Baughman Drain – Division II

PROJECT MANUAL
ISSUED FOR BID

Prepared For:
Allegan County Drain Commissioner
113 Chestnut Street, Allegan, MI 49010

Prepared By:
Land and Resource Engineering
Project No. 15-043
June 2024

LRE ENGINEERS & SURVEYORS
2121 3 Mile Rd. NW
Walker, MI 49544
Ph: 616-301-7888
www.LREMI.com

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Construction Drawings:

ALLEGAN COUNTY DRAIN COMMISSIONER

BAUGHMAN DRAIN

NOTICE OF LETTING

DATE: **July 10, 2024**
TIME: **10:00 a.m.**
LOCATION: **113 Chestnut Street, Allegan, Michigan 49010**
QUESTIONS: **(269) 673-0440**

The Allegan County Drain Commissioner will meet on the above date, time and location to receive construction bids for the Baughman Drain. Bids will then be opened and publicly announced.

The Baughman Drain project will be let in 2 divisions as follows, each division having the length, average depth and width as set forth:

Division I of the Baughman Drain is approximately 3.40 miles and is comprised of open channel, with an average excavation depth of 1-feet and average bottom width of 2.5-feet. The following items will be required, and a contract let for the same:

Open Channel Drain Construction

1	LS	Mobilization
1	LS	Utility Coordination & Protection
1	LS	Traffic Control
6168	LF	Selective Clearing, Grubbing, & Snagging
6,532	LF	Open Channel Excavation, 3-foot bottom width
4844	LF	Open Channel Excavation, 2-foot bottom width
2	EA	Private Crossing Removal

Drain Crossings

Main Alignment Station 30+00, Private Crossing
Place 40 LF 60" CMP Culvert
Main Alignment Station 51+00, Private Crossing
Place 60 LF 60" CMP Culvert
Main Alignment Station 78+25, Springbrook Drive
Place 72 LF 60" CMP Culvert with Tee
Branch 1 Station 17+50, Farm Crossing
Place 160 LF 48" PE Culvert
Branch 2 Station 2+50, Private Crossing
Place 60 LF 48" PE Culvert
Branch 2 Station 7+00, Sycamore Street

Place 80 LF 48" PE Culvert
Branch 2 Station 11+25, Elm Street
Place 40 LF 48" RCP
Branch 2 Station 11+50, Elm Street
Place 4' Diameter Manhole
Branch 2 Station 11+75, Elm Street
Place 40 LF 48" RCP

Soil Erosion and Sedimentation Control

4	EA	Sediment Sump
1	LS	Site Restoration
2	EA	Paved Road Restoration
3	EA	Private Crossing Restoration (Gravel)
1	EA	Private Crossing Restoration (Bituminous)
1	EA	Private Crossing Restoration (Concrete)
245	SY	Tile Outlet Protection
30	SY	Riprap Spillway
515	SY	Riprap End Treatment
11376	LF	Open Channel Seeding
3800	SY	Mulch Blanket

Division II of the Baughman Drain is approximately 0.52 miles and is comprised of storm sewer installation. The following items will be required, and a contract let for the same:

Enclosed Drain Construction

1	LS	Mobilization
1	LS	Utility Coordination & Protection
1	LS	Traffic Control

Branch 4, Elm Street
Place 4' Diameter MH#4
Place 418 LF 12" Perf PE Storm Sewer
Place 4' Diameter MH#5
Place 418 LF 12" Perf PE Storm Sewer
Place 4' Diameter MH#6
Place 419 LF 12" Perf PE Storm Sewer
Place 4' Diameter MH#7
Branch 5, Prairiewood Court
Place 334 LF 12" Perf PE Storm Sewer
Place 4' Diameter MH#1
Place 570 LF 12" Perf PE Storm Sewer
Place 4' Diameter MH#2
Place 569 LF 12" Perf PE Storm Sewer
Place 4' Diameter MH#3

Soil Erosion and Sedimentation Control

1	LS	Site Restoration
5600	LF	Silt Fence
1473	LF	Storm Sewer Restoration
1300	LF	Roadway Restoration

This Notice of Letting, the plans, specifications and bid proposal shall be considered a part of the Contract. The Contract will be let in accordance with the Contract Documents now on file at Allegan County Drain Commissioner's Office and available to interested parties. Bids will be made and received in accordance with these documents. Bidding Documents, including plans and specifications, are available electronically, free of charge, upon request by contacting Dan Fredricks, P.E., of Land & Resource Engineering via email at fredricks@lremi.com or telephone at 616-301-7888.

Copies of Bidding Documents may only be obtained from Land & Resource Engineering at 2121 3 Mile Road NW, Walker, MI 49544 upon payment of a $35.00 non-refundable deposit. An additional non-refundable charge of $15.00 will be required for sending out Bidding Documents.

A security deposit in the amount of 5% of the total bid shall be submitted in the form of a cashier's check, money order, certified check or bidders bond shall be submitted with any bids. No cash will be permitted. The security deposits of all unsuccessful bidders shall be returned after the Contract is awarded.

A non-mandatory pre-bid meeting will be held at 10 a.m. on Wednesday, the 26th day of June, 2024 at the Allegan County Drain Commissioner's Office: 113 Chestnut Street, Allegan, MI 49010. The Engineer will be present to discuss the project. Prospective bidders are encouraged to attend and participate in the conference.

The Contract will be awarded to the lowest responsive and responsible bidder giving adequate security for the performance of the work and meeting all conditions represented in the Instructions to Bidders. The Contract completion date and the terms of payment will be announced at the time and place of letting. If no satisfactory bids are received, we reserve the right to reject any and all bids and to adjourn to a time and location as we shall announce.

The following is a description of the several tracts or parcels of lands constituting the Baughman Drain Drainage District:

Otsego Township, T01N, R12W

Section 21 – The South 700 feet of the East 2,100 feet of the Southeast 1/4.
Section 22 – The South 1,300 feet of the West 1,800 feet of the Southwest 1/4.
Section 26 – The North 2,700 feet of the West 2,100 feet of the Northwest 1/4 except the North 700 feet of the West 2,100 feet of the Northwest 1/4 and the South 800 feet of the West 1,300

feet of the Southwest 1/4.
Section 27 – The North 1/2.
Section 28 – The Northeast 1/4.

City of Otsego, T01N, R12W

Section 22 – The South 2,700 feet of the East 3,400 feet of the South 1/2 and the South 700 feet of the East 2,000 feet of the Northeast 1/4 except the South 700 feet of the East 900 feet of the Northeast 1/4.
Section 23 – The South 1,500 feet of the West 2,100 feet of the Southwest 1/4.
Section 26 – The North 700 feet of the West 2,100 feet of the Northwest 1/4.

ARTICLE 1 – BASIS OF PROPOSAL

1.1 The Bid is based on unit and lump sum prices as stipulated in the Bid Form. The totals of the extensions of unit and lump sum prices will be used as a basis for determining the total bid price.

1.2 All work necessary for completion of the Contract, but not specifically listed as a pay item, will be considered to be covered under one or more of the Bid items.

1.3 Where the Bid consists of separate sections of work, each section may be awarded separately or together with other section(s), whichever will be in the best interests of the OWNER. BIDDERS may bid any or all sections.

ARTICLE 2 - QUALIFICATIONS OF BIDDERS

Bids are solicited only from responsible BIDDERS skilled and regularly engaged in work of similar character and magnitude.

ARTICLE 3 – EXAMINATION OF CONTRACT DOCUMENTS AND SITE

3.1 Before submitting a Bid, each BIDDER shall:

A. Examine the Contract Documents thoroughly;

B. Visit the Site to become familiar with local conditions that may in any manner affect cost, progress, performance or timely completion of the Work;

C. Become familiar with all laws, rules and regulations that may in any manner affect cost, progress, performance or timely completion of the Work; and

D. Study and carefully correlate BIDDER's observations with the Contract Documents.

3.2 Surveys, investigations, and reports of subsurface or latent physical conditions at the Site which have been relied upon by ENGINEER in preparing the Drawings and Specifications are not guaranteed as to accuracy or completeness. Each BIDDER shall, at his own expense, make additional surveys and investigations as necessary to determine his Bid for the performance of the Work.

ARTICLE 4 - INTERPRETATION

Questions about the meaning or intent of the Contract Documents shall be submitted to the ENGINEER not less than seven (7) days prior to date of opening of Bids. Replies will be issued by Addenda mailed or delivered to Planholders of Record not less than three (3) days before Bids are due. ENGINEER may issue other Addenda at any time prior to opening of Bids. Only answers given by Addenda shall be binding. Oral and other interpretations or clarifications shall be without legal effect.

ARTICLE 5 – BID SECURITY

5.1 Each proposal shall be accompanied by a certified check or bid bond by a recognized surety in the amount of five percent (5%) of the total of the bid price made out to the Baughman Drain Drainage District. Bid Security from each BIDDER on the Work shall be by a single Surety.

5.2 A Bid Bond when used as Bid Security, shall be issued by a Surety named in U.S. Treasury Circular 570 licensed to conduct business in the state in which the Work is located.

5.3 The Bid Security of the successful BIDDER will be retained until the executed Agreement, Bonds, insurance certificates and other required information is delivered by the BIDDER to the OWNER.

5.4 Failure of the successful BIDDER to execute and deliver the Agreement, Bonds, insurance certificates and other required information within ten (10) days of the Notice of Award shall be just cause for OWNER to annul the Notice of Award and declare the Bid and Bid Security forfeited.

5.5 The Bid Security of any BIDDER whom OWNER believes to have a reasonable chance of receiving the award may be retained by OWNER until either the executed Agreement, Bonds, insurance certificates and other required information are delivered by the successful BIDDER to the OWNER or the expiration of the time limit specified for the Bid Hold Period, whichever occurs first.

5.6 Unless specifically requested, Bid Bond will not be returned to BIDDER.

ARTICLE 6 – CONTRACT TIME

The time(s) for completion of the Work shall be as stipulated in the Agreement. If the time requirement(s) cannot be met, the BIDDER is requested to stipulate in the Bid Form his schedule for performance of the Work. Consideration will be given to time in evaluating Bids.

ARTICLE 7 - LIQUIDATED DAMAGES AND EXPENSES

Provisions for liquidated damages and expenses for failure to complete on time are set forth in the Agreement.

ARTICLE 8 – BID PREPARATION

8.1 Submit the Bid on the separate Proposal and Bid Form with Bid Security and other required documents. The bound copy is for BIDDER's records.

8.2 No change shall be made in the wording of the form or in any of the items. Bids should be typed or filled out legibly in ink.

8.3 All names must be printed or typed below the signature.

8.4 The Proposal shall contain an acknowledgement of receipt of all Addenda.

8.5 Bid by partnership shall be executed in the partnership name and signed by a partner. Partner's title must appear under signature.

8.6 Bid submitted by two or more firms will not be considered (i.e. no joint bids).

8.7 Bid by corporation must be executed in the corporate name by a corporate officer accompanied by evidence of authority to sign. The corporate address and state of incorporation shall be listed.

8.8 Agreement will be on the basis of material and equipment described in the Contract Documents without consideration of substitute or "or-equal" items; except for alternates which may be offered by the BIDDER in the Bid Form and accepted by the OWNER prior to execution of the Agreement. Applications for substitutions will be considered only after the Agreement has been executed. The procedure for substitutions is set forth in the General Conditions.

8.9 On unit price Bids, BIDDERS shall show the unit price for each item listed, the total price for the quantity of each item, and the total price for all items. If ENGINEER finds any errors in the Bidder's computations, ENGINEER reserves the right to make corrections.

ARTICLE 9 – SUBMISSION OF BIDS

9.1 Bids, Bid Security and other required documents shall be submitted prior to the time and at the place indicated in the Bid Solicitation.

9.2 Submit Bid Documents, in a sealed envelope, properly identified.

9.3 If the Bid Documents are sent through the mail or other delivery system, the sealed envelope shall be enclosed in a separate envelope with the notation "BID ENCLOSED" on the face thereof.

9.4 Bid documents may not be sent by facsimile. Bids must be submitted in a sealed envelope as stated in part 9.2

9.5 A non-mandatory pre-bid meeting will be held at 10 a.m. on Wednesday, the 26th day of June, 2024 at the Allegan County Drain Commissioner's Office: 113 Chestnut Street, Allegan, MI 49010. The Engineer will be present to discuss the project. Prospective bidders are encouraged to attend and participate in the conference.

ARTICLE 10 – MODIFICATION AND WITHDRAWAL OF BIDS

10.1 Bids may be modified or withdrawn by an appropriate document duly executed and delivered to the place where Bids are to be submitted at any time prior to the opening of Bids.

10.2 If, within 24 hours after Bids are opened, any BIDDER files a duly signed notice with OWNER and promptly thereafter demonstrates to the reasonable satisfaction of OWNER that there was a material and substantial mistake in the preparation of Bid, that BIDDER may withdraw its Bid, and the Bid Security will be returned by OWNER.

ARTICLE 11 – OPENING OF BIDS

The Bid opening location and time will be as indicated in the Notice of Letting.

ARTICLE 12 - BID HOLD PERIOD

All bids shall remain firm, after the day of the Bid opening, for the period stipulated in the Notice of Letting.

ARTICLE 13 – AWARD OF CONTRACT(S)

13.1 BIDDER will be required to complete Bid documentation and correct irregularities as a condition of award. OWNER reserves the right to reject any and all Bids and waive any and all irregularities. OWNER further reserves the right to accept or reject nonconforming, qualified, alternate or conditional Bids.

13.2 In evaluating Bids, OWNER will consider the qualifications of the BIDDERS, whether or not the Bids comply with the prescribed requirements and include completed alternates and unit prices if requested in the Bid Form. OWNER may conduct investigations to establish the responsibility, qualifications and financial ability of the BIDDERS and proposed Subcontractors to do the Work within the prescribed time. OWNER reserves the right to reject the Bid of any BIDDER who does not pass such evaluation to OWNER's satisfaction.

13.3 Subject to the rights reserved by the OWNER, it is intended that a contract will be awarded to a responsible, responsive BIDDER whose evaluation indicates to OWNER that such award will be in the best interests of the OWNER.

13.4 Prior to the Notice of Award, ENGINEER will notify the apparent successful BIDDER if OWNER, after due investigation, has reasonable objection to any listed Subcontractor(s), where such listing is requested in the Bid Form. Failure of OWNER to make objection prior to Notice of Award will constitute acceptance of the listed Subcontractor(s), but not a waiver of any right of OWNER to reject defective work, material or equipment, or material and equipment not in conformance with the requirements of the Contract Documents.

13.5 If, prior to the Notice of Award, OWNER refuses to accept any listed Subcontractor(s), the apparent successful BIDDER may:

A. Submit an acceptable substitute without an increase in bid price; or

B. Withdraw Bid and Bid Security.

13.6 If, after Notice of Award, OWNER refuses to accept any Subcontractor, CONTRACTOR shall submit an acceptable substitute and the Contract Price will be adjusted by the difference in cost occasioned by such substitution.

13.7 Concurrently with execution and delivery of Agreement, CONTRACTOR shall deliver to OWNER the Bonds, insurance certificates and other information as required by the Contract Documents.

13.8 If Bidder is a business entity (i.e., corporation, partnership, joint venture, etc.) organized under the laws of a state other than the state of the location of the Work, Bidder must provide evidence of proper registration to do business in the state of the location of the Work as a condition to execution of the Agreement.

13.9 The Agreement and such other documents as required will be signed by OWNER and CONTRACTOR within 25 days of the Notice of Award. OWNER will sign Agreement within 10 days of receipt of required Bonds, insurance certificates, other required information, and CONTRACTOR executed Agreement. OWNER, CONTRACTOR, SURETY and ENGINEER will each receive an executed copy of the Agreement.

Hydrogeological Monitoring and Evaluations were performed by SME and **Fishbeck**.

Copies of the Reports by SME and Technical Memos by Fishbeck are included herein. These documents contain soil borings and groundwater data throughout the project site.

HYDROGEOLOGIC MONITORING SUMMARY REPORT

Baughman Drain
Otsego, Allegan County, Michigan

SME Project Number: 075655.00
August 15, 2017

SME

4705 Clyde Park Avenue SW
Grand Rapids, MI 49509-5114

T (616) 406-1756

www.sme-usa.com

August 15, 2017

Mr. Kyle Visker, PE
Land and Resource Engineering
3800 West River Drive, Suite A
Comstock Park, Michigan 49321

RE: Hydrogeologic Monitoring Summary Report
Baughman Drain
Otsego, Allegan County, Michigan
SME Project No.: 075655.00

Dear Mr. Visker:

We have completed hydrogeologic monitoring for a portion of the Baughman Drain area, more specifically the residential area near the intersections of Springbrook Drive and Sycamore Street, Elm Street, and Prairiewood Court. This report presents the results of our observations and analyses, our water level monitoring results, and our findings and conclusions based on the available information.

We appreciate the opportunity to be of service. If you have questions or require additional information, please contact us.

Sincerely,

SME

Aaron J. Lammers, EIT
Senior Staff Engineer

Matthew A. Vander Eide, PG, CPG
Senior Project Geologist

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1. INTRODUCTION AND BACKGROUND

The Baughman Drain is located in the southern portion of Allegan County, south of the City of Otsego (Figure 1). The Baughman Drain conveys water from the area and discharges to Pine Creek to the west. Multiple natural watercourses also connect to the drain. Residents who live south of the Baughman Drain, near the intersections of Springbrook Drive and Sycamore Street, Elm Street, and Prairiewood Court (evaluation area), have petitioned for evaluations of the drain because of ongoing basement flooding. Specifically, ten residences have reportedly experienced consistent flooding and six additional residences have reportedly experienced periodic flooding (highlighted on Figure 2).

SME was retained by Land and Resource Engineering (LRE) to evaluate groundwater conditions in the evaluation area (Figure 2) over a period of approximately 3 months (evaluation period). We were retained to conduct this evaluation in accordance with our November 4, 2016, proposal number P02931.16.

SME's project team prepared this report to document the results of the hydrogeologic monitoring activities in the evaluation area.

2. PIEZOMETER AND STAFF GAUGE INSTALLATION

On March 7, 2017, we advanced six soil borings for the purpose of collecting and characterizing subsurface soil samples and installing piezometers (PZ-1 through PZ-6; Figure 2). Soil borings PZ-1 through PZ-6 were advanced to a depth of approximately 25 feet below ground surface (bgs) using track-mounted, hydraulically driven, direct-push sampling equipment. The soil column at each boring location was visually evaluated and representative samples were collected from each soil unit for visual classification in general accordance with ASTM D2488, Standard Practice for Description and Identification of Soils (Visual-Manual Procedure). Additionally, we collected soil samples from three soil borings (PZ-1, PZ-3, PZ-6) for grain size analysis. Piezometers were installed in each boring such that the well screens intersected the depth where groundwater was encountered during drilling. Each piezometer was constructed of 1.5-inch diameter, polychlorinated vinyl (PVC) riser pipe and a pre-packed, 0.010-inch slotted (10-slot), five-foot long, screen. After the piezometers were installed, expandable caps were installed, and bentonite was placed around the piezometer casing, in the remaining borehole annulus, from approximately one foot above the screens to approximately one foot below ground surface (bgs). Flush-mount protective covers were installed to protect the piezometers from tampering and damage.

On March 8, 2017, we installed three staff gauges in an unnamed, natural watercourse (SG-1 through SG-3) and two staff gauges in the Baughman Drain (SG-4 and SG-5). The staff gauges were 3.33 feet in length with gradation marks every 1, 0.1 and 0.02 feet. The staff gauges were mounted to metal stakes and hand-driven into the bottom of the unnamed, natural watercourse and Baughman Drain such that a portion of the graduated staff gauge was submerged beneath the surface water.

The piezometer locations were selected to evaluate areas where periodic or consistent flooding in basements has been reported by residents. The staff gauge locations were selected to evaluate surface water elevations and potential correlations with groundwater elevations. A summary of the rationale for each monitoring location is provided in the table below. The piezometer and staff gauge locations, ground surface elevations, bottom of surface water body elevations, and the top of casing or top of staff gauge elevations were surveyed by LRE. Ground surface and top of casing/top of staff gauge elevations are provided in Table 1.

LOCATION ID	LOCATION RATIONALE
PIEZOMETERS	
PZ-1	Near residences with reported flooding located at 1624 and 1627 Elm Street (17-580-006-00 and 17-580-016-00, respectively), in the eastern portion of the evaluation area.
PZ-2	Near a residence with reported flooding located at 1640 Sycamore Street (17-580-033-00), in the northeastern portion of the evaluation area.
PZ-3	Near residences with reported flooding located at 1662 and 1676 Sycamore Street (17-027-002-80 and 17-027-002-70, respectively), in the northwestern portion of the evaluation area.
PZ-4	Near a vacant lot on Prairiewood Court (17-650-001-00), south of residences on Sycamore Street with reported flooding, in the western portion of the evaluation area.
PZ-5	Near residences with reported flooding located at 1683, 1687 and 1691 Prairiewood Court (17-650-005-00, 17-650-006-00, and 17-650-007-00, respectively), in the western portion of the evaluation area.
PZ-6	Near a residence with reported flooding located at 1674 Prairiewood Court (17-650-014-00), in the southwestern portion of the evaluation area.
STAFF GAUGES	
SG-1	The southern portion of the unnamed, natural watercourse, which drains to the Baughman Drain, west of Springbrook Drive and south of Prairiewood Court.
SG-2	The central portion of the unnamed, natural watercourse, which drains to the Baughman Drain, west of Springbrook Drive and south of Prairiewood Court.
SG-3	The western portion of the unnamed, natural watercourse, which drains to the Baughman Drain, west of Springbrook Drive and south of Prairiewood Court.
SG-4	The western portion of the Baughman Drain, west of Springbrook Drive.
SG-5	The eastern portion of the Baughman Drain, west of Springbrook Drive.

3. SURFACE AND SUBSURFACE CONDITIONS

Descriptions of the soil conditions encountered at each of our soil boring locations are documented on the soil boring logs (Appendix A). The surface material consisted of approximately 4 to 18 inches of topsoil, which was generally underlain by fine to medium sand (PZ-1 through PZ-5) or fine sand with silt (PZ-6) to the maximum explored depth of 25 feet bgs. A three-inch thick clay seam and a two-inch thick silty sand seam were encountered at PZ-3 at depths of approximately 12.5 feet to 12.75 feet and 18 feet to 18.16 feet, respectively. Groundwater was encountered during drilling at depths ranging from approximately 4.9 to 7.1 feet bgs. We reviewed publicly available water well logs and noted the reported presence of clay encountered at depths ranging from approximately 40 feet to 83 feet bgs. We also noted the reported presence of soils described as “clay and sand” or “sand and clay” on a few of the water well logs, at various depths and with variable thicknesses. Cross sections depicting the subsurface conditions observed during our drilling activities are provided on Figures 3 and 4.

We collected soil samples from three soil borings (PZ-1, PZ-3 and PZ-6) for grain size analysis. The soil samples were collected from a depth interval that corresponded with the screened interval of the piezometers. The grain size analysis results are provided in the table below and documented on the material test reports in Appendix B.

LOCATION ID	SAMPLE DEPTH (FEET BGS)	SOIL DESCRIPTION	PERCENT FINES
PZ-1	7’ – 10’	Fine to medium sand	3.2%
PZ-3	7.5’ – 12’	Fine to medium sand	3.8%
PZ-6	5’ – 10’	Fine Sand with Silt	14%

4. PRECIPITATION DATA

We obtained publicly available precipitation data from the National Oceanic and Atmospheric Administration (NOAA) National Weather Service (NWS) Kalamazoo International Airport station, the nearest weather station to the evaluation area, for each day during the evaluation period, from March 8, 2017 to June 5, 2017. A chart depicting the precipitation data is provided in Appendix C. We also plotted the precipitation data on water level charts, as discussed in Section 7.

Precipitation events equal to or exceeding 0.01 inches occurred on 32 of the 90 total days. Significant precipitation events (i.e. greater than 0.5 inches) occurred on five days (March 25, 2017; March 30, 2017; April 30, 2017; May 1, 2017; and May 20, 2017). The average daily precipitation amounts for the months of March, April and May were 0.13 inches, 0.09 inches and 0.12 inches, respectively. The total precipitation during the evaluation period was 9.46 inches. The tabulated precipitation data is provided in Table 2.

5. WATER LEVEL MONITORING

We monitored the groundwater level in the piezometers and surface water level at staff gauge locations for an evaluation period of approximately three months, from March 8, 2017 to June 5, 2017. We installed Solinst® Levelogger™ data logger instruments approximately six inches from the bottom of the piezometers to collect and record groundwater level measurements at an interval of approximately 15 minutes. A Solinst® Barologger™ was also installed above the groundwater in one piezometer to collect and record the barometric pressure at an interval of approximately 15 minutes. The barometric data was applied to the groundwater level measurement data to compensate for variations in barometric pressure during the evaluation period. We conducted site visits every other week to maintain the instruments and download the recorded groundwater level measurement data. During each site visit, we also recorded depth to groundwater measurements in the piezometers using a water level indicator tape and recorded surface water level measurements in the staff gauges installed in the unnamed, natural watercourse and the Baughman Drain. Water level measurements were subtracted from the top of casing elevation (piezometers) or top of staff gauge elevations to calculate groundwater and surface water elevations. The water level indicator and staff gauge measurements and elevations are summarized in Table 1. Water level elevations recorded in the piezometers by the data loggers and at the staff gauges are provided in graphical form in Appendices D and E, respectively.

6. GROUNDWATER FLOW

Groundwater elevation contour maps based on the groundwater elevations measured on March 22, 2017; April 20, 2017 and May 16, 2017 are depicted on Figures 5, 6, and 7, respectively. The surface water elevation measurements were not used in our groundwater flow evaluation because these measurements indicated the surface water elevation was at least three feet lower than the groundwater elevation. Groundwater in the evaluation area generally flows in a northerly direction, toward the Baughman Drain. The groundwater flow direction was generally consistent during the evaluation period. The average horizontal groundwater hydraulic gradient between PZ-4 and PZ-3 on May 16, 2017 was 0.002 feet per foot.

We calculated an estimated groundwater flow rate using hydraulic conductivity values from three sources. First, we calculated an estimated hydraulic conductivity of 44 feet per day using the grain size analysis results and the Hazen Method. For comparison, we also used the hydraulic conductivity values of 26.1 feet per day provided by the United States Department of Agriculture (USDA) for the soil types present in the evaluation area and a generalized, textbook value of 25 feet per day for fine to medium sand. Using these three hydraulic conductivity values, the gradient mentioned above, and an assumed average porosity of 30%, we calculated a groundwater flow rate of 0.2 to 0.3 feet per day, or approximately 73 to 110 feet per year.

7. MONITORING RESULTS

We began collecting and recording groundwater level measurement data on March 8, 2017. The data loggers were programmed to collect and record groundwater level measurements at an interval of approximately 15 minutes. The data logger that was installed in PZ-6 on March 8, 2017 malfunctioned and did not record any measurements. A replacement data logger was installed on March 22, 2017, but malfunctioned shortly after being installed, and did not record any measurements. A third data logger was installed in PZ-6 on April 7, 2017, and successfully collected and recorded ground water level measurements at an interval of approximately 15 minutes until the end of the evaluation period. Manual groundwater elevation measurements are not shown on these charts; however, they were generally consistent with measurements collected by the data loggers.

7.1 PIEZOMETER RESULTS

The groundwater elevation readings collected during the evaluation period are summarized in the table below, along with the piezometer screen depths and screen elevations. The general groundwater elevation trends observed in each piezometer were consistent during the evaluation period. The groundwater elevation data generally indicated a decrease from March 8 to March 24; incremental increases from March 24 to April 8; and a decrease from April 8 to June 5. A summary chart showing all six piezometers and charts showing the recorded groundwater elevations in each piezometer compared to rainfall are provided in Appendix D. A summary chart showing the recorded groundwater elevation measurements in all six of the piezometers, and charts showing the recorded groundwater elevation measurements in each individual piezometer are provided in Appendix D.

LOCATION ID	SCREEN DEPTH (FEET BGS)	SCREEN ELEVATION (FEET MSL)	GROUNDWATER ELEVATION RANGE (FEET MSL)
PZ-1	6 to 11	701.96 to 706.96	706.07 to 707.35
PZ-2	6.5 to 11.5	700.97 to 705.95	704.72 to 706.04
PZ-3	6.5 to 11.5	700.44 to 705.44	704.61 to 706.20
PZ-4	6 to 11	701.20 to 706.20	706.35 to 707.78
PZ-5	4.5 to 9.5	702.56 to 707.56	707.20 to 708.53
PZ-6	4 to 9	703.59 to 708.59	707.43 to 708.53

7.2 STAFF GAUGE RESULTS

We collected surface water elevation measurements from the staff gauges on March 22, 2017; April 7, 2017; April 20, 2017; May 1, 2017; May 16, 2017; and June 5, 2017. As much as practical, we attempted to coordinate our site visits and surface water level measurements to occur during or following precipitation events. The surface water elevation measurements collected during the evaluation period are summarized in the table below. Overall, the surface water elevations remained relatively consistent, with only minor fluctuations, including a slight increase noted on April 7, 2017. A summary chart showing the recorded surface water elevations is provided in Appendix E.

The surface water elevation measurements indicate the unnamed, natural watercourse flows to the west-northwest and the Baughman Drain flows to the west. The gradient of the unnamed, natural watercourse on May 16, 2017 was approximately 0.00053 feet per foot between SG-1 and SG-2 and 0.0015 feet per foot between SG-2 and SG-3. The gradient of the Baughman Drain on May 16, 2017 was approximately 0.001 feet per foot between SG-4 and SG-5.

LOCATION ID	SURFACE WATER ELEVATION RANGE (FEET MSL)
SG-1	704.12 to 704.16
SG-2	703.32 to 703.48
SG-3	701.24 to 701.46
SG-4	699.56 to 699.66
SG-5	702.02 to 702.18

8. CONCLUSIONS AND RECOMMENDATIONS

We have evaluated the information collected during our evaluation period, and summarized our conclusions below.

- Groundwater elevations indicate the water table in the evaluation area is shallow, and basements in this area are likely positioned at least partially below the water table.

- Groundwater elevations varied at each piezometer location, but the recorded elevations indicated consistent trends across the evaluation area. Relatively rapid groundwater elevation increases appeared to correlate with precipitation events that occurred in late March and early April; however, the correlation between groundwater elevations and later precipitation events became less pronounced and less obvious during the remainder of the evaluation period, as groundwater elevations decreased.

- Groundwater elevations in the evaluation area were at least three feet higher than the elevations of surface water in the unnamed, natural watercourse and Baughman Drain; therefore, the surface water elevations were not incorporated into the groundwater flow maps.

- Other than a slight increase in surface water elevations observed on April 7, 2017, the surface water elevation trends did not appear to correlate with the observed groundwater elevation trends. It is unclear whether the minor increases in surface water elevations observed in early April are the result of gains from precipitation events, surface runoff, possible ongoing discharge of groundwater to surface water, or a combination of these or other factors.

- It is possible that the unnamed, natural watercourse and the Baughman Drain could have sufficient capacities and flow rates such that the amount of extra water introduced into these features by precipitation events, surface runoff, and possible, ongoing groundwater drainage does not substantially influence surface water elevations.

Additional information is required to further evaluate the potential interaction between groundwater and the surface water present in the unnamed, natural watercourse and Baughman Drain. Options for gathering additional information, if desired, include:

- Advancing additional soil borings between PZ-6 and SG-1 to obtain additional geologic information and evaluate the potential presence of low permeability soil which could be limiting or groundwater flow toward the unnamed, natural watercourse;

- Installing additional piezometers between PZ-6 and SG-1 to evaluate groundwater elevations and gradients (horizontal and vertical) between these two locations;

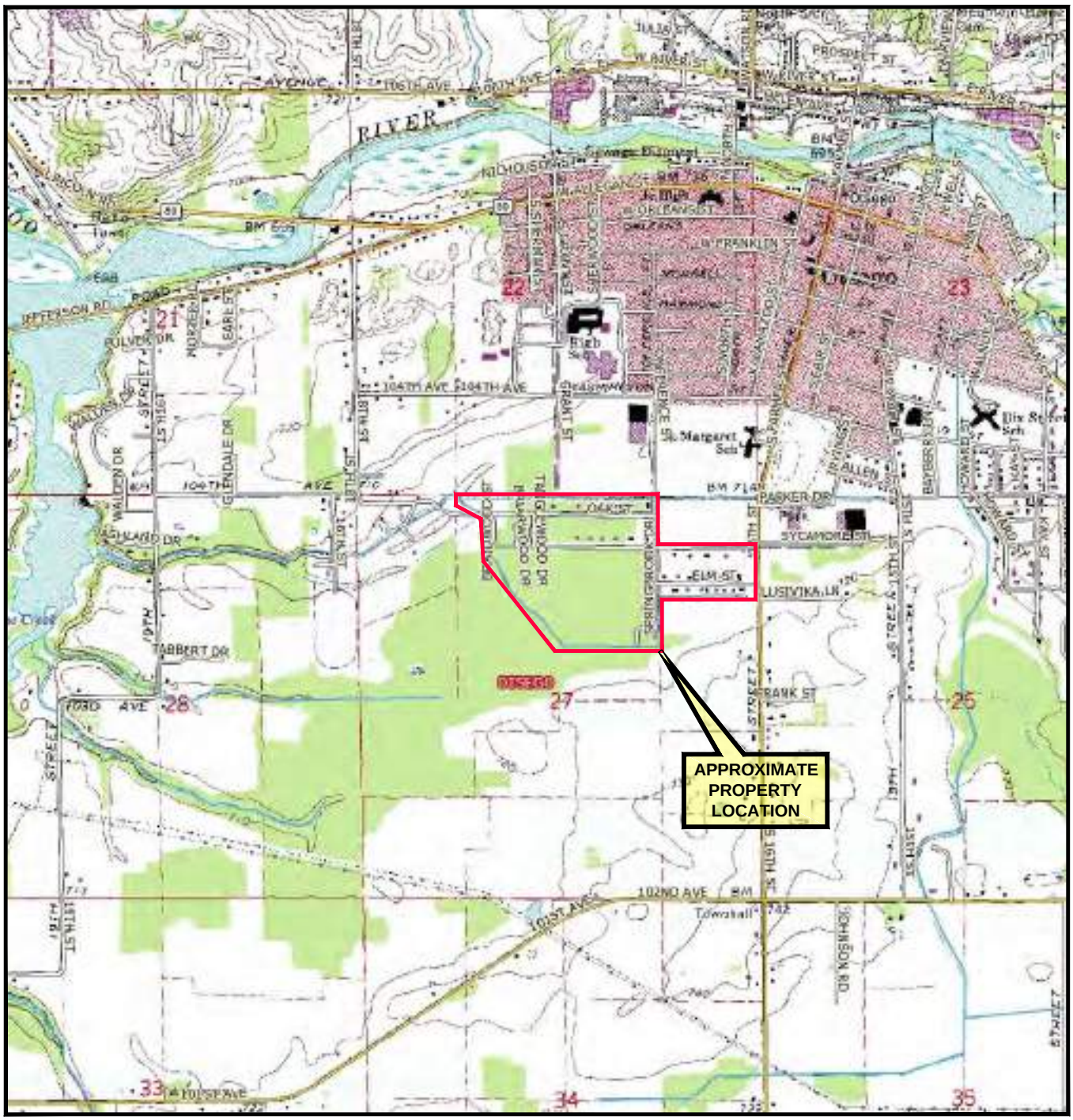
- Installing piezometers at multiple depths within the unnamed, natural watercourse and Baughman Drain to evaluate the potential for vertical gradients;

- Using a computer model to further evaluate groundwater conditions and possible interactions between groundwater and surface water;

- Drilling to evaluate geologic conditions below 25 feet bgs, the depth of soil borings advanced during this evaluation; and/or

- Conducting slug tests in some of the piezometers to more accurately estimate groundwater flow velocity.

FIGURES



Base map obtained from © DeLorme Topo North America™ 10.

USGS QUADRANGLE(s) REFERENCED

OTSEGO (MI) 1979

0' 2000'

SCALE: 1" = 2000'

NORTH

No.	Revision Date		
		Date	5-3-17
		Drawn By	JAB
		Designed By	MAV
		Scale	1" = 2000'
		Project	075655.00

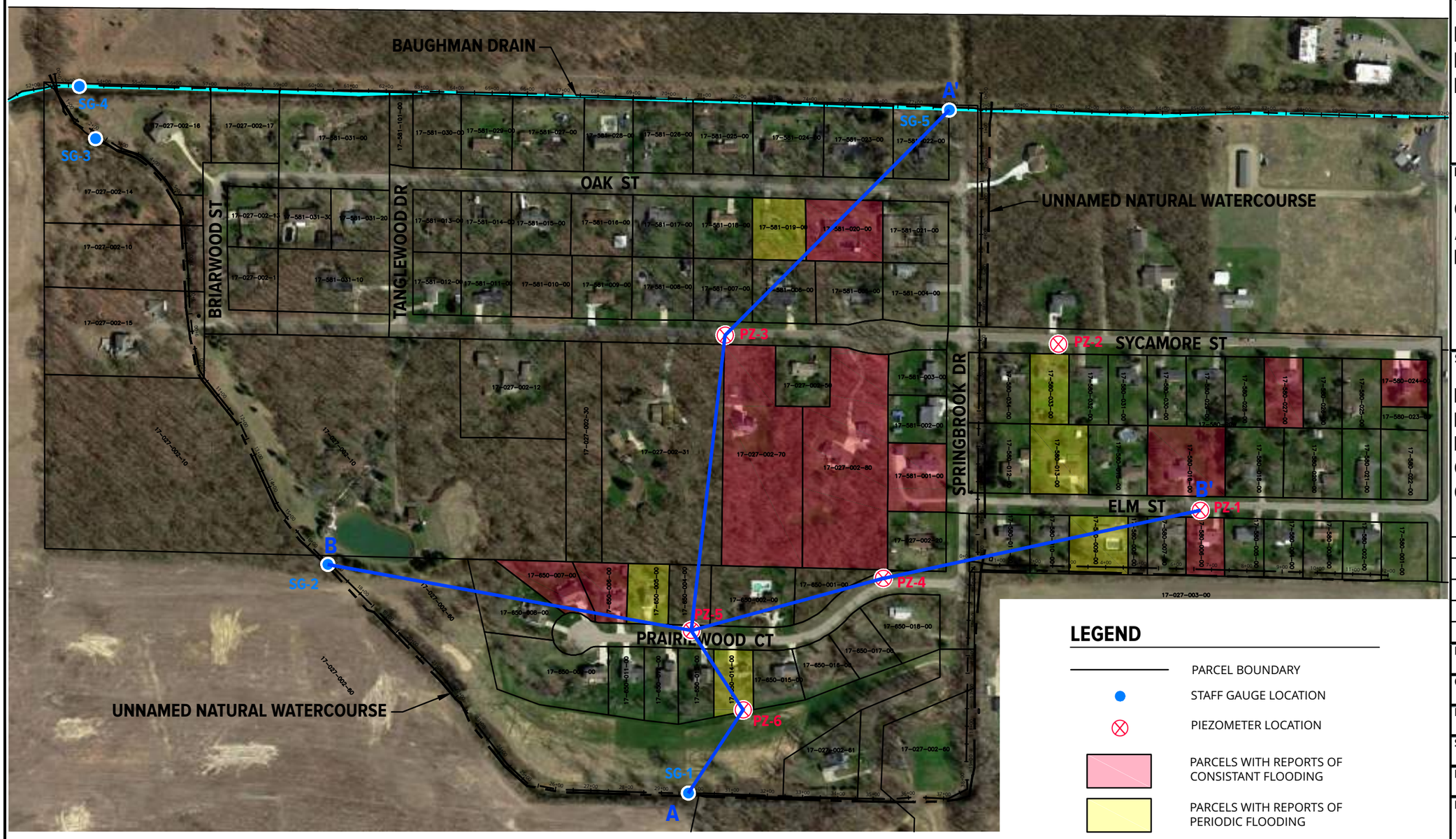
PROPERTY LOCATION MAP
BAUGHMAN DRAIN
HYDROGEOLOGIC EVALUATION
OTSEGO, ALLEGAN COUNTY, MICHIGAN

SME

www.sme-usa.com

Figure No. 1

May 03, 2017 - 3:22pm - jblake \\Sme-inc\pz\WIP\075655.00\CAD\DWGS\rev0\075655.00-01.dwg



NOTES:
1. BASE DRAWING INFORMATION TAKEN FROM A CAD FILE TITLED "CPS.dwg" RECEIVED FROM CLIENT.
2. IMAGE TAKEN FROM GOOGLE EARTH PRO WITH IMAGE DATE 4-14-2016

PLOT DATE: Jun 30, 2017 - 11:40am - jblake FILE LOCATION: \\Sme-inc\pz\WIP\075655.00\CAD\DWGS\rev0\075655.00-SITE.dwg

SME
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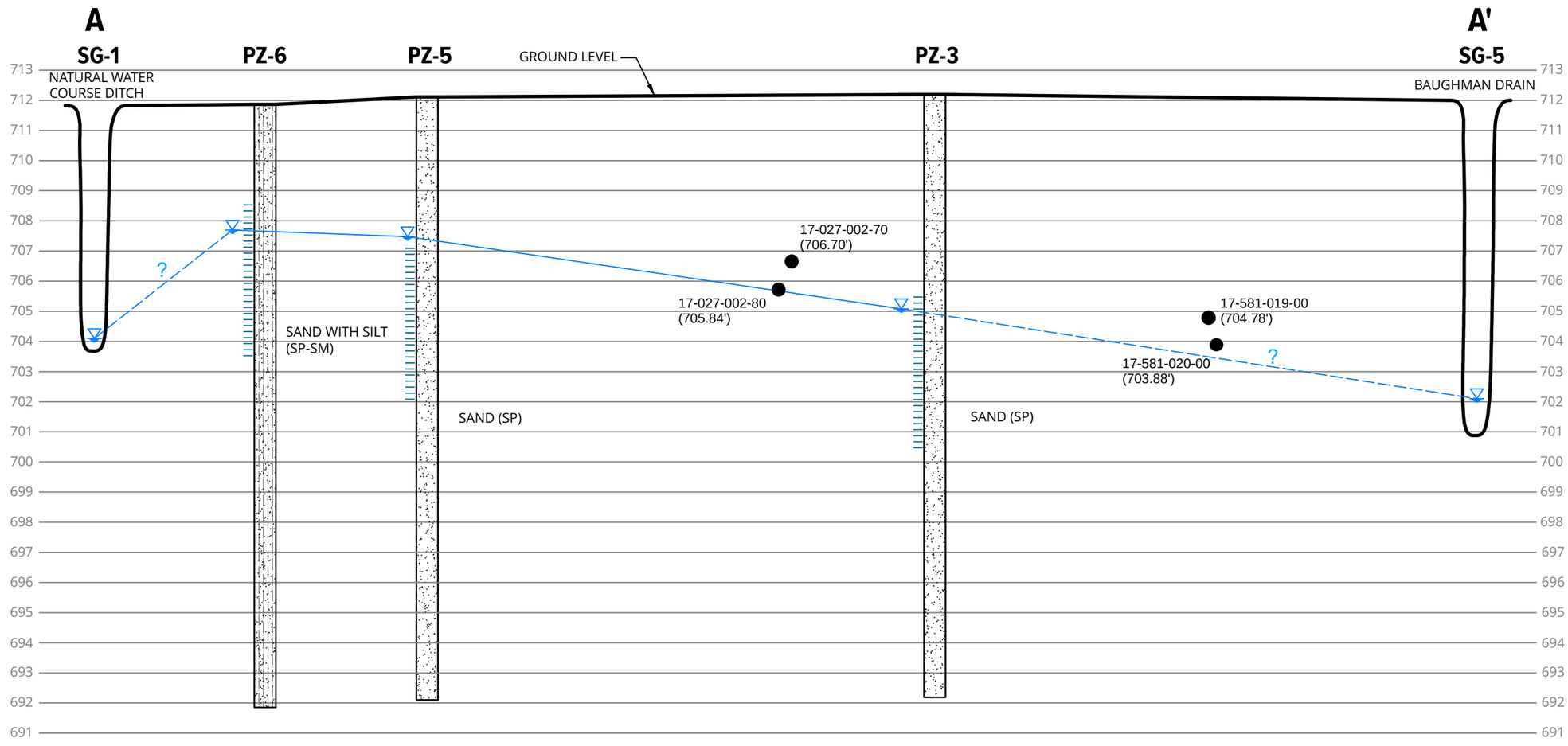
Project
BAUGHMAN DRAIN HYDROGEOLOGIC EVALUATION

Project Location
OTSEGO, ALLEGAN COUNTY, MICHIGAN

Sheet Name
EVALUATION AREA, MONITORING LOCATION, AND GEOLOGICAL CROSS-SECTION

No.	Revision Date

Date: 6-30-17
CADD: JAB
Designer: MAV/AJL
Scale: 1" = 300'
Project: 075655.00
Figure No.: 2



LEGEND

- SAND
- SAND WITH SILT
- WELL SCREEN INTERVAL
- GROUNDWATER ELEVATION MAY 16, 2017
- 17-027-002-80 (705.84') PARCEL ID NUMBER (BASEMENT FLOOR ELEVATION)

SCALE

VERTICAL: 1" = 4'
HORIZONTAL: 1" = 200'

SME
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Project
BAUGHMAN DRAIN HYDROGEOLOGIC EVALUATION

Project Location
OTSEGO, ALLEGAN COUNTY, MICHIGAN

Sheet Name
GEOLOGICAL CROSS-SECTION A-A'

No.	Revision Date

Date 7-21-17
CADD JAB
Designer AJL
Scale AS SHOWN
Project 075655.00
Figure No. 3

PLOT DATE: Jul 24, 2017 - 9:58am - jblake FILE LOCATION: \\Sme-inc\pz\WIP\075655.00\CAD\DWGS\rev0\075655.00-XS.dwg

B

B'

SG-2

PZ-5

PZ-4

PZ-1

NATURAL WATER COURSE DITCH

GROUND LEVEL

713
712
711
710
709
708
707
706
705
704
703
702
701
700
699
698
697
696
695
694
693
692
691

17-650-006-00
(707.00')

?

SAND (SP)

SAND (SP)

17-580-016-00
(706.00')

SAND (SP)

17-580-006-00
(705.65')

LEGEND

SAND

WELL SCREEN INTERVAL

GROUNDWATER ELEVATION
MAY 16, 2017

17-027-002-80
(705.84')

PARCEL ID NUMBER
(BASEMENT FLOOR ELEVATION)

SCALE

VERTICAL: 1" = 4'
HORIZONTAL: 1" = 200'

PLOT DATE: Jul 24, 2017 - 9:59am - jblake

FILE LOCATION: \\Sme-inc\pz\WIP\075655.00\CAD\DWGS\rev0\075655.00-XS.dwg

SME

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Project

BAUGHMAN DRAIN HYDROGEOLOGIC EVALUATION

Project Location

OTSEGO, ALLEGAN COUNTY, MICHIGAN

Sheet Name

GEOLOGICAL CROSS-SECTION B-B'

No.	Revision Date

Date 7-21-17

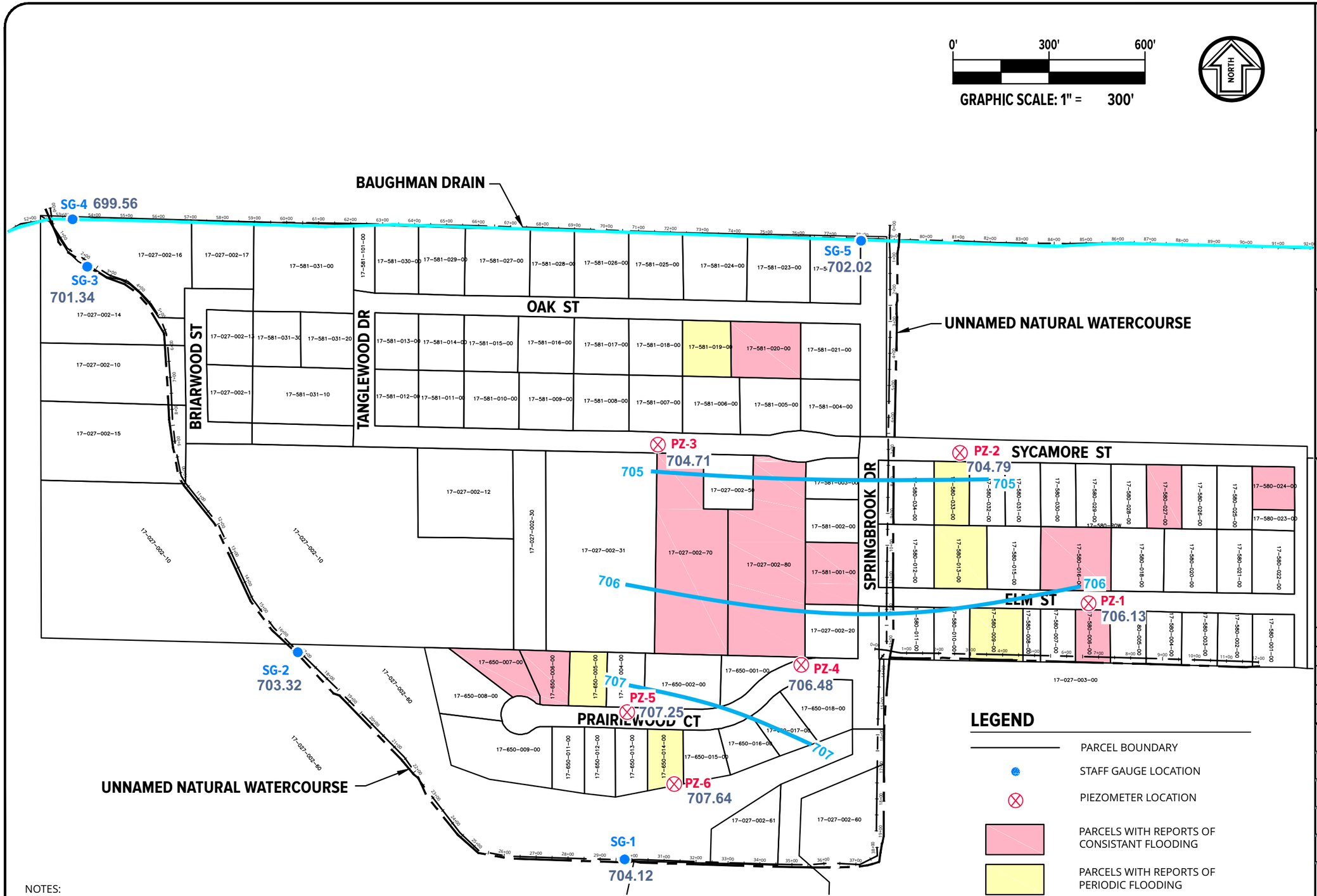
CADD JAB

Designer AJL

Scale AS SHOWN

Project 075655.00

Figure No. 4



NOTES:
1. BASE DRAWING INFORMATION TAKEN FROM A CAD FILE TITLED "CPS.dwg" RECEIVED FROM CLIENT.
2. IMAGE TAKEN FROM GOOGLE EARTH PRO WITH IMAGE DATE 4-14-2016
3. STAFF GAUGE WATER ELEVATIONS NOT USED IN GROUNDWATER FLOW DIRECTION EVALUATION BECAUSE ADDITIONAL INFORMATION IS NEEDED TO DETERMINE IF THE GROUNDWATER AND SURFACE WATER ARE CONNECTED.

PLOT DATE: May 03, 2017 - 3:35pm - jblake FILE LOCATION: \\Sme-inc\pz\WIP\075655.00\CAD\DWGS\rev0\075655.00-SITE.dwg

SME
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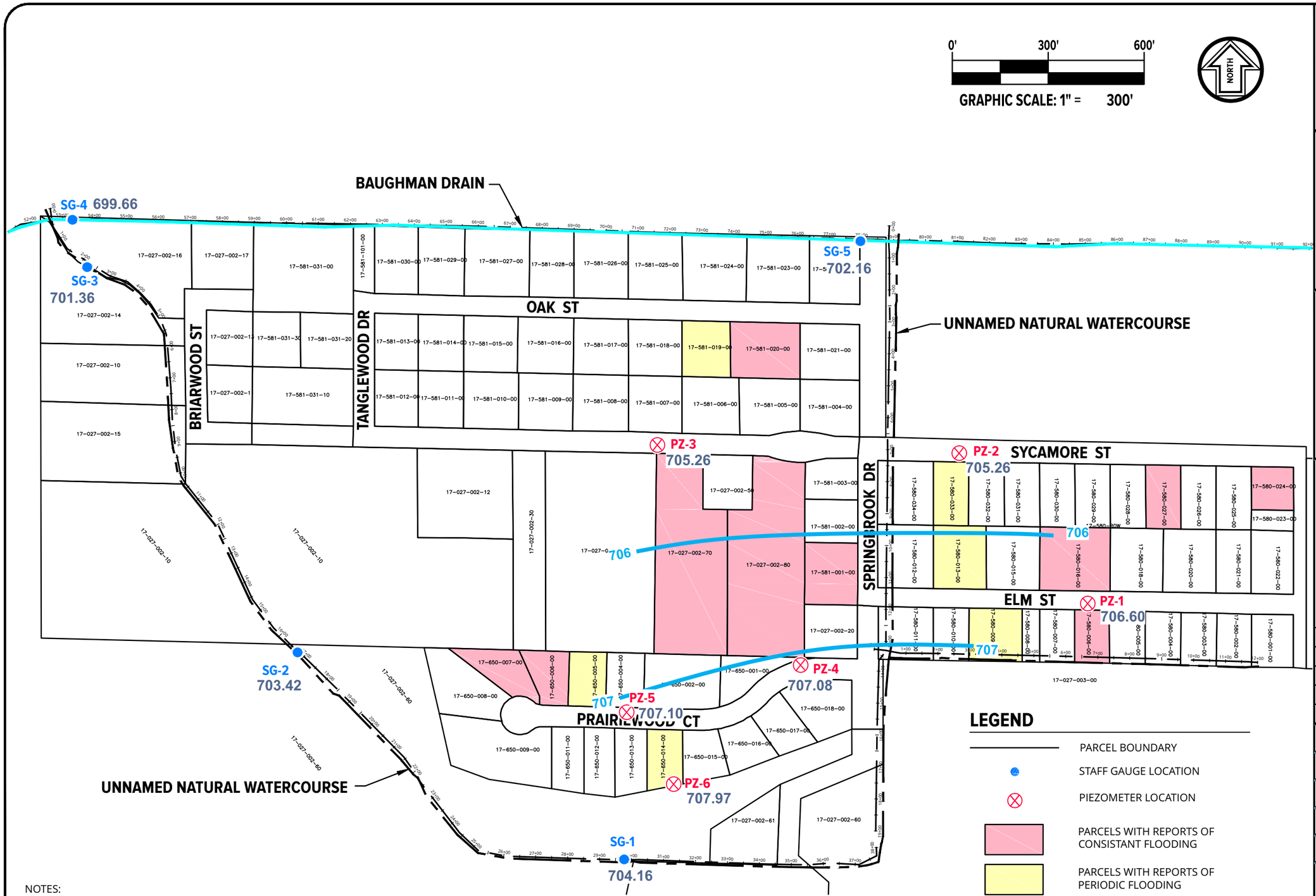
Project
BAUGHMAN DRAIN HYDROGEOLOGIC EVALUATION

Project Location
OTSEGO, ALLEGAN COUNTY, MICHIGAN

Sheet Name
GROUNDWATER ELEVATION CONTOUR DIAGRAM MARCH 22, 2017

No.	Revision Date

Date	7-3-17
CADD	AJL
Designer	MAV
Scale	1" = 300'
Project	075655.00
Figure No.	5



NOTES:
1. BASE DRAWING INFORMATION TAKEN FROM A CAD FILE TITLED "CPS.dwg" RECEIVED FROM CLIENT.
2. IMAGE TAKEN FROM GOOGLE EARTH PRO WITH IMAGE DATE 4-14-2016
3. STAFF GAUGE WATER ELEVATIONS NOT USED IN GROUNDWATER FLOW DIRECTION EVALUATION BECAUSE ADDITIONAL INFORMATION IS NEEDED TO DETERMINE IF THE GROUNDWATER AND SURFACE WATER ARE CONNECTED.

PLOT DATE: May 03, 2017 - 3:35pm - jblake FILE LOCATION: \\Sme-inc\pz\WIP\075655.00\CAD\DWGS\rev0\075655.00-SITE.dwg

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Project
BAUGHMAN DRAIN HYDROGEOLOGIC EVALUATION

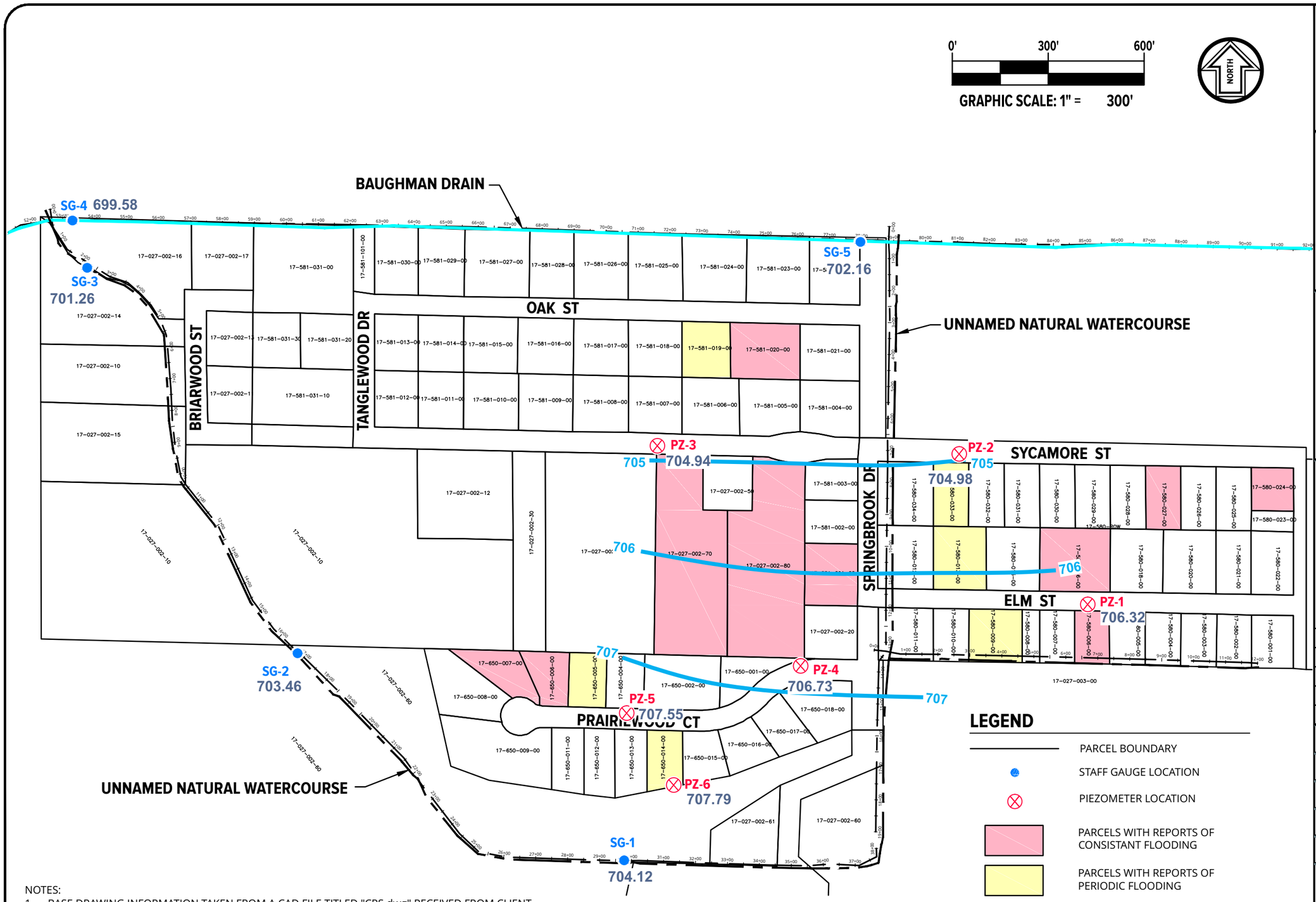
Project Location
OTSEGO, ALLEGAN COUNTY, MICHIGAN

Sheet Name
GROUNDWATER ELEVATION CONTOUR DIAGRAM APRIL 20, 2017

No.	Revision Date

Date	7-3-17
CADD	AJL
Designer	MAV
Scale	1" = 300'
Project	075655.00
Figure No.	6

DRAWING NOTE: SCALE DEPICTED IS MEANT FOR 11" X 17" AND WILL SCALE INCORRECTLY IF PRINTED ON ANY OTHER SIZE MEDIA



NOTES:
1. BASE DRAWING INFORMATION TAKEN FROM A CAD FILE TITLED "CPS.dwg" RECEIVED FROM CLIENT.
2. IMAGE TAKEN FROM GOOGLE EARTH PRO WITH IMAGE DATE 4-14-2016
3. STAFF GAUGE WATER ELEVATIONS NOT USED IN GROUNDWATER FLOW DIRECTION EVALUATION BECAUSE ADDITIONAL INFORMATION IS NEEDED TO DETERMINE IF THE GROUNDWATER AND SURFACE WATER ARE CONNECTED.

PLOT DATE: May 03, 2017 - 3:35pm - jblake FILE LOCATION: \\Sme-inc\pz\WIP\075655.00\CAD\DWGS\rev0\075655.00-SITE.dwg

SME
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Project
BAUGHMAN DRAIN HYDROGEOLOGIC EVALUATION

Project Location
OTSEGO, ALLEGAN COUNTY, MICHIGAN

Sheet Name
GROUNDWATER ELEVATION CONTOUR DIAGRAM MAY 16, 2017

No.	Revision Date

Date	7-3-17
CADD	AJL
Designer	MAV
Scale	1" = 300'
Project	075655.00
Figure No.	7

TABLES

TABLE 1: GROUNDWATER ELEVATION SUMMARY

TABLE 2: PRECIPITAION SUMMARY

TABLE 1
GROUNDWATER ELEVATION SUMMARY
BAUGHMAN DRAIN EVAULATION
SME PROJECT NO. 075655.00

Monitoring Location	Ground Surface Elevation (feet MSL)	TOC Elevation (feet MSL)	Screen Interval Elevation (feet MSL)	3/8/2017		3/22/2017		4/7/2017		4/20/2017		5/1/2017		5/16/2017		6/5/2017	
				Depth to Water from TOC (feet)	Groundwater Elevation (feet MSL)	Depth to Water from TOC (feet)	Groundwater Elevation (feet MSL)	Depth to Water from TOC (feet)	Groundwater Elevation (feet MSL)	Depth to Water from TOC (feet)	Groundwater Elevation (feet MSL)	Depth to Water from TOC (feet)	Groundwater Elevation (feet MSL)	Depth to Water from TOC (feet)	Groundwater Elevation (feet MSL)	Depth to Water from TOC (feet)	Groundwater Elevation (feet MSL)
PZ-1	712.96	712.85	701.96 - 706.96	6.52	706.33	6.72	706.13	5.50	707.35	6.25	706.60	6.34	706.51	6.53	706.32	6.78	706.07
PZ-2	712.47	712.34	700.97 - 705.95	7.32	705.02	7.55	704.79	6.31	706.03	7.08	705.26	7.20	705.14	7.36	704.98	7.62	704.72
PZ-3	711.94	711.54	700.44 - 705.44	6.50	705.04	6.83	704.71	5.40	706.14	6.28	705.26	6.20	705.34	6.60	704.94	6.93	704.61
PZ-4	712.20	712.03	701.20 - 706.20	5.30	706.73	5.55	706.48	4.28	707.75	4.95	707.08	5.05	706.98	5.30	706.73	5.63	706.40
PZ-5	712.06	711.70	702.56 - 707.56	4.20	707.50	4.45	707.25	3.20	708.50	4.60	707.10	3.92	707.78	4.15	707.55	4.50	707.20
PZ-6	712.59	712.19	703.59 - 708.59	4.41	707.78	4.55	707.64	3.66	708.53	4.22	707.97	4.92	707.27	4.40	707.79	4.73	707.46
SG-1	703.66	707.13	--	2.99	704.14	3.01	704.12	2.97	704.16	2.97	704.16	2.99	704.14	3.01	704.12	2.97	704.16
SG-2	702.14	705.53	--	2.18	703.35	2.21	703.32	2.05	703.48	2.11	703.42	2.08	703.45	2.07	703.46	2.17	703.36
SG-3	701.09	704.09	--	2.75	701.34	2.75	701.34	2.63	701.46	2.73	701.36	2.75	701.34	2.83	701.26	2.85	701.24
SG-4	698.66	702.15	--	2.53	699.62	2.59	699.56	2.53	699.62	2.49	699.66	2.55	699.60	2.57	699.58	2.57	699.58
SG-5	700.92	704.51	--	2.45	702.06	2.49	702.02	2.33	702.18	2.35	702.16	2.35	702.16	2.35	702.16	2.41	702.10

Notes:

(1) TOC = Top of Casing / Top of Staff Gauge

(2) feet MSL = feet above mean sea level

TABLE 2
PRECIPITATION SUMMARY
BAUGHMAN DRAIN EVAULATION
SME PROJECT NO. 075655.00

Date	Precipitation (inches)
3/8/2017	0.00
3/9/2017	0.00
3/10/2017	0.00
3/11/2017	0.00
3/12/2017	0.00
3/13/2017	0.26
3/14/2017	0.00
3/15/2017	0.00
3/16/2017	0.00
3/17/2017	0.22
3/18/2017	0.08
3/19/2017	0.00
3/20/2017	0.11
3/21/2017	0.00
3/22/2017	0.00
3/23/2017	0.24
3/24/2017	0.00
3/25/2017	0.64
3/26/2017	0.35
3/27/2017	0.00
3/28/2017	0.00
3/29/2017	0.01
3/30/2017	1.25
3/31/2017	0.00
4/1/2017	0.00
4/2/2017	0.00
4/3/2017	0.40
4/4/2017	0.00
4/5/2017	0.13
4/6/2017	0.42

Date	Precipitation (inches)
4/7/2017	0.00
4/8/2017	0.00
4/9/2017	0.00
4/10/2017	0.07
4/11/2017	0.00
4/12/2017	0.00
4/13/2017	0.00
4/14/2017	0.00
4/15/2017	0.04
4/16/2017	0.01
4/17/2017	0.00
4/18/2017	0.00
4/19/2017	0.24
4/20/2017	0.43
4/21/2017	0.00
4/22/2017	0.00
4/23/2017	0.00
4/24/2017	0.00
4/25/2017	0.00
4/26/2017	0.00
4/27/2017	0.00
4/28/2017	0.00
4/29/2017	0.29
4/30/2017	0.59
5/1/2017	0.74
5/2/2017	0.06
5/3/2017	0.00
5/4/2017	0.36
5/5/2017	0.00
5/6/2017	0.00

Date	Precipitation (inches)
5/7/2017	0.00
5/8/2017	0.00
5/9/2017	0.00
5/10/2017	0.39
5/11/2017	0.07
5/12/2017	0.00
5/13/2017	0.00
5/14/2017	0.00
5/15/2017	0.20
5/16/2017	0.00
5/17/2017	0.00
5/18/2017	0.00
5/19/2017	0.20
5/20/2017	1.01
5/21/2017	0.02
5/22/2017	0.00
5/23/2017	0.05
5/24/2017	0.48
5/25/2017	0.00
5/26/2017	0.06
5/27/2017	0.00
5/28/2017	0.00
5/29/2017	0.00
5/30/2017	0.00
5/31/2017	0.00
6/1/2017	0.00
6/2/2017	0.00
6/3/2017	0.00
6/4/2017	0.04
6/5/2017	0.00

Notes:

1. Precipitation data was obtained from the National Oceanic and Atmospheric Administration (NOAA) National Weather Service (NWS) Kalamazoo International Airport station, the nearest weather station to the evaluation area.

APPENDIX A
SOIL BORING LOGS

BORING PZ-1

PROJECT NAME: Baughman Drain Hydrogeological Evaluation
PROJECT NUMBER: 075655.00
CLIENT: Land & Resource Engineering and Surveying
PROJECT LOCATION: Otsego, Michigan

DATE STARTED: 2/7/17 **COMPLETED:** 2/7/17 **BORING METHOD:** Direct Push
OPERATOR: Nick-Fibertec **RIG NO.:** 7822 DT-1 **LOGGED BY:** AJL **CHECKED BY:** MAV

SURFACE ELEVATION: 712.96 FT

ELEVATION (FEET)	DEPTH (FEET)	PROFILE DESCRIPTION	SAMPLE TYPE/NO.	REMARKS
712.7	0	0.3 TOPSOIL	AS1	
			AS2	
			AS3	
710			AS4	
	5		AS5	
			LS1	A piezometer was installed in the borehole. The piezometer screen was set between 6 feet and 11 feet below ground surface.
705				
	10	Fine to Medium SAND- Brown- Moist to Wet (SP)	LS2	
700				
	15		LS3	
695				
	20		LS4	
690				
688.0	25	25.0 END OF BORING AT 25.0 FEET.		
685				
	30			

DRY DENSITY (pcf) -- ■ (90, 100, 110, 120)
MOISTURE & ATTERBERG LIMITS (%) PL MC LL (10, 20, 30, 40)
▽ HAND PENE. ⊠ TORVANE SHEAR ○ UNC.COMP. ⊡ VANE SHEAR (PK) ⨯ VANE SHEAR (REM) ⊕ TRIAXIAL (UU)
SHEAR STRENGTH (KSF) (1, 2, 3, 4)

GROUNDWATER & BACKFILL INFORMATION

	DEPTH (FT)	ELEV (FT)
▽ **DURING BORING:**	6.7	706.3
▼ **AT END OF BORING:**	6.6	706.4

BACKFILL METHOD: Well Installation - Piezometer

NOTES: 1. The indicated stratification lines are approximate. In situ, the transition between materials may be gradual.
4. A soil sample was collected from 7 to 10 feet below ground surface for a grain size analysis.

BORING PZ-2

PROJECT NAME: Baughman Drain Hydrogeological Evaluation
PROJECT NUMBER: 075655.00
CLIENT: Land & Resource Engineering and Surveying
PROJECT LOCATION: Otsego, Michigan

DATE STARTED: 2/7/17 **COMPLETED:** 2/7/17 **BORING METHOD:** Direct Push
OPERATOR: Nick-Fibertec **RIG NO.:** 7822 DT-1 **LOGGED BY:** AJL **CHECKED BY:** MAV

SURFACE ELEVATION: 712.47 FT

ELEVATION (FEET)	DEPTH (FEET)	PROFILE DESCRIPTION	SAMPLE TYPE/NO. INTERVAL
712	0	TOPSOIL	AS1
	1.5		AS2
710			AS3
	5		AS4
			AS5
705			LS1
	10		
700		Fine to Medium SAND- Brown- Moist to Wet (SP)	LS2
	15		
695			LS3
	20		
690			LS4
	25	END OF BORING AT 25.0 FEET.	
685			
	30		

711.0
687.5
25.0

DRY DENSITY (pcf) -- ■
90 100 110 120
MOISTURE & ATTERBERG LIMITS (%)
PL MC LL
10 20 30 40

▽ HAND PENE.
⊠ TORVANE SHEAR
○ UNC.COMP.
⊡ VANE SHEAR (PK)
× VANE SHEAR (REM)
⊕ TRIAXIAL (UU)
SHEAR STRENGTH (KSF)
1 2 3 4

REMARKS

A piezometer was installed in the borehole. The piezometer screen was set between 6.5 feet and 11.5 feet below ground surface.

GROUNDWATER & BACKFILL INFORMATION

	DEPTH (FT)	ELEV (FT)
▽ **DURING BORING:**	7.1	705.4
▼ **AT END OF BORING:**	7.4	705.1

BACKFILL METHOD: Well Installation - Piezometer

NOTES: 1. The indicated stratification lines are approximate. In situ, the transition between materials may be gradual.
4. A soil sample was collected from 7.5 to 12 feet below ground surface for a grain size analysis.

BORING PZ-3

PROJECT NAME: Baughman Drain Hydrogeological Evaluation
PROJECT NUMBER: 075655.00
CLIENT: Land & Resource Engineering and Surveying
PROJECT LOCATION: Otsego, Michigan

DATE STARTED: 2/7/17 **COMPLETED:** 2/7/17 **BORING METHOD:** Direct Push
OPERATOR: Nick-Fibertec **RIG NO.:** 7822 DT-1 **LOGGED BY:** AJL **CHECKED BY:** MAV

SURFACE ELEVATION: 711.94 FT

ELEVATION (FEET)	DEPTH (FEET)	PROFILE DESCRIPTION	SAMPLE TYPE/NO. INTERVAL
711.4	0	0.5 TOPSOIL	AS1
			AS2
			AS3
			AS4
710			AS5
	5		LS1
705 ▽▼			
	10	Fine to Medium SAND- Lean Clay Seam from 12.5 to 12.75 Feet- Silty Sand Seam from 18.0 to 18.16 Feet- Brown- Moist to Wet (SP)	LS2
700			
	15		LS3
695			
	20		LS4
690			
686.9	25	25.0 END OF BORING AT 25.0 FEET.	
685			
	30		

DRY DENSITY (pcf) -- ■ (90, 100, 110, 120)
MOISTURE & ATTERBERG LIMITS (%) PL MC LL (10, 20, 30, 40)
▽ HAND PENE.
⊠ TORVANE SHEAR
○ UNC.COMP.
⊡ VANE SHEAR (PK)
× VANE SHEAR (REM)
⊕ TRIAXIAL (UU)
SHEAR STRENGTH (KSF) (1, 2, 3, 4)

REMARKS: A piezometer was installed in the borehole. The piezometer screen was set between 6.5 feet and 11.5 feet below ground surface.

GROUNDWATER & BACKFILL INFORMATION

	DEPTH (FT)	ELEV (FT)
▽ **DURING BORING:**	6.8	705.2
▼ **AT END OF BORING:**	6.8	705.2

BACKFILL METHOD: Well Installation - Piezometer

NOTES: 1. The indicated stratification lines are approximate. In situ, the transition between materials may be gradual.

BORING PZ-4

PROJECT NAME: Baughman Drain Hydrogeological Evaluation
PROJECT NUMBER: 075655.00
CLIENT: Land & Resource Engineering and Surveying
PROJECT LOCATION: Otsego, Michigan

DATE STARTED: 2/7/17 **COMPLETED:** 2/7/17 **BORING METHOD:** Direct Push
OPERATOR: Nick-Fibertec **RIG NO.:** 7822 DT-1 **LOGGED BY:** AJL **CHECKED BY:** MAV

SURFACE ELEVATION: 712.2 FT

ELEVATION (FEET)	DEPTH (FEET)	PROFILE DESCRIPTION	SAMPLE TYPE/NO. INTERVAL
710	0	0.5 TOPSOIL 711.7	AS1
			AS2
			AS3
			AS4
			AS5
705	5		LS1
700	10	Fine to Medium SAND- Brown- Moist to Wet (SP)	LS2
695	15		LS3
690	20		LS4
685	25	25.0 687.2 END OF BORING AT 25.0 FEET.	
	30		

DRY DENSITY (pcf) -- ■ (90, 100, 110, 120)
MOISTURE & ATTERBERG LIMITS (%) PL MC LL (10, 20, 30, 40)
▽ HAND PENE.
⊠ TORVANE SHEAR
○ UNC.COMP.
⊡ VANE SHEAR (PK)
× VANE SHEAR (REM)
⊕ TRIAXIAL (UU)
SHEAR STRENGTH (KSF) (1, 2, 3, 4)

REMARKS: A piezometer was installed in the borehole. The piezometer screen was set between 6 feet and 11 feet below ground surface.

GROUNDWATER & BACKFILL INFORMATION

	DEPTH (FT)	ELEV (FT)
▽ **DURING BORING:**	6.5	705.7
▼ **AT END OF BORING:**	6.4	705.9

BACKFILL METHOD: Well Installation - Piezometer

NOTES: 1. The indicated stratification lines are approximate. In situ, the transition between materials may be gradual.

BORING PZ-5

PROJECT NAME: Baughman Drain Hydrogeological Evaluation
PROJECT NUMBER: 075655.00
CLIENT: Land & Resource Engineering and Surveying
PROJECT LOCATION: Otsego, Michigan

DATE STARTED: 2/7/17 **COMPLETED:** 2/7/17 **BORING METHOD:** Direct Push
OPERATOR: Nick-Fibertec **RIG NO.:** 7822 DT-1 **LOGGED BY:** AJL **CHECKED BY:** MAV

SURFACE ELEVATION: 712.06 FT

ELEVATION (FEET)	DEPTH (FEET)	PROFILE DESCRIPTION	SAMPLE TYPE/NO. INTERVAL
712	0	0.5 TOPSOIL 711.6	AS1
			AS2
			AS3
			AS4
710			AS5
	5		
705			LS1
	10	Fine to Medium SAND- Brown- Moist to Wet (SP)	
700			LS2
	15		
695			LS3
	20		
690			LS4
	25	25.0 687.1 END OF BORING AT 25.0 FEET.	
685			
	30		

DRY DENSITY (pcf) -- ■ (90, 100, 110, 120)
MOISTURE & ATTERBERG LIMITS (%) PL MC LL (10, 20, 30, 40)
▽ HAND PENE.
⊠ TORVANE SHEAR
○ UNC.COMP.
⊡ VANE SHEAR (PK)
× VANE SHEAR (REM)
⊕ TRIAXIAL (UU)
SHEAR STRENGTH (KSF) (1, 2, 3, 4)

REMARKS: A piezometer was installed in the borehole. The piezometer screen was set between 4.5 feet and 9.5 feet below ground surface.

GROUNDWATER & BACKFILL INFORMATION

	DEPTH (FT)	ELEV (FT)
▽ **DURING BORING:**	5.0	707.1
▼ **AT END OF BORING:**	4.5	707.6

BACKFILL METHOD: Well Installation - Piezometer

NOTES: 1. The indicated stratification lines are approximate. In situ, the transition between materials may be gradual.

BORING PZ-6

PROJECT NAME: Baughman Drain Hydrogeological Evaluation
PROJECT NUMBER: 075655.00
CLIENT: Land & Resource Engineering and Surveying
PROJECT LOCATION: Otsego, Michigan

DATE STARTED: 2/7/17 **COMPLETED:** 2/7/17 **BORING METHOD:** Direct Push
OPERATOR: Nick-Fibertec **RIG NO.:** 7822 DT-1 **LOGGED BY:** AJL **CHECKED BY:** MAV

SURFACE ELEVATION: 712.59 FT

ELEVATION (FEET)	DEPTH (FEET)	PROFILE DESCRIPTION	SAMPLE TYPE/NO. INTERVAL
712.59	0		
711.6	1.0	TOPSOIL	AS1
			AS2
			AS3
			AS4
			AS5
710	5		
705	10		LS1
			LS2
700	15	Fine SAND with Silt- Brown- Moist to Wet (SP-SM)	
695	20		LS3
			LS4
690	25		
687.6	25.0	END OF BORING AT 25.0 FEET.	
685	30		

DRY DENSITY (pcf) -- ■ (90 100 110 120)
MOISTURE & ATTERBERG LIMITS (%) PL MC LL (10 20 30 40)
▽ HAND PENE.
⊠ TORVANE SHEAR
○ UNC.COMP.
⊡ VANE SHEAR (PK)
× VANE SHEAR (REM)
⊕ TRIAXIAL (UU)
SHEAR STRENGTH (KSF) (1 2 3 4)

REMARKS: A piezometer was installed in the borehole. The piezometer screen was set between 4 feet and 9 feet below ground surface.

GROUNDWATER & BACKFILL INFORMATION

	DEPTH (FT)	ELEV (FT)
▽ **DURING BORING:**	4.9	707.7
▼ **AT END OF BORING:**	4.5	708.1

BACKFILL METHOD: Well Installation - Piezometer

NOTES: 1. The indicated stratification lines are approximate. In situ, the transition between materials may be gradual.
4. A soil sample was collected from 5 to 10 feet below ground surface for a grain size analysis.

APPENDIX B
GRAIN SIZE ANALYSIS RESULTS

4705 Clyde Park Avenue SW
Grand Rapids, MI 49509-5114
(616) 406-1756
www.sme-usa.com

Material Test Report

Project No.:	**075655.00**
Report No.:	**MAT:17-2993-S1-1**

Client: Land & Resource Engineering and Surveying, Inc. **CC:**
Project: Baughman Drain Hydrogeo Evaluation

Various
Otsego MI 49078

Contractor:

Reviewed By: Jeremy S. Hugo, PE

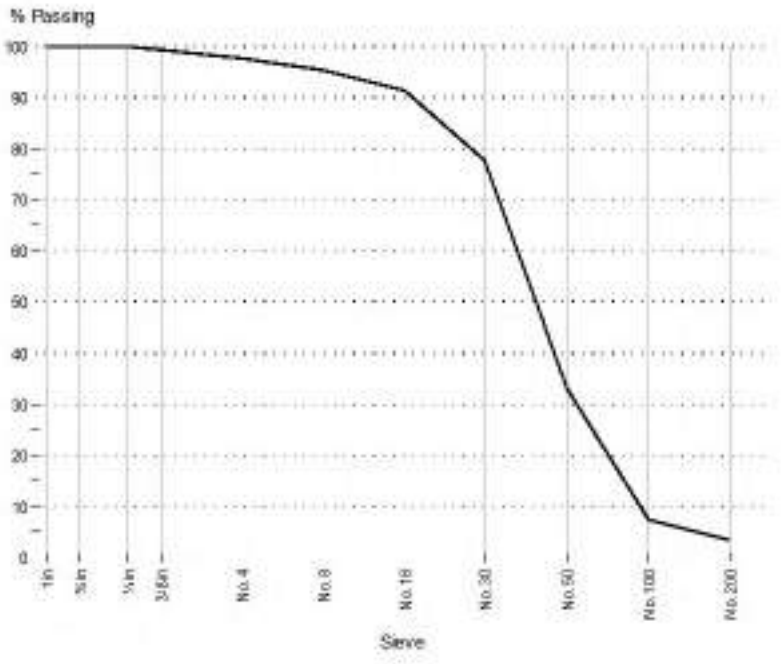
Sample Details

Sample ID	17-2993-S1
Sampled By	Christopher M Holmes
Date Sampled	Mar 10, 2017
Specification	General Sieve Set
Bore Hole	PZ-1
Depth	7'-10'

Sample Description:

Fine to Medium Sand

Particle Size Distribution



COBBLES	GRAVEL		SAND			FINES (3.2%)	
(0.0%)	Coarse (0.0%)	Fine (2.3%)	Coarse (3.3%)	Medium (38.9%)	Fine (52.3%)	Silt	Clay

Grading: ASTM C 136, ASTM C 117

Date Tested: 3/13/2017

Sieve Size	% Passing	Limits
1in	100	
¾in	100	
½in	100	
3/8in	99	
No.4	98	
No.8	95	
No.16	91	
No.30	78	
No.50	33	
No.100	7	
No.200	3.2	
Finer No.200 (75µm)	3.2	

D85: 0.8648 **D60:** 0.4560 **D50:** 0.3902
D30: 0.2758 **D15:** 0.1845 **D10:** 0.1614
Cu: 2.83 **Cc:** 1.03

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Grand Rapids, MI 49509-5114
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Material Test Report

Project No.:	**075655.00**
Report No.:	**MAT:17-2993-S2-1**

Client: Land & Resource Engineering and Surveying, Inc. **CC:**
Project: Baughman Drain Hydrogeo Evaluation

Various
Otsego MI 49078

Contractor:

Reviewed By: Jeremy S. Hugo, PE

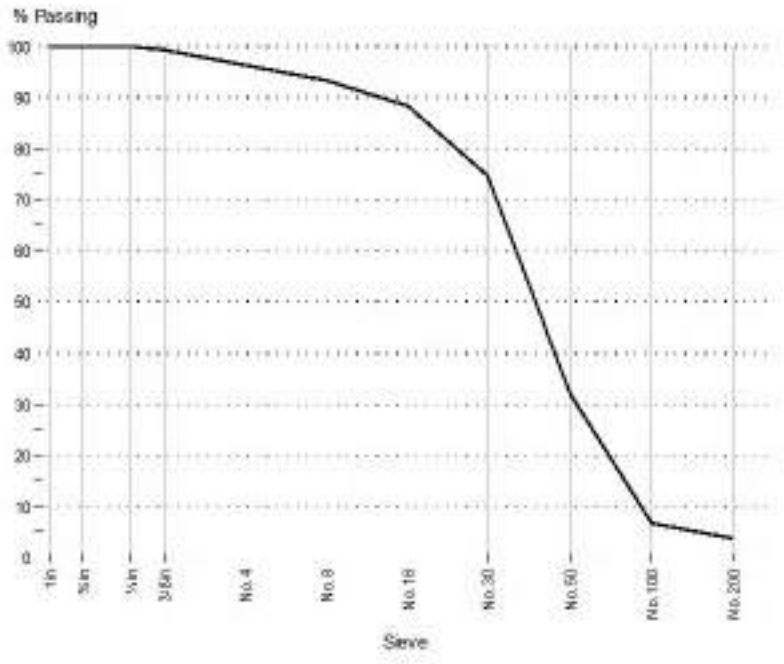
Sample Details

Sample ID	17-2993-S2
Sampled By	Christopher M Holmes
Specification	General Sieve Set
Bore Hole	PZ-3
Depth	7.5'-12'

Sample Description:

Fine to Medium Sand

Particle Size Distribution



COBBLES	GRAVEL		SAND			FINES (3.8%)	
	Coarse	Fine	Coarse	Medium	Fine		
(0.0%)	(0.0%)	(3.8%)	(4.1%)	(38.7%)	(49.7%)	Silt	Clay

Grading: ASTM C 136, ASTM C 117

Date Tested: 3/13/2017

Sieve Size	% Passing	Limits
1in	100	
¾in	100	
½in	100	
3/8in	99	
No.4	96	
No.8	93	
No.16	88	
No.30	75	
No.50	32	
No.100	7	
No.200	3.8	
Finer No.200 (75µm)	3.8	

D85: 0.9986 **D60:** 0.4726 **D50:** 0.4019
D30: 0.2842 **D15:** 0.1884 **D10:** 0.1643
Cu: 2.88 **Cc:** 1.04

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Material Test Report

Project No.:	**075655.00**
Report No.:	**MAT:17-2993-S3-1**

Client: Land & Resource Engineering and Surveying, Inc. **CC:**
Project: Baughman Drain Hydrogeo Evaluation

Various
Otsego MI 49078

Contractor:

Reviewed By: Jeremy S. Hugo, PE

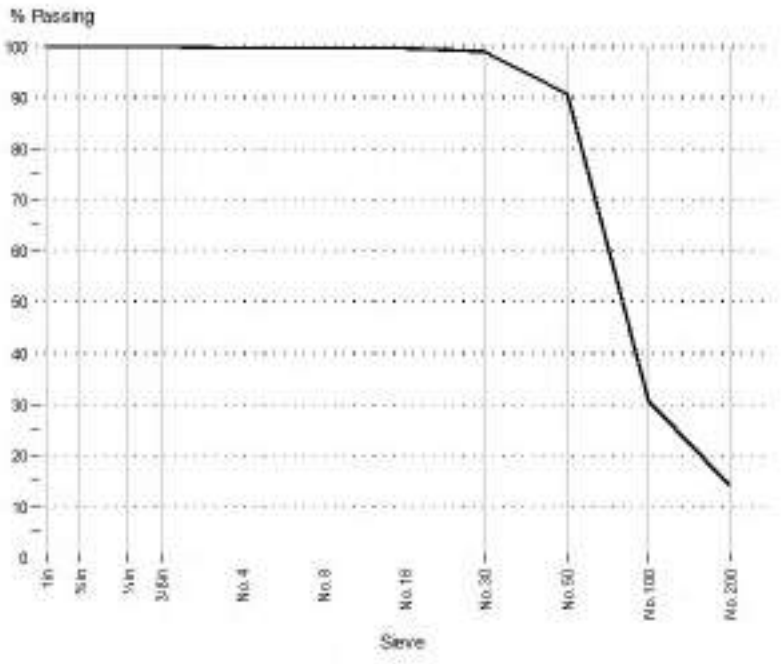
Sample Details

Sample ID	17-2993-S3
Sampled By	Christopher M Holmes
Specification	General Sieve Set
Bore Hole	PZ-6
Depth	5'-10'

Sample Description:

Fine Sand with Silt

Particle Size Distribution



COBBLES	GRAVEL		SAND			FINES (14.0%)	
	Coarse	Fine	Coarse	Medium	Fine		
(0.0%)	(0.0%)	(0.3%)	(0.0%)	(4.9%)	(80.8%)	Silt	Clay

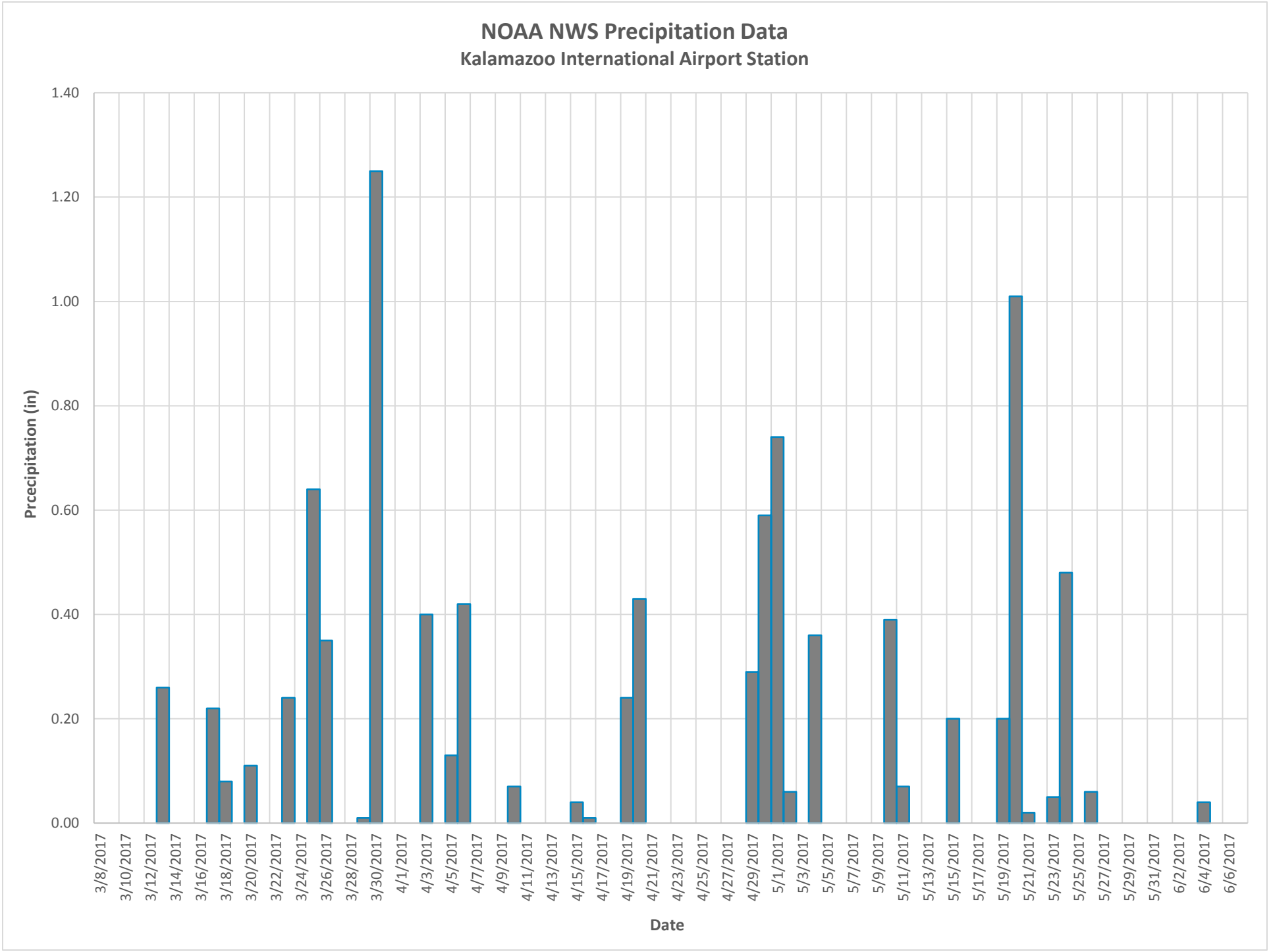
Grading: ASTM C 136, ASTM C 117

Date Tested: 3/13/2017

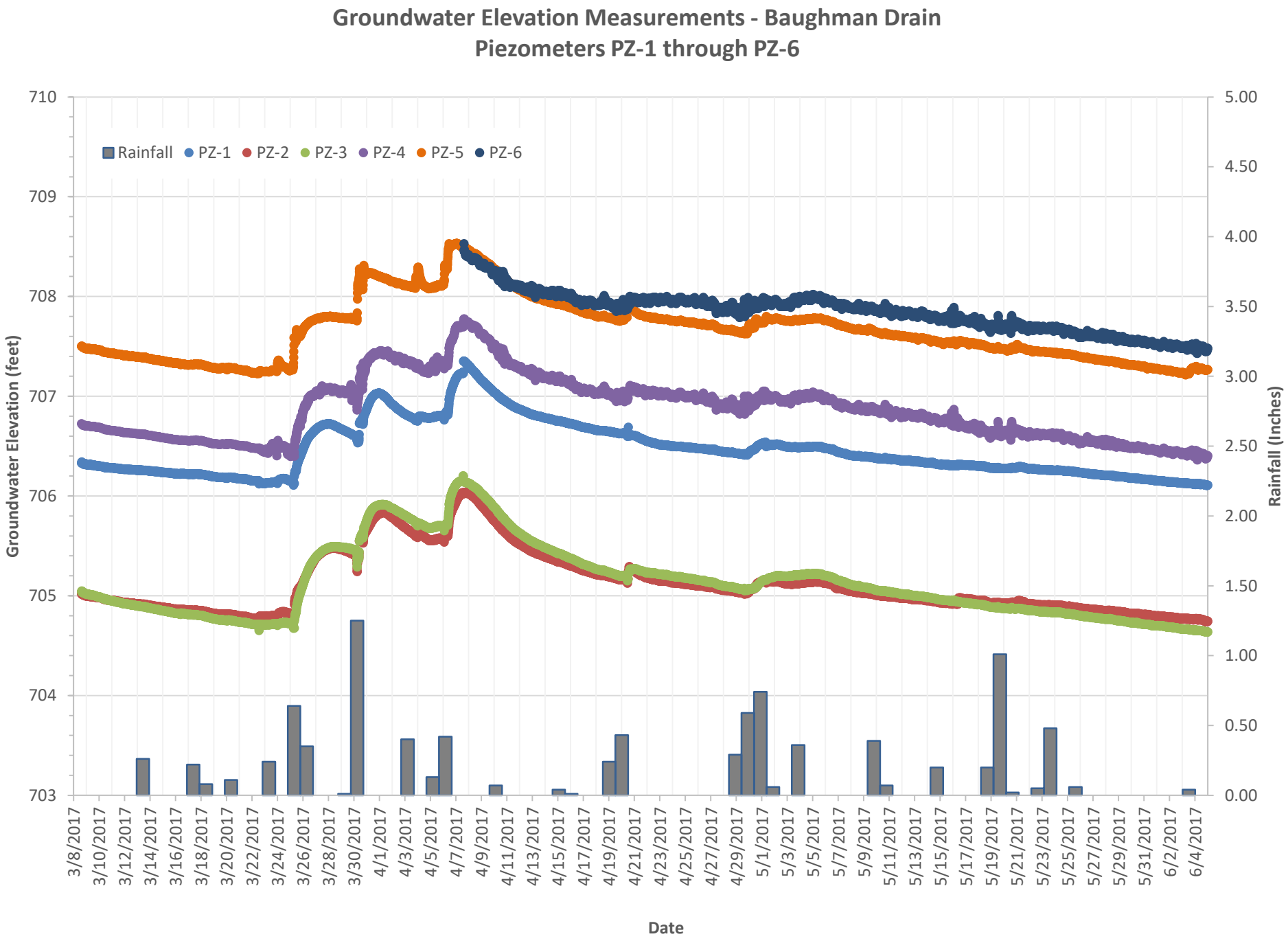
Sieve Size	% Passing	Limits
1in	100	
¾in	100	
½in	100	
3/8in	100	
No.4	100	
No.8	100	
No.16	100	
No.30	99	
No.50	91	
No.100	31	
No.200	14	
Finer No.200 (75µm)	13	

D85: 0.2810 **D60:** 0.2106 **D50:** 0.1876
D30: 0.1462 **D15:** 0.0782 **D10:** N/A

APPENDIX C
PRECIPITATION SUMMARY CHART


NOAA NWS Precipitation Data
Kalamazoo International Airport Station
Prccecipitation (in)
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
3/8/2017
3/10/2017
3/12/2017
3/14/2017
3/16/2017
3/18/2017
3/20/2017
3/22/2017
3/24/2017
3/26/2017
3/28/2017
3/30/2017
4/1/2017
4/3/2017
4/5/2017
4/7/2017
4/9/2017
4/11/2017
4/13/2017
4/15/2017
4/17/2017
4/19/2017
4/21/2017
4/23/2017
4/25/2017
4/27/2017
4/29/2017
5/1/2017
5/3/2017
5/5/2017
5/7/2017
5/9/2017
5/11/2017
5/13/2017
5/15/2017
5/17/2017
5/19/2017
5/21/2017
5/23/2017
5/25/2017
5/27/2017
5/29/2017
5/31/2017
6/2/2017
6/4/2017
6/6/2017
Date

APPENDIX D
PIEZOMETER TIME SERIES CHARTS


Groundwater Elevation Measurements - Baughman Drain
Piezometers PZ-1 through PZ-6
Rainfall
PZ-1
PZ-2
PZ-3
PZ-4
PZ-5
PZ-6
Groundwater Elevation (feet)
Rainfall (Inches)
Date
710
709
708
707
706
705
704
703
5.00
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
3/8/2017
3/10/2017
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3/24/2017
3/26/2017
3/28/2017
3/30/2017
4/1/2017
4/3/2017
4/5/2017
4/7/2017
4/9/2017
4/11/2017
4/13/2017
4/15/2017
4/17/2017
4/19/2017
4/21/2017
4/23/2017
4/25/2017
4/27/2017
4/29/2017
5/1/2017
5/3/2017
5/5/2017
5/7/2017
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5/11/2017
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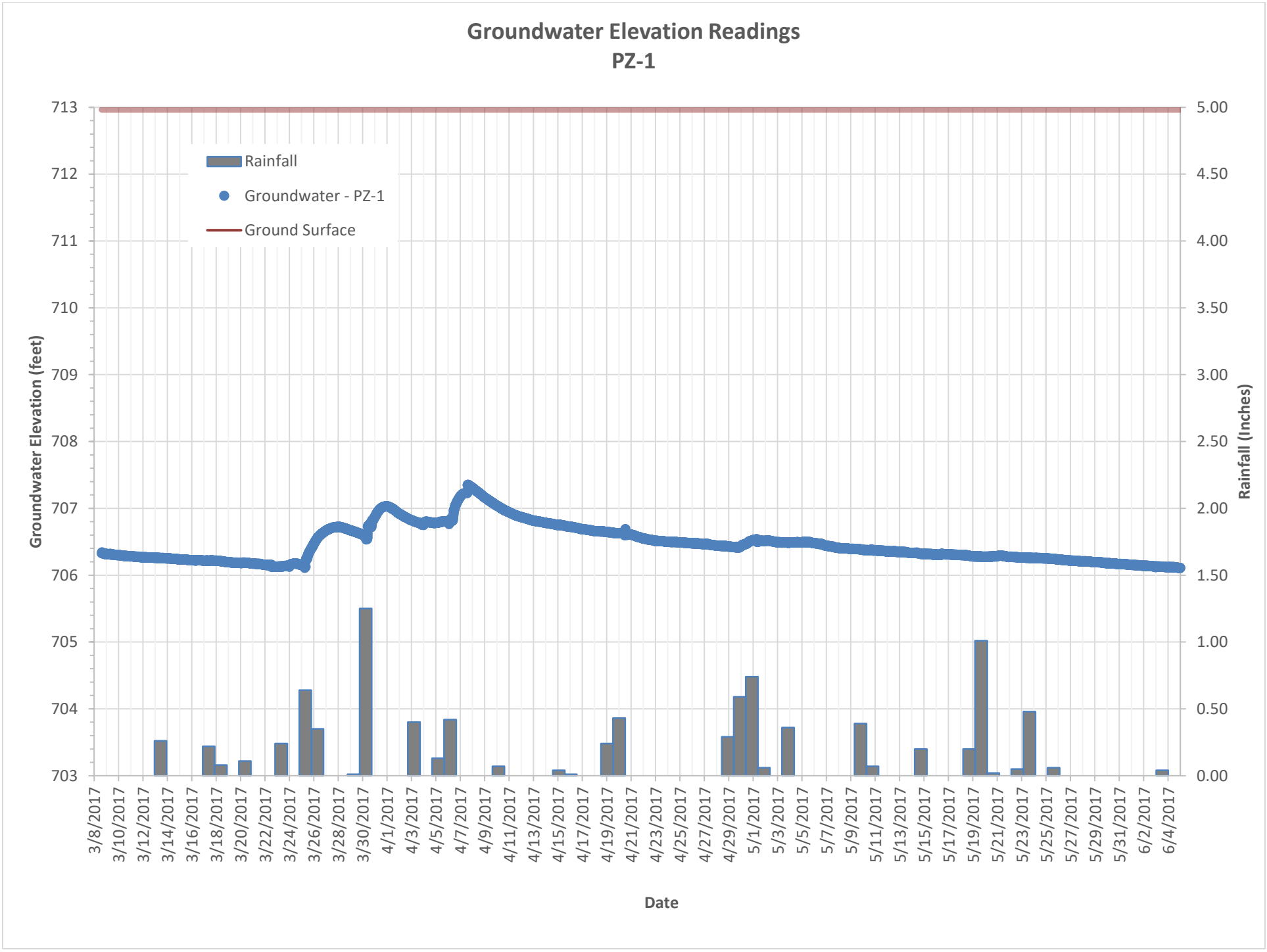
5/31/2017
6/2/2017
6/4/2017


Groundwater Elevation Readings
PZ-1
Rainfall
Groundwater - PZ-1
Ground Surface
Groundwater Elevation (feet)
Rainfall (Inches)
Date
713
712
711
710
709
708
707
706
705
704
703
5.00
4.50
4.00
3.50
3.00
2.50
2.00
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4/11/2017
4/13/2017
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4/17/2017
4/19/2017
4/21/2017
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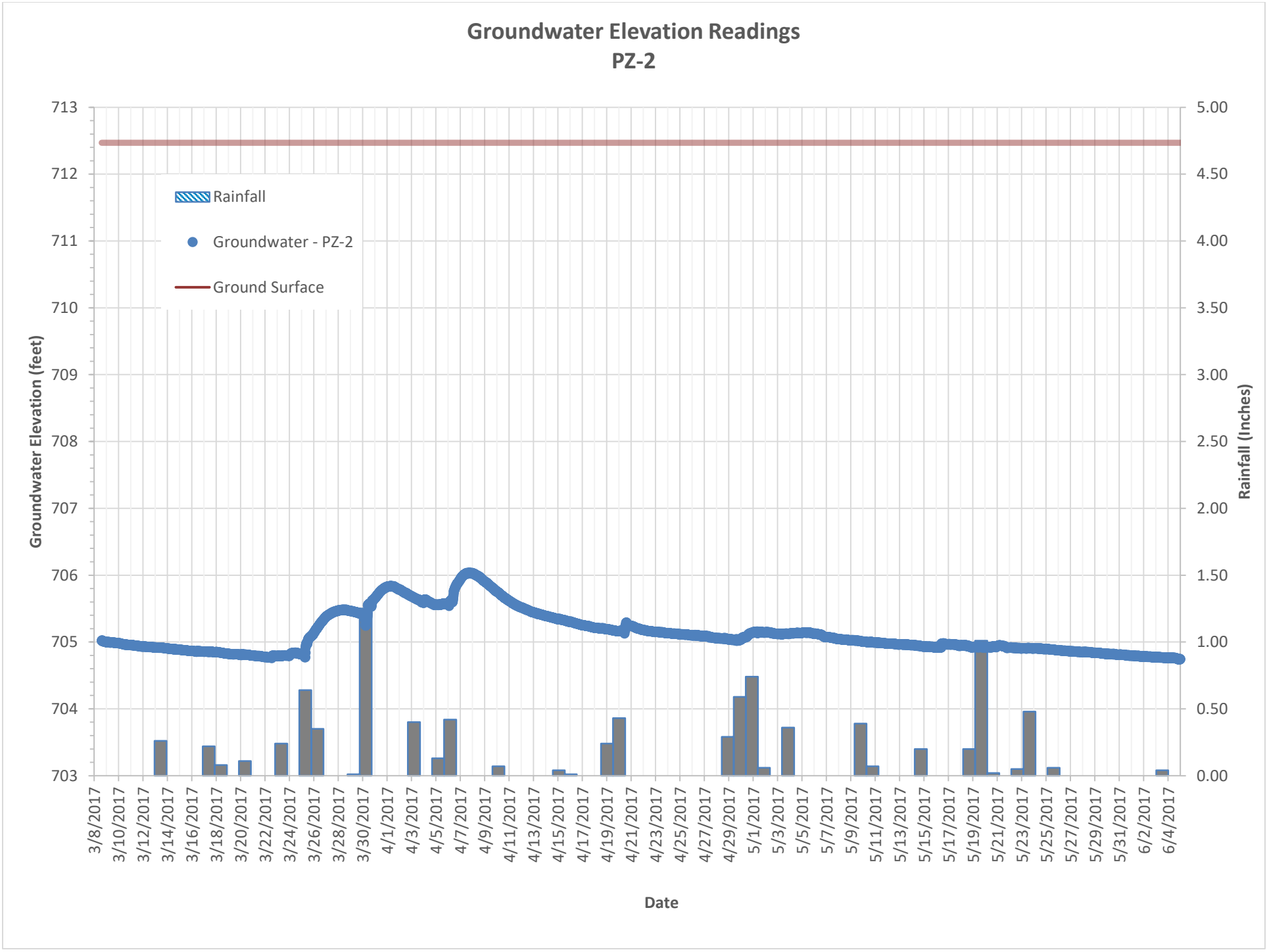
5/31/2017
6/2/2017
6/4/2017


Groundwater Elevation Readings
PZ-2
Rainfall
Groundwater - PZ-2
Ground Surface
Groundwater Elevation (feet)
Rainfall (Inches)
Date
713
712
711
710
709
708
707
706
705
704
703
5.00
4.50
4.00
3.50
3.00
2.50
2.00
1.50
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0.50
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3/8/2017
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3/30/2017
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4/7/2017
4/9/2017
4/11/2017
4/13/2017
4/15/2017
4/17/2017
4/19/2017
4/21/2017
4/23/2017
4/25/2017
4/27/2017
4/29/2017
5/1/2017
5/3/2017
5/5/2017
5/7/2017
5/9/2017
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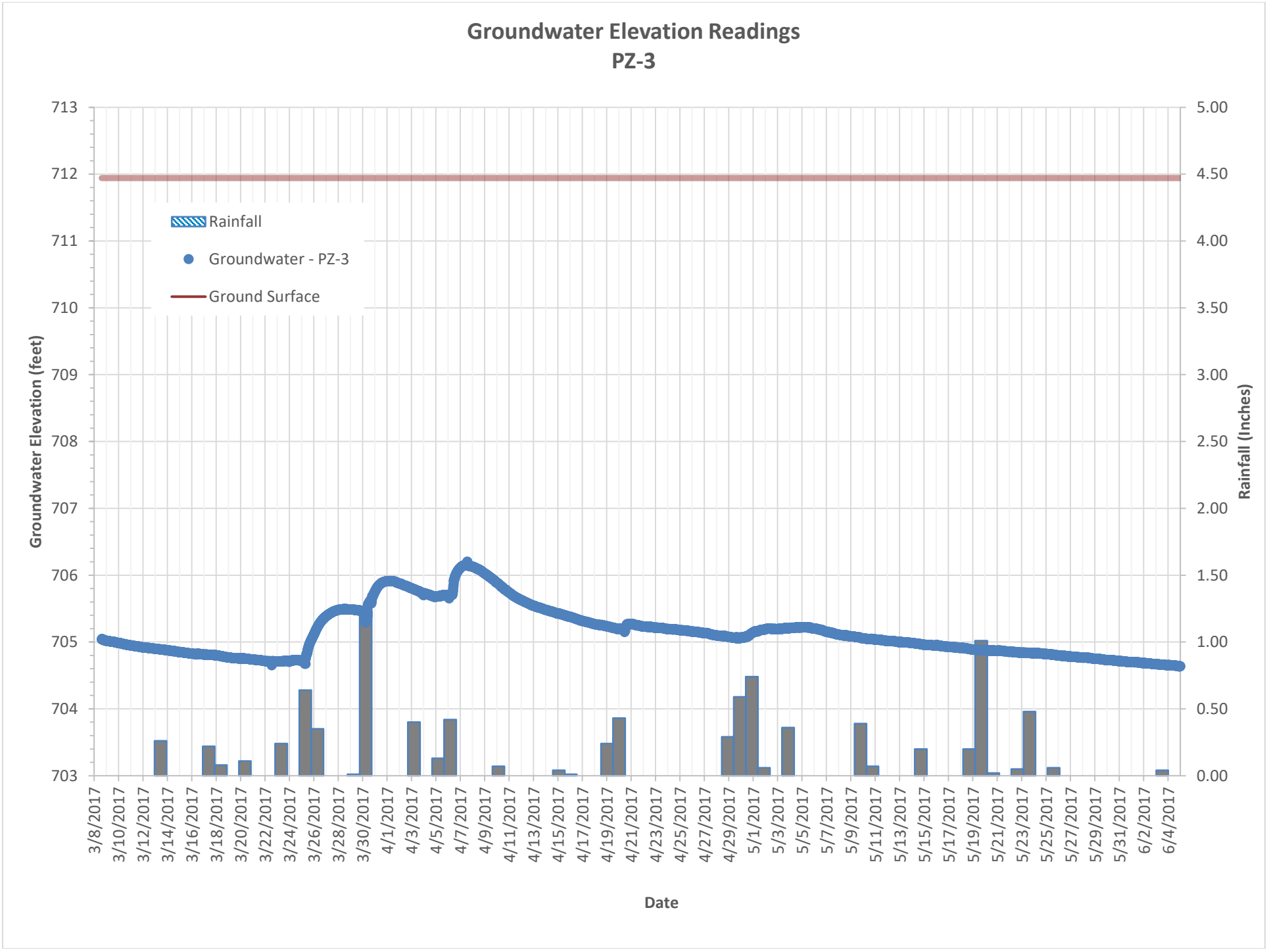
6/4/2017


Groundwater Elevation Readings
PZ-3
Rainfall
Groundwater - PZ-3
Ground Surface
Groundwater Elevation (feet)
Rainfall (Inches)
Date
713
712
711
710
709
708
707
706
705
704
703
5.00
4.50
4.00
3.50
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5/1/2017
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5/9/2017
5/11/2017
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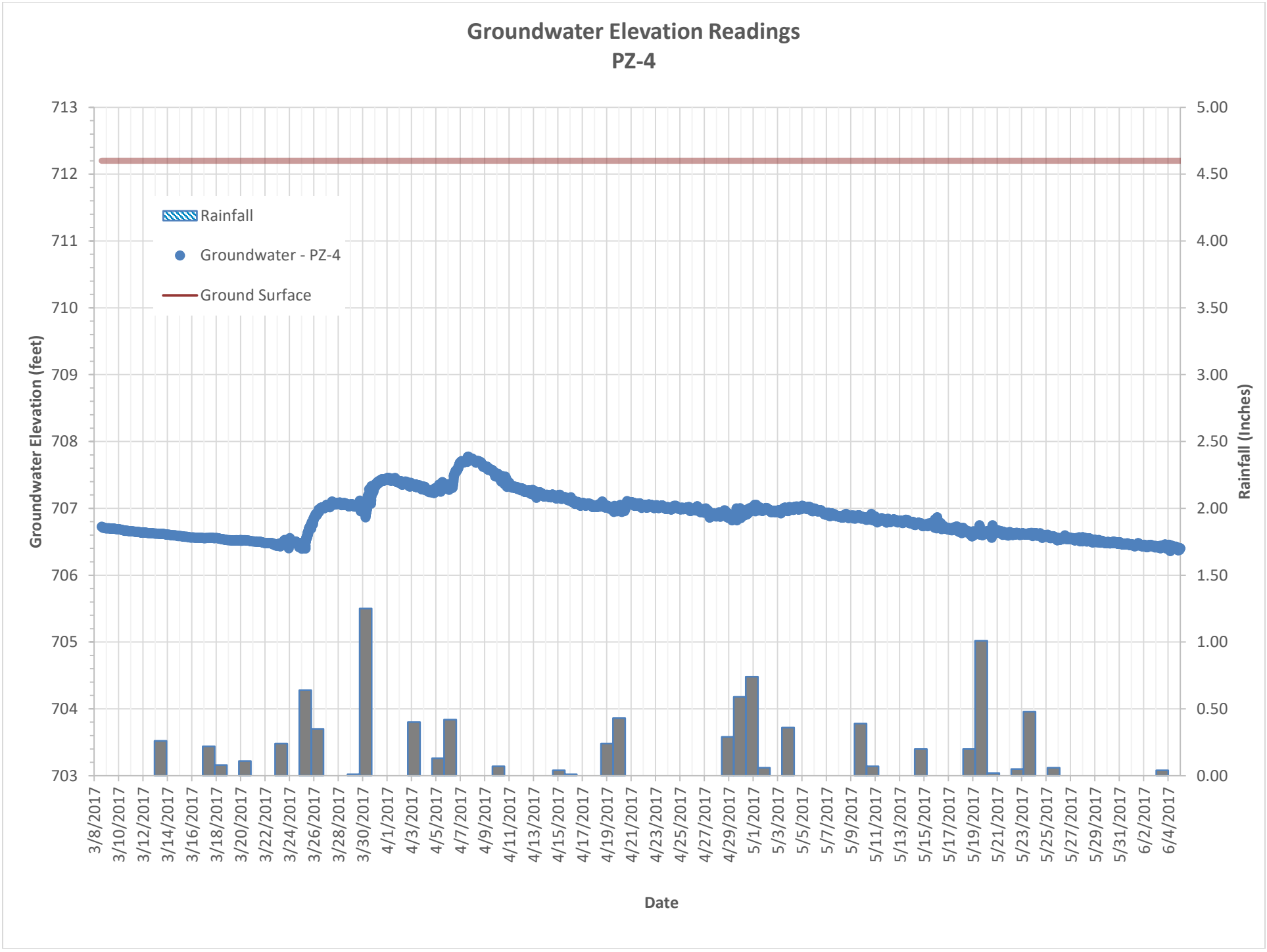
6/4/2017


Groundwater Elevation Readings
PZ-4
Rainfall
Groundwater - PZ-4
Ground Surface
Groundwater Elevation (feet)
Rainfall (Inches)
Date
713
712
711
710
709
708
707
706
705
704
703
5.00
4.50
4.00
3.50
3.00
2.50
2.00
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3/8/2017
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4/7/2017
4/9/2017
4/11/2017
4/13/2017
4/15/2017
4/17/2017
4/19/2017
4/21/2017
4/23/2017
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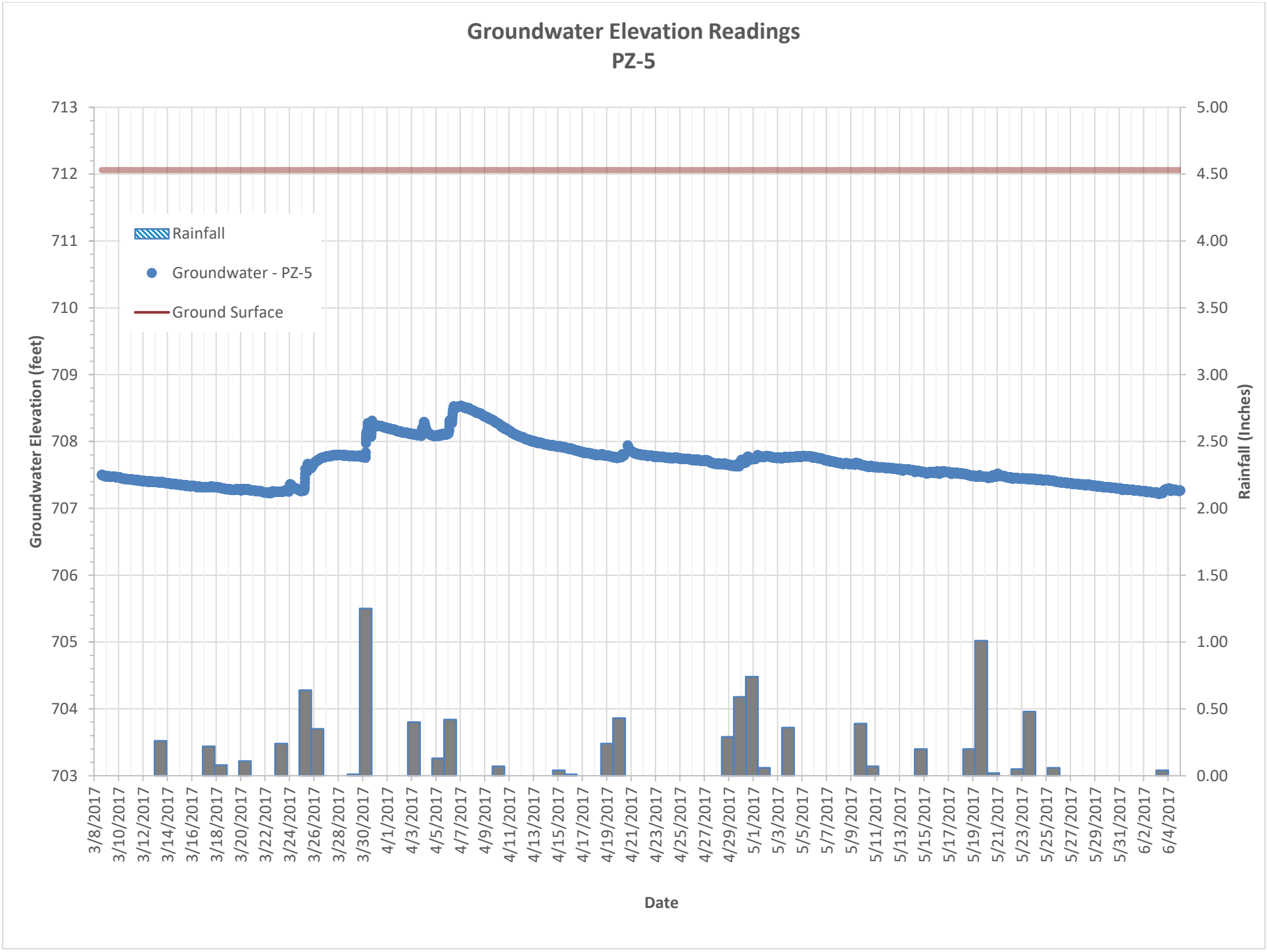
Groundwater Elevation Readings
PZ-5
Rainfall
Groundwater - PZ-5
Ground Surface
Groundwater Elevation (feet)
Rainfall (Inches)
Date
713
712
711
710
709
708
707
706
705
704
703
5.00
4.50
4.00
3.50
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4/3/2017
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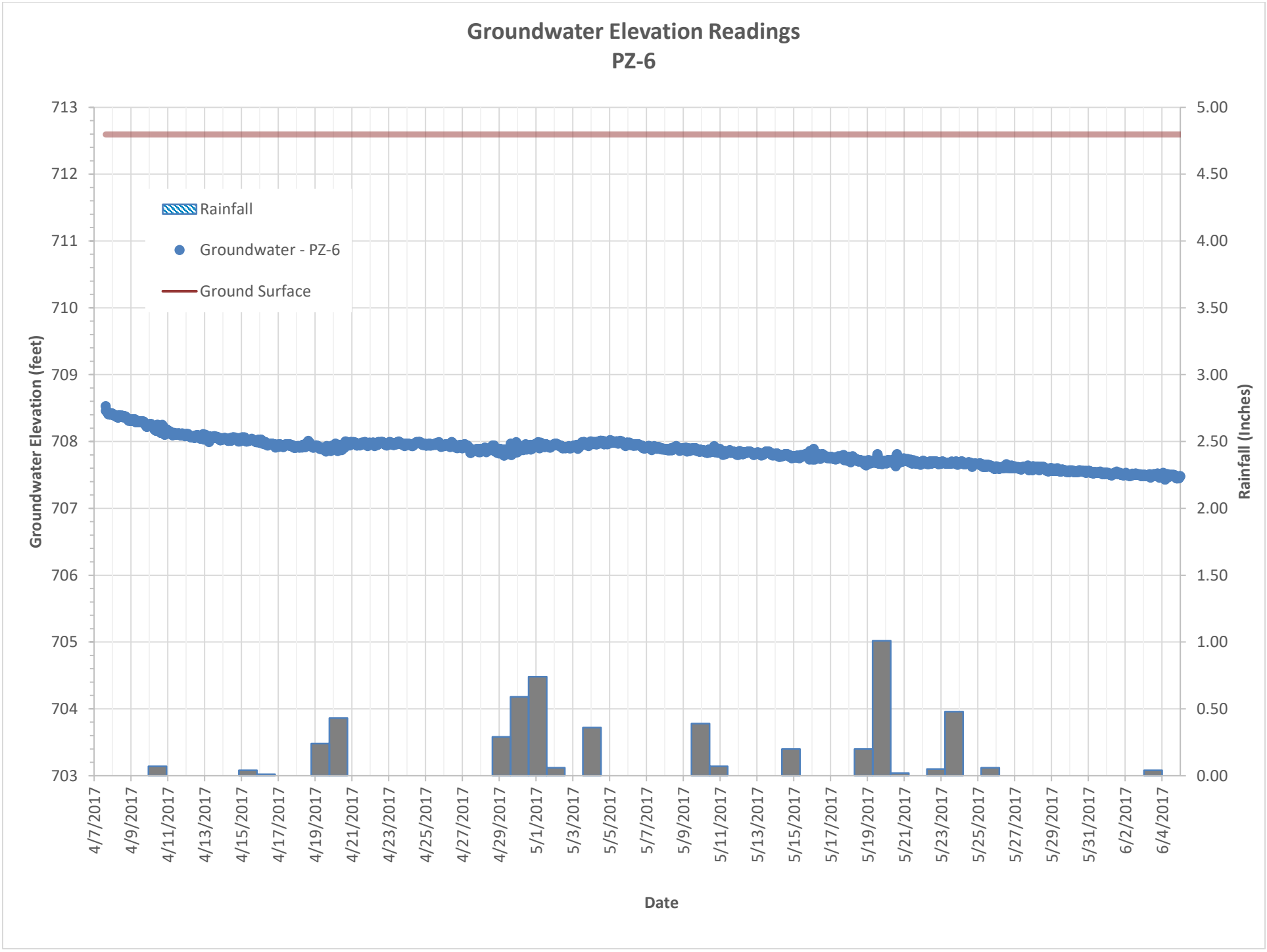
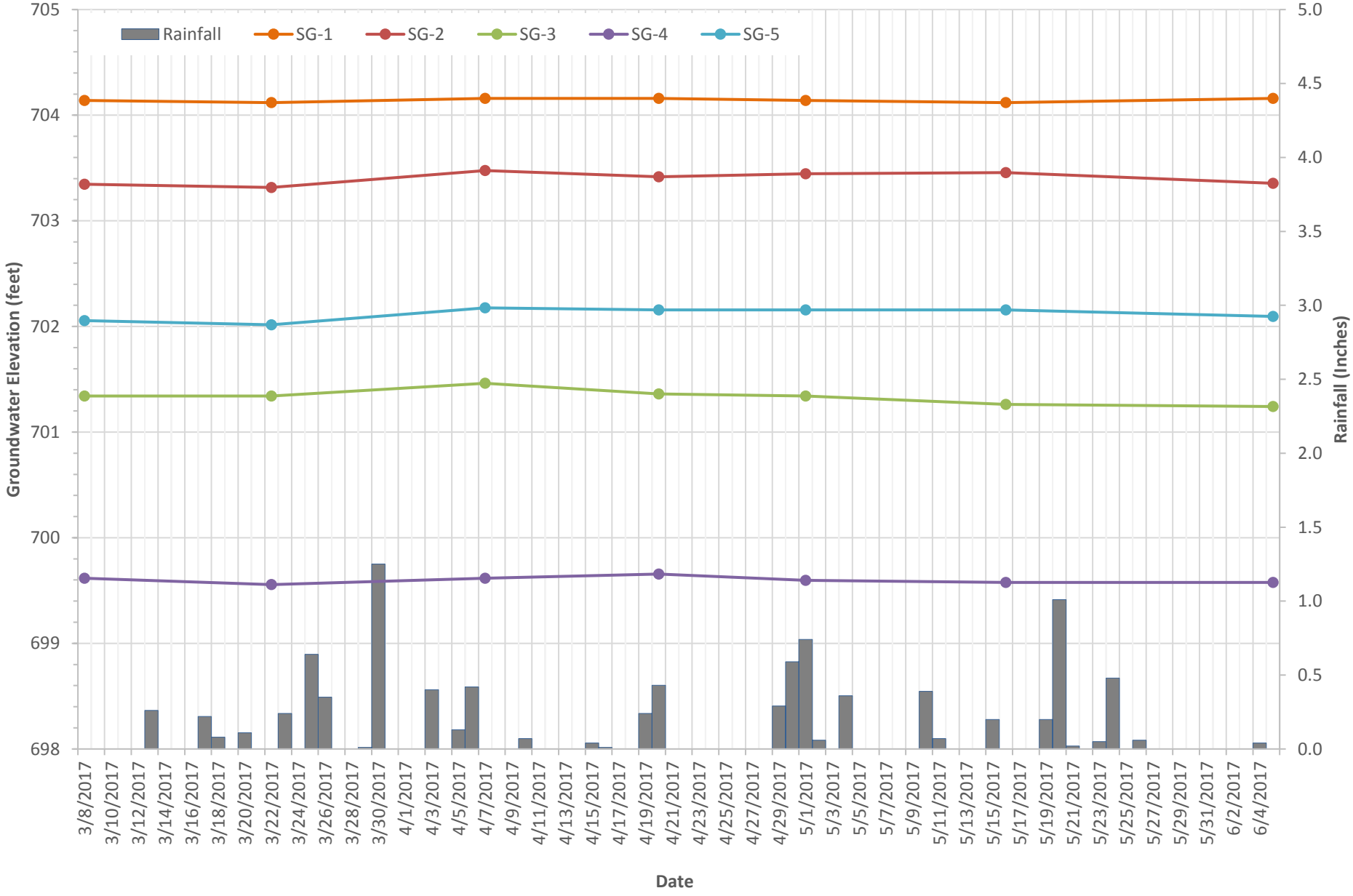

Groundwater Elevation Readings
PZ-6
Rainfall
Groundwater - PZ-6
Ground Surface
Groundwater Elevation (feet)
Rainfall (Inches)
Date
713
712
711
710
709
708
707
706
705
704
703
5.00
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
4/7/2017
4/9/2017
4/11/2017
4/13/2017
4/15/2017
4/17/2017
4/19/2017
4/21/2017
4/23/2017
4/25/2017
4/27/2017
4/29/2017
5/1/2017
5/3/2017
5/5/2017
5/7/2017
5/9/2017
5/11/2017
5/13/2017
5/15/2017
5/17/2017
5/19/2017
5/21/2017
5/23/2017
5/25/2017
5/27/2017
5/29/2017
5/31/2017
6/2/2017
6/4/2017

APPENDIX E
STAFF GAGE TIME SERIES CHARTS

Surface Water Elevation Measurements
Staff Gauges SG-1 through SG-5



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SME

SUPPLEMENTAL HYDROGEOLOGIC EVALUATION SUMMARY REPORT

Baughman Drain
Otsego, Allegan County, Michigan

SME Project Number: 077821.00
February 20, 2018

SME

SME

4505 Clyde Park Avenue SW
Grand Rapids, MI 49509-5714

T (616) 406-1756

www.sme-usa.com

February 20, 2019

Mr. Kyle Visker, PE
Land and Resource Engineering
3800 West River Drive, Suite A
Comstock Park, Michigan 49321

RE: Supplemental Hydrogeologic Evaluation Summary Report
Baughman Drain
Otsego, Allegan County, Michigan
SME Project No.: 077921.00

Dear Mr. Visker:

We have completed a supplemental hydrogeologic evaluation for a portion of the Baughman Drain area, more specifically the area south of Prairiewood Court between previously installed piezometer PZ-6 and staff gauge SG-1. This report presents the findings of our supplemental evaluation, based on the available information.

We appreciate the opportunity to be of service. If you have questions or require additional information, please contact us.

Sincerely,

SME

Aaron J. Lammers, EIT
Senior Staff Engineer

Matthew A. Vander Eide, PG, CPG
Senior Project Geologist

TABLE OF CONTENTS

FIGURES

TABLES

APPENDIX A

1. INTRODUCTION AND BACKGROUND

The Baughman Drain is located in the southern portion of Allegan County, south of the City of Otsego (Figure 1). The Baughman Drain conveys water from the area and discharges to Pine Creek to the west. Multiple natural watercourses also connect to the drain. Residents who live south of the Baughman Drain, near the intersections of Springbrook Drive and Sycamore Street, Elm Street, and Prairiewood Court (evaluation area), have petitioned for evaluations of the drain because of ongoing basement flooding. Specifically, ten residences have reportedly experienced consistent flooding and six additional residences have reportedly experienced periodic flooding (highlighted on Figure 2).

SME was previously retained by Land and Resource Engineering (LRE) to evaluate groundwater conditions in the evaluation area (Figure 2) from March 2017 to June 2017. We were retained to conduct this supplemental evaluation in accordance with our October 31, 2017, proposal number P03237.17.

We prepared this summary report to document our supplemental hydrogeological evaluation activities for a portion of the Baughman Drain area, more specifically the area south of Prairiewood Court, between previously installed piezometer PZ-6 and staff gauge SG-1. This report presents the findings of our supplemental evaluation, based on the available information.

2. PIEZOMETER AND STAFF GAUGE INSTALLATION

On November 22, 2017, we advanced five soil borings (SB1 through SB5; Figure 2) for the purpose of collecting and characterizing subsurface soil samples between the locations of previously installed PZ-6 and SG-1, and installing piezometers (PZ-7 and PZ-8; Figure 2) to obtain groundwater elevations in this portion of the evaluation area. Soil borings SB1 through SB5 were advanced to a depth of approximately 25 feet below ground surface (bgs) using track-mounted, hydraulically driven, direct-push sampling equipment. The soil column at each boring location was visually evaluated and representative samples were collected from each soil unit for visual classification in general accordance with ASTM D2488, Standard Practice for Description and Identification of Soils (Visual-Manual Procedure).

Piezometers (PZ-7 and PZ-8) were installed in two of the borings (SB2 and SB4, respectively) such that the well screens intersected the depth where groundwater was encountered during drilling. Each piezometer was constructed of 1.5-inch diameter, polychlorinated vinyl (PVC) riser pipe and a pre-packed, 0.010-inch slotted (10-slot), five-foot long, screen. After the piezometers were installed, expandable caps were installed, and bentonite was placed around the piezometer casing, in the remaining borehole annulus, from approximately one foot above the screens to approximately one foot bgs. Flush-mount protective covers were installed to protect the piezometers from tampering and damage.

On November 22, 2017, we also installed three staff gauges (SG-6, SG-7 and SG-8) in an unnamed, natural watercourse (Figure 2). The staff gauges were 3.33 feet in length with gradation marks every 1, 0.1 and 0.02 feet. The staff gauges were mounted to metal stakes and hand-driven into the bottom of the unnamed, natural watercourse such that a portion of the graduated staff gauge was submerged beneath the surface water.

The soil boring and piezometer locations were selected to evaluate soil and groundwater conditions in the area of the previously installed piezometer PZ-6 and staff gauge SG-1. The staff gauge locations were selected to evaluate surface water elevations near the residence located at 1624 Elm Street (SG-6) and along Springbrook Drive (SG-7 and SG-8). The piezometer and staff gauge locations, ground surface elevations, bottom of surface water body elevations, and the top of casing or top of staff gauge elevations were surveyed by LRE. The top of casing/top of staff gauge elevations for each monitoring location are provided in Table 1. A summary of the monitoring locations, their installation dates, and the rationale for each location is provided in the table below.

LOCATION ID	DATE INSTALLED	LOCATION RATIONALE
		SOIL BORINGS / PIEZOMETERS
PZ-1 through PZ-6	3/7/17	Installed during our initial evaluation to monitor groundwater elevations over the course of three months. Refer to the previous report for additional detail.
SB1	11/22/17	Evaluate the geologic conditions in the area between PZ-6 and SG-1
SB2 / PZ-7	11/22/17	Evaluate the geologic conditions and groundwater elevation in the area between PZ-6 and SG-1
SB3	11/22/17	Evaluate the geologic conditions in the area between PZ-6 and SG-1
SB4 / PZ-8	11/22/17	Evaluate the geologic conditions and groundwater elevation in the area between PZ-6 and SG-1
SB5	11/22/17	Evaluate the geologic conditions in the area between PZ-6 and SG-1
		STAFF GAUGES
SG-1 through SG-5	3/8/17	Installed during our initial evaluation to monitor surface water elevations over the course of three months. Refer to the previous report for additional detail.
SG-6	11/22/17	Evaluate the water level in the eastern portion of the unnamed, natural watercourse, east of Springbrook Drive, and south of PZ-1 and 1624 Elm Street (17-580-006-00)
SG-7	11/22/17	Evaluate the water level in the eastern portion of the unnamed, natural watercourse, along Springbrook Drive, north of Sycamore Street, and northwest of PZ-2
SG-8	11/22/17	Evaluate the water level in the eastern portion of the unnamed, natural watercourse, along Springbrook Drive, south of Elm Street and Prairiewood Court, and southeast of PZ-4

3. SURFACE AND SUBSURFACE CONDITIONS

Descriptions of the soil conditions encountered at each of our supplemental soil boring locations are documented on the soil boring logs provided in Appendix A. The surface material consisted of approximately 12 inches of topsoil, which was generally underlain by fine to medium sand to the maximum explored depth of 25 feet bgs. Clay was encountered at SB2/PZ-7 (19 to 19.25 feet bgs), SB3 (14 to 19.75 feet bgs), SB4/PZ-8 (12.5 to 19.75 feet bgs) and SB5 (11 to 15 feet bgs). Groundwater was encountered in each soil boring at depths ranging from approximately 4.5 to 7.0 feet bgs during drilling. Revised cross sections depicting the subsurface conditions observed during our drilling activities are provided on Figures 3 and 4.

4. WATER LEVEL MEASUREMENTS

We returned to the evaluation area on December 6, 2017 and recorded depth to groundwater measurements in the piezometers (PZ-1 through PZ-8) using an electronic water level indicator tape. We also recorded surface water level measurements at staff gauges (SG-1 through SG-8). The groundwater water level indicator and staff gauge measurements and elevations are summarized in Table 1.

5. GROUNDWATER FLOW

Groundwater elevation contour maps based on the groundwater elevations measured on December 6, 2017 are depicted on Figures 5 and 6. We evaluated groundwater flow using two data sets: one using only the groundwater elevations obtained from the piezometers (Figure 5); and one using groundwater elevations obtained from the piezometers and the surface water elevations obtained from the staff gauges (Figure 6).

The groundwater elevation data obtained from the piezometers suggests that mounded groundwater conditions are present in the area between piezometers PZ-4, PZ-5 and PZ-6, with groundwater north of this area flowing in a northerly direction, toward the Baughman Drain, and groundwater south of this area flowing south toward the unnamed, natural watercourse. Similarly, the combined groundwater and surface water elevation data suggests that mounded groundwater conditions are present in this area, with groundwater flow radiating from this area toward the Baughman Drain and unnamed, natural watercourse.

The horizontal groundwater hydraulic gradient between PZ-4 and PZ-3 on December 6, 2017 was 0.004 feet per foot. The horizontal groundwater hydraulic gradient between PZ-6 and PZ-8 on December 6, 2017 was 0.006 feet per foot.

We calculated an estimated groundwater flow rate using hydraulic conductivity values from three sources. First, we calculated an estimated hydraulic conductivity of 44 feet per day using the grain size analysis results and the Hazen Method. For comparison, we also used the hydraulic conductivity values of 26.1 feet per day provided by the United States Department of Agriculture (USDA) for the soil types present in the evaluation area and a generalized, textbook value of 25 feet per day for fine to medium sand. Using these three hydraulic conductivity values, the gradient values mentioned above, and an assumed average porosity of 30%, we calculated a groundwater flow rate of approximately 0.3 to 0.6 feet per day (approximately 110 to 220 feet per year) between PZ-4 and PZ-3, and approximately 0.5 feet to 1 foot per day (approximately 183 to 365 feet per year) between PZ-6 and PZ-8.

6. SURFACE WATER FLOW

The surface water elevation measurements and observations indicate the Baughman Drain flows to the west, and the unnamed, natural watercourse flows to the west along Elm Street, north along Springbrook Drive, and to the west-northwest in the southern/western portion of the evaluation area. The gradient of the unnamed, natural watercourse on December 6, 2017 was approximately 0.001 feet per foot between SG-1 and SG-3 and 0.0014 feet per foot between SG-8 and SG-7. The gradient of the Baughman Drain on December 6, 2017 was approximately 0.001 feet per foot between SG-4 and SG-5.

7. WETLAND AREAS

We reviewed the Michigan Department of Environmental Quality Wetlands Map Viewer (http://www.mcgi.state.mi.us/wetlands/mcgiMap.html) to determine if wetland conditions were present in the evaluation area. The southern and western portions of the evaluation area, and the area north of the evaluation area, are listed as Wetlands on the United States Fish and Wildlife Service National Wetland Inventory (NWI). The eastern portion of the evaluation area is also listed as having soil that includes wetland-type soils on the Michigan Department of Natural Resources Michigan Resource Inventory System (MIRIS). The wetland areas and areas having soil including wetland soils are shown on Figure 7.

8. FINDINGS AND CONCLUSIONS

We have evaluated the information collected during our supplemental evaluation and summarized our conclusions below.

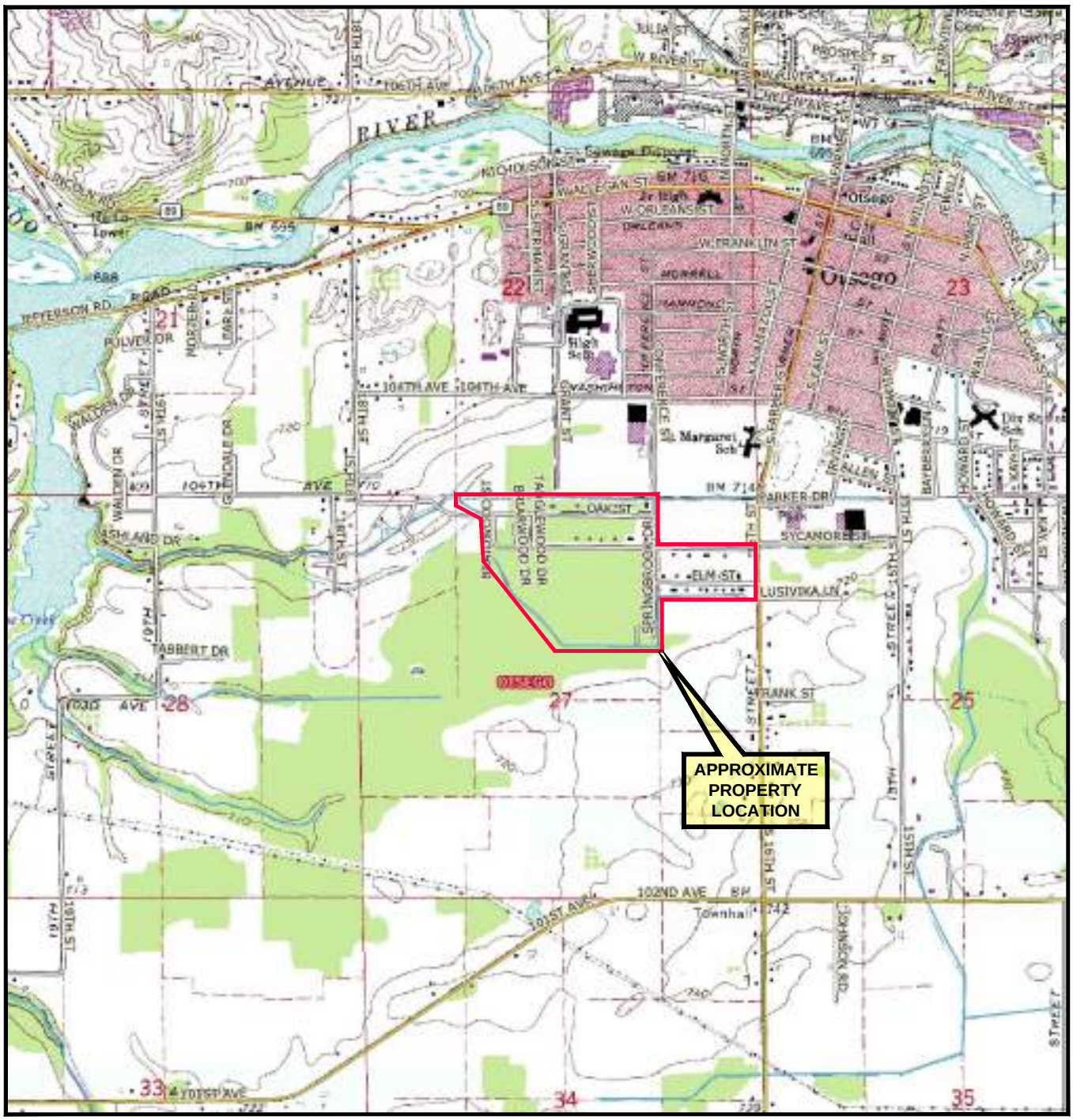
- The supplemental groundwater elevation measurements collected on December 6, 2017 confirm the water table in the evaluation area remains shallow (i.e. only a few feet below grade in some locations), and basements in this area may be positioned near or, in some cases, partially below the water table.
- The groundwater elevations measured in the evaluation area were higher than the surface water elevations measured in the unnamed, natural watercourse and Baughman Drain.
- The supplemental groundwater elevation measurements indicate the presence of a mounded groundwater condition in the vicinity of piezometers PZ-4, PZ-5, and PZ-6. This condition became evident with the addition of the supplemental piezometers and staff gauges, and appears to support our previous conclusion that groundwater flow in this area is minimal.
- The observed decrease in groundwater elevations between PZ-6 and PZ-8 indicates groundwater flow between these two locations is generally to the south-southwest, toward the unnamed, natural watercourse. Similarly, the observed decrease in groundwater elevations between PZ-1 and SG6 indicates groundwater flow between these two locations is generally to the south, toward the unnamed, natural watercourse.
- Clay was observed in the area of PZ-7, SB3, PZ-8, and SB4 at depths below the elevation of the bottom of the unnamed, natural watercourse. The clay does not appear to be preventing groundwater observed in PZ-6 (i.e. the upper portion of the water column) from flowing south-southwest to the unnamed, natural watercourse, but could potentially limit groundwater flow at greater depths.
- Fine sand with silt was observed as the primary soil type during the installation of PZ-6. This soil type likely has a lower hydraulic conductivity than the soils observed in the other soil boring locations, and may be a contributing factor to the minimal groundwater flow in this area of the evaluation area.
- The evaluation area was developed in an area identified on National Wetland Inventory maps and in the Michigan Resource Inventory System as a wetland area or containing soil types indicative of wetland conditions. Although we did not encounter soils that were visually indicative of wetland soils (e.g. organic soils such as peat or muck) in our soil borings, it is possible soils indicative of wetland conditions could be present in areas we did not evaluate.

We understand further evaluation of the hydrogeologic conditions in the evaluation area is not desired at this time. Additional information could aid in further evaluating the groundwater conditions and the potential interaction between groundwater and the surface water present in the unnamed, natural watercourse and Baughman Drain. Some possible options for gathering additional information, if desired, include, but are not limited to:

- Advancing additional soil borings and installing piezometers to evaluate soil and groundwater conditions south and east of the unnamed, natural watercourse;
- Evaluating the presence and depth to clay beneath the unnamed, natural watercourse;
- Installing piezometers at multiple depths within the unnamed, natural watercourse and Baughman Drain to evaluate the potential for vertical gradients;
- Using a computer model to further evaluate groundwater conditions and possible interactions between groundwater and surface water;

- Reinstalling data loggers in the piezometers to monitor groundwater elevations;
- Drilling to evaluate geologic conditions below 25 feet bgs, the maximum depth of exploration during our evaluation; and/or
- Conducting slug tests in some of the piezometers to more accurately estimate hydraulic conductivity and groundwater flow velocity.

FIGURES



Base map obtained from © DeLorme Topo North America™ 10.

USGS QUADRANGLE(s) REFERENCED

OTSEGO (MI) 1979

0' 2000'

SCALE: 1" = 2000'

NORTH

No.	Revision Date		
		Date	12-19-17
		Drawn By	JAB
		Designed By	MAV
		Scale	1" = 2000'
		Project	077821.00

PROPERTY LOCATION MAP
BAUGHMAN DRAIN
HYDROGEOLOGIC EVALUATION
OTSEGO, ALLEGAN COUNTY, MICHIGAN

SME

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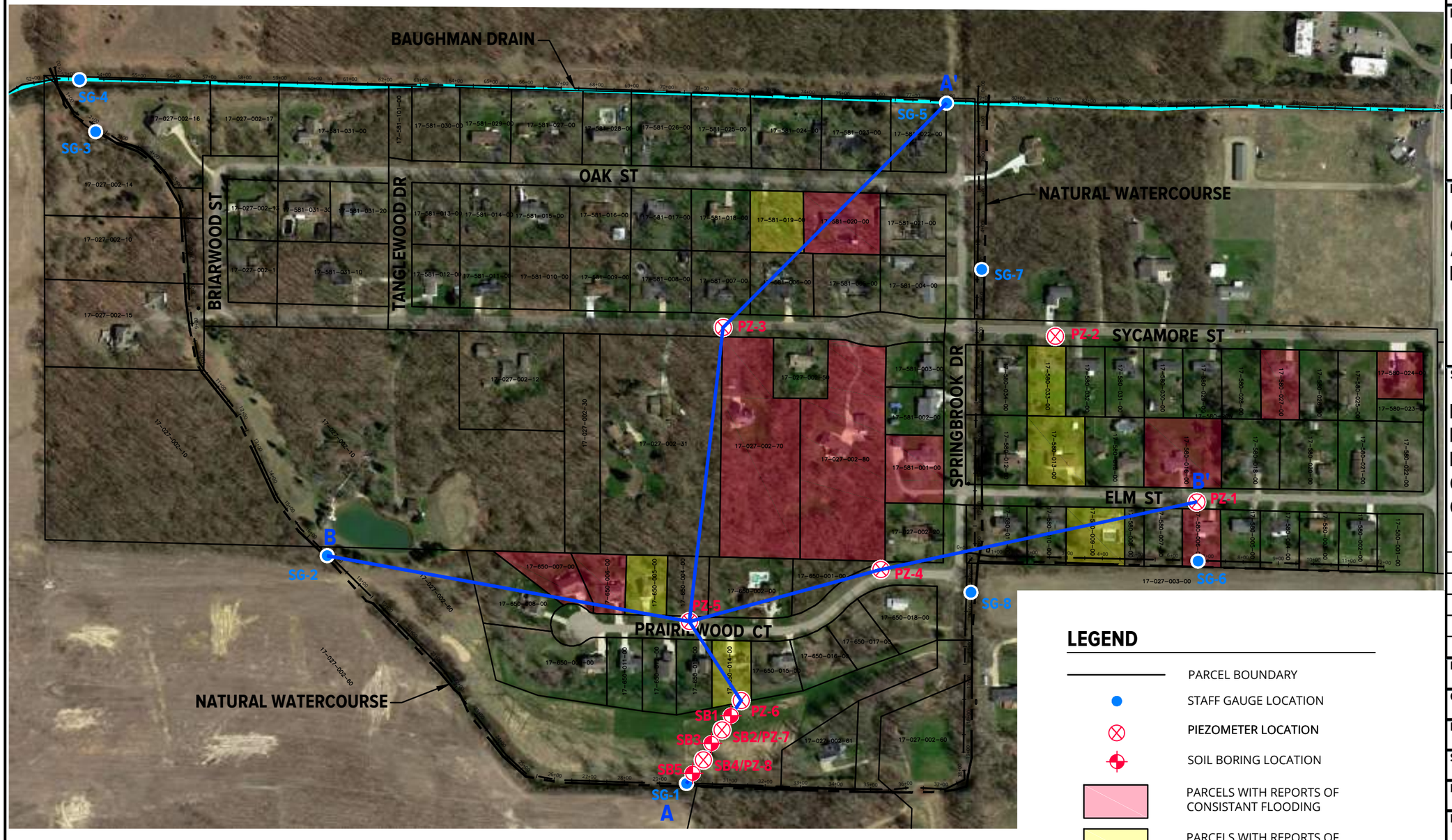
Figure No. 1

Dec 19, 2017 - 11:44am - jblake \\Sme-inc\pz\WIP\077821.00\CAD\DWGS\rev0\077821.00-01.dwg

0' 300' 600'

GRAPHIC SCALE: 1" = 300'

NORTH



LEGEND

- PARCEL BOUNDARY
- STAFF GAUGE LOCATION
- PIEZOMETER LOCATION
- SOIL BORING LOCATION
- PARCELS WITH REPORTS OF CONSISTANT FLOODING
- PARCELS WITH REPORTS OF PERIODIC FLOODING
- A —— A' CROSS-SECTION LOCATION

NOTES:
1. BASE DRAWING INFORMATION TAKEN FROM A CAD FILE TITLED "CPS.dwg" RECEIVED FROM CLIENT.
2. IMAGE TAKEN FROM GOOGLE EARTH PRO WITH IMAGE DATE 4-14-2016

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Project

BAUGHMAN DRAIN HYDROGEOLOGIC EVALUATION

Project Location

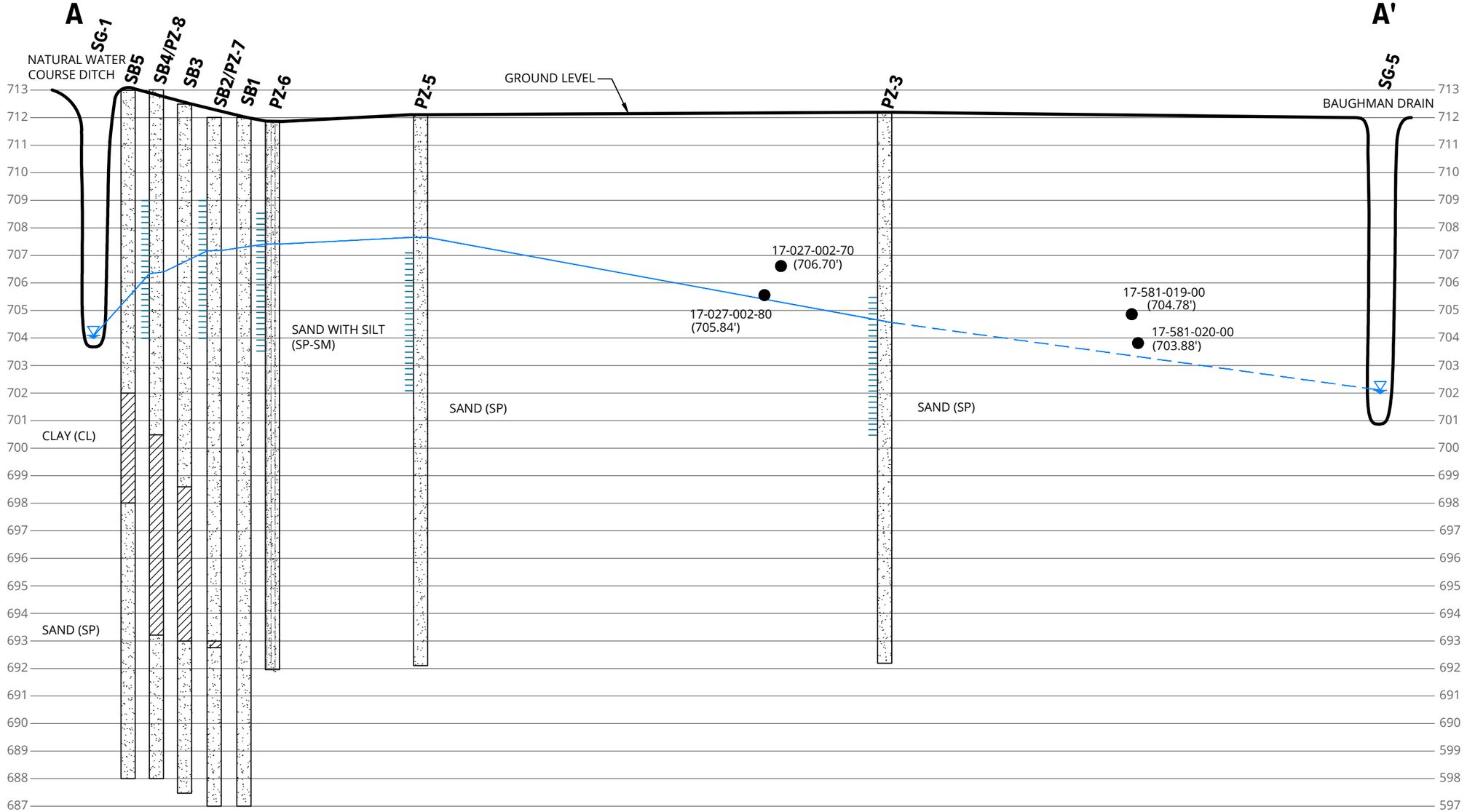
OTSEGO, ALLEGAN COUNTY, MICHIGAN

Sheet Name

EVALUATION AREA, MONITORING LOCATION, AND GEOLOGICAL CROSS-SECTION

No.	Revision Date

Date	12-19-17
CADD	JAB
Designer	MAV/AJL
Scale	1" = 300'
Project	077821.00
Figure No.	2



LEGEND

- CLAY
- SAND
- SAND WITH SILT
- WELL SCREEN INTERVAL
- GROUNDWATER ELEVATION DECEMBER 6, 2017
- 17-027-002-80 (705.84) PARCEL ID NUMBER (BASEMENT FLOOR ELEVATION)

SCALE

VERTICAL: 1" = 1'
HORIZONTAL: 1" = 200'

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BAUGHMAN DRAIN HYDROGEOLOGIC EVALUATION

Project Location
OTSEGO, ALLEGAN COUNTY, MICHIGAN

Sheet Name
GEOLOGICAL CROSS-SECTION A-A'

No.	Revision Date

Date 7-21-17
CADD JAB
Designer AJL
Scale AS SHOWN
Project 077821.00
Figure No. 3

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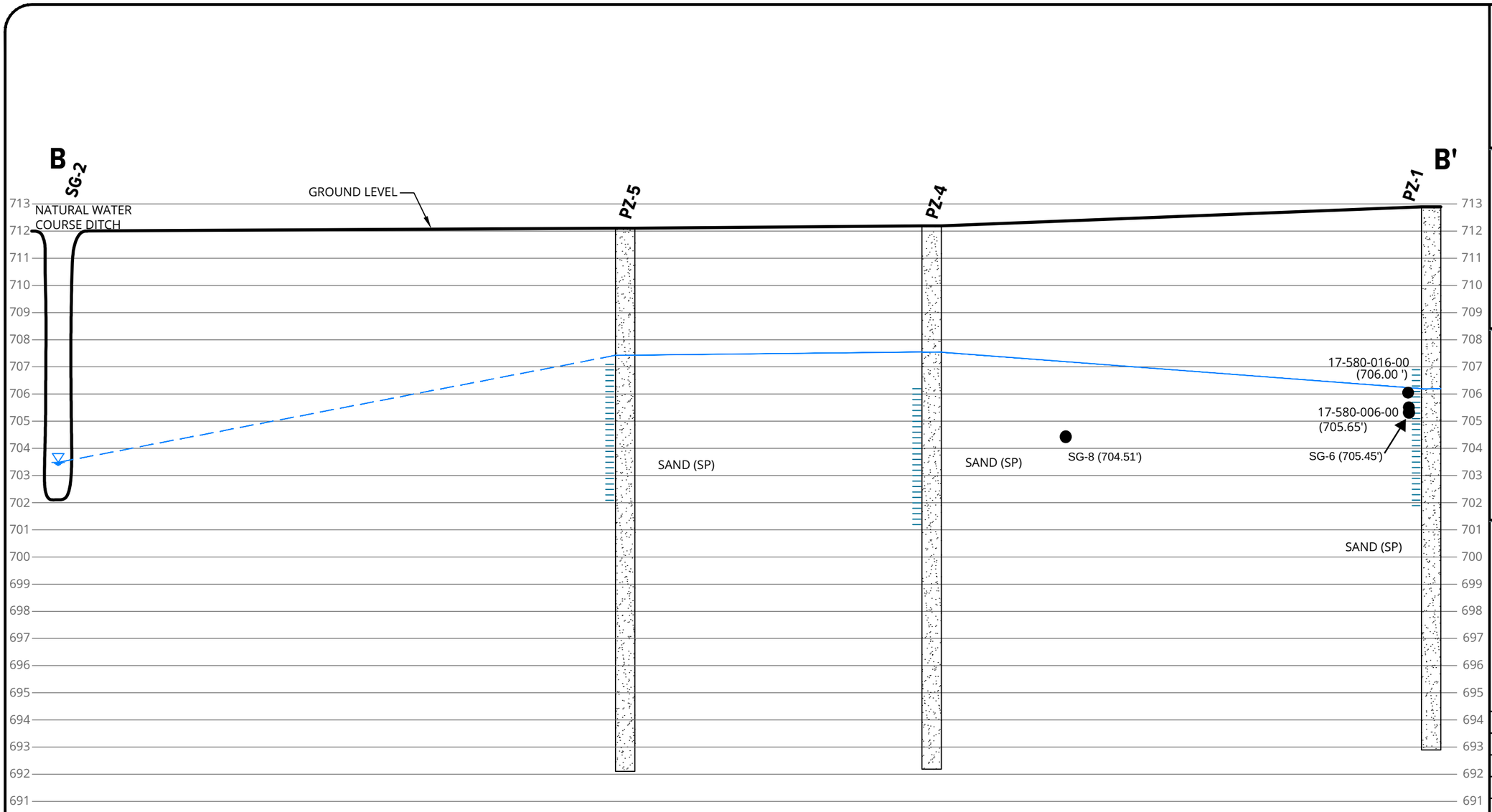

LEGEND

SAND

WELL SCREEN INTERVAL

GROUNDWATER ELEVATION DECEMBER 6, 2017

17-580-016-00 (705.84) PARCEL ID NUMBER (BASEMENT FLOOR ELEVATION)

SCALE

VERTICAL: 1" = 1'
HORIZONTAL: 1" = 200'

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Project
BAUGHMAN DRAIN HYDROGEOLOGIC EVALUATION

Project Location
OTSEGO, ALLEGAN COUNTY, MICHIGAN

Sheet Name
GEOLOGICAL CROSS-SECTION B-B'

No.	Revision Date

Date 12-19-17
CADD JAB
Designer AJL
Scale AS SHOWN
Project 077821.00
Figure No. 4

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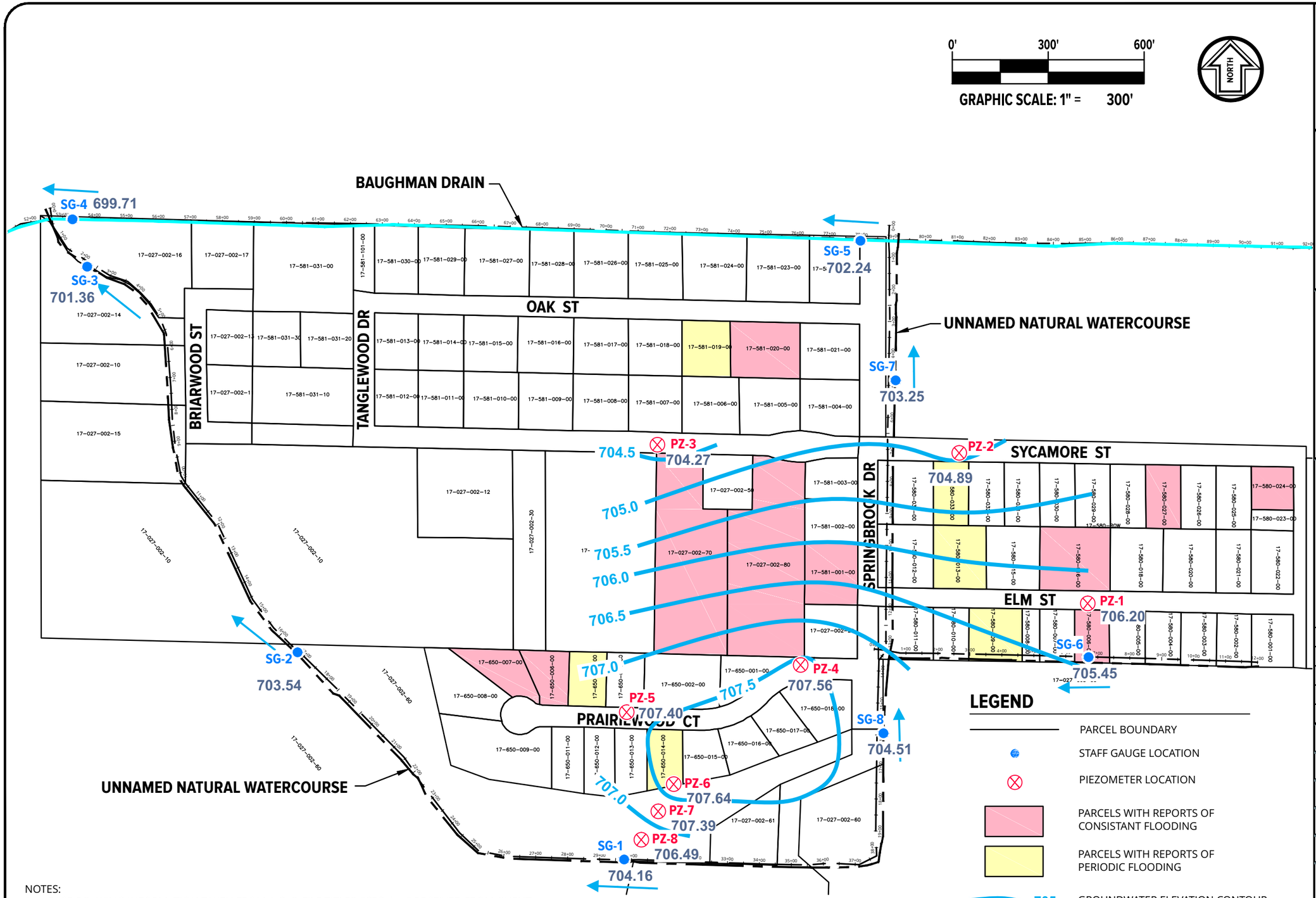

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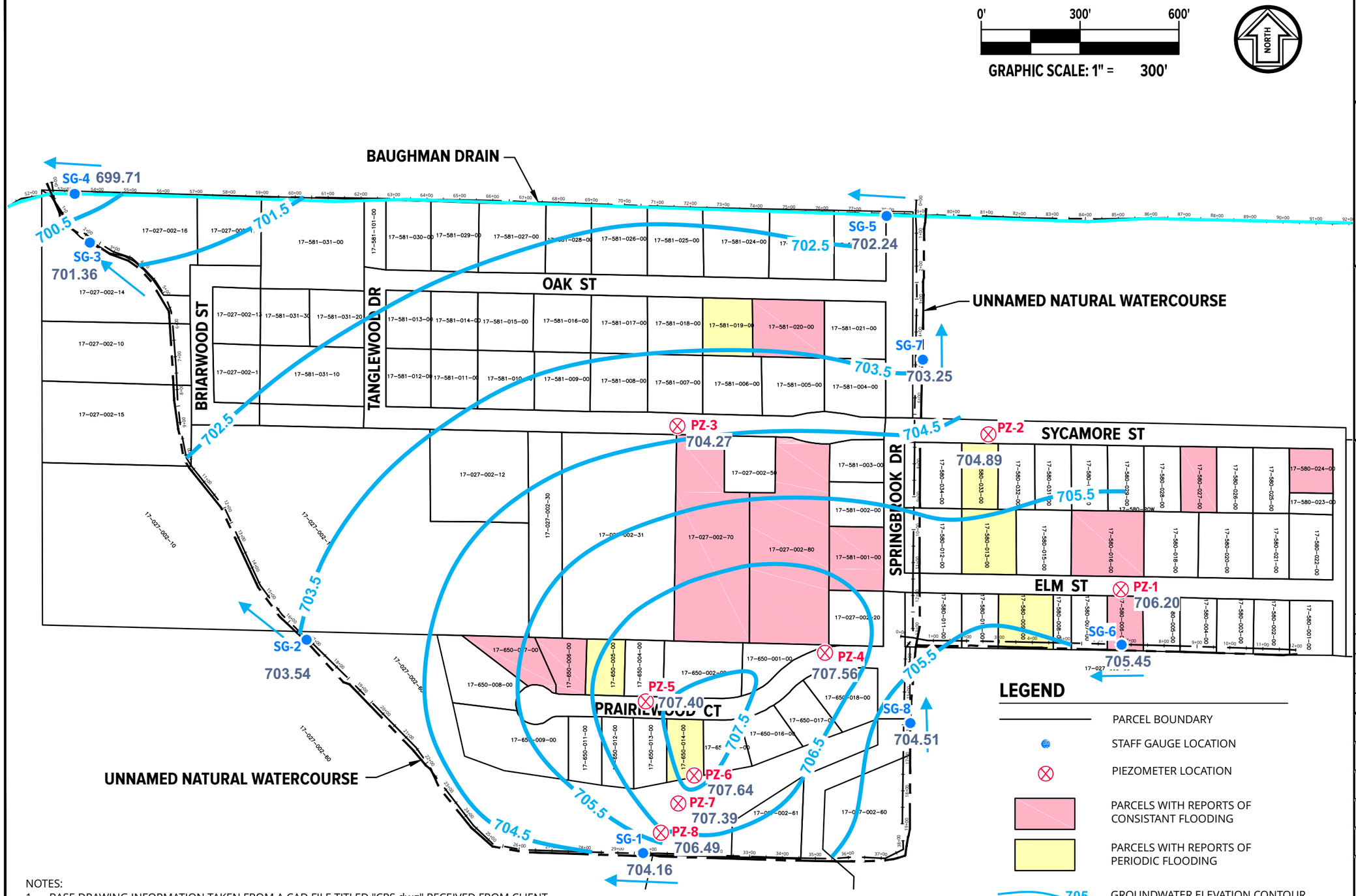
BAUGHMAN DRAIN HYDROGEOLOGIC EVALUATION

Project Location
OTSEGO, ALLEGAN COUNTY, MICHIGAN

Sheet Name
GROUNDWATER ELEVATION CONTOUR DIAGRAM PIEZOMETERS DECEMBER 6, 2017

No.	Revision Date

Date	12-7-17
CADD	AJL
Designer	MAV
Scale	1" = 300'
Project	077821.00
Figure No.	5



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BAUGHMAN DRAIN HYDROGEOLOGIC EVALUATION

Project Location

OTSEGO, ALLEGAN COUNTY, MICHIGAN

Sheet Name

GROUNDWATER ELEVATION CONTOUR DIAGRAM PIEZOMETERS AND STAFF GAUGES DECEMBER 6, 2017

No.	Revision Date

Date	12-7-17
CADD	AJL
Designer	MAV
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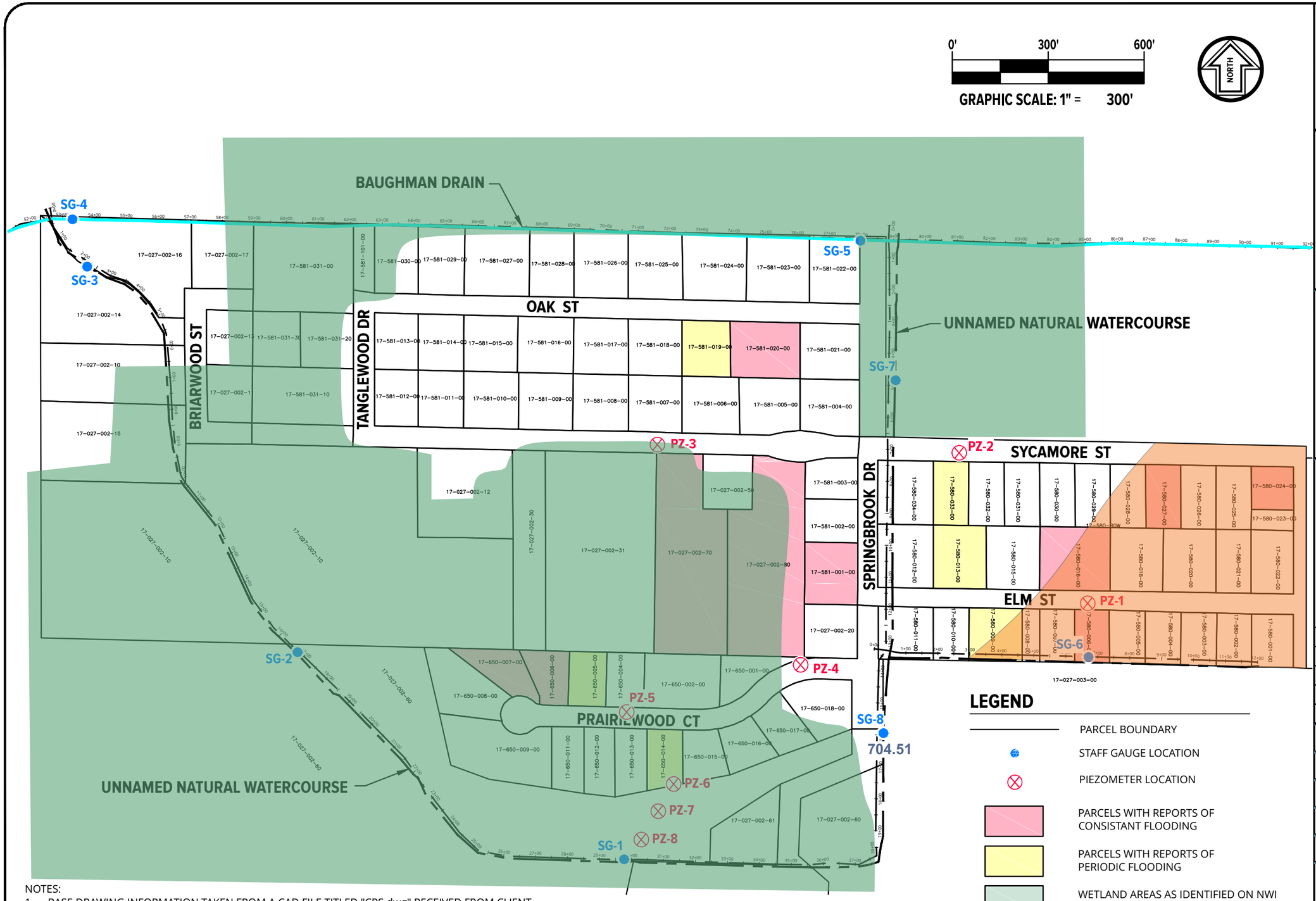
Project	077821.00
Figure No.	6



NOTES:

1. BASE DRAWING INFORMATION TAKEN FROM A CAD FILE TITLED "CPS.dwg" RECEIVED FROM CLIENT.
2. WETLANDS AS IDENTIFIED ON THE MDEQ PART 303 FINAL INVENTORY AND ON THE US FISH AND WILDLIFE SERVICE NATIONAL WETLAND INVENTORY (NWI) AND MICHIGAN DEPARTMENT OF NATURAL RESOURCES MICHIGAN RESOURCE INVENTORY SYSTEM (MIRIS).

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BAUGHMAN DRAIN HYDROGEOLOGIC EVALUATION

Project Location

OTSEGO, ALLEGAN COUNTY, MICHIGAN

Sheet Name

EVALUATION AREA AND WETLAND AREAS

No.	Revision Date

Date	12-7-17
CADD	AJL
Designer	MAV
Scale	1" = 300'
Project	077821.00
Figure No.	7

TABLES

TABLE 1: WATER ELEVATION SUMMARY

TABLE 1
WATER ELEVATION SUMMARY
BAUGHMAN DRAIN EVAULATION
SME PROJECT NO. 077821.00

			12/6/2017	
Monitoring Location	TOC Elevation (feet MSL)	Screen Interval Elevation (feet MSL)	Depth to Water from TOC (feet)	Groundwater Elevation (feet MSL)
PZ-1	712.85	701.96 - 706.96	6.65	706.20
PZ-2	712.34	700.97 - 705.95	7.45	704.89
PZ-3	711.54	700.44 - 705.44	7.27	704.27
PZ-4	712.03	701.20 - 706.20	4.47	707.56
PZ-5	711.70	702.56 - 707.56	4.30	707.40
PZ-6	712.19	703.59 - 708.59	4.55	707.64
PZ-7	712.08	704.08 - 709.08	4.69	707.39
PZ-8	713.09	704.09 - 709.09	6.60	706.49
SG-1	707.13	--	2.97	704.16
SG-2	705.53	--	1.99	703.54
SG-3	704.09	--	2.73	701.36
SG-4	702.15	--	2.44	699.71
SG-5	704.51	--	2.27	702.24
SG-6	708.68	--	3.23	705.45
SG-7	706.08	--	2.83	703.25
SG-8	707.64	--	3.13	704.51

Notes:

(1) TOC = Top of Casing / Top of Staff Gauge

(2) feet MSL = feet above mean sea level

APPENDIX A
SOIL BORING LOGS

BORING SB 1

PROJECT NAME: Baughman Drain Supplemental Hydrogeo
PROJECT NUMBER: 077821.00
CLIENT: Land & Resource Engineering and Surveying, Inc.
PROJECT LOCATION: Otsego, Michigan

DATE STARTED: 11/22/17 **COMPLETED:** 11/22/17 **BORING METHOD:** Direct Push
OPERATOR: Fibertec **RIG NO.:** 7822 DT-1 **LOGGED BY:** AJL **CHECKED BY:** MAV

DEPTH (FEET)	PROFILE DESCRIPTION	SAMPLE TYPE/NO. INTERVAL	RECOVERY (inches)	PID (ppm)	SOIL ANALYTICAL SAMPLE	REMARKS
0	TOPSOIL- SILTY SAND with Organics and Root Fibers- Black- Moist (SM)					
2.0		LS1	38			
5		LS2	48			
	Fine to Medium SAND- Brown- Moist to Wet (SP)					
10		LS3	31			
15.0		LS4	33			
15						
20	Fine SAND- Brown- Wet (SP)	LS5	42			
25.0						
25	END OF BORING AT 25.0 FEET.					
30						

GROUNDWATER & BACKFILL INFORMATION

	DEPTH (FT)
▽ **DURING BORING:**	4.5
▼ **AT END OF BORING:**	4.6

BACKFILL METHOD: Soil Cuttings

NOTES:
1. Soil samples were classified according to ASTM D2488, Standard Practice for Description and Identification of Soils (Visual-Manual Procedure) for environmental purposes only. Therefore, the boring logs and associated report(s) should not be used for geotechnical evaluation or design.
2. The indicated stratification lines are approximate. In situ, the transition between materials may be gradual.
3. Listed depths under the profile description are rounded to the nearest tenth of a foot (e.g. 5.75 = 5.8). Refer to the report and attachments for actual sample depths and/or intervals (where applicable).

BORING SB 2/PZ-7

PROJECT NAME: Baughman Drain Supplemental Hydrogeo
PROJECT NUMBER: 077821.00
CLIENT: Land & Resource Engineering and Surveying, Inc.
PROJECT LOCATION: Otsego, Michigan

DATE STARTED: 11/22/17 **COMPLETED:** 11/22/17 **BORING METHOD:** Direct Push
OPERATOR: Fibertec **RIG NO.:** 7822 DT-1 **LOGGED BY:** AJL **CHECKED BY:** MAV

DEPTH (FEET)	PROFILE DESCRIPTION	SAMPLE TYPE/NO. INTERVAL	RECOVERY (inches)	PID (ppm)	SOIL ANALYTICAL SAMPLE	REMARKS
0	TOPSOIL- SILTY SAND with Organics and Root Fibers- Black- Moist (SM)					
1.0		LS1	38			A piezometer was installed in the borehole. The piezometer screen was set between 3 feet and 8 feet below the ground surface.
5		LS2	48			
10	Fine to Medium SAND- Brown- Moist to Wet (SP)	LS3	29			
15		LS4	42			
19.0						
19.3	Sandy LEAN CLAY- Brown (CL)					
20	Fine SAND- Brown- Wet (SP)	LS5	36			
25.0						
25	END OF BORING AT 25.0 FEET.					
30						

GROUNDWATER & BACKFILL INFORMATION

	DEPTH (FT)
▽ **DURING BORING:**	4.8
▼ **AT END OF BORING:**	4.8

BACKFILL METHOD: Well Installation - Piezometer

NOTES:
1. Soil samples were classified according to ASTM D2488, Standard Practice for Description and Identification of Soils (Visual-Manual Procedure) for environmental purposes only. Therefore, the boring logs and associated report(s) should not be used for geotechnical evaluation or design.
2. The indicated stratification lines are approximate. In situ, the transition between materials may be gradual.
3. Listed depths under the profile description are rounded to the nearest tenth of a foot (e.g. 5.75 = 5.8). Refer to the report and attachments for actual sample depths and/or intervals (where applicable).

BORING SB 3

PROJECT NAME: Baughman Drain Supplemental Hydrogeo
PROJECT NUMBER: 077821.00
CLIENT: Land & Resource Engineering and Surveying, Inc.
PROJECT LOCATION: Otsego, Michigan

DATE STARTED: 11/22/17 **COMPLETED:** 11/22/17 **BORING METHOD:** Direct Push
OPERATOR: Fibertec **RIG NO.:** 7822 DT-1 **LOGGED BY:** AJL **CHECKED BY:** MAV

DEPTH (FEET)	SYMBOLIC PROFILE	PROFILE DESCRIPTION	SAMPLE TYPE/NO. INTERVAL	RECOVERY (inches)	PID (ppm)	SOIL ANALYTICAL SAMPLE	REMARKS
0		TOPSOIL- SILTY SAND with Organics and Root Fibers- Black- Moist (SM)					
1.5			LS1	37			
5		Fine to Medium SAND- Brown- Moist to Wet (SP)	LS2	49			
10			LS3	40			
14.0							
15		Silty LEAN CLAY- Gray (CL)	LS4	50			
19.8							
20		Fine SAND- Brown- Wet (SP)	LS5	37			
25.0							
25		END OF BORING AT 25.0 FEET.					
30							

GROUNDWATER & BACKFILL INFORMATION

	DEPTH (FT)
▽ **DURING BORING:**	4.9
▼ **AT END OF BORING:**	5.0

BACKFILL METHOD: Soil Cuttings

NOTES:
1. Soil samples were classified according to ASTM D2488, Standard Practice for Description and Identification of Soils (Visual-Manual Procedure) for environmental purposes only. Therefore, the boring logs and associated report(s) should not be used for geotechnical evaluation or design.
2. The indicated stratification lines are approximate. In situ, the transition between materials may be gradual.
3. Listed depths under the profile description are rounded to the nearest tenth of a foot (e.g. 5.75 = 5.8). Refer to the report and attachments for actual sample depths and/or intervals (where applicable).

BORING SB 4/PZ-8

PROJECT NAME: Baughman Drain Supplemental Hydrogeo
PROJECT NUMBER: 077821.00
CLIENT: Land & Resource Engineering and Surveying, Inc.
PROJECT LOCATION: Otsego, Michigan

DATE STARTED: 11/22/17 **COMPLETED:** 11/22/17 **BORING METHOD:** Direct Push
OPERATOR: Fibertec **RIG NO.:** 7822 DT-1 **LOGGED BY:** AJL **CHECKED BY:** MAV

DEPTH (FEET)	SYMBOLIC PROFILE	PROFILE DESCRIPTION	SAMPLE TYPE/NO. INTERVAL	RECOVERY (inches)	PID (ppm)	SOIL ANALYTICAL SAMPLE	REMARKS
0		TOPSOIL- SILTY SAND with Organics and Root Fibers- Black- Moist (SM)					
2.0			LS1	38			A piezometer was installed in the borehole. The piezometer screen was set between 4 feet and 9 feet below the ground surface.
5 ▽		Fine to Medium SAND- Brown- Moist to Wet (SP)	LS2	45			
10			LS3	38			
12.5		Silty LEAN CLAY- Gray (CL)	LS4	44			
19.8		Fine SAND- Brown- Wet (SP)	LS5	28			
20							
25.0							
25		END OF BORING AT 25.0 FEET.					
30							

GROUNDWATER & BACKFILL INFORMATION

	DEPTH (FT)
▽ **DURING BORING:**	5.5
▼ **AT END OF BORING:**	6.0

BACKFILL METHOD: Well Installation - Piezometer

NOTES:
1. Soil samples were classified according to ASTM D2488, Standard Practice for Description and Identification of Soils (Visual-Manual Procedure) for environmental purposes only. Therefore, the boring logs and associated report(s) should not be used for geotechnical evaluation or design.
2. The indicated stratification lines are approximate. In situ, the transition between materials may be gradual.
3. Listed depths under the profile description are rounded to the nearest tenth of a foot (e.g. 5.75 = 5.8). Refer to the report and attachments for actual sample depths and/or intervals (where applicable).

BORING SB 5

PROJECT NAME: Baughman Drain Supplemental Hydrogeo
PROJECT NUMBER: 077821.00
CLIENT: Land & Resource Engineering and Surveying, Inc.
PROJECT LOCATION: Otsego, Michigan

DATE STARTED: 11/22/17 **COMPLETED:** 11/22/17 **BORING METHOD:** Direct Push
OPERATOR: Fibertec **RIG NO.:** 7822 DT-1 **LOGGED BY:** AJL **CHECKED BY:** MAV

DEPTH (FEET)	SYMBOLIC PROFILE	PROFILE DESCRIPTION	SAMPLE TYPE/NO. INTERVAL	RECOVERY (inches)	PID (ppm)	SOIL ANALYTICAL SAMPLE	REMARKS
0		TOPSOIL- SILTY SAND with Organics and Root Fibers- Black- Moist (SM)					
1.5			LS1	38			
5		Fine to Medium SAND- Brown- Moist to Wet (SP)					
▽			LS2	36			
10							
11.0			LS3	33			
		Silty LEAN CLAY- Gray (CL)					
15							
15.0			LS4	46			
20		Fine SAND- Brown- Wet (SP)					
			LS5	35			
25.0							
25		END OF BORING AT 25.0 FEET.					
30							

GROUNDWATER & BACKFILL INFORMATION

	DEPTH (FT)
▽ **DURING BORING:**	7.0

BACKFILL METHOD: Soil Cuttings

NOTES:
1. Soil samples were classified according to ASTM D2488, Standard Practice for Description and Identification of Soils (Visual-Manual Procedure) for environmental purposes only. Therefore, the boring logs and associated report(s) should not be used for geotechnical evaluation or design.
2. The indicated stratification lines are approximate. In situ, the transition between materials may be gradual.
3. Listed depths under the profile description are rounded to the nearest tenth of a foot (e.g. 5.75 = 5.8). Refer to the report and attachments for actual sample depths and/or intervals (where applicable).

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TECHNICAL MEMO 1

SUBJECT: Baughman Drain Hydrogeological Evaluation

DATE: April 6, 2018 **PROJECT NO.:** 180488

Table of Contents

Introduction

Fishbeck, Thompson, Carr & Huber, Inc. (FTCH) has prepared this Technical Memorandum on behalf of Land and Resource Engineers (LRE) and the Allegan County Drain Commissioner to evaluate hydrogeological conditions in the vicinity of the Baughman Drain, particularly along and adjacent to Prairiewood Ct. and Elm Street. The area has reportedly been prone to frequent basement flooding. Figure 1 shows the study area and relevant surface water features.

This report presents the findings of a preliminary hydrogeological evaluation and is based on our proposal dated February 15, 2018. The scope of work included a site visit to review the site conditions and hydrology and performing groundwater modeling to provide a preliminary assessment of the potential impact of cleaning/lowering the existing drains and the potential effectiveness of proposed underdrain layouts. The scope of work also included review of existing information.

Summary of Background Information

Existing information for the site was reviewed including information provided by LRE, publicly available geologic and hydrogeologic data, and two hydrogeologic investigations completed for the site by others (*Hydrogeologic Monitoring Summary Report* [SME, August 15, 2017] and *Supplemental Hydrogeologic Evaluation Summary Report* [SME, February 20, 2018]).

Figure 2 presents a site map showing locations of piezometers, staff gages, soil borings, and water supply wells across the study area. The site map also shows the parcels with reports of frequent basement flooding along with the basement elevations for some locations as estimated by LRE. Baughman Drain runs east to west along the northern edge of the study area; Branch No. 1 begins approximately 500 feet east of SG-1 and flows to the west and northwest where it joins Baughman Drain; Branch No. 2 begins near SG-8 and flows approximately 1500 feet north where it joins Baughman Drain. A tributary to Branch No. 2 flows east to west just south of the houses along Elm Street.

Piezometers and soil borings conducted by SME consisted almost exclusively of sand. The exceptions to this were at PZ-6, PZ-7, PZ-8, SB-3, and SB-5 located south of Prairiewood Ct. as shown on Figure 3. PZ-6 exhibited sand with silt throughout the full 25-foot depth of the boring; the others indicated a clay layer ranging from 11 to 19 feet below ground surface (bgs). These lower-permeability deposits are likely inhibiting groundwater flow from the aquifer into the drain to the south and contributing to the groundwater mound beneath Prairiewood Ct. as shown by the groundwater elevation contours illustrated on Figure 3. The hydraulic gradient between PZ-6 and SG-1 is very steep suggesting that the drain is at least partially disconnected from the aquifer. The piezometer and soil boring logs are included in Appendix 1 along with two geologic cross sections depicting the subsurface.

Water supply well logs in the study area were also reviewed. Like the piezometers, most water supply logs indicated primarily sand deposits generally to depths of at least 40 feet bgs. Two water supply locations along Sycamore Street indicated clay from 0 to 5 ft bgs and 0 to 10 ft bgs. The extent of this clay unit is unknown due to the lack of other borings in the area, but could be a barrier to groundwater flow to the north toward Baughman Drain, further contributing to the groundwater mound beneath Prairiewood Ct. Also, two water supply locations in the eastern portion of the study area exhibited more extensive clay. The well log for supply well-02525 located near PZ-1 indicated clay from 8 to 20 ft bgs although PZ-1 indicated all sand. Water supply well-04581 at the eastern end of Elm Street indicated clay from 0 to 32 ft bgs. The water supply well logs are included in Appendix 2.

Representatives of FTCH and LRE conducted a site visit on March 2, 2018, to review the site conditions and hydrology. The condition, slope, and sedimentation of Baughman Drain and the tributaries were examined by walking along or wading in most of the reaches including examination of the drain beds with a soil probe. The drain bottoms were generally sandy like the soils documented in the piezometer borings; however, some portions of the drains did exhibit finer-grained sedimentation and/or organic material buildup as has been noted by LRE. The area with the most low-permeability material was observed near the headwaters of Branch No. 1. This area exhibited areas of clay bottom as well as some areas of upwelling groundwater indicating groundwater under pressure – enough to suspend sand grains. These observations correlate with the steep hydraulic gradients along the reach near SG-1. In addition, a 2-inch diameter flexible pipe was noted at the headwaters of Branch No. 1, and it was flowing into the drain at a substantial rate estimated to be as high as 20 gallons per minute (gpm). The origin of this pipe is unknown but is expected to be associated with the pond or wetland located south of the headwaters at a higher elevation. Also of note was the confluence of Branch No. 1 and Baughman Drain, which exhibited a drop of approximately 3 feet. This suggests at least the northern portion of Branch No. 1 may be perched. The surface water elevations of the remainder of the drains matched the elevations of the aquifer fairly well suggesting good hydraulic connection.

Groundwater Flow Model

A groundwater flow model was constructed to preliminarily evaluate groundwater/surface water flow interactions and evaluate potential solutions to the flooding problems. The groundwater flow modeling was performed using *WinFlow* (Environmental Simulations, Inc., 1997-2013), which is a 2-dimensional, analytical flow model. *WinFlow* uses the analytic element method developed by Strack (1989).

WinFlow uses certain simplifying assumptions to reduce the amount and complexity of the input data required. This includes the use of uniform values for aquifer parameters such as aquifer thickness, hydraulic conductivity, and hydraulic gradient. Despite these limitations, analytical flow models are useful and efficient particularly for preliminary assessments to gain an understanding of a flow system.

Model Setup

The groundwater flow model was constructed based on hydrogeological observations at the site. Figure 4 shows the model domain with the flow field extending north and west toward Baughman Drain. In addition to Baughman Drain and its tributaries, the regional flow direction is likely also influenced by the Pine Creek impoundment to the west and the Kalamazoo River to the north and west (see Figure 1).

Based on the geology at site piezometers and area water supply wells, an aquifer thickness of 30 feet was assumed with a bottom elevation of 684 feet above mean sea level (ft msl). An assumed hydraulic conductivity value of 35 feet per day (ft/day) was used based on the soil descriptions for the piezometers (typically fine- or medium-grained sand).

Calibration 1 and Simulation 1

To calibrate the model, the hydraulic gradient and reference head were adjusted until the simulated flow field matched the observed water levels as closely as possible, particularly near Prairiewood Ct. The simulated contours were calibrated to observed water levels measured on December 6, 2017. The final hydraulic gradient input was 0.00285 ft/ft at an angle of 122 degrees. Figure 4 represents the preliminary calibration prior to adding the surface water elevations in the drains.

Simulation 1 includes the addition of head linesinks in the model to represent the surface water elevations in Baughman Drain and its tributaries. The head linesink elevations are based on surface water elevations from staff gage measurements taken on December 6, 2017. The simulated groundwater elevations shown on Figure 5 represent the predicted groundwater elevations across the study area if the drains were completely open to the aquifer, i.e., fully efficient drains. As expected, the simulated contours do not match the observed contours and indicate:

- the drains are not completely open to the aquifer, i.e., sedimentation in the drains or underlying low-permeability materials impede groundwater flow into the drains;
- the aquifer includes some areas of lower permeability material that inhibits flow toward the drains and contributes to the groundwater mounding below Prairiewood Ct; or
- a combination of the above.

Calibration 2 and Simulations 2 and 3

Adjustments were made to the model so that the simulated groundwater elevation contours matched the observed groundwater elevations better. This calibration was achieved by raising some of the drain (head linesink) elevations and adding a recharge ellipse above the groundwater mound area. Raising of the linesink elevations is similar to reducing the permeability of the drain beds. The addition of recharge could represent either upwelling of groundwater from a deeper portion of the aquifer or concentration of surface water runoff from Prairiewood Ct. In either case, the groundwater elevations shown on Figure 6 more closely match the observed groundwater elevations (Calibration 2) and serve as a starting point for predictive simulations.

Simulation 2 (Figure 7) shows the predicted drawdown created by installing an underdrain along Prairiewood Ct. The underdrain slopes from an elevation of 704.9 ft msl at Springbrook to an elevation of 701.6 ft msl at Branch No. 1. As shown on Figure 7, this underdrain is estimated to result in drawdown of approximately 3.0 feet under most of Prairiewood Ct. and drawdown of 1 foot reaching outward to Sycamore Street.

Simulation 3 (Figure 8) adds an underdrain along Elm Street sloping from an elevation of 705.8 ft msl at 16th Street to an elevation of 702.6 ft msl at Springbrook. This underdrain results in 2.0 feet of drawdown beneath all of Elm Street and extends drawdown of 1.0 feet to portions of Sycamore Street.

Calibration 3 and Simulations 4 and 5

Examination of Simulations 2 and 3 (Figures 7 and 8) show that the simulated drawdown is limited by the head linesinks input along the tributaries of Baughman Drain. This is due to the way head linesinks function in *WinFlow*; when the groundwater elevation in the aquifer drops below the head elevation specified in the linesink, the linesink begins contributing water back into the aquifer. In reality, the drawdown caused by the underdrain could cause the watercourse to go dry and extend the drawdown beyond it.

Due to this limitation of the model, another calibration was performed – this time with only the head linesinks along Baughman Drain and the head linesinks along its tributaries removed as shown on Figure 9. The reference head and hydraulic gradient were again adjusted until the simulated contours matched the observed contours as closely as possible. As shown on Figure 9 (Calibration 3), the calibration resulted in a fairly good match except for the area around PZ-6 through SG-1 and near SG-6 where the simulated contours are higher than the observed. Despite these limitations, the use of this calibration as a starting point will provide an estimate of the upper range of predicted drawdown.

Simulation 4 (Figure 10) depicts the simulated drawdown for the Prairiewood Ct. underdrain compared to Calibration 3. An estimated drawdown of 1.5 feet extends beyond the western portion of Sycamore Street.

Simulation 5 (Figure 11) depicts the simulated drawdown for the Prairiewood Ct. and Elm Street underdrains using the same underdrain elevations. The results as shown on Figure 11 show estimated drawdown of 1.5 feet or greater for most of the study area.

Simulations 4 and 5 likely represent the maximum expected drawdown whereas Simulations 2 and 3 may represent a minimum; however, additional evaluation is recommended due to the inherent limitations of the simplified analytical model as discussed in the next section.

Model Limitations

As with any groundwater model, certain simplifying assumptions have been made based on a limited amount of data. Based on the limited amount of information for the site and the inherent capabilities of a simple analytical model, the primary limitations of the model include, but are not limited to the following:

- The geology of the site has not been fully defined. Although the piezometers indicated the study area consists primarily of fine- to medium-grained sand, some water supply well logs indicated clay near the surface, which may have significant impact on groundwater flow patterns and the effectiveness of underdrains. In addition, the model relies on only 8 piezometer borings to evaluate an area of more than 130 acres.
- The hydraulic conductivity value input to the model was assumed based on soil descriptions; hydraulic conductivity is a critical parameter for groundwater flow for which actual measurements are needed for more accurate simulations. In addition, the analytical model uses a uniform value of hydraulic conductivity even though this parameter will vary across the site and could affect groundwater flow patterns and velocity.
- The degree of hydraulic connection between the aquifer and the drains is not well understood. Although portions of the drains appear to be in good hydraulic communication with the aquifer, other portions are not. In addition, the representation of drains in the simplified analytical model is limited as discussed

in previous sections. More data regarding the relation of the drains to the aquifer and a more sophisticated model may be warranted.

- The groundwater mound beneath Prairiewood Ct. indicated by the observed groundwater elevation contours may be caused by several factors including: sedimentation/clay layers beneath the southern drain, low hydraulic conductivity materials in the aquifer between Prairiewood Ct. and the southern drain, surface water runoff from Prairiewood Ct., clay units or other low-permeability soils north of Prairiewood Ct. that retard groundwater flow, or upwelling of groundwater from deeper aquifers originating from the hilly areas southeast of the study area. Greater understanding of this factor may be warranted.

Despite these limitations, the groundwater flow model provides a greater understanding of the groundwater conditions at the site and reasonable minimum and maximum estimates of the effects of an underdrain system. In addition, the model development provides guidance for additional data needs prior to final design should the project move forward.

Conclusions

Based on the review of available hydrogeologic data, hydrologic data, and this groundwater flow model evaluation, installation of underdrains and improvements to existing surface water drainage would be expected to lower groundwater elevations throughout much of the study area.

Recommendations

Further study is recommended prior to the final design. At a minimum, additional piezometers are recommended to evaluate hydrogeologic conditions along the proposed underdrain route and near the properties with flooding problems. Twelve to fifteen additional piezometer locations are expected depending on the extent and layout of the proposed underdrains. Single-well hydraulic conductivity tests (slug tests) are also recommended at all existing and proposed piezometers to determine the permeability of the aquifer materials in the study area.

If the results of the piezometers and slug tests are optimal, i.e., minimal low-permeability strata that may impede drainage and relatively high hydraulic conductivity, minimal further study will be necessary. Minimal additional study would include a simple numerical model (MODFLOW), which is more capable of simulating the relationship of the surface water bodies to the aquifer and proposed underdrains than the analytical model used for this report. However, if the geology is mixed and hydraulic conductivities are relatively low in some locations, a more extensive evaluation may be warranted to ensure that the proposed underdrains would have the desired effect and reach.

More extensive study would likely include:

- Stream Piezometers/Streamflow Gaging. To further evaluate the hydraulic connection of the aquifer to the streams/drains and vertical hydraulic gradients, several piezometers would be installed in the streambeds. The piezometers equipped with screens would be hand driven into the streambeds at 8 to 12 locations. In addition, streamflow measurements will be conducted at several locations to further support the groundwater flow modeling efforts.

- Complex Groundwater Flow Modeling. If the additional piezometers indicate more complex hydrogeologic conditions, a more sophisticated MODFLOW model may be necessary to more accurately simulate all aspects of the groundwater flow system. This more rigorous effort would include varying aquifer parameters to achieve a better calibration and more confidence in the model simulation results. Calibration parameters in MODFLOW include hydraulic conductivity, aquifer thickness, aquifer recharge, streamflow, and the extent to which surface water bodies are hydraulically connected to the aquifer.

Figures

STUDY AREA

SCALE: 1" = 800'

NORTH 0 400 800 1600

BASE MAP ADAPTED FROM DRAWING PROVIDED BY LRE, 12/19/17

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engineers
scientists
architects
constructors

fishbeck, thompson, carr & huber, inc.

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Baughman Drain

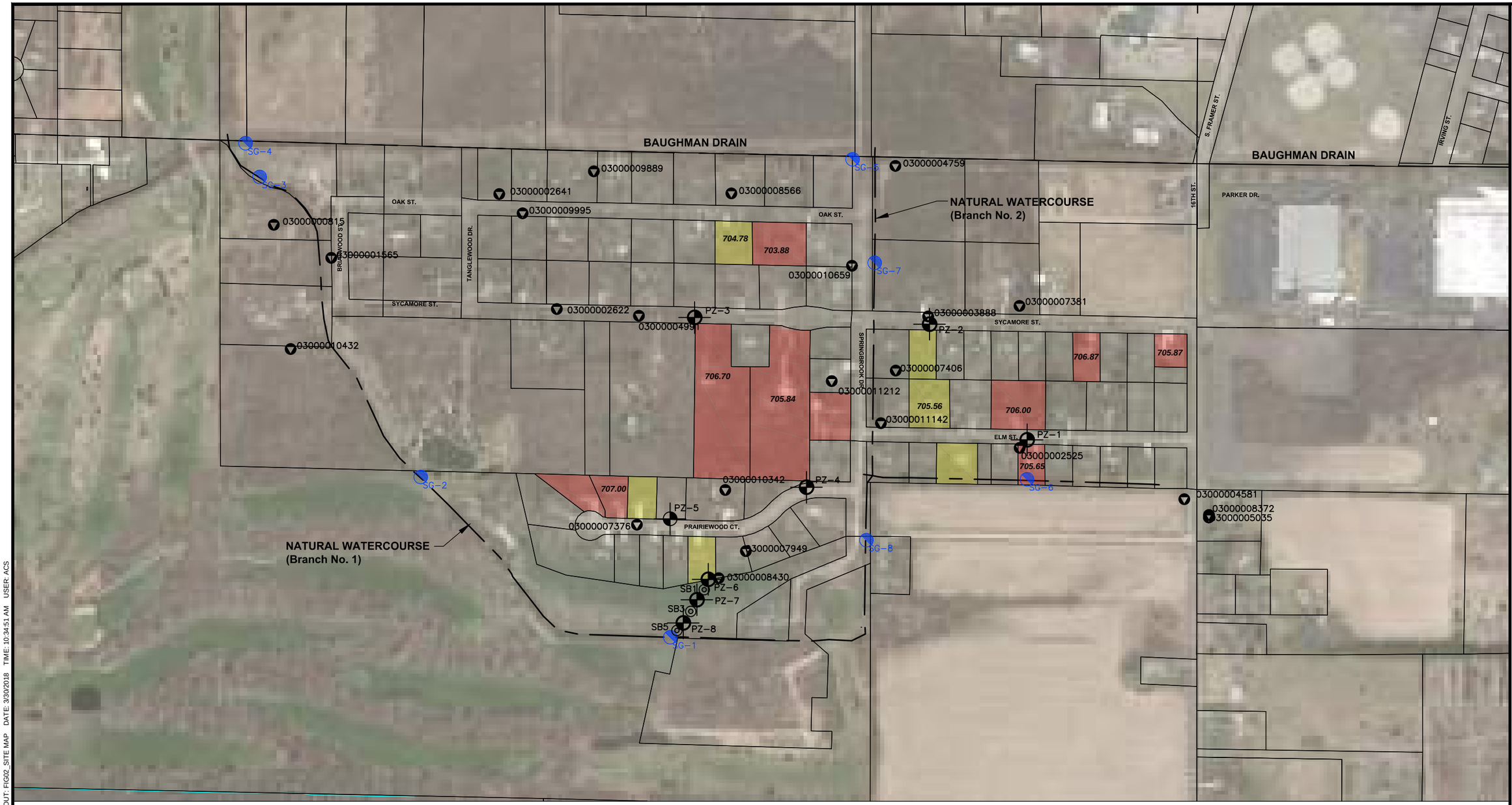
Otsego, Allegan County, Micghian

Preliminary Hydrogeological Evaluation

PROJECT NO.
180488

FIGURE NO.
1

PLOT INFO: Z:\2018\180488\CAD\REF\2002-180488.DWG LAYOUT: FIG01_STUDY AREA DATE: 3/30/2018 TIME: 10:33:35 AM USER: ACS



LEGEND

- SOIL BORING
- STAFF GAUGE LOCATION
- WATER SUPPLY WELL
- PIEZOMETER LOCATION
- PARCELS WITH REPORTS OF CONSISTENT FLOODING
- PARCELS WITH REPORTS OF PERIODIC FLOODING
- *703.88* ESTIMATED BASEMENT ELEVATIONS (FEET AMSL)

BASE MAP ADAPTED FROM DRAWING PROVIDED BY LRE, 12/19/17
ORTHOPHOTO DATED: 2014

NORTH

SITE MAP

SCALE: 1" = 400'

0 200 400 800

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Baughman Drain
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Preliminary Hydrogeological Evaluation

PROJECT NO.
180488

FIGURE NO.
2

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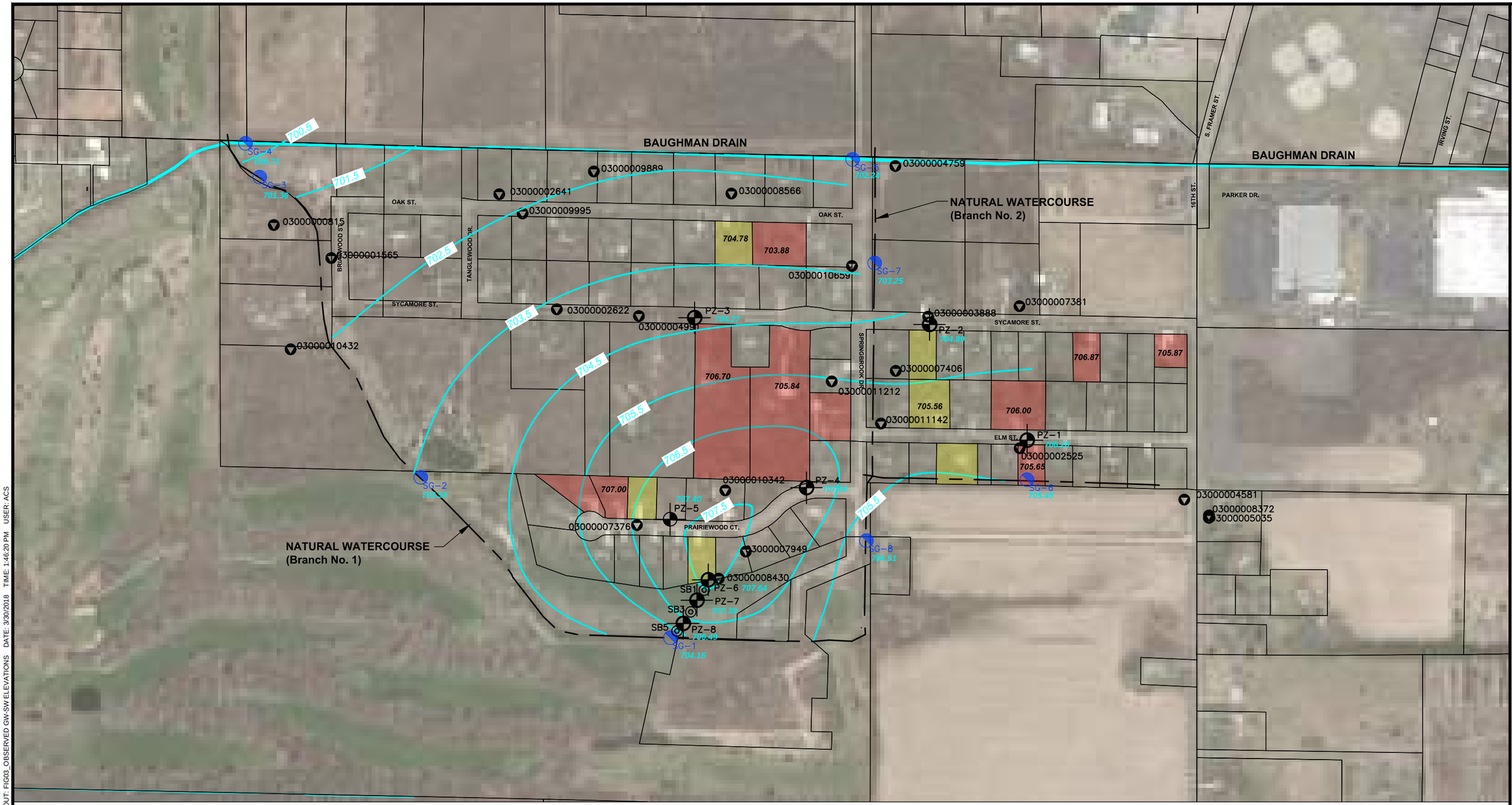

LEGEND

- SOIL BORING
- STAFF GAUGE LOCATION
- WATER SUPPLY WELL
- PIEZOMETER LOCATION
- PARCELS WITH REPORTS OF CONSISTENT FLOODING
- PARCELS WITH REPORTS OF PERIODIC FLOODING
- 703.88 ESTIMATED BASEMENT ELEVATIONS (FEET AMSL)
- OBSERVED CONTOURS (December 6, 2017 data)
- 703.88 GROUNDWATER ELEVATION (FEET AMSL) – December 6, 2017

OBSERVED GROUNDWATER/SURFACE WATER ELEVATIONS

NORTH

SCALE: 1" = 400'

0 200 400 800

BASE MAP ADAPTED FROM DRAWING
PROVIDED BY LRE, 12/19/17
ORTHOPHOTO DATED: 2014

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Baughman Drain
Otsego, Allegan County, Micghian
Preliminary Hydrogeological Evaluation

PROJECT NO.
180488

FIGURE NO.
3

PLOT INFO: Z:\2018\180488\CAD\REF\ZX001-180488.DWG LAYOUT: FIG03_OBSERVED GW-SW ELEVATIONS DATE: 3/30/2018 TIME: 1:46:20 PM USER: ACS

BAUGHMAN DRAIN

NATURAL WATERCOURSE (Branch No. 2)

NATURAL WATERCOURSE (Branch No. 1)

OAK ST.

SYCAMORE ST.

ELM ST.

PRAIRIEWOOD CT.

BRIARWOOD DR.

TANGLEWOOD DR.

SPRINGBROOK DR.

S. FRAMER ST.

IRVING ST.

16TH ST.

PARKER DR.

SG-1 SG-2 SG-3 SG-4 SG-5 SG-6 SG-7 SG-8

PZ-1 PZ-2 PZ-3 PZ-4 PZ-5 PZ-6 PZ-7 PZ-8

SB1 SB3 SB5

03000009889 03000004759 03000002641 03000008566 03000009995 03000008815 03000001565 03000010659 03000002622 03000004991 03000003888 03000007381 03000010432 03000007406 03000011212 03000011142 03000002525 03000004581 03000008372 03000005035 03000010342 03000007376 03000007949 03000008430

704.78 703.88 706.70 705.84 705.56 706.00 706.87 705.87 707.00 705.65

700.5 701.5 702.5 703.5 704.5 705.5 706.5 707.5 708.5 709.5 710.5

LEGEND

- SOIL BORING
- STAFF GAUGE LOCATION
- WATER SUPPLY WELL
- PIEZOMETER LOCATION
- OBSERVED CONTOURS
- SIMULATED CONTOURS
- PARCELS WITH REPORTS OF CONSISTENT FLOODING
- PARCELS WITH REPORTS OF PERIODIC FLOODING
- 703.88 ESTIMATED BASEMENT ELEVATIONS (FEET AMSL)

BASE MAP ADAPTED FROM DRAWING PROVIDED BY LRE, 12/19/17
ORTHOPHOTO DATED: 2014

CALIBRATION 1 PRELIMINARY CALIBRATION AND MODEL DOMAIN

SCALE: 1" = 400'

NORTH 0 200 400 800

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Preliminary Hydrogeological Evaluation

PROJECT NO. 180488

FIGURE NO. 4

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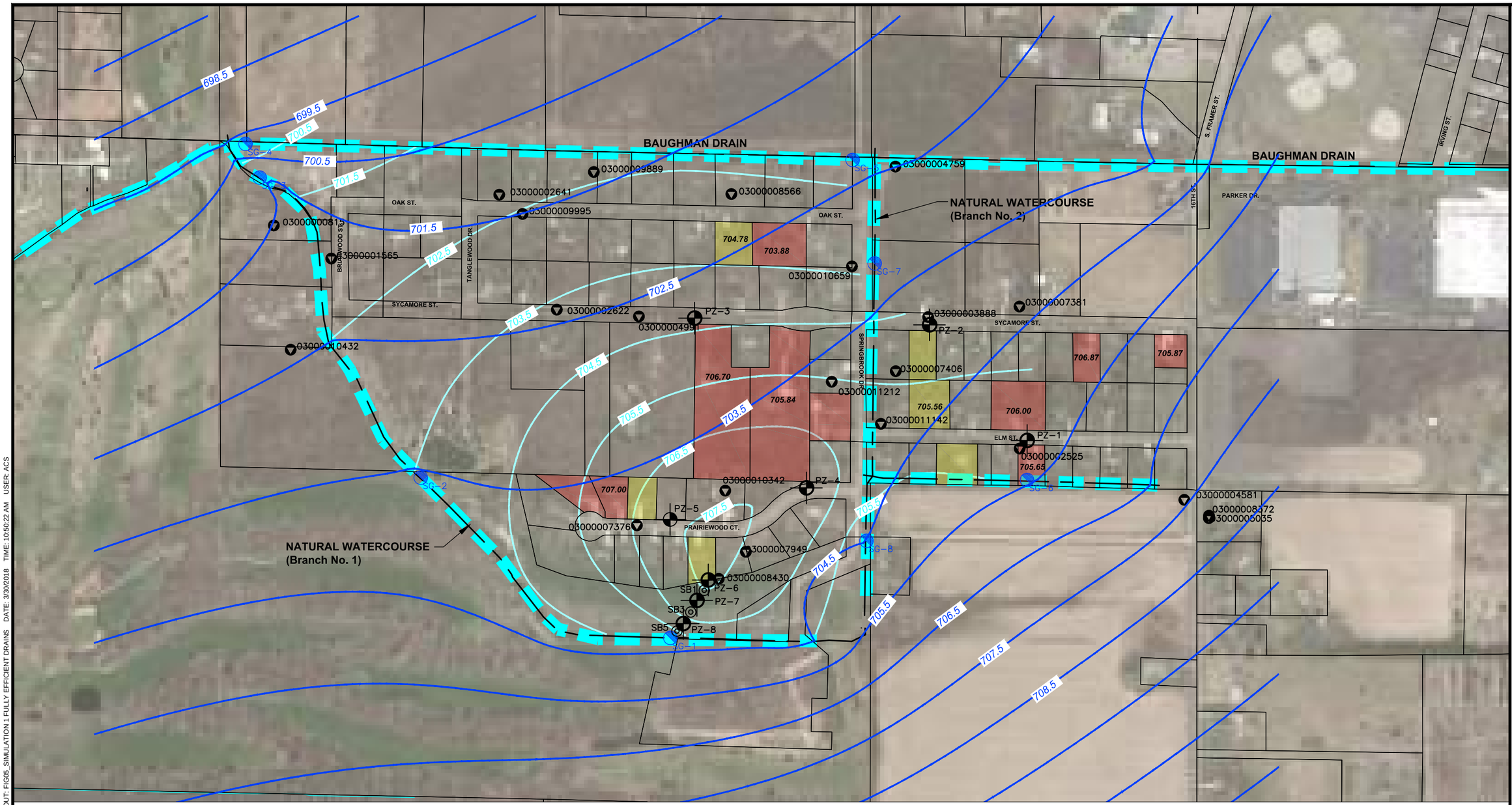

LEGEND

- SOIL BORING
- STAFF GAUGE LOCATION
- WATER SUPPLY WELL
- PIEZOMETER LOCATION
- OBSERVED CONTOURS
- SIMULATED CONTOURS
- HEAD LINESINKS
- PARCELS WITH REPORTS OF CONSISTENT FLOODING
- PARCELS WITH REPORTS OF PERIODIC FLOODING
- ***703.88*** ESTIMATED BASEMENT ELEVATIONS (FEET AMSL)

BASE MAP ADAPTED FROM DRAWING
PROVIDED BY LRE, 12/19/17
ORTHOPHOTO DATED: 2014

SIMULATION 1:
FULLY EFFICIENT DRAINS

SCALE: 1" = 400'

NORTH 0 200 400 800

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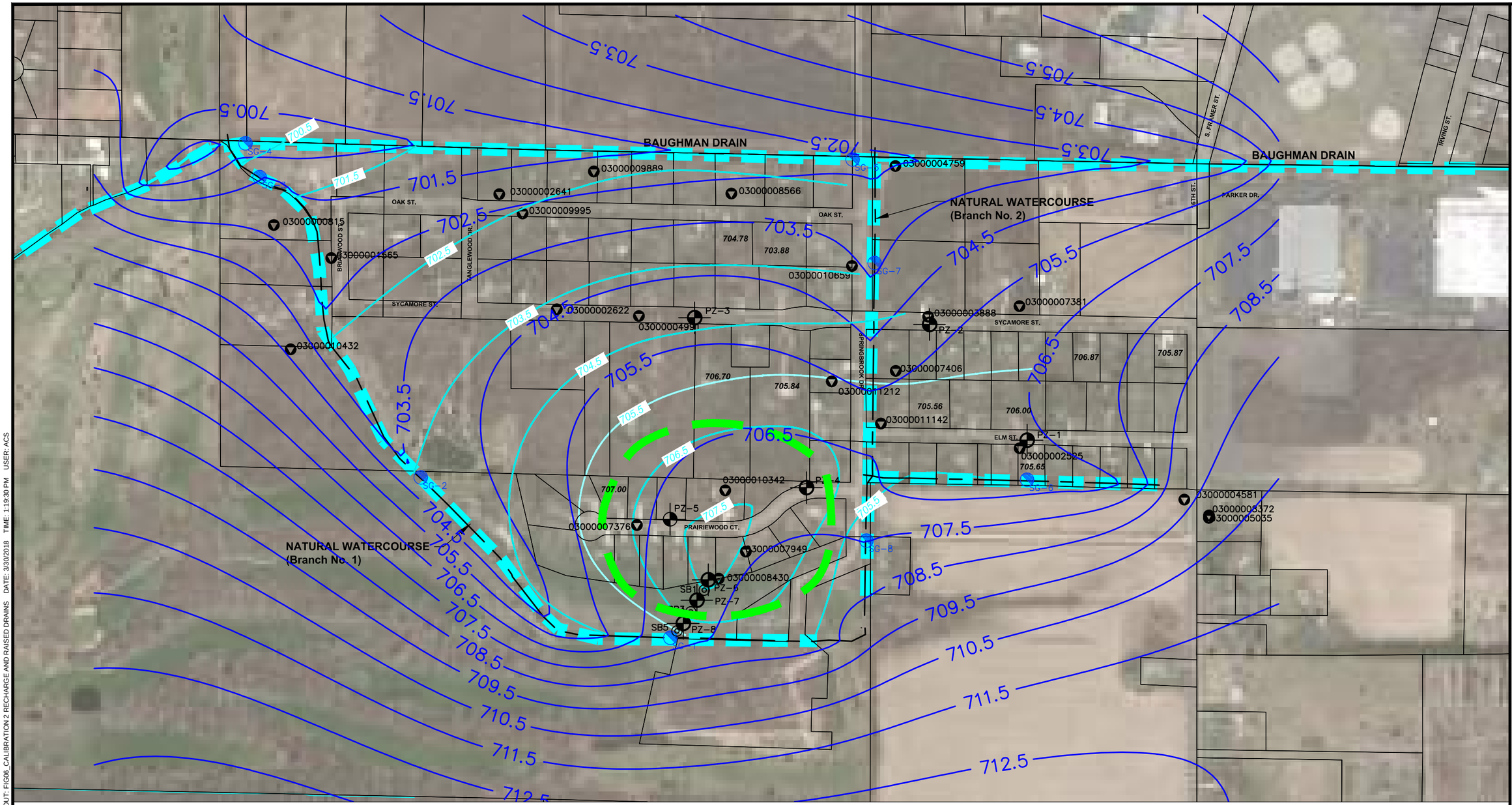
Baughman Drain
Otsego, Allegan County, Micghian
Preliminary Hydrogeological Evaluation

PROJECT NO.
180488

FIGURE NO.
5

PLOT INFO: Z:\2018\180488\CAD\REF\2X001-180488.DWG LAYOUT: FIG05_SIMULATION 1 FULLY EFFICIENT DRAINS DATE: 3/30/2018 TIME: 10:50:22 AM USER: ACS



LEGEND

- SOIL BORING
- STAFF GAUGE LOCATION
- WATER SUPPLY WELL
- PIEZOMETER LOCATION
- OBSERVED CONTOURS
- SIMULATED CONTOURS
- RECHARGE AREA
- HEAD LINESINKS
- 703.88 ESTIMATED BASEMENT ELEVATIONS (FEET AMSL)

BASE MAP ADAPTED FROM DRAWING
PROVIDED BY LRE, 12/19/17
ORTHOPHOTO DATED: 2014

CALIBRATION 2: RECHARGE AND RAISED DRAINS

NORTH

SCALE: 1" = 400'

0 200 400 800

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architects
constructors

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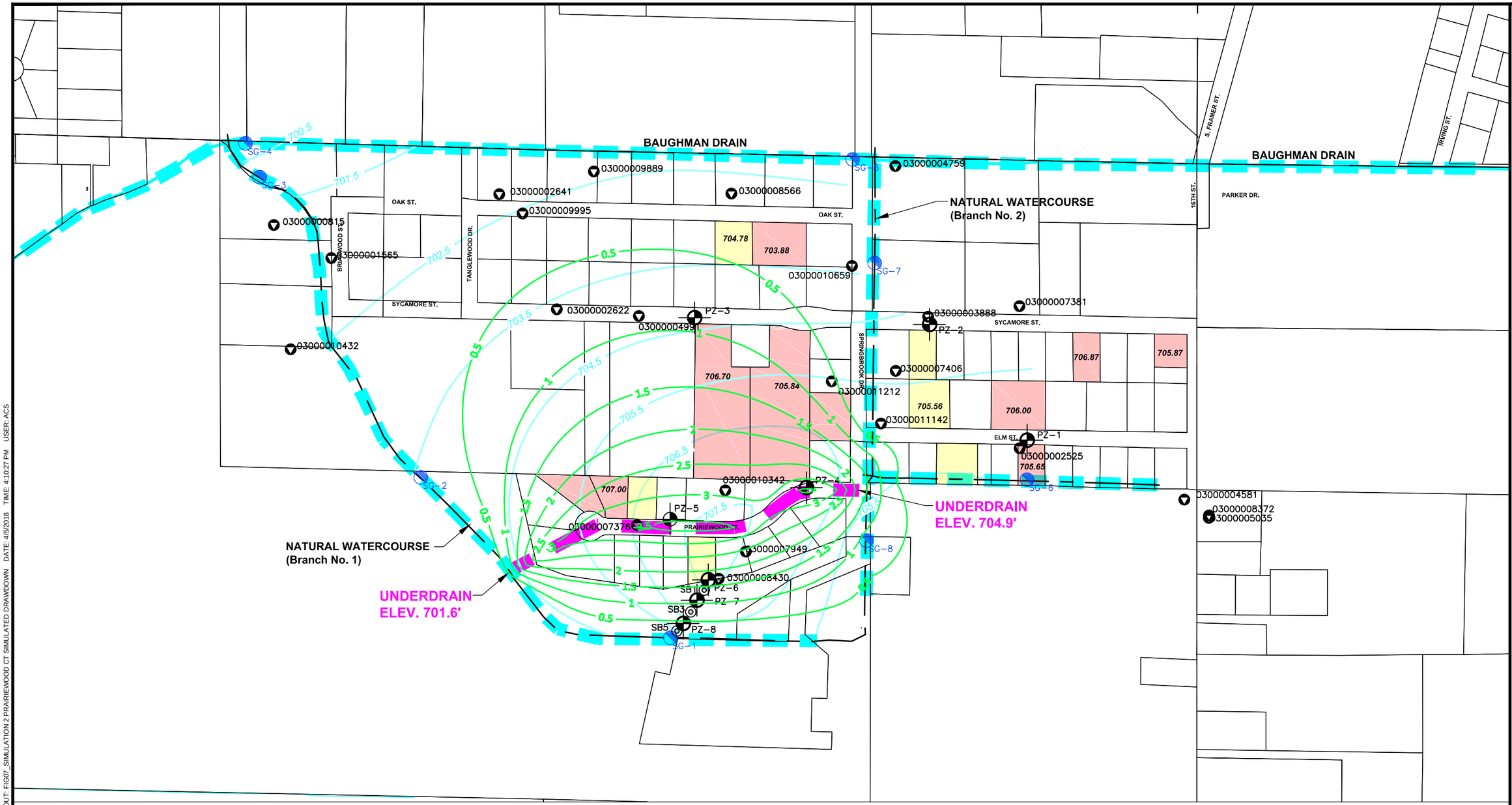
Baughman Drain
Otsego, Allegan County, Micghian
Preliminary Hydrogeological Evaluation

PROJECT NO.
180488

FIGURE NO.
6

PLOT INFO: Z:\2018\180488\CAD\REF\ZX001-180488.DWG LAYOUT: FIG06_CALIBRATION 2 RECHARGE AND RAISED DRAINS DATE: 3/30/2018 TIME: 1:19:30 PM USER: ACS



LEGEND

- SOIL BORING
- STAFF GAUGE LOCATION
- WATER SUPPLY WELL
- PIEZOMETER LOCATION
- OBSERVED CONTOURS
- SIMULATED DRAWDOWN
- HEAD LINESINKS
- PARCELS WITH REPORTS OF CONSISTENT FLOODING
- PARCELS WITH REPORTS OF PERIODIC FLOODING
- *703.88* ESTIMATED BASEMENT ELEVATIONS (FEET AMSL)

BASE MAP ADAPTED FROM DRAWING
PROVIDED BY LRE, 12/19/17
ORTHOPHOTO DATED: 2014

SIMULATION 2
PRAIRIEWOOD CT.
SIMULATED DRAWDOWN

SCALE: 1" = 400'

NORTH 0 200 400 800

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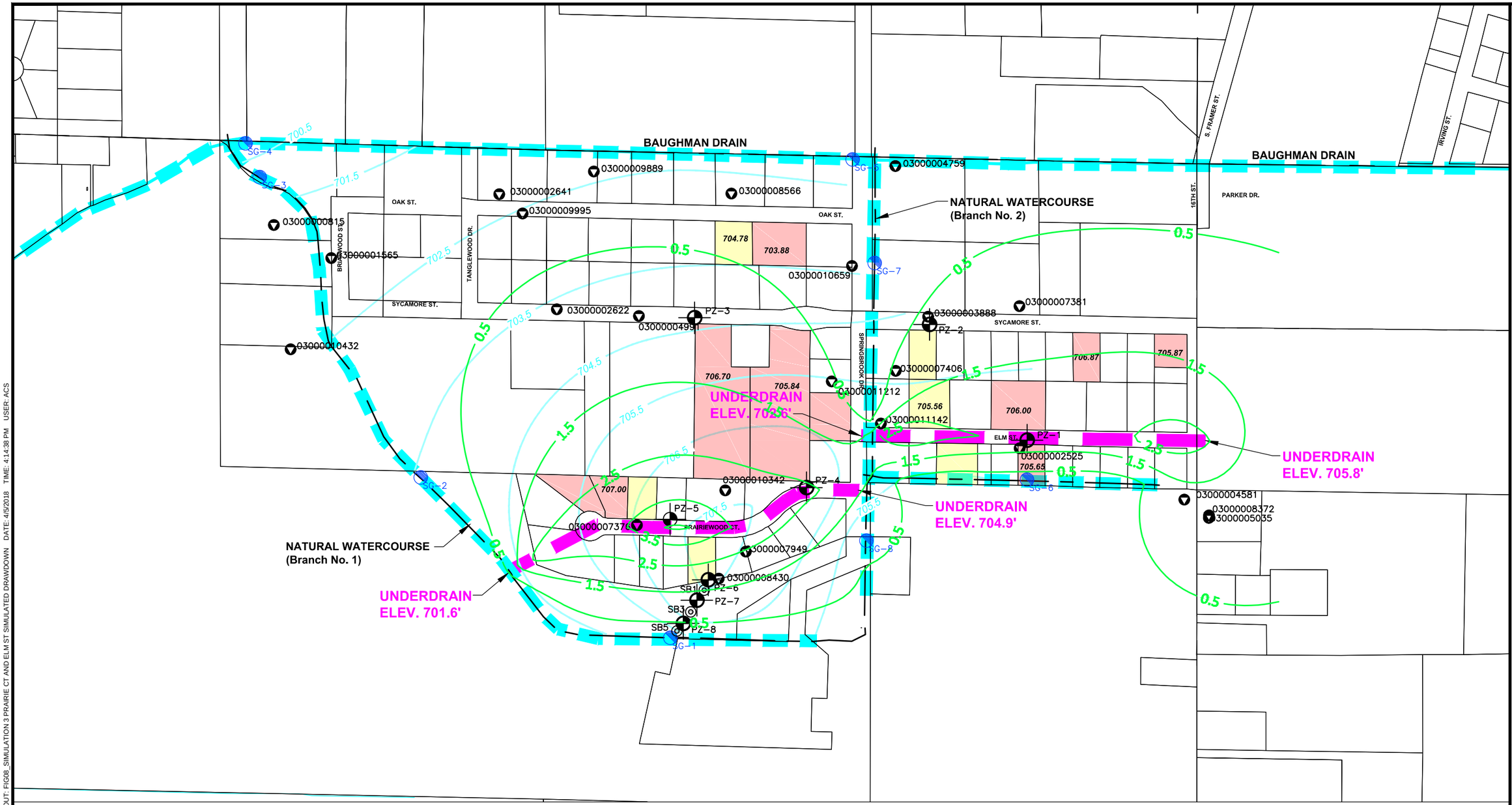
Baughman Drain
Otsego, Allegan County, Micghian
Preliminary Hydrogeological Evaluation

PROJECT NO. 180488

FIGURE NO. 7

PLOT INFO: Z:\2018\180488\CAD\REF\2X001-180488.DWG LAYOUT: FIG07_SIMULATION 2 PRAIRIEWOOD CT SIMULATED DRAWDOWN DATE: 4/5/2018 TIME: 4:10:27 PM USER: ACS



LEGEND

- SOIL BORING
- STAFF GAUGE LOCATION
- WATER SUPPLY WELL
- PIEZOMETER LOCATION
- OBSERVED CONTOURS
- SIMULATED DRAWDOWN
- HEAD LINESINKS
- PARCELS WITH REPORTS OF CONSISTENT FLOODING
- PARCELS WITH REPORTS OF PERIODIC FLOODING
- *703.88* ESTIMATED BASEMENT ELEVATIONS (FEET AMSL)

BASE MAP ADAPTED FROM DRAWING
PROVIDED BY LRE, 12/19/17
ORTHOPHOTO DATED: 2014

SIMULATION 3
PRAIRIEWOOD CT. & ELM STREET SIMULATED DRAWDOWN

SCALE: 1" = 400'

NORTH 0 200 400 800

fishbeck
engineers
scientists
architects
constructors
fishbeck, thompson, carr & huber, inc.

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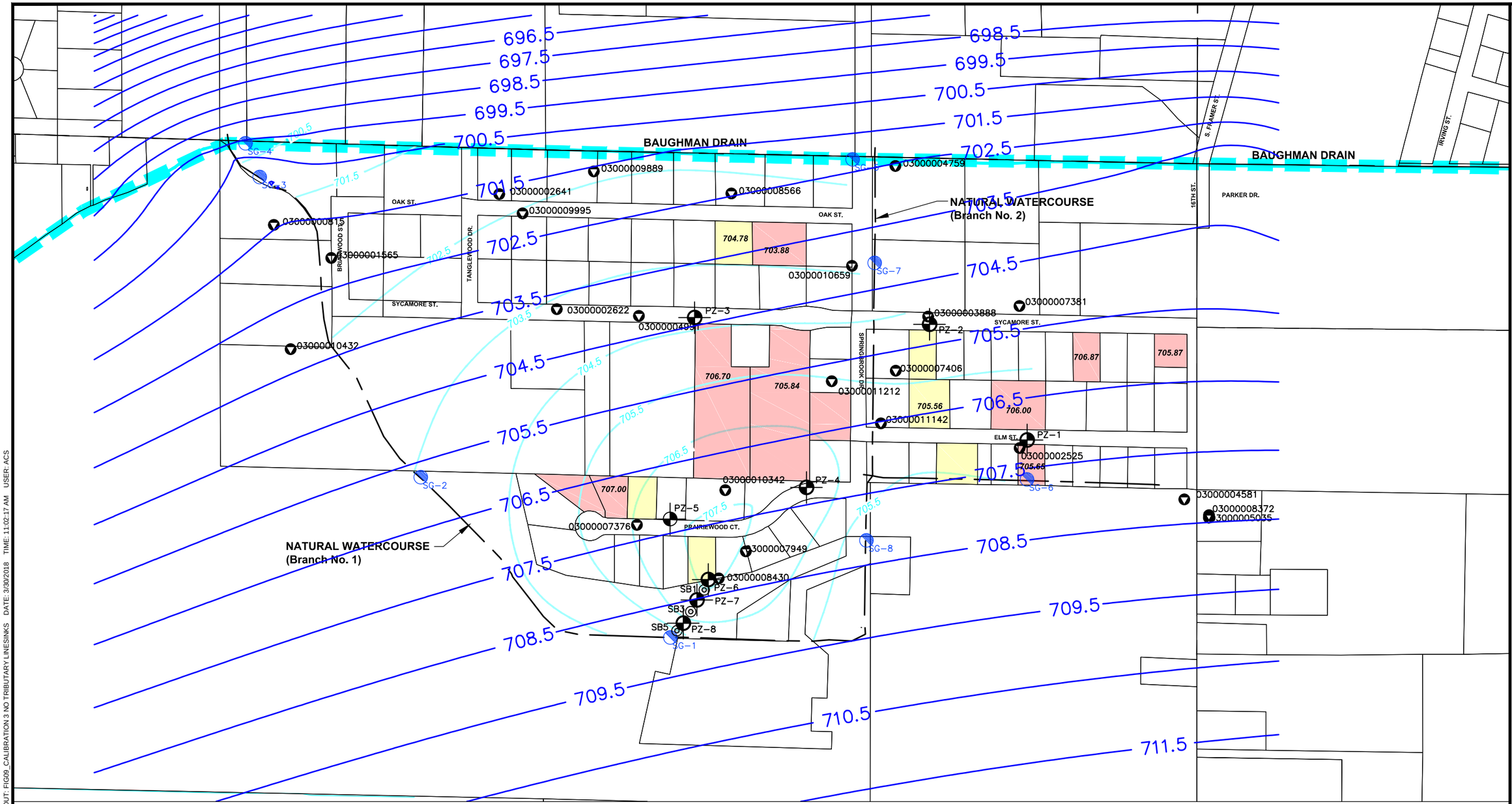
Baughman Drain
Otsego, Allegan County, Micghian
Preliminary Hydrogeological Evaluation

PROJECT NO. 180488

FIGURE NO. 8

PLOT INFO: Z:\2018\180488\CAD\REF\2X001-180488.DWG LAYOUT: FIG08_SIMULATION 3 PRAIRIE CT AND ELM ST SIMULATED DRAWDOWN DATE: 4/5/2018 TIME: 4:14:38 PM USER: ACS



LEGEND

- SOIL BORING
- STAFF GAUGE LOCATION
- WATER SUPPLY WELL
- PIEZOMETER LOCATION
- OBSERVED CONTOURS
- SIMULATED CONTOURS
- LINESINKS
- PARCELS WITH REPORTS OF CONSISTENT FLOODING
- PARCELS WITH REPORTS OF PERIODIC FLOODING
- *703.88* ESTIMATED BASEMENT ELEVATIONS (FEET AMSL)

BASE MAP ADAPTED FROM DRAWING
PROVIDED BY LRE, 12/19/17
ORTHOPHOTO DATED: 2014

CALIBRATION 3
NO TRIBUTARY
LINESINKS

SCALE: 1" = 400'

NORTH 0 200 400 800

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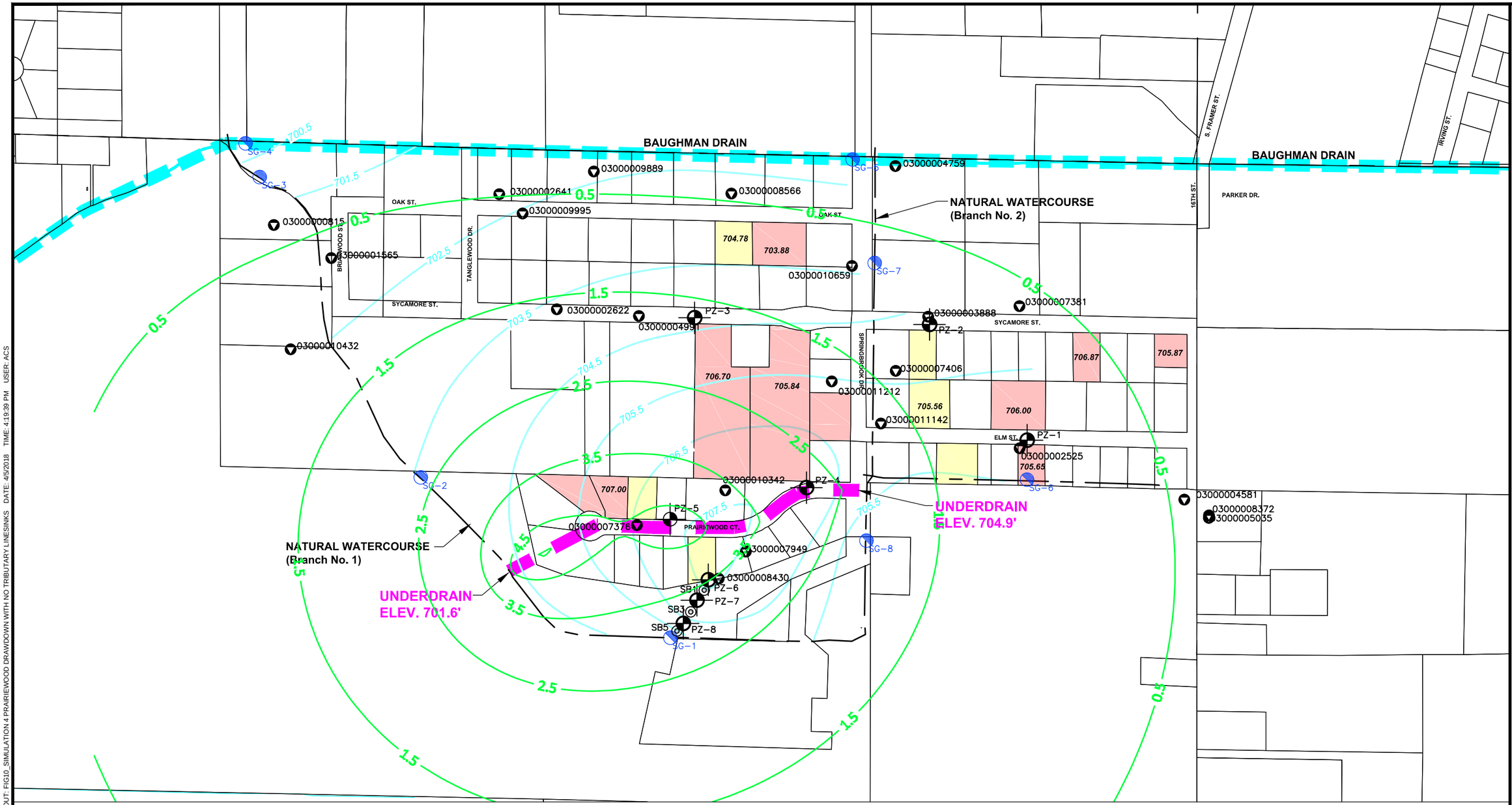
Baughman Drain
Otsego, Allegan County, Micghian
Preliminary Hydrogeological Evaluation

PROJECT NO.
180488

FIGURE NO.
9

PLOT INFO: Z:\2018\180488\CAD\REF\2X001-180488.DWG LAYOUT: FIG09_CALIBRATION 3 NO TRIBUTARY LINESINKS DATE: 3/30/2018 TIME: 11:02:17 AM USER: ACS



LEGEND

- SOIL BORING
- STAFF GAUGE LOCATION
- WATER SUPPLY WELL
- PIEZOMETER LOCATION
- OBSERVED CONTOURS
- SIMULATED DRAWDOWN
- LINESINKS
- PARCELS WITH REPORTS OF CONSISTENT FLOODING
- PARCELS WITH REPORTS OF PERIODIC FLOODING
- *703.88* ESTIMATED BASEMENT ELEVATIONS (FEET AMSL)

BASE MAP ADAPTED FROM DRAWING
PROVIDED BY LRE, 12/19/17
ORTHOPHOTO DATED: 2014

SIMULATION 4 PRAIRIEWOOD CT. DRAWDOWN WITH NO TRIBUTARY LINESINKS

NORTH

SCALE: 1" = 400'

0 200 400 800

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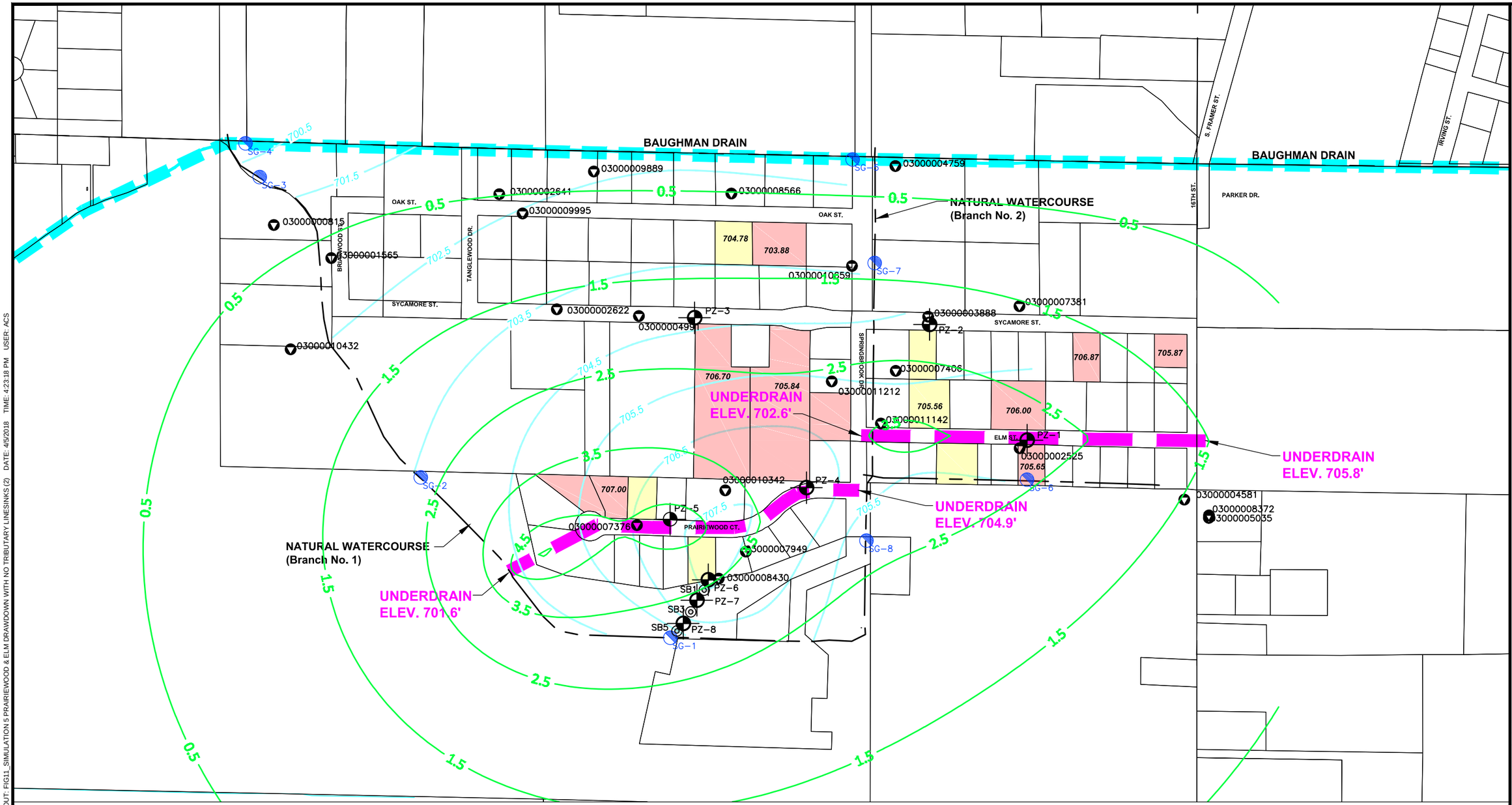
Baughman Drain
Otsego, Allegan County, Micghian
Preliminary Hydrogeological Evaluation

PROJECT NO.
180488

FIGURE NO.
10

PLOT INFO: Z:\2018\180488\CAD\REF\2X001-180488.DWG LAYOUT: FIG10_SIMULATION 4 PRAIRIEWOOD DRAWDOWN WITH NO TRIBUTARY LINESINKS DATE: 4/5/2018 TIME: 4:19:39 PM USER: ACS



LEGEND

- SOIL BORING
- STAFF GAUGE LOCATION
- WATER SUPPLY WELL
- PIEZOMETER LOCATION
- OBSERVED CONTOURS
- SIMULATED DRAWDOWN
- LINESINKS
- PARCELS WITH REPORTS OF CONSISTENT FLOODING
- PARCELS WITH REPORTS OF PERIODIC FLOODING
- *703.88* ESTIMATED BASEMENT ELEVATIONS (FEET AMSL)

BASE MAP ADAPTED FROM DRAWING
PROVIDED BY LRE, 12/19/17
ORTHOPHOTO DATED: 2014

SIMULATION 5 PRAIRIEWOOD CT. & ELM ST. DRAWDOWN WITH NO TRIBUTARY LINESINKS

SCALE: 1" = 400'

NORTH 0 200 400 800

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Hard copy is intended to be 11"x17" when plotted. Scale(s) indicated and graphic quality may not be accurate for any other size.

Baughman Drain
Otsego, Allegan County, Micghian
Preliminary Hydrogeological Evaluation

PROJECT NO.
180488

FIGURE NO.
11

PLOT INFO: Z:\2018\180488\CAD\REF\2X001-180488.DWG LAYOUT: FIG11_SIMULATION 5 PRAIRIEWOOD & ELM DRAWDOWN WITH NO TRIBUTARY LINESINKS (2) DATE: 4/5/2018 TIME: 4:23:18 PM USER: ACS

Appendix 1

BORING PZ-1

PROJECT NAME: Baughman Drain Hydrogeological Evaluation
PROJECT NUMBER: 075655.00
CLIENT: Land & Resource Engineering and Surveying
PROJECT LOCATION: Otsego, Michigan

DATE STARTED: 2/7/17 **COMPLETED:** 2/7/17 **BORING METHOD:** Direct Push
OPERATOR: Nick-Fibertec **RIG NO.:** 7822 DT-1 **LOGGED BY:** AJL **CHECKED BY:** MAV

SURFACE ELEVATION: 712.96 FT

ELEVATION (FEET)	DEPTH (FEET)	PROFILE DESCRIPTION	SAMPLE TYPE/NO.	DRY DENSITY (pcf) -- ■ 90 100 110 120 / MOISTURE & ATTERBERG LIMITS (%) PL MC LL 10 20 30 40	▽ HAND PENE. ⊠ TORVANE SHEAR ○ UNC.COMP. ⊡ VANE SHEAR (PK) × VANE SHEAR (REM) ⊕ TRIAXIAL (UU) SHEAR STRENGTH (KSF) 1 2 3 4	REMARKS
712.7	0	0.3 TOPSOIL	AS1			
			AS2			
710			AS3			
			AS4			
	5		AS5			
			LS1			A piezometer was installed in the borehole. The piezometer screen was set between 6 feet and 11 feet below ground surface.
705						
	10	Fine to Medium SAND- Brown- Moist to Wet (SP)	LS2			
700						
	15		LS3			
695						
	20		LS4			
690						
688.0	25	25.0 END OF BORING AT 25.0 FEET.				
685						
	30					

GROUNDWATER & BACKFILL INFORMATION

	DEPTH (FT)	ELEV (FT)
▽ **DURING BORING:**	6.7	706.3
▼ **AT END OF BORING:**	6.6	706.4

BACKFILL METHOD: Well Installation - Piezometer

NOTES: 1. The indicated stratification lines are approximate. In situ, the transition between materials may be gradual.
4. A soil sample was collected from 7 to 10 feet below ground surface for a grain size analysis.

BORING PZ-2

PROJECT NAME: Baughman Drain Hydrogeological Evaluation
PROJECT NUMBER: 075655.00
CLIENT: Land & Resource Engineering and Surveying
PROJECT LOCATION: Otsego, Michigan

DATE STARTED: 2/7/17 **COMPLETED:** 2/7/17 **BORING METHOD:** Direct Push
OPERATOR: Nick-Fibertec **RIG NO.:** 7822 DT-1 **LOGGED BY:** AJL **CHECKED BY:** MAV

SURFACE ELEVATION: 712.47 FT

ELEVATION (FEET)	DEPTH (FEET)	PROFILE DESCRIPTION	SAMPLE TYPE/NO. INTERVAL
712	0	TOPSOIL	AS1
	1.5		AS2
710			AS3
	5		AS4
			AS5
705 ▽			LS1
	10		
700		Fine to Medium SAND- Brown- Moist to Wet (SP)	LS2
	15		
695			LS3
	20		
690			LS4
	25	25.0	
		END OF BORING AT 25.0 FEET.	
685			
	30		

DRY DENSITY (pcf) -- ■ (90 100 110 120)
MOISTURE & ATTERBERG LIMITS (%) PL MC LL (10 20 30 40)
▽ HAND PENE.
⊠ TORVANE SHEAR
○ UNC.COMP.
⊡ VANE SHEAR (PK)
× VANE SHEAR (REM)
⊕ TRIAXIAL (UU)
SHEAR STRENGTH (KSF) (1 2 3 4)

REMARKS

A piezometer was installed in the borehole. The piezometer screen was set between 6.5 feet and 11.5 feet below ground surface.

GROUNDWATER & BACKFILL INFORMATION

	DEPTH (FT)	ELEV (FT)
▽ **DURING BORING:**	7.1	705.4
▼ **AT END OF BORING:**	7.4	705.1

BACKFILL METHOD: Well Installation - Piezometer

NOTES: 1. The indicated stratification lines are approximate. In situ, the transition between materials may be gradual.
4. A soil sample was collected from 7.5 to 12 feet below ground surface for a grain size analysis.

BORING PZ-3

PROJECT NAME: Baughman Drain Hydrogeological Evaluation
PROJECT NUMBER: 075655.00
CLIENT: Land & Resource Engineering and Surveying
PROJECT LOCATION: Otsego, Michigan

DATE STARTED: 2/7/17 **COMPLETED:** 2/7/17 **BORING METHOD:** Direct Push
OPERATOR: Nick-Fibertec **RIG NO.:** 7822 DT-1 **LOGGED BY:** AJL **CHECKED BY:** MAV

SURFACE ELEVATION: 711.94 FT

ELEVATION (FEET)	DEPTH (FEET)	PROFILE DESCRIPTION	SAMPLE TYPE/NO. INTERVAL	DRY DENSITY (pcf) -- ■ 90 100 110 120 / MOISTURE & ATTERBERG LIMITS (%) PL MC LL 10 20 30 40	▽ HAND PENE. ⊠ TORVANE SHEAR ○ UNC.COMP. ⊡ VANE SHEAR (PK) × VANE SHEAR (REM) ⊕ TRIAXIAL (UU) SHEAR STRENGTH (KSF) 1 2 3 4	REMARKS
711.4	0	0.5 TOPSOIL	AS1			
			AS2			
710			AS3			
			AS4			
	5		AS5			
705 ▼			LS1			A piezometer was installed in the borehole. The piezometer screen was set between 6.5 feet and 11.5 feet below ground surface.
	10	Fine to Medium SAND- Lean Clay Seam from 12.5 to 12.75 Feet- Silty Sand Seam from 18.0 to 18.16 Feet- Brown- Moist to Wet (SP)	LS2			
700						
	15		LS3			
695						
	20		LS4			
690						
686.9	25	25.0 END OF BORING AT 25.0 FEET.				
685						
	30					

GROUNDWATER & BACKFILL INFORMATION

	DEPTH (FT)	ELEV (FT)
▽ **DURING BORING:**	6.8	705.2
▼ **AT END OF BORING:**	6.8	705.2

BACKFILL METHOD: Well Installation - Piezometer

NOTES: 1. The indicated stratification lines are approximate. In situ, the transition between materials may be gradual.

BORING PZ-4

PROJECT NAME: Baughman Drain Hydrogeological Evaluation
PROJECT NUMBER: 075655.00
CLIENT: Land & Resource Engineering and Surveying
PROJECT LOCATION: Otsego, Michigan

DATE STARTED: 2/7/17 **COMPLETED:** 2/7/17 **BORING METHOD:** Direct Push
OPERATOR: Nick-Fibertec **RIG NO.:** 7822 DT-1 **LOGGED BY:** AJL **CHECKED BY:** MAV

SURFACE ELEVATION: 712.2 FT

ELEVATION (FEET)	DEPTH (FEET)	PROFILE DESCRIPTION	SAMPLE TYPE/NO. INTERVAL
710	0	0.5 TOPSOIL 711.7	AS1
			AS2
			AS3
			AS4
			AS5
705	5		LS1
700	10	Fine to Medium SAND- Brown- Moist to Wet (SP)	LS2
695	15		LS3
690	20		LS4
685	25	25.0 687.2 END OF BORING AT 25.0 FEET.	
	30		

DRY DENSITY (pcf) -- ■ (90, 100, 110, 120)
MOISTURE & ATTERBERG LIMITS (%) PL MC LL (10, 20, 30, 40)
▽ HAND PENE. ⊠ TORVANE SHEAR ○ UNC.COMP. ⊡ VANE SHEAR (PK) ⨯ VANE SHEAR (REM) ⊕ TRIAXIAL (UU)
SHEAR STRENGTH (KSF) (1, 2, 3, 4)

REMARKS: A piezometer was installed in the borehole. The piezometer screen was set between 6 feet and 11 feet below ground surface.

GROUNDWATER & BACKFILL INFORMATION

	DEPTH (FT)	ELEV (FT)
▽ **DURING BORING:**	6.5	705.7
▼ **AT END OF BORING:**	6.4	705.9

BACKFILL METHOD: Well Installation - Piezometer

NOTES: 1. The indicated stratification lines are approximate. In situ, the transition between materials may be gradual.

BORING PZ-5

PROJECT NAME: Baughman Drain Hydrogeological Evaluation
PROJECT NUMBER: 075655.00
CLIENT: Land & Resource Engineering and Surveying
PROJECT LOCATION: Otsego, Michigan

DATE STARTED: 2/7/17 **COMPLETED:** 2/7/17 **BORING METHOD:** Direct Push
OPERATOR: Nick-Fibertec **RIG NO.:** 7822 DT-1 **LOGGED BY:** AJL **CHECKED BY:** MAV

SURFACE ELEVATION: 712.06 FT

ELEVATION (FEET)	DEPTH (FEET)	PROFILE DESCRIPTION	SAMPLE TYPE/NO. INTERVAL
710	0	0.5 TOPSOIL 711.6	AS1
			AS2
			AS3
			AS4
	5		AS5
705			LS1
	10		
700		Fine to Medium SAND- Brown- Moist to Wet (SP)	LS2
	15		
695			LS3
	20		
690			LS4
	25	25.0 687.1	
		END OF BORING AT 25.0 FEET.	
685			
	30		

DRY DENSITY (pcf) -- ■ (90 100 110 120)
MOISTURE & ATTERBERG LIMITS (%) PL MC LL (10 20 30 40)
▽ HAND PENE.
⊠ TORVANE SHEAR
○ UNC.COMP.
⊡ VANE SHEAR (PK)
× VANE SHEAR (REM)
⊕ TRIAXIAL (UU)
SHEAR STRENGTH (KSF) (1 2 3 4)

REMARKS

A piezometer was installed in the borehole. The piezometer screen was set between 4.5 feet and 9.5 feet below ground surface.

GROUNDWATER & BACKFILL INFORMATION

	DEPTH (FT)	ELEV (FT)
▽ **DURING BORING:**	5.0	707.1
▼ **AT END OF BORING:**	4.5	707.6

BACKFILL METHOD: Well Installation - Piezometer

NOTES: 1. The indicated stratification lines are approximate. In situ, the transition between materials may be gradual.

BORING PZ-6

PROJECT NAME: Baughman Drain Hydrogeological Evaluation
PROJECT NUMBER: 075655.00
CLIENT: Land & Resource Engineering and Surveying
PROJECT LOCATION: Otsego, Michigan

DATE STARTED: 2/7/17 **COMPLETED:** 2/7/17 **BORING METHOD:** Direct Push
OPERATOR: Nick-Fibertec **RIG NO.:** 7822 DT-1 **LOGGED BY:** AJL **CHECKED BY:** MAV

SURFACE ELEVATION: 712.59 FT

ELEVATION (FEET)	DEPTH (FEET)	PROFILE DESCRIPTION	SAMPLE TYPE/NO. INTERVAL
712.59	0		
	1.0	TOPSOIL	AS1
711.6			AS2
710			AS3
			AS4
	5		AS5
705			LS1
	10		
700		Fine SAND with Silt- Brown- Moist to Wet (SP-SM)	LS2
	15		
695			LS3
	20		
690			LS4
687.6	25		
		END OF BORING AT 25.0 FEET.	
685			
	30		

DRY DENSITY (pcf) -- ■ (90 100 110 120)
MOISTURE & ATTERBERG LIMITS (%) PL MC LL (10 20 30 40)
▽ HAND PENE. ⊠ TORVANE SHEAR ○ UNC.COMP. ⊡ VANE SHEAR (PK) ⨯ VANE SHEAR (REM) ⊕ TRIAXIAL (UU)
SHEAR STRENGTH (KSF) (1 2 3 4)

REMARKS

A piezometer was installed in the borehole. The piezometer screen was set between 4 feet and 9 feet below ground surface.

GROUNDWATER & BACKFILL INFORMATION

	DEPTH (FT)	ELEV (FT)
▽ **DURING BORING:**	4.9	707.7
▼ **AT END OF BORING:**	4.5	708.1

BACKFILL METHOD: Well Installation - Piezometer

NOTES: 1. The indicated stratification lines are approximate. In situ, the transition between materials may be gradual.
4. A soil sample was collected from 5 to 10 feet below ground surface for a grain size analysis.

BORING SB 1

PROJECT NAME: Baughman Drain Supplemental Hydrogeo
PROJECT NUMBER: 077821.00
CLIENT: Land & Resource Engineering and Surveying, Inc.
PROJECT LOCATION: Otsego, Michigan

DATE STARTED: 11/22/17 **COMPLETED:** 11/22/17 **BORING METHOD:** Direct Push
OPERATOR: Fibertec **RIG NO.:** 7822 DT-1 **LOGGED BY:** AJL **CHECKED BY:** MAV

DEPTH (FEET)	SYMBOLIC PROFILE	PROFILE DESCRIPTION	SAMPLE TYPE/NO. INTERVAL	RECOVERY (inches)	PID (ppm)	SOIL ANALYTICAL SAMPLE	REMARKS
0		TOPSOIL- SILTY SAND with Organics and Root Fibers- Black- Moist (SM)					
2.0			LS1	38			
5		Fine to Medium SAND- Brown- Moist to Wet (SP)	LS2	48			
10			LS3	31			
15.0			LS4	33			
20		Fine SAND- Brown- Wet (SP)	LS5	42			
25.0		END OF BORING AT 25.0 FEET.					
30							

GROUNDWATER & BACKFILL INFORMATION

	DEPTH (FT)
▽ **DURING BORING:**	4.5
▼ **AT END OF BORING:**	4.6

BACKFILL METHOD: Soil Cuttings

NOTES:
1. Soil samples were classified according to ASTM D2488, Standard Practice for Description and Identification of Soils (Visual-Manual Procedure) for environmental purposes only. Therefore, the boring logs and associated report(s) should not be used for geotechnical evaluation or design.
2. The indicated stratification lines are approximate. In situ, the transition between materials may be gradual.
3. Listed depths under the profile description are rounded to the nearest tenth of a foot (e.g. 5.75 = 5.8). Refer to the report and attachments for actual sample depths and/or intervals (where applicable).

BORING SB 2/PZ-7

PROJECT NAME: Baughman Drain Supplemental Hydrogeo
PROJECT NUMBER: 077821.00
CLIENT: Land & Resource Engineering and Surveying, Inc.
PROJECT LOCATION: Otsego, Michigan

DATE STARTED: 11/22/17 **COMPLETED:** 11/22/17 **BORING METHOD:** Direct Push
OPERATOR: Fibertec **RIG NO.:** 7822 DT-1 **LOGGED BY:** AJL **CHECKED BY:** MAV

DEPTH (FEET)	PROFILE DESCRIPTION	SAMPLE TYPE/NO. INTERVAL	RECOVERY (inches)	PID (ppm)	SOIL ANALYTICAL SAMPLE	REMARKS
0	TOPSOIL- SILTY SAND with Organics and Root Fibers- Black- Moist (SM)					
1.0		LS1	38			A piezometer was installed in the borehole. The piezometer screen was set between 3 feet and 8 feet below the ground surface.
5		LS2	48			
10	Fine to Medium SAND- Brown- Moist to Wet (SP)	LS3	29			
15		LS4	42			
19.0						
19.3	Sandy LEAN CLAY- Brown (CL)					
20	Fine SAND- Brown- Wet (SP)	LS5	36			
25.0						
25	END OF BORING AT 25.0 FEET.					
30						

GROUNDWATER & BACKFILL INFORMATION

	DEPTH (FT)
▽ **DURING BORING:**	4.8
▼ **AT END OF BORING:**	4.8

BACKFILL METHOD: Well Installation - Piezometer

NOTES:
1. Soil samples were classified according to ASTM D2488, Standard Practice for Description and Identification of Soils (Visual-Manual Procedure) for environmental purposes only. Therefore, the boring logs and associated report(s) should not be used for geotechnical evaluation or design.
2. The indicated stratification lines are approximate. In situ, the transition between materials may be gradual.
3. Listed depths under the profile description are rounded to the nearest tenth of a foot (e.g. 5.75 = 5.8). Refer to the report and attachments for actual sample depths and/or intervals (where applicable).

BORING SB 3

PROJECT NAME: Baughman Drain Supplemental Hydrogeo
PROJECT NUMBER: 077821.00
CLIENT: Land & Resource Engineering and Surveying, Inc.
PROJECT LOCATION: Otsego, Michigan

DATE STARTED: 11/22/17 **COMPLETED:** 11/22/17 **BORING METHOD:** Direct Push
OPERATOR: Fibertec **RIG NO.:** 7822 DT-1 **LOGGED BY:** AJL **CHECKED BY:** MAV

DEPTH (FEET)	SYMBOLIC PROFILE	PROFILE DESCRIPTION	SAMPLE TYPE/NO. INTERVAL	RECOVERY (inches)	PID (ppm)	SOIL ANALYTICAL SAMPLE	REMARKS
0		TOPSOIL- SILTY SAND with Organics and Root Fibers- Black- Moist (SM)					
1.5			LS1	37			
5		Fine to Medium SAND- Brown- Moist to Wet (SP)	LS2	49			
10			LS3	40			
14.0							
15		Silty LEAN CLAY- Gray (CL)	LS4	50			
19.8							
20		Fine SAND- Brown- Wet (SP)	LS5	37			
25.0							
25		END OF BORING AT 25.0 FEET.					
30							

GROUNDWATER & BACKFILL INFORMATION

	DEPTH (FT)
▽ **DURING BORING:**	4.9
▼ **AT END OF BORING:**	5.0

BACKFILL METHOD: Soil Cuttings

NOTES:
1. Soil samples were classified according to ASTM D2488, Standard Practice for Description and Identification of Soils (Visual-Manual Procedure) for environmental purposes only. Therefore, the boring logs and associated report(s) should not be used for geotechnical evaluation or design.
2. The indicated stratification lines are approximate. In situ, the transition between materials may be gradual.
3. Listed depths under the profile description are rounded to the nearest tenth of a foot (e.g. 5.75 = 5.8). Refer to the report and attachments for actual sample depths and/or intervals (where applicable).

BORING SB 4/PZ-8

PROJECT NAME: Baughman Drain Supplemental Hydrogeo
PROJECT NUMBER: 077821.00
CLIENT: Land & Resource Engineering and Surveying, Inc.
PROJECT LOCATION: Otsego, Michigan

DATE STARTED: 11/22/17 **COMPLETED:** 11/22/17 **BORING METHOD:** Direct Push
OPERATOR: Fibertec **RIG NO.:** 7822 DT-1 **LOGGED BY:** AJL **CHECKED BY:** MAV

DEPTH (FEET)	SYMBOLIC PROFILE	PROFILE DESCRIPTION	SAMPLE TYPE/NO. INTERVAL	RECOVERY (inches)	PID (ppm)	SOIL ANALYTICAL SAMPLE	REMARKS
0		TOPSOIL- SILTY SAND with Organics and Root Fibers- Black- Moist (SM)					
2.0			LS1	38			A piezometer was installed in the borehole. The piezometer screen was set between 4 feet and 9 feet below the ground surface.
5		Fine to Medium SAND- Brown- Moist to Wet (SP)	LS2	45			
10							
12.5			LS3	38			
15		Silty LEAN CLAY- Gray (CL)	LS4	44			
19.8							
20		Fine SAND- Brown- Wet (SP)	LS5	28			
25.0							
25		END OF BORING AT 25.0 FEET.					
30							

GROUNDWATER & BACKFILL INFORMATION

	DEPTH (FT)
▽ **DURING BORING:**	5.5
▼ **AT END OF BORING:**	6.0

BACKFILL METHOD: Well Installation - Piezometer

NOTES:
1. Soil samples were classified according to ASTM D2488, Standard Practice for Description and Identification of Soils (Visual-Manual Procedure) for environmental purposes only. Therefore, the boring logs and associated report(s) should not be used for geotechnical evaluation or design.
2. The indicated stratification lines are approximate. In situ, the transition between materials may be gradual.
3. Listed depths under the profile description are rounded to the nearest tenth of a foot (e.g. 5.75 = 5.8). Refer to the report and attachments for actual sample depths and/or intervals (where applicable).

BORING SB 5

PROJECT NAME: Baughman Drain Supplemental Hydrogeo
PROJECT NUMBER: 077821.00
CLIENT: Land & Resource Engineering and Surveying, Inc.
PROJECT LOCATION: Otsego, Michigan

DATE STARTED: 11/22/17 **COMPLETED:** 11/22/17 **BORING METHOD:** Direct Push
OPERATOR: Fibertec **RIG NO.:** 7822 DT-1 **LOGGED BY:** AJL **CHECKED BY:** MAV

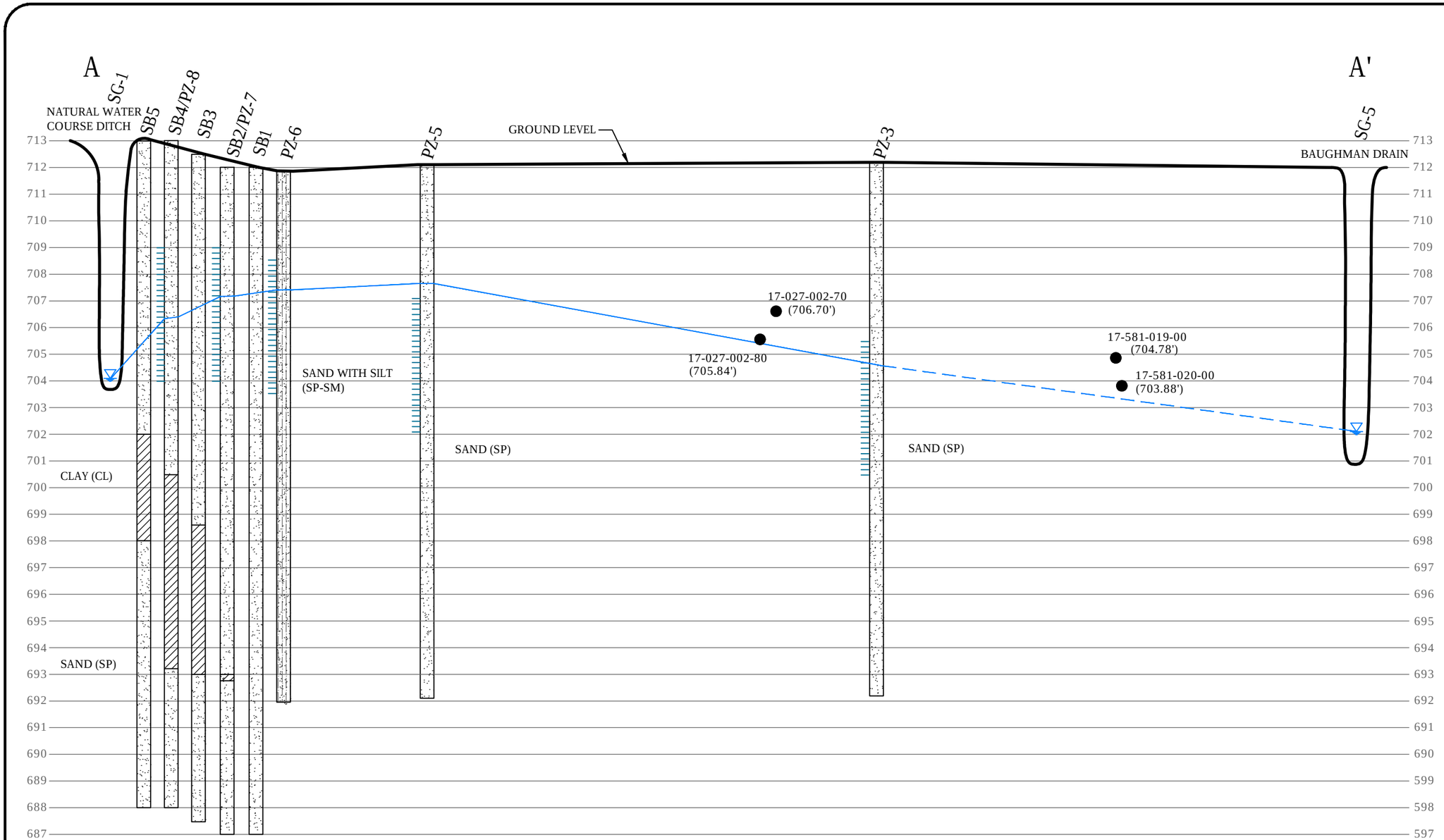
DEPTH (FEET)	SYMBOLIC PROFILE	PROFILE DESCRIPTION	SAMPLE TYPE/NO. INTERVAL	RECOVERY (inches)	PID (ppm)	SOIL ANALYTICAL SAMPLE	REMARKS
0		TOPSOIL- SILTY SAND with Organics and Root Fibers- Black- Moist (SM)					
1.5			LS1	38			
5		Fine to Medium SAND- Brown- Moist to Wet (SP)					
▽			LS2	36			
10							
11.0			LS3	33			
		Silty LEAN CLAY- Gray (CL)					
15							
15.0			LS4	46			
20		Fine SAND- Brown- Wet (SP)					
			LS5	35			
25.0							
25		END OF BORING AT 25.0 FEET.					
30							

GROUNDWATER & BACKFILL INFORMATION

	DEPTH (FT)
▽ **DURING BORING:**	7.0

BACKFILL METHOD: Soil Cuttings

NOTES:
1. Soil samples were classified according to ASTM D2488, Standard Practice for Description and Identification of Soils (Visual-Manual Procedure) for environmental purposes only. Therefore, the boring logs and associated report(s) should not be used for geotechnical evaluation or design.
2. The indicated stratification lines are approximate. In situ, the transition between materials may be gradual.
3. Listed depths under the profile description are rounded to the nearest tenth of a foot (e.g. 5.75 = 5.8). Refer to the report and attachments for actual sample depths and/or intervals (where applicable).



LEGEND

- CLAY
- SAND
- SAND WITH SILT
- WELL SCREEN INTERVAL
- GROUNDWATER ELEVATION DECEMBER 6, 2017
- 17-027-002-80 (705.84) PARCEL ID NUMBER (BASEMENT FLOOR ELEVATION)

SCALE

VERTICAL: 1" = 1'
HORIZONTAL: 1" = 200'

SME
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Project
BAUGHMAN DRAIN HYDROGEOLOGIC EVALUATION

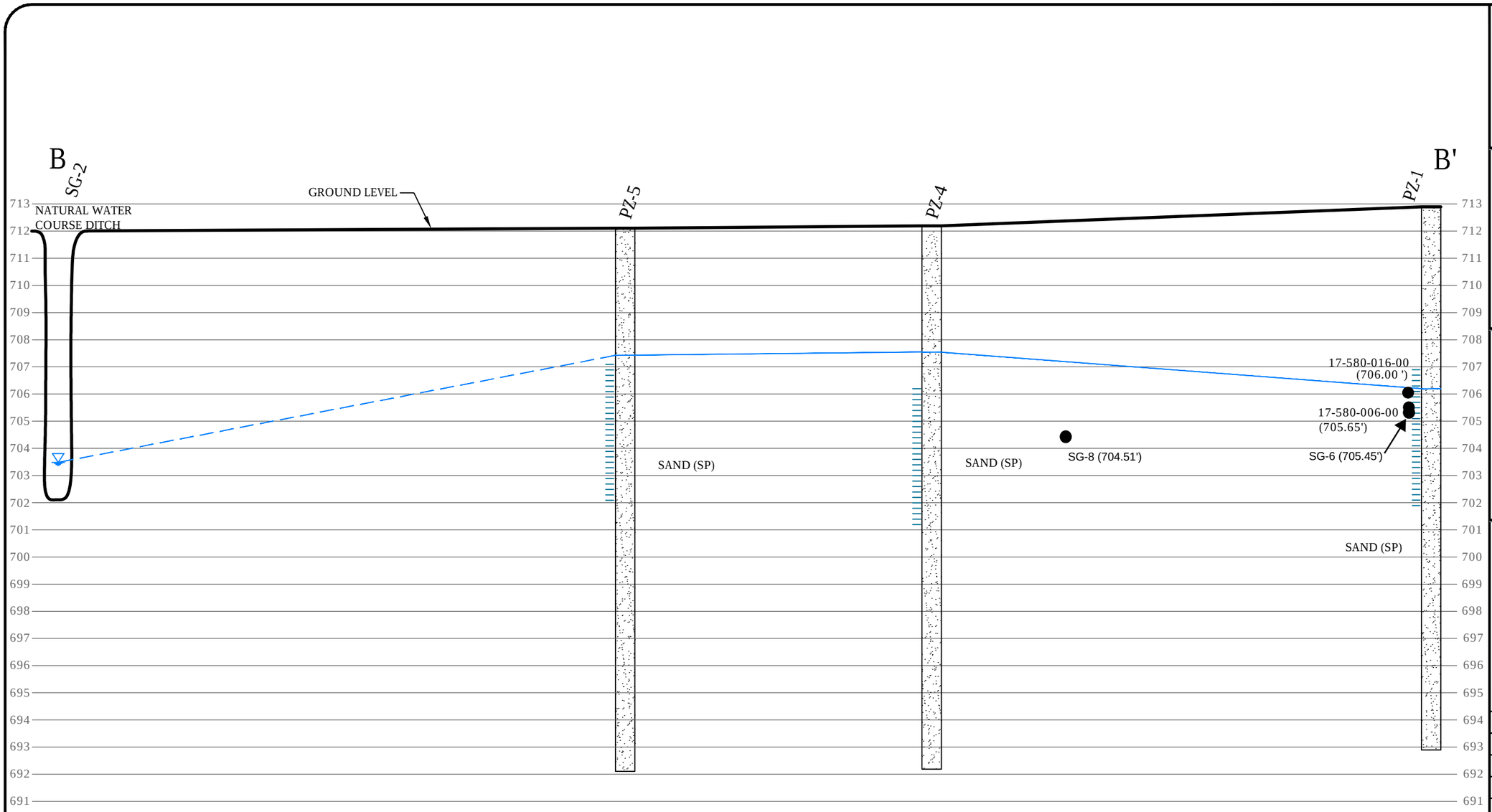
Project Location
OTSEGO, ALLEGAN COUNTY, MICHIGAN

Sheet Name
GEOLOGICAL CROSS-SECTION A-A'

No.	Revision Date

Date: 7-21-17
CADD: JAB
Designer: AJL
Scale: AS SHOWN
Project: 077821.00
Figure No.: 3

PLOT DATE: Dec 19, 2017 - 2:34pm - jblake
FILE LOCATION: \\Sme-inc\pz\WIP\077821.00\CAD\DWGS\rev0\077821.00-XS.dwg



LEGEND

SAND

WELL SCREEN INTERVAL

GROUNDWATER ELEVATION
DECEMBER 6, 2017

17-580-016-00 (705.84) PARCEL ID NUMBER (BASEMENT FLOOR ELEVATION)

SCALE

VERTICAL: 1" = 1'
HORIZONTAL: 1" = 200'

SME
www.sme-usa.com

Project
BAUGHMAN DRAIN HYDROGEOLOGIC EVALUATION

Project Location
OTSEGO, ALLEGAN COUNTY, MICHIGAN

Sheet Name
GEOLOGICAL CROSS-SECTION B-B'

No.	Revision Date

Date 12-19-17
CADD JAB
Designer AJL
Scale AS SHOWN
Project 077821.00
Figure No. 4

PLOT DATE: Dec 19, 2017 - 2:23pm - jblake FILE LOCATION: \\Sme-inc\pz\WIP\077821.00\CAD\DWGS\rev0\077821.00-XS.dwg

Appendix 2

Water Well And Pump Record

Completion is required under authority of Part 127 Act 368 PA 1978.
Failure to comply is a misdemeanor.

Import ID:

Wellogic

Tax No:	Permit No.	County: Allegan			Township: Otsego
		Town/Range: 01N 12W	Section: 27	Well Status: Active	WSSN:

Source ID/Well No:

Well ID: 03000010342

Elevation:

Latitude: 42.44032

Longitude: -85.70762

Method of Collection: GPS Std Positioning Svc SA Off

Distance and Direction from Road Intersection:
1/10 MILE W OF SPRING BROOK DR & 150' N PRAIRIEWOOD CT

Well Owner: KOZAR CONSTRUCTION

Well Address:	Owner Address:
1671 PRAIRIEWOOD CT OTSEGO, MI	1290 HOLIDAY LANE PORTAGE, MI 49024

Drilling Method: Rotary
Well Depth: 87.00 ft
Well Use: Household
Well Type: New
Date Completed: 1/18/2008

Casing Type: PVC plastic
Height:
Casing Joint: Solvent welded/glued
Casing Fitting: None

Diameter: 5.00 in. to 81.00 ft. depth SDR: 21.00

Borehole: 8.75 in. to 87.00 ft. depth

Pump Installed: Yes
Pump Installation Only: No
Pump Installation Date: 1/18/2008
HP: 1.00
Manufacturer: Grundfos
Pump Type: Submersible
Model Number: 22SQE10C15
Pump Capacity: 22 GPM
Drop Pipe Length: 45.00 ft
Pump Voltage:
Drop Pipe Diameter: 1.25 in.
Drilling Record ID:
Draw Down Seal Used: No

Pressure Tank Installed: Yes
Pressure Tank Type: Diaphragm/Bladder
Manufacturer: Well-X-Trol
Model Number: WX101
Tank Capacity: 7.0 Gallons
Pressure Relief Valve Installed: Yes

Static Water Level: 8.00 ft. Below Grade
Well Yield Test:
Yield Test Method: Air
Pumping level 20.00 ft. after 1.00 hrs. at 50 GPM

Formation Description	Thickness	Depth to Bottom
Sand	8.00	8.00
Sand & Gravel	32.00	40.00
Gray Clay	12.00	52.00
Gray Clay & Gravel	6.00	58.00
Sand & Gravel Water Bearing	29.00	87.00

Screen Installed: Yes
Filter Packed: Yes
Screen Diameter: 5.00 in.
Blank:
Screen Material Type: PVC slotted

Slot	Length	Set Between
15.00	6.00 ft.	81.00 ft. and 87.00 ft.

Fittings: Neoprene packer

Well Grouted: Yes
Grouting Method: Tremie

Grouting Material	Bags	Additives	Depth
Bentonite slurry	78.00	None	0.00 ft. to 79.00 ft.

Wellhead Completion: Pitless adapter

Geology Remarks:

Nearest Source of Possible Contamination

Type	Distance	Direction
Sewer line	30 ft.	South

Drilling Machine Operator Name: MITCH VICKERY
Employment: Employee
Pump Installer: GARY COBURN
Contractor Type: Water Well Drilling Contractor
Reg No: 03 1601
Business Name: DRAAI WELL DRILLING
Business Address:

Water Well Contractor's Certification

This well was drilled under my supervision and this report is true to the best of my knowledge and belief.

Signature of Registered Contractor
Date

General Remarks:

Other Remarks

Water Well And Pump Record

Completion is required under authority of Part 127 Act 368 PA 1978.
Failure to comply is a misdemeanor

Wellogic

Import ID:

Tax No:	Permit No:	County: Allegan			Township: Otsego
		Town/Range: 01N 12W	Section: 27	Well Status:	WSSN:	Source ID:Well No:

Well ID: 03000000815

Elevation:

Latitude: 42.449199

Longitude: -85.714451

Method of Collection Address Matching-House Number

Distance and Direction from Road Intersection:
About 1/10 mile east of Primewood Dr. or Fairway Ln

Well Owner: Jim Forder

Well Address:	Owner Address:
1796 Fairway Ln. Otsego, MI	1796 Fairway Ln. Otsego MI

Drilling Method: Cable Tool
Well Depth: 40.00 ft. **Well Use:** Household
Well Type: New **Date Completed:** 4/14/2000

Casing Type: Steel - black **Height:**
Casing Joint: Threaded & coupled
Casing Fitting: Other

Diameter 4.00 in. to 36.00 ft. depth

Borehole:

Pump Installed: Yes **Pump Installation Only:** No
Pump Installation Date: **HP:** 1.00
Manufacturer: Sta-Rite **Pump Type:** Submersible
Model Number: **Pump Capacity:** 20 GPM
Drop Pipe Length: 25.00 ft **Pump Voltage:**
Drop Pipe Diameter: **Drilling Record ID:**
Draw Down Seal Used: No

Pressure Tank Installed: Yes
Pressure Tank Type: Unknown
Manufacturer: Well-X-Trol
Model Number: WX 203 **Tank Capacity:** 32.0 Gallons
Pressure Relief Valve Installed: No

Static Water Level: 14.00 ft. Below Grade
Well Yield Test: **Yield Test Method:** Plunger
Pumping level 14.00 ft. after 0.50 hrs. at 20 GPM

Formation Description	Thickness	Depth to Bottom
Sand	5.00	5.00
Sand W/Stones	10.00	15.00
Sand Fine Water Bearing	25.00	40.00

Screen Installed: Yes **Filter Packed:** No
Screen Diameter: 3.00 in **Blank:** 1.00 ft. Above
Screen Material Type:

Slot	Length	Set Between
7.00	4.00 ft	36.00 ft. and 40.00 ft.

Fittings: Bottom plug

Well Grouted: Yes **Grouting Method:** Unknown

Grouting Material	Bags	Additives	Depth
Bentonite slurry	3.00	None	0.00 ft. to 25.00 ft.

Wellhead Completion: Pitless adapter, 12 inches above grade

Geology Remarks:

Nearest Source of Possible Contamination:

Type	Distance	Direction
Septic tank	75 ft.	North

Drilling Machine Operator Name: Mark
Employment: Employee

Contractor Type: Water Well Drilling Contractor **Reg No:** 30 1038
Business Name: Loversee Well Drilling Inc.
Business Address: 9377 West F Ave, Kalamazoo, MI

Water Well Contractor's Certification

This well was drilled under my supervision and this report is true to the best of my knowledge and belief.

Signature of Registered Contractor **Date**

General Remarks: Screen type: stainless steel
Other Remarks: Casing Fitting Drive coupling

Water Well And Pump Record

Completion is required under authority of Part 127 Act 368 PA 1978.
Failure to comply is a misdemeanor.

Wellogic

Import ID:

Tax No:	Permit No:	County: Allegan			Township: Otsego	
		Town/Range: 01N 12W	Section: 27	Well Status: Active	WSSN:	Source ID/Well No:

Well ID: 03000001565

Elevation:
Latitude: 42.44683103
Longitude: -85.71359152
Method of Collection: Interpolation-Map

Distance and Direction from Road Intersection:
30 FEET WEST OF BRIARWOOD; 40 FEET SOUTH OF OAK

Well Owner: BRUCE MILLS

Well Address:	Owner Address:
396 BRIARWOOD OTSEGO, MI	396 BRIARWOOD OTSEGO, MI

Drilling Method: Cable Tool
Well Depth: 45.00 ft. Well Use: Household
Well Type: New Date Completed: 5/20/2000

Casing Type: Steel - black Height:
Casing Joint: Threaded & coupled
Casing Fitting: Drive shoe

Diameter: 4.00 in. to 40.00 ft. depth

Borehole:

Pump Installed: Yes Pump Installation Only: No
Pump Installation Date: HP: 1.00
Manufacturer: Flint & Walling Pump Type: Submersible
Model Number: 4F27A10305 Pump Capacity: 27 GPM
Drop Pipe Length: 26.00 ft Pump Voltage:
Drop Pipe Diameter Drilling Record ID:
Draw Down Seal Used: No

Pressure Tank Installed: Yes
Pressure Tank Type: Unknown
Manufacturer: Well-X-Trol
Model Number: WX251 Tank Capacity: 19.2 Gallons
Pressure Relief Valve Installed: No

Static Water Level: 10.00 ft. Below Grade
Well Yield Test: Yield Test Method: Plunger
Pumping level 40.00 ft. after 1.00 hrs. at 35 GPM

Formation Description	Thickness	Depth to Bottom
Sand & Clay	5.00	5.00
Sand Coarse	34.00	39.00
Sand & Gravel	6.00	45.00

Screen Installed: Yes Filter Packed: No
Screen Diameter: 2.00 in. Blank: 1.00 ft. Above
Screen Material Type: Stainless steel w rn wrapped

Slot	Length	Set Between
10.00	5.00 ft.	40.00 ft. and 45.00 ft

Fittings: Neoprene packer

Well Grouted: Yes Grouting Method: Unknown

Grouting Material	Bags	Additives	Depth
Bentonite dry granular	20.00	None	1.00 ft. to 40.00 ft.

Wellhead Completion: Pitless adapter

Geology Remarks:

Nearest Source of Possible Contamination

Type	Distance	Direction
Septic tank	75 ft.	Northwest

Drilling Machine Operator Name:
Employment: Unknown

Contractor Type: Water Well Drilling Contractor Reg No: 03-1203
Business Name: RICK MILLER WELL DRILLING CO
Business Address:

Water Well Contractor's Certification

This well was drilled under my supervision and this report is true to the best of my knowledge and belief

Signature of Registered Contractor Date

General Remarks:
Other Remarks:

Water Well And Pump Record

Completion is required under authority of Part 127 Act 368 PA 1978.
Failure to comply is a misdemeanor.

Wellogic

Import ID:

Tax No:	Permit No:	County: Allegan			Township: Otsego	
		Town/Range: 01N 12W	Section: 27	Well Status: Active	WSSN:	Source ID/Well No:

Well ID: 03000002525

Elevation:

Latitude: 42.44864036

Longitude: -85.7032122

Method of Collection: Interpolation-Map

Distance and Direction from Road Intersection:
1/10 MILE WEST ON ELM FROM 16TH

Well Owner: HELEN ROBERTS

Well Address:	Owner Address:
1620 ELM STREET OTSEGO MI	1620 ELM STREET OTSEGO, MI

Drilling Method: Cable Tool
Well Depth: 40.00 ft
Well Use: Household
Well Type: Replacement
Date Completed: 5/31/2001

Casing Type: Steel black
Height:
Casing Joint: Threaded & coupled
Casing Fitting: None

Diameter: 4.00 in. to 36.00 ft. depth

Borehole: 7.00 in. to 25.00 ft. depth

Pump Installed: Yes
Pump Installation Only: No
Pump Installation Date:
HP: 0.5H
Manufacturer: General
Pump Type: Submersible
Model Number:
Pump Capacity: 10 GPM
Drop Pipe Length: 28.00 ft
Pump Voltage:
Drop Pipe Diameter:
Drilling Record ID:
Draw Down Seal Used: No

Pressure Tank Installed: Yes
Pressure Tank Type: Unknown
Manufacturer: Well X Trol
Model Number: 203
Tank Capacity: 1.0 Gallons
Pressure Relief Valve Installed: No

Static Water Level: 7.00 ft Below Grade
Well Yield Test:
Yield Test Method: Other
Pumping level 14.00 ft. after 1.00 hrs. at 40 GPM

Formation Description	Thickness	Depth to Bottom
Topsoil	1.00	1.00
Sand & Gravel	7.00	8.00
Sand & Clay	20.00	28.00
Sand Medium	12.00	40.00

Screen Installed: Yes
Filter Packed: No
Screen Diameter: 3.00 in.
Blank: 1.00 ft Above
Screen Material Type: Stainless steel wire wrapped

Slot	Length	Set Between
10.00	4.00 ft	36.00 ft. and 40.00 ft

Fittings: Neoprene packer

Well Grouted: Yes
Grouting Method: Unknown

Grouting Material	Bags	Additives	Depth
Bentonite dry granular	4.00	None	0.00 ft. to 30.00 ft

Geology Remarks:

Wellhead Completion: Pitless adapter, 12 inches above grade

Nearest Source of Possible Contamination:

Type	Distance	Direction
Septic tank	84 ft.	South

Drilling Machine Operator Name: KAL LOVETT
Employment: Employee

Contractor Type: Water Well Drilling Contractor
Reg No: 03-1984
Business Name: LOVETT WELL DRLG
Business Address:

Abandoned Well Plugged: Yes

Casing Removed:

Water Well Contractor's Certification

This well was drilled under my supervision and this report is true to the best of my knowledge and belief

Signature of Registered Contractor
Date

General Remarks:

Other Remarks: Yield Test Method PLUNGER & TEST PUMP -20

Water Well And Pump Record

Completion is required under authority of Part 127 Act 368 PA 1978
Failure to comply is a misdemeanor

Wellogic

Import ID:

Tax No:	Permit No:	County: Allegan			Township: Otsego	
		Town/Range: 01N 12W	Section: 27	Well Status: Active	WSSN:	Source ID/Well No:

Well ID: 03000002622

Elevation:

Latitude: 42.4463029

Longitude: -85.71019349

Method of Collection: Address Matching-House Number

Distance and Direction from Road Intersection:
0.15 mile west of Springbrook Dr ; 55' north of Sycamore

Well Owner: Dennis Massengill

Well Address:	Owner Address:
1679 Sycamore Otsego, MI 49078	1679 Sycamore Otsego, MI 49078

Drilling Method: Cable Tool
Well Depth: 51.00 ft. Well Use: Household
Well Type: Replacement Date Completed: 4/26/2001

Casing Type: Steel - black Height:
Casing Joint: Threaded & coupled
Casing Fitting: Drive shoe

Diameter: 4.00 in. to 46.00 ft. depth

Borehole: 4.00 in. to 51.00 ft. depth

Pump Installed: Yes Pump Installation Only: No
Pump Installation Date: HP: 1.00
Manufacturer: Flint & Walling Pump Type: Submersible
Model Number: 4F10S10S5 Pump Capacity: 10 GPM
Drop Pipe Length: 36.00 ft. Pump Voltage:
Drop Pipe Diameter: Drilling Record ID:
Draw Down Seal Used: No

Pressure Tank Installed: Yes
Pressure Tank Type: Unknown
Manufacturer: Well X Trol
Model Number: 251 Tank Capacity:
Pressure Relief Valve Installed: No

Static Water Level: 9.00 ft. Below Grade
Well Yield Test: Yield Test Method: Plunger
Pumping level 41.00 ft. after 1.00 hrs. at 30 GPM

Formation Description	Thickness	Depth to Bottom
Clay W/Gravel	5.00	5.00
Sand	41.00	46.00
Gravel W/Sand	5.00	51.00

Screen Installed: Yes Filter Packed: No
Screen Diameter: 3.00 in. Blank: 1.00 ft. to
Screen Material Type: Stainless steel-wire wrapped

Slot	Length	Set Between
10.00	5.00 ft	46.00 ft. and 51.00 ft.

Fittings: Neoprene packer

Well Grouted: Yes Grouting Method: Unknown

Grouting Material	Bags	Additives	Depth
Bentonite dry granular	5.00	None	1.00 ft. to 46.00 ft.

Wellhead Completion: Pitless adapter, 12 inches above grade

Geology Remarks:

Nearest Source of Possible Contamination:

Type	Distance	Direction
Septic tank	100 ft.	North

Drilling Machine Operator Name:
Employment: Unknown

Contractor Type: Water Well Drilling Contractor Reg No: 03-1203
Business Name: Rick Miller Well Drilling Co.
Business Address:

Abandoned Well Plugged: Yes

Casing Removed:

Water Well Contractor's Certification

This well was drilled under my supervision and this report is true to the best of my knowledge and belief.

Signature of Registered Contractor Date

General Remarks:

Other Remarks:

Water Well And Pump Record

Completion is required under authority of Part 127 Act 368 PA 1978.
Failure to comply is a misdemeanor.

Wellogic

Import ID:

Tax No:	Permit No:	County: Allegan	Township: Otsego

Town/Range:	Section:	Well Status:	WSSN:	Source ID/Well No:
01N 12W	27	Active		

Well ID: 03000002641

Elevation:

Latitude: 42.44357086

Longitude: -85.71108614

Method of Collection: Address Matching-House Number

Distance and Direction from Road Intersection:
1 MILE WEST OF SPRINGBROOK 60 FEET NORTH OF OAK STREET

Well Owner: Ken Klump

Well Address:	Owner Address:
1689 Oak St. Otsego MI 49078	1689 Oak St. Otsego , MI 49078

Drilling Method: Cable Tool
Well Depth: 42.00 ft Well Use: Household
Well Type: Replacement Date Completed: 1/5/2001

Casing Type: Steel black Height:
Casing Joint: Threaded & coupled
Casing Fitting: Drive shoe

Diameter: 4.00 in to 37.00 ft depth

Borehole:

Pump Installed: Yes Pump Installation Only: No
Pump Installation Date: HP: 0.50
Manufacturer: Flint & Walling Pump Type: Submersible
Model Number: 4T10SC5305 Pump Capacity: 10 GPM
Drop Pipe Length: 25.00 ft. Pump Voltage:
Drop Pipe Diameter: Drilling Record ID:
Draw Down Seal Used: No

Pressure Tank Installed: Yes
Pressure Tank Type: Unknown
Manufacturer: Well X Trol
Model Number: 203 Tank Capacity: 9.9 Gallons
Pressure Relief Valve Installed: No

Static Water Level: 12.00 ft Below Grade
Well Yield Test: Yield Test Method: Plunger
Pumping level 30.00 ft after 1.00 hrs. at 35 GPM

Formation Description	Thickness	Depth to Bottom
Sand & Gravel	36.00	36.00
Gravel	6.00	42.00

Screen Installed: Yes Filter Packed: No
Screen Diameter: 3.00 in Blank: 1.00 ft Above
Screen Material Type: Stainless steel wire wrapped

Slot	Length	Set Between
10.00	5.00 ft	37.00 ft. and 42.00 ft.

Fittings: None

Well Grouted: Yes Grouting Method: Unknown

Grouting Material	Bags	Additives	Depth
Bentonite slurry	5.00	None	1.00 ft. to 35.00 ft.

Wellhead Completion: Pitless adapter, 12 inches above grade

Geology Remarks:

Nearest Source of Possible Contamination:

Type	Distance	Direction
Septic tank	100 ft.	North

Drilling Machine Operator Name:
Employment: Unknown

Contractor Type: Water Well Drilling Contractor Reg No: 03-2113
Business Name: Rick Miller Drilling Co.
Business Address:

Abandoned Well Plugged: Yes

Casing Removed:

Water Well Contractor's Certification

This well was drilled under my supervision and this report is true to the best of my knowledge and belief

Signature of Registered Contractor Date

General Remarks:
Other Remarks:

Water Well And Pump Record

Completion is required under authority of Part 127 Act 368 PA 1978.
Failure to comply is a misdemeanor.

Wellogic

Import ID:

Tax No:	Permit No:	County: Allegan			Township: Otsego	
		Town/Range: 01N 12W	Section: 27	Well Status: Active	WSSN:	Source ID/Well No:

Well ID: 03000003888

Elevation:

Latitude: 42.44928673

Longitude: -85.70461808

Method of Collection: Address Matching-House Number

Distance and Direction from Road Intersection:
APPROX 1/2 MILE WEST 16TH ST, 100 FEET SOUTH SYCAMORE ST

Well Owner: JAY GOSWICK

Well Address:	Owner Address:
1644 SYCAMORE STREET OTSEGO, MI 49078	1644 SYCAMORE STREET OTSEGO, MI 49078

Drilling Method: Rotary
Well Depth: 43.00 ft
Well Use: Household
Well Type: Replacement
Date Completed: 10/18/2002

Casing Type: PVC plastic
Height:
Casing Joint: Unknown
Casing Fitting: None

Diameter: 5.00 in. to 38.00 ft. depth

Borehole: 8.50 in. to 43.00 ft. depth

Pump Installed: Yes
Pump Installation Only: No
Pump Installation Date:
HP: 0.50
Manufacturer: Grundfos
Pump Type: Submersible
Model Number: 10SQE-9
Pump Capacity: 12 GPM
Drop Pipe Length: 34.00 ft
Pump Voltage:
Drop Pipe Diameter:
Drilling Record ID:
Draw Down Seal Used: No

Pressure Tank Installed: Yes
Pressure Tank Type: Unknown
Manufacturer: Champion
Model Number: CM 203
Tank Capacity:
Pressure Relief Valve Installed: No

Static Water Level: 13.00 ft. Below Grade
Well Yield Test:
Yield Test Method: Air
Pumping level 27.00 ft. after 1.00 hrs. at 30 GPM

Formation Description	Thickness	Depth to Bottom
Peat	5.00	5.00
Sand & Gravel	15.00	20.00
Gray Clay	2.00	22.00
Sand Water Bearing W/Gravel	21.00	43.00

Screen Installed: Yes
Filter Packed: Yes
Screen Diameter: 5.00 in
Blank:
Screen Material Type: PVC-slotted

Slot	Length	Set Between
15.00	5.00 ft	38.00 ft. and 43.00 ft.

Fittings: Unknown

Well Grouted: Yes
Grouting Method: Unknown

Grouting Material	Bags	Additives	Depth
Bentonite slurry	4.00	None	0.00 ft. to 38.00 ft.

Geology Remarks:

Wellhead Completion: Pitless adapter

Nearest Source of Possible Contamination:

Type	Distance	Direction
Septic tank	75 ft	South

Drilling Machine Operator Name: MITCH VICKERY
Employment: Employee

Contractor Type: Water Well Drilling Contractor
Reg No: 03-1601
Business Name: KRAAI WELL DRLG INC
Business Address:

Abandoned Well Plugged: Yes

Casing Removed:

Water Well Contractor's Certification

This well was drilled under my supervision and this report is true to the best of my knowledge and belief

Signature of Registered Contractor
Date

General Remarks:

Other Remarks:

Water Well And Pump Record

Completion is required under authority of Part 127 Act 368 PA 1978
Failure to comply is a misdemeanor.

Wellogic

Import ID:

Tax No:	Permit No:	County: Allegan			Township: Otsego	
		Town/Range: 01N 12W	Section: 27	Well Status: Active	WSSN:	Source ID/Well No:

Well ID: 03000004991

Elevation:
Latitude: 42.443245
Longitude: -85.70995891
Method of Collection: Address Matching-House Number

Distance and Direction from Road Intersection: 500FT W OF SPRINGBROOK 100FT N OF SYCAMORE

Well Owner: RALPH VENEN

Well Address:	Owner Address:
1673 SYCAMORE OTSEGO, MI 49078	1673 SYCAMORE OTSEGO, MI 49078

Drilling Method: Cable Tool
Well Depth: 50.00 ft. Well Use: Household
Well Type: Replacement Date Completed: 6/11/2003

Casing Type: Steel - unknown Height:
Casing Joint: Threaded & coupled
Casing Fitting: Drive shoe

Diameter: 4.00 in. to 45.00 ft. depth

Borehole:

Pump Installed: Yes Pump Installation Only: No
Pump Installation Date: HP: 0.50
Manufacturer: F.E. Myers Pump Type: Submersible
Model Number: Pump Capacity: 10 GPM
Drop Pipe Length: 39.00 ft Pump Voltage:
Drop Pipe Diameter: Drilling Record ID:
Draw Down Seal Used: No

Pressure Tank Installed: No
Pressure Relief Valve Installed: No

Static Water Level: 12.00 ft. Below Grade
Well Yield Test: Yield Test Method: Plunger
Pumping level 44.00 ft. after 1.00 hrs. at 35 GPM

Formation Description	Thickness	Depth to Bottom
Clay & Sand	10.00	10.00
Sand & Gravel Coarse	40.00	50.00

Screen Installed: Yes Filter Packed: No
Screen Diameter: 3.00 in Blank: 1.00 ft. Above
Screen Material Type: Stainless steel-slotted

Slot	Length	Set Between
10.00	5.00 ft.	45.00 ft. and 50.00 ft.

Fittings: Neoprene packer

Well Grouted: Yes Grouting Method: Unknown

Grouting Material	Bags	Additives	Depth
Bentonite dry granular	5.00	None	0.00 ft. to 45.00 ft.

Wellhead Completion: Pitless adapter

Geology Remarks:

Nearest Source of Possible Contamination:

Type	Distance	Direction
Septic tank	80 ft.	West

Drilling Machine Operator Name: RICK MILLER
Employment: Employee

Contractor Type: Water Well Drilling Contractor Reg No: 03-1202
Business Name: RICK MILLER WELL DRILLING
Business Address:

Abandoned Well Plugged: Yes

Casing Diameter: 2 in. Casing Removed: No
Plugging Material: Unknown
No. of Bags: 2.00 Well Depth: 50 ft.

Water Well Contractor's Certification

This well was drilled under my supervision and this report is true to the best of my knowledge and belief.

Signature of Registered Contractor Date

General Remarks:
Other Remarks:

Water Well And Pump Record

Completion is required under authority of Part 127 Act 368 PA 1978.
Failure to comply is a misdemeanor

Wellogic

Import ID:

Tax No:	Permit No:	County: Allegan			Township: Otsego	
		Town/Range: 01N 12W	Section: 27	Well Status: Active	WSSN:	Source ID/Well No:

Well ID: 03000007381

Elevation:
Latitude: 42.44642
Longitude: -85.703248
Method of Collection: Address Matching-House Number

Distance and Direction from Road Intersection:
NORTH S DF FO SYCAMORE ST

Well Owner: ANDY SPARKS

Well Address:	Owner Address:
1629 SYCAMORE ST OTSEGO, MI 49078	1629 SYCAMORE ST OTSEGO, MI 49078

Drilling Method: Rotary
Well Depth: 57.00 ft
Well Use: Household
Well Type: New
Date Completed: 5/4/2005

Casing Type: PVC plastic
Height: 1.00 ft above grade
Casing Joint: Solvent welded/glued
Casing Fitting: Shale packer/trap

Diameter: 5.00 in to 52.00 ft. depth

Borehole: 8.75 in to 52.00 ft. depth

Pump Installed: Yes
Pump Installation Only: No
Pump Installation Date: 5/18/2005
HP: 0.50
Manufacturer: A.Y. McDonald
Pump Type: Submersible
Model Number: 2105DK2
Pump Capacity: 10 GPM
Drop Pipe Length: 20.00 ft.
Pump Voltage:
Drop Pipe Diameter: 1.00 in.
Drilling Record ID:
Draw Down Seal Used: No

Pressure Tank Installed: Yes
Pressure Tank Type: Diaphragm/bladder
Manufacturer: Elbi
Model Number: DV 80
Tank Capacity: 21.0 Gallons
Pressure Relief Valve Installed: Yes

Static Water Level: 10.00 ft. Below Grade
Well Yield Test:
Yield Test Method: Air
Pumping level 45.00 ft. after 1.50 hrs. at 100 GPM

Formation Description	Thickness	Depth to Bottom
Gray Sand & Gravel	40.00	40.00
Gray Clay	11.00	51.00
Brown Sand W/Gravel Coarse	6.00	57.00

Screen Installed: Yes
Filter Packed: No
Screen Diameter: 4.00 in
Blank: 1.00 ft Above
Screen Material Type: Stainless steel-slotted

Slot	Length	Set Between
15.00	4.00 ft.	53.00 ft. and 57.00 ft.

Fittings: None

Well Grouted: Yes
Grouting Method: Grout pipe outside casing

Grouting Material	Bags	Additives	Depth
Bentonite slurry	2.00	None	0.00 ft. to 50.00 ft.

Wellhead Completion: 12 inches above grade

Geology Remarks:

Nearest Source of Possible Contamination:

Type	Distance	Direction
None		

Drilling Machine Operator Name: RYAN KATZ
Employment: Employee
Pump Installer: MIKE SHELLENBERGER
Contractor Type: Water Well Drilling Contractor
Reg No: 13 1583
Business Name: Katz Well Drilling
Business Address: 1479 E Michigan, Battle Creek, MI, 49014

Water Well Contractor's Certification

This well was drilled under my supervision and this report is true to the best of my knowledge and belief.

Signature of Registered Contractor
Date

General Remarks:

Other Remarks: Map Scale:Unknown

Water Well And Pump Record

Completion is required under authority of Part 127 Act 368 PA 1978.
Failure to comply is a misdemeanor.

Wellogic

Import ID:

Tax No:	Permit No:	County: Allegan	Township: Otsego

Well ID: 03000007406

Elevation: 708 ft
Latitude: 42.447678
Longitude: -85.705091
Method of Collection: Interpolation-Map

Town/Range:	Section:	Well Status:	WSSN:	Source ID/Well No:
01N 12W	27	Active		

Distance and Direction from Road Intersection:
2.10 MI WEST ON SYCAMORE FROM 16TH ST

Well Owner: MARK MORAN

Well Address:	Owner Address:
1635 SYCAMORE MI	231 VINE ST WAYLAND PO BOX 22 SHELBYVILLE, MI 49344

Drilling Method: Rotary
Well Depth: 46.00 ft. Well Use: Household
Well Type: New Date Completed: 4/29/2005

Casing Type: PVC plastic Height:
Casing Joint: Unknown
Casing Fitting: None

Diameter 5.00 in. to 41.00 ft. depth

Borehole: 8.75 in. to 46.00 ft. depth

Pump Installed: Yes Pump Installation Only: No
Pump Installation Date: HP: 1.50
Manufacturer: General Pump Type: Submersible
Model Number: Pump Capacity: 10 GPM
Drop Pipe Length: 20.00 ft Pump Voltage:
Drop Pipe Diameter: Drilling Record ID:
Draw Down Seal Used: No

Pressure Tank Installed: Yes
Pressure Tank Type: Unknown
Manufacturer: Well-X-Trol
Model Number: 203 Tank Capacity: 1[illegible].0 Gallons
Pressure Relief Valve Installed: No

Static Water Level: 6.00 ft Below Grade
Well Yield Test: Yield Test Method: Air
Pumping level 9.00 ft. after 1.00 hrs at 30 GPM

Screen Installed: Yes Filter Packed: No
Screen Diameter: 5.00 in Blank:
Screen Material Type: Stainless steel wire wrapped

Slot	Length	Set Between
12.00	5.00 ft	41.00 ft. and 46.00 ft.

Fittings: Unknown

Well Grouted: Yes Grouting Method: Unknown

Grouting Material	Bags	Additives	Depth
Neat cement	5.00	None	0.00 ft. to 46.00 ft.

Wellhead Completion: Pitless adapter, 12 inches above grade

Formation Description	Thickness	Depth to Bottom
Sand & Gravel	19.00	19.00
Gray Clay	3.00	22.00
Sand & Gravel	5.00	27.00
Gray Clay	2.00	29.00
Sand & Gravel Medium	17.00	46.00

Geology Remarks:
GREY CLAY BELOW 46'

Nearest Source of Possible Contamination:

Type	Distance	Direction
Septic tank	75 ft	West

Drilling Machine Operator Name: FOUKE WELL DRLG
Employment: Subcontractor

Contractor Type: Water Well Drilling Contractor Reg No: 03-1384
Business Name: LOVETT WELL DRLG
Business Address:

Water Well Contractor's Certification

This well was drilled under my supervision and this report is true to the best of my knowledge and belief.

Signature of Registered Contractor Date

General Remarks: SEPTIC NOT INSTALLED YET DISTANCE IS APPROX
Other Remarks:

Water Well And Pump Record

Completion is required under authority of Part 127 Act 368 PA 1978.
Failure to comply is a misdemeanor

Wellogic

Import ID:

Tax No:	Permit No:	County: Allegan	Township: Otsego

Town/Range:	Section:	Well Status:	WSSN:	Source ID/Well No:
01N 12W	27	Active		

Well ID: 03000007949

Elevation: 712 ft
Latitude: 42.445645
Longitude: -85.70798
Method of Collection: GPS Std Positioning Svc SA Off

Distance and Direction from Road Intersection:
1/10 MILE SOUTH THEN WEST ON PRAIRIEWOOD FROM ELM ST

Well Owner: JOSEPH FARNSWORTH

Well Address:	Owner Address:
1670 PRAIRIEWOOD OTSEGO MI 49078	1056 16TH OTSEGO, MI 49078

Drilling Method: Rotary
Well Depth: 115.00 ft. Well Use: Household
Well Type: New Date Completed: 9/21/2005

Casing Type: PVC plastic Height:
Casing Joint: Unknown
Casing Fitting: None

Diameter: 5.00 in. to 110.00 ft. depth

Borehole: 8.00 in. to 115.00 ft. depth

Pump Installed: Yes Pump Installation Only: No
Pump Installation Date: HP: 1.00
Manufacturer: General Pump Type: Submersible
Model Number: Pump Capacity: 19 GPM
Drop Pipe Length: 40.00 ft. Pump Voltage:
Drop Pipe Diameter: Drilling Record ID:
Draw Down Seal Used: No

Pressure Tank Installed: Yes
Pressure Tank Type: Unknown
Manufacturer: Well X Trol
Model Number: 251 Tank Capacity: 62.0 Gallons
Pressure Relief Valve Installed: No

Static Water Level: 7.00 ft. Below Grade
Well Yield Test: Yield Test Method: Air
Pumping level 10.00 ft. after 1.00 hrs. at 40 GPM

Formation Description	Thickness	Depth to Bottom
Sand Medium	27.00	27.00
Brown Clay	12.00	39.00
Sand & Gravel Medium	76.00	115.00

Screen Installed: Yes Filter Packed: No
Screen Diameter: 5.00 in Blank:
Screen Material Type: Stainless steel-wire wrapped

Slot	Length	Set Between
12.00	5.00 ft.	110.00 ft. and 115.00 ft

Fittings: None

Well Grouted: Yes Grouting Method: Unknown

Grouting Material	Bags	Additives	Depth
Bentonite slurry	5.00	None	0.00 ft. to 115.00 ft

Geology Remarks:
SHALE BELOW 115'

Wellhead Completion: Pitless adapter, 12 inches above grade

Nearest Source of Possible Contamination:

Type	Distance	Direction
Unknown		

Drilling Machine Operator Name: FOUNTAIN WELL DRILLING
Employment: Subcontractor

Contractor Type: Water Well Drilling Contractor Reg No: 03-1984
Business Name: LOVETT WELL DRILLING
Business Address:

Water Well Contractor's Certification

This well was drilled under my supervision and this report is true to the best of my knowledge and belief.

Signature of Registered Contractor Date

General Remarks: WELL DEPTH KOK PER JAMIE DENTLER
Other Remarks:

Water Well And Pump Record

Completion is required under authority of Part 127 Act 368 PA 1978.
Failure to comply is a misdemeanor

Wellogic

Import ID:

Tax No	Permit No:	County: Allegan			Township: Otsego	
		Town/Range: 01N 12W	Section: 27	Well Status: Active	WSSN:	Source ID/Well No:

Well ID: 03000008430

Elevation:
Latitude: 42.44534
Longitude: -85.7077
Method of Collection: GPS Std Positioning Svc SA Off

Distance and Direction from Road Intersection:
1 MI W 16TH ST 150' S PRAIRIEWOOD

Well Owner: GEORGE KIELER

Well Address:	Owner Address:
1674 PRAIRIEWOOD OTSEGO MI	2525 W F AVE KALAMAZOO, MI 49009

Drilling Method: Rotary
Well Depth: 84.00 ft. Well Use: Household
Well Type: New Date Completed: 2/14/2006

Casing Type: PVC plastic Height:
Casing Joint: Solvent welded/glued
Casing Fitting: None

Diameter: 5.00 in. to 79.00 ft. depth

Borehole: 8.50 in. to 84.00 ft. depth

Pump Installed: Yes Pump Installation Only: No
Pump Installation Date: HP: 0.50
Manufacturer: Grundfos Pump Type: Submersible
Model Number: 10SQE 9 Pump Capacity: 10 GPM
Drop Pipe Length: 84.00 ft. Pump Voltage:
Drop Pipe Diameter: 1.00 in Drilling Record ID:
Draw Down Seal Used: No

Pressure Tank Installed: Yes
Pressure Tank Type: Diaphragm-bladder
Manufacturer: Champion
Model Number: CM-205 Tank Capacity: 10.0 Gallons
Pressure Relief Valve Installed: Yes

Static Water Level: 5.00 ft. Below Grade
Well Yield Test: Yield Test Method: Air
Pumping level 60.00 ft. after 1.00 hrs. at 60 GPM

Formation Description	Thickness	Depth to Bottom
Brown Sand	30.00	30.00
Brown Gravel	17.00	47.00
Gray Clay	1.00	48.00
Brown Sand & Gravel Water Bearing	36.00	84.00

Screen Installed: Yes Filter Packed: Yes
Screen Diameter: 5.00 in. Blank:
Screen Material Type: PVC-slotted

Slot	Length	Set Between
15.00	5.00 ft	79.00 ft. and 84.00 ft.

Fittings: Unknown

Well Grouted: Yes Grouting Method: Unknown

Grouting Material	Bags	Additives	Depth
Bentonite slurry	7.00	None	0.00 ft. to 79.00 ft.

Wellhead Completion: Pitless adapter

Geology Remarks:

Nearest Source of Possible Contamination:

Type	Distance	Direction
Septic tank	75 ft	North

Drilling Machine Operator Name: MITCH VICKERY
Employment: Employee
Pump Installer: MATTHEW KURDELSKI
Contractor Type: Water Well Drilling Contractor Reg No: 03-1801
Business Name: KRAAI WELL DRLG INC
Business Address:

Water Well Contractor's Certification

This well was drilled under my supervision and this report is true to the best of my knowledge and belief

Signature of Registered Contractor Date

General Remarks:
Other Remarks:

Water Well And Pump Record

Completion is required under authority of Part 127 Act 368 PA 1978.
Failure to comply is a misdemeanor

Wellogic

Import ID:

Tax No:	Permit No:	County: Allegan			Township: Otsego	
		Town/Range: 01N 12W	Section: 27	Well Status: Active	WSSN:	Source ID/Well No:

Well ID: 03000008566

Elevation:

Latitude: 42.44962

Longitude: -85.7076

Method of Collection: GPS Std Positioning Svc SA Off

Distance and Direction from Road Intersection:
1/4 MILE WEST OF SPRINGBROOK ON NORTH SIDE OF OAK ST

Well Owner: DONALD TROUTMAN

Well Address:	Owner Address:
1677 OAK ST OTSEGO, MI 49078	1677 OAK ST OTSEGO, MI 49078

Drilling Method: Rotary
Well Depth: 38.00 ft **Well Use:** Household
Well Type: Replacement **Date Completed:** 5/26/2005

Casing Type: PVC plastic **Height:** 1.00 ft above grade
Casing Joint: Solvent welded/glued
Casing Fitting: Shale packer/trap

Diameter: 5.00 in. to 33.00 ft. depth

Borehole: 8.75 in. to 33.00 ft. depth

Pump Installed: Yes **Pump Installation Only:** No
Pump Installation Date: 5/30/2005 **HP:** 0.50
Manufacturer: A.Y. McDonald **Pump Type:** Submersible
Model Number: 21050K2 **Pump Capacity:** 10 GPM
Drop Pipe Length: 20.00 ft. **Pump Voltage:**
Drop Pipe Diameter: 1.00 in **Drilling Record ID:**
Draw Down Seal Used: No

Pressure Tank Installed: No
Pressure Relief Valve Installed: No

Static Water Level: 10.00 ft Below Grade
Well Yield Test: **Yield Test Method:** Air
Pumping level 20.00 ft. after 1.00 hrs. at 25 GPM

Formation Description	Thickness	Depth to Bottom
Brown Clay & Sand	4.00	4.00
Gravel & Sand Fine	29.00	33.00
Sand Water Bearing	5.00	38.00
Gray Clay & Stones	2.00	40.00
Gravel & Stones Fine	3.00	43.00
Gray Clay	13.00	56.00
Clay & Sand Silty	7.00	63.00
Gray Clay	87.00	150.00

Screen Installed: Yes **Filter Packed:** No
Screen Diameter: 4.00 in. **Blank:** 1.00 ft. Above
Screen Material Type: Stainless steel-slotted

Slot	Length	Set Between
15.00	5.00 ft	33.00 ft. and 38.00 ft.

Fittings: Neoprene packer

Well Grouted: Yes **Grouting Method:** Grout pipe outside casing

Grouting Material	Bags	Additives	Depth
Bentonite slurry	5.00	None	0.00 ft. to 33.00 ft.

Wellhead Completion: 12 inches above grade

Geology Remarks:

Nearest Source of Possible Contamination:

Type	Distance	Direction
Septic tank	80 ft.	East

Abandoned Well Plugged: Yes

Casing Diameter: 4 in. **Casing Removed:** No
Plugging Material: Bentonite chips/pellets
No. of Bags: 3.50

Drilling Machine Operator Name: RICK FREY
Employment: Employee
Pump Installer: JOHN CHAPMAN
Contractor Type: Water Well Drilling Contractor **Reg No:** 13-1593
Business Name: Katz Well Drilling
Business Address: 1479 E Michigan, Battle Creek, MI, 49014

Water Well Contractor's Certification

This well was drilled under my supervision and this report is true to the best of my knowledge and belief.

Signature of Registered Contractor **Date**

General Remarks:

Other Remarks:

Water Well And Pump Record

Completion is required under authority of Part 127 Act 368 PA 1978
Failure to comply is a misdemeanor.

Wellogic

Import ID:

Tax No.	Permit No:	County: Allegan			Township: Otsego
		Town/Range: 01N 12W	Section: 27	Well Status: Active	WSSN:

Source ID/Well No:

Well ID: 03000009889

Elevation:

Latitude: 42.44584

Longitude: -85.70967

Method of Collection: GPS Std Positioning Svc SA Off

Distance and Direction from Road Intersection: APPROX 1/4 MI E W OF SPRINGBROOK N SIDE OF OAK ST

Well Owner: KEN KLUMPP

Well Address	Owner Address
1689 OAK ST OTSEGO, MI 49078	1689 OAK ST OTSEGO, MI 49078

Drilling Method: Rotary
Well Depth: 38.00 ft Well Use: Household
Well Type: Replacement Date Completed: 5/1/2008

Casing Type: PVC plastic Height: 1.00 ft above grade
Casing Joint: Solvent welded/glued
Casing Fitting: Snap packer/cap

Diameter: 5.00 in to 33.00 ft depth SCH: 21.00

Borehole: 8.75 in to 33.00 ft. depth

Pump Installed: Yes Pump Installation Only: No
Pump Installation Date: 5/2/2008 HP: 0.50
Manufacturer: A.Y. McDonald Pump Type: Submersible
Model Number: 2105DK2 Pump Capacity: 12 GPM
Drop Pipe Length: 20.00 ft. Pump Voltage:
Drop Pipe Diameter: 1.00 in Drilling Record ID:
Draw Down Seal Used: No

Pressure Tank Installed: No
Pressure Relief Valve Installed: No

Static Water Level: 11.00 ft Below Grade
Well Yield Test: Yield Test Method: Air
Pumping level 27.00 ft. after 1.00 hrs. at 40 GPM

Formation Description	Thickness	Depth to Bottom
Topsoil	1.00	1.00
Brown Sand	11.00	12.00
Gray Sand & Gravel	26.00	38.00

Screen Installed: Yes Filter Packed: No
Screen Diameter: 4.00 in Blank: 1.00 ft. Above
Screen Material Type: Stainless steel-slotted

Slot	Length	Set Between
12.00	4.00 ft.	34.00 ft. and 38.00 ft.

Fittings: Neoprene packer

Well Grouted: Yes Grouting Method: Grout pipe outside casing

Grouting Material	Bags	Additives	Depth
Bentonite slurry	3.00	Other	0.00 ft. to 30.00 ft

Wellhead Completion: Pitless adapter, 12 inches above grade

Geology Remarks:

Nearest Source of Possible Contamination:

Type	Distance	Direction
Septic tank	75 ft	North

Abandoned Well Plugged: Yes

Casing Diameter: 4 in. Casing Removed: No
Plugging Material: Bentonite slurry
No. of Bags: 1.00 Well Depth: 42 ft

Drilling Machine Operator Name: RYAN KATZ
Employment: Employee
Pump Installer: MIKE SHELLENBERGER
Contractor Type: Water Well Drilling Contractor Reg No: 13-1589
Business Name: Katz Well Drilling
Business Address: 1479 E Michigan, Battle Creek, MI, 49014

Water Well Contractor's Certification

This well was drilled under my supervision and this report is true to the best of my knowledge and belief

Signature of Registered Contractor Date

General Remarks:

Other Remarks: Grouting Additive 1:EZ MUD

Water Well And Pump Record

Completion is required under authority of Part 127 Act 368 PA 1978.
Failure to comply is a misdemeanor

Wellogic

Import ID:

Tax No:	Permit No:	County: Allegan			Township: Otsego	
		Town/Range: 01N 12W	Section: 27	Well Status: Active	WSSN:	Source ID/Well No:

Well ID: 03000009995

Elevation:
Latitude: 42.44956
Longitude: -85.71073
Method of Collection: GPS Std Positioning Svc SA Off

Distance and Direction from Road Intersection:
0.5 Mi W 16TH ST & 75' S OAK DR

Well Owner: GARY & BARB RHOADES

Well Address:	Owner Address:
1604 OAK DR OTSEGO, MI	289 39TH ST ALLEGAN, MI 49010

Drilling Method: Rotary
Well Depth: 40.00 ft. Well Use: Household
Well Type: Replacement Date Completed: 9/4/2007

Casing Type: PVC plastic Height:
Casing Joint: Solvent welded/glued
Casing Fitting: Unknown

Diameter: 5.00 in. to 35.00 ft. depth SDR: 21.00

Borehole: 8.75 in. to 40.00 ft. depth

Pump Installed: Yes Pump Installation Only: No
Pump Installation Date: HP: 0.50
Manufacturer: Aermotor Pump Type: Submersible
Model Number: T 12.50 Pump Capacity: 12 GPM
Drop Pipe Length: 34.00 ft Pump Voltage:
Drop Pipe Diameter: 1.00 in. Drilling Record ID:
Draw Down Test Used: No

Pressure Tank Installed: Yes
Pressure Tank Type: Diaphragm/bladder
Manufacturer: Unknown
Model Number: US-20 Tank Capacity: 6.0 Gallons
Pressure Relief Valve Installed: Yes

Static Water Level: 9.00 ft. Below Grade
Well Yield Test Yield Test Method: Air
Pumping level 16.00 ft. after 1.00 hrs. at 20 GPM

Formation Description	Thickness	Depth to Bottom
Sand	9.00	9.00
Sand & Gravel	31.00	40.00

Screen Installed: Yes Filter Packed: Yes
Screen Diameter: 5.00 in. Blank:
Screen Material Type: PVC-slotted

Slot	Length	Set Between
15.00	5.00 ft	35.00 ft. and 40.00 ft

Fittings: Unknown

Well Grouted: Yes Grouting Method: Unknown

Grouting Material	Bags	Additives	Depth
Bentonite slurry	4.00	None	0.00 ft. to 34.00 ft

Geology Remarks:

Wellhead Completion: Pitless adapter

Nearest Source of Possible Contamination:

Type	Distance	Direction
Septic tank	75 ft.	Southwest

Drilling Machine Operator Name: MITCH VICKERY
Employment: Employee
Pump Installer: MATTHEW KURCFISKI
Contractor Type: Water Well Drilling Contractor Reg No: 03-1601
Business Name: KRAAI WELL DRILLING INC
Business Address:

Abandoned Well Plugged: Yes

Casing Diameter: 2 in. Casing Removed: No
Plugging Material: Bentonite chips/pellets
No. of Bags: 1.00 Well Depth: 30 ft.

Water Well Contractor's Certification

This well was drilled under my supervision and this report is true to the best of my knowledge and belief.

Signature of Registered Contractor Date

General Remarks:
Other Remarks:

Water Well And Pump Record

Completion is required under authority of Part 127 Act 368 PA 1978.
Failure to comply is a misdemeanor

Wellogic

Import ID:

Tax No:	Permit No:	County: Allegan			Township: Otsego
		Town/Range: 01N 12W	Section: 27	Well Status: Active	WSSN:

Source ID/Well No:

Well ID: 03000010342

Elevation:

Latitude: 42.44632

Longitude: -85.70762

Method of Collection: GPS Std Positioning Svc SA Off

Distance and Direction from Road Intersection:
1.10 MI E W OF SPRING BROOK DR & 150' N PRAIRIEWOOD CT

Well Owner: KOZAR CONSTRUCTION

Well Address:
1671 PRAIRIEWOOD CT
OTSEGO, MI

Owner Address:
1290 HOLIDAY LANE
PORTAGE, MI 49024

Drilling Method: Rotary
Well Depth: 97.00 ft. Well Use: Household
Well Type: New Date Completed: 1/18/2008

Casing Type: PVC plastic Height:
Casing Joint: Solvent welded/glued
Casing Fitting: None

Diameter: 5.00 in. to 91.00 ft. depth SDR: 21.00

Borehole: 8.75 in. to 97.00 ft. depth

Pump Installed: Yes Pump Installation Only: No
Pump Installation Date: 1/18/2008 HP: 1.00
Manufacturer: Grundfos Pump Type: Submersible
Model Number: 22S0E10C19 Pump Capacity: 22 GPM
Drop Pipe Length: 45.00 ft. Pump Voltage:
Drop Pipe Diameter: 1.25 in Drilling Record ID:
Draw Down Seal Used: No

Pressure Tank Installed: Yes
Pressure Tank Type: Diaphragm/bladder
Manufacturer: Well X Trol
Model Number: WX101 Tank Capacity: 1.0 Gallons
Pressure Relief Valve Installed: Yes

Static Water Level: 6.00 ft Below Grade
Well Yield Test: Yield Test Method: Air
Pumping level 20.00 ft. after 1.00 hrs. at 50 GPM

Formation Description	Thickness	Depth to Bottom
Sand	8.00	8.00
Sand & Gravel	32.00	40.00
Gray Clay	12.00	52.00
Gray Clay & Gravel	6.00	58.00
Sand & Gravel Water Bearing	29.00	87.00

Screen Installed: Yes Filter Packed: Yes
Screen Diameter: 5.00 in Blank:
Screen Material Type: PVC slotted

Slot	Length	Set Between
15.00	6.00 ft.	91.00 ft. and 97.00 ft.

Fittings: Neoprene packer

Well Grouted: Yes Grouting Method: Unknown

Grouting Material	Bags	Additives	Depth
Bentonite slurry	78.00	None	0.00 ft. to 79.00 ft.

Wellhead Completion: Press adapter

Geology Remarks:

Nearest Source of Possible Contamination:

Type	Distance	Direction
Sewer line	30 ft	South

Drilling Machine Operator Name: MITCH VICKERY
Employment: Employee
Pump Installer: GARY COBURN
Contractor Type: Water Well Drilling Contractor Reg No: 09 1601
Business Name: DRAAI WELL DRILLING
Business Address:

Water Well Contractor's Certification

This well was drilled under my supervision and this report is true to the best of my knowledge and belief.

Signature of Registered Contractor Date

General Remarks:
Other Remarks:

Water Well And Pump Record

Completion is required under authority of Part 127 Act 368 PA 1978.
Failure to comply is a misdemeanor

Wellogic

Import ID:

Tax No:	Permit No:	County: Allegan			Township: Otsego	
		Town/Range: 01N 12W	Section: 27	Well Status: Active	WSSN:	Source ID/Well No:

Well ID: 03000010432

Elevation:
Latitude: 42.44781
Longitude: -85.71418
Method of Collection: GPS Std Positioning Svc SA Off

Distance and Direction from Road Intersection:
Approx. 1/2 mile West of Farmers Rd on the SW corner of Sycamore & Briarwood

Well Owner: Mark McPherson

Well Address:	Owner Address:
376 Briarwood Otsego, MI 49078	376 Briarwood Otsego, MI 49078

Drilling Method: Rotary
Well Depth: 77.00 ft Well Use: Household
Well Type: Replacement Date Completed: 2/20/2009

Casing Type: PVC plastic Height: 1.00 ft. above grade
Casing Joint: Solvent welded/glued
Casing Fitting: None

Diameter: 5.00 in. to 67.00 ft. depth

Borehole: 8.50 in. to 77.00 ft. depth

Pump Installed: Yes Pump Installation Only: No
Pump Installation Date: 2/23/2009 HP: 1.00
Manufacturer: Hint & Walling Pump Type: Submersible
Model Number: 4F19S10305 Pump Capacity: 19 GPM
Drop Pipe Length: 40.00 ft. Pump Voltage:
Drop Pipe Diameter: 1.25 in Drilling Record ID:
Draw Down Seal Used: No

Pressure Tank Installed: Yes
Pressure Tank Type: Diaphragm/bladder
Manufacturer: Amtrol
Model Number: WX-302 Tank Capacity: 25.0 Gallons
Pressure Relief Valve Installed: Yes

Static Water Level: 11.00 ft. Below Grade
Well Yield Test: Yield Test Method: Test pump
Pumping level 17.00 ft. after 1.00 hrs. at 35 GPM

Formation Description	Thickness	Depth to Bottom
Sand	4.00	4.00
Sand & Clay	4.00	8.00
Sand & Gravel	69.00	77.00

Screen Installed: Yes Filter Packed: Yes
Screen Diameter: 5.00 in. Blank: Above
Screen Material Type: PVC-slotted

Slot	Length	Set Between
20.00	10.00 ft.	67.00 ft. and 77.00 ft.

Fittings: None

Well Grouted: Yes Grouting Method: Grout pipe outside casing

Grouting Material	Bags	Additives	Depth
Bentonite slurry	4.00	None	0.00 ft. to 60.00 ft.

Wellhead Completion: Pitless adapter, 12 inches above grade

Geology Remarks:
Clay deeper to shale

Nearest Source of Possible Contamination:

Type	Distance	Direction
Septic tank	80 ft	West

Abandoned Well Plugged: Yes

Casing Diameter: 4 in. Casing Removed: No
Plugging Material: Bentonite chips/pellets
No. of Bags: 7.00 Well Depth: 50 ft

Drilling Machine Operator Name: Russ Beckley
Employment: Employee
Pump Installer: Chet & Phil

Contractor Type: Water Well Drilling Contractor Reg No: 03-2342
Business Name: Koops Well Drilling
Business Address: 3811 58th Street, Holland, MI, 49423

Water Well Contractor's Certification

This well was drilled under my supervision and this report is true to the best of my knowledge and belief

Signature of Registered Contractor Date

General Remarks: 7x14 Gravel Pack
Other Remarks:

Water Well And Pump Record

Completion is required under authority of Part 127 Act 368 PA 1978.
Failure to comply is a misdemeanor

Wellogic

Import ID:

Tax No.	Permit No:	County: Allegan			Township: Otsego	
		Town/Range: 01N 12W	Section: 27	Well Status: Active	WSSN:	Source ID/Well No:

Well ID: 03000010659

Elevation:

Latitude: 42.448836

Longitude: -85.705774

Method of Collection: Address Matching-House Number

Distance and Direction from Road Intersection:
5 MILE W 16TH ST & 60' W OF SPRINGBROOK

Well Owner: RALPH WOODSTOCK

Well Address:	Owner Address:
376 SPRINGBROOK DR OTSEGO MI 49078	376 SPRINGBROOK DR OTSEGO , MI 49078

Drilling Method: Rotary
Well Depth: 36.00 ft
Well Use: Unknown
Well Type: Replacement
Date Completed: 11/25/2008

Casing Type: PVC plastic
Height:
Casing Joint: Unknown
Casing Fitting: None

Diameter: 5.00 in. to 30.00 ft. depth. SDR: 21.00

Borehole: 6.75 in. to 36.00 ft. depth

Pump Installed: Yes
Pump Installation Only: No
Pump Installation Date: 11/25/2008
HP: 0.50
Manufacturer: Aermotor
Pump Type: Submersible
Model Number: T 12 50
Pump Capacity: 12 GPM
Drop Pipe Length: 30.00 ft.
Pump Voltage:
Drop Pipe Diameter: 1.00 in.
Drilling Record ID:
Draw Down Seal Used: No

Pressure Tank Installed: Yes
Pressure Tank Type: Diaphragm/Bladder
Manufacturer: Well X Trol
Model Number: WX203
Tank Capacity: 10.0 Gallons
Pressure Relief Valve Installed: Yes

Static Water Level: 16.00 ft. Below Grade
Well Yield Test:
Yield Test Method: Air
Pumping level 30.00 ft. after 1.00 hrs. at 25 GPM

Formation Description	Thickness	Depth to Bottom
Sand & Gravel	30.00	30.00
Sand Water Bearing	6.00	36.00

Screen Installed: Yes
Filter Packed: Yes
Screen Diameter: 5.00 in
Blank:
Screen Material Type: PVC-slotted

Slot	Length	Set Between
15.00	6.00 ft	30.00 ft. and 36.00 ft.

Fittings: Unknown

Well Grouted: Yes
Grouting Method: Unknown

Grouting Material	Bags	Additives	Depth
Bentonite slurry	3.00	None	0.00 ft. to 28.00 ft.

Wellhead Completion: Pitless adapter

Geology Remarks:

Nearest Source of Possible Contamination:

Type	Distance	Direction
Septic tank	80 ft.	Southwest

Drilling Machine Operator Name: MITCH VICKERY
Employment: Employee

Contractor Type: Water Well Drilling Contractor
Reg No: 03-1601
Business Name: KRAAI WELL DRILLING
Business Address:

Abandoned Well Plugged: Yes

Casing Diameter: 2 in.
Casing Removed: No
Plugging Material: Bentonite chips/pellets
No. of Bags: 1.00
Well Depth: 35 ft.

Water Well Contractor's Certification

This well was drilled under my supervision and this report is true to the best of my knowledge and belief.

Signature of Registered Contractor
Date

General Remarks:

Other Remarks:

Water Well And Pump Record

Completion is required under authority of Part 127 Act 368 PA 1978.
Failure to comply is a misdemeanor.

Import ID:

Tax No:	Permit No: 144872	County: Allegan	Township: Otsego

Well ID: 03000011142

Elevation:
Latitude: 42.44709
Longitude: -85.7353
Method of Collection: GPS Carrier Phase Kinematic Relative Position Type

Town/Range:	Section:	Well Status:	WSSN:	Source ID/Well No:
01N 12W	27	Active		

Distance and Direction from Road Intersection:
20 ft east of Springbrook on Elm St

Well Owner: Water Worx Well Drilling

Well Address:	Owner Address:
1645 Elm St Otsego, MI	9568 S. 36th St Scotts, MI 49088

Drilling Method: Rotary
Well Depth: 44.00 ft
Well Use: Household
Well Type: Replacement
Date Completed: 8/5/2010

Casing Type: PVC plastic
Height: 1.00 ft. above grade
Casing Joint: Solvent welded/glued
Casing Fitting: None

Diameter: 5.00 in. to 39.00 ft. depth

Borehole: 8.00 in. to 44.00 ft. depth

Pump Installed: No
Pressure Tank Installed: No
Pressure Relief Valve Installed: No

Static Water Level: 10.00 ft Below Grade
Well Yield Test:
Yield Test Method: Air
Pumping level 10.00 ft. after 1.00 hrs. at 20 GPM

Formation Description	Thickness	Depth to Bottom
Sand & Gravel Fine	6.00	6.00
Black Muck	2.00	8.00
Sand & Gravel Fine	27.00	35.00
Sand & Gravel Coarse	9.00	44.00

Screen Installed: Yes
Filter Packed: No
Screen Diameter: 3.00 in.
Blank: 5.00 ft Above
Screen Material Type: Stainless steel-slotted

Slot	Length	Set Between
12.00	5.00 ft.	39.00 ft and 44.00 ft.

Fittings: None

Well Grouted: Yes
Grouting Method: Grout pipe outside casing

Grouting Material	Bags	Additives	Depth
Bentonite slurry	3.00	None	5.00 ft to 29.00 ft

Geology Remarks:

Wellhead Completion: 12 inches above grade

Nearest Source of Possible Contamination:

Type	Distance	Direction
Septic tank	75 ft	North

Drilling Machine Operator Name: Mike Smith
Employment: Employee

Contractor Type: Water Well Drilling Contractor
Reg No: 08 1793
Business Name: Smith Well & Pump Co
Business Address: 499 W Hickory, Battle Creek, MI, 49017

Abandoned Well Plugged: No
Reason Not Plugged: Well being plugged by another driller

Water Well Contractor's Certification

This well was drilled under my supervision and this report is true to the best of my knowledge and belief.

Signature of Registered Contractor
Date

General Remarks: Well hookup and abandonment is being done by Water Worx Well Drilling
Other Remarks: Map Scale:Unknown, Elevation Datum :Unknown

Water Well And Pump Record

Completion is required under authority of Part 127 Act 368 PA 1978.
Failure to comply is a misdemeanor.

Wellogic

Import ID:

Tax No:	Permit No:	County: Allegan			Township: Otsego
		Town/Range: 01N 12W	Section: 27	Well Status: Active	WSSN:

Source ID/Well No:

Well ID: 03000011212

Elevation:

Latitude: 42.44755

Longitude: -85.70605

Method of Collection: GPS Std Positioning Svc SA On

Distance and Direction from Road Intersection:
ON WEST SIDE OF SPRINGBROOK 100 YARDS SOUTH OF SYCAMORE

Well Owner: CHARLEY MCQUEER

Well Address:	Owner Address:
372 SPRINGBROOK OTSEGO MI 49078	372 SPRINGBROOK OTSEGO, MI 49078

Drilling Method: Rotary
Well Depth: 105.00 ft. **Well Use:** Household
Well Type: New **Date Completed:** 9-22-2010

Casing Type: PVC plastic **Height:** 1.00 ft. above grade
Casing Joint: Solvent welded/glued
Casing Fitting: Shale packer/trap

Diameter 5.00 in. to 100.00 ft. depth SDR: 21.00

Borehole: 8.00 in. to 100.00 ft. depth

Pump Installed: Yes **Pump Installation Only:** No
Pump Installation Date: 9-23-2010 **HP:** 0.75
Manufacturer: A.Y. McDonald **Pump Type:** Submersible
Model Number: 21075P2 **Pump Capacity:** 16 GPM
Drop Pipe Length: 40.00 ft **Pump Voltage:**
Drop Pipe Diameter: 1.00 in. **Drilling Record ID:**
Draw Down Seal Used: No

Pressure Tank Installed: Yes
Pressure Tank Type: Diaphragm/bladder
Manufacturer: Other
Model Number: 16038MV4F **Tank Capacity:** 35.0 Gallons
Pressure Relief Valve Installed: Yes

Static Water Level: 9.00 ft. Below Grade
Well Yield Test: **Yield Test Method:** Air
Pumping level 85.00 ft. after 1.00 hrs. at 80 GPM

Screen Installed: Yes **Filter Packed:** No
Screen Diameter: 4.00 in **Blank:** 1.00 ft. Above
Screen Material Type: Stainless steel-slotted

Slot	Length	Set Between
15.00	4.00 ft.	101.00 ft. and 105.00 ft.

Fittings: Neoprene packer

Formation Description	Thickness	Depth to Bottom
Clay & Sand	4.00	4.00
Sand	27.00	31.00
Gray Clay	6.00	37.00
Sand W/Gravel Fine	7.00	44.00
Sand Fine	11.00	55.00
Gray Clay	38.00	93.00
Sand W/Gravel Fine	12.00	105.00

Well Grouted: Yes **Grouting Method:** Grout pipe outside casing

Grouting Material	Bags	Additives	Depth
Bentonite slurry	6.00	None	0.00 ft. to 55.00 ft.

Wellhead Completion: Pitless adapter 12 inches above grade

Geology Remarks:

Nearest Source of Possible Contamination:

Type	Distance	Direction
Septic tank	75 ft.	West

Drilling Machine Operator Name: MARC MCKEAGUE
Employment: Employee
Pump Installer: MIKE SHELLENBERGER
Contractor Type: Water Well Drilling Contractor **Reg No:** 13-1593
Business Name: Katz Well Drilling
Business Address: 1479 E Michigan, Battle Creek, MI, 49014

Water Well Contractor's Certification

This well was drilled under my supervision and this report is true to the best of my knowledge and belief.

Signature of Registered Contractor **Date**

General Remarks:

Other Remarks: Tank Manufacturer:DURAMAC

Water Well And Pump Record

Completion is required under authority of Part 127 Act 368 PA 1978.
Failure to comply is a misdemeanor

Wellogic

Import ID:

Tax No:	Permit No:	County: Allegan			Township: Otsego	
		Town/Range: 01N 12W	Section: 27	Well Status: Active	WSSN:	Source ID/Well No:

Well ID: 03000004759

Elevation:
Latitude: 42.44965349
Longitude: -85.705.4355
Method of Collection: Interpolation Map

Distance and Direction from Road Intersection:
1000 FEET WEST SPRING BROOK; 100 FEET SOUTH PRAIRIEWOOD DR

Well Owner: PRAIRIEWOOD DEV

Well Address:	Owner Address:
PRAIRIEWOOD DRIVE LOT 10 OTSEGO MI 49078	PRAIRIEWOOD DRIVE LOT 10 OTSEGO, MI 49078

Drilling Method: Rotary
Well Depth: 145.00 ft. Well Use: Test well
Well Type: New Date Completed: 6/4/2003

Casing Type: PVC plastic Height:
Casing Joint: Unknown
Casing Fitting: None

Diameter: 5.00 in to 140.00 ft. depth

Borehole: 8.50 in to 145.00 ft. depth

Pump Installed: No
Pressure Tank Installed: No
Pressure Relief Valve Installed: No

Static Water Level 7.00 ft. Below Grade
Well Yield Test: Yield Test Method: Test pump
Pumping level 81.00 ft. after 4.00 hrs. at 21 GPM

Formation Description	Thickness	Depth to Bottom
Sand & Gravel	80.00	80.00
Gray Clay	57.00	137.00
Sand Water Bearing W/Gravel	8.00	145.00

Screen Installed: Yes Filter Packed: Yes
Screen Diameter: 5.00 in Blank:
Screen Material Type: PVC-Slotted

Slot	Length	Set Between
15.00	5.00 ft	140.00 ft. and 145.00 ft

Fittings: Unknown

Well Grouted: Yes Grouting Method: Unknown

Grouting Material	Bags	Additives	Depth
Bentonite slurry	12.00	None	0.00 ft. to 139.00 ft.

Wellhead Completion: 12 inches above grade

Geology Remarks:

Nearest Source of Possible Contamination:

Type	Distance	Direction
Septic tank	1500 ft.	Southeast

Drilling Machine Operator Name: MITCH VICKERY
Employment: Employee

Contractor Type: Water Well Drilling Contractor Reg No: 03-1911
Business Name: KRAAI WELL DRLG INC
Business Address:

Water Well Contractor's Certification

This well was drilled under my supervision and this report is true to the best of my knowledge and belief.

Signature of Registered Contractor Date

General Remarks:
Other Remarks:

Water Well And Pump Record

Completion is required under authority of Part 127 Act 368 PA 1978.
Failure to comply is a misdemeanor

Wellogic

Import ID:

Tax No:	Permit No:	County: Allegan			Township: Otsego
		Town/Range: 01N 12W	Section: 27	Well Status: Active	WSSN:

Source ID/Well No:

Well ID: 03000004581

Elevation:

Latitude: 42.446299

Longitude: -85.703728

Method of Collection: Address Matching House Number

Distance and Direction from Road Intersection:
3 1/2 MILE NORTH OF 102ND AVE. 50 FEET WEST OF 16TH ST

Well Owner: RICHARD ROUSE

Well Address:	Owner Address:
290 16TH STREET OTSEGO, MI 49078	290 16TH STREET OTSEGO, MI 49078

Drilling Method: Cable Tool
Well Depth: 38.00 ft. **Well Use:** Household
Well Type: Replacement **Date Completed:** 4/10/2003

Casing Type: Steel - unknown **Height:**
Casing Joint: Threaded & coupled
Casing Fitting: None

Diameter: 4.00 in. to 33.00 ft. depth

Borehole:

Pump Installed: Yes **Pump Installation Only:** No
Pump Installation Date: **HP:** 0.50
Manufacturer: Flint & Walling **Pump Type:** Submersible
Model Number: **Pump Capacity:** 10 GPM
Drop Pipe Length: 27.00 ft **Pump Voltage:**
Drop Pipe Diameter: **Drilling Record ID:**
Draw Down Seal Used: No

Pressure Tank Installed: Yes
Pressure Tank Type: Unknown
Manufacturer: Well X Trol
Model Number: 203 **Tank Capacity:** 32.0 Gallons
Pressure Relief Valve Installed: No

Static Water Level: 22.00 ft. Below Grade
Well Yield Test: **Yield Test Method:** Pumper
Pumping level 30.00 ft after 1.00 hrs at 30 GPM

Formation Description	Thickness	Depth to Bottom
Clay	22.00	22.00
Sand & Clay	10.00	32.00
Gravel Coarse	6.00	38.00

Screen Installed: Yes **Filter Packed:** No
Screen Diameter: 3.00 in. **Blank:** 1.00 ft Above
Screen Material Type: Stainless steel wire wrapped

Slot	Length	Set Between
10.00	5.00 ft.	33.00 ft and 38.00 ft

Fittings: Neoprene packer

Well Grouted: Yes **Grouting Method:** Unknown

Grouting Material	Bags	Additives	Depth
Bentonite slurry	5.00	None	0.00 ft to 33.00 ft.

Wellhead Completion: Pitless adapter, 12 inches above grade

Geology Remarks:

Nearest Source of Possible Contamination:

Type	Distance	Direction
Septic tank	75 ft.	West

Abandoned Well Plugged: Yes

Casing Removed:

Drilling Machine Operator Name: RICK MILLER
Employment: Employee

Contractor Type: Water Well Drilling Contractor **Reg No:** 03-1203
Business Name: MILLER WELL DRLG CO
Business Address:

Water Well Contractor's Certification

This well was drilled under my supervision and this report is true to the best of my knowledge and belief

Signature of Registered Contractor **Date**

General Remarks:

Other Remarks:

Water Well And Pump Record

Completion is required under authority of Part 127 Act 368 PA 1978.
Failure to comply is a misdemeanor

Wellogic

Import ID:

Tax No:	Permit No:	County: Allegan			Township: Otsego	
		Town/Range: 01N 12W	Section: 27	Well Status: Active	WSSN:	Source ID/Well No:

Well ID: 03000011678

Elevation:

Latitude: 42.43362

Longitude: -85.70331

Method of Collection GPS Std Positioning Svc SA Off

Distance and Direction from Road Intersection:
440' W summit path & 440' N south point dr

Well Owner: Walls Construction

Well Address:
254 Summit Path
Otsego, MI 49078

Owner Address:
5071 Gull Rd
Kalamazoo, MI 49048

Drilling Method: Rotary
Well Depth: 119.00 ft **Well Use:** Household
Well Type: New **Date Completed:** 8/26/2011

Casing Type: PVC plastic **Height:** 1.00 ft. above grade
Casing Joint: Solvent welded/glued
Casing Fitting: None

Diameter: 5.00 in. to 119.00 ft. depth SCH: 21.00

Borehole: 8.75 in. to 119.00 ft. depth

Pump Installed: Yes **Pump Installation Only:** No
Pump Installation Date: 8/26/2011 **HP:** 0.50
Manufacturer: AquaDuty **Pump Type:** Submersible
Model Number: 15m4cp8.5S **Pump Capacity:** 10 GPM
Drop Pipe Length: 94.00 ft. **Pump Voltage:** 230
Drop Pipe Diameter: 1.00 in **Drilling Record ID:**
Draw Down Seal Used: No

Pressure Tank Installed: Yes
Pressure Tank Type: Diaphragm-bladder
Manufacturer: Flex Life Flexcon
Model Number: pc88 **Tank Capacity:** 10.0 Gallons
Pressure Relief Valve Installed: Yes

Static Water Level: 22.00 ft Below Grade
Well Yield Test: **Yield Test Method:** Air
Pumping level 60.00 ft. after 1.00 hrs at 50 GPM

Formation Description	Thickness	Depth to Bottom
Brown Clay	6.00	6.00
Sand & Gravel	16.00	22.00
Sand & Gravel Water Bearing	97.00	119.00

Screen Installed: Yes **Filter Packed:** Yes
Screen Diameter: 5.00 in. **Blank:** 1.00 ft. Above
Screen Material Type: PVC-slotted

Slot	Length	Set Between
15.00	5.00 ft.	113.00 ft. and 119.00 ft.

Fittings: None

Well Grouted: Yes **Grouting Method:** Grout pipe outside casing

Grouting Material	Bags	Additives	Depth
Bentonite slurry	10.00	None	0.00 ft. to 110.00 ft.

Wellhead Completion: Pitless adapter

Geology Remarks:

Nearest Source of Possible Contamination

Type	Distance	Direction
Septic tank	100 ft.	Northwest

Drilling Machine Operator Name: Mitch Vickery
Employment: Employee
Pump Installer: Anthony Fales

Contractor Type: Water Well Drilling Contractor **Reg No:** 03-1601
Business Name: Kraai Well Drilling
Business Address: 110 124th Ave, Shelbyville, MI, 49344

Water Well Contractor's Certification

This well/pump was constructed under my supervision and I hereby certify that the work complies with Part 127 Act 368 PA 1978 and the well code.

Signature of Registered Contractor **Date**

General Remarks:

Other Remarks:

Water Well And Pump Record

Completion is required under authority of Part 127 Act 368 PA 1978.
Failure to comply is a misdemeanor

Wellogic

Import ID:

Tax No:	Permit No:	County: Allegan			Township: Otsego	
		Town/Range: 01N 12W	Section: 27	Well Status: Active	WSSN:	Source ID/Well No:

Well ID: 03000011679

Elevation:

Latitude: 42.44053

Longitude: -85.7026

Method of Collection: GPS Std Positioning Svc SA Off

Distance and Direction from Road Intersection:
40' w summit & 250' n south point trail

Well Owner: Watts COnstruction

Well Address:
258 Summit Path
Otsego, MI 49078

Owner Address:
5071 Gull Rd
Kalamazoo, MI 49048

Drilling Method: Rotary
Well Depth: 119.00 ft **Well Use:** Heat Pump - Return
Well Type: New **Date Completed:** 8/24/2011

Casing Type: PVC plastic **Height:** 1.00 ft. above grade
Casing Joint: Solvent welded/glued
Casing Fitting: None

Diameter: 5.00 in. to 119.00 ft. depth SDR: 21.00

Borehole: 9.75 in. to 119.00 ft. depth

Pump Installed: Yes **Pump Installation Only:** No
Pump Installation Date: 8/24/2011 **HP:** 0.50
Manufacturer: AquaDuty **Pump Type:** Submersible
Model Number: t5m4cps 52 **Pump Capacity:** 10 GPM
Drop Pipe Length: 84.00 ft. **Pump Voltage:** 230
Drop Pipe Diameter: 1.00 in **Drilling Record ID:**
Draw Down Seal Used No

Pressure Tank Installed: Yes
Pressure Tank Type: Diaphragm/bladder
Manufacturer: Flex Life Flexcon
Model Number: pc88 **Tank Capacity:** 10.0 Gallons
Pressure Relief Valve Installed: Yes

Static Water Level: 22.00 ft. Below Grade
Well Yield Test: **Yield Test Method:** Air
Pumping level 40.00 ft. after 1.00 hrs. at 50 GPM

Formation Description	Thickness	Depth to Bottom
Brown Clay	7.00	7.00
Sand & Gravel	15.00	22.00
Sand & Gravel Water Bearing	97.00	119.00

Screen Installed: Yes **Filter Packed:** Yes
Screen Diameter: 5.00 in. **Blank:** 1.00 ft. Above
Screen Material Type: PVC-slotted

Slot	Length	Set Between
15.00	5.00 ft	113.00 ft. and 119.00 ft.

Fittings: None

Well Grouted: Yes **Grouting Method:** Grout pipe outside casing

Grouting Material	Bags	Additives	Depth
Concrete	10.00	None	0.00 ft. to 110.00 ft.

Wellhead Completion: Pitless adapter

Geology Remarks:

Nearest Source of Possible Contamination:

Type	Distance	Direction
Septic tank	100 ft.	West

Drilling Machine Operator Name: Mitch Vickery
Employment: Employee
Pump Installer: Anthony Fales
Contractor Type: Water Well Drilling Contractor **Reg No:** 01-1811
Business Name: Kraai Well Drilling
Business Address: 110 124th Ave, Shelbyville, MI, 49344

Water Well Contractor's Certification

This well/pump was constructed under my supervision and I hereby certify that the work complies with Part 127 Act 368 PA 1978 and the well code.

Signature of Registered Contractor **Date**

General Remarks:

Other Remarks:

Water Well And Pump Record

Completion is required under authority of Part 127 Act 368 PA 1978.
Failure to comply is a misdemeanor.

Wellogic

Import ID:

Tax No:	Permit No:	County: Allegan			Township: Otsego
		Town/Range: 01N 12W	Section: 27	Well Status: Active	WSSN:

Source ID/Well No:

Well ID: 03000012539

Elevation:

Latitude: 42.44589

Longitude: -85.70227

Method of Collection: GPS-Std Positioning Svc SA Off

Distance and Direction from Road Intersection: 60' S of Elm St & 1/4 Mi W of 16th St

Well Owner: Stewart Wallace

Well Address:	Owner Address:
1616 Elm St Otsego, MI 49078	1616 Elm St Otsego, MI 49078

Drilling Method: Rotary
Well Depth: 40.00 ft. Well Use: Household
Well Type: Replacement Date Completed: 6/15/2013

Casing Type: PVC plastic Height: 1.00 ft above grade
Casing Joint: Solvent welded/glued
Casing Fitting: None

Diameter: 5.00 in. to 35.00 ft. depth SDR 21.00

Borehole: 6.75 in. to 40.00 ft. depth

Pump Installed: Yes Pump Installation Only: No
Pump Installation Date: 6/15/2013 HP: 0.50
Manufacturer: AquaDuty Pump Type: Submersible
Model Number: t5m4cp852 Pump Capacity: 10 GPM
Drop Pipe Length: 24.00 ft. Pump Voltage: 115
Drop Pipe Diameter: 1.00 in Drilling Record ID:
Draw Down Seal Used: No

Pressure Tank Installed: Yes
Pressure Tank Type: Diaphragm/bladder
Manufacturer: Well X Trol
Model Number: wx 202 Tank Capacity: 20.0 Gallons
Pressure Relief Valve Installed: Yes

Static Water Level: 9.00 ft. Below Grade
Well Yield Test: Yield Test Method: Air
Pumping level 30.00 ft. after 1.00 hrs. at 30 GPM

Formation Description	Thickness	Depth to Bottom
Brown Clay & Sand	6.00	6.00
Sand & Gravel	5.00	11.00
Sand & Gravel Water Bearing	29.00	40.00

Screen Installed: Yes Filter Packed: Yes
Screen Diameter: 5.00 in. Blank:
Screen Material Type: PVC-slotted

Slot	Length	Set Between
15.00	5.00 ft.	35.00 ft. and 40.00 ft.

Fittings: None

Well Grouted: Yes Grouting Method: Grout pipe outside casing

Grouting Material	Bags	Additives	Depth
Bentonite slurry	3.00	None	0.00 ft. to 35.00 ft.

Wellhead Completion: Pitless adapter

Geology Remarks:

Nearest Source of Possible Contamination:

Type	Distance	Direction
Sanitary sewer	75 ft.	South

Abandoned Well Plugged: Yes

Casing Diameter: 2 in. Casing Removed: No
Plugging Material: Bentonite chips/pellets
No. of Bags: 1.25 Well Depth: 40 ft.

Drilling Machine Operator Name: Mitch Vickery
Employment: Employee
Pump Installer: Adam Hazen
Contractor Type: Water Well Drilling Contractor Reg No: 03-1671
Business Name: Ronald Kaapi Well Drilling
Business Address: 110-124th Avenue, Shelbyville, MI, 49344

Water Well Contractor's Certification

This well/pump was constructed under my supervision and I hereby certify that the work complies with Part 127 Act 368 PA 1978 and the well code.

Signature of Registered Contractor Date

General Remarks:

Other Remarks:

Water Well And Pump Record

Completion is required under authority of Part 127 Act 368 PA 1978.
Failure to comply is a misdemeanor.

Wellogic

Import ID:

Tax No:	Permit No:	County: Allegan	Township: Otsego

Town/Range:	Section:	Well Status:	WSSN:	Source ID/Well No:
01N 12W	27	Active		

Well ID: 03000012876

Elevation:

Latitude: 42.44571

Longitude: -85.70529

Method of Collection: GPS Std Pos-boxing Svc SA Off

Distance and Direction from Road Intersection:
North 102nd ave, West 16th Street

Well Owner: Lake Asendash

Well Address:	Owner Address:
332 South 16th Street Otsego, MI 49078	332 South 16th Street Otsego, MI 49078

Drilling Method: Rotary
Well Depth: 82.00 ft
Well Use: Household
Well Type: Replacement
Date Completed: 12/3/2013

Casing Type: PVC plastic
Height: 1.00 ft above grade
Casing Joint: Solvent welded/glued
Casing Fitting:

Diameter: 5.00 in. to 76.00 ft. depth SDR 21.00

Borehole: 8.75 in. to 82.00 ft. depth

Static Water Level: 6.00 ft. Below Grade
Well Yield Test:
Yield Test Method: Air
Pumping level 25.00 ft. after 1.00 hrs. at 50 GPM

Screen Installed: Yes
Filter Packed: Yes
Screen Diameter: 5.00 in
Blank:
Screen Material Type: PVC-slotted

Slot	Length	Set Between
15.00	6.00 ft	76.00 ft. and 82.00 ft.

Fittings: None

Well Grouted: Yes
Grouting Method: Grout pipe outside casing

Grouting Material	Bags	Additives	Depth
Bentonite slurry	7.00	None	0.00 ft. to 73.00 ft

Wellhead Completion: Pitless adapter

Nearest Source of Possible Contamination:

Type	Distance	Direction
Septic tank	75 ft	Northeast

Abandoned Well Plugged: Yes

Casing Diameter: 4 in.
Casing Removed: Yes
Plugging Material: Bentonite chips/pellets
No. of Bags: 5.00
Well Depth: 35 ft.

Pump Installed: Yes
Pump Installation Only: No
Pump Installation Date: 12/3/2013
HP: 0.50
Manufacturer: AquaDuty
Pump Type: Submersible
Model Number: T5M4CP9-52
Pump Capacity: 13 GPM
Drop Pipe Length: 44.00 ft
Pump Voltage: 230
Drop Pipe Diameter: 1.00 in
Drilling Record ID:
Draw Down Seal Used: No

Pressure Tank Installed: Yes
Pressure Tank Type: Diaphragm/bladder
Manufacturer: Flex-Ule-Flexcon
Model Number: PC 35
Tank Capacity: 25.0 Gallons
Pressure Relief Valve Installed: Yes

Formation Description	Thickness	Depth to Bottom
Sand	36.00	36.00
Gray Clay	13.00	49.00
Sand & Gravel	10.00	59.00
Gray Clay Sand Gravel	6.00	65.00
Sand & Gravel Water Bearing	17.00	82.00

Geology Remarks:

Drilling Machine Operator Name: Mitch Vickery
Employment: Employee
Pump Installer: Anthony Fales

Contractor Type: Water Well Drilling Contractor
Reg No: 03-1691
Business Name: Ronald Kraai Well Drilling
Business Address: 110-124th Avenue Shelbyville, MI, 49344

Water Well Contractor's Certification

This well/pump was constructed under my supervision and I hereby certify that the work complies with Part 127 Act 368 PA 1978 and the well code

Signature of Registered Contractor
Date

General Remarks:

Other Remarks:

Water Well And Pump Record

Completion is required under authority of Part 127 Act 368 PA 1978,
Failure to comply is a misdemeanor

Wellogic

Import ID:

Tax No:	Permit No:	County: Allegan			Township: Otsego	
		Town/Range: 01N 12W	Section: 27	Well Status: Active	WSSN:	Source ID/Well No:

Well ID: 03000013479

Elevation:

Latitude: 42.44977

Longitude: -85.70504

Method of Collection: GPS Std Positioning Svc SA Off

Distance and Direction from Road Intersection:
North Sycamore East Spring Brook

Well Owner: Jeff Hoyt

Well Address:	Owner Address
393 Spring Brook Otsego , MI 49078	2561 104th Ave Otsego , MI 49078

Drilling Method: Rotary
Well Depth: 46.00 ft Well Use: Household
Well Type: New Date Completed: 10/3/2014

Casing Type: PVC plastic Height: 1.00 ft above grade
Casing Joint: Solvent welded-glued
Casing Fitting: None

Diameter: 5.00 in. to 40.00 ft. depth SDR. 21.00

Borehole: 8.75 in to 46.00 ft depth

Pump Installed: Yes Pump Installation Only: No
Pump Installation Date: 10/3/2014 HP: 0.50
Manufacturer: AquaDuty Pump Type: Submersible
Model Number: 15m4cod 50 Pump Capacity: 10 GPM
Drop Pipe Length: 34.00 ft. Pump Voltage: 230
Drop Pipe Diameter: 1.00 in. Drilling Record ID:
Draw Down Seal Used: No

Pressure Tank Installed: Yes
Pressure Tank Type: Diaphragm/bladder
Manufacturer: Flex Lite-Flexcon
Model Number: Pc-86 Tank Capacity: 26.0 Gallons
Pressure Relief Valve Installed: Yes

Static Water Level 8.00 ft. Below Grade
Well Yield Test: Yield Test Method: Air
Pumping level 25.00 ft after 1.00 hrs at 50 GPM

Formation Description	Thickness	Depth to Bottom
Sand	10.00	10.00
Gray Clay	4.00	14.00
Sand & Gravel Water Bearing	32.00	46.00

Screen Installed: Yes Filter Packed: Yes
Screen Diameter 5.00 in Blank:
Screen Material Type: PVC-slotted

Slot	Length	Set Between
15.00	6.00 ft	40.00 ft. and 46.00 ft

Fittings: None

Well Grouted: Yes Grouting Method: Grout pipe outside casing

Grouting Material	Bags	Additives	Depth
Bentonite slurry	4.00	None	0.00 ft to 35.00 ft

Wellhead Completion: Pitless adapter

Geology Remarks:

Nearest Source of Possible Contamination:

Type	Distance	Direction
Septic tank	75 ft	North

Drilling Machine Operator Name: Mitch Vickery
Employment: Employee
Pump Installer: Adam Hazen

Contractor Type: Water Well Drilling Contractor Reg No: 03-1601
Business Name: Ronald Kraai Well Drilling
Business Address: 110-124th Avenue, Shelbyville, MI, 49344

Water Well Contractor's Certification

This well/pump was constructed under my supervision and I hereby certify that the work complies with Part 127 Act 368 PA 1978 and the well code.

Signature of Registered Contractor Date

General Remarks:

Other Remarks:

Water Well And Pump Record

Completion is required under authority of Part 127 Act 368 PA 1978.
Failure to comply is a misdemeanor.

Wellogic

Import ID:

Tax No:	Permit No:	County: Allegan			Township: Otsego	
		Town/Range: 01N 12W	Section: 27	Well Status: Active	WSSN:	Source ID/Well No.

Well ID: 03000013858

Elevation:

Latitude: 42.44708

Longitude: -85.705585

Method of Collection: GPS Std Positioning Svc SA Off

Distance and Direction from Road Intersection:

Well Owner: BERNIE DEBREEYNE

Well Address:	Owner Address:
1651 ELM STREET OTSEGO, MI 49078	1651 ELM STREET OTSEGO, MI 49078

Drilling Method: Cable Tool
Well Depth: 92.00 ft Well Use: Household
Well Type: Replacement Date Completed: 1-9-2015

Casing Type: Steel galvanized Height: 1.00 ft above grade
Casing Joint: Threaded & coupled
Casing Fitting: Drive shoe

Diameter: 4.00 in to 87.00 ft. depth

Borehole: 4.00 in to 86.00 ft. depth

Pump Installed: Yes Pump Installation Only: No
Pump Installation Date: HP: 0.50
Manufacturer: Flint & Walling Pump Type: Submersible
Model Number: JF10505005 Pump Capacity: 10 GPM
Drop Pipe Length: 25.00 ft Pump Voltage: 230
Drop Pipe Diameter: 1.00 in Drilling Record ID:
Draw Down Seal Used: No

Pressure Tank Installed: No
Pressure Relief Valve Installed: No

Static Water Level: 5.00 ft Below Grade
Well Yield Test: Yield Test Method: Plunger
Pumping level 10.00 ft. after 1.00 hrs. at 25 GPM

Formation Description	Thickness	Depth to Bottom
Sand	27.00	27.00
Clay	51.00	78.00
Sand Water Bearing	14.00	92.00

Screen Installed: Yes Filter Packed: No
Screen Diameter: 3.00 in. Blank: Above
Screen Material Type: Unknown

Slot	Length	Set Between
10.00	5.00 ft.	87.00 ft. and 92.00 ft.

Fittings: Neoprene packer

Well Grouted: Yes Grouting Method: Driveway grout

Grouting Material	Bags	Additives	Depth
Bentonite dry granular	3.00	None	4.00 ft. to 30.00 ft.

Wellhead Completion: Pitless adapter

Geology Remarks:

Nearest Source of Possible Contamination:

Type	Distance	Direction
Septic tank	80 ft	North

Drilling Machine Operator Name: KEN ASHLEY
Employment: Subcontractor

Contractor Type: Water Well Drilling Contractor Reg No: 03-2165
Business Name: MCKENNEY WATER SERVICE
Business Address: 5036 108TH AVE, ALLEGAN, MI, 49010

Abandoned Well Plugged: Yes

Latitude: 42.44719 Longitude: -85.70656
Casing Diameter: 2 in Casing Removed: No
Plugging Material: Bentonite chips/pellets
No. of Bags: 1.00 Well Depth: 30 ft

Water Well Contractor's Certification

This well/pump was constructed under my supervision and I hereby certify that the work complies with Part 127 Act 368 PA 1978 and the well code

Signature of Registered Contractor Date

General Remarks:

Other Remarks:

Water Well And Pump Record

Completion is required under authority of Part 127 Act 368 PA 1978
Failure to comply is a misdemeanor.

Wellogic

Import ID:

Tax No:	Permit No: 144572	County: Allegan	Township: Otsego

Town/Range:	Section:	Well Status:	WSSN:	Source ID/Well No:
01N 12W	27	Active		

Well ID: 03000011232

Elevation:
Latitude: 42.44709
Longitude: -85.70553
Method of Collection: GPS Std Positioning Svc SA Off

Distance and Direction from Road Intersection:
20 FT EAST OF SPRINGBROCK LOCATED ON THE NORTH SIDE OF ELM ST.

Well Owner: VACANT HOUSE

Well Address:	Owner Address:
1645 ELM ST. OTSEGO, MI 49078	1645 ELM ST OTSEGO, MI 49078

Drilling Method: Rotary
Well Depth: 44.00 ft
Well Use: Household
Well Type: Replacement
Date Completed: 8/16/2010

Casing Type:
Height:
Casing Joint:
Casing Fitting:

Diameter:

Borehole:

Static Water Level:
Well Yield Test:
Yield Test Method:

Unrestricted Flow Rate:

Screen Installed:
Filter Packed:
Screen Diameter: in
Blank:
Screen Material Type:
Slot
Length
Set Between

Fittings:

Well Grouted: Unknown

Wellhead Completion: 12 inches above grade

Pump Installed: Yes
Pump Installation Only: Yes
Pump Installation Date: 8/20/2010
HP: 0.50
Manufacturer: Flint & Walling
Pump Type: Submersible
Model Number: 4F10505305
Pump Capacity: 10 GPM
Drop Pipe Length: 25.00 ft
Pump Voltage:
Drop Pipe Diameter: 1.00 in
Drilling Record ID:
Draw Down Seal Used: No

Pressure Tank Installed: Yes
Pressure Tank Type: Diaphragm/bladder
Manufacturer: Amtrol
Model Number: CH4202
Tank Capacity: 5.2 Gallons
Pressure Relief Valve Installed: Yes

Formation Description	Thickness	Depth to Bottom

Geology Remarks:

Nearest Source of Possible Contamination:

Type	Distance	Direction
Septic tank	75 ft	North

Abandoned Well Plugged: No
Reason Not Plugged: Other

Drilling Machine Operator Name: MIKE SMITH
Employment: Subcontractor
Pump Installer: TRAVIS WEESNER
Contractor Type: Water Well Drilling Contractor
Reg No: 38-2458
Business Name: Water Worx Well Drilling
Business Address: 9558 S 38th St, Scotts, MI 49088

Water Well Contractor's Certification

This well was drilled under my supervision and this report is true to the best of my knowledge and belief

Signature of Registered Contractor
Date

General Remarks:

Other Remarks: Not Plugged Reason:WELL IS UNDER A SLAB UNDER A DECK

Water Well And Pump Record

Completion is required under authority of Part 127 Act 368 PA 1978
Failure to comply is a misdemeanor.

Wellogic

Import ID:

Tax No:	Permit No:	County: Allegan			Township: Otsego	
		Town/Range: 01N 12W	Section: 27	Well Status: Active	WSSN:	Source ID/Well No:

Well ID: 03000011342

Elevation:
Latitude: 42.43991
Longitude: -85.70715
Method of Collection: GPS Std Positioning Svc SA Off

Distance and Direction from Road Intersection:
.25 mile w 16th st & 50' S OF SOUTH POINTE TRI

Well Owner: WATTS CONSTRUCTION

Well Address:	Owner Address:
1569 SOUTH POINTE TRAIL OTSEGO MI	5071 GULL RD KALAMAZOO, MI 49048

Drilling Method: Rotary
Well Depth: 114.00 ft. Well Use: Household
Well Type: New Date Completed: 5/4/2010

Casing Type: PVC plastic Height:
Casing Joint: Unknown
Casing Fitting: None

Diameter: 5.00 in. to 108.00 ft. depth SDR: 21.00

Borehole: 8.75 in. to 114.00 ft. depth

Pump Installed: Yes Pump Installation Only: No
Pump Installation Date: 5/4/2010 HP: 0.50
Manufacturer: AquaDuty Pump Type: Submersible
Model Number: Pump Capacity: 10 GPM
Drop Pipe Length: 64.00 ft. Pump Voltage: 120
Drop Pipe Diameter: 1.00 in. Drilling Record ID:
Draw Down Seal Used: No

Pressure Tank Installed: Yes
Pressure Tank Type: Diaphragm/bladder
Manufacturer: Flex Lite Flexcon
Model Number: Tank Capacity: 8.0 Gallons
Pressure Relief Valve Installed: Yes

Static Water Level: 15.00 ft. Below Grade
Well Yield Test: Yield Test Method: Air
Pumping level 32.00 ft. after 1.00 hrs. at 50 GPM

Formation Description	Thickness	Depth to Bottom
Brown Clay	6.00	6.00
Brown Clay Gravel Sand	5.00	11.00
Sand & Gravel	51.00	62.00
Gray Clay	18.00	80.00
Sand & Gravel Water Bearing	34.00	114.00

Screen Installed: Yes Filter Packed: Yes
Screen Diameter: 5.00 in. Blank:
Screen Material Type: PVC-slotted

Slot	Length	Set Between
15.00	6.00 ft	108.00 ft. and 114.00 ft

Fittings: Unknown

Well Grouted: Yes Grouting Method: Unknown

Grouting Material	Bags	Additives	Depth
Bentonite slurry	11.00	None	0.00 ft. to 108.00 ft.

Wellhead Completion: Pitless adapter

Geology Remarks:

Nearest Source of Possible Contamination:

Type	Distance	Direction
Septic tank	100 ft.	South

Drilling Machine Operator Name: MITCH V.
Employment: Employee
Pump Installer: A, FA, FS

Contractor Type: Water Well Drilling Contractor Reg No: 03-1601
Business Name: KRAAI WELL DRLG
Business Address:

Water Well Contractor's Certification

This well/pump was constructed under my supervision and I hereby certify that the work complies with Part 127 Act 368 PA 1978 and the well code

Signature of Registered Contractor Date

General Remarks: IRON = 1-2, HARDNESS = 16

Other Remarks

Water Well And Pump Record

Completion is required under authority of Part 127 Act 368 PA 1978.
Failure to comply is a misdemeanor.

Wellogic

Import ID:

Tax No:	Permit No:	County: Allegan	Township: Otsego

Town/Range:	Section:	Well Status:	WSSN:	Source ID/Well No:
01N 12W	27	Active		

Well ID: 03000011343

Elevation:

Latitude: 42.43978

Longitude: -85.70793

Method of Collection: GPS Std Positioning Svc SA Off

Distance and Direction from Road Intersection:
25 Mi E W 16TH ST & 70' S S OUTH POINTE TRAIL

Well Owner: WATTS CONST

Well Address:	Owner Address:
1672 SOUTH POINTE TRAIL OTSEGO, MI	5071 GULL RD KALAMAZOO, MI 49048

Drilling Method: Rotary
Well Depth: 113.00 ft Well Use: Household
Well Type: New Date Completed 5/4/2010

Casing Type: PVC plastic Height:
Casing Joint: Unknown
Casing Fitting: None

Diameter: 5.00 in. to 107.00 ft. depth SDR: 21.00

Borehole: 8.75 in. to 113.00 ft. depth

Pump Installed: Yes Pump Installation Only: No
Pump Installation Date: 5/4/2010 HP: 0.50
Manufacturer: AquaDuty Pump Type: Submersible
Model Number: Pump Capacity: 10 GPM
Drop Pipe Length: 64.00 ft Pump Voltage: 230
Drop Pipe Diameter: 1.00 in Drilling Record ID:
Draw Down Seal Used: No

Pressure Tank Installed: Yes
Pressure Tank Type: Unknown
Manufacturer: Flex Lite Fiberglass
Model Number: Tank Capacity: 9.0 Gallons
Pressure Relief Valve Installed: Yes

Static Water Level: 15.00 ft. Below Grade
Well Yield Test: Yield Test Method: Air
Pumping level 30.00 ft. after 1.00 hrs. at 50 GPM

Formation Description	Thickness	Depth to Bottom
Brown Clay	9.00	9.00
Sand & Gravel	52.00	61.00
Gray Clay	19.00	80.00
Sand & Gravel Water Bearing	33.00	113.00

Screen Installed: Yes Filter Packed: Yes
Screen Diameter: 5.00 in. Blank:
Screen Material Type: PVC-slotted

Slot	Length	Set Between
15.00	6.00 ft	107.00 ft. and 113.00 ft.

Fittings: Unknown

Well Grouted: Yes Grouting Method: Unknown

Grouting Material	Bags	Additives	Depth
Bentonite slurry	11.00	None	0.00 ft. to 105.00 ft.

Geology Remarks:

Wellhead Completion: Pitless adapter

Nearest Source of Possible Contamination:

Type	Distance	Direction
Septic tank	100 ft.	South

Drilling Machine Operator Name: MITCH VICKERY
Employment: Employee
Pump Installer: ANTONY FALES

Contractor Type: Water Well Drilling Contractor Reg No: 03 1601
Business Name: KRAAI WELL DRLG
Business Address:

Water Well Contractor's Certification

This well/pump was constructed under my supervision and I hereby certify that the work complies with Part 127 Act 368 PA 1978 and the well code.

Signature of Registered Contractor Date

General Remarks: IRON = 1-2, HARDNESS = 15

Other Remarks:

TECHNICAL MEMO 2

SUBJECT: Baughman Drain – Additional Hydrogeological Evaluation

DATE: February 11, 2019 **PROJECT NO.:** 180488HG

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Introduction

Fishbeck, Thompson, Carr & Huber, Inc. (FTCH) has prepared this Technical Memorandum on behalf of Land and Resource Engineers (LRE) and the Allegan County Drain Commissioner to further evaluate hydrogeological conditions in the vicinity of the Baughman Drain, located in Otsego, Allegan County, Michigan. Preliminary evaluation of the site was documented in *Technical Memo 1, Baughman Drain Hydrogeological Evaluation* (FTCH, April 6, 2018).

The preliminary hydrogeological evaluation indicated the proposed installation of underdrains and improvements to existing surface water drainage features would be expected to lower groundwater elevations throughout much of the study area, but that further evaluation was recommended prior to final design. The additional study included the following:

- Review of previous investigation results and published geological/hydrogeological data for the area;
- Installation of 12 piezometers to provide more data regarding the hydrogeological conditions;
- Single-well hydraulic conductivity tests at the new piezometers to estimate the aquifer hydraulic conductivity;
- Installation of stream piezometers to evaluate the hydraulic connection to the aquifer;
- Streamflow gaging to estimate stream discharge; and
- Groundwater flow mapping to confirm groundwater flow conditions.

The additional data was evaluated and incorporated into a three-dimensional numerical groundwater flow model to corroborate the previous analytical groundwater flow modeling efforts. The model was used to provide a greater level of confidence regarding the estimated effects of underdrain installation and improvements to the existing surface water drainage.

Hydrogeological Investigation Methods and Results

General Hydrogeologic Setting

The study area is located just south of the city limits of Otsego, Allegan County, Michigan. Hydrologically, the study area is bounded by the Kalamazoo River to the north and Pine Creek to the west as shown on Figure 1. Baughman Drain joins the Pine Creek impoundment approximately one mile west of the subject neighborhood. Figure 2 depicts the boundaries of the Baughman Drain District and surface elevation contours. The subject neighborhood is also surrounded by three tributaries to the Baughman Drain as illustrated on Figure 3. Branch No. 1 begins near the southeast corner of the study area, flows due west, then angles northwest where it joins Baughman Drain. Branch No. 2 also begins near the southeast corner of the study area and flows due north where it joins Baughman Drain. Branch No. 3 begins on the far east boundary of the study area, flows due west and joins Branch No. 2.

According to *Quaternary Geology of Michigan* (Farrand, W.R. and Bell, D.L., 1982), the entire drainage district lies within an area of glacial outwash sand and gravel and postglacial alluvium. The piezometers and soil borings drilled for this and previous investigations confirmed the generally coarse-grained texture of the geology in the study area.

Piezometer Installation

Twelve piezometers (PZ-9 through PZ-20) were installed at the locations shown on Figure 3. These piezometers were installed from July 9 through 11, 2018, by Job Site Services of Cedar Springs, Michigan, using a direct-push drill rig. The piezometers were constructed of 2-inch-diameter PVC casings, and 2-inch-diameter, 5-foot long, 0.010-inch slotted screens. The screens were generally set approximately 10 to 15 feet below ground surface (bgs), except for PZ-20 which was installed adjacent to PZ-8 into a deeper aquifer beneath a confining clay layer with a screen interval of 34-39 feet bgs. The stratigraphy encountered during drilling at each location was logged by a geologist from FTCH. After installation, the top-of-casing elevations were measured by surveyors from LRE to the nearest 0.01 feet. The construction details are summarized in Table 1 and the boring logs are included in Appendix 1.

The geology encountered at PZ-9 through PZ-20 was generally similar to earlier investigations (PZ-1 through PZ-8). The soils typically consisted of sand or sand and gravel mixtures; the sand size ranged from fine- to coarse-grained. Finer-textured materials (i.e., silts and clays) were rarely observed except for PZ-20, which encountered silty clay and clay between 13.5 and 20 feet bgs. This correlates with the geology encountered in PZ-8, SB-3, and SB-5 of previous investigations. Other exceptions included PZ-19, which encountered approximately 2 feet of clay-rich strata, and PZ-6 of the previous investigation, which indicated sand with silt throughout. Logs for the previous investigations are also included in Appendix 1.

Hydraulic Conductivity Testing

Single-well hydraulic conductivity tests (slug tests) were conducted in all the new piezometers. These tests were conducted by inducing a “slug” of water by vacuum or pressure and recording the return of the water level to static conditions once released. The data were analyzed using the Bouwer and Rice method (1976). The resulting hydraulic conductivity values indicate how rapidly groundwater can move through the aquifer. The results, summarized in Table 2, range from 53 to 289 feet per day (feet/day) with a geometric mean of 99.6 feet/day. These results are consistent with the screened aquifer materials. The slug test analysis graphs are included in Appendix 2.

Stream Piezometers

In addition to piezometers PZ-9 through PZ-20, streambed piezometers were installed by hand at several locations along the drains (see Figure 3). Drive-point piezometers (DP-1 through DP-6) consist of 1.25-inch galvanized casings with 3-foot long, 0.010-inch slotted stainless-steel drive-point screens. These drive-points were driven approximately 4 to 5 feet below the streambed to evaluate groundwater elevations and vertical hydraulic gradients between the aquifer and the surface water. After installation, the top-of-casing elevations were measured by surveyors from LRE to the nearest 0.01 foot. Expendable point piezometers (EXP-1 through EXP-9) were also installed below the streambeds to provide additional information regarding vertical hydraulic gradients. These measuring points consist of 3/8-inch HDPE tubing attached to a 0.5-foot long stainless-steel screen driven below the streambed. Construction logs for the DP and EXP piezometers are included in Appendix 1.

The vertical hydraulic gradients at these locations are summarized in Table 3. The vertical gradients were all negative indicating upward groundwater flow or discharge from the aquifer to the drains (gaining streams). The exception was EXP-3 where flow was neither upward or downward; this may be due to the very coarse-grained material encountered at this location.

Streamflow Gaging

Streamflow was measured at nine locations (SF-01 through SF-09) illustrated on Figure 3. The streamflow measurements were conducted in accordance with U.S. Geological Survey (USGS) methods and the results are presented in Table 4. These flow rates were used to assist with groundwater model calibration.

Groundwater Flow Mapping

Water levels were measured at all site piezometers, staff gages, and drive-point piezometers on July 24, 2018. The water level measurements were converted to groundwater and surface water elevations as summarized in Table 1. The groundwater elevations were contoured as depicted on Figure 4. This groundwater elevation pattern is consistent with previous investigations. South of Branch No. 1, groundwater flow is marked by a steep hydraulic gradient. Between Branch No. 1 and the Baughman Drain, beneath Prairiewood Court, a groundwater mound is present , suggesting a divergent groundwater flow condition with movement toward the north, west, south and east. East of Branch No 2, groundwater flow is westerly to northwesterly. Deflections of the groundwater contours are depicted on the map and indicate venting conditions to the various drains.

Groundwater Flow Model

The data from the hydrogeological investigations were used to develop a three-dimensional, numerical groundwater flow model. The simple groundwater flow model used for the preliminary evaluation was an analytical solution and only allowed constant values for input parameters such as aquifer thickness, hydraulic conductivity, and stream conductance, thereby limiting its ability to simulate real-world conditions. The numerical groundwater flow model utilized during this evaluation allows variable inputs for all these parameters and thus can simulate the hydrogeological conditions more accurately. The following sections briefly describe the model development and predictive simulations; detailed technical information regarding the model setup, sensitivity analysis, and calibration is provided in Appendix 3.

Model Conceptualization

A conceptual site model of groundwater flow was developed based on the hydrogeologic characterization. The conceptual model outlines the assumptions of the groundwater flow system used to guide the groundwater model development.

The site is bounded by two major hydraulic boundaries: the Kalamazoo River to the north and Pine Creek to the west (see Figure 1). Groundwater and surface water within the subject area discharge to one of these surface water bodies. Additional loss of water is through evapotranspiration (ET). Within the study area, leakage of groundwater to deeper aquifers is assumed to be negligible based on low-permeability strata at depth. Rain that falls onto the subject neighborhood will either flow overland toward Baughman Drain and its tributaries, or infiltrate (minus ET) and recharge the groundwater system. Baughman Drain and its tributaries flow to Pine Creek. Some groundwater may underflow Baughman Drain and its tributaries before discharging to either Pine Creek or the Kalamazoo River. Minor tributaries to Pine Creek also exist within the model domain. Southeast of the subject neighborhood, an area of higher topography runs northeast to southwest and appears to form a surface water and groundwater divide. Regional geologic information indicates the overall geology is predominantly coarse-textured materials; however, variations in the hydraulic conductivity of the coarse-textured materials or minor deposits of fine-grained material may have a significant effect on groundwater flow.

Model Software Selection and Model Setup

The conceptual model outlined above was converted to a three-dimensional, finite-difference numerical model (MODFLOW, McDonald and Harbaugh, 1988). The software package *Groundwater Vistas* (Environmental Simulations, Inc., 1996-2017) was used for pre- and post-processing the MODFLOW packages and results. Figures and other information with respect to the model setup are included in Appendix 3.

The model grid consists of 259 rows, 300 columns, and 3 layers with 164,406 active cells. The cell size generally ranges from 20 feet by 20 feet within the subject neighborhood to 100 feet by 100 feet outside of the focus area. The western and northern boundaries are composed of river nodes to simulate the Pine Creek and the Kalamazoo River (see Appendix 3). The elevations for the river nodes were estimated using USGS topographic quadrangle map. The southern and eastern boundaries were set as no-flow or streamline boundaries based on groundwater flow lines oriented perpendicular to the regional water table contour map developed by USGS and the Michigan Department of Environmental Quality (MDEQ). To the southeast, constant head nodes were established based on the regional groundwater flow map; these constant heads are set at a distance great enough from the area of interest so it would not significantly affect the simulation results.

Baughman Drain and its tributaries were modeled as river nodes except for the headwaters of the tributaries which were set as drain nodes (see Appendix 3). The elevations for these local drains were established using data from the streambed piezometers and staff gages. Recharge was initially set to 15 inches per year based on data from the MDEQ's *Groundwater Inventory and Mapping Project* (GWIM, MDEQ/USGS/MSU, 2005)

The aquifer geometry was constructed based on area supply well logs from the MDEQ's Wellogic database and the logs of the investigation borings. Appendix 4 includes figures illustrating the aquifer geometry which were developed using GMS - Groundwater Modeling System (Aquaveo, 2019). Ground surface elevations from water supply well records and the investigation borings were imported into the model for the upper boundary of the model. The top of a basal clay unit was selected and interpolated for use as the base of the model (see Appendix 4). For the purposes of this modeling effort, most of the model domain appears to consist of a single unconfined aquifer. However, the aquifer thickness between the ground surface and the top of the basal clay was divided into three equal layers so that in some areas low-permeability units could be simulated. One of these low-permeability areas exists beneath Branch No. 1 of Baughman Drain; this clay unit was simulated as Layer 2 near PZ-8/PZ-20. In addition, substantial clay units were designated along the eastern border in Layers 1 and 2. These low-permeability units are depicted in the hydraulic conductivity distribution figures in Appendix 3.

Preliminary Calibration and Sensitivity Analysis

The model, set up as described above, was calibrated to the hydraulic heads measured on July 24, 2018 (Figure 4 and Table 1). Additionally, the model was calibrated using stream flux measurements for Baughman Drain and its tributaries. For the initial calibration, constant values were used for hydraulic conductivity. Preliminary calibration resulted in a residual sum of squared error of 33.6. Additional calibration was needed, but a sensitivity analysis was performed first to evaluate the sensitivity of the model results to changes in each of the parameters and to further understand the hydrogeologic system.

The sensitivity analysis was performed using an automated parameter estimation program (PEST, Doherty, J., 2016). The sensitivity analysis indicated the most sensitive parameters were hydraulic conductivity and recharge, but also that the conductance of the drain and river reaches near Prairiewood Court were moderately sensitive.

Although the overall preliminary calibration statistics were within an acceptable range, the difference between simulated and observed heads was still greater than 1 foot along Prairiewood Court and the groundwater flow

characteristics, in particular the groundwater mound, were not adequately represented in the model solution. Due to this inaccuracy, additional calibration was considered warranted.

Model Calibration

To further improve the model calibration, the automated parameter estimation software PEST-ASP (Doherty, 2016) was used. An advantage of PEST-ASP is the use of "pilot points" which allow the user to assign a beginning parameter value at multiple locations throughout the model domain. Each pilot point is assigned an upper and lower bound for that parameter based on prior knowledge, in this case based on the typical hydraulic conductivity range for the various glacial and alluvial deposits. PEST then completes a series of iterative model runs varying the parameters during each execution until the best solution is calculated to most closely match the observed values of head at the head targets. In this case, PEST-ASP estimates the hydraulic conductivity value at each pilot point and each model cell in between using a kriging interpolation method. PEST-ASP was also able to incorporate the hydraulic conductivity data where the slug tests were conducted. River conductance, drain conductance, and recharge were also included in the PEST-ASP run.

The PEST-ASP run resulted in a well-calibrated model with a residual sum of squared error of 2.92. The simulated heads matched the observed heads closely and the calibration statistics were well within acceptable ranges. In general, a well-calibrated model has a scaled residual standard deviation of less than 10 percent; the scaled residual standard deviation for the calibrated model was 1.3 percent. The full head calibration statistics are presented in Table 5. The stream flux for the calibrated model was also within the same order of magnitude as the observed stream flux. The hydraulic conductivity fields generated by PEST for each layer are included in Appendix 3 as well as other calibration details. The calibrated uniform recharge value was 19 inches per year; this is higher than observed estimates but may be due to significant rainfall that occurred two and three days prior to the static water level measurements.

Predictive Simulations

The calibrated model was used as the starting point for predictive simulations. Two proposed underdrain layouts were simulated. Layout 1 includes an underdrain beneath the roadway of Prairiewood Court with a beginning elevation of 704.9 feet above mean sea level (amls) and an ending elevation (at Branch No. 1) of 701.6 feet amsl (see Figure 5). Layout 2 includes an underdrain placed along the back property lines of the parcels along the north side of Prairiewood Court with a beginning elevation of 704.5 feet amsl and an ending elevation of 701.3 feet amsl (see Figure 6). Both Layout 1 and Layout 2 also include a proposed underdrain beneath Elm Street with a beginning elevation of 705.8 feet amsl and an ending elevation of 702.6 feet amsl (at Branch No.2). The underdrains were all simulated as a 1-foot-diameter pipe with a hydraulic conductivity of 3,000 feet/day.

Simulation 1 (Figure 5) illustrates the predicted groundwater elevations in the study area using Layout 1 and with no cleanout of Baughman Drain or its tributaries. Note that the estimated basement elevations are included for some residences for comparison.

Simulation 2 (Figure 6) illustrates the predicted groundwater elevations in the study area using Layout 2 and with no cleanout of Baughman Drain or its tributaries.

For Simulations 3 and 4, the elevations of Baughman Drain and its tributaries were adjusted based on the proposed cleanout elevations from stream survey profiles provided by LRE. The elevations were dropped to the elevations provided by LRE along each profile plus 1 foot. This additional foot was included as a conservative measure so that the model simulations do not overestimate the effect of deepening the drains. The river and drain nodes for these reaches were assigned a streambed hydraulic conductivity of 10 feet/day. This may be low based on the average hydraulic conductivity of the aquifer of 99.6 feet/day but will also provide a reasonable safety factor. The LRE profile is included in Appendix 6.

Figure 7 illustrates Simulation 3 which includes Layout 1 with simulated cleanout of Baughman Drain and its tributaries.

Figure 8 illustrates Simulation 4 which includes Layout 2 with simulated cleanout of Baughman Drain and its tributaries.

The results of the groundwater modeling and predictive simulations are summarized as follows:

- Comparison of Figures 5 and 6 indicate Layout 1 is more effective at dropping water levels along Prairiewood Court and Layout 2 is only marginally more effective for parcels north of the Prairiewood Court parcels.
- Comparison of Figures 7 and 8 illustrate that the cleanout of Baughman Drain and its tributaries improve the overall drainage substantially for either underdrain layout, especially for parcels further north along West Sycamore and Oak Streets. Drawdown is predicted to be at least 1.5 feet greater along Oak Street with the drains cleaned out rather than just the underdrains.
- The underdrains and drain cleanouts are less effective for the Elm Street neighborhood; this may be due to groundwater under pressure due to the hills to the east and southeast. Still, cleanout of the drains reduces groundwater levels in the Elm Street and East Sycamore Street areas by approximately 0.5 feet compared to only underdrain installation.
- All simulations estimate that water levels will be below the estimated basement elevations shown on Figures 5 through 8 except for the eastern most parcel on Sycamore Street with no drain cleanouts.

Discussion and Model Limitations

Despite the extensive data collected in this and previous investigations, the exact cause of the groundwater mound observed beneath Prairiewood Court is uncertain given the available data. It is possible the groundwater mound is caused by upward leakage from a deeper aquifer; insufficient data is available to completely evaluate this possibility. However, if this is the cause, the underdrains would still drop the water table to the level of the underdrains. Another possible cause is unknown areas of low-permeability deposits. Although all the piezometers (besides PZ-6) documented relatively permeable materials, it is possible lower-permeability deposits exist between piezometers. For example, there are fairly large distances between PZ-16 and PZ-3, and PZ-18 and PZ-10. Low-permeability deposits in this area could inhibit groundwater flow toward Baughman Drain and or Branch No. 1. This is considered unlikely given the overall distribution of the piezometers and the lack of low-permeability deposits encountered. More borings could be drilled to fill in data gaps; however, the combination of underdrains and drain cleanouts are likely to reduce water levels over most of the study area given the prevalence of high-permeability material as encountered in the piezometers and measured by the slug tests. A third cause could be attributed to artificial recharge in the area (i.e., leaky water supply lines or storm sewers, etc.); however, there are no known sources of artificial recharge. There is a catch basin located on the south side of Prairiewood Court; but based on groundwater modeling and runoff calculations, this would not appear to contribute sufficient recharge to cause the relatively large groundwater mound.

As with any groundwater model, the accuracy of the simulation results may be limited by the accuracy of the input parameter estimates and the simplifying assumptions used to construct the flow model. The primary limitation for this flow model is the lack of measured data outside of the subject neighborhood. Even within the subject neighborhood, 20 piezometers have been installed to evaluate an area of over 130 acres. The highest density of measured data was collected in the vicinity of Prairiewood Court; inputs for outlying areas were limited to interpretation of published data. Supply well logs in outlying areas were used to evaluate hydrogeologic conditions, but supply wells are relatively sparse in some areas.

Despite these limitations, the groundwater flow model is considered the best reasonable method to predict the effects of the proposed underdrains and cleanout of Baughman Drain and its tributaries. Model calibration was well within accepted standards and the calibration generally correlates with the overall hydrogeologic conceptual site model.

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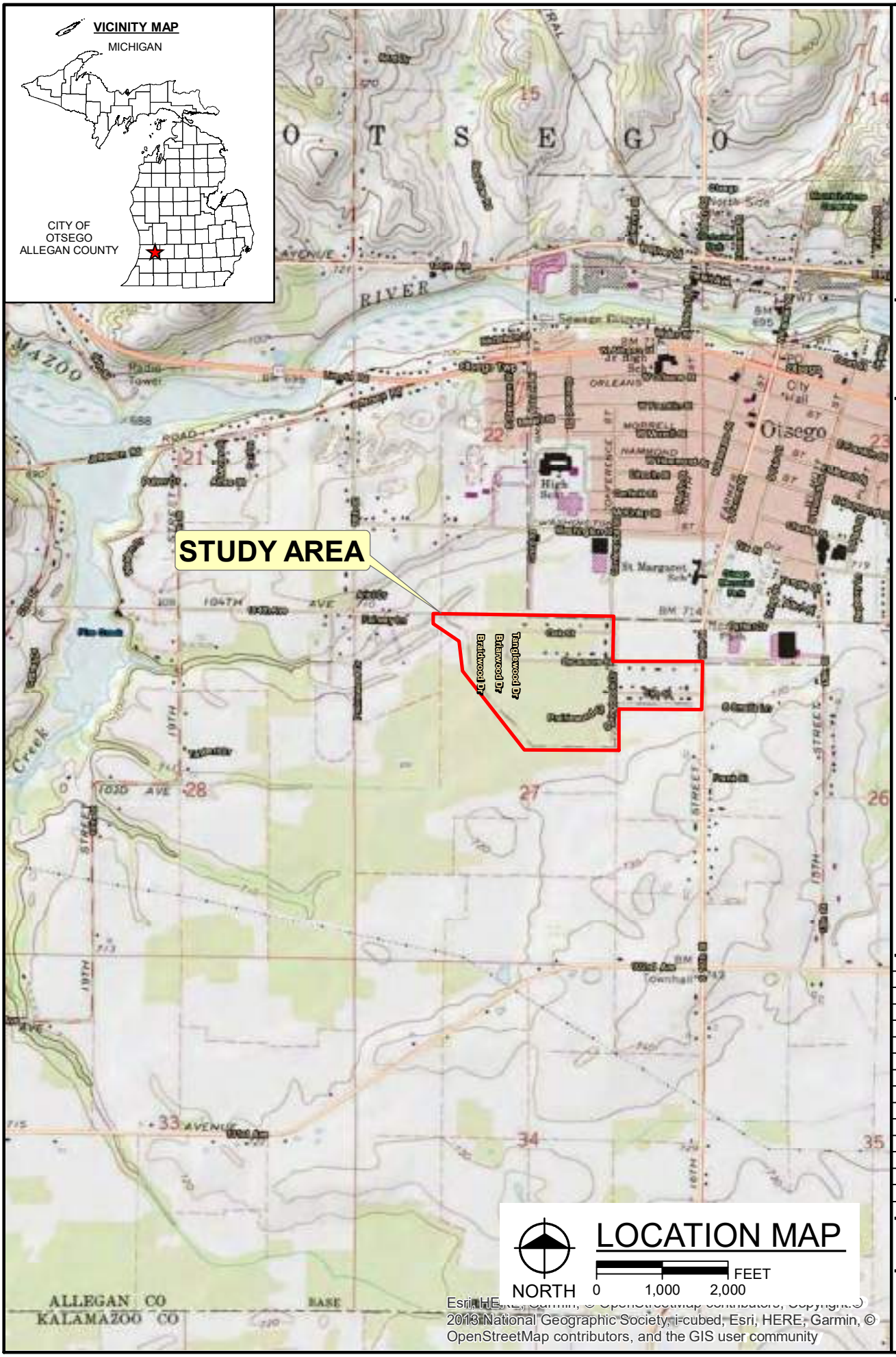
Figures



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Baughman Drain

Otsego, Allegan County, Michigan

Additional Hydrogeological Investigation

PROJECT NO.
180488

FIGURE NO.
1

PLOT INFO: Z:\2018\180488\CAD\GIS\mapdoc\Additional Hydro Invest\FIG01_LOCATION MAP.mxd Date: 2/11/2019 8:24:34 AM User: ACS

STUDY AREA

SCALE: 1" = 800'

NORTH

0 400 800 1600

BASE MAP ADAPTED FROM DRAWING PROVIDED BY LRE, 12/19/17

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Baughman Drain

Otsego, Allegan County, Michigan

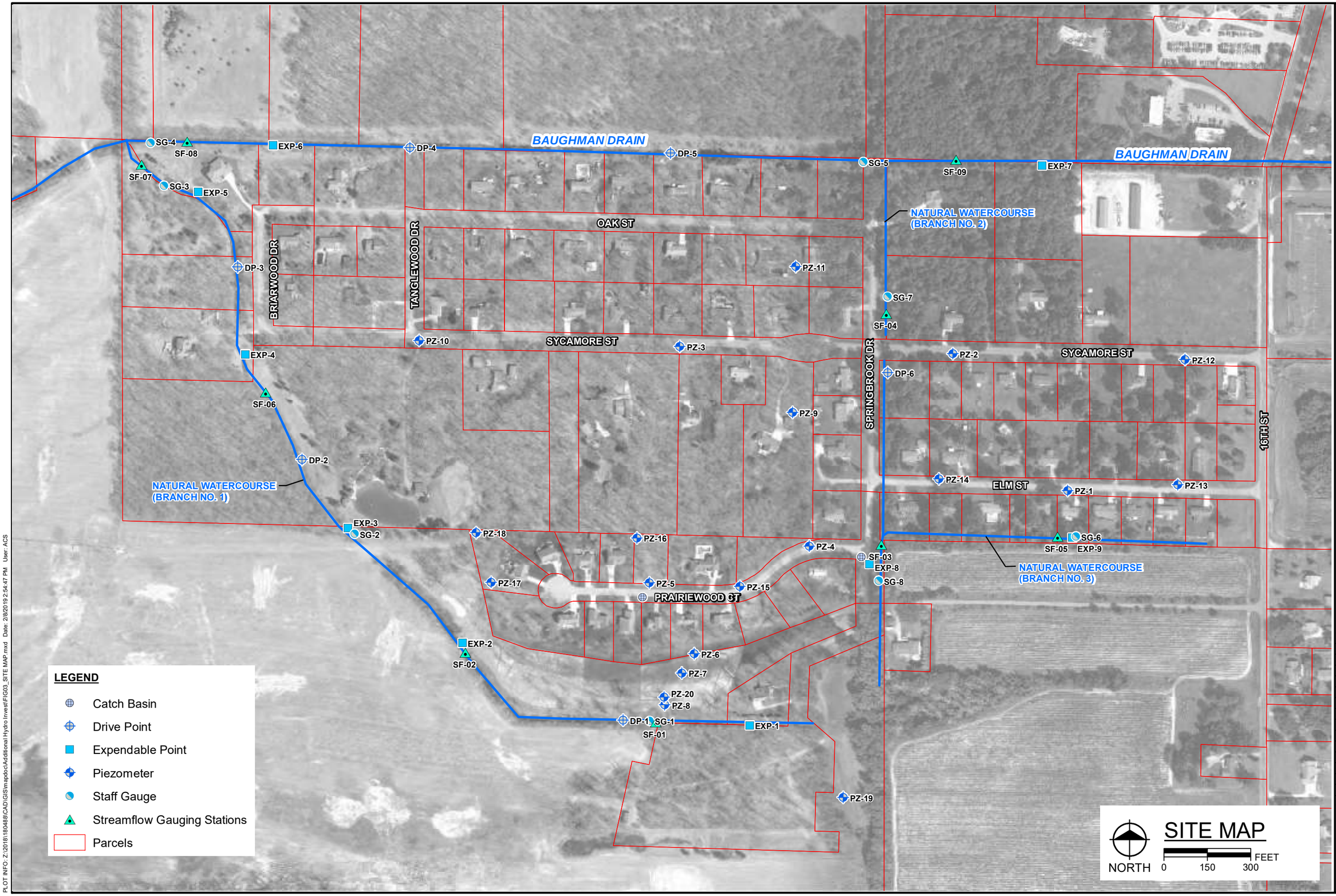
Additional Hydrogeological Investigation

PROJECT NO.

180488

FIGURE NO.

2



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Baughman Drain

Otsego, Allegan County, Michigan

Additional Hydrogeological Investigation

PROJECT NO.
180488

FIGURE NO.
3

PLOT INFO: Z:\2018\180488\CAD\GIS\mapdoc\Additional Hydro Invest\FIG03_SITE MAP.mxd Date: 2/8/2019 2:54:47 PM User: ACS

BAUGHMAN DRAIN

BAUGHMAN DRAIN

NATURAL WATERCOURSE (BRANCH NO. 2)

NATURAL WATERCOURSE (BRANCH NO. 1)

OAK ST

SYCAMORE ST

SYCAMORE ST

ELM ST

PRAIRIEWOOD CT

BRIARWOOD DR

TANGLEWOOD DR

SPRINGBROOK DR

15TH ST

699.63 SG-4

EXP-6

DP-4 700.92

DP-5 701.63

SG-5 702.19

EXP-7

SG-3 701.75

EXP-5

DP-3 702.45

EXP-4

DP-2 703.52

EXP-3

SG-2 (703.49)

EXP-2

PZ-10 704.09

PZ-3 704.38

PZ-11 703.71

703.88

704.78

SG-7 703.05

PZ-2 704.61

DP-6 703.52

PZ-12 706.71

706.87

705.87

706.70

705.84

PZ-9 704.77

705.56

706.00

PZ-14 705.07

PZ-1 706.02

705.65

705.37

SG-6

EXP-9

PZ-13 706.72

705.40 PZ-18

706.53 PZ-16

707.00

706.15 PZ-4

EXP-8

SG-8 704.45

705.35 PZ-17

706.82 PZ-5

707.36 PZ-15

PZ-6 707.12

PZ-7 706.88

PZ-20 (708.13)

PZ-8 706.08

DP-1 704.05

SG-1 (704.04)

EXP-1

PZ-19 709.34

700 701 702 703 704 705 706 707 708 709

LEGEND

- Catch Basin
- Drive Point
- Expendable Point
- Piezometer
- Staff Gauge
- Parcels
- Groundwater Flow Direction
- Groundwater Contours - July 24, 2018
- Groundwater Contours - July 24, 2018 (inferred)
- 704.05 Groundwater Elevation (feet amsl) - July 24, 2018
- (704.04) Data Not Used in Contouring
- 706.70 Approximate Basement Elevation

GROUNDWATER ELEVATION CONTOUR MAP JULY 24, 2018

NORTH

0 150 300 FEET

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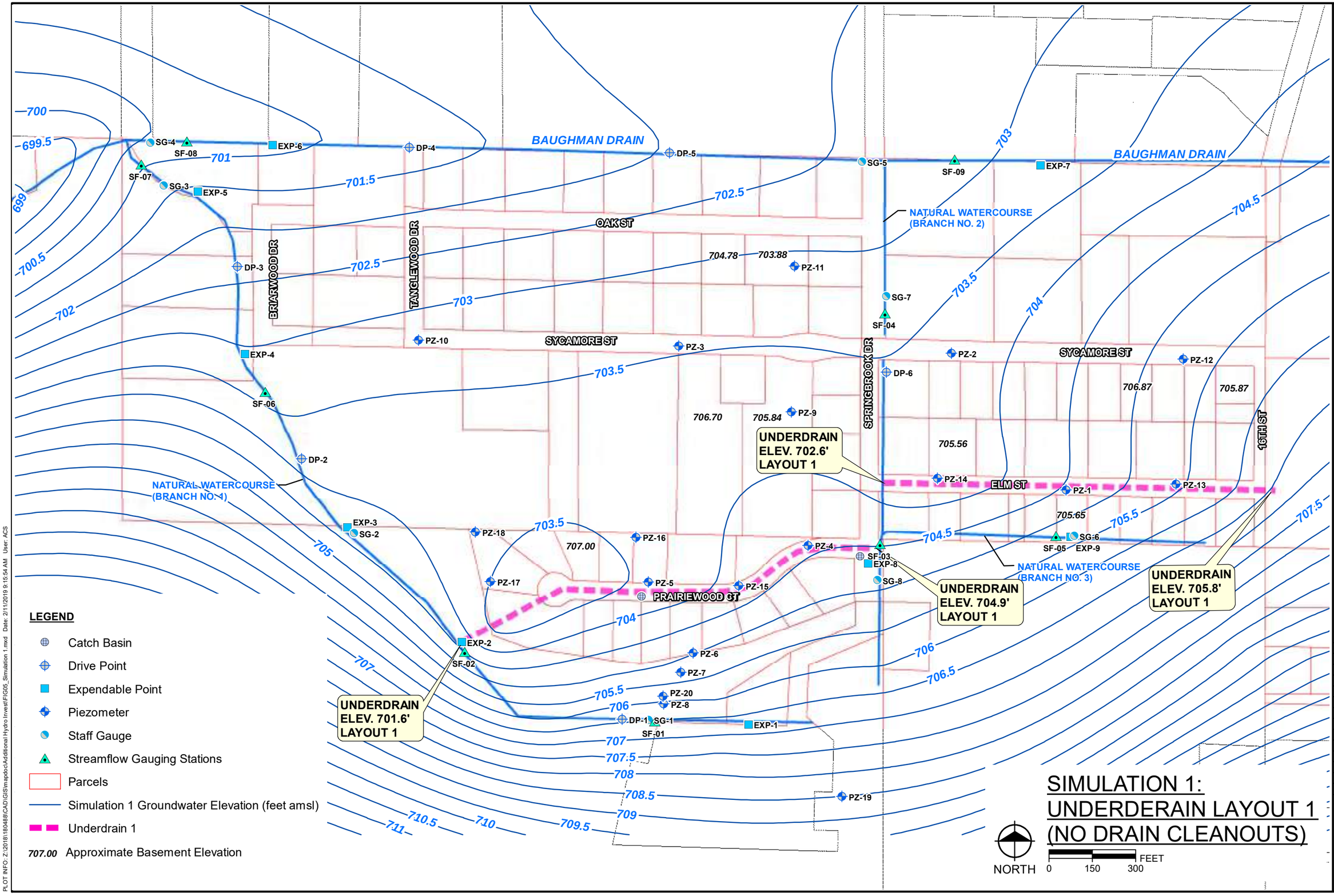
Baughman Drain
Otsego, Allegan County, Michigan
Additional Hydrogeological Investigation

PROJECT NO.
180488

FIGURE NO.
4

PLOT INFO: Z:\2018\180488\CAD\GIS\mapdoc\Additional Hydro Invest\FIG04_GW Elevation Contour Map-July 24 2018.mxd Date: 2/8/2019 4:28:00 PM User: ACS



LEGEND

- Catch Basin
- Drive Point
- Expendable Point
- Piezometer
- Staff Gauge
- Streamflow Gauging Stations
- Parcels
- Simulation 1 Groundwater Elevation (feet amsl)
- Underdrain 1
- *707.00* Approximate Basement Elevation

NORTH

0 150 300 FEET

SIMULATION 1: UNDERDERAIN LAYOUT 1 (NO DRAIN CLEANOUTS)

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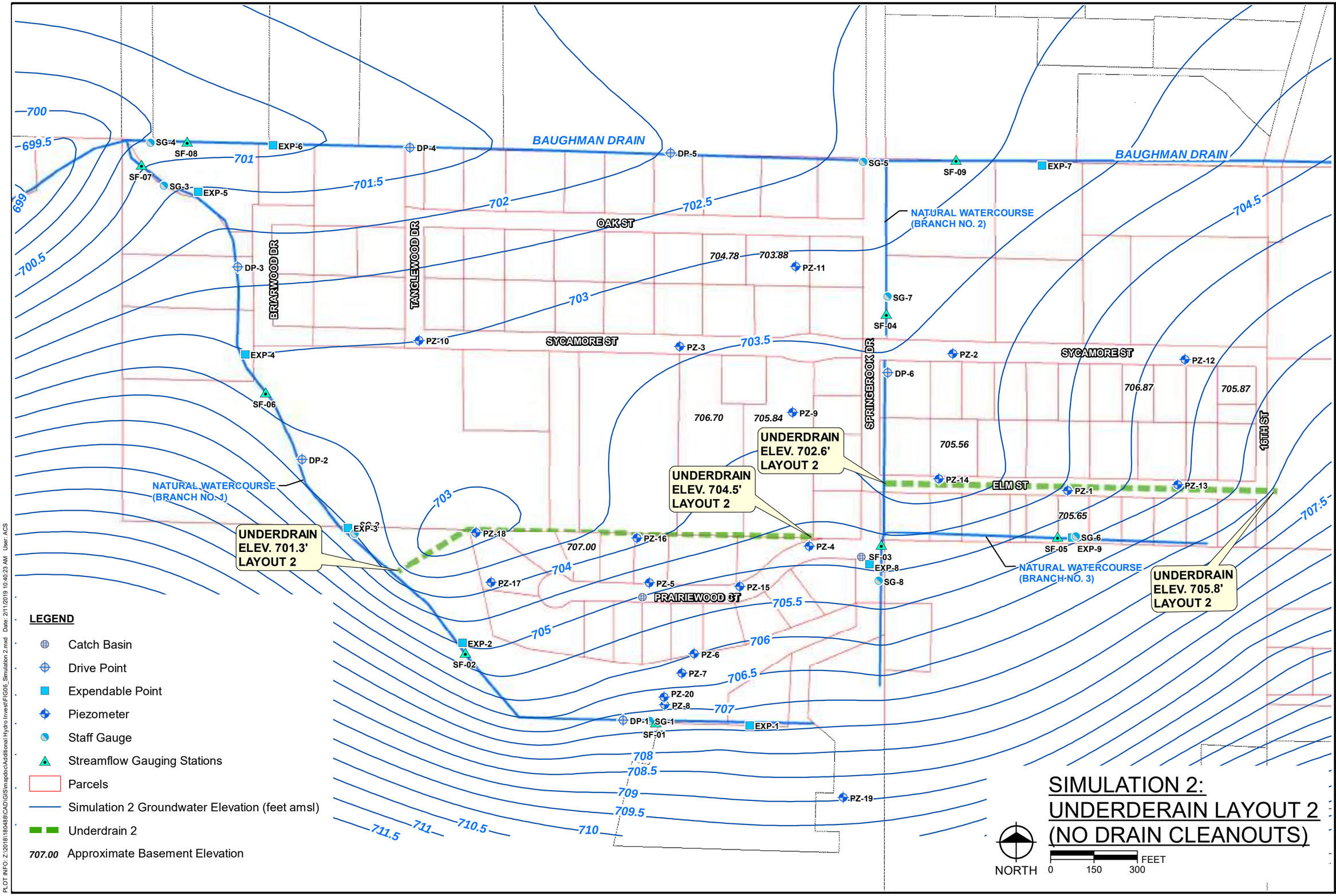
Baughman Drain
Otsego, Allegan County, Michigan
Additional Hydrogeological Investigation

PROJECT NO.
180488

FIGURE NO.
5

PLOT INFO: Z:\2018\180488\CAD\GIS\mapdoc\Additional Hydro Invest\FIG05_Simulation 1.mxd Date: 2/11/2019 9:15:54 AM User: ACS



LEGEND

- Catch Basin
- Drive Point
- Expendable Point
- Piezometer
- Staff Gauge
- Streamflow Gauging Stations
- Parcels
- Simulation 2 Groundwater Elevation (feet amsl)
- Underdrain 2
- *707.00* Approximate Basement Elevation

NORTH

0 150 300 FEET

SIMULATION 2: UNDERDERAIN LAYOUT 2 (NO DRAIN CLEANOUTS)

PLOT INFO: Z:\2018\180488\CAD\GIS\mapdoc\Additional Hydro Invest\FIG06_Simulation 2.mxd Date: 2/11/2019 10:40:23 AM User: ACS

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Baughman Drain
Otsego, Allegan County, Michigan
Additional Hydrogeological Investigation

PROJECT NO.
180488

FIGURE NO.
6

BAUGHMAN DRAIN

BAUGHMAN DRAIN

NATURAL WATERCOURSE (BRANCH NO. 2)

NATURAL WATERCOURSE (BRANCH NO. 1)

NATURAL WATERCOURSE (BRANCH NO. 3)

OAK ST

SYCAMORE ST

SYCAMORE ST

ELM ST

PRAIRIEWOOD CT

16TH ST

BRIARWOOD DR

TANGLEWOOD DR

SPRINGBROOK DR

698.5 699 699.5 700 700.5 701 701.5 702 702.5 703 703.5 704 704.5 705 705.5 706 706.5 707 707.5 708 708.5 709 709.5 710 710.5 711

SG-4 SF-08 SF-07 SG-3 EXP-5 EXP-6 DP-4 DP-5 SG-5 SF-09 EXP-7

DP-3 EXP-4 SF-06 DP-2 EXP-3 SG-2 EXP-2 SF-02

PZ-10 PZ-3 PZ-11 PZ-18 PZ-16 PZ-17 PZ-5 PZ-15 PZ-4 PZ-6 PZ-7 PZ-20 PZ-8 PZ-9 PZ-2 PZ-12 PZ-14 PZ-1 PZ-13 PZ-19

SG-7 SF-04 DP-6

SF-03 EXP-8 SG-8

SF-05 EXP-9 SG-6

DP-1 SG-1 SF-01 EXP-1

704.78 703.88 706.70 705.84 705.56 706.87 705.87 705.65 707.00

UNDERDRAIN ELEV. 702.6' LAYOUT 1

UNDERDRAIN ELEV. 704.9' LAYOUT 1

UNDERDRAIN ELEV. 705.8' LAYOUT 1

UNDERDRAIN ELEV. 701.6' LAYOUT 1

LEGEND

- Catch Basin
- Drive Point
- Expendable Point
- Piezometer
- Staff Gauge
- Streamflow Gauging Stations
- Parcels
- Simulation 3 Groundwater Elevation (feet amsl)
- Underdrain 1
- *707.00* Approximate Basement Elevation

SIMULATION 3: UNDERDERAIN LAYOUT 1 (WITH DRAIN CLEANOUTS)

NORTH

0 150 300 FEET

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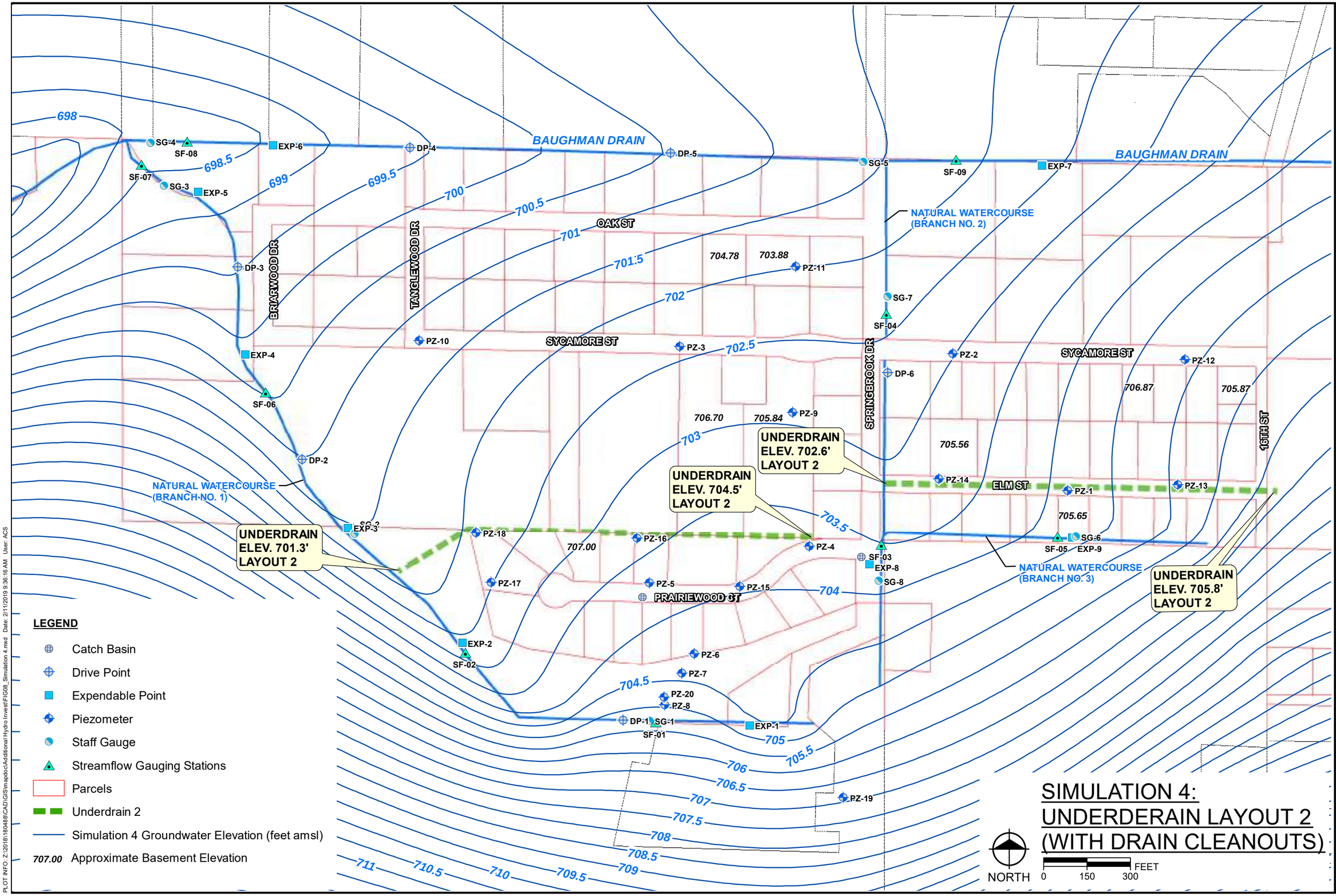
Baughman Drain
Otsego, Allegan County, Michigan
Additional Hydrogeological Investigation

PROJECT NO.
180488

FIGURE NO.
7

PLOT INFO: Z:\2018\180488\CAD\GIS\mapdoc\Additional Hydro Invest\FIG07_Simulation 3.mxd Date: 2/11/2019 9:26:21 AM User: ACS



LEGEND

- Catch Basin
- Drive Point
- Expendable Point
- Piezometer
- Staff Gauge
- Streamflow Gauging Stations
- Parcels
- Underdrain 2
- Simulation 4 Groundwater Elevation (feet amsl)
- *707.00* Approximate Basement Elevation

NORTH

0 150 300 FEET

SIMULATION 4: UNDERDERAIN LAYOUT 2 (WITH DRAIN CLEANOUTS)

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Baughman Drain
Otsego, Allegan County, Michigan
Additional Hydrogeological Investigation

PROJECT NO.
180488

FIGURE NO.
8

PLOT INFO: Z:\2018\180488\CAD\GIS\mapdoc\Additional Hydro Invest\FIG08_Simulation 4.mxd Date: 2/11/2019 9:36:16 AM User: ACS

Tables

Table 1 - Summary of Well Construction and Static Water Level Elevations

Additional Hydrogeological Evaluation - Baughman Drain

February 2019

Location	Measuring Point Elevation (ft msl)	Measurement Date	Depth to Groundwater (ft)	Groundwater Elevation (ft)	Depth to Surface Water (ft)	Surface Water Elevation (ft)	Screened Interval (ft bgs)	Screen Midpoint Elevation (ft)	Date Installed
PZ-1	712.85	07/24/18	6.83	706.02	--	--	6-11	8.50	2017
PZ-2	712.34	07/24/18	7.73	704.61	--	--	6.5-1.5	9.0	2017
PZ-3	711.54	07/24/18	7.16	704.38	--	--	6.5-11.5	9.0	2017
PZ-4	712.03	07/24/18	5.88	706.15	--	--	6-11	8.5	2017
PZ-5	711.70	07/24/18	4.88	706.82	--	--	4.5-9.5	7.0	2017
PZ-6	712.19	07/24/18	5.07	707.12	--	--	4-9	6.5	2017
PZ-7	712.08	07/24/18	5.20	706.88	--	--	3-8	5.5	2017
PZ-8	713.09	07/24/18	7.01	706.08	--	--	4-9	6.5	2017
PZ-9	712.57	07/24/18	7.80	704.77	--	--	10-15	12.5	2018
PZ-10	712.03	07/24/18	7.94	704.09	--	--	10-15	12.5	2018
PZ-11	710.11	07/24/18	6.40	703.71	--	--	10-15	12.5	2018
PZ-12	712.46	07/24/18	5.75	706.71	--	--	10-15	12.5	2018
PZ-13	712.47	07/24/18	5.75	706.72	--	--	10-15	12.5	2018
PZ-14	712.38	07/24/18	7.31	705.07	--	--	10-15	12.5	2018
PZ-15	712.90	07/24/18	5.54	707.36	--	--	10-15	12.5	2018
PZ-16	712.20	07/24/18	5.67	706.53	--	--	10-15	12.5	2018
PZ-17	711.89	07/24/18	6.54	705.35	--	--	10-15	12.5	2018
PZ-18	710.94	07/24/18	5.54	705.40	--	--	10-15	12.5	2018
PZ-19	716.21	07/24/18	6.87	709.34	--	--	10-15	12.5	2018
PZ-20	713.09	07/24/18	4.96	708.13	--	--	34-39	1.5	2018
SG-1	707.05	07/24/18	0.32	--	--	704.04	--	--	2017
SG-2	705.62	07/24/18	1.20	--	--	703.49	--	--	2017
SG-3	704.66	07/24/18	0.42	--	--	701.75	--	--	2017
SG-4	702.18	07/24/18	0.78	--	--	699.63	--	--	2017
SG-5	704.51	07/24/18	1.01	--	--	702.19	--	--	2017
SG-6	708.68	07/24/18	0.02	--	--	705.37	--	--	2017
SG-7	706.08	07/24/18	0.30	--	--	703.05	--	--	2017
SG-8	707.64	07/24/18	0.14	--	--	704.45	--	--	2017
DP-1	707.86	07/24/18	3.81	704.05	3.88	703.98	0.84-3.84	2.34	2018
DP-2	706.34	07/28/18	2.82	703.52	3.07	703.27	1.39-4.39	2.89	2018
DP-3	705.04	07/24/18	2.59	702.45	2.72	702.32	1.66-4.66	3.16	2018
DP-4	703.82	07/24/18	2.90	700.92	3.07	700.75	1.13-4.13	2.63	2018
DP-5	704.42	07/24/18	2.79	701.63	2.98	701.44	1.38-4.38	2.88	2018
DP-6	706.69	07/24/18	3.17	703.52	3.34	703.35	1.16-4.16	2.66	2018

Footnotes:

ft msl - Feet above mean sea level

bgs - Below ground surface

Table 2 - Summary of Hydraulic Conductivity Testing
Additional Hydrogeological Evaluation - Baughman Drain
February 2019

ID	Method	Well Depth (ft)	Well Depth Elev. (ft amsl)	Screen Length (ft)	TOC (ft amsl)	DTW (ft) 7/23/18	GWE (ft amsl)	Slug Displacement (ft)	K (ft/day)	Remarks
PZ-9	Vacuum	15	697.57	5	712.57	7.79	704.78	5.83	108.1	Fine to coarse Sand
PZ-10	Vacuum	14	698.03	5	712.03	7.92	704.11	7.01	96.1	Fine to v. Fine Sand
PZ-11	Vacuum	15	695.11	5	710.11	6.40	703.71	4.34	76.3	Sand and Silt, Fine to v. Fine
PZ-12	Vacuum	15	697.46	5	712.46	5.73	706.73	1.14	105.3	Medium Sand
PZ-13	Vacuum	15	697.47	5	712.47	5.72	706.75	4.74	132.4	Fine to coarse Sand
PZ-14	Vacuum	15	697.38	5	712.38	7.30	705.08	5.34	88.6	V. Fine to Fine Sand
PZ-15	Vacuum	15	697.90	5	712.90	5.52	707.38	4.05	82.9	V. Fine Sand
PZ-16	Vacuum	15	697.20	5	712.20	5.66	706.54	2.77	134.1	Find Sand, trace Med./Coarse
PZ-17	Vacuum	15	696.89	5	711.89	6.53	705.36	4.78	98.1	Fine Sand
PZ-18	Pressure	15	695.94	5	710.94	5.54	705.40	4.45	53.3	Find Sand, trace Med./Coarse
PZ-19	Vacuum	15	701.21	5	716.21	6.87	709.34	4.83	289.9	Sandy Gravel/Gravel
PZ-20	Vacuum	39	674.09	5	713.09	4.96	708.13	4.85	57.9	Sandy Gravel/Gravel (Deeper Aquifer)

Abbreviations:
ft amsl - feet above mean sea level
TOC - Top of Casing
DTW - Depth to Water
GWE - Groundwater Elevation
SWL - Static Water Level
K - Hydraulic Conductivity

Average	110.3
Geometric mean	99.6

Table 3 - Vertical Hydraulic Gradients

Additional Hydrogeological Evaluation - Baughman Drain

February 2019

Monitoring Location	Measuring Point Elevation (ft)	Depth to Groundwater** (ft bmp)	Groundwater Elevation (ft msl)	Depth to Surface Water (ft bmp)	Surface Water Elevation (ft msl)	Screen Interval (ft bgs)	Top of Screen (ft bgs)	Screen Elevation Difference (ft)	Vertical Gradient*
DP-1	707.86	3.81	704.05	3.88	703.98	0.84-3.84	0.84	0.84	-0.08
DP-2	706.34	2.82	703.52	3.07	703.27	1.39-4.39	1.39	1.39	-0.18
DP-3	705.04	2.59	702.45	2.72	702.32	1.66-4.66	1.66	1.66	-0.08
DP-4	703.82	2.90	700.92	3.07	700.75	1.13-4.13	1.13	1.13	-0.15
DP-5	704.42	2.79	701.63	2.98	701.44	1.38-4.38	1.38	1.38	-0.14
DP-6	706.69	3.17	703.52	3.34	703.35	1.16-4.16	1.16	1.16	-0.15
EXP-1	--	0.33	--	0.19	--	1-1.5	1.0	1.0	-0.14
EXP-2	--	0.37	--	0.35	--	3-3.5	3.0	3.0	-0.01
EXP-3	--	0.51	--	0.50	--	3-3.5	3.0	3.0	0.00
EXP-4	--	0.68	--	0.45	--	2.5-3	2.5	2.5	-0.09
EXP-5	--	0.44	--	0.43	--	2-2.5	2.0	2.0	-0.01
EXP-6	--	1.25	--	1.06	--	2.5-3	2.5	2.5	-0.08
EXP-7	--	0.59	--	0.22	--	2.5-3	2.5	2.5	-0.15
EXP-8	--	0.44	--	0.14	--	2.5-3	2.5	2.5	-0.12
EXP-9	--	0.2	--	0.05	--	2.5-3	2.5	2.5	-0.06

Abbreviations/Acronyms:

bmp - below measuring point

bgs - below ground surface

ft msl - feet above mean sea level

NA - not available

* Negative values indicate upward vertical gradients; postive values are downward vertical gradients.

** EXP (Expendable Point) locations were not surveyed. Measurements are from streambed.

Table 4 - Streamflow Results

Additional Hydrogeological Evaluation - Baughman Drain

February 2019

Location	Streamflow (CFS)	Streamflow (GPM)
SF-01	0.504	226
SF-02	1.622	728
SF-03	0.166	75
SF-04	0.895	402
SF-05	0.249	112
SF-06	1.488	668
SF-07	1.399	628
SF-08	1.944	873
SF-09	0.629	282

Footnotes:

CFS - Cubic Feet per Second

GPM - Gallons per Minute

Table 5 - Calibrated Model Statistics

Additional Hydrogeological Evaluation - Baughman Drain

February 2019

Name	X	Y	Observed	Computed	Layer	Weight	Group	Residual
PZ-20	12761284	347235.6	708.13	707.79	3	1	1	0.34
PZ-1	12762680	347950.9	706.02	706.1	1	1	1	-0.08
PZ-2	12762282	348423.6	704.61	704.49	1	1	1	0.12
PZ-3	12761338	348448.9	704.38	704.48	1	1	1	-0.1
PZ-4	12761786	347758.7	706.15	706.02	1	1	1	0.13
PZ-5	12761233	347631	706.82	706.67	1	1	1	0.15
PZ-6	12761388	347386	707.12	707.26	1	1	1	-0.14
PZ-7	12761345	347319.7	706.88	707.34	1	1	1	-0.46
PZ-8	12761286	347209.2	706.08	706.65	1	1	1	-0.57
PZ-9	12761728	348220.2	704.77	704.82	1	1	1	-0.05
PZ-10	12760437	348469.7	704.09	703.86	1	1	1	0.23
PZ-11	12761739	348724.1	703.71	703.59	1	1	1	0.12
PZ-12	12763085	348403.1	706.71	706.28	1	1	1	0.43
PZ-13	12763060	347970.2	706.72	706.98	1	1	1	-0.26
PZ-14	12762234	347990.7	705.07	705.13	1	1	1	-0.06
PZ-15	12761546	347618.6	707.36	706.72	1	1	1	0.64
PZ-16	12761190	347786.6	706.53	706.31	1	1	1	0.22
PZ-17	12760686	347632.2	705.35	705.58	1	1	1	-0.23
PZ-18	12760634	347804.2	705.4	705.3	1	1	1	0.1
PZ-19	12761903	346889.3	709.34	709.69	1	1	1	-0.35
PZ-20	12761284	347235.6	708.13	707.79	3	1	1	0.34
DP-1	12761142	347156.3	704.05	704.32	1	1	1	-0.27
DP-2	12760031	348057.3	703.52	703.46	1	1	1	0.06
DP-3	12759809	348723.2	702.45	702.42	1	1	1	0.03
DP-4	12760405	349137.1	700.92	700.78	1	1	1	0.14
DP-5	12761306	349117.9	701.63	701.71	1	1	1	-0.08
DP-6	12762058	348358.1	703.52	703.72	1	1	1	-0.2
SG-2*	12760214	347800.5	703.49	703.97	1	0.5	1	-0.24
SG-3*	12759555	349005.1	701.75	701.64	1	0.5	1	0.05
SG-4*	12759508	349153.1	699.63	700.49	1	0.5	1	-0.43
SG-5*	12761973	349086.4	702.19	702.39	1	0.5	1	-0.1
SG-6*	12762708	347791.3	705.37	706.15	1	0.5	1	-0.39
SG-7*	12762057	348620.1	703.05	703.23	1	0.5	1	-0.09
SG-8*	12762026	347638.1	704.45	705.82	1	0.5	1	-0.68
SW1**	12757542	346173.9	710	710	1	0.75	1	0
SW2**	12758687	347326.6	710	709.86	1	0.75	1	0.1
S1**	12760525	345616.4	720	719.72	1	0.75	1	0.21
N1**	12762258	351923.4	700	699.89	1	0.75	1	0.08
Residual Mean								-0.03
Absolute Residual Mean								0.22
Residual Std. Deviation								0.27
Sum of Squares								2.92
RMS Error								0.28
Min. Residual								-0.68
Max. Residual								0.64
Number of Observations								38
Range in Observations								20.37
Scaled Residual Std. Deviation								0.013
Scaled Absolute Residual Mean								0.011
Scaled RMS Error								0.014
Scaled Residual Mean								-0.002

Footnotes:

* Staff gage targets were weighted at 0.5 to minimize calibration to surface water.

** These locations not measured but estimated from regional water table contours in outlying areas to assist calibration for regional groundwater flow direction.

Appendix 1

Boring Logs

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BOREHOLE LOG

BORING/WELL ID: **PZ-09**

TOTAL DEPTH (ft.): **15**

PROJECT: Baughman Drain Hydrogeo
SITE LOCATION: Otsego, MI
PROJECT NO.: 180488 HG
PROJECT MANAGER: B. Gillett
LOGGED BY: B. Gillett

START DATE: 07/11/18
END DATE: 07/11/18
TOC ELEV.: --
GROUND ELEV.: --
STATIC WATER LVL.: ~7.8' bgs

DRILLING CO.: Job Site Services
DRILLER: Bob / Ben
RIG TYPE: Geoprobe 7720DT
METHOD OF DRILLING: Direct Push
SAMPLING METHODS: Macrocore

NOTES: Location is 1662 Sycamore; 15' north of center of garage.
NR - no recovery

▼ Static Water Level

DESCRIPTION	PID ppm	GRAPHIC LOG	DEPTH (ft. bgl)	Static Water Level	Sample/ Revovery	Sample ID	Blow Counts	WELL CONSTRUCTION DETAIL
TOPSOIL: Sandy. Black to dark brown, loose, moist.			0					2" PVC Casing
SILTY SAND: Sand (75%), fine to medium grained with trace coarse grains; some Silt (20%); trace Clay (5%). Orange brown, medium dense, moist.			1–4		3.0'			Hole Plug
SAND: Sand (90%), fine to coarse grained; little Gravel (10%), fine. Brown, loose.			5		——			Natural Collapse
Sand (95%), fine to medium grained; trace Silt (5%). Brown, loose, saturated.			6–8	▼	4.0'			
No Recovery; Appearance similar to above. Infer: SAND: Sand (95%), fine to coarse grained; trace Gravel (5%), fine.			9–10		——			2" PVC Screen (10 Slot)
Driller indicates finer Sand/Silt.			11–15		NR			

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BOREHOLE LOG

BORING/WELL ID: **PZ-10**

TOTAL DEPTH (ft.): **15**

PROJECT: Baughman Drain Hydrogeo
SITE LOCATION: Otsego, MI
PROJECT NO.: 180488 HG
PROJECT MANAGER: B. Gillett
LOGGED BY: B. Gillett

START DATE: 07/11/18
END DATE: 07/11/18
TOC ELEV.: --
GROUND ELEV.: --
STATIC WATER LVL.: ~8.0' bgs

DRILLING CO.: Job Site Services
DRILLER: Bob / Ben
RIG TYPE: Geoprobe 7720DT
METHOD OF DRILLING: Direct Push
SAMPLING METHODS: Macrocore

NOTES: Location is 1700 Sycamore (front); at intersection of Tanglewood.
NR - no recovery

▼ Static Water Level

DESCRIPTION	PID ppm	GRAPHIC LOG	DEPTH (ft. bgl)	Static Water Level	Sample/ Revovery	Sample ID	Blow Counts	WELL CONSTRUCTION DETAIL
TOPSOIL			0					2" PVC Casing
GRAVELLY SAND: Compacted.			1					
SAND: Sand (95%), fine to medium grained with little coarse grains (15%); trace Gravel (5%), fine. Brown, loose.			2					
			3		3.0'			Hole Plug
			4					
			5		—			
			6					
SAND: Same as above. Saturated.			7					
			8	▼	4.4'			Natural Collapse
			9					
			10		—			2" PVC Screen (10 Slot)
No Recovery; Appearance similar to above. Infer: SAND: Same as above transitioning to fine grained.			11					
			12					
			13		NR			
			14					
SAND: Sand (90%), very fine to fine grained; little Silt (10%). Brown, loose, saturated.			15					

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BOREHOLE LOG

BORING/WELL ID: **PZ-11**

TOTAL DEPTH (ft.): **15**

PROJECT: Baughman Drain Hydrogeo
SITE LOCATION: Otsego, MI
PROJECT NO.: 180488 HG
PROJECT MANAGER: B. Gillett
LOGGED BY: B. Gillett

START DATE: 07/11/18
END DATE: 07/11/18
TOC ELEV.: --
GROUND ELEV.: --
STATIC WATER LVL.: ~6.5' bgs

DRILLING CO.: Job Site Services
DRILLER: Bob / Ben
RIG TYPE: Geoprobe 7720DT
METHOD OF DRILLING: Direct Push
SAMPLING METHODS: Macrocore

NOTES: Location is ~12' east of fence near brush line, southeast corner of property.

▼ Static Water Level

DESCRIPTION	PID ppm	GRAPHIC LOG	DEPTH (ft. bgl)	Static Water Level	Sample/ Revovery	Sample ID	Blow Counts	WELL CONSTRUCTION DETAIL
TOPSOIL: Sandy. Dark brown.			0					2" PVC Casing
SAND: Sand (95%), fine to medium grained with little coarse grains (15%); trace Gravel (5%), fine. Light brown, loose, moist.			1					
			2		3.5'			Hole Plug
			3					
			4					
SAND: Fine to medium grained with trace coarse grains. Brown, loose.			5					Natural Collapse
			6	▼				
SAND: Same as above. Saturated.			7					
			8		4.0'			
			9					
			10					2" PVC Screen (10 Slot)
			11					
			12		4.0'			
			13					
			14					
SAND AND SILT: Very fine to fine grained. Brown, medium dense, saturated.			15					

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BOREHOLE LOG

BORING/WELL ID: **PZ-12**

TOTAL DEPTH (ft.): **15**

PROJECT: Baughman Drain Hydrogeo
SITE LOCATION: Otsego, MI
PROJECT NO.: 180488 HG
PROJECT MANAGER: B. Gillett
LOGGED BY: M. Ingersoll

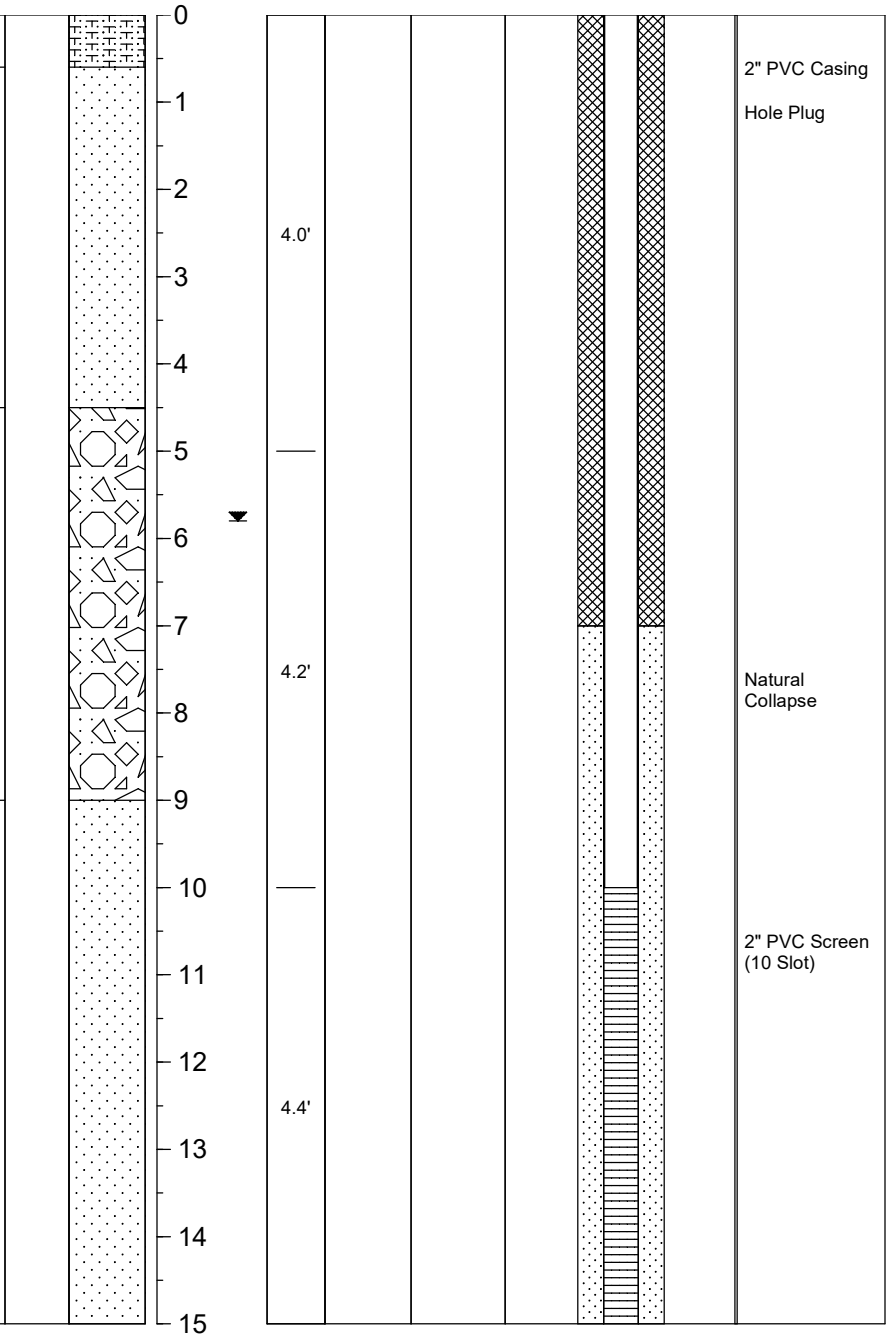
START DATE: 07/10/18
END DATE: 07/10/18
TOC ELEV.: --
GROUND ELEV.: --
STATIC WATER LVL.: ~5.8' bgs

DRILLING CO.: Job Site Services
DRILLER: Bob / Ben
RIG TYPE: Geoprobe 7720DT
METHOD OF DRILLING: Direct Push
SAMPLING METHODS: Macrocore

NOTES:

▼ Static Water Level

DESCRIPTION	PID ppm	GRAPHIC LOG	DEPTH (ft. bgl)	Static Water Level	Sample/ Revovery	Sample ID	Blow Counts	WELL CONSTRUCTION DETAIL
TOPSOIL: 7" thick.								
SAND: Fine grained; organic. Dark brown and black, dry.								
SAND: Fine grained. Dark brown, moist.								
SAND WITH GRAVEL: Sand (70%), fine to coarse grained (50/30/20); Gravel (30%), fine to medium (60/40). Light brown, dry to slightly moist.								
SAND WITH GRAVEL: Sand (85%), fine to coarse grained (40/40/20); little Gravel (15%), fine to medium. Light brown, saturated.								
SAND: Sand (90%), fine to coarse grained (40/40/20); little Gravel (10%), fine. Light brown, saturated.								
SAND: same as above. Medium brown.								



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BOREHOLE LOG

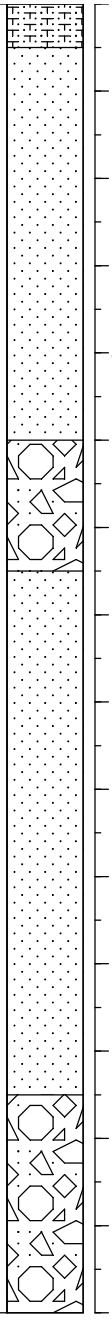
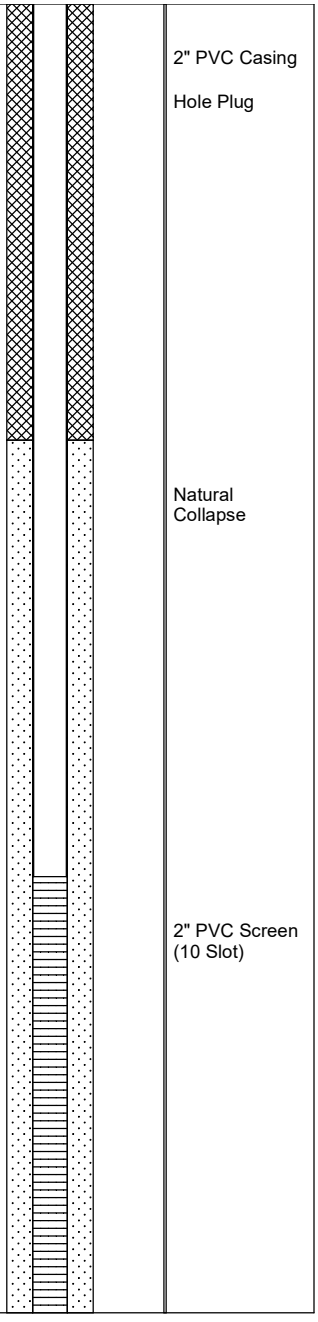
BORING/WELL ID: **PZ-13**

TOTAL DEPTH (ft.): **15**

PROJECT: Baughman Drain Hydrogeo	**START DATE:** 07/10/18	**DRILLING CO.:** Job Site Services
SITE LOCATION: Otsego, MI	**END DATE:** 07/10/18	**DRILLER:** Bob / Ben
PROJECT NO.: 180488 HG	**TOC ELEV.:** --	**RIG TYPE:** Geoprobe 7720DT
PROJECT MANAGER: B. Gillett	**GROUND ELEV.:** --	**METHOD OF DRILLING:** Direct Push
LOGGED BY: M. Ingersoll	**STATIC WATER LVL.:** ~6.0' bgs	**SAMPLING METHODS:** Macrocore

NOTES:

▼ Static Water Level

DESCRIPTION	PID ppm	GRAPHIC LOG	DEPTH (ft. bgl)	Static Water Level	Sample/ Revovery	Sample ID	Blow Counts	WELL CONSTRUCTION DETAIL
TOPSOIL: 6" thick. SAND: Fine grained. Medium brown, dry. SAND: same as above. Orange brown. SAND: Fine to coarse grained (40/30/30). Light brown, slightly moist. SAND WITH GRAVEL: Sand (60%), fine to coarse grained (30/30/40); Gravel (40%), fine to coarse (50/30/20). Light brown, saturated. SAND: Fine grained. Light brown, saturated. SAND: Sand (90%), fine to coarse grained (60/25/15); little Gravel (10%), fine. Light brown, saturated. SAND: Sand (90%), fine to coarse grained (40/30/30); little Gravel (10%), fine. Light gray brown, saturated. SAND WITH GRAVEL: Sand (80-85%), fine to coarse grained (30/40/30); some Gravel (15-20%), fine to medium. Light brown, saturated.			0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15	▼	4.3' 4.5' 3.9'			 2" PVC Casing Hole Plug Natural Collapse 2" PVC Screen (10 Slot)

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BOREHOLE LOG

BORING/WELL ID: **PZ-14**

TOTAL DEPTH (ft.): **15**

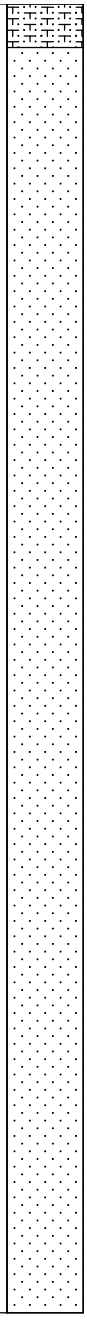
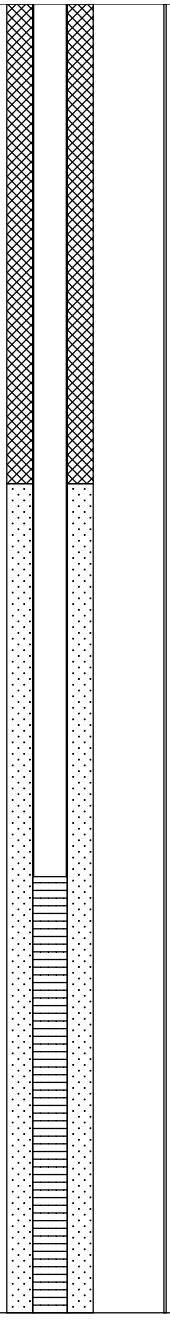
PROJECT: Baughman Drain Hydrogeo
SITE LOCATION: Otsego, MI
PROJECT NO.: 180488 HG
PROJECT MANAGER: B. Gillett
LOGGED BY: M. Ingersoll

START DATE: 07/10/18
END DATE: 07/10/18
TOC ELEV.: --
GROUND ELEV.: --
STATIC WATER LVL.: ~7.5' bgs

DRILLING CO.: Job Site Services
DRILLER: Bob / Ben
RIG TYPE: Geoprobe 7720DT
METHOD OF DRILLING: Direct Push
SAMPLING METHODS: Macrocore

NOTES:

▼ Static Water Level

DESCRIPTION	PID ppm	GRAPHIC LOG	DEPTH (ft. bgl)	Static Water Level	Sample/ Revovery	Sample ID	Blow Counts	WELL CONSTRUCTION DETAIL
TOPSOIL: 6" thick. SAND: Sand (90%), fine to coarse grained (70/20/10); little Gravel (10%), fine. Medium brown, dry to slightly moist. SAND: Fine grained. Light brown, slightly moist. SAND: Fine grained with little medium to coarse grains (15%). Light brown, slightly moist. SAND: Same as above. Saturated. SAND: Fine to coarse grained (60/25/15). Light brown, saturated. SAND: Very fine to fine grained (50/50). Light gray brown, saturated.			0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15	▼	4.0' 4.3' 4.5'			 2" PVC Casing Hole Plug Natural Collapse 2" PVC Screen (10 Slot)

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BOREHOLE LOG

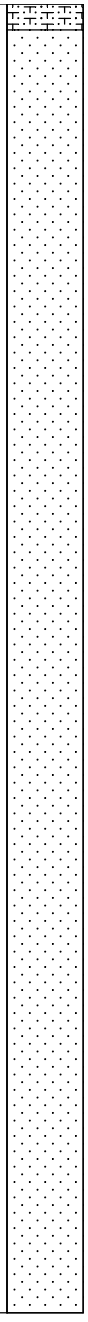
BORING/WELL ID: **PZ-15**

TOTAL DEPTH (ft.): **15**

PROJECT: Baughman Drain Hydrogeo	**START DATE:** 07/10/18	**DRILLING CO.:** Job Site Services
SITE LOCATION: Otsego, MI	**END DATE:** 07/10/18	**DRILLER:** Bob / Ben
PROJECT NO.: 180488 HG	**TOC ELEV.:** --	**RIG TYPE:** Geoprobe 7720DT
PROJECT MANAGER: B. Gillett	**GROUND ELEV.:** --	**METHOD OF DRILLING:** Direct Push
LOGGED BY: M. Ingersoll	**STATIC WATER LVL.:** ~5.7' bgs	**SAMPLING METHODS:** Macrocore

NOTES:

▼ Static Water Level

DESCRIPTION	PID ppm	GRAPHIC LOG	DEPTH (ft. bgl)	Static Water Level	Sample/ Revovery	Sample ID	Blow Counts	WELL CONSTRUCTION DETAIL
TOPSOIL: 4" thick. SAND: Fine grained with little medium to coarse grains (10%). Medium brown, slightly moist. SAND: Fine to coarse grained (50/25/25). Orange brown, moist. SAND: Fine grained. Light orange brown, moist. SAND: Same as above. Saturated. SAND: Sand (90%), fine to coarse grained (40/30/30); little Gravel (10%), fine. Light orange brown, saturated. SAND: Same as above. Light brown gray.			0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15	▼	4.3' 4.2' 4.3'			2" PVC Casing Hole Plug Natural Collapse 2" PVC Screen (10 Slot)

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BOREHOLE LOG

BORING/WELL ID: **PZ-16**

TOTAL DEPTH (ft.): **15**

PROJECT: Baughman Drain Hydrogeo
SITE LOCATION: Otsego, MI
PROJECT NO.: 180488 HG
PROJECT MANAGER: B. Gillett
LOGGED BY: M. Ingersoll

START DATE: 07/09/18
END DATE: 07/09/18
TOC ELEV.: --
GROUND ELEV.: --
STATIC WATER LVL.: ~5.6' bgs

DRILLING CO.: Job Site Services
DRILLER: Bob / Ben
RIG TYPE: Geoprobe 7720DT
METHOD OF DRILLING: Direct Push
SAMPLING METHODS: Macrocore

NOTES:

▼ Static Water Level

DESCRIPTION	PID ppm	GRAPHIC LOG	DEPTH (ft. bgl)	Static Water Level	Sample/ Revovery	Sample ID	Blow Counts	WELL CONSTRUCTION DETAIL
TOPSOIL: 7" thick.			0					2" PVC Casing
SAND: Fine grained. Light brown, slightly moist.			1					Hole Plug
			2		4.1'			
			3					
SAND WITH GRAVEL: Sand (70%), fine to coarse grained (60/20/20); Gravel (30%), fine to coarse (50/30/20). Light brown, slightly moist.			4					
			5	▼				
			6					
SAND: Fine to coarse grained (50/40/10). Light brown, saturated.			7		4.3'			Natural Collapse
			8					
SAND WITH GRAVEL: Sand (70%), fine to coarse grained (60/20/20); Gravel (30%), fine to coarse (50/30/20). Light brown, slightly moist.			9					
			10					
SAND: Fine grained with little medium to coarse grains (15%). Light brown, saturated.			11					2" PVC Screen (10 Slot)
			12		4.5'			
			13					
			14					
			15					

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BOREHOLE LOG

BORING/WELL ID: **PZ-17**

TOTAL DEPTH (ft.): **15**

PROJECT: Baughman Drain Hydrogeo
SITE LOCATION: Otsego, MI
PROJECT NO.: 180488 HG
PROJECT MANAGER: B. Gillett
LOGGED BY: M. Ingersoll

START DATE: 07/10/18
END DATE: 07/10/18
TOC ELEV.: --
GROUND ELEV.: --
STATIC WATER LVL.: ~6.6' bgs

DRILLING CO.: Job Site Services
DRILLER: Bob / Ben
RIG TYPE: Geoprobe 7720DT
METHOD OF DRILLING: Direct Push
SAMPLING METHODS: Macrocore

NOTES:

▼ Static Water Level

DESCRIPTION	PID ppm	GRAPHIC LOG	DEPTH (ft. bgl)	Static Water Level	Sample/ Revovery	Sample ID	Blow Counts	WELL CONSTRUCTION DETAIL
TOPSOIL: 6" thick. SAND: Fine grained. Light brown, dry.			0 1 2 3		4.0'			2" PVC Casing Hole Plug
SAND WITH GRAVEL: Sand (80-85%), fine to coarse grained (50/30/20); some Gravel (15-20%), fine to coarse. Light brown, slightly moist.			4					
GRAVEL AND SAND: Gravel (50%), fine to coarse (60/30/10); Sand (50%), fine to coarse grained (25/25/50). Light brown, saturated.			5					Natural Collapse
SAND: Fine grained with little medium to coarse grains (15%). Light brown, saturated.			6 7	▼	4.5'			
SAND: Sand (90%), fine to coarse grained (50/35/15); little Gravel (10%), fine. Light brown, saturated.			8 9					
			10					2" PVC Screen (10 Slot)
SAND: Fine grained. Light brown, saturated.			11 12		4.5'			
			13 14 15					

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BOREHOLE LOG

BORING/WELL ID: **PZ-18**

TOTAL DEPTH (ft.): **15**

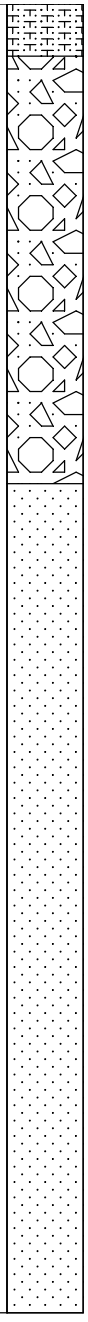
PROJECT: Baughman Drain Hydrogeo
SITE LOCATION: Otsego, MI
PROJECT NO.: 180488 HG
PROJECT MANAGER: B. Gillett
LOGGED BY: M. Ingersoll

START DATE: 07/10/18
END DATE: 07/10/18
TOC ELEV.: --
GROUND ELEV.: --
STATIC WATER LVL.: ~5.7 bgs

DRILLING CO.: Job Site Services
DRILLER: Bob / Ben
RIG TYPE: Geoprobe 7720DT
METHOD OF DRILLING: Direct Push
SAMPLING METHODS: Macrocore

NOTES:

▼ Static Water Level

DESCRIPTION	PID ppm	GRAPHIC LOG	DEPTH (ft. bgl)	Static Water Level	Sample/ Revovery	Sample ID	Blow Counts	WELL CONSTRUCTION DETAIL
TOPSOIL: 7" thick. SAND WITH GRAVEL: Sand (85%), fine to coarse grained (60/20/20); little Gravel (15%), fine to medium. Orange, dry. SAND WITH GRAVEL: Sand (75%), fine to coarse grained (40/30/30); some Gravel (25%), fine to coarse (50/40/10). Light brown, moist. SAND: Fine to coarse grained (30/40/30). Light brown, saturated. SAND: Fine to medium grained (60/40) with trace coarse grains (10%). Light brown, saturated. SAND: Fine grained with trace medium to coarse grains (10%). Light brown, saturated. SAND: Sand (90%), fine grained with trace medium to coarse grains (10%); little Gravel (10%), fine. Light brown, saturated.			0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15	▼	4.6' 4.2' 4.5'			2" PVC Casing Hole Plug Natural Collapse 2" PVC Screen (10 Slot)

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BOREHOLE LOG

BORING/WELL ID: **PZ-19**

TOTAL DEPTH (ft.): **15**

PROJECT: Baughman Drain Hydrogeo
SITE LOCATION: Otsego, MI
PROJECT NO.: 180488 HG
PROJECT MANAGER: B. Gillett
LOGGED BY: M. Ingersoll

START DATE: 07/09/18
END DATE: 07/09/18
TOC ELEV.: --
GROUND ELEV.: --
STATIC WATER LVL.: ~5.5' bgs

DRILLING CO.: Job Site Services
DRILLER: Bob / Ben
RIG TYPE: Geoprobe 7720DT
METHOD OF DRILLING: Direct Push
SAMPLING METHODS: Macrocore

NOTES:

▼ Static Water Level

DESCRIPTION	PID ppm	GRAPHIC LOG	DEPTH (ft. bgl)	Static Water Level	Sample/ Revovery	Sample ID	Blow Counts	WELL CONSTRUCTION DETAIL
TOPSOIL: With Grass. 6" thick.			0					2" PVC Casing
SAND: Fine grained. Medium brown, slightly moist.			1					Hole Plug
SAND: Same as above; organic. Dark brown.			2		4.1'			
			3					
SILTY SAND: Sand (80%), fine to medium grained (80/20); some Silt (20%). Medium gray brown, very moist.			4					
SILTY SAND: Same as above. Saturated.			5	▼				
CLAY WITH GRAVEL AND SILT: Clay (60%); some Gravel (20%), coarse; some Silt (20%). Gray, low plasticity, high cohesiveness, stiff, moist.			6					
GRAVEL: Fine to coarse (50/30/20). Gray, saturated.			7		4.0'			
			8					Natural Collapse
CLAY: Gray, medium plasticity, high cohesiveness, stiff, moist.			9					
GRAVEL: Fine to coarse (40/30/30). Medium brown, saturated.			10					
			11					2" PVC Screen (10 Slot)
GRAVEL WITH SAND: Gravel (65%), fine to coarse (40/40/20); Sand (35%), fine to coarse grained.			12		4.1'			
			13					
GRAVEL: Fine to coarse (50/25/25). Medium brown, saturated.			14					
			15					

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BOREHOLE LOG

BORING/WELL ID: **PZ-20**

TOTAL DEPTH (ft.): **40**

PROJECT: Baughman Drain Hydrogeo	**START DATE:** 07/09/18	**DRILLING CO.:** Job Site Services
SITE LOCATION: Otsego, MI	**END DATE:** 07/09/18	**DRILLER:** Bob / Ben
PROJECT NO.: 180488 HG	**TOC ELEV.:** --	**RIG TYPE:** Geoprobe 7720DT
PROJECT MANAGER: B. Gillett	**GROUND ELEV.:** --	**METHOD OF DRILLING:** Direct Push
LOGGED BY: M. Ingersoll	**STATIC WATER LVL.:** ~6.6' bgs	**SAMPLING METHODS:** Macrocore

NOTES:

▼ Static Water Level

DESCRIPTION	PID ppm	GRAPHIC LOG	DEPTH (ft. bgl)	Static Water Level	Sample/ Revovery	Sample ID	Blow Counts	WELL CONSTRUCTION DETAIL
TOPSOIL: With Grass. 6" thick.			0					2" PVC Casing
PEAT: Organic. Black, slightly moist.								Hole Plug
SAND: Fine grained with little medium to coarse grains (10%). Light brown, slightly moist.			2		4.4'			
SAND: Same as above. Orange brown.								
SAND: Same as above. Light brown.			4					
SAND WITH GRAVEL: Sand (85%), fine to coarse grained (50/30/20); little Gravel (15%), fine to coarse. Light brown, very moist.			6	▼				
SAND WITH GRAVEL: Same as above. Saturated.					4.8'			
SAND: Fine to coarse grained (40/40/20). Light brown, moist.			8					
SAND WITH GRAVEL: Sand (85%), fine to coarse grained (40/40/20); little Gravel (15%), fine to medium. Light brown, very moist.								
SAND: Sand (90%), fine to coarse grained (60/20/20); little Gravel (10%), fine. Medium brown, saturated.			10					
			12		4.6'			
SILTY CLAY: Clay (70%); Silt (30%). Gray, medium plasticity, medium cohesiveness, stiff, moist.			14					
			16					
CLAY: Gray, medium plasticity, high cohesiveness, stiff, moist.					5.0'			
			18					
			20					

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BOREHOLE LOG

BORING/WELL ID: **PZ-20**

TOTAL DEPTH (ft.): **40**

PROJECT: Baughman Drain Hydrogeo
SITE LOCATION: Otsego, MI
PROJECT NO.: 180488 HG
PROJECT MANAGER: B. Gillett
LOGGED BY: M. Ingersoll

START DATE: 07/09/18
END DATE: 07/09/18
TOC ELEV.: --
GROUND ELEV.: --
STATIC WATER LVL.: ~6.6' bgs

DRILLING CO.: Job Site Services
DRILLER: Bob / Ben
RIG TYPE: Geoprobe 7720DT
METHOD OF DRILLING: Direct Push
SAMPLING METHODS: Macrocore

NOTES:

▼ Static Water Level

DESCRIPTION	PID ppm	GRAPHIC LOG	DEPTH (ft. bgl)	Static Water Level	Sample/ Revovery	Sample ID	Blow Counts	WELL CONSTRUCTION DETAIL
SAND: Fine grained. Medium brown, saturated.			20					2" PVC Casing Natural Collapse
			22		4.2'			
			24					
			26					
			28		5.0'			
			30					
			32		5.0'			
CLAY: Gray, high plasticity, high cohesiveness, soft, moist.			34					
SAND: Fine grained. Medium brown, saturated.								2" PVC Screen (10 Slot)
GRAVEL AND SAND: Gravel (50%), fine to coarse (50/25/25); Sand (50%), fine to coarse grained (30/30/40). Orange brown, saturated.			36					
					4.8'			
GRAVEL: Fine to coarse (40/40/20). Orange brown, saturated.			38					
TILL: Silt (70%); little Gravel (15%), fine to medium; little Sand (15%), very fine grained. Gray, hard.			40					

BORING LOG

Project Name:	Dangleman Drain	Boring/Well Number:	DP-1
Project Number:	180485	Start/End Date:	7/9/18
Project Manager:	BTC	Logged By:	ADF
Site Location:	Cotrago, MI	Ground Elevation:	------
Contractor:	N/A	Static Water Level:	------
Driller/Helper	------	Abandonment Method:	Backfill w/ soil
Rig Type:	------	Development Method:	------
Drilling Method:	Hand Auger	Sampling Methods:	------
Borehole Purpose:	Soil Description	PAGE	1 OF 1

Blows per 6"	Recovery (feet)	Depth (ft bgs)	Sample Description	PID (ppm)	Well Construction Details
		0.25	Sand: Fine 85%, medium 10%, trace coarse (5%), Larger grains are sub-angular, L. brown, saturated		Stick-up: Pitless adapter Casing: Drive Point diameter: 1.25" material: 1.0 BGS - 4.0 AGS Galvanized
		0.50			
		0.75			
		1.0			Screen diameter: 1.25" material: 1.0 - 4.0 BGS machine slots slot size
		1.25			
		1.50			
		1.75			Sand Pack type: Natural/Colwater metric: 0 - 4.0'
		2.0			
		2.25	Clay: 100%, low/med. cohesiveness, high positivity, grey color, saturated.		Seal type: ------ material: ------
		2.50			
		2.75			Grout type: ------ material: ------
		3.0			
		3.25			
		3.5	End of boring @ 3.5'		
		3.75			
		4.0			

Density Sands

(blows/count per foot)	
very loose	0 or less
loose	4-10
med dense	11-30
dense	31-50
very dense	>50

Density Clays/Silts

(blows/count per foot)	
very soft	<2
soft	2-4
medium stiff	4-8
stiff	8-15
very stiff	15-30
hard	>30

Comments: N 42° 26' 40.9", W 85° 42' 31.6". Located 120' downstream of culvert, + staff gage. staff gage reads 0.31ft. 4" PVC drain pipe ≈ 30 ft downstream of culvert on N. side, flowing @ 1200 mL/min. Culvert is 24", bent slightly to oval shape, 8" of sediment, 3.75" depth of water.

BORING LOG

Project Name:	Baughman Drain	Boring/Well Number:	DP-2
Project Number:	180188	Start/End Date:	9/9/18
Project Manager:	BEG	Logged By:	ADF
Site Location:	Ortego, MI	Ground Elevation:	------
Contractor:	N/A	Static Water Level:	------
Driller/Helper:	------	Abandonment Method:	Backfill w/ soil
Rig Type:	------	Development Method:	------
Drilling Method:	Hand Auger	Sampling Methods:	------
Borehole Purpose:	Soil Description	PVC#	: Of : 1

Blows per 6"	Recovery (feet)	Depth (ft bgs)	Sample Description	PID (ppm)	Well Construction Details
		0.25	SAND: Fine 85%, medium 10%, trace coarse 5%, Larger grains sub-angular, L. Brown, saturated.		Stick-up: Flushmount Casing: Direct Push diameter: 1.25" interval: 1.5 BGS - 3.5 BGS material: Galvanized
		0.50			
		0.75	Cobbles: 2-4" diameter, angular, Light color		
		1.0			Screen diameter: 1.25" interval: 1.5-4.5 BGS material: Stainless slot size: 0.010" (.25 mm)
		1.25	Sand w/ some organics: Fine 85%, medium 10%, trace coarse 5%, Larger grains sub-angular, dark grey/black color, organic smell, compacted, Saturated.		
		1.50			
		1.75			Sand Pack type: Natural Colosio #/bag:
		2.0			
		2.25			Seal type: ------ #/bag: ------
		2.50			
		2.75			Grout type: ------ #/bag: ------
		3.0			
		3.25			Density Sands (Blow counts per foot) very loose: 4 or less loose: 5-10 medium dense: 11-30 dense: 31-50 very dense: >50
		3.50			
		3.75			
		4.0	End of boring @ 4.0'		
		4.25			Density Clays/Silts (Blow counts per foot) very soft: <2 soft: 2-4 medium stiff: 4-8 stiff: 8-15 very stiff: 15-30 hard: >30
		4.50			
		4.75			
		5.0			

Comments: N. 42° 26' 49.7", W. 85° 42' 46.5". Top of Screen 1.5' BGS. Depth of water 7".

BORING LOG

Project Name	Baughman Drain	Boring/Well Number	DP-3
Project Number:	190488	Start/End Date:	9/7/18
Project Manager:	BEG	Logged By	ADF
Site Location:	Otsego, MI	Ground Elevation:	------
Contractor	N/A	Static Water Level :	------
Driller/Helper:	------	Abandonment Method:	Backfill w/ soil
Rig Type	------	Development Method:	------
Drilling Method:	Hand Auger	Sampling Methods:	------
Borehole Purpose	Soil Description	PAGE	1 OF 1

Blows per 6"	Recovery (feet)	Depth (Ft bgs)	Sample Description	Rig (ppm)	Well Construction Details
		0.25	SAND w/ organics: fine 80%, medium 10%, organic material 10%, very soft, coarse grains sub-angular, dark grey/black, saturated		Stick-up: Flexmeter Casing: Sch 40 PVC Diameter: 1.25" Depths: 1.5' BGS - 3.5' AGS Material: Galvanized Screen Slot Size: 1.25" Depths: 1.5-4.5 Material: Stainless Filter Pack Type: Natural Cohesive Depths: Seal Type: ------ Depths: ------ Grout Type: ------ Depths: ------
		0.5			
		0.75			
		1.0			
		1.25			
		1.5			
		1.75	SAND: Fine 85%, medium 10%, trace course 5%. Larger grains sub-angular, L. Brown color, saturated, soft/loose		
		2.0			
		2.25			
		2.5			
		2.75	SAA, but more compacted		
		3.0			
		3.25			
		3.50			
		3.75			
		4.0			
		4.25			
		4.50	End of boring @ 4.50'		

Density - Sands (blows per foot)

very loose	0 to less
loose	5-10
med dense	11-30
dense	31-50
very dense	> 50

Density - Clays/Silts (blows per foot)

very soft	0-2
soft	3-4
Medium stiff	4-8
stiff	8-15
very stiff	15-30
hard	> 30

Comments: N 42° 26' 56.5", W 85° 42' 41.6". TOS 1.5' BGS. Water depth 8.5'.

BORING LOG

Project Name:	LRE / Baughman Dam	Boring/Well Number:	DP-4
Project Number:	180484HG	Start/End Date:	7/12/18
Project Manager:	BEG	Logged By:	MJI
Site Location:	Otsego, MI	Ground Elevation:	
Contractor:	FTCH	Static Water Level:	1.0' AGS
Driller/Helper:	MJI / APS	Abandonment Method:	
Rig Type:	Hand Auger	Development Method:	
Borehole Purpose:	Soil Description	Sampling Methods:	

PAGE 1 OF 1

Blows per 6"	Recovery (Feet)	Depth (ft bgs)	Sample Description	PID (ppm)	Well Construction Details
		0.25	Sand: fine to med. (75/25), trace of coarse (10%), med. brown, loose		Casing: diameter 1.25", interval 0-1', material Galv. St.
		0.5	Sand: SAA		
		0.75			
		1.0	Sand: fine to coarse (50/40/10), trace fine Gravel (10%), med. grey brown, loose		Screen: diameter 1.25", interval 1-4', material Mesh S.S., slot size Mesh
		1.25			
		1.5	Sand: SAA		
		1.75			Sand Pack: type, interval
		2.0	Sand: SAA		
		2.25			Seal: type, interval
		2.5	Sand: SAA		
		2.75			Grout: type, interval
		3.0			
		3.25			
		3.5	Clay: grey, stiff, med. cohesiveness, med. plasticity, compact		
		3.75			
		4.0			
			EOB=4' bgs		

Density - Sands (blow count per foot)

very loose	0-4
loose	5-10
med dense	11-30
dense	31-50
very dense	>50

Density - Clays/Silts (blow counts per foot)

very soft	<2
soft	2-4
medium stiff	5-8
stiff	9-15
very stiff	16-30
hard	>30

Comments: N42.450078 W85.715743. Installed top of drive-point screen 1.0' bgs. SWL = 1.0' AGS

BORING LOG

Project Name	LRE / Bangham Drain	Boring/Well Number	DP-5
Project Number	180488 HG	Start/End Date	7/12/18
Project Manager:	BEG	Logged By	MJI
Site Location:	Otsego, MI	Ground Elevation:	U
Contractor:	ETCH	Static Water Level:	0.8' AGS
Driller/Helper	MJI / APS	Abandonment Method:	
Rig Type	Hand Auger	Development Method	
Borehole Purpose	Soil Description	Sampling Methods	

PAGE 1 OF 1

Blows per 6"	Recovery (feet)	Depth (ft bgs)	Sample Description	PID (ppm)	Well Construction Details
		0.25	Sand: fine to med. (70/30), trace coarse (10%), med. grey brown, loose		Riser: diameter 1.25", interval 0-1.25', material GalV. St.
		0.5			
		0.75	Sand: SAA		Screen: diameter 1.25", interval 1.25-4.25', material S.S., screen Mesh
		1.0			
		1.25	Sand: SAA		
		1.5			Sand Pack: type, interval
		1.75			
		2.0	Sand: fine to coarse (60/20/20), little fine Gravel (15-20%), med. grey brown		Seal: type, interval
		2.25			
		2.5	Sand: SAA, little fine to med. Gravel (15%)		Grout: type, interval
		2.75			
		3.0			
		3.25	Sand: SAA		Density - Sands (blows counts per foot): very loose 0-4, loose 5-10, med dense 11-30, dense 31-50, very dense >50
		3.5			
		3.75	Sand: fine to med. (80/20), trace fine Gravel (10%), med. grey brown, compact		
		4.0			Density - Clays/Silts (blows counts per foot): very soft <2, soft 2-3, medium stiff 4-8, stiff 9-15, very stiff 16-30, hard >30
			EOB = 4.25' bgs		

Comments: N42.4500451 W85.7083033 Installed top of drivepoint screen 1.25' bgs.

BORING LOG

Project Name	LRE/Baughman Drain	Boring/Well Number	DP-6
Project Number	180485HG	Start/End Date	7/12/18
Project Manager	BEG	Logged By	MJI
Site Location	Otsego, MI	Ground Elevation	
Contractor	ETCH	Static Water Level	0.5' AGS
Driller/Helper	MJI/APS	Abandonment Method	
Rig Type	Hand Auger	Development Method	
Borehole Purpose	Soil Description	Sampling Methods	

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Blows per 6"	Recovery (feet)	Depth (ft bgs)	Sample Description	PID (ppm)	Well Construction Details
		0.25	Sand: fine to med. (75/15), trace coarse (10%), med. grey, loose		Casing: material 1.25" interval 0-1.5' type Sch. 40
		0.5			
		0.75			
		1.0	Sand: SAA, grey brown		Screen: diameter 1.25" interval 1.5-4.5' type S.S. slot size Mesh
		1.25			
		1.5	Sand: fine to coarse (70/20/10), grey brown, loose		Sand Pack: type ____ interval ____
		1.75			
		2.0	Sand: SAA, trace fine Gravel (10%)		Seal: type ____ interval ____
		2.25			
		2.5			Grout: type ____ interval ____
		2.75	Sand: SAA		
		3.0			
		3.25	Sand: fine to coarse (60/25/15), little fine Gravel (15%), grey brown, compact		
		3.50			
		3.75			
		4.0			
			EOB = 4' bgs		

Density - Sands (blows counts per foot)

very loose	5 or less
loose	5-10
med dense	11-30
dense	31-50
very dense	>50

Density - Clays/Silts (blow counts per foot)

very soft	<2
soft	2-4
medium soft	4-8
stiff	8-15
very stiff	15-30
hard	>30

Comments: N42.4479380 W85.7054028 Installed the top of the drivepoint screen 1.5' bgs. SWL = 0.5' AGS

BORING LOG

Project Name:	Baughman Drain	Boring/Well Number:	EXP-1
Project Number:	180488	Start/End Date:	7/9/18
Project Manager:	BEG	Logged By:	ADF
Site Location:	Otsego, MI	Ground Elevation	------
Contractor	N/A	Static Water Level	------
Driller/Helper:	------	Abandonment Method:	Backfill w/ soil
Rig Type:	------	Development Method:	------
Drilling Method:	Hand Auger	Sampling Method:	------
Borehole Purpose:	Soil Description	PAGE	1 OF 1

Blows per 6"	Recovery (feet)	Depth (ft bgs)	Sample Description	PID (ppm)	Well Construction Details
		0.25	Sand: Fine grained 95%, Trace med/coarse grain 5%. Light brown, wet/saturated. Well sorted,		Set-up: Peristaltic Casing: Tubing diameter: 3/8" material: ------ Screen diameter: 1/2" interval: 1-1.5' BGS material: SS slot size: ------ Sand Pack type: Natural Collapse interval: 0-1.5' Seal type: ------ interval: ------ Grout type: ------ interval: ------
		0.50			
		0.75			
		1.0			
		1.25			
		1.50			
		1.75	Clay: 100%, low-med cohesiveness, high plasticity, grey color, saturated		
		2.0			
		2.25			
		2.50	End of boring @ 2.5'		

Density - Sands

(blow counts per foot)

very loose:	0-4
loose:	4-10
med dense:	10-30
dense:	30-50
very dense:	>50

Density - Clays/Silts

(blow counts per foot)

very soft:	<2
soft:	2-4
med stiff:	4-8
stiff:	8-15
very stiff:	15-30
hard:	>30

Comments: 42° 26' 40.9" 85° 42' 24.8". Depth of water ≈ 4'. 6" expendable point installed: Top of screen is 1.0' BGS.

BORING LOG

Project Name:	Baughman Drain	Boring/Well Number:	EXP-#2
Project Number:	182458	Start/End Date:	7/9/18
Project Manager	BCC	Logged By:	ADF
Site Location:	Cologo, WI	Ground Elevation:	------
Contractor:	N/A	Static Water Level:	------
Driller/Helper	------	Abandonment Method:	Backfill w/ soil
Rig Type:	------	Development Method:	------
Drilling Method:	Hand Auger	Sampling Methods:	------
Borehole Purpose:	Soil Description	PAGE	1 OF 1

Blows per 6"	Recovery (Feet)	Depth (ft bgs)	Sample Description	PID (ppm)	Well Construction Details
		0.25	SAND + Gravel: Gravel 15%, sub rounded, Sand: fine 75%, 10% medium/coarse, larger grains, sub-angular, Loose, L. Brown, saturated		Backup: Peristaltic Tubing Casing diameter: 3/8" interval: 3.0-BGS = 3.0 AGS material:
		0.5			
		0.75			
		1.0	SAND: Fine 85%, medium 10%, Trace coarse 5%, larger grains sub-angular, Dark Gray/black (organic matter), saturated Loose		Screen diameter: 1/2" interval: 3.0-3.5' material: SS slot size:
		1.25			
		1.5			
		1.75	SAA, color back to L. Brown		Sand Pack type: material: 0-3.5'
		2.0			
		2.25			Seal type: material:
		2.50			
		2.75			Grout type: material:
		3.0			
		3.25			Density - Sands (blow counts per foot)
		3.5			very loose 0-4
		2.75			loose 5-10
		4.0			med dense 11-30
		4.25			dense 31-50
		4.50	End of boring @ 4.50'		very dense >50
		4.75			Density - Clays/Silts (blow counts per foot)
		5.0			very soft <2
					soft 2-4
					medium stiff 4-8
					stiff 8-15
					very stiff 15-30
					hard >30

Comments: N 42° 26' 43.5", W 85° 42' 39.0". 6" expendable point installed: Top of screen is 3.0' BGS. Depth of water 5" (0.42 ft).

BORING LOG

Project Name:	Staghman Drain	Boring/Well Number:	EXP-3
Project Number:	180488	Start/End Date:	7/9/18
Project Manager:	DCG	Logged By:	ADF
Site Location:	Otsego, MI	Ground Elevation:	———
Contractor:	N/A	Static Water Level:	———
Driller/Helper:	———	Abandonment Method:	Backfill w/ soil
Rig Type:	———	Development Method:	———
Drilling Method:	Hand Auger	Sampling Methods:	———
Borehole Purpose:	Soil Description	Page: 1	Of: 1

Blows per 6"	Recovery (feet)	Depth (ft bgs)	Sample Description	PID (ppm)
		0.25	Sand + Organics: 70% Fine Sand, 30% organics, black color, saturated, jelly-like texture	
		0.50		
		0.75	Cobbles: 2-4" diameter, angular, Light color.	
		1.0		
		1.25	Sand: Fine 85%, medium 10%, trace Coarse (5%). Lager grains sub-angular, Compacted, L. Brown color, saturated	
		1.50		
		1.75		
		2.0		
		2.25		
		2.50		
		2.75		
		3.0		
		3.25		
		3.50		
			End of boring @ 3.50'	

Well Construction Details:

Stick-up: Peristaltic tubing

Casing
- diameter: 3/8"
- material:
- material:

Screen
- diameter: 1/2"
- material:
- material: SS
- [illegible]:

Sand Pack
- type: Natural Collapse
- material:

Seal
- type: ———
- material: ———

Grout
- type: ———
- material: ———

Density - Sands
(Blow counts per foot)

very loose	< 4 or less
loose	5-10
med dense	11-30
dense	31-50
very dense	> 50

Density - Clays/Silts
(Blow counts per foot)

very soft	<2
soft	2-4
medium stiff	4-8
stiff	9-15
very stiff	15-30
hard	>30

Comments: N. 42° 26' 47.3" W 85° 42' 44.4". Located 30' downstream of SG-2. SG-2 read 1.20'. Expandable point (top of screen) is 3.0' BGS. Water depth 5.0" (0.42 ft)

BORING LOG

Project Name:	Bridgeman Drain	Boring/Well Number:	EXP-4
Project Number:	L80438	Start/End Date	7/9/18
Project Manager:	BES	Logged By:	ADF
Site Location:	Otsego, MI	Ground Elevation:	------
Contractor	N/A	Static Water Level :	------
Driller/Helper:	------	Abandonment Method	Backfill w/ soil
Rig Type:	------	Development Method:	------
Drilling Method:	Hand Auger	Sampling Methods:	------
Borehole Purpose:	Soil Description	WAF	1 of 1

Blows per 6	Recovery (feet)	Depth (ft bgs)	Sample Description	PID (ppm)	Well Construction Details
		0.25	SAND: Fine 85%, medium 10%, trace coarse 5% Larger grains sub-angular, L. Brown, saturated		Pitcher: Peristaltic Tubing. Casing: diameter: 3/8" material: 2.5 BGS - 3.0' AGS Screen: diameter: 1/2" interval: 2.5-3.0 material: SS slot size: Sand Pack: type: Morie Co Sand material: Seal: type: ------ material: ------ Grout: type: ------ material: ------
		0.50			
		0.75	Cobbles/Gravel/Organics: 75% cobbles 2-4" diameter, sub-rounded, Gravel 10% sub-rounded, Leaves/sticks/etc 15%		
		1.0			
		1.25			
		1.5	SAND w/ some organics: Fine 85%, medium 10%, trace coarse @ 5%, dark grey color, organic smell, compacted, saturated.		
		1.75			
		2.0			
		2.25			
		2.50	End of boring @ 2.0'		
		2.75			
		3.0			

Density, Sands

very loose	0 to 4
loose	5 to 10
medium dense	11 to 30
dense	31 to 50
very dense	> 50

Density, Clays/Silts

very soft	<2
soft	2-4
firm	5-8
stiff	9-15
very stiff	16-30
hard	>30

Comments: N 42° 26' 53.2", W 85° 42' 49.3". Depth of water 6" (0.5 ft)
Top of Screen 2.5' BGS

BORING LOG

Project Name:	LRE / Binghamton Area	Boring/Well Number:	EXP-5
Project Number:	180488HG	Start/End Date:	7/12/18
Project Manager:	BEG	Logged By:	MJI
Site Location:	Otsego, NY	Ground Elevation:	
Contractor:	ETEH	Static Water Level:	0.5' AGS
Driller/Helper:	MJI / APS	Abandonment Method:	
Rig Type:	Hand Auger	Development Method:	
Borehole Purpose:	Soil Description	Sampling Methods:	

PAGE 1 OF 1

Blows per 6"	Recovery (feet)	Depth (ft bgs)	Sample Description	PID (ppm)	Well Construction Details
		0.25	Muck: black, organic, w/ some fine Sand (40%)		Casing: Peristaltic Tubing; diameter: 3/8"; interval: 0-2'; material: PolyE
		0.5			
		0.75	Sand: fine, organic, med. grey brown compact		
		1.0	Sand: fine to med. (70/30), med. grey loose		Screen: 3/8"; diameter: 0.5"; interval: 2-2.5'; material: SS; details:
		1.25			
		1.5	Sand: SAA		
		1.75			Sand Pack: type: ; interval:
		2.0	Sand: fine to coarse (60/25/15), med. grey, loose		
		2.25			Seal: type: ; interval:
		2.5	~~backfill~~ clay: grey, stiff, med cohesive, med. plasticity		
		2.75			Grout: type: ; interval:
		3.0			
			EOB = 3.0' bgs		

Density Sands (Blows counts per foot)	
very loose	5 or less
loose	6-10
med dense	11-30
dense	31-50
very dense	>50

Density Clays/Silts (Blows counts per foot)	
very soft	<2
soft	2-4
firm	5-8
stiff	9-15
very stiff	16-30
hard	>30

Comments: N42.4496124 W85.7142933 Installed 6" expandable point w/ top of screen 2.0' bgs. SWL = 0.5' AGS

BORING LOG

Project Name:	LRE/Bauglerman Dairy	Boring/Well Number:	EXP-6
Project Number:	180488.16	Start/End Date:	7/12/18
Project Manager:	BEL	Logged By:	MJI
Site Location:	Otsego, MI	Ground Elevation:	
Contractor:	FTCH	Static Water Level:	1.0' AGS
Driller/Helper:	MJI/APS	Abandonment Method:	
Rig Type:	Hand Auger	Development Method:	
Borehole Purpose:	Soil Description	Sampling Methods:	

PAGE 1 OF 1

Blows per 6"	Recovery (Inch)	Depth (ft bgs)	Sample Description (50/30/20)	PID (ppm)	Well Construction Details
		0.25	Sand: fine to coarse w/ little fine Gravel (15%), light brown, loose		Peristaltic Tubing Casing: Diameter 3/8"; Interval 0'-2.5'; Material Poly E
		0.5	Sand: very fine, med. grey brown, loose		
		0.75			
		1.0	Sand: SAA		Screen: Diameter 3/8" .05"; Interval 2.5-3.0'; Material SS; Detail
		1.25			
		1.5	Sand: SAA		Sand Pack: Type; Interval
		1.75			
		2.0	Sand: fine to med. (70/30), trace fine to med. Gravel (10%), med. grey, loose		Seal: Type; Interval
		2.25			
		2.5	Sand: fine, med. grey, compact		Grout: Type; Interval
		2.75			
		3.0	EOB = 3.0' bgs		

Density - Sands

(blow counts per foot)	
very loose	5 or less
loose	6-10
medium dense	11-30
dense	31-50
very dense	>50

Density - Clays/Silts

(blow counts per foot)	
very soft	<2
soft	2-4
medium stiff	5-8
stiff	9-15
very stiff	16-30
hard	>30

Comments: N42.4500604 W85.7133479 Installed 6" expendable point w/ top of screen 2.5' bgs. SWL=1.0' AGS

BORING LOG

Project Name:	LRE/Baughman Drain	Boring/Well Number:	EXP-7
Project Number:	180488116	Start/End Date:	7/12/18
Project Manager:	BEG	Logged By:	MJI
Site Location:	Otsego, MI	Ground Elevation:	
Contractor:	ETEH	Static Water Level:	0.4' AGS
Driver/Helper:	MJI/APS	Abandonment Method:	
Rig Type:	Hand Auger	Development Method:	
Borehole Purpose:	Soil Description	Sampling Methods:	

PAGE 1 OF 1

Blows per 6"	Recovery (feet)	Depth (ft bgs)	Sample Description	PID (ppm)	Well Construction Details
		0.25	Sand: fine to med (80/20), trace coarse (0%), med. grey brown, loose		Casing: Peristaltic Tubing; diameter: 3/8"; interval: 0-2.5'; material: Poly E
		0.5			
		0.75	Sand: SAA		Screen: 3/8"; diameter: 2.5'; interval: 2.5-3'; material: SS; slot size:
		1.0			
		1.25	Sand: SAA		
		1.5			Sand Pack: type; interval:
		1.75	Sand: fine to coarse (30/50/20), trace fine Gravel (10%), med. grey brown, compact		Seal: type; interval:
		2.0			
		2.25			Grout: type; interval:
		2.5	Sand: SAA		
		2.75			
		3.0			
			EOB = 3' bgs		

Density - Sands (blows counts per foot)

very loose:	0 to 4
loose:	5 to 10
med dense:	11 to 30
dense:	31 to 50
very dense:	>50

Density - Clays/Silts (Blows counts per foot)

very soft:	<2
soft:	3 to 4
medium stiff:	5 to 8
stiff:	9 to 15
very stiff:	16 to 30
hard:	>30

Comments: N42.4500463 W85.7036027 6" expendable point installed at top of screen 2.5' bgs. SWL = 0.4' AGS

BORING LOG

Project Name	LRE/Baughman Drain	Boring/Well Number	EXP-8
Project Number	180488 H6	Start/End Date	7/12/18
Project Manager	BEG	Logged By	MJI
Site Location	Otsego, MI	Ground Elevation	
Contractor	FTCH	Static Water Level	0.2' AGS
Driller/Helper	MJI/APS	Abandonment Method	
Rig Type	Hand Auger	Development Method	
Borehole Purpose	Soil Description	Sampling Methods	

Page 1 of 1

Blows per 6"	Recovery (Inches)	Depth (ft bgs)	Sample Description	PID (ppm)	Well Construction Details
		0.25	Sand: fine w/ trace coarse (10%), med. brown, compact		Tubing: Peristaltic Tubing; diameter: 3/8"; interval: 0-2.5'; material: Poly E
		0.5	Sand: SAA		
		0.75			
		1.0	Sand: fine w/ trace med. (10%), med. brown,		Screen: diameter: 3/8"; slot size: 2.5-3'; material: S.S
		1.25			
		1.5	Sand: SAA		
		1.75			Sand Pack: type; interval
		2.0	Sand: SAA		
		2.25			Seal: type; interval
		2.5	Sand: SAA		
		2.75			Grout: type; interval
		3.0			
			EOB = 3' bgs		

Density: Sands (blow counts per foot)	
very loose	5 or less
loose	6-10
med dense	11-30
dense	11-50
very dense	>30

Density: Clays/Silts (blow counts per foot)	
very soft	<2
soft	2-4
medium stiff	4-8
stiff	8-15
very stiff	15-30
hard	>30

Comments: N42.4463064 W85.7055272 Installed expendable point w/ top of screen 2.5' bgs. SWL = 0.2' AGS

BORING LOG

Project Name:	~~North Muskegon Dry Cleaners~~	Boring/Well Number:	EXP-9
Project Number:	~~150846~~ / 150484 HG	Start/End Date:	~~7/10/18~~ 7/12/18
Project Manager	~~Mr. Smith~~ BEG	Logged By:	~~AMS~~ MJI
Site Location:	~~Muskegon, MI~~ Otsego, MI	Ground Elevation	NA
Contractor:	FTCH	Static Water Level:	0.1' AGS
Driller/Helper:	~~Alex Sackett~~ MJI / APS	Abandonment Method:	Cuttings
Rig Type:	NA	Development Method:	NA
Drilling Method:	Hand Auger	Sampling Methods:	~~Composites~~
Borehole Purpose:	~~Waste Characterization~~ Soil Description	PAGE	1 Of 1

Blows per 6"	Recovery (feet)	Depth (ft bgs)	Sample Description	PID (ppm)	Well Construction Details
		0.25	Sand: fine to med. (75/25), trace coarse (10%), med. brown, loose		Stick-up: Polyethylene Tubing
		0.5	– Sand: SAA		Casing diameter: ~~NA~~ 3/8"
		0.75			interval: ~~NA~~ 0-2.5'
		1.0	– Sand: SAA, compact		material: ~~NA~~ PolyE
		1.25			Screen diameter: ~~NA~~ 3/8"
		1.5	– Sand: ~~NA~~ fine to med coarse (60/40)		interval: NA 2.5-3'
		1.75			material: ~~NA~~ SS
		2.0	– Sand: SAA, trace fine gravel (10%)		slot size: NA
		2.25			Sand Pack type: NA
		2.5	– Sand: SAA		interval: NA
		2.75			Seal type: NA
		3.0			interval: NA
			EOB = 3' bgs		Grout type: NA
					interval: NA

Density - Sands (blow counts per foot)

very loose	0-4
loose	5-10
med dense	11-30
dense	31-50
very dense	>50

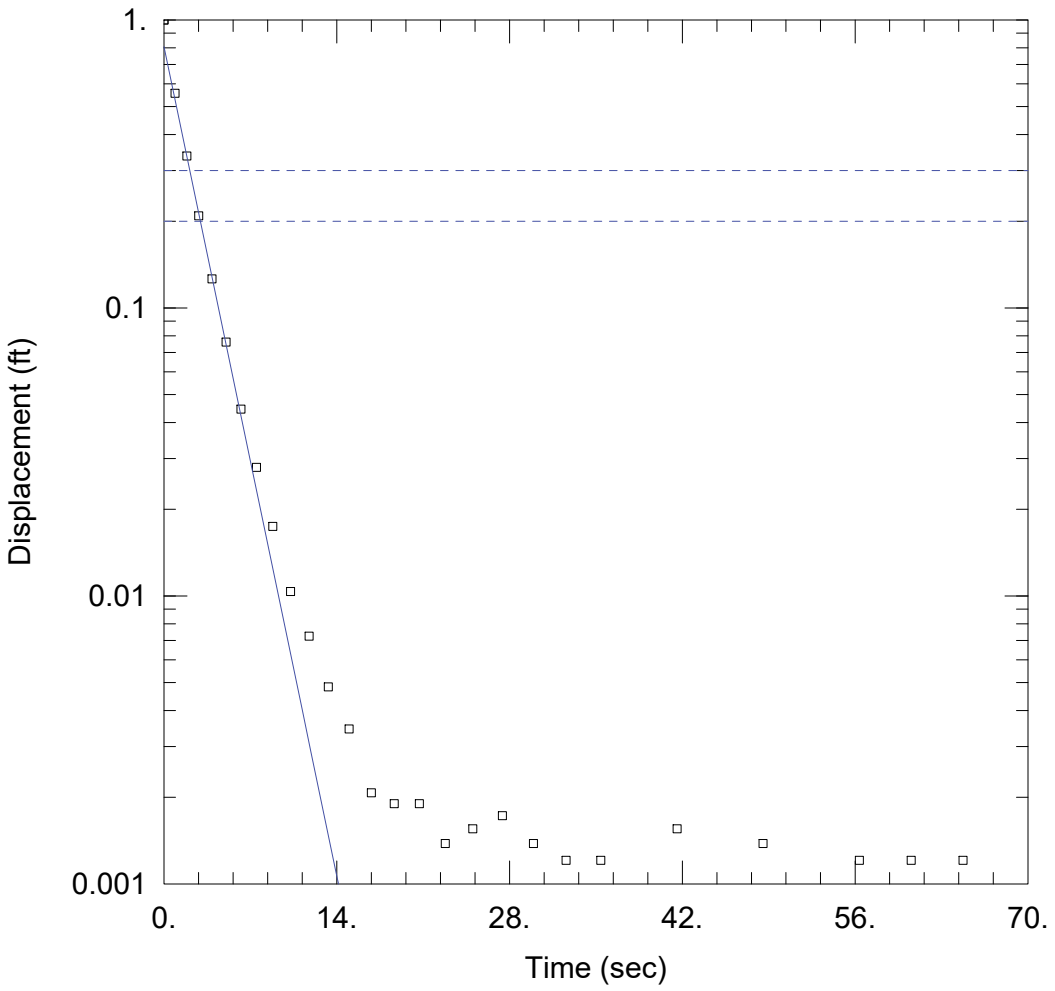
Density - Clays/Silts (blow counts per foot)

very soft	<2
soft	3-4
med stiff	5-8
stiff	9-15
very stiff	16-30
hard	>30

Comments: N42.4465410 W85.7030405 Installed the expendable point w/ the top of screen 2.5' bgs. SWL = 0.1' AGS

Appendix 2

Slug Test
Analysis Graphs



VACUUM #1

Data Set: \...\PZ-9_Vac1.aqt
Date: 12/21/18 Time: 14:08:58

PROJECT INFORMATION

Company: FTCH
Client: Baughman Drain
Project: 180488
Location: Ostego, Michigan
Test Well: PZ-9
Test Date: 7/23/2018

AQUIFER DATA

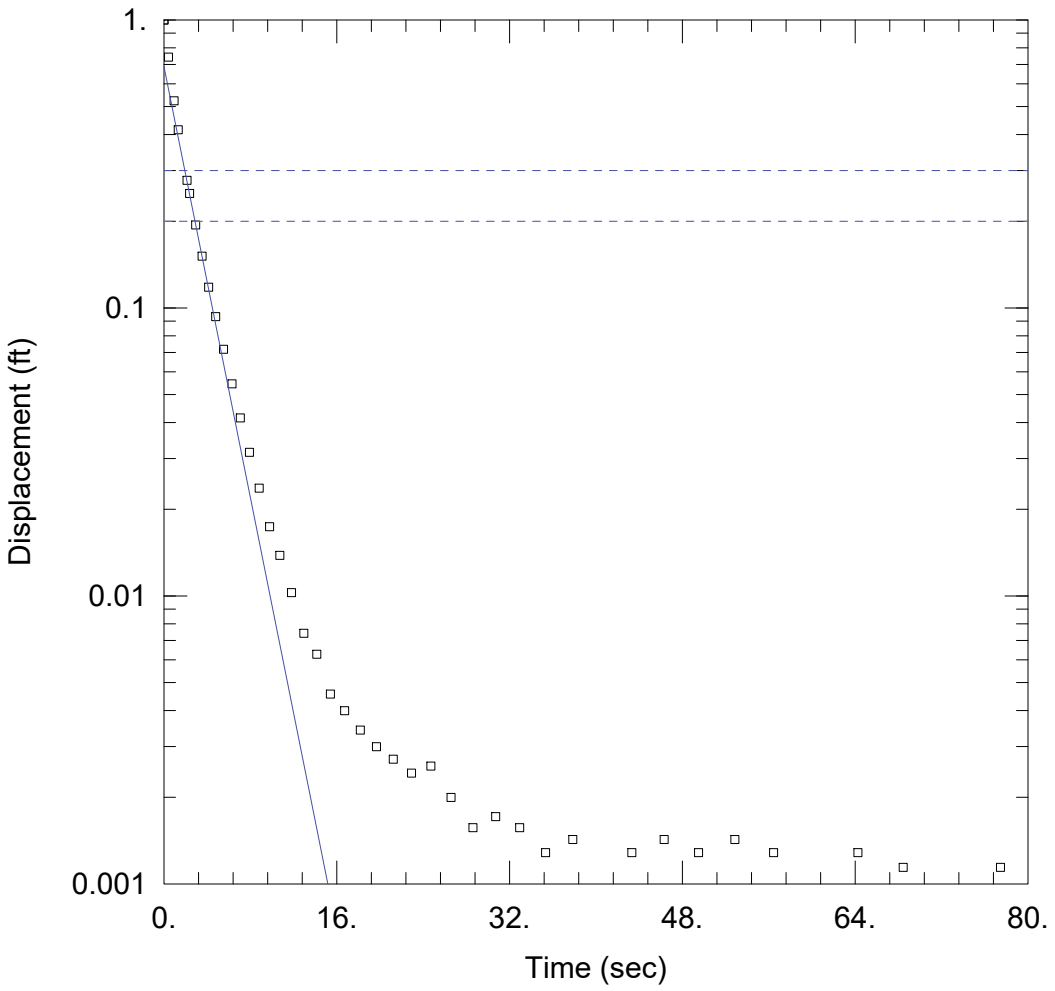
Saturated Thickness: 32.21 ft Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (PZ-9)

Initial Displacement: 1. ft
Total Well Penetration Depth: 7.21 ft
Casing Radius: 0.08333 ft
Static Water Column Height: 7.21 ft
Screen Length: 5. ft
Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 108.1 ft/day
y0 = 0.8073 ft



VACUUM #1

Data Set: \...\PZ-10_Vac.1.aqt
Date: 12/21/18 Time: 14:10:05

PROJECT INFORMATION

Company: FTCH
Client: Baughman Drain
Project: 180488
Location: Ostego, Michigan
Test Well: PZ-10
Test Date: 7/23/2018

AQUIFER DATA

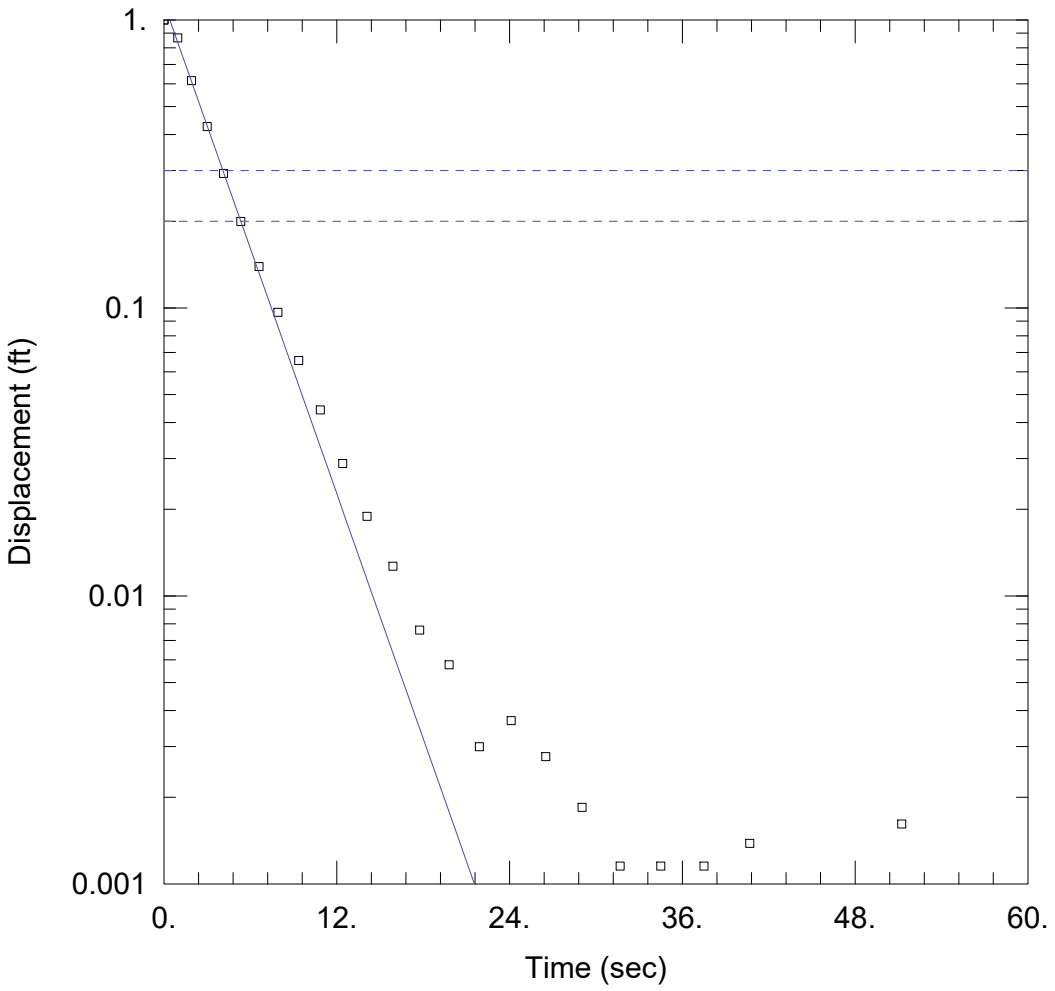
Saturated Thickness: 32.08 ft Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (PZ-10)

Initial Displacement: 1. ft
Total Well Penetration Depth: 6.08 ft
Casing Radius: 0.08333 ft
Static Water Column Height: 6.08 ft
Screen Length: 5. ft
Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 96.1 ft/day
y0 = 0.6882 ft



VACUUM #1

Data Set: \...\PZ-11_Vac1.aqt
Date: 12/21/18 Time: 14:11:11

PROJECT INFORMATION

Company: FTCH
Client: Baughman Drain
Project: 180488
Location: Ostego, Michigan
Test Well: PZ-11
Test Date: 7/23/2018

AQUIFER DATA

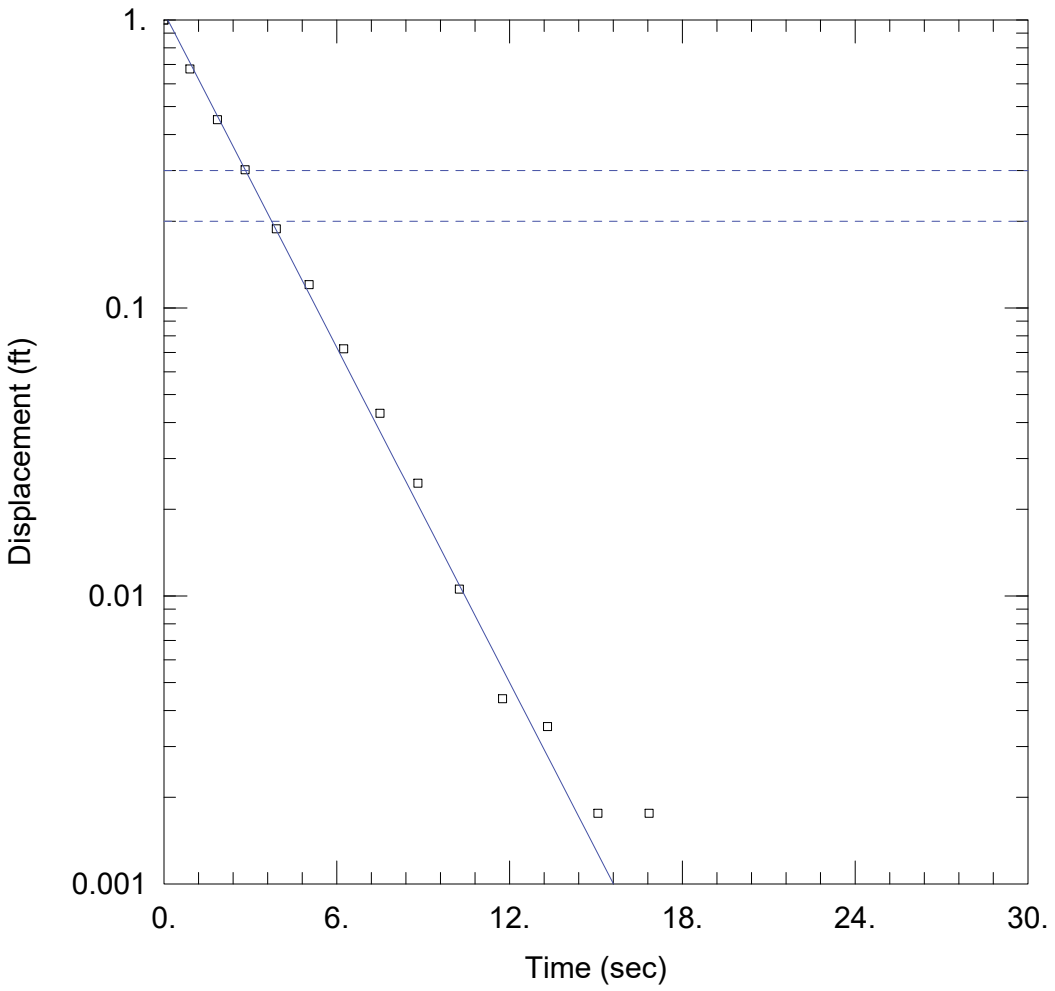
Saturated Thickness: 33.6 ft Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (PZ-11)

Initial Displacement: 1. ft
Total Well Penetration Depth: 8.6 ft
Casing Radius: 0.08333 ft
Static Water Column Height: 8.6 ft
Screen Length: 5. ft
Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 76.3 ft/day
y0 = 1.141 ft



VACUUM #1

Data Set: \...\PZ-12_Vac1.aqt
Date: 12/21/18 Time: 14:13:07

PROJECT INFORMATION

Company: FTCH
Client: Baughman Drain
Project: 180488
Location: Ostego, Michigan
Test Well: PZ-12
Test Date: 7/23/2018

AQUIFER DATA

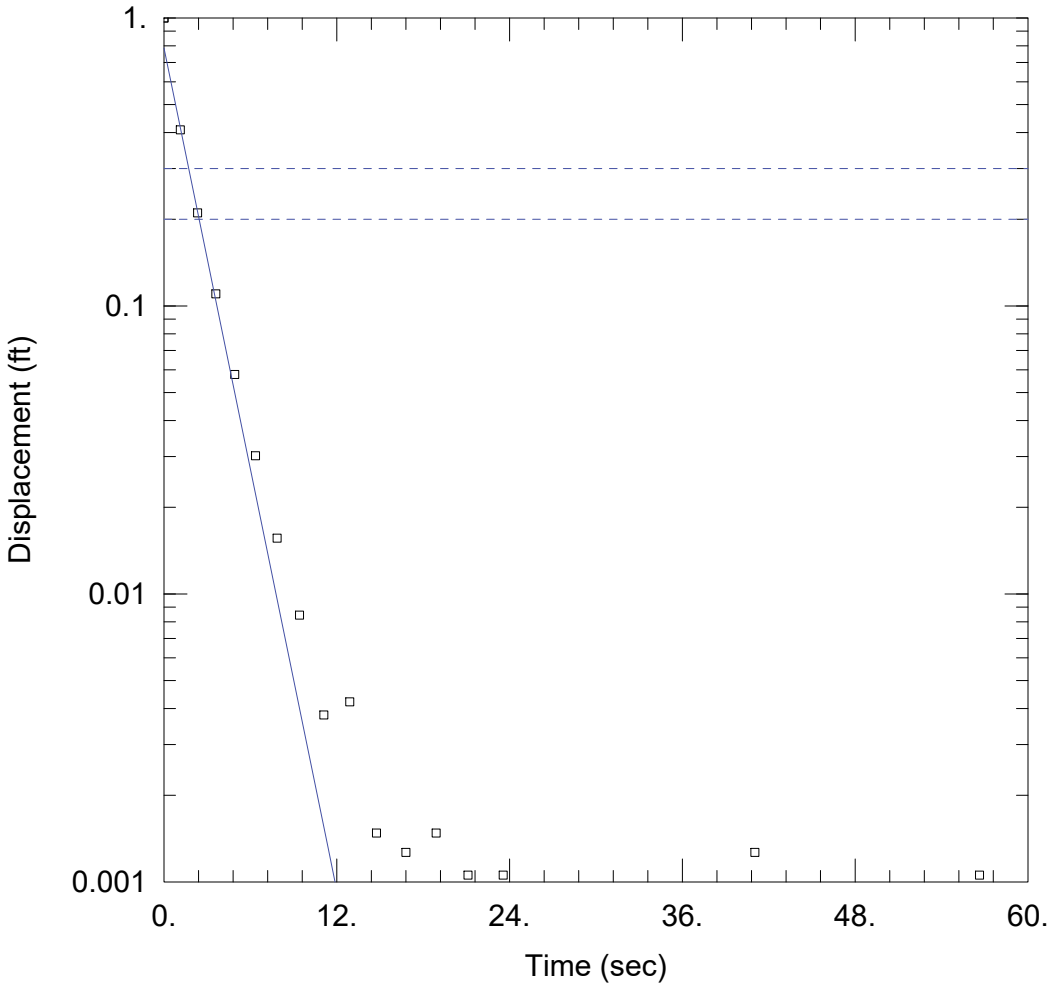
Saturated Thickness: 34.27 ft Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (PZ-12)

Initial Displacement: 1. ft
Total Well Penetration Depth: 9.27 ft
Casing Radius: 0.08333 ft
Static Water Column Height: 9.27 ft
Screen Length: 5. ft
Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 105.3 ft/day
y0 = 1.062 ft



VACUUM #1

Data Set: \...\PZ-13_Vac1.aqt
Date: 12/21/18 Time: 14:16:34

PROJECT INFORMATION

Company: FTCH
Client: Baughman Drain
Project: 180488
Location: Ostego, Michigan
Test Well: PZ-13
Test Date: 7/23/2018

AQUIFER DATA

Saturated Thickness: 34.28 ft Anisotropy Ratio (Kz/Kr): 0.1

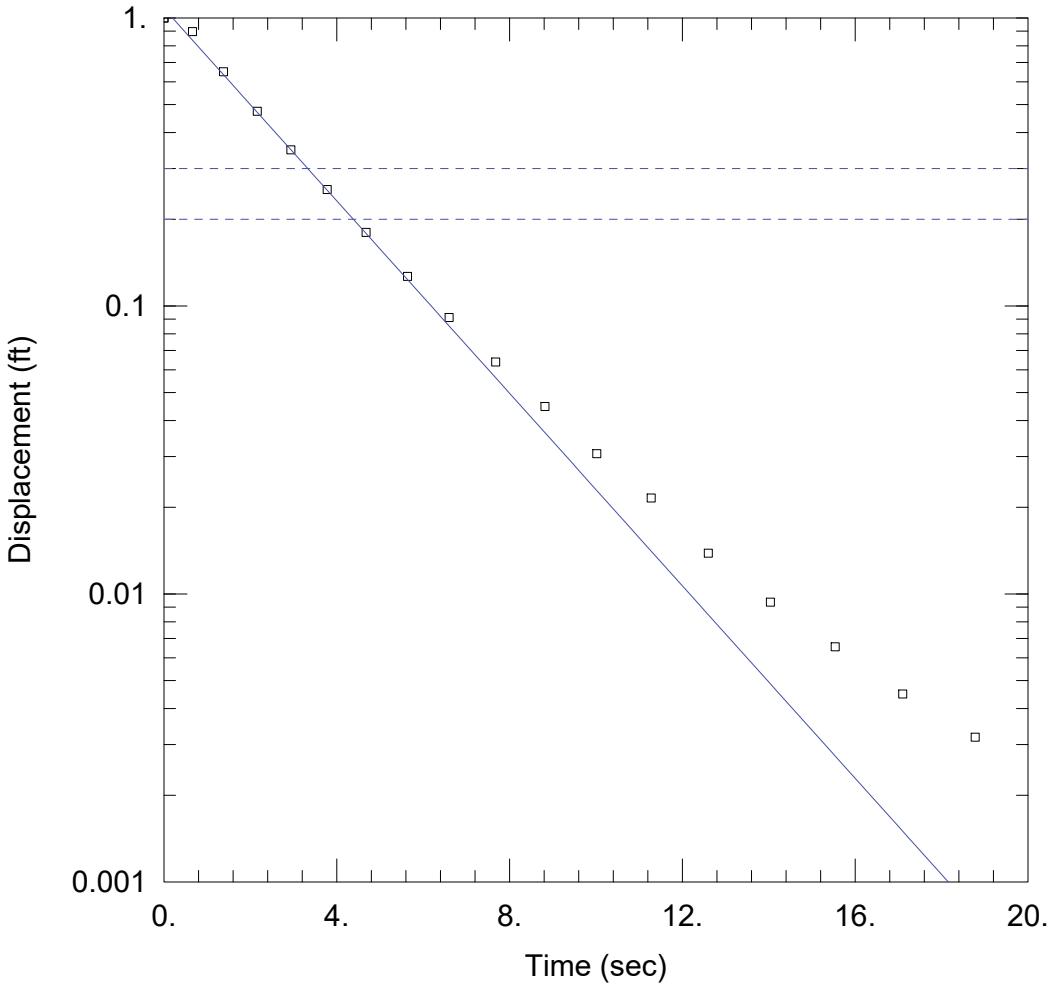
WELL DATA (PZ-13)

Initial Displacement: 1. ft
Total Well Penetration Depth: 9.28 ft
Casing Radius: 0.08333 ft
Static Water Column Height: 9.28 ft
Screen Length: 5. ft
Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice

K = 132.4 ft/day y0 = 0.7861 ft



VACUUM #1

Data Set: \...\PZ-14_Vac1.aqt
Date: 12/21/18 Time: 14:19:47

PROJECT INFORMATION

Company: FTCH
Client: Baughman Drain
Project: 180488
Location: Ostego, Michigan
Test Well: PZ-14
Test Date: 7/23/2018

AQUIFER DATA

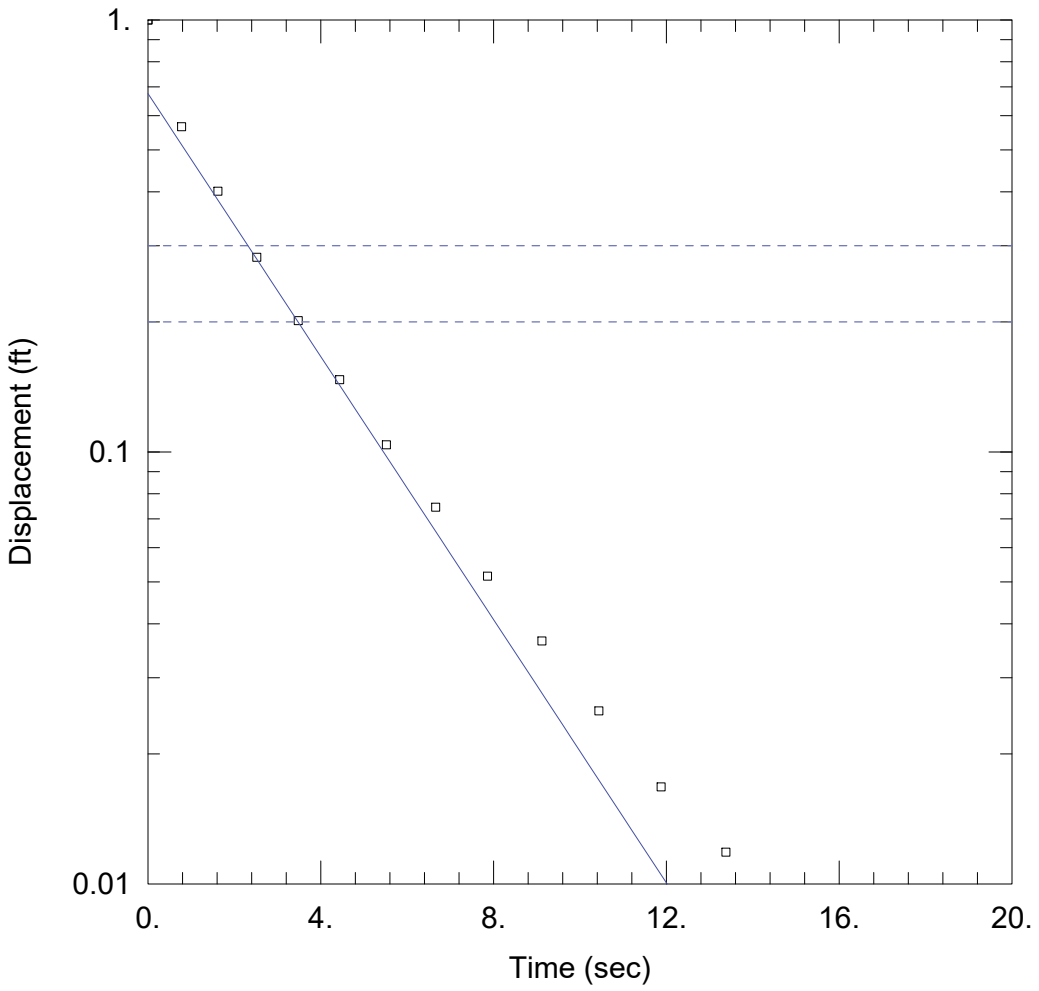
Saturated Thickness: 32.7 ft Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (PZ-14)

Initial Displacement: 1. ft
Total Well Penetration Depth: 7.7 ft
Casing Radius: 0.08333 ft
Static Water Column Height: 7.7 ft
Screen Length: 5. ft
Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 88.6 ft/day
y0 = 1.079 ft



VACUUM #1

Data Set: \...\PZ-15_Vac1.aqt
Date: 12/21/18 Time: 15:13:19

PROJECT INFORMATION

Company: FTCH
Client: Baughman Drain
Project: 180488
Location: Ostego, Michigan
Test Well: PZ-15
Test Date: 7/23/2018

AQUIFER DATA

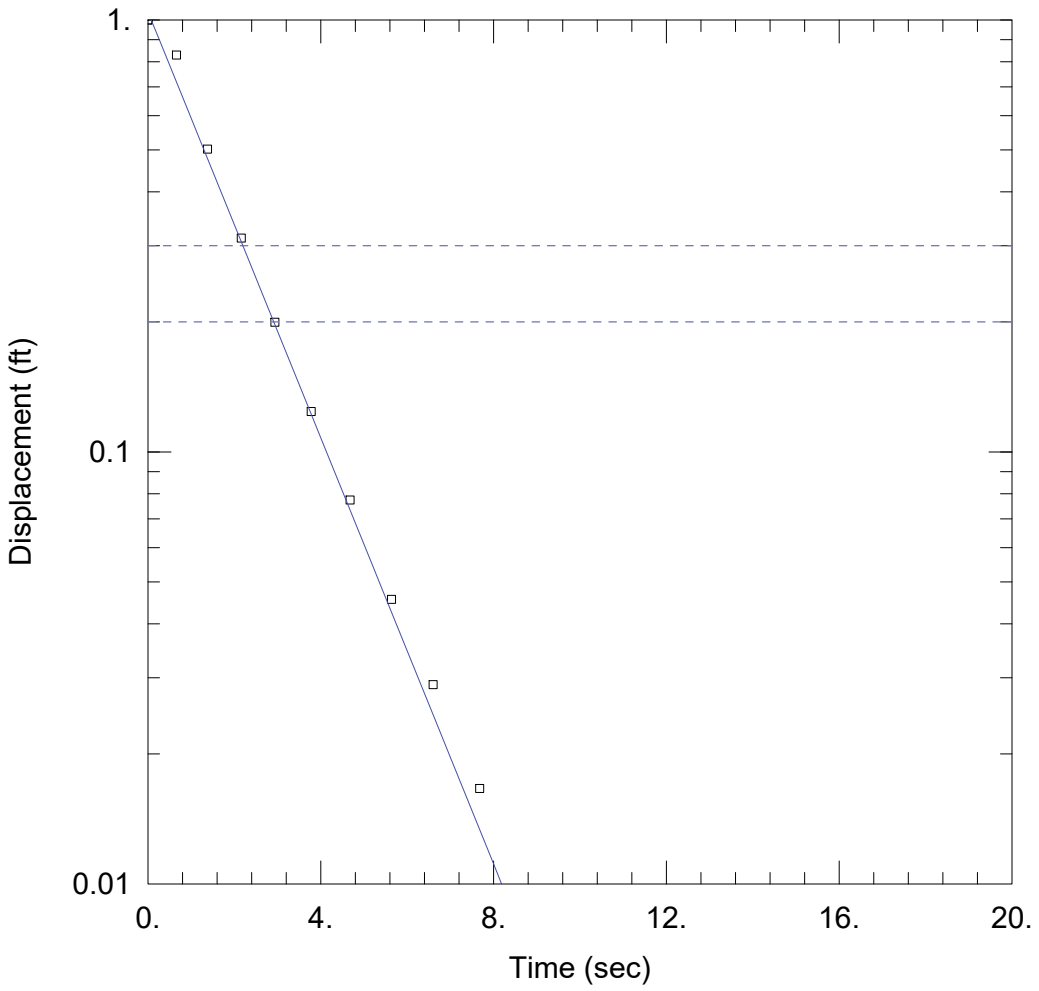
Saturated Thickness: 34.48 ft Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (PZ-15)

Initial Displacement: 1. ft
Total Well Penetration Depth: 9.48 ft
Casing Radius: 0.08333 ft
Static Water Column Height: 9.48 ft
Screen Length: 5. ft
Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 82.91 ft/day
y0 = 0.6752 ft



VACUUM #1

Data Set: \...\PZ-16_Vac1.aqt
Date: 12/21/18 Time: 15:13:51

PROJECT INFORMATION

Company: FTCH
Client: Baughman Drain
Project: 180488
Location: Ostego, Michigan
Test Well: PZ-16
Test Date: 7/23/2018

AQUIFER DATA

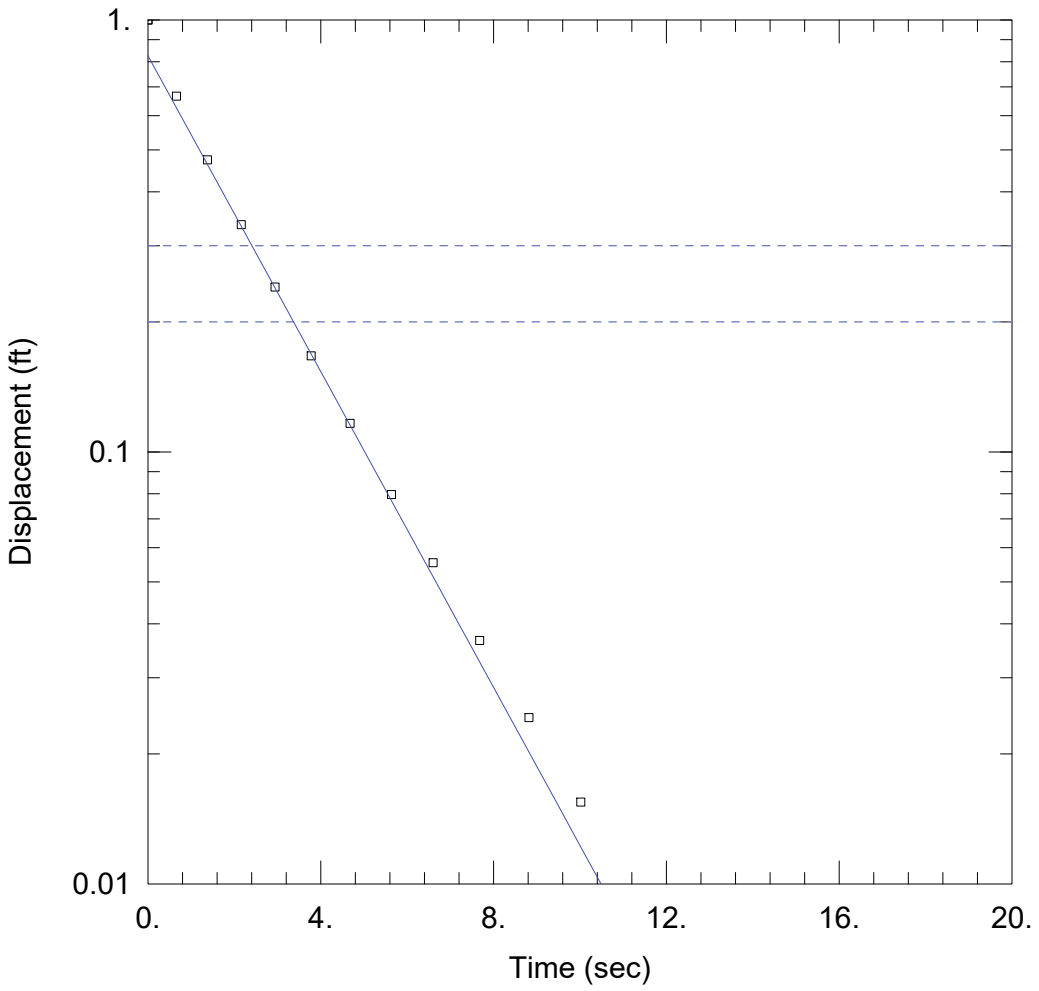
Saturated Thickness: 34.34 ft Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (PZ-16)

Initial Displacement: 1. ft
Total Well Penetration Depth: 9.34 ft
Casing Radius: 0.08333 ft
Static Water Column Height: 9.34 ft
Screen Length: 5. ft
Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 134.1 ft/day
y0 = 1.044 ft



VACUUM #1

Data Set: \...\PZ-17_Vac1.aqt
Date: 12/21/18 Time: 15:14:03

PROJECT INFORMATION

Company: FTCH
Client: Baughman Drain
Project: 180488
Location: Ostego, Michigan
Test Well: PZ-17
Test Date: 7/23/2018

AQUIFER DATA

Saturated Thickness: 33.47 ft Anisotropy Ratio (Kz/Kr): 0.1

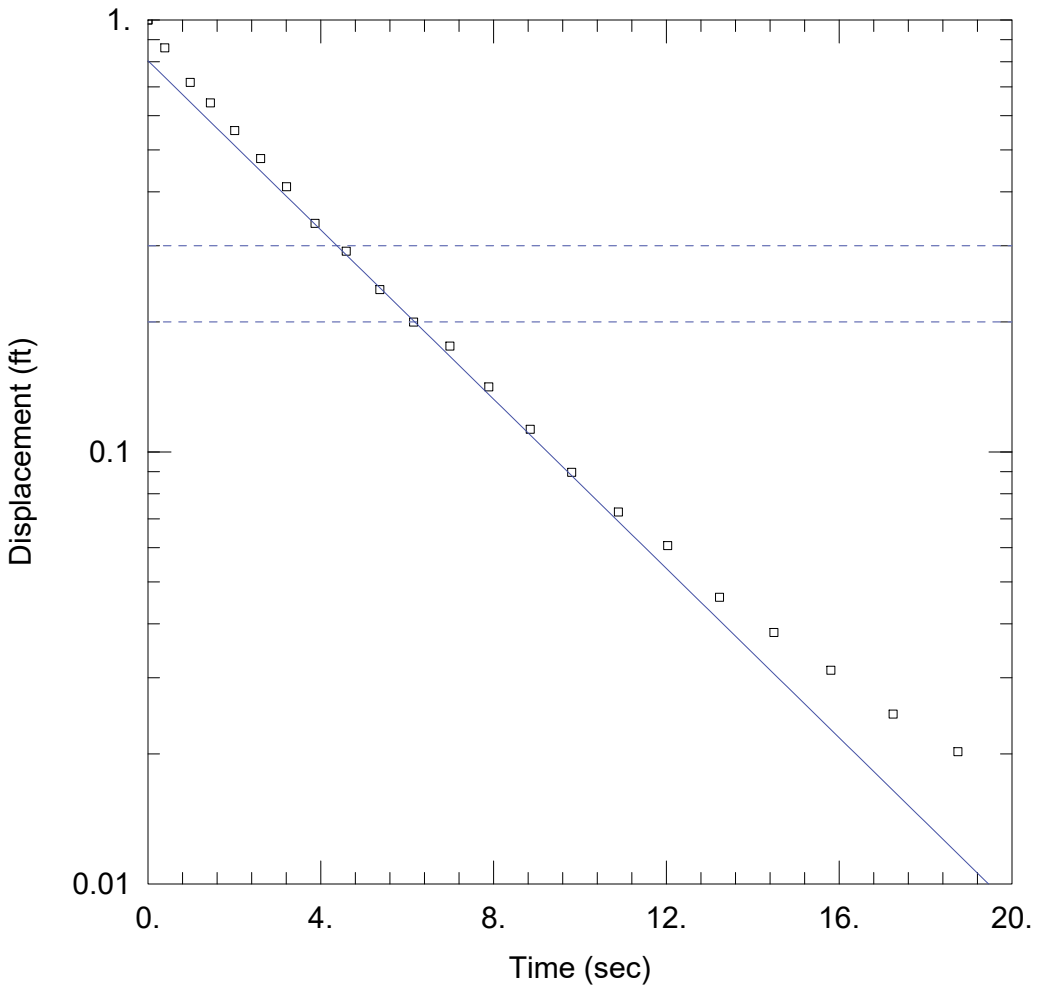
WELL DATA (PZ-17)

Initial Displacement: 1. ft
Total Well Penetration Depth: 8.47 ft
Casing Radius: 0.08333 ft
Static Water Column Height: 8.47 ft
Screen Length: 5. ft
Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice

K = 98.14 ft/day y0 = 0.8258 ft



PRESSURE #1

Data Set: \...\PZ-18_Press2.aqt
Date: 12/21/18 Time: 15:14:25

PROJECT INFORMATION

Company: FTCH
Client: Baughman Drain
Project: 180488
Location: Ostego, Michigan
Test Well: PZ-18
Test Date: 7/23/2018

AQUIFER DATA

Saturated Thickness: 34.46 ft Anisotropy Ratio (Kz/Kr): 0.1

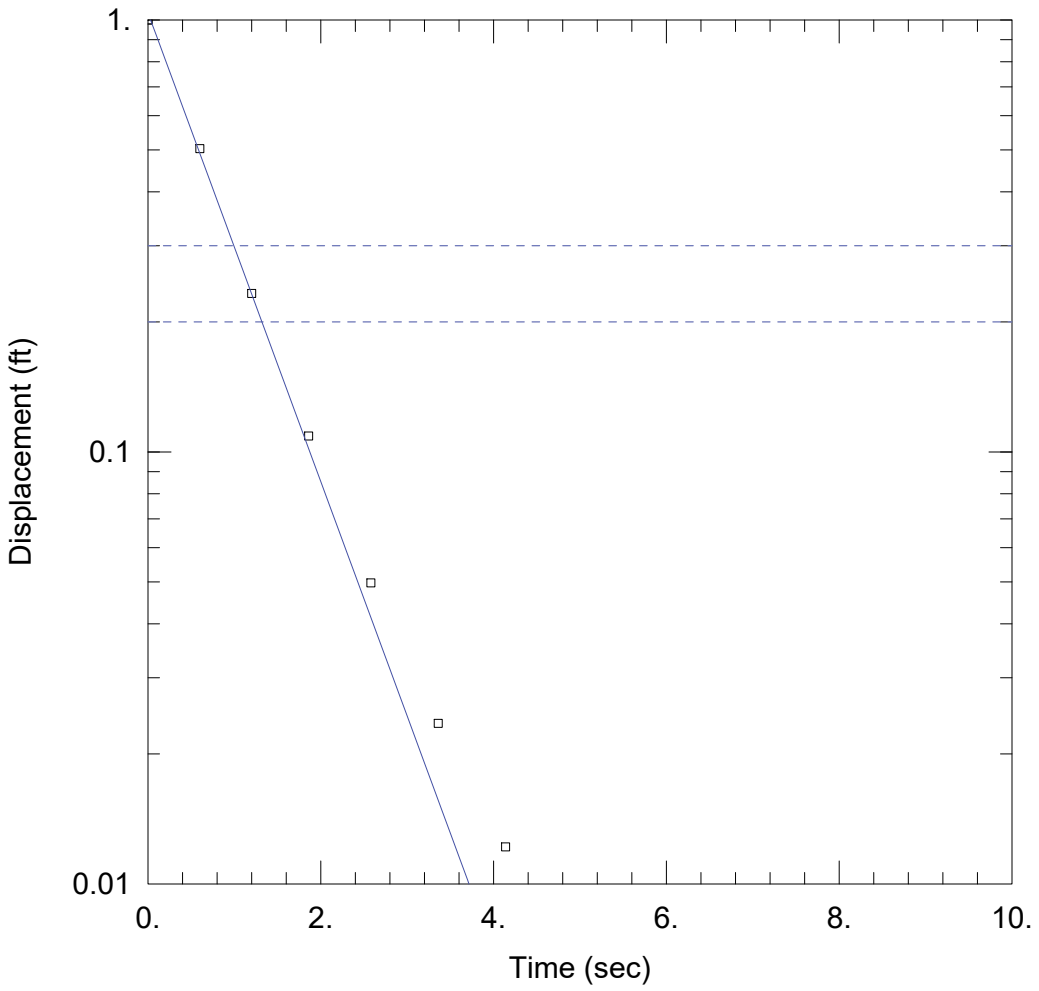
WELL DATA (PZ-18)

Initial Displacement: 1. ft
Total Well Penetration Depth: 9.46 ft
Casing Radius: 0.08333 ft
Static Water Column Height: 9.46 ft
Screen Length: 5. ft
Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice

K = 53.33 ft/day y0 = 0.8045 ft



VACUUM #1

Data Set: \...\PZ-19_Vac1.aqt
Date: 12/21/18 Time: 15:14:49

PROJECT INFORMATION

Company: FTCH
Client: Baughman Drain
Project: 180488
Location: Ostego, Michigan
Test Well: PZ-19
Test Date: 7/23/2018

AQUIFER DATA

Saturated Thickness: 33.13 ft Anisotropy Ratio (Kz/Kr): 0.1

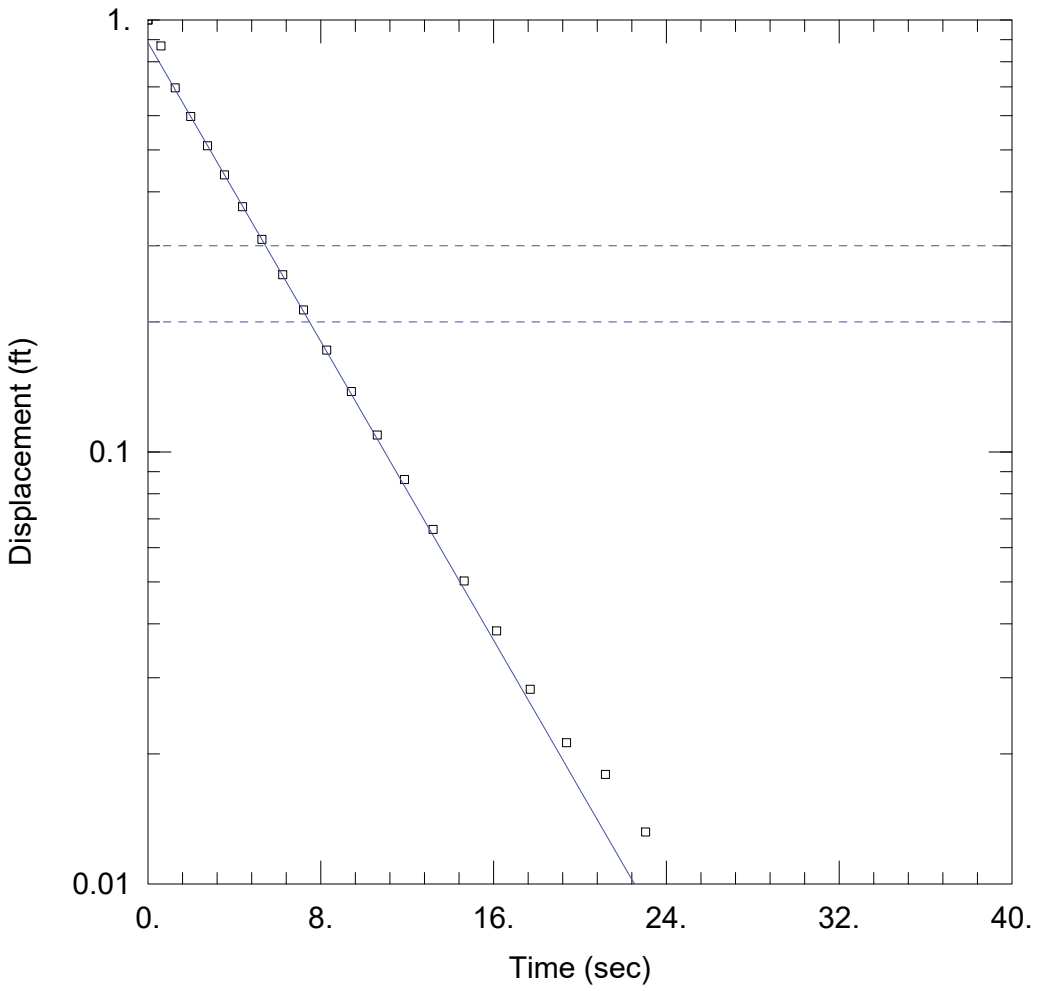
WELL DATA (PZ-19)

Initial Displacement: 1. ft
Total Well Penetration Depth: 8.13 ft
Casing Radius: 0.08333 ft
Static Water Column Height: 8.13 ft
Screen Length: 5. ft
Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice

K = 289.9 ft/day y0 = 1.039 ft



VACUUM #1

Data Set: \...\PZ-20_Vac1.aqt
Date: 12/21/18 Time: 15:16:51

PROJECT INFORMATION

Company: FTCH
Client: Baughman Drain
Project: 180488
Location: Ostego, Michigan
Test Well: PZ-20
Test Date: 7/23/2018

AQUIFER DATA

Saturated Thickness: 35.04 ft Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (PZ-20)

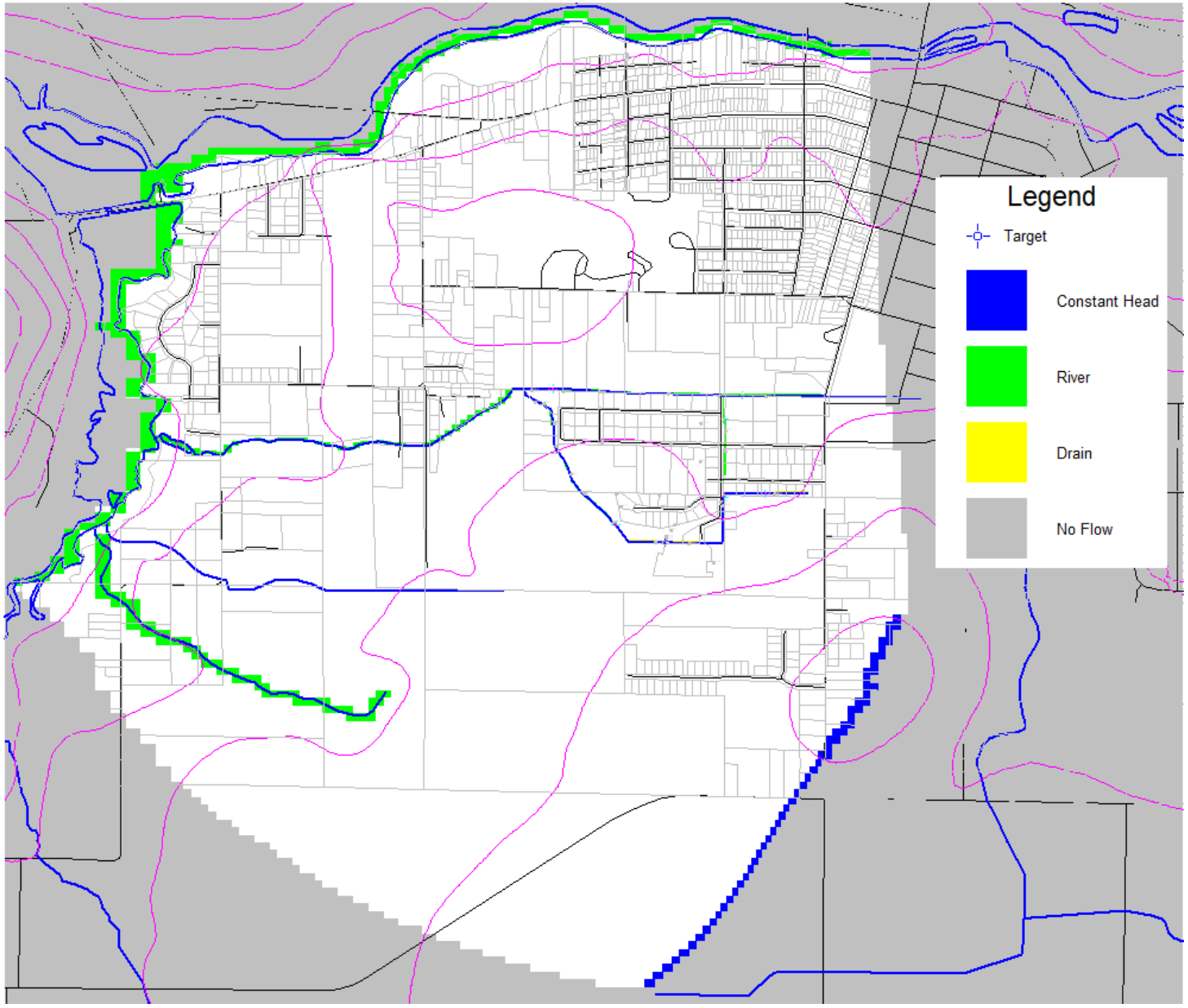
Initial Displacement: 1. ft
Total Well Penetration Depth: 34.04 ft
Casing Radius: 0.08333 ft
Static Water Column Height: 34.04 ft
Screen Length: 5. ft
Well Radius: 0.08333 ft

SOLUTION

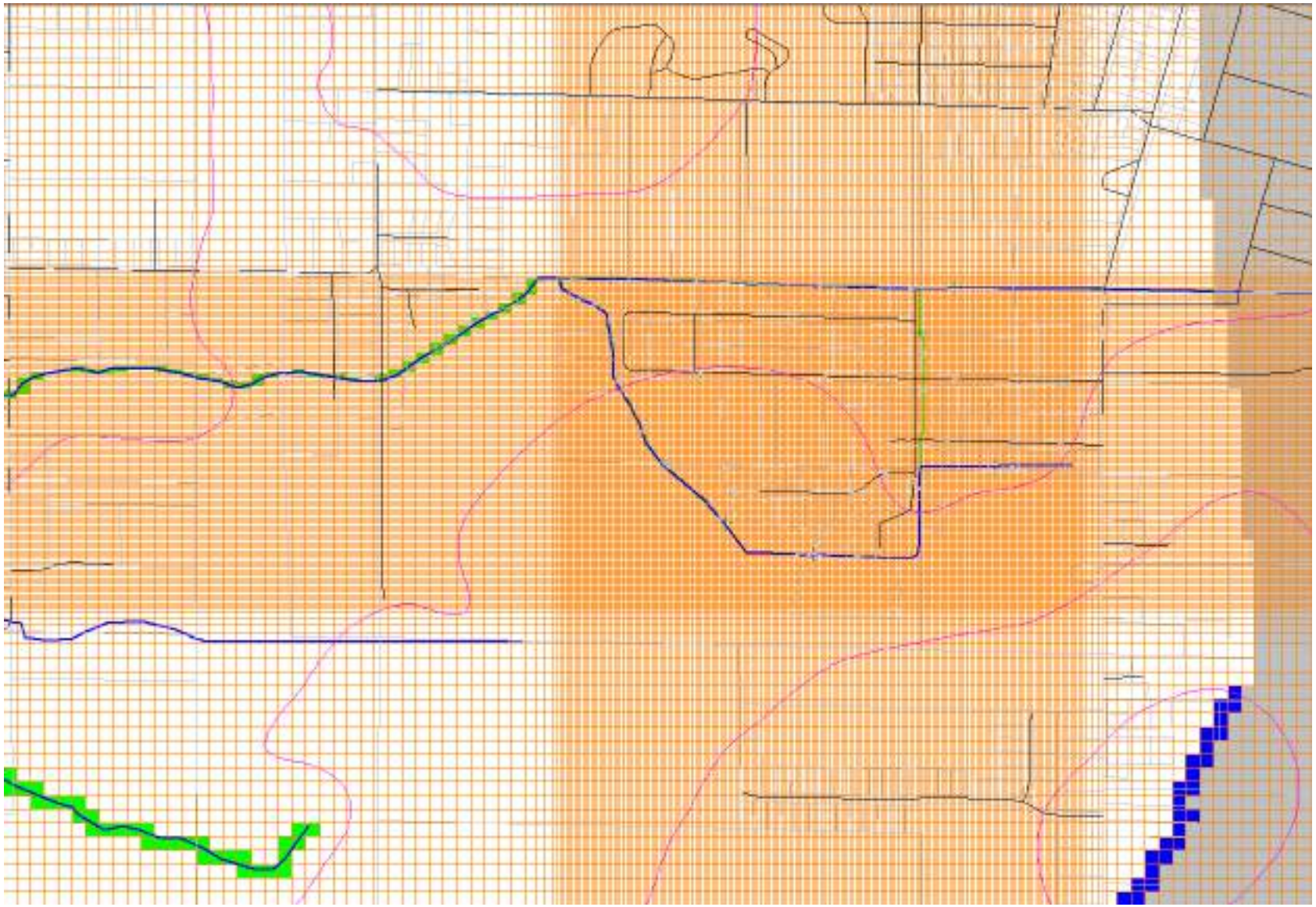
Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 57.86 ft/day
y0 = 0.8857 ft

Appendix 3

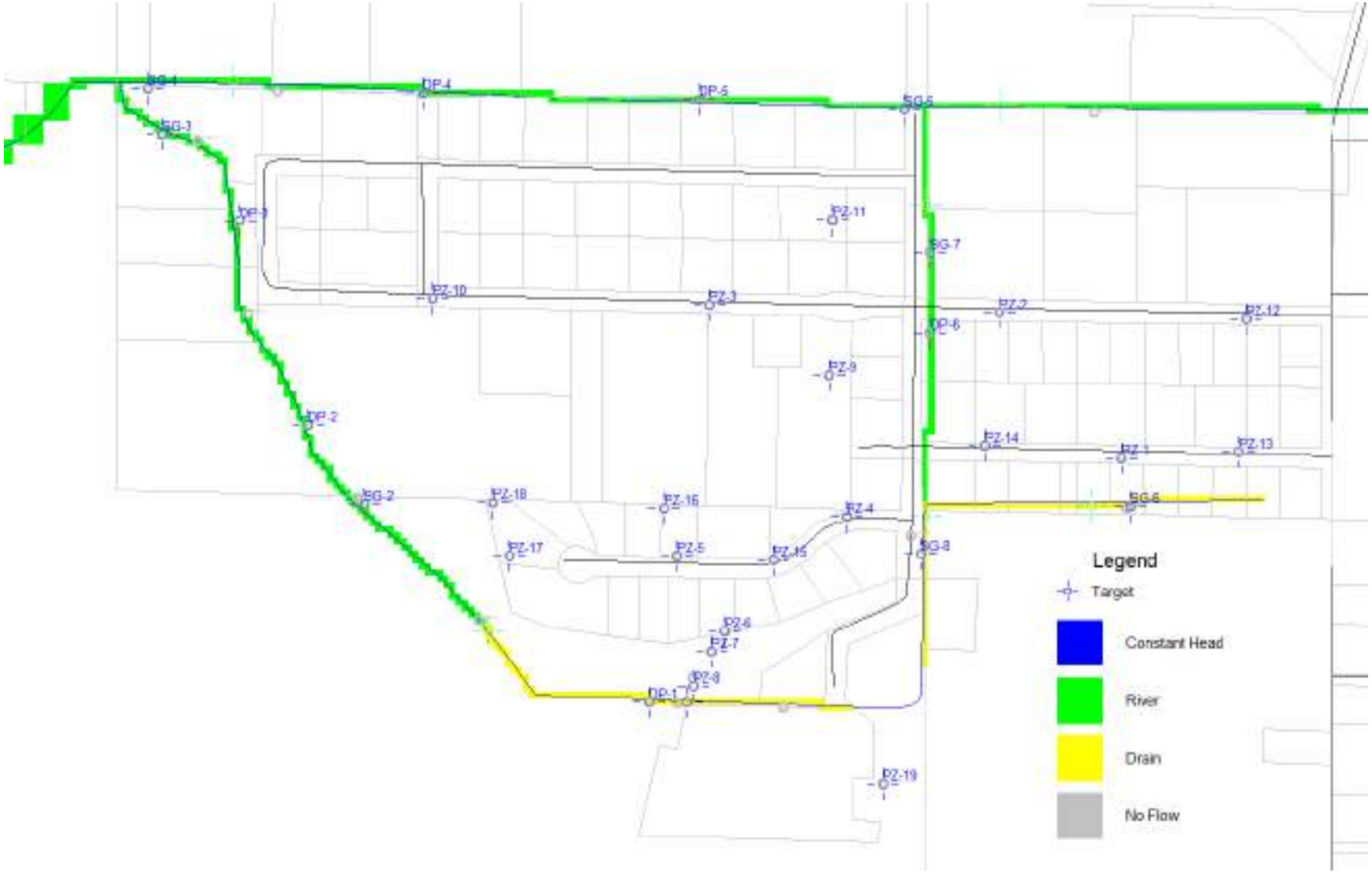
Model Information



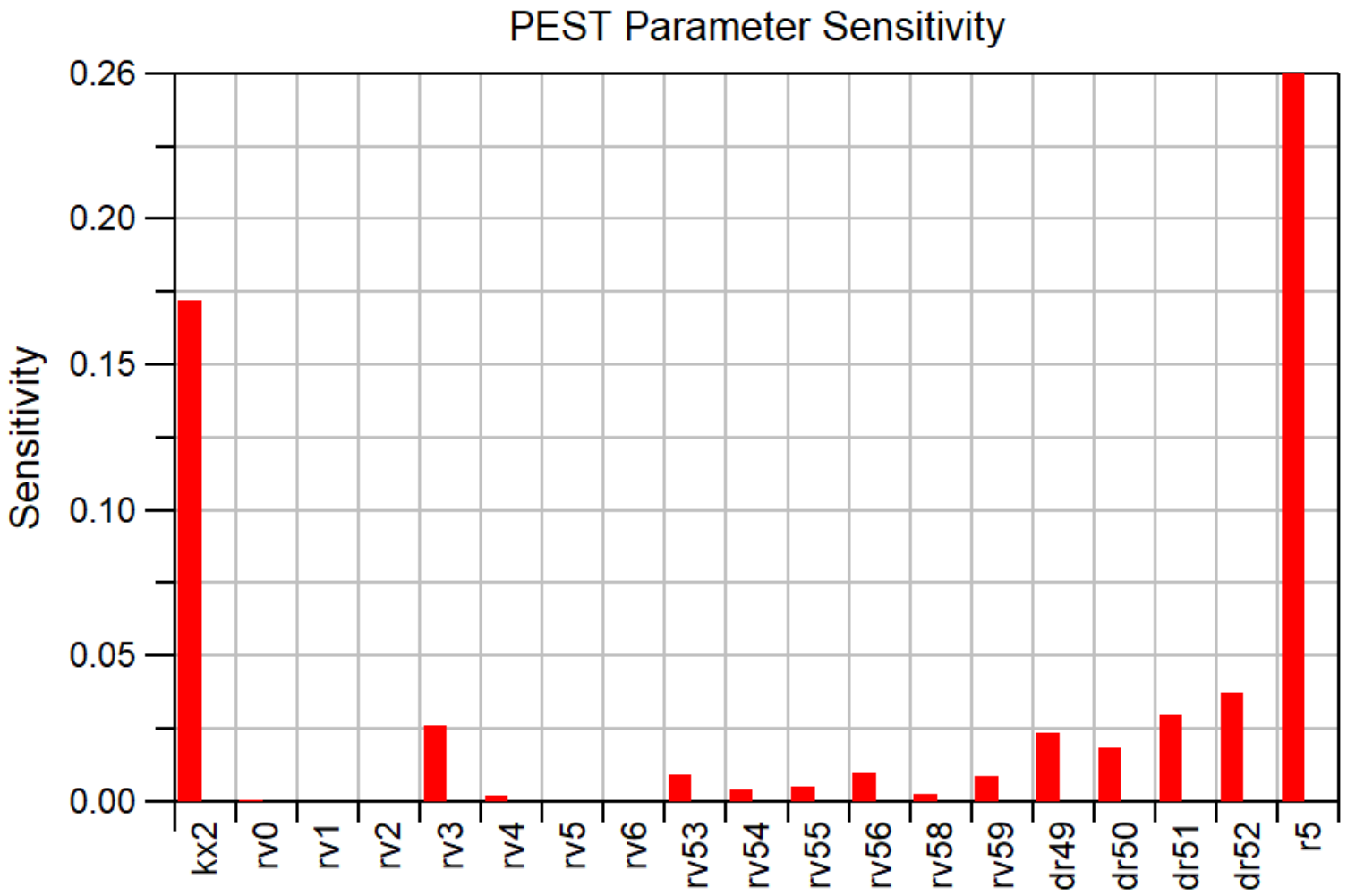
Full model domain. Pink lines are regional water table contours from MDEQ Groundwater Inventory and Mapping project.



Model discretization from 20 feet in the center to 100 feet at the edges.



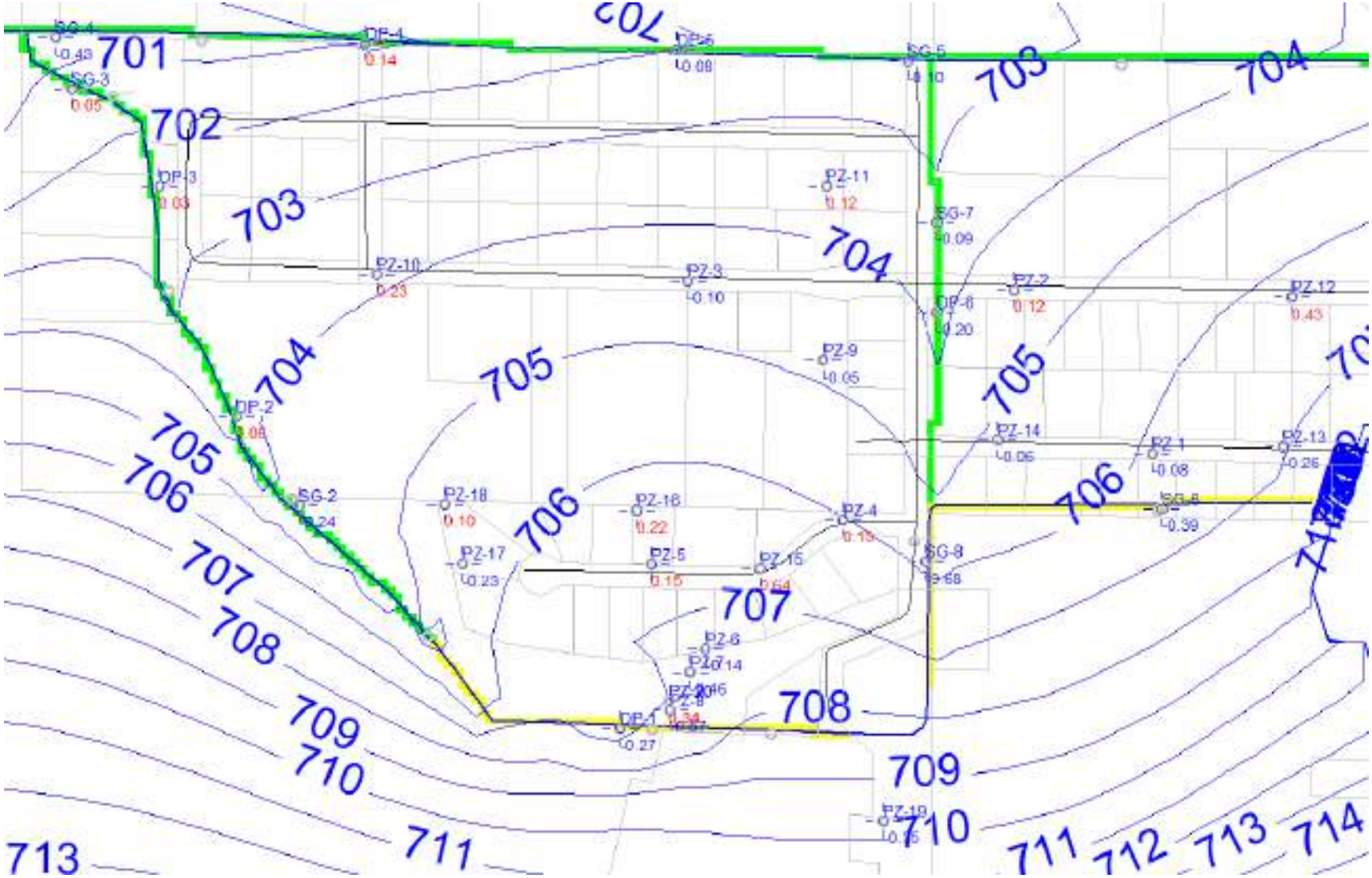
Local area model setup.



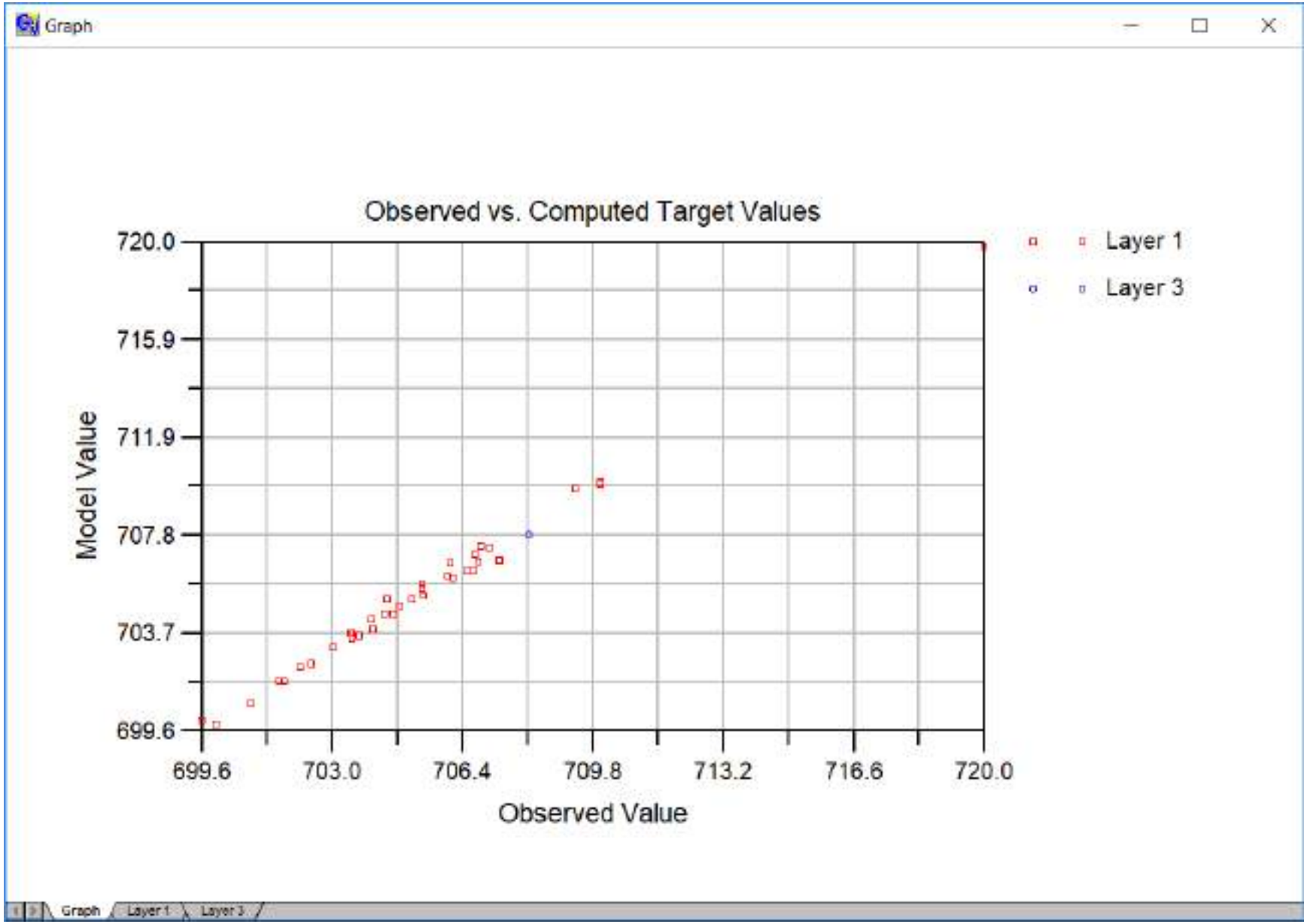
Sensitivity Analysis Results. Kx2 = hydraulic conductivity; rv = river reaches; dr = drains; r5 = recharge

Name	X	Y	Target	Layer	Group	Minimum	Maximum
kp1	12762680	347951	90	1	2	30	150
kp2	12762282	348424	90	1	2	30	150
kp3	12761338	348449	90	1	2	30	150
kp4	12761786	347759	90	1	2	30	150
kp5	12761233	347631	90	1	2	30	150
kp6	12761388	347386	10	1	2	0.1	50
kp7	12761345	347320	90	1	2	30	150
kp8	12761286	347209	90	1	2	30	150
kp9	12761728	348220	108.1	1	2	86.5	129.7
kp10	12760437	348470	96.1	1	2	76.9	115.3
kp11	12761739	348724	76.3	1	2	61	91.6
kp12	12763085	348403	105.3	1	2	84.2	126.4
kp13	12763060	347970	132.4	1	2	105.9	158.9
kp14	12762234	347991	88.6	1	2	70.9	106.3
kp15	12761546	347619	82.9	1	2	66.3	99.5
kp16	12761190	347787	134.1	1	2	107.3	160.9
kp17	12760686	347632	98.1	1	2	78.5	117.7
kp18	12760634	347804	53.3	1	2	42.6	64
kp19	12761903	346889	289.9	1	2	231.9	347.9
kp20	12761284	347236	57.9	1	2	29	115.8

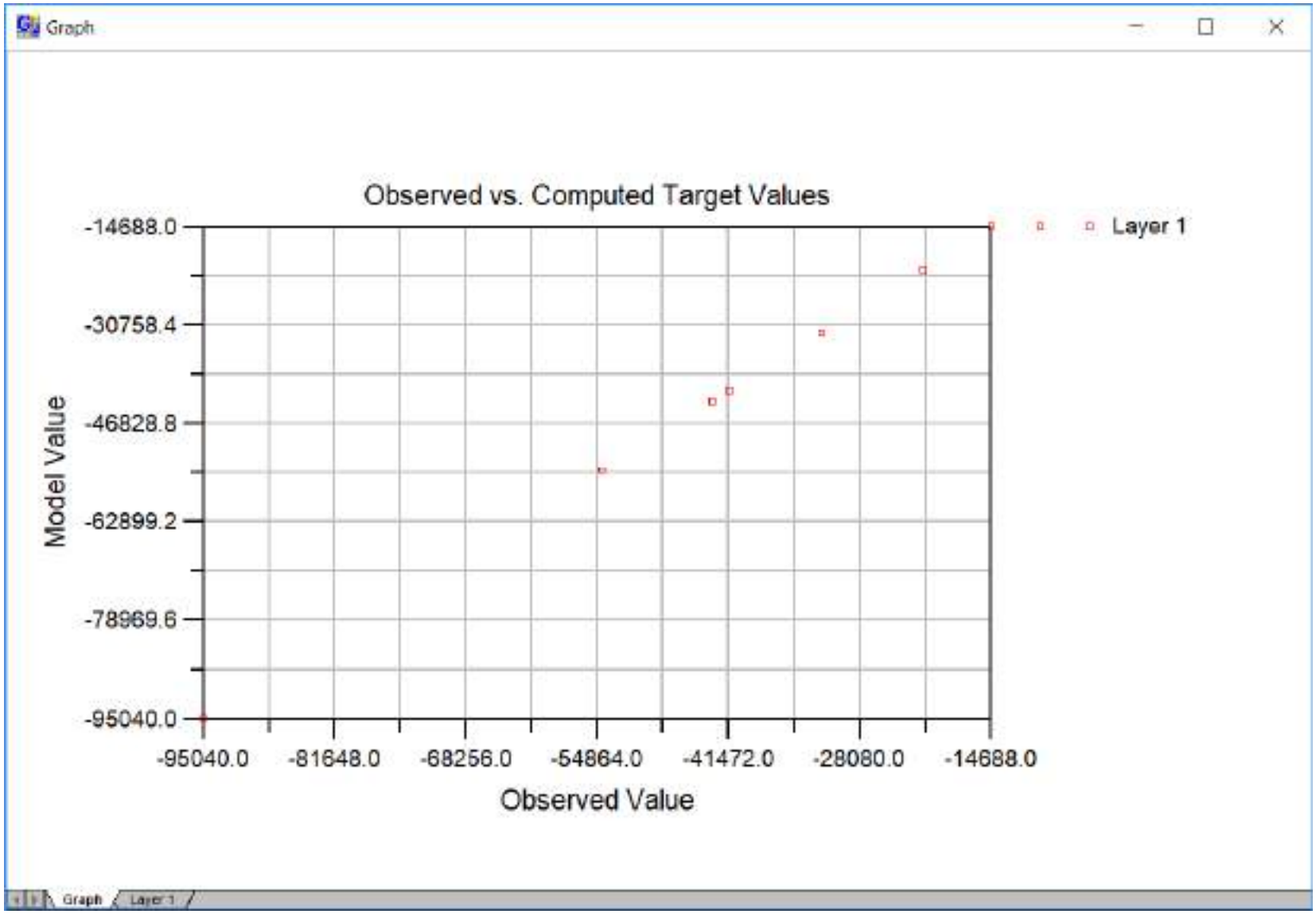
PEST pilot point parameters for hydraulic conductivity in local area (ft/d). All other K targets were 100 ft/d with bounds of 0.1 to 400 ft/d.



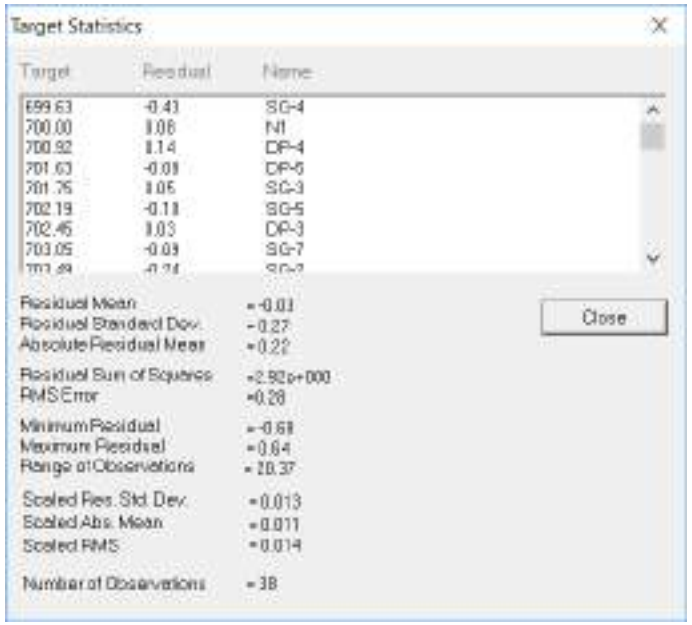
Calibrated model showing weighted residuals. Red values are lower than observed; blue values are higher than observed.



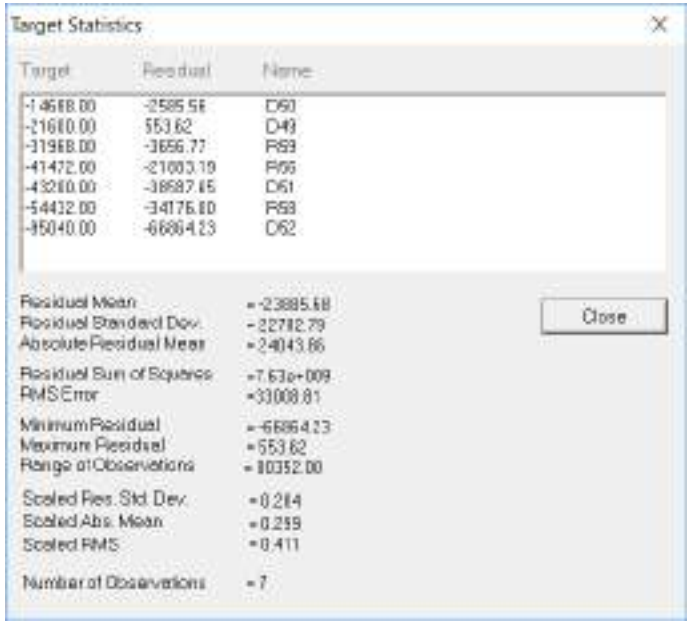
Hydraulic head values – modeled versus observed.



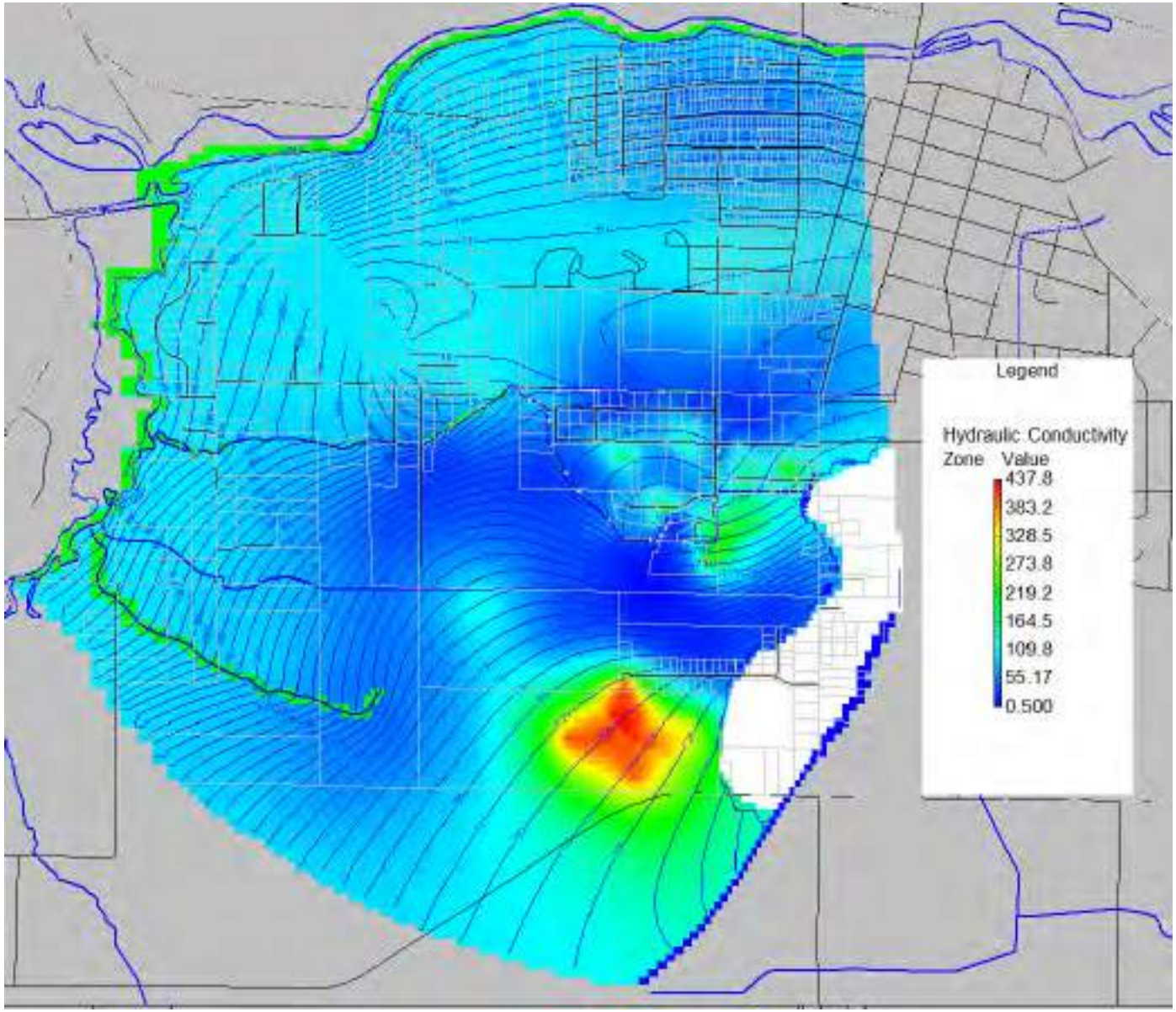
Predicted versus Observed Streamflow



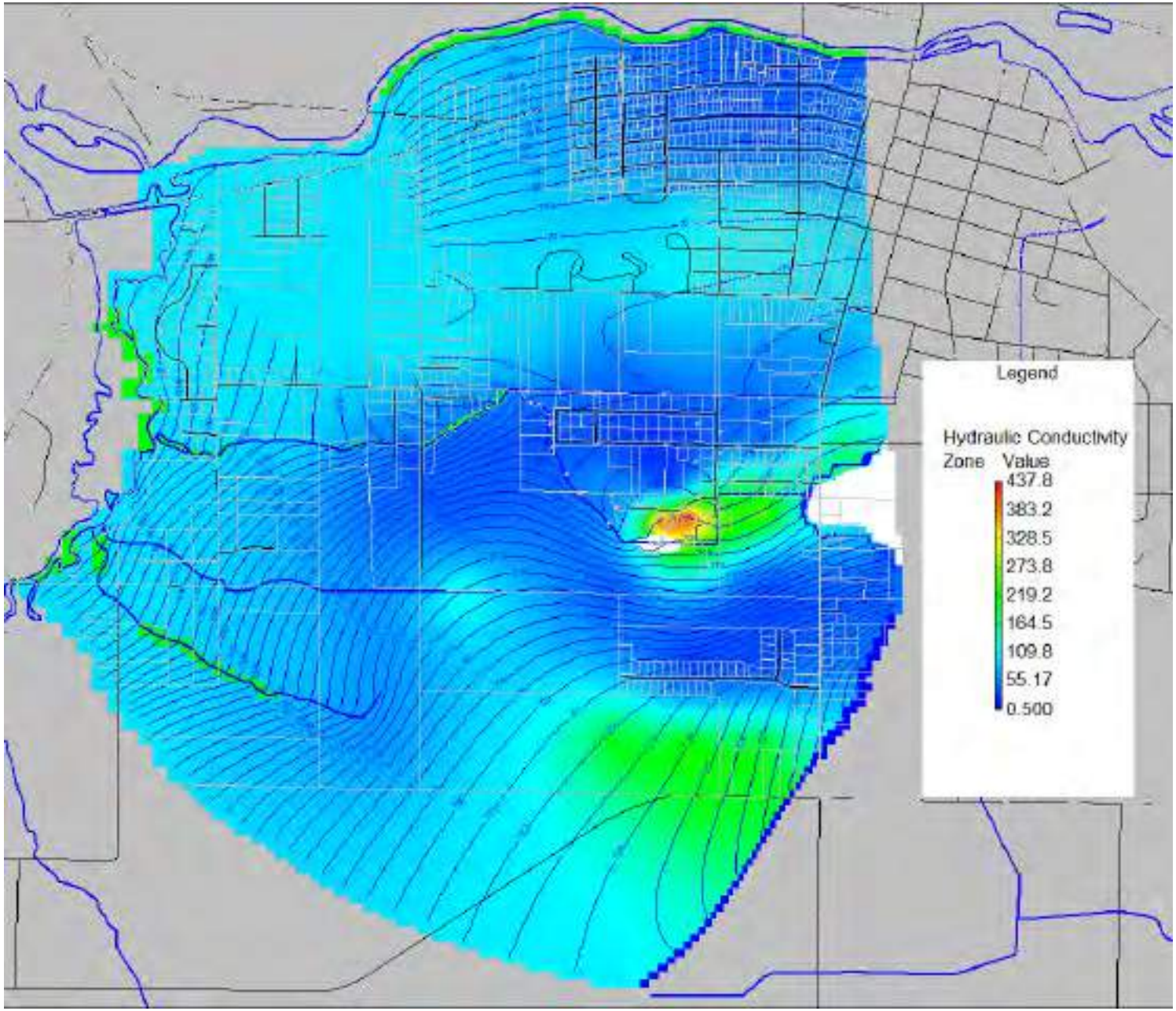
Weighted head residual statistics – full statistics in Table 5.



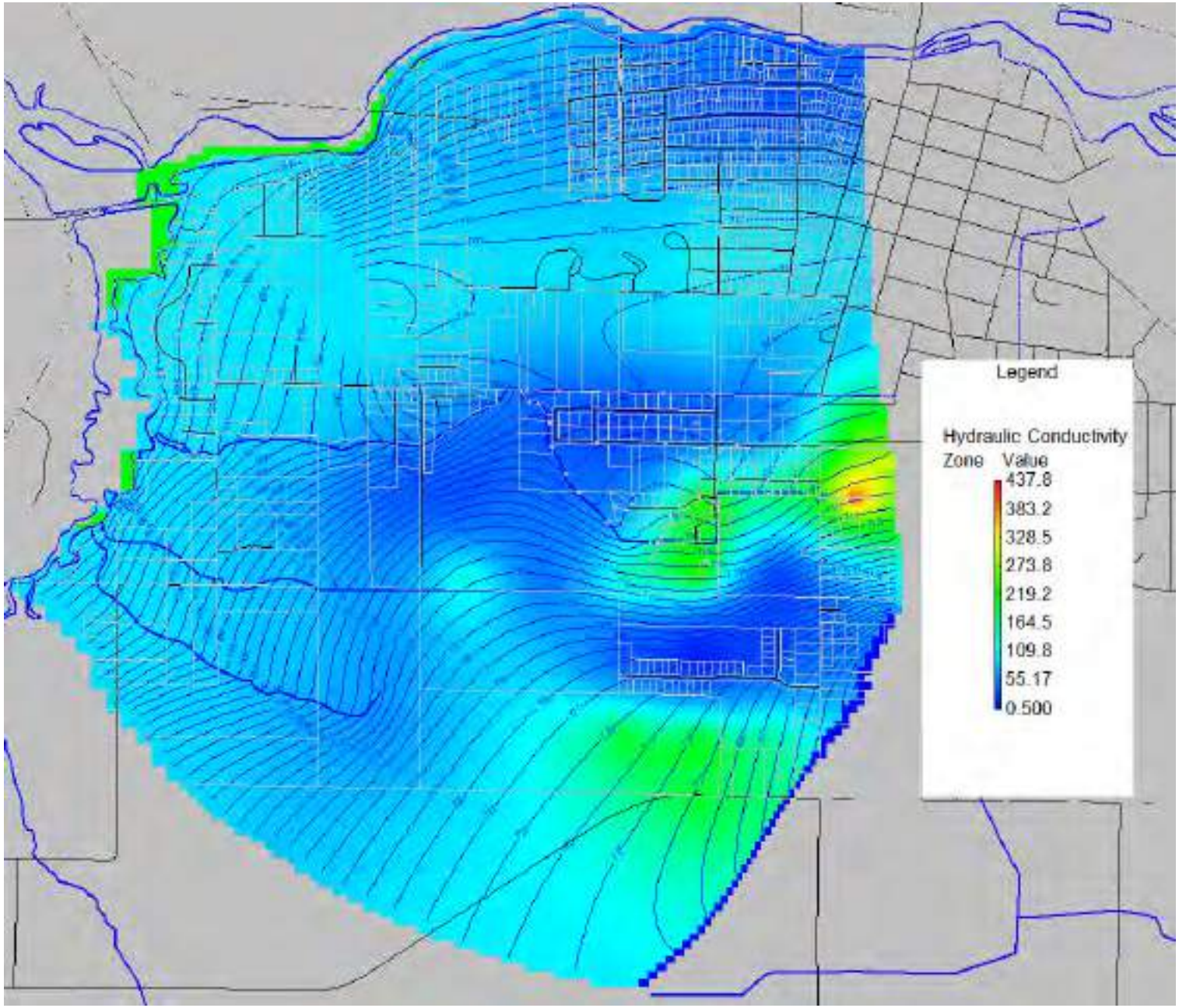
Residual flux statistics (these were weighted x 1E-005 for use in PEST)



Hydraulic Conductivity field – Layer 1. White area is low-K clay till.



Hydraulic Conductivity field – Layer 2.



Hydraulic Conductivity – Layer 3

Appendix 4

Hydrostratigraphic Model

Fishbeck, Thompson, Carr & Huber, Inc.

Baughman Drain Hydrogeological Evaluation

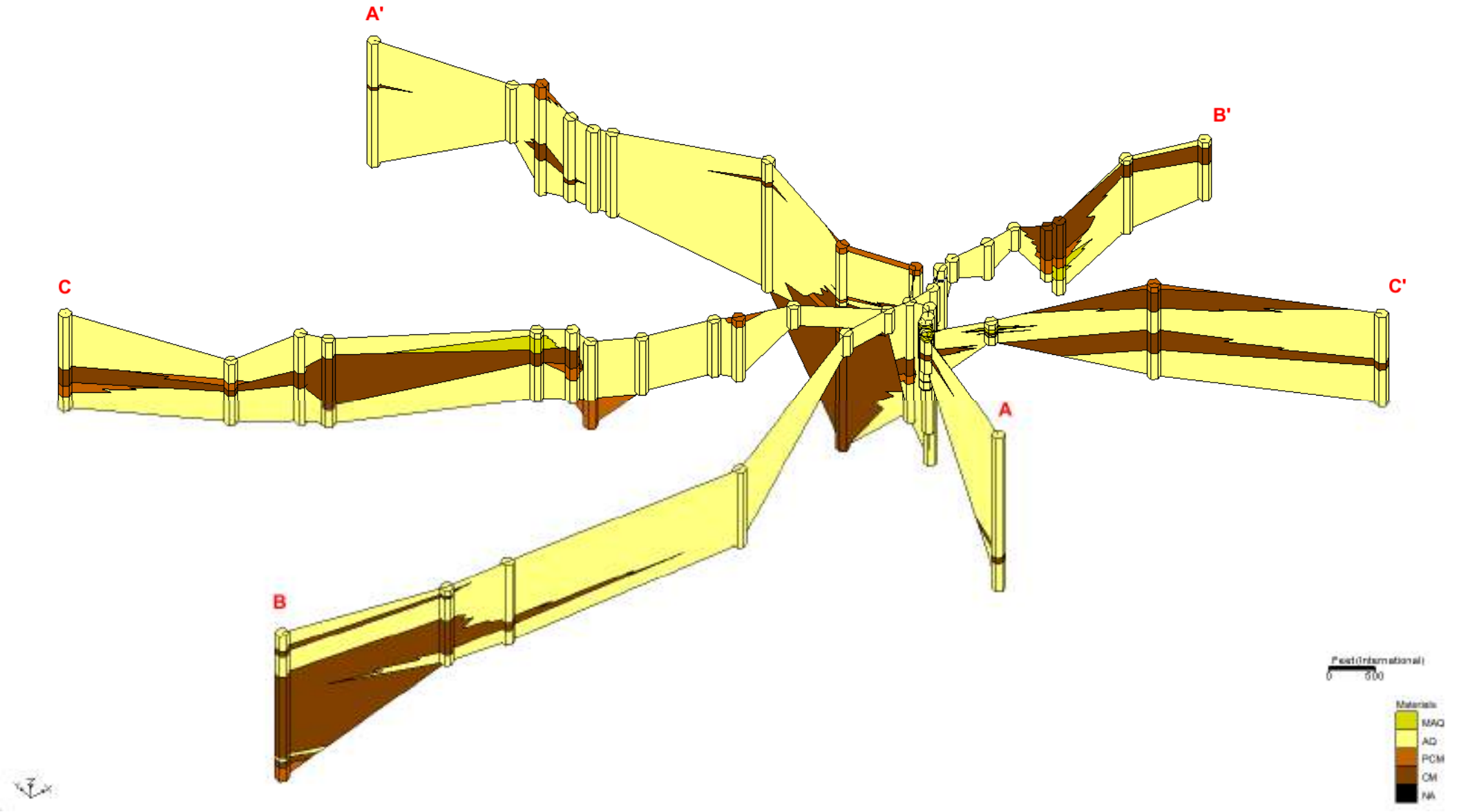
Borehole Hydrostratigraphic Model to Develop Groundwater Flow Model

Project No. 180488

Project No.:	180488	Date:	12/05/2018	Project Name:	Baughman Drain Hydrogeological Evaluation


PZ-10
PZ-14
PZ-13
PZ-19
A
B
C


A
B
C
0
500



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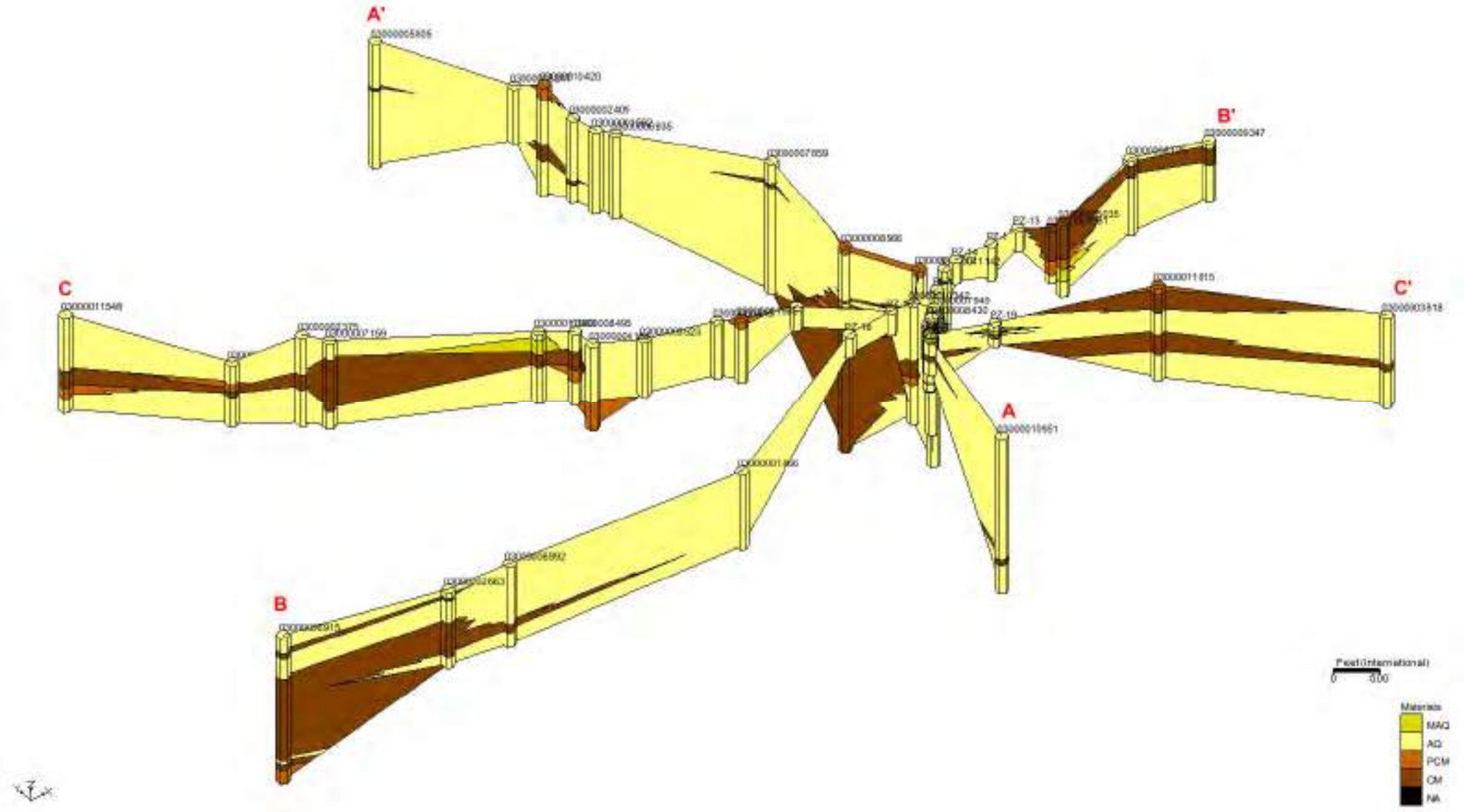
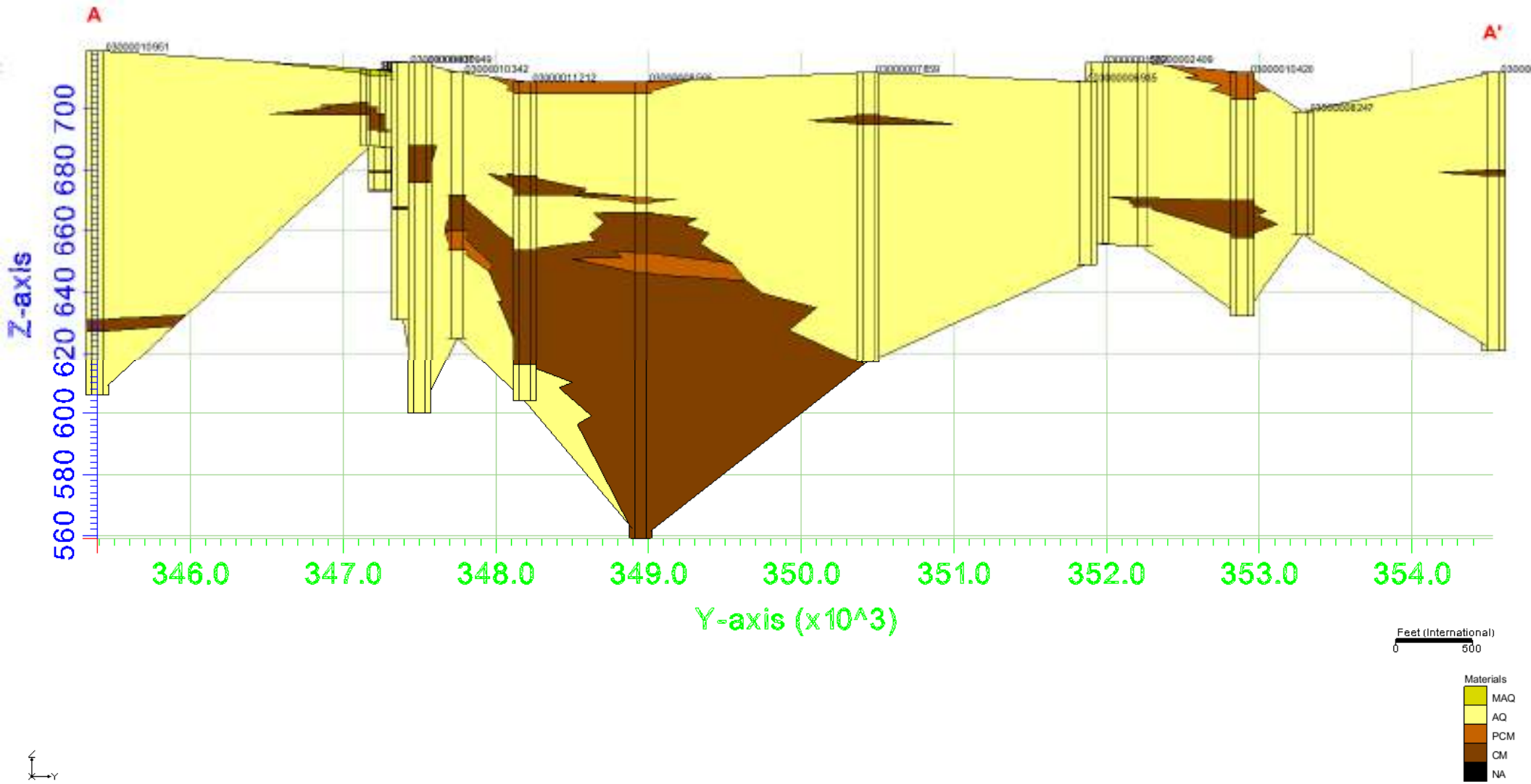
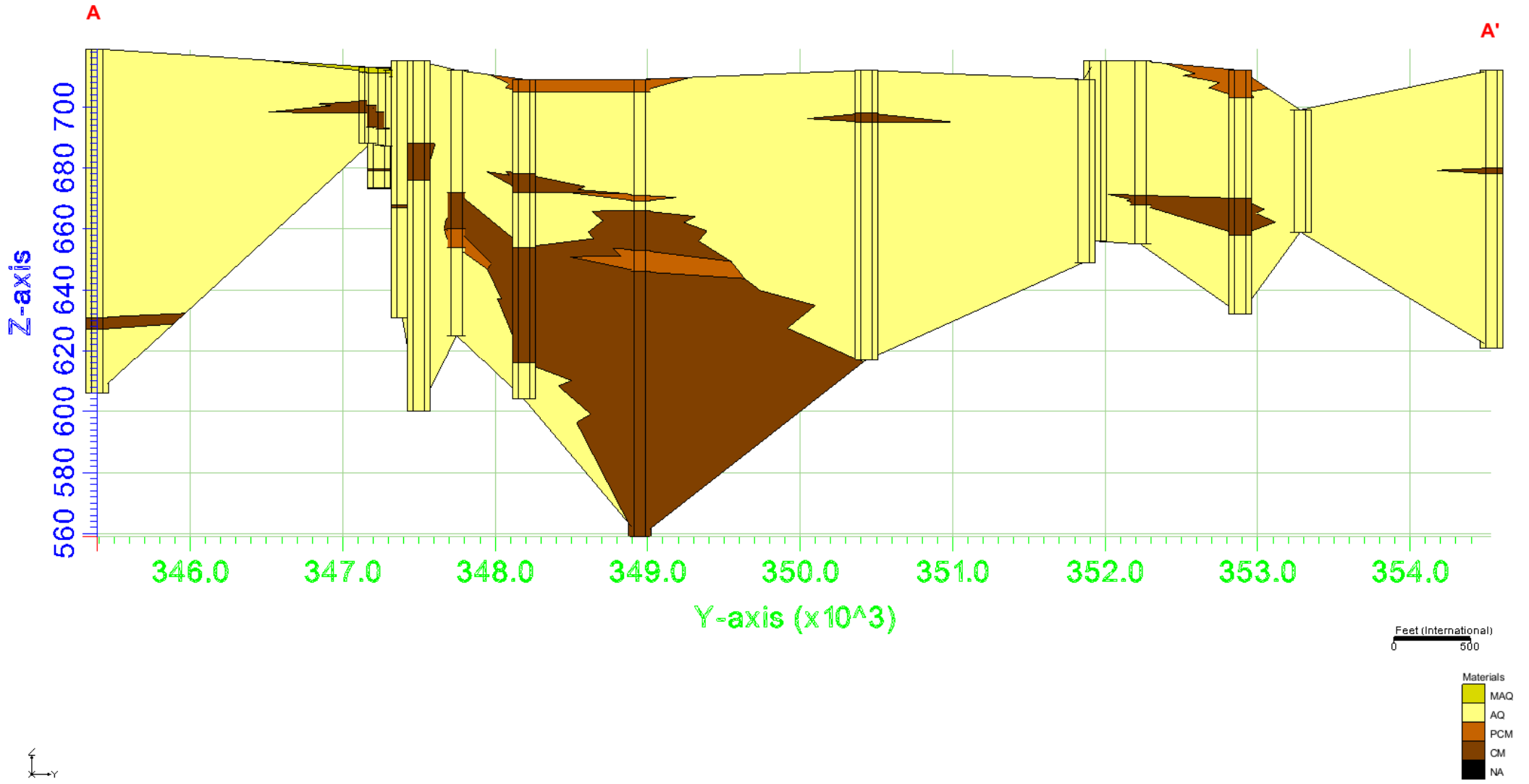


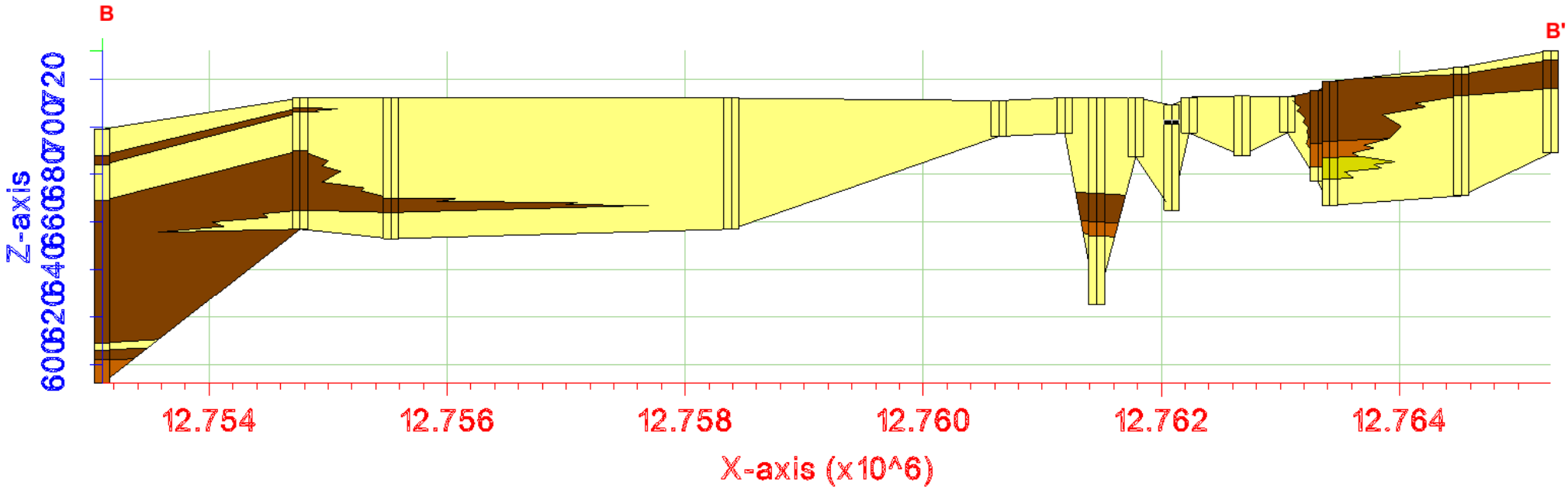
Project No.:	180488	**Date:**	12/05/2018	**Project Name:**	Baughman Drain Hydrogeological Evaluation



Project No.:	180488	Date:	12/05/2018	Project Name:	Baughman Drain Hydrogeological Evaluation



Project No.:	180488	Date:	12/05/2018	Project Name:	Baughman Drain Hydrogeological Evaluation



Feet (International)
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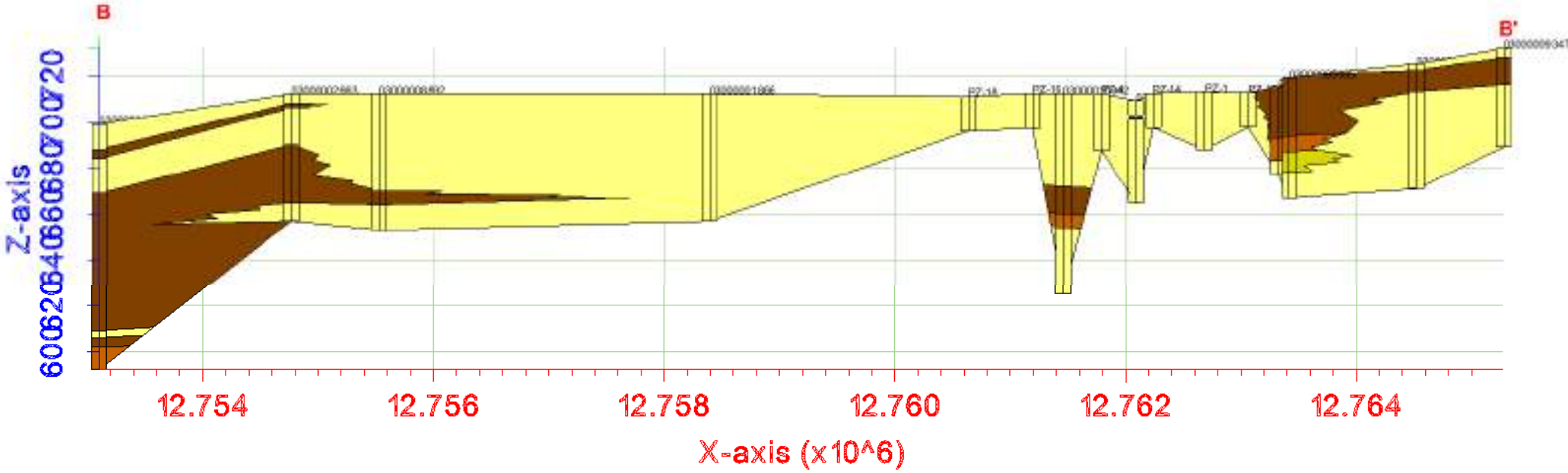
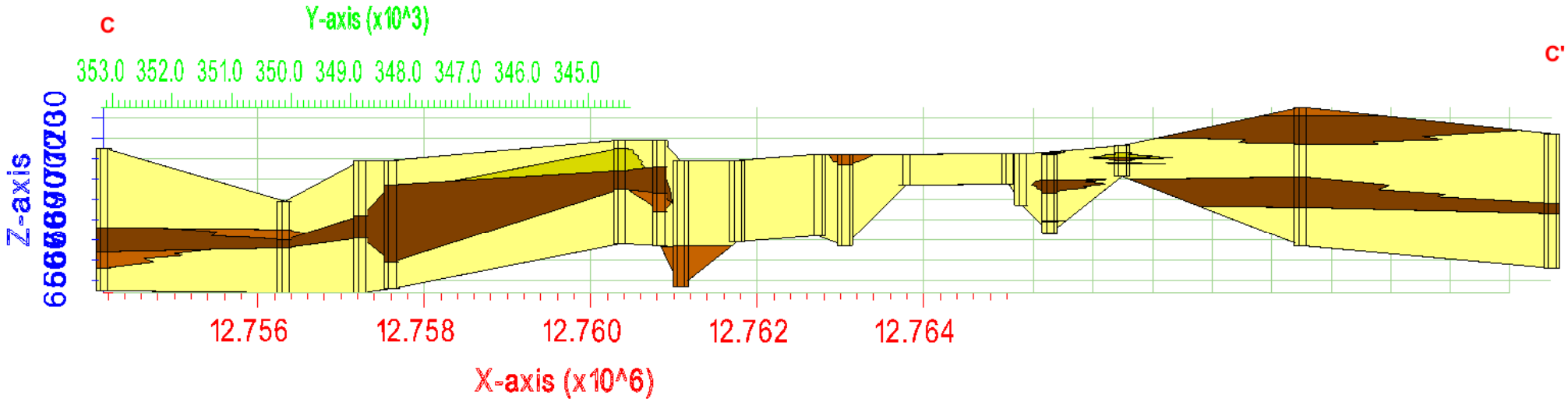
Materials
MAQ
AQ
PCM
CM
NA

Project No.:	180488	Date:	12/05/2018	Project Name:	Baughman Drain Hydrogeological Evaluation



Project No.:	180488	Date:	12/05/2018	Project Name:	Baughman Drain Hydrogeological Evaluation



Feet (International)
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Materials
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AQ
PCM
CM
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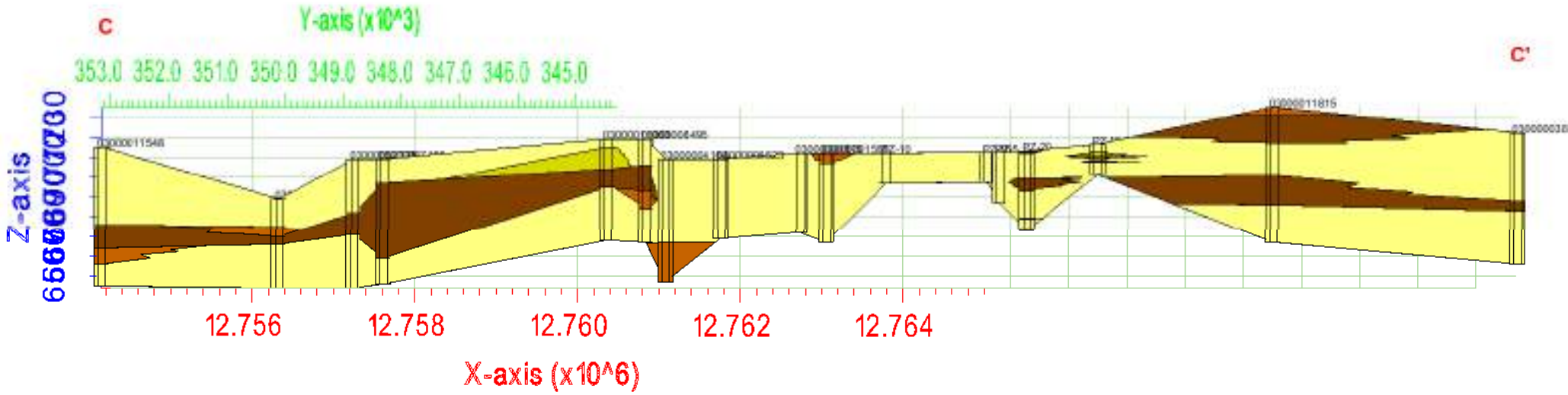
Project No.:	180488	Date:	12/05/2018	Project Name:	Baughman Drain Hydrogeological Evaluation



Feet (International)
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Materials
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AQ
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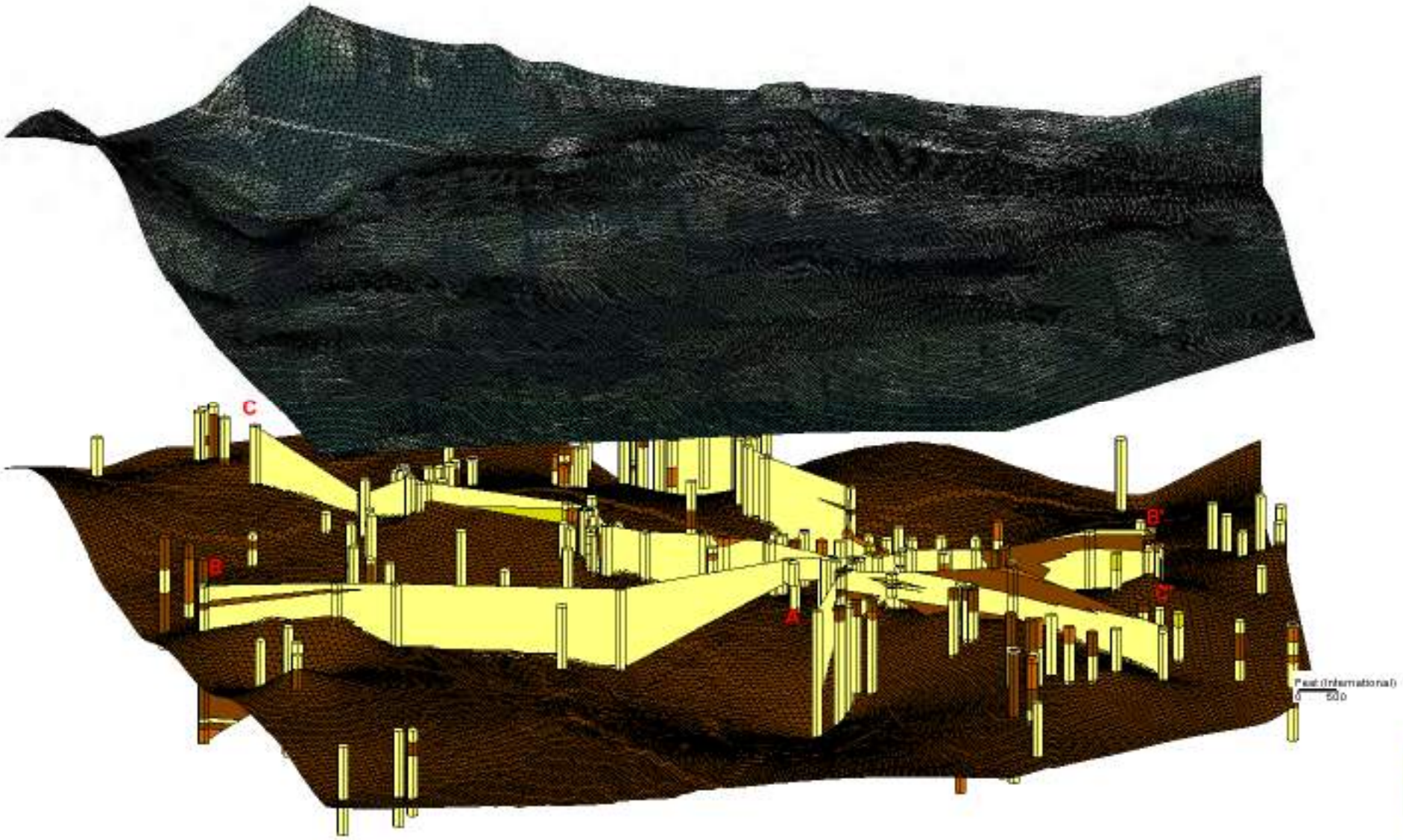
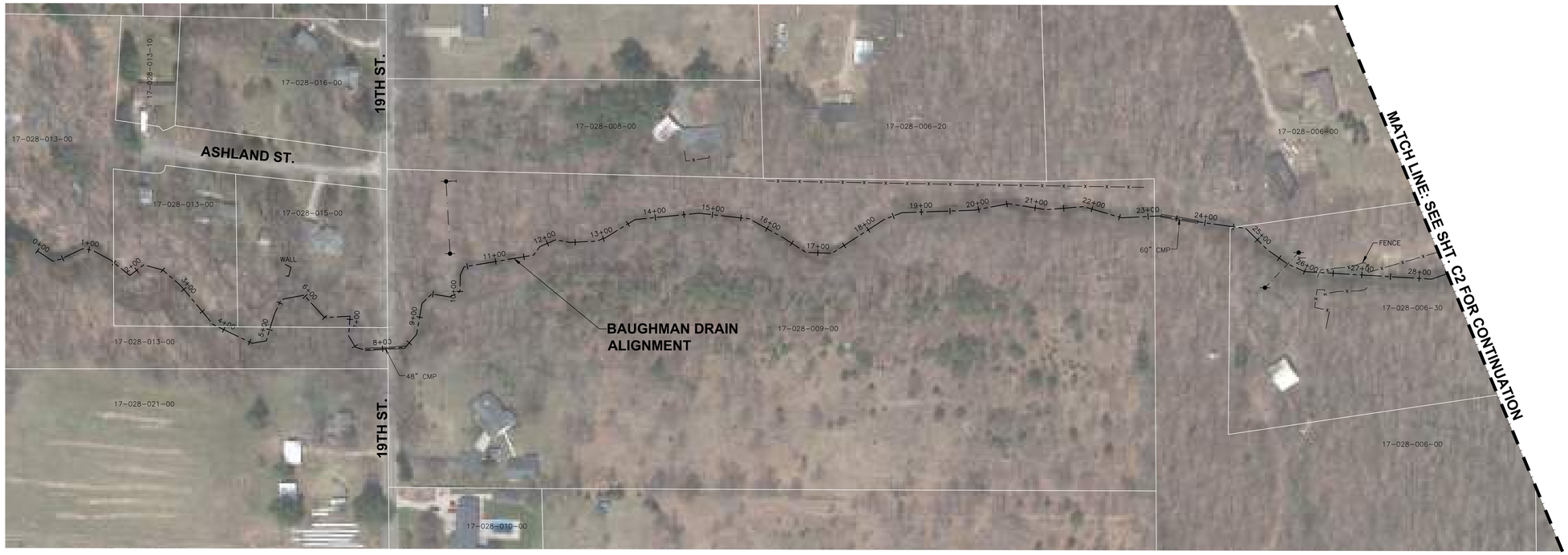
Project No.:	180488	Date:	12/05/2018	Project Name:	Baughman Drain Hydrogeological Evaluation



Project No.:	180488	**Date:**	12/05/2018	**Project Name:**	Baughman Drain Hydrogeological Evaluation

Appendix 5

Stream Profile

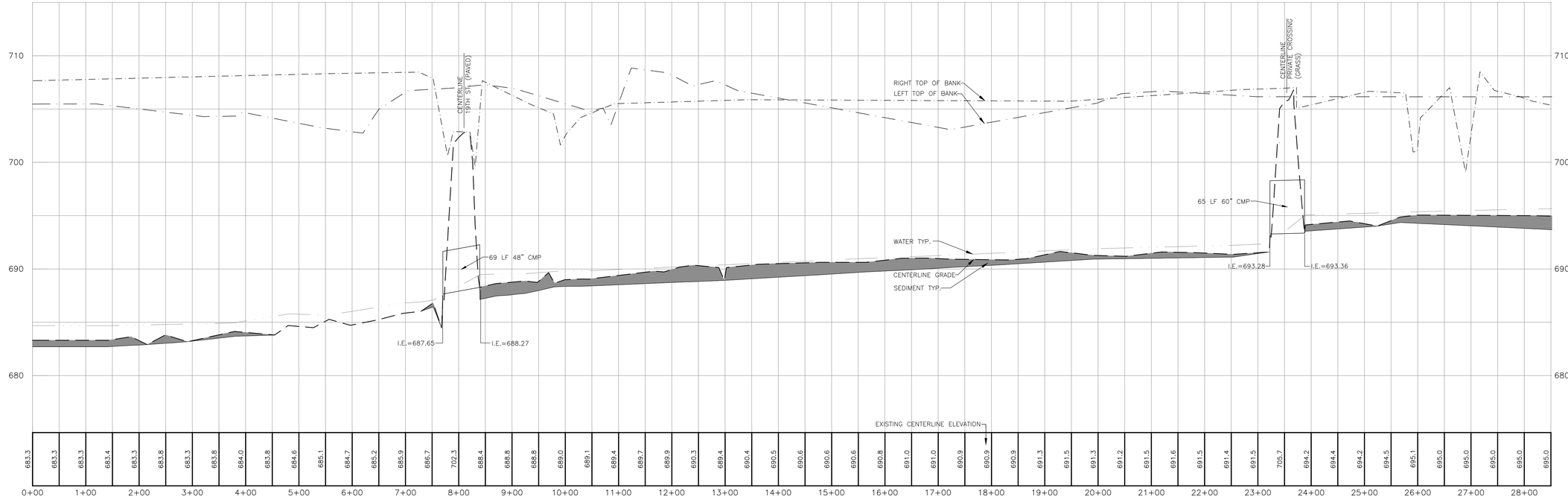


NORTH

SITE PLAN

0 100 200

Horizontal Scale in Feet



CENTERLINE PROFILE

SCALE: HORIZONTAL: 1" = 100'
VERTICAL: 1" = 5'

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CLIENT:
Allegan County Drain Commissioner
Allegan, Michigan

PROJECT:
Baughman Drain
Ostego Township, Allegan County, Michigan

PROJECT NUMBER: 15-043	
DESIGNED BY: DJF	DATE: JULY, 2016
CHECKED BY: MPB	DATE: JULY, 2016
DRAFTED BY: LGG	DATE: JULY, 2016

REVISIONS:

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2.	PRELIMINARY REVIEW	NOV., 2016

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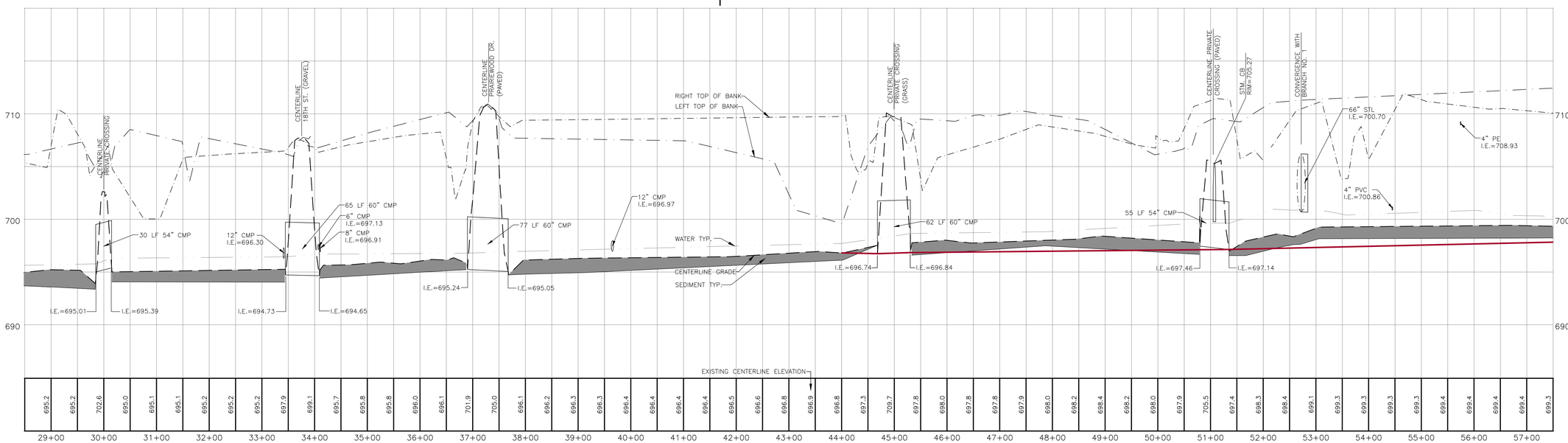
NORTH

SITE PLAN

0 100 200

Horizontal Scale in Feet



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Allegan, Michigan

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Ostego Township, Allegan County, Michigan

PROJECT NUMBER: 15-043	
DESIGNED BY: DJF	DATE: JULY, 2016
CHECKED BY: MPB	DATE: JULY, 2016
DRAFTED BY: LGG	DATE: JULY, 2016

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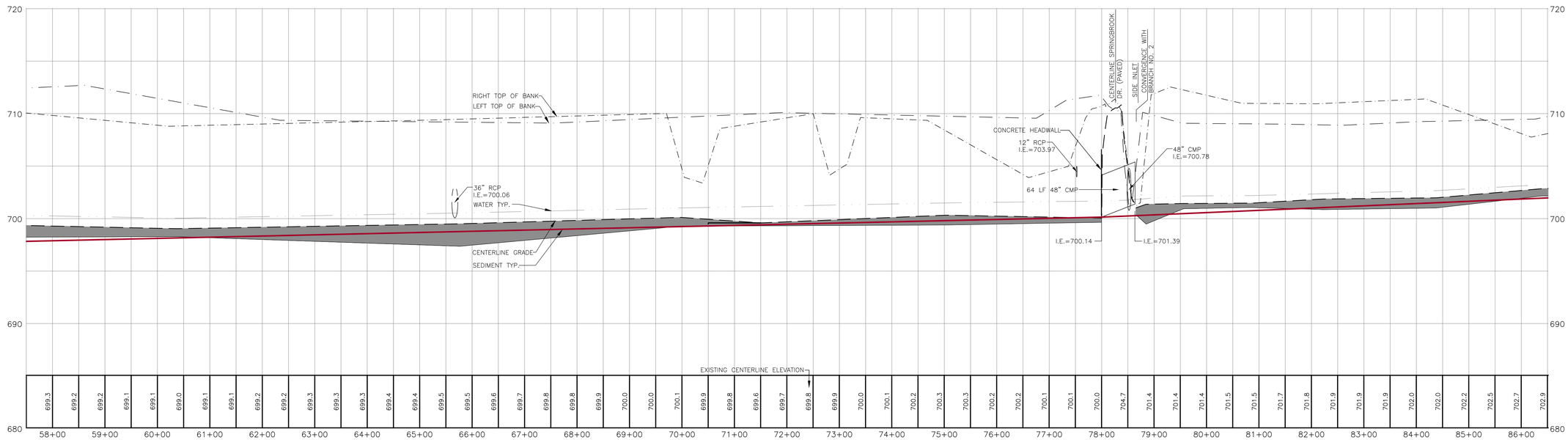
By:KYLE MSER

NORTH

SITE PLAN

0 100 200

Horizontal Scale in Feet



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VERTICAL: 1" = 5'

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Allegan, Michigan

PROJECT:
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Ostego Township, Allegan County, Michigan

PROJECT NUMBER: 15-043	
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CHECKED BY: MPB	DATE: JULY, 2016
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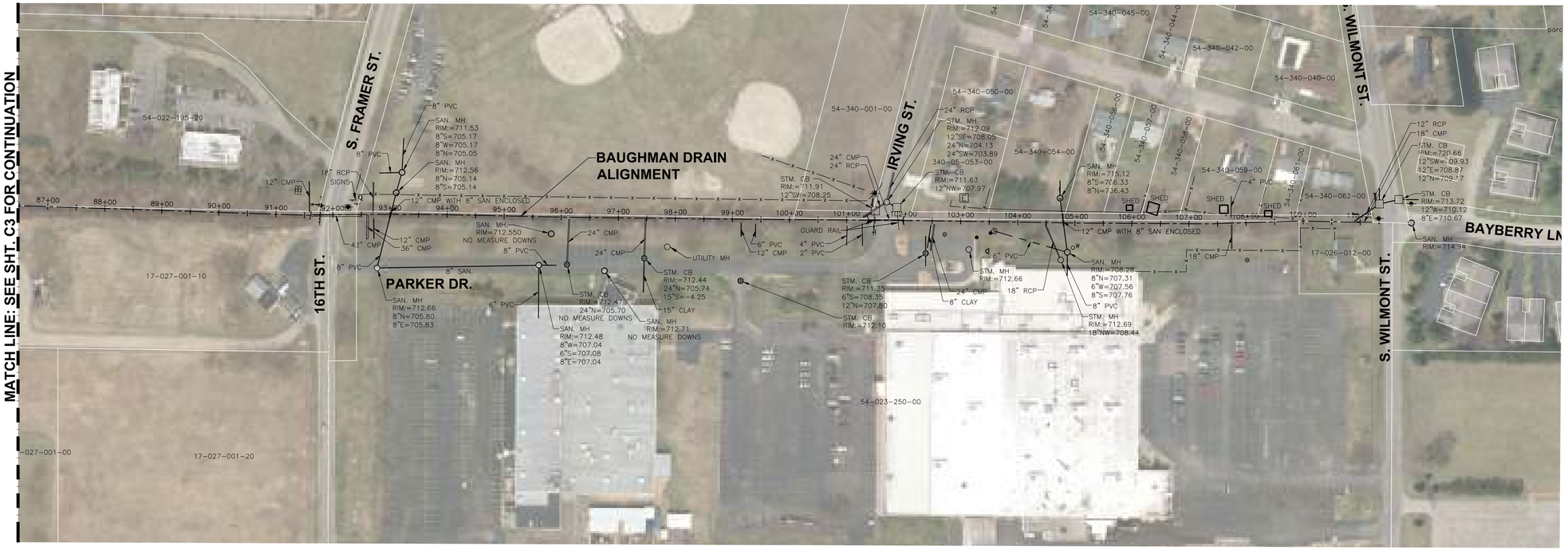

NORTH

SITE PLAN

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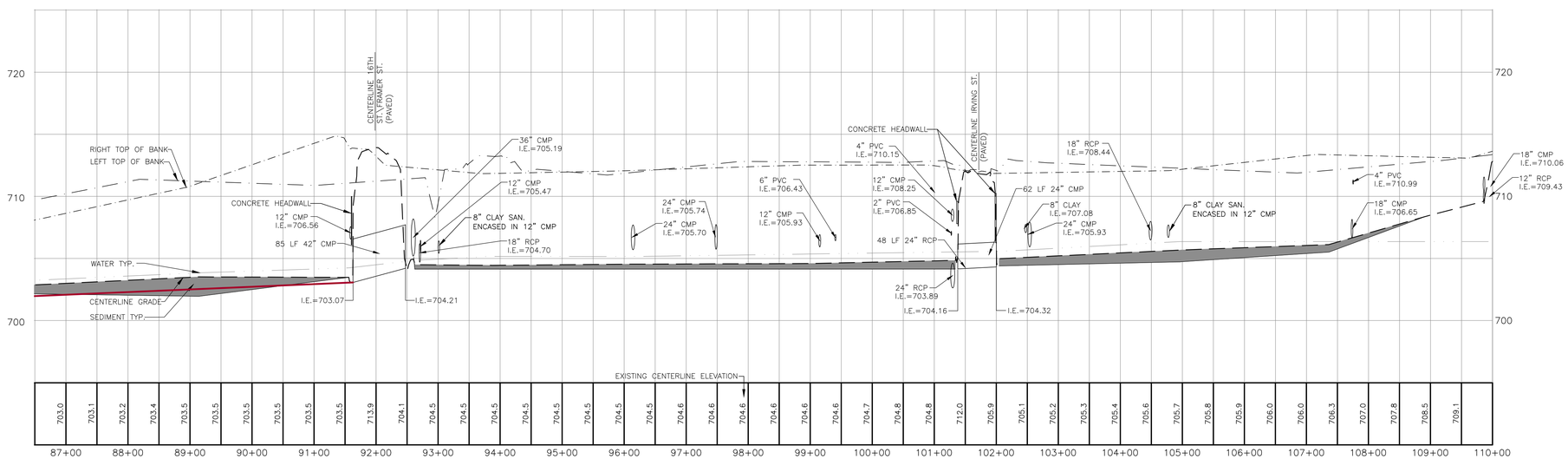
Horizontal Scale in Feet



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Allegan, Michigan

PROJECT:
Baughman Drain
Ostego Township, Allegan County, Michigan

PROJECT NUMBER: 15-043	
DESIGNED BY: DJF	DATE: JULY, 2016
CHECKED BY: MPB	DATE: JULY, 2016
DRAFTED BY: LGG	DATE: JULY, 2016

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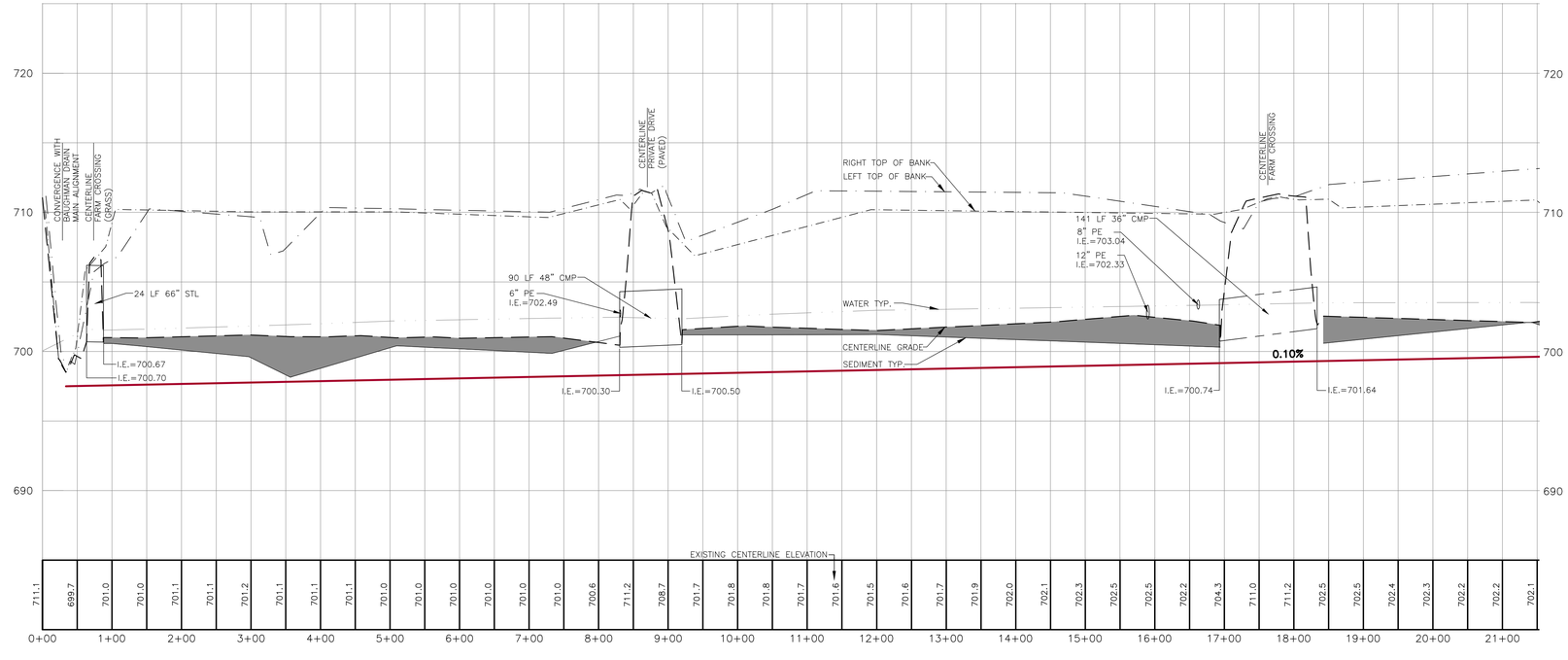
NORTH

SITE PLAN

0 100 200

Horizontal Scale in Feet



CENTERLINE PROFILE

SCALE: HORIZONTAL: 1" = 100'
VERTICAL: 1" = 5'

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CLIENT:
Allegan County Drain Commissioner
Allegan, Michigan

PROJECT:
Baughman Drain
Ostego Township, Allegan County, Michigan

PROJECT NUMBER: 15-043	
DESIGNED BY: DJF	DATE: JULY, 2016
CHECKED BY: MPB	DATE: JULY, 2016
DRAFTED BY: LGG	DATE: JULY, 2016

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NORTH

SITE PLAN

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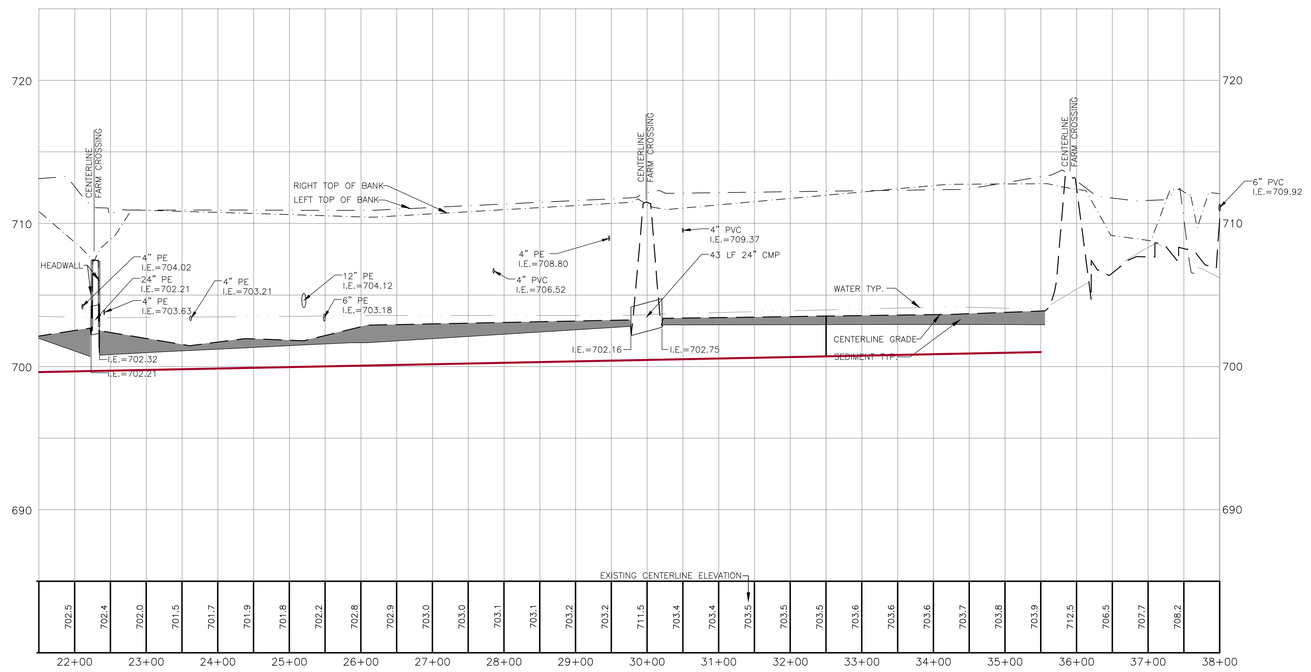
Horizontal Scale in Feet



CENTERLINE PROFILE

SCALE: HORIZONTAL: 1" = 100'
VERTICAL: 1" = 5'

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PROJECT NUMBER: 15-043	
DESIGNED BY: DJF	DATE: JULY, 2016
CHECKED BY: MPB	DATE: JULY, 2016
DRAFTED BY: LGG	DATE: JULY, 2016

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1.	PRELIMINARY REVIEW	JULY, 2016
2.	PRELIMINARY REVIEW	NOV., 2016

PLAN & PROFILE
BRANCH 1
STA. 21+50 - 38+00

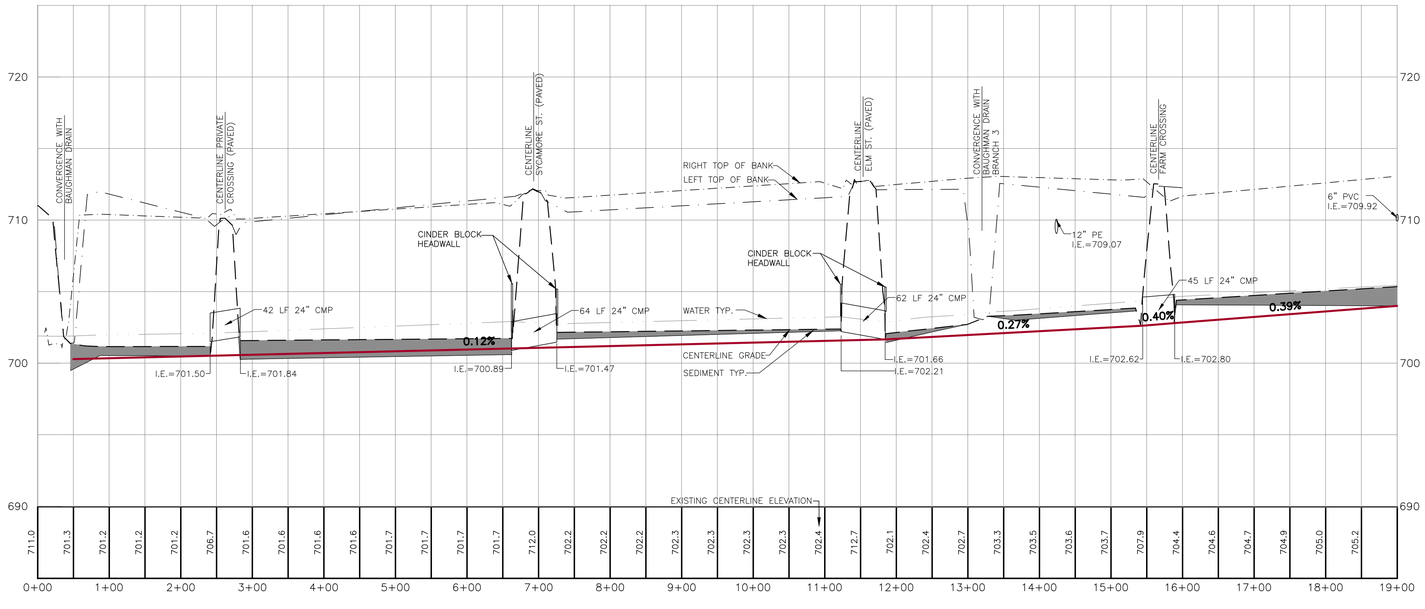
SHEET NUMBER
C6

NORTH

SITE PLAN

0 100 200

Horizontal Scale in Feet



CENTERLINE PROFILE

SCALE: HORIZONTAL: 1" = 100'
VERTICAL: 1" = 5'

3 WORKING DAYS
BEFORE YOU DIG
CALL MISS DIG®
1-800-482-7171

ALL UTILITIES AS SHOWN ARE APPROXIMATE LOCATIONS DERIVED FROM ACTUAL MEASUREMENTS AND AVAILABLE RECORDS. THEY SHOULD NOT BE INTERPRETED TO BE EXACT LOCATION NOR SHOULD IT BE ASSUMED THAT THEY ARE THE ONLY UTILITIES IN THE AREA.

LAND & RESOURCE
ENGINEERING INC.
Common Sense ● Lasting Solutions
3800 West River Drive, Ste. A, Comstock Park, MI, 49321 Ph:616.301.7888

CLIENT:
Allegan County Drain Commissioner
Allegan, Michigan

PROJECT:
Baughman Drain
Ostego Township, Allegan County, Michigan

PROJECT NUMBER: 15-043	
DESIGNED BY: DJF	DATE: JULY, 2016
CHECKED BY: MPB	DATE: JULY, 2016
DRAFTED BY: LGG	DATE: JULY, 2016

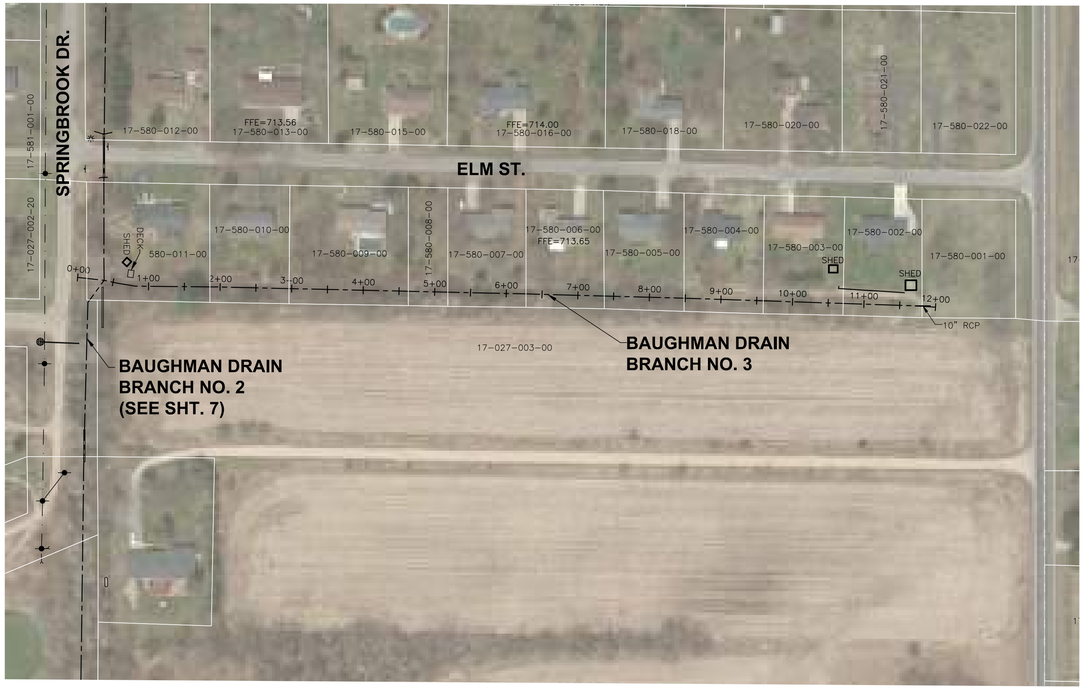
REVISIONS:

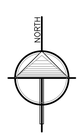
NO.	ISSUED FOR	DATE
1.	PRELIMINARY REVIEW	JULY, 2016
2.	PRELIMINARY REVIEW	NOV., 2016

PLAN & PROFILE
BRANCH 2
STA. 0+00 - 19+00

SHEET NUMBER C7

Nov 07, 2016 – 8:22pm C:\Users\Kyle Weier\appdata\local\Temp\AcPublish_7900\02-Plan and Profile.dwg, XREFs: [cpa] [brdr by:KYLE WEIER

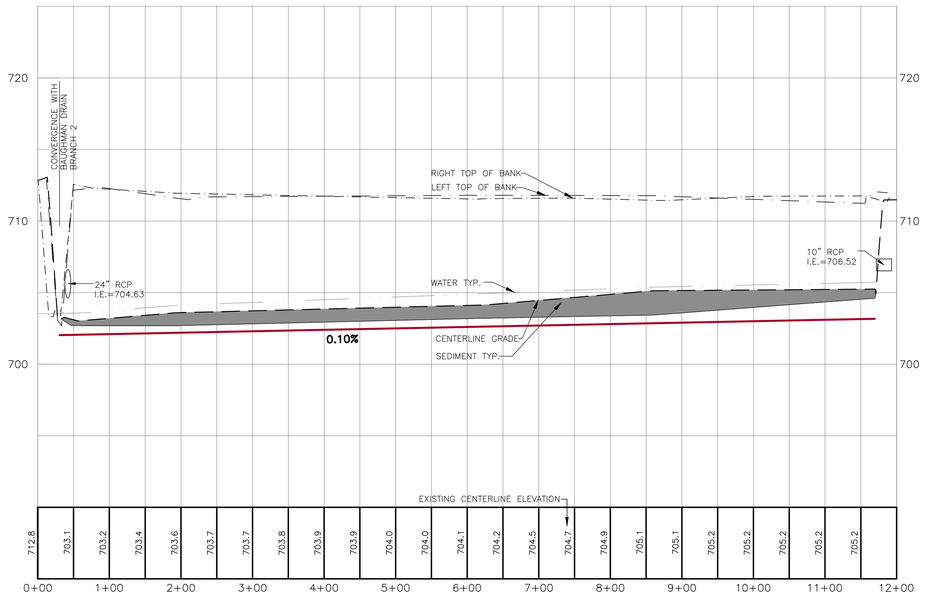




SITE PLAN

0 100 200

Horizontal Scale in Feet



CENTERLINE PROFILE

SCALE: HORIZONTAL: 1" = 100'
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REVISIONS:

NO.	ISSUED FOR	DATE
1.	PRELIMINARY REVIEW	JULY, 2016
2.	PRELIMINARY REVIEW	NOV., 2016

PLAN & PROFILE
BRANCH 3
STA. 0+00 - 12+00

SHEET NUMBER **C8**

SECTION 00300 PROPOSAL

Denise Medemar
Allegan County Drain Commissioner
113 Chestnut Street
Allegan, MI 49010

ARTICLE 1-CONTRACT PRICE

Having carefully examined the site of the proposed Work; being fully informed of the conditions to be met in the prosecution and completion of the Work; having read and examined the Contract Documents applicable to this Work and agreeing to be bound thereby; the undersigned proposes to perform all services, and furnish all necessary labor, materials, tools, and equipment to complete the Work described in the Contract Documents for the amounts set forth in the accompanying Bid Form.

ARTICLE 2-CONTRACT TIME

If awarded a Contract, undersigned agrees to prosecute the Work regularly and diligently to ensure full completion within the Contract Time(s) indicated in the Agreement.

ARTICLE 3-LIQUIDATED DAMAGES

The undersigned agrees that liquidated damages, in the amount stipulated in the Agreement, shall be assessed for each day that expires after the completion time(s), stipulated in the Agreement, until the Work is complete.

ARTICLE 4 -BIDDER'S QUALIFICATIONS

The undersigned agrees to furnish, upon request, a list of projects of a similar nature completed in the last 3 years.

ARTICLE 5-WAIVER

The undersigned certifies the price(s) entered in the Bid Form are correct and complete and that all information given or furnished in connection therewith is correct, complete and submitted as intended. The undersigned waives any right to:

5.1 Claims he may now have or which may accrue to him,

5.2 Refuse to execute the Contract if awarded to him,

5.3 Demand the return of the Bid Security,

5.4 Be relieved from any obligation by reason of any errors, mistakes or omissions, subject to right of withdrawal of Bid as provided in the Instructions to Bidders.

ARTICLE 6-BID NON-COLLUSIVE

The undersigned certifies that this Proposal is fair, genuine and not collusive or sham, and has not in any manner, directly or indirectly, agreed or colluded with any other person, firm or association to submit a sham Bid, to refrain from bidding, or in any way to fix the amount of this Bid or that of any other BIDDER, or to secure any advantage against the OWNER. The undersigned further certifies that no officer or employee of the OWNER is personally or financially interested, directly or indirectly, in this Bid or in the undersigned.

ARTICLE 7-BID SECURITY

The undersigned encloses a Bid Security in the form and amount stipulated in the Instructions to Bidders. The undersigned agrees to contract for the Work and to furnish the necessary Bonds, Insurance Certificates and other information, as stipulated in the Instructions to Bidders. If this Proposal shall be accepted by the OWNER and the undersigned shall fail to contract as aforesaid and to furnish the required Bonds, Insurance Certificates and other information, then the undersigned shall be considered to have abandoned the Contract and the Bid Security accompanying this Proposal shall become due and payable to the OWNER.

ARTICLE 8-OWNERS' RIGHTS

In submitting this Bid, it is understood that the right is reserved by the OWNER to accept any Bid, or reject any or all Bids, or to waive irregularities and/or informalities in any Bid and to make the award in any manner deemed in the best interest of the OWNER. By submission of this bid, undersigned agrees to provide sufficient additional information to allow the OWNER to deduce the qualifications and capabilities of the undersigned to perform the WORK and to waive any claim that it has, or may have, against the OWNER, any of its agents, or employees, arising out of, or in connection with, the administration, evaluation or recommendation of any PROPOSAL.

ARTICLE 9-RECEIPT OF ADDENDA

Receipt of Addenda _____ through _____ is acknowledged.

SIGNED THIS _____ DAY OF _____, 20___.

_____ (Firm Name)

_____ (Signature)

_____ (Street Address)

_____ (Name Printed)

_____ (City, State and Zip)

_____ (Title)

_____ (Telephone No.)

LEGAL STATUS OF BIDDER: (Fill out appropriate form and cross out others.)

*A Corporation, duly organized in good standing and doing business under the laws of the state of _____, for whom _____ bearing the office title of _____ whose signature is affixed to this proposal, is duly authorized to execute contracts. If a foreign corporation, the BIDDER states this corporation is qualified to and will register in state in which project Work is located.

*A Partnership, all members of which with address are:

_____ _____

_____ _____

_____ _____

_____ _____

*An Individual whose name with address is:

_____ _____

ARTICLE 1-SCHEDULE OF PRICES

Having reviewed the site and being fully informed of the conditions and having thoroughly examined the plans and specifications pertaining to this work, the undersigned proposes to furnish all labor, materials (unless otherwise noted), tools and equipment for the specified work within the Contract Time and accepts the provisions for Liquidated Damages as described in Article 3 of the Agreement for the **Baughman Drain - Division II**.

Item	Description	Unit	Qty.	Price	Amount
1	Mobilization (5% Max)	LS	1		
2	Utility Coordination & Protection	LS	1		
3	Traffic Control	LS	1		
4	Silt Fence	LF	5,600		
5	12-inch Storm Sewer, Perforated	LF	2,728		
6	4-foot Diameter Man Hole	EA	7		
7	Storm Sewer Restoration	LF	1,473		
8	Roadway Restoration	LF	1,300		
9	Site Restoration	LS	1		

Total = _____

SECTION 00500 AGREEMENT

This Agreement is dated the _____ day of _____ 20___, by and between the Allegan County Drain Commissioner, hereinafter called OWNER, and _____, hereinafter called CONTRACTOR.

OWNER and CONTRACTOR, in consideration of the mutual covenants set forth herein, agree as follows:

ARTICLE 1-WORK

CONTRACTOR shall complete the Work as specified or indicated in the Contract Documents, generally described as follows: Baughman Drain – Division II.

ARTICLE 2-ENGINEER

The Work has been designed by the firm of Land & Resource Engineering, who will act as ENGINEER on the Work, unless notice is otherwise given by the OWNER.

ARTICLE 3-CONTRACT TIME

3.1 The Work to be completed under this Contract shall be commenced immediately after receipt of a fully executed Contract and Notice to Proceed.

3.2 The Work under this Contract shall be substantially complete on or before September 26, 2025 and completed and set for final payment in accordance with the General Conditions on or before October 31, 2025 which shall be the Contract Time.

3.3 OWNER and CONTRACTOR recognize that time is of the essence of this Contract and that OWNER will suffer financial loss if the Work is not completed within the Contract Time(s) plus any extensions as provided for in the General Conditions. They recognize that the financial loss suffered by OWNER in the event that CONTRACTOR fails to complete the Work within the Contract Time(s) would be most difficult to determine accurately in any legal or arbitration proceedings. Instead of requiring such proof, OWNER and CONTRACTOR agree that as liquidated damages, but not as a penalty, CONTRACTOR shall pay OWNER Five Hundred & 00/100 Dollars ($500.00) for each day of delay in the completion of the Work beyond the Contract Time(s).

3.4 CONTRACTOR agrees to pay, in addition to liquidated damages, expenses arising from failure to complete the Work within the Contract Time including expenses for engineering services, attorney's fees, technical services and administration costs.

ARTICLE 4-CONTRACT PRICE

4.1 OWNER shall pay CONTRACTOR for performance of the Work in accordance with the Contract Documents in current funds as follows: _____ Dollars ($_____).

4.2 The amount paid shall be equitably adjusted to cover changes in the Work ordered by the ENGINEER but not required by the specifications. Such increases or decreases in the Contract Price shall be determined by agreement between the OWNER and CONTRACTOR.

ARTICLE 5-PAYMENTS

5.1 CONTRACTOR will prepare and submit monthly and final payment requests in accordance with the General Conditions.

5.2 OWNER will make monthly and final payments in accordance with the GENERAL CONDITIONS.

5.3 All monies not paid when due shall bear interest at the greater of the rate of 7% per annum, or the highest rate allowed by law.

ARTICLE 6-CONTRACT DOCUMENTS

6.1 The complete Contract between OWNER and CONTRACTOR consists of the following Contract Documents:

Bid Solicitation	General Conditions
Instruction to Bidders	Supplemental Conditions
Proposal	Specifications
Bid Form	Drawings
Bonds	Agreement
Modifications	Addenda (numbers ___ thru ___ inclusive)

6.2 In resolving conflicts, errors and discrepancies, the Contract Documents shall be given precedence in the following order: Modifications, Agreement, Addenda Supplemental Conditions, General Conditions, Specifications, Drawings, Advertisement, Instructions to Bidders, Proposal/Bid Form, and Bonds.

ARTICLE 7-CONTRACTOR'S REPRESENTATION

7.1 By executing the Agreement, CONTRACTOR represents that CONTRACTOR has visited the Site and assumes full responsibility for being familiar with the nature and extent of the Contract Documents, Work, locality, local conditions and availability of manpower, materials and machinery that may in any manner affect the Work to be done, the Contract Price or the Contract Time.

7.2 Contractor is familiar with all federal, state and local laws and regulations that pertain to completion of the Work as specified in the contract documents.

7.3 CONTRACTOR has carefully studied and compared the Contract Documents and checked and verified all figures shown thereon and all field measurements. CONTRACTOR has reported to ENGINEER any conflict, error or discrepancy which CONTRACTOR has discovered.

ARTICLE 8-MISCELLANEOUS

8.1 Terms used in this Agreement are defined in the General Conditions.

8.2 Neither party shall assign, in whole or in part, any of its rights or obligations, including any monies due, or to become due, under the terms of the Contract Documents without the written prior consent of the other party. This paragraph shall not be construed to limit the powers vested in the OWNER under the General Conditions.

8.3 The OWNER and CONTRACTOR each binds itself, successors and assigns to the other party hereto in respect to all covenants, agreements, and obligations contained in the Contract Documents.

8.4 The Contract Documents may only be altered, amended, or repealed by a Modification.

IN TESTIMONY WHEREOF, the parties hereto have executed this contract in at least three (3) counterparts, each of which shall be deemed an original, the day and year first above written.

WITNESS

CONTRACTOR

_____
(Contractor)

_____
(Name)

_____ By_____
(Signature)

Title_____

WITNESS

OWNER

Allegan County Drain Commissioner

Denise Medemar

_____ By_____
(Signature)

Title Drain Commissioner

LEGAL STATUS OF CONTRACTOR: (Fill out appropriate form and cross out others.)

*A Corporation: The same officer shall not execute both the Agreement and this certificate, unless only one person occupies all corporation offices.

I, _____ certify that I am the _____ _____ of the corporation named as CONTRACTOR herein; that _____, who signed this Agreement on behalf of the corporation, was then _____ of the corporation, that the Agreement was duly signed for and in behalf of the corporation by authority of its board of directors, and is within the scope of its corporate powers. If a foreign corporation, this corporation is qualified to and will register in state in which project Work is located.

_____ _____ LS
(Date) (Signature)

*A Partnership: The same officer shall not execute both the Agreement and this certificate, unless only one person occupies all partnership offices.

I, _____, certify that I am the _____ _____ of the partnership named as CONTRACTOR herein; that _____, who signed this Agreement on behalf of the partnership, was then _____ of the partnership, that the Agreement was duly signed for and in behalf of the partnership by authority of its partners, and is within the scope of its partnership powers. If a foreign partnership, this partnership is qualified to and will register in state in which project Work is located.

_____ _____ L.S.
(Date) (Signature)

SECTION 00600 AFFIDAVIT OF COMPLETION

ARTICLE 1-AFFIDAVIT OF COMPLETION

STATE OF MICHIGAN _____)
) ss
COUNTY OF _____)

The undersigned _____, as CONTRACTOR, being duly sworn, deposes and says that he entered into a contract with the Allegan County Drain Commissioner, as OWNER, on the ____ day of _____, 20____ for the construction of the Baughman Drain – Division II. Deponent further says that the Work under the terms of the said Contract has been completed and all indebtedness incurred by him to subcontractors, material-men, and laborers in his employ has been paid in full or satisfactorily secured.

Deponent further says this affidavit is furnished before final payment or before the retainage, withheld in accordance with the provisions stated in said Contract, may be reduced.

Deponent further says he hereby waives and releases any and all claims or rights which he may have, in connection with said Contract, against OWNER or the premises upon which said Contract Work was performed, and agrees to indemnify OWNER against any and all such claims or rights which may be asserted by subcontractors, material-men, and laborers with whom CONTRACTOR has contracted for performance under said Contract.

Further, deponent saith not.

WITNESSES: SIGNED:

_____ _____

By:_____

Title:_____

Subscribed and sworn to before me this _____ day of _____, 20____.

_____

Notary Public, _____ County,_____

My commission expires: _____

We, _____, as Surety on the above described Contract, hereby give our consent to the payment to the CONTRACTOR as indicated above.

DATE: _____ SIGNED: _____
(Attorney-in-fact)

PERFORMANCE BOND

KNOW ALL MEN BY THESE PRESENTS, that _____ _____, as Principal, and _____, a Corporation, organized and existing under the laws of the State of _____, and duly authorized to transact business in the State of Michigan, as Surety, are held and firmly bound unto the Baughman Drain Drainage District, c/o Denise Medemar, Allegan County Drain Commissioner, as obligee, and hereinafter called OWNER, in the just and full sum of _____ Dollars ($_____) lawful money of the United States of America, for the payment whereof the Principal and Surety bind themselves, their heirs, administrators, executors, successors and assigns, jointly and severally, firmly by these presents.

WHEREAS, the above Principal has entered into a written Contract with the OWNER, dated the _____ day of _____, 20____, for Baughman Drain – Div. II in accordance with plans and specifications prepared by Land & Resource Engineering, 2121 3 Mile Road NW, Walker, MI 49544 which Contract is hereby referred to and made a part hereof as fully and to the same extent as if the same were entirely written herein.

NOW, THEREFORE, the conditions of this obligation are such, that if the said Principal shall in all respects well and truly keep and perform the said Contract, and shall pay all sums of money due or to become due, for any labor, materials, apparatus, fixtures or equipment furnished for the purpose of constructing the work provided in said Contract, and shall defend, indemnify and save harmless the OWNER against any and all liens, encumbrances, damages, demands, expenses, costs and charges of every kind except as otherwise provided in said Contract Documents, arising out of or in relation to the performance of said Work and the provisions of said Contract, and shall remove and replace any defects in workmanship or materials which may be apparent or may develop within a period for one year from the date of final acceptance, then this obligation shall be null and void; otherwise it shall remain in full force and effect;

AND PROVIDED, that any alterations which may be made in the terms of said Contract, or in the Work to be done under it, or any extension of time for the performance of said Contract, or any forbearance on the part of either party to the other, or the placing of an inspector or resident engineer thereon by the OWNER, shall not in any way release the Principal and Surety or either of them, their heirs, executors, administrators, successors or assigns from any liability hereunder; notice to the surety of any such alteration, extension or forbearance being hereby waived.

Signed and sealed this _____ day of _____A.D., 20__.

WITNESS: PRINCIPAL:

_____

By_____(Seal)

_____ By _____

WITNESS: SURETY:

_____ By_____(Seal)

Title_____

LOCAL ADDRESS OF AGENT FOR SURETY:

_____

Street City State Zip Code

PAYMENT BOND

KNOW ALL MEN BY THESE PRESENTS, that _____ _____, as Principal, and _____, a Corporation, organized and existing under the laws of the State of _____, and duly authorized to transact business in the State of Michigan, as Surety, are held and firmly bound unto the Baughman Drain Drainage District, c/o Denise Medemar, Allegan County Drain Commissioner, as obligee, and hereinafter called OWNER, in the just and full sum of ($_____) lawful money of the United States of America, or the payment whereof the Principal and Surety bind themselves, their heirs, administrators, executors, successors and assigns, jointly and severally, firmly by these presents.

WHEREAS, the above Principal has entered into a written Contract with the OWNER, dated the _____ day of _____, 20__ for the Baughman Drain – Div. II in accordance with plans and specifications prepared by Land & Resource Engineering, 2121 3 Mile Road NW, Walker, MI 49544 which Contract is hereby referred to and made a part hereof as fully and to the same extent as if the same were entirely written herein;

AND WHEREAS, this bond is given in compliance with subject to the provisions of Act. No. 213 of the Public Acts of Michigan, for the year 1963, as amended by subsequent acts to date.

NOW, THEREFORE, the condition of this obligation is that if the Principal and his Subcontractors shall make all payments as they become due and payable of all amounts owing to Subcontractors and to parties supplying labor or materials to the Principal or to his Subcontractors in the prosecution of the Work provided for in said Contract (intending to include herein all claimants as defined in Section 6 of Act 213 of 1963, as amended), then this obligation shall be void, otherwise the same shall be in full force and effect;

AND PROVIDED, that any alterations which may be made in the terms of said Contract, or in the Work to be done under it, or the giving by the party of the first part of said Contract, any extension of time for the performance of said Contract or any other forbearance on the part of either party to the other, shall not in any way release the Principal and the Surety or either of them, their heirs, executors, administrators, successors or assigns from any liability hereunder; notice to the Surety of any alterations, extensions of or of any forbearance being hereby waived.

Signed and sealed this _____ day of _____A.D., 20__.

WITNESS:

_____

WITNESS:

_____

PRINCIPAL:

_____

By_____(Seal)

By _____

SURETY:

By_____(Seal)

Title_____

LOCAL ADDRESS OF AGENT FOR SURETY:

_____

Street City State Zip Code

ARTICLE 1-DEFINITIONS

Wherever used in these General Conditions or in the other Contract Documents, the following terms shall have the meanings indicated which shall be applicable to both the singular and plural thereof:

Act of God	Unpredictable phenomenon of nature such as earthquake, flood or cyclone.
Addendum	A document issued by ENGINEER prior to the receipt of bids which sets forth additional provisions, changes or clarifications of the Contract Documents.
Advertisement	The notice published by OWNER to solicit Bids.
Affidavit of Completion	A document which includes the CONTRACTOR's sworn statement that the Work has been completed in accordance with the Contract Documents and that labor and material men have been paid and the Surety's consent to final payment.
Agreement	An instrument, signed by OWNER and CONTRACTOR covering the Work to be performed and setting forth the Contract Time, the Contract Price and other matters.
Allowance	A fixed sum stipulated in the Contract Documents, to be used in total or in part, as determined by the OWNER, for a specific service, product or group of products to be furnished by CONTRACTOR. All cash allowances shall be included in the Contract Price.
Bid	The offer of the BIDDER submitted on the prescribed forms setting forth the conditions under and prices for which the Work will be performed.
Bid Documents	The Bid and additional documents required to be submitted with the Bid as set forth in the Instructions to Bidders.
BIDDER	Any person, firm, joint venture or corporation submitting a Bid for the Work.
Bid Security	Bid Bond or other instrument of security furnished by BIDDER.
Bonds	Bid, Performance and Payment Bonds furnished by CONTRACTOR.
Bulletin	A document issued by ENGINEER which clarifies and interprets the Contract Documents or which directs minor changes or alterations in the Work not involving extra cost.
Certificate of Completion	Notice from ENGINEER to OWNER that the Work has been completed and establishing a one year bonded correction period.
Change Order	An order to CONTRACTOR signed by OWNER authorizing an addition, deletion or revision in the Work, or an adjustment in the Contract Price or the Contract Time or both, issued after execution of the Agreement.
Construction Schedule	The timetable outline of CONTRACTOR's sequence of operations.
Contract	The agreement between OWNER and CONTRACTOR set forth in the Contract Documents.
Contract Documents	The Agreement and all related documents as identified in the Agreement.
Contract Price	The total moneys payable to CONTRACTOR for the Work.
Contract Time	The stated date or number of days for the completion of the Work.
CONTRACTOR	The person, firm, joint venture or corporation with whom OWNER has executed the Contract.
Day	Calendar day of 24 hours from midnight to the next midnight.
Defective Work	Work that does not conform to the requirements of the Contract Documents and damaged Work.
Drawings	The Drawings prepared or approved by ENGINEER and approved by OWNER, which show the character and scope of the Work to be performed.
Effective Date of Contract	The date shown in the Agreement.

ENGINEER	The designated representative of the OWNER.
General Requirements	The Sections of Division 1 of the Specifications.
Inspect, Inspection, Inspector	Observe the work of the CONTRACTOR as it relates to implementing CONSULTANT's plans, specifications, reports, and other instruments of professional service. An inspector has no authority or responsibility to direct any construction workers, and may not stop the work. An inspector is not responsible for the means, methods, sequences, or operations of construction, or safety procedures attendant thereto.
Insurance Certificate	The documents issued by CONTRACTOR's insurer listing policies and extent of coverage applicable to the Work.
Liens	Claims, security interests, and encumbrances.
Modification	(a) An amendment of the Contract Documents signed by both parties, (b) a Change Order, or (c) Bulletin. A Modification may only be issued after the Effective Date of the Contract.
Notice	A written communication between the parties specifically called for by the Contract Documents.
Notice of Award	The Notice by OWNER to BIDDER that BIDDER has been awarded the Contract.
Notice of Termination	Notice from OWNER to CONTRACTOR terminating services of the CONTRACTOR.
Notice to Proceed	A Notice by ENGINEER to CONTRACTOR fixing the date on which the Contract Time will commence and on which CONTRACTOR shall start the Work.
OWNER	The public body or authority, corporation, association, partnership, or individual with whom CONTRACTOR has entered into the Contract and for whom the Work is to be performed.
Partial Completion	For the Work that is being constructed in phases, Partial Completion is Substantial Completion of a defined portion of the Work. Partial Completion is reached whenever the defined portion of the Work is ready for use by OWNER. To be considered partially complete, use must not be prevented by other activities of CONTRACTOR. When use is delayed by factors that are beyond CONTRACTOR's control, the designated portion of the Work shall be considered partially complete.
Partial Utilization	Partial Utilization is placing a portion of the Work or facility in service for the purpose for which it was intended or for a related use before reaching Partial Completion or Substantial Completion.
Planholders of Record	Parties recorded by ENGINEER as having received a copy of Contract Documents and a separate set of Bid Documents and as making required deposit therefor, under their own name.
Product	Materials, systems, and equipment incorporated or to be incorporated in the Work.
Product Data	Catalog data, illustrations, standard schedules, performance charts, instructions, and other information prepared by manufacturer or supplier.
Project	Work and other related facilities of the OWNER.
Project Manual	The volume or volumes containing the bidding information, schedules, equipment uses, page-size details, and the Contract Documents for the Work except large drawings and modifications.
Proposal	The document which forms a portion of the Bid.
Provide	Furnish and install.
Resident Project Representative	The authorized representative of ENGINEER who is assigned to the Work site or any part thereof.

Schedule of Values	The breakdown of the Bid into component parts aggregating the total Bid.
Shop Drawings	All drawings, diagrams, illustrations, schedules and other data specifically prepared by CONTRACTOR, a Subcontractor, manufacturer, fabricator, supplier or distributor to illustrate the equipment, material or some portion of the Work.
Site	The location(s) where the Work is to performed.
Specifications	Those portions of the Contract Documents consisting of technical descriptions of materials, equipment, systems, standards and workmanship as applied to the Work, and certain administrative details applicable thereto, specifically Divisions 1 through 16.
Subcontractor	An individual, firm, joint venture or corporation having a direct contract with CONTRACTOR or with any other Subcontractor for the performance of a part of the Work at the Site.
Substantial Completion	The stage in construction when the Work can be utilized for the purposes for which it was intended. This includes the completion of all contract items in accordance with the plans and specifications with the exception of restoration.
Supplier	Firm providing products to CONTRACTOR.
Surety	A company which provides a Bond.
Work	The entire completed construction and the various separately identified parts thereof required to be furnished under the Contract Documents. Work is the result of performing services, furnishing labor, and furnishing and incorporating Products into the construction as required by the Contract Documents.

ARTICLE 2-PRELIMINARY MATTERS

COPIES OF DOCUMENTS

2.1 OWNER will furnish CONTRACTOR up to 10 copies of the Contract Documents. Additional copies will be furnished, upon request, as ENGINEER determines are necessary for execution of the Work. Copies requested beyond these limits are available at the cost of reproduction.

CONTRACTOR'S REPRESENTATION:

2.2 By executing the Agreement, CONTRACTOR represents that CONTRACTOR has visited the Site and assumes full responsibility for being familiar with the nature and extent of the Contract Documents, Work, locality, local conditions and availability of manpower, materials and machinery that may in any manner affect the Work to be done, the Contract Price or the Contract Time.

CONTRACT TIME

2.3 The Contract Time will commence on the day indicated in the Notice to Proceed; but in no event shall the Contract Time commence later than the later of 30 days after the time stipulated for Bids to remain firm or 30 days after the Effective Date of Contract.

2.4 The date of beginning and the Contract Time for completion of the Work are essential conditions of the Contract Documents. Time requirements are for the benefit of OWNER, CONTRACTOR and other Project Contractors.

2.5 CONTRACTOR shall proceed with the Work at a rate of progress to ensure completion within the stipulated Contract Time. It is expressly agreed by CONTRACTOR that the Contract Time is reasonable, taking into consideration the average climatic and economic conditions and the availability of manpower, products, and construction machinery prevailing at the locality of the Work.

BEFORE STARTING THE WORK

2.6 CONTRACTOR shall carefully study and compare the Contract Documents and check and verify all figures shown thereon and all field measurements. CONTRACTOR shall, within 48 hours, report to ENGINEER any conflict, error or discrepancy which CONTRACTOR may discover before proceeding with the Work.

2.7 CONTRACTOR shall submit to the ENGINEER:
Construction Schedules;
Schedule of Values;
Schedule of Shop Drawings,
Product Data and samples.

2.8 A preconstruction meeting will be held to review the Construction Schedules, to establish procedures for handling Shop Drawings and other submissions and for processing payments, and to establish working relationships between the parties.

STARTING THE WORK

2.9 CONTRACTOR shall start to perform the Work on the date when the Contract Time commences.

2.10 CONTRACTOR shall attend a progress meeting a minimum of once each month at a time and place designated by the ENGINEER.

ARTICLE 3-CONTRACT DOCUMENTS INTENT

GENERAL:

3.1 It is the intent that the Contract Documents comprise the entire agreement between OWNER and CONTRACTOR and may be altered only by a Modification.

3.2 All communications between OWNER, CONTRACTOR, and ENGINEER intended to affect or modify any of the terms or obligations contained in the Contract Documents shall be in writing in order to be valid. Communications intended to affect or modify the Contract Documents include the following terms: claim, submission, notice, request, acceptance, report, objection, order, consent, advise, communicate, communications, certify, authorize, authorization, issue, or like terms.

3.3 No oral order, objection, claim or notice by OWNER, CONTRACTOR or ENGINEER shall affect or modify any of the terms or obligations contained in the Contract Documents.

3.4 The Contract Documents are complementary; what is called for by one is as binding as if called for by all. In resolving conflicts, errors and discrepancies, the documents shall be given precedence in the order stipulated in the Agreement. Detailed drawings shall govern over general drawings. Any Work that may reasonably be inferred from the Contract Documents as being required to produce the intended result shall be supplied whether or not it is specifically called for. Work, materials or equipment described in words which, so applied, have a well-known technical or trade meaning shall be deemed to refer to such recognized standards or meanings.

3.5 The Contract Documents shall be governed by the law of the place of the Work.

REUSE OF DOCUMENTS

3.6 Neither CONTRACTOR nor any Subcontractor, manufacturer, fabricator, supplier or distributor shall have or acquire any title to or ownership rights in any of the Drawings, Specifications or other documents or copies thereof prepared by or bearing the seal of ENGINEER; and they shall not reuse any of them on extensions of the Project or any other project without written consent of OWNER and ENGINEER and specific written verification or adaptation by ENGINEER.

ARTICLE 4-LANDS AND CONTROLS

GENERAL

4.1 OWNER will, upon request, furnish to CONTRACTOR copies of all available boundary surveys and subsurface tests.

AVAILABILITY OF LANDS

4.2 OWNER will furnish, not later than CONTRACTOR's Construction Schedule starting date, the lands or rights-of-way upon which or within which the Work is to be performed, rights-of-way for access thereto, and lands designated for the use of CONTRACTOR. Easements for permanent structures or permanent changes in existing facilities will be obtained by OWNER. CONTRACTOR shall obtain all additional lands and access required for temporary construction facilities and storage of materials and equipment.

UNFORESEEN SUBSURFACE CONDITIONS

4.3 The underground conditions indicated in the Contract Documents represent the information available at the time of preparation and are not guaranteed as to accuracy or completeness. CONTRACTOR shall within 48 hours after discovery notify OWNER and ENGINEER of any subsurface or latent physical conditions at the site differing materially from those indicated in the Contract Documents. ENGINEER will investigate within 72 hours after Notice and, if warranted, advise OWNER to obtain additional investigations and tests. If said additional investigations and tests show subsurface or latent physical conditions to be materially different and which could not have reasonably been anticipated by CONTRACTOR, a Change Order will be issued incorporating the necessary revision.

REFERENCE POINTS

4.4 CONTRACTOR shall be responsible for the preservation of established property corners, monuments, bench marks and similar reference points outside of the normal working area. CONTRACTOR shall report to ENGINEER whenever any reference point is lost, destroyed or requires relocation.

4.5 Replacement of reference points within the normal working area are the responsibility of OWNER. CONTRACTOR shall report to ENGINEER whenever any reference point is in danger of being lost or destroyed or requires relocation.

4.6 Construction stakes will be provided by the OWNER to the extent as may be set forth in the Specifications.

ARTICLE 5 - BONDS AND INSURANCE

PERFORMANCE AND PAYMENT BONDs:

5.1 CONTRACTOR shall furnish separate Bonds as security for the faithful performance and payment of all CONTRACTOR's obligations under the Contract Documents. Each of these Bonds shall be in amounts at least equal to the Contract Price and in such form and with such Sureties as are acceptable to OWNER. Bond forms for the aforementioned securities are a part of the Contract Documents and CONTRACTOR shall ensure that each executed copy of the Bond form is complete and sealed.

A. Bonds shall be issued by a Surety named in U.S. Treasury Circular 570 licensed to conduct business in the state where the Work is located.

B. If the Surety on any Bond is declared bankrupt or becomes insolvent or its right to do business is terminated in the state where the Work is located, or it ceases to be listed as an acceptable Surety in U.S. Treasury Circular 570, CONTRACTOR shall, within 5 days thereafter, substitute another Bond from an acceptable Surety.

CONTRACTOR'S LIABILITY INSURANCE

5.2 CONTRACTOR shall purchase and maintain such comprehensive general liability and other insurance from an insurance company authorized to write casualty insurance in the state where the Work is located and

shall provide protection from claims set forth below which may arise out of, or result from, CONTRACTOR's performance of the Work and CONTRACTOR's other obligations under the Contract Documents, whether such performance is by CONTRACTOR, by any Subcontractor, by anyone directly or indirectly employed by any of them, or by anyone for whose acts any of them may be liable.

A. Claims under worker's compensation, disability benefits, and other similar employee benefits.

B. Claims for damages because of bodily injury, occupational sickness or disease, or death of CONTRACTOR's employees.

C. Claims for damages because of bodily injury, sickness or disease, or death of any person other than CONTRACTOR's employees.

D. Claims for damages insured by personal injury liability coverage which are sustained by any person as a result of an offense directly or indirectly related to the employment of such person by CONTRACTOR or by any other person for any other reason.

E. Claims for damages because of injury to, or destruction of, tangible property, including loss of use resulting therefrom.

F. Claims for damages because of bodily injury or death of any person or property damage arising out of the ownership, maintenance or use of any motor vehicle.

ARTICLE 6-CONTRACTOR'S RESPONSIBILITIES

GENERAL

6.1 CONTRACTOR will issue communications relative to the Work, to OWNER through ENGINEER.

6.2 CONTRACTOR shall supervise and direct the Work competently, efficiently and with skill and attention required to complete the Work in accordance with the Contract Documents. CONTRACTOR shall be solely responsible for the means, methods, techniques, sequences and procedures of construction. CONTRACTOR shall be responsible for accurate compliance of the finished Work with the Contract Documents.

6.3 CONTRACTOR shall keep on the Work, at all times the Work is in progress, a competent superintendent who shall be replaced only under extraordinary circumstances with Notice to OWNER and ENGINEER. The superintendent shall have authority to act on behalf of CONTRACTOR. All communications given to the superintendent shall be binding on CONTRACTOR.

6.4 CONTRACTOR shall provide notice to allow all utilities to locate their facilities prior to the performance of Work. The form and time of notice, the person(s) notified and all other issues related to notice to utilities which may be affected by the Work shall be in accordance with the laws and regulations of the state in which the Work is to be performed.

6.5 Unless otherwise specified, restricted work times shall be as follows, except in the event of an emergency as defined in this Article: Sunday or holiday work will not be permitted; and, work will not be permitted from 8:00 p.m. to 7:00 a.m.

LABOR, MATERIALS AND EQUIPMENT

6.6 CONTRACTOR shall provide competent, suitably qualified personnel to execute and complete the Work as required by the Contract Documents. CONTRACTOR shall at all times maintain good discipline and order at the Site. ENGINEER may judge the competency and qualifications of personnel and, upon his written request to the CONTRACTOR, the CONTRACTOR shall cause the immediate dismissal from the Work of any personnel considered by ENGINEER to be incompetent and/or unqualified.

6.7 CONTRACTOR shall guarantee that he has available the quantities and quality of labor and supervision necessary to fulfill the CONTRACTOR'S obligations under the Contract Documents.

6.8 CONTRACTOR shall furnish all materials, equipment, labor, transportation, construction equipment and machinery, tools, appliances, fuel, power, light, heat, telephone, water, sanitary facilities, and all other facilities and incidentals necessary for the execution, testing, initial operation, and completion of the Work.

6.9 All Products shall be of good quality and new. When required by ENGINEER, CONTRACTOR shall furnish satisfactory evidence as to the kind and quality of materials and installed equipment. CONTRACTOR shall submit to the ENGINEER Shop Drawings, Product Data and samples of Products to be incorporated in the Work.

SUBCONTRACTORS

6.10 CONTRACTOR shall be fully responsible for all acts and omissions of Subcontractors and of persons directly or indirectly employed by them and persons for whose acts any of them may be liable to the same extent that CONTRACTOR is responsible for the acts and omissions of persons directly employed by CONTRACTOR. Nothing in the Contract Documents shall create any contractual relationship between any Subcontractor and OWNER or ENGINEER or any obligation on the part of OWNER or ENGINEER to pay or to see to the payment of any moneys due any Subcontractor, except as may otherwise be required by law. OWNER or ENGINEER may furnish to any Subcontractor, to the extent practicable, evidence of amounts paid to CONTRACTOR for specific work done.

6.11 The Divisions and Sections of the Specifications and the identifications of any Drawings shall not control CONTRACTOR in dividing the Work among Subcontractors or delineating work to be performed by any specific trade.

6.12 All work performed for CONTRACTOR by a Subcontractor shall be pursuant to an appropriate agreement between CONTRACTOR and the Subcontractor, subject to the applicable terms and conditions of the Contract Documents.

SUBSTITUTE PRODUCTS

6.13 Whenever Products are specified or described in the Drawings or Specifications by using the name of a proprietary item or the name of a particular manufacturer, fabricator, supplier or distributor, it is intended to establish the type, function and quality required. Unless the substitution is specifically prohibited, substitute items may be accepted by ENGINEER. ENGINEER will be the sole judge of the acceptability of proposed substitutions. No substitution shall be ordered or installed without ENGINEER's prior acceptance. OWNER may require CONTRACTOR to furnish a special performance guarantee or other surety with respect to any substitute.

A. During the bidding period, requests for substitutions may be given consideration by the ENGINEER, and if approved, an Addendum will be issued to incorporate the approved Product into the Contract Documents. Such requests must be received by the ENGINEER in ample time, not later than 10 days before bid due date, so that any necessary Addendum can be issued to all prospective BIDDERS before submission of the Bids.

B. A request for substitution after award of the Contract shall be accepted from the CONTRACTOR only, shall be accompanied by manufacturer's data or other detailed description of the proposed Product and will be considered for one of the following reasons only:

1. Increased value to the OWNER.
2. Decreased cost to the OWNER.
3. Specified item not procurable.

C. A request for a substitution constitutes a representation that the CONTRACTOR has investigated and determined that the proposed Product is equal to or superior in all respects to that specified.

D. CONTRACTOR shall reimburse OWNER for the charges of ENGINEER and ENGINEER's consultants for evaluating accepted or rejected substitutes and for resulting changes in Drawings and Specifications.

OWNER FURNISHED PRODUCTS:

6.14 When the Contract Documents stipulate that the OWNER will furnish Products to be incorporated in the Work, the CONTRACTOR'S responsibilities will be:

A. Coordinate the delivery of each product with the OWNER. OWNER'S requirements for notification for each product will be determined at the pre-construction meeting but under no circumstance shall the notification period be less than 3 business days.

B. Review the Shop Drawings, Product Data and samples.

C. Submit to ENGINEER Notice of any discrepancies or problems anticipated in the use of the Product.

D. Receive and unload the Products at the Site.

E. Promptly inspect Products jointly with the OWNER, record shortages, and damaged or defective items.

F. Handle Products at the Site, including uncrating and storage.

G. Protect the Products from exposure to the elements and from damage.

H. Assemble, install, connect, and adjust the Products as stipulated in the Specifications.

I. Repair or replace items damaged by the CONTRACTOR.

PERMITS

6.15 CONTRACTOR shall obtain all temporary permits required to complete the Work. Application and inspection fees associated with temporary permits shall be paid by the CONTRACTOR.

USE OF PREMISES

6.16 CONTRACTOR shall confine Work operations to the Site and other designated areas. All disturbed areas shall be restored to equal to or better than original condition.

6.17 Material and equipment storage areas on Site shall be established and maintained in a manner that will not disrupt or impair the use of the Site.

PATENT FEES AND ROYALTIES

6.18 CONTRACTOR shall pay license fees, royalties and costs incident to the use of any invention, design, process or device which is the subject of patent rights or copyrights in connection with the Work. OWNER will pay for processes involved in the operation of the completed facilities.

SAFETY AND PROTECTION

6.19 CONTRACTOR shall be responsible for initiating, maintaining and supervising safety programs in connection with the Work. CONTRACTOR shall take precautions and provide protection to prevent damage, injury or loss to:

A. Employees on the Work and other persons who may be affected thereby;
B. The Work and Products to be incorporated therein, whether in storage on or off the site; and
C. Other property at the Site or adjacent thereto, both above and below ground, not designated for removal, relocation or replacement. CONTRACTOR shall erect and maintain necessary safeguards for safety and protection of property and shall notify owners of adjacent utilities when prosecution of the Work may affect them. CONTRACTOR shall be responsible for costs associated with all damage, injury or loss.

6.20 CONTRACTOR shall designate a superintendent at the site as safety officer, whose duty shall be the prevention of accidents.

6.21 Damage, injury or loss to property referred to in this Article caused, directly or indirectly, in whole or in part, by CONTRACTOR, any Subcontractor and anyone directly or indirectly employed by any of them and anyone for whose acts any of them may be liable, shall be remedied by CONTRACTOR at CONTRACTOR'S cost. CONTRACTOR's duties and responsibilities for the safety and protection of the Work shall continue until the Work is completed and ENGINEER has issued the Certificate of Completion.

LAWS AND REGULATIONS

6.22 CONTRACTOR shall comply with all laws, ordinances, rules, regulations and orders of public bodies applicable to the Work.

6.23 When the CONTRACTOR becomes aware that the Contract Documents, or any requirements thereof, are at variance to laws and regulations, CONTRACTOR shall promptly serve written Notice to the ENGINEER. Any alterations required to bring the Work in compliance will be made by Modification.

6.24 When the CONTRACTOR is aware that the Contract Documents, or any requirements thereof, are at variance to laws and regulations and performs any of the Work contrary to laws and regulations without Notice to the ENGINEER, all costs incurred in correcting the Work shall be borne by the CONTRACTOR.

HAZARDOUS MATERIALS

6.25 In the event CONTRACTOR discovers on the Site unexpected regulated hazardous materials, including without limitation, inorganics, organics and asbestos, CONTRACTOR shall immediately give Notice to ENGINEER and request a determination of how to proceed. In the event CONTRACTOR releases, under any circumstances, regulated hazardous materials on the Site, CONTRACTOR shall immediately give Notice to ENGINEER, take emergency action as appropriate and, following approval by ENGINEER of CONTRACTOR'S proposed plan of remediation, CONTRACTOR shall remediate said release at CONTRACTOR'S expense, all in compliance with all applicable laws and regulations.

EMERGENCIES

6.26 In emergencies affecting the safety of persons, the Work or adjacent property, CONTRACTOR, without authorization from ENGINEER or OWNER, is obligated to act, at CONTRACTOR's discretion, to prevent threatened damage, injury or loss. CONTRACTOR shall give ENGINEER prompt Notice of the emergency action taken, and any significant changes in the Work or deviations from the Contract Documents caused thereby.

INDEMNIFICATION

6.27 CONTRACTOR shall indemnify, defend and hold harmless OWNER and ENGINEER, their consultants, agents and employees, from and against claims, damages, losses, attorney's fees, and expenses arising out of, or resulting from, the performance of the Work, provided that any such claim, damage, loss or expense:

A. is attributable to bodily injury, sickness, disease or death, or to injury to, or destruction of, tangible property other than the Work itself, including the loss of use resulting therefrom; and

B. is caused in whole or in part by any negligent act or omission of CONTRACTOR, any Subcontractor, anyone directly or indirectly employed by any of them, or anyone for whose acts any of them may be liable, regardless of whether or not it is caused in part by a party indemnified hereunder.

6.28 In all claims against OWNER or ENGINEER or their agents or employees, by any employee of CONTRACTOR or Subcontractors or anyone for whose acts they may be liable, the indemnification obligation shall not be limited by the amount or type of damages, compensation or benefits under workmen's compensation acts, disability benefit acts, or other employee benefit acts.

6.29 The indemnification obligation of CONTRACTOR shall not extend to the liability of ENGINEER, agents or employees arising out of the preparation or approval of maps, Drawings, reports, surveys, Change Orders, designs or Specifications.

ARTICLE 7-WORK BY OTHERS

7.1 OWNER may perform or may contract with others to do additional work related to the Project. CONTRACTOR shall afford others a reasonable opportunity to perform work as well as to store materials and equipment on Site and shall properly integrate and coordinate CONTRACTOR's work with others. CONTRACTOR shall coordinate and cooperate with contractors working in the area for other owners or jurisdictions.

7.2 If any part of CONTRACTOR's work depends for proper execution or results upon the work of other contractors, other owners, or OWNER, CONTRACTOR shall inspect and promptly report to ENGINEER any defects or deficiencies in such work. CONTRACTOR's failure to so report shall constitute an acceptance of the other work as fit and proper for integration with CONTRACTOR's work.

7.3 Additional Work resulting from other contracts, or work by OWNER not noted in the Contract Documents will be added by Change Order.

ARTICLE 8-OWNER'S RESPONSIBILITIES

GENERAL

8.1 In case of termination of the employment of ENGINEER, OWNER will appoint an engineer against whom CONTRACTOR makes no substantial objections, whose status under the Contract Documents will be that of the former ENGINEER.

8.2 OWNER will furnish the data required under the Contract Documents promptly and will make payments to CONTRACTOR promptly.

OWNER FURNISHED PRODUCTS

8.3 When the Contract Documents stipulate that the OWNER will furnish Products to be incorporated in the Work, the OWNER'S responsibilities will be:

A. Arrange for and deliver the necessary Shop Drawings, Product Data, and samples to the CONTRACTOR.

B. Arrange and pay for delivery of the Products to the Site in accordance with the Construction Schedule.

C. Deliver supplier's bill of materials to the CONTRACTOR.

D. Inspect deliveries jointly with the CONTRACTOR.

E. Submit claims for transportation damage.

ARTICLE 9-ENGINEER'S STATUS

OWNER'S REPRESENTATIVE

9.1 ENGINEER will be OWNER'S representative during the bidding and construction period. Communications between the OWNER and the CONTRACTOR, or claimant, will be directed through the ENGINEER. The duties, responsibilities and limitations of authority of ENGINEER as OWNER's representative during the

bidding and construction are set forth in these Contract Documents and shall be modified only with consent of OWNER and ENGINEER.

9.2 ENGINEER will not be responsible for the construction means, methods, techniques, sequences or procedures, or the safety precautions and programs incident thereto, and ENGINEER will not be responsible for the CONTRACTOR's failure to perform the Work in accordance with the Contract Documents.

9.3. ENGINEER will not be responsible for the acts or omissions of the CONTRACTOR, or any Subcontractors, or any of their agents or employees, or any other persons performing any of the Work.

VISITS TO SITE

9.4 ENGINEER will make visits to the site at intervals appropriate to the various stages of construction to observe the progress and quality of the executed Work and to determine, in general, if the Work is proceeding in accordance with the Contract Documents. ENGINEER will not be required to make exhaustive or continuous on-site inspections to check the quality or quantity of the Work. ENGINEER'S efforts will be directed toward providing for OWNER a greater degree of confidence that the completed Work will conform to the Contract Documents. On the basis of such visits and on-site observations as an experienced and qualified professional, ENGINEER will keep OWNER informed of the progress of the Work and will endeavor to guard OWNER against defects and deficiencies in the Work.

CLARIFICATIONS AND INTERPRETATIONS

9.5 ENGINEER may issue clarifications or interpretations consistent with, or inferable from, the intent of the Contract Documents.

SHOP DRAWINGS, PRODUCT DATA AND SAMPLES

9.6 ENGINEER shall review Shop Drawings, Product Data and samples of Products submitted by the CONTRACTOR.

REJECTING DEFECTIVE WORK

9.7 ENGINEER will have authority to disapprove of or reject Defective Work. ENGINEER will also have authority to require special inspection or testing of Work whether or not the Work is fabricated, installed or completed.

SITE REPRESENTATIVE

9.8 ENGINEER will furnish a Resident Project Representative, who may have one or more assistants, to aid OWNER and ENGINEER in carrying out their responsibilities at the Site. The duties, responsibilities and authority of the Resident Project Representative are set forth in Article 18 of these General Conditions.

DECISIONS ON DISAGREEMENT

9.9 ENGINEER will be initial interpreter of the requirements of Contract Documents and judge of acceptability of the Work. Claims, disputes, and other matters pertaining to bidding, execution and progress of the Work shall be referred initially to ENGINEER with a request for an informal meeting and a formal decision. Notice of each such claim, dispute and other matter shall be delivered by claimant to ENGINEER and other party within 15 days of occurrence of the event giving rise thereto. Additional supporting data shall be supplied within 30 days of occurrence. ENGINEER's written decision will be rendered within 40 days after the occurrence. In ENGINEER's capacity as interpreter and judge, ENGINEER will be impartial to OWNER, CONTRACTOR or claimant and will not be liable for any decision rendered in good faith.

9.10 The rendering of a decision by ENGINEER with respect to any such claim, dispute or other matter, will be a condition precedent to arbitration under these General Conditions. The ENGINEER's decision shall become final and binding on the parties 30 days after the decision is rendered unless deferred by an arbitration request, litigation or administrative appeal (if applicable) filed by either party within the 30-day period to a court of competent jurisdiction.

9.11 No decision made by ENGINEER in good faith, either to exercise or not to exercise authority under this Article shall give rise to any duty, liability or responsibility of ENGINEER to claimant, CONTRACTOR, any Subcontractor, any of their agents or employees, or any other person performing any of the Work.

ARTICLE 10-CHANGES IN THE WORK

10.1 Without invalidating the Contract, OWNER may, at any time, order additions, deletions or revisions in the Work by Change Orders. Upon receipt of an executed Change Order, CONTRACTOR shall proceed with the Work involved.

10.2 ENGINEER may authorize minor changes or alterations in the Work not involving extra cost and not inconsistent with the overall intent of the Contract Documents. These changes will be authorized by a Bulletin and will be binding upon OWNER and CONTRACTOR.

10.3 Additional work performed by CONTRACTOR without authorization of a Change Order will not entitle CONTRACTOR to an increase in the Contract Price or an extension of the Contract Time, except as set forth in these General Conditions.

10.4 OWNER shall execute appropriate Change Orders recommended by ENGINEER as set forth in these General Conditions.

10.5 It shall be CONTRACTOR's responsibility to notify Surety of any changes affecting the general scope of the Work or change in the Contract Price or Time. The amount of the applicable Bonds shall be adjusted accordingly.

ARTICLE 11-CHANGE OF CONTRACT PRICE

GENERAL

11.1 The Contract Price constitutes the total compensation payable for performing all duties, responsibilities and obligations assigned to or undertaken by CONTRACTOR, and includes all taxes payable by CONTRACTOR as a result of the Work.

11.2 The Contract Price shall only be changed by a Change Order. Claims for a change in the Contract Price shall be submitted, with supporting data, to ENGINEER within 15 days of the occurrence of the event giving rise to the claim.

11.3 Claims for extra compensation shall not be made by CONTRACTOR for reasonable delays:

A. caused by the work of other Project contractors or subcontractors.

B. due to the failure of OWNER to perform any obligations required of OWNER under these Contract Documents.

11.4 Value of the Work covered by a Change Order shall be determined by one of the following methods:

A. where the Work is covered by Contract unit prices by application of unit prices to the items involved.

B. by mutual acceptance of a lump sum.

C. on the basis of the cost of the Work, plus overhead and profit, but only in the event OWNER and CONTRACTOR cannot agree on one of the above methods.

COST-PLUS WORK

11.5 Cost-plus work means cost of the Work plus a fee. Cost of the Work means the sum of all costs incurred and paid by CONTRACTOR in the performance of cost-plus work. Such costs shall be in amounts no higher than those prevailing in the locality of the Work. Cost of the Work shall only include:

A. payroll costs for employees including superintendents and foremen at the Site in the direct employ of CONTRACTOR under schedules of job classifications. Payroll costs shall include, but not be limited to, salaries and wages, social security contributions, unemployment, excise and payroll taxes, workers' or workmen's compensation, health and retirement benefits, bonuses, sick leave, vacation and holiday pay.

B. cost of all materials and equipment furnished and incorporated in the Work, including costs of transportation, storage and manufacturers' field services.

C. rentals of all construction equipment, machinery and accessories, and costs of transportation, loading, unloading, installation, dismantling and removal. Rental rates shall not exceed rates listed in the "Rental Rate Blue Book for Construction Equipment" published by Equipment Guide Book Company. Rates allowed will be based on the most economical time unit. The rental determined by multiplying the rate (e.g., hourly, daily, weekly, etc.) by the period of use shall not exceed the rental determined by applying the next highest rate (e.g., for this purpose the daily rate would be "higher" than the hourly rate, etc.) to the corresponding period of use.

D. fees of special consultants.

E. cost, including transportation and maintenance, of all materials, supplies, equipment, machinery, appliances, hand tools, office and temporary facilities at the Site.

F. transportation, travel and subsistence expenses.

G. sales, use or similar taxes imposed by any governmental authority.

H. unavoidable deposit losses, royalty payments, and fees for permits and licenses, and losses and damages to the Work not compensated by insurance.

I. the cost of utilities, fuel, telegrams, long distance telephone calls, and expressage.

11.6 Cost of the Work shall not include:

A. compensation for CONTRACTOR's officers, executives, principals, managers, professionals, clerks and other personnel, whether at the Site or office.

B. any part of CONTRACTOR's capital expenses, including interest on CONTRACTOR's capital employed for the Work and charges against CONTRACTOR for delinquent payments.

C. cost due to the negligence of CONTRACTOR, any Subcontractor, or anyone directly or indirectly employed by any of them or for whose acts any of them may be liable, including but not limited to, the correction of Defective Work or damage to the property, disposal of materials or equipment wrongly supplied.

D. other overhead or general expense costs.

11.7 The fee allowed to the CONTRACTOR for overhead and profit shall be 10 percent of the cost of the Work; except for payments to Subcontractors in which case the fee shall be 5 percent.

11.8 Payments to Subcontractors will be determined in the same manner as CONTRACTOR's cost of the Work. The fee allowed to the Subcontractors for overhead and profit shall be 10 percent.

11.9 The amount of credit to OWNER for any change which results in a net decrease in cost will be the amount of the actual net decrease, exclusive of any fee for overhead and profit. When both additions and credits are involved in any one change, the overhead and profit shall be based on the net increase in the Work.

11.10 CONTRACTOR shall submit daily cost reports of cost-plus work to the ENGINEER.

ARTICLE 12-CHANGE OF THE CONTRACT TIME

12.1 The Contract Time may only be altered by a Change Order. Claim for a change of Contract Time shall be delivered to OWNER and ENGINEER within 15 days of the event giving rise to the claim. Adjustment in the Contract Time will be determined by ENGINEER.

12.2 The Contract Time will be extended in an amount equal to time lost due to unreasonable time delays beyond control of CONTRACTOR. Reasons for such delays shall be restricted to fires, labor disputes, epidemics, abnormal weather conditions, and Acts of God. In addition Contract Time may be extended for unreasonable time delays:

A. caused solely by work of other Project contractors or subcontractors directly contracted by the OWNER

B. due to failure of OWNER to perform any obligations required of OWNER under these Contract Documents.

ARTICLE 13-WARRANTY, TESTS AND DEFECTIVE WORK

WARRANTY AND GUARANTEE

13.1 CONTRACTOR warrants and guarantees to OWNER and ENGINEER that materials and equipment shall be new and that Work shall be of good quality and free from faults or defects and in accordance with requirements of the Contract Documents. Prompt Notice of any defects will be given to CONTRACTOR.

13.2 CONTRACTOR warrants and guarantees that title to all Work, materials and equipment covered by monthly estimates, passes automatically to OWNER at the time of payment, free and clear of all liens.

TESTS AND INSPECTIONS

13.3 If the Contract Documents, laws, ordinances, rules, regulations or orders of any public authority having jurisdiction require any portion of the Work to be inspected, tested, or approved by someone other than CONTRACTOR, CONTRACTOR shall give ENGINEER timely notice of readiness therefore. Such tests shall be in accordance with the methods prescribed by the applicable organization or the Contract Documents. All certification fees, testing laboratory fees, and inspection fees of said public authorities will be paid by CONTRACTOR. Inspection coordination is the responsibility of the CONTRACTOR, unless otherwise indicated in the Contract Documents.

13.4 Neither observations by ENGINEER nor inspections, tests or approvals by persons other than CONTRACTOR shall relieve CONTRACTOR from obligations to perform the Work required by the Contract Documents, laws, ordinances, rules, regulations or orders of public authority having jurisdiction.

13.5 When inspection readiness is declared by the CONTRACTOR and the inspection proves unsuccessful, all costs for the inspection shall be borne by the CONTRACTOR.

ACCESS TO THE WORK

13.6 ENGINEER, his representatives, and representatives of OWNER shall at all times have access to the Work. CONTRACTOR shall provide proper facilities for access, observation of the Work, and for any inspection or testing by manufacturers, suppliers, material men, and other parties as authorized by OWNER.

UNCOVERING WORK

13.7 If Work requiring inspection, testing or approval is covered either without ENGINEER's written approval where required, or contrary to ENGINEER's specific request, the Work shall, if requested by ENGINEER, be uncovered for observation and replaced at CONTRACTOR's expense.

13.8 If ENGINEER considers it necessary or advisable that covered Work be inspected or tested, other than as outlined under the previous paragraph, CONTRACTOR, at ENGINEER's request, shall uncover and expose

that portion of the Work. If the Work is defective, CONTRACTOR shall bear all the expenses of satisfactory repair and reconstruction, including compensation for additional engineering services resulting therefrom. If such Work is not found to be defective, CONTRACTOR shall be allowed an increase in Contract Price, an extension of Contract Time, or both, directly attributable to such uncovering and reconstruction.

CUTTING AND PATCHING

13.9 CONTRACTOR shall be responsible for all cutting, fitting and patching required to complete the Work, to make its several parts fit together properly, or to uncover portions of the Work to provide for installation of ill-timed Work. CONTRACTOR shall not cut or alter any part of the Work or the work of another Contractor or Subcontractor without written approval of the ENGINEER. In no case shall the CONTRACTOR endanger any portion of the Work by cutting or altering any part of it.

CORRECTION OR REMOVAL OF DEFECTIVE WORK

13.10 CONTRACTOR shall promptly, as specified by ENGINEER, either correct any Defective Work or remove it from the Site and replace it with acceptable Work. If CONTRACTOR does not correct or remove and replace such Defective Work within a reasonable time, OWNER may have the deficiency corrected or the Defective Work removed and replaced by others. All direct and indirect costs of such correction or removal, and replacement, including compensation for additional engineering services, shall be paid by CONTRACTOR in an amount as verified by ENGINEER. CONTRACTOR shall also repair all Work of others destroyed or damaged by replacement of CONTRACTOR's Defective Work.

ONE YEAR CORRECTION PERIOD

13.11 Prior to the expiration of one year after the date of Acceptance or such longer period of time as may be prescribed by law or by the terms of any applicable special guarantee required by the Contract Documents, CONTRACTOR shall promptly correct identified Defective Work or remove it from the Site and replace it with acceptable Work. If CONTRACTOR does not promptly comply, OWNER's rights to correction will be the same as for Defective Work in this Article. Repairs and replacements made under this paragraph shall bear an additional 12-month correction period dated from the acceptance of repair and replacement.

ACCEPTANCE OF DEFECTIVE WORK

13.12 If OWNER prefers to accept Defective Work, an appropriate reduction in the Contract Price will be made. If the acceptance occurs after final payment, an appropriate amount, as determined by ENGINEER, shall be paid by CONTRACTOR to OWNER.

OWNER'S RIGHT TO DO WORK:

13.13 If CONTRACTOR should neglect to prosecute the Work properly and diligently, or fail to perform any provision of this Contract, including requirements of the Construction Schedule, OWNER, after three (3) days Notice to CONTRACTOR and his Surety may, without prejudice to any other remedy that OWNER may have, correct and remedy any such deficiency. Direct and indirect costs of OWNER, including compensation for additional engineering services, shall be verified by ENGINEER and an appropriate reduction in the Contract Price will be made. If the payments due CONTRACTOR are not sufficient to cover such amount, CONTRACTOR shall pay the difference to OWNER.

ARTICLE 14-PAYMENTS AND COMPLETION

PROGRESS PAYMENTS AND RETAINAGES

14.1 As a condition precedent to the first progress payment, CONTRACTOR shall submit a Construction Schedule and Schedule of Values.

14.2 CONTRACTOR will prepare a monthly payment request, supported by such data as ENGINEER may reasonably request from CONTRACTOR.

14.3 The payment requests shall not include Products not incorporated in the Work unless specifically requested by CONTRACTOR and approved by OWNER subject to the following mandatory conditions:

A. the Products have been specifically manufactured for the Work;

B. the Products have been delivered and suitably stored at the Site or at another location agreed to; and

C. CONTRACTOR has furnished supporting data, satisfactory to OWNER that establishes OWNER's title to the Products, free of any Liens or other encumbrances, and protects OWNER's interest therein, including applicable insurance.

14.4 Progress payments and retainage shall conform to the following, provided CONTRACTOR'S progress is in accordance with the approved Construction Schedule and the conditions for payment as set forth in this Article.

A. Progress payments covering the first 50 percent of the Work shall be 90 percent of the progress period Work completed and 75 percent of the Products furnished and not incorporated in the Work, but specifically authorized by the OWNER.

B. Progress payments covering the final 50 percent of the Work, at the discretion of the OWNER, may be increased to 100 percent of the progress period Work completed and 75 percent of Products furnished and not incorporated in the Work, but specifically authorized by the OWNER.

C. All payments to the CONTRACTOR by the OWNER, including retainage, shall be in accordance with all laws and regulations applicable to these activities in the state in which the Work is performed.

APPROVAL OF PAYMENT

14.5 CONTRACTOR will prepare monthly payment requests and present them to ENGINEER for recommendation to the OWNER. ENGINEER shall complete review of such requests, make adjustments as deemed appropriate, and forward to the OWNER within ten (10) days of receipt from the CONTRACTOR.

14.6 ENGINEER'S submittal and recommendation of any payment request shall constitute a representation by ENGINEER to OWNER, based on ENGINEER's on-site observations of Work in progress as an experienced qualified professional, that the Work has progressed to the point indicated; that, to the best of ENGINEER's knowledge, information and belief, the quality of the Work is in accordance with the Contract Documents; and that CONTRACTOR is entitled to payment. However, by recommending payment, ENGINEER shall not thereby be deemed to have represented that ENGINEER made exhaustive or continuous on-site inspections to check the quality or the quantity of the Work, or that ENGINEER has reviewed the means, methods, techniques, sequences, and procedures of construction or that ENGINEER has made any examination to ascertain how or for what purpose CONTRACTOR has used the moneys paid or to be paid to CONTRACTOR or that title to any Work, materials, or equipment has passed to OWNER free and clear of any liens.

14.7 OWNER will make payment to CONTRACTOR on monthly requests within 30 days of ENGINEER'S presentation to OWNER.

PAYMENT WITHHELD

14.8 ENGINEER may not recommend any payment or may nullify any payment previously recommended, to such extent as may be necessary to protect OWNER from loss because:

A. Work is defective or completed Work has been damaged requiring correction or replacement.

B. Written claims have been made against OWNER or liens have been filed in connection with the Work.

C. Contract Price has been reduced by Modifications.

D. CONTRACTOR has failed to file receipts for payment of equipment and materials not incorporated in the Work.

E. OWNER has been required to correct Defective Work or complete neglected Work.

F. Unsatisfactory prosecution of the Work, including failure to clean-up or failure to perform testing as required by the Contract Documents.

PARTIAL UTILIZATION

14.9 OWNER shall have the right to take possession of, and use any completed or partially completed portions of the Work prior to completion. The OWNER's possession and use shall not be deemed an acceptance of any Work not completed in accordance with the Contract Documents. Unless otherwise called for in the Contract Documents, CONTRACTOR will be reimbursed for any extra costs or provide an extension of Contract Time for any delays or both which result from Partial Utilization of Work. Special insurance coverage, if required, shall be provided by the OWNER. Upon receipt of a request from OWNER to utilize a portion of the Work, ENGINEER shall:

A. make an inspection and shall prepare a list of items of incomplete and Defective Work remaining for the portion of the Work to be utilized.

B. determine if any extra compensation or time extension is due the CONTRACTOR due to the OWNER'S Partial Utilization of the Work.

SUBSTANTIAL COMPLETION

14.10 When ENGINEER considers that the Work has been substantially but not entirely completed and full completion thereof is materially delayed through no fault of CONTRACTOR, ENGINEER will issue a Certification of Substantial Completion. Liquidated damages for that portion of Work will not be assessed beyond the date of Substantial Completion.

PAYMENT FOR SUBSTANTIAL COMPLETION

14.11 OWNER will, upon Certificate of Substantial Completion by ENGINEER and without terminating the Contract, make payment of the balance due for Work fully completed and accepted. Consent of the Surety shall be submitted by CONTRACTOR to ENGINEER prior to certification of such payment. Such payment shall be made under the terms and conditions governing final payment, except that it shall not constitute a waiver of claims.

NOTIFICATION OF COMPLETION

14.12 When CONTRACTOR considers the Work required in the performance of this Contract to be complete and ready for final inspection, CONTRACTOR shall provide Notice to the ENGINEER.

FINAL INSPECTION

14.13 CONTRACTOR shall serve Notice of completion on ENGINEER who will, within 7 days, schedule the final inspection with OWNER and CONTRACTOR, and will notify CONTRACTOR of incomplete and Defective Work. CONTRACTOR shall remedy such defects immediately and again submit a Notice of completion. Questions regarding quantities for payment will be measured jointly by the CONTRACTOR and ENGINEER.

FINAL PAYMENT

14.14 After CONTRACTOR has remedied all incomplete and Defective Work and delivered documents required by the Contract Documents, CONTRACTOR will prepare a request for final payment. CONTRACTOR shall furnish an executed Affidavit of Completion, in the form set forth in Article 19 of these General Conditions, including consent of the Surety to final payment. In lieu thereof, CONTRACTOR may furnish a Bond satisfactory to OWNER to indemnify OWNER against any lien.

APPROVAL OF FINAL PAYMENT

14.15 If ENGINEER is satisfied that the Work has been completed, and has received CONTRACTOR's Affidavit of Completion, ENGINEER will, within 10 days, issue the Certificate of Completion and present a

recommendation for final payment to the OWNER for approval and payment. If said documentation is satisfactory in form and substance, OWNER shall pay CONTRACTOR within 30 days of receipt thereof.

CONTRACTOR'S CONTINUING OBLIGATION

14.16 The CONTRACTOR's obligation to perform the Work in accordance with the Contract Documents shall be absolute. Recommendation of any progress or final payment by ENGINEER, issuance of a Certificate of Substantial Completion, any payment by OWNER to CONTRACTOR, any use or occupancy of the Work or any part thereof by OWNER, any act of acceptance by OWNER or any failure to do so, or any correction of Defective Work by OWNER shall not constitute an acceptance of Work contrary to the Contract Documents.

14.17 The duties and obligations imposed on CONTRACTOR by these General Conditions, and the rights and remedies available hereunder, and the rights and remedies available to OWNER and ENGINEER hereunder, shall be in addition to, and not a limitation of, any otherwise imposed or available by law, by special guarantee, or other provisions of the Contract Documents.

WAIVER OF CLAIMS

14.18 The making and acceptance of final payment shall constitute:

A. a waiver of all claims by OWNER against CONTRACTOR, except claims arising from unsettled Liens, from Defective Work appearing after final inspection pursuant to this Article or from failure to comply with the Contract Documents. However, it shall not constitute a waiver by OWNER of any rights with respect to CONTRACTOR's continuing obligations under the Contract Documents; and

B. A waiver of all claims by CONTRACTOR against OWNER, except those claims under negotiation, arbitration, or litigation.

14.19 CONTRACTOR'S refusal to accept the final payment as tendered by OWNER shall constitute a waiver of any right to interest thereon.

LIQUIDATED DAMAGES

14.20 OWNER will deduct the amount of any liquidated damages and expenses, calculated in accordance with the Agreement, from moneys due or to become due to CONTRACTOR. If such amount exceeds such unpaid balance, the CONTRACTOR shall pay the difference to the OWNER.

ARTICLE15-SUSPENSION AND TERMINATION

WORK SUSPENSION

15.1 OWNER may order CONTRACTOR to suspend the Work, or any portion thereof, until the reason for such suspension has been eliminated; however, this right shall not give rise to any duty by OWNER to exercise this right for the benefit of CONTRACTOR or any other party.

15.2 OWNER may suspend the Work for the following reasons:

A. Defective Work.

B. CONTRACTOR fails to supply sufficient skilled workmen or suitable Products.

C. CONTRACTOR fails to make prompt payments to Subcontractors or for labor or Products.

D. CONTRACTOR fails to maintain proper insurance, bonds, licenses, or federal, state, or local permits.

OWNER TERMINATION OF WORK

15.3 Upon the occurrence of any one or more of the following events OWNER may, after giving CONTRACTOR and Surety 10 days written Notice of Termination, terminate the services of the CONTRACTOR.

A. CONTRACTOR fails to initiate and diligently proceed with the Work.

B. CONTRACTOR is adjudged bankrupt or insolvent.

C. CONTRACTOR makes a general assignment for the benefit of creditors.

D. a trustee or receiver is appointed for CONTRACTOR or for any of CONTRACTOR's property.

E. CONTRACTOR files a petition to take advantage of any debtor's act, or to reorganize under the bankruptcy or similar laws.

F. CONTRACTOR repeatedly fails to supply sufficient skilled workmen or suitable Products.

G. CONTRACTOR repeatedly fails to make prompt payments to Subcontractors or for labor or Products.

H. CONTRACTOR disregards laws, ordinances, rules, regulations or orders of any public body having jurisdiction.

I. CONTRACTOR disregards the authority of the ENGINEER.

J. CONTRACTOR otherwise violates any provisions of the Contract Documents.

OWNER COMPLETION OF WORK ON TERMINATION:

15.4 If the Surety does not resume performance of the Work within 10 days after Notice of Termination is received from OWNER, OWNER shall have the absolute right to complete the Work in the most expeditious manner and shall have the right to exclude CONTRACTOR from the Site and take possession of the Work and of all CONTRACTOR's tools, appliances, equipment and machinery at the Site and use the same without liability to CONTRACTOR for trespass or conversion. OWNER may incorporate in the Work all Products for which OWNER has paid CONTRACTOR but which are stored elsewhere. In such case CONTRACTOR shall not be entitled to receive any further payment until the Work is finished. If the balance due to CONTRACTOR at the time of termination exceeds the direct and indirect costs of completing the Work, including compensation for additional engineering services, attorney's fees, technical services and administrative costs, such excess shall be paid to CONTRACTOR. If such costs exceed such unpaid balance, CONTRACTOR shall pay the difference to OWNER. Such costs incurred by OWNER shall be verified by ENGINEER and incorporated in a Change Order, but in finishing the Work OWNER shall not be required to obtain the lowest cost for the remaining portion of the Work performed.

OWNER'S ADDITIONAL TERMINATION RIGHTS

15.5 Where CONTRACTOR's services have been terminated by OWNER, said termination shall not affect any rights of OWNER against CONTRACTOR then existing or which may thereafter accrue. Any retention due or payment of money by OWNER to CONTRACTOR shall not release CONTRACTOR from liability.

OWNER'S TERMINATION FOR CONVENIENCE

15.6 Upon 10 days' written Notice to CONTRACTOR, Surety and ENGINEER, OWNER may, without cause and without prejudice to any other right or remedy, elect to abandon the Work and terminate the Contract. In such case, CONTRACTOR will be paid for Work executed and expense sustained plus a reasonable profit.

CONTRACTOR'S CONTINUING WORK DURING DISPUTES

15.7 CONTRACTOR shall carry on the Work and maintain the Construction Schedule during all disputes or disagreements with OWNER. No Work shall be delayed or postponed pending resolution of any disputes or disagreements, except as CONTRACTOR and OWNER may otherwise agree.

CONTRACTOR MAY STOP WORK OR TERMINATE

15.8 If, through no act or fault of CONTRACTOR, the Work is suspended for a period of more than 90 days by the OWNER or by an order of court or other public authority, or OWNER fails to pay CONTRACTOR any sum recommended by ENGINEER within 90 days of its presentation, then CONTRACTOR may, upon 10 days' written Notice to OWNER, terminate this Contract and recover from OWNER payment for all Work executed and any expense sustained plus a reasonable profit. In lieu of terminating the Contract, CONTRACTOR may, upon 10 days' notice to OWNER, stop the Work until CONTRACTOR has been paid amounts then due.

ARTICLE 16-ARBITRATION

16.1 In the event that a claim, dispute or other question arises relating to the Contract Documents, except claims which have been waived by the making or acceptance of final payment or claims not subject to arbitration under applicable law, OWNER and CONTRACTOR may, by mutual agreement, submit the claim, dispute or matter to arbitration. In the event the parties agree to arbitration, the right to proceed to arbitration shall be subject to the terms and conditions in this Article.

16.2 The parties must agree on the specific claims, disputes or matters to be arbitrated. The written arbitration submission shall state the nature and circumstances surrounding the claim or dispute, state the amount claimed or relief sought, and the specific supporting provisions relied upon in the Contract Documents. The scope of the arbitration shall be strictly limited to matters defined in the arbitration submission.

16.3 Once the arbitration submission has been signed by both parties, it shall be submitted to the American Arbitration Association which shall proceed to process the case in accordance with the Construction Industry Arbitration Rules, except to the extent that the same have been modified by this Article and the arbitration submission.

16.4 The arbitration panel shall consist of one Professional Engineer or Architect, one Contractor, and one Attorney selected in accordance with the applicable rules of the American Arbitration Association. In lieu of the appointment of an Arbitration Panel to settle an existing claim or dispute, OWNER and CONTRACTOR may agree upon a permanent arbitrator or Arbitration Panel to decide all claims, disputes, and other matters relating to the Contract Documents.

16.5 The arbitrator or Arbitration Panel shall apply the terms and conditions of the Contract Documents to the claim, dispute or matter submitted to it and shall base its decision on said Contract Documents.

16.6 The arbitrator's or Arbitration Panel's decision shall be set forth in writing, shall state the decision on each claim, dispute or matter submitted, and the reason for each decision.

16.7 Once a written arbitration submission has been executed, the agreement to arbitrate shall be specifically enforceable under the prevailing arbitration law. The arbitration award rendered by the arbitrator(s) shall be final and judgment may be entered upon it in any court having jurisdiction thereof.

16.8 During the pendency of the arbitration proceedings, CONTRACTOR covenants and agrees that CONTRACTOR shall continue to proceed with the Work required pursuant to the Contract Documents. In the event that CONTRACTOR is terminated by OWNER at any time prior to the issuance of the arbitrator's or Arbitration Panel's written decision, or if CONTRACTOR fails to proceed with the Work during the pendency of the arbitration proceedings, OWNER shall be entitled to obtain a court order enjoining the continuance of said arbitration proceedings by reason of such action.

ARTICLE 17-MISCELLANEOUS

17.1 Whenever any provision of the Contract Documents requires the giving of Notice, it shall be deemed to have been validly given, if delivered in person to the individual or to a member of the firm or to an officer of the corporation for whom it is intended, or if sent by certified mail or commercial carrier, with provision for receipt acknowledgement, to the last business address known to party who gives the Notice. Notice may also be made by facsimile transmission. In such case, Notice will be deemed received when the transmission is made. The party making such facsimile transmissions shall also forward a copy of such Notice by regular mail.

17.2 If any section, paragraph, clause or provision of the Contract Documents shall be held invalid, the invalidity of such section, paragraph, clause or provision shall not affect any of the other provisions of the Contract Documents. The Article and paragraph headings in the Contract Documents are furnished for convenience of reference only and shall not be considered to be a part of the Contract Documents.

ARTICLE 18-RESIDENT PROJECT REPRESENTATIVE

GENERAL

18.1 Resident Project Representative is ENGINEER's Agent under the supervision of ENGINEER in matters pertaining to the on-site Work. Dealings with Subcontractors shall be through, or with knowledge of, CONTRACTOR.

DUTIES AND RESPONSIBILITIES

18.2 Resident Project Representative will:

A. Review the Construction Schedule, schedule of Shop Drawing submissions, and Schedule of Values prepared by CONTRACTOR, and consult with ENGINEER concerning their acceptability.

B. Attend preconstruction conferences, progress meetings, and other job conferences; chair meetings and maintain and circulate copies of minutes and notices thereof.

C. Serve as ENGINEER's liaison with CONTRACTOR, principally through with CONTRACTOR's Superintendent. Assist ENGINEER as OWNER's liaison when CONTRACTOR's operations affect OWNER's on-site operations.

D. Assist ENGINEER in obtaining from OWNER additional details or information when required for proper execution of the Work.

E. Receive Shop Drawings, Product Data and samples, submittals, and receive samples delivered at the site for ENGINEER's examination.

F. Advise ENGINEER and CONTRACTOR immediately of the commencement of any Work requiring a Shop Drawing of sample submission if the submission has not been approved by ENGINEER.

G. Conduct on-site observations of the Work to assist ENGINEER in determining compliance with the Contract Documents.

H. Report to ENGINEER whenever it appears that any portion of the Work does not conform to the Contract Documents or has been damaged prior to final payment; and advise ENGINEER when it appears any portion of the Work should be uncovered for observation or requires special testing, inspection or approval.

I. Verify that required tests, equipment and systems startups, and operating and maintenance instructions are conducted in the presence of required personnel, and that CONTRACTOR maintains adequate records thereof; observe, record and report to ENGINEER details of test procedures, startups, inspections, and operating and maintenance instructions.

J. Accompany inspectors representing public or other agencies having jurisdiction on the Project; record and report to ENGINEER on the outcome of these inspections.

K. Transmit to CONTRACTOR, ENGINEER's clarifications and interpretations of the Contract Documents.

L. Consider and evaluate CONTRACTOR's suggestions for modifications in Drawings or Specifications and report them with recommendations to ENGINEER.

M. Maintain at the Site orderly files for correspondence, reports of job conferences, Shop Drawings, Product Data and samples submissions, reproductions of original Contract Documents, including all

Addenda, Change Orders, additional Drawings, ENGINEER's clarifications and interpretations of the Contract Documents, progress reports, and other Project related documents.

N. Maintain a log book, recording hours on the Site, weather conditions, data relative to extras or deductions, list of visiting officials and representatives of manufacturers, fabricators, suppliers and distributors, daily activities, decisions, and general and specific observations of test procedures.

O. Consult with ENGINEER relative to scheduled major tests, inspections or start of critical phases of the Work.

P. Report accidents immediately to ENGINEER.

Q. Review applications for payment with CONTRACTOR and forward them with recommendations to ENGINEER, noting relation to the Schedule of Values, Work completed, and payment for materials and equipment not incorporated in the Work.

R. During the course of the Work, verify that certificates, maintenance and operation manuals, and other data required to be assembled and furnished by CONTRACTOR are applicable to the items actually installed; and that this material is delivered to ENGINEER for review and forwarding to OWNER prior to final acceptance of the Work.

S. Prior to, and as a condition of, recommending to ENGINEER issuance of a Certificate of Substantial Completion, Resident Project Representative will:

1. Prepare a list of incomplete or Defective Work.

2. Verify that all items required for Substantial Completion have been corrected or completed.

3. Secure agreement between OWNER and CONTRACTOR relative to responsibilities for utilities, heat, janitorial services, insurance, Project security, access by the parties, safety and any other matters.

4. Secure CONTRACTOR's specific Construction Schedule to fully complete the Work.

T. Conduct final inspection with ENGINEER, OWNER and CONTRACTOR and prepare a final list of items to be completed or corrected.

U. Verify that all items on final list have been completed or corrected and make recommendations to ENGINEER concerning acceptance.

LIMITATIONS OF AUTHORITY

18.3 Resident Project Representative shall not guarantee or warrant CONTRACTOR's Work. Except upon written instructions of ENGINEER, Resident Project Representative shall not:

A. Authorize any deviation from the Contract Documents or approve any substitute Products.

B. Exceed limitations on ENGINEER's authority as set forth in the Contract Documents.

C. Undertake any of the responsibilities of CONTRACTOR, Subcontractors or CONTRACTOR's Superintendent, or expedite the Work.

D. Advise on, or issue directions relative to, any aspect of the means, methods, techniques, sequences or procedures of construction unless such is specifically called for in the Contract Documents.

E. Advise on, or issue directions as to, safety precautions and programs in connection with the Work.

F. Authorize OWNER to occupy the Project in whole or in part.

G. Participate in specialized field or laboratory tests.

These Supplemental Conditions amend or supplement the General Conditions and other provisions of the Contract Documents as indicated below. All provisions which are not so amended or supplemented remain in full force and effect.

The terms used in these supplemental Conditions will have the meanings indicated in the General Conditions. Additional terms used in these Supplemental Conditions have the meanings indicated below, which are applicable to both the singular and plural thereof.

ARTICLE 4 – LANDS AND CONTROLS

AVAILABILITY OF LANDS

Add the following new paragraphs immediately after paragraph 4.2:

This Contract shall be subject to the provisions of the Baughman Drain Land Owner Agreement Form, being one (1) page in length and being incorporated herein, in its entirety, by reference.

The Baughman Drain Land Owner Agreement Form shall be filled out and submitted to the Engineer prior to accessing the Drain or completing work outside of the Drain easement.

This Contract shall be subject to the provisions of the Baughman Drain Easement Special Provisions as incorporated herein. Contractor shall adhere to the provisions as described in said document.

BAUGHMAN DRAIN
LANDOWNER AGREEMENT FORM

Property Owner(s): _____

Address: _____

Parcel No: _____

Impacted County Drain: Baughman Drain

Request Permission To: _____

_____

_____

_____

_____

_____

I (we) certify, as applicant(s), we are the legal owners of the property stated above.

As such, I (we) hereby authorize _____, as the Contractor for the Baughman Drain – Div. II construction project to temporarily utilize our property to complete the scope of work indicated above.

I (we) understand that the requested work is beyond the scope of said Drain project. We agree to waive any and all damages or claims against the North Point Drain Drainage District arising from work performed by said Contractor.

_____ _____
Owner's Signature Date

_____ _____
Contractor's Signature Date

BAUGHMAN DRAIN – EASEMENT SPECIAL PROVISIONS

Tax ID	Address	Name	Description
17-027-002-80	1662 Sycamore Street	John & Karin Caston	Upon completion of construction, the drainage infrastructure located on the property shall be located underground. The Drainage District's access rights on Property shall be restricted to the Drain Easement Area and shall not include rights to traverse the Property outside the Drain Easement Area. The Drainage District shall coordinate with Landowners regarding removal of trees on the Property. The Drainage District, in its sole discretion, shall only remove those trees necessary for the establishment, construction, operation, maintenance and improvement of the Drain.
17-027-002-16	396 Briarwood Street	Bruce & Connie Meles	The Drainage District shall coordinate with Landowner regarding removal of trees on the Property and provide advance notice of which trees shall be removed within the Drain Easement Area. The Drainage District, in its sole discretion, shall only remove those trees necessary for the establishment, construction, operation, maintenance and improvement of the Drain. Notwithstanding the above, Landowner shall have the right to maintain and replace an irrigation pump and water and electric lines for the purpose of operating a sprinkler system ("Sprinkler System") within the Drain Easement Area. Landowner shall be responsible for repairing or replacing the Sprinkler System.
17-580-006-00	1624 Elm Street	Joshua Dale	Per email conversation - Property owner would like to keep all adequately sized wood for burning. 15-20' max log length, stacked on the house side of the drain. Prop owner to mark his septic field to avoid.
17-027-002-30	1688 Sycamore Street	Thomas & Darcy Pavlack	The Drainage District shall coordinate with Landowners regarding removal of trees on the Property. The Drainage District, in its sole discretion, shall only remove those trees necessary for the establishment, construction, operation, maintenance and improvement of the Drain.
17-027-002-31	1689 Sycamore Street	Thomas & Darcy Pavlack	The Drainage District shall coordinate with Landowners regarding removal of trees on the Property. The Drainage District, in its sole discretion, shall only remove those trees necessary for the establishment, construction, operation, maintenance and improvement of the Drain.
17-027-002-15	376 Briarwood	Todd & Melissa Harrington	Notwithstanding the above, Landowner shall have the right to maintain and replace the driveway within the easement area.
17-580-034-00	1644 Sycamore	Elton & Romilda Goswick	No heavy construction equipment (i.e. excavators, bulldozers, etc.) shall be allowed east of the easterly top of bank without written permission from the property owner.
17-027-002-63	Prairiewood Dr (farm parcel, no street address)	Deyoung Farmland, LLC	The Drainage District acknowledges that at certain locations within the Drain Easement Area buried irrigation lines and private electric lines that serve them ("Crossings"). The approximate locations of these Crossings are indicated and labeled in Exhibit A. The Drain to be located within the Drain Easement Area shall be constructed, maintained and operated in manner that will not interfere or damage the irrigation or electric lines within the Crossings. Drainage District shall restore any irrigation or electric lines within the Crossings that are damaged due to Drainage District's construction, maintenance or operation of the Drain at the Crossings. Landowner shall not construct any additional Crossings without the advance written approval of the Drainage District.
17-580-009-00	1636 Elm Street	Christine Boyett	Neither heavy construction equipment (i.e. excavators, bulldozers, etc.) nor excavation shall be allowed north of the northerly top of bank without written permission from the property owner due to the presence of the existing septic drain field within the easement area.
17-027-002-80	1662 Sycamore Street	John & Karin Caston	Upon completion of construction, the drainage infrastructure located on the property shall be located underground. The Drainage District's access rights on Property shall be restricted to the Drain Easement Area and shall not include rights to traverse the Property outside the Drain Easement Area. The Drainage District, in its sole discretion, shall only remove those trees necessary for the establishment , construction, operation, maintenance and improvement of the Drain.
17-580-004-00	1616 Elm Street	Jill Wallace	No spoil or excavated materials shall be placed in the Drain Easement without consent from the Landowner

ARTICLE 5 – BONDS AND INSURANCE

Add the following new paragraphs immediately after paragraph 5.2.:

5.3 This insurance shall be written for the following minimum limits of liability and shall have an endorsement covering all CONTRACTOR'S obligations under the Contract Documents:

A. Worker's Compensation & Employer's Liability Insurance:

Worker's Compensation	Statutory
Employer's Liability	$500,000

B. Comprehensive General Liability (personal injury, bodily injury and property damage) - covering premises; underground, explosion and collapse hazard; products completed operations; independent contractors' property damage; personal injury and blanket broad form contractual liability.

General Aggregate	$2,000,000
Each Occurrence	$1,000,000

This Policy must include coverage for the liability assumed by the CONTRACTOR under the indemnity provisions of the Contract.

C. Automobile Liability Insurance (bodily injury and property damage) - covering all owned, hired and non-owned automobile equipment.

Combined Single Limit	$1,000,000

Coverage will also comply with all applicable automobile statutes and no-fault laws.

Comprehensive General Liability and Comprehensive Automobile Liability Insurance may be arranged under a single policy for the full limits required or a combination of underlying policies with the balance provided by an Excess or Umbrella Liability Policy.

OWNER'S LIABILITY INSURANCE

5.4 CONTRACTOR shall obtain Owner's Protective liability insurance in the name of OWNER and ENGINEER as agent for OWNER, with such provisions as will protect OWNER and ENGINEER from contingent liability under this Contract, and shall maintain and pay the premiums of such insurance. The amounts of coverage shall be the same as CONTRACTOR's liability insurance requirements in this Article.

CERTIFICATE OF INSURANCE:

5.5 Before commencing performance of Contract, CONTRACTOR shall furnish the OWNER with Certificates of Insurance evidencing:

A. Owner Allegan County Drain Commissioner shall be listed as Certificate Holder.

B. The following shall be listed as additional insured:
1. Allegan County Drain Commissioner
2. Land and Resource Engineering
3. Allegan County Road Commission
4. Otsego Township
5. People of the State of Michigan

C. Insurer(s) affording coverage, acceptable to the OWNER.

D. Effective and expiration dates of policies.

E. That the OWNER will be given 30 days written notice of any cancellation, non-renewal or material change in any policy.

F. That the Contractual Liability Endorsement has been included in Comprehensive General Liability policy.

G. Any deductibles and/or self-insured retentions.

H. Any exclusions to policies which are not part of the standard form.

SECTION 01270 MEASUREMENT AND PAYMENT

PART 1 - GENERAL

1.01 SECTION INCLUDES:

A. Measurement and payment criteria applicable to the Work.

1.02 AUTHORITY:

A. Measurement methods delineated in the individual specification sections are intended to complement the criteria of this section.

B. The ENGINEER will take all measurements and compute quantities accordingly.

C. Assist by providing necessary equipment, Workers, and survey personnel as required.

1.03 UNIT QUANTITIES SPECIFIED:

A. Quantities and measurements indicated in the Bid Form are for bidding and contract purposes only. Quantities and measurements supplied or placed in the Work and verified by the ENGINEER shall determine payment.

B. If the actual Work requires more or fewer quantities than those quantities indicated, provide the required quantities at the unit prices contracted.

1.04 MEASUREMENT OF QUANTITIES:

A. Measurement Devices:
1. Weigh Scales: Inspected, tested and certified.
2. Platform Scales: Of sufficient size and capacity to accommodate the conveying vehicle.
3. Metering Devices: Inspected, tested and certified.

B. Measurement by Weight: Concrete reinforcing steel, rolled or formed steel or other metal shapes will be measured by handbook weights. Welded assemblies will be measured by handbook weights.

C. Measurement by Volume: Measured by cubic dimension using mean length, width and height or thickness.

D. Measurement by Area: Measured by square dimension using mean length and width or radius.

E. Linear Measurement: Measured by linear dimension, at the item centerline.

1.05 PAYMENT:

A. Payment Includes: Full compensation for all required labor, products, tools, equipment, plant, transportation, services and incidentals; erection, application or installation of an item of the Work; overhead and profit.

B. Final payment for Work governed by unit prices will be made on the basis of the actual measurements and quantities accepted by the ENGINEER multiplied by the unit price for Work which is incorporated in or made necessary by the Work.

1.06 MEASUREMENT AND PAYMENT SCHEDULE:

A. The following schedule outlines the method of measurement and basis of payment to be used on this project. Requirements for materials and methods described under each unit price are included in the specification sections.

1. Mobilization (5% Max):
   a. Includes the following as indicated on the drawings and in accordance with the specifications:
      i. Preparatory Work and expenses incurred prior to beginning Work onsite.
      ii. Transporting material, personnel and equipment to the jobsite.
      iii. Establishing temporary onsite construction facilities including traffic control.
      iv. Insurances, bonding and other costs associated with the project in general and not included in any other pay items.
   b. Unit of Measure:
      i. Lump Sum limited to 10% of the bid total.
      ii. 50% payment will be made after 5% of the original contract amount is earned.
      iii. 50% will be made after 25% if the contract amount is earned.

2. Utility Coordination:
   a. Includes the following as indicated on the drawings and in accordance with the specifications:
      i. Furnishing all labor, materials and equipment as necessary to excavate in vicinity of proposed drain location ahead of the progress of Work to locate existing underground utilities.
      ii. Coordinating the removal, replacement, or relocation of utilities with the service provider or property owner as required to complete the Work.
   b. Unit of Measure: Lump Sum.

3. Traffic Control:
   a. Includes the following as indicated on the Drawings and in accordance with the specifications:
      i. Furnishing all labor, materials, and equipment as necessary to complete the Work.
      ii. Traffic control devices including barricades, barrels and signage as directed by the ENGINEER, OWNER or Allegan County Road Commission.
      iii. Maintaining access to residential driveways.
      iv. Maintaining one access lane at all times for emergency vehicles.
   b. Unit of Measure: Lump Sum.

4. Silt Fence:
   a. Includes the following as indicated on the Drawings and in accordance with the Specifications:
      i. Furnishing all labor, materials and equipment as required to complete the Work.
      ii. Installing, maintaining and removal of silt fence in accordance with Allegan County SESC standards.
      iii. Cleanup and maintenance of the Work in the finished condition until final acceptance.
   b. Unit of Measure: Linear Foot

5. 12-inch Storm Sewer, Perforated:
   a. Includes the following as indicated on the Drawings and in accordance with the Specifications:
      i. Furnishing all labor, materials and equipment as necessary to complete the Work.
      ii. Clearing, grubbing and snagging the drain right of way as necessary to access and complete the Work.
      iii. Remove and dispose of surface improvements including but not limited to bituminous pavement and driveways as required for completing the Work.
      iii. Dewatering as necessary to install storm sewer and all appurtenances, including but not limited to use of wells, portable pumps, temporary underdrains, crushed stone or other methods as necessary.
      Iv. Bracing or sheeting of trench or pit(s), temporary support adjacent to utilities, structures and other miscellaneous items necessary for installation.
      v. Furnish and install storm sewer and all appurtenances.
      vi. Excavate, backfill, and compact trench.
      vii. Cleanup and maintenance of the Work in the finished condition until final acceptance.
   b. Unit of Measure: Linear Foot of storm sewer as measured along the centerline of the survey stationing indicated on the Drawings.

6. 4-foot Diameter Catch Basin:
   a. Includes the following as indicated on the Drawings and in accordance with the Specifications:
      i. Furnishing all labor, materials and equipment as necessary to complete the Work.
      ii. Dewatering as necessary to install drainage structure and all appurtenances, including but not limited to use of wells, portable pumps, temporary underdrains, crushed stone or other methods as necessary.
      iii. Clearing, excavating, dewatering, bedding and backfilling.
      Iv. Bracing or sheeting of trench or pit(s), temporary support adjacent to utilities, structures and other miscellaneous items necessary for installation.
      v. Furnish and install drainage structure and appurtenances.
      vi. Adjust casting to finish grade.
      vii. Provide resilient connector between pipe and drainage structure for all pipe diameters less than or equal to 24-inch.
      viii. Cleanup and maintenance of the Work in the finished condition until final acceptance.
   b. Unit of Measure: Each.

7. Storm Sewer Restoration
   a. Includes the following as indicated on the Drawings and in accordance with the Specifications:
      i. Furnishing all labor, materials and equipment as required to complete the Work.
      ii. Salvaging, stockpiling, replacing and grading existing topsoil.
      iii. Placing seed and straw mulch along storm sewer alignment and all other disturbed areas.
      iv. Cleanup and maintenance of the Work in the finished condition until final acceptance.
   b. Unit of Measure: Linear foot as measured along the storm sewer centerline from end of pipe to end of pipe and centerline of drainage structure.

8. Roadway Restoration:
   a. Includes the following as indicated on the Drawings and in accordance with the Specifications:
      i. Furnishing and/or installing all labor, materials and equipment as necessary to complete the Work.
      ii. Sawcuting, removing and disposing of existing bituminous pavement as necessary to complete the Work.
      iii. Removal and disposal or salvaging (as indicated on plans) of existing storm sewers, culverts or bridges and surface improvements, including but not limited to asphalt pavement, curb and gutter, and signage.
      iv. Cutting, filling, shaping, grading, compacting, or otherwise preparing a finished subgrade, sand subbase and aggregate base.
      v. Furnishing, placing and compacting bituminous base and top course mixtures.
      vi. Spreading topsoil stripped during grading adjacent to roadway.
      vii. Restoration of all other disturbed areas with seed and straw mulch.
      viii. Cleanup and maintenance of the Work in the finished condition until final acceptance.
   b. Unit of Measure: Linear Foot of roadway as measured along the centerline of the survey stationing indicated on the Drawings.

9. Site Restoration:
   a. Includes the following as indicated on the Drawings and in accordance with the Specifications:
      i. Furnishing all labor, materials and equipment as required to complete the Work.
      ii. Remove, salvage, and/or replace structures including but not limited to fences, sheds, trampolines, underground sprinkling, etc. as necessary to complete the Work.
      iii. Cleanup and maintenance of the Work in the finished condition until final acceptance.
   b. Unit of Measure: Lump Sum.

SECTION 01330 SUBMITTAL PROCEDURES

PART 1-GENERAL

1.01 CONSTRUCTION SCHEDULES:

A. General:
1. Coordinate with work by others as explained in the General Conditions
2. CONTRACTOR shall notify the ENGINEER 72 hours prior to start of work or a major increase in the work force if these vary from schedule as submitted.

B. Form of Schedules:
1. CONTRACTOR shall prepare and submit a construction schedule in an acceptable format to the OWNER and ENGINEER.

C. Content of Schedules:
1. The construction project schedule shall include as a minimum:
a. Project start date.
b. Start dates and durations for each major trade group, work tasks or other subdivisions of the work.
c. Shop drawings, product data, and sample submittal dates and dates when reviewed copies will be required.
d. Equipment and/or material delivery dates if approved.
e. Total project duration and end date.

D. Updating:
1. Show all occurring changes of previous submission.
2. Show progress completion dates of each activity.
3. Submit a narrative report, if required by ENGINEER defining:
a. Problem areas: Impact of current and anticipated delay factors.
b. Schedule changes: Effect on other contractors.
c. Revision description: Effect of change of scope and duration of activities.

E. Submittal of Schedules:
1. The CONTRACTOR shall submit the initial detailed construction schedule within seven (7) days after the notice of award. ENGINEER will return copy within ten (10) days of receipt. The resubmittal, if required, shall be within (10) days.
2. An updated schedule shall be submitted on the first work day of each month.

F. Distribution:
1. The reviewed schedule shall be distributed by ENGINEER to:
a. The job site file.
b. OWNER.

1.02 SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES:

A. General:
1. Where required by the specifications, the CONTRACTOR shall submit descriptive information which will enable the ENGINEER to advise the OWNER whether the CONTRACTOR's proposed materials, equipment, or methods of work are in general conformance to the design concept and in compliance with the drawings and specifications. The information to be submitted shall consist of drawings, specifications, descriptive data, certificates, samples, test results and such other information, all as specifically required in the specifications.

B. CONTRACTOR Responsibility:
1. CONTRACTOR shall be responsible for the accuracy and completeness of the information contained in each submittal and shall assure that the material, equipment or method of work shall be as described in the submittal. The CONTRACTOR shall verify that the material and equipment described in each submittal conform to the requirements of the specifications and drawings. If the information shows deviations from the specifications or drawings, the CONTRACTOR shall insure that there is no conflict with other submittals and notify the ENGINEER in each case where his submittal may affect the work of another

CONTRACTOR or the OWNER. The CONTRACTOR shall insure coordination of submittals among the related crafts and subcontractors.

2. The CONTRACTOR shall be responsible to check and verify all field measurements, all dimensions on shop and setting drawings and all schedules required for the work of all the various trades.
3. The CONTRACTOR may authorize in writing a material or equipment supplier to deal directly with the ENGINEER or with the OWNER with regard to a submittal. These dealings shall be limited to contract interpretations.
4. The CONTRACTOR shall stamp each submittal with stamp, initialed and signed, certifying to review of the submittal by the CONTRACTOR, verification of field measurements and compliance with Contract Documents.

C. Transmittal Procedure:
1. General:
   a. Submittals shall be submitted promptly in accordance with dates in proposals, approved schedules and in such sequence that there is no delay in the Work or the work of any other CONTRACTOR.
   b. Submittals regarding material and equipment shall be accompanied by the attached Transmittal Form identifying the equipment and any variations from these specifications. A separate form shall be used for each specific item, class of material, equipment, and items specified in separate, discrete sections, for which the submittal is required. Submittals for various items shall be made with a single form when the items taken together constitute a manufacturer's package or are so functionally related that expediency indicates checking or review of the group or package as a whole
   c. A unique number, sequentially arranged, shall be noted on the transmittal form accompanying each item's submittal. Original submittal numbers shall have the following format "XXX-Y:; where "XXX is the originally assigned submittal number, and "Y" is a sequential letter assigned for resubmittals, i.e., A, B, or C being the 1st, 2nd and 3rd resubmittals, respectively. Submittal 25-B, for example, is the second resubmittal of submittal 25.
2. Deviation From Contract:
   a. If the CONTRACTOR proposed to provide material or equipment which does not conform to the specifications and drawings, he shall indicate so under "deviations" on the transmittal form accompanying the submittal copies. He shall prepare his reason for a change, including cost differential, and request a change order to cover the deviations.
3. Submittal Completeness:
   b. Submittals which do not have all the information required to be submitted, including deviations, are not acceptable and will be returned without review.

D. Review Procedure:
1. When the contract documents require a submittal, the CONTRACTOR shall submit five (5), and no more than eight (8), copies of all submittal data of which two (2) copies will be retained by the ENGINEER. For samples this number may vary. For samples, submit the number stated in each specifications section.
2. Unless otherwise specified, within 14 calendar days after receipt of the submittal, the ENGINEER shall review the submittal and return a minimum of three (3) copies which carry the ENGINEER's stamp of approval. The returned submittal shall indicated one of the following actions:
   a. If the review indicates that the material, equipment or work method is in general conformance with the design concept and complies with the drawings and specifications, submittal copies will be marked "FURNISH AS SUBMITTED". In this event the CONTRACTOR may begin to implement the work method or incorporate the material or equipment covered by the submittal.
   b. If the review indicates limited corrections are required, submitted copies will be marked "FURNISH AS CORRECTED". The CONTRACTOR may begin implementing the work method by the submittal in accordance with the noted corrections. Where submittal information will be incorporated in O&M data, a corrected copy shall be provided.

c. If the review reveals that the submittal is insufficient or contains incorrect data, submitted copies will be marked "REVISE AND RESUBMIT". Except at his own risk, the CONTRACTOR shall not undertake work covered by this submittal until it has been revised, resubmitted and returned marked either "FURNISH AS SUBMITTED" or "FURNISH AS CORRECTED".

d. If the review indicates that the material, equipment or work method is not in general conformance with the drawings and specifications, copies of the submittal will be marked "REJECTED". Submittals with deviations which have not been identified clearly may be rejected. Except at his own risk the CONTRACTOR shall not undertake the work covered by such submittals until it has been revised, resubmitted and returned marked either "FURNISH AS SUBMITTED" or "FURNISH AS CORRECTED".

e. If the review indicates that the material or equipment is not from an acceptable manufacturer, as indicated in the specifications, copies of the submittal will be marked "SUBMIT SPECIFIED ITEM". Except as his own risk, the CONTRACTOR shall not undertake the work covered by such submittals until it has been revised, resubmitted and returned marked either "FURNISH AS SUBMITTED" or "FURNISH AS CORRECTED".

E. Effect of Review of CONTRACTOR's Submittal:

1. Review of drawings, methods of work, or information regarding materials or equipment the CONTRACTOR proposes to provide, shall not relieve the CONTRACTOR of his responsibility for errors therein and shall not be regarded as an assumption of risks or liabilities by the ENGINEER or the OWNER, or by an officer or employee thereof, and the CONTRACTOR shall have no claim under the contract on account of the failure, or partial failure, of the method of work, material, or equipment so reviewed. A mark of "FURNISH AS SUBMITTED" or "FURNISH AS CORRECTED" shall mean that the OWNER has no objection to the CONTRACTOR, upon his own responsibility, using the plan or method of work proposed, or providing the materials or equipment proposed.

1.03 RECORD DOCUMENTS:

A. Requirements:

1. The CONTRACTOR shall maintain on the construction site a minimum of one (1) complete set of contract documents amended by "RED LINE" or highlight inclusion to reflect the most immediate status methods, materials, and locations and routings of construction. Supplementary sketches shall be included, if necessary, to clearly indicate all work as constructed.
2. At conclusion of work, the CONTRACTOR shall submit to the ENGINEER one (1) complete amended record set of these site documents.
3. Submittal shall be thirty (30) days prior to final payment.
4. Failure of the CONTRACTOR to maintain an up-to-date set of modified drawings on the project site shall be reason to withhold payments.

SECTION 01410 REGULATORY REQUIREMENTS

PART 1-GENERAL

1.01 SUMMARY:

A. This Section includes provisions for requirements and fees of regulatory agencies.

B. The General Conditions requires that Contractor obtain and pay for all construction permits. This Section includes provisions for specific permits but does not include all permits.

1.02 PERMITS:

A. Highway, Road or Street:
1. Work performed and operations of Contractor within the limits of rights-of-way shall fulfill the requirements of the authority having jurisdiction over and control of the rights-of-way.
2. Owner will obtain permits to occupy and maintain the utility in the rights-of-way, but contractor shall obtain permits to perform construction and shall furnish necessary insurance and bonds required by the authority.
3. Contractor shall obtain a written release from the authority having jurisdiction stating that all repairs within said rights-of-way have been completed to their satisfaction prior to final acceptance to Owner.

B. Soil Erosion and Sedimentation Control (Part 91, Act 451, PA 1994)
1. The Allegan County Drain Commissioner is an Authorized Public Agency (APA) and a separate SESC permit is not required.
2. CONTRACTOR shall comply with the requirements and conditions of the APA.

NOTICE OF AUTHORIZATION

Permit Number: WRP040142 v. 1 **Date Issued: January 25, 2024**
Site Name: 03-Baughman Drain-Otsego **Expiration Date: January 25, 2029**

The Michigan Department of Environment, Great Lakes, and Energy (EGLE), Water Resources Division, P.O. Box 30458, Lansing, Michigan 48909-7958, under provisions of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended; specifically:

☐ Part 31, Floodplain Regulatory Authority of the Water Resources Protection.

☒ Part 301, Inland Lakes and Streams.

☐ Part 303, Wetlands Protection.

Authorized activity:

Install turbidity curtain prior to in-water work. Expand the existing Baughman Drain by including three new branches of the Baughman Drain:
•Branch 1: Dredge approximately 308 cubic yards of stream bottomland in two areas: one area approximately 3050 feet long, 0.9 foot wide, and 1.5 feet deep, and one area approximately 470 feet long, 5.98 feet wide, and 1.5 feet deep. Place filter fabric and approximately 92 cubic yards of 8"-16" MDOT Plain riprap in approximately 1620 square feet of the bottomland to a maximum depth of 1.5 feet. Remove two existing culverts and replace one existing culvert with a circular plastic culvert that is a minimum diameter of 4 feet and a maximum length of 160 feet, burying the culvert approximately 6 inches in stream bottomland. Install a tile with a 12-inch diameter outfall in the bottomland of Branch 1.
•Branch 2: Dredge approximately 449 cubic yards of stream bottomland in an area approximately 1900 feet long, 4.9 feet wide, and 1.3 feet deep. Place filter fabric and approximately 80 cubic yards of 8"-16" MDOT Plain riprap in approximately 1385.5 square feet of the bottomland to a maximum depth of 1.5 feet. Remove 3 existing culverts and replace with circular plastic culverts that are a maximum diameter of 4 feet and a maximum length of 80 feet; each culvert shall be buried approximately 6 inches in stream bottomland. Install a tile with a 12-inch diameter outfall in the bottomland of Branch 2.
•Branch 3: Dredge approximately 205 cubic yards of stream bottomland in an area approximately 1140 feet long, 2.70 feet wide, and 1.8 feet deep. Place filter fabric and approximately 5 cubic yards of riprap in approximately 90 square feet of the stream bottomland to a maximum depth of 1.5 feet.
All work shall be completed in accordance with the attached plans and the terms and conditions of this permit.

To be conducted at property located in: Allegan County, Waterbody: Baughman Drain, tributaries
Section 26, Town 01N, Range 12W, Otsego Township

Permittee:
Denise Medemar, Allegan County Drain Commission
113 Chestnut Street
Allegan, MI 49010

This notice must be displayed at the site of work.
Laminating this notice or utilizing sheet protectors is recommended.
Please refer to the above permit number with any questions or concerns.

Jason Combs
Kalamazoo District Office
Water Resources Division
269-568-2693

This notice must be displayed at the site of work.
Laminating this notice or utilizing sheet protectors is recommended.
Please refer to the above permit number with any questions or concerns.

MICHIGAN DEPARTMENT OF ENVIRONMENT, GREAT LAKES, AND ENERGY
WATER RESOURCES DIVISION
PERMIT

Issued To:

Denise Medemar, Allegan County Drain Commission
113 Chestnut Street
Allegan, MI 49010

Permit No: **WRP040142 v.1**
Submission No.: **HPP-HE82-R4162**
Site Name: **03-Baughman Drain-Otsego**
Issued: **January 25, 2024**
Revised:
Expires: **January 25, 2029**

This permit is being issued by the Michigan Department of Environment, Great Lakes, and Energy (EGLE), Water Resources Division, under the provisions of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended (NREPA); specifically:

- ☒ **Part 301, Inland Lakes and Streams**
- ☐ **Part 303, Wetlands Protection**
- ☐ **Part 315, Dam Safety**
- ☐ **Part 323, Shorelands Protection and Management**
- ☐ **Part 325, Great Lakes Submerged Lands**
- ☐ **Part 353, Sand Dunes Protection and Management**
- ☐ **Part 31, Water Resources Protection (Floodplain Regulatory Authority)**

EGLE certifies that the activities authorized under this permit are in compliance with the State Coastal Zone Management Program and certifies without conditions under the Federal Clean Water Act, Section 401 that the discharge from the activities authorized under this permit will comply with Michigan's water quality requirements in Part 31, Water Resources Protection, of the NREPA and associated administrative rules, where applicable.

Permission is hereby granted, based on permittee assurance of adherence to State of Michigan requirements and permit conditions, to:

Authorized Activity:

Install turbidity curtain prior to in-water work. Expand the existing Baughman Drain by including three new branches of the Baughman Drain:
•Branch 1: Dredge approximately 308 cubic yards of stream bottomland in two areas: one area approximately 3050 feet long, 0.9 foot wide, and 1.5 feet deep, and one area approximately 470 feet long, 5.98 feet wide, and 1.5 feet deep. Place filter fabric and approximately 92 cubic yards of 8"-16" MDOT Plain riprap in approximately 1620 square feet of the bottomland to a maximum depth of 1.5 feet. Remove two existing culverts and replace one existing culvert with a circular plastic culvert that is a minimum diameter of 4 feet and a maximum length of 160 feet, burying the culvert approximately 6 inches in stream bottomland. Install a tile with a 12-inch diameter outfall in the bottomland of Branch 1.

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All work shall be completed in accordance with the attached plans and the terms and conditions of this permit.

Waterbody Affected: Baughman Drain, Baughman Drain channels
Property Location. Allegan County, Otsego Township, Town/Range/Section 01N 12W 26

Authority granted by this permit is subject to the following limitations:

A. Initiation of any work on the permitted project confirms the permittee's acceptance and agreement to comply with all terms and conditions of this permit.
B. The permittee, in exercising the authority granted by this permit, shall not cause unlawful pollution as defined by Part 31 of the NREPA.
C. This permit shall be kept at the site of the work and available for inspection at all times during the duration of the project or until its date of expiration
D. All work shall be completed in accordance with the approved plans and specifications submitted with the application and/or plans and specifications attached to this permit.
E. No attempt shall be made by the permittee to forbid the full and free use by the public of public waters at or adjacent to the structure or work approved
F. It is made a requirement of this permit that the permittee give notice to public utilities in accordance with 2013 PA 174 (Act 174) and comply with each of the requirements of Act 174.
G. This permit does not convey property rights in either real estate or material nor does it authorize any injury to private property or invasion of public or private rights, nor does it waive the necessity of seeking federal assent, all local permits, or complying with other state statutes.
H. This permit does not prejudice or limit the right of a riparian owner or other person to institute proceedings in any circuit court of this state when necessary to protect his rights.
I. Permittee shall notify EGLE within one week after the completion of the activity authorized by this permit by completing and forwarding the attached preaddressed postcard to the office addressed thereon.
J. This permit shall not be assigned or transferred without the written approval of EGLE.
K. Failure to comply with conditions of this permit may subject the permittee to revocation of permit and criminal and/or civil action as cited by the specific state act, federal act, and/or rule under which this permit is granted.
L. All dredged or excavated materials shall be disposed of in an upland site (outside of floodplains, unless exempt under Part 31 of the NREPA, and wetlands).
M. In issuing this permit, EGLE has relied on the information and data that the permittee has provided in connection with the submitted application for permit. If, subsequent to the issuance of a permit, such information and data prove to be false, incomplete, or inaccurate, EGLE may modify, revoke, or suspend the permit, in whole or in part, in accordance with the new information.
N. The permittee shall indemnify and hold harmless the State of Michigan and its departments, agencies, officials, employees, agents, and representatives for any and all claims or causes of action arising from acts or omissions of the permittee, or employees, agents, or representative of

the permittee, undertaken in connection with this permit. The permittee's obligation to indemnify the State of Michigan applies only if the state: (1) provides the permittee or its designated representative written notice of the claim or cause of action within 30 days after it is received by the state, and (2) consents to the permittee's participation in the proceeding on the claim or cause of action. It does not apply to contested case proceedings under the Administrative Procedures Act, 1969 PA 306, as amended, challenging the permit. This permit shall not be construed as an indemnity by the State of Michigan for the benefit of the permittee or any other person.

O. Noncompliance with these terms and conditions and/or the initiation of other regulated activities not specifically authorized shall be cause for the modification, suspension, or revocation of this permit, in whole or in part. Further, EGLE may initiate criminal and/or civil proceedings as may be deemed necessary to correct project deficiencies, protect natural resource values, and secure compliance with statutes.

P. If any change or deviation from the permitted activity becomes necessary, the permittee shall request, in writing, a revision of the permitted activity from EGLE. Such revision request shall include complete documentation supporting the modification and revised plans detailing the proposed modification. Proposed modifications must be approved, in writing, by EGLE prior to being implemented.

Q. This permit may be transferred to another person upon written approval of EGLE. The permittee must submit a written request to EGLE to transfer the permit to the new owner. The new owner must also submit a written request to EGLE to accept transfer. The new owner must agree, in writing, to accept all conditions of the permit. A single letter signed by both parties that includes all the above information may be provided to EGLE. EGLE will review the request and, if approved, will provide written notification to the new owner.

R. Prior to initiating permitted construction, the permittee is required to provide a copy of the permit to the contractor(s) for review. The property owner, contractor(s), and any agent involved in exercising the permit are held responsible to ensure that the project is constructed in accordance with all drawings and specifications. The contractor is required to provide a copy of the permit to all subcontractors doing work authorized by the permit.

S. Construction must be undertaken and completed during the dry period of the wetland. If the area does not dry out, construction shall be done on equipment mats to prevent compaction of the soil.

T. Authority granted by this permit does not waive permit requirements under Part 91, Soil Erosion and Sedimentation Control, of the NREPA, or the need to acquire applicable permits from the County Enforcing Agent (CEA).

U. Authority granted by this permit does not waive permit requirements under the authority of Part 305, Natural Rivers, of the NREPA. A Natural Rivers Zoning Permit may be required for construction, land alteration, streambank stabilization, or vegetation removal along or near a natural river.

V. The permittee is cautioned that grade changes resulting in increased runoff onto adjacent property is subject to civil damage litigation.

W. Unless specifically stated in this permit, construction pads, haul roads, temporary structures, or other structural appurtenances to be placed in a wetland or on bottomland of the water body are not authorized and shall not be constructed unless authorized by a separate permit or permit revision granted in accordance with the applicable law.

X. For projects with potential impacts to fish spawning or migration, no work shall occur within fish spawning or migration timelines (i.e., windows) unless otherwise approved in writing by the Michigan Department of Natural Resources, Fisheries Division.

Y. Work to be done under authority of this permit is further subject to the following special instructions and specifications:

1. No work or dredging within the water authorized by this permit is allowed from May 1 to June 30 due to critical spawning, migration, and/or recreational use periods

2. Prior to commencement of any dredging authorized by this permit, the entire dredged area shall be enclosed with a turbidity curtain to prevent off-site siltation. The turbidity curtain shall be installed to extend from the bed of the waterbody to a point above the existing water's surface. The turbidity curtain shall be maintained for the duration of the project and shall be left in place after completion of dredging until all disturbed sediments have settled. In the event there is a problem with the turbidity curtain, and a failure to contain the sediments from leaving the project site, the project shall be immediately stopped, evaluated, and appropriate measures shall be taken to stop the release of sediments/turbidity.

3. To avoid take of Northern long-eared bat, which is federally listed as a threatened species, and Indiana bat, which is federally listed as an endangered species, any trees larger than 3 inches in diameter shall not be cut between April 1 and September 30 in any permit year.

4. Applicant agrees to have construction employees review box turtle identification and habitat characteristics prior to construction activities to determine the presence of Eastern Box Turtle, a State Threatened Species, within the sediment barrier and/or wetland or upland construction area prior to, and during any construction activities. Identification and habitat characteristic information can be located at the Michigan Natural Features Inventory website at: http://mnfi.anr.msu.edu/abstracts/zoology/Terrapene_carolina.pdf . It is encouraged to report any observation of this species, live or dead, to the Michigan Herp Atlas at https://www.miherpatlas.org/

5. The permittee and contractors will take steps to minimize the risk of spreading terrestrial and aquatic invasive species during this project and will take measures to prevent spread, where feasible, including:

   - Visually inspecting and removing any plants or mud from footwear (boots, hip-boots, and waders).
   - Visually inspecting and removing and properly disposing of any plants and mud from field equipment (nets, shovels, rakes, etc.) and vehicles.
   - Draining all water from vehicles and equipment, prior to leaving the site and before entering a new waterbody.
   - Thoroughly drying equipment (5-7 days, if possible) between sites, when possible
   - Disinfecting vehicles and equipment between sites (e.g. diluted bleach solution, heated pressure washer), when possible. Disinfection should be conducted away from surface waters, where the disinfecting solution will not enter any storm sewers and/or surface waters
     - Typical diluted bleach solution treatment is ½ cup (4 fluid ounces) bleach to 5 gallons of water, applied by spraying or sponge so surface is thoroughly exposed to bleach solution for 10 minutes
     - Typical heated pressure wash is 140° water temperature, sprayed for 5-10 seconds.
     - Thoroughly washing vehicles and boats between sites (e.g. drive-through car wash).

- Using only native plants and seed for restorations and best management practices.

If invasive aquatic or terrestrial plants are removed from a site, the permittee will take steps to minimize the spread of these species. Dispose of invasive plant material by bagging and transporting to a landfill, composting, or burning, as appropriate and in compliance with local and state laws.

A "Watch List" of Michigan's high priority aquatic invasive species along with how to report sightings can be found at www.michigan.gov/aquaticinvasives.

6. Prior to the start of construction, all adjacent non-work wetland areas shall be protected by properly trenched sedimentation barrier to prevent sediment from entering the wetland. Orange construction fencing shall be installed as needed to prohibit construction personnel and equipment from entering or performing work in these areas. Fence shall be maintained daily throughout the construction process. Upon project completion, the accumulated materials shall be removed and disposed of at an upland site, the sedimentation barrier shall then be removed in its entirety and the area restored to its original configuration and cover

7. Exposed streambanks resulting from this construction shall be stabilized with temporary measures in accordance with appropriate Best Management Practices based on site conditions, and if necessary, may be riprapped extending above the ordinary high water mark, to provide adequate erosion protection. Temporary stabilization measures shall be maintained until permanent measures are in place.

8. The permittee is hereby notified that portions of the parcel, not covered by this permit, fall under the regulatory authority of Part 301, Inland Lakes and Streams, and/or Part 31, Floodplain Regulatory Authority/Water Resources Protection, and/or Part 303, Wetlands Protection, of the NREPA. A permit from the EGLE's Water Resources Division may be required for certain regulated activities. Failure to comply with the requirements of the NREPA may subject the owner to compliance actions as provided by statute

9. The permittee is responsible for acquiring all necessary easements or rights-of-way before commencing any work authorized by this permit. All construction operations relating to or part of this project shall be confined to the existing right-of-way limits or other acquired easements.

10. This permit is limited to authorizing the construction as specified above and carries with it no assurances or implications that associated lake, stream, wetland or floodplain areas can be developed and serviced by the structures authorized by this permit.

11. The existing structure shall be kept open to pass the stream flow during removal of the existing road fill

12. The placement of the new culvert and the initial placement of fill in the stream shall be done immediately after removal of the existing culvert. The placement shall be conducted in such a manner that all flow is immediately passed through the new culverts, allowing the major placement of fill to be done in the dry or in still water where erosion and siltation will be minimized. The fill material used in this initial placement shall be washed gravel, coarse aggregate, or rock and shall be placed at both ends of the culvert to a level above normal water level before backfill material is placed

13. The culvert shall be installed to align with the center line of the existing stream at both the inlet and outlet ends and must be buried below the stream bed to provide a natural channel substrate through the structure as shown on the approved plans.

14. Road fill side slopes shall not be steeper than 1-on-2 (1 vertical to 2 horizontal) except where headwalls of reinforced concrete, mortar masonry, dry masonry, or other acceptable methods are used.

15. Road fill side slopes terminating in the stream and any raw streambanks resulting from the construction shall be stabilized with temporary measures in accordance with appropriate Best Management Practices based on site conditions, and if necessary, may be riprapped extending above the ordinary high water mark, before or upon commencement of the permitted activity. Temporary stabilization measures shall be maintained until permanent measures are in place.

16. All other road fill slopes, ditches, and other raw areas draining directly to the stream may be protected with riprap, sod and/or seed and mulch as may be necessary to provide effective erosion protection. The placement of riprap shall be limited to the minimum necessary to ensure proper stabilization of the side slopes and fill in the immediate vicinity of the structure.

17. If the project or any portion of the project, is stopped and lies incomplete for any length of time other than that encountered in a normal work week, every precaution shall be taken to protect the incomplete work from erosion, including the placement of temporary gravel bag riprap, temporary seed and mulch, or other acceptable temporary protection.

18. No work shall be done in the stream during periods of above-normal flows except as necessary to prevent erosion.

19. During removal or repair of the existing structure, every precaution shall be taken to prevent debris from entering any watercourse. Any debris reaching the watercourse during the removal and/or reconstruction of the structure shall be immediately retrieved from the water. All material shall be disposed of in an acceptable manner consistent with local, state, and federal regulations.

20. All riprap shall be properly sized and graded based on wave action and velocity, and shall consist of clean natural field stone or rock (free of paint, soil or other fines, asphalt, soluble chemicals, or organic material). Broken concrete, free of protruding metal, contaminants, and other foreign material may be used.

21. Dredging in wetland is not authorized by this permit.

22. All dredge/excavated spoils including organic and inorganic soils, vegetation, and other material removed shall be placed on upland (non-wetland, non-floodplain or non-bottomland), prepared for stabilization, and stabilized with sod and/or seed and mulch in such a manner to prevent and ensure against erosion of any material into any waterbody, wetland, or floodplain.

23. All raw areas in uplands resulting from the permitted construction activity shall be effectively stabilized with sod and/or seed and mulch (or other technology specified by this permit or project plans) in a sufficient quantity and manner to prevent erosion and any potential siltation to surface waters or wetlands. Temporary stabilization measures shall be installed before or

upon commencement of the permitted activity and shall be maintained until permanent measures are in place. Permanent measures shall be in place within five (5) days of achieving final grade. All raw earth within 100 feet of a lake, stream, or wetland that is not brought to final stabilization by the end of the active growing season shall be temporarily stabilized with mulch blankets in accordance with the following dates: September 20th for the Upper Peninsula, October 1st for the Lower Peninsula north of US-10, and October 10th for the Lower Peninsula south of US-10.

24. Prior to the initiation of any permittee construction activities, a sedimentation barrier shall be constructed immediately down gradient of the construction site. Sedimentation barriers shall be specifically designed to handle the sediment type, load, water depth, and flow conditions of each construction site throughout the anticipated time of construction and unstable site conditions. The sedimentation barrier shall be maintained in good working order throughout the duration of the project. Upon project completion, the accumulated materials shall be removed and disposed of at an upland (non-wetland, non-floodplain) site and stabilized with seed and mulch. The sedimentation barrier shall then be removed in its entirety and the area restored to its original configuration and cover.

25. The channel shall stay in place and have minimal indications of bank erosion (e.g., undermining or other indications of instability). Qualified individuals shall visually inspect the constructed channel following two bankfull or 5-year or greater storm events occurring in two separate years. If channel instability is documented, the permittee shall notify EGLE in writing, and EGLE may require corrective actions.

26. Authority granted by this permit does not waive permit or program requirements under Part 91 of the NREPA or the need to acquire applicable permits from the CEA. To locate the Soil Erosion Program Administrator for your county, visit https://www.michigan.gov/egle/about/organization/water-resources/soil-erosion/sesc-overview and select "Soil Erosion and Sedimentation Control Agencies".

27. The authority to conduct the activity as authorized by this permit is granted solely under the provisions of the governing act as identified above. This permit does not convey, provide, or otherwise imply approval of any other governing act, ordinance, or regulation, nor does it waive the permittee's obligation to acquire any local, county, state, or federal approval or authorization necessary to conduct the activity.

28. No fill, excess soil, or other material shall be placed in any wetland, floodplain, or surface water area not specifically authorized by this permit, its plans, and specifications.

29. This permit does not authorize or sanction work that has been completed in violation of applicable federal, state, or local statutes.

30. The permit placard shall be kept posted at the work site in a prominent location at all times for the duration of the project or until permit expiration.

31. This permit is being issued for the maximum time allowed and no extensions of this permit will be granted. Initiation of the construction work authorized by this permit indicates the permittee's acceptance of this condition. The permit, when signed by EGLE, will be for a five-year period beginning on the date of issuance. If the project is not completed by the expiration date, a new permit must be sought.

32. Upon signing by the permittee named herein, this permit must be returned to the EGLE's Water Resources Division for final execution. This permit shall become effective on the date of the EGLE representative's signature.

Permittee hereby accepts and agrees to comply with the terms and conditions of this permit.

X Denise Medemar January 24, 2024
Permittee Date

X Denise Medemar Allegan County Drain Commissioner
Printed Name and Title of Permittee

Issued By: Jason Combs
Jason Combs
Kalamazoo District Office
Water Resources Division
269-568-2693

THIS PERMIT MUST BE SIGNED BY THE PERMITTEE TO BE VALID.

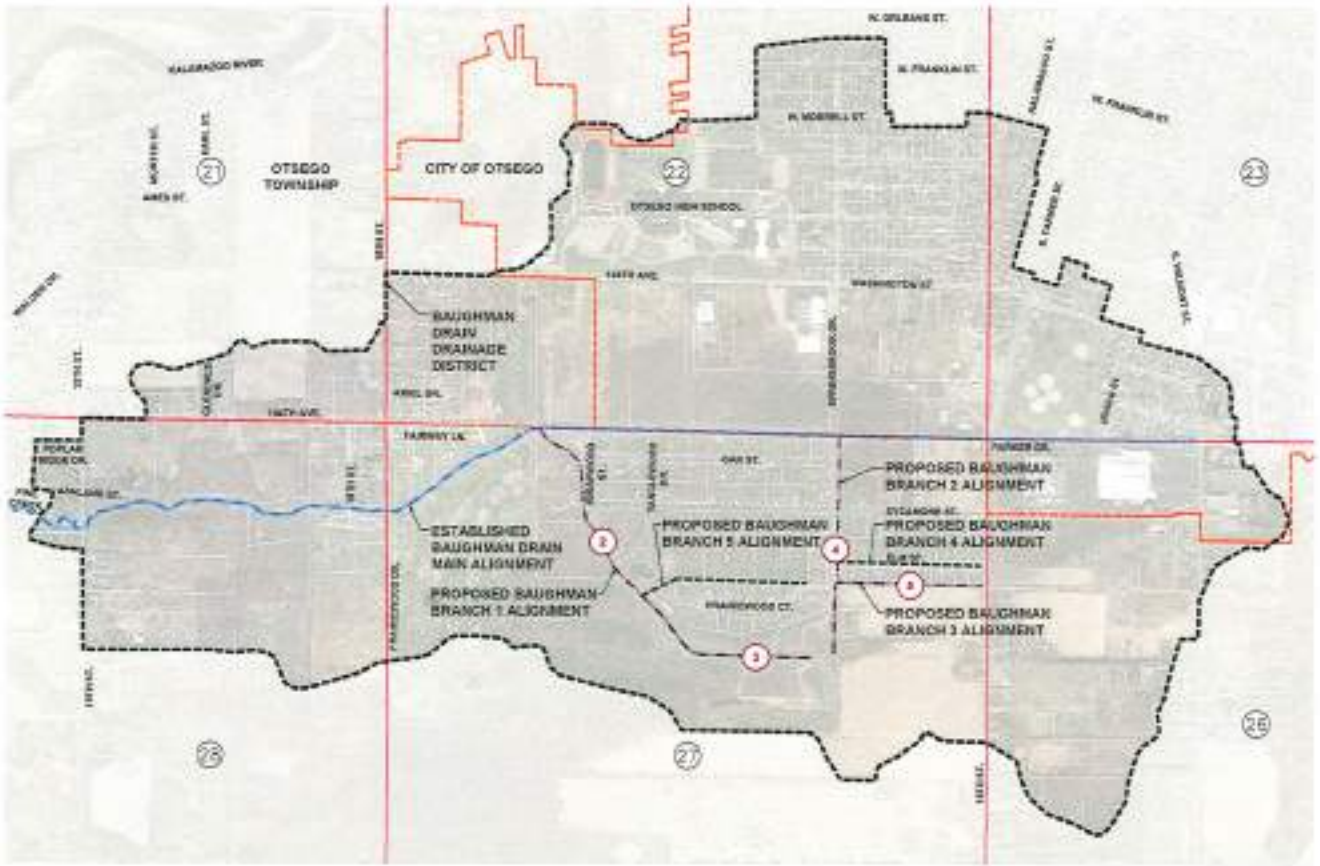
I hereby assure that I have read, am familiar with, and agree to adhere to the terms and conditions of this permit.

Permittee Signature Date

cc: Otsego Township Clerk
Randy Rapp, Allegan County CEA
Dan Fredericks, Land and Resources Engineering, Agent
Matt Diana, DNR Fisheries
Kate Kirkpatrick, EGLE
Derek Haroldson, EGLE
Christopher Gothberg, EGLE

Baughman Drain

Sections 21-23 & 26-28
T01N, R12W
Otsego Township & City of Otsego,
Allegan County, Michigan



VICINITY MAP

INDEX OF SHEETS

DRAIN INFORMATION

BAUGHMAN DRAIN LENGTH	3,600 MLED
BAUGHMAN BRANCH 1 LENGTH	072 MLED
BAUGHMAN BRANCH 2 LENGTH	038 MLED
BAUGHMAN BRANCH 3 LENGTH	025 MLED
BAUGHMAN DRAINAGE DISTRICT AREA	6637 ACRES

LEGEND

- ENCLOSED CHANNEL DRAIN
- PROPOSED ENCLOSED CHANNEL DRAIN
- ESTABLISHED OPEN CHANNEL DRAIN
- PROPOSED OPEN CHANNEL DRAIN
- OTSEGO CITY LIMITS
- DRAINAGE DISTRICT BOUNDARY
- SECTION LINE
- TOWNSHIP LINE
- ROADS
- PROPERTY LINES
- (3) SECTION NUMBERS
- (8) SHEET NUMBERS

CALL MISS DIG
BEFORE YOU DIG

COVER SHEET	
APPLICANT:	ALLEGAN COUNTY DRAIN COMMISSIONER
TOWNSHIP:	OTSEGO TOWNSHIP
COUNTY:	ALLEGAN
NUMBER OF SHEETS:	1 OF 8
DATE:	7/5/2023

LRE

1-24-2024
dm

PLAN VIEW - BRANCH NO. 1

WETLAND DELINEATION

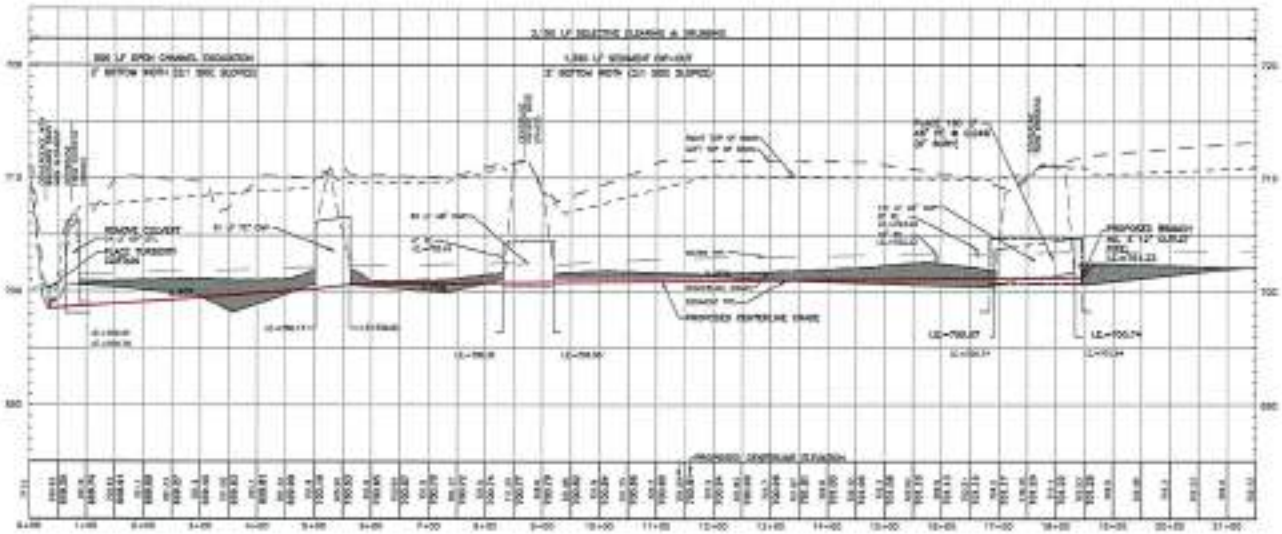
WETLAND PRESENT ALONG NO. DRAIN 19' WATERCOURSE = 0.014 ACRES

NOTE:
NO WETLAND DETERMINATION, ALL WORK TO BE WITHIN CENTER OF DRAINAGE, AND BELOW BANKFULL (SEE DRAINAGE SECTION 11.04.01 ON SHEET 6)

SUMMARY OF ACTIVITIES

	SHEET	TOTAL
OPEN CHANNEL EXCAVATION BELOW BANK (CY)	116	116
SEDIMENT DISPOSAL BELOW BANK (CY)	116	116
SELECTIVE CLEARING AND GRUBBING (LF)	3,100	3,100
REMOVE PRIVATE CROSSING (EA)	1	2
REPLACE PRIVATE CROSSING (EA)	1	2
RIPRAP BELOW BANK (CY)	83	167

NOTES:
1. CLEARING AND RE-SPREAD TOPSOIL AND SEED ALL DISTURBED AREAS AND FOR 50' OF OPEN CHANNEL REMOVAL.
2. OPEN CHANNEL EXCAVATION / SEDIMENT REMOVAL INCLUDES CLEARING / REMOVING SEDIMENT FROM EXISTING CULVERTS.
4. NO TREE CLEARING FROM APRIL 1 TO SEPTEMBER 30.



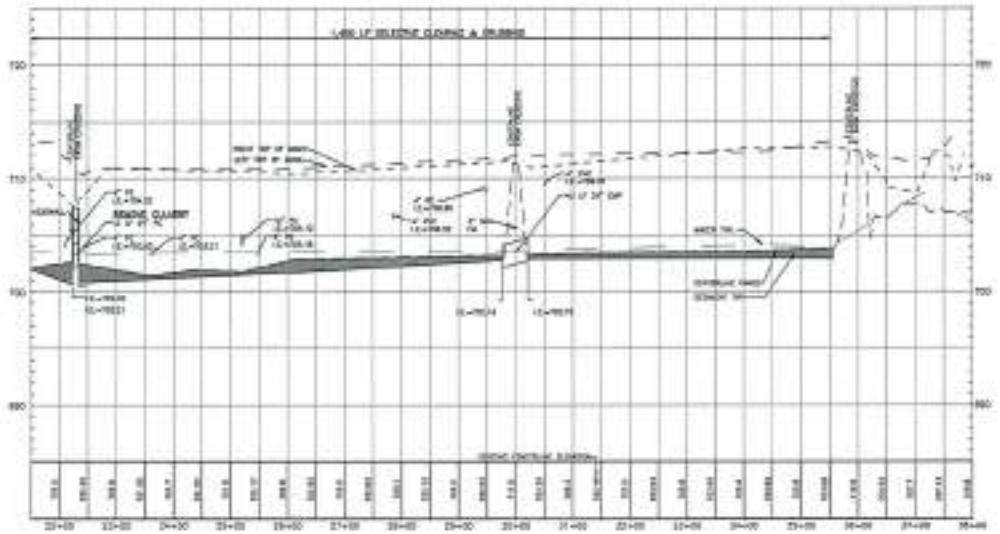
CENTERLINE PROFILE

BEFORE YOU DIG CALL MISS DIG

PLAN & PROFILE BRANCH 1
APPLICANT: ALLEGAN COUNTY DRAIN COMMISSIONER
TOWNSHIP: OTSEGO TOWNSHIP
COUNTY: ALLEGAN
NUMBER OF SHEETS: 2 OF 8
DATE: 7/5/2023

1-24-2024
dm

PLAN VIEW - BRANCH NO. 1



CENTERLINE PROFILE

SUMMARY OF ACTIVITIES

SELECTIVE CLEARING AND GRUBBING (LF)	1,489	0.34
REMOVE PRIVATE CROSSING (EA)	1	1
REPAIR BELOW GRADE (SY)	20	13

NOTES:
1. ...
2. ...
3. ...
4. ...

BEFORE YOU DIG CALL MISS DIG

PLAN & PROFILE BRANCH 1

APPLICANT: ALLEGAN COUNTY DRAIN COMMISSIONER
TOWNSHIP: OTSEGO TOWNSHIP
COUNTY: ALLEGAN
NUMBER OF SHEETS: 3 OF 8
DATE: 7/5/2023

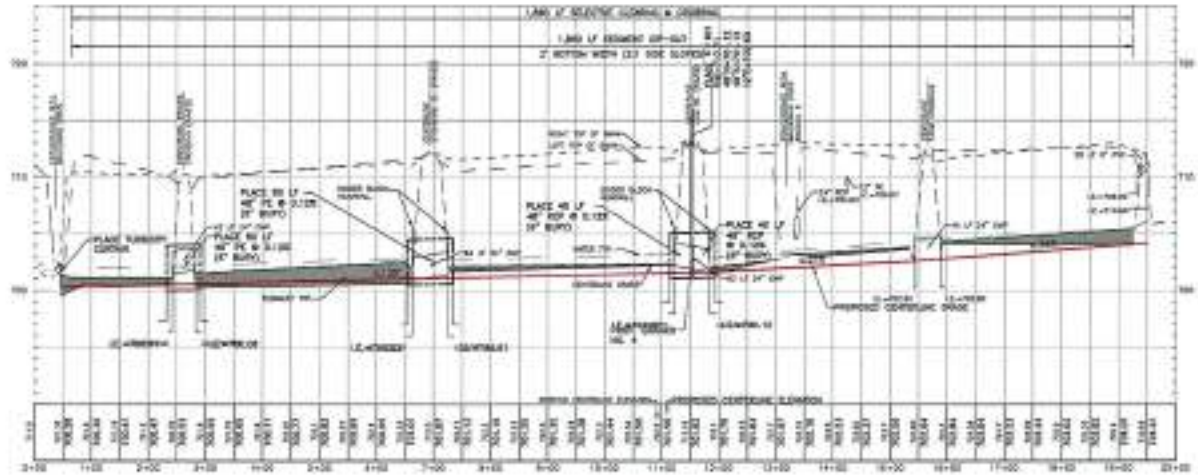
1-24-2024
dm

PLAN VIEW - BRANCH NO. 2

SCALE: 1" = 100'

SUMMARY OF ACTIVITIES

SEGMENT DP-007 BELOW DAMM (DT)	448	909
SELECTIVE CLEARING AND GRUBBING (LF)	1,660	6,344
REPLACE PUBLIC ROAD CROSSING (EA)	1	1
REPLACE PRIVATE DRIVEWAY (EA)	1	1
ADRAIN BELOW DAMM (DT)	70	137



CENTERLINE PROFILE

SCALE: HORIZONTAL 1" = 100'
VERTICAL 1" = 1'

1. DRAIN S.O.W. (MAR).
2. REMOVE AND RE-SPREAD TOPSOIL AND SEED ALL DISTURBED AREAS, AND USE 80' LF OPEN CHANNEL SEEDING.
3. OPEN CHANNEL EXCAVATION / SEGMENT REMOVAL INCLUDES CLEARING REMOVING SEGMENT FROM EXISTING CULVERTS.
4. NO TREE CLEARING FROM APRIL 1 TO SEPTEMBER 30.

CALL MISS DIG
1-800-482-7171

ALL CONTRACTS AS DESIGN AND SPECIFICATIONS CONTAINED THEREIN SHALL BE IN ACCORDANCE WITH AND GOVERNED BY THE LATEST EDITION OF THE MICHIGAN DEPARTMENT OF TRANSPORTATION STANDARD SPECIFICATIONS FOR CONSTRUCTION AND ANY AMENDMENTS THERETO.

PLAN & PROFILE BRANCH 2

APPLICANT: ALLEGAN COUNTY DRAIN COMMISSIONER
TOWNSHIP: OTSEGO TOWNSHIP
COUNTY: ALLEGAN
NUMBER OF SHEETS: 4 OF 8
DATE: 7/5/2023

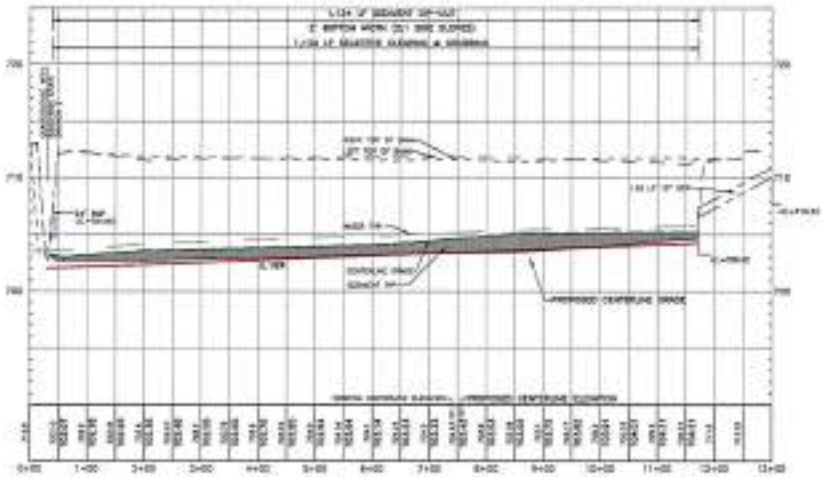
LRE ENGINEERING

1-24-2024
dm

PLAN VIEW - BRANCH NO. 3

SUMMARY OF ACTIVITIES

	Item Unit(s)	Totals
SEDIMENT DIP-OUT BELOW GRADE (DT)	200	600
SELECTIVE CLEARING AND GRUBBING (LF)	1,734	6,344
REPAIR BELOW GRADE (DT)	0	197



CENTERLINE PROFILE

NOTES:
1. [illegible]
2. [illegible]
3. DITCH CHANNEL EXCAVATION / SEDIMENT REMOVAL INCLUDES CLEARING [illegible]
4. NO TREE CLEARING FROM AREA 1 TO DOWNSTREAM SO.

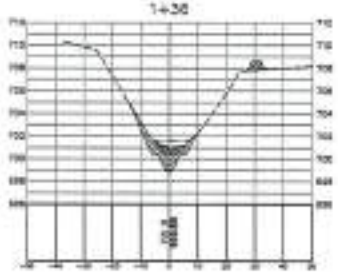
BEFORE YOU DIG CALL MISS DIG

PLAN & PROFILE BRANCH 3
APPLICANT: ALLEGAN COUNTY DRAIN COMMISSIONER
TOWNSHIP: OTSEGO TOWNSHIP
COUNTY: ALLEGAN
NUMBER OF SHEETS: 5 OF 8
DATE: 7/5/2023

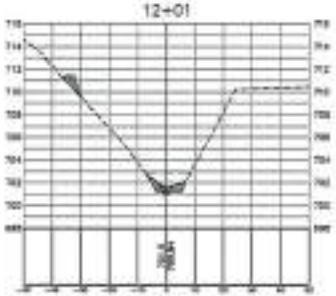
LRE ENGINEERING

1-24-2024
dm

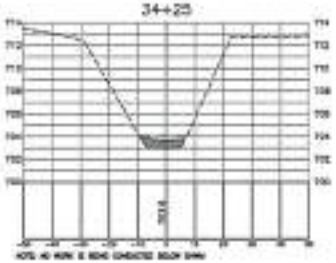
1+36



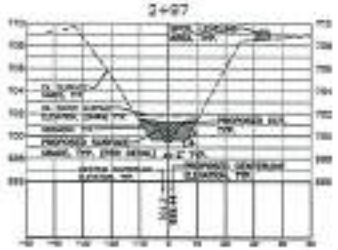
12+01



34+25



2+97



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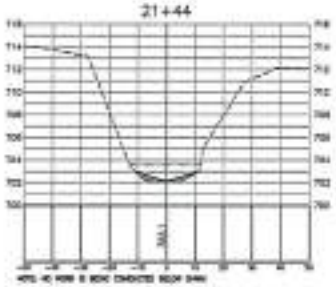
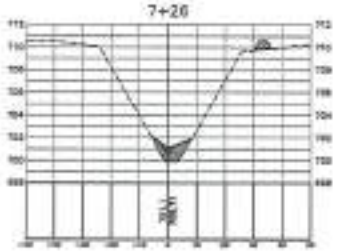


7+26



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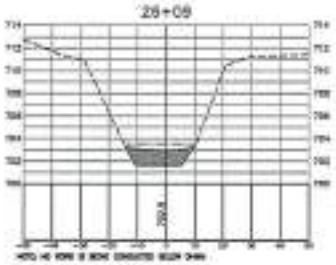
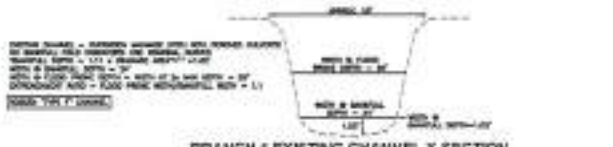


CROSS SECTIONS - BRANCH NO. 1



BRANCH 1 EXISTING CHANNEL X-SECTION

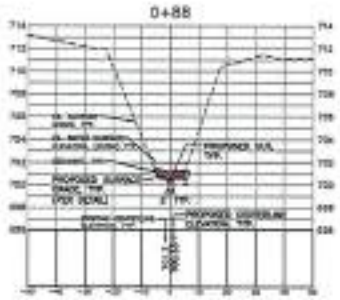
BRANCH 1 PROPOSED CHANNEL X-SECTION

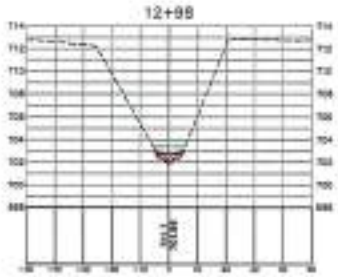
BEFORE YOU DIG CALL MISS DIG

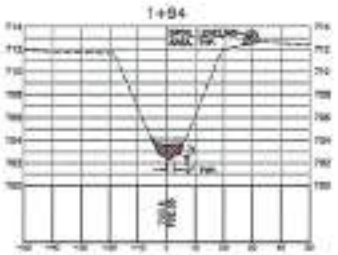
CROSS SECTIONS
APPLICANT: ALLEGAN COUNTY DRAIN COMMISSIONER
TOWNSHIP: OTSEGO TOWNSHIP
(COUNTY): ALLEGAN
NUMBER OF SHEETS: 6 OF 6
DATE: 9/6/2023

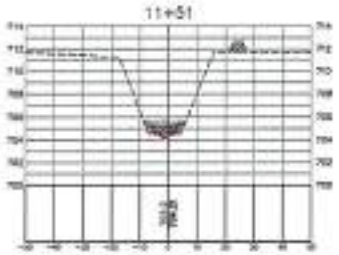
LRE

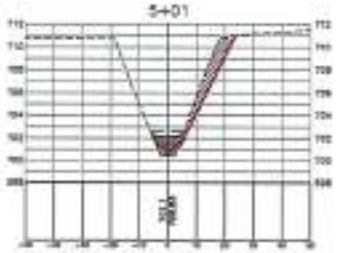
1-24-2024
dm

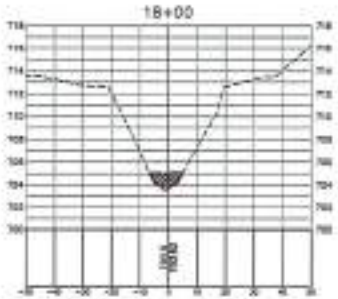


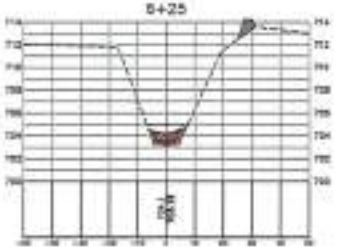




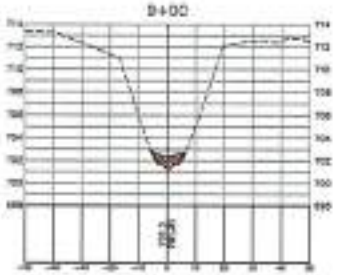








CROSS SECTIONS - BRANCH NO. 3



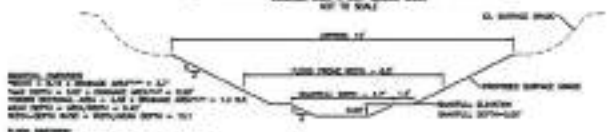
CROSS SECTIONS - BRANCH NO. 3

NOTE:
SPOILS TO BE HAULED OFF-SITE
FOR DRAIN NO. 2

BRANCH 2 EXISTING CHANNEL X-SECTION

BRANCH 2 PROPOSED CHANNEL X-SECTION

BRANCH 3 EXISTING CHANNEL X-SECTION



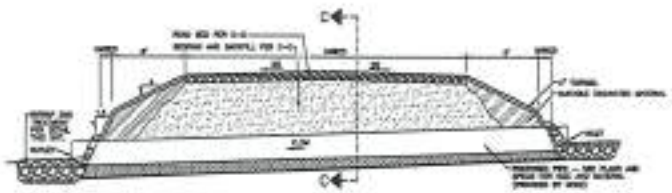
BRANCH 3 PROPOSED CHANNEL X-SECTION

BEFORE YOU DIG
CALL MISS DIG

CROSS SECTIONS
APPLICANT: ALLEGAN COUNTY DRAIN COMMISSIONER
TOWNSHIP: OTSEGO TOWNSHIP
COUNTY: ALLEGAN
NUMBER OF SHEETS: 7 OF 8
DATE: 7/5/2023

LRE

1-24-2024
dm

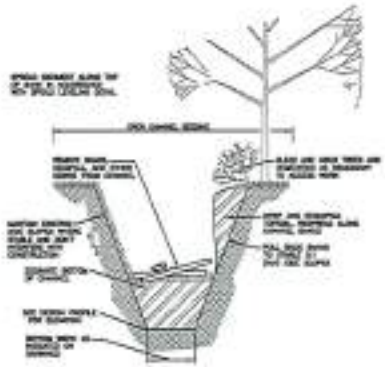


TYPICAL BITUMINOUS ROAD CULVERT CROSSING CROSS SECTION

NOT TO SCALE

TYPICAL BITUMINOUS ROAD CULVERT CROSSING CROSS SECTION B-B

NOT TO SCALE



OPEN CHANNEL EXCAVATION DETAIL

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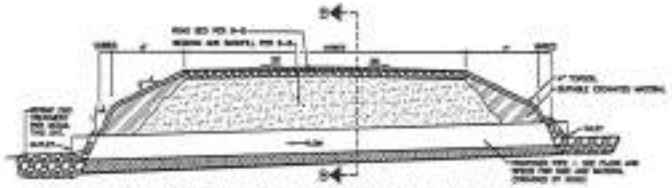

TYPICAL GRAVEL ROAD CULVERT CROSSING CROSS SECTION

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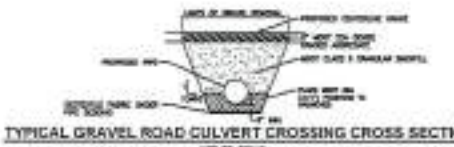
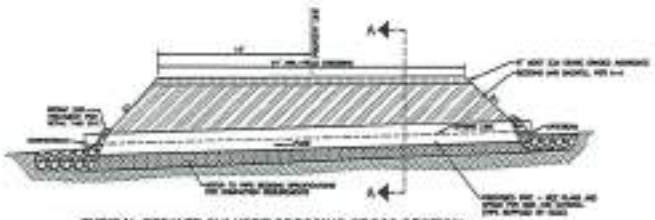


TYPICAL GRAVEL ROAD CULVERT CROSSING CROSS SECTION B-B

NOT TO SCALE

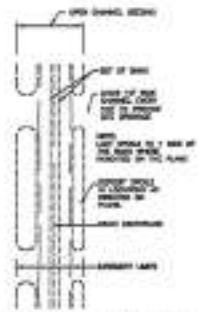


TYPICAL PRIVATE CULVERT CROSSING CROSS SECTION

NOT TO SCALE

TYPICAL PRIVATE CULVERT CROSSING CROSS SECTION A-A

NOT TO SCALE



SPOILS LEVELING DETAIL

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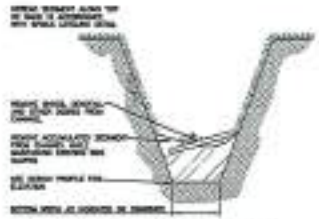

SEDIMENT DIP-OUT DETAIL

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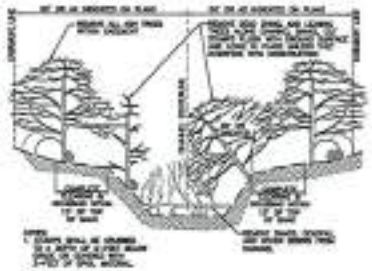
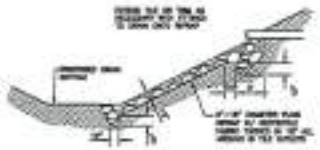


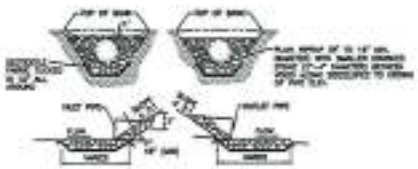
SELECTIVE CLEARING & GRUBBING

NOT TO SCALE



TILE OUTLET PROTECTION DETAIL

NOT TO SCALE



UPSTREAM DOWNSTREAM

RIPRAP END TREATMENT DETAIL

NOT TO SCALE

DETAILS
APPLICANT: ALLEGAN COUNTY DRAIN COMMISSIONER
TOWNSHIP: OTSEGO TOWNSHIP
COUNTY: ALLEGAN
NUMBER OF SHEETS: 8 OF 8
DATE: 7/5/2023

LRE

EGLE

Permit No. 40142 v1.0

Approved

Issued On:01/25/2024

Expires On:01/25/2029

1-24-2024

AM

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Work Included:
1. Provide permanent and/or temporary erosion and sedimentation control as called for on the plans.

B. Intent and Purpose of Control:
1. Keep disturbed areas small.
2. Stabilize and protect disturbed areas as soon as possible.
3. Keep storm water runoff velocities low.
4. Protect disturbed areas from runoff.
5. Retain sediment within the corridor or site area.

C. Method of Measurement and Basis of Payment:
1. Temporary Measures - Incidental to construction.
2. Permanent Measures - See Proposal for pay item.

1.02 PERMIT:

A. Soil Erosion and Sedimentation Control (Part 91, Act 451, PA 1994)
1. The Allegan County Drain Commissioner is an Authorized Public Agency (APA) and a separate SESC permit is not required.
2. CONTRACTOR shall comply with the requirements and conditions of the APA.

1.03 JOB CONDITIONS:

A. Scheduling:
1. Control measures shall be constructed prior to the time construction starts uphill or upstream from the control measure location.
2. Removal and cleanup of temporary control structures: Within one week after control measure is no longer needed.

PART 2 – PRODUCTS

2.01 MATERIALS:

A. Seeding:
1. Permanent Measures: MDOT 816.02, 917.12.
2. Storm Sewer: MDOT TDS at a rate of 220lb/acre.
3. Open Channel / Detention Basin:
   a. Native Connections: Stormwater Mix (see attached); or
   b. Natural Communities: Mix A – Detention Basin Native Seed Mix (see attached)

B. Topsoil:
1. Temporary Measures: Not required unless readily available.
2. Permanent Measures: MDOT 816.02, 917.07.

C. Mulching:
1. Temporary and Permanent Measures: MDOT 816 and 917 shall apply. Required as specified on plans and/or in Project Specifications.

D. Riprap:
1. Crushed Cobblestone: Sound, non-stratified, durable rock free from structural defects. Material shall be range in dimension as indicated on the Drawings. MDOT 916.01 shall apply.
2. Limestone: Sound, non-stratified, durable rock free from structural defects. Material shall range in dimension as indicated on the Drawings. MDOT 916.01 shall apply.
3. Broken Concrete: Not Allowed.

E. Geotextile Fabric:
1. Mirafi 140N or approved equal.

PART 3 - EXECUTION

3.01 PERFORMANCE:

A. General:
1. Abide with all applicable rules and regulations as established by the State of Michigan and the local governmental unit pursuant to Part 91, Soil Erosion and Sedimentation Control, of the Natural Resources and Environmental Protection Act, Act 451, PA 1994.
2. Achieve Effective Erosion Control:
b. Provide all materials.
c. Promptly take actions necessary to prevent off Site sedimentation.
3. Maintain erosion controls.
4. Remove temporary soil erosion and sedimentation control measures once permanent measures are established and accepted by the ENGINEER.
5. Even though a specific erosion control measure is not called out on the plans, this does not relieve the CONTRACTOR from his obligation under the above Act to properly control and/or prevent all erosion caused by the CONTRACTOR's construction operation.

B. Sediment Removal:
1. Take such steps as are necessary to assure the retention and removal of any sediment which enters an existing storm sewer or open ditch along the construction route before said sewer or ditch discharges into a stream or pond.
2. If eroded material is allowed to enter a storm sewer system it shall be the CONTRACTOR's responsibility to see that all catch basins and manholes are cleaned following construction prior to receipt of final payment. Unless the CONTRACTOR can document positively to what extent an existing storm sewer system along the construction area is silted in prior to construction, no credit will be allowed for cleaning the system stem.
3. The CONTRACTOR shall be responsible for maintaining the roadways in a passable condition until the paving is completed. This includes any maintenance necessary for dust control.

3.02 SEEDING:

A. Scheduling:
1. Within 5 Days of Achieving Final Grade.
2 Channel Banks: Within 24 hours from the time the area was first disturbed.
3. Seasonal Limitations:
a April 20 through November 1.
b. No Dormant Seeding Allowed

B. Sowing:
1. Sow the seed following or in conjunction with the fertilizer and while the seed bed is in a friable condition.
2. Do not sow seed through mulch.

C. Method:
1. Broadcast: Do not seed when wind velocity exceeds 5 miles per hour.
2. Mechanical drills.
3. Hydroseeder:
a. Use only equipment specifically designed for hydraulic seeding application.
b. Mix seed, fertilizer and pulverized mulch in water until uniformly blended into homogeneous slurry.
c. Continue mixing during application.

D. Inspection:
1. Visually inspect for uniform distribution.
2. Reseed areas as required to establish a uniform and stable stand of grass.

E. Finishing: Incorporate seed into the upper 1/2-inch of soil.

3.03 TEMPORARY VEGETATIVE COVER:

A. General:
1. Provide temporary seed if permanent measures will not be placed within 15 days of initial disturbance and area will not undergo further earth change within 15 days of initial disturbance:
2. Within 15 days from the time final grade has been established, provide permanent soil erosion and sedimentation control measures.

B. Seed: Apply uniformly at a minimum rate of 55 pounds per acre.

C. Mulch: As needed to effectively control soil erosion.

3.04 MULCH BLANKET:

A. General: Directions of installation, staple patterns and other requirements in accordance with Manufacturer's directions.

B. Location: Where indicated on the Drawings or as directed by the ENGINEER.

3.05 RIPRAP:

A. General:
1. Includes riprap spillway, end treatment, energy dissipator, etc.
2. Conform to slopes and dimensions indicated on the Drawings.

B. Grading:
1. Excavate to finished grade of required section and slope.
2. Excavate header and footer trench at upstream and downstream toe.

C. Geotextile Fabric:
1. Place geotextile fabric beneath all riprap areas.
2. Extend geotextile fabric into trenches for anchorage at upstream and downstream.

D. Placing Riprap: As indicated on the Drawings or as directed by ENGINEER.

E. Engineers Approval: Obtain approval from ENGINEER that riprap spillway is functioning properly.

E. Maintenance: Regrade, relay riprap and geotextile fabric as necessary.

3.06 OPEN CHANNEL EXCAVATION

A. Power equipment such as bulldozers shall not enter the water unless approved by ENGINEER.

B. Complete excavation, clearing, grubbing, snagging, tree cutting, pulling, raking, and related work in such a way as to minimize erosion of soil in the areas in which work is completed.

C. Channel banks and other disturbed areas.
1. Stabilize within 24 hours after a disturbance unless otherwise approved by ENGINEER.
2. In no case shall banks be left un-stabilized for more than 7 days.

D. Construct sediment basins or traps prior to excavation.

E. Comply with measures for soil erosion and sediment control as indicated on the Drawings.

3.07 GEOTEXTILE SILT FENCE:

A. General: Install silt fence in accordance with manufacturer's recommendations.

B. Location: Where indicated on the Drawings or as directed by the Engineer.

3.08 AIRBORNE SEDIMENT

A. Dust Control:
1. Use legal means necessary to control dust on and near the Work and on and near off Site borrow areas if such dust is caused by CONTRACTOR's operations during performance of the Work or if resulting from the condition of the Site when earthwork operations are suspended.
2. Treat haul roads, delivery roads, temporary Site access roads and other surfaces as required to prevent dust from being a nuisance to the public, neighbors, and concurrent performance of other work on the Site, and as directed by ENGINEER.
3. Periodically scrape and broom adjacent streets and paved areas to remove tracked dirt.

B. Wind Erosion:
1. Erect and maintain barriers to prevent migration of windblown sediment off Site.
2. Conduct operations in such a manner as to minimize the amount of Site area exposed to wind erosion.
3. Be responsible for removal of windblown sediments deposited off Site, including costs for repairs required due to sediment deposition and removal.

PART 1 - GENERAL

1.01 STAKING:

A. Construction staking will be furnished by the OWNER through the ENGINEER as needed on the following basis:

1. Roadway – One staking: Line and Grade points at 100-foot station intervals.

3. Storm Sewer – One staking: Line and Grade every 200-feet and every drainage structure.

B. CONTRACTOR shall order the staking Three (3) working days in advance of the need for said staking.

1.02 RESTAKING:

A. If restaking or additional staking is required, it shall be performed by the ENGINEER at the CONTRACTOR'S expense.

PART 1 - GENERAL

1.01 DESCRIPTION

A. Cleaning:
1. General:
a. Manufactured products: Manufacturer's instructions.
b. Clean-up during construction: Maintain premises and public properties free from accumulations of waste, debris and rubbish caused by operations.
c. Final clean-up: Remove waste materials, rubbish, tools, equipment, machinery and surplus materials, and clean all surfaces; leave the work clean and ready for occupancy.
2. Delinquency:
a. Remedies: Failure to clean-up promptly is considered to be defective Work:
(1) Payment: Per ARTICLE 14 of SECTION 00700, GENERAL CONDITIONS.
(2) OWNER may correct per ARTICLE 13 of SECTION 00700, GENERAL CONDITIONS.

B. Work Record Documents:
1. Maintenance of Documents:
a. Maintain 1 copy at jobsite in good order of:
(1) Contract Drawings.
(2) Specifications.
(3) Addenda.
(4) Reviewed shop drawings.
(5) Change Orders.
(6) Other contract Modifications.
b. Filing: Work specification format.
c. Accessibility: To OWNER and ENGINEER.

2. Recording:
a. Keep record documents current.
b. Contract Drawings: Legibly mark to record actual construction:
(1) Field changes of dimension and detail.
(2) Changes made by Change Orders and Bulletins.
(3) Details not on original contract Drawings.
c. Specifications and Addenda: Legibly mark up each SECTION to record:
(1) Manufacturer, trade name, catalog number and supplier of products actually installed.
(2) Changes made by Change Orders and Bulletins.
(3) Other matters not originally specified.

3. Submittal:
a. Transmittal letter: Contain:
(1) Date.
(2) Project title and number.
(3) CONTRACTOR'S name and address.
(4) Title and number of each record documents.
(5) Certification that each document as submitted is complete and accurate.

SECTION 02220 SITE DEMOLITION

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Demolition, salvage and/or removal of existing structures, equipment, and related work necessary to complete the project as shown or specified is a part of the Contract unless otherwise noted.

1.02 PERMITS:

A. Permit for transport and disposal of debris by CONTRACTOR.

B. Submit demolition procedures and operational sequence for review and approval by ENGINEER.

1.03 PROTECTION:

A. Provide and place bracing or shoring as required for safety and/or support of structures.

B. Protect and maintain utility services.

PART 2 - PRODUCTS

2.01 MATERIALS:

A. CONTRACTOR maintains possession of all materials being demolished.

B. Carefully remove, store and protect for reinstallation all structures and equipment so designated.

C. Carefully remove, clean and deliver salvaged materials to the OWNER's storage area.

PART 3 - EXECUTION

3.01 DEMOLITION:

A. Completely demolish above grade structures and appurtenances to extent indicated on drawings and in specifications. Remove all scrap materials from site. Demolish in an orderly and careful manner. Install plugs or blind flanges on pipes as indicated or implied.

B. Do not remove underground piping which is to be abandoned, except where it interferes with new construction or is specifically noted for removal. Plug cut ends of abandoned underground piping with non-shrink grout.

3.02 REPAIR:

A. Repair damage to adjacent structures, pavement, landscaping, underground private utilities, etc.

3.03 SALVAGE AND/OR REPLACE:

A. Temporarily remove and salvage movable structures that interfere with construction, including but not limited to sheds, fences, trampolines, underground sprinkling, landscaping, signage and other comparable items. Replace the salvaged movable structures after construction is complete. Items damaged during construction shall be repaired / replaced at the Contractor's expense.

PART 1 - GENERAL

1.01 DESCRIPTION:

A. This work consists of clearing, selective thinning and application of any growth preventive material where required. CLEARING: Shall consist of cutting, removing from the ground, and disposing of trees, stumps, brush, shrubs, and other vegetation occurring within the project site which interfere with excavation, embankment, channel flow or clear vision, or are otherwise noted on the construction drawings to be removed and includes the preservation from injury or defacement of all vegetation and objects designated to remain. Where removal of a stump may result in damage to existing utilities, the stump shall be removed by chipping to a depth of at least one foot below the finished ground surface. Other stumps may be removed by chipping when approved by the ENGINEER. Any trees or shrubs that are designated to be saved but are damaged by the CONTRACTOR's operations shall be repaired or replaced by the CONTRACTOR, as directed by the ENGINEER, at no additional cost to the Owner.

1.02 PERMITS:

A. Permit for transport and disposal of debris by CONTRACTOR.

PART 2 - PRODUCTS

2.01 MATERIALS:

A. Except as noted the CONTRACTOR maintains possession of all materials being demolished.

B. Growth preventative material shall be provided by OWNER and applied by a certified applicator.

PART 3 - EXECUTION

3.01 GENERAL:

A. Unless specified otherwise on the Plans.

B. Contractor shall adhere to the easement special provisions and coordinate tree removal with property owners.

C. Limits of Work:
1. Clear within drain right-of-way for access lane on one side. Remove trees on opposite side within 5' of the top of bank.
2. Clear both sides of channel to top of bank (Brush hog / mow) and remove log jams and debris from the channel. Healthy trees are to remain if they do not interfere with the flow or the construction process and are not in danger of falling into the drain, leaning, and root structure has not been undermined.
3. Grubbing is not required except where tree roots interfere with construction.

D. Precautions: Avoid damage to stable, vegetated channel banks, or to trees and shrubs that are not designated for excavation or removal during completion of the clearing operations.

E. Ownership:
1. The property owner shall have the option of retaining ownership of trees that are removed on his property.
2. CONTRACTOR shall notify the property owner of CONTRACTOR's schedule for clearing in order to allow a reasonable amount of time for removal of material by the property owner.
3. If the owner of the property to be cleared requests to maintain possession of the material to be cleared the CONTRACTOR shall have the property owner complete the Land Owner Agreement Form found in the Supplemental Conditions. Cleared material claimed by the property owner shall be placed outside of the drain easement

4. Trees, stumps, etc., that are not removed by the property owner after a reasonable amount of time shall become the property of CONTRACTOR and shall be removed or disposed of in accordance with the Specifications.

3.02 CLEARING:

A. Cutting:
1. Cut trees and brush a maximum of 4 inches above the ground.
2. Remove tree tops and limbs prior to cutting the entire tree if necessary to avoid damage to adjacent structures or trees that are not designated for removal.
3. The final cut shall be an even cut, parallel with the ground.

B. Log Jams, Deadfall and Debris:
1. Trees, log jams, deadfall and debris within the drain cross section shall be removed.

C. Access:
1. Restrict equipment access for Clearing operations to areas indicated on the Drawings or as designated by ENGINEER.
2. Equipment shall remain outside of the channel limits unless authorized by ENGINEER.

D. Fruit Trees: Clear only when authorized by ENGINEER.

3.03 GRUBBING:

A. Stump Removal: Stumps shall be removed if they interfere with the flow or construction of the Drain.

B. Stump Treatment: Treat all stumps with a growth preventer provided by Owner.

C. Utilities:
1. Notify ENGINEER of instances in which stump removal may result in damage to existing utilities or culverts.
2. Be responsible for damage to utilities that may result from stump removal.

3.04 DISPOSAL:

A. Trash, debris and other nonwoody material: Sort out and dispose of in a licensed landfill.

B. Burning:
1. Woody material may be disposed of by burning where authorized by ENGINEER and in accordance with all local, State and Federal regulations.
2. Maintain a minimum 200 feet horizontal isolation distance between overhead public utilities or wooded areas and burning piles.
3. Bury material that remains following burning or remove from the Site.
4. Burning will not be permitted in areas with combustible organic soils.

C. Chipping:
1. Chipping may be allowed in areas authorized by ENGINEER that do not conflict with the present land use.
2. Wood chip piles may not exceed 6-inches in height (thickness).

D. Debris Piles:
1. All brush shall be brush mowed.
2. Brush too large for the brush mower shall be burned, chipped, or hauled offsite.
3. Brush piles shall not be laid along the easement.
4. Logs larger than 8-inches in diameter can be stacked in sporadic, neat piles within the drainage easement so long as they do not conflict with present land use.

E. Removal: Material that is required to be removed from the site shall become the property of the CONTRACTOR.

3.05 MAINTENANCE:

A. Clear and snag trees that become unstable (lean) or fall into drain between completion of the work and final completion.

PART 1 - GENERAL

1.01 DESCRIPTION:

A. This section includes the work required for trenching, excavating and backfilling, clearing, special pipe foundations, and special work below grade.

1.02 DEFINITIONS:

A. Maximum density: Maximum dry weight in pounds per cubic foot of a specific material.

B. Optimum moisture: Percentage of water at maximum density.

C. Rock excavation: Includes all boulders or rock weighing 400 pounds (approx. one cubic yard) or more and all solid or ledge rock, slate, shale, sandstone, and other hard materials that require continuous use of pneumatic tools, heavy rippers, or continuous drilling and blasting for removal. Pavements are not included.

D. Suitable Excavated Material: Mineral (inorganic) soil free of cinders, refuse, sod, boulders, rocks, pavement, soft or plastic clays, vegetable or other organic material and capable of being compacted as specified. Moisture content has no bearing on the suitability of materials to be used.

E. Granular Material: Coarse grained material having no cohesion, which derives its resistance to displacement from internal stability.

F. Cohesive Material: Fine grained material which derives its resistance to displacement by mutual attraction between particles of the mass, involving forces of molecular origin (i.e. Clays are considered cohesive).

1.03 REFERENCES:

A. MDOT - Michigan Department of Transportation, "Standard Specifications for Construction," 2020

B. MDOT – Density Control Handbook, latest edition.

C. American Society of Testing Materials, latest edition.

1.04 SUBMITTALS:

A. Quality Assurance/Control Submittals: For imported materials:
1. Source.
2. MDOT classification.
3. Gradation.

B. Testing and Inspection Reports: Written reports shall be submitted to ENGINEER, with copy to the CONTRACTOR, documenting testing and/or inspection results. Tests shall include:
1. Test results on borrow material.
2. Gradation analysis for granular backfill and sub-base materials.
3. Field reports for in-place soil density tests.

1.05 JOB CONDITIONS:

A. Obtain and comply with construction permits from agencies having jurisdiction over the work.

B. Scheduling: Clean up promptly following utility installation backfilling.

C. Dust Control: Broom or apply dust palliatives as needed.

D. Existing Structures, Utility Structures, and Utilities:
1. Call MISS DIG to locate existing underground utilities prior to starting excavation.

2. Where utilities, utility structures or structures are encountered which are in active use:
   a. Provide adequate protection for them.
   b. Be responsible for damage to them.
3. Provide stand-by utility service if temporary removal is necessary for a period exceeding 2 hours.
4. Where utility service connections to occupied buildings must be temporarily disconnected, give 48 hours notice to the affected occupants of the time and duration of the anticipated shutoff.
5. Notify Fire Department 48 hours in advance if water main or fire supply line shutoff is required.
6. Raise, lower, or move underground utilities, utility structures or structures which interfere with the utility or utility structure being constructed as part of this Work.

PART 2 - PRODUCTS

2.01 MATERIALS:

A. General:
   1. Approval Required: Material shall be subject to the approval of ENGINEER.
   2. Notification: For approval of imported material, notify ENGINEER at least 1 week in advance of intention to import material, designate the proposed borrow area, and permit ENGINEER to sample as necessary from the borrow area for the purpose of making acceptance tests to prove the quality of the material.

B. Material Sources and Uses:
   1. Imported Material:
      a. Stone stabilization course.
      b. Bedding.
      c. Trench backfill.
   2. Native material unless quantity is not sufficient; then shall be imported material: Suitable material.

C. Stone Stabilization Course:
   1. Crushed Stone: MDOT 6A or crushed concrete ranging from 1 to 3 inches in nominal diameter and containing less than 7 percent passing the No. 200 sieve.
   2. Filter Fabric:
      a. By Mirafi; Amoco; Exxon; Nicolon; or equal.
      b. Monofilament polypropylene heavy, woven fabric.
      c. Equivalent opening size of 70.

D. Bedding: MDOT 902 Coarse Aggregate 17A or 26A.

E. Trench Backfill: MDOT 902 Granular Material Class II.

F. Suitable Material:
   1. Native Material Which is Used as Backfill:
      a. Exclusive of gray or blue clay, peat, organic matter, or frozen lumps.
      b. Containing no rocks or lumps over 3 inches in greatest dimension.
      c. Having a moisture content such that material is capable of being compacted to 90% maximum density.
   2. MDOT 902 Granular Material Class II if native material is not adequate in opinion of ENGINEER.

PART 3 - EXECUTION

3.01 PREPARATION:

A. Conflicting Utilities:
1. Before starting excavation, establish location and extent of existing utilities in work area.
2. Establish potential conflict areas prior to construction.
3. Excavate and expose existing utilities presenting potential conflict to determine their exact location and elevation.
4. Provide adequate means of support and protection during operations.
5. Advise ENGINEER of conflicts and obtain instructions on how to proceed.
6. Make adjustments in proposed utility location at no additional cost to OWNER.
7. Make arrangements with owner of existing utility for relocation, if necessary.
8. Schedule work accordingly.

B. Signs, mailboxes, fences and other movable surface features:
1. Witness location prior to removal. Relocate to accessible location and maintain during construction.
2. Upon completion of construction, replace to original position and condition.
3. Replace regulatory traffic control signs immediately after utilities are placed and backfilled.

C Property Irons
1. Protect existing property irons at edge of right-of-way. If property iron must be removed for construction, the CONTRACTOR shall have a registered professional surveyor witness the property iron(s) prior to disturbance and replace the existing property iron(s) at the CONTRACTOR'S expense.

D. Clearing and Grubbing:
1. Remove trees and shrubs not indicated to be preserved, as required.
2. Grub out all roots.
a. To a minimum depth of 4 feet below finished grade within roadways.
b. To a minimum depth 2.0 feet below finished grade other location.
3. Remove all debris from site resulting from clearing and grubbing.

E. Topsoil: Remove from all areas of new construction and stockpile on site in designated areas.

F. Protect Plantings and other features to remain as part of final landscaping.

3.02 EXCAVATION:

A. General:
1. Dispose of surplus and unsuitable excavated material.
2. Remove, salvage and stockpile topsoil on-site in area designated by ENGINEER.
3. Unsuitable material encountered in subgrade or below payment line: Notify ENGINEER and obtain instruction on how to proceed.

B. Trenches:
1. Depth: Provide a uniform and continuous bearing and support for proposed utility on solid and undisturbed or compact granular material.
2. Minimum Width: Allow space for jointing and bedding.
3. Maximum Width: Limitations apply at utility crown.
a. 6 inch through 10 inch diameter: 30 inches.
b. 12 inch to 30 inch diameter: Outside diameter plus 24 inches.
c. 30 inch and over diameter: Outside diameter plus 36 inches.
d. Elliptical: Outside pipe width plus 36 inches.
4. Maximum Width of Trench at Ground Surface:
a. Not outside of the property line or easement.
b. As required for protection of the Work and safety of workers.
c. Use sheeting, bracing and shoring if required.

C. Length of Open Trench: Maximum 200 feet.

D. Damage to Existing Underground Utilities:
1. Report all damage to ENGINEER and Utility Owner.
2. Repair to utility owner's standard at CONTRACTOR's expense.

3.03 BACKFILLING:

A. Pipe bedding area: Compact granular material to 95% of maximum density.

B. Compaction:
1. Determine density by the modified Proctor method, ASTM D1557.
2. Compact trench backfill and bedding to at least 95% maximum density.
3. Compact suitable material to at least 90% maximum density.
4. The first 12 inches of native material at the bottom of utility trenches:
a. Test for density.
b. Compact to at least 95% maximum density if the existing density is below 95%.

C. Structures:
1. Density requirements: Same as Trenches.
2. Concrete structure: Place backfill only after 75 percent of concrete design strength has been reached.

3.04 TESTING AND INSPECTION:

A. Performance and test equipment: Paid for by the CONTRACTOR, performed by ENGINEER or OWNER approved independent laboratory.

B. Moisture - Density relationships:
1. AASHTO T99 Method C

C. Field Density: Either of following:
1. ASTM D-2167 (Rubber Balloon)
2. ASTM D-2922 (Nuclear)
3. AASHTO T191
4. One Point Michigan Cone

D. Furnish equipment and personnel to provide access to test location and depth. Density tests will be performed at various levels, as determined by ENGINEER, during or after backfilling operation.

E. Correct any deficiencies resulting from insufficient or improper compaction. Retest if required.

3.05 SOIL EROSION AND SEDIMENTATION CONTROL:

A. In accordance with Section 01570 "EROSION AND SEDIMENTATION CONTROL"

3.06 SURPLUS MATERIALS:

A. Surplus excavated and unsuitable excavated material becomes the property of the CONTRACTOR.

C. Dispose of surplus excavated or unsuitable excavated materials off-site or on-site in areas designated by ENGINEER in accordance with all Local, State and Federal regulations.

3.07 EXCESS WATER CONTROL

A. Regulations and Permits: Comply with soil erosion control permit in accordance with Mich. P.A. 451, Part 91 of 1994, the Natural Resource and Environmental Protection Act, and all pertinent rules, laws, and regulations.

B. Unfavorable Weather:
1. Do not place, spread or roll fill material during unfavorable weather conditions.
2. Do not resume operations until moisture content and fill density are satisfactory to ENGINEER.

C. Pumping and Drainage:
1. Provide, maintain and use at all times during construction adequate means and devices to promptly remove and dispose of water from every source entering the excavations or other parts of the Work.
2. Dewater by means which will ensure dry excavations, preserve final lines and grades, and do not disturb or displace adjacent soil. Use wells, portable pumps, temporary underdrains, or other methods as necessary.
3. Perform Pumping and Drainage:
   a. In such a manner to cause no damage to property or structures and without interference to the rights of the public, owners of private property, pedestrians, vehicular traffic, or the work of other CONTRACTORs.
   b. In accordance with pertinent laws, rules, ordinances, and regulations.
4. Do not overload or obstruct existing drainage facilities.

D. General:
1. Keep excavations dry during construction.
2. Remove water by use of wells, well points, portable pumps, bailing, drains, underdrains or other acceptable methods.
3. Provide crushed stone or gravel as required to aid dewatering operations.
4. Divert or temporarily reroute existing sewers and drainage of discharge lines to adequate and acceptable outlets during construction. CONTRACTOR responsible to ascertain availability of outlets.
5. Divert surface water from entering excavations by construction and maintenance of channels or berms.
6. Sediment traps and other soil erosion control measures shall prevent soil particles from entering any sewer, watercourse or similar conveyance.
7. Protect utilities, utility structures, and structures, existing and new, from hydrostatic uplift.

3.5 SHEETING, SHORING AND BRACING EXCAVATIONS

A. General:
1. Furnish, put in place and maintain sheeting, bracing and shoring as may be required to properly support the sides of excavations and to prevent movement of earth which could in any way injure the Work or adjacent property.
2. Exercise care in the removal of sheeting, shoring, bracing and timbering to prevent collapse or caving of the excavation faces being supported and damage to the Work and adjacent property.
3. A pipe-laying box may be used in lieu of sheeting.

B. Sheeting:
1. Do not install by jetting.
2. Remove as backfilling proceeds, unless ordered left in place by ENGINEER. Use care to fill and compact voids created by removal, especially below mid-height of utility.
3. Sheeting Left in Place:
   a. Requires written approval of ENGINEER.
   b. Cut off minimum of 2 feet below finished grade.

3.6 CLEANUP

A. Upon completion of the work of this Section, remove all excess excavated material, trash, and debris resulting from construction operations. Remove equipment and tools. Leave the Site in a neat and orderly condition acceptable to ENGINEER.

PART 1 - GENERAL

1.01 DESCRIPTION:
A. This section includes work required for storm sewer pipe, structures and related work.

1.02 DEFINITIONS:
A. Line and grade control terminology: SEE PLAN DETAILS

1.03 SUBMITTALS:
A. Submit the following in accordance with SECTION 01330 – SUBMITTAL PROCEDURES.
1. Product Data for all pipe.
2. Shop Drawings on radius pipe.
3. Shop Drawings for all structures.

B. Notify ENGINEER on presence of wastewater:

C. Line and grade control method other than Laser Beam shall be approved by ENGINEER.

1.04 JOB CONDITIONS:
A. Maintain operation of existing storm sewer.

B. Install catch basins and inlet leads as pipe laying progresses and within maximum of 600 feet of mainline sewer installation.

C. Clean-up promptly following pipe installation and within maximum of 400 feet behind pipe laying operation.

PART 2 – PRODUCTS

2.01 PIPE:
A. Dual Wall High Density Polyethylene (PE): Smooth lined corrugated meeting AASHTO M294.

B. Reinforced Concrete Pipe: MDOT Section 402, 909.

2.02 PREMIUM JOINTS:
A. PE: AASHTO M252 or M294, ASTM D3212.

B. Reinforced Concrete Pipe: MDOT 402, 909

2.03 CONCRETE MANHOLES AND CATCH BASINS:
A. Concrete Precast Units: ASTM C478 and ASTM C76 Class III.
1. Joints: Cement mortar, preformed bituminous rope or "o"-ring gaskets.
2. Pipe openings: Pipe diameter plus 6 inch, maximum.

B. Concrete Radial Units: ASTM C139.

C. Grade Rings: ASTM C478. Ladtech HDPE adjusting rings are a suitable alternative.

D. Manhole Steps:
1. Plastic with 3/8 inch steel rod reinforcement.
2. Dimensions: 10-inch deep by 10-inch wide, 5-inch tread depth.

E. Manhole Castings: SEE PLAN DETAILS.

2.04 NYLOPLAST DRAINAGE STRUCTURE:

A. General: As indicated on the Drawings.

B. Type of Unit: ADS Nyloplast 24" Drain Basin: 2824AG, or Equal.

C. Cover: ADS 2499CGD "DOME", or Equal.

PART 3 - EXECUTION

3.01 PREPARATION:

A. Alignment and Grade:

1. Deviations: Notify ENGINEER and obtain instructions to proceed where there is a grade discrepancy or an obstruction not shown on the plans.

2. Expose existing utilities at crossings of proposed storm sewer in advance of laying pipe to verify existing depth. Advise ENGINEER of conflicts in grade and provide adjustments in grade of storm sewer at no additional cost to OWNER.

B. Laser Beam Control:

1. Check grade at set-up point, 25 feet, 50 feet, 100 feet and 200 foot points thereafter to the next set-up point.
2. Laser advancement: Reset at each manhole.

C. Bedding:

1. Method: As indicated on the Drawings.
2. Provide bedding area backfill in accordance with SECTION 02315 EXCAVATION AND FILL.
3. Provide continuous bearing by supporting entire length of pipe barrel evenly.

3.02 INSTALLATION:

A. Laying Pipe:

1. Install in accordance with manufacturers recommendations.
2. Provide continuous bearing by supporting entire length of pipe barrel evenly.
3. Direction shall be upstream with spigot or tongue end downstream and bell end upstream.
4. Joints shall be smooth and clean.
5. Wrap joint surfaces with geotextile fabric.
6. Place pipe length and bedding as a unit in a frost free, dry trench.
7. Special supports and saddles: As indicated on the Drawings.

B. Manholes, Catch Basins and Inlets:

1. General: SEE PLAN DETAILS
2. Base bedding: Provide 4 inches of pea stone with full and even bearing in impervious soils or wet conditions. Otherwise provide on undisturbed frost-free dry subgrade.
3. Adjusting rings: Set in full bed of mortar, joints maximum 1/2 inch at inside face and wipe joints. Plaster coat complete interior of structure with 1/2-inch coat of cement mortar. For HDPE adjusting rings, follow manufacturers installation instructions.
4. Provide manhole casting grade setting as follows:
   a. Existing pavement: Finished grade.
   b. Gravel or lawn grade: 4 inches below.
   c. Unpaved areas: Finished grade.
5. Provide catch basin casting grade setting as follows:
   a. Gutter grade: 1/2 inch below.

C. Connections:

1. Existing storm sewer:
   a. Structures: Relay and repoint loose blocks and bricks.
2. Future Storm Sewer:
   a. Bulkhead: Pipe 24 inch and larger with brick and mortar, 1/2 inch plaster outside.

3.03 GENERAL CONSTRUCTION and TOLERANCES:

A. General:

1. Coordination: By ENGINEER.
2. Completion: Before connecting to active system.
3. Notification: Arrange with ENGINEER for inspection.
4. Keep pipe and structures clean as work progresses.

B. Line and Grade Tolerances: Allowable drift between structures from proposed alignment will be as follows:

1. Line:
   a. Thru 36 inch: 0.40 foot.
   b. Over 36 inch: 0.80 foot.
2. Grade:
   a. Thru 36 inch: 0.05 foot.
   b. Over 36 inch: 0.10 foot.

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Work includes construction of new HMA pavements including associated earthwork, paving and surfacing for all roads.

B. Definitions:
1. Pavement structure: Any combination of subbase, base course, and surface course, including shoulders, placed on a subgrade.
2. Permanent pavement: All improved pavement surfaces above the quality of treated or untreated gravel.
3. Subgrade: That portion of the earth grade upon which the pavement structure is to be placed.
4. Subbase: The layer of specified material of designed thickness placed on the subgrade as a part of the pavement structure.
5. Base course: The layer or layers of specified or selected material of designed thickness placed on a subbase or a subgrade to support leveling and surface courses.
6. Leveling course: Layer of specified material placed on the base course in preparation for the surface course.
7. Surface course: The top layer of a pavement structure.
8. Maximum density (soils): Maximum unit weight of soil material according to Modified Proctor Method ASTM D1557.
9. Maximum density (HMA): Maximum unit weight of a representative sample of the hot mix asphalt according to the Marshall Method ASTM D2726.

1.02 REFERENCES:

A. Michigan Department of Transportation (MDOT), "Standard Specifications for Construction," 2020.

B. American Society of Testing Materials (ASTM), latest edition.

1.03 SUBMITTALS:

A. Asphalt Mix Design: Provide job-mix formula prepared by independent lab or approved by MDOT for HMA leveling and surface courses to ENGINEER two weeks prior to paving.

B. Certification of quality by producer for the following:
1. Cement
2. Aggregates
3. Asphalt cement
4. Pavement marking material
5. Prime coat
6. Bond coat

C. Concrete Test Specimens: Provide sample.

1.04 JOB CONDITIONS:

A. Seasonal Limitations:
1. Removal of permanent pavement: Unless otherwise specified, execute during the period from March 15 to October 15.
2. Restoration of permanent pavement: Unless otherwise specified, execute during the period from May 5 to November 15 (Region South of M-46).

B. Clean up promptly following pavement installation.

C. Maintenance of Temporary Surfaces: Maintain temporary surfaces until permanent pavement installation is completed.

D. Driveway Closing: 48-hour maximum

E. Allow access to the HMA plant for verification of mix proportions, aggregate gradations, and temperatures.

PART 2 - PRODUCTS

2.01 MATERIALS:

A. Subbase: Granular material MDOT Class II or IIA, MDOT 301 and 902.07.

B. Aggregate Base Course: For bases to be surfaced with concrete or HMA, use Aggregate 22A unless otherwise specified. MDOT 302 and 902.05.

C. Aggregate Surface Course:
1. Use Aggregate 22A when the Aggregate surface course is to receive a HMA surface at a later date. MDOT 306 and 902.05.
2. Use Aggregate 23A when the Aggregate Surface Course is to be constructed without a HMA surface. MDOT 306 and 902.05.

D. Aggregate Shoulders and Approaches:
1. Use Aggregate 22A for construction of Class AA shoulders and approaches. MDOT 307 and 902.05.
2. Use Aggregate 23A for construction of Class A shoulders and approaches. MDOT 307 and 902.05.
3. Use roadway excavation or borrow material for construction of Class B shoulders and approaches. MDOT 307 and 902.05.

E. HMA Base Course: Shall be an MDOT mixture as indicated on Plans.

F. HMA Leveling and Surface Courses: Shall be an MDOT mixture as indicated on Plans.

G. HMA Bond Coat: HMA material. MDOT Table 904-5 and Table 904-6. (SS-1h, CSS-1h Asphalt emulsion)

I. Pavement Marking: Conform to MDOT 920.

PART 3 - EXECUTION

3.01 PREPARATION:

A. Removal: Remove all existing pavement structure required, as shown on the plans or in the proposal.
1. Pavement remnant limit: Remove pavement to edge or joint, where dimension is less than 3 feet. All removals shall be to a saw cut edge if a joint is more than three feet away.
2. Butt joint: Provide where new pavement meets existing pavement.

B. Dispose of all material removed during the construction.

C. Subgrade:
1. Obtain approval prior to placing the subbase or base course.
2. Construct to the required line, grade and cross section. MDOT 205.03.N.
   a. Tolerance if subbase is required: Trim within $\pm$ 1inch of design grade.
   b. Tolerance if subbase is not required: Trim within $\pm$ 3/4 inch of design grade.
3. Compaction:
   a. Compact to not less than 95 percent of the maximum density using Modified Proctor.

D. Excavation: Conform to MDOT 205.03.G.

E. Embankment: Conform to MDOT 205.03.H.

3.02 PERFORMANCE:

A. Subbase:
1. Thickness: Conform to design cross section.
2. Construction method:
a. Place in layers not exceeding 12 inches loose measure.
b. Spread evenly and compact to not less than 95 percent maximum density according to Modified Proctor.
c. Conform construction to MDOT 301.01 thru 301.03.

B. Aggregate Base Course:
1. Thickness: Compacted depth of any layer of aggregate placed, maximum 6 inches, minimum 3 inches.
2. Construction Method: Conform the placing of aggregate base course with MDOT 302.01 thru 302.03.
3. Tolerances:
a. Curbed streets: Shape the aggregate base course to the established grade and cross section, within a tolerance of 1/4 inch.
b. Other: Unless otherwise specified, shape within 1/2 inch of the established grade and cross section.
c. Check and correct grades prior to pavement placement.

C. Aggregate Surface Course:
1. Thickness: Maximum 6 inches thickness of any one layer when compacted, unless otherwise specified.
2. Construction Method: Conform construction of an aggregate surface course to MDOT 306.01 thru 306.03.

D. Shoulder Area (aggregate): Provide 4 inches thickness of compacted aggregate shoulder on an aggregate base, unless otherwise specified.

E. Shoulder Area (other than aggregate): Stabilize shoulder to a 4 inch depth with compacted soil or topsoil.

F. HMA Base Course:
1. Thickness: Maximum lift thickness - 2 inches compacted, unless otherwise approved. MDOT 501.03.F.
2. Construction Methods: Conform placement of the HMA base course mixture in accordance with MDOT 501.03.F.
3. Tolerances:
a. Curbed streets: Shape the HMA base course to the established grade and cross section, within a tolerance of 1/4 inch. Windrowing (placing a lift of varying thickness to create a crown) HMA shall not be allowed to correct grading deficiencies.
b. Other: Unless otherwise specified, shape within 1/2 inch of the established grade and cross section.

G. HMA Bond Coat:
1. Construction method: Apply between successive paving courses where any soils are tracked onto the finished mat between successive lifts.
2. Application rate: Provide 0.10 gallon per square yard.
3. Not required when permitted by ENGINEER.

H. HMA Leveling and Surface Courses:
1. Cutting: Saw vertically and in straight lines at any angle with pavement centerline.
2. Thickness: Do not place HMA top course mixture in lifts exceeding 2 inches unless otherwise approved.
3. Construction Methods:
a. Paving: Conform method of paving to MDOT 501.03.F.

b. Prior to placement of HMA surface, crowns and grades of roadway will be verified by CONTRACTOR for positive drainage. Any deficiencies in grade or crown shall be corrected prior to placement of surface course.

4. Tolerances: HMA surface on streets with new curbs shall have a finish elevation of 1/4 inch above curb. Windrowing (placing a lift of varying thickness to create a crown) HMA shall not be allowed to correct grading deficiencies.

5. Pavement density: Minimum density of in-place course material when the course thickness is greater than 3 times the maximum aggregate size of the mix shall be 97 percent of the recorded laboratory specimen density and 95 percent when the course thickness is less.

3.03 STRUCTURE ADJUSTMENT:

A. Street Castings.

1. Adjust castings to finish grade or to a maximum of 1/4" below finish grade of all manholes, catch basins, and valve boxes.

a. Set grades of castings and valve boxes from street grades with a tilt of castings where necessary to meet proposed street grades and crown.

b. All castings, when adjusted to finish grade, shall be placed in a bed of hot HMA mix placed in entire area disturbed for casting adjustment. Alternately, as approved by the ENGINEER, a concrete mix may be used in the void created to raise the casting.

2. Castings shall be adjusted to finish grade after the leveling course is complete.

a. Castings shall be kept below grade or flush with the proposed sand subgrade so as not to conflict with grading operations or conflict with placement of leveling course.

3. Adjustment of new structures will not be paid for separately.

3.04 TESTING AND INSPECTION:

A. Inspection: By the ENGINEER or his designated authorized representative.

B. Acceptance Testing:

1. By the CONTRACTOR in accordance with plans and specifications and performed by OWNER and ENGINEER approved third party.

2. If initial testing indicates failed or nonconformance to specifications, perform additional tests. If further testing verifies nonconformance, additional testing shall be paid by CONTRACTOR. Replace nonconforming material at no additional cost to OWNER.

C. Aggregates:

1. Sampling and analysis: Michigan Testing Methods, Series 100.

2. Exception: Provide certification of approved stockpiled material.

D. HMA Mix Composition:

1. Sampling: ASTM D979, one sample per mix or one per two thousand tons.

2. Extraction: ASTM D2172.

3. Sieve analysis: ASTM C117 and ASTM C136.