
Baughman Drain – Division I

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



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



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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-foot 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

SECTION 00100

00100.2
NOTICE OF LETTING

- 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

SECTION 00100

00100.4
NOTICE OF LETTING

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.

SECTION 00200INSTRUCTIONS TO BIDDERS

- 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.

SECTION 00200INSTRUCTIONS TO BIDDERS

- 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





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

A handwritten signature in blue ink, appearing to read "Aaron J. Lammers", positioned above a horizontal line.

cosign

Aaron J. Lammers, EIT
Senior Staff Engineer

A handwritten signature in blue ink, appearing to read "Matt Vander Eide", positioned above a horizontal line.

cosign

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

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FIGURE 6: GROUNDWATER ELEVATION CONTOUR DIAGRAM – APRIL 20, 2017

FIGURE 7: GROUNDWATER ELEVATION CONTOUR DIAGRAM – MAY 16, 2017

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TABLE 2: PRECIPITATION SUMMARY

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SOIL BORING LOGS

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GRAIN SIZE ANALYSIS RESULTS

APPENDIX C

PRECIPITATION SUMMARY CHART

APPENDIX D

PIEZOMETER TIME SERIES CHARTS

APPENDIX E

STAFF GAGE TIME SERIES CHARTS

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® Levellogger™ 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 Boughman 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 Boughman 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

FIGURE 1: PROPERTY LOCATION MAP

FIGURE 2: EVALUATION AREA AND MONITORING LOCATION DIAGRAM

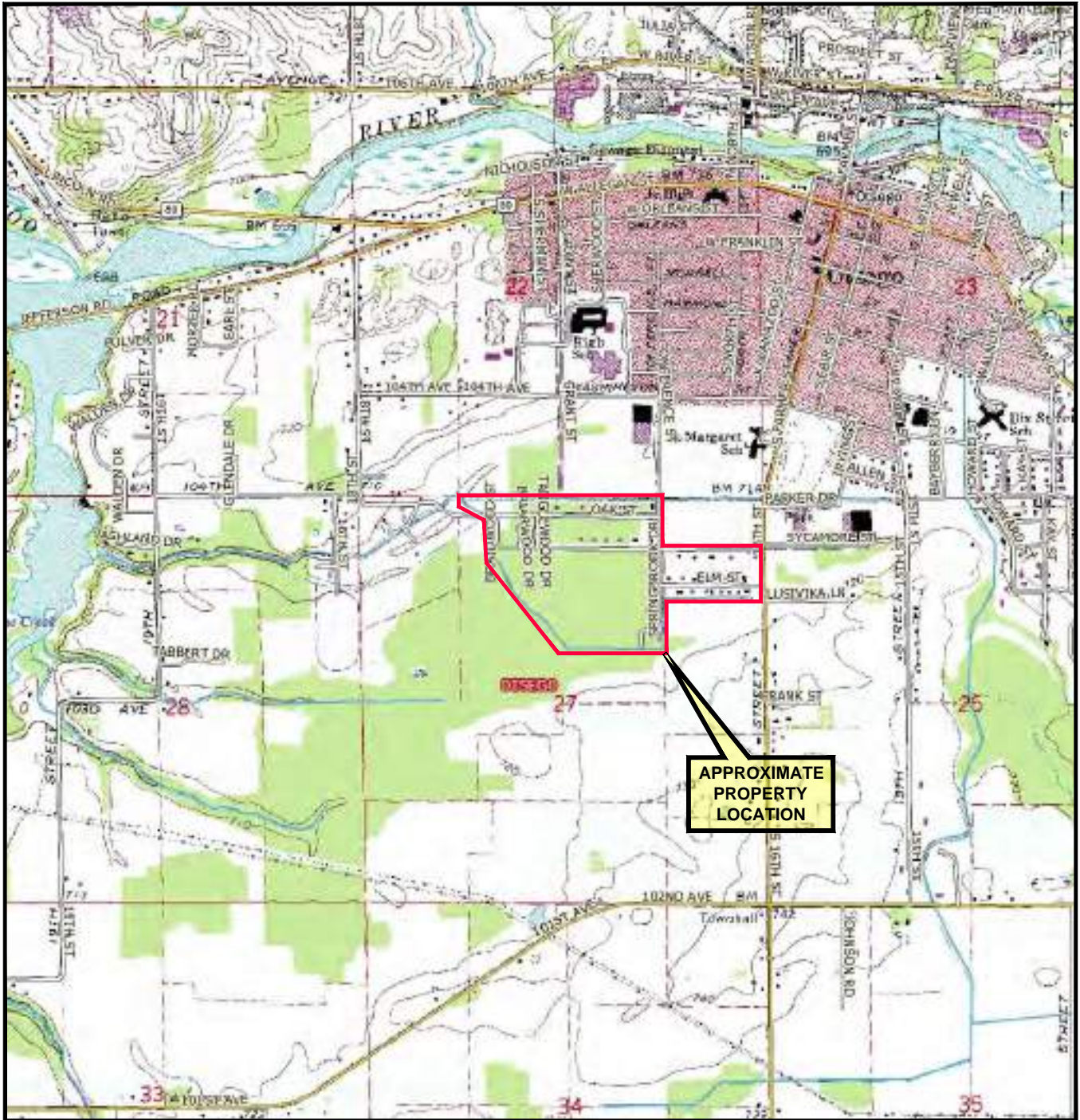
FIGURE 3: GEOLOGICAL CROSS-SECTION A-A'

FIGURE 4: GEOLOGICAL CROSS-SECTION B-B'

FIGURE 5: GROUNDWATER ELEVATION CONTOUR DIAGRAM – MARCH 22, 2017

FIGURE 6: GROUNDWATER ELEVATION CONTOUR DIAGRAM – APRIL 20, 2017

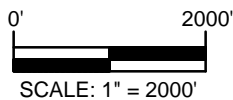
FIGURE 7: GROUNDWATER ELEVATION CONTOUR DIAGRAM – MAY 16, 2017



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

USGS QUADRANGLE(S) REFERENCED

OTSEGO (MI) 1979

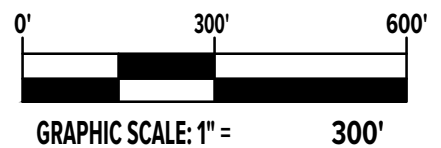


No.	Revision Date	Date	5-3-17
	Drawn By	JAB	
	Designed By	MAV	
	Scale	1" = 2000'	
	Project	075655.00	

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



Figure No. 1



Project
**BAUGHMAN DRAIN
 HYDROGEOLOGIC
 EVALUATION**

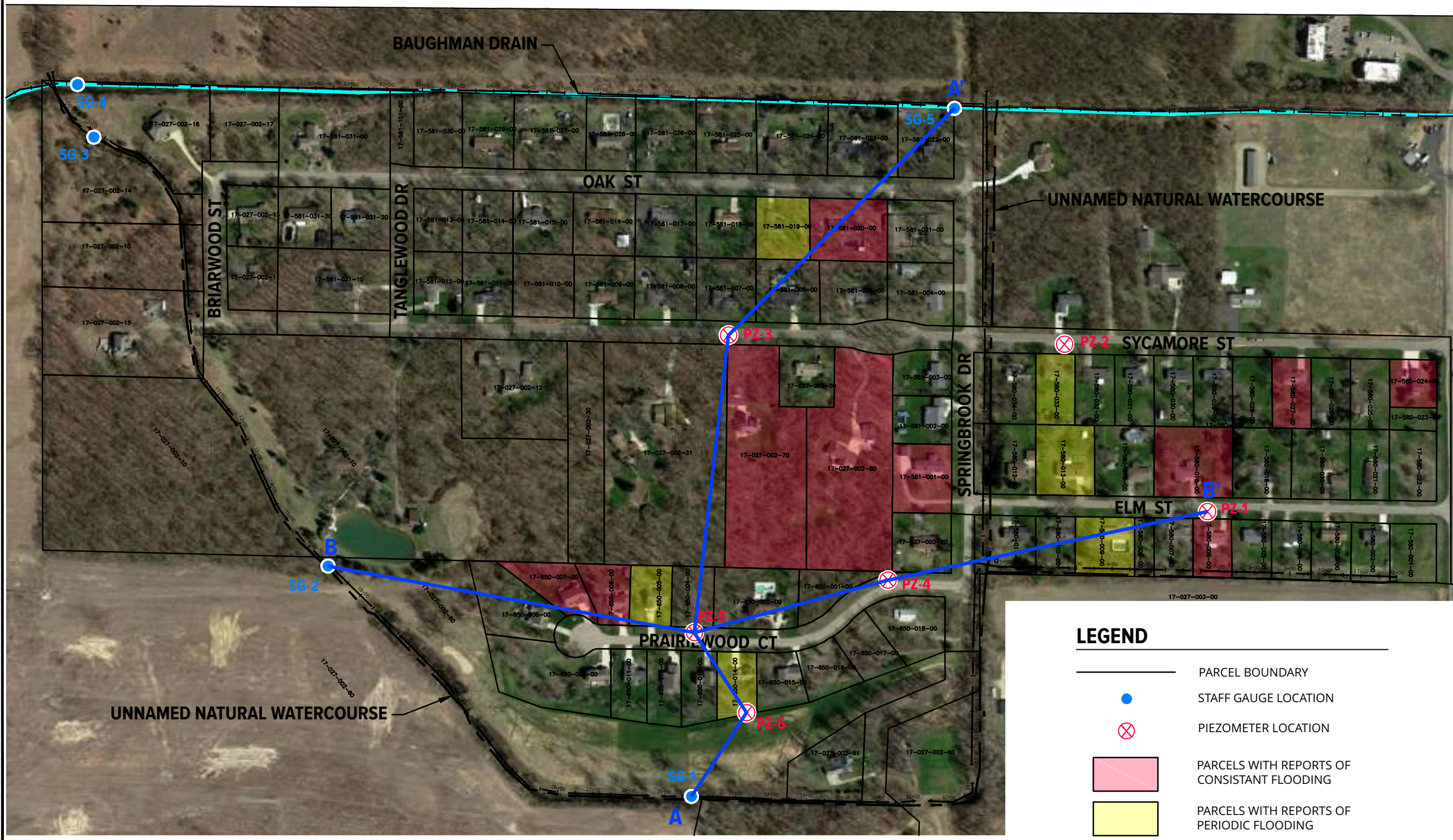
Project Location
**OTSEGO,
 ALLEGAN COUNTY,
 MICHIGAN**

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

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LEGEND

- PARCEL BOUNDARY
- STAFF GAUGE LOCATION
- PIEZOMETER LOCATION
- PARCELS WITH REPORTS OF CONSISTANT FLOODING
- PARCELS WITH REPORTS OF PERIODIC FLOODING
- 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

FILE LOCATION: \\sme-inc\p2\WP\075655.00\CAD\DWG\rev\075655.00-SITE.dwg
 PLOT DATE: Jun 30, 2017 - 11:40am - jblake



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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

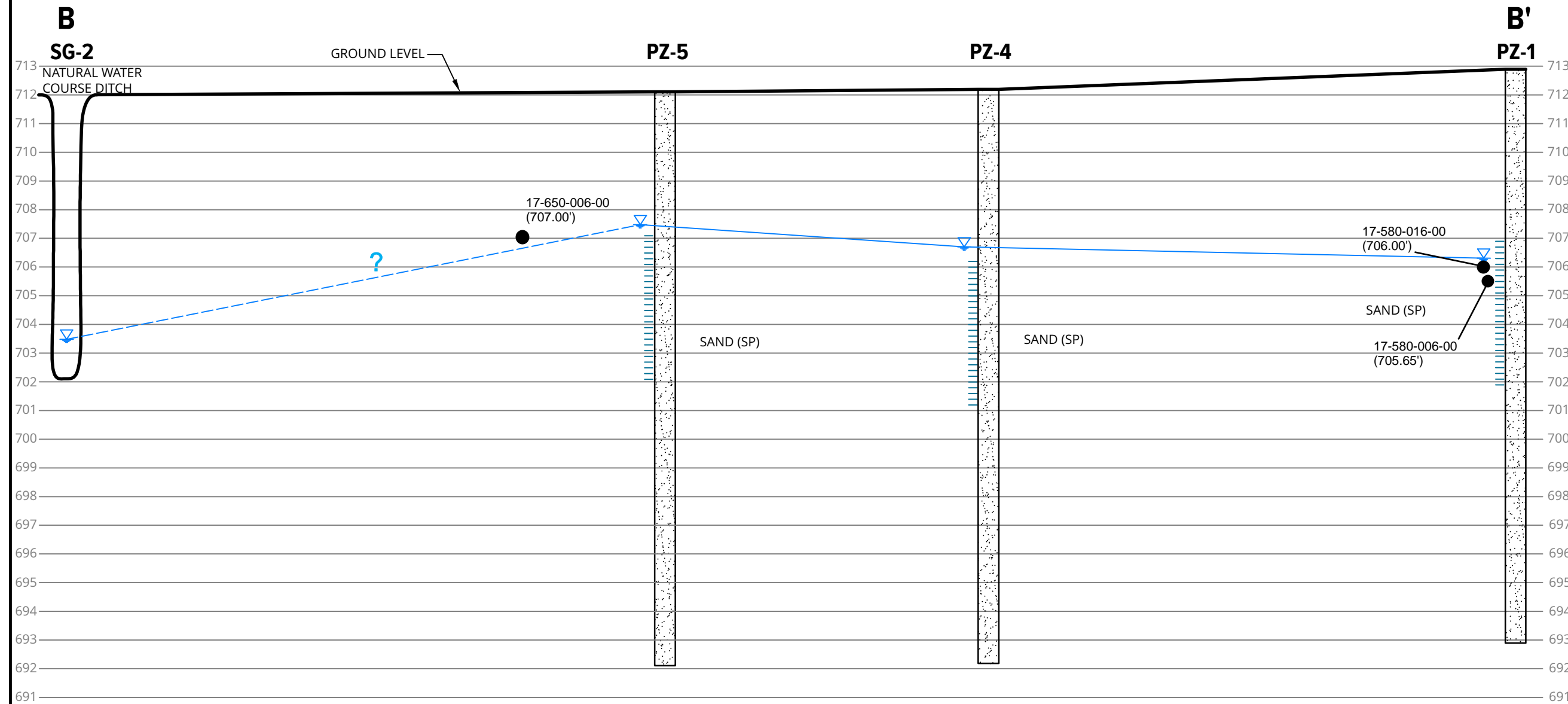
Designer AJL

Scale AS SHOWN

Project 075655.00

Figure No.
4

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LEGEND



SAND



WELL SCREEN INTERVAL



GROUNDWATER ELEVATION
MAY 16, 2017



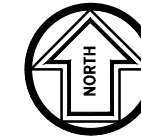
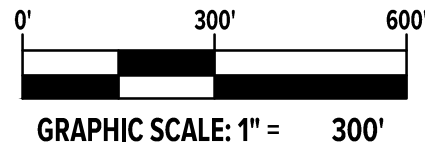
PARCEL ID NUMBER
(BASEMENT FLOOR ELEVATION)

SCALE

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

FILE LOCATION: \\Sme-inc\lpz\WIP\075655.00\CAD\DWGS\rev\075655.00-XS.dwg

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



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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**

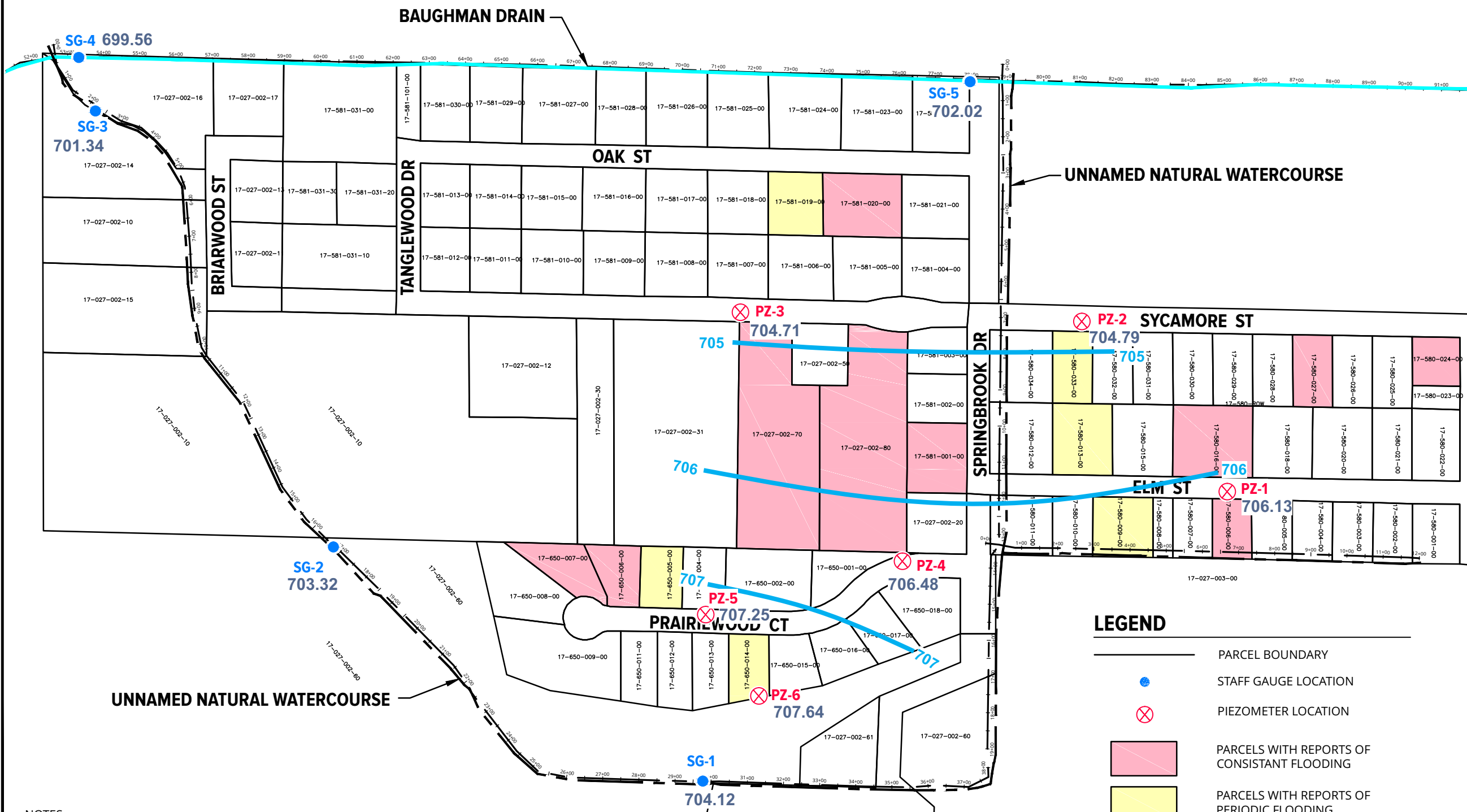
Designer **MAV**

Scale **1" = 300'**

Project **075655.00**

Figure No.
5

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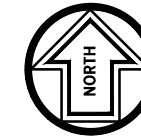
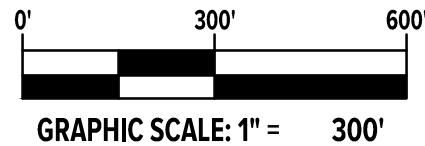


LEGEND

	PARCEL BOUNDARY
	STAFF GAUGE LOCATION
	PIEZOMETER LOCATION
	PARCELS WITH REPORTS OF CONSTANT FLOODING
	PARCELS WITH REPORTS OF PERIODIC FLOODING
	705 GROUNDWATER ELEVATION CONTOUR

- NOTES:
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FILE LOCATION: \\Sme-inc\p\p\075655.00\CAD\DWGS\rev\075655.00-SITE.dwg
 PLOT DATE: May 03, 2017 - 3:35pm - jblake



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Project
BAUGHMAN DRAIN
HYDROGEOLOGIC
EVALUATION

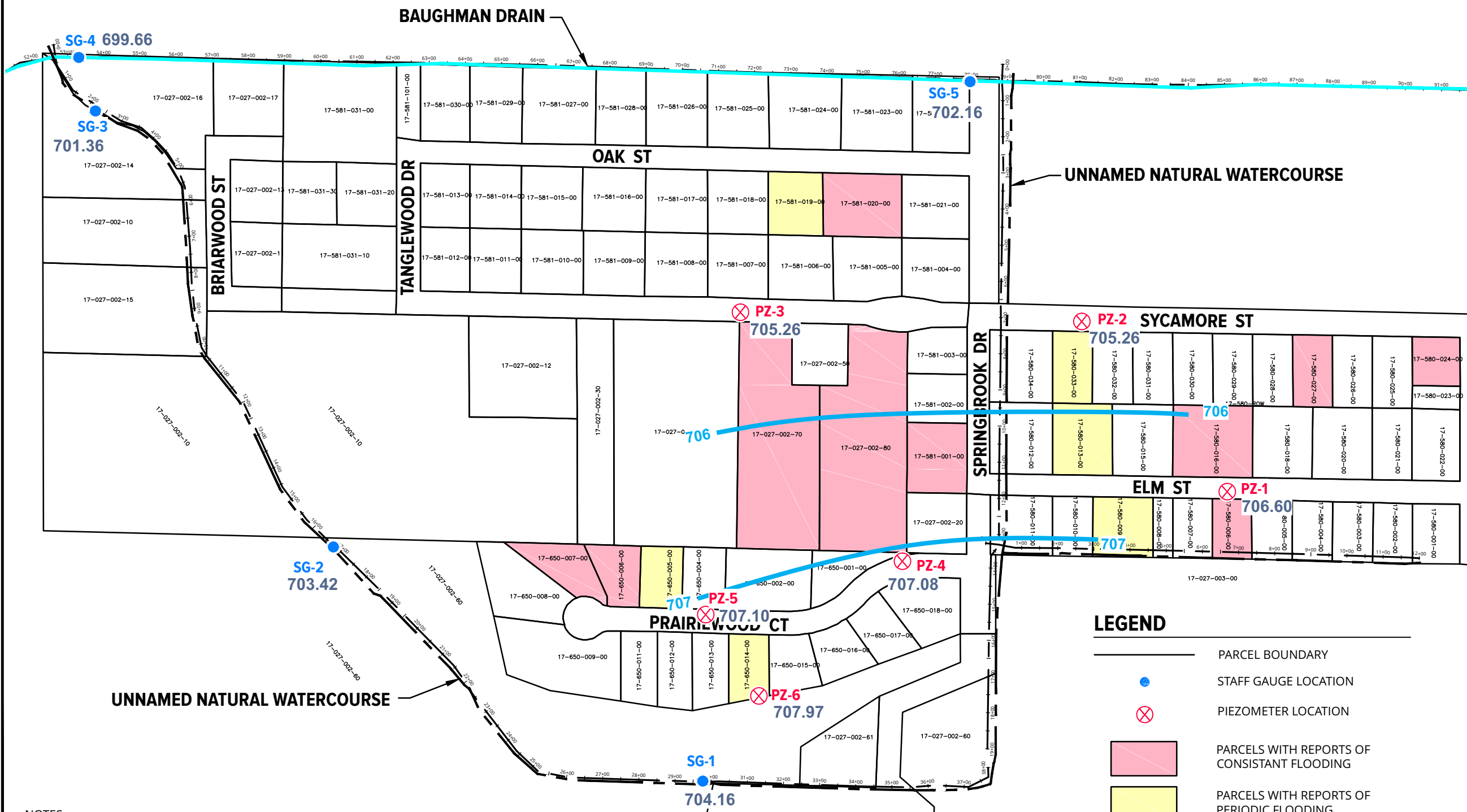
Project Location
OTSEGO,
ALLEGAN COUNTY,
MICHIGAN

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

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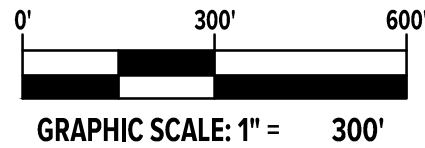


LEGEND

- PARCEL BOUNDARY
- STAFF GAUGE LOCATION
- PIEZOMETER LOCATION
- PARCELS WITH REPORTS OF CONSISTANT FLOODING
- PARCELS WITH REPORTS OF PERIODIC FLOODING
- 705 GROUNDWATER ELEVATION CONTOUR

- NOTES:**
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 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.

FILE LOCATION: \\sme-inc\p\p\075655.00\CAD\DWGS\rev\075655.00-SITE.dwg
 PLOT DATE: May 03, 2017 - 3:35pm - jblake



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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**

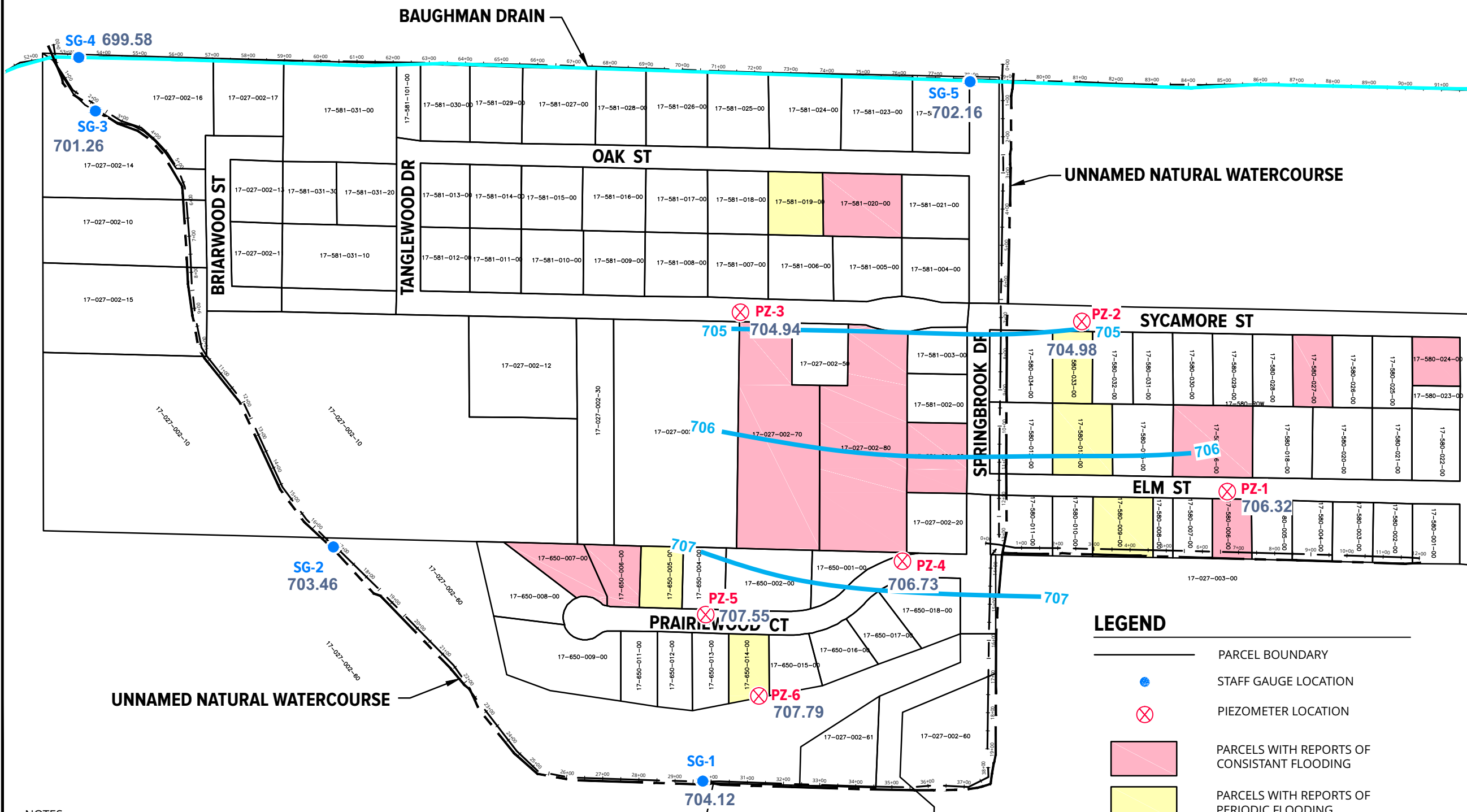
Designer **MAV**

Scale **1" = 300'**

Project **075655.00**

Figure No. **7**

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LEGEND

- PARCEL BOUNDARY
- STAFF GAUGE LOCATION
- PIEZOMETER LOCATION
- PARCELS WITH REPORTS OF CONSTANT FLOODING
- PARCELS WITH REPORTS OF PERIODIC FLOODING
- 705** GROUNDWATER ELEVATION CONTOUR

- 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.

FILE LOCATION: \\sme-inc\p\p\075655.00\CAD\DWGS\rev\075655.00-SITE.dwg
 PLOT DATE: May 03, 2017 - 3:35pm - jblake

TABLES

TABLE 1: GROUNDWATER ELEVATION SUMMARY

TABLE 2: PRECIPITAION SUMMARY



**TABLE 1
GROUNDWATER ELEVATION SUMMARY
BAUGHMAN DRAIN EVALUATION
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 EVALUATION
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



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

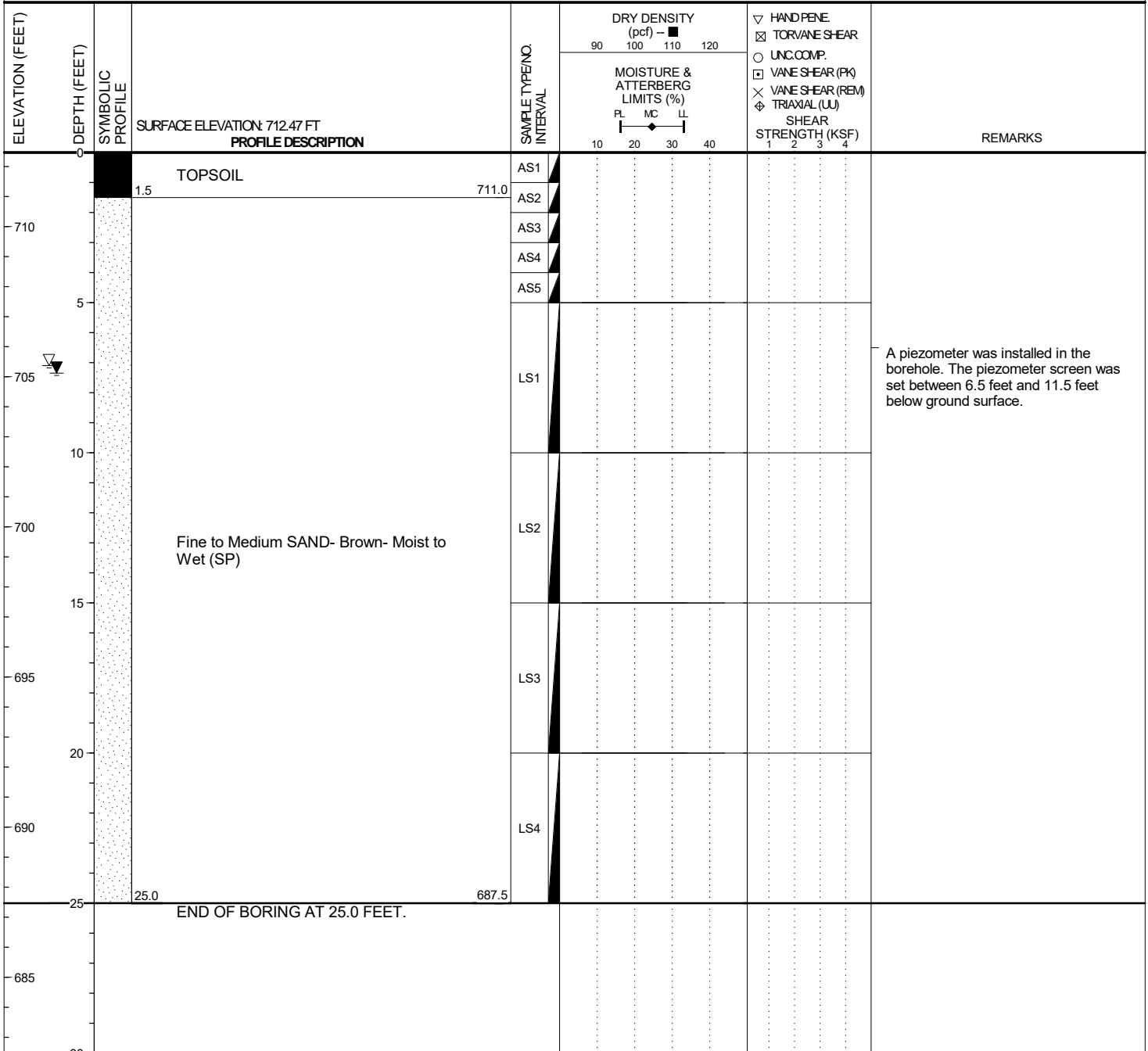
BORING METHOD: Direct Push

OPERATOR: Nick-Fibertec

RIG NO.: 7822 DT-1

LOGGED BY: AJL

CHECKED BY: MAV



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

PAGE 1 OF 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

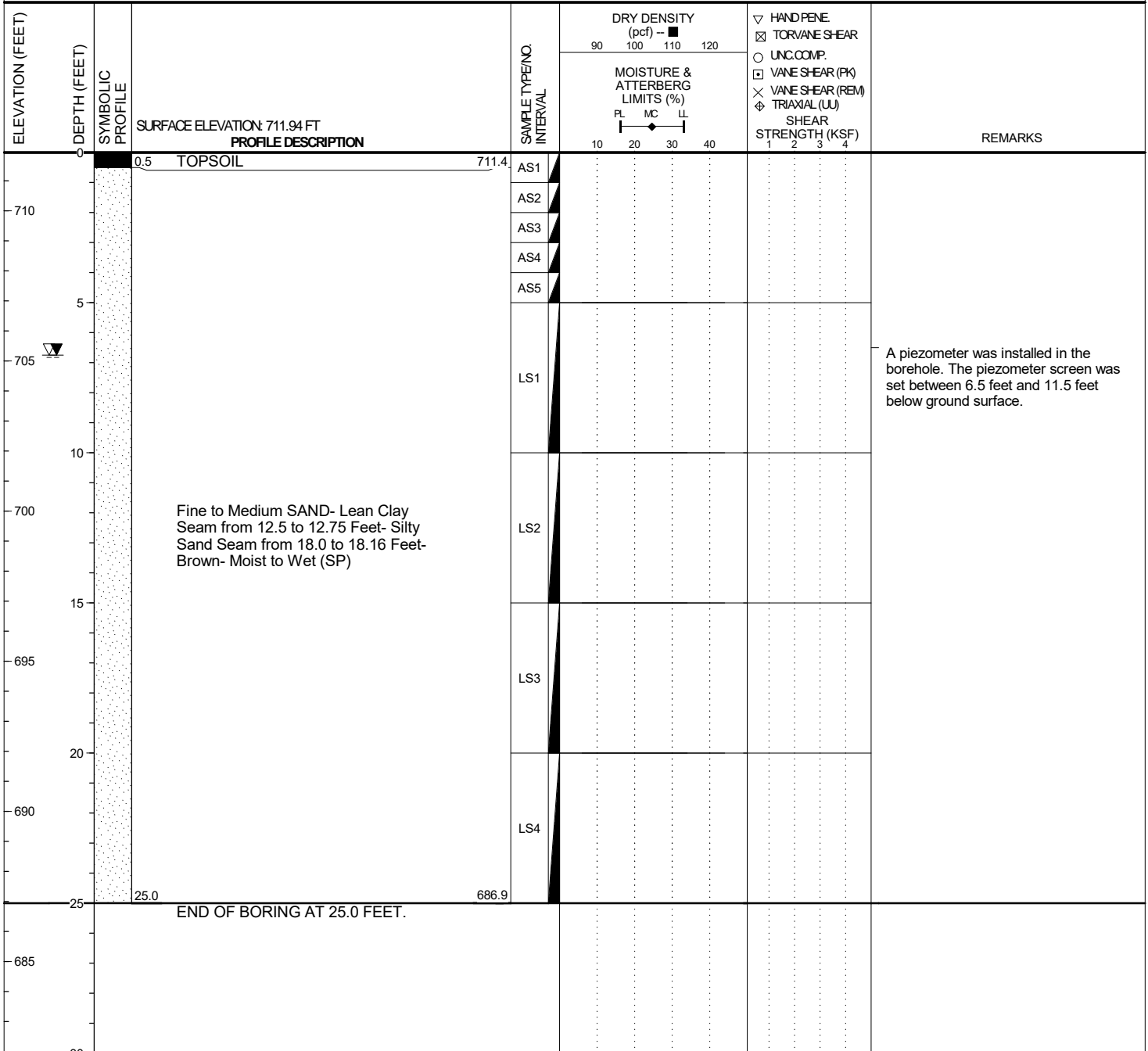
BORING METHOD: Direct Push

OPERATOR: Nick-Fibertec

RIG NO.: 7822 DT-1

LOGGED BY: AJL

CHECKED BY: MAV



GROUNDWATER & BACKFILL INFORMATION		
	DEPTH (FT)	ELEV (FT)
<input type="checkbox"/> DURING BORING:	6.8	705.2
<input checked="" type="checkbox"/> 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.



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

ELEVATION (FEET)	DEPTH (FEET)	SYMBOLIC PROFILE	SURFACE ELEVATION: 712.2 FT PROFILE DESCRIPTION	SAMPLE TYPE/NO. INTERVAL	DRY DENSITY (pcf)	MOISTURE & ATTERBERG LIMITS (%)				TESTS				REMARKS
					90 100 110 120	PL	MC	LL	1	2	3	4		
0	0.5	TOPSOIL	711.7	AS1										
710				AS2										
				AS3										
				AS4										
				AS5										
705				LS1										A piezometer was installed in the borehole. The piezometer screen was set between 6 feet and 11 feet below ground surface.
700			Fine to Medium SAND- Brown- Moist to Wet (SP)	LS2										
695				LS3										
690				LS4										
687.2	25.0		END OF BORING AT 25.0 FEET.											

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

PAGE 1 OF 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

ELEVATION (FEET)	DEPTH (FEET)	SYMBOLIC PROFILE	SURFACE ELEVATION: 712.06 FT PROFILE DESCRIPTION	SAMPLE TYPE/NO. INTERVAL	DRY DENSITY (pcf)	<input type="checkbox"/> HAND PENE <input checked="" type="checkbox"/> TORVANE SHEAR <input type="checkbox"/> UNC. COMP. <input checked="" type="checkbox"/> VANE SHEAR (PK) <input checked="" type="checkbox"/> VANE SHEAR (REM) <input checked="" type="checkbox"/> TRIAXIAL (UU) SHEAR STRENGTH (KSF)	REMARKS
					90 100 110 120		
	0		0.5 TOPSOIL	AS1			
	710			AS2			
				AS3			
				AS4			
	5			AS5			
	705			LS1			A piezometer was installed in the borehole. The piezometer screen was set between 4.5 feet and 9.5 feet below ground surface.
	700		Fine to Medium SAND- Brown- Moist to Wet (SP)	LS2			
	15			LS3			
	695			LS4			
	20						
	690						
	25		25.0 END OF BORING AT 25.0 FEET.				
	685						
	30						

GROUNDWATER & BACKFILL INFORMATION

	DEPTH (FT)	ELEV (FT)
<input type="checkbox"/> DURING BORING:	5.0	707.1
<input checked="" type="checkbox"/> 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

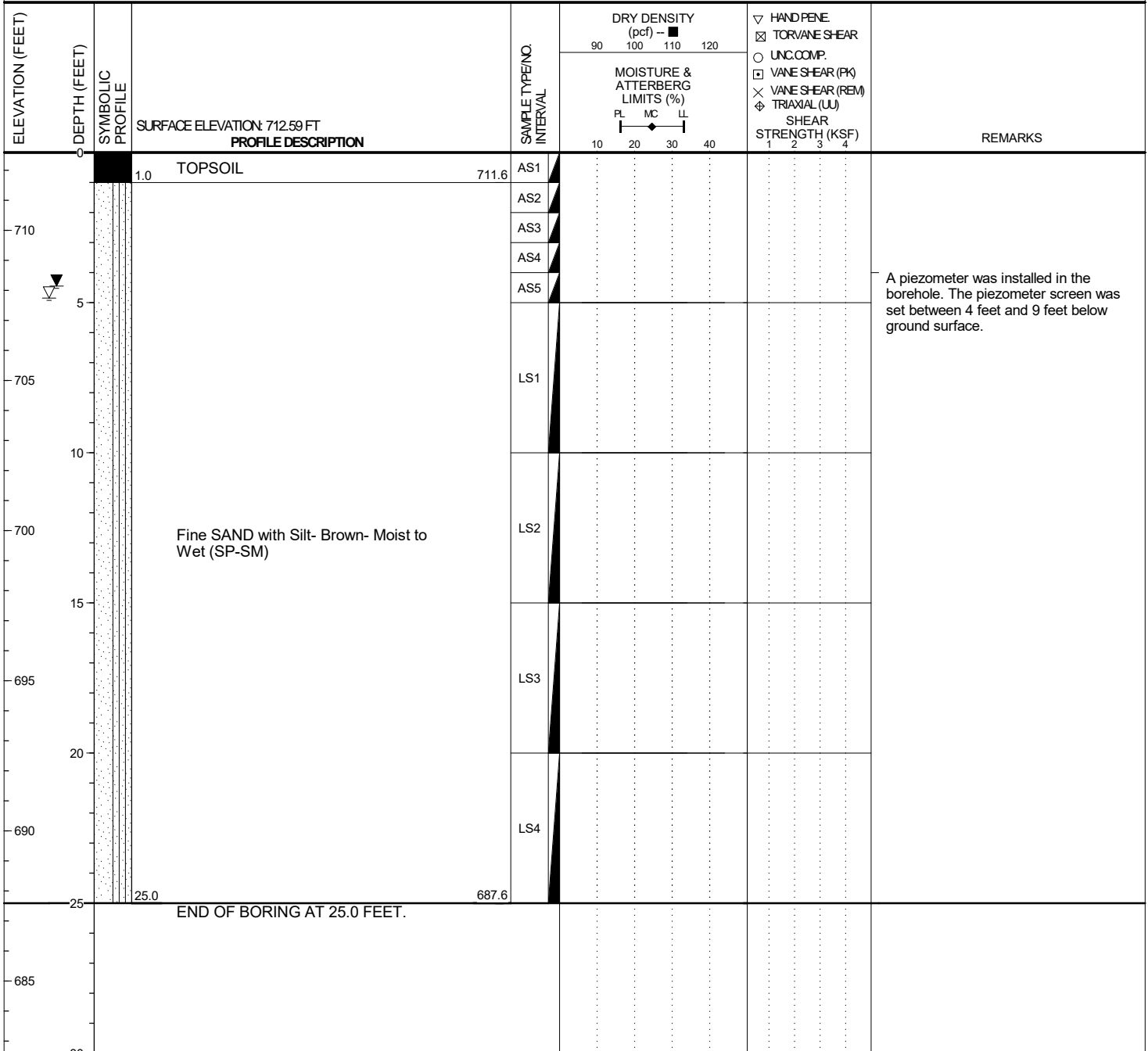
BORING METHOD: Direct Push

OPERATOR: Nick-Fibertec

RIG NO.: 7822 DT-1

LOGGED BY: AJL

CHECKED BY: MAV



GROUNDWATER & BACKFILL INFORMATION		
	DEPTH (FT)	ELEV (FT)
<input type="checkbox"/> DURING BORING:	4.9	707.7
<input checked="" type="checkbox"/> 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



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:

This report represents conditions at specific locations, therefore, conditions might vary away from those locations. No one except our client may rely on our findings/opinions, or reproduce this report. SME is not responsible for site safety on this project.

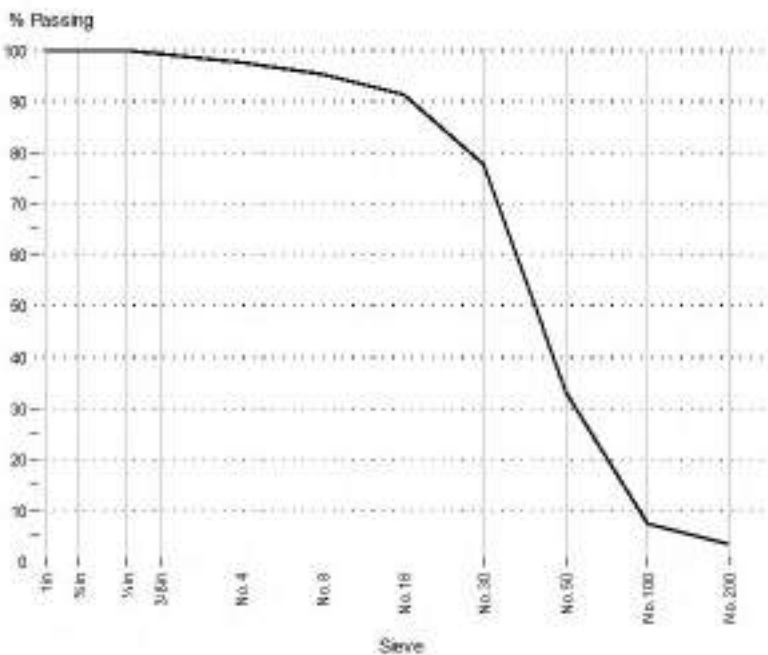

Reviewed By: Jeremy S. Hugo, PE

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

Grading: ASTM C 136, ASTM C 117



Date Tested: 3/13/2017

Sieve Size	% Passing	Limits
1in	100	
3/4in	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	

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

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



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:

This report represents conditions at specific locations, therefore, conditions might vary away from those locations. No one except our client may rely on our findings/opinions, or reproduce this report. SME is not responsible for site safety on this project.

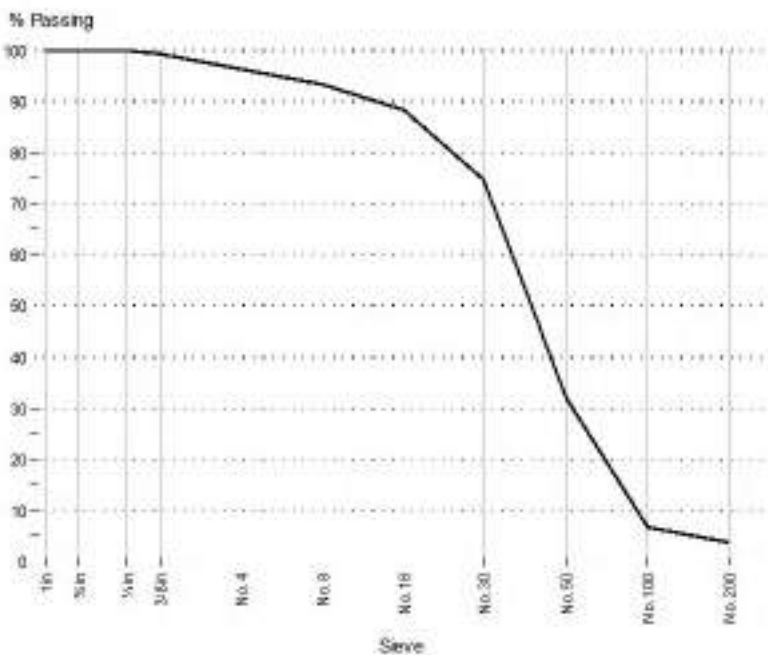

Reviewed By: Jeremy S. Hugo, PE

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

Grading: ASTM C 136, ASTM C 117



Date Tested: 3/13/2017

Sieve Size	% Passing	Limits
1in	100	
3/4in	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	

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

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



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:

This report represents conditions at specific locations, therefore, conditions might vary away from those locations. No one except our client may rely on our findings/opinions, or reproduce this report. SME is not responsible for site safety on this project.



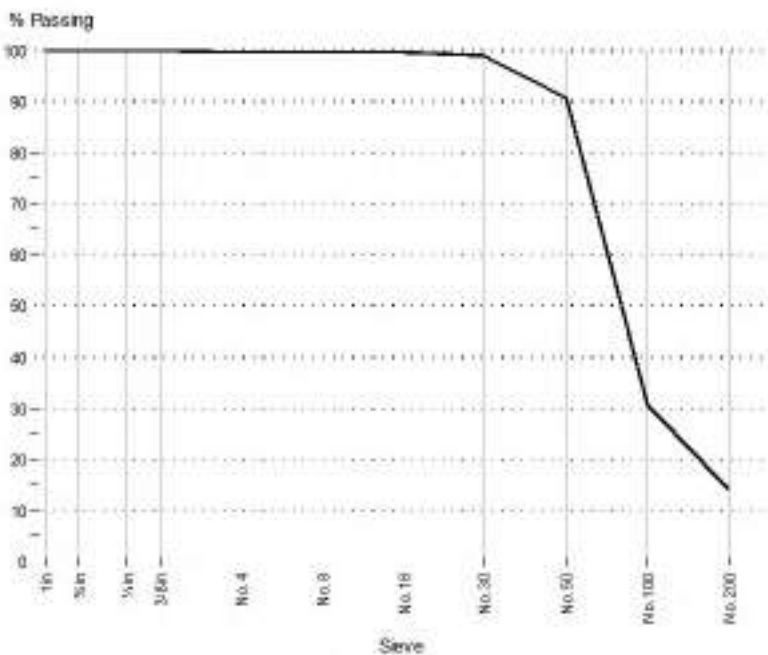
Reviewed By: Jeremy S. Hugo, PE

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

Grading: ASTM C 136, ASTM C 117



Date Tested: 3/13/2017

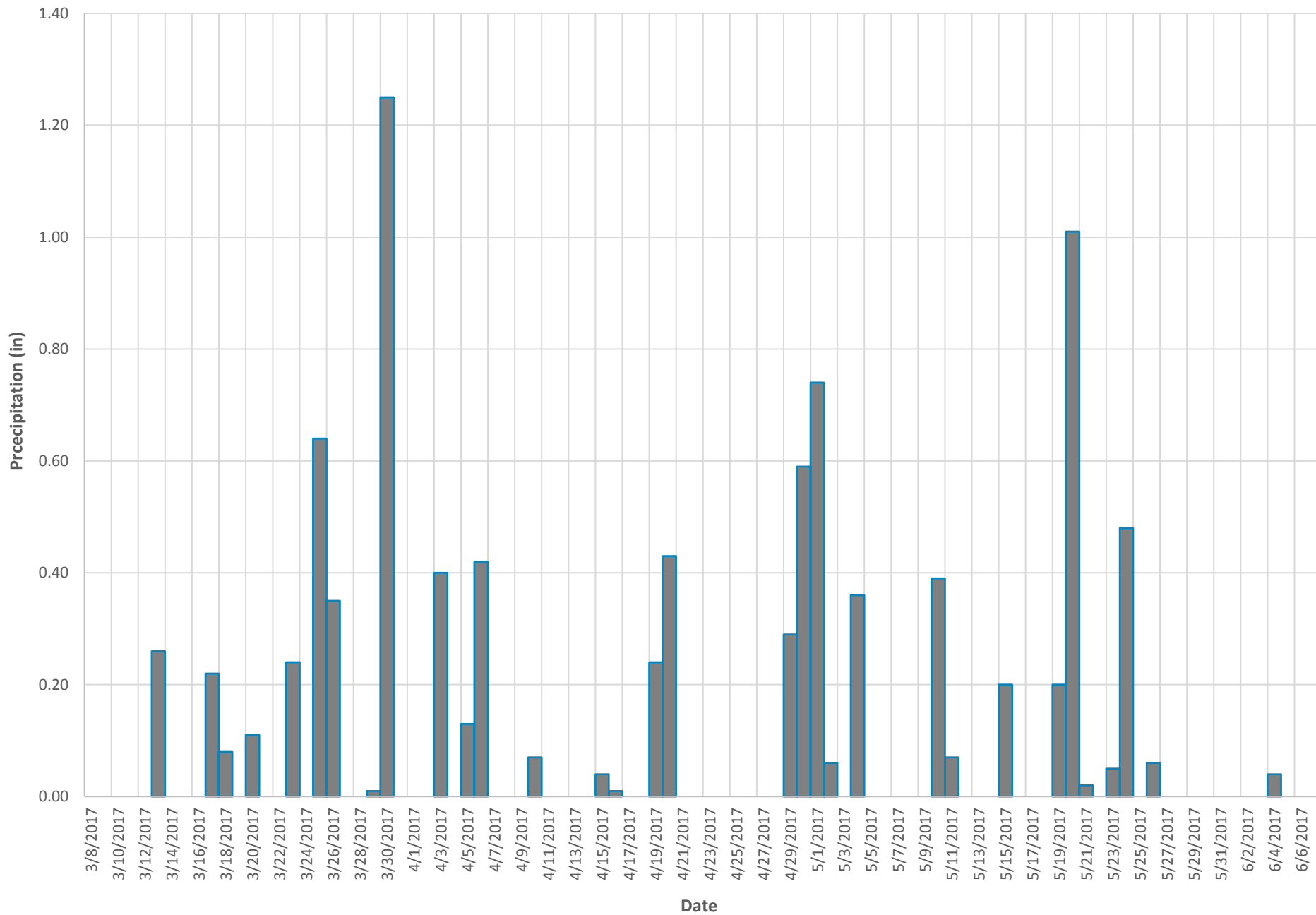
Sieve Size	% Passing	Limits
1in	100	
3/4in	100	
1/2in	100	
3/8in	100	
No. 4	100	
No. 8	100	
No. 16	100	
No. 30	99	
No. 50	91	
No. 100	31	
No. 200	14	
Finer No. 200 (75µm)	13	

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

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

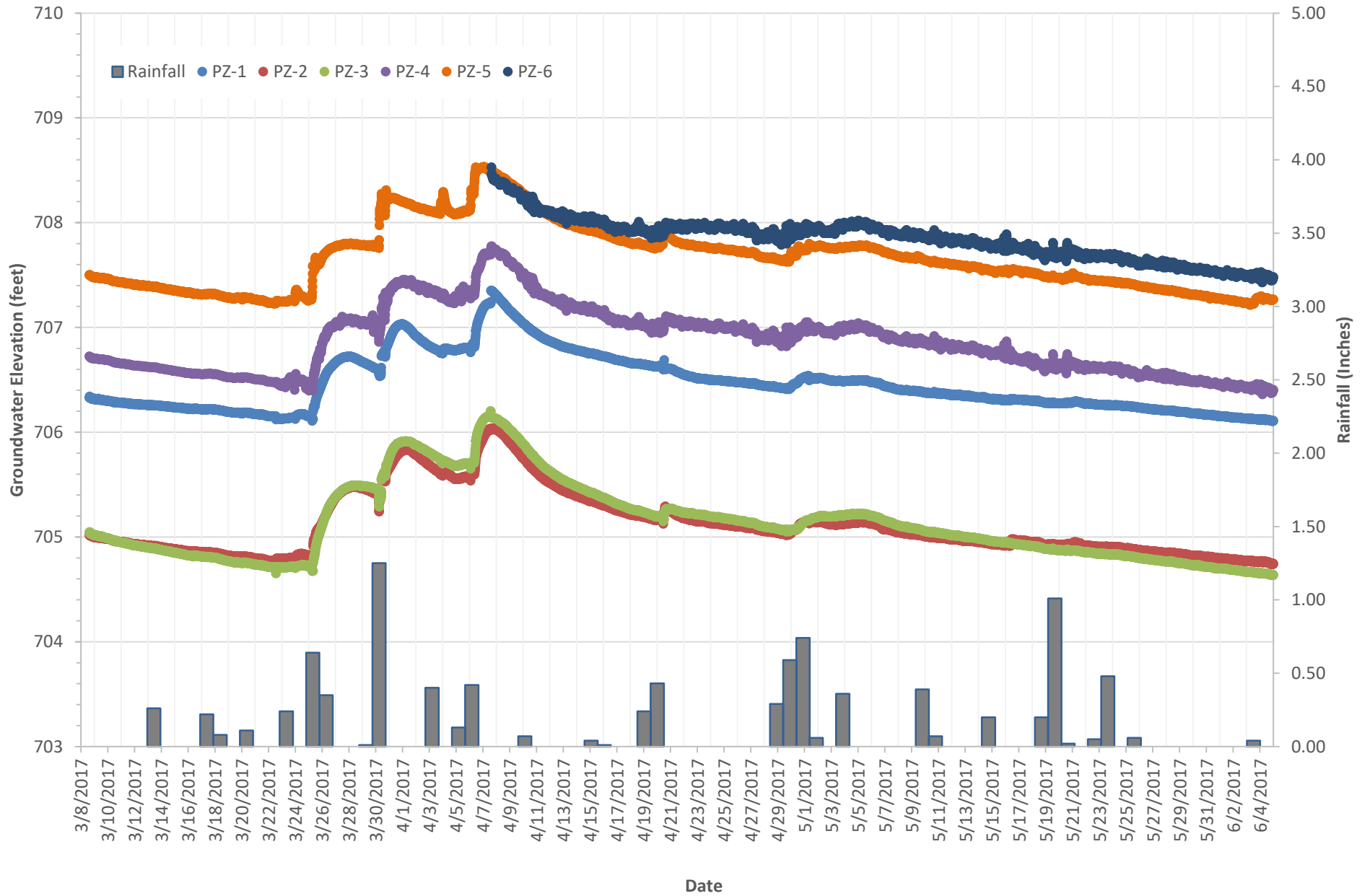
APPENDIX C
PRECIPITATION SUMMARY CHART

NOAA NWS Precipitation Data Kalamazoo International Airport Station

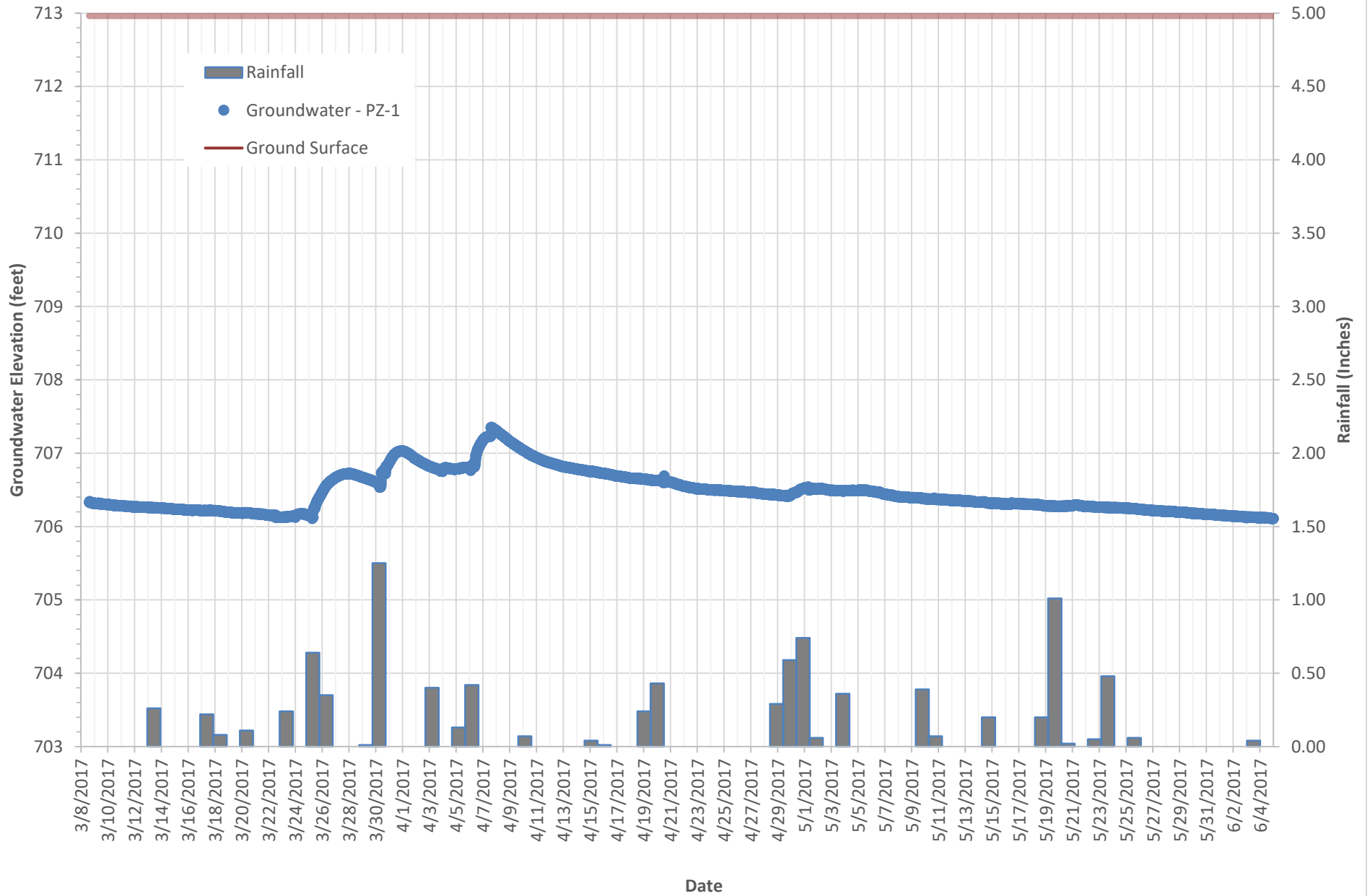


APPENDIX D
PIEZOMETER TIME SERIES CHARTS

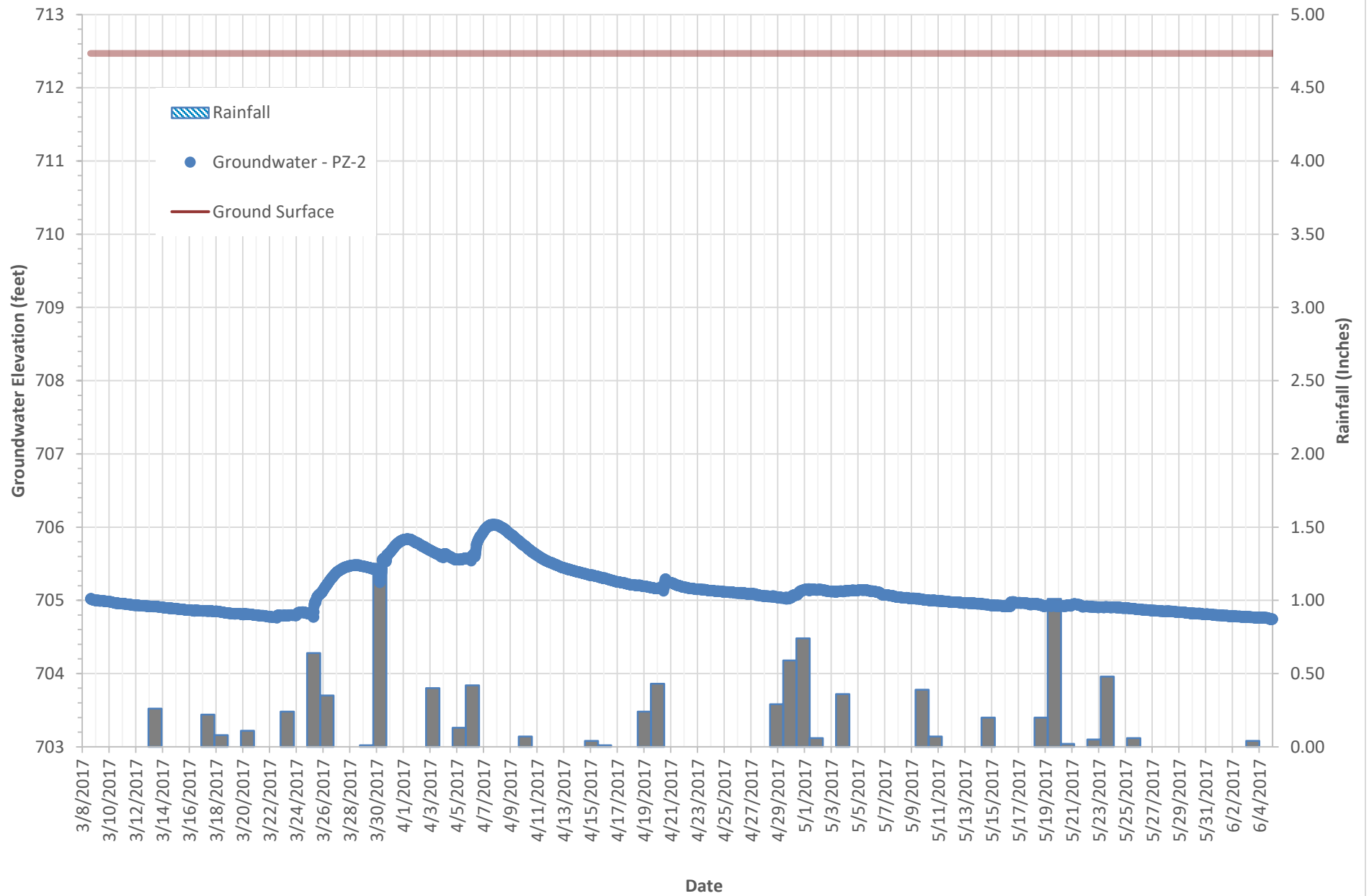
Groundwater Elevation Measurements - Baughman Drain Piezometers PZ-1 through PZ-6



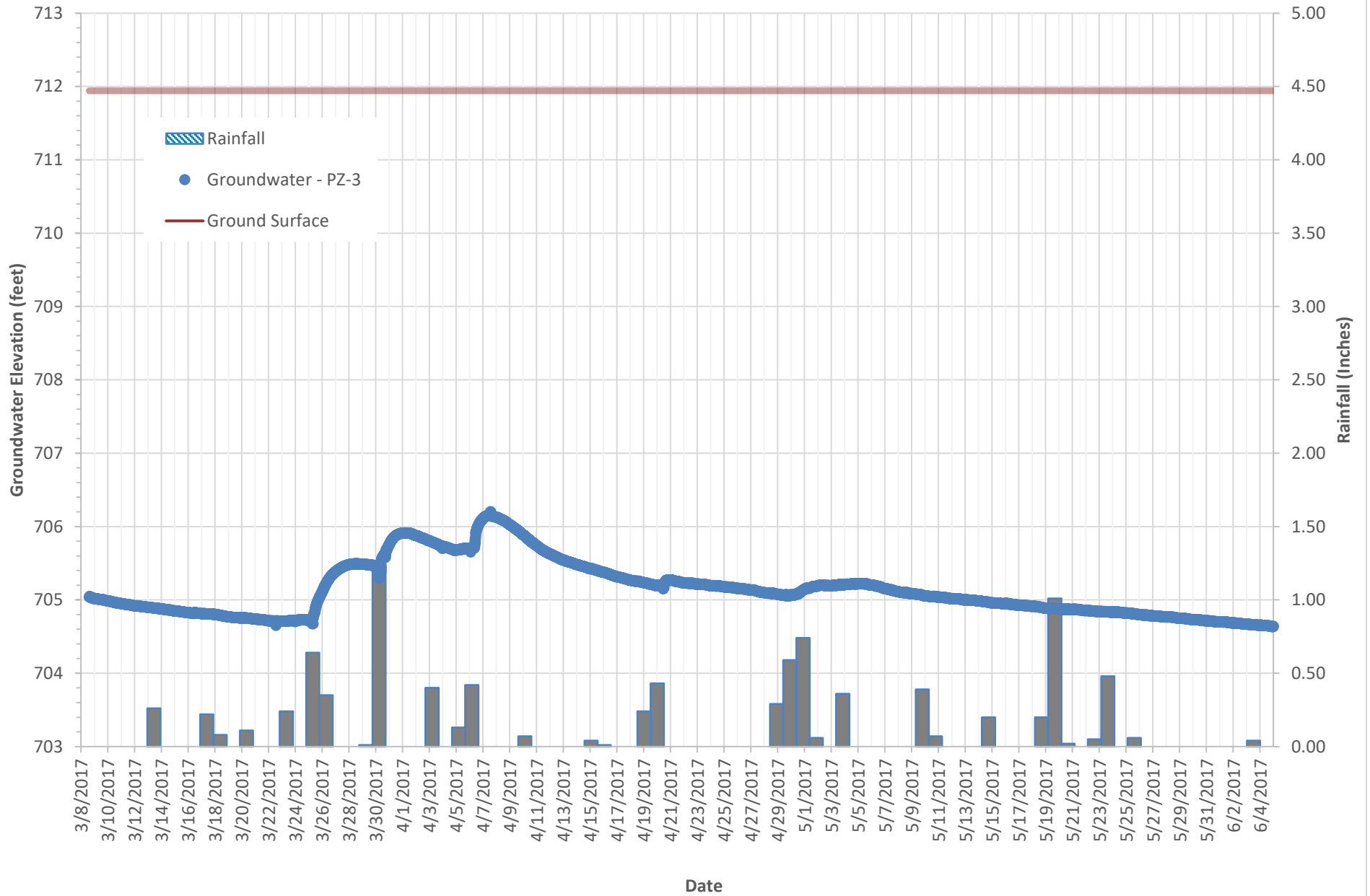
Groundwater Elevation Readings PZ-1



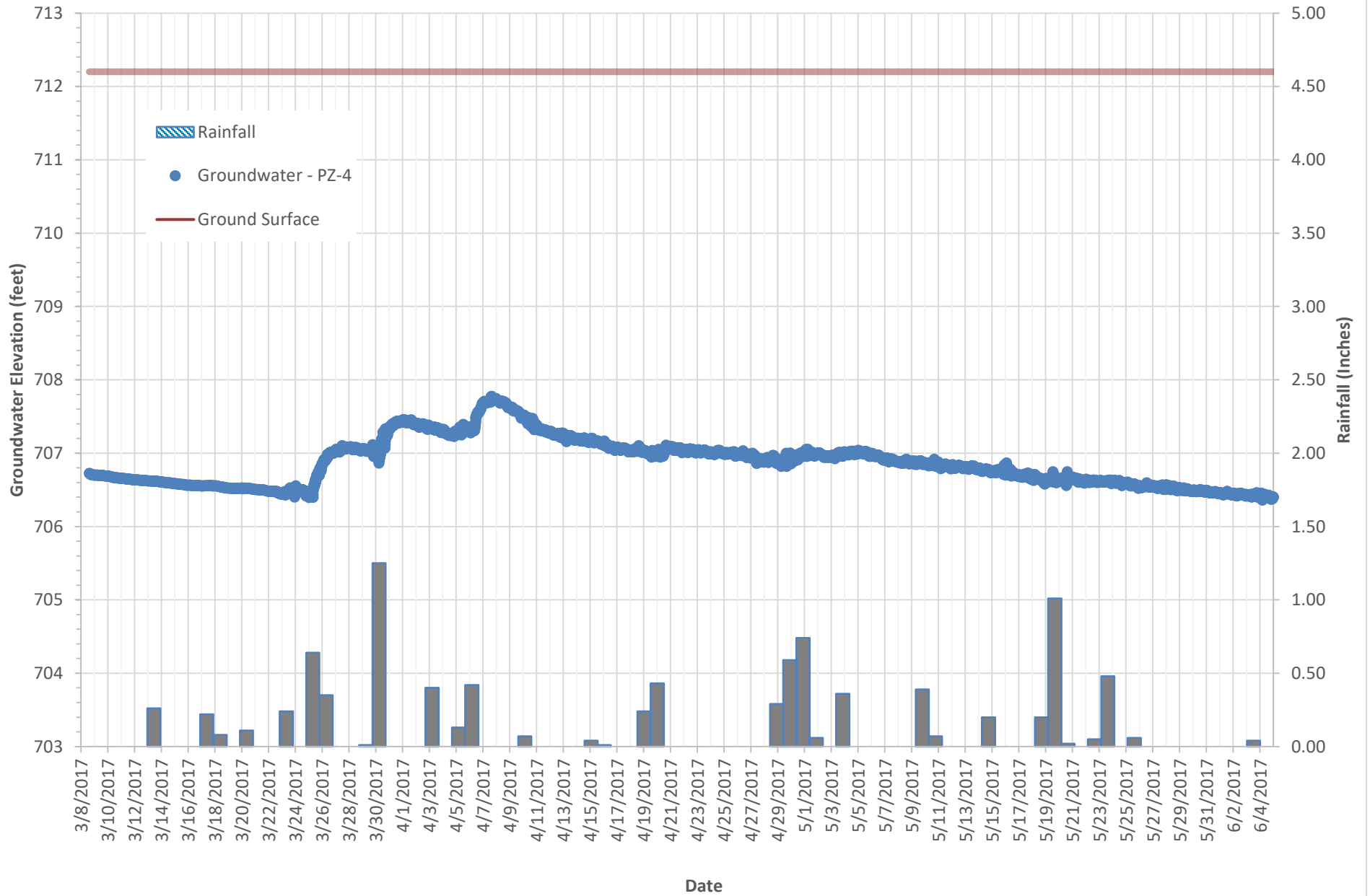
Groundwater Elevation Readings PZ-2



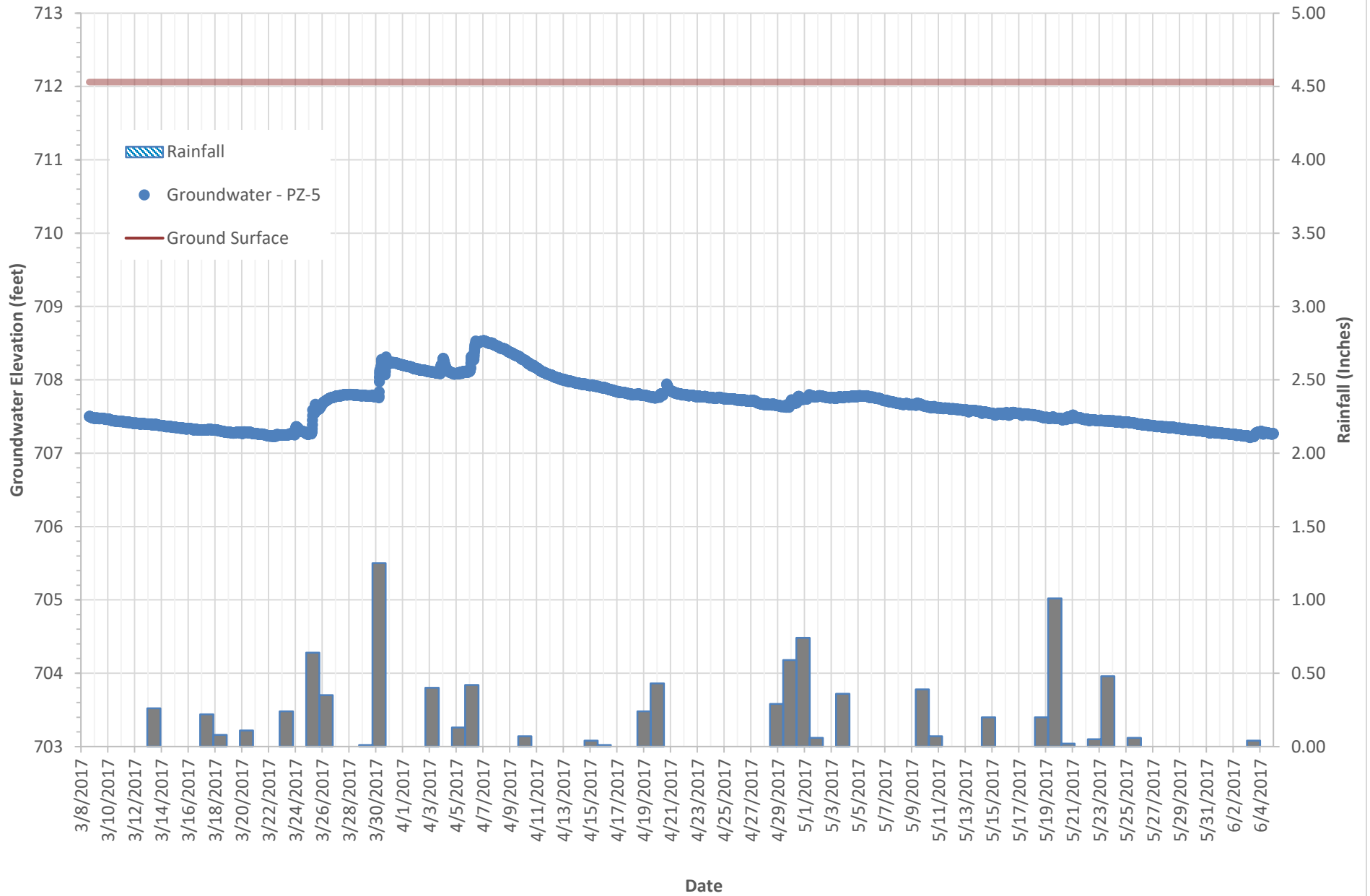
Groundwater Elevation Readings PZ-3



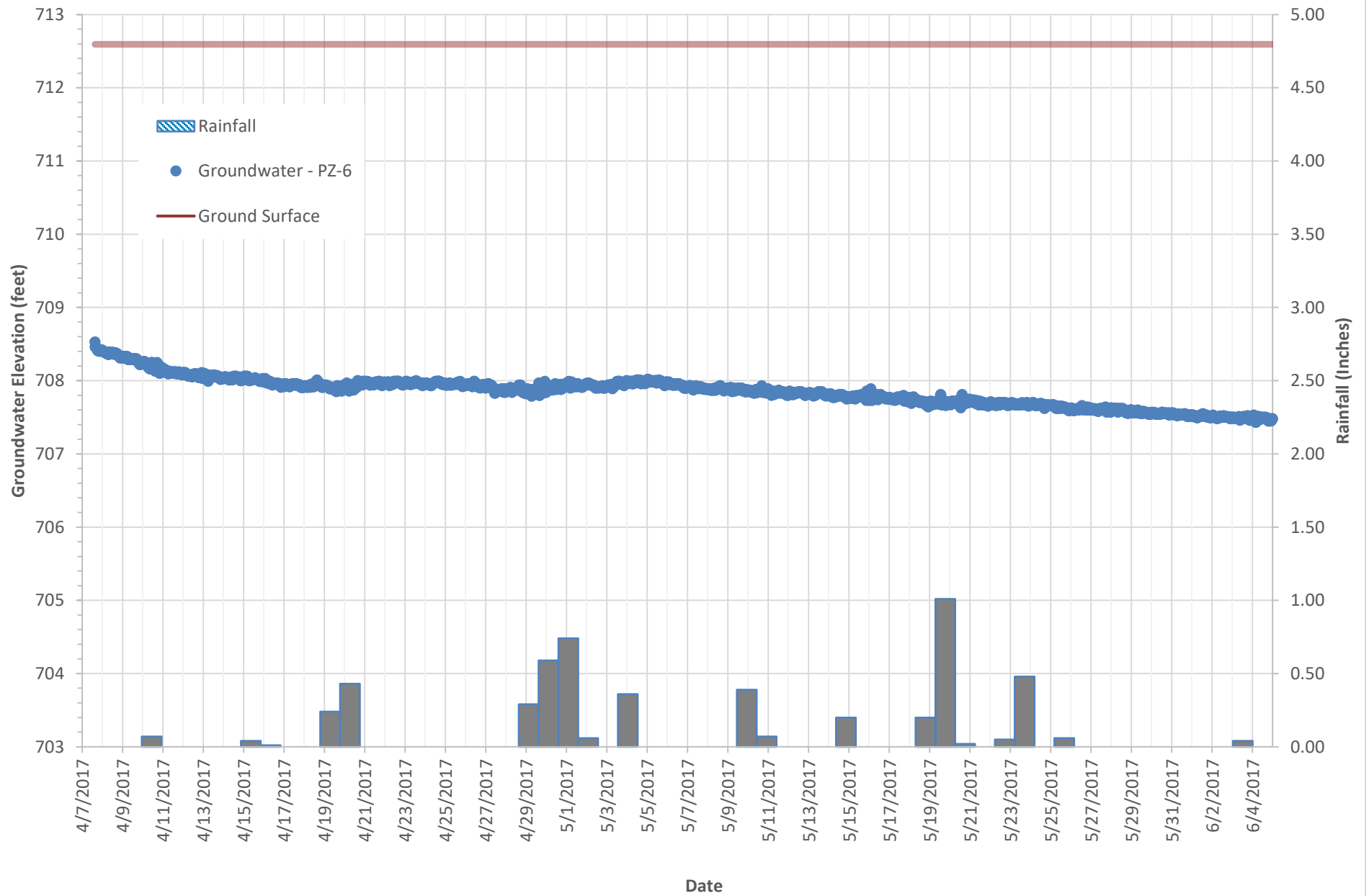
Groundwater Elevation Readings PZ-4



Groundwater Elevation Readings PZ-5

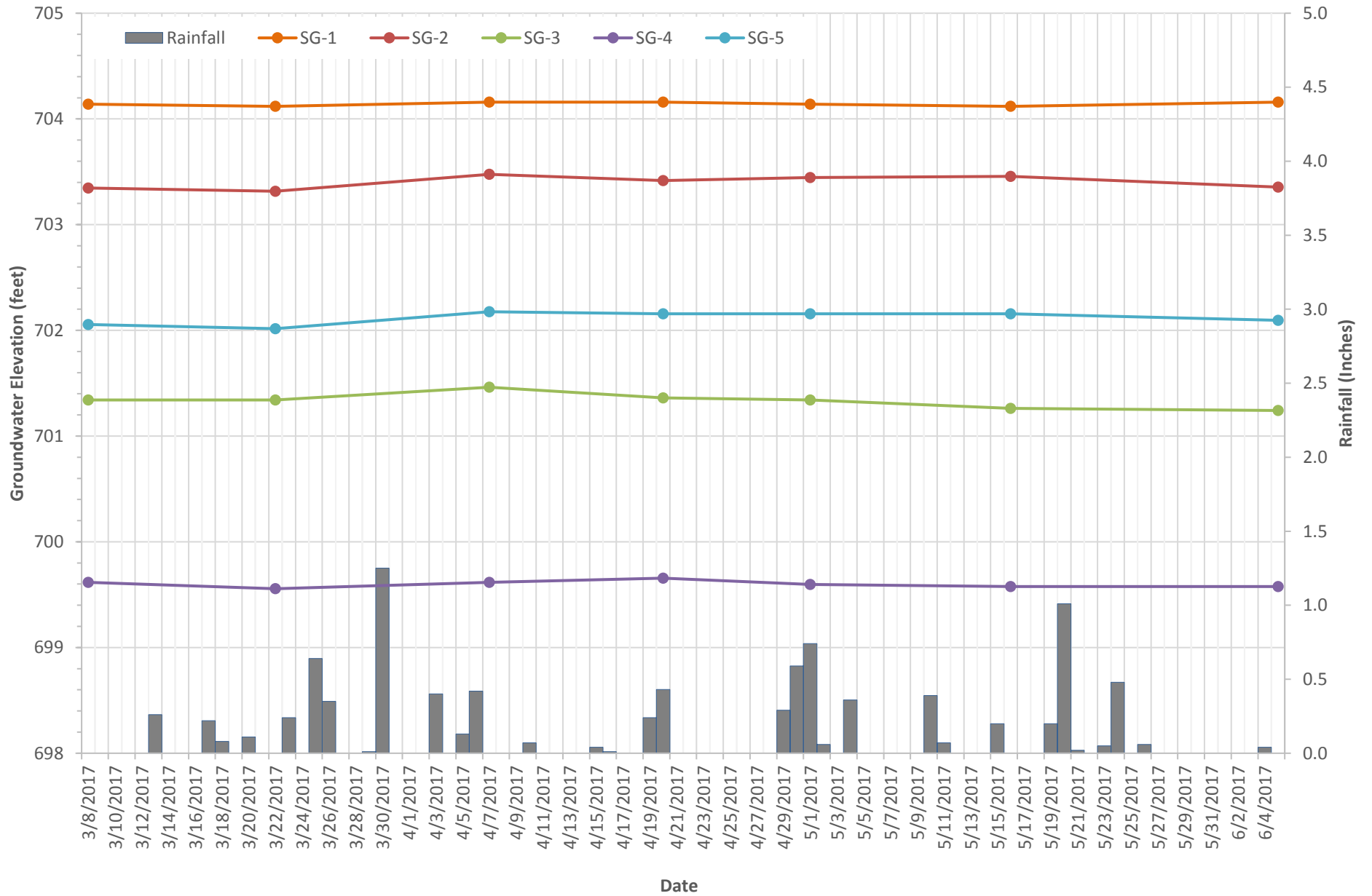


Groundwater Elevation Readings PZ-6



APPENDIX E
STAFF GAGE TIME SERIES CHARTS

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





*Passionate People Building
and Revitalizing our World*





SUPPLEMENTAL HYDROGEOLOGIC EVALUATION SUMMARY REPORT

Baughman Drain
Otsego, Allegan County, Michigan

SME Project Number: 077821.00
February 20, 2018





4705 Cyle Park Avenue SW
Grand Rapids, MI 49501-1114

T (616) 406-1756

www.sme-usa.com

February 20, 2018

Mr. Kyle Visser, 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. Visser:

We have completed a supplemental hydrogeologic evaluation for a portion of the Baughman Drain area, more specifically the area south of Prainewood 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

1. INTRODUCTION AND BACKGROUND	1
2. PIEZOMETER AND STAFF GAUGE INSTALLATION	1
3. SURFACE AND SUBSURFACE CONDITIONS	2
4. WATER LEVEL MEASUREMENTS.....	2
5. GROUNDWATER FLOW	3
6. SURFACE WATER FLOW.....	3
7. WETLAND AREAS.....	3
8. FINDINGS AND CONCLUSIONS	4

FIGURES

FIGURE 1: PROPERTY LOCATION MAP

FIGURE 2: EVALUATION AREA AND MONITORING LOCATION DIAGRAM

FIGURE 3: GEOLOGICAL CROSS-SECTION A-A'

FIGURE 4: GEOLOGICAL CROSS-SECTION B-B'

**FIGURE 5: GROUNDWATER ELEVATION CONTOUR DIAGRAM – PIEZOMETERS,
DECEMBER 6, 2017**

**FIGURE 6: GROUNDWATER ELEVATION CONTOUR DIAGRAM – PIEZOMETERS
AND STAFF GAUGES, DECEMBER 6, 2017**

FIGURE 7: EVALUATION AREA AND WETLAND AREAS

TABLES

TABLE 1: WATER LEVEL ELEVATION SUMMARY

APPENDIX A

SOIL BORING LOGS

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

FIGURE 1: PROPERTY LOCATION MAP

FIGURE 2: EVALUATION AREA AND MONITORING LOCATION DIAGRAM

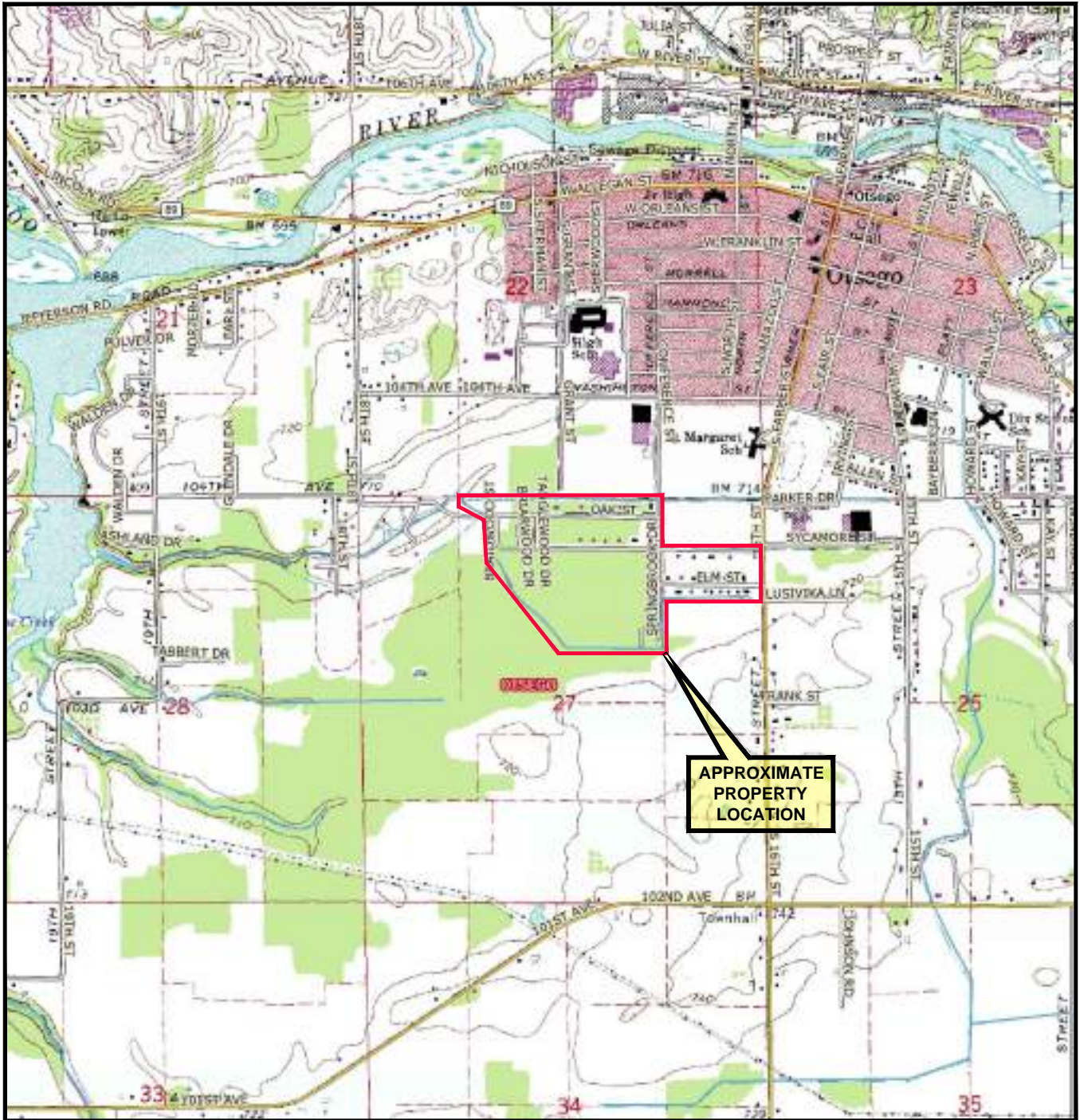
FIGURE 3: GEOLOGICAL CROSS-SECTION A-A'

FIGURE 4: GEOLOGICAL CROSS-SECTION B-B'

**FIGURE 5: GROUNDWATER ELEVATION CONTOUR DIAGRAM – PIEZOMETERS,
DECEMBER 6, 2017**

**FIGURE 6: GROUNDWATER ELEVATION CONTOUR DIAGRAM – PIEZOMETERS
AND STAFF GAUGES, DECEMBER 6, 2017**

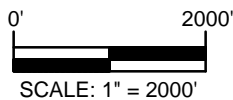
FIGURE 7: EVALUATION AREA AND WETLAND AREAS



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

USGS QUADRANGLE(S) REFERENCED

OTSEGO (MI) 1979



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

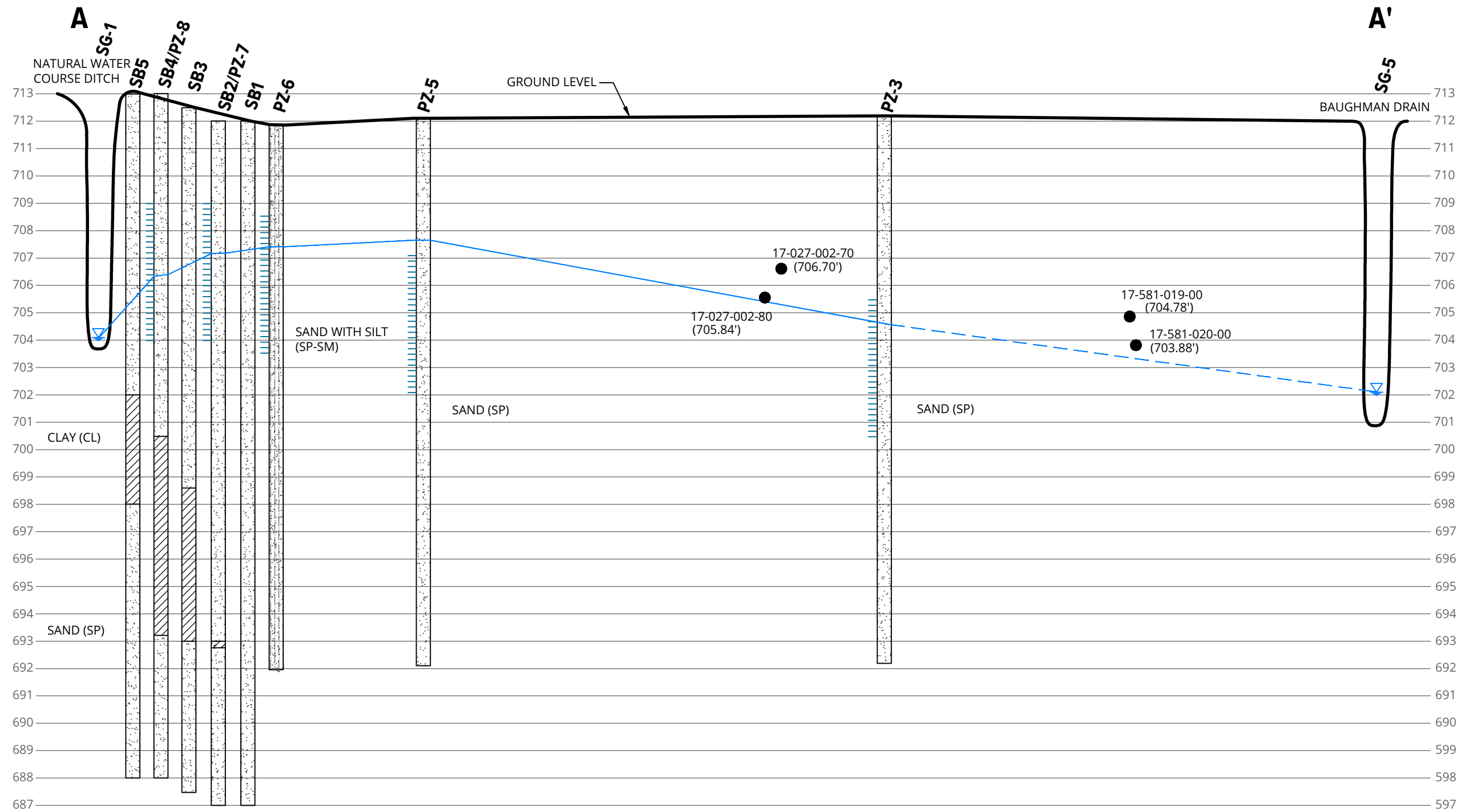


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Figure No. 1

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PLOT DATE: Dec 19, 2017 - 2:34pm - jblake



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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

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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

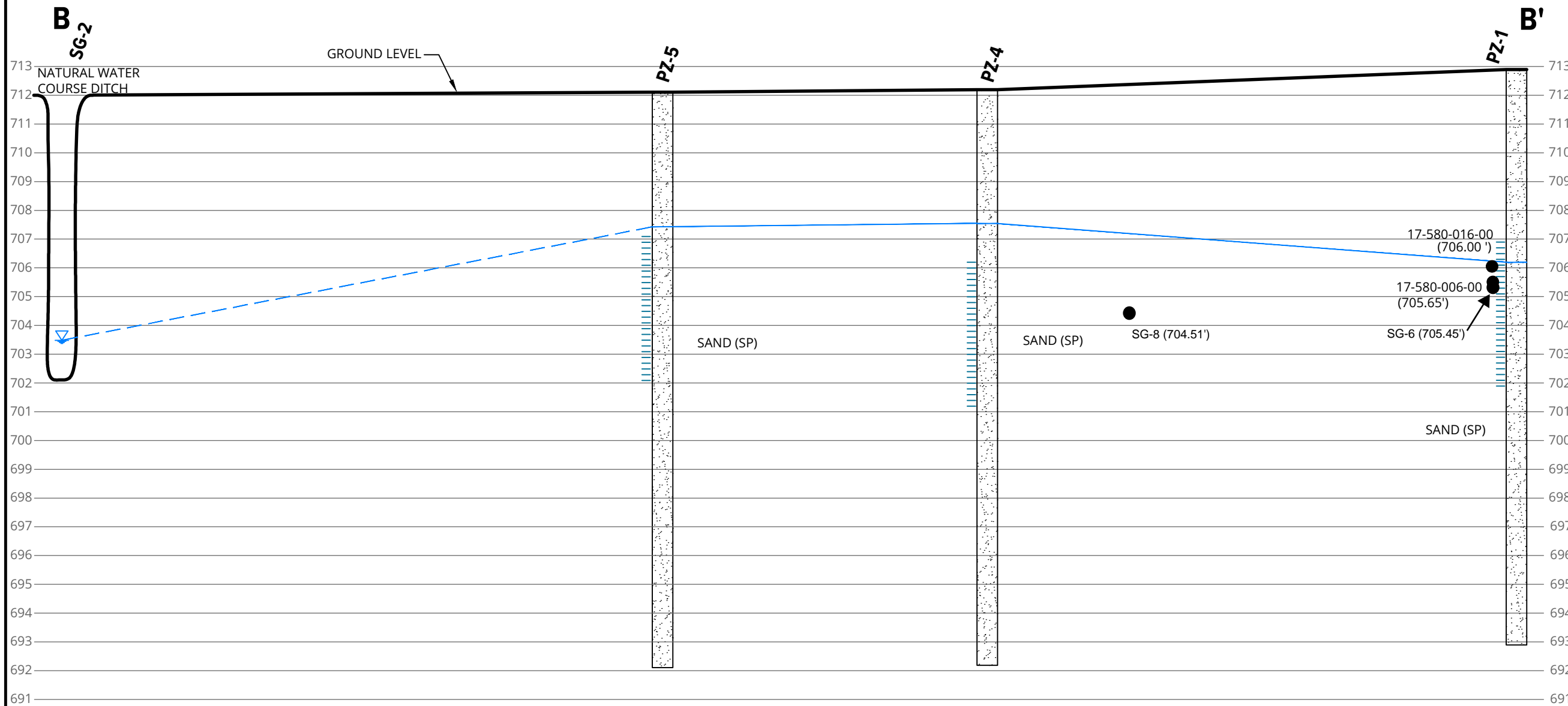
Designer AJL

Scale AS SHOWN

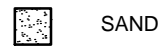
Project 077821.00

Figure No. 4

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LEGEND



SAND



WELL SCREEN INTERVAL



GROUNDWATER ELEVATION
DECEMBER 6, 2017

17-580-016-00
(705.84)

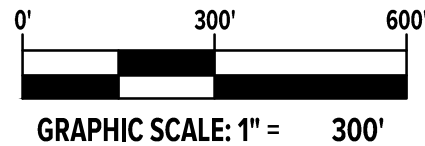
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(BASEMENT FLOOR ELEVATION)

SCALE

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

FILE LOCATION: \\Sme-inc\p2\WIP\077821.00\CADD\DWGS\rev\077821.00-X5.dwg

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Project

**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**

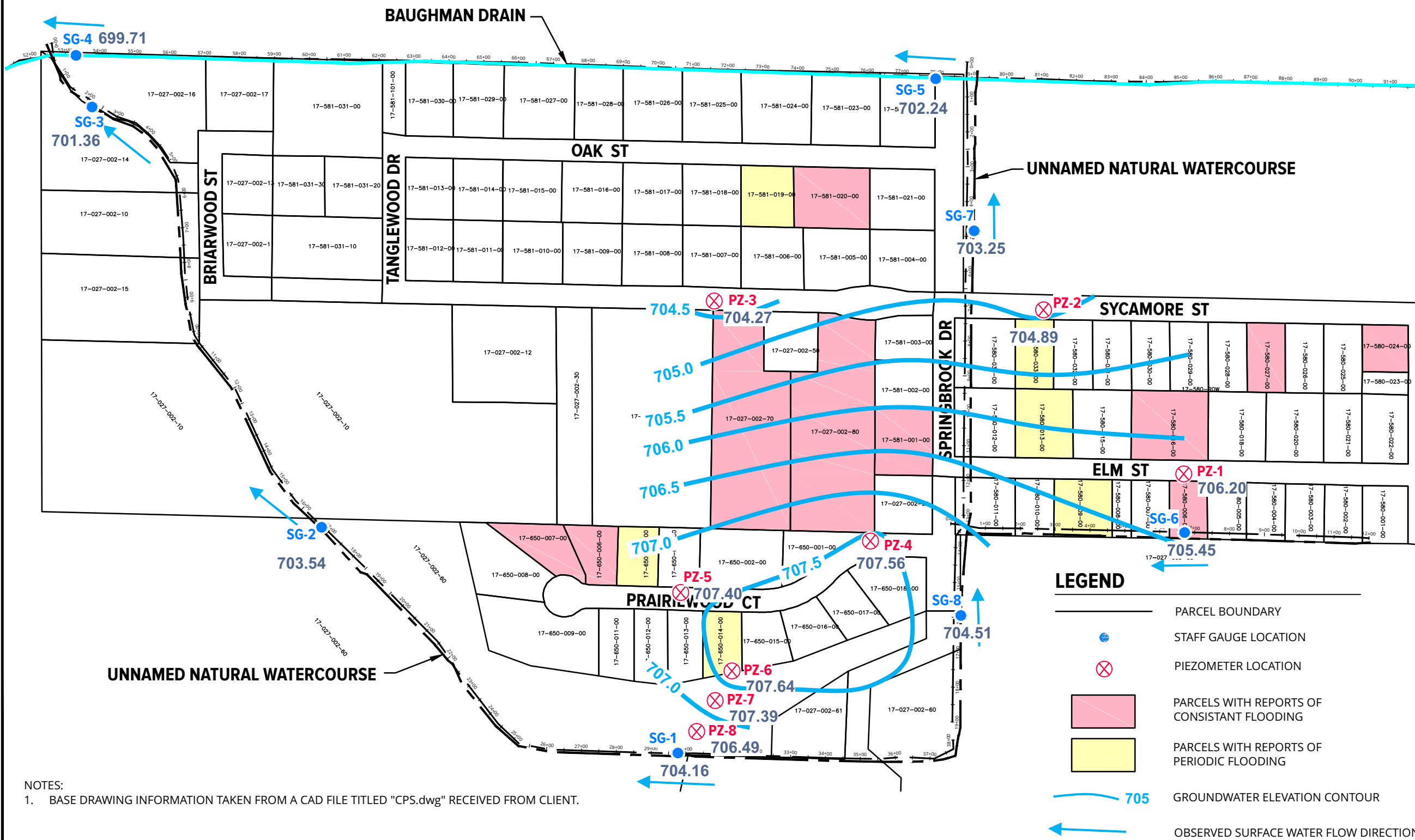
Designer **MAV**

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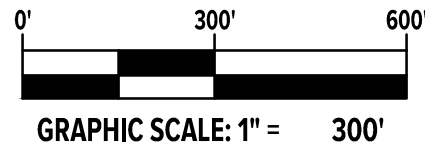
Project **077821.00**

Figure No. **5**

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EVALUATION

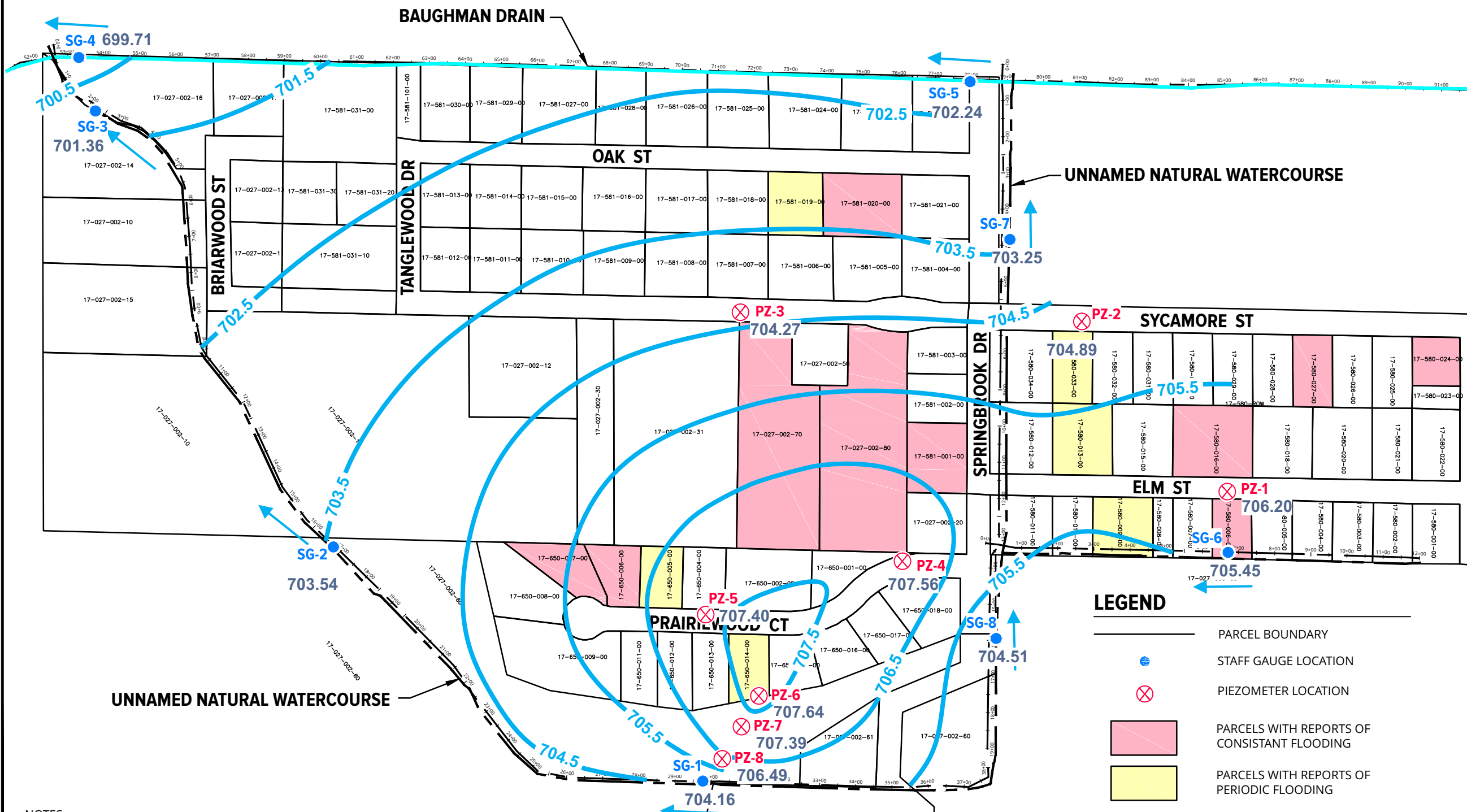
Project Location
OTSEGO,
ALLEGAN COUNTY,
MICHIGAN

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

No.	Revision Date

Date	12-7-17
CADD	AJL
Designer	MAV
Scale	1" = 300'
Project	077821.00
Figure No.	6

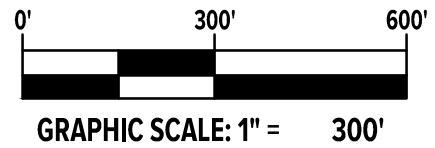
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LEGEND

- PARCEL BOUNDARY
- STAFF GAUGE LOCATION
- PIEZOMETER LOCATION
- PARCELS WITH REPORTS OF CONSTANT FLOODING
- PARCELS WITH REPORTS OF PERIODIC FLOODING
- 705 GROUNDWATER ELEVATION CONTOUR
- OBSERVED SURFACE WATER FLOW DIRECTION

NOTES:
 1. BASE DRAWING INFORMATION TAKEN FROM A CAD FILE TITLED "CPS.dwg" RECEIVED FROM CLIENT.



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Project

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**

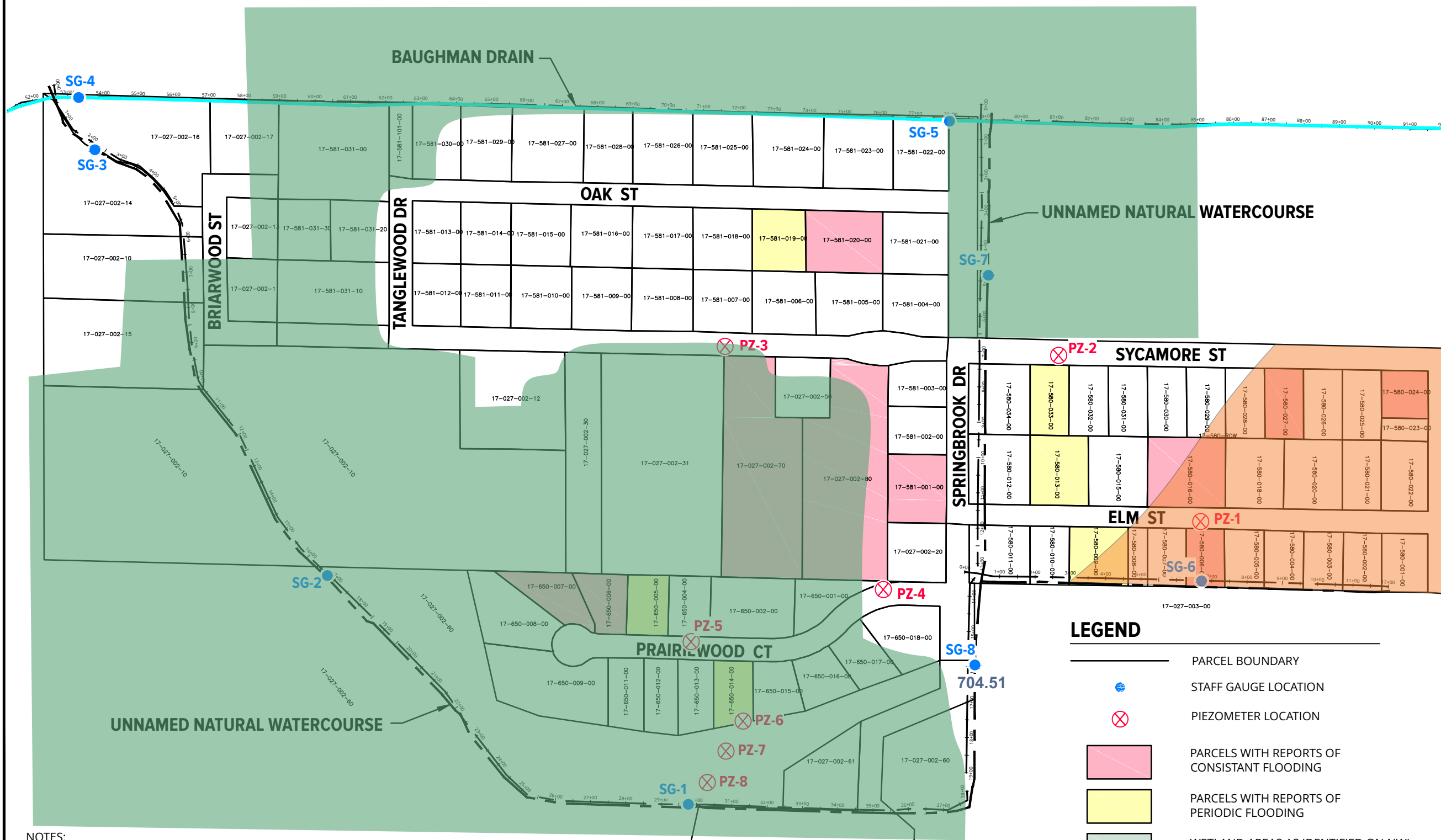
Designer **MAV**

Scale **1" = 300'**

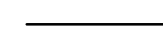


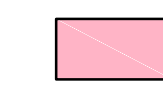



Project **077821.00**

Figure No.
7

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LEGEND

-  PARCEL BOUNDARY
-  STAFF GAUGE LOCATION
-  PIEZOMETER LOCATION
-  PARCELS WITH REPORTS OF CONSTANT FLOODING
-  PARCELS WITH REPORTS OF PERIODIC FLOODING
-  WETLAND AREAS AS IDENTIFIED ON NWI AND MIRIS MAPS
-  SOIL AREAS WHICH INCLUDE WETLAND SOILS

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).

TABLES

TABLE 1: WATER ELEVATION SUMMARY



TABLE 1
WATER ELEVATION SUMMARY
BAUGHMAN DRAIN EVALUATION
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
CLIENT: Land & Resource Engineering and Surveying, Inc.

PROJECT NUMBER: 077821.00
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							
			LS4	33			
20		Fine SAND- Brown- Wet (SP)					
			LS5	42			
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).



PROJECT NAME: Baughman Drain Supplemental Hydrogeo
CLIENT: Land & Resource Engineering and Surveying, Inc.

PROJECT NUMBER: 077821.00
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)					
1.0			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		Fine to Medium SAND- Brown- Moist to Wet (SP)	LS2	48			
10			LS3	29			
15			LS4	42			
19.0		Sandy LEAN CLAY- Brown (CL)					
19.3							
20		Fine SAND- Brown- Wet (SP)	LS5	36			
25.0		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).



PROJECT NAME: Baughman Drain Supplemental Hydrogeo
CLIENT: Land & Resource Engineering and Surveying, Inc.

PROJECT NUMBER: 077821.00
PROJECT LOCATION: Otsego, Michigan

DATE STARTED: 11/22/17 **COMPLETED:** 11/22/17
OPERATOR: Fibertec **RIG NO.:** 7822 DT-1

BORING METHOD: Direct Push
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		END OF BORING AT 25.0 FEET.					
30							

GROUNDWATER & BACKFILL INFORMATION		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).
	DEPTH (FT)	
▽ DURING BORING:	4.9	
▽ AT END OF BORING:	5.0	
BACKFILL METHOD: Soil Cuttings		



PROJECT NAME: Baughman Drain Supplemental Hydrogeo
CLIENT: Land & Resource Engineering and Surveying, Inc.

PROJECT NUMBER: 077821.00
PROJECT LOCATION: Otsego, Michigan

DATE STARTED: 11/22/17 **COMPLETED:** 11/22/17
OPERATOR: Fibertec **RIG NO.:** 7822 DT-1

BORING METHOD: Direct Push
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			
12.5			LS3	38			
15		Silty LEAN CLAY- Gray (CL)	LS4	44			
19.8			LS5	28			
25.0		Fine SAND- Brown- Wet (SP)					
END OF BORING AT 25.0 FEET.							
30							

GROUNDWATER & BACKFILL INFORMATION		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).
▽ DURING BORING:	DEPTH (FT) 5.5	
▽ AT END OF BORING:	6.0	
BACKFILL METHOD: Well Installation - Piezometer		



PROJECT NAME: Baughman Drain Supplemental Hydrogeo
CLIENT: Land & Resource Engineering and Surveying, Inc.

PROJECT NUMBER: 077821.00
PROJECT LOCATION: Otsego, Michigan

DATE STARTED: 11/22/17 **COMPLETED:** 11/22/17
OPERATOR: Fibertec **RIG NO.:** 7822 DT-1

BORING METHOD: Direct Push
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			
11.0		Silty LEAN CLAY- Gray (CL)	LS3	33			
15.0			LS4	46			
20		Fine SAND- Brown- Wet (SP)	LS5	35			
25.0		END OF BORING AT 25.0 FEET.					

<p>GROUNDWATER & BACKFILL INFORMATION</p> <p>DEPTH (FT) ▽ DURING BORING: 7.0</p> <p>BACKFILL METHOD: Soil Cuttings</p>	<p>NOTES:</p> <ol style="list-style-type: none"> 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).
--	--



*Passionate People Building
and Revitalizing our World*





TECHNICAL MEMO 1

SUBJECT: Baughman Drain Hydrogeological Evaluation

DATE: April 6, 2018

PROJECT NO.: 180488

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Groundwater Flow Model	2
Model Setup.....	3
Calibration 1 and Simulation 1	3
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Calibration 3 and Simulations 4 and 5	4
Model Limitations	4
Conclusions.....	5
Recommendations.....	5

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

Kalamazoo River



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

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

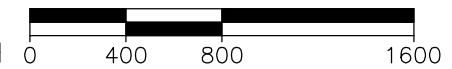
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NORTH

STUDY AREA

SCALE: 1" = 800'



ftc&h

engineers

scientists

architects

constructors

fishbeck, thompson,
carr & huber, inc.

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

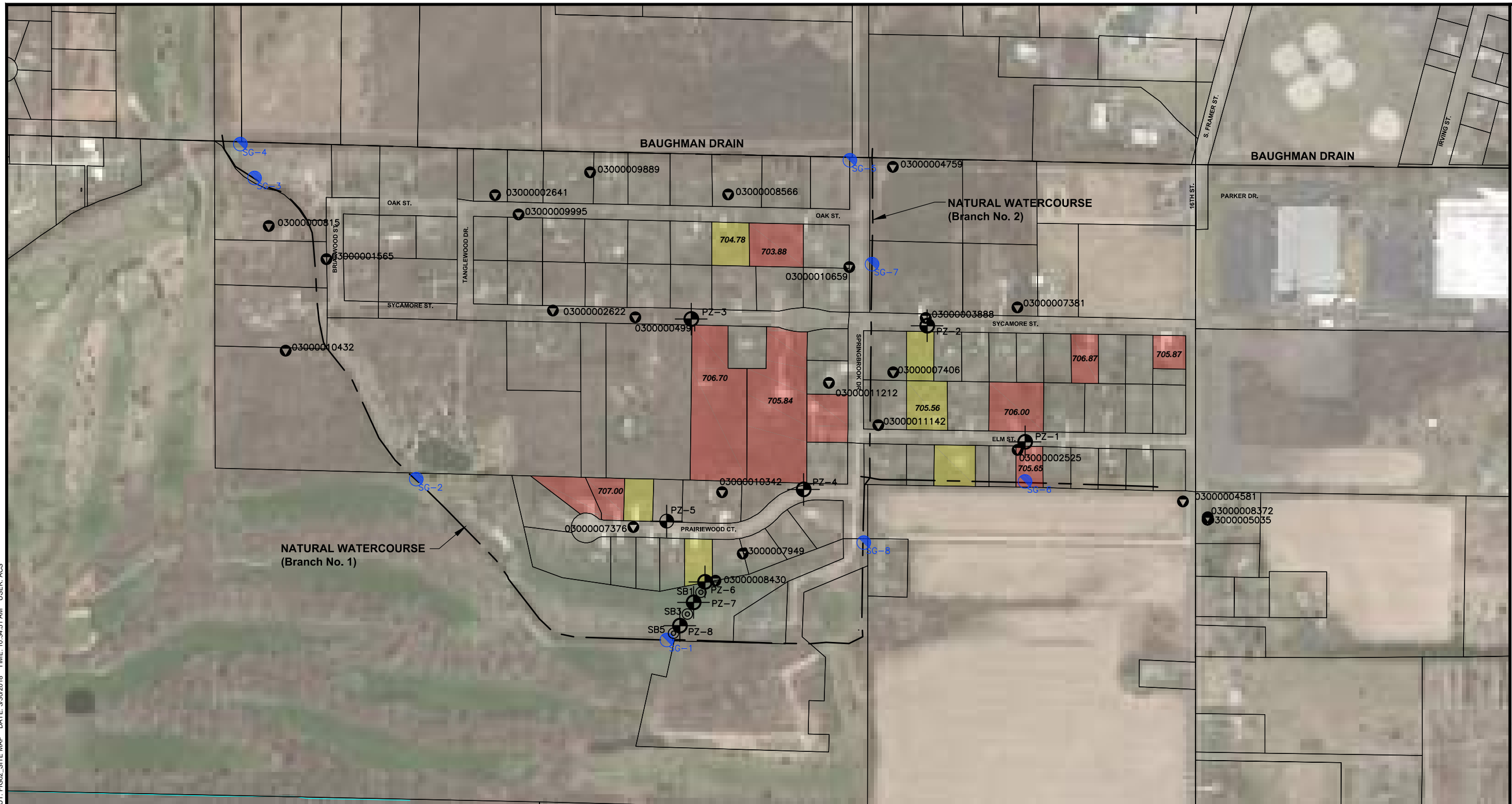
Baughman Drain
Otsego, Allegan County, Michigan
Preliminary Hydrogeological Evaluation

PROJECT NO.

180488

FIGURE NO.

1



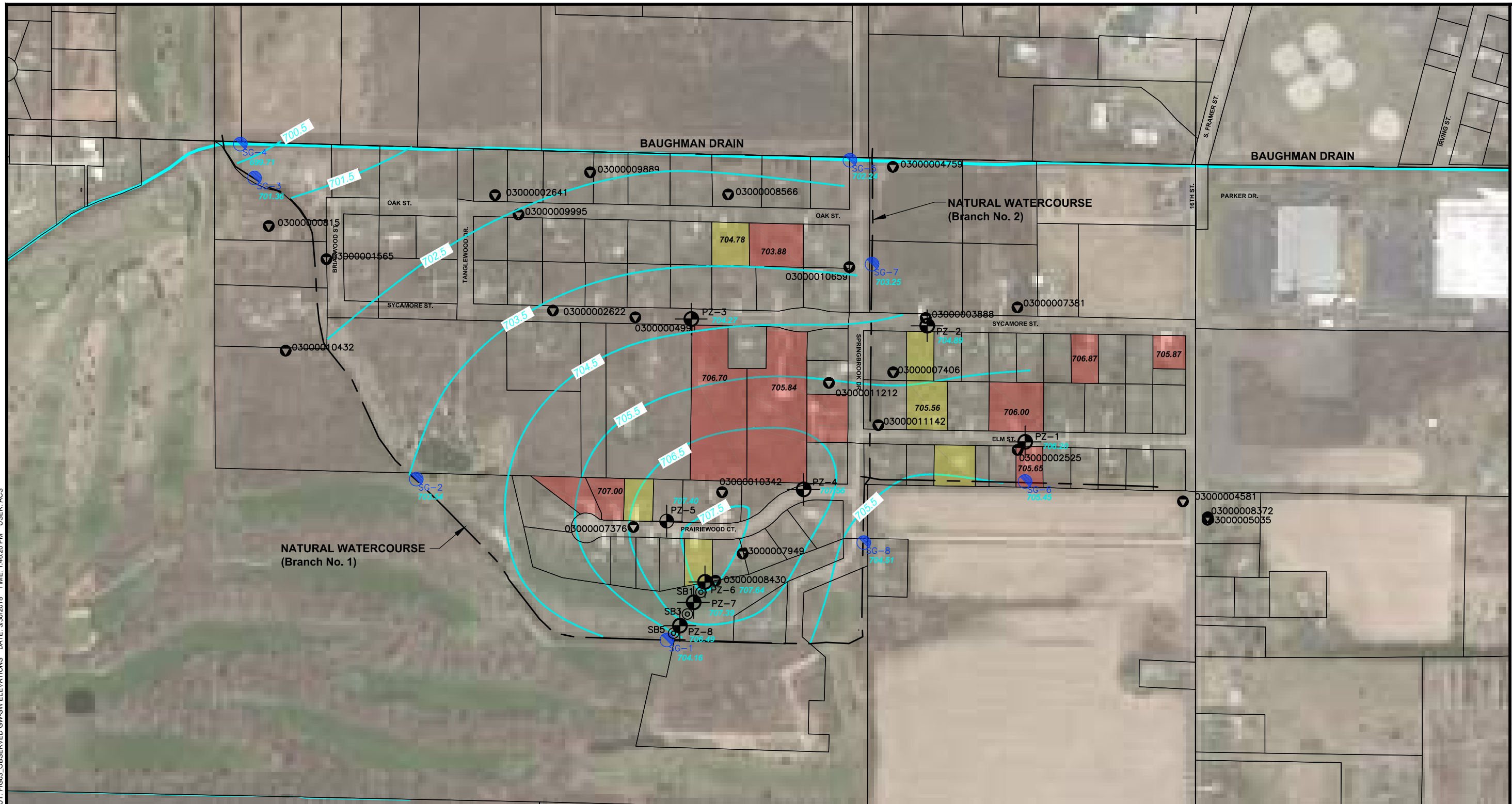
LEGEND

- 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)

SITE MAP
SCALE: 1" = 400'

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

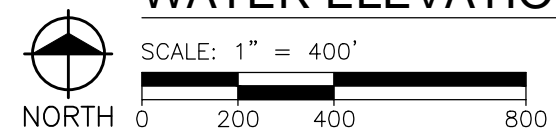
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LEGEND

- 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**



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

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



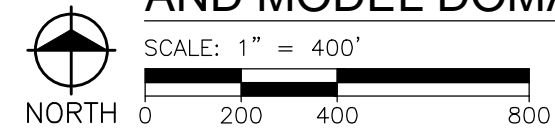
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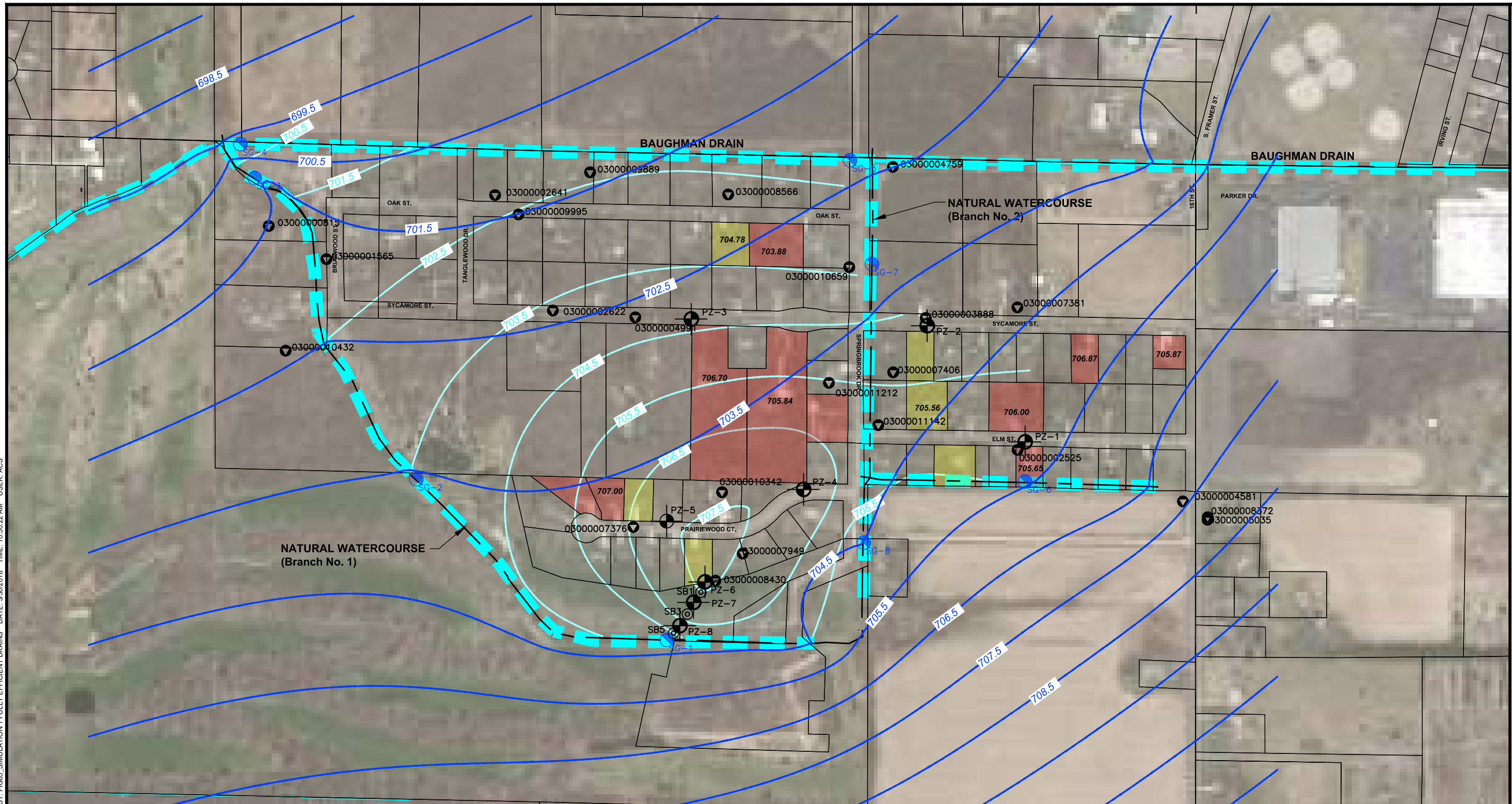
BASE MAP ADAPTED FROM DRAWING
PROVIDED BY LRE, 12/19/17
ORTHO PHOTO DATED: 2014

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)

**CALIBRATION 1
PRELIMINARY CALIBRATION
AND MODEL DOMAIN**



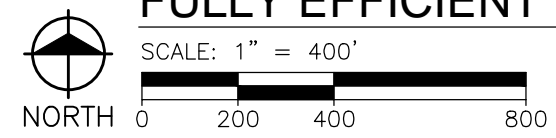


LEGEND

- 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)

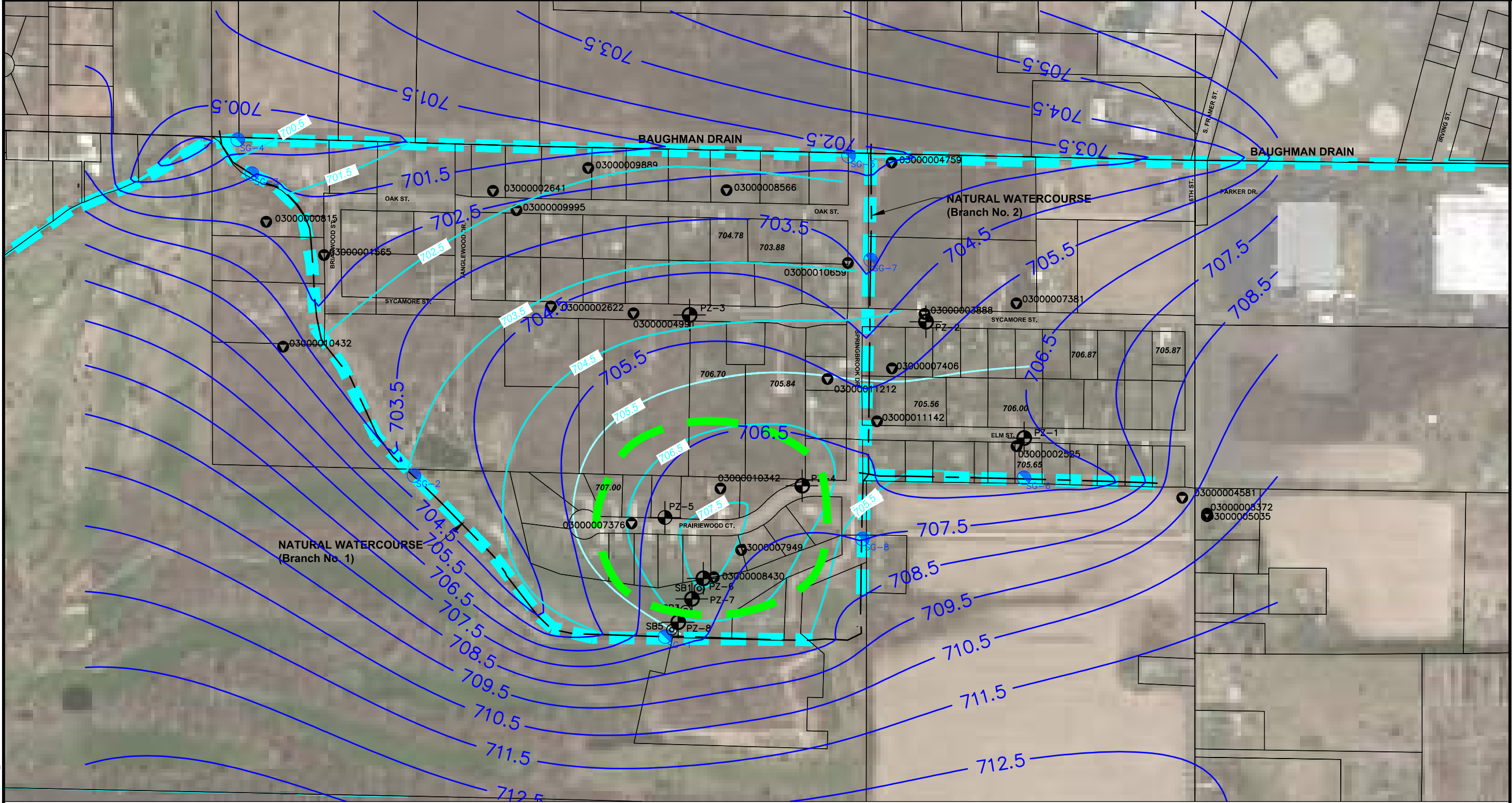
**SIMULATION 1:
FULLY EFFICIENT DRAINS**

SCALE: 1" = 400'



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

PLOT INFO: Z:\2018\180488\CAD\REF\2001-180488.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 LINES/SINKS
 - 703.88 ESTIMATED BASEMENT ELEVATIONS (FEET AMSL)

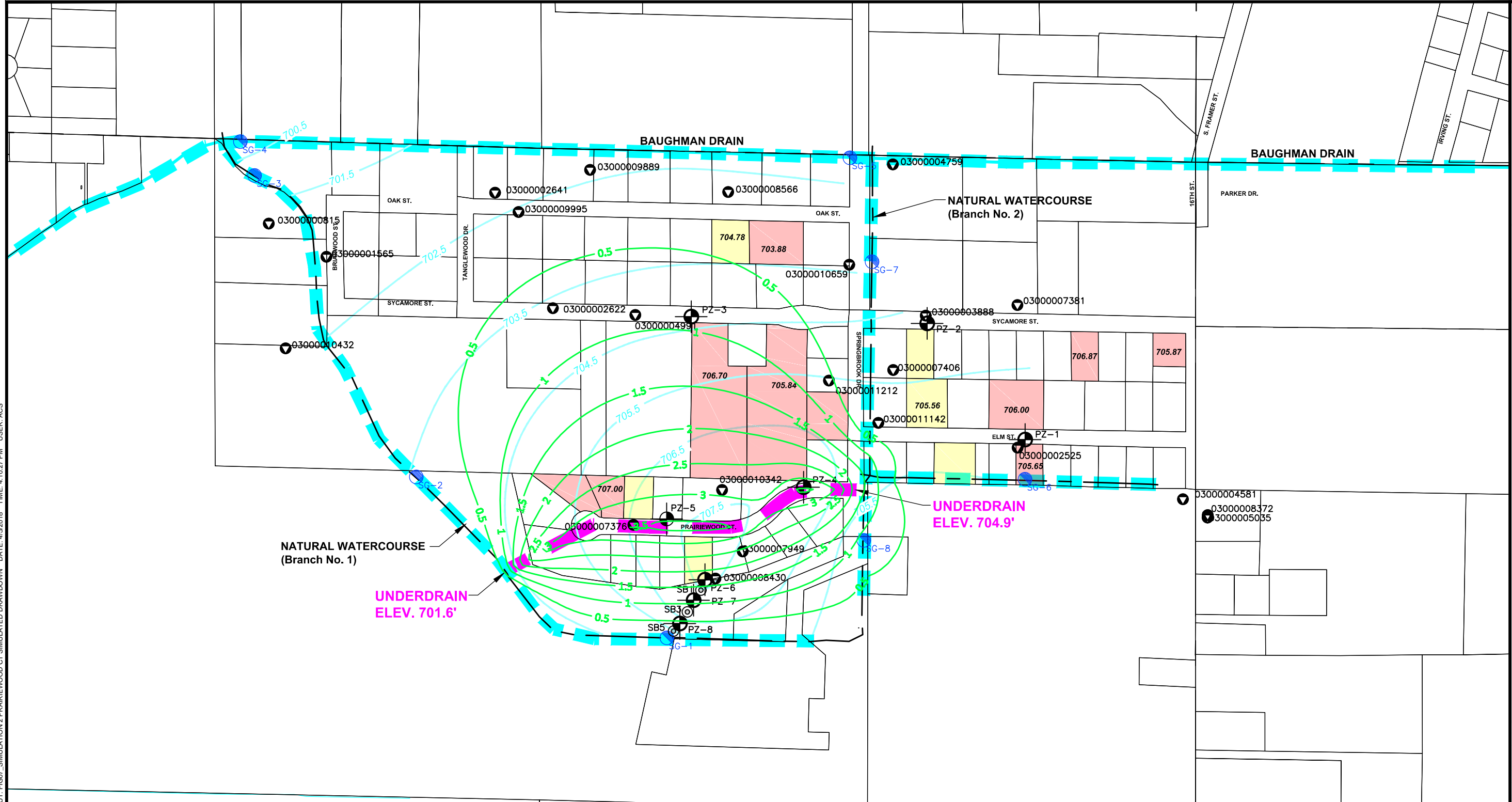
**CALIBRATION 2:
RECHARGE AND RAISED
DRAINS**

SCALE: 1" = 400'
0 200 400 800



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

PLOT INFO: Z:\2018\180488\CAD\REF\2001-180488.DWG LAYOUT: FIG06 - CALIBRATION 2 RECHARGE AND RAISED DRAINS DATE: 3/30/2018 TIME: 1:19:30 PM USER: ACS

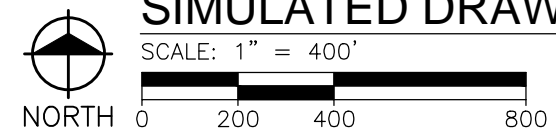


LEGEND

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

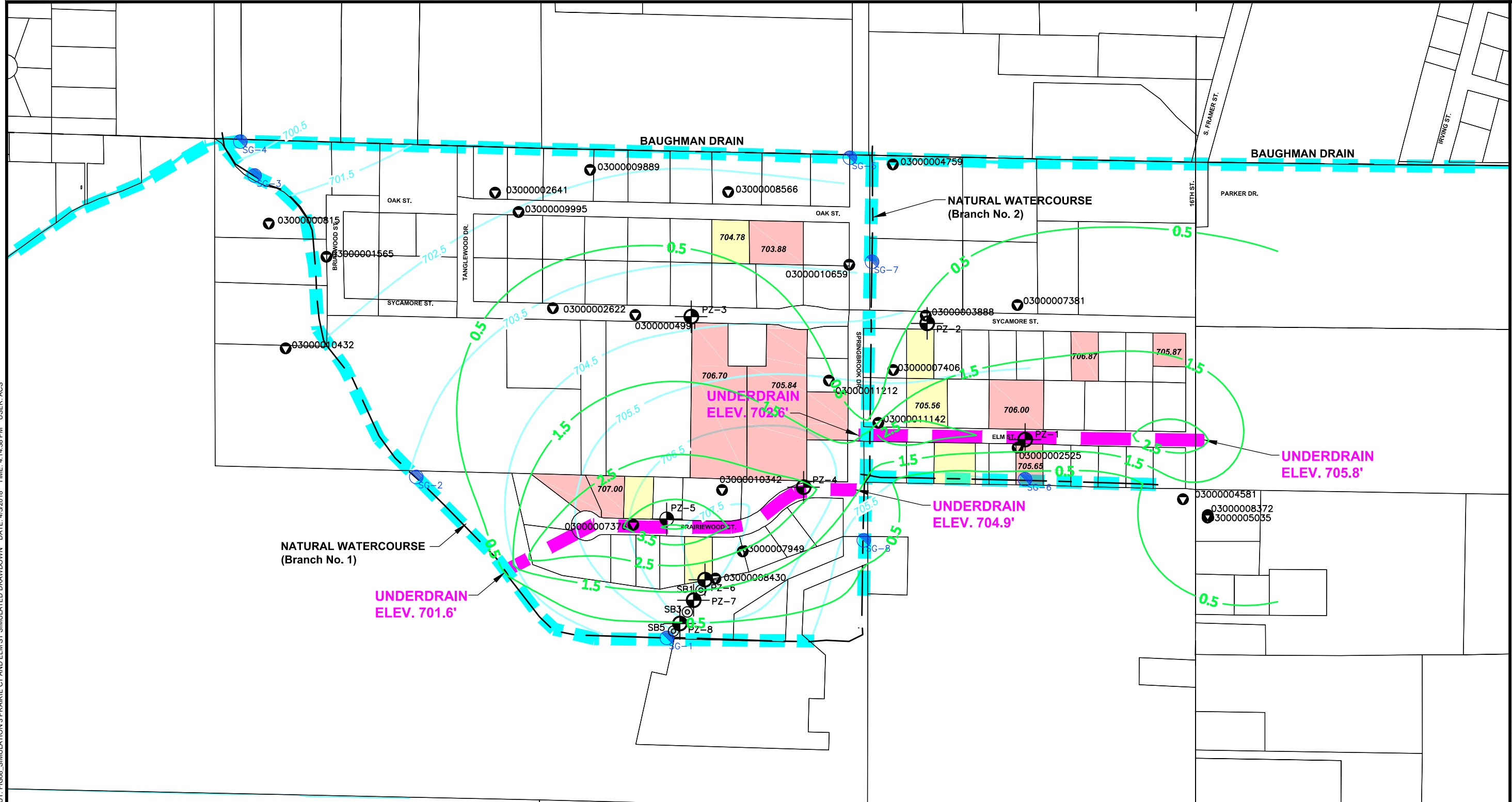
SIMULATION 2
PRAIRIEWOOD CT.
SIMULATED DRAWDOWN

SCALE: 1" = 400'



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

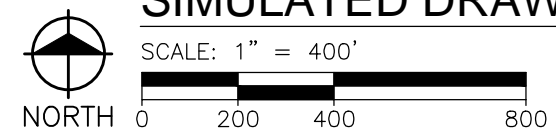
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LEGEND

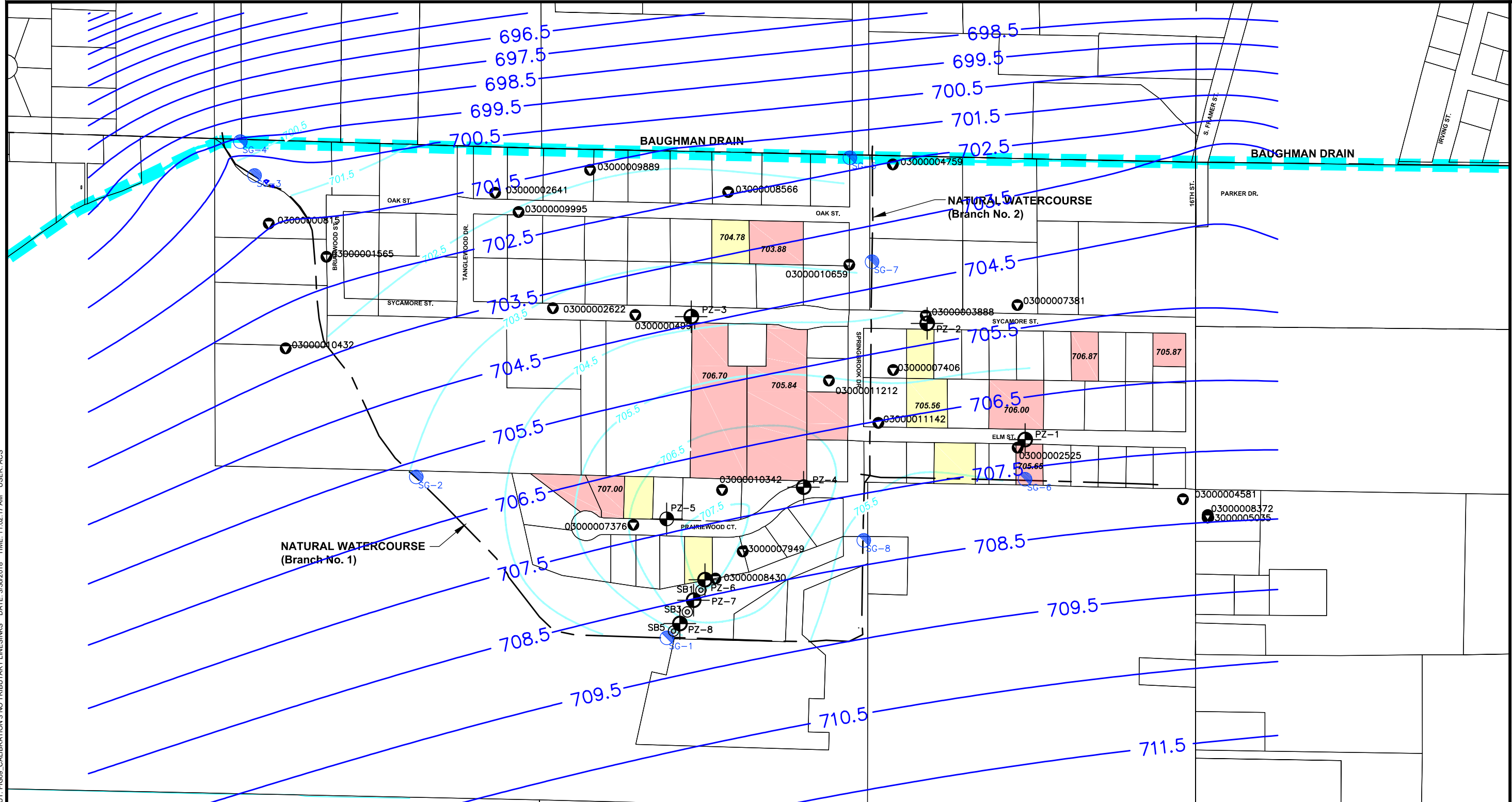
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	STAFF GAUGE LOCATION		PARCELS WITH REPORTS OF PERIODIC FLOODING
	WATER SUPPLY WELL	703.88	ESTIMATED BASEMENT ELEVATIONS (FEET AMSL)
	PIEZOMETER LOCATION		
	OBSERVED CONTOURS		
	SIMULATED DRAWDOWN		
	HEAD LINES/SINKS		

**SIMULATION 3
PRAIRIEWOOD CT. &
ELM STREET
SIMULATED DRAWDOWN**



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

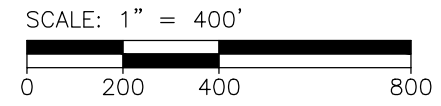
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LEGEND

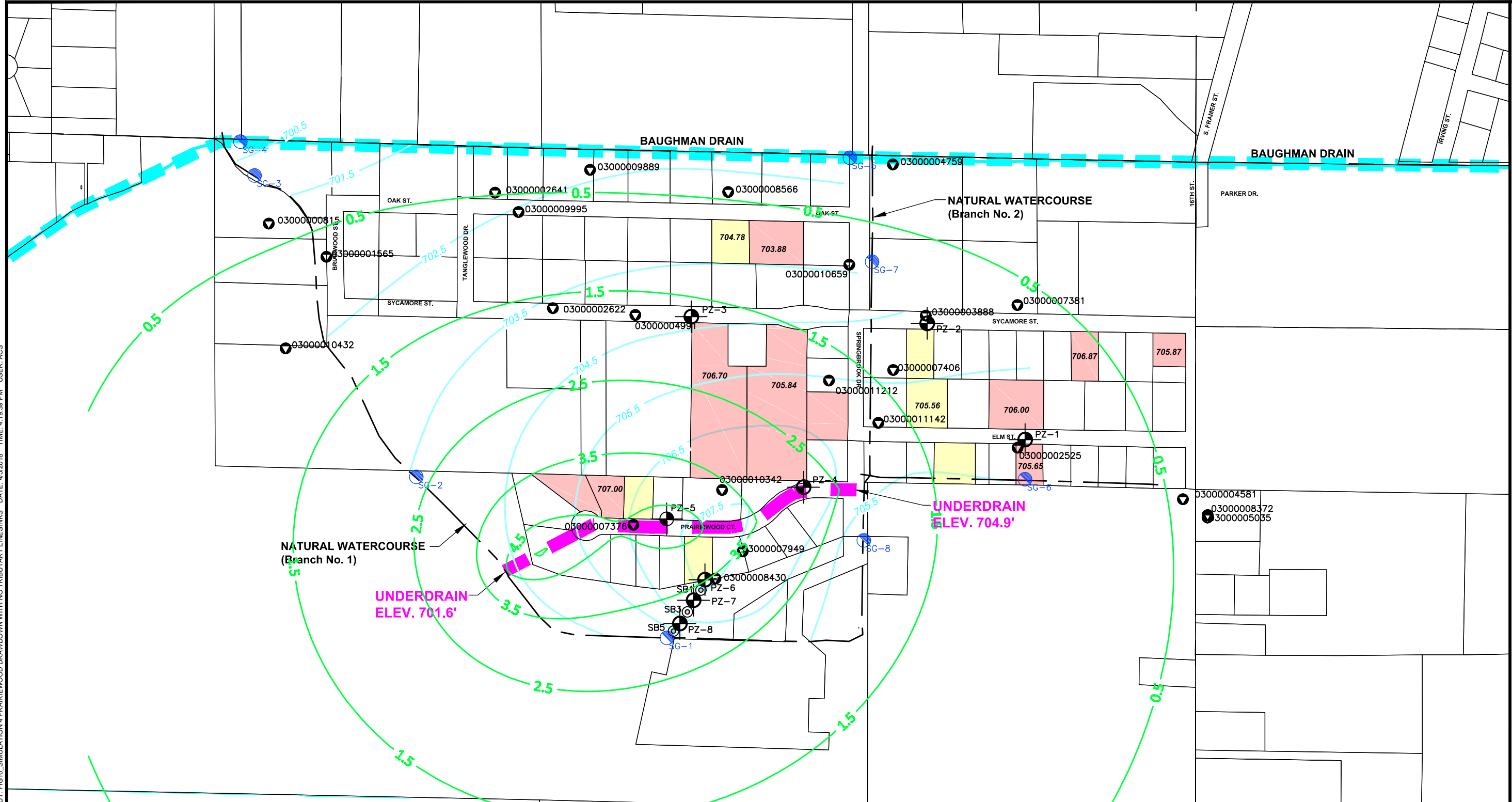
- SOIL BORING
- STAFF GAUGE LOCATION
- WATER SUPPLY WELL
- PIEZOMETER LOCATION
- OBSERVED CONTOURS
- SIMULATED CONTOURS
- LINESINKS
- PARCELS WITH REPORTS OF CONSISTENT FLOODING
- PARCELS WITH REPORTS OF PERIODIC FLOODING
- 703.88** ESTIMATED BASEMENT ELEVATIONS (FEET AMSL)

CALIBRATION 3
NO TRIBUTARY
LINESINKS



PLOT INFO: Z:\2018\180488\CAD\REF\2001-180488.DWG LAYOUT: FIG09 - CALIBRATION 3 NO TRIBUTARY LINESINKS DATE: 3/30/2018 TIME: 11:02:17 AM USER: ACS

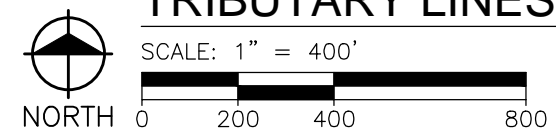
BASE MAP ADAPTED FROM DRAWING
PROVIDED BY LRE, 12/19/17
ORTHO PHOTO DATED: 2014



LEGEND

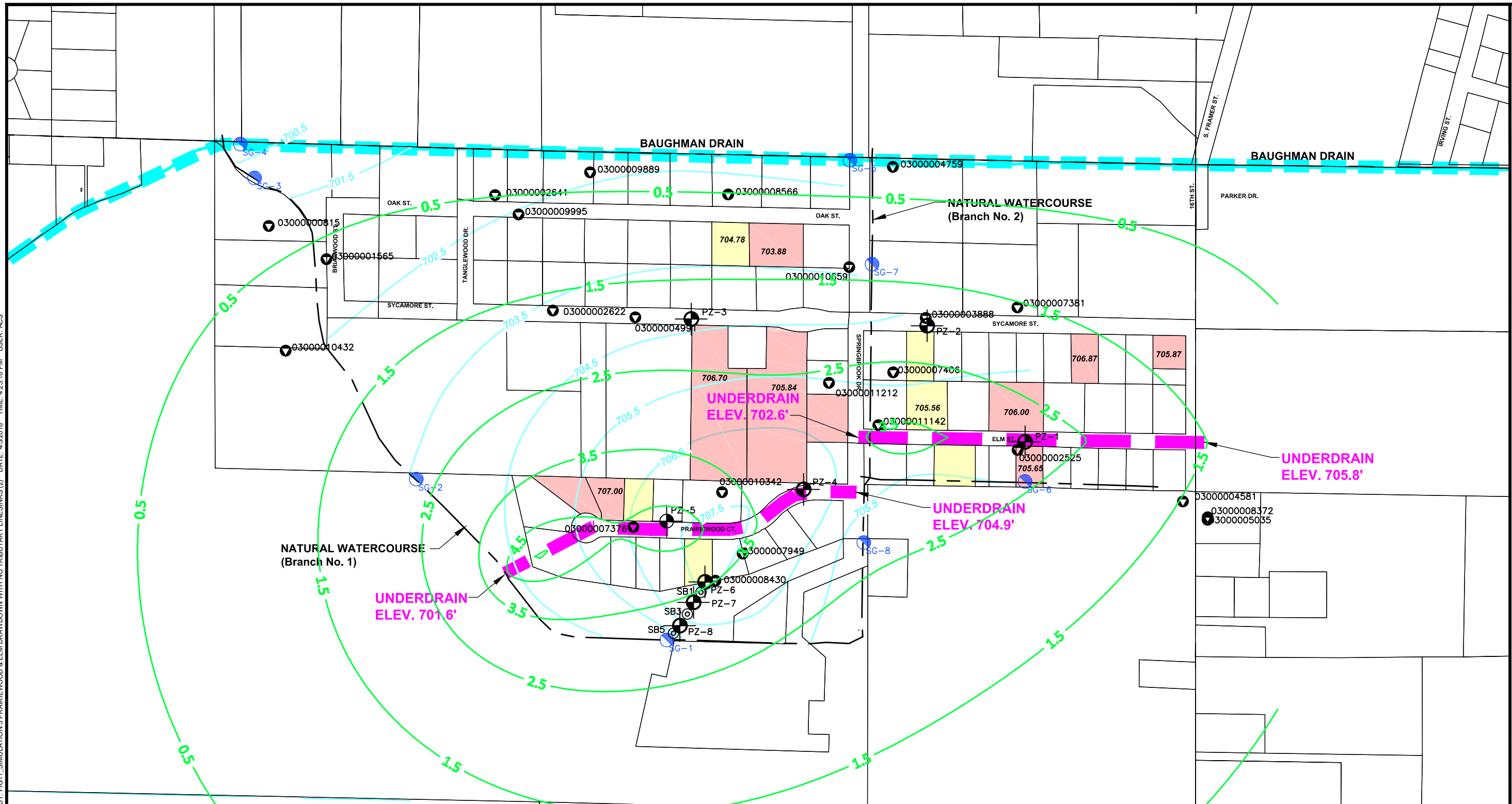
- ⊙ SOIL BORING
- ⊙ STAFF GAUGE LOCATION
- ⊙ WATER SUPPLY WELL
- ⊙ PIEZOMETER LOCATION
- OBSERVED CONTOURS
- SIMULATED DRAWDOWN
- LINESINKS
- ▭ PARCELS WITH REPORTS OF CONSISTENT FLOODING
- ▭ PARCELS WITH REPORTS OF PERIODIC FLOODING
- 703.88 ESTIMATED BASEMENT ELEVATIONS (FEET AMSL)

**SIMULATION 4
PRAIRIEWOOD CT.
DRAWDOWN WITH NO
TRIBUTARY LINESINKS**



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

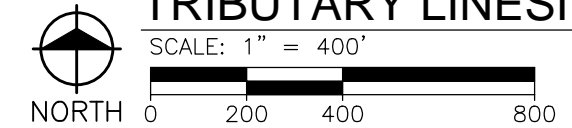
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LEGEND

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

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



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

PLOT INFO: Z:\2018\180488\CADD\REF\2001-180488.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

PAGE 1 OF 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

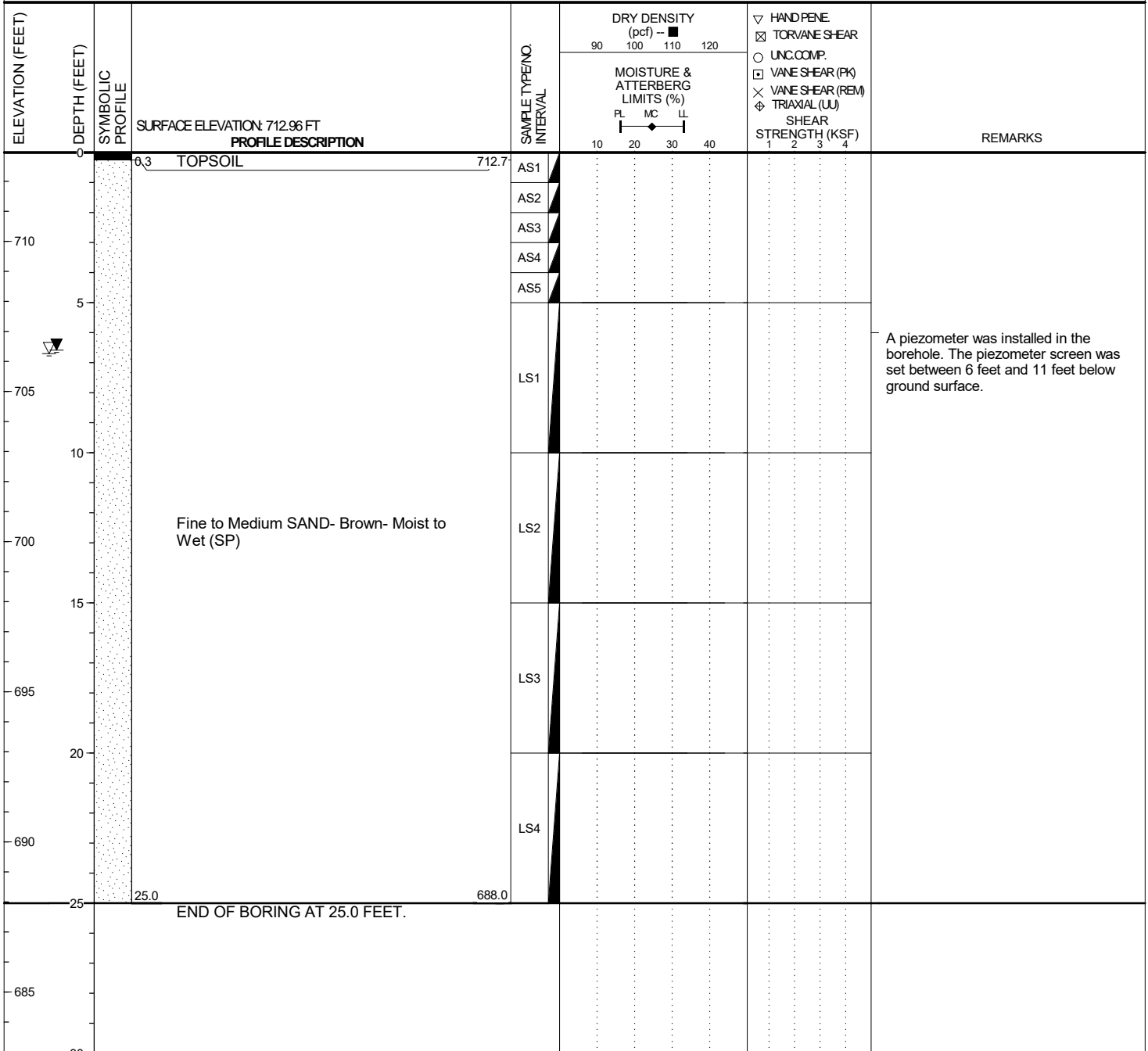
BORING METHOD: Direct Push

OPERATOR: Nick-Fibertec

RIG NO.: 7822 DT-1

LOGGED BY: AJL

CHECKED BY: MAV



GROUNDWATER & BACKFILL INFORMATION		
	DEPTH (FT)	ELEV (FT)
<input type="checkbox"/> DURING BORING:	6.7	706.3
<input checked="" type="checkbox"/> 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

PAGE 1 OF 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

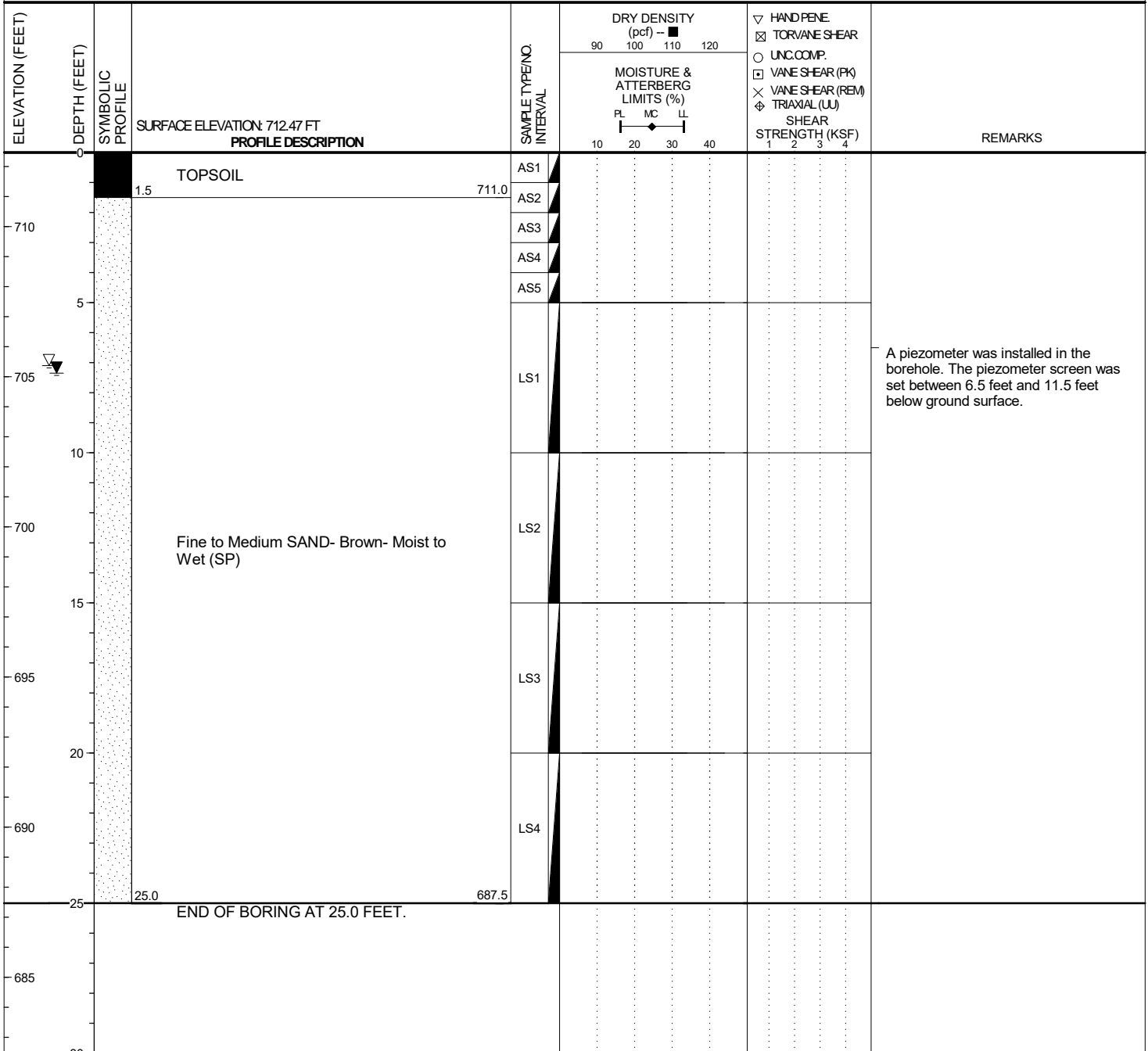
BORING METHOD: Direct Push

OPERATOR: Nick-Fibertec

RIG NO.: 7822 DT-1

LOGGED BY: AJL

CHECKED BY: MAV



GROUNDWATER & BACKFILL INFORMATION		
	DEPTH (FT)	ELEV (FT)
<input type="checkbox"/> DURING BORING:	7.1	705.4
<input checked="" type="checkbox"/> 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.



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

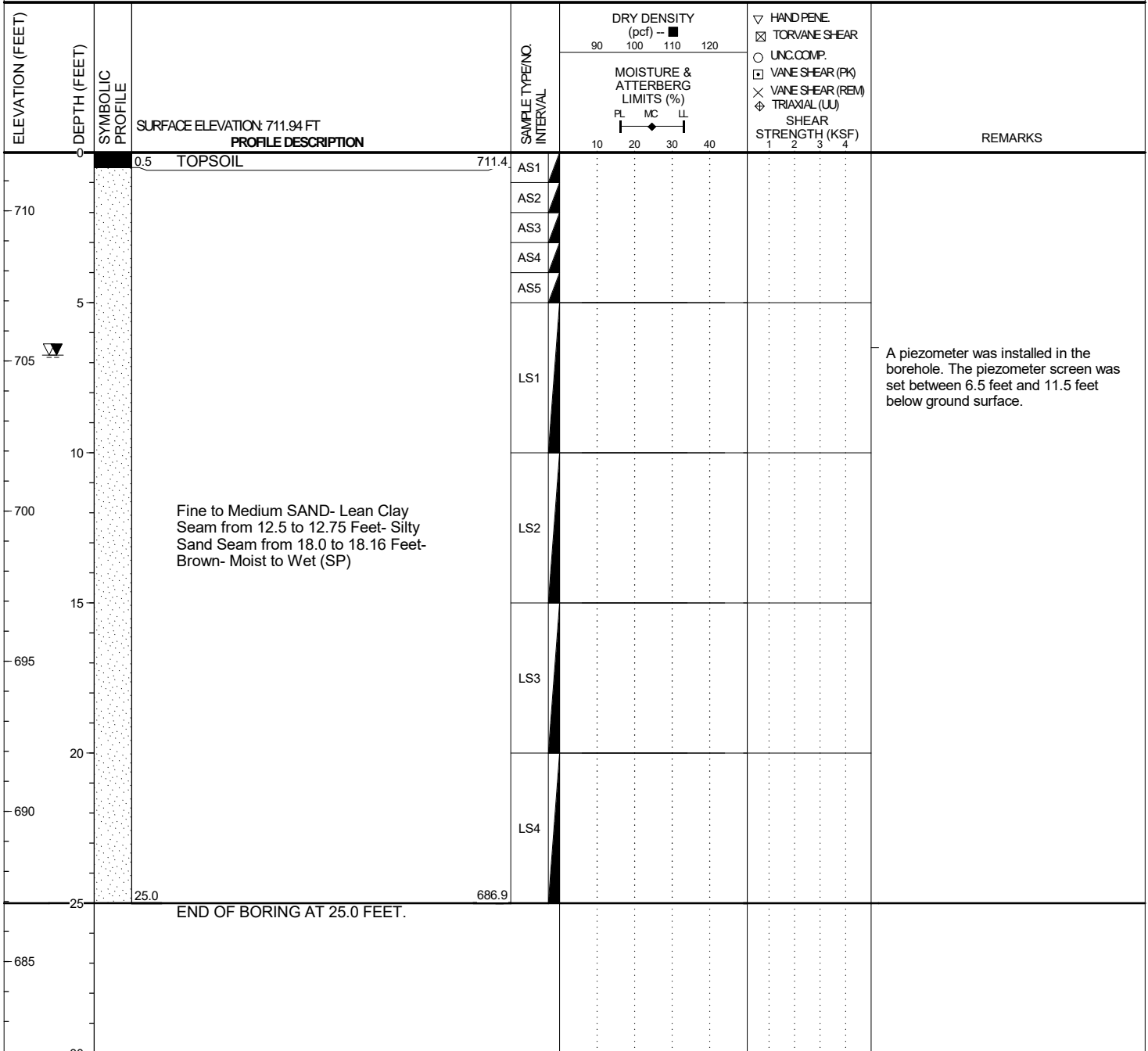
BORING METHOD: Direct Push

OPERATOR: Nick-Fibertec

RIG NO.: 7822 DT-1

LOGGED BY: AJL

CHECKED BY: MAV



GROUNDWATER & BACKFILL INFORMATION		
	DEPTH (FT)	ELEV (FT)
<input type="checkbox"/> DURING BORING:	6.8	705.2
<input checked="" type="checkbox"/> 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

PAGE 1 OF 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

ELEVATION (FEET)	DEPTH (FEET)	SYMBOLIC PROFILE	SURFACE ELEVATION: 712.2 FT PROFILE DESCRIPTION	SAMPLE TYPE/NO. INTERVAL	DRY DENSITY (pcf) -- ■				MOISTURE & ATTERBERG LIMITS (%)	TEST METHODS				REMARKS	
					90	100	110	120		PL	MC	LL	SH		TV
711.7	0.5	TOPSOIL		AS1											
710				AS2											
				AS3											
				AS4											
				AS5											
705				LS1											A piezometer was installed in the borehole. The piezometer screen was set between 6 feet and 11 feet below ground surface.
700			Fine to Medium SAND- Brown- Moist to Wet (SP)	LS2											
695				LS3											
690				LS4											
687.2	25.0		END OF BORING AT 25.0 FEET.												

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

PAGE 1 OF 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

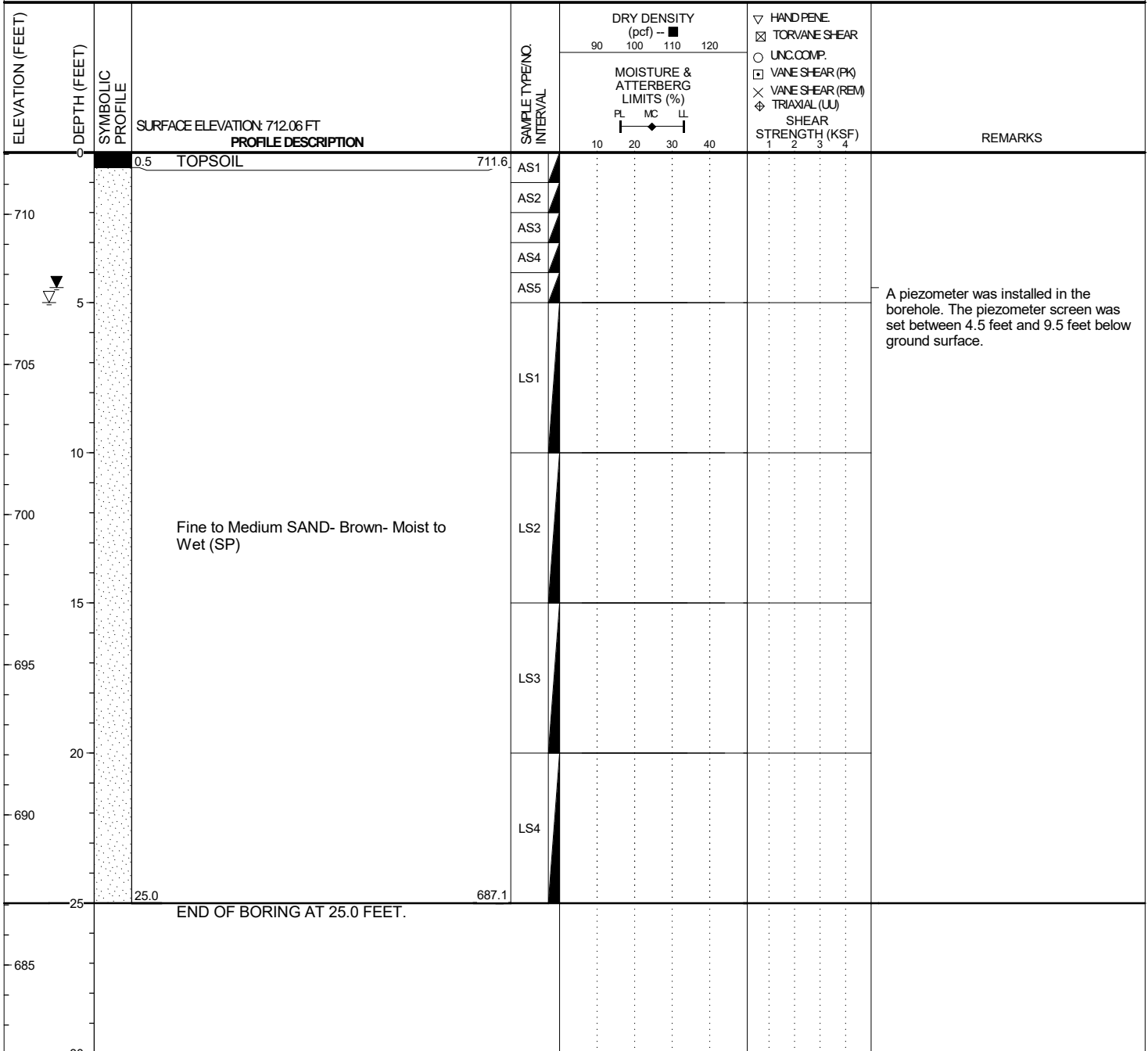
BORING METHOD: Direct Push

OPERATOR: Nick-Fibertec

RIG NO.: 7822 DT-1

LOGGED BY: AJL

CHECKED BY: MAV



GROUNDWATER & BACKFILL INFORMATION		
	DEPTH (FT)	ELEV (FT)
<input type="checkbox"/> DURING BORING:	5.0	707.1
<input checked="" type="checkbox"/> 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

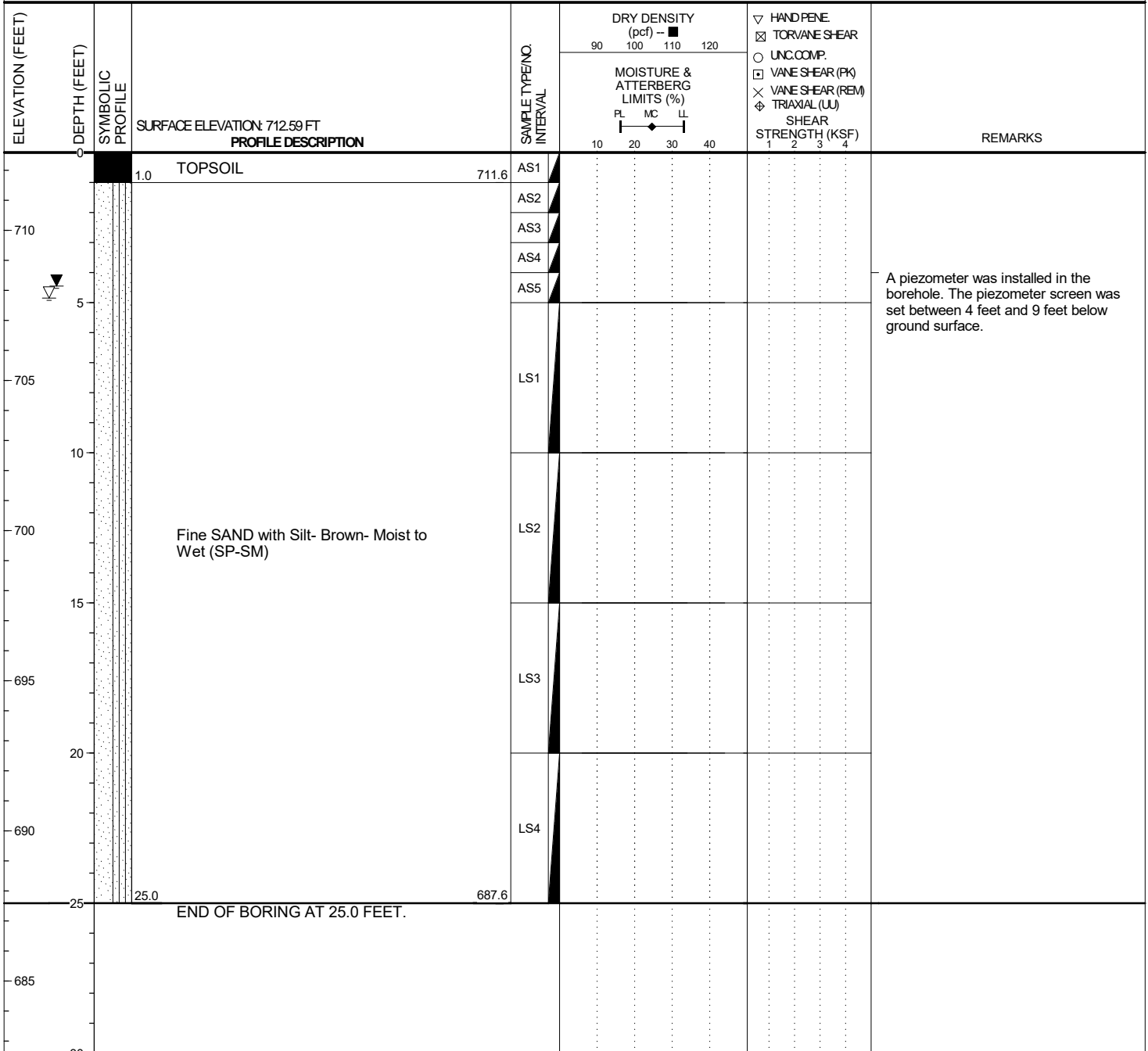
BORING METHOD: Direct Push

OPERATOR: Nick-Fibertec

RIG NO.: 7822 DT-1

LOGGED BY: AJL

CHECKED BY: MAV



GROUNDWATER & BACKFILL INFORMATION		
	DEPTH (FT)	ELEV (FT)
<input type="checkbox"/> DURING BORING:	4.9	707.7
<input checked="" type="checkbox"/> 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
CLIENT: Land & Resource Engineering and Surveying, Inc.

PROJECT NUMBER: 077821.00
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							
			LS4	33			
20		Fine SAND- Brown- Wet (SP)					
			LS5	42			
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).



PROJECT NAME: Baughman Drain Supplemental Hydrogeo
CLIENT: Land & Resource Engineering and Surveying, Inc.

PROJECT NUMBER: 077821.00
PROJECT LOCATION: Otsego, Michigan

DATE STARTED: 11/22/17 **COMPLETED:** 11/22/17
OPERATOR: Fibertec **RIG NO.:** 7822 DT-1

BORING METHOD: Direct Push
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)					
1.0			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		Fine to Medium SAND- Brown- Moist to Wet (SP)	LS2	48			
10			LS3	29			
15			LS4	42			
19.0		Sandy LEAN CLAY- Brown (CL)					
19.3							
20		Fine SAND- Brown- Wet (SP)	LS5	36			
25.0		END OF BORING AT 25.0 FEET.					
30							

GROUNDWATER & BACKFILL INFORMATION		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).
	DEPTH (FT)	
▽ DURING BORING:	4.8	
▽ AT END OF BORING:	4.8	
BACKFILL METHOD: Well Installation - Piezometer		



PROJECT NAME: Baughman Drain Supplemental Hydrogeo
CLIENT: Land & Resource Engineering and Surveying, Inc.

PROJECT NUMBER: 077821.00
PROJECT LOCATION: Otsego, Michigan

DATE STARTED: 11/22/17 **COMPLETED:** 11/22/17
OPERATOR: Fibertec **RIG NO.:** 7822 DT-1

BORING METHOD: Direct Push
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							
		Silty LEAN CLAY- Gray (CL)					
			LS4	50			
15							
19.8							
		Fine SAND- Brown- Wet (SP)					
			LS5	37			
20							
25.0		END OF BORING AT 25.0 FEET.					
25							
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).



PROJECT NAME: Baughman Drain Supplemental Hydrogeo
CLIENT: Land & Resource Engineering and Surveying, Inc.

PROJECT NUMBER: 077821.00
PROJECT LOCATION: Otsego, Michigan

DATE STARTED: 11/22/17 **COMPLETED:** 11/22/17
OPERATOR: Fibertec **RIG NO.:** 7822 DT-1

BORING METHOD: Direct Push
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			
12.5			LS3	38			
15		Silty LEAN CLAY- Gray (CL)	LS4	44			
19.8			LS5	28			
25.0		Fine SAND- Brown- Wet (SP)					
END OF BORING AT 25.0 FEET.							
30							

GROUNDWATER & BACKFILL INFORMATION		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).
▽ DURING BORING:	DEPTH (FT) 5.5	
▽ AT END OF BORING:	6.0	
BACKFILL METHOD: Well Installation - Piezometer		



PROJECT NAME: Baughman Drain Supplemental Hydrogeo
CLIENT: Land & Resource Engineering and Surveying, Inc.

PROJECT NUMBER: 077821.00
PROJECT LOCATION: Otsego, Michigan

DATE STARTED: 11/22/17 **COMPLETED:** 11/22/17
OPERATOR: Fibertec **RIG NO.:** 7822 DT-1

BORING METHOD: Direct Push
LOGGED BY: AJL **CHECKED BY:** MAV

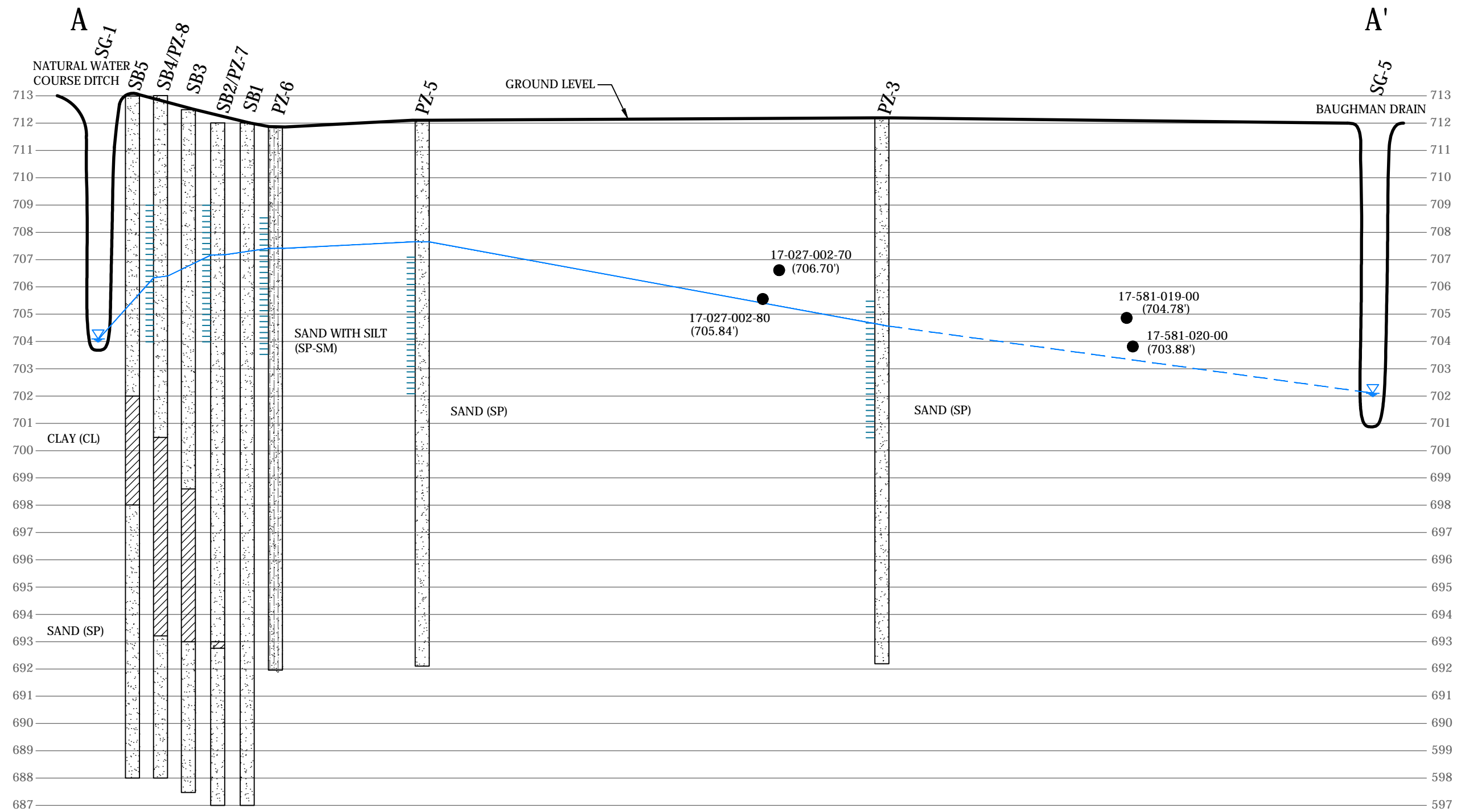
DEPTH (FEET)	SYMBOLIC PROFILE	PROFILE DESCRIPTION	SAMPLE TYPE/NO. INTERVAL	RECOVERY (inches)	PID (ppm)	SOIL ANALYTICAL SAMPLE	REMARKS
0		TOPSOIL- SILTY SAND with Organics and Root Fibers- Black- Moist (SM)					
1.5			LS1	38			
5		Fine to Medium SAND- Brown- Moist to Wet (SP)	LS2	36			
11.0		Silty LEAN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

GROUNDWATER & BACKFILL INFORMATION	
▽ DURING BORING: BACKFILL METHOD: Soil Cuttings	DEPTH (FT) 7.0

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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PLOT DATE: Dec 19, 2017 - 2:34pm - jblake



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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

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Project
**BAUGHMAN DRAIN
HYDROGEOLOGIC
EVALUATION**

Project Location
**OTSEGO,
ALLEGAN COUNTY,
MICHIGAN**

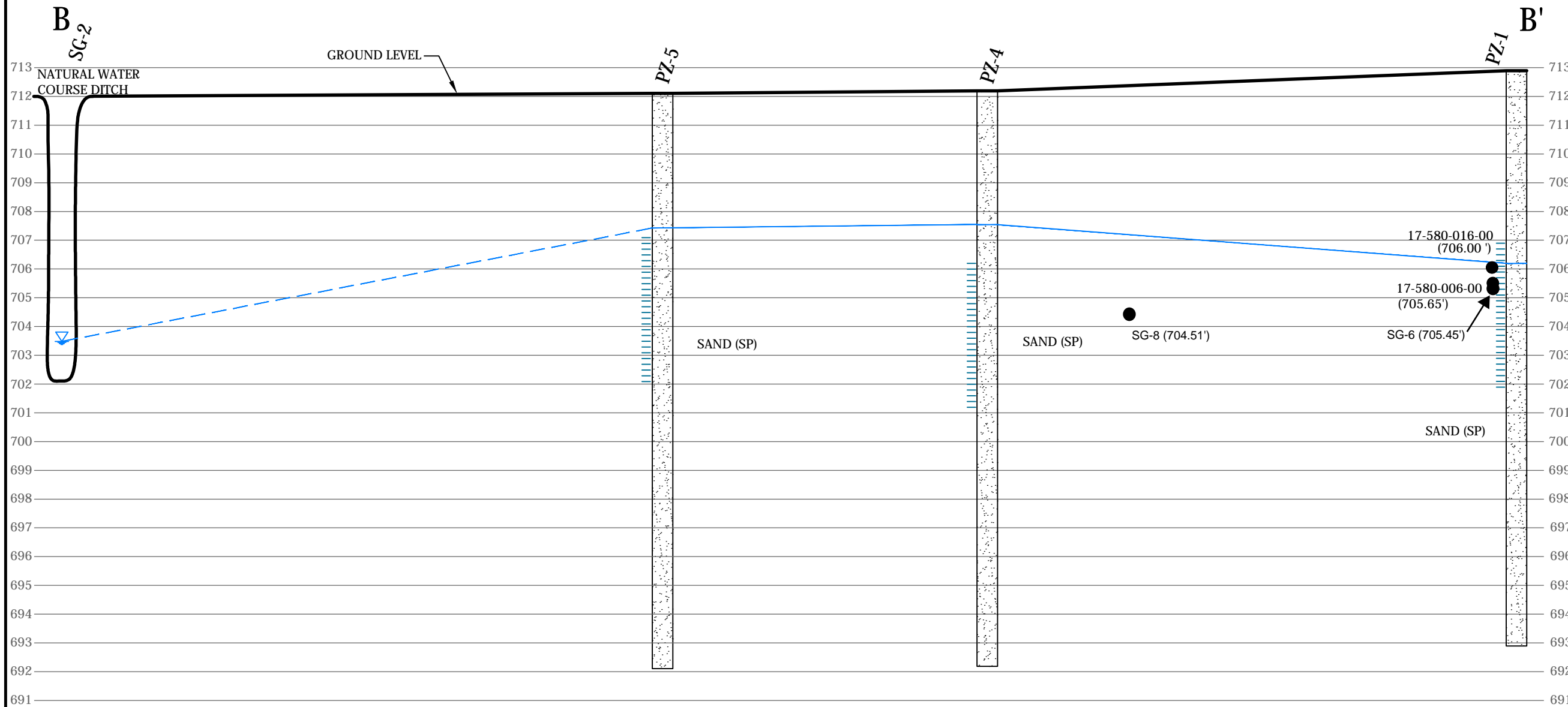
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**GEOLOGICAL
CROSS-SECTION B-B'**

No.	Revision Date

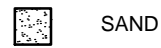
Date	12-19-17
CADD	JAB
Designer	AJL
Scale	AS SHOWN
Project	077821.00

Figure No.
4

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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'

FILE LOCATION: \\Sme-inc\pz\WIP\077821.00\CAD\DWGS\rev\077821.00-XS.dwg

PLOT DATE: Dec 19, 2017 - 2:23pm - jblake

Appendix 2



Water Well And Pump Record



Completion is required under authority of Part 127 Act 366 PA 1976.

Failure to comply is a misdemeanor.

Import ID:

Tax No:	Permit No:	County: Allegan	Township: Osage
Well ID: 03000000815		Town/Range: 01N 12W	Section: 27
		Well Status:	WSSN:
Elevation:		Distance and Direction from Road Intersection: About 1.10 mile east of Prinerwood Dr. on Fairway Ln	
Latitude: 42.449199		Well Owner: Jim Forder	
Longitude: 85.714451		Well Address: 1796 Fairway Ln. Osage, MI	Owner Address: 1796 Fairway Ln. Osage MI
Method of Collection: Address Matching-House Number			

Drilling Method: Cable Tool	Well Use: Household	Pump Installed: Yes	Pump Installation Only: No
Well Depth: 40.00 ft.	Date Completed: 4/14/2000	Pump Installation Date:	HP: 1.00
Well Type: New		Manufacturer: Sta-Rex	Pump Type: Submersible
Casing Type: Steel - black	Height:	Model Number:	Pump Capacity: 20 GPM
Casing Joint: Threaded & coupled		Drop Pipe Length: 25.00 ft	Pump Voltage:
Casing Fitting: Other		Drop Pipe Diameter:	Drilling Record ID:
Diameter: 4.00 in. to 36.00 ft depth		Draw Down Seal Used: No	
Borehole:		Pressure Tank Installed: Yes	
		Pressure Tank Type: Unknown	
		Manufacturer: Well-X-Trol	Tank Capacity: 32.0 Gallons
		Model Number: WX 203	
		Pressure Relief Valve Installed: No	

Static Water Level: 14.00 ft. Below Grade	Yield Test Method: Plunger	Formation Description	Thickness	Depth to Bottom
Well Yield Test:				
Pumping level 14.00 ft. after 0.50 hrs. at 20 GPM		Sand	5.00	5.00
		Sand w/ Stones	10.00	15.00
		Sand Fine Water Bearing	25.00	40.00

Screen Installed: Yes	Filler 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: Filler adapter, 12 inches above grade

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: 39 1036
Business Name: Loversco 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.

Import ID:

Tax No:	Permit No:	County: Allegan	Township: Osego
Well ID: 03000001565		Town/Range: 01N 12W	Section: 27
Elevation:		Well Status: Active	WSSM:
Latitude: 42.44683103		Source ID/Well No:	
Longitude: -85.71359152		Distance and Direction from Road Intersection: 30 FEET WEST OF BRIARWOOD; 40 FEET SOUTH OF OAK	
Method of Collection: Interpolation-Map		Well Owner: BRUCE MILLS	
		Well Address: 396 BRIARWOOD OTSEGO, MI	Owner Address: 396 BRIARWOOD OTSEGO, MI

Drilling Method: Cable Tool	Pump Installed: Yes	Pump Installation Only: No
Well Depth: 45.00 ft.	Pump Installation Date:	HP: 1.00
Well Type: New	Manufacturer: First & Welling	Pump Type: Submersible
Well Use: Household	Model Number: 4F27A10305	Pump Capacity: 27 GPM
Date Completed: 5/20/2000	Drop Pipe Length: 28.00 ft	Pump Voltage:
Casing Type: Steel black	Drop Pipe Diameter:	Drilling Record ID:
Casing Joint: Threaded & coupled	Draw Down Seal Used: No	
Casing Fitting: Drive shoe	Pressure Tank Installed: Yes	
Diameter: 4.00 in. to 40.00 ft. depth	Pressure Tank Type: Unknown	
Borehole:	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	Formation Description	Thickness	Depth to Bottom
Well Yield Test: Pumping level 40.00 ft. after 1.00 hrs. at 35 GPM			
Yield Test Method: Plunger	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: 3.00 in.	Blank: 1.00 ft. Above
Screen Material Type: Stainless steel wire wrapped	
Slot Length	Set Between
10.00	3.00 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: Plugless adapter	Geology Remarks:
---------------------------------------	------------------

Nearest Source of Possible Contamination	Drilling Machine Operator Name:
Type	Employment: Unknown
Septic tank	Distance: 75 ft.
	Direction: Northwest

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.

Import ID:

Tax No:	Perm# No:	County: Allegan	Township: Otsego
Well ID: 03000002525		Town/Range: 01N 12W	Section: 27
		Well Status: Active	WSSN:
Elevation:		Distance and Direction from Road Intersection: 1.10 MILE WEST ON ELM FROM 15TH	
Latitude: 42.44564036		Well Owner: HELEN ROBERTS	
Longitude: -85.7032122		Well Address: 1620 ELM STREET OTSEGO MI	Owner Address: 1620 ELM STREET OTSEGO, MI
Method of Collection: Interpolation-Map			

Drilling Method: Cable Tool	Pump Installed: Yes	Pump Installation Only: No
Well Depth: 40.00 ft	Pump Installation Date:	HP: 0.5H
Well Type: Replacement	Manufacturer: General	Pump Type: Submersible
Well Use: Household	Model Number:	Pump Capacity: 10 GPM
Date Completed: 5/31/2001	Drop Pipe Length: 28.00 ft	Pump Voltage:
Casing Type: Steel back	Drop Pipe Diameter:	Drilling Record ID:
Casing Joint: Threaded & coupled	Draw Down Seal Used: No	
Casing Filling: None	Pressure Tank Installed: Yes	
Height:	Pressure Tank Type: Unknown	
Diameter: 4.00 in. to 36.00 ft. depth	Manufacturer: Well X Tool	
	Model Number: 203	Tank Capacity: 1' 0-Galons
Borehole: 7.00 in. to 25.00 ft. depth	Pressure Relief Valve Installed: No	

Static Water Level: 7.00 ft. Below Grade	Formation Description	Thickness	Depth to Bottom
Well Yield Test:			
Pumping level 14.00 ft. after 1.00 hrs. at 40 GPM	Topsoil	1.00	1.00
	Sand & Gravel	7.30	8.30
	Sand & Clay	20.00	28.30
	Sand Medium	12.00	40.30

Screen Installed: Yes	Filler 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
Fillings: 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

Wellhead Completion: Fitters adapter, 12 inches above grade

Nearest Source of Possible Contamination:	Drilling Machine Operator Name: KAL LOVETT
Type	Employment: Employee
Septic tank	
Distance	
34 ft.	
Direction	
South	

Abandoned Well Plugged: Yes	Contractor Type: Water Well/Utility Contractor	Reg No: 03-1964
	Business Name: LOVETT WELL DRUG	
	Business Address:	

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 366 PA 1978



Failure to comply is a misdemeanor

Import ID:

Tax No:	Permit No:	County: Algon	Township: Otsego		
Well ID: 03000002622		Town/Range: 01N 12W	Section: 27	Well Status: Active	WSSN:
		Source ID/Well No:			
Elevation:					
Latitude: 42.4463028					
Longitude: -85.71019349					
Method of Collection: Address Maching-House Number					
Distance and Direction from Road Intersection: 0.15 mile west of Springbrook Dr ; 55' north of Sycamore					
Well Owner: Dennis Massariti					
Well Address: 1679 Sycamore Oshtemo, MI 49078				Owner Address: 1679 Sycamore Oshtemo, MI 49078	

Drilling Method: Cable Tool	Well Use: Household	Pump Installed: Yes	Pump Installation Only: No
Well Depth: 51.00 ft.	Date Completed: 4/26/2001	Pump Installation Date:	HP: 1.00
Well Type: Replacement		Manufacturer: Flint & Walling	Pump Type: Submersible
Casing Type: Steel black	Height:	Model Number: 4F1981005	Pump Capacity: 19 GPM
Casing Joint: Threaded & coupled		Drop Pipe Length: 35.00 ft.	Pump Voltage:
Casing Fitting: Drive shoe		Drop Pipe Diameter:	Drilling Record ID:
Diameter: 4.00 in. to 46.00 ft. depth		Draw Down Seal Used: No	
Borehole: 4.00 in. to 51.00 ft. depth		Pressure Tank Installed: Yes	
		Pressure Tank Type: Unknown	
		Manufacturer: Well X Tral	Tank Capacity:
		Model Number: 251	
		Pressure Relief Valve Installed: No	

Static Water Level: 9.00 ft. Below Grade	Formation Description	Thickness	Depth to Bottom
Well Yield Test:			
Yield Test Method: Plunger	Clay w/Gravel	5.00	5.00
Pumping level: 41.00 ft. after 1.00 hrs. at 30 GPM	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
10.00	5.00 ft
Set Between	
	46.00 ft. and 51.00 ft.
Fittings: Neoprene packer	

Well Grouted: Yes	Grouting Method: Unknown
Grouting Material: Bags	Additives:
Bentonite dry granular	None
Depth:	
1.00 ft. to 46.00 ft.	
Geology Remarks:	

Wellhead Completion: Pileless adapter, 12 inches above grade

Nearest Source of Possible Contamination:	Drilling Machine Operator Name:
Type:	Employment: Unknown
Septic tank	
Distance:	
100 ft.	
Direction:	
North	

Abandoned Well Plugged: Yes	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.

Import ID:

Tax No:	Permit No:	County: Allegan	Township: Oshtemo
Well ID: 03000002641		Town/Range: 01N 12W	Section: 27
		Well Status: Active	WSSN:
Elevation:		Distance and Direction from Road Intersection:	
Latitude: 42.44357086		1 MILE WEST OF SPRINGBROOK 60 FEET NORTH OF OAK STREET	
Longitude: -85.71108614		Well Owner: Ken Klump	
Method of Collection: Address Matching- House Number		Well Address: 1689 Oak St. Oshtemo, MI 49078	Owner Address: 1689 Oak St. Oshtemo, MI 49078

Drilling Method: Cable Tool	Pump Installed: Yes	Pump Installation Only: No
Well Depth: 42.00 ft	Pump Installation Date:	HP: 0.50
Well Type: Replacement	Well Use: Household	Pump Type: Submersible
Date Completed: 1/5/2001	Manufacturer: Ring & Waring	Pump Capacity: 10 GPM
Casing Type: Steel black	Model Number: 4F10SC5305	Pump Voltage:
Height:	Drop Pipe Length: 25.00 ft.	Drilling Record ID:
Casing Joint: Threaded & coupled	Drop Pipe Diameter:	
Casing Filling: Drive shoe	Draw Down Seal Used: No	
Diameter: 4.00 in to 37.00 ft depth	Pressure Tank Installed: Yes	
Borehole:	Pressure Tank Type: Unknown	
	Manufacturer: Well X Tool	
	Model Number: 203	Tank Capacity: 9.9 Gallons
	Pressure Relief Valve Installed: No	

Static Water Level: 12.00 ft Below Grade	Formation Description	Thickness	Depth to Bottom
Well Yield Test: Pumping level 30.00 ft after 1.00 hrs. at 3.5 GPM			
Yield Test Method: Plunger	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: Pileless adapter, 12 inches above grade

Nearest Source of Possible Contamination:	Drilling Machine Operator Name:		
Type: Septic tank	Distance: 100 ft.	Direction: North	Employment: Unknown

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

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 366 PA 1978

Failure to comply is a misdemeanor.

Import ID:

Tax No:	Permit No:	County: Allegan	Township: Disego
Well ID: 03000004991		Town/Range: 01N 12W	Section: 27
		Well Status: Active	WSSN:
Elevation:		Distance and Direction from Road Intersection: 500FT W OF SPRINGBROOK 100FT N OF SYCAMORE	
Latitude: 42.4482415		Well Owner: RALPH VENEN	
Longitude: -85.70985891		Well Address: 1673 SYCAMORE OTSEGO, MI 49078	Owner Address: 1673 SYCAMORE OTSEGO, MI 49078
Method of Collection: Address Matching- House Number			

Drilling Method: Cable Tool	Pump Installed: Yes	Pump Installation Only: No
Well Depth: 50.00 ft	Pump Installation Date:	HP: 1.50
Well Type: Replacement	Manufacturer: F.E. Myers	Pump Type: Submersible
Casing Type: Steel - unknown	Model Number:	Pump Capacity: 10 GPM
Casing Joint: Threaded & coupled	Drop Pipe Length: 39.00 ft	Pump Voltage:
Casing Fitting: Drive shoe	Drop Pipe Diameter:	Drilling Record ID:
Diameter: 4.00 in. to 45.00 ft depth	Draw Down Seal Used: No	
Borehole:	Pressure Tank Installed: No	
	Pressure Relief Valve Installed: No	

Static Water Level: 12.00 ft Below Grade	Formation Description	Thickness	Depth to Bottom
Well Yield Test: Pumping level 44.00 ft after 1.00 hrs at 35 GPM			
Yield Test Method: Plunger	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: Pileless adapter	Geology Remarks:
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Nearest Source of Possible Contamination:	Drilling Machine Operator Name: RICK MILLER
Type: Septic tank	Employment: Employee
Distance: 80 ft	
Direction: West	

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

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

General Remarks:	Water Well Contractor's Certification
Other Remarks:	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



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:		County: Alogen		Township: Osego			
Well ID: 03000007406				Town/Range: 01N 12W	Section: 27	Well Status: Active	WSSN:		
				Source ID/Well No:		Distance and Direction from Road Intersection: 2.13 MI WEST ON SYCAMORE FROM 16TH ST			
				Well Owner: MARK MORAN				Well Address: 1635 SYCAMORE MI	
Elevation: 709 ft				Owner Address: 231 VINE ST WAYLAND PO BOX 22 SHELBYVILLE, MI 49344					
Latitude: 42.447678				Method of Collection: Interpolation-Map					
Longitude: 85.705091									

Drilling Method: Rotary	Pump Installed: Yes	Pump Installation Only: No
Well Depth: 45.00 ft	Pump Installation Date:	HP: 11.50
Well Use: Household	Manufacturer: General	Pump Type: Submersible
Well Type: New	Date Completed: 4/29/2005	Pump Capacity: 10 GPM
Casing Type: PVC plastic	Model Number:	Pump Voltage:
Casing Joint: Unknown	Drop Pipe Length: 20.00 ft	Drilling Record ID:
Casing Fitting: None	Drop Pipe Diameter:	
Diameter: 5.00 in. to 41.00 ft. depth	Draw Down Seal Used: No	
Borehole: 8.75 in. to 46.00 ft. depth	Pressure Tank Installed: Yes	
	Pressure Tank Type: Unknown	
	Manufacturer: Well-X-Trol	Tank Capacity: 11.0 Gallons
	Model Number: 203	
	Pressure Relief Valve Installed: No	

Static Water Level: 8.00 ft Below Grade	Well Yield Test: Yield Test Method: Air	Purping level 9.00 ft. after 1.00 hrs. at 30 GPM	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	

Screen Installed: Yes	Filter Packed: No
Screen Diameter: 3.00 in	Blank
Screen Material Type: Stainless steel wire wrapped	
Slot Length: 12.00	Set Between: 5.00 ft
	41.00 ft. and 46.00 ft.
Fittings: Unknown	
Well Grouted: Yes	Grouting Method: Unknown
Grouting Material: Neat cement	Bags: 5.00
	Additives: None
	Depth: 0.00 ft. to 46.00 ft.
Wellhead Completion: Pitless adapter, 12 inches above grade	

Geology Remarks:
GREY CLAY BELOW 46'

Nearest Source of Possible Contamination.			Drilling Machine Operator Name: FOUKE WELL DRLLG
Type: Septic tank	Distance: 75 ft	Direction: West	Employment: Subcontractor
			Contractor Type: Water Well Drilling Contractor
			Reg No: 03-1384
			Business Name: LOVETT WELL DRLLG
			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

Import ID:

Tax No:	Permit No:	County: Allegan		Township: Otsego	
Well ID: 03000007949		Town/Range: 01N 12W	Section: 27	Well Status: Active	WSSN:
		Source ID/Well No:			
		Distance and Direction from Road Intersection: 1.10 MILE SOUTH THEN WEST ON PRAIRIEWOOD FROM ELM ST			
Elevation: 712 ft		Well Owner: JOSEPH FARNSWORTH			
Latitude: 42.445645		Well Address: 1670 PRAIRIEWOOD OTSEGO MI 49078		Owner Address: 1056 16TH OTSEGO, MI 49078	
Longitude: -85.707298					
Method of Collection: GPS Std Positioning Sys SA Off					

Drilling Method: Rotary	Well Depth: 115.00 ft	Well Use: Household	Pump Installed: Yes	Pump Installation Only: No
Well Type: New	Date Completed: 9/21/2005		Pump Installation Date:	HP: 1.00
Casing Type: PVC plastic	Height:		Manufacturer: General	Pump Type: Submersible
Casing Joint: Unknown			Model Number:	Pump Capacity: 19 GPM
Casing Fitting: None			Drop Pipe Length: 40.00 ft	Pump Voltage:
			Drop Pipe Diameter:	Drilling Record ID:
Diameter: 5.00 in. to 110.00 ft. depth			Draw Down Seal Used: No	
			Pressure Tank Installed: Yes	
Borehole: 8.80 in. to 115.00 ft. depth			Pressure Tank Type: Unknown	
			Manufacturer: Well X Tool	
			Model Number: 251	Tank Capacity: 62.0 Gallons
			Pressure Relief Valve Installed: No	

Static Water Level: 7.00 ft. Below Grade	Formation Description	Thickness	Depth to Bottom
Well Yield Test:			
Yield Test Method: Air	Sand Medium	27.00	27.00
Pumping level: 10.00 ft. after 1.00 hrs. at 40 GPM	Brown Clay	2.00	39.00
	Sand & Gravel Medium	76.00	115.00

Screen Installed: Yes	Filter Packed: No	
Screen Diameter: 3.00 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	8.00	None	0.00 ft. to 115.00 ft
Geology Remarks: SHALE BELOW 15'			

Wellhead Completion: Pitless adapter, 12 inches above grade
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Nearest Source of Possible Contamination:	Drilling Machine Operator Name: FINE WEL DRILLING
Type	Employment: Subcontractor
Distance	
Direction	
Unknown	

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 OK PER JAIME DENTLER
Other Remarks:



Water Well And Pump Record

Completion is required under authority of Part 127 Act 36B PA 1978.



Import ID:

Failure to comply is a misdemeanor

Tax No:	Permit No:	County: Allegan		Township: Otsego	
Well ID: 03000008430		Town/Range: 01N 12W	Section: 27	Well Status: Active	WSSN:
		Source ID/Well No:			
Elevation:		Distance and Direction from Road Intersection: 1 MI W 16TH ST 150' S PRAIRIEWOOD			
Latitude: 42.44534		Well Owner: GEORGE KIBLER			
Longitude: -85.7077		Well Address: 1674 PRAIRIEWOOD OTSEGO MI		Owner Address: 2525 W F AVE KALAMAZOO, MI 49002	
Method of Collection: GPS Std Positioning Sys SA Off					

Drilling Method: Rotary	Well Depth: 84.00 ft.	Well Use: Household	Pump Installed: Yes	Pump Installation Only: No
Well Type: New	Date Completed: 2/4/2005	Height:	Pump Installation Date:	NP: 0.50
Casing Type: PVC plastic	Casing Joint: Solvent welded/glued	Casing Fitting: None	Manufacturer: Grundfos	Pump Type: Submersible
Diameter: 5.00 in. to 75.00 ft. depth	Borehole: 3.50 in. to 84.00 ft. depth	Model Number: 10605 ft	Drop Pipe Length: 84.00 ft.	Pump Capacity: 10 GPM
		Drop Pipe Diameter: 1.00 in	Draw Down Seal Used: No	Pump Voltage:
		Pressure Tank Installed: Yes	Pressure Tank Type: Diaphragm/bladder	Drilling Record ID:
		Manufacturer: Champion	Model Number: CM-205	Tank Capacity: 10.0 Galons
		Pressure Relief Valve Installed: Yes		

Static Water Level: 5.00 ft. Below Grade	Well Yield Test:	Yield Test Method: Air	Formation Description	Thickness	Depth to Bottom
Pumping level: 60.00 ft. after 1.00 hrs. at 60 GPM			Brown Sand	20.00	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: 15.00	Length: 5.00 ft.	Set Between: 75.00 ft. and 84.00 ft.
Fittings: Unknown			

Well Grouted: Yes	Grouting Method: Unknown
Grouting Material: Bentonite slurry	Depth: 0.00 ft. to 75.00 ft.
Wellhead Completion: Pileless adapter	

Nearest Source of Possible Contamination:	Drilling Machine Operator Name: MITCHELL VICKERY
Type: Sepsic tank	Employment: Employee
Distance: 75 ft.	Pump Installer: MATTHEW KURDELSKI
Direction: North	Contractor Type: Water Well Drilling Contractor
	Reg No: 03-1801
	Business Name: KFAAI WELL DRILG 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 36B PA 1978.

Failure to comply is a misdemeanor

Import ID:

Tax No:	Permit No:	County: Allegan	Township: Otsego
Well ID: 03000008566		Town/Range: 01N 12W	Section: 27
Elevation:		Well Status: Active	WSSN:
Latitude: 42.44862		Source ID/Well No:	
Longitude: -85.7078		Distance and Direction from Road Intersection: 1/4 MILE WEST OF SPRINGBROOK ON NORTH SIDE OF OAK ST	
Method of Collection: GPS Std Positioning Sys. SA Off		Well Owner: DONALD TROUTMAN	
		Well Address: 1677 OAK ST OTSEGO, MI 49078	Owner Address: 1677 OAK ST OTSEGO, MI 49078

Drilling Method: Rotary	Pump Installed: Yes	Pump Installation Only: No
Well Depth: 38.00 ft	Pump Installation Date: 5/30/2005	HP: 0.50
Well Type: Replacement	Well Use: Household	Manufacturer: A Y, McDonald
Date Completed: 5/26/2005	Model Number: 21950K2	Pump Type: Submersible
Casing Type: PVC plastic	Drop Pipe Length: 20.00 ft	Pump Capacity: 10 GPM
Casing Joint: Solvent welded/glood	Drop Pipe Diameter: 1.00 in	Pump Voltage:
Casing Fitting: Shale packer/trap	Draw Down Seal Used: No	Drilling Record ID:
Diameter: 5.00 in to 33.00 ft depth	Pressure Tank Installed: No	
Borehole: 8.75 in to 33.00 ft depth	Pressure Relief Valve Installed: No	

Static Water Level: 10.00 ft Below Grate	Formation Description	Thickness	Depth to Bottom
Well Yield Test: Yield Test Method: Air			
Pumping level 20.00 ft after 1.00 hrs. at 25 GPM	Brown Clay & Sand	4.00	4.00
Screen Installed: Yes	Gravel & Sand Fine	29.00	33.00
Filter Packed: No	Sand Water Bearing	5.00	38.00
Screen Diameter: 4.00 in.	Gray Clay & Stones	3.00	41.00
Blank: 1.00 ft. Above	Gravel & Stones Fine	3.00	43.00
Screen Material Type: Stainless steel-slotted	Gray Clay	13.00	56.00
Slot Length: 5.00 in	Clay & Sand Silty	7.00	63.00
Set Between: 33.00 ft. and 38.00 ft.	Gray Clay	87.00	150.00
Fittings: Neoprene packer			
Well Grouted: Yes			
Grouting Method: Grout pipe outside casing			
Grouting Material: Bentonite slurry			
Bags: 5.00			
Additives: None			
Depth: 3.00 ft. to 33.00 ft.			

Wellhead Completion: 12 inches above grade	Geology Remarks:
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Nearest Source of Possible Contamination:	Drilling Machine Operator Name: RICK FREY	
Type: Septic tank	Distance: 80 ft.	Direction: East
Employment: Employee	Contractor Type: Water Well Drilling Contractor	Reg No: 13-1593
Abandoned Well Plugged: Yes	Pump Installer: JOHN CHAPMAN	Business Name: Katz Well Drilling
	Business Address: 1478 E Michigan, Battle Creek, MI, 49014	

Casing Diameter: 4 in.	Casing Removed: No
Plugging Material: Bentonite chips/pellets	
No. of Bags: 3.50	
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.	County: Alagan	Township: Otsego
Well ID: 03000009889		Town/Range: 01N 12W	Section: 27
		Well Status: Active	WSSN:
Elevation:		Distance and Direction from Road Intersection: APPROX 1/4 MI E W OF SPRINGROCK N SIDE OF OAK ST	
Latitude: 42 4456d		Well Owner: KEN KLUMPP	
Longitude: -85 70967		Well Address	Owner Address
Method of Collection: GPS Std Positioning Sys SA Off		1689 OAK ST OTSEGO, MI 49078	1689 OAK ST OTSEGO, MI 49073

Drilling Method: Rotary	Pump Installed: Yes	Pump Installation Only: No
Well Depth: 38.00 ft	Pump Installation Date: 5/2/2008	HP: 0.50
Well Type: Replacement	Well Use: Household	Pump Type: Submersible
Date Completed: 5/1/2008	Manufacturer: A.Y. McDonald	Pump Capacity: 12 GPM
Casing Type: PVC plastic	Model Number: 21050K2	Pump Voltage:
Height: 1.00 ft above grade	Drop Pipe Length: 20.00 ft.	Drilling Record ID:
Casing Joint: Solvent weld/diglac	Drop Pipe Diameter: 1.00 in	
Casing Fitting: Shale packer/trap	Draw Down Seal Used: No	
Diameter: 5.00 in to 33.00 ft depth SOH: 21.00	Pressure Tank Installed: No	
Borehole: 8.75 in to 33.00 ft. depth	Pressure Relief Valve Installed: No	

Static Water Level: 11.00 ft Below Grade	Formation Description	Thickness	Depth to Bottom
Well Yield Test: Yield Test Method: Air			
Purping level 27.00 ft. after 1.00 hrs. at 40 GPM	Topsol	1.00	1.30
	Brown Sand	1.00	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 38.00 ft

Wellhead Completion: Pileless adapter, 12 inches above grade	Geology Remarks:
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Nearest Source of Possible Contamination:	Drilling Machine Operator Name: RYAN KATZ
Type: Septic tank	Employment: Employee
Distance: 75 ft	Pump Installer: MIKE SHELL ENBERGER
Direction: North	Contractor Type: Water Well Drilling Contractor
	Reg No: 13-1583

Abandoned Well Plugged: Yes	Business Name: Katz Well Drilling
	Business Address: 1479 E Michigan, Battle Creek, MI, 49014

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

General Remarks:	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.
Other Remarks: Grouting Additive 1-EZ MUD	



Water Well And Pump Record



Completion is required under authority of Part 127 Act 369 PA 1978.

Failure to comply is a misdemeanor

Import ID:

Tax No:	Permit No:	County: Alcona		Township: Disage	
Well ID: 03000009995		Town/Range: 01N 12W	Section: 27	Well Status: Active	WSSN:
		Source ID/Well No:			
Elevation:		Distance and Direction from Road Intersection: 0.5 Mi W 16TH ST & 75' S OAK DR			
Latitude: 47.44896		Well Owner: GARY I BARB RHOADES			
Longitude: -85.71073		Well Address: 1604 OAK DR OTSEGO, MI		Owner Address: 289 39TH ST ALLEGAN, MI 49010	
Method of Collection: GPS Std Postering Svc SA Off					

Drilling Method: Rotary	Well Use: Household	Pump Installed: Yes	Pump Installation Only: No
Well Depth: 40.00 ft.	Date Completed: 9/4/2007	Pump Installation Date:	HP: 0.50
Well Type: Replacement		Manufacturer: Aermotor	Pump Type: Submersible
Casing Type: PVC plastic	Height:	Model Number: T 12.50	Pump Capacity: 12 GPM
Casing Joint: Solvent welded/glued		Drop Pipe Length: 34.00 ft	Pump Voltage:
Casing Fitting: Unknown		Drop Pipe Diameter: 1.00 in.	Drilling Record ID:
Diameter: 5.00 in. to 35.00 ft. depth SOR: 21.00		Draw Down Seal Used: No	
Borehole: 8.75 in. to 40.00 ft. depth		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	Formation Description	Thickness	Depth to Bottom
Well Yield Test			
Yield Test Method: Air	Sand	9.00	9.00
Pumping level 16.00 ft. after 1.00 hrs. at 40 GPM	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 34.30 ft

Wellhead Completion: Plugless adapter	Geology Remarks:

Nearest Source of Possible Contamination:	Drilling Machine Operator Name: MITCH VICKERY
Type	Employment: Employee
Septic tank	Pump Installer: MATTHEW KURCZSKI
Distance	Contractor Type: Water Well Drilling Contractor
75 ft.	Reg No: 133-1601
Direction	Business Name: KRAAI WELL DRILLING INC
Southwest	Business Address:

Abandoned Well Plugged: Yes	Water Well Contractor's Certification
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Casing Diameter: 2 in.	Casing Removed: No
Plugging Material: Bentonite chips/pellets	
No. of Bags: 1.00	Well Depth: 30 ft.
Signature of Registered Contractor	Date

General Remarks:
Other Remarks:



Water Well And Pump Record

Completion is required under authority of Pa'l 127 Act 366 PA 1978.



Import ID:

Failure to comply is a misdemeanor

Tax No:	Permit No:	County: Allegan		Township: Otsego	
Well ID: 03000010432		Town/Range: Q1N 12W	Section: 27	Well Status: Active	WSSN:
		Source ID/Well No:			
Elevation:		Distance and Direction from Road Intersection: Approx. 1/2 mile West of Farmers Rd on the SW corner of Sycamore & Branwood			
Latitude: 42.44781		Well Owner: Mark McPherson			
Longitude: -85.71418		Well Address: 376 Branwood Otsego, MI 49078		Owner Address: 376 Branwood Otsego, MI 49078	
Method of Collection: GPS Std Positioning Sys SA Off					

Drilling Method: Rotary	Well Use: Household	Pump Installed: Yes	Pump Installation Only: No
Well Depth: 77.00 ft	Date Completed: 2/20/2009	Pump Installation Date: 2/23/2009	HP: 1.00
Well Type: Replacement	Height: 1.00 ft, above grade	Manufacturer: Hml & Waling	Pump Type: Submersible
Casing Type: PVC plastic	Casing Joint: Solvent welded/glued	Model Number: 4F19S13305	Pump Capacity: 19 GPM
Casing Fitting: None	Diameter: 5.00 in. to 67.00 ft. depth	Drop Pipe Length: 40.00 ft.	Pump Voltage:
	Borehole: 8.50 in. to 77.00 ft. depth	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	Formation Description	Thickness	Depth to Bottom
Well Yield Test: Yield Test Method: Test pump	Sand	4.00	4.00
Pumping level 17.00 ft. after 1.00 hrs. at 35 GPM	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: Drop pipe outside casing		
Grouting Material	Bags	Additives	Depth
Bentonite slurry	4.00	None	0.00 ft. to 60.00 ft.
Geology Remarks: Clay deeper to shale			

Wellhead Completion: Fltless adapter, 1/2 inches above grade

Nearest Source of Possible Contamination:			Drilling Machine Operator Name: Russ Beckley
Type	Distance	Direction	Employment: Employee
Septic tank	80 ft.	West	Pump Installer: Chet & Phil
Abandoned Well Plugged: Yes			Contractor Type: Water Well Drilling Contractor
			Reg No: 03-2342
			Business Name: Kopus Well Drilling
			Business Address: 3811 58th Street, Holland, MI, 49423

Casing Diameter: 4 in.	Casing Removed: No
Plugging Material: Bentonite chips/pellets	
No. of Bags: 7.00	Well Depth: 50 ft.
General Remarks: 70lb# Gravel Pack	
Other Remarks:	

Water Well Contractor's Certification

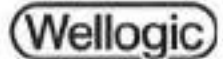
This well was drilled under my supervision and this report is true to the best of my knowledge and belief.

Signature of Registered Contractor _____ Date _____



Water Well And Pump Record

Completion is required under authority of Part 127 Act 368 PA 1978.



Import ID:

Failure to comply is a misdemeanor

Tax No.	Permit No.	County: Alcona		Township: Otsego	
Well ID: 03000010659		Town/Range:	Section:	Well Status:	WSSN:
		01N 12W	27	Active	
Elevation:		Distance and Direction from Road Intersection:			
Latitude: 42.448836		5 MILE W 16TH ST & 60' W OF SPRINGBROOK			
Longitude: -85.705774		Well Owner: RALPH WOODSTOCK			
Method of Collection: Address Matching- House Number		Well Address:		Owner Address:	
		376 SPRINGBROOK DR OTSEGO MI 49078		376 SPRINGBROOK DR OTSEGO MI 49078	

Drilling Method: Rotary	Pump Installed: Yes	Pump Installation Only: No
Well Depth: 36.00 ft	Pump Installation Date: 11/25/2008	HP: 0.50
Well Type: Replacement	Well Use: Unknown	Manufacturer: Aermotor
Date Completed: 1/25/2008	Date Completed: 1/25/2008	Model Number: T 12 50
Casing Type: PVC plastic	Drop Pipe Length: 30.00 ft.	Drop Pipe Diameter: 1.00 in.
Casing Joint: Unknown	Draw Down Seal Used: No	Pressure Tank Installed: Yes
Casing Fitting: None	Pressure Tank Type: Diaphragm/bladder	Manufacturer: Well X Trof
Diameter: 5.00 in. to 30.00 ft depth 6.00 in. to 36.00 ft depth	Model Number: WX203	Tank Capacity: 10.0 Gallons
Borehole: 6.75 in. to 36.00 ft. depth	Pressure Relief Valve Installed: Yes	

Static Water Level: 16.00 ft Below Grade	Formation Description	Thickness	Depth to Bottom
Well Yield Test: Yield Test Method: Air			
Pumping level 30.00 ft. after 1.00 hrs. at 25 GPM	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-slatot	
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 28.30 ft

Wellhead Completion: Press adapter	Geology Remarks:
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Nearst Source of Possible Contamination:	Drilling Machine Operator Name: MITCH VICKERY
Type	Employment: Employee
Septic tank	80 ft. Southwest

Abandoned Well Plugged: Yes	Contractor Type: Water Well Drilling Contractor	Reg No: 03-1801
	Business Name: KRAAI WELL DRILLING	
	Business Address:	

Casing Diameter: 2 in.	Casing Removed: 0 in
Plugging Material: Bentonite chips/pellets	
No. of Bags: 1.00	Well Depth: 35 ft.

General Remarks:	Water Well Contractor's Certification
Other Remarks:	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



Water Well And Pump Record



Completion is required under authority of Part 127 Act 359 PA 1978,
Failure to comply is a misdemeanor.

Import ID:

Tax No:	Permit No:	County: Allegan		Township: Otsego	
Well ID: 03000011212		Town Range: 01N12W	Section: 27	Well Status: Active	WSSN:
		Source ID/Well No:			
Elevation:		Distance and Direction from Road Intersection: ON WEST SIDE OF SPRINGBROOK 103 YARDS SOUTH OF SYCAMORE			
Latitude: 42.44755		Well Owner: CHARLEY MCQUEER			
Longitude: -85.70605		Well Address: 373 SPRINGBROOK OTSEGO MI 49078		Owner Address: 373 SPRINGBROOK OTSEGO, MI 49078	
Method of Collection: GPS Svd Positioning Svc SA ON					

Drilling Method: Rotary	Well Use: Household	Pump Installed: Yes	Pump Installation Only: No
Well Depth: 105.00 ft.	Date Completed: 9-22-2010	Pump Installation Date: 3-23-2010	HP: 0.75
Well Type: New	Height: 1.00 ft. above grade	Manufacturer: A.Y. McDonald	Pump Type: Submersible
Casing Type: PVC plastic	Casing Joint: Solvent welded/glued	Model Number: 2107SP2	Pump Capacity: 18 GPM
Casing Fitting: Stale packer/trap		Drop Pipe Length: 40.00 ft	Pump Voltage:
		Drop Pipe Diameter: 1.00 in.	Drilling Record ID:
Diameter: 5.00 in to 100.00 ft depth SDR 21.00		Draw Down Seal Used: No	
Borehole: 4.00 in to 100.00 ft depth		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: 8.00 ft. Below Crude	Yield Test Method: Air	Formation Description	Thickness	Depth to Bottom
Well Yield Test:	Pumping level: 85.00 ft. after 1.00 hrs. at 80 GPM			
Screen Installed: Yes	Filter Packed: No	Clay & Sand	4.00	4.00
Screen Diameter: 4.00 in	Blank: 1.00 ft. Above	Sand	27.00	31.00
Screen Material Type: Stainless steel-slotted		Gray Clay	5.00	37.00
Slot Length: 4.00 ft.	Set Between: 10.00 ft and 10.50 ft.	Sand W/Gravel Fine	7.00	44.00
		Sand Fine	11.00	55.00
		Gray Clay	33.00	93.00
		Sand W/Gravel Fine	12.00	105.00
Fittings: Neoprene packer				
Well Grouted: Yes	Grouting Method: Grout pipe outside casing			
Grouting Material: Bentonite slurry	Bags: 8.00	Additives: None	Depth: 0.00 ft. to 55.00 ft	

Wellhead Completion: Pflss adapter 12 inches above grade	Geology Remarks:
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Nearest Source of Possible Contamination:	Drilling Machine Operator Name: MARIO MCKEAGUE
Type: Sepsis tank	Employment: Employee
Distance: 75 ft	Pump Installer: MIKE SHELL FNB2R3GFR
Direction: West	Contractor Type: Water Well Drilling Contractor Reg No: 13-1593
	Business Name: Katz Well Drilling
	Business Address: 1479 E Michigan, Balle 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

Import ID:

Tax No:	Permit No:	County: Alean	Township: Otsego
Well ID: 03000004759		Town/Range: 01N 12W	Section: 27
		Well Status: Active	WSSN:
Elevation:		Distance and Direction from Road Intersection:	
Latitude: 42 44955349		1000 FEET WEST SPRING BROOK; 100 FEET SOUTH PRAIRIEWOOD DR	
Longitude: -85 705' 435E		Well Owner: PRAIR EWOOD DEV	
Method of Collection: Interpolation Map		Well Address:	Owner Address:
		PRAIRIEWOOD DRIVE LOT 10 OTSEGO MI 49078	PRAIRIEWOOD DRIVE LOT 13 OTSEGO MI 49078

Drilling Method: Rotary	Pump Installed: No
Well Depth: 145.00 ft.	Pressure Tank Installed: No
Well Type: New	Pressure Relief Valve Installed: No
Well Use: Test well	
Date Completed: 6/4/2003	
Casing Type: PVC plastic	
Casing Joint: Unknown	
Casing Fitting: None	
Height:	
Diameter: 5.00 in to 140.00 ft. depth	
Borehole: 8.50 in to 145.00 ft. depth	

Static Water Level: 7.00 ft. Below Grade	Formation Description	Thickness	Depth to Bottom
Well Yield Test:			
Pumping level 81.00 ft. after 4.00 hrs. at 21 GPM	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.

Geology Remarks:
Wellhead Completion: 12 inches above grade

Nearst Source of Possible Contamination:	Drilling Machine Operator Name: MITCH VICKERY
Type	Employment: Employee
Septic tank	1500 ft. Southeast

Contractor Type: Water Well Drilling Contractor	Reg No: 03-16911
Business Name: KRAAI WELL DR.LG NC	
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

Import ID:

Tax No:	Permit No:	County: Allegan		Township: Otsego	
Well ID: 03000004581		Town-Range: 01N 12W	Section: 27	Well Status: Active	WSSN:
		Source ID/Well No:			
Elevation:		Distance and Direction from Road Intersection: 3.10 MILE NORTH OF 102ND AVE. 50 FEET WEST OF 18TH ST			
Latitude: 42.446299		Well Owner: RICHARD ROUSE			
Longitude: -85.703728		Well Address: 290 16TH STREET OTSEGO, MI 49078		Owner Address: 290 16TH STREET OTSEGO, MI 49078	
Method of Collection: Address Matching House Number					

Drilling Method: Cable Tool	Well Use: Household	Pump Installed: Yes	Pump Installation Only: No
Well Depth: 38.00 ft.	Date Completed: 4/10/2003	Pump Installation Date:	HP: 0.50
Well Type: Replacement		Manufacturer: Pini & Waling	Pump Type: Submersible
Casing Type: Steel - unknown	Height:	Model Number:	Pump Capacity: 10 GPM
Casing Joint: Threaded & coupled		Drop Pipe Length: 27.00 ft	Pump Voltage:
Casing Fitting: None		Drop Pipe Diameter:	Drilling Record ID:
Diameter: 4.00 in. to 33.00 ft. depth		Draw Down Seal Used: No	
Borehole:		Pressure Tank Installed: Yes	Tank Capacity: 32.0 Gallons
		Pressure Tank Type: Unknown	
		Manufacturer: Well X Trail	
		Model Number: 233	
		Pressure Relief Valve Installed: No	

Static Water Level: 22.00 ft. Below Grade	Yield Test Method: Pungor	Formation Description	Thickness	Depth to Bottom
Well Yield Test:	Yield Test Method: Pungor	Clay	22.00	22.00
Pumping level: 30.00 ft. after 1.00 hrs. at 30 GPM		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			

Nearest Source of Possible Contamination:	Drilling Machine Operator Name: RICK MILLER
Type	Employment: Employee
Septic tank	
Distance	Direction
75 ft.	West

Abandoned Well Plugged: Yes	Contractor Type: Water Well Drilling Contractor	Reg No: 03-1203
	Business Name: 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	
Casing Removed:	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:	County: Afton		Township: Otsego	
Well ID: 03000011678		Town/Range: 01N 12W	Section: 27	Well Status: Active	WSSN:
		Distance and Direction from Road Intersection: 44' W summit path & 44' N south point dr			
Elevation:		Well Owner: Walls Construction			
Latitude: 42.43362		Well Address: 254 Summit Path Otsego, MI 49078		Owner Address: 5071 Gul Rd Kalamazoo, MI 49048	
Longitude: -85.70331					
Method of Collection: GPS Sid Positioning Sys SA OII					

Drilling Method: Rotary	Well Use: Household	Pump Installed: Yes	Pump Installation Only: No
Well Depth: 119.00 ft	Date Completed: 5/26/2011	Pump Installation Date: 5/26/2011	HP: 0.50
Well Type: New	Height: 1.00 ft. above grade	Manufacturer: AquaDuty	Pump Type: Submersible
Casing Type: PVC plastic	Casing Joint: Solvent welded/glued	Model Number: 15m4cp3 52	Pump Capacity: 10.0 GPM
Casing Fitting: None		Drop Pipe Length: 94.00 ft.	Pump Voltage: 230
		Drop Pipe Diameter: 1.00 in	Drilling Record ID:
Diameter: 5.00 in. to 113.00 ft depth SCIR: 21.00		Draw Down Seal Used: No	
Borehole: 3.75 in to 119.00 ft depth		Pressure Tank Installed: Yes	
		Pressure Tank Type: Diaphragm/bladder	
		Manufacturer: Flex Lite Flexcon	
		Model Number: pc28	Tank Capacity: 10.0 Gallons
		Pressure Relief Valve Installed: Yes	

Static Water Level: 22.00 ft Below Grade	Yield Test Method: Ar	Formation Description	Thickness	Depth to Bottom
Well Yield Test:	Pumping level: 60.00 ft. after 1.00 hrs. at 50 GPM	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	6.00 ft.	113.00 ft. and 119.00 ft.
Fillings: None		

Well Grouted: Yes	Grouting Method: Grout pipe outside casing		
Grouting Material	Bags	Additives	Depth
Bentonite slurry	10.00	None	0.00 ft to 119.00 ft

Wellhead Completion: Pileless adapter

Nearest Source of Possible Contamination	Drilling Machine Operator Name: Mitch Vickary
Type	Employment: Employee
Septic tank	Pump Installer: Anthony Fales
	Contractor Type: Water Well Drilling Contractor Reg No: 03-1001
	Business Name: Kraai Well Drilling
	Business Address: 110 124th Ave, Shelbyville MI, 49044

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

Import ID:

Tax No:	Permit No:	County: Allegan	Township: Otsego
Well ID: 03000011679		Town/Range: 01N 12W	Section: 27
		Well Status: Active	WSSN:
Elevation:		Distance and Direction from Road Intersection:	
Latitude: 42.44053		40' w summit & 250' n south point trail	
Longitude: -85.7026		Well Owner: Walts Construction	
Method of Collection: GPS Std Positioning Sys 5A Off		Well Address:	Owner Address:
		258 Summit Path Oshtemo, MI 49078	5071 Gull Rd Kalamazoo, MI 49048

Drilling Method: Rotary	Pump Installed: Yes	Pump Installation Only: No
Well Depth: 119.00 ft	Pump Installation Date: 8/24/2011	HP: 0.50
Well Use: Heat Pump - Return	Manufacturer: AquaDuty	Pump Type: Submersible
Well Type: New	Date Completed: 8/24/2011	Pump Capacity: 10 GPM
Casing Type: PVC plastic	Model Number: t5m4cp8 52	Pump Voltage: 230
Height: 1.00 ft above grade	Drop Pipe Length: 84.00 ft.	Drilling Record ID:
Casing Joint: Solvent welded/glued	Drop Pipe Diameter: 1.00 in	
Casing Fitting: None	Draw Down Seal Used: No	
Diameter: 5.00 in. to 113.00 ft. depth SDR: 21.00	Pressure Tank Installed: Yes	
Borehole: 8.75 in. to 119.00 ft. depth	Pressure Tank Type: Diaphragm/bladder	
	Manufacturer: Flex Lite 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: A _r 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	6.00 ft 113.00 ft and 119.00 ft
Fittings: None	

Well Grouted: Yes	Grouting Method: Grout pipe outside casing
Grouting Material: Concrete	Depth: 0.00 ft to 119.00 ft
Bags: 10.00	Additives: None

Wellhead Completion: Pnless adapte:

Nearest Source of Possible Contamination:	Drilling Machine Operator Name: Mitch Vickery
Type: Septic tank	Employment: Employee
Distance: 100 ft.	Pump Installer: Anthony Fales
Direction: West	Contractor Type: Water Well Drilling Contractor
	Reg No: 0011611
	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 1973.

Failure to comply is a misdemeanor.

Import ID:

Tax No:	Permit No:	County: Allagan	Township: Otsego		
Well ID: 03000012539		Town/Range: 01N 12W	Section: 27	Well Status: Active	WSSN:
		Source ID/Well No:			
Elevation:		Distance and Direction from Road Intersection: 60' S of Elm St & 1/4 Mi W of 16th St			
Latitude: 42.44689		Well Owner: Stewart Wallace			
Longitude: -85.70227		Well Address: 1616 Elm St Otsego, MI 49078		Owner Address: 1616 Elm St Otsego, MI 49078	
Method of Collection: GPS Std Positioning Sys SA Off					

Drilling Method: Rotary	Pump Installed: Yes	Pump Installation Only: No
Well Depth: 40.00 ft	Pump Installation Date: 6/15/2013	HP: 0.50
Well Type: Replacement	Manufacturer: AquaDuty	Pump Type: Submersible
Well Use: Household	Model Number: 15m4cp952	Pump Capacity: 10 GPM
Date Completed: 6/15/2013	Drop Pipe Length: 24.00 ft	Pump Voltage: 115
Casing Type: PVC plastic	Drop Pipe Diameter: 1.00 in	Drilling Record ID:
Height: 1.00 ft above grade	Draw Down Seal Used: No	
Casing Joint: Solvent welded/glued	Pressure Tank Installed: Yes	
Casing Fitting: None	Pressure Tank Type: Diaphragm/bladder	
Diameter: 5.00 in. to 35.00 ft depth SDR 21.00	Manufacturer: Well X Trei	
	Model Number: wx 202	Tank Capacity: 20.0 Gallons
Borehole: 6.75 in to 40.00 ft depth	Pressure Relief Valve Installed: Yes	

Static Water Level: 9.00 ft. Below Grade	Formation Description	Thickness	Depth to Bottom
Well Yield Test:			
Yield Test Method: Air	Brown Clay & Sand	6.00	6.00
Pumping level: 30.00 ft after 1.00 hrs at 30 GPM	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.
Fillings: None		

Well Grouted: Yes	Grouting Method: Grout pipe 2LTS de casing		
Grouting Material:	Bags	Additives	Depth
Bentonite slurry	3.00	None	0.00 ft. to 39.00 ft

Wellhead Completion: Finess adapter	Geology Remarks:
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Nearest Source of Possible Contamination:	Drilling Machine Operator Name: Mick Victory
Type:	Employment: Employee
Sanitary sewer	Pump Installer: Adam Hazen
Distance: 75 ft	Direction: South

Abandoned Well Plugged: Yes	Contractor Type: Water Well Drilling Contractor	Reg No: 03-1631
	Business Name: Ronad Kaapi Well Drilling	
	Business Address: 110-124th Avenue, Shelbyville, MI, 49144	

Casing Diameter: 2 in.	Casing Removed: No
Plugging Material: Bentonite chips/pellets	
No. of Bags: 1.25	Well Depth: 40 ft

General Remarks:	Water Well Contractor's Certification	
Other Remarks:	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



Water Well And Pump Record



Completion is required under authority of Part 127 Act 366 PA 1978.
Failure to comply is a misdemeanor.

Import ID:

Tax No:	Permit No:	County: Alcona	Township: Disage
Well ID: 03000013479		Town/Range: 01N 12W	Section: 27
Elevation:		Well Status: Active	WSSN:
Latitude: 42.44977		Source ID/Well No:	
Longitude: -85.70504		Distance and Direction from Road Intersection: North Sycamore East Spring Brook	
Method of Collection: GPS Std Positioning Sys SA Off		Well Owner: Jeff Hoyt	
		Well Address: 393 Spring Brook Orisago, MI 49078	Owner Address: 2561 104th Ave Orisago, MI 49078

Drilling Method: Rotary	Well Use: Household	Pump Installed: Yes	Pump Installation Only: No
Well Depth: 46.00 ft	Date Completed: 10/5/2014	Pump Installation Date: 10/3/2014	HP: 3.50
Well Type: New	Height: 1.00 ft above grade	Manufacturer: AquaDuty	Pump Type: Submersible
Casing Type: PVC plastic	Casing Joint: Solvent welded-glued	Model Number: 15m400 5S	Pump Capacity: 10 GPM
Casing Fitting: None		Drop Pipe Length: 34.00 ft.	Pump Voltage: 230
Diameter: 5.00 in. to 46.00 ft. depth SDR 21.00		Drop Pipe Diameter: 1.00 in.	Drilling Record ID:
Borehole: 3.75 in. to 46.00 ft. depth		Draw Down Seal Used: No	
		Pressure Tank Installed: Yes	
		Pressure Tank Type: Diaphragm/Bladder	
		Manufacturer: Flex Lite-Flextron	
		Model Number: PC-88	Tank Capacity: 26.0 Gallons
		Pressure Relief Valve Installed: Yes	

Static Water Level: 8.00 ft. Below Grade	Yield Test Method: Air	Formation Description	Thickness	Depth to Bottom
Well Yield Test: Pumping level 25.00 ft. after 1.00 hrs. at 50 GPM		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-sotted			
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	Geology Remarks:
Grouting Material: Bentonite slurry	Bags: 4.00	
	Additives: None	
	Depth: 0.00 ft. to 35.00 ft.	

Wellhead Completion: Fitters adapter

Nearest Source of Possible Contamination:	Drilling Machine Operator Name: Mitch Vickery
Type: Septic tank	Employment: Employee
Distance: 75 ft	Pump Installer: Adam Hazen
Direction: North	Contractor Type: Water Well Drilling Contractor
	Reg No: 03-1801
	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 366 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.

Import ID:

Tax No:	Permit No:	County: Allegan		Township: Otsego	
Well ID: 03000013858		Town/Range: G1N 12W	Section: 27	Well Status: Active	WSSN:
		Source ID/Well No.			
Elevation:		Distance and Direction from Road Intersection:			
Latitude: 42.44708		Well Owner: BERNIE DEBREEYNE			
Longitude: -85.705586		Well Address: 1651 ELM STREET OTSEGO, MI 49078		Owner Address: 1651 ELM STREET OTSEGO, MI 49078	
Method of Collection: GPS Std Positioning Sys SA CM					

Drilling Method: Cable Tool	Well Use: Household	Pump Installed: Yes	Pump Installation Only: No
Well Depth: 92.00 ft	Date Completed: 1/9/2015	Pump Installation Date:	HP: 0.50
Well Type: Replacement	Height: 1.00 ft above grade	Manufacturer: Flint & Walling	Pump Type: Submersible
Casing Type: Steel galvanized	Casing Joint: Threaded & coupled	Model Number: JF13505065	Pump Capacity: 10 GPM
Casing Fitting: Drive shoe		Drop Pipe Length: 25.00 ft	Pump Voltage: 200
		Drop Pipe Diameter: 1.00 in	Drilling Record ID:
Diameter: 4.30 in to 87.00 ft depth		Draw Down Seal Used: No	
Borehole: 4.30 in to 86.00 ft depth		Pressure Tank Installed: No	
		Pressure Relief Valve Installed: No	

Static Water Level: 5.00 ft Below Grade	Yield Test Method: Plunger	Formation Description	Thickness	Depth to Bottom
Well Yield Test:	Pumping level: 10.00 ft, after 1.00 hrs. at 25 GPM	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: 3.30 in.	Blank: Above
Screen Material Type: Unknown	
Slot Length: 5.00 ft.	Set Between: 67.00 ft. and 92.00 ft.
Fittings: Neoprene packer	

Well Grouted: Yes	Grouting Method: Driven/dry grout
Grouting Material: Bentonite dry granular	Depth: 4.00 ft. to 30.00 ft.
Bags: 2.00	Additives: None

Wellhead Completion: Pinless adapter	Geology Remarks:
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Nearest Source of Possible Contamination:	Drilling Machine Operator Name: KEN ASHLEY
Type: Septic tank	Employment: Subcontractor
Distance: 80 ft	
Direction: North	

Abandoned Well Plugged: Yes	Contractor Type: Water Well Drilling Contractor
	Reg No: 03-2185
	Business Name: MCKENNEY WATER SERVICE
	Business Address: 5036 108TH AVE, ALLEGAN, MI, 49010

Latitude: 42.44715	Longitude: -85.70556	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.
Casing Diameter: 2 in	Casing Removed: No	
Plugging Material: Bentonite chips/pellets		
No. of Bags: 1.00	Well Depth: 30 ft	
General Remarks:	Signature of Registered Contractor	Date
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: 144672	County: Alogon	Township: Otsego
Well ID: 03000011232	Town/Range: 01N 12W	Section: 27	Well Status: Active
	WSSN: Source ID/Well No:		
	Distance and Direction from Road Intersection: 20 FT EAST OF SPRINGBROCK LOCATED ON THE NORTH SIDE OF ELM ST.		
Elevation:	Well Owner: VACANT HOUSE		
Latitude: 42.44709	Well Address: 1645 ELM ST. OTSEGO, MI 49078		Owner Address: 1645 ELM ST OTSEGO, MI 49078
Longitude: -85.7053			
Method of Collection: GPS Sid Positioning Sys: SA Off			

Drilling Method: Rotary	Pump Installed: Yes	Pump Installation Only: Yes
Well Depth: 44.00 ft	Pump Installation Date: 8/20/2010	HP: 0.50
Well Type: Replacement	Manufacturer: Flint & Watling	Pump Type: Submersible
Casing Type:	Model Number: 4F10505305	Pump Capacity: 10 GPM
Casing Joint:	Drop Pipe Length: 25.00 ft.	Pump Voltage:
Casing Filling:	Drop Pipe Diameter: 1.00 in	Drilling Record ID:
Diameter:	Draw Down Seal Used: No	
Boothole:	Pressure Tank Installed: Yes	
	Pressure Tank Type: Diaphragm/bladder	
	Manufacturer: Amtrol	
	Model Number: GH4202	Tank Capacity: 5.2 Gallons
	Pressure Relief Valve Installed: Yes	

Static Water Level:	Yield Test Method:	Formation Description	Thickness	Depth to Bottom
Well Yield Test:				
Unrestricted Flow Rate:				
Screen Installed:	Filter Packed:			
Screen Diameter: in	Blank:			
Screen Material Type:				
Slot Length	Set Between			
Finings:				

Well Grouted: Unknown	Geology Remarks:
Wellhead Completion: 12 inches above grade	

Nearest Source of Possible Contamination:	Drilling Machine Operator Name: MIKE SMITH
Type: Septic tank	Employment: Subcontractor
Distance: 75 ft	Pump Installer: TRAVIS WEESENER
Direction: North	Contractor Type: Water Well Drilling Contractor
	Reg No: 38-2458
Abandoned Well Plugged: No	Business Name: Water Work Well Drilling
Reason Not Plugged: Other	Business Address: 9558 S 31st 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 UNFIT FOR A SURFACE DECK



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:	County: Allegan	Township: Otsego
Well ID: 03000011343		Town/Range: 01N 12W	Section: 27
		Well Status: Active	WSSN:
		Source ID/Well No:	
Elevation:		Distance and Direction from Road Intersection: .25 MI E W 16TH ST & 70' S S OUTH POINTE TRAIL	
Latitude: 42.43278		Well Owner: WATTS CONST.	
Longitude: -85.70793		Well Address: 1672 SOUTH POINTE TRAIL OTSEGO, MI	Owner Address: 5071 GULL RD KALAMAZOO, MI 49048
Method of Collection: GPS Std Positioning Sys SA OK			

Drilling Method: Rotary	Pump Installed: Yes	Pump Installation Only: No
Well Depth: 113.00 ft	Pump Installation Date: 5/4/2010	HP: 0.50
Well Type: New	Manufacturer: AquaDuty	Pump Type: Submersible
Casing Type: PVC plastic	Model Number:	Pump Capacity: 10 GPM
Casing Joint: Unknown	Drop Pipe Length: 64.00 ft	Pump Voltage: 230
Casing Filling: None	Drop Pipe Diameter: 1.00 in	Drilling Record ID:
Diameter: 5.00 in to 107.00 ft depth SDH: 21.00	Draw Down Seal Used: No	
Borehole: 8.75 in. to 113.00 ft depth	Pressure Tank Installed: Yes	Tank Capacity: 9.0 Gallons
	Pressure Tank Type: Unknown	
	Manufacturer: Flex Lite Flexcon	
	Model Number:	
	Pressure Relief Valve Installed: Yes	

Static Water Level: 15.00 ft Below Grade	Formation Description	Thickness	Depth to Bottom
Well Yield Test: Yield Test Method: Air			
Purping level 30.00 ft, after 1.00 hrs. at 50 GPM	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 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

Wellhead Completion: Pileless adapter

Nearest Source of Possible Contamination:			Drilling Machine Operator Name: MITCH V CKERY
Type	Distance	Direction	Employment: Employee
Septic tank	100 ft.	South	Pump Installer: ANTONY FA. FS

Contractor Type: Water Well Drilling Contractor Reg No: 031801
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 Wellog 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 (amsl) 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

VICINITY MAP

MICHIGAN



CITY OF
OTSEGO
ALLEGAN COUNTY

fish

engineers
scientists
architects
constructors

fishbeck, thompson,
carr & huber, inc.

Hard copy is
intended to be
8.5"x11" when
plotted. Scale(s)
indicated and
graphic quality may
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any other size.

STUDY AREA

Tangerwood Dr
Barkwood Dr
Barkwood Dr

Baughman Drain
Otsego, Allegan County, Michigan

Additional Hydrogeological Investigation



LOCATION MAP

0 1,000 2,000 FEET

NORTH

Esri, HERE, Garmin, © OpenStreetMap contributors, Copyright (c) 2013 National Geographic Society, i-cubed, Esri, HERE, Garmin, © OpenStreetMap contributors, and the GIS user community

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180488

FIGURE NO.

1

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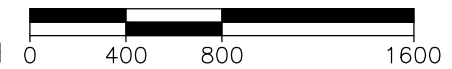
Kalamazoo River



NORTH

STUDY AREA

SCALE: 1" = 800'



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

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fish
th

engineers

scientists

architects

constructors

fishbeck, thompson,
carr & huber, inc.

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Baughman Drain
Otsego, Allegan County, Michigan

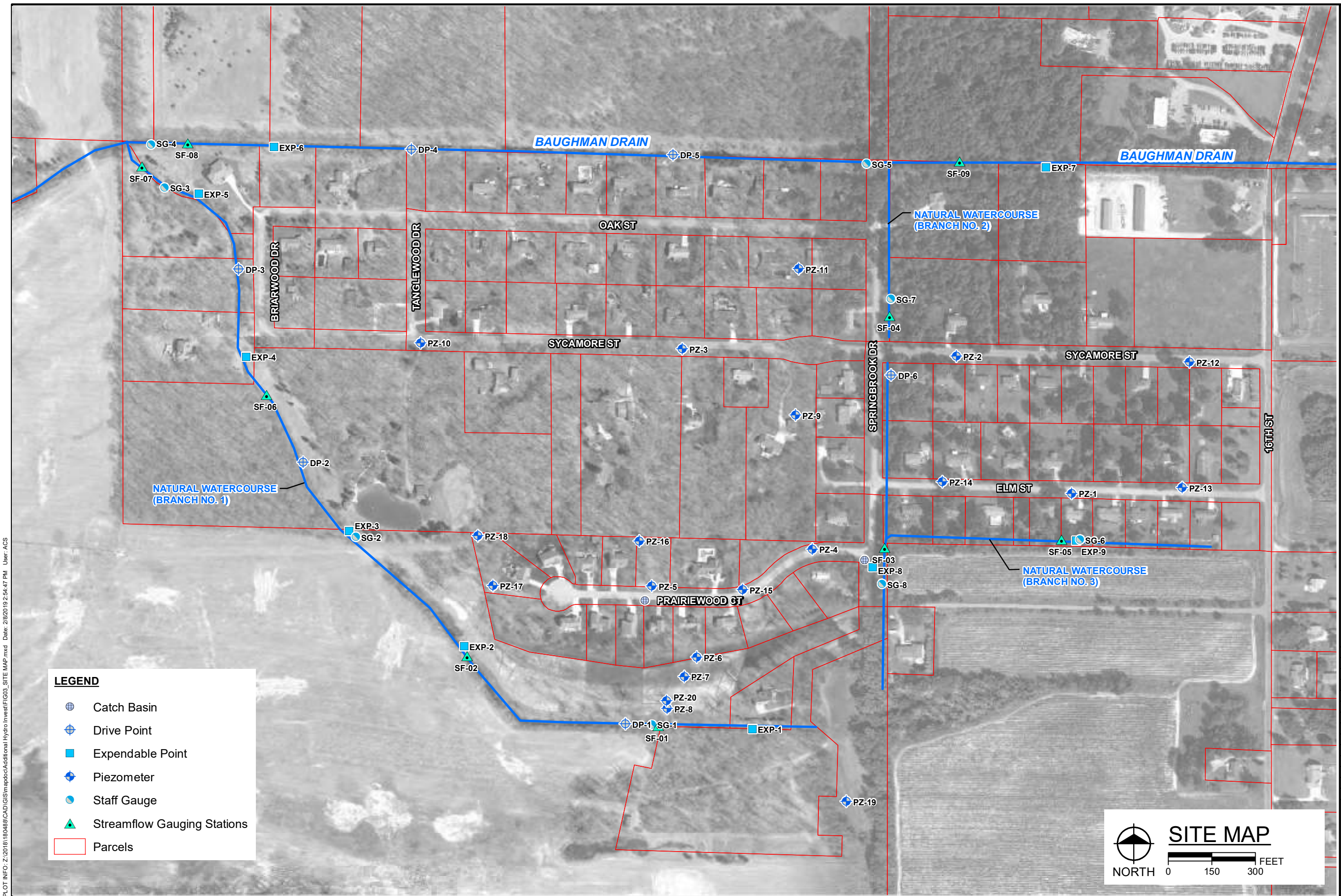
Additional Hydrogeological Investigation

PROJECT NO.

180488

FIGURE NO.

2



LEGEND

- Catch Basin
- Drive Point
- Expendable Point
- Piezometer
- Staff Gauge
- Streamflow Gauging Stations
- Parcels

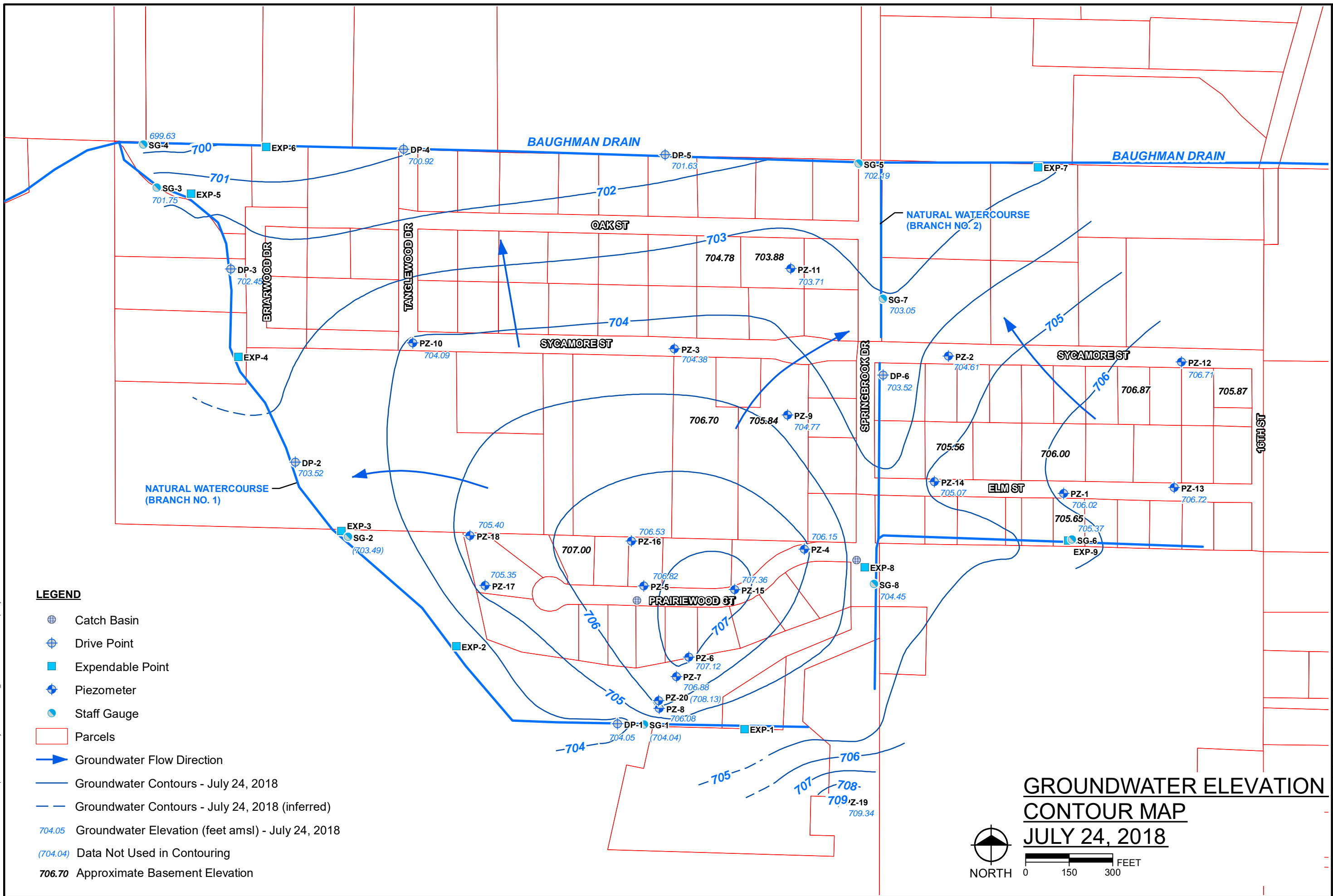
SITE MAP

NORTH

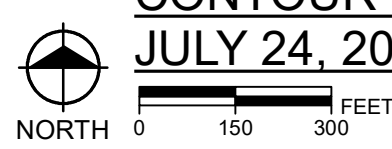
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PLOT INFO: Z:\2018\180488\CADD\GIS\mapdoc\Additional Hydro Invest\FIG04_GW Elevation Contour Map-July 24, 2018.mxd Date: 2/8/2019 4:28:00 PM User: ACS



- LEGEND**
- Catch Basin
 - Drive Point
 - Expendable Point
 - Piezometer
 - Staff Gauge
 - 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

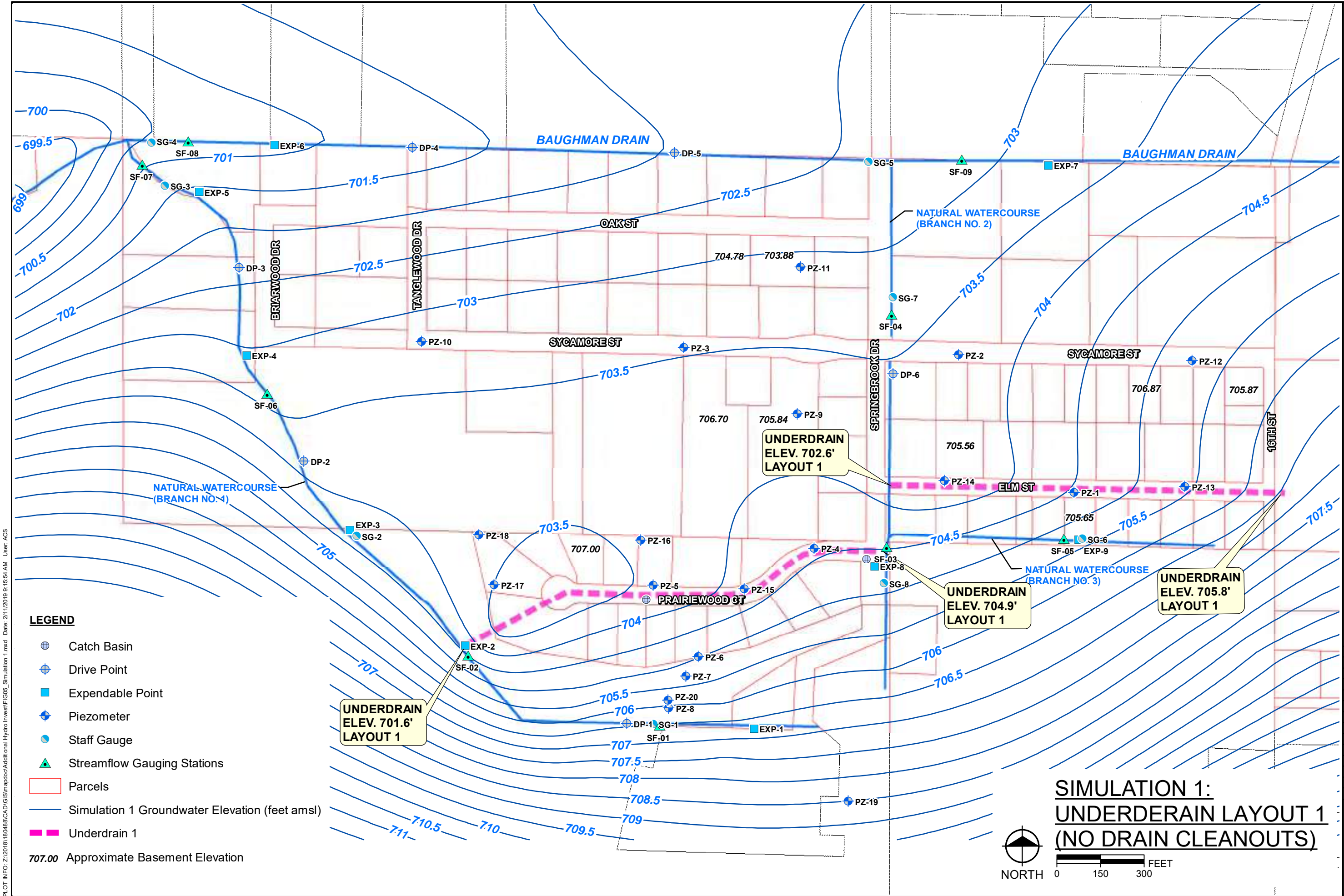


**GROUNDWATER ELEVATION
CONTOUR MAP
JULY 24, 2018**

PROJECT NO.
180488

FIGURE NO.
4

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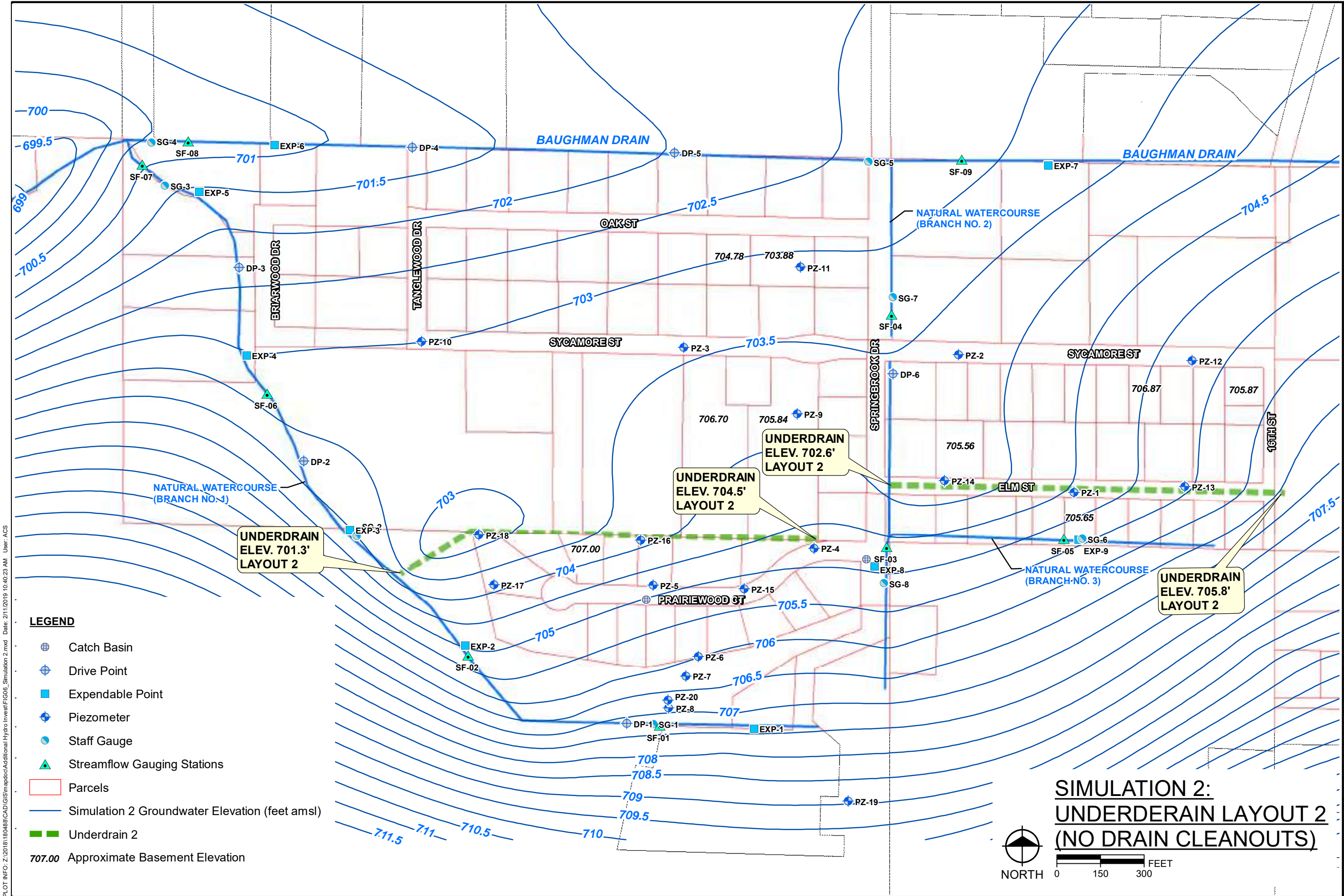
- LEGEND**
- Catch Basin
 - Drive Point
 - Expendable Point
 - Piezometer
 - Staff Gauge
 - Streamflow Gauging Stations
 - Parcels
 - Simulation 1 Groundwater Elevation (feet amsl)
 - Underdrain 1
- 707.00 Approximate Basement Elevation

**SIMULATION 1:
UNDERDRAIN LAYOUT 1
(NO DRAIN CLEANOUTS)**

PROJECT NO.
180488

FIGURE NO.
5

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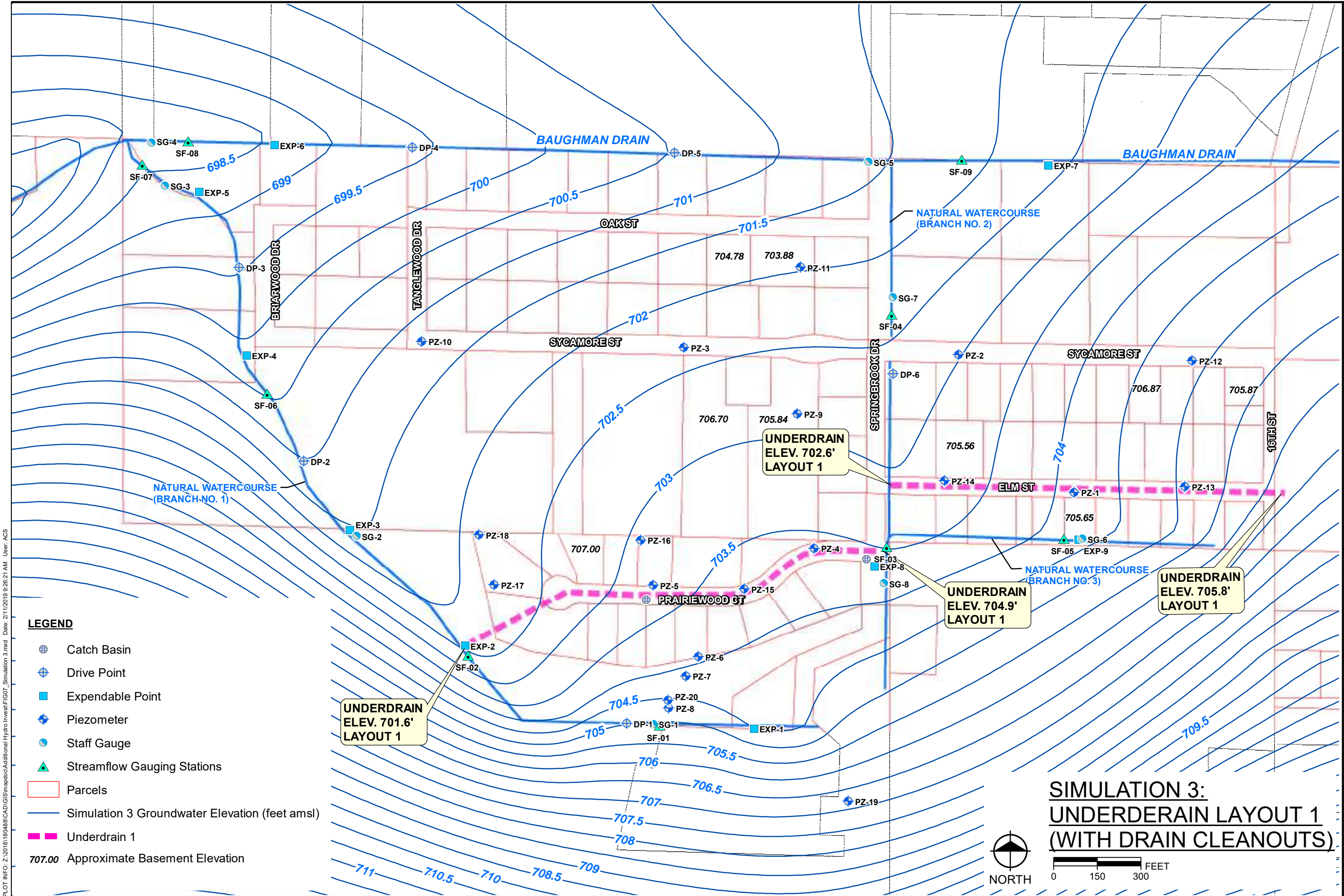
LEGEND

- 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

**SIMULATION 2:
UNDERDRAIN LAYOUT 2
(NO DRAIN CLEANOUTS)**

PROJECT NO.
180488

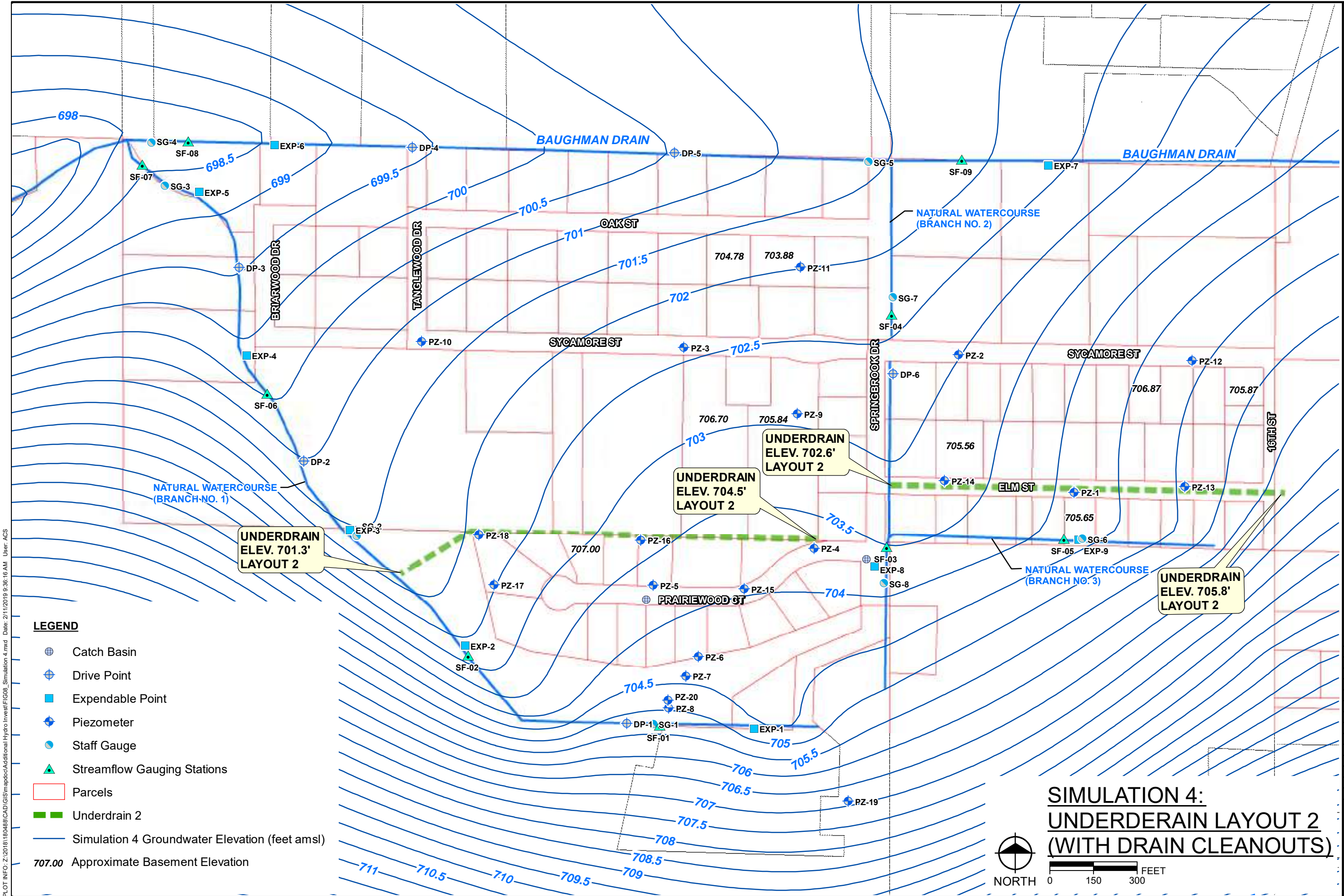
FIGURE NO.
6



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- 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

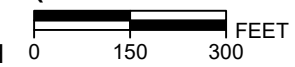
**SIMULATION 3:
UNDERDRAIN LAYOUT 1
(WITH DRAIN CLEANOUTS)**



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

**SIMULATION 4:
UNDERDRAIN LAYOUT 2
(WITH DRAIN CLEANOUTS)**



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

PROJECT NO.
180488

FIGURE NO.
8

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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; positive 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



FISHBECK, THOMPSON, CARR & HUBER
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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

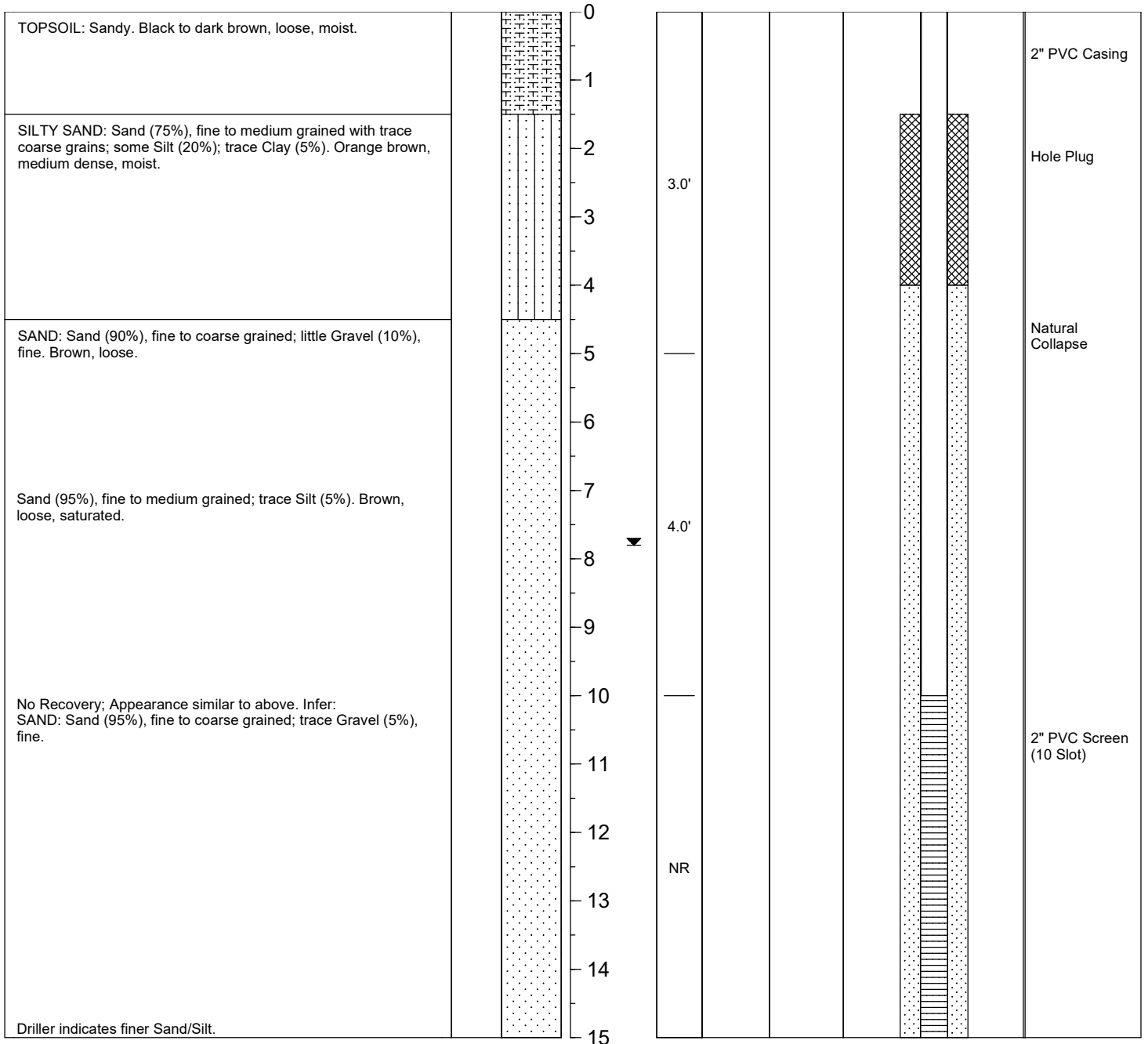
SAMPLING METHODS: Macrocore

NOTES: Location is 1662 Sycamore; 15' north of center of garage.
NR - no recovery

▼ Static Water Level

Page 1 of 1

DESCRIPTION	PID ppm	GRAPHIC LOG	DEPTH (ft. bgl)	Static Water Level	Sample/ Recovery	Sample ID	Blow Counts	WELL CONSTRUCTION DETAIL
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Driller indicates finer Sand/Silt.



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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

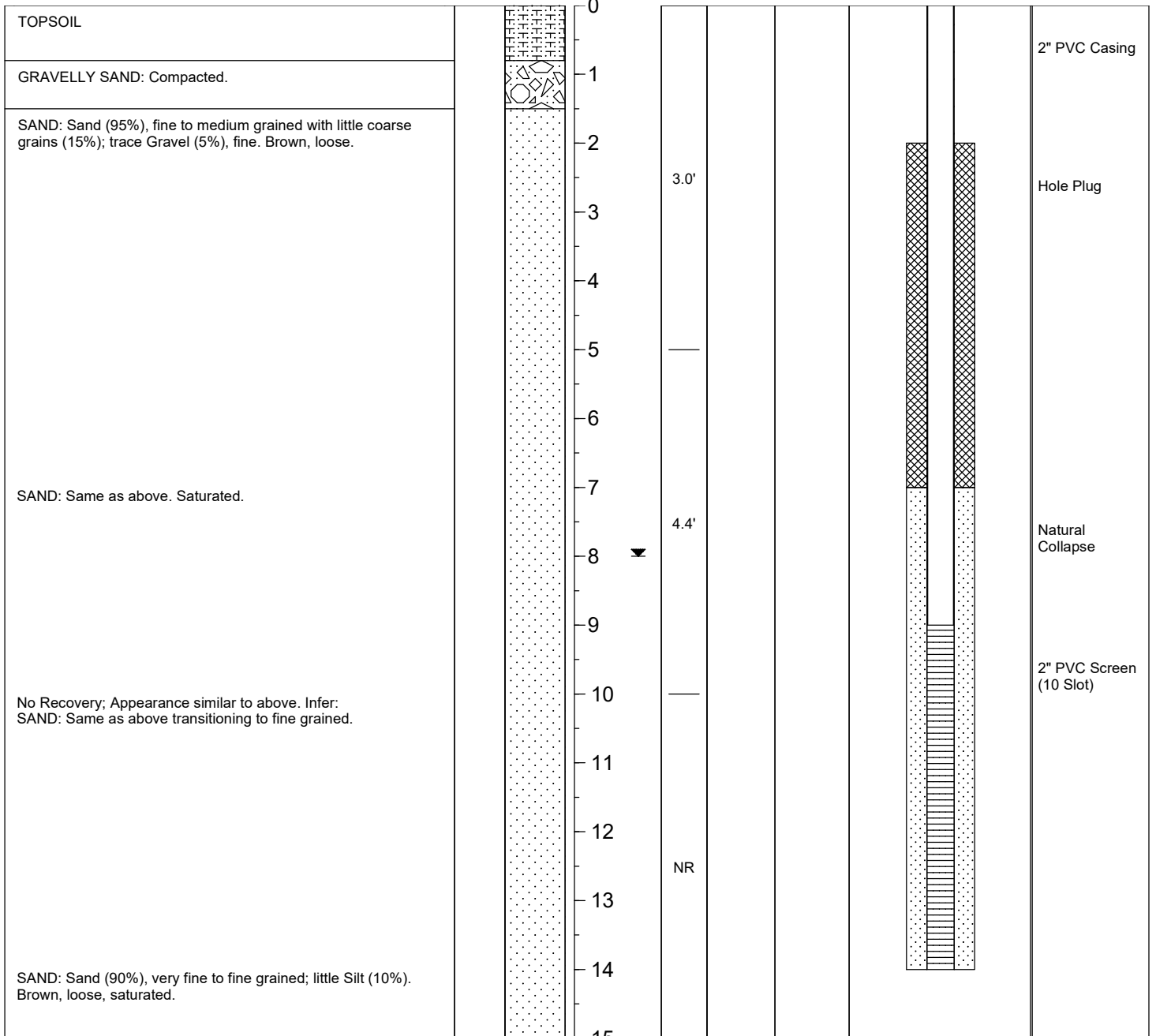
SAMPLING METHODS: Macrocore

NOTES: Location is 1700 Sycamore (front); at intersection of Tanglewood.
NR - no recovery

▼ Static Water Level

Page 1 of 1

DESCRIPTION	PID ppm	GRAPHIC LOG	DEPTH (ft. bgl)	Static Water Level	Sample/ Recovery	Sample ID	Blow Counts	WELL CONSTRUCTION DETAIL
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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

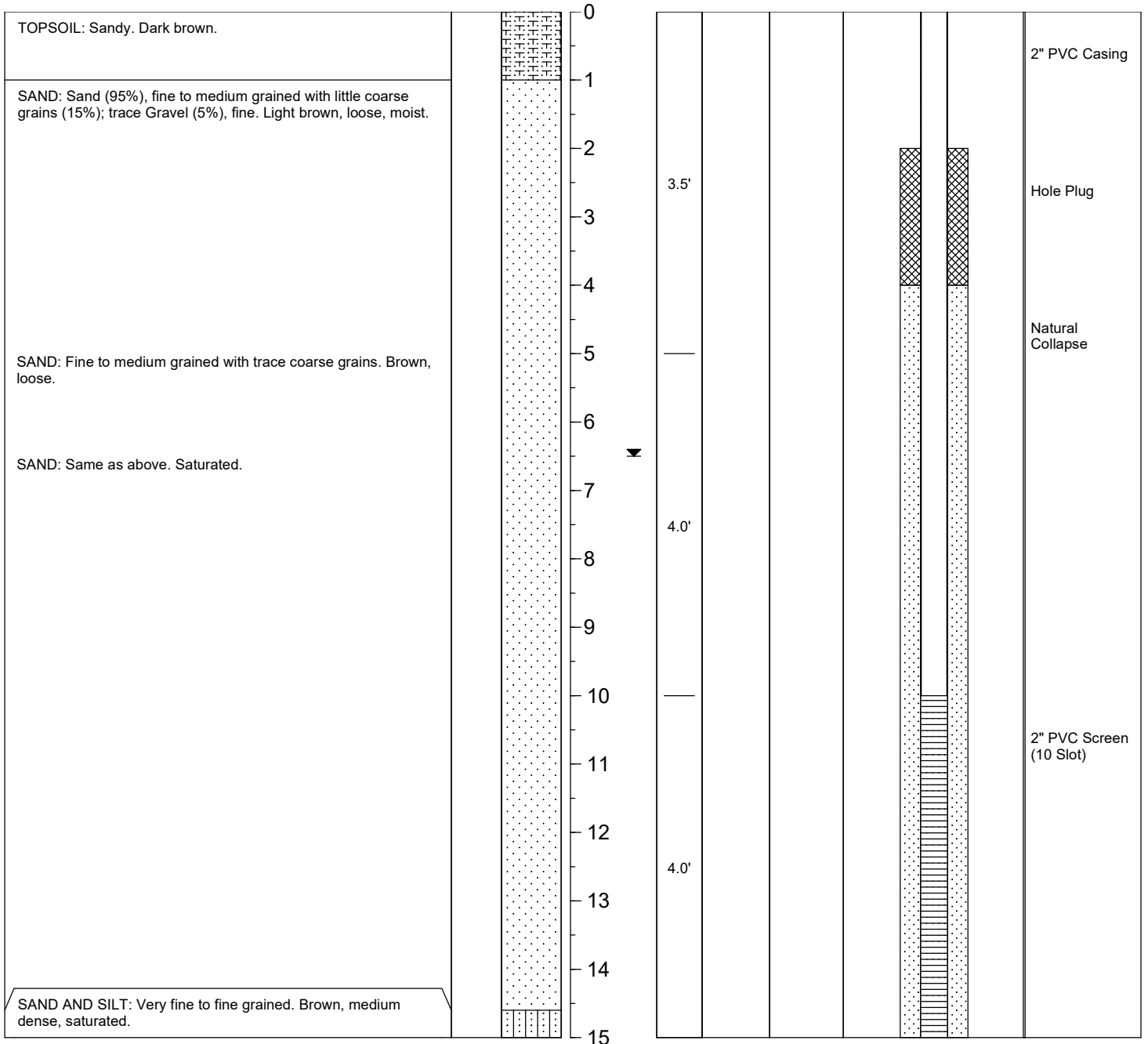
SAMPLING METHODS: Macrocore

NOTES: Location is ~12' east of fence near brush line, southeast corner of property.

▼ Static Water Level

Page 1 of 1

DESCRIPTION	PID ppm	GRAPHIC LOG	DEPTH (ft. bgl)	Static Water Level	Sample/ Recovery	Sample ID	Blow Counts	WELL CONSTRUCTION DETAIL
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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

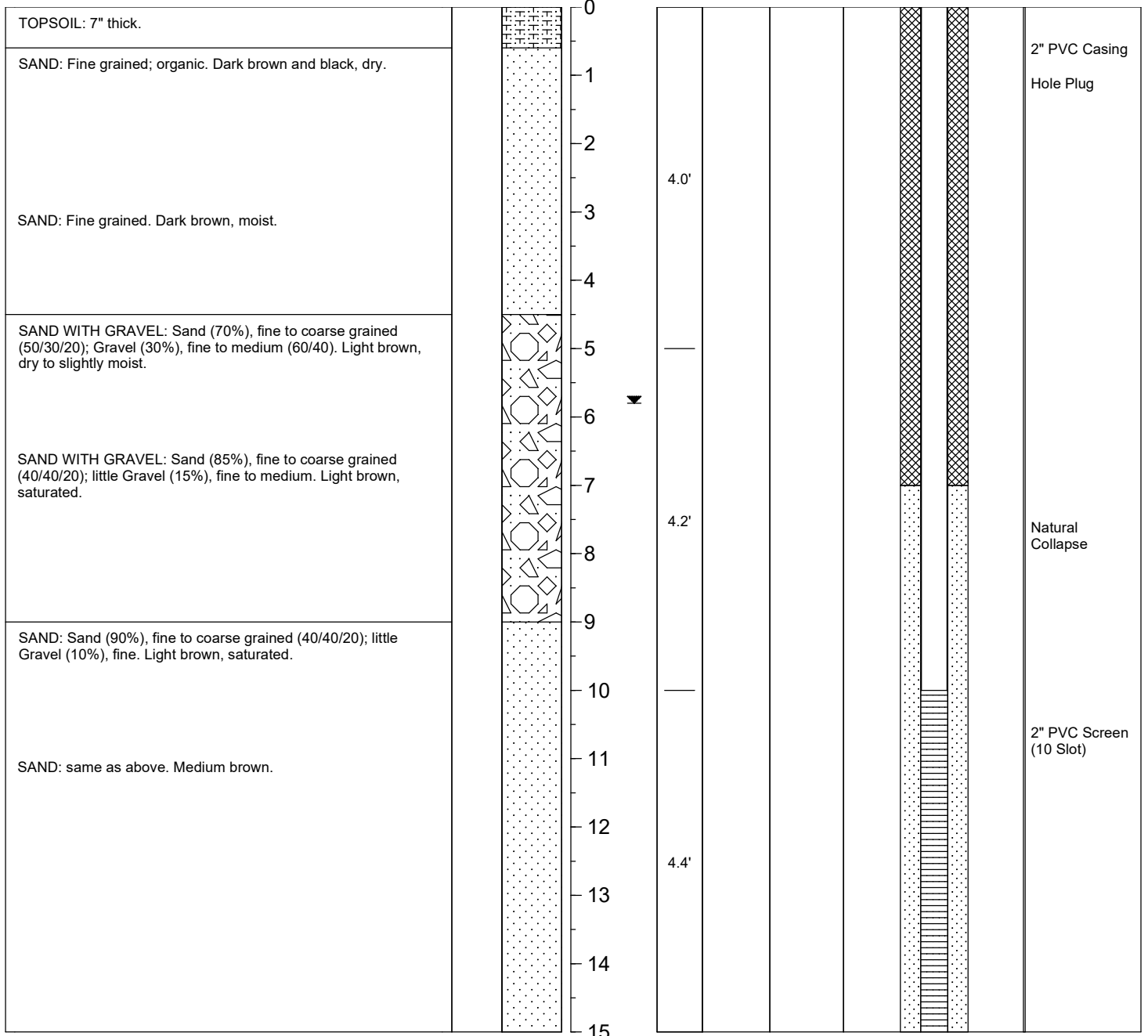
SAMPLING METHODS: Macrocore

NOTES:

▼ Static Water Level

Page 1 of 1

DESCRIPTION	PID ppm	GRAPHIC LOG	DEPTH (ft. bgl)	Static Water Level	Sample/ Recovery	Sample ID	Blow Counts	WELL CONSTRUCTION DETAIL
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BOREHOLE LOG

BORING/WELL ID: PZ-13

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.: ~6.0' bgs

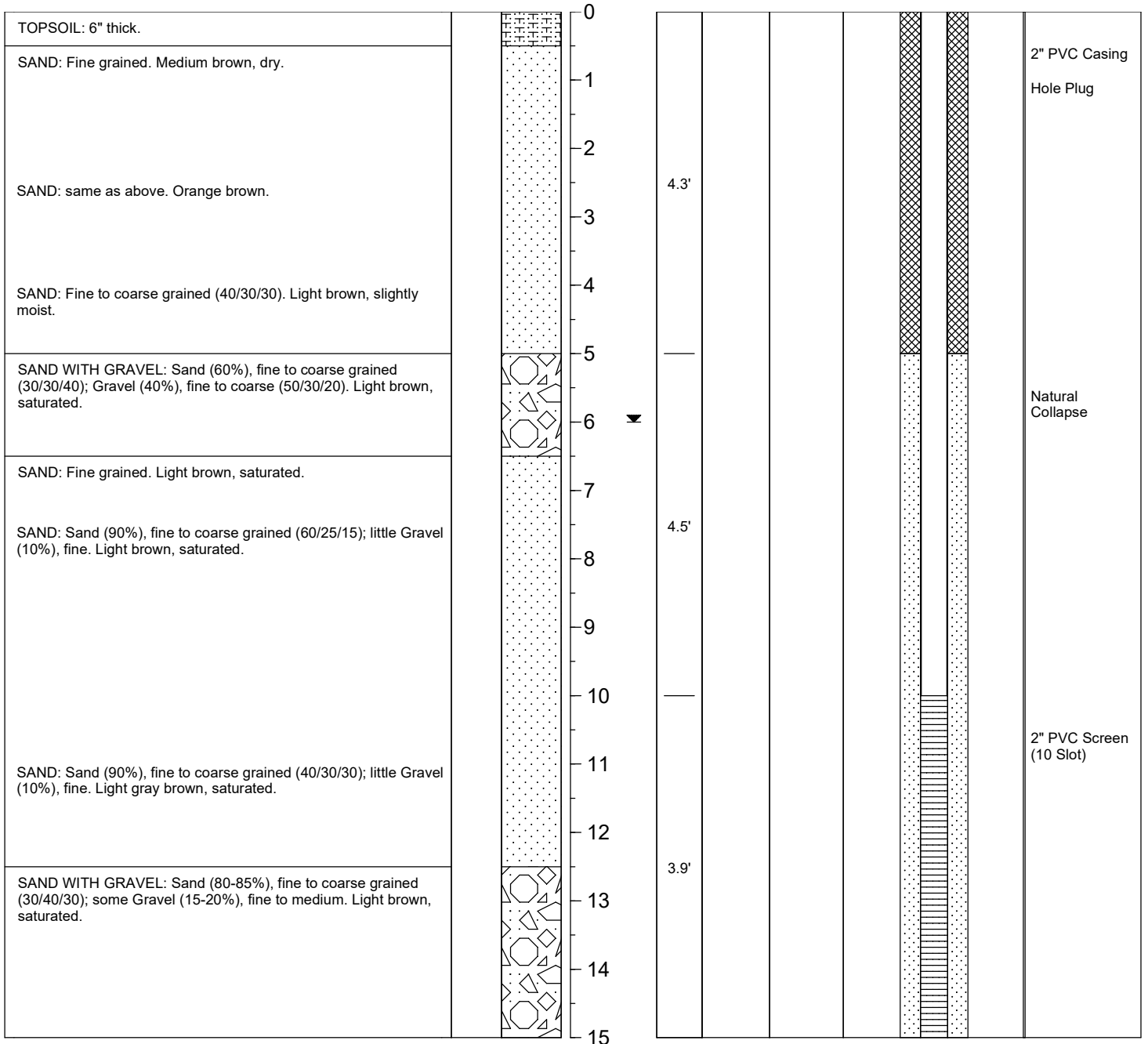
DRILLING CO.: Job Site Services
DRILLER: Bob / Ben
RIG TYPE: Geoprobe 7720DT
METHOD OF DRILLING: Direct Push
SAMPLING METHODS: Macrocore

NOTES:

▼ Static Water Level

Page 1 of 1

DESCRIPTION	PID ppm	GRAPHIC LOG	DEPTH (ft. bgl)	Static Water Level	Sample/ Recovery	Sample ID	Blow Counts	WELL CONSTRUCTION DETAIL
-------------	---------	-------------	-----------------	--------------------	------------------	-----------	-------------	--------------------------





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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

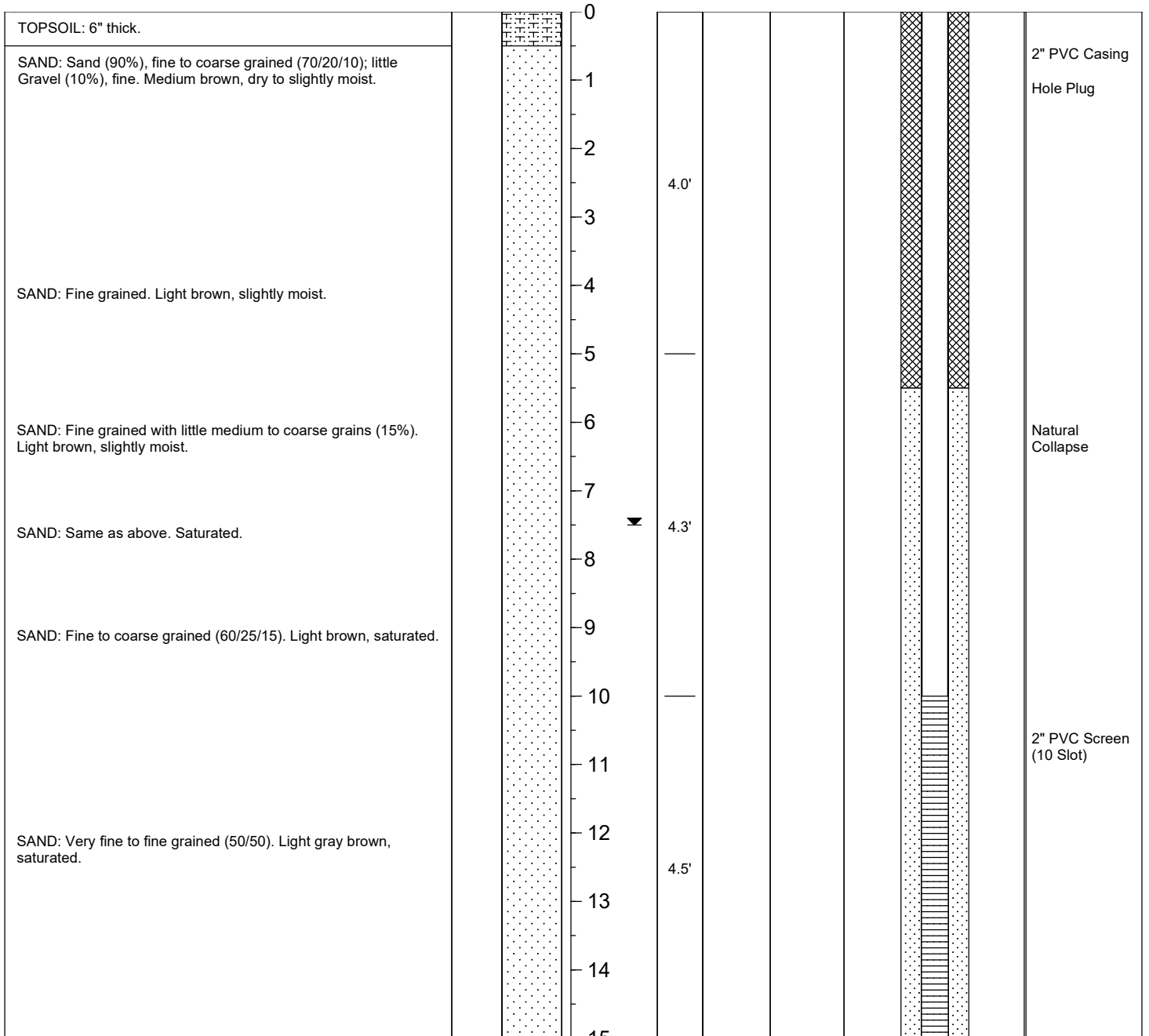
SAMPLING METHODS: Macrocore

NOTES:

▼ Static Water Level

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DESCRIPTION	PID ppm	GRAPHIC LOG	DEPTH (ft. bgl)	Static Water Level	Sample/ Recovery	Sample ID	Blow Counts	WELL CONSTRUCTION DETAIL
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BOREHOLE LOG

BORING/WELL ID: PZ-15

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

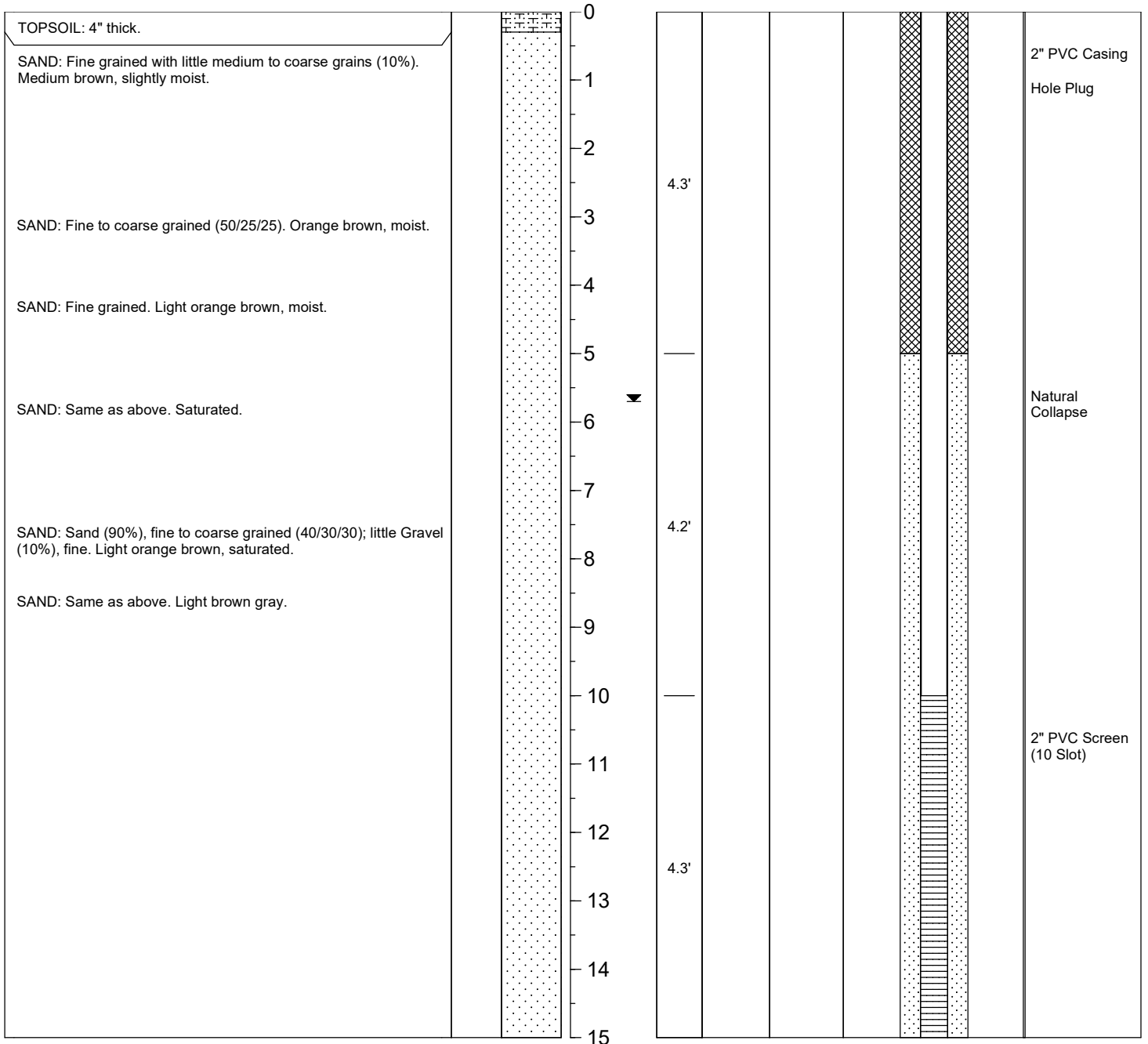
SAMPLING METHODS: Macrocore

NOTES:

▼ Static Water Level

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DESCRIPTION	PID ppm	GRAPHIC LOG	DEPTH (ft. bgl)	Static Water Level	Sample/ Recovery	Sample ID	Blow Counts	WELL CONSTRUCTION DETAIL
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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

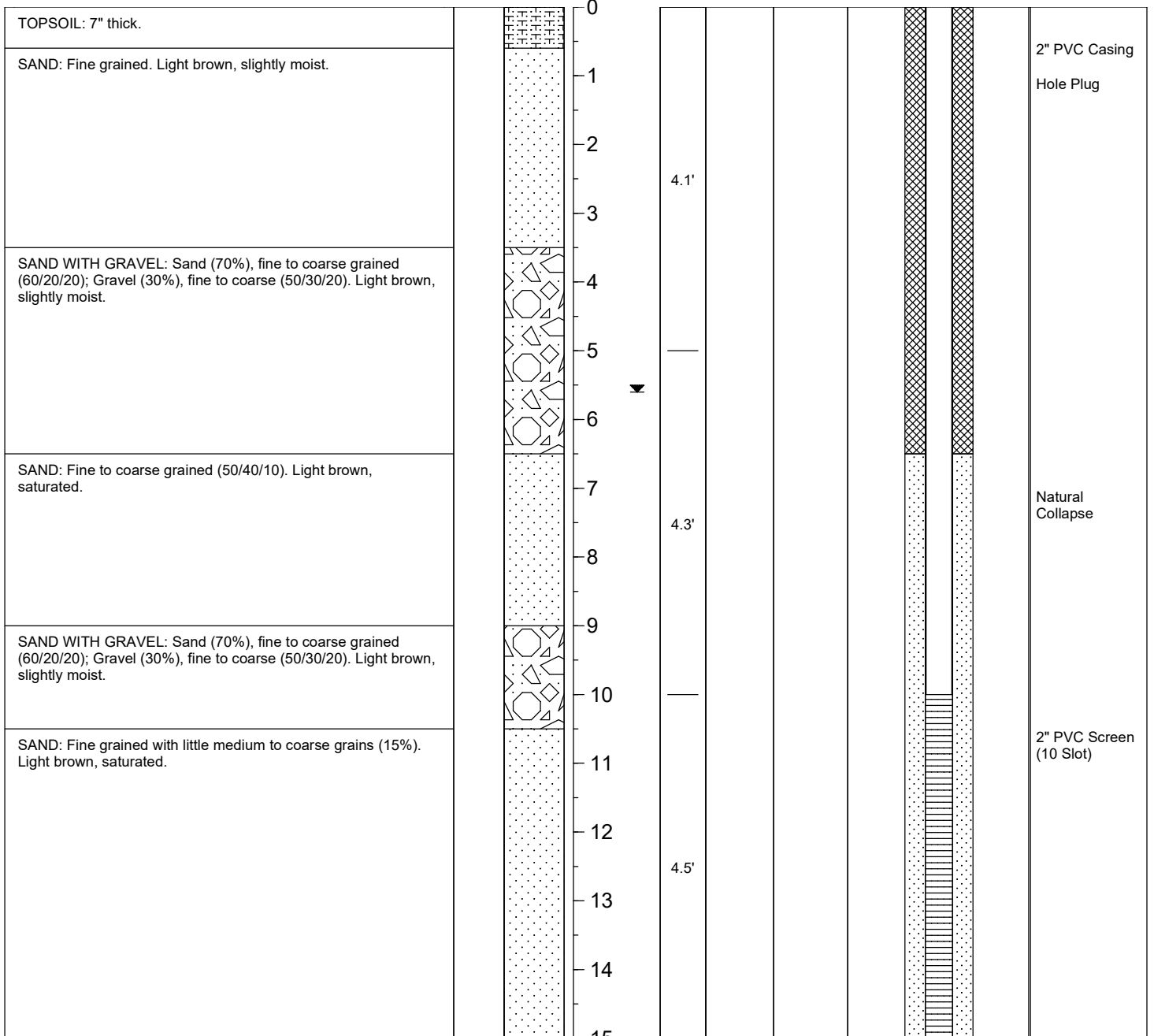
SAMPLING METHODS: Macrocore

NOTES:

▼ Static Water Level

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DESCRIPTION	PID ppm	GRAPHIC LOG	DEPTH (ft. bgl)	Static Water Level	Sample/ Recovery	Sample ID	Blow Counts	WELL CONSTRUCTION DETAIL
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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

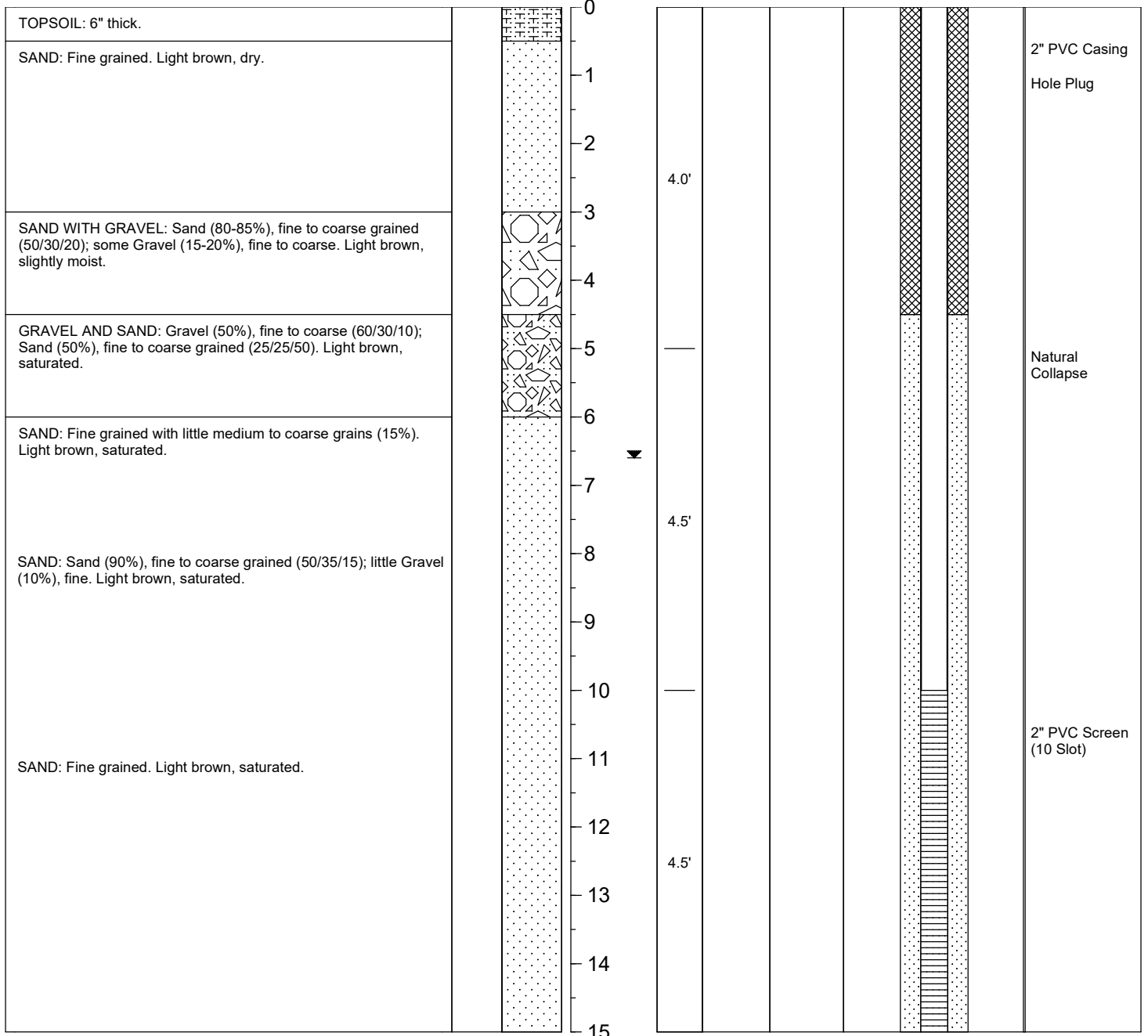
SAMPLING METHODS: Macrocore

NOTES:

▼ Static Water Level

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DESCRIPTION	PID ppm	GRAPHIC LOG	DEPTH (ft. bgl)	Static Water Level	Sample/ Recovery	Sample ID	Blow Counts	WELL CONSTRUCTION DETAIL
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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

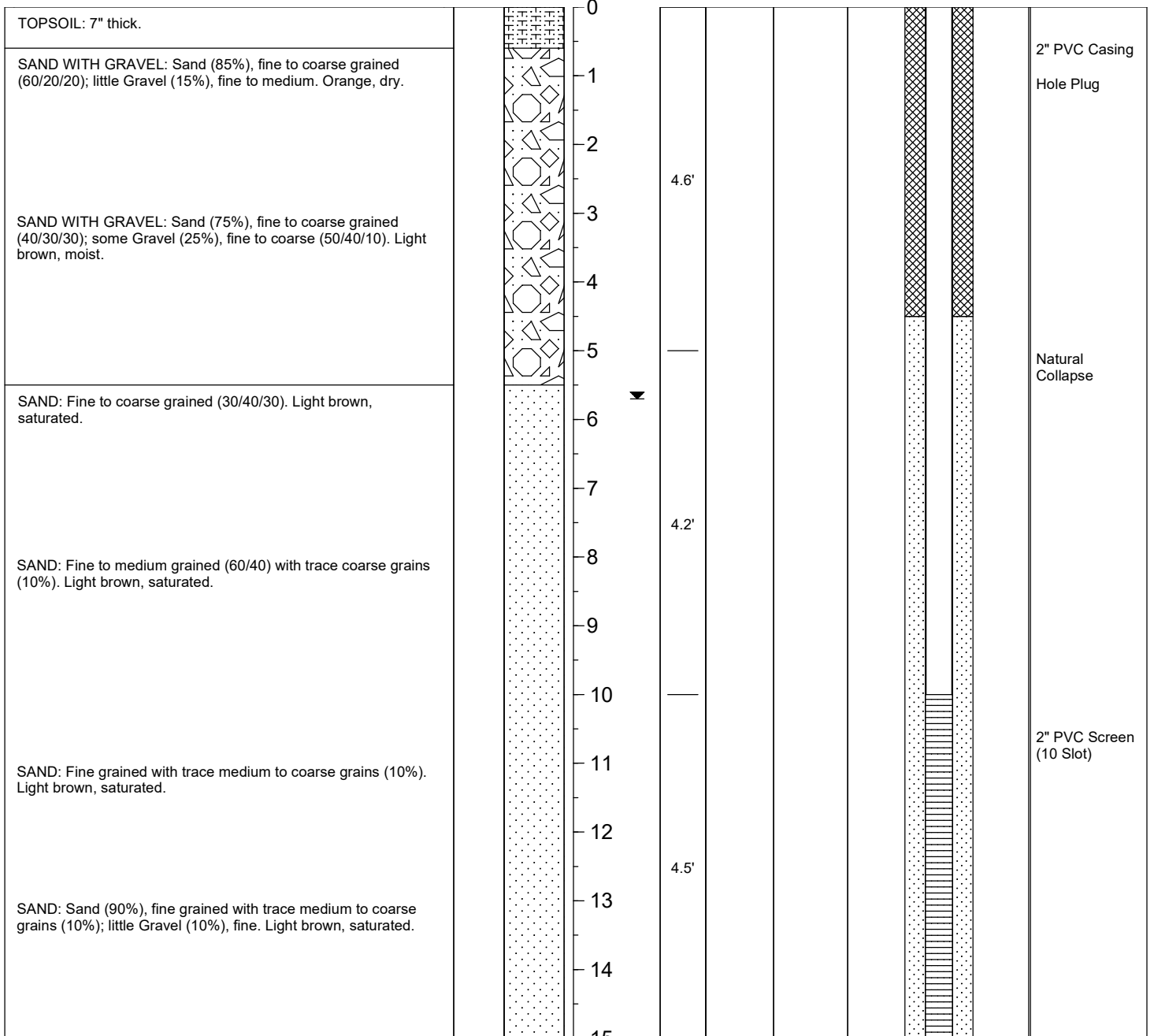
SAMPLING METHODS: Macrocore

NOTES:

▼ Static Water Level

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DESCRIPTION	PID ppm	GRAPHIC LOG	DEPTH (ft. bgl)	Static Water Level	Sample/ Recovery	Sample ID	Blow Counts	WELL CONSTRUCTION DETAIL
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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

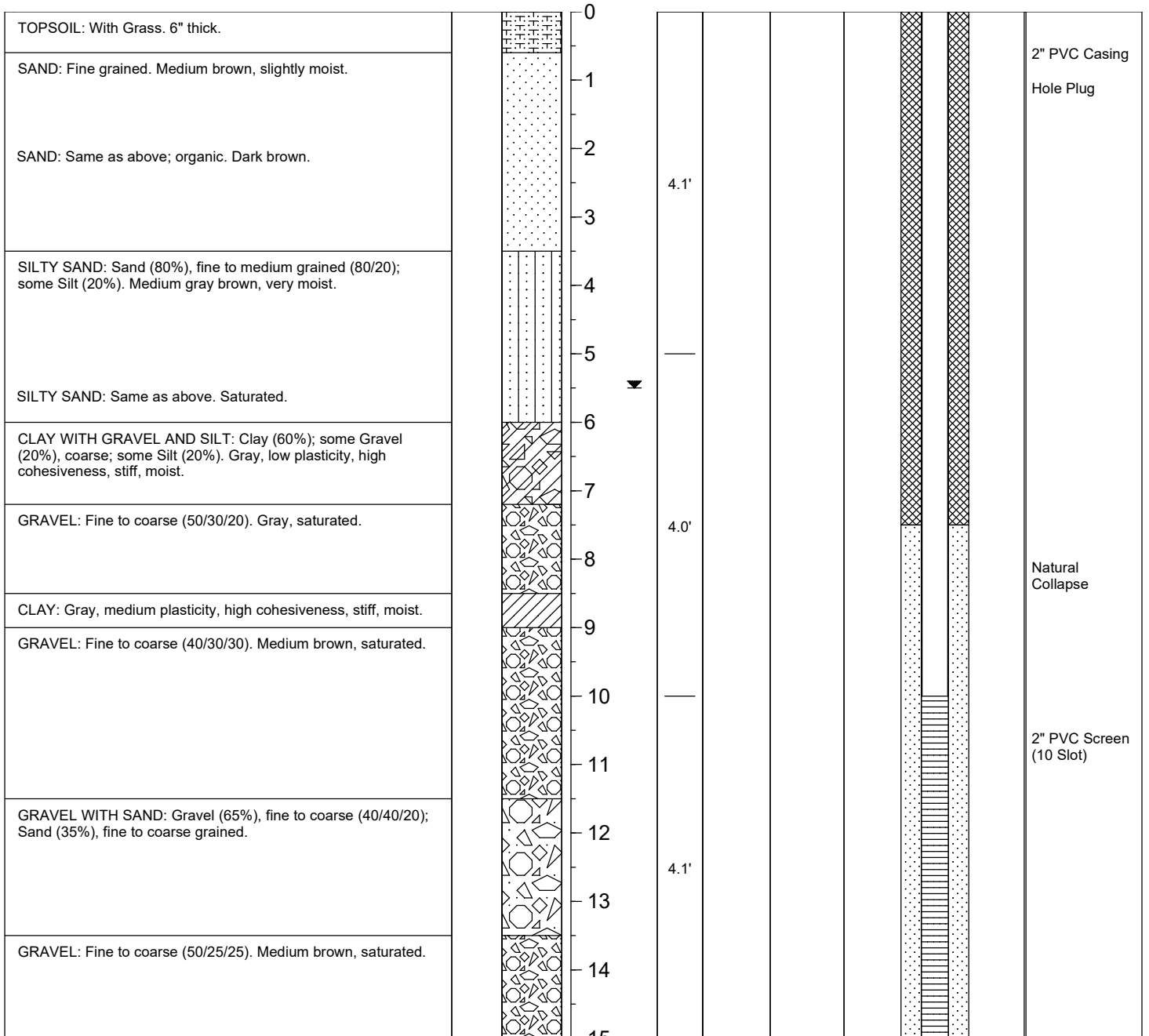
SAMPLING METHODS: Macrocore

NOTES:

▼ Static Water Level

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DESCRIPTION	PID ppm	GRAPHIC LOG	DEPTH (ft. bgl)	Static Water Level	Sample/ Recovery	Sample ID	Blow Counts	WELL CONSTRUCTION DETAIL
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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

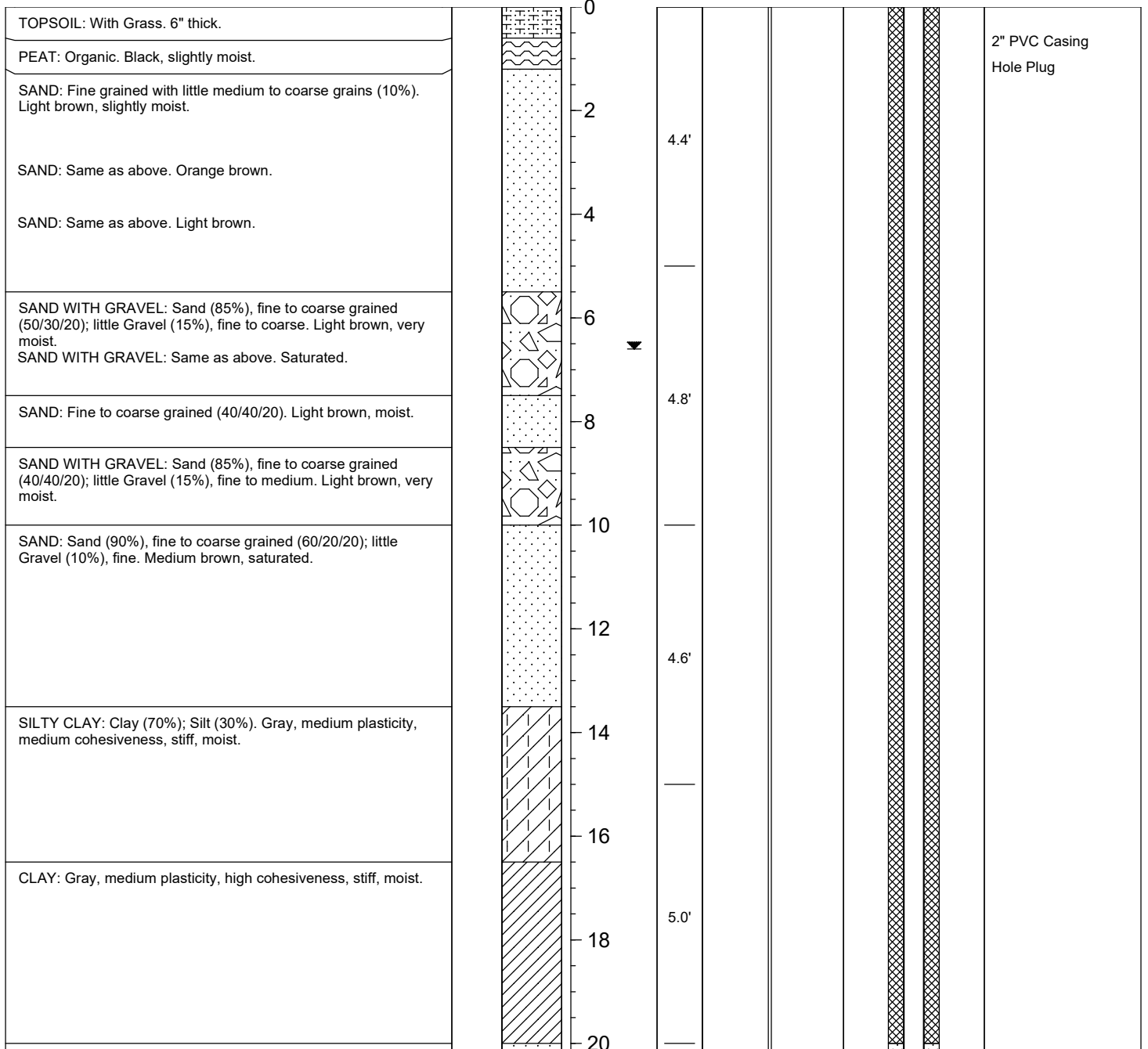
SAMPLING METHODS: Macrocore

NOTES:

▼ Static Water Level

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DESCRIPTION	PID ppm	GRAPHIC LOG	DEPTH (ft. bgl)	Static Water Level	Sample/ Recovery	Sample ID	Blow Counts	WELL CONSTRUCTION DETAIL
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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

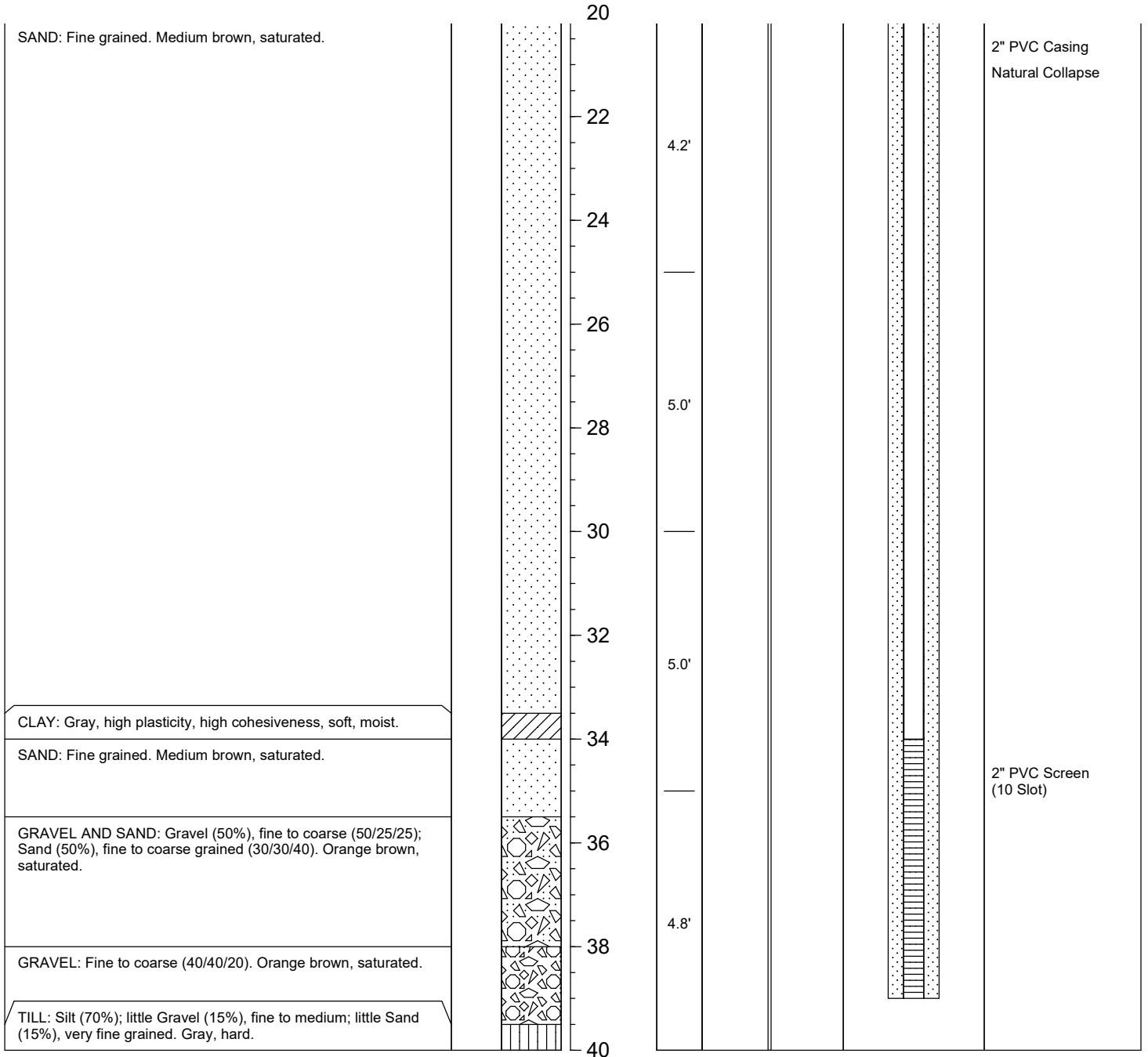
SAMPLING METHODS: Macrocore

NOTES:

▼ Static Water Level

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DESCRIPTION	PID ppm	GRAPHIC LOG	DEPTH (ft. bgl)	Static Water Level	Sample/ Recovery	Sample ID	Blow Counts	WELL CONSTRUCTION DETAIL
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BORING LOG

Project Name: <u>Barrington Drain</u> Project Number: <u>18D485</u> Project Manager: <u>BL</u> Site Location: <u>Chicago, MI</u> Contractor: <u>N/A</u> Driller/Helper: _____ Rig Type: _____ Drilling Method: <u>Hand Auger</u> Borehole Purpose: <u>Soil Description</u>	Boring/Waif Number: <u>DP-1</u> Start/End Date: <u>7/9/18</u> Logged By: <u>ADF</u> Ground Elevation: _____ Static Water Level: _____ Abandonment Method: <u>Backfill w/ soil</u> Development Method: _____ Sampling Methods: _____ PAGE <u>1</u> OF <u>1</u>
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Blow per ft	Recovery (feet)	Depth (feet)	Sample Description	PIU (ppm)	Well Construction Details
		0.25	Sand: Fine 85%, medium 10%, trace coarse (5%), larger grains are sub-angular, L. brown, saturated		Stick up: Fiberglass Casing: Drive pipe diameter: 1.25" interval: <u>1.0 BGS - 4.0 AGS</u> material: Galvanized Screen diameter: 1.25" interval: <u>1.0 - 4.0 BGS</u> register: Stakeless diameter: 2.00"
		0.50			
		0.75			
		1.0			
		1.25			
		1.50			Sand Pack type: Natural/Galvanized runs: <u>0 - 4.0'</u>
		1.75			
		2.0	Clay: 100%, low/med. cohesion, high plasticity, grey color, saturated. End of boring @ 3.5'		Soil type: _____ interval: _____ Grout type: _____ interval: _____
		2.25			
		2.50			
		2.75			
		3.0			
		3.25			
		3.5			
		3.75			
		4.0			Density Sands (lbm/cu ft per ft)
					very loose: 10-12 loose: 12-15 medium-dense: 15-20 dense: 20-30 very dense: > 30
					Density Clays/Sils (lbm/cu ft per foot)
					very soft: < 4 soft: 4-8 medium-stiff: 8-15 stiff: 15-30 very stiff: > 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: <u>Laughlin Drain</u>	Boring/Well Number: <u>DP-2</u>
Project Number: <u>JBC182</u>	Start/End Date: <u>9/19/18</u>
Project Manager: <u>EEG</u>	Logged By: <u>ADF</u>
Site Location: <u>Oshtemo, MI</u>	Ground Elevation: _____
Contractor: <u>SVA</u>	Static Water Level: _____
Driller/Helper: _____	Abandonment Method: <u>Backfill w/ soil</u>
Rig Type: _____	Development Method: _____
Drilling Method: <u>Hand dug</u>	Sampling Method: _____
Borehole Purpose: <u>Soil Description</u>	WCA : <u>01</u> 1

Blows per 5'	Recovery (feet)	Depth (ft age)	Sample Description	PIT (ft/m)	Well Construction Details
		0.25	SAND: Fine 85%, medium 10%, trace coarse 5%, larger grains sub-angular, L. Brown, saturated.		Stick-up: _____ Casing: _____ diameter: 1.25" interval: <u>1.5 BGS</u> 3.5 AGS run-in: _____ Screen: _____ sampler: _____ interval: <u>1.5-4.5 BGS</u> material: _____ diameter: 0.30" (30 mesh)
		0.50			
		0.75			
		1.0	Cobbles: 2-4" diameter, angular, Light color		
		1.25			
		1.50	Sand w/ some organics: Fine 85%, medium 10%, trace coarse 5%, larger grains sub-angular, dark grey/black color, organic smell, compacted, saturated.		
		1.75			
		2.0			
		2.25			
		2.50			
		2.75			
		3.0			
		3.25			
		3.50			
		3.75			
		4.0	End of boring @ 4.0'		
		4.25			
		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: LRE / Banghuan Drain
 Project Number: 180484HG
 Project Manager: BEL
 Site Location: Oshtemo, MI
 Contractor: FTEH
 Estimator: MJI / APS
 Rig Type: Hand Auger
 Borehole Purpose: Soil Description

Spring/Well Number: DR-4
 Start/End Date: 2/12/18
 Logged By: MJI
 Ground Elevation: _____
 Static Water Level: 1.0' AGL
 Abandonment Method: _____
 Development Method: _____
 Sampling Methods: _____

PAGE 1 of 1

Blow per 5'	Remarks (ft/cf)	Depth ft	Sample Description	FIU (ppm)	Well Construction Details
		0.25-	Sand: fine to med. (75/25), trace of coarse (10%), med. brown, loose		Casing diameter: <u>1.25"</u> interval: <u>0-1'</u> material: <u>Galv. St.</u> Screen diameter: <u>1.25"</u> interval: <u>1-4'</u> material: <u>Mesh 5/16"</u> diameter: <u>Mesh</u> Sand Pack size: _____ thickness: _____ Seal size: _____ interval: _____ Grout type: _____ interval: _____
		0.5-	Sand: SAA		
		0.75-			
		1.0-	Sand: fine to coarse (50/40/10), trace fine Gravel (10%), med. grey brown, loose		
		1.25-			
		1.5-	Sand: SAA		
		1.75-			
		2.0-	Sand: SAA		
		2.25-			
		2.5-	Sand: SAA		
		2.75-			
		3.0-			
		3.25-			
		3.5-	Clay: grey, stiff, med. cohesiveness, med. plasticity, compact		Density - Sande (Sieve counts per foot) very loose 5-15 loose 6-20 med dense 11-20 dense 21-30 very dense 4-50 Density - Clay/Silt (100% @ 100% Wet Foot) very soft <2 soft 2-4 medium stiff 4-8 stiff 9-15 very stiff 16-30 hard >30
		3.75-			
		4.0-	EDIS = 4' by 2'		

Comments: N42.4500787 W49.715743. Installed top of drive-point screen 1.0' below bgs. SWL = 1.0' AGL



BORING LOG

Project Name: <u>LRE / Baughman Drain</u>	Boring/Well Number: <u>DP-5</u>
Project Number: <u>180488 HG</u>	Start/End Date: <u>7/12/18</u>
Project Manager: <u>REG</u>	Logged By: <u>MJI</u>
Site Location: <u>Oshtemo, MI</u>	Ground Elevation: <u>0</u>
Contractor: <u>ETCH</u>	Static Water Level: <u>0.8' AGL</u>
Driller/Helper: <u>MJI/APS</u>	Reconnaissance Method: _____
Rig Type: <u>Hand Auger</u>	Development Method: _____
Borehole Purpose: <u>Soil Description</u>	Sampling Methods: _____

PAGE | OF |

Elev. per ft	Recovery (feet)	Depth (ft)	Sample Description	pH (ppm)	Well Construction Details
		0.25 -	Sand: fine to med. (70/30), trace coarse (10%), med. grey brown, loose		Filter diameter: <u>1.25"</u> interval: <u>0-1.25'</u> material: <u>Galv. St.</u>
		0.5 -			
		0.75 -	Sand: SAA		Screen diameter: <u>1.25"</u> interval: <u>1.25-4.25'</u> material: <u>S.S.</u> screen: <u>Mesh</u>
		1.0 -			
		1.25 -	Sand: SAA		Sand Pack type: _____ interval: _____
		1.5 -			
		1.75 -			Soil type: _____ interval: _____
		2.0 -	Sand: fine to coarse (60/20/20), little fine gravel (15-20%), med. grey brown		
		2.25 -			Soil type: _____ interval: _____
		2.5 -	Sand: SAA, little fine to med. gravel (15%)		
		2.75 -			Soil type: _____ interval: _____
		3.0 -			
		3.25 -	Sand: SAA		Permeability (flow course per foot) very slow < 0.1 slow 0.1-1 moderate 1-10 dense 10-50 very dense > 50
		3.5 -			
		3.75 -	Sand: fine to med. (80/20), trace fine gravel (10%), med. grey brown, compact		Density - Clay/Silt (flow course per foot) very soft < 2 soft 2-3 medium stiff 4-5 stiff 6-10 very stiff 10-20 hard > 20
		4.0 -			
			EOB = 4.25' bgs		

Comments: N42.4500451 W85.7083033 installed top of drivepoint & screen 1.25' bgs.



BORING LOG

Project Name: LRE/Broughman Drain
 Project Number: 180488HG
 Project Manager: REG
 Site Address: 03590, MI
 Contractor: ETCH
 Owner/Client: MJI/APS
 Log Type: Hand Auger
 Borehole Purpose: Soil Description

Boring/Well Number: DP-6
 Start/End Date: 7/12/18
 Logged By: MJI
 Ground Elevation: _____
 Static Water Level: 0.5' AGL
 Advancement Method: _____
 Development Method: _____
 Sampling Methods: _____

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Blow Count	Recovery (%)	Depth (ft)	Sample Description	PII (ppm)	Well Construction Details
		0.25	Sand: fine to med. (75/25), trace coarse (10%), med. grey, loose		Cong outside: <u>1.25"</u> inside: <u>0-1.5"</u> screen: <u>lock. st.</u>
		0.5			
		0.75			
		1.0	Sand: SAA, grey brown		Kerf outside: <u>1.25"</u> inside: <u>1.5-4.5"</u> screen: <u>S.S.</u> filter: <u>Mesh</u>
		1.25			
		1.5	Sand: fine to coarse (70/20/10), grey brown, loose		
		1.75			Sand Pack type: _____ screen: _____
		2.0	Sand: SAA, trace fine gravel (10%)		
		2.25			
		2.5			Gravel type: _____ screen: _____
		2.75	Sand: SAA		
		3.0			
		3.25	Sand: fine to coarse (60/25/15), 1.7% fine gravel (15%), grey brown, compact		Screen - Sands (blow counts per foot) very loose 5 or less loose 5-11 med dense 11-21 dense 21-31 very dense 31-50
		3.50			
		3.75			
		4.0	EDB = 4' bgs		Density - Clays/Sils (blow counts per foot) very soft 0-2 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' AGL

BORING LOG

Project Name:	Baughman Drain	Boring/Well Number:	EXP-1
Project Number:	1.01498	Start/End Date:	7/1/18
Project Manager:	BEG	Logged By:	ADF
Site Location:	Outcrop, 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		

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Blow count	Recovery Feet	Depth ft. Log	Sample Description	PIU (ppm)	Well Construction Details
		0.25	Sand: Fine grained 95%, Trace med/coarse grain 5%. Light brown, wet/saturated. Well sorted,		Back-up: Peristaltic Casing Tubing: 3/8" diameter: interval: material:
		0.50			
		0.75			
		1.0			
		1.25			
		1.50			
		1.75	Clay: 100%, low-med cohesiveness, high plasticity, grey color, saturated		Screen diameter: 1/2" interval: 1-1.5' BG5 material: SS type:
		2.0			
		2.25			
		2.50			
			End of boring @ 2.5'		Sand Pack type: Actual Collapse interval: 0-1.5' Seal type: interval: Grout type: interval:
					Density - Sands (blow counts per foot) very loose: 5 or less loose: 6-11 med dense: 12-30 dense: 41-50 very dense: >50
					Density - Clays/Sils (blow counts per foot) very soft: 0 soft: 1-4 med-lem stiff: 5-15 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' BG5.



BORING LOG

Project Name: <u>Laughlin Drain</u>	Boring/Well Number: <u>EXP-02</u>
Project Number: <u>190438</u>	Start/End Date: <u>7/9/18</u>
Project Manager: <u>BCG</u>	Logged By: <u>ADP</u>
Site Location: <u>Catoga, Wv</u>	Ground Elevation: _____
Contractor: <u>N/A</u>	Static Water Level: _____
Driller/Logger: _____	Abandonment Method: <u>Backfill w/ soil</u>
Rig Type: _____	Development Method: _____
Drilling Method: <u>Hand Auger</u>	Sampling Methods: _____
Borehole Purpose: <u>Soil Description</u>	PAGE <u>1</u> OF <u>1</u>

Elev (feet)	Recovery (feet)	Depth (ft/bat)	Sample Description	FIN (feet)	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		Sideslip <u>Peristaltic Tubing</u> Casing diameter: <u>3/8"</u> Interval: <u>3.0-8.65</u> = 3.0 AGS material _____
		0.5			
		0.95			
		1.0	SAND: Fine 85%, medium 10%, Trace coarse 5%, larger grains sub-angular, Dark Gray/black (organic matter), saturated Loose		Screen diameter: <u>1/2"</u> screen <u>3.0-3.5'</u> mesh: <u>SS</u> material _____
		1.25			
		1.5	SAA, color back to L. Brown		Saw Mark type <u>Natural Collapse</u> interval <u>0-3.5'</u>
		1.75			
		2.0			
		2.25			Seal type _____ material _____
		2.50			
		2.75			
		3.0			
		3.25			
		3.5			Density Sands blow count per foot: very loose 3 to 10 loose 10-15 med loose 15-30 dense 30-50 very dense >50
		3.75			
		4.0			
		4.25			Density - (lb/ft ³) blow count per foot: very soft <5 soft 5-8 med soft 8-13 stiff 13-20 hard >20
		4.50	End of boring @ 4.50'		
		4.75			
		5.0			

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:	Baughman Drain	Boring/Well Number:	EXP-3
Project Number:	180438	Start/End Date:	9/9/18
Project Manager:	DCG	Logged By:	ADF
Site Location:	Ostego, 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 Descriptive		

Blow count (ft)	Recovery (feet)	Depth (ft)	Sample Description	FIU (ft)	Well Construction Details	
		0.25	Sand + Organics: 70% Fine sand, 30% organics, black color, saturated, jelly-like texture		Stick-up: <i>Possible tubing</i>	
		0.50				Casing diameter: <u>3/8"</u>
		0.75	Cobbles: 2-4" diameter, angular, Light color.		material: _____	
		1.0				Screen diameter: <u>1/2"</u>
		1.25	Sand: Fine 85%, medium 10%, trace coarse (5%). Larger grains sub-angular, Compacted, L. Brown color, saturated		material: <u>SS</u>	
		1.50				corrosion: _____
		1.75				Sealant type: <u>Neural Colloid</u>
		2.0				material: _____
		2.25			Seal type: _____	
		2.50			material: _____	
		2.75			Grout type: _____	
		3.0			material: _____	
		3.25				
		3.50	End of boring @ 3.50'			

Comments: N. 42° 26' 42.3" W 85° 42' 44.4". Located 30' downstream of stone SG1-2 read 1.20'. Expandable point (top of screen) is 3.0' BGS. Water depth 5.0" (0.42 ft)



BORING LOG

Project Name: <u>Baughman Drain</u>	Boring/Well Number: <u>EXP-4</u>
Project Number: <u>180438</u>	Start/End Date: <u>7/9/18</u>
Project Manager: <u>DEG</u>	Logged By: <u>ADF</u>
Site Location: <u>Osteo, MI</u>	Ground Elevation: _____
Contractor: <u>N/A</u>	Static Water Level: _____
Driller/Helper: _____	Abandonment Method: <u>Backfill w/ soil</u>
Rig Type: _____	Development Method: _____
Drilling Method: <u>Hand Auger</u>	Sampling Methods: _____
Borehole Purpose: <u>Soil Description</u>	VLF _____ 1 _____ 1 _____

Flow pipe	Recovery (feet)	Depth (feet)	Sample Description	PTD (feet)	Well Construction Details
		0.25	SAND: Fine 85%, medium 10%, trace coarse 5% Larger grains sub-angular, L. Brown, saturated		Strapping: <u>Plastic Tubing</u> Casing: _____ diameter: <u>3/8"</u> interval: <u>2.5 BGS - 3.0' ABS</u> material: _____ Screen: _____ diameter: <u>1/2"</u> interval: <u>2.5-3.0</u> material: <u>SS</u> well ID: _____ Sand Pack: _____ type: <u>Neutr to base</u> 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	SAND w/ some organics: Fine 85%, medium 10%, trace coarse @ 5%, dark grey color, organic smell, compacted, saturated.		
		1.5			
		1.75			
		2.0			
		2.25			
		2.50			
		2.75	End of boring @ 2.0'		
		3.0			

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: <u>LRE/Bangham Area</u>	Boring/Well Number: <u>EXP-5</u>
Project Number: <u>180488 HG</u>	Start/End Date: <u>7/12/18</u>
Project Manager: <u>BEL</u>	Logged By: <u>MJI</u>
Site Location: <u>Duxbury, MA</u>	Ground Elevation: _____
Contractor: <u>FTCH</u>	Static Water Level: <u>0.5' AGL</u>
Driller/Helper: <u>MJI/APS</u>	Abandonment Method: _____
Rig Type: <u>Hand Auger</u>	Development Method: _____
Primary Purpose: <u>Soil Description</u>	Sampling Methods: _____
PAGE <u>1</u> OF <u>1</u>	

Blow per ft	Penetration (feet)	Depth (ft) bgs	Soil Description	SP (ppm)	Well Construction Details																
		0.25-	Mud: black, organic, w/ some fine sand (40%)		Casing <u>Peristaltic Tubing</u> diameter: <u>3/8"</u> interval: <u>0-2'</u> material: <u>PolyE</u>																
		0.5-	Sand: fine, organic, med. grey brown compact																		
		0.75-			Screen diameter: <u>3/8"</u> interval: <u>2-2.5'</u> material: <u>SS</u> status: _____																
		1.0-	Sand: fine to med. (70/30), med. grey loose																		
		1.25-			Sand Pack type: _____ interval: _____																
		1.5-	Sand: SAA																		
		1.75-			Seal type: _____ interval: _____																
		2.0-	Sand: fine to coarse (60/25/15), med. grey, loose																		
		2.25-			Grout type: _____ interval: _____																
		2.5-	expansive clay: grey, stiff, med cohesive, med. plasticity																		
		2.75-			<table border="1" style="width:100%; border-collapse: collapse;"> <tr><td align="center" colspan="2">Jenny Sand</td></tr> <tr><td align="center" colspan="2">blow count per foot</td></tr> <tr><td>very loose</td><td>0-10</td></tr> <tr><td>loose</td><td>11-20</td></tr> <tr><td>med dense</td><td>21-30</td></tr> <tr><td>dense</td><td>31-40</td></tr> <tr><td>very dense</td><td>41-50</td></tr> </table>	Jenny Sand		blow count per foot		very loose	0-10	loose	11-20	med dense	21-30	dense	31-40	very dense	41-50		
Jenny Sand																					
blow count per foot																					
very loose	0-10																				
loose	11-20																				
med dense	21-30																				
dense	31-40																				
very dense	41-50																				
		3.0-	EDB = 3.0' bgs		<table border="1" style="width:100%; border-collapse: collapse;"> <tr><td align="center" colspan="2">Density Class</td></tr> <tr><td align="center" colspan="2">blow count per foot</td></tr> <tr><td>very soft</td><td>0</td></tr> <tr><td>soft</td><td>1-4</td></tr> <tr><td>medium stiff</td><td>5-9</td></tr> <tr><td>stiff</td><td>10-15</td></tr> <tr><td>very stiff</td><td>16-30</td></tr> <tr><td>hard</td><td>>30</td></tr> </table>	Density Class		blow count per foot		very soft	0	soft	1-4	medium stiff	5-9	stiff	10-15	very stiff	16-30	hard	>30
Density Class																					
blow count per foot																					
very soft	0																				
soft	1-4																				
medium stiff	5-9																				
stiff	10-15																				
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' AGL



BORING LOG

Project Name	<u>LRE/Broughman Drive</u>	Boring/Well Number	<u>EXP-6</u>
Project Number	<u>19048816</u>	Start/End Date	<u>7/12/18</u>
Project Manager	<u>BEL</u>	Logged By	<u>MJI</u>
Site Location	<u>Oshtemo, MI</u>	Ground Elevation	
Contractor	<u>FTEH</u>	Static Water Level	<u>1.0' AGL</u>
Driller/Helper	<u>MJI/APS</u>	Abandonment Method	
Rig Type	<u>Hand Auger</u>	Development Method	
Borehole Purpose	<u>Soil Description</u>	Sampling Methods	

PAGE | OF |

Blow count	Necessary Tests	Depth ft	Soil Description	PIE (psf)	Well Construction Details
			<u>(50/30/20)</u>		
		0.25	<u>Sand: fine to coarse w/ little fine gravel (15%), light brown, loose</u>		<u>Peristaltic Tubing</u>
		0.5	<u>Sand: very fine, med. gray brown, loose</u>		<u>Diameter: 3/8"</u>
		0.75			<u>Interval: 0-2.5'</u>
		1.0	<u>Sand: SAA</u>		<u>Material: Poly E</u>
		1.25			<u>Screen: 3/8"</u>
		1.5	<u>Sand: SAA</u>		<u>Diameter: 0.5"</u>
		1.75			<u>Interval: 2.5-3.0'</u>
		2.0	<u>Sand: fine to med. (70/30), trace fine to med. gravel (10%), med. gray, loose</u>		<u>Material: SS</u>
		2.25			<u>Interval:</u>
		2.5	<u>Sand: fine, med. gray, compact</u>		<u>Interval:</u>
		2.75			<u>Interval:</u>
		3.0	<u>EOB = 3.0' bgs</u>		<u>Interval:</u>

Comments: N47.4500604 W85.7133479 Installed 6" expandable point w/ top of screen 2.5' bgs. SWL=1.0' AGL



BORING LOG

Project Name: <u>LRE/Boughman Drivn</u>	Boring/Well Number: <u>EXP-7</u>
Project Number: <u>180485 HG</u>	Start/End Date: <u>7/12/18</u>
Project Manager: <u>REG</u>	Logged By: <u>MJI</u>
Site Location: <u>Orange, ME</u>	Ground Elevation: _____
Contractor: <u>FEH</u>	Static Water Level: <u>0.4' AGL</u>
Driver/Helper: <u>MJI/APS</u>	Abandonment Method: _____
Rig Type: <u>Hand Auger</u>	Development Method: _____
Borehole Purpose: <u>Soil Description</u>	Sampling Methods: _____
PAGE <u>1</u> OF <u>1</u>	

Depth (ft)	Recovery (%)	Depth (ft)	Soil Description	SPT (blows)	Well Construction Details
0-15		0-15	Sand: fine to med (80/20), trace coarse (10%), med. grey brown, loose		Casing: <u>Peristaltic Tubing</u> diameter: <u>3/8"</u> interval: <u>0-2.5'</u> material: <u>PolyE</u> Screen: <u>3/8"</u> diameter: <u>2.5'</u> interval: <u>2.5-3'</u> material: <u>SS</u> closure: _____ Sand Pack: _____ yes _____ interval: _____ Seal: _____ yes _____ interval: _____ Grout: _____ type: _____ interval: _____ Density - Sands (blows per foot) very loose: 5 or less loose: 6-11 med dense: 11-30 dense: 31-50 very dense: >50 Density - Clays/Sils (blows per foot) very soft: <7 soft: 7-14 medium stiff: 14-30 stiff: 30-50 very stiff: 50-100 hard: >100
0.5		0.5			
0.75		0.75	Sand: SAA		
1.0		1.0			
1.15		1.15	Sand: SAA		
1.5		1.5			
1.75		1.75	Sand: fine to coarse (50/50/20), trace fine gravel (10%), med. grey brown, compact		
2.0		2.0			
2.15		2.15			
2.5		2.5	Sand: SAA		
2.75		2.75			
3.0		3.0			
			EOB = 3' bgs		

Comments: N42.4500463 W85.7036027 6" expandable point installed w/ top of screen 2.5' bgs. SWL = 0.4' AGL



BORING LOG

Project Name	<u>LRE/Baugher Drain</u>	Boring/Well Number	<u>EXP-8</u>
Project Number	<u>180458 HG</u>	Start/End Date	<u>7/12/18</u>
Project Manager	<u>BEV</u>	Logged By	<u>MJI</u>
Site Location	<u>Olsgo, MI</u>	Ground Elevation	
Contractor	<u>FCH</u>	Status Water Level	<u>0.2' AGS</u>
Driller/Helper	<u>MJI/APS</u>	Abandonment Method	
Rig Type	<u>Hand Auger</u>	Development Method	
Borehole Purpose	<u>Soil Description</u>	Sampling Methods	

Page | 1 | of | 1 |

Soil Depth (ft)	Soil Description	W.C. (ft)	Well Construction Details
0.25	Sand: fine, w/ trace coarse (10%), med. brown, compact		Type: <u>Perforated Tubing</u> diameter: <u>3/8"</u> interval: <u>0-2.5'</u> screen: <u>Polys 5'</u> Screen diameter: <u>3/8"</u> screen: <u>2.5-3'</u> mesh: <u>S.S</u> slots: _____ Sand type: _____ mesh: _____ Seal type: _____ screen: _____ Gravel type: _____ mesh: _____ Details: Sand (blow count per foot) very loose: 0-10 loose: 10-15 med dense: 15-30 dense: 30-50 very dense: >50 Details: Clean/Dirty (blow count per foot) very soft: <2 soft: 2-4 med. h.c. H: 4-8 h.c. H: 8-10 very h.c. H: 10-15 hard: >10
0.5	Sand: SAA		
0.75			
1.0	Sand: fine w/ trace med. (10%), med. brown,		
1.25			
1.5	Sand: SAA		
1.75			
2.0	Sand: SAA		
2.25			
2.5	Sand: SAA		
2.75			
3.0	EDB = 3' bgs		

Comments: N42.4463064 W85.7055272 Installed expendable point w/ top of screen 2.5' bgs. SWL = 0.2' AGS



BORING LOG

Project Name: <u>North Muskegon Dry Cleaner</u>	Boring/Well Number: <u>EXP-9</u>
Project Number: <u>JL0846-180486116</u>	Start/End Date: <u>2/16/18 7/16/18</u>
Project Manager: <u>M. J. Sachs</u>	Logged By: <u>M. J. Sachs</u>
Site Location: <u>Muskegon, MI 49504, MI</u>	Ground Elevation: <u>NA</u>
Contractor: <u>FISH</u>	Static Water Level: <u>0.1' AGLS</u>
Driller/Helper: <u>Alex Sachs</u>	Abandonment Method: <u>Cuttings</u>
Rig Type: <u>NA</u>	Development Method: <u>NA</u>
Drilling Method: <u>Hand Auger</u>	Sampling Method: <u>Composite</u>
Borehole Purpose: <u>Waste Characterization - Soil Description</u>	XCF <u> </u> I <u> </u> OI <u> </u> L <u> </u>

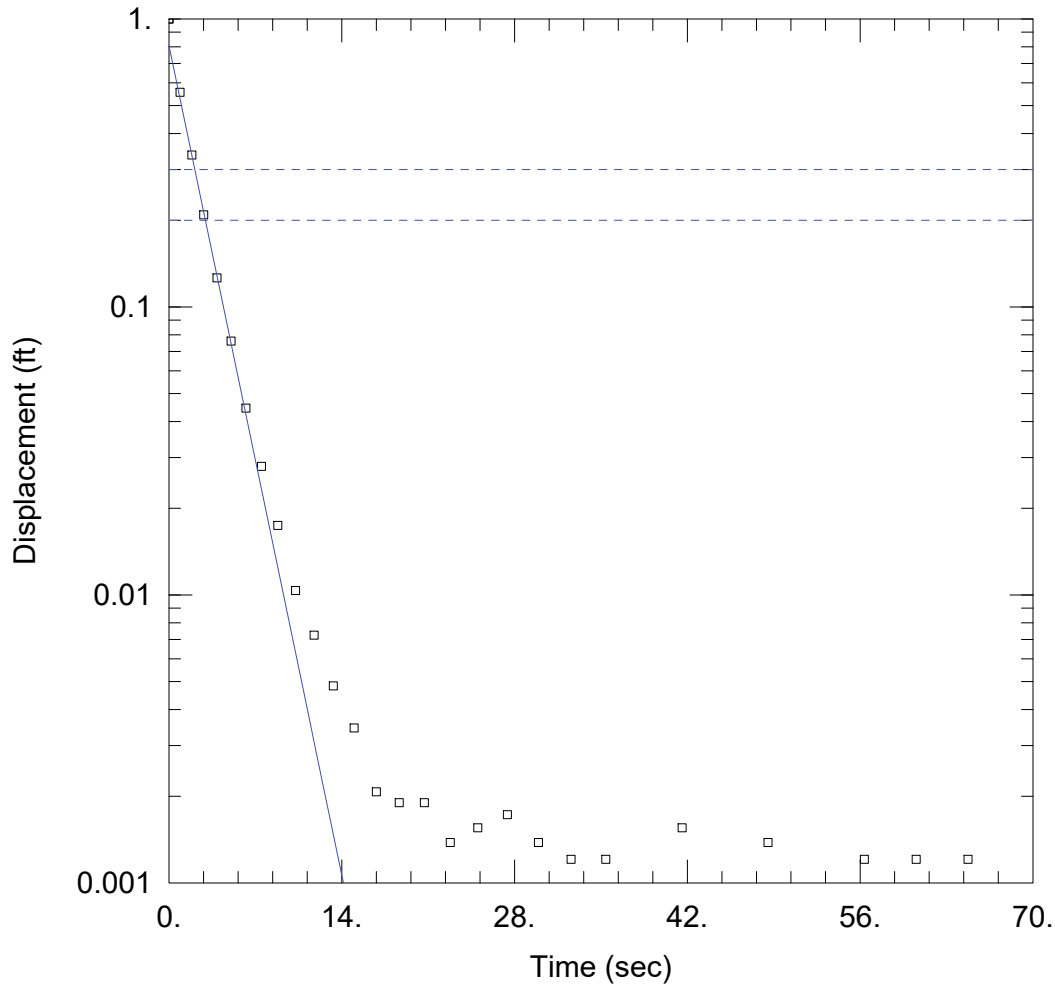
Blow per 6"	Recovery (feet)	Depth (ft bgs)	Sample Description	PIU (ft)	Well Construction Data	
		0.25	Sand: fine to med. (75/25), trace coarse (10%), med. gravel, loose		Stick-up: <u>Perforated Tubing</u> diameter: <u>3/8"</u> interval: <u>0-2.5'</u> material: <u>Poly E</u>	
		0.5	Sand: SAA			
		0.75				
		1.0	Sand: SAA, compact		Screen diameter: <u>3/8"</u> interval: <u>NA 2.5-3'</u> material: <u>SS</u> decl. arc: <u>NA</u>	
		1.25				
		1.5	Sand: SAA fine to ^{med} coarse (60/40)			
		1.75			Sand Pack type: <u>NA</u> interval: <u>NA</u>	
		2.0	Sand: SAA, trace fine gravel (10%)			
		2.25				
		2.5	Sand: SAA		Seal type: <u>NA</u> interval: <u>NA</u>	
		2.75				
		3.0				
		EOTB = 3' bgs				Grout type: <u>NA</u> interval: <u>NA</u>
					Density - Sands (pcf count per foot) very soft: 5-11 soft: 11-13 med. sand: 13-15 sand: 15-16 very sand: 16-18	
					Density - Clay/Silt (Blow count per foot) very soft: 0-2 soft: 2-4 med. soft: 4-8 soft: 8-15 very soft: 15-30 hard: 30+	

Remarks: N42.4465410 W85.7030405 Installed the expendable point w/ the top of screen 2.5' bgs. SWL = 0.1' AGLS



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)

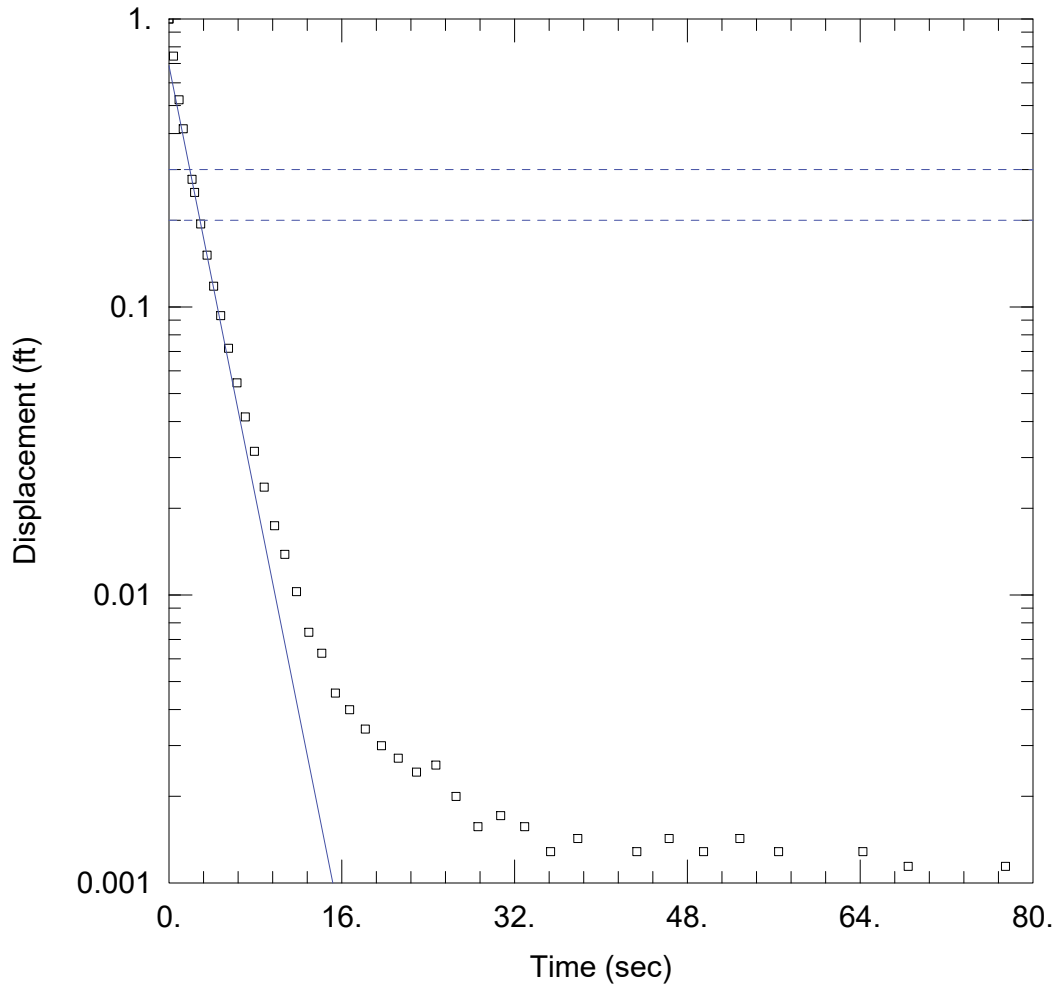
Initial Displacement: 1. ft
 Total Well Penetration Depth: 7.21 ft
 Casing Radius: 0.08333 ft

Static Water Column Height: 7.21 ft
 Screen Length: 5. ft
 Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Unconfined
 K = 108.1 ft/day

Solution Method: Bower-Rice
 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)

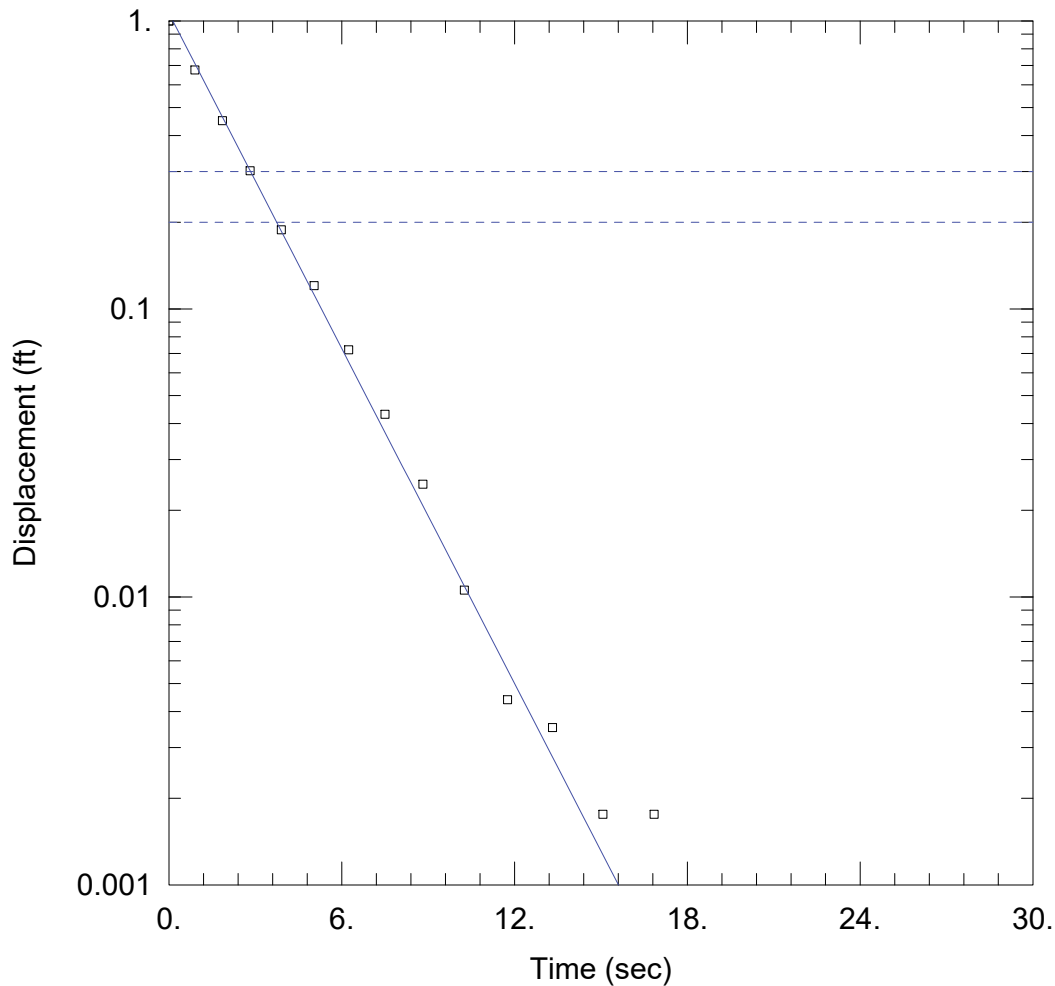
Initial Displacement: 1. ft
 Total Well Penetration Depth: 6.08 ft
 Casing Radius: 0.08333 ft

Static Water Column Height: 6.08 ft
 Screen Length: 5. ft
 Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Unconfined
 K = 96.1 ft/day

Solution Method: Bowser-Rice
 y0 = 0.6882 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

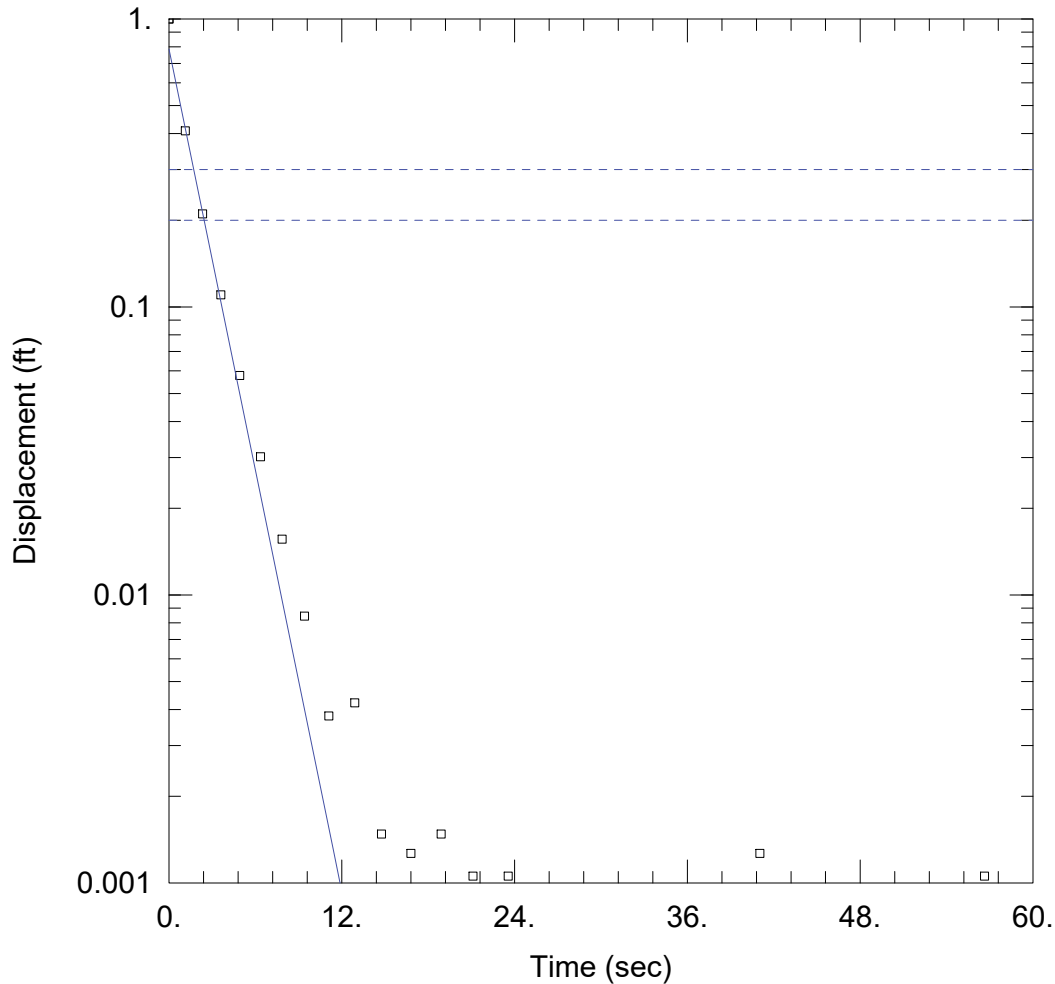
Saturated Thickness: 34.27 ft Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (PZ-12)

Initial Displacement: 1. ft Static Water Column Height: 9.27 ft
 Total Well Penetration Depth: 9.27 ft Screen Length: 5. ft
 Casing Radius: 0.08333 ft Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Unconfined Solution Method: Bower-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

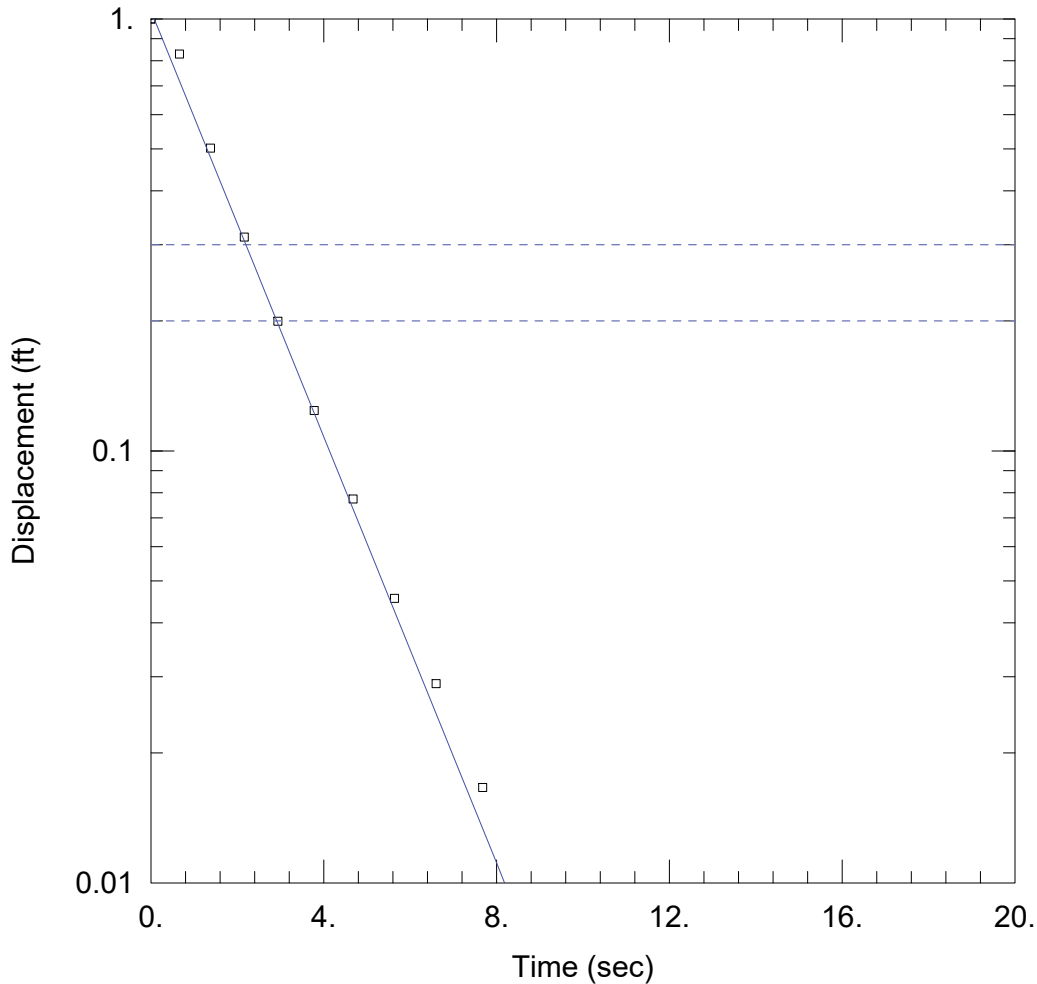
Saturated Thickness: 34.28 ft Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (PZ-13)

Initial Displacement: 1. ft Static Water Column Height: 9.28 ft
 Total Well Penetration Depth: 9.28 ft Screen Length: 5. ft
 Casing Radius: 0.08333 ft Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Unconfined Solution Method: Bower-Rice
 K = 132.4 ft/day y0 = 0.7861 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)

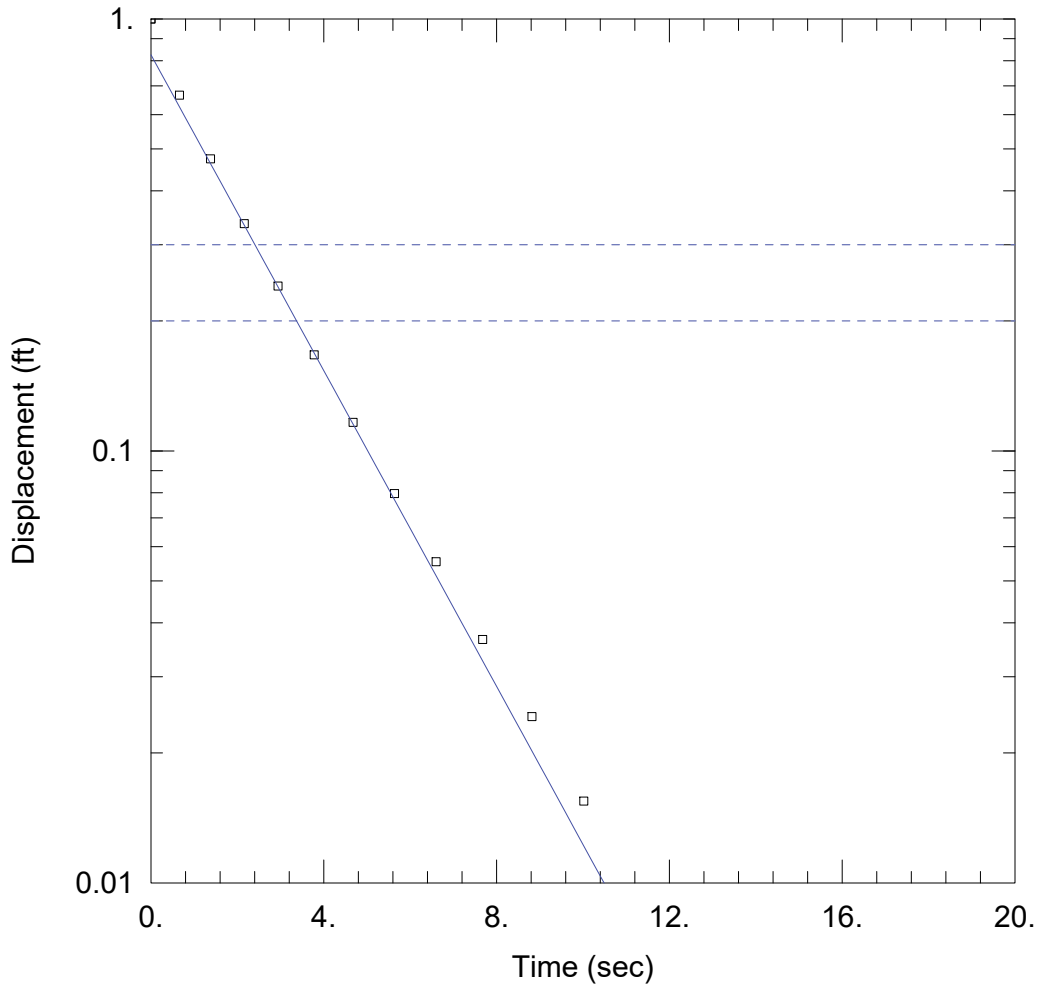
Initial Displacement: 1. ft
 Total Well Penetration Depth: 9.34 ft
 Casing Radius: 0.08333 ft

Static Water Column Height: 9.34 ft
 Screen Length: 5. ft
 Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Unconfined
 K = 134.1 ft/day

Solution Method: Bouwer-Rice
 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)

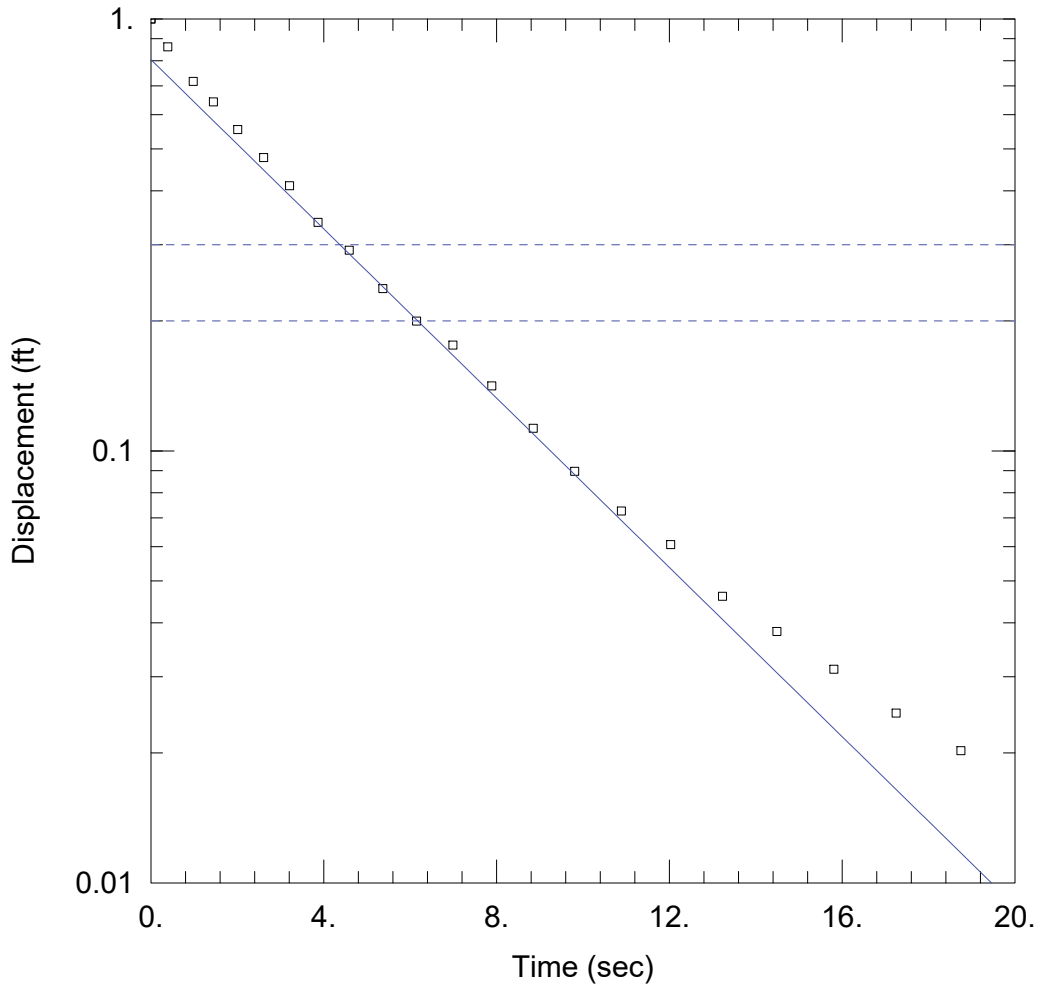
Initial Displacement: 1. ft
 Total Well Penetration Depth: 8.47 ft
 Casing Radius: 0.08333 ft

Static Water Column Height: 8.47 ft
 Screen Length: 5. ft
 Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Unconfined
 K = 98.14 ft/day

Solution Method: Bouwer-Rice
 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)

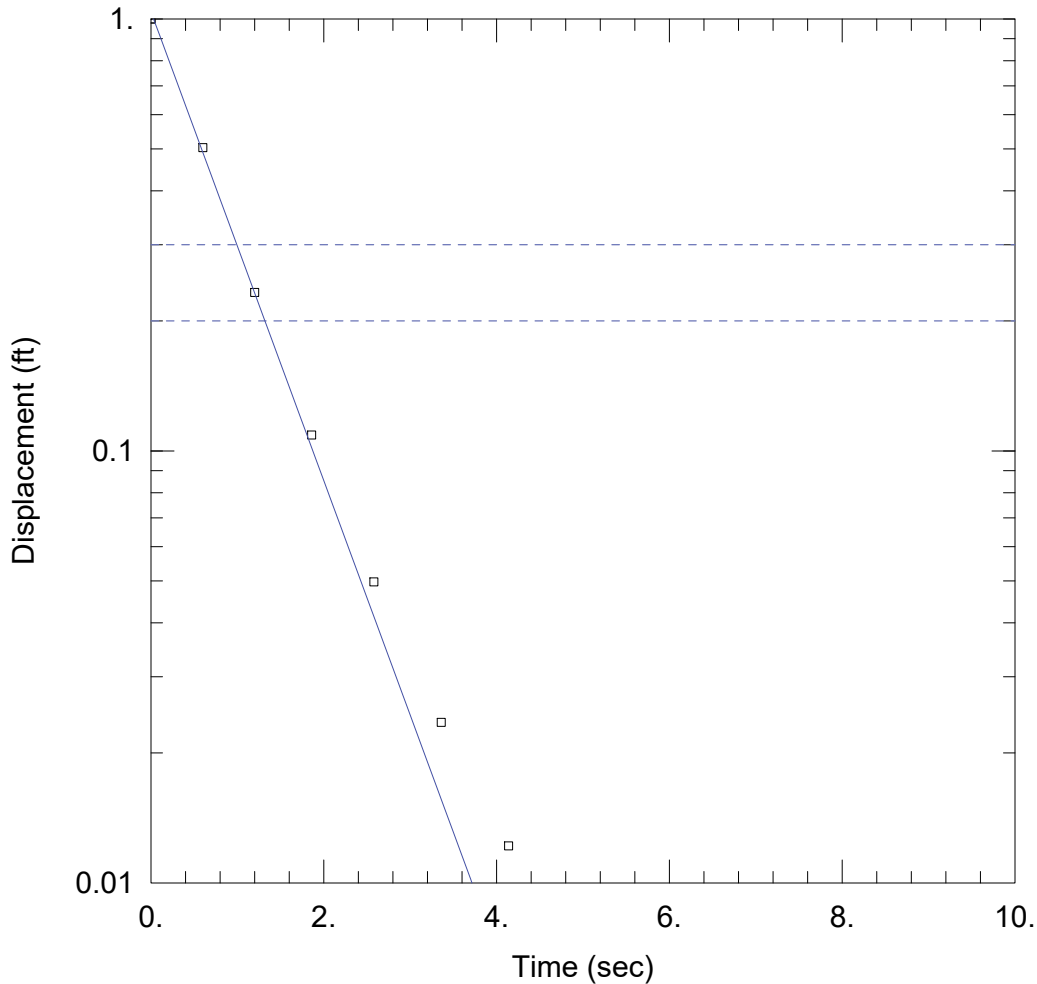
Initial Displacement: 1. ft
 Total Well Penetration Depth: 9.46 ft
 Casing Radius: 0.08333 ft

Static Water Column Height: 9.46 ft
 Screen Length: 5. ft
 Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Unconfined
 K = 53.33 ft/day

Solution Method: Bouwer-Rice
 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

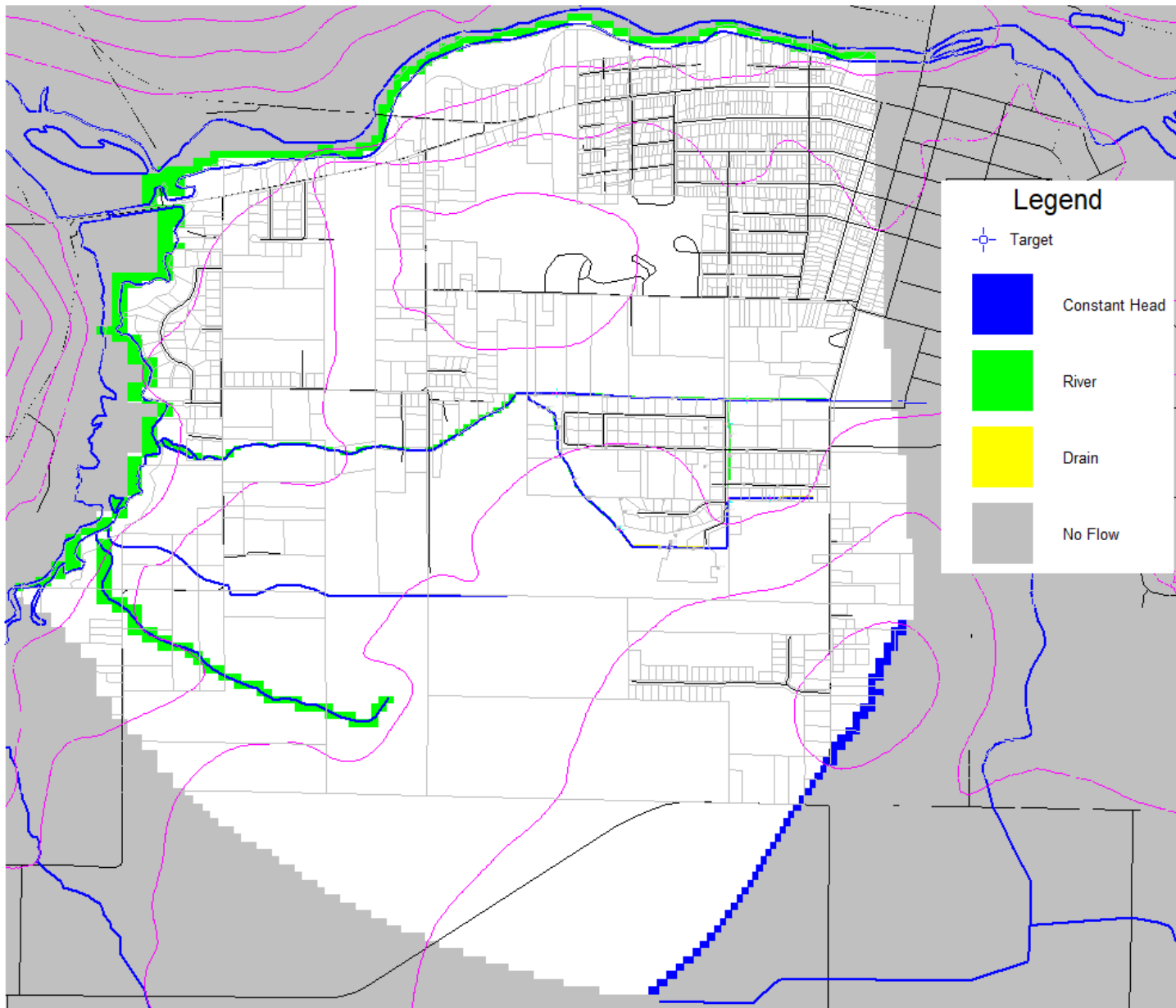
SOLUTION

Aquifer Model: Unconfined
 K = 289.9 ft/day

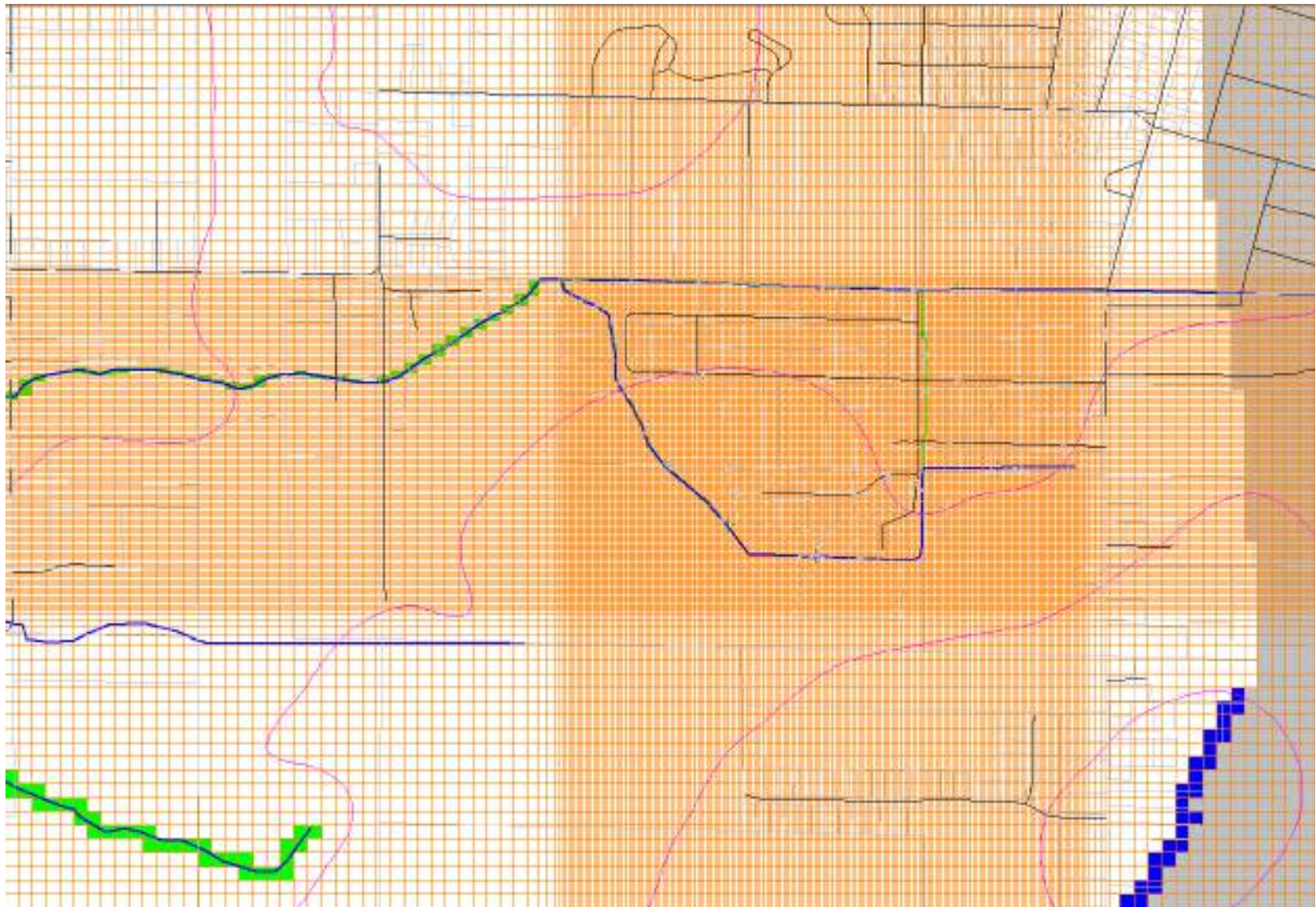
Solution Method: Bower-Rice
 y0 = 1.039 ft

Appendix 3

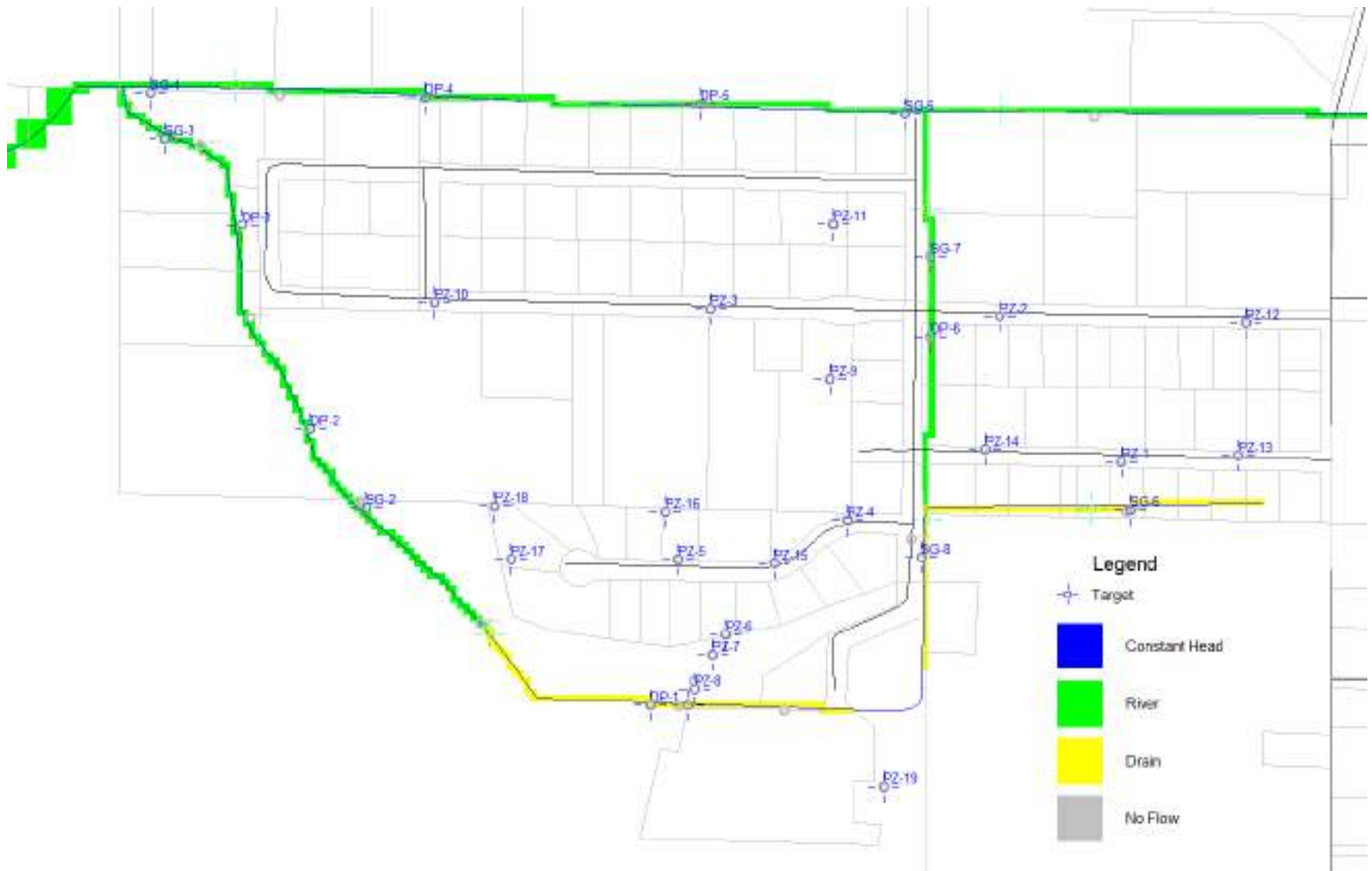
Model Information



Full model domain. Pink lines are regional water table contours from MDEQ Groundwater Inventory and Mapping project.

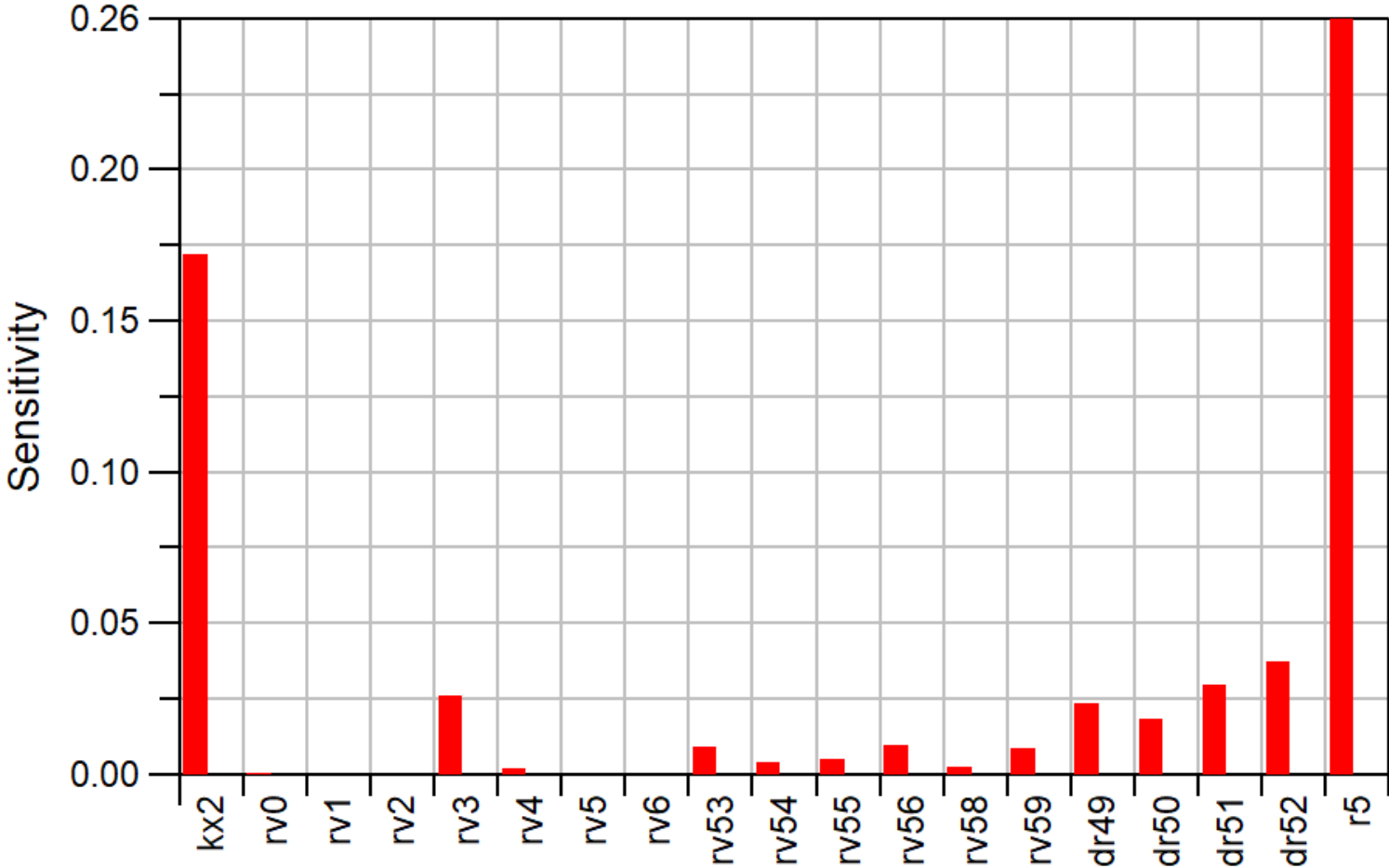


Model discretization from 20 feet in the center to 100 feet at the edges.



Local area model setup.

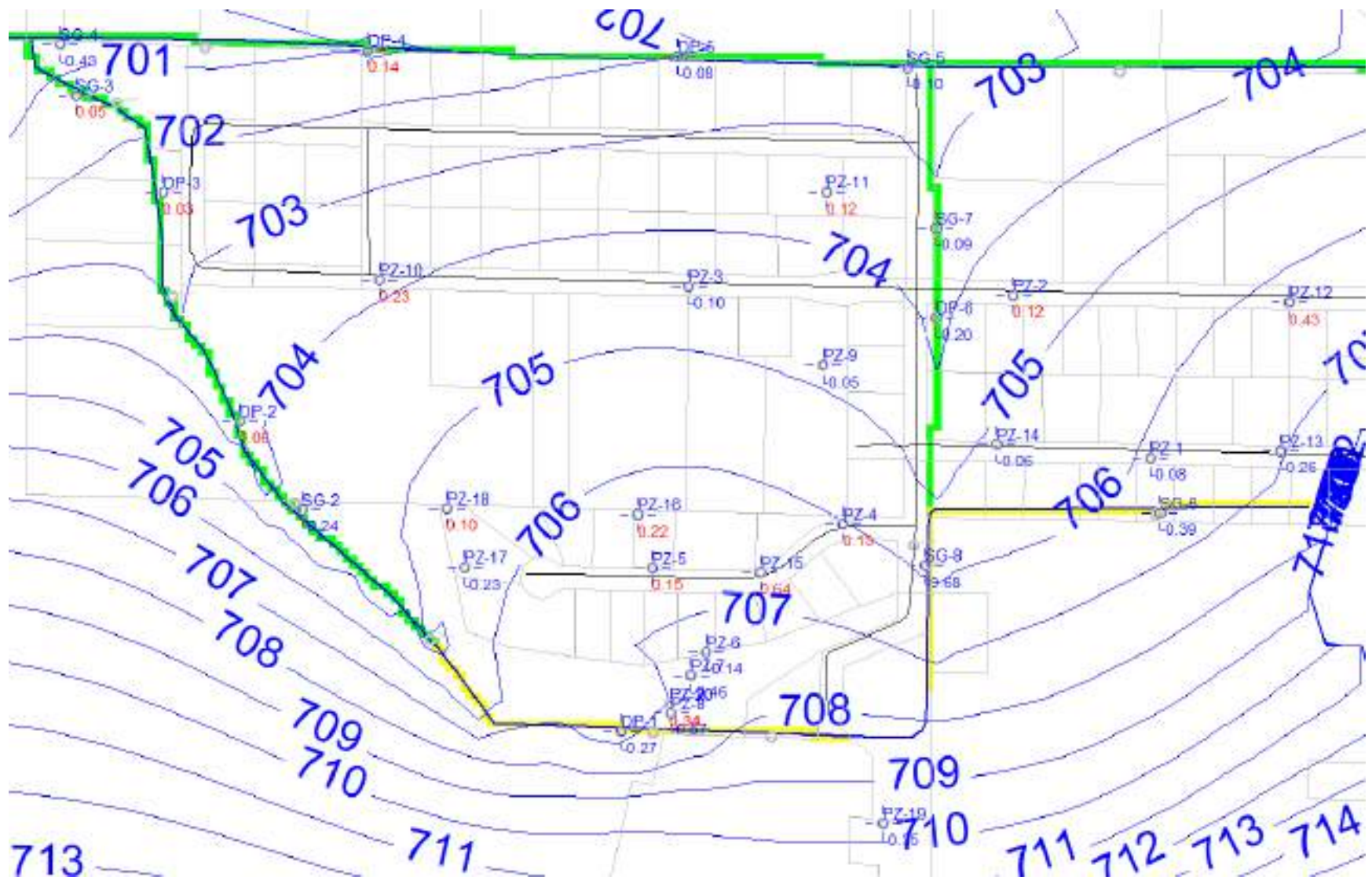
PEST Parameter Sensitivity



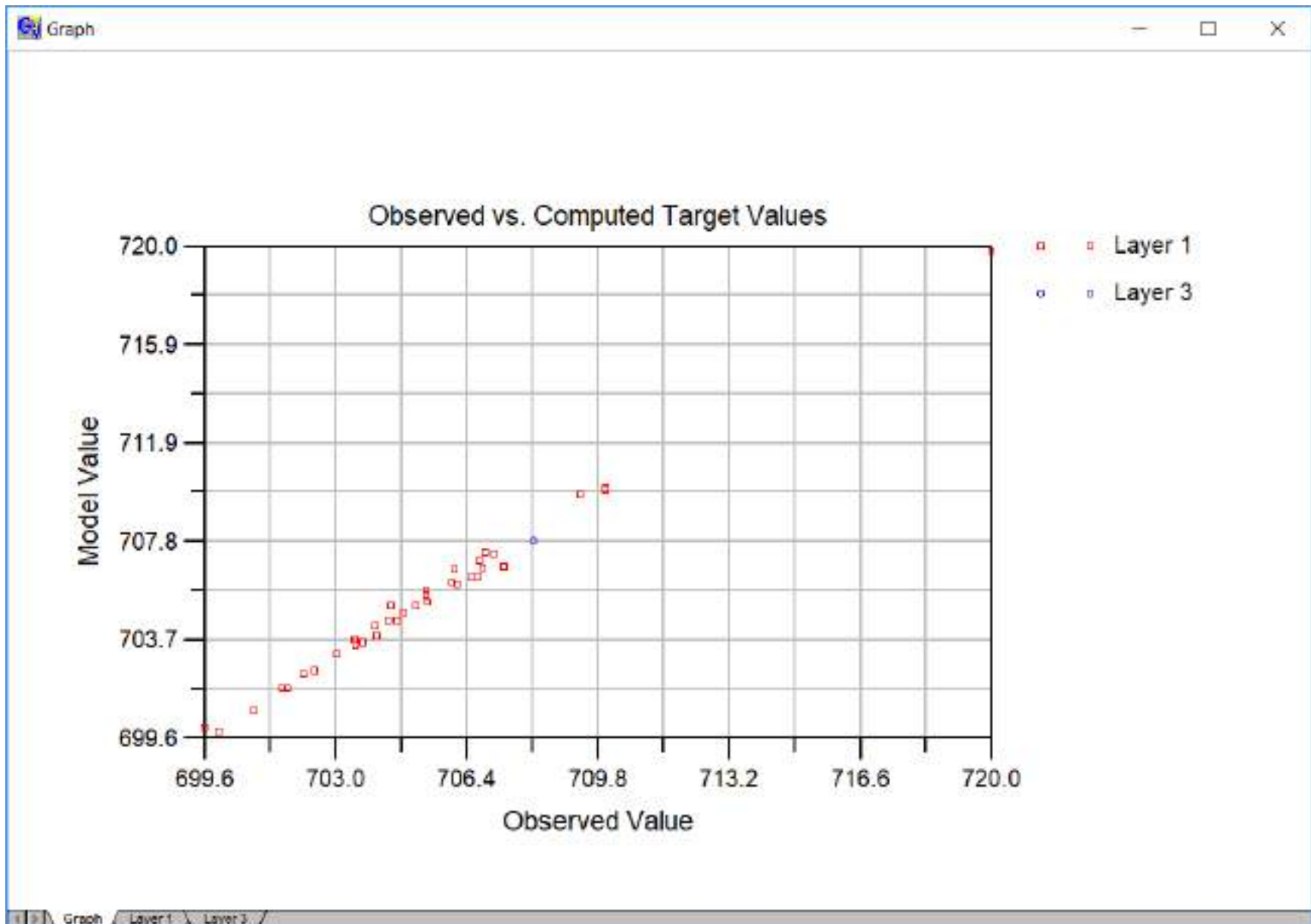
Sensitivity Analysis Results. Kx2 = hydraulic conductivity; rv = river reaches; dr = drains; r5 = recharge

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

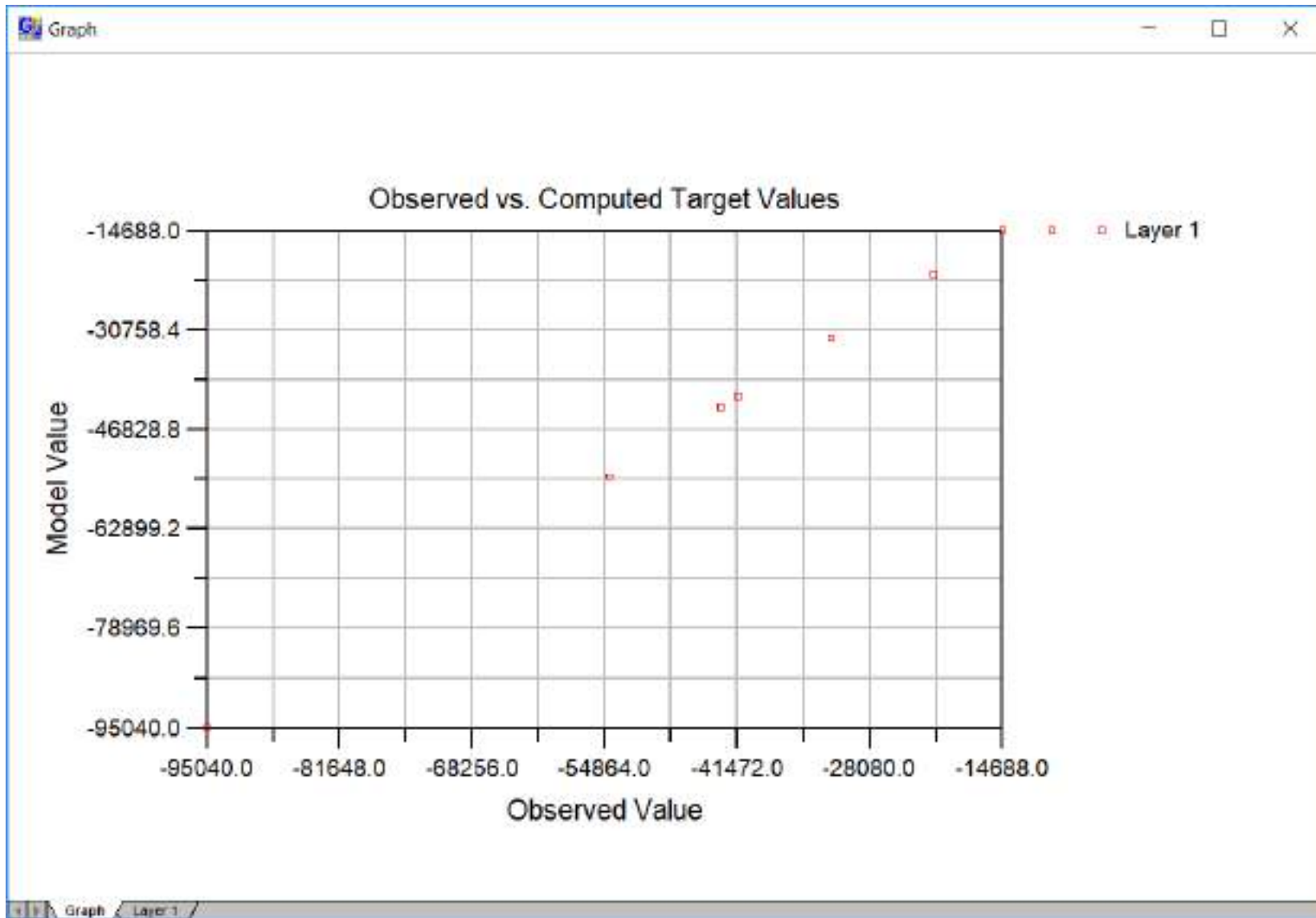
PEST pilot point parameters for hydraulic conductivity in local area (ft/d). All other K targets were 100 ft/d with bounds of 0.1 to 400 ft/d.



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

Target	Residual	Name
699.63	-0.43	SG-4
700.00	0.06	NI
700.92	1.14	CP-4
701.63	-0.09	CP-6
701.76	0.05	SG-3
702.19	-0.11	SG-5
702.46	0.03	CP-3
703.05	-0.09	SG-7
703.89	-0.74	SG-7

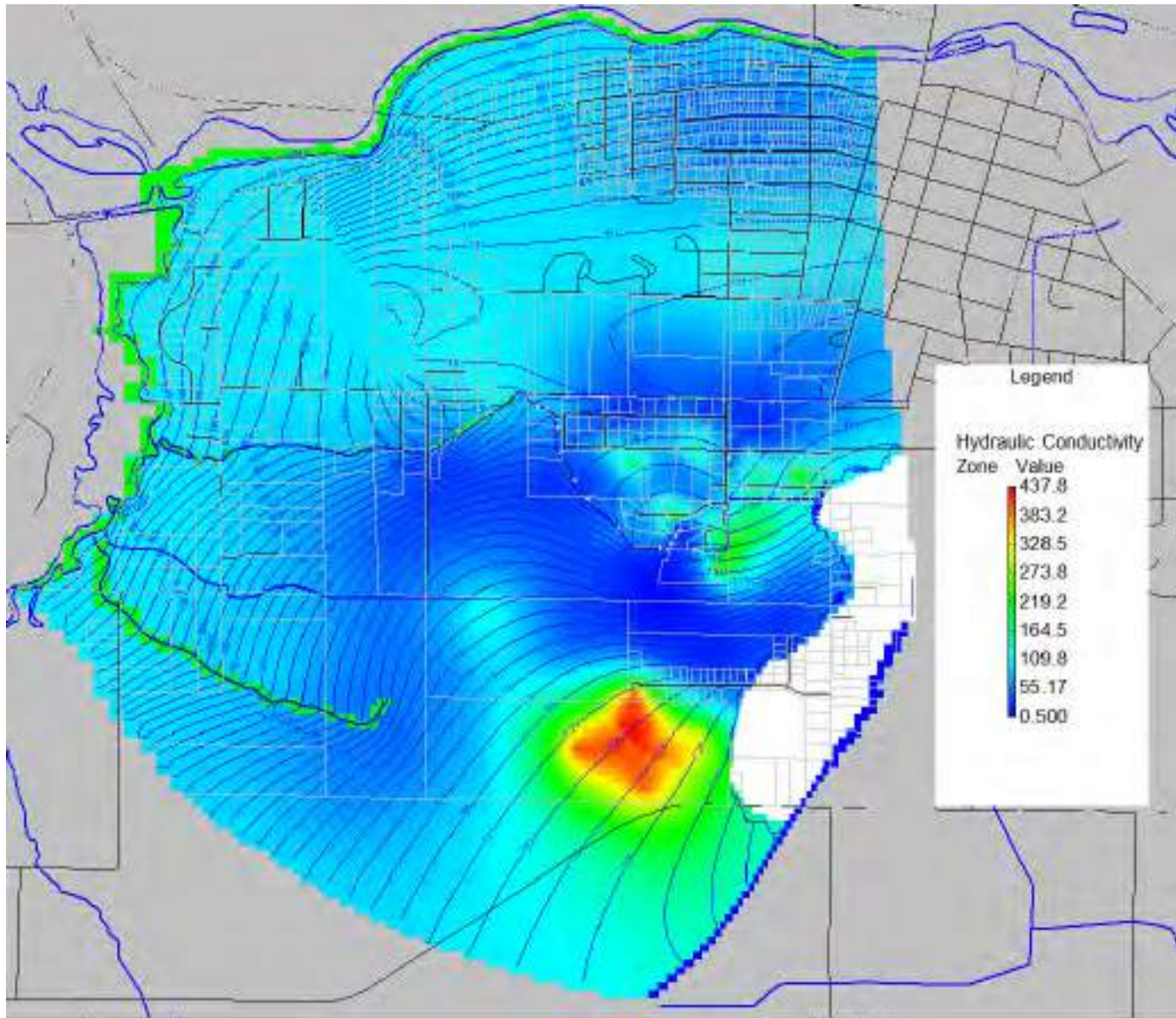
Residual Mean	= -0.03
Residual Standard Dev.	= 0.27
Absolute Residual Mean	= 0.22
Residual Sum of Squares	= 2.92e+000
RMS Error	= 0.28
Minimum Residual	= -0.61
Maximum Residual	= 0.64
Range of Observations	= 10.37
Scaled Res. Std. Dev.	= 0.013
Scaled Abs. Mean	= 0.011
Scaled RMS	= 0.014
Number of Observations	= 38

Weighted head residual statistics – full statistics in Table 5.

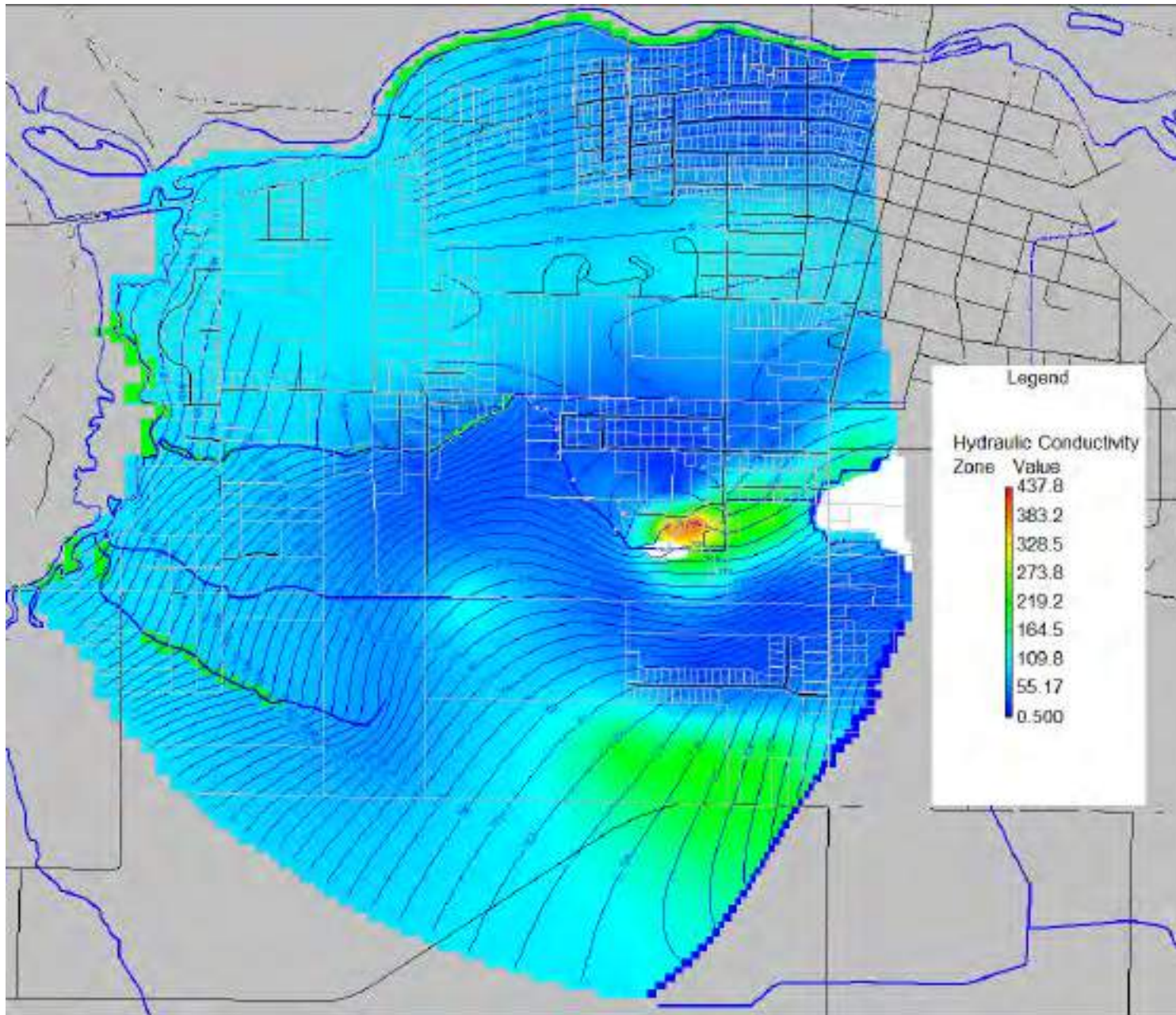
Target	Residual	Name
-14688.00	-2585.58	D60
-21680.00	553.62	D49
-31988.00	-3656.77	P59
-41472.00	-21003.19	P55
-43280.00	-38687.85	D61
-54432.00	-34176.80	P59
-85040.00	-66864.23	D62

Residual Mean	= -23895.88
Residual Standard Dev.	= 22782.79
Absolute Residual Mean	= 24043.86
Residual Sum of Squares	= 7.63e+009
RMS Error	= 33008.81
Minimum Residual	= -66864.23
Maximum Residual	= 553.62
Range of Observations	= 80352.00
Scaled Res. Std. Dev.	= 0.284
Scaled Abs. Mean	= 0.259
Scaled RMS	= 0.411
Number of Observations	= 7

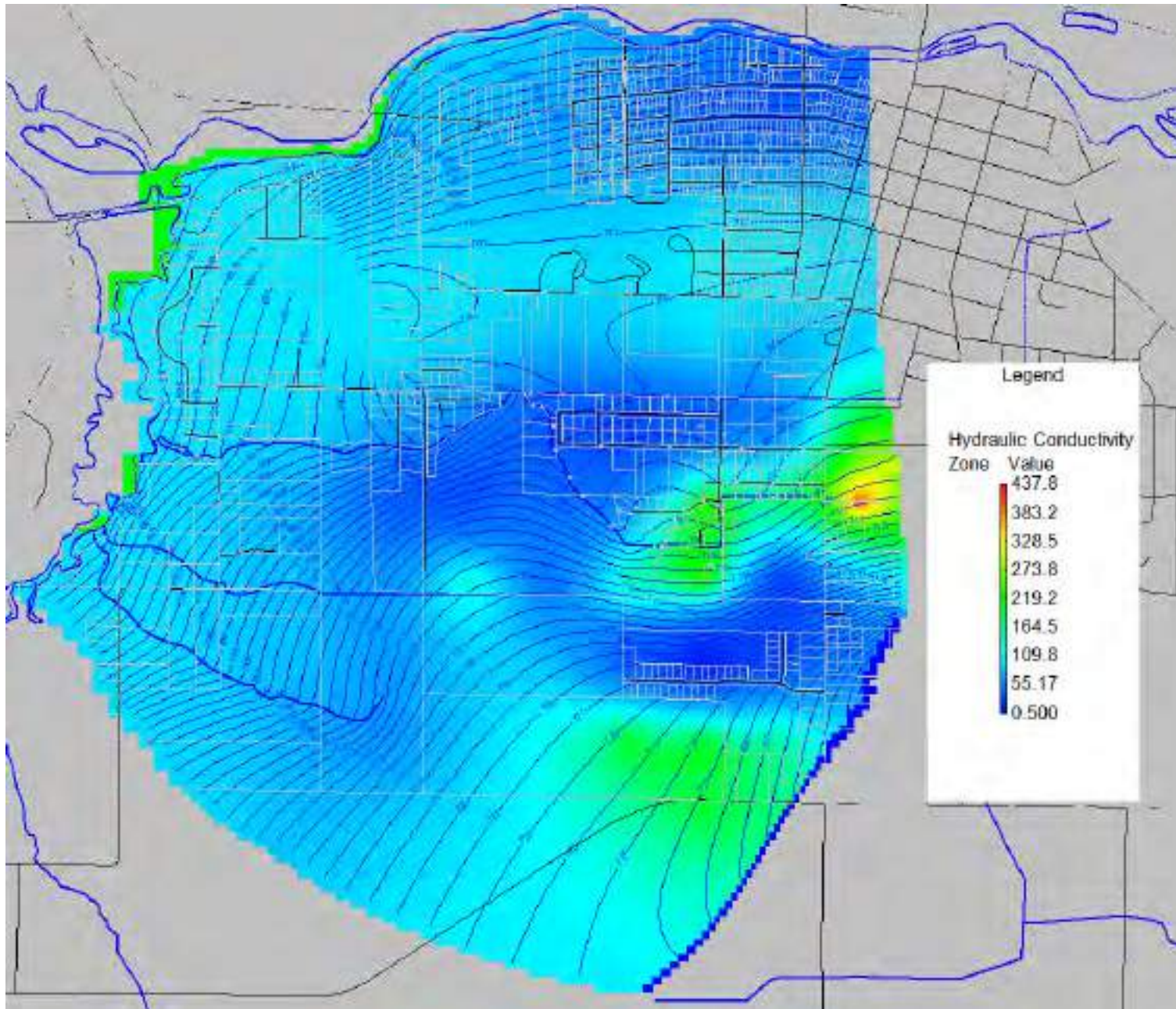
Residual flux statistics (these were weighted x 1E-005 for use in PEST)



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

Baughman Drain Hydrogeological Evaluation Borehole Hydrostratigraphic Model to Develop Groundwater Flow Model





Project No.:

180488

Date: 12/05/2018

Project Name:

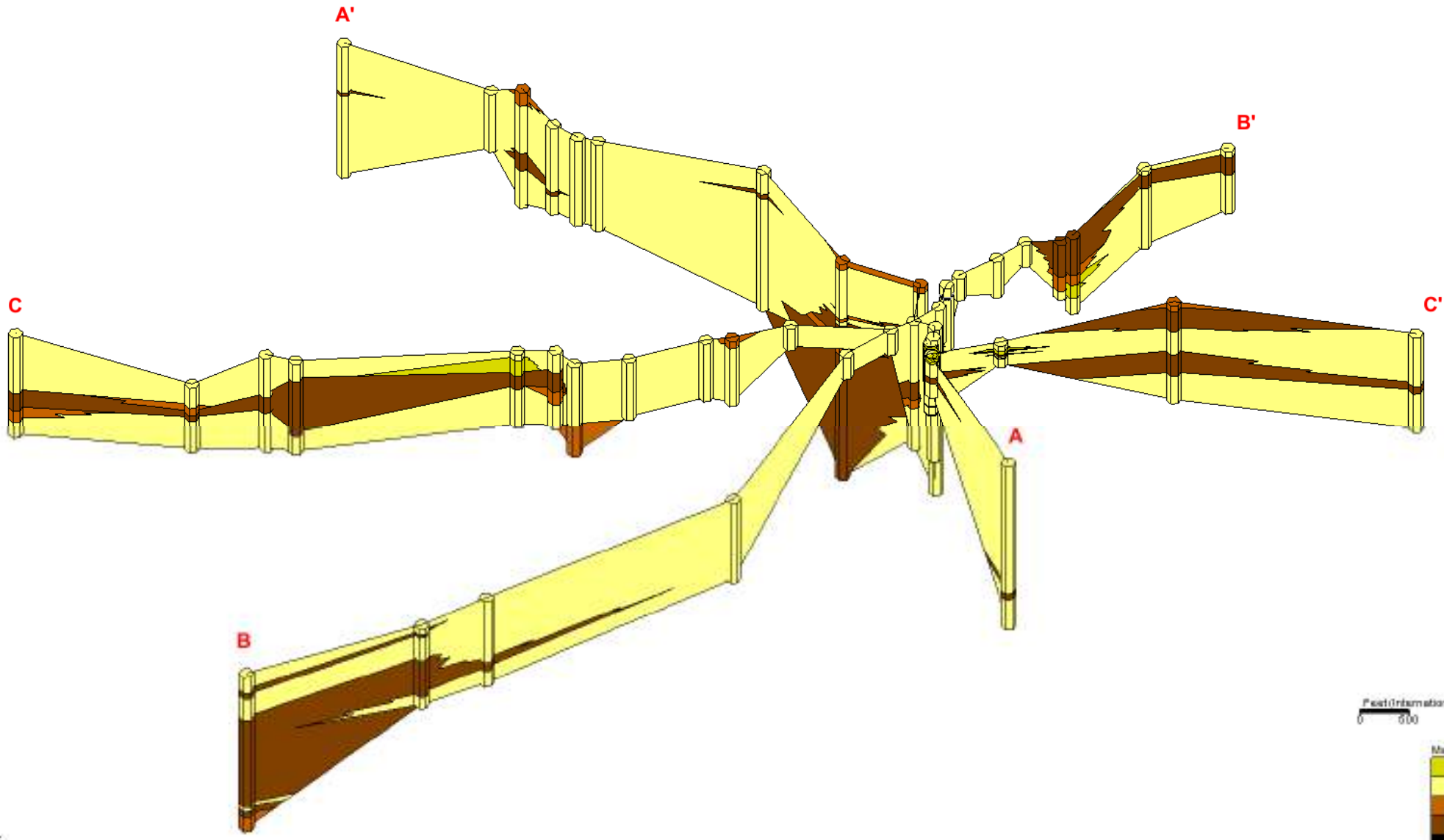
Baughman Drain Hydrogeological Evaluation



Project No.:	180488	Date:	12/05/2018	Project Name:	Baughman Drain Hydrogeological Evaluation
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Project No.:	180488	Date:	12/05/2018	Project Name:	Baughman Drain Hydrogeological Evaluation
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Feet (International)
0 500

- Materials
- MAQ
 - AD
 - PCM
 - CM
 - NA



Project No.:

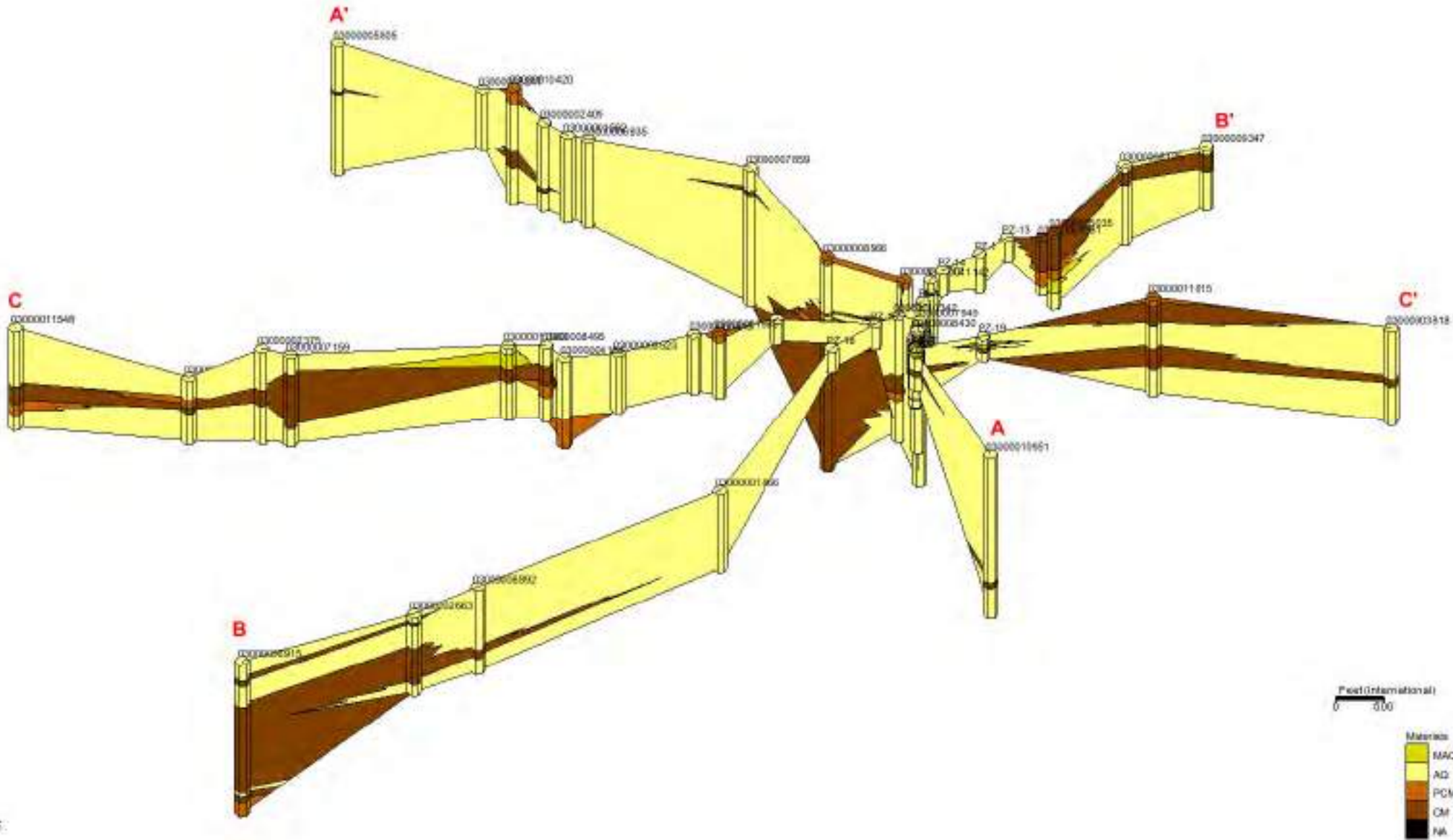
180488

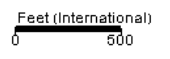
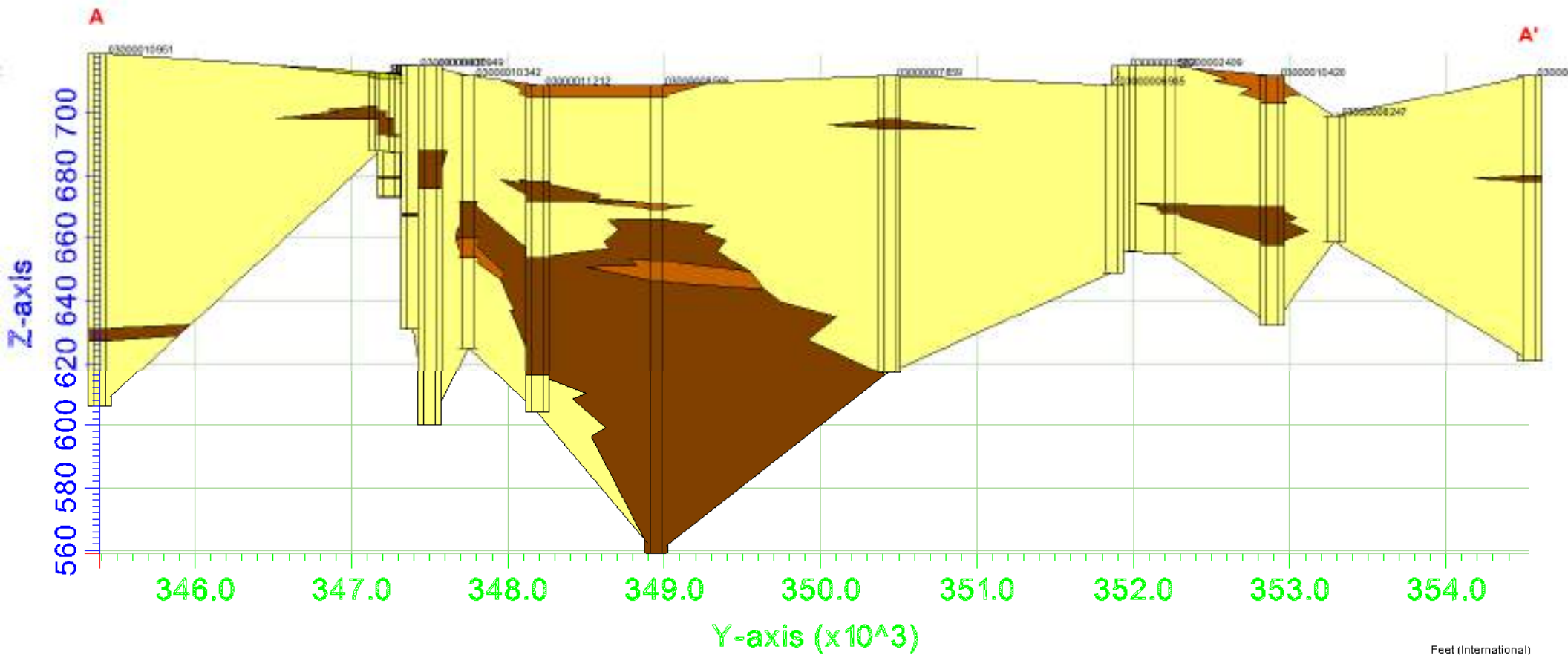
Date:

12/05/2018

Project Name:

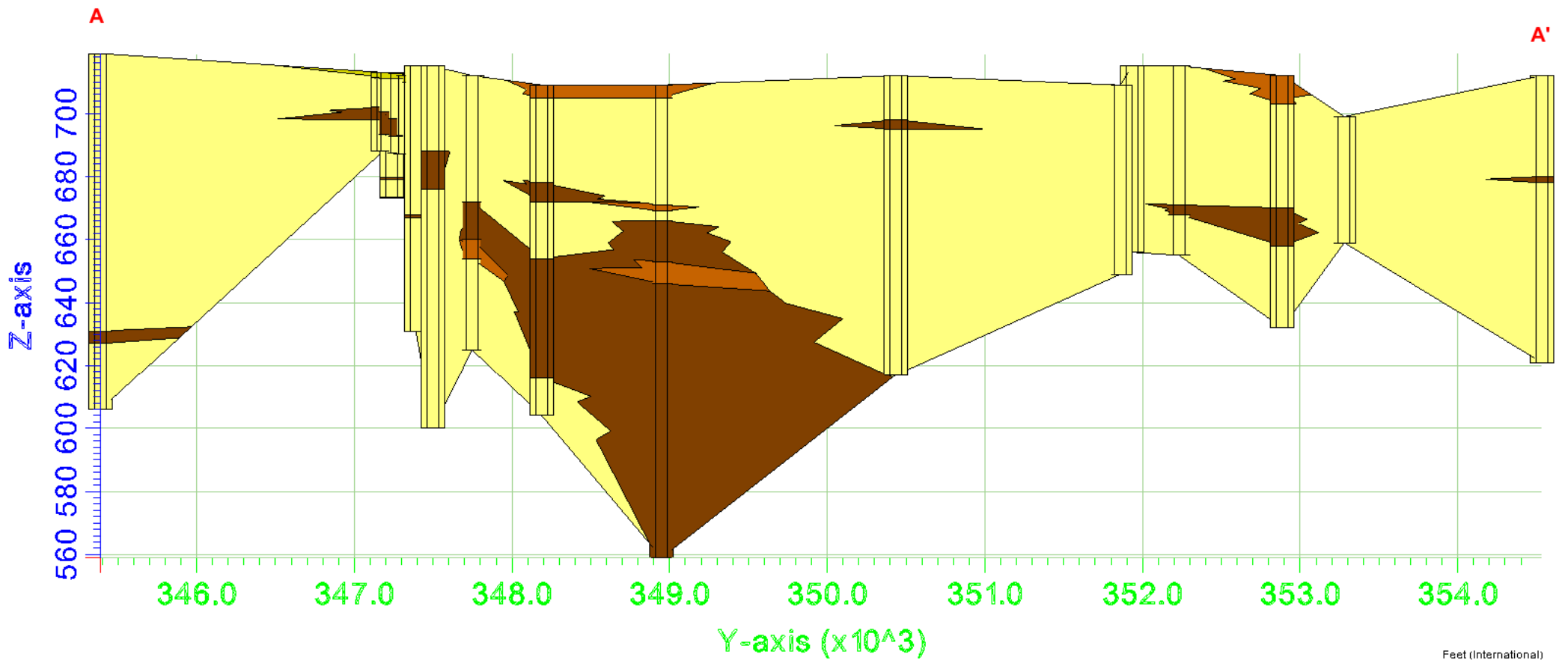
Baughman Drain Hydrogeological Evaluation





- Materials
- MAQ
 - AQ
 - PCM
 - CM
 - NA

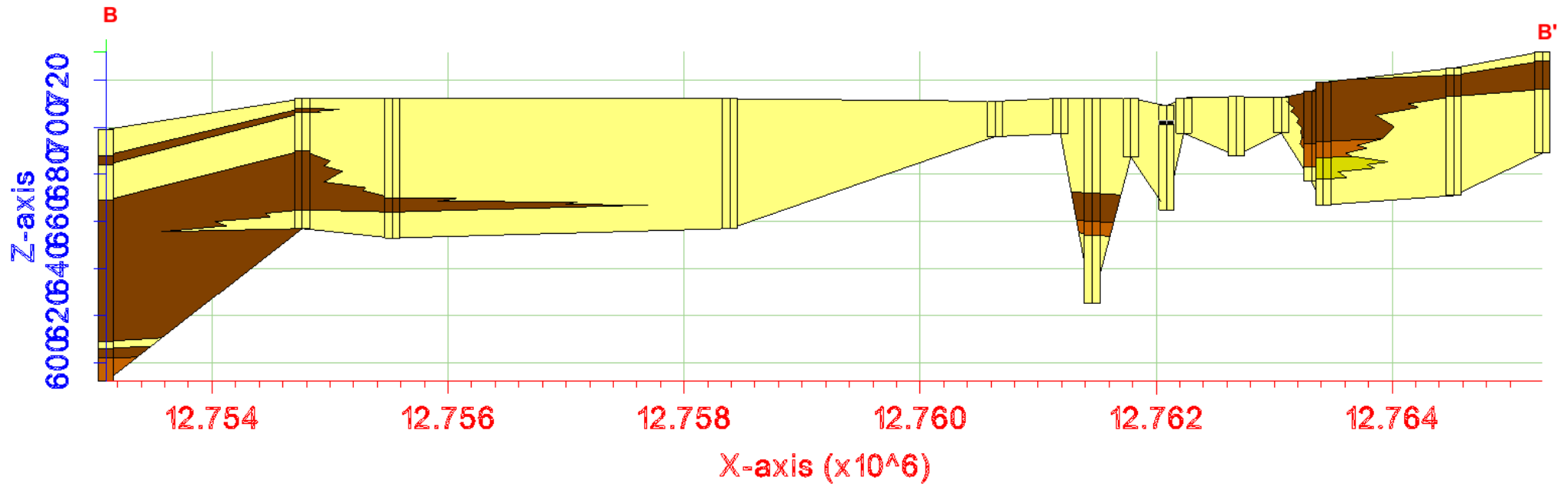




Feet (International)
0 500

- Materials
- MAQ
 - AQ
 - PCM
 - CM
 - NA





Feet (International)
57100

- Materials
- MAQ
 - AQ
 - PCM
 - CM
 - NA



Project No.:

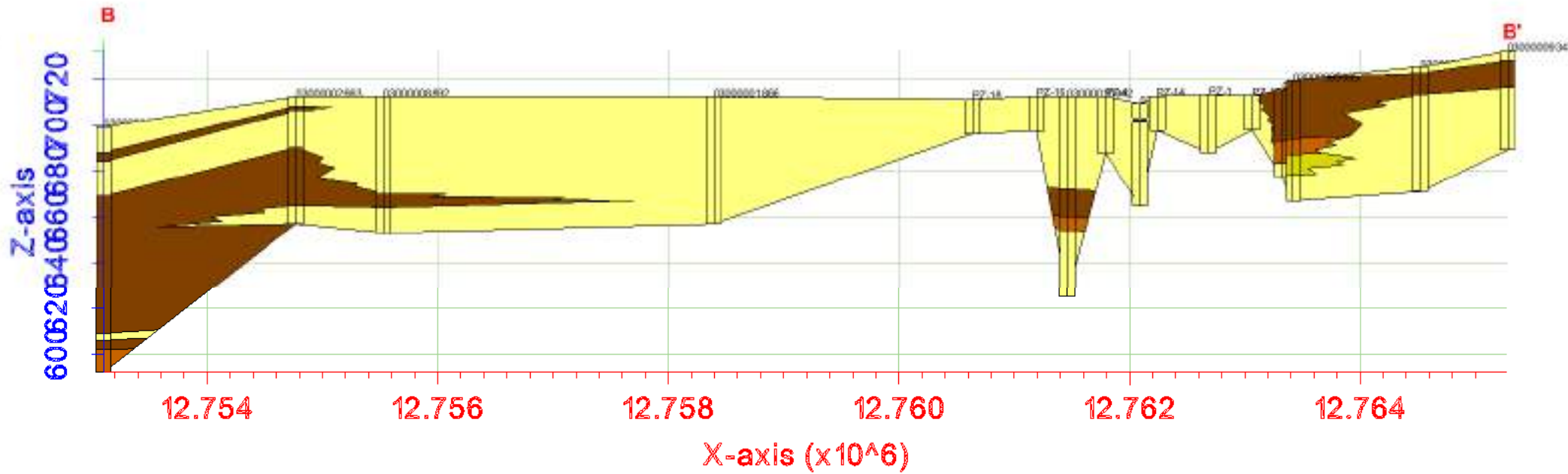
180488

Date:

12/05/2018

Project Name:

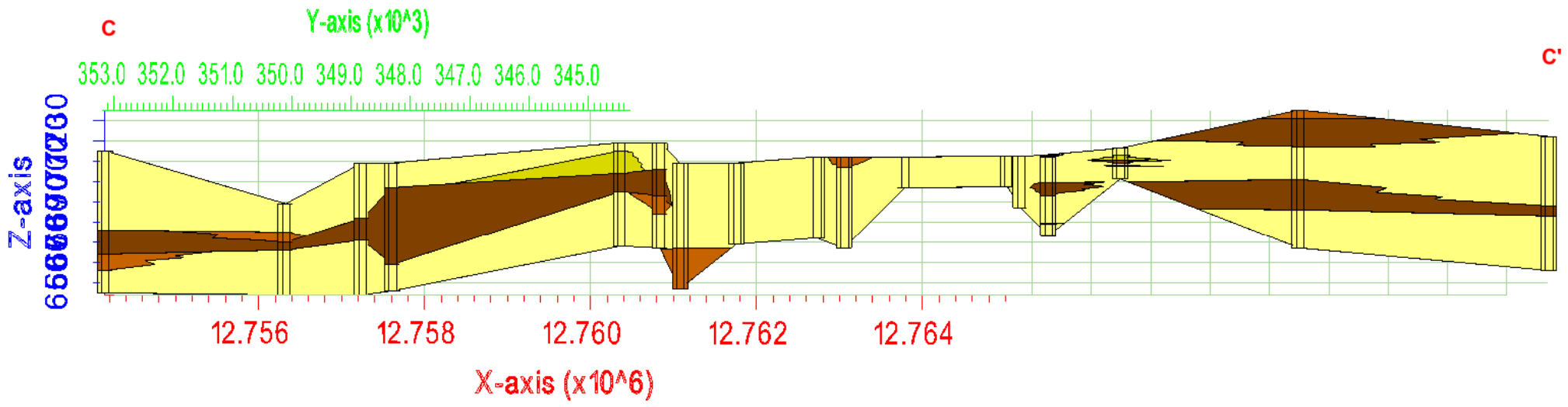
Baughman Drain Hydrogeological Evaluation



Feet (International)
57100

- Materials
- MAQ
 - AQ
 - PCM
 - CM
 - NA

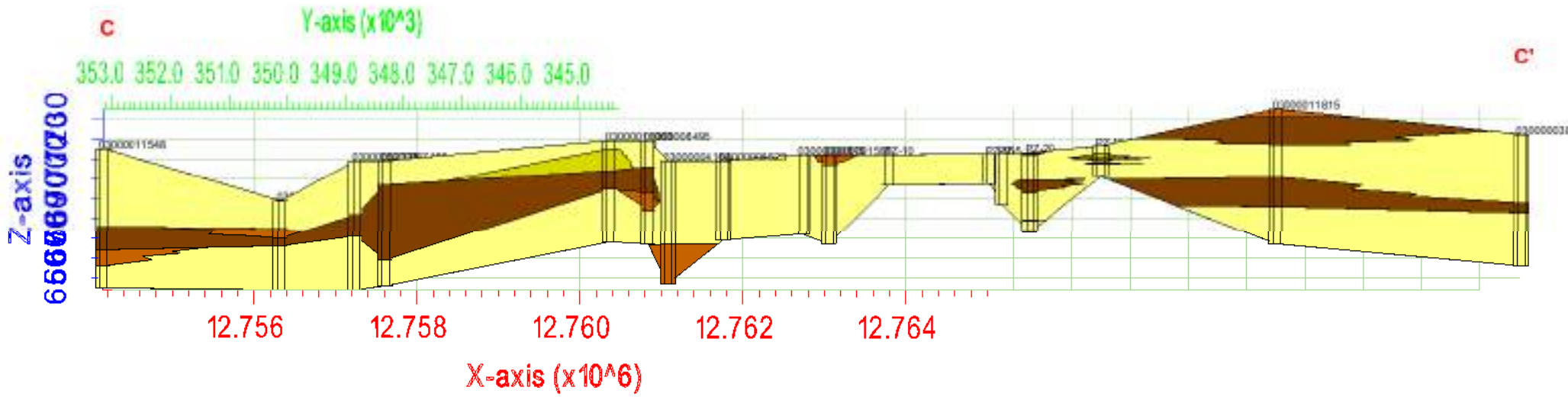




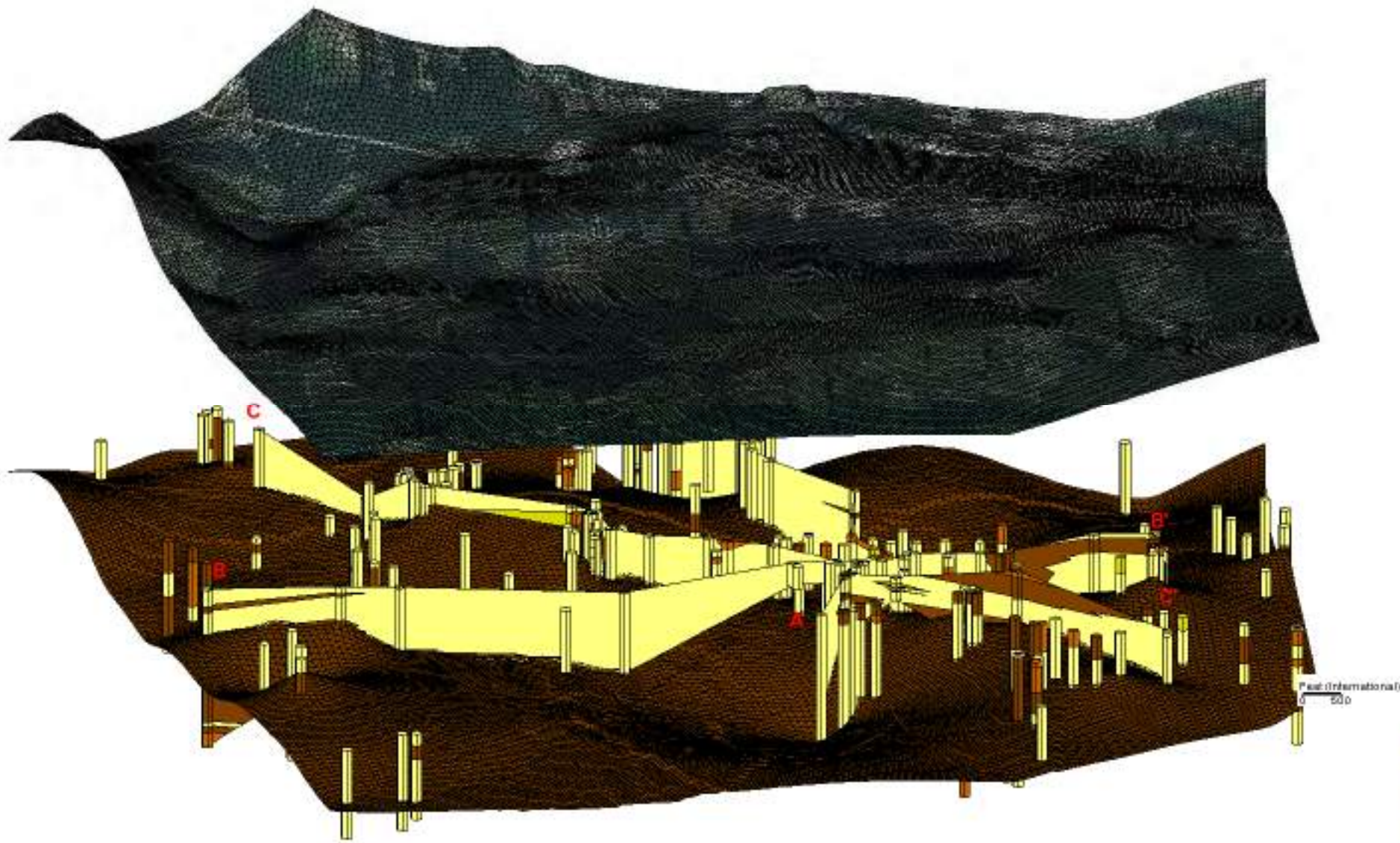
Feet (International)
5' 100

- Materials
- MAQ
 - AQ
 - PCM
 - CM
 - NA



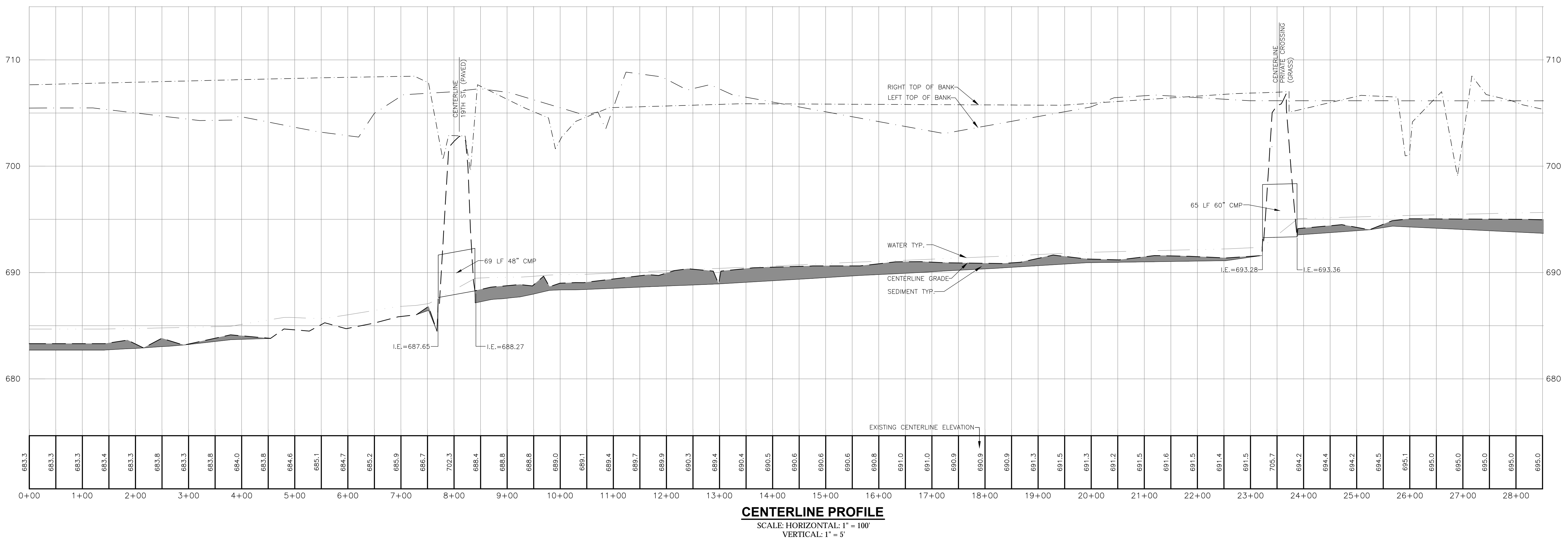
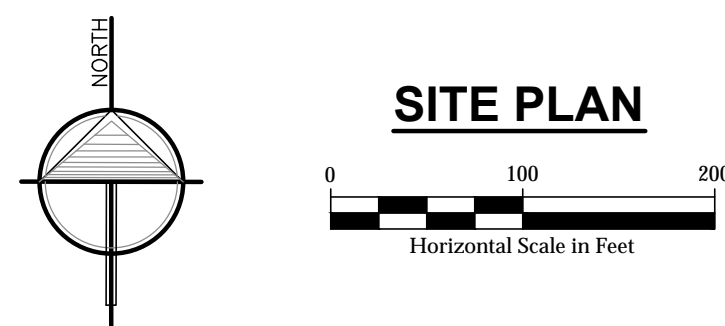


Project No.: 180488 Date: 12/05/2018 Project Name: Baughman Drain Hydrogeological Evaluation



Appendix 5

Stream Profile



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

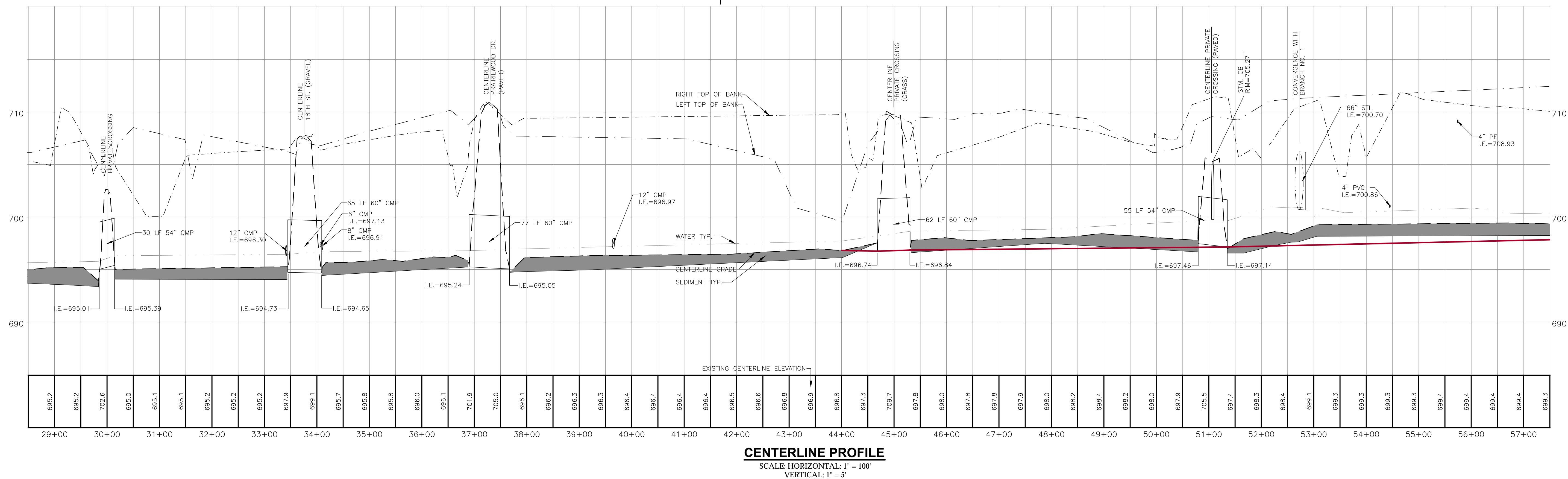
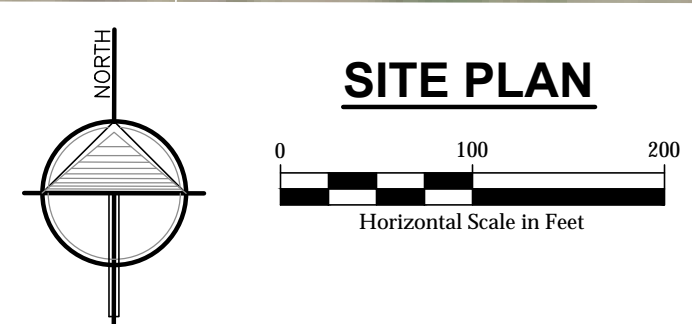
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CHECKED BY: MPB DATE: JULY, 2016
DRAFTED BY: LGG DATE: JULY, 2016

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2.	PRELIMINARY REVIEW	NOV., 2016

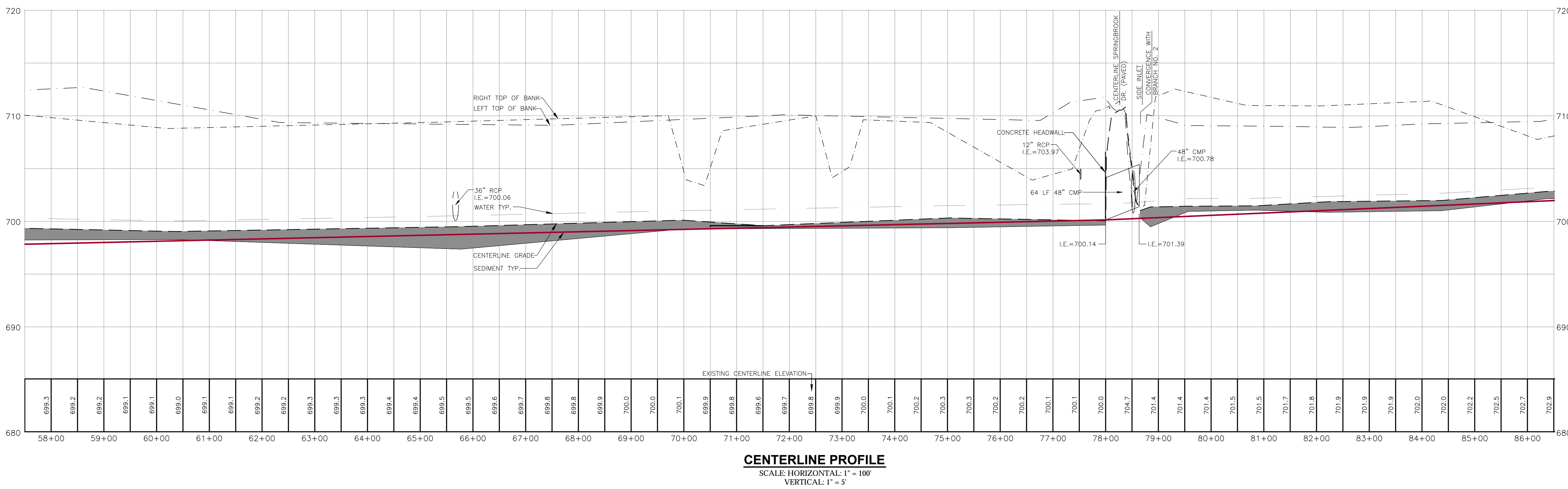
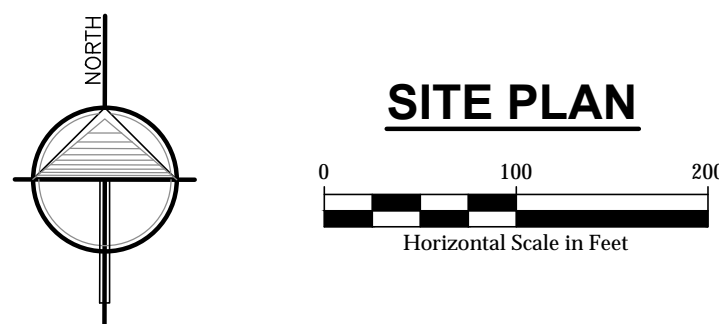
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MATCH LINE: SEE SHT. C4 FOR CONTINUATION



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 Allegan, Michigan

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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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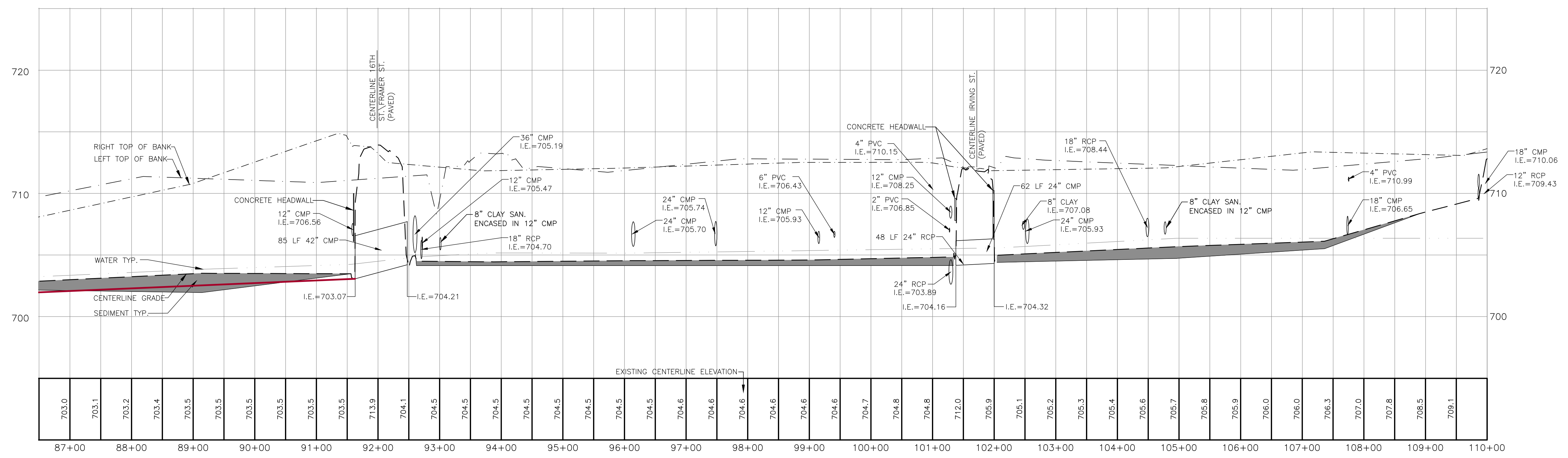
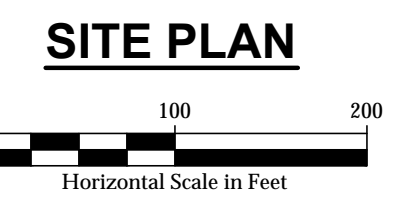
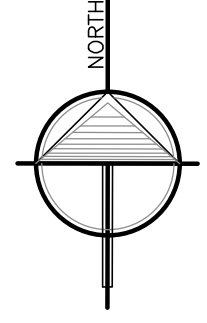
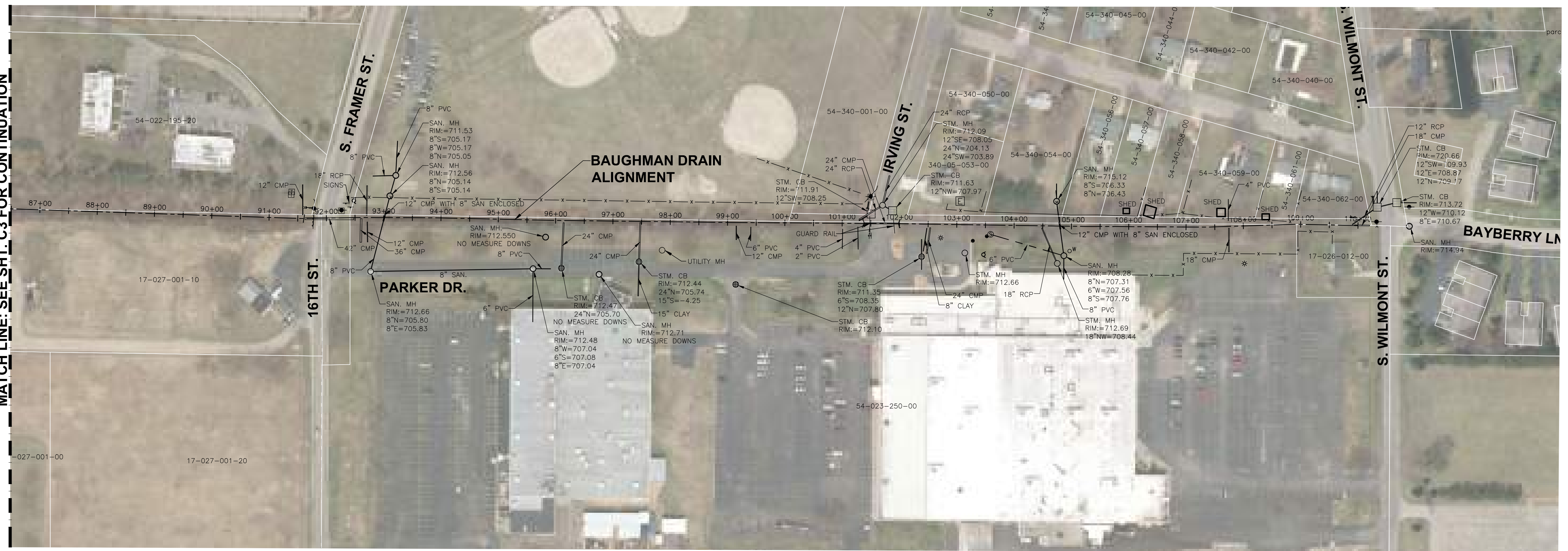
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 Allegan, Michigan

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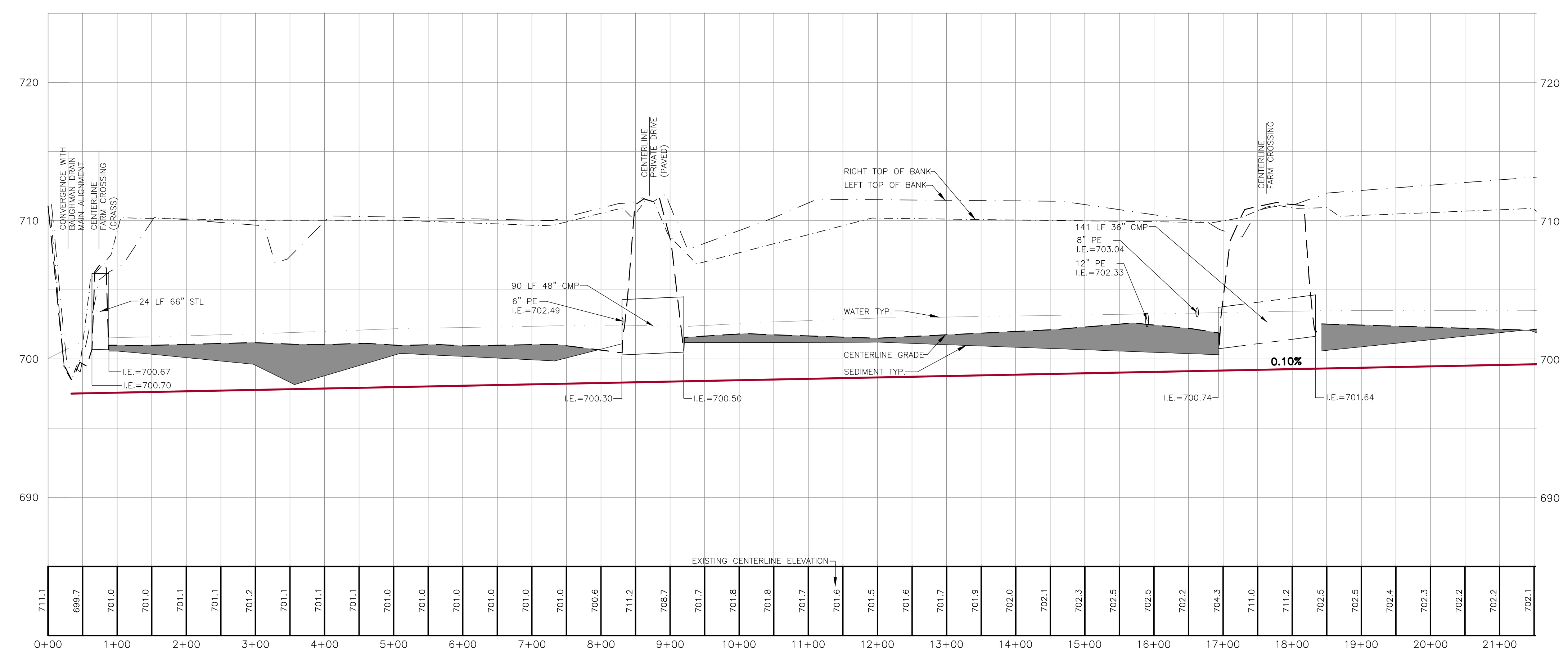
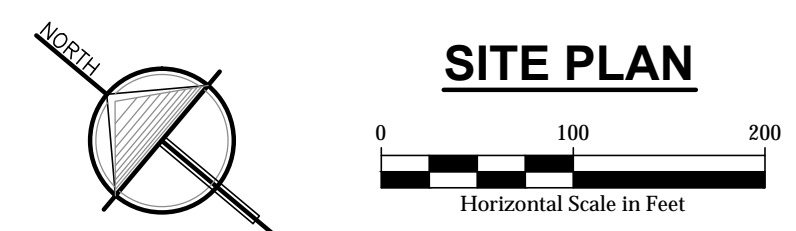
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Allegan, Michigan

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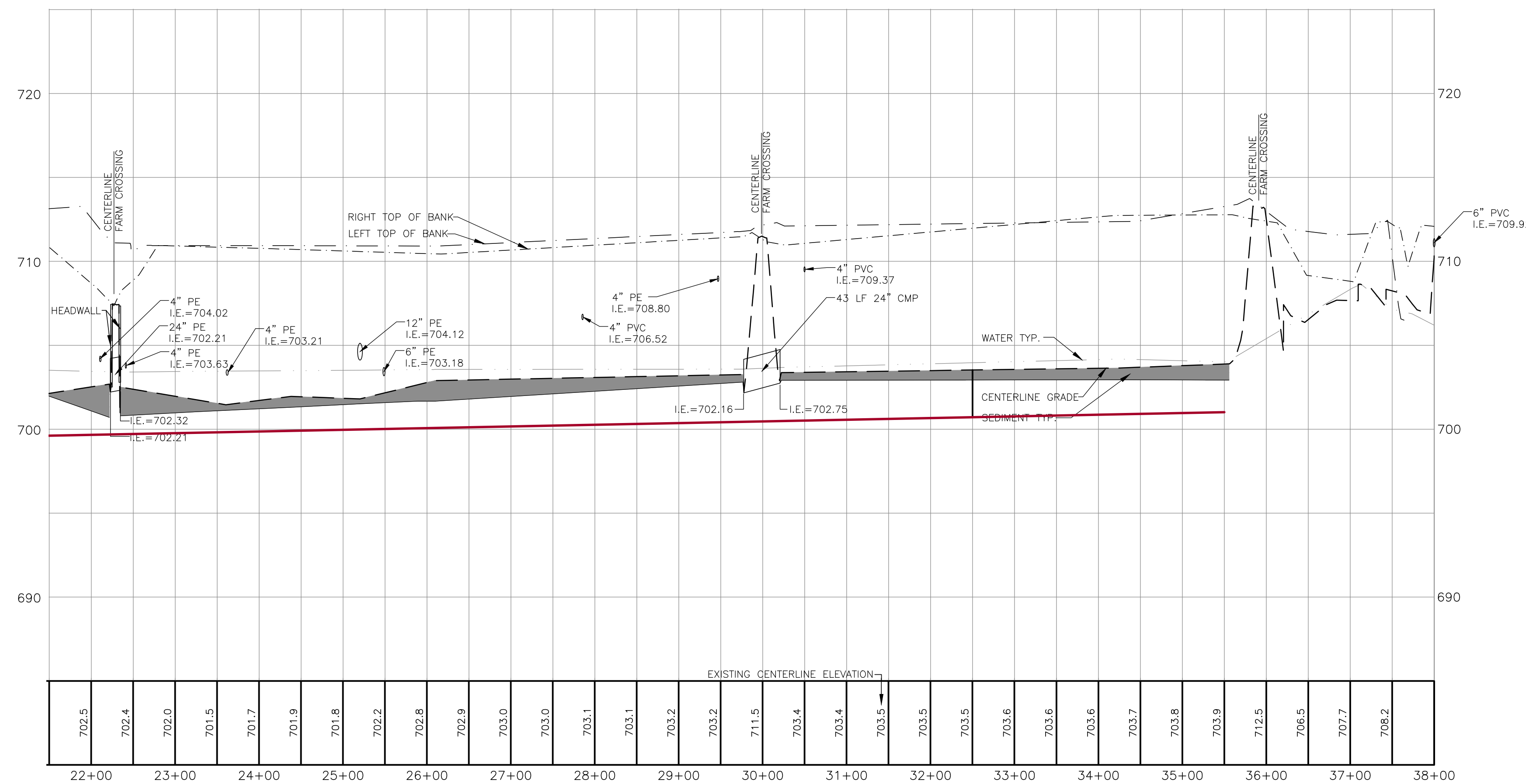
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PROJECT:
Baughman Drain
 Ostego Township, Allegan County, Michigan

PROJECT NUMBER: 15-043
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 CHECKED BY: MPB DATE: JULY, 2016
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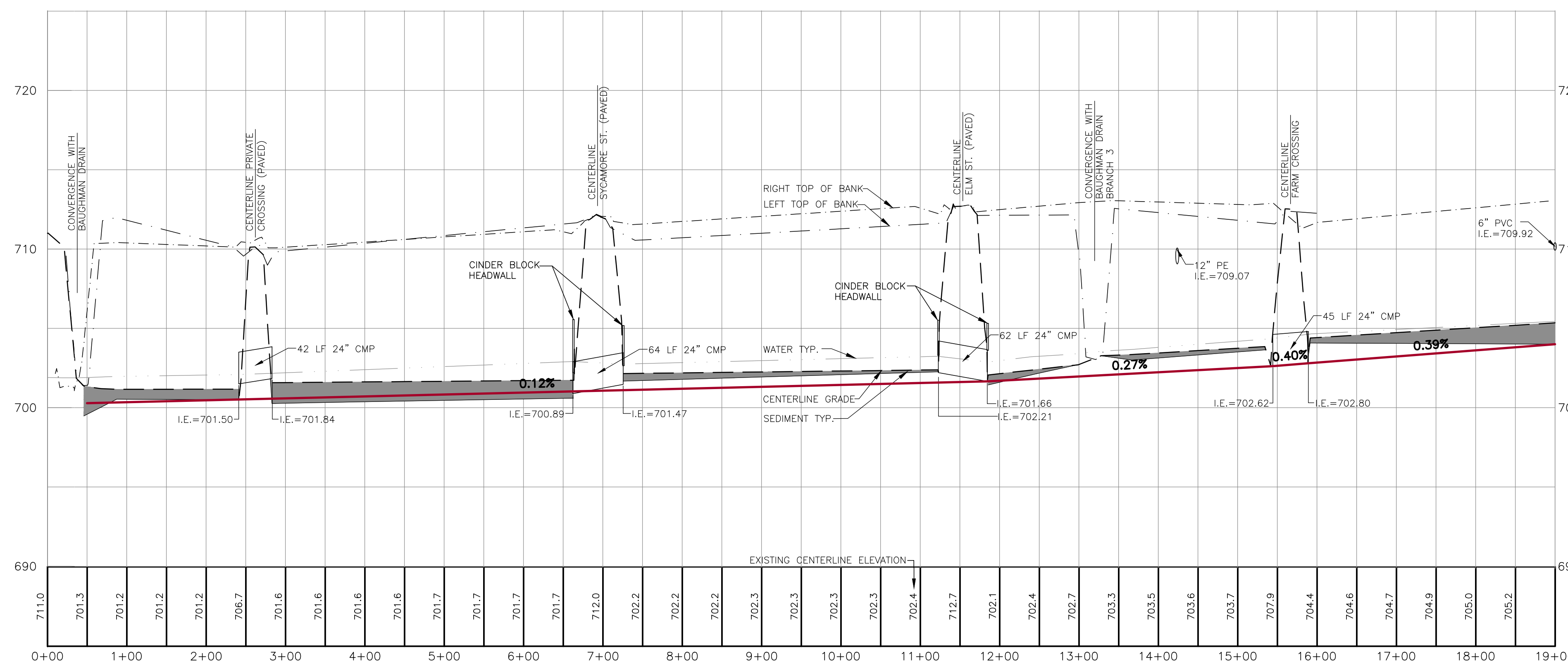
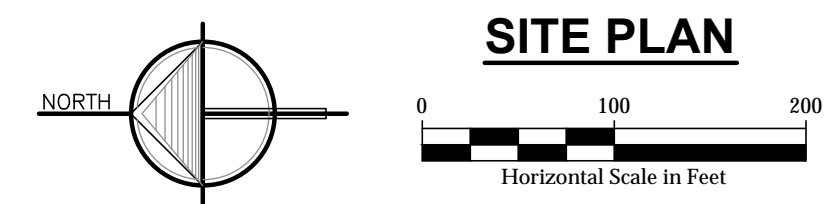
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 STA. 21+50 - 38+00**

C6

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Baughman Drain
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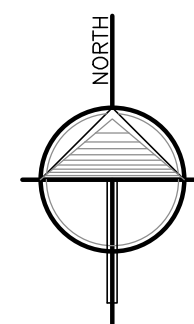
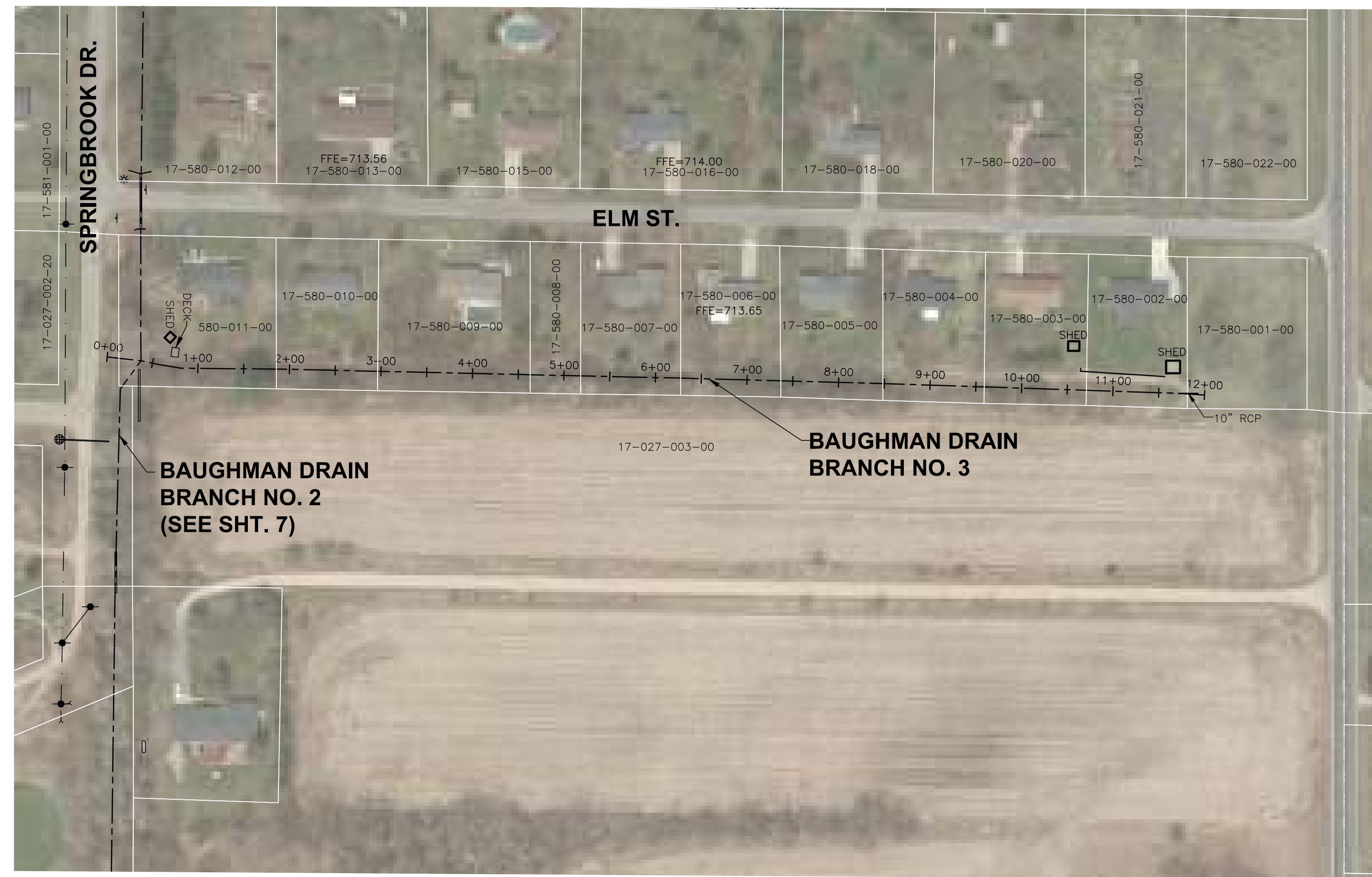
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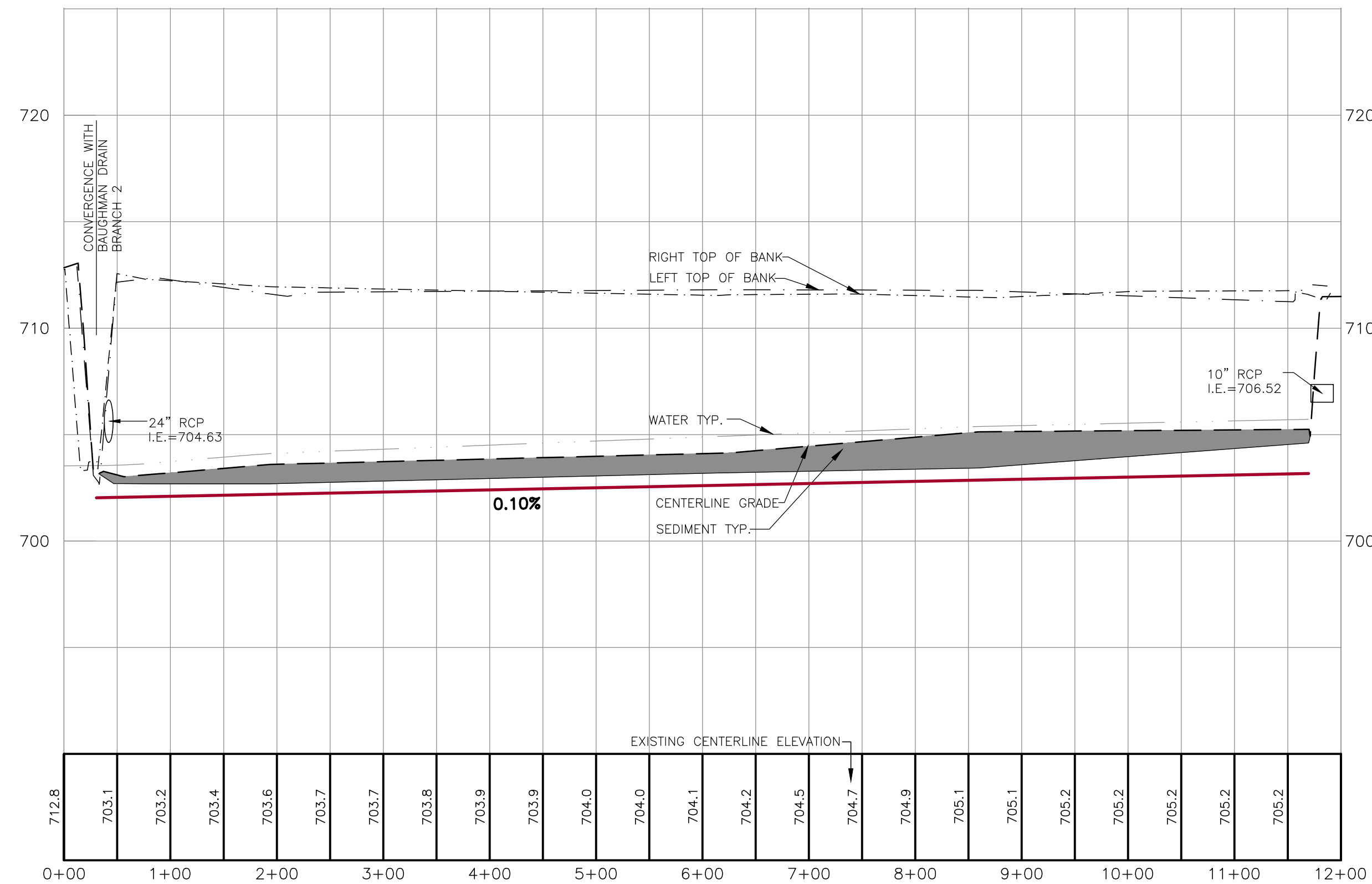
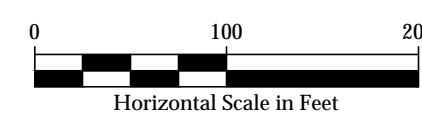
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STA. 0+00 - 19+00

SHEET NUMBER

C7



SITE PLAN



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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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BRANCH 3
STA. 0+00 - 12+00**

SHEET NUMBER

C8

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 I**.

<u>Item</u>	<u>Description</u>	<u>Unit</u>	<u>Qty.</u>	<u>Price</u>	<u>Amount</u>
1	Mobilization (5% Max)	LS	1	_____	_____
2	Utility Coordination & Protection	LS	1	_____	_____
3	Traffic Control	LS	1	_____	_____
4	Sediment Sump	EA	4	_____	_____
5	Selective Clearing, Grubbing, & Snagging	LF	6,168	_____	_____
6	Open Channel Excavation, 3-foot bottom width	LF	6,532	_____	_____
7	Open Channel Excavation, 2-foot bottom width	LF	4,844	_____	_____
8	Culvert, 60-inch CMP	LF	172	_____	_____
9	Culvert, 48-inch PE	LF	300	_____	_____
10	Culvert, 48-inch RCP	LF	80	_____	_____
11	6-foot Diameter Manhole	EA	1	_____	_____
12	Private Crossing Removal	EA	2	_____	_____
13	Paved Road Restoration	EA	2	_____	_____
14	Private Crossing Restoration (Gravel)	EA	3	_____	_____
15	Private Crossing Restoration (Bituminous)	EA	1	_____	_____
16	Private Crossing Restoration (Concrete)	EA	1	_____	_____
17	Riprap Tile Outlet Protection	SY	245	_____	_____
18	Riprap Spillway	SY	30	_____	_____
19	Riprap End Treatment	SY	515	_____	_____
20	Open Channel Seeding	LF	11,376	_____	_____
21	Mulch Blanket	SY	3,800	_____	_____
22	Site Restoration	LS	1	_____	_____

Total = _____

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: Boughman Drain – Division I.

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:

Notice of Letting	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.

(Date) (Signature) LS

*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.

(Date) (Signature) L.S.

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 _____, as OWNER, on the ____ day of _____, 20__ for the construction of _____. 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. I 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. I 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:

PRINCIPAL:

By _____ (Seal)
By _____

WITNESS:

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.

SECTION 00700GENERAL CONDITIONS

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 be 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 MATTERSCOPIES 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.

SECTION 00700GENERAL CONDITIONS

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.

SECTION 00700GENERAL CONDITIONS

- 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.

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- 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.

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- 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.

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- 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

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- 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 WORKWARRANTY 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:

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- 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.

ARTICLE 15-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: _____

We certify, as applicant, we are the legal owners of the property stated above.

As such, we hereby authorize _____, as the Contractor for the Baughman Drain – Div. I construction project to temporarily utilize our property to complete the scope of work indicated above.

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 Baughman 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
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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. City of Otsego
 6. 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.

3PART 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, but not limited to, the following in accordance with these Documents:
 - i. Preparatory work and expenses incurred prior to beginning work onsite.
 - ii. Transporting materials, personnel, and equipment to the job site.
 - iii. Establishing temporary onsite construction facilities.
 - iv. Insurances, bonding, and other costs associated with the project in general and not included in 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. Additional 50% payment will be made after 25% of the contract amount is earned
 2. Utility Coordination and Protection:
 - a. Includes the following as indicated on the drawings and in accordance with the specifications:
 - i. All labor, equipment and material required for excavation in vicinity of proposed improvements location ahead of the progress of the work to locate existing underground utilities.
 - ii. Coordinating the removal, replacement, or relocation of utilities with the service provider as required for installing the proposed improvements and all appurtenances.
 - b. Unit of Measure: Lump sum.
 3. Traffic Control:
 - a. Includes furnishing, installing, and maintaining 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:
 - i. Lump Sum.
 - ii. 50% payment shall be made for installation of traffic control devices.
 - iii. 50% payment shall be made after removal of traffic control devices
 4. Sediment Sump:
 - a. Includes the following as indicated on the drawings and in accordance with the specifications:
 - i. Furnishing and/pr installing ass labor, materials, and equipment to complete the work.
 - ii. Removing accumulated sediment when it reaches 1/3 the height of the coir log or sump depth.
 - iii. Replacing Stakes and/or coir log, if damaged.
 - iv. Removal of the materials following final acceptance of the Work.
 - b. Unit of Measurement: Each.

5. Selective Clearing & Grubbing:
 - 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. Clear all trees and brush within the areas specified on the plans.
 - iii. Clearing and snagging of all ash, dead, dying, or leaning trees within width specified on plans. Remove woody debris generated from this clearing as well as older branches and deadfall on the banks that could be carried downstream during bankfull storm events.
 - iv. Brush-hog and mow banks of all brush and grass.
 - v. Apply dyed growth preventer to all exposed stumps.
 - vi. Disposal of all items from clearing, grubbing, and snagging operations in accordance with all local, state, and federal regulations.
 - vii. Cleanup and maintenance of the Work in the finished condition until final acceptance.
 - b. Unit of Measure: Linear foot of open channel as measured along the centerline of the survey stationing indicated on the Drawing.
6. Open Channel Excavation, 3-foot bottom width:
7. Open Channel Excavation, 2-foot bottom width:
 - 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. Excavating open channel to the lines and grades indicated on the Drawings or as directed by the ENGINEER.
 - iv. Cleanout of sediment from existing culverts.
 - v. Disposal of all items from clearing, grubbing and snagging operations off-site in accordance with all local, state and federal regulations.
 - vi. Spread, level and grade spoil material if sufficient width exists within Drain right of way. All excess spoil material shall be removed, hauled and disposed of off-site in accordance with all local, state and federal regulations.
 - vii. Cleanup and maintenance of the Work in the finished condition until final acceptance.
 - b. Unit of Measure: Linear Foot of open channel as measured along the centerline of the survey stationing indicated on the Drawings.
8. Culvert, 60-inch CMP:
9. Culvert, 48-inch PE:
10. Culvert, 48-inch RCP:
 - a. Includes the following as indicated on the drawings and in accordance with the specifications.
 - i. Furnishing all labor and equipment as necessary to complete the Work.
 - ii. Clearing, excavating and dewatering
 - iii. Removal and disposal of existing culverts, crossing surfaces, and appurtenance items.
 - iv. Placing and compacting bedding and backfill.
 - v. Installing pipe and appurtenant items.
 - vi. Removal and disposal of all vegetation and debris including inorganic material, trees, brush, stumps and roots as required for construction of surface
 - vii. Cleanup and maintenance of the Work in the finished condition until final acceptance.
 - b. Unit of Measure: Linear Foot as measured along the pipe centerline from end of pipe to end of pipe.

11. 6-foot Diameter Manhole:
- 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, excavating, dewatering, bedding and backfilling.
 - iii. Furnish and install drainage structure and appurtenances.
 - iv. Adjust casting to finish grade.
 - v. Provide resilient connector between pipe and drainage structure for all pipe diameters less than or equal to 24-inch.
 - vi. Cleanup and maintenance of the Work in the finished condition until final acceptance.
 - b. Unit of Measure: Each.
12. Private Crossing Removal:
- 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. Excavating, cutting and removing existing culvert.
 - iii. Disposal of culvert and all related items off-site in accordance with all local, state and federal regulations.
 - b. Unit of Measure: Linear Foot
13. Paved Road Restoration:
14. Private Crossing Restoration (Gravel):
15. Private Crossing Restoration (Bituminous):
16. Private Crossing Restoration (Concrete):
- 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. Removal and disposal of all vegetation, crossing surface, and debris including inorganic material, trees, brush, stumps and roots as required for construction of surface.
 - iii. Cutting, filling, shaping, grading, compacting, or otherwise preparing a finished subgrade.
 - iv. Furnishing, placing, fine grading and compacting surface course.
 - v. Restoration of all other disturbed areas with seed, fertilizer and mulch.
 - vi. Cleanup and maintenance of the Work in the finished condition until final acceptance.
 - b. Unit of Measure: Each
17. Riprap Tile Outlet Protection:
- 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 including but not limited to rock and geotextile fabric.
 - ii. Excavating and grading as necessary to complete the work.
 - iii. Placing rock and geotextile fabric as indicated on the Drawings or as directed by the ENGINEER.
 - iv. Cutting or extending tile outlet as necessary.
 - v. Adjustments as directed by the ENGINEER in order to ensure proper function.
 - vi. Cleanup and maintenance of the Work in the finished condition until final acceptance.
 - b. Unit of Measure: Square Yard.

18. Riprap Spillway:
19. Riprap End Treatment:
- 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 including but not limited to rock and geotextile fabric.
 - ii. Excavating and grading as necessary to complete the work.
 - iii. Placing rock and geotextile fabric as indicated on the Drawings or as directed by the ENGINEER.
 - iv. Adjustments as directed by the ENGINEER in order to ensure proper function.
 - v. Cleanup and maintenance of the Work in the finished condition until final acceptance.
 - b. Unit of Measure: Square Yard.
20. Open Channel Seeding
- 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 along channel banks 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 of open channel as measured along the centerline of the survey stationing indicated on the drawings.
21. Mulch Blanket:
- a. Includes the following as indicated on the Drawings and in accordance with Specifications.
 - i. Furnishing all labor, materials, and equipment as necessary to complete the Work.
 - ii. Placing and anchoring mulch blanket as indicated on the Drawings or as directed by the ENGINEER.
 - iii. Cleanup and maintenance of the Work in the finished condition until final acceptance.
 - b. Unit of Measure: Square Yard.
22. 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.
 - a. Unit of Measure: Lump Sum

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 01410REGULATORY REQUIREMENTSPART 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.
- C. Owner has obtained EGLE/USACE joint permit No. WRP040142. A copy of the permit is included at the end of this section:
 - 1. Contractor shall comply with the requirements and conditions of the permit.



NOTICE OF AUTHORIZATION

Permit Number: WRP040142 v. 1
Site Name: 03-Baughman Drain-Otsego

Date Issued: January 25, 2024
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.

EGLE
WRP040142 v1.0
Approved
Issued On:01/25/2024
Expires On:01/25/2029



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.

EGLE
WRP040142 v1.0
Approved
Issued On:01/25/2024
Expires On:01/25/2029



**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:

- | | |
|--|---|
| <input checked="" type="checkbox"/> Part 301, Inland Lakes and Streams | <input type="checkbox"/> Part 323, Shorelands Protection and Management |
| <input type="checkbox"/> Part 303, Wetlands Protection | <input type="checkbox"/> Part 325, Great Lakes Submerged Lands |
| <input type="checkbox"/> Part 315, Dam Safety | <input type="checkbox"/> Part 353, Sand Dunes Protection and Management |
| <input type="checkbox"/> 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.

**EGLE
WRP040142 v1.0
Approved
Issued On:01/25/2024
Expires On:01/25/2029**

•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.

Waterbody Affected: Baughman Drain, Baughman Drain channels
Property Location: Allegan County, Otsego Township, Town/Range/Section 01N12W26

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.mitherpatlas.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.
 - o 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.
 - o Typical heated pressure wash is 140° water temperature, sprayed for 5-10 seconds.
 - o 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 rock 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 permitted 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.

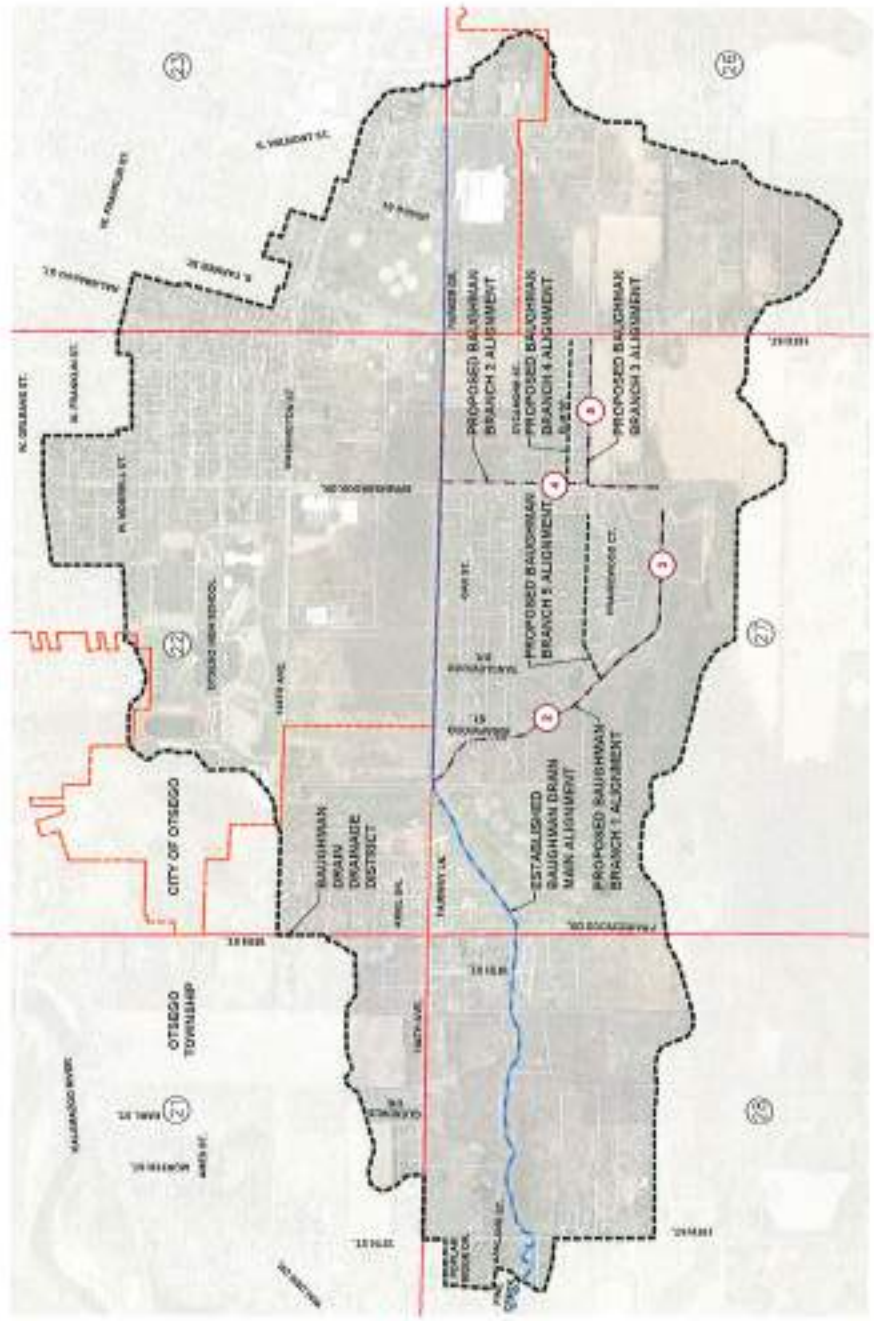
I hereby assure that I have read, am familiar with, and agree to adhere to the terms and conditions of this permit.

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



- INDEX OF SHEETS**
- 1 - COVER SHEET
 - 2 - PLAN & PROFILE
BRANCH 1 (STL. 8+00 - 8+100)
 - 3 - PLAN & PROFILE
BRANCH 2 (STL. 2+00 - 2+400)
 - 4 - PLAN & PROFILE
BRANCH 3 (STL. 8+00 - 20+00)
 - 5 - PLAN & PROFILE
BRANCH 4 (STL. 8+00 - 13+00)
 - 6 - CROSS SECTIONS
CROSSER NO. 1
 - 7 - CROSS SECTIONS
CROSSER NO. 2 & BRANCH NO. 5
 - 8 - DETAIL SHEET

DRAWING INFORMATION

DESIGNED BY: [Name]
CHECKED BY: [Name]
DATE: [Date]

LEGEND

- ENCLOSED CHANNEL DRAIN
- PROPOSED ENCLOSED CHANNEL DRAIN
- ESTABLISHED OPEN CHANNEL DRAIN
- PROPOSED OPEN CHANNEL DRAIN
- OTSEGO CITY LIMITS
- SALVAGE DISTRICT
- BOUNDARY
- SECTION LINE
- TOWNSHIP LINE
- ROAD
- PROPERTY LINE
- SECTION NUMBER
- SHEET NUMBER



COVER SHEET

APPLICANT: ALLEGAN COUNTY
DRAIN COMMISSIONER
TOWNSHIP: OTSEGO TOWNSHIP
COUNTY: ALLEGAN
NUMBER OF SHEETS: 1 OF 8
DATE: 7/25/2023



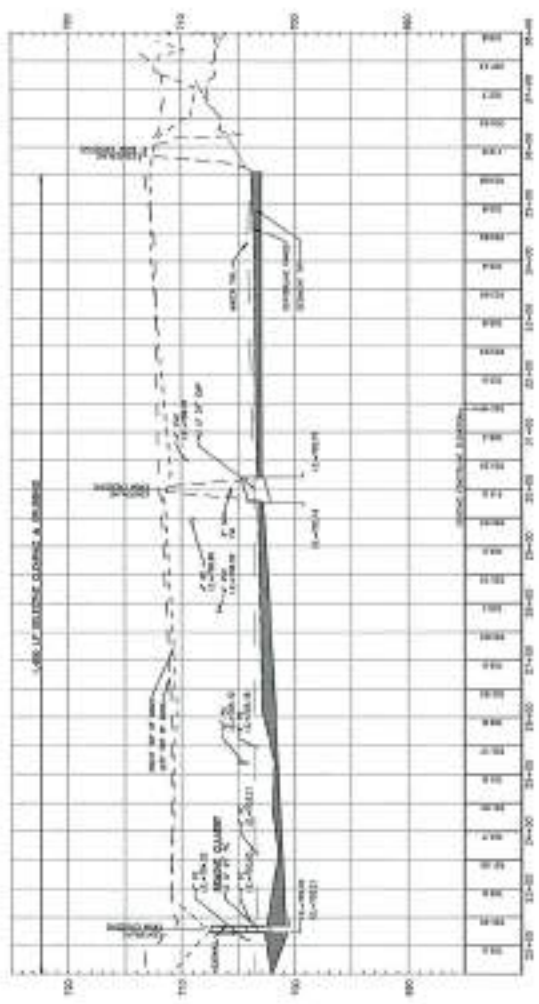
1-24-2024

dm



SUMMARY OF ACTIVITIES
 TOTALING DRAINAGE AND NUMBER OF
 EXPOSED SHAFTS (DRAINAGE)
 FROM SHEET 1 TO SHEET 2

NO. OF SHEETS	NO. OF SHAFTS
1	1
2	1
3	1
4	1
5	1
6	1
7	1
8	1
9	1
10	1
11	1
12	1
13	1
14	1
15	1
16	1
17	1
18	1
19	1
20	1
21	1
22	1
23	1
24	1
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28	1
29	1
30	1
31	1
32	1
33	1
34	1
35	1
36	1
37	1
38	1
39	1
40	1
41	1
42	1
43	1
44	1
45	1
46	1
47	1
48	1
49	1
50	1



CENTERLINE PROFILE
 ELEVATION: 17.8
 STATION: 17.8



PA DEPARTMENT OF ENVIRONMENTAL PROTECTION
WATER USE PERMITTING DIVISION
CALL 800-392-6639
WWW.PA.gov

PLAN & PROFILE BRANCH 1
 APPLICANT: ALLEGAN COUNTY
 DRAIN COMMISSIONER
 TOWNSHIP: OTSEGO TOWNSHIP
 COUNTY: ALLEGAN
 NUMBER OF SHEETS: 3 OF 6
 DATE: 7/5/2023

1-24-2024
 dm



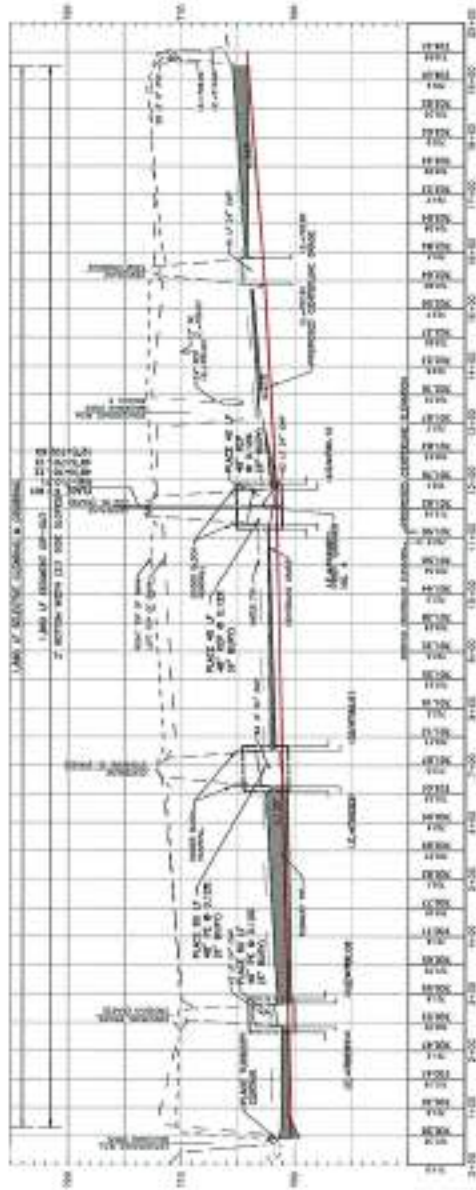
PLAN VIEW - BRANCH NO. 2



SUMMARY OF ACTIVITIES

- 1. EXISTING 18" DIA. R/W (10' DIA. R/W) EXISTING 18" DIA. R/W (10' DIA. R/W) EXISTING 18" DIA. R/W (10' DIA. R/W)
- 2. EXISTING 18" DIA. R/W (10' DIA. R/W) EXISTING 18" DIA. R/W (10' DIA. R/W) EXISTING 18" DIA. R/W (10' DIA. R/W)
- 3. EXISTING 18" DIA. R/W (10' DIA. R/W) EXISTING 18" DIA. R/W (10' DIA. R/W) EXISTING 18" DIA. R/W (10' DIA. R/W)
- 4. EXISTING 18" DIA. R/W (10' DIA. R/W) EXISTING 18" DIA. R/W (10' DIA. R/W) EXISTING 18" DIA. R/W (10' DIA. R/W)

DATE	BY	CHK
1/15/24	W.P.	W.P.
1/15/24	W.P.	W.P.
1/15/24	W.P.	W.P.



CENTERLINE PROFILE



APPLICANT: ALLEGAN COUNTY
 TOWNSHIP: OTSEGO TOWNSHIP
 COUNTY: ALLEGAN
 NUMBER OF SHEETS: 4 OF 8
 DATE: 7/5/2023

PLAN & PROFILE BRANCH 2
 APPLICANT: ALLEGAN COUNTY
 TOWNSHIP: OTSEGO TOWNSHIP
 COUNTY: ALLEGAN
 NUMBER OF SHEETS: 4 OF 8
 DATE: 7/5/2023

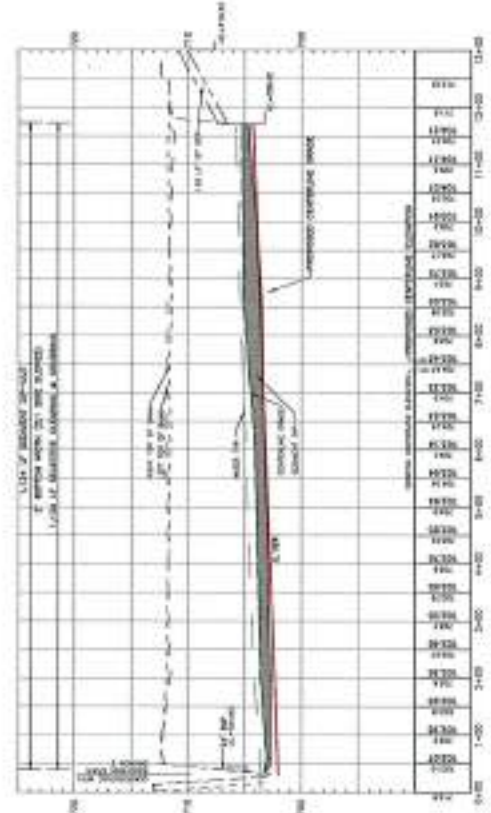
1-24-2024
 W.P.



PLAN VIEW - BRANCH NO. 3

SUMMARY OF ACTIVITIES

NO. OF SHEETS	308
NO. OF SHEETS	308
NO. OF SHEETS	1/28
NO. OF SHEETS	1
NO. OF SHEETS	0.34



CROSS-SECTION PROFILE
BRANCH NO. 3

1. THE PLAN AND PROFILE SHALL BE CONSIDERED AS PART OF THE PROJECT AND SHALL BE KEPT ON FILE AT THE PROJECT OFFICE.
2. THE PLAN AND PROFILE SHALL BE KEPT ON FILE AT THE PROJECT OFFICE.
3. THE PLAN AND PROFILE SHALL BE KEPT ON FILE AT THE PROJECT OFFICE.
4. THE PLAN AND PROFILE SHALL BE KEPT ON FILE AT THE PROJECT OFFICE.



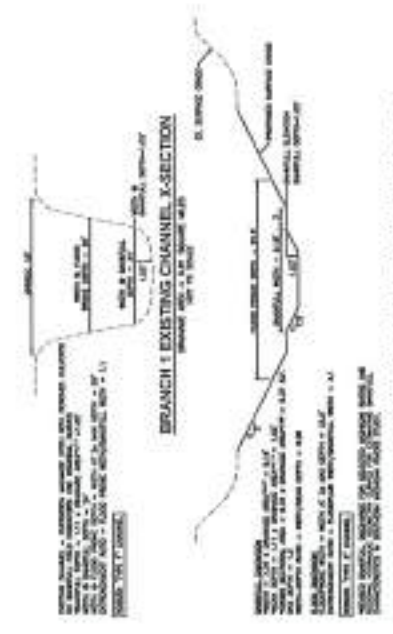
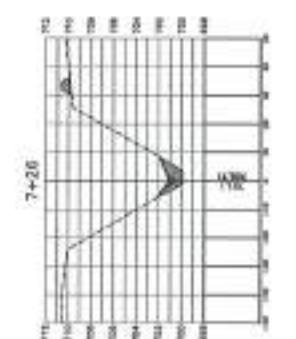
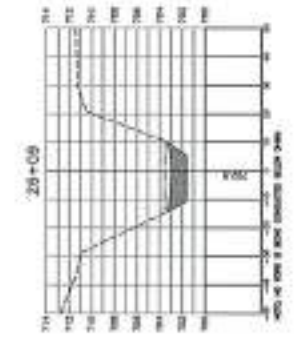
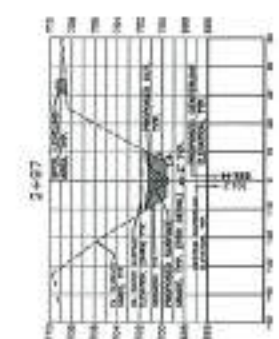
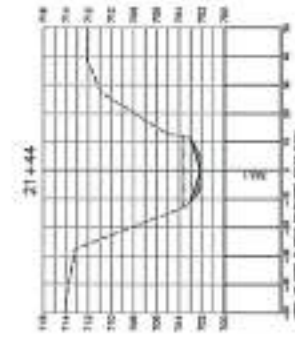
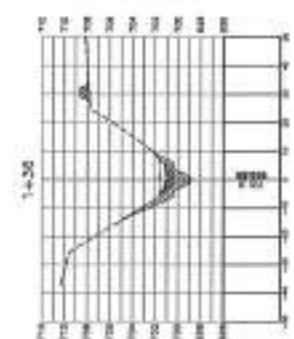
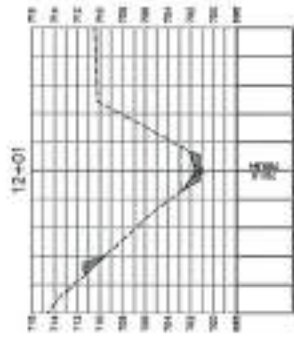
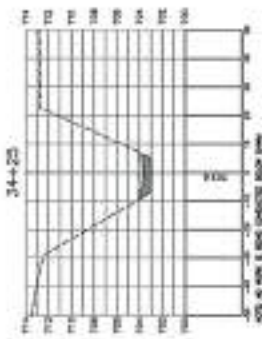
FOR MORE INFORMATION
CALL 724-863-3100
WWW.ALEGGHONYCOUNTYPA.GOV

PLAN & PROFILE BRANCH 3
APPLICANT: ALLEGANY COUNTY
DRAIN COMMISSIONER
TOWNSHIP: DISBOLD TOWNSHIP
COUNTY: ALLEGANY
NUMBER OF SHEETS: 5 OF 8
DATE: 7/5/2023

1-24-2024
DM



LRE ENGINEERING, INC.
W/P040142 v1.0
Approved
Issued On: 01/25/2024
Expires On: 01/25/2029



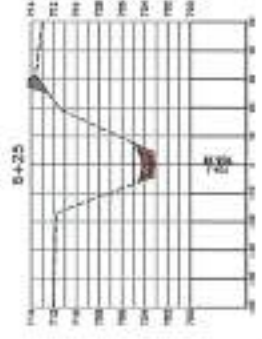
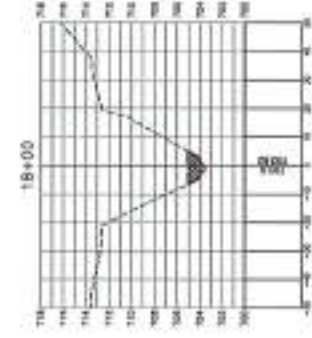
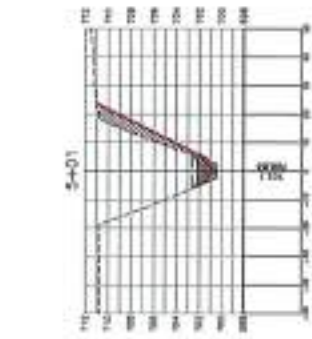
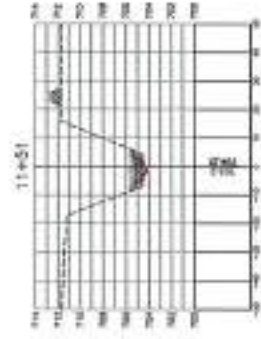
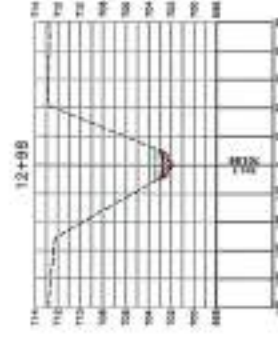
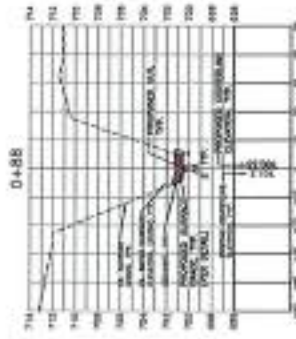
BRANCH 1 EXISTING CHANNEL X-SECTION
BRANCH 1 PROPOSED CHANNEL X-SECTION

CROSS SECTIONS - BRANCH NO. 1

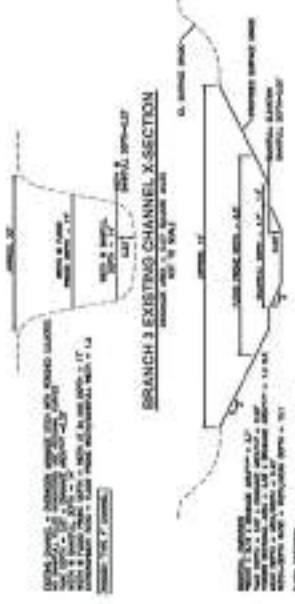
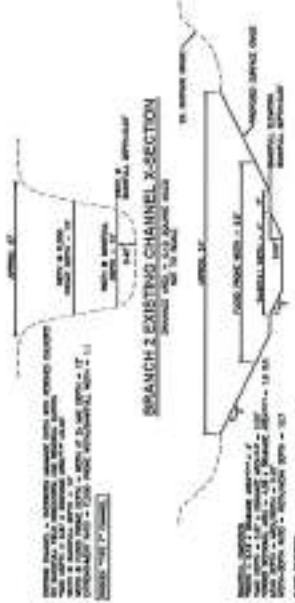
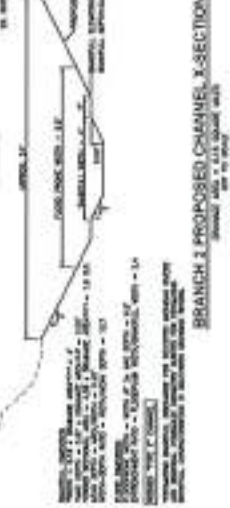
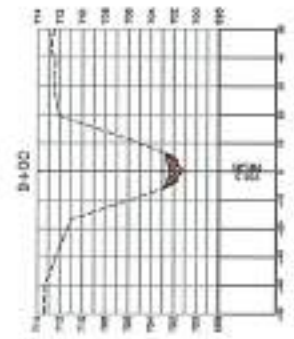
FOR MORE INFORMATION
CONTACT YOUR DESIGNER
CALL 866.533.0367
149-00-0171

CROSS SECTIONS
APPLICANT: ALLEGAN COUNTY
DEAN COMBESHER
TOWNSHIP: OTISCO TOWNSHIP
COUNTY: ALLEGAN
NUMBER OF SHEETS: 6 OF 6
DATE: 9/6/2023

1-24-2024
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CROSS SECTIONS - BRANCH NO. 3
VERTICAL F.T.



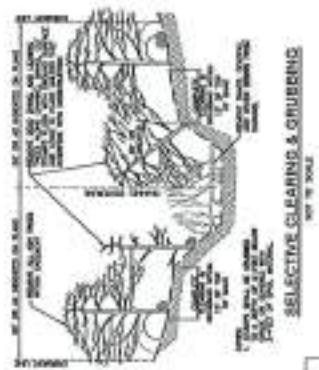
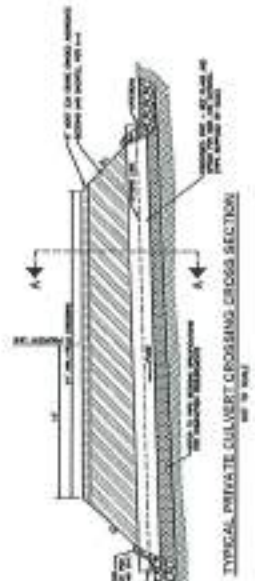
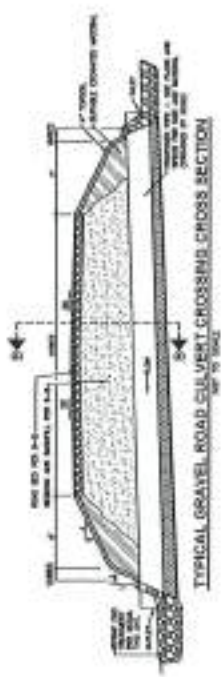
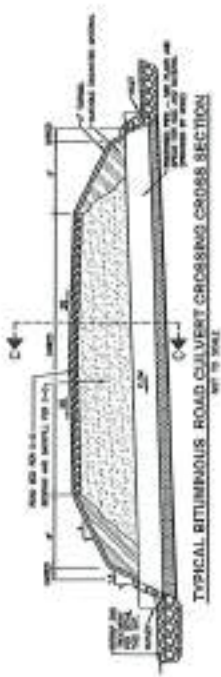
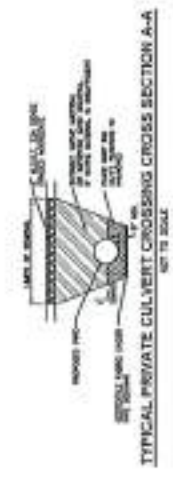
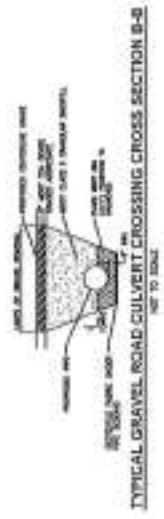
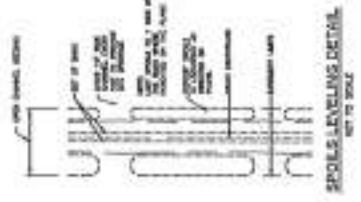
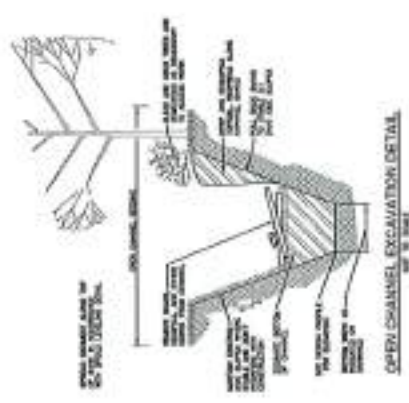
NOTE:
FOR BRANCH NO. 3



APPLICANT: ALLEGANY COUNTY
DRAIN COMMISSIONER
TOWNSHIP: OTSEGO TOWNSHIP
COUNTY: ALLEGANY
NUMBER OF SHEETS: 7 OF 8
DATE: 7/5/2023

APPLICANT: ALLEGANY COUNTY
DRAIN COMMISSIONER
TOWNSHIP: OTSEGO TOWNSHIP
COUNTY: ALLEGANY
NUMBER OF SHEETS: 7 OF 8
DATE: 7/5/2023

1-24-2024
dm



1-24-2024
JLM

DETAILS
 APPLICANT: ALLEGAN COUNTY
 DRAIN COMMISSIONER
 TOWNSHIP: OTSEGO TOWNSHIP
 COUNTY: ALLEGAN
 NUMBER OF SHEETS: 8 OF 8
 DATE: 7/5/2023



SECTION 01570EROSION AND SEDIMENTATION CONTROLPART 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. MDOT 816.02, 917.11
 2. Temporary Measures: MDOT Table 816-2
 3. Permanent Measures: MDOT Table 816-1, 917.2
- B. Topsoil:
 1. Temporary Measures: Not required unless readily available.
 2. Permanent Measures: MDOT 816.02, 917.06.
- 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.

SECTION 01570EROSION AND SEDIMENTATION CONTROL

- 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:
 - a. Provide all materials.
 - b. 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 7 days from the time the area was first disturbed.
 - 2. Channel Banks: Within 24 hours from the time the area was first disturbed.
 - 3. Seasonal Limitations:
 - a. April 20 through November 1.
 - b. Dormant seeding after November 1 to freeze up.
- 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.

SECTION 01570EROSION AND SEDIMENTATION CONTROL

- 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 70 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 END TREATMENT:
- A. General:
 - 1. Includes riprap bank stabilization and riprap end treatment.
 - 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. Maintenance: Regrade, relay riprap and geotextile fabric as necessary.
- 3.06 RIPRAP SPILLWAY:
- A. General:
 - 1. 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 rock areas.
 - 2. Extend geotextile fabric into trenches for anchorage at upstream and downstream.
 - D. Placing Rock: As indicated on the Drawings or as directed by ENGINEER.
 - E. Engineers Approval: Obtain approval from ENGINEER that riprap spillway is functioning properly.

SECTION 01570EROSION AND SEDIMENTATION CONTROL

- F. Maintenance: Regrade, relay and adjust rock as necessary in order to ensure that riprap spillway is functioning properly.

3.07 TILE OUTLET PROTECTION:

- A. General:
 - 1. Backfill with suitable material.
 - 2. Minimum pipe slope: 0.10%.
 - 3. Extend or trim drain tile to prevent erosion of the channel bank.
 - 4. Joints:
 - a. Like Materials: Manufactured connector.
 - b. Unlike materials: Wrap with geotextile fabric and pour concrete collar to form a soil tight joint.
 - 5. Outlet Protection: Riprap splash pad in accordance with the Drawings or as directed by the ENGINEER.
- B. Maintenance: Regrade, replace pipe, relay riprap and geotextile fabric as necessary.

3.08 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.

3.09 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. Open Channel Excavation – One staking: Line and Grade points at 250 foot station intervals and at bends in the drain alignment.
 - 2. Culverts – One staking: Line and Grade points at culvert ends.
- 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.

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.

SECTION 02230

02230.3
SITE CLEARING

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. The work includes excavation of open channel drains.

1.02 DEFINITIONS:

- A. Earth: Materials which can be excavated with equal facility by equipment used for normal earth excavation. Examples include, but are not limited to:
 - 1. Common materials such as sand, clay, loam, gravel, silt, and stones less than 1/2 cubic yard in volume.
 - 2. Organic materials such as muck, peat, and marl.
 - 3. Rock-like material that is fragile, friable, or fragmented.
- B. Rock: Igneous, metamorphic and sedimentary rock and hardpan requiring continuous drilling, blasting or use of ripper:
 - 1. Solid ledge rock.
 - 2. Solid boulders more than 1/2 cubic yard in volume.
 - 3. Hardpan consists of cemented soil layers but does not include uncemented clay layers.
- C. Other:
 - 1. Natural items, such as trees, stumps, logs, brush, shrubs, and other vegetation.
 - 2. Man-made items, including but not limited to:
 - a. Surface items, such as bituminous and concrete paving, curb, headwalls, and the like.
 - b. Underground items, such as pipes, culverts, manholes, catch basins, foundations, walls, chambers, refuse, and the like.

PART 2 - PRODUCTS

Not used.

PART 3 – EXECUTION

3.01 OPEN CHANNEL EXCAVATION:

- A. Location: Excavate existing channels from one side only with the intent to incur minimal disturbance to the opposite bank.
- B. Tolerance:
 - 1. Excavation of the open channel drain shall conform to the cross-sections and horizontal and vertical alignment indicated on the Drawings.
 - 2. The completed cross-section shall not be more than 0.2-foot above or 0.5-foot below the plan elevation without the prior approval of ENGINEER.
 - 3. The finished bottom grade shall not be greater than 0.5 foot below the plan elevation within 300 feet upstream or downstream of structures or enclosures.
- C. Rock Excavation:
 - 1. CONTRACTOR shall notify ENGINEER immediately when rock is encountered during excavation.
 - 2. Rock excavation and removal methods shall be approved by ENGINEER prior to initiating the work.
 - 3. Rock excavation shall be paid under separate change order unless a specific item appears in the Bid Form.

- D. Other Excavation:
1. Natural Items: In accordance with Division 2 Section "SITE CLEARING."
 2. Manmade Items:
 - a. CONTRACTOR shall notify ENGINEER immediately when manmade items are encountered during excavation.
 - b. Excavation and removal methods of manmade items shall be approved by ENGINEER prior to initiating the Work.
 - c. Excavation, removal and disposal of manmade items greater than 1/2-cubic yard in volume shall be paid under separate change order unless a specific item appears in the Bid Form.
- E. Unstable Soils:
1. CONTRACTOR shall notify ENGINEER immediately when a significant amount of unstable soils are encountered during excavation.
 2. Additional excavation that is deemed necessary by ENGINEER to compensate for unstable soil conditions shall be paid under a separate change order, unless a specific item appears in the Bid Form.
- F. Spoil Banks:
1. Spoil material shall be placed and graded in the location and to the slopes indicated on the Drawings.
 2. Location:
 - a. On one side of channel only unless indicated otherwise on the Drawings.
 - b. Away from existing tributary water courses or drains.
 - c. Away from landscaped areas.
 - d. Away from the trunks of trees.
 - e. Initial placement: Minimum 8 feet between the top of channel bank and the edge of the spoil pile.
 3. Grading:
 - a. Grade spoil banks to no steeper than 4 on 1 side slopes away from the drain in open areas and a minimum 2 on 1 side slopes in wooded areas unless indicated otherwise on the Drawings.
 - b. Level spoil to allow broad, flat drainage ways to enter the drain without the ponding of surface water behind the spoil banks.
 - c. Maintain a minimum 4-foot buffer strip between the leveled spoil and the top of the channel bank.
 4. Organic Soils: Maintain a minimum 15-foot buffer strip between the leveled spoil and the top of the channel bank.
 5. Sticks and Stones: Sticks 1-inch diameter or larger and 18 inches in length or longer, and rocks or boulders 8 inches in diameter or larger shall be removed or buried within the drain right-of-way in accordance with Division 2 Section "SITE CLEARING".
- G. Spoil Ownership: If the owner of the property requests or is willing to accept excavated material, the CONTRACTOR shall have the property owner complete the Land Owner Agreement Form found in the Supplemental Conditions. Excavated material claimed by the property owner shall be spread in accordance with the agreed upon instructions in the Land Owner Agreement. Otherwise spoil material becomes property of the CONTRACTOR and shall be disposed of in accordance with all local, state and federal regulations.
- H. Tributaries:
1. Grade tributaries at a constant slope away from the drain excavation throughout the limit of the available right-of-way or 75 feet, whichever is less.
 2. Begin tributary grading at the proposed drain elevation and meet the existing grade at the limit of the regrading.
 3. Regrade the tributary to a bottom width equal to the existing bottom width. Regraded channel side slopes shall be a minimum of 2 on 1.
- I. Channels Parallel to Roads:
1. Excavate from field side of drain.
 2. Comply with requests of highway authority having jurisdiction within road right-of-way.
 3. Preserve and maintain existing driveways.

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. Corrugated Metal:
 - 1. Metallic coated (Galvanized): AASHTO M 36, MDOT 402, 909.
 - 2. Wall thickness: Gauge as indicated on the Drawings.
 - i. For pipe sizes 36-inches or greater use 12 gauge (0.109-inch thick) 3x1 Corrugated Metal Pipe.
 - ii. For pipe sizes less than 36-inches use 14 gauge (0.747-inch thick) 3x1 Corrugated Metal Pipe.
 - B. Dual Wall High Density Polyethylene (PE): Smooth lined corrugated meeting AASHTO M294.
 - C. Reinforced Concrete Pipe: MDOT Section 402, 909.
 - D. Footing Drains:
 - 1. PVC: ASTM D 3034-SDR 35 with premium joints.
 - 2. Fittings: Connect to storm sewer with tee or Kor-N-Tee connector (flexible rubber boot) or equal.
 - E. Chlorinated Poly Vinyl Chloride (CPVC): AASHTO M 304 tested per MTM 728.
- 2.02 PREMIUM JOINTS:
 - A. Corrugated Metal: Not Allowed.
 - B. PE: AASHTO M252 or M294, ASTM D3212.
 - C. Reinforced Concrete Pipe: MDOT 402, 909
 - D. CPVC: AASHTO 304.

- 2.03 MANHOLES, CATCH BASINS AND INLETS:
- A. 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 alternate.
 - 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.

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 replace loose blocks and bricks.
 2. Future Storm Sewer:
 - a. Bulkhead: Pipe 24 inch and larger with brick and mortar, 1/2 inch plaster outside.
 - (1) up to - 36 inch: 4 inch thick
 - (2) 42 inch - 60 inch: 8 inch thick
 - (3) 60 inch & larger: 12 inch thick
- 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 1 inch 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.