Cranston, RI

Intersection of Oaklawn Avenue and Wilbur Avenue

October 2026

DRAINAGE ASSESSMENT

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Cranston, RI

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Prepared for: Rhode Island Department of Transportation (RIDOT)

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EXECUTIVE SUMMARY

PROJECT OVERVIEW

On behalf of the Rhode Island Department of Transportation (RIDOT), BETA Group, Inc. (BETA) completed a drainage assessment of the Oaklawn Avenue (Route 5) and Wilbur Avenue intersection and the associated closed drainage system extending through Wilbur Avenue, Warren Avenue, and Allard Street to its outfall near Meshanticut Brook. The assessment evaluated the hydraulic performance of the existing drainage infrastructure, identified deficiencies contributing to recurring roadway flooding, and developed conceptual improvement alternatives to increase system capacity and mitigate flooding.

The study area encompasses a 273.3-acre watershed, approximately 50.5% of which is impervious. RIDOT right-of-way accounts for only 13.1 acres (4.8%) of the contributing watershed, with the remaining runoff originating predominantly from surrounding municipal and privately developed areas. Field investigations and CCTV inspections identified sediment accumulation, root intrusions, pipe defects, and a potentially submerged or obstructed outfall that adversely affects system performance. Hydrologic and hydraulic analyses determined that the existing 36-inch outfall has a capacity of approximately 57.9 cubic feet per second (cfs), compared to estimated peak flows of 165 cfs and 391 cfs during the 1-year and 25-year storm events, respectively. The existing drainage system is therefore substantially undersized for the contributing watershed, resulting in surcharge conditions and recurring flooding at the Oaklawn Avenue and Wilbur Avenue intersection.

The assessment determined that flooding is primarily attributable to runoff originating outside RIDOT right-of-way. Limited municipal drainage capacity and steep topography allow substantial runoff to bypass existing collection systems and flow overland toward Oaklawn Avenue, and ultimately the intersection of Oaklawn Avenue and Wilbur Avenue, which represents a localized low point. When considering only runoff generated within RIDOT right-of-way, the existing drainage system has sufficient capacity to convey approximately the 10-year storm event. Therefore, effective flood mitigation will require improvements that address both existing drainage restrictions and runoff contributions from the surrounding municipal watershed.

ALTERNATIVES

BETA evaluated several improvement alternatives based on anticipated benefits, implementation feasibility, priority, timeframe, and planning-level construction costs. The highest-priority, short-term recommendation consists of outfall improvements and rehabilitation of the existing trunkline, including cleaning, removal of root intrusions, repair of pipe defects, and relocation of the outfall outside the wetland limits to mitigate tailwater restrictions. These improvements, estimated at approximately $150,000, would restore available hydraulic capacity and improve overall system functionality.

Four conceptual stormwater treatment unit (STU) alternatives were also identified to provide supplemental storage, runoff reduction, and water quality benefits. These include underground chamber systems near Immaculate Conception Church (STU-OAK-002) and Exchange Street (STU-OAK-003), and infiltration (or detention) basins near Oak Lawn Elementary School (STU-OAK-001) and south of the Oaklawn Avenue/Wilbur Avenue intersection (STU-OAK-004). The proposed improvements provide individual storage volumes ranging from approximately 6,990 to 42,000 cubic feet, with estimated construction costs between $500,000 and $840,000. STU-OAK-002 was identified as a high-priority, mid-term opportunity due to the large contributing watershed areas and partnership opportunity with the church property, while the remaining STUs were assigned medium priority for mid-term or long-term implementation. These improvements all require coordination with municipal and private stakeholders

and additional investigations to confirm feasibility. All STUs have been sized based on available space; low flows will be diverted to ensure the system meets the 10-year design storm.

Two large-scale conveyance alternatives were evaluated to accommodate the 25-year design storm and eliminate flooding at the intersection. Alternative 1 proposes a parallel drainage system and new 4-foot by 12-foot culvert outfall, at an estimated cost of $16.1 million. Alternative 2 combines watershed-scale impervious cover reduction within the municipal neighborhoods by implementing stormwater management measures with a smaller 4-foot by 8-foot culvert outfall, at an estimated cost of $14.7 million. While both alternatives would provide sufficient conveyance capacity for the 25-year storm, their substantial costs, potential downstream and construction impacts, and feasibility resulted in a low priority relative to the targeted improvements.

RECOMMENDATIONS

BETA recommends a phased implementation strategy, beginning with the $150,000 outfall improvements, followed by monitoring of flooding conditions to evaluate their effectiveness. Concurrently, RIDOT should coordinate with the City of Cranston and private stakeholders to advance the higher-priority STU opportunities and evaluate additional watershed-based runoff reduction measures. The larger-scale conveyance alternatives should be reconsidered if flooding persists following implementation of the higher-priority improvements.

Prior to advancing improvements, additional hydraulic evaluations, site investigations, and coordination with the Rhode Island Department of Environmental Management (RIDEM) will be necessary to confirm feasibility, permitting requirements, and potential downstream impacts. This phased approach prioritizes cost-effective improvements, provides opportunities for municipal/private partnerships and water quality benefits, and allows RIDOT to make informed decisions regarding future capital investments based on observed flooding and system performance. The table below summarizes the alternatives, including benefits, priority, time-frame, and estimated cost of each.

Alternative	Description	Potential Benefits	Priority[1]	Time Frame[2]	Cost[3]
Outfall Improvements	• Relocate new outfall outside of wetlands. • Assess tide gate at new outfall. • Clean and flush trunkline, repair pipe/structure defects, and root intrusions.	• Restore existing available capacity. • Improve overall system performance and functionality. • Mitigate tailwater conditions.	High	Short-Term	Low $150,000
STU-OAK-002 Underground Chamber System	• Underground Chamber System at the Immaculate Conception Church. • Divert runoff from Oaklawn Avenue (RIDOT) and the Garden Hills neighborhood (Cranston) • Private Partnership	• Mitigate bypass contributing to low point. • Flood Storage, Runoff Reduction o Storage Volume = 12,950 c.f. • WQ Improvements/STU Credits o Effective IC Reduction = 12.7 acres	High	Mid-Term	Medium $840,000
STU-OAK-003 Underground Chamber System	• Underground Chamber System at the Exchange Street/Wilbur Avenue intersection. • Divert runoff from Exchange Street (Cranston). • Municipal Partnership	• Mitigate bypass contributing to low point. • Flood Storage, Runoff Reduction o Storage Volume = 6,990 c.f. • WQ Improvements/STU Credits o Effective IC Reduction = 3.9 acres	Medium	Mid-Term	Medium $570,000
STU-OAK-001 Infiltration Basin	• Infiltration Basin at the Oak Lawn Elementary School • Divert runoff from entire Oaklawn Avenue system (RIDOT and Cranston). • Municipal Partnership	• Supplemental storage and capacity downstream of the low point; no effect on bypass to low point. • Flood Storage, Runoff Reduction o Storage Volume = 42,000 c.f. • WQ Improvements/STU Credits o Effective IC Reduction = 55.8 acres	Medium	Long-Term	Medium $510,000
STU-OAK-004 Infiltration Basin	• Infiltration Basin south of the Oaklawn Avenue/Wilbur Avenue intersection. • Divert runoff from Oaklawn Avenue (RIDOT), Scenic Drive and Brayton Avenue (Cranston) systems. • Private Partnership	• Mitigate bypass contributing to low point. • Flood Storage, Runoff Reduction o Storage Volume = 10,800 c.f. • WQ Improvements/STU Credits o Effective IC Reduction = 11.1 acres	Medium	Long-Term	Medium $500,000
Alternative 2 IC Reduction w/ Parallel System	• Construct new parallel drainage system with 4' x 8' culvert outfall. • IC reduction within City neighborhoods.	• Sized to convey the 25-year design storm. • Eliminate flooding at low point. • Conveyance only, no runoff reduction or WQ benefits.	Low	Long-Term	High $14,700,000
Alternative 1 Install Parallel System	• Construct new parallel drainage system with 4' x 12' culvert outfall.	• Sized to convey the 25-year design storm. • Eliminate flooding at low point. • Conveyance only, no runoff reduction or WQ benefits.	Low	Long-Term	High $16,110,000

[1] Observed flooding should be monitored after the high priority alternatives are implemented to assess the need for other mid-term or long-term solutions.
[2] Time Frame Range: Short-Term (<1 Year), Mid-Term (1-5 Years), Long-Term (>5 Years)
[3] Cost Range: Low (≤$150,000), Medium ($150,001-$1,000,000), High (>$1,000,001)

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1.0 INTRODUCTION

On behalf of the Rhode Island Department of Transportation (RIDOT), BETA Group, Inc., (BETA) has prepared the following drainage assessment of the intersection of Oaklawn Avenue (Route 5) and Wilbur Avenue in the City of Cranston. The assessment analyzes the capacity of the existing RIDOT-owned closed drainage system in Oaklawn Avenue, Wilbur Avenue, Allard Street, and Warren Avenue that conveys stormwater flow from the low point at the Oaklawn Avenue and Wilbur Avenue intersection to the outfall along Allard Street. The purpose of the analysis was to determine whether the system is properly sized when in full operating condition and offer recommendations for any necessary improvements.

RIDOT asset management data and record information were used in conjunction with the field investigations to determine existing conditions. A review of the RIDOT-provided CCTV inspection videos was used to verify the location, pipe size, material, and deficiencies in the closed stormwater systems. The findings from the field inspections and CCTV were used to analyze the hydrologic and hydraulic characteristics of the stormwater network.

1.1 GENERAL PROJECT NARRATIVE

The watershed contributing runoff to the analysis area on Oaklawn Avenue and Wilbur Avenue is a subwatershed of the Meshanticut Brook (RI0006017R-02) which ultimately discharges to the Pawtuxet River (RI0006017R-03). The analyzed watershed area is generally bound by the intersection of Old Spring Road and Oaklawn Avenue to the south, Warren Avenue and the Washington Secondary Trail bike path to the west, the intersection of Freehold Avenue and Oaklawn Avenue to the north, and New London Avenue (Route 2) to the east (see *Appendix D* for Watershed Plans). The subcatchments of the watershed have been delineated based on changes in pipe size in the existing trunkline, with larger watersheds from the neighborhoods delineated to Cranston-owned closed drainage networks and their respective interconnection to the RIDOT system.

The stormwater runoff that is generated from the overall watershed is captured by two closed drainage networks within Oaklawn Avenue. The systems converge into a single 30" trunkline at the intersection of Oaklawn Avenue and Wilbur Avenue. The system within Wilbur Avenue conveys flow southwesterly along Warren Avenue to the outfall southwest of the Oak Lawn Elementary School. The system discharges into the Meshanticut Brook via a 36" outfall, which then flows south approximately 1.5 miles to the convergence with the Pawtuxet River. There has been reported flooding issues at the intersection of Oaklawn Avenue and Wilbur Avenue, which is located at the low point of the watershed, where the two systems converge. The analysis will be focused on RIDOT owned infrastructure and potential alternatives to address identified capacity issues.

1.2 VICINITY MAP

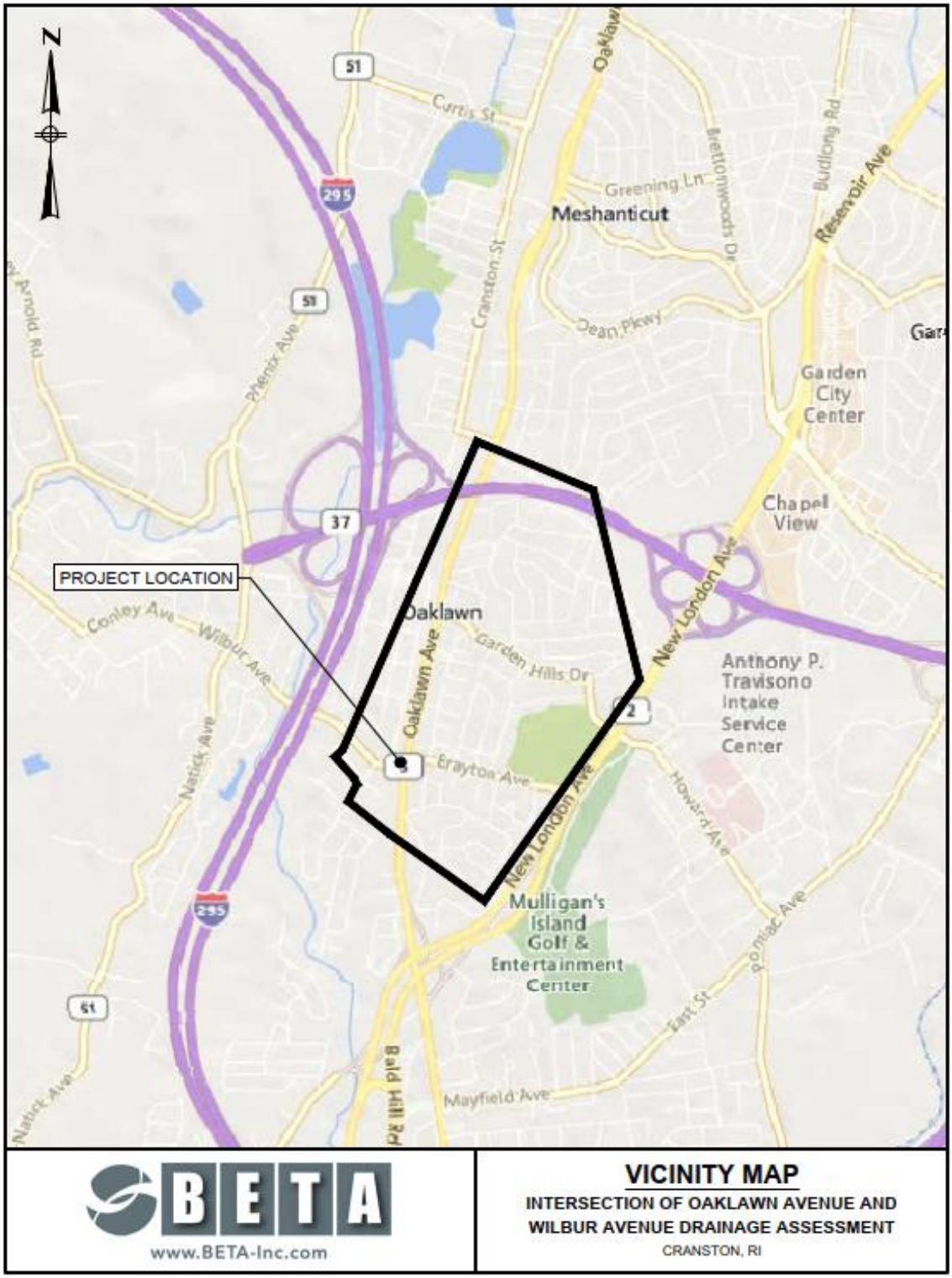


Figure 1.2-1: Vicinity Map

2.0 Data Collection and Review

Record plans, field investigations, asset management data, and CCTV data were used to compile the existing conditions base mapping utilized for the feasibility assessment.

2.1 Record Plans

The following record plans were provided by RIDOT or obtained by BETA:

- Possible R.O.W. Encroachments Oaklawn Avenue (Route 5) (March 2009)
- RIC No. 9918 – Washington Secondary Bike Path Contract 1 (1999)
- PWSB Water GIS Records – Oaklawn Ave from Rt 37 to Allard St (January 2026)
- Plat No. 616 Oaklawn Avenue from Reservoir Ave to R.R. South Cranston (June 1939)

2.2 Field Investigations

BETA performed multiple site visits from October of 2025 through August of 2026 to investigate the existing drainage structures within the Oaklawn Avenue, Wilbur Avenue, and Warren Avenue systems. The investigations were conducted in dry and wet weather to assess how the system functions in both conditions and calibrate the hydraulic models using actual rain events. BETA opened and inspected the structures along the trunkline, field measurements for pipe size and inverts were taken at each structure that was accessible; however, rim elevations were not obtained during the field investigation. All field data and observations collected were input into the RIDOT Stormwater Database. In addition to the structure inspections, the watershed limits were refined based on field verified connectivity and topography.

Avizinis Environmental Services, Inc., (AES) completed wetland delineations on March 31, 2026, along the Meshanticut Brook and also identified a wetland area north of Stoneham Street, refer to *Appendix E* for the full wetland delineation report. The existing conditions plans depicting the drainage system and wetland areas can be found in *Appendix F*.

2.3 CCTV Inspection – Significant Findings

RIDOT provided the CCTV inspection report for the work performed on Oaklawn Avenue on March 31, 2025. The primary objective of the work was to determine the system connectivity, pipe size, material, and the presence of deficiencies within the closed drainage network. All pipe sections were noted as "Unknown" for pre-cleaning of the system prior to performing the CCTV inspections.

A total of four (4) pipe sections were inspected from Oaklawn Avenue to the intersection of Warren Avenue and Stoneham Street. The inspections identified multiple pipe intrusions, material changes, and blockages found along the trunkline, which collectively are adversely impacting the hydraulic performance of the drainage system. The investigations are briefly described below.

The first section of pipe inspected extends from MH01 Wilbur to CB01 Warren Ave, noted as a 30" reinforced concrete pipe (RCP). The inspection started at CB01 Wilbur and covered a length of 188.3 feet. The CCTV identified roots at 7 o'clock, approximately 12.4 feet downstream, from 5 o'clock to 7 o'clock, approximately 36.1 feet downstream, and roots from 5 o'clock to 7 o'clock approximately 48.4 feet downstream. All roots were noted at approximately 10% of the cross sectional area, with fine to medium joints within 8 inches. The water level was observed at approximately 10% of the vertical dimension for the whole length of pipe inspected.

The second segment inspected was from CB01 Warren Ave to MH01 Warren Ave, covering 108.1 feet of 30" RCP. Notable observations included water level at approximately 10% of the vertical dimension, and roots from 4 o'clock to 8 o'clock at approximately 12.2, feet and 92.1 feet. Additionally, there was a tap break-in at 2 o'clock, with a 10-inch diameter opening located at approximately 92.1 feet. A point repair was also observed at approximately 96.2 feet where the pipe angles westerly.

The third section of pipe inspected starts at Buried MH Stoneham Street, noted as a 30" RCP, covering a length of 34.5 feet. Roots were observed from 12 o'clock to 12 o'clock at approximately 4.8 feet and 34.5 downstream. The survey was abandoned due to an inability to pass at 34.5 feet from roots and sediment obstructing the pipe. The water level was observed at approximately 20% of the vertical dimension for the whole length of pipe inspected.

The fourth segment inspected covered 106.2 feet of 30" RCP from Buried MH Wilbur Ave to MH01 Wilbur. Water levels were observed at 10% of the vertical dimension for the length of pipe, roots from 5 o'clock to 7 o'clock were found at approximately 1.4 feet, and additional roots were observed from 4 o'clock to 8 o'clock at approximately 41.5 feet and 106.2 feet downstream. Roots were noted at approximately 15% of the cross-sectional area, with fine joints within 8 inches.

Following BETA's first round of field investigations, additional cleaning and CCTV inspection was requested by BETA. RIDOT provided the CCTV inspection report for the work performed on Allard Avenue on May 20, 2026.

One (1) section of pipe was inspected on Allard Avenue, from the last DMH to the existing 36" outfall. The inspection started at MH9108496 and covered a length of 200 feet. The CCTV identified the water level at approximately 15% of the vertical dimension upstream at the DMH and 50% of the vertical dimension 41.4 feet downstream of the DMH. The survey was abandoned at 200 feet due to an inability to pass. It is assumed that the existing pipe outfall is either completely submerged or buried, which is significantly limiting the functionality of the system.

A third day of CCTV inspections were performed by RIDOT on May 28, 2026. A total of four (4) pipe sections were inspected within Oaklawn Avenue. The investigations are briefly described below.

The first section of pipe inspected extends from MH Scenic Drive to MH9108854, noted as a 12" RCP. The inspection started at MH9108854 and covered a length of 104.3 feet. The CCTV identified roots at 7 o'clock to 10 o'clock at approximately 2.9 feet downstream at 25% of the cross sectional area. Root balls at 8.1 feet downstream were identified, blocking approximately 90% of the cross sectional area. Additionally, roots were identified from 10 o'clock to 2 o'clock approximately 23.6 feet downstream at 20% of the cross sectional area. The CCTV also identified deposits settled fines at 5 o'clock to 7 o'clock 55.4 feet downstream at 25% of the cross sectional area. The water level was observed at approximately 10% of the vertical dimension for the whole length of pipe inspected.

The second section of pipe inspected starts at MH9108854, noted as a 12" RCP, only covering a length of 2.0 feet. Roots were observed from 12 o'clock to 12 o'clock at approximately 2.0 feet at 90% of its cross-sectional area, the survey was abandoned here due to an inability to pass. The water level was observed at approximately 0% of the vertical dimension.

The third section of pipe inspected extends from MH25166 to MH9108854, noted as a 12" RCP. The inspection started at MH9108854 and covered a length of 43.3 feet. No deficiencies were noted from the inspection. The water level was observed at approximately 0% of the vertical dimension for the whole length of pipe inspected.

The fourth section of pipe inspected extends from MH9108854 to MH23511, noted as a 12" RCP. The inspection started at MH23511 and covered a length of 180.9 feet. Root balls were observed from 8 o'clock to 4 o'clock at 75% of the cross sectional area, survey was abandoned here due to inability to pass. The water level was identified at 5% of the vertical dimension, no other deficiencies were noted.

Other than the items noted above, the overall condition of the drainage system was fair, with all minor deficiencies noted in the full CCTV reports. Photos and maps summarizing the findings can be found in *Appendix A.*

3.0 Analysis Methodology and Results

The following section describes the methodology that was used to analyze the watersheds, pipe networks, and culverts.

3.1 Watershed and Closed Drainage Network Descriptions

3.1.1 Soil Classification

Please refer to the soil map in *Appendix B* for more information. According to the Soil Survey of Rhode Island, prepared by the U.S. Department of Agriculture Natural Resources Conservation Service (NRCS), the soil types present within the project area consist of mainly two soils: Merrimac-Urban Land Complex (MU) and Paxton-Urban land (PD), with small areas of Hinckley Loamy Sand (HkA), Newport-Urban land complex (NP), Paxton fine sandy loam (PaA and PaB), Udorthents-Urban land complex (UD), and Urban land (UR).

MU soils are classified in hydrologic soil group "A." Group A consists mainly of deep, well-drained to excessively drained sands or gravelly sands, which display good drainage characteristics (high infiltration rate when thoroughly wet). PD soils are classified in hydrologic soil group "C." Group C consists of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils typically have a very slow rate of water transmission.

3.1.2 Flood Zone Classification

According to the Flood Insurance Rate Map for Cranston, Rhode Island (FIRM) for (Map Number 44007C0426H dated October 2nd, 2015), the majority of the limit of work within Oaklawn Avenue falls within the Zone X – Area of Minimal Flood Hazard. The off-road portion of the pipe network through Wilbur, Stoneham, and Allard Street is located within Zone X – 0.2% Annual Change Flood Hazard. The outfall is located within Zone AE – Special Flood Hazard Area with a BFE of 41. Please refer to the FEMA FIRMette in *Appendix C.*

3.1.3 Existing Watersheds

The watersheds within the analyzed area were delineated using one (1) foot contours, generated from "2022 USGS Lidar: RI Statewide" NOAA LIDAR data.

The total watershed area contributing to the Allard Street outfall is 273.3 acres, of which approximately 137.9± acres is impervious (50.5%). The RIDOT right-of-way only accounts for approximately 13.1± acres of this watershed (4.8% of total), of which approximately 8.9± acres is impervious (6.5% of total impervious). The RIDOT-owned Oaklawn Avenue slopes gradually from north to south with drainage structures on either side of the roadway to capture stormwater runoff. The remaining Cranston-owned watershed consists primarily of residential properties and streets to the east of Oaklawn Avenue. This eastern portion of the watershed area is approximately 219.3± acres (80.2% of the total), of which

approximately 107.4± acres is impervious (49.0%). The local topography of this area slopes from the east toward Oaklawn Avenue. There are limited municipal owned closed drainage systems in the neighborhoods which interconnect to the RIDOT system in Oaklawn Avenue. The existing and proposed watershed areas are depicted in *Appendix D*.

For analysis purposes, sub-watersheds for the main trunklines of the closed drainage system were delineated based on changes in pipe size of the trunkline, while neighborhoods and side streets contributing stormwater to the system were delineated based on interconnections to the RIDOT drainage system in Oaklawn Avenue. Flows associated with the neighborhood/side street sub-watersheds were then conservatively input into the first node where the flow enters the system. The hydrologic and hydraulic analysis as included in *Appendix I.*

3.1.4 Existing Closed Drainage Networks

The stormwater runoff generated by the watershed is captured by two closed drainage networks within Oaklawn Avenue. The main trunkline runs north to south to the intersection with Wilbur Avenue, while a smaller system runs south to north. The systems converge into one network at the low point at the intersection of Oaklawn Avenue and Wilbur Avenue. The system continues westerly off-road through the flagged wetlands, where the system then crosses Warren Avenue and continues off-road westerly toward Oak Lawn Elementary School.

The system discharges to the Meshanticut Brook and the associated wetland complexes near the dead end of Allard Street. The existing state-owned drainage networks consist of a trunkline varying in size (12-inch to 36-inch) all of which is RCP. There are several sets of catch basins with 12" laterals, which were not analyzed as part of this study. In general, the systems convey flow from catch basin to catch basin and have very flat slopes due to the topography of the project area. The following is a brief description of the different systems as well as any deficiencies or restrictions noted during this drainage assessment.

3.1.4.1 RIDOT Drainage System

The intersection of concern, Oaklawn Avenue at Wilbur Avenue, is the junction of the two RIDOT-owned closed drainage networks within Oaklawn Avenue, and a localized low point within the watershed. To the north of the intersection within Oaklawn Avenue, there are seventeen (17) sets of structures that are connected catch basin to catch basin, with the trunkline conveying flow southerly within the eastern sidewalk of the roadway. The existing catch basins are spaced anywhere from 100' to 300' along this stretch of Oaklawn Avenue, with the most upstream structures approximately 150 feet north of the Route 37 overpass. The trunkline extends southerly and increases from 12" RCP to a 15" RCP at the intersection of Camelia Drive. The system remains a 15" RCP until the intersection of Garden Hills Drive, where it increases to an 18" RCP. The trunkline continues southerly toward the intersection of Weaver Street where it increases to a 24" RCP. The system increases to 30" RCP at the intersection with Brayton Avenue, where there is an interconnection from the City of Cranston drainage system.

The southern section of the Oaklawn Avenue closed drainage network consists entirely of a 12" trunkline of RCP conveying flow south to north within the eastern sidewalk of the roadway. There are five (5) sets of structures that are connected catch basin to catch basin, with the structures spaced anywhere from 125' to 250' along this stretch of Oaklawn Avenue. The 12" trunkline crosses Oaklawn Avenue to the west at the third structure before continuing north within the western sidewalk. A localized depression south of the intersection with Scenic Drive and Old Spring Road includes an overflow pipe which ties into the RIDOT system along with a City of Cranston interconnection at the first structure along this section of drainage.

From the low point at the Oaklawn-Wilbur intersection, the system conveys flow west cross county via a 30" RCP pipe. The trunkline crosses Warren Avenue at the intersection with Stoneham Street through a single inlet structure and continues off-road through residential properties westerly toward Oaklawn Elementary School. The system ultimately discharges via a 36" outfall to the Meshanticut Brook and the associated wetland complexes near the dead end of Allard Street. The outfall location has not been able to be located in the field through field investigations or CCTV inspections.

The intersection of Oaklawn Avenue and Wilbur Avenue was observed during multiple rain events, during which the existing drainage network conveyed flows in smaller storms, and experienced major flooding during higher intensity storms. The intersection is the low point of the watershed, excess runoff that is not intercepted by the inlet structures in Oaklawn Avenue or the Cranston neighborhoods will ultimately sheet flow to this point. During a July 7, 2026, storm event, no flooding was observed at the intersection of Oaklawn Avenue and Wilbur Avenue with the existing drainage system functioning. On July 21, 2026, a storm event caused flooding of the intersection and resulted in the road being closed. Weather Underground's KRICRANS89 station recorded 3.58 inches of rain over a 24-hour period, the equivalent of over a 2-year event (3.38 in from NOAA). However, the peak rainfall for this storm event was 2.58 in/hr for a 30 minute period, the equivalent of almost a 10-year storm event (2.79 in/hr from NOAA). Based on observations of the intersection, the high-intensity storms typically result in short duration road closures until the system can relieve itself. In addition to the large contributing watershed areas, the closed drainage system is undersized which causes the system to surcharge at the intersection. *Photo 1* and *Photo 2* were taken of the intersection with Wilbur Avenue during the July 7, 2026, and July 21, 2026, rain events.



Photo 1: Wilbur Avenue at Oaklawn Avenue on July 7, 2026.
(View from Wilbur Avenue facing east)



Photo 2: Flooding at Oaklawn-Wilbur intersection on July 21, 2026. (Photo taken from WJAR)
(View from Oaklawn Avenue facing southwest)

Downstream of the Oaklawn-Wilbur intersection, there is a single inlet structure at the intersection of Warren Avenue and Stoneham Street. The contributing watershed to this inlet is approximately 9.8± acres, of which 4.3± is impervious. The RIDOT right-of-way only accounts for approximately 1.7± acres of this watershed, of which approximately 0.2± acres is impervious. During wet-weather events, ponding is frequently observed at this location. Field observations indicate that the trunk line bypasses the structure at a skewed alignment rather than connecting directly through the structure. Flow is conveyed into the trunk line through an opening in the structure wall. This non-standard connection configuration and skewed alignment results in hydraulic inefficiencies and increased head losses. *Photo 3* and *Photo 4* show the inlet during a wet weather event and inside of the inlet structure, respectively.



Photo 3: Intersection of Warren Avenue and Stoneham Street.
(View from Warren Avenue facing north)



Photo 4: Drainage Structure at Corner of Warren Avenue and Stoneham Street

The outfall associated with this drainage system was not able to be located during any of the field visits. Review of available mapping, CCTV inspections, and site observations suggest that the outfall is located within the adjacent wetlands and is likely submerged under normal water levels. A downstream analysis should be performed for Alternative 1 and 2 to determine if added flow will have an adverse impact to the wetland complex downstream of the outfall or the ultimate discharge point Meshanticut Brook.

3.1.4.2 MUNICIPAL CLOSED SYSTEMS & INTERCONNECTIONS

There are six (6) incoming interconnections to the RIDOT system, for the purpose of this study, subcatchments were delineated for each network and routed through the last municipal pipe in the system. Each watershed is briefly described below:

Blossom Drive

This watershed is approximately 36.5± acres, of which 18.4± acres is impervious (50.4%). The watershed consists of residential properties and roadways within the Garden Hills neighborhoods. The watershed slopes from east to west toward Oaklawn Avenue. The drainage system within the watershed captures and conveys flow to the RIDOT system via a 12" RCP at the intersection of Oaklawn Avenue and Blossom Drive. The capacity of the existing 12" RCP interconnection is approximately 3.0 cfs, while the total watershed yield for this area is 61.6 cfs during the 25-year storm event.

Camelia Drive

This watershed is approximately 31.6± acres, of which 15.6± acres is impervious (49.4%). The watershed consists of residential properties and roadways within the Garden Hills neighborhoods. The watershed slopes from east to west toward Oaklawn Avenue. The drainage system within the watershed captures and conveys flow to the RIDOT system via a 12" RCP at the intersection of Oaklawn Avenue and Camelia Drive. The capacity of the existing 12" RCP interconnection is approximately 5.8 cfs, while the total watershed yield for this area is 52.0 cfs during the 25-year storm event.

Brayton Avenue

This watershed is approximately 74.9± acres, of which 31.6± acres is impervious (42.2%). The watershed consists of a portion of Brayton Avenue, Garden Hills Drive, Garden Hills Parkway, Aspen Drive, Mount View Drive, Wildwood Drive, Woodmont Drive, Wildacre Drive, Rockcrest Drive, and the adjacent residential properties. The watershed slopes from east to west toward Oaklawn Avenue. The drainage system within the watershed captures and conveys flow to the RIDOT system via an 18" RCP at the intersection of Oaklawn Avenue and Brayton Avenue. The capacity of the existing 18" RCP interconnection is approximately 14.4 cfs, while the total watershed yield for this area is 108.3 cfs during the 25-year storm event.

An incoming 24" RCP interconnection was observed within Oaklawn Avenue at RIDOT DMH 9108853, upstream connectivity could not be confirmed in the field. The available Cranston GIS mapping indicates a potential connection with the drainage system within Brayton Avenue. Available resource maps and historical images indicate a wetland area within Brayton Park and potential underground stream. Therefore, for the purpose of the this study the area draining to the 24" RCP was included in the Brayton Avenue watershed.

Scenic Drive/Old Spring Road

This watershed is approximately 34.3± acres, of which 16.6± acres is impervious (48.4%). The watershed consists of a portion of Scenic Drive, Old Spring Road, Rock Hill Drive, Roseview Drive, Thistle Drive, Hibiscus Drive, and the adjacent residential properties. The watershed slopes from east to west toward Oaklawn Avenue. The drainage system within the watershed captures and conveys flow to the RIDOT system via a 12" RCP interconnection at the three-way intersection of Oaklawn Avenue, Scenic Drive and Old Spring Road. The capacity of the existing 12" RCP interconnection is approximately 4.2 cfs, while the total watershed yield for this area is 63.2 cfs during the 25-year storm event.

Vinton Avenue

The Vinton Avenue watershed is west of Oaklawn Avenue and approximately 8.4± acres, of which 4.8± acres is impervious (57.1%). The watershed consists of a portion of Vinton Avenue, Harrison Avenue, Turner Avenue, Angell Avenue, and the adjacent residential properties. The municipal system captures runoff and conveys it east to Oaklawn Avenue to CB 25160 via a 12" HDPE interconnection. The capacity of the existing 12" HDPE interconnection is approximately 6.8 cfs, while the total watershed yield for this area is 15.6 cfs during the 25-year storm event. Due to the existing topography excess runoff from this watershed ponds on Vinton Avenue.

Exchange Street

The Exchange Street watershed is west of Oaklawn Avenue and approximately 6.0± acres, of which 3.8± acres is impervious (63.3%). The watershed consists of Exchange Street, a portion of Vinton Avenue, Searle Avenue, Olive Avenue, and the adjacent residential properties. The municipal system captures runoff and conveys it to the inlet structures at the Oaklawn-Wilbur intersection low point via an 18" RCP

interconnection to the RIDOT system. The capacity of the existing 18" RCP interconnection is approximately 27.0 cfs, while the total watershed yield for this area is 13.3 cfs during the 25-year storm event. Excess runoff that is not intercepted by the municipal drainage system, bypasses and sheet flows to the low point.

3.2 HYDROLOGIC AND HYDRAULIC ANALYSIS

The existing and proposed conditions hydraulic analyses were performed using the Rational Method, utilizing Hydraflow Storm Sewers software. Peak flows were calculated for the 1, 2, 10, 25, and 100-year storm events. The peak discharge rates, times of concentration, and pipe capacities for the analyzed storm events are summarized in this section. Output files for the 10- and 25-year storm events are included in *Appendix I*.

The following rainfall amounts for Cranston, Rhode Island were utilized for each analyzed storm event, based on rainfall data provided by the National Oceanic and Atmospheric Administration (NOAA). These rainfall quantities are calculated using the upper range of historical data to predict the potential increase in rainfall totals due to global warming and other factors.

1-Year Storm: 2.82 inches
2-Year Storm: 3.38 inches
10-Year Storm: 5.04 inches
25-Year Storm: 6.08 inches
100-Year Storm: 7.69 inches

The hydraulic analysis and drainage design for the alternatives followed the guidance provided in Chapter 8 of RIDOT's Highway Design Manual for pipe and inlet designs. Notably, the following standards and guidance were utilized in the analysis:

- Pipe Sizing – 25-year Storm Event
- Asphalt Surface Runoff Coefficient = 0.016
- Mannings Roughness Coefficients
  - 12" and 15" RCP: n = 0.015
  - 18" and greater RCP: n = 0.012
  - HDPE (12" to 60"): n = 0.012
- Hydraulic gradient does not encroach upon 1.5 feet from the proposed finish frame grate.

For the existing conditions analysis, the project watershed was divided into twelve (12) subcatchments, weighted coefficients for each were calculated using the RIGIS Impervious 2020 layer clipped to the individual subcatchment boundaries. The pipe capacities of the drainage system were calculated using Manning's equation, and peaks flows were calculated using the rational method. The capacity of the existing outfall is 57.9 cfs. The existing drainage network and intersection shows surcharging even for the 1-year storm, with larger storms causing flooding issues throughout the system. The cumulative peak flow for the 1-, 2-, 10-, 25-, and 100-year rainfall event frequencies for the 36" outfall are summarized in *Table 3.2-1*.

Table 3.2.1 : Existing System Peak Flows vs. Capacity

Rainfall Event Frequency	Peak Flow Rate (CFS)	Outfall Capacity (CFS)
1-Year	165.0	57.9
2-year	203.0	
10-year	319.3	
25-year	391.1	
100-Year	502.7	

The RIDOT contributing area in the watershed is approximately 13.1± acres which is significantly less than the City of Cranston contributing area of about 260.2± acres. BETA performed a separate existing conditions analysis to determine if the system was properly sized for the RIDOT area during a 1-, 2-, 10-, 25-, and 100-year storm. The RIDOT watershed area is predominantly impervious (8.9± acres) with a majority of the pervious area being within the Washington Secondary Trail bike path right-of-way. The total flows generated by the RIDOT contributing watershed during the design storms are summarized in *Table 3.2-2.* The analysis indicates that the existing system has the capacity to convey up to the 10-year storm when excluding the City of Cranston contributing area and only analyzing the RIDOT-owned ROW area.

Table 3.2-2 : RIDOT Generated Flows vs. Capacity

Rainfall Event Frequency	Peak Flow Rate (CFS)	Outfall Capacity (CFS)
1-Year	20.3	57.9
2-year	27.1	
10-year	49.6	
25-year	64.5	
100-Year	88.7	

3.3 CONCEPTUAL IMPROVEMENTS CONCEPTUAL IMPROVEMENTS

The following section presents alternatives to provide additional capacity to the existing closed drainage system along Oaklawn and Wilbur Avenue as well as help alleviate flooding issues at the intersection. The alternatives have been developed to address the deficiencies identified in *Section 3.2*. The alternatives provide capacity to convey stormwater flows for up to the 25-year design storm within the closed drainage system. These alternatives require work within private property and/or City layout. The work within state owned property is limited to upsizing the closed drainage system within Oaklawn Avenue and Wilbur Avenue. Plans showing Alternatives 1-2 and Conceptual STU Plans can be found in Appendix G and Appendix H, respectively.

Budgetary estimates have been developed for the conceptual alternatives mentioned above. These estimates were developed based on unit cost pricing for the work proposed in each alternative. Unit prices were developed using RIDOT's published weighted average unit prices in combination with recent bid results from projects of similar size and scope. Estimates do not include additional design fees or private property easement acquisitions required to complete work. The estimates also do not include any downstream upgrades that may be required as a result of the downstream analysis. A summary of the budgetary estimates is shown in *Table 3.3-1*. Refer to *Appendix J* for the unit cost breakdowns.

Given the project location is a densely-populated urban area with both commercial and residential properties abutting most of the project area, a 10% utility relocation allowance has been added to the estimates. A detailed analysis of utility conflicts will need to be performed in the next step of design for the chosen alternative(s). Known and anticipated existing utilities within Oaklawn Avenue, Warren Avenue, and Wilbur Avenue include sewer, water, gas, telecom, traffic infrastructure, and underground/overhead electric.

The budgetary cost estimates also include other contingency or lump sum items that were based on an assumed percentage. Mobilization and Traffic Control lump sum items were assumed at 5% and 6% of the project cost, respectively. A Site Preparation lump sum item was added to include work such as erosion and sedimentation control, while work such as clearing and grubbing and tree removal was included as individual items. A restoration lump sum was also added to the budgetary cost estimates to include work items such as loam and seeding, restoration of landscaped areas or vegetation, removing and resetting/replacing traffic signs, restoration of pavement markings, driveway aprons, fences, walls, and other incidentals. A wetland restoration lump sum was included as removal of the existing drainage infrastructure and installation of the proposed alternatives will impact the wetlands. For the purposes of the budgetary estimates, it was assumed the drainage work would be restored with permanent trench patch, curb to curb restoration of the roadway has not been included.

Table 3.3.1 : Budgetary Estimates for Conceptual Alternatives

Alternative	Estimated Cost
Alternative 1 – Install Parallel System	$16,110,000
Alternative 2 – Watershed IC Reduction	$14,700,000
STU-OAK-001 – Infiltration Basin	$510,000
STU-OAK-002 – Underground Chamber System	$840,000
STU-OAK-003 – Underground Chamber System	$570,000
STU-OAK-004 – Infiltration Basin	$500,000
Interim Improvements	$150,000

3.3.1 Alternative 1 – Install Parallel Systems

The first alternative assessed was to install a parallel system within Oaklawn Avenue to increase the overall conveyance capacity of the existing drainage system to meet the 25-year design storm. Pipe sizing was performed using the methodologies and procedures outlined in the Federal Highway Administration (FHWA) Hydraulic Engineering Circular No. 22 (HEC-22), Urban Drainage Design Manual, utilizing the calculated runoff from the contributing watershed areas.

The primary design intent of this alternative is to convey stormwater runoff from the Blossom Drive and Camelia Drive subwatersheds to a new trunkline within the western side of Oaklawn Avenue to minimize the required size of the eastern trunkline. A limitation associated with this alternative is in accordance with HEC-22 and Chapter 8 of RIDOT's Highway Design Manual, pipes are to be sized to convey the full watershed yield. However, under existing conditions the municipal closed drainage systems within the Blossom Drive and Camelia Drive subwatersheds do not have sufficient capacity to capture and convey the design storm, resulting in a considerable amount of flow bypassing the system and sheet flowing to Oaklawn Avenue. To mimic this bypass condition (from the Cranston neighborhoods) in the model, BETA utilized generic inlets with an interception capacity of 6.0 CFS (assuming double grates) to size pipes based on the bypass flow that could potentially be captured within Oaklawn Avenue. There was no inlet spacing performed, with the intent to provide inlets every 200' along Oaklawn Avenue and at each intersection.

In addition, at the intersections where the municipal closed drainage systems interconnect to the RIDOT system, additional inlets were assumed.

Alternative 1 proposes the two trunklines converge at the Oaklawn-Wilbur intersection to a 4' x 12' box culvert. The culvert will generally follow the existing alignment approximately 1,200 feet to the outfall at a slope of 0.5%. The outfall would be relocated outside of the wetland area, and a tide gate or other appropriate end treatment would be installed to mitigate tailwater impacts. During future design phases, the feasibility of incorporating an open-channel conveyance section through the wetland area south of Wilbur Avenue should be evaluated. This approach could provide additional storage and allow controlled ponding to occur within the wetland area during storm events exceeding the 25-year design storm, thereby reducing flooding impacts along the roadway.

The estimated project cost for Alternative 1 is approximately $16,110,000, as summarized in *Table 3.3-1*. The estimated value does not include the cost for the acquisition of a drainage easement. No available records were found for existing drainage easements or agreements. A comparison of the peak flow rates and capacity of Alternative 1 is shown in *Table 3.3-2*.

Table 3.3.2 : Alternative 1 – Peak Flows vs. Capacity

Rainfall Event Frequency	Peak Flow Rate (CFS)	Outfall Capacity (CFS)
1-Year	149.3	543.9
2-year	186.7	
10-year	301.2	
25-year	372.1	
100-Year	479.8	

3.3.2 Alternative 2 – Watershed Impervious Cover Reduction

The second alternative assessed was to reduce the stormwater runoff to Oaklawn Avenue from the Cranston neighborhoods to the east. The design intent was to reduce the impervious cover and implement stormwater treatment units within the neighborhood subcatchments.

The area to the east of Oaklawn Avenue is approximately 219.3± acres, of which approximately 107.4± acres is impervious area (49.0%). The hydraulic model was developed as a skeleton model, therefore the area to the east of Oaklawn Avenue was divided into seven (7) separate subcatchments, with the local topography directing all stormwater toward Oaklawn Avenue. This alternative was developed to evaluate whether reducing the effective impervious cover to the east of Oaklawn Avenue could reduce peak runoff rates.

The initial analysis considered a 10% impervious cover reduction, which would require the removal or treatment of approximately 10.7 acres of impervious surface. Potential improvements considered to achieve this target include:

- Pavement Removal on City of Cranston Roadways
  - The pavement width of municipal roadways to the east of Oaklawn Avenue have potential to be reduced by 6’ feet from 30’ to 24’. The potential reduction would be 6’ over a total length of 42,500 feet of roadways, thus providing an effective IC reduction of 4.7 acres, for an estimated cost of $2,000,000.

- Bayton Avenue Infiltration Swale
  - This potential swale is to the north of Brayton Avenue. It has the potential dimensions of 575' long, 6' feet wide, and 2' deep within in the City ROW with a storage volume of 6,900 cf. The effective IC reduction of the swale is 0.9 acres, for an estimated cost of $100,000.
- Mount View Road Sand Filter
  - This potential STU is an exfiltrating sand filter located at the intersection of Mount View Road and Brayton Avenue. It has the potential dimensions of 75' long, 25' wide and 4' feet deep within the City ROW with a storage volume of 2,475 cf. The effective IC reduction of the sand filter is 3.1 acres, for an estimated cost of $100,000.
- Camelia Drive Extended Detention Basin:
  - This potential STU is a detention system within a private parking lot. The system has the potential dimensions of 75' long, 65' width and 4' deep providing a storage volume of 20,000 cf. The effective IC reduction of the sand filter is 4.2 acres, for an estimated cost of $300,000.

Utilizing the RIDOT SCP calculator, these measures collectively are estimated to provide an effective IC reduction of 12.8 acres, exceeding the 10% reduction goal of 10.7 acres. To evaluate the hydraulic benefits of these improvements, runoff calculations were revised by recalculating composite runoff coefficients (C-values) after removing 10% of the impervious area from all seven subcatchments. Incorporating the 10% reduction, the total watershed yield for the study area had a reduction from 372.1 cfs to 354.1 cfs, representing a total reduction of 18 cfs (4.8%). Despite this reduction, the required pipe sizes for conveyance of the 25-year design storm did not significantly change.

A secondary analysis considered providing a 25% impervious cover reduction, which would require 26.9 acres of impervious surface to be treated or removed. Potential improvements considered to achieve this target include the 10% reduction improvements discussed above, in addition to the following:

- Infiltration Trenches (various locations):
  - These potential STUs are infiltration trenches located within the pavement reduction limits. To achieve the 25% reduction target, approximately 7,250' of trenches that are 3' wide and 2' deep are required. The effective IC reduction of the infiltration trenches is 14.1 acres, for an estimated cost of $2,150,000.

Another potential improvement to reduce the impervious area within this watershed was to replace the existing catch basins in the City of Cranston drainage system with leaching catch basins. Based on an assumed contributing area of 20,000 sf of impervious area, each basin would result in 0.2 acres of reduction. There are 78 inlets within this watershed that could be replaced, with a total potential impervious cover reduction of 15.6 acres.

To evaluate the reduction, the composite C-values for the seven subcatchments were calculated after removing 25% of the impervious area. The total watershed yield for the project area decreased from 372.1 cfs to 314.6 cfs, representing a total reduction of 57.5 cfs (15.5%) for the 25-year storm. With the 25% reduction, both the drainage system and culvert sizes could be reduced compared to Alternative 1. Most notably, the culvert extending from the intersection of Oaklawn Avenue and Wilbur Avenue to the new outfall could be reduced from a 4' x 12' culvert to a 4' x 8' culvert to convey the 25-year storm.

The estimated project cost for Alternative 2 is approximately $14,700,000, as summarized in *Table 3.3-1*. The estimated value does not include the cost for the acquisition of a drainage easement. No available records were found for existing drainage easements or agreements. The proposed STUs within the Cranston neighborhoods were not estimated separately with unit prices, as it is assumed the City would

be responsible. Instead, SCP calculator costs were utilized for the Cranston STUs, which total $4,650,000 for the STUs identified for 25% reduction. The SCP calculators for the proposed STUs are included in *Appendix K*. A comparison of the peak flow rates for existing conditions and Alternative 2 capacity is shown in *Table 3.3-3*.

Table 3.3.3 : Alternative 2 – Peak Flows vs. Capacity

Rainfall Event Frequency	Peak Flow Rate (CFS)	Outfall Capacity (CFS)
1-Year	125.1	335.2
2-year	156.8	
10-year	254.3	
25-year	314.6	
100-Year	408.4	

3.3.3 NON-FEASIBLE ALTERNATIVES

Several other alternatives were investigated and determined to be non-feasible due to construction constraints and associated costs. The alternatives are briefly described below:

3.3.3.1 NEW CLOSED DRAINAGE SYSTEM & OUTFALL FOR BLOSSOM AND CAMELIA INTERCONNECTIONS

The design intent of this alternative was to install a new closed drainage system to convey the stormwater from the Blossom Drive and Camelia Drive interconnections to a new outfall in the median of the I-295 northbound off-ramp to Route 37 westbound. There is an active infiltration swale at this location (SCP-PR2-327) indicating the potential for stormwater credit. The proposed drainage system would cross Oaklawn Avenue and the bike path to the south of Camelia Drive to Vinton Avenue. The system would continue north within Vinton Avenue, which becomes Cranston Street, before passing under Route 37, and turning west to cross the 295 off-ramp to the median. This alternative would eliminate the need for a parallel trunkline and reduce the potential upsizing required to the existing trunkline. In accordance with RIDOT pipe sizing, the new system would be a 42" RCP. However, without significant upgrades to the municipal systems within Blossom Avenue and Camelia Drive to intercept the generated stormwater, the watershed yield would not be captured and conveyed by the new 42" system based on an overall watershed area of 111.6± acres and yield of 165.6 cfs. In addition, based on topography of Oaklawn Avenue and the elevation of the existing interconnections, the new system and outfall would need to buck grade approximately 1,100 feet, resulting in the system reaching depths of up to 20'. For these reasons, this alternative was not explored further.

3.3.3.2 NEW CLOSED DRAINAGE SYSTEM & OUTFALL FOR SCENIC DRIVE INTERCONNECTION

The design intent of this alternative was to install a new closed drainage system to convey the stormwater from the Scenic Road interconnection to a new outfall at the southern end of Fairway Drive. The proposed drainage system would convey flow from the Oaklawn Avenue, Scenic Drive and Old Spring Road intersection to the south in Oaklawn Avenue to the intersection with Fairway Drive. From here, the system would flow south within Fairway Drive to a new outfall adjacent to the wetland complexes of the Meshanticut Brook. The alternative would reduce the amount of flow within the existing Oaklawn Avenue system; however, due to the undersized municipal systems within this subcatchment, any runoff not captured by the municipal system would continue to sheet flow to the Oaklawn-Wilbur intersection. In accordance with RIDOT pipe sizing the new system would require a 42" RCP based on an overall watershed area of 34.2± acres and yield of 63.2 cfs. Without significant upgrades to the municipal systems, the new system would not convey the yield of the watersheds due to the amount of flow bypassing within the Cranston watershed that cannot be captured without additional inlets upstream. In addition, based on

topography of Oaklawn Avenue and the elevation of the existing interconnections, the new system and outfall would need to buck grade south approximately 1,200 feet, resulting in the system reaching depths of up to 15'. For these reasons, this alternative was not explored further.

3.3.3.3 UPSIZE EXISTING TRUNKLINE

The design intent of this alternative was to upsize the existing trunkline to maintain the existing drainage network layout. The existing trunkline to the north of the Oaklawn-Wilbur intersection is within the eastern sidewalk and gutter line. From record plans and dig safe markings, it was determined that the water main and gas main are on either side of the existing pipe. Due to the utility constraints, there is limited space for upsizing. In addition to utility conflicts, the invert at the low point at the Oaklawn-Wilbur intersection needs to be maintained in order to keep the minimum 0.5% slope of the culvert. This would result in increased pipe sizes for the single trunkline in the northern portion of the network to have less than 1 foot of cover. In addition, the pipe sizes would be large diameter (>60") for much of Oaklawn Avenue, which would result in other issues such as blocking out sewer or other utility services. Therefore, this alternative was not explored further.

3.3.3.4 DETENTION SYSTEM

This alternative investigated the installation of an underground detention system within a vacant parcel (Plat 15/Lot 74) located at the intersection of Brayton Avenue and Oaklawn Avenue. The RIDEM Environmental Resource Map identifies a leaking underground storage tank (L-UST) at the site, proposed work would require removal of the tank. Additionally, the extensive excavation required for installation of the underground detention system would likely trigger environmental remediation activities. These remediation requirements, combined with the need to acquire the parcel, would contribute significantly to the overall project cost. Due to the high cost and potential environmental challenges, this alternative was not explored further.

3.3.4 CONCEPTUAL STU ALTERNATIVES

The following alternatives are being proposed to provide additional capacity and detention along Oaklawn Avenue, Wilbur Avenue, and Allard Street, to help mitigate flooding issues at the intersection of Oaklawn Avenue and Wilbur Avenue. These STUs were analyzed separately from the proposed closed drainage system alternatives.

3.3.4.1 STU-OAK-001 – INFILTRATION BASIN (OAK LAWN ELEMENTARY SCHOOL)

There are two undeveloped, wooded City-owned parcels along the southern side of the Oak Lawn Elementary School (Plat 18/Lot 692 and Plat 18/Lot 1556) available for a partnership opportunity with the City of Cranston. The main 36" trunkline for the Oaklawn Avenue drainage system traverses through these parcels to an existing outfall to the wetlands on the southwest side of the school. The improvements identified for this alternative include installing a diversion manhole along the 30" trunkline to direct low flows to an infiltration basin to store and/or infiltrate stormwater runoff. An overflow structure would control outlet flows to the wetlands through a new outfall. The total watershed area contributing to this STU is 273.3 acres, 137.9 acres of which is impervious (50.4%). The RIDOT right-of-way only accounts for approximately 13.4 acres of the contributing watershed (4.9% of total), with 8.8 acres being impervious.

Based on the available space within the City-owned parcels, a 100' x 70' x 6' deep basin could fit within the area. The total available volume for the basin is approximately 42,000 c.f. The privately-owned residential parcel to the east, the school parking lot and driveway to the north and west, and Allard Street to the south encompass the extents of the basin. For the 10-Year storm, approximately 49,400 c.f. would

infiltrate through the basin in addition to the storage volume. The estimated project cost for STU-OAK-001 is approximately $510,000. The potential total IC reduction is 55.8 acres (12.4 acres if lined).

3.3.4.2 STU-OAK-002 – UNDERGROUND CHAMBER SYSTEM (IMMACULATE CONCEPTION CHURCH)

Along the northbound side of Oaklawn Avenue, there is a grassed shoulder along the Immaculate Conception Church property (Plat 16/Lot 316) available for a partnership opportunity with the Church. The 18" trunkline is located parallel to the property on the east side of the Oaklawn Avenue drainage system. The improvements identified for this alternative include installing a diversion manhole along the 18" trunkline to direct low flows to an underground chamber system to store and/or infiltrate stormwater runoff. An overflow pipe from the system would convey excess flows back into the closed drainage network via a doghouse manhole. The total watershed area contributing to this STU is approximately 91.5 acres, 48.2 acres of which is impervious (52.7%). The RIDOT right-of-way only accounts for approximately 2.7 acres of the contributing watershed (3.0% of total), with the majority being impervious area (2.5 acres).

Based on the available space between the RIDOT ROW along Oaklawn Avenue and the steeply sloped portion of the privately-owned Church parcel, a narrow UIC system can fit within the area. The steep topography of the grassed area to the southwest corner of the property flattens out to allow for a larger system. The total available volume of the UIC is approximately 12,900 c.f. The footprints of the UICs are limited by the depth of the existing system and maximum allowable cover on the chambers, as this area is steeply sloped (~25%) under existing conditions. For the 10-year storm, approximately 10,400 c.f. would infiltrate through the system in addition to the storage volume. The estimated project cost for STU-OAK-002 is approximately $840,000. The potential total IC reduction is 12.7 acres (7.5 acres if lined).

3.3.4.3 STU-OAK-003 – UNDERGROUND CHAMBER SYSTEM (WILBUR AVENUE AT EXCHANGE STREET)

Northwest of the intersection of Oaklawn Avenue and Wilbur Avenue is a City of Cranston-owned parcel (Plat 18/Lot 1467) and RIDOT-owned right-of-way that contain a "Woodland Trail Historic Oaklawn Village" sign and a war memorial, as well as the Washington Secondary Trail bike path. Based on BETA's review of the field conditions, the improvements identified for this alternative include diverting flow from the existing inlet on Exchange Street to direct low flows to an underground chamber system to store and/or infiltrate stormwater runoff. An overflow pipe from the system would convey excess flows back into the closed drainage network at the existing inlet within Wilbur Avenue. The total watershed area contributing to this STU is approximately 6.4 acres, of which 4.7 acres are impervious (73.1%). The RIDOT right-of-way only accounts for approximately 0.2 acres of the contributing watershed (3.1% of total), all of which is impervious area (0.2 acres).

Based on the available space within the City-owned parcel and RIDOT right-of-way, a UIC with the potential dimensions of 100' x 30' could fit within this area. This UIC requires removal and replacement of trees, relocation of signage and benches, and potentially other affected park amenities). The total available volume of the UIC is approximately 7,000 c.f. The footprint of the UIC is limited by the available open space and existing elevations in the parcels. For the 10-year storm, approximately 9,800 c.f. would infiltrate through the system in addition to the storage volume. The estimated project cost for STU-OAK-003 is approximately $570,000. The potential total IC reduction is 3.9 acres (2.2 acres if lined).

3.3.4.4 STU-OAK-004 – INFILTRATION BASIN (OAKLAWN AVENUE AT WILBUR AVENUE)

South of the intersection of Oaklawn Avenue at Wilbur Avenue is a privately-owned wooded parcel (Plat 18/Lot 1398) between the Washington Secondary Trail bike path and Oaklawn Avenue that runs parallel to the 12" drainage system. Although on a private property, this location could be a potential acquisition

as the land is largely unbuildable due to the size, adjacent ROW for the roadway and bike path, as well as the steep topography. Based on BETA's review of the field conditions, the improvements identified for this alternative include installing a diversion manhole along the 12" trunkline to direct low flows to an infiltration basin to store and/or infiltrate stormwater runoff. An overflow structure would control outlet flows back into the system within Oaklawn Avenue through a new doghouse manhole. The total watershed area contributing to this STU is approximately 34.9 acres, 17.8 acres of which is impervious (51.0%). The RIDOT right-of-way only accounts for approximately 1.5 acres of the contributing watershed (4.3% of total), with 1.2 acres being impervious.

Based on the available space within the wooded parcel, surrounding topography, and elevations of existing drainage infrastructure, a 90' x 30' x 4' deep basin could fit within the area. The total available volume for the basin is approximately 10,800 c.f. The Washington Secondary Trail bike path to the west and Oaklawn Avenue to the east limit the extents of the basin. For the 10-Year Storm, approximately 20,800 c.f. would infiltrate through the system in addition to the storage volume. The estimated project cost for STU-OAK-004 is approximately $500,000. The potential total IC reduction is 11.1 acres (2.9 acres if lined).

Further investigation is required at all STU locations including conducting test pits to determine the feasibility of infiltrating stormwater. BETA recommends soil evaluations to determine seasonal high groundwater table (SHGWT) and infiltration testing to determine design infiltration rates. If infiltration is not feasible at these locations, a lined detention system (extended detention basin or UIC sand filter) would be an option for detention of stormwater. Both scenarios (infiltration and storage) have been analyzed in HydroCAD and summarized above. Soil maps of the area indicate Merrimac-Urban Land complex (MU) soils, which are classified in hydrologic soil group "A", consisting of mainly deep, well-drained to excessively drained sands or gravelly sands, which display good drainage characteristics. MU soils typically have a depth to water table of greater than 80 inches; however, this would need to be confirmed with test pits. The STUs were modeled with an infiltration rate of 2.41 in/hr to be conservative.

Budgetary estimates have been developed based on unit cost pricing for the work proposed in each of the conceptual alternatives. Unit prices were developed using RIDOT's published weighted average unit prices in combination with recent bid results from projects of similar size and scope. Estimates do not include additional design and permitting fees or private property easement acquisitions required to complete work. Conceptual plans and estimates are included in *Appendix H* and *Appendix J* of this report, respectively.

3.3.5 Outfall Improvements

BETA also reviewed short-term improvements that could be made based on the deficiencies found in the CCTV inspections listed in Section 2.3. These improvements can be completed during planning and design of other alternatives. Outfall improvements include the following:

- Cleaning and flushing the entire trunkline between the intersection of Oaklawn Avenue and Wilbur Avenue to the outfall as there were several deficiencies noted in the CCTV inspections. RIDOT has already conducted cleaning of several of the upstream structures at the intersection of Scenic Drive and Oaklawn Avenue that has alleviated some of the localized flooding in the area.
- Repair or replacement of sections or pipe noted with openings or root intrusions are recommended to be addressed in the short term.
- The existing outfall was unable to be located during any field visits or CCTV inspections; it is assumed the pipe is either completely submerged or buried. Based on prior inspections the outfall is located within the wetland complex and is susceptible to tailwater effects. The outfall should

be removed and relocated outside of the wetland limits with a new headwall and tide gate to prevent tailwater conditions and improve the hydraulic functionality of the outfall.

The estimated project cost for these interim improvements is approximately $150,000, as summarized in *Table 3.3.1*. Given that these improvements are $150,000, it is anticipated that RIDOT could perform these improvements under their existing MPA contracts.

4.0 CONCLUSION

The existing drainage network was reviewed and analyzed for Oaklawn Avenue, Wilbur Avenue, and Warren Avenue in Cranston. The assessment goal was to calculate the capacity of the state-owned infrastructure in accordance with the 1-, 2-, 10-, 25-, and 100-year design storm events and recommend potential alternatives to address identified deficiencies, particularly to address flooding issues at the intersection of Oaklawn Avenue and Wilbur Avenue.

During the field inspections, flooding was observed at the intersection of Oaklawn Avenue and Wilbur Avenue, as well as excessive gutter spread along the majority of municipal roads to the east of Oaklawn Avenue. In the short term, BETA recommends replacing the outfall by pulling the new outfall back outside of the wetlands to eliminate tailwater effects and improve efficiency of the system. In addition, the cleaning and flushing of the trunkline to the south of the Oaklawn-Wilbur intersection to remove blockages is advised. Repair of several root intrusions and pipe openings is also recommended.

The results of the analysis showed that the flooding that occurs at the intersection of Oaklawn Avenue and Wilbur Avenue is mainly attributed to a large contributing watershed, the majority being outside of RIDOT ROW from surrounding City of Cranston neighborhoods. Lack of upstream catch basins within the Cranston neighborhoods leads to significant bypass of stormwater flow down to Oaklawn Avenue, which is further exacerbated by flat and undersized drainage infrastructure. The existing drainage network and intersection shows surcharging even for the 1-year storm, with any larger storm events causing major flooding issues throughout the system. The proposed parallel system alternatives are designed to meet the 25-year storm event.

Based on the location of the existing drainage infrastructure and the proposed work as part of the alternatives, permitting through RIDEM is anticipated. Potential permitting could include applications to Freshwater Wetlands, Stormwater, and RIPDES. The conceptual designs and cost estimates do not account for any required water quality treatment, if required by RIDEM; however, several conceptual STUs have been identified which could be used to meet the stormwater requirements. As noted previously, a downstream analysis will need to be performed for Alternative 1 and 2 to assess downstream impacts of the added flow to the outfall.

The potential alternatives presented in this report aim to address the capacity and related flooding issues at the intersection of Oaklawn Avenue and Wilbur Avenue. These alternatives were developed for planning and feasibility purposes only. To implement these potential alternatives, a detailed analysis and design would be required.

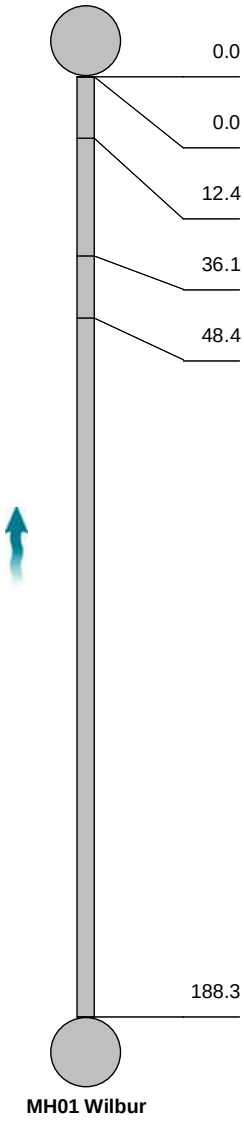
APPENDIX A

CCTV INSPECTION REPORTS

Inspection report

Date:	Work Order:	Weather:	Surveyed By:	Certificate Number:	Pipe Segment Ref.:
3/31/2025		**Dry Weather/Wet Ground**	**Ian Kirby**	**0**	**3/31/2025 10:30:10 AM**
Year laid:	Pre-cleaning:	Direction:	Pipe Joint Length:	Total Length:	Length Surveyed:
	Not Known	**Upstream**		**188.3 '**	**188.3 '**

City:	**Cranston**	Drainage Area:		Upstream MH:	**MH01 Wilbur**
Street:	**Wilbur Ave**	Media Label:		Up Rim to Invert:	**0.0**
Location Code:		Flow Control:		Downstream MH:	**CB01 Warren Ave**
Location Details:		Sheet Number:		Down Rim to Invert:	**0.0**
Pipe shape:	**Circular**	Sewer Use:	**Stormwater Pipe**	Total gallons used:	**0.0**
Pipe size:	**30 "**	Sewer Category:	**SEC**	Joints passed:	**0**
Pipe material:	**Reinforced Concrete Pipe**	Purpose:		Joints failed:	**0**
Lining Method:		Owner:			
Additional Info:					

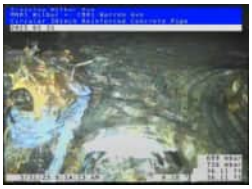


Distance	Code	Observation	Grade
0.0	AMH	Manhole / CB01 Warren Ave	
0.0	MWL	Water Level, 10% of the vertical dimension	
12.4	RFJ	Roots Fine Joint at 7 o'clock, within 8 inch	
36.1	RMJ	Roots Medium Joint from 5 o'clock to 7 o'clock, 10% of cross sectional area, within 8 inch	
48.4	RFJ	Roots Fine Joint from 5 o'clock to 7 o'clock, within 8 inch	
188.3	AMH	Manhole / Buried MH	


AMH - 0.00


MWL - 0.00


RFJ - 12.37


RMJ - 36.11


RMJ - 36.11

Inspection report

Date:	Work Order:	Weather:	Surveyed By:	Certificate Number:	Pipe Segment Ref.:
3/31/2025		**Dry Weather/Wet Ground**	**Ian Kirby**	**0**	**3/31/2025 10:30:10 AM**
Year laid:	Pre-cleaning:	Direction:	Pipe Joint Length:	Total Length:	Length Surveyed:
	Not Known	**Upstream**		**188.3 '**	**188.3 '**



RFJ - 48.43



AMH - 188.28

QSR	QMR	QOR	SPR	MPR	OPR	SPRI	MPRI	OPRI
0000	3112	3112	0.0	5.0	5.0	0.0	1.7	1.7

Section Pictures - 3/31/2025 - 3/31/2025 10:30:10 AM

City	Street	Date	Lateral Segment Reference	Section No.
Cranston	**Wilbur Ave**	**3/31/2025**	**3/31/2025 10:30:10 AM**	**872**



3_31_2025 10_30_10 AM_53cd947c-ee61-49bd-a467-344a967c96de_20250331_103126_836.jpg, 00:00:00, 0.00ft
Manhole / CB01 Warren Ave



3_31_2025 10_30_10 AM_12c7893c-d22c-4329-9f1c-d572ee4d00e8_20250331_103134_949.jpg, 00:00:02, 0.00ft
Water Level, 10% of the vertical dimension



3_31_2025 10_30_10 AM_0375fb6b-8c7f-4944-9cc7-a305cf2a8656_20250331_103224_337.jpg, 00:00:37, 12.37ft
Roots Fine Joint at 7 o'clock, within 8 inch



3_31_2025 10_30_10 AM_7449ba8e-a875-47bd-bf79-68711b608e2c_20250331_103326_487.jpg, 00:01:23, 36.11ft
Roots Medium Joint from 5 o'clock to 7 o'clock, 10% of cross sectional area, within 8 inch

Section Pictures - 3/31/2025 - 3/31/2025 10:30:10 AM

City	Street	Date	Lateral Segment Reference	Section No.
Cranston	**Wilbur Ave**	**3/31/2025**	**3/31/2025 10:30:10 AM**	**872**



3_31_2025 10_30_10 AM_4c73fb36-5ca2-4d8d-9fe7-857b43338f51_20250331_103342_564.jpg, 00:01:23, 36.11ft
Roots Medium Joint from 5 o'clock to 7 o'clock, 10% of cross sectional area, within 8 inch



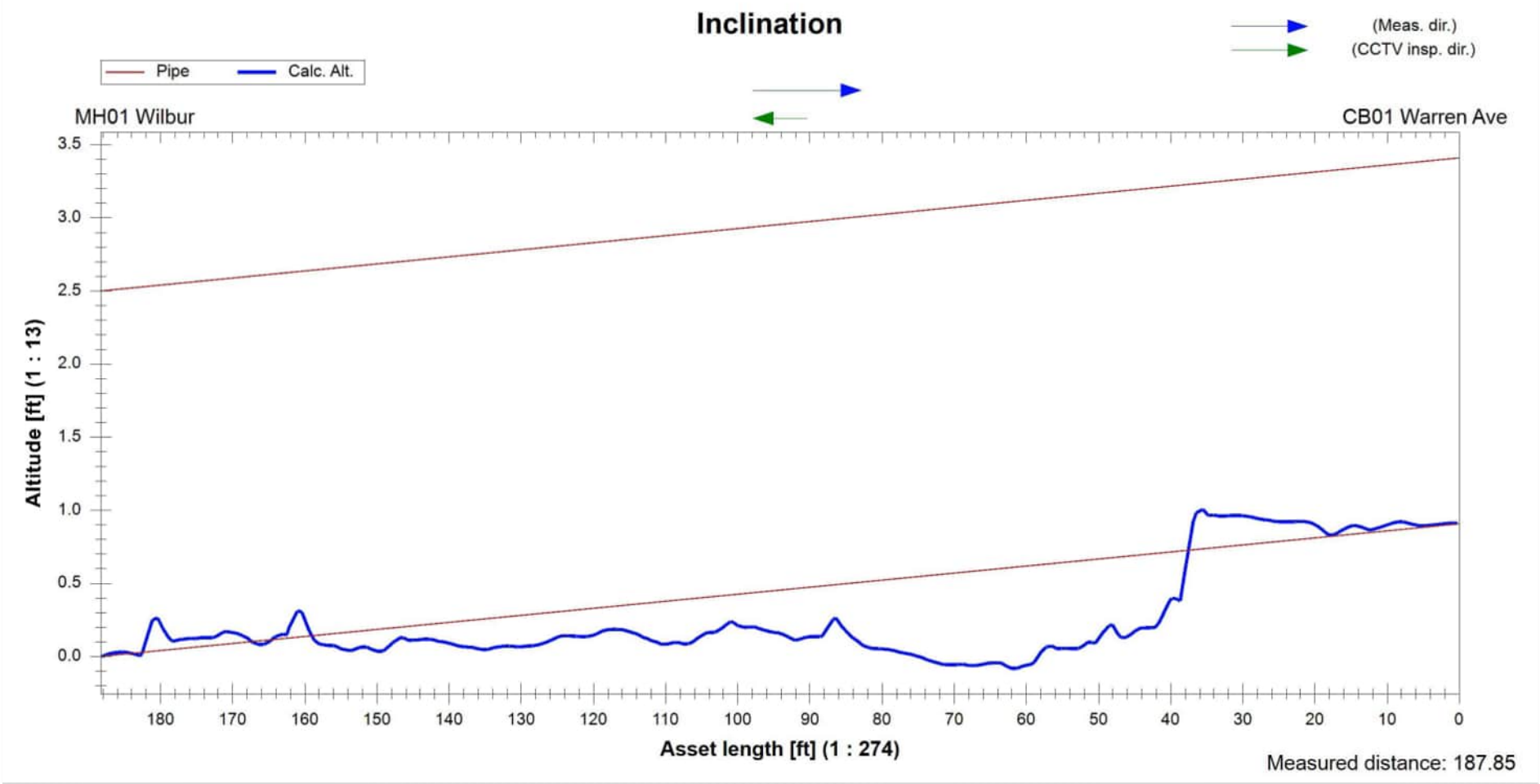
3_31_2025 10_30_10 AM_2644e376-b5b2-4a68-8d91-e862580c600a_20250331_103430_399.jpg, 00:02:14, 48.43ft
Roots Fine Joint from 5 o'clock to 7 o'clock, within 8 inch



3_31_2025 10_30_10 AM_bd5a27ed-4b74-4f14-9303-556f6043d29e_20250331_104426_892.jpg, 00:11:49, 188.28ft
Manhole / Buried MH

WinCan Section Inclination - 3/31/2025 - 3/31/2025 10:30:10

Lateral Segment Referen	Date	Time	Surveyed By	City	Street	Direction	Length Surveyed
3/31/2025 10:30:10 AM	3/31/2025	10:31 AM	Ian Kirby	Cranston	Wilbur Ave	Upstream	187.85
Pipe Shape	**Size**	**Width**	**Upstream MH**	**Downstream MH**	**Start altitude**	**End altitude**	**Measured Inc**
Circular	30	30	MH01 Wilbur	CB01 Warren Ave	0.000	0.909	1.588 %



Inspection report

Date:	Work Order:	Weather:	Surveyed By:	Certificate Number:	Pipe Segment Ref.:
3/31/2025		**Dry Weather/Wet Ground**	**Ian Kirby**	**0**	**3/31/2025 10:47:49 AM**
Year laid:	Pre-cleaning:	Direction:	Pipe Joint Length:	Total Length:	Length Surveyed:
	Not Known	**Downstream**		**108.1 '**	**108.1 '**

City:	**Cranston**	Drainage Area:		Upstream MH:	**CB01 Warren Ave**
Street:	**Wilbur Ave**	Media Label:		Up Rim to Invert:	**0.0**
Location Code:		Flow Control:		Downstream MH:	**MH01 Warren Ave**
Location Details:		Sheet Number:		Down Rim to Invert:	**0.0**
Pipe shape:	**Circular**	Sewer Use:	**Stormwater Pipe**	Total gallons used:	**0.0**
Pipe size:	**30 "**	Sewer Category:	**SEC**	Joints passed:	**0**
Pipe material:	**Reinforced Concrete Pipe**	Purpose:		Joints failed:	**0**
Lining Method:		Owner:			
Additional Info:					

1:817	Distance		Code	Observation	Grade
CB01 Warren Ave					
	0.0		AMH	Manhole / CB01 Warren Ave	
	0.0		MWL	Water Level, 10% of the vertical dimension	
	12.2	S01	RFJ	Roots Fine Joint from 4 o'clock to 8 o'clock, Start, within 8 inch	
	92.1	F01	RFJ	Roots Fine Joint from 4 o'clock to 8 o'clock, Finish, within 8 inch	
	92.1		TB	Tap Break-in/Hammer at 2 o'clock, dia/height: 10inch	
	96.2		RPZ	Point Repair Other / pipe continuation and angle change	
	108.1		AMH	Manhole / Buried MH Stoneham Ct	
MH01 Warren Ave					


AMH - 0.00


MWL - 0.00


RFJ - 12.22


RFJ - 92.12


TB - 92.12

Inspection report

Date:	Work Order:	Weather:	Surveyed By:	Certificate Number:	Pipe Segment Ref.:
3/31/2025		**Dry Weather/Wet Ground**	**Ian Kirby**	**0**	**3/31/2025 10:47:49 AM**
Year laid:	Pre-cleaning:	Direction:	Pipe Joint Length:	Total Length:	Length Surveyed:
	Not Known	**Downstream**		**108.1 '**	**108.1 '**



TB - 92.12



RPZ - 96.17



AMH - 108.15

QSR	QMR	QOR	SPR	MPR	OPR	SPRI	MPRI	OPRI
0000	1B00	1B00	0.0	16.0	16.0	0.0	1.0	1.0

Section Pictures - 3/31/2025 - 3/31/2025 10:47:49 AM

City	Street	Date	Lateral Segment Reference	Section No.
Cranston	**Wilbur Ave**	**3/31/2025**	**3/31/2025 10:47:49 AM**	**873**



3_31_2025 10_47_49
AM_e9cec652-1945-4871-bade-4a05d7fb8de6_20250331_104932_149.jpg, 00:00:00, 0.00ft
Manhole / CB01 Warren Ave



3_31_2025 10_47_49
AM_bb40477e-26f7-4de8-a2d9-04fedfcd7784_20250331_104943_388.jpg, 00:00:02, 0.00ft
Water Level, 10% of the vertical dimension



3_31_2025 10_47_49
AM_ca9a2b82-c9cf-43f7-8174-58d5f4eb35d6_20250331_105019_941.jpg, 00:00:29, 12.22ft
Roots Fine Joint from 4 o'clock to 8 o'clock, Start, within 8 inch



3_31_2025 10_47_49
AM_c661f596-68ef-4d21-b018-b0b7f5a698fd_20250331_105203_103.jpg, 00:01:58, 92.12ft
Roots Fine Joint from 4 o'clock to 8 o'clock, Finish, within 8 inch

WinCan

Section Pictures - 3/31/2025 - 3/31/2025 10:47:49 AM

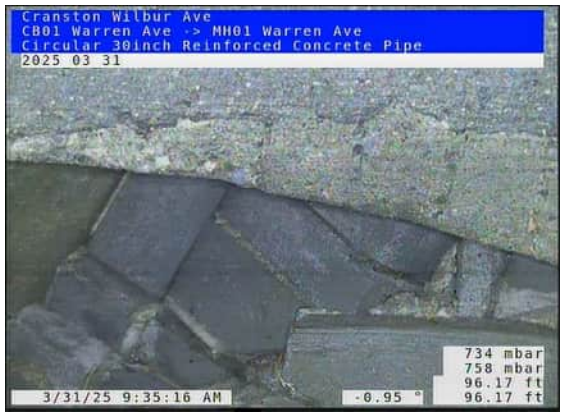
City	Street	Date	Lateral Segment Reference	Section No.
Cranston	**Wilbur Ave**	**3/31/2025**	**3/31/2025 10:47:49 AM**	**873**



3_31_2025 10_47_49
AM_f734146d-5f37-46ee-9a2b-5d0d1085d575_20250331_105306_452.jpg, 00:02:06, 92.12ft
Tap Break-in/Hammer at 2 o'clock, dia/height: 10inch



3_31_2025 10_47_49
AM_0540140a-63c0-4c06-844b-366e17e5209e_20250331_105317_141.jpg, 00:02:06, 92.12ft
Tap Break-in/Hammer at 2 o'clock, dia/height: 10inch



3_31_2025 10_47_49
AM_1780df18-8ff5-4ac2-99b2-5660c4f293a2_20250331_105429_338.jpg, 00:03:07, 96.17ft
Point Repair Other / pipe continuation and angle change

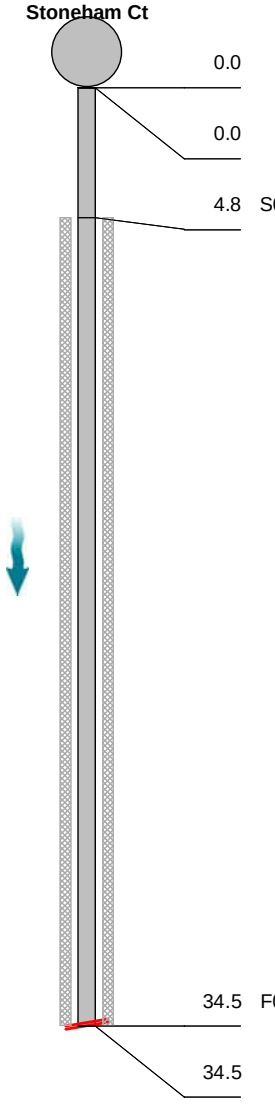


3_31_2025 10_47_49
AM_a5f3225b-4860-447c-a062-e3b5e93ba021_20250331_105827_015.jpg, 00:03:46, 108.15ft
Manhole / Buried MH Stoneham Ct

Inspection report

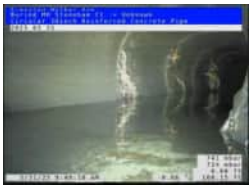
Date:	Work Order:	Weather:	Surveyed By:	Certificate Number:	Pipe Segment Ref.:
3/31/2025		**Dry Weather/Wet Ground**	**Ian Kirby**	**0**	**3/31/2025 10:58:36 AM**
Year laid:	Pre-cleaning:	Direction:	Pipe Joint Length:	Total Length:	Length Surveyed:
	Not Known	**Downstream**		**34.5 '**	**34.5 '**

City:	**Cranston**	Drainage Area:		Upstream MH:	**Buried MH Stoneham**
Street:	**Wilbur Ave**	Media Label:		Up Rim to Invert:	**0.0**
Location Code:		Flow Control:		Downstream MH:	**Unknown**
Location Details:		Sheet Number:		Down Rim to Invert:	**0.0**
Pipe shape:	**Circular**	Sewer Use:	**Stormwater Pipe**	Total gallons used:	**0.0**
Pipe size:	**30 "**	Sewer Category:	**SEC**	Joints passed:	**0**
Pipe material:	**Reinforced Concrete Pipe**	Purpose:		Joints failed:	**0**
Lining Method:		Owner:			
Additional Info:					



1:261 Distance		Code	Observation	Grade
0.0		AMH	Manhole / Buried MH Stoneham Ct	
0.0		MWL	Water Level, 20% of the vertical dimension	
4.8	S01	RFJ	Roots Fine Joint from 12 o'clock to 12 o'clock, Start, within 8 inch	
34.5	F01	RFJ	Roots Fine Joint from 12 o'clock to 12 o'clock, Finish, within 8 inch	
34.5		MSA	Miscellaneous Survey Abandoned / Cannot Pass Roots and Sediment	


AMH - 0.00


MWL - 0.00


RFJ - 4.80


RFJ - 34.49


MSA - 34.49

QSR	QMR	QOR	SPR	MPR	OPR	SPRI	MPRI	OPRI
0000	1600	1600	0.0	6.0	6.0	0.0	1.0	1.0

Section Pictures - 3/31/2025 - 3/31/2025 10:58:36 AM

City	Street	Date	Lateral Segment Reference	Section No.
Cranston	**Wilbur Ave**	**3/31/2025**	**3/31/2025 10:58:36 AM**	**874**



3_31_2025 10_58_36
AM_a608a2ba-ac65-4c9d-8c7f-ab38f1831c73_20250331_105912_646.jpg, 00:00:00, 0.00ft
Manhole / Buried MH Stoneham Ct



3_31_2025 10_58_36
AM_506caf65-b81d-4e27-96d8-a0a6b103fbe2_20250331_105923_228.jpg, 00:00:03, 0.00ft
Water Level, 20% of the vertical dimension



3_31_2025 10_58_36
AM_8e17bc81-b858-4284-ba7a-04bcfb04a154_20250331_105957_245.jpg, 00:00:27, 4.80ft
Roots Fine Joint from 12 o'clock to 12 o'clock, Start, within 8 inch



3_31_2025 10_58_36
AM_cebab694-5ae3-4d91-9194-6f6efa66e504_20250331_110212_082.jpg, 00:02:37, 34.49ft
Roots Fine Joint from 12 o'clock to 12 o'clock, Finish, within 8 inch

Section Pictures - 3/31/2025 - 3/31/2025 10:58:36 AM

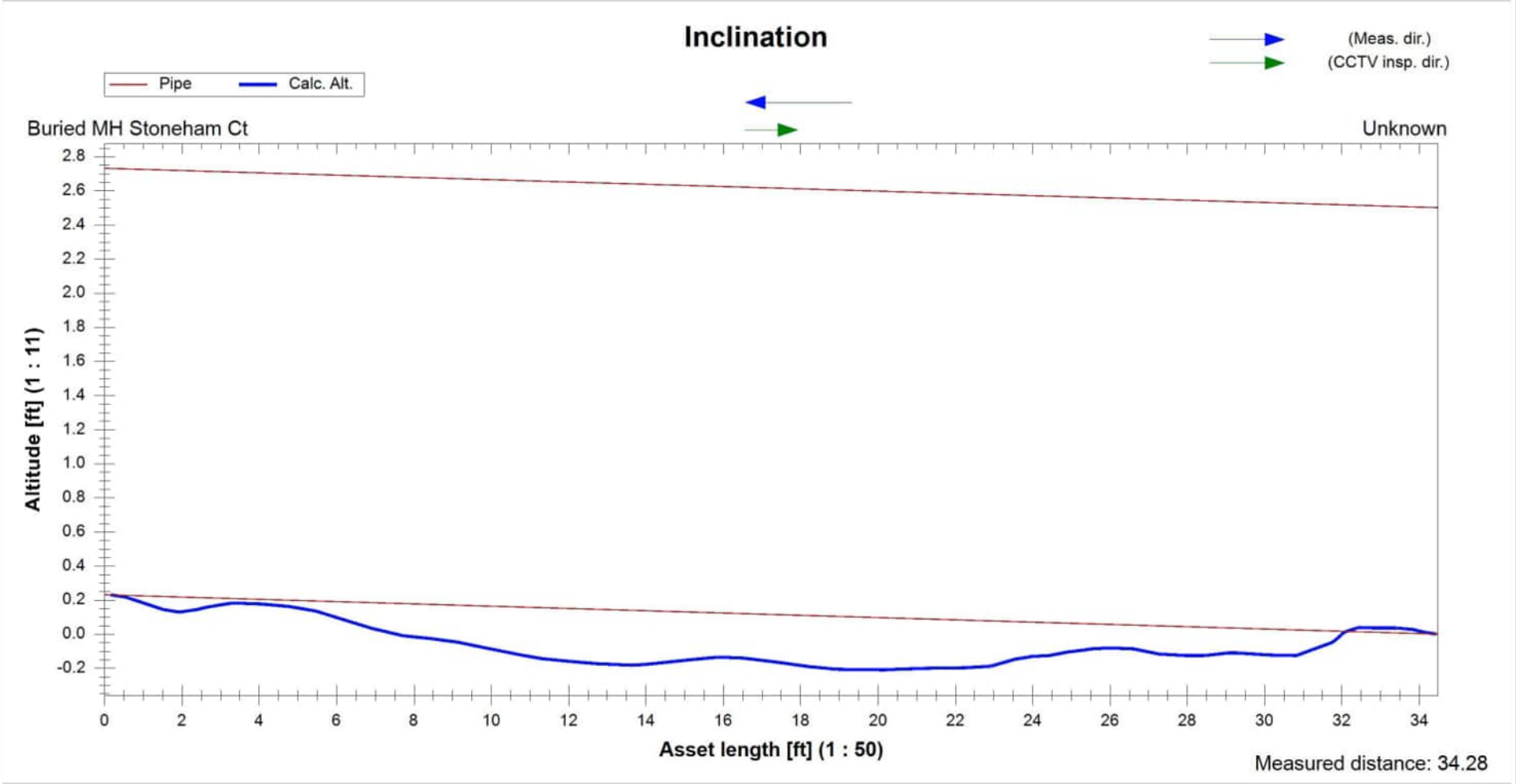
City	Street	Date	Lateral Segment Reference	Section No.
Cranston	**Wilbur Ave**	**3/31/2025**	**3/31/2025 10:58:36 AM**	**874**



3_31_2025 10_58_36 AM_27637f1f-037e-430e-aa15-95e9ab787fb1_20250331_110225_106.jpg, 00:02:40, 34.49ft
Miscellaneous Survey Abandoned / Cannot Pass Roots and Sediment

WinCan Section Inclination - 3/31/2025 - 3/31/2025 10:58:36

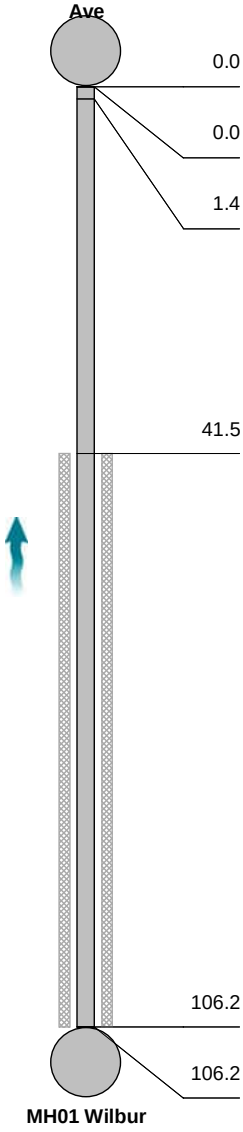
Lateral Segment Referen	Date	Time	Surveyed By	City	Street	Direction	Length Surveyed
3/31/2025 10:58:36 AM	3/31/2025	10:59 AM	Ian Kirby	Cranston	Wilbur Ave	Downstream	34.28
Pipe Shape	**Size**	**Width**	**Upstream MH**	**Downstream MH**	**Start altitude**	**End altitude**	**Measured Inc**
Circular	30	30	Buried MH Stoneham Ct	Unknown	0.001	0.231	-2.203 %



Inspection report

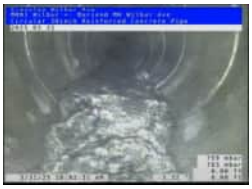
Date:	Work Order:	Weather:	Surveyed By:	Certificate Number:	Pipe Segment Ref.:
3/31/2025		**Dry Weather/Wet Ground**	**Ian Kirby**	**0**	**3/31/2025 11:20:30 AM**
Year laid:	Pre-cleaning:	Direction:	Pipe Joint Length:	Total Length:	Length Surveyed:
	Not Known	**Upstream**		**106.2 '**	**106.2 '**

City:	**Cranston**	Drainage Area:		Upstream MH:	**MH01 Wilbur**
Street:	**Wilbur Ave**	Media Label:		Up Rim to Invert:	**0.0**
Location Code:		Flow Control:		Downstream MH:	**Buriend MH Wilbur Av**
Location Details:		Sheet Number:		Down Rim to Invert:	**0.0**
Pipe shape:	**Circular**	Sewer Use:	**Stormwater Pipe**	Total gallons used:	**0.0**
Pipe size:	**30 "**	Sewer Category:	**SEC**	Joints passed:	**0**
Pipe material:	**Reinforced Concrete Pipe**	Purpose:		Joints failed:	**0**
Lining Method:		Owner:			
Additional Info:					



1:802 Distance		Code	Observation	Grade
0.0		AMH	Manhole / Buriend MH Wilbur Ave	
0.0		MWL	Water Level, 10% of the vertical dimension	
1.4		RTJ	Roots Tap Joint from 5 o'clock to 7 o'clock, 15% of cross sectional area, within 8 inch	
41.5	S01	RFJ	Roots Fine Joint from 4 o'clock to 8 o'clock, Start, within 8 inch	
106.2	F01	RFJ	Roots Fine Joint from 4 o'clock to 8 o'clock, Finish, within 8 inch	
106.2		AMH	Manhole / MH01 Wilbur	


AMH - 0.00


MWL - 0.00


RTJ - 1.37


RFJ - 41.49


RFJ - 106.25

Inspection report

Date:	Work Order:	Weather:	Surveyed By:	Certificate Number:	Pipe Segment Ref.:
3/31/2025		**Dry Weather/Wet Ground**	**Ian Kirby**	**0**	**3/31/2025 11:20:30 AM**
Year laid:	Pre-cleaning:	Direction:	Pipe Joint Length:	Total Length:	Length Surveyed:
	Not Known	**Upstream**		**106.2 '**	**106.2 '**



AMH - 106.25

QSR	QMR	QOR	SPR	MPR	OPR	SPRI	MPRI	OPRI
0000	211A	211A	0.0	15.0	15.0	0.0	1.1	1.1

Section Pictures - 3/31/2025 - 3/31/2025 11:20:30 AM

City	Street	Date	Lateral Segment Reference	Section No.
Cranston	**Wilbur Ave**	**3/31/2025**	**3/31/2025 11:20:30 AM**	**875**



3_31_2025 11_20_30 AM_308b3b93-889c-4f68-8d7a-e46193b5bddc_20250331_112134_444.jpg, 00:00:00, 0.00ft
Manhole / Buriend MH Wilbur Ave



3_31_2025 11_20_30 AM_429e80bd-b925-4377-b7a1-e2b967a253ce_20250331_112144_684.jpg, 00:00:04, 0.00ft
Water Level, 10% of the vertical dimension



3_31_2025 11_20_30 AM_141f9b48-aaee-48cf-9b7f-866da22b4723_20250331_112218_162.jpg, 00:00:25, 1.37ft
Roots Tap Joint from 5 o'clock to 7 o'clock, 15% of cross sectional area, within 8 inch



3_31_2025 11_20_30 AM_89d7711b-9ec8-4d98-abcb-d5067fc4849d_20250331_112315_396.jpg, 00:01:13, 41.49ft
Roots Fine Joint from 4 o'clock to 8 o'clock, Start, within 8 inch

Section Pictures - 3/31/2025 - 3/31/2025 11:20:30 AM

City	Street	Date	Lateral Segment Reference	Section No.
Cranston	**Wilbur Ave**	**3/31/2025**	**3/31/2025 11:20:30 AM**	**875**



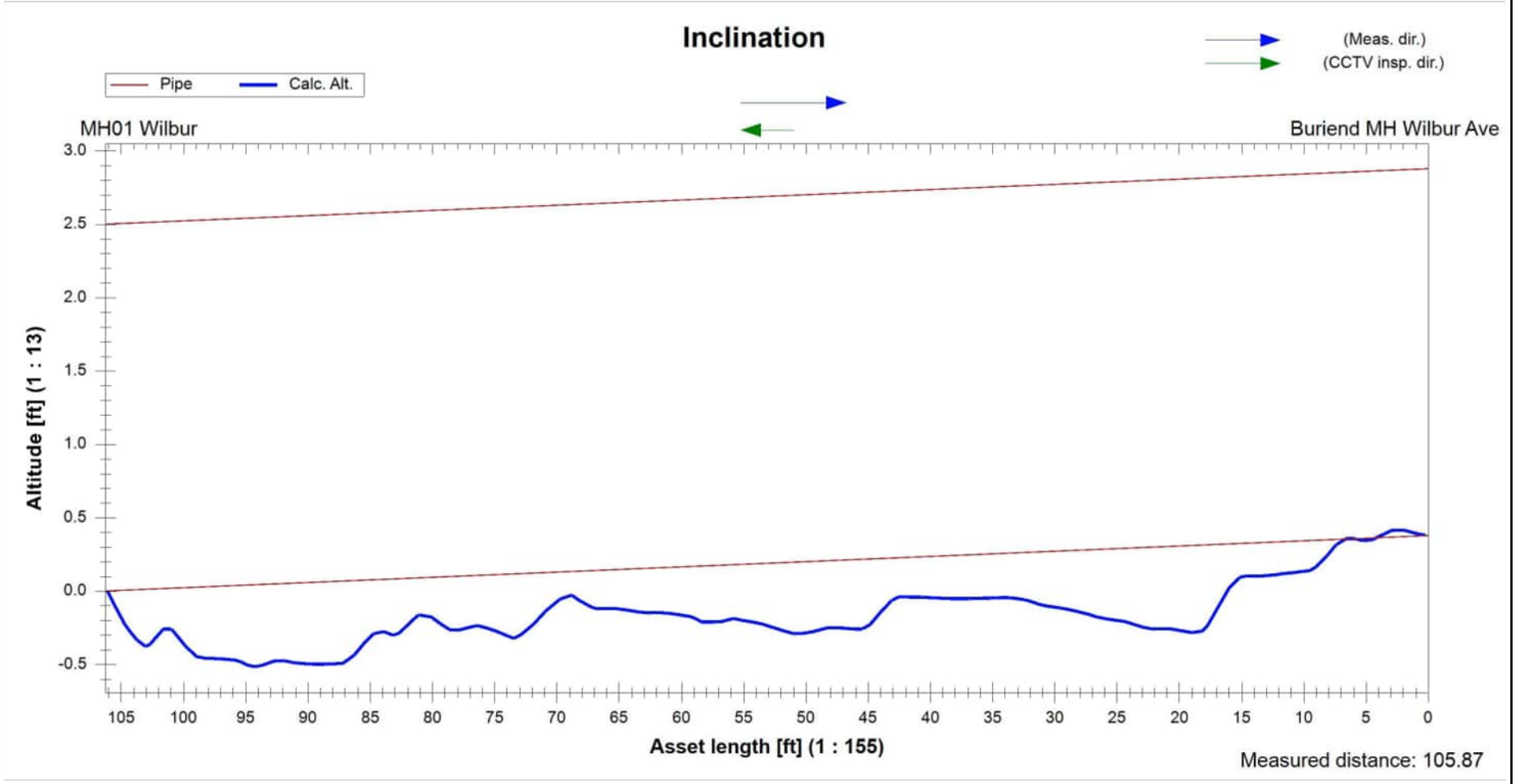
3_31_2025 11_20_30 AM_9f8354aa-bcac-44de-b64e-05ab7dca5370_20250331_113724_475.jpg, 00:15:17, 106.25ft
Roots Fine Joint from 4 o'clock to 8 o'clock, Finish, within 8 inch



3_31_2025 11_20_30 AM_d430a1a1-8c22-4cc7-88cc-4c62b5bcbea8_20250331_113734_698.jpg, 00:15:20, 106.25ft
Manhole / MH01 Wilbur

WinCan Section Inclination - 3/31/2025 - 3/31/2025 11:20:30

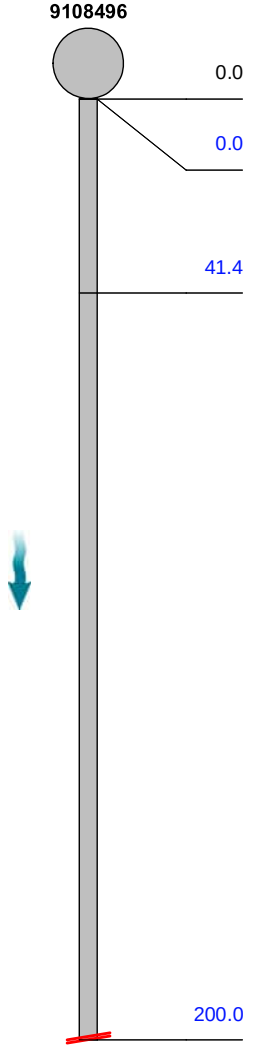
Lateral Segment Referen	Date	Time	Surveyed By	City	Street	Direction	Length Surveyed
3/31/2025 11:20:30 AM	3/31/2025	11:21 AM	Ian Kirby	Cranston	Wilbur Ave	Upstream	105.87
Pipe Shape	**Size**	**Width**	**Upstream MH**	**Downstream MH**	**Start altitude**	**End altitude**	**Measured Inc**
Circular	30	30	MH01 Wilbur	Buriend MH Wilbur Ave	0.000	0.380	1.175 %



Inspection report

Date:	Work Order:	Weather:	Surveyed By:	Certificate Number:	Pipe Segment Ref.:
5/20/2026		**Dry**	**Ian Kirby**	**70402069**	**5/20/2026 10:39:29 AM**
Year laid:	Pre-cleaning:	Direction:	Pipe Joint Length:	Total Length:	Length Surveyed:
	Not Known	**Downstream**		**200.0 '**	**200.0 '**

City:	**Cranston**	Drainage Area:		Upstream MH:	**9108496**
Street:	**Allard Ave**	Media Label:		Up Rim to Invert:	
Location Code:		Flow Control:		Downstream MH:	**9108550**
Location Details:		Sheet Number:		Down Rim to Invert:	
Pipe shape:	**Circular**	Sewer Use:	**Stormwater Pipe**	Total gallons used:	**0.0**
Pipe size:	**36 "**	Sewer Category:	**SEC**	Joints passed:	**0**
Pipe material:	**Reinforced Concrete Pipe**	Purpose:		Joints failed:	**0**
Lining Method:		Owner:			
Additional Info:					



Distance	Code	Observation	Counter	Photo	Grade
0.0	AMH	Manhole / 9108496	00:00:00	1	
0.0	MWL	Water Level, 15% of the vertical dimension	00:00:03	2	
41.4	MWL	Water Level, 50% of the vertical dimension	00:01:16	3	
200.0	MSA	Miscellaneous Survey Abandoned / CANNOT PASS/ UNKNOWN AHEAD	00:18:04	4	

QSR	QMR	QOR	SPR	MPR	OPR	SPRI	MPRI	OPRI
0000	0000	0000	0.0	0.0	0.0	0.0	0.0	0.0

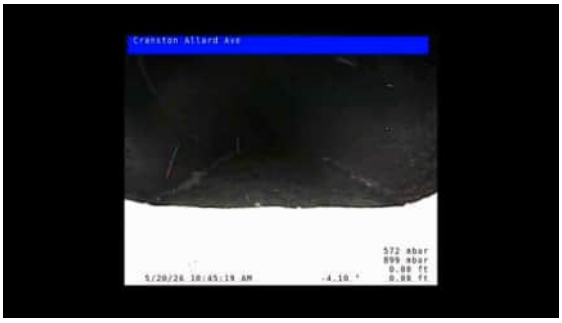
WINCAN

Section Pictures - 5/20/2026 - 5/20/2026 10:39:29 AM

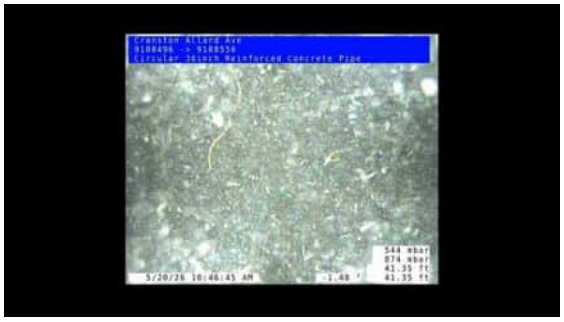
City	Street	Date	Lateral Segment Reference	Section No.
Cranston	**Allard Ave**	**5/20/2026**	**5/20/2026 10:39:29 AM**	**1148**



1, 00:00:00, 0.00ft
Manhole / 9108496



2, 00:00:03, 0.00ft
Water Level, 15% of the vertical dimension



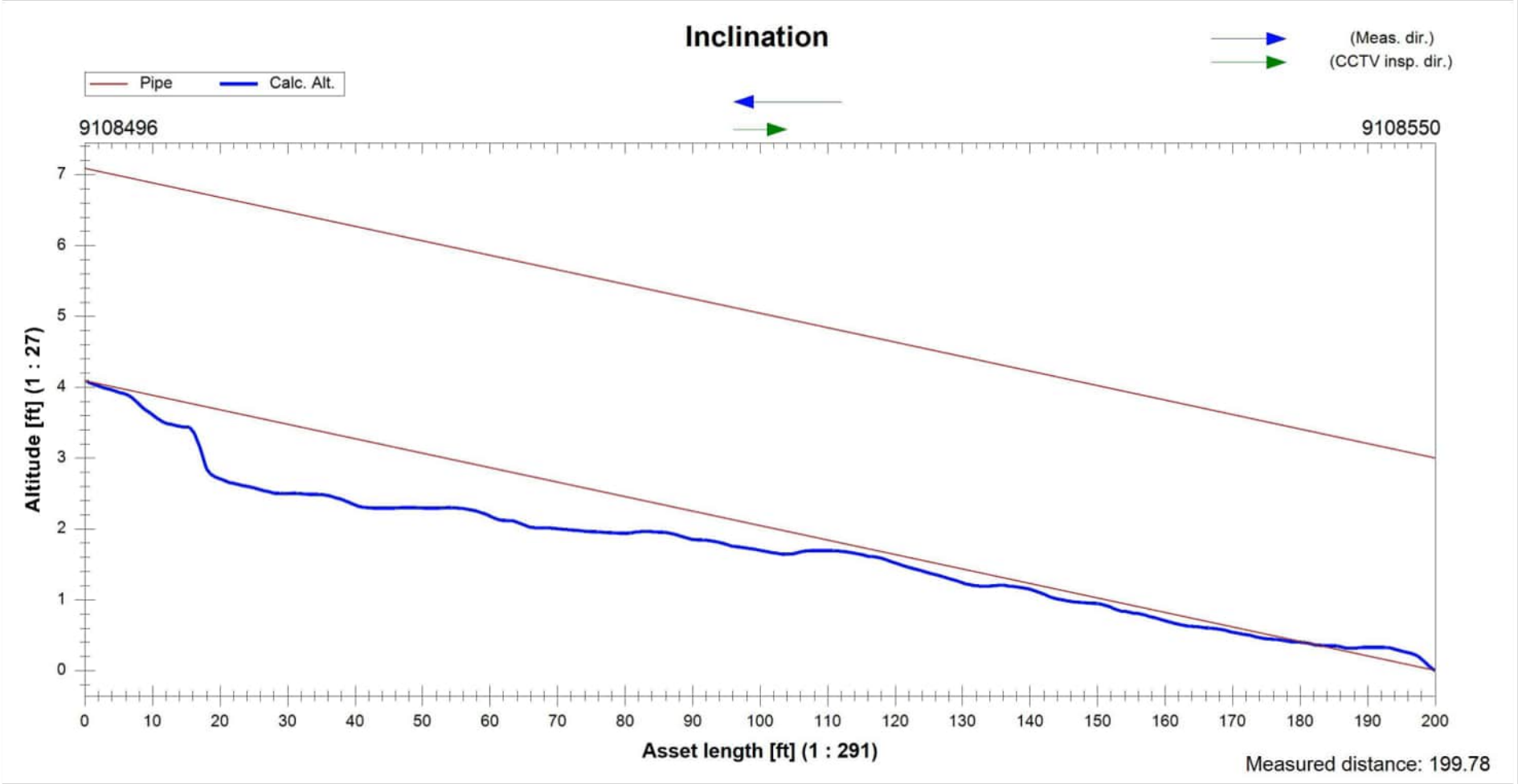
3, 00:01:16, 41.36ft
Water Level, 50% of the vertical dimension



4, 00:18:04, 200.04ft
Miscellaneous Survey Abandoned / CANNOT PASS/ UNKNOWN AHEAD

WINCAN Section Inclination - 5/20/2026 - 5/20/2026 10:39:29

Lateral Segment Reference	Date	Time	Surveyed By	City	Street	Direction	Length Surveyed
5/20/2026 10:39:29 AM	5/20/2026	10:45 AM	Ian Kirby	Cranston	Allard Ave	Downstream	199.78
Pipe Shape	**Size**	**Width**	**Lateral Upstream Access Point**	**Lateral Downstream Access Point**	**Start altitude**	**End altitude**	**Measured Inc**
Circular	36	36	9108496	9108550	0.000	4.079	-2.042 %

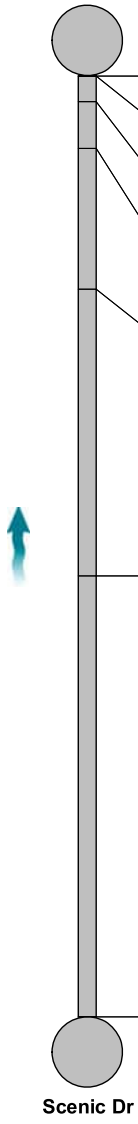


Inspection report

Date:	Work Order:	Weather:	Surveyed By:	Certificate Number:	Pipe Segment Ref.:
5/28/2026		**Dry**	**Ian Kirby**	**70402069**	**5/28/2026 9:27:17 AM**
Year laid:	Pre-cleaning: **Heavy Cleaning**	Direction: **Upstream**	Pipe Joint Length:	Total Length: **104.3 '**	Length Surveyed: **104.3 '**

City:	**Cranston**	Drainage Area:		Upstream MH:	**Scenic Dr**
Street:	**Oaklawn Ave**	Media Label:		Up Rim to Invert:	
Location Code:		Flow Control:		Downstream MH:	**9108854**
Location Details:		Sheet Number:		Down Rim to Invert:	
Pipe shape:	**Circular**	Sewer Use:	**Stormwater Pipe**	Total gallons used:	**0.0**
Pipe size:	**12 "**	Sewer Category:	**SEC**	Joints passed:	**0**
Pipe material:	**Reinforced Concrete Pipe**	Purpose:		Joints failed:	**0**
Lining Method:		Owner:			

Additional Info:



1:787 Distance	Code	Observation	Counter	Photo	Grade
0.0	AMH	Manhole / 9108854	00:00:00	1	
0.0	MWL	Water Level, 10% of the vertical dimension	00:00:03	2	
2.9	RTJ	Roots Tap Joint from 7 o'clock to 10 o'clock, 25% of cross sectional area, within 8 inch	00:00:25	3	M2
8.1	RBL	Roots Ball Lateral from 2 o'clock to 11 o'clock, 90% of cross sectional area	00:00:54	4	M4
23.6	RTJ	Roots Tap Joint from 10 o'clock to 2 o'clock, 20% of cross sectional area, within 8 inch	00:01:22	5	M2
55.4	DSF	Deposits Settled Fine, 25% of cross sectional area from 5 o'clock to 7 o'clock	00:02:06	6	M4
104.3	AMH	Manhole / Scenic Dr	00:03:52	7	

QSR	QMR	QOR	SPR	MPR	OPR	SPRI	MPRI	OPRI
0000	4222	4222	0.0	12.0	12.0	0.0	3.0	3.0

WINCAN

Section Pictures - 5/28/2026 - 5/28/2026 9:27:17 AM

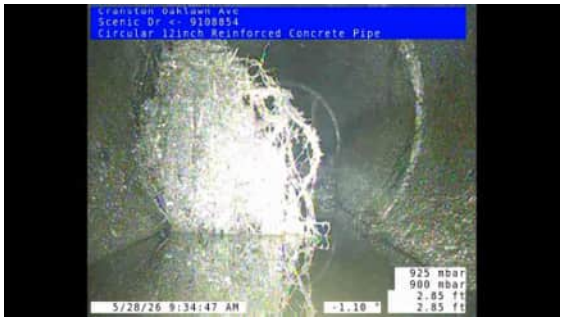
City	Street	Date	Lateral Segment Reference	Section No.
Cranston	**Oaklawn Ave**	**5/28/2026**	**5/28/2026 9:27:17 AM**	**1152**



1, 00:00:00, 0.00ft
Manhole / 9108854



2, 00:00:03, 0.00ft
Water Level, 10% of the vertical dimension



3, 00:00:25, 2.85ft
Roots Tap Joint from 7 o'clock to 10 o'clock, 25% of cross sectional area, within 8 inch

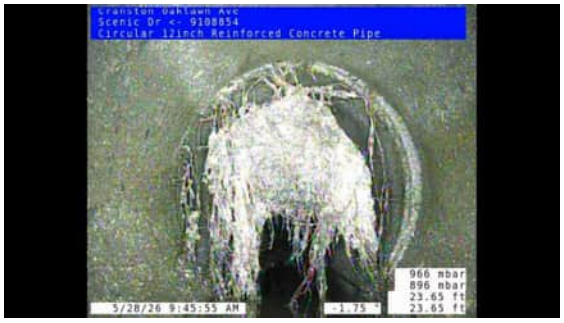


4, 00:00:54, 8.10ft
Roots Ball Lateral from 2 o'clock to 11 o'clock, 90% of cross sectional area

WINCAN

Section Pictures - 5/28/2026 - 5/28/2026 9:27:17 AM

City	Street	Date	Lateral Segment Reference	Section No.
Cranston	**Oaklawn Ave**	**5/28/2026**	**5/28/2026 9:27:17 AM**	**1152**



5, 00:01:22, 23.65ft
Roots Tap Joint from 10 o'clock to 2 o'clock, 20% of cross sectional area, within 8 inch



6, 00:02:06, 55.35ft
Deposits Settled Fine, 25% of cross sectional area from 5 o'clock to 7 o'clock

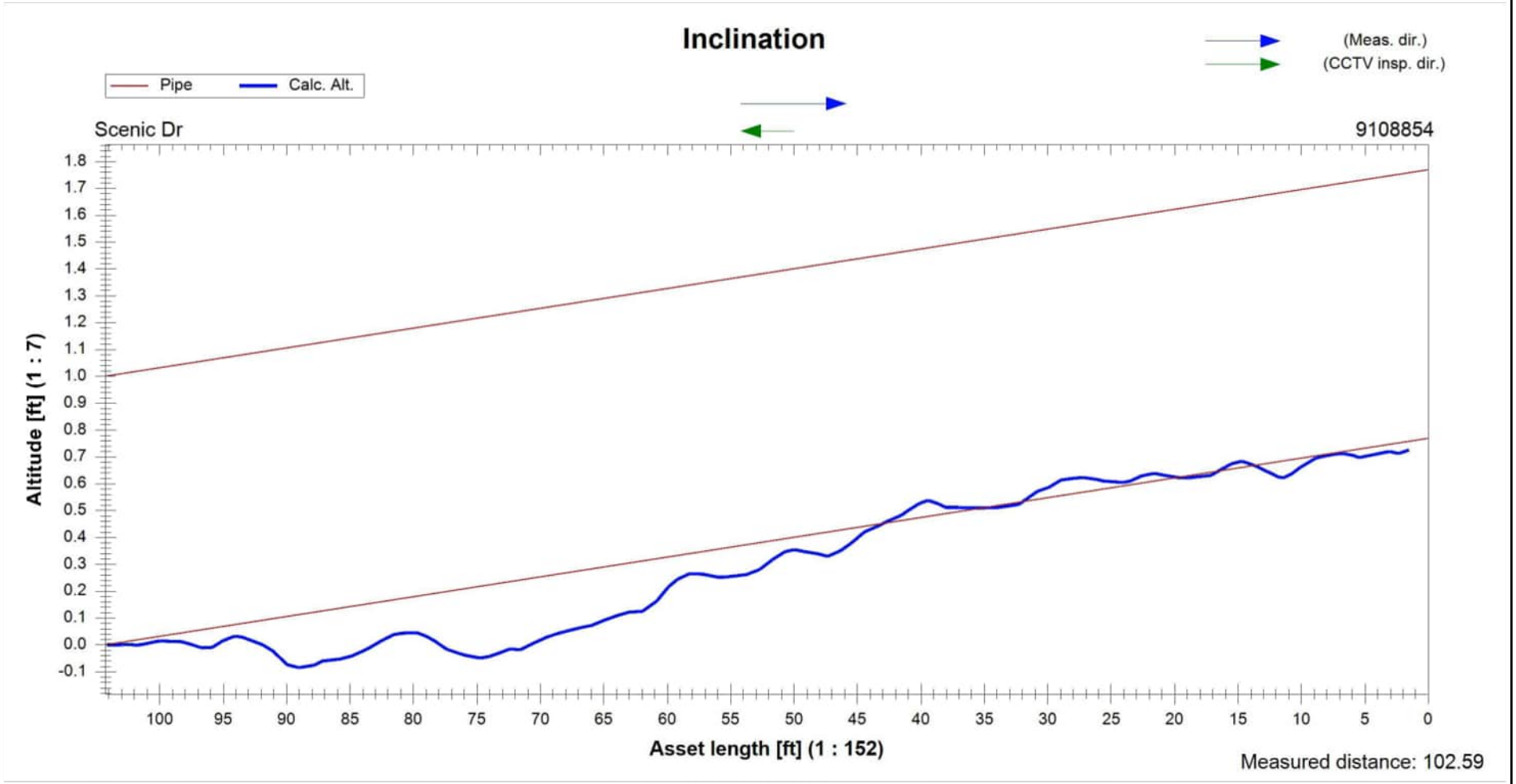


7, 00:03:52, 104.26ft
Manhole / Scenic Dr

WINCAN

Section Inclination - 5/28/2026 - 5/28/2026 9:27:17

Lateral Segment Reference	Date	Time	Surveyed By	City	Street	Direction	Length Surveyed
5/28/2026 9:27:17 AM	5/28/2026	9:35 AM	Ian Kirby	Cranston	Oaklawn Ave	Upstream	102.59
Pipe Shape	**Size**	**Width**	**Lateral Upstream Access Point**	**Lateral Downstream Access Point**	**Start altitude**	**End altitude**	**Measured Inc**
Circular	12	12	Scenic Dr	9108854	0.000	0.725	0.707 %

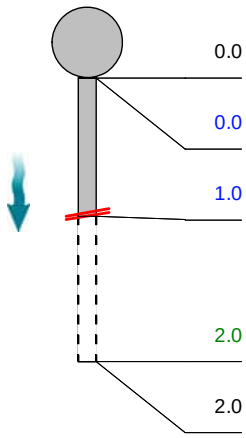


Inspection report

Date:	Work Order:	Weather:	Surveyed By:	Certificate Number:	Pipe Segment Ref.:
5/28/2026		**Dry**	**Ian Kirby**	**70402069**	**5/28/2026 10:44:21 AM**
Year laid:	Pre-cleaning: **Heavy Cleaning**	Direction: **Downstream**	Pipe Joint Length:	Total Length: **2.0 '**	Length Surveyed: **2.0 '**

City:	**Cranston**	Drainage Area:		Upstream MH:	**9108854**
Street:	**Oaklawn Ave**	Media Label:		Up Rim to Invert:	
Location Code:		Flow Control:		Downstream MH:	**23511**
Location Details:		Sheet Number:		Down Rim to Invert:	
Pipe shape:	**Circular**	Sewer Use:	**Stormwater Pipe**	Total gallons used:	**0.0**
Pipe size:	**12 "**	Sewer Category:	**SEC**	Joints passed:	**0**
Pipe material:	**Reinforced Concrete Pipe**	Purpose:		Joints failed:	**0**
Lining Method:		Owner:			

Additional Info:



1:50	Distance	Code	Observation	Counter	Photo	Grade
	0.0	AMH	Manhole / 9108854	00:00:00	1	
	0.0	MWL	Water Level, 0% of the vertical dimension	00:00:02	2	
	1.0	MSA	Miscellaneous Survey Abandoned / Cannot Pass	00:00:47	3	
	2.0	RBB	Roots Ball Barrell from 12 o'clock to 12 o'clock, 90% of cross sectional area	00:00:42	4	M5
	2.0		End of pipe			

QSR	QMR	QOR	SPR	MPR	OPR	SPRI	MPRI	OPRI
0000	5100	5100	0.0	5.0	5.0	0.0	5.0	5.0

WINCAN

Section Pictures - 5/28/2026 - 5/28/2026 10:44:21 AM

City	Street	Date	Lateral Segment Reference	Section No.
Cranston	**Oaklawn Ave**	**5/28/2026**	**5/28/2026 10:44:21 AM**	**1153**



1, 00:00:00, 0.00ft
Manhole / 9108854



2, 00:00:02, 0.00ft
Water Level, 0% of the vertical dimension



3, 00:00:47, 0.97ft
Miscellaneous Survey Abandoned / Cannot Pass



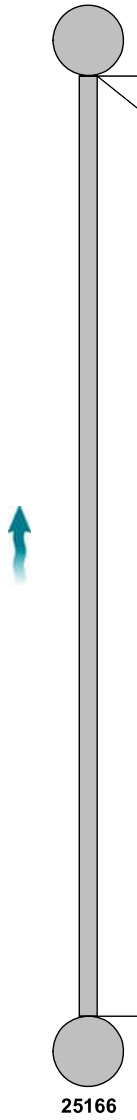
4, 00:00:42, 2.00ft
Roots Ball Barrell from 12 o'clock to 12 o'clock, 90% of cross sectional area

WINCAN

Inspection report

Date:	Work Order:	Weather:	Surveyed By:	Certificate Number:	Pipe Segment Ref.:
5/28/2026		**Dry**	**Ian Kirby**	**70402069**	**5/28/2026 11:38:03 AM**
Year laid:	Pre-cleaning:	Direction:	Pipe Joint Length:	Total Length:	Length Surveyed:
	Heavy Cleaning	**Upstream**		**43.3 '**	**43.3 '**

City:	**Cranston**	Drainage Area:		Upstream MH:	**25166**
Street:	**Oaklawn Ave**	Media Label:		Up Rim to Invert:	
Location Code:		Flow Control:		Downstream MH:	**9108854**
Location Details:		Sheet Number:		Down Rim to Invert:	
Pipe shape:	**Circular**	Sewer Use:	**Stormwater Pipe**	Total gallons used:	**0.0**
Pipe size:	**12 "**	Sewer Category:	**SEC**	Joints passed:	**0**
Pipe material:	**Reinforced Concrete Pipe**	Purpose:		Joints failed:	**0**
Lining Method:		Owner:			
Additional Info:					



Distance	Code	Observation	Counter	Photo	Grade
0.0	AMH	Manhole / 9108854	00:00:00	1	
0.0	MWL	Water Level, 0% of the vertical dimension	00:00:03	2	
43.3	AMH	Manhole / 25166	00:12:46	3	

QSR	QMR	QOR	SPR	MPR	OPR	SPRI	MPRI	OPRI
0000	0000	0000	0.0	0.0	0.0	0.0	0.0	0.0

WINCAN

Section Pictures - 5/28/2026 - 5/28/2026 11:38:03 AM

City	Street	Date	Lateral Segment Reference	Section No.
Cranston	**Oaklawn Ave**	**5/28/2026**	**5/28/2026 11:38:03 AM**	**1154**



1, 00:00:00, 0.00ft
Manhole / 9108854



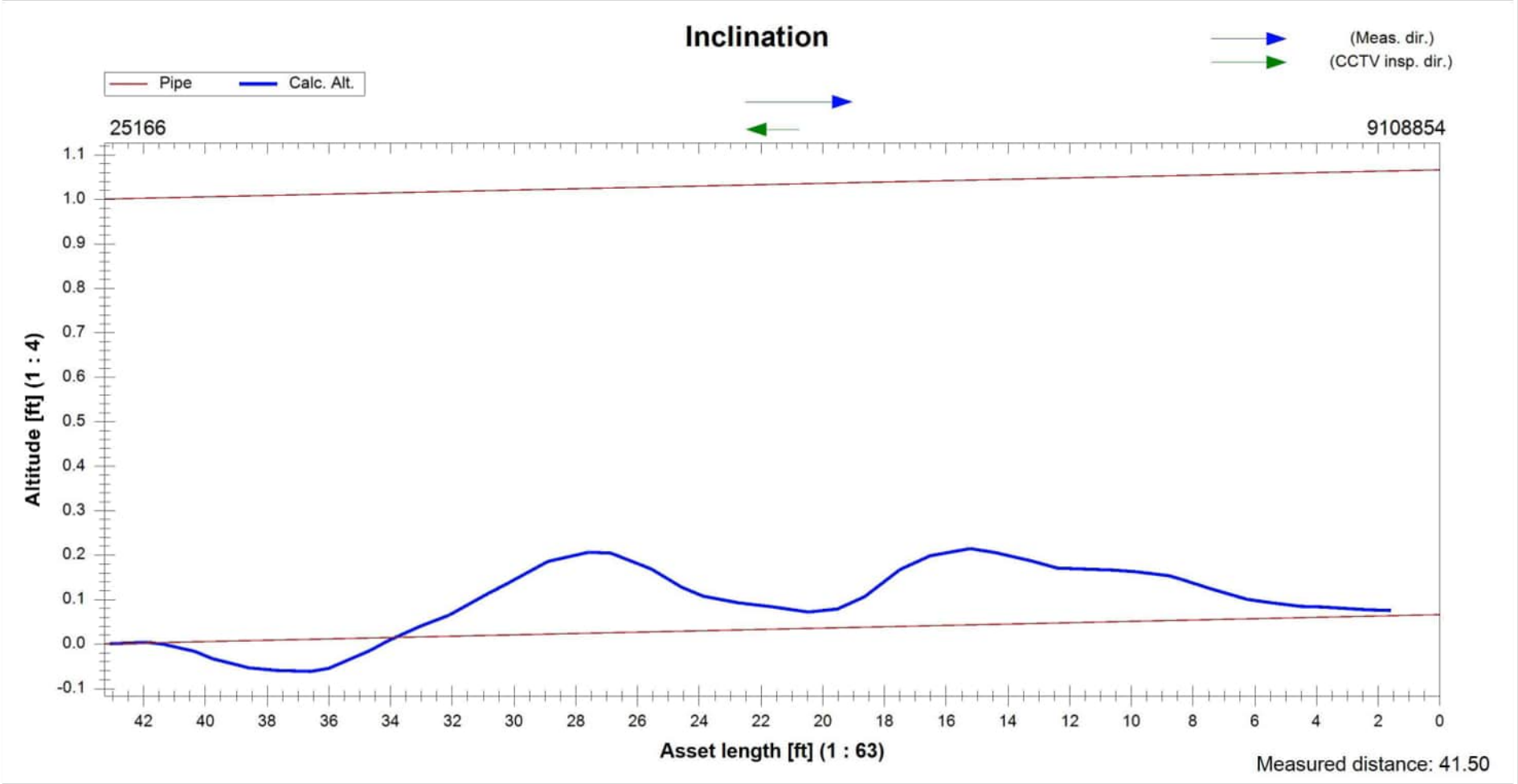
2, 00:00:03, 0.00ft
Water Level, 0% of the vertical dimension



3, 00:12:46, 43.26ft
Manhole / 25166

WINCAN Section Inclination - 5/28/2026 - 5/28/2026 11:38:03

Lateral Segment Reference	Date	Time	Surveyed By	City	Street	Direction	Length Surveyed
5/28/2026 11:38:03 AM	5/28/2026	11:39 AM	Ian Kirby	Cranston	Oaklawn Ave	Upstream	41.50
Pipe Shape	**Size**	**Width**	**Lateral Upstream Access Point**	**Lateral Downstream Access Point**	**Start altitude**	**End altitude**	**Measured Inc**
Circular	12	12	25166	9108854	0.000	0.075	0.179 %

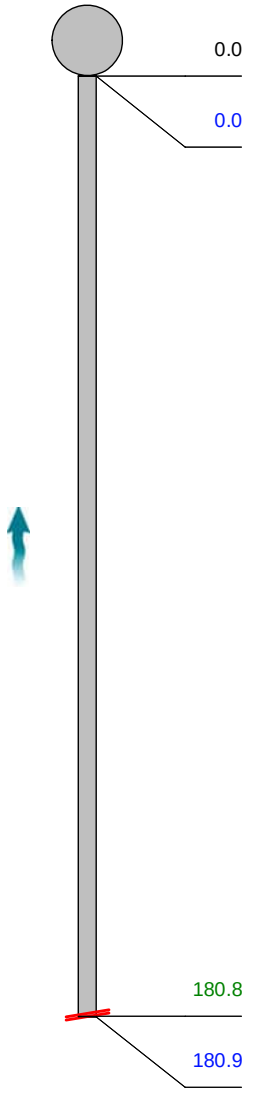


WINCAN

Inspection report

Date:	Work Order:	Weather:	Surveyed By:	Certificate Number:	Pipe Segment Ref.:
5/28/2026		**Dry**	**Ian Kirby**	**70402069**	**5/28/2026 12:30:21 PM**
Year laid:	Pre-cleaning:	Direction:	Pipe Joint Length:	Total Length:	Length Surveyed:
	Heavy Cleaning	**Upstream**		**180.9 '**	**180.9 '**

City:	**Cranston**	Drainage Area:		Upstream MH:	**9108854**
Street:	**Oaklawn Ave**	Media Label:		Up Rim to Invert:	
Location Code:		Flow Control:		Downstream MH:	**23511**
Location Details:		Sheet Number:		Down Rim to Invert:	
Pipe shape:	**Circular**	Sewer Use:	**Stormwater Pipe**	Total gallons used:	**0.0**
Pipe size:	**12 "**	Sewer Category:	**SEC**	Joints passed:	**0**
Pipe material:	**Reinforced Concrete Pipe**	Purpose:		Joints failed:	**0**
Lining Method:		Owner:			
Additional Info:					



Distance	Code	Observation	Counter	Photo	Grade
0.0	AMH	Manhole / 23511	00:00:00	1	
0.0	MWL	Water Level, 5% of the vertical dimension	00:00:03	2	
180.8	RBJ	Roots Ball Joint from 8 o'clock to 4 o'clock, 75% of cross sectional area, within 8 inch	00:03:10	3	M4
180.9	MSA	Miscellaneous Survey Abandoned / Cannot Pass	00:03:41	4	

QSR	QMR	QOR	SPR	MPR	OPR	SPRI	MPRI	OPRI
0000	4100	4100	0.0	4.0	4.0	0.0	4.0	4.0

WINCAN

Section Pictures - 5/28/2026 - 5/28/2026 12:30:21 PM

City	Street	Date	Lateral Segment Reference	Section No.
Cranston	**Oaklawn Ave**	**5/28/2026**	**5/28/2026 12:30:21 PM**	**1155**



1, 00:00:00, 0.00ft
Manhole / 23511



2, 00:00:03, 0.00ft
Water Level, 5% of the vertical dimension



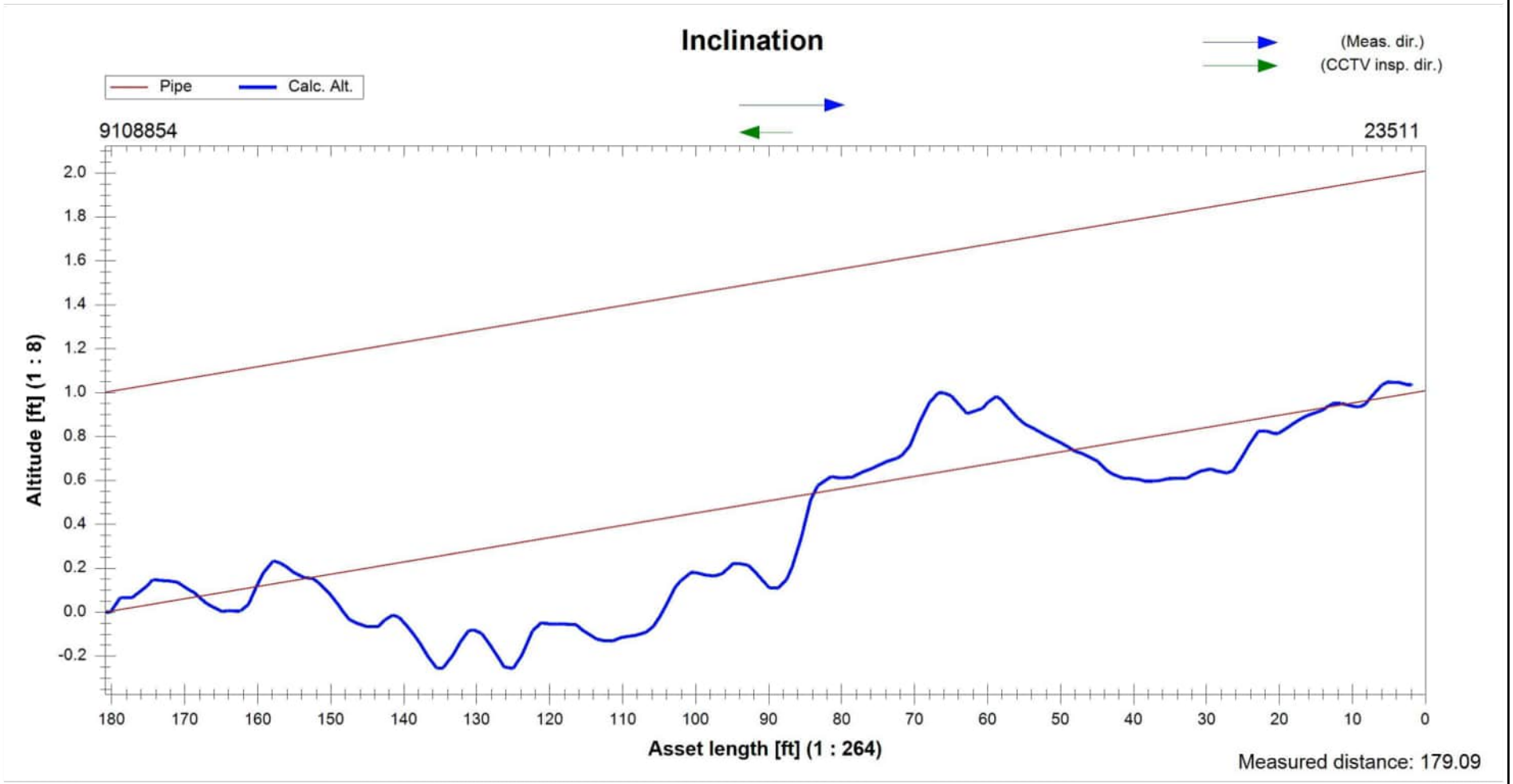
3, 00:03:10, 180.77ft
Roots Ball Joint from 8 o'clock to 4 o'clock, 75% of cross sectional area, within 8 inch

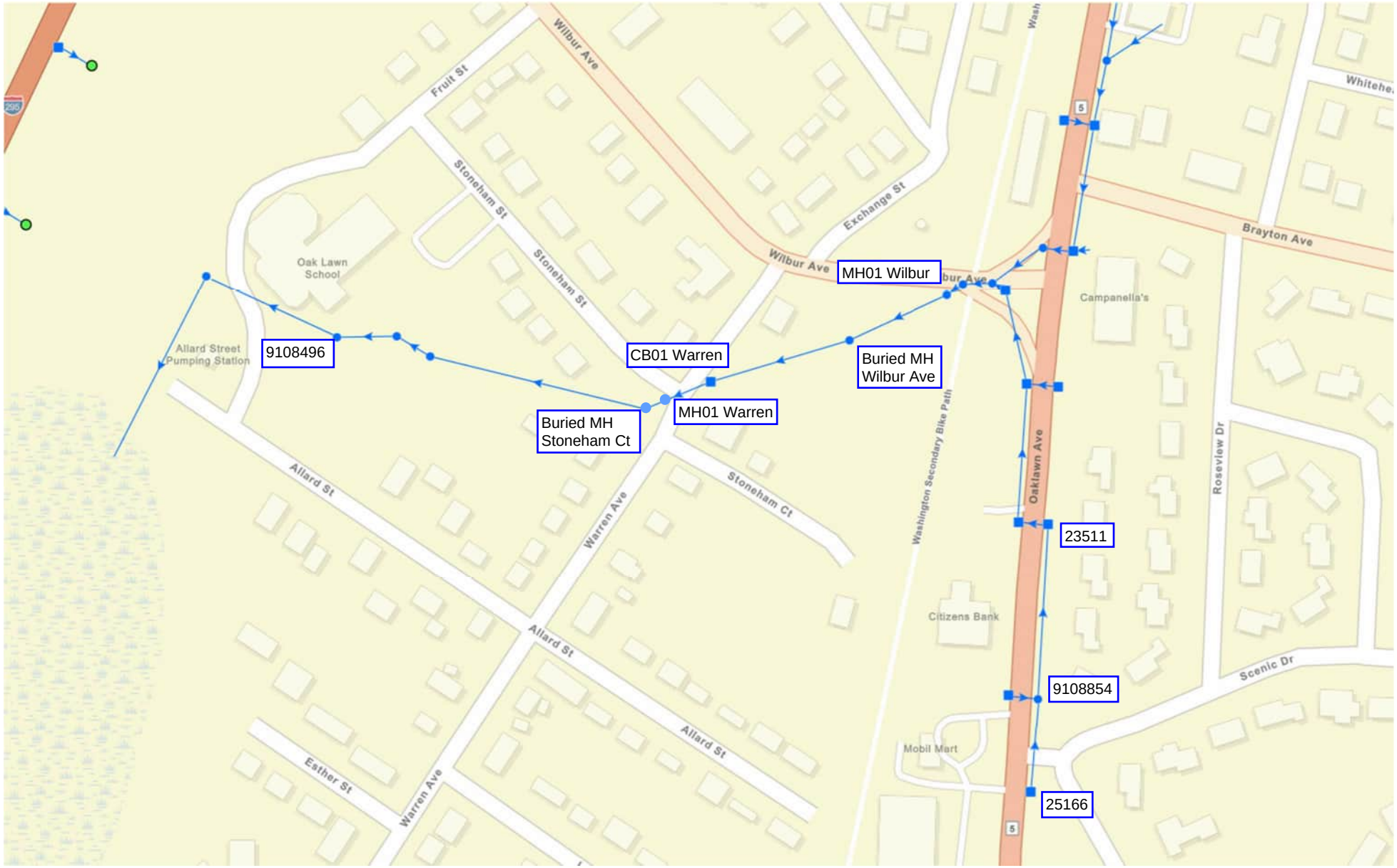


4, 00:03:41, 180.87ft
Miscellaneous Survey Abandoned / Cannot Pass

WINCAN Section Inclination - 5/28/2026 - 5/28/2026 12:30:21

Lateral Segment Reference	Date	Time	Surveyed By	City	Street	Direction	Length Surveyed
5/28/2026 12:30:21 PM	5/28/2026	12:32 PM	Ian Kirby	Cranston	Oaklawn Ave	Upstream	179.09
Pipe Shape	**Size**	**Width**	**Lateral Upstream Access Point**	**Lateral Downstream Access Point**	**Start altitude**	**End altitude**	**Measured Inc**
Circular	12	12	9108854	23511	0.000	1.033	0.577 %




9108496
CB01 Warren
MH01 Warren
Buried MH
Stoneham Ct
MH01 Wilbur
Buried MH
Wilbur Ave
23511
9108854
25166
Wilbur Ave
Fruit St
Stoneham St
Exchange St
Brayton Ave
Oak Lawn
School
Allard Street
Pumping Station
Allard St
Warren Ave
Stoneham Ct
Esther St
Oaklawn Ave
Washington Secondary Bike Path
Roseview Dr
Scenic Dr
Campanella's
Citizens Bank
Mobil Mart

APPENDIX B

SOIL MAP

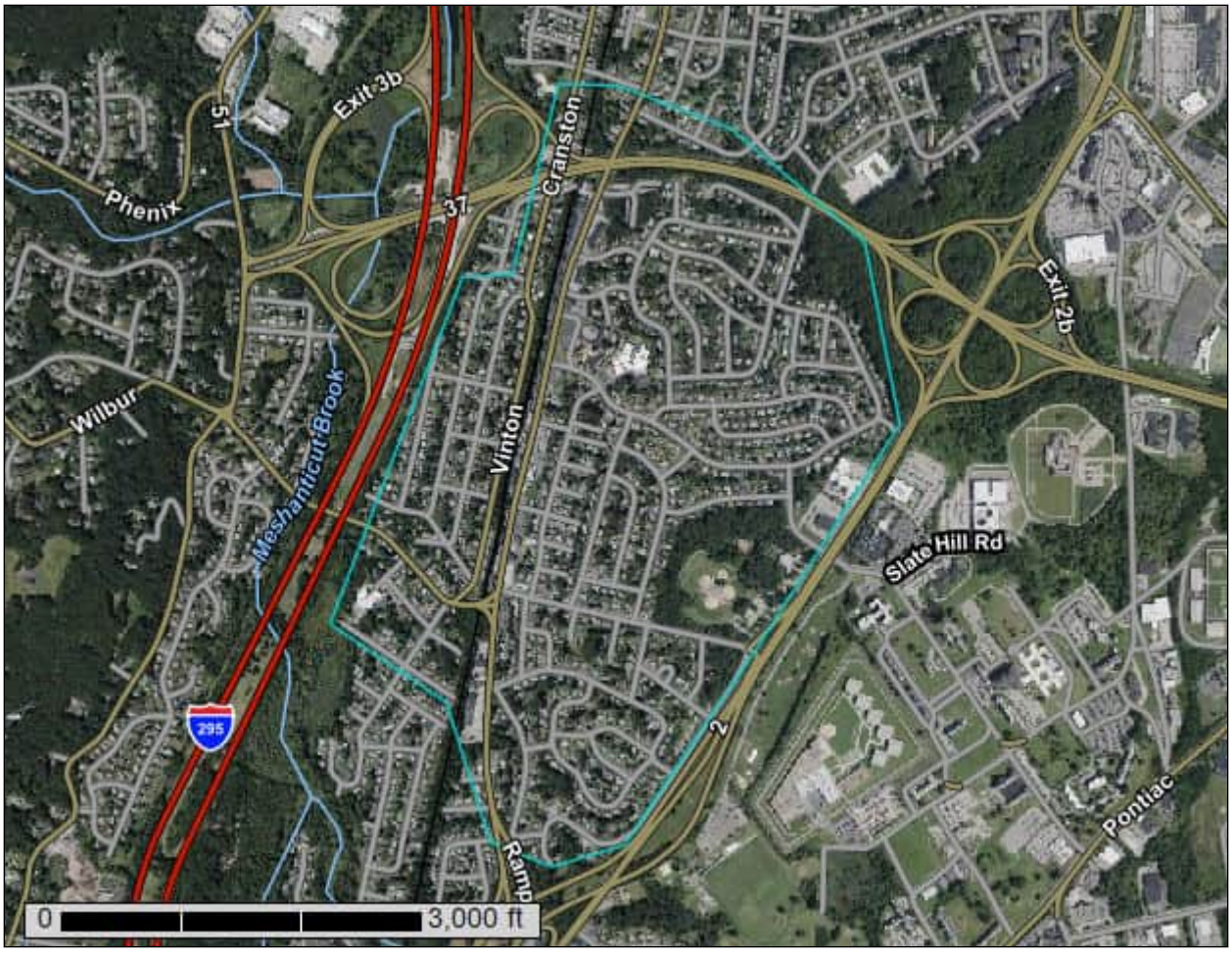
United States Department of Agriculture

NRCS

Natural Resources Conservation Service

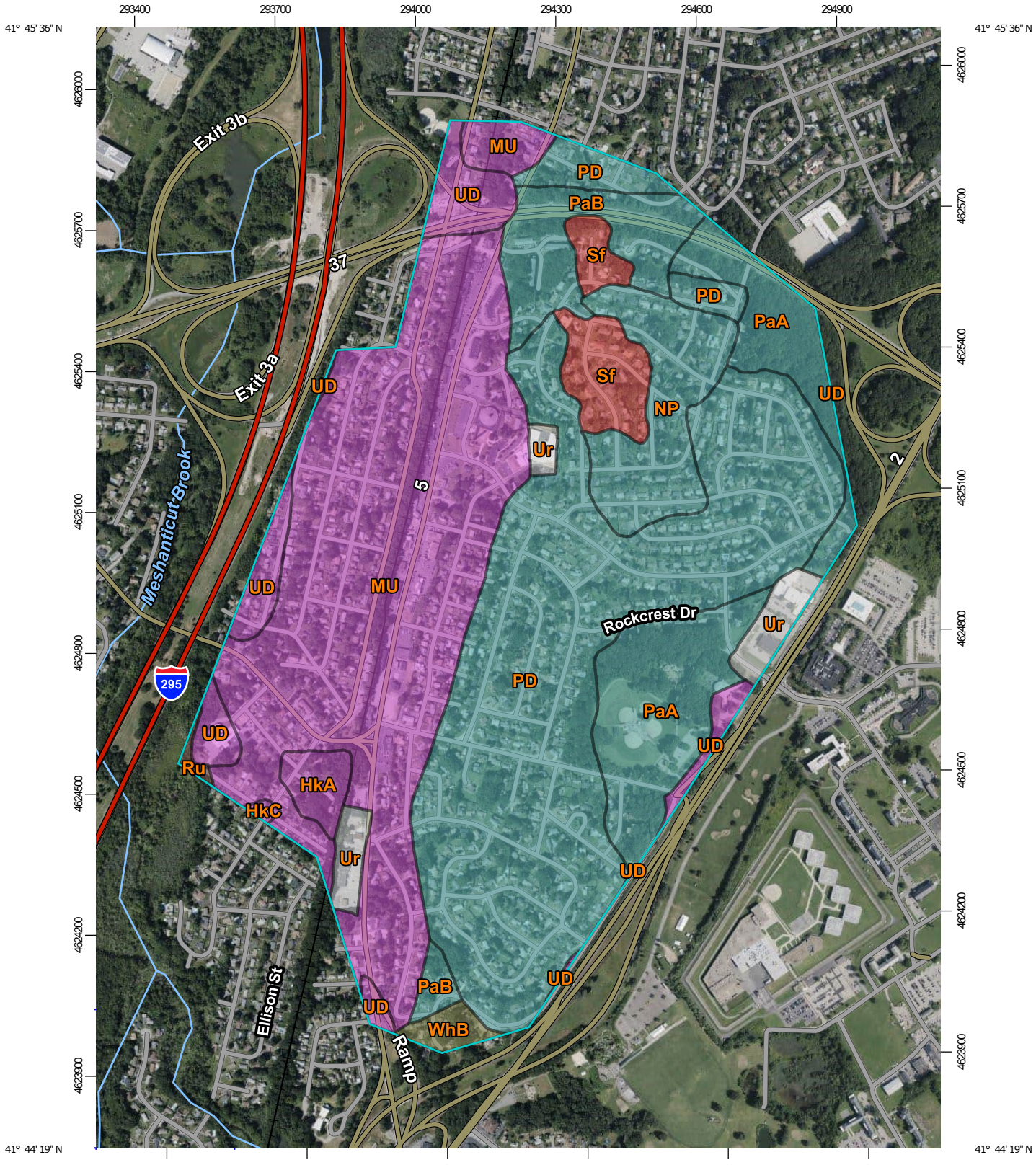
A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for State of Rhode Island: Bristol, Kent, Newport, Providence, and Washington Counties



February 12, 2026

Custom Soil Resource Report
Map—Hydrologic Soil Group



Map Scale: 1:11,600 if printed on A portrait (8.5" x 11") sheet.

N

Meters: 0 150 300 600 900

Feet: 0 500 1000 2000 3000

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 19N WGS84

MAP LEGEND

Area of Interest (AOI)

- Area of Interest (AOI)

Soils

Soil Rating Polygons

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Lines

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Points

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Water Features

- Streams and Canals

Transportation

- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background

- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:12,000.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: State of Rhode Island: Bristol, Kent, Newport, Providence, and Washington Counties
Survey Area Data: Version 25, Sep 3, 2025

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Mar 1, 2024—Jul 1, 2024

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Table—Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
HkA	Hinckley loamy sand, 0 to 3 percent slopes	A	4.9	1.1%
HkC	Hinckley loamy sand, 8 to 15 percent slopes	A	0.5	0.1%
MU	Merrimac-Urban land complex, 0 to 8 percent slopes	A	138.5	32.5%
NP	Newport-Urban land complex	C	23.5	5.5%
PaA	Paxton fine sandy loam, 0 to 3 percent slopes	C	44.5	10.4%
PaB	Paxton fine sandy loam, 3 to 8 percent slopes	C	21.7	5.1%
PD	Paxton-Urban land complex, 3 to 15 percent slopes	C	146.3	34.3%
Ru	Rippowam fine sandy loam	B/D	0.8	0.2%
Sf	Stissing very stony silt loam	D	13.6	3.2%
UD	Udorthents-Urban land complex	A	18.8	4.4%
Ur	Urban land		9.9	2.3%
WhB	Woodbridge fine sandy loam, 3 to 8 percent slopes	C/D	3.2	0.7%
Totals for Area of Interest			**426.1**	**100.0%**

Rating Options—Hydrologic Soil Group

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

State of Rhode Island: Bristol, Kent, Newport, Providence, and Washington Counties

HkA—Hinckley loamy sand, 0 to 3 percent slopes

Map Unit Setting

National map unit symbol: 2svm7
Landscape: Valleys
Elevation: 0 to 1,420 feet
Mean annual precipitation: 36 to 71 inches
Mean annual air temperature: 39 to 55 degrees F
Frost-free period: 140 to 250 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Hinckley and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Hinckley

Setting

Landscape: Valleys
Landform: Outwash deltas, Kame terraces, Outwash plains, Outwash terraces
Landform position (three-dimensional): Tread
Down-slope shape: Concave, convex, linear
Across-slope shape: Convex, linear, concave
Parent material: Sandy and gravelly glaciofluvial deposits derived from gneiss and/or granite and/or schist

Typical profile

Oe - 0 to 1 inches: moderately decomposed plant material
A - 1 to 8 inches: loamy sand
Bw1 - 8 to 11 inches: gravelly loamy sand
Bw2 - 11 to 16 inches: gravelly loamy sand
BC - 16 to 19 inches: very gravelly loamy sand
C - 19 to 65 inches: very gravelly sand

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Excessively drained
Runoff class: Negligible
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to very high (1.42 to 99.90 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline (0.0 to 1.9 mmhos/cm)
Available water supply, 0 to 60 inches: Low (about 3.1 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3s
Hydrologic Soil Group: A

Ecological site: F144AY022MA - Dry Outwash
Hydric soil rating: No

Minor Components

Windsor
Percent of map unit: 5 percent
Landscape: Valleys
Landform: Outwash terraces, Kame terraces, Outwash deltas
Landform position (three-dimensional): Tread
Down-slope shape: Concave, convex, linear
Across-slope shape: Convex, linear, concave
Hydric soil rating: No

Merrimac
Percent of map unit: 5 percent
Landscape: Valleys
Landform: Kame terraces, Outwash terraces, Outwash deltas
Landform position (three-dimensional): Tread
Down-slope shape: Concave, convex, linear
Across-slope shape: Convex, linear, concave
Hydric soil rating: No

Sudbury
Percent of map unit: 4 percent
Landscape: Valleys
Landform: Kame terraces, Outwash terraces, Outwash deltas
Landform position (three-dimensional): Tread
Down-slope shape: Concave, convex, linear
Across-slope shape: Convex, linear, concave
Hydric soil rating: No

Walpole
Percent of map unit: 1 percent
Landscape: Outwash plains
Landform: Deltas, Depressions, Outwash terraces, Outwash plains, Depressions
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Tread, talf, dip
Down-slope shape: Concave
Across-slope shape: Concave
Hydric soil rating: Yes

HkC—Hinckley loamy sand, 8 to 15 percent slopes

Map Unit Setting
National map unit symbol: 2svm9
Landscape: Valleys, uplands
Elevation: 0 to 1,480 feet
Mean annual precipitation: 36 to 71 inches
Mean annual air temperature: 39 to 55 degrees F
Frost-free period: 140 to 240 days

Farmland classification: Farmland of statewide importance

Map Unit Composition

Hinckley and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Hinckley

Setting

Landscape: Valleys, uplands
Landform: Eskers, Moraines, Outwash terraces, Outwash deltas, Kames, Outwash plains, Kame terraces
Landform position (two-dimensional): Shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Head slope, nose slope, side slope, crest, riser
Down-slope shape: Concave, convex, linear
Across-slope shape: Convex, linear, concave
Parent material: Sandy and gravelly glaciofluvial deposits derived from gneiss and/or granite and/or schist

Typical profile

Oe - 0 to 1 inches: moderately decomposed plant material
A - 1 to 8 inches: loamy sand
Bw1 - 8 to 11 inches: gravelly loamy sand
Bw2 - 11 to 16 inches: gravelly loamy sand
BC - 16 to 19 inches: very gravelly loamy sand
C - 19 to 65 inches: very gravelly sand

Properties and qualities

Slope: 8 to 15 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Excessively drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to very high (1.42 to 99.90 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline (0.0 to 1.9 mmhos/cm)
Available water supply, 0 to 60 inches: Low (about 3.1 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: A
Ecological site: F144AY022MA - Dry Outwash
Hydric soil rating: No

Minor Components

Windsor

Percent of map unit: 5 percent
Landscape: Valleys, uplands
Landform: Moraines, Eskers, Kames, Outwash deltas, Outwash terraces, Outwash plains, Kame terraces
Landform position (two-dimensional): Shoulder, backslope, footslope, toeslope

Landform position (three-dimensional): Head slope, nose slope, side slope, crest, riser
Down-slope shape: Concave, convex, linear
Across-slope shape: Convex, linear, concave
Hydric soil rating: No

Sudbury

Percent of map unit: 5 percent
Landscape: Uplands, valleys
Landform: Outwash deltas, Moraines, Outwash plains, Kame terraces, Outwash terraces
Landform position (two-dimensional): Backslope, footslope
Landform position (three-dimensional): Base slope, tread
Down-slope shape: Concave, linear
Across-slope shape: Concave, linear
Hydric soil rating: No

Merrimac

Percent of map unit: 5 percent
Landscape: Outwash plains, valleys
Landform: Kames, Outwash plains, Outwash terraces, Moraines, Eskers
Landform position (two-dimensional): Shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Head slope, nose slope, side slope, crest, riser
Down-slope shape: Convex
Across-slope shape: Convex
Hydric soil rating: No

MU—Merrimac-Urban land complex, 0 to 8 percent slopes

Map Unit Setting

National map unit symbol: 2tyr9
Landscape: Outwash plains, valleys
Elevation: 0 to 820 feet
Mean annual precipitation: 36 to 71 inches
Mean annual air temperature: 39 to 55 degrees F
Frost-free period: 140 to 250 days
Farmland classification: Not prime farmland

Map Unit Composition

Merrimac and similar soils: 45 percent
Urban land: 40 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Merrimac

Setting

Landscape: Outwash plains, valleys
Landform: Outwash plains, Outwash terraces, Moraines, Eskers, Kames

Landform position (two-dimensional): Summit, shoulder, backslope, footslope
Landform position (three-dimensional): Side slope, crest, riser, tread
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Loamy glaciofluvial deposits derived from granite, schist, and gneiss over sandy and gravelly glaciofluvial deposits derived from granite, schist, and gneiss

Typical profile

Ap - 0 to 10 inches: fine sandy loam
Bw1 - 10 to 22 inches: fine sandy loam
Bw2 - 22 to 26 inches: stratified gravel to gravelly loamy sand
2C - 26 to 65 inches: stratified gravel to very gravelly sand

Properties and qualities

Slope: 0 to 8 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat excessively drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to very high (1.42 to 99.90 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 2 percent
Maximum salinity: Nonsaline (0.0 to 1.4 mmhos/cm)
Sodium adsorption ratio, maximum: 1.0
Available water supply, 0 to 60 inches: Low (about 4.6 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: A
Ecological site: F144AY022MA - Dry Outwash
Hydric soil rating: No

Description of Urban Land

Setting

Landscape: Glaciated uplands
Anthropogenic Feature: Urban land

Typical profile

M - 0 to 10 inches: cemented material

Properties and qualities

Slope: 0 to 8 percent
Depth to restrictive feature: 0 inches to manufactured layer
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Very low (0.00 to 0.00 in/hr)
Available water supply, 0 to 60 inches: Very low (about 0.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 8
Hydrologic Soil Group: D
Hydric soil rating: Unranked

Minor Components

Hinckley

Percent of map unit: 5 percent
Landscape: Valleys, outwash plains
Landform: Outwash plains, Deltas, Kames, Eskers
Landform position (two-dimensional): Summit, shoulder, backslope
Landform position (three-dimensional): Head slope, nose slope, side slope, crest, rise
Down-slope shape: Convex
Across-slope shape: Linear, convex
Hydric soil rating: No

Sudbury

Percent of map unit: 5 percent
Landscape: Valleys, lake plains
Landform: Outwash plains, Terraces, Deltas
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Tread, dip
Down-slope shape: Concave
Across-slope shape: Linear
Hydric soil rating: No

Windsor

Percent of map unit: 5 percent
Landscape: Valleys
Landform: Deltas, Outwash plains, Dunes, Outwash terraces
Landform position (three-dimensional): Riser, tread
Down-slope shape: Linear, convex
Across-slope shape: Linear, convex
Hydric soil rating: No

NP—Newport-Urban land complex

Map Unit Setting

National map unit symbol: 9lvx
Landscape: Uplands
Elevation: 0 to 280 feet
Mean annual precipitation: 44 to 50 inches
Mean annual air temperature: 48 to 50 degrees F
Frost-free period: 115 to 211 days
Farmland classification: Not prime farmland

Map Unit Composition

Newport and similar soils: 40 percent
Urban land: 30 percent
Minor components: 30 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Newport

Setting

Landscape: Uplands
Landform: Drumlins
Down-slope shape: Linear
Across-slope shape: Convex
Parent material: Loamy lodgment till derived from metamorphic and sedimentary rock

Typical profile

Ap - 0 to 8 inches: silt loam
Bw - 8 to 24 inches: channery silt loam
Cd - 24 to 65 inches: channery silt loam

Properties and qualities

Slope: 1 to 15 percent
Surface area covered with cobbles, stones or boulders: 1.6 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately high (0.00 to 0.20 in/hr)
Depth to water table: About 23 to 24 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Low (about 4.1 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: C
Ecological site: F144AY007CT - Well Drained Dense Till Uplands
Hydric soil rating: No

Description of Urban Land

Setting

Parent material: Human transported material

Typical profile

R - 0 to 6 inches: variable

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 8s
Hydric soil rating: No

Minor Components

Poquonock

Percent of map unit: 10 percent
Landscape: Uplands
Landform: Ground moraines, Drumlins
Down-slope shape: Convex
Across-slope shape: Convex
Hydric soil rating: No

Udorthents

Percent of map unit: 10 percent
Landscape: Uplands
Anthropogenic features: Fills
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: No

Birchwood

Percent of map unit: 5 percent
Landscape: Uplands
Landform: Drumlins
Down-slope shape: Linear
Across-slope shape: Concave
Hydric soil rating: No

Pittstown

Percent of map unit: 5 percent
Landscape: Uplands
Landform: Drumlins
Down-slope shape: Linear
Across-slope shape: Concave
Hydric soil rating: No

PaA—Paxton fine sandy loam, 0 to 3 percent slopes

Map Unit Setting

National map unit symbol: 2t2r1
Landscape: Uplands
Elevation: 0 to 810 feet
Mean annual precipitation: 36 to 71 inches
Mean annual air temperature: 39 to 55 degrees F
Frost-free period: 145 to 240 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Paxton and similar soils: 90 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Paxton

Setting

Landscape: Uplands
Landform: Ground moraines, Hills, Drumlins
Landform position (two-dimensional): Summit, shoulder
Landform position (three-dimensional): Crest
Down-slope shape: Convex, linear
Across-slope shape: Convex

Parent material: Coarse-loamy lodgment till derived from gneiss, granite, and/or schist

Typical profile

Ap - 0 to 8 inches: fine sandy loam
Bw1 - 8 to 15 inches: fine sandy loam
Bw2 - 15 to 26 inches: fine sandy loam
Cd - 26 to 65 inches: gravelly fine sandy loam

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: 18 to 39 inches to densic material
Drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.14 in/hr)
Depth to water table: About 18 to 37 inches
Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline (0.0 to 1.9 mmhos/cm)
Available water supply, 0 to 60 inches: Low (about 3.1 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2s
Hydrologic Soil Group: C
Ecological site: F144AY007CT - Well Drained Dense Till Uplands
Hydric soil rating: No

Minor Components

Woodbridge

Percent of map unit: 5 percent
Landscape: Uplands
Landform: Hills, Drumlins, Ground moraines
Landform position (two-dimensional): Summit, backslope, footslope
Landform position (three-dimensional): Side slope
Down-slope shape: Concave
Across-slope shape: Linear
Hydric soil rating: No

Charlton

Percent of map unit: 3 percent
Landscape: Uplands
Landform: Ground moraines, Hills, Drumlins
Landform position (two-dimensional): Summit, shoulder
Landform position (three-dimensional): Crest
Down-slope shape: Convex, linear
Across-slope shape: Convex
Hydric soil rating: No

Ridgebury

Percent of map unit: 2 percent
Landscape: Uplands
Landform: Drumlins, Depressions, Ground moraines, Hills, Drainageways
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Head slope, base slope

Down-slope shape: Concave
Across-slope shape: Concave
Hydric soil rating: Yes

PaB—Paxton fine sandy loam, 3 to 8 percent slopes

Map Unit Setting

National map unit symbol: 2t2qp
Landscape: Uplands
Elevation: 0 to 1,570 feet
Mean annual precipitation: 36 to 71 inches
Mean annual air temperature: 39 to 55 degrees F
Frost-free period: 140 to 240 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Paxton and similar soils: 80 percent
Minor components: 20 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Paxton

Setting

Landscape: Uplands
Landform: Ground moraines, Drumlins, Hills
Landform position (two-dimensional): Summit, shoulder, backslope
Landform position (three-dimensional): Nose slope, side slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Convex
Parent material: Coarse-loamy lodgment till derived from gneiss, granite, and/or schist

Typical profile

Ap - 0 to 8 inches: fine sandy loam
Bw1 - 8 to 15 inches: fine sandy loam
Bw2 - 15 to 26 inches: fine sandy loam
Cd - 26 to 65 inches: gravelly fine sandy loam

Properties and qualities

Slope: 3 to 8 percent
Depth to restrictive feature: 18 to 39 inches to densic material
Drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.14 in/hr)
Depth to water table: About 18 to 37 inches
Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline (0.0 to 1.9 mmhos/cm)
Available water supply, 0 to 60 inches: Low (about 3.1 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2s
Hydrologic Soil Group: C
Ecological site: F144AY007CT - Well Drained Dense Till Uplands
Hydric soil rating: No

Minor Components

Woodbridge

Percent of map unit: 9 percent
Landscape: Uplands
Landform: Ground moraines, Drumlins, Hills
Landform position (two-dimensional): Summit, backslope, footslope
Landform position (three-dimensional): Side slope
Down-slope shape: Concave
Across-slope shape: Linear
Hydric soil rating: No

Ridgebury

Percent of map unit: 6 percent
Landscape: Uplands
Landform: Depressions, Ground moraines, Hills, Drainageways
Landform position (two-dimensional): Toeslope, backslope, footslope
Landform position (three-dimensional): Base slope, head slope, dip
Down-slope shape: Concave
Across-slope shape: Concave
Hydric soil rating: Yes

Charlton

Percent of map unit: 5 percent
Landscape: Uplands
Landform: Hills
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: No

PD—Paxton-Urban land complex, 3 to 15 percent slopes

Map Unit Setting

National map unit symbol: 2w67k
Landscape: Uplands
Elevation: 0 to 930 feet
Mean annual precipitation: 36 to 71 inches
Mean annual air temperature: 39 to 55 degrees F
Frost-free period: 145 to 240 days
Farmland classification: Not prime farmland

Map Unit Composition

Paxton and similar soils: 45 percent

Urban land: 35 percent
Minor components: 20 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Paxton

Setting
Landscape: Uplands
Landform: Drumlins, Hills, Ground moraines
Landform position (two-dimensional): Summit, shoulder, backslope
Landform position (three-dimensional): Side slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Convex
Parent material: Coarse-loamy lodgment till derived from gneiss, granite, and/or schist

Typical profile
Ap - 0 to 8 inches: fine sandy loam
Bw1 - 8 to 15 inches: fine sandy loam
Bw2 - 15 to 26 inches: fine sandy loam
Cd - 26 to 65 inches: gravelly fine sandy loam

Properties and qualities
Slope: 3 to 15 percent
Depth to restrictive feature: 20 to 39 inches to densic material
Drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.14 in/hr)
Depth to water table: About 18 to 37 inches
Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline (0.0 to 1.9 mmhos/cm)
Available water supply, 0 to 60 inches: Low (about 4.1 inches)

Interpretive groups
Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: C
Ecological site: F144AY007CT - Well Drained Dense Till Uplands
Hydric soil rating: No

Description of Urban Land

Setting
Landscape: Glaciated uplands
Anthropogenic Feature: Urban land

Typical profile
M - 0 to 10 inches: cemented material

Properties and qualities
Slope: 3 to 15 percent
Depth to restrictive feature: 0 inches to manufactured layer
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Very low (0.00 to 0.00 in/hr)
Available water supply, 0 to 60 inches: Very low (about 0.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 8
Hydrologic Soil Group: D
Hydric soil rating: Unranked

Minor Components

Woodbridge

Percent of map unit: 9 percent
Landscape: Uplands
Landform: Hills, Ground moraines, Drumlins
Landform position (two-dimensional): Summit, backslope, footslope
Landform position (three-dimensional): Side slope, crest
Down-slope shape: Concave
Across-slope shape: Linear
Hydric soil rating: No

Charlton

Percent of map unit: 6 percent
Landscape: Uplands
Landform: Hills
Landform position (two-dimensional): Summit, shoulder, backslope
Landform position (three-dimensional): Side slope, crest
Down-slope shape: Convex
Across-slope shape: Convex
Hydric soil rating: No

Udorthents

Percent of map unit: 4 percent
Landscape: Uplands
Anthropogenic features: Fills
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: No

Ridgebury

Percent of map unit: 1 percent
Landscape: Uplands
Landform: Drainageways, Hills, Ground moraines, Depressions, Drumlins
Landform position (two-dimensional): Footslope, toeslope
Landform position (three-dimensional): Head slope, base slope
Down-slope shape: Concave, linear
Across-slope shape: Concave, linear
Hydric soil rating: Yes

Ru—Rippowam fine sandy loam

Map Unit Setting

National map unit symbol: 9lx2
Landscape: Alluvial plains
Elevation: 0 to 810 feet
Mean annual precipitation: 44 to 50 inches
Mean annual air temperature: 48 to 50 degrees F
Frost-free period: 115 to 190 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Rippowam and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Rippowam

Setting

Landscape: Alluvial plains
Landform: Flood plains
Down-slope shape: Linear
Across-slope shape: Concave
Parent material: Coarse-loamy alluvium over sandy and gravelly alluvium derived from granite and gneiss

Typical profile

A - 0 to 5 inches: fine sandy loam
Bg1 - 5 to 12 inches: fine sandy loam
Bg2 - 12 to 19 inches: fine sandy loam
BCg1 - 19 to 24 inches: sandy loam
BCg2 - 24 to 27 inches: sandy loam
Cg1 - 27 to 31 inches: loamy sand
Cg2 - 31 to 65 inches: stratified very gravelly coarse sand to loamy fine sand

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Poorly drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 5.95 in/hr)
Depth to water table: About 0 to 18 inches
Frequency of flooding: Frequent
Frequency of ponding: None
Available water supply, 0 to 60 inches: Low (about 5.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified

Land capability classification (nonirrigated): 4w
Hydrologic Soil Group: B/D
Ecological site: F144AY014CT - Wet Sandy Low Floodplain
Hydric soil rating: Yes

Minor Components

Swansea
Percent of map unit: 8 percent
Landscape: Outwash plains
Landform: Marshes, Kettles, Depressions, Bogs, Swamps
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Talf
Down-slope shape: Concave
Across-slope shape: Concave
Hydric soil rating: Yes

Pootatuck
Percent of map unit: 7 percent
Landscape: Alluvial plains
Landform: Flood plains
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: No

Sf—Stissing very stony silt loam

Map Unit Setting
National map unit symbol: 9lx7
Landscape: Uplands
Elevation: 0 to 250 feet
Mean annual precipitation: 44 to 50 inches
Mean annual air temperature: 48 to 50 degrees F
Frost-free period: 185 to 211 days
Farmland classification: Not prime farmland

Map Unit Composition
Stissing and similar soils: 90 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Stissing

Setting
Landscape: Uplands
Landform: Depressions
Down-slope shape: Concave
Across-slope shape: Concave
Parent material: Loamy lodgment till derived from metamorphic and sedimentary rock

Typical profile

A - 0 to 8 inches: very stony silt loam
Bg - 8 to 15 inches: silt loam
Cdg - 15 to 60 inches: silt loam

Properties and qualities

Slope: 0 to 3 percent
Surface area covered with cobbles, stones or boulders: 1.6 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Poorly drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: About 0 to 18 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Very low (about 2.7 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7s
Hydrologic Soil Group: D
Ecological site: F144AY009CT - Wet Till Depressions
Hydric soil rating: Yes

Minor Components

Mansfield

Percent of map unit: 6 percent
Landscape: Uplands
Landform: Depressions
Down-slope shape: Concave
Across-slope shape: Concave
Hydric soil rating: Yes

Pittstown

Percent of map unit: 4 percent
Landscape: Uplands
Landform: Drumlins
Down-slope shape: Linear
Across-slope shape: Concave
Hydric soil rating: No

UD—Udorthents-Urban land complex

Map Unit Setting

National map unit symbol: 9lxj
Landscape: Uplands
Elevation: 0 to 670 feet
Mean annual precipitation: 44 to 50 inches

Mean annual air temperature: 48 to 50 degrees F
Frost-free period: 120 to 211 days
Farmland classification: Not prime farmland

Map Unit Composition

Udorthents and similar soils: 70 percent
Urban land: 20 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Udorthents

Setting

Landscape: Uplands
Anthropogenic Feature: Fills
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Human transported material

Typical profile

A - 0 to 12 inches: sandy loam
C1 - 12 to 25 inches: sandy loam
C2 - 25 to 60 inches: stratified sand to very gravelly coarse sand

Properties and qualities

Slope: 0 to 15 percent
Depth to restrictive feature: More than 80 inches
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): High (2.00 to 6.00 in/hr)
Depth to water table: About 42 to 54 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Low (about 5.5 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Hydrologic Soil Group: A
Ecological site: F149BY100NY - Urban Site Complex
Hydric soil rating: No

Description of Urban Land

Setting

Parent material: Human transported material

Typical profile

R - 0 to 6 inches: variable

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 8s
Hydric soil rating: No

Minor Components

Merrimac

Percent of map unit: 5 percent

Landscape: Valleys
Landform: Kames, Outwash plains, Terraces
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: No

Quonset

Percent of map unit: 5 percent
Landscape: Outwash plains
Landform: Eskers, Outwash terraces, Terraces, Outwash plains
Down-slope shape: Convex
Across-slope shape: Convex
Hydric soil rating: No

Ur—Urban land

Map Unit Setting

National map unit symbol: 9lxk
Elevation: 0 to 810 feet
Mean annual precipitation: 44 to 50 inches
Mean annual air temperature: 48 to 50 degrees F
Frost-free period: 100 to 211 days
Farmland classification: Not prime farmland

Map Unit Composition

Urban land: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Urban Land

Setting

Parent material: Human transported material

Minor Components

Udorthents

Percent of map unit: 5 percent
Landscape: Uplands
Anthropogenic features: Fills
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: No

Canton

Percent of map unit: 2 percent
Landscape: Uplands
Landform: Hills
Down-slope shape: Convex
Across-slope shape: Convex

Hydric soil rating: No

Charlton

Percent of map unit: 2 percent
Landscape: Uplands
Landform: Hills
Down-slope shape: Linear
Across-slope shape: Convex
Hydric soil rating: No

Pittstown

Percent of map unit: 2 percent
Landscape: Uplands
Landform: Drumlins
Down-slope shape: Linear
Across-slope shape: Concave
Hydric soil rating: No

Merrimac

Percent of map unit: 1 percent
Landscape: Valleys
Landform: Kames, Outwash plains, Terraces
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: No

Newport

Percent of map unit: 1 percent
Landscape: Uplands
Landform: Drumlins
Down-slope shape: Linear
Across-slope shape: Convex
Hydric soil rating: No

Sudbury

Percent of map unit: 1 percent
Landscape: Valleys
Landform: Outwash plains, Terraces
Down-slope shape: Linear
Across-slope shape: Concave
Hydric soil rating: No

Sutton

Percent of map unit: 1 percent
Landscape: Uplands
Landform: Depressions, Drainageways
Down-slope shape: Linear, concave
Across-slope shape: Concave
Hydric soil rating: No

WhB—Woodbridge fine sandy loam, 3 to 8 percent slopes

Map Unit Setting

National map unit symbol: 2t2ql
Landscape: Uplands
Elevation: 0 to 1,470 feet
Mean annual precipitation: 36 to 71 inches
Mean annual air temperature: 39 to 55 degrees F
Frost-free period: 140 to 240 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Woodbridge, fine sandy loam, and similar soils: 82 percent
Minor components: 18 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Woodbridge, Fine Sandy Loam

Setting

Landscape: Uplands
Landform: Hills, Drumlins, Ground moraines
Landform position (two-dimensional): Summit, backslope, footslope
Landform position (three-dimensional): Side slope
Down-slope shape: Concave
Across-slope shape: Linear
Parent material: Coarse-loamy lodgment till derived from gneiss, granite, and/or schist

Typical profile

Ap - 0 to 7 inches: fine sandy loam
Bw1 - 7 to 18 inches: fine sandy loam
Bw2 - 18 to 30 inches: fine sandy loam
Cd - 30 to 65 inches: gravelly fine sandy loam

Properties and qualities

Slope: 3 to 8 percent
Depth to restrictive feature: 20 to 39 inches to densic material
Drainage class: Moderately well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.14 in/hr)
Depth to water table: About 18 to 30 inches
Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline (0.0 to 1.9 mmhos/cm)
Available water supply, 0 to 60 inches: Low (about 3.6 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2w

Hydrologic Soil Group: C/D
Ecological site: F144AY037MA - Moist Dense Till Uplands
Hydric soil rating: No

Minor Components

Paxton

Percent of map unit: 10 percent
Landscape: Uplands
Landform: Hills, Ground moraines, Drumlins
Landform position (two-dimensional): Summit, shoulder, backslope
Landform position (three-dimensional): Nose slope, side slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Convex
Hydric soil rating: No

Ridgebury

Percent of map unit: 8 percent
Landscape: Uplands
Landform: Drainageways, Hills, Ground moraines, Depressions
Landform position (two-dimensional): Backslope, footslope, toeslope
Landform position (three-dimensional): Head slope, base slope, dip
Down-slope shape: Concave
Across-slope shape: Concave
Hydric soil rating: Yes

APPENDIX C

FEMA FIRMETTE

National Flood Hazard Layer FIRMette

FEMA

71°29'18"W 41°44'59"N



71°28'41"W 41°44'32"N

0 250 500 1,000 1,500 2,000 Feet

1:6,000

Basemap Imagery Source: USGS National Map 2023

Legend

SEE FIS REPORT FOR DETAILED LEGEND AND INDEX MAP FOR FIRM PANEL LAYOUT

SPECIAL FLOOD HAZARD AREAS
- Without Base Flood Elevation (BFE) *Zone A, V, A99*
- With BFE or Depth *Zone AE, AO, AH, VE, AR*
- Regulatory Floodway

OTHER AREAS OF FLOOD HAZARD
- 0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile *Zone X*
- Future Conditions 1% Annual Chance Flood Hazard *Zone X*
- Area with Reduced Flood Risk due to Levee. See Notes. *Zone X*
- Area with Flood Risk due to Levee *Zone D*

OTHER AREAS
- NO SCREEN Area of Minimal Flood Hazard *Zone X*
- Effective LOMRs
- Area of Undetermined Flood Hazard *Zone D*

GENERAL STRUCTURES
- Channel, Culvert, or Storm Sewer
- Levee, Dike, or Floodwall

OTHER FEATURES
- 20.2 Cross Sections with 1% Annual Chance
- 17.5 Water Surface Elevation
- Coastal Transect
- Base Flood Elevation Line (BFE)
- Limit of Study
- Jurisdiction Boundary
- Coastal Transect Baseline
- Profile Baseline
- Hydrographic Feature

MAP PANELS
- Digital Data Available
- No Digital Data Available
- Unmapped

N

The pin displayed on the map is an approximate point selected by the user and does not represent an authoritative property location.

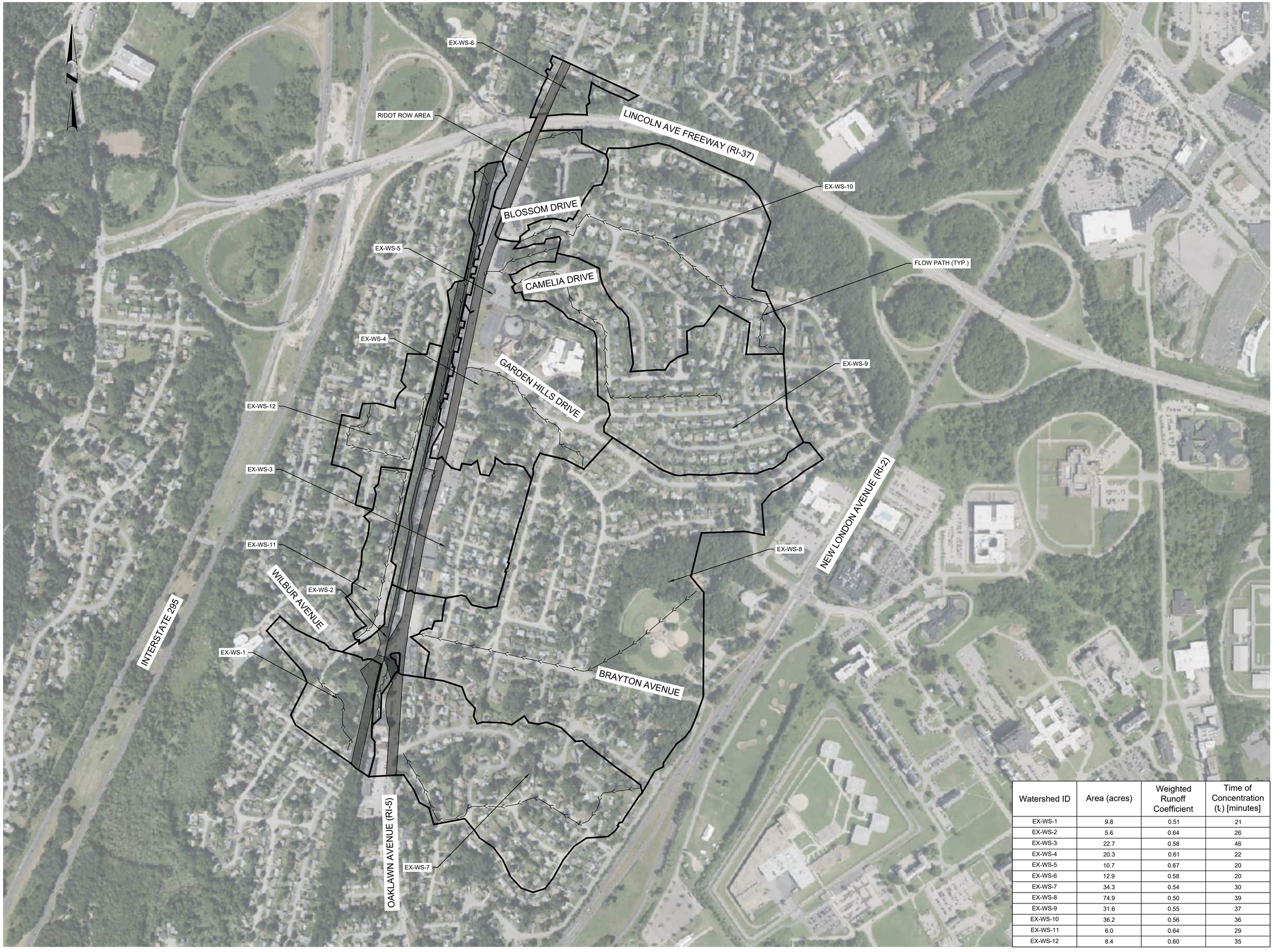
This map complies with FEMA's standards for the use of digital flood maps if it is not void as described below. The basemap shown complies with FEMA's basemap accuracy standards

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 8/20/2026 at 1:57 PM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

This map image is void if the one or more of the following map elements do not appear: basemap imagery, flood zone labels, legend, scale bar, map creation date, community identifiers, FIRM panel number, and FIRM effective date. Map images for unmapped and unmodernized areas cannot be used for regulatory purposes.

APPENDIX D

WATERSHED PLANS



Watershed ID	Area (acres)	Weighted Runoff Coefficient	Time of Concentration (t_c) [minutes]
EX-WS-1	9.8	0.51	21
EX-WS-2	5.6	0.64	26
EX-WS-3	22.7	0.58	46
EX-WS-4	20.3	0.61	22
EX-WS-5	10.7	0.67	20
EX-WS-6	12.9	0.58	20
EX-WS-7	34.3	0.54	30
EX-WS-8	74.9	0.50	39
EX-WS-9	31.6	0.55	37
EX-WS-10	36.2	0.56	36
EX-WS-11	6.0	0.64	29
EX-WS-12	8.4	0.60	35

PREPARED BY

BETA
www.BETA-Inc.com

REGISTERED PROFESSIONAL

SUBCONSULTANT

PROJECT

Stormwater Planning for Oaklawn Avenue at Wilbur Avenue

Cranston, RI

TITLE

EXISTING WATERSHED PLAN

NO.	REVISIONS	DATE

DRAWN BY: AJM
DESIGNED BY: JMC
CHECKED BY: JML
ISSUE DATE: AUGUST 2026
BETA JOB NO.: 05598

SCALE

300 0 300 600
SCALE IN FEET: 1"=300'

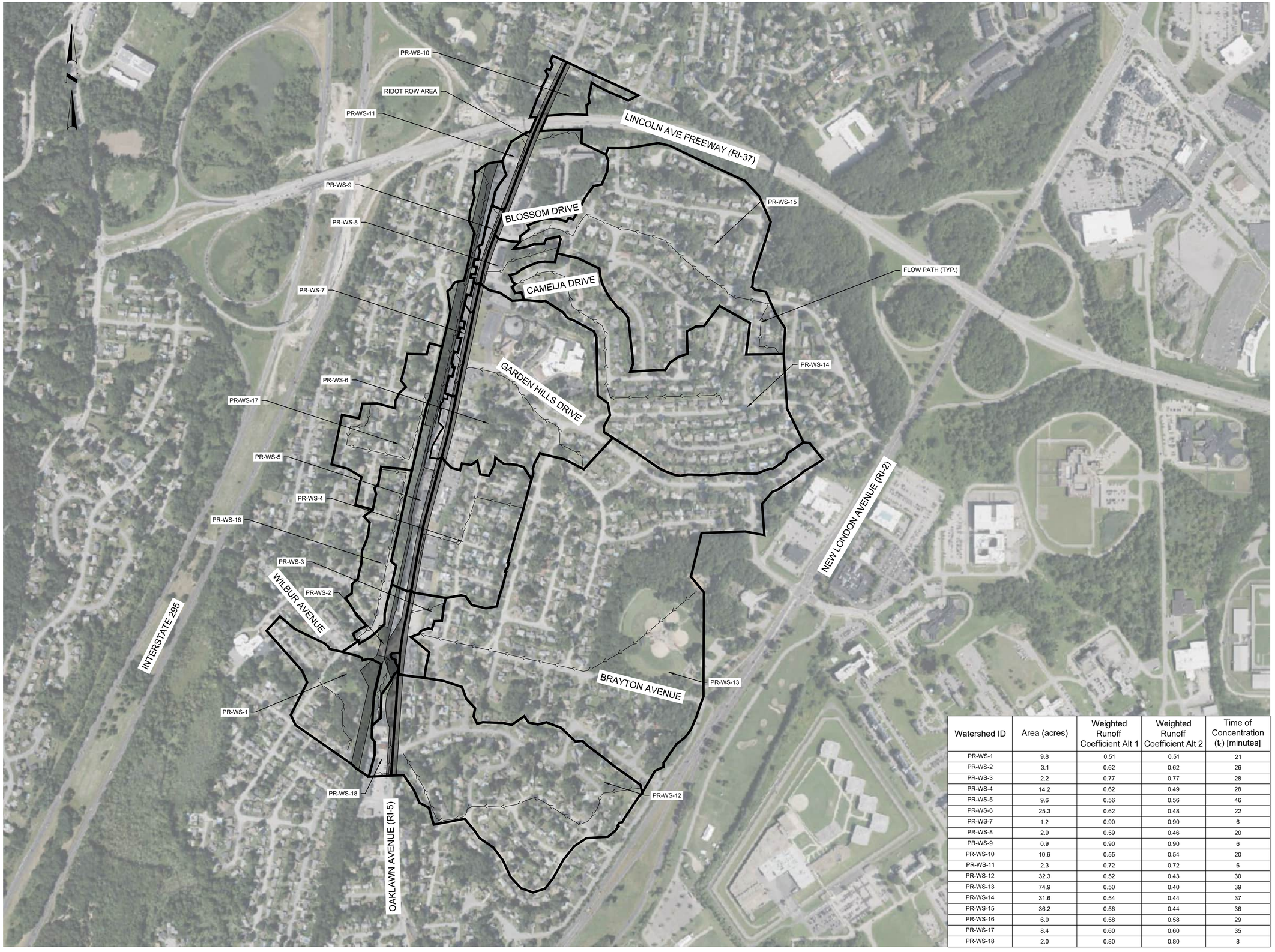
UNLESS OTHERWISE NOTED OR CHANGED BY REPRODUCTION

For Review Only

SHEET NO.

EX-WS

8/19/2026 3:56 PM \\BETA-INC.COM\RI\TRANS\5500\S\5598 - RIDOT OAKLAWN AT WILBUR\DRAWINGFILES\MISC\5598 - OAKLAWN WATERSHEDS.DWG (BETA STB BW STB)



Watershed ID	Area (acres)	Weighted Runoff Coefficient Alt 1	Weighted Runoff Coefficient Alt 2	Time of Concentration (t_c) [minutes]
PR-WS-1	9.8	0.51	0.51	21
PR-WS-2	3.1	0.62	0.62	26
PR-WS-3	2.2	0.77	0.77	28
PR-WS-4	14.2	0.62	0.49	28
PR-WS-5	9.6	0.56	0.56	46
PR-WS-6	25.3	0.62	0.48	22
PR-WS-7	1.2	0.90	0.90	6
PR-WS-8	2.9	0.59	0.46	20
PR-WS-9	0.9	0.90	0.90	6
PR-WS-10	10.6	0.55	0.54	20
PR-WS-11	2.3	0.72	0.72	6
PR-WS-12	32.3	0.52	0.43	30
PR-WS-13	74.9	0.50	0.40	39
PR-WS-14	31.6	0.54	0.44	37
PR-WS-15	36.2	0.56	0.44	36
PR-WS-16	6.0	0.58	0.58	29
PR-WS-17	8.4	0.60	0.60	35
PR-WS-18	2.0	0.80	0.80	8

PREPARED BY

BETA
www.BETA-Inc.com

REGISTERED PROFESSIONAL

SUBCONSULTANT

PROJECT

Stormwater Planning for Oaklawn Avenue at Wilbur Avenue

Cranston, RI

TITLE

PROPOSED WATERSHED PLAN

NO.	REVISIONS	DATE

DRAWN BY: AJM

DESIGNED BY: JMC

CHECKED BY: JML

ISSUE DATE: AUGUST 2026

BETA JOB NO.: 05598

SCALE

300 0 300 600

SCALE IN FEET: 1"=300'

UNLESS OTHERWISE NOTED OR CHANGED BY REPRODUCTION

For Review Only

SHEET NO.

PR-WS

8/20/2026 10:10 AM \\BETA-INC.COM\RI\TRANS\55005\55598 - RIDOT OAKLAWN AT WILBUR\DRAWINGFILES\MISC\55598 - OAKLAWN WATERSHEDS.DWG (BETA STB BW STB)

APPENDIX E

WETLAND REPORT

AVIZINIS
ENVIRONMENTAL
SERVICES INC

WETLAND REPORT

SITE LOCATION:
Oaklawn Avenue Drainage Assessment
Allard Street and Stoneham Court
Cranston, Rhode Island

PREPARED FOR:
Nicole Iannuzzi, P.E.
BETA Group, Inc.
NIannuzzi@beta-inc.com

Delineation by:_____
Timothy J. Avizinis, VP
March 31, 2026

Report by:_____
Edward J. Avizinis, CPSS, PWS
April 1, 202

INTRODUCTION

Avizinis Environmental Services, Inc., (AES), has completed the requested field work at the identified project areas on Allard Street and Stoneham Court in Cranston, Rhode Island. AES staff visited the sites on March 31, 2026 to delineate the regulated wetlands that occur within the areas.

Wetlands in Rhode Island are regulated by two agencies, the Department of Environmental Management (DEM), or the Coastal Resources Management Council (CRMC). The State of Rhode Island has created predetermined maps that identify which properties are under which regulatory agency. These maps identify that the project is within DEM jurisdiction. Therefore, AES has delineated all onsite wetland features to meet the standards outlined in section 3.21 of the Rules and Regulations Governing the Administration and Enforcement of the Freshwater Wetlands Act (250-RICR-150-15-3).

EXISTING CONDITIONS

The project encompasses two sites in Cranston, Rhode Island, one extending west from the western terminus of Allard Street and the other extending north from Stoneham Court. The sites are undeveloped and primarily forested and surrounded by neighborhoods. The I-295 corridor serves as the wetern boundary of the western project area. Meshanticut Brook crosses the southern portion of the western site. All limits of wetland impacting the project areas have been delineated by AES.

The DEM Environmental Resource Maps show the western project area lies within local and state conservation land managed for conservation and habitat protection. These maps also show the riparian area associated with Meshanticut Brook is listed as a wildlife corridor. Several stormwater outfalls are present along the I-295 corridor in the western portion of the western project area and one within the eastern portion of the same site.

A review of historical aerial photographs available from the DEM Environmental Resource Maps shows little change to these project areas as of the earliest available photographs taken in 1939. At that time the I-295 corridor had yet to be constructed, but both sites were undeveloped forested areas surrounded by neighborhoods. The I-295 corridor can first be seen on the imagery from 1972.

WETLAND FEATURES

AES has established three wetland flag series within the project areas. Flagging labeled **A1 – A29** delineates the closest limit of a swamp associate with Meshanticut Brook that covers much of the western project area. The course of Meshanticut Brook was GIS located.

Flagging labeled **B1 – B14** and **C1 – C10** delineate the closest limits of a small swamp within the eastern project area north of Stoneham Court.

REGULATORY SETBACKS

In accordance with wetland regulations (250-RICR-150-15-3), all freshwater wetlands will require a 100-foot Jurisdictional Area, and all rivers, streams, and intermittent streams require a 200-foot jurisdictional area. Any proposed alterations with this zone will require some degree of application and review by the DEM.

Furthermore, a separate buffer zone and construction setback will be required for the wetland. The buffer zone is a naturally vegetated or planted area left to naturalize that is immediately contiguous with the wetland. The setback is a separate zone that limits the placement of structures.

The size of the buffer zone is based on numerous factors including wetland vegetative type, subtype, position within the watershed, and habitat types among other factors. The project area lies within River Protection Region 2. The wetland feature delineated by the A-series of flags within the western project area is a deciduous-dominated swamp that is greater than 10 acres in size. This wetland will therefore receive a 75-foot buffer zone per section 3.23.H.3.e.

Within the eastern project area, the wetland feature delineated by the B and C-series of flags is also a deciduous-dominated swamp, but this one is less than an acre in size. Per section 3.23.H.3.h., this swamp is entitled to a 25-foot buffer zone.

Meshanticut Brook is shown as a blue-lined feature on the USGS Topographic Maps and is therefore classified as a river. In accordance with 3.23.H.6., Mile Brook shall require the application of a 150-foot buffer zone.

In addition, a 20-foot construction setback shall be applied to the landward limit of the buffer. Certain construction activities are limited within the setback related to primary structures. Only a 5-foot construction setback pertains to accessory structures (section 3.71.C.1.).

AES Delineation and Regulatory Requirements

Flag Series	Classification	Jurisdictional Area* (ft)	Buffer Zone (ft)	Existing Buffer (ft)	Construction Setback (ft)
A1 – A29	Swamp	100	75	**variable extent of existing vegetation out to 75 ft**	20
B1 – B14 C1 – C10	Swamp	100	25	**variable extent of existing vegetation out to 25 ft**	20
GIS/GPS delineated watercourse	River (Meshanticut Brook)	200	150	**variable extent of existing vegetation out to 150 ft**	20

*Any area designated as flood plain (excluding X) shall be considered jurisdictional area.

CLOSING

Thank you for giving AES the opportunity to assist you with this project. Please review the attached wetland delineation map which represents the findings of our field work. AES staff have located the wetland flags and other pertinent site features with a Juniper GEOde submetric GPS/GNSS. Although this is not of survey quality it is useful for preliminary planning. This data has also been forwarded to you in conjunction with this report and is in the NAD 1983 RI State Plane format in case this information is useful to you. Please do not hesitate to contact AES should you have any questions on this report.

Although much of the area is comprised of "buffer zone", since it was historically developed, most of it is not "existing buffer". Therefore, proposed redevelopment / alterations / additions on the property, while still requiring a DEM permit, should be a fairly simple process with minimal regulatory requirements. I am happy to review a concept plan to provide feedback on the application process.

Certain activities related to roadwork for existing features are exempt within DEM jurisdiction. AES would be happy to review any prepared site plans for this property to assess whether a permit is needed or of the proposed activity is exempt by regulation.

ATTACHMENTS

1) NOVEMBER 2025 AERIAL MAP
2) USDA – NRCS SOIL SURVEY MAP
3) USGS TOPOGRAPHIC MAP
4) WETLAND DELINEATION MAP



AVIZINIS
ENVIRONMENTAL
SERVICES INC

2025 AERIAL MAP
Oaklawn Avenue Drainage Assessment
Cranston, Rhode Island

LEGEND

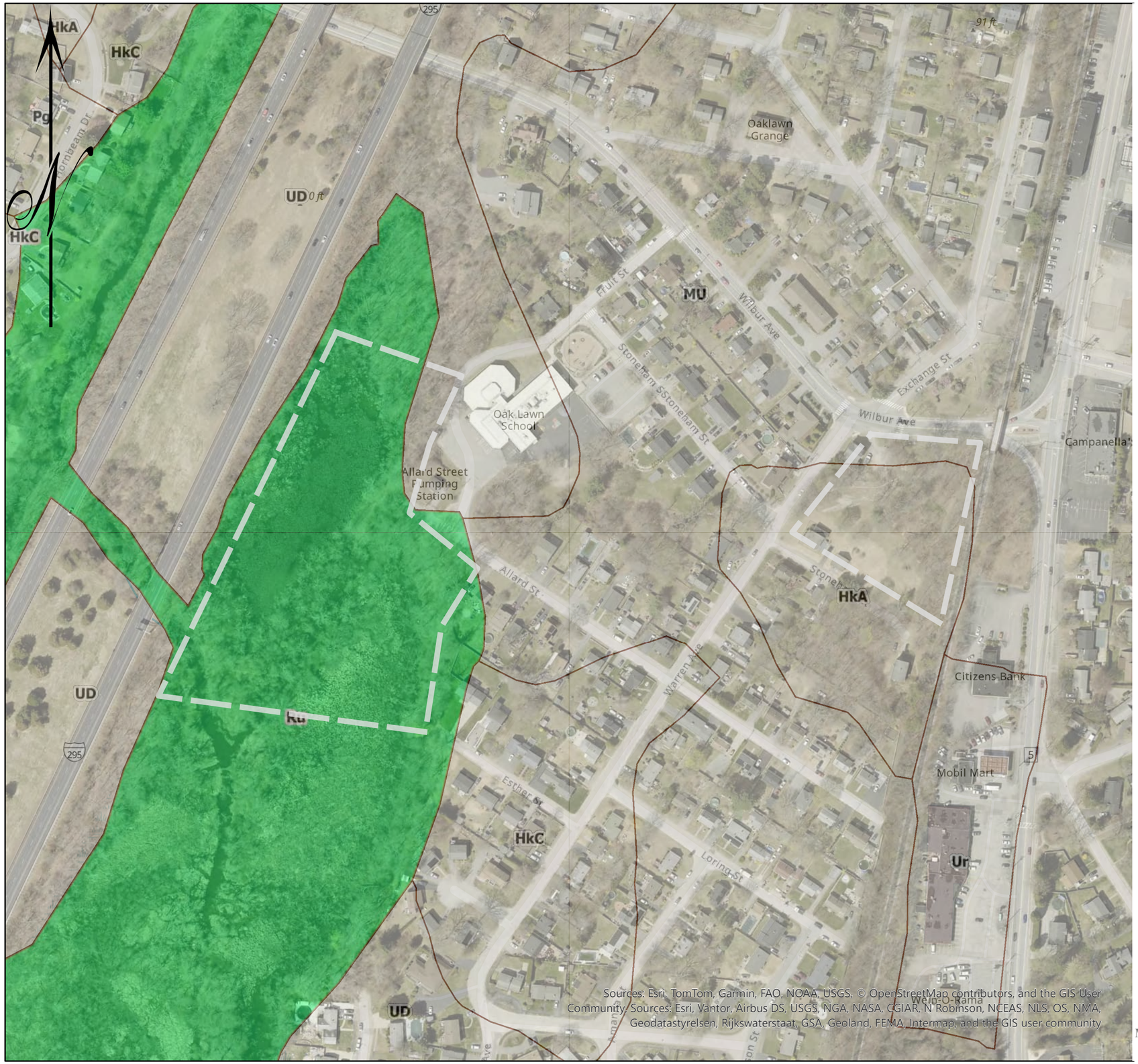
Project Area

200 100 0 200 400
Feet

General Notes:
1. This map should not be interpreted as a survey quality graphic. It is designed for preliminary planning purposes only. AES recommends consultation with a Professional Land Surveyor for accurate site feature locations.
2. Property lines as depicted on this map have been approximated from plat maps available from the town assessor's online database.
3. Aerial photograph base map and other data layers acquired from the RI DEM and RIGIS database.

Map created by: Patrick J. Loveland, GIS Specialist 02/27/2026

26-057



AVIZINIS
ENVIRONMENTAL
SERVICES INC

USDA - NRCS SOIL SURVEY MAP
Oaklawn Avenue Drainage Assessment
Cranston, Rhode Island

LEGEND

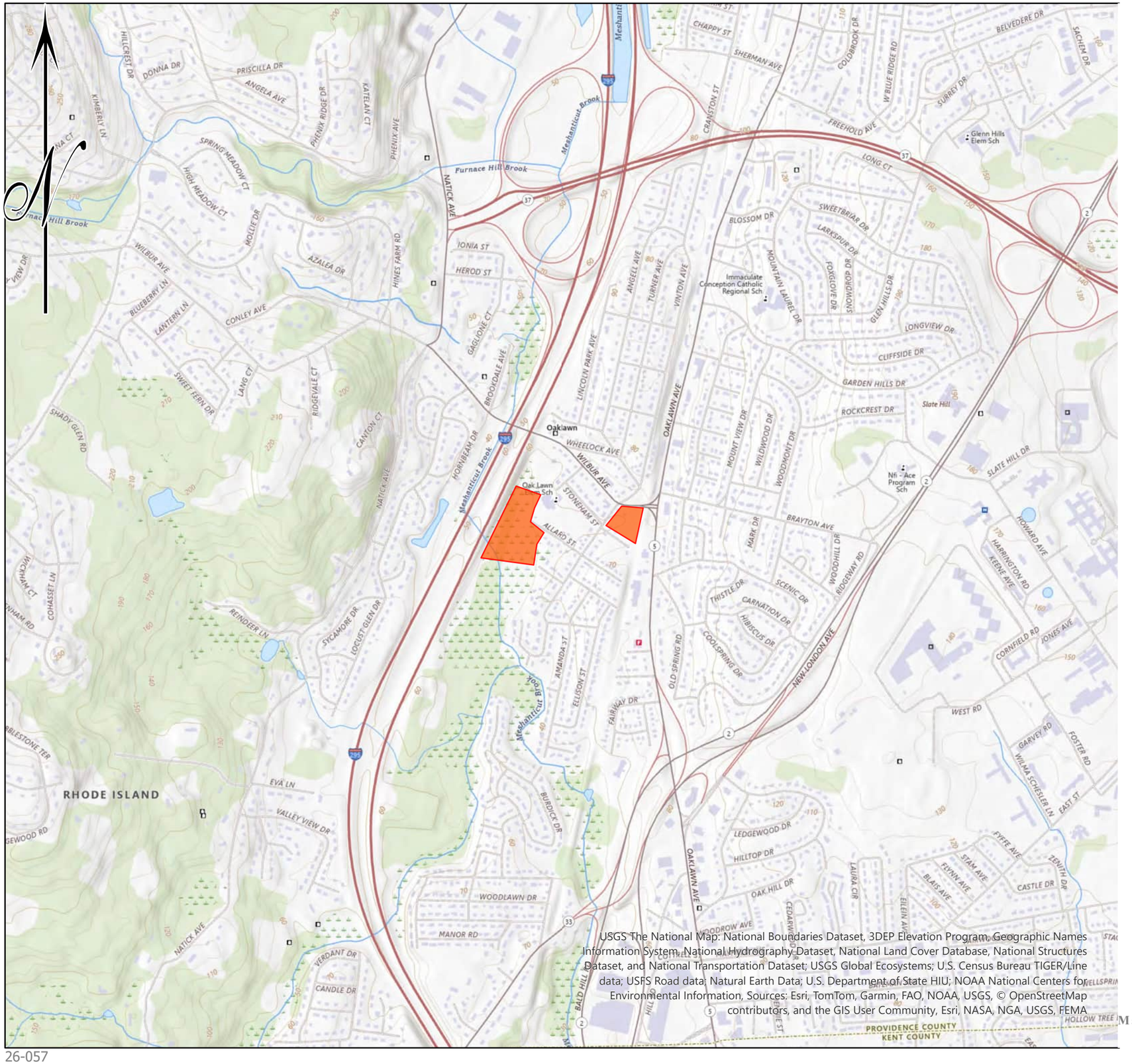
HkA - Hinckley loamy sand, 0 to 3 percent slopes
HkC - Hinckley loamy sand, 8 to 15 percent slopes
MU - Merrimac-Urban land complex, 0 to 8 percent slopes
Pg - Pits, gravel
Ru - Rippowam fine sandy loam
UD - Udorthents-Urban land complex
Ur - Urban land

200 100 0 200 400 600
Feet

General Notes:
1. This map should not be interpreted as a survey quality graphic. It is designed for preliminary planning purposes only. AES recommends consultation with a Professional Land Surveyor for accurate site feature locations.
2. Property lines as depicted on this map have been approximated from plat maps available from the town assessor's online database.
3. Aerial photograph base map and other data layers acquired from the RI DEM and RIGIS database.

Map created by: **Patrick J. Loveland, GIS Specialist** **02/27/2026**

26-057



USGS The National Map: National Boundaries Dataset, 3DEP Elevation Program, Geographic Names Information System, National Hydrography Dataset, National Land Cover Database, National Structures Dataset, and National Transportation Dataset; USGS Global Ecosystems; U.S. Census Bureau TIGER/Line data; USFS Road data; Natural Earth Data; U.S. Department of State HIU; NOAA National Centers for Environmental Information, Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors, and the GIS User Community, Esri, NASA, NGA, USGS, FEMA

AVIZINIS
ENVIRONMENTAL
SERVICES INC

USGS TOPOGRAPHIC MAP
Oaklawn Avenue Drainage Assessment
Cranston, Rhode Island

LEGEND

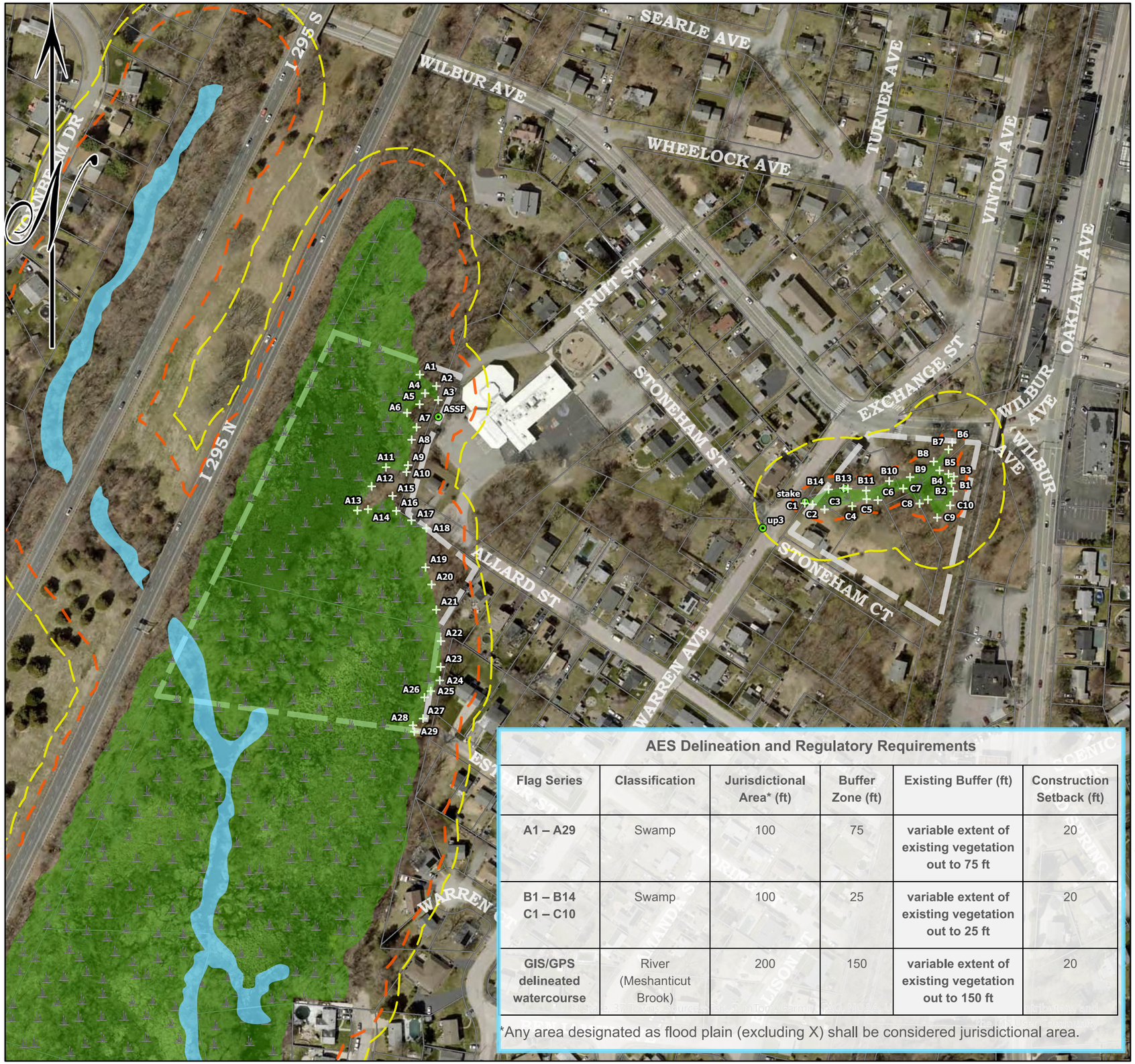
Project Area

1,000 500 0 1,000 2,000 3,000
Feet

General Notes:
1. This map should not be interpreted as a survey quality graphic. It is designed for preliminary planning purposes only. AES recommends consultation with a Professional Land Surveyor for accurate site feature locations.
2. Property lines as depicted on this map have been approximated from plat maps available from the town assessor's online database.
3. Aerial photograph base map and other data layers acquired from the RI DEM and RIGIS database.

Map created by: Patrick J. Loveland, GIS Specialist 02/27/2026

26-057



AVIZINIS ENVIRONMENTAL SERVICES INC

2026 WETLAND DELINEATION MAP
Oaklawn Avenue Drainage Assessment
Cranston, Rhode Island

LEGEND

- Project Area
- AES Wetland Flag
- GPS Benchmark
- Meshanticut Brook
- Wetland Feature
- Buffer Zone
- Jurisdictional Area

200 100 0 200 400 Feet

AES Delineation and Regulatory Requirements

Flag Series	Classification	Jurisdictional Area* (ft)	Buffer Zone (ft)	Existing Buffer (ft)	Construction Setback (ft)
A1 – A29	Swamp	100	75	variable extent of existing vegetation out to 75 ft	20
B1 – B14 C1 – C10	Swamp	100	25	variable extent of existing vegetation out to 25 ft	20
GIS/GPS delineated watercourse	River (Meshanticut Brook)	200	150	variable extent of existing vegetation out to 150 ft	20

*Any area designated as flood plain (excluding X) shall be considered jurisdictional area.

General Notes:
1. This map should not be interpreted as a survey quality graphic. It is designed for preliminary planning purposes only. AES recommends consultation with a Professional Land Surveyor for an accurate site plan.
2. Property lines as depicted on this map have been approximated from plat maps available from the town assessor's online database.
3. Aerial photograph base map and other data layers acquired from the RI DEM and RIGIS database.
4. Site features located with a Juniper Geode Submetric GNSS receiver with SWmaps data collection software. Non-delineated wetland edges have not been field verified and are depicted for graphic purposes only. The required 20-foot construction setbacks are not shown on this map.

Action	Staff	Signed	Dated
Map Prepared By:	Patrick J. Loveland		04/01/2026
Delineation By:	Timothy J. Avizinis, VP		03/31/2026
Reviewed By:	Edward J. Avizinis, CPSS, PWS		04/01/2026

Certified Professional Soil Scientist

SWS PWS EDWARD J. AVIZINIS 2746 PROFESSIONAL WETLAND SCIENTIST

26-057

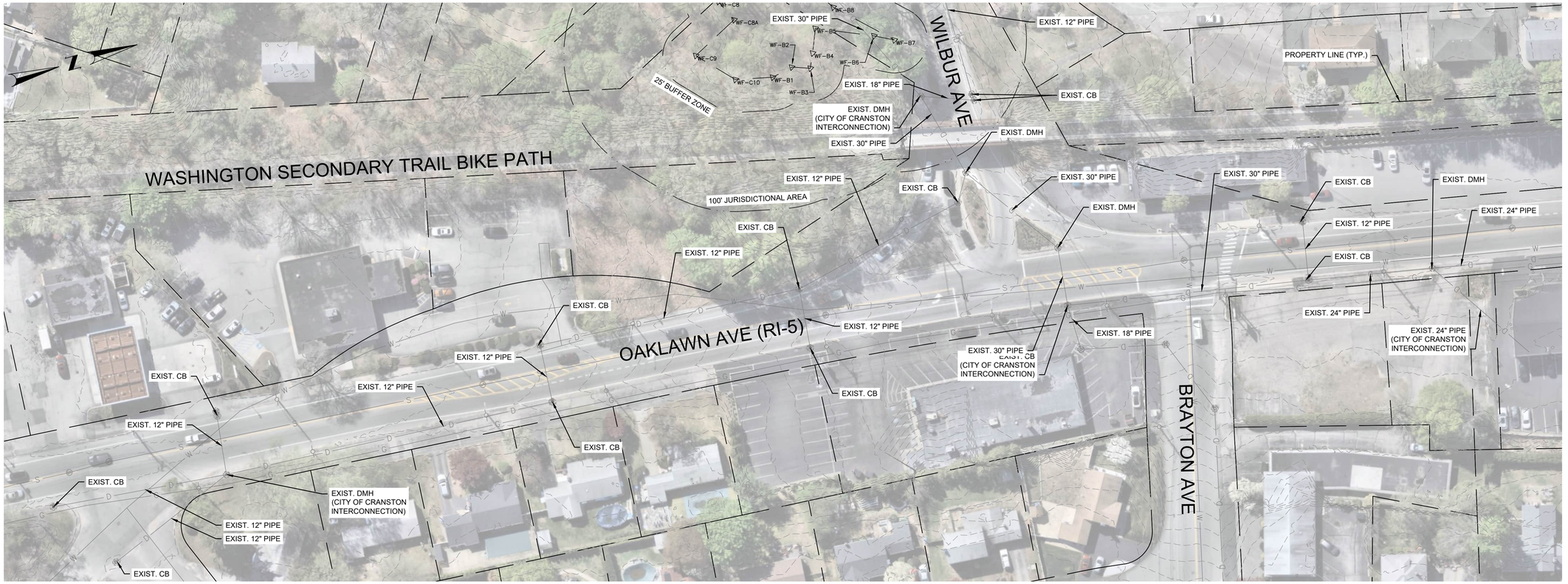
APPENDIX F

EXISTING CONDITIONS PLANS



CONTINUE BELOW

CONTINUE ABOVE



CONTINUE ON SHEET 2

PREPARED BY

BETA
www.BETA-Inc.com

REGISTERED PROFESSIONAL

SUBCONSULTANT

PROJECT

Stormwater Planning for Oaklawn Avenue at Wilbur Avenue

Cranston, RI

TITLE

EXISTING CONDITIONS PLAN NO. 1

NO.	REVISIONS	DATE

DRAWN BY: AJM

DESIGNED BY: JMC

CHECKED BY: JML

ISSUE DATE: AUGUST 2026

BETA JOB NO.: 05598

SCALE

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SCALE IN FEET: 1"=40'

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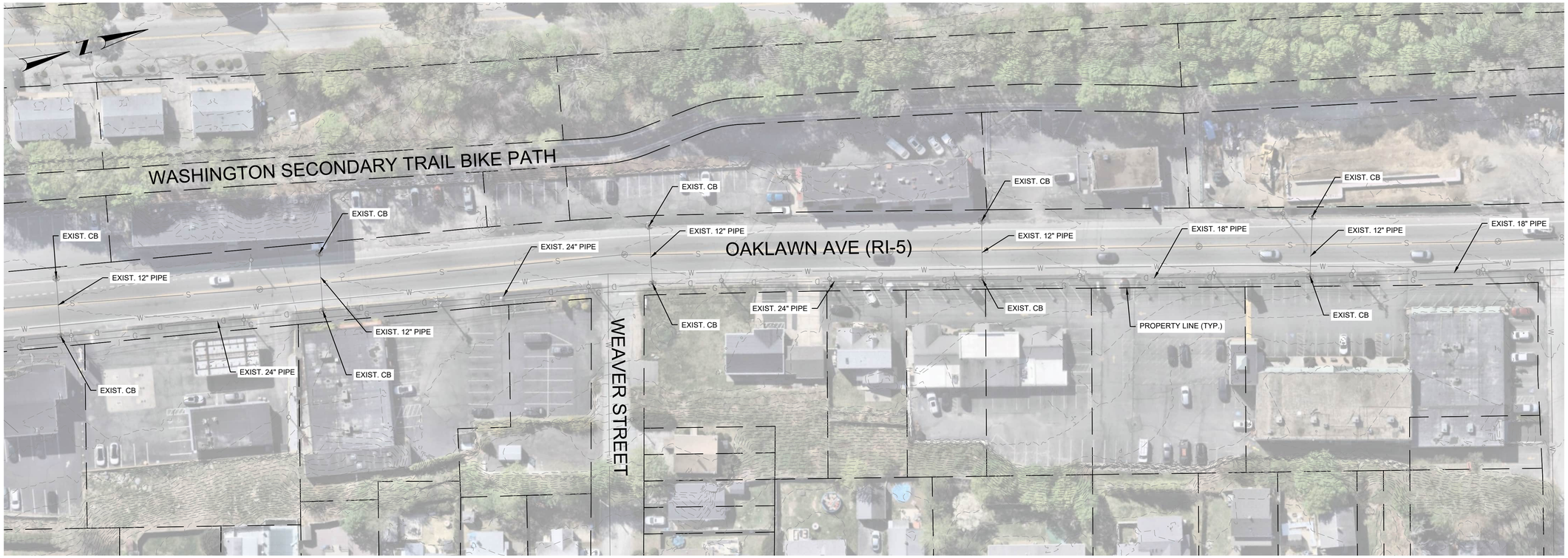
Not for Construction

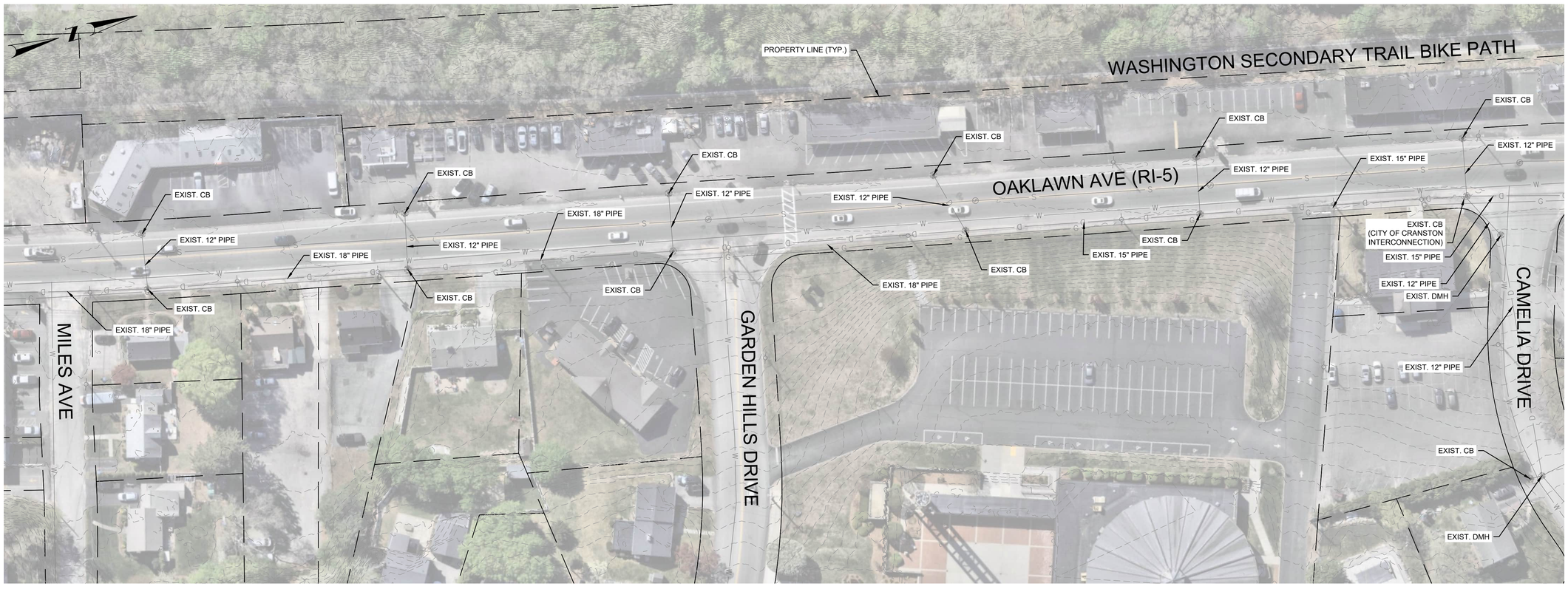
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CONTINUE ON SHEET 1





CONTINUE ABOVE

CONTINUE ON SHEET 3

PREPARED BY

BETA
www.BETA-Inc.com

REGISTERED PROFESSIONAL

SUBCONSULTANT

PROJECT

Stormwater Planning for Oaklawn Avenue at Wilbur Avenue

Cranston, RI

TITLE

EXISTING CONDITIONS PLAN NO. 2

NO.	REVISIONS	DATE

DRAWN BY:	AJM
DESIGNED BY:	JMC
CHECKED BY:	JML
ISSUE DATE:	AUGUST 2026
BETA JOB NO.:	05598

SCALE

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SCALE IN FEET: 1"=40'

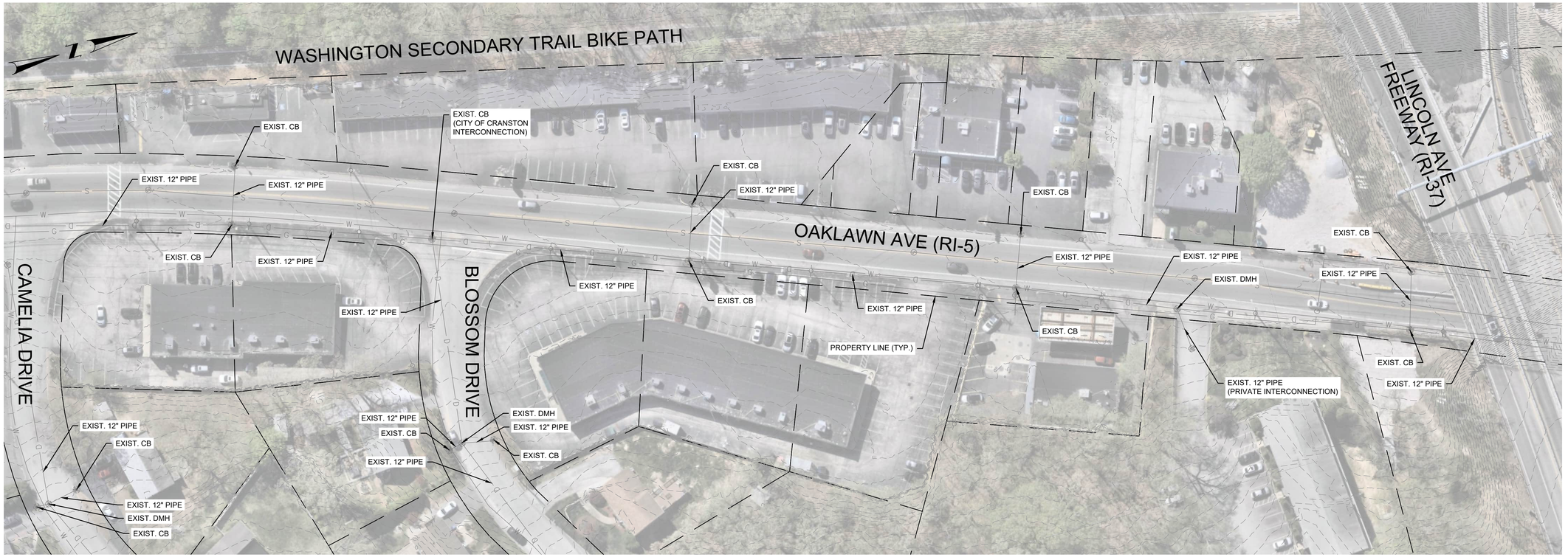
UNLESS OTHERWISE NOTED OR CHANGED BY REPRODUCTION

Not for Construction

SHEET NO.

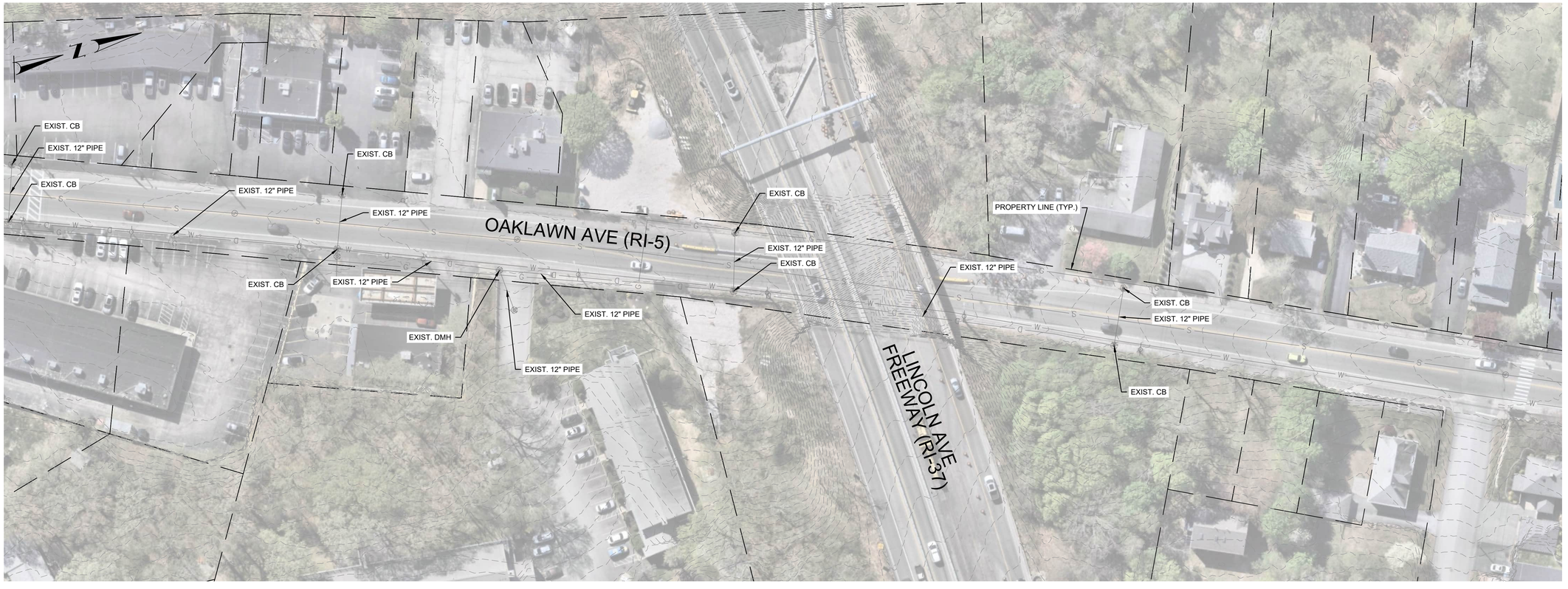
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CONTINUE ON SHEET 2

CONTINUE BELOW



CONTINUE ABOVE

PREPARED BY

BETA
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REGISTERED PROFESSIONAL

SUBCONSULTANT

PROJECT

Stormwater Planning for Oaklawn Avenue at Wilbur Avenue

Cranston, RI

TITLE

EXISTING CONDITIONS PLAN NO. 3

NO.	REVISIONS	DATE

DRAWN BY: AJM

DESIGNED BY: JMC

CHECKED BY: JML

ISSUE DATE: AUGUST 2026

BETA JOB NO.: 05598

SCALE

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SCALE IN FEET: 1"=40'

UNLESS OTHERWISE NOTED OR CHANGED BY REPRODUCTION

Not for Construction

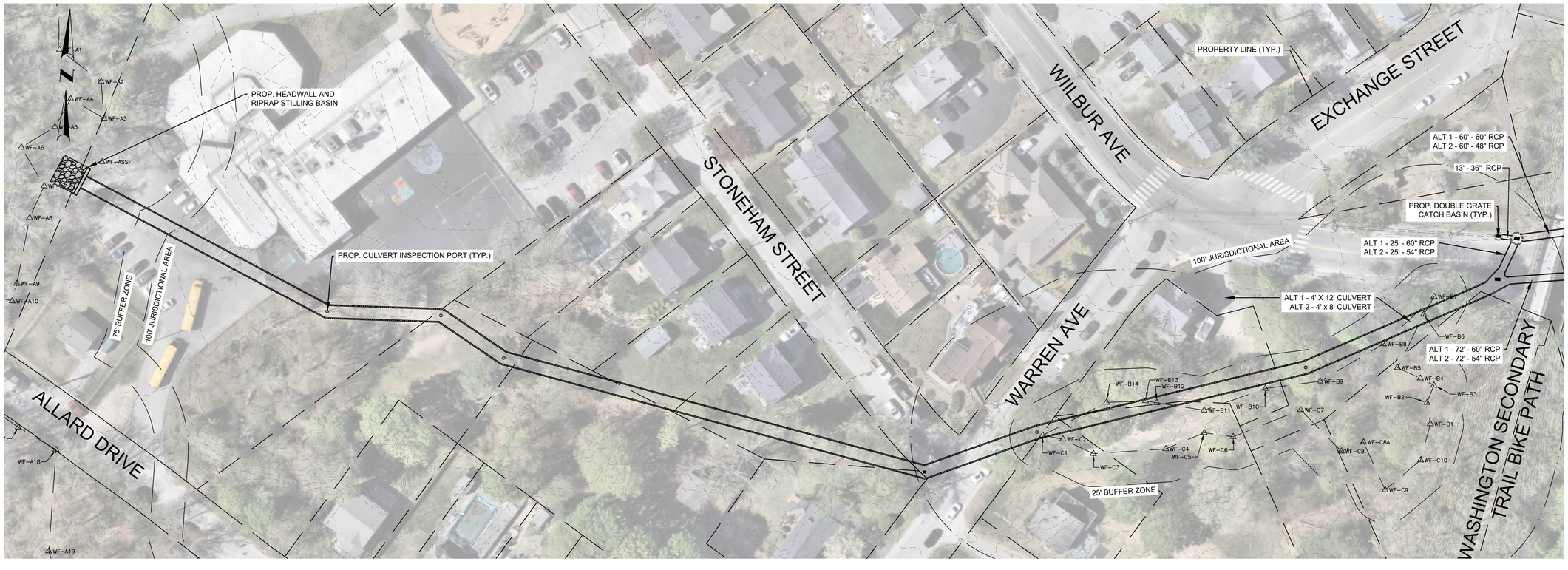
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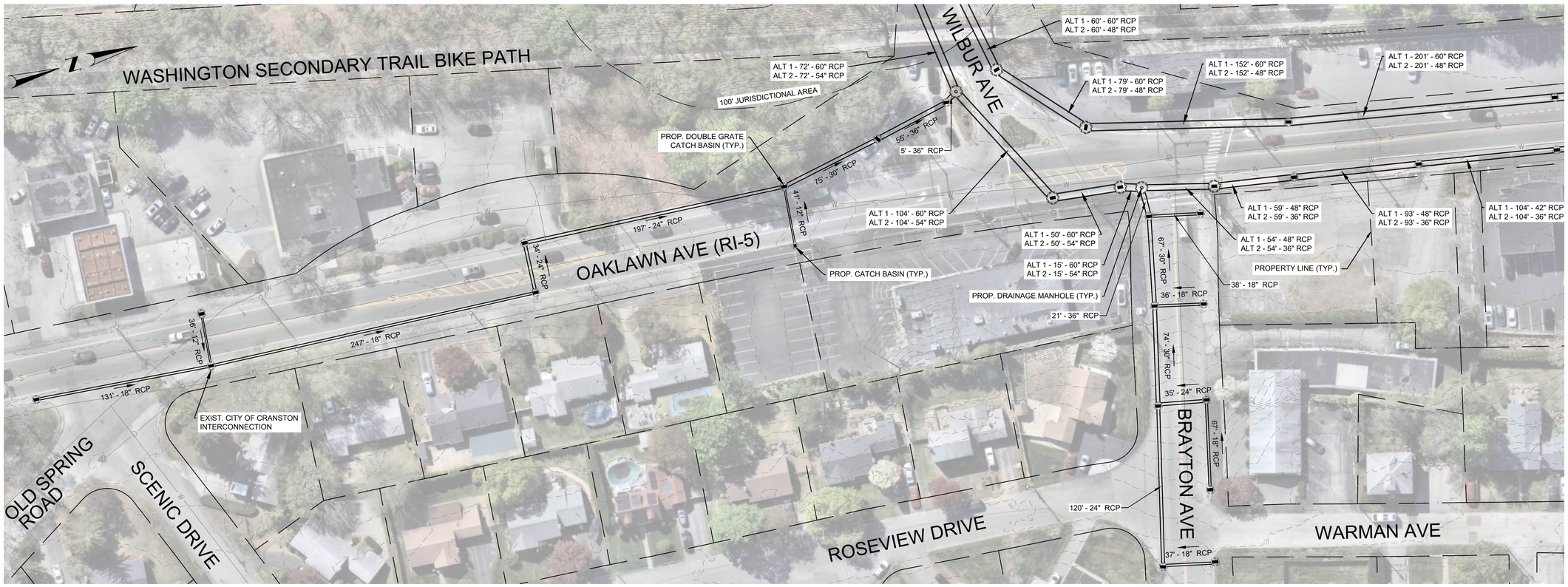
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APPENDIX G

PROPOSED ALTERNATIVES PLANS



CONTINUE ABOVE



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SUBCONSULTANT

PROJECT

Stormwater Planning for Oaklawn Avenue at Wilbur Avenue

Cranston, RI

TITLE

PROPOSED ALTERNATIVES PLAN NO. 1

NO.	REVISIONS	DATE

DRAWN BY:	AJM
DESIGNED BY:	JMC
CHECKED BY:	JML
ISSUE DATE:	AUGUST 2026
BETA JOB NO.:	05598

SCALE

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SCALE IN FEET: 1"=40'

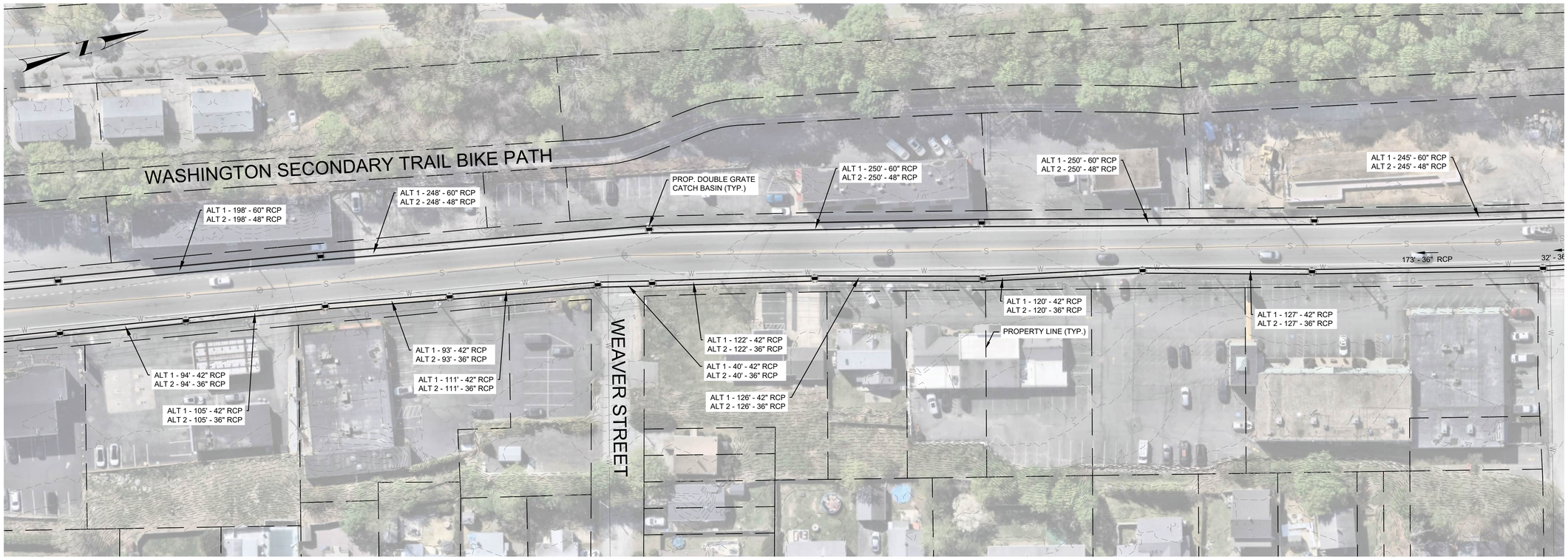
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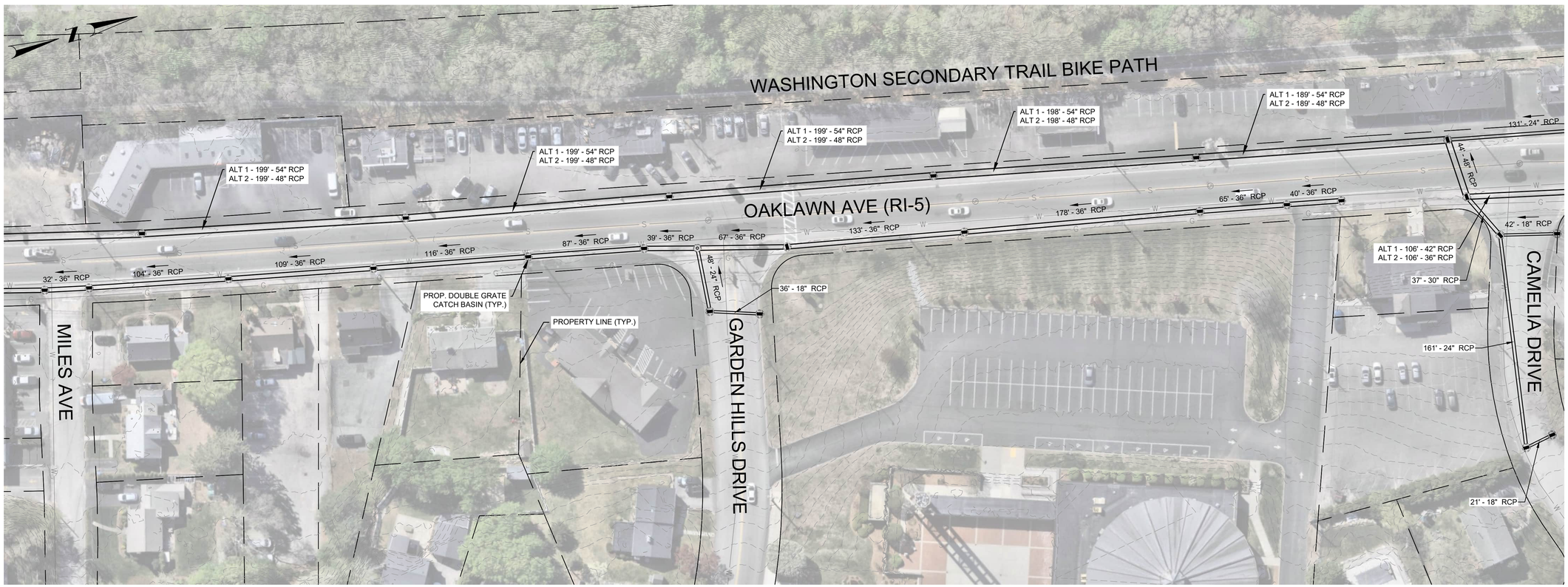
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SUBCONSULTANT

PROJECT

Stormwater Planning for Oaklawn Avenue at Wilbur Avenue

Cranston, RI

TITLE

PROPOSED ALTERNATIVES PLAN NO. 2

NO.	REVISIONS	DATE

DRAWN BY:	AJM
DESIGNED BY:	JMC
CHECKED BY:	JML
ISSUE DATE:	AUGUST 2026
BETA JOB NO.:	05598

SCALE

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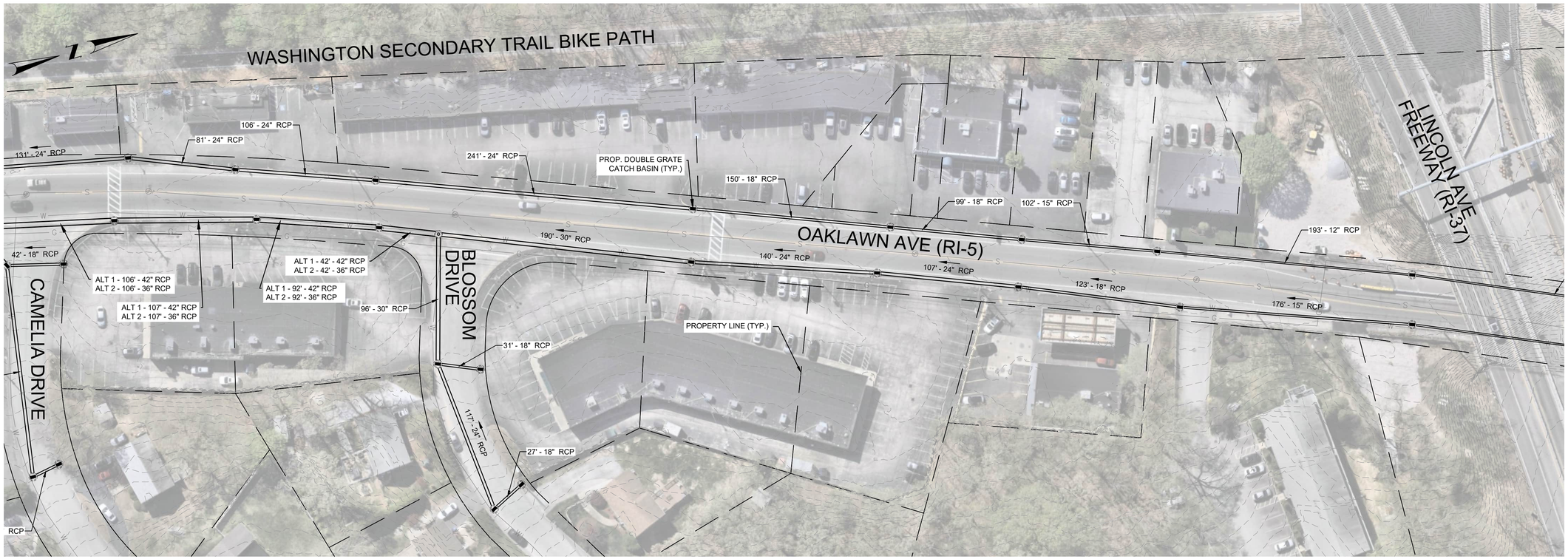
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For Review Only

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PREPARED BY

BETA
www.BETA-Inc.com

REGISTERED PROFESSIONAL

SUBCONSULTANT

PROJECT

Stormwater Planning for Oaklawn Avenue at Wilbur Avenue

Cranston, RI

TITLE

PROPOSED ALTERNATIVES PLAN NO. 3

NO.	REVISIONS	DATE

DRAWN BY: AJM

DESIGNED BY: JMC

CHECKED BY: JML

ISSUE DATE: AUGUST 2026

BETA JOB NO.: 05598

SCALE

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SCALE IN FEET: 1"=40'

UNLESS OTHERWISE NOTED OR CHANGED BY REPRODUCTION

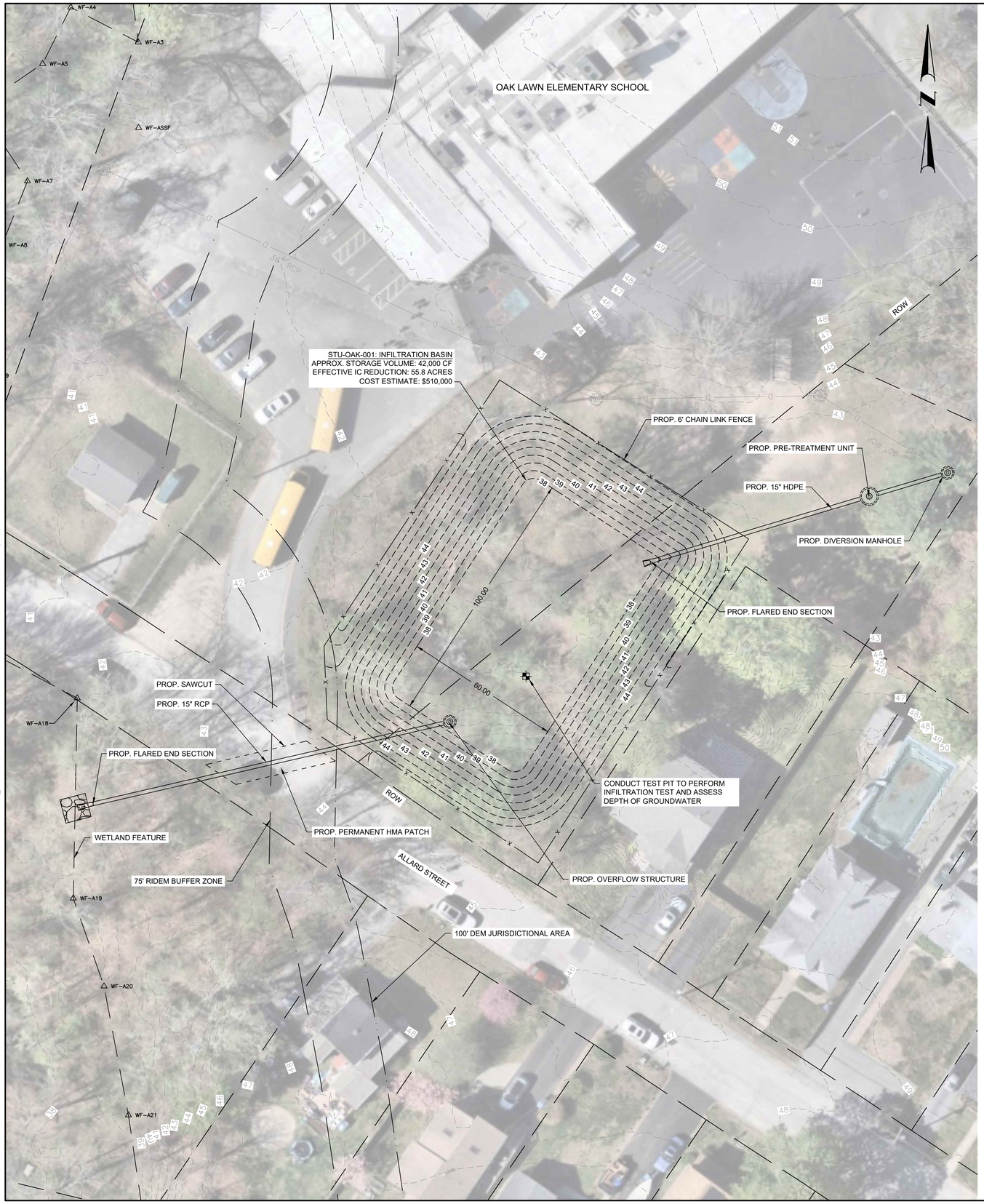
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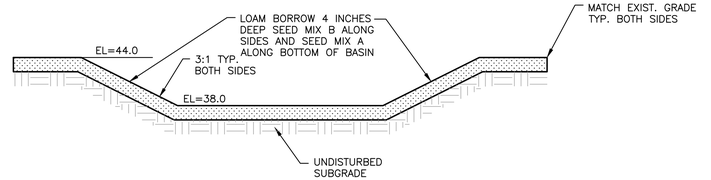
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APPENDIX H

CONCEPTUAL STU PLANS

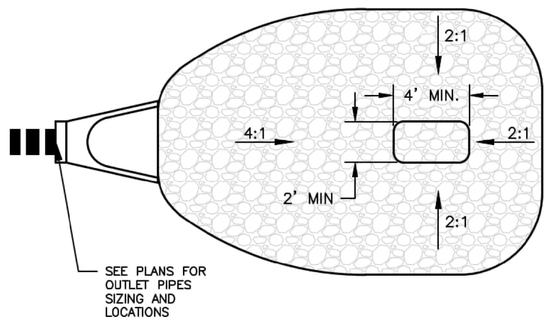




NOTES:
1. SHALL BE IN ACCORDANCE WITH SECTIONS L01 AND L02 OF THE R.I. STANDARD SPECIFICATIONS.
2. SEED MIX A SHALL BE "NEW ENGLAND EROSION CONTROL/RESTORATION MIX FOR DETENTION BASINS AND MOIST SITES" AS PRODUCED BY NEW ENGLAND WETLAND PLANTS, INC. OR APPROVED EQUAL. SEED MIX B SHALL BE RESIDENTIAL SEEDING (TYPE 2) IN ACCORDANCE WITH SECTION L02 AND M18 OF THE STANDARD SPECIFICATIONS.

INFILTRATION BASIN CROSS-SECTION

NOT TO SCALE



RIPRAP OUTFALL

NOT TO SCALE

PREPARED BY

BETA
www.BETA-Inc.com

REGISTERED PROFESSIONAL

SUBCONSULTANT

PROJECT

Stormwater Planning for Oaklawn Avenue at Wilbur Avenue

Cranston, RI

TITLE

CONCEPTUAL STU PLANS STU-OAK-001

NO.	REVISIONS	DATE

DRAWN BY: AJM

DESIGNED BY: JMC

CHECKED BY: JML

ISSUE DATE: AUGUST 2026

BETA JOB NO.: 05598

SCALE

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SCALE IN FEET: 1"=20'

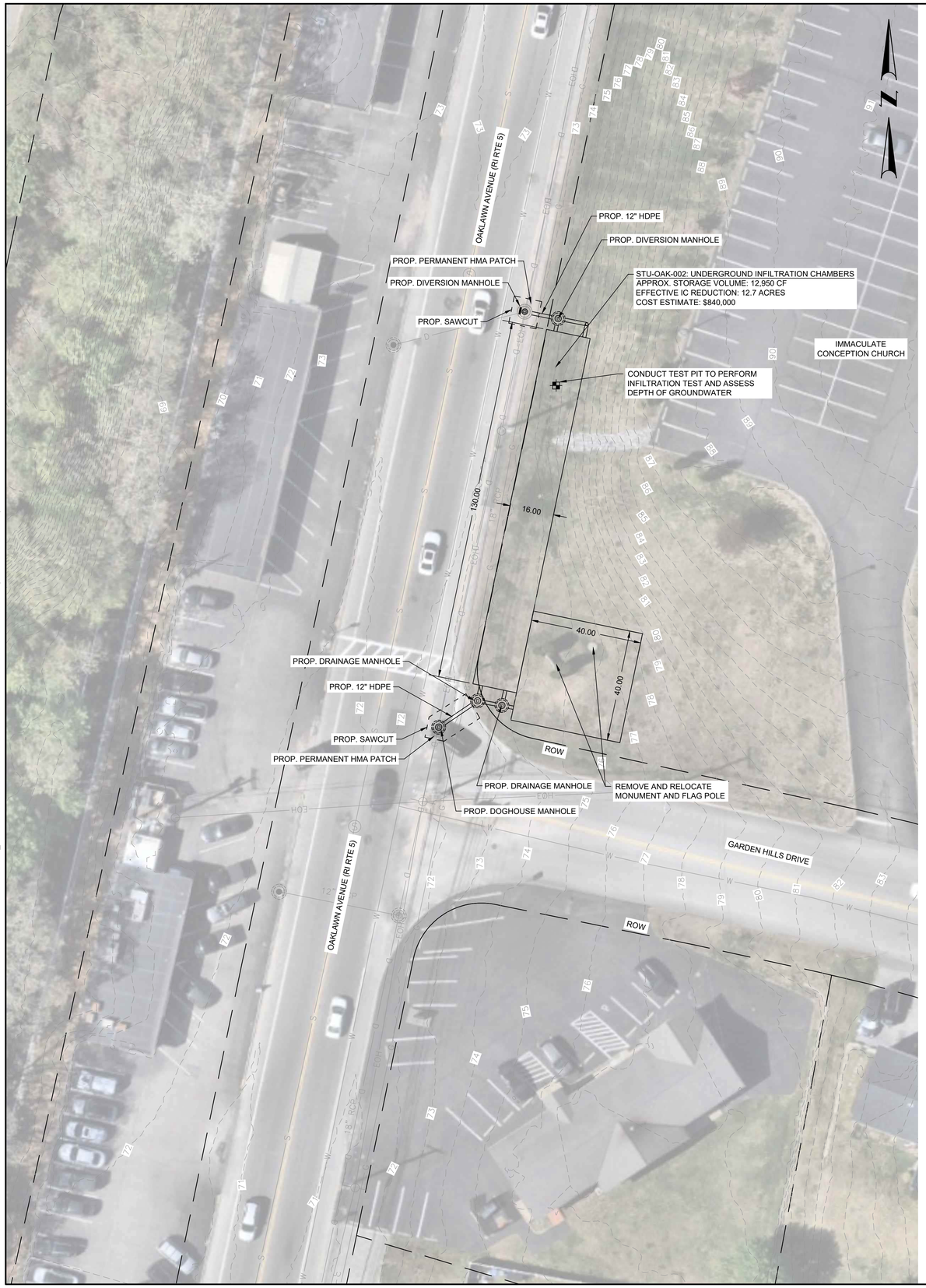
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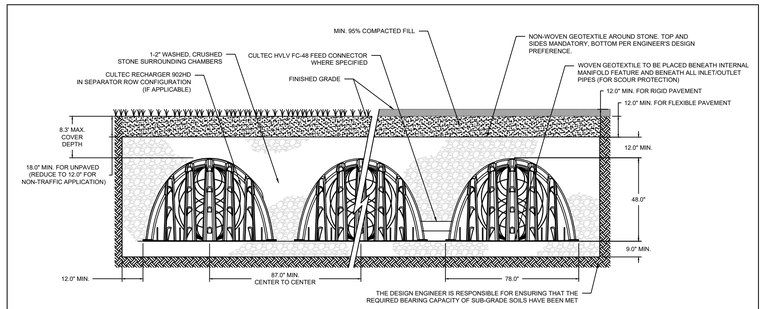
For Review Only

SHEET NO.

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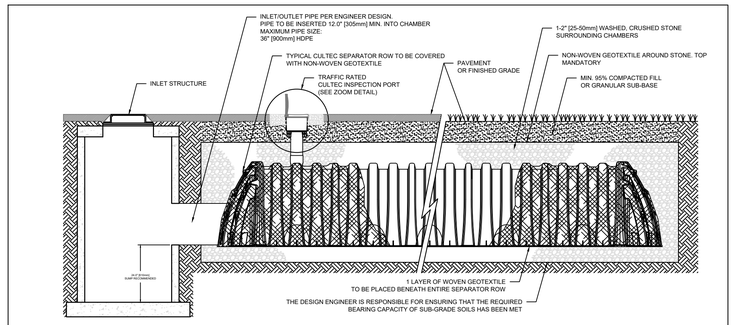
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NOTES:
1. THE CHAMBERS SHALL BE DESIGNED AND TESTED IN ACCORDANCE WITH ASTM F2787 "STANDARD PRACTICE FOR STRUCTURAL DESIGN OF THERMOPLASTIC CORRUGATED WALL STORMWATER COLLECTION CHAMBERS." THE LOAD CONFIGURATION SHALL INCLUDE:
   1.a. INSTANTANEOUS AASHTO DESIGN TRUCK LIVE LOAD AT MINIMUM COVER
   1.b. MAXIMUM PERMANENT (50-YEAR) COVER LOAD
   1.c. 1-WEEK PARKED AASHTO DESIGN TRUCK LOAD
2. THE CHAMBERS SHALL MEET THE REQUIREMENTS OF ASTM F3430-20 "STANDARD SPECIFICATION FOR CELLULAR POLYPROPYLENE (PP) CORRUGATED WALL STORMWATER COLLECTION CHAMBERS"
3. THE INSTALLED CHAMBER SYSTEM SHALL PROVIDE RESISTANCE TO THE LOADS AND LOAD FACTORS AS DEFINED IN THE AASHTO LRFD BRIDGE DESIGN SPECIFICATIONS SECTION 12.12, WHEN INSTALLED ACCORDING TO CULTEC'S RECOMMENDED INSTALLATION INSTRUCTIONS. THE STRUCTURAL DESIGN OF THE CHAMBERS SHALL INCLUDE THE FOLLOWING:
   3.a. THE CREEP MODULUS SHALL BE 50-YEAR AS SPECIFIED IN ASTM F3430
   3.b. THE MINIMUM SAFETY FACTOR FOR LIVE LOADS SHALL BE 1.75
   3.c. THE MINIMUM SAFETY FACTOR FOR DEAD LOADS SHALL BE 1.95

CULTEC RECHARGER 902HD CROSS SECTION



NOTES:
1. THE CHAMBERS SHALL BE DESIGNED AND TESTED IN ACCORDANCE WITH ASTM F2787 "STANDARD PRACTICE FOR STRUCTURAL DESIGN OF THERMOPLASTIC CORRUGATED WALL STORMWATER COLLECTION CHAMBERS." THE LOAD CONFIGURATION SHALL INCLUDE:
   1.a. INSTANTANEOUS AASHTO DESIGN TRUCK LIVE LOAD AT MINIMUM COVER
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   3.a. THE CREEP MODULUS SHALL BE 50-YEAR AS SPECIFIED IN ASTM F3430
   3.b. THE MINIMUM SAFETY FACTOR FOR LIVE LOADS SHALL BE 1.75
   3.c. THE MINIMUM SAFETY FACTOR FOR DEAD LOADS SHALL BE 1.95

CULTEC SEPARATOR ROW - CULTEC INSPECTION PORT DETAIL

(OR APPROVED EQUAL)

PREPARED BY

BETA
www.BETA-Inc.com

REGISTERED PROFESSIONAL

SUBCONSULTANT

PROJECT

Stormwater Planning for Oaklawn Avenue at Wilbur Avenue

Cranston, RI

TITLE

CONCEPTUAL STU PLANS STU-OAK-002

NO.	REVISIONS	DATE

DRAWN BY: AJM
DESIGNED BY: JMC
CHECKED BY: JML
ISSUE DATE: AUGUST 2026
BETA JOB NO.: 05598

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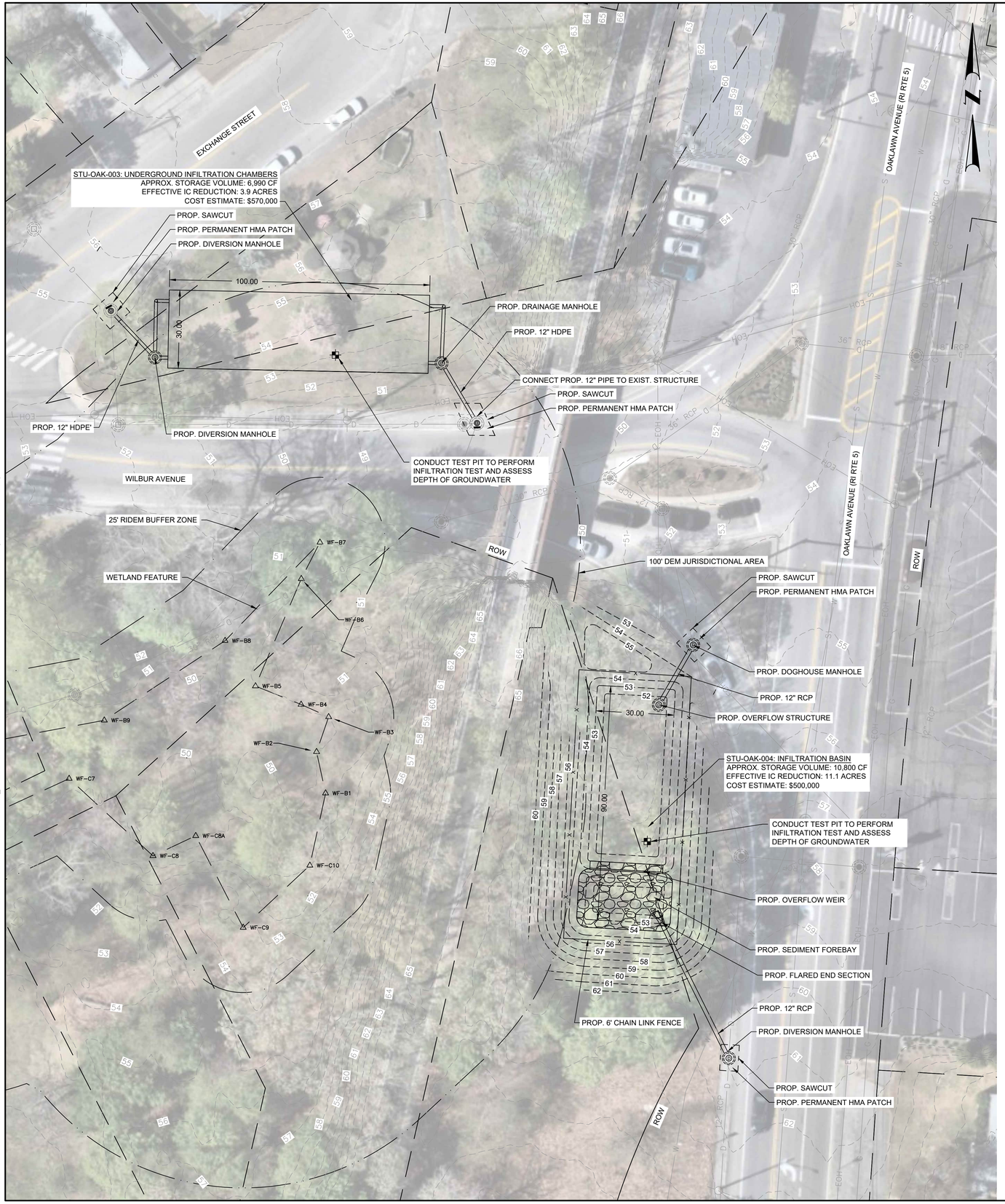
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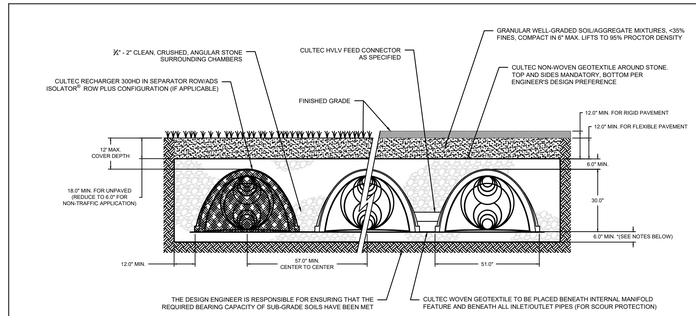
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SHEET NO.
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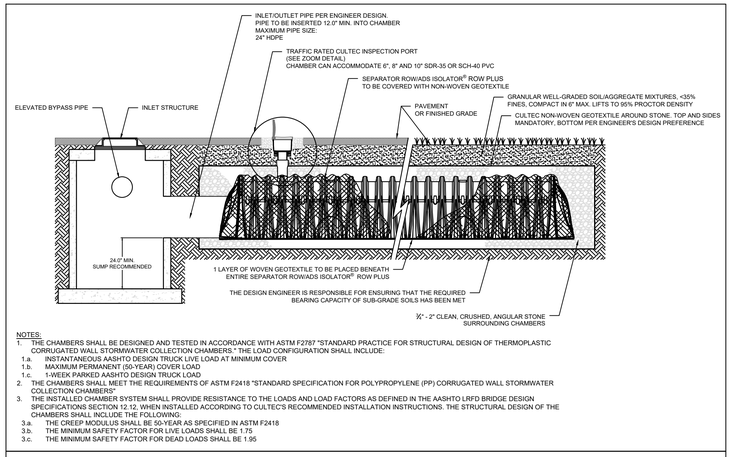




NOTES:

*FOR COVER DEPTHS FROM 18.0" - 8.0". INCREASE DEPTH OF BEDDING STONE TO 9.0" MIN. FOR COVER DEPTHS GREATER THAN 8.0"
**UTILIZE HVLV FC-24 FEED CONNECTOR FOR 6" ROW SPACING. UTILIZE HVLV FC-48 FEED CONNECTOR FOR ROW SPACING GREATER THAN 6"
1. THE CHAMBERS SHALL BE DESIGNED AND TESTED IN ACCORDANCE WITH ASTM F2787 "STANDARD PRACTICE FOR STRUCTURAL DESIGN OF THERMOPLASTIC CORRUGATED WALL STORMWATER COLLECTION CHAMBERS." THE LOAD CONFIGURATION SHALL INCLUDE:
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2. THE CHAMBERS SHALL MEET THE REQUIREMENTS OF ASTM F2418 "STANDARD SPECIFICATION FOR POLYPROPYLENE (PP) CORRUGATED WALL STORMWATER COLLECTION CHAMBERS"
3. THE INSTALLED CHAMBER SYSTEM SHALL PROVIDE RESISTANCE TO THE LOADS AND LOAD FACTORS AS DEFINED IN THE AASHTO LRFD BRIDGE DESIGN SPECIFICATIONS SECTION 12.12, WHEN INSTALLED ACCORDING TO CULTEC'S RECOMMENDED INSTALLATION INSTRUCTIONS. THE STRUCTURAL DESIGN OF THE CHAMBERS SHALL INCLUDE THE FOLLOWING:
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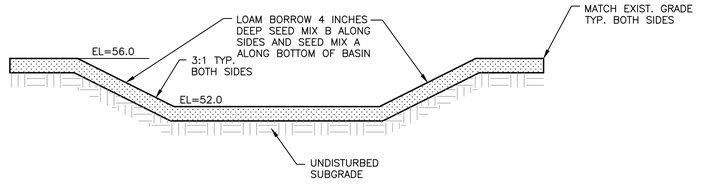
CULTEC RECHARGER 300HD HEAVY DUTY CROSS SECTION



NOTES:
1. THE CHAMBERS SHALL BE DESIGNED AND TESTED IN ACCORDANCE WITH ASTM F2787 "STANDARD PRACTICE FOR STRUCTURAL DESIGN OF THERMOPLASTIC CORRUGATED WALL STORMWATER COLLECTION CHAMBERS." THE LOAD CONFIGURATION SHALL INCLUDE:
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CULTEC SEPARATOR ROW - CULTEC INSPECTION PORT DETAIL

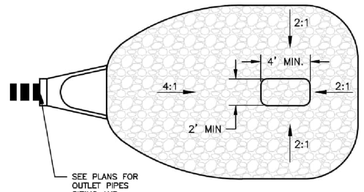
(OR APPROVED EQUAL)



NOTES:
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2. SEED MIX A SHALL BE "NEW ENGLAND EROSION CONTROL/RESTORATION MIX FOR DETENTION BASINS AND MOIST SITES" AS PRODUCED BY NEW ENGLAND WETLAND PLANTS, INC. OR APPROVED EQUAL. SEED MIX B SHALL BE RESIDENTIAL SEEDING (TYPE 2) IN ACCORDANCE WITH SECTION L02 AND M18 OF THE STANDARD SPECIFICATIONS.

INFILTRATION BASIN CROSS-SECTION

NOT TO SCALE



RIPRAP FOREBAY

NOT TO SCALE

PREPARED BY

BETA
www.BETA-Inc.com

REGISTERED PROFESSIONAL

SUBCONSULTANT

PROJECT

Stormwater Planning for Oaklawn Avenue at Wilbur Avenue

Cranston, RI

TITLE

CONCEPTUAL STU PLANS STU-OAK-003 & STU-OAK-004

NO.	REVISIONS	DATE

DRAWN BY:	AJM
DESIGNED BY:	JMC
CHECKED BY:	JML
ISSUE DATE:	AUGUST 2026
BETA JOB NO.:	05598

SCALE

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SCALE IN FEET: 1"=20'

UNLESS OTHERWISE NOTED OR CHANGED BY REPRODUCTION

For Review Only

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8/21/2026 8:28 AM \\BETA-INC.COM\RI\TRANS\5500\05598 - RIDOT OAKLAWN AT WILBUR\DRAWINGFILES\FIGURES_PRESENTATIONS\5598 OAKLAWN CONCEPTUAL BMP FIGURES.DWG (BETA_STB_BW_STB)

APPENDIX I

HYDRAULIC CALCULATIONS

Point precipitation frequency estimates (inches/hour)
NOAA Atlas 14 Volume 10 Version 3

Data type: Precipitation intensity
Time series type: Partial duration
Project area: Northeastern States
Location name (ESRI Maps): Cranston, Rhode Island, USA
Station Name: N/A
Latitude: 41.7464 Degree
Longitude: -71.4788 Degree
Elevation (USGS): 56 ft

PRECIPITATION FREQUENCY ESTIMATES										
by duration for ARI (years):	**1**	**2**	**5**	**10**	**25**	**50**	**100**	**200**	**500**	**1000**
5-min:	3.82	4.67	6.06	7.21	8.8	9.98	11.3	12.7	14.9	16.7
10-min:	2.7	3.31	4.29	5.11	6.23	7.07	7.97	9.01	10.6	11.8
15-min:	2.12	2.59	3.36	4	4.89	5.55	6.25	7.07	8.28	9.29
30-min:	1.46	1.79	2.34	2.79	3.41	3.88	4.38	4.95	5.81	6.53
60-min:	0.929	1.14	1.5	1.79	2.19	2.49	2.81	3.19	3.74	4.2
2-hr:	0.608	0.756	0.997	1.2	1.47	1.68	1.9	2.16	2.54	2.86
3-hr:	0.474	0.588	0.775	0.93	1.14	1.3	1.47	1.67	1.97	2.21
6-hr:	0.309	0.379	0.494	0.589	0.719	0.817	0.921	1.04	1.22	1.37
12-hr:	0.196	0.236	0.302	0.356	0.431	0.487	0.546	0.614	0.712	0.794
24-hr:	0.118	0.141	0.179	0.21	0.254	0.286	0.32	0.36	0.417	0.464
2-day:	0.066	0.079	0.102	0.12	0.146	0.165	0.185	0.208	0.243	0.271
3-day:	0.048	0.057	0.073	0.086	0.104	0.118	0.132	0.148	0.173	0.193
4-day:	0.038	0.046	0.058	0.068	0.082	0.093	0.104	0.116	0.135	0.151
7-day:	0.026	0.031	0.038	0.044	0.053	0.059	0.066	0.074	0.084	0.093
10-day:	0.021	0.024	0.03	0.034	0.041	0.045	0.05	0.056	0.063	0.069
20-day:	0.015	0.017	0.02	0.022	0.025	0.028	0.031	0.033	0.036	0.039
30-day:	0.012	0.014	0.016	0.017	0.02	0.022	0.024	0.025	0.027	0.028
45-day:	0.01	0.011	0.013	0.014	0.016	0.017	0.018	0.019	0.021	0.021
60-day:	0.009	0.01	0.011	0.012	0.013	0.014	0.015	0.016	0.017	0.018

Point precipitation frequency estimates (inches)
NOAA Atlas 14 Volume 10 Version 3

Data type: Precipitation Depth
Time series type: Partial duration
Project area: Northeastern States
Location name (ESRI Maps): Cranston, Rhode Island, USA
Station Name: N/A
Latitude: 41.7464 Degree
Longitude: -71.4788 Degree
Elevation (USGS): 56 ft

PRECIPITATION FREQUENCY ESTIMATES										
by duration for ARI (years):	**1**	**2**	**5**	**10**	**25**	**50**	**100**	**200**	**500**	**1000**
5-min:	0.318	0.389	0.505	0.601	0.733	0.832	0.938	1.06	1.24	1.39
10-min:	0.45	0.551	0.715	0.852	1.04	1.18	1.33	1.5	1.76	1.97
15-min:	0.53	0.648	0.841	1	1.22	1.39	1.56	1.77	2.07	2.32
30-min:	0.729	0.896	1.17	1.4	1.71	1.94	2.19	2.48	2.9	3.26
60-min:	0.929	1.14	1.5	1.79	2.19	2.49	2.81	3.19	3.74	4.2
2-hr:	1.22	1.51	1.99	2.39	2.95	3.36	3.8	4.31	5.07	5.71
3-hr:	1.42	1.76	2.33	2.79	3.44	3.91	4.42	5.02	5.91	6.65
6-hr:	1.85	2.27	2.96	3.52	4.31	4.89	5.52	6.24	7.3	8.19
12-hr:	2.37	2.85	3.64	4.29	5.19	5.86	6.58	7.39	8.58	9.57
24-hr:	2.82	3.38	4.29	5.04	6.08	6.86	7.69	8.63	10	11.1
2-day:	3.15	3.81	4.88	5.77	6.99	7.9	8.87	10	11.7	13
3-day:	3.42	4.12	5.25	6.19	7.49	8.46	9.49	10.7	12.4	13.9
4-day:	3.67	4.39	5.56	6.54	7.88	8.89	9.95	11.2	13	14.5
7-day:	4.37	5.14	6.4	7.44	8.87	9.95	11.1	12.4	14.2	15.7
10-day:	5.06	5.86	7.17	8.25	9.75	10.9	12.1	13.3	15.1	16.5
20-day:	7.14	8.01	9.44	10.6	12.2	13.5	14.7	15.9	17.5	18.6
30-day:	8.87	9.8	11.3	12.6	14.3	15.7	17	18.1	19.5	20.4
45-day:	11	12	13.6	15	16.9	18.4	19.8	20.9	22.2	23
60-day:	12.8	13.9	15.6	17.1	19.1	20.7	22.2	23.3	24.6	25.3

I.1 – Existing Conditions

Line	To Line	Line Length	Incr. Area	Total Area	Runoff Coeff.	Inlet Time	Time Conc	Total Runoff	Capac Full	Veloc	Pipe Size	Pipe Slope	Inv Elev Dn	Inv Elev Up	HGL Dn	HGL Up	Grnd/ Rim Dn	Grnd/ Rim Up	Line ID
		(ft)	(ac)	(ac)	(C)	(min)	(min)	(cfs)	(cfs)	(ft/ s)	(in)	(%)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	
1	Outfall	964	9.78	273.30	0.51	21.0	46.6	319.30	57.94	45.18	36	0.64	35.00	41.20	38.00	226.33	43.78	46.75	P-1
2	1	467	0.00	263.52	0.00	0.0	46.4	309.36	21.86	63.03	30	0.24	41.20	42.33	258.05	484.54	46.75	48.00	P-2
3	2	67	0.00	257.55	0.00	0.0	46.4	301.36	56.67	61.40	30	1.63	42.33	43.42	558.02	588.87	48.00	51.04	P-3
4	3	127	0.00	223.23	0.00	0.0	46.4	262.30	80.22	53.44	30	3.26	43.42	47.56	632.82	677.11	51.04	53.94	P-4
5	4	183	5.62	148.37	0.64	26.0	46.3	183.28	33.01	37.34	30	0.55	47.56	48.57	735.27	766.43	53.94	54.93	P-5
6	5	897	22.71	142.75	0.58	46.0	46.0	176.32	22.80	56.13	24	0.87	49.10	56.87	777.26	1241.89	54.93	62.19	P-6
7	6	698	0.00	120.04	0.00	0.0	37.2	169.98	12.18	96.20	18	1.15	57.00	65.00	1266.38	2825.15	62.19	70.80	P-7
8	7	422	20.32	111.63	0.61	22.0	37.1	157.90	9.32	89.36	18	0.67	65.00	67.83	3040.93	3854.16	70.80	73.00	P-8
9	8	379	0.00	91.31	0.00	0.0	37.0	127.76	4.16	104.12	15	0.55	67.83	69.92	3916.23	5891.97	73.00	74.00	P-9
10	9	196	10.66	59.72	0.67	20.0	36.1	86.66	1.13	70.63	15	0.04	70.25	70.33	6089.13	6559.29	74.00	75.03	P-10
11	10	152	0.00	49.06	0.00	0.0	36.1	68.95	4.40	87.80	12	2.03	70.75	73.84	6598.06	7356.90	75.03	77.53	P-11
12	11	875	12.91	12.91	0.58	20.0	20.0	26.71	4.26	34.01	12	1.90	74.00	90.65	7528.25	8183.73	77.53	95.35	P-12
13	11	206	36.15	36.15	0.56	36.0	36.0	50.38	3.01	64.15	12	0.95	73.84	75.80	7528.25	8077.31	77.53	88.83	P-13
14	7	204	8.41	8.41	0.60	35.0	35.0	12.78	6.80	16.28	12	4.85	65.10	75.00	3040.93	3075.94	70.80	80.44	P-14
15	9	49	31.59	31.59	0.55	37.0	37.0	42.50	5.77	54.11	12	3.49	69.92	71.63	6089.13	6182.07	74.00	76.19	P-15
16	4	40	74.86	74.86	0.50	39.0	39.0	88.54	14.39	50.11	18	1.60	49.15	49.79	735.27	759.52	53.94	56.29	P-16
17	3	783	34.32	34.32	0.54	30.0	30.0	51.71	4.21	65.84	12	1.86	47.25	61.83	632.82	2830.95	51.04	54.17	P-17
18	2	37	5.97	5.97	0.64	29.0	29.0	10.89	27.04	6.16	18	5.65	43.00	45.09	558.02	558.36	48.00	49.97	P-18

Line	To Line	Line Length	Incr. Area	Total Area	Runoff Coeff.	Inlet Time	Time Conc	Total Runoff	Capac Full	Veloc	Pipe Size	Pipe Slope	Inv Elev Dn	Inv Elev Up	HGL Dn	HGL Up	Grnd/ Rim Dn	Grnd/ Rim Up	Line ID
		(ft)	(ac)	(ac)	(C)	(min)	(min)	(cfs)	(cfs)	(ft/ s)	(in)	(%)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	
1	Outfall	964	9.78	273.30	0.51	21.0	46.5	391.06	57.94	55.33	36	0.64	35.00	41.20	38.00	320.48	43.78	46.75	P-1
2	1	467	0.00	263.52	0.00	0.0	46.3	378.75	21.86	77.17	30	0.24	41.20	42.33	368.07	707.56	46.75	48.00	P-2
3	2	67	0.00	257.55	0.00	0.0	46.3	368.94	56.67	75.17	30	1.63	42.33	43.42	817.70	863.95	48.00	51.04	P-3
4	3	127	0.00	223.23	0.00	0.0	46.3	321.09	80.22	65.42	30	3.26	43.42	47.56	929.81	996.18	51.04	53.94	P-4
5	4	183	5.62	148.37	0.64	26.0	46.2	224.30	33.01	45.70	30	0.55	47.56	48.57	1083.33	1129.99	53.94	54.93	P-5
6	5	897	22.71	142.75	0.58	46.0	46.0	215.64	22.80	68.65	24	0.87	49.10	56.87	1146.22	1841.17	54.93	62.19	P-6
7	6	698	0.00	120.04	0.00	0.0	37.1	207.92	12.18	117.67	18	1.15	57.00	65.00	1877.79	4210.10	62.19	70.80	P-7
8	7	422	20.32	111.63	0.61	22.0	37.1	193.10	9.32	109.28	18	0.67	65.00	67.83	4532.96	5749.12	70.80	73.00	P-8
9	8	379	0.00	91.31	0.00	0.0	37.0	156.21	4.16	127.30	15	0.55	67.83	69.92	5841.93	8795.41	73.00	74.00	P-9
10	9	196	10.66	59.72	0.67	20.0	36.1	105.98	1.13	86.37	15	0.04	70.25	70.33	9090.14	9793.22	74.00	75.03	P-10
11	10	152	0.00	49.06	0.00	0.0	36.0	84.31	4.40	107.36	12	2.03	70.75	73.84	9851.20	10985.76	75.03	77.53	P-11
12	11	875	12.91	12.91	0.58	20.0	20.0	32.63	4.26	41.55	12	1.90	74.00	90.65	11241.95	12220.03	77.53	95.35	P-12
13	11	206	36.15	36.15	0.56	36.0	36.0	61.59	3.01	78.43	12	0.95	73.84	75.80	11241.95	12062.58	77.53	88.83	P-13
14	7	204	8.41	8.41	0.60	35.0	35.0	15.63	6.80	19.90	12	4.85	65.10	75.00	4532.96	4585.28	70.80	80.44	P-14
15	9	49	31.59	31.59	0.55	37.0	37.0	51.96	5.77	66.16	12	3.49	69.92	71.63	9090.14	9229.05	74.00	76.19	P-15
16	4	40	74.86	74.86	0.50	39.0	39.0	108.25	14.39	61.27	18	1.60	49.15	49.79	1083.33	1119.58	53.94	56.29	P-16
17	3	783	34.32	34.32	0.54	30.0	30.0	63.20	4.21	80.47	12	1.86	47.25	61.83	929.81	4213.43	51.04	54.17	P-17
18	2	37	5.97	5.97	0.64	29.0	29.0	13.31	27.04	7.53	18	5.65	43.00	45.09	817.70	818.21	48.00	49.97	P-18

I.2 – RIDOT Existing Conditions

Line	To Line	Line Length	Incr. Area	Total Area	Runoff Coeff.	Inlet Time	Time Conc	Total Runoff	Capac Full	Veloc	Pipe Size	Pipe Slope	Inv Elev Dn	Inv Elev Up	HGL Dn	HGL Up	Grnd/ Rim Dn	Grnd/ Rim Up	Line ID
		(ft)	(ac)	(ac)	(C)	(min)	(min)	(cfs)	(cfs)	(ft/ s)	(in)	(%)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	
1	Outfall	964	0.00	13.00	0.00	0.0	14.8	49.56	57.94	7.79	36	0.64	35.00	41.20	38.00	43.49	43.78	46.75	P-1
2	1	467	2.83	13.00	0.90	6.0	13.7	51.78	21.86	10.55	30	0.24	41.20	42.33	43.70	50.05	46.75	48.00	P-2
3	2	67	0.00	10.17	0.00	0.0	13.5	40.84	56.67	8.32	30	1.63	42.33	43.42	50.91	51.48	48.00	51.04	P-3
4	3	127	0.00	8.75	0.00	0.0	13.1	35.79	80.33	7.29	30	3.27	43.42	47.56	52.28	53.11	51.04	53.94	P-4
5	4	183	0.00	8.75	0.00	0.0	12.4	36.75	33.01	7.49	30	0.55	47.56	48.57	54.20	55.45	53.94	54.93	P-5
6	5	897	4.70	8.75	0.90	6.0	10.7	39.79	22.80	12.67	24	0.87	49.10	56.87	55.89	79.56	54.93	62.19	P-6
7	6	698	0.00	4.05	0.00	0.0	9.3	19.84	12.18	11.23	18	1.15	57.00	65.00	80.81	102.03	62.19	70.80	P-7
8	7	422	1.45	4.05	0.90	6.0	8.4	20.75	9.31	11.74	18	0.67	65.00	67.83	103.01	117.07	70.80	73.00	P-8
9	8	379	0.00	2.60	0.00	0.0	7.7	13.91	4.15	11.33	15	0.55	67.83	69.92	118.14	141.56	73.00	74.00	P-9
10	9	196	0.89	2.60	0.90	6.0	7.4	14.22	1.13	11.59	15	0.04	70.25	70.33	142.56	155.20	74.00	75.03	P-10
11	10	152	0.00	1.71	0.00	0.0	7.1	9.51	4.40	12.11	12	2.04	70.75	73.84	156.24	170.64	75.03	77.53	P-11
12	11	875	1.71	1.71	0.90	6.0	6.0	10.26	4.26	13.07	12	1.90	74.00	90.65	171.78	268.59	77.53	95.35	P-12
13	3	783	1.42	1.42	0.90	6.0	6.0	8.52	4.21	10.85	12	1.86	47.25	61.83	52.28	112.00	51.04	54.17	P-17

Line	To Line	Line Length	Incr. Area	Total Area	Runoff Coeff.	Inlet Time	Time Conc	Total Runoff	Capac Full	Veloc	Pipe Size	Pipe Slope	Inv Elev Dn	Inv Elev Up	HGL Dn	HGL Up	Grnd/ Rim Dn	Grnd/ Rim Up	Line ID
		(ft)	(ac)	(ac)	(C)	(min)	(min)	(cfs)	(cfs)	(ft/ s)	(in)	(%)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	
1	Outfall	964	0.00	13.00	0.00	0.0	13.2	64.45	57.94	9.12	36	0.64	35.00	41.20	38.00	45.67	43.78	46.75	P-1
2	1	467	2.83	13.00	0.90	6.0	12.3	67.02	21.86	13.65	30	0.24	41.20	42.33	46.97	57.60	46.75	48.00	P-2
3	2	67	0.00	10.17	0.00	0.0	12.1	52.82	56.67	10.76	30	1.63	42.33	43.42	59.04	59.99	48.00	51.04	P-3
4	3	127	0.00	8.75	0.00	0.0	11.8	46.18	80.33	9.41	30	3.27	43.42	47.56	61.34	62.71	51.04	53.94	P-4
5	4	183	0.00	8.75	0.00	0.0	11.3	47.28	33.01	9.63	30	0.55	47.56	48.57	64.53	66.60	53.94	54.93	P-5
6	5	897	4.70	8.75	0.90	6.0	9.9	50.68	22.80	16.13	24	0.87	49.10	56.87	67.32	105.72	54.93	62.19	P-6
7	6	698	0.00	4.05	0.00	0.0	8.7	25.01	12.18	14.15	18	1.15	57.00	65.00	107.74	141.49	62.19	70.80	P-7
8	7	422	1.45	4.05	0.90	6.0	8.0	25.99	9.31	14.71	18	0.67	65.00	67.83	143.04	165.08	70.80	73.00	P-8
9	8	379	0.00	2.60	0.00	0.0	7.4	17.30	4.15	14.10	15	0.55	67.83	69.92	166.76	203.01	73.00	74.00	P-9
10	9	196	0.89	2.60	0.90	6.0	7.1	17.62	1.13	14.36	15	0.04	70.25	70.33	204.56	223.97	74.00	75.03	P-10
11	10	152	0.00	1.71	0.00	0.0	6.9	11.75	4.40	14.96	12	2.04	70.75	73.84	225.57	247.58	75.03	77.53	P-11
12	11	875	1.71	1.71	0.90	6.0	6.0	12.52	4.26	15.94	12	1.90	74.00	90.65	249.32	393.36	77.53	95.35	P-12
13	3	783	1.42	1.42	0.90	6.0	6.0	10.40	4.21	13.24	12	1.86	47.25	61.83	61.34	150.19	51.04	54.17	P-17

I.3 – Alternative 1

Line	To Line	Line Length	Incr. Area	Total Area	Runoff Coeff.	Inlet Time	Time Conc	Total Runoff	Capac Full	Veloc	Pipe Size	Pipe Slope	Inv Elev Dn	Inv Elev Up	HGL Dn	HGL Up	Grnd/ Rim Dn	Grnd/ Rim Up	Line ID
		(ft)	(ac)	(ac)	(C)	(min)	(min)	(cfs)	(cfs)	(ft/ s)	(in)	(%)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	
1	Outfall	964	9.78	273.33	0.51	21.0	50.7	301.99	543.93	11.65	48 X 144	0.49	35.00	39.70	37.68	43.04	0.00	46.75	C-0
2	1	467	0.00	263.55	0.00	0.0	49.8	295.54	546.68	10.18	48 X 144	0.49	39.70	42.00	43.04	45.27	46.75	48.00	C-1
3	2	67	0.00	153.98	0.00	0.0	40.8	193.02	255.66	13.88	60	0.82	42.00	42.55	45.76	46.86	48.00	51.04	E-0
4	3	127	0.00	119.66	0.00	0.0	39.1	154.79	201.87	10.47	60	0.51	42.55	43.20	46.86	47.02	51.04	53.94	E-1
5	4	183	3.13	44.80	0.62	26.0	30.7	77.22	112.12	8.65	48	0.52	43.70	44.65	47.02	47.51	53.94	54.93	E-2
6	5	101	2.19	41.67	0.77	28.0	30.5	72.26	109.49	8.83	48	0.50	44.65	45.15	47.51	47.91	54.93	55.09	E-3
7	6	796	0.00	39.48	0.00	0.0	28.7	70.21	107.20	8.90	42	0.97	45.15	52.85	47.91	55.48	55.09	62.19	E-4
8	7	253	14.23	39.48	0.62	28.0	28.0	71.27	108.99	7.96	42	1.00	52.85	55.38	55.48	57.78	62.19	65.20	E-5
9	8	446	0.00	25.25	0.00	0.0	23.9	50.26	81.11	8.78	36	1.26	55.38	61.00	57.78	63.36	65.20	70.80	E-6
10	2	37	5.97	109.57	0.58	29.0	49.7	125.95	207.46	11.28	60	0.54	42.00	42.20	45.43	45.93	48.00	49.97	W-0
11	10	131	0.00	103.60	0.00	0.0	49.4	119.37	278.92	10.32	60	0.98	42.20	43.48	45.93	47.10	49.97	51.83	W-1
12	11	288	0.00	103.60	0.00	0.0	48.9	120.30	281.19	10.48	60	0.99	43.48	46.34	47.10	49.96	51.83	56.00	W-2
13	12	1392	9.59	103.60	0.56	46.0	46.0	125.08	281.57	10.64	60	1.00	46.44	60.30	49.96	63.92	56.00	71.10	W-3
14	13	804	1.22	85.60	0.90	6.0	38.1	116.12	200.91	10.56	54	0.89	60.30	67.45	63.92	70.95	71.10	74.03	W-4
15	14	544	0.88	3.16	0.90	6.0	10.7	12.32	110.09	3.54	42	1.02	67.45	73.00	70.95	74.23	74.03	81.01	W-5
16	13	161	8.41	8.41	0.60	35.0	35.0	12.78	5.55	7.07	12	3.23	60.30	65.50	63.92	69.13	71.10	80.44	W-3A
17	3	30	2.00	34.32	0.80	8.0	40.7	42.37	93.28	7.96	36	1.67	42.55	43.05	46.86	47.04	51.04	54.17	E-0A
18	4	40	74.86	74.86	0.50	39.0	39.0	88.54	137.87	11.84	42	1.60	49.15	49.79	50.95	52.45	53.94	56.29	E-1A
19	14	151	0.00	81.22	0.00	0.0	37.8	108.12	155.10	10.38	48	0.99	67.35	68.85	70.95	72.13	74.03	79.50	W-100
20	19	197	0.00	49.63	0.00	0.0	37.3	67.53	108.44	8.73	42	0.99	69.55	71.50	72.13	74.04	79.50	0.00	W-101
21	20	151	2.85	49.63	0.59	20.0	36.9	68.05	108.27	7.30	42	0.99	71.25	72.74	74.04	75.03	0.00	0.00	W-102
22	21	1037	10.63	10.63	0.55	20.0	20.0	20.86	43.35	5.70	30	0.95	73.00	82.87	75.03	84.42	0.00	0.00	W-103
23	21	206	36.15	36.15	0.56	36.0	36.0	50.38	70.48	7.97	36	0.95	73.84	75.80	75.13	77.48	0.00	0.00	W-102A
24	19	49	31.59	31.59	0.54	37.0	37.0	41.72	83.00	7.04	30	3.49	69.92	71.63	72.13	73.49	79.50	0.00	W-100A
25	9	662	25.25	25.25	0.62	22.0	22.0	52.77	72.25	7.48	36	1.00	61.00	67.62	63.36	69.73	70.80	0.00	E-7
26	17	783	32.32	32.32	0.52	30.0	30.0	46.89	22.91	4.72	24	1.37	50.50	61.20	51.05	61.89	54.17	0.00	E-0B
27	15	977	2.28	2.28	0.72	6.0	6.0	10.95	15.04	5.22	24	0.59	73.00	78.75	74.27	80.02	81.01	0.00	W-6

Line	To Line	Line Length	Incr. Area	Total Area	Runoff Coeff.	Inlet Time	Time Conc	Total Runoff	Capac Full	Veloc	Pipe Size	Pipe Slope	Inv Elev Dn	Inv Elev Up	HGL Dn	HGL Up	Grnd/ Rim Dn	Grnd/ Rim Up	Line ID
		(ft)	(ac)	(ac)	(C)	(min)	(min)	(cfs)	(cfs)	(ft/ s)	(in)	(%)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	
1	Outfall	964	9.78	273.33	0.51	21.0	50.1	372.12	543.93	12.41	48 X 144	0.49	35.00	39.70	38.04	43.49	0.00	46.75	C-0
2	1	467	0.00	263.55	0.00	0.0	49.4	363.42	546.68	10.88	48 X 144	0.49	39.70	42.00	43.49	45.73	46.75	48.00	C-1
3	2	67	0.00	153.98	0.00	0.0	40.8	236.03	255.66	14.58	60	0.82	42.00	42.55	46.44	47.09	48.00	51.04	E-0
4	3	127	0.00	119.66	0.00	0.0	39.1	189.26	201.87	11.41	60	0.51	42.55	43.20	47.09	47.70	51.04	53.94	E-1
5	4	183	3.13	44.80	0.62	26.0	30.0	95.85	112.12	9.79	48	0.52	43.70	44.65	50.37	51.51	53.94	54.93	E-2
6	5	101	2.19	41.67	0.77	28.0	29.8	89.57	109.49	9.31	48	0.50	44.65	45.15	52.26	52.83	54.93	55.09	E-3
7	6	796	0.00	39.48	0.00	0.0	28.5	86.19	107.20	9.98	42	0.97	45.15	52.85	53.50	59.68	55.09	62.19	E-4
8	7	253	14.23	39.48	0.62	28.0	28.0	87.10	108.99	8.73	42	1.00	52.85	55.38	60.45	61.96	62.19	65.20	E-5
9	8	446	0.00	25.25	0.00	0.0	23.9	61.41	81.11	11.04	36	1.26	55.38	61.00	62.55	67.75	65.20	70.80	E-6
10	2	37	5.97	109.57	0.58	29.0	49.3	154.86	207.46	12.04	60	0.54	42.00	42.20	46.12	46.32	48.00	49.97	W-0
11	10	131	0.00	103.60	0.00	0.0	49.1	146.70	278.92	9.09	60	0.98	42.20	43.48	48.71	49.24	49.97	51.83	W-1
12	11	288	0.00	103.60	0.00	0.0	48.6	147.73	281.19	9.09	60	0.99	43.48	46.34	50.24	51.33	51.83	56.00	W-2
13	12	1392	9.59	103.60	0.56	46.0	46.0	152.97	281.57	10.09	60	1.00	46.44	60.30	51.97	64.12	56.00	71.10	W-3
14	13	804	1.22	85.60	0.90	6.0	38.0	142.19	200.91	11.22	54	0.89	60.30	67.45	64.12	71.14	71.10	74.03	W-4
15	14	544	0.88	3.16	0.90	6.0	9.8	15.68	110.09	3.89	42	1.02	67.45	73.00	71.14	74.36	74.03	81.01	W-5
16	13	161	8.41	8.41	0.60	35.0	35.0	15.63	5.55	7.07	12	3.23	60.30	65.50	64.12	69.33	71.10	80.44	W-3A
17	3	30	2.00	34.32	0.80	8.0	40.7	51.81	93.28	8.18	36	1.67	42.55	43.05	47.09	47.28	51.04	54.17	E-0A
18	4	40	74.86	74.86	0.50	39.0	39.0	108.25	137.87	11.84	42	1.60	49.15	49.79	50.95	52.45	53.94	56.29	E-1A
19	14	151	0.00	81.22	0.00	0.0	37.8	132.34	155.10	11.00	48	0.99	67.35	68.85	71.14	72.26	74.03	79.50	W-100
20	19	197	0.00	49.63	0.00	0.0	37.3	82.61	108.44	8.95	42	0.99	69.55	71.50	72.26	74.13	79.50	0.00	W-101
21	20	151	2.85	49.63	0.59	20.0	36.9	83.19	108.27	7.63	42	0.99	71.25	72.74	74.13	75.13	0.00	0.00	W-102
22	21	1037	10.63	10.63	0.55	20.0	20.0	25.48	43.35	6.40	30	0.95	73.00	82.87	75.13	84.59	0.00	0.00	W-103
23	21	206	36.15	36.15	0.56	36.0	36.0	61.59	70.48	7.95	36	0.95	73.84	75.80	75.13	77.48	0.00	0.00	W-102A
24	19	49	31.59	31.59	0.54	37.0	37.0	51.01	83.00	6.92	30	3.49	69.92	71.63	72.26	73.49	79.50	0.00	W-100A
25	9	662	25.25	25.25	0.62	22.0	22.0	64.47	72.25	5.94	36	1.00	61.00	67.62	68.70	70.93	70.80	0.00	E-7
26	17	783	32.32	32.32	0.52	30.0	30.0	57.31	22.91	4.72	24	1.37	50.50	61.20	51.05	61.89	54.17	0.00	E-0B
27	15	977	2.28	2.28	0.72	6.0	6.0	13.35	15.04	5.41	24	0.59	73.00	78.75	74.47	80.22	81.01	0.00	W-6

I.4 – Alternative 2

Line	To Line	Line Length	Incr. Area	Total Area	Runoff Coeff.	Inlet Time	Time Conc	Total Runoff	Capac Full	Veloc	Pipe Size	Pipe Slope	Inv Elev Dn	Inv Elev Up	HGL Dn	HGL Up	Grnd/ Rim Dn	Grnd/ Rim Up	Line ID
		(ft)	(ac)	(ac)	(C)	(min)	(min)	(cfs)	(cfs)	(ft/ s)	(in)	(%)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	
1	Outfall	964	9.78	273.33	0.51	21.0	50.8	254.30	335.22	10.93	48 X 96	0.49	35.00	39.70	37.70	42.85	0.00	46.75	C-0
2	1	467	0.00	263.55	0.00	0.0	49.7	247.81	336.92	9.91	48 X 96	0.49	39.70	42.00	42.85	45.10	46.75	48.00	C-1
3	2	67	0.00	153.98	0.00	0.0	39.3	160.35	203.95	11.00	60	0.52	42.00	42.35	45.34	45.98	48.00	51.04	E-0
4	3	127	0.00	119.66	0.00	0.0	39.1	124.44	152.42	9.54	54	0.51	42.35	43.00	45.98	46.28	51.04	53.94	E-1
5	4	183	3.13	44.80	0.62	26.0	30.5	62.73	87.76	9.34	36	1.48	43.00	45.70	46.28	48.25	53.94	54.93	E-2
6	5	101	2.19	41.67	0.77	28.0	30.3	57.64	88.05	9.16	36	1.49	45.70	47.20	48.25	49.66	54.93	55.09	E-3
7	6	796	0.00	39.48	0.00	0.0	28.5	54.94	72.21	8.96	36	1.00	47.20	55.15	49.66	57.55	55.09	62.19	E-4
8	7	253	14.23	39.48	0.49	28.0	28.0	55.59	71.82	9.13	36	0.99	55.15	57.65	57.55	60.07	62.19	65.20	E-5
9	8	446	0.00	25.25	0.00	0.0	23.9	38.86	72.17	7.01	36	1.00	57.65	62.10	60.07	64.13	65.20	70.80	E-6
10	2	37	5.97	109.57	0.58	29.0	49.6	109.98	156.64	9.45	54	0.54	42.00	42.20	45.10	45.28	48.00	49.97	W-0
11	10	131	0.00	103.60	0.00	0.0	49.3	103.35	153.83	9.96	48	0.98	42.20	43.48	45.28	46.56	49.97	51.83	W-1
12	11	288	0.00	103.60	0.00	0.0	48.7	104.20	155.08	10.03	48	0.99	43.48	46.34	46.56	49.43	51.83	56.00	W-2
13	12	1392	9.59	103.60	0.56	46.0	46.0	108.11	155.28	10.47	48	1.00	46.44	60.30	49.43	63.44	56.00	71.10	W-3
14	13	804	1.22	85.60	0.90	6.0	37.5	97.90	146.44	9.47	48	0.89	60.30	67.42	63.44	70.42	71.10	74.03	W-4
15	14	544	0.88	3.16	0.90	6.0	10.7	12.32	24.48	4.91	24	1.00	67.62	73.05	70.42	74.31	74.03	81.01	W-5
16	13	161	8.41	8.41	0.60	35.0	35.0	12.78	5.55	16.28	12	3.23	60.30	65.50	63.44	91.07	71.10	80.44	W-3A
17	3	30	2.00	34.32	0.80	8.0	32.4	41.23	72.25	7.06	36	1.00	43.35	43.65	45.98	45.74	51.04	54.17	E-0A
18	4	40	74.86	74.86	0.40	39.0	39.0	70.83	92.10	11.93	36	1.62	44.15	44.80	46.28	47.47	53.94	56.29	E-1A
19	14	151	0.00	81.22	0.00	0.0	37.2	89.90	155.10	9.00	48	0.99	67.35	68.85	70.42	71.72	74.03	79.50	W-100
20	19	197	0.00	49.63	0.00	0.0	36.7	56.40	71.88	9.74	36	0.99	69.55	71.50	71.72	73.93	79.50	0.00	W-101
21	20	151	2.85	49.63	0.46	20.0	36.4	56.71	72.01	9.23	36	0.99	71.50	73.00	73.93	75.44	0.00	0.00	W-102
22	21	1037	10.63	10.63	0.54	20.0	20.0	20.48	43.35	5.34	30	0.95	73.00	82.87	75.44	84.41	0.00	0.00	W-103
23	21	206	36.15	36.15	0.44	36.0	36.0	39.59	39.16	8.52	30	1.21	73.00	75.50	75.44	77.62	0.00	0.00	W-102A
24	19	49	31.59	31.59	0.44	37.0	37.0	34.00	39.66	8.56	30	1.24	69.92	70.53	71.72	72.51	79.50	0.00	W-100A
25	9	662	25.25	25.25	0.48	22.0	22.0	40.86	72.14	7.93	36	1.00	62.10	68.70	64.13	70.78	70.80	0.00	E-7
26	17	783	32.32	32.32	0.43	30.0	30.0	38.77	72.11	7.10	36	1.00	43.40	51.20	45.74	53.23	54.17	0.00	E-0B
27	15	977	2.28	2.28	0.72	6.0	6.0	10.95	11.97	4.32	24	0.37	74.05	77.69	75.55	79.19	81.01	0.00	W-6

Line	To Line	Line Length	Incr. Area	Total Area	Runoff Coeff.	Inlet Time	Time Conc	Total Runoff	Capac Full	Veloc	Pipe Size	Pipe Slope	Inv Elev Dn	Inv Elev Up	HGL Dn	HGL Up	Grnd/ Rim Dn	Grnd/ Rim Up	Line ID
		(ft)	(ac)	(ac)	(C)	(min)	(min)	(cfs)	(cfs)	(ft/ s)	(in)	(%)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	
1	Outfall	964	9.78	273.33	0.51	21.0	49.9	314.57	335.22	11.68	48 X 96	0.49	35.00	39.70	38.14	43.33	0.00	46.75	C-0
2	1	467	0.00	263.55	0.00	0.0	49.0	305.80	336.92	10.63	48 X 96	0.49	39.70	42.00	43.33	45.56	46.75	48.00	C-1
3	2	67	0.00	153.98	0.00	0.0	39.3	196.25	203.95	11.74	60	0.52	42.00	42.35	45.94	46.35	48.00	51.04	E-0
4	3	127	0.00	119.66	0.00	0.0	39.1	152.18	152.42	10.38	54	0.51	42.35	43.00	46.35	46.82	51.04	53.94	E-1
5	4	183	3.13	44.80	0.62	26.0	30.0	77.40	87.76	10.95	36	1.48	43.00	45.70	49.10	51.20	53.94	54.93	E-2
6	5	101	2.19	41.67	0.77	28.0	29.9	71.05	88.05	10.05	36	1.49	45.70	47.20	52.13	53.11	54.93	55.09	E-3
7	6	796	0.00	39.48	0.00	0.0	28.4	67.29	72.21	9.52	36	1.00	47.20	55.15	53.89	60.80	55.09	62.19	E-4
8	7	253	14.23	39.48	0.49	28.0	28.0	67.94	71.82	9.61	36	0.99	55.15	57.65	61.50	63.74	62.19	65.20	E-5
9	8	446	0.00	25.25	0.00	0.0	23.6	47.90	72.17	6.78	36	1.00	57.65	62.10	64.46	66.42	65.20	70.80	E-6
10	2	37	5.97	109.57	0.58	29.0	48.9	135.69	156.64	10.25	54	0.54	42.00	42.20	45.56	45.62	48.00	49.97	W-0
11	10	131	0.00	103.60	0.00	0.0	48.7	127.42	153.83	11.19	48	0.98	42.20	43.48	45.62	46.86	49.97	51.83	W-1
12	11	288	0.00	103.60	0.00	0.0	48.2	128.28	155.08	11.31	48	0.99	43.48	46.34	46.86	49.73	51.83	56.00	W-2
13	12	1392	9.59	103.60	0.56	46.0	46.0	132.21	155.28	11.74	48	1.00	46.44	60.30	49.73	63.73	56.00	71.10	W-3
14	13	804	1.22	85.60	0.90	6.0	37.4	119.97	146.44	10.64	48	0.89	60.30	67.42	63.73	70.71	71.10	74.03	W-4
15	14	544	0.88	3.16	0.90	6.0	9.8	15.68	24.48	5.77	24	1.00	67.62	73.05	70.71	74.48	74.03	81.01	W-5
16	13	161	8.41	8.41	0.60	35.0	35.0	15.63	5.55	19.90	12	3.23	60.30	65.50	63.73	105.02	71.10	80.44	W-3A
17	3	30	2.00	34.32	0.80	8.0	31.9	50.82	72.25	7.93	36	1.00	43.35	43.65	46.35	45.97	51.04	54.17	E-0A
18	4	40	74.86	74.86	0.40	39.0	39.0	86.60	92.10	12.25	36	1.62	44.15	44.80	49.10	49.67	53.94	56.29	E-1A
19	14	151	0.00	81.22	0.00	0.0	37.1	110.03	155.10	10.03	48	0.99	67.35	68.85	70.71	72.02	74.03	79.50	W-100
20	19	197	0.00	49.63	0.00	0.0	36.6	69.11	71.88	10.79	36	0.99	69.55	71.50	72.02	74.14	79.50	0.00	W-101
21	20	151	2.85	49.63	0.46	20.0	36.3	69.43	72.01	10.52	36	0.99	71.50	73.00	74.14	75.65	0.00	0.00	W-102
22	21	1037	10.63	10.63	0.54	20.0	20.0	25.01	43.35	6.06	30	0.95	73.00	82.87	75.65	84.57	0.00	0.00	W-103
23	21	206	36.15	36.15	0.44	36.0	36.0	48.39	39.16	9.86	30	1.21	73.00	75.50	75.65	79.47	0.00	0.00	W-102A
24	19	49	31.59	31.59	0.44	37.0	37.0	41.56	39.66	9.16	30	1.24	69.92	70.53	72.10	72.71	79.50	0.00	W-100A
25	9	662	25.25	25.25	0.48	22.0	22.0	49.91	72.14	7.83	36	1.00	62.10	68.70	66.78	71.00	70.80	0.00	E-7
26	17	783	32.32	32.32	0.43	30.0	30.0	47.39	72.11	7.86	36	1.00	43.40	51.20	45.97	53.44	54.17	0.00	E-0B
27	15	977	2.28	2.28	0.72	6.0	6.0	13.35	11.97	4.25	24	0.37	74.05	77.69	76.05	80.58	81.01	0.00	W-6

APPENDIX J

PRELIMINARY COST ESTIMATES

STORMWATER PLANNING FOR OAKLAWN AVENUE AT WILBUR AVENUE

ALTERNATIVE #1 - PARALLEL TRUNKLINE

CONCEPTUAL COST ESTIMATE

Item No.	Qty.	Unit	Item Description	Unit Price	Amount
201.0303	30	EACH	CUTTING, REMOVING, AND DISPOSING ISOLATED TREES AND STUMPS	$ 2,000.00	$ 60,000.00
201.0321	2,550	SY	CLEARING AND GRUBBING	$ 15.00	$ 38,250.00
201.0403	3,650	SY	REMOVE AND DISPOSE SIDEWALKS	$ 25.00	$ 91,250.00
201.0414	8,150	LF	REMOVE AND DISPOSE PIPE - ALL SIZES	$ 25.00	$ 203,750.00
201.0428	60	EACH	REMOVE AND DISPOSE FRAME AND GRATE OR FRAME AND COVER	$ 100.00	$ 6,000.00
201.0436	1,750	LF	REMOVAL AND DISPOSAL OF CURBING	$ 45.00	$ 78,750.00
201.0437	60	EACH	REMOVAL AND DISPOSAL OF DRAINAGE AND UTILITY STRUCTURES	$ 1,500.00	$ 90,000.00
201.9901	1	LS	SITE PREPARATION	$ 100,000.00	$ 100,000.00
202.0201	25	CY	ROCK EXCAVATION MECHANICAL	$ 200.00	$ 5,000.00
202.0300	500	CY	UNCLASSIFIED EXCAVATION	$ 35.00	$ 17,500.00
202.0700	500	CY	COMMON BORROW	$ 40.00	$ 20,000.00
410.2000	1,570	TON	TEMPORARY PATCHING OF TRENCHES	$ 300.00	$ 471,000.00
410.9901	2,090	TON	PERMANENT TRENCH PATCH	$ 350.00	$ 731,500.00
701.0312	860	LF	REINFORCED CONCRETE PIPE - 12 INCH	$ 150.00	$ 129,000.00
701.0315	280	LF	REINFORCED CONCRETE PIPE - 15 INCH	$ 160.00	$ 44,800.00
701.0318	1,100	LF	REINFORCED CONCRETE PIPE - 18 INCH	$ 180.00	$ 198,000.00
701.0324	1,415	LF	REINFORCED CONCRETE PIPE - 24 INCH	$ 200.00	$ 283,000.00
701.0330	540	LF	REINFORCED CONCRETE PIPE - 30 INCH	$ 250.00	$ 135,000.00
701.0336	1,240	LF	REINFORCED CONCRETE PIPE - 36 INCH	$ 275.00	$ 341,000.00
701.0342	1,390	LF	REINFORCED CONCRETE PIPE - 42 INCH	$ 350.00	$ 486,500.00
701.0348	250	LF	REINFORCED CONCRETE PIPE - 48 INCH	$ 400.00	$ 100,000.00
701.0354	1,045	LF	REINFORCED CONCRETE PIPE - 54 INCH	$ 450.00	$ 470,250.00
701.0360	1,950	LF	REINFORCED CONCRETE PIPE - 60 INCH	$ 500.00	$ 975,000.00
701.9901	0	LF	4 x 8 CONCRETE BOX CULVERT	$ 2,500.00	$ -
701.9902	1,140	LF	4 X 12 CONCRETE BOX CULVERT	$ 3,000.00	$ 3,420,000.00
702.0501	91	EACH	FRAME AND GRATE - ALL SIZES AND TYPES	$ 1,500.00	$ 136,500.00
702.0502	9	EACH	FRAME AND COVER - ALL SIZES AND TYPES	$ 1,500.00	$ 13,500.00
702.1000	93	EACH	MANHOLE, CATCH BASIN, OR DROP INLET ASSEMBLY - (0' - 12' DEPTH)	$ 7,500.00	$ 697,500.00
702.9901	1	LS	CULVERT JUNCTION BOX	$ 30,000.00	$ 30,000.00
702.9902	1	EA	CONCRETE HEADWALL AT CULVERT OUTFALL	$ 25,000.00	$ 25,000.00
905.2000	3,650	SY	ASPHALT CONCRETE SIDEWALKS AND DRIVEWAYS	$ 85.00	$ 310,250.00
906.0310	1,750	LF	GRANITE CURB	$ 75.00	$ 131,250.00
906.0700	5,150	LF	REMOVE, HANDLE, HAUL TRIM RESET CURB EDGING, STRAIGHT, CIRCULAR ALL TYPES	$ 45.00	$ 231,750.00
920.0320	100	SY	RIPRAP R-3, R-4, R-5 STANDARD 8.3.0	$ 200.00	$ 20,000.00
936.0110	1	LS	MOBILIZATION	$ 505,000.00	$ 505,000.00
937.0100	1	LS	FURNISH, INSTALL, MAINTAIN, AND MOVE TEMPORARY TRAFFIC PROTECTION	$ 610,000.00	$ 610,000.00
L01.9901	1	LS	WETLAND RESTORATION	$ 150,000.00	$ 150,000.00
ALL1	1	ALL	MISCELLANEOUS UTILITY RELOCATION ALLOWANCE	$ 1,010,000.00	$ 1,010,000.00
ALL2	1	ALL	TESTING OF MATERIALS AND METHODS	$ 20,000.00	$ 20,000.00
				SUBTOTAL CONTRACT PAY ITEMS	**$12,386,300.00**
				PLUS 30% CONTINGENCY	**$3,715,890.00**
				CONSTRUCTION COST	**$16,102,190.00**
				SAY	**$16,110,000.00**

STORMWATER PLANNING FOR OAKLAWN AVENUE AT WILBUR AVENUE

ALTERNATIVE #2 - WATERSHED IMPERVIOUS COVER REDUCTION

CONCEPTUAL COST ESTIMATE

Item No.	Qty.	Unit	Item Description	Unit Price	Amount
201.0303	30	EACH	CUTTING, REMOVING, AND DISPOSING ISOLATED TREES AND STUMPS	$ 2,000.00	$ 60,000.00
201.0321	2,550	SY	CLEARING AND GRUBBING	$ 15.00	$ 38,250.00
201.0403	3,650	SY	REMOVE AND DISPOSE SIDEWALKS	$ 25.00	$ 91,250.00
201.0414	8,150	LF	REMOVE AND DISPOSE PIPE - ALL SIZES	$ 25.00	$ 203,750.00
201.0428	60	EACH	REMOVE AND DISPOSE FRAME AND GRATE OR FRAME AND COVER	$ 100.00	$ 6,000.00
201.0436	1,750	LF	REMOVAL AND DISPOSAL OF CURBING	$ 45.00	$ 78,750.00
201.0437	60	EACH	REMOVAL AND DISPOSAL OF DRAINAGE AND UTILITY STRUCTURES	$ 1,500.00	$ 90,000.00
201.9901	1	LS	SITE PREPARATION	$ 100,000.00	$ 100,000.00
202.0201	25	CY	ROCK EXCAVATION MECHANICAL	$ 200.00	$ 5,000.00
202.0300	500	CY	UNCLASSIFIED EXCAVATION	$ 35.00	$ 17,500.00
202.0700	500	CY	COMMON BORROW	$ 40.00	$ 20,000.00
410.2000	1,540	TON	TEMPORARY PATCHING OF TRENCHES	$ 300.00	$ 462,000.00
410.9901	2,050	TON	PERMANENT TRENCH PATCH	$ 350.00	$ 717,500.00
701.0312	865	LF	REINFORCED CONCRETE PIPE - 12 INCH	$ 150.00	$ 129,750.00
701.0315	280	LF	REINFORCED CONCRETE PIPE - 15 INCH	$ 160.00	$ 44,800.00
701.0318	1,035	LF	REINFORCED CONCRETE PIPE - 18 INCH	$ 180.00	$ 186,300.00
701.0324	1,530	LF	REINFORCED CONCRETE PIPE - 24 INCH	$ 200.00	$ 306,000.00
701.0330	555	LF	REINFORCED CONCRETE PIPE - 30 INCH	$ 250.00	$ 138,750.00
701.0336	2,850	LF	REINFORCED CONCRETE PIPE - 36 INCH	$ 275.00	$ 783,750.00
701.0342	0	LF	REINFORCED CONCRETE PIPE - 42 INCH	$ 350.00	$ -
701.0348	2,715	LF	REINFORCED CONCRETE PIPE - 48 INCH	$ 400.00	$ 1,086,000.00
701.0354	270	LF	REINFORCED CONCRETE PIPE - 54 INCH	$ 450.00	$ 121,500.00
701.0360	115	LF	REINFORCED CONCRETE PIPE - 60 INCH	$ 500.00	$ 57,500.00
701.9901	1,140	LF	4 x 8 CONCRETE BOX CULVERT	$ 2,500.00	$ 2,850,000.00
701.9902	0	LF	4 X 12 CONCRETE BOX CULVERT	$ 3,000.00	$ -
702.0501	91	EACH	FRAME AND GRATE - ALL SIZES AND TYPES	$ 1,500.00	$ 136,500.00
702.0502	9	EACH	FRAME AND COVER - ALL SIZES AND TYPES	$ 1,500.00	$ 13,500.00
702.1000	93	EACH	MANHOLE, CATCH BASIN, OR DROP INLET ASSEMBLY - (0' - 12' DEPTH)	$ 7,500.00	$ 697,500.00
702.9901	1	LS	CULVERT JUNCTION BOX	$ 30,000.00	$ 30,000.00
702.9902	1	EA	CONCRETE HEADWALL AT CULVERT OUTFALL	$ 25,000.00	$ 25,000.00
905.2000	3,650	SY	ASPHALT CONCRETE SIDEWALKS AND DRIVEWAYS	$ 85.00	$ 310,250.00
906.0310	1,750	LF	GRANITE CURB	$ 75.00	$ 131,250.00
906.0700	5,150	LF	REMOVE, HANDLE, HAUL TRIM RESET CURB EDGING, STRAIGHT, CIRCULAR ALL TYPES	$ 45.00	$ 231,750.00
920.0320	100	SY	RIPRAP R-3, R-4, R-5 STANDARD 8.3.0	$ 200.00	$ 20,000.00
936.0110	1	LS	MOBILIZATION	$ 460,000.00	$ 460,000.00
937.0100	1	LS	FURNISH, INSTALL, MAINTAIN, AND MOVE TEMPORARY TRAFFIC PROTECTION	$ 560,000.00	$ 560,000.00
L01.9901	1	LS	WETLAND RESTORATION	$ 150,000.00	$ 150,000.00
ALL1	1	ALL	MISCELLANEOUS UTILITY RELOCATION ALLOWANCE	$ 920,000.00	$ 920,000.00
ALL2	1	ALL	TESTING OF MATERIALS AND METHODS	$ 20,000.00	$ 20,000.00
			SUBTOTAL CONTRACT PAY ITEMS		**$11,300,100.00**
			PLUS 30% CONTINGENCY		**$3,390,030.00**
			CONSTRUCTION COST		**$14,690,130.00**
			SAY		**$14,700,000.00**

STORMWATER PLANNING FOR OAKLAWN AVENUE AT WILBUR AVENUE					
STU-OAK-001 - INFILTRATION BASIN					
CONCEPTUAL COST ESTIMATE					
Item No.	Qty.	Unit	Item Description	Unit Price	Amount
201.0303	25	EACH	CUTTING, REMOVING, AND DISPOSING ISOLATED TREES AND STUMPS	$ 2,000.00	$ 50,000.00
201.0321	1,800	SY	CLEARING AND GRUBBING	$ 15.00	$ 27,000.00
201.0417	45	SY	REMOVAL AND DISPOSAL OF PAVEMENT	$ 30.00	$ 1,350.00
201.0437	1	EACH	REMOVAL AND DISPOSAL OF DRAINAGE AND UTILITY STRUCTURES	$ 1,500.00	$ 1,500.00
201.0438	400	LF	REMOVAL AND DISPOSAL OF FENCES AND RAILINGS	$ 30.00	$ 12,000.00
202.0100	1,125	CY	EARTH EXCAVATION	$ 30.00	$ 33,750.00
202.0800	0	CY	GRAVEL BORROW	$ 50.00	$ -
202.9902	0	CY	ASTM C-33 CONCRETE SAND	$ 75.00	$ -
206.0301	1,000	LF	COMPOST FILTER SOCK	$ 10.00	$ 10,000.00
209.0220	0	EACH	SACK INSERT INLET PROTECTION	$ 200.00	$ -
211.0200	1	EACH	CONSTRUCTION ACCESSES STANDARD 9.9.0	$ 1,000.00	$ 1,000.00
212.2200	1	LS	MAINTENANCE AND CLEANING OF EROSION, SEDIMENT, AND POLLUTION PREVENTION CONTROLS	$ 5,000.00	$ 5,000.00
401.2000	10	TON	CLASS 12.5 HMA	$ 250.00	$ 2,500.00
401.3000	10	TON	CLASS 9.5 HMA	$ 250.00	$ 2,500.00
601.9901	0	CY	PORTLAND CEMENT CONCRETE, CLASS B	$ 500.00	$ -
701.0300	300	LF	REINFORCED CONCRETE PIPE M 170 - ALL SIZES	$ 125.00	$ 37,500.00
701.7711	2	EACH	REINFORCED CONCRETE PIPE END SECTION STANDARD 2.3.0 - ALL SIZES	$ 1,500.00	$ 3,000.00
702.0501	1	EACH	FRAME AND GRATE - ALL SIZES AND TYPES	$ 1,500.00	$ 1,500.00
702.0502	1	EACH	FRAME AND COVER - ALL SIZES AND TYPES	$ 1,500.00	$ 1,500.00
702.1000	2	EACH	MANHOLE, CATCH BASIN, OR DROP INLET ASSEMBLY - (0' - 12' DEPTH)	$ 7,500.00	$ 15,000.00
702.9901	0	SY	IMPERMEABLE LINER	$ 15.00	$ -
703.0849	0	LF	UNDERDRAIN WITH FILTER MATERIAL - ALL TYPES & SIZES	$ 75.00	$ -
708.9040	500	LF	CLEANING AND FLUSHING PIPE ALL SIZES	$ 3.00	$ 1,500.00
708.9044	4	EACH	CLEANING AND FLUSHING VERTICAL STRUCTURE	$ 250.00	$ 1,000.00
903.0510	500	LF	FENCE - PERMANENT ALL TYPES AND SIZES	$ 100.00	$ 50,000.00
906.0320	80	LF	PRECAST CONCRETE CURB	$ 65.00	$ 5,200.00
914.6010	160	HR	FLAGPERSONS	$ 80.00	$ 12,800.00
914.6020	16	HR	FLAGPERSONS - OVERTIME	$ 120.00	$ 1,920.00
919.0101	1	EACH	TEST PITS	$ 1,000.00	$ 1,000.00
920.0320	15	SY	RIPRAP R-3, R-4, R-5 STANDARD 8.3.0	$ 200.00	$ 3,000.00
920.9901	0	SY	FILTER FABRIC	$ 15.00	$ -
932.0500	110	LF	CUTTING AND MATCHING PAVEMENT	$ 5.00	$ 550.00
936.0110	1	LS	MOBILIZATION	$ 17,000.00	$ 17,000.00
937.0100	1	LS	FURNISH, INSTALL, MAINTAIN, AND MOVE TEMPORARY TRAFFIC PROTECTION	$ 17,000.00	$ 17,000.00
990.9901	1	EACH	CDS PRETREATMENT UNIT	$ 35,000.00	$ 35,000.00
990.9902	0	EACH	JELLYFISH FILTER	$ 35,000.00	$ -
990.9903	0	EACH	HYDRODYNAMIC SEPARATOR	$ 35,000.00	$ -
L01.0102	2,225	SY	LOAM BORROW 4 INCHES DEEP	$ 12.00	$ 26,700.00
L02.0107	2,225	SY	SEEDING	$ 3.50	$ 7,787.50
L11.0102	10	EACH	TREE PLANT PROTECTION DEVICE STANDARD 51.1.0	$ 400.00	$ 4,000.00
			SUBTOTAL CONTRACT PAY ITEMS		**$389,557.50**
			PLUS 30% CONTINGENCY		**$116,867.25**
			CONSTRUCTION COST		**$506,424.75**
			SAY		**$510,000.00**

STORMWATER PLANNING FOR OAKLAWN AVENUE AT WILBUR AVENUE

STU-OAK-002 - UNDERGROUND INFILTRATION CHAMBERS

CONCEPTUAL COST ESTIMATE

Item No.	Qty.	Unit	Item Description	Unit Price	Amount
201.0303	4	EACH	CUTTING, REMOVING, AND DISPOSING ISOLATED TREES AND STUMPS	$ 2,000.00	$ 8,000.00
201.0321	10	SY	CLEARING AND GRUBBING	$ 10.00	$ 100.00
201.0414	0	LF	REMOVE AND DISPOSE PIPE - ALL SIZES	$ 85.00	$ -
201.0415	0	LF	REMOVE AND DISPOSE GUARDRAIL AND POST ALL TYPES	$ 6.00	$ -
201.0428	1	EACH	REMOVE AND DISPOSE FRAME AND GRATE OR FRAME AND COVER	$ 275.00	$ 275.00
201.0436	20	LF	REMOVAL AND DISPOSAL OF CURBING	$ 12.00	$ 240.00
201.0437	1	EACH	REMOVAL AND DISPOSAL OF DRAINAGE AND UTILITY STRUCTURES	$ 1,400.00	$ 1,400.00
201.0438	0	LF	REMOVAL AND DISPOSAL OF FENCES AND RAILINGS	$ 10.00	$ -
201.9901	0	LF	REMOVE AND STOCKPILE CONCRETE BLOCK	$ 10.00	$ -
202.0900	2,100	TON	HANDLE, HAUL, AND STOCKPILE MANAGEMENT OF CONTAMINATED SOILS AND UNCLASSIFIED SOILS	$ 20.00	$ 42,000.00
202.0910	2,100	TON	LOAD, HAUL, AND DISPOSE SOIL, TYPE 1	$ 45.00	$ 94,500.00
202.0100	1,400	CY	EARTH EXCAVATION	$ 40.00	$ 56,000.00
202.0700	100	CY	COMMON BORROW	$ 40.00	$ 4,000.00
205.0220	100	CY	TRENCH ROCK EXCAVATION - MECHANICAL	$ 200.00	$ 20,000.00
206.0301	400	LF	COMPOST FILTER SOCK	$ 6.00	$ 2,400.00
209.0220	2	EACH	SACK INSERT INLET PROTECTION	$ 200.00	$ 400.00
211.0200	1	EACH	CONSTRUCTION ACCESSES STANDARD 9.9.0	$ 5,000.00	$ 5,000.00
212.2200	1	LS	MAINTENANCE AND CLEANING OF EROSION, SEDIMENT, AND POLLUTION PREVENTION CONTROLS	$ 20,000.00	$ 20,000.00
302.0100	10	CY	GRAVEL BORROW SUBBASE COURSE	$ 60.00	$ 600.00
401.0520	30	SY	HOT MIX ASPHALT PREPARATION – FULL DEPTH	$ 25.00	$ 750.00
401.2100	10	TON	MODIFIED CLASS 12.5 HMA	$ 160.00	$ 1,600.00
401.2005	5	TON	CLASS 12.5 HMA FOR MISCELLANEOUS WORK	$ 200.00	$ 1,000.00
401.3100	2	TON	MODIFIED CLASS 9.5 HMA	$ 180.00	$ 360.00
701.0300	0	LF	REINFORCED CONCRETE PIPE M 170 - ALL SIZES	$ 350.00	$ -
701.4311	90	LF	SMOOTH INTERIOR CORRUGATED POLYETHYLENE PIPE - ALL SIZES	$ 100.00	$ 9,000.00
701.7711	0	EACH	REINFORCED CONCRETE PIPE END SECTION STANDARD 2.3.0 - ALL SIZES	$ 2,000.00	$ -
701.8003	0	CY	PIPE BEDDING CLASS C	$ 50.00	$ -
702.0501	1	EACH	FRAME AND GRATE - ALL SIZES AND TYPES	$ 1,500.00	$ 1,500.00
702.0502	2	EACH	FRAME AND COVER - ALL SIZES AND TYPES	$ 1,800.00	$ 3,600.00
702.1000	3	EACH	MANHOLE, CATCH BASIN, OR DROP INLET ASSEMBLY - (0' - 12' DEPTH)	$ 8,000.00	$ 24,000.00
702.1100	0	VLF	ADDITIONAL DEPTH OF MANHOLE, CATCH BASIN, OR DROP INLET ASSEMBLY - (OVER 12' DEPTH)	$ 1,200.00	$ -
702.9901	1	LS	UNDERGROUND INFILTRATION CHAMBER SYSTEM	$ 150,000.00	$ 150,000.00
702.9902	2	EACH	DIVERSION MANHOLE	$ 10,000.00	$ 20,000.00
702.9903	1	EACH	PRETREATMENT UNIT	$ 30,000.00	$ 30,000.00
706.9000	0	EACH	PLUG AND CAP PIPE ALL SIZES	$ 750.00	$ -
708.9040	325	LF	CLEANING AND FLUSHING PIPE ALL SIZES	$ 4.00	$ 1,300.00
708.9044	8	EACH	CLEANING AND FLUSHING VERTICAL STRUCTURE	$ 210.00	$ 1,680.00
901.1000	0	LF	STEEL BEAM GUARDRAIL	$ 40.00	$ -
903.0520	400	LF	FENCE - TEMPORARY ALL TYPES AND SIZES	$ 15.00	$ 6,000.00
904.0100	0	LF	REMOVE AND RESET FENCE AND/OR RAILING	$ 60.00	$ -
919.0101	1	EACH	TEST PITS	$ 1,500.00	$ 1,500.00
920.0320	0	SY	RIPRAP R-3, R-4, R-5 STANDARD 8.3.0	$ 200.00	$ -
936.0110	1	LS	MOBILIZATION	$ 60,000.00	$ 60,000.00
937.0100	1	LS	FURNISH, INSTALL, MAINTAIN, AND MOVE TEMPORARY TRAFFIC PROTECTION	$ 40,000.00	$ 40,000.00
L01.0102	2,225	SY	LOAM BORROW 4 INCHES DEEP	$ 10.00	$ 22,250.00
L02.0107	2,225	SY	SEEDING	$ 4.00	$ 8,900.00
L11.0102	0	EACH	TREE PLANT PROTECTION DEVICE STANDARD 51.1.0	$ 400.00	$ -
L11.0104	200	LF	DRIP-LINE TREE PROTECTION DEVICE STANDARD 51.1.1	$ 10.00	$ 2,000.00
T15.0200	0	EACH	REMOVE AND RELOCATE DIRECTIONAL REGULATORY AND WARNING SIGN	$ 350.00	$ -
			SUBTOTAL CONTRACT PAY ITEMS		**$640,355.00**
			PLUS 30% CONTINGENCY		**$192,106.50**
			CONSTRUCTION COST		**$832,461.50**
			SAY		**$840,000.00**

STORMWATER PLANNING FOR OAKLAWN AVENUE AT WILBUR AVENUE

STU-OAK-003-UNDERGROUND INFILTRATION CHAMBERS

CONCEPTUAL COST ESTIMATE

Item No.	Qty.	Unit	Item Description	Unit Price	Amount
201.0303	6	EACH	CUTTING, REMOVING, AND DISPOSING ISOLATED TREES AND STUMPS	$ 2,000.00	$ 12,000.00
201.0321	840	SY	CLEARING AND GRUBBING	$ 10.00	$ 8,400.00
201.0414	0	LF	REMOVE AND DISPOSE PIPE - ALL SIZES	$ 85.00	$ -
201.0415	0	LF	REMOVE AND DISPOSE GUARDRAIL AND POST ALL TYPES	$ 6.00	$ -
201.0428	2	EACH	REMOVE AND DISPOSE FRAME AND GRATE OR FRAME AND COVER	$ 275.00	$ 550.00
201.0436	20	LF	REMOVAL AND DISPOSAL OF CURBING	$ 12.00	$ 240.00
201.0437	2	EACH	REMOVAL AND DISPOSAL OF DRAINAGE AND UTILITY STRUCTURES	$ 1,400.00	$ 2,800.00
201.0438	0	LF	REMOVAL AND DISPOSAL OF FENCES AND RAILINGS	$ 10.00	$ -
201.9901	0	LF	REMOVE AND STOCKPILE CONCRETE BLOCK	$ 10.00	$ -
202.0900	900	TON	HANDLE, HAUL, AND STOCKPILE MANAGEMENT OF CONTAMINATED SOILS AND UNCLASSIFIED SOILS	$ 20.00	$ 18,000.00
202.0910	900	TON	LOAD, HAUL, AND DISPOSE SOIL, TYPE 1	$ 45.00	$ 40,500.00
202.0100	600	CY	EARTH EXCAVATION	$ 40.00	$ 24,000.00
202.0700	100	CY	COMMON BORROW	$ 40.00	$ 4,000.00
205.0220	100	CY	TRENCH ROCK EXCAVATION - MECHANICAL	$ 200.00	$ 20,000.00
206.0301	500	LF	COMPOST FILTER SOCK	$ 6.00	$ 3,000.00
209.0220	4	EACH	SACK INSERT INLET PROTECTION	$ 200.00	$ 800.00
211.0200	1	EACH	CONSTRUCTION ACCESSES STANDARD 9.9.0	$ 5,000.00	$ 5,000.00
212.2200	1	LS	MAINTENANCE AND CLEANING OF EROSION, SEDIMENT, AND POLLUTION PREVENTION CONTROLS	$ 20,000.00	$ 20,000.00
302.0100	10	CY	GRAVEL BORROW SUBBASE COURSE	$ 60.00	$ 600.00
401.0520	20	SY	HOT MIX ASPHALT PREPARATION – FULL DEPTH	$ 25.00	$ 500.00
401.2100	5	TON	MODIFIED CLASS 12.5 HMA	$ 160.00	$ 800.00
401.2005	5	TON	CLASS 12.5 HMA FOR MISCELLANEOUS WORK	$ 200.00	$ 1,000.00
401.3100	2	TON	MODIFIED CLASS 9.5 HMA	$ 180.00	$ 360.00
701.0300	0	LF	REINFORCED CONCRETE PIPE M 170 - ALL SIZES	$ 350.00	$ -
701.4311	105	LF	SMOOTH INTERIOR CORRUGATED POLYETHYLENE PIPE - ALL SIZES	$ 100.00	$ 10,500.00
701.7711	0	EACH	REINFORCED CONCRETE PIPE END SECTION STANDARD 2.3.0 - ALL SIZES	$ 2,000.00	$ -
701.8003	0	CY	PIPE BEDDING CLASS C	$ 50.00	$ -
702.0501	2	EACH	FRAME AND GRATE - ALL SIZES AND TYPES	$ 1,500.00	$ 3,000.00
702.0502	0	EACH	FRAME AND COVER - ALL SIZES AND TYPES	$ 1,800.00	$ -
702.1000	2	EACH	MANHOLE, CATCH BASIN, OR DROP INLET ASSEMBLY - (0' - 12' DEPTH)	$ 8,000.00	$ 16,000.00
702.1100	0	VLF	ADDITIONAL DEPTH OF MANHOLE, CATCH BASIN, OR DROP INLET ASSEMBLY - (OVER 12' DEPTH)	$ 1,200.00	$ -
702.9901	1	LS	UNDERGROUND INFILTRATION CHAMBER SYSTEM	$ 95,000.00	$ 95,000.00
702.9902	2	EACH	DIVERSION MANHOLE	$ 10,000.00	$ 20,000.00
702.9903	1	EACH	PRETREATMENT UNIT	$ 30,000.00	$ 30,000.00
706.9000	0	EACH	PLUG AND CAP PIPE ALL SIZES	$ 750.00	$ -
708.9040	500	LF	CLEANING AND FLUSHING PIPE ALL SIZES	$ 4.00	$ 2,000.00
708.9044	7	EACH	CLEANING AND FLUSHING VERTICAL STRUCTURE	$ 210.00	$ 1,470.00
901.1000	0	LF	STEEL BEAM GUARDRAIL	$ 40.00	$ -
903.0520	400	LF	FENCE - TEMPORARY ALL TYPES AND SIZES	$ 15.00	$ 6,000.00
904.0100	0	LF	REMOVE AND RESET FENCE AND/OR RAILING	$ 60.00	$ -
919.0101	1	EACH	TEST PITS	$ 1,500.00	$ 1,500.00
920.0320	0	SY	RIPRAP R-3, R-4, R-5 STANDARD 8.3.0	$ 200.00	$ -
936.0110	1	LS	MOBILIZATION	$ 40,000.00	$ 40,000.00
937.0100	1	LS	FURNISH, INSTALL, MAINTAIN, AND MOVE TEMPORARY TRAFFIC PROTECTION	$ 30,000.00	$ 30,000.00
L01.0102	850	SY	LOAM BORROW 4 INCHES DEEP	$ 10.00	$ 8,500.00
L02.0107	850	SY	SEEDING	$ 4.00	$ 3,400.00
L11.0102	0	EACH	TREE PLANT PROTECTION DEVICE STANDARD 51.1.0	$ 400.00	$ -
L11.0104	200	LF	DRIP-LINE TREE PROTECTION DEVICE STANDARD 51.1.1	$ 10.00	$ 2,000.00
T15.0200	6	EACH	REMOVE AND RELOCATE DIRECTIONAL REGULATORY AND WARNING SIGN	$ 350.00	$ 2,100.00
			SUBTOTAL CONTRACT PAY ITEMS		**$434,020.00**
			PLUS 30% CONTINGENCY		**$130,206.00**
			CONSTRUCTION COST		**$564,226.00**
			SAY		**$570,000.00**

STORMWATER PLANNING FOR OAKLAWN AVENUE AT WILBUR AVENUE

STU-OAK-004 - INFILTRATION BASIN

CONCEPTUAL COST ESTIMATE

Item No.	Qty.	Unit	Item Description	Unit Price	Amount
201.0303	50	EACH	CUTTING, REMOVING, AND DISPOSING ISOLATED TREES AND STUMPS	$ 2,000.00	$ 100,000.00
201.0321	1,700	SY	CLEARING AND GRUBBING	$ 15.00	$ 25,500.00
201.0417	20	SY	REMOVAL AND DISPOSAL OF PAVEMENT	$ 30.00	$ 600.00
201.0437	0	EACH	REMOVAL AND DISPOSAL OF DRAINAGE AND UTILITY STRUCTURES	$ 1,500.00	$ -
201.0438	0	LF	REMOVAL AND DISPOSAL OF FENCES AND RAILINGS	$ 30.00	$ -
202.0100	300	CY	EARTH EXCAVATION	$ 30.00	$ 9,000.00
202.0800	50	CY	GRAVEL BORROW	$ 50.00	$ 2,500.00
202.9902	0	CY	ASTM C-33 CONCRETE SAND	$ 75.00	$ -
206.0301	500	LF	COMPOST FILTER SOCK	$ 10.00	$ 5,000.00
209.0220	4	EACH	SACK INSERT INLET PROTECTION	$ 200.00	$ 800.00
211.0200	1	EACH	CONSTRUCTION ACCESSES STANDARD 9.9.0	$ 1,000.00	$ 1,000.00
212.2200	1	LS	MAINTENANCE AND CLEANING OF EROSION, SEDIMENT, AND POLLUTION PREVENTION CONTROLS	$ 5,000.00	$ 5,000.00
401.2000	5	TON	CLASS 12.5 HMA	$ 250.00	$ 1,250.00
401.3000	5	TON	CLASS 9.5 HMA	$ 250.00	$ 1,250.00
601.9901	1	CY	PORTLAND CEMENT CONCRETE, CLASS B	$ 500.00	$ 500.00
701.0300	85	LF	REINFORCED CONCRETE PIPE M 170 - ALL SIZES	$ 125.00	$ 10,625.00
701.7711	1	EACH	REINFORCED CONCRETE PIPE END SECTION STANDARD 2.3.0 - ALL SIZES	$ 1,500.00	$ 1,500.00
702.0501	1	EACH	FRAME AND GRATE - ALL SIZES AND TYPES	$ 1,500.00	$ 1,500.00
702.0502	2	EACH	FRAME AND COVER - ALL SIZES AND TYPES	$ 1,500.00	$ 3,000.00
702.1000	3	EACH	MANHOLE, CATCH BASIN, OR DROP INLET ASSEMBLY - (0' - 12' DEPTH)	$ 7,500.00	$ 22,500.00
702.9901	0	SY	IMPERMEABLE LINER	$ 15.00	$ -
703.0849	0	LF	UNDERDRAIN WITH FILTER MATERIAL - ALL TYPES & SIZES	$ 75.00	$ -
708.9040	500	LF	CLEANING AND FLUSHING PIPE ALL SIZES	$ 3.00	$ 1,500.00
708.9044	4	EACH	CLEANING AND FLUSHING VERTICAL STRUCTURE	$ 250.00	$ 1,000.00
903.0510	500	LF	FENCE - PERMANENT ALL TYPES AND SIZES	$ 100.00	$ 50,000.00
906.0320	25	LF	PRECAST CONCRETE CURB	$ 65.00	$ 1,625.00
914.6010	160	HR	FLAGPERSONS	$ 80.00	$ 12,800.00
914.6020	16	HR	FLAGPERSONS - OVERTIME	$ 120.00	$ 1,920.00
919.0101	0	EACH	TEST PITS	$ 1,000.00	$ -
920.0320	100	SY	RIPRAP R-3, R-4, R-5 STANDARD 8.3.0	$ 200.00	$ 20,000.00
920.9901	0	SY	FILTER FABRIC	$ 15.00	$ -
932.0500	80	LF	CUTTING AND MATCHING PAVEMENT	$ 5.00	$ 400.00
936.0110	1	LS	MOBILIZATION	$ 16,000.00	$ 16,000.00
937.0100	1	LS	FURNISH, INSTALL, MAINTAIN, AND MOVE TEMPORARY TRAFFIC PROTECTION	$ 16,000.00	$ 16,000.00
990.9901	1	EACH	CDS PRETREATMENT UNIT	$ 35,000.00	$ 35,000.00
990.9902	0	EACH	JELLYFISH FILTER	$ 35,000.00	$ -
990.9903	0	EACH	HYDRODYNAMIC SEPARATOR	$ 35,000.00	$ -
L01.0102	1,670	SY	LOAM BORROW 4 INCHES DEEP	$ 12.00	$ 20,040.00
L02.0107	1,670	SY	SEEDING	$ 3.50	$ 5,845.00
L11.0102	10	EACH	TREE PLANT PROTECTION DEVICE STANDARD 51.1.0	$ 400.00	$ 4,000.00
			SUBTOTAL CONTRACT PAY ITEMS		**$377,655.00**
			PLUS 30% CONTINGENCY		**$113,296.50**
			CONSTRUCTION COST		**$490,951.50**
			SAY		**$500,000.00**

STORMWATER PLANNING FOR OAKLAWN AVENUE AT WILBUR AVENUE					
INTERIM IMPROVEMENTS					
CONCEPTUAL COST ESTIMATE					
Item No.	Qty.	Unit	Item Description	Unit Price	Amount
201.0303	5	EACH	CUTTING, REMOVING, AND DISPOSING ISOLATED TREES AND STUMPS	$ 2,000.00	$ 10,000.00
201.0321	500	SY	CLEARING AND GRUBBING	$ 15.00	$ 7,500.00
201.0414	50	LF	REMOVE AND DISPOSE PIPE - ALL SIZES	$ 25.00	$ 1,250.00
201.0437	1	EACH	REMOVAL AND DISPOSAL OF DRAINAGE AND UTILITY STRUCTURES	$ 1,500.00	$ 1,500.00
206.0301	150	LF	COMPOST FILTER SOCK	$ 10.00	$ 1,500.00
212.2200	1	LS	MAINTENANCE AND CLEANING OF EROSION, SEDIMENT, AND POLLUTION PREVENTION CONTROLS	$ 5,000.00	$ 5,000.00
701.0300	50	LF	REINFORCED CONCRETE PIPE M 170 - ALL SIZES	$ 250.00	$ 12,500.00
702.0502	1	EACH	FRAME AND COVER - ALL SIZES AND TYPES	$ 1,500.00	$ 1,500.00
702.1000	1	EACH	MANHOLE, CATCH BASIN, OR DROP INLET ASSEMBLY - (0' - 12' DEPTH)	$ 7,500.00	$ 7,500.00
702.9901	1	EACH	CONCRETE HEADWALL	$ 15,000.00	$ 15,000.00
708.9040	1,200	LF	CLEANING AND FLUSHING PIPE ALL SIZES	$ 3.00	$ 3,600.00
708.9044	10	EACH	CLEANING AND FLUSHING VERTICAL STRUCTURE	$ 250.00	$ 2,500.00
920.0320	25	SY	RIPRAP R-3, R-4, R-5 STANDARD 8.3.0	$ 200.00	$ 5,000.00
936.011	1	LS	MOBILIZATION	$ 5,000.00	$ 5,000.00
937.01	1	LS	FURNISH, INSTALL, MAINTAIN, AND MOVE TEMPORARY TRAFFIC PROTECTION	$ 6,000.00	$ 6,000.00
L01.0102	560	SY	LOAM BORROW 4 INCHES DEEP	$ 12.00	$ 6,720.00
L02.0107	560	SY	SEEDING	$ 3.50	$ 1,960.00
L11.0102	10	EACH	TREE PLANT PROTECTION DEVICE STANDARD 51.1.0	$ 400.00	$ 4,000.00
			SUBTOTAL CONTRACT PAY ITEMS		**$108,045.00**
			PLUS 30% CONTINGENCY		**$32,413.50**
			CONSTRUCTION COST		**$140,458.50**
			SAY		**$150,000.00**

APPENDIX K

SCP CALCULATORS

K.1 – SCP Calculator for RIDOT STUs

Appendix K

Stormwater Controls Pollutant Calculations

SCP Calculator: Catchments

																	Catchment Pollutant Load, lb/yr			
Catchment ID	WBID	Ownership*	Ownership Notes	Discharge ID	Discharge ID Owner*	Discharge Owner Notes	Treatment Status*	Treatment Status Notes	STU Name	Impervious Area (sq ft)	TIP Project ID	TIP Year	Land Use*	NOTES	Catchment Length (ft)	Catchment Area (sq ft)	Phosphorus Load	TSS Load	Nitrogen Load	Zinc Load
WS-OAK-001A		RIDOT			RIDOT		Potential		STU-OAK-001	384775			Highway			572354	12.35	5542.00	77.99	10.95
WS-OAK-001B		Private			RIDOT		Potential		STU-OAK-001	5,620,941			Residential			11,333,120	316.42	60503.00	1966.27	93.87
WS-OAK-002A		RIDOT			RIDOT		Potential		STU-OAK-002	109991			Highway			118,838	3.40	1554.00	21.39	3.11
WS-OAK-002B		Private			RIDOT		Potential		STU-OAK-002	1,990,917			Residential			3,867,106	111.64	21330.00	692.54	33.17
WS-OAK-003A		Private			RIDOT		Potential		STU-OAK-003	195631			Highway			271906	6.22	2805.00	39.75	5.56
WS-OAK-003B		RIDOT			RIDOT		Potential		STU-OAK-003	8153			Highway			8153	0.25	115.00	1.57	0.23
WS-OAK-004A		RIDOT			RIDOT		Potential		STU-OAK-004	52356			Highway			66635	1.65	746.00	10.38	1.48
WS-OAK-004B		Private			RIDOT		Potential		STU-OAK-004	722116			Residential			1455762	40.65	7773.00	252.60	12.06
WS-OAK-001B-A		RIDOT			RIDOT		Potential		STU-OAK-001B	384775			Highway			572354	12.35	5542.00	77.99	10.95
WS-OAK-001B-B		Private			RIDOT		Potential		STU-OAK-001B	5,620,941			Residential			11,333,120	316.42	60503.00	1966.27	93.87
WS-OAK-002B-A		RIDOT			RIDOT		Potential		STU-OAK-002B	109991			Highway			118,838	3.40	1554.00	21.39	3.11
WS-OAK-002B-B		Private			RIDOT		Potential		STU-OAK-002B	1,990,917			Residential			3,867,106	111.64	21330.00	692.54	33.17
WS-OAK-003B-A		Private			RIDOT		Potential		STU-OAK-003B	195631			Highway			271906	6.22	2805.00	39.75	5.56
WS-OAK-003B-B		RIDOT			RIDOT		Potential		STU-OAK-003B	8153			Highway			8153	0.25	115.00	1.57	0.23
WS-OAK-004B-A		RIDOT			RIDOT		Potential		STU-OAK-004B	52356			Highway			66635	1.65	746.00	10.38	1.48
WS-OAK-004B-B		Private			RIDOT		Potential		STU-OAK-004B	722116			Residential			1455762	40.65	7773.00	252.60	12.06

STU Name	Waterbody ID	Current STU Status*	Current STU Type*	Unit Type	Location	PTSID	Contract Number	Installed Year	Consultant	System Responsibility*	Partnership*	Partnership Type*	OSM Project*	SCP Priority*	Notes	Edit Notes	Structure ID	Target Construction Date	SCP Group ID	TIP ID	Legacy ID
STU-OAK-001	RI0006017R-02		Infiltration Basin		Oak Lawn Elementary				BETA Group, Inc.	RIDOT	Yes	Municipal	Yes								
STU-OAK-002	RI0006017R-02		Underground Infiltration System		Immaculate Conception Church				BETA Group, Inc.	RIDOT	Yes	Private	Yes								
STU-OAK-003	RI0006017R-02		Underground Infiltration System		Oak Lawn Village Park				BETA Group, Inc.	RIDOT	Yes	Municipal	Yes								
STU-OAK-004	RI0006017R-02		Infiltration Basin		Oaklawn at Wilbur Intersection				BETA Group, Inc.	RIDOT	Yes	Private	Yes								
STU-OAK-001B	RI0006017R-02		Extended Detention Basin		Oak Lawn Elementary				BETA Group, Inc.	RIDOT	Yes	Municipal	Yes								
STU-OAK-002B	RI0006017R-02		Sand Filter		Immaculate Conception Church				BETA Group, Inc.	RIDOT	Yes	Private	Yes								
STU-OAK-003B	RI0006017R-02		Sand Filter		Oak Lawn Village Park				BETA Group, Inc.	RIDOT	Yes	Municipal	Yes								
STU-OAK-004B	RI0006017R-02		Extended Detention Basin		Oaklawn at Wilbur Intersection				BETA Group, Inc.	RIDOT	Yes	Private	Yes								

STU Name	Legacy ID	Structure ID	PTSID	Waterbody ID	STU Progress*	Progress Date	Consultant	STU Type*	STU Soil Type*	STU Storage Volume (cuft)
STU-OAK-001				RI0006017R-02	Desktop Review	8/21/2026	BETA Group, Inc.	Infiltration Basin	Loamy Sand (2.41 in/hr)	42000
STU-OAK-002				RI0006017R-02	Desktop Review	8/21/2026	BETA Group, Inc.	Underground Infiltration System	Loamy Sand (2.41 in/hr)	12934
STU-OAK-003				RI0006017R-02	Desktop Review	8/21/2026	BETA Group, Inc.	Underground Infiltration System	Loamy Sand (2.41 in/hr)	6990
STU-OAK-004				RI0006017R-02	Desktop Review	8/21/2026	BETA Group, Inc.	Infiltration Basin	Loamy Sand (2.41 in/hr)	10800
STU-OAK-001B				RI0006017R-02	Desktop Review	8/21/2026	BETA Group, Inc.	Extended Detention Basin		42000
STU-OAK-002B				RI0006017R-02	Desktop Review	8/21/2026	BETA Group, Inc.	Sand Filter		14822
STU-OAK-003B				RI0006017R-02	Desktop Review	8/21/2026	BETA Group, Inc.	Sand Filter		8970
STU-OAK-004B				RI0006017R-02	Desktop Review	8/21/2026	BETA Group, Inc.	Extended Detention Basin		10800

Fields from GIS			Ponding (Surface) Volume				Void (Subsurface) Volume					Total Storage Volume (ft^3)
STU Name	STU Type	Storage Volume (ft^3)	Length (ft)	Width (ft)	Depth (ft)		Length (ft)	Width (ft)	Depth (ft)	Void Space	Notes	
STU-OAK-001	Infiltration Basin	42000	100	70	6						Void Volume N/A	*42000*
STU-OAK-002	Underground Infiltration System	12934	130	22	4.0		130	22	1.58	0.33	Sand/Crushed Stone Storage	*12934*
STU-OAK-003	Underground Infiltration System	6990	100	30	2.0		100	30	1	0.33	Sand/Crushed Stone Storage	*6990*
STU-OAK-004	Infiltration Basin	10800	90	30	4						Void Volume N/A	*10800*
STU-OAK-001B	Extended Detention Basin	42000	100	70	6						Void Volume N/A	*42000*
STU-OAK-002B	Sand Filter	14822	130	22	4.0		130	22	3.58	0.33	Sand/Crushed Stone Storage	*14822*
STU-OAK-003B	Sand Filter	8970	100	30	2.0		100	30	3	0.33	Sand/Crushed Stone Storage	*8970*
STU-OAK-004B	Extended Detention Basin	10800	90	30	4						Void Volume N/A	*10800*

Appendix K

Stormwater Controls Pollutant Calculations

SCP Calculator: Structural Water Quality Calcs

									STU Treatment Credit Results																							
STU Name	STU Type*	Total Catchment Area (sq. ft.)	Impervious Catchment Area (Sq. Ft.)	STU Storage Volume (ft^3)	STU Treatment Depth (in.)	STU Soil Type*	Pervious Catchment Area (sq. ft.)	Catchment % Impervious	P Load (lb/yr)	P Removal Credit (%)	P Reduction (lb/yr)	TSS Load (lb/yr)	TSS Removal Credit (%)	TSS Reduction (lb/yr)	Nitrogen Load (lb/yr)	Nitrogen Removal Credit (%)	Nitrogen Reduction (lb/yr)	Zinc Load (lb/yr)	Zinc Removal Credit (%)	Zinc Reduction (lb/yr)	Impervious Catchment Area (Acres)	TSS Reduction Factor	Phosphorus Reduction Factor	Runoff Factor	Flow Factor	Pervious Cover Factor	Effective IC Reduction (acres)	Runoff Reduction %	Runoff Reduction (ac-ft)
STU-OAK-001	Infiltration Basin	11,905,474	6,005,716	42,000	0.1	Loamy Sand	5899758	50%	328.8	39%	126.9	66045	59%	38797	2044.3	54%	1097.9	104.8	69%	72.1	137.9	0.7	0.4	0.3	0.2	0.40	55.8	30%	156.4
STU-OAK-002	Underground Infiltration System	3,985,944	2,100,908	12,934	0.1	Loamy Sand	1885036	53%	115.0	24%	28.0	22884	37%	8453	713.9	48%	342.8	36.3	60%	21.7	48.2	0.4	0.3	0.2	0.1	0.26	12.7	21%	38.6
STU-OAK-003	Underground Infiltration System	280,059	203,784	6,990	0.4	Loamy Sand	76275	73%	6.5	82%	5.3	2920	97%	2837	41.3	95%	39.3	5.8	100%	5.8	4.7	1.0	0.9	0.8	0.6	0.83	3.9	76%	12.9
STU-OAK-004	Infiltration Basin	1,522,397	774,472	10,800	0.2	Loamy Sand	747925	51%	42.3	60%	25.4	8519	82%	6996	263.0	76%	200.2	13.5	91%	12.3	17.8	0.9	0.7	0.6	0.4	0.63	11.1	51%	34.7
STU-OAK-001B	Extended Detention Basin	11,905,474	6,005,716	42,000	0.1	0	5899758	50%	328.8	2%	5.5	66045	15%	9976	2044.3	1%	24.0	104.8	44%	46.6	137.9	0.2	0.0	0.1	0.1	0.09	12.4	9%	45.7
STU-OAK-002B	Sand Filter	3,985,944	2,100,908	14,822	0.1	0	1885036	53%	115.0	12%	13.6	22884	37%	8524	713.9	8%	54.4	36.3	58%	20.9	48.2	0.4	0.1	0.0	0.1	0.16	7.5	0%	0.0
STU-OAK-003B	Sand Filter	280,059	203,784	8,970	0.5	0	76275	73%	6.5	41%	2.7	2920	95%	2770	41.3	26%	10.8	5.8	96%	5.5	4.7	1.0	0.5	0.1	0.3	0.46	2.2	7%	1.2
STU-OAK-004B	Extended Detention Basin	1,522,397	774,472	10,800	0.2	0	747925	51%	42.3	4%	1.7	8519	27%	2279	263.0	2%	6.4	13.5	62%	8.5	17.8	0.3	0.0	0.2	0.1	0.17	2.9	16%	11.1

STU Name	Construction & Design						Annual Inspection and Maintenance Cost
	STU Type*	Effective IC Reduction (ac)	P Removal (lb/yr)	Estimated Cost[1]	Cost per IC Reduction Acre ($/ac)	Cost Per lb P Removed ($/lb P)	
STU-OAK-001	Infiltration Basin	3.6	4.8	$510,000	$142,900	$106,900	$2,622
STU-OAK-002	Underground Infiltration System	0.7	0.8	$840,000	$1,253,700	$1,012,000	$3,095
STU-OAK-003	Underground Infiltration System	0.2	0.2	$570,000	$3,562,500	$2,850,000	$3,095
STU-OAK-004	Infiltration Basin	0.8	1.0	$50,000	$66,700	$50,500	$2,622
STU-OAK-001B	Extended Detention Basin	0.8	0.2	$510,000	$645,600	$2,428,600	$2,622
STU-OAK-002B	Sand Filter	0.4	0.4	$840,000	$2,153,800	$2,100,000	$3,092
STU-OAK-003B	Sand Filter	0.1	0.1	$570,000	$6,333,300	$5,700,000	$3,092
STU-OAK-004B	Extended Detention Basin	0.2	0.1	$50,000	$250,000	$714,300	$2,622

K.2 – SCP Calculator for Cranston STUs

Appendix K

Stormwater Controls Pollutant Calculations

SCP Calculator: Catchments

Catchment ID	WBID	Ownership*	Ownership Notes	Discharge ID	Discharge ID Owner*	Discharge Owner Notes	Treatment Status*	Treatment Status Notes	STU Name	Impervious Area (sq ft)	TIP Project ID	TIP Year	Land Use*	NOTES	Catchment Length (ft)	Catchment Area (sq ft)	Catchment Pollutant Load, lb/yr			
																	Phosphorus Load	TSS Load	Nitrogen Load	Zinc Load
WS-CRAN-IC		Municipality					Potential		STU-CRAN-IC	203745			Highway	Reduce 80% of the roadway width by 6ft (Total Roadway Length from GIS Centerlines 42,447 LF)		203745	6.24	2867.00	39.29	5.75
WS-CRAN-LB-1		Municipality					Potential		STU-CRAN-LB	20000			Residential	Replace all CBs with Leaching Basins (assume avg. 20,000 sf IC to each)		20000	1.07	202.00	6.46	0.32
WS-CRAN-SF		Municipality					Potential		STU-CRAN-SF-1	260684			Residential			643523	15.03	2886.00	94.32	4.41
WS-CRAN-EDB		Municipality					Potential		STU-CRAN-EDB-1	681360			Residential			1375942	38.36	7335.00	238.40	11.38
WS-CRAN-BA		Municipality					Potential		STU-CRAN-IS-1	38672			Highway	Catchment to potential Brayton Avenue Swale		76493	1.30	570.00	8.46	1.11
WS-CRAN-IT-1		Municipality					Potential		STU-CRAN-IT1	4489074			Residential			9,550,347	254.19	48657.00	1583.59	75.23

STU Name	Waterbody ID	Current STU Status*	Current STU Type*	Unit Type	Location	PTSID	Contract Number	Installed Year	Consultant	System Responsibility*	Partnership*	Partnership Type*	OSM Project*	SCP Priority*	Notes	Edit Notes	Structure ID	Target Construction Date	SCP Group ID	TIP ID	Legacy ID
STU-CRAN-IC	RI0006017R-02		Pavement Removal		6ft reduction Garden Hills				BETA Group, Inc.	Cranston	Yes	Municipal	No		Reduce roadway widths by 6 ft						
STU-CRAN-IS-1	RI0006017R-02		Infiltration Swale		Infiltration Swale Brayton Avenue				BETA Group, Inc.	Cranston	Yes	Municipal	No		Potetntial Swale along Brayton Ave						
STU-CRAN-SF-1	RI0006017R-02		Sand Filter (Exfiltrating)		Mount View Intersection				BETA Group, Inc.	Cranston	Yes	Municipal	No		Potential sand filter at Mount View Road						
STU-CRAN-EDB-1	RI0006017R-02		Extended Detention Basin		Parking lot between Camelia and Church				BETA Group, Inc.	Cranston	Yes	Municipal	No		Detention Basin in parking lot						
STU-CRAN-IT1	RI0006017R-02		Infiltration Trench		Various Locations				BETA Group, Inc.	Cranston	Yes	Municipal	No		Sized to reduce 26.9 acres of impervious cover						
STU-CRAN-LB	RI0006017R-02		Leaching Basin		Various Locations				BETA Group, Inc.	Cranston	Yes	Municipal	No		Treatment credit for switching 1 CB to LB (78 Potential Locations)						

STU Name	Legacy ID	Structure ID	PTSID	Waterbody ID	STU Progress*	Progress Date	Consultant	STU Type*	STU Soil Type*	STU Storage Volume (cuft)
STU-CRAN-IC				RI0006017R-02	Desktop Review	8/21/2026	BETA Group, Inc.	Pavement Removal	Unknown	203745
STU-CRAN-SF-1				RI0006017R-02	Desktop Review	8/21/2026	BETA Group, Inc.	Sand Filter (Exfiltrating)	Loamy Sand (2.41 in/hr)	2475
STU-CRAN-EDB-1				RI0006017R-02	Desktop Review	8/21/2026	BETA Group, Inc.	Extended Detention Basin	Unknown	20000
STU-CRAN-IS-1				RI0006017R-02	Desktop Review	8/21/2026	BETA Group, Inc.	Infiltration Swale	Loamy Sand (2.41 in/hr)	6900
STU-CRAN-IT1				RI0006017R-02	Desktop Review	8/21/2026	BETA Group, Inc.	Infiltration Trench	Loamy Sand (2.41 in/hr)	14355

Fields from GIS			Ponding (Surface) Volume				Void (Subsurface) Volume					Total Storage Volume (ft^3)
STU Name	STU Type	Storage Volume (ft^3)	Length (ft)	Width (ft)	Depth (ft)	Notes	Length (ft)	Width (ft)	Depth (ft)	Void Space	Notes	
STU-CRAN-IC	Pavement Removal	203745										*203745*
STU-CRAN-SF-1	Sand Filter (Exfiltrating)	2475					25	75	4	0.33		*2475*
STU-CRAN-EDB-1	Extended Detention Basin	20000	1250	4	4							*20000*
STU-CRAN-IS-1	Infiltration Swale	6900	575	6	2	Bottom Width=2ft, 3:1 Side Slopes						*6900*
STU-CRAN-IT1	Infiltration Trench	14355					7250	3	2	0.33		*14355*

									STU Treatment Credit Results																							
STU Name	STU Type*	Total Catchment Area (sq. ft.)	Impervious Catchment Area (Sq. Ft.)	STU Storage Volume (ft^3)	STU Treatment Depth (in.)	STU Soil Type*	Pervious Catchment Area (sq. ft.)	Catchment % Impervious	P Load (lb/yr)	P Removal Credit (%)	P Reduction (lb/yr)	TSS Load (lb/yr)	TSS Removal Credit (%)	TSS Reduction (lb/yr)	Nitrogen Load (lb/yr)	Nitrogen Removal Credit (%)	Nitrogen Reduction (lb/yr)	Zinc Load (lb/yr)	Zinc Removal Credit (%)	Zinc Reduction (lb/yr)	Impervious Catchment Area (Acres)	TSS Reduction Factor	Phosphorus Reduction Factor	Runoff Factor	Flow Factor	Pervious Cover Factor	Effective IC Reduction (acres)	Runoff Reduction %	Runoff Reduction (ac-ft)
STU-CRAN-IC	Pavement Removal	203,745	203,745	203,745	12.0	Unknown	0	100%	0.0	100%	0.0	0	100%	0	0.0	100%	0.0	0.0	100%	0.0	4.7	1.0	1.0	1.0	1.0	1.00	4.7	100%	16.6
STU-CRAN-IS-1	Infiltration Swale	76,493	38,672	6,900	2.1	Loamy Sand (2.41 in/hr)	37821	51%	1.3	100%	1.3	570	100%	570	8.5	100%	8.5	1.1	100%	1.1	0.9	1.0	1.0	1.0	1.0	1.00	0.9	100%	3.4
STU-CRAN-SF-1	Sand Filter (Exfiltrating)	643,523	260,684	2,475	0.1	Loamy Sand (2.41 in/hr)	382839	41%	15.0	49%	7.4	2886	73%	2093	94.3	67%	62.7	4.4	84%	3.7	6.0	0.8	0.5	0.4	0.3	0.51	3.1	39%	9.1
STU-CRAN-EDB-1	Extended Detention Basin	1,375,942	681,360	20,000	0.4	Unknown	694582	50%	38.4	8%	3.1	7335	36%	2665	238.4	5%	12.0	11.4	68%	7.7	15.6	0.4	0.1	0.3	0.3	0.27	4.2	28%	16.8
STU-CRAN-IT1	Infiltration Trench	9,550,347	4,489,074	14,355	0.0	Loamy Sand (2.41 in/hr)	5061273	47%	254.2	13%	32.2	48657	19%	9336	1583.6	25%	395.0	75.2	31%	23.4	103.1	0.2	0.1	0.1	0.1	0.14	14.1	11%	43.5

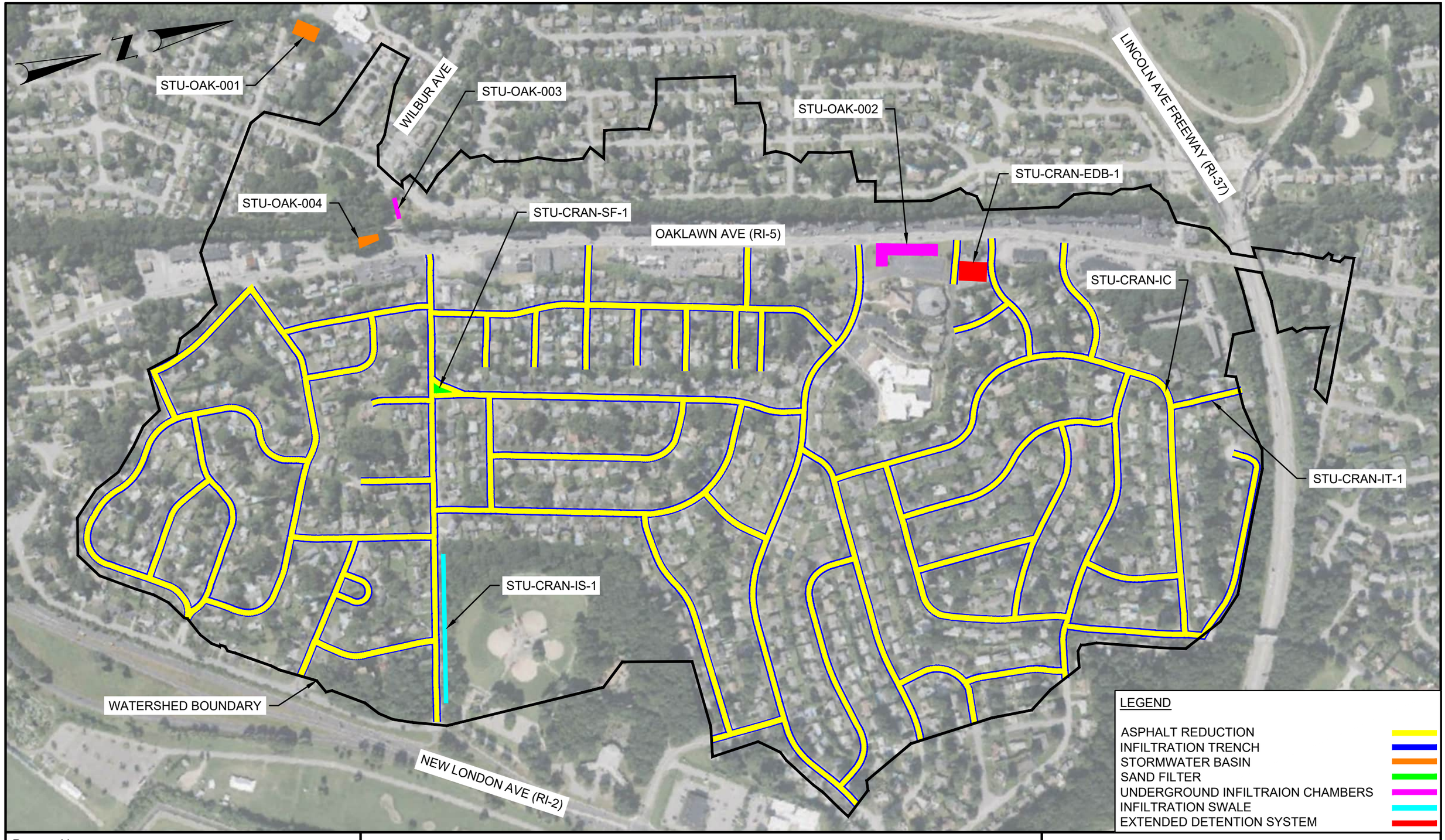
			Water Quality Results												
STU Name	STU Type*	Impervious Area (sq ft)	TP Load (lb/yr)	TP Reduction (%)	TP Reduction (lb/yr)	TN Load (lb/yr)	TN Reduction (%)	TN Reduction (lb/yr)	TSS Load (lb/yr)	TSS Reduction (%)	TSS Reduction (lb/yr)	Flow Factor	Runoff Factor	Effective IC Reduction (%)	Equivalent IC Removal Credit (ac)
STU-CRAN-LB	Leaching Basin	20000	1.1	#N/A		6.5	#N/A		202	#N/A		#N/A	#N/A	38%	0.2

Reference Data

STU Type	TSS Reduction (%)	TP Reduction (%)	TN Reduction (%)	Runoff Factor	Flow Factor	Pervious Cover Factor
Hydrodynamic Separator	25%	10%	0%	0	0	0.1
Jellyfish Filter	85%	50%	30%	0	0	0.4
MWS-Linear	85%	64%	45%	0	0	0.4
Stormceptor	75%	0%	0%	0	0	0.2

STU Name	Construction & Design						Annual Inspection and Maintenance Cost
	STU Type*	Effective IC Reduction (ac)	P Removal (lb/yr)	Estimated Cost[1]	Cost per IC Reduction Acre ($/ac)	Cost Per lb P Removed ($/lb P)	
STU-CRAN-IC	Pavement Removal	0.0	0.0	$1,680,000			
STU-CRAN-IS-1	Infiltration Swale	0.0	0.0	$96,600			$2,622
STU-CRAN-SF-1	Sand Filter (Exfiltrating)	0.0	0.0	$99,000			$3,092
STU-CRAN-EDB-1	Extended Detention Basin	0.0	0.0	$300,000			$2,622
STU-CRAN-IT1	Infiltration Trench	0.0	0.0	$2,153,300			$3,095

K.3 – STUs Figure



Prepared by:

BETA

Stormwater Planning for Oaklawn Avenue at Wilbur Avenue

STUs Figure

400 0 400 800

SCALE IN FEET: 1"=400'