PRELIMINARY DESIGN REPORT

AND

COST ESTIMATE

PROPOSED BRANCH TO THE PINE RUN

CLAYTON BRANCH, #1419

Submitted To:

Genesee County Drain Commissioner's Office
Jeffrey Wright, Drain Commissioner
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Flint, Michigan 48532

Submitted By:

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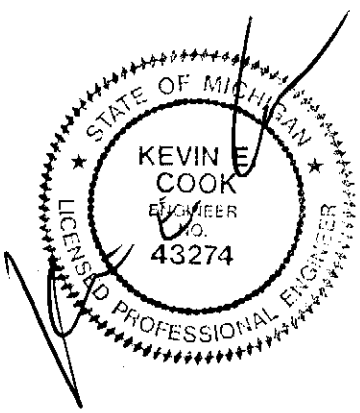

November 2012
Project No. 12004300

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I. Summary

The proposed branch to the Clayton Branch #1419 of the Pine Run Drain is located in sections 7 and 18 of Vienna Township. The drainage basin begins at a high point approximately one-half mile south of Farrand Road, traverses northerly across Section 18 of Vienna Township, crosses Farrand Road approximately 1,400 feet east of Elms Road and continues north across Section 7 to the Clayton Branch of Pine Run, #1419.

Drain improvements include constructing 1,700 lineal feet of open ditch across parcels 18-18-100-007, 18-18-100-012 and 18-18-100-013 consistent with the natural drainage course, constructing 400 lineal feet of 48" storm sewer along the common property line of parcels 18-18-100-007 and 18-18-100-008, removing existing 24-inch culvert under Farrand Road, reconstructing a 54-inch culvert under Farrand Road, regarding the roadway ditches, constructing 320 lineal feet of 54-inch storm sewer along the common property lines of parcels 18-07-300-018 and 18-07-300-044, and clearing/cleaning out approximately 1,000 lineal feet of existing ditch from the northwest corner of parcel 18-07-300-018 to the existing drain. The cost to perform the above-described work is estimated at $113,800.

A second option considered limiting the upstream open ditch across parcels 18-18-100-007, 18-18-100-012 and 18-18-100-013 to the rear lot line of parcels 18-18-100-008 and 18-18-100-009 thus reducing the open ditch by 1,500 feet. The cost to perform this option is estimated at $98,900.

All costs are estimated in year 2012 dollars and actual costs may be higher or lower depending upon final design, contractor's bid prices, and the year of construction.

II. Basin Characteristics

A. General

The proposed branch to the Clayton Branch #1419 of the Pine Run Drain drainage basin has an area of approximately 178 acres. The ground surface elevations range from 668' to 684'.

The proposed branch was surveyed at the existing roadway crossing of Farrand Road approximately ¼ mile east of Elms Road. Also, the existing natural drainage course was field surveyed north and south of Farrand Road along the documented area of concern.

The existing 24-inch diameter roadway cross culvert was located and invert elevations measured. All pipe invert elevations are noted on the crossing detail.

B. Existing Conditions

The following problem exists in the basin:

Based on testimony and associated photographs provided in the Board of Determinations minutes, several lots have experienced street, yard and basement flooding in past years.

The existing 24-inch roadway culvert crossing Farrand Road is undersized for the 170 acre drainage area south of Farrand Road.

III. Basis of Design

A. Hydrology

1. Drainage Area
The drainage area of the district is approximately 178 acres

2. Land Use

The land is residential north and south of Farrand Road with some large, unfarmed parcels. It has been assumed for the purposes of this study that land use for the year 2030 in the basin will remain essentially as it exists today.

3. Soils

The following soil types are found in the district. (See Figure A)

Map Symbol	Soil Series Name	Hydrologic Soil Group
AuB	Au Gres loamy sand, loamy substratum, 0 to 6% slopes	B
CxB	Croswell sand, 0 to 6% slopes	A
DrA	Del Ray sandy loam, 0 to 2% Slopes	C
Gm	Granby loamy sand	D/A
Le	Lenawee silty clay loam	D/B
PnA	Pinconning-Allendale loamy fine sands, 0 to 2% slopes	D/B

The hydrologic parameter, A, B, C or D, is an indicator of the minimum rate of infiltration obtained for a bare soil after prolonged wetting.

The hydrologic soil groups, as defined by SCS Soil Scientists, are:

A. (Lowest Runoff Potential). Soils having a high infiltration rate even when thoroughly wetted and consisting chiefly of deep, well to excessively drained sands or gravels.

B. (Moderately Low Runoff Potential). Soils having a moderate infiltration rate when thoroughly wetted and consisting chiefly of moderately deep to deep, moderately well to well drained soils

with moderately fine to moderately coarse texture.

C. (Moderately High Runoff Potential). Soils having a slow infiltration rate when thoroughly wetted and consisting chiefly of soils with a layer that impedes downward movement of water or soils with moderately fine to fine textures.

D. (Highest Runoff Potential). Soils having a very slow infiltration rate when thoroughly wetted and consisting chiefly of clay soils with a high swelling potential, soils with a permanent high water table, soils with a clay pan or clay layer at or near the surface, and shallow sinks over nearly impervious materials.

Some soils area classified as belonging to two hydrologic groups by a symbol such as D/B. The first letter indicates the soil's hydrologic characteristics in the drained condition, the second describes its characteristics in the undrained condition.

The majority of the soil in the district are loam with somewhat poor drainage; seasonal high water table; moderately slow permeability; and wet depressions in some areas.

4. Rainfall Information

Rainfall information is obtained from the Soil Conservation Service. The 24-hour rainfalls for the drainage area are as follows:

Frequency (Years)	24 Hour Rainfall (Inches)
1	2.1
2	2.3
5	3.0
10	3.5
25	3.9
50	4.2
100	4.6

It is noted that there have been numerous rainfalls in the mid-Michigan area which have exceeded the 100 year frequency event.

The rainfall intensity curves used were provided by the Genesee County Drain Commissioner's Office.

5. Runoff Coefficients

"The runoff coefficient as used in the Rational Method expresses the percent of rainfall that appears as runoff. The coefficient C combines the effects of infiltration and surface storage of the watershed." (Handbook of Concrete Pipe Hydraulics) Below are the runoff coefficients used in this analysis.

	Land Use	C
A.	Flat undeveloped lands, farms, nonwooded	0.25
B.	Woodlands and sloped undeveloped land	0.30
C.	Residential	0.40
D.	Roads	1.00

6. Quantity of Flow

The methodology used to estimate flows is the Rational Method. This is one of the most widely used techniques for estimating peak runoff in an urbanized watershed. A description of the method as found in the Handbook of Concrete Culvert Pipe Hydraulics follows:

"The rational formula is fundamentally a ratio in which the total quantity of water falling at a uniform rate on an area is related by simple proportion to the total quantity of water that appears as runoff. This can be expressed in instantaneous form as $Q = CiA$ where Q is runoff in cubic feet per seconds, i is rainfall intensity in inches per hour, A is the area of the drainage basin in acres, and C is the ratio expressing the proportional amount of the rainfall that appears as runoff. This formula is only applicable where the rainfall can be assumed to be uniform both in intensity and in aerial distribution throughout the storm. This assumption applies fairly well to areas of less than 200 square miles."

7. Design

Based on the following criteria:

Runoff Coefficient (C) = 0.25
Time of Concentration (Tc1) = 54 minutes
Time of Concentration (Tc2) = 60 minutes
10-Year Storm Event for Open Ditch and Enclosed Pipe
25-Year Storm Event for Roadways Crossings/Culverts

The flow generated from the upper end of the watershed south of Farrand Road (170 acres) is approximately 92 cubic feet per second (cfs) (102 cfs for 25-year event). The watershed continues north of Farrand Road across parcel 18-07-300-044 (property address 6402 Farrand Road) and parcel 18-07-300-041 (6260 Farrand Road).

IV. Proposed Improvements

Construct 1,500 lineal feet of open ditch from the center of parcel 18-18-100-013 (6319 Farraand Road) northwesterly across parcel 18-18-100-012 (6351 Farrand Road) and 18-18-100-007 (6411 Farrand Road) to the southwest corner of parcel 18-18-100-008 (6393 Farrand Road) within an 80-foot easement. Construct 400 lineal feet of 48-inch diameter storm sewer from said corner along the common property line of parcels 18-18-100-007 (6411 Farrand Road) and 18-18-100-008 (6393 Farrand Road) to roadway ditch in a 30-foot easement. Remove existing 24-inch culvert Farrand Road that is undersized and replace with a 54-inch culvert. Regrade roadway ditch to match new storm sewer infrastructure. Construct 320 lineal feet of 54-inch storm sewer along the common property lines of parcels 18-07-300-018 (6378 Farrand Road) and 18-07-300-044 (6402 Farrand Road) in a 30-foot easement. Clear, widen, and deepen 1,000 lineal feet of existing ditch from the northwest corner of parcel 18-07-300-018 across the southwesterly corner of parcel 18-07-300-041 (6260 Farrand Road) to the existing drain.

Open ditch along the common property lines of parcel number 18-18-100-007 (6411 Farrand Road) and parcel number 18-18-100-008 (6393 Farrand Road) and the commons property lines of 18-07-300-018 (6378 Farrand Road) and 18-07-300-044 (6402 Farrand Road) was not considered due to insufficient open space to accommodate the 80-wide easement requirement. Enclosed pipe easements typically require less width.

A second option considered limiting the upstream open ditch across parcels 18-18-100-007, 18-18-100-012 and 18-18-100-013. The ditch would be constructed along to the rear lot line of parcels 18-18-100-008 and 18-18-100-009 beginning at the low spot near the southeast corner of parcel 18-18-100-009 (6383 Farrand Road).

IV. Cost Estimate

ENGINEER'S COST ESTIMATE

The drain improvement cost estimates are summarized below as follows:

Option #1

Item No.	Description	Quantity	Unit	Unit Price	Amount
	Open Ditch Excavation	1,700	L.F.	$7.00	$11,900.00
1	48" Dia. RCP Pipe	400	L.F.	$100.00	$40,000.00
2	Roadway Ditch Reconstruction	200	L.F.	$6.00	$1,200.00
3	54" Dia. CSP Culvert	50	L.F.	$250.00	$12,500.00
4	54" Dia. RCP Pipe	320	L.F.	$110.00	$35,200.00
5	Open Ditch Excavation - Widen & Deepen	1,000	L.F.	$6.00	$6,000.00
6	Leveling Spoils	2,500	L.F.	$1.00	$2,500.00
7	Seed, Class B (125 lbs. per acre)	250	LB	$4.00	$1,000.00
8	Mulch	6	TON	$500.00	$3,000.00
9	Fertilizer	250	LB	$2.00	$500.00
	TOTAL COST				$113,800.00

Option #2

Item No.	Description	Quantity	Unit	Unit Price	Amount
	Open Ditch Excavation	200	L.F.	$7.00	$1,400.00
1	48" Dia. RCP Pipe	400	L.F.	$100.00	$40,000.00
2	Roadway Ditch Reconstruction	200	L.F.	$6.00	$1,200.00
3	54" Dia. CSP Culvert	50	L.F.	$250.00	$12,500.00
4	54" Dia. RCP Pipe	320	L.F.	$110.00	$35,200.00
5	Open Ditch Excavation - Widen & Deepen	1,000	L.F.	$6.00	$6,000.00
6	Leveling Spoils	1,000	L.F.	$1.00	$1,000.00
7	Seed, Class B (125 lbs. per acre)	100	LB	$4.00	$400.00
8	Mulch	2	TON	$500.00	$1,000.00
9	Fertilizer	100	LB	$2.00	$200.00
	TOTAL COST				$98,900.00

VI. Reference Materials

1. Genesee County Drain Map, Vienna Township

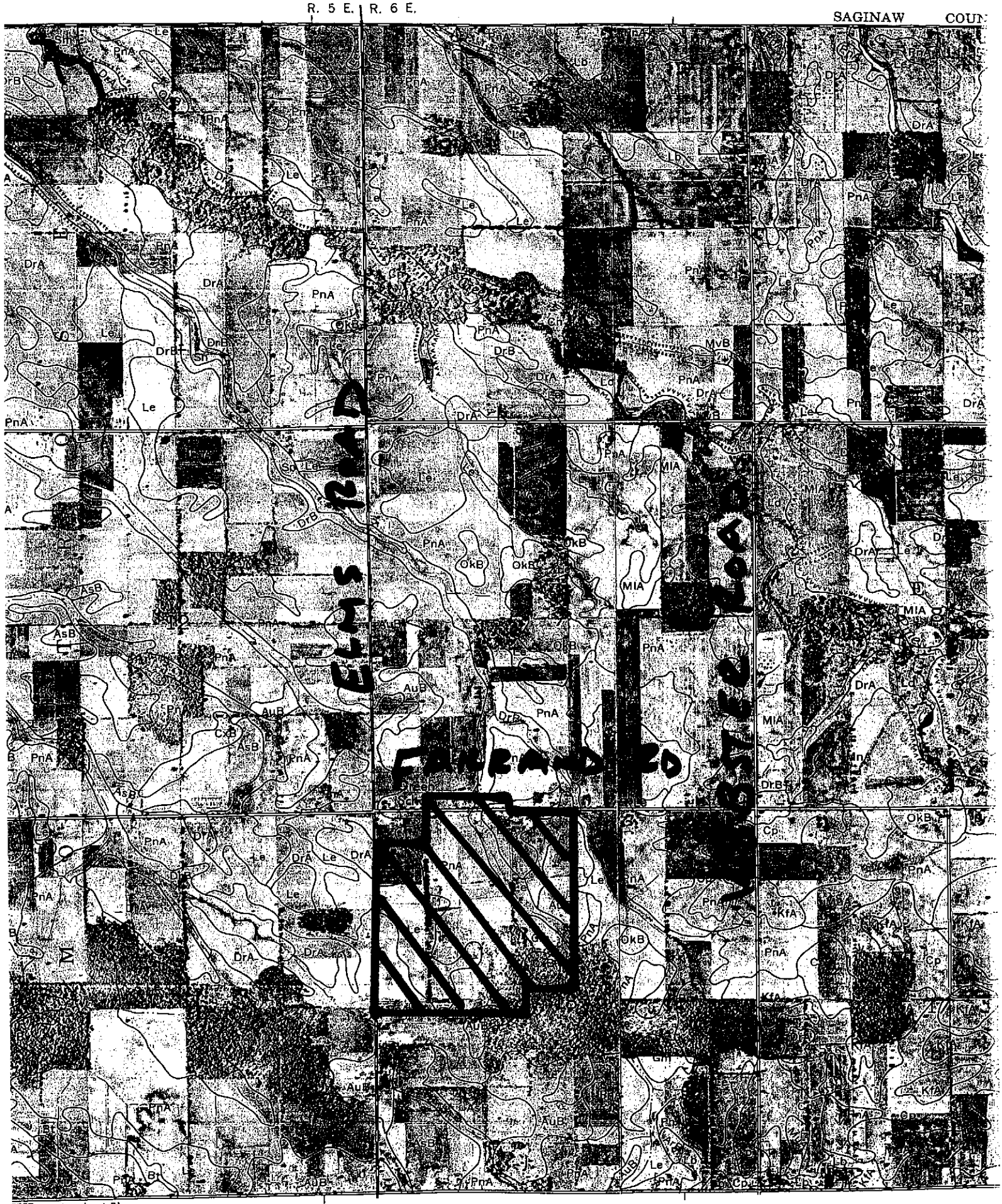
2. Genesee County Composite Map, Sections 7 and 18 of Vienna Township.

3. Soil Survey of Genesee County, Michigan, United States Department of Agriculture Soil Conservation Service, April, 1972.

VII. Appendix

Soil Survey Map (1)
Time of Concentration Calculations (1)
Flow Calculations (1)
Open Channel Flow Calculations (1)
Culvert Calculations (4)
Drainage District Map and Survey (1)

GENESEE COUNTY, MICHIGAN — SHEET NUMBER 2



FEET *(Joins sheet 8)*

CHMP, INC.
architecture, engineering
planning, interior design
landscapre acrhitecture
surveying

PROPOSED BRANCH TO THE PINE RUN, CLAYTON BRANCH, #1419

Time of Concentration Calculations — Date: 10/25/2012

Initial Time			10	minutes
South of Farrand Road - Section 18 Vienna Township				
Surface flow over grass (300 foot maximum)				
upper end elevation =	684			
lower end elevation =	683			
length =	300	feet		
slope =	0.003			
T-Surface flow =	10.69	minutes		
Tc - Grass multiply by:	2		21.4	minutes
Shallow concentrated flow				
upper end elevation =	683			
lower end elevation =	676			
length =	2500	feet		
slope =	0.003			
T-Surface flow =	11.41	minutes		
Tc - Grass multiply by:	2		22.8	minutes
Time of Concentration (C1) =			54.2	
North of Farrand Road - Section 13 Vienna Township				
Open Channel Flow to Elms Road Crossing				
velocity =	3.8	feet per second		
length =	1300	feet		
T-Surface flow =			5.7	minutes
Time of Concentration (C2) =			59.9	minutes

PROPOSED BRANCH TO THE PINE RUN, CLAYTON BRANCH, #1419

Flow Calculations

Date: 10/25/12

DESIGN FLOOD FREQUENCY = 10 YEAR STORM
INTENSITY CONSTANTS FOR I = A/(T+D)^N

A =	166.37
D =	22.35
N =	1
n =	0.013

DRAINAGE DISTRICT		AREA A	RUNOFF COEFF.	A x C	SUM A x C	TIME OF CONC.	INTENSITY I	DISCHARGE Q
UPPER	LOWER	(Ac.)	C			(Minutes)	(In/Hr)	(cfs)
CP1	CP2	170	0.25	42.50	42.50	54.2	2.173	92.35
CP2	OUTLET	8	0.25	2.00	44.50	59.9	2.023	90.02

PIPE SIZING

		PIPE DIAMETER (Inches)	LENGTH L (Feet)	VELOCITY (fps)	TOTAL TIME (Minutes)	HYDR. GRADE LINE	DESIGN GRADE %	DESIGN VELOCITY (fps)	DESIGN CAPACITY (cfs)
CP1	CP2	48	400	7.35	55.11	0.41	0.42	7.43	93.34

CULVERT ANALYSIS

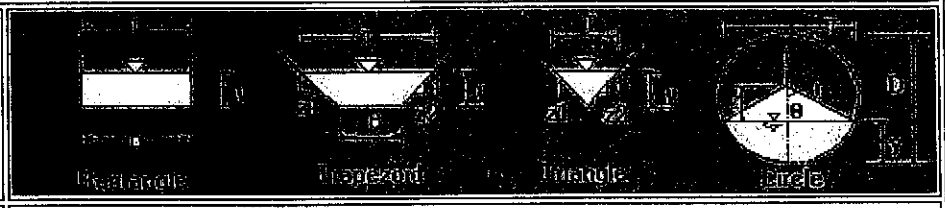
DESIGN FLOOD FREQUENCY = 25 YEAR STORM
INTENSITY CONSTANTS FOR I = A/(T+D)^N

A =	191.76
D =	25.93
N =	1

DRAINAGE DISTRICT		AREA A	RUNOFF COEFF.	A x C	SUM A x C	TIME OF CONC.	INTENSITY I	DISCHARGE Q
UPPER	LOWER	(Acres)	C			(Minutes)	(In/Hr)	(cfs)
CP1	CP2	170	0.25	42.50	42.50	54.2	2.39	101.70
CP2	OUTLET	8	0.25	2.00	44.50	59.9	2.23	99.41

The open channel flow calculator

Select Channel Type:
Trapezoid



Depth from Q

Select unit system: Feet(ft)

Channel slope: .003 ft/ft	Water depth(y): 3.08 ft	Bottom width(b) 2.5 ft
Flow velocity 3.767 ft/s	LeftSlope(Z1): 2 ft/ft	RightSlope(Z2): 2 ft/ft
Flow discharge 100.5942 ft^3/s	Input n value 0.03 or select n	
Calculate!	Status: Calculation finished	Reset
Wetted perimeter 16.28 ft	Flow area 26.7 ft^2	Top width(T) 14.83 ft
Specific energy 3.3 ft	Froude number 0.49	Flow status Subcritical flow
Critical depth 2.21 ft	Critical slope 0.0133 ft/ft	Velocity head 0.22 ft

HY-8 Analysis Results

Crossing Summary Table

Culvert Crossing: Existing Farrand Road Crossing

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 1 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
677.38	20.00	20.00	0.00	1
679.08	33.00	28.75	8.25	3
680.77	46.00	42.06	10.40	3
682.44	59.00	55.31	12.57	3
684.10	72.00	68.51	14.74	3
685.77	85.00	81.67	16.92	3
687.42	98.00	94.78	19.08	3
687.54	100.00	89.57	0.00	100
690.74	124.00	100.95	29.71	5
692.40	137.00	102.64	42.79	3
694.05	150.00	104.31	54.56	3
677.60	21.66	21.66	0.00	Overtopping

HY-8 Analysis Results

Water Surface Profiles

Culvert Crossing: Existing Farrand Road Crossing

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth(ft)	Outlet Control Depth(ft)	Flow Type	Length Full (ft)	Length Free (ft)	Last Step (ft)	Mean Slope (%)	First Depth (ft)	Last Depth (ft)
20.00	20.00	677.38	0.59	3.20	3-M1t	0.00	50.03	0.51	0.00	3.29	3.19
33.00	28.75	679.08	0.73	4.91	3-M1t	0.00	50.19	0.50	0.00	5.00	4.90
46.00	42.06	680.77	0.95	6.59	3-M1t	0.00	50.13	0.50	0.00	6.68	6.58
59.00	55.31	682.44	1.17	8.26	3-M1t	0.00	50.09	0.50	0.00	8.36	8.26
72.00	68.51	684.10	1.39	9.93	3-M1t	0.00	50.07	0.50	0.00	10.02	9.92
85.00	81.67	685.77	1.62	11.59	3-M1t	0.00	50.06	0.50	0.00	11.68	11.58
98.00	94.78	687.42	1.86	13.25	3-M1t	0.00	50.06	0.50	0.00	13.34	13.24
100.00	89.57	687.54	1.76	13.50	3-M1t	0.00	50.05	0.50	0.00	13.60	13.50
124.00	100.95	690.74	1.97	16.56	3-M1t	0.00	50.03	0.50	0.00	16.66	16.56
137.00	102.64	692.40	2.00	18.22	3-M1t	0.00	50.03	0.50	0.00	18.32	18.22
150.00	104.31	694.05	2.04	19.87	3-M1t	0.00	50.03	0.50	0.00	19.97	19.87

HY-8 Analysis Results

Crossing Summary Table

Culvert Crossing: Proposed Farrand Road Crossing

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 1 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
674.28	20.00	20.00	0.00	1
674.91	33.00	33.00	0.00	1
675.46	46.00	46.00	0.00	1
675.96	59.00	59.00	0.00	1
676.44	72.00	72.00	0.00	1
676.90	85.00	85.00	0.00	1
677.37	98.00	98.00	0.00	1
677.45	100.00	100.00	0.00	1
677.75	124.00	107.43	16.44	8
677.81	137.00	107.93	28.92	5
677.87	150.00	107.89	41.86	4
677.60	104.27	104.27	0.00	Overtopping

HY-8 Analysis Results

Water Surface Profiles

Culvert Crossing: Proposed Farrand Road Crossing

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth(ft)	Outlet Control Depth(ft)	Flow Type	Length Full (ft)	Length Free (ft)	Last Step (ft)	Mean Slope (%)	First Depth (ft)	Last Depth (ft)
20.00	20.00	674.28	1.88	2.08	3-M1t	0.00	50.00	0.00	0.41	1.67	1.67
33.00	33.00	674.91	2.47	2.71	3-M2t	0.00	49.73	9.69	0.46	2.06	2.13
46.00	46.00	675.46	2.99	3.26	3-M2t	0.00	49.60	0.52	0.52	2.37	2.52
59.00	59.00	675.96	3.48	3.76	3-M2t	0.00	49.76	3.32	0.58	2.63	2.85
72.00	72.00	676.44	3.97	4.24	3-M2t	0.00	49.51	0.25	0.64	2.86	3.17
85.00	85.00	676.90	4.46	4.70	3-M2t	0.00	49.55	0.19	0.73	3.06	3.46
98.00	98.00	677.37	4.99	5.17	3-M2t	0.00	49.60	0.15	0.83	3.25	3.75
100.00	100.00	677.45	5.07	5.25	3-M2t	0.00	49.55	0.15	0.85	3.27	3.80
124.00	107.43	677.75	5.40	5.55	3-M2t	0.00	49.62	0.13	0.90	3.57	4.05
137.00	107.93	677.81	5.42	5.61	3-M2t	0.00	49.66	0.16	0.92	3.72	4.13
150.00	107.89	677.87	5.42	5.67	3-M2t	0.00	49.64	0.15	0.94	3.86	4.22