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PRELIMINARY ENGINEERING REPORT FOR THE LEACH DRAIN #0339

PREPARED FOR:

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GENESEE COUNTY, MICHIGAN

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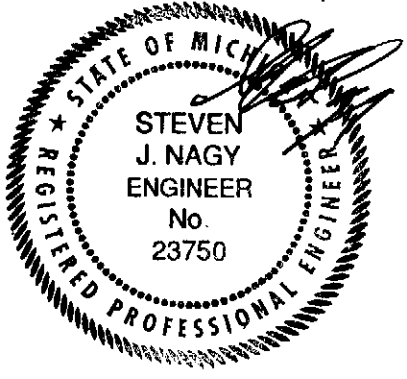

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Scope of Services
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Established in 1916

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1. Introduction

The Leach Drain #0339 is a proposed extension to the main branch of the Leach Drain. This preliminary engineering report for the Leach Drain #0339 evaluates the existing drainage course and existing culverts which comprise the drainage system that drains to the main Leach Drain. This report also discusses alternatives to improve the existing drainage course and existing culverts.

2. Site Location

The drainage area for the Leach Drain #0339 is located in portions of Sections 11, 13, and 14 of Montrose Township, Genesee County, Michigan. The overall drainage area is approximately 235± acres (0.37 square miles) and ultimately outlets to the main branch of the Leach Drain. The limits of the existing drainage area for the Leach Drain #0339 are shown on the Location Map located in Appendix 'A' and the Existing Drainage Area Map located in Appendix 'C'.

3. Existing Drainage Course

The Leach Drain #0339 is proposed to be improved and extended from the main Leach Drain. On January 29, 2008, a drainage Board of Determination meeting was held with local residents at Montrose Township Hall in order to discuss the drainage problems along the existing drainage course. At the meeting, several residents along Morrish Road and Farrand Road reported flooding problems on their property and adjacent properties. One resident stated that once the snow melts in the spring that the upper end of the existing drainage course and adjacent land typically experiences standing water for months. Others stated that the standing water posed a threat to their homes and businesses. The Board of Determination members determined the petition necessary.

The existing drainage course outlets to the main branch of the Leach Drain at a point approximately 370 feet north of Farrand Road and approximately 2,455 feet west of Morrish Road near existing collection point 6 (ECP-6). Please see Appendix 'C' – Existing Drainage Area Map. From the outlet at the main branch of the Leach Drain, the existing drainage course travels upstream through an enclosed 24-inch round storm sewer in a southerly direction to the existing roadside ditch on the north side of Farrand Road and approximately 2,440 feet west of Morrish Road. From this point, the existing drainage course continues upstream through the roadside ditch along the north side of Farrand Road in an easterly direction to an existing 18-inch round, corrugated steel pipe culvert beneath Farrand Road, located approximately 680 feet west of Morrish Road. After traveling southerly through the existing culvert, the existing drainage course travels easterly through the existing roadside ditch and an additional 18-inch round, corrugated steel pipe driveway culvert on the south side of Farrand Road. Approximately 585 feet west of Morrish Road, the existing natural

drainage course then turns and travels upstream in a southerly and southeasterly direction through wooded, non-wooded, and rural residential areas. The existing drainage course heads southerly and crosses several residential properties approximately 350 feet west of Morrish Road. Access to the rear of the residential properties is provided through a series of culverts, which range in size from 12-inch to 24-inch. The existing culverts also differ in material and include plastic, steel, and concrete. At a point approximately 2,370 feet south of Farrand Road, the existing drainage course turns and travels upstream in an easterly direction and ends at an existing 30-inch round, corrugated steel pipe culvert beneath Morrish Road.

Field visits by Gould Engineering, Inc. staff were completed to review the existing drainage course, to verify the approximate limits of the overall existing drainage area, and to review the problem areas mentioned by local residents at the Board of Determination meeting.

4. Basis of Evaluation and Design

A. Hydrology – (Stormwater Runoff)

DRAINAGE AREAS

Topographic field data collected by Gould Engineering, Inc., field visit observations, and Genesee County Drain Commissioner's Office two foot (2') contour maps were used to determine the overall drainage area. Please see Appendix 'C' for a map of the overall drainage area. Gould Engineering, Inc. determined the overall drainage area to be approximately 235± acres (0.37 square miles). Therefore, based on Genesee County Drain Commissioner's Office-SWM standards, the Rational Method was used to calculate peak runoff flows for a 10% chance (10 year) storm event for the existing natural drainage course and proposed open drain improvements. A 4% chance (25 year) storm event was used to evaluate the existing county road crossings and their proposed improvements.

RATIONAL

The Rational Method (Q = CIA) is used to calculate the peak storm water runoff flow rate (Q) to be used in the evaluation of the existing drainage course and the preliminary design of the various alternatives. The land use of the overall drainage area includes rural residential areas, farmlands, and woodlands. The GCDC-SWM standard runoff coefficients (C) were used to calculate weighted C-values for each drainage sub-area. Please see Appendix 'B' for various charts and values used as a basis of analysis for the calculations computed for this study.

TIME OF CONCENTRATION

The time of concentration for various drainage paths was calculated in order to determine the rainfall intensity (I_{10}) for each drainage sub-area. The GCDC-SWM standard of thirty (30) minutes for rural basins was used as a minimum initial time of concentration for the existing drainage course. This minimum initial time plus the travel time calculated to the collection points determines the time of concentration.

EXISTING FLOWS

The overall drainage area was divided into sub-areas and storm water runoff flows calculated at six (6) collection points along the drainage course. The following chart identifies the Rational Method parameters used in calculating the peak flow at each collection point:

Collection Point	Runoff Coefficient, $C_{weighted}$	Time of Concentration, T_c (minutes)	Intensity, I_{10} (in/hr)	Area (acres)	Peak Flow, $Q_{10} = (C_w)(I_{10})(A)$ (cfs)
ECP-1	0.34±	116±	1.20±	39±	15.9±
ECP-2	0.34±	121±	1.17±	77±	30.7±
ECP-3	0.33±	127±	1.13±	92±	34.4±
ECP-4	0.33±	139±	1.04±	120±	41.4±
ECP-5	0.33±	157±	0.94±	163±	50.7±
ECP-6	0.33±	184±	0.82±	235±	63.8±

Peak Flow for Road Crossings – Based on 4% Chance (25 Year) Storm Event

Collection Point	Runoff Coefficient, $C_{weighted}$	Time of Concentration, T_c (minutes)	Intensity, I_{25} (in/hr)	Area (acres)	Peak Flow, $Q_{25} = (C_w)(I_{25})(A)$ (cfs)
ECP-1	0.34±	116±	1.39±	39±	18.4±
ECP-5	0.33±	157±	1.09±	163±	58.8±
ECP-6A	0.33±	91±	1.65±	73±	39.7±

B. Hydraulics – (Open Drain and Culverts)

OPEN DRAINS/CULVERTS

The GCDC-SWM standard for open drain and culvert evaluation (existing conditions and design alternatives) for open drain improvements is to evaluate and design for no surcharging, where surcharging is defined as water rising above the crown of the culvert or the banks of a ditch.

FLOW MASTER/OPEN DRAINS

Haestad Method's FlowMaster program was used to evaluate the existing natural drainage course and design the proposed open drain improvements. FlowMaster uses Manning's Equation to calculate the water surface elevation within each open drain cross-section using the input flow, taking into consideration the affects of the downstream slope. The roughness, shape, and height vary along an open drain; the Manning's Equation takes into consideration all of these factors and has become

one of the most widely used uniform flow formulas for evaluating open channels. The Manning's coefficient of roughness (n) used to evaluate the existing roadside ditch was 0.035, as this portion of the existing drainage course is newly cleaned out. The Manning's coefficient of roughness (n) used to evaluate the remainder of the existing drainage course was 0.050, as the drainage course is not maintained and contains brush and weeds. The Manning's coefficient of roughness (n) used to evaluate the proposed open drain for the proposed improvement alternatives is 0.035. The FlowMaster program also calculates the velocity of water within the open drain cross-section. This information is necessary in determining whether the flow passing through the existing drainage course or proposed open drains meets GCDC-SWM requirements.

HAESTAD CULVERT MASTER

Haestad Method's CulvertMaster was used to evaluate the existing and proposed culverts. CulvertMaster computations utilize the design methods of the Federal Highway Administration (FHWA) HDS No. 5 and solve for various hydraulic variables, such as culvert capacity, headwater elevation, etc. A Manning's roughness coefficient (n) of 0.024 was used for corrugated steel pipe culverts and 0.013 was used for concrete culverts.

5. Evaluation of Existing Drainage System

Existing Drainage Course Evaluation

Cross-sections of the existing drainage course were evaluated to determine if they were capable of conveying the calculated flow from a 10% chance (10 year) storm event.

Field surveys and field visits completed by Gould Engineering, Inc. have determined that portions of the existing drainage course do not have the capacity to handle the calculated storm water runoff flows, particularly in the areas between ECP-1 and ECP-4. As reported by several residents, this leads to flooding at the upper end of the existing drainage course at Morrish Road.

In addition, for the purpose of preliminary evaluation, the assumption was made that all of the flow at ECP-5 would flow through the existing roadside ditch on the north side of Farrand Road. It is likely that a portion of the flow also travels along the existing roadside ditch on the south side of Farrand Road. During final design some flow along the south side of Farrand Road may be evaluated and considered.

The following table shows the calculated peak flows for a 10% chance (10 year) storm event, the corresponding water surface elevation and the approximate top of bank elevation for each surveyed cross-section along the existing drainage course.

Ex. Drainage Course Cross-Section	Calculated Runoff Q_{10} (cfs)	Water Surface Elev. (WSE) of Ex. Drainage Course for Calculated Q_{10}	Top of Bank of Existing Drainage Course
A-A	30.7	677.1±	676.2±
B-B	34.4	677.6±	676.7±
C-C	34.4	676.5±	675.6±
D-D	34.4	676.7±	675.7±
E-E	41.4	676.6±	676.3±
F-F	41.4	675.5±	675.8±
G-G	41.4	676.3±	676.1±
H-H	41.4	674.8±	674.6±
I-I	41.4	675.0±	675.5±
J-J	41.4	674.8±	676.1±
K-K	41.4	672.1±	672.2±
L-L	41.4	670.6±	669.7±
M-M	50.7	670.2±	669.8±
N-N	50.7	669.9±	669.1±
O-O	50.7	669.1±	667.9±

It should be noted that the above listed Water Surface Elevations do not take into consideration the affects of the existing culverts located along the existing drainage course nor do they take into consideration the water surface elevation of other downstream cross-sections. The headwater elevation at the downstream culverts or the water surface elevation of a cross-section affects the water surface elevation at some cross-sections along the existing drainage course. The following discussion related to the existing culverts discusses this further.

Existing Culvert Evaluation

An evaluation of the existing culverts along the drainage course determined that all of the existing culverts are deficient in conveying the calculated runoff in accordance with GCDC-SWM requirements, resulting in the back-up or restriction of flow in the areas upstream of each culvert. The restriction of flow through most of the existing culverts results in greater headwater elevations at upstream culverts due to their close proximity to one another and these headwater elevations are above the top of banks for almost all of the cross-sections in between the culverts.

The following table shows the calculated 10% chance (10 year) storm event flows to the culverts not located beneath an existing road, the corresponding headwater (HW) elevation, and the elevation of the top inside of the culvert. Please see Appendix 'B' for calculations related to the existing culvert evaluations.

Ex. Culvert	Calculated Flow to Ex. Culvert, Q_{10} (cfs)	Headwater Elevation at Ex. Culvert	Upstream Elevation of Top Inside of Ex. Culvert
Ex. 12" round concrete cross culvert (E2)	30.7	677.75±	675.75
Ex. 12" round plastic cross culvert (E3)	34.4	677.05±	676.52
Ex. 15" round plastic cross culvert (E4)	34.4	676.71±	676.11
Ex. 18" round CSP cross culvert (E5)	41.4	676.48±	675.52
Ex. 24" round plastic cross culvert (E6)	41.4	675.80±	674.31
Ex. 18" round CSP driveway culvert (E7)	50.7	671.31±	669.79
Ex. 18" round CSP driveway culvert (E9)	50.7	669.84±	667.15
Ex. 18" round CSP driveway culvert (E10)	50.7	669.61±	666.98
Ex. 18" round CSP driveway culvert (E11)	50.7	668.34±	666.70
Ex. 24" round CSP Inlet pipe (E12A)	50.7	668.16±	667.15
Ex. 24" round CSP Outlet pipe (E12)	63.8	668.15±	665.77

The following table shows the calculated 4% chance (25 year) storm event flows to the culverts located beneath existing roads, the corresponding headwater (HW) elevation, and the elevation of the top inside of the culvert. Please see Appendix 'B' for calculations related to the existing culvert evaluations.

Ex. Culvert	Calculated Flow to Ex. Culvert, Q_{25} (cfs)	Headwater Elevation at Ex. Culvert	Elevation of Top Inside of Ex. Culvert
Ex. 35" by 24" CSPA beneath Morrish Road (E1)	18.4	677.52±	677.22
Ex. 18" CSP beneath Farrand Road (E8)	58.8	671.32±	669.85
Ex. 18" round CSP beneath Farrand Road (E12B)	39.7	668.09±	667.50

6. Proposed Improvement Alternatives

Two (2) alternatives were analyzed in order to improve the existing drainage course so that it meets current GCDC-SWM standards.

Alternative 1 discusses improvements along the existing drainage course, including the improvements to the existing culverts for road and driveway crossings and property connection. Alternative 2 discusses improvements to the existing drainage course as a result of re-routing an

upstream portion of the drainage area to the roadside ditch on the west side of Morrish Road and then north to the roadside ditch on the north side of Farrand Road. All of the improvement alternatives will require new easements along the proposed routes for drainage purposes for the Genesee County Drain Commission and for those areas which are located outside of the existing Genesee County Road Commission road right-of-way. The following discusses each alternative in more detail:

- **ALTERNATIVE 1:**

Improvement Alternative 1 involves the cleaning, deepening, and widening of the existing drainage course and removal and replacement of all of the existing culverts and the existing outlet pipes to the main branch of the Leach Drain. This alternative includes a 42" x 29" corrugated steel pipe arch culvert (equivalent 36" round pipe) to replace the existing Morrish Road culvert, 42" round corrugated steel culverts for property connections, 48" round corrugated steel culverts for property connections and driveway crossings, 34" x 53" and 38" x 60" concrete horizontal elliptical culverts (equivalent 42" round pipe and 48" round pipe, respectively) at the Farrand Road crossings to replace the existing culverts, and 38" x 60" and 43" x 63" concrete horizontal elliptical pipes (equivalent 48" round pipe and 54" round pipe, respectively) for the outlet system to the main branch of the Leach Drain. The pipe arch culverts are required due to the minimal amount of cover available beneath Morrish Road, Farrand Road, and along the outlet pipes to the main branch of the Leach Drain. Please see Appendix 'D' for a plan view drawing of proposed Improvement Alternative 1 and the calculations related to the proposed open drain and culvert improvements.

Alternative 1 proposes to clean, deepen, and widen the existing drainage course, because much of the existing drainage course lacks an adequate cross-section and slope to provide drainage. Even though the Genesee County Road Commission re-ditched the roadside ditch, the roadside ditch does not meet GCDC-SWM requirements in order to handle the calculated flows. The typical proposed open drain cross-section consists of a two foot (2') wide bottom and 2:1 (H:V) side slopes. Downstream of ECP-5, the proposed open drain cross-section consists of a two foot (2') wide bottom and 3:1 (H:V) side slopes as the roadside ditch is located within the Genesee County Road Commission right-of-way. The improved roadside ditch on the north side of Farrand Road will require easements adjacent to the existing road right-of-way. Along the drainage course, the open drain will be approximately 3.0-feet to 6.0-feet deep.

The existing 35" x 24" corrugated steel pipe arch culvert beneath Morrish Road (located at ECP-1) is proposed to be removed and replaced with a 42" x 29" corrugated steel pipe arch culvert

(equivalent 36" round pipe). The existing culvert cannot adequately convey the existing flow reaching the culvert. Therefore, under existing conditions water backs up along the ditches on the east side of Morrish Road and into the large, flat low-lying area east of Morrish Road. Residents along the east side of Morrish Road have complained of ponding water very close to their homes. A headwater elevation of approximately 677.5± was computed for the existing culvert, which is close to the existing grade of the adjacent low-lying area. The culvert proposed under Improvement Alternative 1 is intended to be constructed at a lower elevation and provide more adequate conveyance of the runoff in the immediate area. A pipe arch culvert is proposed due to the limited amount of cover available beneath Morrish Road and to provide a lower headwater elevation.

Near ECP-5, the drainage course is proposed to be re-routed so that the drainage course crosses beneath Farrand Road approximately 100 feet east of the existing 18-inch corrugated steel culvert located at ECP-5. The existing 18-inch corrugated steel culvert is proposed to remain in place and will allow storm water runoff to run through it. The re-routed drainage course is proposed to cross beneath Farrand Road through a 38" x 60" horizontal elliptical culvert (equivalent 48" round pipe). The existing culvert cannot adequately convey the existing flow reaching the culvert. Therefore, water backs up along the ditches on the south side of Farrand Road and into the yard areas adjacent to the culvert – which was reported by a resident at the Board of Determination meeting. The proposed 38" x 60" culvert is intended to provide more adequate conveyance of the runoff in the immediate area. A horizontal elliptical culvert is proposed due to the limited amount of cover available beneath Farrand Road. For the purpose of this preliminary evaluation, the assumption was made that all of the flow at ECP-5 would flow through the improved roadside ditch on the north side of Farrand Road. It is likely that a portion of the flow will also travel along the existing roadside ditch on the south side of Farrand Road. During final design some flow along the south side of Farrand Road may be evaluated and considered.

The outlet pipe (P12) to the main branch portion of the Leach Drain is intended to be constructed at the same downstream invert elevation as the existing outfall pipe (E12). Gould Engineering, Inc. field surveyed a cross-section of the existing main branch of the Leach Drain approximately 27-feet downstream of the existing outfall and found the existing drain centerline elevation to be approximately 0.7-foot higher than the existing outfall invert elevation. For this reason, this report recommends that a portion of the main branch of the Leach Drain be re-graded and cleaned out in order to provide positive flow from the outfall.

The following chart lists the proposed culvert sizes required in order to meet Genesee County Drain Commissioner's Office-Surface Water Management standards:

Culvert	Ex. Culvert Size & Type (inches)	Proposed Size & Type (inches)	Calculated Flow to Ex. Culvert, Q_{10} (cfs) or Q_{25} (cfs)	Headwater Elevation at Culvert	Upstream Elevation of Top Inside of Culvert
P1	35" x 24", CSPA	42" x 29", CSPA	Q_{25} = 18.4	676.08±	676.59
P2	12", round concrete	42", round CSP	Q_{10} = 30.7	676.09±	676.49
P3	12", round plastic	42", round CSP	Q_{10} = 34.4	675.62±	676.06
P4	15", round plastic	42", round CSP	Q_{10} = 34.4	674.87±	675.10
P5	18", round CSP	48", round CSP	Q_{10} = 41.4	674.32±	674.96
P6	24", round plastic	48", round CSP	Q_{10} = 41.4	673.76±	674.55
P8	18", round CSP	38" x 60", conc. arch	Q_{25} = 58.8	668.47±	668.77
P9	18", round CSP	48", round CSP	Q_{10} = 50.7	667.84±	667.84
P10	18", round CSP	48", round CSP	Q_{10} = 50.7	667.17±	667.53
P11	18", round CSP	48", round CSP	Q_{10} = 50.7	666.05±	666.39
P12A	24", round CSP	38" x 60", conc. arch	Q_{10} = 50.7	664.99±	665.34
P12	24", round concrete	43" x 63", conc. arch	Q_{10} = 63.8	664.30±	665.04
P12B	18", round CSP	34" x 53", conc. arch	Q_{25} = 39.7	665.41±	665.58

Although some of the above-listed Headwater Elevations may be above the reported Water Surface Elevations of upstream improved drain cross-sections, it should be noted that these headwater elevations are not outside the top of bank of the improved drainage course.

The Preliminary Opinion of Probable Construction Cost (POPCC) for Alternative 1 is $309,306.25±. Further information related to this POPCC may be found in Section 9.

Consideration was given to dividing the flow at ECP-5 between the roadside ditches along the north and south side of Farrand Road. However, it became apparent that this option would still require improvements be made to the roadside ditches on both sides of the road, including improvements to the existing three (3) culverts on the north side of Farrand Road and nine (9) driveway culverts on the south side of Farrand Road. It is presumed that the cost to split the flows at ECP-5 would be greater than the cost of routing all of the flow along the north side of Farrand Road. This option may be further investigated during final design.

- **ALTERNATIVE 2:**

Improvement Alternative 2 involves re-routing some of the existing upstream drainage areas to the roadside ditch on the west side of Morrish Road which would then connect to the roadside ditch on the north side of Farrand Road. Alternative 2 would include the removal and replacement of the existing Morrish Road culvert, the construction of two (2) additional culverts, and the construction or the cleaning, deepening, and widening of an additional 430 feet of roadside ditch. The existing

roadside ditch and culverts along the north side of Farrand Road and downstream from collection point ECP-5 would need to be improved similar to Alternative 1. Please see Appendix 'E' for a plan view drawing of proposed Improvement Alternative 2.

The Preliminary Opinion of Probable Construction Cost (POPCC) for Alternative 2 is $349,285.20±. Further information related to this POPCC may be found in Section 9.

Alternative 2 does not include work in the rear of the parcels like Alternative 1. Alternative 2 is intended to reroute the upstream drainage areas along Morrish Road as previously stated. The rerouting of the upstream drainage areas would reduce the storm water flow along the existing natural drainage course. However, the reduction in flow is not enough that the existing culverts and drainage course along this route would meet GCDC-SWM requirements. The existing natural drainage course from collection point ECP-3 to ECP-5 has enough elevation difference that storm water runoff would appear to be able to flow to the north from ECP-3 without any grading being done along this route. However, between ECP-2 and ECP-3, the natural drainage course has little elevation difference so the storm water runoff in this area will seek its own drainage path either to the north or to the south depending on the amount of rain that occurs. If improvements were to also be proposed along the natural drainage course in addition to those along Morrish Road then the cost for Alternative 2 would increase even more.

8. Recommendations

Based on the preliminary opinion of probable construction costs, the most cost effective alternative appears to be Improvement Alternative 1. Improvement Alternative 1 requires the least amount of new construction and would also result in less culverts and open drains to be maintained and cleaned. Improvement Alternative 1 also improves the natural drainage course, where Alternative 2 does not. Improvement Alternative 2, as discussed above, would require more culverts and open drain improvements and/or construction than Improvement Alternative 1. If constructed, Improvement Alternative 1 should be constructed as one project.

9. Preliminary Opinion of Probable Construction Costs (POPCC)

- **ALTERNATIVE 1:**

Item Description	Qty	Pay Unit	Unit Price	Amount
1. Clearing and Grubbing	2624±	L.F.	$7.00±	$18,368.00±
2. Selective Clearing and Grubbing	1793±	L.F.	$7.00±	$12,551.00±
3. Open Drain Excavation, 2' Bottom	2624±	L.F.	$6.00±	$15,744.00±
4. Restricted Open Drain Excavation, 2' Bottom	1793±	L.F.	$8.00±	$14,344.00±
5. Machine Grading	4417±	L.F.	$5.00±	$22,085.00±
6. 42" Corrugated Steel Pipe	60±	L.F.	$85.00±	$5,100.00±
7. 48" Corrugated Steel Pipe	100±	L.F.	$105.00±	$10,500.00±
8. 42" x 29" Corrugated Steel Pipe Arch	42±	L.F.	$120.00±	$5,040.00±
9. 53" x 34", HE-III culvert	40±	L.F.	$170.00±	$6,800.00±
10. 60" x 38", HE-III culvert	52±	L.F.	$205.00±	$10,660.00±
11. 63" x 43", HE-III culvert	337±	L.F.	$225.00±	$75,825.00±
12. Junction Chamber	1±	Each	$6,000.00±	$6,000.00±
13. Drainage Structure Covers	200±	Lb.	$1.50±	$300.00±
14. 42" x 29" Steel End Section w/ grate	2±	Each	$775.00±	$1,550.00±
15. 64" x 43" Steel End Section w/ grate	1±	Each	$1,800.00±	$1,800.00±
16. 71" x 47" Steel End Section w/ grate	3±	Each	$2,000.00±	$6,000.00±
17. 83" x 57" Steel End Section w/ grate	1±	Each	$2,200.00±	$2,200.00±
18. Plain Rip Rap	80±	S.Y.	$56.00±	$4,480.00±
19. Restoration, open drain (seeding, fertilizer, mulch)	4417±	L.F.	$5.50±	$24,293.50±
20. Restoration, culvert pipe (seeding, fertilizer, mulch)	349±	L.F.	$3.00±	$1,047.00±
21. Compacted Sand Backfill	122±	L.F.	$10.00±	$1,220.00±
22. Road Surface Removal & Replacement	136±	S.Y.	$60.00±	$8,160.00±
23. Driveway Removal & Replacement, Aggregate	178±	S.Y.	$40.00±	$7,120.00±
24. Soil Erosion & Sedimentation Control	1±	LSum	$10,000.00±	$10,000.00±
25. Traffic Control	1±	LSum	$10,000.00±	$10,000.00±
			Total	$281,187.50±
			Contingency 10 %	$28,118.75±
			Grand Total	$309,306.25±

Note: The figures given for each item and the total figure of the POPCC is only a preliminary opinion based on data from similar projects as of the date of this study and are subject to change. Easement acquisitions, legal, financial, contract administration, engineering, permits, construction staking, and as-builts drawings are not included in these figures.

- **ALTERNATIVE 2:**

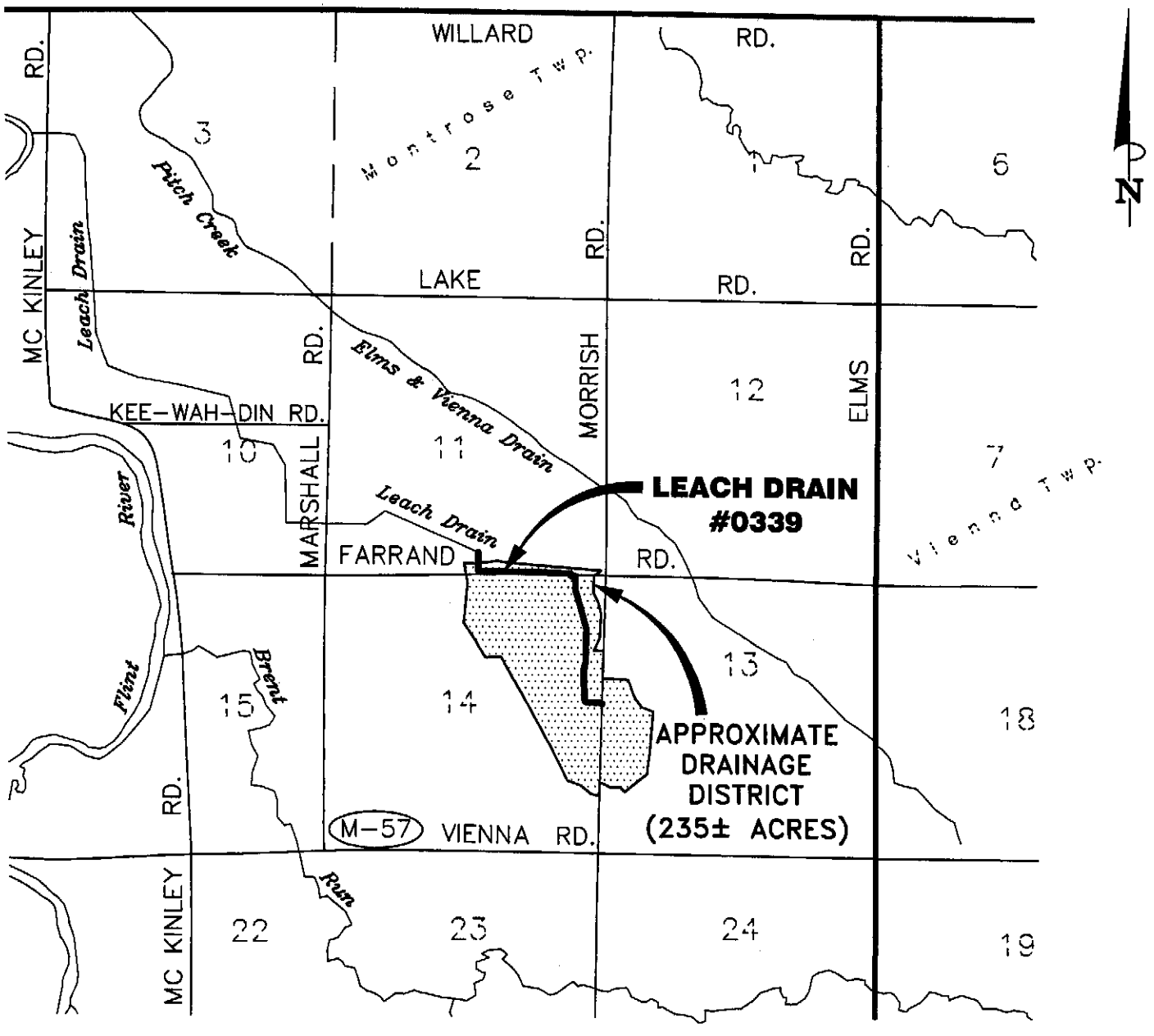
Item Description	Qty	Pay Unit	Unit Price	Amount
1. Selective Clearing and Grubbing	4850±	L.F.	$7.00±	$33,950.00±
2. Restricted Open Drain Excavation, 2' Bottom	4850±	L.F.	$8.00±	$38,800.00±
3. Machine Grading	4850±	L.F.	$5.00±	$24,250.00±
4. 48" Corrugated Steel Pipe	245±	L.F.	$105.00±	$25,725.00±
5. 42" x 29" Corrugated Steel Pipe Arch	42±	L.F.	$120.00±	$5,040.00±
6. 53" x 34", HE-III culvert	40±	L.F.	$170.00±	$6,800.00±
7. 60" x 38", HE-III culvert	52±	L.F.	$205.00±	$10,660.00±
8. 63" x 43", HE-III culvert	337±	L.F.	$225.00±	$75,825.00±
9. Junction Chamber	1±	Each	$6,000.00±	$6,000.00±
10. Drainage Structure Covers	200±	Lb.	$1.50±	$300.00±
11. 42" x 29" Steel End Section w/ grate	2±	Each	$775.00±	$1,550.00±
12. 64" x 43" Steel End Section w/ grate	1±	Each	$1,800.00±	$1,800.00±
13. 71" x 47" Steel End Section w/ grate	1±	Each	$2,000.00±	$2,000.00±
14. 83" x 57" Steel End Section w/ grate	1±	Each	$2,200.00±	$2,200.00±
15. Plain Rip Rap	80±	S.Y.	$56.00±	$4,480.00±
16. Restoration, Restricted Open Drain (seeding, fertilizer, mulch)	4850±	L.F.	$5.50±	$26,675.00±
17. Restoration, culvert pipe (seeding, fertilizer, mulch)	349±	L.F.	$3.00±	$1,047.00±
18. Compacted Sand Backfill	287±	L.F.	$10.00±	$2,870.00±
19. Road Surface Removal & Replacement	136±	S.Y.	$60.00±	$8,160.00±
20. Driveway Removal & Replacement, Aggregate	235±	S.Y.	$40.00±	$9,400.00±
21. Soil Erosion & Sedimentation Control	1±	LSum	$15,000.00±	$15,000.00±
22. Traffic Control	1±	LSum	$15,000.00±	$15,000.00±
			Total	$317,532.00±
			Contingency 10 %	$31,753.20±
			Grand Total	$349,285.20±

Note: The figures given for each item and the total figure of the POPCC is only a preliminary opinion based on data from similar projects as of the date of this study and are subject to change. Easement acquisitions, legal, financial, contract administration, engineering, permits, construction staking, and as-builts drawings are not included in these figures.

10. Appendices

Appendix 'A'

- **Location Map**



APPENDIX 'A'

LOCATION MAP

SCALE: 1" = 3000'±

PRELIMINARY DRAINAGE STUDY FOR:

LEACH DRAIN #0339

DATE: OCTOBER 8, 2008

PREPARED FOR:
GENESEE COUNTY DRAIN COMMISSIONER
SURFACE WATER MANAGEMENT DIVISION
G-4608 BEECHER ROAD, FLINT, MICHIGAN 48532

GOULD ENGINEERING, INC.
2040 E. MAPLE AVENUE FLINT, MICHIGAN 48507
PHONE: 810-743-9120 FAX: 810-743-1797
www.gouldengineering.com

Appendix 'B'

- **Standard Charts and Values Used in Calculations**

GENESEE COUNTY DRAIN COMMISSIONER'S OFFICE
-DIVISION OF
SURFACE WATER MANAGEMENT
JEFFREY WRIGHT
COMMISSIONER
G-4608 BEECHER ROAD, FLINT, MI 48532
PHONE (810) 732-1590 FAX (810) 732-1474

Revised November 1, 2006
Effective immediately

STORM SEWER DESIGN PARAMETERS
FOR GENESEE COUNTY

IN AN EFFORT TO STANDARDIZE DESIGN PROCEDURES FOR STORM SEWERS AND OPEN CHANNELS IN GENESEE COUNTY, THE GENESEE COUNTY DRAIN COMMISSIONER HAS DEVELOPED THESE STANDARDS. IT IS HOPED THAT THESE STANDARDS WILL FACILITATE PLANNING FROM BOTH THE POSIITON OF THE DESIGN AND REVIEWING ENGINEER.

IT IS RECOGNIZED THE DESIGN CONDITIONS VARY AND THERE IS NO SUBSTITUTE FOR THE JUDGEMENT OF AN EXPERIENCED ENGINEER. IN ALL CASES THIS JUDGEMENT SHOULD BE APPLIED.

MANY STREAMS LOCATED IN THIS COUNTY DO NOT HAVE STREAM GAGING DATA AVAILABLE OR THE PERIOD OF RECORD IS NOT OF SUFFICIENT LENGTH TO ALLOW THE DESIGN ENGINEER TO ESTIMATE FLOOD FLOWS BY USING FLOOD-FREQUENCY ANALYSIS AS DEVELOPED BY U.S.G.S. PRIOR TO DESIGN OF ANY STORM DRAIN IMPROVEMENT OR ENCLOSURE THE CONSULTANT SHALL INVESTIGATE ANY GAGING STATION, PARTIAL RECORD GAGING STATION OR CREST STAGE GAGES ON THE DESIGN BASIN FOR AVAILABLE PERTINENT DATA ON FLOOD FLOWS.

WHERE INSUFFICIENT DATA IS PRESENT TO DEVELOP BASIN HYDROLOGY BY THE ABOVE METHOD THE CONSULTANT SHALL DETERMINE FLOWS ALONG THE BASIN BY THE S.C.S. METHOD, THE RATIONAL METHOD, THE BRATER METHOD OR A COMBINATION OF ANY OF THE ABOVE NAMED METHODS. THE BASIN HYDROLOGY SHALL BE APPROVED BY THE GENESEE COUNTY DRAIN COMMISSIONER'S OFFICE PRIOR TO PROCEEDING WITH THE FINAL DESIGN OF A GIVEN PROJECT.

DESIGN PROJECTS SHALL BE DEVELOPED IN ACCORDANCE WITH THE FOLLOWING FLOOD FREQUENCIES.

A. 100 YEAR STORM ON BASIN DEVELOPMENT PROJECT TO YEAR 2000:

1. CULVERTS OR BRIDGES CROSSING STATE HIGHWAYS OR EXPRESSWAYS WHERE THE UPSTREAM DRAINAGE AREA IS IN EXCESS OF 2 SQUARE MILES.
2. DETENTION PONDS.
3. DRAINAGE ENCLOSURES IN EXCESS OF 100 FEET WHERE THE UPSTREAM DRAINAGE AREA IS IN EXCESS OF 2 SQUARE MILES.

SUMMATION OF THE INLET TIME PLUS THE TIME OF FLOW IN THE SEWER. FOR URBANIZED AREA A MINIMUM INITIAL TIME OF 20 MINUTES SHALL BE ACCEPTABLE FOR DESIGN AND FOR AVERAGE RURAL BASINS AN INITIAL TIME OF CONCENTRATION OF 30 MINUTES WILL PRESENT AN ADEQUATE TIME FOR STORM FLOWS TO PEAK. THE FLOW TIME IN AN ENCLOSED SYSTEM SHALL BE CALCULATED BY STANDARD DESIGN CHARTS. FOR CHANNEL VELOCITY THE STANDARD MANNING EQUATION $V=1.486\ R^{2/3}\ S^{1/2}$ SHALL BE ACCEPTED. A CHART LISTING ACCEPTED N VALUES FOR STORM SEWER DESIGN IS ENCLOSED FOR USE IN DESIGN ANALYSIS.

3. **RUNOFF COEFFICIENT** - THE BASIN DEVELOPMENT SHALL BE PROJECTED TO THE YEAR 2000 AND THE RUNOFF COEFFICIENT MUST BE DETERMINED ON THE BASIS OF THIS PROJECTED DEVELOPMENT USING THE FOLLOWING:

A	FLAT UNDEVELOPED LANDS, FARMS, NONWOODED	0.25
B	WOODLANDS & SLOPED UNDEVELOPED LAND	0.30
C	PARKS, CEMETARIES, PLAYGROUNDS, DISTURBED GROUND	0.35
D	RESIDENTIAL	0.40
E	APARTMENTS, CONDOMINIUMS OF LT. MANUFACTURER	0.50
F	COMMERICAL AND INDUSTRIAL	0.70
G	IMPERVIOUS AREAS (PARKING, ROOF, ETC..)	0.95
H	OPEN WATER	1.00

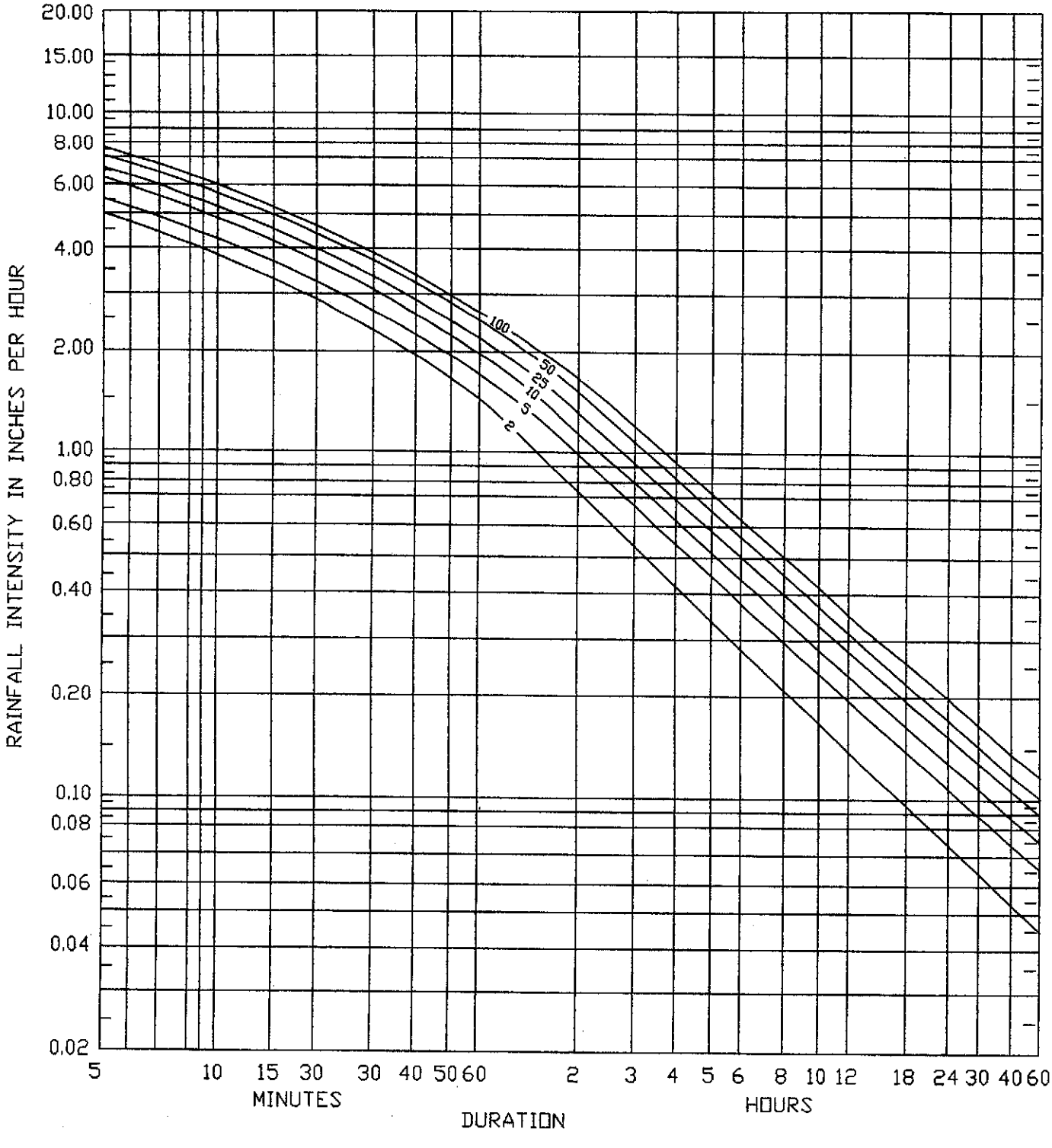
OUTLET CONDITIONS

ALL STORM SYSTEMS SHALL BE DESIGNED TO EXIT INTO AN OUTLET WITH SUFFIECIENT CARRYING CAPACITY TO CARRY THE ADDITIONAL DESIGN FLOW.

THE DESIGNER SHALL ANALYZE THIS CONDITION AND SUBMIT DATA SUBSTANTIATING HIS CONCLUSIONS. THIS INFORMATION SHALL BE SUBMITTED TO THE DRAIN COMMISSIONER ALONG WITH THE REQUIRED DESIGN FORMS.

IN THE EVENT THE DESIGNER DOES NOT HAVE SUFFICIENT CAPACITY IN THE OUTLET THE FOLLOWING CRITERIA SHALL APPLY:

1. THE SYSTEM SHALL BE DESIGNED TO OUTLET ONLY EXISTING RUNOFF. EXISTING RUNOFF SHALL CONSIST OF ALL WATER



GENESEE COUNTY
SWM
DRAIN COMMISSIONER

RAINFALL INTENSITY - DURATION - FERQUENCY CURVES
FOR FLINT, MI

Appendix 'C'

- **Existing Drainage Area Map**
- **Existing Drainage System Calculations**