Oak Hill Parkway (US 290 / SH 71)

CSJ 0113-08-060
CSJ 0700-03-077

Preliminary
Water Quality Analysis and Design

Prepared For:

Texas Department of Transportation (TxDOT)
Austin District

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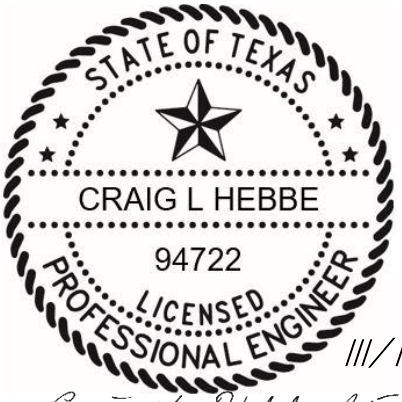

11/1/2019

Craig L Hebbe, P.E.

Table of Contents

Index of Tables

Appendices

1.0 INTRODUCTION

1.1. *PROJECT DESCRIPTION*

This report provides updated preliminary water quality analysis and design for the Oak Hill Parkway project. After the previous Preliminary Water Quality Report was finalized, TxDOT selected Alternative A as the preferred alternative and is no longer considering Alternative C. This report addresses the current schematic design of Alternative A including the extension of the project area and updates to the roadway schematic. The original project limits extended from West of Tara Lane to East of Williamson Creek along US 290 and from Silvermine Drive to the US 290 interchange along SH 71. In its current state the Oak Hill Parkway project consists of roadway improvements along US 290 and SH 71 from East of Tara Lane to East of Mopac Expressway along US 290 and from Silvermine Drive to the US 290 interchange along SH 71. They include main lane and frontage road construction along US 290, SH 71 and the William Cannon and US 290 / SH 71 interchanges. This report considers the updates made to the schematic in regards to the ramp relocations, roadway realignments and elevation adjustments, widening of the roadway East of Williamson Creek, and modifications made to the shared use paths.

K Friese + Associates, Inc. has prepared preliminary water quality analysis and design to assist with the schematic development and environmental process. This study estimates the current pollutant load removal achieved by the existing water quality control facilities, summarizes the requirements for pollutant load removal for the proposed project, and recommends required improvements to ensure compliance with current water quality regulations and commitments.

2.0 DESIGN CRITERIA

2.1. *WATER QUALITY REGULATIONS*

Most of the project (including SH 71) is located within the Edwards Aquifer Contributing Zone. The US 290 improvements east of William Cannon Drive are located in the Edwards Aquifer Recharge Zone. The project is therefore subject to the Texas Commission on Environmental Quality (TCEQ) Edwards Aquifer Protection Program regulations. In addition, the project must meet the requirements of the TCEQ Texas Pollution Discharge Elimination System (TPDES), United States Army Corps of Engineers (USACE) Section 401 of the Clean Water Act, and United States Fish and Wildlife Service (USFWS) commitment.

2.1.1 TCEQ Edwards Aquifer Protection Program

The Edwards Aquifer provides water to numerous communities within the greater Austin area, and also provides a habitat for the endangered species. The Oak Hill Parkway project is located partially within the Contributing Zone and Recharge Zone and will require a TCEQ Edwards Aquifer Protection Plan (EAPP); i.e. Water Pollution Abatement Plan (WPAP) or Contributing Zone Plan (CZP), as applicable.

For projects that follow a Design-Bid-Build delivery method, the TCEQ permitting process is clear. However, the Oak Hill Parkway project will use a Design-Build delivery method which poses challenges with TCEQ permitting and does not fit into the traditional requirements of a TCEQ EAPP application. Typically, in order to submit an EAPP, the application must include construction drawings signed and sealed by a licensed engineer in the state of Texas. However, within a Design-Build project, the DB contractor performs the project final design and construction begins before design is complete. TxDOT and TCEQ met on July 31, 2019 to discuss permitting the Design-Build project and meeting minutes are included in **Appendix L**. At the meeting, it was agreed that a phased permitting approach would be acceptable and details of the phasing sequence can be found in the meeting minutes. Due to the fact that the project is located over both the Contributing Zone and the Recharge Zone, different phases will require a different EAPP, either a CZP or WPAP.

Chapter 213, of the Texas Administrative Code (TAC) states that, "BMPs and measures must be implemented to control the discharge of pollution from regulated activities after the completion of construction. These practices and measures must be designed, constructed, operated, and maintained to ensure that 80% of the incremental increase in the annual mass loading of total suspended solids from the site caused by the regulated activity is removed. These quantities must be calculated in accordance with technical guidance prepared or accepted by the executive director."[1] The TCEQ has developed a technical guidance manual, *Complying with the Edwards Aquifer Rules – Technical Guidance on Best Management Practices, RG-348* (RG-348)[2], to ensure that new construction activities provide stormwater mitigation measures compliant with the Edwards Aquifer rules and regulations outlined in chapter 213 of the TAC. This document describes in detail the selection and design of permanent, structural and non-structural Best Management Practices (BMPs) to provide treatment of the incremental increase in Total Suspended Solid (TSS) caused by the construction of impervious cover on the Oak Hill Parkway project.

Along with the RG-348 guidance manual, TCEQ provides a spreadsheet[3] to assist in calculating the required TSS load removal for a proposed project and to calculate the required sizing of a proposed permanent BMP based on a desired pollutant load removal. This spreadsheet was developed for the purpose of assisting a project through the TCEQ permit application review process.

Note that the contractor will be responsible for ensuring regulated utility adjustments are included in the EAPP application as necessary. The contractor will be responsible for determining if any wastewater utility adjustments require approval of a TCEQ Organized Sewage Collection System (SCS) Plan application. If an SCS plan is required, it must be approved prior to commencing construction.

2.1.2 Permanent Water Quality Best Management Practices (TCEQ)

Permanent BMPs are implemented to reduce pollution of surface water or stormwater that originates on site or upstream from the site and flows across the project site. Chapter 3 of the TCEQ RG-348 document provides technical guidance to designers on how to adequately select and size BMPs to meet the pollutant reduction requirements for stormwater runoff defined in the Edwards Aquifer Rules[4].

RG-348 describes in detail 10 permanent BMPs that are appropriate for the Edwards Aquifer Region, along with maintenance guidelines necessary to ensure the long-term performance of the controls function as designed. For a description of additional BMP's approved since 2005, refer to the Addendum Sheet Complying with the Edwards Aquifer Rules – Technical Guidance on Best Management Practices RG-348 (Revised July 2005), July 5, 2012 shows a summary of the potential permanent structural BMPs to be used in the Edwards Aquifer Region. Not all BMPs provided in the Addendum Sheet (June 2018) are listed in **Table 2-1.**

1 Texas Administrative Code, Title 30, Part 1, Chapter 213, Subchapter A,(4),(D),(ii),(I). http://texreg.sos.state.tx.us/public/readtac$ext.TacPage?sl=T&app=9&p_dir=F&p_rloc=103547&p_tloc=14809&p_ploc=1&pg=2&p_tac=&ti=30&pt=1&ch=213&rl=5

2 Complying with the Edwards Aquifer Rules – Technical Guidance on Best Management Practices (RG-348). Texas Commission on Environmental Quality, Revised July 2005, http://www.tceq.texas.gov/publications/rg/rg-348/rg-348.html; see also: Addendum Sheet Complying with the Edwards Aquifer Rules – Technical Guidance on Best Management Practices RG-348 (Revised July 2005), July 5, 2012.

3 Calculation Spreadsheet: TSS Removal. Texas Commission on Environmental Quality, Revised April 20, 2009. http://www.tceq.texas.gov/field/eapp/spreadsheet.html

4 Edwards Aquifer Rules. Texas Commission on Environmental Quality, Revised March 31, 2011. http://www.tceq.state.tx.us/rules/indxpdf.html/#213

Table 2-1: Summary of TCEQ Approved Permanent BMPs

Permanent Structural BMP	Maintenance Requirements	TSS Removal
Retention/Irrigation	High	100%
Extended Detention Basin	Low to Medium	75%
Grassy Swales	Low to Medium	70%
Vegetative Filter Strips (VFS)	Low	85%
Sand Filter Systems	Medium	89%
AquaLogic Cartridge System	High	95%
Wet Basins	Medium to High	93%
Bioretention	Medium to High	89%
Permeable Friction Course*	Medium	90%

*See the Addendum Sheet (June 2018) and Appendix I (PFC addendum memo)

2.1.3 TPDES Stormwater General Permit

All construction sites located in the state of Texas greater than 1 Acre that discharge stormwater associated with construction activity to surface water are required to obtain a Construction General Permit to Discharge (Construction General Permit TXR150000) under the Texas Pollutant Discharge Elimination System (TPDES) permit from the TCEQ[5]. It is anticipated that all discharges related to the proposed construction of Oak Hill Parkway will be covered under the TPDES Construction General Permit, provided that a Stormwater Pollution Prevention Plan (SW3P) is developed prior to any construction activities in accordance with the guidelines set forth in the General Permit document. The contents of the SW3P will be included in the TCEQ EAPP. A Notice of Intent (NOI) will be required.

2.1.4 Temporary Stormwater Protections

During the construction of the Project, the contractor shall follow the TCEQ Edwards Aquifer Protection Program guidelines for protecting overall water quality on the Contributing and Recharge Zones. Temporary protections will be described in detail in the Temporary Stormwater Section (TCEQ-0602) of the EAPP, including:

- Spill Response Actions
- Potential Sources of Contamination
- Sequence of Major Activities
- Temporary Best Management Practices and Measures
- Request to Temporarily Seal a Feature, if sealing a feature
- Structural Practices
- Drainage Area Map
- Temporary Sediment Pond(s) Plans and Calculations
- Inspection and Maintenance for BMPs

5 General Permit to Discharge under the Texas Pollutant Discharge Elimination System. Texas Commission on Environmental Quality, Effective March 5, 2013. https://www.tceq.texas.gov/assets/public/permitting/stormwater/txr150000-cgp.pdf

- Schedule of Interim and Permanent Soil Stabilization Practices

For both types of EAPP application, TCEQ general construction notes will be required to be provided with in the construction plan set. The TCEQ general construction notes differ for WPAP and CZP applications and can be found on TCEQ's website and are listed below[6,7]

Water Pollution Abatement Plan General Construction Notes

1. A written notice of construction must be submitted to the TCEQ regional office at least 48 hours prior to the start of any regulated activities. This notice must include:

- the name of the approved project;
- the activity start date; and
- the contact information of the prime contractor.

2. All contractors conducting regulated activities associated with this project must be provided with complete copies of the approved Water Pollution Abatement Plan (WPAP) and the TCEQ letter indicating the specific conditions of its approval. During the course of these regulated activities, the contractors are required to keep on-site copies of the approved plan and approval letter.

3. If any sensitive feature(s) (caves, solution cavity, sink hole, etc.) is discovered during construction, all regulated activities near the sensitive feature must be suspended immediately. The appropriate TCEQ regional office must be immediately notified of any sensitive features encountered during construction. Construction activities may not be resumed until the TCEQ has reviewed and approved the appropriate protective measures in order to protect any sensitive feature and the Edwards Aquifer from potentially adverse impacts to water quality.

4. No temporary or permanent hazardous substance storage tank shall be installed within 150 feet of a water supply source, distribution system, well, or sensitive feature.

5. Prior to beginning any construction activity, all temporary erosion and sedimentation (E&S) control measures must be properly installed and maintained in accordance with the approved plans and manufacturers specifications. If inspections indicate a control has been used inappropriately, or incorrectly, the applicant must replace or modify the control for site situations. These controls must remain in place until the disturbed areas have been permanently stabilized.

6. Any sediment that escapes the construction site must be collected and properly disposed of before the next rain event to ensure it is not washed into surface streams, sensitive features, etc.

7. Sediment must be removed from the sediment traps or sedimentation basins not later than when it occupies 50% of the basin's design capacity.

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6 Texas Commission on Environmental Quality Water Pollution Abatement Plan General Construction Notes. Texas Commission on Environmental Quality, Revised July 15, 2015. https://www.tceq.texas.gov/assets/public/compliance/field_ops/eapp/F-0592_WPAP_const_notes.pdf

7 Texas Commission on Environmental Quality Contributing Zone Plan General Construction Notes. Texas Commission on Environmental Quality, Revised July 15, 2015. https://www.tceq.texas.gov/assets/public/compliance/field_ops/eapp/F-0592A_CZ_const_notes.pdf

8. Litter, construction debris, and construction chemicals exposed to stormwater shall be prevented from being discharged offsite.

9. All spoils (excavated material) generated from the project site must be stored on-site with proper E&S controls. For storage or disposal of spoils at another site on the Edwards Aquifer Recharge Zone, the owner of the site must receive approval of a water pollution abatement plan for the placement of fill material or mass grading prior to the placement of spoils at the other site.

10. If portions of the site will have a temporary or permanent cease in construction activity lasting longer than 14 days, soil stabilization in those areas shall be initiated as soon as possible prior to the 14th day of inactivity. If activity will resume prior to the 21st day, stabilization measures are not required. If drought conditions or inclement weather prevent action by the 14th day, stabilization measures shall be initiated as soon as possible.

11. The following records shall be maintained and made available to the TCEQ upon request:

- the dates when major grading activities occur;
- the dates when construction activities temporarily or permanently cease on a portion of the site; and
- the dates when stabilization measures are initiated.

12. The holder of any approved Edward Aquifer protection plan must notify the appropriate regional office in writing and obtain approval from the executive director prior to initiating any of the following:

A. any physical or operational modification of any water pollution abatement structure(s), including but not limited to ponds, dams, berms, sewage treatment plants, and diversionary structures;

B. any change in the nature or character of the regulated activity from that which was originally approved or a change which would significantly impact the ability of the plan to prevent pollution of the Edwards Aquifer;

C. any development of land previously identified as undeveloped in the original water pollution abatement plan.

Austin Regional Office 12100 Park 35 Circle, Building A Austin, Texas 78753-1808 Phone (512) 339-2929 Fax (512) 339-3795	San Antonio Regional Office 14250 Judson Road San Antonio, Texas 78233-4480 Phone (210) 490-3096 Fax (210) 545-4329

Contributing Zone Plan General Construction Notes

1. A written notice of construction must be submitted to the TCEQ regional office at least 48 hours prior to the start of any ground disturbance or construction activities. This notice must include:
   - the name of the approved project;
   - the activity start date; and
   - the contact information of the prime contractor.

2. All contractors conducting regulated activities associated with this project should be provided

with complete copies of the approved Contributing Zone Plan (CZP) and the TCEQ letter indicating the specific conditions of its approval. During the course of these regulated activities, the contractor(s) should keep copies of the approved plan and approval letter on-site.

3. No hazardous substance storage tank shall be installed within 150 feet of a water supply source, distribution system, well, or sensitive feature.

4. Prior to beginning any construction activity, all temporary erosion and sedimentation (E&S) control measures must be properly installed and maintained in accordance with the manufacturers specifications. If inspections indicate a control has been used inappropriately, or incorrectly, the applicant must replace or modify the control for site situations. These controls must remain in place until the disturbed areas have been permanently stabilized.

5. Any sediment that escapes the construction site must be collected and properly disposed of before the next rain event to ensure it is not washed into surface streams, sensitive features, etc.

6. Sediment must be removed from the sediment traps or sedimentation basins when it occupies 50% of the basin's design capacity.

7. Litter, construction debris, and construction chemicals exposed to stormwater shall be prevented from being discharged offsite.

8. All excavated material that will be stored on-site must have proper E&S controls.

9. If portions of the site will have a cease in construction activity lasting longer than 14 days, soil stabilization in those areas shall be initiated as soon as possible prior to the 14th day of inactivity. If activity will resume prior to the 21st day, stabilization measures are not required. If drought conditions or inclement weather prevent action by the 14th day, stabilization measures shall be initiated as soon as possible.

10. The following records should be maintained and made available to the TCEQ upon request:
    - the dates when major grading activities occur;
    - the dates when construction activities temporarily or permanently cease on a portion of the site; and
    - the dates when stabilization measures are initiated.

11. The holder of any approved CZP must notify the appropriate regional office in writing and obtain approval from the executive director prior to initiating any of the following:

    A. any physical or operational modification of any best management practices (BMPs) or structure(s), including but not limited to temporary or permanent ponds, dams, berms, silt fences, and diversionary structures;

    B. any change in the nature or character of the regulated activity from that which was originally approved;

    C. any change that would significantly impact the ability to prevent pollution of the Edwards Aquifer; or

    D. any development of land previously identified as undeveloped in the approved contributing zone plan.

Austin Regional Office 12100 Park 35 Circle, Building A Austin, Texas 78753-1808 Phone (512) 339-2929 Fax (512) 339-3795	San Antonio Regional Office 14250 Judson Road San Antonio, Texas 78233-4480 Phone (210) 490-3096 Fax (210) 545-4329

2.1.5 Section 401 Water Quality Certification for USACE Section 404 Permits

Section 404 of the Clean Water Act requires a permit to be issued by the U.S. Army Corps of Engineers (USACE) to regulate the discharge of dredged or fill material into any streams, lakes, rivers, wetlands or any other waterways classified as Waters of the United States (WOTUS). Preliminary environmental investigation determined that Williamson Creek is considered WOTUS. The proposed construction activities will cross Williamson Creek along both US 290 and SH 71 as well as Wheeler Branch along US 290. The USACE will need to approve a Section 404 permit for the Oak Hill project. TCEQ has the authority to certify that the permit meets the state's water quality standards. From the Indirect and Cumulative Impacts Analysis Technical Addendum of the Oak Hill project, "TCEQ carries out this responsibility under the Section 404 permitting program and can require the installation of temporary and permanent stormwater BMPs as part of the conditions of a Section 404 permit"[9].

2.1.6 EPA Sole Source Aquifer Program

The Environmental Protection Agency (EPA) Soul Source Aquifer (SSA) Program defines a SSA as an aquifer that, "supplies at least 50 percent of the drinking water for its service area" and/or "there are no reasonable available drinking water sources should the aquifer become contaminated"[10]. At the western end of the project along US 290 near Circle drive, the project limits enter the Edwards Aquifer II (Austin Area) Sole Source Aquifer – Streamflow Source Zone. See **Appendix B** for a map of the SSA zone as related to the proposed project limits. Any project that is located within the SSA zone and will receive federal funding must be submitted to the EPA regional office for review upon design completion per the Memorandum of Understanding (MOU) between TxDOT and the EPA included in **Appendix C**. Refer to the MOU for submittal process.

2.1.7 United States Fish and Wildlife Service Commitment

For the Oak Hill Parkway project, TxDOT has committed to complying with United States Fish and Wildlife Service (USFWS) agreement for water quality design and TSS load removal. The specific requirement is stated in the technical specifications for this project as a "commitment of 0lbs/yr TSS net increase leaving the project from existing conditions to proposed based on TCEQ calculation methodology"[11].

3.0 EXISTING CONDITIONS

Existing impervious cover was delineated using project topographic survey and aerial imagery. In the area just east of the US 290 and SH 71 intersection, abandoned parking lots and building foundations were used by TxDOT for stockpiling and storing road materials and equipment. In a letter dated June 26,

9 Indirect and Cumulative Impacts Analysis Technical Addendum, Texas Department of Transportation, Effective December 21, 2018
https://www.oakhillparkway.com/files/impact/AppendixH.IndirectandCumulativeImpactAnalysesTechnicalReportAddendum.pdf
10 EPA Overview of the Drinking Water Sole Source Aquifer Program.
https://www.epa.gov/dwssa/overview-drinking-water-sole-source-aquifer-program#What_Is_SSA
11 Design-Build Standard Specifications Items 10-28, Texas Department of Transportation, Revised December 21, 2018.
http://ftp.dot.state.tx.us/pub/txdot/pfd/strategic-contracts/programmatic-docs/db-strandspecs.pdf

2013, TxDOT notified the TCEQ of their removal of impervious cover in this area and requested that the TCEQ acknowledge this impervious cover as existing in the Oak Hill Parkway project. The letter and corresponding exhibit are located in **Appendix A**. The area is approximately five acres and is shown in the existing impervious cover exhibit in **Appendix D**. The water quality benefit from counting this storage area as existing impervious cover on the Oak Hill Parkway project is illustrated in the TCEQ calculation in **Table 3-1.**

Table 3-1: TCEQ Calculation of Storage Area Water Quality Benefit

Drainage Basin/Outfall Area No. =	EX Storage Area	
Total drainage basin/outfall area =	5.05	acres
Predevelopment impervious area within drainage basin/outfall area =	5.05	acres
Post-development impervious area within drainage basin/outfall area =	0.00	acres
Post-development impervious fraction within drainage basin/outfall area =	0	
$L_{R\ THIS\ BASIN}$ =	-5,584	lbs.

3.1. *EXISTING WATER QUALITY CONTROLS*

Existing water quality controls were determined from existing WPAP's and Contributing Zone Plans (CZP) prepared for previous projects along US 290 and SH 71. All WPAP's and CZP's reviewed were provided by TxDOT. Of the WPAP/CZP's found within the project corridor, two utilized Permeable Friction Course (PFC) overlay as the permanent water quality control, one utilized a Wet Basin as the permanent water quality control, and one utilized a Sand Filter pond as the permanent water quality control. Another project which included the intersection improvements at William Cannon and the SH 71 / US 290 interchange, removed existing impervious cover within the ROW in the northeast corner of the William Cannon intersection. The removal of this impervious cover offset the addition of impervious cover due to roadway widening, so no additional water quality treatment was required.

In addition to existing water quality controls associated with the roadways, there are multiple existing water quality and detention facilities within the proposed ROW that are owned and operated by others. It is expected that these ponds have been permitted with either or both TCEQ and COA and that any existing ponds located within proposed ROW will be reviewed during the ROW acquisition process. Note that any modifications made to existing ponds permitted through TCEQ by the Oak Hill Parkway project will require coordination and a TCEQ modification application by the contractor. Any modifications to ponds permitted through the COA will require coordination with the City.

Existing permits and Water Quality Control Facilities associated with TxDOT roadway projects have been summarized in **Table 3-2** and are illustrated in **Appendix G.**

3.2. *EXISTING ANALYSIS APPROACH*

This report utilizes the TCEQ RG-348 formulae and methodology to determine the TSS removed by the existing systems. Treated areas and existing impervious cover areas were delineated for each BMP based on limits defined within the permit documents, as-builts, and aerial imagery. The appropriate removal efficiency was applied for each BMP (see **Table 2-1**).

3.3. *EXISTING RESULTS*

The existing TSS removal results are shown in **Table 3-2.** The total TSS removed value of **70,514 lbs** is the computed annual TSS removal amount for the entire project area under current conditions.

Table 3-2: Summary of Existing Water Quality Controls

TCEQ Permit Number	Project Description	Station	Treatment Type	TSS Removed (lbs)
11-13050801	SH 71 left turn lanes	1050+50 - 1100+00* (SH 71)	Permeable Friction Course	8,546
11-12101101	US 290 from William Cannon to Convict Hill	N/A	None	0
11-12051501	US 290 from William Cannon to Convict Hill	296+00 - 342+00 (US 290)	Permeable Friction Course	9,883
11-96121802	US 290 mainlanes and frontage rds from Williamson Ck to Industrial Oaks	464+00 (US 290)	Wet Basin	31,388
11-97030701	US 290 Phase III at Loop 1	500+50 (US 290)	Sand Filter Pond	20,698
			Total:	**70,514**

*TCEQ Permit extended between station limits 1050+50 to 1084+70. However, the PFC limits were extended to Station 1100+00 during construction.

Complying with the USFWS criteria requires that the annual TSS load discharged from the site in Proposed conditions must not exceed **86,290 lbs**. This value is arrived at based on the existing conditions of the project area which produces an annual TSS load of **156,804 lbs** and, through the existing BMPs, removes **70,514 lbs** of the annual TSS load. **Table 3-3** summarizes the existing conditions of the project site in terms of the annual TSS load.

Table 3-3: Annual TSS Loading Under Existing Conditions

Existing Annual TSS Load Produced (lbs)	156,804
Existing Annual TSS Load Removed (lbs)	70,514
Existing Annual TSS Load Discharged (lbs)	86,290

4.0 PROPOSED CONDITIONS

Proposed impervious cover was delineated using design files provided by Rodriguez Transportation Group (RTG) in July 2019. Proposed impervious cover maps were created for the project and can be found in **Appendix E**.

4.1. *PROPOSED IMPACTS*

The proposed Oak Hill Parkway project will cause the overall drainage patterns for the project site to change from existing conditions as the vertical alignment high and low points will shift to accommodate grade separations for main lanes, ramps, and frontage roads.

Water quality controls were preliminarily designed for the project. The existing PFC will be eliminated due to roadway realignment and reconstruction. The existing Retention Irrigation pond for the NXP facility discussed in **Section 3.1** will not be affected by the schematic. In final design, efforts should be made to minimize impacts to this existing Retention Irrigation pond or regrading in this area may be required to

return the pond to its designed volume. Modifications to the existing pond will require approval of a TCEQ modification plan prior to construction on the facility.

4.2. PROPOSED DESIGN APPROACH

The TCEQ spreadsheet calculates the required removal (L_M) in compliance with the TAC and technical guidance, as 80% of the TSS load generated by the incremental increase in impervious cover. To comply with USFWS agreement, BMPs were designed to achieve 0 lbs/yr TSS net increase leaving the project from existing conditions to proposed. For a typical TCEQ EAPP application which does not include an area previously approved, the existing conditions reflect the impervious cover at the time of application, this area is shown in **Table 4-2.** For the Oak Hill Parkway project, the proposed conditions reflect the proposed area of impervious cover based on the preliminary roadway schematic. The project area should include all areas where a regulated activity will be performed. For this project, the project area reflects the limits of the project within the ROW and includes the area where the Bee Caves Detention Pond will be constructed. The area for the Bee Caves Pond was delineated along the proposed easement line and totals 14.15 acres.

For the purposes of water quality analysis, impervious cover was delineated on all roadway, driveway and sidewalk surfaces composed of concrete or asphalt pavement. Both existing and proposed impervious cover were delineated to include overlapping impervious area such as overpasses and underpasses. For example, everywhere there is a bridge, all impervious area below the bridge and the impervious area on the bridge surface were included in the water quality calculations. The addition of this overlapping area must be included in the impervious area as well as the total project area and individual BMP drainage areas. It is important to ensure the additional area is included in all three places so the total pervious area on the project or to any individual BMP is not artificially reduced. A summary of the overlapping impervious area included in the calculations is shown in **Table 4-1**. Water quality pond areas were not counted as impervious cover.

Table 4-1: Summary of Overlapping Impervious Area

Existing Overlapping Impervious Area (ac)	2.29
Proposed Overlapping Impervious Area (ac)	10.80

Table 4-2 summarizes the total TSS removal required for proposed conditions. Since the proposed project has more overlapping impervious areas than exist under existing conditions, the total project area under proposed conditions is larger.

Table 4-2: Proposed TSS Removal Required

	Existing	Proposed
Total Project Area (AC)	338.31	346.82
Impervious Area (AC)	138.58	220.74
Annual TSS Load Produced (lbs)	156,804	246,435
Annual TSS Load Removed (lbs)	70,514	See Section 4.6
Annual TSS Load Discharged (lbs)	86,290	See Section 4.6
[1] TCEQ TSS Removal Required for Project Area (lbs)	**128,116**	
[2] USFWS TSS Removal Required for Project Area (lbs)	**160,145**	

[1] TCEQ Required Removal = 0.80 x (Proposed Annual TSS Load Produced – Existing Annual TSS Load Discharged)
[2] USFWS Required Removal = Proposed Annual TSS Load Produced – Existing Annual TSS Load Discharged

Recognizing that the existing PFC along US 290 and SH 71 and the Wet Basin and Sand Filter System along US 290 are currently providing **70,514 lbs** of TSS removal, which is accounted for the in the calculated TSS

removal required for the project area, the project proposes to provide additional treatment. Furthermore, the project proposes to request a water quality credit of **5,584 lbs** provided from the removal of impervious cover in the TxDOT storage area. See **Appendix K** for calculation spreadsheets.

In addition to following the design criteria laid out in Section 2.0, preliminary design of the water quality BMPs was based on the technical specifications outlined in the Oak Hill Parkway Project Design-Build Standard Specifications (August 2019) prepared by TxDOT in **Appendix H**. Key elements utilized in the preliminary analysis and design are summarized below:

- The selected BMPs must be allowed per TCEQ Edwards Aquifer Protection Program guidance and must be one or more of the following types: vegetative filter strip (VFS) adjacent to pavement, bioretention basins, or sand filter basins. Additionally, the use of PFC, batch detention or proprietary BMPs from TCEQ Edwards Aquifer Protection Program guidance is prohibited without prior written approval from TxDOT.
- The use of underground water quality facilities is prohibited.
- Shutoff valves must be located on the downstream end of all ponds and they must be easily accessible without tools and in all weather conditions.
- Earthen pond side slopes shall be 4:1 (H:V) or flatter with a minimum embankment top width of six (6) feet.
- Vertical pond side slopes are allowed as long as access to basins is maintained and side slopes meet retaining wall design standards.
- Concrete or geomembrane impermeable liners must be used in all water quality basins.
- Piping within water quality ponds will be Schedule 40 PVC with a minimum size of 4 inch perforated inside ponds and 6 inch unperforated at pond outfalls. No PVC is allowed under pavement. The transition of PVC to 24-inch RCP must occur within 100 feet from the entrance to the pond outlet.
- DB Contractor shall design and construct a permanent access concrete drive to each pond. General requirements for maintenance access must meet TCEQ Edwards Aquifer Protection Program guidance. Access drives must have a minimum width of 12 feet and slopes not exceeding 4:1. Access drive turning radii shall be at least 50 feet. Access drives or ramps shall be designed into each pond chamber. All ponds must have an access maintenance staging area measuring 40 feet by 40 feet.
- Ponds that require fall protection will be designed with security fencing and 12 feet wide gates installed in each travel direction.
- DB Contractor shall design water quality ponds to function as temporary sediment basins during construction with a means to detain stormwater and control the discharge if dewatering becomes necessary. DB Contractor may provide a dewatering mechanism that is accessible from outside the ponded area.
- DB Contractor shall design berms for water quality ponds permitted with TCEQ to be higher than the 100-yr WSE of Williamson Creek or the 100-yr WSE of the adjacent outfall location if the water quality pond outfall location is different than Williamson Creek. DB Contractor shall design the water quality ponds to prevent the back flow of water from Williamson Creek to the water quality ponds, and will obtain prior approval from TxDOT of the method of preventing backflow.

- Where possible the pond must provide water quality capture volume of the first one-half (0.5) inch of runoff plus an additional one-tenth (0.1) inch for each ten (10) percent increase of impervious cover over twenty (20) percent within the drainage area. Ponds C and E do not meet this requirement.
- Each pond must have an equivalent effluent removal rate to that of Sedimentation/Filtration to the extent possible.

4.3. OFFSITE CONTRIBUTING DRAINAGE AREAS

Offsite drainage areas that contribute runoff to the project ROW were evaluated for feasibility of separating onsite and offsite runoff. The design of the onsite drainage system should first consider all options to separate onsite and offsite runoff for water quality treatment. It is the preference of TxDOT and TCEQ for offsite runoff to bypass onsite water quality controls. However, there are some areas along the project where ROW width is limited and capture of offsite runoff separate from onsite runoff will not be feasible.

At the schematic level, it was determined that separation of onsite and offsite flows would not be feasible for 7 of the 18 ponds and the ponds would need to accept offsite runoff. The basic assumption was:

- If there was at least 8-feet from the back of sidewalk or retaining wall to the ROW line, it would be feasible to collect offsite runoff in a ditch and/or separate storm drain system. The 8-feet theoretically gives enough space for a shallow trapezoidal ditch with inlets or a v-ditch.

Table 4-3 summarizes the ponds, approximate offsite drainage area, and offsite impervious area. The offsite drainage area and impervious area was added to the TCEQ calculation spreadsheet under step 6: *Calculate Capture Volume required by the BMP Type for this drainage basin / outfall area.*

Table 4-3: Summary of Ponds with Offsite Contributing Area

Basin ID	Approximate Offsite Basin Drainage Area (AC)	Approximate Offsite Impervious Cover (AC)	Approximate Offsite Impervious Cover (%)
Pond A	8.8	2.6	30%
Pond G	5.4	0.0	0%
Pond H	29.0	2.9	10%
Pond I	6.1	1.1	18%
Pond J	11.3	2.1	19%
Pond O	22.5	8.5	38%
Pond P	20.0	7.6	38%

Overall, the addition of the offsite area to 7 of the ponds had a relatively small impact. Because of the USFWS commitment, many of the ponds were already designed to operate at a high fraction treated, 0.90 and above. When the ponds have a high fraction treated, increases or decreases in water quality treatment volume have small impacts on the total TSS treatment provided by the pond. Therefore, using a portion of the pond volume to accept the offsite flows did not have a significant effect on the total TSS load removal provided.

During final design there are other options that could be considered by the DB team to minimize pond volumes and maximize treatment. Note that before any of the options listed below are pursued, the DB team should talk with TCEQ on what is and is not acceptable for this project. It is recommended that the DB team speak with TCEQ and obtain written guidance that can be submitted with the EAPP. Both items

listed below would require detailed research on the developments located within the offsite drainage areas to prove the approach and concept is valid.

1. Where offsite drainage is previously treated by a TCEQ permitted BMP, it may be acceptable to assume that the previously treated drainage area is pervious. The entire drainage area must still be accounted for as offsite area draining to the BMP, however all impervious surfaces may be assumed pervious if conveyed to a water quality BMP prior to entering the project ROW.
2. Where offsite drainage areas are currently untreated, consideration could be given to quantifying treatment of those areas. Note that developments that are currently untreated, but could be re-developed and treated in the future would not be eligible for this potential option (i.e. A commercial site).

4.4. PROPOSED WATER QUALITY CONTROLS

Various structural and non-structural BMPs were reviewed for use along the corridor including, VFS, Sand Filter Systems, Bioretention ponds, Batch Detention Basins, and PFC. Due to their high removal efficiency and relatively low cost, VFS are utilized when a water quality basin is not practicable or in series to a water quality basin along the new mainlanes, frontage roads, ramps and sidewalks by providing flat side slopes adjacent to the new pavement edges. VFS along the sidewalks and shared use path utilized the sizing provided in **Table 4-4**, where the filter strip width is approximately one-half the path width.

Table 4-4: Filter Strip Sizing for Shared Use Paths

Shared Use Path Width (ft)	Engineered VFS Width (ft)
4	2.1
6	3.1
8	4.2
10	5.2
12	6.3
14	7.3

As for the mainlanes and frontage roads, the filter strip width should not be less than 15 feet in the direction of flow. VFS should be placed where the roadway width of the contributing impervious area does not exceed 72 feet on one side or 144 feet if placed along both sides of the roadway.

In addition to VFS, three types of water quality ponds were utilized at various locations along the corridor including, Sand Filter Systems, Bioretention, and Batch Detention Basins. Due to the high removal efficiency and aesthetic appeal, Bioretention ponds were designed wherever feasible. Bioretention ponds followed the revisions to the requirements for media depth, water depth over media, and filter media specifications outlined in the TCEQ Bioretention Memo in **Appendix I**. Limitations to Bioretention ponds include:

- Only one foot of allowable ponding depth – ponds require large surface area.
- Need to be in direct sunlight to remain vegetated – cannot be placed under bridges.
- Media depth and underdrain pipe slopes require significant amount of fall from bottom of pond to outfall.

When Bioretention was not feasible, a Sand Filter System was evaluated. Sand Filters can be placed under bridges and have allowable ponding depths between two and eight feet. Therefore, the location and

treatment volume of the Sand Filter System is more flexible than that of the Bioretention pond, making it a more appropriate BMP for corridors with limited open space within the ROW. However, like Bioretention ponds, Sand Filter Systems require a significant amount of hydraulic head with media depth and underdrain pipe slopes. All preliminary Sand Filter Systems were designed as full sedimentation and filtration.

In cases where neither a Bioretention pond nor a Sand Filter System were feasible, a Batch Detention Basin was proposed. The geometry and hydraulic head required with a Batch Detention Basin is more flexible than the Sand Filter System or Bioretention pond and can be designed within tight elevation and geometric constraints.

BMPs were proposed to meet TCEQ requirements and the commitment to the USFWS. The proposed ponds and VFS were able to satisfy the TCEQ TSS load removals requirements. However, the annual TSS load discharged from the project site failed to comply with the commitment to the USFWS when only the ponds and VFS were utilized. PFC was necessary to meet the net 0 lbs/yr increase in TSS discharged from the site between existing and proposed conditions.

In addition to VFS and water quality ponds, PFC was utilized to achieve the required USFWS load removals. PFC locations were determined based on the criteria outlined in the TCEQ Memorandum issued February 26, 2016 which includes revisions to the PFC guidance in RG-348. The revised PFC criteria can be found in **Appendix J.** In addition to the TCEQ PFC criteria, the following TxDOT guidelines and preferences for PFC on the project were also considered when selecting locations.

- PFC shall be placed on main lanes before being placed on frontage roads. As part of TxDOT approval, DB must show that PFC on main lanes does not achieve required removal before placing on frontage roads as a last resort.
- PFC shall begin on the west end of US 290 heading east first to meet TSS removal requirements. Placement of PFC on SH 71 shall be a last resort.
- Minimum section lengths of 1500’.
- The minimum space between sections of PFC is 2000’. Otherwise PFC should be continuous.
- No PFC within 500’ of signalized intersections or stop signs.
- No PFC in areas with multiple driveways.
- No PFC on bridges or bridge approach slabs.
- PFC shall be the width of the pavement, including shoulders. This is not required across entire main lanes separated by barriers or medians where turn lanes are not counted as medians. Only the upgradient 48’ of PFC is counted for TSS removal where the full width of PFC is greater than 48’.
- Roadway cross slopes shall be less than or equal to 2.7% for PFC to be counted for treatment.

To achieve load removal goals, BMPs were located in series including instances of VFS and PFC within pond drainage areas and the overlap of PFC in VFS drainage areas. The process of performing the series calculations involved careful consideration to prevent the double counting of treatment of an area of impervious cover. For instance, Pond C is proposed to have 10.98 total acres of impervious cover including 0.10 acres of impervious cover that drains to a patch of VFS prior to draining to Pond C. This water will be treated by both the VFS and Pond C which will have a greater removal efficiency than either BMP individually. The increased efficiency of BMPs in series was accounted for using the following process:

- To determine the fraction of removal for Pond C, the VFS in series was ignored and the 0.10 acres of impervious cover was included in the 10.98 total acres of proposed impervious cover for pond C. The TCEQ spreadsheet calculated the fraction of removal for Pond C.
- Another sheet within the workbook was created for the modified Pond C drainage area to account for the VFS in series. The 0.10 acres was subtracted out from the 10.98 total acres of proposed impervious cover for Pond C and the fraction of removal for the modified Pond C was set equal to the fraction of removal for the original Pond C. With these changes input, the TSS removal of Pond C only was determined.
- Then, series calculations were performed on the 0.10 acres of VFS inside Pond C's drainage area using the TCEQ spreadsheet for BMP's in a series. This process was followed for all BMPs in series.

A total of 18 water quality ponds are proposed for the project in addition to limited PFC along frontage roads where possible and VFS adjacent to the roadway, sidewalk, and shared use path where practicable. All proposed water quality control facilities are summarized in **Table 4-5** and can be seen in the preliminary water quality site plans located in **Appendix F**. Preliminary Pond layouts can be found in **Appendix G.**

Table 4-5: Summary of Proposed Water Quality Control Facilities

Project Designation	Station	Roadway	Treatment Type	TSS Removed (lbs)
DEVIL'S PEN CREEK WATERSHED				
POND A	232+00 LT	US 290	Bioretention Pond	680
POND B	234+00 RT	US 290	Batch Detention	4,014
PFC to Pond B in Series	Varies	US 290	PFC/Batch Detention Pond	2,030
VFS	Varies	US 290	Vegetated Filter Strip	3,433
PFC	Varies	US 290	Permeable Friction Course	5,534
WILLIAMSON CREEK WATERSHED				
POND C	279+00 RT	US 290	Sand Filter Pond	5,465
POND D	287+00 RT	US 290	Sand Filter Pond	2,850
POND E	303+00 LT	US 290	Sand Filter Pond	5,368
POND F	362+00 LT	US 290	Sand Filter Pond	17,868
POND G	353+00 LT	US 290	Sand Filter Pond	3,275
POND H	374+00 RT	US 290	Sand Filter Pond	5,325
POND I	390+00 Median	US 290	Sand Filter Pond	10,350
POND J	399+00 LT	US 290	Batch Detention	3,170
POND K	25+00 LT	Wm Cannon	Bioretention Pond	2,715
POND L	1124+00 Median	SH 71	Sand Filter Pond	2,379
POND M	1117+50 Median	SH 71	Sand Filter Pond	830
POND N	1115+00 Median	SH 71	Sand Filter Pond	1,133
POND O	1098+00 LT	SH 71	Sand Filter Pond	2,003
POND P	1082+00 Median	SH 71	Bioretention Pond	121
POND Q	1075+00 Median	SH 71	Bioretention Pond	767
VFS to Pond C in Series	Varies	US 290	VFS/Sand Filter Pond	102
VFS to Pond D in Series	Varies	US 290	VFS/Sand Filter Pond	2,217
VFS to Pond E in Series	Varies	US 290	VFS/Sand Filter Pond	2,121
VFS to Pond F in Series	Varies	US 290	VFS/Sand Filter Pond	3,710
PFC to Pond C in Series	Varies	US 290	PFC/Sand Filter Pond	4,144
PFC to Pond D in Series	Varies	SH 72	PFC/Sand Filter Pond	1,933
PFC to Pond F in Series	Varies	SH 71	PFC/Sand Filter Pond	3,060
PFC to Pond O in series	Varies	SH 73	PFC/Sand Filter Pond	2,387
PFC to Pond P in series	Varies	Varies	PFC/Bioretention Pond	773
PFC to Pond Q in Series	Varies	Varies	PFC/Bioretention Pond	2,164
VFS SUP	Varies	Varies	Vegetated Filter Strip	522
PFC	Varies	Varies	Permeable Friction Course	3,708
BARTON CREEK WATERSHED				
POND R (EXISTING)	464+00	US 290	Wet Basin	34,407
POND S (EXISTING)	500+50	US 290	Sand Filter Pond	21,565
POND T	407+00	US 290	Batch Detention	2,740
			Total:	**164,863**

Complying with the USFWS criteria requires that the annual TSS load discharged from the site in proposed conditions must not exceed the **86,290 lbs** of annual TSS load discharged under existing conditions. The impervious cover within the project area results in **246,435 lbs** of annual TSS load produced in proposed conditions. The proposed BMPs remove **164,863 lbs** resulting in **81,571 lbs** of annual TSS load discharged. **Table 4-6** summarizes the proposed conditions of the project site in terms of the annual TSS load.

Table 4-6: Annual TSS Loading Under Proposed Conditions

Proposed Annual TSS Load Produced (lbs)	246,435
Proposed Annual TSS Load Removed (lbs)	164,863
Proposed Annual TSS Load Discharged (lbs)	81,571

A few ponds fail to meet certain criteria outlined earlier in this section and in the Technical Provisions:

- Ponds C and E fail to meet the City of Austin capture volume requirement due to large drainage areas and elevation constraints on the ponds. These ponds will need to be reviewed further during final design.

Given ROW constraints and grade differences between the mainlanes and frontage roads, many ponds will require structural walls. A few ponds will require relatively deep structural walls or structural walls that are directly adjacent to proposed retaining walls for the roadway. The depth and nature of these vertical walled ponds raises a few issues including:

- Maintenance access.
- Safety concerns with the vertical drop off.
- Greater cost.

During final design, the design-build contractor should pay special attention to maintenance access requirements and consider creative solutions for integrating pond walls and roadway walls. See **Table 4-7** for ponds identified needing vertical structural walls.

Table 4-7: Summary of Ponds with Vertical Walls

Pond	Station	Max Estimated Wall Height (ft)
Pond C	279+00 RT	18.5
Pond D	287+00 RT	14.5
Pond E	303+00 LT	29.5
Pond F	362+00 LT	4
Pond G	353+00 LT	13
Pond H	374+00 RT	4.5
Pond J	399+00 LT	12

Between the previous water quality analysis and design report completed in March 2017 and this current report, a couple major changes occurred to the proposed ponds:

- Overlapping impervious cover was accounted for within the water quality calculations; i.e. where there is an overpass, both the bridge pavement and the roadway pavement below the bridge were included as impervious cover within the calculations.
- A new pond, Pond T, is now proposed adjacent to Williamson Creek on the east side below the mainlane bridges.

- Pond H has been relocated from between the eastbound mainlane and frontage road to south of the frontage road.
- Offsite drainage areas to each pond were evaluated.
- Water Quality Ponds within the floodplain were reviewed.
- Existing impervious cover was corrected to accurately account for the storage area.

4.5. *WATER QUALITY POND FLOODPLAIN ANALYSIS*

To comply with TCEQ regulations and the requirements within the technical specifications outlined in the Oak Hill Parkway Project Design-Build Standard Specifications (August 2019), water quality ponds within the effective FEMA 100-year floodplain were reviewed. Due to site constraints, it may not be practical to build all pond berms higher than the FEMA 100-year water surface elevation (WSEL). In fact, for some ponds, building the berm above the FEMA 100-year WSEL may result in adverse hydraulic impacts. In addition, there are some ponds where the roadway drainage area contributing to the pond is also within the FEMA 100-year floodplain. Therefore, an analysis was done to determine which ponds could be protected from the FEMA 100-year floodplain without causing adverse impacts and still meeting the TCEQ regulations by providing treatment for 80% of the incremental increase in TSS loading.

The ponds that partly or wholly located within the FEMA floodplain are F, H, I, J, M, N, O, P, Q, and T. Based on the hydraulic analysis completed by Teague Nall and Perkins, Inc. (TNP), (refer to TNP technical memorandum with subject: “Atlas 14 Rainfall Updates” for more information), and the water quality calculations, it was determined that Ponds H, I, J and Q could be protected from the FEMA 100-year WSEL without causing adverse impacts. Therefore, ponds H, I, J and Q could be permitted with TCEQ.

A secondary set of water quality calculations were performed wherein, all BMPs including ponds, VFS, and PFC located within the FEMA 100-year floodplain were removed from the TSS removal calculations. The only BMP’s located within the floodplain that remain in the secondary set of calculations are Ponds H, I, J, and Q with the understanding that they would need to have a berm height above the FEMA 100-year WSEL. A summary table of the results of this secondary calculation can be found in **Appendix K** and is titled “WATER QUALITY CALCULATIONS SUMMARIES – PROPOSED CONDITIONS – TCEQ”. The objective of this set of calculations is to ensure the project can meet TCEQ regulations and obtain the necessary permits while also meeting other project objectives such as no adverse hydraulic impacts. **Table 4-8** summarizes the Proposed Water Quality Control Facilities to be permitted with TCEQ and the resultant total TSS removals.

Table 4-8: Summary of Proposed Water Quality Control Facilities – TCEQ Permit Requirement

Project Designation	Station	Roadway	Treatment Type	TSS Removed (lbs)
DEVIL'S PEN CREEK WATERSHED				
POND A	232+00 LT	US 290	Bioretention Pond	680
POND B	234+00 RT	US 290	Batch Detention	4,014
PFC to Pond B in Series	Varies	US 290	PFC/Batch Detention Pond	2,030
VFS	Varies	US 290	Vegetated Filter Strip	3,433
PFC	Varies	US 290	Permeable Friction Course	4,668
WILLIAMSON CREEK WATERSHED				
POND C	279+00 RT	US 290	Sand Filter Pond	5,465
POND D	287+00 RT	US 290	Sand Filter Pond	2,850
POND E	303+00 LT	US 290	Sand Filter Pond	5,368
POND G	353+00 LT	US 290	Sand Filter Pond	3,275
POND H	374+00 RT	US 290	Sand Filter Pond	5,325
POND I	390+00 Median	US 290	Sand Filter Pond	10,350
POND J	399+00 LT	US 290	Batch Detention	3,170
POND K	25+00 LT	Wm Cannon	Bioretention Pond	2,715
POND L	1124+00 Median	SH 71	Sand Filter Pond	2,379
POND Q	1075+00 Median	SH 71	Bioretention Pond	1,017
VFS to Pond C in Series	Varies	US 290	VFS/Sand Filter Pond	102
VFS to Pond D in Series	Varies	US 290	VFS/Sand Filter Pond	2,217
VFS to Pond E in Series	Varies	US 290	VFS/Sand Filter Pond	2,121
VFS to Pond F in Series	Varies	US 290	VFS/Sand Filter Pond	2,899
PFC to Pond C in Series	Varies	US 290	PFC/Sand Filter Pond	4,144
PFC to Pond D in Series	Varies	SH 72	PFC/Sand Filter Pond	1,933
PFC to Pond F in Series	Varies	SH 71	PFC/Sand Filter Pond	2,875
PFC to Pond O in series	Varies	SH 73	PFC/Sand Filter Pond	1,475
PFC to Pond Q in Series	Varies	Varies	PFC/Bioretention Pond	1,749
PFC	Varies	Varies	Permeable Friction Course	2,343
BARTON CREEK WATERSHED				
POND R (EXISTING)	464+00	US 290	Wet Basin	34,407
POND S (EXISTING)	500+50	US 290	Sand Filter Pond	21,565
			Total:	**134,571**

4.6. *PROPOSED* RESULTS

Table 4-5 summarizes the TSS removal amount for each of the proposed permanent Water Quality BMPs. The total TSS removed value of **164,863 lbs** is the TSS removal amount for the entire project area under proposed conditions. TCEQ water quality calculations for the entire project area and each BMP can be found in **Appendix K**. With the BMPs proposed, the anticipated TSS removal exceeds the total required removal, see **Table 4-9**.

Table 4-9: Proposed TSS Removal Summary

	Existing	Proposed
Total Project Area (AC)	338.31	346.82
Impervious Area (AC)	138.58	220.74
Annual TSS Load Produced (lbs)	156,804	246,435
Annual TSS Load Removed (lbs)	70,514	164,863
Annual TSS Load Discharged (lbs)	86,290	81,571
[1] TCEQ TSS Removal Required for Project Area (lbs)	**128,116**	
[2] USFWS TSS Removal Required for Project Area (lbs)	**160,145**	

[1] TCEQ Required Removal = 0.80 x (Proposed Annual TSS Load Produced – Existing Annual TSS Load Discharged)
[2] USFWS Required Removal = Proposed Annual TSS Load Produced – Existing Annual TSS Load Discharged

5.0 CONCLUSION & RECOMMENDATIONS

The preliminary water quality controls for the project have been designed to meet all TCEQ Edwards Aquifer Protection Program requirements. Any sensitive features encountered during construction will be addressed in conformance to chapter 213.5 of the TAC. It is recommended that a combination of VFS, Sand Filter Systems, Bioretention ponds, Batch Detention Basins, and PFC be designed as the permanent water quality controls for the Oak Hill Parkway project. **Table 5-10** summarizes the changes in impervious cover and annual TSS load discharged in existing and proposed conditions. By providing a combination of the aforementioned BMPs, the project will be able to meet the TSS removal required by the TCEQ and the USFWS.

Table 5-10: Summary of Impervious Cover and TSS Load Discharged

	Impervious Cover (AC)	Annual TSS Load Discharged (lbs)
Existing	138.58	86,290
Proposed	220.74	81,571

Appendix A: Notice of Activity over the Contributing Zone; and Request of Agreement

Texas Department of Transportation
P.O. DRAWER 15426 • AUSTIN, TEXAS 78761-5426 • (512) 832-7000

June 26, 2013

Texas Commission on Environmental Quality
Region 11
Edwards Program
12100 Park 35 Circle, Bldg. A, Rm. 179
Austin, Texas 78753

ATTN: Kevin Smith, P.E.

RE: Notice of Activity over the Contributing Zone; and Request of Agreement

Dear Kevin:

This notice of upcoming activity is within the vicinity just east of the US 290 and SH 71 split in Travis County. Specifically, an area as outlined in the attachment. Within the boundary shown, there are abandoned parking lots, building foundations and driveways. For years, the remnants of these structures have provided a hard flat surface that was useful for stockpiling road materials and storing TxDOT maintenance equipment.

Recently, TxDOT has received complaints about the appearance of this storage use area. TxDOT also confirms that illegal dumping occurs beyond these paved areas. The pavement fosters clandestine trespass by providing access to areas hidden from view. TxDOT has promised to clear the storage area, remove the pavement and concrete, and restrict unauthorized access. Before and during the process of obliterating and removing these materials, suitable temporary controls will be appropriately placed for the prevention of sediment loss. Then, after re-grading the exposed soil, the area will be seeded for vegetative cover.

The total area is just at the 5 acre threshold for Contributing Zone disturbance, (est. 220K s.f.). And since this activity is demolition and revegetation only, TxDOT is seeking Exemption status for the action.

This request for agreement also extends to the upcoming US 71 and US 290 construction in this same area. The full reconstruction project at the "Y" will not occur soon, but is imminent. TxDOT is seeking TCEQ acknowledgment that the 5 acres of impervious cover soon to be removed, can still be considered "existing conditions" of impervious cover when evaluating the TSS reduction in the forthcoming CZAP.

The department respectfully requests your balanced consideration of both the administration of the Edwards Rules as well as TxDOT's responsibility to provide this public service. The demolition needs to commence soon. A timely response would be greatly appreciated.

If any questions or further clarifications are needed, please contact either me, or Mr. Ben Engelhardt, the South Travis Area Engineer. His contact address: 9725 S. IH 35 Austin, TX. 78744 or, (512) 292-2401 or, ben.engelhardt@txdot.gov).

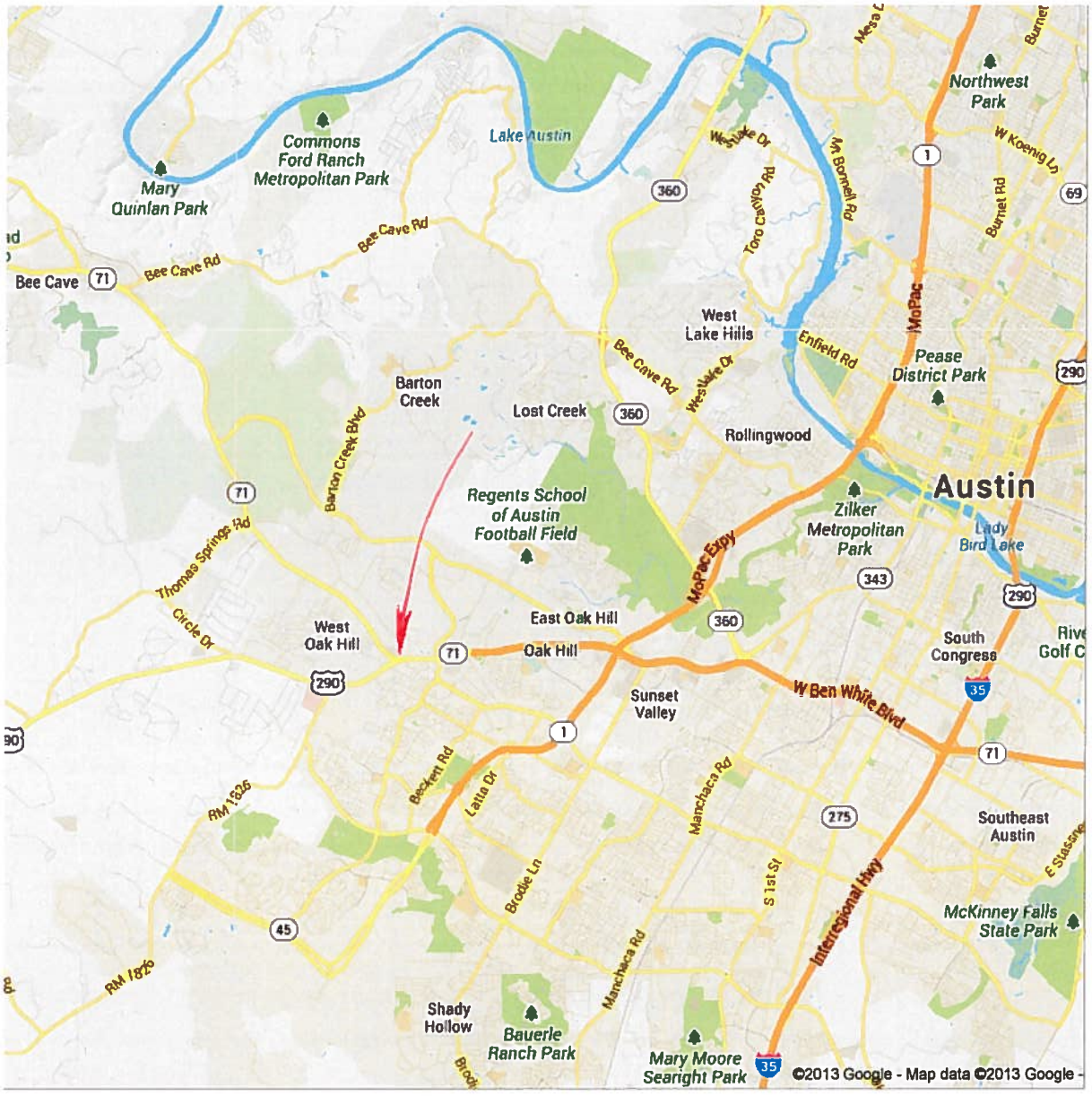
Sincerely,

J. Gary Lantrip, P.G., P.E.
Austin District, TxDOT

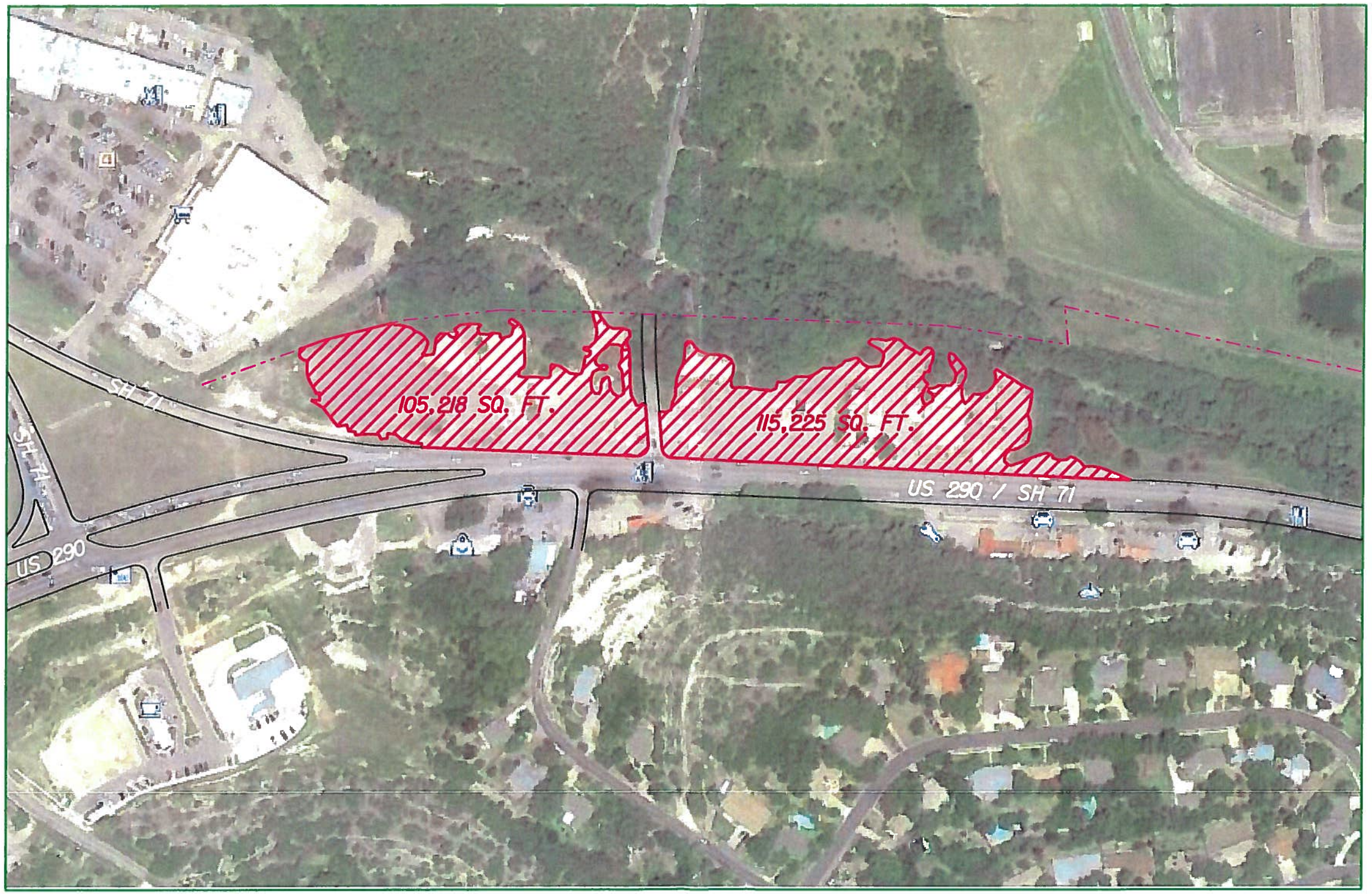
Attachment: location map and layout

Google

Location of;
US 290 @ SH 71 (the "Y")



FILE: T:\DATA\Construction\ALL PROJECTS\011308076 US290 Y Intersection Innovative CJ Jordan\US290IMPCOV.dgn
DATE: 02-May-13 07:14



105,218 SQ. FT.
115,225 SQ. FT.
220,443 SQ. FT.

5.06 ac.)

US 290

IMPERVIOUS COVER

SCALE : 1" = 200'

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SHEET 1 OF 1

FED. RD. DIV. NO.	FEDERAL AID PROJECT NO.		SHEET NO.
6			
STATE	STATE DIST. NO.	COUNTY	
TEXAS	14	TRAVIS	
CONT.	SECT.	JOB	HIGHWAY NO.
0113	08		US 290

Appendix B: EPA Sole Source Aquifer Map

WILLIAMSON CREEK

SH 71

FEMA ZONE AE

PROJECT LIMITS

SCENIC BROOK TRIBUTARY

US 290

PROJECT LIMITS

WHEELER BRANCH

EDWARDS AQUIFER II (AUSTIN AREA)
SOLE SOURCE AQUIFER
STREAMFLOW SOURCE ZONE

EDWARDS AQUIFER CONTRIBUTING ZONE

EDWARDS AQUIFER RECHARGE ZONE

OAK HILL PARKWAY
EPA SOLE SOURCE AQUIFER ZONE EXHIBIT

Texas Department of Transportation

K·FRIESE + ASSOCIATES
PUBLIC PROJECT ENGINEERING

1120 S. Capital of Texas Highway
CityView 2, Suite 100
Austin, Texas 78746
P – 512.338.1704 F – 512.338.1784
TBPE Firm Number 6535
www.kfriese.com

Appendix C: MOU Between the EPA, Region 6 and the TxDOT

Texas Department of Transportation

125 EAST 11TH STREET, AUSTIN, TEXAS 78701-2483 | 512.463.8588 | WWW.TXDOT.GOV

May 31, 2018

Ms. Anne L. Idsal, Regional Administrator
U.S. Environmental Protection Agency, Region 6
1445 Ross Avenue, Ste. 1200
Dallas, Texas 78202-2733

Dear Ms. Idsal:

The Texas Department of Transportation (TxDOT) has been working with Mr. Michael Overbay and Mr. Omar Martinez of your office on a Memorandum of Understanding Between the Environmental Protection Agency, Region 6 and the Texas Department of Transportation Regarding EPA's Review of Projects Potentially Affecting the Edwards Aquifer (MOU).

TxDOT Executive Director James Bass has signed the MOU, and it is now ready for execution by EPA Region 6.

Please find enclosed two partially executed originals. We request that you sign both, and return one original to TxDOT at the following address:

Patrick Lee
Texas Department of Transportation
Environmental Affairs Division
125 E. 11th Street
Austin, Texas 78704

Please feel free to call me at (512) 416-2734 if you have any questions.

Sincerely,

Carlos Swonke
Director of Environmental Affairs Division

Enclosures

cc: Mr. Omar Martinez
Sole Source Aquifer Coordinator
Ground Water/Underground Injection Control Section
Mail Code: 6 WQ-SG
U.S. Environmental Protection Agency, Region 6
1445 Ross Avenue, Ste. 1200
Dallas, Texas 78202-2733

Texas Department of Transportation

125 EAST 11TH STREET, AUSTIN, TEXAS 78701-2483 | 512.463.8588 | WWW.TXDOT.GOV

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Dear Ms. Idsal:

The Texas Department of Transportation (TxDOT) has been working with Mr. Michael Overbay and Mr. Omar Martinez of your office on a Memorandum of Understanding Between the Environmental Protection Agency, Region 6 and the Texas Department of Transportation Regarding EPA's Review of Projects Potentially Affecting the Edwards Aquifer (MOU).

TxDOT Executive Director James Bass has signed the MOU, and it is now ready for execution by EPA Region 6.

Please find enclosed two partially executed originals. We request that you sign both, and return one original to TxDOT at the following address:

Patrick Lee
Texas Department of Transportation
Environmental Affairs Division
125 E. 11th Street
Austin, Texas 78704

Please feel free to call me at (512) 416-2734 if you have any questions.

Sincerely,

Carlos Swonke
Director of Environmental Affairs Division

COPY

Enclosures

cc: Mr. Omar Martinez
Sole Source Aquifer Coordinator
Ground Water/Underground Injection Control Section
Mail Code: 6 WQ-SG
U.S. Environmental Protection Agency, Region 6
1445 Ross Avenue, Ste. 1200
Dallas, Texas 78202-2733

MEMORANDUM OF UNDERSTANDING
BETWEEN
THE ENVIRONMENTAL PROTECTION AGENCY, REGION 6
AND
THE TEXAS DEPARTMENT OF TRANSPORTATION
REGARDING
EPA'S REVIEW OF PROJECTS POTENTIALLY AFFECTING THE EDWARDS AQUIFER

This Memorandum of Understanding ("MOU") is entered into by and between the Environmental Protection Agency, Region 6 ("EPA Region 6") and the State of Texas, acting by and through its Texas Department of Transportation ("TxDOT").

Whereas, §1424(e) of the Safe Drinking Water Act establishes the sole source aquifer program;

Whereas, EPA has designated the Edwards Aquifer as a sole source aquifer under §1424(e) of the Safe Drinking Water Act through two separate designations;

Whereas, first, in 1975, EPA designated that part of the Edwards Aquifer that exists in the San Antonio area ("Edwards I"), consisting of the Edwards I Streamflow Source Area and the Edwards I Recharge Zone, both of which are shown on **Exhibit A** (small scale) and **Exhibit B** (large scale);

Whereas, second, in 1988, EPA designated that part of the Edwards Aquifer that exists in the Austin Area ("Edwards II"), consisting of the Edwards II Streamflow Source Area, the Edwards II Recharge Zone, and the Edwards II Artesian Zone, all three of which are shown on **Exhibit A** (small scale) and **Exhibit C** (large scale);

Whereas, EPA has promulgated rules regarding "Review of Projects Affecting the Edwards Underground Reservoir, A Designated Sole Source Aquifer in the San Antonio, Texas Area," codified at 40 C.F.R. Part 149, Subpart B ("EPA's Edwards I rules");

Whereas, EPA's Edwards I rules, at 40 C.F.R. §149.103, require federal agencies (in this case, TxDOT as a delegee) to maintain lists of projects that require an environmental impact statement ("EIS") under the National Environmental Policy Act ("NEPA") and are located within the Edwards Aquifer I Streamflow Source Area and the Edwards I Recharge Zone, and revise the list at regular intervals and submit it to EPA;

Whereas, EPA's Edwards I rules, at 40 C.F.R. §149.104, also allow any person to submit a petition requesting the EPA Regional Administrator to review any particular project, regardless of whether it is the subject of an EIS, to determine if such project may contaminate the aquifer;

Whereas, EPA's Edwards I rules, at 40 C.F.R. §149.105 & 149.106, require the EPA Regional Administrator to review all federally funded EIS projects that may have an impact on ground water quality, and give the EPA Regional Administrator discretion to review non-EIS projects, either in response to a petition from the public or on his or her own motion, in which case he or she is required

to provide written notice to the federal agency (in this case, TxDOT as a delegee) of his decision to undertake a review;

Whereas, in 1997, EPA Region 6 and Federal Highway Administration ("FHWA") Region 6 voluntarily entered into a memorandum of understanding regarding EPA's review of projects potentially affecting sole source aquifers in Arkansas, Louisiana, New Mexico, Oklahoma, and Texas under the sole source aquifer program ("1997 FHWA-EPA MOU");

Whereas, the Texas Commission on Environmental Quality has established regulations, known as the "Edwards Aquifer Rules" and codified at 30 Tex. Admin. Code Chapter 213, that are designed to protect water quality in the Edwards Aquifer;

Whereas, TxDOT projects are required to comply with applicable provisions of the Edwards Aquifer Rules, including the requirement to prepare a project-specific water pollution abatement plan, as applicable; and

Whereas, FHWA has delegated to TxDOT its responsibilities to comply with various federal environmental laws, including the Safe Drinking Water Act, with respect to highway projects in Texas by a memorandum of understanding dated December 16, 2014 ("FHWA-TxDOT NEPA Assignment MOU").

Now, therefore, EPA Region 6 and TxDOT agree as follows with respect to FHWA-funded projects for which TxDOT has been delegated responsibility under the FHWA-TxDOT NEPA Assignment MOU:

1. For federal projects for which TxDOT has authority under the FHWA-TxDOT NEPA Assignment MOU, TxDOT and EPA Region 6 will follow the process detailed below.

2. TxDOT will submit for EPA Region 6's review any federally funded TxDOT project that **(a)** is partially or wholly located within the boundary of the EPA-designated Edwards I Streamflow Source Area, Edwards I Recharge Zone, Edwards II Streamflow Source Area, or Edwards II Recharge Zone; **(b)** is the subject of an Environmental Assessment (EA) or EIS; and **(c)** consists of one or more of the following project types (which are the four types of projects that normally require an EIS according to the FHWA's rules at 23 CFR §771.115(a)):

   a. A new controlled access freeway.

   b. A highway project of four or more lanes on a new location.

   c. Construction or extension of a fixed transit facility (e.g., rapid rail, light rail, commuter rail, bus rapid transit) that will not be located within an existing transportation right-of-way.

   d. New construction or extension of a separate roadway for buses or high occupancy vehicles not located within an existing highway facility.

TxDOT may, at its discretion, submit for EPA Region 6's review, any other federally funded TxDOT project for which TxDOT determines such review is appropriate. Further, nothing in this MOU affects EPA Region 6's authority under 40 C.F.R. §149.102 to review any other specific project or project(s) that EPA Region 6 considers may potentially contaminate the aquifer through its recharge zone so as to create a significant hazard to public health.

3. A map showing the boundaries of the EPA-designated Edwards I Streamflow Source Area, Edwards I Recharge Zone, Edwards II Streamflow Source Area, and Edwards II Recharge Zone is attached as **Exhibit A** (small scale). Large scale maps showing these areas are attached as **Exhibit B** and **Exhibit C**. The boundaries of these zones and areas are also shown on EPA's interactive map of sole source aquifers, which is accessible on-line at https://www.epa.gov/dwssa. An additional zone, the Edwards II Artesian Zone, is depicted both on **Exhibit A** and **Exhibit C,** and on EPA's interactive map of sole source aquifers; however, this MOU does not apply to projects with the Edwards II Artesian Zone.

4. For any project that meets the conditions set forth above, TxDOT will provide to EPA Region 6 written notice of the availability of the draft EIS or draft EA for the project and either a paper or electronic copy (e.g., flash drive, CDs, etc.) of the draft EIS or draft EA on or around the same time the draft EIS or draft EA is made available for public review.

5. TxDOT will provide the notice described above by mailing it to the following address (or an alternative mailing address provided by EPA Region 6):

Mr. Omar T. Martinez
Sole Source Aquifer Coordinator
Ground Water/Underground Injection Control Section
Mail Code: 6WQ-SG

USEPA Region 6
1445 Ross Avenue
Suite 1200
Dallas, TX 75202

6. EPA Region 6 intends to provide any written comments to TxDOT within 45 calendar days of receiving a notice of availability as described above. However, no assumption of a determination of a lack of impacts can be assumed if EPA is unable to complete its review within that timeframe.

7. The process set forth above satisfies the requirement at 40 C.F.R. §149.103 to submit a list of EIS projects to EPA at regular intervals.

8. This MOU is entered into in accordance with EPA's sole source aquifer program. It does not modify or pertain to any other EPA programs.

9. Coordination under this MOU will preclude the requirements of the 1997 FHWA-EPA MOU with respect to any FHWA-funded projects for which TxDOT has assumed responsibility under the FHWA-TxDOT NEPA Assignment MOU.

10. Nothing in this MOU shall be construed as limiting or altering in any way EPA's authority to review projects and make determinations as provided in EPA's Edwards I rules or under Section 1424(e) of the Safe Drinking Water Act.

In witness thereof, the parties hereto have caused this MOU to be duly executed in duplicate as of the date of the last signature written below.

EPA REGION 6

Anne L. Idsal Dated: 6/18/18

Anne L. Idsal
Regional Administrator
Environmental Protection Agency, Region 6

STATE OF TEXAS

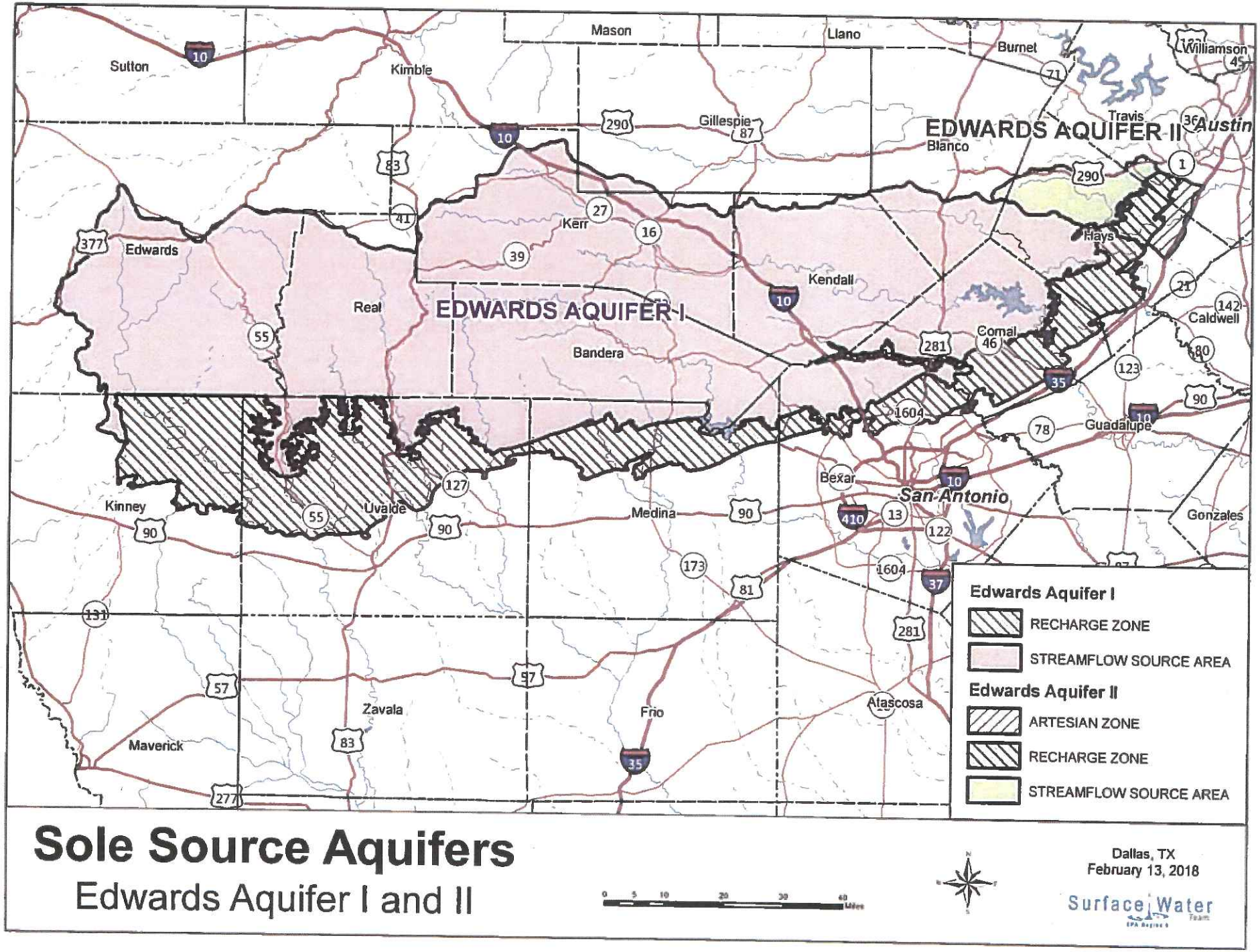
James M Bass Dated: 5/25/18

James Bass
Executive Director
Texas Department of Transportation

EXHIBIT A

MAP OF EPA'S
EDWARDS AQUIFER I AND II SOLE SOURCE AQUIFER AREAS

(small scale)



Sole Source Aquifers

Edwards Aquifer I and II

Dallas, TX
February 13, 2018

Surface Water

EXHIBIT B

MAP OF EPA'S
EDWARDS AQUIFER I SOLE SOURCE AQUIFER AREA

(large scale)

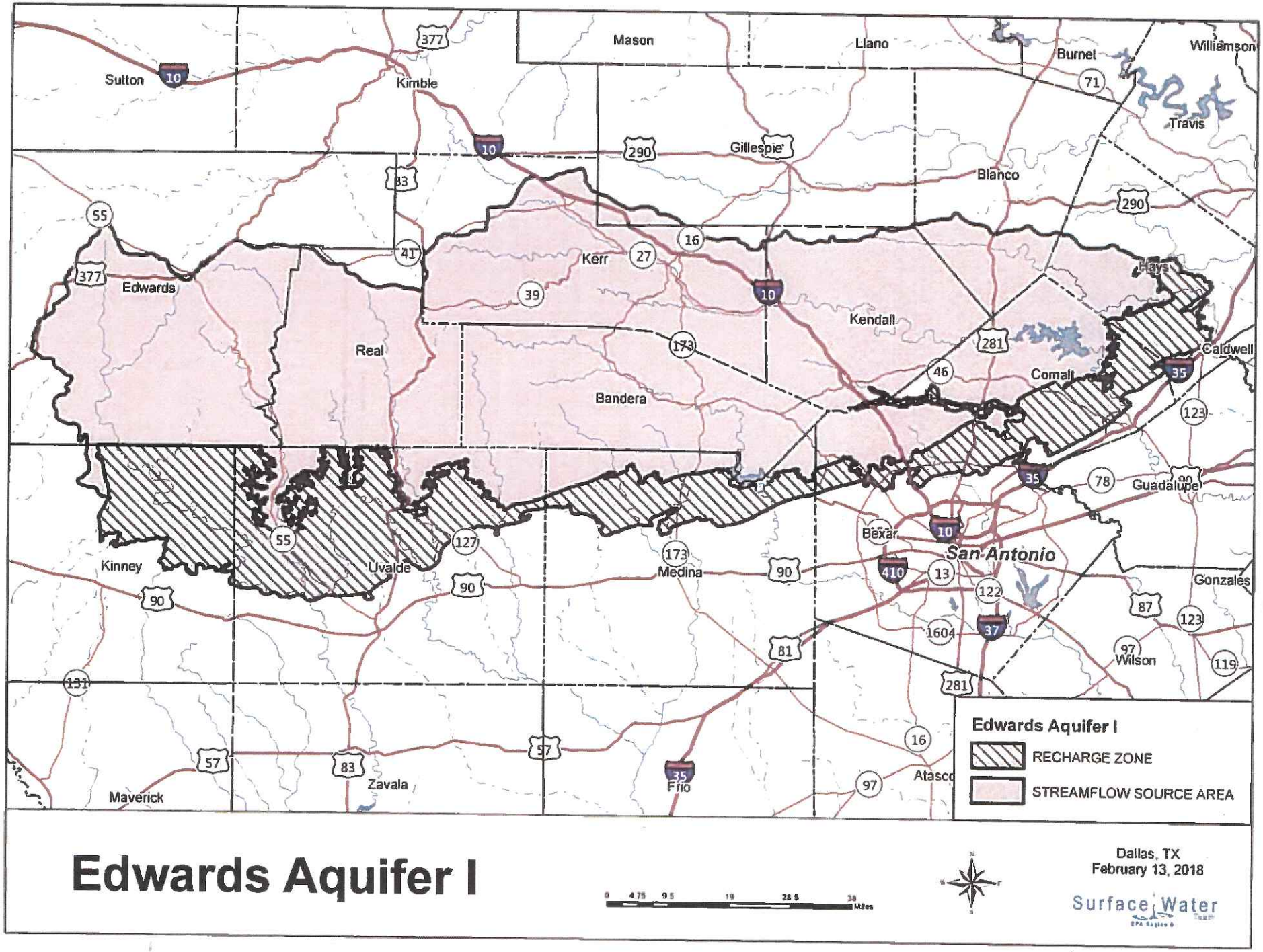
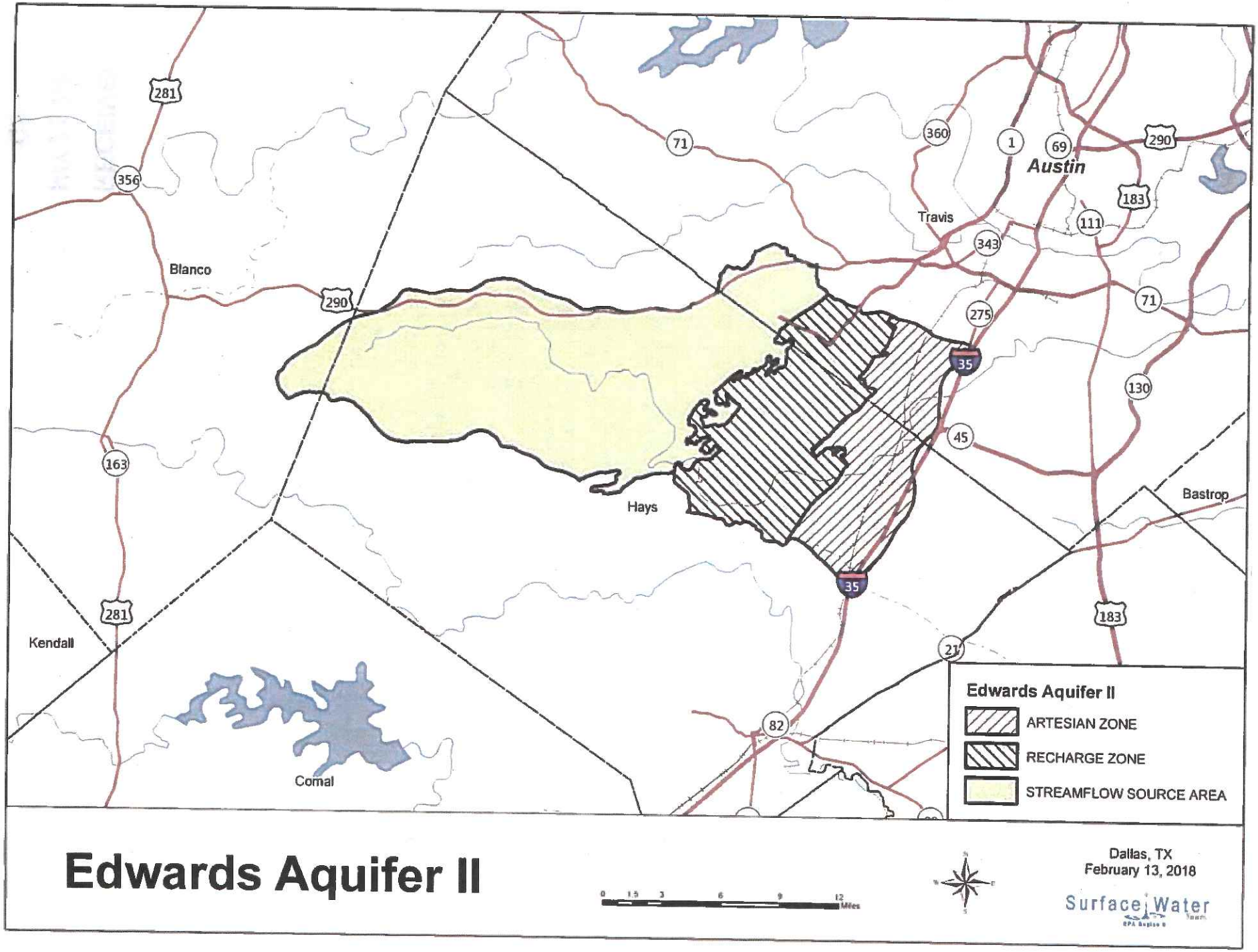

Sutton
Kimble
Mason
Llano
Burnet
Williamson
Travis
Gillespie
Blanco
Kerr
Hays
Edwards
Real
Kendall
Caldwell
Comal
Bandera
Guadalupe
Bexar
San Antonio
Kinney
Uvalde
Medina
Gonzales
Wilson
Maverick
Zavala
Frio
Atasco
Edwards Aquifer I
RECHARGE ZONE
STREAMFLOW SOURCE AREA
Edwards Aquifer I
0 4.75 9.5 19 28.5 38 Miles
Dallas, TX
February 13, 2018
Surface Water

EXHIBIT C

MAP OF EPA'S
EDWARDS AQUIFER II SOLE SOURCE AQUIFER AREA

(large scale)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356
71
360
1
69
290
Austin
183
Travis
111
343
Blanco
290
71
275
35
130
45
163
Hays
Bastrop
35
281
183
Kendall
21
82
Comal
Edwards Aquifer II
ARTESIAN ZONE
RECHARGE ZONE
STREAMFLOW SOURCE AREA
Edwards Aquifer II
0 1.5 3 6 9 12 Miles
Dallas, TX
February 13, 2018
Surface Water

Appendix D: Existing Impervious Cover Exhibit

Total Existing Project Area (AC)	338.31
Total Existing Impervious Area (AC)	138.58
Total Existing PFC (AC)	18.49
Total Existing Overlapping Impervious Area (AC)	2.29

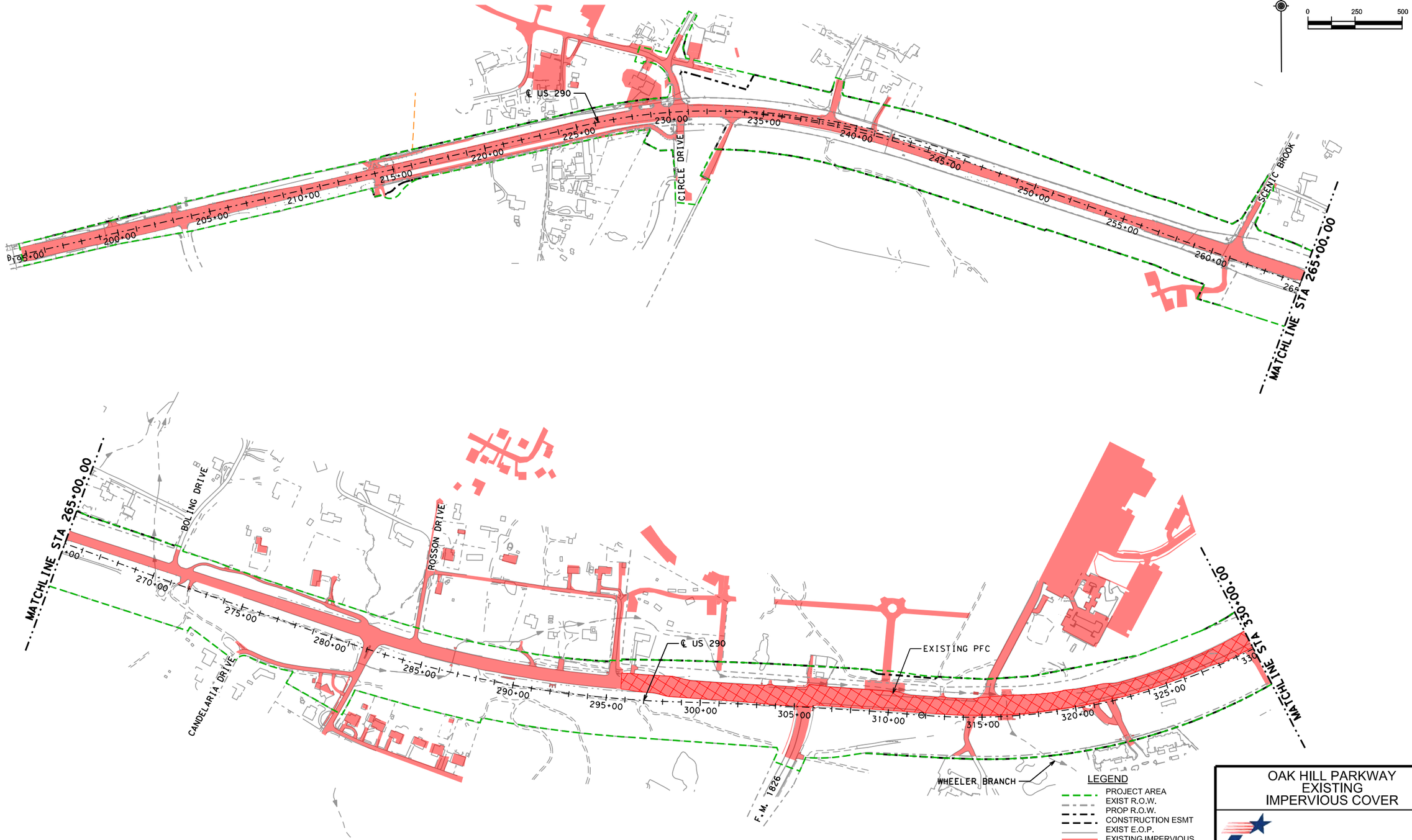
LEGEND

- PROJECT AREA
- EXIST R.O.W.
- PROP R.O.W.
- CONSTRUCTION ESMT
- EXIST E.O.P.
- EXISTING IMPERVIOUS COVER
- EXISTING OVERLAPPING IMPERVIOUS COVER
- EXISTING PFC
- EXISTING FEMA ZONE AE

OAK HILL PARKWAY EXISTING IMPERVIOUS COVER

Texas Department of Transportation

K·FRIESE + ASSOCIATES
PUBLIC PROJECT ENGINEERING
1120 S. Capital of Texas Highway
CityView 2, Suite 100
Austin, Texas 78746
P – 512.338.1704 F – 512.338.1784
TBPE Firm Number 6535
www.kfriese.com



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- CONSTRUCTION ESMT
- EXIST E.O.P.
- EXISTING IMPERVIOUS COVER
- EXISTING OVERLAPPING IMPERVIOUS COVER
- EXISTING PFC
- EXISTING FEMA ZONE AE

OAK HILL PARKWAY EXISTING IMPERVIOUS COVER

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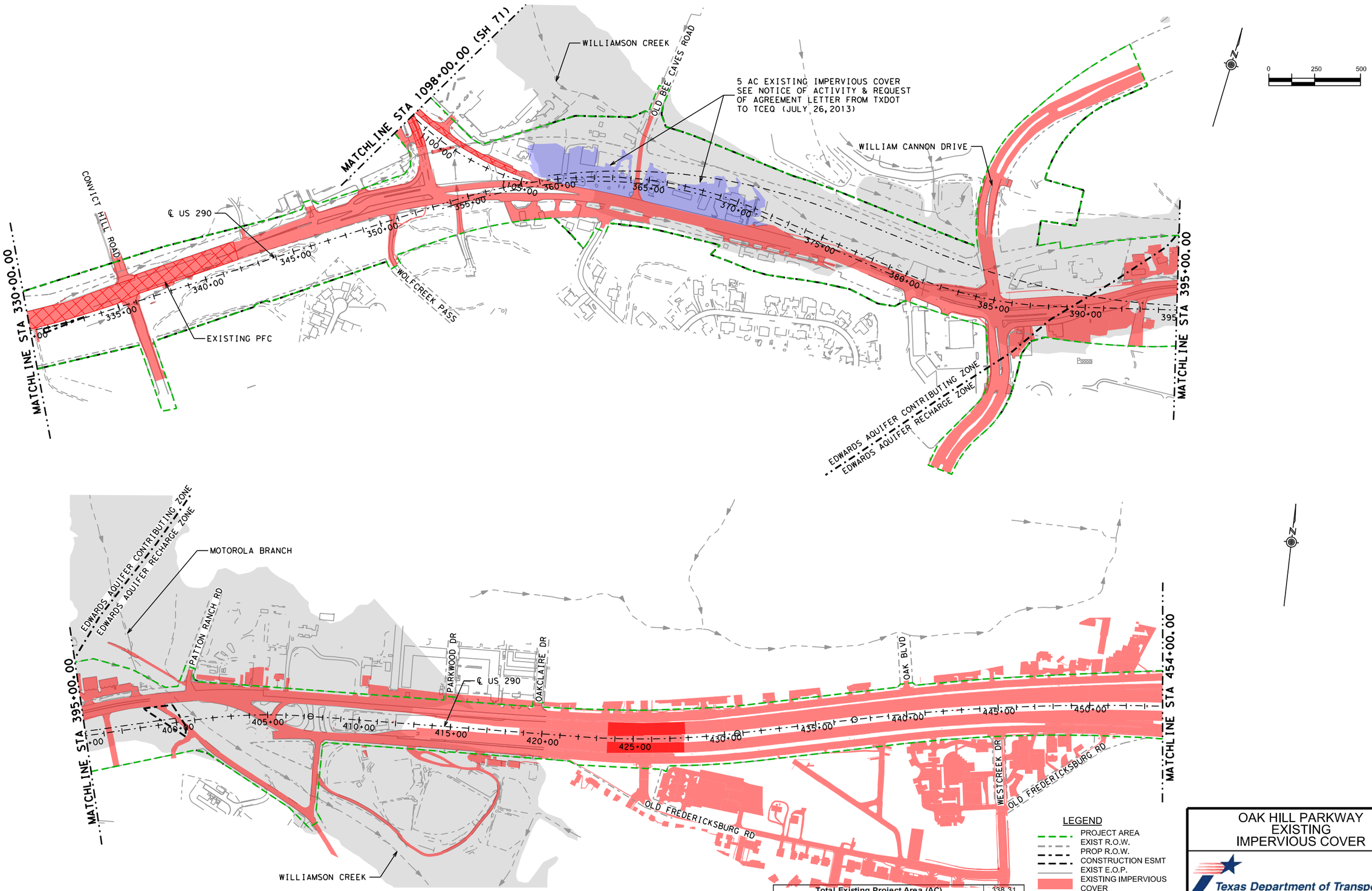

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OAK HILL PARKWAY EXISTING IMPERVIOUS COVER

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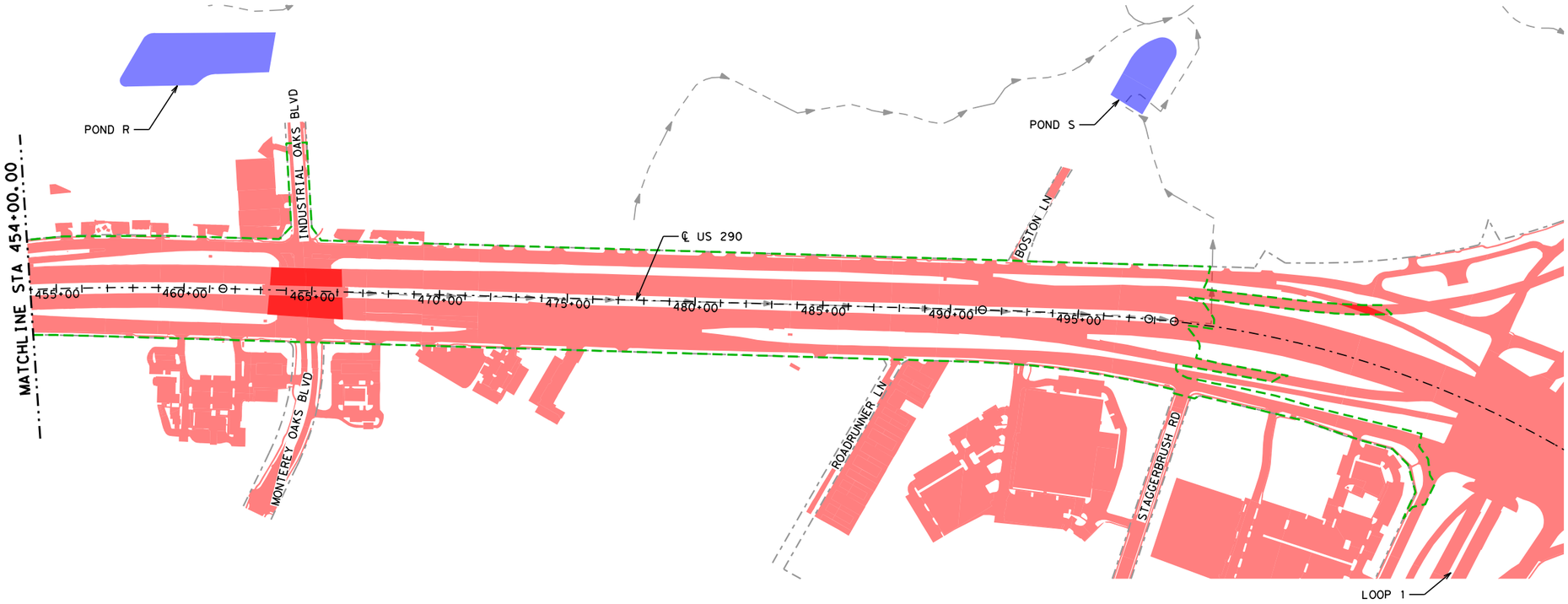

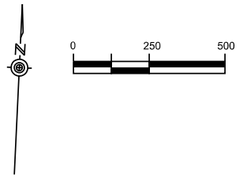

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- EXISTING FEMA ZONE AE

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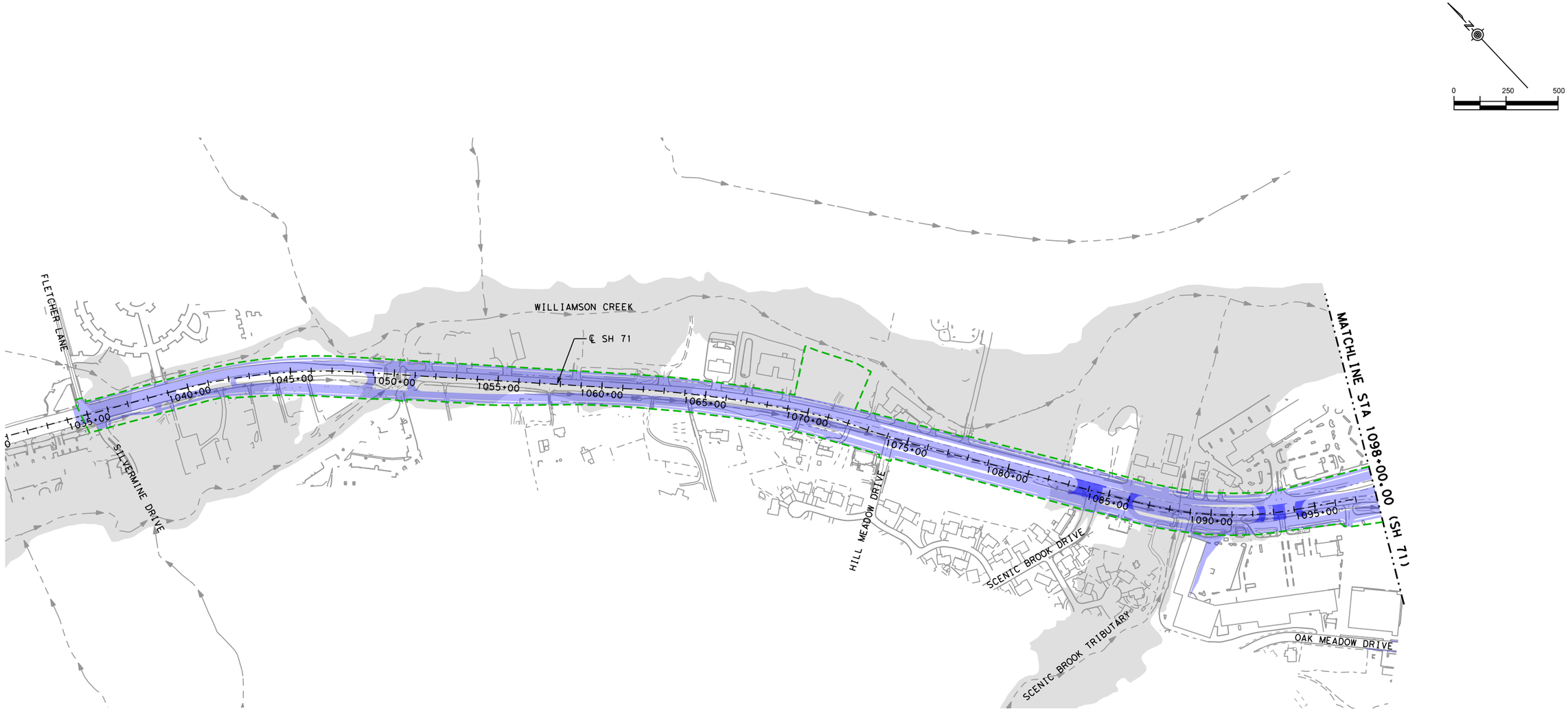
Appendix E: Proposed Impervious Cover Exhibit



Total Proposed Area (AC)	346.82
Total Proposed Impervious Area (AC)	220.74
Total Proposed PFC (AC)	24.82
Total Proposed Overlapping Impervious Area (AC)	10.80

LEGEND

- PROJECT AREA
- EXIST R.O.W.
- PROP R.O.W.
- CONSTRUCTION ESMT
- EXIST E.O.P.
- PROP E.O.P.
- PROPOSED IMPERVIOUS COVER
- PROPOSED OVERLAPPING IMPERVIOUS COVER
- FEMA ZONE AE

OAK HILL PARKWAY PROPOSED IMPERVIOUS COVER

Texas Department of Transportation

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- PROP E.O.P.
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OAK HILL PARKWAY PROPOSED IMPERVIOUS COVER

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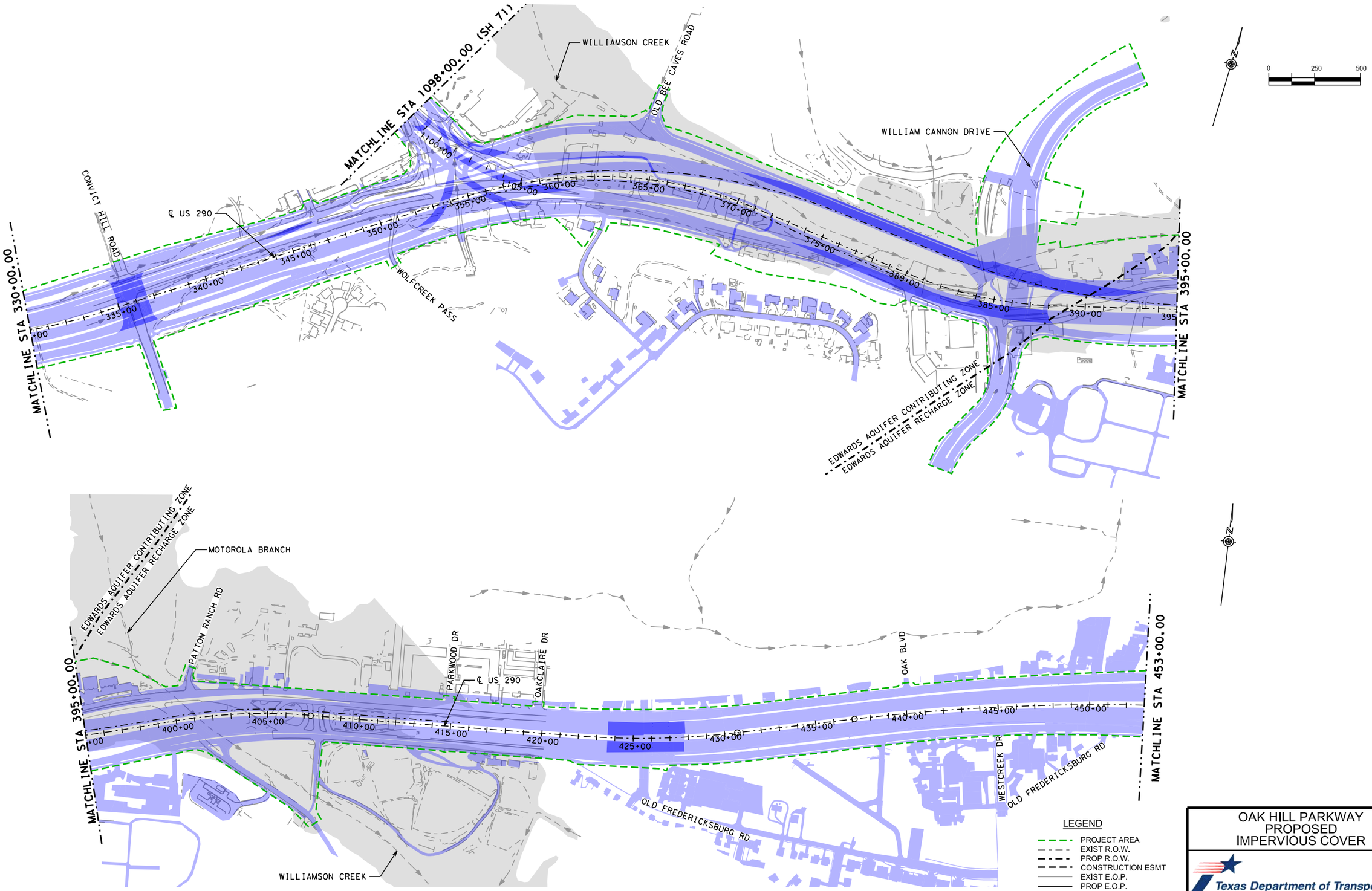

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- PROP E.O.P.
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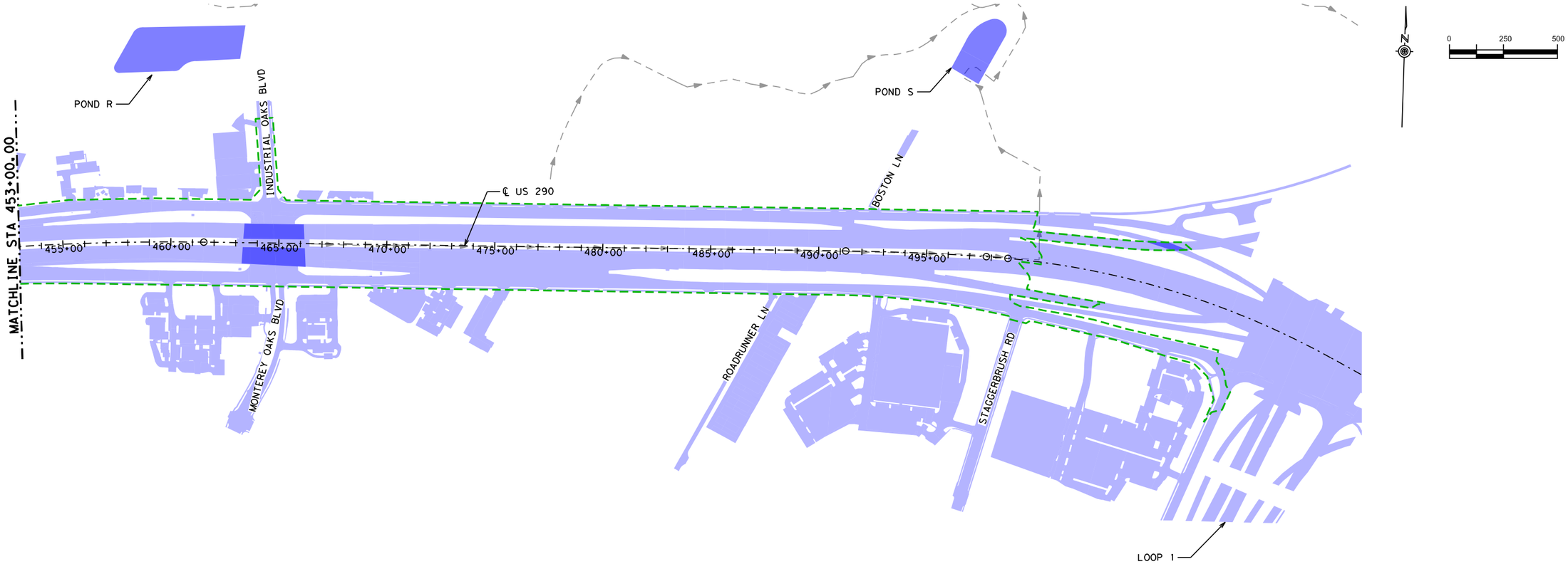

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- PROP R.O.W.
- CONSTRUCTION ESMT
- EXIST E.O.P.
- PROP E.O.P.
- PROPOSED IMPERVIOUS COVER
- PROPOSED OVERLAPPING IMPERVIOUS COVER
- FEMA ZONE AE

OAK HILL PARKWAY PROPOSED IMPERVIOUS COVER

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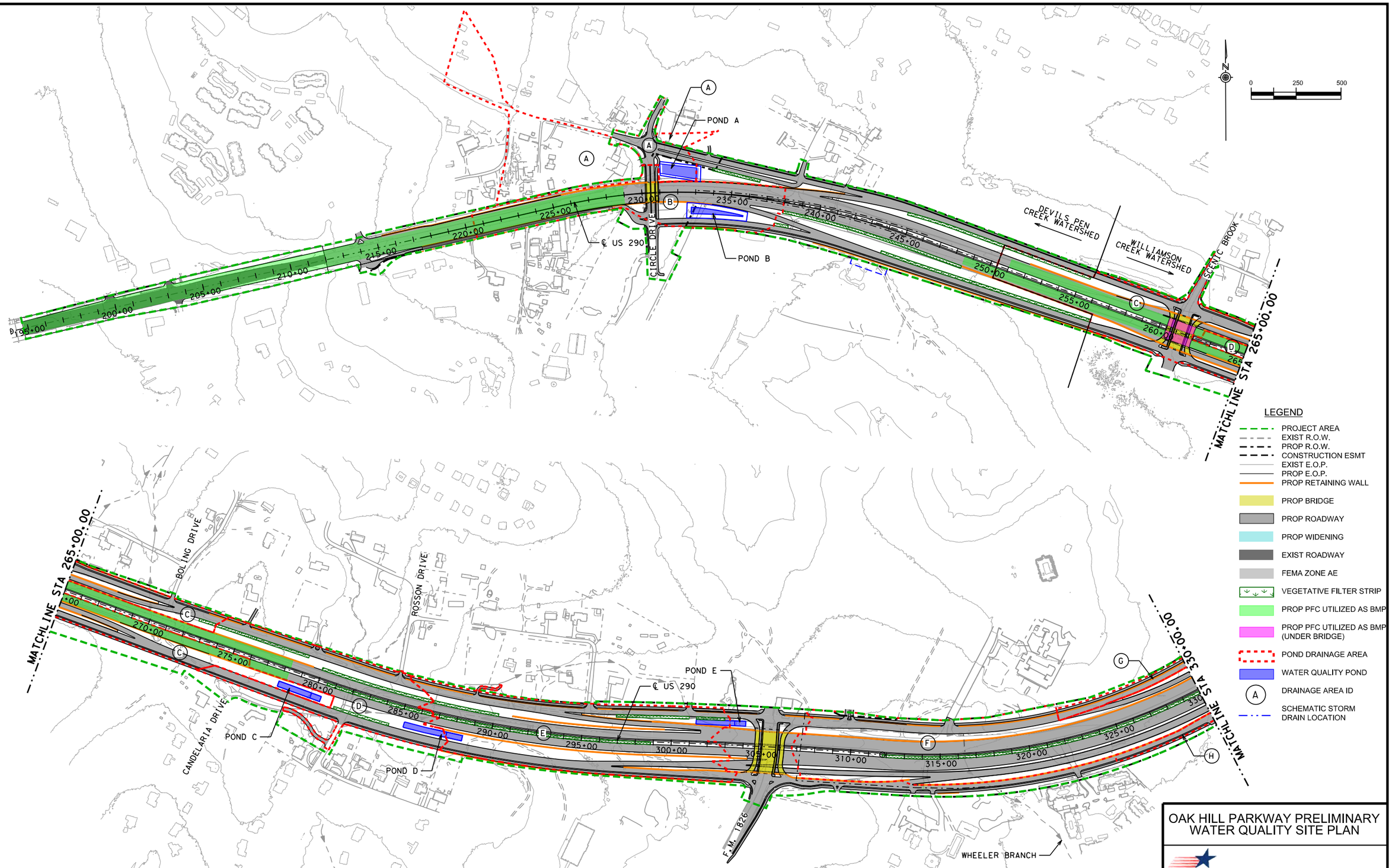
Appendix F: Preliminary Water Quality Site Plan



OAK HILL PARKWAY PRELIMINARY WATER QUALITY SITE PLAN

Texas Department of Transportation

K·FRIESE + ASSOCIATES
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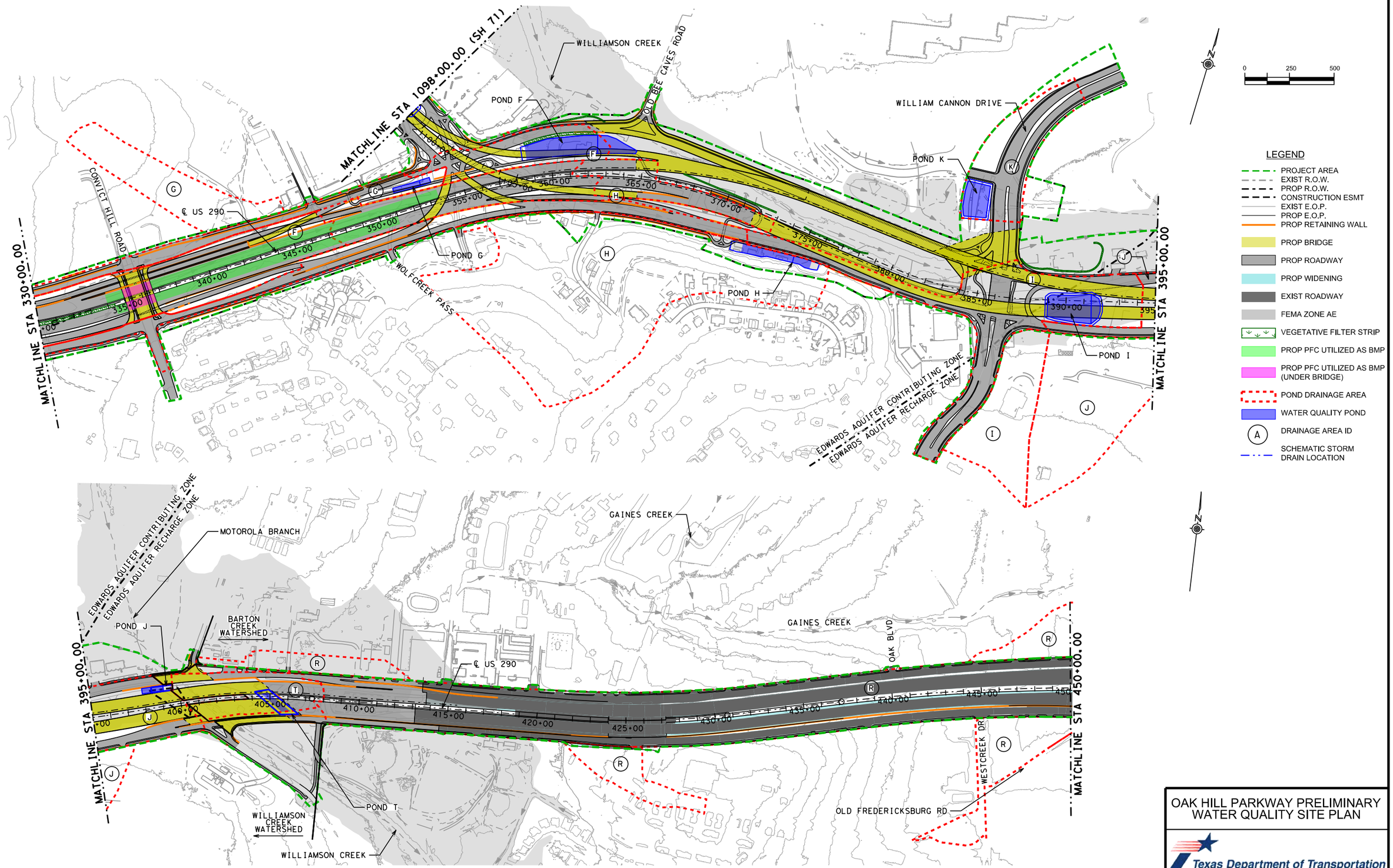

OAK HILL PARKWAY PRELIMINARY WATER QUALITY SITE PLAN

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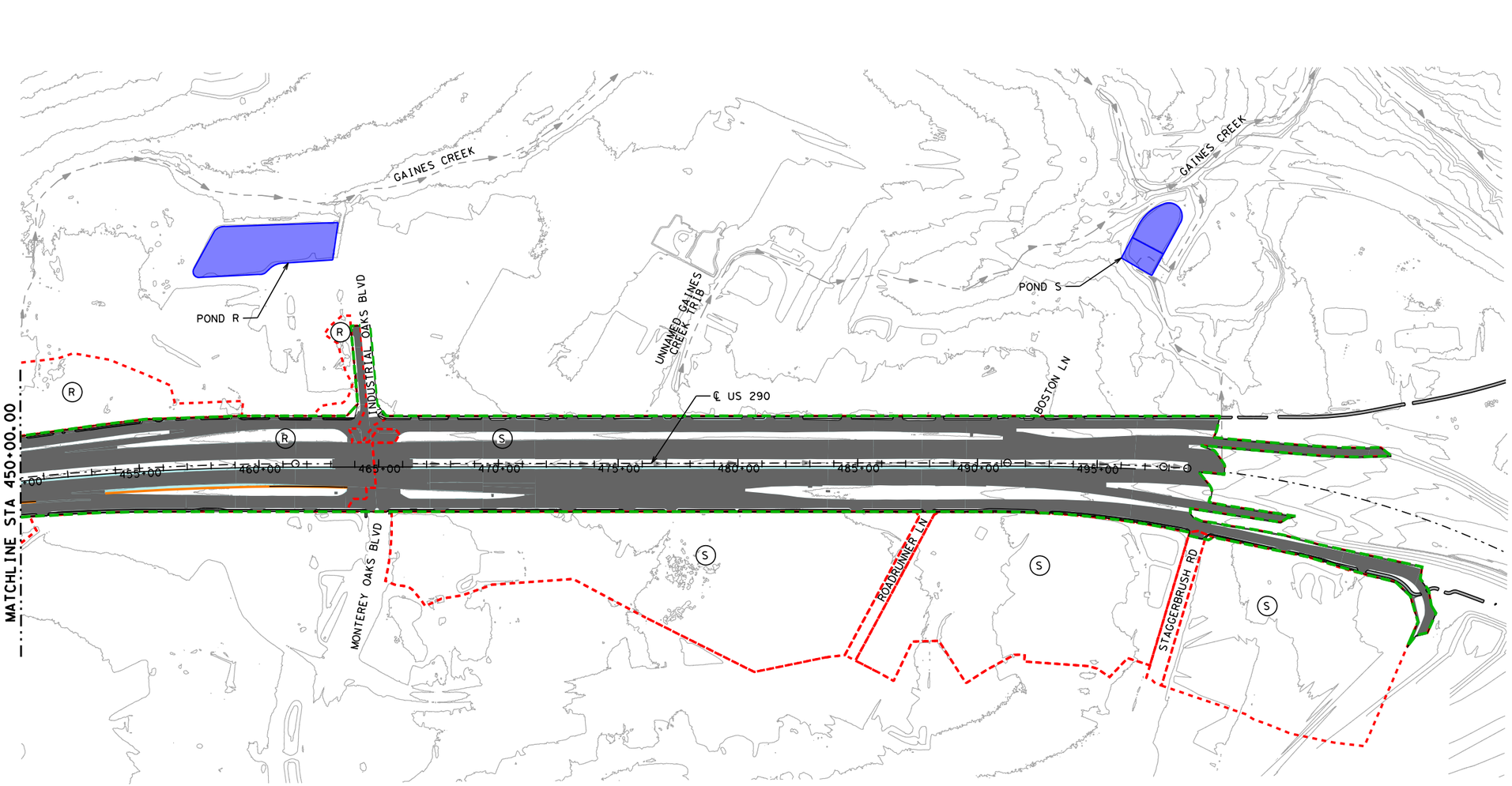

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LEGEND

- PROJECT AREA
- EXIST R.O.W.
- PROP R.O.W.
- CONSTRUCTION ESMT
- EXIST E.O.P.
- PROP E.O.P.
- PROP RETAINING WALL
- PROP BRIDGE
- PROP ROADWAY
- PROP WIDENING
- EXIST ROADWAY
- FEMA ZONE AE
- VEGETATIVE FILTER STRIP
- PROP PFC UTILIZED AS BMP
- PROP PFC UTILIZED AS BMP (UNDER BRIDGE)
- POND DRAINAGE AREA
- WATER QUALITY POND
- (A) DRAINAGE AREA ID
- SCHEMATIC STORM DRAIN LOCATION

OAK HILL PARKWAY PRELIMINARY WATER QUALITY SITE PLAN

Texas Department of Transportation

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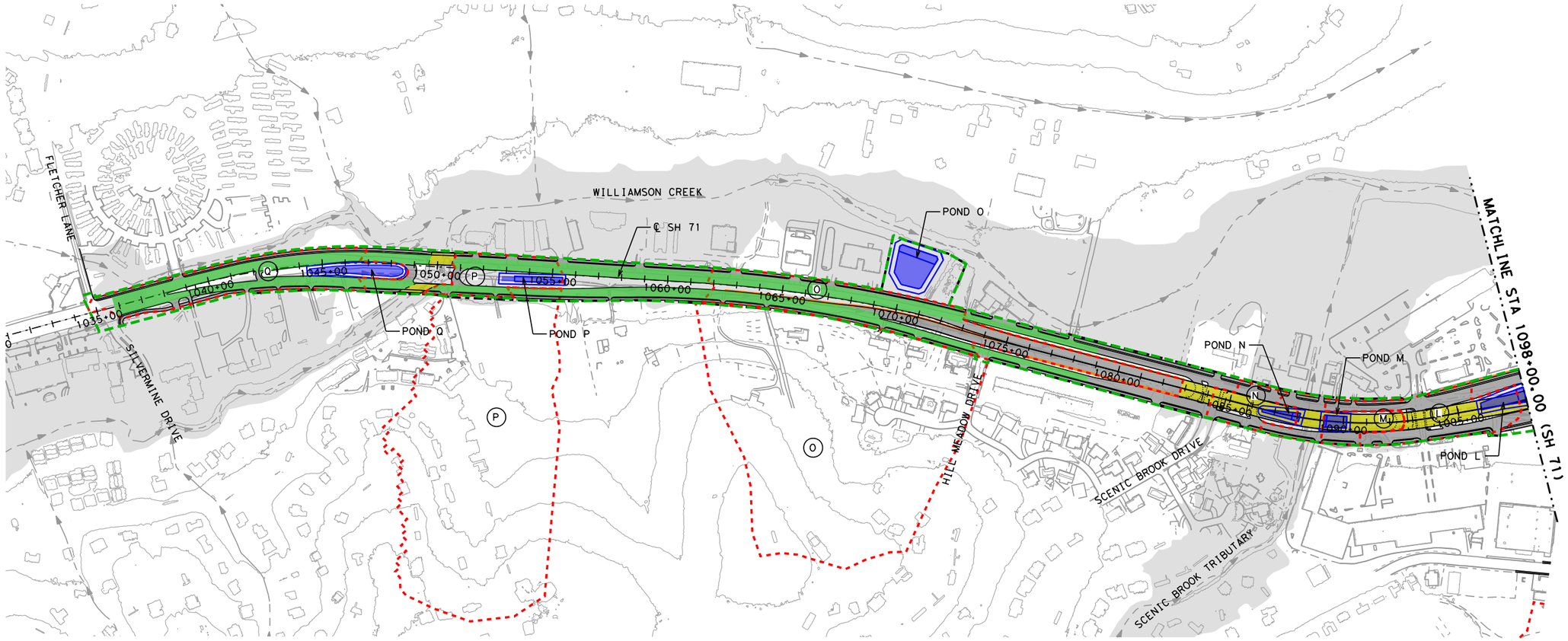

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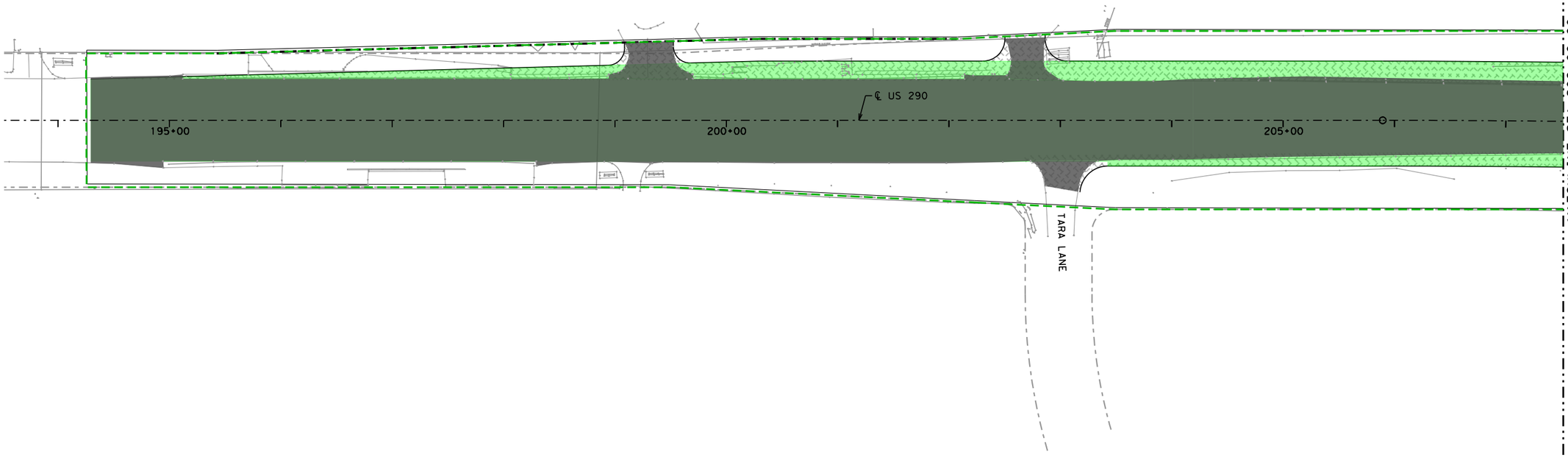

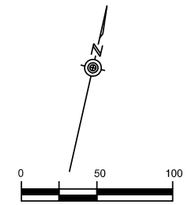

LEGEND

- PROJECT AREA
- EXIST R.O.W.
- PROP R.O.W.
- CONSTRUCTION ESMT
- EXIST E.O.P.
- PROP E.O.P.
- PROP RETAINING WALL
- PROP BRIDGE
- PROP ROADWAY
- PROP WIDENING
- EXIST ROADWAY
- FEMA ZONE AE
- VEGETATIVE FILTER STRIP
- PROP PFC UTILIZED AS BMP
- PROP PFC UTILIZED AS BMP (UNDER BRIDGE)
- POND DRAINAGE AREA
- WATER QUALITY POND
- (A) DRAINAGE AREA ID
- SCHEMATIC STORM DRAIN LOCATION
- MAINTENANCE PATH/PAD

OAK HILL PARKWAY PRELIMINARY WATER QUALITY SITE PLAN

Texas Department of Transportation

K·FRIESE + ASSOCIATES
PUBLIC PROJECT ENGINEERING
1120 S. Capital of Texas Highway
CityView 2, Suite 100
Austin, Texas 78746
P – 512.338.1704 F – 512.338.1784
TBPE Firm Number 6535
www.kfriese.com

MATCHLINE STA 208+00.00

210+00

215+00

℄ US 290

220+00

B

MATCHLINE STA 222+00.00

Pool

N

0 50 100

LEGEND

- PROJECT AREA
- EXIST R.O.W.
- PROP R.O.W.
- CONSTRUCTION ESMT
- EXIST E.O.P.
- PROP E.O.P.
- PROP RETAINING WALL
- PROP BRIDGE
- PROP ROADWAY
- PROP WIDENING
- EXIST ROADWAY
- FEMA ZONE AE
- VEGETATIVE FILTER STRIP
- PROP PFC UTILIZED AS BMP
- PROP PFC UTILIZED AS BMP (UNDER BRIDGE)
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- WATER QUALITY POND
- (A) DRAINAGE AREA ID
- SCHEMATIC STORM DRAIN LOCATION
- MAINTENANCE PATH/PAD

OAK HILL PARKWAY PRELIMINARY WATER QUALITY SITE PLAN

Texas Department of Transportation

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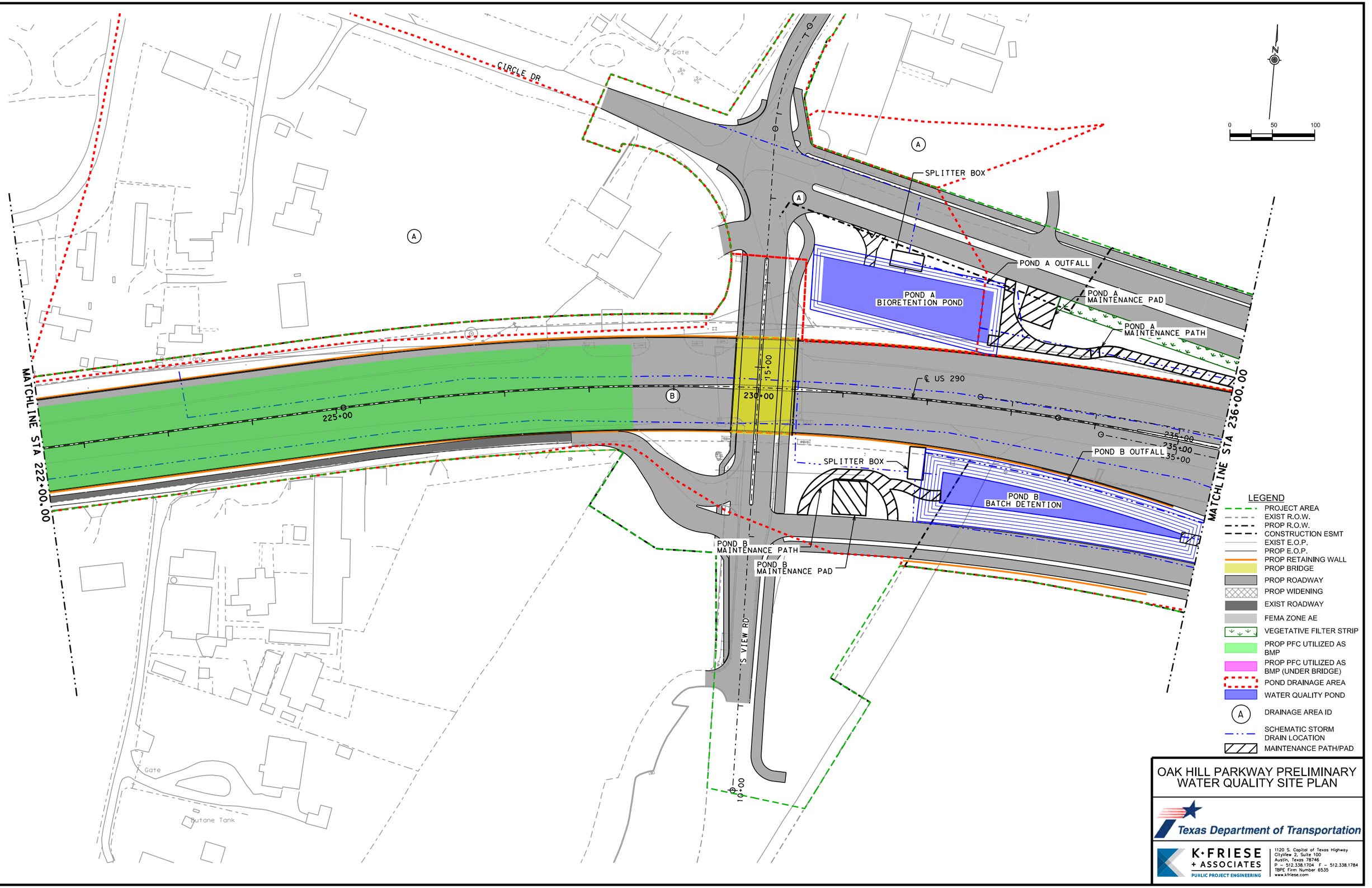

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THUNDERBIRD RD

℄ US 290

℄ US 290 WB

℄ US 290 EB

240+00

240+00

240+00

245+00

245+00

245+00

MATCHLINE STA 236+00.00

MATCHLINE STA 250+00.00

B

POND B OUTFALL

Gate

PROP DRAINAGE ESMT

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LEGEND

- PROJECT AREA
- EXIST R.O.W.
- PROP R.O.W.
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- EXIST E.O.P.
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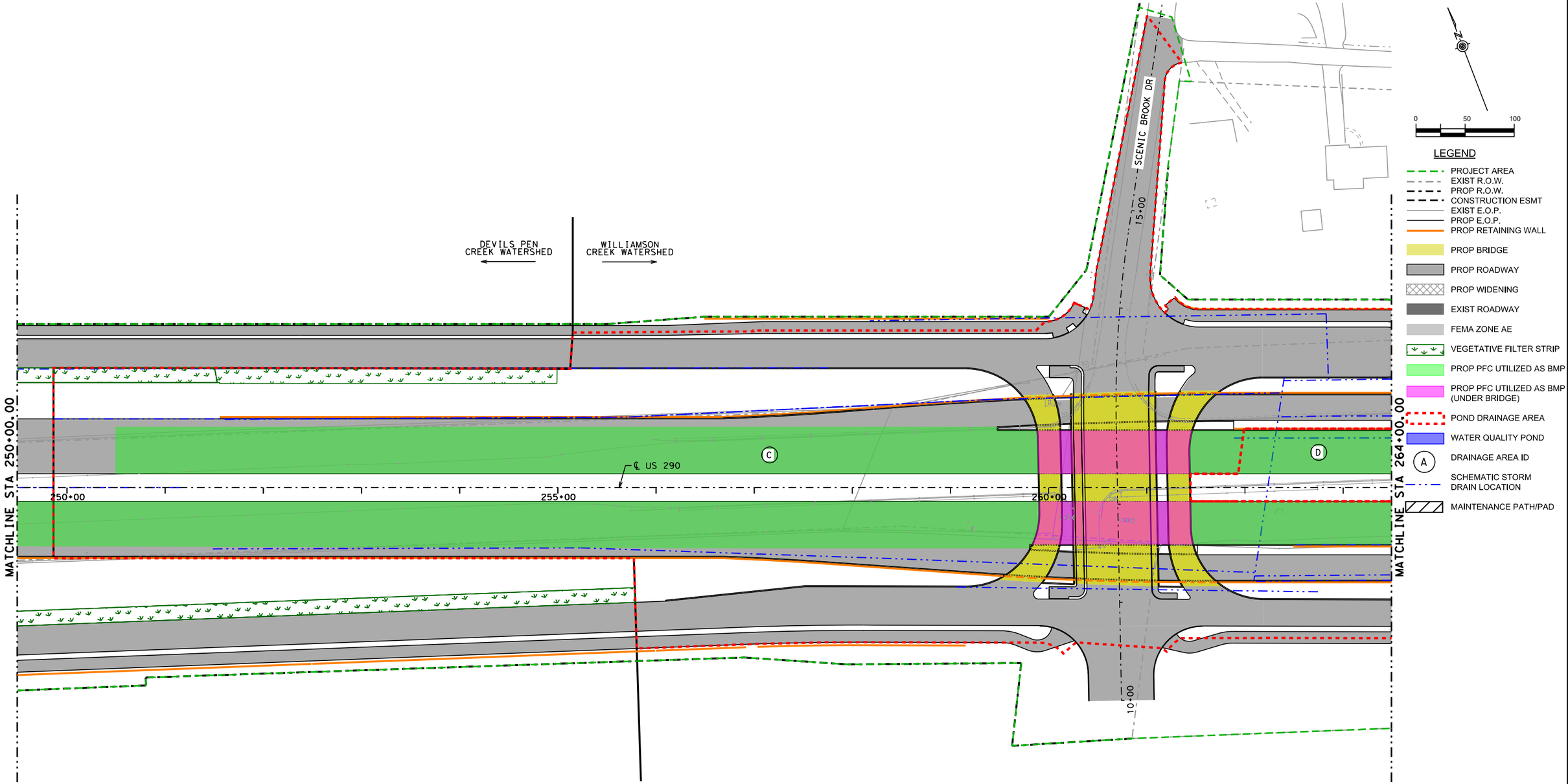

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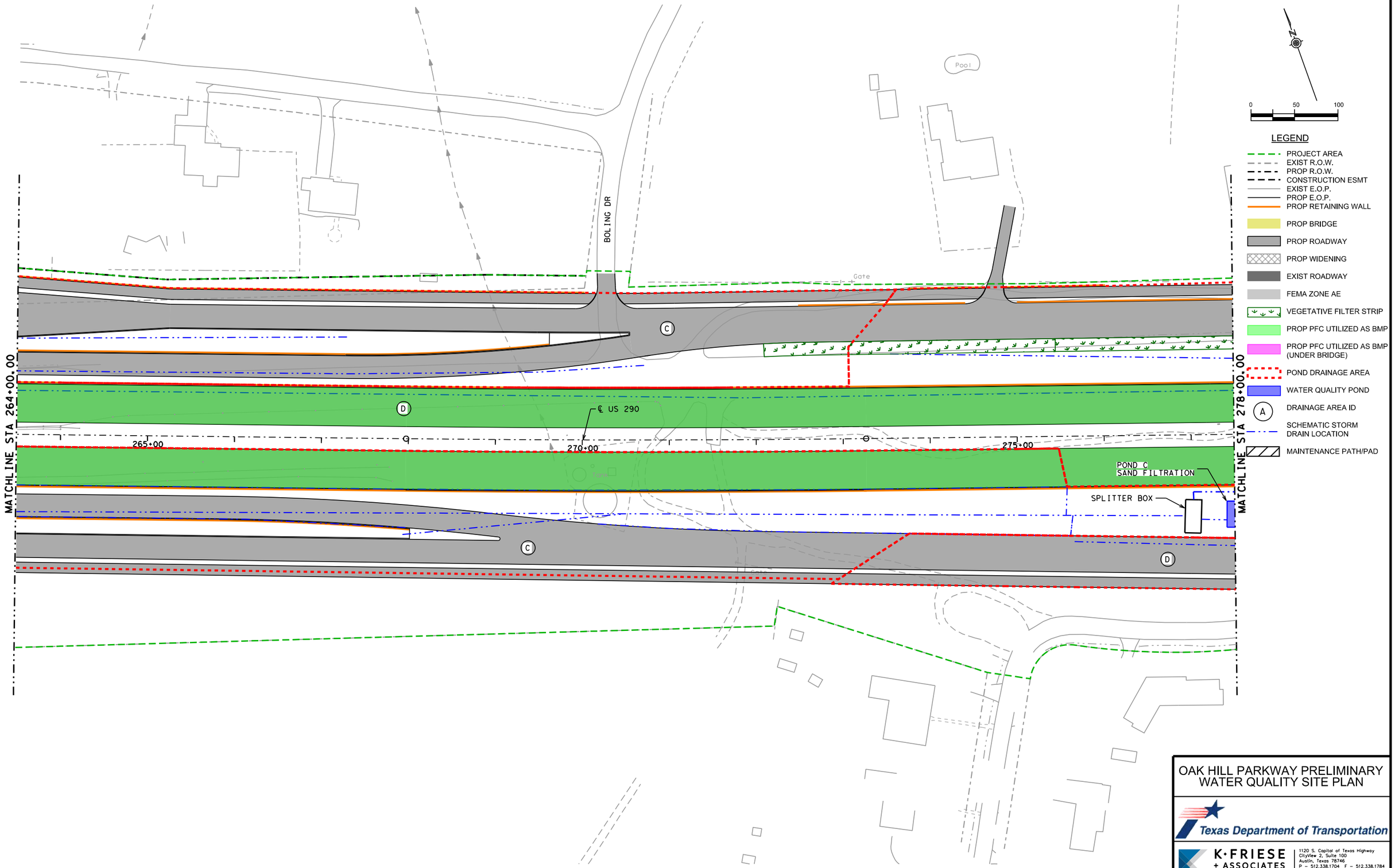

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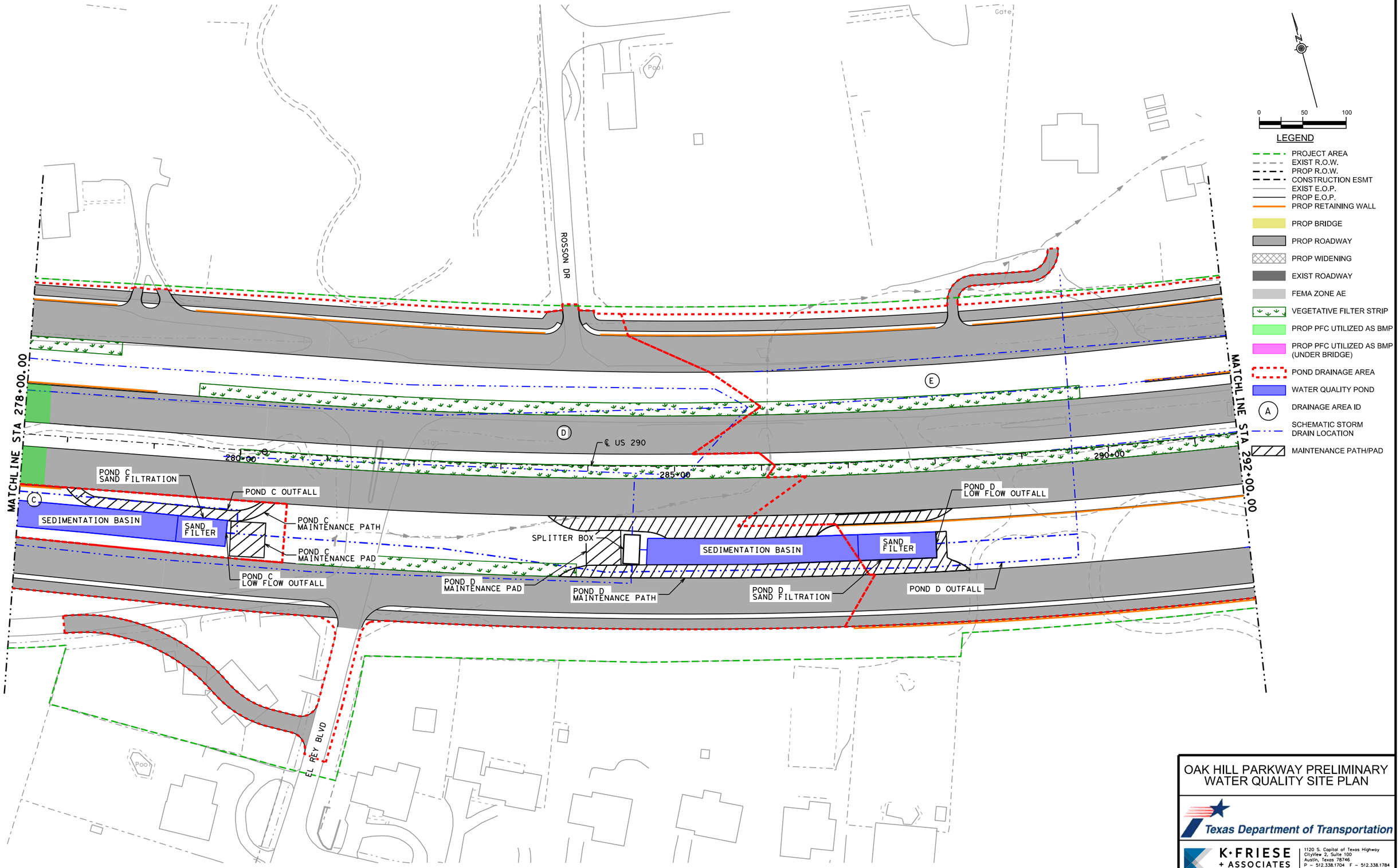

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HUDSON LOOP

POND E
MAINTENANCE PAD

POND E
MAINTENANCE PATH

POND E
SAND FILTRATION

POND E
LOW FLOW OUTFALL

SEDIMENTATION BASIN

SAND
FILTER

SPLITTER BOX

POND E OUTFALL

℄ US 290

STA 292+00.00

MATCHLINE STA 292+00.00

295+00

300+00

305+00

STA 306+00.00

MATCHLINE STA 306+00.00

20+00

15+00

FM 1826

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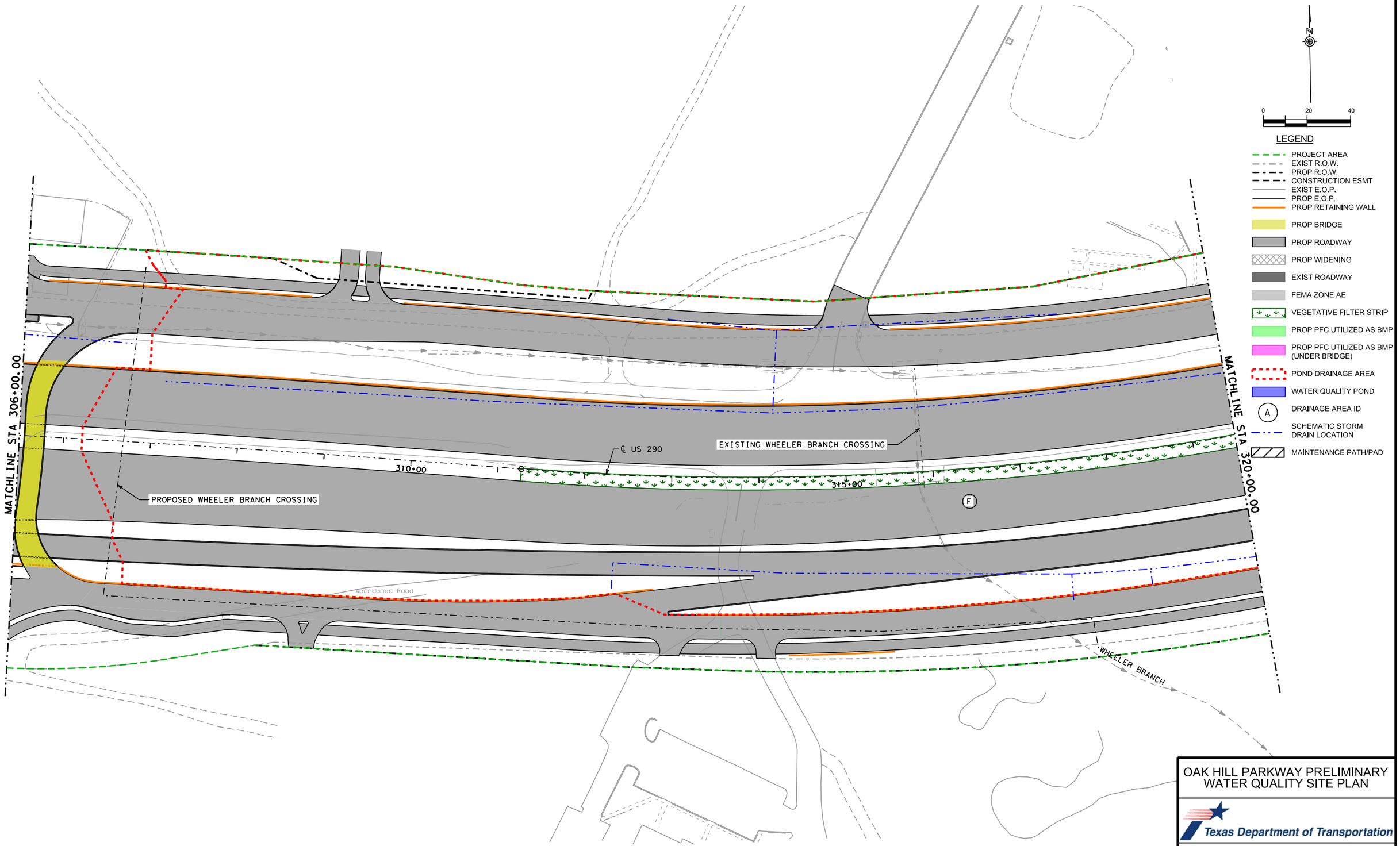

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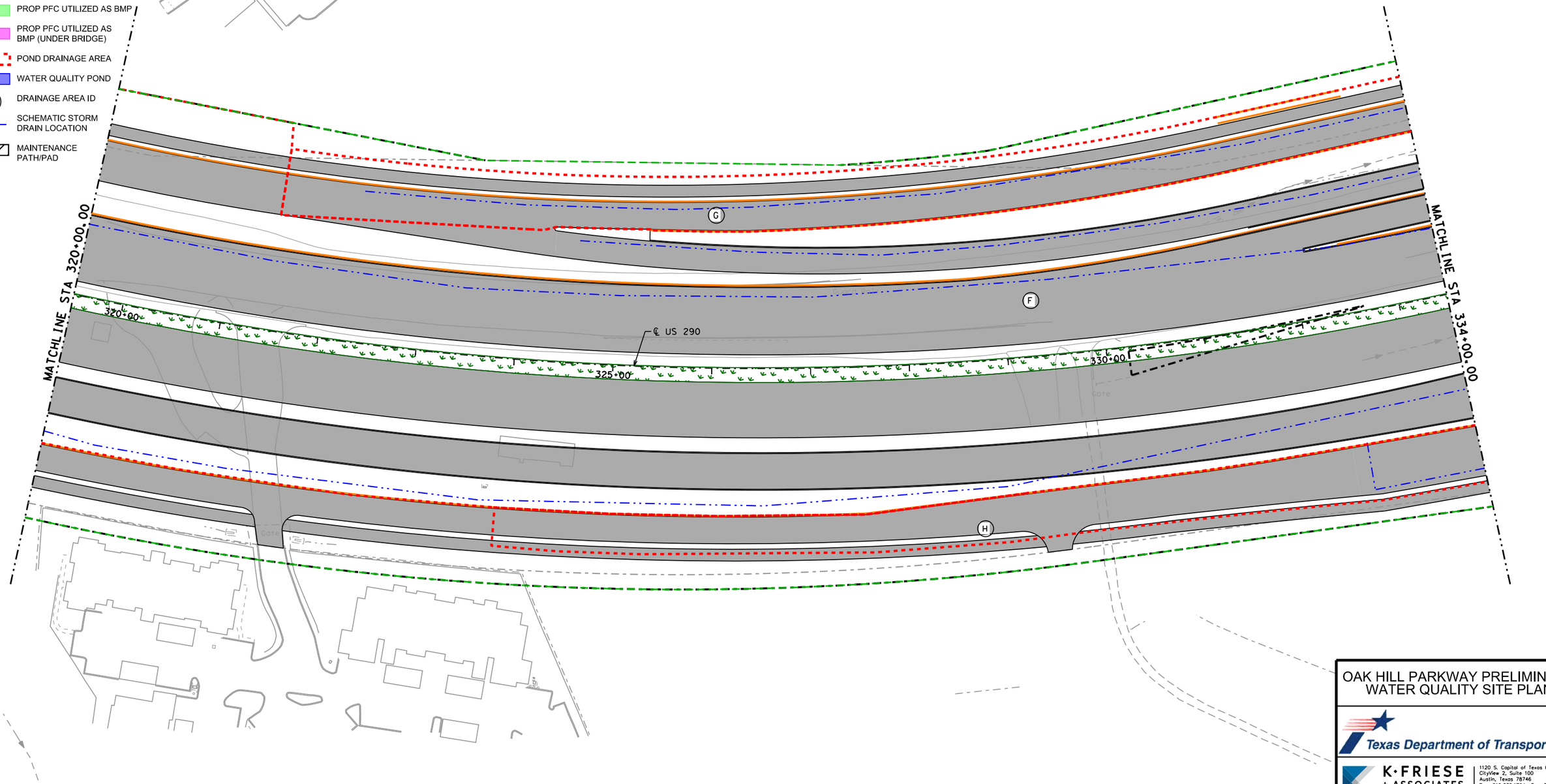

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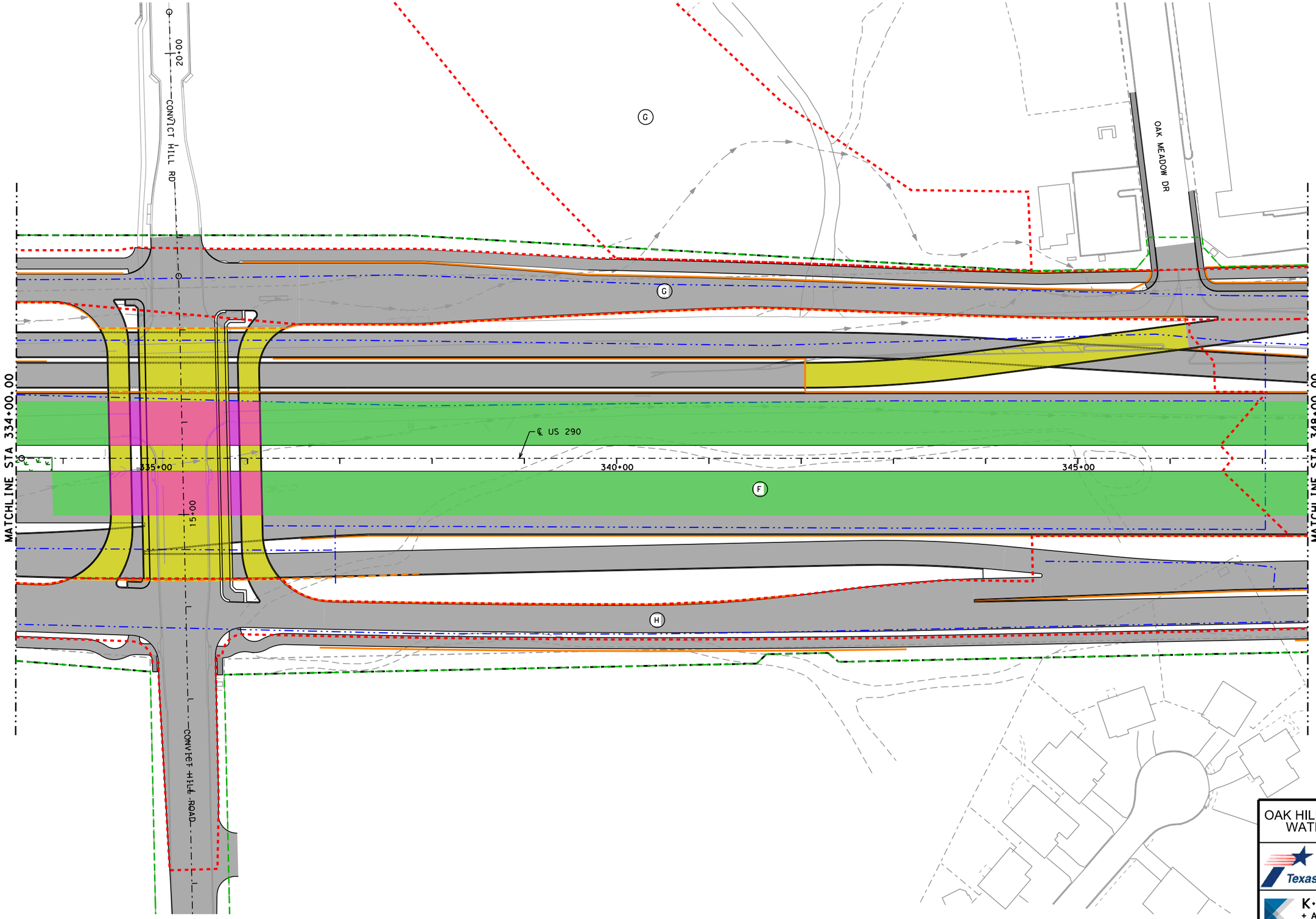

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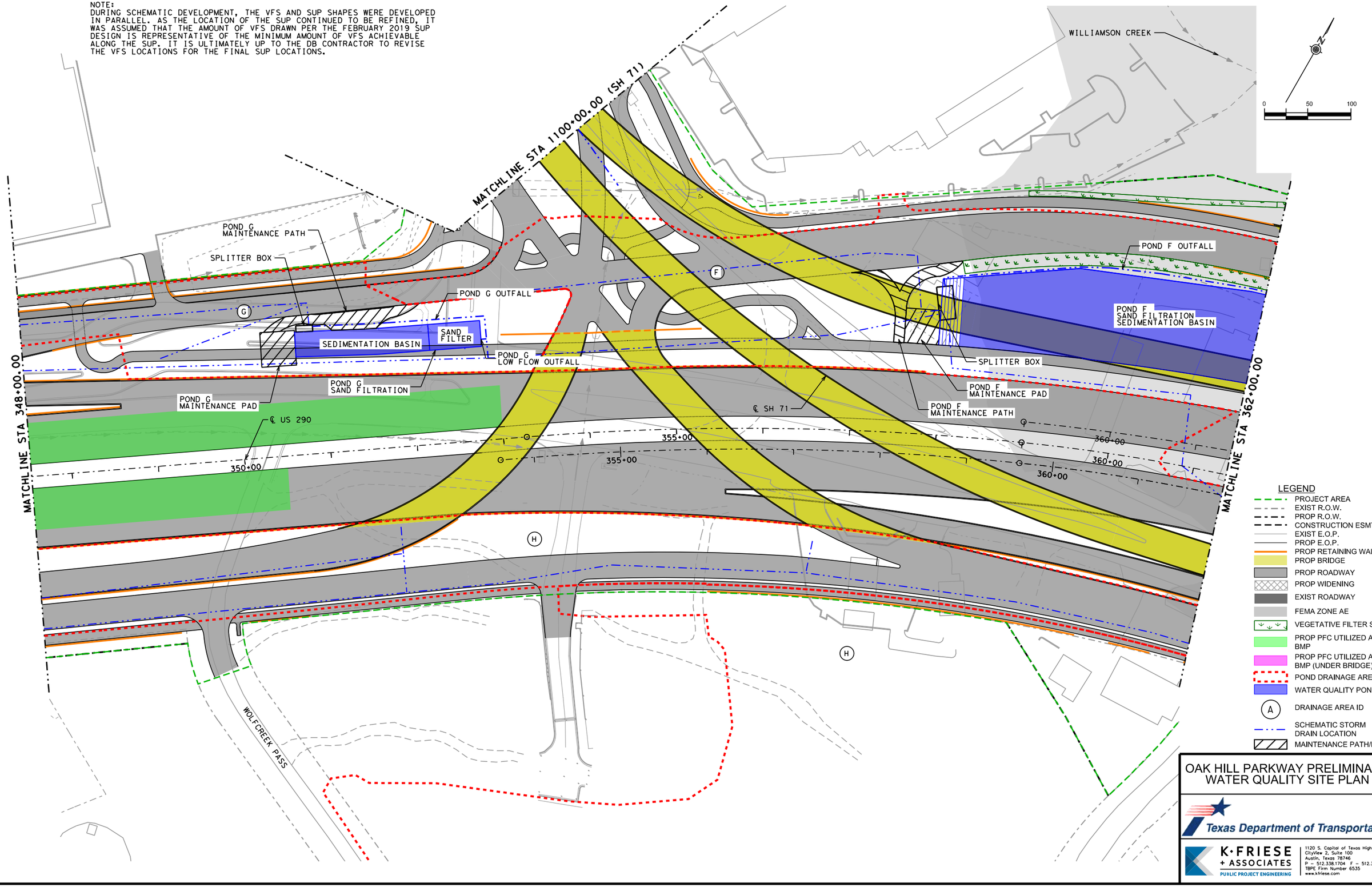

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N

0 50 100

OLD BEE CAVES ROAD

POND F OUTFALL

POND F
LOW FLOW OUTFALL

SAND FILTER

POND F
SAND FILTRATION
SEDIMENTATION BASIN

℄ US 290 WB

℄ US 290

℄ US 290 EB

365+00

370+00

375+00

WILLIAMSON CREEK

MATCHLINE STA 362+00.00

MATCHLINE STA 376+00.00

POND H
MAINTENANCE PATH

POND H
SAND FILTRATION
SEDIMENTATION BASIN

SAND FILTER

POND H OUTFALL

POND H
MAINTENANCE PAD

SPLITTER BOX

HILL OAKS DRIVE

F H I

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MATCHLINE STA 26+00.00 (WILLIAM CANNON)

EXIST RETENTION POND

EXIST IRRIGATION POND

POND K
BIORETENTION POND

POND K
MAINTENANCE PATH

POND K
MAINTENANCE PAD

25+00

℄ US 290 WB

380+00

385+00

PONDS I AND J
MAINTENANCE PATH

POND I OUTFALL

POND I
MAINTENANCE PAD

MATCHLINE STA 376+00.00

WILLIAMSON CREEK

℄ US 290

℄ US 290 EB

380+00

385+00

390+00.00

POND I
SAND FILTRATION
SEDIMENTATION
BASIN

SPLITTER BOX

POND H
LOW FLOW OUTFALL

POND H OUTFALL

EDWARDS AQUIFER CONTRIBUTING ZONE

EDWARDS AQUIFER RECHARGE ZONE

WILLIAM CANNON DRIVE

MATCHLINE STA 17+00.00 (WILLIAM CANNON)

0 50 100

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WILLIAMSON CREEK

EDWARDS AQUIFER CONTRIBUTING ZONE
EDWARDS AQUIFER RECHARGE ZONE

WILLIAMSON CREEK WATERSHED

PATTON RANCH ROAD

BARTON CREEK WATERSHED

N

0 50 100

PONDS I AND J MAINTENANCE PATH

POND J OUTFALL

POND J MAINTENANCE PAD

POND J BATCH DETENTION

℄ US 290 WB

MATCHLINE STA 390+00.00

390+00

395+00

395+00

400+00

400+00

MATCHLINE STA 404+00.00

SAND FILTER

POND I LOW FLOW OUTFALL

I

J

℄ US 290

POND I SAND FILTRATION SEDIMENTATION BASIN

J

MCCARTY LANE

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MATCHLINE STA 404+00.00

MATCHLINE STA 418+00.00

PARKWOOD DR

POND T
MAINTENANCE PAD

POND T
BATCH DETENTION

POND T
MAINTENANCE PATH

POND T OUTFALL

WILLIAMSON CREEK

℄ US 290

405+00

405+00

410+00

410+00

415+00

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R

T

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0 50 100

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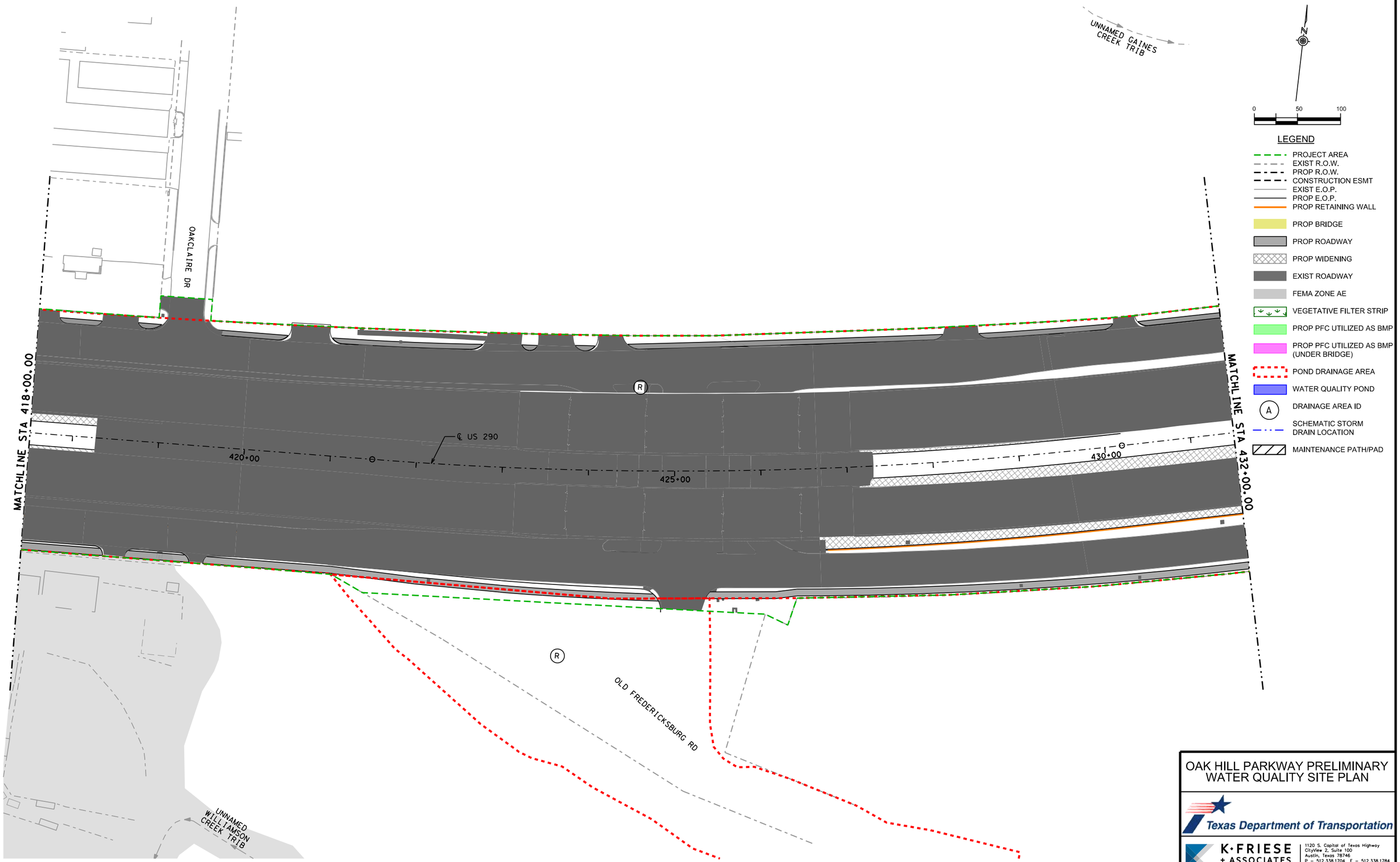

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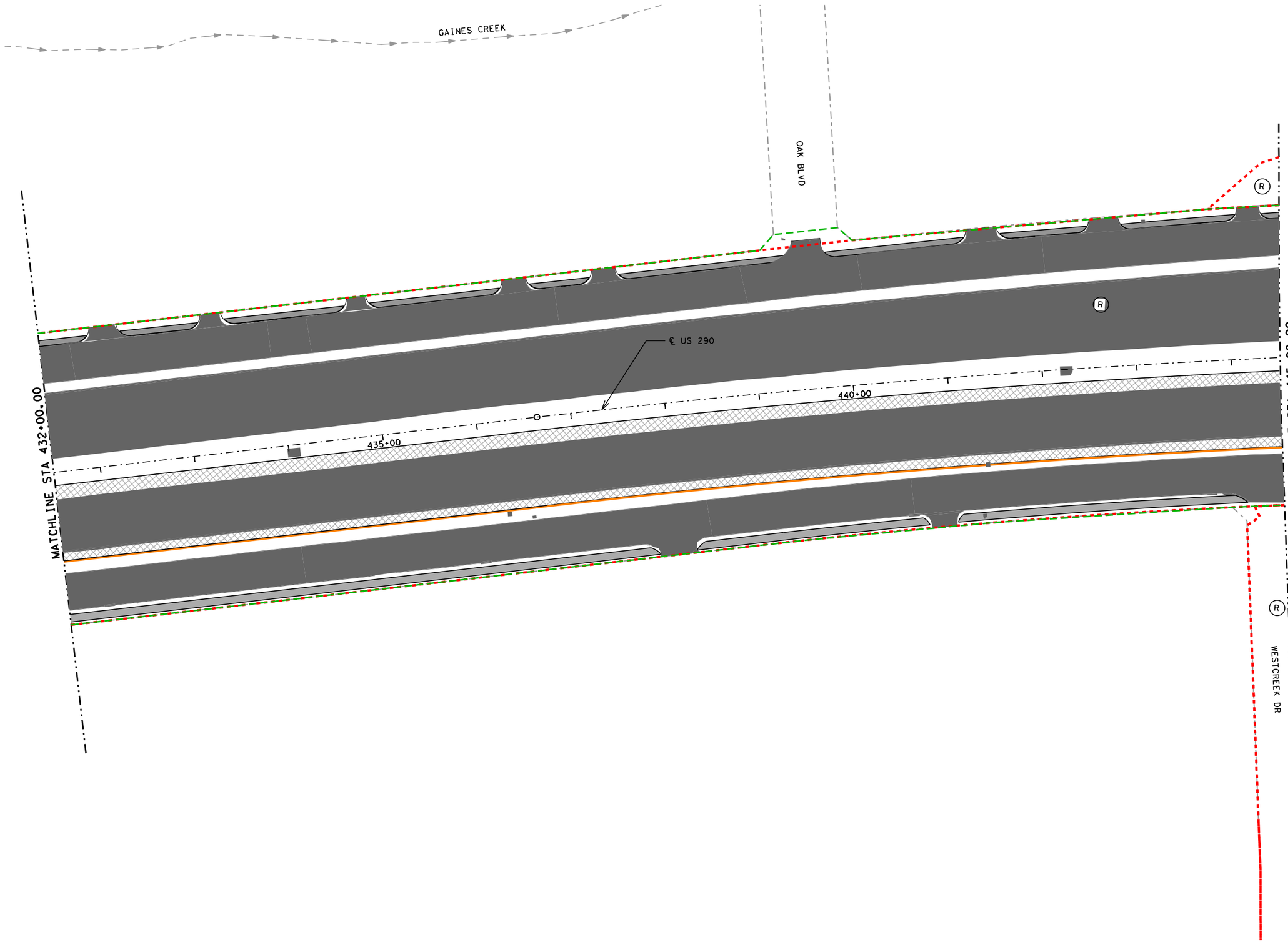

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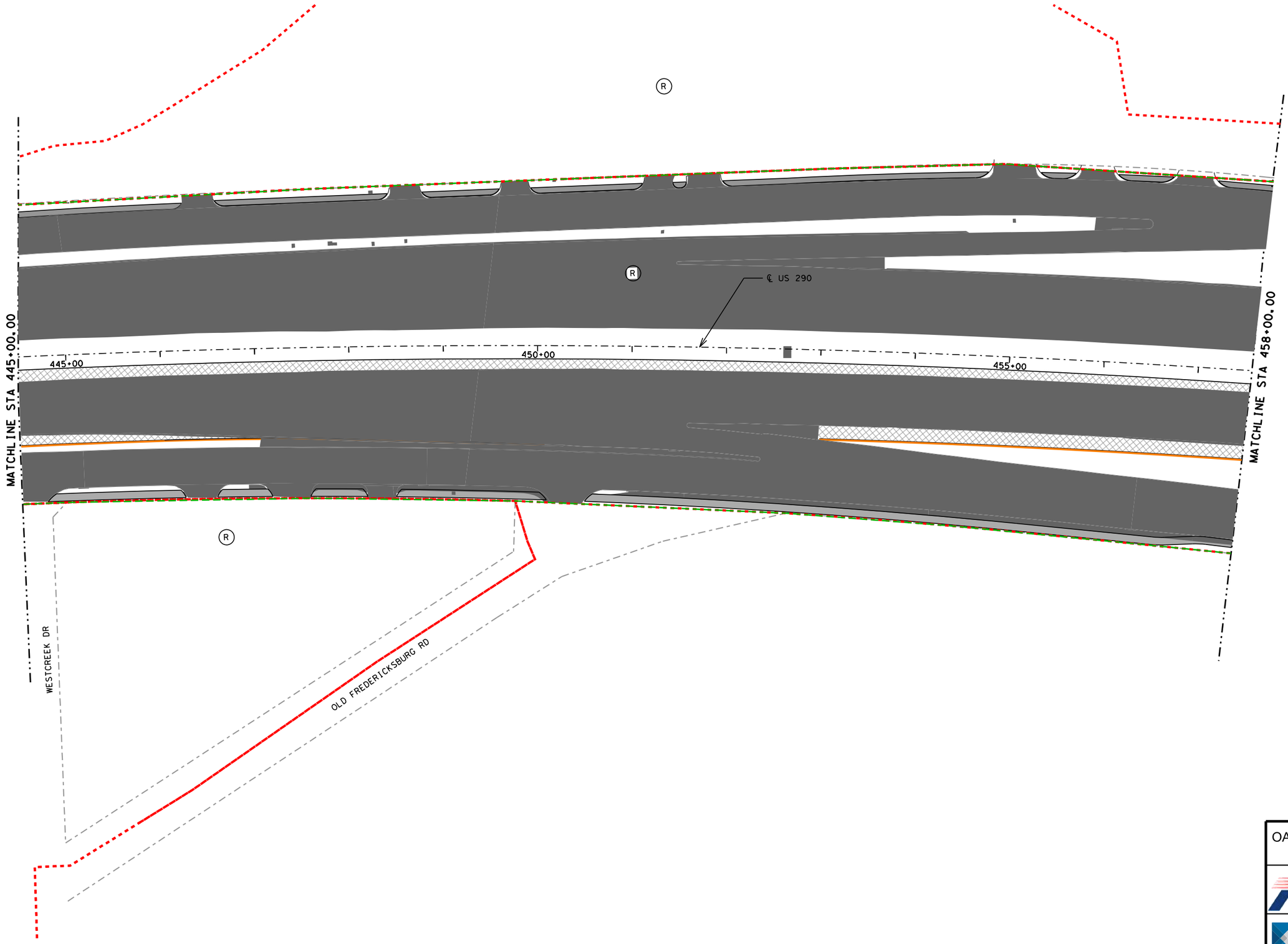

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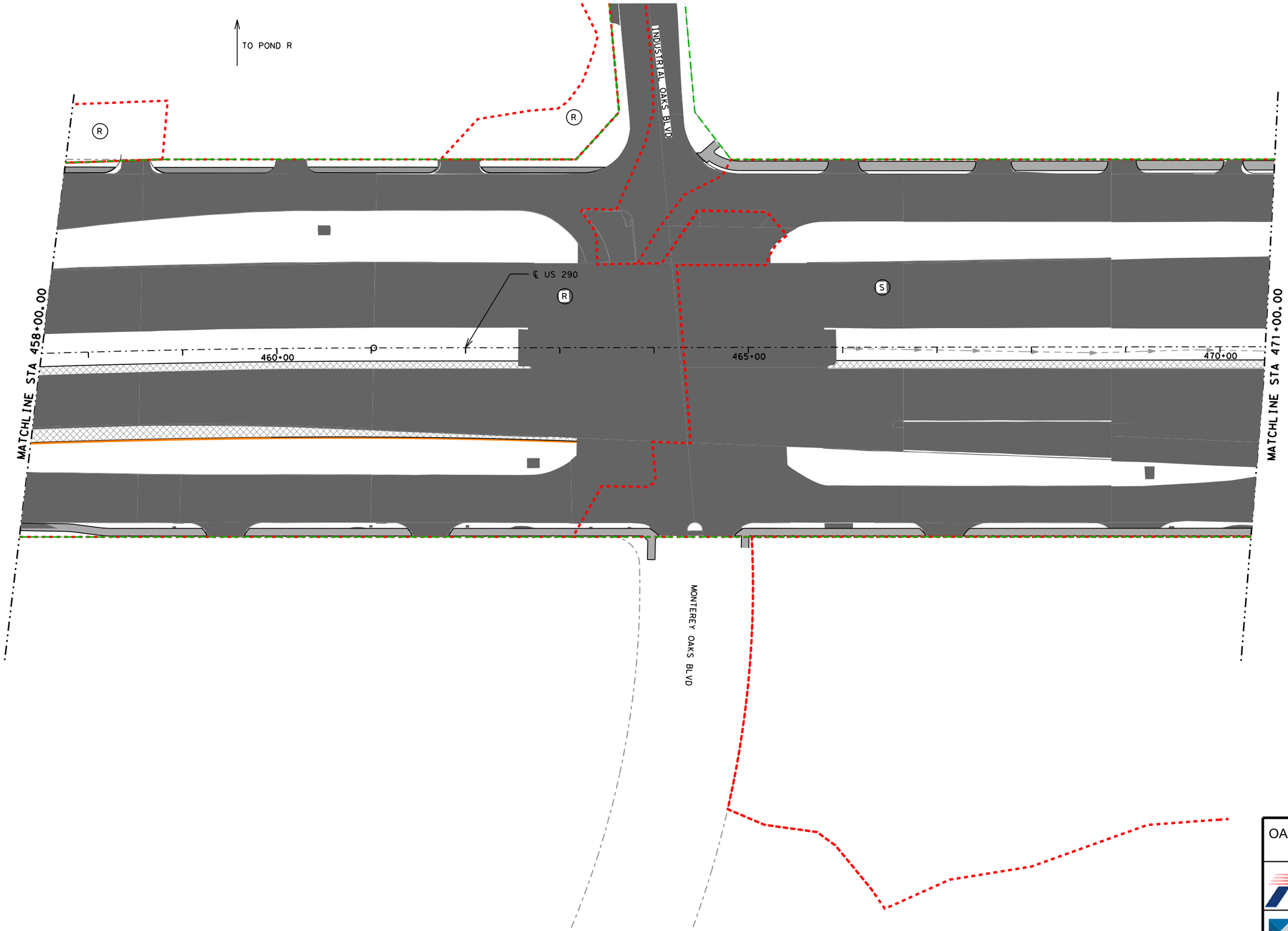

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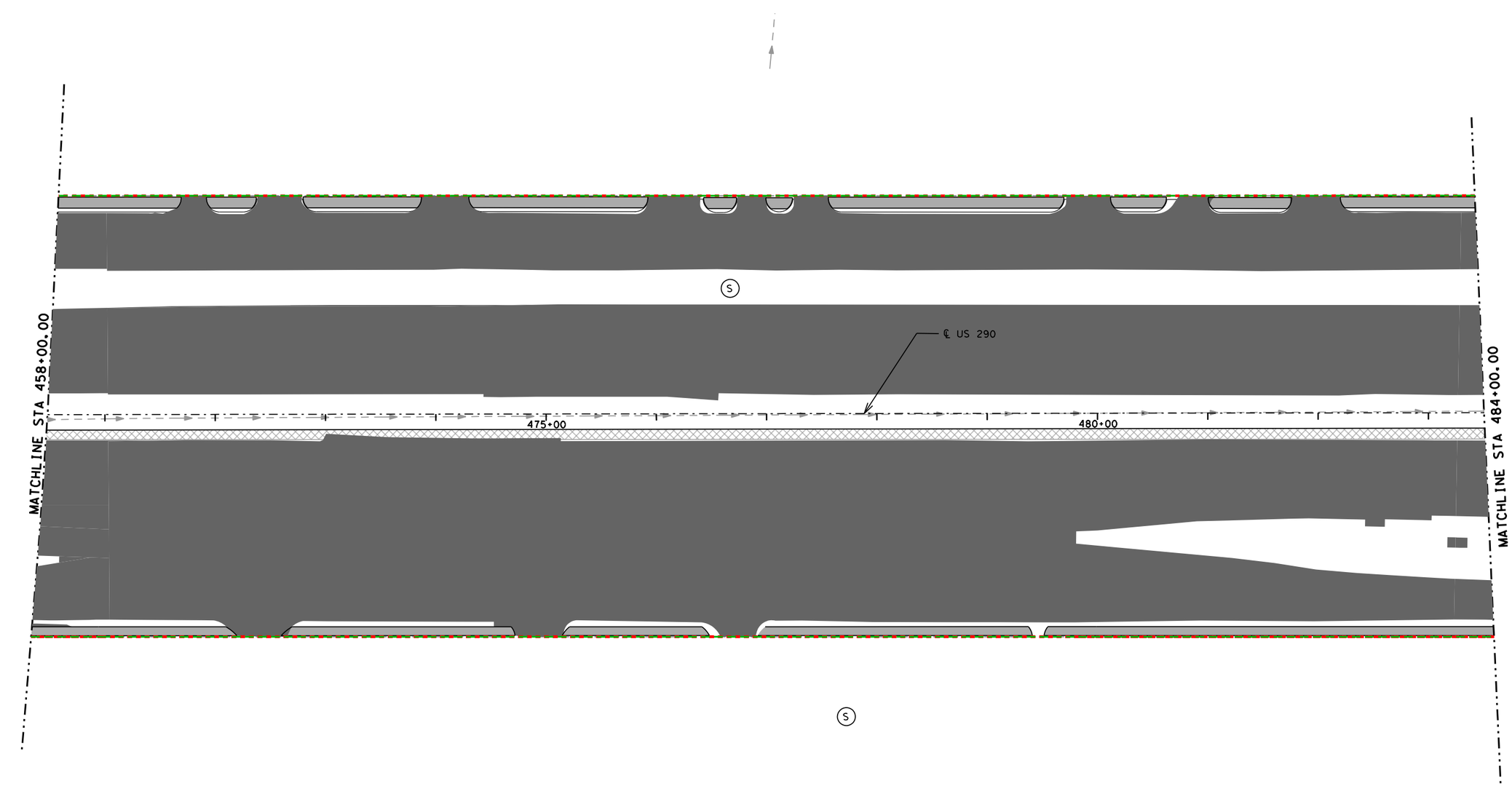

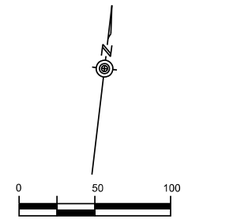

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K·FRIESE + ASSOCIATES
PUBLIC PROJECT ENGINEERING
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Austin, Texas 78746
P – 512.338.1704 F – 512.338.1784
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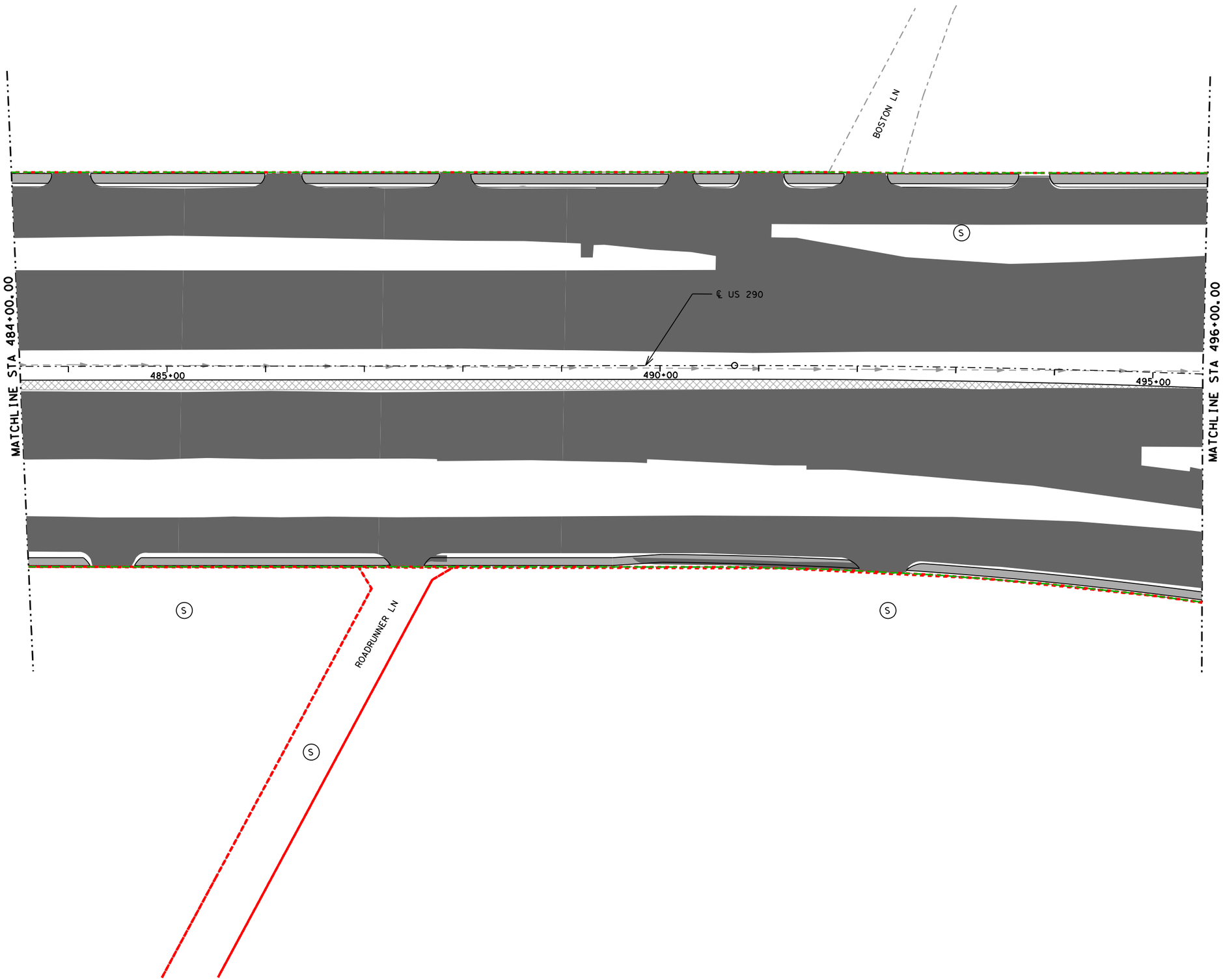

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LEGEND

- PROJECT AREA
- EXIST R.O.W.
- PROP R.O.W.
- CONSTRUCTION ESMT
- EXIST E.O.P.
- PROP E.O.P.
- PROP RETAINING WALL
- PROP BRIDGE
- PROP ROADWAY
- PROP WIDENING
- EXIST ROADWAY
- FEMA ZONE AE
- VEGETATIVE FILTER STRIP
- PROP PFC UTILIZED AS BMP
- PROP PFC UTILIZED AS BMP (UNDER BRIDGE)
- POND DRAINAGE AREA
- WATER QUALITY POND
- (A) DRAINAGE AREA ID
- SCHEMATIC STORM DRAIN LOCATION
- MAINTENANCE PATH/PAD

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STAGGERBRUSH RD

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- PROP R.O.W.
- CONSTRUCTION ESMT
- EXIST E.O.P.
- PROP E.O.P.
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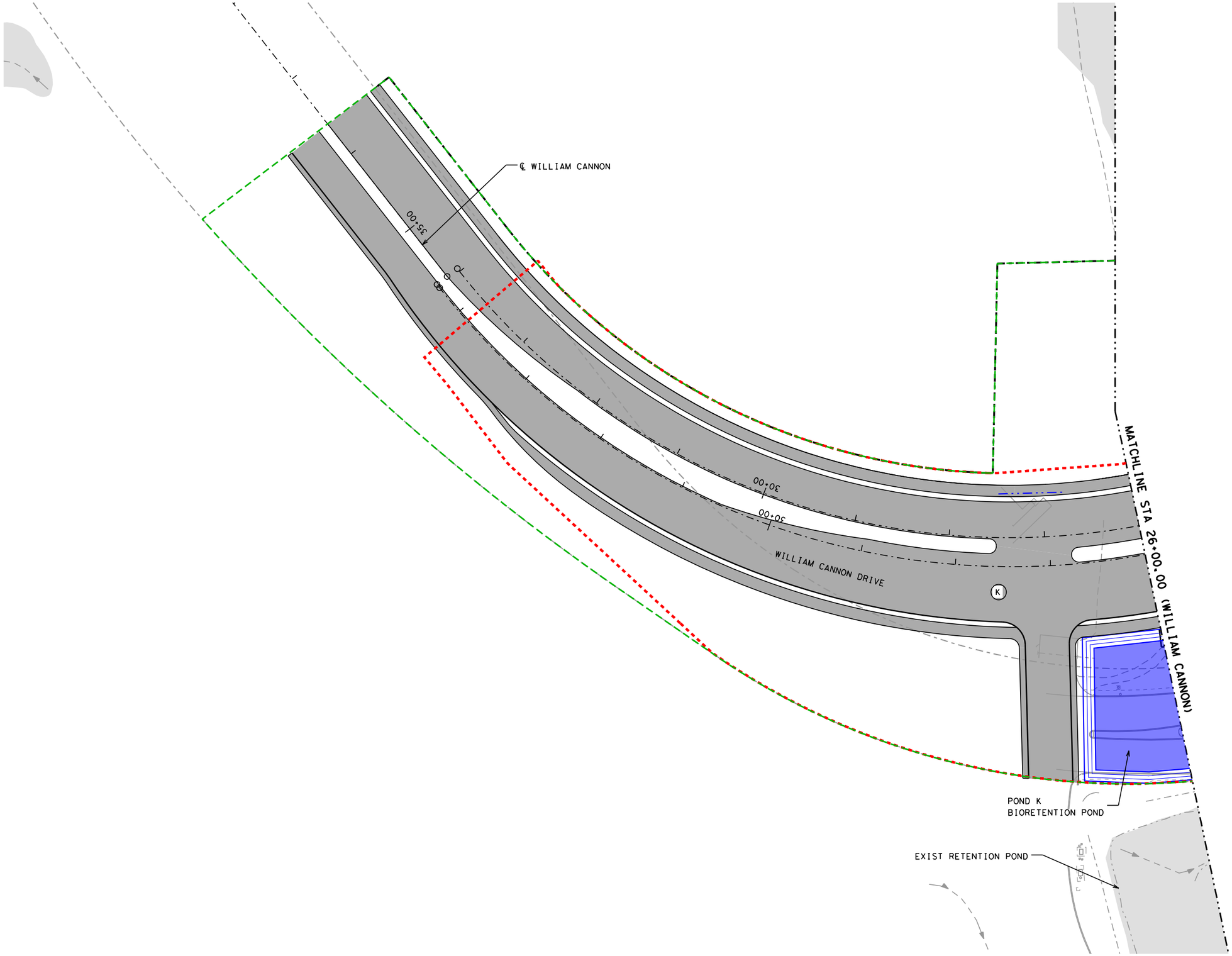

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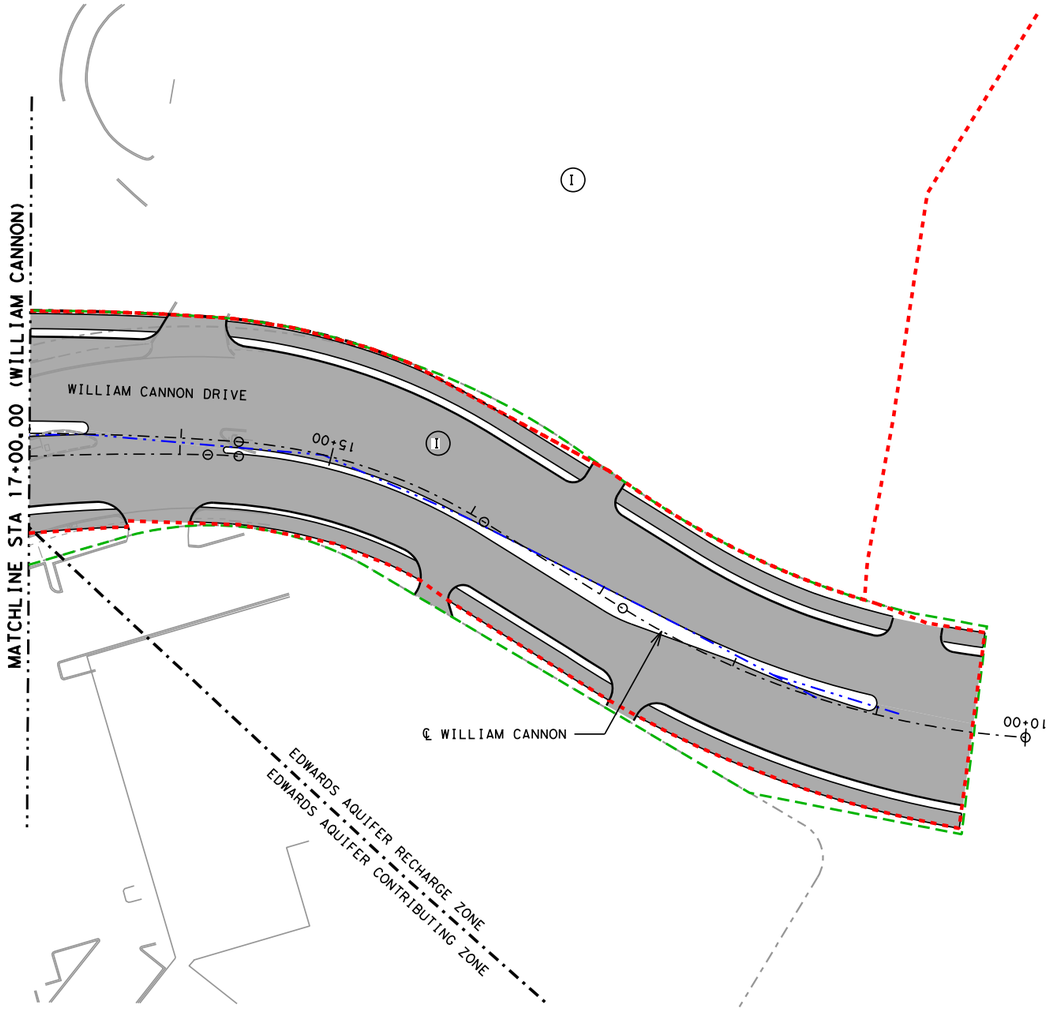

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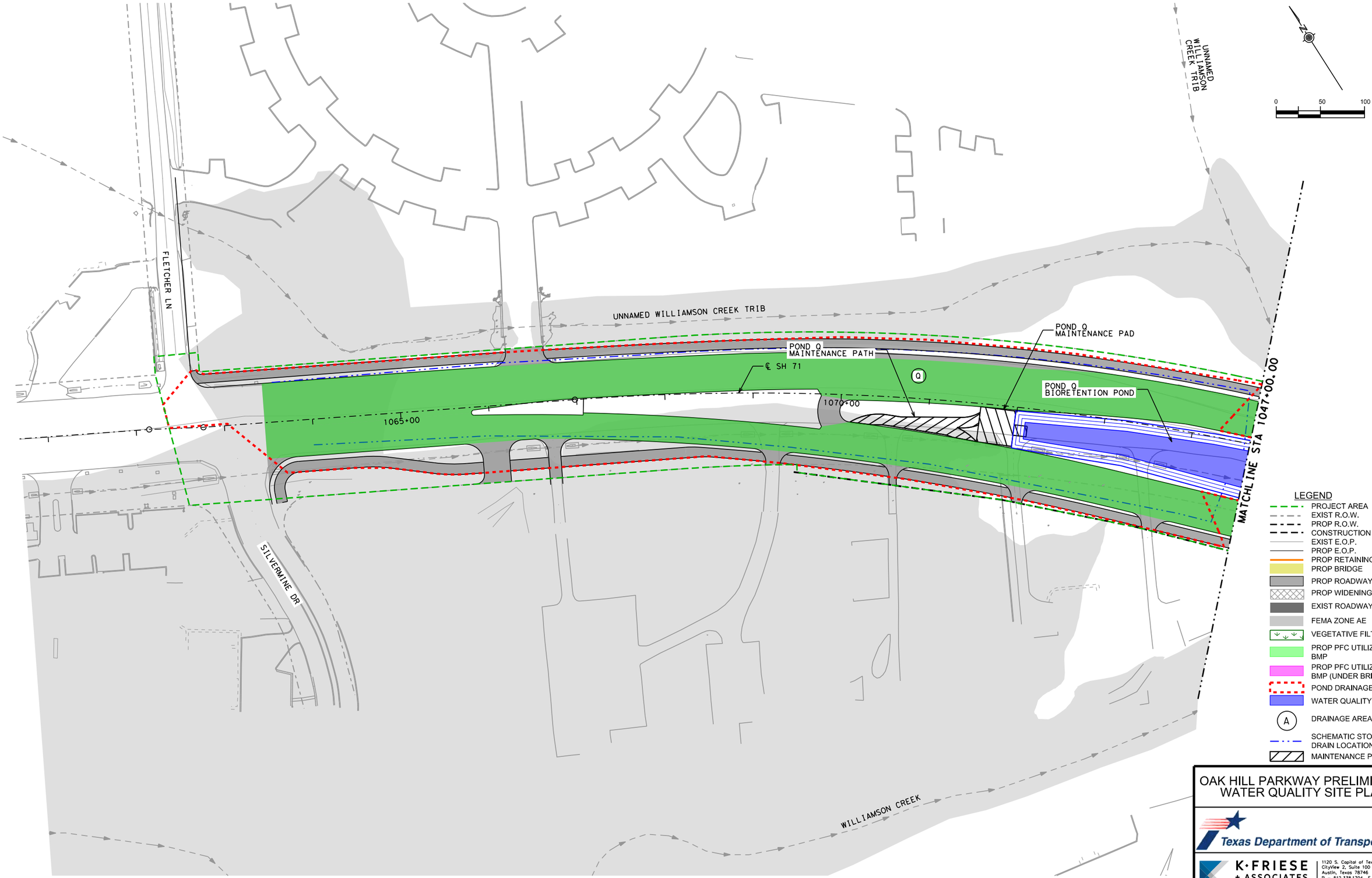

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WILLIAMSON CREEK

WILLIAMSON CREEK

POND O
LOW FLOW OUTFALL

SAND FILTER

POND O
SAND FILTRATION

SEDIMENTATION BASIN

POND O OUTFALL

POND O
MAINTENANCE PAD

POND O
MAINTENANCE PATH

SPLITTER BOX

℄ SH 71

MATCHLINE STA 1061+00.00

1090+00

1095+00

1100+00

MATCHLINE STA 1075+00.00

HILL MEADOW DR

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LEGEND

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- PROP R.O.W.
- CONSTRUCTION ESMT
- EXIST E.O.P.
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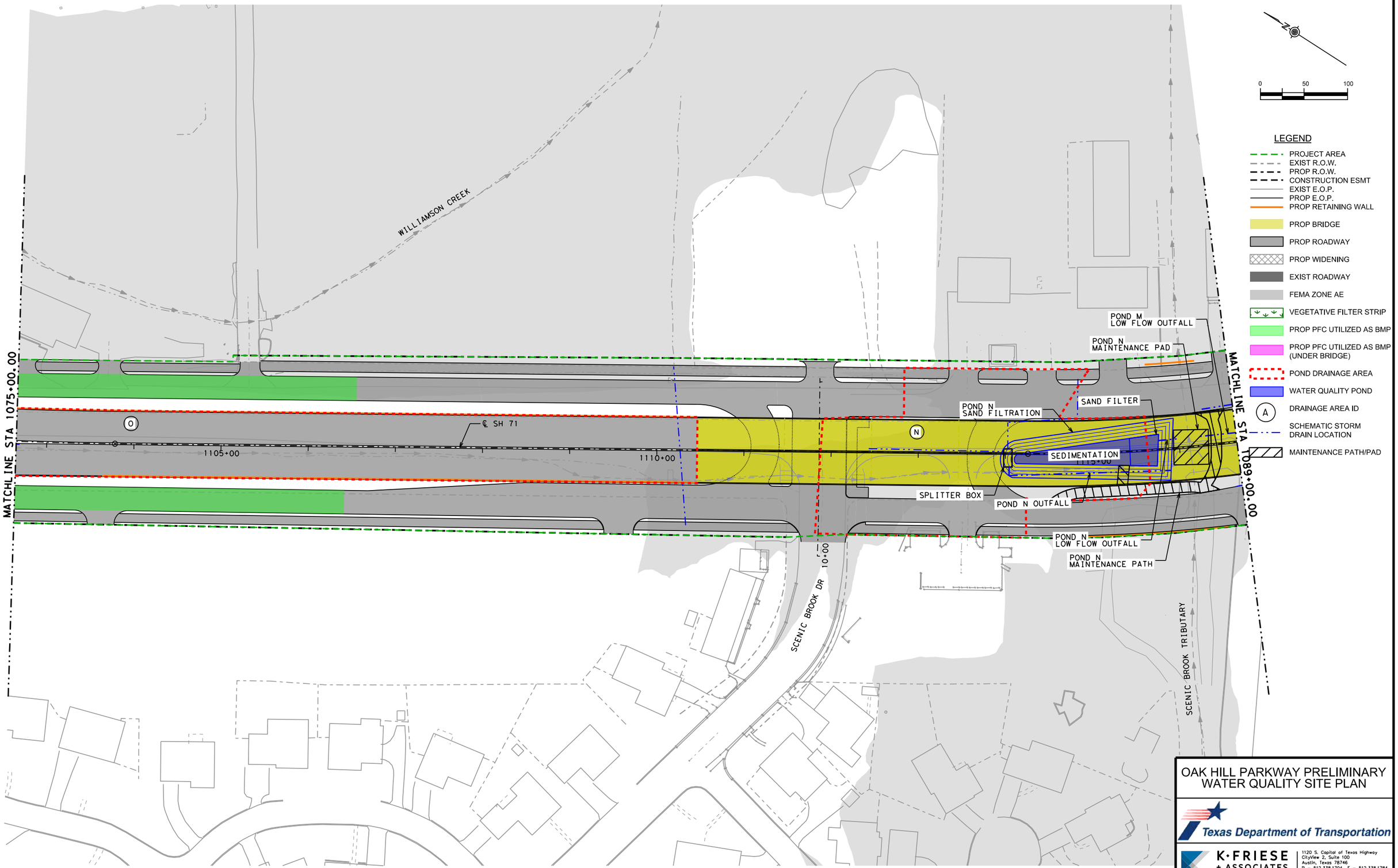

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POND M
SAND FILTRATION

POND M OUTFALL

POND M
MAINTENANCE PATH

SEDIMENTATION

SAND FILTER

SPLITTER BOX

POND M
MAINTENANCE PAD

℄ SH 71

MATCHLINE STA 1089+00.00

1120+00

1000

POND L
MAINTENANCE PATH

SPLITTER BOX

POND L OUTFALL

SAND FILTER

SEDIMENTATION

POND L
SAND FILTRATION

POND L
MAINTENANCE PAD

POND L
LOW FLOW OUTFALL

MATCHLINE STA 1100+00.00

0 50 100

LEGEND

- PROJECT AREA
- EXIST R.O.W.
- PROP R.O.W.
- CONSTRUCTION ESMT
- EXIST E.O.P.
- PROP E.O.P.
- PROP RETAINING WALL
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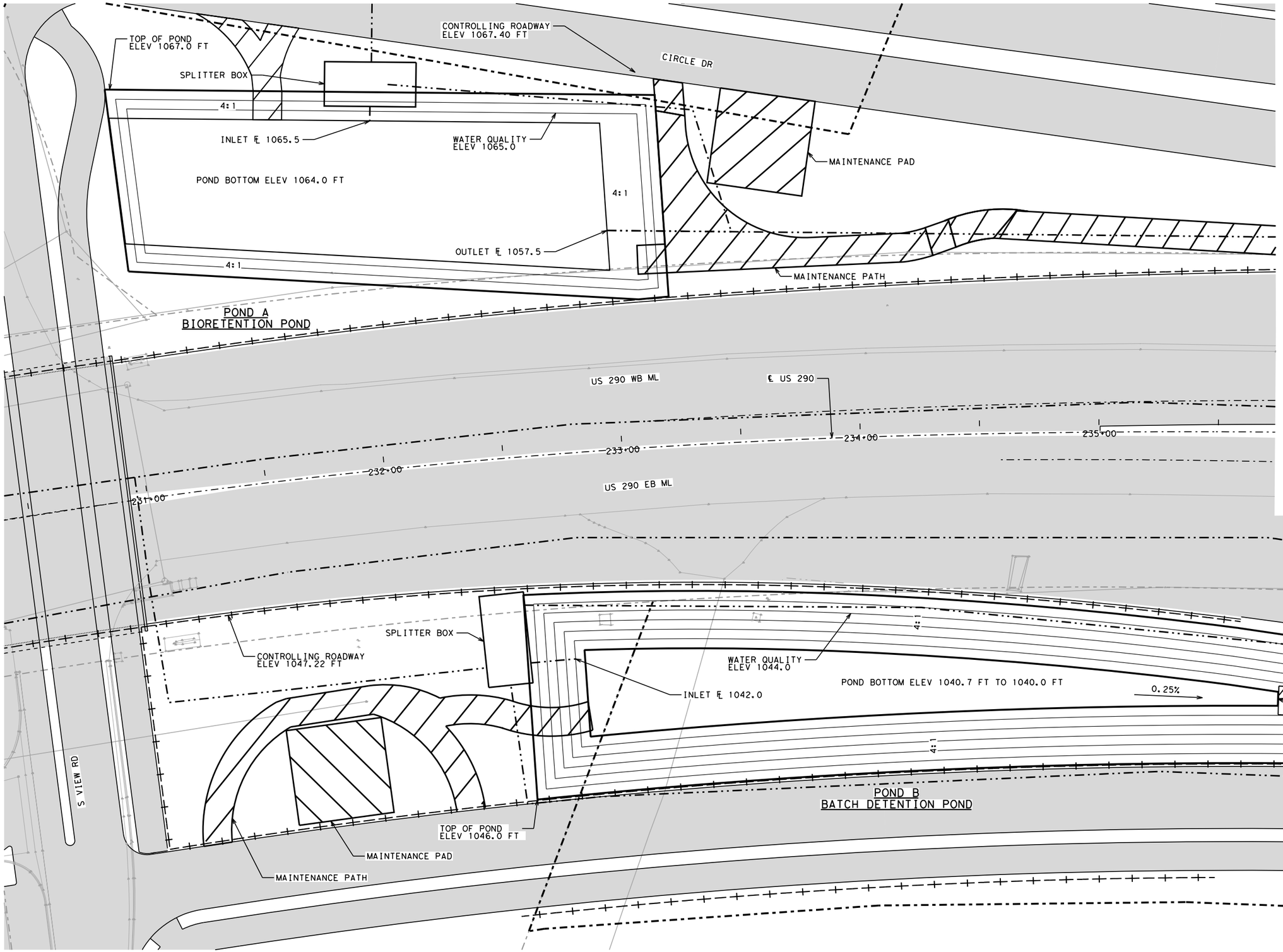
Appendix G: Preliminary Water Quality Pond Layout



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LEGEND

- POND OUTLINE
- EXIST R.O.W.
- PROP R.O.W.
- RETAINING WALL
- EXIST E.O.P.
- PROP E.O.P.
- STORM SEWER PIPELINE
- EXISTING CONTOUR
- PROP IMPERVIOUS COVER
- FEMA ZONE AE
- MAINTENANCE PATH/PAD

0 20 40

POND A WATER QUALITY VOLUME:

REQUIRED: 12,672 CF
PROVIDED: 12,677 CF

POND B WATER QUALITY VOLUME:

REQUIRED: 47,600 CF
PROVIDED: 47,705 CF

NOTE:

SCHEMATIC POND ELEVATIONS WERE DETERMINED USING ASSUMPTIONS FOR STORM DRAIN SLOPES AND DEPTHS BASED ON SCHEMATIC ROADWAY DESIGN AND SURVEYED OUTFALL ELEVATIONS.

OAK HILL PARKWAY PRELIMINARY WATER QUALITY POND LAYOUTS POND A AND POND B

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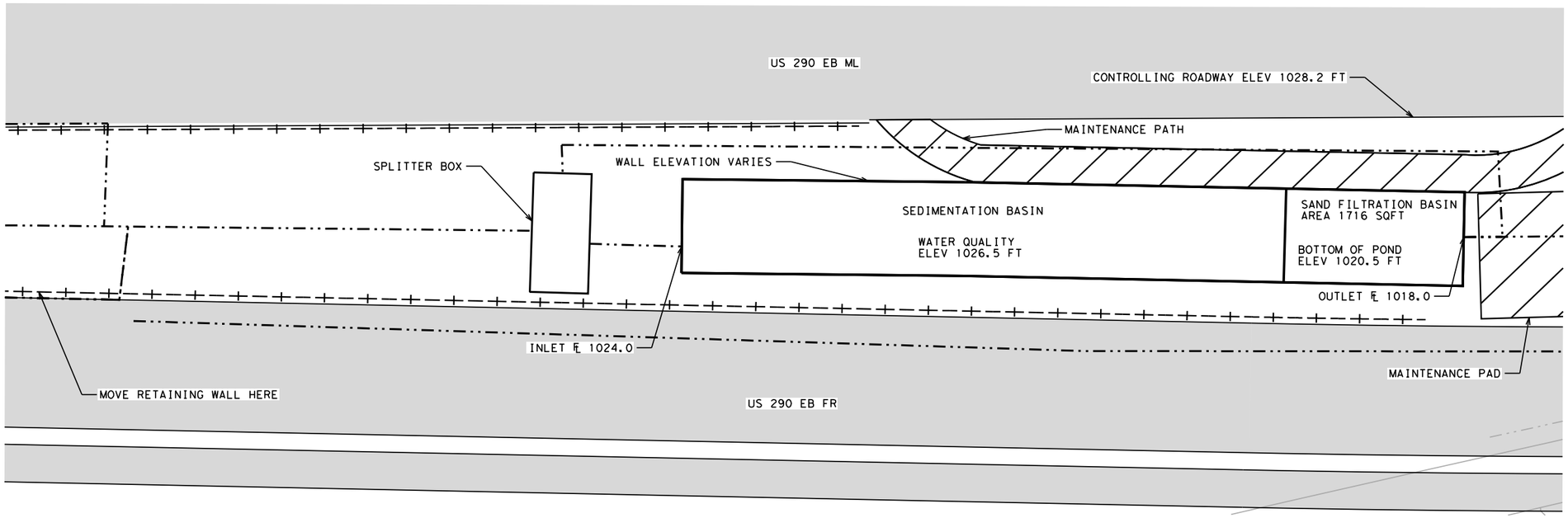
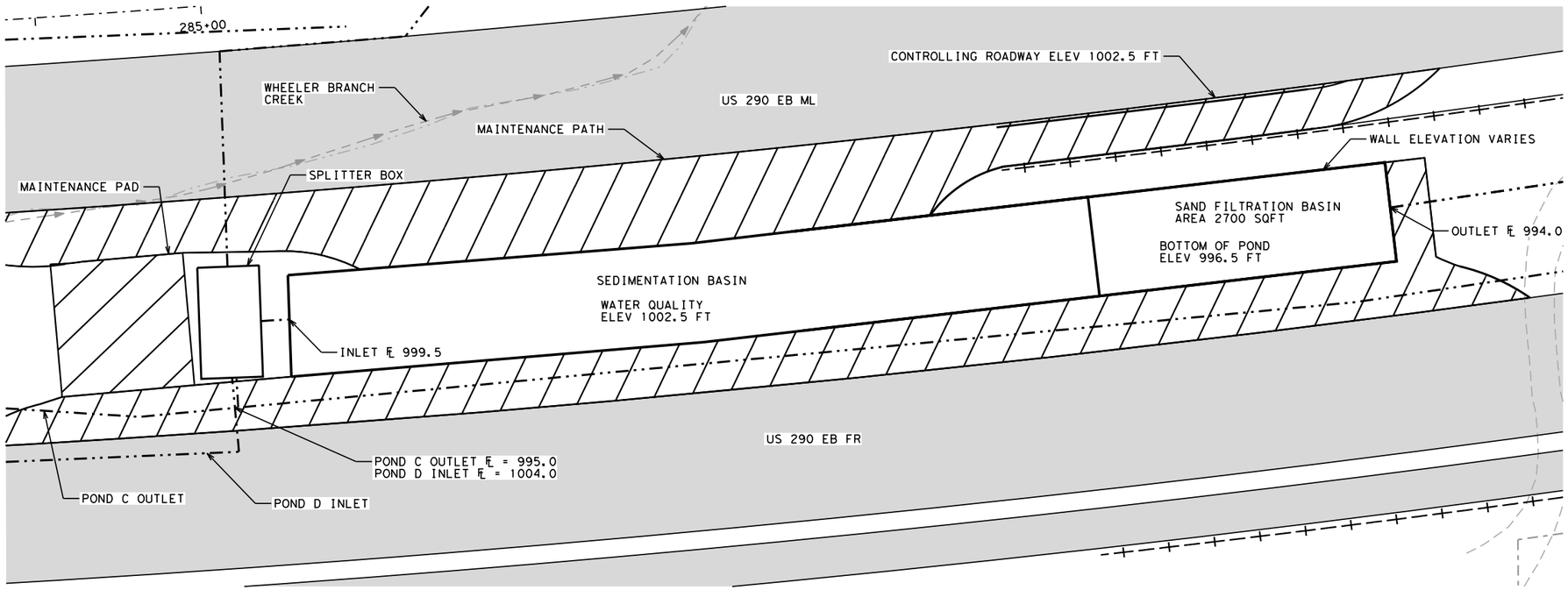
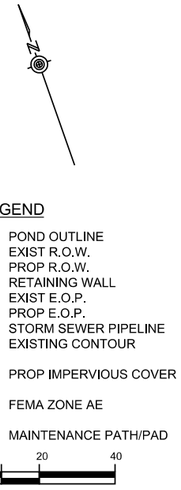


POND C
SAND FILTRATION POND



POND D
SAND FILTRATION POND



POND C WATER QUALITY VOLUME:

REQUIRED: 34,145 CF
PROVIDED: 34,729 CF

POND D WATER QUALITY VOLUME:

REQUIRED: 42,570 CF
PROVIDED: 44,006 CF

NOTE:

SCHEMATIC POND ELEVATIONS WERE DETERMINED USING ASSUMPTIONS FOR STORM DRAIN SLOPES AND DEPTHS BASED ON SCHEMATIC ROADWAY DESIGN AND SURVEYED OUTFALL ELEVATIONS.

OAK HILL PARKWAY PRELIMINARY WATER QUALITY POND LAYOUTS POND C AND POND D

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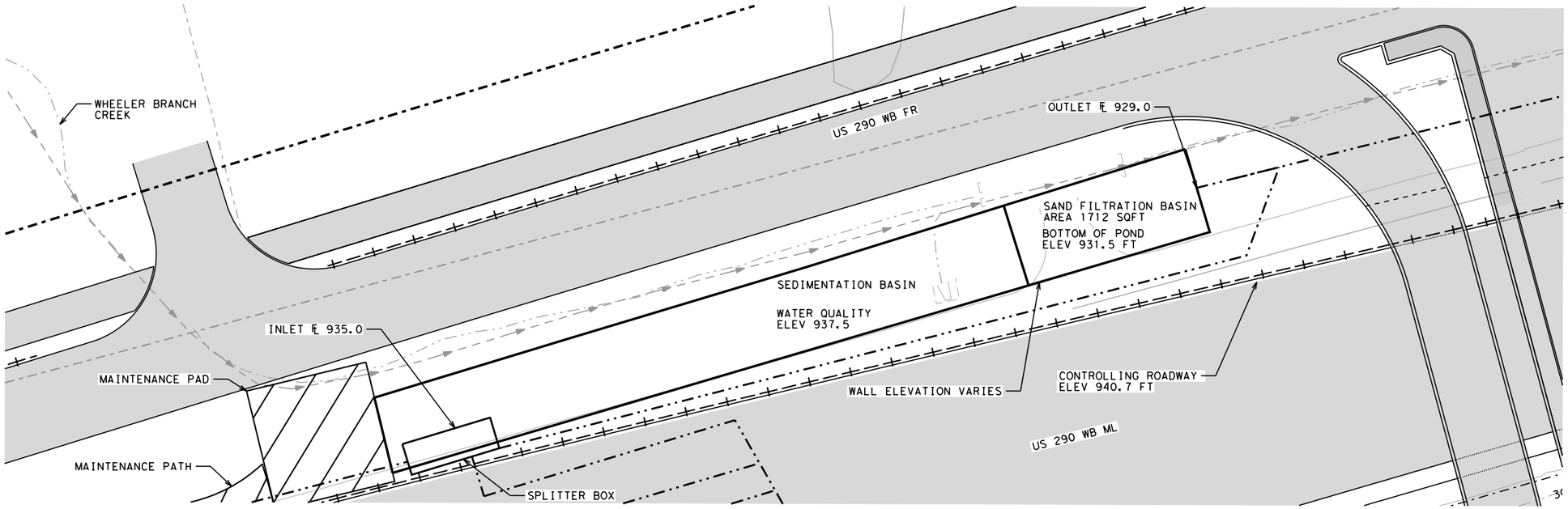
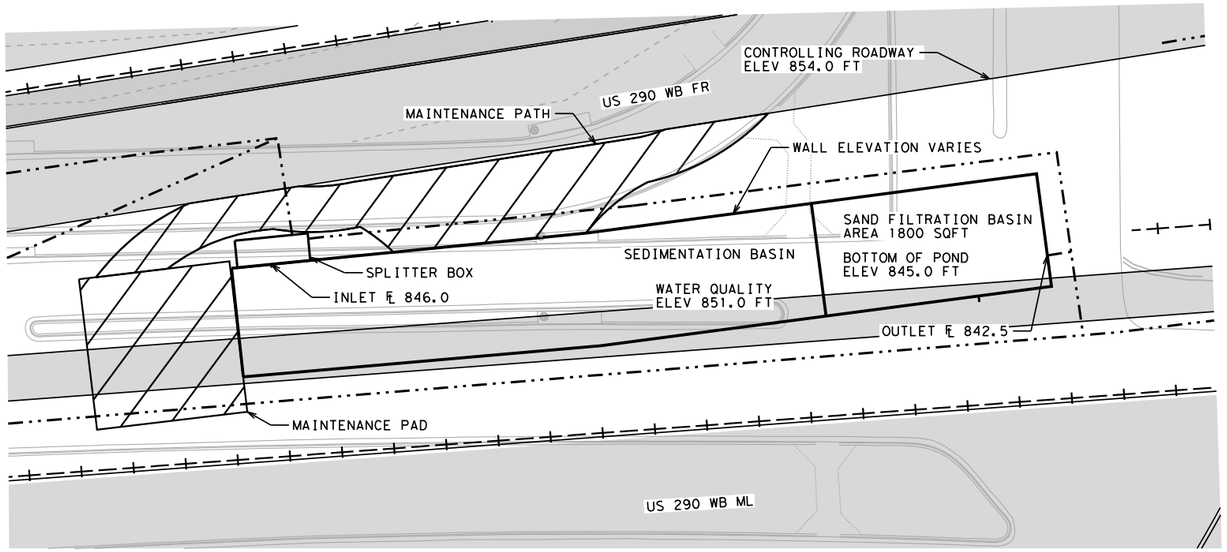


POND E
SAND FILTRATION POND



POND G
SAND FILTRATION POND

LEGEND

- POND OUTLINE
- EXIST R.O.W.
- PROP R.O.W.
- RETAINING WALL
- EXIST E.O.P.
- PROP E.O.P.
- STORM SEWER PIPELINE
- EXISTING CONTOUR
- PROP IMPERVIOUS COVER
- FEMA ZONE AE
- MAINTENANCE PATH/PAD

0 20 40

POND E WATER QUALITY VOLUME:

REQUIRED: 32,602 CF
PROVIDED: 33,714 CF

POND G WATER QUALITY VOLUME:

REQUIRED: 26,177 CF
PROVIDED: 27,453 CF

NOTE:

1. SCHEMATIC POND ELEVATIONS WERE DETERMINED USING ASSUMPTIONS FOR STORM DRAIN SLOPES AND DEPTHS BASED ON SCHEMATIC ROADWAY DESIGN AND SURVEYED OUTFALL ELEVATIONS.

2. DURING SCHEMATIC DEVELOPMENT, THE VFS AND SUP SHAPES WERE DEVELOPED IN PARALLEL. AS THE LOCATION OF THE SUP CONTINUED TO BE REFINED, IT WAS ASSUMED THAT THE AMOUNT OF VFS DRAWN PER THE FEBRUARY 2019 SUP DESIGN IS REPRESENTATIVE OF THE MINIMUM AMOUNT OF VFS ACHIEVABLE ALONG THE SUP. IT IS ULTIMATELY UP TO THE DB CONTRACTOR TO REVISE THE VFS LOCATIONS FOR THE FINAL SUP LOCATIONS.

OAK HILL PARKWAY PRELIMINARY WATER QUALITY POND LAYOUTS POND E AND POND G

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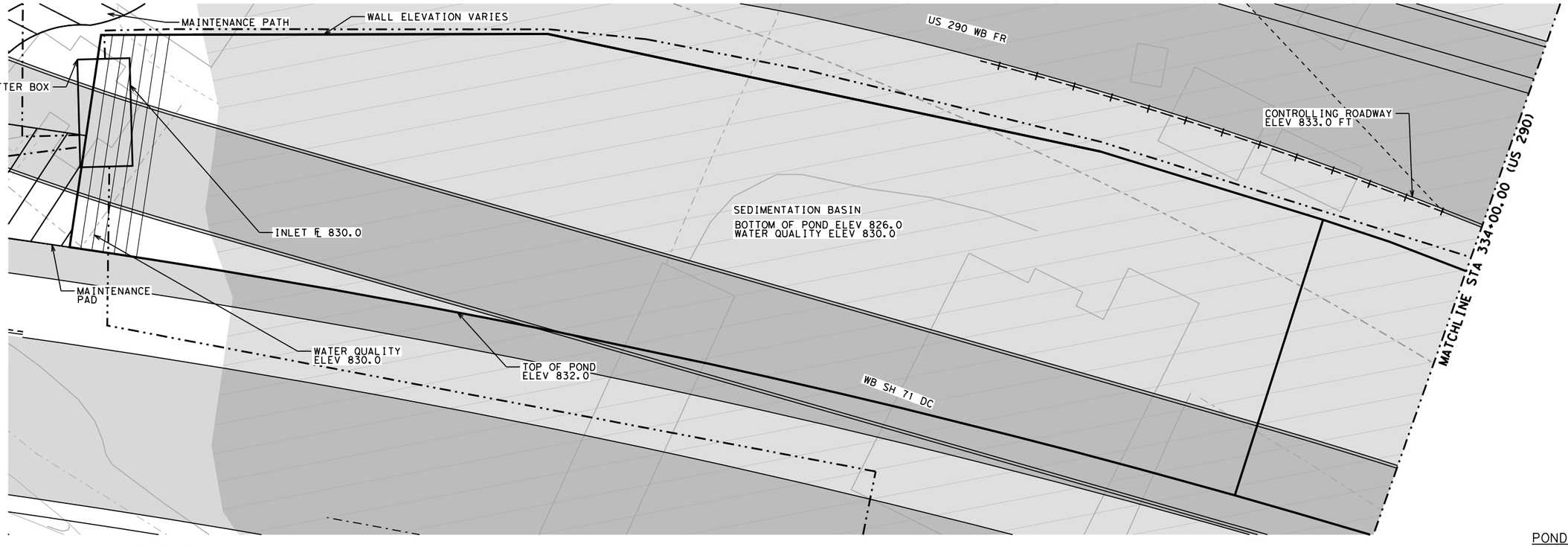
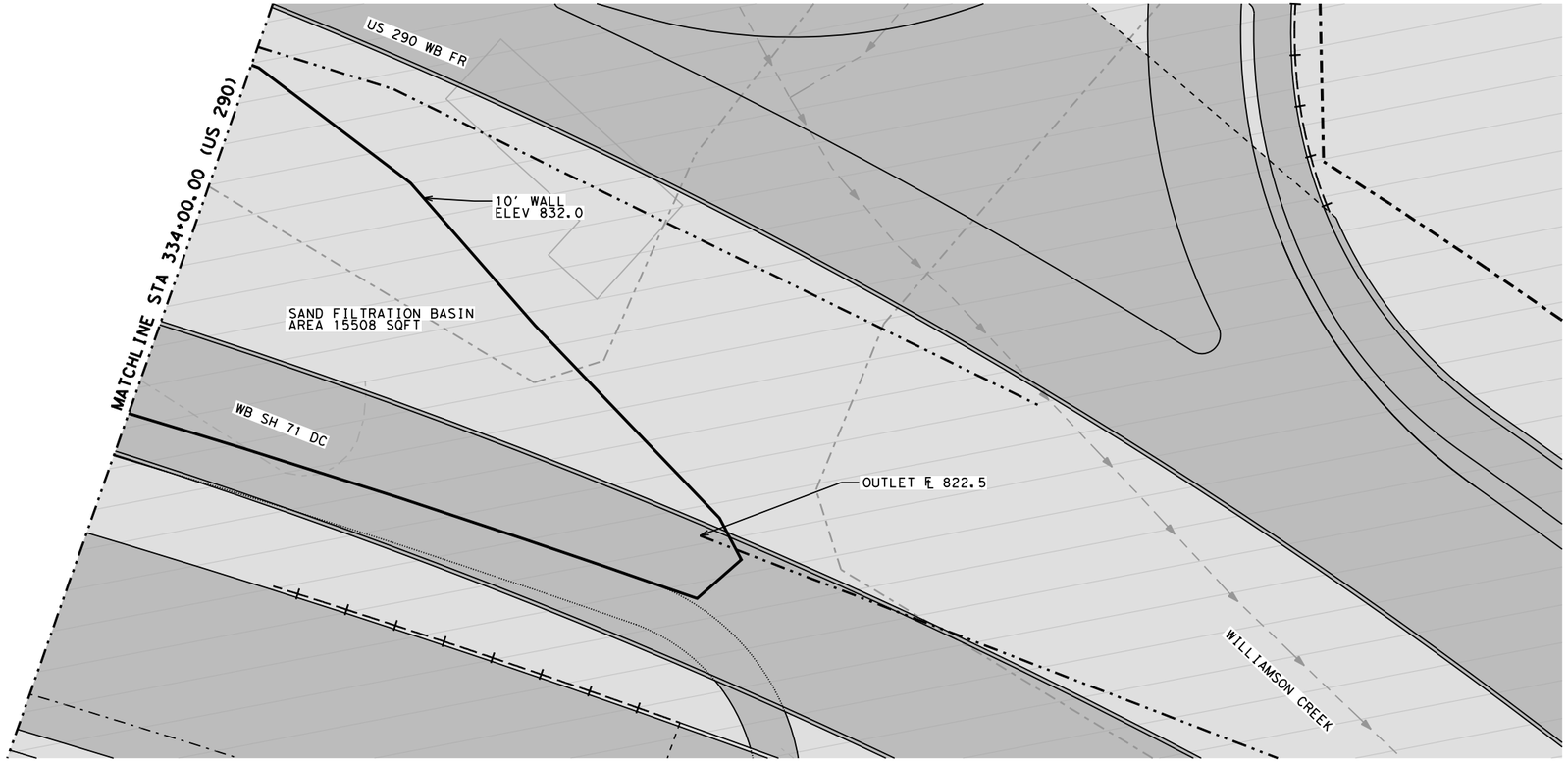
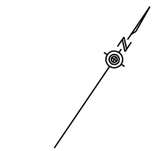


POND F
SAND FILTRATION POND





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- PROP E.O.P.
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- EXISTING CONTOUR
- PROP IMPERVIOUS COVER
- FEMA ZONE AE
- MAINTENANCE PATH/PAD

0 20 40

POND F WATER QUALITY VOLUME:

REQUIRED: 162,383 CF
PROVIDED: 163,726 CF

NOTE:

SCHEMATIC POND ELEVATIONS WERE DETERMINED USING ASSUMPTIONS FOR STORM DRAIN SLOPES AND DEPTHS BASED ON SCHEMATIC ROADWAY DESIGN AND SURVEYED OUTFALL ELEVATIONS.

OAK HILL PARKWAY PRELIMINARY
WATER QUALITY POND LAYOUT
POND F

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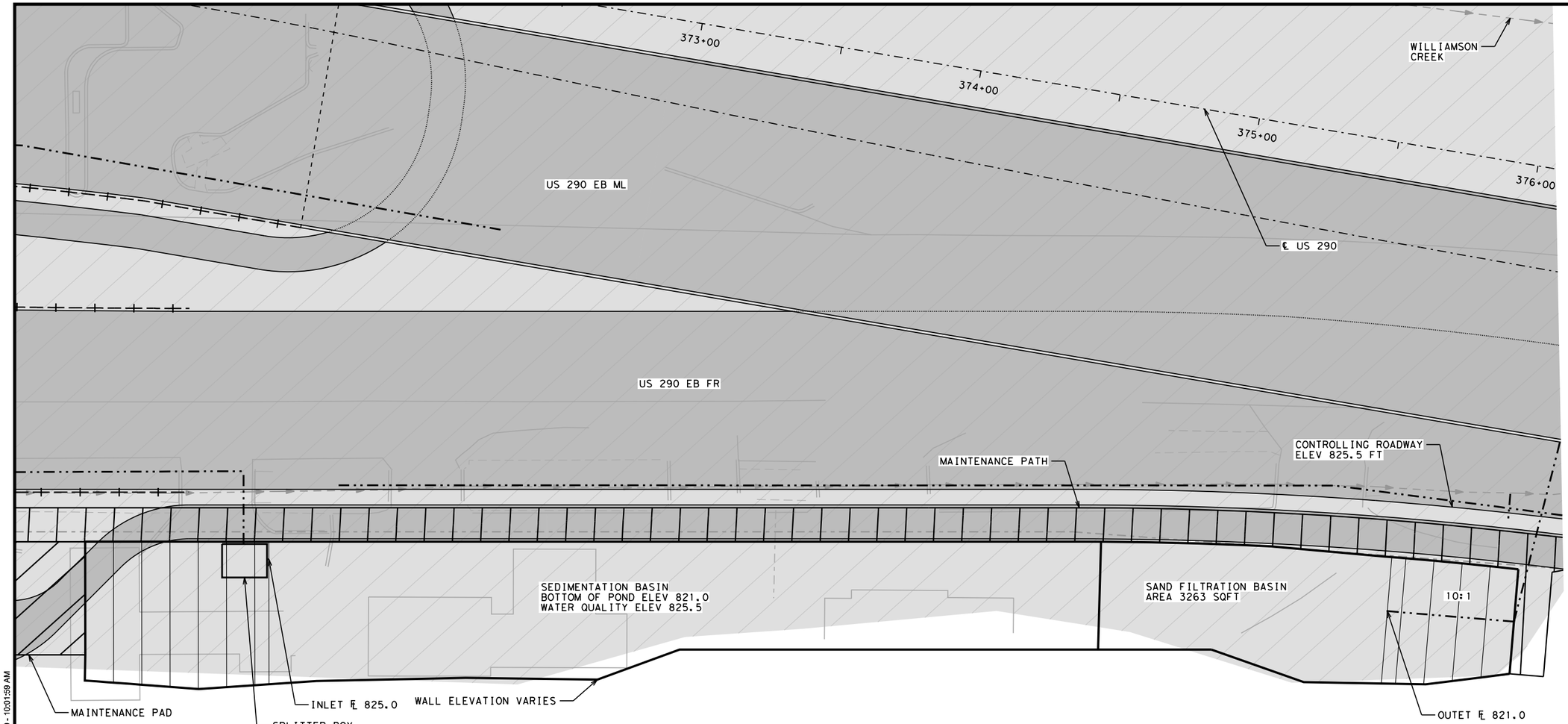

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- FEMA ZONE AE
- MAINTENANCE PATH/PAD

0 20 40

POND H WATER QUALITY VOLUME:

REQUIRED: 61,301 CF
PROVIDED: 61,904 CF

NOTE:

1. SCHEMATIC POND ELEVATIONS WERE DETERMINED USING ASSUMPTIONS FOR STORM DRAIN SLOPES AND DEPTHS BASED ON SCHEMATIC ROADWAY DESIGN AND SURVEYED OUTFALL ELEVATIONS.

2. DURING SCHEMATIC DEVELOPMENT, THE VFS AND SUP SHAPES WERE DEVELOPED IN PARALLEL. AS THE LOCATION OF THE SUP CONTINUED TO BE REFINED, IT WAS ASSUMED THAT THE AMOUNT OF VFS DRAWN PER THE FEBRUARY 2019 SUP DESIGN IS REPRESENTATIVE OF THE MINIMUM AMOUNT OF VFS ACHIEVABLE ALONG THE SUP. IT IS ULTIMATELY UP TO THE DB CONTRACTOR TO REVISE THE VFS LOCATIONS FOR THE FINAL SUP LOCATIONS.

POND H
SAND FILTRATION POND

OAK HILL PARKWAY PRELIMINARY WATER QUALITY POND LAYOUT POND H

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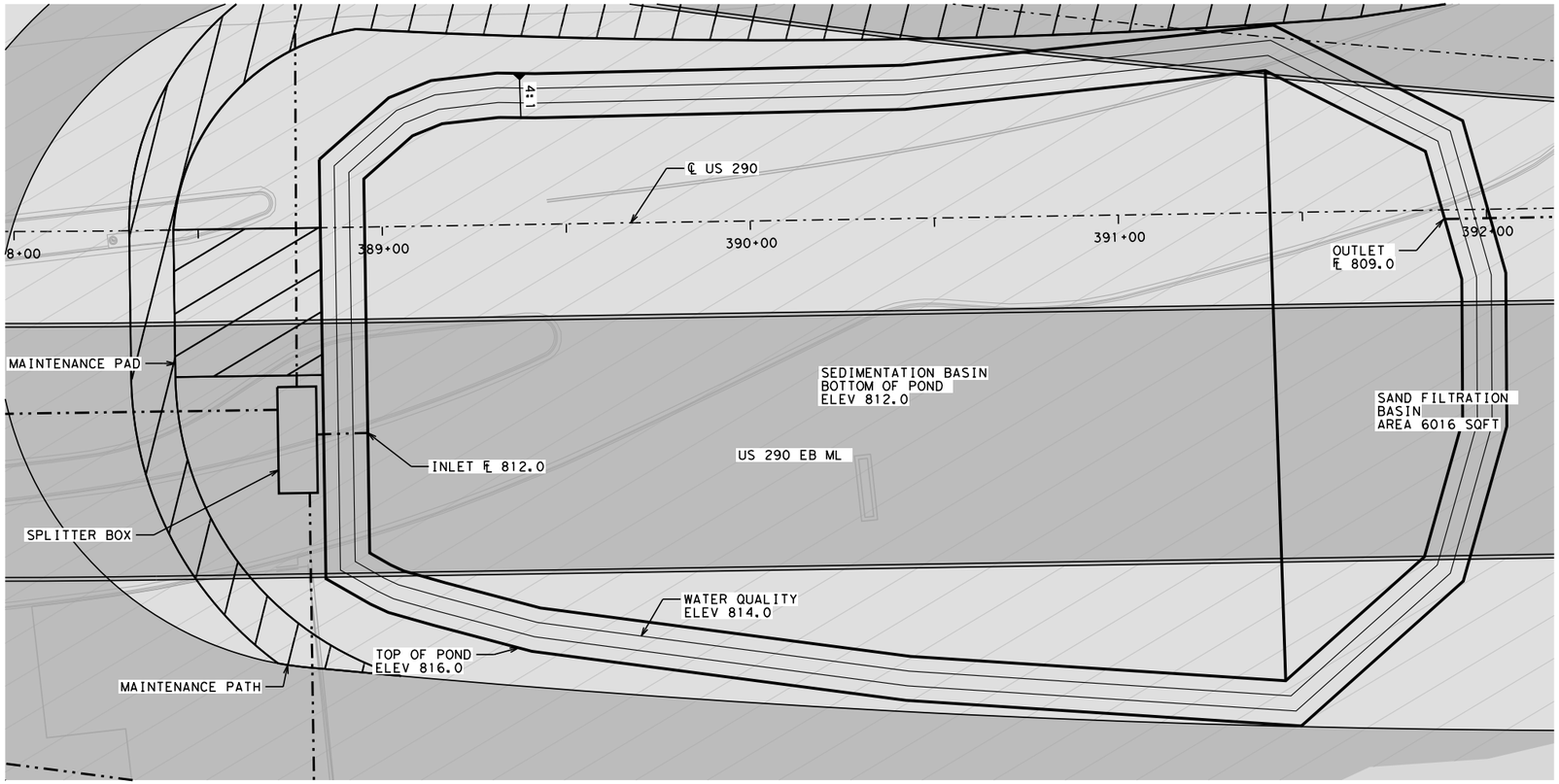
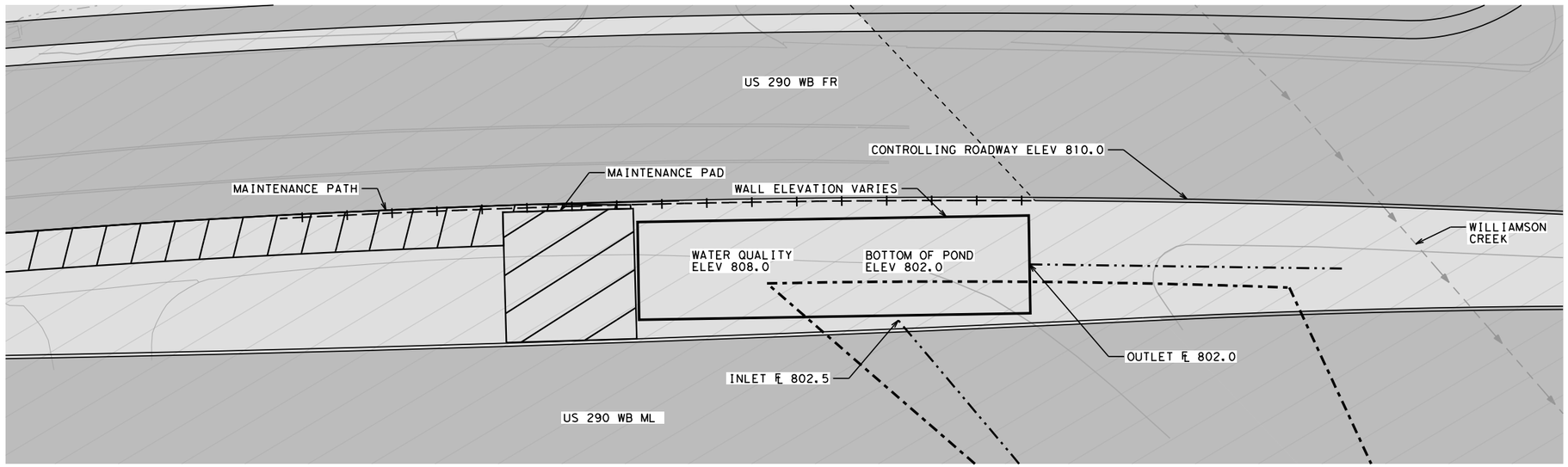


POND I
SAND FILTRATION POND



POND J
BATCH DETENTION POND

LEGEND

- POND OUTLINE
- EXIST R.O.W.
- PROP R.O.W.
- RETAINING WALL
- EXIST E.O.P.
- PROP E.O.P.
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- EXISTING CONTOUR
- PROP IMPERVIOUS COVER
- FEMA ZONE AE
- MAINTENANCE PATH/PAD

0 20 40

POND I WATER QUALITY VOLUME:

REQUIRED: 76,874 CF
PROVIDED: 77,272 CF

POND J WATER QUALITY VOLUME:

REQUIRED: 21,414 CF
PROVIDED: 21,600 CF

NOTE:

SCHEMATIC POND ELEVATIONS WERE DETERMINED USING ASSUMPTIONS FOR STORM DRAIN SLOPES AND DEPTHS BASED ON SCHEMATIC ROADWAY DESIGN AND SURVEYED OUTFALL ELEVATIONS.

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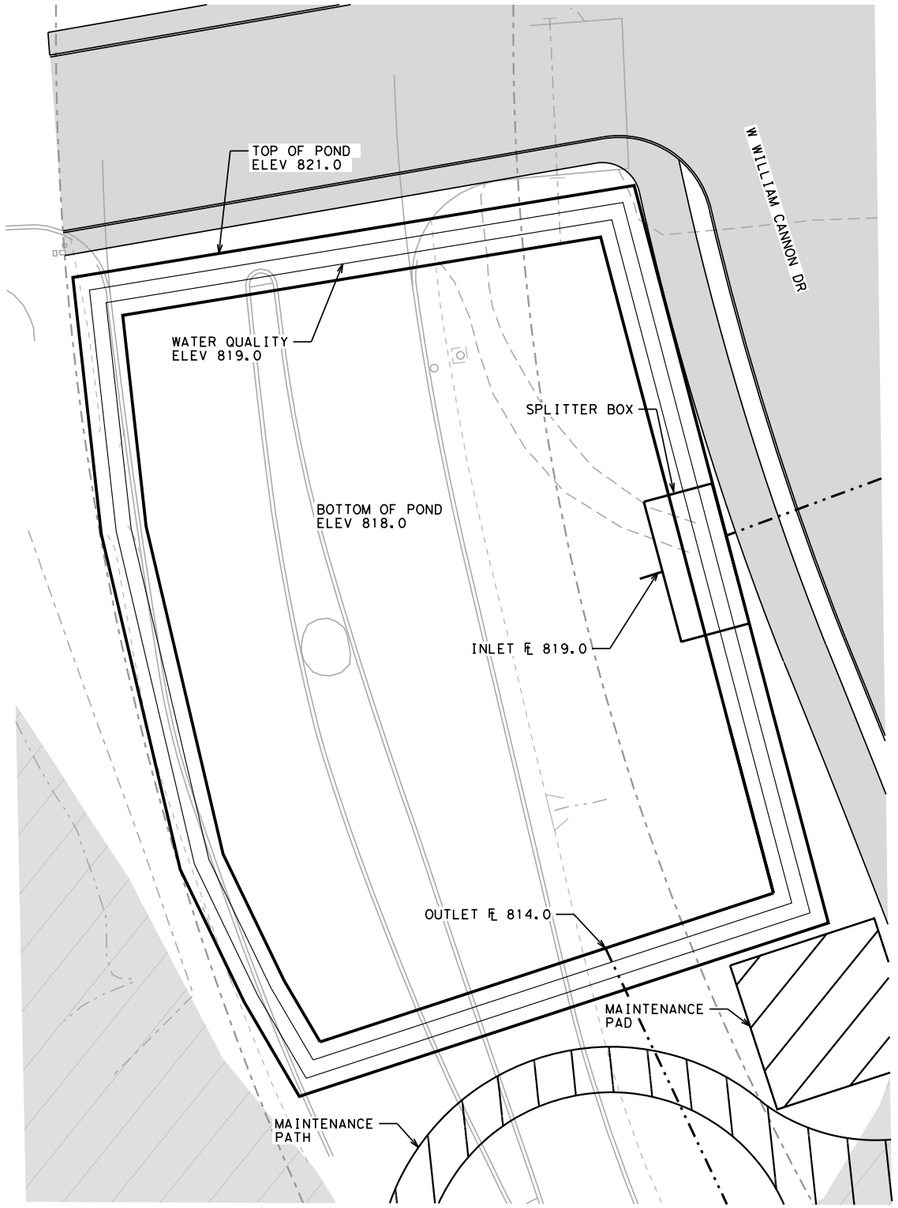
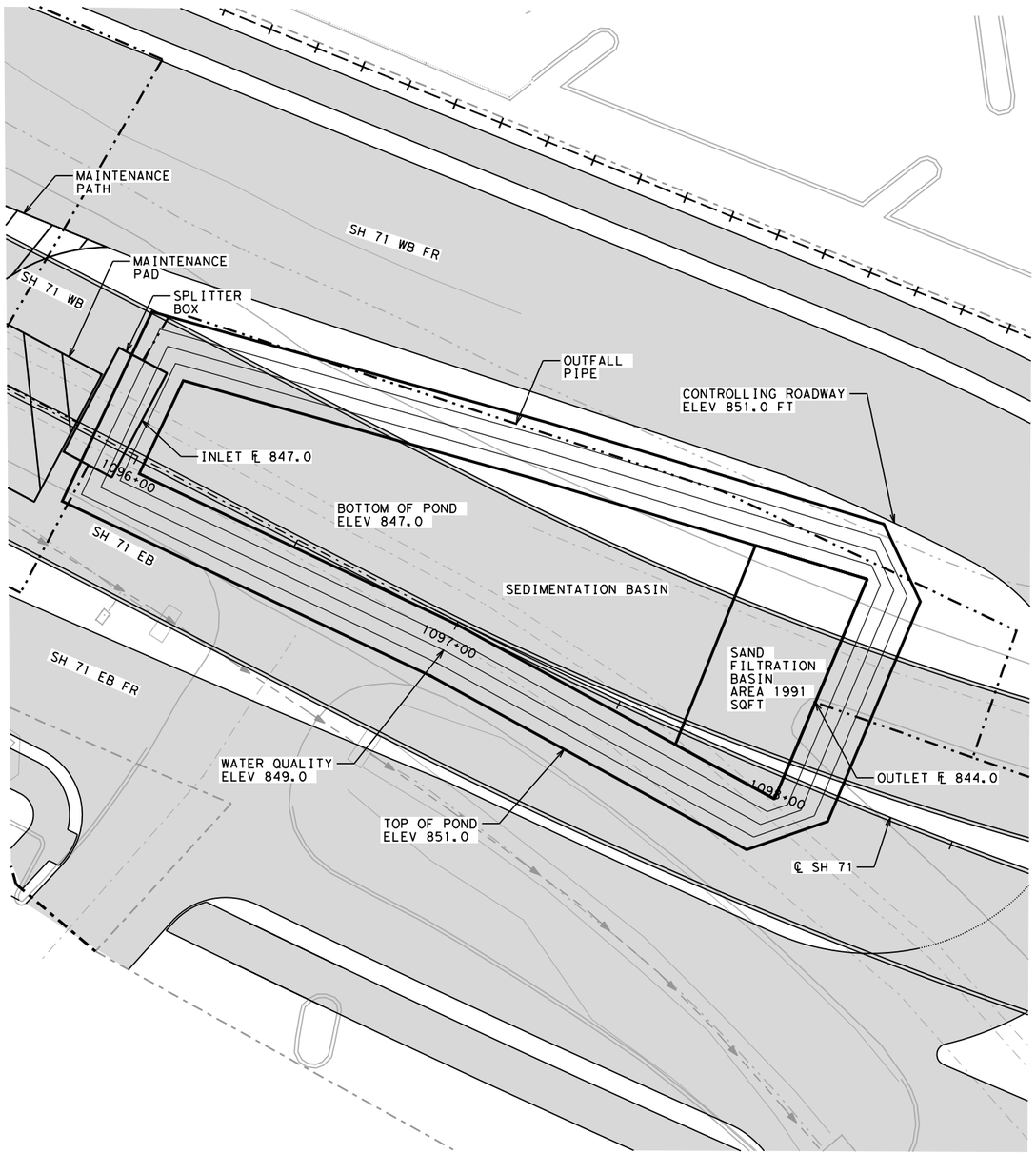


POND K
BIORETENTION POND



POND L
SAND FILTRATION POND

N

LEGEND

- POND OUTLINE
- EXIST R.O.W.
- PROP R.O.W.
- RETAINING WALL
- EXIST E.O.P.
- PROP E.O.P.
- STORM SEWER PIPELINE
- EXISTING CONTOUR
- PROP IMPERVIOUS COVER
- FEMA ZONE AE
- MAINTENANCE PATH/PAD

0 20 40

POND K WATER QUALITY VOLUME:

REQUIRED: 26,039 CF
PROVIDED: 26,685 CF

POND L WATER QUALITY VOLUME:

REQUIRED: 16,904 CF
PROVIDED: 17,243 CF

NOTE:

SCHEMATIC POND ELEVATIONS WERE DETERMINED USING ASSUMPTIONS FOR STORM DRAIN SLOPES AND DEPTHS BASED ON SCHEMATIC ROADWAY DESIGN AND SURVEYED OUTFALL ELEVATIONS.

OAK HILL PARKWAY PRELIMINARY WATER QUALITY POND LAYOUTS POND K AND POND L

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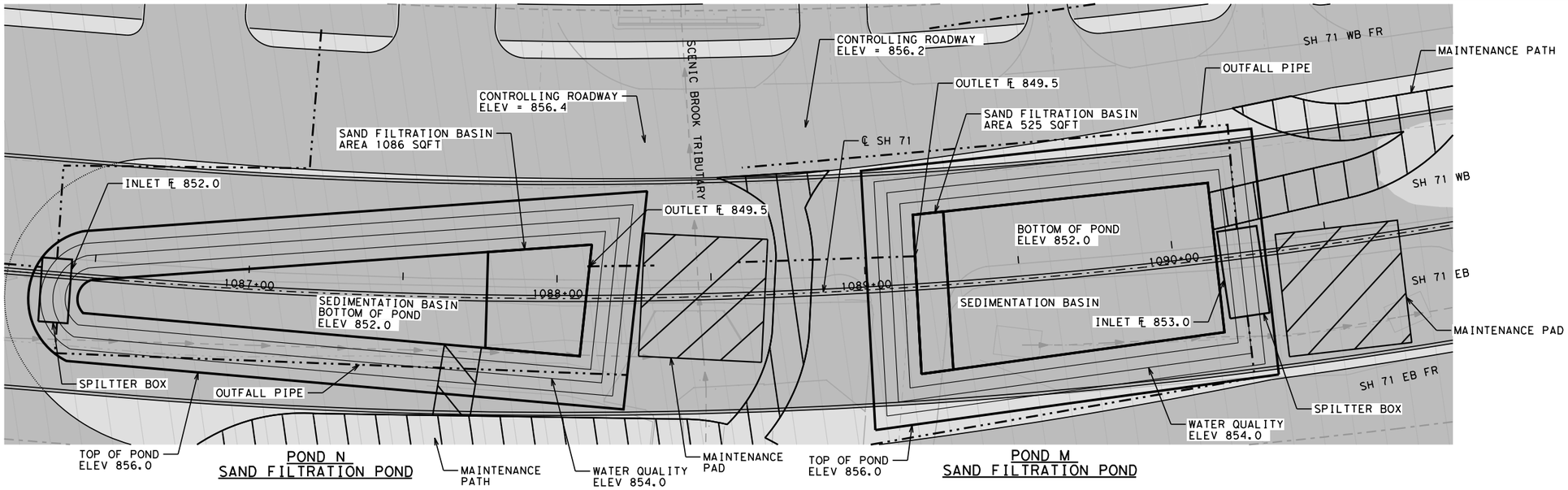

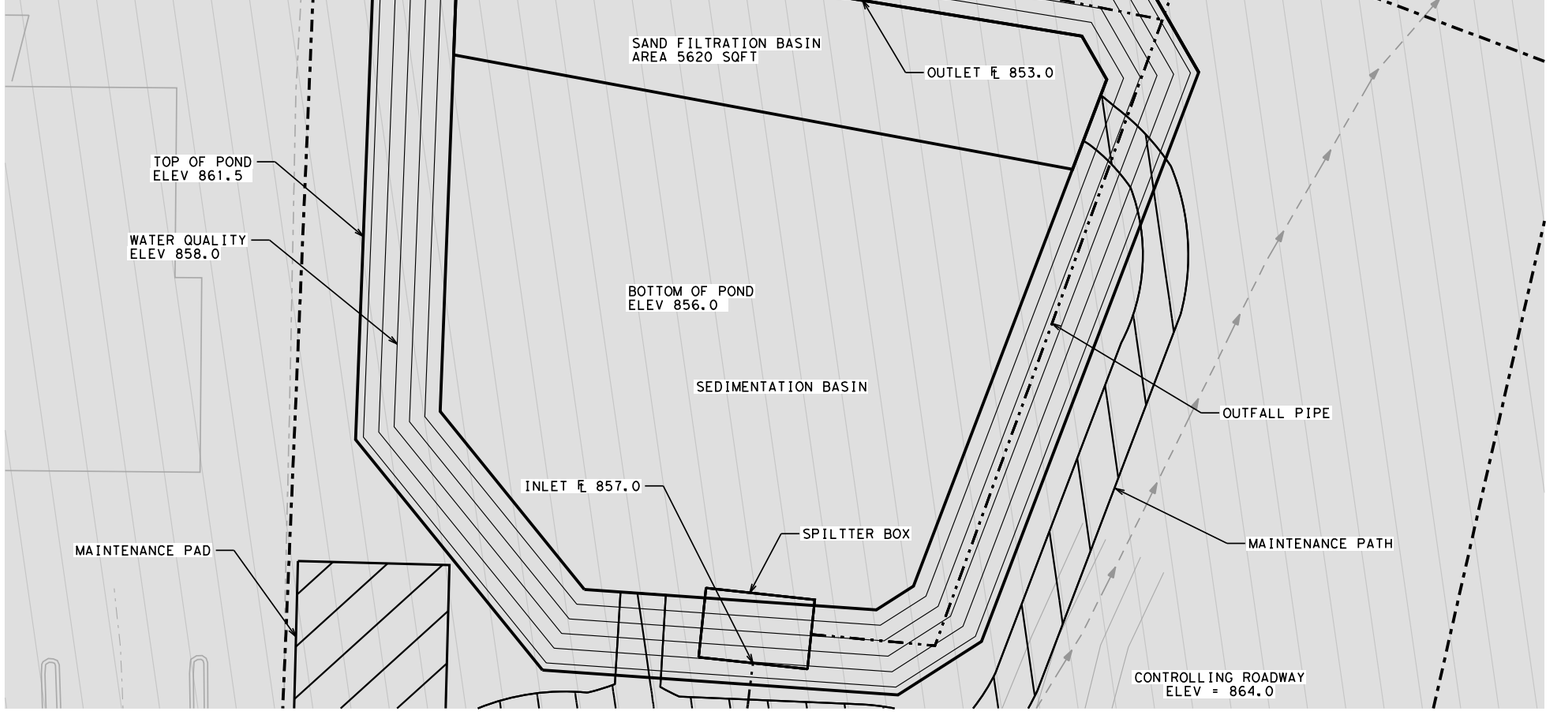

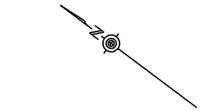

LEGEND

- POND OUTLINE
- EXIST R.O.W.
- PROP R.O.W.
- RETAINING WALL
- EXIST E.O.P.
- PROP E.O.P.
- STORM SEWER PIPELINE
- EXISTING CONTOUR
- PROP IMPERVIOUS COVER
- FEMA ZONE AE
- MAINTENANCE PATH/PAD

0 20 40

POND M WATER QUALITY VOLUME:

REQUIRED: 10,167 CF
PROVIDED: 10,674 CF

POND N WATER QUALITY VOLUME:

REQUIRED: 7,303 CF
PROVIDED: 7,758 CF

POND O WATER QUALITY VOLUME:

REQUIRED: 37,883 CF
PROVIDED: 38,806 CF

NOTE:

SCHEMATIC POND ELEVATIONS WERE DETERMINED USING ASSUMPTIONS FOR STORM DRAIN SLOPES AND DEPTHS BASED ON SCHEMATIC ROADWAY DESIGN AND SURVEYED OUTFALL ELEVATIONS.

OAK HILL PARKWAY PRELIMINARY WATER QUALITY POND LAYOUTS POND M, POND N AND POND O

Texas Department of Transportation

K·FRIESE + ASSOCIATES
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1120 S. Capital of Texas Highway
CityView 2, Suite 100
Austin, Texas 78746
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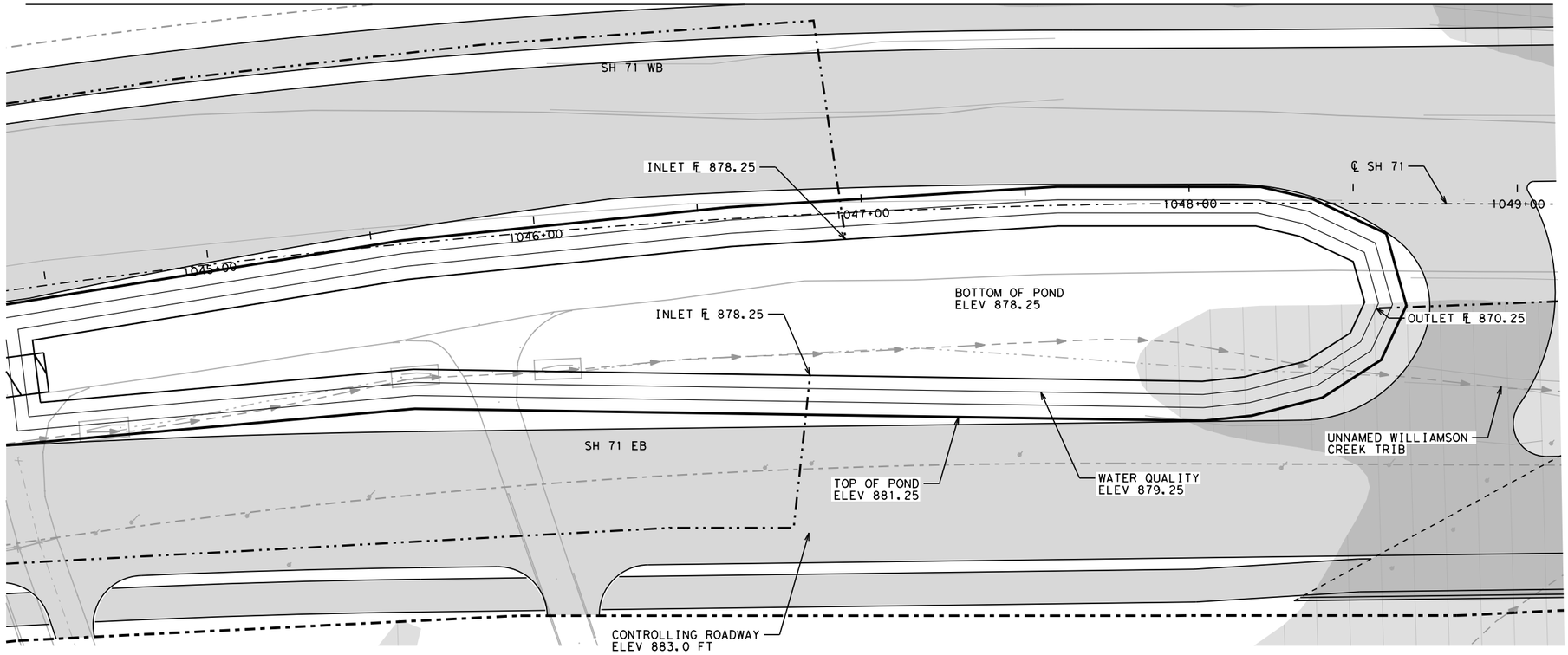
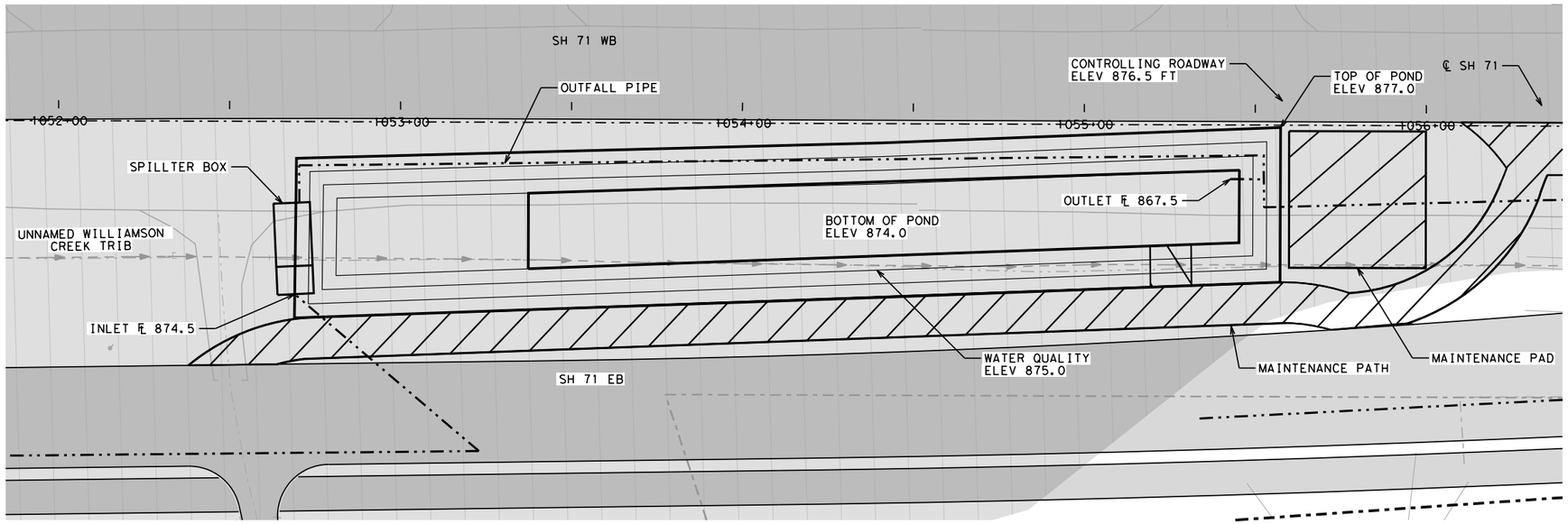


POND Q
BIORETENTION POND



POND P
BIORETENTION POND

LEGEND

- POND OUTLINE
- EXIST R.O.W.
- PROP R.O.W.
- RETAINING WALL
- EXIST E.O.P.
- PROP E.O.P.
- STORM SEWER PIPELINE
- EXISTING CONTOUR
- PROP IMPERVIOUS COVER
- FEMA ZONE AE
- MAINTENANCE PATH/PAD

0 20 40

POND P WATER QUALITY VOLUME:

REQUIRED: 6,798 CF
PROVIDED: 6,893 CF

POND Q WATER QUALITY VOLUME:

REQUIRED: 15,121 CF
PROVIDED: 15,821 CF

NOTE:

SCHEMATIC POND ELEVATIONS WERE DETERMINED USING ASSUMPTIONS FOR STORM DRAIN SLOPES AND DEPTHS BASED ON SCHEMATIC ROADWAY DESIGN AND SURVEYED OUTFALL ELEVATIONS.

OAK HILL PARKWAY PRELIMINARY WATER QUALITY POND LAYOUTS POND P AND POND Q

Texas Department of Transportation

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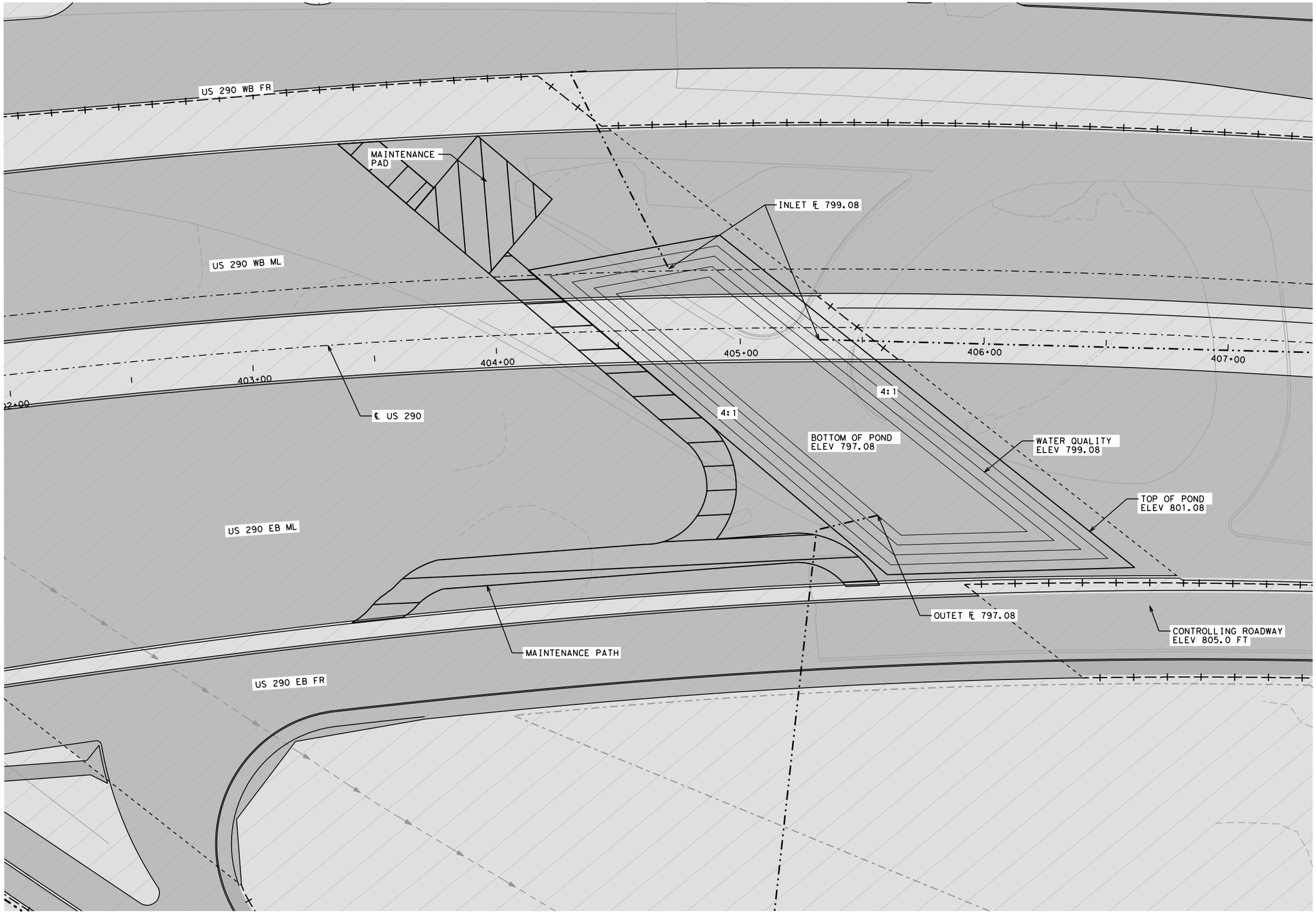

POND T
BATCH DETENTION POND

LEGEND

- POND OUTLINE
- EXIST R.O.W.
- PROP R.O.W.
- RETAINING WALL
- EXIST E.O.P.
- PROP E.O.P.
- STORM SEWER PIPELINE
- EXISTING CONTOUR
- PROP IMPERVIOUS COVER
- FEMA ZONE AE
- MAINTENANCE PATH/PAD

0 20 40

POND T WATER QUALITY VOLUME:

REQUIRED: 13,579 CF
PROVIDED: 13,720 CF

NOTE:

SCHEMATIC POND ELEVATIONS WERE DETERMINED USING ASSUMPTIONS FOR STORM DRAIN SLOPES AND DEPTHS BASED ON SCHEMATIC ROADWAY DESIGN AND SURVEYED OUTFALL ELEVATIONS.

OAK HILL PARKWAY PRELIMINARY
WATER QUALITY POND LAYOUT
POND T

Texas Department of Transportation

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Appendix H: Permanent Water Quality Technical Specifications (August 2019)

12.2.2.6 **Water Quality**

DB Contractor shall develop, implement, and maintain a stormwater pollution prevention plan (SW3P) in accordance with Section 402 of the Clean Water Act throughout the course of the Work. The SW3P shall be designed to successfully manage a 2-year storm measuring 2.64 inches of rainfall in 3 hours. DB Contractor shall perform all dewatering operations in a manner that discharges stormwater into a sedimentation basin prior to be being discharged off Site. When discharge of stormwater into a sedimentation basin is not practicable, DB Contractor shall treat stormwater discharge using a dewatering bag prior to being discharged off Site.

DB Contractor shall perform weekly inspections of the erosion and sediment control systems in accordance with TxDOT Form 2118. DB Contractor shall also monitor turbidity levels of the stormwater runoff entering waterbodies (i.e. Williamson Creek) and correct all system deficiencies and perform required modifications as soon as practicable to maintain required water quality standards.

All existing and proposed clay liners used for water quality treatment shall be supplemented with an impermeable geomembrane liner in accordance with TxDOT Special Specification 5056.

12.2.2.7 **Williamson Creek United States Geological Survey (USGS) Water Quality Monitoring Station**

DB Contractor shall relocate the Williamson Creek USGS water quality monitoring station during construction as stated in the FEIS and ROD. DB Contractor shall coordinate with the USGS and City of Austin to identify a suitable new location for the monitoring station.

12.2.2.8 **Edwards Aquifer**

DB Contractor shall comply with all laws and regulations relating to the protection of the Edwards Aquifer. DB Contractor shall be responsible for preparing and implementing a WPAP, or multiple WPAPs, in accordance with TAC Title 30 Part 1 Chapter 213. DB Contractor shall be responsible for coordinating the WPAP(s) with TCEQ prior to start of construction.

DB Contractor shall design water quality protection measures and best management practices to ensure a net reduction in total suspended solids leaving the Site.

PSLs located within the Edwards Aquifer Recharge and Contributing Zones require approval from TCEQ prior to construction/use of the PSL site. DB Contractor shall be responsible for developing and coordinating the signed PSL SW3P site plan with TCEQ prior to the construction/use of the PSL site.

20.3.1 **Permanent Water Quality**

DB Contractor shall base the project's required water quality design and TSS load removal on the following:

- TCEQ requirements for water quality found in 30 TAC Chapter 213 and associated TCEQ Edwards Aquifer Protection Program guidance (TCEQ EAPP guidance).
- Comply with USFW commitment of 0 lbs/yr TSS net increase leaving the project from existing conditions to proposed based on TCEQ calculation methodology.

In addition to TCEQ requirements, at a minimum each pond shall be designed to meet the following:

- Water quality capture volume of the first one-half (0.5) inch of runoff plus an additional one-tenth (0.1) inch for each ten (10) percent increase of impervious cover over twenty (20) percent within the drainage area. If it is not feasible to meet this volumetric requirement and the pond still meets the TCEQ and USFWS criteria, the DB contractor will need prior approval from TxDOT and a detailed engineering explanation as to why it is infeasible.
- Have an equivalent effluent removal rate to that of Sedimentation/Filtration to the extent possible.

DB Contractor shall select BMPs that are currently allowed per TCEQ EAPP guidance and must be one or more of the following types: vegetative filter strip (VFS) adjacent to pavement, bioretention basins, or sand filter basins. The use of VFS should not take the place of or reduce the number of ponds shown in the schematic. Additionally, the use and placement of PFC, batch detention or proprietary BMPs from TCEQ EAPP guidance is prohibited without prior written approval from TxDOT. Additional area of PFC beyond what is shown in the "Oak Hill Parkway Pavement Designations" located in the RIDs will not be allowed to count as a water quality BMP. Prior to requesting the use of batch detention, DB Contractor shall provide design

variances approved by TCEQ to TxDOT for sand filtration ponds such as flatter underdrains, shallower sand filter media depth, etc.

VFS shall be designed in accordance with TCEQ program guidance. VFS along sidewalks and SUP's shall utilize the sizing in Table 20-1.

Table 20-1: Filter Strip Sizing for Shared Use Paths

Shared Path Width (ft)	Engineered VFS Width (ft)
4	2.10
6	3.10
8	4.20
10	5.20
12	6.30
14	7.30

If the use of PFC is approved by TxDOT, placement of PFC shall meet the following criteria:

- PFC shall be placed on the main lanes before being placed on frontage roads. As part of TxDOT approval, DB must show that PFC on main lanes does not achieve required removal before placing on frontage roads as a last resort.
- PFC shall be placed on west end of 290 heading east first to meet TSS removal requirements. Placement of PFC on SH 71 shall be a last resort.
- PFC shall be placed with minimum section lengths of 1500'.
- Minimum spacing between PFC sections shall be 2000'. If this can't be achieved make PFC continuous.
- PFC shall not be placed within 500' of a signalized intersection or stop signs.
- PFC shall not be placed in areas with multiple driveways.
- PFC shall not be placed on bridges or approach slabs.
- PFC shall be placed the full width of pavement, including shoulders but is not required across entire main lanes separated by barrier or medians. A turn lane is not considered a median. If the full width of pavement is greater than 48' (approximately 4 lanes), only the upgradient 48' of PFC shall be counted for TSS removal.
- PFC shall only be counted for treatment on roadway sections with a cross slope less than or equal to 2.7%.

Design requirements in addition to and superseding TCEQ EAPP guidance are as follows:

- The use of underground water quality facilities is prohibited.
- DB Contractor shall design and construct water quality pond inlets to be above the vertical limits of the 20% sediment storage volume.
-
- All ponds shall have shutoff valves on the downstream end of the ponds that are accessible in all weather conditions and require no tools to open or close. Valves shall be enclosed in a ground box with apron. All surfaces of the valve assembly shall be accessible.
- Earthen pond side slopes shall be 4:1 (H:V) or flatter with a minimum embankment top width of six (6) feet.
- Vertical pond side slopes are allowed as long as access to basins is maintained and side slopes meet retaining wall design standards.

- Impermeable liners shall be used for all water quality basins. Impermeable liners may be concrete or geomembrane.
- The use of Schedule 40 PVC will be allowed within water quality ponds and to outfall water quality ponds. The minimum PVC pipe size inside ponds shall be 4 inch perforated and 6 inch unperforated for pond outfalls. The use of PVC under pavement is prohibited. The PVC shall transition to 24-inch RCP no further than 100 feet from the entrance to the pond outlet.
- DB Contractor shall design and construct a permanent access all weather drive to each pond. General requirements for maintenance access must meet TCEQ EAPP guidance. Access drives must have a minimum width of 12 feet and slopes not exceeding 4:1. Access drive turning radii shall be at least 50 feet. Access drives or ramps shall be designed into each pond chamber. All ponds must have an access maintenance staging area measuring 40 feet by 40 feet.
- DB contractor shall design security fencing and gates as shown in the Aesthetics and Landscaping Plan. At least one gate opening must be provided in each travel direction. Gate openings must be at least 12 feet wide. Security fencing and gates are limited to ponds that need fall protection.
- DB Contractor shall design water quality ponds to function as temporary sediment basins during construction with a means to detain stormwater and control the discharge if dewatering becomes necessary. DB Contractor may provide a dewatering mechanism that is accessible from outside the ponded area.
- DB Contractor shall design water quality pond berms to be higher than the 100-yr WSE of Williamson Creek or the 100-yr WSE of the adjacent outfall location if the water quality pond outfall location is different than Williamson Creek, DB Contractor shall design the water quality ponds to prevent the back flow of water from Williamson Creek to the water quality ponds, and will obtain prior approval from TxDOT of the method of preventing backflow. Design of a water quality pond with a berm lower than the 100-year WSE of the outfall location will require prior approval from TxDOT and detailed engineering explanation."
- DB Contractor shall confirm elevations of underdrain pipe after installation and prior to covering with filter media. DB Contractor shall provide an electronic pdf of Record Drawings within 60 calendar days of a water quality pond becoming active. Record Drawings of the water quality ponds shall include GPS coordinates and elevations of all flowlines for inlets, flowlines for outlets, elevations of underdrain pipes, top of the pond, and bottom of the pond. DB Contractor shall schedule and conduct a walk thru inspection with a TxDOT registered professional engineer prior to providing the Record Drawings of the water quality ponds. DB Contractor shall clean the pond to be free of sediment and debris prior to Final Acceptance.

DB Contractor shall set up a meeting with TCEQ and TxDOT to coordinate construction activities, and schedule and WPAP approval(s) within 30 days of NTP1.

DB Contractor shall provide Water Quality plan sets that contain the following with the Preliminary Design and Final Design:

Site Plan Sheets including:

- All TCEQ Site Plan requirements from TCEQ-0584 form
- Contributing areas identified and quantified
- Location and type of BMP shown
  - Begin and End stations and lengths of VFS
- Project areas including:
  - Total Project area boundary
  - BMP contributing drainage area boundaries
  - Existing and Proposed impervious cover area boundaries
- Drainage flow direction arrows
- FEMA floodplains shown with floodplains labeled
- ROW and drainage easements shown and labeled

Water Quality Data sheets with tables including:

- Project ID/TxDOT maintenance number
- Total Project Area
- Total Project Existing and Proposed Impervious areas
- Total Project TSS removal required
- BMP ID and type
- Runoff depth captured for ponds
- BMP efficiency
- Load removed (Project Total and per BMP)
- Pond volume required
- Pond volume provided
- Existing load leaving project, proposed load leaving project and difference

TCEQ General Notes Sheet as shown in the Austin District Standards

Water Quality Pond Layout Sheets including:

- All design elements required by TCEQ for the specific BMP type
- BMP ID
- Area and Storage Table with
  - Area and volume for each foot of elevation
  - Cumulative Volume for each foot of elevation
  - Discharge Table: 25-yr and 100-yr weir with flow, weir length, weir coefficient, weir depth and freeboard
- Pond Locations Table
  - Point number, Station/Offset, XY Coordinates (decimal degrees), Elevation and Description
  - Points for top and bottom of berm/wall, top of weir, flowlines, toe of slope, access drive location, riser pipe, splitter box, inlet and outlet structure(s), and valves
- Label berm width and side slopes
- Pond basin dimensions
- Label shutoff valves and cleanouts
- At least one cross section through pond oriented from inlet to outlet
- Label access drive and staging area

Water Quality Pond Detail Sheet(s) including:

- Impermeable liner type, placement, installation attachment details
- Filtration bed section
- Underdrain pipe
- Filtration bed clean-out
- Vertical sediment depth marker
- Outfall structure details
- Valve installation
- Splitter Box

Access Drive and Maintenance Staging Area Layout and Details Sheet including:

- Access from the roadway
- Drive and staging area dimensions: width, cross slope, radii
- Drive material
- Fence and gate details and dimensioned layout

Appendix I: TCEQ Bioretention Memorandum

TCEQ Interoffice Memorandum

To: Susan Jablonski, P.E., Director, Central Texas Area

Thru: Candy Garrett, Edwards Aquifer Program Liaison
Amy Settemeyer, Edwards Aquifer Program Liaison

From: Edwards Aquifer Program Committee

Date: June 1, 2012

Subject: **Revision of Bioretention in Technical Guidance Manual**

Brief Description of Problem

The program needs to update the applicability and design criteria for bioretention.

Background

Bioretention is recognized as an appropriate Best Management Practice (BMP) for use on the aquifer. Bioretention is equivalent to biofiltration, which uses a biologically active filtration bed to remove contaminants. This type of BMP is preferred because it provides the opportunity for pollutant uptake (particularly nutrients) by vegetation in an aesthetically pleasing design (UT Austin paper cited in attachment).

Options and Considerations

The recommendation from our contractor is attached. During our review, we realized that staff had previously drafted changes for the BMP that included one other item: to make the grassy strip optional because it is not necessary to pre-treat the inflow to this BMP. See the replacement text for the applicability section of the guidance and the associated figures that are also attached.

The increase in water depth means that bioretention will become a more attractive option to treat stormwater runoff because a greater water depth results in a smaller facility footprint. The chief concern with water depth is plant survivability. The consensus is that a 12 inch depth is not a problem with plant survival. Water depths up to 3 ft. are being considered by the City of Austin to make this BMP even more attractive. The committee wants to wait and see what results from greater than 12-inch water depth installations before recommending a greater increase.

Reducing the filtration media thickness also makes the BMP more attractive. The decrease to 18 inches also brings TCEQ guidance in line with the City of Austin's criteria.

Reducing the organic matter (and eliminating compost) in the filtration media is recommended because research has shown better nutrient reduction with less organic matter. The Edwards Aquifer rules target total suspended solids removal as the performance standard but the program considers the TSS parameter as a surrogate for other pollutants (23 Tex Reg 10443). Nutrient removal should be considered in BMP design.

Staff also believed it was not necessary to have our guidance exactly match City of Austin's. Small differences, such as closely planted shrubs inside the pond, may exist that would be acceptable to our program.

Committee Recommendation

- Accept all the changes on the marked versions of the bioretention applicability document and the bioretention design document.
- Replace the current sections 3.2.6 and 3.4.8, respectively with these new versions in the next revision of the program technical guidance manual, RG-348.

Feedback to the Committee

☑ The recommendation is accepted as proposed. (Select distribution instructions below)

☐ The recommendation is accepted with the following modifications. (Select distribution instructions below). Comments:

☐ The recommendation is being returned for further consideration. Comments:

Distribution: The accepted or modified recommendation will be incorporated into the:

☐ Program Investigator Manual (at various locations on the Website)

☐ FOD SOP Procedures (at various locations on the Website)

TCEQ Interoffice Memorandum

☐ FOD WEBSITE at:

- ☐ Organizational
  - ☐ Organizational Information ☐ Division Protocols
- ☐ Operational Support
  - ☐ Budget, ☐ Purchasing, ☐ Property Management, ☐ Safety, ☐ PDP
- ☐ Management
  - ☐ Workload/Staff ☐ Section Manager ☐ Region Manager
- ☐ Programs
  - ☐ All Investigations
  - ☐ CCEDS
  - ☐ Equipment
  - ☐ Air
  - ☐ Water
  - ☐ Waste
  - ☐ Emergency Response

☐ Distribute in Hard Copy

TCEQ Interoffice Memorandum

Bioretention Revision Summary

I am requesting certain revisions to the language currently incorporated by TCEQ in RG-348 regarding bioretention design guidelines. These revisions include:

- Reducing the required depth of media from 3 feet to 18 inches.
- Increase the maximum water depth over the media from 6 inches to 1.0 foot.
- Modifying the filter media specifications to reduce the amount of organic matter required and eliminate the use of compost.

The initial design recommendations for bioretention systems were based on guidance used in Maryland and other mid-Atlantic states. Since that time, additional research has been conducted in Texas by both UT Austin and Texas A&M that support the proposed revisions.

A series of experiments were performed at UT using 18 inch of media dosed regularly with up to 1 foot of water. These experiments indicated that the thinner media thickness and greater ponding depth had no noticeable impact on TSS removal and that the performance was still comparable to the removal observed in Austin sand filters. The results of the UT Austin experiments are available at: http://www.crwr.utexas.edu/reports/pdf/2010/rpt10-05.pdf. These two changes will substantially reduce the cost and footprint of bioretention facilities and make this Low Impact Development practice more competitive with traditional end of pipe systems.

A number of researchers have observed substantial nutrient export from bioretention systems that contain a substantial amount of compost in their filter media. A study from Texas A&M that was recently completed used 30% compost in the media mixture, which is consistent with the current recommendations in RG-348. In their five pilot systems, they observed "removal" of total phosphorus of between -954% to -3251% (i.e., their effluent concentrations were 10 to 30 times the influent concentration). Likewise the observed change in nitrate concentration ranges from -713% to -4139%. Consequently, I am recommending elimination of the use of compost and a reduction in the total organic matter in the media. The full results of the A&M study are available at: http://tti.tamu.edu/documents/0-5949-2.pdf.

3.2.7 Bioretention

The bioretention best management practice (BMP) functions as a soil and plant-based filtration device that removes pollutants through a variety of physical, biological, and chemical treatment processes. These facilities normally consist of plants inside a ponding area, mulch layer, planting soil, and an underdrain collection system. The runoff velocity may be reduced by passing over a grass buffer strip and subsequently distributed evenly along a ponding area. Exfiltration of the stored water in the bioretention area planting soil into the underlying soils occurs over a period of days. A schematic of a bioretention system is presented in Figure 3-5.

Selection Criteria

- Good choice of an onsite system serving a relatively small drainage area, since it can be incorporated into the site landscaping.
- Bioretention provides storm water treatment that enhances the quality of downstream water bodies by temporarily storing runoff in the BMP and releasing it over a period of four days to the receiving water (EPA, 1999).
- The vegetation provides shade and wind breaks, absorbs noise, and improves an area's landscape.

Limitations

- The bioretention BMP is not recommended for areas with slopes greater than 20% or where mature tree removal would be required
- Catchments with high sediment loads may result in clogging and excessive maintenance requirements (EPA, 1999).

Cost Considerations

The major costs associated with bioretention systems are the soil mixture and plants. The costs are greater than those for landscaping alone; however, the water quality benefits can be substantial. Many systems include only a few plants since pollutant uptake by the vegetation is not considered to be substantial.

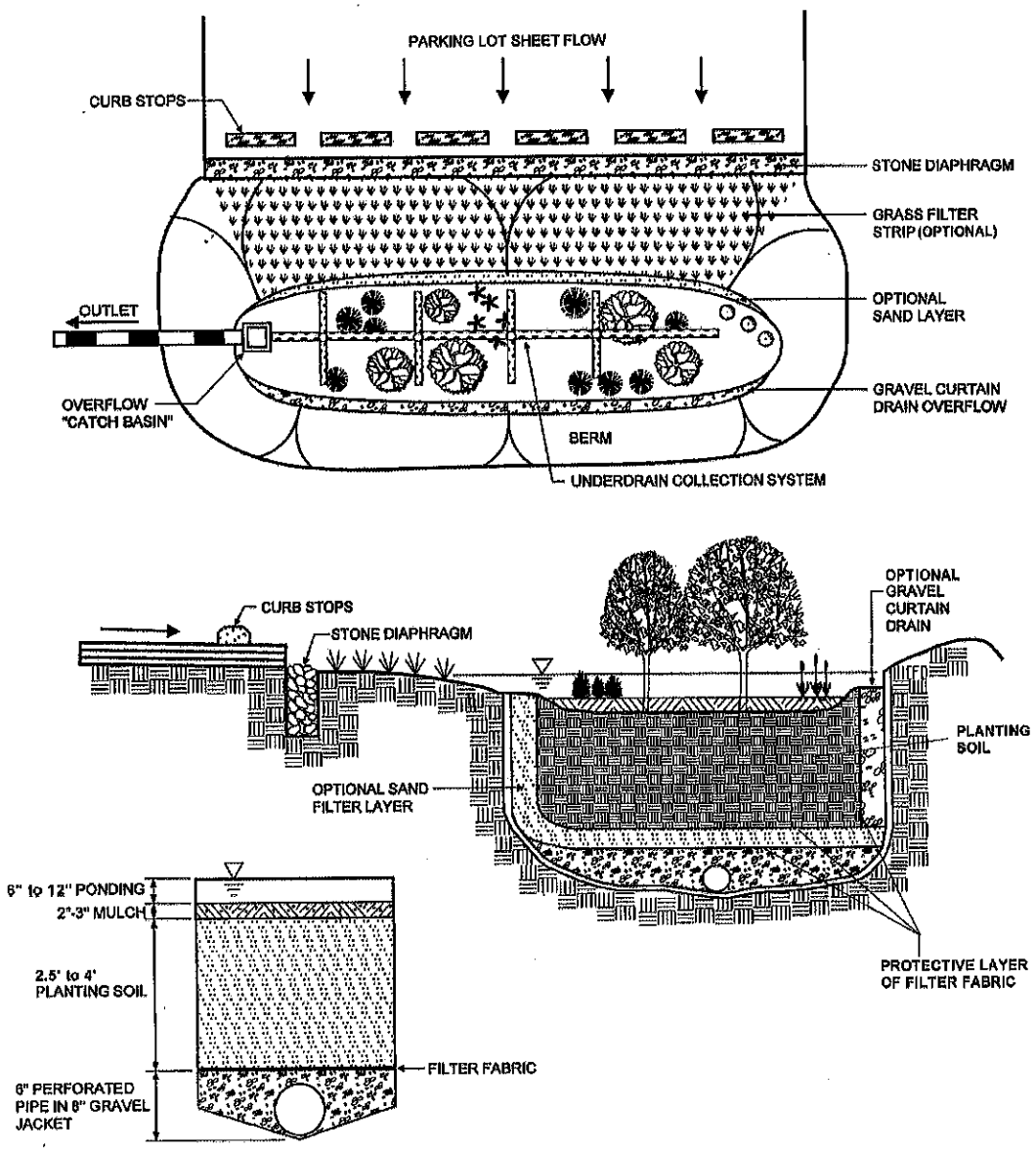


Figure 3-5. Schematic of a Bioretention Facility (MDE, 2000)

3.4.8 Bioretention

Bioretention facilities are effectively sand filters that include additional organic and soil material in the filtration media to support vegetation. This allows these facilities to be integrated into the site landscaping where they can provide unobtrusive treatment of stormwater runoff. The following areas should be considered when designing a bioretention facility.

1) *Water Quality Volume* – The water quality is calculated according to the guidelines in Section 3.3. This volume should be increased by a factor of 20% to accommodate reductions in the available storage volume due to deposition of solids in the time between full-scale maintenance activities. A fixed vertical sediment depth marker should be installed in the facility to indicate when sediment accumulation equals 20% of the water quality volume and sediment removal is required.

2) *Inlet Design* - When siting bioretention facilities to intercept drainage, the designer should attempt to use the preferred "off-line" facility design. Off-line facilities are defined by the flow path through the facility. Any facility that utilizes the same entrance and exit flow path upon reaching pooling capacity is considered an off-line facility.

3) *Filtration Area* – The footprint of the media should be sufficiently large that it underlies the entire flooded area for the design water quality volume calculated according to the guidelines in Section 3.3. The water depth over the media for the design storm should not exceed 1 foot.

4) *Media Properties* – The filtration media should have a minimum thickness of 18 inches and should have a maximum clay content of less than 5%. The soil mixture should be 75-90% sand; 0-4% organic matter; and 10-25% screened bulk topsoil. The soil should be a uniform mix, free of stones, stumps, roots, or other similar objects larger than two inches. No other materials or substances should be mixed or dumped within the bioretention that may be harmful to plant growth, or prove a hindrance to the planting or maintenance operations. Provide clean sand, free of deleterious materials. Sand may be composed of either ASTM C-33 (concrete sand) or ASTM C-144 (masonry sand). The organic matter should not include compost, but material such as peat moss or shredded bark mulch is acceptable.

5) *Underdrains* – Underdrains should be incorporated in all designs. The underdrain piping should consist of a main collector pipe and two or more lateral branch pipes, each with a minimum diameter of 4 inches. Underdrains should be perforated with ¼ - ½ inch openings, 6 inches center to center. The pipes should have a minimum slope of 1% (1/8 inch per foot) and the laterals should be spaced at intervals of no more than 10 feet. Each individual underdrain pipe should have a cleanout access location. All piping is to be Schedule 40 PVC.

6) *Grading* - The designer/landscape architect can develop a landscaping plan for bioretention in similar fashion to conventional site landscaping design. The main

difference is essentially the integrated stormwater management control- "functional landscaping" as well as the aesthetic appeal. Even though the facility is being designed to capture and treat stormwater, the designer is cautioned *not* to view bioretention as a wetland, pond, or other water feature. Rather, the designer should utilize plant species that are tolerant to wide fluctuations in soil moisture content.

7) *Setbacks* - When siting bioretention facilities, a 50-foot setback from septic fields should be provided. Setback from a foundation or slab should be 5 feet or greater if the system is unlined.

8) *Liners* – There are two possible configurations of bioretention facilities, with and without liners. Liners must be used in facilities constructed in the recharge zone. A configuration like that shown in Figure 3-25 is preferred. In the contributing zone, liners are not required and this will allow some portion of the runoff to infiltrate. In this configuration, the underdrain is installed above the invert of the excavation to promote infiltration as shown in Figure 3-26. When constructing a facility like that shown in Figure 3-26, the filter fabric does not need to extend to the side walls. The filter fabric may be installed horizontally above the gravel blanket- extending just 1-2 feet on either side of the underdrain pipe below. Do ***not*** wrap the underdrain with filter fabric.

9) *Vegetation* – Vegetation selected for the bioretention system should be tolerant of frequent inundation during extended periods of wet weather. In addition, large trees or other plants with root systems that might penetrate the liner should not be used. Buffalograss and Big Muhly have both been shown to provide enhanced nutrient removal.

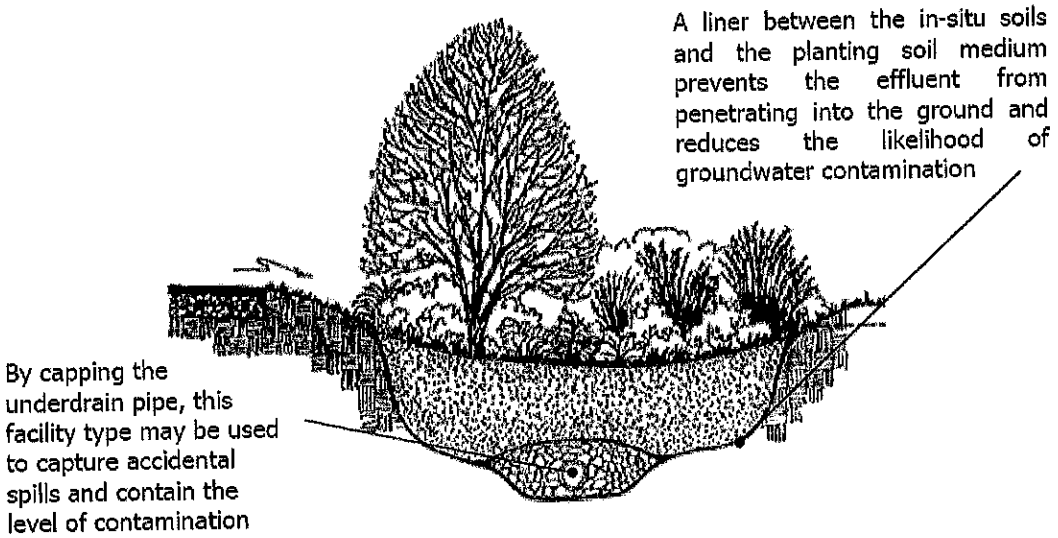


Figure 3-25. Bioretention with Underdrain and Liner

Appendix J: TCEQ PFC Specifications Memorandum

TCEQ Interoffice Memorandum

To: Susan M. Jablonski, P.E., Area Director, Central Texas

Thru: Beryl Thatcher, Manager, Program Support Section
Rick Smathers, Field Support Team Leader
Macy Beauchamp, Water Liaison

From: Edwards Aquifer Protection Program Innovative Technology (IT) Subcommittee

Date: February 26, 2016

Subject: Proposed Revisions to the Permeable Friction Course (PFC) BMP to the Addendum Technical Guidance Manual

Brief Description of Problem

The Committee should consider allowing revisions to the Permeable Friction Coarse (PFC) guidance. The recommendations by the third party contractor include:

- Use of PFC in curb and gutter applications;
- Allowing PFC on roadway sections with up to four lanes in one direction; and
- Revising testing criteria to increase permeability drainage time from 60 seconds to 120 seconds for the initial 24-month test period and increase permeability drainage time from 100 seconds to 200 seconds for the subsequent yearly tests.

Background

A PFC is an engineered layer of porous asphalt up to two inches thick that is placed as an overlay on top of an existing conventional concrete or asphalt surface. PFC was originally approved on August 19, 2009 and revised on July 5, 2012. The current guidance allows for PFC to be used on high speed roadways with a rural cross-section that do not include curb and gutter.

In March 2013, TCEQ contracted consultant, Dr. Michael Barrett, issued recommendations based on the results of a study, "Water Quality and Hydraulic Performance of Permeable Friction Coarse on Curbed Sections of Highways". The study monitored two PFC locations along curbed sections of Mopac freeway in Austin, Texas. The results of the study showed that the pollutant reductions along curbed sections of highway were similar to those without curb and gutter on rural sections of roadway. The TSS removal efficiencies achieved on the studied sections of Mopac were greater than 90 percent. The Mopac typical section consisted of four lanes in one direction and a shoulder.

Options and Considerations

Since a PFC is not a catch-and-treat type permanent BMP, it is generally not appropriate to use for overtreatment. In addition, a PFC may have durability issues in areas with high stopping and turning movements such as in intersections. Excessive stopping and turning movements may cause the PFC to ravel or delaminate. In addition, a PFC typically is not applied on bridges. For the above reasons and applications, overtreatment credit gained from PFC in the project limits may be approved to be applied to bridges and intersections. Overtreatment credit gained from PFC will only be applied and considered for the project under review. In other words, overtreatment credit may not be collected ("banked") and transferred to another project.

The TSS removal efficiency was reported 90 percent from a contractor's study result.

The TCEQ contractor has recommended increasing the initial drainability test (Tex-246-F) time (triggering more frequent testing) from 60 seconds to 120 seconds. TCEQ contractor also recommended increasing the Tex-246-F test time that triggers replacement of the pavement from 100 seconds to 200 seconds. TCEQ contractor based his recommendation on a study that states that PFC begins to lose its water quality benefit at 150 in/hr/lane, which equates to a 200-second drain time. Nonetheless, TCEQ's contractor recommendations for increasing Tex-246-F test times will not be incorporated because "Performance and Cost Effectiveness of Permeable Friction Course Pavements", a Texas Department of Transportation sponsored paper, shows and considers PFC to be poor performing at a Tex-246-F test time of 80 seconds. For reference the above mentioned paper also considers PFC to be impervious at a Tex-246-F test time of 90 seconds.

Revisions are shown on the marked version of the PFC Addendum Guidance Document RG-348. See the attached revised Addendum Guidance Document for PFC.

Committee Recommended Option and Distribution

Accept the revisions made to the attached Addendum Sheet Guidance Document RG-348.

Feedback to the Committee

☐ The recommendation is accepted as proposed.

☐ The recommendation is accepted with the following modifications. Comments:

Click here to enter text.

☐ The recommendation is being returned for further consideration. Comments:

Click here to enter text.

Section 3.2.16 – The Permeable Friction Course

A permeable friction course (PFC) is a layer of porous asphalt up to 2 inches thick that is placed as an overlay on top of an existing conventional concrete or asphalt surface. Porous asphalt is an alternative to traditional hot mix asphalt and is produced by eliminating the fine aggregate from the asphalt mix. The overlay typically is referred to in the U.S. as Permeable Friction Courses (PFC) or Open Graded Friction Courses (OGFC). The void space in a PFC overlay generally is 18-22%. Rain that falls on the friction course drains through the porous layer to the original impervious road surface at which point the water drains along the boundary between the pavement types until the runoff emerges at the edge of the pavement. Historically, the main use of PFC in Texas has been to increase safety through improved visibility and better traction. An example of the reduction in spray behind vehicles is documented in Figure 1.

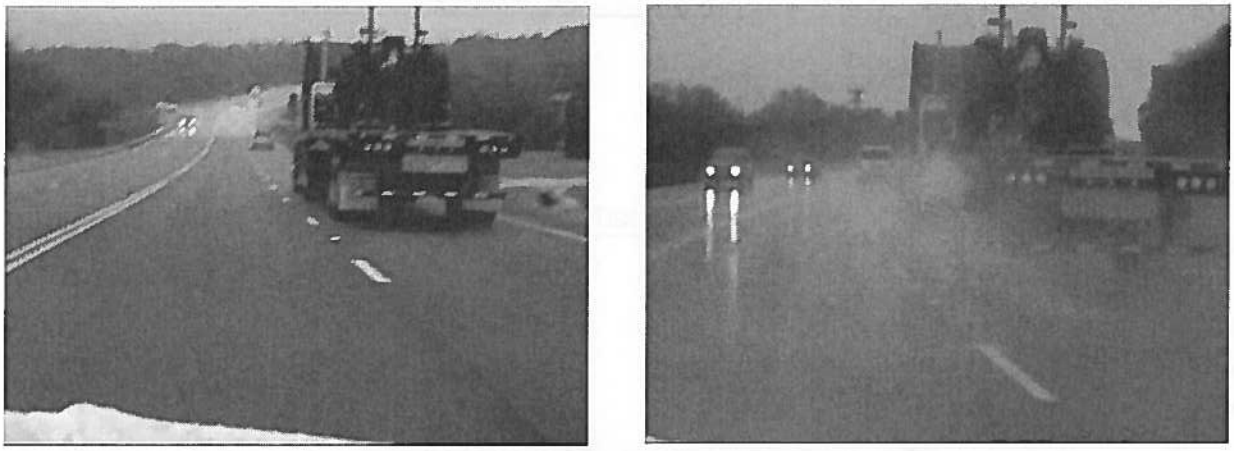
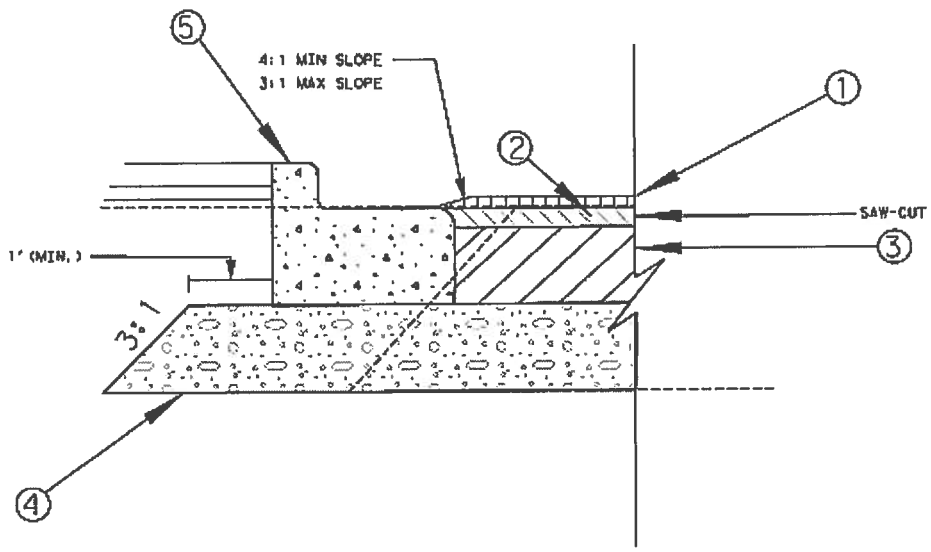


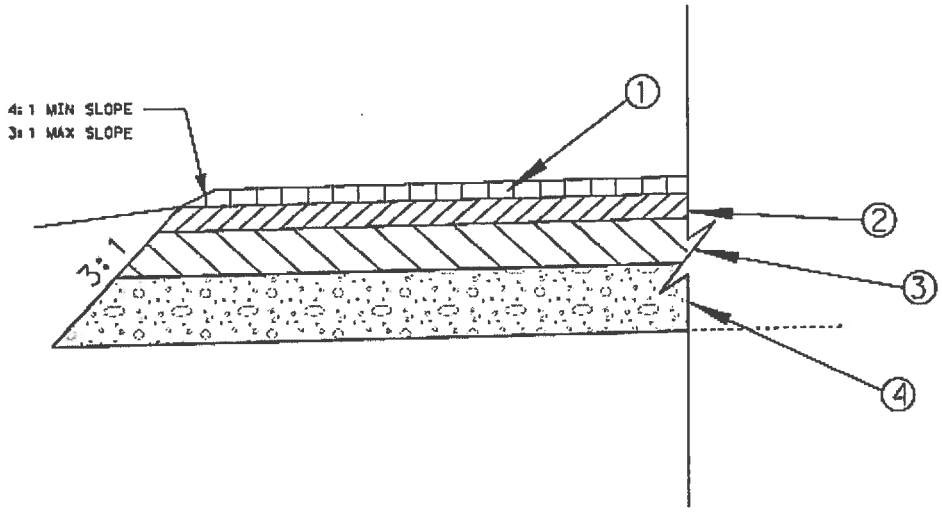
Figure 1 Difference in Spray from PFC Pavement (left) and Conventional Pavement (right)

When used as an overlay on high speed roadways with a rural cross-section (no curbs), and on urban roadways with an urban cross-section (curbs) recent research has documented TSS removal of 90 % compared with conventional concrete or asphalt pavements. Consequently, this material can be used to meet the TSS reduction requirements of the Edwards Aquifer Protection Rules, chapter 213.5 (b)(4)(D)(ii). The open nature of the pavement reduces its strength over time, so the pavement will have to be replaced or rehabilitated periodically (approximately every 10 years) to maintain the water quality benefit, and prevent excessive raveling and pavement failure. See typical sections of the rural cross-section and urban cross- section in Figure 2.

CURB AND GUTTER



NON-CURB AND GUTTER



LEGEND

1. POROUS FRICTION COURSE (PFC)
2. D-GR HMA TY-D SAC B
3. D-GR HMA TY-B SAC-B
4. FLEXABLE BASE
5. CURB & GUTTER

Figure 2 Pavement Structure and Edge Detail

Selection Criteria

- Achieves 90 percent TSS removal, so can be used as a standalone BMP
- Incorporates stormwater treatment within the highway pavement
- Requires no additional purchase of right-of-way to provide stormwater treatment
- Appropriate for retrofits of existing roadways

Limitations

- May only be used on roadways with a minimum posted speed of 50 mph
- May require specific R.O.W. restrictions and assurances of such restrictions
- Must be tested immediately following installation to demonstrate that desired permeability has been achieved.
- Should not be used in areas of heavy construction, since material tracked onto the roadway can fill the pores in the pavement and eliminate the water quality benefits
- Sand should not be applied to the pavement in cold whether to increase traction, since this will substantially reduce the permeability; however, deicing salts may be used.
- Will require milling and replacement of the overlay at regular intervals, which entails significant expense.

Section 3.4.16 – Design Criteria for Permeable Friction Course

A permeable friction course (PFC) is a porous asphalt overlay that removes 90 % of the TSS in runoff in comparison with conventional concrete and asphalt pavements. The objectives of these design criteria are to ensure that the pavement has sufficient permeability and porosity to convey most runoff to the shoulder of the road within the pavement itself (not on the surface) and to provide storage for the accumulated TSS. To achieve a TSS removal of 90 % the PFC must meet the following specifications:

(1) *Material* – The PFC must meet the mixture and placement specifications in TxDOT Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges, Item 342.

(http://www.dot.state.tx.us/business/specifications.htm)

(2) *Thickness* – The PFC must have a minimum thickness of 1.5 inches

(3) Typical Section – In curb and gutter sections PFC shall be placed over an impermeable surface such as Hot Mix Asphalt. The PFC layer should be above and taper towards the gutter lip. See typical section details in Figure 2.

(4) *Roadway Characteristics* – The roadway should have a posted speed of at least 50 mph, and not more than 4 lanes in each direction, with typical cross slope of about 2%.

Water Quality Volume – The water quality volume does not need to be calculated, since the design guidelines specified above ensure that the minimum annual pollutant reduction will be achieved.

(5) *Initial Permeability Testing* – Initial permeability testing is performed after the overlay cools using the TxDOT Test Procedure Tex-246-F. Typical infiltration rate is normally less than 20 seconds for newly constructed PFC mixtures. The test should demonstrate that desired permeability of less than 60 seconds has been achieved.

PFC has the capacity to meet the required TSS removal requirement for storm water generated from rain water that falls upon it. Since PFC is not a catch-and-treat type permanent BMP, it is generally not appropriate to use for overtreatment. However, PFC may have durability issues in areas with stopping and turning movements such as in intersections, right turn lanes, bus stops etc. Excessive stopping and turning movements may cause PFC to ravel or delaminate. For the above reasons and applications, overtreatment credit will only be considered for bridges and intersections. Overtreatment credit gained from PFC will only be applied and considered for the project under review. Overtreatment credit applied to bridges and intersections will be reviewed on a case by case basis. No TCEQ calculations are required for areas using PFC.

Section 3.5.16 – Maintenance Guidelines

Inspections

In addition to the testing immediately following installation to demonstrate that the desired permeability has been achieved, routine inspections must be performed to determine that the PFC is achieving the necessary TSS removal. During the inspections a permeability test using the TxDOT Test Procedure Tex-246-F must be performed. Routine inspections should begin within 36 months after installation. Subsequent inspections should occur on a rolling 24 month period as long as the drainage time in the permeability test is less than 60 seconds. Once the drainage time exceeds 60 seconds, subsequent inspections should occur annually (rolling 12 month period).

At least one such test must be performed for each mile of roadway in the project and the test locations should be located approximately equidistance from each other. A test location on the shoulder is preferred if available. At each location three tests at slightly different spots on the pavement should be tested and the geometric mean of the results reported.

If more than 100 seconds are required for the water to drain, additional testing should be performed to determine the extent of clogging and the length of pavement to be maintained. The new pavement must then be recertified by a Texas Licensed P.E. as achieving the desired drainage characteristics.

Maintenance

Maintenance of the pavement will consist of either actions to restore the permeability of the existing pavement or milling the old overlay, disposing of the used asphalt appropriately, and applying a new overlay in accordance with the guidelines specified in Section 3.4.16. Measures to restore the permeability might include sweeping or pressure washing the pavement. Material

removed from the pavement must be collected and properly disposed of. Records of material disposal must be maintained for five years.

Permeability tests must be performed at the time of rehabilitation or replacement to demonstrate that the pavement has the required permeability and then recertified by a Texas Licensed P.E. that the desired drainage characteristics have been achieved. The Tex-246-F permeability test results must be maintained for 5 years or the life the PFC, whichever is shorter.

Tracking at construction exits/entrances can leave a significant quantity of sediment causing voids in PFC to fill. If PFC becomes clogged at construction exit/entrances, the PFC should be flushed or replaced. Records of material disposal must be maintained for five years.

If a material spill occurs on the PFC pavement, the spilled material must be removed to the extent possible including flushing of the pavement and capture of this material. The permeability of the pavement must be re-tested at the spill location to document that the material has not reduced the permeability below the 100 sec threshold. If the material contains solvents that affect the structural integrity of the pavement that section may need to be milled and replaced.

Appendix K: Water Quality Calculations Spreadsheet

WATER QUALITY CALCULATION SUMMARY - EXISTING CONDITIONS

	BASIN ID	TCEQ EDWARDS AQUIFER ZONE	PROPOSED BMP	ONSITE BASIN DRAINAGE AREA (AC)	OFFSITE BASIN DRAINAGE AREA (AC)	OFFSITE IMPERVIOUS COVER (AC)	EXISTING ONSITE IMPERVIOUS COVER (AC)	TCEQ CALCULATED CAPTURE VOLUME (CU FT)	TCEQ RAINFALL CAPTURE DEPTH (IN) [5]	PROVIDED POND VOLUME (CU FT)	COA CALCULATED CAPTURE DEPTH (IN) [5]	COA REQUIRED ONSITE CAPTURE DEPTH (IN)	COA REQUIRED OFFSITE CAPTURE DEPTH (IN)	COA REQUIRED CAPTURE VOLUME (CU FT)	CONTROLLING VOLUME REQUIREMENT	EXISTING ANNUAL TSS LOAD PRODUCED (LBS)	ANNUAL TSS LOAD REMOVED (LBS)	ANNUAL TSS LOAD DISCHARGED (LBS)
	DEVIL'S PEN CREEK WATERSHED																	
	UNTREATED AREA	Contributing	N/A	38.37	N/A	N/A	11.59	N/A	N/A	N/A	N/A	0.60	N/A	83,857	N/A	13,289	0	13,289
	TOTAL FOR DEVIL'S PEN CREEK WATERSHED - CONTRIBUTING ZONE			**38.37**	**N/A**	**N/A**	**11.59**	**N/A**	**N/A**	**N/A**	**N/A**	**0.60**	**N/A**	**83,857**	**N/A**	**13,289**	**0**	**13,289**
	WILLIAMSON CREEK WATERSHED																	
	STORAGE AREA	Contributing	Storage Area	5.05	N/A	N/A	5.05	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	5,584	0	5,584
7	PFC	Contributing	Permeable Friction Course	18.49	N/A	N/A	18.49	N/A	4.00	N/A	N/A	1.30	N/A	87,269	N/A	20,463	18,428	2,035
	UNTREATED AREA	Contributing	N/A	151.33	N/A	N/A	29.99	N/A	N/A	N/A	N/A	0.50	N/A	274,664	N/A	35,286	0	35,286
	BEE CAVES DETENTION POND	Contributing	N/A	14.15	N/A	N/A	0.00	N/A	N/A	N/A	N/A	0.00	N/A	0	N/A	246	0	246
	SUBTOTAL FOR WILLIAMSON CREEK WATERSHED - CONTRIBUTING ZONE			**189.02**	**N/A**	**N/A**	**53.53**	**N/A**	**N/A**	**N/A**	**N/A**	**0.58**	**N/A**	**400,145**	**N/A**	**61,579**	**18,428**	**43,151**
	TOTAL FOR CONTRIBUTING ZONE			**227.39**	**N/A**	**N/A**	**65.12**	**N/A**	**N/A**	**N/A**	**N/A**	**0.59**	**N/A**	**484,002**	**N/A**	**74,868**	**18,428**	**56,440**
	UNTREATED AREA	Recharge	N/A	28.94	N/A	N/A	13.93	N/A	N/A	N/A	N/A	0.78	N/A	82,082	N/A	15,674	0	15,674
3	**SUBTOTAL FOR WILLIAMSON CREEK WATERSHED - RECHARGE ZONE**			**28.94**	**N/A**	**N/A**	**13.93**	**N/A**	**N/A**	**N/A**	**N/A**	**0.78**	**N/A**	**82,082**	**N/A**	**15,674**	**0**	**15,674**
	TOTAL FOR WILLIAMSON CREEK WATERSHED - ALL ZONES			**217.96**	**N/A**	**N/A**	**67.46**	**N/A**	**N/A**	**N/A**	**N/A**	**0.61**	**N/A**	**482,226**	**N/A**	**77,253**	**18,428**	**58,825**
	BARTON CREEK WATERSHED																	
	POND R	Recharge	Wet Basin	44.88	16.07	6.42	33.08	256,080	2.00	264,630.0	1.62	1.04	0.15	177,718	TCEQ	36,811	31,388	5,423
	POND S	Recharge	Sand Filter Pond	36.18	54.44	22.97	25.93	170,306	1.08	174,894.0	1.33	1.02	0.15	163,185	COA	28,874	20,698	8,176
	UNTREATED AREA	Recharge	N/A	0.915	N/A	N/A	0.515	N/A	N/A	N/A	N/A	0.86	N/A	2,866	N/A	577	0	577
	SUBTOTAL FOR BARTON CREEK WATERSHED - RECHARGE ZONE			**81.98**	**70.50**	**29.39**	**59.53**	**N/A**	**N/A**	**439,524**	**1.48**	**1.03**	**0.15**	**343,769**	**N/A**	**66,262**	**52,086**	**14,176**
	TOTAL FOR RECHARGE ZONE			**110.92**	**70.50**	**29.39**	**73.46**	**N/A**	**N/A**	**439,524**	**1.09**	**0.96**	**0.15**	**425,850**	**N/A**	**81,936**	**52,086**	**29,850**
	TOTALS FOR PROJECT[10]			**338.31**	**70.50**	**29.39**	**138.58**	**N/A**	**N/A**	**439,524**	**0.36**	**0.71**	**0.15**	**909,852**	**N/A**	**156,804**	**70,514**	**86,290**

4 ANNUAL PRECIP TRAVIS CO= 32 in

NOTES:

1 COA minimum VFS width is 25-feet versus the TCEQ 15-feet for roadway runoff. A VFS width of 5.2' was used for SUP VFS. COA does not require treatment of SUP's located within public ROW or easement.
2 Pond I is located in the Recharge Zone, but discharges in the Contributing Zone.
3 Recharge zone boundary drawn with respect to TCEQ boundary and Pond I drainage area.
4 Annual Precipitation value based on guidance in RG-348.
5 Rainfall Capture Depth within the TCEQ spreadsheet is calculated differently than described in the COA ECM.
6 COA capture volumes are based on the efficiency of a Sedimentation Filtration (Sand Filter) BMP. Volumes for BMPS with lower efficiencies would need to be larger than shown.
7 Annual load produced, removed and discharged based on existing condition. This PFC will be removed and the loading added to the requirement.
8 Net increase in TSS load discharged for the project = (Proposed Annual TSS Load Discharged) - (Existing Annual TSS Load Produced)
9 For preliminary calculations, areas of proposed PFC and VFS were assumed to have no existing IC. Existing IC is accounted for within the Untreated Area.
10 Total basin drainage areas differ from existing conditions and post-project cnditions due to the inclusion of underpasses in the project totals.
11 Drainage areas and impervious cover are shown to the hundeths place (0.01), however inputs in the spreadsheet are to the ten thousandths place (0.0001).

WATER QUALITY CALCULATION SUMMARIES - PROPOSED CONDITIONS

	BASIN ID	TCEQ EDWARDS AQUIFER ZONE	PROPOSED BMP	ONSITE BASIN DRAINAGE AREA (AC)	OFFSITE BASIN DRAINAGE AREA (AC)	OFFSITE IMPERVIOUS COVER (AC)	ONSITE EXISTING IMPERVIOUS COVER (AC)	ONSITE PROPOSED IMPERVIOUS COVER (AC)	TCEQ CALCULATED CAPTURE VOLUME (CU FT)	TCEQ RAINFALL CAPTURE DEPTH (IN) [5]	PROVIDED POND VOLUME (CU FT)	COA CALCULATED CAPTURE DEPTH (IN) [5]	COA REQUIRED CAPTURE DEPTH (IN)	COA REQUIRED OFFSITE CAPTURE DEPTH (IN)	COA REQUIRED CAPTURE VOLUME (CU FT)	CONTROLLING VOLUME REQUIREMENT	PROPOSED ANNUAL TSS LOAD PRODUCED (LBS)	ANNUAL TSS LOAD REMOVED (LBS)	ANNUAL TSS LOAD DISCHARGED (LBS)	% OF TOTAL TSS LOAD TREATED
	DEVIL'S PEN CREEK WATERSHED																			
	POND A	Contributing	Bioretention Pond	1.91	8.79	2.64	0.56	0.87	12,672	1.00	12,677	1.83	0.76	N/A	5,253	TCEQ	985	680	305	69%
6	POND B	Contributing	Batch Detention	8.06	N/A	N/A	3.58	4.17	47,600	2.40	47,705	1.63	0.82	N/A	23,911	TCEQ	4,679	4,014	666	86%
1/9	PFC to Pond B in Series	Contributing	PFC/Batch Detention Pond	1.91	N/A	N/A	0.00	1.91	N/A	1.00	N/A	N/A	1.30	N/A	9,022	N/A	2,116	2,030	85	96%
1/9	VFS	Contributing	Vegetated Filter Strip	3.65	N/A	N/A	0.00	3.65	N/A	4.00	N/A	N/A	1.30	N/A	17,215	N/A	4,036	3,433	603	85%
1/9	PFC	Contributing	Permeable Friction Course	5.55	N/A	N/A	0.00	5.55	N/A	4.00	N/A	N/A	1.30	N/A	26,208	N/A	6,145	5,534	611	90%
	UNTREATED AREA	Contributing	N/A	15.04	N/A	N/A	6.69	5.41	0	0.00	N/A	N/A	0.66	N/A	36,015	N/A	6,153	0	6,153	0%
	TOTAL FOR DEVIL'S PEN CREEK WATERSHED - CONTRIBUTING ZONE			**36.13**	**N/A**	**N/A**	**10.84**	**21.57**	**N/A**	**N/A**	**60,382**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**24,115**	**15,691**	**8,424**	**65%**
	WILLIAMSON CREEK WATERSHED																			
	POND C	Contributing	Sand Filter Pond	15.95	N/A	N/A	2.74	6.93	34,145	1.00	34,729	0.60	0.73	N/A	42,506	COA	7,820	5,465	2,355	70%
	POND D	Contributing	Sand Filter Pond	11.24	N/A	N/A	3.40	3.00	42,570	2.00	44,006	1.08	0.57	N/A	23,130	TCEQ	3,463	2,850	613	82%
	POND E	Contributing	Sand Filter Pond	14.27	N/A	N/A	3.13	6.30	33,602	1.32	33,714	0.65	0.74	N/A	38,400	COA	7,108	5,368	1,740	76%
	POND F	Contributing	Sand Filter Pond	37.74	N/A	N/A	14.20	19.50	162,383	2.00	163,726	1.20	0.82	N/A	111,890	TCEQ	21,896	17,868	4,027	82%
	POND G	Contributing	Sand Filter Pond	4.81	5.36	0.00	1.21	3.55	26,177	2.20	27,453	1.57	1.04	N/A	18,120	TCEQ	3,948	3,275	673	83%
	POND H	Contributing	Sand Filter Pond	7.45	29.04	2.90	2.15	5.96	61,301	1.70	61,904	2.29	1.10	N/A	29,747	TCEQ	6,620	5,325	1,295	80%
	POND K	Contributing	Bioretention Pond	5.57	N/A	N/A	1.94	2.79	26,039	3.00	26,685	1.32	0.80	N/A	16,185	TCEQ	3,132	2,715	417	87%
	POND L	Contributing	Sand Filter Pond	2.96	N/A	N/A	1.28	2.64	16,904	1.80	17,243	1.60	1.19	N/A	12,808	TCEQ	2,927	2,379	548	81%
	POND M	Contributing	Sand Filter Pond	0.97	N/A	N/A	0.48	0.86	10,167	3.33	10,674	3.03	1.18	N/A	4,174	TCEQ	952	830	122	87%
	POND N	Contributing	Sand Filter Pond	1.43	N/A	N/A	0.76	1.28	7,303	1.60	7,758	1.50	1.20	N/A	6,214	TCEQ	1,422	1,133	289	80%
	POND O	Contributing	Sand Filter Pond	5.87	22.45	8.53	3.58	2.82	37,883	0.80	38,806	1.82	0.78	N/A	16,636	TCEQ	3,174	2,003	1,171	63%
	POND P	Contributing	Bioretention Pond	1.80	20.02	7.61	0.95	0.32	6,798	0.23	6,893	1.05	0.48	N/A	3,134	TCEQ	383	121	262	32%
	POND Q	Contributing	Bioretention Pond	4.16	N/A	N/A	2.51	0.81	15,121	1.70	15,821	1.05	0.49	N/A	7,457	TCEQ	952	767	185	81%
1/9	VFS to Pond C in Series	Contributing	VFS/Sand Filter Pond	0.10	N/A	N/A	0.00	0.10	N/A	2.00	N/A	N/A	1.30	N/A	464	N/A	109	102	7	94%
1/9	VFS to Pond D in Series	Contributing	VFS/Sand Filter Pond	2.14	N/A	N/A	0.00	2.14	N/A	2.00	N/A	N/A	1.30	N/A	10,087	N/A	2,365	2,217	148	94%
1/9	VFS to Pond E in Series	Contributing	VFS/Sand Filter Pond	2.05	N/A	N/A	0.00	2.05	N/A	1.32	N/A	N/A	1.30	N/A	9,651	N/A	2,263	2,121	142	94%
1/9	VFS to Pond F in Series	Contributing	VFS/Sand Filter Pond	3.58	N/A	N/A	0.00	3.58	N/A	2.00	N/A	N/A	1.30	N/A	16,879	N/A	3,958	3,710	248	94%
1/9	PFC to Pond C in Series	Contributing	PFC/Sand Filter Pond	3.91	N/A	N/A	0.00	3.91	N/A	1.00	N/A	N/A	1.30	N/A	18,440	N/A	4,324	4,144	180	96%
9	PFC to Pond D in Series	Contributing	PFC/Sand Filter Pond	1.82	N/A	N/A	0.00	1.82	N/A	1.00	N/A	N/A	1.30	N/A	8,602	N/A	2,017	1,933	84	96%
9	PFC to Pond F in Series	Contributing	PFC/Sand Filter Pond	2.89	N/A	N/A	0.00	2.89	N/A	1.00	N/A	N/A	1.30	N/A	13,617	N/A	3,193	3,060	133	96%
9	PFC to Pond O in series	Contributing	PFC/Sand Filter Pond	2.25	N/A	N/A	0.00	2.25	N/A	1.00	N/A	N/A	1.30	N/A	10,620	N/A	2,490	2,387	103	96%
9	PFC to Pond P in series	Contributing	PFC/Sand Filter Pond	0.73	N/A	N/A	0.00	0.73	N/A	1.00	N/A	N/A	1.30	N/A	3,440	N/A	807	773	34	96%
9	PFC to Pond Q in Series	Contributing	PFC/Sand Filter Pond	2.04	N/A	N/A	0.00	2.04	N/A	1.00	N/A	N/A	1.30	N/A	9,628	N/A	2,258	2,164	94	96%
1/9	VFS SUP	Contributing	Vegetated Filter Strip	0.55	N/A	N/A	0.00	0.55	N/A	4.00	N/A	N/A	1.30	N/A	2,617	N/A	614	522	92	85%
9	PFC	Contributing	Permeable Friction Course	3.72	N/A	N/A	0.00	3.72	N/A	4.00	N/A	N/A	1.30	N/A	17,560	N/A	4,117	3,708	409	90%
	UNTREATED AREA	Contributing	N/A	64.78	N/A	N/A	15.96	51.15	N/A	N/A	N/A	N/A	1.09	N/A	256,224	N/A	56,836	0	56,836	0%
	BEE CAVES DETENTION POND	Contributing	N/A	14.15	N/A	N/A	0.00	0.00	N/A	N/A	N/A	N/A	0.00	N/A	0	N/A	246	0	246	0%
	SUBTOTAL FOR WILLIAMSON CREEK WATERSHED - CONTRIBUTING ZONE			**197.41**	**N/A**	**N/A**	**54.28**	**112.18**	**N/A**	**N/A**	**489,411**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**125,610**	**76,940**	**48,670**	**61%**
	TOTAL FOR CONTRIBUTING ZONE			**233.54**	**N/A**	**N/A**	**65.12**	**133.75**	**N/A**	**N/A**	**549,793**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**149,725**	**92,631**	**57,094**	**62%**
2	POND I	Recharge	Sand Filter Pond	14.04	6.12	1.09	8.35	11.57	76,874	1.70	77,272	1.52	1.12	N/A	57,285	TCEQ	12,843	10,350	2,493	81%
6	POND J	Recharge	Batch Detention	5.57	11.27	2.11	1.57	4.11	21,414	0.94	21,600	1.07	1.04	N/A	20,965	TCEQ	4,569	3,170	1,399	69%
	UNTREATED AREA	Recharge	N/A	7.63	N/A	N/A	2.37	2.76	0	0.00	N/A	N/A	0.66	N/A	18,338	N/A	3,142	0	3,142	0%
3	**SUBTOTAL FOR WILLIAMSON CREEK WATERSHED - RECHARGE ZONE**			**27.24**	**N/A**	**N/A**	**12.29**	**18.44**	**N/A**	**N/A**	**98,872**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**20,553**	**13,520**	**7,033**	**66%**
	TOTAL FOR WILLIAMSON CREEK WATERSHED - ALL ZONES			**224.65**	**N/A**	**N/A**	**66.57**	**130.62**	**N/A**	**N/A**	**588,284**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**146,163**	**90,460**	**55,704**	**62%**
	BARTON CREEK WATERSHED																			
	POND R	Recharge	Wet Basin	44.61	16.04	6.42	32.87	36.39	264,634	1.80	264,630	1.63	1.04	0.15	176,641	TCEQ	40,411	34,407	6,004	85%
	POND S	Recharge	Sand Filter Pond	36.18	54.44	22.95	25.93	27.40	171,426	1.04	174,894	1.33	1.02	0.15	163,185	TCEQ	30,466	21,565	8,901	71%
6	POND T	Recharge	Batch Detention	3.84	N/A	N/A	1.65	3.29	13,578	1.16	13,720	0.98	0.73	N/A	10,180	TCEQ	3,650	2,740	910	75%
	UNTREATED AREA	Recharge	N/A	1.409	N/A	N/A	0.714	1.474	0	0.00	N/A	N/A	0.81	N/A	4,126	N/A	1,629	0	1,629	0%
	SUBTOTAL FOR BARTON CREEK WATERSHED - RECHARGE ZONE			**86.04**	**70.48**	**29.36**	**61.17**	**68.55**	**N/A**	**N/A**	**453,244**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**76,156**	**58,712**	**17,444**	**77%**
	TOTAL FOR RECHARGE ZONE			**113.28**	**70.48**	**29.36**	**73.46**	**86.99**	**N/A**	**N/A**	**552,116**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**96,710**	**72,232**	**24,478**	**75%**
	TOTALS FOR PROJECT[10]			**346.82**	**173.53**	**54.25**	**138.58**	**220.74**	**N/A**	**N/A**	**1,101,909**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**246,435**	**164,863**	**81,571**	**67%**
																	NET INCREASE IN TSS LOADING FOR PROJECT[8] =		**-4,718**	**lbs**

4 ANNUAL PRECIP TRAVIS CO= **32** in

WATER QUALITY CALCULATION SUMMARIES - PROPOSED CONDITIONS - TCEQ

	BASIN ID	TCEQ EDWARDS AQUIFER ZONE	PROPOSED BMP	ONSITE BASIN DRAINAGE AREA (AC)	OFFSITE BASIN DRAINAGE AREA (AC)	OFFSITE IMPERVIOUS COVER (AC)	ONSITE EXISTING IMPERVIOUS COVER (AC)	ONSITE PROPOSED IMPERVIOUS COVER (AC)	TCEQ CALCULATED CAPTURE VOLUME (CU FT)	TCEQ RAINFALL CAPTURE DEPTH (IN) [5]	PROVIDED POND VOLUME (CU FT)	COA CALCULATED CAPTURE DEPTH (IN) [5]	COA REQUIRED CAPTURE DEPTH (IN)	COA REQUIRED OFFSITE CAPTURE DEPTH (IN)	COA REQUIRED CAPTURE VOLUME (CU FT)	CONTROLLING VOLUME REQUIREMENT	PROPOSED ANNUAL TSS LOAD PRODUCED (LBS)	ANNUAL TSS LOAD REMOVED (LBS)	ANNUAL TSS LOAD DISCHARGED (LBS)	% OF TOTAL TSS LOAD TREATED
	DEVIL'S PEN CREEK WATERSHED																			
	POND A	Contributing	Bioretention Pond	1.91	8.79	2.64	0.56	0.87	12,672	1.00	12,677	1.83	0.76	N/A	5,253	TCEQ	985	680	305	69%
6	POND B	Contributing	Batch Detention	8.06	N/A	N/A	3.58	4.17	47,600	2.40	47,705	1.63	0.82	N/A	23,911	TCEQ	4,679	4,014	665	86%
1/9	PFC to Pond B in Series	Contributing	PFC/Batch Detention Pond	1.91	N/A	N/A	0.00	1.91	N/A	1.00	N/A	N/A	1.30	N/A	9,022	N/A	2,116	2,030	85	96%
1/9	VFS	Contributing	Vegetated Filter Strip	3.65	N/A	N/A	0.00	3.65	N/A	4.00	N/A	N/A	1.30	N/A	17,215	N/A	4,036	3,433	603	85%
1/9	PFC	Contributing	Permeable Friction Course	4.68	N/A	N/A	0.00	4.68	N/A	4.00	N/A	N/A	1.30	N/A	22,107	N/A	5,183	4,668	515	90%
	UNTREATED AREA	Contributing	N/A	15.91	N/A	N/A	6.69	6.28	0	0.00	N/A	N/A	0.69	N/A	40,116	N/A	7,115	0	7,115	0%
	TOTAL FOR DEVIL'S PEN CREEK WATERSHED - CONTRIBUTING ZONE			**36.13**	**N/A**	**N/A**	**10.84**	**21.57**	**N/A**	**N/A**	**60,382**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**24,115**	**14,826**	**9,289**	**61%**
	WILLIAMSON CREEK WATERSHED																			
	POND C	Contributing	Sand Filter Pond	15.95	N/A	N/A	2.74	6.93	34,145	1.00	34,729	0.60	0.73	N/A	42,506	COA	7,820	5,465	2,355	70%
	POND D	Contributing	Sand Filter Pond	11.24	N/A	N/A	3.40	3.00	42,570	2.00	44,006	1.08	0.57	N/A	23,130	TCEQ	3,463	2,850	613	82%
	POND E	Contributing	Sand Filter Pond	14.27	N/A	N/A	3.13	6.30	33,602	1.32	33,714	0.65	0.74	N/A	38,400	COA	7,108	5,368	1,740	76%
	~~POND F~~	~~Contributing~~	~~Sand Filter Pond~~	~~37.74~~	~~N/A~~	~~N/A~~	~~14.20~~	~~20.00~~	~~162,383~~	~~2.00~~	~~163,726~~	~~1.20~~	~~0.83~~	~~N/A~~	~~113,690~~	~~TCEQ~~	~~22,436~~	~~0~~	22,436	~~0%~~
	POND G	Contributing	Sand Filter Pond	4.81	5.36	0.00	1.21	3.55	26,177	2.20	27,453	1.57	1.04	N/A	18,120	TCEQ	3,948	3,275	673	83%
	POND H	Contributing	Sand Filter Pond	7.45	29.04	2.90	2.15	5.96	61,301	1.70	61,904	2.29	1.10	N/A	29,747	TCEQ	6,620	5,325	1,295	80%
	POND K	Contributing	Bioretention Pond	5.57	N/A	N/A	1.94	2.79	26,039	3.00	26,685	1.32	0.80	N/A	16,185	TCEQ	3,132	2,715	417	87%
	POND L	Contributing	Sand Filter Pond	2.96	N/A	N/A	1.28	2.64	16,904	1.80	17,243	1.60	1.19	N/A	12,808	TCEQ	2,927	2,379	548	81%
	~~POND M~~	~~Contributing~~	~~Sand Filter Pond~~	~~0.97~~	~~N/A~~	~~N/A~~	~~0.48~~	~~0.86~~	~~10,167~~	~~3.33~~	~~10,674~~	~~3.03~~	~~1.18~~	~~N/A~~	~~4,174~~	~~TCEQ~~	~~952~~	~~0~~	952	~~0%~~
	~~POND N~~	~~Contributing~~	~~Sand Filter Pond~~	~~1.43~~	~~N/A~~	~~N/A~~	~~0.76~~	~~1.28~~	~~7,303~~	~~1.60~~	~~7,758~~	~~1.50~~	~~1.20~~	~~N/A~~	~~6,214~~	~~TCEQ~~	~~1,422~~	~~0~~	1,422	~~0%~~
	~~POND O~~	~~Contributing~~	~~Sand Filter Pond~~	~~5.87~~	~~22.45~~	~~8.53~~	~~3.58~~	~~3.59~~	~~37,883~~	~~0.80~~	~~38,806~~	~~1.82~~	~~0.91~~	N/A	~~19,433~~	~~TCEQ~~	~~4,013~~	~~0~~	4,013	~~0%~~
	~~POND P~~	~~Contributing~~	~~Bioretention Pond~~	~~1.80~~	~~20.02~~	~~7.61~~	~~0.95~~	~~1.05~~	~~6,798~~	~~0.23~~	~~6,893~~	~~1.05~~	~~0.88~~	~~N/A~~	~~5,780~~	~~TCEQ~~	~~1,177~~	~~0~~	1,177	~~0%~~
	POND Q	Contributing	Bioretention Pond	4.16	N/A	N/A	2.51	1.09	15,121	1.70	15,821	1.05	0.56	N/A	8,491	TCEQ	1,262	1,017	245	81%
1/9	VFS to Pond C in Series	Contributing	VFS/Sand Filter Pond	0.10	N/A	N/A	0.00	0.10	N/A	2.00	N/A	N/A	1.30	N/A	464	N/A	109	102	7	94%
1/9	VFS to Pond D in Series	Contributing	VFS/Sand Filter Pond	2.14	N/A	N/A	0.00	2.14	N/A	2.00	N/A	N/A	1.30	N/A	10,087	N/A	2,365	2,217	148	94%
1/9	VFS to Pond E in Series	Contributing	VFS/Sand Filter Pond	2.05	N/A	N/A	0.00	2.05	N/A	1.32	N/A	N/A	1.30	N/A	9,651	N/A	2,263	2,121	142	94%
1/9	VFS to Pond F in Series	Contributing	VFS/Sand Filter Pond	3.08	N/A	N/A	0.00	3.08	N/A	2.00	N/A	N/A	1.30	N/A	14,539	N/A	3,409	2,899	510	85%
1/9	PFC to Pond C in Series	Contributing	PFC/Sand Filter Pond	3.91	N/A	N/A	0.00	3.91	N/A	1.00	N/A	N/A	1.30	N/A	18,440	N/A	4,324	4,144	180	96%
9	PFC to Pond D in Series	Contributing	PFC/Sand Filter Pond	1.82	N/A	N/A	0.00	1.82	N/A	1.00	N/A	N/A	1.30	N/A	8,602	N/A	2,017	1,933	84	96%
9	PFC to Pond F in Series	Contributing	PFC/Sand Filter Pond	2.89	N/A	N/A	0.00	2.89	N/A	1.00	N/A	N/A	1.30	N/A	13,617	N/A	3,193	2,875	317	90%
9	PFC to Pond O in series	Contributing	PFC/Sand Filter Pond	1.48	N/A	N/A	0.00	1.48	N/A	1.00	N/A	N/A	1.30	N/A	6,983	N/A	1,637	1,475	163	90%
9	~~PFC to Pond P in series~~	~~Contributing~~	~~PFC/Sand Filter Pond~~	~~0.00~~	~~N/A~~	~~N/A~~	~~0.00~~	~~0.00~~	~~N/A~~	~~1.00~~	~~N/A~~	~~N/A~~	~~0.00~~	~~N/A~~	0	~~N/A~~	0	~~0~~	0	~~0%~~
9	PFC to Pond Q in Series	Contributing	PFC/Sand Filter Pond	1.76	N/A	N/A	0.00	1.76	N/A	1.00	N/A	N/A	1.30	N/A	8,284	N/A	1,942	1,749	193	90%
1/9	~~VFS SUP~~	~~Contributing~~	~~Vegetated Filter Strip~~	~~0.55~~	~~N/A~~	~~N/A~~	~~0.00~~	~~0.55~~	~~N/A~~	~~4.00~~	~~N/A~~	~~N/A~~	~~1.30~~	~~N/A~~	~~2,617~~	~~N/A~~	614	~~0~~	614	~~0%~~
9	PFC	Contributing	Permeable Friction Course	2.35	N/A	N/A	0.00	2.35	N/A	4.00	N/A	N/A	1.30	N/A	11,096	N/A	2,602	2,343	259	90%
	UNTREATED AREA	Contributing	N/A	66.15	N/A	N/A	15.96	50.24	N/A	N/A	N/A	N/A	1.06	N/A	254,411	N/A	55,868	0	55,868	0%
	BEE CAVES DETENTION POND	Contributing	N/A	14.15	N/A	N/A	0.00	0.00	N/A	N/A	N/A	N/A	0.00	N/A	0	N/A	246	0	246	0%
	SUBTOTAL FOR WILLIAMSON CREEK WATERSHED - CONTRIBUTING ZONE			**197.41**	**N/A**	**N/A**	**54.28**	**112.18**	**N/A**	**N/A**	**489,411**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**125,610**	**50,253**	**75,357**	**40%**
	TOTAL FOR CONTRIBUTING ZONE			**233.54**	**N/A**	**N/A**	**65.12**	**133.75**	**N/A**	**N/A**	**549,793**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**149,725**	**65,079**	**84,646**	**43%**
2	POND I	Recharge	Sand Filter Pond	14.04	6.12	1.09	8.35	11.57	76,874	1.70	77,272	1.52	1.12	N/A	57,285	TCEQ	12,843	10,350	2,493	81%
6	POND J	Recharge	Batch Detention	5.57	11.27	2.11	1.57	4.11	21,414	0.94	21,600	1.07	1.04	N/A	20,965	TCEQ	4,569	3,170	1,399	69%
	UNTREATED AREA	Recharge	N/A	7.63	N/A	N/A	2.37	2.76	0	0.00	N/A	N/A	0.66	N/A	18,338	N/A	3,142	0	3,142	0%
3	**SUBTOTAL FOR WILLIAMSON CREEK WATERSHED - RECHARGE ZONE**			**27.24**	**N/A**	**N/A**	**12.29**	**18.44**	**N/A**	**N/A**	**98,872**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**20,553**	**13,520**	**7,033**	**66%**
	TOTAL FOR WILLIAMSON CREEK WATERSHED - ALL ZONES			**224.65**	**N/A**	**N/A**	**66.57**	**130.62**	**N/A**	**N/A**	**588,284**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**146,163**	**63,773**	**82,390**	**44%**
	BARTON CREEK WATERSHED																			
	POND R	Recharge	Wet Basin	44.61	16.04	6.42	32.87	36.39	264,634	1.80	264,630	1.63	1.04	0.15	176,641	TCEQ	40,411	34,407	6,004	85%
	POND S	Recharge	Sand Filter Pond	36.18	54.44	22.95	25.93	27.40	171,426	1.04	174,894	1.33	1.02	0.15	163,185	TCEQ	30,466	21,565	8,901	71%
6	~~POND T~~	~~Recharge~~	~~Batch Detention~~	~~3.84~~	~~N/A~~	~~N/A~~	~~1.65~~	~~3.29~~	~~13,578~~	~~1.16~~	~~13,720~~	~~0.98~~	~~0.73~~	~~N/A~~	~~10,180~~	~~TCEQ~~	~~3,650~~	~~0~~	3,650	~~0%~~
	UNTREATED AREA	Recharge	N/A	1.409	N/A	N/A	0.714	1.474	0	0.00	N/A	N/A	0.81	N/A	4,126	N/A	1,629	0	1,629	0%
	SUBTOTAL FOR BARTON CREEK WATERSHED - RECHARGE ZONE			**86.04**	**70.48**	**29.36**	**61.17**	**68.55**	**N/A**	**N/A**	**453,244**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**76,156**	**55,972**	**20,184**	**73%**
	TOTAL FOR RECHARGE ZONE			**113.28**	**70.48**	**29.36**	**73.46**	**86.99**	**N/A**	**N/A**	**552,116**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**96,710**	**69,492**	**27,218**	**72%**
	TOTALS FOR PROJECT[10]			**346.82**	**173.53**	**54.25**	**138.58**	**220.74**	**N/A**	**N/A**	**1,101,909**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**246,435**	**134,571**	**111,864**	**55%**

NET INCREASE IN TSS LOADING FOR PROJECT[8] = **25,574** lbs

TCEQ 80% TSS REMOVAL REQUIRED= **128,116**

4 ANNUAL PRECIP TRAVIS CO= **32** in

SHADING KEY:
PONDS REMOVED | PONDS LOCATED WITHIN THE FLOODPLAIN TO BE PROTECTED | PONDS OR BMPS WHERE REMOVAL RATES CHANGE DUE TO FLOODPLAIN CONSIDERATIONS

Texas Commission on Environmental Quality

TSS Removal Calculations 04-20-2009

Project Name: 290 West Oak Hill
Date Prepared: 10/29/2019

Additional information is provided for cells with a red triangle in the upper right corner. Place the cursor over the cell.
Text shown in blue indicate location of instructions in the Technical Guidance Manual - RG-348.
Characters shown in red are data entry fields.
Characters shown in black (Bold) are calculated fields. Changes to these fields will remove the equations used in the spreadsheet.

1. The Required Load Reduction for the total project: Calculations from RG-348 Pages 3-27 to 3-30

Page 3-29 Equation 3.3: $L_M = 27.2(A_N \times P)$

where:

$L_{M\ TOTAL\ PROJECT}$ = Required TSS removal resulting from the proposed development = 80% of increased load
A_N = Net increase in impervious area for the project
P = Average annual precipitation, inches

Site Data: Determine Required Load Removal Based on the Entire Project

County =	Travis	
Total project area included in plan * =	346.82	acres
Predevelopment impervious area within the limits of the plan* =	138.58	acres
Total post-development impervious area within the limits of the plan* =	220.74	acres
Total post-development impervious cover fraction * =	0.64	
P =	32	inches
$L_{M\ TOTAL\ PROJECT}$ =	246435	lbs.

* The values entered in these fields should be for the total project area.

Number of drainage basins / outfalls areas leaving the plan area = 19

2. Drainage Basin Parameters (This information should be provided for each basin):

Drainage Basin/Outfall Area No. = EX Storage Area

Total drainage basin/outfall area =	5.05	acres
Predevelopment impervious area within drainage basin/outfall area =	0.00	acres
Post-development impervious area within drainage basin/outfall area =	5.05	acres
Post-development impervious fraction within drainage basin/outfall area =	1.00	
$L_{M\ THIS\ BASIN}$ =	4393	lbs.
Annual TSS load produced =	5584	lbs.

Texas Commission on Environmental Quality

TSS Removal Calculations 04-20-2009

Project Name: 290 West Oak Hill
Date Prepared: 10/29/2019

Additional information is provided for cells with a red triangle in the upper right corner. Place the cursor over the cell.
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Site Data: Determine Required Load Removal Based on the Entire Project

County =	Travis	
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Predevelopment impervious area within the limits of the plan* =	138.58	acres
Total post-development impervious area within the limits of the plan* =	220.74	acres
Total post-development impervious cover fraction * =	0.64	
P =	32	inches

$L_{M\ TOTAL\ PROJECT}$ = **246435** lbs.

* The values entered in these fields should be for the total project area.

Number of drainage basins / outfalls areas leaving the plan area = 19

2. Drainage Basin Parameters (This information should be provided for each basin):

Drainage Basin/Outfall Area No. = 71 EX PFC

Total drainage basin/outfall area =	8.58	acres
Predevelopment impervious area within drainage basin/outfall area =	0.00	acres
Post-development impervious area within drainage basin/outfall area =	8.58	acres
Post-development impervious fraction within drainage basin/outfall area =	1.00	
$L_{M\ THIS\ BASIN}$ =	7464	lbs.

3. Indicate the proposed BMP Code for this basin.

Proposed BMP = Permeable Friction Course
Removal efficiency = 90 percent

4. Calculate Maximum TSS Load Removed (L_R) for this Drainage Basin by the selected BMP Type.

RG-348 Page 3-33 Equation 3.7: $L_R = (\text{BMP efficiency}) \times P \times (A_I \times 34.6 + A_P \times 0.54)$

where:

A_C = Total On-Site drainage area in the BMP catchment area
A_I = Impervious area proposed in the BMP catchment area
A_P = Pervious area remaining in the BMP catchment area
L_R = TSS Load removed from this catchment area by the proposed BMP

A_C =	8.58	acres
A_I =	8.58	acres
A_P =	0.00	acres
L_R =	8546	lbs

5. Calculate Fraction of Annual Runoff to Treat the drainage basin / outfall area

Desired $L_{M\ THIS\ BASIN}$ = 8546 lbs.

F = **1.00**

Texas Commission on Environmental Quality

TSS Removal Calculations 04-20-2009

Project Name: 290 West Oak Hill
Date Prepared: 10/29/2019

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1. The Required Load Reduction for the total project: Calculations from RG-348 Pages 3-27 to 3-30

Page 3-29 Equation 3.3: $L_M = 27.2(A_N \times P)$

where:

$L_{M\ TOTAL\ PROJECT}$ = Required TSS removal resulting from the proposed development = 80% of increased load
A_N = Net increase in impervious area for the project
P = Average annual precipitation, inches

Site Data: Determine Required Load Removal Based on the Entire Project

County =	Travis	
Total project area included in plan * =	346.82	acres
Predevelopment impervious area within the limits of the plan* =	138.58	acres
Total post-development impervious area within the limits of the plan* =	220.74	acres
Total post-development impervious cover fraction * =	0.64	
P =	32	inches

$L_{M\ TOTAL\ PROJECT}$ = **246435** lbs.

* The values entered in these fields should be for the total project area.

Number of drainage basins / outfalls areas leaving the plan area = 19

2. Drainage Basin Parameters (This information should be provided for each basin):

Drainage Basin/Outfall Area No. = 290 EX PFC

Total drainage basin/outfall area =	9.92	acres
Predevelopment impervious area within drainage basin/outfall area =	0.00	acres
Post-development impervious area within drainage basin/outfall area =	9.92	acres
Post-development impervious fraction within drainage basin/outfall area =	1.00	
$L_{M\ THIS\ BASIN}$ =	8632	lbs.

3. Indicate the proposed BMP Code for this basin.

Proposed BMP = Permeable Friction Course
Removal efficiency = 90 percent

4. Calculate Maximum TSS Load Removed (L_R) for this Drainage Basin by the selected BMP Type.

RG-348 Page 3-33 Equation 3.7: $L_R = (\text{BMP efficiency}) \times P \times (A_I \times 34.6 + A_P \times 0.54)$

where:

A_C = Total On-Site drainage area in the BMP catchment area
A_I = Impervious area proposed in the BMP catchment area
A_P = Pervious area remaining in the BMP catchment area
L_R = TSS Load removed from this catchment area by the proposed BMP

A_C =	9.92	acres
A_I =	9.92	acres
A_P =	0.00	acres
L_R =	9883	lbs

5. Calculate Fraction of Annual Runoff to Treat the drainage basin / outfall area

Desired $L_{M\ THIS\ BASIN}$ = 9883 lbs.

F = **1.00**

Texas Commission on Environmental Quality

TSS Removal Calculations 04-20-2009

Project Name: 290 West Oak Hill
Date Prepared: 10/29/2019

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1. The Required Load Reduction for the total project: Calculations from RG-348 Pages 3-27 to 3-30

Page 3-29 Equation 3.3: $L_M = 27.2(A_N \times P)$

where:

$L_{M\ TOTAL\ PROJECT}$ = Required TSS removal resulting from the proposed development = 80% of increased load
A_N = Net increase in impervious area for the project
P = Average annual precipitation, inches

Site Data: Determine Required Load Removal Based on the Entire Project

County =	Travis	
Total project area included in plan * =	346.82	acres
Predevelopment impervious area within the limits of the plan* =	138.58	acres
Total post-development impervious area within the limits of the plan* =	220.74	acres
Total post-development impervious cover fraction * =	0.64	
P =	32	inches

$L_{M\ TOTAL\ PROJECT}$ = **246435** lbs.

* The values entered in these fields should be for the total project area.

Number of drainage basins / outfalls areas leaving the plan area = 19

2. Drainage Basin Parameters (This information should be provided for each basin):

Drainage Basin/Outfall Area No. = EX Pond R

Total drainage basin/outfall area =	44.88	acres
Predevelopment impervious area within drainage basin/outfall area =	0.00	acres
Post-development impervious area within drainage basin/outfall area =	33.08	acres
Post-development impervious fraction within drainage basin/outfall area =	0.74	
$L_{M\ THIS\ BASIN}$ =	28796	lbs.

3. Indicate the proposed BMP Code for this basin.

Proposed BMP = Wet Basin
Removal efficiency = 93 percent

4. Calculate Maximum TSS Load Removed (L_R) for this Drainage Basin by the selected BMP Type.

RG-348 Page 3-33 Equation 3.7: $L_R = (\text{BMP efficiency}) \times P \times (A_I \times 34.6 + A_P \times 0.54)$

where:

A_C = Total On-Site drainage area in the BMP catchment area
A_I = Impervious area proposed in the BMP catchment area
A_P = Pervious area remaining in the BMP catchment area
L_R = TSS Load removed from this catchment area by the proposed BMP

A_C =	44.88	acres
A_I =	33.08	acres
A_P =	11.80	acres
L_R =	34255	lbs

5. Calculate Fraction of Annual Runoff to Treat the drainage basin / outfall area

Desired $L_{M\ THIS\ BASIN}$ = 31388 lbs.

F = **0.92**

6. Calculate Capture Volume required by the BMP Type for this drainage basin / outfall area. Calculations from RG-348

Rainfall Depth =	2.00	inches
Post Development Runoff Coefficient =	0.55	
On-site Water Quality Volume =	177628	cubic feet

Calculations from RG-348 Pages 3-36 to 3-37

Off-site area draining to BMP =	16.07	acres
Off-site Impervious cover draining to BMP =	6.42	acres
Impervious fraction of off-site area =	0.40	
Off-site Runoff Coefficient =	0.31	
Off-site Water Quality Volume =	35772	cubic feet
Storage for Sediment =	42680	
Total Capture Volume (required water quality volume(s) x 1.20) =	256080	cubic feet

The following sections are used to calculate the required water quality volume(s) for the selected BMP.
The values for BMP Types not selected in cell C45 will show NA.

11. Wet Basins Designed as Required in RG-348 Pages 3-66 to 3-71

Required capacity of Permanent Pool =	256080	cubic feet	**Permanent Pool Capacity is 1.20 times the WQV**
Required capacity at WQV Elevation =	433709	cubic feet	**Total Capacity should be the Permanent Pool Capacity plus a second WQV.**

Texas Commission on Environmental Quality

TSS Removal Calculations 04-20-2009

Project Name: 290 West Oak Hill
Date Prepared: 10/29/2019

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1. The Required Load Reduction for the total project: Calculations from RG-348 Pages 3-27 to 3-30

Page 3-29 Equation 3.3: $L_M = 27.2(A_N \times P)$

where:

$L_{M\ TOTAL\ PROJECT}$ = Required TSS removal resulting from the proposed development = 80% of increased load
A_N = Net increase in impervious area for the project
P = Average annual precipitation, inches

Site Data: Determine Required Load Removal Based on the Entire Project

County =	Travis	
Total project area included in plan * =	346.82	acres
Predevelopment impervious area within the limits of the plan* =	138.58	acres
Total post-development impervious area within the limits of the plan* =	220.74	acres
Total post-development impervious cover fraction * =	0.64	
P =	32	inches
$L_{M\ TOTAL\ PROJECT}$ =	246435	lbs.

* The values entered in these fields should be for the total project area.

Number of drainage basins / outfalls areas leaving the plan area = 19

2. Drainage Basin Parameters (This information should be provided for each basin):

Drainage Basin/Outfall Area No. = EX Pond S

Total drainage basin/outfall area =	36.18	acres
Predevelopment impervious area within drainage basin/outfall area =	0.00	acres
Post-development impervious area within drainage basin/outfall area =	25.93	acres
Post-development impervious fraction within drainage basin/outfall area =	0.72	
$L_{M\ THIS\ BASIN}$ =	22573	lbs.

3. Indicate the proposed BMP Code for this basin.

Proposed BMP = Sand Filter
Removal efficiency = 89 percent

4. Calculate Maximum TSS Load Removed (L_R) for this Drainage Basin by the selected BMP Type.

RG-348 Page 3-33 Equation 3.7: $L_R = (\text{BMP efficiency}) \times P \times (A_I \times 34.6 + A_P \times 0.54)$

where:

A_C = Total On-Site drainage area in the BMP catchment area
A_I = Impervious area proposed in the BMP catchment area
A_P = Pervious area remaining in the BMP catchment area
L_R = TSS Load removed from this catchment area by the proposed BMP

A_C =	36.18	acres
A_I =	25.93	acres
A_P =	10.25	acres
L_R =	25713	lbs

5. Calculate Fraction of Annual Runoff to Treat the drainage basin / outfall area

Desired $L_{M\ THIS\ BASIN}$ = 20698 lbs.

F = 0.80

6. Calculate Capture Volume required by the BMP Type for this drainage basin / outfall area. Calculations from RG-348

Rainfall Depth =	1.08	inches
Post Development Runoff Coefficient =	0.52	
On-site Water Quality Volume =	74170	cubic feet

Calculations from RG-348 Pages 3-36 to 3-37

Off-site area draining to BMP =	54.44	acres
Off-site Impervious cover draining to BMP =	22.97	acres
Impervious fraction of off-site area =	0.42	
Off-site Runoff Coefficient =	0.32	
Off-site Water Quality Volume =	67752	cubic feet
Storage for Sediment =	28384	
Total Capture Volume (required water quality volume(s) x 1.20) =	170306	cubic feet

The following sections are used to calculate the required water quality volume(s) for the selected BMP.
The values for BMP Types not selected in cell C45 will show NA.

9. Filter area for Sand Filters Designed as Required in RG-348 Pages 3-58 to 3-63

9A. Full Sedimentation and Filtration System

Water Quality Volume for sedimentation basin =	170306	cubic feet	
Minimum filter basin area =	4121	square feet	
Maximum sedimentation basin area =	37085	square feet	For minimum water depth of 2 feet
Minimum sedimentation basin area =	9271	square feet	For maximum water depth of 8 feet

9B. Partial Sedimentation and Filtration System

Water Quality Volume for combined basins =	170306	cubic feet	
Minimum filter basin area =	7417	square feet	
Maximum sedimentation basin area =	29668	square feet	For minimum water depth of 2 feet
Minimum sedimentation basin area =	1854	square feet	For maximum water depth of 8 feet

Texas Commission on Environmental Quality

TSS Removal Calculations 04-20-2009

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Date Prepared: 10/29/2019

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1. The Required Load Reduction for the total project: Calculations from RG-348 Pages 3-27 to 3-30

Page 3-29 Equation 3.3: $L_M = 27.2(A_N \times P)$

where:

$L_{M\ TOTAL\ PROJECT}$ = Required TSS removal resulting from the proposed development = 80% of increased load
A_N = Net increase in impervious area for the project
P = Average annual precipitation, inches

Site Data: Determine Required Load Removal Based on the Entire Project

County =	Travis	
Total project area included in plan * =	346.82	acres
Predevelopment impervious area within the limits of the plan* =	138.58	acres
Total post-development impervious area within the limits of the plan* =	220.74	acres
Total post-development impervious cover fraction * =	0.64	
P =	32	inches
$L_{M\ TOTAL\ PROJECT}$ =	246435	lbs.

* The values entered in these fields should be for the total project area.

Number of drainage basins / outfalls areas leaving the plan area = 1

2. Drainage Basin Parameters (This information should be provided for each basin):

Drainage Basin/Outfall Area No. = Devil's Pen Contributing

Total drainage basin/outfall area =	36.13	acres
Predevelopment impervious area within drainage basin/outfall area =	10.84	acres
Post-development impervious area within drainage basin/outfall area =	21.57	acres
Post-development impervious fraction within drainage basin/outfall area =	0.60	
$L_{M\ THIS\ BASIN}$ =	9336	lbs.

Texas Commission on Environmental Quality

TSS Removal Calculations 04-20-2009

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Date Prepared: 10/29/2019

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1. The Required Load Reduction for the total project: Calculations from RG-348 Pages 3-27 to 3-30

Page 3-29 Equation 3.3: $L_M = 27.2(A_N \times P)$

where:

$L_{M\ TOTAL\ PROJECT}$ = Required TSS removal resulting from the proposed development = 80% of increased load
A_N = Net increase in impervious area for the project
P = Average annual precipitation, inches

Site Data: Determine Required Load Removal Based on the Entire Project

County =	Travis	
Total project area included in plan * =	346.82	acres
Predevelopment impervious area within the limits of the plan* =	138.58	acres
Total post-development impervious area within the limits of the plan* =	220.74	acres
Total post-development impervious cover fraction * =	0.64	
P =	32	inches
$L_{M\ TOTAL\ PROJECT}$ =	246435	lbs.

* The values entered in these fields should be for the total project area.

Number of drainage basins / outfalls areas leaving the plan area = 19

2. Drainage Basin Parameters (This information should be provided for each basin):

Drainage Basin/Outfall Area No. = Pond A

Total drainage basin/outfall area =	1.91	acres
Predevelopment impervious area within drainage basin/outfall area =	0.56	acres
Post-development impervious area within drainage basin/outfall area =	0.87	acres
Post-development impervious fraction within drainage basin/outfall area =	0.46	
$L_{M\ THIS\ BASIN}$ =	270	lbs.

3. Indicate the proposed BMP Code for this basin.

Proposed BMP = Bioretention
Removal efficiency = 89 percent

4. Calculate Maximum TSS Load Removed (L_R) for this Drainage Basin by the selected BMP Type.

RG-348 Page 3-33 Equation 3.7: $L_R = (\text{BMP efficiency}) \times P \times (A_I \times 34.6 + A_P \times 0.54)$

where:

A_C = Total On-Site drainage area in the BMP catchment area
A_I = Impervious area proposed in the BMP catchment area
A_P = Pervious area remaining in the BMP catchment area
L_R = TSS Load removed from this catchment area by the proposed BMP

A_C =	1.91	acres
A_I =	0.87	acres
A_P =	1.04	acres
L_R =	877	lbs

5. Calculate Fraction of Annual Runoff to Treat the drainage basin / outfall area

Desired $L_{M\ THIS\ BASIN}$ =	**680**	lbs.
F =	**0.78**	

6. Calculate Capture Volume required by the BMP Type for this drainage basin / outfall area. Calculations from RG-348

Rainfall Depth =	**1.00**	inches
Post Development Runoff Coefficient =	**0.34**	
On-site Water Quality Volume =	**2324**	cubic feet

Calculations from RG-348 Pages 3-36 to 3-37

Off-site area draining to BMP =	**8.79**	acres
Off-site Impervious cover draining to BMP =	**2.64**	acres
Impervious fraction of off-site area =	**0.30**	
Off-site Runoff Coefficient =	**0.26**	
Off-site Water Quality Volume =	**8237**	cubic feet
Storage for Sediment =	**2112**	
Total Capture Volume (required water quality volume(s) x 1.20) =	**12672**	cubic feet

The following sections are used to calculate the required water quality volume(s) for the selected BMP.
The values for BMP Types not selected in cell C45 will show NA.

10. Bioretention System Designed as Required in RG-348 Pages 3-63 to 3-65

Required Water Quality Volume for Bioretention Basin =	**12672**	cubic feet

Texas Commission on Environmental Quality

TSS Removal Calculations 04-20-2009

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1. The Required Load Reduction for the total project: Calculations from RG-348 Pages 3-27 to 3-30

Page 3-29 Equation 3.3: $L_M = 27.2(A_N \times P)$

where:

$L_{M\ TOTAL\ PROJECT}$ = Required TSS removal resulting from the proposed development = 80% of increased load
A_N = Net increase in impervious area for the project
P = Average annual precipitation, inches

Site Data: Determine Required Load Removal Based on the Entire Project

County =	Travis	
Total project area included in plan * =	346.82	acres
Predevelopment impervious area within the limits of the plan* =	138.58	acres
Total post-development impervious area within the limits of the plan* =	220.74	acres
Total post-development impervious cover fraction * =	0.64	
P =	32	inches
$L_{M\ TOTAL\ PROJECT}$ =	246435	lbs.

* The values entered in these fields should be for the total project area.

Number of drainage basins / outfalls areas leaving the plan area = 19

2. Drainage Basin Parameters (This information should be provided for each basin):

Drainage Basin/Outfall Area No. = Pond B

Total drainage basin/outfall area =	8.06	acres
Predevelopment impervious area within drainage basin/outfall area =	3.58	acres
Post-development impervious area within drainage basin/outfall area =	6.08	acres
Post-development impervious fraction within drainage basin/outfall area =	0.75	
$L_{M\ THIS\ BASIN}$ =	2172	lbs.

3. Indicate the proposed BMP Code for this basin.

Proposed BMP = Batch Detention
Removal efficiency = 91 percent

4. Calculate Maximum TSS Load Removed (L_R) for this Drainage Basin by the selected BMP Type.

RG-348 Page 3-33 Equation 3.7: $L_R = (\text{BMP efficiency}) \times P \times (A_I \times 34.6 + A_P \times 0.54)$

where:

A_C = Total On-Site drainage area in the BMP catchment area
A_I = Impervious area proposed in the BMP catchment area
A_P = Pervious area remaining in the BMP catchment area
L_R = TSS Load removed from this catchment area by the proposed BMP

A_C =	8.06	acres
A_I =	6.08	acres
A_P =	1.99	acres
L_R =	6157	lbs

5. Calculate Fraction of Annual Runoff to Treat the drainage basin / outfall area

Desired $L_{M\ THIS\ BASIN}$ =	**5800**	lbs.
F =	**0.94**	

6. Calculate Capture Volume required by the BMP Type for this drainage basin / outfall area. Calculations from RG-348

Rainfall Depth =	**2.40**	inches
Post Development Runoff Coefficient =	**0.56**	
On-site Water Quality Volume =	**39666**	cubic feet

Calculations from RG-348 Pages 3-36 to 3-37

Off-site area draining to BMP =	**0.00**	acres
Off-site Impervious cover draining to BMP =	**0.00**	acres
Impervious fraction of off-site area =	**0**	
Off-site Runoff Coefficient =	**0.00**	
Off-site Water Quality Volume =	**0**	cubic feet
Storage for Sediment =	**7933**	
Total Capture Volume (required water quality volume(s) x 1.20) =	**47600**	cubic feet

Texas Commission on Environmental Quality

TSS Removal Calculations 04-20-2009

Project Name: 290 West Oak Hill
Date Prepared: 10/29/2019

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1. The Required Load Reduction for the total project: Calculations from RG-348 Pages 3-27 to 3-30

Page 3-29 Equation 3.3: $L_M = 27.2(A_N \times P)$

where:

$L_{M\ TOTAL\ PROJECT}$ = Required TSS removal resulting from the proposed development = 80% of increased load
A_N = Net increase in impervious area for the project
P = Average annual precipitation, inches

Site Data: Determine Required Load Removal Based on the Entire Project

County =	Travis	
Total project area included in plan * =	346.82	acres
Predevelopment impervious area within the limits of the plan* =	138.58	acres
Total post-development impervious area within the limits of the plan* =	220.74	acres
Total post-development impervious cover fraction * =	0.64	
P =	32	inches
$L_{M\ TOTAL\ PROJECT}$ =	246435	lbs.

* The values entered in these fields should be for the total project area.

Number of drainage basins / outfalls areas leaving the plan area = 19

2. Drainage Basin Parameters (This information should be provided for each basin):

Drainage Basin/Outfall Area No. = Pond B

Total drainage basin/outfall area =	8.06	acres
Predevelopment impervious area within drainage basin/outfall area =	3.58	acres
Post-development impervious area within drainage basin/outfall area =	4.17	acres
Post-development impervious fraction within drainage basin/outfall area =	0.52	
$L_{M\ THIS\ BASIN}$ =	508	lbs.

3. Indicate the proposed BMP Code for this basin.

Proposed BMP = Batch Detention
Removal efficiency = 91 percent

4. Calculate Maximum TSS Load Removed (L_R) for this Drainage Basin by the selected BMP Type.

RG-348 Page 3-33 Equation 3.7: $L_R = (\text{BMP efficiency}) \times P \times (A_I \times 34.6 + A_P \times 0.54)$

where:

A_C = Total On-Site drainage area in the BMP catchment area
A_I = Impervious area proposed in the BMP catchment area
A_P = Pervious area remaining in the BMP catchment area
L_R = TSS Load removed from this catchment area by the proposed BMP

A_C =	8.06	acres
A_I =	4.17	acres
A_P =	3.90	acres
L_R =	4260	lbs

5. Calculate Fraction of Annual Runoff to Treat the drainage basin / outfall area

Desired $L_{M\ THIS\ BASIN}$ =	**4014**	lbs.
F =	**0.94**	

6. Calculate Capture Volume required by the BMP Type for this drainage basin / outfall area. Calculations from RG-348

Rainfall Depth =	**2.40**	inches
Post Development Runoff Coefficient =	**0.37**	
On-site Water Quality Volume =	**25779**	cubic feet

Calculations from RG-348 Pages 3-36 to 3-37

Off-site area draining to BMP =	**0.00**	acres
Off-site Impervious cover draining to BMP =	**0.00**	acres
Impervious fraction of off-site area =	**0**	
Off-site Runoff Coefficient =	**0.00**	
Off-site Water Quality Volume =	**0**	cubic feet
Storage for Sediment =	**5156**	
Total Capture Volume (required water quality volume(s) x 1.20) =	**30935**	cubic feet

Texas Commission on Environmental Quality

TSS Removal Calculations 04-20-2009

Project Name: 290 West Oak Hill
Date Prepared: 10/29/2019

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1. The Required Load Reduction for the total project: Calculations from RG-348 Pages 3-27 to 3-30

Page 3-29 Equation 3.3: $L_M = 27.2(A_N \times P)$

where:

$L_{M\ TOTAL\ PROJECT}$ = Required TSS removal resulting from the proposed development = 80% of increased load
A_N = Net increase in impervious area for the project
P = Average annual precipitation, inches

Site Data: Determine Required Load Removal Based on the Entire Project

County =	Travis	
Total project area included in plan * =	346.82	acres
Predevelopment impervious area within the limits of the plan* =	138.58	acres
Total post-development impervious area within the limits of the plan* =	220.74	acres
Total post-development impervious cover fraction * =	0.64	
P =	32	inches
$L_{M\ TOTAL\ PROJECT}$ =	246435	lbs.

* The values entered in these fields should be for the total project area.

Number of drainage basins / outfalls areas leaving the plan area = 19

2. Drainage Basin Parameters (This information should be provided for each basin):

Drainage Basin/Outfall Area No. = PFC Pond B PFC/Batch Detention

Total drainage basin/outfall area =	1.91	acres
Predevelopment impervious area within drainage basin/outfall area =	0.00	acres
Post-development impervious area within drainage basin/outfall area =	1.91	acres
Post-development impervious fraction within drainage basin/outfall area =	1.00	
$L_{M\ THIS\ BASIN}$ =	1664	lbs.

3. Indicate the proposed BMP Code for this basin.

Proposed BMP = Permeable Friction Course
Removal efficiency = 90 percent

4. Calculate Maximum TSS Load Removed (L_R) for this Drainage Basin by the selected BMP Type.

RG-348 Page 3-33 Equation 3.7: $L_R = (\text{BMP efficiency}) \times P \times (A_I \times 34.6 + A_P \times 0.54)$

where:

A_C = Total On-Site drainage area in the BMP catchment area
A_I = Impervious area proposed in the BMP catchment area
A_P = Pervious area remaining in the BMP catchment area
L_R = TSS Load removed from this catchment area by the proposed BMP

A_C =	1.91	acres
A_I =	1.91	acres
A_P =	0.00	acres
L_R =	1905	lbs

16. Vegetated Filter Strips Designed as Required in RG-348 Pages 3-55 to 3-57

There are no calculations required for determining the load or size of vegetative filter strips.
The 80% removal is provided when the contributing drainage area does not exceed 72 feet (direction of flow) and the sheet flow leaving the impervious cover is directed across 15 feet of engineered filter strips with maximum slope of 20% or across 50 feet of natural vegetation with a maximum slope of 10%. There can be a break in grade as long as no slope exceeds 20%.

If vegetative filter strips are proposed for an interim permanent BMP, they may be sized as described on Page 3-56 of RG-348.

19. BMPs Installed in a Series Designed as Required in RG-348 Pages 3-32

Michael E. Barrett, Ph.D.. P.E. recommended that the coefficient for E_2 be changed from 0.5 to 0.65 on May 3, 2006

$E_{TOT} = [1 - ((1 - E_1) X (1 - 0.65E_2) x (1 - 0.25E_3))] X 100 =$ 95.92 percent NET EFFICIENCY OF THE BMPs IN THE SERIES

EFFICIENCY OF FIRST BMP IN THE SERIES = E_1 = 90.00 percent PFC

EFFICIENCY OF THE SECOND BMP IN THE SERIES = E_2 = 91.00 percent **Batch Detention**

EFFICIENCY OF THE THIRD BMP IN THE SERIES = E_3 = 0.00 percent

THEREFORE, THE NET LOAD REMOVAL WOULD BE:
(A_I AND A_P VALUES ARE FROM SECTION 3 ABOVE)

$L_R = E_{TOT} X P X (A_I X 34.6 X A_P X0.54)$ = 2030.38 lbs

Texas Commission on Environmental Quality

TSS Removal Calculations 04-20-2009

Project Name: 290 West Oak Hill
Date Prepared: 10/29/2019

Additional information is provided for cells with a red triangle in the upper right corner. Place the cursor over the cell.
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Characters shown in red are data entry fields.
Characters shown in black (Bold) are calculated fields. Changes to these fields will remove the equations used in the spreadsheet.

1. The Required Load Reduction for the total project: Calculations from RG-348 Pages 3-27 to 3-30

Page 3-29 Equation 3.3: $L_M = 27.2(A_N \times P)$

where:

$L_{M\ TOTAL\ PROJECT}$ = Required TSS removal resulting from the proposed development = 80% of increased load
A_N = Net increase in impervious area for the project
P = Average annual precipitation, inches

Site Data: Determine Required Load Removal Based on the Entire Project

County =	Travis	
Total project area included in plan * =	321.87	acres
Predevelopment impervious area within the limits of the plan* =	136.29	acres
Total post-development impervious area within the limits of the plan* =	209.94	acres
Total post-development impervious cover fraction * =	0.65	
P =	32	inches
$L_{M\ TOTAL\ PROJECT}$ =	234241	lbs.

* The values entered in these fields should be for the total project area.

Number of drainage basins / outfalls areas leaving the plan area = 1

2. Drainage Basin Parameters (This information should be provided for each basin):

Drainage Basin/Outfall Area No. = VFS

Total drainage basin/outfall area =	3.65	acres
Predevelopment impervious area within drainage basin/outfall area =	0.00	acres
Post-development impervious area within drainage basin/outfall area =	3.65	acres
Post-development impervious fraction within drainage basin/outfall area =	1.00	
$L_{M\ THIS\ BASIN}$ =	3175	lbs.

3. Indicate the proposed BMP Code for this basin.

Proposed BMP = Vegetated Filter Strips
Removal efficiency = 85 percent

4. Calculate Maximum TSS Load Removed (L_R) for this Drainage Basin by the selected BMP Type.

RG-348 Page 3-33 Equation 3.7: $L_R = (\text{BMP efficiency}) \times P \times (A_I \times 34.6 + A_P \times 0.54)$

where:

A_C = Total On-Site drainage area in the BMP catchment area
A_I = Impervious area proposed in the BMP catchment area
A_P = Pervious area remaining in the BMP catchment area
L_R = TSS Load removed from this catchment area by the proposed BMP

A_C =	3.65	acres
A_I =	3.65	acres
A_P =	0.00	acres
L_R =	3433	lbs

5. Calculate Fraction of Annual Runoff to Treat the drainage basin / outfall area

Desired $L_{M\ THIS\ BASIN}$ = 3433 lbs.

F = 1.00

6. Calculate Capture Volume required by the BMP Type for this drainage basin / outfall area. Calculations from RG-348

Rainfall Depth =	4.00	inches
Post Development Runoff Coefficient =	0.82	
On-site Water Quality Volume =	43238	cubic feet

Calculations from RG-348 Pages 3-36 to 3-37

Off-site area draining to BMP = 0.00 acres

Off-site Impervious cover draining to BMP =	0.00	acres
Impervious fraction of off-site area =	0	
Off-site Runoff Coefficient =	0.00	
Off-site Water Quality Volume =	0	cubic feet
Storage for Sediment =	8648	
Total Capture Volume (required water quality volume(s) x 1.20) =	**51886**	cubic feet

The following sections are used to calculate the required water quality volume(s) for the selected BMP.
The values for BMP Types not selected in cell C45 will show NA.

16. Vegetated Filter Strips Designed as Required in RG-348 Pages 3-55 to 3-57

There are no calculations required for determining the load or size of vegetative filter strips.
The 80% removal is provided when the contributing drainage area does not exceed 72 feet (direction of flow) and the sheet flow leaving the impervious cover is directed across 15 feet of engineered filter strips with maximum slope of 20% or across 50 feet of natural vegetation with a maximum slope of 10%. There can be a break in grade as long as no slope exceeds 20%.

If vegetative filter strips are proposed for an interim permanent BMP, they may be sized as described on Page 3-56 of RG-348.

Texas Commission on Environmental Quality

TSS Removal Calculations 04-20-2009

Project Name: 290 West Oak Hill
Date Prepared: 10/29/2019

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1. The Required Load Reduction for the total project: Calculations from RG-348 Pages 3-27 to 3-30

Page 3-29 Equation 3.3: $L_M = 27.2(A_N \times P)$

where:

$L_{M\ TOTAL\ PROJECT}$ = Required TSS removal resulting from the proposed development = 80% of increased load
A_N = Net increase in impervious area for the project
P = Average annual precipitation, inches

Site Data: Determine Required Load Removal Based on the Entire Project

County =	Travis	
Total project area included in plan * =	321.87	acres
Predevelopment impervious area within the limits of the plan* =	136.29	acres
Total post-development impervious area within the limits of the plan* =	209.94	acres
Total post-development impervious cover fraction * =	0.65	
P =	32	inches
$L_{M\ TOTAL\ PROJECT}$ =	234241	lbs.

* The values entered in these fields should be for the total project area.

Number of drainage basins / outfalls areas leaving the plan area = 19

2. Drainage Basin Parameters (This information should be provided for each basin):

Drainage Basin/Outfall Area No. = PFC

Total drainage basin/outfall area =	5.55	acres
Predevelopment impervious area within drainage basin/outfall area =	0.00	acres
Post-development impervious area within drainage basin/outfall area =	5.55	acres
Post-development impervious fraction within drainage basin/outfall area =	1.00	
$L_{M\ THIS\ BASIN}$ =	4834	lbs.

3. Indicate the proposed BMP Code for this basin.

Proposed BMP = Permeable Friction Course
Removal efficiency = 90 percent

4. Calculate Maximum TSS Load Removed (L_R) for this Drainage Basin by the selected BMP Type.

RG-348 Page 3-33 Equation 3.7: $L_R = (\text{BMP efficiency}) \times P \times (A_I \times 34.6 + A_P \times 0.54)$

where:

A_C = Total On-Site drainage area in the BMP catchment area
A_I = Impervious area proposed in the BMP catchment area
A_P = Pervious area remaining in the BMP catchment area
L_R = TSS Load removed from this catchment area by the proposed BMP

A_C =	5.55	acres
A_I =	5.55	acres
A_P =	0.00	acres
L_R =	5534	lbs

5. Calculate Fraction of Annual Runoff to Treat the drainage basin / outfall area

Desired $L_{M\ THIS\ BASIN}$ = 5534 lbs.

F = 1.00

6. Calculate Capture Volume required by the BMP Type for this drainage basin / outfall area. Calculations from RG-348

Rainfall Depth =	4.00	inches
Post Development Runoff Coefficient =	0.82	
On-site Water Quality Volume =	65826	cubic feet

Calculations from RG-348 Pages 3-36 to 3-37

Off-site area draining to BMP =	**0.00**	acres
Off-site Impervious cover draining to BMP =	**0.00**	acres
Impervious fraction of off-site area =	**0**	
Off-site Runoff Coefficient =	**0.00**	
Off-site Water Quality Volume =	**0**	cubic feet
Storage for Sediment =	**13165**	
Total Capture Volume (required water quality volume(s) x 1.20) =	**78992**	cubic feet

Texas Commission on Environmental Quality

TSS Removal Calculations 04-20-2009

Project Name: 290 West Oak Hill
Date Prepared: 10/29/2019

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1. The Required Load Reduction for the total project: Calculations from RG-348 Pages 3-27 to 3-30

Page 3-29 Equation 3.3: $L_M = 27.2(A_N \times P)$

where:

$L_{M\ TOTAL\ PROJECT}$ = Required TSS removal resulting from the proposed development = 80% of increased load
A_N = Net increase in impervious area for the project
P = Average annual precipitation, inches

Site Data: Determine Required Load Removal Based on the Entire Project

County =	Travis	
Total project area included in plan * =	346.82	acres
Predevelopment impervious area within the limits of the plan* =	138.58	acres
Total post-development impervious area within the limits of the plan* =	220.74	acres
Total post-development impervious cover fraction * =	0.64	
P =	32	inches
$L_{M\ TOTAL\ PROJECT}$ =	246435	lbs.

* The values entered in these fields should be for the total project area.

Number of drainage basins / outfalls areas leaving the plan area = 1

2. Drainage Basin Parameters (This information should be provided for each basin):

Drainage Basin/Outfall Area No. = Williamson Contributing

Total drainage basin/outfall area =	197.41	acres
Predevelopment impervious area within drainage basin/outfall area =	54.28	acres
Post-development impervious area within drainage basin/outfall area =	112.18	acres
Post-development impervious fraction within drainage basin/outfall area =	0.57	
$L_{M\ THIS\ BASIN}$ =	50399	lbs.

Texas Commission on Environmental Quality

TSS Removal Calculations 04-20-2009

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Date Prepared: 10/29/2019

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1. The Required Load Reduction for the total project: Calculations from RG-348 Pages 3-27 to 3-30

Page 3-29 Equation 3.3: $L_M = 27.2(A_N \times P)$

where:

$L_{M\ TOTAL\ PROJECT}$ = Required TSS removal resulting from the proposed development = 80% of increased load
A_N = Net increase in impervious area for the project
P = Average annual precipitation, inches

Site Data: Determine Required Load Removal Based on the Entire Project

County =	Travis	
Total project area included in plan * =	346.82	acres
Predevelopment impervious area within the limits of the plan* =	138.58	acres
Total post-development impervious area within the limits of the plan* =	220.74	acres
Total post-development impervious cover fraction * =	0.64	
P =	32	inches
$L_{M\ TOTAL\ PROJECT}$ =	246435	lbs.

* The values entered in these fields should be for the total project area.

Number of drainage basins / outfalls areas leaving the plan area = 19

2. Drainage Basin Parameters (This information should be provided for each basin):

Drainage Basin/Outfall Area No. = Pond C Sand Filter

Total drainage basin/outfall area =	15.95	acres
Predevelopment impervious area within drainage basin/outfall area =	2.74	acres
Post-development impervious area within drainage basin/outfall area =	10.93	acres
Post-development impervious fraction within drainage basin/outfall area =	0.69	
$L_{M\ THIS\ BASIN}$ =	7133	lbs.

3. Indicate the proposed BMP Code for this basin.

Proposed BMP = Sand Filter
Removal efficiency = 89 percent

4. Calculate Maximum TSS Load Removed (L_R) for this Drainage Basin by the selected BMP Type.

RG-348 Page 3-33 Equation 3.7: $L_R = (\text{BMP efficiency}) \times P \times (A_I \times 34.6 + A_P \times 0.54)$

where:

A_C = Total On-Site drainage area in the BMP catchment area
A_I = Impervious area proposed in the BMP catchment area
A_P = Pervious area remaining in the BMP catchment area
L_R = TSS Load removed from this catchment area by the proposed BMP

A_C =	15.95	acres
A_I =	10.93	acres
A_P =	5.01	acres
L_R =	10850	lbs

5. Calculate Fraction of Annual Runoff to Treat the drainage basin / outfall area

Desired $L_{M\ THIS\ BASIN}$ = 8515 lbs. L_M for pond sizing

F = 0.78

6. Calculate Capture Volume required by the BMP Type for this drainage basin / outfall area. Calculations from RG-348

Rainfall Depth =	1.00	inches
Post Development Runoff Coefficient =	0.49	
On-site Water Quality Volume =	28454	cubic feet

Calculations from RG-348 Pages 3-36 to 3-37

Off-site area draining to BMP =	0.00	acres
Off-site Impervious cover draining to BMP =	0.00	acres
Impervious fraction of off-site area =	0	
Off-site Runoff Coefficient =	0.00	
Off-site Water Quality Volume =	0	cubic feet
Storage for Sediment =	5691	
Total Capture Volume (required water quality volume(s) x 1.20) =	34145	cubic feet

The following sections are used to calculate the required water quality volume(s) for the selected BMP.
The values for BMP Types not selected in cell C45 will show NA.

9. Filter area for Sand Filters Designed as Required in RG-348 Pages 3-58 to 3-63

9A. Full Sedimentation and Filtration System

Water Quality Volume for sedimentation basin =	34145	cubic feet	
Minimum filter basin area =	1581	square feet	
Maximum sedimentation basin area =	14227	square feet	For minimum water depth of 2 feet
Minimum sedimentation basin area =	3557	square feet	For maximum water depth of 8 feet

9B. Partial Sedimentation and Filtration System

Water Quality Volume for combined basins =	34145	cubic feet	
Minimum filter basin area =	2845	square feet	
Maximum sedimentation basin area =	11382	square feet	For minimum water depth of 2 feet
Minimum sedimentation basin area =	711	square feet	For maximum water depth of 8 feet

Texas Commission on Environmental Quality

TSS Removal Calculations 04-20-2009

Project Name: 290 West Oak Hill
Date Prepared: 10/29/2019

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1. The Required Load Reduction for the total project: Calculations from RG-348 Pages 3-27 to 3-30

Page 3-29 Equation 3.3: $L_M = 27.2(A_N \times P)$

where:

$L_{M\ TOTAL\ PROJECT}$ = Required TSS removal resulting from the proposed development = 80% of increased load
A_N = Net increase in impervious area for the project
P = Average annual precipitation, inches

Site Data: Determine Required Load Removal Based on the Entire Project

County =	Travis	
Total project area included in plan * =	346.82	acres
Predevelopment impervious area within the limits of the plan* =	138.58	acres
Total post-development impervious area within the limits of the plan* =	220.74	acres
Total post-development impervious cover fraction * =	0.64	
P =	32	inches
$L_{M\ TOTAL\ PROJECT}$ =	246435	lbs.

* The values entered in these fields should be for the total project area.

Number of drainage basins / outfalls areas leaving the plan area = 19

2. Drainage Basin Parameters (This information should be provided for each basin):

Drainage Basin/Outfall Area No. =	Pond C	Sand Filter
Total drainage basin/outfall area =	15.95	acres
Predevelopment impervious area within drainage basin/outfall area =	2.74	acres
Post-development impervious area within drainage basin/outfall area =	6.93	acres
Post-development impervious fraction within drainage basin/outfall area =	0.43	
$L_{M\ THIS\ BASIN}$ =	3646	lbs.

3. Indicate the proposed BMP Code for this basin.

Proposed BMP = Sand Filter
Removal efficiency = 89 percent

4. Calculate Maximum TSS Load Removed (L_R) for this Drainage Basin by the selected BMP Type.

RG-348 Page 3-33 Equation 3.7: $L_R = (\text{BMP efficiency}) \times P \times (A_I \times 34.6 + A_P \times 0.54)$

where:

A_C = Total On-Site drainage area in the BMP catchment area
A_I = Impervious area proposed in the BMP catchment area
A_P = Pervious area remaining in the BMP catchment area
L_R = TSS Load removed from this catchment area by the proposed BMP

A_C =	15.95	acres
A_I =	6.93	acres
A_P =	9.02	acres
L_R =	6964	lbs

5. Calculate Fraction of Annual Runoff to Treat the drainage basin / outfall area

Desired $L_{M\ THIS\ BASIN}$ = 5465 lbs. L_M provided by Pond Only

F = 0.78

6. Calculate Capture Volume required by the BMP Type for this drainage basin / outfall area. Calculations from RG-348
See Sand Filter Pond C worksheet for pond sizing

Texas Commission on Environmental Quality

TSS Removal Calculations 04-20-2009

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Date Prepared: 10/29/2019

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1. The Required Load Reduction for the total project: Calculations from RG-348 Pages 3-27 to 3-30

Page 3-29 Equation 3.3: $L_M = 27.2(A_N \times P)$

where:

$L_{M\ TOTAL\ PROJECT}$ = Required TSS removal resulting from the proposed development = 80% of increased load
A_N = Net increase in impervious area for the project
P = Average annual precipitation, inches

Site Data: Determine Required Load Removal Based on the Entire Project

County =	Travis	
Total project area included in plan * =	346.82	acres
Predevelopment impervious area within the limits of the plan* =	138.58	acres
Total post-development impervious area within the limits of the plan* =	220.74	acres
Total post-development impervious cover fraction * =	0.64	
P =	32	inches
$L_{M\ TOTAL\ PROJECT}$ =	246435	lbs.

* The values entered in these fields should be for the total project area.

Number of drainage basins / outfalls areas leaving the plan area = 19

2. Drainage Basin Parameters (This information should be provided for each basin):

Drainage Basin/Outfall Area No. = VFS Pond C VFS/Sand Filter

Total drainage basin/outfall area =	0.10	acres
Predevelopment impervious area within drainage basin/outfall area =	0.00	acres
Post-development impervious area within drainage basin/outfall area =	0.10	acres
Post-development impervious fraction within drainage basin/outfall area =	1.00	
$L_{M\ THIS\ BASIN}$ =	86	lbs.

3. Indicate the proposed BMP Code for this basin.

Proposed BMP = Sand Filter
Removal efficiency = 89 percent

4. Calculate Maximum TSS Load Removed (L_R) for this Drainage Basin by the selected BMP Type.

RG-348 Page 3-33 Equation 3.7: $L_R = (\text{BMP efficiency}) \times P \times (A_I \times 34.6 + A_P \times 0.54)$

where:

A_C = Total On-Site drainage area in the BMP catchment area
A_I = Impervious area proposed in the BMP catchment area
A_P = Pervious area remaining in the BMP catchment area
L_R = TSS Load removed from this catchment area by the proposed BMP

A_C =	0.10	acres
A_I =	0.10	acres
A_P =	0.00	acres
L_R =	97	lbs

16. Vegetated Filter Strips Designed as Required in RG-348 Pages 3-55 to 3-57

There are no calculations required for determining the load or size of vegetative filter strips.
The 80% removal is provided when the contributing drainage area does not exceed 72 feet (direction of flow) and the sheet flow leaving the impervious cover is directed across 15 feet of engineered filter strips with maximum slope of 20% or across 50 feet of natural vegetation with a maximum slope of 10%. There can be a break in grade as long as no slope exceeds 20%.

If vegetative filter strips are proposed for an interim permanent BMP, they may be sized as described on Page 3-56 of RG-348.

19. BMPs Installed in a Series Designed as Required in RG-348 Pages 3-32

Michael E. Barrett, Ph.D.. P.E. recommended that the coefficient for E_2 be changed from 0.5 to 0.65 on May 3, 2006

$E_{TOT} = [1 - ((1 - E_1) X (1 - 0.65E_2) x (1 - 0.25E_3))] X 100 =$ 93.68 percent NET EFFICIENCY OF THE BMPs IN THE SERIES

EFFICIENCY OF FIRST BMP IN THE SERIES = E_I = 85.00 percent VFS

EFFICIENCY OF THE SECOND BMP IN THE SERIES = E_2 = 89.00 percent **Sand Filter**

EFFICIENCY OF THE THIRD BMP IN THE SERIES = E_3 = 0.00 percent

THEREFORE, THE NET LOAD REMOVAL WOULD BE:
(A_I AND A_P VALUES ARE FROM SECTION 3 ABOVE)

$L_R = E_{TOT} \times P \times (A_I \times 34.6 \times A_P \times 0.54)$ = 102.06 lbs

Texas Commission on Environmental Quality

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1. The Required Load Reduction for the total project: Calculations from RG-348 Pages 3-27 to 3-30

Page 3-29 Equation 3.3: $L_M = 27.2(A_N \times P)$

where:

$L_{M\ TOTAL\ PROJECT}$ = Required TSS removal resulting from the proposed development = 80% of increased load
A_N = Net increase in impervious area for the project
P = Average annual precipitation, inches

Site Data: Determine Required Load Removal Based on the Entire Project

County =	Travis	
Total project area included in plan * =	346.82	acres
Predevelopment impervious area within the limits of the plan* =	138.58	acres
Total post-development impervious area within the limits of the plan* =	220.74	acres
Total post-development impervious cover fraction * =	0.64	
P =	32	inches
$L_{M\ TOTAL\ PROJECT}$ =	246435	lbs.

* The values entered in these fields should be for the total project area.

Number of drainage basins / outfalls areas leaving the plan area = 19

2. Drainage Basin Parameters (This information should be provided for each basin):

Drainage Basin/Outfall Area No. = PFC Pond C PFC/Sand Filter

Total drainage basin/outfall area =	3.91	acres
Predevelopment impervious area within drainage basin/outfall area =	0.00	acres
Post-development impervious area within drainage basin/outfall area =	3.91	acres
Post-development impervious fraction within drainage basin/outfall area =	1.00	
$L_{M\ THIS\ BASIN}$ =	3401	lbs.

3. Indicate the proposed BMP Code for this basin.

Proposed BMP = Permeable Friction Course
Removal efficiency = 90 percent

4. Calculate Maximum TSS Load Removed (L_R) for this Drainage Basin by the selected BMP Type.

RG-348 Page 3-33 Equation 3.7: $L_R = (\text{BMP efficiency}) \times P \times (A_I \times 34.6 + A_P \times 0.54)$

where:

A_C = Total On-Site drainage area in the BMP catchment area
A_I = Impervious area proposed in the BMP catchment area
A_P = Pervious area remaining in the BMP catchment area
L_R = TSS Load removed from this catchment area by the proposed BMP

A_C =	3.91	acres
A_I =	3.91	acres
A_P =	0.00	acres
L_R =	3894	lbs

19. BMPs Installed in a Series Designed as Required in RG-348 Pages 3-32

Michael E. Barrett, Ph.D.. P.E. recommended that the coefficient for E_2 be changed from 0.5 to 0.65 on May 3, 2006

$E_{TOT} = [1 - ((1 - E_1) X (1 - 0.65E_2) x (1 - 0.25E_3))] X 100$ =	95.79	percent	NET EFFICIENCY OF THE BMPs IN THE SERIES
EFFICIENCY OF FIRST BMP IN THE SERIES = E_1 =	90.00	percent	PFC
EFFICIENCY OF THE SECOND BMP IN THE SERIES = E_2 =	89.00	percent	Sand Filter
EFFICIENCY OF THE THIRD BMP IN THE SERIES = E_3 =	0.00	percent	

THEREFORE, THE NET LOAD REMOVAL WOULD BE:
(A_I AND A_P VALUES ARE FROM SECTION 3 ABOVE)

$L_R = E_{TOT} X P X (A_I X 34.6 X A_P X0.54)$ = 4144.13 lbs

Texas Commission on Environmental Quality

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1. The Required Load Reduction for the total project: Calculations from RG-348 Pages 3-27 to 3-30

Page 3-29 Equation 3.3: $L_M = 27.2(A_N \times P)$

where:

$L_{M\ TOTAL\ PROJECT}$ = Required TSS removal resulting from the proposed development = 80% of increased load
A_N = Net increase in impervious area for the project
P = Average annual precipitation, inches

Site Data: Determine Required Load Removal Based on the Entire Project

County =	Travis	
Total project area included in plan * =	346.82	acres
Predevelopment impervious area within the limits of the plan* =	138.58	acres
Total post-development impervious area within the limits of the plan* =	220.74	acres
Total post-development impervious cover fraction * =	0.64	
P =	32	inches
$L_{M\ TOTAL\ PROJECT}$ =	246435	lbs.

* The values entered in these fields should be for the total project area.

Number of drainage basins / outfalls areas leaving the plan area = 19

2. Drainage Basin Parameters (This information should be provided for each basin):

Drainage Basin/Outfall Area No. = Pond D Sand Filter

Total drainage basin/outfall area =	11.24	acres
Predevelopment impervious area within drainage basin/outfall area =	3.40	acres
Post-development impervious area within drainage basin/outfall area =	6.96	acres
Post-development impervious fraction within drainage basin/outfall area =	0.62	
$L_{M\ THIS\ BASIN}$ =	3100	lbs.

3. Indicate the proposed BMP Code for this basin.

Proposed BMP = Sand Filter
Removal efficiency = 89 percent

4. Calculate Maximum TSS Load Removed (L_R) for this Drainage Basin by the selected BMP Type.

RG-348 Page 3-33 Equation 3.7: $L_R = (\text{BMP efficiency}) \times P \times (A_I \times 34.6 + A_P \times 0.54)$

where:

A_C = Total On-Site drainage area in the BMP catchment area
A_I = Impervious area proposed in the BMP catchment area
A_P = Pervious area remaining in the BMP catchment area
L_R = TSS Load removed from this catchment area by the proposed BMP

A_C =	11.24	acres
A_I =	6.96	acres
A_P =	4.28	acres
L_R =	6925	lbs

5. Calculate Fraction of Annual Runoff to Treat the drainage basin / outfall area

Desired $L_{M\ THIS\ BASIN}$ = 6400 lbs. L_M for pond sizing

F = 0.92

6. Calculate Capture Volume required by the BMP Type for this drainage basin / outfall area. Calculations from RG-348

Rainfall Depth =	2.00	inches
Post Development Runoff Coefficient =	0.43	
On-site Water Quality Volume =	35475	cubic feet

Calculations from RG-348 Pages 3-36 to 3-37

Off-site area draining to BMP =	0.00	acres
Off-site Impervious cover draining to BMP =	0.00	acres
Impervious fraction of off-site area =	0	
Off-site Runoff Coefficient =	0.00	
Off-site Water Quality Volume =	0	cubic feet
Storage for Sediment =	7095	
Total Capture Volume (required water quality volume(s) x 1.20) =	42570	cubic feet

The following sections are used to calculate the required water quality volume(s) for the selected BMP.
The values for BMP Types not selected in cell C45 will show NA.

9. Filter area for Sand Filters Designed as Required in RG-348 Pages 3-58 to 3-63

9A. Full Sedimentation and Filtration System

Water Quality Volume for sedimentation basin =	42570	cubic feet	
Minimum filter basin area =	1971	square feet	
Maximum sedimentation basin area =	17737	square feet	For minimum water depth of 2 feet
Minimum sedimentation basin area =	4434	square feet	For maximum water depth of 8 feet

9B. Partial Sedimentation and Filtration System

Water Quality Volume for combined basins =	42570	cubic feet	
Minimum filter basin area =	3547	square feet	
Maximum sedimentation basin area =	14190	square feet	For minimum water depth of 2 feet
Minimum sedimentation basin area =	887	square feet	For maximum water depth of 8 feet

Texas Commission on Environmental Quality

TSS Removal Calculations 04-20-2009

Project Name: 290 West Oak Hill
Date Prepared: 10/29/2019

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1. The Required Load Reduction for the total project: Calculations from RG-348 Pages 3-27 to 3-30

Page 3-29 Equation 3.3: $L_M = 27.2(A_N \times P)$

where:

$L_{M\ TOTAL\ PROJECT}$ = Required TSS removal resulting from the proposed development = 80% of increased load
A_N = Net increase in impervious area for the project
P = Average annual precipitation, inches

Site Data: Determine Required Load Removal Based on the Entire Project

County =	Travis	
Total project area included in plan * =	346.82	acres
Predevelopment impervious area within the limits of the plan* =	138.58	acres
Total post-development impervious area within the limits of the plan* =	220.74	acres
Total post-development impervious cover fraction * =	0.64	
P =	32	inches
$L_{M\ TOTAL\ PROJECT}$ =	246435	lbs.

* The values entered in these fields should be for the total project area.

Number of drainage basins / outfalls areas leaving the plan area = 19

2. Drainage Basin Parameters (This information should be provided for each basin):

Drainage Basin/Outfall Area No. =	Pond D	Sand Filter
Total drainage basin/outfall area =	11.24	acres
Predevelopment impervious area within drainage basin/outfall area =	3.40	acres
Post-development impervious area within drainage basin/outfall area =	3.00	acres
Post-development impervious fraction within drainage basin/outfall area =	0.27	
$L_{M\ THIS\ BASIN}$ =	-347	lbs.

3. Indicate the proposed BMP Code for this basin.

Proposed BMP = Sand Filter
Removal efficiency = 89 percent

4. Calculate Maximum TSS Load Removed (L_R) for this Drainage Basin by the selected BMP Type.

RG-348 Page 3-33 Equation 3.7: $L_R = (\text{BMP efficiency}) \times P \times (A_I \times 34.6 + A_P \times 0.54)$

where:

A_C = Total On-Site drainage area in the BMP catchment area
A_I = Impervious area proposed in the BMP catchment area
A_P = Pervious area remaining in the BMP catchment area
L_R = TSS Load removed from this catchment area by the proposed BMP

A_C =	11.24	acres
A_I =	3.00	acres
A_P =	8.24	acres
L_R =	3083	lbs

5. Calculate Fraction of Annual Runoff to Treat the drainage basin / outfall area

Desired $L_{M\ THIS\ BASIN}$ = 2850 lbs. L_M provided by Pond Only

F = 0.92

6. Calculate Capture Volume required by the BMP Type for this drainage basin / outfall area. Calculations from RG-348
See Sand Filter Pond D worksheet for pond sizing

Texas Commission on Environmental Quality

TSS Removal Calculations 04-20-2009

Project Name: 290 West Oak Hill
Date Prepared: 10/29/2019

Additional information is provided for cells with a red triangle in the upper right corner. Place the cursor over the cell.
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1. The Required Load Reduction for the total project: Calculations from RG-348 Pages 3-27 to 3-30

Page 3-29 Equation 3.3: $L_M = 27.2(A_N \times P)$

where:

$L_{M\ TOTAL\ PROJECT}$ = Required TSS removal resulting from the proposed development = 80% of increased load
A_N = Net increase in impervious area for the project
P = Average annual precipitation, inches

Site Data: Determine Required Load Removal Based on the Entire Project

County =	Travis	
Total project area included in plan * =	346.82	acres
Predevelopment impervious area within the limits of the plan* =	138.58	acres
Total post-development impervious area within the limits of the plan* =	220.74	acres
Total post-development impervious cover fraction * =	0.64	
P =	32	inches
$L_{M\ TOTAL\ PROJECT}$ =	246435	lbs.

* The values entered in these fields should be for the total project area.

Number of drainage basins / outfalls areas leaving the plan area = 19

2. Drainage Basin Parameters (This information should be provided for each basin):

Drainage Basin/Outfall Area No. = VFS Pond D VFS/Sand Filter

Total drainage basin/outfall area =	2.14	acres
Predevelopment impervious area within drainage basin/outfall area =	0.00	acres
Post-development impervious area within drainage basin/outfall area =	2.14	acres
Post-development impervious fraction within drainage basin/outfall area =	1.00	
$L_{M\ THIS\ BASIN}$ =	1861	lbs.

3. Indicate the proposed BMP Code for this basin.

Proposed BMP = Sand Filter
Removal efficiency = 89 percent

4. Calculate Maximum TSS Load Removed (L_R) for this Drainage Basin by the selected BMP Type.

RG-348 Page 3-33 Equation 3.7: $L_R = (\text{BMP efficiency}) \times P \times (A_I \times 34.6 + A_P \times 0.54)$

where:

A_C = Total On-Site drainage area in the BMP catchment area
A_I = Impervious area proposed in the BMP catchment area
A_P = Pervious area remaining in the BMP catchment area
L_R = TSS Load removed from this catchment area by the proposed BMP

A_C =	2.14	acres
A_I =	2.14	acres
A_P =	0.00	acres
L_R =	2106	lbs

16. Vegetated Filter Strips Designed as Required in RG-348 Pages 3-55 to 3-57

There are no calculations required for determining the load or size of vegetative filter strips.
The 80% removal is provided when the contributing drainage area does not exceed 72 feet (direction of flow) and the sheet flow leaving the impervious cover is directed across 15 feet of engineered filter strips with maximum slope of 20% or across 50 feet of natural vegetation with a maximum slope of 10%. There can be a break in grade as long as no slope exceeds 20%.

If vegetative filter strips are proposed for an interim permanent BMP, they may be sized as described on Page 3-56 of RG-348.

19. BMPs Installed in a Series Designed as Required in RG-348 Pages 3-32

Michael E. Barrett, Ph.D.. P.E. recommended that the coefficient for E_2 be changed from 0.5 to 0.65 on May 3, 2006

$E_{TOT} = [1 - ((1 - E_1) \times (1 - 0.65E_2) \times (1 - 0.25E_3))] \times 100$ = 93.68 percent NET EFFICIENCY OF THE BMPs IN THE SERIES

EFFICIENCY OF FIRST BMP IN THE SERIES = E_1 = 85.00 percent VFS

EFFICIENCY OF THE SECOND BMP IN THE SERIES = E_2 = 89.00 percent **Sand Filter**

EFFICIENCY OF THE THIRD BMP IN THE SERIES = E_3 = 0.00 percent

THEREFORE, THE NET LOAD REMOVAL WOULD BE:
(A_I AND A_P VALUES ARE FROM SECTION 3 ABOVE)

$L_R = E_{TOT} X P X (A_I X 34.6 X A_P X0.54)$ = 2217.11 lbs

Texas Commission on Environmental Quality

TSS Removal Calculations 04-20-2009

Project Name: 290 West Oak Hill
Date Prepared: 10/29/2019

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1. The Required Load Reduction for the total project: Calculations from RG-348 Pages 3-27 to 3-30

Page 3-29 Equation 3.3: $L_M = 27.2(A_N \times P)$

where:

$L_{M\ TOTAL\ PROJECT}$ = Required TSS removal resulting from the proposed development = 80% of increased load
A_N = Net increase in impervious area for the project
P = Average annual precipitation, inches

Site Data: Determine Required Load Removal Based on the Entire Project

County =	Travis	
Total project area included in plan * =	346.82	acres
Predevelopment impervious area within the limits of the plan* =	138.58	acres
Total post-development impervious area within the limits of the plan* =	220.74	acres
Total post-development impervious cover fraction * =	0.64	
P =	32	inches
$L_{M\ TOTAL\ PROJECT}$ =	246435	lbs.

* The values entered in these fields should be for the total project area.

Number of drainage basins / outfalls areas leaving the plan area = 19

2. Drainage Basin Parameters (This information should be provided for each basin):

Drainage Basin/Outfall Area No. = PFC Pond D PFC/Sand Filter

Total drainage basin/outfall area =	1.82	acres	2.0507
Predevelopment impervious area within drainage basin/outfall area =	0.00	acres	
Post-development impervious area within drainage basin/outfall area =	1.82	acres	
Post-development impervious fraction within drainage basin/outfall area =	1.00		
$L_{M\ THIS\ BASIN}$ =	1587	lbs.	

3. Indicate the proposed BMP Code for this basin.

Proposed BMP = Permeable Friction Course
Removal efficiency = 90 percent

4. Calculate Maximum TSS Load Removed (L_R) for this Drainage Basin by the selected BMP Type.

RG-348 Page 3-33 Equation 3.7: $L_R = (\text{BMP efficiency}) \times P \times (A_I \times 34.6 + A_P \times 0.54)$

where:

A_C = Total On-Site drainage area in the BMP catchment area
A_I = Impervious area proposed in the BMP catchment area
A_P = Pervious area remaining in the BMP catchment area
L_R = TSS Load removed from this catchment area by the proposed BMP

A_C =	1.82	acres
A_I =	1.82	acres
A_P =	0.00	acres
L_R =	1816	lbs

19. BMPs Installed in a Series Designed as Required in RG-348 Pages 3-32

Michael E. Barrett, Ph.D.. P.E. recommended that the coefficient for E_2 be changed from 0.5 to 0.65 on May 3, 2006

$E_{TOT} = [1 - ((1 - E_1) X (1 - 0.65E_2) x (1 - 0.25E_3))] X 100$ =	95.79	percent	NET EFFICIENCY OF THE BMPs IN THE SERIES
EFFICIENCY OF FIRST BMP IN THE SERIES = E_1 =	90.00	percent	PFC
EFFICIENCY OF THE SECOND BMP IN THE SERIES = E_2 =	89.00	percent	Sand Filter
EFFICIENCY OF THE THIRD BMP IN THE SERIES = E_3 =	0.00	percent	

THEREFORE, THE NET LOAD REMOVAL WOULD BE:
(A_I AND A_P VALUES ARE FROM SECTION 3 ABOVE)

$L_R = E_{TOT} X P X (A_I X 34.6 X A_P X0.54)$ = 1933.24 lbs

Texas Commission on Environmental Quality

TSS Removal Calculations 04-20-2009

Project Name: 290 West Oak Hill
Date Prepared: 10/29/2019

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1. The Required Load Reduction for the total project: Calculations from RG-348 Pages 3-27 to 3-30

Page 3-29 Equation 3.3: $L_M = 27.2(A_N \times P)$

where:

$L_{M\ TOTAL\ PROJECT}$ = Required TSS removal resulting from the proposed development = 80% of increased load
A_N = Net increase in impervious area for the project
P = Average annual precipitation, inches

Site Data: Determine Required Load Removal Based on the Entire Project

County =	Travis	
Total project area included in plan * =	346.82	acres
Predevelopment impervious area within the limits of the plan* =	138.58	acres
Total post-development impervious area within the limits of the plan* =	220.74	acres
Total post-development impervious cover fraction * =	0.64	
P =	32	inches
$L_{M\ TOTAL\ PROJECT}$ =	246435	lbs.

* The values entered in these fields should be for the total project area.

Number of drainage basins / outfalls areas leaving the plan area = 19

2. Drainage Basin Parameters (This information should be provided for each basin):

Drainage Basin/Outfall Area No. =	Pond E		Sand Filter
Total drainage basin/outfall area =	14.27	acres	
Predevelopment impervious area within drainage basin/outfall area =	3.13	acres	
Post-development impervious area within drainage basin/outfall area =	8.34	acres	
Post-development impervious fraction within drainage basin/outfall area =	0.58		
$L_{M\ THIS\ BASIN}$ =	4536	lbs.	

3. Indicate the proposed BMP Code for this basin.

Proposed BMP = Sand Filter
Removal efficiency = 89 percent

4. Calculate Maximum TSS Load Removed (L_R) for this Drainage Basin by the selected BMP Type.

RG-348 Page 3-33 Equation 3.7: $L_R = (\text{BMP efficiency}) \times P \times (A_I \times 34.6 + A_P \times 0.54)$

where:

A_C = Total On-Site drainage area in the BMP catchment area
A_I = Impervious area proposed in the BMP catchment area
A_P = Pervious area remaining in the BMP catchment area
L_R = TSS Load removed from this catchment area by the proposed BMP

A_C =	14.27	acres
A_I =	8.34	acres
A_P =	5.92	acres
L_R =	8313	lbs

5. Calculate Fraction of Annual Runoff to Treat the drainage basin / outfall area

Desired $L_{M\ THIS\ BASIN}$ = 7050 lbs. L_M for pond sizing

F = 0.85

6. Calculate Capture Volume required by the BMP Type for this drainage basin / outfall area. Calculations from RG-348

Rainfall Depth =	1.32	inches
Post Development Runoff Coefficient =	0.41	
On-site Water Quality Volume =	28001	cubic feet

Calculations from RG-348 Pages 3-36 to 3-37

Off-site area draining to BMP =	0.00	acres
Off-site Impervious cover draining to BMP =	0.00	acres
Impervious fraction of off-site area =	0	
Off-site Runoff Coefficient =	0.00	
Off-site Water Quality Volume =	0	cubic feet
Storage for Sediment =	5600	
Total Capture Volume (required water quality volume(s) x 1.20) =	33602	cubic feet

The following sections are used to calculate the required water quality volume(s) for the selected BMP.
The values for BMP Types not selected in cell C45 will show NA.

9. Filter area for Sand Filters Designed as Required in RG-348 Pages 3-58 to 3-63

9A. Full Sedimentation and Filtration System

Water Quality Volume for sedimentation basin =	33602	cubic feet	
Minimum filter basin area =	1556	square feet	
Maximum sedimentation basin area =	14001	square feet	For minimum water depth of 2 feet
Minimum sedimentation basin area =	3500	square feet	For maximum water depth of 8 feet

9B. Partial Sedimentation and Filtration System

Water Quality Volume for combined basins =	33602	cubic feet	
Minimum filter basin area =	2800	square feet	
Maximum sedimentation basin area =	11201	square feet	For minimum water depth of 2 feet
Minimum sedimentation basin area =	700	square feet	For maximum water depth of 8 feet

Texas Commission on Environmental Quality

TSS Removal Calculations 04-20-2009

Project Name: 290 West Oak Hill
Date Prepared: 10/29/2019

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1. The Required Load Reduction for the total project: Calculations from RG-348 Pages 3-27 to 3-30

Page 3-29 Equation 3.3: $L_M = 27.2(A_N \times P)$

where:

$L_{M\ TOTAL\ PROJECT}$ = Required TSS removal resulting from the proposed development = 80% of increased load
A_N = Net increase in impervious area for the project
P = Average annual precipitation, inches

Site Data: Determine Required Load Removal Based on the Entire Project

County =	Travis	
Total project area included in plan * =	346.82	acres
Predevelopment impervious area within the limits of the plan* =	138.58	acres
Total post-development impervious area within the limits of the plan* =	220.74	acres
Total post-development impervious cover fraction * =	0.64	
P =	32	inches

$L_{M\ TOTAL\ PROJECT}$ = **246435** lbs.

* The values entered in these fields should be for the total project area.

Number of drainage basins / outfalls areas leaving the plan area = 19

2. Drainage Basin Parameters (This information should be provided for each basin):

Drainage Basin/Outfall Area No. =	Pond E	Sand Filter
Total drainage basin/outfall area =	14.27	acres
Predevelopment impervious area within drainage basin/outfall area =	3.13	acres
Post-development impervious area within drainage basin/outfall area =	6.30	acres
Post-development impervious fraction within drainage basin/outfall area =	0.44	
$L_{M\ THIS\ BASIN}$ =	2756	lbs.

3. Indicate the proposed BMP Code for this basin.

Proposed BMP = Sand Filter
Removal efficiency = 89 percent

4. Calculate Maximum TSS Load Removed (L_R) for this Drainage Basin by the selected BMP Type.

RG-348 Page 3-33 Equation 3.7: $L_R = (\text{BMP efficiency}) \times P \times (A_I \times 34.6 + A_P \times 0.54)$

where:

A_C = Total On-Site drainage area in the BMP catchment area
A_I = Impervious area proposed in the BMP catchment area
A_P = Pervious area remaining in the BMP catchment area
L_R = TSS Load removed from this catchment area by the proposed BMP

A_C =	14.27	acres
A_I =	6.30	acres
A_P =	7.97	acres
L_R =	6329	lbs

5. Calculate Fraction of Annual Runoff to Treat the drainage basin / outfall area

Desired $L_{M\ THIS\ BASIN}$ = 5368 lbs. L_M provided by Pond Only

F = **0.85**

6. Calculate Capture Volume required by the BMP Type for this drainage basin / outfall area. Calculations from RG-348
See Sand Filter Pond E worksheet for pond sizing

Texas Commission on Environmental Quality

TSS Removal Calculations 04-20-2009

Project Name: 290 West Oak Hill
Date Prepared: 10/29/2019

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1. The Required Load Reduction for the total project: Calculations from RG-348 Pages 3-27 to 3-30

Page 3-29 Equation 3.3: $L_M = 27.2(A_N \times P)$

where:

$L_{M\ TOTAL\ PROJECT}$ = Required TSS removal resulting from the proposed development = 80% of increased load
A_N = Net increase in impervious area for the project
P = Average annual precipitation, inches

Site Data: Determine Required Load Removal Based on the Entire Project

County =	Travis	
Total project area included in plan * =	346.82	acres
Predevelopment impervious area within the limits of the plan* =	138.58	acres
Total post-development impervious area within the limits of the plan* =	220.74	acres
Total post-development impervious cover fraction * =	0.64	
P =	32	inches
$L_{M\ TOTAL\ PROJECT}$ =	246435	lbs.

* The values entered in these fields should be for the total project area.

Number of drainage basins / outfalls areas leaving the plan area = 19

2. Drainage Basin Parameters (This information should be provided for each basin):

Drainage Basin/Outfall Area No. = VFS Pond E VFS/Sand Filter

Total drainage basin/outfall area =	2.05	acres
Predevelopment impervious area within drainage basin/outfall area =	0.00	acres
Post-development impervious area within drainage basin/outfall area =	2.05	acres
Post-development impervious fraction within drainage basin/outfall area =	1.00	
$L_{M\ THIS\ BASIN}$ =	1780	lbs.

3. Indicate the proposed BMP Code for this basin.

Proposed BMP = Sand Filter
Removal efficiency = 89 percent

4. Calculate Maximum TSS Load Removed (L_R) for this Drainage Basin by the selected BMP Type.

RG-348 Page 3-33 Equation 3.7: $L_R = (\text{BMP efficiency}) \times P \times (A_I \times 34.6 + A_P \times 0.54)$

where:

A_C = Total On-Site drainage area in the BMP catchment area
A_I = Impervious area proposed in the BMP catchment area
A_P = Pervious area remaining in the BMP catchment area
L_R = TSS Load removed from this catchment area by the proposed BMP

A_C =	2.05	acres
A_I =	2.05	acres
A_P =	0.00	acres
L_R =	2015	lbs

16. Vegetated Filter Strips Designed as Required in RG-348 Pages 3-55 to 3-57

There are no calculations required for determining the load or size of vegetative filter strips.
The 80% removal is provided when the contributing drainage area does not exceed 72 feet (direction of flow) and the sheet flow leaving the impervious cover is directed across 15 feet of engineered filter strips with maximum slope of 20% or across 50 feet of natural vegetation with a maximum slope of 10%. There can be a break in grade as long as no slope exceeds 20%.

If vegetative filter strips are proposed for an interim permanent BMP, they may be sized as described on Page 3-56 of RG-348.

19. BMPs Installed in a Series Designed as Required in RG-348 Pages 3-32

Michael E. Barrett, Ph.D.. P.E. recommended that the coefficient for E_2 be changed from 0.5 to 0.65 on May 3, 2006

$E_{TOT} = [1 - ((1 - E_1) \times (1 - 0.65E_2) \times (1 - 0.25E_3))] \times 100$ = 93.68 percent NET EFFICIENCY OF THE BMPs IN THE SERIES

EFFICIENCY OF FIRST BMP IN THE SERIES = E_1 = 85.00 percent VFS

EFFICIENCY OF THE SECOND BMP IN THE SERIES = E_2 = 89.00 percent **Sand Filter**

EFFICIENCY OF THE THIRD BMP IN THE SERIES = E_3 = 0.00 percent

THEREFORE, THE NET LOAD REMOVAL WOULD BE:
(A_I AND A_P VALUES ARE FROM SECTION 3 ABOVE)

$L_R = E_{TOT} \times P \times (A_I \times 34.6 \times A_P \times 0.54)$ = 2121.28 lbs

Texas Commission on Environmental Quality

TSS Removal Calculations 04-20-2009

Project Name: 290 West Oak Hill
Date Prepared: 10/29/2019

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1. The Required Load Reduction for the total project: Calculations from RG-348 Pages 3-27 to 3-30

Page 3-29 Equation 3.3: $L_M = 27.2(A_N \times P)$

where:

$L_{M\ TOTAL\ PROJECT}$ = Required TSS removal resulting from the proposed development = 80% of increased load
A_N = Net increase in impervious area for the project
P = Average annual precipitation, inches

Site Data: Determine Required Load Removal Based on the Entire Project

County =	Travis	
Total project area included in plan * =	346.82	acres
Predevelopment impervious area within the limits of the plan* =	138.58	acres
Total post-development impervious area within the limits of the plan* =	220.74	acres
Total post-development impervious cover fraction * =	0.64	
P =	32	inches
$L_{M\ TOTAL\ PROJECT}$ =	246435	lbs.

* The values entered in these fields should be for the total project area.

Number of drainage basins / outfalls areas leaving the plan area = 19

2. Drainage Basin Parameters (This information should be provided for each basin):

Drainage Basin/Outfall Area No. = PFC Pond E PFC/Sand Filter

Total drainage basin/outfall area =	0.00	acres	2.0507
Predevelopment impervious area within drainage basin/outfall area =	0.00	acres	
Post-development impervious area within drainage basin/outfall area =	0.00	acres	
Post-development impervious fraction within drainage basin/outfall area =	#DIV/0!		
$L_{M\ THIS\ BASIN}$ =	0	lbs.	

3. Indicate the proposed BMP Code for this basin.

Proposed BMP = Permeable Friction Course
Removal efficiency = 90 percent

4. Calculate Maximum TSS Load Removed (L_R) for this Drainage Basin by the selected BMP Type.

RG-348 Page 3-33 Equation 3.7: $L_R = (\text{BMP efficiency}) \times P \times (A_I \times 34.6 + A_P \times 0.54)$

where:

A_C = Total On-Site drainage area in the BMP catchment area
A_I = Impervious area proposed in the BMP catchment area
A_P = Pervious area remaining in the BMP catchment area
L_R = TSS Load removed from this catchment area by the proposed BMP

A_C =	0.00	acres
A_I =	0.00	acres
A_P =	0.00	acres
L_R =	0	lbs

19. BMPs Installed in a Series Designed as Required in RG-348 Pages 3-32

Michael E. Barrett, Ph.D.. P.E. recommended that the coefficient for E_2 be changed from 0.5 to 0.65 on May 3, 2006

$E_{TOT} = [1 - ((1 - E_1) X (1 - 0.65E_2) x (1 - 0.25E_3))] X 100$ =	95.79	percent	NET EFFICIENCY OF THE BMPs IN THE SERIES
EFFICIENCY OF FIRST BMP IN THE SERIES = E_1 =	90.00	percent	PFC
EFFICIENCY OF THE SECOND BMP IN THE SERIES = E_2 =	89.00	percent	Sand Filter
EFFICIENCY OF THE THIRD BMP IN THE SERIES = E_3 =	0.00	percent	

THEREFORE, THE NET LOAD REMOVAL WOULD BE:
(A_I AND A_P VALUES ARE FROM SECTION 3 ABOVE)

$L_R = E_{TOT} X P X (A_I X 34.6 X A_P X0.54)$ = 0.00 lbs

Texas Commission on Environmental Quality

TSS Removal Calculations 04-20-2009

Project Name: 290 West Oak Hill
Date Prepared: 10/29/2019

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1. The Required Load Reduction for the total project: Calculations from RG-348 Pages 3-27 to 3-30

Page 3-29 Equation 3.3: $L_M = 27.2(A_N \times P)$

where:

$L_{M\ TOTAL\ PROJECT}$ = Required TSS removal resulting from the proposed development = 80% of increased load
A_N = Net increase in impervious area for the project
P = Average annual precipitation, inches

Site Data: Determine Required Load Removal Based on the Entire Project

County =	Travis	
Total project area included in plan * =	346.82	acres
Predevelopment impervious area within the limits of the plan* =	138.58	acres
Total post-development impervious area within the limits of the plan* =	220.74	acres
Total post-development impervious cover fraction * =	0.64	
P =	32	inches
$L_{M\ TOTAL\ PROJECT}$ =	246435	lbs.

* The values entered in these fields should be for the total project area.

Number of drainage basins / outfalls areas leaving the plan area = 19

2. Drainage Basin Parameters (This information should be provided for each basin):

Drainage Basin/Outfall Area No. = Pond F Sand Filter

Total drainage basin/outfall area =	37.74	acres
Predevelopment impervious area within drainage basin/outfall area =	14.20	acres
Post-development impervious area within drainage basin/outfall area =	25.96	acres
Post-development impervious fraction within drainage basin/outfall area =	0.69	
$L_{M\ THIS\ BASIN}$ =	10239	lbs.

3. Indicate the proposed BMP Code for this basin.

Proposed BMP = Sand Filter
Removal efficiency = 89 percent

4. Calculate Maximum TSS Load Removed (L_R) for this Drainage Basin by the selected BMP Type.

RG-348 Page 3-33 Equation 3.7: $L_R = (\text{BMP efficiency}) \times P \times (A_I \times 34.6 + A_P \times 0.54)$

where:

A_C = Total On-Site drainage area in the BMP catchment area
A_I = Impervious area proposed in the BMP catchment area
A_P = Pervious area remaining in the BMP catchment area
L_R = TSS Load removed from this catchment area by the proposed BMP

A_C =	37.74	acres
A_I =	25.96	acres
A_P =	11.77	acres
L_R =	25767	lbs

5. Calculate Fraction of Annual Runoff to Treat the drainage basin / outfall area

Desired $L_{M\ THIS\ BASIN}$ =	**23613**	lbs.	**L_M for pond sizing**
F =	**0.92**		

6. Calculate Capture Volume required by the BMP Type for this drainage basin / outfall area. Calculations from RG-348

Rainfall Depth =	**2.00**	inches
Post Development Runoff Coefficient =	**0.49**	
On-site Water Quality Volume =	**135319**	cubic feet

Calculations from RG-348 Pages 3-36 to 3-37

Off-site area draining to BMP =	**0.00**	acres
Off-site Impervious cover draining to BMP =	**0.00**	acres
Impervious fraction of off-site area =	**0**	
Off-site Runoff Coefficient =	**0.00**	
Off-site Water Quality Volume =	**0**	cubic feet
Storage for Sediment =	**27064**	
Total Capture Volume (required water quality volume(s) x 1.20) =	**162383**	cubic feet

The following sections are used to calculate the required water quality volume(s) for the selected BMP.
The values for BMP Types not selected in cell C45 will show NA.

9. Filter area for Sand Filters Designed as Required in RG-348 Pages 3-58 to 3-63

9A. Full Sedimentation and Filtration System

Water Quality Volume for sedimentation basin =	**162383**	cubic feet	
Minimum filter basin area =	**7518**	square feet	
Maximum sedimentation basin area =	**67660**	square feet	**For minimum water depth of 2 feet**
Minimum sedimentation basin area =	**16915**	square feet	**For maximum water depth of 8 feet**

9B. Partial Sedimentation and Filtration System

Water Quality Volume for combined basins =	**162383**	cubic feet	
Minimum filter basin area =	**13532**	square feet	
Maximum sedimentation basin area =	**54128**	square feet	**For minimum water depth of 2 feet**
Minimum sedimentation basin area =	**3383**	square feet	**For maximum water depth of 8 feet**

Texas Commission on Environmental Quality

TSS Removal Calculations 04-20-2009

Project Name: 290 West Oak Hill
Date Prepared: 10/29/2019

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1. The Required Load Reduction for the total project: Calculations from RG-348 Pages 3-27 to 3-30

Page 3-29 Equation 3.3: $L_M = 27.2(A_N \times P)$

where:

$L_{M\ TOTAL\ PROJECT}$ = Required TSS removal resulting from the proposed development = 80% of increased load
A_N = Net increase in impervious area for the project
P = Average annual precipitation, inches

Site Data: Determine Required Load Removal Based on the Entire Project

County =	Travis	
Total project area included in plan * =	346.82	acres
Predevelopment impervious area within the limits of the plan* =	138.58	acres
Total post-development impervious area within the limits of the plan* =	220.74	acres
Total post-development impervious cover fraction * =	0.64	
P =	32	inches

$L_{M\ TOTAL\ PROJECT}$ = **246435** lbs.

* The values entered in these fields should be for the total project area.

Number of drainage basins / outfalls areas leaving the plan area = 19

2. Drainage Basin Parameters (This information should be provided for each basin):

Drainage Basin/Outfall Area No. = Pond F Sand Filter

Total drainage basin/outfall area =	37.74	acres
Predevelopment impervious area within drainage basin/outfall area =	14.20	acres
Post-development impervious area within drainage basin/outfall area =	19.50	acres
Post-development impervious fraction within drainage basin/outfall area =	0.52	
$L_{M\ THIS\ BASIN}$ =	4615	lbs.

3. Indicate the proposed BMP Code for this basin.

Proposed BMP = Sand Filter
Removal efficiency = 89 percent

4. Calculate Maximum TSS Load Removed (L_R) for this Drainage Basin by the selected BMP Type.

RG-348 Page 3-33 Equation 3.7: $L_R = (\text{BMP efficiency}) \times P \times (A_I \times 34.6 + A_P \times 0.54)$

where:

A_C = Total On-Site drainage area in the BMP catchment area
A_I = Impervious area proposed in the BMP catchment area
A_P = Pervious area remaining in the BMP catchment area
L_R = TSS Load removed from this catchment area by the proposed BMP

A_C =	37.74	acres
A_I =	19.50	acres
A_P =	18.24	acres
L_R =	19498	lbs

5. Calculate Fraction of Annual Runoff to Treat the drainage basin / outfall area

Desired $L_{M\ THIS\ BASIN}$ = 17868 lbs. L_M provided by Pond Only

F = 0.92

6. Calculate Capture Volume required by the BMP Type for this drainage basin / outfall area. Calculations from RG-348
See Sand Filter Pond F worksheet for pond sizing

Texas Commission on Environmental Quality

TSS Removal Calculations 04-20-2009

Project Name: 290 West Oak Hill
Date Prepared: 10/29/2019

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1. The Required Load Reduction for the total project: Calculations from RG-348 Pages 3-27 to 3-30

Page 3-29 Equation 3.3: $L_M = 27.2(A_N \times P)$

where:

$L_{M\ TOTAL\ PROJECT}$ = Required TSS removal resulting from the proposed development = 80% of increased load
A_N = Net increase in impervious area for the project
P = Average annual precipitation, inches

Site Data: Determine Required Load Removal Based on the Entire Project

County =	Travis	
Total project area included in plan * =	346.82	acres
Predevelopment impervious area within the limits of the plan* =	138.58	acres
Total post-development impervious area within the limits of the plan* =	220.74	acres
Total post-development impervious cover fraction * =	0.64	
P =	32	inches

$L_{M\ TOTAL\ PROJECT}$ = **246435** lbs.

* The values entered in these fields should be for the total project area.

Number of drainage basins / outfalls areas leaving the plan area = 19

2. Drainage Basin Parameters (This information should be provided for each basin):

Drainage Basin/Outfall Area No. = VFS Pond F VFS/Sand Filter

Total drainage basin/outfall area =	3.58	acres
Predevelopment impervious area within drainage basin/outfall area =	0.00	acres
Post-development impervious area within drainage basin/outfall area =	3.58	acres
Post-development impervious fraction within drainage basin/outfall area =	1.00	
$L_{M\ THIS\ BASIN}$ =	3113	lbs.

3. Indicate the proposed BMP Code for this basin.

Proposed BMP = Sand Filter
Removal efficiency = 89 percent

4. Calculate Maximum TSS Load Removed (L_R) for this Drainage Basin by the selected BMP Type.

RG-348 Page 3-33 Equation 3.7: $L_R = (\text{BMP efficiency}) \times P \times (A_I \times 34.6 + A_P \times 0.54)$

where:

A_C = Total On-Site drainage area in the BMP catchment area
A_I = Impervious area proposed in the BMP catchment area
A_P = Pervious area remaining in the BMP catchment area
L_R = TSS Load removed from this catchment area by the proposed BMP

A_C =	3.58	acres
A_I =	3.58	acres
A_P =	0.00	acres
L_R =	3525	lbs

16. Vegetated Filter Strips Designed as Required in RG-348 Pages 3-55 to 3-57

There are no calculations required for determining the load or size of vegetative filter strips.
The 80% removal is provided when the contributing drainage area does not exceed 72 feet (direction of flow) and the sheet flow leaving the impervious cover is directed across 15 feet of engineered filter strips with maximum slope of 20% or across 50 feet of natural vegetation with a maximum slope of 10%. There can be a break in grade as long as no slope exceeds 20%.

If vegetative filter strips are proposed for an interim permanent BMP, they may be sized as described on Page 3-56 of RG-348.

19. BMPs Installed in a Series Designed as Required in RG-348 Pages 3-32

Michael E. Barrett, Ph.D.. P.E. recommended that the coefficient for E_2 be changed from 0.5 to 0.65 on May 3, 2006

$E_{TOT} = [1 - ((1 - E_1) \times (1 - 0.65E_2) \times (1 - 0.25E_3))] \times 100$ = 93.68 percent NET EFFICIENCY OF THE BMPs IN THE SERIES

EFFICIENCY OF FIRST BMP IN THE SERIES = E_1 = 85.00 percent VFS

EFFICIENCY OF THE SECOND BMP IN THE SERIES = E_2 = 89.00 percent **Sand Filter**

EFFICIENCY OF THE THIRD BMP IN THE SERIES = E_3 = 0.00 percent

THEREFORE, THE NET LOAD REMOVAL WOULD BE:
(A_I AND A_P VALUES ARE FROM SECTION 3 ABOVE)

$L_R = E_{TOT} \times P \times (A_I \times 34.6 \times A_P \times 0.54)$ = 3709.95 lbs

Texas Commission on Environmental Quality

TSS Removal Calculations 04-20-2009

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Date Prepared: 10/29/2019

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1. The Required Load Reduction for the total project: Calculations from RG-348 Pages 3-27 to 3-30

Page 3-29 Equation 3.3: $L_M = 27.2(A_N \times P)$

where:

$L_{M\ TOTAL\ PROJECT}$ = Required TSS removal resulting from the proposed development = 80% of increased load
A_N = Net increase in impervious area for the project
P = Average annual precipitation, inches

Site Data: Determine Required Load Removal Based on the Entire Project

County =	Travis	
Total project area included in plan * =	346.82	acres
Predevelopment impervious area within the limits of the plan* =	138.58	acres
Total post-development impervious area within the limits of the plan* =	220.74	acres
Total post-development impervious cover fraction * =	0.64	
P =	32	inches
$L_{M\ TOTAL\ PROJECT}$ =	246435	lbs.

* The values entered in these fields should be for the total project area.

Number of drainage basins / outfalls areas leaving the plan area = 19

2. Drainage Basin Parameters (This information should be provided for each basin):

Drainage Basin/Outfall Area No. = PFC Pond F PFC/Sand Filter

Total drainage basin/outfall area =	2.89	acres
Predevelopment impervious area within drainage basin/outfall area =	0.00	acres
Post-development impervious area within drainage basin/outfall area =	2.89	acres
Post-development impervious fraction within drainage basin/outfall area =	1.00	
$L_{M\ THIS\ BASIN}$ =	2512	lbs.

3. Indicate the proposed BMP Code for this basin.

Proposed BMP = Permeable Friction Course
Removal efficiency = 90 percent

4. Calculate Maximum TSS Load Removed (L_R) for this Drainage Basin by the selected BMP Type.

RG-348 Page 3-33 Equation 3.7: $L_R = (\text{BMP efficiency}) \times P \times (A_I \times 34.6 + A_P \times 0.54)$

where:

A_C = Total On-Site drainage area in the BMP catchment area
A_I = Impervious area proposed in the BMP catchment area
A_P = Pervious area remaining in the BMP catchment area
L_R = TSS Load removed from this catchment area by the proposed BMP

A_C =	2.89	acres
A_I =	2.89	acres
A_P =	0.00	acres
L_R =	2875	lbs

19. BMPs Installed in a Series Designed as Required in RG-348 Pages 3-32

Michael E. Barrett, Ph.D.. P.E. recommended that the coefficient for E_2 be changed from 0.5 to 0.65 on May 3, 2006

$E_{TOT} = [1 - ((1 - E_1) X (1 - 0.65E_2) x (1 - 0.25E_3))] X 100$ =	95.79	percent	NET EFFICIENCY OF THE BMPs IN THE SERIES
EFFICIENCY OF FIRST BMP IN THE SERIES = E_1 =	90.00	percent	PFC
EFFICIENCY OF THE SECOND BMP IN THE SERIES = E_2 =	89.00	percent	Sand Filter
EFFICIENCY OF THE THIRD BMP IN THE SERIES = E_3 =	0.00	percent	

THEREFORE, THE NET LOAD REMOVAL WOULD BE:
(A_I AND A_P VALUES ARE FROM SECTION 3 ABOVE)

$L_R = E_{TOT} X P X (A_I X 34.6 X A_P X0.54)$ = 3060.16 lbs

Texas Commission on Environmental Quality

TSS Removal Calculations 04-20-2009

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1. The Required Load Reduction for the total project: Calculations from RG-348 Pages 3-27 to 3-30

Page 3-29 Equation 3.3: $L_M = 27.2(A_N \times P)$

where:

$L_{M\ TOTAL\ PROJECT}$ = Required TSS removal resulting from the proposed development = 80% of increased load
A_N = Net increase in impervious area for the project
P = Average annual precipitation, inches

Site Data: Determine Required Load Removal Based on the Entire Project

County =	Travis	
Total project area included in plan * =	346.82	acres
Predevelopment impervious area within the limits of the plan* =	138.58	acres
Total post-development impervious area within the limits of the plan* =	220.74	acres
Total post-development impervious cover fraction * =	0.64	
P =	32	inches

$L_{M\ TOTAL\ PROJECT}$ = **246435** lbs.

* **The values entered in these fields should be for the total project area.**

Number of drainage basins / outfalls areas leaving the plan area = 19

2. Drainage Basin Parameters (This information should be provided for each basin):

Drainage Basin/Outfall Area No. = Pond G

Total drainage basin/outfall area =	4.81	acres
Predevelopment impervious area within drainage basin/outfall area =	1.21	acres
Post-development impervious area within drainage basin/outfall area =	3.55	acres
Post-development impervious fraction within drainage basin/outfall area =	0.74	
$L_{M\ THIS\ BASIN}$ =	2038	lbs.

3. Indicate the proposed BMP Code for this basin.

Proposed BMP = Sand Filter
Removal efficiency = 89 percent

4. Calculate Maximum TSS Load Removed (L_R) for this Drainage Basin by the selected BMP Type.

RG-348 Page 3-33 Equation 3.7: $L_R = (\text{BMP efficiency}) \times P \times (A_I \times 34.6 + A_P \times 0.54)$

where:

A_C = Total On-Site drainage area in the BMP catchment area
A_I = Impervious area proposed in the BMP catchment area
A_P = Pervious area remaining in the BMP catchment area
L_R = TSS Load removed from this catchment area by the proposed BMP

A_C =	4.81	acres
A_I =	3.55	acres
A_P =	1.26	acres
L_R =	3516	lbs

5. Calculate Fraction of Annual Runoff to Treat the drainage basin / outfall area

Desired $L_{M\ THIS\ BASIN}$ = 3275 lbs.

F = **0.93**

6. Calculate Capture Volume required by the BMP Type for this drainage basin / outfall area. Calculations from RG-348

Rainfall Depth =	2.20	inches
Post Development Runoff Coefficient =	0.55	
On-site Water Quality Volume =	20958	cubic feet

Calculations from RG-348 Pages 3-36 to 3-37

Off-site area draining to BMP =	5.36	acres
Off-site Impervious cover draining to BMP =	0.00	acres
Impervious fraction of off-site area =	0.00	
Off-site Runoff Coefficient =	0.02	
Off-site Water Quality Volume =	856	cubic feet
Storage for Sediment =	4363	
Total Capture Volume (required water quality volume(s) x 1.20) =	26177	cubic feet

The following sections are used to calculate the required water quality volume(s) for the selected BMP.
The values for BMP Types not selected in cell C45 will show NA.

9. Filter area for Sand Filters Designed as Required in RG-348 Pages 3-58 to 3-63

9A. Full Sedimentation and Filtration System

Water Quality Volume for sedimentation basin =	26177	cubic feet	
Minimum filter basin area =	1164	square feet	
Maximum sedimentation basin area =	10479	square feet	**For minimum water depth of 2 feet**
Minimum sedimentation basin area =	2620	square feet	**For maximum water depth of 8 feet**

9B. Partial Sedimentation and Filtration System

Water Quality Volume for combined basins =	26177	cubic feet	
Minimum filter basin area =	2096	square feet	
Maximum sedimentation basin area =	8383	square feet	**For minimum water depth of 2 feet**
Minimum sedimentation basin area =	524	square feet	**For maximum water depth of 8 feet**

Texas Commission on Environmental Quality

TSS Removal Calculations 04-20-2009

Project Name: 290 West Oak Hill
Date Prepared: 10/29/2019

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1. The Required Load Reduction for the total project: Calculations from RG-348 Pages 3-27 to 3-30

Page 3-29 Equation 3.3: $L_M = 27.2(A_N \times P)$

where:

$L_{M\ TOTAL\ PROJECT}$ = Required TSS removal resulting from the proposed development = 80% of increased load
A_N = Net increase in impervious area for the project
P = Average annual precipitation, inches

Site Data: Determine Required Load Removal Based on the Entire Project

County =	Travis	
Total project area included in plan * =	346.82	acres
Predevelopment impervious area within the limits of the plan* =	138.58	acres
Total post-development impervious area within the limits of the plan* =	220.74	acres
Total post-development impervious cover fraction * =	0.64	
P =	32	inches

$L_{M\ TOTAL\ PROJECT}$ = **246435** lbs.

* **The values entered in these fields should be for the total project area.**

Number of drainage basins / outfalls areas leaving the plan area = 19

2. Drainage Basin Parameters (This information should be provided for each basin):

Drainage Basin/Outfall Area No. = Pond H

Total drainage basin/outfall area =	7.45	acres
Predevelopment impervious area within drainage basin/outfall area =	2.15	acres
Post-development impervious area within drainage basin/outfall area =	5.96	acres
Post-development impervious fraction within drainage basin/outfall area =	0.80	
$L_{M\ THIS\ BASIN}$ =	3313	lbs.

3. Indicate the proposed BMP Code for this basin.

Proposed BMP = Sand Filter
Removal efficiency = 89 percent

4. Calculate Maximum TSS Load Removed (L_R) for this Drainage Basin by the selected BMP Type.

RG-348 Page 3-33 Equation 3.7: $L_R = (\text{BMP efficiency}) \times P \times (A_I \times 34.6 + A_P \times 0.54)$

where:

A_C = Total On-Site drainage area in the BMP catchment area
A_I = Impervious area proposed in the BMP catchment area
A_P = Pervious area remaining in the BMP catchment area
L_R = TSS Load removed from this catchment area by the proposed BMP

A_C =	7.45	acres
A_I =	5.96	acres
A_P =	1.49	acres
L_R =	5896	lbs

5. Calculate Fraction of Annual Runoff to Treat the drainage basin / outfall area

Desired $L_{M\ THIS\ BASIN}$ =	**5325**	lbs.
F =	**0.90**	

6. Calculate Capture Volume required by the BMP Type for this drainage basin / outfall area. Calculations from RG-348

Rainfall Depth =	**1.70**	inches
Post Development Runoff Coefficient =	**0.62**	
On-site Water Quality Volume =	**28680**	cubic feet

Calculations from RG-348 Pages 3-36 to 3-37

Off-site area draining to BMP =	**29.04**	acres
Off-site Impervious cover draining to BMP =	**2.90**	acres
Impervious fraction of off-site area =	**0.10**	
Off-site Runoff Coefficient =	**0.13**	
Off-site Water Quality Volume =	**22404**	cubic feet
Storage for Sediment =	**10217**	
Total Capture Volume (required water quality volume(s) x 1.20) =	**61301**	cubic feet

The following sections are used to calculate the required water quality volume(s) for the selected BMP.
The values for BMP Types not selected in cell C45 will show NA.

9. Filter area for Sand Filters Designed as Required in RG-348 Pages 3-58 to 3-63

9A. Full Sedimentation and Filtration System

Water Quality Volume for sedimentation basin =	**61301**	cubic feet	
Minimum filter basin area =	**1593**	square feet	
Maximum sedimentation basin area =	**14340**	square feet	**For minimum water depth of 2 feet**
Minimum sedimentation basin area =	**3585**	square feet	**For maximum water depth of 8 feet**

9B. Partial Sedimentation and Filtration System

Water Quality Volume for combined basins =	**61301**	cubic feet	
Minimum filter basin area =	**2868**	square feet	
Maximum sedimentation basin area =	**11472**	square feet	**For minimum water depth of 2 feet**
Minimum sedimentation basin area =	**717**	square feet	**For maximum water depth of 8 feet**

Texas Commission on Environmental Quality

TSS Removal Calculations 04-20-2009

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Date Prepared: 10/29/2019

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1. The Required Load Reduction for the total project: Calculations from RG-348 Pages 3-27 to 3-30

Page 3-29 Equation 3.3: $L_M = 27.2(A_N \times P)$

where:

$L_{M\ TOTAL\ PROJECT}$ = Required TSS removal resulting from the proposed development = 80% of increased load
A_N = Net increase in impervious area for the project
P = Average annual precipitation, inches

Site Data: Determine Required Load Removal Based on the Entire Project

County =	Travis	
Total project area included in plan * =	346.82	acres
Predevelopment impervious area within the limits of the plan* =	138.58	acres
Total post-development impervious area within the limits of the plan* =	220.74	acres
Total post-development impervious cover fraction * =	0.64	
P =	32	inches

$L_{M\ TOTAL\ PROJECT}$ = **246435** lbs.

* **The values entered in these fields should be for the total project area.**

Number of drainage basins / outfalls areas leaving the plan area = 19

2. Drainage Basin Parameters (This information should be provided for each basin):

Drainage Basin/Outfall Area No. = Pond K

Total drainage basin/outfall area =	5.57	acres
Predevelopment impervious area within drainage basin/outfall area =	1.94	acres
Post-development impervious area within drainage basin/outfall area =	2.79	acres
Post-development impervious fraction within drainage basin/outfall area =	0.50	
$L_{M\ THIS\ BASIN}$ =	735	lbs.

3. Indicate the proposed BMP Code for this basin.

Proposed BMP = Bioretention
Removal efficiency = 89 percent

4. Calculate Maximum TSS Load Removed (L_R) for this Drainage Basin by the selected BMP Type.

RG-348 Page 3-33 Equation 3.7: $L_R = (\text{BMP efficiency}) \times P \times (A_I \times 34.6 + A_P \times 0.54)$

where:

A_C = Total On-Site drainage area in the BMP catchment area
A_I = Impervious area proposed in the BMP catchment area
A_P = Pervious area remaining in the BMP catchment area
L_R = TSS Load removed from this catchment area by the proposed BMP

A_C =	5.57	acres
A_I =	2.79	acres
A_P =	2.79	acres
L_R =	2789	lbs

5. Calculate Fraction of Annual Runoff to Treat the drainage basin / outfall area

Desired $L_{M\ THIS\ BASIN}$ =	**2715**	lbs.
F =	**0.97**	

6. Calculate Capture Volume required by the BMP Type for this drainage basin / outfall area. Calculations from RG-348

Rainfall Depth =	**3.00**	inches
Post Development Runoff Coefficient =	**0.36**	
On-site Water Quality Volume =	**21699**	cubic feet

Calculations from RG-348 Pages 3-36 to 3-37

Off-site area draining to BMP =	**0.00**	acres
Off-site Impervious cover draining to BMP =	**0.00**	acres
Impervious fraction of off-site area =	**0**	
Off-site Runoff Coefficient =	**0.00**	
Off-site Water Quality Volume =	**0**	cubic feet
Storage for Sediment =	**4340**	
Total Capture Volume (required water quality volume(s) x 1.20) =	**26039**	cubic feet

10. Bioretention System Designed as Required in RG-348 Pages 3-63 to 3-65

Required Water Quality Volume for Bioretention Basin =	**26039**	cubic feet

Texas Commission on Environmental Quality

TSS Removal Calculations 04-20-2009

Project Name: 290 West Oak Hill
Date Prepared: 10/29/2019

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1. The Required Load Reduction for the total project: Calculations from RG-348 Pages 3-27 to 3-30

Page 3-29 Equation 3.3: $L_M = 27.2(A_N \times P)$

where:

$L_{M\ TOTAL\ PROJECT}$ = Required TSS removal resulting from the proposed development = 80% of increased load
A_N = Net increase in impervious area for the project
P = Average annual precipitation, inches

Site Data: Determine Required Load Removal Based on the Entire Project

County =	Travis	
Total project area included in plan * =	346.82	acres
Predevelopment impervious area within the limits of the plan* =	138.58	acres
Total post-development impervious area within the limits of the plan* =	220.74	acres
Total post-development impervious cover fraction * =	0.64	
P =	32	inches

$L_{M\ TOTAL\ PROJECT}$ = **246435** lbs.

* **The values entered in these fields should be for the total project area.**

Number of drainage basins / outfalls areas leaving the plan area = 19

2. Drainage Basin Parameters (This information should be provided for each basin):

Drainage Basin/Outfall Area No. = Pond L

Total drainage basin/outfall area =	2.96	acres
Predevelopment impervious area within drainage basin/outfall area =	1.28	acres
Post-development impervious area within drainage basin/outfall area =	2.64	acres
Post-development impervious fraction within drainage basin/outfall area =	0.89	
$L_{M\ THIS\ BASIN}$ =	1185	lbs.

3. Indicate the proposed BMP Code for this basin.

Proposed BMP = Sand Filter
Removal efficiency = 89 percent

4. Calculate Maximum TSS Load Removed (L_R) for this Drainage Basin by the selected BMP Type.

RG-348 Page 3-33 Equation 3.7: $L_R = (\text{BMP efficiency}) \times P \times (A_I \times 34.6 + A_P \times 0.54)$

where:

A_C = Total On-Site drainage area in the BMP catchment area
A_I = Impervious area proposed in the BMP catchment area
A_P = Pervious area remaining in the BMP catchment area
L_R = TSS Load removed from this catchment area by the proposed BMP

A_C =	2.96	acres
A_I =	2.64	acres
A_P =	0.32	acres
L_R =	2607	lbs

5. Calculate Fraction of Annual Runoff to Treat the drainage basin / outfall area

Desired $L_{M\ THIS\ BASIN}$ = 2379 lbs.

F = **0.91**

6. Calculate Capture Volume required by the BMP Type for this drainage basin / outfall area. Calculations from RG-348

Rainfall Depth =	1.80	inches
Post Development Runoff Coefficient =	0.73	
On-site Water Quality Volume =	14087	cubic feet

Calculations from RG-348 Pages 3-36 to 3-37

Off-site area draining to BMP =	0.00	acres
Off-site Impervious cover draining to BMP =	0.00	acres
Impervious fraction of off-site area =	0	
Off-site Runoff Coefficient =	0.00	
Off-site Water Quality Volume =	0	cubic feet
Storage for Sediment =	2817	
Total Capture Volume (required water quality volume(s) x 1.20) =	16904	cubic feet

The following sections are used to calculate the required water quality volume(s) for the selected BMP.
The values for BMP Types not selected in cell C45 will show NA.

9. Filter area for Sand Filters Designed as Required in RG-348 Pages 3-58 to 3-63

9A. Full Sedimentation and Filtration System

Water Quality Volume for sedimentation basin =	16904	cubic feet	
Minimum filter basin area =	783	square feet	
Maximum sedimentation basin area =	7043	square feet	For minimum water depth of 2 feet
Minimum sedimentation basin area =	1761	square feet	For maximum water depth of 8 feet

9B. Partial Sedimentation and Filtration System

Water Quality Volume for combined basins =	16904	cubic feet	
Minimum filter basin area =	1409	square feet	
Maximum sedimentation basin area =	5635	square feet	For minimum water depth of 2 feet
Minimum sedimentation basin area =	352	square feet	For maximum water depth of 8 feet

Texas Commission on Environmental Quality

TSS Removal Calculations 04-20-2009

Project Name: 290 West Oak Hill
Date Prepared: 10/29/2019

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1. The Required Load Reduction for the total project: Calculations from RG-348 Pages 3-27 to 3-30

Page 3-29 Equation 3.3: $L_M = 27.2(A_N \times P)$

where:

$L_{M\ TOTAL\ PROJECT}$ = Required TSS removal resulting from the proposed development = 80% of increased load
A_N = Net increase in impervious area for the project
P = Average annual precipitation, inches

Site Data: Determine Required Load Removal Based on the Entire Project

County =	Travis	
Total project area included in plan * =	346.82	acres
Predevelopment impervious area within the limits of the plan* =	138.58	acres
Total post-development impervious area within the limits of the plan* =	220.74	acres
Total post-development impervious cover fraction * =	0.64	
P =	32	inches

$L_{M\ TOTAL\ PROJECT}$ = **246435** lbs.

* The values entered in these fields should be for the total project area.

Number of drainage basins / outfalls areas leaving the plan area = 19

2. Drainage Basin Parameters (This information should be provided for each basin):

Drainage Basin/Outfall Area No. = Pond M

Total drainage basin/outfall area =	0.97	acres
Predevelopment impervious area within drainage basin/outfall area =	0.48	acres
Post-development impervious area within drainage basin/outfall area =	0.86	acres
Post-development impervious fraction within drainage basin/outfall area =	0.88	
$L_{M\ THIS\ BASIN}$ =	334	lbs.

3. Indicate the proposed BMP Code for this basin.

Proposed BMP = Sand Filter
Removal efficiency = 89 percent

4. Calculate Maximum TSS Load Removed (L_R) for this Drainage Basin by the selected BMP Type.

RG-348 Page 3-33 Equation 3.7: $L_R = (\text{BMP efficiency}) \times P \times (A_I \times 34.6 + A_P \times 0.54)$

where:

A_C = Total On-Site drainage area in the BMP catchment area
A_I = Impervious area proposed in the BMP catchment area
A_P = Pervious area remaining in the BMP catchment area
L_R = TSS Load removed from this catchment area by the proposed BMP

A_C =	0.97	acres
A_I =	0.86	acres
A_P =	0.11	acres
L_R =	848	lbs

5. Calculate Fraction of Annual Runoff to Treat the drainage basin / outfall area

Desired $L_{M\ THIS\ BASIN}$ = 830 lbs.

F = **0.98**

6. Calculate Capture Volume required by the BMP Type for this drainage basin / outfall area. Calculations from RG-348

Rainfall Depth =	3.33	inches
Post Development Runoff Coefficient =	0.72	
On-site Water Quality Volume =	8473	cubic feet

Calculations from RG-348 Pages 3-36 to 3-37

Off-site area draining to BMP =	0.00	acres
Off-site Impervious cover draining to BMP =	0.00	acres
Impervious fraction of off-site area =	0	
Off-site Runoff Coefficient =	0.00	
Off-site Water Quality Volume =	0	cubic feet
Storage for Sediment =	1695	
Total Capture Volume (required water quality volume(s) x 1.20) =	10167	cubic feet

The following sections are used to calculate the required water quality volume(s) for the selected BMP.
The values for BMP Types not selected in cell C45 will show NA.

9. Filter area for Sand Filters Designed as Required in RG-348 Pages 3-58 to 3-63

9A. Full Sedimentation and Filtration System

Water Quality Volume for sedimentation basin =	10167	cubic feet	
Minimum filter basin area =	471	square feet	
Maximum sedimentation basin area =	4236	square feet	For minimum water depth of 2 feet
Minimum sedimentation basin area =	1059	square feet	For maximum water depth of 8 feet

9B. Partial Sedimentation and Filtration System

Water Quality Volume for combined basins =	10167	cubic feet	
Minimum filter basin area =	847	square feet	
Maximum sedimentation basin area =	3389	square feet	For minimum water depth of 2 feet
Minimum sedimentation basin area =	212	square feet	For maximum water depth of 8 feet

Texas Commission on Environmental Quality

TSS Removal Calculations 04-20-2009

Project Name: 290 West Oak Hill
Date Prepared: 10/29/2019

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1. The Required Load Reduction for the total project: Calculations from RG-348 Pages 3-27 to 3-30

Page 3-29 Equation 3.3: $L_M = 27.2(A_N \times P)$

where:

$L_{M\ TOTAL\ PROJECT}$ = Required TSS removal resulting from the proposed development = 80% of increased load
A_N = Net increase in impervious area for the project
P = Average annual precipitation, inches

Site Data: Determine Required Load Removal Based on the Entire Project

County =	Travis	
Total project area included in plan * =	346.82	acres
Predevelopment impervious area within the limits of the plan* =	138.58	acres
Total post-development impervious area within the limits of the plan* =	220.74	acres
Total post-development impervious cover fraction * =	0.64	
P =	32	inches

$L_{M\ TOTAL\ PROJECT}$ = **246435** lbs.

* **The values entered in these fields should be for the total project area.**

Number of drainage basins / outfalls areas leaving the plan area = 19

2. Drainage Basin Parameters (This information should be provided for each basin):

Drainage Basin/Outfall Area No. = Pond N

Total drainage basin/outfall area =	1.43	acres
Predevelopment impervious area within drainage basin/outfall area =	0.76	acres
Post-development impervious area within drainage basin/outfall area =	1.28	acres
Post-development impervious fraction within drainage basin/outfall area =	0.90	
$L_{M\ THIS\ BASIN}$ =	460	lbs.

3. Indicate the proposed BMP Code for this basin.

Proposed BMP = Sand Filter
Removal efficiency = 89 percent

4. Calculate Maximum TSS Load Removed (L_R) for this Drainage Basin by the selected BMP Type.

RG-348 Page 3-33 Equation 3.7: $L_R = (\text{BMP efficiency}) \times P \times (A_I \times 34.6 + A_P \times 0.54)$

where:

A_C = Total On-Site drainage area in the BMP catchment area
A_I = Impervious area proposed in the BMP catchment area
A_P = Pervious area remaining in the BMP catchment area
L_R = TSS Load removed from this catchment area by the proposed BMP

A_C =	1.43	acres
A_I =	1.28	acres
A_P =	0.15	acres
L_R =	1267	lbs

5. Calculate Fraction of Annual Runoff to Treat the drainage basin / outfall area

Desired $L_{M\ THIS\ BASIN}$ = 1133 lbs.

F = **0.89**

6. Calculate Capture Volume required by the BMP Type for this drainage basin / outfall area. Calculations from RG-348

Rainfall Depth =	1.60	inches
Post Development Runoff Coefficient =	0.73	
On-site Water Quality Volume =	6086	cubic feet

Calculations from RG-348 Pages 3-36 to 3-37

Off-site area draining to BMP =	0.00	acres
Off-site Impervious cover draining to BMP =	0.00	acres
Impervious fraction of off-site area =	0	
Off-site Runoff Coefficient =	0.00	
Off-site Water Quality Volume =	0	cubic feet
Storage for Sediment =	1217	
Total Capture Volume (required water quality volume(s) x 1.20) =	7303	cubic feet

The following sections are used to calculate the required water quality volume(s) for the selected BMP.
The values for BMP Types not selected in cell C45 will show NA.

9. Filter area for Sand Filters Designed as Required in RG-348 Pages 3-58 to 3-63

9A. Full Sedimentation and Filtration System

Water Quality Volume for sedimentation basin =	7303	cubic feet	
Minimum filter basin area =	338	square feet	
Maximum sedimentation basin area =	3043	square feet	For minimum water depth of 2 feet
Minimum sedimentation basin area =	761	square feet	For maximum water depth of 8 feet

9B. Partial Sedimentation and Filtration System

Water Quality Volume for combined basins =	7303	cubic feet	
Minimum filter basin area =	609	square feet	
Maximum sedimentation basin area =	2434	square feet	For minimum water depth of 2 feet
Minimum sedimentation basin area =	152	square feet	For maximum water depth of 8 feet

Texas Commission on Environmental Quality

TSS Removal Calculations 04-20-2009

Project Name: 290 West Oak Hill
Date Prepared: 10/29/2019

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1. The Required Load Reduction for the total project: Calculations from RG-348 Pages 3-27 to 3-30

Page 3-29 Equation 3.3: $L_M = 27.2(A_N \times P)$

where:

$L_{M\ TOTAL\ PROJECT}$ = Required TSS removal resulting from the proposed development = 80% of increased load
A_N = Net increase in impervious area for the project
P = Average annual precipitation, inches

Site Data: Determine Required Load Removal Based on the Entire Project

County =	Travis	
Total project area included in plan * =	346.82	acres
Predevelopment impervious area within the limits of the plan* =	138.58	acres
Total post-development impervious area within the limits of the plan* =	220.74	acres
Total post-development impervious cover fraction * =	0.64	
P =	32	inches

$L_{M\ TOTAL\ PROJECT}$ = **246435** lbs.

* **The values entered in these fields should be for the total project area.**

Number of drainage basins / outfalls areas leaving the plan area = 19

2. Drainage Basin Parameters (This information should be provided for each basin):

Drainage Basin/Outfall Area No. = Pond O Sand Filter

Total drainage basin/outfall area =	5.87	acres
Predevelopment impervious area within drainage basin/outfall area =	3.58	acres
Post-development impervious area within drainage basin/outfall area =	5.07	acres
Post-development impervious fraction within drainage basin/outfall area =	0.86	
$L_{M\ THIS\ BASIN}$ =	1299	lbs.

3. Indicate the proposed BMP Code for this basin.

Proposed BMP = Sand Filter
Removal efficiency = 89 percent

4. Calculate Maximum TSS Load Removed (L_R) for this Drainage Basin by the selected BMP Type.

RG-348 Page 3-33 Equation 3.7: $L_R = (\text{BMP efficiency}) \times P \times (A_I \times 34.6 + A_P \times 0.54)$

where:

A_C = Total On-Site drainage area in the BMP catchment area
A_I = Impervious area proposed in the BMP catchment area
A_P = Pervious area remaining in the BMP catchment area
L_R = TSS Load removed from this catchment area by the proposed BMP

A_C =	5.87	acres
A_I =	5.07	acres
A_P =	0.80	acres
L_R =	5009	lbs

5. Calculate Fraction of Annual Runoff to Treat the drainage basin / outfall area

Desired $L_{M\ THIS\ BASIN}$ = 3550 lbs. L_M for pond sizing

F = **0.71**

6. Calculate Capture Volume required by the BMP Type for this drainage basin / outfall area. Calculations from RG-348

Rainfall Depth =	0.80	inches
Post Development Runoff Coefficient =	0.70	
On-site Water Quality Volume =	12086	cubic feet

Calculations from RG-348 Pages 3-36 to 3-37

Off-site area draining to BMP =	**22.45**	acres
Off-site Impervious cover draining to BMP =	**8.53**	acres
Impervious fraction of off-site area =	**0.38**	
Off-site Runoff Coefficient =	**0.30**	
Off-site Water Quality Volume =	**19484**	cubic feet
Storage for Sediment =	**6314**	
Total Capture Volume (required water quality volume(s) x 1.20) =	**37883**	cubic feet

The following sections are used to calculate the required water quality volume(s) for the selected BMP.
The values for BMP Types not selected in cell C45 will show NA.

9. Filter area for Sand Filters Designed as Required in RG-348 Pages 3-58 to 3-63

9A. Full Sedimentation and Filtration System

Water Quality Volume for sedimentation basin =	**37883**	cubic feet	
Minimum filter basin area =	**671**	square feet	
Maximum sedimentation basin area =	**6043**	square feet	**For minimum water depth of 2 feet**
Minimum sedimentation basin area =	**1511**	square feet	**For maximum water depth of 8 feet**

9B. Partial Sedimentation and Filtration System

Water Quality Volume for combined basins =	**37883**	cubic feet	
Minimum filter basin area =	**1209**	square feet	
Maximum sedimentation basin area =	**4834**	square feet	**For minimum water depth of 2 feet**
Minimum sedimentation basin area =	**302**	square feet	**For maximum water depth of 8 feet**

Texas Commission on Environmental Quality

TSS Removal Calculations 04-20-2009

Project Name: 290 West Oak Hill
Date Prepared: 10/29/2019

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1. The Required Load Reduction for the total project: Calculations from RG-348 Pages 3-27 to 3-30

Page 3-29 Equation 3.3: $L_M = 27.2(A_N \times P)$

where:

$L_{M\ TOTAL\ PROJECT}$ = Required TSS removal resulting from the proposed development = 80% of increased load
A_N = Net increase in impervious area for the project
P = Average annual precipitation, inches

Site Data: Determine Required Load Removal Based on the Entire Project

County =	Travis	
Total project area included in plan * =	346.82	acres
Predevelopment impervious area within the limits of the plan* =	138.58	acres
Total post-development impervious area within the limits of the plan* =	220.74	acres
Total post-development impervious cover fraction * =	0.64	
P =	32	inches

$L_{M\ TOTAL\ PROJECT}$ = **246435** lbs.

* **The values entered in these fields should be for the total project area.**

Number of drainage basins / outfalls areas leaving the plan area = 19

2. Drainage Basin Parameters (This information should be provided for each basin):

Drainage Basin/Outfall Area No. = Pond O Sand Filter

Total drainage basin/outfall area =	5.87	acres
Predevelopment impervious area within drainage basin/outfall area =	3.58	acres
Post-development impervious area within drainage basin/outfall area =	2.82	acres
Post-development impervious fraction within drainage basin/outfall area =	0.48	
$L_{M\ THIS\ BASIN}$ =	-660	lbs.

3. Indicate the proposed BMP Code for this basin.

Proposed BMP = Sand Filter
Removal efficiency = 89 percent

4. Calculate Maximum TSS Load Removed (L_R) for this Drainage Basin by the selected BMP Type.

RG-348 Page 3-33 Equation 3.7: $L_R = (\text{BMP efficiency}) \times P \times (A_I \times 34.6 + A_P \times 0.54)$

where:

A_C = Total On-Site drainage area in the BMP catchment area
A_I = Impervious area proposed in the BMP catchment area
A_P = Pervious area remaining in the BMP catchment area
L_R = TSS Load removed from this catchment area by the proposed BMP

A_C =	5.87	acres
A_I =	2.82	acres
A_P =	3.05	acres
L_R =	2826	lbs

5. Calculate Fraction of Annual Runoff to Treat the drainage basin / outfall area

Desired $L_{M\ THIS\ BASIN}$ = 2003 lbs. L_M provided by Pond Only

F = **0.71**

6. Calculate Capture Volume required by the BMP Type for this drainage basin / outfall area. Calculations from RG-348

Texas Commission on Environmental Quality

TSS Removal Calculations 04-20-2009

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1. The Required Load Reduction for the total project: Calculations from RG-348 Pages 3-27 to 3-30

Page 3-29 Equation 3.3: $L_M = 27.2(A_N \times P)$

where:

$L_{M\ TOTAL\ PROJECT}$ = Required TSS removal resulting from the proposed development = 80% of increased load
A_N = Net increase in impervious area for the project
P = Average annual precipitation, inches

Site Data: Determine Required Load Removal Based on the Entire Project

County =	Travis	
Total project area included in plan * =	346.82	acres
Predevelopment impervious area within the limits of the plan* =	138.58	acres
Total post-development impervious area within the limits of the plan* =	220.74	acres
Total post-development impervious cover fraction * =	0.64	
P =	32	inches
$L_{M\ TOTAL\ PROJECT}$ =	246435	lbs.

* The values entered in these fields should be for the total project area.

Number of drainage basins / outfalls areas leaving the plan area = 19

2. Drainage Basin Parameters (This information should be provided for each basin):

Drainage Basin/Outfall Area No. = PFC Pond O VFS/Sand Filter

Total drainage basin/outfall area =	2.25	acres
Predevelopment impervious area within drainage basin/outfall area =	0.00	acres
Post-development impervious area within drainage basin/outfall area =	2.25	acres
Post-development impervious fraction within drainage basin/outfall area =	1.00	
$L_{M\ THIS\ BASIN}$ =	1959	lbs.

3. Indicate the proposed BMP Code for this basin.

Proposed BMP = Permeable Friction Course
Removal efficiency = 90 percent

4. Calculate Maximum TSS Load Removed (L_R) for this Drainage Basin by the selected BMP Type.

RG-348 Page 3-33 Equation 3.7: $L_R = (\text{BMP efficiency}) \times P \times (A_I \times 34.6 + A_P \times 0.54)$

where:

A_C = Total On-Site drainage area in the BMP catchment area
A_I = Impervious area proposed in the BMP catchment area
A_P = Pervious area remaining in the BMP catchment area
L_R = TSS Load removed from this catchment area by the proposed BMP

A_C =	2.25	acres
A_I =	2.25	acres
A_P =	0.00	acres
L_R =	2242	lbs

19. BMPs Installed in a Series Designed as Required in RG-348 Pages 3-32

Michael E. Barrett, Ph.D.. P.E. recommended that the coefficient for E_2 be changed from 0.5 to 0.65 on May 3, 2006

$E_{TOT} = [1 - ((1 - E_1) X (1 - 0.65E_2) x (1 - 0.25E_3))] X 100$ =	95.79	percent	NET EFFICIENCY OF THE BMPs IN THE SERIES
EFFICIENCY OF FIRST BMP IN THE SERIES = E_1 =	90.00	percent	PFC
EFFICIENCY OF THE SECOND BMP IN THE SERIES = E_2 =	89.00	percent	Sand Filter
EFFICIENCY OF THE THIRD BMP IN THE SERIES = E_3 =	0.00	percent	

THEREFORE, THE NET LOAD REMOVAL WOULD BE:
(A_I AND A_P VALUES ARE FROM SECTION 3 ABOVE)

$L_R = E_{TOT} X P X (A_I X 34.6 X A_P X0.54)$ = 2386.62 lbs

Texas Commission on Environmental Quality

TSS Removal Calculations 04-20-2009

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1. The Required Load Reduction for the total project: Calculations from RG-348 Pages 3-27 to 3-30

Page 3-29 Equation 3.3: $L_M = 27.2(A_N \times P)$

where:

$L_{M\ TOTAL\ PROJECT}$ = Required TSS removal resulting from the proposed development = 80% of increased load
A_N = Net increase in impervious area for the project
P = Average annual precipitation, inches

Site Data: Determine Required Load Removal Based on the Entire Project

County =	Travis	
Total project area included in plan * =	346.82	acres
Predevelopment impervious area within the limits of the plan* =	138.58	acres
Total post-development impervious area within the limits of the plan* =	220.74	acres
Total post-development impervious cover fraction * =	0.64	
P =	32	inches

$L_{M\ TOTAL\ PROJECT}$ = **246435** lbs.

* **The values entered in these fields should be for the total project area.**

Number of drainage basins / outfalls areas leaving the plan area = 19

2. Drainage Basin Parameters (This information should be provided for each basin):

Drainage Basin/Outfall Area No. =	**Pond P**	**Bioretention**
Total drainage basin/outfall area =	1.80	acres
Predevelopment impervious area within drainage basin/outfall area =	0.95	acres
Post-development impervious area within drainage basin/outfall area =	1.05	acres
Post-development impervious fraction within drainage basin/outfall area =	0.58	
$L_{M\ THIS\ BASIN}$ =	86	lbs.

3. Indicate the proposed BMP Code for this basin.

Proposed BMP = Bioretention
Removal efficiency = 89 percent

4. Calculate Maximum TSS Load Removed (L_R) for this Drainage Basin by the selected BMP Type.

RG-348 Page 3-33 Equation 3.7: $L_R = (\text{BMP efficiency}) \times P \times (A_I \times 34.6 + A_P \times 0.54)$

where:

A_C = Total On-Site drainage area in the BMP catchment area
A_I = Impervious area proposed in the BMP catchment area
A_P = Pervious area remaining in the BMP catchment area
L_R = TSS Load removed from this catchment area by the proposed BMP

A_C =	1.80	acres
A_I =	1.05	acres
A_P =	0.75	acres
L_R =	1048	lbs

5. Calculate Fraction of Annual Runoff to Treat the drainage basin / outfall area

Desired $L_{M\ THIS\ BASIN}$ =	**372**	lbs.	**L_M for pond sizing**
F =	**0.35**		

6. Calculate Capture Volume required by the BMP Type for this drainage basin / outfall area. Calculations from RG-348

Rainfall Depth =	**0.23**	inches
Post Development Runoff Coefficient =	**0.41**	
On-site Water Quality Volume =	**624**	cubic feet

Calculations from RG-348 Pages 3-36 to 3-37

Off-site area draining to BMP =	**20.02**	acres
Off-site Impervious cover draining to BMP =	**7.61**	acres
Impervious fraction of off-site area =	**0.38**	
Off-site Runoff Coefficient =	**0.30**	
Off-site Water Quality Volume =	**5041**	cubic feet
Storage for Sediment =	**1133**	
Total Capture Volume (required water quality volume(s) x 1.20) =	**6798**	cubic feet

The following sections are used to calculate the required water quality volume(s) for the selected BMP.
The values for BMP Types not selected in cell C45 will show NA.

10. Bioretention System Designed as Required in RG-348 Pages 3-63 to 3-65

Required Water Quality Volume for Bioretention Basin =	**6798**	cubic feet

Texas Commission on Environmental Quality

TSS Removal Calculations 04-20-2009

Project Name: 290 West Oak Hill
Date Prepared: 10/29/2019

Additional information is provided for cells with a red triangle in the upper right corner. Place the cursor over the cell.
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Characters shown in red are data entry fields.
Characters shown in black (Bold) are calculated fields. Changes to these fields will remove the equations used in the spreadsheet.

1. The Required Load Reduction for the total project: Calculations from RG-348 Pages 3-27 to 3-30

Page 3-29 Equation 3.3: $L_M = 27.2(A_N \times P)$

where:

$L_{M\ TOTAL\ PROJECT}$ = Required TSS removal resulting from the proposed development = 80% of increased load
A_N = Net increase in impervious area for the project
P = Average annual precipitation, inches

Site Data: Determine Required Load Removal Based on the Entire Project

County =	Travis	
Total project area included in plan * =	346.82	acres
Predevelopment impervious area within the limits of the plan* =	138.58	acres
Total post-development impervious area within the limits of the plan* =	220.74	acres
Total post-development impervious cover fraction * =	0.64	
P =	32	inches

$L_{M\ TOTAL\ PROJECT}$ = **246435** lbs.

* **The values entered in these fields should be for the total project area.**

Number of drainage basins / outfalls areas leaving the plan area = 19

2. Drainage Basin Parameters (This information should be provided for each basin):

Drainage Basin/Outfall Area No. = Pond P Bioretention

Total drainage basin/outfall area =	1.80	acres
Predevelopment impervious area within drainage basin/outfall area =	0.95	acres
Post-development impervious area within drainage basin/outfall area =	0.32	acres
Post-development impervious fraction within drainage basin/outfall area =	0.18	
$L_{M\ THIS\ BASIN}$ =	-548	lbs.

3. Indicate the proposed BMP Code for this basin.

Proposed BMP = Bioretention
Removal efficiency = 89 percent

4. Calculate Maximum TSS Load Removed (L_R) for this Drainage Basin by the selected BMP Type.

RG-348 Page 3-33 Equation 3.7: $L_R = (\text{BMP efficiency}) \times P \times (A_I \times 34.6 + A_P \times 0.54)$

where:

A_C = Total On-Site drainage area in the BMP catchment area
A_I = Impervious area proposed in the BMP catchment area
A_P = Pervious area remaining in the BMP catchment area
L_R = TSS Load removed from this catchment area by the proposed BMP

A_C =	1.80	acres
A_I =	0.32	acres
A_P =	1.48	acres
L_R =	341	lbs

5. Calculate Fraction of Annual Runoff to Treat the drainage basin / outfall area

Desired $L_{M\ THIS\ BASIN}$ = **121** lbs. **L_M provided by Pond Only**

F = **0.35**

6. Calculate Capture Volume required by the BMP Type for this drainage basin / outfall area. Calculations from RG-348

Texas Commission on Environmental Quality

TSS Removal Calculations 04-20-2009

Project Name: 290 West Oak Hill
Date Prepared: 10/29/2019

Additional information is provided for cells with a red triangle in the upper right corner. Place the cursor over the cell.
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1. The Required Load Reduction for the total project: Calculations from RG-348 Pages 3-27 to 3-30

Page 3-29 Equation 3.3: $L_M = 27.2(A_N \times P)$

where:

$L_{M\ TOTAL\ PROJECT}$ = Required TSS removal resulting from the proposed development = 80% of increased load
A_N = Net increase in impervious area for the project
P = Average annual precipitation, inches

Site Data: Determine Required Load Removal Based on the Entire Project

County =	Travis	
Total project area included in plan * =	346.82	acres
Predevelopment impervious area within the limits of the plan* =	138.58	acres
Total post-development impervious area within the limits of the plan* =	220.74	acres
Total post-development impervious cover fraction * =	0.64	
P =	32	inches
$L_{M\ TOTAL\ PROJECT}$ =	246435	lbs.

* The values entered in these fields should be for the total project area.

Number of drainage basins / outfalls areas leaving the plan area = 19

2. Drainage Basin Parameters (This information should be provided for each basin):

Drainage Basin/Outfall Area No. = PFC Pond P VFS/Bioretention

Total drainage basin/outfall area =	0.73	acres
Predevelopment impervious area within drainage basin/outfall area =	0.00	acres
Post-development impervious area within drainage basin/outfall area =	0.73	acres
Post-development impervious fraction within drainage basin/outfall area =	1.00	
$L_{M\ THIS\ BASIN}$ =	634	lbs.

3. Indicate the proposed BMP Code for this basin.

Proposed BMP = Permeable Friction Course
Removal efficiency = 90 percent

4. Calculate Maximum TSS Load Removed (L_R) for this Drainage Basin by the selected BMP Type.

RG-348 Page 3-33 Equation 3.7: $L_R = (\text{BMP efficiency}) \times P \times (A_I \times 34.6 + A_P \times 0.54)$

where:

A_C = Total On-Site drainage area in the BMP catchment area
A_I = Impervious area proposed in the BMP catchment area
A_P = Pervious area remaining in the BMP catchment area
L_R = TSS Load removed from this catchment area by the proposed BMP

A_C =	0.73	acres
A_I =	0.73	acres
A_P =	0.00	acres
L_R =	726	lbs

19. BMPs Installed in a Series Designed as Required in RG-348 Pages 3-32

Michael E. Barrett, Ph.D.. P.E. recommended that the coefficient for E_2 be changed from 0.5 to 0.65 on May 3, 2006

$E_{TOT} = [1 - ((1 - E_1) X (1 - 0.65E_2) x (1 - 0.25E_3))] X 100$ =	95.79	percent	NET EFFICIENCY OF THE BMPs IN THE SERIES
EFFICIENCY OF FIRST BMP IN THE SERIES = E_1 =	90.00	percent	PFC
EFFICIENCY OF THE SECOND BMP IN THE SERIES = E_2 =	89.00	percent	Bioretention
EFFICIENCY OF THE THIRD BMP IN THE SERIES = E_3 =	0.00	percent	

THEREFORE, THE NET LOAD REMOVAL WOULD BE:
(A_I AND A_P VALUES ARE FROM SECTION 3 ABOVE)

$L_R = E_{TOT} X P X (A_I X 34.6 X A_P X0.54)$ = 773.02 lbs

Texas Commission on Environmental Quality

TSS Removal Calculations 04-20-2009

Project Name: 290 West Oak Hill
Date Prepared: 10/29/2019

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1. The Required Load Reduction for the total project: Calculations from RG-348 Pages 3-27 to 3-30

Page 3-29 Equation 3.3: $L_M = 27.2(A_N \times P)$

where:

$L_{M\ TOTAL\ PROJECT}$ = Required TSS removal resulting from the proposed development = 80% of increased load
A_N = Net increase in impervious area for the project
P = Average annual precipitation, inches

Site Data: Determine Required Load Removal Based on the Entire Project

County =	Travis	
Total project area included in plan * =	346.82	acres
Predevelopment impervious area within the limits of the plan* =	138.58	acres
Total post-development impervious area within the limits of the plan* =	220.74	acres
Total post-development impervious cover fraction * =	0.64	
P =	32	inches
$L_{M\ TOTAL\ PROJECT}$ =	246435	lbs.

* The values entered in these fields should be for the total project area.

Number of drainage basins / outfalls areas leaving the plan area = 19

2. Drainage Basin Parameters (This information should be provided for each basin):

Drainage Basin/Outfall Area No. =	Pond Q	Bioretention
Total drainage basin/outfall area =	4.16	acres
Predevelopment impervious area within drainage basin/outfall area =	2.51	acres
Post-development impervious area within drainage basin/outfall area =	2.85	acres
Post-development impervious fraction within drainage basin/outfall area =	0.69	
$L_{M\ THIS\ BASIN}$ =	293	lbs.

3. Indicate the proposed BMP Code for this basin.

Proposed BMP = Bioretention
Removal efficiency = 89 percent

4. Calculate Maximum TSS Load Removed (L_R) for this Drainage Basin by the selected BMP Type.

RG-348 Page 3-33 Equation 3.7: $L_R = (\text{BMP efficiency}) \times P \times (A_I \times 34.6 + A_P \times 0.54)$

where:

A_C = Total On-Site drainage area in the BMP catchment area
A_I = Impervious area proposed in the BMP catchment area
A_P = Pervious area remaining in the BMP catchment area
L_R = TSS Load removed from this catchment area by the proposed BMP

A_C =	4.16	acres
A_I =	2.85	acres
A_P =	1.31	acres
L_R =	2827	lbs

5. Calculate Fraction of Annual Runoff to Treat the drainage basin / outfall area

Desired $L_{M\ THIS\ BASIN}$ =	**2558**	lbs.	**L_M for pond sizing**
F =	**0.90**		

6. Calculate Capture Volume required by the BMP Type for this drainage basin / outfall area. Calculations from RG-348

Rainfall Depth =	**1.70**	inches
Post Development Runoff Coefficient =	**0.49**	
On-site Water Quality Volume =	**12601**	cubic feet

Calculations from RG-348 Pages 3-36 to 3-37

Off-site area draining to BMP =	**0.00**	acres
Off-site Impervious cover draining to BMP =	**0.00**	acres
Impervious fraction of off-site area =	**0**	
Off-site Runoff Coefficient =	**0.00**	
Off-site Water Quality Volume =	**0**	cubic feet
Storage for Sediment =	**2520**	
Total Capture Volume (required water quality volume(s) x 1.20) =	**15121**	cubic feet

The following sections are used to calculate the required water quality volume(s) for the selected BMP.
The values for BMP Types not selected in cell C45 will show NA.

10. Bioretention System Designed as Required in RG-348 Pages 3-63 to 3-65

Required Water Quality Volume for Bioretention Basin =	**15121**	cubic feet

Texas Commission on Environmental Quality

TSS Removal Calculations 04-20-2009

Project Name: 290 West Oak Hill
Date Prepared: 10/29/2019

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1. The Required Load Reduction for the total project: Calculations from RG-348 Pages 3-27 to 3-30

Page 3-29 Equation 3.3: $L_M = 27.2(A_N \times P)$

where:

$L_{M\ TOTAL\ PROJECT}$ = Required TSS removal resulting from the proposed development = 80% of increased load
A_N = Net increase in impervious area for the project
P = Average annual precipitation, inches

Site Data: Determine Required Load Removal Based on the Entire Project

County =	Travis	
Total project area included in plan * =	346.82	acres
Predevelopment impervious area within the limits of the plan* =	138.58	acres
Total post-development impervious area within the limits of the plan* =	220.74	acres
Total post-development impervious cover fraction * =	0.64	
P =	32	inches

$L_{M\ TOTAL\ PROJECT}$ = **246435** lbs.

* **The values entered in these fields should be for the total project area.**

Number of drainage basins / outfalls areas leaving the plan area = 19

2. Drainage Basin Parameters (This information should be provided for each basin):

Drainage Basin/Outfall Area No. =	**Pond Q**	**Bioretention**
Total drainage basin/outfall area =	4.16	acres
Predevelopment impervious area within drainage basin/outfall area =	2.51	acres
Post-development impervious area within drainage basin/outfall area =	0.81	acres
Post-development impervious fraction within drainage basin/outfall area =	0.19	
$L_{M\ THIS\ BASIN}$ =	-1483	lbs.

3. Indicate the proposed BMP Code for this basin.

Proposed BMP = Bioretention
Removal efficiency = 89 percent

4. Calculate Maximum TSS Load Removed (L_R) for this Drainage Basin by the selected BMP Type.

RG-348 Page 3-33 Equation 3.7: $L_R = (\text{BMP efficiency}) \times P \times (A_I \times 34.6 + A_P \times 0.54)$

where:

A_C = Total On-Site drainage area in the BMP catchment area
A_I = Impervious area proposed in the BMP catchment area
A_P = Pervious area remaining in the BMP catchment area
L_R = TSS Load removed from this catchment area by the proposed BMP

A_C =	4.16	acres
A_I =	0.81	acres
A_P =	3.35	acres
L_R =	847	lbs

5. Calculate Fraction of Annual Runoff to Treat the drainage basin / outfall area

Desired $L_{M\ THIS\ BASIN}$ = **767** lbs. **L_M provided by Pond Only**

F = **0.90**

6. Calculate Capture Volume required by the BMP Type for this drainage basin / outfall area. Calculations from RG-348

Texas Commission on Environmental Quality

TSS Removal Calculations 04-20-2009

Project Name: 290 West Oak Hill
Date Prepared: 10/29/2019

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1. The Required Load Reduction for the total project: Calculations from RG-348 Pages 3-27 to 3-30

Page 3-29 Equation 3.3: $L_M = 27.2(A_N \times P)$

where:

$L_{M\ TOTAL\ PROJECT}$ = Required TSS removal resulting from the proposed development = 80% of increased load
A_N = Net increase in impervious area for the project
P = Average annual precipitation, inches

Site Data: Determine Required Load Removal Based on the Entire Project

County =	Travis	
Total project area included in plan * =	346.82	acres
Predevelopment impervious area within the limits of the plan* =	138.58	acres
Total post-development impervious area within the limits of the plan* =	220.74	acres
Total post-development impervious cover fraction * =	0.64	
P =	32	inches
$L_{M\ TOTAL\ PROJECT}$ =	246435	lbs.

* The values entered in these fields should be for the total project area.

Number of drainage basins / outfalls areas leaving the plan area = 19

2. Drainage Basin Parameters (This information should be provided for each basin):

Drainage Basin/Outfall Area No. = PFC Pond Q VFS/Bioretention

Total drainage basin/outfall area =	2.04	acres
Predevelopment impervious area within drainage basin/outfall area =	0.00	acres
Post-development impervious area within drainage basin/outfall area =	2.04	acres
Post-development impervious fraction within drainage basin/outfall area =	1.00	
$L_{M\ THIS\ BASIN}$ =	1776	lbs.

3. Indicate the proposed BMP Code for this basin.

Proposed BMP = Permeable Friction Course
Removal efficiency = 90 percent

4. Calculate Maximum TSS Load Removed (L_R) for this Drainage Basin by the selected BMP Type.

RG-348 Page 3-33 Equation 3.7: $L_R = (\text{BMP efficiency}) \times P \times (A_I \times 34.6 + A_P \times 0.54)$

where:

A_C = Total On-Site drainage area in the BMP catchment area
A_I = Impervious area proposed in the BMP catchment area
A_P = Pervious area remaining in the BMP catchment area
L_R = TSS Load removed from this catchment area by the proposed BMP

A_C =	2.04	acres
A_I =	2.04	acres
A_P =	0.00	acres
L_R =	2033	lbs

19. BMPs Installed in a Series Designed as Required in RG-348 Pages 3-32

Michael E. Barrett, Ph.D.. P.E. recommended that the coefficient for E_2 be changed from 0.5 to 0.65 on May 3, 2006

$E_{TOT} = [1 - ((1 - E_1) X (1 - 0.65E_2) x (1 - 0.25E_3))] X 100$ =	95.79	percent	NET EFFICIENCY OF THE BMPs IN THE SERIES
EFFICIENCY OF FIRST BMP IN THE SERIES = E_1 =	90.00	percent	PFC
EFFICIENCY OF THE SECOND BMP IN THE SERIES = E_2 =	89.00	percent	Bioretention
EFFICIENCY OF THE THIRD BMP IN THE SERIES = E_3 =	0.00	percent	

THEREFORE, THE NET LOAD REMOVAL WOULD BE:
(A_I AND A_P VALUES ARE FROM SECTION 3 ABOVE)

$L_R = E_{TOT} X P X (A_I X 34.6 X A_P X0.54)$ = 2163.80 lbs

Texas Commission on Environmental Quality

TSS Removal Calculations 04-20-2009

Project Name: 290 West Oak Hill
Date Prepared: 10/29/2019

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1. The Required Load Reduction for the total project: Calculations from RG-348 Pages 3-27 to 3-30

Page 3-29 Equation 3.3: $L_M = 27.2(A_N \times P)$

where:

$L_{M\ TOTAL\ PROJECT}$ = Required TSS removal resulting from the proposed development = 80% of increased load
A_N = Net increase in impervious area for the project
P = Average annual precipitation, inches

Site Data: Determine Required Load Removal Based on the Entire Project

County =	Travis	
Total project area included in plan * =	346.82	acres
Predevelopment impervious area within the limits of the plan* =	138.58	acres
Total post-development impervious area within the limits of the plan* =	220.74	acres
Total post-development impervious cover fraction * =	0.64	
P =	32	inches
$L_{M\ TOTAL\ PROJECT}$ =	246435	lbs.

* **The values entered in these fields should be for the total project area.**

Number of drainage basins / outfalls areas leaving the plan area = 19

2. Drainage Basin Parameters (This information should be provided for each basin):

Drainage Basin/Outfall Area No. = SUP/SW

Total drainage basin/outfall area =	0.55	acres
Predevelopment impervious area within drainage basin/outfall area =	0.00	acres
Post-development impervious area within drainage basin/outfall area =	0.55	acres
Post-development impervious fraction within drainage basin/outfall area =	1.00	
$L_{M\ THIS\ BASIN}$ =	483	lbs.

3. Indicate the proposed BMP Code for this basin.

Proposed BMP = Vegetated Filter Strips
Removal efficiency = 85 percent

4. Calculate Maximum TSS Load Removed (L_R) for this Drainage Basin by the selected BMP Type.

RG-348 Page 3-33 Equation 3.7: $L_R = (\text{BMP efficiency}) \times P \times (A_I \times 34.6 + A_P \times 0.54)$

where:

A_C = Total On-Site drainage area in the BMP catchment area
A_I = Impervious area proposed in the BMP catchment area
A_P = Pervious area remaining in the BMP catchment area
L_R = TSS Load removed from this catchment area by the proposed BMP

A_C =	0.55	acres
A_I =	0.55	acres
A_P =	0.00	acres
L_R =	522	lbs

5. Calculate Fraction of Annual Runoff to Treat the drainage basin / outfall area

Desired $L_{M\ THIS\ BASIN}$ = 522 lbs.

F = 1.00

The following sections are used to calculate the required water quality volume(s) for the selected BMP.
The values for BMP Types not selected in cell C45 will show NA.

16. Vegetated Filter Strips Designed as Required in RG-348 Pages 3-55 to 3-57

There are no calculations required for determining the load or size of vegetative filter strips.
The 80% removal is provided when the contributing drainage area does not exceed 72 feet (direction of flow) and the sheet flow leaving the impervious cover is directed across 15 feet of engineered filter strips with maximum slope of 20% or across 50 feet of natural vegetation with a maximum slope of 10%. There can be a break in grade as long as no slope exceeds 20%.

If vegetative filter strips are proposed for an interim permanent BMP, they may be sized as described on Page 3-56 of RG-348.

Texas Commission on Environmental Quality

TSS Removal Calculations 04-20-2009

Project Name: 290 West Oak Hill
Date Prepared: 10/29/2019

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1. The Required Load Reduction for the total project: Calculations from RG-348 Pages 3-27 to 3-30

Page 3-29 Equation 3.3: $L_M = 27.2(A_N \times P)$

where:

$L_{M\ TOTAL\ PROJECT}$ = Required TSS removal resulting from the proposed development = 80% of increased load
A_N = Net increase in impervious area for the project
P = Average annual precipitation, inches

Site Data: Determine Required Load Removal Based on the Entire Project

County =	Travis	
Total project area included in plan * =	321.87	acres
Predevelopment impervious area within the limits of the plan* =	136.29	acres
Total post-development impervious area within the limits of the plan* =	209.94	acres
Total post-development impervious cover fraction * =	0.65	
P =	32	inches
$L_{M\ TOTAL\ PROJECT}$ =	234241	lbs.

* The values entered in these fields should be for the total project area.

Number of drainage basins / outfalls areas leaving the plan area = 19

2. Drainage Basin Parameters (This information should be provided for each basin):

Drainage Basin/Outfall Area No. = PFC

Total drainage basin/outfall area =	3.72	acres
Predevelopment impervious area within drainage basin/outfall area =	0.00	acres
Post-development impervious area within drainage basin/outfall area =	3.72	acres
Post-development impervious fraction within drainage basin/outfall area =	1.00	
$L_{M\ THIS\ BASIN}$ =	3239	lbs.

3. Indicate the proposed BMP Code for this basin.

Proposed BMP = Permeable Friction Course
Removal efficiency = 90 percent

4. Calculate Maximum TSS Load Removed (L_R) for this Drainage Basin by the selected BMP Type.

RG-348 Page 3-33 Equation 3.7: $L_R = (\text{BMP efficiency}) \times P \times (A_I \times 34.6 + A_P \times 0.54)$

where:

A_C = Total On-Site drainage area in the BMP catchment area
A_I = Impervious area proposed in the BMP catchment area
A_P = Pervious area remaining in the BMP catchment area
L_R = TSS Load removed from this catchment area by the proposed BMP

A_C =	3.72	acres
A_I =	3.72	acres
A_P =	0.00	acres
L_R =	3708	lbs

5. Calculate Fraction of Annual Runoff to Treat the drainage basin / outfall area

Desired $L_{M\ THIS\ BASIN}$ = 3708 lbs.

F = 1.00

6. Calculate Capture Volume required by the BMP Type for this drainage basin / outfall area. Calculations from RG-348

Rainfall Depth =	4.00	inches
Post Development Runoff Coefficient =	0.82	
On-site Water Quality Volume =	44104	cubic feet

Calculations from RG-348 Pages 3-36 to 3-37

Off-site area draining to BMP =	**0.00**	acres
Off-site Impervious cover draining to BMP =	**0.00**	acres
Impervious fraction of off-site area =	**0**	
Off-site Runoff Coefficient =	**0.00**	
Off-site Water Quality Volume =	**0**	cubic feet
Storage for Sediment =	**8821**	
Total Capture Volume (required water quality volume(s) x 1.20) =	**52925**	cubic feet

Texas Commission on Environmental Quality

TSS Removal Calculations 04-20-2009

Project Name: 290 West Oak Hill
Date Prepared: 10/29/2019

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1. The Required Load Reduction for the total project: Calculations from RG-348 Pages 3-27 to 3-30

Page 3-29 Equation 3.3: $L_M = 27.2(A_N \times P)$

where:

$L_{M\ TOTAL\ PROJECT}$ = Required TSS removal resulting from the proposed development = 80% of increased load
A_N = Net increase in impervious area for the project
P = Average annual precipitation, inches

Site Data: Determine Required Load Removal Based on the Entire Project

County =	Travis	
Total project area included in plan * =	346.82	acres
Predevelopment impervious area within the limits of the plan* =	138.58	acres
Total post-development impervious area within the limits of the plan* =	220.74	acres
Total post-development impervious cover fraction * =	0.64	
P =	32	inches
$L_{M\ TOTAL\ PROJECT}$ =	246435	lbs.

* The values entered in these fields should be for the total project area.

Number of drainage basins / outfalls areas leaving the plan area = 1

2. Drainage Basin Parameters (This information should be provided for each basin):

Drainage Basin/Outfall Area No. = Williamson Recharge

Total drainage basin/outfall area =	27.24	acres
Predevelopment impervious area within drainage basin/outfall area =	12.29	acres
Post-development impervious area within drainage basin/outfall area =	18.44	acres
Post-development impervious fraction within drainage basin/outfall area =	0.68	
$L_{M\ THIS\ BASIN}$ =	5350	lbs.

Texas Commission on Environmental Quality

TSS Removal Calculations 04-20-2009

Project Name: 290 West Oak Hill
Date Prepared: 10/29/2019

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Page 3-29 Equation 3.3: $L_M = 27.2(A_N \times P)$

where:

$L_{M\ TOTAL\ PROJECT}$ = Required TSS removal resulting from the proposed development = 80% of increased load
A_N = Net increase in impervious area for the project
P = Average annual precipitation, inches

Site Data: Determine Required Load Removal Based on the Entire Project

County =	Travis	
Total project area included in plan * =	346.82	acres
Predevelopment impervious area within the limits of the plan* =	138.58	acres
Total post-development impervious area within the limits of the plan* =	220.74	acres
Total post-development impervious cover fraction * =	0.64	
P =	32	inches
$L_{M\ TOTAL\ PROJECT}$ =	246435	lbs.

* The values entered in these fields should be for the total project area.

Number of drainage basins / outfalls areas leaving the plan area = 19

2. Drainage Basin Parameters (This information should be provided for each basin):

Drainage Basin/Outfall Area No. = Pond I

Total drainage basin/outfall area =	14.04	acres
Predevelopment impervious area within drainage basin/outfall area =	8.35	acres
Post-development impervious area within drainage basin/outfall area =	11.57	acres
Post-development impervious fraction within drainage basin/outfall area =	0.82	
$L_{M\ THIS\ BASIN}$ =	2800	lbs.

3. Indicate the proposed BMP Code for this basin.

Proposed BMP = Sand Filter
Removal efficiency = 89 percent

4. Calculate Maximum TSS Load Removed (L_R) for this Drainage Basin by the selected BMP Type.

RG-348 Page 3-33 Equation 3.7: $L_R = (\text{BMP efficiency}) \times P \times (A_I \times 34.6 + A_P \times 0.54)$

where:

A_C = Total On-Site drainage area in the BMP catchment area
A_I = Impervious area proposed in the BMP catchment area
A_P = Pervious area remaining in the BMP catchment area
L_R = TSS Load removed from this catchment area by the proposed BMP

A_C =	14.04	acres
A_I =	11.57	acres
A_P =	2.48	acres
L_R =	11437	lbs

5. Calculate Fraction of Annual Runoff to Treat the drainage basin / outfall area

Desired $L_{M\ THIS\ BASIN}$ =	**10350**	lbs.
F =	**0.90**	

6. Calculate Capture Volume required by the BMP Type for this drainage basin / outfall area. Calculations from RG-348

Rainfall Depth =	**1.70**	inches
Post Development Runoff Coefficient =	**0.66**	
On-site Water Quality Volume =	**57006**	cubic feet

Calculations from RG-348 Pages 3-36 to 3-37

Off-site area draining to BMP =	**6.12**	acres
Off-site Impervious cover draining to BMP =	**1.09**	acres
Impervious fraction of off-site area =	**0.18**	
Off-site Runoff Coefficient =	**0.19**	
Off-site Water Quality Volume =	**7055**	cubic feet
Storage for Sediment =	**12812**	
Total Capture Volume (required water quality volume(s) x 1.20) =	**76874**	cubic feet

The following sections are used to calculate the required water quality volume(s) for the selected BMP.
The values for BMP Types not selected in cell C45 will show NA.

9. Filter area for Sand Filters Designed as Required in RG-348 Pages 3-58 to 3-63

9A. Full Sedimentation and Filtration System

Water Quality Volume for sedimentation basin =	**76874**	cubic feet	
Minimum filter basin area =	**3167**	square feet	
Maximum sedimentation basin area =	**28503**	square feet	**For minimum water depth of 2 feet**
Minimum sedimentation basin area =	**7126**	square feet	**For maximum water depth of 8 feet**

9B. Partial Sedimentation and Filtration System

Water Quality Volume for combined basins =	**76874**	cubic feet	
Minimum filter basin area =	**5701**	square feet	
Maximum sedimentation basin area =	**22802**	square feet	**For minimum water depth of 2 feet**
Minimum sedimentation basin area =	**1425**	square feet	**For maximum water depth of 8 feet**

Texas Commission on Environmental Quality

TSS Removal Calculations 04-20-2009

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Date Prepared: 10/29/2019

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1. The Required Load Reduction for the total project: Calculations from RG-348 Pages 3-27 to 3-30

Page 3-29 Equation 3.3: $L_M = 27.2(A_N \times P)$

where:

$L_{M\ TOTAL\ PROJECT}$ = Required TSS removal resulting from the proposed development = 80% of increased load
A_N = Net increase in impervious area for the project
P = Average annual precipitation, inches

Site Data: Determine Required Load Removal Based on the Entire Project

County =	Travis	
Total project area included in plan * =	346.82	acres
Predevelopment impervious area within the limits of the plan* =	138.58	acres
Total post-development impervious area within the limits of the plan* =	220.74	acres
Total post-development impervious cover fraction * =	0.64	
P =	32	inches

$L_{M\ TOTAL\ PROJECT}$ = **246435** lbs.

* **The values entered in these fields should be for the total project area.**

Number of drainage basins / outfalls areas leaving the plan area = 19

2. Drainage Basin Parameters (This information should be provided for each basin):

Drainage Basin/Outfall Area No. = Pond J

Total drainage basin/outfall area =	5.57	acres
Predevelopment impervious area within drainage basin/outfall area =	1.57	acres
Post-development impervious area within drainage basin/outfall area =	4.11	acres
Post-development impervious fraction within drainage basin/outfall area =	0.74	
$L_{M\ THIS\ BASIN}$ =	2204	lbs.

3. Indicate the proposed BMP Code for this basin.

Proposed BMP = Batch Detention
Removal efficiency = 91 percent

4. Calculate Maximum TSS Load Removed (L_R) for this Drainage Basin by the selected BMP Type.

RG-348 Page 3-33 Equation 3.7: $L_R = (\text{BMP efficiency}) \times P \times (A_I \times 34.6 + A_P \times 0.54)$

where:

A_C = Total On-Site drainage area in the BMP catchment area
A_I = Impervious area proposed in the BMP catchment area
A_P = Pervious area remaining in the BMP catchment area
L_R = TSS Load removed from this catchment area by the proposed BMP

A_C =	5.57	acres
A_I =	4.11	acres
A_P =	1.46	acres
L_R =	4160	lbs

5. Calculate Fraction of Annual Runoff to Treat the drainage basin / outfall area

Desired $L_{M\ THIS\ BASIN}$ =	**3170**	lbs.
F =	**0.76**	

6. Calculate Capture Volume required by the BMP Type for this drainage basin / outfall area. Calculations from RG-348

Rainfall Depth =	**0.94**	inches
Post Development Runoff Coefficient =	**0.55**	
On-site Water Quality Volume =	**10411**	cubic feet

Calculations from RG-348 Pages 3-36 to 3-37

Off-site area draining to BMP =	**11.27**	acres
Off-site Impervious cover draining to BMP =	**2.11**	acres
Impervious fraction of off-site area =	**0.19**	
Off-site Runoff Coefficient =	**0.19**	
Off-site Water Quality Volume =	**7434**	cubic feet
Storage for Sediment =	**3569**	
Total Capture Volume (required water quality volume(s) x 1.20) =	**21414**	cubic feet

The following sections are used to calculate the required water quality volume(s) for the selected BMP.
The values for BMP Types not selected in cell C45 will show NA.

Texas Commission on Environmental Quality

TSS Removal Calculations 04-20-2009

Project Name: 290 West Oak Hill
Date Prepared: 10/29/2019

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1. The Required Load Reduction for the total project: Calculations from RG-348 Pages 3-27 to 3-30

Page 3-29 Equation 3.3: $L_M = 27.2(A_N \times P)$

where:

$L_{M\ TOTAL\ PROJECT}$ = Required TSS removal resulting from the proposed development = 80% of increased load
A_N = Net increase in impervious area for the project
P = Average annual precipitation, inches

Site Data: Determine Required Load Removal Based on the Entire Project

County =	Travis	
Total project area included in plan * =	346.82	acres
Predevelopment impervious area within the limits of the plan* =	138.58	acres
Total post-development impervious area within the limits of the plan* =	220.74	acres
Total post-development impervious cover fraction * =	0.64	
P =	32	inches
$L_{M\ TOTAL\ PROJECT}$ =	246435	lbs.

* The values entered in these fields should be for the total project area.

Number of drainage basins / outfalls areas leaving the plan area = 19

2. Drainage Basin Parameters (This information should be provided for each basin):

Drainage Basin/Outfall Area No. = Barton Recharge

Total drainage basin/outfall area =	86.04	acres
Predevelopment impervious area within drainage basin/outfall area =	61.17	acres
Post-development impervious area within drainage basin/outfall area =	68.55	acres
Post-development impervious fraction within drainage basin/outfall area =	0.80	
$L_{M\ THIS\ BASIN}$ =	6424	lbs.

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1. The Required Load Reduction for the total project: Calculations from RG-348 Pages 3-27 to 3-30

Page 3-29 Equation 3.3: $L_M = 27.2(A_N \times P)$

where:

$L_{M\ TOTAL\ PROJECT}$ = Required TSS removal resulting from the proposed development = 80% of increased load
A_N = Net increase in impervious area for the project
P = Average annual precipitation, inches

Site Data: Determine Required Load Removal Based on the Entire Project

County =	Travis	
Total project area included in plan * =	346.82	acres
Predevelopment impervious area within the limits of the plan* =	138.58	acres
Total post-development impervious area within the limits of the plan* =	220.74	acres
Total post-development impervious cover fraction * =	0.64	
P =	32	inches

$L_{M\ TOTAL\ PROJECT}$ = **246435** lbs.

* The values entered in these fields should be for the total project area.

Number of drainage basins / outfalls areas leaving the plan area = 19

2. Drainage Basin Parameters (This information should be provided for each basin):

Drainage Basin/Outfall Area No. = PR Pond R

Total drainage basin/outfall area =	44.61	acres
Predevelopment impervious area within drainage basin/outfall area =	32.87	acres
Post-development impervious area within drainage basin/outfall area =	36.39	acres
Post-development impervious fraction within drainage basin/outfall area =	0.82	
$L_{M\ THIS\ BASIN}$ =	3064	lbs.

3. Indicate the proposed BMP Code for this basin.

Proposed BMP = Wet Basin
Removal efficiency = 93 percent

4. Calculate Maximum TSS Load Removed (L_R) for this Drainage Basin by the selected BMP Type.

RG-348 Page 3-33 Equation 3.7: $L_R = (\text{BMP efficiency}) \times P \times (A_I \times 34.6 + A_P \times 0.54)$

where:

A_C = Total On-Site drainage area in the BMP catchment area
A_I = Impervious area proposed in the BMP catchment area
A_P = Pervious area remaining in the BMP catchment area
L_R = TSS Load removed from this catchment area by the proposed BMP

A_C =	44.61	acres
A_I =	36.39	acres
A_P =	8.22	acres
L_R =	37605	lbs

5. Calculate Fraction of Annual Runoff to Treat the drainage basin / outfall area

Desired $L_{M\ THIS\ BASIN}$ = 34407 lbs.

F = **0.91**

6. Calculate Capture Volume required by the BMP Type for this drainage basin / outfall area. Calculations from RG-348

Rainfall Depth =	1.80	inches
Post Development Runoff Coefficient =	0.65	
On-site Water Quality Volume =	188354	cubic feet

Calculations from RG-348 Pages 3-36 to 3-37

Off-site area draining to BMP =	16.04	acres
Off-site Impervious cover draining to BMP =	6.42	acres
Impervious fraction of off-site area =	0.40	
Off-site Runoff Coefficient =	0.31	
Off-site Water Quality Volume =	32174	cubic feet
Storage for Sediment =	44106	
Total Capture Volume (required water quality volume(s) x 1.20) =	264634	cubic feet

The following sections are used to calculate the required water quality volume(s) for the selected BMP.
The values for BMP Types not selected in cell C45 will show NA.

11. Wet Basins Designed as Required in RG-348 Pages 3-66 to 3-71

Required capacity of Permanent Pool =	264634	cubic feet	**Permanent Pool Capacity is 1.20 times the WQV**
Required capacity at WQV Elevation =	452987	cubic feet	**Total Capacity should be the Permanent Pool Capacity plus a second WQV.**

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where:

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A_N = Net increase in impervious area for the project
P = Average annual precipitation, inches

Site Data: Determine Required Load Removal Based on the Entire Project

County =	Travis	
Total project area included in plan * =	346.82	acres
Predevelopment impervious area within the limits of the plan* =	138.58	acres
Total post-development impervious area within the limits of the plan* =	220.74	acres
Total post-development impervious cover fraction * =	0.64	
P =	32	inches
$L_{M\ TOTAL\ PROJECT}$ =	246435	lbs.

* The values entered in these fields should be for the total project area.

Number of drainage basins / outfalls areas leaving the plan area = 19

2. Drainage Basin Parameters (This information should be provided for each basin):

Drainage Basin/Outfall Area No. = PR Pond S

Total drainage basin/outfall area =	36.18	acres
Predevelopment impervious area within drainage basin/outfall area =	25.93	acres
Post-development impervious area within drainage basin/outfall area =	27.40	acres
Post-development impervious fraction within drainage basin/outfall area =	0.76	
$L_{M\ THIS\ BASIN}$ =	1273	lbs.

3. Indicate the proposed BMP Code for this basin.

Proposed BMP = Sand Filter
Removal efficiency = 89 percent

4. Calculate Maximum TSS Load Removed (L_R) for this Drainage Basin by the selected BMP Type.

RG-348 Page 3-33 Equation 3.7: $L_R = (\text{BMP efficiency}) \times P \times (A_I \times 34.6 + A_P \times 0.54)$

where:

A_C = Total On-Site drainage area in the BMP catchment area
A_I = Impervious area proposed in the BMP catchment area
A_P = Pervious area remaining in the BMP catchment area
L_R = TSS Load removed from this catchment area by the proposed BMP

A_C =	36.18	acres
A_I =	27.40	acres
A_P =	8.79	acres
L_R =	27131	lbs

5. Calculate Fraction of Annual Runoff to Treat the drainage basin / outfall area

Desired $L_{M\ THIS\ BASIN}$ = 21565 lbs.

F = 0.79

6. Calculate Capture Volume required by the BMP Type for this drainage basin / outfall area. Calculations from RG-348

Rainfall Depth =	1.04	inches
Post Development Runoff Coefficient =	0.57	
On-site Water Quality Volume =	77657	cubic feet

Calculations from RG-348 Pages 3-36 to 3-37

Off-site area draining to BMP =	54.44	acres
Off-site Impervious cover draining to BMP =	22.95	acres
Impervious fraction of off-site area =	0.42	
Off-site Runoff Coefficient =	0.32	
Off-site Water Quality Volume =	65199	cubic feet
Storage for Sediment =	28571	
Total Capture Volume (required water quality volume(s) x 1.20) =	171426	cubic feet

The following sections are used to calculate the required water quality volume(s) for the selected BMP.
The values for BMP Types not selected in cell C45 will show NA.

9. Filter area for Sand Filters Designed as Required in RG-348 Pages 3-58 to 3-63

9A. Full Sedimentation and Filtration System

Water Quality Volume for sedimentation basin =	171426	cubic feet	
Minimum filter basin area =	4314	square feet	
Maximum sedimentation basin area =	38828	square feet	For minimum water depth of 2 feet
Minimum sedimentation basin area =	9707	square feet	For maximum water depth of 8 feet

9B. Partial Sedimentation and Filtration System

Water Quality Volume for combined basins =	171426	cubic feet	
Minimum filter basin area =	7766	square feet	
Maximum sedimentation basin area =	31063	square feet	For minimum water depth of 2 feet
Minimum sedimentation basin area =	1941	square feet	For maximum water depth of 8 feet

Texas Commission on Environmental Quality

TSS Removal Calculations 04-20-2009

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Date Prepared: 10/29/2019

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where:

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A_N = Net increase in impervious area for the project
P = Average annual precipitation, inches

Site Data: Determine Required Load Removal Based on the Entire Project

County =	Travis	
Total project area included in plan * =	346.82	acres
Predevelopment impervious area within the limits of the plan* =	138.58	acres
Total post-development impervious area within the limits of the plan* =	220.74	acres
Total post-development impervious cover fraction * =	0.64	
P =	32	inches

$L_{M\ TOTAL\ PROJECT}$ = **246435** lbs.

* **The values entered in these fields should be for the total project area.**

Number of drainage basins / outfalls areas leaving the plan area = 19

2. Drainage Basin Parameters (This information should be provided for each basin):

Drainage Basin/Outfall Area No. = Pond T

Total drainage basin/outfall area =	3.84	acres
Predevelopment impervious area within drainage basin/outfall area =	1.65	acres
Post-development impervious area within drainage basin/outfall area =	3.29	acres
Post-development impervious fraction within drainage basin/outfall area =	0.86	
$L_{M\ THIS\ BASIN}$ =	1426	lbs.

3. Indicate the proposed BMP Code for this basin.

Proposed BMP = Batch Detention
Removal efficiency = 91 percent

4. Calculate Maximum TSS Load Removed (L_R) for this Drainage Basin by the selected BMP Type.

RG-348 Page 3-33 Equation 3.7: $L_R = (\text{BMP efficiency}) \times P \times (A_I \times 34.6 + A_P \times 0.54)$

where:

A_C = Total On-Site drainage area in the BMP catchment area
A_I = Impervious area proposed in the BMP catchment area
A_P = Pervious area remaining in the BMP catchment area
L_R = TSS Load removed from this catchment area by the proposed BMP

A_C =	3.84	acres
A_I =	3.29	acres
A_P =	0.55	acres
L_R =	3324	lbs

5. Calculate Fraction of Annual Runoff to Treat the drainage basin / outfall area

Desired $L_{M\ THIS\ BASIN}$ = 2740 lbs.

F = **0.82**

6. Calculate Capture Volume required by the BMP Type for this drainage basin / outfall area. Calculations from RG-348

Rainfall Depth =	1.16	inches
Post Development Runoff Coefficient =	0.70	
On-site Water Quality Volume =	11315	cubic feet

Calculations from RG-348 Pages 3-36 to 3-37

Off-site area draining to BMP =	**0.00**	acres
Off-site Impervious cover draining to BMP =	**0.00**	acres
Impervious fraction of off-site area =	**0**	
Off-site Runoff Coefficient =	**0.00**	
Off-site Water Quality Volume =	**0**	cubic feet
Storage for Sediment =	**2263**	
Total Capture Volume (required water quality volume(s) x 1.20) =	**13578**	cubic feet

Appendix L: TCEQ WPAP Application Meeting Minutes

Oak Hill Parkway – TCEQ WPAP Application Meeting
Summary

Date and time:	31 July 2019 - 1:30 PM
Location:	TCEQ Building A - Austin Regional Office

Attendees:

Kevin Smith	TCEQ
Robert Sadlier	TCEQ
Roberto Castro	TCEQ
Savannah Rains	TCEQ
Heather Ashley-Nguyen	TxDOT
Zach Lanfear	TxDOT
Jerel Rackley	Atkins

I. Oak Hill Parkway Description

a. The TxDOT project team described the Oak Hill Parkway project, covering the following:
   i. Project Limits
   ii. Proposed configuration
   iii. Project schedule and delivery method
   iv. Limits with Edward Aquifer Recharge and Contributing Zones

II. Description of Design-Build Projects

a. The key elements of a Design-Build (DB) project and what separates it from a typical Design-Bid-Build (DBB) project were discussed. These primarily consist of:
   i. Structure – The DB Contractor performs the project final design
   ii. Schedule - Construction begins before design is complete

III. Applicable TCEQ Edward Aquifer Rules and challenges to a Design-Build Project

a. Construction Activities cannot begin until a Water Pollution Abatement Plan (WPAP) is approved by the TCEQ Executive Director. Final Signed and Sealed plans are required with a WPAP application.
   i. This requirement fits well within the project development of a DBB Project where WPAP application/approval can occur at the end of project design and before construction. This presents a significant challenge to a DB project where construction begins before design is complete.

b. The owner must have the right to possess and control all ROW before submitting a WPAP.

Oak Hill Parkway – TCEQ WPAP Application Meeting
Summary

IV. Project Segmentation and Phasing as potential approaches to WPAP Applications

a. Segmentation

i. The TxDOT project team proposed the following approach to segmenting the project.

1. The DB Contractor could break the project into individual areas for WPAP application. If a break-out area is within the Edwards Aquifer Contributing Zone, it may be submitted and reviewed as a Contributing Zone Plan.
2. These areas would be determined by the DB Contractor
3. Potential Segmentation is shown in **Attachment 1**

ii. The TCEQ staff agreed segmentation as presented would be appropriate and stressed that each segmented area needed to serve as a stand-alone WPAP application; A WPAP for one segment could not rely on the information or water quality controls from a separate WPAP

b. Phasing

i. The TxDOT project team proposed phasing the WPAP applications based on project work activities. The Project phasing would be determined by the DB Contractor.

ii. The following potential phasing structure was presented to TCEQ staff

	Work Type:	**WPAP to Include:**
Phase 1	- Clearing and Grubbing - Mass Grading - Drainage Structures - Drilled Shafts - Temporary Pavement	- Right to possess and control all ROW - Signed and sealed plans: * Clearing and Grubbing * Mass Grading * Drainage Structures * Drainage Areas * Temporary Pavement * Temporary BMPs (Full and Detailed)
Phase 2	- Final Pavement - Permanent BMPs	- Signed and sealed plans: * All plan sheets related to Impervious Cover, Drainage, and Permanent BMPs

iii. The TCEQ staff agreed phasing of the WPAP applications would be acceptable.

iv. The TCEQ staff stressed that final (signed and sealed) plans for the phased work must be submitted with the WPAP application.

v. The TCEQ staff indicated interim permanent BMPs may be required to treat temporary impervious cover.

c. Combination of segmenting and phasing

i. The TxDOT project team also asked if segmenting and phasing could be combined in a structure similar to the table below, again explaining that the organization of the WPAP application packages would be determined by the DB Contractor.

ii. The TCEQ staff explained that both segmenting and phasing WPAP applications is reasonable and is consistent with previously approved segmented/phased projects. They also explained each WPAP application must be able to demonstrate how it complies with the Edwards Aquifer Rule requirements (independent of a previously approved WPAP) and each application must include the appropriate reference/background information (of prior WPAP's) indicating what phase/segment was previously approved and how it relates to the proposed application.

	Segment 1	**Segment 2**	**Segment 3**
Phase 1	OHP Seg1 Phase1 WPAP	OHP Seg2 Phase1 WPAP	OHP Seg3 Phase1 WPAP
Phase 2	OHP Seg1 Phase2 WPAP	OHP Seg2 Phase2 WPAP	OHP Seg3 Phase2 WPAP

Attachments

Attachment 1 – Oak Hill Parkway Potential Segmentation

Oak Hill Parkway – TCEQ WPAP Application Meeting
Summary

Attachment 1

Oak Hill Parkway Potential Segmentation

Oak Hill Parkway Potential Segmentation: