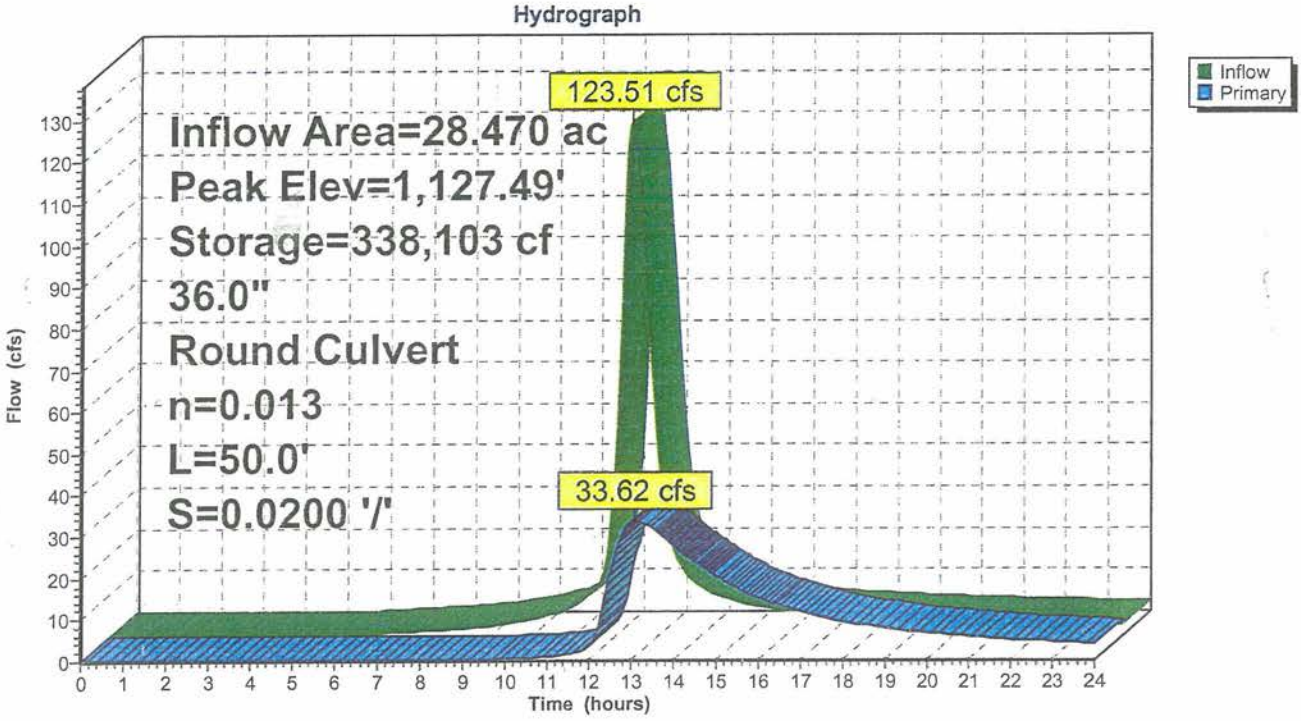
Volume	Invert	Avail.Storage	Storage Description
#1	1,125.00'	1,088,000 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
1,125.00	136,000	0	0
1,133.00	136,000	1,088,000	1,088,000

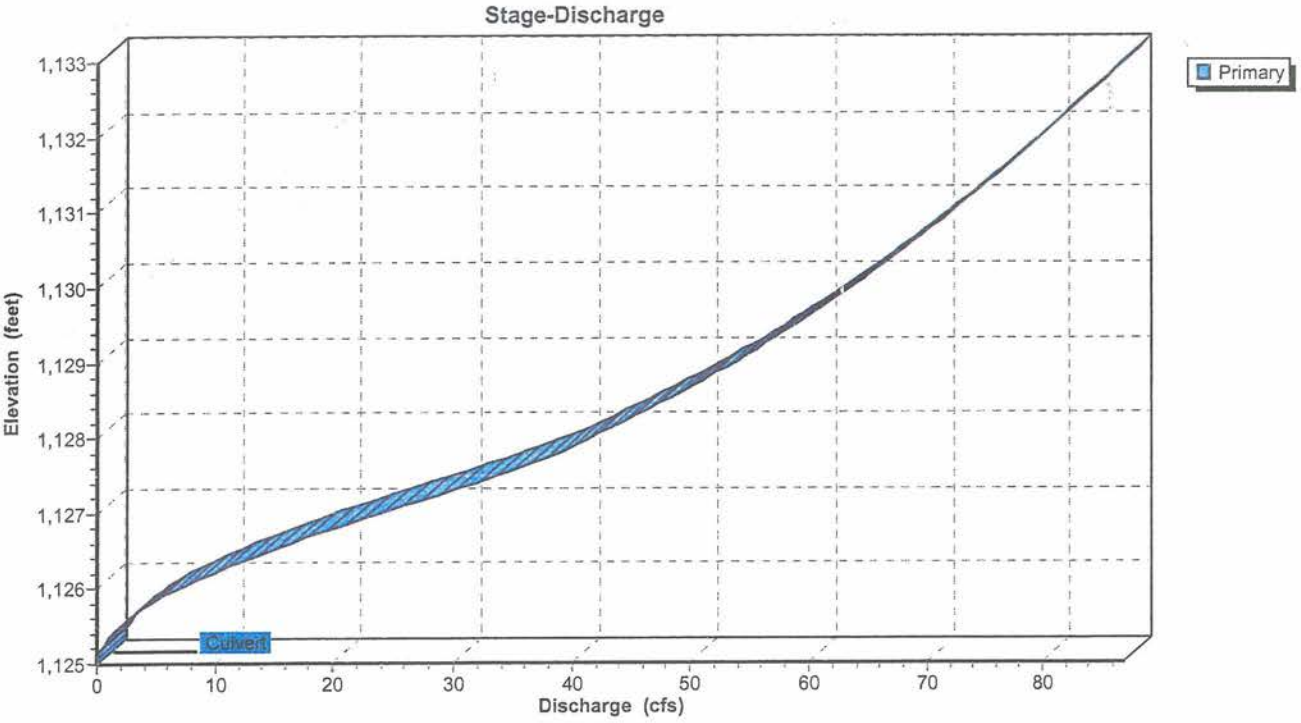
Device	Routing	Invert	Outlet Devices
#1	Primary	1,125.00'	**36.0" Round Culvert** L= 50.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 1,125.00' / 1,124.00' S= 0.0200 '/' Cc= 0.900 n= 0.013, Flow Area= 7.07 sf

Primary OutFlow Max=33.61 cfs @ 13.11 hrs HW=1,127.49' (Free Discharge)
└**1=Culvert** (Inlet Controls 33.61 cfs @ 5.37 fps)

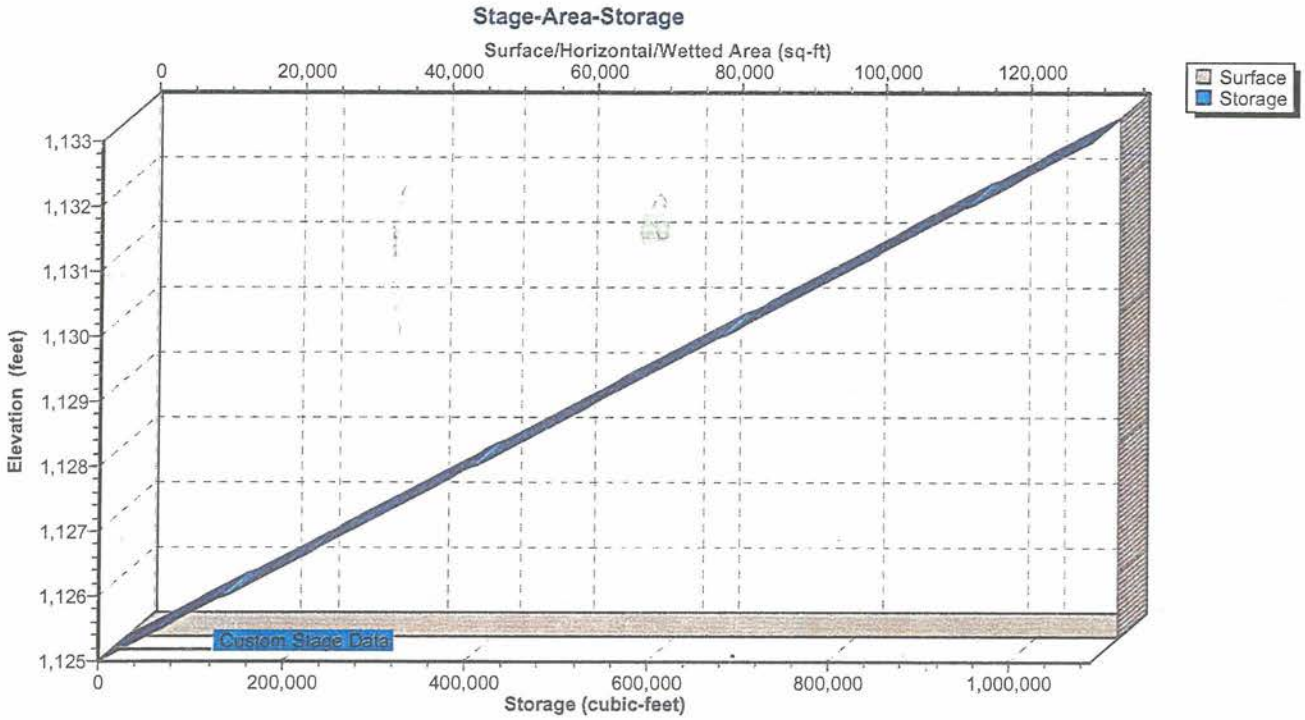
Pond 14P: Pond A.8



Pond 14P: Pond A.8



Pond 14P: Pond A.8



Summary for Pond 18P: Pond A.1

Inflow Area = 22.930 ac, 0.00% Impervious, Inflow Depth > 6.29" for 100-Year event
Inflow = 99.12 cfs @ 12.39 hrs, Volume= 12.023 af
Outflow = 77.48 cfs @ 12.63 hrs, Volume= 11.795 af, Atten= 22%, Lag= 14.56 min
Primary = 77.48 cfs @ 12.63 hrs, Volume= 11.795 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 1,134.55' @ 12.63 hrs Surf.Area= 19,508 sf Storage= 88,704 cf

Plug-Flow detention time= 33.64 min calculated for 11.795 af (98% of inflow)
Center-of-Mass det. time= 22.50 min (841.75 - 819.25)

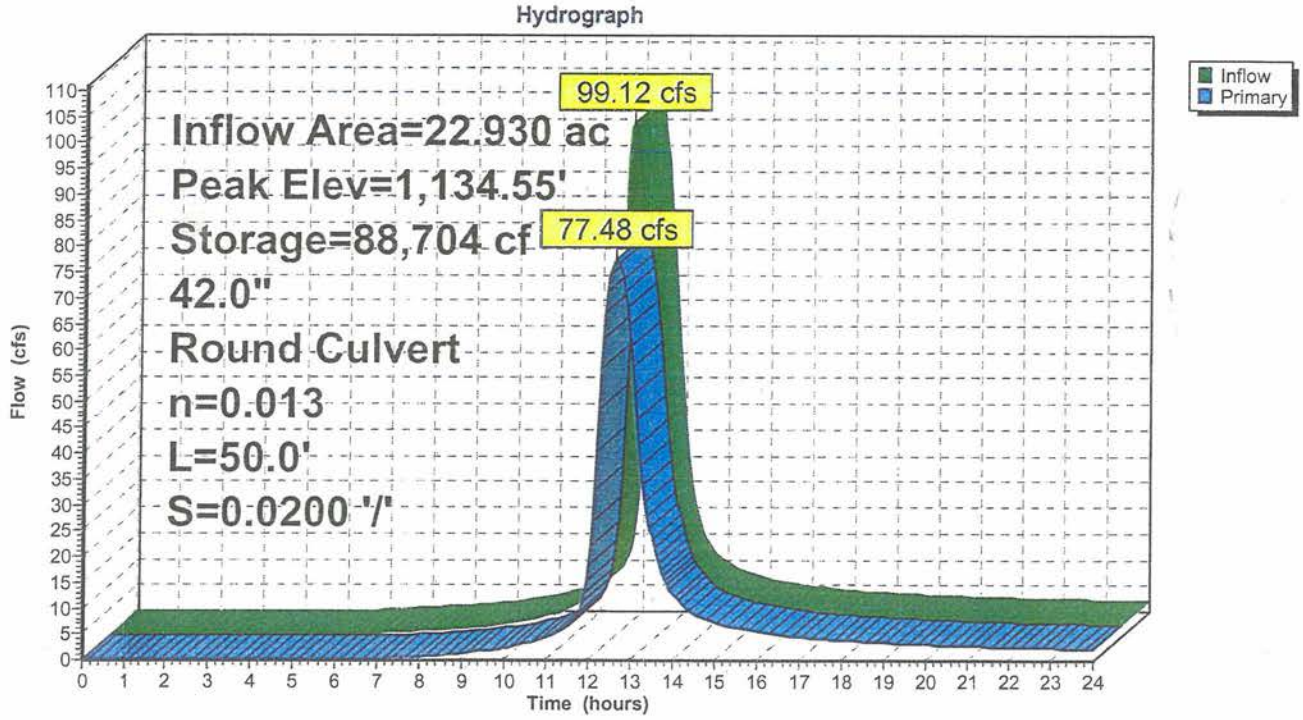
Volume	Invert	Avail.Storage	Storage Description
#1	1,130.00'	97,540 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
1,130.00	19,508	0	0
1,135.00	19,508	97,540	97,540

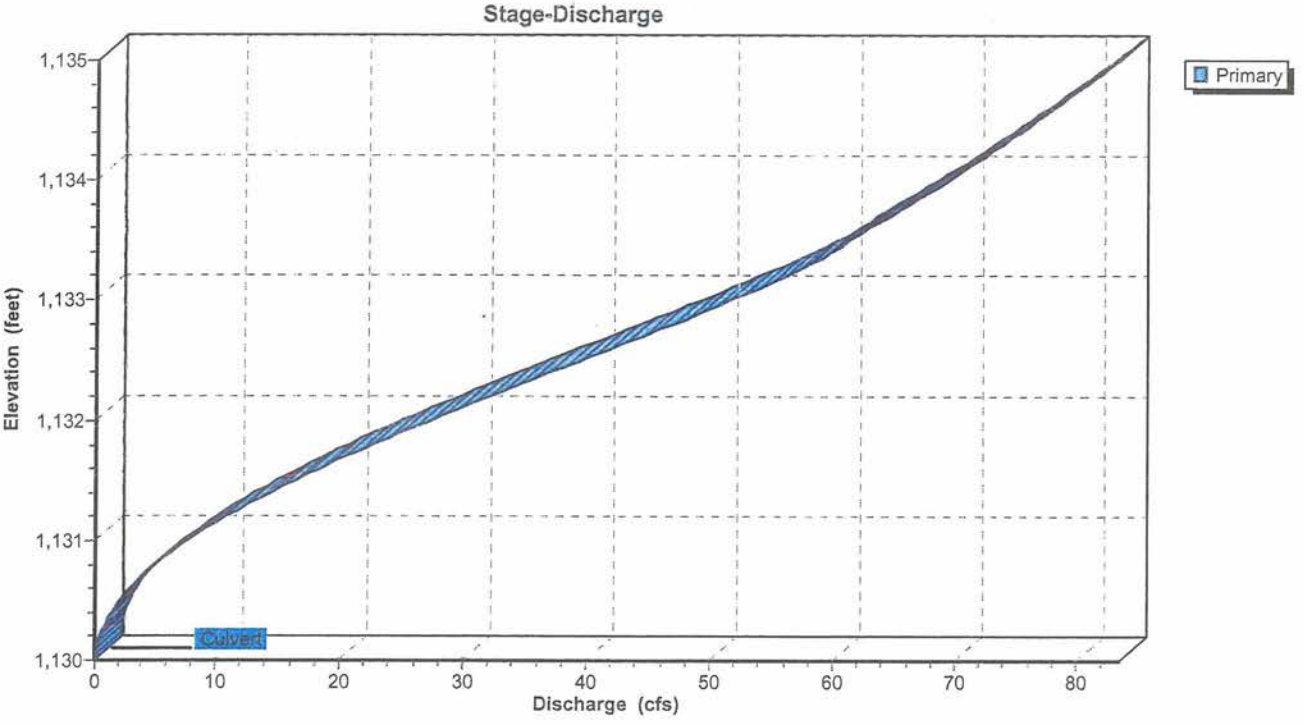
Device	Routing	Invert	Outlet Devices
#1	Primary	1,130.00'	**42.0" Round Culvert** L= 50.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 1,130.00' / 1,129.00' S= 0.0200 '/' Cc= 0.900 n= 0.013, Flow Area= 9.62 sf

Primary OutFlow Max=77.40 cfs @ 12.63 hrs HW=1,134.54' (Free Discharge)
↑—**1=Culvert** (Inlet Controls 77.40 cfs @ 8.04 fps)

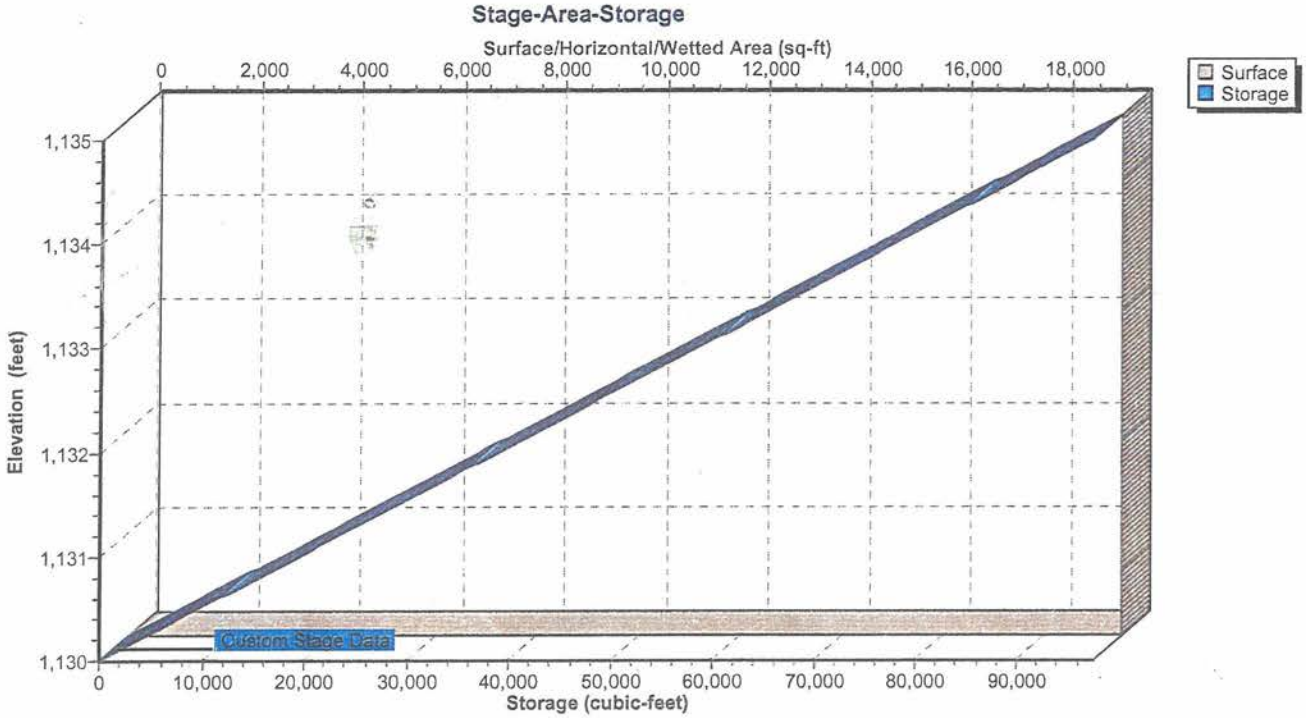
Pond 18P: Pond A.1



Pond 18P: Pond A.1



Pond 18P: Pond A.1

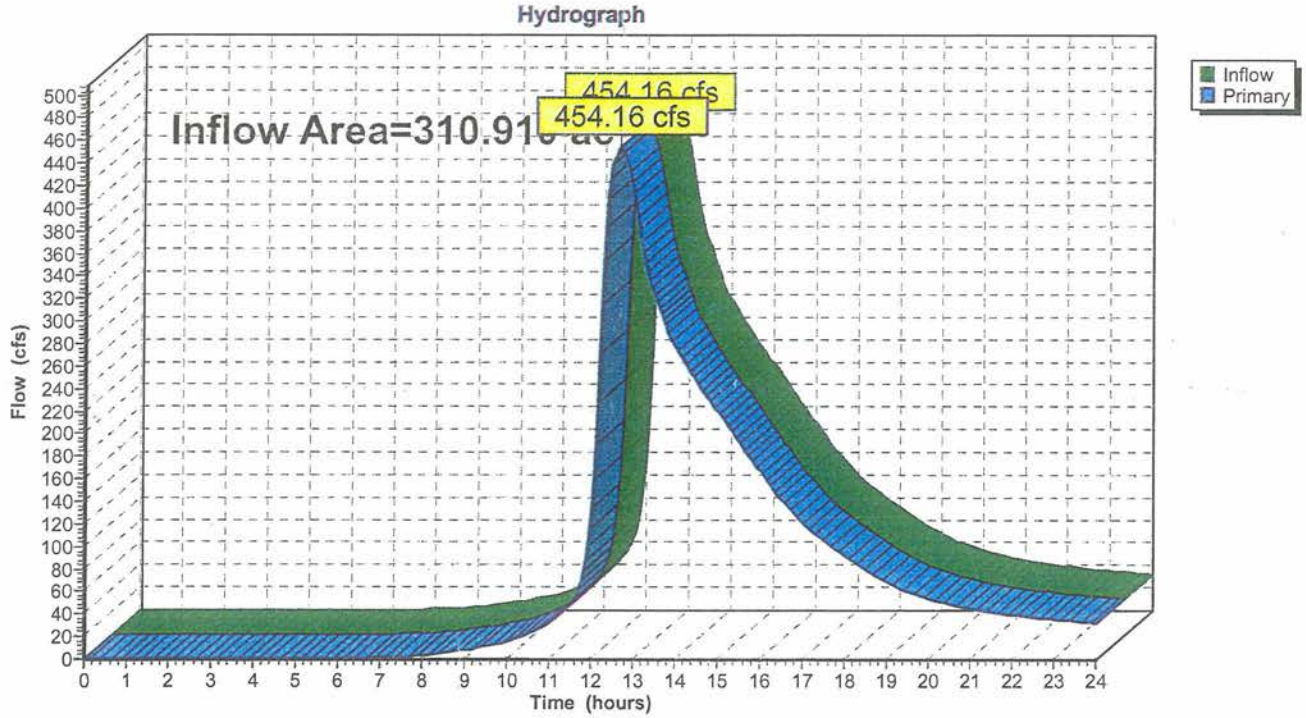


Summary for Link 15L: Proposed A

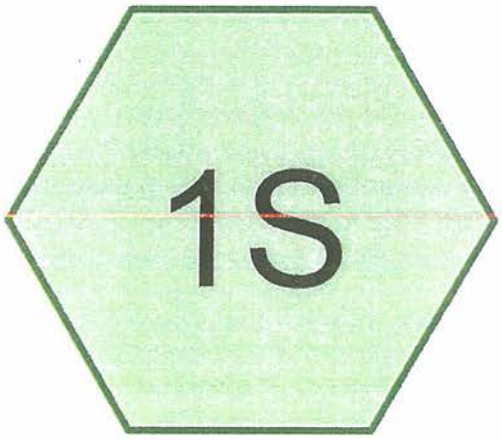
Inflow Area = 310.910 ac, 0.00% Impervious, Inflow Depth > 5.70" for 100-Year event
Inflow = 454.16 cfs @ 12.68 hrs, Volume= 147.681 af
Primary = 454.16 cfs @ 12.68 hrs, Volume= 147.681 af, Atten= 0%, Lag= 0.00 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Link 15L: Proposed A



Appendix C
Drainage Calculations
Area B



Historic Area B

Subcat Reach Pond Link

Routing Diagram for Historic Area B
Prepared by SMC Consulting Engineers, P.C., Printed 1/10/2015

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
18.600	58	Type B soil (1S)
57.400	71	Type C soil (1S)
46.100	78	Type D soil (1S)

Summary for Subcatchment 1S: Historic Area B

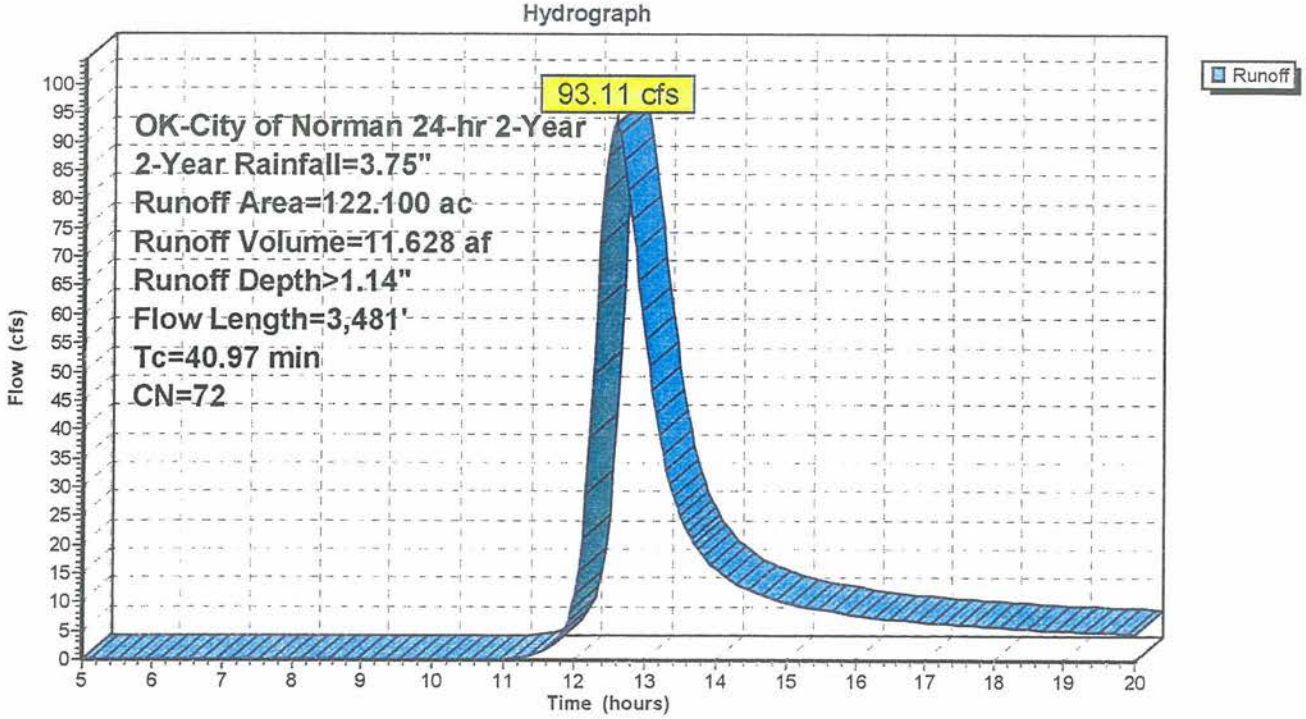
Runoff = 93.11 cfs @ 12.56 hrs, Volume= 11.628 af, Depth> 1.14"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
OK-City of Norman 24-hr 2-Year 2-Year Rainfall=3.75"

	Area (ac)	CN	Description
*	18.600	58	Type B soil
*	57.400	71	Type C soil
*	46.100	78	Type D soil
	122.100	72	Weighted Average
	122.100		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
25.65	300	0.0100	0.19		**Sheet Flow, Overland flow** Range n= 0.130 P2= 3.75"
15.32	3,181	0.0217	3.46	51.91	**Channel Flow, Creek** Area= 15.0 sf Perim= 25.0' r= 0.60' n= 0.045
40.97	3,481	Total			

Subcatchment 1S: Historic Area B



Summary for Subcatchment 1S: Historic Area B

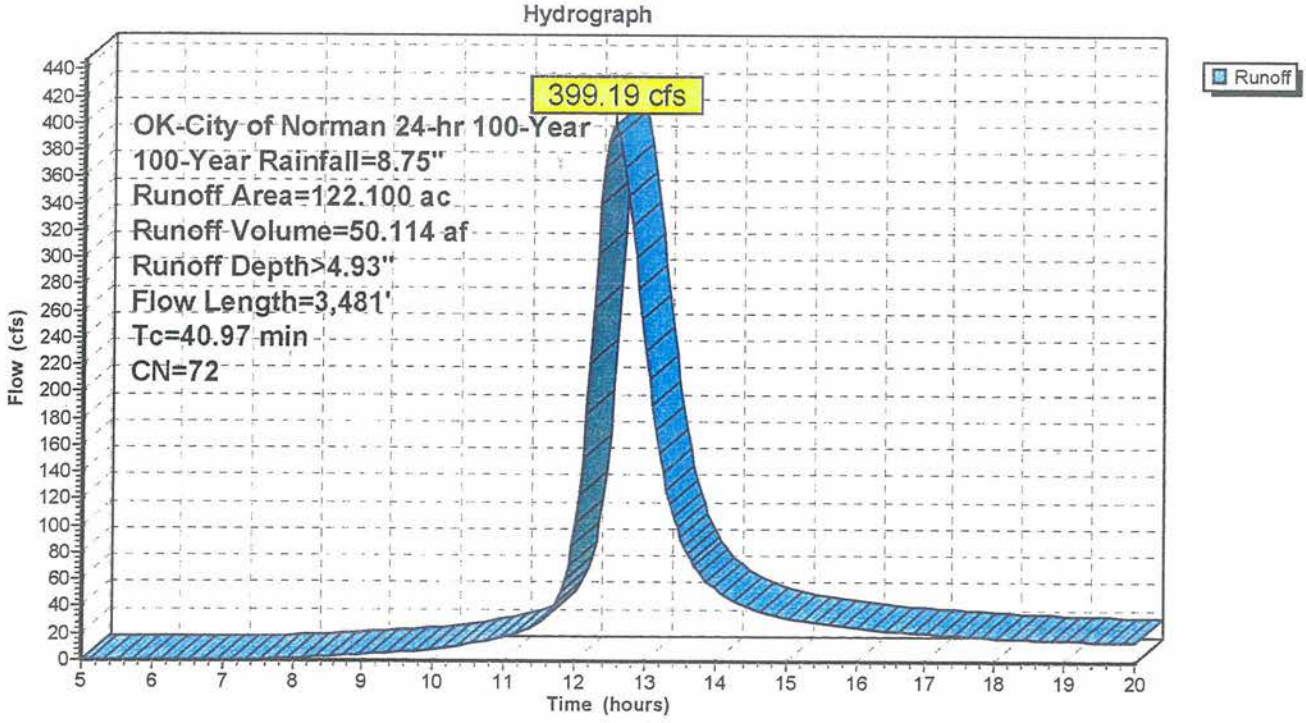
Runoff = 399.19 cfs @ 12.54 hrs, Volume= 50.114 af, Depth> 4.93"

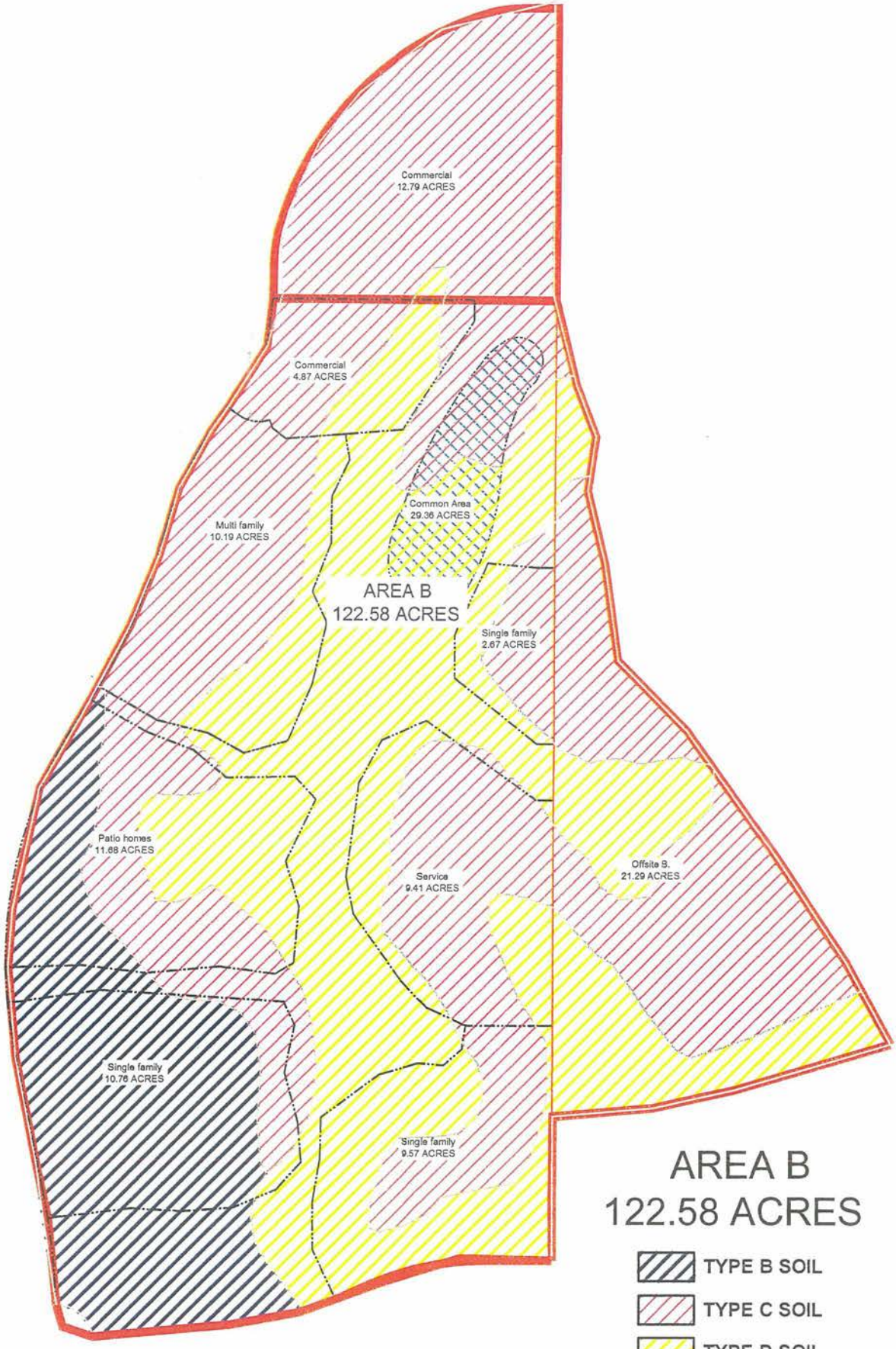
Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
OK-City of Norman 24-hr 100-Year 100-Year Rainfall=8.75"

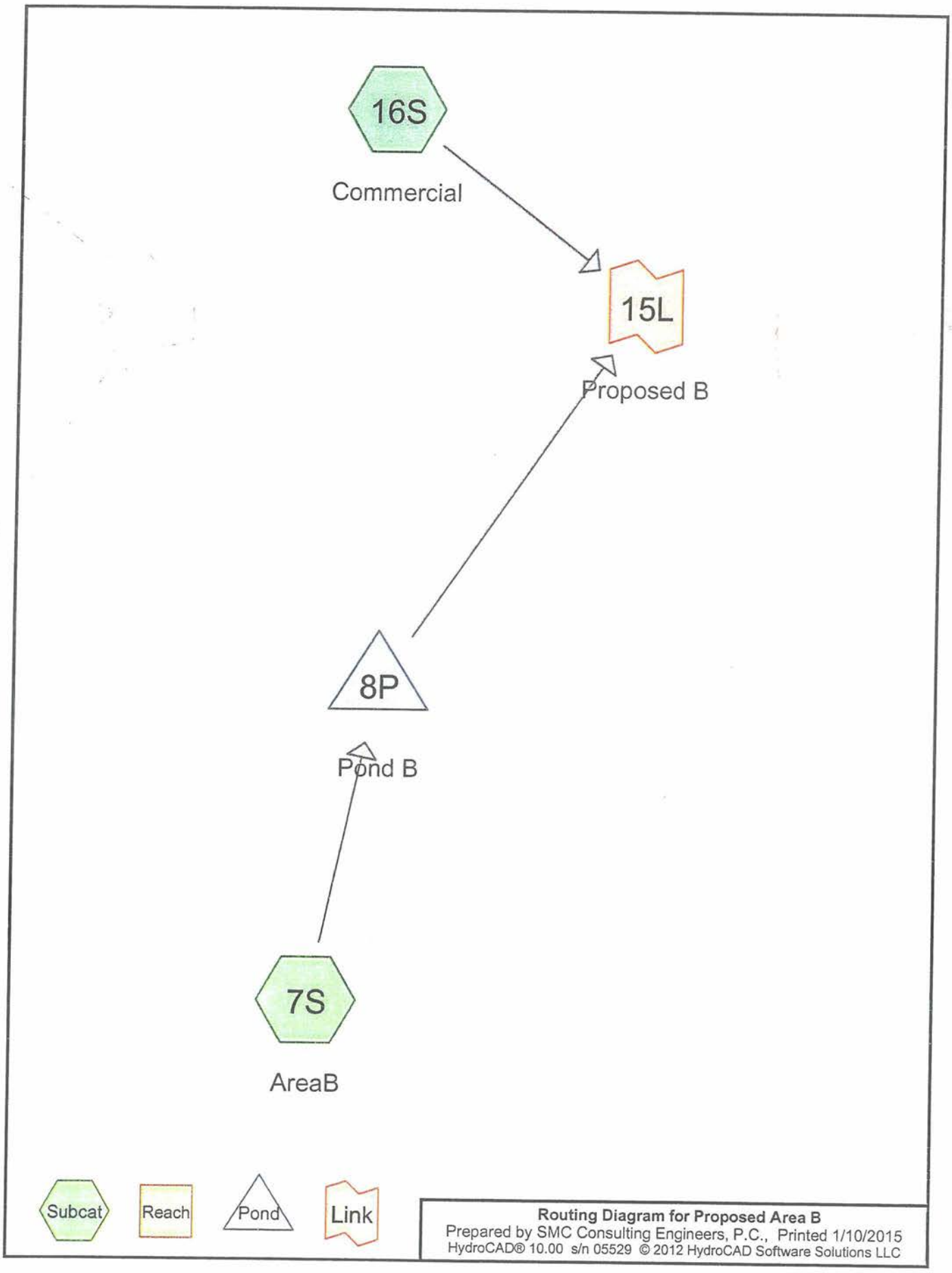
	Area (ac)	CN	Description
*	18.600	58	Type B soil
*	57.400	71	Type C soil
*	46.100	78	Type D soil
	122.100	72	Weighted Average
	122.100		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
25.65	300	0.0100	0.19		**Sheet Flow, Overland flow** Range n= 0.130 P2= 3.75"
15.32	3,181	0.0217	3.46	51.91	**Channel Flow, Creek** Area= 15.0 sf Perim= 25.0' r= 0.60' n= 0.045
40.97	3,481	Total			

Subcatchment 1S: Historic Area B




Commercial
12.79 ACRES
Commercial
4.87 ACRES
Common Area
29.36 ACRES
Multi family
10.19 ACRES
AREA B
122.58 ACRES
Single family
2.67 ACRES
Patio homes
11.68 ACRES
Service
9.41 ACRES
Offsite B.
21.29 ACRES
Single family
10.76 ACRES
Single family
9.57 ACRES
AREA B
122.58 ACRES
TYPE B SOIL
TYPE C SOIL
TYPE D SOIL



Routing Diagram for Proposed Area B
Prepared by SMC Consulting Engineers, P.C., Printed 1/10/2015

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
109.800	83	Developed (7S)
12.790	94	Developed (16S)

Summary for Subcatchment 7S: AreaB

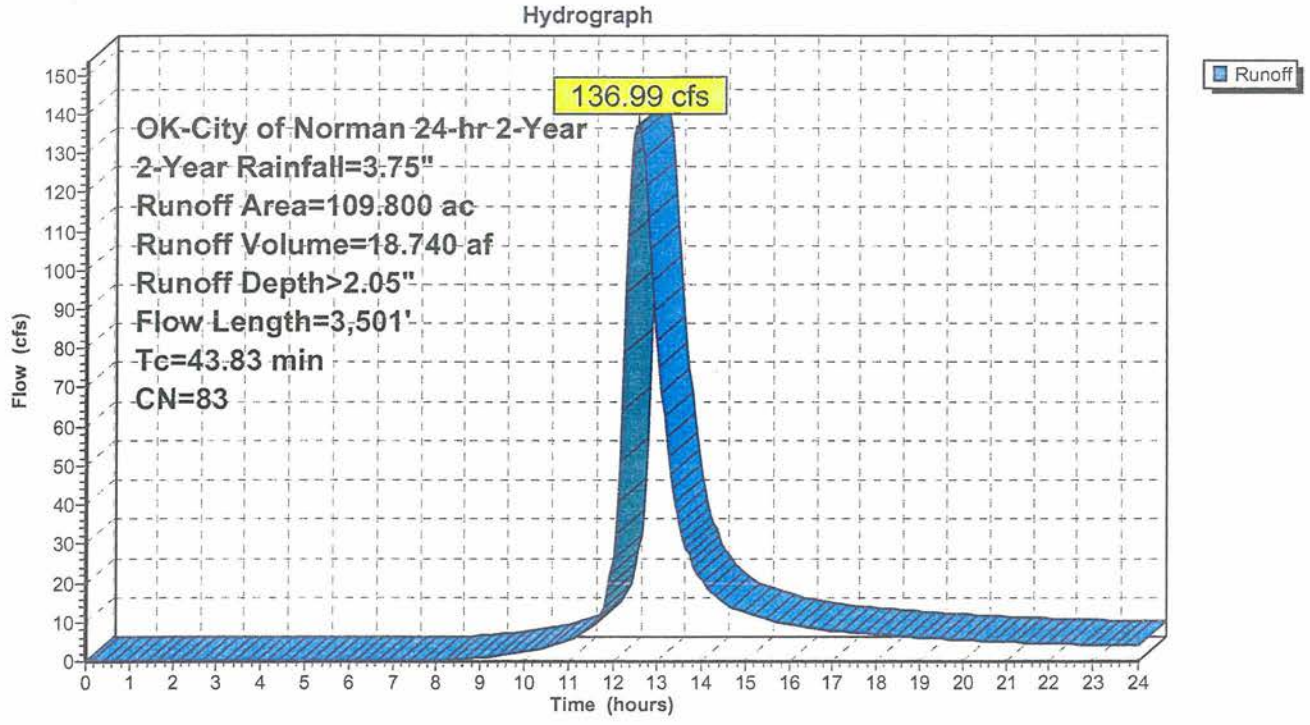
Runoff = 136.99 cfs @ 12.57 hrs, Volume= 18.740 af, Depth> 2.05"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
OK-City of Norman 24-hr 2-Year 2-Year Rainfall=3.75"

	Area (ac)	CN	Description
*	109.800	83	Developed
	109.800		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
26.70	100	0.0100	0.06		**Sheet Flow, Overland** Grass: Bermuda n= 0.410 P2= 3.75"
1.81	220	0.0100	2.03		**Shallow Concentrated Flow, Street** Paved Kv= 20.3 fps
15.32	3,181	0.0217	3.46	51.91	**Channel Flow, Creek** Area= 15.0 sf Perim= 25.0' r= 0.60' n= 0.045
43.83	3,501	Total			

Subcatchment 7S: AreaB



Summary for Subcatchment 16S: Commercial

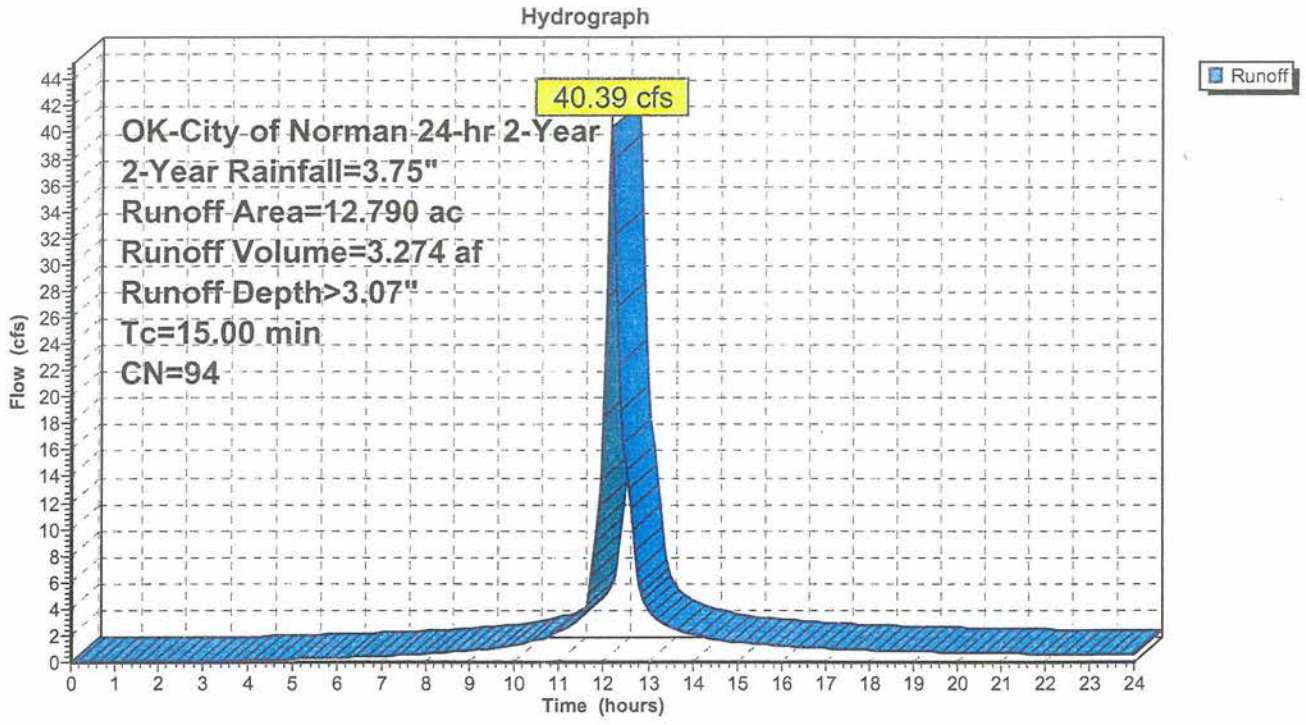
Runoff = 40.39 cfs @ 12.15 hrs, Volume= 3.274 af, Depth> 3.07"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
OK-City of Norman 24-hr 2-Year 2-Year Rainfall=3.75"

	Area (ac)	CN	Description
*	12.790	94	Developed
	12.790		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
15.00					**Direct Entry, Overland**

Subcatchment 16S: Commercial



Summary for Pond 8P: Pond B

Inflow Area = 109.800 ac, 0.00% Impervious, Inflow Depth > 2.05" for 2-Year event
Inflow = 136.99 cfs @ 12.57 hrs, Volume= 18.740 af
Outflow = 37.67 cfs @ 13.45 hrs, Volume= 15.879 af, Atten= 73%, Lag= 53.05 min
Primary = 37.67 cfs @ 13.45 hrs, Volume= 15.879 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 1,135.71' @ 13.45 hrs Surf.Area= 149,146 sf Storage= 389,236 cf

Plug-Flow detention time= 188.54 min calculated for 15.879 af (85% of inflow)
Center-of-Mass det. time= 122.97 min (979.08 - 856.11)

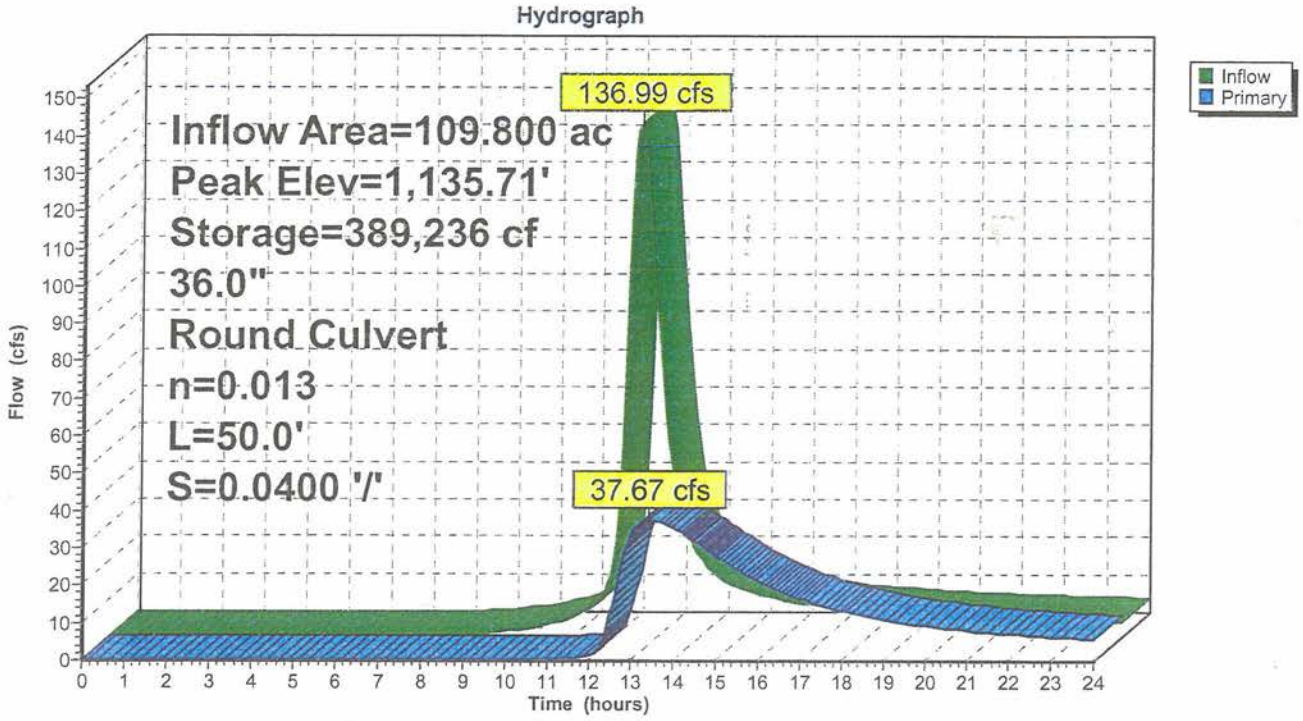
Volume	Invert	Avail.Storage	Storage Description
#1	1,133.00'	1,408,500 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
1,133.00	138,000	0	0
1,142.00	175,000	1,408,500	1,408,500

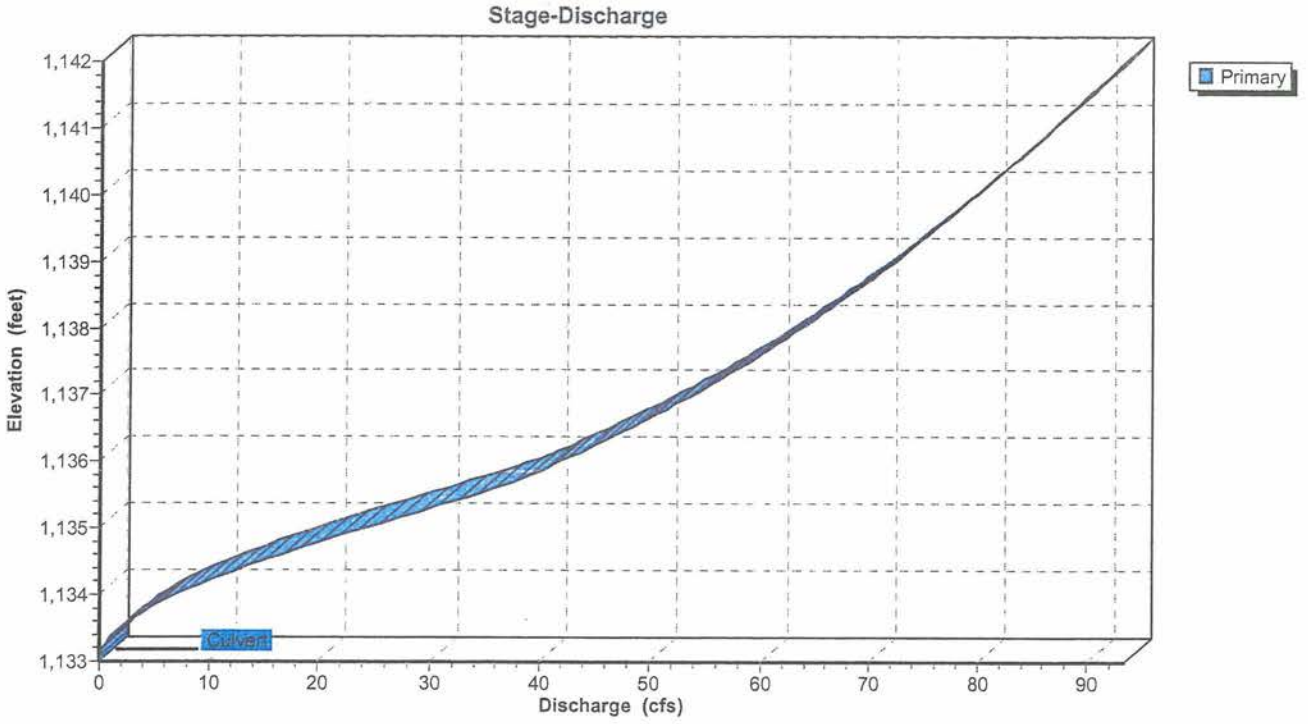
Device	Routing	Invert	Outlet Devices
#1	Primary	1,133.00'	**36.0" Round Culvert** L= 50.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 1,133.00' / 1,131.00' S= 0.0400 '/' Cc= 0.900 n= 0.013, Flow Area= 7.07 sf

Primary OutFlow Max=37.67 cfs @ 13.45 hrs HW=1,135.71' (Free Discharge)
↑**1=Culvert** (Inlet Controls 37.67 cfs @ 5.61 fps)

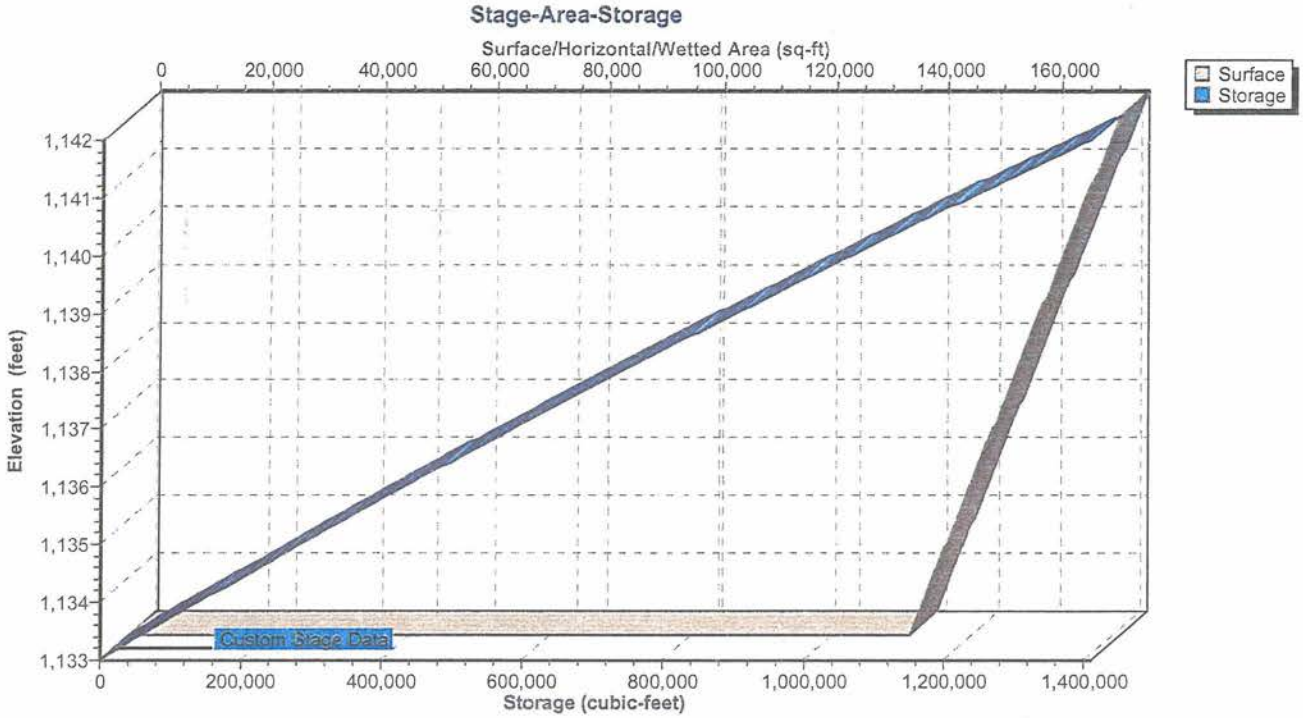
Pond 8P: Pond B



Pond 8P: Pond B



Pond 8P: Pond B

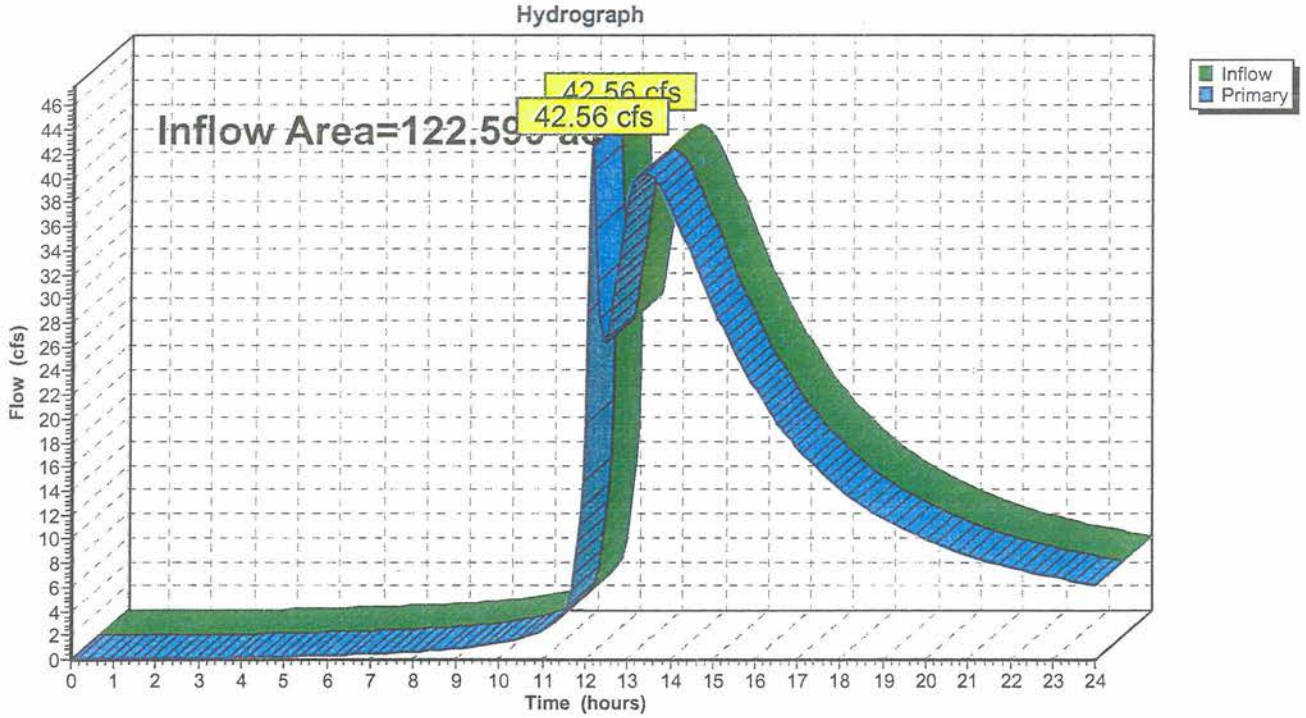


Summary for Link 15L: Proposed B

Inflow Area = 122.590 ac, 0.00% Impervious, Inflow Depth > 1.87" for 2-Year event
Inflow = 42.56 cfs @ 12.16 hrs, Volume= 19.153 af
Primary = 42.56 cfs @ 12.16 hrs, Volume= 19.153 af, Atten= 0%, Lag= 0.00 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Link 15L: Proposed B



Summary for Subcatchment 7S: AreaB

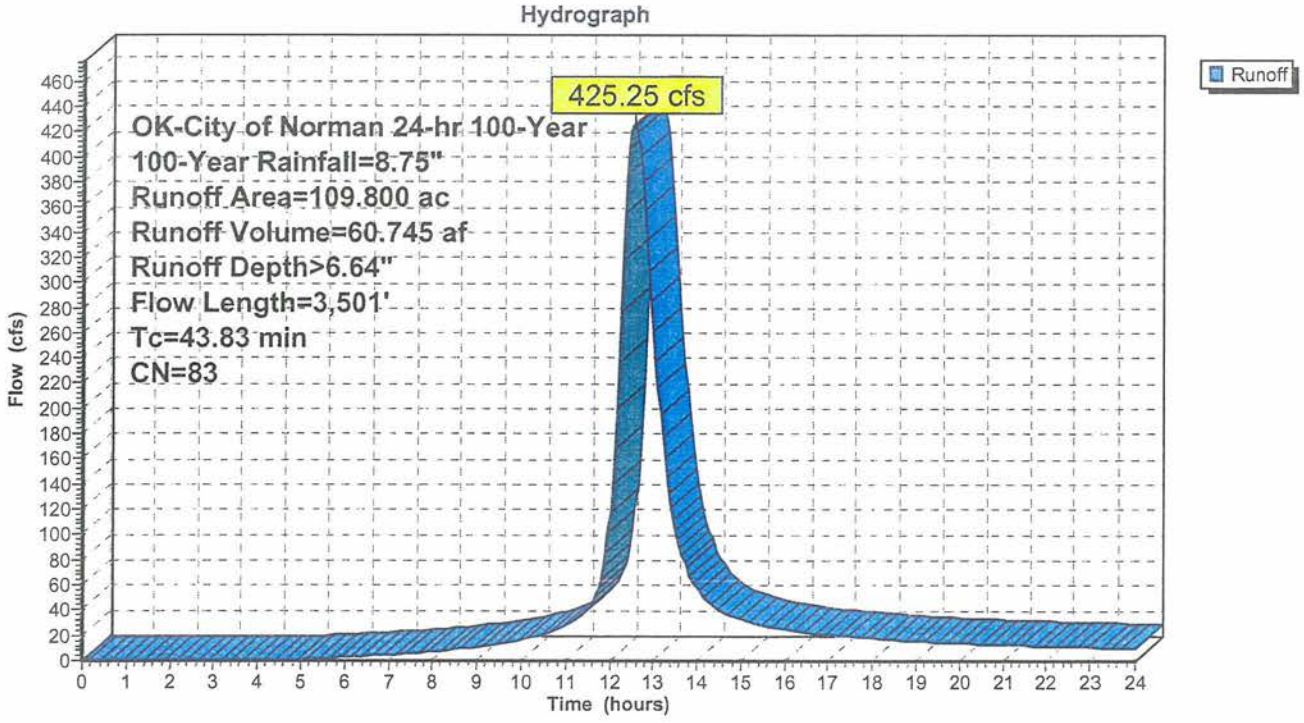
Runoff = 425.25 cfs @ 12.56 hrs, Volume= 60.745 af, Depth> 6.64"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
OK-City of Norman 24-hr 100-Year 100-Year Rainfall=8.75"

	Area (ac)	CN	Description
*	109.800	83	Developed
	109.800		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
26.70	100	0.0100	0.06		**Sheet Flow, Overland** Grass: Bermuda n= 0.410 P2= 3.75"
1.81	220	0.0100	2.03		**Shallow Concentrated Flow, Street** Paved Kv= 20.3 fps
15.32	3,181	0.0217	3.46	51.91	**Channel Flow, Creek** Area= 15.0 sf Perim= 25.0' r= 0.60' n= 0.045
43.83	3,501	Total			

Subcatchment 7S: AreaB



Summary for Subcatchment 16S: Commercial

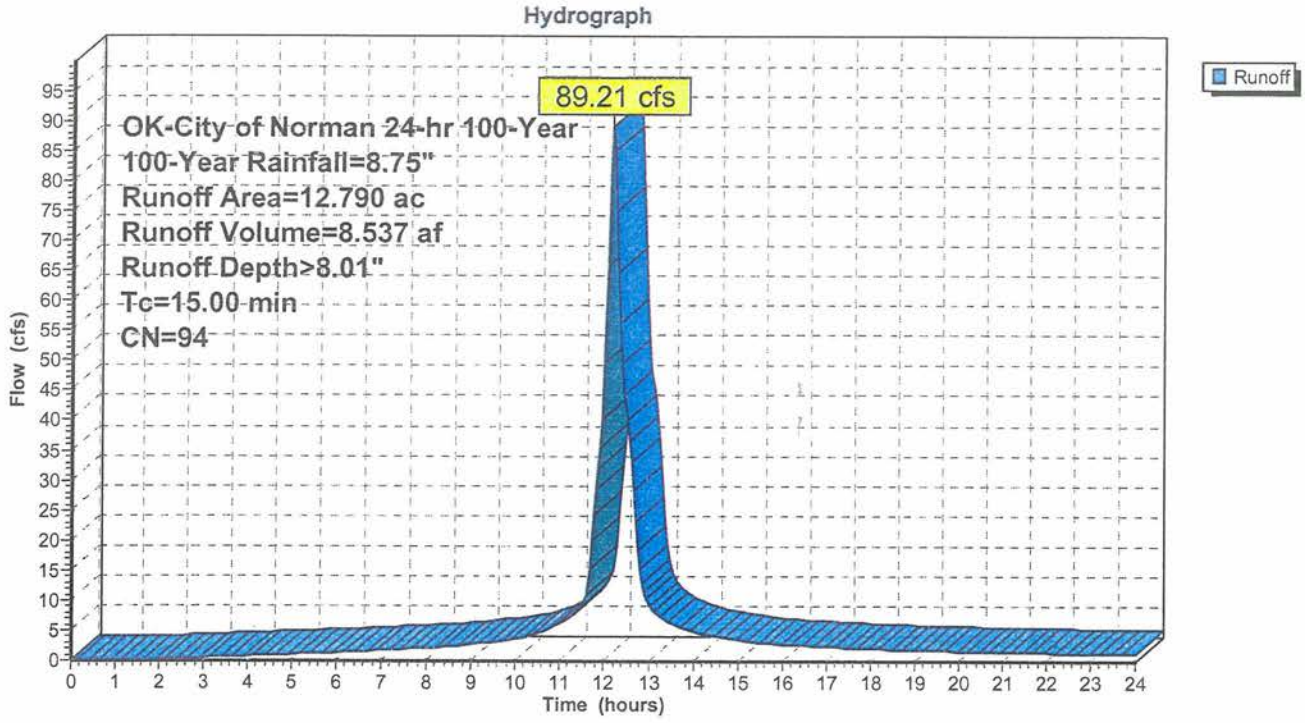
Runoff = 89.21 cfs @ 12.16 hrs, Volume= 8.537 af, Depth> 8.01"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
OK-City of Norman 24-hr 100-Year 100-Year Rainfall=8.75"

	Area (ac)	CN	Description
*	12.790	94	Developed
	12.790		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
15.00					**Direct Entry, Overland**

Subcatchment 16S: Commercial



Summary for Pond 8P: Pond B

Inflow Area = 109.800 ac, 0.00% Impervious, Inflow Depth > 6.64" for 100-Year event
Inflow = 425.25 cfs @ 12.56 hrs, Volume= 60.745 af
Outflow = 91.85 cfs @ 13.58 hrs, Volume= 55.744 af, Atten= 78%, Lag= 61.18 min
Primary = 91.85 cfs @ 13.58 hrs, Volume= 55.744 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 1,141.78' @ 13.58 hrs Surf.Area= 174,110 sf Storage= 1,370,716 cf

Plug-Flow detention time= 201.65 min calculated for 55.744 af (92% of inflow)
Center-of-Mass det. time= 160.68 min (982.86 - 822.18)

Volume	Invert	Avail.Storage	Storage Description
#1	1,133.00'	1,408,500 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)

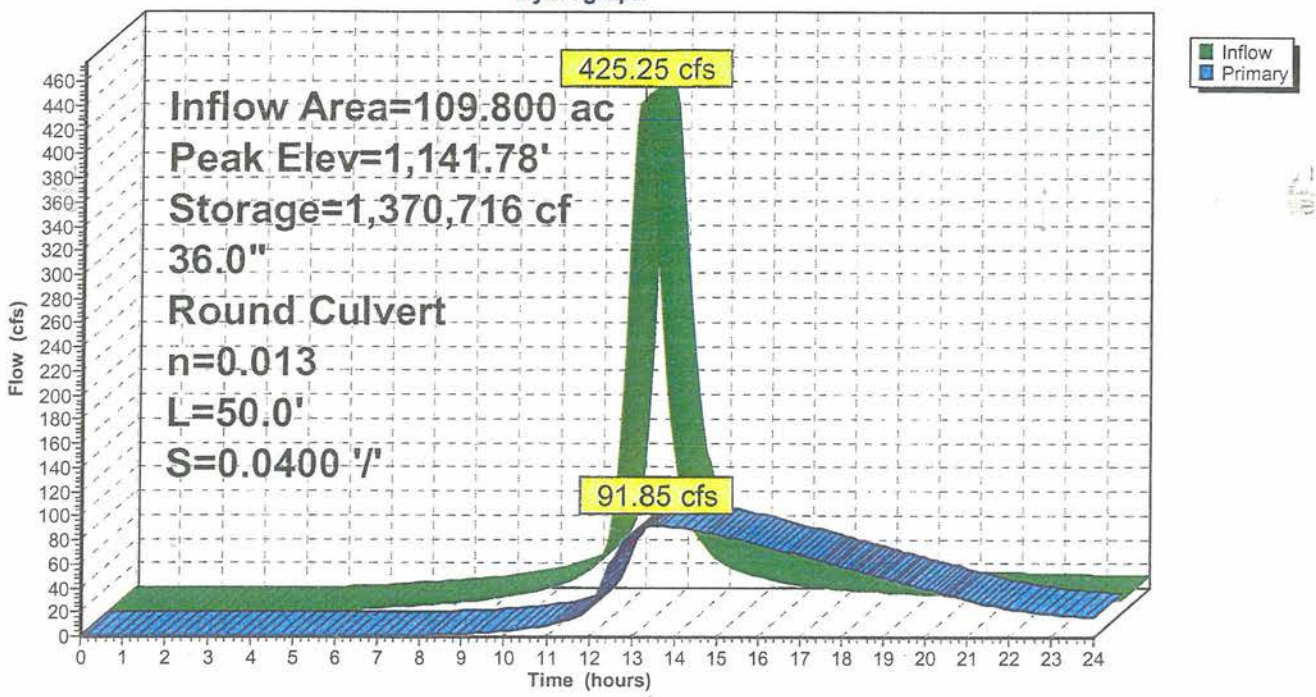
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
1,133.00	138,000	0	0
1,142.00	175,000	1,408,500	1,408,500

Device	Routing	Invert	Outlet Devices
#1	Primary	1,133.00'	**36.0" Round Culvert** L= 50.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 1,133.00' / 1,131.00' S= 0.0400 '/' Cc= 0.900 n= 0.013, Flow Area= 7.07 sf

Primary OutFlow Max=91.85 cfs @ 13.58 hrs HW=1,141.78' (Free Discharge)
└**1=Culvert** (Inlet Controls 91.85 cfs @ 12.99 fps)

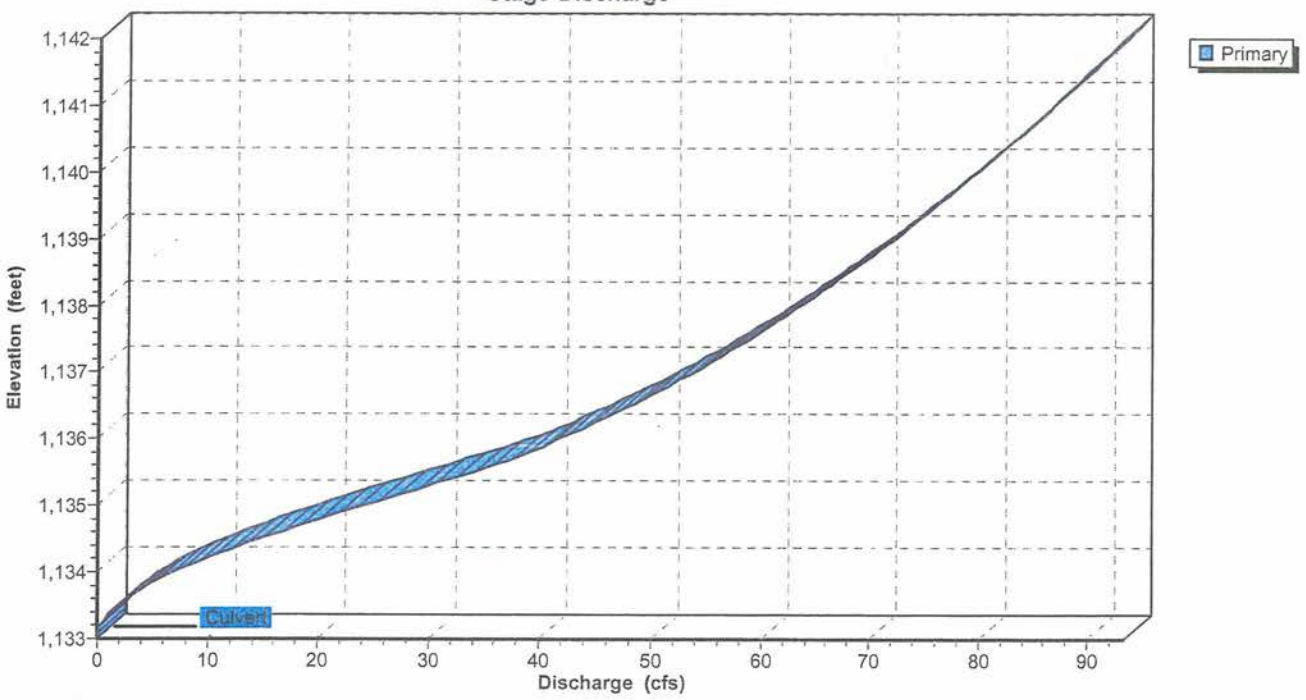
Pond 8P: Pond B

Hydrograph

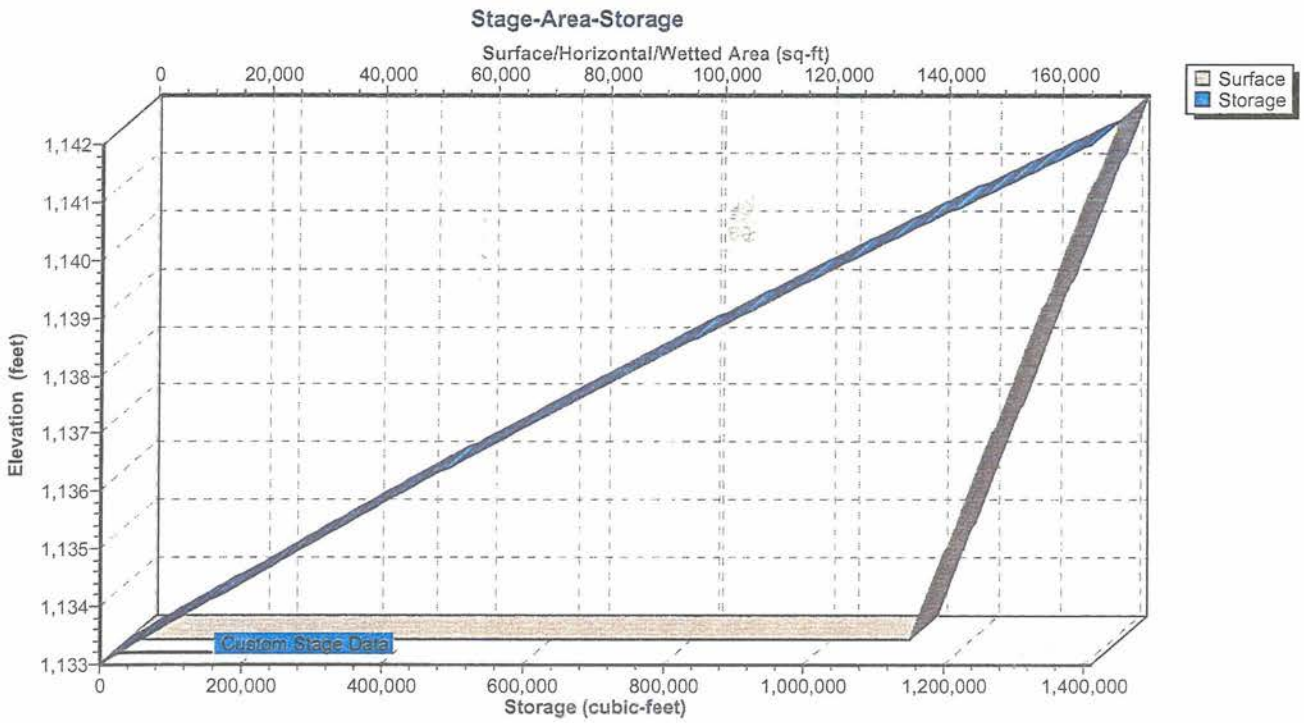


Pond 8P: Pond B

Stage-Discharge



Pond 8P: Pond B

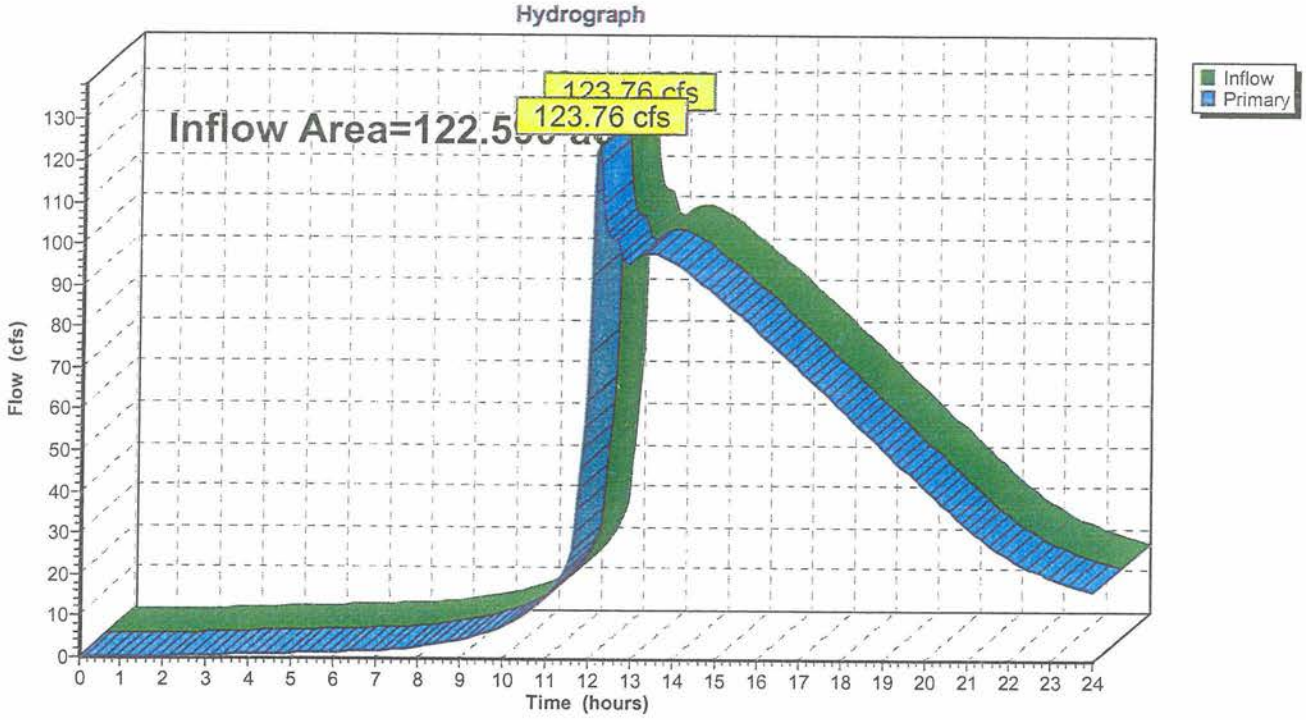


Summary for Link 15L: Proposed B

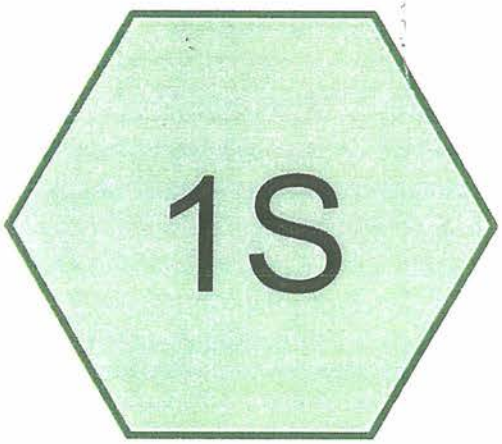
Inflow Area = 122.590 ac, 0.00% Impervious, Inflow Depth > 6.29" for 100-Year event
Inflow = 123.76 cfs @ 12.17 hrs, Volume= 64.281 af
Primary = 123.76 cfs @ 12.17 hrs, Volume= 64.281 af, Atten= 0%, Lag= 0.00 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Link 15L: Proposed B



Appendix D
Drainage Calculations
Area C



Historic Area C

Subcat Reach Pond Link

Routing Diagram for Historic Area C
Prepared by SMC Consulting Engineers, P.C., Printed 1/10/2015

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
40.800	58	Type B soil (1S)
10.300	71	Type C soil (1S)

Summary for Subcatchment 1S: Historic Area C

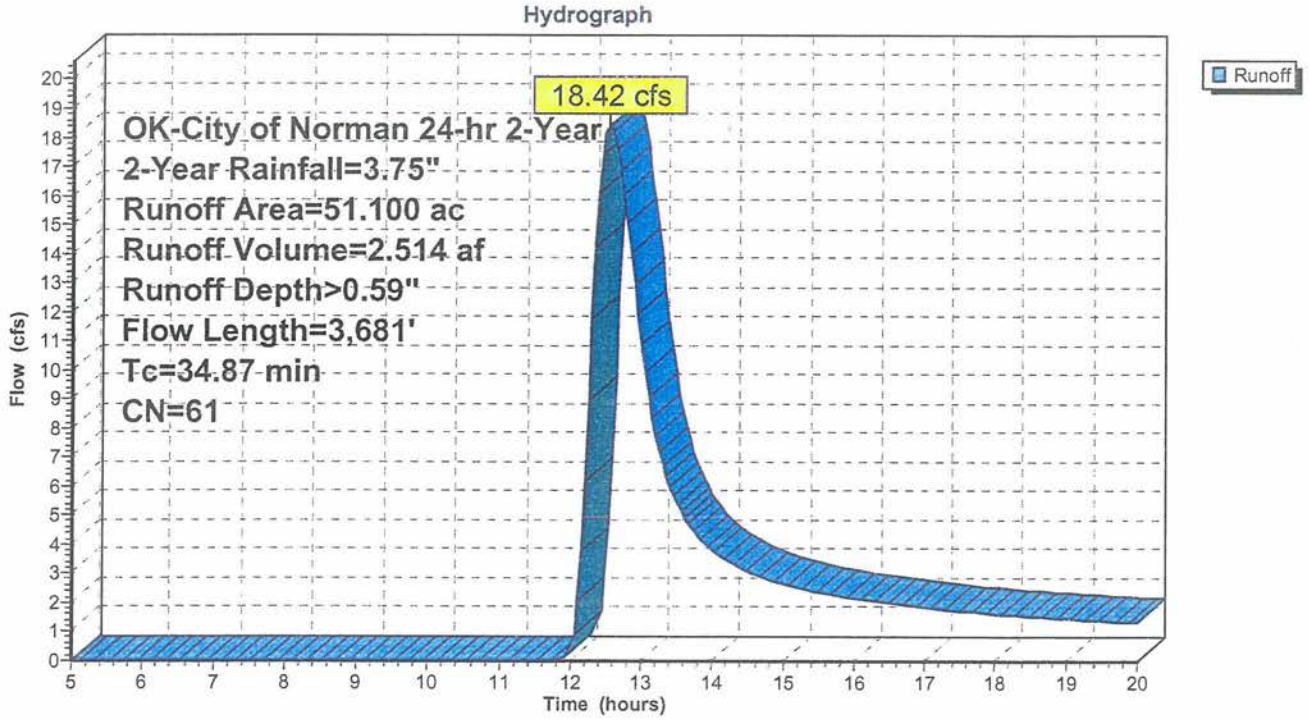
Runoff = 18.42 cfs @ 12.55 hrs, Volume= 2.514 af, Depth> 0.59"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
OK-City of Norman 24-hr 2-Year 2-Year Rainfall=3.75"

	Area (ac)	CN	Description
*	40.800	58	Type B soil
*	10.300	71	Type C soil
	51.100	61	Weighted Average
	51.100		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
20.89	300	0.0167	0.24		**Sheet Flow, Overland flow** Range n= 0.130 P2= 3.75"
2.13	200	0.0500	1.57		**Shallow Concentrated Flow, Swale** Short Grass Pasture Kv= 7.0 fps
11.85	3,181	0.0363	4.48	67.14	**Channel Flow, Creek** Area= 15.0 sf Perim= 25.0' r= 0.60' n= 0.045
34.87	3,681	Total			

Subcatchment 1S: Historic Area C



Summary for Subcatchment 1S: Historic Area C

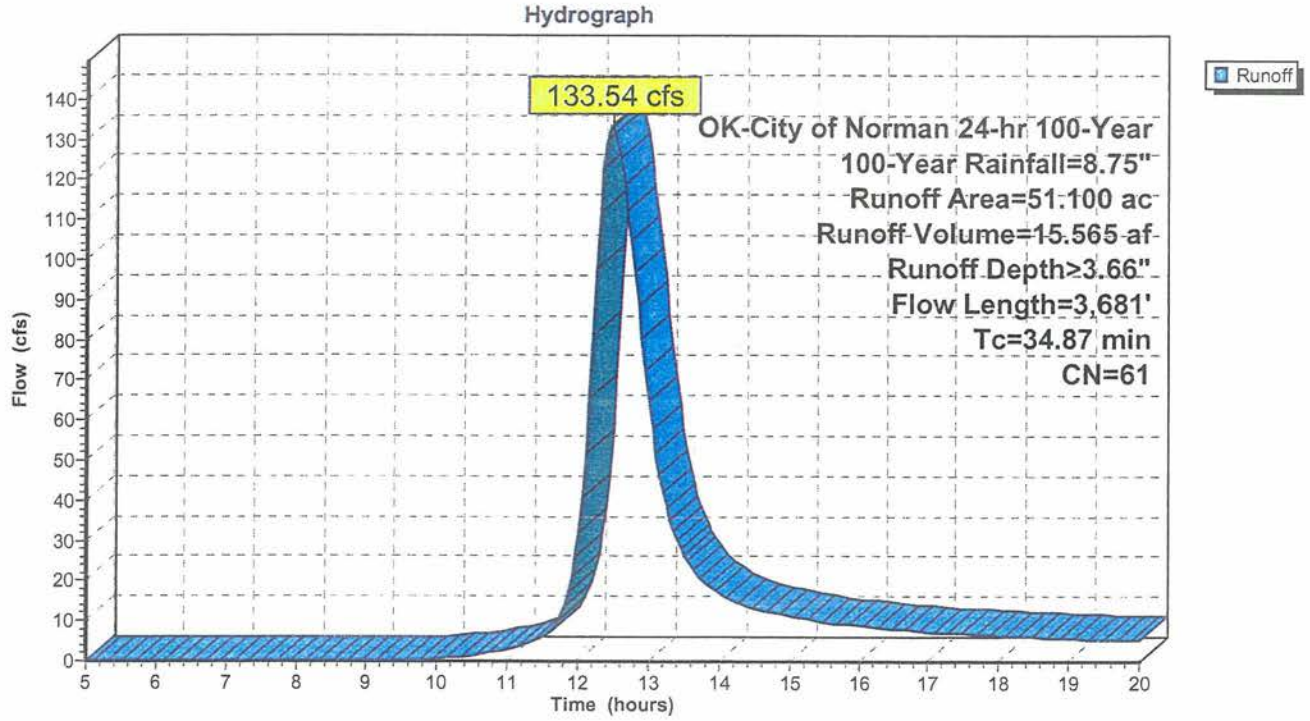
Runoff = 133.54 cfs @ 12.47 hrs, Volume= 15.565 af, Depth> 3.66"

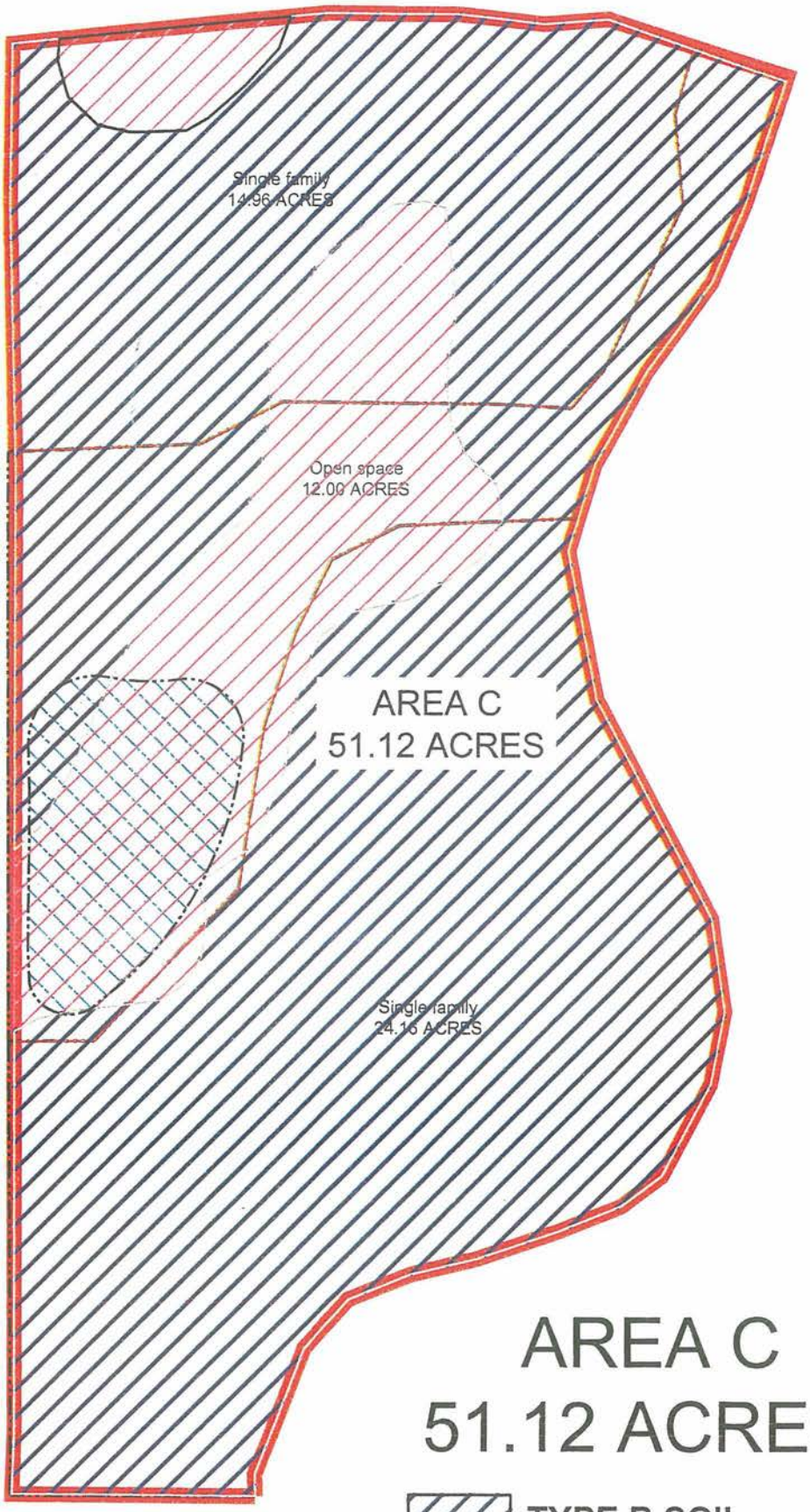
Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
OK-City of Norman 24-hr 100-Year 100-Year Rainfall=8.75"

	Area (ac)	CN	Description
*	40.800	58	Type B soil
*	10.300	71	Type C soil
	51.100	61	Weighted Average
	51.100		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
20.89	300	0.0167	0.24		**Sheet Flow, Overland flow** Range n= 0.130 P2= 3.75"
2.13	200	0.0500	1.57		**Shallow Concentrated Flow, Swale** Short Grass Pasture Kv= 7.0 fps
11.85	3,181	0.0363	4.48	67.14	**Channel Flow, Creek** Area= 15.0 sf Perim= 25.0' r= 0.60' n= 0.045
34.87	3,681	Total			

Subcatchment 1S: Historic Area C

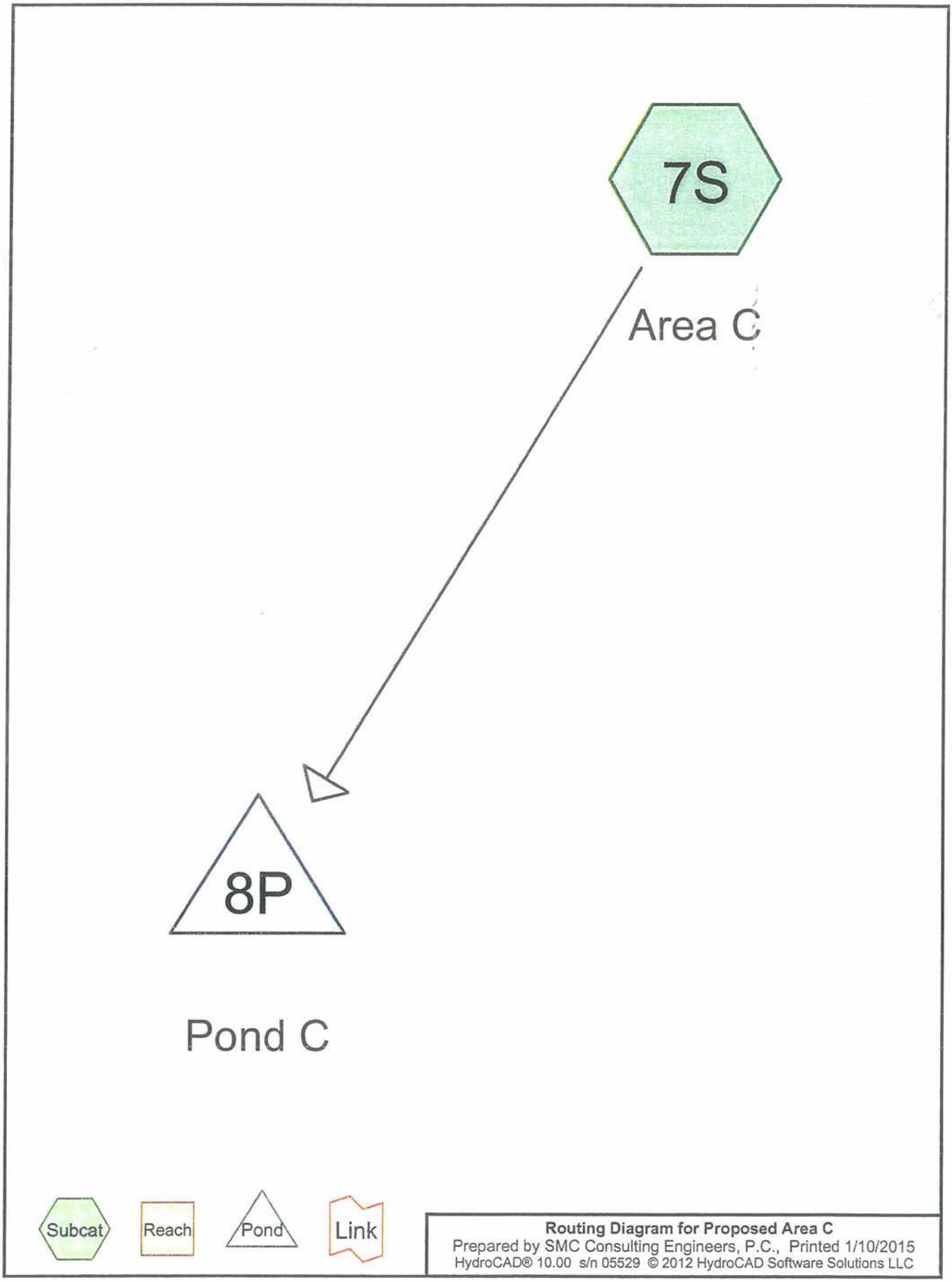




AREA C
51.12 ACRES

TYPE B SOIL

TYPE C SOIL



Routing Diagram for Proposed Area C
Prepared by SMC Consulting Engineers, P.C., Printed 1/10/2015

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
51.120	73	Developed (7S)

Summary for Subcatchment 7S: Area C

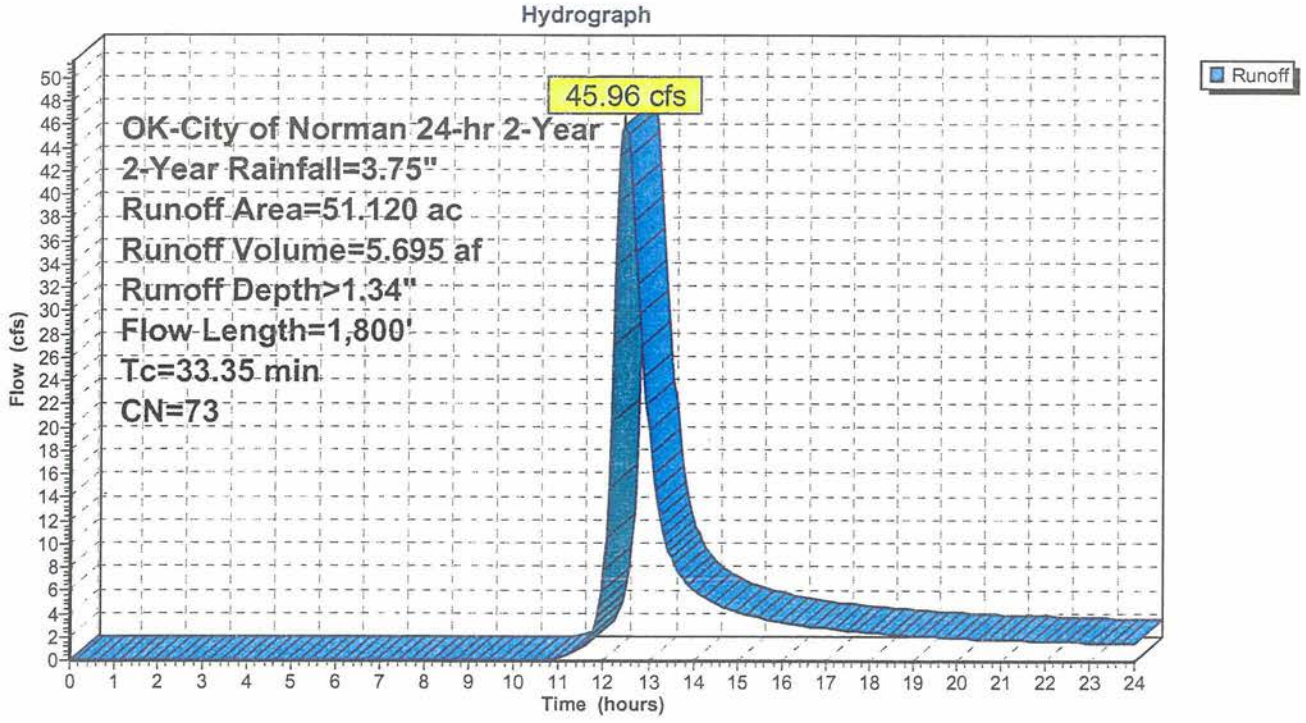
Runoff = 45.96 cfs @ 12.44 hrs, Volume= 5.695 af, Depth> 1.34"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
OK-City of Norman 24-hr 2-Year 2-Year Rainfall=3.75"

	Area (ac)	CN	Description
*	51.120	73	Developed
	51.120		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
26.70	100	0.0100	0.06		**Sheet Flow, Overland** Grass: Bermuda n= 0.410 P2= 3.75"
1.10	300	0.0500	4.54		**Shallow Concentrated Flow, Street** Paved Kv= 20.3 fps
5.55	1,400	0.0320	4.20	63.03	**Channel Flow, Creek** Area= 15.0 sf Perim= 25.0' r= 0.60' n= 0.045
33.35	1,800	Total			

Subcatchment 7S: Area C



Summary for Pond 8P: Pond C

Inflow Area = 51.120 ac, 0.00% Impervious, Inflow Depth > 1.34" for 2-Year event
Inflow = 45.96 cfs @ 12.44 hrs, Volume= 5.695 af
Outflow = 13.59 cfs @ 13.19 hrs, Volume= 5.041 af, Atten= 70%, Lag= 44.84 min
Primary = 13.59 cfs @ 13.19 hrs, Volume= 5.041 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 1,141.55' @ 13.19 hrs Surf.Area= 78,507 sf Storage= 99,763 cf

Plug-Flow detention time= 145.75 min calculated for 5.031 af (88% of inflow)
Center-of-Mass det. time= 91.78 min (968.82 - 877.04)

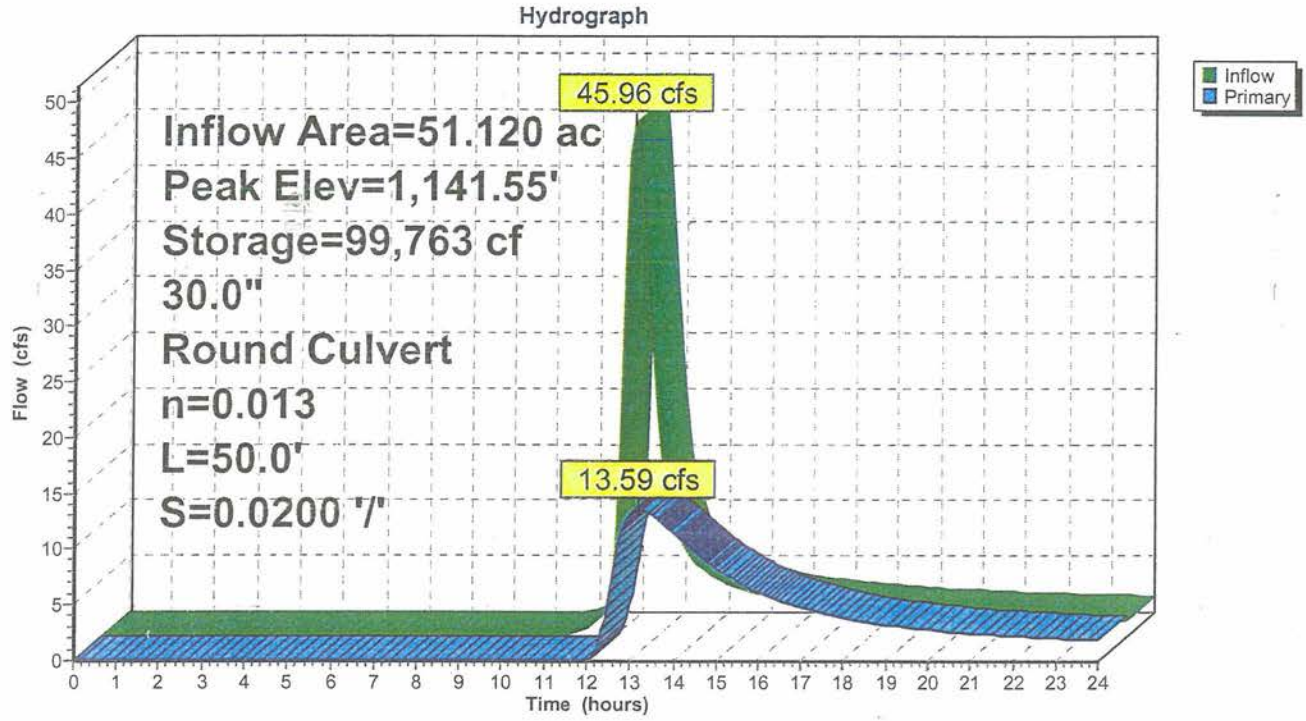
Volume	Invert	Avail.Storage	Storage Description
#1	1,140.00'	479,500 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
1,140.00	50,000	0	0
1,145.00	141,800	479,500	479,500

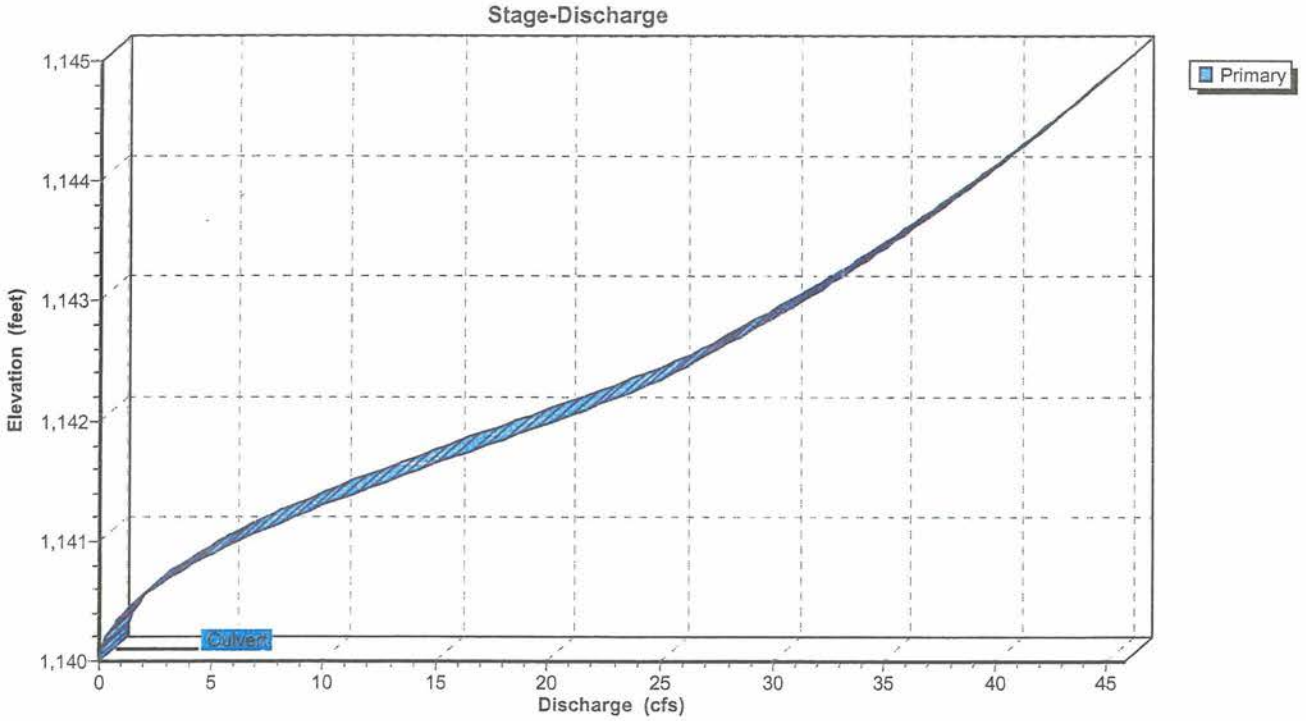
Device	Routing	Invert	Outlet Devices
#1	Primary	1,140.00'	**30.0" Round Culvert** L= 50.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 1,140.00' / 1,139.00' S= 0.0200 '/' Cc= 0.900 n= 0.013, Flow Area= 4.91 sf

Primary OutFlow Max=13.59 cfs @ 13.19 hrs HW=1,141.55' (Free Discharge)
↑**1=Culvert** (Inlet Controls 13.59 cfs @ 4.24 fps)

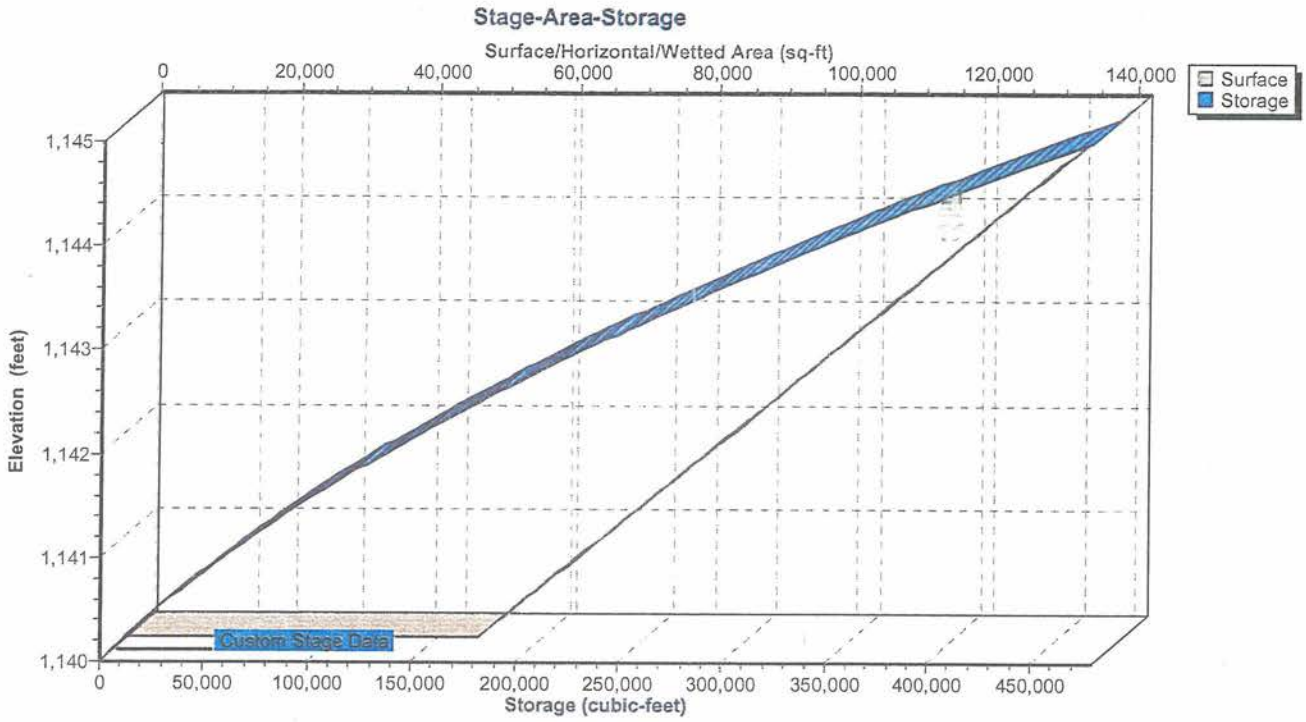
Pond 8P: Pond C



Pond 8P: Pond C



Pond 8P: Pond C



Summary for Subcatchment 7S: Area C

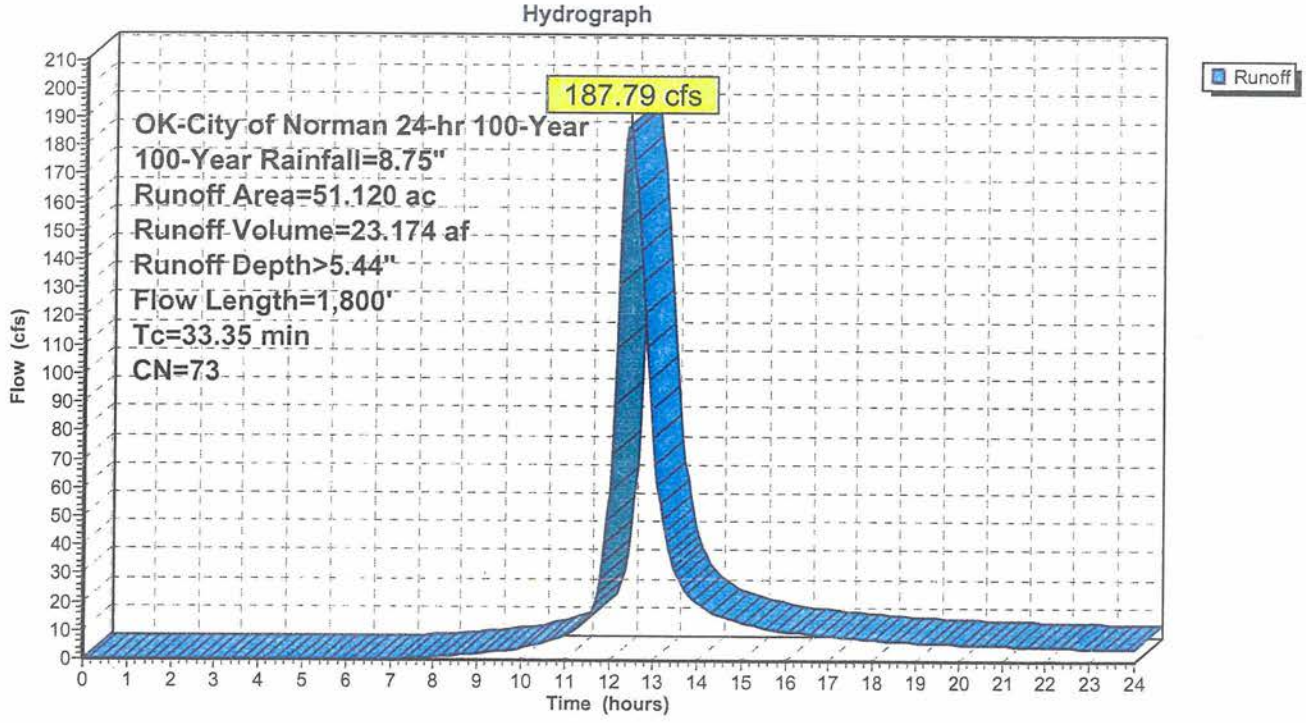
Runoff = 187.79 cfs @ 12.42 hrs, Volume= 23.174 af, Depth> 5.44"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
OK-City of Norman 24-hr 100-Year 100-Year Rainfall=8.75"

	Area (ac)	CN	Description
*	51.120	73	Developed
	51.120		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
26.70	100	0.0100	0.06		**Sheet Flow, Overland** Grass: Bermuda n= 0.410 P2= 3.75"
1.10	300	0.0500	4.54		**Shallow Concentrated Flow, Street** Paved Kv= 20.3 fps
5.55	1,400	0.0320	4.20	63.03	**Channel Flow, Creek** Area= 15.0 sf Perim= 25.0' r= 0.60' n= 0.045
33.35	1,800	Total			

Subcatchment 7S: Area C



Summary for Pond 8P: Pond C

Inflow Area = 51.120 ac, 0.00% Impervious, Inflow Depth > 5.44" for 100-Year event
Inflow = 187.79 cfs @ 12.42 hrs, Volume= 23.174 af
Outflow = 45.38 cfs @ 13.25 hrs, Volume= 21.977 af, Atten= 76%, Lag= 49.32 min
Primary = 45.38 cfs @ 13.25 hrs, Volume= 21.977 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 1,144.94' @ 13.25 hrs Surf.Area= 140,637 sf Storage= 470,555 cf

Plug-Flow detention time= 139.56 min calculated for 21.977 af (95% of inflow)
Center-of-Mass det. time= 111.83 min (947.25 - 835.43)

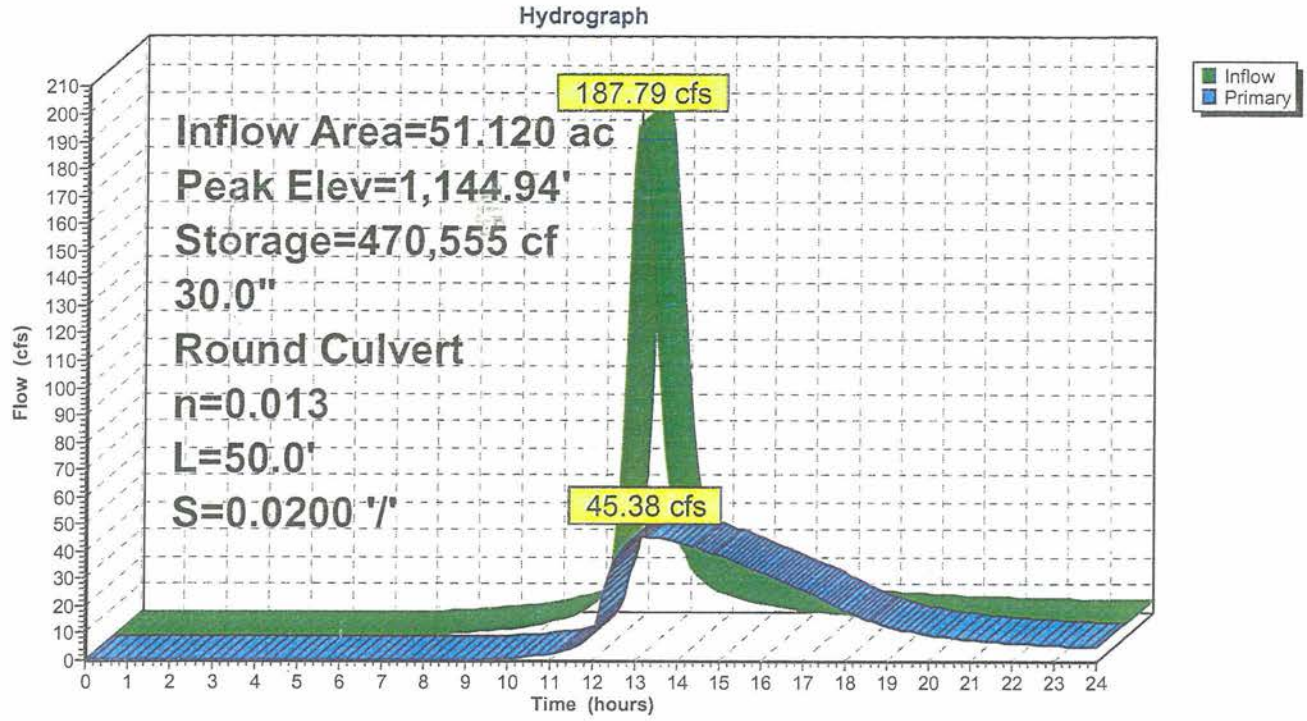
Volume	Invert	Avail.Storage	Storage Description
#1	1,140.00'	479,500 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
1,140.00	50,000	0	0
1,145.00	141,800	479,500	479,500

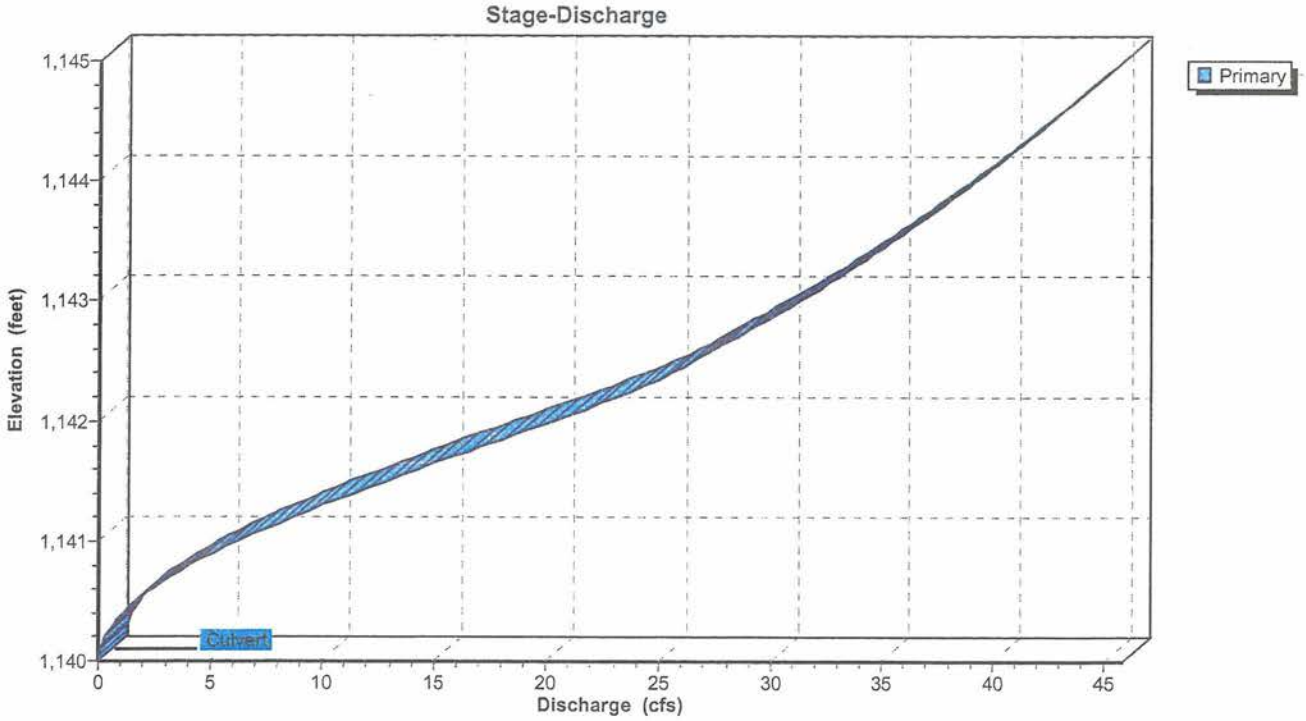
Device	Routing	Invert	Outlet Devices
#1	Primary	1,140.00'	**30.0" Round Culvert** L= 50.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 1,140.00' / 1,139.00' S= 0.0200 '/' Cc= 0.900 n= 0.013, Flow Area= 4.91 sf

Primary OutFlow Max=45.38 cfs @ 13.25 hrs HW=1,144.94' (Free Discharge)
↑**1=Culvert** (Inlet Controls 45.38 cfs @ 9.24 fps)

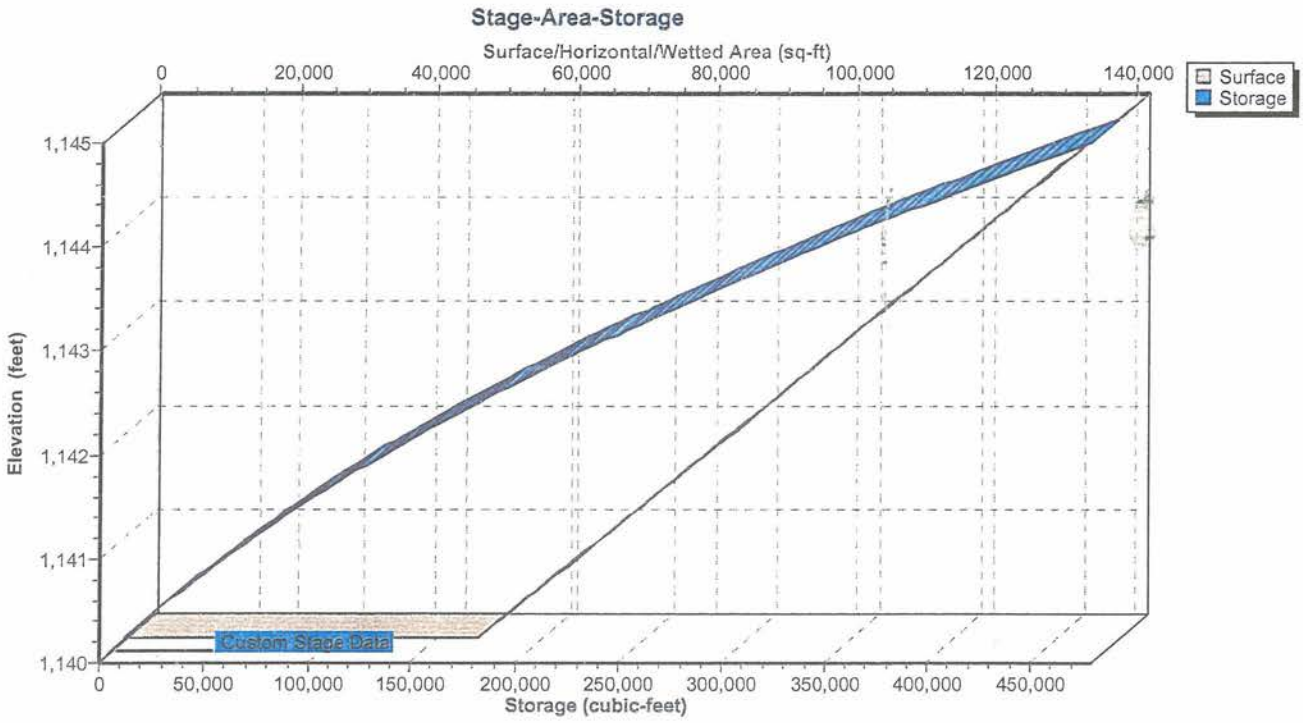
Pond 8P: Pond C



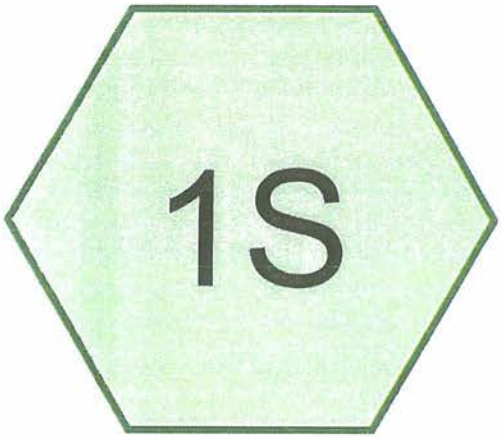
Pond 8P: Pond C



Pond 8P: Pond C



Appendix E
Drainage Calculations
Area D



Historic Area D

Subcat Reach Pond Link

Routing Diagram for Historic Area D
Prepared by SMC Consulting Engineers, P.C., Printed 1/10/2015

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
37.900	58	Type B soil (1S)
15.500	71	Type C soil (1S)
42.700	78	Type D soil (1S)

Summary for Subcatchment 1S: Historic Area D

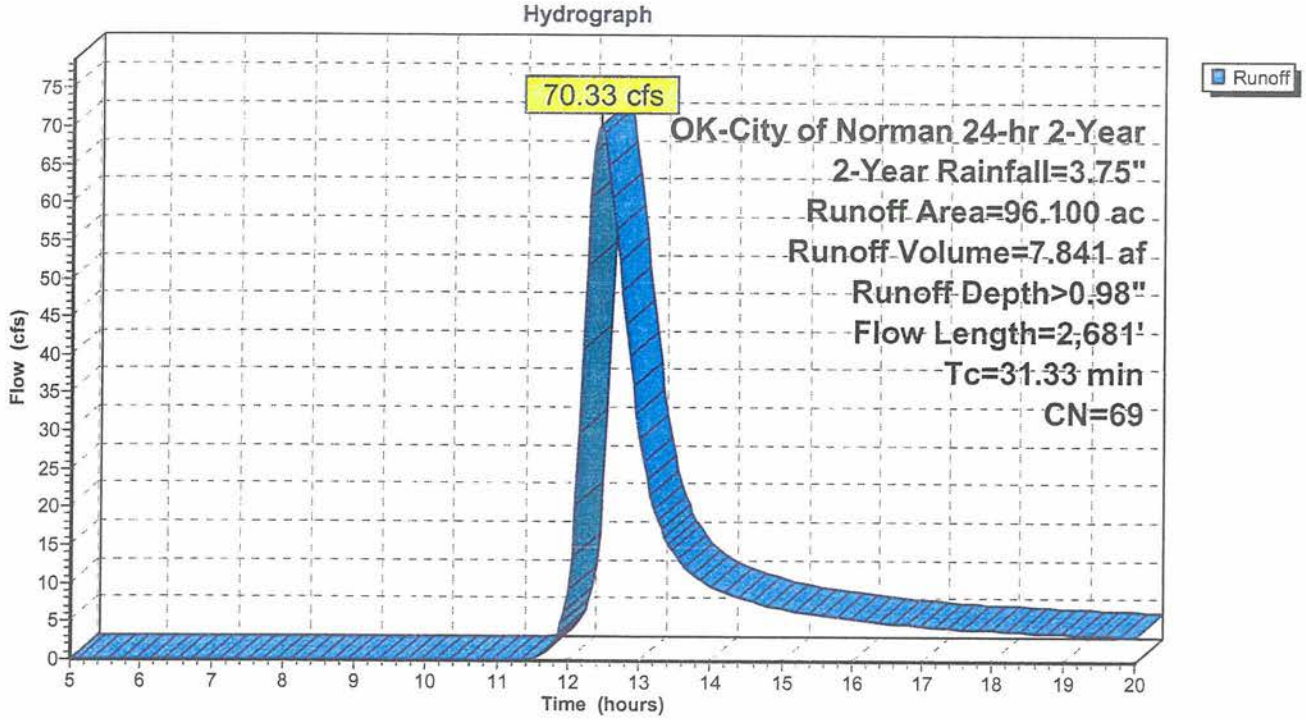
Runoff = 70.33 cfs @ 12.43 hrs, Volume= 7.841 af, Depth> 0.98"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
OK-City of Norman 24-hr 2-Year 2-Year Rainfall=3.75"

	Area (ac)	CN	Description
*	37.900	58	Type B soil
*	15.500	71	Type C soil
*	42.700	78	Type D soil
	96.100	69	Weighted Average
	96.100		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
19.44	300	0.0200	0.26		**Sheet Flow, Overland flow** Range n= 0.130 P2= 3.75"
11.89	2,381	0.0202	3.34	50.08	**Channel Flow, Creek** Area= 15.0 sf Perim= 25.0' r= 0.60' n= 0.045
31.33	2,681	Total			

Subcatchment 1S: Historic Area D



Summary for Subcatchment 1S: Historic Area D

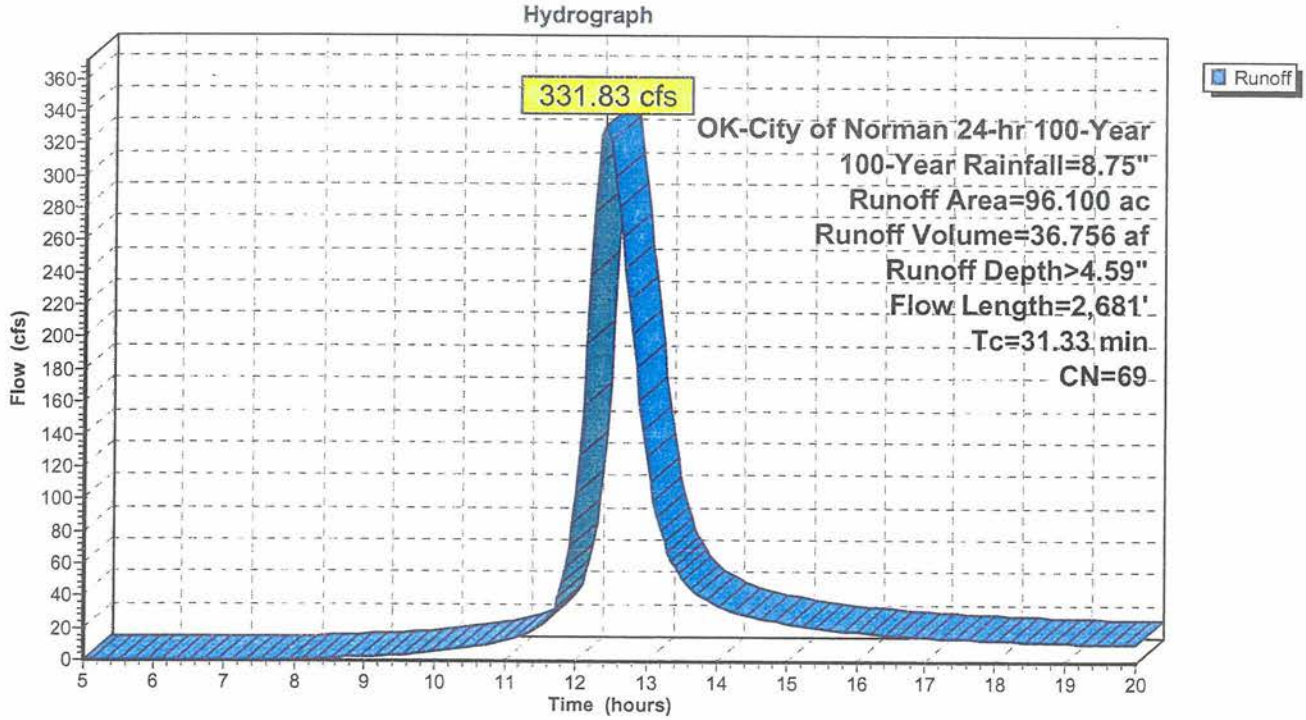
Runoff = 331.83 cfs @ 12.41 hrs, Volume= 36.756 af, Depth> 4.59"

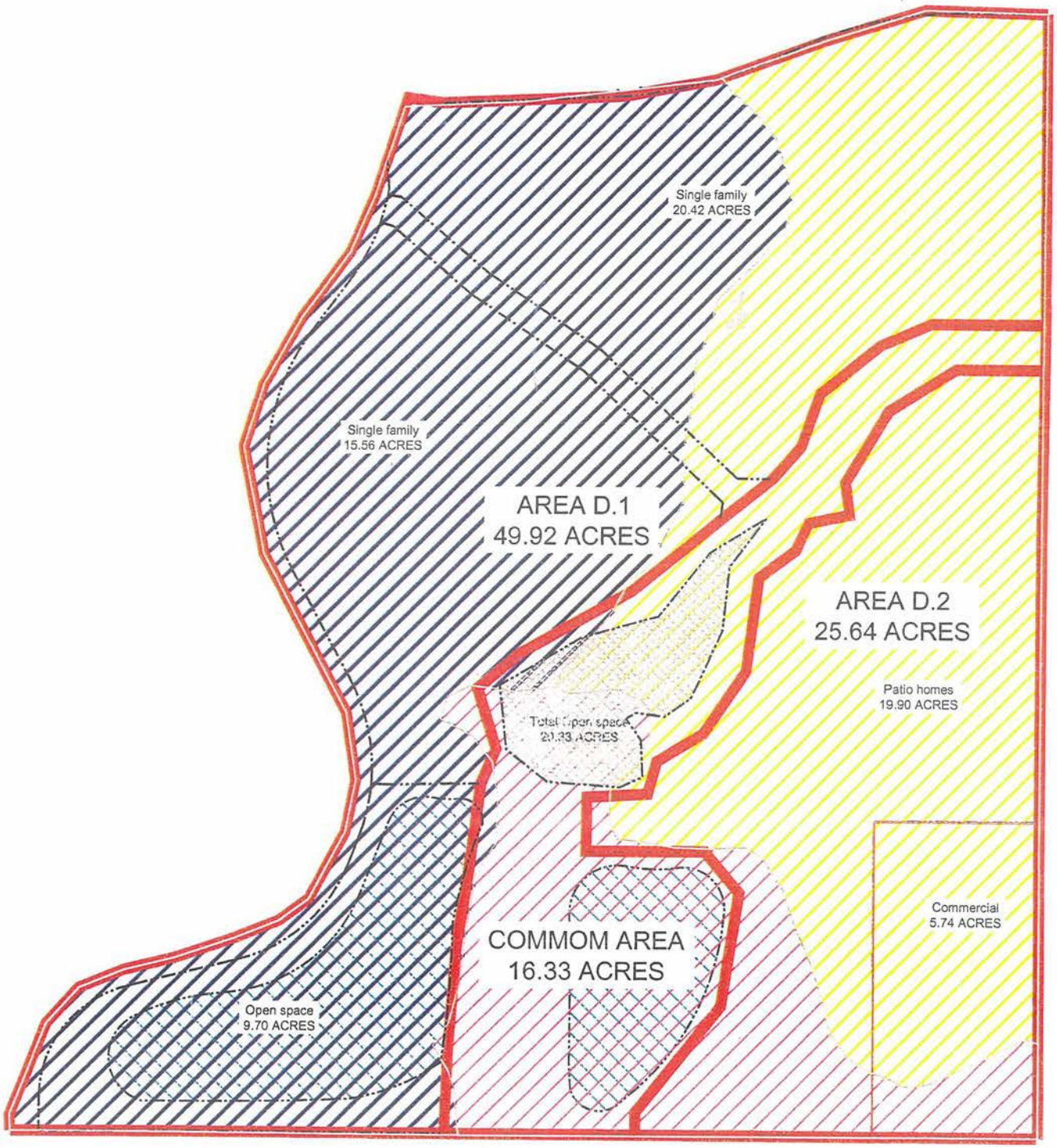
Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
OK-City of Norman 24-hr 100-Year 100-Year Rainfall=8.75"

	Area (ac)	CN	Description
*	37.900	58	Type B soil
*	15.500	71	Type C soil
*	42.700	78	Type D soil
	96.100	69	Weighted Average
	96.100		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
19.44	300	0.0200	0.26		**Sheet Flow, Overland flow** Range n= 0.130 P2= 3.75"
11.89	2,381	0.0202	3.34	50.08	**Channel Flow, Creek** Area= 15.0 sf Perim= 25.0' r= 0.60' n= 0.045
31.33	2,681	Total			

Subcatchment 1S: Historic Area D



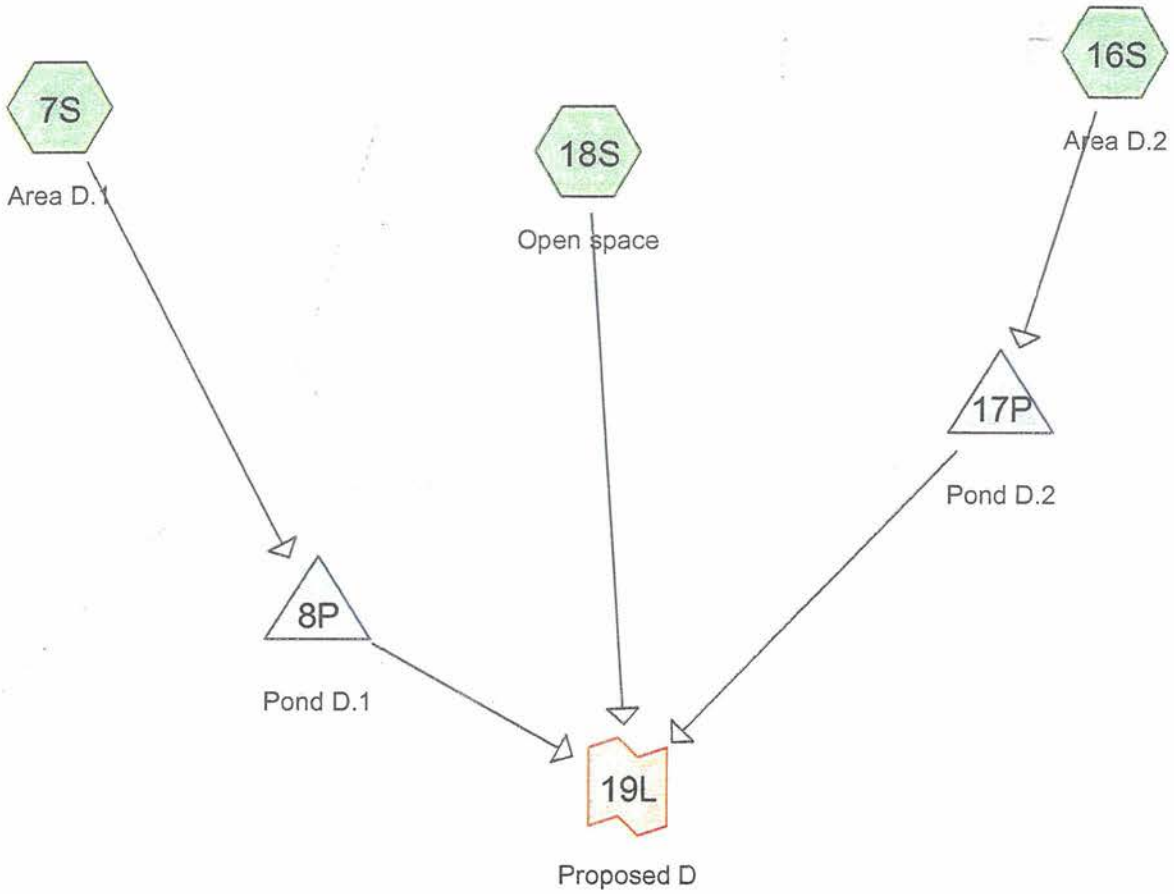


AREA D
91.89 ACRES

TYPE B SOIL

TYPE C SOIL

TYPE D SOIL



Subcat Reach Pond Link

Routing Diagram for Proposed Area D
Prepared by SMC Consulting Engineers, P.C., Printed 1/10/2015

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
25.640	92	(16S)
16.330	69	(18S)
49.920	75	Developed (7S)

Summary for Subcatchment 7S: Area D.1

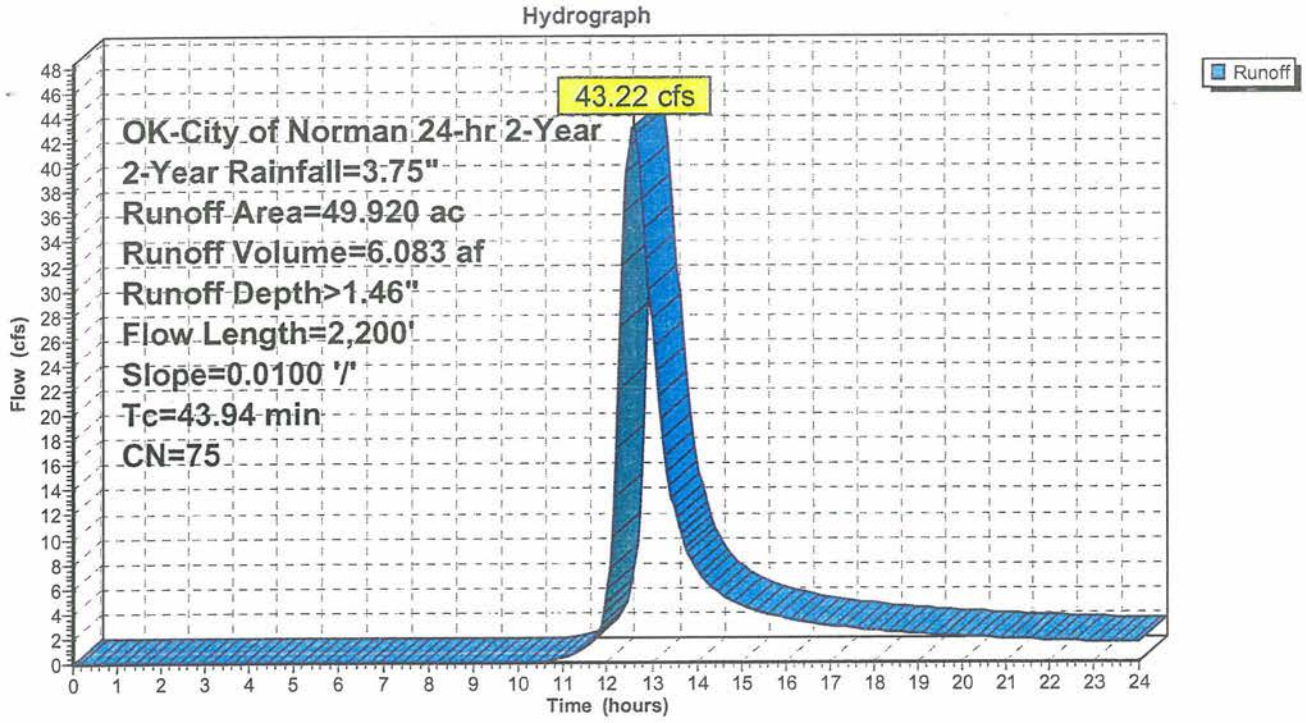
Runoff = 43.22 cfs @ 12.59 hrs, Volume= 6.083 af, Depth> 1.46"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
OK-City of Norman 24-hr 2-Year 2-Year Rainfall=3.75"

	Area (ac)	CN	Description
*	49.920	75	Developed
	49.920		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
26.70	100	0.0100	0.06		**Sheet Flow, Overland** Grass: Bermuda n= 0.410 P2= 3.75"
17.24	2,100	0.0100	2.03		**Shallow Concentrated Flow, Street** Paved Kv= 20.3 fps
43.94	2,200	Total			

Subcatchment 7S: Area D.1



Summary for Subcatchment 16S: Area D.2

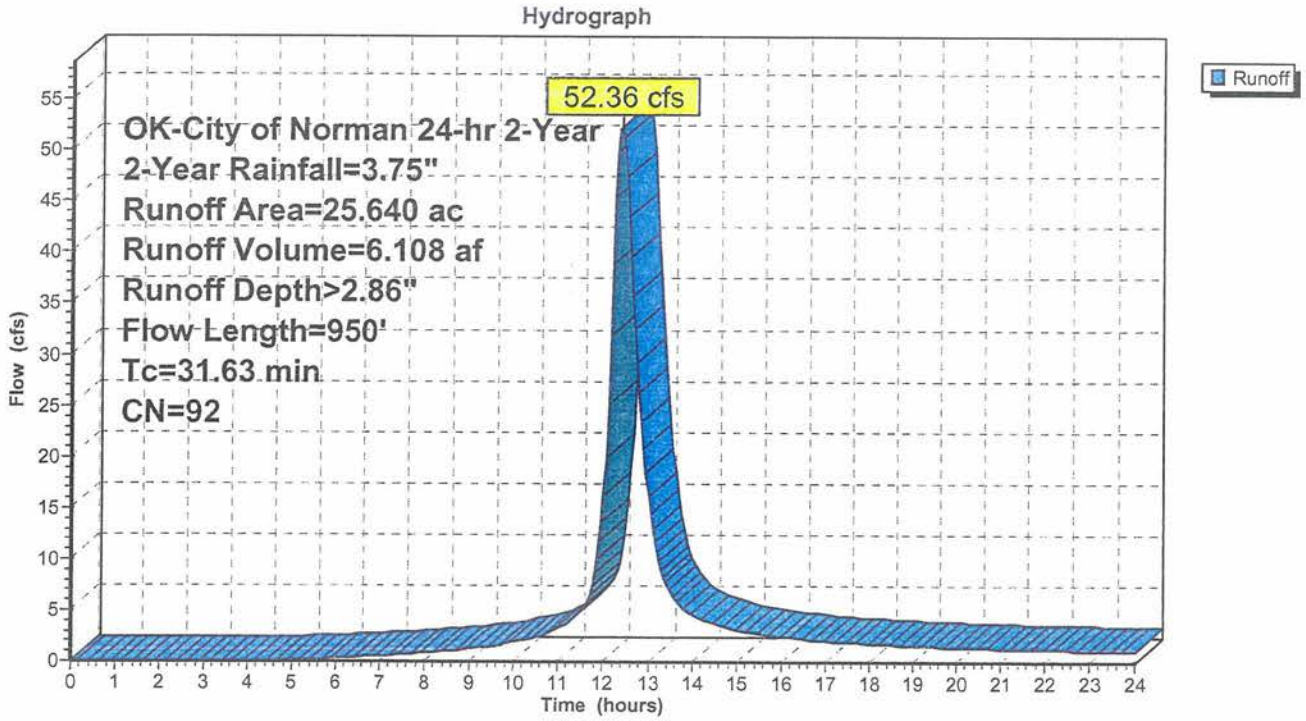
Runoff = 52.36 cfs @ 12.38 hrs, Volume= 6.108 af, Depth> 2.86"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
OK-City of Norman 24-hr 2-Year 2-Year Rainfall=3.75"

	Area (ac)	CN	Description
*	25.640	92	
	25.640		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
26.70	100	0.0100	0.06		**Sheet Flow, Overland** Grass: Bermuda n= 0.410 P2= 3.75"
4.93	850	0.0200	2.87		**Shallow Concentrated Flow, Street** Paved Kv= 20.3 fps
31.63	950	Total			

Subcatchment 16S: Area D.2



Summary for Subcatchment 18S: Open space

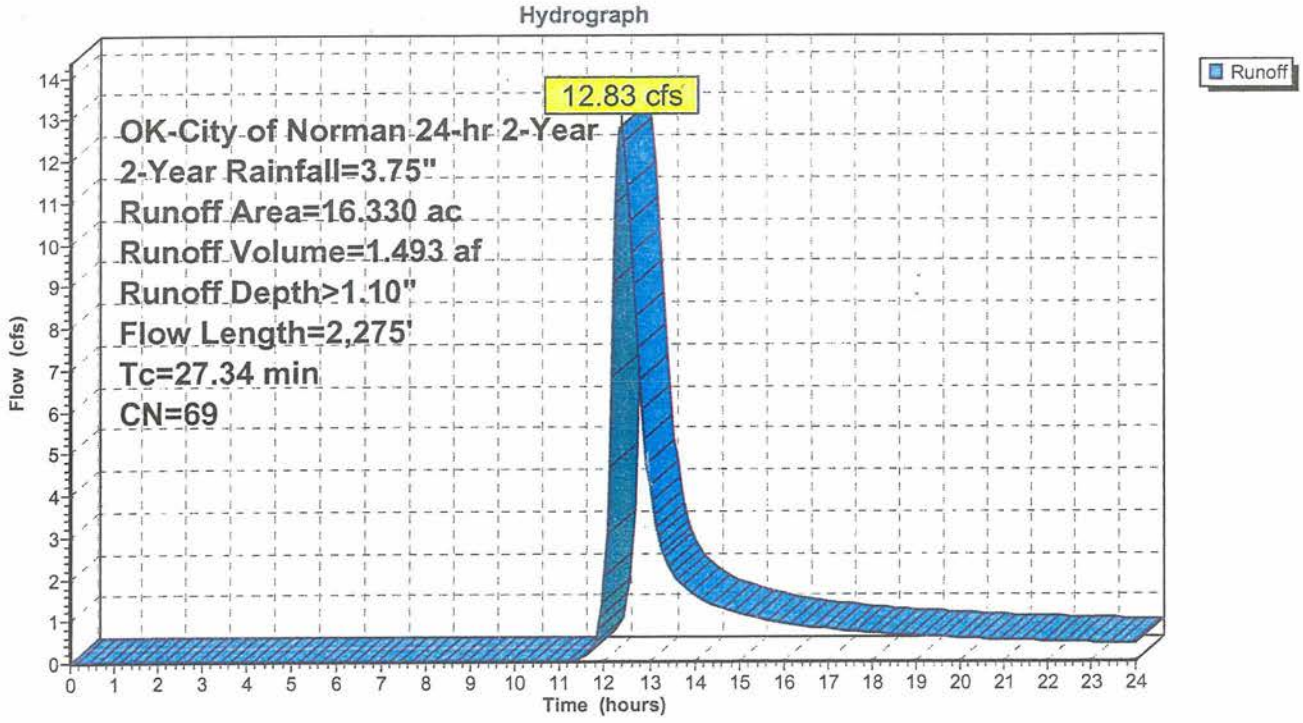
Runoff = 12.83 cfs @ 12.37 hrs, Volume= 1.493 af, Depth> 1.10"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
OK-City of Norman 24-hr 2-Year 2-Year Rainfall=3.75"

	Area (ac)	CN	Description
*	16.330	69	
	16.330		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
15.33	50	0.0100	0.05		**Sheet Flow, Overland** Grass: Bermuda n= 0.410 P2= 3.75"
12.01	2,225	0.0150	3.09	30.86	**Channel Flow, Ex. creek** Area= 10.0 sf Perim= 15.0' r= 0.67' n= 0.045
27.34	2,275	Total			

Subcatchment 18S: Open space



Summary for Pond 8P: Pond D.1

Inflow Area = 49.920 ac, 0.00% Impervious, Inflow Depth > 1.46" for 2-Year event
Inflow = 43.22 cfs @ 12.59 hrs, Volume= 6.083 af
Outflow = 3.09 cfs @ 16.72 hrs, Volume= 2.584 af, Atten= 93%, Lag= 247.92 min
Primary = 3.09 cfs @ 16.72 hrs, Volume= 2.584 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 1,155.69' @ 16.72 hrs Surf.Area= 251,372 sf Storage= 172,009 cf

Plug-Flow detention time= 353.52 min calculated for 2.578 af (42% of inflow)
Center-of-Mass det. time= 225.64 min (1,104.84 - 879.20)

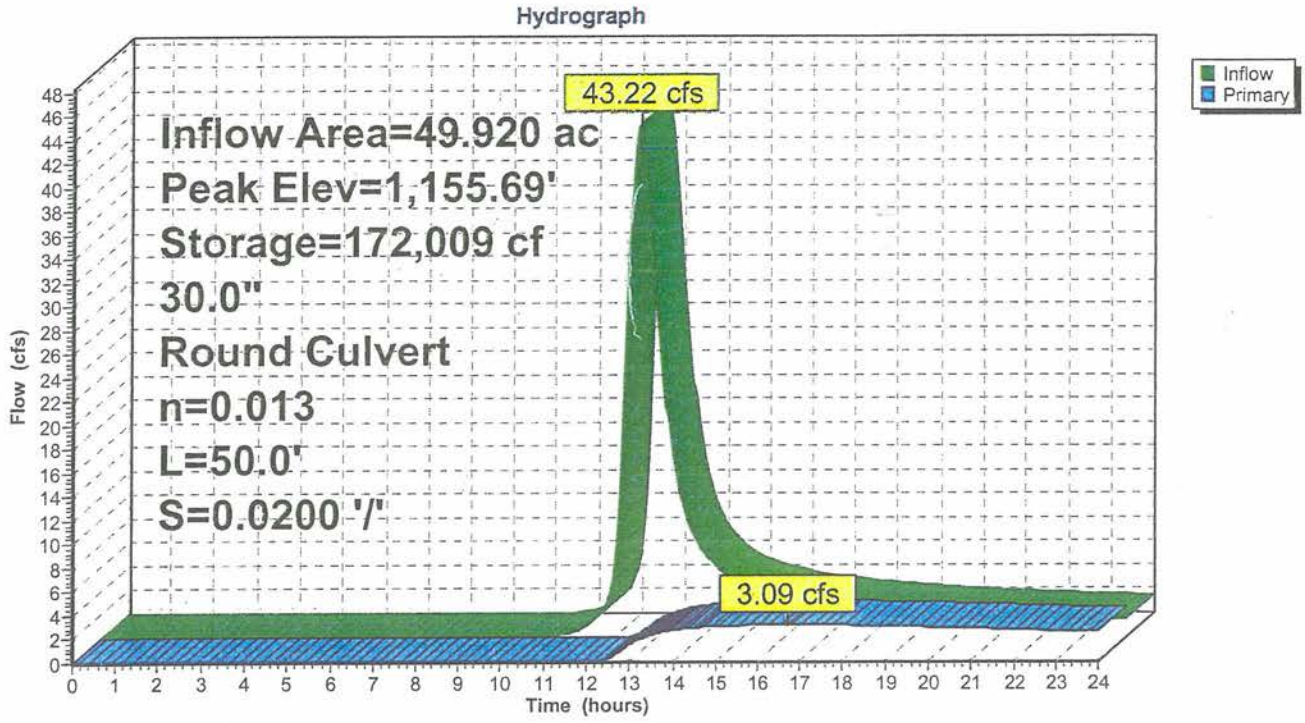
Volume	Invert	Avail.Storage	Storage Description
#1	1,155.00'	1,275,000 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
1,155.00	250,000	0	0
1,160.00	260,000	1,275,000	1,275,000

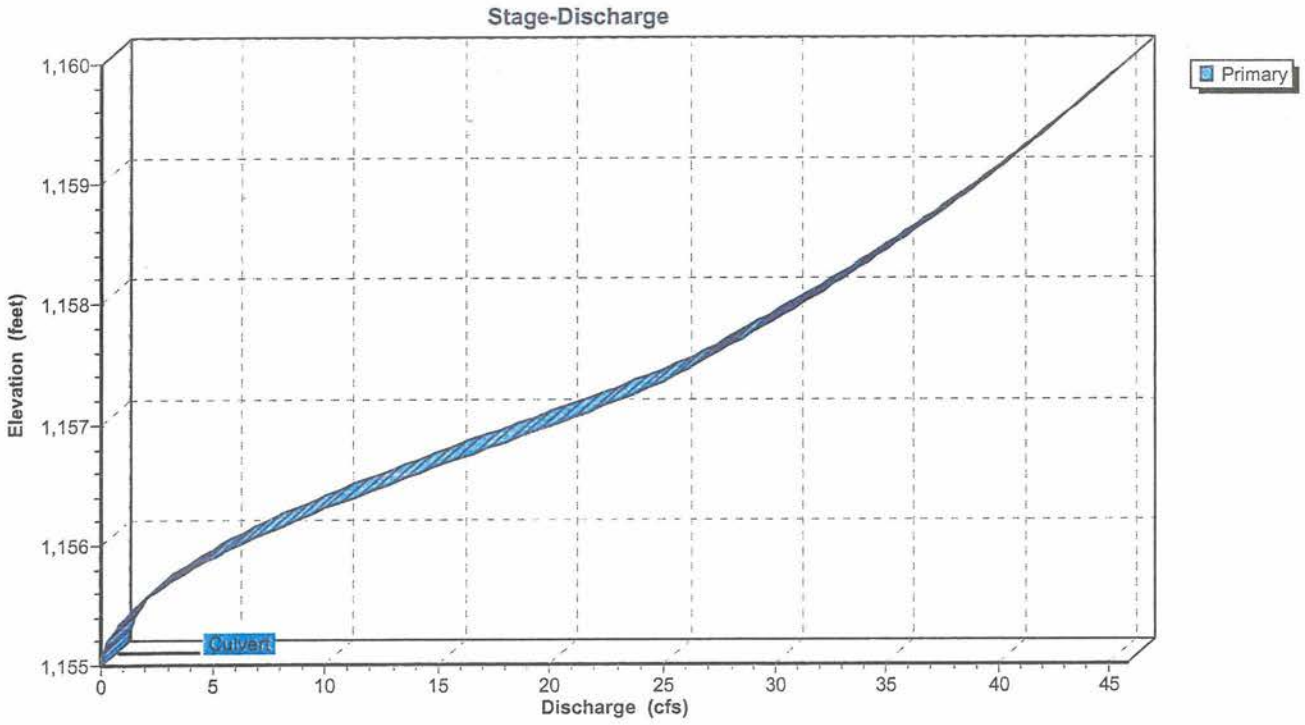
Device	Routing	Invert	Outlet Devices
#1	Primary	1,155.00'	**30.0" Round Culvert** L= 50.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 1,155.00' / 1,154.00' S= 0.0200 '/' Cc= 0.900 n= 0.013, Flow Area= 4.91 sf

Primary OutFlow Max=3.09 cfs @ 16.72 hrs HW=1,155.69' (Free Discharge)
1=Culvert (Inlet Controls 3.09 cfs @ 2.82 fps)

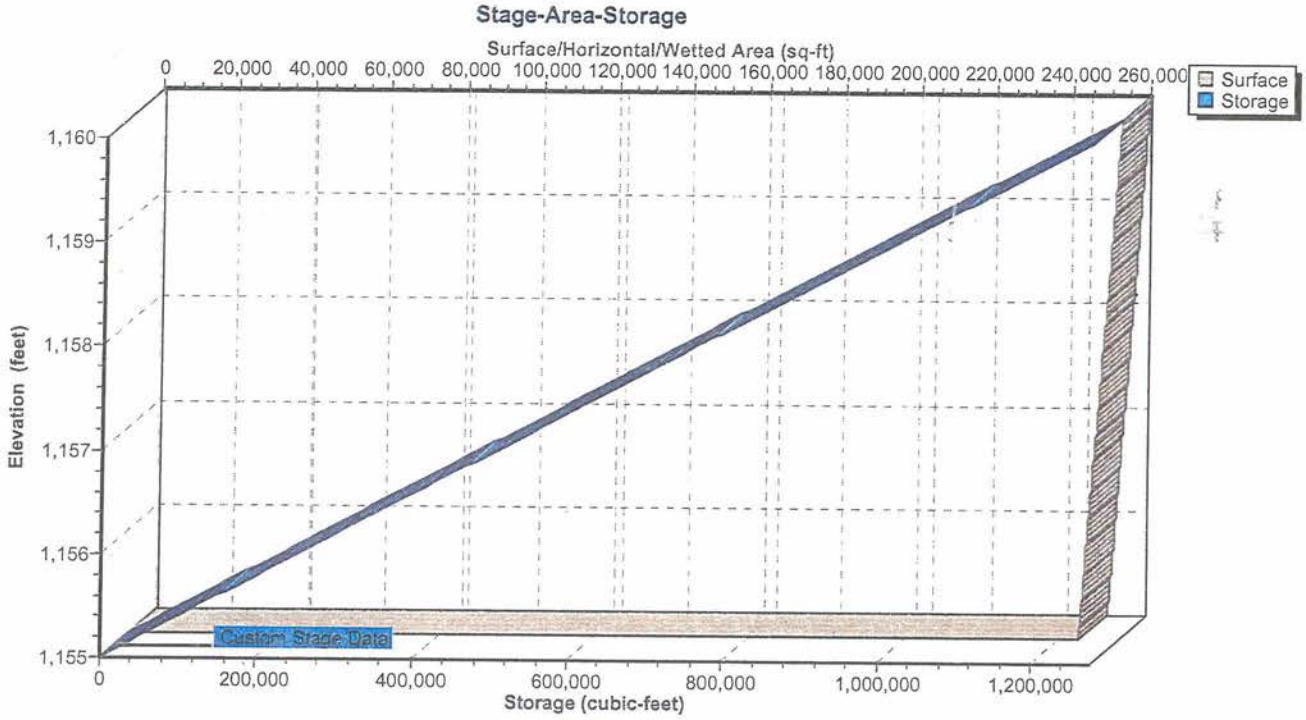
Pond 8P: Pond D.1



Pond 8P: Pond D.1



Pond 8P: Pond D.1



Summary for Pond 17P: Pond D.2

Inflow Area = 25.640 ac, 0.00% Impervious, Inflow Depth > 2.86" for 2-Year event
Inflow = 52.36 cfs @ 12.38 hrs, Volume= 6.108 af
Outflow = 8.98 cfs @ 13.30 hrs, Volume= 4.545 af, Atten= 83%, Lag= 55.52 min
Primary = 8.98 cfs @ 13.30 hrs, Volume= 4.545 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 1,161.22' @ 13.30 hrs Surf.Area= 128,911 sf Storage= 155,164 cf

Plug-Flow detention time= 267.38 min calculated for 4.535 af (74% of inflow)
Center-of-Mass det. time= 181.93 min (995.14 - 813.21)

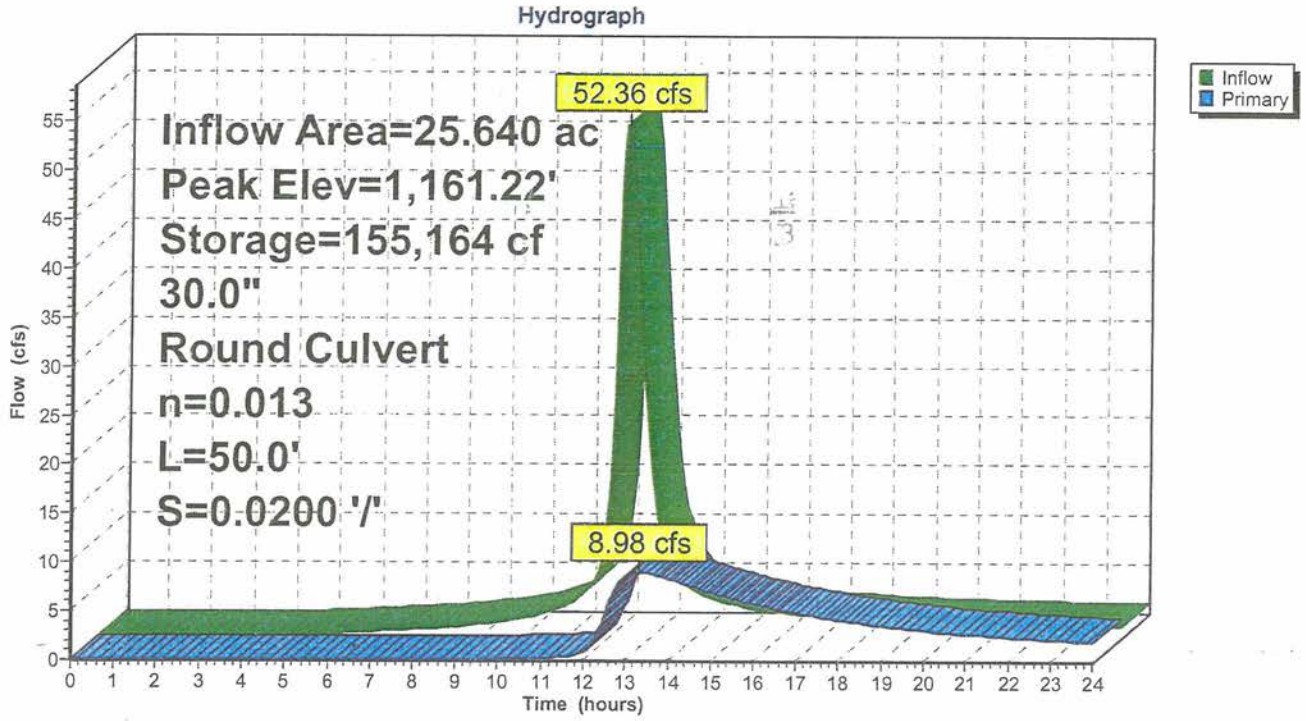
Volume	Invert	Avail.Storage	Storage Description
#1	1,160.00'	665,000 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
1,160.00	125,000	0	0
1,165.00	141,000	665,000	665,000

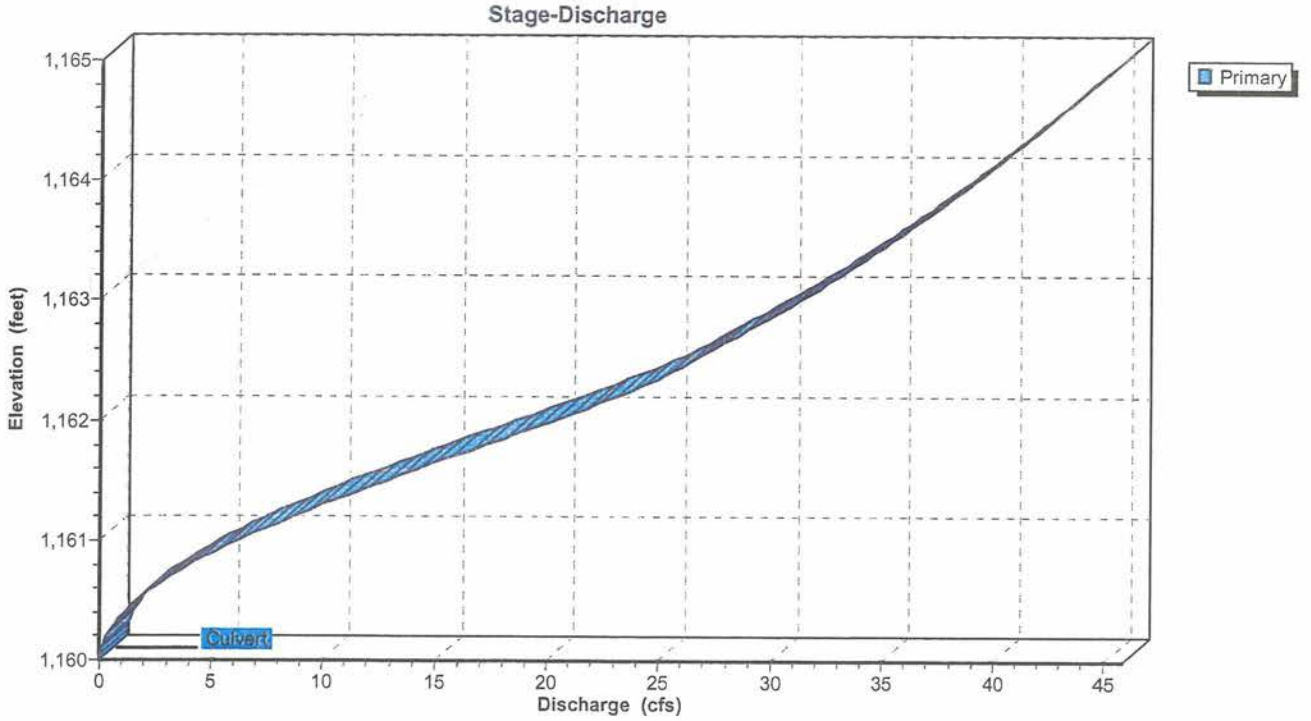
Device	Routing	Invert	Outlet Devices
#1	Primary	1,160.00'	**30.0" Round Culvert** L= 50.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 1,160.00' / 1,159.00' S= 0.0200 '/' Cc= 0.900 n= 0.013, Flow Area= 4.91 sf

Primary OutFlow Max=8.98 cfs @ 13.30 hrs HW=1,161.22' (Free Discharge)
1=Culvert (Inlet Controls 8.98 cfs @ 3.76 fps)

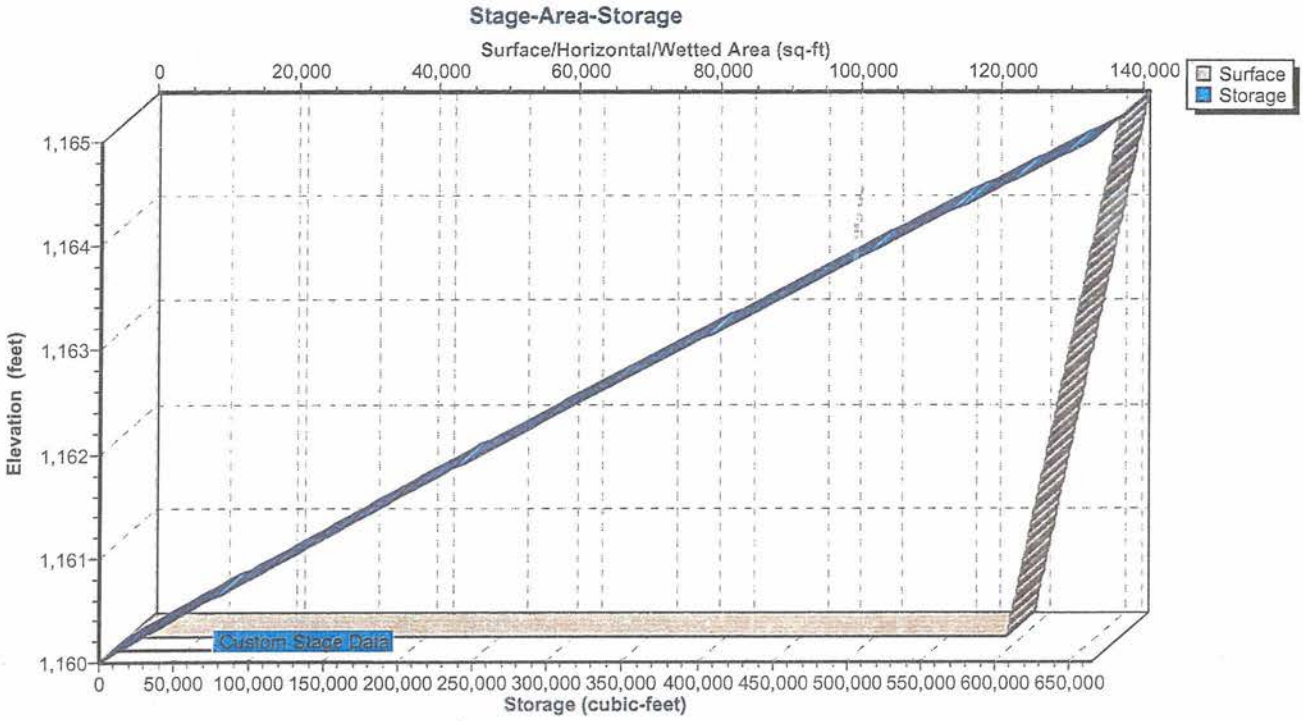
Pond 17P: Pond D.2



Pond 17P: Pond D.2



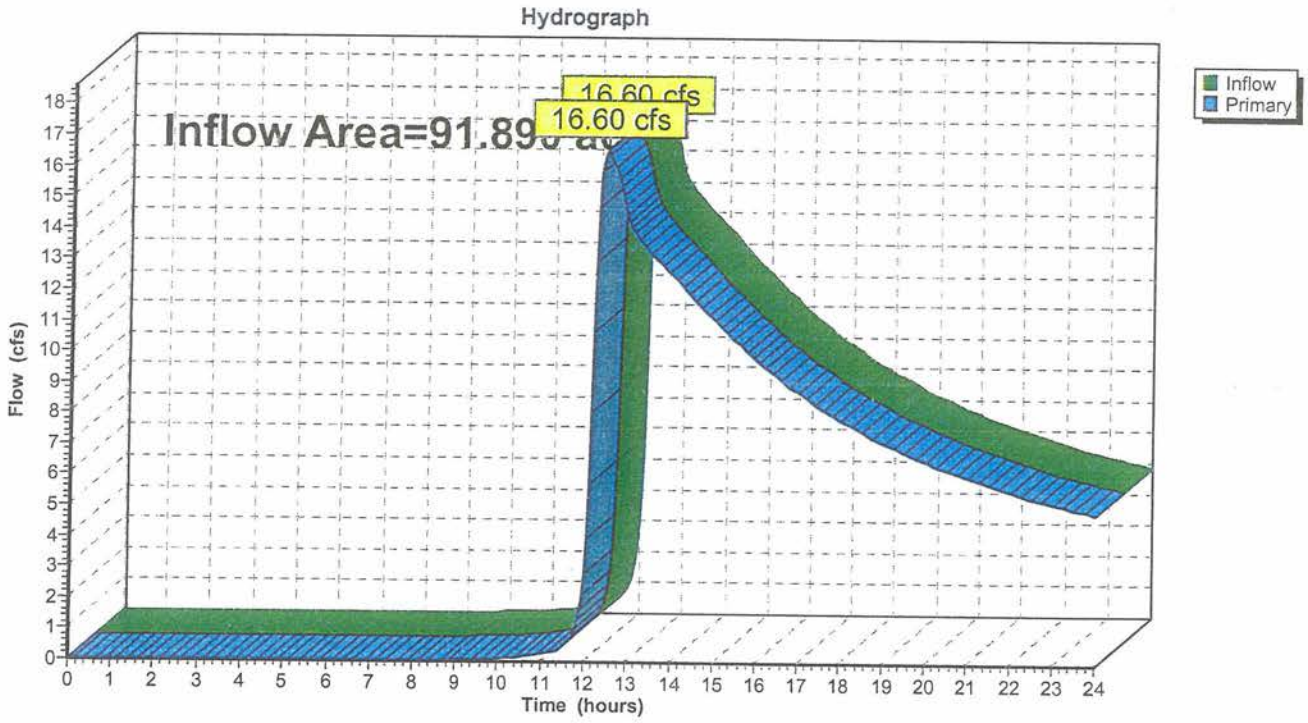
Pond 17P: Pond D.2



Summary for Link 19L: Proposed D

Inflow Area = 91.890 ac, 0.00% Impervious, Inflow Depth > 1.13" for 2-Year event
Inflow = 16.60 cfs @ 12.45 hrs, Volume= 8.622 af
Primary = 16.60 cfs @ 12.45 hrs, Volume= 8.622 af, Atten= 0%, Lag= 0.00 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs



Summary for Subcatchment 7S: Area D.1

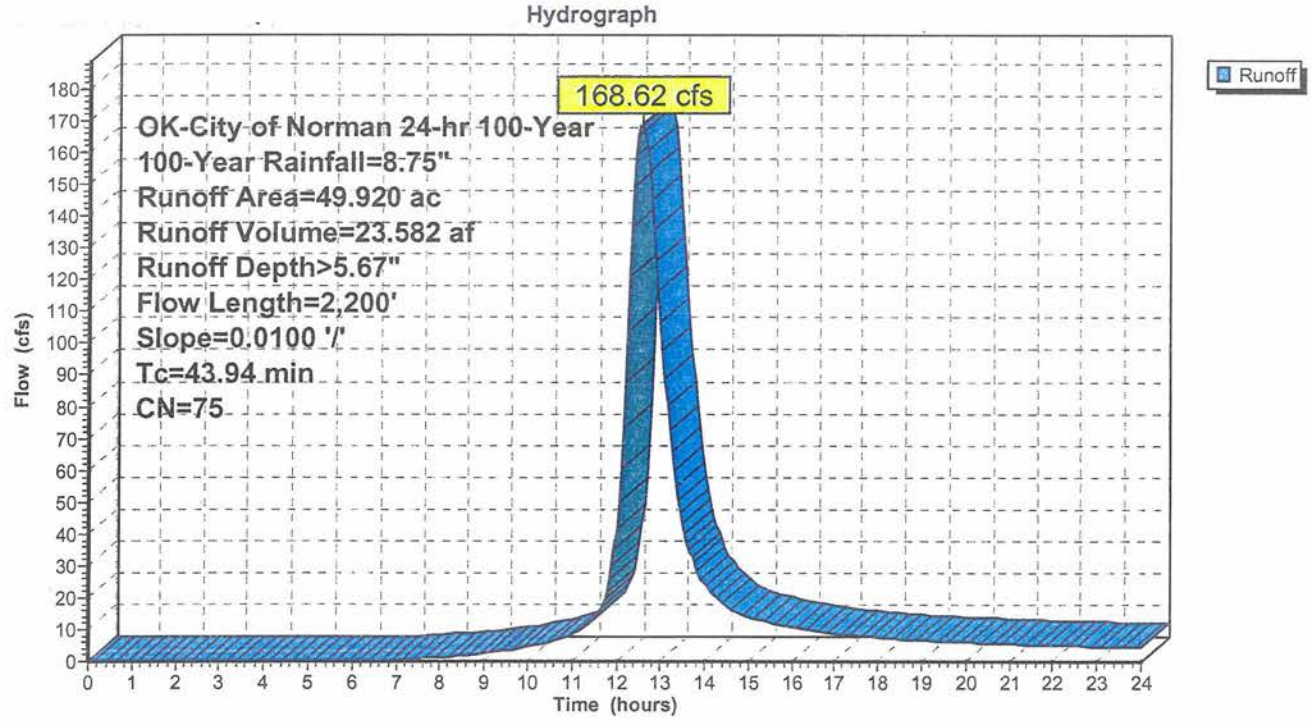
Runoff = 168.62 cfs @ 12.57 hrs, Volume= 23.582 af, Depth> 5.67"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
OK-City of Norman 24-hr 100-Year 100-Year Rainfall=8.75"

	Area (ac)	CN	Description
*	49.920	75	Developed
	49.920		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
26.70	100	0.0100	0.06		**Sheet Flow, Overland** Grass: Bermuda n= 0.410 P2= 3.75"
17.24	2,100	0.0100	2.03		**Shallow Concentrated Flow, Street** Paved Kv= 20.3 fps
43.94	2,200	Total			

Subcatchment 7S: Area D.1



Summary for Subcatchment 16S: Area D.2

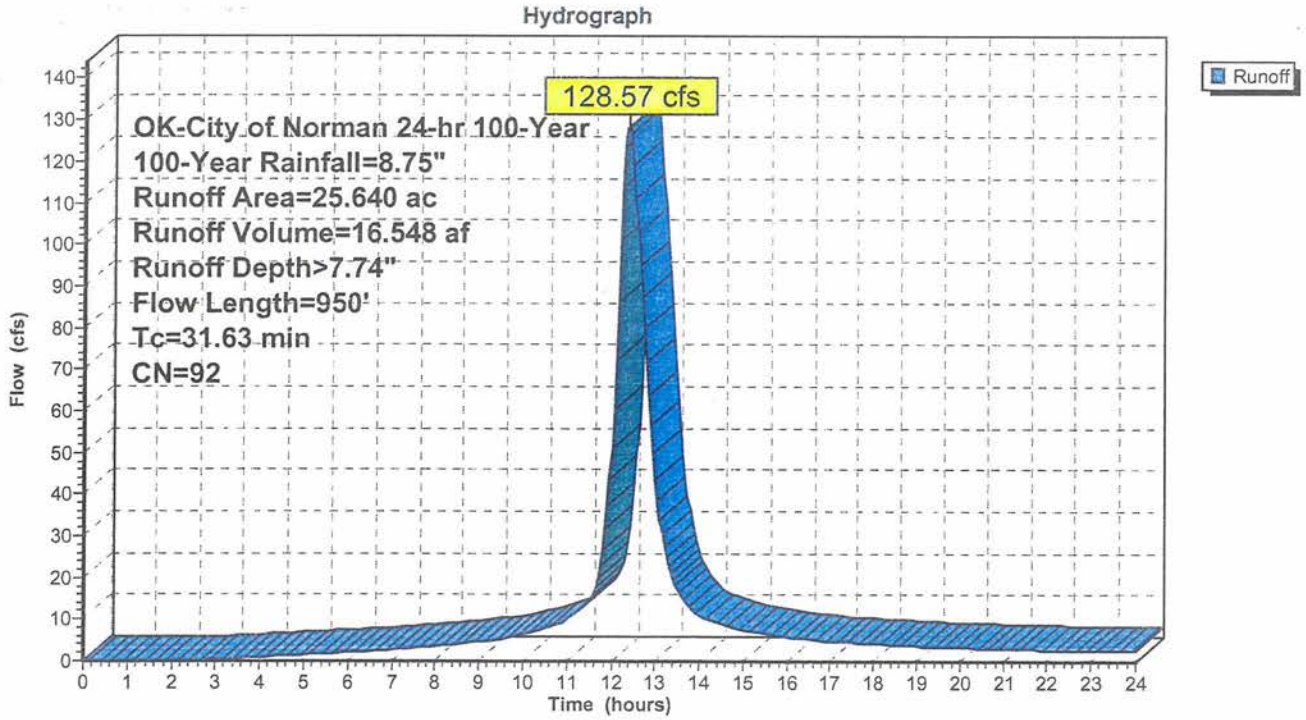
Runoff = 128.57 cfs @ 12.38 hrs, Volume= 16.548 af, Depth> 7.74"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
OK-City of Norman 24-hr 100-Year 100-Year Rainfall=8.75"

	Area (ac)	CN	Description
*	25.640	92	
	25.640		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
26.70	100	0.0100	0.06		**Sheet Flow, Overland** Grass: Bermuda n= 0.410 P2= 3.75"
4.93	850	0.0200	2.87		**Shallow Concentrated Flow, Street** Paved Kv= 20.3 fps
31.63	950	Total			

Subcatchment 16S: Area D.2



Summary for Subcatchment 18S: Open space

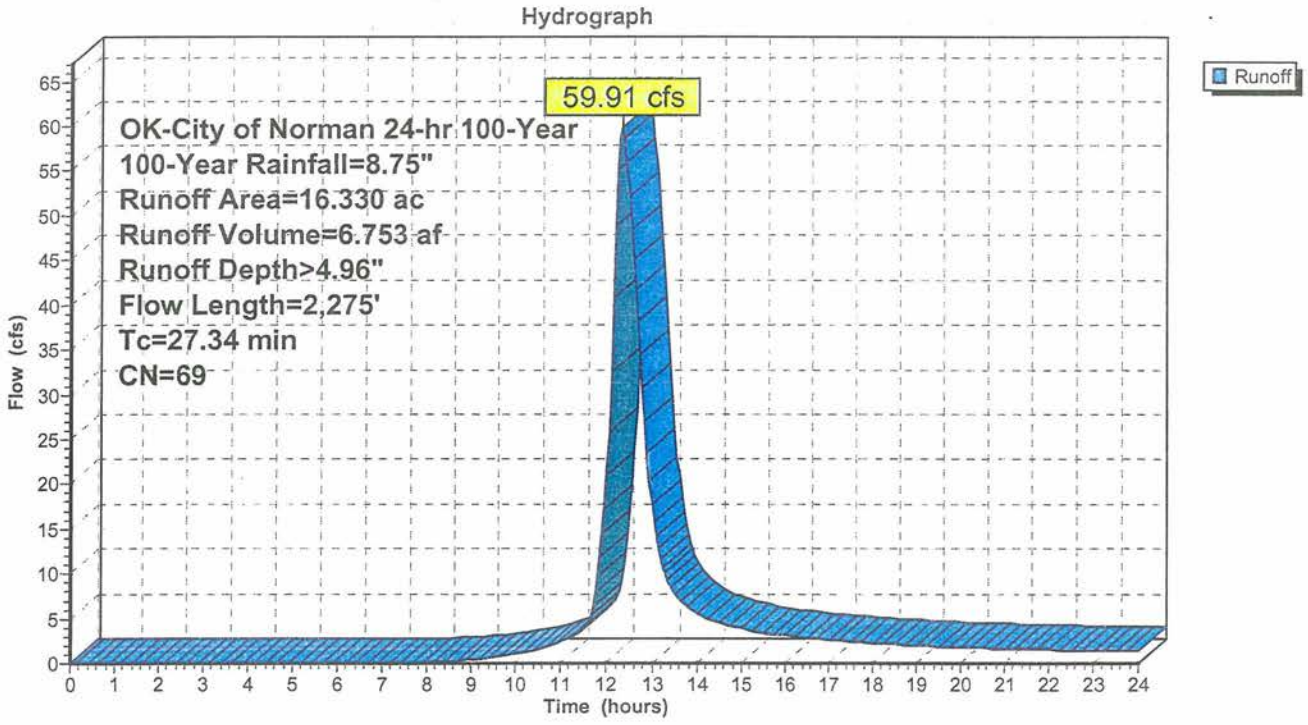
Runoff = 59.91 cfs @ 12.35 hrs, Volume= 6.753 af, Depth> 4.96"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
OK-City of Norman 24-hr 100-Year 100-Year Rainfall=8.75"

	Area (ac)	CN	Description
*	16.330	69	
	16.330		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
15.33	50	0.0100	0.05		**Sheet Flow, Overland** Grass: Bermuda n= 0.410 P2= 3.75"
12.01	2,225	0.0150	3.09	30.86	**Channel Flow, Ex. creek** Area= 10.0 sf Perim= 15.0' r= 0.67' n= 0.045
27.34	2,275	Total			

Subcatchment 18S: Open space



Summary for Pond 8P: Pond D.1

Inflow Area = 49.920 ac, 0.00% Impervious, Inflow Depth > 5.67" for 100-Year event
Inflow = 168.62 cfs @ 12.57 hrs, Volume= 23.582 af
Outflow = 25.81 cfs @ 13.92 hrs, Volume= 16.545 af, Atten= 85%, Lag= 80.99 min
Primary = 25.81 cfs @ 13.92 hrs, Volume= 16.545 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 1,157.43' @ 13.92 hrs Surf.Area= 254,854 sf Storage= 612,641 cf

Plug-Flow detention time= 284.98 min calculated for 16.510 af (70% of inflow)
Center-of-Mass det. time= 195.43 min (1,035.12 - 839.69)

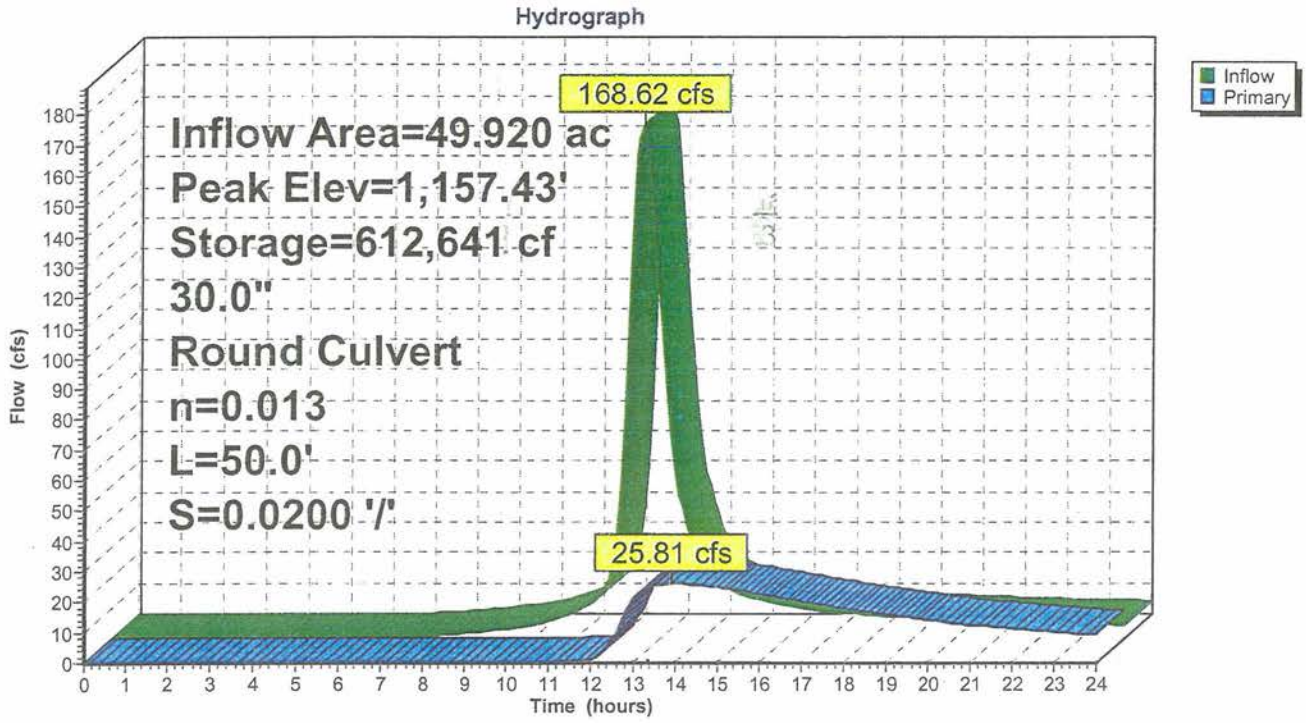
Volume	Invert	Avail.Storage	Storage Description
#1	1,155.00'	1,275,000 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
1,155.00	250,000	0	0
1,160.00	260,000	1,275,000	1,275,000

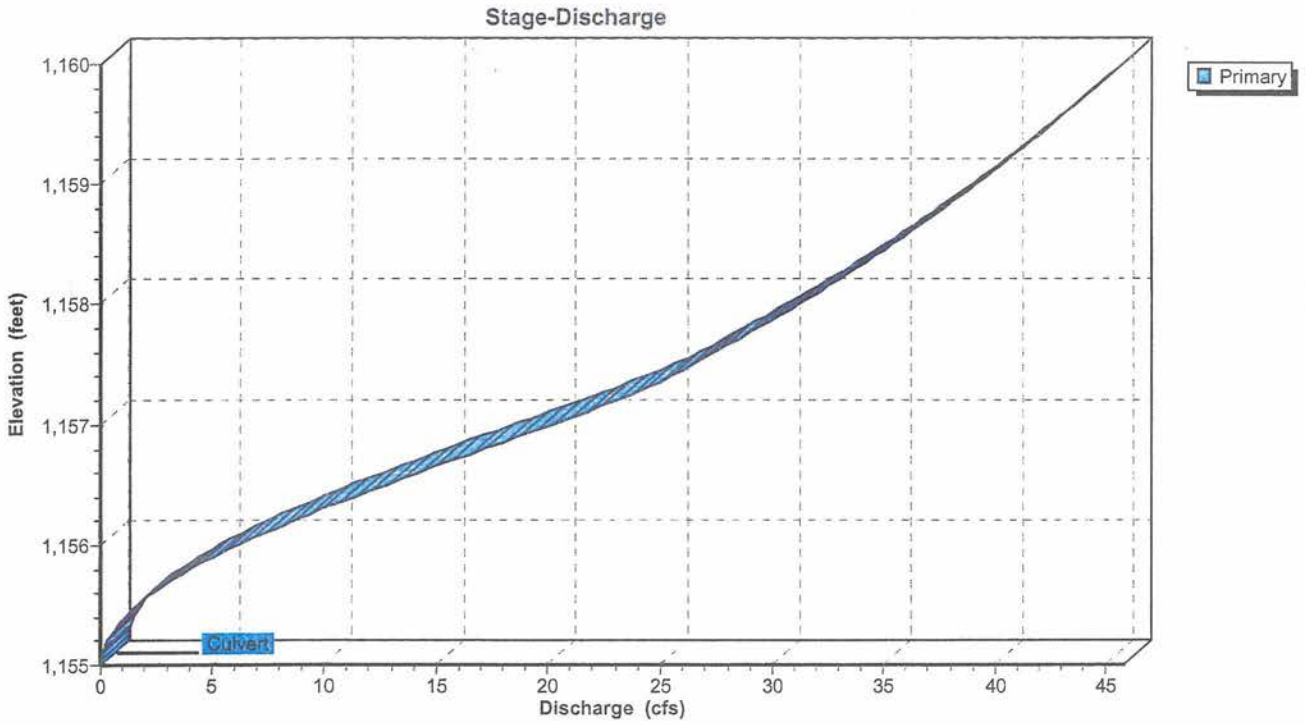
Device	Routing	Invert	Outlet Devices
#1	Primary	1,155.00'	**30.0" Round Culvert** L= 50.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 1,155.00' / 1,154.00' S= 0.0200 '/' Cc= 0.900 n= 0.013, Flow Area= 4.91 sf

Primary OutFlow Max=25.82 cfs @ 13.92 hrs HW=1,157.43' (Free Discharge)
└**1=Culvert** (Inlet Controls 25.82 cfs @ 5.30 fps)

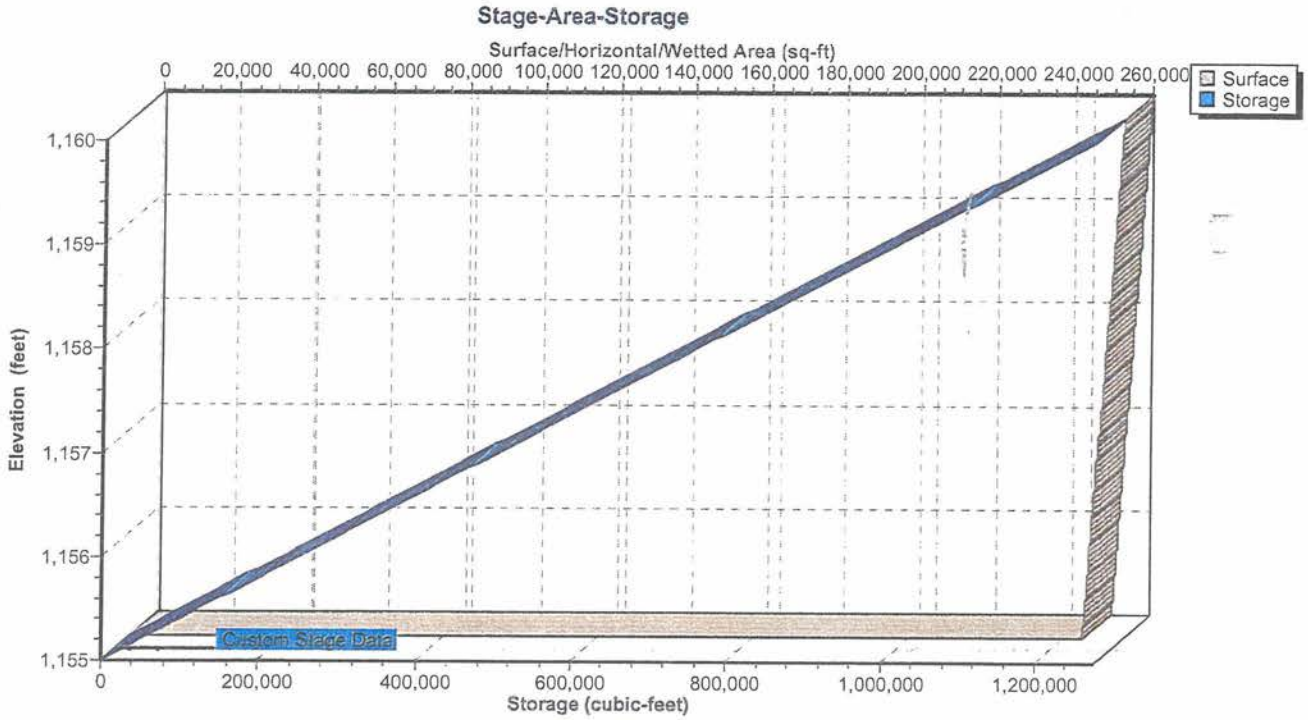
Pond 8P: Pond D.1



Pond 8P: Pond D.1



Pond 8P: Pond D.1



Summary for Pond 17P: Pond D.2

Inflow Area = 25.640 ac, 0.00% Impervious, Inflow Depth > 7.74" for 100-Year event
Inflow = 128.57 cfs @ 12.38 hrs, Volume= 16.548 af
Outflow = 31.19 cfs @ 13.14 hrs, Volume= 14.276 af, Atten= 76%, Lag= 45.63 min
Primary = 31.19 cfs @ 13.14 hrs, Volume= 14.276 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 1,162.99' @ 13.14 hrs Surf.Area= 134,571 sf Storage= 388,195 cf

Plug-Flow detention time= 217.84 min calculated for 14.276 af (86% of inflow)
Center-of-Mass det. time= 157.21 min (943.96 - 786.74)

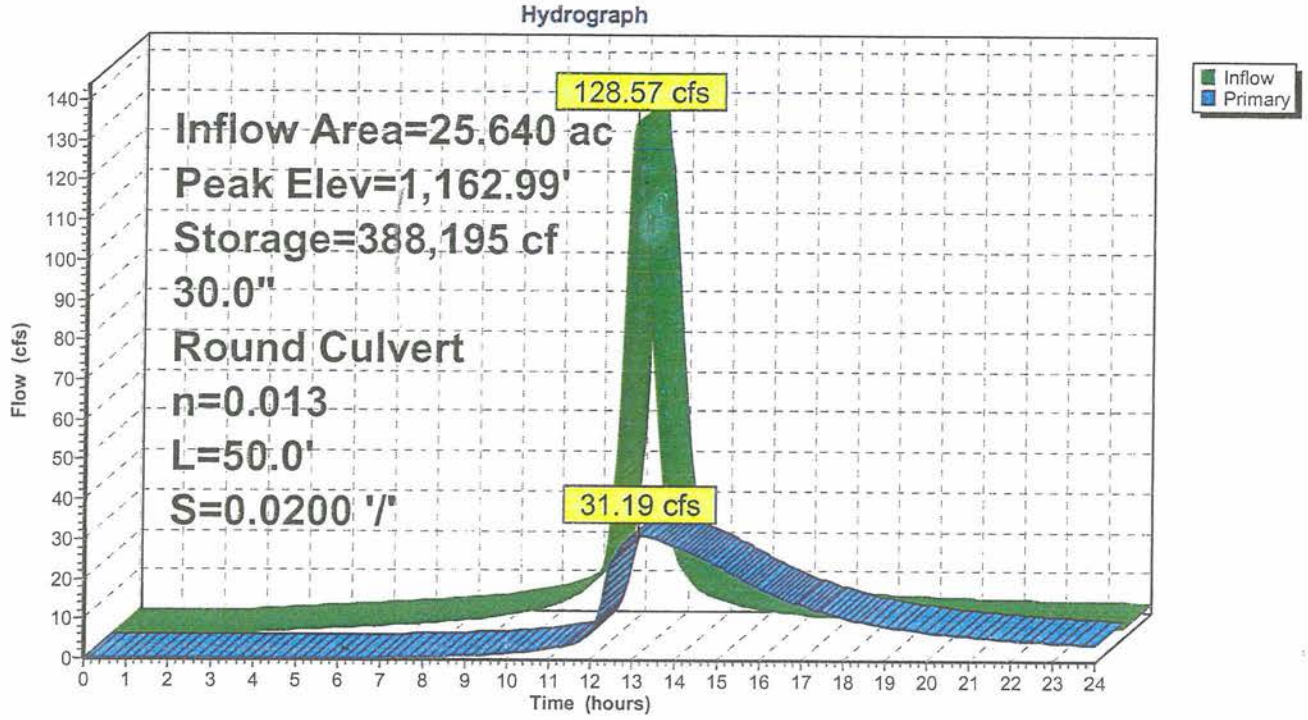
Volume	Invert	Avail.Storage	Storage Description
#1	1,160.00'	665,000 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
1,160.00	125,000	0	0
1,165.00	141,000	665,000	665,000

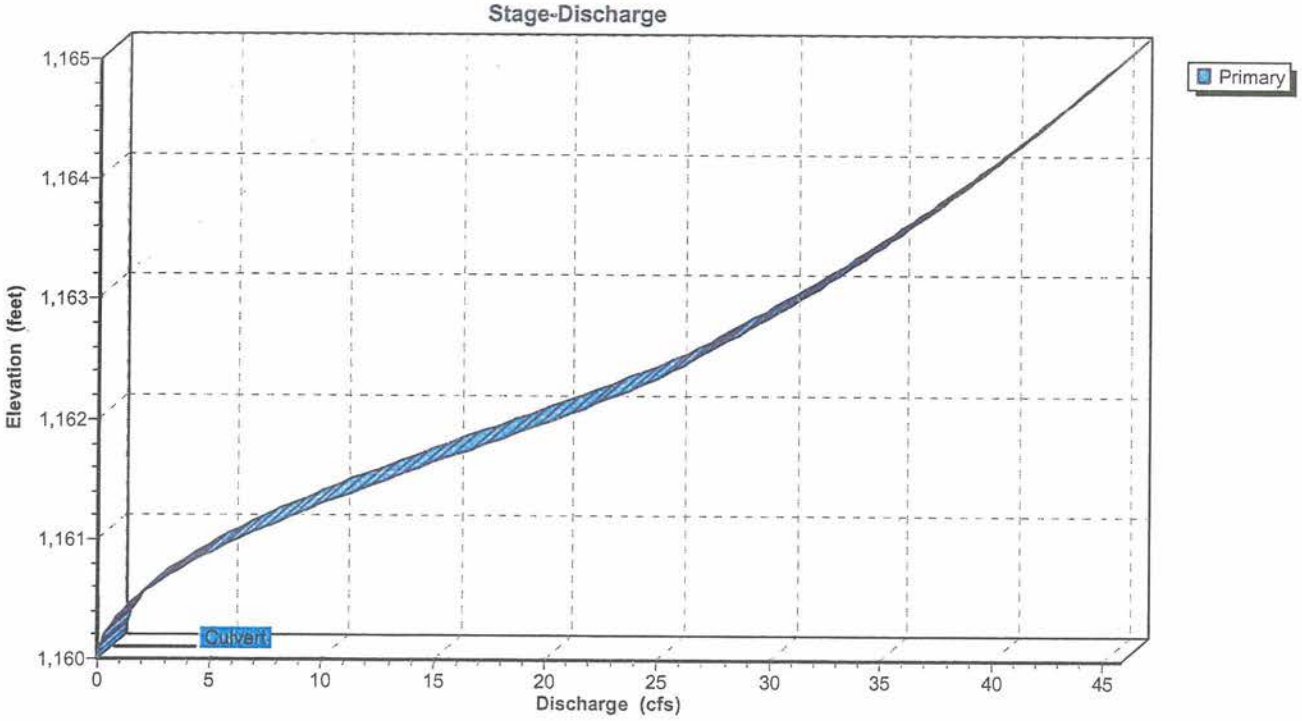
Device	Routing	Invert	Outlet Devices
#1	Primary	1,160.00'	**30.0" Round Culvert** L= 50.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 1,160.00' / 1,159.00' S= 0.0200 '/' Cc= 0.900 n= 0.013, Flow Area= 4.91 sf

Primary OutFlow Max=31.18 cfs @ 13.14 hrs HW=1,162.99' (Free Discharge)
↑**1=Culvert** (Inlet Controls 31.18 cfs @ 6.35 fps)

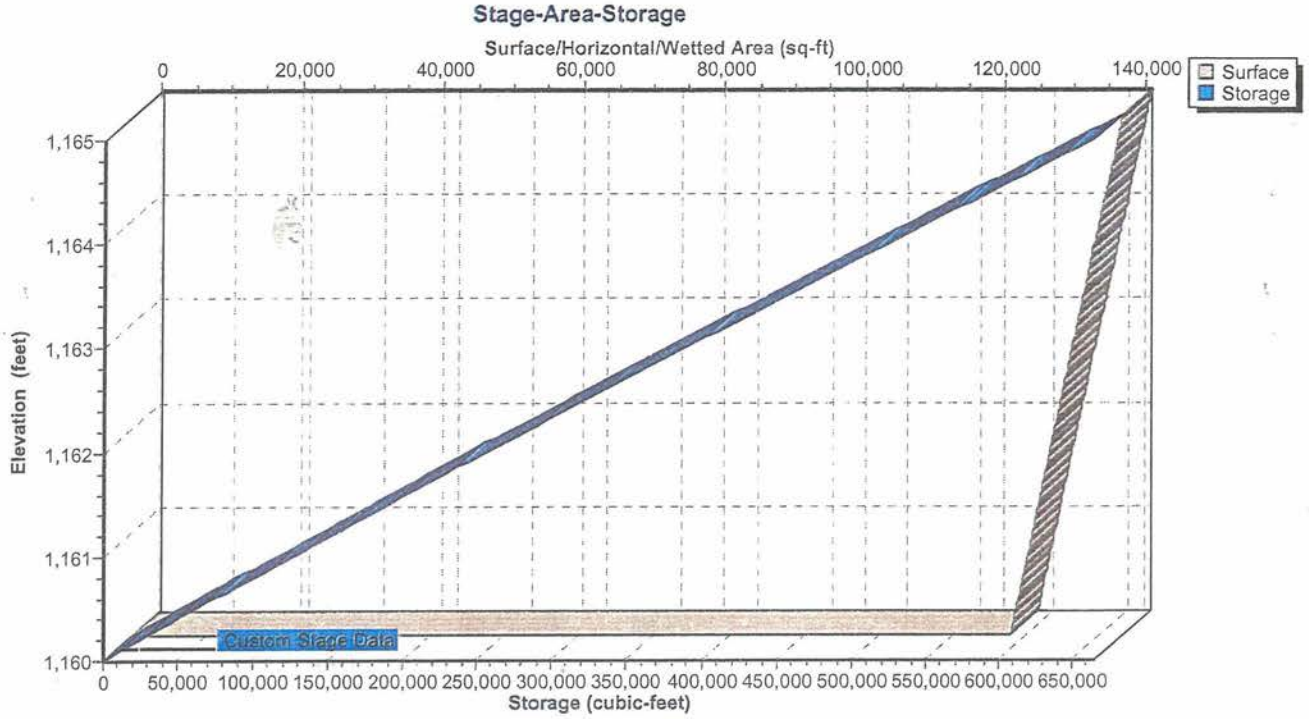
Pond 17P: Pond D.2



Pond 17P: Pond D.2



Pond 17P: Pond D.2

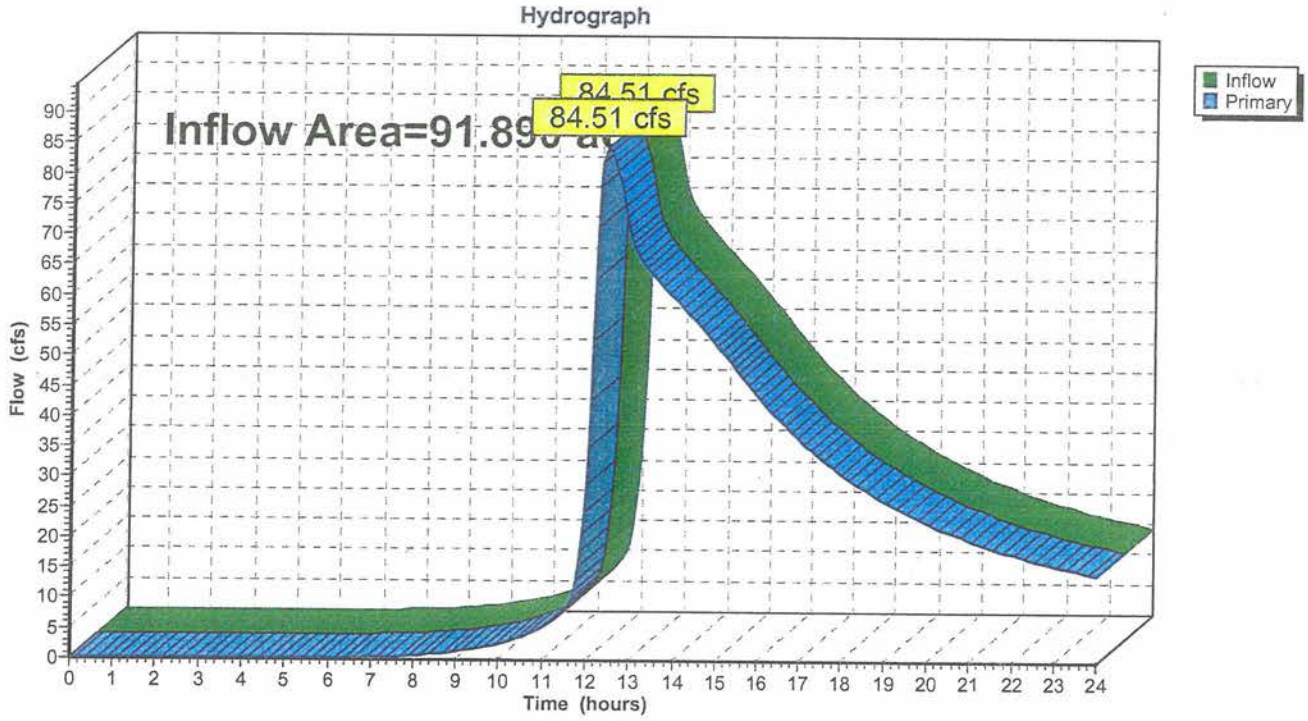


Summary for Link 19L: Proposed D

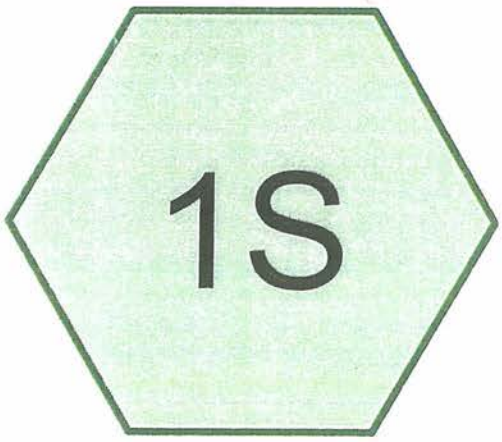
Inflow Area = 91.890 ac, 0.00% Impervious, Inflow Depth > 4.91" for 100-Year event
Inflow = 84.51 cfs @ 12.44 hrs, Volume= 37.574 af
Primary = 84.51 cfs @ 12.44 hrs, Volume= 37.574 af, Atten= 0%, Lag= 0.00 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Link 19L: Proposed D



Appendix F
Drainage Calculations
Area E



Historic Area E

Subcat Reach Pond Link

Routing Diagram for Historic Area E
Prepared by SMC Consulting Engineers, P.C., Printed 1/10/2015

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
14.800	71	Type C soil (1S)
19.400	78	Type D soil (1S)

Summary for Subcatchment 1S: Historic Area E

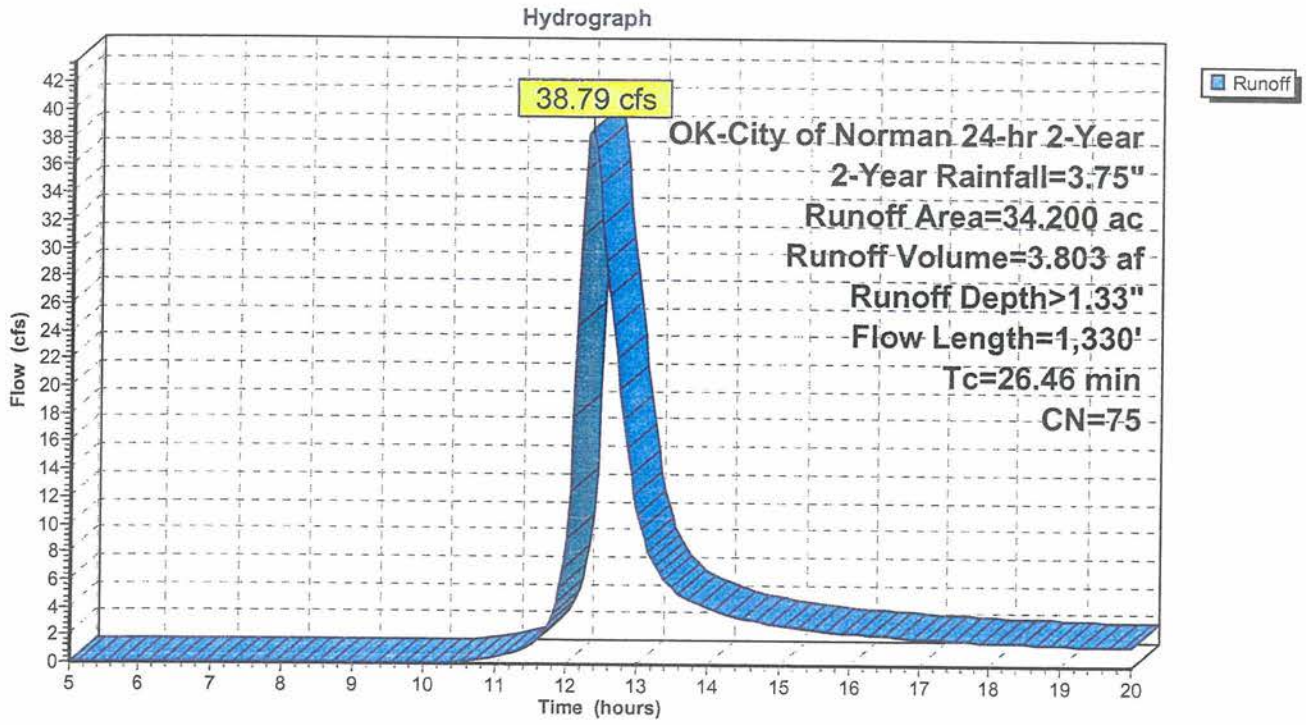
Runoff = 38.79 cfs @ 12.34 hrs, Volume= 3.803 af, Depth> 1.33"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
OK-City of Norman 24-hr 2-Year 2-Year Rainfall=3.75"

	Area (ac)	CN	Description
*	14.800	71	Type C soil
*	19.400	78	Type D soil
	34.200	75	Weighted Average
	34.200		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
20.89	300	0.0167	0.24		**Sheet Flow, Overland flow** Range n= 0.130 P2= 3.75"
2.19	150	0.0267	1.14		**Shallow Concentrated Flow, Swale** Short Grass Pasture Kv= 7.0 fps
3.38	880	0.0341	4.34	65.07	**Channel Flow, Creek** Area= 15.0 sf Perim= 25.0' r= 0.60' n= 0.045
26.46	1,330	Total			

Subcatchment 1S: Historic Area E



Summary for Subcatchment 1S: Historic Area E

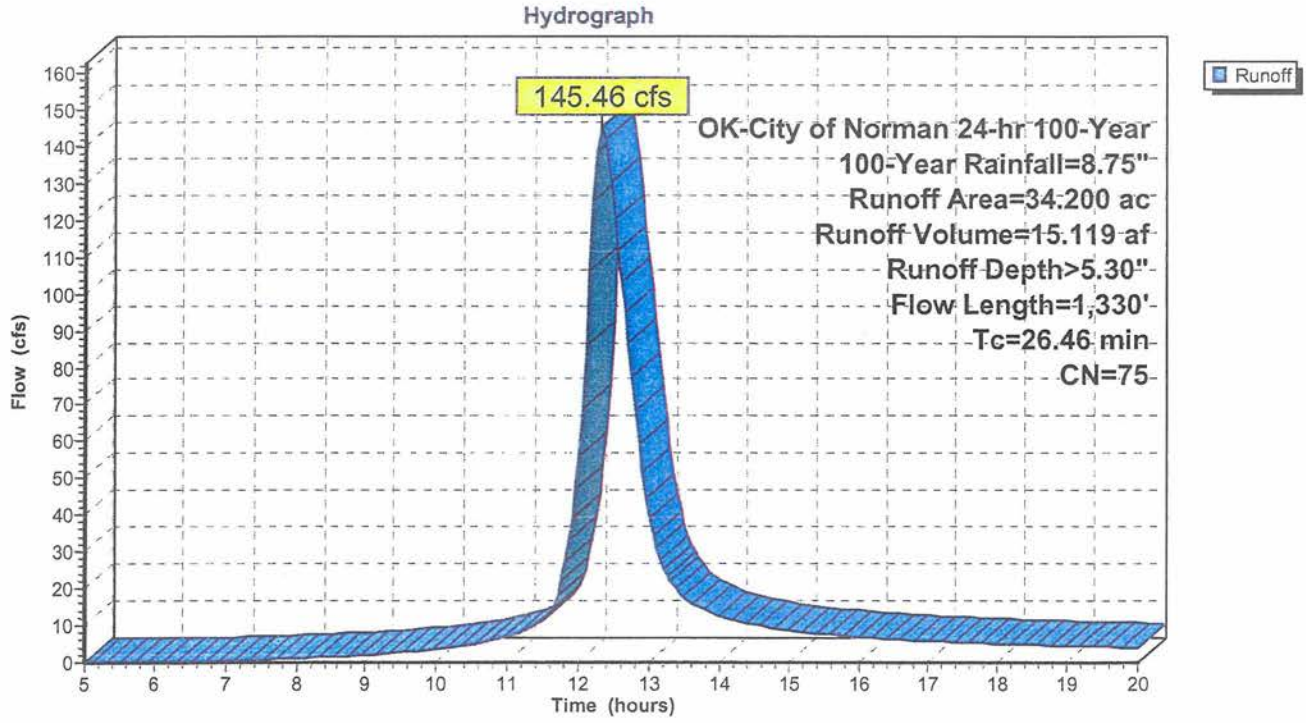
Runoff = 145.46 cfs @ 12.32 hrs, Volume= 15.119 af, Depth> 5.30"

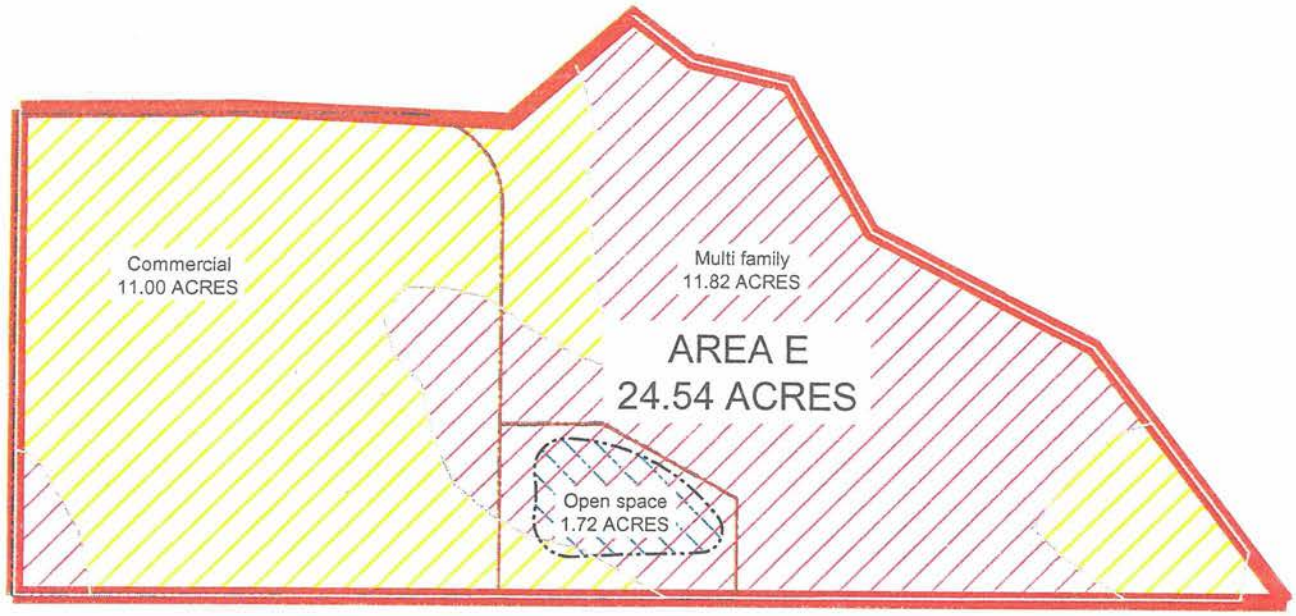
Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
OK-City of Norman 24-hr 100-Year 100-Year Rainfall=8.75"

	Area (ac)	CN	Description
*	14.800	71	Type C soil
*	19.400	78	Type D soil
	34.200	75	Weighted Average
	34.200		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
20.89	300	0.0167	0.24		**Sheet Flow, Overland flow** Range n= 0.130 P2= 3.75"
2.19	150	0.0267	1.14		**Shallow Concentrated Flow, Swale** Short Grass Pasture Kv= 7.0 fps
3.38	880	0.0341	4.34	65.07	**Channel Flow, Creek** Area= 15.0 sf Perim= 25.0' r= 0.60' n= 0.045
26.46	1,330	Total			

Subcatchment 1S: Historic Area E

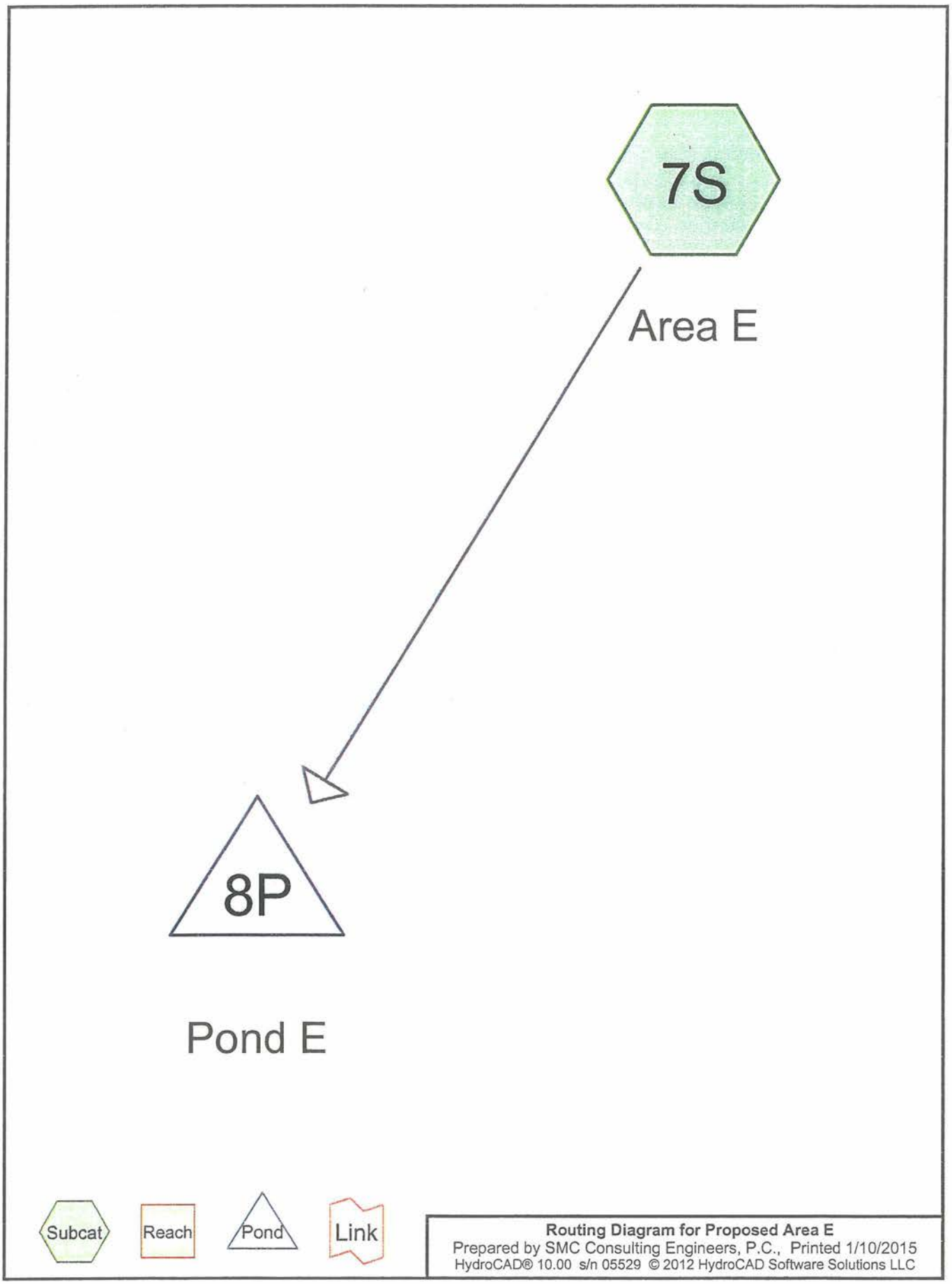




AREA E
24.54 ACRES

TYPE C SOIL

TYPE D SOIL



Routing Diagram for Proposed Area E
Prepared by SMC Consulting Engineers, P.C., Printed 1/10/2015

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
24.540	88	Developed (7S)

Summary for Subcatchment 7S: Area E

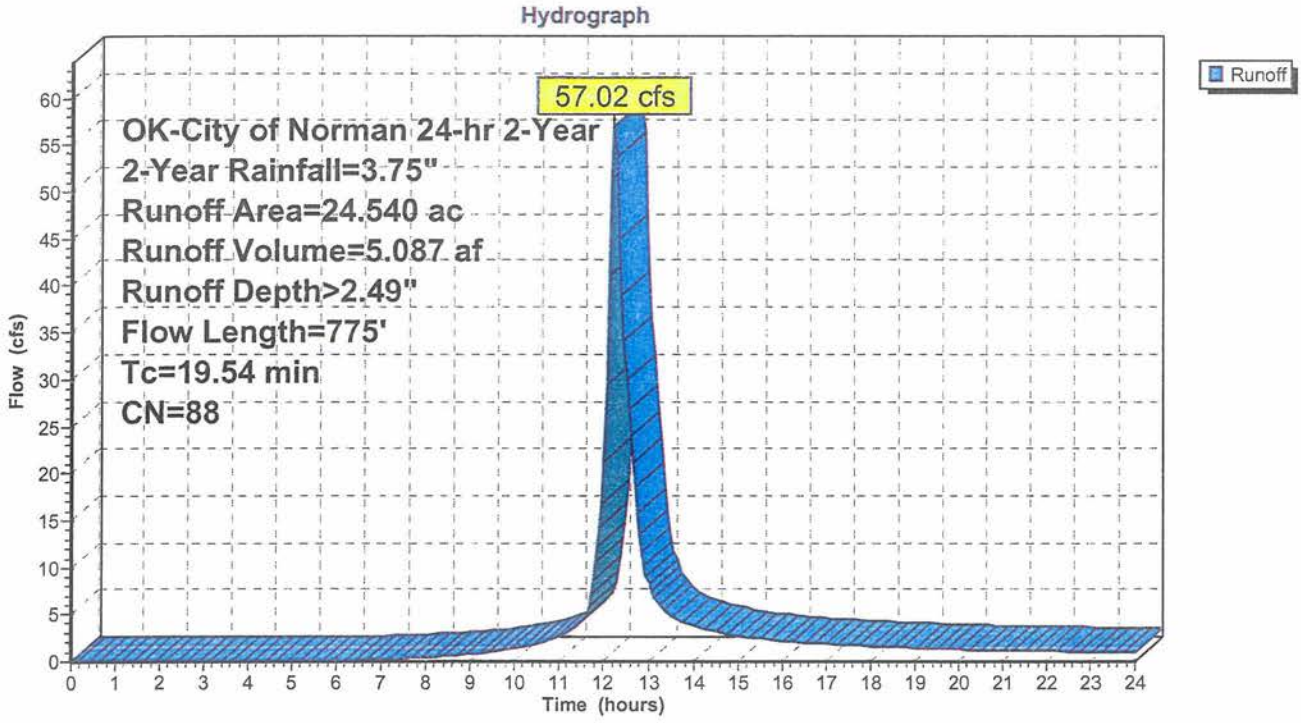
Runoff = 57.02 cfs @ 12.22 hrs, Volume= 5.087 af, Depth> 2.49"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
OK-City of Norman 24-hr 2-Year 2-Year Rainfall=3.75"

	Area (ac)	CN	Description
*	24.540	88	Developed
	24.540		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
15.33	50	0.0100	0.05		**Sheet Flow, Overland** Grass: Bermuda n= 0.410 P2= 3.75"
4.21	725	0.0200	2.87		**Shallow Concentrated Flow, Parking** Paved Kv= 20.3 fps
19.54	775	Total			

Subcatchment 7S: Area E



Summary for Pond 8P: Pond E

Inflow Area = 24.540 ac, 0.00% Impervious, Inflow Depth > 2.49" for 2-Year event
Inflow = 57.02 cfs @ 12.22 hrs, Volume= 5.087 af
Outflow = 27.15 cfs @ 12.55 hrs, Volume= 4.864 af, Atten= 52%, Lag= 19.47 min
Primary = 27.15 cfs @ 12.55 hrs, Volume= 4.864 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 1,157.57' @ 12.55 hrs Surf.Area= 29,038 sf Storage= 69,434 cf

Plug-Flow detention time= 70.86 min calculated for 4.854 af (95% of inflow)
Center-of-Mass det. time= 46.49 min (866.93 - 820.44)

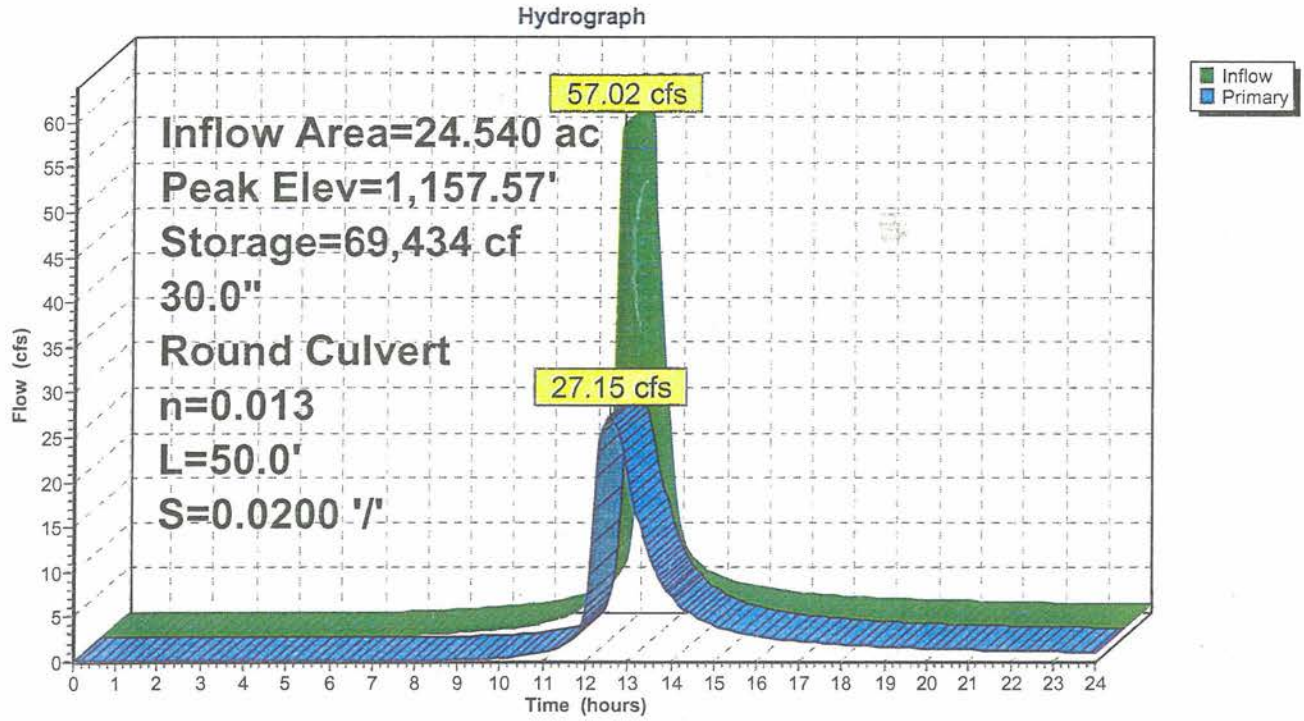
Volume	Invert	Avail.Storage	Storage Description
#1	1,155.00'	213,500 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
1,155.00	25,000	0	0
1,162.00	36,000	213,500	213,500

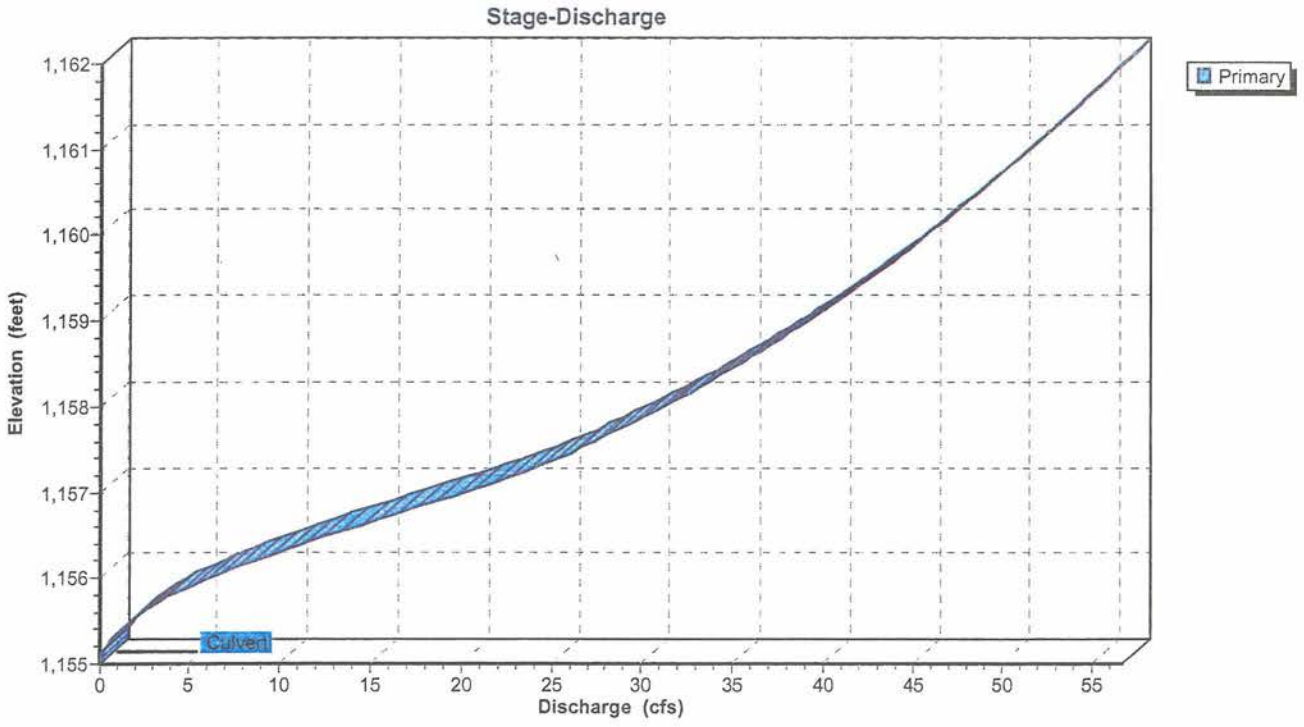
Device	Routing	Invert	Outlet Devices
#1	Primary	1,155.00'	**30.0" Round Culvert** L= 50.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 1,155.00' / 1,154.00' S= 0.0200 '/' Cc= 0.900 n= 0.013, Flow Area= 4.91 sf

Primary OutFlow Max=27.15 cfs @ 12.55 hrs HW=1,157.57' (Free Discharge)
1=Culvert (Inlet Controls 27.15 cfs @ 5.53 fps)

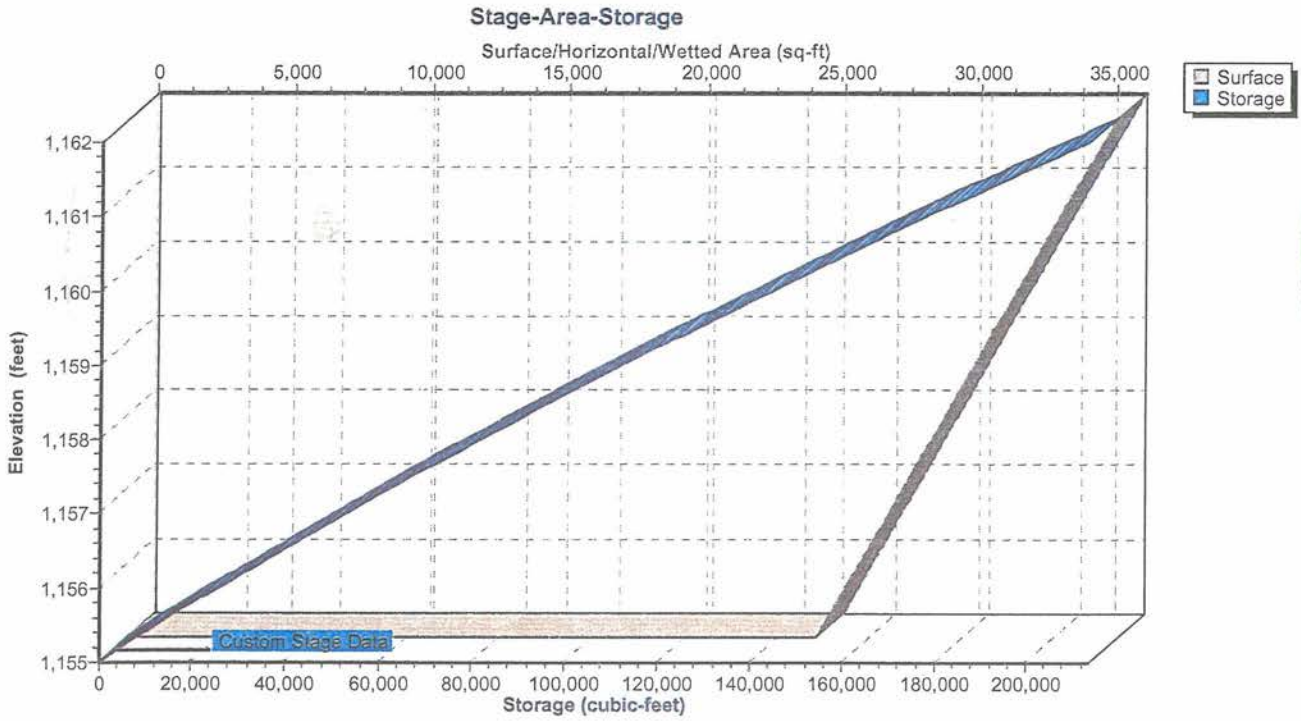
Pond 8P: Pond E



Pond 8P: Pond E



Pond 8P: Pond E



Summary for Subcatchment 7S: Area E

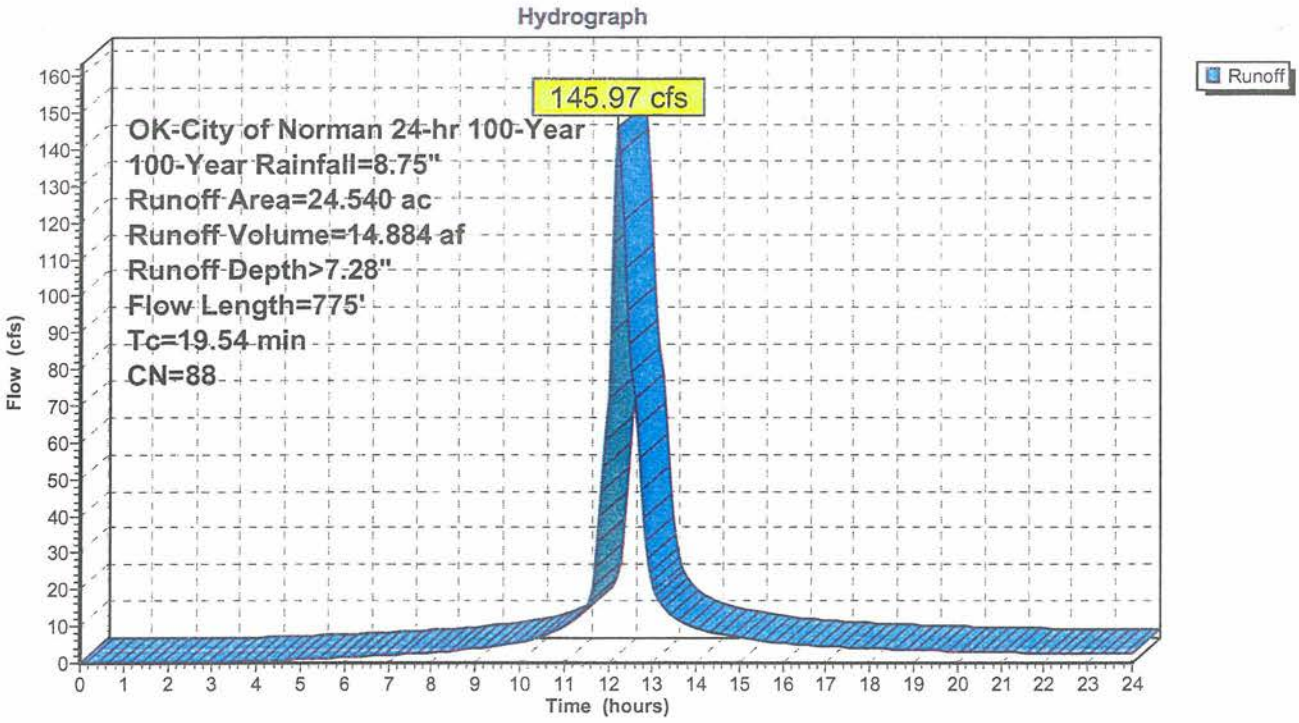
Runoff = 145.97 cfs @ 12.22 hrs, Volume= 14.884 af, Depth> 7.28"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
OK-City of Norman 24-hr 100-Year 100-Year Rainfall=8.75"

	Area (ac)	CN	Description
*	24.540	88	Developed
	24.540		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
15.33	50	0.0100	0.05		**Sheet Flow, Overland** Grass: Bermuda n= 0.410 P2= 3.75"
4.21	725	0.0200	2.87		**Shallow Concentrated Flow, Parking** Paved Kv= 20.3 fps
19.54	775	Total			

Subcatchment 7S: Area E



Summary for Pond 8P: Pond E

Inflow Area = 24.540 ac, 0.00% Impervious, Inflow Depth > 7.28" for 100-Year event
Inflow = 145.97 cfs @ 12.22 hrs, Volume= 14.884 af
Outflow = 56.40 cfs @ 12.70 hrs, Volume= 14.537 af, Atten= 61%, Lag= 28.59 min
Primary = 56.40 cfs @ 12.70 hrs, Volume= 14.537 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 1,161.94' @ 12.70 hrs Surf.Area= 35,912 sf Storage= 211,485 cf

Plug-Flow detention time= 61.31 min calculated for 14.537 af (98% of inflow)
Center-of-Mass det. time= 47.15 min (836.84 - 789.68)

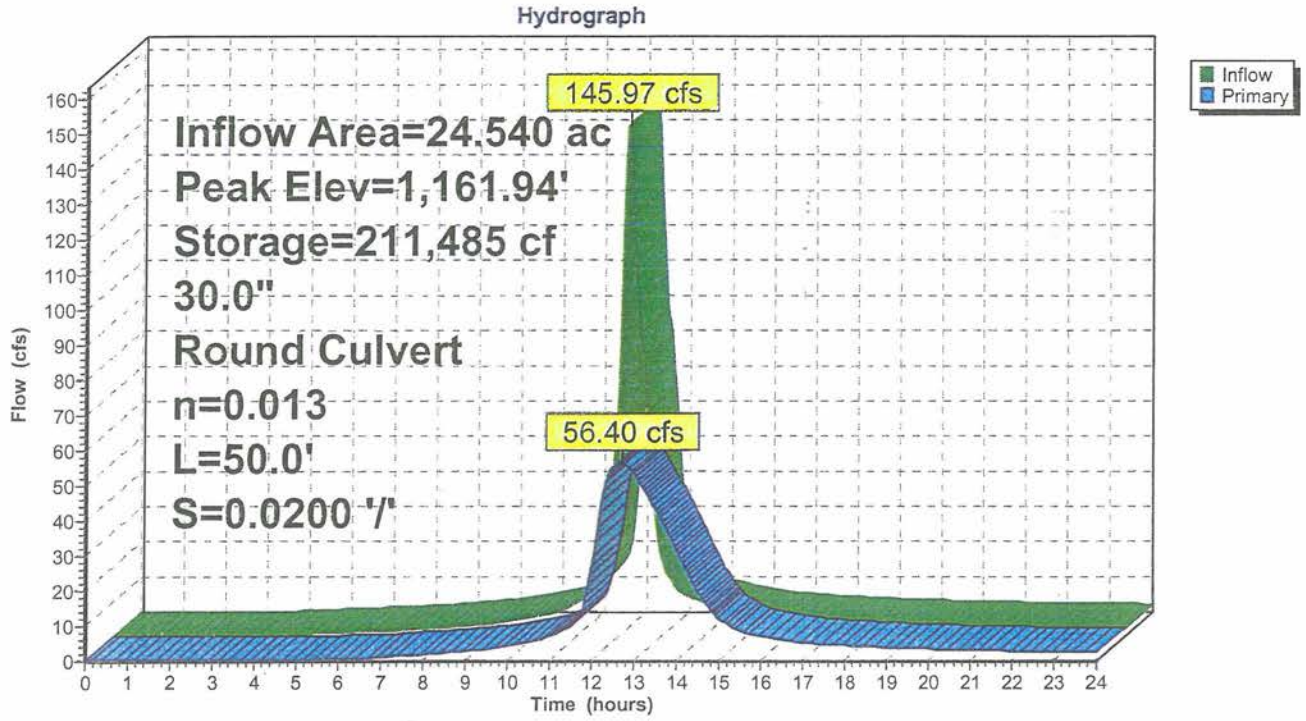
Volume	Invert	Avail.Storage	Storage Description
#1	1,155.00'	213,500 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
1,155.00	25,000	0	0
1,162.00	36,000	213,500	213,500

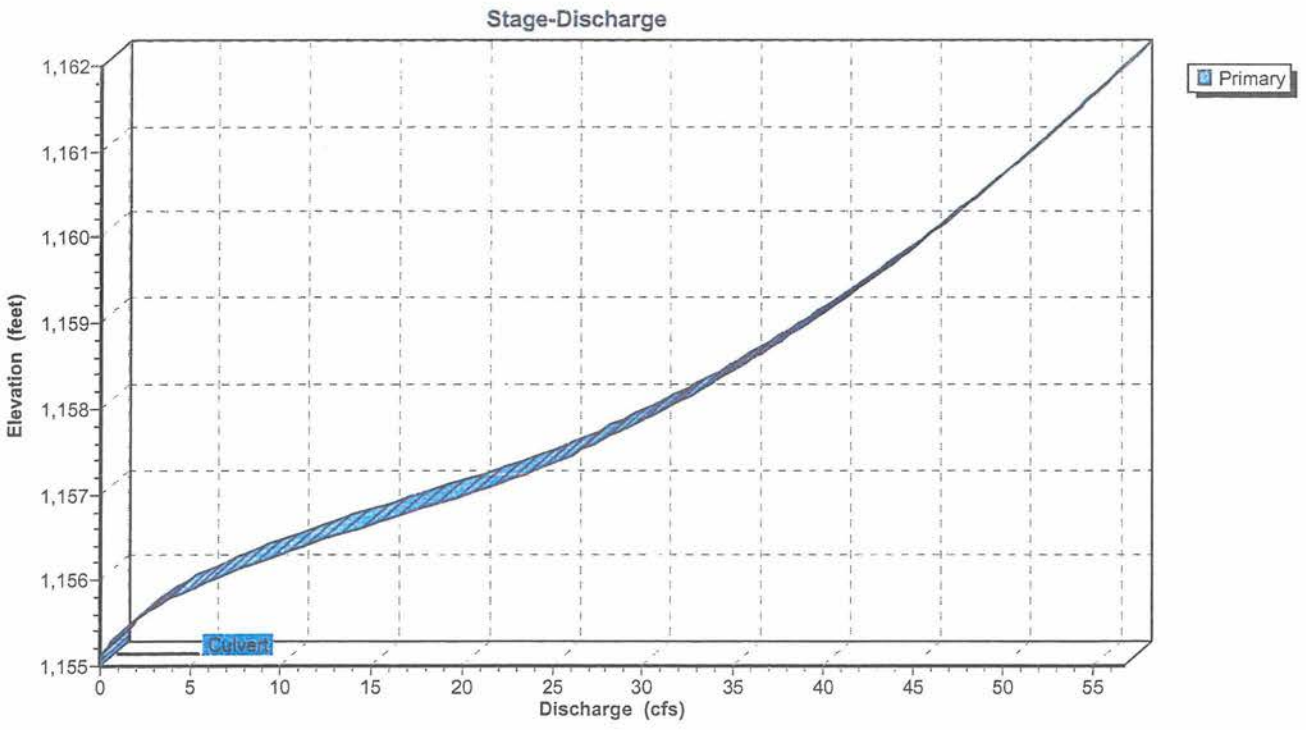
Device	Routing	Invert	Outlet Devices
#1	Primary	1,155.00'	**30.0" Round Culvert** L= 50.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 1,155.00' / 1,154.00' S= 0.0200 '/' Cc= 0.900 n= 0.013, Flow Area= 4.91 sf

Primary OutFlow Max=56.39 cfs @ 12.70 hrs HW=1,161.94' (Free Discharge)
1=Culvert (Inlet Controls 56.39 cfs @ 11.49 fps)

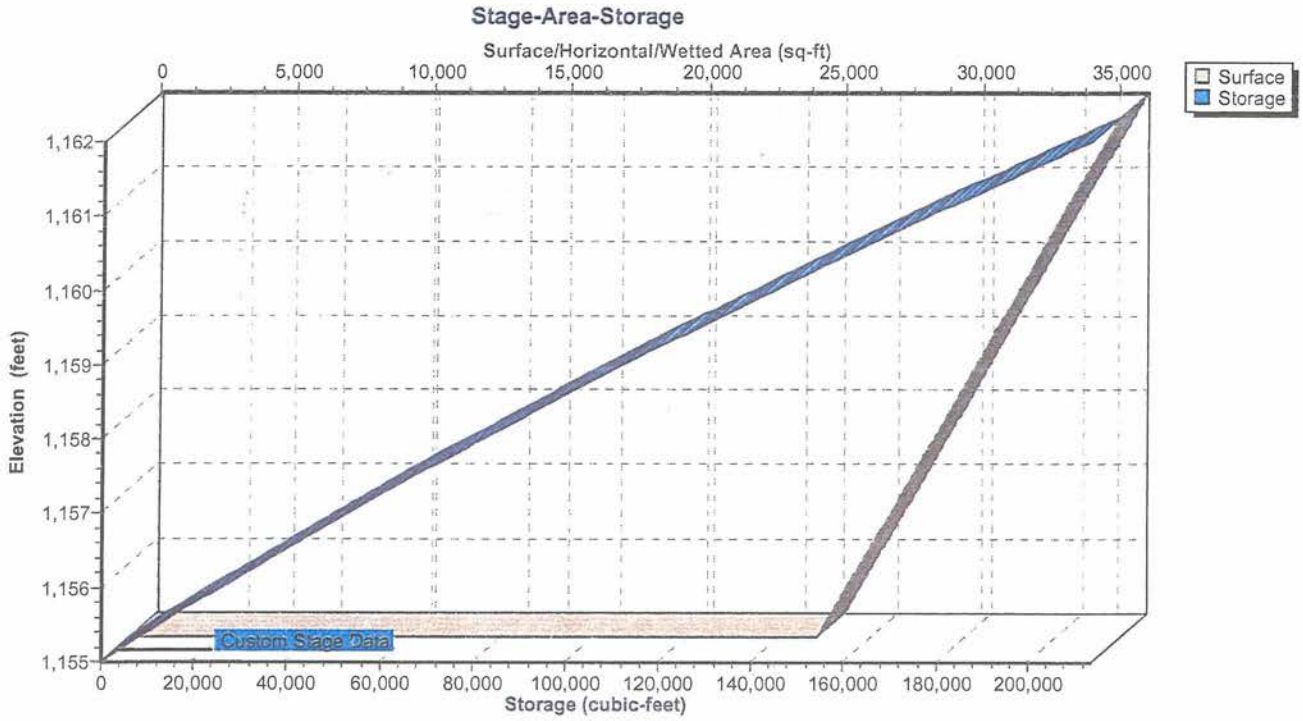
Pond 8P: Pond E



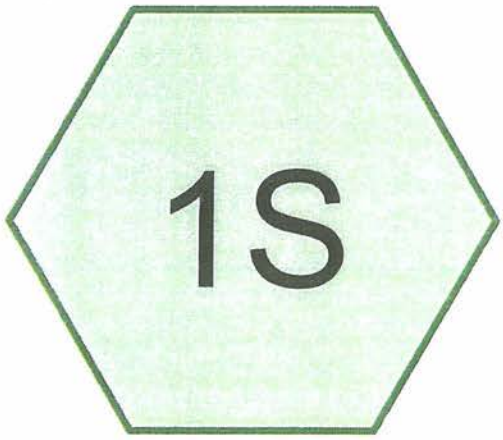
Pond 8P: Pond E



Pond 8P: Pond E



Appendix G
Drainage Calculations
Area F



Historic Area F

Subcat Reach Pond Link

Routing Diagram for Historic Area F
Prepared by SMC Consulting Engineers, P.C., Printed 1/10/2015

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
10.500	58	Type B soil (1S)
156.300	71	Type C soil (1S)
48.600	78	Type D soil (1S)

Summary for Subcatchment 1S: Historic Area F

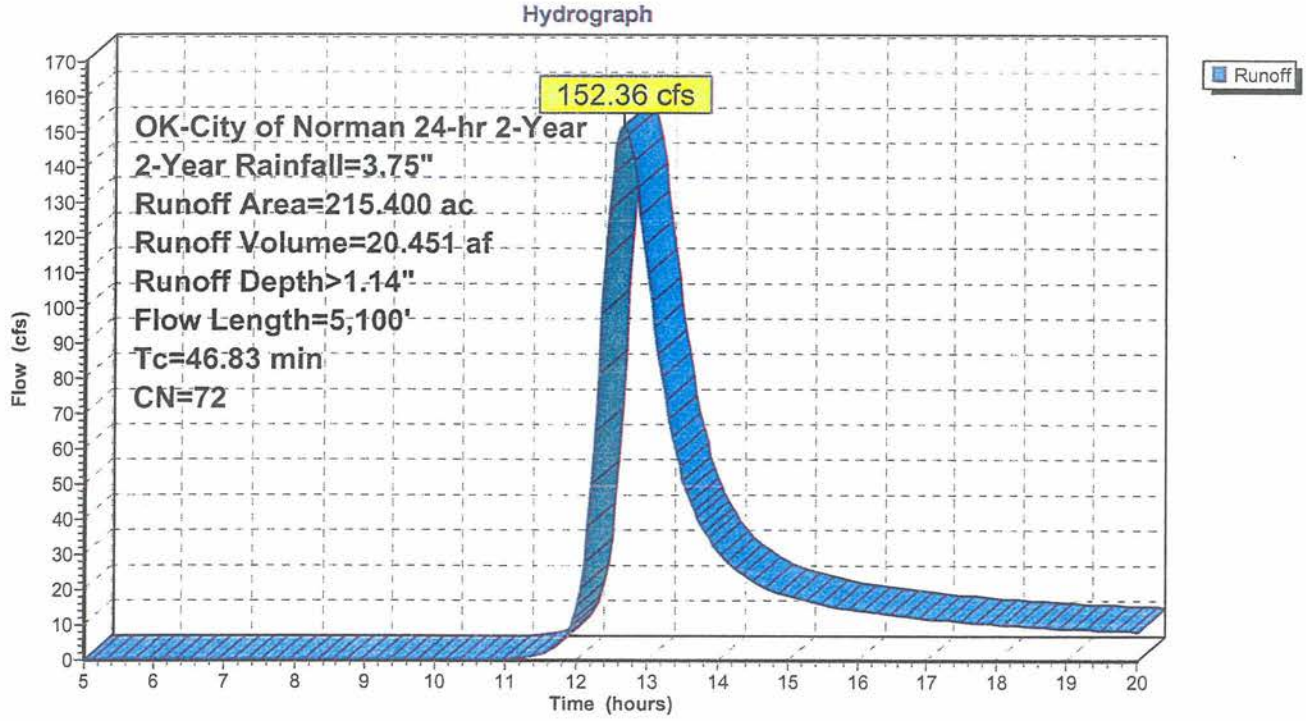
Runoff = 152.36 cfs @ 12.66 hrs, Volume= 20.451 af, Depth> 1.14"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
OK-City of Norman 24-hr 2-Year 2-Year Rainfall=3.75"

	Area (ac)	CN	Description
*	10.500	58	Type B soil
*	156.300	71	Type C soil
*	48.600	78	Type D soil
	215.400	72	Weighted Average
	215.400		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
20.89	300	0.0167	0.24		**Sheet Flow, Overland flow** Range n= 0.130 P2= 3.75"
2.75	200	0.0300	1.21		**Shallow Concentrated Flow, Swale** Short Grass Pasture Kv= 7.0 fps
23.19	4,600	0.0198	3.31	49.58	**Channel Flow, Creek** Area= 15.0 sf Perim= 25.0' r= 0.60' n= 0.045
46.83	5,100	Total			

Subcatchment 1S: Historic Area F



Summary for Subcatchment 1S: Historic Area F

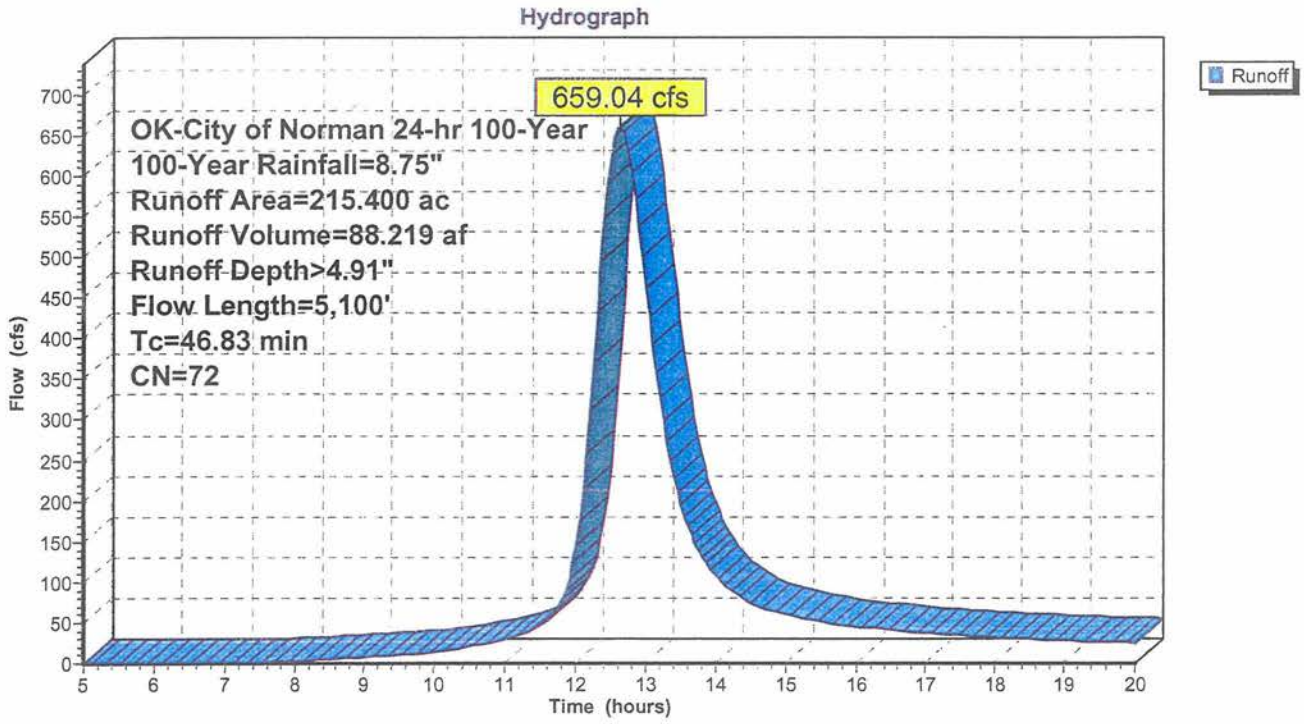
Runoff = 659.04 cfs @ 12.63 hrs, Volume= 88.219 af, Depth> 4.91"

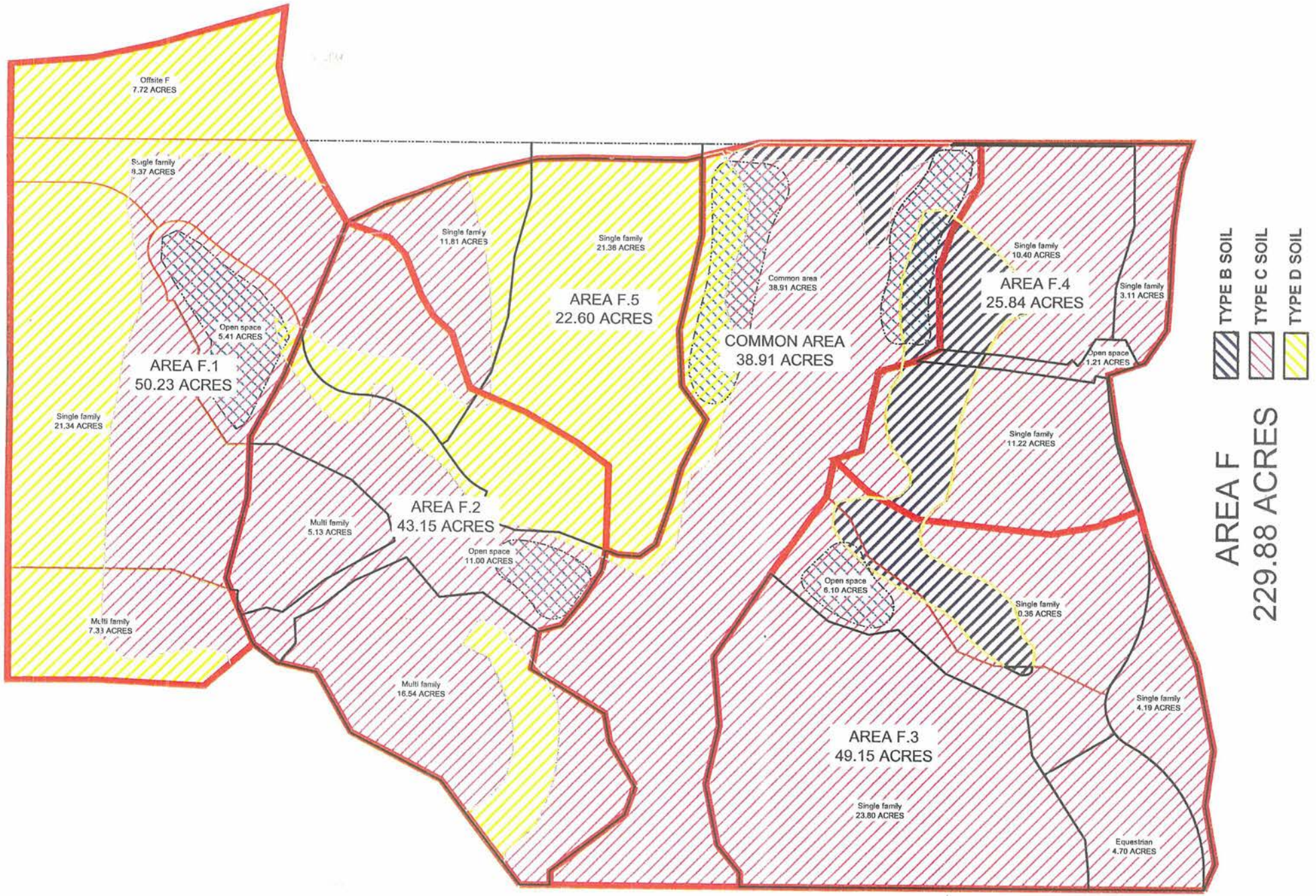
Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
OK-City of Norman 24-hr 100-Year 100-Year Rainfall=8.75"

	Area (ac)	CN	Description
*	10.500	58	Type B soil
*	156.300	71	Type C soil
*	48.600	78	Type D soil
	215.400	72	Weighted Average
	215.400		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
20.89	300	0.0167	0.24		**Sheet Flow, Overland flow** Range n= 0.130 P2= 3.75"
2.75	200	0.0300	1.21		**Shallow Concentrated Flow, Swale** Short Grass Pasture Kv= 7.0 fps
23.19	4,600	0.0198	3.31	49.58	**Channel Flow, Creek** Area= 15.0 sf Perim= 25.0' r= 0.60' n= 0.045
46.83	5,100	Total			

Subcatchment 1S: Historic Area F

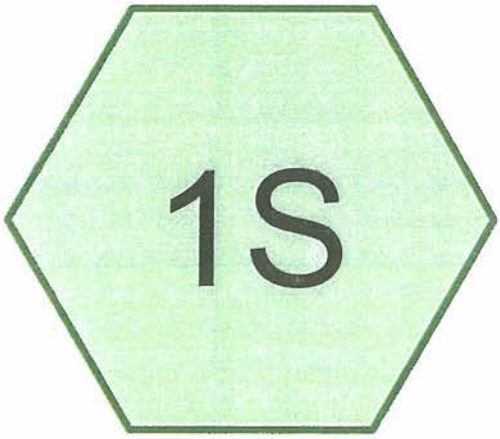



Offsite F
7.72 ACRES
Single family
9.37 ACRES
Single family
21.34 ACRES
Open space
5.41 ACRES
AREA F.1
50.23 ACRES
Multi family
7.33 ACRES
Single family
11.81 ACRES
Single family
21.36 ACRES
AREA F.5
22.60 ACRES
Multi family
5.13 ACRES
AREA F.2
43.15 ACRES
Open space
11.00 ACRES
Multi family
16.54 ACRES
Common area
38.91 ACRES
COMMON AREA
38.91 ACRES
Single family
10.40 ACRES
AREA F.4
25.84 ACRES
Single family
3.11 ACRES
Open space
1.21 ACRES
Single family
11.22 ACRES
Open space
6.10 ACRES
Single family
0.36 ACRES
Single family
4.19 ACRES
AREA F.3
49.15 ACRES
Single family
23.80 ACRES
Equestrian
4.70 ACRES
TYPE B SOIL
TYPE C SOIL
TYPE D SOIL
AREA F
229.88 ACRES

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
42.300	71	Type C soil (1S)
45.200	78	Type D soil (1S)

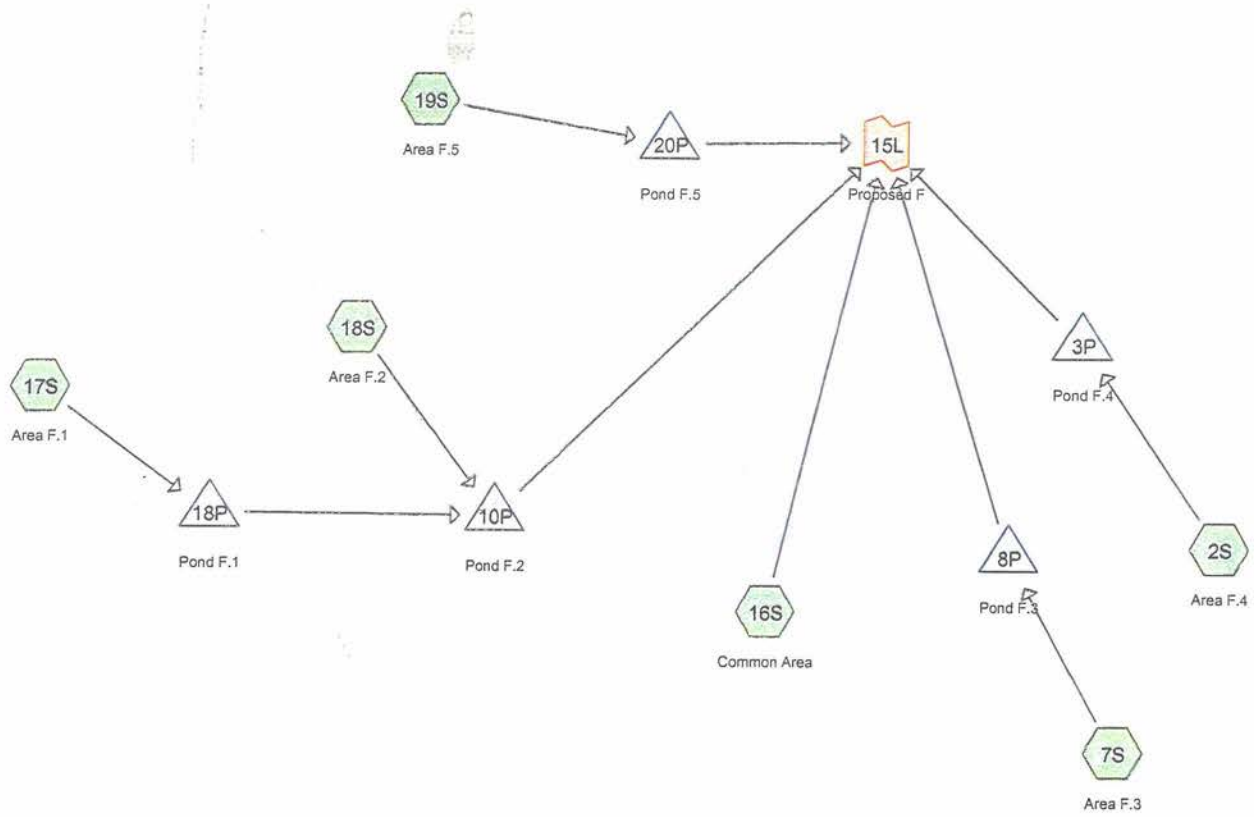
Appendix H
Drainage Calculations
Area G



Historic Area G

Subcat Reach Pond Link

Routing Diagram for Historic Area G
Prepared by SMC Consulting Engineers, P.C., Printed 1/10/2015



Subcat Reach Pond Link

Routing Diagram for Proposed Area F

Prepared by SMC Consulting Engineers, P.C., Printed 1/10/2015

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
92.300	81	Developed (7S, 18S)
38.910	66	Developed (16S)
50.230	83	Developed (17S)
22.600	86	Developed (19S)
25.840	81	Offsite & developed (2S)

Summary for Subcatchment 2S: Area F.4

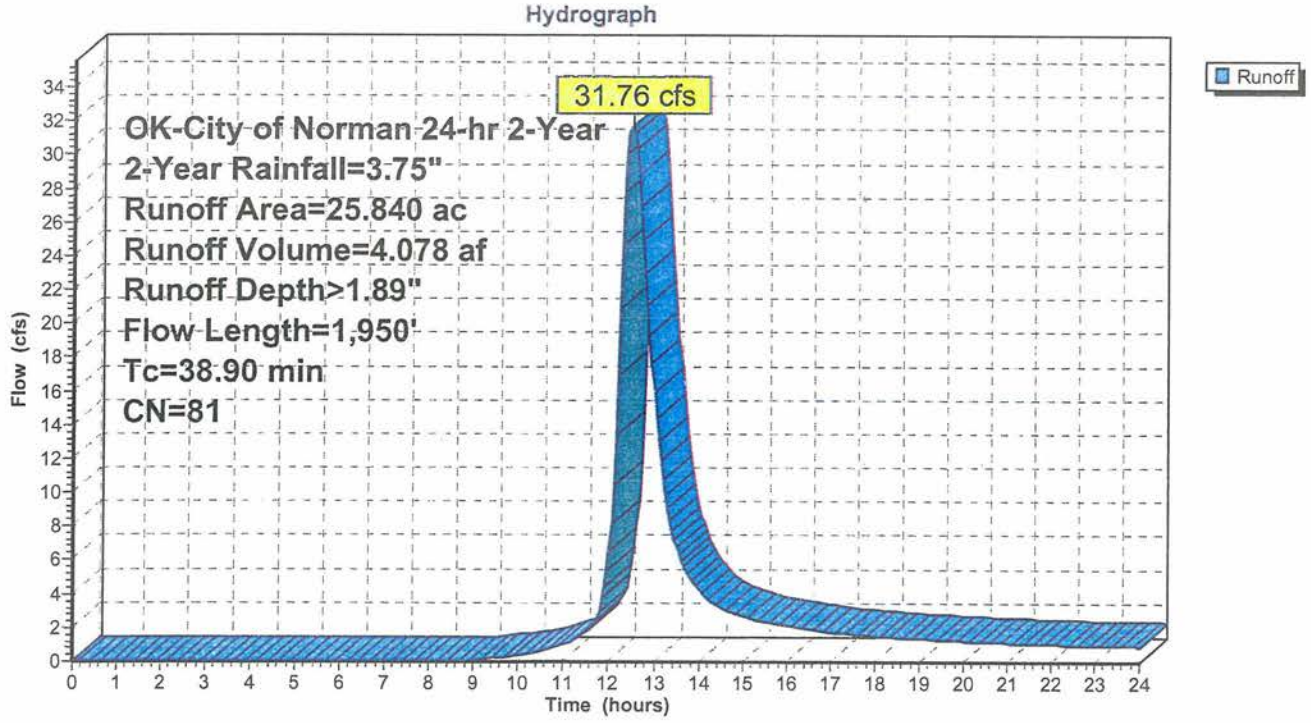
Runoff = 31.76 cfs @ 12.50 hrs, Volume= 4.078 af, Depth> 1.89"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
OK-City of Norman 24-hr 2-Year 2-Year Rainfall=3.75"

	Area (ac)	CN	Description
*	25.840	81	Offsite & developed
	25.840		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
26.70	100	0.0100	0.06		**Sheet Flow, Overland** Grass: Bermuda n= 0.410 P2= 3.75"
4.35	750	0.0200	2.87		**Shallow Concentrated Flow, Street** Paved Kv= 20.3 fps
7.85	1,100	0.0050	2.34	23.35	**Channel Flow, Ex. channel** Area= 10.0 sf Perim= 10.0' r= 1.00' n= 0.045
38.90	1,950	Total			

Subcatchment 2S: Area F.4



Summary for Subcatchment 7S: Area F.3

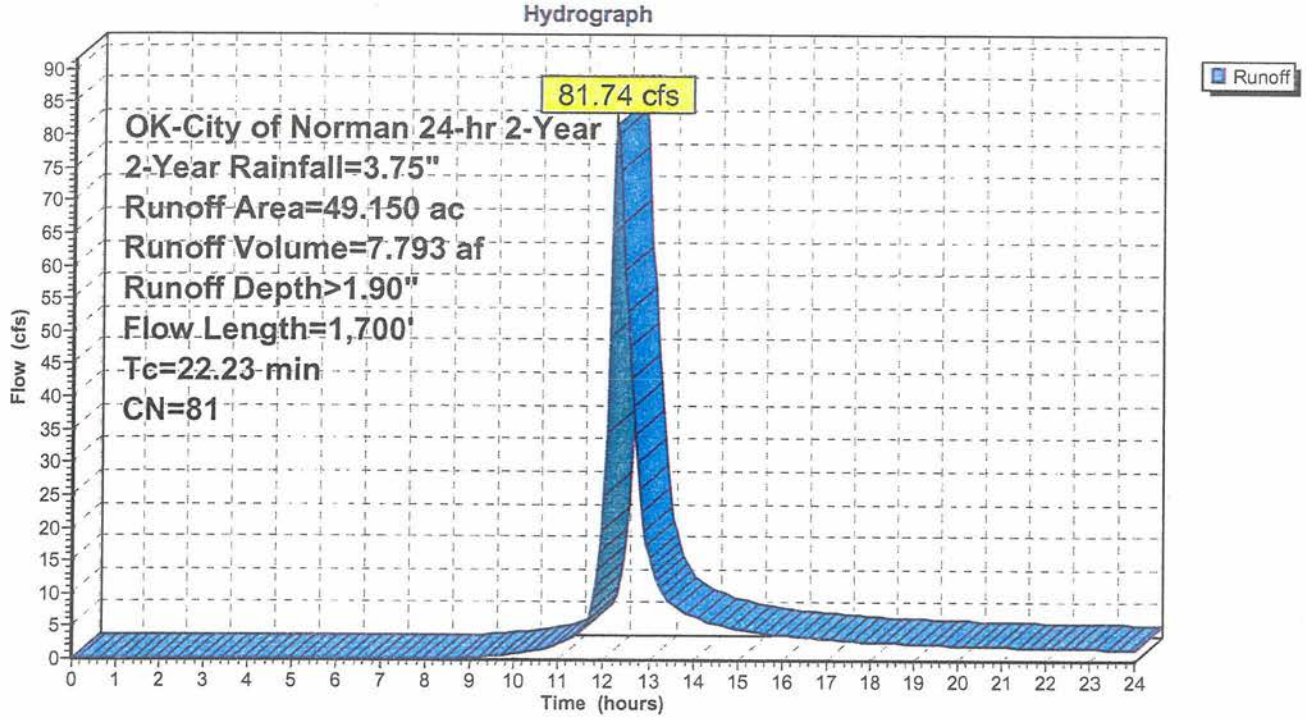
Runoff = 81.74 cfs @ 12.27 hrs, Volume= 7.793 af, Depth> 1.90"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
OK-City of Norman 24-hr 2-Year 2-Year Rainfall=3.75"

	Area (ac)	CN	Description
*	49.150	81	Developed
	49.150		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
15.33	50	0.0100	0.05		**Sheet Flow, Overland** Grass: Bermuda n= 0.410 P2= 3.75"
6.90	1,650	0.0250	3.98	39.85	**Channel Flow, Ex. channel** Area= 10.0 sf Perim= 15.0' r= 0.67' n= 0.045
22.23	1,700	Total			

Subcatchment 7S: Area F.3



Summary for Subcatchment 16S: Common Area

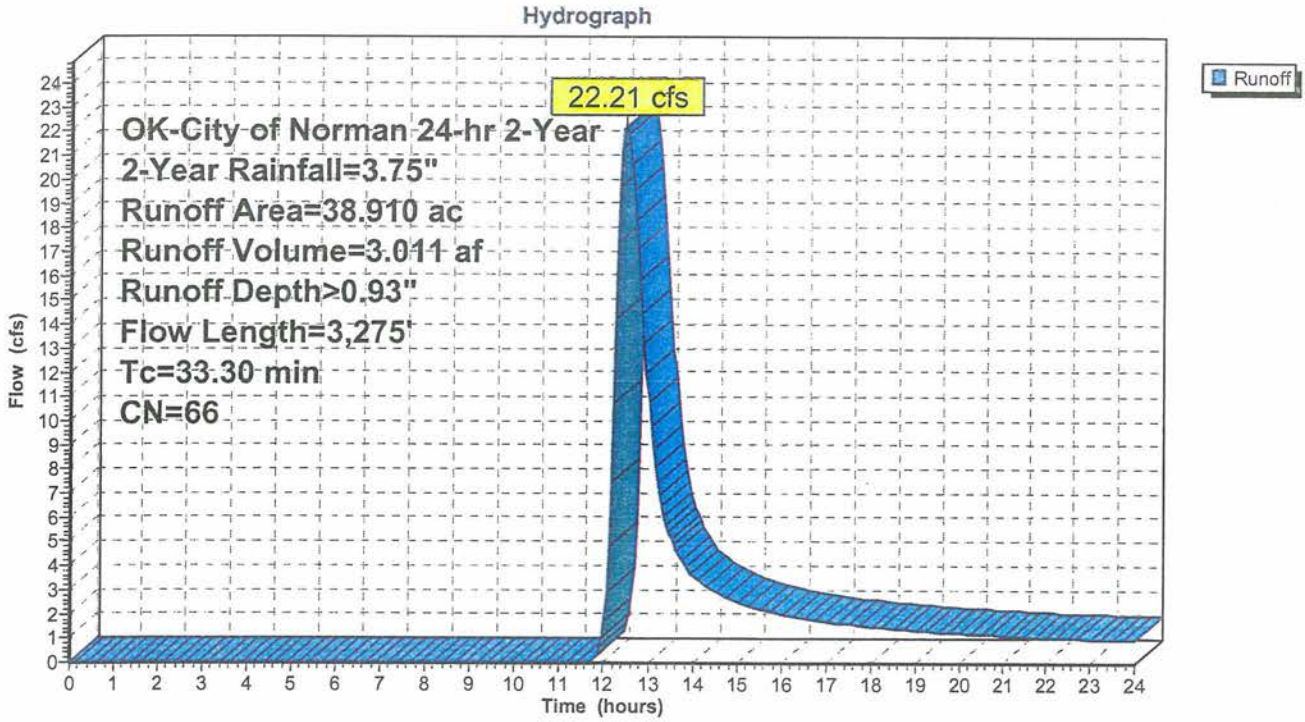
Runoff = 22.21 cfs @ 12.48 hrs, Volume= 3.011 af, Depth> 0.93"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
OK-City of Norman 24-hr 2-Year 2-Year Rainfall=3.75"

	Area (ac)	CN	Description
*	38.910	66	Developed
	38.910		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.05	100	0.0200	0.18		**Sheet Flow, Overland** Grass: Short n= 0.150 P2= 3.75"
24.25	3,175	0.0075	2.18	21.82	**Channel Flow, Ex. channel** Area= 10.0 sf Perim= 15.0' r= 0.67' n= 0.045
33.30	3,275	Total			

Subcatchment 16S: Common Area



Summary for Subcatchment 17S: Area F.1

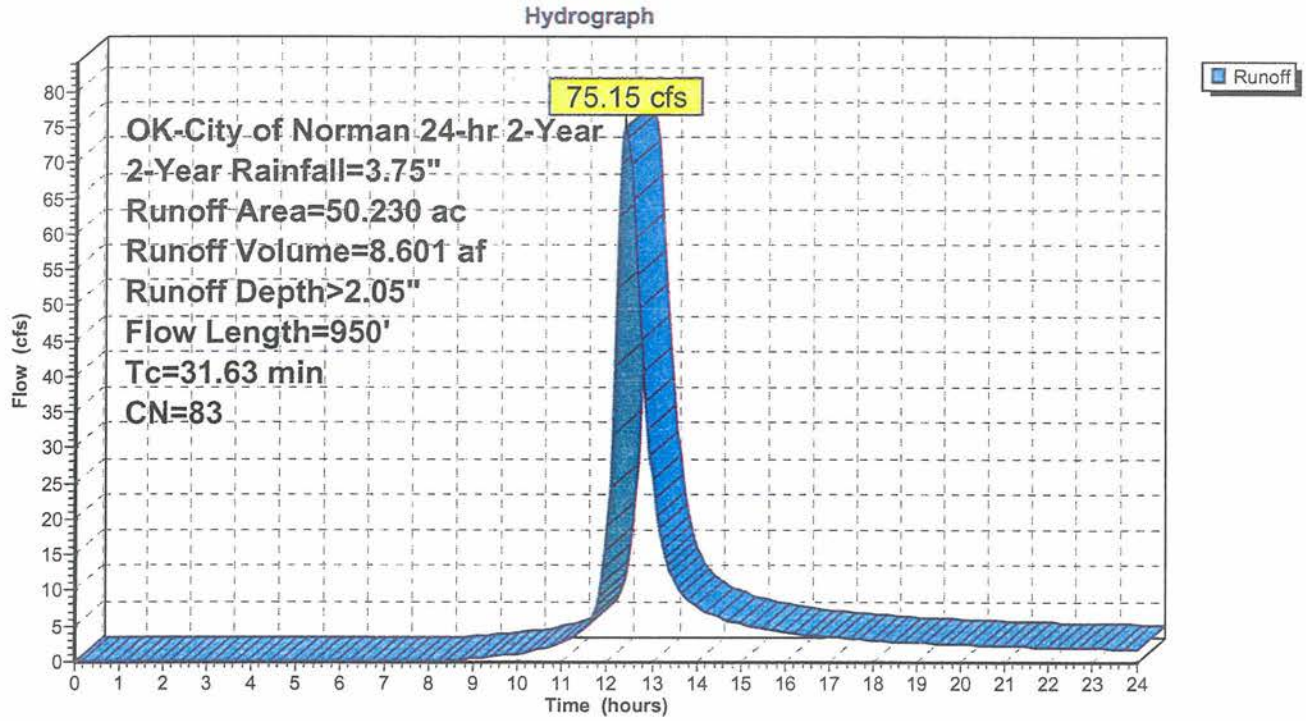
Runoff = 75.15 cfs @ 12.39 hrs, Volume= 8.601 af, Depth> 2.05"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
OK-City of Norman 24-hr 2-Year 2-Year Rainfall=3.75"

	Area (ac)	CN	Description
*	50.230	83	Developed
	50.230		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
26.70	100	0.0100	0.06		**Sheet Flow, Overland** Grass: Bermuda n= 0.410 P2= 3.75"
4.93	850	0.0200	2.87		**Shallow Concentrated Flow, Street** Paved Kv= 20.3 fps
31.63	950	Total			

Subcatchment 17S: Area F.1



Summary for Subcatchment 18S: Area F.2

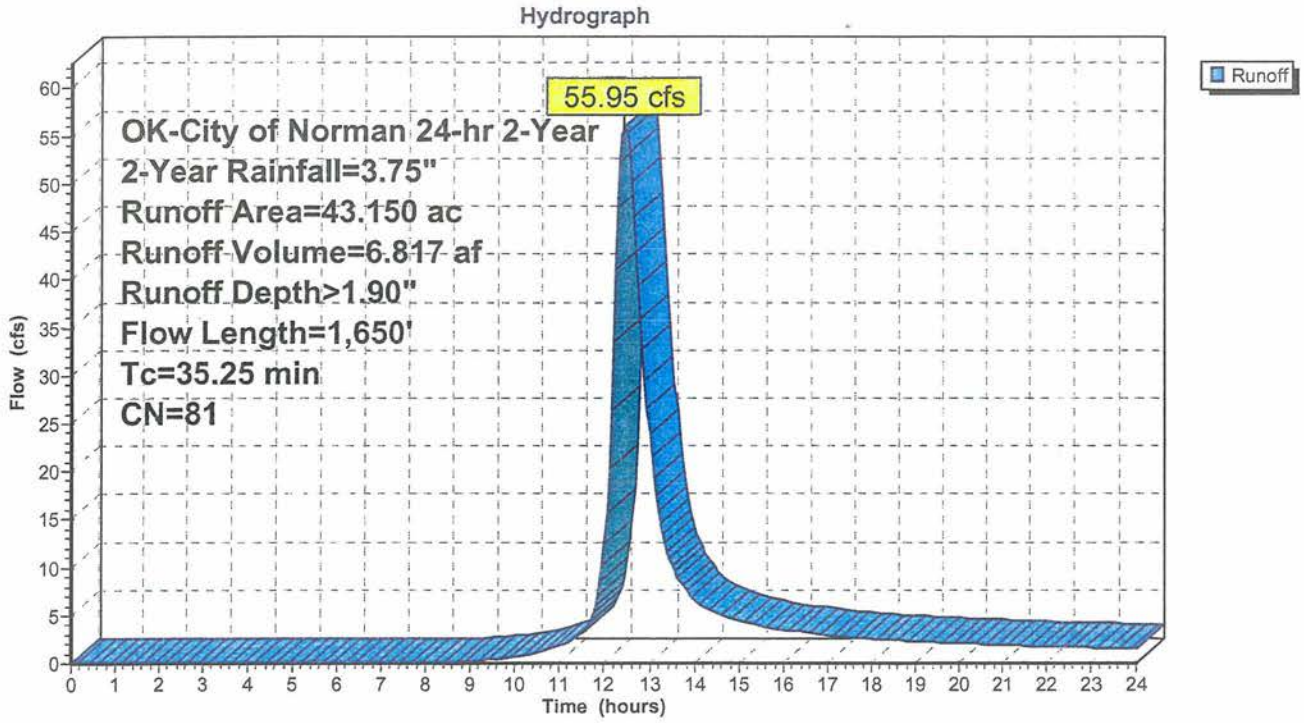
Runoff = 55.95 cfs @ 12.45 hrs, Volume= 6.817 af, Depth> 1.90"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
OK-City of Norman 24-hr 2-Year 2-Year Rainfall=3.75"

	Area (ac)	CN	Description
*	43.150	81	Developed
	43.150		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
26.70	100	0.0100	0.06		**Sheet Flow, Overland** Grass: Bermuda n= 0.410 P2= 3.75"
2.53	435	0.0200	2.87		**Shallow Concentrated Flow, Street** Paved Kv= 20.3 fps
6.02	1,115	0.0150	3.09	30.86	**Channel Flow, Ex. channel** Area= 10.0 sf Perim= 15.0' r= 0.67' n= 0.045
35.25	1,650	Total			

Subcatchment 18S: Area F.2



Summary for Subcatchment 19S: Area F.5

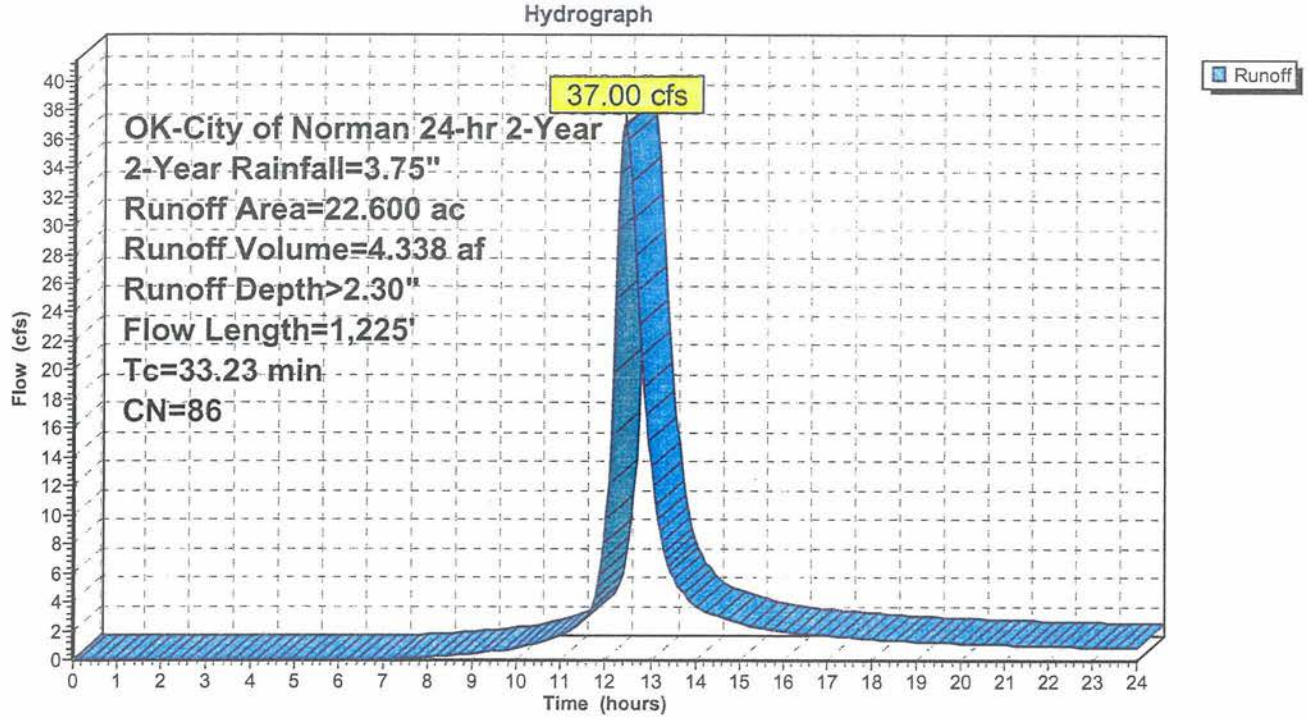
Runoff = 37.00 cfs @ 12.41 hrs, Volume= 4.338 af, Depth> 2.30"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
OK-City of Norman 24-hr 2-Year 2-Year Rainfall=3.75"

	Area (ac)	CN	Description
*	22.600	86	Developed
	22.600		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
26.70	100	0.0100	0.06		**Sheet Flow, Overland** Grass: Bermuda n= 0.410 P2= 3.75"
6.53	1,125	0.0200	2.87		**Shallow Concentrated Flow, Street** Paved Kv= 20.3 fps
33.23	1,225	Total			

Subcatchment 19S: Area F.5



Summary for Pond 3P: Pond F.4

Inflow Area = 25.840 ac, 0.00% Impervious, Inflow Depth > 1.89" for 2-Year event
Inflow = 31.76 cfs @ 12.50 hrs, Volume= 4.078 af
Outflow = 5.23 cfs @ 13.73 hrs, Volume= 3.023 af, Atten= 84%, Lag= 73.85 min
Primary = 5.23 cfs @ 13.73 hrs, Volume= 3.023 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 1,116.14' @ 13.73 hrs Surf.Area= 88,199 sf Storage= 95,767 cf

Plug-Flow detention time= 256.93 min calculated for 3.016 af (74% of inflow)
Center-of-Mass det. time= 166.03 min (1,024.34 - 858.31)

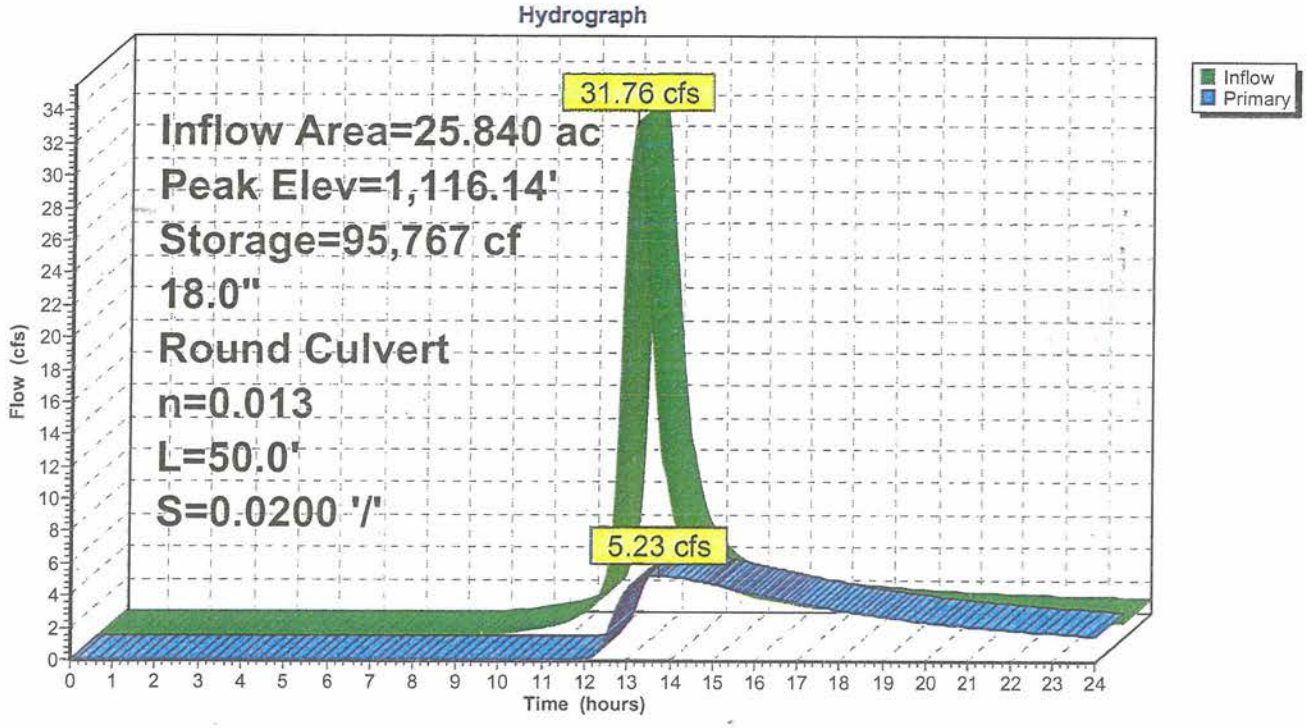
Volume	Invert	Avail.Storage	Storage Description
#1	1,115.00'	490,000 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
1,115.00	80,000	0	0
1,120.00	116,000	490,000	490,000

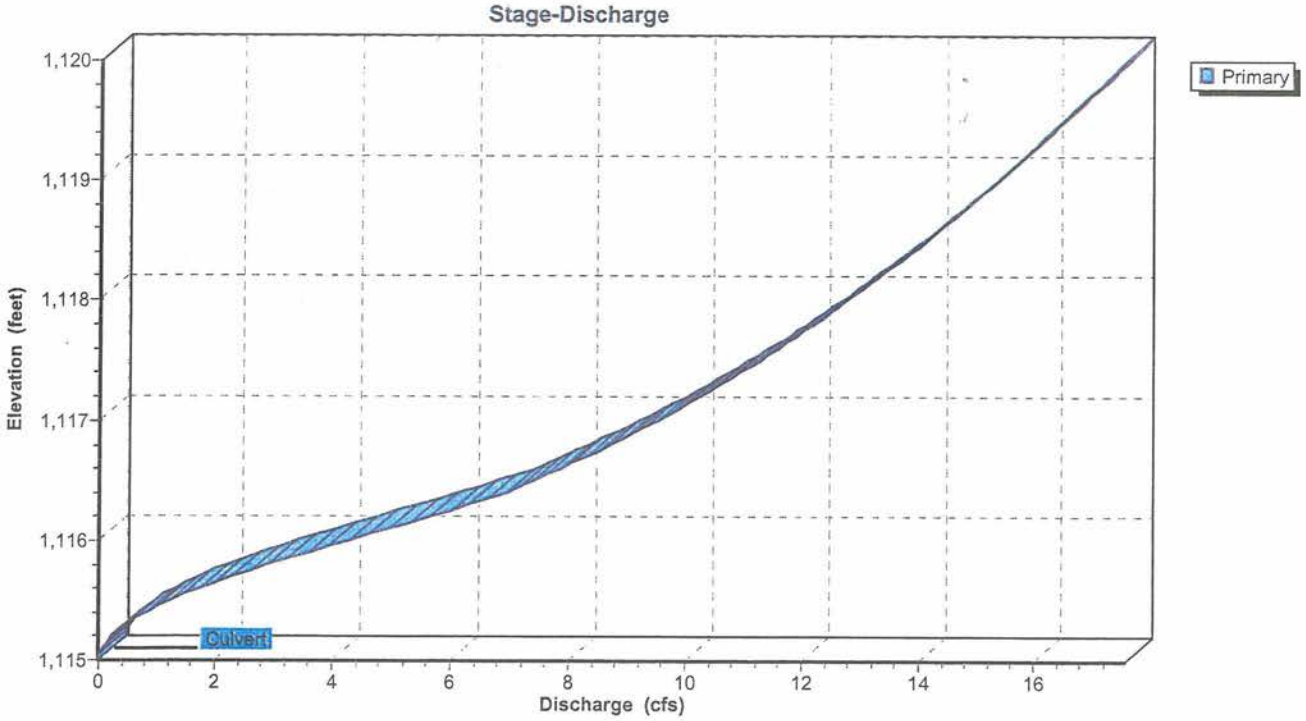
Device	Routing	Invert	Outlet Devices
#1	Primary	1,115.00'	**18.0" Round Culvert** L= 50.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 1,115.00' / 1,114.00' S= 0.0200 '/' Cc= 0.900 n= 0.013, Flow Area= 1.77 sf

Primary OutFlow Max=5.23 cfs @ 13.73 hrs HW=1,116.14' (Free Discharge)
↑**1=Culvert** (Inlet Controls 5.23 cfs @ 3.63 fps)

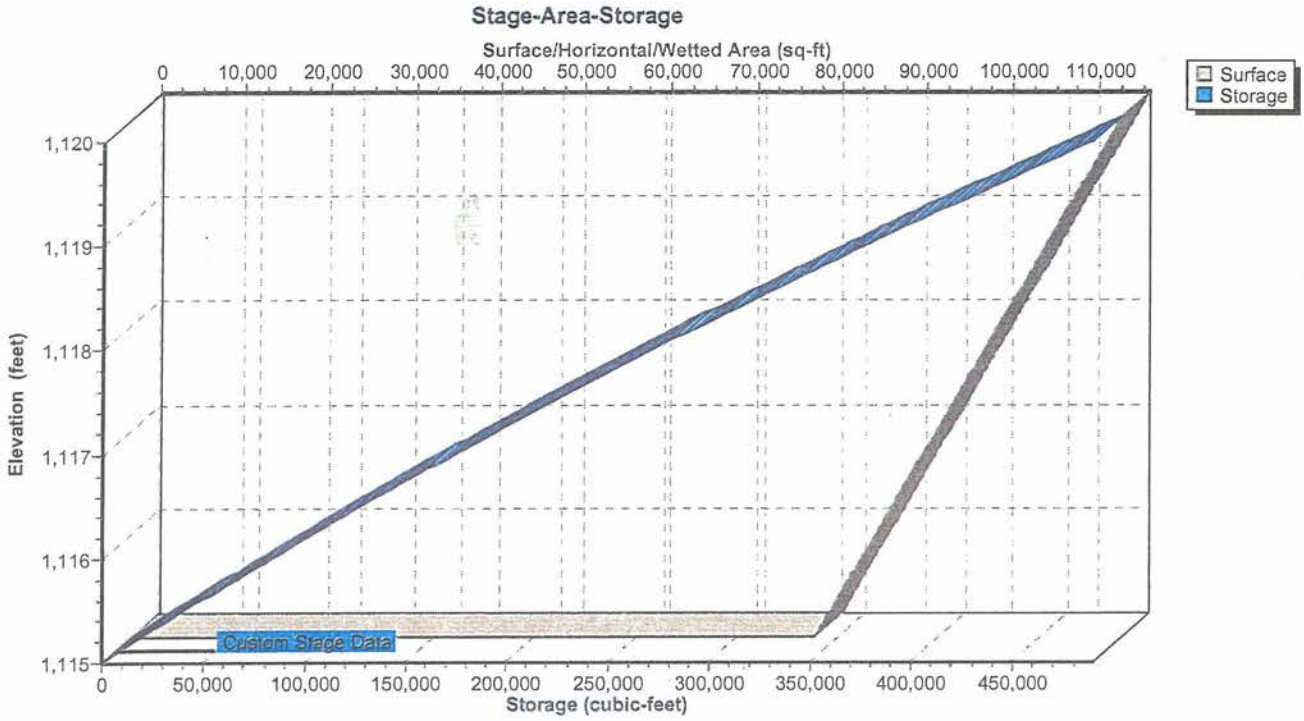
Pond 3P: Pond F.4



Pond 3P: Pond F.4



Pond 3P: Pond F.4



Summary for Pond 8P: Pond F.3

Inflow Area = 49.150 ac, 0.00% Impervious, Inflow Depth > 1.90" for 2-Year event
Inflow = 81.74 cfs @ 12.27 hrs, Volume= 7.793 af
Outflow = 48.44 cfs @ 12.55 hrs, Volume= 7.517 af, Atten= 41%, Lag= 16.83 min
Primary = 48.44 cfs @ 12.55 hrs, Volume= 7.517 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 1,127.86' @ 12.55 hrs Surf.Area= 35,293 sf Storage= 86,198 cf

Plug-Flow detention time= 52.03 min calculated for 7.502 af (96% of inflow)
Center-of-Mass det. time= 32.53 min (878.14 - 845.61)

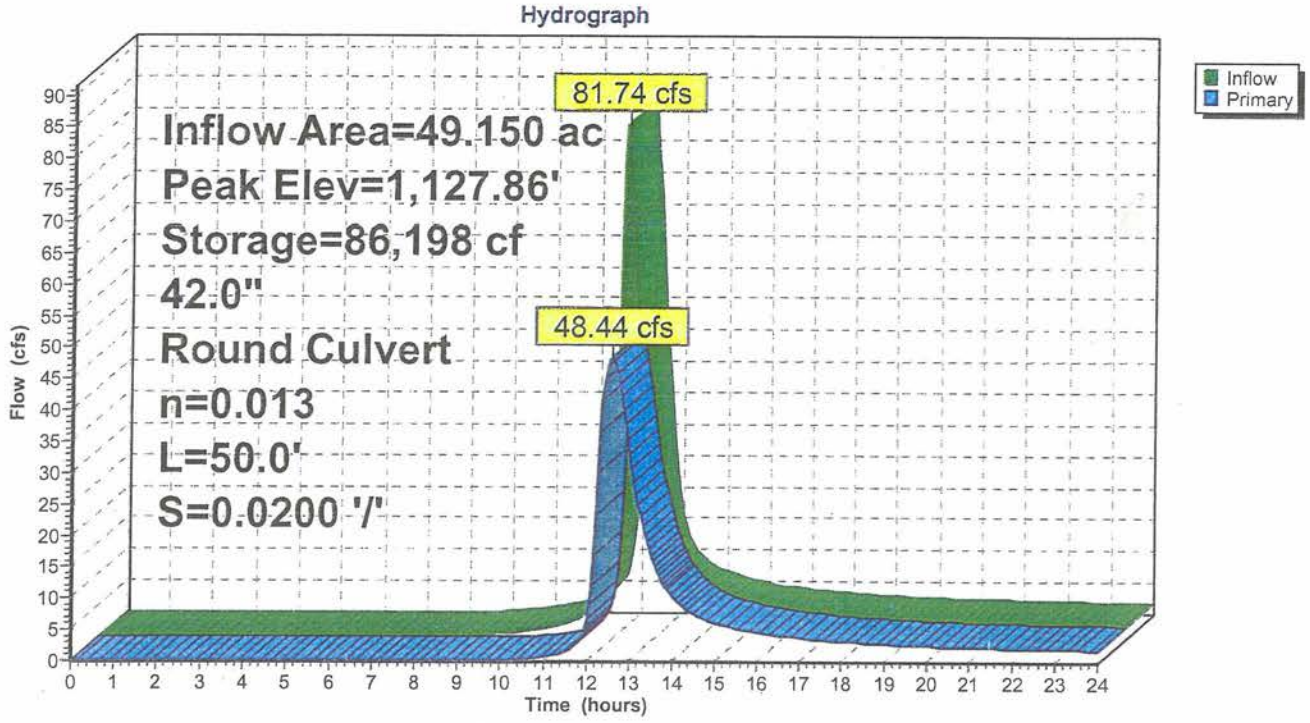
Volume	Invert	Avail.Storage	Storage Description
#1	1,125.00'	430,000 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
1,125.00	25,000	0	0
1,135.00	61,000	430,000	430,000

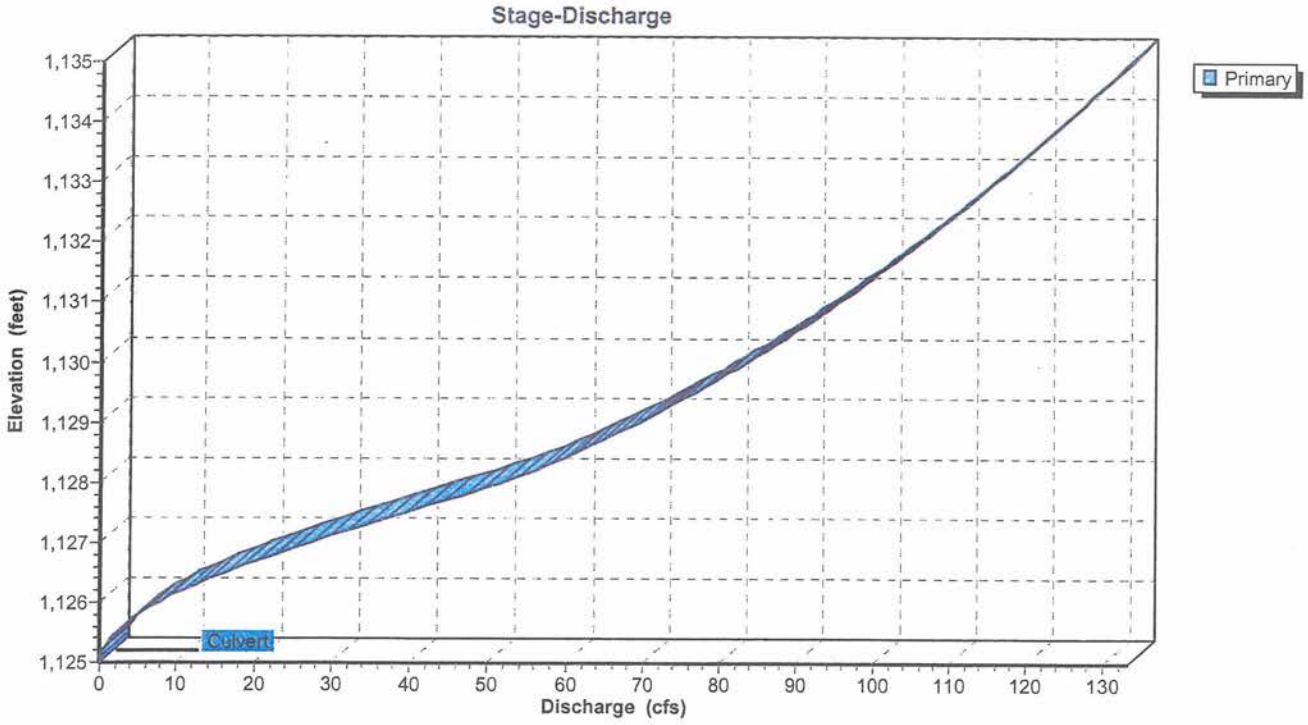
Device	Routing	Invert	Outlet Devices
#1	Primary	1,125.00'	**42.0" Round Culvert** L= 50.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 1,125.00' / 1,124.00' S= 0.0200 '/' Cc= 0.900 n= 0.013, Flow Area= 9.62 sf

Primary OutFlow Max=48.42 cfs @ 12.55 hrs HW=1,127.86' (Free Discharge)
1=Culvert (Inlet Controls 48.42 cfs @ 5.76 fps)

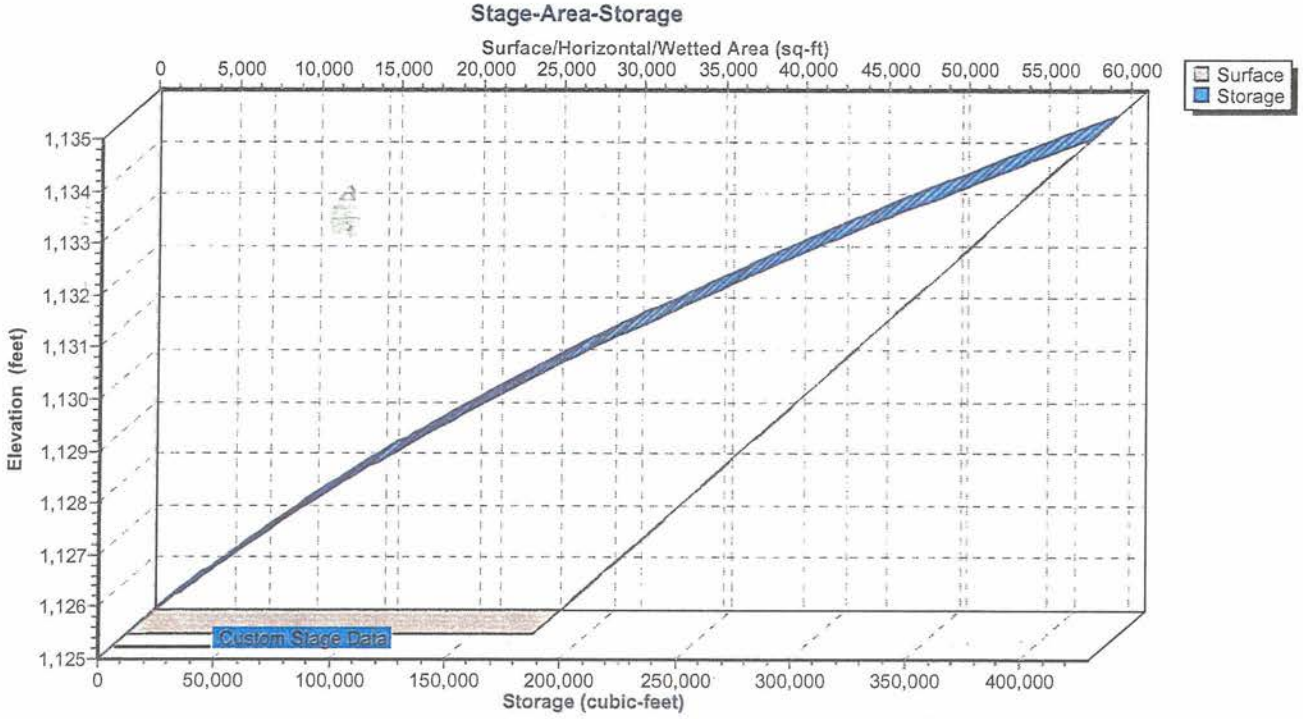
Pond 8P: Pond F.3



Pond 8P: Pond F.3



Pond 8P: Pond F.3



Summary for Pond 10P: Pond F.2

Inflow Area = 93.380 ac, 0.00% Impervious, Inflow Depth > 1.92" for 2-Year event
Inflow = 74.99 cfs @ 12.49 hrs, Volume= 14.969 af
Outflow = 48.64 cfs @ 12.99 hrs, Volume= 14.544 af, Atten= 35%, Lag= 29.72 min
Primary = 48.64 cfs @ 12.99 hrs, Volume= 14.544 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 1,127.54' @ 12.99 hrs Surf.Area= 36,595 sf Storage= 109,114 cf

Plug-Flow detention time= 45.46 min calculated for 14.544 af (97% of inflow)
Center-of-Mass det. time= 30.70 min (920.46 - 889.76)

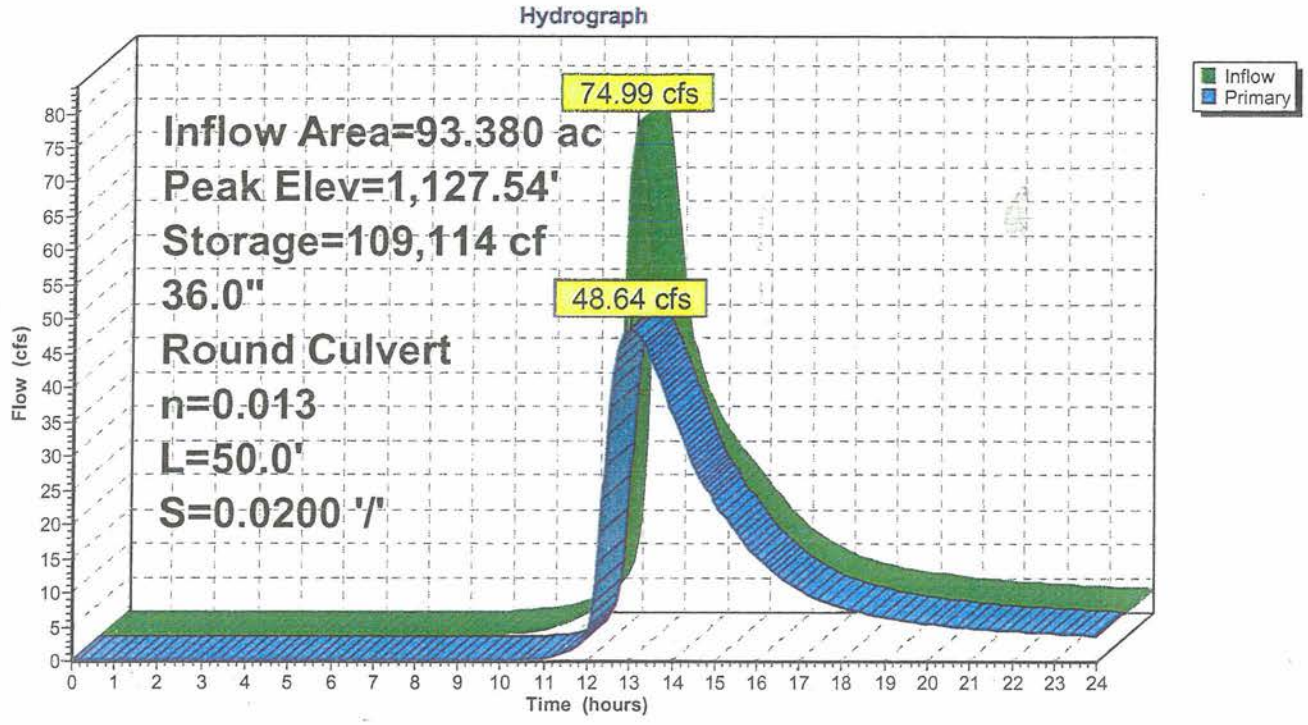
Volume	Invert	Avail.Storage	Storage Description
#1	1,124.00'	473,000 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
1,124.00	25,000	0	0
1,135.00	61,000	473,000	473,000

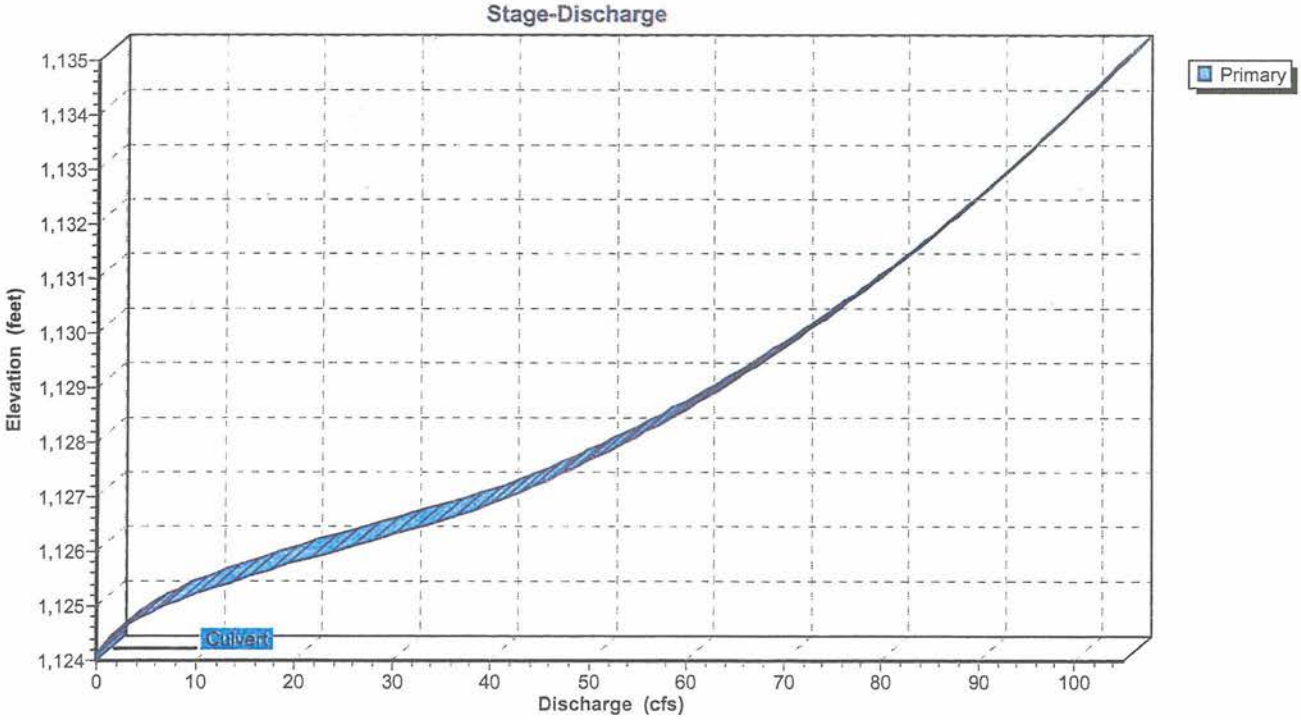
Device	Routing	Invert	Outlet Devices
#1	Primary	1,124.00'	**36.0" Round Culvert** L= 50.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 1,124.00' / 1,123.00' S= 0.0200 '/' Cc= 0.900 n= 0.013, Flow Area= 7.07 sf

Primary OutFlow Max=48.63 cfs @ 12.99 hrs HW=1,127.54' (Free Discharge)
1=Culvert (Inlet Controls 48.63 cfs @ 6.88 fps)

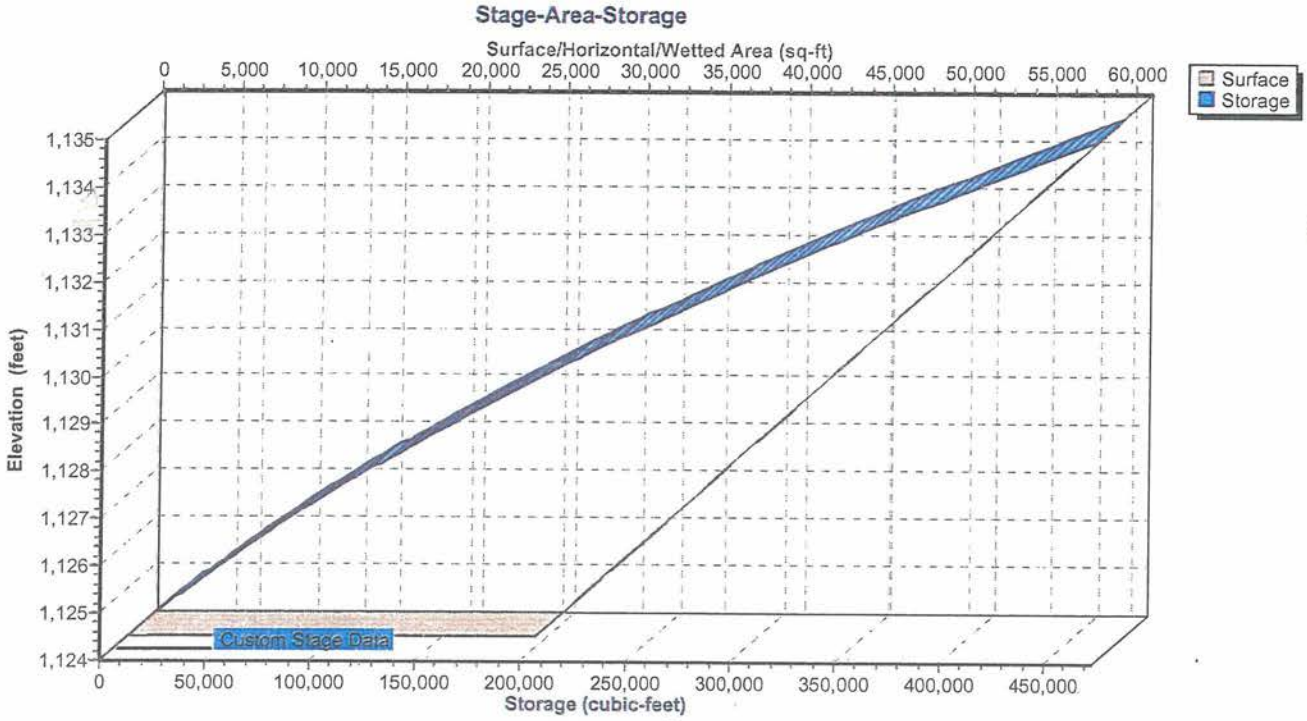
Pond 10P: Pond F.2



Pond 10P: Pond F.2



Pond 10P: Pond F.2



Summary for Pond 18P: Pond F.1

Inflow Area = 50.230 ac, 0.00% Impervious, Inflow Depth > 2.05" for 2-Year event
Inflow = 75.15 cfs @ 12.39 hrs, Volume= 8.601 af
Outflow = 24.14 cfs @ 13.03 hrs, Volume= 8.152 af, Atten= 68%, Lag= 38.05 min
Primary = 24.14 cfs @ 13.03 hrs, Volume= 8.152 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 1,157.55' @ 13.03 hrs Surf.Area= 51,463 sf Storage= 148,001 cf

Plug-Flow detention time= 99.50 min calculated for 8.152 af (95% of inflow)
Center-of-Mass det. time= 71.63 min (918.35 - 846.72)

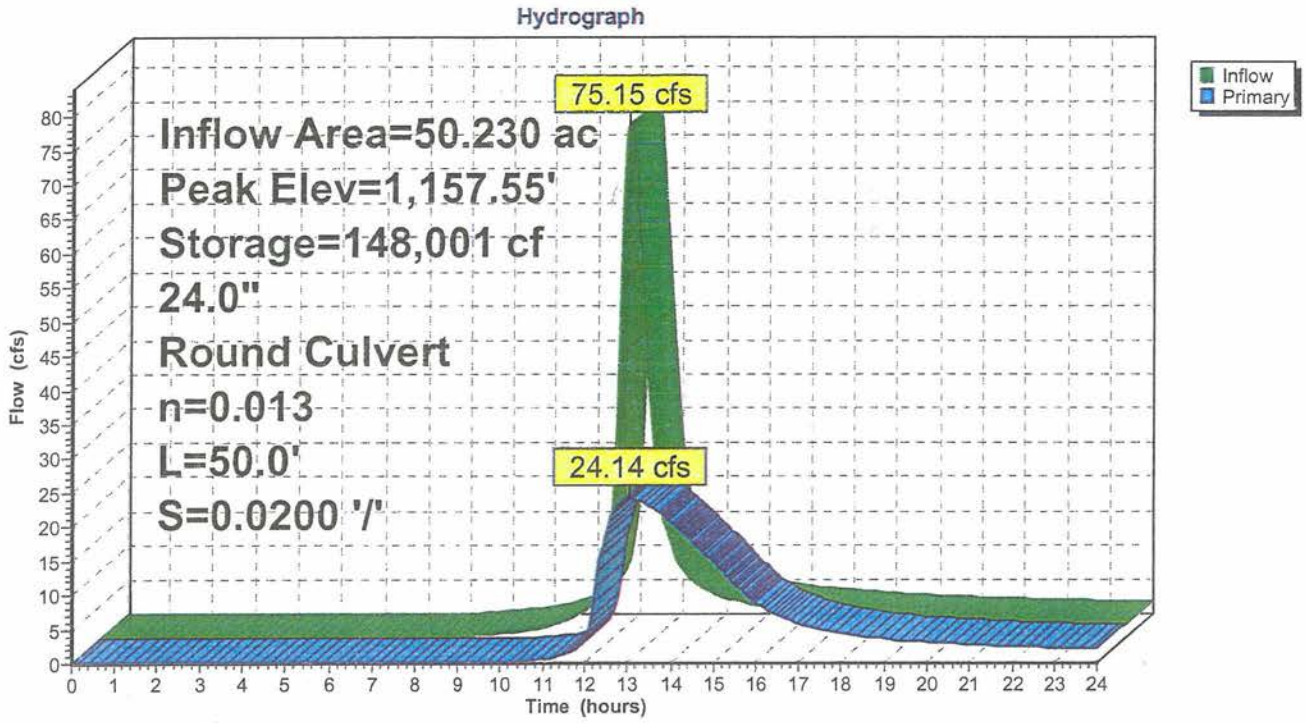
Volume	Invert	Avail.Storage	Storage Description
#1	1,154.00'	684,024 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
1,154.00	32,000	0	0
1,165.00	92,368	684,024	684,024

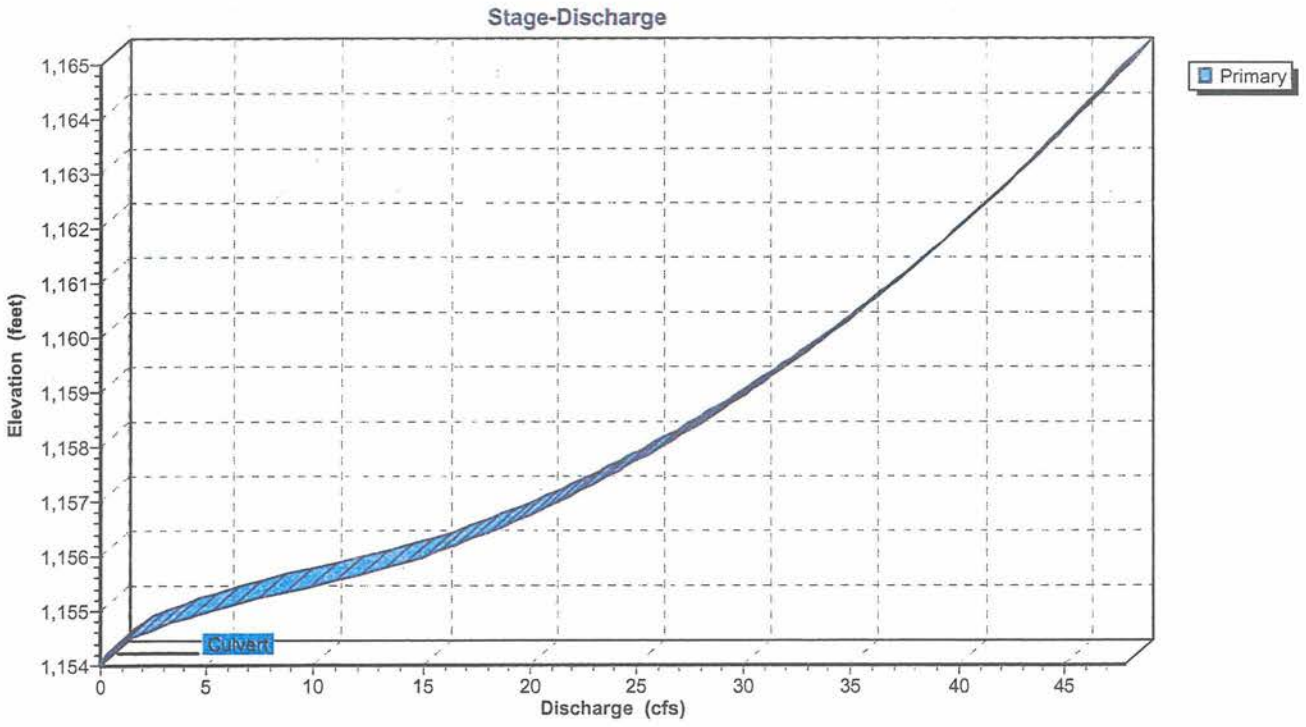
Device	Routing	Invert	Outlet Devices
#1	Primary	1,154.00'	**24.0" Round Culvert** L= 50.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 1,154.00' / 1,153.00' S= 0.0200 '/' Cc= 0.900 n= 0.013, Flow Area= 3.14 sf

Primary OutFlow Max=24.13 cfs @ 13.03 hrs HW=1,157.55' (Free Discharge)
1=Culvert (Inlet Controls 24.13 cfs @ 7.68 fps)

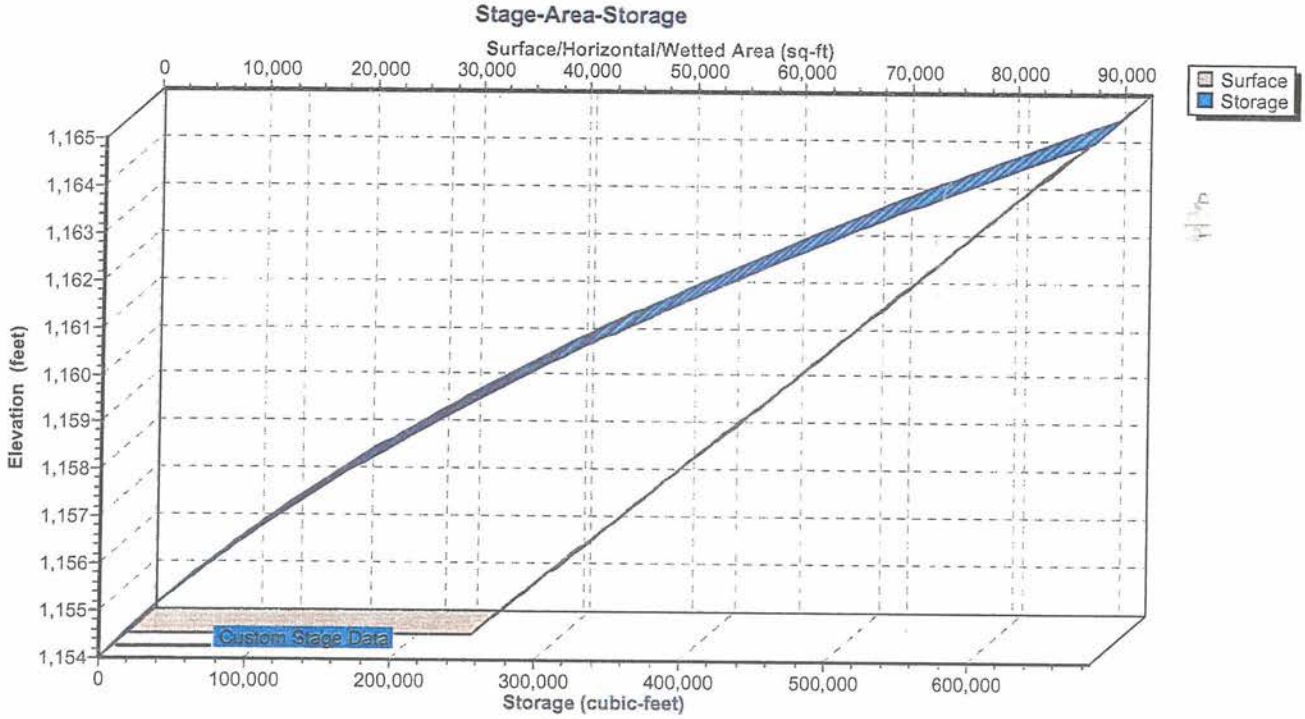
Pond 18P: Pond F.1



Pond 18P: Pond F.1



Pond 18P: Pond F.1



Summary for Pond 20P: Pond F.5

Inflow Area = 22.600 ac, 0.00% Impervious, Inflow Depth > 2.30" for 2-Year event
Inflow = 37.00 cfs @ 12.41 hrs, Volume= 4.338 af
Outflow = 3.80 cfs @ 13.98 hrs, Volume= 2.614 af, Atten= 90%, Lag= 93.92 min
Primary = 3.80 cfs @ 13.98 hrs, Volume= 2.614 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 1,120.77' @ 13.98 hrs Surf.Area= 153,827 sf Storage= 116,268 cf

Plug-Flow detention time= 313.19 min calculated for 2.608 af (60% of inflow)
Center-of-Mass det. time= 209.42 min (1,047.68 - 838.26)

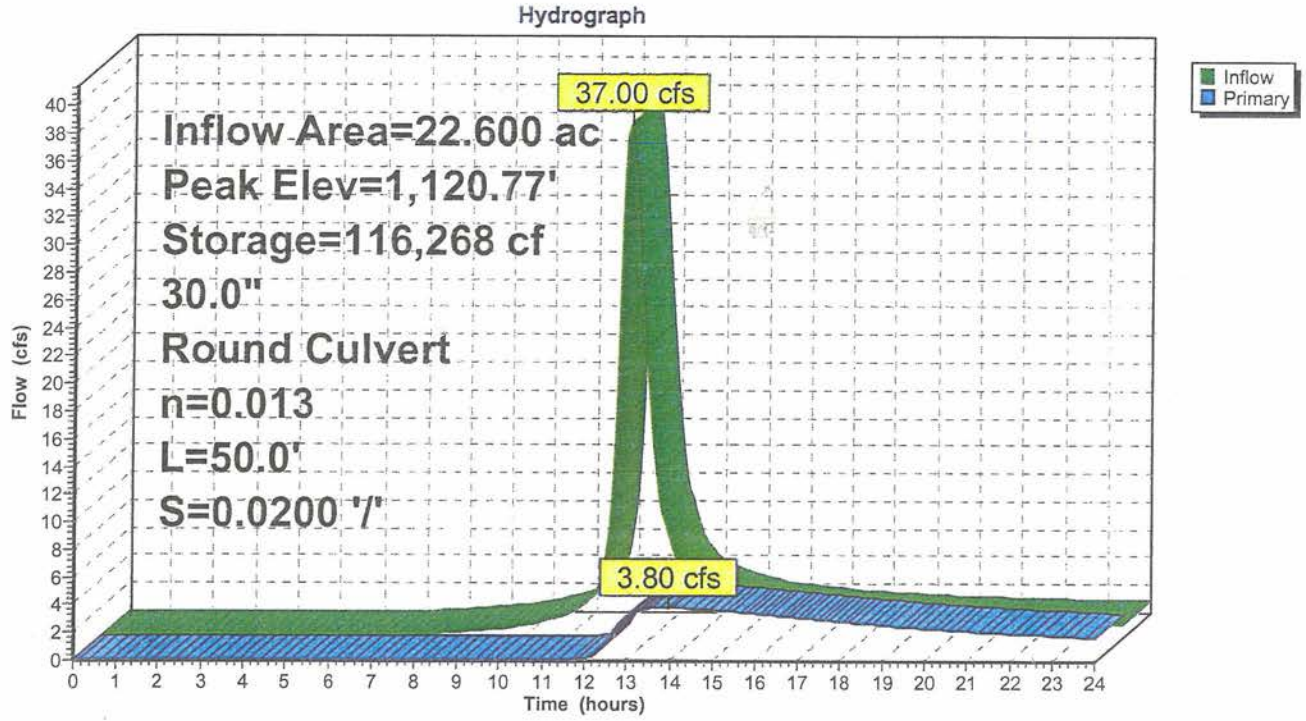
Volume	Invert	Avail.Storage	Storage Description
#1	1,120.00'	812,500 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
1,120.00	150,000	0	0
1,125.00	175,000	812,500	812,500

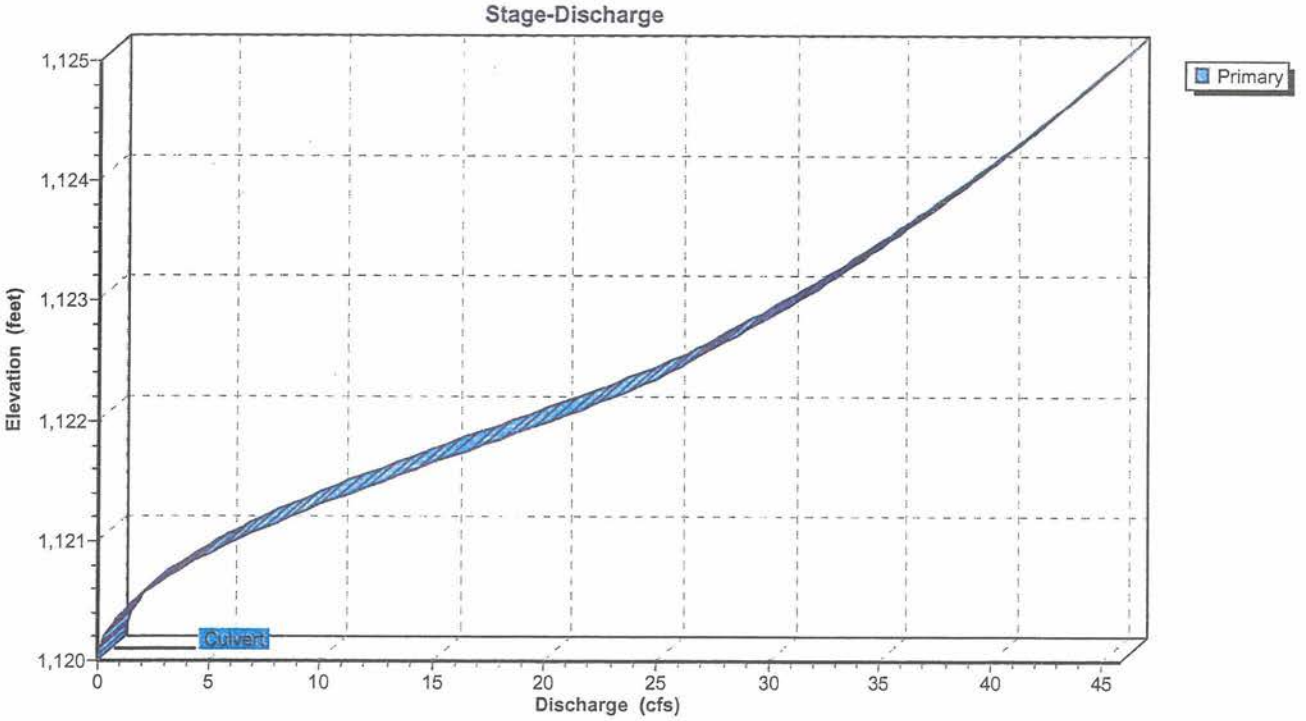
Device	Routing	Invert	Outlet Devices
#1	Primary	1,120.00'	**30.0" Round Culvert** L= 50.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 1,120.00' / 1,119.00' S= 0.0200 '/' Cc= 0.900 n= 0.013, Flow Area= 4.91 sf

Primary OutFlow Max=3.79 cfs @ 13.98 hrs HW=1,120.77' (Free Discharge)
1=Culvert (Inlet Controls 3.79 cfs @ 2.98 fps)

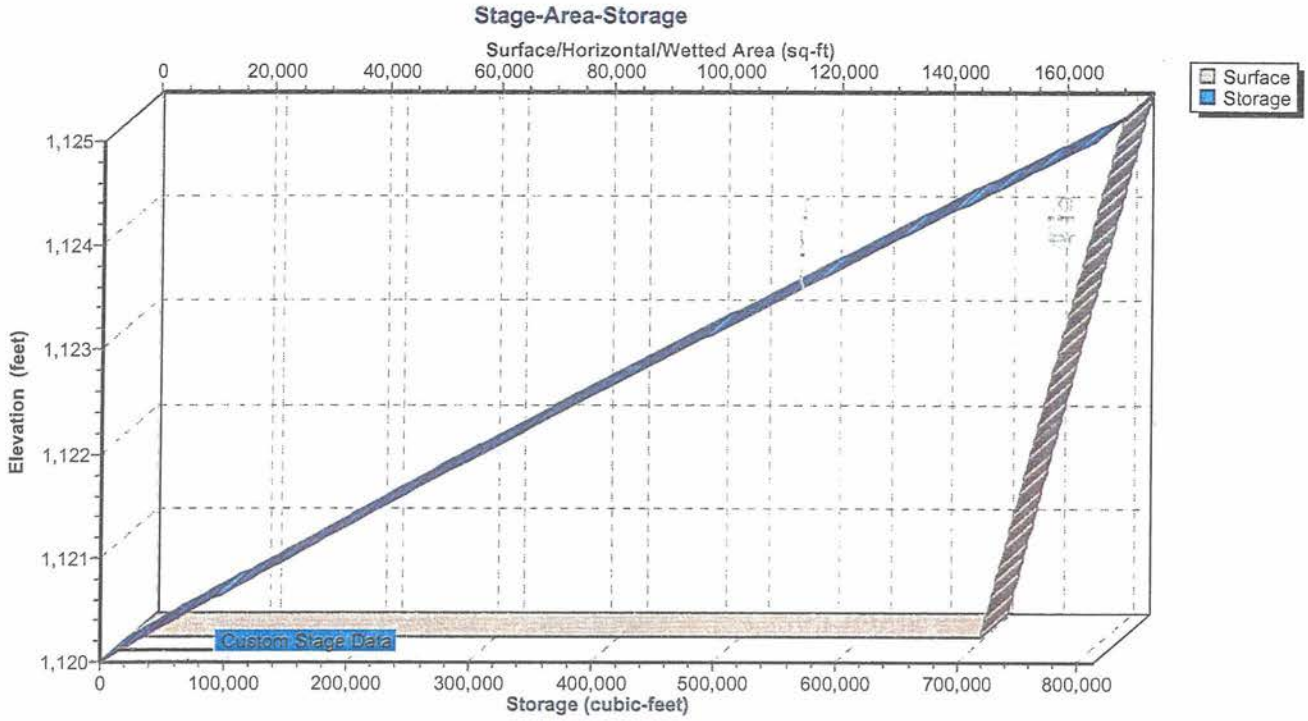
Pond 20P: Pond F.5



Pond 20P: Pond F.5



Pond 20P: Pond F.5

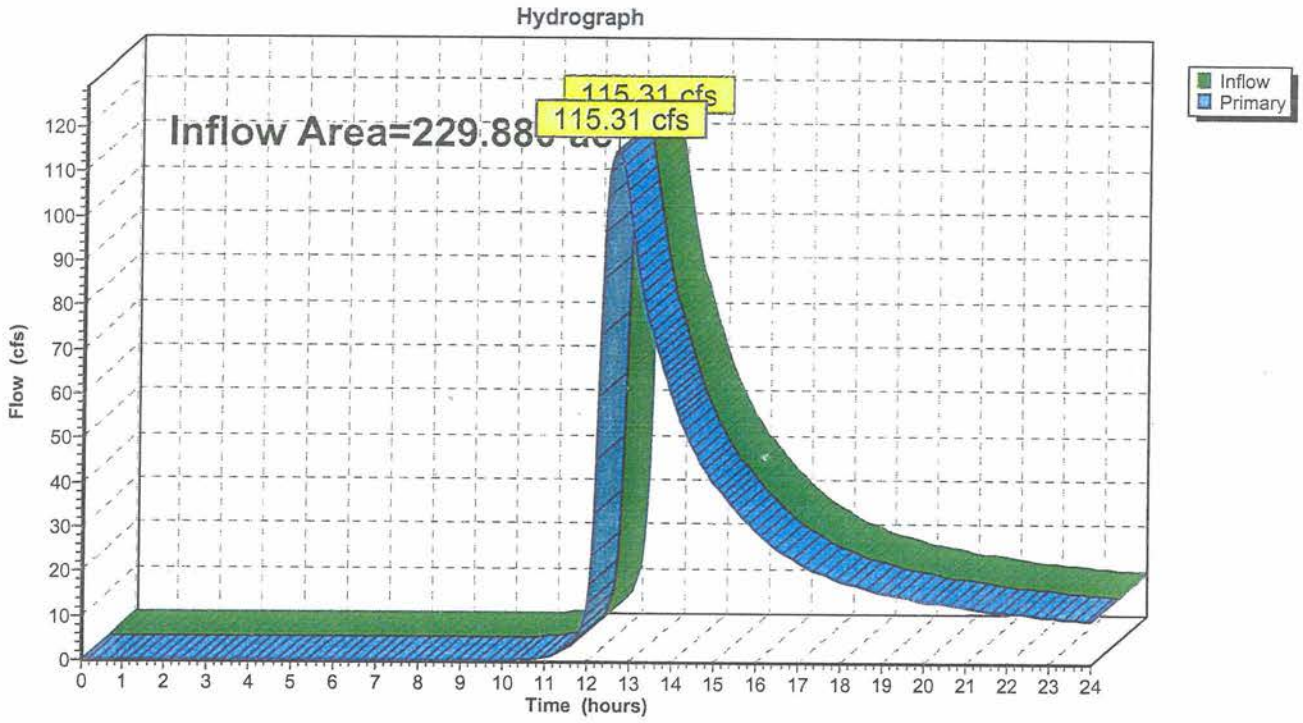


Summary for Link 15L: Proposed F

Inflow Area = 229.880 ac, 0.00% Impervious, Inflow Depth > 1.60" for 2-Year event
Inflow = 115.31 cfs @ 12.65 hrs, Volume= 30.708 af
Primary = 115.31 cfs @ 12.65 hrs, Volume= 30.708 af, Atten= 0%, Lag= 0.00 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Link 15L: Proposed F



Summary for Subcatchment 2S: Area F.4

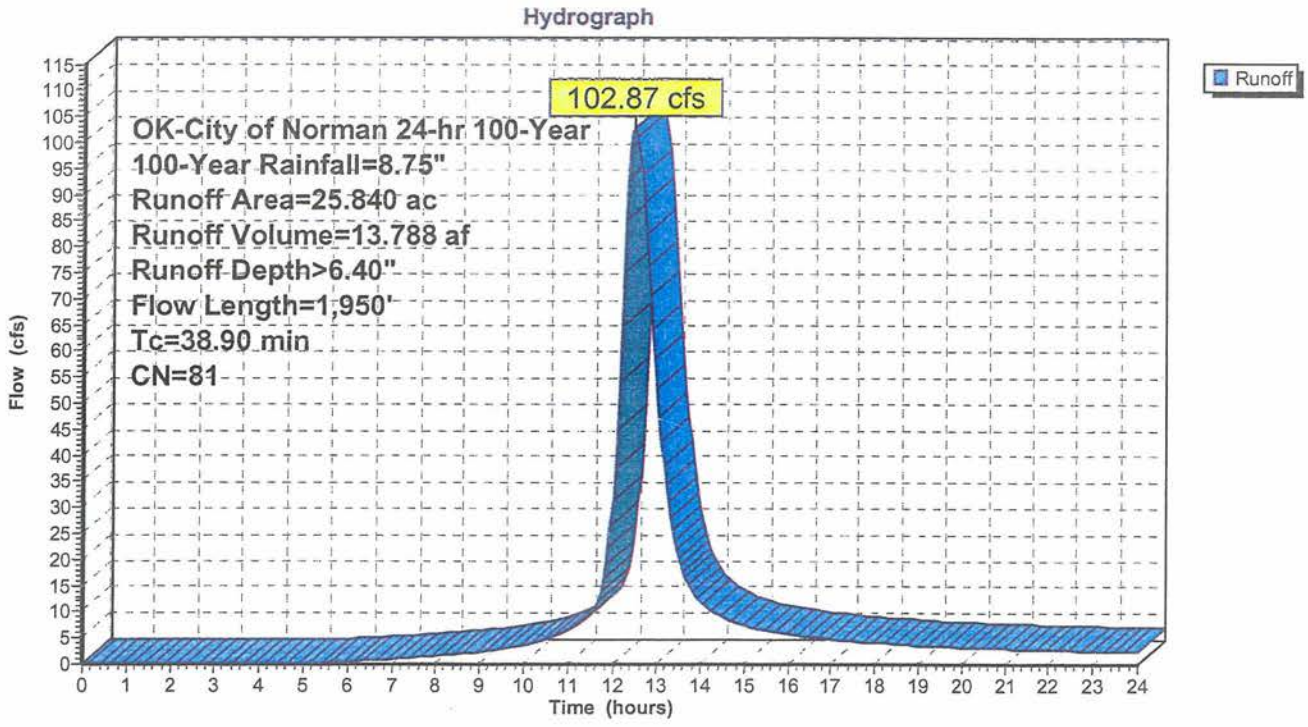
Runoff = 102.87 cfs @ 12.49 hrs, Volume= 13.788 af, Depth> 6.40"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
OK-City of Norman 24-hr 100-Year 100-Year Rainfall=8.75"

	Area (ac)	CN	Description
*	25.840	81	Offsite & developed
	25.840		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
26.70	100	0.0100	0.06		**Sheet Flow, Overland** Grass: Bermuda n= 0.410 P2= 3.75"
4.35	750	0.0200	2.87		**Shallow Concentrated Flow, Street** Paved Kv= 20.3 fps
7.85	1,100	0.0050	2.34	23.35	**Channel Flow, Ex. channel** Area= 10.0 sf Perim= 10.0' r= 1.00' n= 0.045
38.90	1,950	Total			

Subcatchment 2S: Area F.4



Summary for Subcatchment 7S: Area F.3

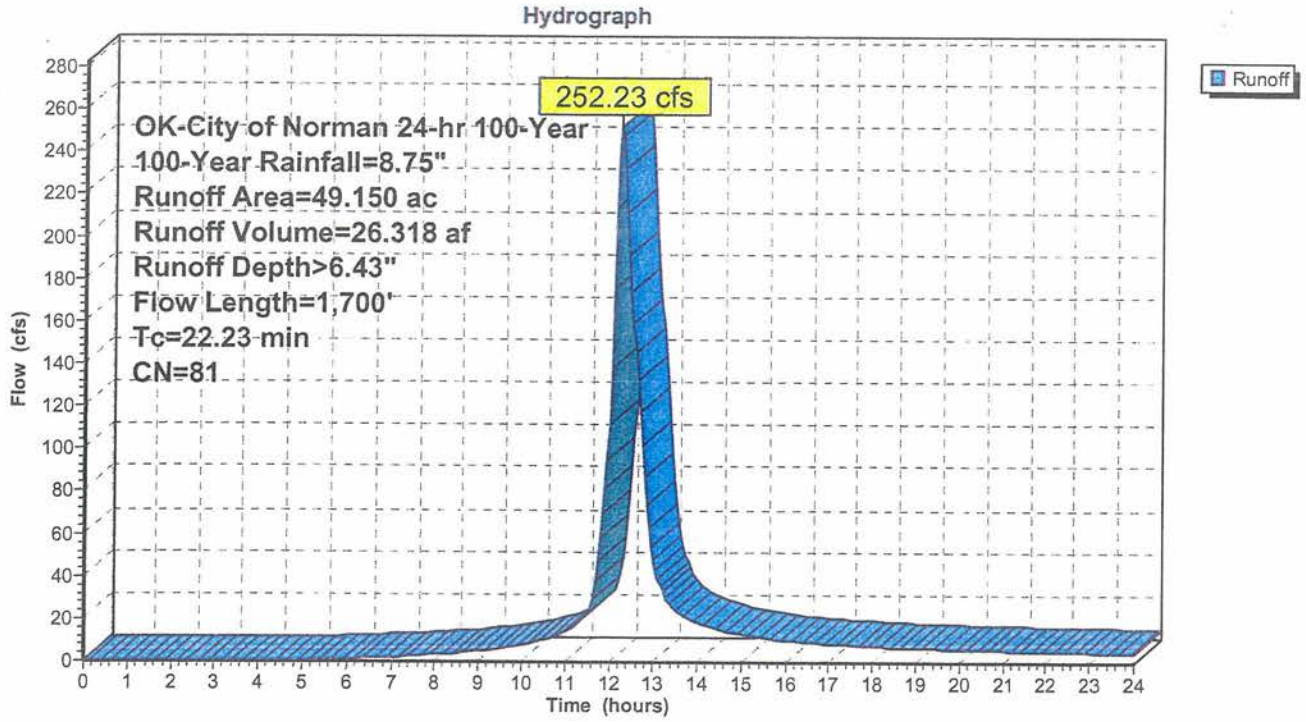
Runoff = 252.23 cfs @ 12.26 hrs, Volume= 26.318 af, Depth> 6.43"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
OK-City of Norman 24-hr 100-Year 100-Year Rainfall=8.75"

	Area (ac)	CN	Description
*	49.150	81	Developed
	49.150		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
15.33	50	0.0100	0.05		**Sheet Flow, Overland** Grass: Bermuda n= 0.410 P2= 3.75"
6.90	1,650	0.0250	3.98	39.85	**Channel Flow, Ex. channel** Area= 10.0 sf Perim= 15.0' r= 0.67' n= 0.045
22.23	1,700	Total			

Subcatchment 7S: Area F.3



Summary for Subcatchment 16S: Common Area

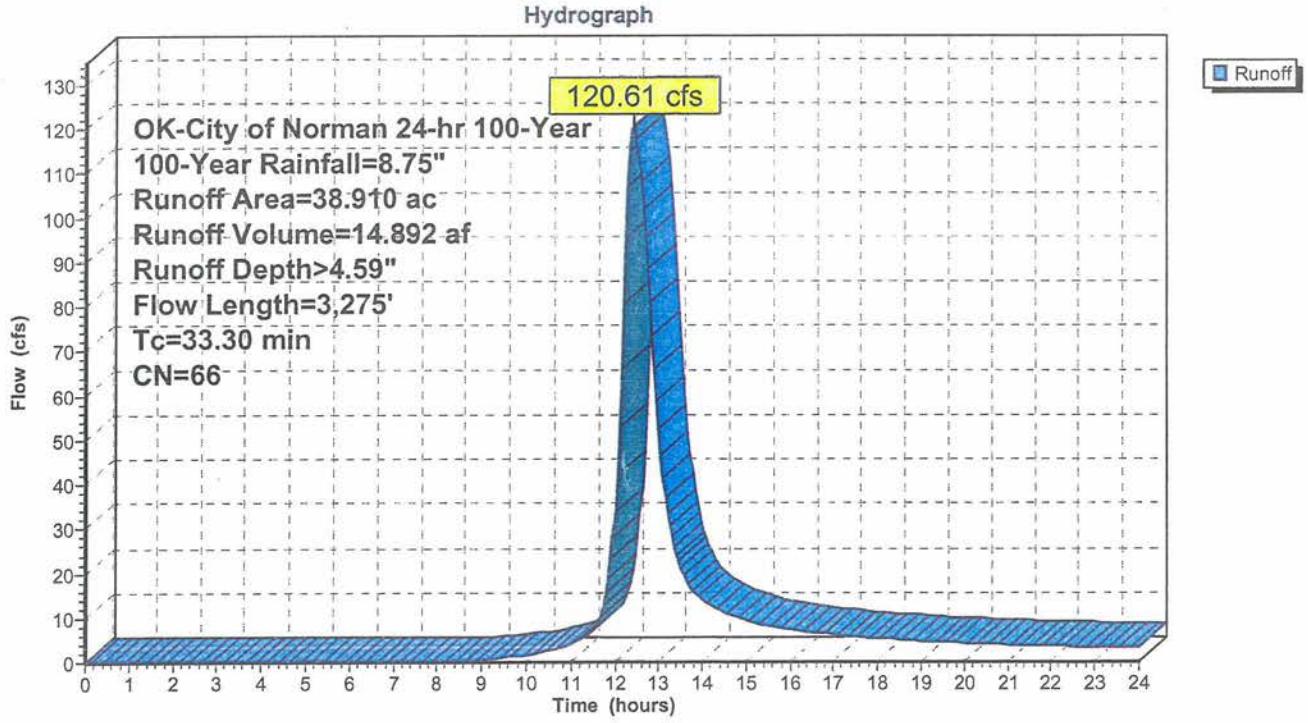
Runoff = 120.61 cfs @ 12.44 hrs, Volume= 14.892 af, Depth> 4.59"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
OK-City of Norman 24-hr 100-Year 100-Year Rainfall=8.75"

	Area (ac)	CN	Description
*	38.910	66	Developed
	38.910		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.05	100	0.0200	0.18		**Sheet Flow, Overland** Grass: Short n= 0.150 P2= 3.75"
24.25	3,175	0.0075	2.18	21.82	**Channel Flow, Ex. channel** Area= 10.0 sf Perim= 15.0' r= 0.67' n= 0.045
33.30	3,275	Total			

Subcatchment 16S: Common Area



Summary for Subcatchment 17S: Area F.1

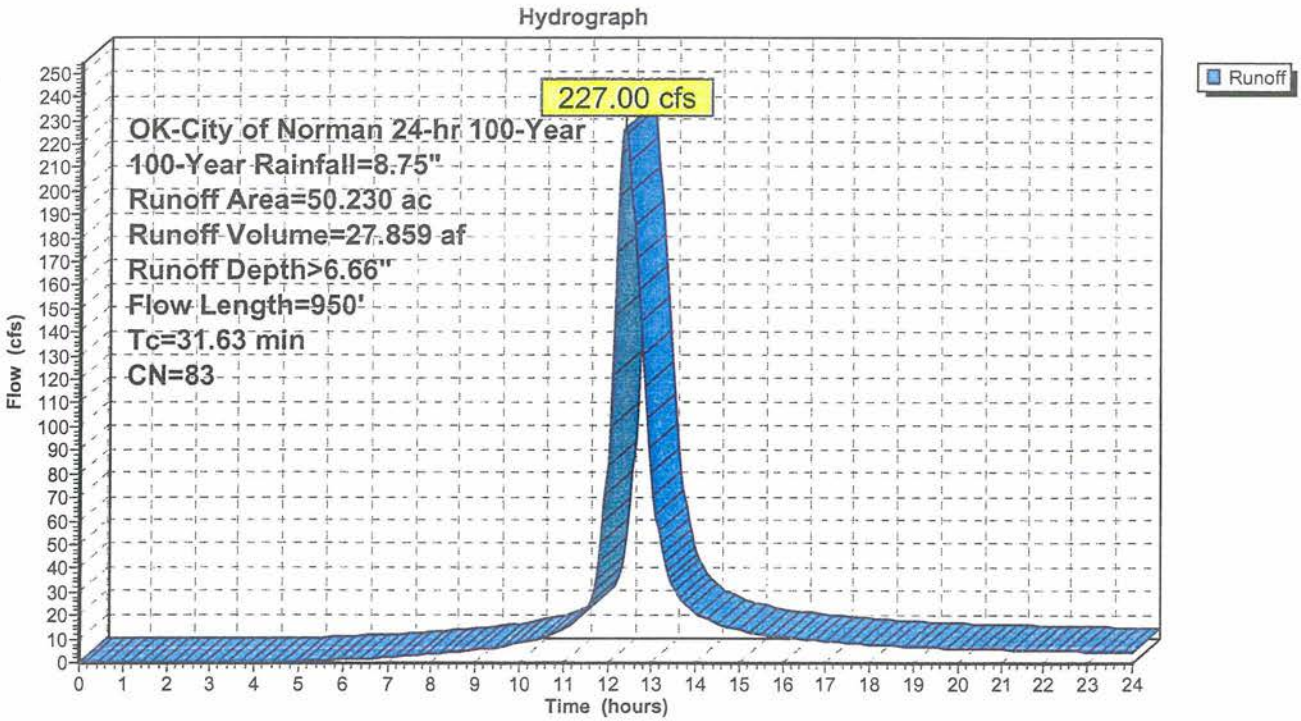
Runoff = 227.00 cfs @ 12.39 hrs, Volume= 27.859 af, Depth> 6.66"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
OK-City of Norman 24-hr 100-Year 100-Year Rainfall=8.75"

	Area (ac)	CN	Description
*	50.230	83	Developed
	50.230		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
26.70	100	0.0100	0.06		**Sheet Flow, Overland** Grass: Bermuda n= 0.410 P2= 3.75"
4.93	850	0.0200	2.87		**Shallow Concentrated Flow, Street** Paved Kv= 20.3 fps
31.63	950	Total			

Subcatchment 17S: Area F.1



Summary for Subcatchment 18S: Area F.2

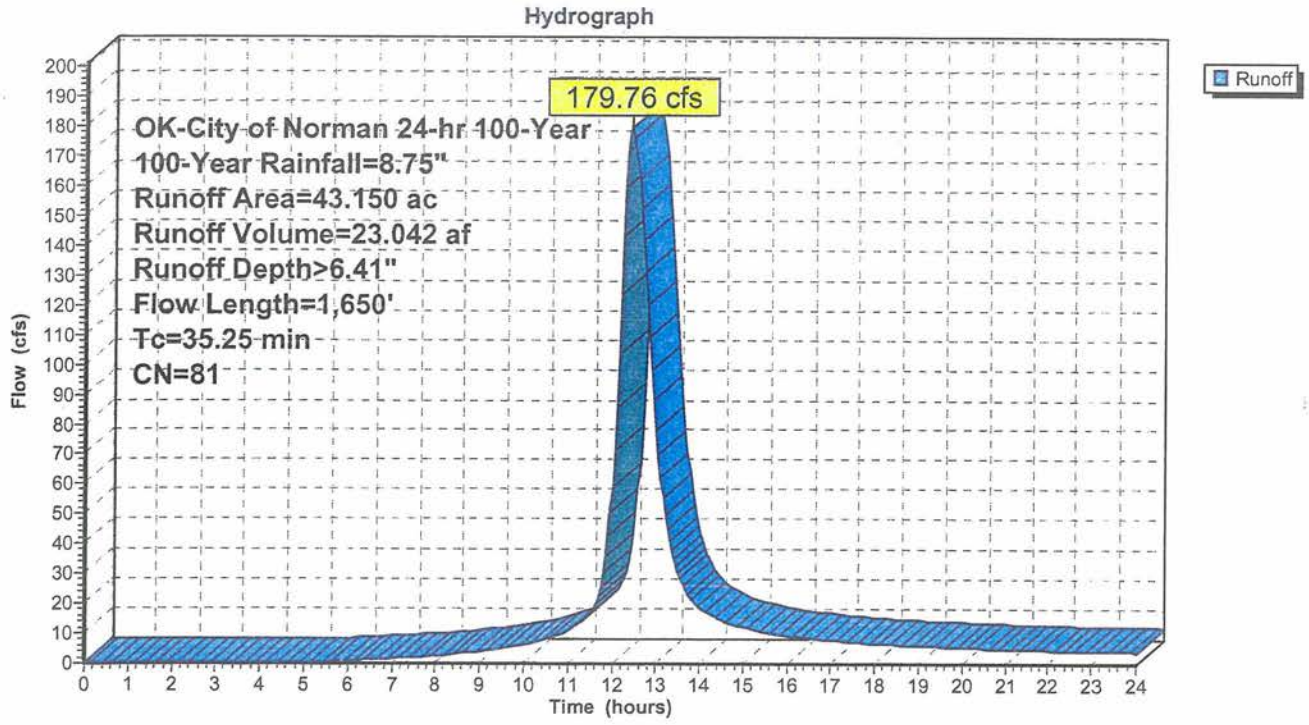
Runoff = 179.76 cfs @ 12.44 hrs, Volume= 23.042 af, Depth> 6.41"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
OK-City of Norman 24-hr 100-Year 100-Year Rainfall=8.75"

	Area (ac)	CN	Description
*	43.150	81	Developed
	43.150		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
26.70	100	0.0100	0.06		**Sheet Flow, Overland** Grass: Bermuda n= 0.410 P2= 3.75"
2.53	435	0.0200	2.87		**Shallow Concentrated Flow, Street** Paved Kv= 20.3 fps
6.02	1,115	0.0150	3.09	30.86	**Channel Flow, Ex. channel** Area= 10.0 sf Perim= 15.0' r= 0.67' n= 0.045
35.25	1,650	Total			

Subcatchment 18S: Area F.2



Summary for Subcatchment 19S: Area F.5

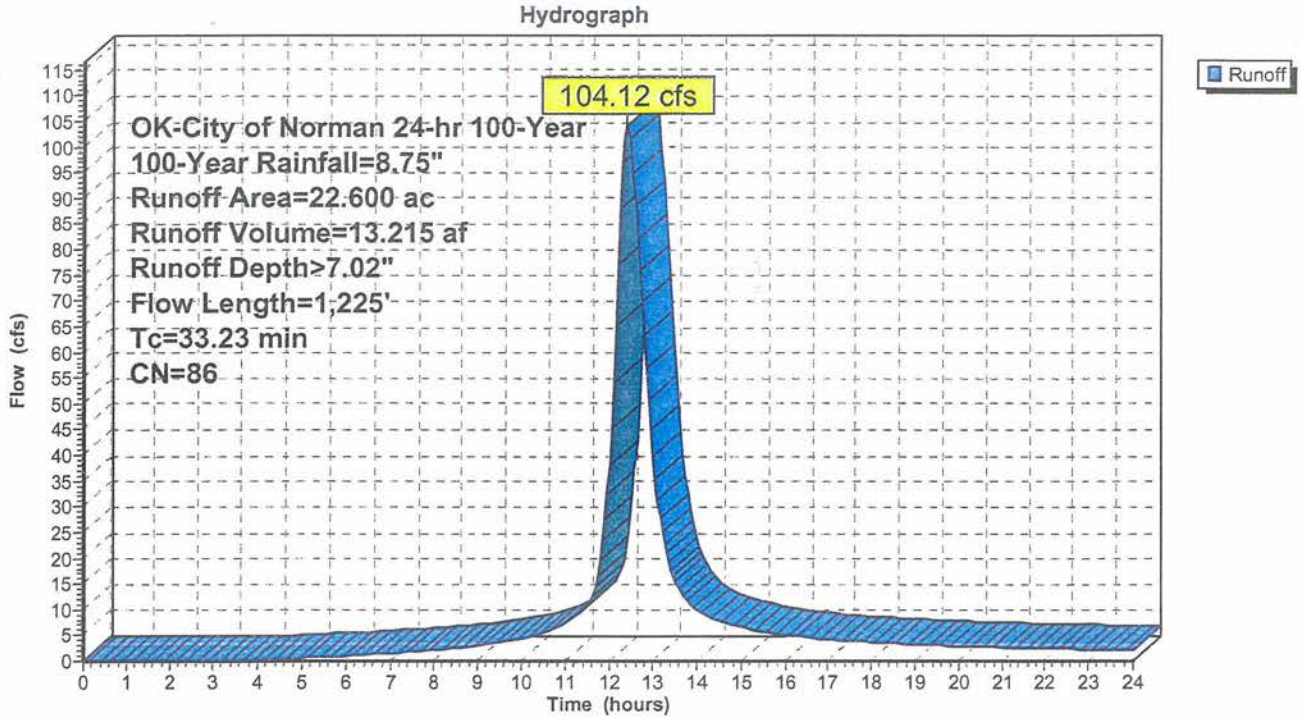
Runoff = 104.12 cfs @ 12.41 hrs, Volume= 13.215 af, Depth> 7.02"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
OK-City of Norman 24-hr 100-Year 100-Year Rainfall=8.75"

	Area (ac)	CN	Description
*	22.600	86	Developed
	22.600		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
26.70	100	0.0100	0.06		**Sheet Flow, Overland** Grass: Bermuda n= 0.410 P2= 3.75"
6.53	1,125	0.0200	2.87		**Shallow Concentrated Flow, Street** Paved Kv= 20.3 fps
33.23	1,225	Total			

Subcatchment 19S: Area F.5



Summary for Pond 3P: Pond F.4

Inflow Area = 25.840 ac, 0.00% Impervious, Inflow Depth > 6.40" for 100-Year event
Inflow = 102.87 cfs @ 12.49 hrs, Volume= 13.788 af
Outflow = 14.75 cfs @ 13.76 hrs, Volume= 11.262 af, Atten= 86%, Lag= 75.96 min
Primary = 14.75 cfs @ 13.76 hrs, Volume= 11.262 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 1,118.75' @ 13.76 hrs Surf.Area= 107,026 sf Storage= 351,007 cf

Plug-Flow detention time= 284.10 min calculated for 11.239 af (82% of inflow)
Center-of-Mass det. time= 213.36 min (1,036.25 - 822.89)

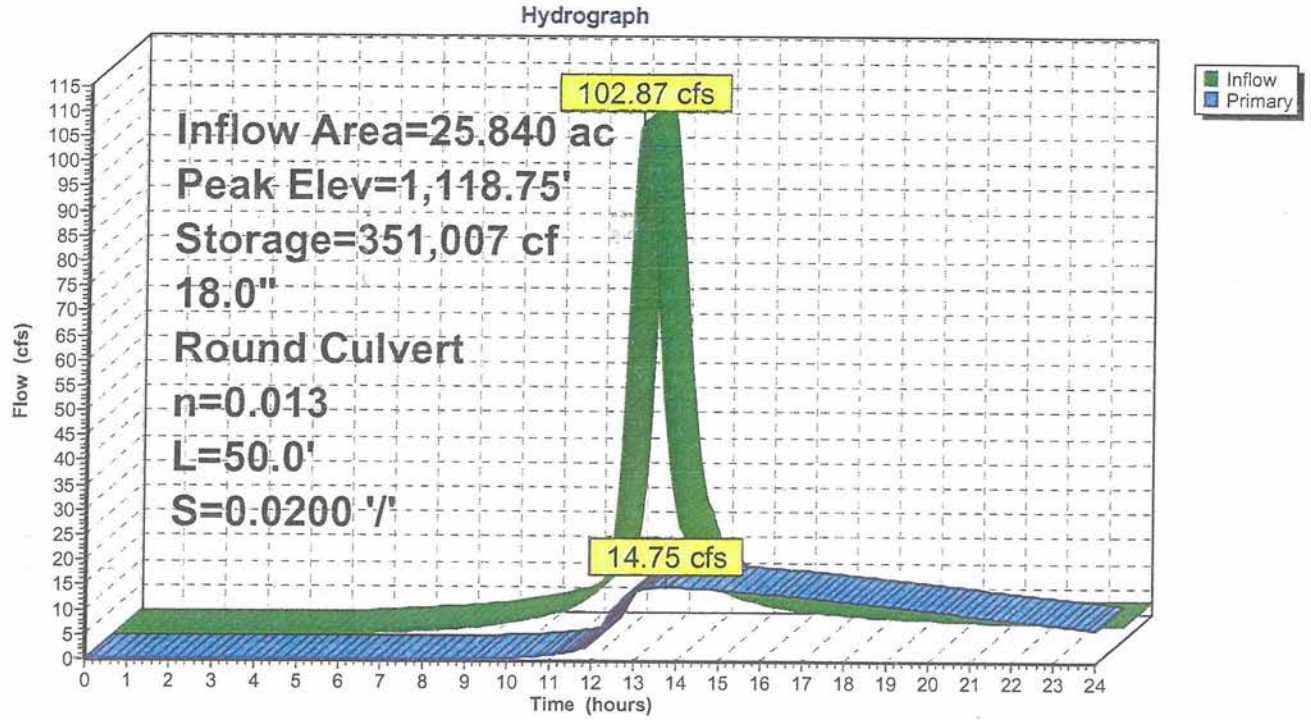
Volume	Invert	Avail.Storage	Storage Description
#1	1,115.00'	490,000 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
1,115.00	80,000	0	0
1,120.00	116,000	490,000	490,000

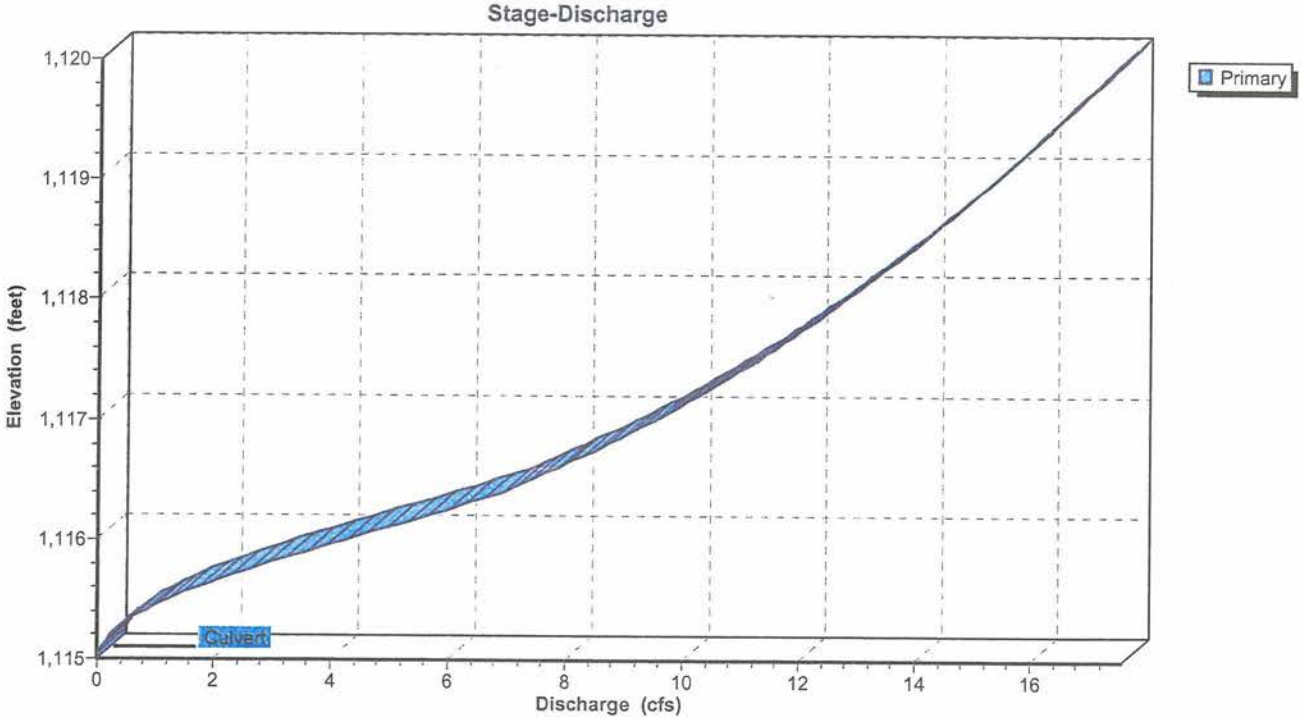
Device	Routing	Invert	Outlet Devices
#1	Primary	1,115.00'	**18.0" Round Culvert** L= 50.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 1,115.00' / 1,114.00' S= 0.0200 '/' Cc= 0.900 n= 0.013, Flow Area= 1.77 sf

Primary OutFlow Max=14.75 cfs @ 13.76 hrs HW=1,118.75' (Free Discharge)
↑**1=Culvert** (Inlet Controls 14.75 cfs @ 8.34 fps)

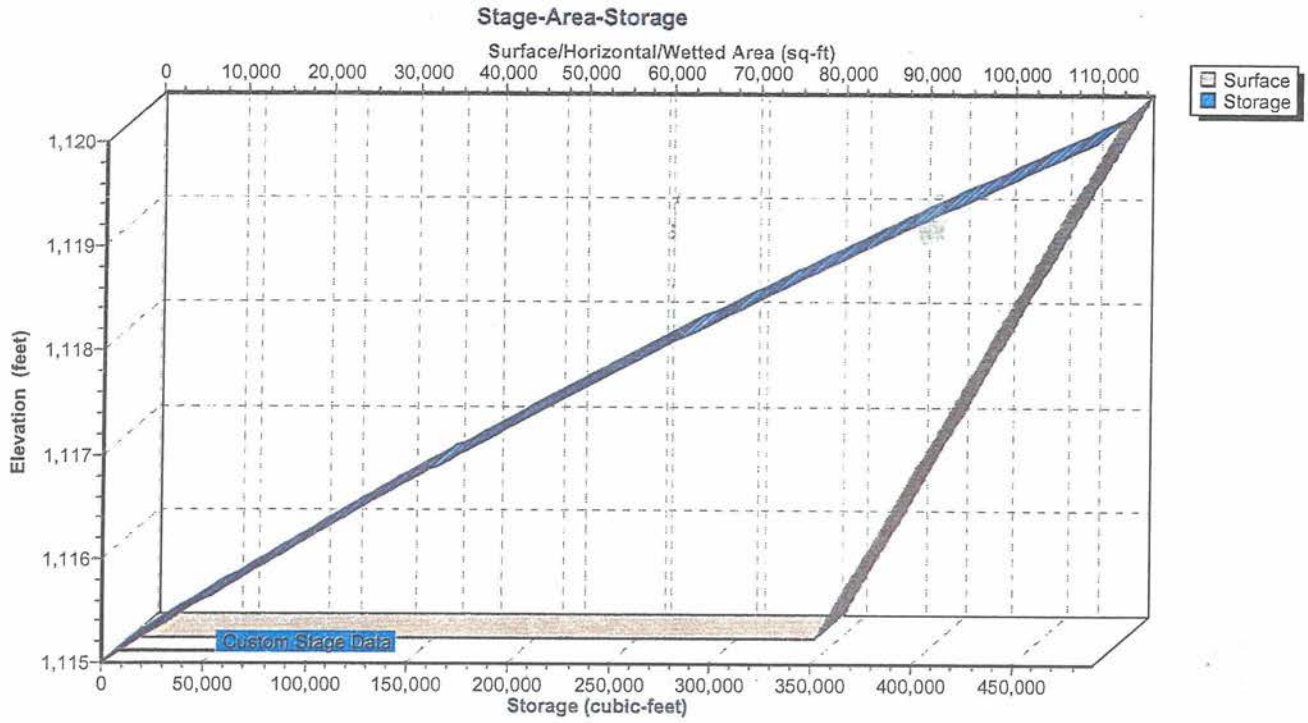
Pond 3P: Pond F.4



Pond 3P: Pond F.4



Pond 3P: Pond F.4



Summary for Pond 8P: Pond F.3

Inflow Area = 49.150 ac, 0.00% Impervious, Inflow Depth > 6.43" for 100-Year event
Inflow = 252.23 cfs @ 12.26 hrs, Volume= 26.318 af
Outflow = 116.95 cfs @ 12.70 hrs, Volume= 25.864 af, Atten= 54%, Lag= 26.46 min
Primary = 116.95 cfs @ 12.70 hrs, Volume= 25.864 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 1,133.12' @ 12.70 hrs Surf.Area= 54,243 sf Storage= 321,851 cf

Plug-Flow detention time= 43.78 min calculated for 25.864 af (98% of inflow)
Center-of-Mass det. time= 33.43 min (843.10 - 809.67)

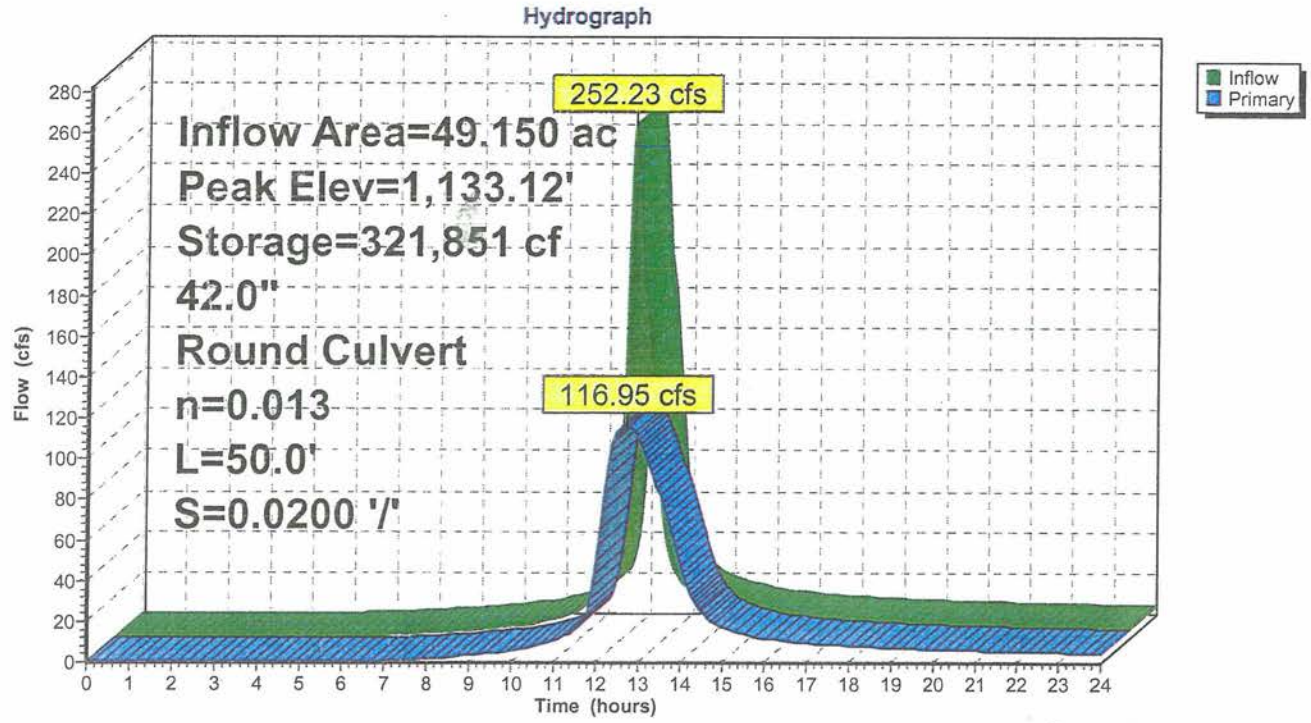
Volume	Invert	Avail.Storage	Storage Description
#1	1,125.00'	430,000 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
1,125.00	25,000	0	0
1,135.00	61,000	430,000	430,000

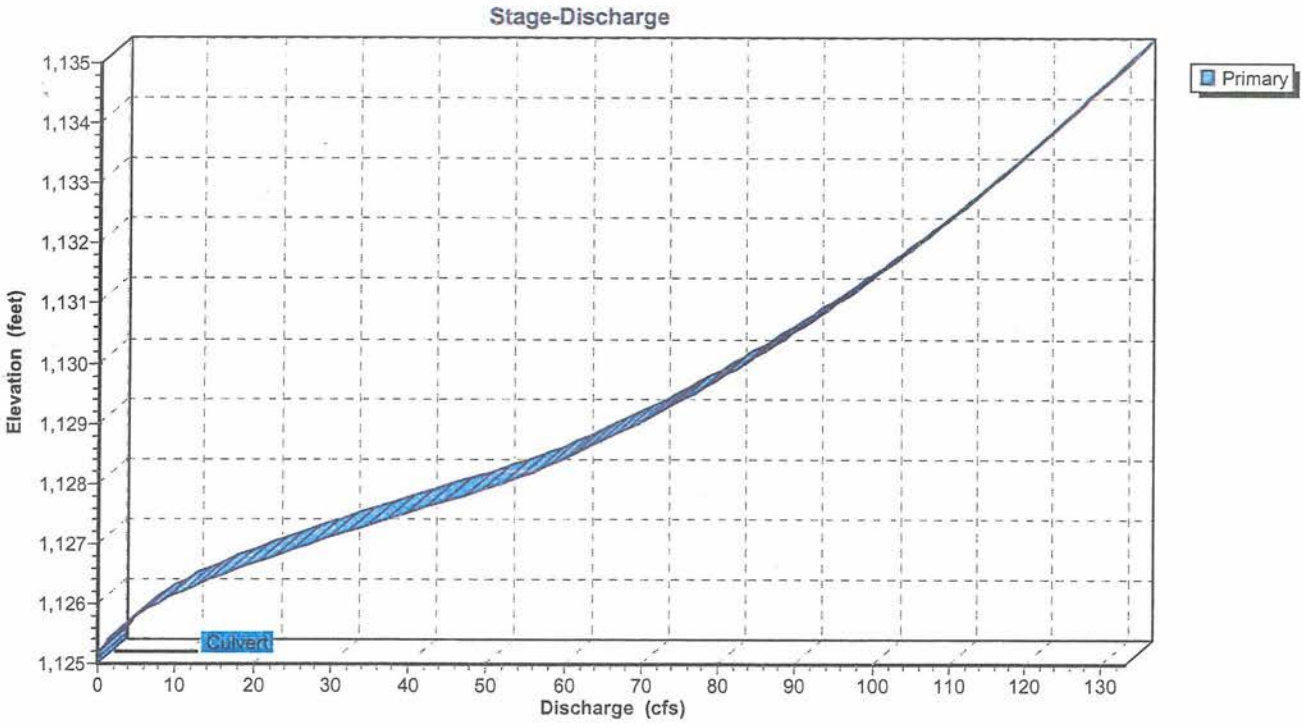
Device	Routing	Invert	Outlet Devices
#1	Primary	1,125.00'	**42.0" Round Culvert** L= 50.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 1,125.00' / 1,124.00' S= 0.0200 '/' Cc= 0.900 n= 0.013, Flow Area= 9.62 sf

Primary OutFlow Max=116.94 cfs @ 12.70 hrs HW=1,133.12' (Free Discharge)
1=Culvert (Inlet Controls 116.94 cfs @ 12.15 fps)

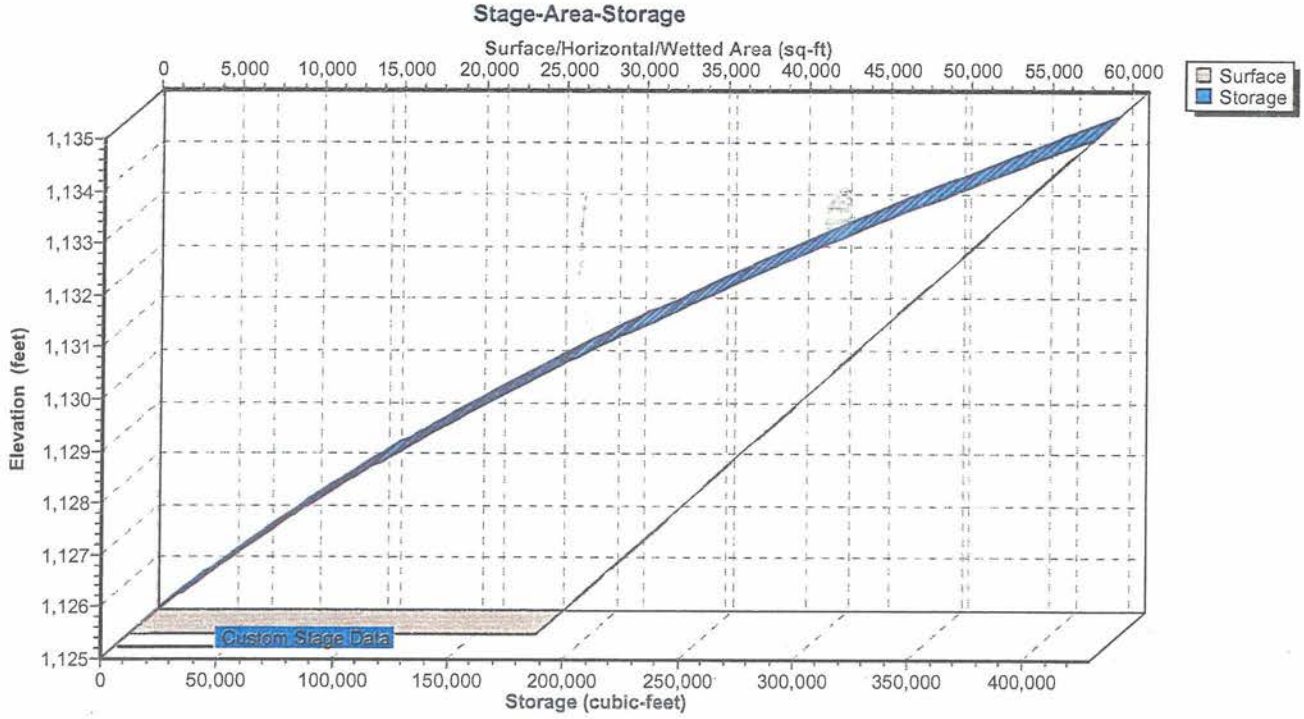
Pond 8P: Pond F.3



Pond 8P: Pond F.3



Pond 8P: Pond F.3



Summary for Pond 10P: Pond F.2

Inflow Area = 93.380 ac, 0.00% Impervious, Inflow Depth > 6.44" for 100-Year event
Inflow = 216.26 cfs @ 12.46 hrs, Volume= 50.130 af
Outflow = 99.51 cfs @ 13.16 hrs, Volume= 49.407 af, Atten= 54%, Lag= 41.59 min
Primary = 99.51 cfs @ 13.16 hrs, Volume= 49.407 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 1,134.05' @ 13.16 hrs Surf.Area= 57,888 sf Storage= 416,472 cf

Plug-Flow detention time= 50.57 min calculated for 49.407 af (99% of inflow)
Center-of-Mass det. time= 42.96 min (929.95 - 886.99)

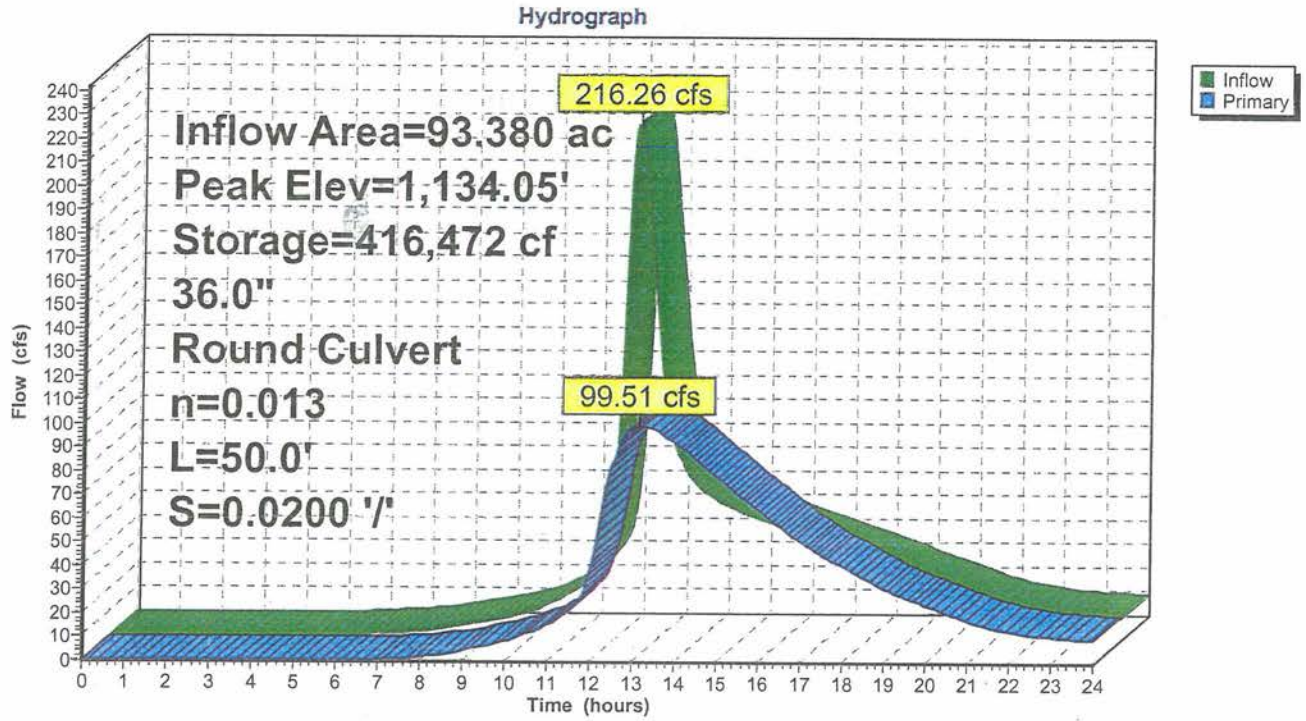
Volume	Invert	Avail.Storage	Storage Description
#1	1,124.00'	473,000 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
1,124.00	25,000	0	0
1,135.00	61,000	473,000	473,000

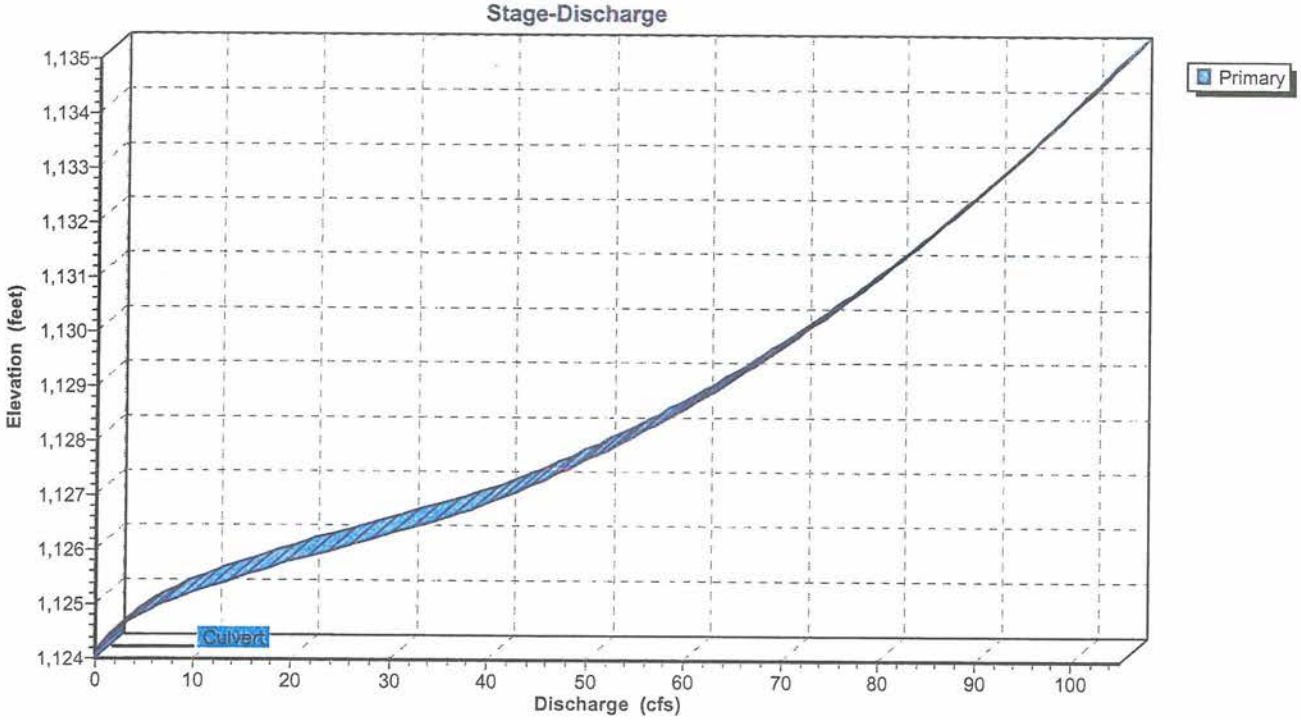
Device	Routing	Invert	Outlet Devices
#1	Primary	1,124.00'	**36.0" Round Culvert** L= 50.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 1,124.00' / 1,123.00' S= 0.0200 '/' Cc= 0.900 n= 0.013, Flow Area= 7.07 sf

Primary OutFlow Max=99.51 cfs @ 13.16 hrs HW=1,134.05' (Free Discharge)
↑—**1=Culvert** (Inlet Controls 99.51 cfs @ 14.08 fps)

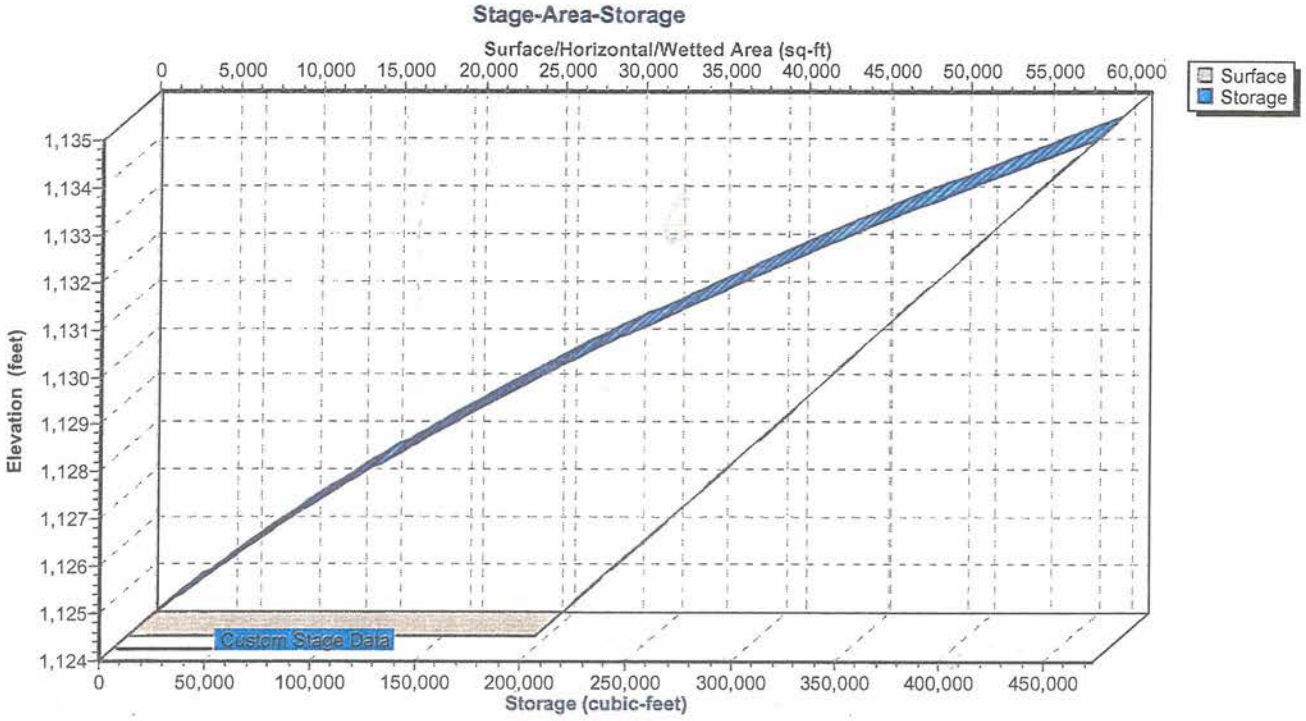
Pond 10P: Pond F.2



Pond 10P: Pond F.2



Pond 10P: Pond F.2



Summary for Pond 18P: Pond F.1

Inflow Area = 50.230 ac, 0.00% Impervious, Inflow Depth > 6.66" for 100-Year event
Inflow = 227.00 cfs @ 12.39 hrs, Volume= 27.859 af
Outflow = 44.82 cfs @ 13.27 hrs, Volume= 27.088 af, Atten= 80%, Lag= 52.65 min
Primary = 44.82 cfs @ 13.27 hrs, Volume= 27.088 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 1,163.78' @ 13.27 hrs Surf.Area= 85,676 sf Storage= 575,471 cf

Plug-Flow detention time= 147.61 min calculated for 27.088 af (97% of inflow)
Center-of-Mass det. time= 131.51 min (943.95 - 812.45)

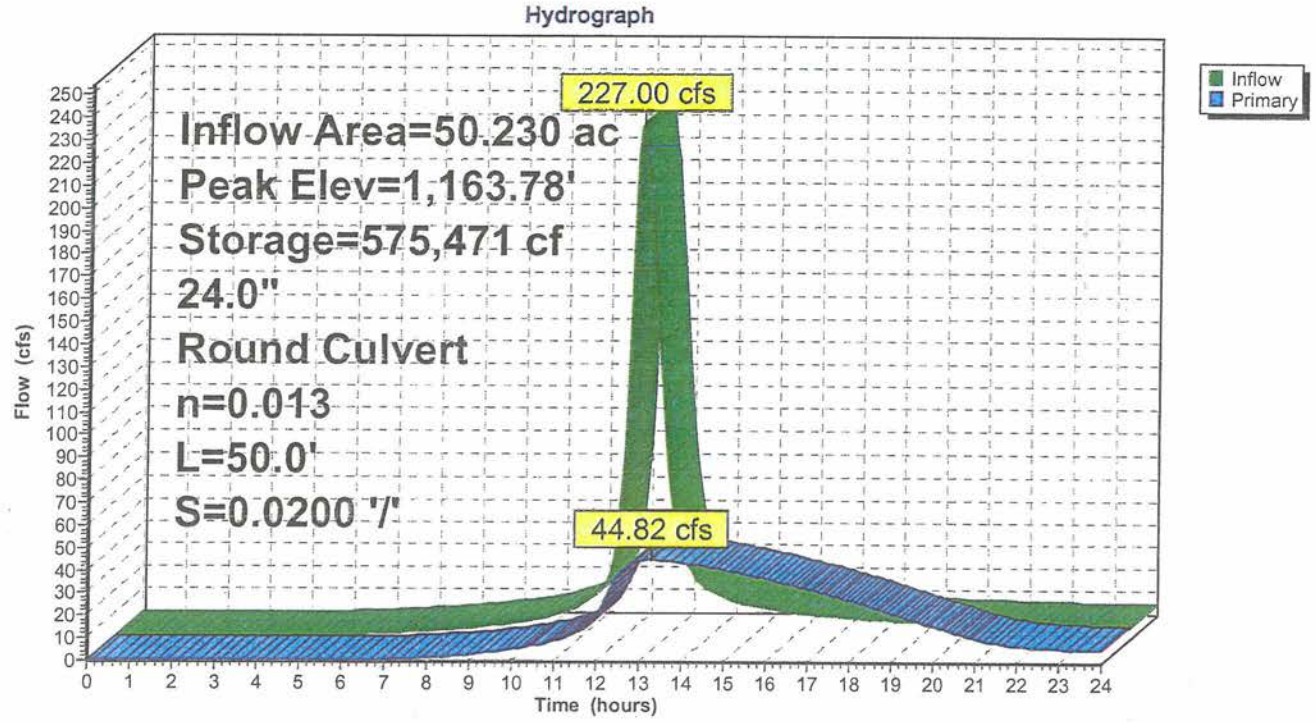
Volume	Invert	Avail.Storage	Storage Description
#1	1,154.00'	684,024 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
1,154.00	32,000	0	0
1,165.00	92,368	684,024	684,024

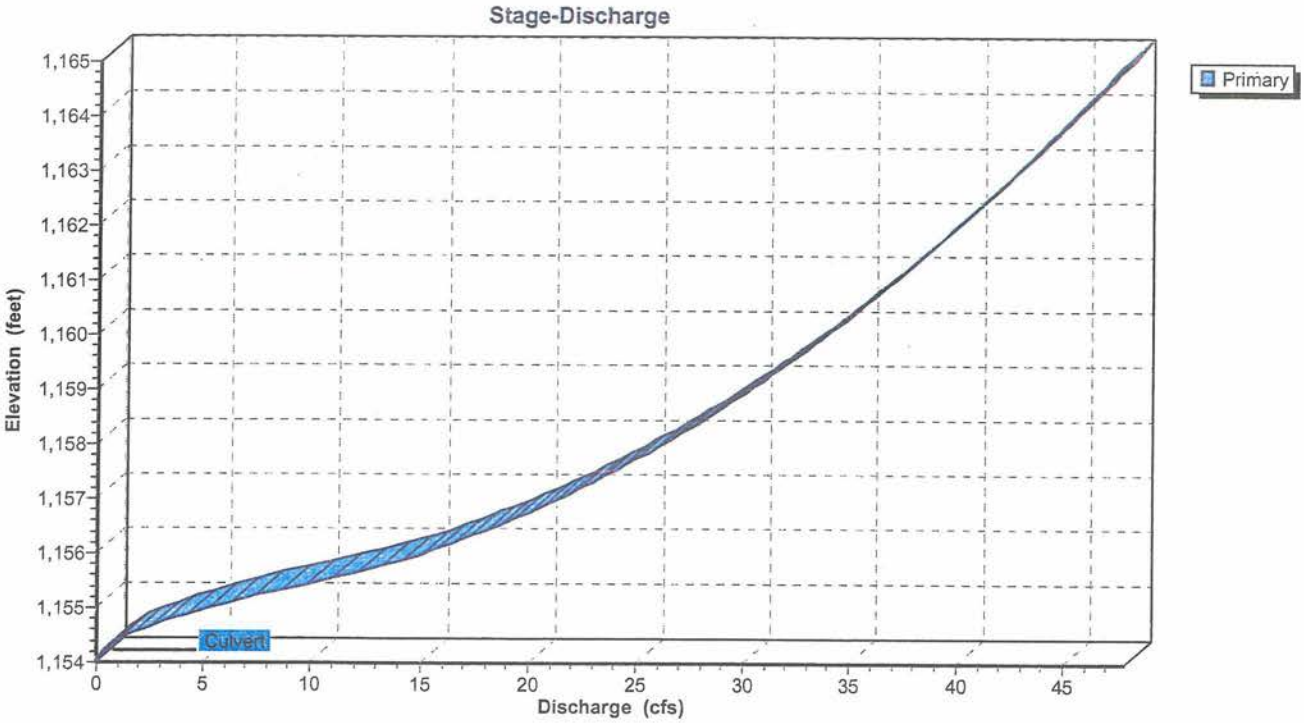
Device	Routing	Invert	Outlet Devices
#1	Primary	1,154.00'	**24.0" Round Culvert** L= 50.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 1,154.00' / 1,153.00' S= 0.0200 '/' Cc= 0.900 n= 0.013, Flow Area= 3.14 sf

Primary OutFlow Max=44.82 cfs @ 13.27 hrs HW=1,163.78' (Free Discharge)
↑**1=Culvert** (Inlet Controls 44.82 cfs @ 14.27 fps)

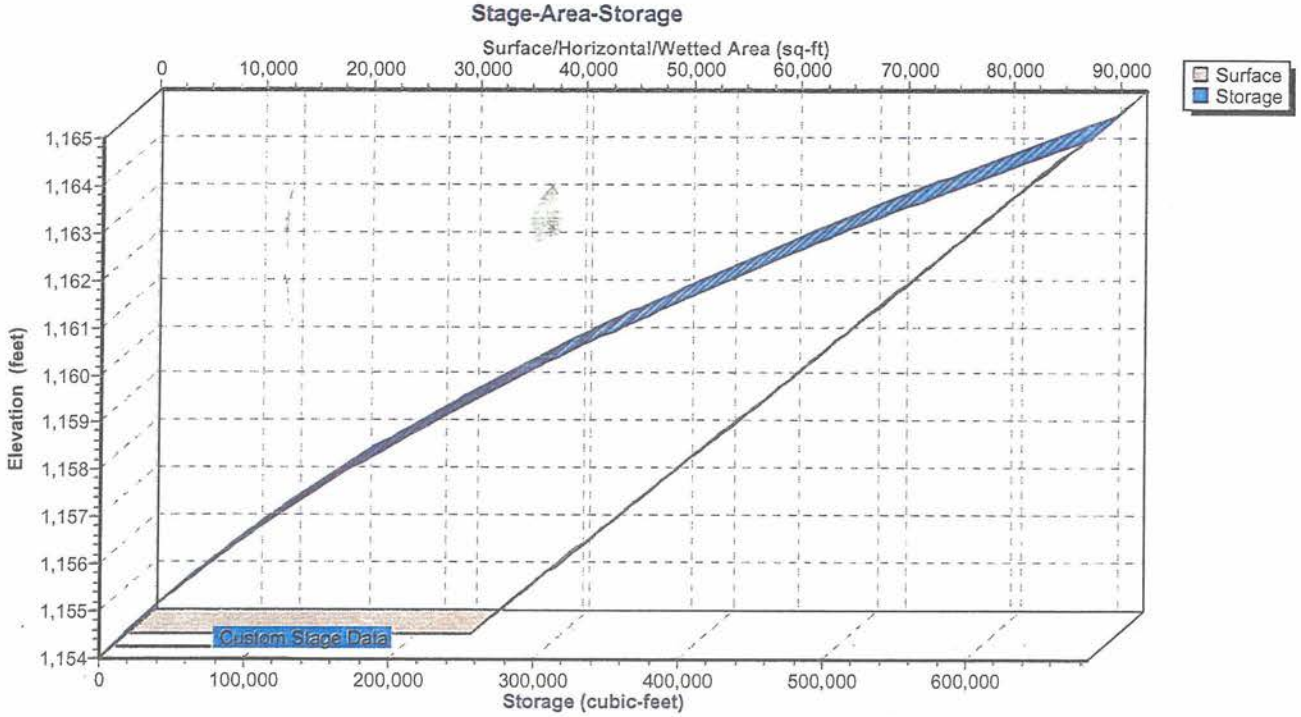
Pond 18P: Pond F.1



Pond 18P: Pond F.1



Pond 18P: Pond F.1



Summary for Pond 20P: Pond F.5

Inflow Area = 22.600 ac, 0.00% Impervious, Inflow Depth > 7.02" for 100-Year event
Inflow = 104.12 cfs @ 12.41 hrs, Volume= 13.215 af
Outflow = 22.05 cfs @ 13.27 hrs, Volume= 10.513 af, Atten= 79%, Lag= 51.40 min
Primary = 22.05 cfs @ 13.27 hrs, Volume= 10.513 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 1,122.12' @ 13.27 hrs Surf.Area= 160,616 sf Storage= 329,764 cf

Plug-Flow detention time= 247.60 min calculated for 10.491 af (79% of inflow)
Center-of-Mass det. time= 172.86 min (979.04 - 806.18)

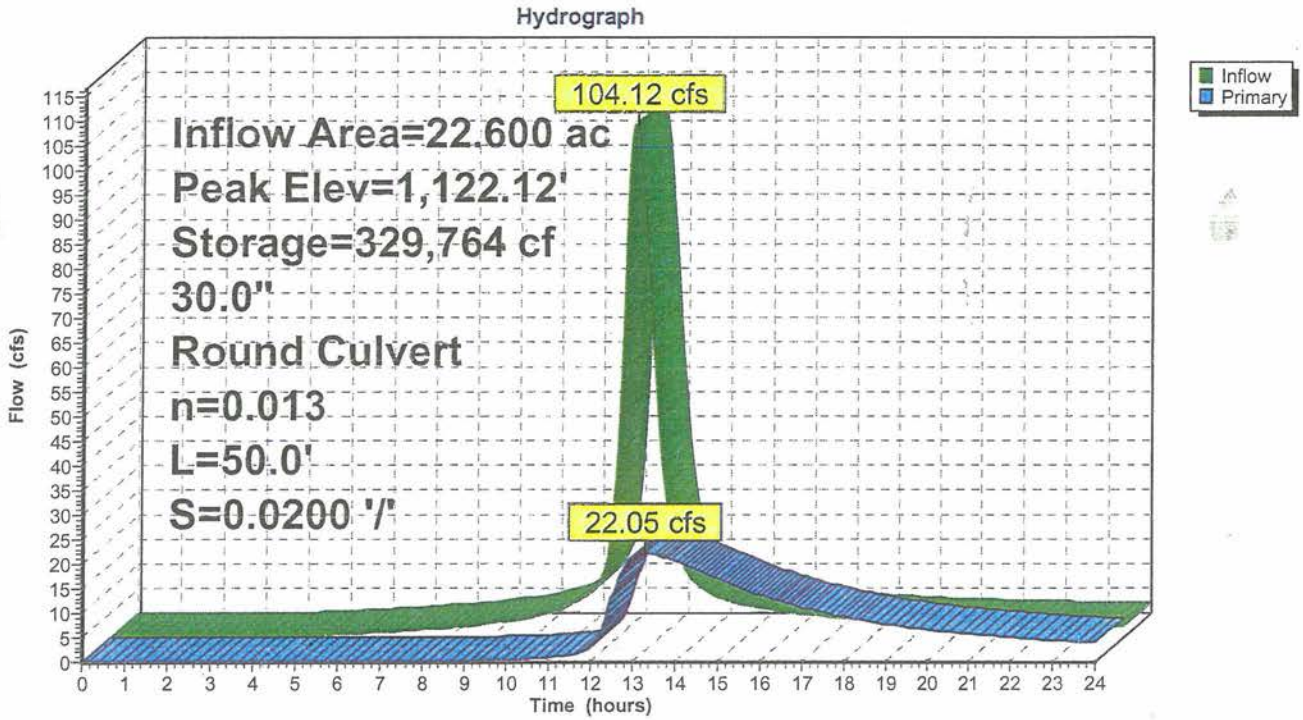
Volume	Invert	Avail.Storage	Storage Description
#1	1,120.00'	812,500 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
1,120.00	150,000	0	0
1,125.00	175,000	812,500	812,500

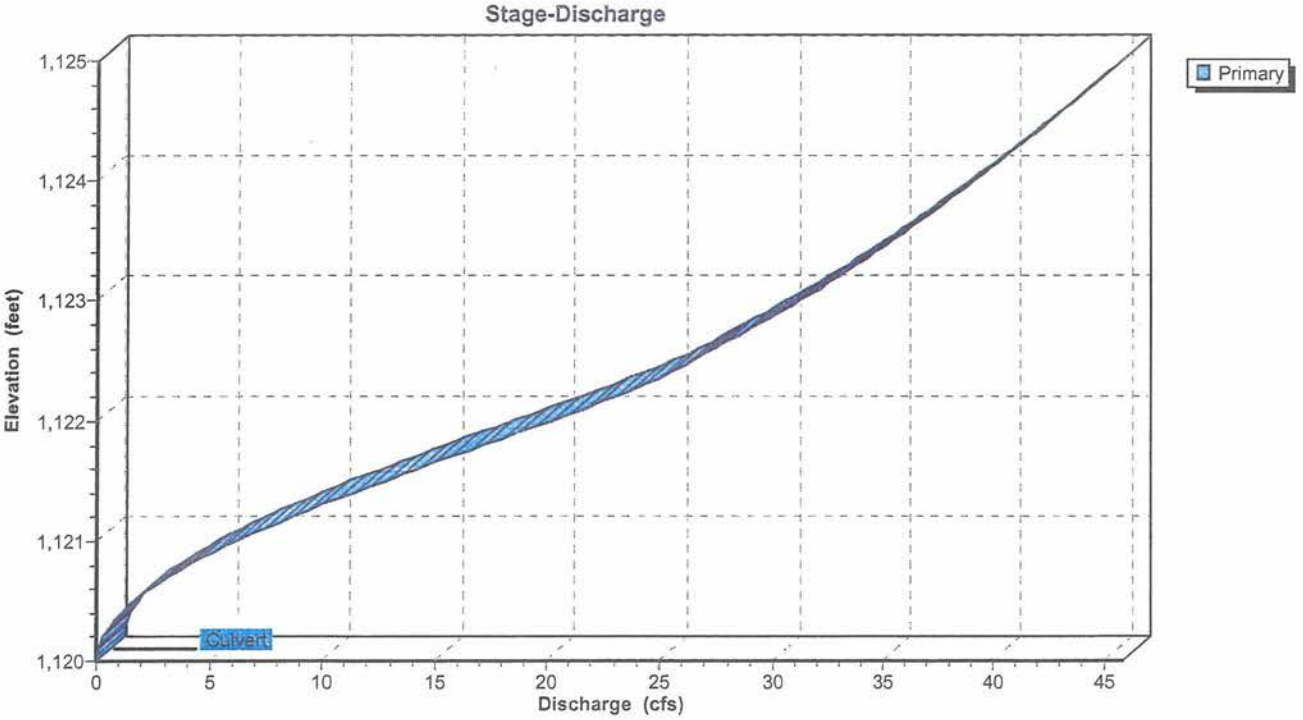
Device	Routing	Invert	Outlet Devices
#1	Primary	1,120.00'	**30.0" Round Culvert** L= 50.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 1,120.00' / 1,119.00' S= 0.0200 '/' Cc= 0.900 n= 0.013, Flow Area= 4.91 sf

Primary OutFlow Max=22.04 cfs @ 13.27 hrs HW=1,122.12' (Free Discharge)
↑**1=Culvert** (Inlet Controls 22.04 cfs @ 4.96 fps)

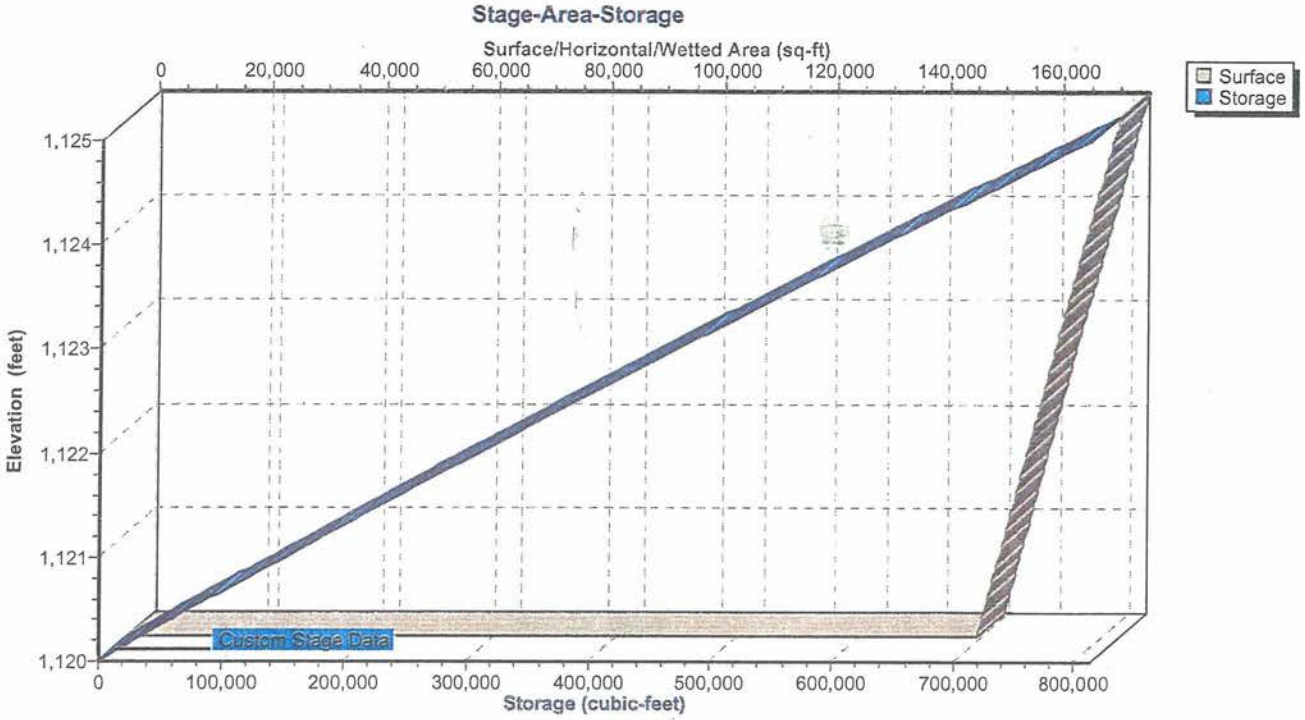
Pond 20P: Pond F.5



Pond 20P: Pond F.5



Pond 20P: Pond F.5

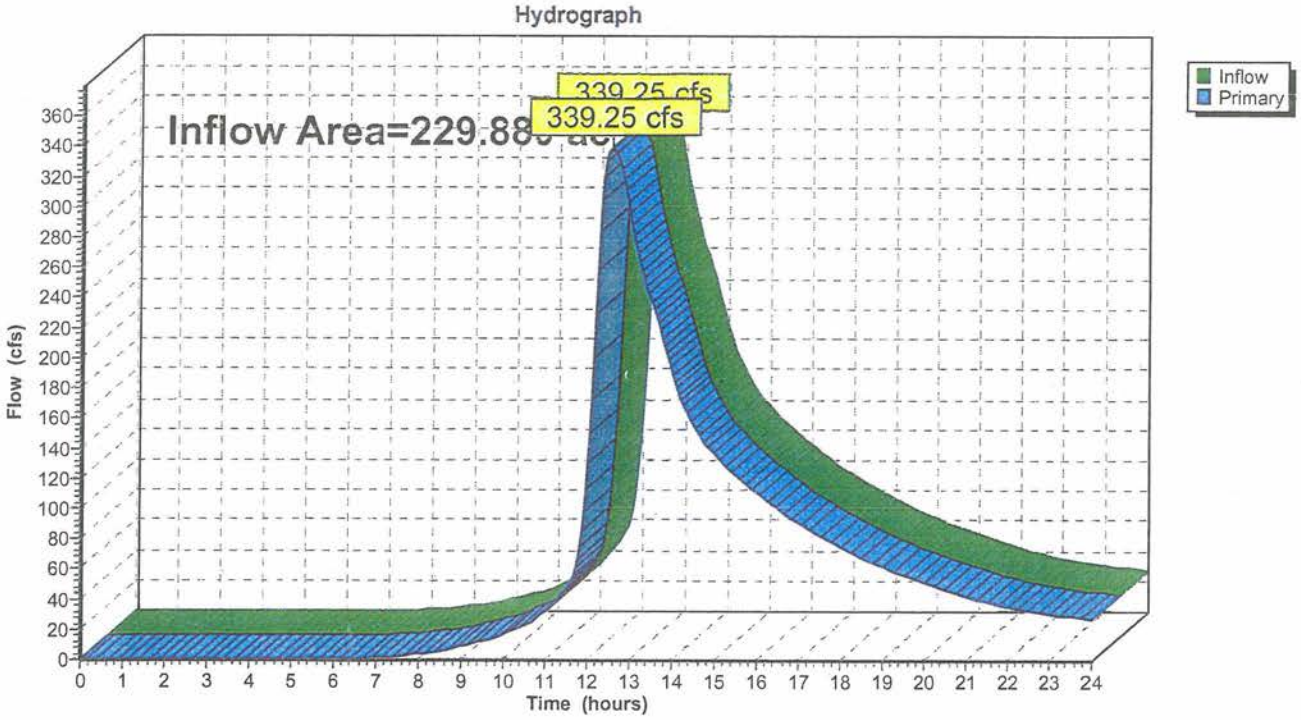


Summary for Link 15L: Proposed F

Inflow Area = 229.880 ac, 0.00% Impervious, Inflow Depth > 5.84" for 100-Year event
Inflow = 339.25 cfs @ 12.57 hrs, Volume= 111.938 af
Primary = 339.25 cfs @ 12.57 hrs, Volume= 111.938 af, Atten= 0%, Lag= 0.00 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Link 15L: Proposed F



Summary for Subcatchment 1S: Historic Area G

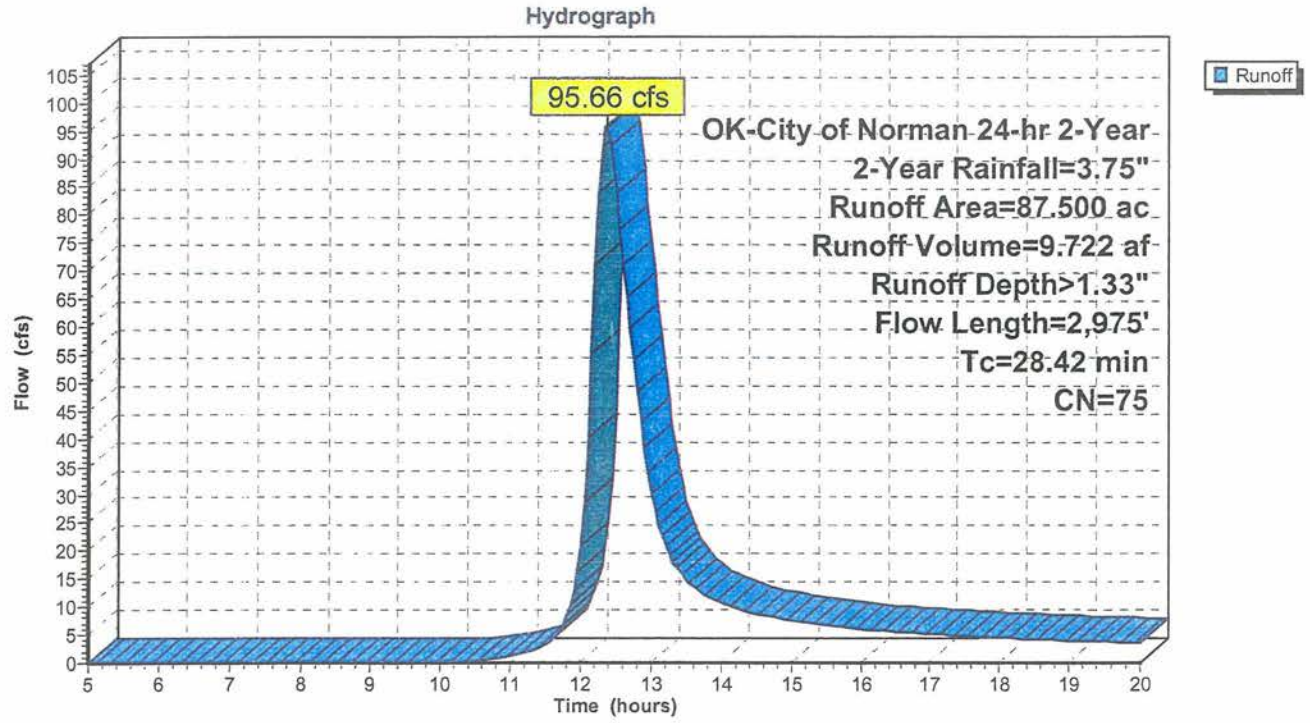
Runoff = 95.66 cfs @ 12.36 hrs, Volume= 9.722 af, Depth> 1.33"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
OK-City of Norman 24-hr 2-Year 2-Year Rainfall=3.75"

	Area (ac)	CN	Description
*	42.300	71	Type C soil
*	45.200	78	Type D soil
	87.500	75	Weighted Average
	87.500		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
13.85	300	0.0467	0.36		**Sheet Flow, Overland flow** Range n= 0.130 P2= 3.75"
1.98	255	0.0940	2.15		**Shallow Concentrated Flow, Swale** Short Grass Pasture Kv= 7.0 fps
12.59	2,420	0.0186	3.20	48.06	**Channel Flow, Creek** Area= 15.0 sf Perim= 25.0' r= 0.60' n= 0.045
28.42	2,975	Total			

Subcatchment 1S: Historic Area G



Summary for Subcatchment 1S: Historic Area G

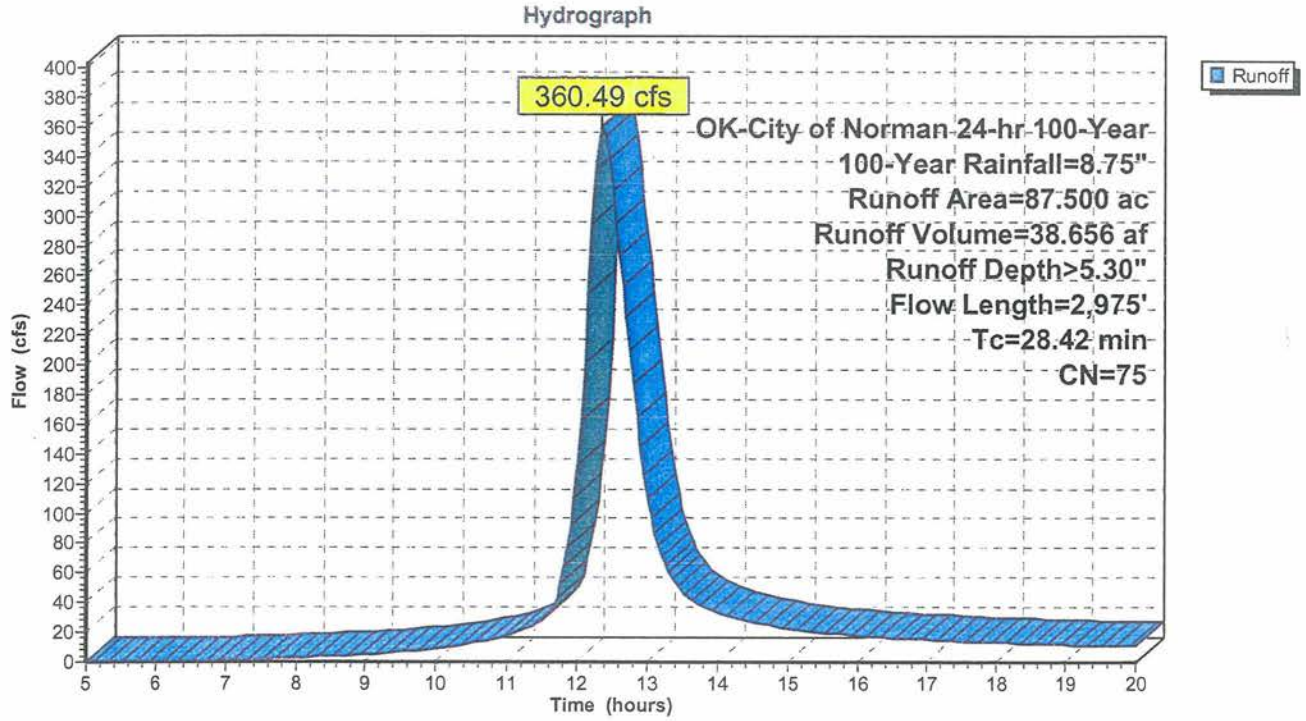
Runoff = 360.49 cfs @ 12.35 hrs, Volume= 38.656 af, Depth> 5.30"

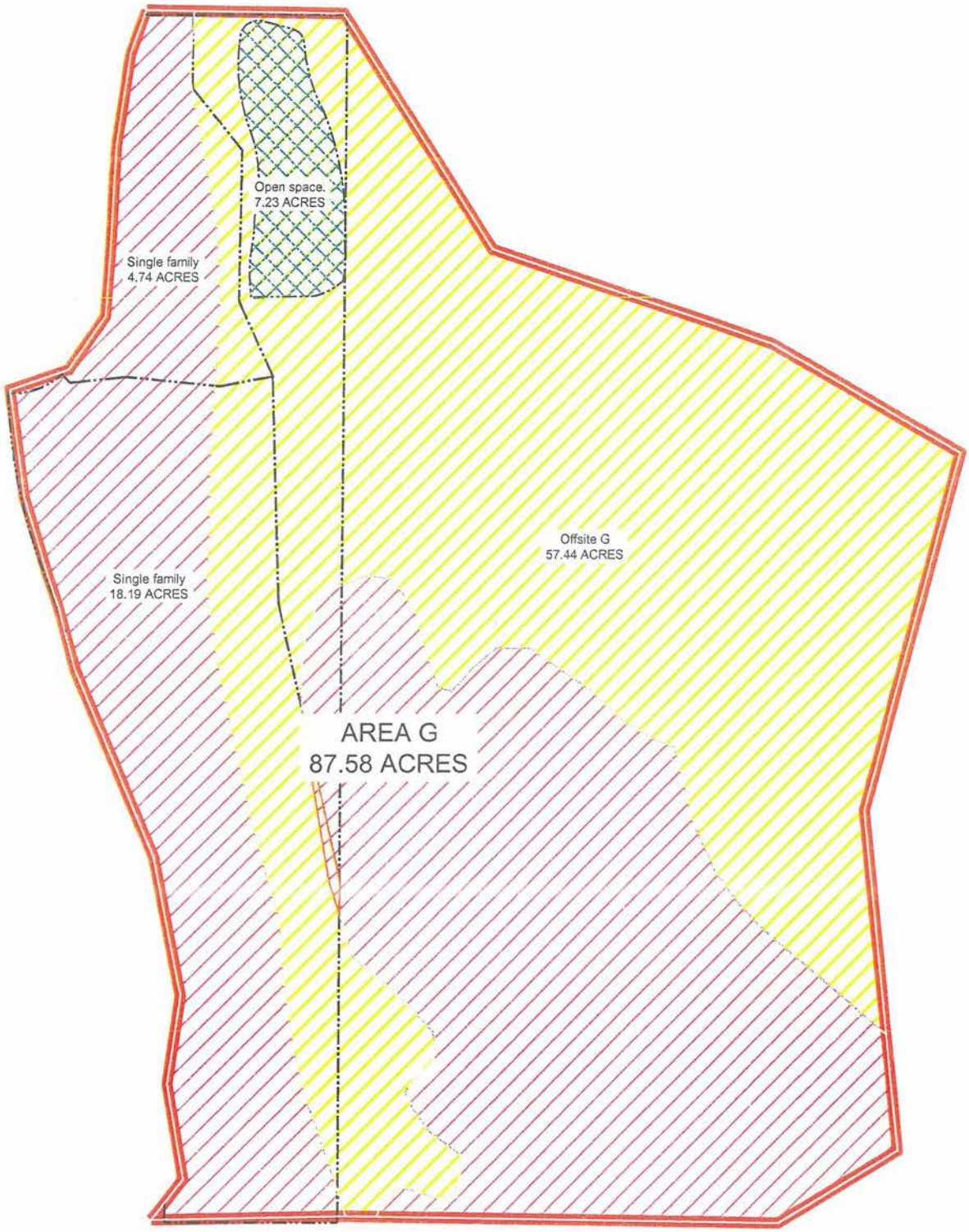
Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
OK-City of Norman 24-hr 100-Year 100-Year Rainfall=8.75"

	Area (ac)	CN	Description
*	42.300	71	Type C soil
*	45.200	78	Type D soil
	87.500	75	Weighted Average
	87.500		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
13.85	300	0.0467	0.36		**Sheet Flow, Overland flow** Range n= 0.130 P2= 3.75"
1.98	255	0.0940	2.15		**Shallow Concentrated Flow, Swale** Short Grass Pasture Kv= 7.0 fps
12.59	2,420	0.0186	3.20	48.06	**Channel Flow, Creek** Area= 15.0 sf Perim= 25.0' r= 0.60' n= 0.045
28.42	2,975	Total			

Subcatchment 1S: Historic Area G

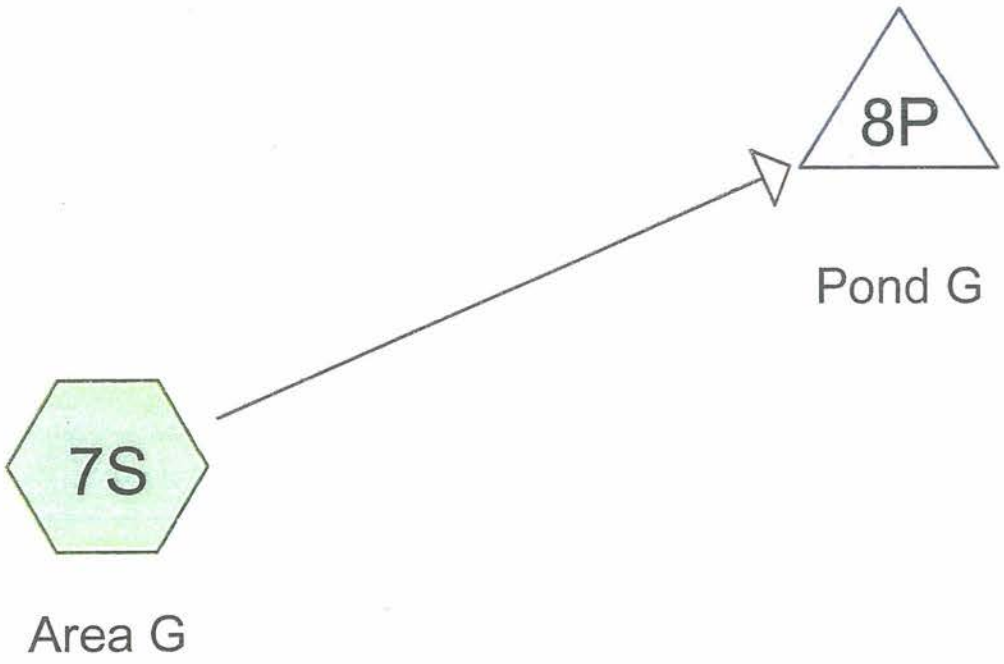




AREA G
87.58 ACRES

TYPE C SOIL

TYPE D SOIL



Subcat Reach Pond Link

Routing Diagram for Proposed Area G
Prepared by SMC Consulting Engineers, P.C., Printed 1/10/2015

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
87.580	78	Developed (7S)

Summary for Subcatchment 7S: Area G

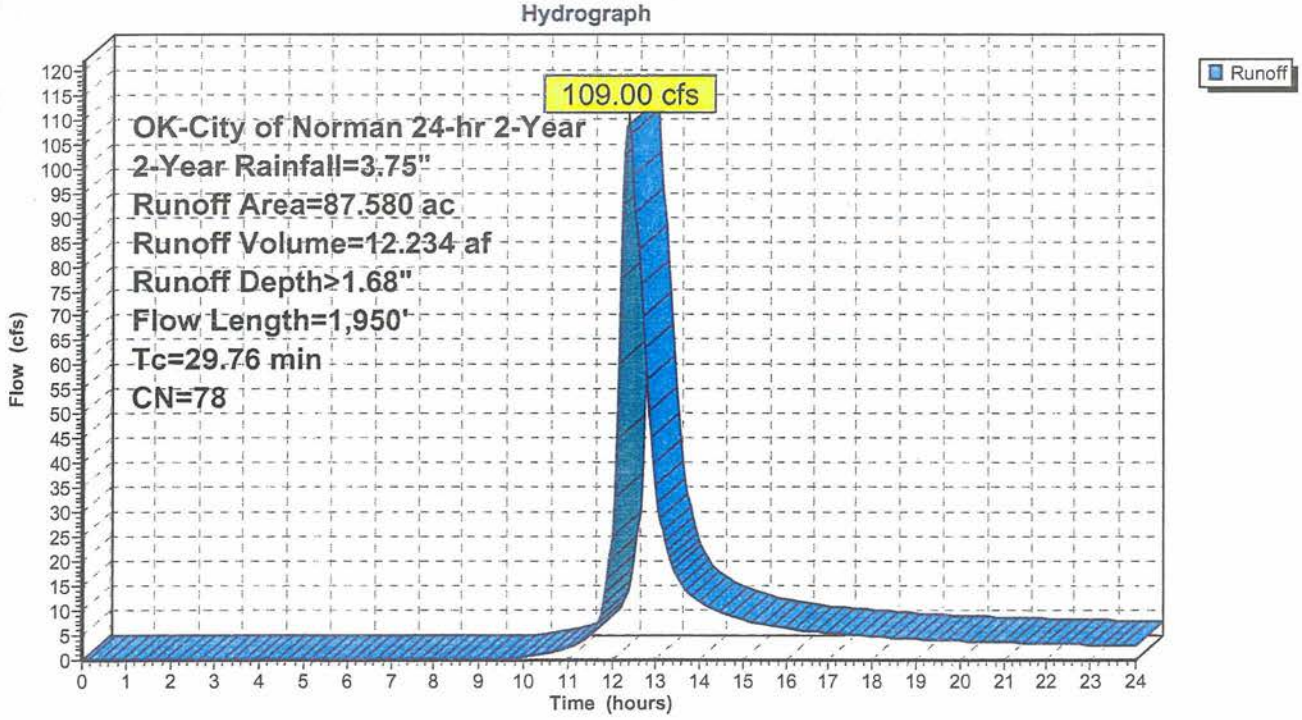
Runoff = 109.00 cfs @ 12.38 hrs, Volume= 12.234 af, Depth> 1.68"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
OK-City of Norman 24-hr 2-Year 2-Year Rainfall=3.75"

	Area (ac)	CN	Description
*	87.580	78	Developed
	87.580		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
19.44	300	0.0200	0.26		**Sheet Flow, Overland** Range n= 0.130 P2= 3.75"
3.66	500	0.0200	2.28		**Shallow Concentrated Flow, Swale** Unpaved Kv= 16.1 fps
6.66	1,150	0.0150	2.88	43.16	**Channel Flow, Creek** Area= 15.0 sf Perim= 25.0' r= 0.60' n= 0.045
29.76	1,950	Total			

Subcatchment 7S: Area G



Summary for Pond 8P: Pond G

Inflow Area = 87.580 ac, 0.00% Impervious, Inflow Depth > 1.68" for 2-Year event
Inflow = 109.00 cfs @ 12.38 hrs, Volume= 12.234 af
Outflow = 41.36 cfs @ 12.94 hrs, Volume= 11.110 af, Atten= 62%, Lag= 33.44 min
Primary = 41.36 cfs @ 12.94 hrs, Volume= 11.110 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 1,128.57' @ 12.94 hrs Surf.Area= 83,571 sf Storage= 203,858 cf

Plug-Flow detention time= 118.66 min calculated for 11.110 af (91% of inflow)
Center-of-Mass det. time= 73.32 min (933.45 - 860.13)

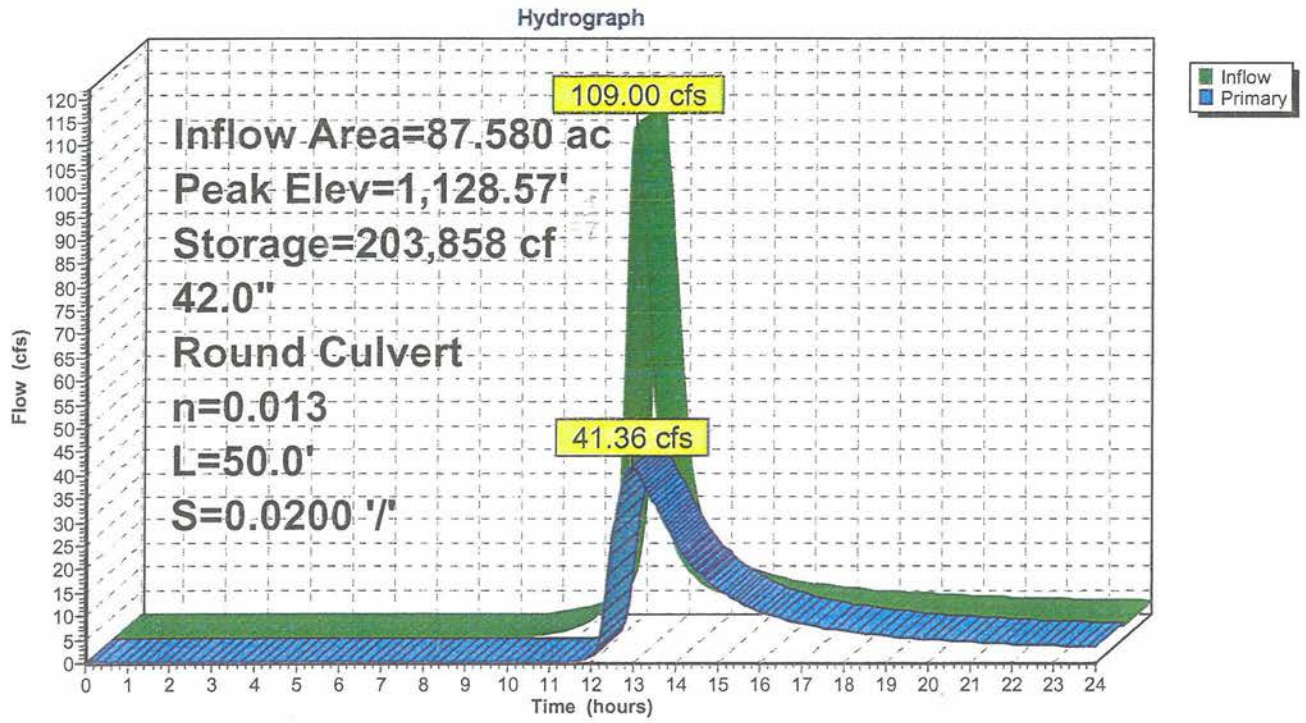
Volume	Invert	Avail.Storage	Storage Description
#1	1,126.00'	810,000 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
1,126.00	75,000	0	0
1,135.00	105,000	810,000	810,000

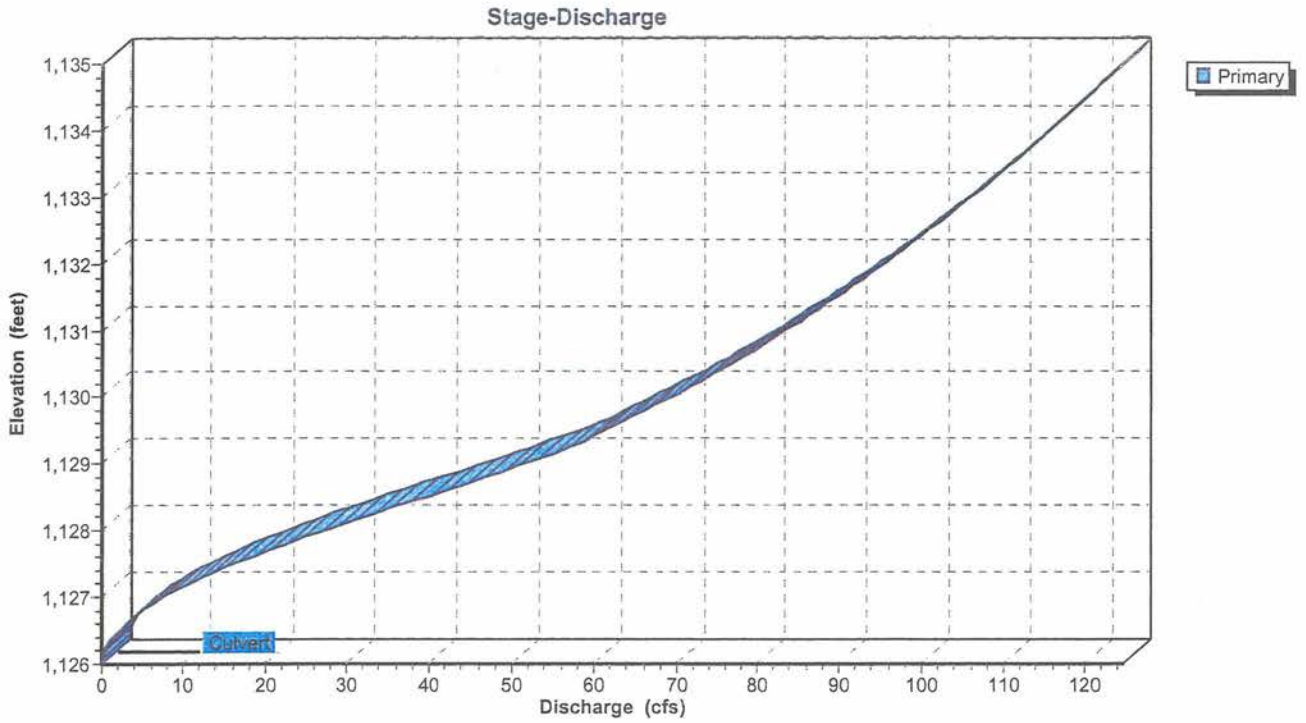
Device	Routing	Invert	Outlet Devices
#1	Primary	1,126.00'	**42.0" Round Culvert** L= 50.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 1,126.00' / 1,125.00' S= 0.0200 '/' Cc= 0.900 n= 0.013, Flow Area= 9.62 sf

Primary OutFlow Max=41.33 cfs @ 12.94 hrs HW=1,128.57' (Free Discharge)
1=Culvert (Inlet Controls 41.33 cfs @ 5.46 fps)

Pond 8P: Pond G



Pond 8P: Pond G



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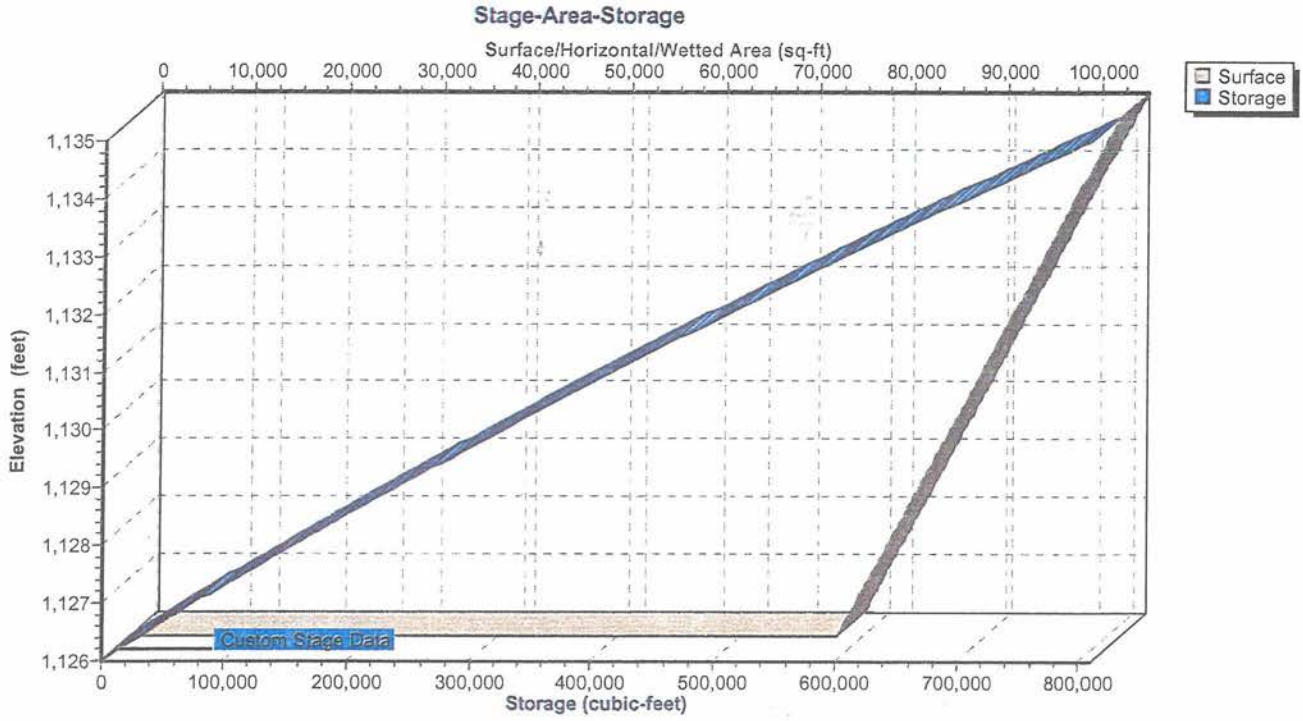


Summary for Subcatchment 7S: Area G

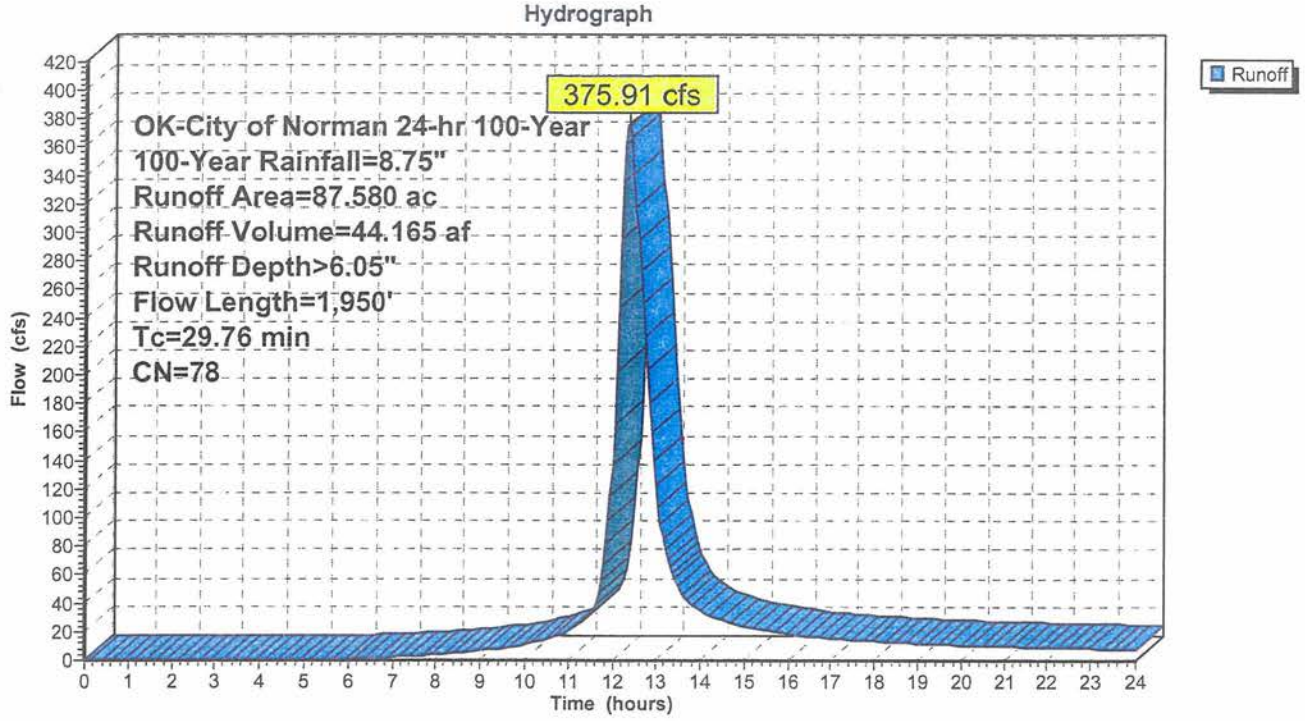
Runoff = 375.91 cfs @ 12.37 hrs, Volume= 44.165 af, Depth> 6.05"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
OK-City of Norman 24-hr 100-Year 100-Year Rainfall=8.75"

	Area (ac)	CN	Description
*	87.580	78	Developed
	87.580		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
19.44	300	0.0200	0.26		**Sheet Flow, Overland** Range n= 0.130 P2= 3.75"
3.66	500	0.0200	2.28		**Shallow Concentrated Flow, Swale** Unpaved Kv= 16.1 fps
6.66	1,150	0.0150	2.88	43.16	**Channel Flow, Creek** Area= 15.0 sf Perim= 25.0' r= 0.60' n= 0.045
29.76	1,950	Total			

Subcatchment 7S: Area G



Summary for Pond 8P: Pond G

Inflow Area = 87.580 ac, 0.00% Impervious, Inflow Depth > 6.05" for 100-Year event
Inflow = 375.91 cfs @ 12.37 hrs, Volume= 44.165 af
Outflow = 122.96 cfs @ 13.00 hrs, Volume= 42.321 af, Atten= 67%, Lag= 37.70 min
Primary = 122.96 cfs @ 13.00 hrs, Volume= 42.321 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 1,134.80' @ 13.00 hrs Surf.Area= 104,318 sf Storage= 788,592 cf

Plug-Flow detention time= 98.43 min calculated for 42.321 af (96% of inflow)
Center-of-Mass det. time= 75.20 min (897.51 - 822.31)

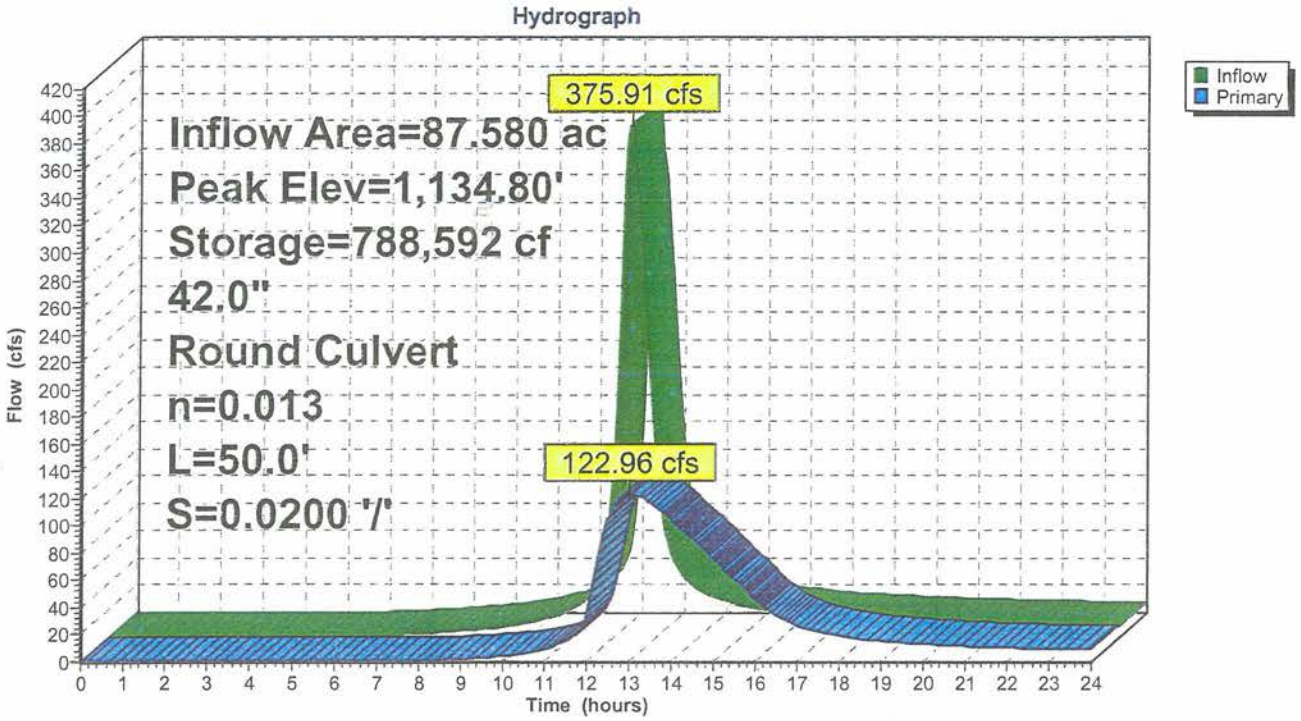
Volume	Invert	Avail.Storage	Storage Description
#1	1,126.00'	810,000 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
1,126.00	75,000	0	0
1,135.00	105,000	810,000	810,000

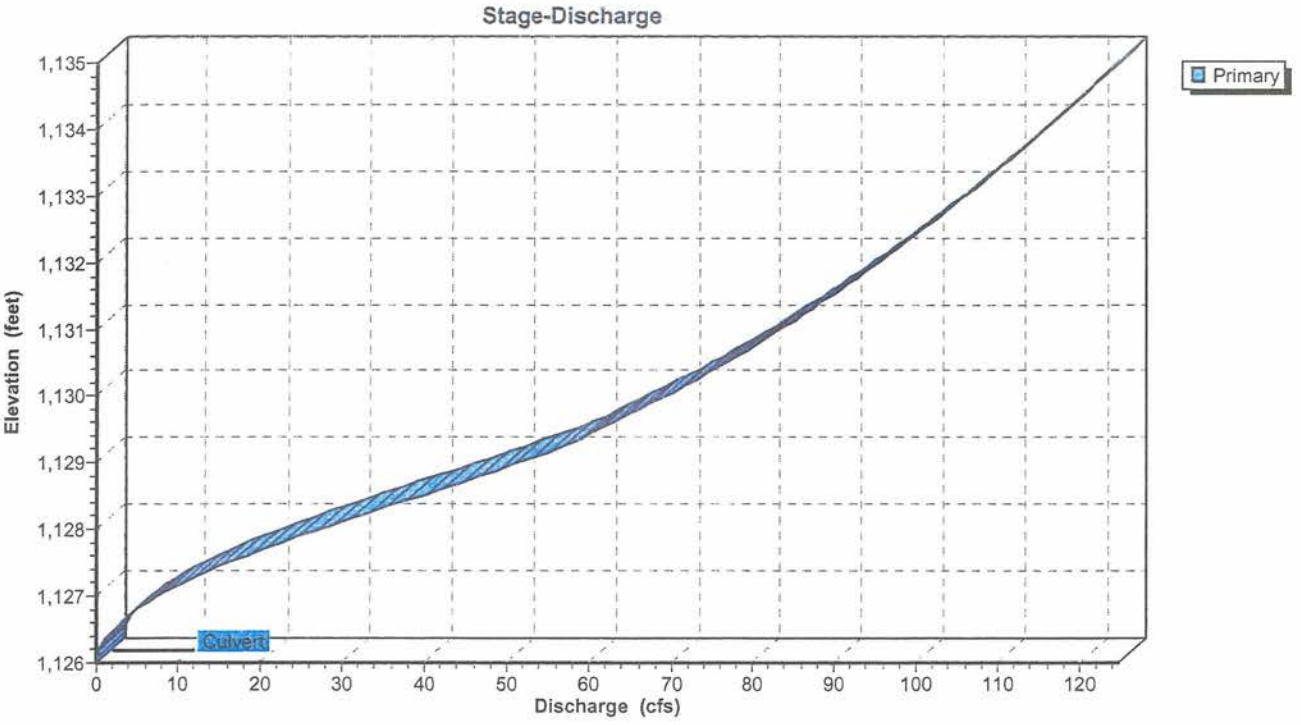
Device	Routing	Invert	Outlet Devices
#1	Primary	1,126.00'	**42.0" Round Culvert** L= 50.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 1,126.00' / 1,125.00' S= 0.0200 '/' Cc= 0.900 n= 0.013, Flow Area= 9.62 sf

Primary OutFlow Max=122.96 cfs @ 13.00 hrs HW=1,134.79' (Free Discharge)
1=Culvert (Inlet Controls 122.96 cfs @ 12.78 fps)

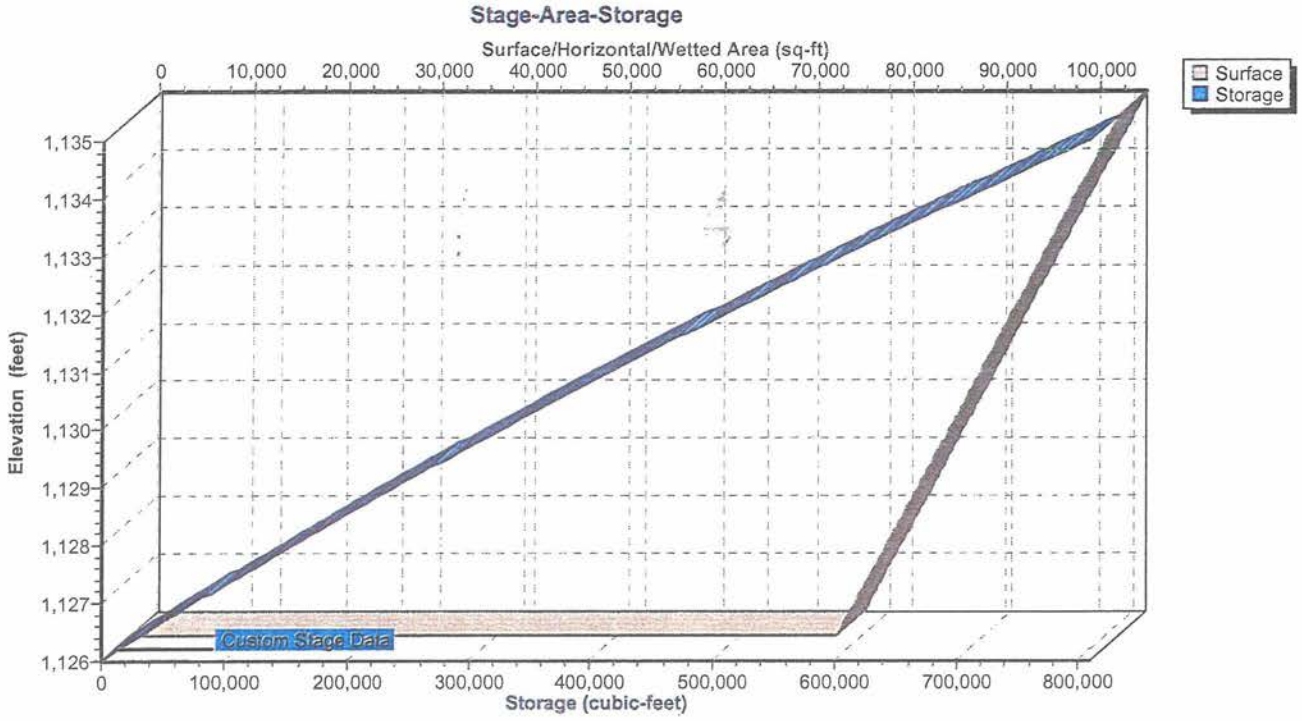
Pond 8P: Pond G



Pond 8P: Pond G



Pond 8P: Pond G



Appendix I
Pollutant removal table

Table of Design Pollutant Removal Efficiencies for Storm Water Controls (%)				
Structural Control	Total Suspended Solids	Total Phosphorus	Total Nitrogen	Metals
Storm Water Pond	80	55	30	50
Dry Extended Detention Pond	60	35	25	25
Enhanced Dry Swales	90	50	50	40
Grass Channel	50	25	20	30
Infiltration Trench	90	60	60	90
Soaking Trench	90	60	60	90
Vegetative Filter Strips	50	20	20	40
Surface Sand Filters	80	50	30	50

C. For each portion of any 25 foot segment of the buffer, as set forth in Section 19-411(B), that has a slope over 20%, 25 feet shall be added to the width of the WQPZ. To determine the extent of steep slopes, a cross section of the topography every 100 feet shall be prepared and utilized by the Applicant.

D. In second-order streams with continuous water or in higher order streams, 25 feet shall be added to the base width outlined in Section 19-411 (B) above.

E. Drainage easements, of sufficient size to carry the runoff of a 1% chance flood event from all drainage areas on the Plat greater than forty (40) acres within the WQPZ must be shown on dotted lines on the Preliminary and Final Plats, along with a written legal description of any such easement, all certified by a licensed Professional Engineer. Such easement shall be granted to the City of Norman for the purpose of access for inspecting, repairing, and maintaining drainage channels.

F. For all developments, particularly those containing some portion of the WQPZ, utilization of low impact development strategies are encouraged. For plats or Norman Rural Certificates of Survey that include portions of the WQPZ, the current Engineering Design Criteria may be modified when Low Impact Development strategies are utilized in accordance with City of Wichita/Sedgwick County Stormwater Manual.

G. Water Pollution Hazards. The following land uses and/or activities are designated as potential water pollution hazards and must be set back from the top of the bank of any stream or waterbody by the distance indicated below:

Exhibit A
Soils Type map