CHAPMAN DRAIN, DYE ROAD EXTENSION OF #0541

SECTION 17, T7N-R6E,
FLINT TOWNSHIP,
GENESEE COUNTY, MICHIGAN

PRELIMINARY ENGINEERING REPORT (PHASE I)

DECEMBER 2009

• PREPARED FOR •

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° CIVIL ENGINEERS ° SURVEYORS ° LAND PLANNERS

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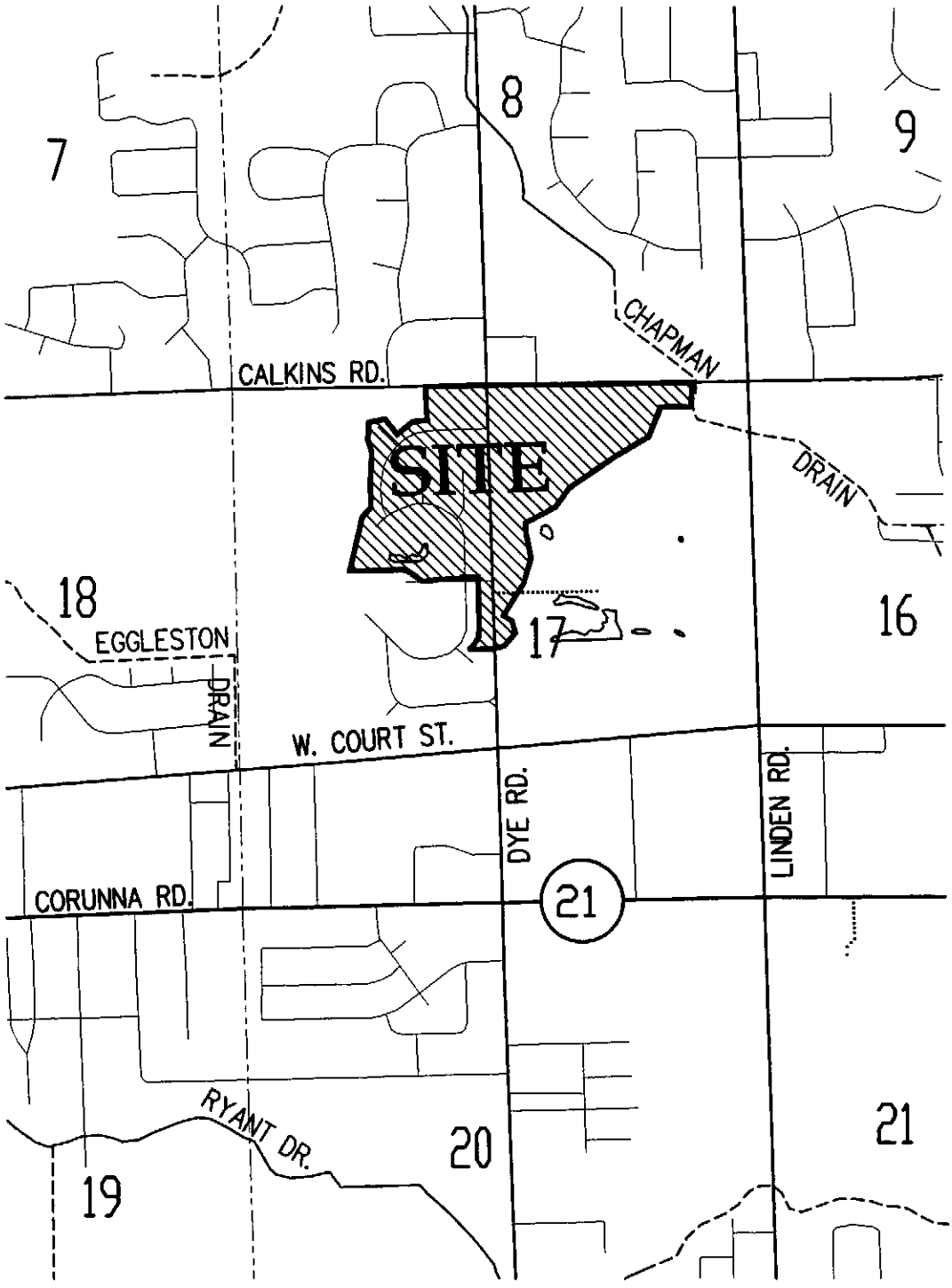

SUMMARY

The purpose of this report is to identify existing drainage concerns and issues, and to offer solutions for drainage problems occurring within the Chapman Drain, Dye Road Extension of #0541 Drainage District. The study area is located west and east of Dye Road between Court Street and Calkins Road, and includes the northern half of the Dyewood Subdivisions in Section 17 of Flint Township. The study area includes approximately 104 acres of land, all tributary to the Chapman Drain and all within the existing drainage district.[1]

Presently there are drainage problems and concerns along both sides of Dye Road between Court Street and Calkins Road, and within the Dyewood Subdivisions where existing residential properties are subject to flooding due to the lack of an adequate drainage system. Residents submitted a petition to the County Drain Commissioner of the County of Genesee, dated June 21, 2009. Various residents of the Dyewood Subdivisions signed the petition calling for the cleaning, deepening, widening, straightening, extending, tiling, relocating, maintaining of the drain known and designated as the Chapman Drain, Dye Road Extension of #0541.

A Board of Determination meeting was held at the Flint Township Hall on August 25, 2009. The recorded meeting minutes indicate that many of the residents had concerns about drainage problems and issues within the Dyewood Subdivisions and along Dye Road. Residents expressed concerns over drainage improvements that will be necessary to facilitate the proposed Dyewood Subdivision road pavement rehabilitation project that is currently being designed by Kraft Engineering and Surveying, Inc., as a consultant to the Genesee County Road Commission. Following the petition and public comments, the Board of Determination determined that the Chapman Drain, Dye Road Extension of, project was necessary.

The existing drainage system for the study area consists of a combination of open ditch and storm sewer pipe. The downstream end of the existing main line drainage system begins at thee existing road ditch on the south side of Calkins Road at the Chapman Drain. The road ditch then proceeds westerly 1,100 feet along the south side of Calkins Road to the end of an existing 18 inch storm sewer; the 18 inch storm sewer then proceeds westerly approximately 700 feet; (the exact location of the existing 18 inch storm sewer is unknown); a 12 inch storm sewer then proceeds southwesterly and southerly along the east side of Dye Road to a point approximately 1,100 feet south of Calkins Road to the end of the existing County Drain (the exact location of the existing 12 inch storm sewer is unknown); the project would also include taking over the existing private storm sewer within the Dyewood Subdivision along the following course: the 12 inch storm then proceeds southwesterly and westerly across Dye Road and Butternut Tree Court to the northwesterly corner of Lot 129 of Dyewood No. 6 Subdivision; the 12 inch storm sewer then proceeds southwesterly to North Dyewood Drive and westerly along North Dyewood Drive to Tuliptree Court; the 12 inch storm sewer then proceeds southerly across Lot 109 of Dyewood No. 6 to the north edge of the Islamic Center property. There are two 12 inch storm sewer inlet branches flowing from North Dyewood Drive to the northerly and easterly sides of the Islamic Center Property along westerly line of Lot 111 and the northerly line of Lot 104 of said Dyewood No. 6. There is another 12 inch storm sewer branch running along Oaktree

[1] See Page1 "Site Location Map"

Drive from Dye Road westerly to the westerly side of Oaktree Court that currently drains into the Dye Road ditch.

We have determined from the meeting minutes, and from our direct observation of the study area that there are several drainage issues tied to the flooding problems in the study area. The main issues to be addressed by this study therefore are as follows:

1. Flooding on both sides of Dye Road within the road right-of-way and on private property.
2. Flooding within the Dyewood Subdivisions, primarily in the rear yards fronting on the south side of North Dyewood Drive.
3. Inadequacy of drainage conveyance within and from the Dyewood Subdivisions to the existing Chapman Drain.
4. Several washouts along the existing drainage system indicate necessary replacement.

From our observations, the existing storm sewer system within the Dyewood Subdivision is undersized and in poor to fair condition at best. The existing storm sewer(s) draining to and from the low area on the north side of the Islamic Center property are plugged up and not working properly. The existing storm sewer outlet running northerly and easterly from the east side of Dye Road is undersized and plugged up immediately east of Dye Road and is not functioning properly, which causes the Dye Road ditches to fill up with storm water after heavy rainfalls. The Oaktree Drive storm sewer branch is shallow and plugged up where it outlets into the Dye Road ditch. The entire drainage system within the study area does not meet current design standards.

POTENTIAL SOLUTIONS:

Two alternative solutions have been developed to address the drainage issues in the study area. Each plan would provide a drainage system that would provide a proper drainage outlet for the entire study area, including the Dyewood Subdivisions. The existing and/or proposed drainage system would collect drainage from all roads, yards, fields, and other areas within the study drainage area. The two alternative plans are described in detail later in this report.

DRAINAGE AREAS

For hydrologic analysis and preliminary design, a drainage area map was prepared showing the tributary areas.[2] The map is based upon aerial photogrammetry from the Genesee County Drain Commission, ca. 2002, current tax parcel and zoning information from Genesee County Equalization, existing as-built drawings of public record, satellite imagery from the National Map, 3/27/1999, and current survey data by Kraft Engineering & Surveying, Inc.

The drainage basin, and sub-basin areas were delineated on the Drainage Area Map. From the map, it has been determined that a total of approximately 104 acres will be served by the proposed drainage system(s) in the #0541 Dye Road Extension of Chapman Drain area.

[2] See Exhibit Nos. 5 & 6 "Drainage Maps

LAND USE

The Dye Road and Calkins Road frontage areas are primarily occupied by rural residential parcels with areas from 1/2 acre to 2-1/2 acres. Areas east and south of the Dye Road and Calkins Road frontage parcels are vacant land. Two churches are located on the south side of Calkins Road east of Dye Road. Dyewood No. 2 and Dyewood No. 6 Subdivisions are included in the study area, along with the northerly side of the Islamic property lying between North Dyewood Drive and South Dyewood Drive.

SOIL TYPES

Soil types have been determined from the "Soil Survey of Genesee County, Michigan", Map Sheet #24, April 1972, USDA. The predominant soil classification in this area is Perrin Loamy Sand and Boyer Loamy Sand.

The hydrologic soil groups for the above soils, as defined by the Soil Conservation services, are as follows:

Map Unit Legend

Genesee County, Michigan (MI049)			
Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
BrA	Boyer loamy sand, 0 to 2 percent slopes	14.9	12.9%
BrB	Boyer loamy sand, 2 to 6 percent slopes	9.5	8.2%
Bw	Brookston loam	6.6	5.7%
CvA	Conover loam, 0 to 2 percent slopes	2.2	1.9%
CxB	Croswell sand, 0 to 6 percent slopes	8.4	7.3%
Gd	Gilford sandy loam	0.2	0.2%
PeA	Perrin loamy sand, 0 to 2 percent slopes	69.7	60.3%
W	Water	0.7	0.6%
WeA	Wasepi sandy loam, 0 to 2 percent slopes	3.3	2.9%
Totals for Area of Interest		**115.6**	**100.0%**

PeA: The Perrin series consists of moderately well drained, nearly level and gently sloping sandy and loamy soils on washout plains and river terraces.

BrA & BrB: The Boyer Series consists of well drained, nearly level to moderately steep soils that formed in sandy and loamy deposits.


83° 47' 27"
83° 46' 21"
43° 1' 1"
43° 1' 3"
272600
272700
272800
272900
273000
273100
273200
273300
273400
273500
273600
273700
273800
273900
274000
4766400
4766300
4766200
4766100
4766000
4765900
4765800
4765700
4765600
4765500
Oakrees Rd
Oakrose Dr
Oakrose Ct
Tulip Tree Ct
Butternut Tree Ct
Dyer Rd
Dyerwood Dr
Maplecrest Dr
Birchtree Ct
Villa Lurise Pkwy
Villa Lurise Ct
Linden Rd
43° 0' 29"
43° 0' 30"
83° 47' 26"
83° 46' 20"
N
Map Scale: 1:7,170 if printed on A size (8.5" x 11") sheet.
Meters
0 50 100 200 300
Feet
0 350 700 1,400 2,100

HYDROLOGY

For this report, and for purposes of estimating pipe sizes and costs, the Rational Method has been used to determine peak runoff at various points of concentration in this watershed.

Use of the rational method is approved by the Genesee County Drain Commission for determining the 10-year flood flows for areas less than 300 acres in size. The standard form of the rational formula is:

$Qp = C * i * A$ | where Qp is the peak flow in cubic feet per second,'C' is a coefficient of runoff determined by surface conditions, 'i' is the rainfall intensity in inches/hour, and 'A' is the watershed area in acres.

In the Rational Method, many factors such as: land usage, land form, impervious surface area, rainfall, soils, slopes and conveyances are taken into account in the determination of the three factors.

The value for C is generally determined either by weighted averaging for the area under consideration, or by Engineer's estimation and judgment, or by consulting the Genesee County Drain Commission's regulatory chart based upon standard land usage patterns. For this report, the Genesee County Drain Commission's regulatory chart based upon standard land usage patterns was used to determine 'C'.

The rainfall intensity "i" may be determined from tabulated values, or from I.D.F. (Intensity, Duration, Frequency) charts for Genesee County, or from the formula:

$i\ (10\text{-yr}) = 166.37 / (tc + 23.305)$ where 'tc' is the time of concentration in minutes for the drainage basin in question. For this report, the formula method was used.

For road cross culvert, the Genesee County Road Commission requires that the culvert convey the 25-year storm water flow with no headwater. To determine the 25-year flow the formula is changed to:

$i\ (25\text{-yr}) = 191.76 / (tc + 25.93)$

Areas for 'A' were determined from the drainage area map.

ESTIMATED PEAK FLOWS

The mapped drainage areas were analyzed and peak flows were determined using the Rational Method. In general a runoff coefficient of 0.35 was used for the residential lots in the Dyewood Subdivisions; a runoff coefficient of 0.40 was used for the church area at the southeast corner of Dye Road and Calkins Road; and a runoff coefficient of 0.25 was used for the larger vacant grass/field/wooded areas with the drainage area.

To determine the rainfall intensity, the following information was used:

- Flow lengths were determined from the drainage area maps. The overall slope of the tributary area in the Dye Road to Calkins Road area is 0.001 feet per foot (or 0.10 percent). The overall slope of the tributary area in the Calkins Road area east of Dye Road is 0.013 feet per foot (or 1.3 percent).
- The types of cover in the upper reaches of the drainage district were generally determined to be 'Grass Fields & Lawns.'
- Time of Concentration for sheet and waterway flows was determined using the formula approved by the Genesee County Drain Commission.
- A minimum initial time of concentration of 30 minutes was selected. Pipeline transmission times were added to the initial time to determine the downstream time of concentrations. A 50 minute initial time of concentration was used for the large areas east of Dye Road flowing to the south side of Calkins Road.
- The Genesee County Drain Commission's previously mentioned formula was then used to calculate the rainfall intensity for each drainage area.

Ten year flood flows were calculated for each map point, 1 thru 23, utilizing the overall drainage maps which may be found in Exhibit Nos. 3 and 4 at the back of this report. The estimated ten year flood flows are summarized as follows:

DYE ROAD EXTENSION OF CHAPMAN DRAIN

Location/Point No.	Description	Est. Peak Flows (cfs) Alt. No. 1	Alt. No. 2
Pt. 1-2A	Inlet	3.87	3.87
Pt. 3-5A	Inlet	3.54	3.54
Pt. 6A - 7	Outlet	3.68	9.05
Pt. 8 - 9	Storm Sewer	4.16	14.41
Pt. 9 - 11	Storm Sewer	7.70	21.01
Pt. 12 - 13	Storm Sewer	9.21	26.39
Pt. 13 - 14	Storm Sewer	10.65	28.35
Pt. 15 - 14	Storm Sewer	8.42	8.42
Pt. 14 - 21	Storm Sewer	27.12	50.78
Pt. 16 - 17	Storm Sewer	1.28	1.28
Pt. 18 - 19	Storm Sewer	4.12	4.12
Pt. 19 - 20	Storm Sewer	8.39	8.39
Pt. 20 - 21	Storm Sewer	10.53	10.53
Pt. 21 - 22	Storm Sewer	33.83	57.12
Pt. 22 - 23	Storm Sewer	37.58	60.80
Pt. 23 - 28	Ditch Outlet	40.05	63.89

HYDRAULICS

To estimate both pipe, and channel sizes for this report, Genesee County Drain Commission standard calculations have been used. [3]

Hydraulic computations for both open channel flow and for enclosed pipe flow, have been computed using "Manning's Equation", with standard Manning's friction coefficients specified by the Genesee County Drain Commission.

Manning's Equation derives from the empirical Chezy-Manning relationship used to study the relationship of channel velocity to parameters slope, channel bed condition, and shape. Its general form is:

V = 1.486 * R^(2/3) * S0^(1/2) / n - | where 'V' is average velocity, 'S0' is the slope, 'n' is the Manning's friction coefficient, 1.486 is a conversion factor to English Customary units, and 'R' is the hydraulic radius of the conveyance, determined from its geometry using the equation:

R = A / P | where 'A' is the cross-sectional area of flow, and 'P' is the wetted perimeter.

By substitution of V (average velocity) = Q (discharge) / A (area of cross-section), the equation may be solved for Q and placed in its common form (U.S. customary units) as:

Q = 1.486 * A * R^(2/3) * S0^(1/2) / n

Values for 'n' were chosen from the GCDC-SWM's tabulated values.

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[3] See Exhibits Nos. 3 & 4, Storm Sewer System Design (Spreadsheets)

ALTERNATIVES, DISCUSSION, AND ESTIMATED COSTS

There are two alternatives that have been developed to establish and provide a new drainage system that would address drainage problems and issues within the study area. Both alternatives would provide a new drainage system from the Chapman Drain that would run along Calkins Road and Dye Road to and within the northerly half of the Dyewood Subdivisions. Alternative No. 1 would include a combination of open drain, storm sewer pipe, and a storm water detention basin on the northerly side of the Islamic Center property. Alternative No. 2 would include a combination of open drain and storm sewer pipe, but it would not include a public detention basin on the Islamic Center property as part of the proposed public County Drain. The drainage currently flowing to the Islamic Center property would be rerouted along North Dyewood Drive and the downstream storm sewer pipe and culverts would be larger with Alternative No. 2.

Alternative Nos. 1 and 2 are discussed in detail as follows:

Alternative No. 1: See Exhibit No. 5 for a drainage map showing the proposed open drain and storm sewer, and Exhibit No. 5A for a drainage map showing the proposed storm water detention basin. The current existing drainage system would be replaced with a new drainage system along its entire length. The new main line drain would begin with a open drain that would begin at the existing road ditch on the south side of Calkins Road at the Chapman Drain. A new open drain that would replace the existing road ditch would run westerly 1,250 feet along the south side of Calkins Road. Existing driveway culverts would be replaced with new 49 inch by 33 inch and 57 inch by 38 inch CSP culverts; a new 36 inch storm sewer would then proceed westerly 800 feet along the south side of Calkins Road to the southwest corner of Calkins Road and Dye Road; the new 36 inch storm sewer would continue south 1,160 feet along the west side of Calkins Road to the location of where the existing 12 inch storm sewer outlet currently leaves the Dyewood Subdivision; a new 24 inch storm sewer would then proceed westerly 254 feet into the Dyewood Subdivision to the west side of Butternut Tree Court, along the same route as the existing 12 inch storm sewer; a new 21 inch storm sewer would then proceed along the same route as the existing 12 inch storm sewer westerly 118 feet, southerly 146 feet, and westerly 222 feet along the north side of North Dyewood Drive; a new 15 inch storm sewer would then proceed southwesterly 89 feet across North Dyewood Drive and southerly 210 feet along the west line of Lot 109 of Dyewood No. 6 Subdivision to the north edge of the Islamic Center property where a new storm water detention basin would be constructed along the north side of the Islamic Center property. The new detention basin would collect drainage from the Islamic Center property, from the North Dyewood Drive inlet storm sewers, and from the rear yards of lots fronting on the south side of North Dyewood Drive where storm water currently ponds because there is no functioning drainage outlet.

In addition to the new main line drain described above, new 15 inch storm sewer inlet branches would be constructed to replace the existing 12 inch inlets from North Dyewood Drive to the proposed detention basin along the westerly line of Lot 111 and the northerly line of Lot 104 of Dyewood No. 6 Subdivision. The proposed detention basin would collect storm water drainage from approximately 18.42 acres of land that would be retained in the basin and released at a restricted outlet rate of 0.20 cfs/acre. The restricted outflow reduces the size of the proposed outlet storm sewer from the basin to the Chapman Drain by between 6 and 9 inches in diameter.

Another new storm sewer branch ranging in size from 12 inch to 21 inch in diameter would be constructed along Oaktree Drive from Dye Road to the westerly side of Oaktree Court, to replace the existing 12 inch storm sewer.

It is planned that all proposed new open drain and storm sewer along Calkins Road, Dye Road, North Dyewood Drive, and Oaktree Drive will be constructed within the existing road right-of-way. Some new easements may be required adjacent to the road right-of-way of Oaktree Drive to fit the proposed sewer at its existing location and along the road curve. There are existing 12 foot wide cross lot drainage easements within the Dyewood Subdivisions which may have to be widened and/or upgraded as determined by the Drain Commission. New drainage easements will be required from Lots 109 and Lot 110 of Dyewood No. 6 for the proposed storm sewer outlet from the detention basin. A new easement of approximately 1.6 acres in size will also be required to construct the proposed detention basin on the Islamic Center property.

The estimated cost of Alternative No. 1, not including the cost of land or right-of-way, is as follows:

	Alternative No. 1		
1.	Estimated Net Construction Cost	=	$ 559,680.00
2.	Estimated Total Engineering Cost	=	$ 139,920.00
	Estimated Total Project Cost	=	**$ 699,600.00**

See Exhibit No. 1 for a detailed Cost Estimate of Alternative No. 1

The Cost Estimate for Alternative No. 1 has been divided into two separate costs to reflect the estimated cost of improvements within the Dyewood Subdivisions separately from the estimated costs of improvements outside the Subdivisions. The estimated cost for Alternative No. 1 – Phase 1 includes all proposed improvements west of Dye Road within the Dyewood Subdivisions including the proposed Detention Basin. This work could be constructed as part of the Dyewood Subdivision road rehabilitation project which is currently in the design stage. A temporary new road ditch along Dye Road south of Oaktree Drive is included with the Phase 1 cost to temporarily connect the Oaktree Drive drainage to the existing 12 inch outlet sewer east of Dye Road. The estimated cost for Alternative 1 – Phase 2 includes all proposed downstream drainage outlet improvements along Dye Road and Calkins Road.

The separate estimated costs for Alternative No. 1 – Phases 1 and 2, not including the cost of land or right-of-way, are as follows:

	Alternative No. 1		**Phase 1**	**Phase 2**
1.	Estimated Net Construction Cost	=	$318,175.00	$246,323.00
2.	Estimated Total Engineering Cost	=	$ 79,544.00	$ 61,581.00
	Estimated Total Project Cost	=	**$397,719.00***	**$307,904.00***

* Note that the total amount of Phase 1 and Phase 2 added together ($705,623.00) does not match the total amount of Alternative No. 1 above ($699,600.00), because Phase 1 by itself would require a new temporary and deeper road ditch along Dye Road south of Oaktree Drive until Phase 2 could be constructed.

See Exhibit No. 1A for a detailed Cost Estimate of Phase 1, and Exhibit No. 1B for a detailed Cost Estimate of Phase 2.

Alternative No. 2: See Exhibit No. 6 for a drainage map showing this alternative. This alternative is similar to Alternative No. 1 and follows the same route and course, but it does not include a detention basin, which results in a larger main line drain then Alternative No.1. Drainage from the Islamic Center property has been computed to provide for a ten year storm under a existing land use conditions. A private detention basin would have to be constructed to provide for any possible future development on the Islamic Center property. The new driveway culverts on Calkins Road would be increased to 57 inch x by 38 inch and 64 inch by 43 inch CSP culverts, instead of 49 inch by 33 inch and 57 inch by 38 inch CSP culverts. The new storm sewer along Calkins Road and Dye Road would be 42 inch diameter sewer instead of 36 inch diameter. The new storm sewer within the Dyewood Subdivisions between Dye Road and North Dyewood Drive would be 30 inch diameter sewer instead of 24 inch and 21 inch diameter, and the new storm sewer between North Dyewood Drive and the north edge of the Islamic Center property would be 21 inch diameter sewer instead of 15 inch diameter. A new storm sewer and open drain would be constructed along the rear lot lines of the lots west of the 21 inch outlet to provide a drainage outlet where storm water is currently ponding in the rear yards.

The proposed 15 inch inlet storm sewers from North Dyewood Drive to the north edge of the Islamic Center property are not required with Alternative No. 2. The proposed drainage would be rerouted along North Dyewood Drive to the proposed 30 inch storm sewer outlet. The proposed new 12 inch and 21 inch storm sewer branch on Oaktree Drive would also be included as part of Alternative No. 2.

The drainage easement requirement for Alternative No. 2 is the same as Alternative No. 1, except that an easement will not be required on the Islamic Center property, and new easements would be required across the south side of Lots 109 thru 113 of Dyewood No. 6 to provide for the rear yard drainage.

The estimated cost of Alternative No. 2, not including the cost of and or right-of-way, is as follows:

	Alternative No. 2		
1.	Estimated Net Construction Cost	=	$568,068.00
2.	Estimated Total Engineering Cost	=	$142,017.00
	Estimated Total Project Cost	=	**$710,085.00**

See Exhibit No. 2 for detailed Cost Estimate for Alternative No. 2.

The Cost Estimate for Alternative No. 2 has also been divided into two separate costs to reflect the estimated cost of improvements within the Dyewood Subdivisions separately from the estimated costs of improvements outside the Subdivisions. Alternative No. 2 – Phase 1 includes all proposed improvements west of Dye Road within the Dyewood Subdivisions. This work could be constructed as part of the Dyewood Subdivision road rehabilitation project which is currently in the design stage. A temporary new road ditch along Dye Road south of Oaktree Drive is included within

the Phase 1 cost to temporarily connect the Oaktree Drive drainage to the existing 12" outlet sewer east of Dye Road. The estimated cost for Alternative No. 2 – Phase 2, includes all proposed downstream drainage outlet improvements along Dye Road and Calkins Road.

The separate estimated costs for Alternative No. 2 – Phases 1 and 2, not including the cost of land or right-of-way, are as follows:

	Alternative No. 2		**Phase 1**	**Phase 2**
1.	Estimated Net Construction Cost	=	$294,679.00	$278,295.00
2.	Estimated Total Engineering Cost	=	$ 73,670.00	$ 69,574.00
	Estimated Total Project Cost	=	**$368,349.00***	**$347,869.00***

* Note that the total amount of Phase 1 and Phase 2 added together ($716,218.00) does not match the total amount of Alternative No. 2 on the previous page ($710,085.00), because Phase 1 by itself would require a new temporary and deeper road ditch along Dye Road south of Oaktree Drive until Phase 2 could be constructed.

See Exhibit No. 2A for a detailed cost estimate of Phase 1, and Exhibit No. 2B for a detailed cost estimated of Phase 2.

RECOMMENDATION

Alternative No. 1 (proposed open drain, storm sewer, and detention basin) is slightly less costly than Alternative No. 2 (proposed open drain and storm sewer without detention basin), but it requires that a 1.60 acre drainage easement must be obtained from the Islamic Center property to facilitate construction of the detention basin. The cost estimates do not include the possible cost of land or right-of-way. The cost of an easement for the detention basin could make Alternative No. 1 more costly, and it could also likely take a significant amount of time to actually obtain the easement.

Alternative No. 2 would eliminate the need for a public detention basin by rerouting drainage along North Dyewood Drive and by increasing the size of the proposed downstream storm sewer and culverts.

It is our recommendation that Alternative No. 2 be constructed. Although construction is more expensive, an easement would not be required from the Islamic Center property, which could save money and time that may be required to obtain the easement. The residents have expressed their desire to have this project done as quickly as possible and Alternative No. 2 can provide a faster solution. The time it takes to obtain the detention basin easement could further delay the proposed road rehabilitation project.

EXHIBIT NO. 1

DYE RD. EXTENSION OF CHAPMAN DRAIN COST ESTIMATE ALTERNATIVE NO. 1, Phase 1 & 2

ITEM	AMOUNT	UNIT	UNIT COST	TOTAL
Road Surface Removal and Replacement	350	SY	$ 50.00	$ 17,500
Driveway Surface Removal and Replacement	800	SY	$ 30.00	$ 24,000
Shoulder Removal and Replacement	150	SY	$ 30.00	$ 4,500
Open Drain, 2' Bottom	300	LF	$ 5.00	$ 1,500
Open Drain, 4' Bottom	1050	LF	$ 10.00	$ 10,500
Detention Basin Excavation	5500	CYD	$ 8.00	$ 44,000
Clearing and Grubbing	0.75	ACRE	$ 10,000.00	$ 7,500
12" PVC, SDR 26, Trench Detail 1	50	LF	$ 20.00	$ 1,000
12" Corrugated Steel Sewer, Class III, Trench Detail 1	100	LF	$ 25.00	$ 2,500
15" Corrugated Steel Sewer, Class III, Trench Detail 1	90	LF	$ 30.00	$ 2,700
28" x 20" Corrugated Steel Sewer, Class III, Trench Detail 1	60	LF	$ 35.00	$ 2,100
12" Sewer, Class III, Trench Detail 1	150	LF	$ 30.00	$ 4,500
15" Sewer, Class III, Trench Detail 1	677	LF	$ 35.00	$ 23,695
21" Sewer, Class III, Trench Detail 1	1004	LF	$ 45.00	$ 45,180
24" Sewer, Class III, Trench Detail 1	260	LF	$ 50.00	$ 13,000
36" Sewer, Class III, Trench Detail 1	1810	LF	$ 60.00	$ 108,600
12" Sewer, Class III, Trench Detail 2	92	LF	$ 35.00	$ 3,220
15" Sewer, Class III, Trench Detail 2	142	LF	$ 45.00	$ 6,390
21" Sewer, Class III, Trench Detail 2	397	LF	$ 50.00	$ 19,850
24" Sewer, Class III, Trench Detail 2	82	LF	$ 55.00	$ 4,510
36" Sewer, Class III, Trench Detail 2	150	LF	$ 75.00	$ 11,250
4 ft. diam. Drainage Structure, Catch Basin, 0 to 8 Ft.	20	EA	$ 1,200.00	$ 24,000
5 ft. diam. Drainage Structure, Catch Basin, 0 to 8 Ft.	6	EA	$ 2,000.00	$ 12,000
Additional depth of Drainage Structure	3	FT	$ 250.00	$ 750
Drainage Structure Covers	7850	LB	$ 1.50	$ 11,775
Steel End Section 12" with Steel Bar Grate	5	EA	$ 200.00	$ 1,000
Steel End Section 15" with Steel Bar Grate	3	EA	$ 250.00	$ 750
Steel End Section 28" x 20" with Steel Bar Grate	1	EA	$ 400.00	$ 400
Steel End Section for 15" Concrete Pipe with Steel Bar Grate	2	EA	$ 300.00	$ 600
49" X 33" Corrugated Steel Pipe, 2-2/3" x 1/2" Corrugations, 12 gauge	125	FT	$ 60.00	$ 7,500
57" X 38" Corrugated Steel Pipe, 2-2/3" x 1/2" Corrugations, 12 gauge	250	FT	$ 65.00	$ 16,250
Steel End Section for 36" Concrete Pipe with Steel Bar Grate	1	EA	$ 1,500.00	$ 1,500
49" x 33" Steel Pipe End Section	6	EA	$ 800.00	$ 4,800
57" x 38" Steel Pipe End Section	16	EA	$ 1,000.00	$ 16,000
Plain Riprap	30	SY	$ 40.00	$ 1,200
Topsoil Surface, 4"	20000	SY	$ 2.00	$ 40,000
Chemical Fertilizer Nutrient (240 Lbs/Acre)	960	LB	$ 3.00	$ 2,880
Class A Seeding (200 Lbs/Acre)	800	LB	$ 4.00	$ 3,200
Mulch (2 Tons/Acre)	8	TON	$ 400.00	$ 3,200
Soil Erosion & Sedimentation Control Measures	1	LSUM	$ 3,000.00	$ 3,000

Subtotal				$ 508,800
Contingency @ 10 percent				$ 50,880
Estimated Net Construction Costs				$ 559,680
Estimated Preliminary and Final Engineering Design				$ 55,968
Estimated Construction Engineering				$ 83,952
Engineering Total				$ 139,920
Total Estimated Project Cost (not including Land or Right-of-Way)				$ 699,600

EXHIBIT NO. 1A

DYE RD. EXTENSION OF CHAPMAN DRAIN COST ESTIMATE ALTERNATIVE NO. 1, Phase 1
(Dyewood Subdivision Work)

ITEM	AMOUNT	UNIT	UNIT COST	TOTAL
Road Surface Removal and Replacement	300	SY	$ 50.00	$ 15,000
Driveway Surface Removal and Replacement	300	SY	$ 30.00	$ 9,000
Shoulder Removal and Replacement	75	SY	$ 30.00	$ 2,250
Temporary Open Drain, 2' Bottom	600	LF	$ 5.00	$ 3,000
Open Drain, 2' Bottom	300	LF	$ 5.00	$ 1,500
Detention Basin Excavation	5500	CYD	$ 8.00	$ 44,000
Clearing and Grubbing	0.75	ACRE	$ 10,000.00	$ 7,500
12" PVC, SDR 26, Trench Detail 1	50	LF	$ 20.00	$ 1,000
12" Corrugated Steel Sewer, Class III, Trench Detail 1	100	LF	$ 25.00	$ 2,500
15" Corrugated Steel Sewer, Class III, Trench Detail 1	90	LF	$ 30.00	$ 2,700
28" x 20" Corrugated Steel Sewer, Class III, Trench Detail 1	60	LF	$ 35.00	$ 2,100
12" Sewer, Class III, Trench Detail 1	150	LF	$ 30.00	$ 4,500
15" Sewer, Class III, Trench Detail 1	677	LF	$ 35.00	$ 23,695
21" Sewer, Class III, Trench Detail 1	1004	LF	$ 45.00	$ 45,180
24" Sewer, Class III, Trench Detail 1	260	LF	$ 50.00	$ 13,000
36" Sewer, Class III, Trench Detail 1	8	LF	$ 60.00	$ 480
12" Sewer, Class III, Trench Detail 2	92	LF	$ 35.00	$ 3,220
15" Sewer, Class III, Trench Detail 2	142	LF	$ 45.00	$ 6,390
21" Sewer, Class III, Trench Detail 2	397	LF	$ 50.00	$ 19,850
24" Sewer, Class III, Trench Detail 2	82	LF	$ 55.00	$ 4,510
36" Sewer, Class III, Trench Detail 2	71	LF	$ 75.00	$ 5,325
4 ft. diam. Drainage Structure, Catch Basin, 0 to 8 Ft.	20	EA	$ 1,200.00	$ 24,000
5 ft. diam. Drainage Structure, Catch Basin, 0 to 8 Ft.	3	EA	$ 2,000.00	$ 6,000
Additional depth of Drainage Structure	1	FT	$ 250.00	$ 250
Drainage Structure Covers	5500	LB	$ 1.50	$ 8,250
Steel End Section 12" with Steel Bar Grate	5	EA	$ 200.00	$ 1,000
Steel End Section 15" with Steel Bar Grate	3	EA	$ 250.00	$ 750
Steel End Section 28" x 20" with Steel Bar Grate	1	EA	$ 400.00	$ 400
Steel End Section for 15" Concrete Pipe with Steel Bar Grate	2	EA	$ 300.00	$ 600
Topsoil Surface, 4"	12000	SY	$ 2.00	$ 24,000
Chemical Fertilizer Nutrient (240 Lbs/Acre)	600	LB	$ 3.00	$ 1,800
Class A Seeding (200 Lbs/Acre)	500	LB	$ 4.00	$ 2,000
Mulch (2 Tons/Acre)	5	TON	$ 400.00	$ 2,000
Soil Erosion & Sedimentation Control Measures	1	LSUM	$ 1,500.00	$ 1,500

Subtotal				$ 289,250
Contingency @ 10 percent				$ 28,925
Estimated Net Construction Costs				$ 318,175
Estimated Preliminary and Final Engineering Design				$ 31,818
Estimated Construction Engineering				$ 47,726
Engineering Total				$ 79,544
Total Estimated Project Cost (not including Land or Right-of-Way)				$ 397,719

EXHIBIT 1B

DYE RD. EXTENSION OF CHAPMAN DRAIN COST ESTIMATE ALTERNATIVE NO. 1, Phase 2
(Dye Road and Calkins Road Outlet Work)

ITEM	AMOUNT	UNIT	UNIT COST	TOTAL
Road Surface Removal and Replacement	50	SY	$ 50.00	$ 2,500
Driveway Surface Removal and Replacement	500	SY	$ 30.00	$ 15,000
Shoulder Removal and Replacement	75	SY	$ 30.00	$ 2,250
Open Drain, 4' Bottom	1050	FT	$ 10.00	$ 10,500
12" Sewer, Class III, Trench Detail 1	30	LF	$ 30.00	$ 900
36" Sewer, Class III, Trench Detail 1	1810	LF	$ 60.00	$ 108,600
36" Sewer, Class III, Trench Detail 2	79	LF	$ 75.00	$ 5,925
5 ft. diam. Drainage Structure, Catch Basin, 0 to 8 Ft.	3	EA	$ 2,000.00	$ 6,000
Additional depth of Drainage Structure	2	FT	$ 250.00	$ 500
Drainage Structure Covers	2350	LB	$ 1.50	$ 3,525
49" X 33" Corrugated Steel Pipe, 2-2/3" x 1/2" Corrugations, 12 gauge	125	FT	$ 60.00	$ 7,500
57" X 38" Corrugated Steel Pipe, 2-2/3" x 1/2" Corrugations, 12 gauge	250	FT	$ 65.00	$ 16,250
Steel End Section for 36" Concrete Pipe with Steel Bar Grate	1	EA	$ 1,500.00	$ 1,500
49" x 33" Steel Pipe End Section	6	EA	$ 800.00	$ 4,800
57" x 38" Steel Pipe End Section	16	EA	$ 1,000.00	$ 16,000
Plain Riprap	30	SY	$ 40.00	$ 1,200
Topsoil Surface, 4"	8000	SY	$ 2.00	$ 16,000
Chemical Fertilizer Nutrient (240 Lbs/Acre)	360	LB	$ 3.00	$ 1,080
Class A Seeding (200 Lbs/Acre)	300	LB	$ 4.00	$ 1,200
Mulch (2 Tons/Acre)	3	TON	$ 400.00	$ 1,200
Soil Erosion & Sedimentation Control Measures	1	LSUM	$ 1,500.00	$ 1,500

Subtotal				$ 223,930
Contingency @ 10 percent				$ 22,393
Estimated Net Construction Costs				$ 246,323
Estimated Preliminary and Final Engineering Design				$ 24,632
Estimated Construction Engineering				$ 36,948
Engineering Total				$ 61,581
Total Estimated Project Cost (not including Land or Right-of-Way)				$ 307,904

EXHIBIT NO. 2

DYE RD. EXTENSION OF CHAPMAN DRAIN COST ESTIMATE ALTERNATIVE NO. 2, Phase 1 & 2

ITEM	AMOUNT	UNIT	UNIT COST	TOTAL
Road Surface Removal and Replacement	350	SY	$ 50.00	$ 17,500
Driveway Surface Removal and Replacement	1000	SY	$ 30.00	$ 30,000
Shoulder Removal and Replacement	150	SY	$ 30.00	$ 4,500
Open Drain, 2' Bottom	300	FT	$ 5.00	$ 1,500
Open Drain, 4' Bottom	1050	FT	$ 10.00	$ 10,500
12" Corrugated Steel Sewer, Class III, Trench Detail 1	100	LF	$ 25.00	$ 2,500
15" Corrugated Steel Sewer, Class III, Trench Detail 1	90	LF	$ 30.00	$ 2,700
28" x 20" Corrugated Steel Sewer, Class III, Trench Detail 1	60	LF	$ 35.00	$ 2,100
12" Sewer, Class III, Trench Detail 1	330	LF	$ 30.00	$ 9,900
15" Sewer, Class III, Trench Detail 1	793	LF	$ 35.00	$ 27,755
21" Sewer, Class III, Trench Detail 1	1000	LF	$ 45.00	$ 45,000
30" Sewer, Class III, Trench Detail 1	494	LF	$ 55.00	$ 27,170
42" Sewer, Class III, Trench Detail 1	1810	LF	$ 70.00	$ 126,700
12" Sewer, Class III, Trench Detail 2	92	LF	$ 35.00	$ 3,220
21" Sewer, Class III, Trench Detail 2	175	LF	$ 50.00	$ 8,750
24" Sewer, Class III, Trench Detail 2	147	LF	$ 55.00	$ 8,085
30" Sewer, Class III, Trench Detail 2	246	LF	$ 60.00	$ 14,760
42" Sewer, Class III, Trench Detail 2	150	LF	$ 85.00	$ 12,750
4 ft. diam. Drainage Structure, Catch Basin, 0 to 8 Ft.	15	EA	$ 1,200.00	$ 18,000
6 ft. diam. Drainage Structure, Catch Basin, 0 to 8 Ft.	5	EA	$ 2,500.00	$ 12,500
8 ft. diam. Drainage Structure, Catch Basin, 0 to 8 Ft.	6	EA	$ 3,500.00	$ 21,000
Additional depth of Drainage Structure	3	FT	$ 350.00	$ 1,050
Drainage Structure Covers	7850	LB	$ 1.50	$ 11,775
Steel End Section 12" with Steel Bar Grate	5	EA	$ 200.00	$ 1,000
Steel End Section 15" with Steel Bar Grate	3	EA	$ 250.00	$ 750
Steel End Section 28" x 20" with Steel Bar Grate	1	EA	$ 400.00	$ 400
57" X 38" Corrugated Steel Pipe, 2-2/3" x 1/2" Corrugations, 12 gauge	125	FT	$60	$ 7,500
64" X 43" Corrugated Steel Pipe, 2-2/3" x 1/2" Corrugations, 12 gauge	250	FT	$65	$ 16,250
Steel End Section for 12" Concrete Pipe with Steel Bar Grate	1	EA	$ 250.00	$ 250
Steel End Section for 42" Concrete Pipe with Steel Bar Grate	1	EA	$ 2,000.00	$ 2,000
57" X 38" Steel Pipe End Section	6	EA	$1,000	$ 6,000
64" X 43" Steel Pipe End Section	16	EA	$1,400	$ 22,400
Plain Riprap	30	SY	$ 40.00	$ 1,200
Topsoil Surface, 4"	14500	SY	$ 2.00	$ 29,000
Chemical Fertilizer Nutrient (240 Lbs/Acre)	720	LB	$ 3.00	$ 2,160
Class A Seeding (200 Lbs/Acre)	600	LB	$ 4.00	$ 2,400
Mulch (2 Tons/Acre)	6	TON	$ 400.00	$ 2,400
Soil Erosion & Sedimentation Control Measures	1	LSUM	$ 3,000.00	$ 3,000

Subtotal				$ 516,425
Contingency @ 10 percent				$ 51,643
Estimated Net Construction Costs				$ 568,068
Estimated Preliminary and Final Engineering Design	1	LSUM		$ 56,807
Estimated Construction Engineering	1	LSUM		$ 85,210
Engineering Total				$ 142,017
Total Estimated Project Cost (not including Land or Right-of-Way)				$ 710,085

EXHIBIT NO. 2A

DYE RD. EXTENSION OF CHAPMAN DRAIN COST ESTIMATE ALTERNATIVE NO. 2, Phase 1
(Dyewood Subdivision Work)

ITEM	AMOUNT	UNIT	UNIT COST	TOTAL
Road Surface Removal and Replacement	300	SY	$ 50.00	$ 15,000
Driveway Surface Removal and Replacement	500	SY	$ 30.00	$ 15,000
Shoulder Removal and Replacement	75	SY	$ 30.00	$ 2,250
Temporary Open Drain, 2' Bottom	600	FT	$ 5.00	$ 3,000
Open Drain, 2' Bottom	300	FT	$ 5.00	$ 1,500
12" Corrugated Steel Sewer, Class III, Trench Detail 1	100	LF	$ 25.00	$ 2,500
15" Corrugated Steel Sewer, Class III, Trench Detail 1	90	LF	$ 30.00	$ 2,700
28" x 20" Corrugated Steel Sewer, Class III, Trench Detail 1	60	LF	$ 35.00	$ 2,100
12" Sewer, Class III, Trench Detail 1	330	LF	$ 30.00	$ 9,900
15" Sewer, Class III, Trench Detail 1	793	LF	$ 35.00	$ 27,755
21" Sewer, Class III, Trench Detail 1	1000	LF	$ 45.00	$ 45,000
30" Sewer, Class III, Trench Detail 1	494	LF	$ 55.00	$ 27,170
42" Sewer, Class III, Trench Detail 1	8	LF	$ 70.00	$ 560
12" Sewer, Class III, Trench Detail 2	92	LF	$ 35.00	$ 3,220
21" Sewer, Class III, Trench Detail 2	175	LF	$ 50.00	$ 8,750
24" Sewer, Class III, Trench Detail 2	147	LF	$ 55.00	$ 8,085
30" Sewer, Class III, Trench Detail 2	246	LF	$ 60.00	$ 14,760
42" Sewer, Class III, Trench Detail 2	71	LF	$ 85.00	$ 6,035
4 ft. diam. Drainage Structure, Catch Basin, 0 to 8 Ft.	15	EA	$ 1,200.00	$ 18,000
6 ft. diam. Drainage Structure, Catch Basin, 0 to 8 Ft.	5	EA	$ 2,500.00	$ 12,500
8 ft. diam. Drainage Structure, Catch Basin, 0 to 8 Ft.	3	EA	$ 3,500.00	$ 10,500
Additional depth of Drainage Structure	1	FT	$ 350.00	$ 350
Drainage Structure Covers	7250	LB	$ 1.50	$ 10,875
Steel End Section 12" with Steel Bar Grate	5	EA	$ 200.00	$ 1,000
Steel End Section 15" with Steel Bar Grate	3	EA	$ 250.00	$ 750
Steel End Section 28" x 20" with Steel Bar Grate	1	EA	$ 400.00	$ 400
Steel End Section for 12" Concrete Pipe with Steel Bar Grate	1	EA	$ 250.00	$ 250
Topsoil Surface, 4"	6500	SY	$ 2.00	$ 13,000
Chemical Fertilizer Nutrient (240 Lbs/Acre)	360	LB	$ 3.00	$ 1,080
Class A Seeding (200 Lbs/Acre)	300	LB	$ 4.00	$ 1,200
Mulch (2 Tons/Acre)	3	TON	$ 400.00	$ 1,200
Soil Erosion & Sedimentation Control Measures	1	LSUM	$ 1,500.00	$ 1,500

Subtotal				$ 267,890
Contingency @ 10 percent				$ 26,789
Estimated Net Construction Costs				$ 294,679
Estimated Preliminary and Final Engineering Design	1	LSUM		$ 29,468
Estimated Construction Engineering	1	LSUM		$ 44,202
Engineering Total				$ 73,670
Total Estimated Project Cost (not including Land or Right-of-Way)				$ 368,349

EXHIBIT NO. 2B

DYE RD. EXTENSION OF CHAPMAN DRAIN COST ESTIMATE ALTERNATIVE NO. 2, Phase 2
(Dye Road and Calkins Road Outlet Work)

ITEM	AMOUNT	UNIT	UNIT COST	TOTAL
Road Surface Removal and Replacement	50	SY	$ 50.00	$ 2,500
Driveway Surface Removal and Replacement	500	SY	$ 30.00	$ 15,000
Shoulder Removal and Replacement	75	SY	$ 30.00	$ 2,250
Open Drain, 4' Bottom	1050	FT	$ 10.00	$ 10,500
12" Sewer, Class III, Trench Detail 1	30	LF	$ 30.00	$ 900
42" Sewer, Class III, Trench Detail 1	1810	LF	$ 70.00	$ 126,700
42" Sewer, Class III, Trench Detail 2	79	LF	$ 85.00	$ 6,715
8 ft. diam. Drainage Structure, Catch Basin, 0 to 8 Ft.	3	EA	$ 3,500.00	$ 10,500
Additional depth of Drainage Structure	2	FT	$ 350.00	$ 700
Drainage Structure Covers	600	LB	$ 1.50	$ 900
57" X 38" Corrugated Steel Pipe, 2-2/3" x 1/2" Corrugations, 12 gauge	125	FT	$60	$ 7,500
64" X 43" Corrugated Steel Pipe, 2-2/3" x 1/2" Corrugations, 12 gauge	250	FT	$65	$ 16,250
Steel End Section for 42" Concrete Pipe with Steel Bar Grate	1	EA	$ 2,000.00	$ 2,000
57" X 38" Steel Pipe End Section	6	EA	$1,000	$ 6,000
64" X 43" Steel Pipe End Section	16	EA	$1,400	$ 22,400
Plain Riprap	30	SY	$ 40.00	$ 1,200
Topsoil Surface, 4"	8000	SY	$ 2.00	$ 16,000
Chemical Fertilizer Nutrient (240 Lbs/Acre)	360	LB	$ 3.00	$ 1,080
Class A Seeding (200 Lbs/Acre)	300	LB	$ 4.00	$ 1,200
Mulch (2 Tons/Acre)	3	TON	$ 400.00	$ 1,200
Soil Erosion & Sedimentation Control Measures	1	LSUM	$ 1,500.00	$ 1,500

Subtotal				$ 252,995
Contingency @ 10 percent				$ 25,300
Estimated Net Construction Costs				$ 278,295
Estimated Preliminary and Final Engineering Design	1	LSUM		$ 27,830
Estimated Construction Engineering	1	LSUM		$ 41,744
Engineering Total				$ 69,574
Total Estimated Project Cost (not including Land or Right-of-Way)				$ 347,869

Exhibit No. 3

STORM SEWER SYSTEM DESIGN
ALTERNATIVE NO. 1

$Q = A \frac{1.486}{n} R^{2/3} S^{1/2}$ $\quad Q = CIA \quad I = \frac{166.37}{T + 23.31}$

By Tim O'Dell
Date November 17, 2009

STRUCTURE #	INCREMENT AREA Ai	INCREMENT AREA Ai	TOTAL AREA A	RUNOFF COEF. C	EQUIVALENT AREA C A I	TOTAL EQUIV. AREA TOTAL C A I	TIME T	RAINFALL INTENSITY I	FLOW Q = I TOTAL C A I	DIAMETER OF PIPE	LENGTH OF PIPE TO NEXT STRUCT.	SLOPE OF PIPE	SLOPE OF H.G.	VELOCITY OF FLOW	TIME OF FLOW	
	SFT	AC.	AC.				MIN.	IN/HR	C.F.S	IN.	FT.	%	%	FT/SEC	MIN.	
1	80600	1.85	1.85	0.35	0.65	0.65	30.00	3.12	2.02	12	24	0.80		4.40	0.09	New Storm sewer
2	74050	1.70	3.55	0.35	0.60	1.24	30.09	3.12	3.87	15	232	0.30		3.12	1.24	New Storm sewer
2A																Detention inlet
3	68400	1.57	1.57	0.35	0.55	0.55	30.00	3.12	1.72	12	30	0.30		2.69	0.19	Existing Storm sewer
4	51000	1.17	2.74	0.35	0.41	0.96	30.19	3.11	2.98	12	66	0.50		3.47	0.32	Existing Storm sewer
5	23100	0.53	3.27	0.35	0.19	1.14	30.50	3.09	3.54	15	235	0.50		4.03	0.97	New Storm sewer
5A																Detention inlet
6A							50.00		3.68	12	50	1.00		4.91	0.17	Detention outlet, 11.80 + 3.55 + 3.27 = 18.42 acre @ 0.20CFS per Acre =
6							50.17		3.68	15	210	0.40		3.61	0.97	New Storm sewer
7						1.20	51.14	2.23	3.68	15	45	0.40		3.61	0.21	New Storm sewer
8	82350	1.89	1.89	0.35	0.66	1.86	51.35	2.23	4.15	15	44	0.40		3.61	0.20	New Storm sewer
9A	83650	1.92	1.92	0.35	0.67	0.67	30.00	3.12	2.10	12	25	0.88		4.61	0.09	Existing Storm sewer
9	115900	2.66	6.47	0.35	0.93	3.46	51.55	2.22	7.69	21	222	0.30		3.91	0.95	New Storm sewer
10	0	0.00	6.47	0.35	0.00	3.46	52.50	2.19	7.59	21	146	0.30		3.91	0.62	New Storm sewer
11	0	0.00	6.47	0.35	0.00	3.46	53.12	2.18	7.53	21	118	0.30		3.91	0.50	New Storm sewer
12	98450	2.26	8.73	0.35	0.79	4.25	53.63	2.16	9.19	24	24	0.20		3.49	0.11	New Storm sewer
13	83650	1.92	10.65	0.35	0.67	4.92	53.74	2.16	10.63	24	230	0.20		3.49	1.10	New Storm sewer to DS #14
15A	493250	11.32	11.32	0.30	3.40	3.40	50.00	2.27	7.71	15	30	1.50		10.99	0.03	East road frontage of Dye Road, South of DS #15.
15B	44900	1.03	1.03	0.30	0.31	0.31	30.00	3.12	0.96	12	30	1.00		2.46	0.20	East road frontage of Dye Road, North of DS #15.
15	0	0.00	12.35	0.30	0.00	3.71	50.03	2.27	8.42	24	58	0.50		2.76	0.35	New Storm sewer to DS #14.
14A	246550	5.66	5.66	0.35	1.98	1.98	40.00	2.63	5.21	15	30	1.00		5.70	0.09	West road frontage of Dye Road, South of DS #14.
14B	259200	5.95	5.95	0.35	2.08	2.08	30.00	3.12	6.50	15	30	1.00		5.70	0.09	West road frontage of Dye Road, North of DS #14.
14						12.69	54.55	2.14	27.12	36	720	0.15		3.96	3.03	New Storm sewer to DS #21.
16	41400	0.95	0.95	0.35	0.33	0.33	20.00	3.84	1.28	12	25	0.62		3.87	0.11	Existing Storm sewer
17	42250	0.97	1.92	0.35	0.34	0.67	20.11	3.83	2.58	12	172	1.00		4.91	0.58	New Storm sewer
18	51850	1.19	3.11	0.35	0.42	1.09	20.69	3.78	4.12	15	53	0.40		3.61	0.24	New Storm sewer
19A	42700	0.98	0.98	0.35	0.34	0.34	20.00	3.84	1.32	12	195	0.33		2.82	1.15	Existing Storm sewer
19	99350	2.28	6.37	0.35	0.80	2.23	20.94	3.76	8.39	21	618	0.24		3.50	2.95	New Storm sewer
20A	45750	1.05	1.05	0.35	0.37	0.37	20.00	3.84	1.41	12	46	0.40		3.11	0.25	New Storm sewer
20	42250	0.97	8.39	0.35	0.34	2.94	23.88	3.53	10.35	21	297	0.38		4.40	1.13	New Storm sewer to DS #21
21A	101500	2.33	2.33	0.35	0.82	0.82	30.00	3.12	2.55	12	30	1.00		4.91	0.10	New Storm sewer to DS #21
21	0	0.00	0.00		0.00	16.45	57.58	2.06	33.83	36	440	0.22		4.79	1.53	New Storm sewer to DS #22
22	314500	7.22	7.22	0.30	2.17	18.62	59.11	2.02	37.58	36	400	0.28		5.41	1.23	West side Dye Road frontage
23	165500	3.80	11.02	0.40	1.52	20.14	60.34	1.99	40.05	36	400	0.32		5.78	1.15	East side Dye Road, pick up old storm system, to Calkins ditch outlet.
24	0	0.00	0.00		0.00	20.14	61.49	1.96	39.51	0	400	0.00		0.00	3.33	Drive Culvert, 2% ditch slope = 2'/sec
25	915600	21.02	21.02	0.25	5.25	25.39	64.82	1.89	47.94	0	600	0.00		0.00	10.00	Drive Culvert, 1% ditch slope = 1'/sec
26	48800	1.12	22.14	0.35	0.39	25.79	74.82	1.70	43.72	0	200	0.00		0.00	3.33	Drive Culvert, 1% ditch slope = 1'/sec
27	161600	3.71	25.85	0.35	1.30	27.09	78.15	1.64	44.41	0	200	0.00		0.00	3.33	Drive Culvert, 1% ditch slope = 1'/sec
28	135900	3.12	28.97	0.35	1.09	28.18	81.48	1.59	44.74	0	350	0.00		0.00	5.83	Drive Culvert, 1% ditch slope = 1'/sec

EXHIBIT NO. 3A

Detention Basin Design Data

1)	Drainage Area (A)	=	18.42 acres
2)	Runoff Coefficient (C proposed)	=	0.35
3)	Allowable Outflow (Qa)	=	0.20 cfs/acre x 18.42 acres
		=	3.68 CFS
4)	Required Detention Basin volume	=	53,492 CFT
	(See Detention Basin Volume calculations per the Rational Method on page 21)		
5)	Provided Detention Basin Volume	=	55,721 CFT
	Surface Area at high water elevation (760.50)	=	32,930 SFT
	Surface Area at Basin Bottom	=	16,600 SFT
	Average Surface Area	=	24,765 SFT
	Average Water Depth	=	2.25 FT
	Volume Provided = 24,765 SFT X 2.25 FT	=	55,721 CFT

Basin Outlet Restrictor Calculations

$$A = \frac{Qa}{0.62\ \sqrt{2gh}}$$

Qa = 3.68 CFS

h = head = Basin HW Elevation - center elevation of outlet pipe
= 760.50 - 757.50 = 3 feet

$$A = \frac{3.68}{0.62\ \sqrt{2 \times 32.2 \times 3}} = 0.43 \text{ SFT} = 62 \text{ SIN}$$

$3.14r^2$ = 62 SIN ; r = 4.4 inches; d = 8.8 inches

Place cap over proposed 12" outlet pipe with 9" diameter restrictor hole.

KRAFT ENGINEERING AND SURVEYING, INC.
409 W. 7th St.
Flint, MI 48503

RATIONAL METHOD **Q=CIA**

DETENTION POND VOLUME CALCULATIONS

Area= **18.42**

C_{prop}= **0.35**

$Q_{allowable}$= **3.68**

Time conc	I 100	CwA	Qin	Qout/Qallow	Qin-Qout	V=(Qin=Qout)*Tc*60
min					Ft^3/s	Ft^3
10	5.77	6.45	37.20	3.68	33.52	20,109.11
20	4.60	6.45	29.66	3.68	25.97	31,166.64
30	3.90	6.45	25.14	3.68	21.46	38,626.74
40	3.40	6.45	21.92	3.68	18.24	43,765.92
50	3.00	6.45	19.34	3.68	15.66	46,971.00
60	2.70	6.45	17.41	3.68	13.72	49,402.44
70	2.50	6.45	16.12	3.68	12.43	52,220.70
80	**2.30**	**6.45**	**14.83**	**3.68**	**11.14**	**53,491.68**
90	2.10	6.45	13.54	3.68	9.85	53,215.38
100	1.90	6.45	12.25	3.68	8.57	51,391.80
110	1.80	6.45	11.60	3.68	7.92	52,275.96
120	1.70	6.45	10.96	3.68	7.28	52,386.48
130	1.60	6.45	10.32	3.68	6.63	51,723.36
140	1.50	6.45	9.67	3.68	5.99	50,286.60
150	1.45	6.45	9.35	3.68	5.66	50,977.35
160	1.40	6.45	9.03	3.68	5.34	51,281.28
170	1.30	6.45	8.38	3.68	4.70	47,910.42
180	1.25	6.45	8.06	3.68	4.37	47,247.30
190	1.20	6.45	7.74	3.68	4.05	46,197.36
200	1.15	6.45	7.41	3.68	3.73	44,760.60
210	1.10	6.45	7.09	3.68	3.41	42,937.02
220	1.00	6.45	6.45	3.68	2.76	36,471.60
230	0.95	6.45	6.12	3.68	2.44	33,680.97
240	0.93	6.45	6.00	3.68	2.31	33,288.62
270	0.83	6.45	5.35	3.68	1.67	27,005.56
300	0.73	6.45	4.71	3.68	1.02	18,401.58
330	0.66	6.45	4.26	3.68	0.57	11,306.20
360	0.62	6.45	4.00	3.68	0.31	6,763.82
390	0.59	6.45	3.80	3.68	0.12	2,801.68
420	0.55	6.45	3.55	3.68	-0.14	-3,481.38
450	0.53	6.45	3.42	3.68	-0.27	-7,211.43
480	0.50	6.45	3.22	3.68	-0.46	-13,262.40
510	0.48	6.45	3.09	3.68	-0.59	-18,036.86
540	0.45	6.45	2.90	3.68	-0.78	-25,364.34
570	0.43	6.45	2.77	3.68	-0.91	-31,183.22
600	0.41	6.45	2.64	3.68	-1.04	-37,466.28

Culvert Calculator Report
ALTERNATIVE NO. 1 - 49"x33" CULVERTS FROM POINT 24 TO POINT 25

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	741.45	ft	Headwater Depth/Height	1.04	
Computed Headwater Elev	741.55	ft	Discharge	40.00	cfs
Inlet Control HW Elev.	741.29	ft	Tailwater Elevation	740.75	ft
Outlet Control HW Elev.	741.55	ft	Control Type	Outlet Control	

Grades					
Upstream Invert	738.70	ft	Downstream Invert	738.00	ft
Length	35.00	ft	Constructed Slope	0.020000	ft/ft

Hydraulic Profile					
Profile	S1		Depth, Downstream	2.75	ft
Slope Type	Steep		Normal Depth	1.33	ft
Flow Regime	Subcritical		Critical Depth	1.57	ft
Velocity Downstream	4.49	ft/s	Critical Slope	0.012400	ft/ft

Section					
Section Shape	Arch		Mannings Coefficient	0.022	
Section Material	Steel and Aluminum Var CR		Span	4.08	ft
Section Size	49 x 33 inch		Rise	2.75	ft
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	741.55	ft	Upstream Velocity Head	0.42	ft
Ke	0.70		Entrance Loss	0.30	ft

Inlet Control Properties					
Inlet Control HW Elev.	741.29	ft	Flow Control	Unsubmerged	
Inlet Type	Mitered to slope (arch)		Area Full	8.9	ft²
K	0.03000		HDS 5 Chart	34	
M	1.00000		HDS 5 Scale	2	
C	0.04630		Equation Form	1	
Y	0.75000				

Culvert Calculator Report
ALTERNATIVE NO. 1 - 57"x38" CULVERTS FROM POINT 25 TO POINT 26

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	738.05	ft	Headwater Depth/Height	0.97	
Computed Headwater Elev	738.38	ft	Discharge	48.00	cfs
Inlet Control HW Elev.	737.93	ft	Tailwater Elevation	737.75	ft
Outlet Control HW Elev.	738.38	ft	Control Type	Outlet Control	

Grades					
Upstream Invert	735.30	ft	Downstream Invert	735.00	ft
Length	30.00	ft	Constructed Slope	0.010000	ft/ft

Hydraulic Profile					
Profile	M1		Depth, Downstream	2.75	ft
Slope Type	Mild		Normal Depth	1.68	ft
Flow Regime	Subcritical		Critical Depth	1.62	ft
Velocity Downstream	4.33	ft/s	Critical Slope	0.010990	ft/ft

Section					
Section Shape	Arch		Mannings Coefficient	0.022	
Section Material	Steel and Aluminum Var CR		Span	4.75	ft
Section Size	57 x 38 inch		Rise	3.17	ft
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	738.38	ft	Upstream Velocity Head	0.33	ft
Ke	0.70		Entrance Loss	0.23	ft

Inlet Control Properties					
Inlet Control HW Elev.	737.93	ft	Flow Control	Unsubmerged	
Inlet Type	Mitered to slope (arch)		Area Full	11.6	ft²
K	0.03000		HDS 5 Chart	34	
M	1.00000		HDS 5 Scale	2	
C	0.04630		Equation Form	1	
Y	0.75000				

Exhibit No. 4

STORM SEWER SYSTEM DESIGN
ALTERNATIVE NO. 2

$Q = A \frac{1.486}{n} R^{2/3} S^{1/2}$ $\quad Q = C I A \quad$ $I = \frac{166.37}{T + 23.31}^{10}$

By Tim O'Dell
Date November 17, 2009

STRUCTURE #	INCREMENT AREA Ai	INCREMENT AREA Ai	TOTAL AREA A	RUNOFF COEF. C	EQUIVALENT AREA C A I	TOTAL EQUIV. AREA TOTAL C A I	TIME T	RAINFALL INTENSITY I	FLOW Q = I TOTAL C A I	DIAMETER OF PIPE	LENGTH OF PIPE TO NEXT STRUCT.	SLOPE OF PIPE	SLOPE OF H.G.	VELOCITY OF FLOW	TIME OF FLOW	
	SFT	AC.	AC.				MIN.	IN/HR	C.F.S.	IN.	FT.	%	%	FT/SEC	MIN.	
1	80600	1.85	1.85	0.35	0.65	0.65	30.00	3.12	2.02	12	24	0.80		4.40	0.09	New Storm sewer
2	74050	1.70	3.55	0.35	0.59	1.24	30.09	3.12	3.87	15	475	0.70		4.77	1.66	New Storm sewer
2C																To point 10
3	68400	1.57	1.57	0.35	0.55	0.55	30.00	3.12	1.72	12	30	0.30		2.69	0.19	Existing Storm sewer
4	51000	1.17	2.74	0.35	0.41	0.96	30.19	3.11	2.98	12	66	0.50		3.47	0.32	Existing Storm sewer
5	23100	0.53	3.27	0.35	0.19	1.14	30.50	3.09	3.54	15	265	1.00		5.70	0.77	New Storm sewer
5A																To point 7
6A	505300	11.60	11.60	0.25	2.90	2.90	30.00	3.12	9.05	21	50	0.40		4.51	0.18	New outlet storm sewer
6				0.25	0.00	2.90	30.18	3.11	9.02	21	210	0.40		4.51	0.78	New Storm sewer
7		3.27	14.87	0.35	1.14	4.04	30.96	3.07	12.40	24	45	0.30		3.61	0.21	New Storm sewer
8	82350	1.89	1.89	0.35	0.66	4.71	31.17	3.05	14.37	24	44	0.40		4.93	0.15	New Storm sewer
9A	83650	1.92	1.92	0.35	0.67	0.67	30.00	3.12	2.10	12	25	0.88		4.61	0.09	Existing Storm sewer
9	115900	2.66	4.58	0.35	0.93	6.87	31.09	3.06	21.01	30	222	0.24		4.43	0.83	New Storm sewer
10	0	3.55	8.13	0.35	1.24	8.11	31.92	3.01	24.44	30	146	0.30		4.96	0.49	New Storm sewer
11	0	0.00	8.13	0.35	0.00	8.11	32.42	2.99	24.22	30	118	0.30		4.96	0.40	New Storm sewer
12	98450	2.26	10.39	0.35	0.79	8.90	32.81	2.96	26.39	30	24	0.40		5.73	0.07	New Storm sewer
13	83650	1.92	8.76	0.35	0.67	9.58	32.88	2.96	28.35	30	230	0.42		5.87	0.65	New Storm sewer to DS #14
15A	493250	11.32	11.32	0.30	3.40	3.40	50.00	2.27	7.72	15	30	1.50		10.99	0.03	East road frontage of Dye Road, South of DS #15.
15B	44900	1.03	1.03	0.30	0.31	0.31	30.00	3.12	0.97	12	30	1.00		2.46	0.20	East road frontage of Dye Road, North of DS #15.
15	0	0.00	12.35	0.30	0.00	3.71	50.03	2.27	8.42	24	58	0.50		2.76	0.35	New Storm sewer to DS #14.
14A	246550	5.66	5.66	0.35	1.98	1.98	40.00	2.63	5.21	15	30	1.00		5.70	0.09	West road frontage of Dye Road, South of DS #14.
14B	259200	5.95	5.95	0.35	2.08	2.08	30.00	3.12	6.50	15	30	1.00		5.70	0.09	West road frontage of Dye Road, North of DS #14.
14						17.35	33.53	2.93	50.78	42	720	0.22		5.31	2.26	New Storm sewer to DS #21.
16	41400	0.95	0.95	0.35	0.33	0.33	20.00	3.84	1.28	12	25	0.62		3.87	0.11	Existing Storm sewer
17	42250	0.97	1.92	0.35	0.34	0.67	20.11	3.83	2.58	12	172	1.00		4.91	0.58	New Storm sewer
18	51850	1.19	3.11	0.35	0.42	1.09	20.69	3.78	4.12	15	53	0.40		3.61	0.24	New Storm sewer
19A	42700	0.98	0.98	0.35	0.34	0.34	20.00	3.84	1.32	12	195	0.33		2.82	1.15	Existing Storm sewer
19	99350	2.28	6.37	0.35	0.80	2.23	20.94	3.76	8.39	21	618	0.24		3.50	2.95	New Storm sewer
20A	45750	1.05	1.05	0.35	0.37	0.37	20.00	3.84	1.41	12	46	0.40		3.11	0.25	New Storm sewer
20	42250	0.97	8.39	0.35	0.34	2.94	23.88	3.53	10.35	21	297	0.40		4.51	1.10	New Storm sewer to DS #21
21A	101500	2.33	2.33	0.35	0.82	0.82	30.00	3.12	2.55	12	30	1.00		4.91	0.10	New Storm sewer to DS #21
21	0	0.00	0.00			20.29	35.79	2.82	57.12	42	440	0.30		6.20	1.18	New Storm sewer to DS #22
22	314500	7.22	7.22	0.30	2.17	22.03	36.97	2.76	60.80	42	400	0.32		6.41	1.04	West side Dye Road frontage
23	165500	3.80	3.80	0.40	1.52	23.55	38.01	2.71	63.89	42	400	0.35		6.70	0.99	East side Dye Road, pick up old storm system, to Calkins ditch outlet.
24	0	0.00	0.00			23.55	39.00	2.67	62.88	0	400	0.00		0.00	3.33	Drive Culvert, 2% ditch slope = 2'/sec
25	915600	21.02	21.02	0.25	5.25	28.80	42.33	2.53	73.01	0	600	0.00		0.00	10.00	Drive Culvert, 1% ditch slope = 1'/sec
26	48800	1.12	22.14	0.35	0.39	29.19	52.33	2.20	64.20	0	200	0.00		0.00	3.33	Drive Culvert, 1% ditch slope = 1'/sec
27	161600	3.71	25.85	0.35	1.30	30.49	55.66	2.11	64.23	0	200	0.00		0.00	3.33	Drive Culvert, 1% ditch slope = 1'/sec
28	135900	3.12	28.97	0.35	1.09	31.58	58.99	2.02	63.84	0	350	0.00		0.00	5.83	Drive Culvert, 1% ditch slope = 1'/sec

Culvert Calculator Report
ALTERNATIVE NO. 2 - 57"x38" CULVERTS FROM POINT 24 TO POINT 25

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	741.87	ft	Headwater Depth/Height	1.11	
Computed Headwater Elev	742.23	ft	Discharge	63.00	cfs
Inlet Control HW Elev.	741.89	ft	Tailwater Elevation	741.17	ft
Outlet Control HW Elev.	742.23	ft	Control Type	Outlet Control	

Grades					
Upstream Invert	738.70	ft	Downstream Invert	738.00	ft
Length	35.00	ft	Constructed Slope	0.020000	ft/ft

Hydraulic Profile					
Profile	CompositePressureProfileS1		Depth, Downstream	3.17	ft
Slope Type	N/A		Normal Depth	1.59	ft
Flow Regime	Subcritical		Critical Depth	1.90	ft
Velocity Downstream	5.43	ft/s	Critical Slope	0.012334	ft/ft

Section					
Section Shape	Arch		Mannings Coefficient	0.022	
Section Material	Steel and Aluminum Var CR		Span	4.75	ft
Section Size	57 x 38 inch		Rise	3.17	ft
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	742.23	ft	Upstream Velocity Head	0.54	ft
Ke	0.70		Entrance Loss	0.38	ft

Inlet Control Properties					
Inlet Control HW Elev.	741.89	ft	Flow Control	Unsubmerged	
Inlet Type	Mitered to slope (arch)		Area Full	11.6	ft²
K	0.03000		HDS 5 Chart	34	
M	1.00000		HDS 5 Scale	2	
C	0.04630		Equation Form	1	
Y	0.75000				

Culvert Calculator Report
ALTERNATIVE NO. 2 - 64"x43" CULVERTS FROM POINT 25 TO POINT 26

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	738.88	ft	Headwater Depth/Height	1.13	
Computed Headwater Elev	739.36	ft	Discharge	74.00	cfs
Inlet Control HW Elev.	738.58	ft	Tailwater Elevation	738.58	ft
Outlet Control HW Elev.	739.36	ft	Control Type	Outlet Control	

Grades					
Upstream Invert	735.30	ft	Downstream Invert	735.00	ft
Length	30.00	ft	Constructed Slope	0.010000	ft/ft

Hydraulic Profile					
Profile	M1		Depth, Downstream	3.58	ft
Slope Type	Mild		Normal Depth	2.06	ft
Flow Regime	Subcritical		Critical Depth	1.98	ft
Velocity Downstream	4.90	ft/s	Critical Slope	0.011095	ft/ft

Section					
Section Shape	Arch		Mannings Coefficient	0.022	
Section Material	Steel and Aluminum Var CR		Span	5.33	ft
Section Size	64 x 43 inch		Rise	3.58	ft
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	739.36	ft	Upstream Velocity Head	0.39	ft
Ke	0.70		Entrance Loss	0.27	ft

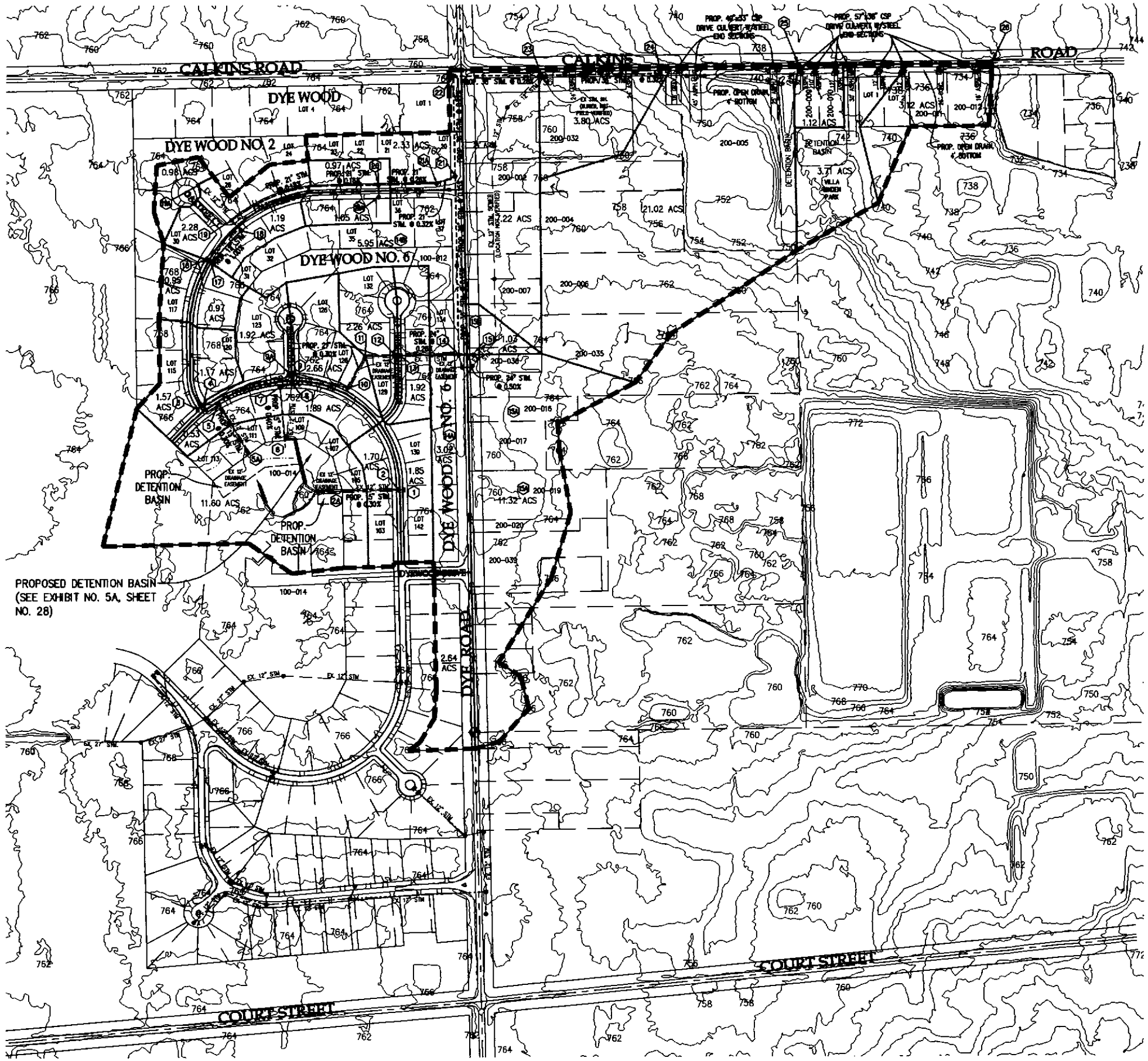
Inlet Control Properties					
Inlet Control HW Elev.	738.58	ft	Flow Control	Unsubmerged	
Inlet Type	Mitered to slope (arch)		Area Full	14.7	ft²
K	0.03000		HDS 5 Chart	34	
M	1.00000		HDS 5 Scale	2	
C	0.04630		Equation Form	1	
Y	0.75000				

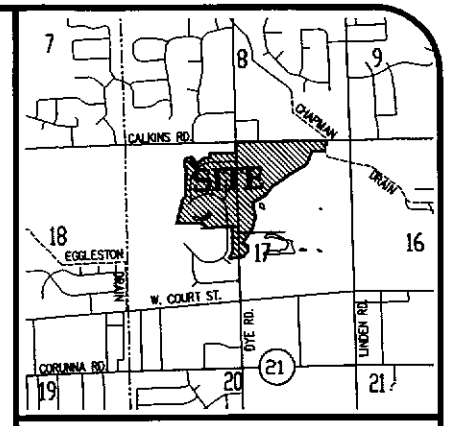
GRAPHIC SCALE
200 0 100 200
(IN FEET)
1 inch = 200 ft.

DYE ROAD EXTENSION OF CHAPMAN DRAIN NO. 0541

(PART OF THE NORTH 1/2, SECTION 17, T7N-R6E, FLINT TOWNSHIP, GENESEE COUNTY, MICHIGAN)

(ALTERNATIVE NO. 1)





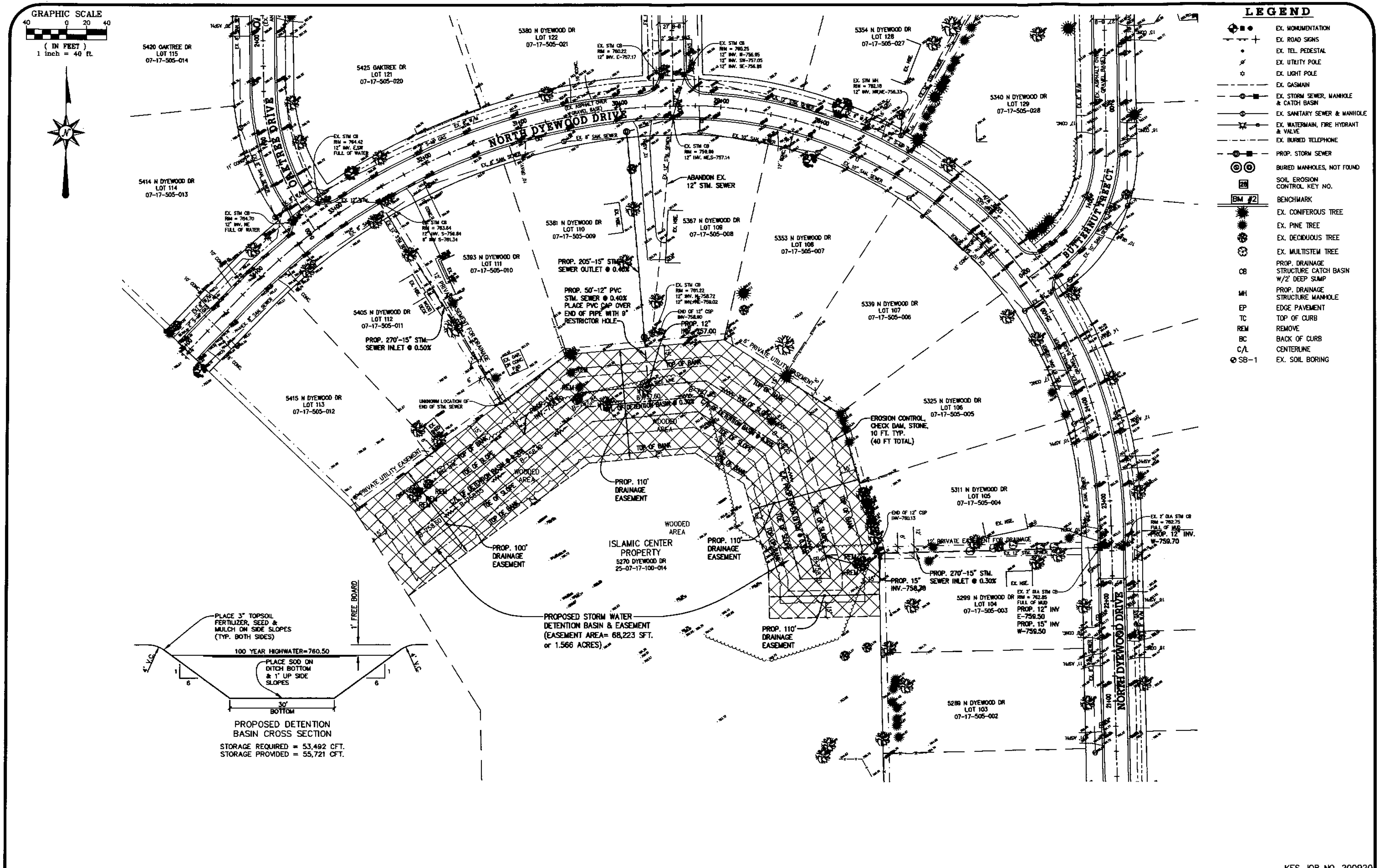
LOCATION MAP

LEGEND

- 750 EX. CONTOUR LINE
- LOT LINE
- EX. STORM MANHOLE
- DRAINAGE DISTRICT BOUNDARY
- (5) DRAINAGE REFERENCE POINT
- PROPOSED STORM SEWER

KES JOB NO. 200920

SCALE: 1" = 200'	PREPARED FOR: GCDC-SWM, G-4608 BEECHER ROAD, FLINT, MICHIGAN 48532, PHONE: 810.732.1590	Three full working days before you dig, call the MISS DIG System at 1-800-482-7171	PREPARED BY: KRAFT ENGINEERING & SURVEYING, INC. engineers - surveyors - planners, 409 WEST SEVENTH STREET FLINT, MICHIGAN 48503, PHONE: 810.234.2694 or 810.234.2695 FAX: 810.234.2696, E-MAIL: MAIL@KRAFTENGINEERING.COM	DYE ROAD EXTENSION OF CHAPMAN DRAIN, PART OF SECTION 17 & 18, T7N-R6E, FLINT TOWNSHIP, GENESEE COUNTY, MICHIGAN	EXHIBIT NO. 5, DRAINAGE MAP, ALTERNATIVE NO. 1	REVISIONS	DRN. BY: RADO 12.11.09; CKD. BY: T.L.O. "; APPR. BY: M.R.P. "	SHEET NO: 27



KES JOB NO. 200920

SCALE: HOR: 1"=40'	PREPARED FOR: **GCDC-SWM** G-4608 BEECHER ROAD FLINT, MICHIGAN 48532 PHONE: 810.732.1590	Three full working days before you dig, call the MISS DIG System of 1-800-482-7171	PREPARED BY: KRAFT ENGINEERING & SURVEYING, INC. engineers - surveyors - planners 409 WEST SEVENTH STREET FLINT, MICHIGAN 48503 PHONE: 810.234.2694 or 810.234.2695 FAX: 810.234.2696 E-MAIL: MAIL@KRAFTENGINEERING.COM	DYE ROAD EXTENSION OF CHAPMAN DRAIN PART OF SECTION 17 & 18, T7N-R6E FLINT TOWNSHIP, GENESEE COUNTY, MICHIGAN	EXHIBIT NO. 5A PROP. DETENTION BASIN ALTERNATIVE NO. 1

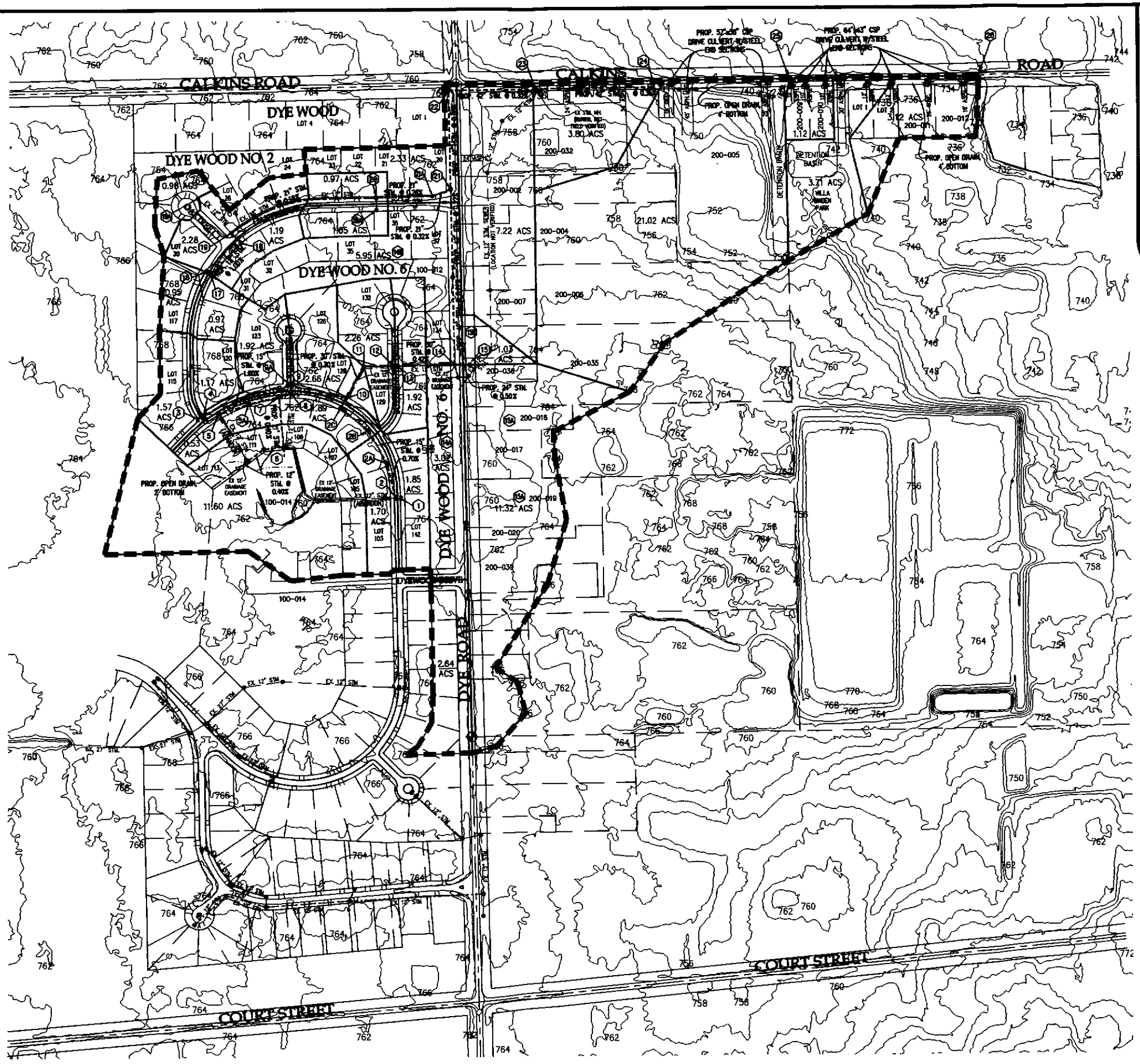
REVISIONS			
DRN. BY:	RADO	12.11.09	SHEET NO: 28
DSN. BY:	T.L.O.	"	
CKD. BY:	M.R.P.	"	
APPR. BY:	M.R.P.	"	

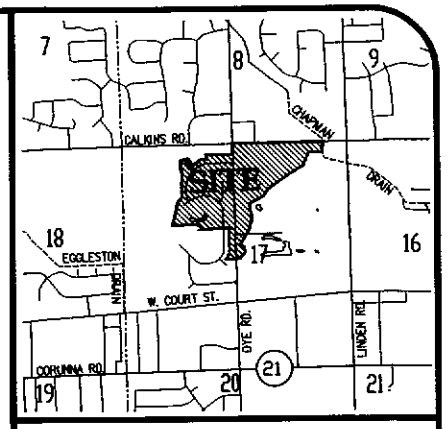
GRAPHIC SCALE
200 0 100 200
(IN FEET)
1 inch = 200 ft.

DYE ROAD EXTENSION OF CHAPMAN DRAIN NO. 0541

(PART OF THE NORTH 1/2, SECTION 17, T7N-R6E, FLINT TOWNSHIP, GENESEE COUNTY, MICHIGAN)

(ALTERNATIVE NO. 2)





LOCATION MAP

LEGEND

- 750 EX. CONTOUR LINE
- LOT LINE
- EX. STORM MANHOLE
- DRAINAGE DISTRICT BOUNDARY
- (S) DRAINAGE REFERENCE POINT
- PROPOSED STORM SEWER

KES JOB NO. 200920

SCALE: 1" = 200'	PREPARED FOR: GCDC-SWM, G-4608 BEECHER ROAD, FLINT, MICHIGAN 48532, PHONE: 810.732.1590	Three full working days before you dig, call the MISS DIG System at 1-800-482-7171	PREPARED BY: KRAFT ENGINEERING & SURVEYING, INC. engineers - surveyors - planners, 409 WEST SEVENTH STREET FLINT, MICHIGAN 48503, PHONE: 810.234.2694 or 810.234.2695 FAX: 810.234.2696, E-MAIL: MAIL@KRAFTENGINEERING.COM	DYE ROAD EXTENSION OF CHAPMAN DRAIN, PART OF SECTION 17 & 18, T7N-R6E, FLINT TOWNSHIP, GENESEE COUNTY, MICHIGAN	EXHIBIT NO. 6, DRAINAGE MAP, ALTERNATIVE NO. 2

REVISIONS			
DRN. BY:	RADO	12.11.09	SHEET NO: 29
DSN. BY:	T.L.O.	"	
CKD. BY:	M.R.P.	"	
APPR. BY:	M.R.P.	"	