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MARYLAND

I-495 & I-270 Managed Lanes Study

CA-5 (UNNAMED TRIBUTARY TO GREAT SENECA CREEK) STREAM RESTORATION MITIGATION

Semi-Final Design Report

April 2022

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U.S. Department of Transportation
Federal Highway Administration

MDOT MARYLAND DEPARTMENT OF TRANSPORTATION
STATE HIGHWAY ADMINISTRATION

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1. Executive Summary

The Unnamed Tributary to Great Seneca Creek (referred to in this report as CA-5) stream restoration design project is located in Montgomery County, Maryland within Quince Orchard Valley Neighborhood Park. The Park is owned by Maryland National Capital Park and Planning Commission (M-NCPPC). In order to mitigate for impacts to waters of the U.S. associated with the I-495 & I-270 Managed Lanes Study under the I-495 & I-270 Public-Private Partnership (P3) Program, the P3 Program identified stream restoration as partial compensatory mitigation for the project at site CA-5. This includes the restoration of the CA-5 Mainstem 1 (WC7), Mainstem 2 (WC6) and two tributaries (WC9 and WC2) to Mainstem 1. The overall stream restoration of this site is 3,868 LF. To assist in the assessment of erosion causes and potential restoration strategies, background information was collected on land use, geology, soils, and future development in the contributing watershed. According to GISHydro, 35%, approximately 56.5 acres, of the total watershed is impervious.

2. Introduction

Approximately 2,799 linear feet (LF) of CA-5, a first order stream, was evaluated, as well as 1,128 LF of tributaries to CA-5. The Project Area Vicinity/Location is shown in Figure 1 below. The purpose of the project will restore approximately 3,568 LF of CA-5, 3,079 LF of which will be used as partial compensatory mitigation for the I-495 & I-270 Managed Lanes Study. Credit will not be sought for the 179 LF of stream restoration within the PEPCO easement.

The CA-5 stream restoration site is located in the Seneca Creek 8-digit watershed (Maryland Department of the Environment (MDE) 8-Digit: 02140208). The CA-5 stream restoration site is also identified as a tributary of Great Seneca Creek under the Maryland Department of Natural Resources (MDNR) 12 Digit Watershed 021402080857. CA-5 is classified as use I-P (Water Contact Recreation, Protection of Aquatic Life, and Public Water Supply) by COMAR 26.08.02.02. Instream construction in use I streams is prohibited between March 1 and June 15, inclusive, during any year.

The data collection and assessment efforts were completed by Coastal Resources Inc. and included geologic and historic data collection, hydrologic analysis, visual site investigations, a stream bank sediment and soil study, geomorphic surveys and analysis, a channel stability assessment, wetland and forest delineations, and specimen tree surveys. These efforts have been performed to develop an understanding of the existing impacts within the stream corridor, current geomorphic processes, and causes of instability in order to develop potential restoration recommendations.

Specific objectives were satisfied in order to make appropriate recommendations including:

1. Determining the existing conditions of the watershed and stream system
2. Determining potential causes and impacts to the current state of the stream
3. Determining sediment sources, morphological conditions, and existing hydraulic parameters of the channel
4. Recommending a design option that promotes long-term stability and environmental benefits within the project reaches

These objectives were achieved through the following tasks:

1. Determining historic and more modern anthropogenic influences on the current system
2. Obtaining and evaluating available geomorphic and hydrologic/hydraulic information
3. Obtaining and analyzing site specific geomorphic data to characterize bankfull conditions, hydraulic parameters, bedload composition, stream type, and sediment competence
4. Developing a conceptual design approach based on conditions specific to the sediment supply and current state of the stream

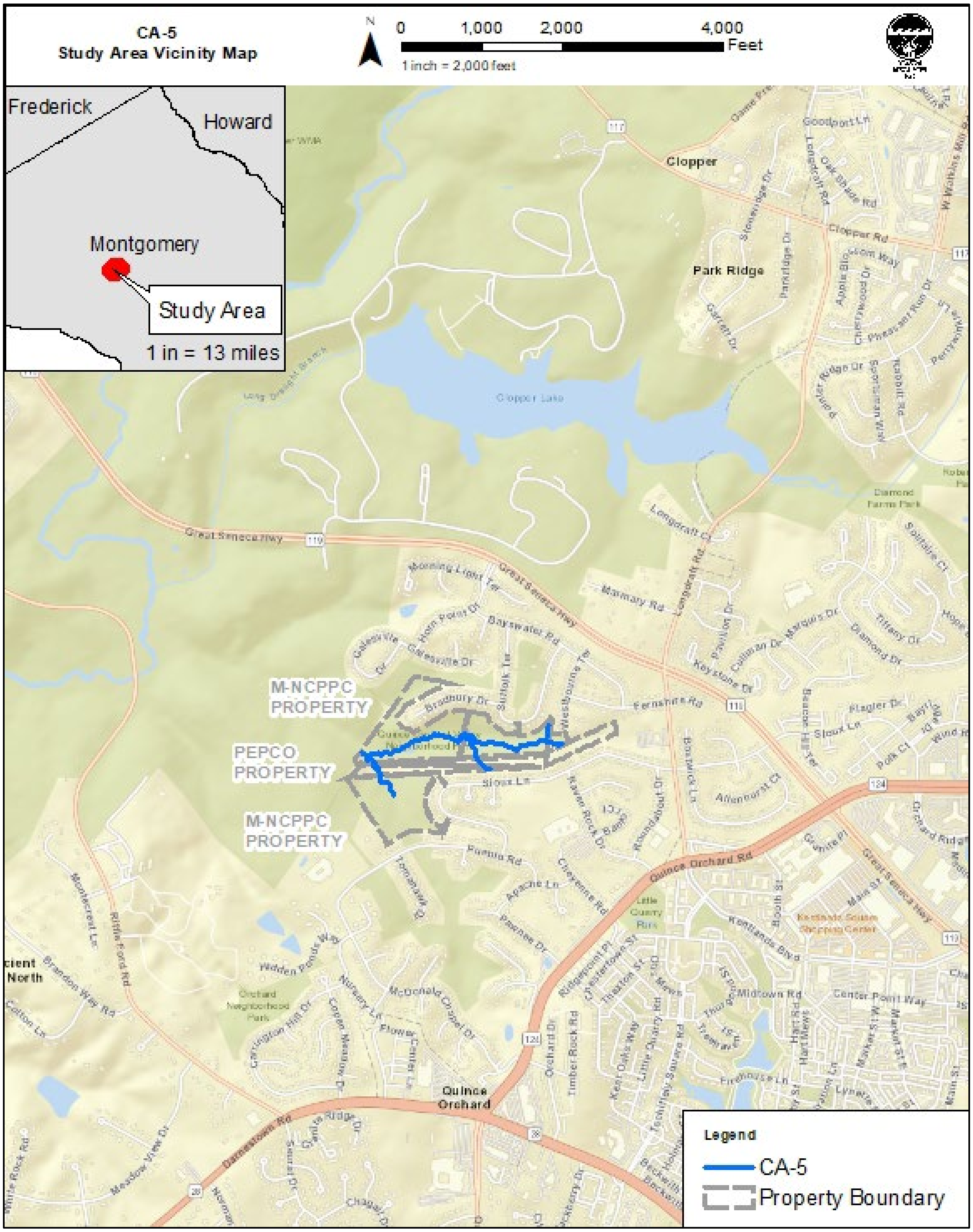

Figure 1. Study Area Vicinity Map

3. Watershed Context

In order to accurately understand the functions and uplift opportunities possible at the CA-5 stream restoration site a review of historical information and current conditions of the watershed and site were completed. To assist in the assessment of erosion causes and potential channel stability and ecological uplift, background information was collected on land use, geology, soils, and future development in the contributing watershed. Historical mapping and aerial photography were evaluated to determine the extents and duration of the major development seen within the watershed, which is the major cause of the serious erosion seen onsite.

3.1 Physiographic Region, Surface Geology, and Watershed Characteristics

The CA-5 stream restoration site is a tributary to Great Seneca Creek within the Seneca Creek Watershed which outlets to the Potomac River and eventually to the Chesapeake Bay. Great Seneca Creek is 21.5 miles long and travels through Montgomery County, Maryland. Great Seneca Creek begins in Damascus, roughly 40 miles west of Baltimore City. The river flows southwest through Germantown, Gaithersburg, and Seneca Creek State Park before converging with Little Seneca Creek to form Seneca Creek. The CA-5 stream restoration site joins Great Seneca Creek approximately 1,500 LF downstream of the study area, in Gaithersburg. The CA-5 stream restoration site is classified as use I-P (Water Contact Recreation, Protection of Aquatic Life, and Public Water Supply) by COMAR 26.08.02.02. Instream construction in use I streams is prohibited between March 1 and June 15, inclusive, during any year. The CA-5 stream restoration site watershed has approved TMDLs for Phosphorus (2010) and Total Suspended Solids (TSS; 2010 and 2011). In 2010 there was an approved Category 5 impairment for Chloride in the CA-5 stream restoration site watershed (2018 IR). The total drainage area to the downstream end of the CA-5 stream restoration site is 0.25 square miles (160 acres). The land use throughout the watershed varies, but the majority is mixed forest, medium-density residential, and institutional. Based on the 2010 Maryland Department of Planning (MDP) Land Use data (MDP, 2010) most common land use in the watershed is medium-density residential, which accounts for 76% of the total area. Forest land cover accounts for approximately 13% of the watershed, with industrial covering 9% and high-density residential the remaining 2%. Impervious area accounts for 35% of the watershed (GISHydro, 2010), which is much higher than the 15% threshold required for classification as an impaired urban watershed (Maryland Hydrology Panel, 2016).

The study reach is located in Quince Orchard Valley Neighborhood Park in Gaithersburg, MD between Suffolk Terrace and Sioux Lane. The watershed is characterized by runoff and sediment deposition from historical land clearing for agricultural production and current residential communities. With increased runoff due to land clearing and development the study reach receives increased flashier flows events. These events over time have caused severe erosion in portions of the site. Additionally, the runoff from the surrounding residential area brings nutrients and other pollution that ultimately decrease water quality and harm the aquatic species. The surrounding neighborhoods were constructed in the 1970's and 1980's prior to the adaptation of SWM requirements in Maryland.

The study reach is located within the Piedmont physiographic province of middle Montgomery County. The Piedmont physiographic province is comprised of mostly clay covered by a thin layer of rocky surface soil (MDP, 2010). The overall drainage area to the site is characterized predominately by Glenelg and Gaila silt loams, both well drained soils, and Travilah silt loam, a somewhat poorly drained soil. The study watershed is composed of B, C, and C/D soils (USDA, 2017).

3.2 Historical/Modern Impacts and Potential Sources of Stream Instability

In order to develop the proper restoration design for the CA-5 stream restoration site, the causes of current instabilities were assessed. Because no two streams or rivers are alike and each project site presents a unique set of circumstances, an understanding of past and modern-day impacts and influences on a stream or river from a combination of field observations, historical documentation, and multidisciplinary review and analysis is integral to a stable solution. A historical perspective is a particularly important design element as many rivers today are still adjusting to the events of the past (Rosgen, 1996).

The study area is located on the western border of Gaithersburg. The City of Gaithersburg started as a small agriculture settlement in 1850 known as Log Town, officially becoming Gaithersburg in 1878. Due to the Baltimore and Ohio Railroad coming to Gaithersburg in 1873 the agriculture business was able to expand, and a large summer community came to the area causing a swift increase in development. The earliest available aerial imagery of the study area from 1951 shows most of the surrounding land as still being used for agricultural purposes (Figure 2). Starting around the 1970s, urban sprawl began and the rapid development of the agricultural lands into residential communities can be seen (Figure 3 and 4). By 1988, major roads such as MD 119 and MD 124 were constructed (Figure 5). Since 1988, the immediate area around the study reach has remained mostly unchanged (Figure 6).

Figure 2. 1951 Historic Aerial of Montgomery County, MD (Montgomery County, Maryland Interactive Map)

Figure 3. 1970 Historic Aerial of Montgomery County, MD (Montgomery County, Maryland Interactive Map)

Figure 4. 1979 Historic Aerial of Montgomery County, MD (Montgomery County, Maryland Interactive Map)

Figure 5. 1988 Historic Aerial of Montgomery County, MD (Montgomery County, Maryland Interactive Map)

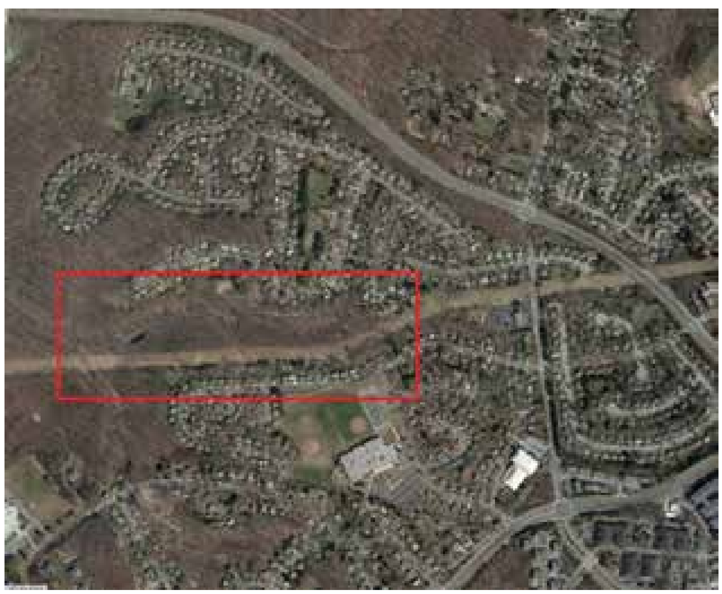

Figure 6. 2017 Historic Aerial of Montgomery County, MD (Montgomery County, Maryland Interactive Map)

3.3 Biological Site Data

Maryland Stream Waders is a statewide volunteer stream monitoring program that was started in 2000 and is managed by Maryland Department of Natural Resources (DNR). This program is the volunteer component of the Maryland Biological Stream Survey (MBSS) and is meant to fill the gaps left in the watershed areas not sampled by MBSS. Stream Waders site 857-5-2001 is located 0.31 miles downstream of the confluence of the CA-5 stream restoration site within a tributary to Great Seneca Creek. In 2001, this site received a Benthic Index of Biotic Integrity (BIBI) Rating of Poor (1.57). Twelve different taxa of macroinvertebrates were found at this site, including three EPT taxa. EPT are the generally intolerant insect orders of Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies). This value summarizes taxa richness with macroinvertebrates that are considered to be sensitive to pollution and therefore, a lower number of taxa within the sample suggests poor water quality conditions (Stribling, *et al.* 1998).

There are three MBSS monitoring sites along different tributaries within approximately a two mile radius from the CA-5 stream restoration site. In order to report biological data that could closely compare to what may be found in the study reach, a site with a similar watershed size, land use, and soils was selected.

MBSS site SENE-101-R-2001 is located along an unnamed tributary to Great Seneca Creek, about two miles northwest of CA-5 stream restoration site. The drainage area for this site is 0.15 square miles. Site SENE-101-R-2001 received a Fish Index of Biotic Integrity (FIBI) score of Poor (1.3). The sample included 68 Eastern Blacknose Daces (*Rhinichthys atratulus*), a species tolerant to pollution. No other fish species was collected. SENE-101-R-2001 also received a Poor BIBI rating (2.0).

Physical habitat was assessed at this site during the 2001 study using MBSS protocols, which included visual assessments of various parameters. Aquatic habitat assessment methods are based on the Environmental Protection Agency's Rapid Bioassessment Protocol (RBP) (Barbour *et al.* 1999) and modified for use in Maryland streams. This protocol assigns a value out of 20 to each parameter. At site SENE-101-R-2001 instream habitat received a score of 9 (marginal), epifaunal substrate was scored at 14 (suboptimal), velocity/depth diversity a 6 (marginal), pool quality a 4 (poor), and riffle run quality a 7 (marginal). Shading for this site was 92% with an embeddedness of 10%.

4. Site Protection Instrument

Pursuant to the Maryland Nontidal Wetlands Protection Act Rules (COMAR 26.23.04), and the Federal Clean Water Act, plus its implementing regulations at 33 CFR Part 332.7(a), the CA-5 stream restoration site will be protected to ensure conservation in perpetuity. The majority of the property for CA-5 stream restoration site is owned by M-NCPPC. M-NCPPC and MDOT SHA will develop a long-term agreement that will allow MDOT SHA future access to monitor and maintain the restored stream segment. The process of ensuring protection of the site is underway and described below. A small portion of the project area is on property owned by Potomac Electric Power Company (PEPCO), under a current utility easement. Further coordination between MDOT SHA and PEPCO will determine the details of how specific protection and access will occur for that portion of the restoration site, within the current easements.

M-NCPPC

Montgomery County M-NCPPC mitigation sites are already considered protected by park policies and M-NCPPC does not encumber properties with deed restrictions on parkland mitigation sites. M-NCPPC mitigation sites will be protected in accordance with M-NCPPC Montgomery County's integrated natural resource management plan, Natural Resource Management Plan for Natural Areas in M-NCPPC Parkland in Montgomery County, Maryland. This plan published in February 2013 requires preservation and conservation of natural areas and wetlands like the proposed mitigation sites. This protection has been successfully used and accepted by USACE and MDE to preserve M-NCPPC mitigation sites on past projects.

The proposed mitigation sites would be considered environmentally sensitive areas in Natural Resource Management Plan for Natural Areas in M-NCPPC Parkland in Montgomery County, Maryland and are protected park resources. The following goals, visions and legal protection are identified in the plan.

1. M-NCPPC Montgomery County Mission: Protect and interpret our valuable natural and cultural resources; balance the demand for recreation with the need for conservation; offer a variety of enjoyable recreational activities that encourage healthy lifestyles; and provide clean, safe, and accessible places for leisure-time activities.

2. Goal 11 of the Vision 2030 Strategic Plan: Inventory, conserve, and enhance ecologically healthy and biologically diverse natural areas with a focus on Park Best Natural Areas, Biodiversity Areas, and Environmentally Sensitive Areas as defined in the Land Preservation, Parks, and Recreation Plan (M-NCPPC, 2005)

3. Environmental Guidelines for Management and Development in Montgomery County Parks: "…the Montgomery County General Plan and local area master plans articulate County-wide and planning area-wide goals, objectives, principles, and policies to protect sensitive areas from the adverse effects of development, as required by the Annotated Code of Maryland Article 66B

5. Detailed Site Assessments

As part of the site assessments, the streams were traversed from upstream to downstream under low-flow conditions. CA-5 stream restoration site is classified use I-P waters. Significant stream and valley features are described below. The site assessments included geomorphic assessment, and a bank erosion analysis. The geomorphic assessment of the study reach was used to determine existing hydraulic parameters and included a detailed longitudinal profile and cross section survey, pebble counts, and a subpavement sample. The bank erosion analysis was performed, and the results are in **Appendix B**.

5.1 Reach Description

The study area on the CA-5 stream restoration site extends from where stream enters the eastern edge of M-NCPPC property in Quince Orchard Terrace Neighborhood Park to the confluence of the CA-5 stream restoration site and includes another unnamed tributary to Great Seneca Creek, near the western edge of M-NCPPC property. A map of the study area is in Figure 7 below. Photo documentation of the study area can be found in **Appendix A**.

The CA-5 stream restoration site, a perennial tributary Mainstem 1 (WC7) to Great Seneca Creek, was split into Reaches 1, 2, 3, and 4. Two tributaries were also evaluated in addition to a larger unnamed tributary at the bottom of the study area that we refer to as Mainstem 2/Reach 5. Reach 1 extends from the M-NCPPC property line downstream to the confluence with the first tributary. Reach 2 extends from the first tributary to a significant change in valley slope where the valley gets steeper, and the stream drops over a bedrock control and gets significantly more incised. Reach 3 extends from the bedrock control to just upstream of the confluence with the second tributary, where the channel sinuosity increases significantly, and the slope decreases significantly. Reach 4 extends to the end of the study reach at the confluence with the Mainstem 2. The first tributary begins at the outlet of a 36" RCP and extends to the confluence Reach 1/2. The second tributary begins at the southern boundary of M-NCPPC property and extends to the confluence with Reach 4. The Mainstem 2/Reach 5 tributary begins approximately 50 linear feet downstream of an existing stormwater facility where previous stream restoration efforts have left off. The work extends to the confluence of Reach 4 of the tributary to Great Seneca Creek.

The overall slope of the channel is 2.1% however, the existing longitudinal profile is concave. There are steep slopes in reach 1 that slowly get less and less steep as you go downstream. The varying slopes appear to be the result of historic downcutting that has reached an equilibrium in the upper reaches when the stream has cut down to boulder and bedrock. The three upstream reaches have higher slopes and are able to effectively move sediment from the eroding banks through the reaches. The bank heights are lowest in the upper reaches, and highest in Reach 3 where the greatest downcutting has occurred. The slope flattens out significantly at the top of Reach 4, where addition excess sediment from Tributary 2 is also added to the stream. The change in slope along with the additional bedload has caused significant instability within this area.

Reach 1 is characterized by bedrock control. A large bedrock outcrop is exposed for the majority of the reach with the channel flowing over and between the bedrock. Large boulders and chunks of bedrock have also washed into the channel. The reach is fairly stable due to the bedrock control, with small patches of erosion on some banks where bare soil is exposed. There are mature trees on both banks. The slope of Reach 1 is 4.9%, with a moderate width/depth ratio and moderate sinuosity that led to a Rosgen stream classification of a B4a channel. Due to the bedrock control and stability of this reach, it will likely not be included in the restoration extents.

Reach 2 begins downstream of the first tributary and is characterized by low, eroded banks with a few tortuous meanders. The reach has grade controls throughout of exposed bedrock and exposed sewer casings. It is unclear whether any or all of the sewer casings contain active pipes. Due to these grade controls, there are multiple long backwatered pools throughout the reach. The upstream end of the reach contains large boulders washed out from the bedrock of Reach 1, as well as riprap placed across a pedestrian bridge that crosses the reach just downstream of the tributary. The rest of the reach is mostly gravel and sand with some larger cobbles. A significant headcut from a wetland seep on the right floodplain has created an eroded channel that joins Reach 2 near the downstream end. Just downstream of where the eroded channel joins Reach 2, there is a 24" RCP outfall on the right bank. Reach 2 ends at a significant change in valley slope. At the grade break in valley slope, there is a bedrock outcrop in the channel as well as sewer casing and placed riprap protecting the sewer casing. The channel drops approximately 3 feet over the exposed bedrock and sewer protection. The slope of Reach 2 is 2.6%, with moderate entrenchment, moderate width/depth ratio, and moderate sinuosity that led to a Rosgen stream classification of a B4 channel.

Reach 3 begins downstream of the exposed bedrock and sewer protection and is characterized by higher, more severely eroded banks. The slope and sinuosity remain fairly consistent from Reach 2 to Reach 3, but the entrenchment increases significantly in Reach 3. There is less bedrock control through Reach 3 and no exposed sewer crossings, leading to a more consistent riffle/pool sequence through this reach. Reach 3 contains mostly gravel and sand, with some larger cobble deposits that appear to be coming from a lens of loose material exposed in the eroded banks. Due to the high eroded banks, there is an increased presence of down trees and woody debris in the channel through this reach. Reach 3 ends where the valley slope flattens out again, the banks get slightly lower, and the channel sinuosity increase. The slope of Reach 3 is 2.3%, with a high entrenchment ratio and moderate to high width/depth ratio that led to an F4b Rosgen stream classification.

Reach 4 begins just upstream of the second tributary, where the valley and channel slopes flatten out and the channel increases in sinuosity. The reach has several tortuous meander bends with highly eroded banks and large deposits of sediment on the inner meander bend. It appears that the majority of sediment from the wetland headcut at Reach 2, the loose bank material in Reach 3, and the erosion and headcutting in the second tributary are settling out in Reach 4. There does not appear to be a significant source of sediment supply upstream of the study area, so most of the sediment load appears to be coming from within the site. Reach 4 also has down trees and woody debris throughout the reach due to the eroded outer meander bends. The reach is mostly sand and gravel with some cobble and bedrock outcrops. There is one sewer crossing at the upstream end of Reach 4, but no casing is exposed. A 15” RCP outlets on the right bank of Reach 4 approximately halfway down the reach. On the left floodplain near the 15” RCP there is an old man-made pond. No records could be found of the pond as a stormwater facility, so it may be an old farm pond. The pond outlets to the channel through a rock weir. Reach 4 ends where CA-5 joins with the Mainstem 2, another unnamed tributary to Great Seneca Creek. The slope of Reach 4 is 1.7%, with a moderate entrenchment ratio, moderate width/depth ratio, and moderate sinuosity that led to a B4c Rosgen stream classification.

Tributary 1 (Trib 1-WC2), an ephemeral and perennial tributary to the tributary to Great Seneca Creek, begins at the outfall of a 36” RCP and extends to the confluence with CA-5. There is a hillside seep approximately halfway down the tributary that drains into the tributary channel and results in a constant flow in the downstream end of the tributary. A pedestrian bridge crosses the downstream end of the tributary. and the channel is piped through a 36” RCP. The bed of the tributary is mostly sand, gravel, and cobble. The slope of Trib 1 is 3.5%.

Tributary 2 (Trib 2- WC9), an ephemeral and intermittent tributary to the tributary to Great Seneca Creek, begins at the southern boundary of M-NCPPC property and extends to the confluence with CA-5. The upstream end of the tributary flows over exposed bedrock before transitioning to sand, gravel, and cobble. Approximately halfway down the channel there is a large headcut over the roots of a tree where the channel bed drops approximately 4 feet. Downstream of the headcut the banks are eroded and there is an exposed sewer pipe. A pedestrian footpath crosses the channel at the upstream side. The slope of Trib 2 is 6.6%. Evaluation of the tributary did not extend into the adjacent Pepco property; however, an access easement was requested in order to evaluate the need for continuing any restoration further upstream.

The Mainstem 2 /Reach 5 (WC6) is an additional unnamed perennial tributary to Mainstem 1 (WC7) that contains a drainage area of approximately 0.43 square miles and contains perennial flow. This section contains approximately 766 linear feet of existing stream. A stormwater management (SWM) facility is located upstream of the proposed work area. Tight meanders are noted throughout the reach with undercut banks and active erosion along the outer meander banks. Localized bank erosion appears to be the main source of fine sediments that are minimal throughout the reach. Significant sediment deposition is noted upstream of the SWM facility that is preventing the transport of sediment downstream. Additionally, the SWM facility significantly reduces the storm discharges in the tributary. The tributary begins in a forested area before traversing through a cleared Right of Way owned by Potomac Electric Power Company (PEPCO.) The tributary enters a wooded corridor before joining Reach 4 of Mainstem 1 tributary. Woody material is present in the channel, particularly through the PEPCO ROW where existing brush along the streambanks is extending into the channel creating debris jams. Mainstem 2 tributary contains short steep riffles that average a length of 11.4 linear feet and a slope of 4.3%. The overall channel slope is 0.97%. The Mainstem 2 has a moderate entrenchment ratio, a low width to depth ratio, and moderate sinuosity that led to a B4c Rosgen stream classification.

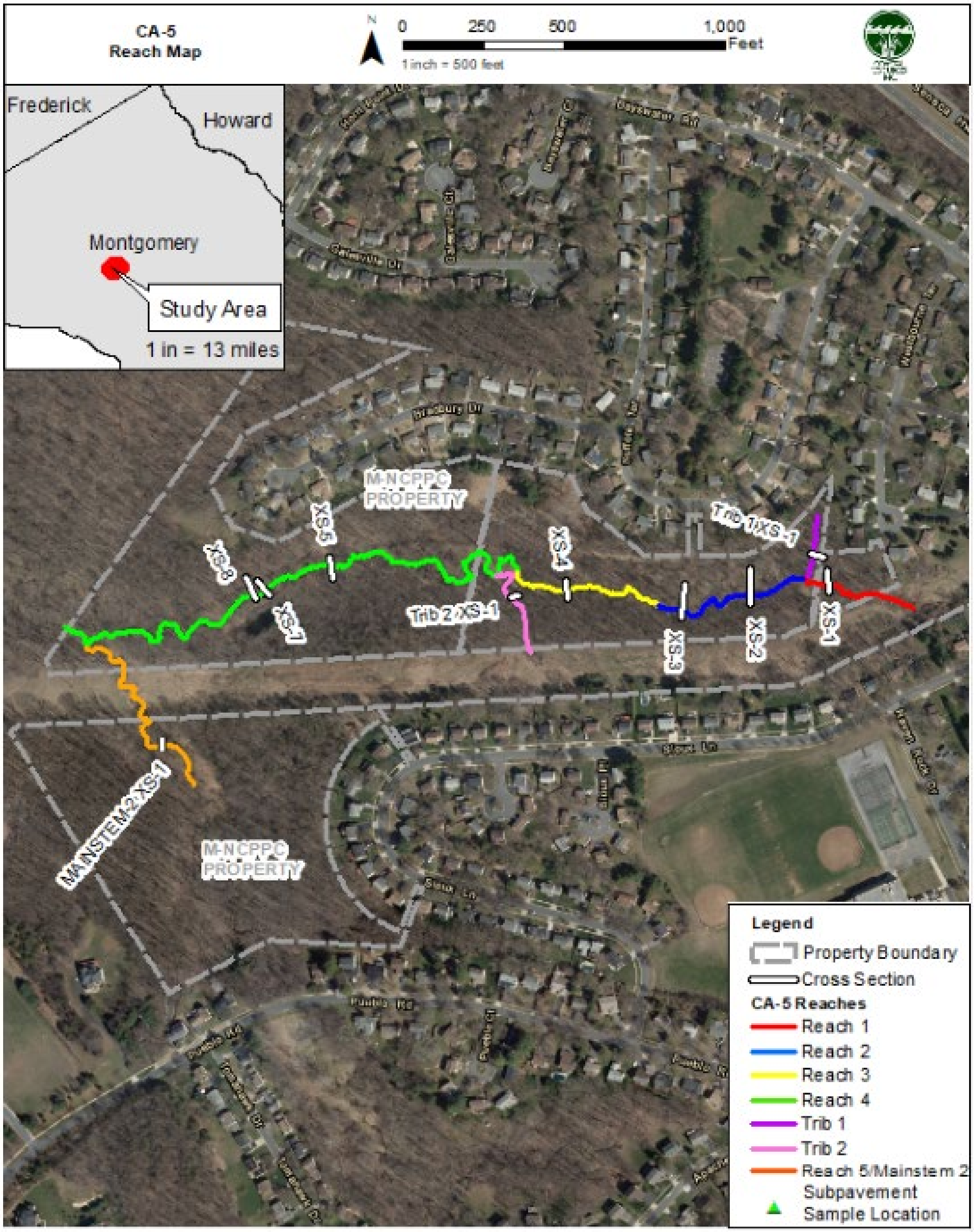

Figure 7. Reach Map

5.2 Watershed Hydrology Study

The CA-5 watershed is located within the Piedmont Physiographic province (MGS, 2008). Of the total 161.5-acre watershed, 35% is impervious surfaces (GISHydro, 2010) and 13.9% is covered in deciduous forest based on the 2010 Maryland Department of Planning (MDP) Land Use data (MDP, 2010) in GISHydro. The rest of the watershed is mostly medium density residential with some high density residential and institutional. The stream bisects two medium density residential neighborhoods, one of which includes a middle school campus.

The soils in the watershed are mostly Hydrologic Soil Group (HSG) 'B' (69%), then 'C' (27%), then 'D' (4%) with no HSG 'A' (USDA, 2017).

The basic inputs required to model the peak runoff hydrograph to the outlet of the watershed include drainage area, runoff curve number, and time of concentration. The drainage area was roughly delineated using StreamStats and then manually edited using Montgomery County 2-foot topographic data and field verifications. The time of concentration was calculated using the velocity method in Win TR-55 version 1.00.10 for Small Watershed Hydrology. The runoff curve number (RCN) was calculated using the USDA NRCS soil data (USDA, 2017) and the land use from aerial data in TR-55. Watershed characteristics are presented in **Table 1** below.

Table 1: Watershed Characteristics

Study Area	Drainage Area, acres	Runoff Curve Number	Time of concentration, hr.
Upper Mainstem 1	66.1	79	0.15
Tributary 1	17.9	77	0.375
Tributary 2	23.0	80	0.374
Storm Drain 1	18	75	0.282
Storm Drain 2	3.65	75	0.15
Pond on Main Stem 1	1.81	69	0.1
Residual	32.9	75	0.285
Mainstem 1 @ below SD 2	161.5	79	0.298
Mainstem 2 to SWM Pond	225.1	77	0.369
Mainstem 2 Below Pond	37.3	70	0.230
Mainstem 2 @ Mainstem 1	262.4	70	0.425

The National Oceanic and Atmospheric Administration (NOAA) Atlas-14 was used to obtain the rainfall amounts (Bonnin, et al., 2006). The rainfall depths and distributions were obtained from GISHydro. **Table 2** shows the rainfall depths that were used for each return period and rainfall distribution. The TR-55 outputs and watershed maps are included in **Appendix D.**

Table 2: Rainfall Depths

Return period (years)	Rainfall Distribution (hr)	Rainfall Depth (in.)
1	6	1.81
2	6	2.19
10	12	3.97
100	24	8.88 (90%)

Table 3 shows the characteristics for the two mainstem reaches of the CA-5 stream restoration site that were used to determine the Fixed Region Regression (FRR) equation discharges (Thomas, 2019).

Table 3: Regression Equation Characteristics: Mainstem 1

Reach	Drainage Area, sq.mi. (acres)	Impervious Area, %
Mainstem 1	0.252 (161.5)	35
Mainstem 2	0.41 (262.4)	33.8

TR20 was used to calibrate the watershed. Mainstem 1 was treated as a single watershed in TR20. Mainstem 2 was also treated as a single watershed and the stormwater facility was not incorporated for calibration purposes and in accordance with the Application of Hydrologic Methods in Maryland (2020, Hydrology Panel). Hydrologic Engineering Center's Hydrologic Modeling System (HEC-HMS) was used to model the watershed to create flow hydrographs for HEC-RAS 2D. A comparison is shown here to show that the modeling methods produce similar results. The FRR estimates, the TR20 flows and the HEC-HMS flows for Mainstem 1 watershed are presented in **Table 4**, and the results for Mainstem 2 are presented in 4. See **Appendix D** for the program outputs.

Table 4: Hydrologic Analysis Results: Mainstem 1

Recurrence Interval (years)	1	1.25	1.5	2	10	100
Fixed region Regression Equation Q, cfs (+1 Stand. Dev.)	-	68 (104)	89 (132)	120 (173)	341 (448)	914 (1216)
TR-20 Q, cfs	89			143	354	916
HEC-HMS Q, cfs	90			144	355	920

Table 5: Hydrologic Analysis Results: Mainstem 2

Recurrence Interval (years)	1	1.25	1.5	2	10	100
Fixed region Regression Equation Q, cfs (+1 Stand. Dev.)	-	94 (144)	121 (180)	164 (235)	455 (599)	1207 (1605)
TR-20 Q Without SWM Pond, cfs	97			164	451	1226
HEC-HMS without SWM Pond Q, cfs	98			166	455	1239

The TR-20 and HEC-HMS flows for Mainstem 1 are very close in values and within the Fixed Region Regression Equation calibration envelope of between the estimate and plus one standard prediction interval. The TR-20 and HEC-HMS flows for Mainstem 2 are slightly lower than the calibration envelope for the 10-year storm, but within the calibration envelope for the 2- and 100-year storms. In order to calibrate the 100-year storm for both mainstems, the 90% confidence interval for the 100-year storm rainfall depth was used and the TR-20 built-in NOAA C rainfall distribution was used rather than the GISHydro derived rainfall distribution.

After calibrating the overall watershed model, a hydrologic model using the same curve numbers and rainfall durations was developed in HEC-HMS. This model incorporated the stormwater management pond in Mainstem 2 and delineated watersheds at different outfall points for Mainstem 1. The Mainstem 1 watershed was split into six subwatersheds and the Mainstem 2 was split into two watersheds. See **Appendix D** for the drainage area maps of each watershed. Mainstem 2 was routed through an existing stormwater facility that has a weir outlet. As-builts were obtained to develop the stage storage discharge for the facility. A rainfall depth of 2.65 inches was used for the 2-year 6-hour duration return period. This differs from the calibration rainfall depth of 2.19 inches but can be considered conservative in the evaluation of the stream shears and velocities. See **Table 6** for the 2-year return peak flows at different input points. See **Appendix D** for the program output.

Table 6: Peak Discharges for Different Locations in the Stream Network

Study Area	2-year Return Period Peak Discharge, cfs
Upper Mainstem 1	115
Tributary 1	19.1
Tributary 2	30.0
Storm Drain 1	18.9
Storm Drain 2	4.9
Pond on Main Stem 1	1.63
Residual	34.2
Mainstem 1 @ below SD 2	198.1
Mainstem 2 to SWM Pond	241.4
Mainstem 2 Below Pond	28.3
Mainstem 2 @ Mainstem 1	85.4

5.3 Design Discharge

The proposed design discharge for the site is based on the field-measured bankfull dimensions of the representative design riffle (Cross Section 2) of Mainstem 1 and bankfull indicators observed throughout the reach in the longitudinal profile. Cross section 2 was chosen as the representative cross section because it was observed to be the most stable riffle throughout the project area, had relatively low banks, and was classified as a Rosgen type B channel which is the designed stream type. The field determined bankfull discharge fits within the TR-55 and FRR estimates; however, as seen in **Table 6** the TR-55 estimates, and the field observed bankfull discharge are higher than the estimates from U.S. Fish & Wildlife Service (USFWS) Regional curve for the Piedmont (McCandless, 2002). It is assumed that this is because the reaches used to create this regional curve generally had much larger drainage areas, and of the sites that had a drainage area less than 10 square miles only one site had a comparable percent forested in the drainage area. A summary of the discharges is shown in **Table 7.** A design discharge slightly lower than the field observed bankfull discharge for the representative riffle cross section was chosen in order to ensure that storm flows regularly access the floodplain.

Table 7: Design Discharge Comparison

Location	Field Observed Bankfull Q (cfs)	USFWS Piedmont Regional Curve Q	HEC-HMS Q 1-year return period	Fixed Region Regression Equation Q, 1.25-year return period	Urban Piedmont curve, Gemmill	Design Discharge, Q
		(cfs)	(cfs)	(cfs)	(cfs)	(cfs)
Mainstem 1	64.3	29.66	63.6*	57.97	76.74	60
Mainstem 2	47.3	44.52	9.3**	94	N/A	45

*Flow observed below Trib 2 which more accurately reflects the in-stream flow
**Flow below SWM Pond; 2-year return period flow is 85 cfs

Proposed Mainstem 2 is designed to a smaller discharge to more accurately reflect the flows downstream of the SWM Pond.

5.4 Geomorphic Assessment Data

5.4.1 Channel Planform and Morphology

Channel Planform and Morphology

An analysis of channel planform included sinuosity and radius of curvature measurements. Sinuosity was calculated by dividing stream length by valley length. Stream length was measured using the longitudinal profile stationing while the valley length was measured using Environmental Systems Research Institute (ESRI)'s ArcMap version 10.5 (ESRI, 2016). Sinuosity is summarized in **Table 8**. Reach 1 has a sinuosity of 1.26, Reach 2 has a sinuosity of 1.17, Reach 3 has a sinuosity of 1.04 and Reach 4 has a sinuosity of 1.33. Mainstem 2 tributary has a sinuosity of 1.23.

Table 8: Sinuosity

	Mainstem 1				Mainstem 2
	Reach 1	Reach 2	Reach 3	Reach 4	Reach 5
Channel Length (ft)	297.5	556.2	488	1829	747
Valley Length (ft)	236	476	470	1353	604
Reach Slope (%)	4.9	2.6	2.3	1.7	1.0
Sinuosity	1.26	1.17	1.04	1.33	1.23

Radius of curvature was measured for several bends on the study reaches using ESRI's ArcMap version 10.5 (ESRI, 2016). The mean radius of curvature measurements for Reach 1, 2, 3, and 4 were 80 feet, 55 feet, 83 feet, and 47 feet, respectively. The mean radius of curvature for the mainstem 2 is 13.8. Radius of curvature can be expressed as a dimensionless ratio by dividing the radius measurement by bankfull width. A summary of the ratio of radius of curvature to the bankfull width by reach is summarized in T**able 9**.

Table 9: Radius of Curvature

Reach	Number of Bends	Rc/Wbkf		
		Mean	Minimum	Maximum
Mainstem 1/Reach 1	3	5.87	2.51	9.12
Mainstem 1/Reach 2	8	3.60	1.41	8.58
Mainstem 1/Reach 3	5	5.11	1.65	9.60
Mainstem 1/Reach 4	23	2.20	0.75	4.99
Mainstem 2/Reach 5	17	1.23	0.89	1.90

Reach Slopes

Water surface slopes for the study reaches were calculated from head of riffle to head of riffle. The data is summarized in **Table 10**. The overall water surface slope of the site was 2.1%. In existing conditions, the stream has a concave slope, with steeper slopes at the top of the reach and shallower slopes near the confluence. This appears to be due to downcutting that occurred from downstream to upstream but was hindered by the occurrence of large boulders and bedrock in the middle and upper sections of the reach.

The Mainstem 2 maintains an overall slope of 0.97 %. The tributary is slightly steeper at the beginning and loses slope just before the confluence.

Table 10: Reach Slopes

Reach	Slope (%)
Overall	2.1
Mainstem 1/Reach 1	4.5
Mainstem 1/Reach 2	2.4
Mainstem 1/Reach 3	2.3
Mainstem 1/Reach 4	1.5
Mainstem 2/Reach 5	1.0

Riffle Lengths and Slopes

A summary of the riffle lengths and slopes is shown in **Table 11**. Of the surveyed longitudinal profile of mainstem 1, (3,144 LF), approximately 31% was riffle. The average riffle length was 12.5 feet, and the average riffle slope was 6.3%. The mainstem 2 tributary (747 LF) contains approximately 20% riffles. The average riffle length was 11.4 feet, and the average slope was 4.3%.

Table 11: Summary of Riffle Lengths and Slopes

Mainstem 1/Reach 1	Length (ft)	Ratio	Slope (%)
Mean	10.5	0.73	9.4
Minimum	2.0	0.14	2.2
Maximum	21.7	1.52	32.0

Mainstem 1/Reach 2	Length (ft)	Ratio	Slope (%)
Mean	11.0	0.75	4.6
Minimum	1.0	0.07	0.85
Maximum	29.7	2.03	10.5

Mainstem 1/Reach 3	Length (ft)	Ratio	Slope (%)
Mean	14.8	0.92	6.1
Minimum	2.0	0.12	1.3
Maximum	55.0	3.42	15.3

Mainstem 1/Reach 4	Length (ft)	Ratio	Slope (%)
Mean	13.8	0.64	5.1
Minimum	1.0	0.05	1.5
Maximum	62.3	2.87	24.0

Mainstem 2/Reach 5	Length (ft)	Ratio	Slope (%)
Mean	11.4	0.8	4.3
Minimum	3.0	0.3	1.5
Maximum	41.0	3.0	16.0

Pool Lengths, Depths, Slopes, and Spacing

A summary of the pool lengths, depths, slopes, and pool-to-pool spacing is shown in 12. Of the surveyed longitudinal profile for mainstem 1 (3,144 LF), approximately 50% was pool. The average pool length was 9.1 feet, the average maximum depth was 0.8 feet, and the average slope was 0.2%. Of the surveyed longitudinal profile (747 LF), approximately 76% were pools. The average pool length was 44.1 feet, the average depth was 2.1 feet, and the average slope was 0.42%. Pool-to-pool spacing was measured between the same locations in each pool starting at the maximum depth of pool. Compound pools, two pools that do not have a riffle in between, were treated as one pool for spacing measurements.

Table 12: Summary of Pool Lengths, Depths, Slopes, and Pool to Pool Spacing

Mainstem 1/Reach 1	Length (ft)	Ratio	Maximum Depth (ft)	Slope (%)	Pool-to-Pool Spacing (ft)
Mean	7.0	0.49	0.7	0.0	20.4
Minimum	4.0	0.28	0.4	0.0	6.2
Maximum	13.2	0.93	1.1	4.8	80.0

Mainstem 1/Reach 2	Length (ft)	Ratio	Maximum Depth (ft)	Slope (%)	Pool-to-Pool Spacing (ft)
Mean	10.8	0.74	0.7	0.6	17.5
Minimum	1.0	0.07	0.3	0.0	5.3
Maximum	28.0	1.92	1.9	4.6	49

Mainstem 1/Reach 3	Length (ft)	Ratio	Maximum Depth (ft)	Slope (%)	Pool-to-Pool Spacing (ft)
Mean	11.5	0.71	0.6	0.0	25.2
Minimum	4.0	0.25	0.3	0.0	5.1
Maximum	25	1.55	1.78	1.4	79.6

Mainstem 1/Reach 4	Length (ft)	Ratio	Maximum Depth (ft)	Slope (%)	Pool-to-Pool Spacing (ft)
Mean	17.2	0.79	1.0	0.0	33.6
Minimum	3.0	0.14	0.2	0.0	7.5
Maximum	39.5	1.82	2.5	1.0	91

Mainstem 2/Reach 5	Length (ft)	Ratio	Maximum Depth (ft)	Slope (%)	Pool-to-Pool Spacing (ft)
Mean	44.1	3.2	1.0	0.42	52.2
Minimum	19.0	1.4	2.1	0.0	1.7
Maximum	80.5	5.9	3.3	2.4	6.6

5.4.2 Bed Material Characterization

Pebble counts and a subpavement sample were collected to determine the particle size distribution of the reaches. Pebble counts were performed at each riffle cross section. Two subpavement samples were collected from the channel at cross section 2 and cross section 6 and wet sieved. Subpavement samples were collected instead of bar samples because there were not any representative point bars found at the site. The pebble count and sieve analysis results are summarized in **Table 13** and **Table 14**.

Cross sections 1-6 were riffles, while cross section 7 was a pool. Other than cross section 1, All the riffle cross sections had similar D50s of medium to coarse gravel (ranging from 14 mm-20 mm) and consisted almost entirely of gravel and sand, with some cobble present. Cross section 1 was located in Reach 1 where there was much larger material due to a bedrock outcrop that spanned most of Reach 1.

The Mainstem 2 cross section was taken through a riffle. The D50 of the Mainstem 2 cross section was 29. This was higher than Mainstem 1 apart from cross section 1 due to the absence of sediment within the tributary because of the upstream stormwater facility. No silt, clay, or sand was selected during the pebble count.

Table 13: Summary of Pebble Count Data

		Riffle Pebble Counts						
		XS-1	XS-2	XS-3	XS-4	XS-5	XS-6	Mainstem 2 XS-1
Particle Size (mm)	D16	10	1.2	1.2	1.3	1.2	1.2	17
	D35	23	2	8.5	1.9	2	2	22
	D50	40	16	18	20	14	14	29
	D65	66	28	37	34	25	25	41
	D84	110	55	65	72	48	48	60
	D95	220	98	90	120	74	74	97
Substrate Type (%)	Silt Clay (0 - 0.062 mm)	0	1	1	0	1	1	0
	Sand (0.062 - 2mm)	0	35	31	37	35	35	0
	Gravel (2 - 64 mm)	63	51	51	46	56	56	87
	Cobble (64 - 256 mm)	35	13	17	17	8	8	13
	Boulder (256 - 4096 mm)	2	0	0	0	0	0	0
	Bedrock	0	0	0	0	0	0	0

The subpavement sample locations were chosen based on methodology from Rosgen (Rosgen, 2008). The D50 of both subpavement samples was 1.2 mm, which falls into the category of very coarse sand. No subpavement sample was taken in the Mainstem 2 tributary due to the upstream SWM facility restricting the transport of sediment downstream.

Table 14: Summary of Bulk Sample Data

	Bulk Sample 1	Bulk Sample 2
	Particle Size (mm)	Particle Size (mm)
D16	--	--
D35	--	--
D50	1.2	1.2
D65	3.1	3.6
D84	16	31
D95	41	68

5.4.3 Hydraulic Variable Analysis

The representative riffle cross sections were evaluated using The Reference Reach Spreadsheet Version 4.3L (Mecklenburg, 2006) for the bankfull discharge identified by regional curve data, fixed region regression, stream gage data, and field indicators (see Section *4.2, Watershed Hydrology* for more information). All pertinent hydraulic variables were computed using flow continuity, incipient motion, and flow resistance relationships. Channel characteristics for bankfull discharge are summarized in **Table 15**. Cross section graphs are included in **Appendix B**.

Table 15: Hydraulic Variables and Bankfull Dimensions

	Mainstem 1				Mainstem 2
	Reach 1 XS-1 Riffle	**Reach 2 XS-2 Riffle**	**Reach 3 XS-4 Riffle**	**Reach 4 XS-5 Riffle**	**Reach 5 XS-1 Riffle**
Slope (%)	4.9	2.6	2.3	1.7	0.97
Cross Sectional Area (ft^2)	11.4	13.5	16.9	17.8	12.3
Width (ft)	13.7	15.4	16.3	21.5	11.3
Max Depth (ft)	1.2	1.4	1.4	1.3	1.6
Mean Depth (ft)	0.8	0.9	1	0.8	1.1
Width/Depth Ratio	16.4	17.5	15.8	25.9	10.3
Velocity (ft/s)	5.9	5.9	5.6	4.8	3.8
Discharge (cfs)	67.3	79.7	94.1	85.7	47.3
Froude Number	1.15	1.15	1.01	0.95	0.71
Entrenchment Ratio	1.3	1.4	1	2	2.0
Width of Flood Prone Area (ft)	18.1	22	16.9	43.6	22.3
D50 (mm)	40	15	20	14	29
D84 (mm)	110	55	72	48	60
Threshold Grain Size (mm)	122	65	67	41	27
Shear Velocity (ft/s)	1.13	0.83	0.84	0.66	0.53
Shear Stress (lbs/ft^2)	2.47	1.33	1.36	0.84	0.55
Unit Stream Power (lb/ft/s)	15	8.4	8.3	4.2	2.5
Manning's Roughness Coefficient	0.049	0.036	0.039	0.035	0.036
Rosgen Channel Classification	B4a	B4	F4b	B4c	B4c

Based on the variables in **Table 15** and the sinuosity (Table 8), Reach 1 classifies as a B4a channel due to the moderate width/depth ratio and moderate sinuosity. Reach 2 is less steep, with similar sinuosity, entrenchment, and width depth to Reach 1, and therefore it classifies as a B4 channel. Reach 3 has a similar slope and width depth ratio to Reach 2 but is less sinuous and more entrenched, and therefore classifies as a F4b channel. Reach 4 has a flatter slope than Reaches 1-3 and is less entrenched, with a higher width/depth ratio and higher sinuosity and classifies as a B4c channel. Mainstem 2 classifies as a B4c due to a moderate entrenchment ratio and moderate sinuosity. This tributary has the lowest width to depth ratio that may be due to the undercut banks and its high max depth.

5.5 Bank Erosion Estimate

To estimate erosion rates in the project area, the Bank Assessment for Non-Point Source Consequences of Sediment (BANCS) model was used (Rosgen, 2001; Rosgen, 2006). The BANCS model consists of two commonly used bank erodibility estimation tools to predict stream bank erosion for discrete sections of streambank: the Bank Erosion Hazard Index (BEHI) and the Near Bank Stress (NBS) methods. BEHI and NBS analyses were performed on all eroding stream banks within the project reach. The BEHI methodology uses field data to determine expected erosion rates at a specific stream bank. The BEHI is computed by analyzing the following characteristics: the ratio of bank height to bankfull height, the ratio of root depth to bank height, root density, surface protection, and bank angle. NBS predicts the amount of energy distributed to a streambank, which can accelerate erosion. NBS method #1, which is based on channel pattern and depositional features, was used for this study. BEHI and NBS methods are described in the *Watershed Assessment of River Stability and Sediment Supply (WARSSS)* manual (Rosgen, 2006). Estimated bank erosion rates and the resultant pollutant removal rates will be used to estimate potential nutrient removal using the State Highway Administration worksheet that averages the results of three bank erosion rating curves.

The BEHI and NBS analysis of CA-5 returned ratings of Low to Extreme for each scored bank. These ratings were translated into estimated bank erosion rates using the erosion rating curves developed by the USFWS for Hickey Run in Washington, DC (Berg et al., 2014), USDA Forest Service for Colorado (Rosgen, 2006), and North Carolina State University for Piedmont streams (NC State Stream Restoration Program, 1989). These predictions provided a rate of expected mass wasting or surface erosion from the analyzed stream bank in feet per year. These rates are then multiplied by the area of the eroding bank to obtain an annual erosion rate, which will serve as a prediction for bank erosion rates at the study reach.

BEHI and NBS data and mapping and BANCS calculations are shown in **Appendix B**. BEHI results are summarized in **Table 16**. Approximately 80% of Reach 1 had stable banks with no quantifiable erosion. Approximately 50% of the banks in Reach 2 were eroded, 75% of the banks in Reach 3 were eroded, and 40% of the banks in Reach 4 were eroded. Approximately 43% of the banks in Mainstem 2 were eroded. The banks that were eroded mostly received BEHI ratings of Moderate, High, or Very High. The results in **Table 14**, below, shows the BEHI results for each reach. Based on the BANCS data provided in **Appendix B**, the erosion rate within the project area of the Tributary to Seneca Creek is 2,705,113.6pounds per year.

Table 16: BEHI Summary Table

	Mainstem 1								Mainstem 2	
	Reach 1		Reach 2		Reach 3		Reach 4		Reach 5	
BEHI Rating	Length of Bank (ft)	Percent of Reach (%)	Length of Bank (ft)	Percent of Reach (%)	Length of Bank (ft)	Percent of Reach (%)	Length of Bank (ft)	Percent of Reach (%)	Length of Bank (ft)	Percent of Bank (%)
Very Low	0	0%	0	0%	0	0%	0	0%	0	0%
Low	0	0%	0	0%	0	0%	37	1%	25	2%
Moderate	0	0%	75	7%	133	14%	90	2%	156	10%
High	80	13%	272	24%	144	15%	635	17%	350	23%
Very High	50	8%	171	15%	324	33%	467	13%	117	8%
Extreme	0	0%	0	0%	106	11%	126	3%	0	0%

5.6 Site Constraints

The primary vertical site constraints for the project area are utility crossings and pipe outlets, and the primary horizontal constraints are sewer manholes, as well as the mature forest and valley walls. Bedrock throughout the site and pedestrian bridges and footpaths throughout the park present another constraint both vertically and horizontally. The abandoned farm pond on the left bank of the site is an additional constraint. Continued efforts will be made with the design to minimize impacts to mature trees. The majority of the proposed restoration work is within M-NCPPC property. The parcel is bordered to the south by a PEPCO parcel. CRI received access to perform geomorphic assessments through the PEPCO parcel. The survey was conducted on October 27, 2020. Upon evaluation it was determined that proposed design work would occur from the outfall of the Stormwater Management facility downstream to the confluence with Mainstem. Upon evaluation it was determined that no work could be conducted to extend Tributary 2.

5.7 Natural Resource Inventories

CRI conducted wetland and waterway delineations as well as forest stand delineations within the CA-5 study area. The complete memos for the two assessments are provided in **Appendix C**, and a summary of the existing environmental features on site is below.

5.7.1 Wetland Delineation

CRI performed the wetland delineation between March 24, March 27, and November 10, 2020. The study area consists of a buffer along the proposed restoration reach, which ranges in width from 50 to 200 feet along the stream channel and includes approximately 3,667 linear feet of an unnamed tributary to Great Seneca Creek and two tributaries. The field identified stream and wetland boundaries were flagged and labeled by CRI staff and then surveyed during the detailed topographic survey. During the field investigations, 18 waters of the U.S., including wetlands, were identified within the study area. Ten watercourses and eight wetlands were identified, two PEM wetlands and six PFO wetlands. The wetlands were clustered at the upper and lower ends of the site. The impact to these wetlands will be minimized. Grading on the floodplains where there are existing wetlands will be minimized to maintain the hydrology and habitat provided in the floodplains. The stream design will aim to reconnect the center portion of the stream with the floodplain, creating additional floodplain wetlands in the process.

5.7.2 Forest Stand Determination

A forest stand characterization and tree survey were conducted in the study area on March 27, April 9, and November 10, 2020, in accordance with the MDNR *State Forest Conservation Technical Manual* (MDNR, 1997). The study area consists of a buffer along the proposed restoration reach, which ranges in width from 50 to 200 feet along the stream channel and includes approximately 3,667 linear feet of an unnamed tributary to Great Seneca Creek and two tributaries. All trees were measured using a diameter at breast height (DBH) tape at 4.5 feet above the ground. The species, size, and condition of all identified trees were recorded. Specimen trees, which are trees with a 30-inch DBH or greater, were tagged and numbered for future field location. A total of four forest stands (A, B, C and D) were identified within the study area. A total of 49 specimen trees were identified within the CA-5 stream restoration site study area. The locations of the specimen trees were GPS'd in the field and the locations will be compared with the topographic survey to ensure the locations of the specimen trees are accurately shown on the plans.

5.7.3 Existing Invasive Species

Existing invasive species were present throughout the site. The most prevalent invasive species was Japanese Stiltgrass (*Microstegium vimineum)*. It makes up a large proportion of the overall herbaceous species throughout the site. Other herbaceous invasive species that were also present within the study area included; Garlic Mustard (*Alliaria petiolate*), Wild Garlic (*Allium vineale*), and Speedwell species (*Veronica sp.*). A few species of invasive vines and shrubs were also present on site such as: Japanese Barberry (*Berberis thunbergii*), Autumn Olive (*Elaeagnus umbellate*), Wineberry (*Rubus phoenicolasius*), Japanese Honeysuckle (*Lonicera japonica*), and Multiflora Rose (*Rosa multiflora*). During construction, any invasive species with the LOD will be removed and native vegetation will be established. The Japanese Stiltgrass is prevalent throughout the valley just beyond the limits of the work and would be virtually impossible to completely eradicate on site. Native vegetation will be planted and established with the MDOT SHA standard a one-year warranty on establishment (seed) and plantings which includes treatment with in the LOD for invasive species.

6. Restoration and Uplift Opportunity Identification

The CA-5 stream restoration site was examined to identify the impaired functions of the stream and the degree of impairment. Based on the identified impaired functions, ecological uplift opportunities were evaluated in the context of the site conditions and the design constraints at the Site. Tributaries 1 & 2 are excluded from the function-based scoring because they are ephemeral channels. A comparison of existing stream functions with potential functions based on the stream functions pyramid established the quantitative uplift goals and measurable performance standards for this project. The stream functions pyramid includes five hierarchical stream functions: hydrology, hydraulics, geomorphology, physicochemical, and biology. Functions are evaluated as functioning, functioning-at-risk, and not-functioning.

At the Semi-final 65% level, the analysis includes a discussion of the existing condition for each parameter and how the potential uplift differs for the design options. After selection of the design approach, the report will be updated to include a functional uplift table clearly showing the uplift and performance standard for each project reach.

Table 17: Function Based Scores and Ratings

Reach	Hydrology		Hydraulics		Geomorphology		Physicochemical		Biological	
	Ex	Prop	Ex	Prop	Ex	Prop	Ex	Prop	Ex	Prop
Mainstem 1	4	7	18	35	28	66	11	14	13	20
Mainstem 2	9	9	22	36	42	64	16	16	13	21

6.1 Hydrology

The Site's hydrology is Not-functioning or Functioning-at risk based on the Function Based Assessment. This rating is based on the high impervious cover (over 15%) in the contributing drainage area and concentrated flow paths reaching the stream. The project will not result in significant land use change, or any stormwater management practices; therefore, hydrology is to remain as Not-functioning or Functioning-at risk for the proposed condition.

6.2 Hydraulics

The bank height ratio ranges from reach to reach, however it is Not Functioning. The designs propose reducing the low bank height to improve the bank height ratio in all restored reaches. A bank height ratio below 1.2 (Functioning) is proposed in all design options.

The entrenchment ratio ranges from Functioning to Functioning-at-risk, and this ratio will be improved with the design. The width of the flood prone area will be increased to the maximum extent feasible while still preserving the adjacent forest as much as possible.

The design provides the most opportunity for uplift since the proposed bank height ratio will be between 1.0 and 1.2 and the entrenchment ratio will be approximately 1.5 or greater. In all designs the proposed uplift potential was estimated to be Functioning upon restoration.

6.3 Geomorphology

Geomorphology is based on BEHI and NBS data, lateral stability, for Mainstem 1 was determined to be Not Functioning for the left and right banks. The lateral stability for Mainstem 2 was determined to Functioning-at-risk for the left and right banks.

Bedform diversity based on the pre-construction assessment bedform diversity is considered Functioning-at-Risk for Mainstem 2 Mainstem 2 is considered Not Functioning. The data from the BANCS model indicates there is widespread lateral instability. Reducing instability is one of the primary goals, and design aims to stabilize the streambanks throughout the site. Improving bedform diversity will be achieved by increasing the percent stable riffles and adding stable substrate.

6.4 Physiochemical

Physicochemical functional uplift is not proposed in this restoration site based on the limitations of the watershed, which include a high percentage of impervious cover. The existing and proposed conditions are rated at Functioning-at risk.

6.5 Biological

Biological functional uplift is not proposed in this restoration based on the limitations of the watershed, which include a high percentage of impervious cover and the fact that the reaches begin at pipe outfalls. The existing and proposed conditions are rated as Functioning-at risk. Some increases in score will be obtained through the addition of in-channel substrate (gravels, logs, etc.). However, biology was not a goal of the design.

Table 18: Function Based Restoration Goals

Streams Functional Pyramid Category: Hydraulic			
Goal	**Parameter**	**Performance Standard**	**Measurement Method**
Floodplain reconnection	Floodplain connectivity	Entrenchment Ratio, Bank Height Ratio	Cross-Section
Streams Functional Pyramid Category: Geomorphology			
Goal	**Parameter**	**Performance Standard**	**Measurement Method**
Channel stability	Vertical/Lateral migration	Stream bed/bank stability	Longitudinal Profile/BANCS
Stabilize stream bed	Bedform Diversity	Increase in percent stable riffles from pre- to post-restoration	Quantify percent of stable riffles

7. Design Approach

7.1 Project Goals

The CA-5 stream restoration efforts consist of the CA-5 Mainstem 1, CA-5 Mainstem 2, and two ephemeral tributaries. The goals of the stream restoration include the following:

- **Provide 3,079 LF of stream mitigation, providing 721 functional feet of mitigation credit**
- Increase floodplain connection
- Provide a stable channel design
- Increase bank stability
- Stabilize groundwater seep and tributary headcut channels
- Minimize the impact to adjacent trees and other natural resources
- Provide consistent unit stream power to convey sediment through the stream reach
- Stabilize the existing pond outlet and lower the overall pond elevation to create a functioning wetland habitat.
- Provide diverse habitat for wildlife and other aquatic species

7.2 Stream Restoration Approach

The restoration of the CA-5 stream restoration site begins just upstream of the pedestrian bridge, at the beginning of evaluation Reach 2, and continues downstream just over 2400 LF to the confluence at the end of the site. Restoration of Tributary 2 extends to the M-NCPPC property line and multiple smaller headcuts along the left and right banks is also proposed. The outlet from the farm pond along the left bank near the end of the site will be lowered, dropping the surface elevation of the water in the pond, reducing the overall hazard.

The Mainstem 1 channel is designed with stable dimension, pattern, and profile in order to tie-in to existing stable channel bed features at the upstream and downstream ends of the restoration. The proposed channel design is based on a Rosgen type B channel. The intent of the design is to reduce shear stresses within the channel and access the limited floodplain surface during high flow events to keep shear stress below the critical shear stress threshold of the substrate. The overall size of the floodplain will be limited to avoid major earthwork and minimize impacts to existing trees and natural resources. Proposed channel bed features such as Riffle, Run, Pool and Glide will provide stable epifaunal substrate and create diverse in-stream habitat. The riffle and run features will be stabilized using rock and log structures. Energy dissipation will be achieved mainly through drops and hardened structures within the channel due to the confined floodplain. The existing conditions in the stable reaches of the channel suggest that this channel is transporting the majority of the fine sediments to the downstream reaches. Areas of instability are occurring where sinuosity has increased, and fine sediments are being deposited within the channel. The proposed design will establish a more consistent slope throughout the channel. The riffle slopes vary from 3.8-4.5%. This will stabilize the stream unit power and provide consistent sediment transport capacity throughout the channel. The existing overall profile shows a concave slope with Reaches 2 and 3 having higher slopes and Reach 4 having a relatively flat slope. The consistent slope will also raise the channel in Reaches 2, 3, and the upstream section of reach 4. This will provide additional protection to sanitary sewer crossings and help reconnect the channel to the existing floodplain at higher flows. The existing utilities are shown with the approximate elevations and locations. Utility test pits will be performed prior to the next design phase to verify the elevations and locations of the sewer and water crossings. By raising the channel extensive floodplain grading will be minimized while keeping bank heights low. **Appendix E** includes design documentation used to support the proposed stream designs. Proposed Riffle Grade Control structures and other log and rock in-stream structures are proposed in the transitions between meanders will provide grade control and protect the designed channel from vertical degradation.

At the downstream end of the site, the outlet of the farm pond will be lowered by about 1.5' and a stable weir/step pool is proposed to stabilize the outlet. A laser level survey of the existing conditions of the pond showed that the pond depth was consistently 2.0' deep. Therefore, in order to reduce the hazard and create a more sustainable wetland habitat, the outlet of the pond will be lowered by 1.5' and the area will be planted with native wetland vegetation. Once the outlet is lowered, the hazard of a deep pool in the park will be minimized and the property owner request to make the pond more of a functioning wetland/vernal pool will be achieved.

Tributary 1 at the upstream end of the site will be stabilized downstream of the pedestrian crossing. A rock cascade structure is proposed to provide a stable transition to the main channel. The upstream section of the channel is lined with riprap and does not require much stabilization. A plunge pool is proposed to stabilize the pipe outfall at the top of the reach.

Tributary 2 will also be stabilized. The tributary will be realigned at the downstream end to access an abandoned channel meander, and to provide a more stable tie in angle to the mainstem. The realigned channel will cross the now exposed sewer line approximately perpendicular and will tie into the main channel within a pool feature. The channel has been raised and rock features are proposed in the channel downstream of the footpath crossing to protect the existing sewer. Upstream of the crossing there is exposed bedrock and lower banks. Since this area is somewhat stable and unlikely to show significant uplift from any major disturbance, it will remain as-is. The Tributary 2 channel is designed to convey the predicted 2-year storm from TR-55.

The Mainstem 2 channel design approach is similar to Mainstem 1. A large existing stormwater management structure is located at the upstream end of Mainstem 2 that attenuates storm flows, therefore the proposed channel was sized to the 2-year discharge from the structure rather than the 2-year discharge from the stream hydrology. The Mainstem 2 proposed channel is designed with stable dimension, pattern, and profile in order to tie-in to existing stable channel bed features at the upstream end of the restoration and the proposed Mainstem 1 channel at the downstream end of the restoration. The proposed channel design is based on a Rosgen type B channel. The intent of the design is to reduce shear stresses within the channel and access the limited floodplain surface during high flow events to keep shear stress below the critical shear stress threshold of the substrate. The overall size of the floodplain will be limited to avoid major earthwork and minimize impacts to existing trees and natural resources. Proposed channel bed features such as Riffle, Run, Pool and Glide will provide stable epifaunal substrate and create diverse in-stream habitat. The riffle and run features will be stabilized using rock and log structures. Energy dissipation will be achieved mainly through drops and hardened structures within the channel due to the confined floodplain. A stream crossing will be provided where the channel flows through the PEPCO ROW, and potential for increased floodplain wetland development in the PEPCO ROW will be minimized. Areas of instability are occurring where sinuosity has increased due to the increase in slope from the hardened upstream elevation of the stormwater structure. The proposed design will raise the channel to provide floodplain access and provide stable drop structures to meet the downstream elevation of Mainstem 1. The riffle slopes vary from 1.2%-2.75%. Shallow riffles are proposed at the upstream end of the channel to raise the channel bed. Steeper riffles with rock drop structures are proposed at the downstream end of the channel to stably drop the channel to meet the Mainstem 1 elevation at the confluence. Due to the stormwater management structure at the upstream end of the channel, sediment transport and fish passage are not a major design consideration. Stone toe will be used to protect adjacent utilities. The existing utilities are shown with the approximate elevations and locations. Utility test pits will be performed prior to the next design phase to verify the elevations and locations of the sewer and water lines in the work area. By raising the channel extensive floodplain grading will be minimized while keeping bank heights low. **Appendix E** includes design documentation used to support the proposed stream designs. Proposed Riffle Grade Control structures and other rock in-stream structures are proposed in the transitions between meanders will provide grade control and protect the designed channel from vertical degradation.

The channel alignments were developed by examining valley slope and width, existing land constraints, and expected flood flow pattern. A longitudinal profile was created along the proposed alignment with riffles along straight portions of the planform and pools at the bends. The channel profiles are designed to have an alternating riffle-pool sequence to create varying instream habitats. Nearly all of the water surface elevation drop in the relocated stream channels occurs in riffle reaches, rather than in pools, which were designed to be nearly flat. The proposed thalweg elevations of the longitudinal profile at the upstream and downstream tie-in locations matches the existing grades. The proposed channel cross section design is based on the existing bankfull dimensions of the representative cross sections. **Table 19** provides a summary of the proposed typical riffle cross section dimensions.

Table 19: CA-5 Stream Restoration Site Mainstem 1 & Mainstem 2 Proposed Riffle Dimensions

Design Parameter	Mainstem 1	Mainstem 2
Drainage Area (Mi^2)	0.25	0.43
Discharge (cfs)	59	45.4
Cross-Sectional Area (ft^2)	12.0	14.01
Width (ft)	14.7	15.0
Mean Depth (ft)	0.82	0.94
Max. Depth (ft)	1.10	1.22
Width/Depth Ratio	18.0	16.0
Hydraulic Radius (ft)	0.78	1.03
Proposed Riffle Slopes (%)	3.8-4.5	1.2–2.75

7.2.1 Sediment Competency

Sediment competency is the ability of a stream to mobilize bed sediments, specifically the largest particle made available from the immediate upstream sediment supply. Competency is an important factor for proposed channel design as it helps determine channel dimensions necessary to maintain sediment transport conditions and prevent excessive aggradation.

Sediment competence was calculated using the methodology outlined by Part 654, Chapter 11, of the Stream Restoration Design National Engineering Handbook (NEH, 2007). First, the average Bankfull Shear Stress ($\tau_{c,}$ lb/ft^2) was calculated for the estimated hydraulic dimensions of the proposed channels where:

$$\tau_c = gRS$$

The median diameter of the riffle bed, D_{50}, was set to the proposed D50 from the Riffle Grade Control material (See Section 5.9). The ratios for $D_{50}/\hat{D}_{50}$ and D_{max}/D_{50} were calculated where:

$\hat{D}_{50}$ = the median diameter from the bar sample

D_{max} = largest particle from the bar sample (or the subpavement sample)

D_{50} = median diameter of the riffle bed (from 100 count in the riffle or the pavement sample)

Dimensional Shear Stress, or the average Bankfull Shear Stress, was used in the following equations to determine the stable channel slope and bankfull depth:

$$d = {}^{\tau}/_{\gamma S}$$
$$S = {}^{\tau}/_{\gamma d}$$

Where, d= bankfull depth, S= bankfull slope, and γ= specific weight of water (62.4).

The results of the required depth and slope based on the maximum shear stress were compared to the design hydraulic conditions. Both the calculated hydraulic conditions and the proposed channel dimensions were adjusted and solved iteratively until the channel dimensions and slope were deemed to be stable, that is, where the calculated bankfull depth and bankfull slope were within at least 5 percent of the proposed bankfull depth and slope. The completed competence worksheet can be found in **Appendix D**. **Table 20**, below, shows a comparison of the required bankfull slope and depth calculated using the critical dimensionless shear stress and the proposed conditions.

Entrainment calculations were not completed for Mainstem 2 tributary due to the upstream SWM facility. No point bars or channel bars were noted below in the tributary. The proposed substrate material in the Mainstem 2 tributary will be sized accordingly to prevent the substrate from moving since it is not receiving a stable source of material from upstream. Additionally, entrainment calculations are based on the bankfull discharge. Entrainment calculations would not be suitable to evaluate the Mainstem 2 tributary due to the undersized design discharge of 45.3 cfs being used to size the channel.

Table 20: Comparison of Required Bankfull Channel Dimensions from Entrainment Calculations vs Proposed Channel Dimensions

	Required Bankfull Conditions	Proposed Bankfull Conditions	Percent Difference (%)
Slope (ft/ft)	0.0204	0.0209	2.45
Depth (ft)	0.80	0.82	2.5

Below are some of the benefits of the restoration/relocation:

- Improves stream stability of the designed sections by reducing bank erosion and bed degradation
- Realignment addresses unstable geometry observed in Reach 4 and provides stable connection to the existing channel to support the unobstructed and efficient conveyance of the flow
- Increase access to the existing floodplain by raising the channel in parts of the reach.
- Improves water quality by reducing bank erosion and increasing the potential for de-nitrification to occur throughout the floodplain.
- Stabilize headcuts and wetland seep channels
- Stabilize and protect existing utilities that cross and/or run adjacent to the stream.
- Lower the surface water level in the existing pond and provide a stable outlet into the stream.
- Improves aquatic and terrestrial riparian habitat
- Reduce non-point source pollution, including sediment, nutrient, and thermal pollution.

7.3 HEC-RAS Modeling

7.3.1 HEC-RAS Methods

Hydraulic analysis was performed using the US Army Corps of Engineers HEC-RAS (Hydraulic Engineering Center River Analysis System) computer program, version 6.1.0 (USACE, 2021). HEC RAS 2D was used with a surveyed digital terrain model (DTM) for the existing terrain and a drafted DTM for the proposed terrain. Montgomery County land use data was used to define the base Manning's n coefficient. Additional Manning's 'n' regions were added to the model to define the existing and proposed conditions more accurately. **Table 21** shows Manning's 'n' values that were used in the model. The storm hydrographs from HEC-HMS for the two-, ten-year and 100-year recurrence intervals were used as the upstream boundary conditions in four locations and normal depth was used for the downstream boundary condition. The four locations were Upper Mainstem 1, Tributary 1, Tributary 2, and Mainstem 2. There were two additional hydrographs added into the model for Mainstem 1: Stormdrain 1 and Stormdrain 2. These hydrographs are introduced as internal boundaries at the outlet of the storm drains. Please see Appendix D for a schematic.

Existing and proposed models were developed. The model was calibrated by comparing the HEC-HMS flows with the sampled flows in the HEC-RAS model at the downstream end. For example, the 2-year flow is towards the downstream end of the HEC-RAS model is 158 cfs for Mainstem 1. The 2-year flow in the HEC HMS model at this point is 143 cfs. The 2-year flow in the regression equation at this point is 120 cfs. These values are close enough to consider the HEC-RAS model to be a relatively good model of what is occurring in the real world.

The Manning roughness coefficient is an estimate of resistance to flow in a channel. The selection of a reasonable value is significant to the accuracy of the computed water surface profiles. Factors that can affect roughness include bed material, vegetation, channel irregularities, obstructions, and channel alignment. The model was run in the unsteady flow regime.

Table 21: Manning's 'n' Values used in HEC-RAS Modeling

Land use	Manning's n
Existing stream channel	0.036
Proposed stream channel	0.045
Forested	0.13
Residential	0.07

7.3.2 HEC-RAS Results

HEC-RAS model outputs were examined to determine any changes in velocity and shear stress at the 2- and 10- year discharges from existing to proposed conditions. The 100-year inundation boundary for the existing and proposed conditions were also compared. The highest shear stress and velocity values were determined for the proposed condition. The stations where the shear or velocity was greater than the permissible velocity for the material proposed were considered "hot" spots. These spots will be treated with larger rock to stabilize the stream. The table below shows the permissible shear and velocity ranges for different types of material (Fischenich, 2001).

Table 22: Permissible Shear and Velocity for Material Types

Lining Material	Shear, psf	Velocity, fps
Natural Channel	2	4.5
Vegetated Coir Mat	4-8	9.5
Rock 9 in d50 (Class I)	3.8	7-11
Rock 18 in. d50 (Class II)	7.6	12-16
Rock 24 in. d50 (Class III)	10.1	14-18

The shear stresses and velocities were evaluated at the time step that showed the highest shear stress and velocity. **Table 23** below shows the time steps used for each storm.

Table 23: HEC RAS 2D Timesteps

Storm	Timestep
2-yr	3:20
10-yr	6:20

The proposed stream network alignment is drastically different than the existing stream network. This makes a side-by-side comparison difficult. Where the stream may have been a pool in the existing condition it could be a riffle in the proposed. Where it was once was on the inside of a meander now it may be on the outside of a meander. It is proposed to raise up the channel bed and tie into the existing condition on the upstream and downstream ends to remove the concave shape of the existing profile. This will also affect the ability to compare the existing and proposed conditions.

Velocity

A visual assessment of the model results was used to determine the “hot” spots. Profile lines drawn along the proposed alignment and the tops of banks were used to approximate the station of the higher velocity values. The higher velocity values are located on the proposed alignment.

The proposed condition model only showed ten stations over 7 fps for the 10-year recurrence interval on Mainstem 1. For Mainstem 2 there was no stations that had velocities over 7 fps. See the maps in Appendix D to compare the velocity in the existing condition and the proposed condition. **Table 24** shows stations on mainstem 1 where the velocity is above 7 ft/s for the 10-year recurrence interval.

Table 24: HEC RAS Velocities for the Proposed Condition

Tributary	River Station	10-year Velocity, fps
Mainstem 1	140	7.21
	653	7.08
	708	7.04
	878	7.06
	928	7.17
	1426	7.10
	1631	7.92
	1661	7.09
	2606	8.35
	2606 left	7.34

The greatest proposed velocity from the observed cross sections is the 10-yr storm at station 26+06 with a velocity of 8.35 fps. This cross section is at the outlet of the site and the existing velocity is higher at 8.89 fps. All other stations listed above will have rock riprap protection of at least class I with a permissible velocity of 7 to 11 fps . Refer to maps in Appendix D.

Shear Stress

Shear stress values were determined similarly to velocity values: visual assessment and profiles along the alignment and tops of banks. The higher shear stress values are located on the tops of the banks. The profiles can be found in Appendix D. The proposed condition model shows one station on the left bank and two on the right bank for the 10-year storm with a shear stress over 8 lb/sf. The permissible shear stress for vegetated coir mat is 4-8 lb/sf. **Table 25** shows stations where the shear stress is above the permissible shear stress for vegetated coir matting for the 10-year storm unless indicated otherwise. NOTE: Stations are approximate because they are taken from the top of bank profile line. They may not match the alignment stationing.

Table 25: HEC RAS Shear Stress for Proposed Conditions

Tributary	River Station	10-year Storm Shear Stress (lb/sf)
Mainstem 1	68 left	12.83
	1426 right	8.42
	1675 right	10.68

The highest proposed shear stress observed was 12.83 lb/sf for the 10-yr storm at station 0+68 on the left bank of Mainstem 1. This cross section is located on the inside curve of a meander just above the pedestrian bridge. The second highest shear is at station 16+75 on the right bank. This shear is on a riffle grade control and will be protected with rock riprap. Refer to maps in Appendix D.

Table 26 summarizes the HEC-RAS cross sections where shear stress is above 8 psf in the proposed condition and explains how the design will withstand that shear pressure. All stations are Mainstem 1 unless indicated.

Table 26: Design Justification

River Station	Variable of Concern	Design Justification
68 left	Shear Stress is above 8 psf	The high shear area is located upstream of the existing pedestrian bridge. There is existing riprap here that is Class II or larger. The left bank will be the location of the boulder arm of a rock j-hook. The boulder arm will be comprised of imbricated rock which can withstand the increase in shear.
1426 right	Shear Stress is above 8 psf	The high shear area is located on the right bank of a riffle and the bank will be treated with stone toe to withstand the shear stress.
1675 right	Shear Stress is above 8 psf	The high shear area is located on the right bank of a riffle which will be treated with stone toe to withstand the shear stress.

Channel Stability

In addition to the evaluations discussed above, 2D HEC-RAS was used to model the highest shear stresses and velocities that may be experienced in the proposed channel in order to evaluate the stability of the designed channel bed. To determine the highest shear stress and velocities in the channel a profile along the proposed alignment was evaluated. The plan view showing the profile along the proposed alignment, as well as corresponding graphs showing the shear stresses and velocities for the 2- and 10-year return intervals, are shown in **Appendix D**.

The profile along the proposed alignment for Mainstem 1 and 2 was evaluated to find the maximum shear stresses and velocities occurring during the 2- and 10-year storm event. Two outliers on both ends of the

Mainstem 1 and 2 alignments have been excluded. The following table shows the maximum shear stress and velocity for the 2-year and the 10-year storm events.

Table 27: Maximum Shear Stress and Velocity along Alignment

Tributary	River Station	2-year Storm Shear Stress (lb/sf)	10-year Storm Shear Stress (lb/sf)	2-year Storm Velocity (ft/s)	10-year Storm Velocity (ft/s)
Mainstem 1	1636	1.82 (708)	2.52	6.24	7.92 (1631)
Mainstem 2	515	0.91	1.73	3.81	6.87

The maximum shear stress for the 2-year storm event was used to determine the D_{50} for the riffle grade control mix, as described in **Section 7.4** below. Since the stream is being relocated and is directly adjacent to infrastructure, the D_{50} of the riffle mix was designed to not mobilize during a 2-year storm event. Additionally, the maximum shear stress and velocity for the 10-year storm event was used to evaluate the proposed riffle grade control material for long-term stability, as described in **Section 7.4**.

<u>100 Year Water Surface Elevation</u>

A comparison was made between the existing and proposed 100-year water surface elevation. The map can be found in **Appendix D**. For Mainstem 1 the proposed condition is slightly higher in some locations in elevation than the existing condition, but all increased flooding is within M-NCPPC property. For Mainstem 2, the proposed 100-year water surface is slightly lower than the existing 100-year water surface except for at the upstream end.

7.3.3 HEC-RAS Conclusions

The stream restoration effort is designed to reduce bank erosion and in-stream sedimentation throughout the project and provide improved storm relief within the floodplain. The hydrologic and hydraulic analyses completed for the project reach describes the hydraulic effects that occur from the proposed design. The resultant hydraulic variables computed within the proposed model show that the proposed design will manage changes to velocity and shear stresses within the design reach to provide a stable stream reach, while remaining within permissible design ranges.

7.4 Rock Sizing

As described in **Section 7.3**, the 2D HEC-RAS model was used to determine the maximum shear stress and velocity along the alignments of the proposed channel for the 2- and 10-year storm event. The maximum shear stress and velocity was evaluated at the thalweg because that is where the rock is being placed. Rock sizing was designed for the 2-year recurrence interval. The 10-year storm was evaluated.

Since the stream is being relocated and is directly adjacent to infrastructure, a safety factor was applied to the maximum shear stress from the 2-year storm event and used to determine the maximum designed shear stress, or the critical shear stress. A safety factor of 1.5 was applied to the 2-year maximum shear stress and velocity from the HEC RAS 2D model to obtain the maximum design shear stress and velocity as shown in the table below. The 10-year storm maximum shear stress for mainstem 1 (2.52) is within the range of the 2-year maximum shear stress (1.82) and the 2-year shear stress times the safety factor (2.73). The rock will be sized for Mainstem 1 which has larger values for shear and velocity than Mainstem 2. All of the 10-year storm values fall within the safety factor envelope.

Table 28: Design Shear Stress and Velocity along Alignment

	2-year Storm Shear Stress (lb/sf)	Design Shear Stress (lb/sf)	Permissible Shear Stress	2-year Storm Velocity (ft/s)	Design Storm Velocity (ft/s)	Permissible Velocity
Mainstem 1	1.82	2.73	3.8	6.24	9.36	7-11
Mainstem 2	0.91	1.37	3.8	3.85	5.72	7-11

A standard MDOT SHA Riprap size will be washed in with salvaged or furnished natural channel material to create a well-mixed matrix within the Riffle Grade Controls. The riprap size is designed to withstand the maximum design shear stress and velocities predicted by the HEC RAS 2D model. The maximum design shear stress was compared to the Permissible Shear and Velocity for Selected Lining Materials (Fischenich, 2001). MDOT SHA Class I riprap (with approximately a 9” d50) has a maximum permissible shear stress of 3.8 psf, and a maximum permissible velocity of 7-11 fps. The Riffle Grade Control Mix will resist the forces acting on the surface by the water for the 2-year storm with a factor of safety.

All other rock structures are over-designed with rock/boulder sizes that will withstand the maximum shear/velocity in the channel up to the 10-year storm. The channel is designed for flows above the 10-year storm to access the floodplain. Therefore, flows above the 10-year storm shear and velocity are no longer an issue in the channel.

7.5 Instream Structures

A few in-stream structures are proposed which will be used to achieve the design goals. Wherever possible, the structures will be made of, or incorporate, riprap that was previously placed within the channel, and rootwads and/or logs from the site. There are multiple locations along the stream channel where riprap had been placed throughout the years in an attempt to stabilize the banks near sanitary sewer assets and other park assets such as bridges or walking paths. When work is being completed in areas where riprap has been placed, every effort will be taken to reuse the existing material. Along the same lines, the stream is located within a forested area, and grading outside of the existing stream channel will result in the removal of trees. Wherever possible, trees being removed on site will be used in structures.

Instream structures such as Log Rollers, Rock J-hooks, Rock Sills, and Boulder Cascades will be utilized to provide grade control to prevent any potential downcutting. The wood introduces carbon to the stream for nutrient retention and processing. These will create permanent grade controls that will withstand large storms.

Stone toe and Log Toe structures will be added along outside meander bends to provide additional bank protection in areas of high velocity and shear stress. The stone/logs will serve as bank protection to ensure bank stability and reduce erosion.

Riffle Grade Controls are proposed to provide permanent grade control at riffle bed features, increase flow diversity and withstand large storms. Since the stream is confined with no wide floodplain to deposit excess sediment onto, the system will be designed to continue to move some sediment through the narrow valley. In many instances, Riffle Grade Control structures will be coupled with drop structures to make up grade and provide flow diversity.

Oxbow wetlands are proposed in some areas where the existing channel is abandoned. The wetlands will have large woody debris (LWD) installed to provide additional habitat.

7.6 Landscaping Design

The stream restoration landscaping plans are included in the design plans. The proposed landscaping plans include six separate landscaping zones; Riparian Planting (lowland meadow establishment), Riparian shrub planting (lowland meadow establishment), Live Stake Planting (lowland meadow establishment), Oxbow wetland (wet meadow establishment), Disturbed PFO (riparian plantings and wet meadow establishment), and Turfgrass Establishment. Live stakes will be installed on the outside meanders and adjacent to straight sections along the slope of the stream bank, from bankfull to just above normal base flow. Riparian plantings will be installed adjacent to the stream channel in areas that are void of natural vegetation or have been impacted by restoration activities. Every effort will be made to save as many large trees as possible which should keep some of the original canopy cover. Trees to be removed are indicated with “X’s” on the landscaping plans. The plant species are listed in the planting schedules and included in the design plans; the planting is designed in accordance with the Forest Conservation Act (FCA) Section 5-1601(ll) (2). Forest impacts were avoided and minimized, and the Landscape Plan proposes to plant an equivalent number of trees to the number removed by the project on-site. Lowland meadow establishment seed mix will be applied to the areas where lives stakes, or riparian reforestation have been installed. Wet meadow establishment seed mix and herbaceous wetland plantings will be applied in the proposed floodplain depression areas, as shown on the plans. Turfgrass will be established in the areas of existing grass needed for access and stockpile.

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APPENDIX A. PHOTODOCUMENTATION

I-495 & I-270 Managed Lanes Study
Phase II Mitigation Design Plan
Stream Site CA-5: Great Seneca Creek
Bradbury Dr. Tributary
Appendix A: CA-5 Site Sketch Map
Sheet 1 of 12

Photo Point
Bulk Sample
Log Jam
Placed Boulders
Bedrock
Culvert
Outlet
Bank Height (ft)
Waters
Foot Path
Trails
Cross Section Pin
Cross Section
Exposed Pipe
Exposed Sewer Pipe
Headcut
Bench
Sediment Bar
Mainstem 1 Reach 1
Mainstem 1 Reach 2
Mainstem 1 Reach 3
Mainstem 1 Reach 4
Mainstem 2
Tributary 1
Tributary 2
2 FT Contour
Study

1 inch = 20 feet
0 10 20
Feet

COASTAL RESOURCES INC.
495 270 MANAGED LANES STUDY

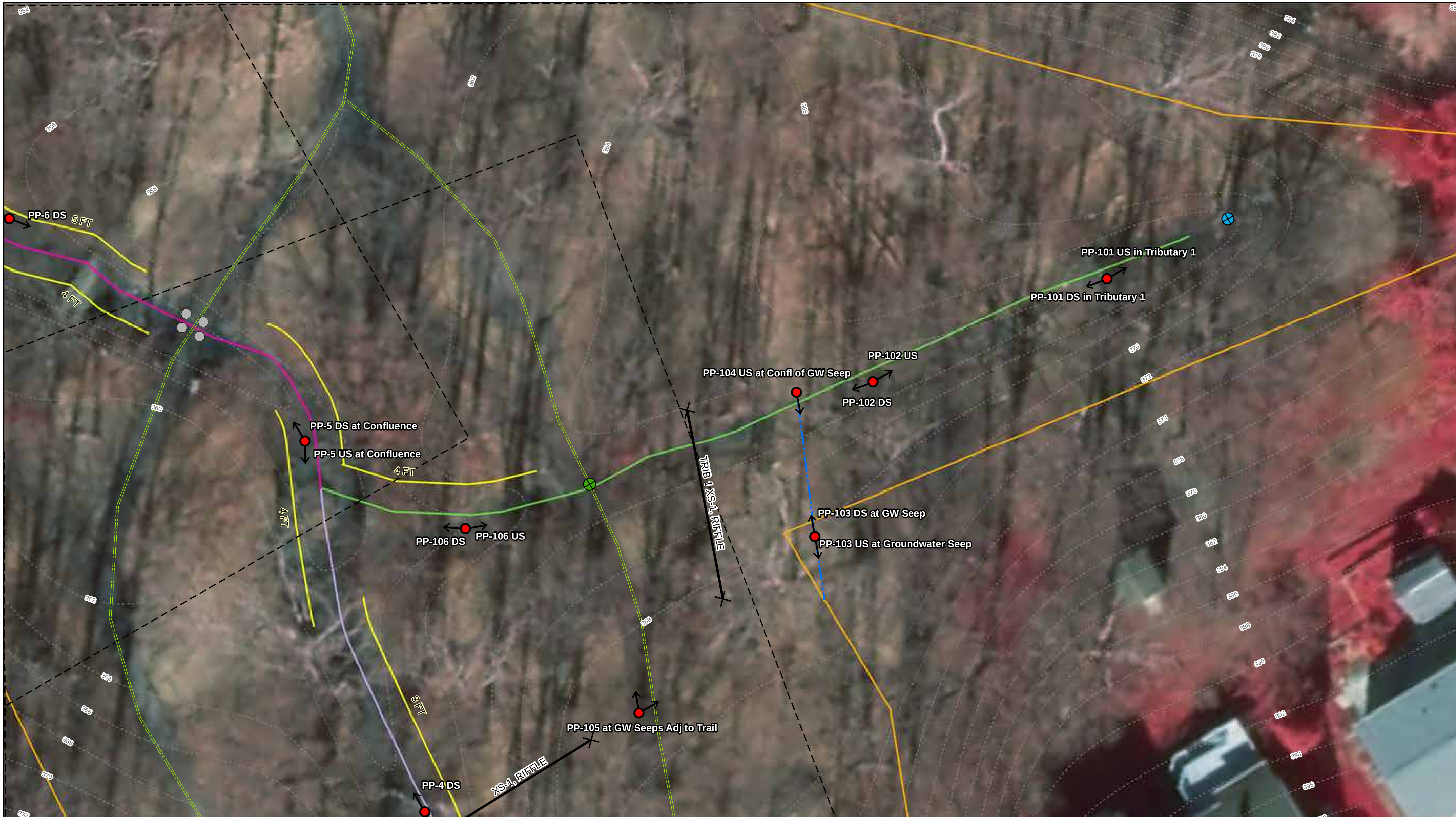

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Photo Point
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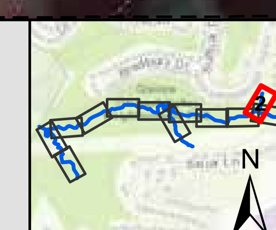
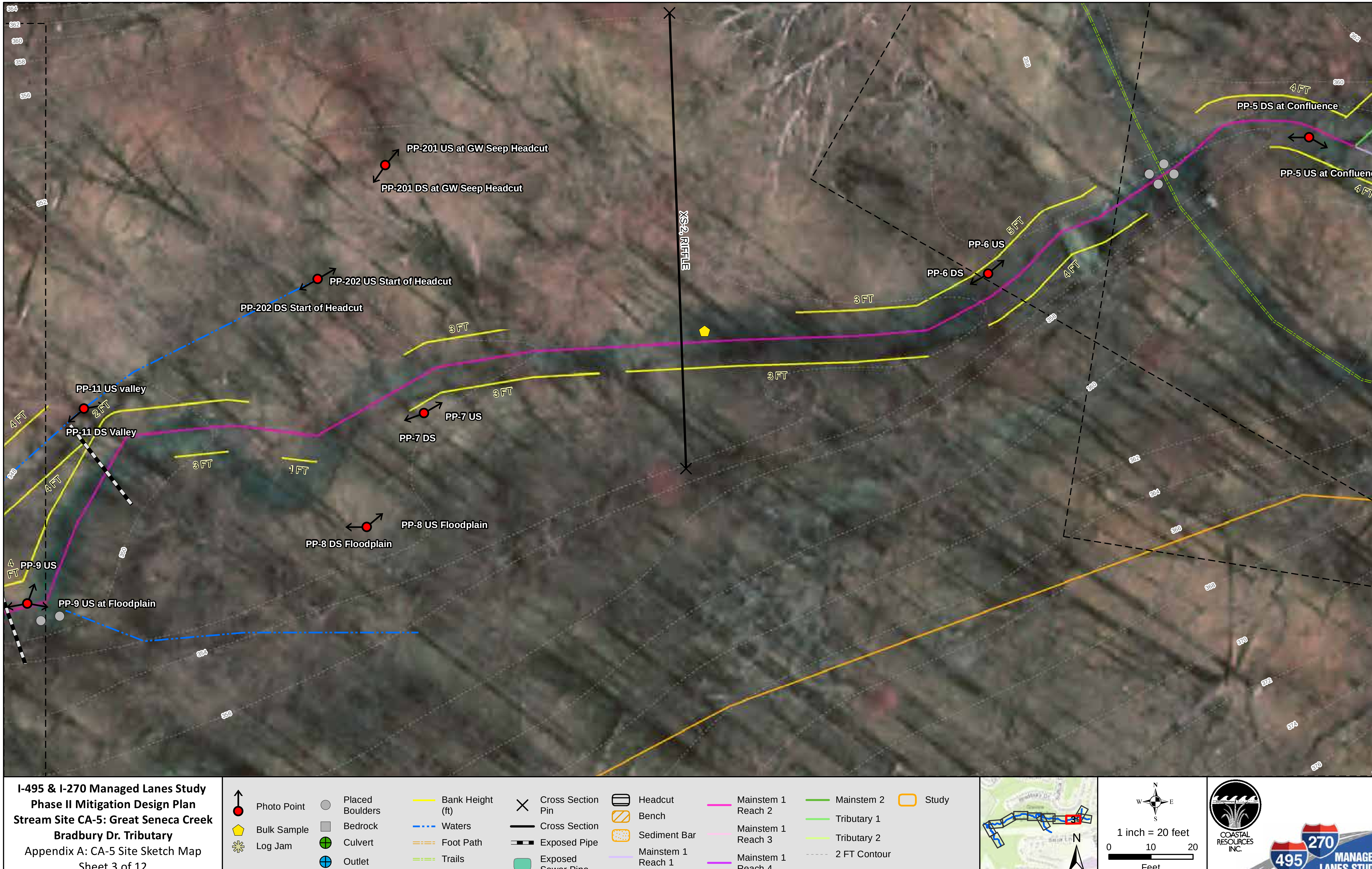
Waters
Foot Path
Trails
Cross Section Pin
Cross Section
Exposed Pipe
Exposed Sewer Pipe
Headcut
Bench
Sediment Bar
Mainstem 1 Reach 1
Mainstem 1 Reach 2
Mainstem 1 Reach 3
Mainstem 1 Reach 4
Mainstem 2
Tributary 1
Tributary 2
2 FT Contour
Study



1 inch = 20 feet
0 10 20
Feet



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Appendix A: CA-5 Site Sketch Map
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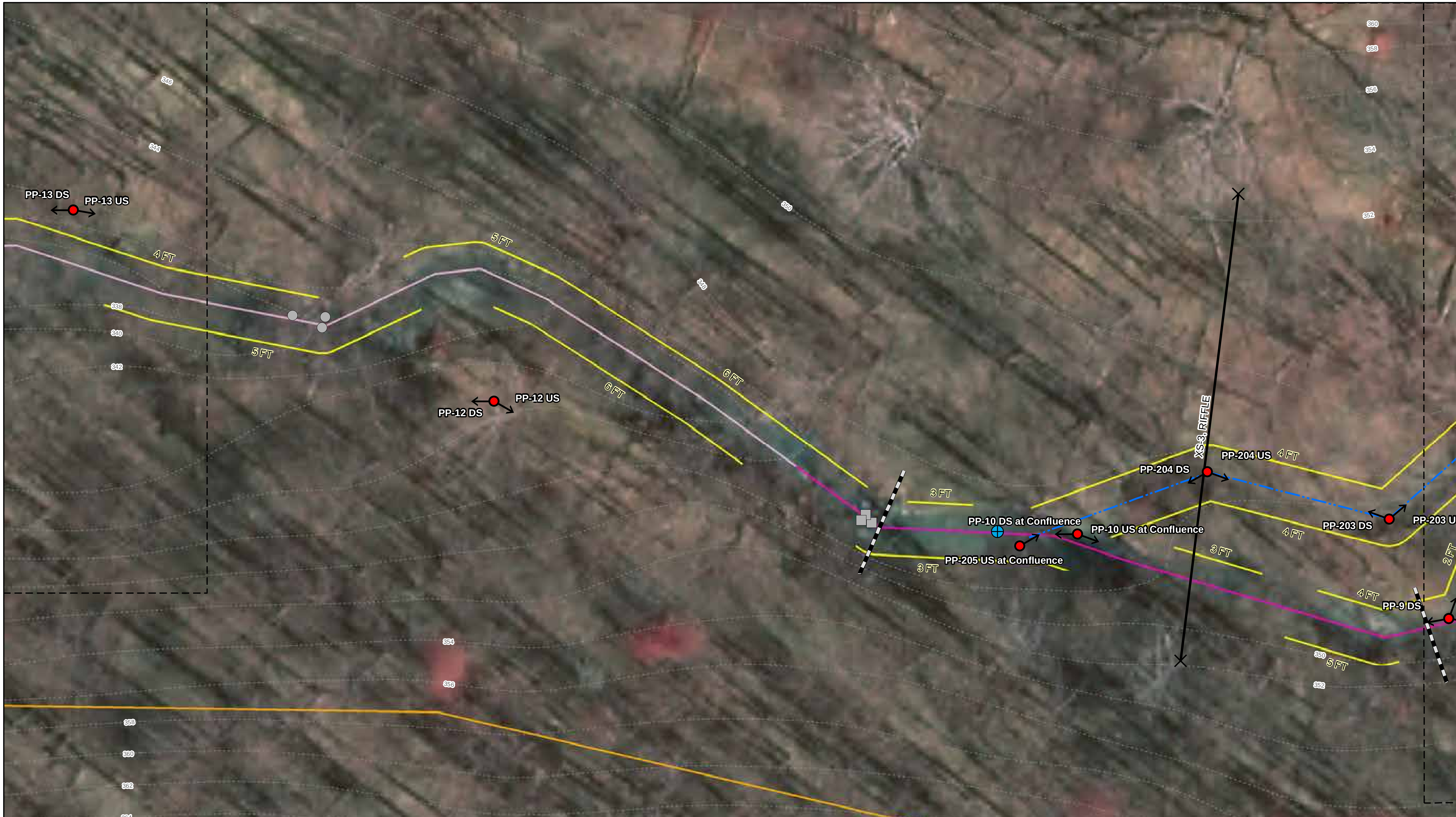

I-495 & I-270 Managed Lanes Study
Phase II Mitigation Design Plan
Stream Site CA-5: Great Seneca Creek
Bradbury Dr. Tributary
Appendix A: CA-5 Site Sketch Map
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Photo Point
Bulk Sample
Log Jam
Placed Boulders
Bedrock
Culvert
Outlet
Bank Height (ft)
Waters
Foot Path
Trails
Cross Section Pin
Cross Section
Exposed Pipe
Exposed Sewer Pipe
Headcut
Bench
Sediment Bar

1 inch = 20 feet
0 10 20
Feet

COASTAL RESOURCES INC.

495 270 MANAGED LANES STUDY

I-495 & I-270 Managed Lanes Study
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Bradbury Dr. Tributary
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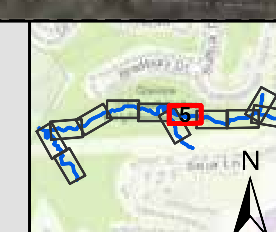
Photo Point	Placed Boulders	Bank Height (ft)	Cross Section Pin	Headcut	Mainstem 1 Reach 2	Mainstem 2
Bulk Sample	Bedrock	Waters	Cross Section	Bench	Mainstem 1 Reach 3	Tributary 1
Log Jam	Culvert	Foot Path	Exposed Pipe	Sediment Bar	Mainstem 1 Reach 4	Tributary 2
	Outlet	Trails	Exposed Sewer Pipe	Mainstem 1 Reach 1		2 FT Contour
						Study



1 inch = 20 feet
0 10 20
Feet

COASTAL RESOURCES INC.

270 495 MANAGED LANES STUDY

I-495 & I-270 Managed Lanes Study
Phase II Mitigation Design Plan
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Bradbury Dr. Tributary
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Photo Point
Bulk Sample
Log Jam
Placed Boulders
Bedrock
Culvert
Outlet
Bank Height (ft)
Waters
Foot Path
Trails
Cross Section Pin
Cross Section
Exposed Pipe
Exposed Sewer Pipe
Headcut
Bench
Sediment Bar
Mainstem 1 Reach 1
Mainstem 1 Reach 2
Mainstem 1 Reach 3
Mainstem 1 Reach 4
Mainstem 2
Tributary 1
Tributary 2
2 FT Contour
Study

1 inch = 20 feet
0 10 20
Feet

COASTAL RESOURCES INC.
270 495 MANAGED LANES STUDY

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Phase II Mitigation Design Plan
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Bradbury Dr. Tributary
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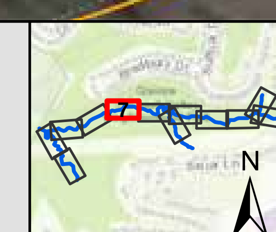
Legend:
- Photo Point
- Bulk Sample
- Log Jam
- Placed Boulders
- Bedrock
- Culvert
- Outlet
- Bank Height (ft)
- Waters
- Foot Path
- Trails
- Cross Section Pin
- Cross Section
- Exposed Pipe
- Exposed Sewer Pipe
- Headcut
- Bench
- Sediment Bar
- Mainstem 1 Reach 1
- Mainstem 1 Reach 2
- Mainstem 1 Reach 3
- Mainstem 1 Reach 4
- Mainstem 2
- Tributary 1
- Tributary 2
- 2 FT Contour
- Study



1 inch = 20 feet
0 10 20
Feet

COASTAL RESOURCES INC.

495 270 MANAGED LANES STUDY

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Bradbury Dr. Tributary
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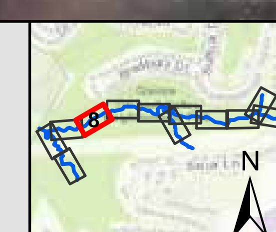
Photo Point
Bulk Sample
Log Jam
Placed Boulders
Bedrock
Culvert
Outlet
Bank Height (ft)
Waters
Foot Path
Trails
Cross Section Pin
Cross Section
Exposed Pipe
Exposed Sewer Pipe
Headcut
Bench
Sediment Bar
Mainstem 1 Reach 1
Mainstem 1 Reach 2
Mainstem 1 Reach 3
Mainstem 1 Reach 4
Mainstem 2
Tributary 1
Tributary 2
2 FT Contour
Study



1 inch = 20 feet
0 10 20
Feet

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270 495 MANAGED LANES STUDY

I-495 & I-270 Managed Lanes Study
Phase II Mitigation Design Plan
Stream Site CA-5: Great Seneca Creek
Bradbury Dr. Tributary
Appendix A: CA-5 Site Sketch Map
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Photo Point
Bulk Sample
Log Jam
Placed Boulders
Bedrock
Culvert
Outlet
Bank Height (ft)
Waters
Foot Path
Trails
Cross Section Pin
Cross Section
Exposed Pipe
Exposed Sewer Pipe
Headcut
Bench
Sediment Bar
Mainstem 1 Reach 1
Mainstem 1 Reach 2
Mainstem 1 Reach 3
Mainstem 1 Reach 4
Mainstem 2
Tributary 1
Tributary 2
2 FT Contour
Study

1 inch = 20 feet
0 10 20
Feet

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495 270 MANAGED LANES STUDY

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Phase II Mitigation Design Plan
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Appendix A: CA-5 Site Sketch Map
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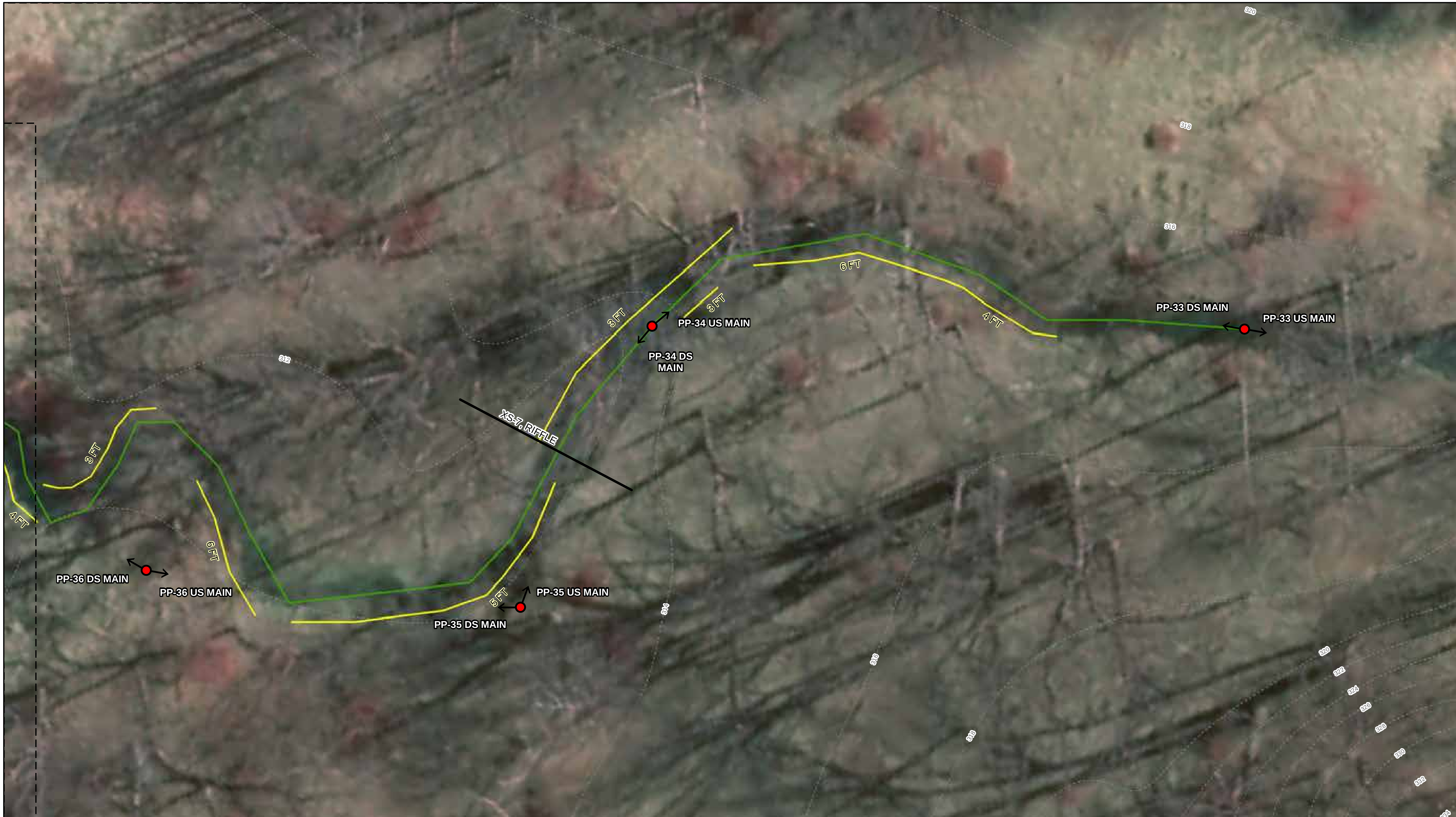
Photo Point
Bulk Sample
Log Jam
Placed Boulders
Bedrock
Culvert
Outlet
Bank Height (ft)
Waters
Foot Path
Trails
Cross Section Pin
Cross Section
Exposed Pipe
Exposed Sewer Pipe
Headcut
Bench
Sediment Bar
Mainstem 1 Reach 1
Mainstem 1 Reach 2
Mainstem 1 Reach 3
Mainstem 1 Reach 4
Mainstem 2
Tributary 1
Tributary 2
2 FT Contour
Study

N

1 inch = 20 feet
0 10 20
Feet

COASTAL RESOURCES INC.

495 270 MANAGED LANES STUDY



I-495 & I-270 Managed Lanes Study
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Stream Site CA-5: Great Seneca Creek
Bradbury Dr. Tributary
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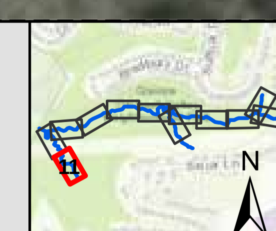
Photo Point
Bulk Sample
Log Jam
Placed Boulders
Bedrock
Culvert
Outlet
Bank Height (ft)
Waters
Foot Path
Trails
Cross Section Pin
Cross Section
Exposed Pipe
Exposed Sewer Pipe
Headcut
Bench
Sediment Bar
Mainstem 1 Reach 1
Mainstem 1 Reach 2
Mainstem 1 Reach 3
Mainstem 1 Reach 4
Mainstem 2
Tributary 1
Tributary 2
2 FT Contour
Study



1 inch = 20 feet
0 10 20
Feet

COASTAL RESOURCES INC.

270 495 MANAGED LANES STUDY

I-495 & I-270 Managed Lanes Study
Phase II Mitigation Design Plan
Stream Site CA-5: Great Seneca Creek
Bradbury Dr. Tributary
Appendix A: CA-5 Site Sketch Map
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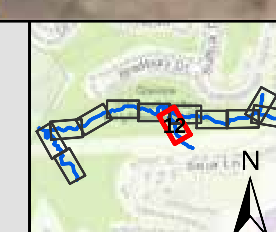
Photo Point
Bulk Sample
Log Jam
Placed Boulders
Bedrock
Culvert
Outlet
Bank Height (ft)
Waters
Foot Path
Trails
Cross Section Pin
Cross Section
Exposed Pipe
Exposed Sewer Pipe
Headcut
Bench
Sediment Bar
Mainstem 1 Reach 1
Mainstem 1 Reach 2
Mainstem 1 Reach 3
Mainstem 1 Reach 4
Mainstem 2
Tributary 1
Tributary 2
2 FT Contour
Study



1 inch = 20 feet
0 10 20
Feet

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270 495 MANAGED LANES STUDY

CA-5 Photo Point 1 Upstream; Long Pro Start

CA-5 Photo Point 1 Downstream

CA-5 Photo Point 2 Upstream

CA-5 Photo Point 2 Downstream


CA-5 Photo Point 3 Upstream


CA-5 Photo Point 3 Downstream


CA-5 Photo Point 4 Upstream


CA-5 Photo Point 4 Downstream


CA-5 Photo Point 5 Upstream at Confluence


CA-5 Photo Point 5 Downstream at Confluence


CA-5 Photo Point 6 Upstream


CA-5 Photo Point 6 Downstream


CA-5 Photo Point 7 Upstream


CA-5 Photo Point 7 Downstream


CA-5 Photo Point 8 Upstream at Floodplain


CA-5 Photo Point 8 Downstream at Floodplain


CA-5 Photo Point 9 Upstream


CA-5 Photo Point 9 Downstream


CA-5 Photo Point 9 Upstream at Floodplain Seep

CA-5 Photo Point 10 Upstream at Confluence with Headcut Trib

CA-5 Photo Point 10 Downstream at Confluence with Headcut Trib

CA-5 Photo Point 11 Upstream at Valley

CA-5 Photo Point 11 Downstream at Valley


CA-5 Photo Point 12 Upstream


CA-5 Photo Point 12 Downstream


CA-5 Photo Point 13 Upstream


CA-5 Photo Point 13 Downstream


CA-5 Photo Point 14 Upstream


CA-5 Photo Point 14 Downstream


CA-5 Photo Point 15 Upstream


CA-5 Photo Point 15 Downstream


CA-5 Photo Point 16 Upstream


CA-5 Photo Point 16 Downstream


CA-5 Photo Point 17 Upstream


CA-5 Photo Point 17 Downstream


CA-5 Photo Point 18 Upstream


CA-5 Photo Point 18 Downstream


CA-5 Photo Point 19 Upstream


CA-5 Photo Point 19 Downstream


CA-5 Photo Point 20 Upstream


CA-5 Photo Point 20 Downstream


CA-5 Photo Point 21 Upstream


CA-5 Photo Point 21 Downstream


CA-5 Photo Point 22 Upstream


CA-5 Photo Point 22 Downstream


CA-5 Photo Point 23 Upstream


CA-5 Photo Point 23 Downstream

CA-5 Photo Point 24 Down Valley at Farm Pond

CA-5 Photo Point 25 Upstream Pond Outfall

CA-5 Photo Point 25 Downstream Pond Outfall

CA-5 Photo Point 26 Up Valley at Farm Pond


CA-5 Photo Point 27 Upstream


CA-5 Photo Point 27 Downstream


CA-5 Photo Point 28 Upstream


CA-5 Photo Point 28 Downstream


CA-5 Photo Point 29 Upstream


CA-5 Photo Point 29 Downstream


CA-5 Photo Point 30 Upstream


CA-5 Photo Point 30 Downstream


CA-5 Photo Point 31 Upstream


CA-5 Photo Point 31 Downstream


CA-5 Photo Point 32 Upstream at Confluence with Mainstem 2


CA-5 Photo Point 32 Upstream Mainstem 2


CA-5 Photo Point 32 Downstream Mainstem 2

- CA-5 Photo Point 33 Upstream Main Channel

- CA-5 Photo Point 33 Downstream Main Channel

- CA-5 Photo Point 34 Upstream Main Channel

- CA-5 Photo Point 34 Downstream Main Channel

- CA-5 Photo Point 35 Upstream Main Channel

- CA-5 Photo Point 35 Downstream Main Channel

- CA-5 Photo Point 36 Upstream Main Channel

- CA-5 Photo Point 36 Downstream Main Channel

- CA-5 Photo Point 37 Upstream Main Channel

- CA-5 Photo Point 37 Downstream Main Channel

- CA-5 Photo Point 38 Upstream Main Channel

- CA-5 Photo Point 38 Downstream Main Channel

- CA-5 Photo Point 39 Upstream Main Channel

- CA-5 Photo Point 39 Downstream Main Channel

- CA-5 Photo Point 40 Upstream Main Channel

- CA-5 Photo Point 40 Downstream Main Channel


CA-5 Photo Point 101 Upstream in Tributary 1


CA-5 Photo Point 101 Downstream in Tributary 1


CA-5 Photo Point 101 36” Reinforced Concrete Pipe
with Energy Dissipation into Tributary 1


CA-5 Photo Point 102 Upstream


CA-5 Photo Point 102 Downstream


CA-5 Photo Point 103 Upstream at Groundwater Seep


CA-5 Photo Point 103 Downstream at Groundwater Seep

CA-5 Photo Point 104 Upstream at Groundwater Seep from Confluence

CA-5 Photo Point 104 Downstream from Confluence

CA-5 Photo Point 105 at Groundwater seep adjacent to Trail

CA-5 Photo Point 105 at Groundwater seep adjacent to Trail


CA-5 Photo Point 106 Upstream


CA-5 Photo Point 106 Downstream


CA-5 Photo Point 201 Upstream at Groundwater Seep Headcut


CA-5 Photo Point 201 Downstream at Groundwater Seep Headcut

CA-5 Photo Point 202 Upstream Start of Headcut

CA-5 Photo Point 202 Downstream Start of Headcut

CA-5 Photo Point 203 Upstream

CA-5 Photo Point 203 Downstream


CA-5 Photo Point 204 Upstream


CA-5 Photo Point 204 Downstream


CA-5 Photo Point 205 Upstream at Confluence


CA-5 Photo Point 301 Upstream at Top of Tributary 2


CA-5 Photo Point 301 Downstream at Top of Tributary 2


CA-5 Photo Point 302 Upstream Near Trail


CA-5 Photo Point 302 Downstream Near Trail


CA-5 Photo Point 303 Upstream at Headcut

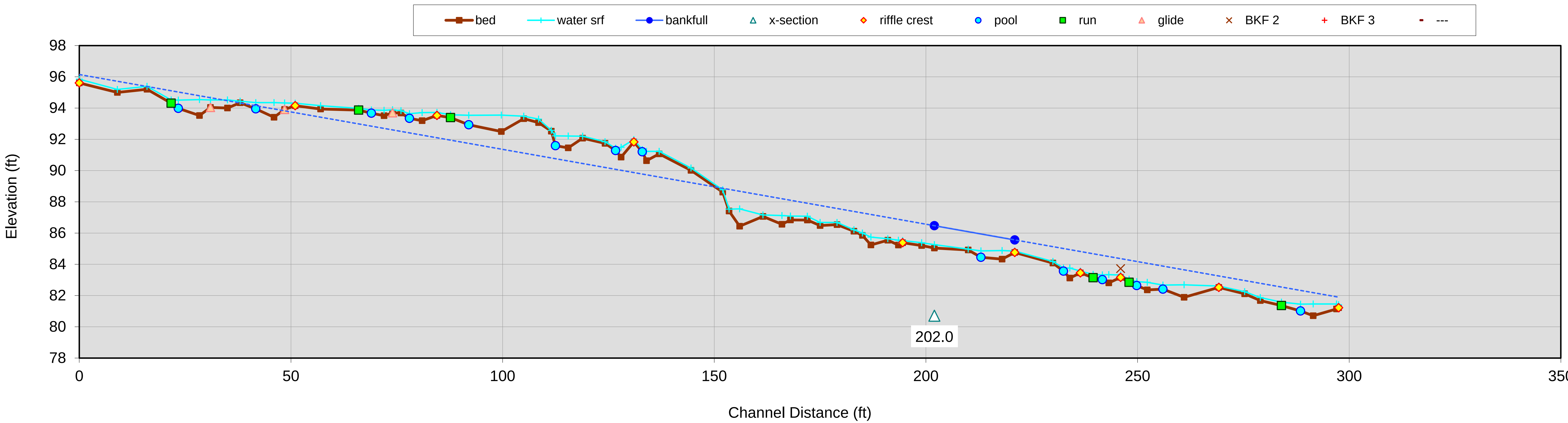

CA-5 Photo Point 303 Downstream


CA-5 Photo Point 303 at Abandoned Tributary

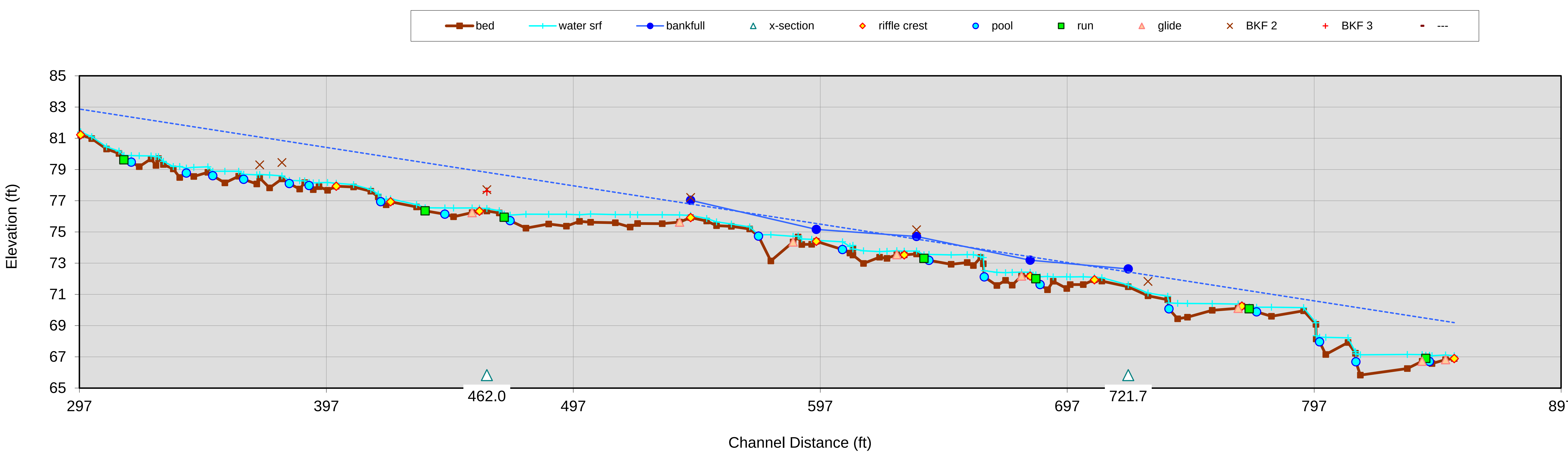

CA-5 Photo Point 304 Upstream at Confluence

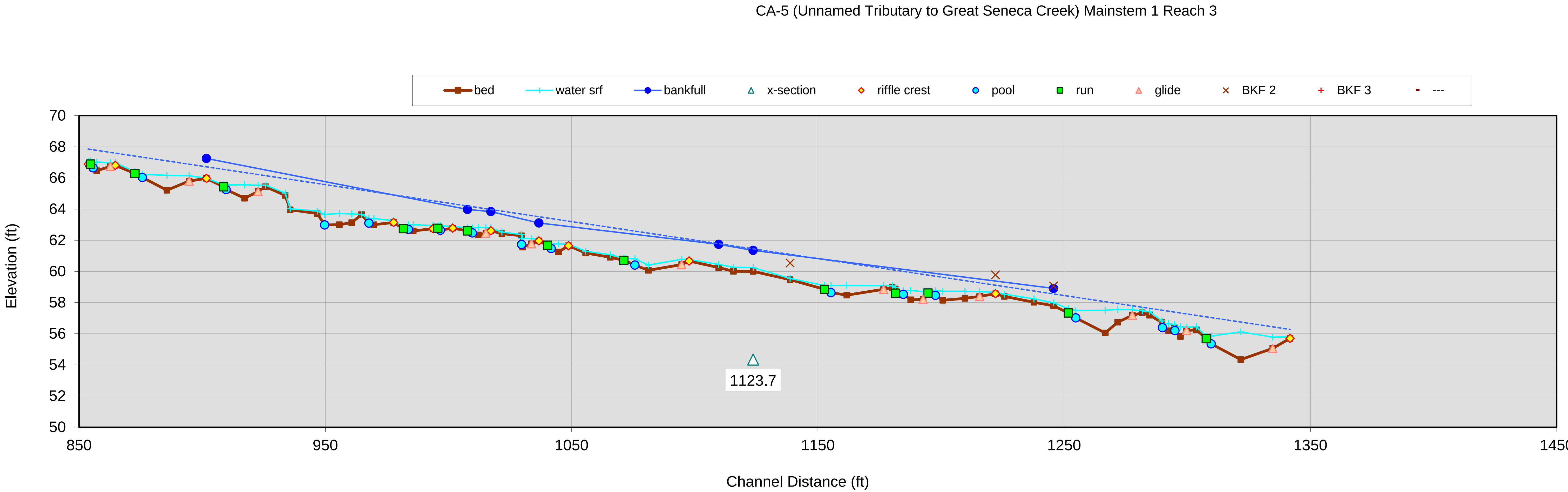
APPENDIX B. GEOMORPHIC DATA

CA-5 (Unnamed Tributary to Great Seneca Creek) Mainstem 1 Reach 1



CA-5 (Unnamed Tributary to Great Seneca Creek) Mainstem 1 Reach 2

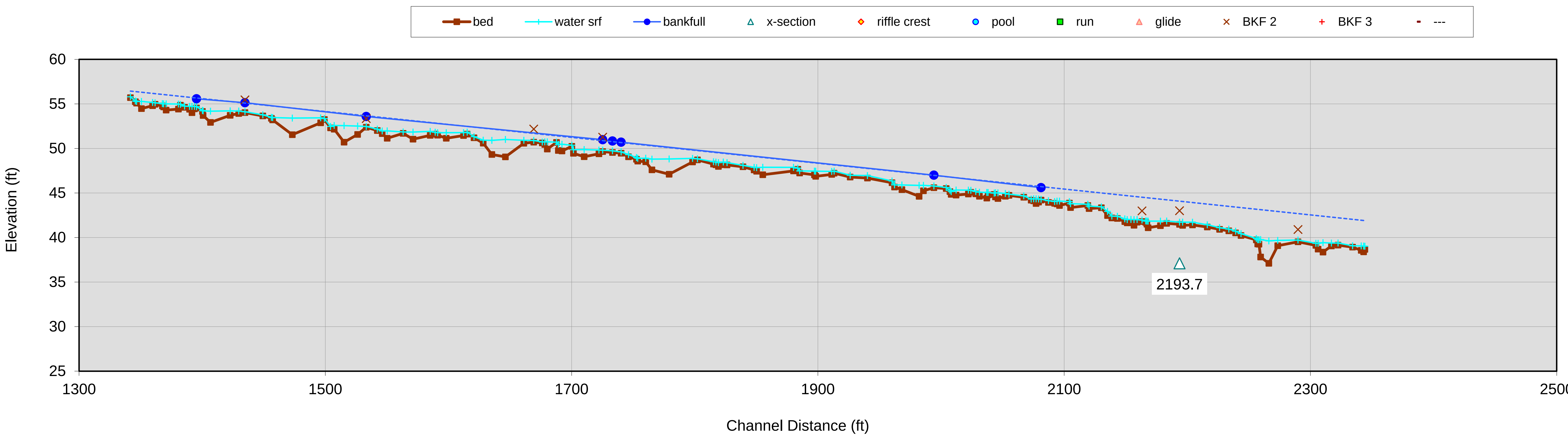




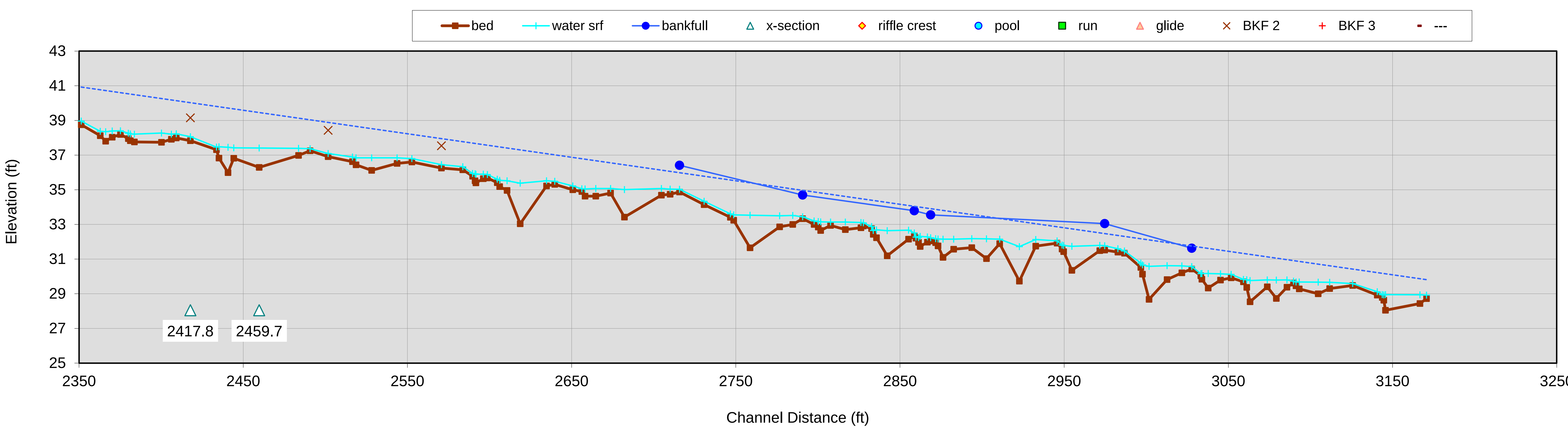
CA-5 (Unnamed Tributary to Great Seneca Creek) Mainstem 1 Reach 3
bed
water srf
bankfull
x-section
riffle crest
pool
run
glide
BKF 2
BKF 3

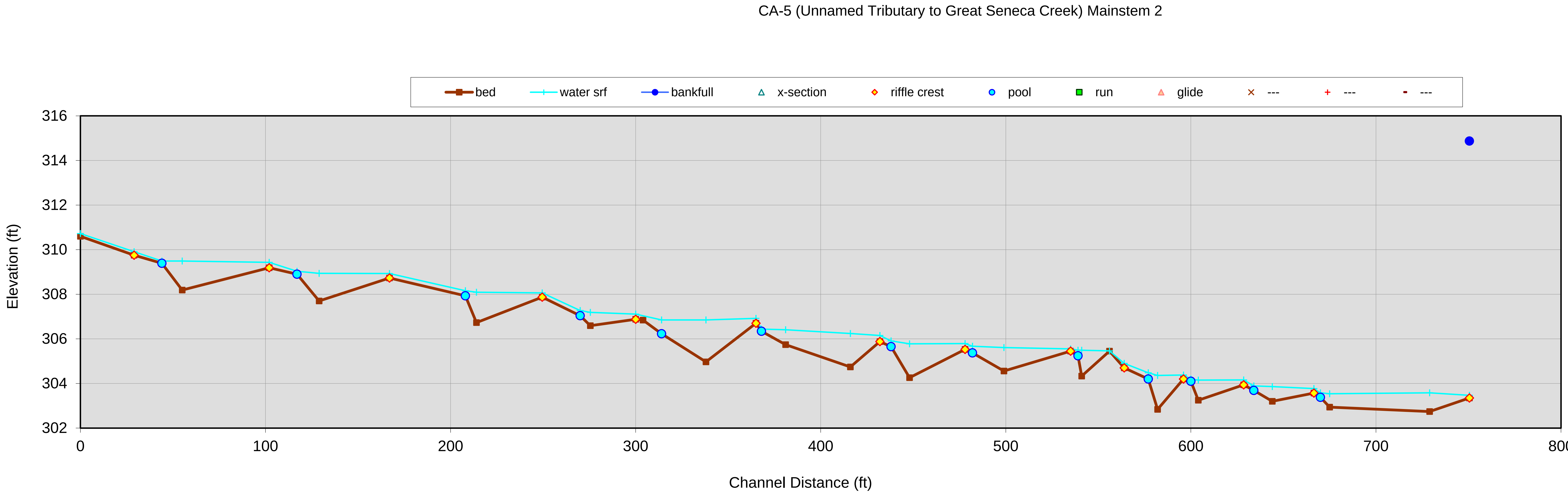
Elevation (ft)
70
68
66
64
62
60
58
56
54
52
50
1123.7
850
950
1050
1150
1250
1350
1450
Channel Distance (ft)

CA-5 (Unnamed Tributary to Great Seneca Creek) Mainstem 1 Reach 4

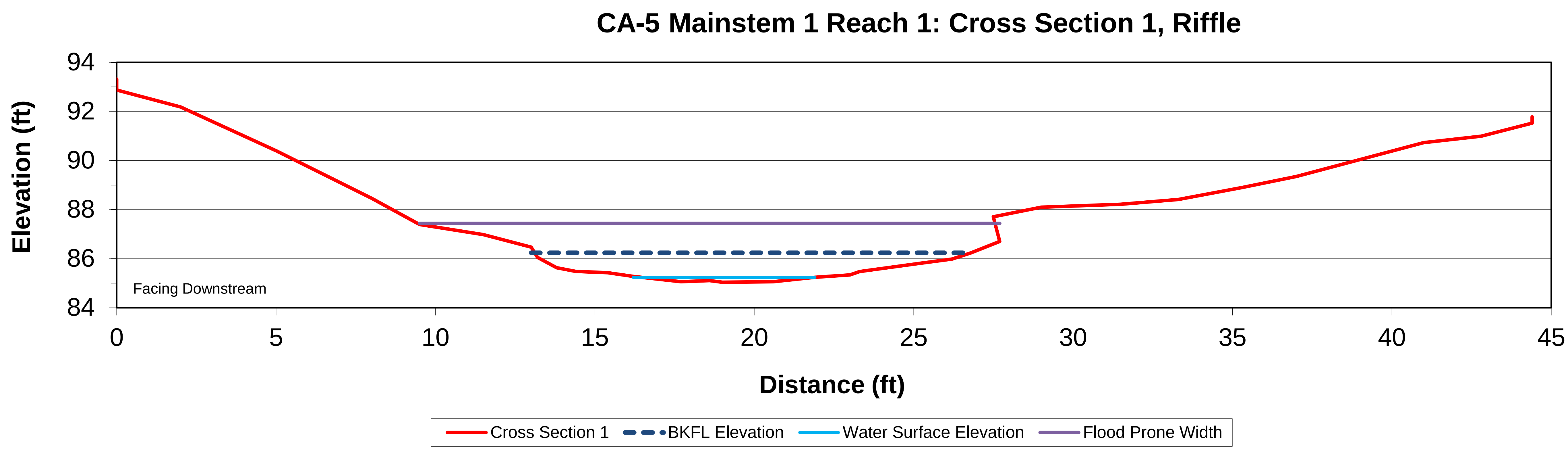


CA-5 (Unnamed Tributary to Great Seneca Creek) Mainstem 1 Reach 4 (cont'd)




CA-5 (Unnamed Tributary to Great Seneca Creek) Mainstem 2
bed
water srf
bankfull
x-section
riffle crest
pool
run
glide

Elevation (ft)
316
314
312
310
308
306
304
302
0
100
200
300
400
500
600
700
800
Channel Distance (ft)

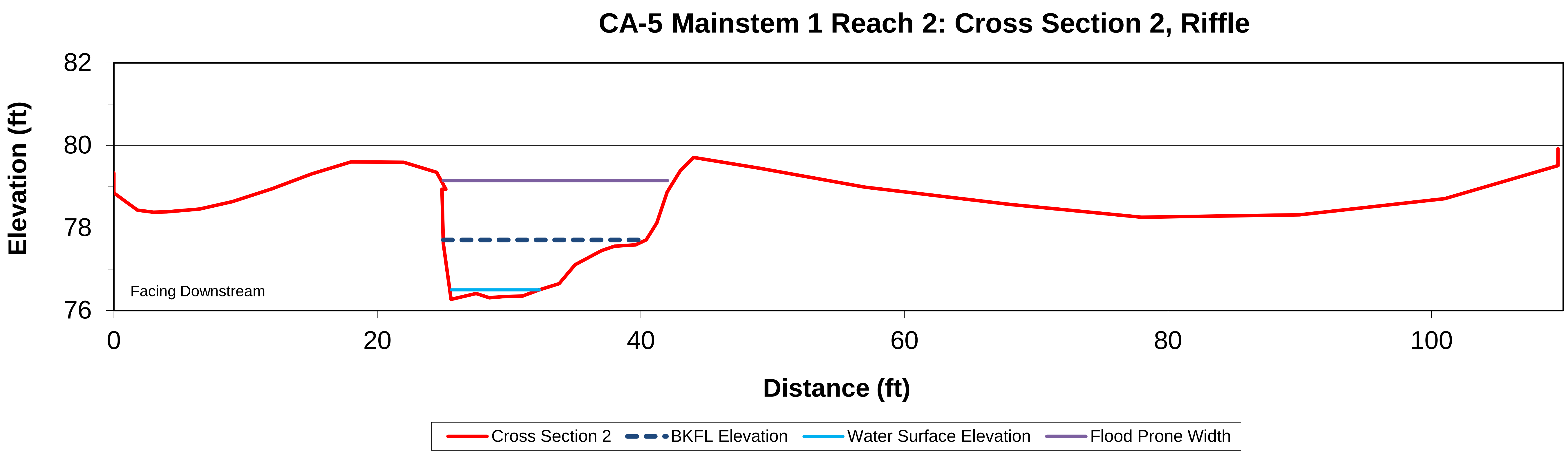


Left Bank

Facing Downstream

Facing Upstream

Right Bank

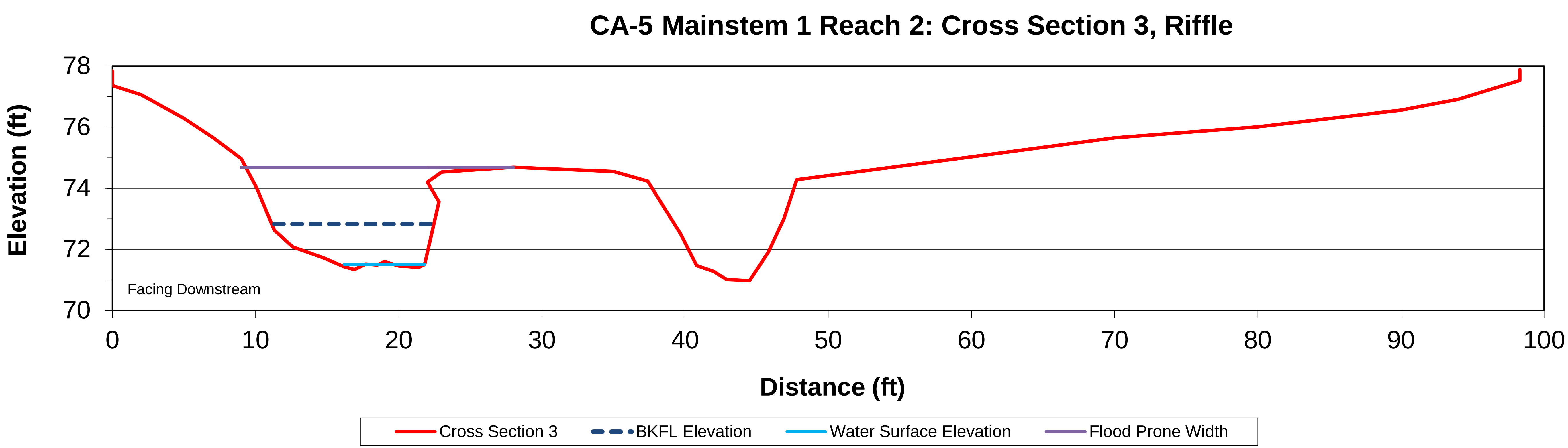


Left Bank

Facing Downstream

Facing Upstream

Right Bank



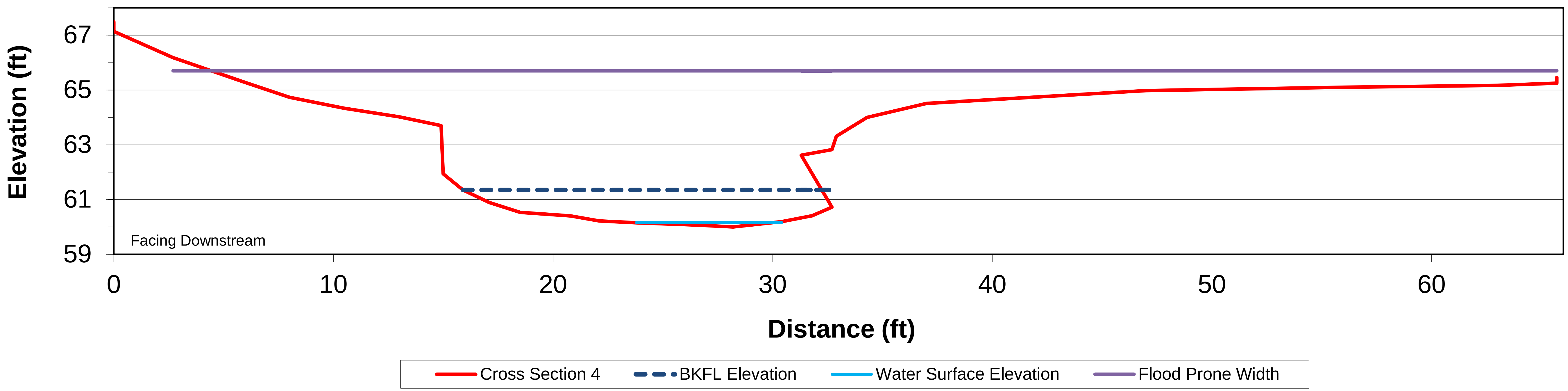
Left Bank

Facing Downstream

Facing Upstream

Right Bank

CA-5 Mainstem 1 Reach 3: Cross Section 4, Riffle

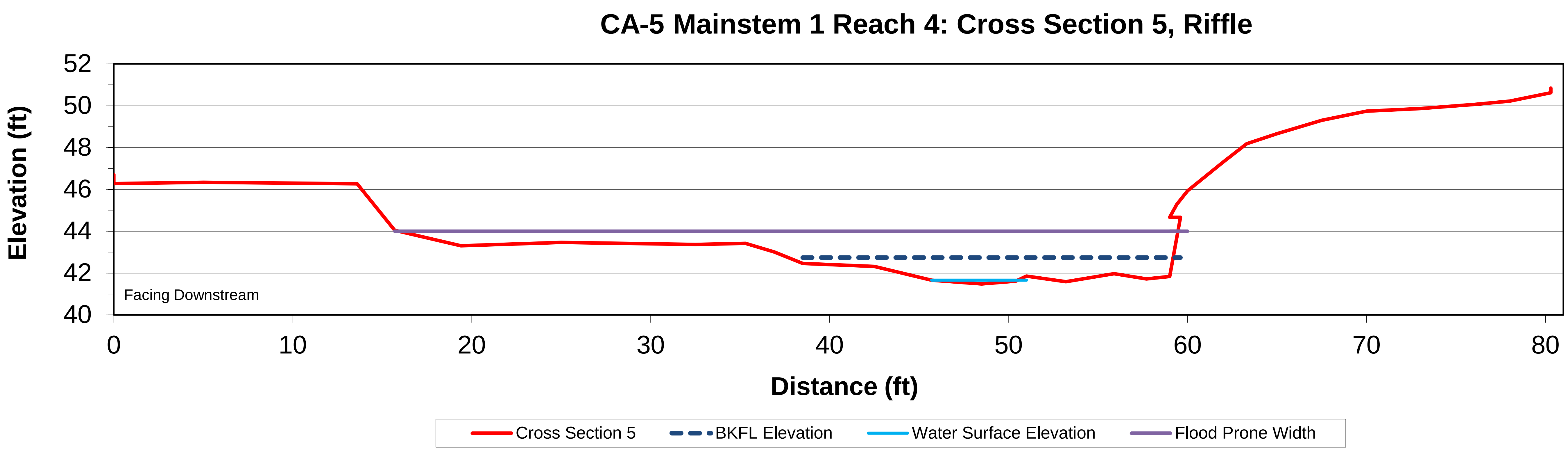


Left Bank

Facing Downstream

Facing Upstream

Right Bank

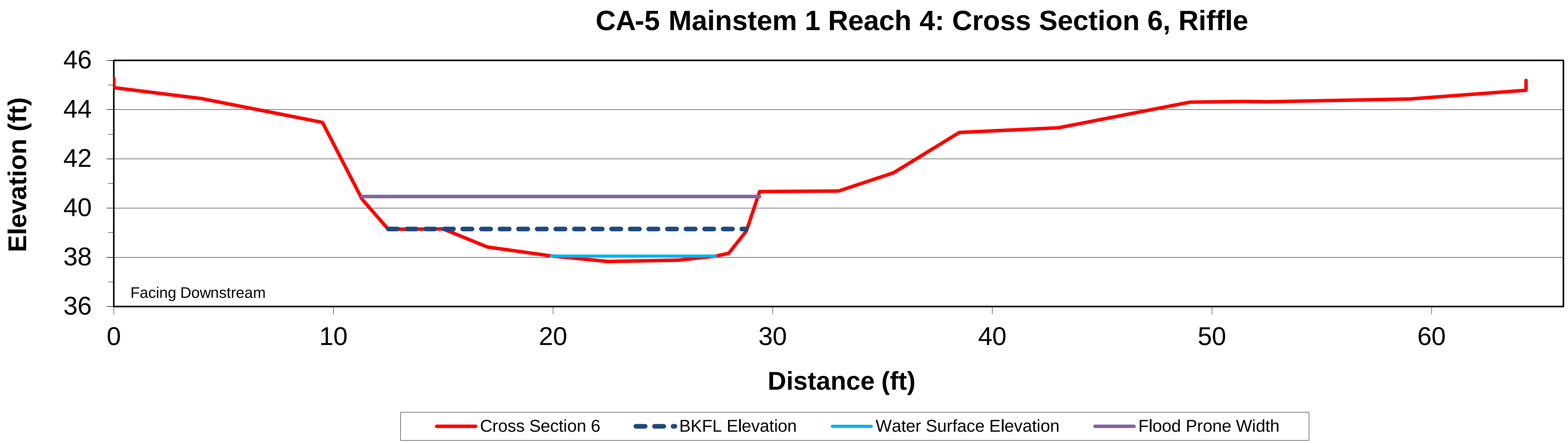


Left Bank

Facing Downstream

Facing Upstream

Right Bank

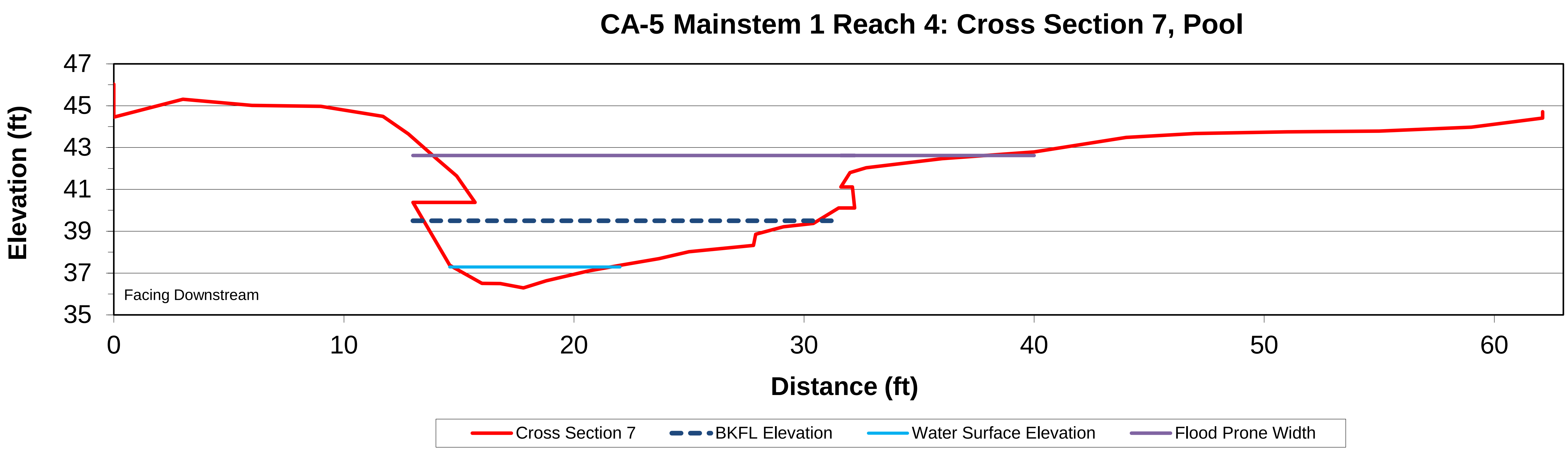


Left Bank

Facing Downstream

Facing Upstream

Right Bank

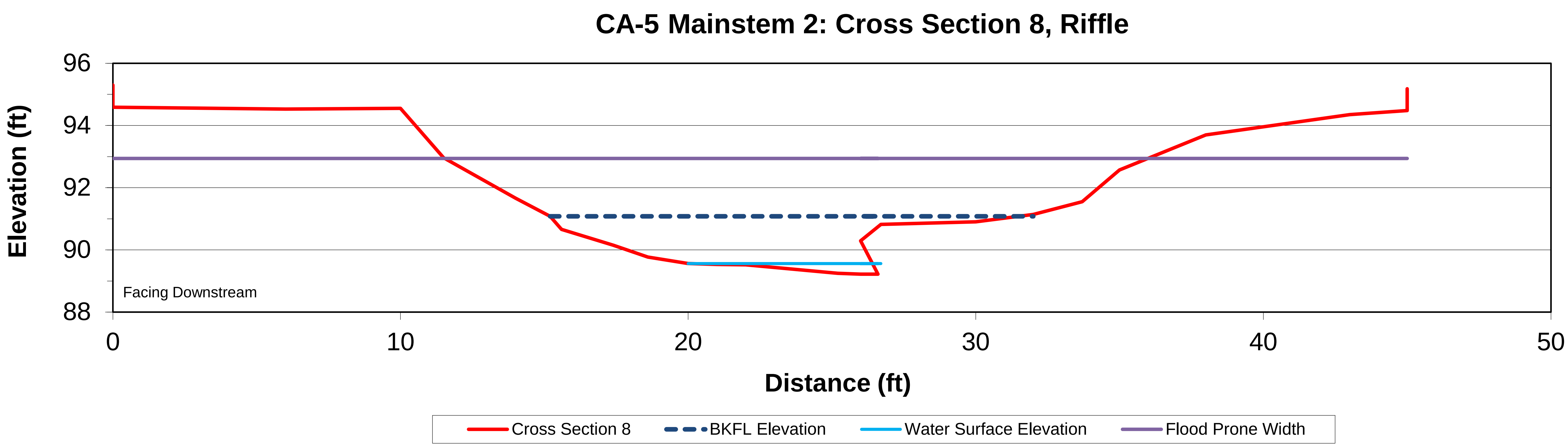


Left Bank

Facing Downstream

Facing Upstream

Right Bank

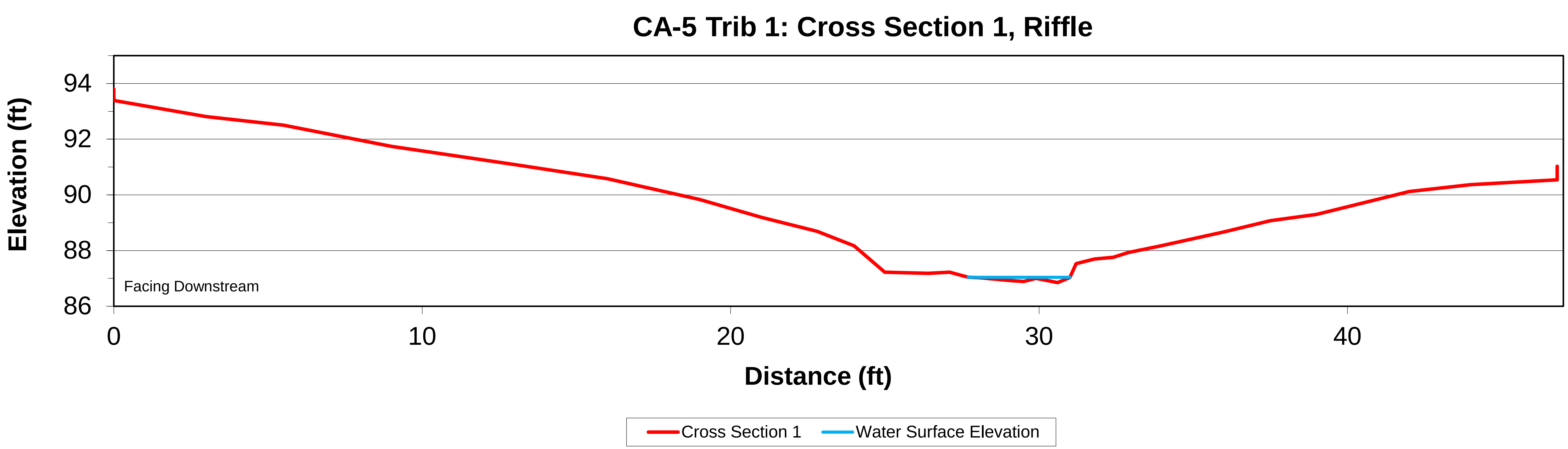


Left Bank

Facing Downstream

Facing Upstream

Right Bank

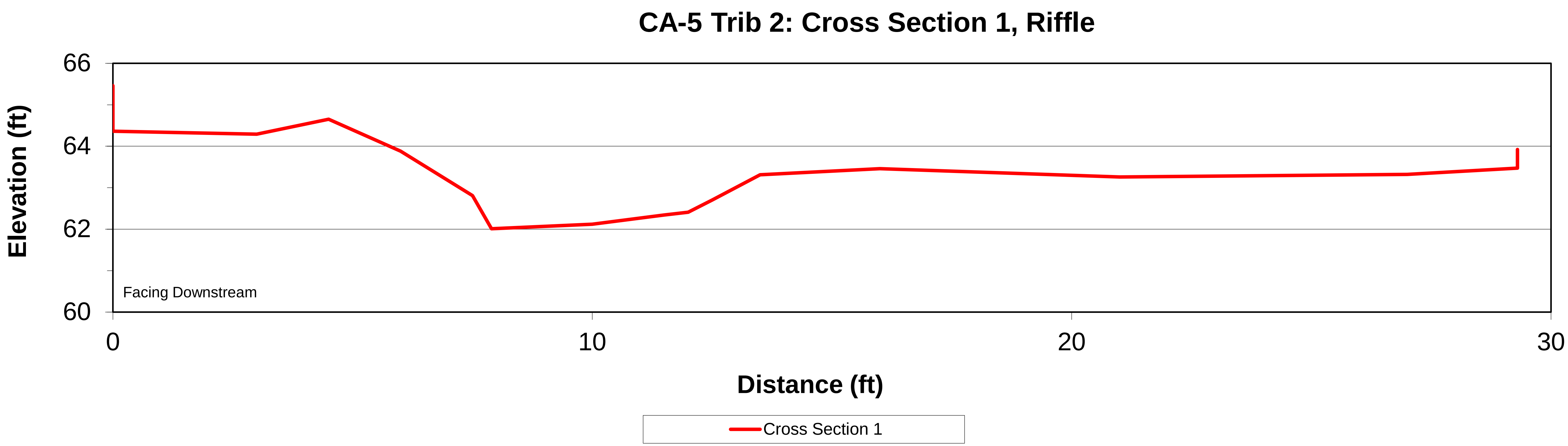


Left Bank

Facing Downstream

Facing Upstream

Right Bank



Left Bank

Facing Downstream

Facing Upstream

Right Bank

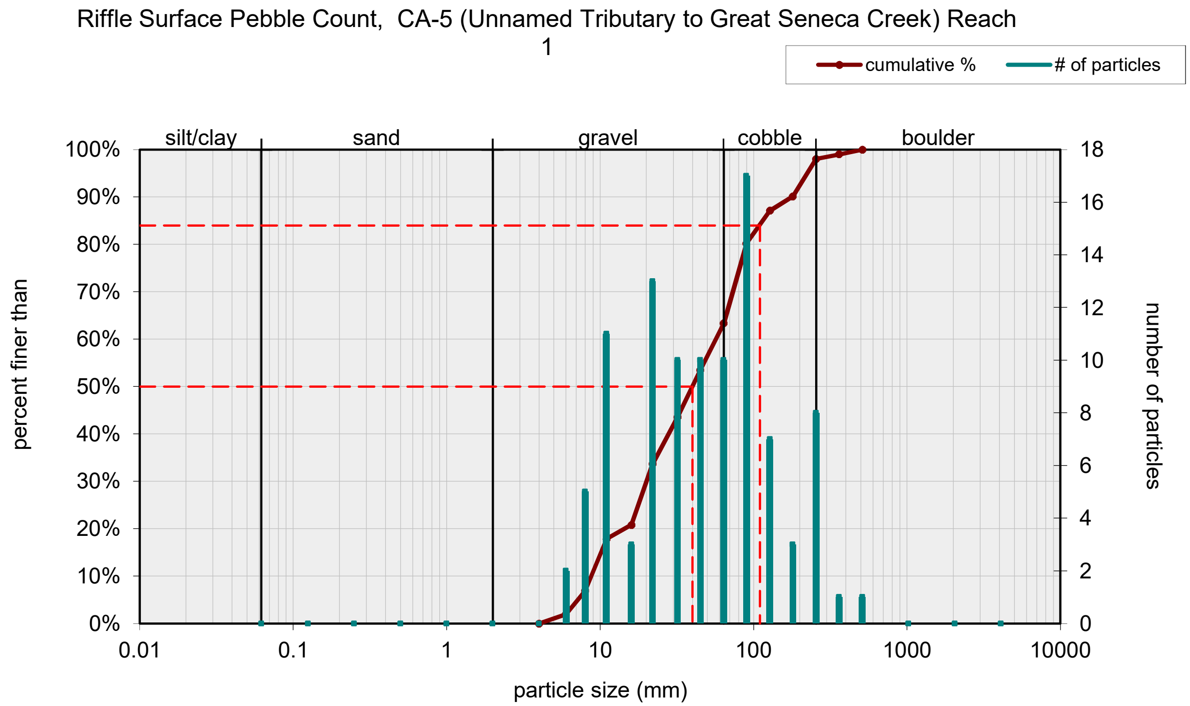
1) Individual Pebble Count

Two individual samples may be entered below. Select sample type for each.

Riffle Surface

Material	Size Range (mm)	Count
silt/clay	0 - 0.062	0
very fine sand	0.062 - 0.125	0
fine sand	0.125 - 0.25	0
medium sand	0.25 - 0.5	0
coarse sand	0.5 - 1	0
very coarse sand	1 - 2	0
very fine gravel	2 - 4	0
fine gravel	4 - 6	2
fine gravel	6 - 8	5
medium gravel	8 - 11	11
medium gravel	11 - 16	3
coarse gravel	16 - 22	13
coarse gravel	22 - 32	10
very coarse gravel	32 - 45	10
very coarse gravel	45 - 64	10
small cobble	64 - 90	17
medium cobble	90 - 128	7
large cobble	128 - 180	3
very large cobble	180 - 256	8
small boulder	256 - 362	1
small boulder	362 - 512	1
medium boulder	512 - 1024	0
large boulder	1024 - 2048	0
very large boulder	2048 - 4096	0
total particle count:		101
bedrock	-------------	
clay hardpan	-------------	
detritus/wood	-------------	
artificial	-------------	
total count:		101

Note: XS-1



Size (mm)	
D16	10
D35	23
D50	40
D65	66
D84	110
D95	220

Size Distribution	
mean	33.2
dispersion	3.4
skewness	-0.08

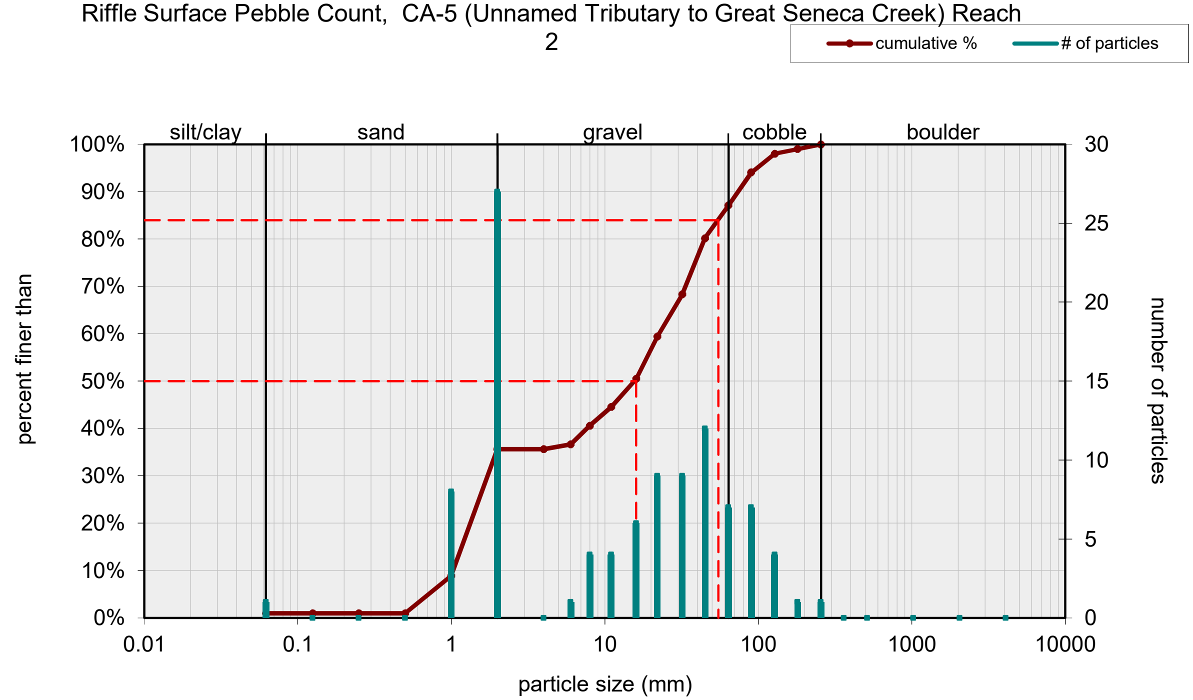
Type	
silt/clay	0%
sand	0%
gravel	63%
cobble	35%
boulder	2%

Riffle Surface

Material	Size Range (mm)	Count
silt/clay	0 - 0.062	1
very fine sand	0.062 - 0.125	0
fine sand	0.125 - 0.25	0
medium sand	0.25 - 0.5	0
coarse sand	0.5 - 1	8
very coarse sand	1 - 2	27
very fine gravel	2 - 4	0
fine gravel	4 - 6	1
fine gravel	6 - 8	4
medium gravel	8 - 11	4
medium gravel	11 - 16	6
coarse gravel	16 - 22	9
coarse gravel	22 - 32	9
very coarse gravel	32 - 45	12
very coarse gravel	45 - 64	7
small cobble	64 - 90	7
medium cobble	90 - 128	4
large cobble	128 - 180	1
very large cobble	180 - 256	1
small boulder	256 - 362	0
small boulder	362 - 512	0
medium boulder	512 - 1024	0
large boulder	1024 - 2048	0
very large boulder	2048 - 4096	0
total particle count:		101
bedrock	-------------	
clay hardpan	-------------	
detritus/wood	-------------	
artificial	-------------	
total count:		101

Note: XS-2

Riffle Surface Pebble Count, CA-5 (Unnamed Tributary to Great Seneca Creek) Reach 2



Size (mm)	
D16	1.2
D35	2
D50	16
D65	28
D84	55
D95	98

Size Distribution	
mean	8.1
dispersion	8.4
skewness	-0.23

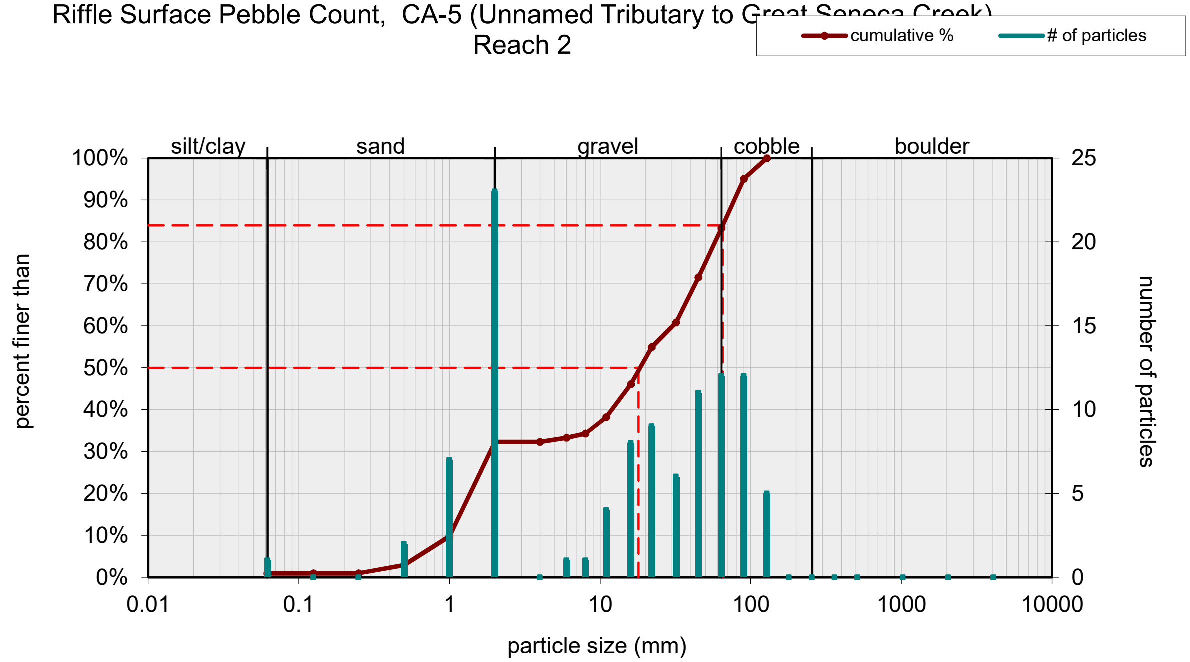
Type	
silt/clay	1%
sand	35%
gravel	51%
cobble	13%
boulder	0%

Riffle Surface

Material	Size Range (mm)	Count
silt/clay	0 - 0.062	1
very fine sand	0.062 - 0.125	0
fine sand	0.125 - 0.25	0
medium sand	0.25 - 0.5	2
coarse sand	0.5 - 1	7
very coarse sand	1 - 2	23
very fine gravel	2 - 4	0
fine gravel	4 - 6	1
fine gravel	6 - 8	1
medium gravel	8 - 11	4
medium gravel	11 - 16	8
coarse gravel	16 - 22	9
coarse gravel	22 - 32	6
very coarse gravel	32 - 45	11
very coarse gravel	45 - 64	12
small cobble	64 - 90	12
medium cobble	90 - 128	5
large cobble	128 - 180	0
very large cobble	180 - 256	0
small boulder	256 - 362	0
small boulder	362 - 512	0
medium boulder	512 - 1024	0
large boulder	1024 - 2048	0
very large boulder	2048 - 4096	0
	total particle count:	102
bedrock	---------------------	
clay hardpan	---------------------	
detritus/wood	---------------------	
artificial	---------------------	
	total count:	102

Note: XS-3

Riffle Surface Pebble Count, CA-5 (Unnamed Tributary to Great Seneca Creek) Reach 2



Size (mm)			
D16	1.2	3.4	
D35	8.5	12	
D50	18	17	
D65	37	20	
D84	65	29	
D95	90	39	

Size Distribution	
mean	8.8
dispersion	9.3
skewness	-0.23

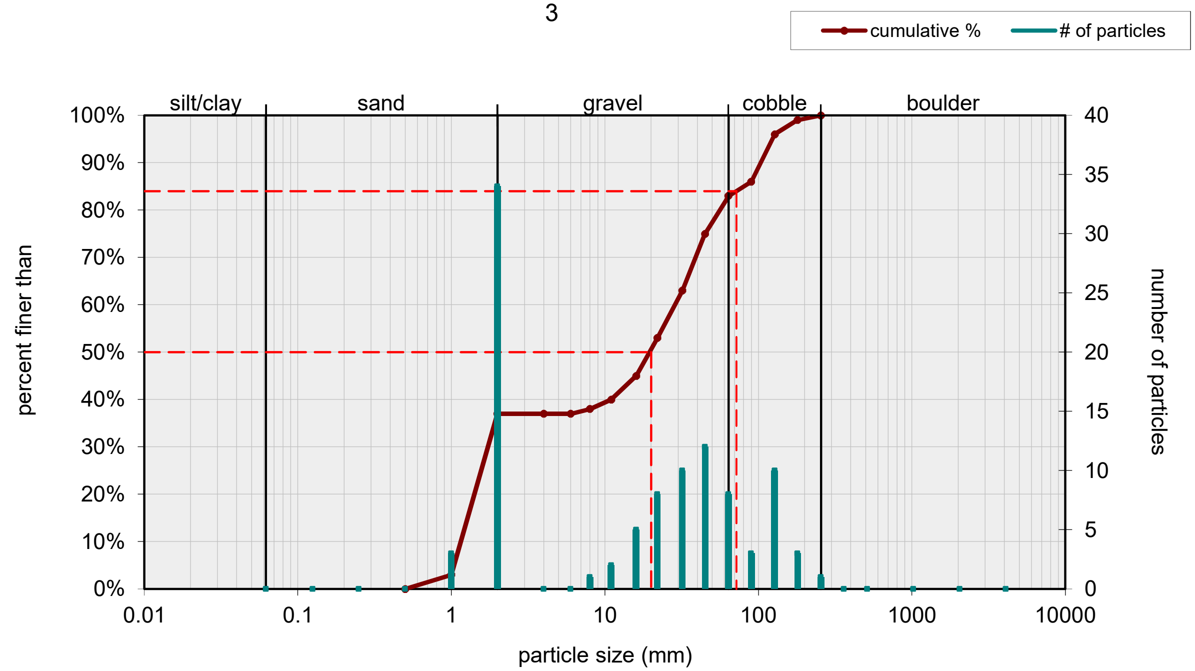
Type	
silt/clay	1%
sand	31%
gravel	51%
cobble	17%
boulder	0%

Riffle Surface

Material	Size Range (mm)	Count
silt/clay	0 - 0.062	0
very fine sand	0.062 - 0.125	0
fine sand	0.125 - 0.25	0
medium sand	0.25 - 0.5	0
coarse sand	0.5 - 1	3
very coarse sand	1 - 2	34
very fine gravel	2 - 4	0
fine gravel	4 - 6	0
fine gravel	6 - 8	1
medium gravel	8 - 11	2
medium gravel	11 - 16	5
coarse gravel	16 - 22	8
coarse gravel	22 - 32	10
very coarse gravel	32 - 45	12
very coarse gravel	45 - 64	8
small cobble	64 - 90	3
medium cobble	90 - 128	10
large cobble	128 - 180	3
very large cobble	180 - 256	1
small boulder	256 - 362	0
small boulder	362 - 512	0
medium boulder	512 - 1024	0
large boulder	1024 - 2048	0
very large boulder	2048 - 4096	0
total particle count:		100
bedrock	-------------	
clay hardpan	-------------	
detritus/wood	-------------	
artificial	-------------	
total count:		100

Note: XS-4

Riffle Surface Pebble Count, CA-5 (Unnamed Tributary to Great Seneca Creek) Reach 3



Size (mm)	
D16	1.3
D35	1.9
D50	20
D65	34
D84	72
D95	120

Size Distribution	
mean	9.7
dispersion	9.5
skewness	-0.24

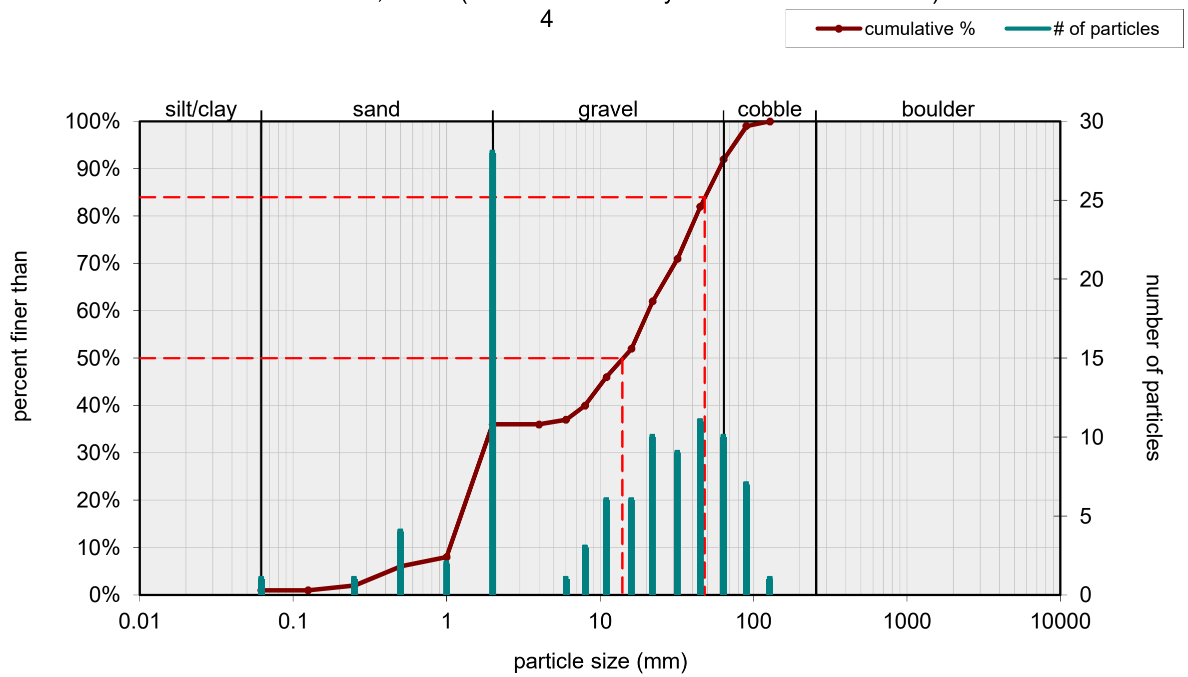
Type	
silt/clay	0%
sand	37%
gravel	46%
cobble	17%
boulder	0%

Riffle Surface

Material	Size Range (mm)	Count
silt/clay	0 - 0.062	1
very fine sand	0.062 - 0.125	
fine sand	0.125 - 0.25	1
medium sand	0.25 - 0.5	4
coarse sand	0.5 - 1	2
very coarse sand	1 - 2	28
very fine gravel	2 - 4	
fine gravel	4 - 6	1
fine gravel	6 - 8	3
medium gravel	8 - 11	6
medium gravel	11 - 16	6
coarse gravel	16 - 22	10
coarse gravel	22 - 32	9
very coarse gravel	32 - 45	11
very coarse gravel	45 - 64	10
small cobble	64 - 90	7
medium cobble	90 - 128	1
large cobble	128 - 180	
very large cobble	180 - 256	
small boulder	256 - 362	
small boulder	362 - 512	
medium boulder	512 - 1024	
large boulder	1024 - 2048	
very large boulder	2048 - 4096	
total particle count:		100
bedrock		
clay hardpan		
detritus/wood		
artificial		
total count:		100

Note: XS-5

Riffle Surface Pebble Count, CA-5 (Unnamed Tributary to Great Seneca Creek) Reach 4



Size (mm)	
D16	1.2
D35	2
D50	14
D65	25
D84	48
D95	74

Size Distribution	
mean	7.6
dispersion	7.5
skewness	-0.21

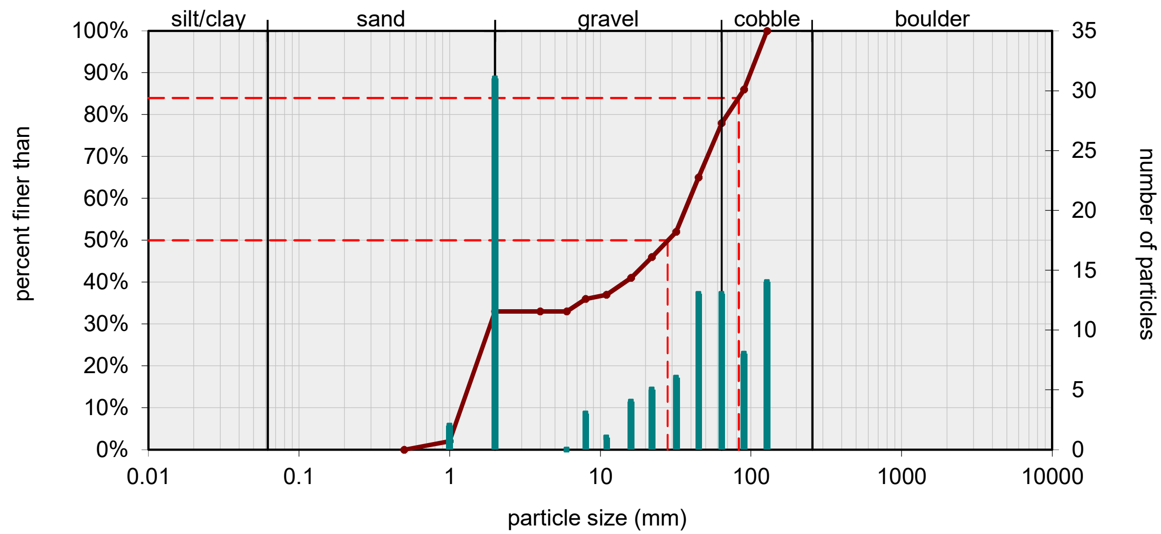
Type	
silt/clay	1%
sand	35%
gravel	56%
cobble	8%
boulder	0%

Riffle Surface

Material	Size Range (mm)	Count
silt/clay	0 - 0.062	
very fine sand	0.062 - 0.125	
fine sand	0.125 - 0.25	
medium sand	0.25 - 0.5	
coarse sand	0.5 - 1	2
very coarse sand	1 - 2	31
very fine gravel	2 - 4	
fine gravel	4 - 6	0
fine gravel	6 - 8	3
medium gravel	8 - 11	1
medium gravel	11 - 16	4
coarse gravel	16 - 22	5
coarse gravel	22 - 32	6
very coarse gravel	32 - 45	13
very coarse gravel	45 - 64	13
small cobble	64 - 90	8
medium cobble	90 - 128	14
large cobble	128 - 180	
very large cobble	180 - 256	
small boulder	256 - 362	
small boulder	362 - 512	
medium boulder	512 - 1024	
large boulder	1024 - 2048	
very large boulder	2048 - 4096	
	total particle count:	100
bedrock		
clay hardpan		
detritus/wood		
artificial		
	total count:	100

Note: XS-6

Riffle Surface Pebble Count, CA-5 (Unnamed Tributary to Great Seneca Creek)
Reach 4



Size (mm)		
D16	1.4	3.4
D35	7.3	12
D50	28	17
D65	45	20
D84	83	29
D95	110	39

Size Distribution	
mean	10.8
dispersion	11.5
skewness	-0.31

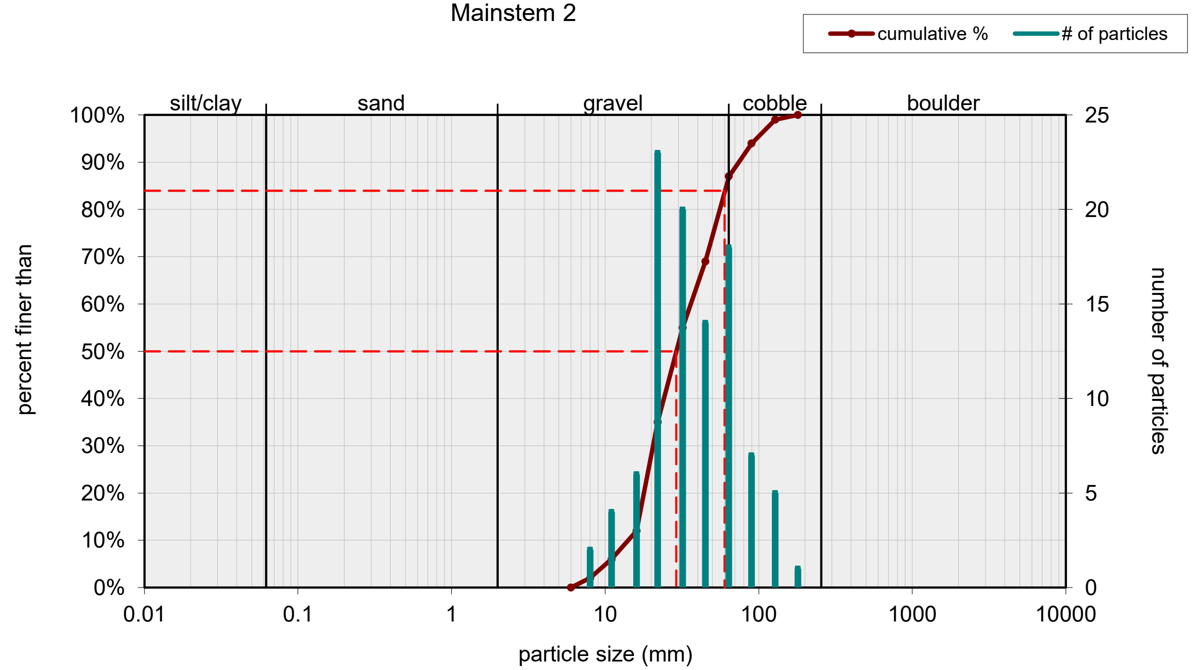
Type	
silt/clay	0%
sand	33%
gravel	45%
cobble	22%
boulder	0%

Riffle Surface

Material	Size Range (mm)	Count
silt/clay	0 - 0.062	
very fine sand	0.062 - 0.125	
fine sand	0.125 - 0.25	
medium sand	0.25 - 0.5	
coarse sand	0.5 - 1	
very coarse sand	1 - 2	
very fine gravel	2 - 4	
fine gravel	4 - 6	
fine gravel	6 - 8	2
medium gravel	8 - 11	4
medium gravel	11 - 16	6
coarse gravel	16 - 22	23
coarse gravel	22 - 32	20
very coarse gravel	32 - 45	14
very coarse gravel	45 - 64	18
small cobble	64 - 90	7
medium cobble	90 - 128	5
large cobble	128 - 180	1
very large cobble	180 - 256	
small boulder	256 - 362	
small boulder	362 - 512	
medium boulder	512 - 1024	
large boulder	1024 - 2048	
very large boulder	2048 - 4096	
total particle count:		100
bedrock	-------------	
clay hardpan	-------------	
detritus/wood	-------------	
artificial	-------------	
total count:		100

Note: XS-8

Riffle Surface Pebble Count, CA-5 (Unnamed Tributary to Great Seneca Creek)
Mainstem 2



Size (mm)	
D16	17
D35	22
D50	29
D65	41
D84	60
D95	97

Size Distribution	
mean	31.9
dispersion	1.9
skewness	0.06

Type	
silt/clay	0%
sand	0%
gravel	87%
cobble	13%
boulder	0%

3) Bulk Sample Sieve Analysis

Two samples may be entered below. Select sample type for each.

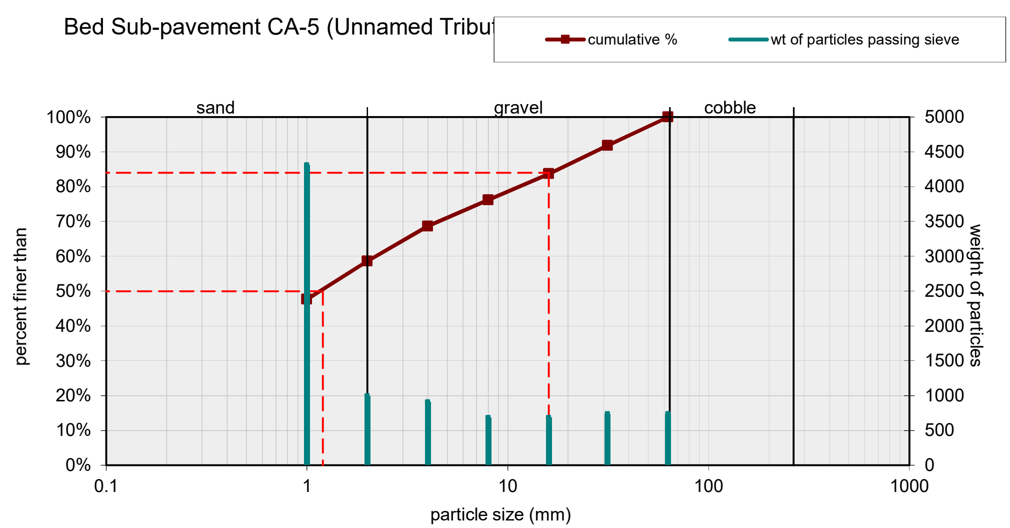
Bed Sub-pavement

Sieve Size (mm)	Sieve Weight (g)	Sieve & Sample Weight (g)	Retained on Sieve (g)		Passing Sieve	
Bucket	850.485	5159.61	4309	48%	---	---
1	1247.38	2239.61	992	11%	48%	48%
2	481.942	1389.13	907	10%	11%	59%
4	510.291	1190.68	680	8%	10%	69%
8	510.291	1190.68	680	8%	8%	76%
16	538.641	1275.73	737	8%	8%	84%
31.5	538.6405	1275.73	737	8%	8%	92%
63	538.641		0	0%	8%	100%

total wt retained in sieves: 9043

Note: XS-2

Bed Sub-pavement CA-5 (Unnamed Tribut



	Size (mm)		
D16	---	D65	3.1
D35	---	D84	16
D50	1.2	D95	41

sand 100%

3) Bulk Sample Sieve Analysis

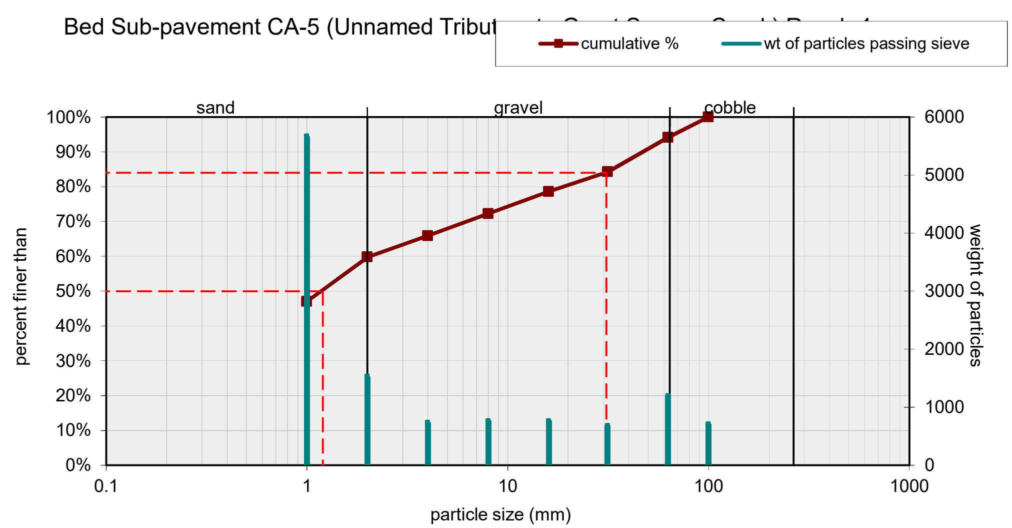
Two samples may be entered below. Select sample type for each.

Bed Sub-pavement

Sieve Size (mm)	Sieve Weight (g)	Sieve & Sample Weight (g)	Retained on Sieve (g)		Passing Sieve	
Bucket	850.485	6520.39	5670	47%	---	---
1	1247.38	2778.25	1531	13%	47%	47%
2	481.942	1219.03	737	6%	13%	60%
4	510.291	1275.73	765	6%	6%	66%
8	510.291	1275.73	765	6%	6%	72%
16	538.641	1219.03	680	6%	6%	79%
31.5	538.6405	1729.32	1191	10%	6%	84%
63	538.641	1247.38	709	6%	10%	94%
100	538.641		0	0%	6%	100%

total wt retained in sieves: 12049

Note: XS-6



	Size (mm)		
D16	---	D65	3.6
D35	---	D84	31
D50	1.2	D95	68

sand 100%

I-495 & I-270 Managed Lanes Study
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Stream Site CA-5: Great Seneca Creek
Bradbury Dr. Tributary
Appendix B: CA-5 Bank Erosion Map
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Erosion Rate (ft/yr)

- 0.042 - 0.113
- 0.113 - 0.398
- 0.398 - 1.023
- 1.023 - 1.707
- 1.707 - 3.367
- No Erosion
- Evaluated Reaches
- Trails
- Foot Path
- Study Area

1 inch = 20 feet

0 10 20

Feet

COASTAL RESOURCES INC.

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Erosion Rate (ft/yr)

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- 0.113 - 0.398
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- 1.023 - 1.707
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- No Erosion
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- Foot Path
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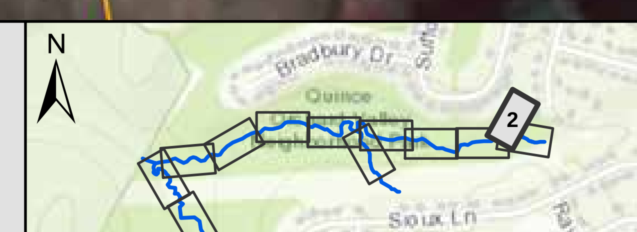

1 inch = 20 feet
0 10 20
Feet

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Erosion Rate (ft/yr)

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- 0.113 - 0.398
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- 1.023 - 1.707
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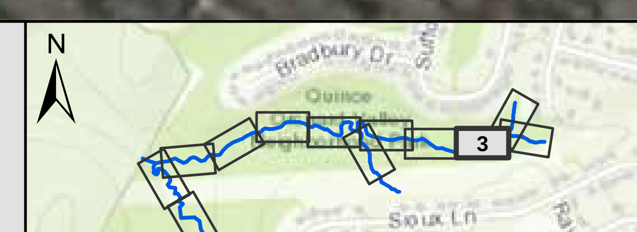
- Foot Path
- Study Area



1 inch = 20 feet
0 10 20
Feet

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Erosion Rate (ft/yr)

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- 0.113 - 0.398
- 0.398 - 1.023
- 1.023 - 1.707
- 1.707 - 3.367
- No Erosion
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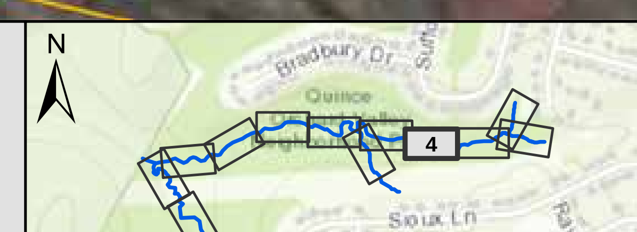
- Trails
- Foot Path
- Study Area



1 inch = 20 feet
0 10 20
Feet

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Erosion Rate (ft/yr)

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- 0.113 - 0.398
- 0.398 - 1.023
- 1.023 - 1.707
- 1.707 - 3.367
- No Erosion
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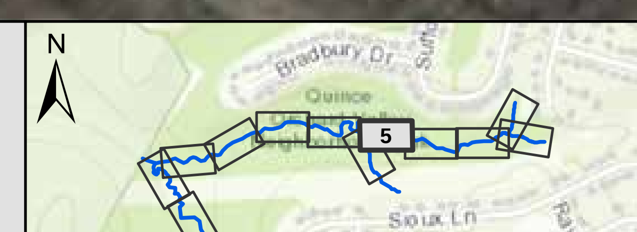
- Trails
- Foot Path
- Study Area



1 inch = 20 feet
0 10 20
Feet

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Erosion Rate (ft/yr)

- 0.042 - 0.113
- 0.113 - 0.398
- 0.398 - 1.023
- 1.023 - 1.707
- 1.707 - 3.367
- No Erosion
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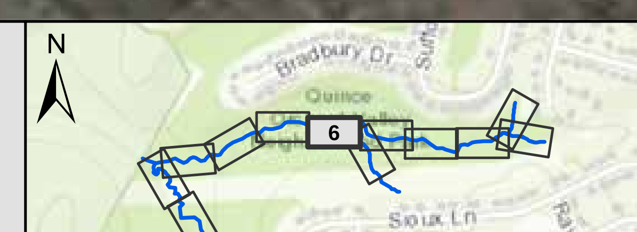

1 inch = 20 feet
0 10 20
Feet

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Erosion Rate (ft/yr)

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- 0.398 - 1.023
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1 inch = 20 feet
0 10 20
Feet

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Erosion Rate (ft/yr)

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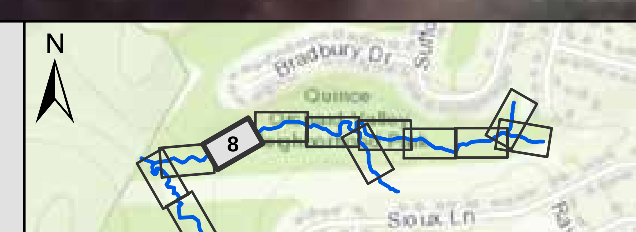

1 inch = 20 feet

0 10 20

Feet

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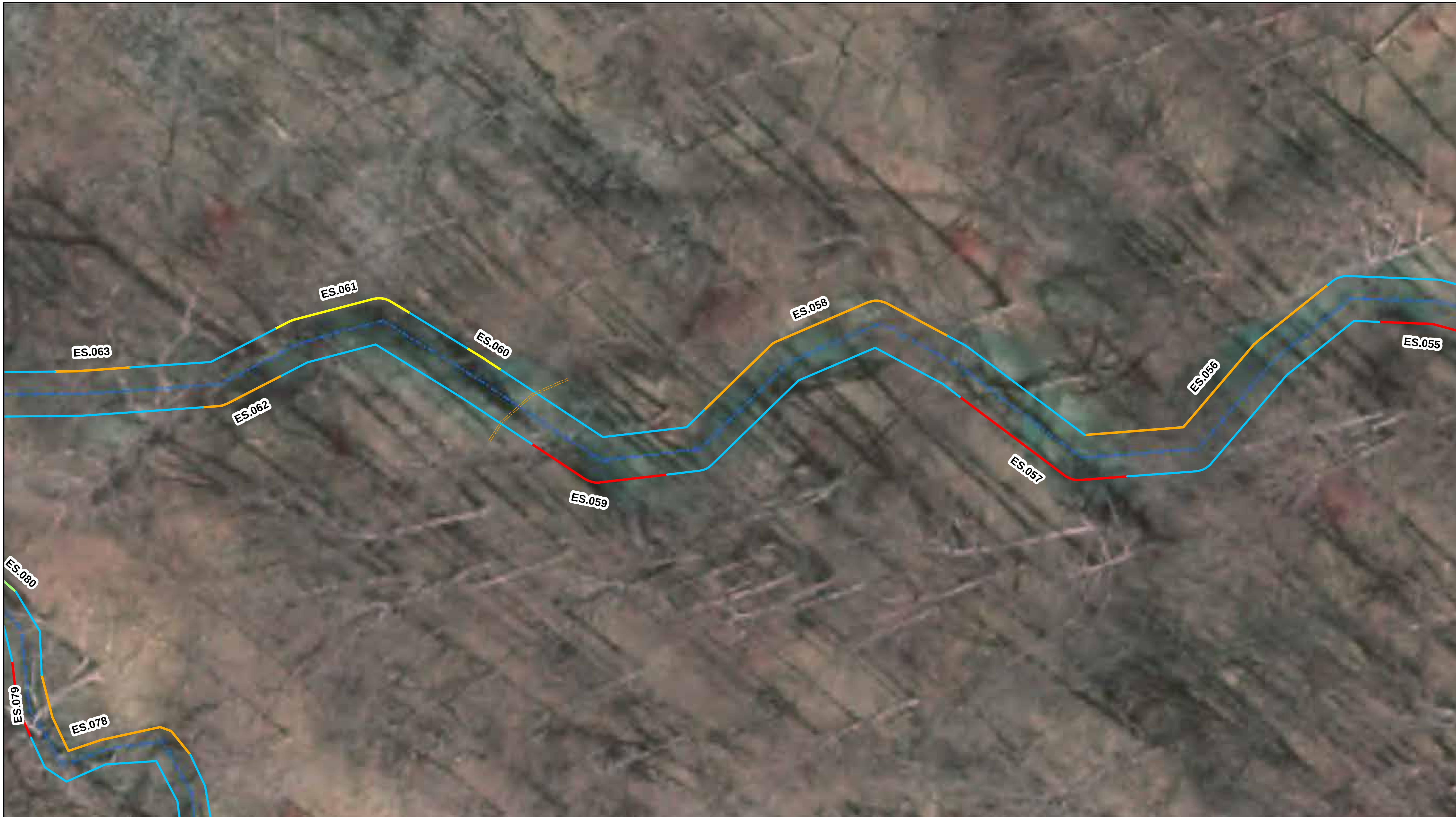

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Erosion Rate (ft/yr)

- 0.042 - 0.113
- 0.113 - 0.398
- 0.398 - 1.023
- 1.023 - 1.707
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1 inch = 20 feet
0 10 20
Feet

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Erosion Rate (ft/yr)

- 0.042 - 0.113
- 0.113 - 0.398
- 0.398 - 1.023
- 1.023 - 1.707
- 1.707 - 3.367
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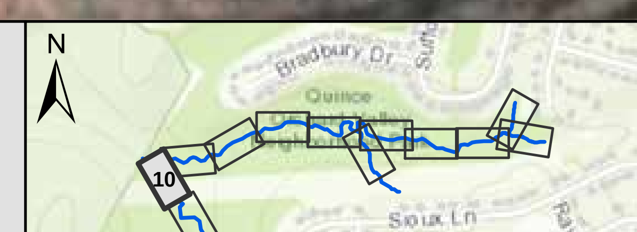

1 inch = 20 feet
0 10 20
Feet

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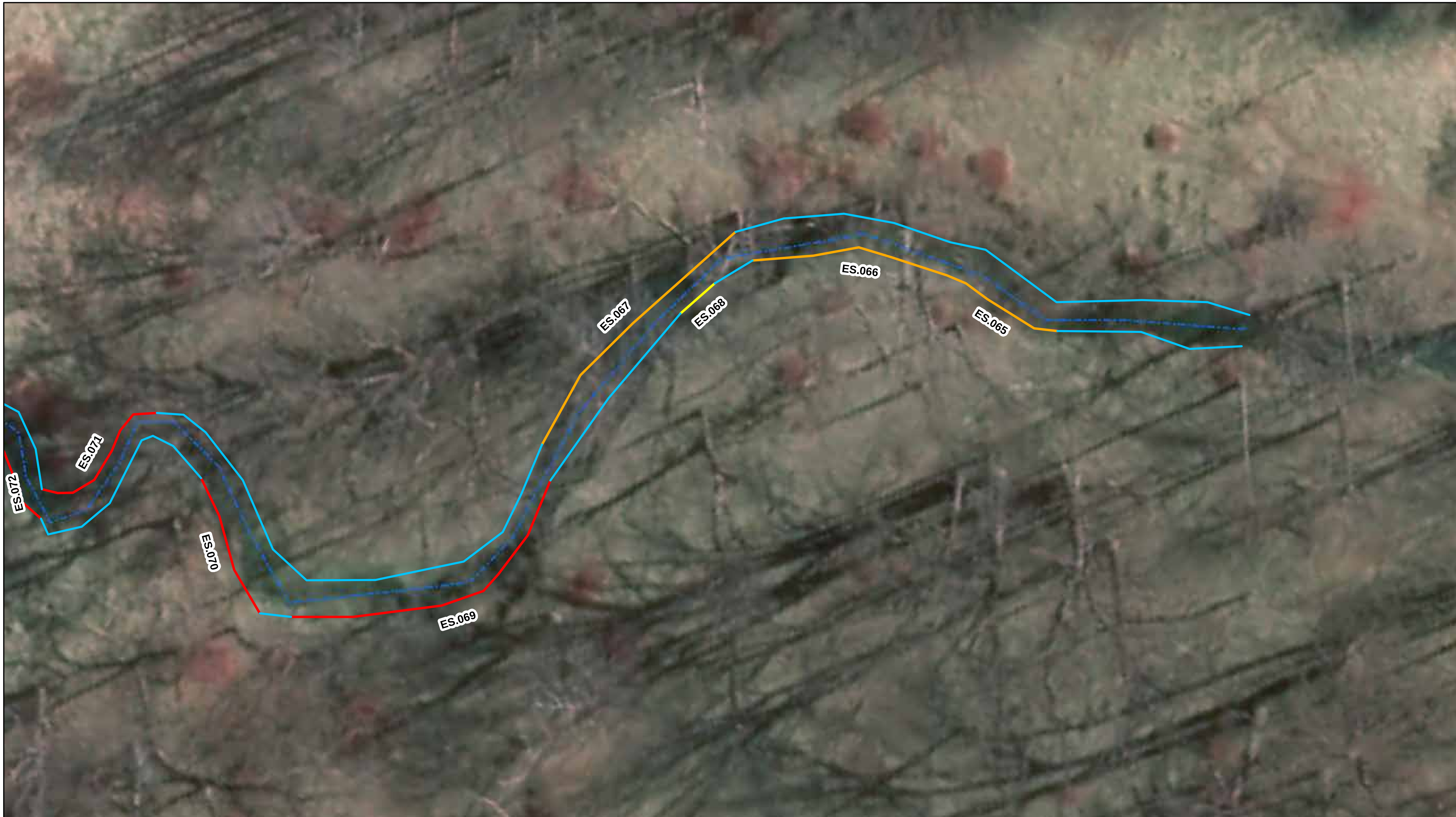

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Erosion Rate (ft/yr)

- 0.042 - 0.113
- 0.113 - 0.398
- 0.398 - 1.023
- 1.023 - 1.707
- 1.707 - 3.367
- No Erosion
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- Foot Path
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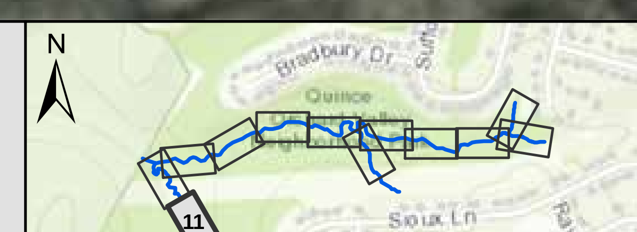

1 inch = 20 feet
0 10 20
Feet

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270 495 MANAGED LANES STUDY

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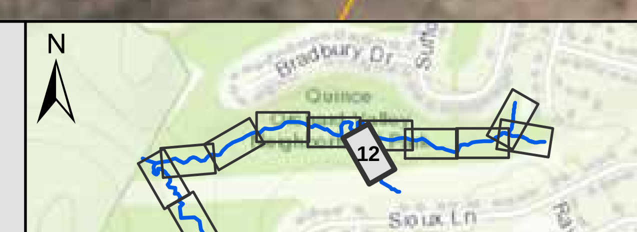
Erosion Rate (ft/yr)

- 0.042 - 0.113
- 0.113 - 0.398
- 0.398 - 1.023
- 1.023 - 1.707
- 1.707 - 3.367
- No Erosion
- Evaluated Reaches
- Trails
- Foot Path
- Study Area



1 inch = 20 feet
0 10 20
Feet

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495 270 MANAGED LANES STUDY

CA-5
BANCS Assessment

			Step 1				USFWS Draft DC					
ID	Length	Bank	A. Study Bank Height	BEHI Rating	NBS Method	NBS Rating	NBS x-value	Area (sf)	Erosion Rate (ft/yr)	Sediment Load (ton/yr)	Sediment Load per ft (ton/yr/ft)	Sediment Load per ft (ton/yr/ft)
ES.001	21.3687	Left	4.0	Very High	1	High	4	85.474984	1.023	5.466	0.256	0.256
ES.002	59.0784	Right	3.0	High	1	Moderate	3	177.2352	0.638	7.068	0.120	0.120
ES.003	49.7592	Left	4.0	Very High	1	Extreme	6	199.03673	2.631	32.735	0.658	0.658
ES.004	37.4131	Right	4.0	High	1	Extreme	6	149.65224	2.631	24.613	0.658	0.658
ES.005	45.1667	Right	4.0	Moderate	1	Moderate	3	180.6668	0.303	3.424	0.076	0.076
ES.006	46.6302	Left	4.0	High	1	Moderate	3	186.52083	0.638	7.438	0.160	0.160
ES.007	48.6425	Right	5.0	Very High	1	Moderate	3	243.21247	0.638	9.699	0.199	0.199
ES.008	71.9345	Left	3.0	High	1	Very High	5	215.80343	1.641	22.132	0.308	0.308
ES.009	32.6549	Right	3.0	Very High	1	Very High	5	97.964784	1.641	10.047	0.308	0.308
ES.010	47.3352	Left	3.0	Moderate	1	Moderate	3	142.00558	0.303	2.691	0.057	0.057
ES.011	27.7578	Right	3.0	Moderate	1	Moderate	3	83.273271	0.303	1.578	0.057	0.057
ES.012	8.20068	Left	1.0	High	1	Low	2	8.2006815	0.398	0.204	0.025	0.025
ES.013	12.9206	Left	3.0	High	1	Very High	5	38.761942	1.641	3.975	0.308	0.308
ES.014	70.9233	Right	2.0	Very High	1	Very High	5	141.84666	1.641	14.547	0.205	0.205
ES.015	37.1635	Right	4	Very High	1	Very High	5	148.65397	1.641	15.245	0.410	0.410
ES.016	26.0118	Left	5	High	1	Very High	5	130.05919	1.641	13.338	0.513	0.513
ES.017	20.6506	Right	3	High	1	Moderate	3	61.951831	0.638	2.470	0.120	0.120
ES.018	100.339	Left	4	Very High	1	Very Low	1	401.35471	0.248	6.223	0.062	0.062
ES.018	109.782	Right	4	Very High	1	Very Low	1	439.12919	0.248	6.809	0.062	0.062
ES.019	48.7918	Left	3	High	1	High	4	146.37532	1.023	9.361	0.192	0.192
ES.020	14.7038	Right	3	Very High	1	Moderate	3	44.111338	0.638	1.759	0.120	0.120
ES.021	77.6837	Right	6	High	1	High	4	466.10226	1.023	29.807	0.384	0.384
ES.022	66.2733	Left	6	High	1	High	4	397.63962	1.023	25.429	0.384	0.384
ES.023	41.7642	Right	5	Very High	1	Very High	5	208.82099	1.641	21.416	0.513	0.513
ES.024	73.7561	Left	5	Very High	1	Very High	5	368.78028	1.641	37.820	0.513	0.513
ES.025	19.8365	Right	4	Extreme	1	Moderate	3	79.34612	1.707	8.464	0.427	0.427
ES.026	50.6409	Right	4	Very High	1	Moderate	3	202.5634	0.638	8.078	0.160	0.160
ES.027	105.51	Right	4	Extreme	1	Moderate	3	422.03882	1.707	45.019	0.427	0.427
ES.028	88.9888	Left	4	Moderate	1	Moderate	3	355.95502	0.303	6.745	0.076	0.076
ES.029	43.492	Right	4	Moderate	1	Moderate	3	173.96818	0.303	3.297	0.076	0.076
ES.030	157.24	Left	4	Very High	1	Very High	5	628.96177	1.641	64.503	0.410	0.410
ES.031	19.5329	Right	8	Very High	1	Very High	5	156.26339	1.641	16.026	0.820	0.820
ES.032	27.4216	Right	5	Moderate	1	Very High	5	137.10779	1.641	14.061	0.513	0.513
ES.033	78.2208	Right	3	High	1	Very Low	1	234.66247	0.248	3.639	0.047	0.047
ES.034	90.5682	Left	2	Moderate	1	Very Low	1	181.13636	0.042	0.479	0.005	0.005

Appendix B

CA-5
BANCS Assessment

			Step 1				USFWS Draft DC					
ID	Length	Bank	A. Study Bank Height	BEHI Rating	NBS Method	NBS Rating	NBS x-value	Area (sf)	Erosion Rate (ft/yr)	Sediment Load (ton/yr)	Sediment Load per ft (ton/yr/ft)	Sediment Load per ft (ton/yr/ft)
ES.035	57.6131	Left	7	Very High	1	Very Low	1	403.29177	0.248	6.253	0.109	0.109
ES.036	55.0643	Right	7	High	1	Very Low	1	385.45029	0.248	5.977	0.109	0.109
ES.037	15.9244	Right	6	Very High	1	Very Low	1	95.546326	0.248	1.481	0.093	0.093
ES.038	76.0911	Left	6	Very High	1	Very High	5	456.54647	1.641	46.821	0.615	0.615
ES.039	61.6049	Right	8	Very High	1	Very High	5	492.83894	1.641	50.543	0.820	0.820
ES.040	23.5436	Right	1	Low	1	Moderate	3	23.543645	0.077	0.113	0.005	0.005
ES.041	55.1881	Right	4	High	1	Very High	5	220.7526	1.641	22.639	0.410	0.410
ES.042	118.102	Left	5	Very High	1	Very High	5	590.50978	1.641	60.560	0.513	0.513
ES.043	69.9318	Right	5	Very High	1	Very High	5	349.65921	1.641	35.859	0.513	0.513
ES.044	37.2285	Left	4	High	1	High	4	148.91387	1.023	9.523	0.256	0.256
ES.045	70.2876	Right	5	Extreme	1	High	4	351.43797	2.397	52.658	0.749	0.749
ES.046	55.227	Left	4	High	1	High	4	220.90804	1.023	14.127	0.256	0.256
ES.047	55.5298	Left	4	Extreme	1	Very High	5	222.11904	3.367	46.749	0.842	0.842
ES.048	18.3091	Right	3	Moderate	1	Low	2	54.927413	0.113	0.389	0.021	0.021
ES.049	23.2507	Left	4	High	1	Low	2	93.002612	0.398	2.313	0.099	0.099
ES.050	27.5597	Right	2	Moderate	1	High	4	55.119331	0.812	2.796	0.101	0.101
ES.051	38.3444	Left	4	Very High	1	Moderate	3	153.37753	0.638	6.116	0.160	0.160
ES.052	81.9304	Right	5	High	1	Moderate	3	409.6519	0.638	16.336	0.199	0.199
ES.053	50.2488	Left	6	High	1	High	4	301.49252	1.023	19.280	0.384	0.384
ES.054	103.503	Right	4	High	1	Moderate	3	414.01135	0.638	16.510	0.160	0.160
ES.055	56.4354	Left	4	High	1	Very High	5	225.74177	1.641	23.151	0.410	0.410
ES.056	67.6649	Right	4	High	1	High	4	270.65956	1.023	17.309	0.256	0.256
ES.057	43.6086	Left	4	High	1	Very High	5	174.4345	1.641	17.889	0.410	0.410
ES.058	64.5109	Right	5	Very High	1	High	4	322.55457	1.023	20.627	0.320	0.320
ES.059	32.9346	Left	4	High	1	Very High	5	131.73845	1.641	13.510	0.410	0.410
ES.060	9.15345	Right	2	Low	1	High	4	18.306903	0.315	0.361	0.039	0.039
ES.061	32.2273	Right	4	High	1	Low	2	128.90938	0.398	3.205	0.099	0.099
ES.062	19.3017	Left	4	Very High	1	High	4	77.206972	1.023	4.937	0.256	0.256
ES.063	16.8808	Right	3	Moderate	1	High	4	50.642273	0.812	2.569	0.152	0.152
ES.064	5.88223	Left	2	High	1	Moderate	3	11.76446	0.638	0.469	0.080	0.080
ES.065	28	Left	4	High	1	High	4	112	1.023	7.162	0.256	0.256
ES.066	44.6	Left	6	High	1	Moderate	3	267.6	0.638	10.671	0.239	0.239
ES.067	65	Right	3	Moderate	1	High	4	195	0.812	9.893	0.152	0.152
ES.068	10	Left	3	Moderate	1	Moderate	3	30	0.303	0.569	0.057	0.057
ES.069	73	Left	5	High	1	Very High	5	365	1.641	37.433	0.513	0.513

CA-5
BANCS Assessment

ID	Length	Bank	Step 1 A. Study Bank Height	BEHI Rating	NBS Method	NBS Rating	USFWS Draft DC NBS x-value	Area (sf)	Erosion Rate (ft/yr)	Sediment Load (ton/yr)	Sediment Load per ft (ton/yr/ft)	Sediment Load per ft (ton/yr/ft)
ES.070	33	Left	6	Very High	1	Very High	5	198	1.641	20.306	0.615	0.615
ES.071	35	Right	3	Very High	1	Very High	5	105	1.641	10.768	0.308	0.308
ES.072	31	Left	4	High	1	Very High	5	124	1.641	12.717	0.410	0.410
ES.073	27	Right	5	High	1	Very High	5	135	1.641	13.845	0.513	0.513
ES.074	28	Right	3	Moderate	1	Moderate	3	84	0.303	1.592	0.057	0.057
ES.075	20	Left	3	Moderate	1	Very High	5	60	1.641	6.153	0.308	0.308
ES.076	34	Right	4	High	1	Very High	5	136	1.641	13.947	0.410	0.410
ES.077	48	Left	5	Very High	1	Very High	5	240	1.641	24.613	0.513	0.513
ES.078	49	Right	3	Moderate	1	High	4	147	0.812	7.458	0.152	0.152
ES.079	18	Left	4	High	1	Very High	5	72	1.641	7.384	0.410	0.410
ES.080	24	Right	3	Low	1	Moderate	3	72	0.077	0.345	0.014	0.014
ES.081	7	Left	3	High	1	Low	2	21	0.398	0.522	0.075	0.075
ES.082	38	Left	4	High	1	Very High	5	152	1.641	15.588	0.410	0.410
									TOTALS	**1207.640**	**23.881**	**23.887**

APPENDIX C. NATURAL RESOURCES INVENTORIES

COASTAL RESOURCES INC.
25 Old Solomons Island Road
Annapolis, MD 21401
410-956-9000
410-956-0566 (Fax)

MEMORANDUM

Date: January 15,2021

Subject: I-495/I-270 Stream and Floodplain Wetland Mitigation Site No. CA-5
Wetland Delineation

Introduction

Coastal Resources, Inc. (CRI), under contract to the Maryland State Highway Administration (SHA), has completed wetland and waterway delineations at the I-495/I-270 Stream and Floodplain Wetland Mitigation Site No. CA-5 project in Montgomery County, Maryland. Mitigation Site No CA-5 is a stream and floodplain restoration project proposed by SHA in order to prepare Phase II Mitigation Documents with permit agency and landowner support, obtain PRD Concept Approval, and prepare the PRD Site Development Plan submittal. Field investigations were conducted on March 24th, March 27th, and November 10th, 2020.

Study Area Description

The study area consists of a buffer along the proposed restoration reach, which ranges in width from 50 to 200 feet along the stream channel and includes approximately 3,562 linear feet of an unnamed tributary to Great Seneca Creek and two tributaries. The study area is located in Gaithersburg, Maryland and is bound by Suffolk Terrace and Bradbury Lane to the north and a powerline ROW to the south (see **Appendix A** – Vicinity Map). Land use classifications within and adjacent to the study area include institutional, deciduous forest, and medium density residential. The proposed stream restoration occurs within the Seneca Creek watershed (MDE 8-digit 02140208), within the Piedmont Plateau physiographic province (MGS, 2008)**.**

Methods

The study area was field investigated to identify and locate boundaries of waters of the United States (U.S.), including wetlands. Wetland boundaries were flagged with pink wetland delineation survey ribbon labeled consecutively with an alphanumeric designation. Each flag was then traditionally surveyed. Stream boundaries were delineated using detailed topographic survey.

Prior to the field investigation, possible wetland areas were located using the United States Fish & Wildlife Service (USFWS) National Wetland Inventory and Maryland Department of Natural Resources (NWI/MDNR) wetland maps and the Natural Resource Conservation Service (NRCS) Soil Survey Maps for Montgomery County, Maryland.

Wetlands were identified in accordance with the *Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Eastern Mountains and Piedmont Region, Version 2.0* (USACE 2010). This methodology requires interpretation of a three-parameter approach representing hydrology, vegetation, and soils, which are known indicators of a wetland. Soils were sampled using three-inch diameter Dutch augers and Munsell Color charts were used to identify color (Munsell 1975). Wetland Determination Data Forms (USACE 2010) were completed during the field work in order to describe wetland characteristics and provide a rationale for delineation of the wetland boundary. Stream characteristics were recorded for each identified watercourse on a stream field datasheet. Each wetland and watercourse were photographed, and a photo log was compiled (see **Appendix C**).

All identified waters of the U.S., including wetlands, were classified according to a *Classification of Wetland and Deep-Water Habitats in the United States* (USFWS 1979). The wetland indicator status of the observed vegetation was identified using the *National Wetland Plant List* (NWPL) (Lichvar 2016).

Results

During the field investigations, 18 waters of the U.S., including wetlands, were identified within the study area. The surveyed locations of these resources are shown on the detailed maps provided in **Appendix B**. All wetland and stream field datasheets can be found in **Appendix D**. The delineated systems are described below.

An agency field meeting with the Maryland Department of the Environment (MDE) and the U.S. Army Corps of Engineers (USACE) was conducted on January 14, 2021 to review the boundaries of the delineated wetlands and waters within the study area. The discussion points of the agency field review are included below for each system.

Watercourse 1 (WC1) is perennial stream with a gravel, sand, and organic substrate (R3UB1/2/4). WC1 is located in the eastern portion of the study area and flows west from a hillside seep into Watercourse 2 (WC2). The average channel width and depth are four feet and one foot, respectively. During the site visit, the average water depth was four inches. Overall, habitat complexity was considered low. Flow was almost entirely shallow run and the stream lacked stable habitat. Bank erosion was considered minor along both banks which were well vegetated. Approximately 90 percent of the channel was shaded by woody species. *MDE and USACE requested the channel be changed from intermittent to a perennial stream as it appeared to be receiving hydrology from a groundwater seep at the time of the agency review meeting.*

Watercourse 2 (WC2) is an ephemeral and perennial tributary to Watercourse 7 (WC7) with a cobble, gravel, and sand substrate (R3UB1/2). WC2 is located in the eastern portion of the study area and flows south from a culvert into WC7. The average channel width is four feet and channel depth ranges from one to three feet, respectively. During the site visit, the average water depth was variable throughout the reach, ranging from one to six inches. Habitat complexity was considered poor due to a general lack of stable habitat and having primarily shallow runs. Overall, bank erosion was considered minor with a small area of scour downstream of the foot bridge. Approximately 90 percent of the channel was shaded by woody species. *MDE and USACE considered the ephemeral channel non-jurisdictional. Furthermore, MDE and USACE requested the intermittent portion be changed to perennial as the channel was receiving flow from WC1* *which the agencies classified as perennial during the agency review meeting.*

Watercourse 3 (WC3) is an intermittent tributary to WC7 with a cobble, gravel, and sand substrate (R4SB3/4). WC3 is located in the eastern portion of the study area and flows southwest from Wetland 2 (WL2) into WC7. The average channel width and depth are six and three feet, respectively. During the site visit, the average water depth was two inches. Habitat complexity was considered poor, as instream habitat was lacking. Overall, bank erosion was severe as the banks are actively eroding. Approximately 70 percent of the channel was shaded by woody species. *MDE and USACE accepted this system as delineated.*

Watercourse 4 (WC4) is an intermittent tributary to WC7 with a cobble, gravel, and sand substrate (R4SB3/4). WC4 is located in the western portion of the study area and flows southwest from outside the study area into WC7. The average channel width and depth are four feet and one foot, respectively. During the site visit, the average water depth was four inches. Habitat complexity was considered moderate with many leaf packs and riffle-run complexes; however, the stream was lacking stable cover. Overall, bank erosion was moderate as portions of both banks were actively eroding. Approximately 80 percent of the channel was shaded by woody species. *MDE and USACE accepted this system as delineated.*

Watercourse 5 (WC5) is an intermittent tributary to WC7 with a gravel and sand substrate (R4SB3/4). WC5 is located in the western portion of the study area and flows west from Wetland 3 (WL3) to WC7 outside the study area. The average channel width and depth are three feet and one foot, respectively. During the site visit, the average water depth was three inches. Habitat complexity was considered marginal as there were shallow flows, but the stream had some root wads and leaf packs throughout. Overall, bank erosion was moderate as there was some scour throughout. Approximately 60 percent of the channel was shaded by woody species. *MDE and USACE accepted this system as delineated.*

Watercourse 6 (WC6) is a perennial tributary to WC7 with a cobble, gravel, and sand substrate (R3UB1/2). WC6 is located in the western portion of the study area and flows northwest from outside the study area into WC7. The average channel width ranges from eight to 20 feet and the channel depth is four feet. During the site visit, the average water depth ranged from one to 10 inches. Habitat complexity was considered marginal as there was some stable woody debris and undercut banks, however the substrate within the riffles was mostly gravel. Overall, bank erosion was moderate but severe along meanders. Approximately 60 percent of the channel was shaded by woody species. *MDE and USACE accepted this system as delineated.*

Watercourse 7 (WC7) is an unnamed, perennial tributary to Great Seneca Creek with a cobble, gravel, and sand substrate (R3UB1/2). WC7 enters the study area at the eastern end and flows west through the study area. The average channel width ranges from eight to 20 feet and the channel depth is four feet. During the site visit, the average water depth ranged from one to 12 inches. Habitat complexity was considered marginal as there was limited flow diversity, short riffles with mostly gravel substrate, and some large woody debris. Overall, bank erosion was moderate throughout most of the stream, however severe erosion was present along meanders and at some confluences with tributaries. Approximately 75 percent of the channel was shaded by woody species. *MDE and USACE accepted this system as delineated.*

Watercourse 8 (WC8) is an intermittent tributary to WC7 with boulder, cobble, and gravel substrate (R4SB3/4). WC8 flows northwest from an old farm pond (WC10) into WC7. The average channel width and depth ranges from one to two feet. During the site visit, the average water depth was two inches. Habitat complexity was considered marginal as there was some larger boulders however the stream is subject to intermittent flows and lacked other stable habitat. Overall, bank erosion was minor with slight erosion present at the confluence with WC7. Approximately 75 percent of the channel was shaded by woody species. *MDE and USACE accepted this system as delineated.*

Watercourse 9 (WC9) is an ephemeral and intermittent tributary to WC7 with cobble, gravel, and sand substrate (R4SB3/4). WC9 flows north from outside the study area into WC7. The average channel width ranges from four to 15 feet and the channel depth ranges from one to seven feet. During the site visit, the average water depth ranged from zero to three inches. Habitat complexity was considered poor as the stream was lacking stable habitat and is subject to ephemeral and intermittent flows. Overall, bank erosion was severe in the intermittent portion of the stream and minor to moderate in the ephemeral portion. In addition, a water or sewer line was exposed within the intermittent portion of the stream. Approximately 75 percent of the channel was shaded by woody species. *USACE confirmed the ephemeral portion is non-jurisdictional and will not be regulated; MDE concurred. Both agencies agreed with the delineated system.*

Watercourse 10 (WC10) is an old farm pond that is classified as palustrine open water (POW). This pond is in the southern floodplain of WC7 and drains north to WC8. *MDE and USACE accepted this system as delineated.*

Wetland 1 (WL1) is a toe-of-slope seep located in the eastern portion of the study area that abuts WC1. Test plot WTP-1 characterizes this system, which is classified as a palustrine forested wetland with a seasonally saturated water regime (PFO1B). Primary hydrologic indicators observed during the site visit included a high water table, saturation, and water-stained leaves. Based on the dominance test for hydrophytic vegetation, 63 percent of the dominant species within the test plot were considered OBL, FACW, or FAC. Dominant species within the sampling plot included red maple (*Acer rubrum*), ash-leaf maple (*Acer negundo*), northern spicebush (*Lindera benzoin*), winged burning bush (*Euonymus alatus*), Japanese stilt grass (*Microstegium vimineum*), groundivy (*Glechoma hederacea*), Japanese honeysuckle (*Lonicera japonica*), and horsebrier (*Smilax rotundifolia*). Soils in the wetland are mapped as Brinklow-Blocktown channery silt loams, which is considered predominantly hydric by NRCS. Soil samples met the Depleted Matrix (F3) hydric soil indicator. Potential functions and values provided by this wetland include groundwater recharge/discharge, floodflow alteration, sediment/toxicant retention, nutrient removal, wildlife habitat, recreation, educational/scientific value, and uniqueness/heritage. *MDE and USACE accepted this system as delineated.*

Wetland 2 (WL2) is a floodplain wetland located in the eastern portion of the study area that abuts WC3. Test plot WTP-2 characterizes this system, which is classified as a PFO1B wetland. Primary hydrologic indicators observed during the site visit included surface water, drift deposits, and water-stained leaves. Based on the dominance test for hydrophytic vegetation, 67 percent of the dominant species within the test plot were considered OBL, FACW, or FAC. Dominant species within the sampling plot included ash-leaf maple, red maple, wine raspberry (*Rubus phoenicolasius*), rambler rose (*Rosa multiflora*), Japanese stilt grass, and small-spike false nettle (*Boehmeria cylindrica*).

Soils in the wetland are mapped as Brinklow-Blocktown channery silt loam, which is considered predominantly hydric by NRCS. Soil samples met the Redox Dark Surface (F6) hydric soil indicator. Potential functions and values provided by this wetland include floodflow alteration, sediment/toxicant retention, nutrient removal, wildlife habitat, recreation, education/scientific value, and uniqueness/heritage. *MDE and USACE accepted this system as delineated.*

Wetland 3 (WL3) is a floodplain wetland located in the western portion of the study area that abuts WC4 and WC5. Test plot WTP-3 characterizes this system, which is classified as a palustrine forest wetland with a temporarily flooded water regime (PFO1A). Primary hydrologic indicators observed during the site visit included surface water, a high water table, saturation, and water-stained leaves. Based on the dominance test for hydrophytic vegetation, 67 percent of the dominant species within the test plot were considered OBL, FACW, or FAC. Dominant species within the sampling plot included river birch (*Betula nigra*), eastern cottonwood (*Populus deltoides*), rambler rose, Japanese barberry (*Berberis thunbergii*), Japanese stilt grass, and small-spike false nettle. Soils in the wetland are mapped as Codorus silt loam, which is considered predominantly non-hydric by NRCS. However, soil samples met the Depleted Matrix (F3) hydric soil indicator. Potential functions and values provided by this wetland include floodflow alteration, wildlife habitat, recreation, education/scientific value, and uniqueness/heritage. *MDE and USACE accepted this system as delineated.*

Wetland 4 (WL4) is an oxbow wetland located in the western portion of the study area that abuts WC6. Test plot WTP-4 characterizes this system, which is classified as a PFO1A wetland because it is an emergent wetland within a forested setting with approximately 60 percent canopy cover. Primary hydrologic indicators observed during the visit included a high water table, saturation, and water-stained leaves. Based on the dominance test for hydrophytic vegetation, 100 percent of the dominant species within the test plot were considered OBL, FACW, or FAC. The dominant species within the sampling plot was sweet wood-reed (*Cinna arundinacea*). Soils in the wetland are mapped as Codorus silt loam, which is considered predominantly non-hydric by NRCS. However, soil samples met the Depleted Matrix (F3) hydric soil indicator. Potential functions and values provided by this wetland include floodflow alteration, sediment/shoreline stabilization, wildlife habitat, recreation, educational/scientific value, and uniqueness/heritage. *MDE and USACE accepted this system as delineated.*

Wetland 5 (WL5) is floodplain depression wetland located in the western portion of the study area adjacent to WC6. Test plot WTP-5 characterizes this system, which is classified as a PFO1A wetland. Primary hydrologic indicators observed during the visit included saturation and water-stained leaves. Based on the dominance test for hydrophytic vegetation, 80 percent of the dominant species within the test plot were considered OBL, FACW, or FAC. Dominant species within the sampling plot included red maple, autumn-olive (*Elaeagnus umbellata*), rambler rose, Japanese stilt grass, and sweet wood-reed. Soils in the wetland are mapped as Codorus silt loam, which is considered predominantly non-hydric by NRCS. However, soil samples met the Depleted Matrix (F3) hydric soil indicator. Potential functions and values provided by this wetland include floodflow alteration, wildlife habitat, recreation, educational/scientific value, and uniqueness/heritage. *MDE and USACE accepted this system as delineated.*

Wetland 6 (WL6) is a floodplain wetland located in the eastern portion of the study area adjacent to WC7. Test plot WTP-6 characterizes this system, which is classified as a PFO1A wetland. Primary hydrologic indicators observed during the visit included saturation and water-stained leaves. Based on the dominance test for hydrophytic vegetation, 100 percent of the dominant species within the test plot were considered OBL, FACW, or FAC. Dominant species within the sampling plot included red maple, ash-leaf maple, and Japanese stilt grass. Soils in the wetland are mapped as Baile silt loam, which is considered predominantly hydric by NRCS. Soil samples met the Redox Dark Surface (F6) hydric soil indicator. Potential functions and values provided by this wetland include floodflow alteration, sediment/toxicant retention, nutrient removal, sediment/shoreline stabilization, wildlife habitat, recreation, educational/scientific value, and uniqueness/heritage. *MDE and USACE accepted this system as delineated.*

Wetland 7 (WL7) is a wetland bench located in the southwestern portion of the study area abutting WC6. Test plot WTP-7 characterizes this system, which is classified as a palustrine emergent wetland with a seasonally saturated water regime (PEM1B). Primary hydrologic indicators observed during the visit included high water table, saturation, geomorphic position, and the FAC-Neutral test. Based on the dominance test for hydrophytic vegetation, 100 percent of the dominant species within the test plot were considered OBL, FACW, or FAC. Dominant species within the sampling plot included leafy bulrush (*Scirpus polyphyllus*), Japanese stilt grass, rice cut grass (*Leersia oryzoides*), and small carp grass (*Arthraxon hispidus*). Soils in the wetland are mapped as Codorus silt loam, which is considered predominantly hydric by NRCS. Soil samples met the Depleted Matrix (F3) hydric soil indicator. Potential functions and values provided by this wetland include groundwater recharge/discharge, floodflow alteration, and wildlife habitat. *MDE and USACE accepted this system as delineated.*

Wetland 8 (WL8) is a wetland bench and oxbow located in the southwestern portion of the study area abutting WC6. Test plot WTP-8 characterizes this system, which is classified as a PEM1A. Primary hydrologic indicators observed during the visit included drainage patterns and geomorphic position. Based on the dominance test for hydrophytic vegetation, 100 percent of the dominant species within the test plot were considered OBL, FACW, or FAC. Dominant species within the sampling plot included Japanese stilt grass. Soils in the wetland are mapped as Codorus silt loam, which is considered predominantly hydric by NRCS. Soil samples met the Depleted Matrix (F3) hydric soil indicator. Potential functions and values provided by this wetland include groundwater recharge/discharge, floodflow alteration, and wildlife habitat, recreation, education/scientific value, and uniqueness/heritage. *MDE and USACE accepted this system as delineated.*

Conclusions

A total of 18 waters of the U.S., including wetlands, were identified within the study area. Disturbances to these systems will require a permit from the USACE and the Maryland Department of the Environment (MDE). All wetland boundaries were reviewed during the agency review meeting and are considered final.

Appendix A: Vicinity Map
Appendix B: Waters of the U.S. Delineation Map
Appendix C: Photograph Log
Appendix D: Waters of the U.S. Datasheets

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Appendix A – Vicinity Map

Appendix A
I-495 & I-270 Managed Lanes Study
Phase II Mitigation Design Plan
Stream Site CA-5
Great Seneca Creek
Bradbury Dr. Tributary

Montgomery County, Maryland
April 2020

N
W E
S

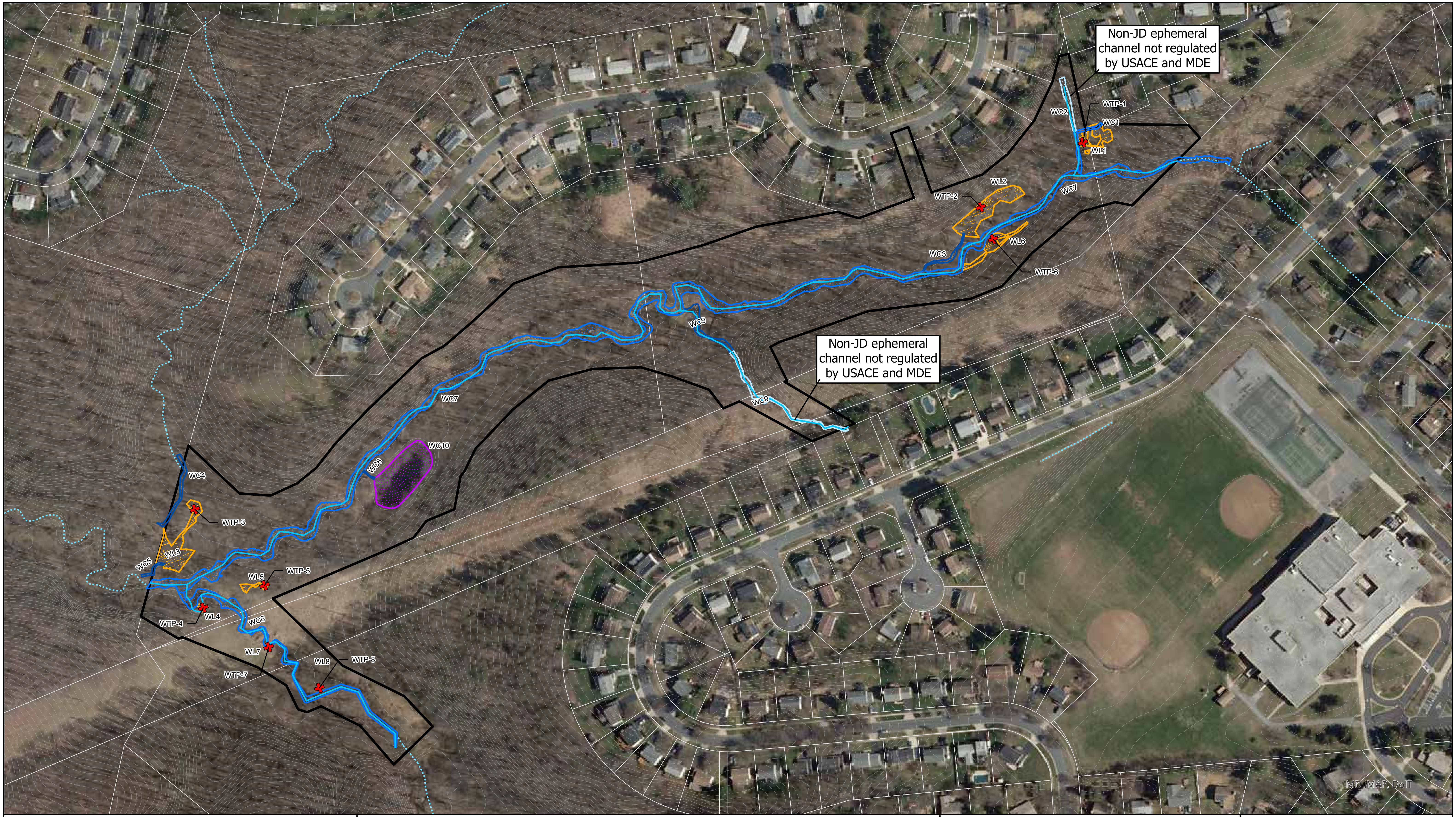
1 inch = 2,400 feet

0 2,400 4,800
feet

Study Area

270 495 MANAGED LANES STUDY

Appendix B – Wetland Delineation Map



Appendix B
I-495 & I-270 Managed Lanes Study
Phase II Mitigation Design Plan
Stream Site CA-5: Great Seneca Creek Bradbury Dr. Tributary
Revised January 2021
Wetland Delineation

Study Area
Test Plot
Palustrine Forested Wetland
Palustrine Open Water
Perennial Stream
Intermittent Stream
Ephemeral Stream
Potential Stream Restoration Reach
County Streams and Ponds
Parcel Boundary
2' Contour

N E S W

1:2,400

0 200 400
Feet

270 495 MANAGED LANES STUDY

Appendix C – Photograph Log

CA-5 Mitigation Site Photograph Log – March 2020

Photo 1: Looking downstream at WC1, a perennial stream.

Photo 2: Looking upstream at the ephemeral portion of WC2.

Photo 3: Looking upstream at the perennial portion of WC2.

Photo 4: Looking downstream at the perennial portion of WC2.


Photo 5: Looking downstream at WC3, an intermittent stream.


Photo 6: Looking downstream at WC5, an intermittent stream.


Photo 7: Looking downstream at WC6, a perennial stream.


Photo 8: Looking downstream at the upstream end of WC7, a perennial stream.

Photo 9: Looking downstream at the downstream end of WC7.

Photo 10: Looking upstream at WC8, an intermittent stream.


Photo 11: Looking downstream at the ephemeral portion of WC9.


Photo 12: Looking downstream at the intermittent portion of WC9.


Photo 13: Looking northwest at WC10, a palustrine open water (POW).


Photo 14: Looking west at WL1, a palustrine forested (PFO) wetland.

Photo 15: Looking west at WL2, a PFO wetland.

Photo 16: Looking north at WL3, a PFO wetland.


Photo 17: Looking south at WL4, a PFO wetland.


Photo 18: Looking west at WL5, a PFO wetland.

Photo 19: Looking west at WL6, a PFO wetland.

Appendix D – Field Datasheets

Non-tidal Stream Features Field Datasheet

Date: 3/24/20 **Project Site:** CA-5 **Stream ID:** WC-1

Observer(s): HT, EB **Photos:** Upstream: 2 Downstream: 3

Flow Type: ✓

☒ Perennial ☐ Intermittent ☐ Ephemeral **Cowardin Classification:** R3UB1/2/4

Justification: originates at spring seep

Channel Characteristics:

☒ Natural ☐ Artificial (made-made) ☐ Manipulated (man-altered)

Explain:

Channel Gradient (%): 3-10% **Average Bank Slope:** ☐ Vertical ☐ 2:1 ☒ 3:1 ☐ 4:1 or greater

Channel Has (check all that apply):

☒ Bed and banks

☒ OHWM

- ☒ clear, natural line impressed on the bank
- ☒ changes in character of soil
- ☐ shelving
- ☒ vegetation matted down, bent, or absent
- ☒ leaf litter disturbed or washed away
- ☐ sediment deposition
- ☐ water staining
- ☐ the presence of litter and debris
- ☐ destruction of terrestrial vegetation
- ☐ the presence of wrack line
- ☐ sediment sorting
- ☐ scour
- ☐ multiple observed or predicted flow events
- ☐ abrupt change in plant community
- ☐ other (list):

☐ Discontinuous OHWM (explain):

Avg. Channel Width: 4' **Depth:** 1' **Avg. Water Depth:** 4"

Hydrological Connectivity: Flow direction: west

Upstream: N/A Downstream: WC2 Adjacent/abutting: W1

Substrate: ☐ Bedrock ☐ Rubble ☐ Cobble ☒ Gravel ☒ Sand

☐ Mud ☒ Organic ☐ Vegetated ☐ Other

Habitat Complexity (characterize): Low, intermittent flows, lacks stable habitat.

Bank Erosion: ☐ Severe ☐ Moderate ☒ Minor

Describe: banks very stable, well vegetated.

Pollutants (field observations, potential sources, stormwater outfalls, etc.): runoff from residential properties

Wildlife Observations: Frogs ✓

Riparian Zone:

Describe (forest, residential yard, emergent wetland, etc.): Left bank: forest, residential yard

Right bank: forest

Approximate Shading by Woody Species (%): 90%

Riparian Buffer Width: 40' (Left); >50' (right)

Dominant species: PLOC, ROMU, LITU

Other Comments: spring seep abutted by wetlands flags 1A-5A; 1B-5B

Non-tidal Stream Features Field Datasheet

Date: 3/24/20 **Project Site:** CA-5 **Stream ID:** WC2

Observer(s): HT, EB **Photos:** Upstream: 4 (ephem) 5 (perennial) Downstream: 6 (perennial)

Flow Type:

☒ Perennial ☐ Intermittent ☒ Ephemeral Cowardin Classification: R3UB1/2.

Justification: ephemeral above WC1 confluence, perennial below WC1 and below foot bridge.

Channel Characteristics:

☐ Natural ☐ Artificial (made-made) ☒ Manipulated (man-altered)

Explain: originates at culvert, flows through culvert under foot bridge.

Channel Gradient (%): 5% **Average Bank Slope:** ☐ Vertical ☒ 2:1 ☐ 3:1 ☐ 4:1 or greater

Channel Has (check all that apply):

☒ Bed and banks

☒ OHWM

- ☒ clear, natural line impressed on the bank
- ☐ changes in character of soil
- ☐ shelving
- ☒ vegetation matted down, bent, or absent
- ☒ leaf litter disturbed or washed away
- ☒ sediment deposition
- ☐ water staining
- ☐ the presence of litter and debris
- ☐ destruction of terrestrial vegetation
- ☐ the presence of wrack line
- ☐ sediment sorting
- ☒ scour
- ☐ multiple observed or predicted flow events
- ☐ abrupt change in plant community
- ☐ other (list): ______

☐ Discontinuous OHWM (explain): ______

Avg. Channel Width: 4' **Depth:** 1-3' **Avg. Water Depth:** 1-6"

Hydrological Connectivity: Flow direction: South

Upstream: culvert/unknown Downstream: mainstem Adjacent/abutting: WC1, WL1

Substrate: ☐ Bedrock ☐ Rubble ☒ Cobble ☒ Gravel ☒ Sand ☐ Mud ☐ Organic ☐ Vegetated ☒ Other boulders

Habitat Complexity (characterize): general lack of stable habitat & habitat variety, primarily shallow runs, few leaf packs

Bank Erosion: ☐ Severe ☐ Moderate ☒ Minor

Describe: small area of scour downstream of bridge

Pollutants (field observations, potential sources, stormwater outfalls, etc.): runoff from residential properties

Wildlife Observations: ______

Riparian Zone:

Describe (forest, residential yard, emergent wetland, etc.):

Right bank: forest, residential yards Left bank: forest, residential yards

Riparian Buffer Width: 10-350' **Approximate Shading by Woody Species (%):** 90

Dominant species: LITU, ACRU, LIBE, ROMU, LOJA

Other Comments: not flagged in field

Non-tidal Stream Features Field Datasheet

Date: 3/24/20 **Project Site:** CA-5 **Stream ID:** WC3

Observer(s): HT, EB **Photos:** Upstream: 8 Downstream: 9

Flow Type:

☐ Perennial ☒ Intermittent ☐ Ephemeral Cowardin Classification: R4SB3/4

Justification: Flowing during visit, hydric soils.

Channel Characteristics:

☒ Natural ☐ Artificial (made-made) ☐ Manipulated (man-altered)

Explain:

Channel Gradient (%): 3-5 **Average Bank Slope:** ☐ Vertical ☒ 2:1 ☐ 3:1 ☐ 4:1 or greater

Channel Has (check all that apply):

☒ Bed and banks

☒ OHWM

- ☒ clear, natural line impressed on the bank
- ☒ changes in character of soil
- ☐ shelving
- ☒ vegetation matted down, bent, or absent
- ☒ leaf litter disturbed or washed away
- ☐ sediment deposition
- ☐ water staining
- ☐ the presence of litter and debris
- ☐ destruction of terrestrial vegetation
- ☐ the presence of wrack line
- ☐ sediment sorting
- ☒ scour
- ☐ multiple observed or predicted flow events
- ☐ abrupt change in plant community
- ☐ other (list):

☐ Discontinuous OHWM (explain):

Avg. Channel Width: 6 **Depth:** 3' **Avg. Water Depth:** 2"

Hydrological Connectivity: Flow direction: West

Upstream: WL2 Downstream: mainstem Adjacent/abutting: WL2

Substrate: ☐ Bedrock ☐ Rubble ☒ Cobble ☒ Gravel ☒ Sand

☐ Mud ☐ Organic ☐ Vegetated ☐ Other

Habitat Complexity (characterize): shallow flow w/a lack of stable habitat

Bank Erosion: ☒ Severe ☐ Moderate ☐ Minor

Describe: majority of banks are raw/actively eroding

Pollutants (field observations, potential sources, stormwater outfalls, etc.): residential runoff

Wildlife Observations: None

Riparian Zone:

Describe (forest, residential yard, emergent wetland, etc.):

Right bank: forest Left bank: forest

Riparian Buffer Width: >50' **Approximate Shading by Woody Species (%):** 70

Dominant species: LITU, ACNE, ACRU, BENI, MIVI, ROMU, LIBE

Other Comments: originates as headcut w/in WL2

Non-tidal Stream Features Field Datasheet

Date: 3/24/20 **Project Site:** CA-5 **Stream ID:** WC4

Observer(s): HT, EB **Photos:** Upstream: 10 Downstream: 11

Flow Type:

☐ Perennial ☒ Intermittent ☐ Ephemeral Cowardin Classification: R4SB3/4

Justification: Hydric soils flowing during visit

Channel Characteristics:

☒ Natural ☐ Artificial (made-made) ☐ Manipulated (man-altered)

Explain: appears natural as it flows through study area

Channel Gradient (%): 1-3% **Average Bank Slope:** ☐ Vertical ☒ 2:1 ☐ 3:1 ☐ 4:1 or greater

Channel Has (check all that apply):

☒ Bed and banks

☒ OHWM

- ☒ clear, natural line impressed on the bank
- ☒ changes in character of soil
- ☐ shelving
- ☒ vegetation matted down, bent, or absent
- ☐ leaf litter disturbed or washed away
- ☒ sediment deposition
- ☐ water staining
- ☐ the presence of litter and debris
- ☐ destruction of terrestrial vegetation
- ☒ the presence of wrack line
- ☒ sediment sorting
- ☒ scour
- ☐ multiple observed or predicted flow events
- ☐ abrupt change in plant community
- ☐ other (list):

☐ Discontinuous OHWM (explain):

Avg. Channel Width: 4' **Depth:** 1' **Avg. Water Depth:** 4"

Hydrological Connectivity: Flow direction: Southwest

Upstream: N/A Downstream: WC5 Adjacent/abutting: WL3

Substrate: ☐ Bedrock ☐ Rubble ☒ Cobble ☒ Gravel ☒ Sand

☐ Mud ☐ Organic ☐ Vegetated ☐ Other

Habitat Complexity (characterize): lack of stable cover, primarily riffle-run complexes w/ many leaf packs throughout

Bank Erosion: ☐ Severe ☒ Moderate ☐ Minor

Describe: exposed/raw banks throughout

Pollutants (field observations, potential sources, stormwater outfalls, etc.): runoff from upslope residential properties

Wildlife Observations: None

Riparian Zone:

Describe (forest, residential yard, emergent wetland, etc.):

Right bank: forest Left bank: forest

Riparian Buffer Width: >50' **Approximate Shading by Woody Species** (%): 80

Dominant species: LITU, ACRU, Privet, MIVI, ALVI, ACNE

Other Comments:

Flags 1A-11A & 1B-14B

Non-tidal Stream Features Field Datasheet

Date: 3/24/20 **Project Site:** CA-5 **Stream ID:** WC5

Observer(s): HT, EB **Photos:** Upstream: 13 Downstream: 12

Flow Type:

☐ Perennial ☒ Intermittent ☐ Ephemeral Cowardin Classification: R4SB3/4

Justification: Flowing during visit, hydric soils

Channel Characteristics:

☐ Natural ☒ Artificial (made-made) ☐ Manipulated (man-altered)

Explain: Sewer manhole in/adjacent

Channel Gradient (%): 3% **Average Bank Slope:** ☐ Vertical ☒ 2:1 ☐ 3:1 ☐ 4:1 or greater

Channel Has (check all that apply):

☒ Bed and banks

☒ OHWM

- ☒ clear, natural line impressed on the bank
- ☒ changes in character of soil
- ☐ shelving
- ☒ vegetation matted down, bent, or absent
- ☒ leaf litter disturbed or washed away
- ☐ sediment deposition
- ☐ water staining
- ☐ the presence of litter and debris
- ☐ destruction of terrestrial vegetation
- ☒ the presence of wrack line
- ☒ sediment sorting
- ☒ scour
- ☐ multiple observed or predicted flow events
- ☐ abrupt change in plant community
- ☐ other (list):

☐ Discontinuous OHWM (explain):

Avg. Channel Width: 3' **Depth:** 1' **Avg. Water Depth:** 3"

Hydrological Connectivity: Flow direction: west

Upstream: WL3 Downstream: — Adjacent/abutting: WL3

Substrate: ☐ Bedrock ☐ Rubble ☐ Cobble ☒ Gravel ☒ Sand

☐ Mud ☐ Organic ☐ Vegetated ☐ Other

Habitat Complexity (characterize): very shallow flows, some roots, woody debris & leaf packs throughout, all shallow run

Bank Erosion: ☐ Severe ☒ Moderate ☐ Minor

Describe: Some areas of scour

Pollutants (field observations, potential sources, stormwater outfalls, etc.):
runoff from upslope residential properties

Wildlife Observations: None

Riparian Zone:

Describe (forest, residential yard, emergent wetland, etc.):

Right bank: forest Left bank: forest

Riparian Buffer Width: >50' **Approximate Shading by Woody Species (%):** 60%

Dominant species: LITU, ACRU, PLOC, PODE, Privet, ROMU, MIVI

Other Comments:
flags WC5-1A to 7A & 1B to 7B

Non-tidal Stream Features Field Datasheet

Date: 3/27/2020 **Project Site:** CA 5 Mitigation Site **Stream ID:** WC6

Observer(s): BB, MN **Photos:** Upstream: 2 Downstream: 3

Flow Type:

☑ Perennial ☐ Intermittent ☐ Ephemeral Cowardin Classification: R3UB1/2

Justification: Bed + banks, flowing during visit

Channel Characteristics:

☑ Natural ☐ Artificial (made-made) ☐ Manipulated (man-altered)

Explain:

Channel Gradient (%): 3% **Average Bank Slope:** ☑ Vertical ☐ 2:1 ☐ 3:1 ☐ 4:1 or greater

Channel Has (check all that apply):

☑ Bed and banks

☑ OHWM

- ☑ clear, natural line impressed on the bank
- ☐ changes in character of soil
- ☐ shelving
- ☑ vegetation matted down, bent, or absent
- ☑ leaf litter disturbed or washed away
- ☑ sediment deposition
- ☐ water staining
- ☑ the presence of litter and debris
- ☐ destruction of terrestrial vegetation
- ☑ the presence of wrack line
- ☑ sediment sorting
- ☑ scour
- ☑ multiple observed or predicted flow events
- ☐ abrupt change in plant community
- ☐ other (list):

☐ Discontinuous OHWM (explain):

Avg. Channel Width: 8-20' **Depth:** 4' **Avg. Water Depth:** 1-10"

Hydrological Connectivity: Flow direction: NW

Upstream: Outside SA Downstream: WC7 Adjacent/abutting: WL4

Substrate: ☐ Bedrock ☐ Rubble ☑ Cobble ☑ Gravel ☑ Sand

☐ Mud ☐ Organic ☐ Vegetated ☐ Other

Habitat Complexity (characterize): Low to moderate, some stable woody debris, undercut bank, substrate in riffles is mostly gravel

Bank Erosion: ☑ Severe ☑ Moderate ☐ Minor

Describe: Moderate overall but severe along meanders

Pollutants (field observations, potential sources, stormwater outfalls, etc.): Residences outside SA but reach w/in SA is in forested setting.

Wildlife Observations: Dead minnow, no others observed but likely present.

Riparian Zone:

Describe (forest, residential yard, emergent wetland, etc.):

Right bank: Forest Left bank: Forest

Riparian Buffer Width: >100' **Approximate Shading by Woody Species (%):** 60

Dominant species: LITU, PLOC, JUNI, ACRU

Other Comments:

Non-tidal Stream Features Field Datasheet

Date: 3/27/2020 **Project Site:** SA 5 Mitigation Site **Stream ID:** WC7

Observer(s): EB, NN **Photos:** Upstream: 7 (DS end) 17 (US end) Downstream: 6 (DS end) 18 - US end

Flow Type:

☑ Perennial ☐ Intermittent ☐ Ephemeral Cowardin Classification: R3UB1/2

Justification: Bed+banks, many tribs

Channel Characteristics:

☑ Natural ☐ Artificial (made-made) ☑ Manipulated (man-altered)

Explain: Some foot bridges crossing stream, blown out culvert in stream

Channel Gradient (%): 2-5 **Average Bank Slope:** ☑ Vertical ☐ 2:1 ☐ 3:1 ☐ 4:1 or greater

Channel Has (check all that apply):

☑ Bed and banks

☑ OHWM

- ☑ clear, natural line impressed on the bank
- ☐ changes in character of soil
- ☐ shelving
- ☑ vegetation matted down, bent, or absent
- ☑ leaf litter disturbed or washed away
- ☑ sediment deposition
- ☐ water staining
- ☑ the presence of litter and debris
- ☑ destruction of terrestrial vegetation
- ☑ the presence of wrack line
- ☑ sediment sorting
- ☑ scour
- ☑ multiple observed or predicted flow events
- ☐ abrupt change in plant community
- ☐ other (list): ______

☐ Discontinuous OHWM (explain): ______

Avg. Channel Width: 8-20' **Depth:** 4' **Avg. Water Depth:** 1"-12"

Hydrological Connectivity: Flow direction: W

Upstream: Outside SA Downstream: Outside SA Adjacent/abutting: WL1-WL6

Substrate: ☑ Bedrock ☑ Rubble ☑ Cobble ☑ Gravel ☑ Sand

☐ Mud ☐ Organic ☐ Vegetated ☐ Other ______

Habitat Complexity (characterize): Low to moderate, limited flow diversity, short riffles w/ mostly gravel, some large woody debris

Bank Erosion: ☑ Severe ☑ Moderate ☐ Minor

Describe: Moderate through most but severe at meanders + some confluences

Pollutants (field observations, potential sources, stormwater outfalls, etc.): Residences outside study area, run off from storm drains that outlet to stream, sewer line near stream

Wildlife Observations: Green frogs

Riparian Zone:

Describe (forest, residential yard, emergent wetland, etc.):

Right bank: Forest Left bank: Forest

Riparian Buffer Width: 50' to >100' **Approximate Shading by Woody Species (%):** 75%

Dominant species: LITU, ACRU, PLOC, PRSE, BENI

Other Comments: ______

Non-tidal Stream Features Field Datasheet

Date: 3/27/20 **Project Site:** CA-5 **Stream ID:** WC8

Observer(s): EB, MN **Photos:** Upstream: 12 Downstream: 11

Flow Type:

☐ Perennial ☑ Intermittent ☐ Ephemeral Cowardin Classification: R4SB3/4

Justification: Bed + banks, drains pond to WC7

Channel Characteristics:

☐ Natural ☐ Artificial (made-made) ☑ Manipulated (man-altered)

Explain: Bermed on both sides

Channel Gradient (%): 5% **Average Bank Slope:** ☐ Vertical ☑ 2:1 ☐ 3:1 ☐ 4:1 or greater

Channel Has (check all that apply):

☑ Bed and banks

☑ OHWM

- ☑ clear, natural line impressed on the bank
- ☑ changes in character of soil
- ☐ shelving
- ☐ vegetation matted down, bent, or absent
- ☑ leaf litter disturbed or washed away
- ☑ sediment deposition
- ☐ water staining
- ☐ the presence of litter and debris
- ☐ destruction of terrestrial vegetation
- ☐ the presence of wrack line
- ☐ sediment sorting
- ☐ scour
- ☑ multiple observed or predicted flow events
- ☐ abrupt change in plant community
- ☐ other (list):

☐ Discontinuous OHWM (explain):

Avg. Channel Width: 1-2' **Depth:** 1-2' **Avg. Water Depth:** 2"

Hydrological Connectivity: Flow direction: N

Upstream: Pond Downstream: WC7 Adjacent/abutting: None

Substrate: ☐ Bedrock ☐ Rubble ☑ Cobble ☑ Gravel ☐ Sand

☐ Mud ☐ Organic ☐ Vegetated ☑ Other Boulder

Habitat Complexity (characterize): Some larger boulders, no large woody debris, runs only.

Bank Erosion: ☐ Severe ☐ Moderate ☑ Minor

Describe: Slight erosion at confluence w/ WC7

Pollutants (field observations, potential sources, stormwater outfalls, etc.): Runoff from neighborhood upslope

Wildlife Observations: Green frogs

Riparian Zone:

Describe (forest, residential yard, emergent wetland, etc.):

Right bank: Forest Left bank: Forest

Riparian Buffer Width: >100' **Approximate Shading by Woody Species (%):** 75

Dominant species: LITU, ACRU, PRSE, PLOC, ROMU, ELUM

Other Comments: Flags 1A-3A, 1B-4B

Non-tidal Stream Features Field Datasheet

Date: 3/27/20 **Project Site:** CA-5 Mitigation Site **Stream ID:** WC9

Observer(s): EB, MN **Photos:** Upstream: 14 (R4) 15 (EPH) Downstream: 13 (R4) 16 (EPH)

Flow Type:

☐ Perennial ☑ Intermittent ☑ Ephemeral Cowardin Classification: R4SB3/4

Justification: Bed + banks throughout, large headcut @ start of int. water in pools in int. sect. or lightly flowing

Channel Characteristics:

☑ Natural ☐ Artificial (made-made) ☐ Manipulated (man-altered)

Explain: Walking trail crosses eph sect.

Channel Gradient (%): 10% **Average Bank Slope:** ☑ Vertical ☐ 2:1 ☐ 3:1 ☐ 4:1 or greater

Channel Has (check all that apply):

☑ Bed and banks

☑ OHWM

- ☑ clear, natural line impressed on the bank
- ☐ changes in character of soil
- ☐ shelving
- ☑ vegetation matted down, bent, or absent
- ☑ leaf litter disturbed or washed away
- ☑ sediment deposition
- ☐ water staining
- ☐ the presence of litter and debris
- ☑ destruction of terrestrial vegetation
- ☑ the presence of wrack line
- ☑ sediment sorting
- ☑ scour
- ☑ multiple observed or predicted flow events
- ☐ abrupt change in plant community
- ☐ other (list):

☐ Discontinuous OHWM (explain):

Avg. Channel Width: 4-15 **Depth:** 1-7' **Avg. Water Depth:** 0-3"

Hydrological Connectivity: Flow direction: N

Upstream: Outside Downstream: WC7 Adjacent/abutting: None

Substrate: ☐ Bedrock ☐ Rubble ☑ Cobble ☑ Gravel ☑ Sand

☐ Mud ☐ Organic ☐ Vegetated ☐ Other

Habitat Complexity (characterize): Poor, lacking stable habitat, ephemeral/intermittent flows

Bank Erosion: ☑ Severe ☑ Moderate ☑ Minor

Describe: Mostly severe erosion in int. sec, Moderate/Minor in eph. Exposed water or sewer line

Pollutants (field observations, potential sources, stormwater outfalls, etc.): Exposed water or sewer line, Runoff from residences upslope

Wildlife Observations: None

Riparian Zone:

Describe (forest, residential yard, emergent wetland, etc.):

Right bank: Forest Left bank: Forest

Riparian Buffer Width: >100' **Approximate Shading by Woody Species (%):** 75%

Dominant species: LITU, PYCA, LIBE, MIVI, RUPH, THBE

Other Comments:

WETLAND DETERMINATION DATA FORM – Eastern Mountains and Piedmont Region

Project/Site: CK-5 City/County: Montgomery Sampling Date: 3/24/20

Applicant/Owner: MDOT SHA State: MD Sampling Point: WTP-1

Investigator(s): EB, HT Section, Township, Range: ___

Landform (hillslope, terrace, etc.): Seep Local relief (concave, convex, none): Concave Slope (%): 0-5

Subregion (LRR or MLRA): MLRA 148 Lat: 39.130591 Long: -77.249894 Datum: NAD83(2011)

Soil Map Unit Name: Brinklow-Blocktown channery silt loams, 15-25% slopes NWI classification: PFO1B

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ✓ No ___ (If no, explain in Remarks.)

Are Vegetation ___, Soil ___, or Hydrology ✓ significantly disturbed? Y Are "Normal Circumstances" present? Yes ✓ No ___

Are Vegetation ___, Soil ___, or Hydrology ___ naturally problematic? N (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ✓ No ___	Is the Sampled Area within a Wetland? Yes ✓ No ___
Hydric Soil Present?	Yes ✓ No ___	
Wetland Hydrology Present?	Yes ✓ No ___	

Remarks:
Photo 1 - west
flags WL1-1 to WL1-30
WL1-1A to 4A
- wetland bisected by paved path
- someone recently dug a ditch along the trail to make wetland drain to stream faster

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

- ___ Surface Water (A1)
- ✓ High Water Table (A2)
- ✓ Saturation (A3)
- ___ Water Marks (B1)
- ___ Sediment Deposits (B2)
- ___ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ___ Iron Deposits (B5)
- ___ Inundation Visible on Aerial Imagery (B7)
- ✓ Water-Stained Leaves (B9)
- ___ Aquatic Fauna (B13)
- ___ True Aquatic Plants (B14)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres on Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Thin Muck Surface (C7)
- ___ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ___ Surface Soil Cracks (B6)
- ✓ Sparsely Vegetated Concave Surface (B8)
- ___ Drainage Patterns (B10)
- ___ Moss Trim Lines (B16)
- ___ Dry-Season Water Table (C2)
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Stunted or Stressed Plants (D1)
- ✓ Geomorphic Position (D2)
- ___ Shallow Aquitard (D3)
- ___ Microtopographic Relief (D4)
- ___ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present?	Yes ___ No ✓	Depth (inches): ___	
Water Table Present?	Yes ✓ No ___	Depth (inches): 8"	
Saturation Present? (includes capillary fringe)	Yes ✓ No ___	Depth (inches): 0"	Wetland Hydrology Present? Yes ✓ No ___

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:
- rain w/in previous 24 hours
- wetland seep draining to WC1 & WC2.

VEGETATION (Four Strata) – Use scientific names of plants. Sampling Point: WTP-1

Tree Stratum (Plot size: *)	Absolute % Cover	Dominant Species?	Indicator Status
1. Acer rubrum	15	✓	FAC
2. Acer negundo	20	✓	FAC
3.			
4.			
5.			
6.			
7.			
	35 = Total Cover		
50% of total cover: 17.5	20% of total cover: 7		

Sapling/Shrub Stratum (Plot size: *)	Absolute % Cover	Dominant Species?	Indicator Status
1. Lindera benzoin	30	✓	FAC
2. Euonymus alatus	15	✓	N/A
3.			
4.			
5.			
6.			
7.			
8.			
9.			
	45 = Total Cover		
50% of total cover: 27.5	20% of total cover: 9		

Herb Stratum (Plot size: *)	Absolute % Cover	Dominant Species?	Indicator Status
1. Lonicera japonica	10		FACU
2. Impatiens capensis	5		FACW
3. Microstegium vimineum	20	✓	FAC
4. Acer negundo	3		FAC
5. Euonymus alatus	3		N/A
6. Glechoma hederacea	30	✓	FACU
7. Rosa multiflora	3		FACU
8. Alliaria petiolata	10		FACU
9.			
10.			
11.			
	84 = Total Cover		
50% of total cover: 42	20% of total cover: 16.8		

Woody Vine Stratum (Plot size: *)	Absolute % Cover	Dominant Species?	Indicator Status
1. Lonicera japonica	3	✓	FACU
2. Smilax rotundifolia	5	✓	FAC
3.			
4.			
5.			
	8 = Total Cover		
50% of total cover: 4	20% of total cover: 1.6		

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 5 (A)

Total Number of Dominant Species Across All Strata: 8 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 62.5% (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species		x 1 =
FACW species		x 2 =
FAC species		x 3 =
FACU species		x 4 =
UPL species		x 5 =
Column Totals:	(A)	(B)

Prevalence Index = B/A =

Hydrophytic Vegetation Indicators:

- ___ 1 - Rapid Test for Hydrophytic Vegetation
- ✓ 2 - Dominance Test is >50%
- ___ 3 - Prevalence Index is ≤3.0[1]
- ___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Definitions of Four Vegetation Strata:

Tree – Woody plants, excluding vines, 3 in. (7.6 cm) or more in diameter at breast height (DBH), regardless of height.

Sapling/Shrub – Woody plants, excluding vines, less than 3 in. DBH and greater than or equal to 3.28 ft (1 m) tall.

Herb – All herbaceous (non-woody) plants, regardless of size, and woody plants less than 3.28 ft tall.

Woody vine – All woody vines greater than 3.28 ft in height.

Hydrophytic Vegetation Present? Yes ✓ No ___

Remarks: (Include photo numbers here or on a separate sheet.)

* plot size is limited by wetland shape

Euonymus alatus does not have an indicator status.

SOIL

Sampling Point: WTP-1

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	%	Redox Features Color (moist)	%	Type[1]	Loc[2]	Texture	Remarks
0-4	2.5Y4/2	60	10YR5/6	10	C	M	SiL	Gravel
	10YR3/1	30						
4-10+	10YR3/1	40	10YR5/6	10	C	M	SiL	gravel
	2.5Y4/3	30						
	2.5Y4/1	20						

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators:

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5)
- ___ 2 cm Muck (A10) **(LRR N)**
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1) **(LRR N, MLRA 147, 148)**
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Dark Surface (S7)
- ___ Polyvalue Below Surface (S8) **(MLRA 147, 148)**
- ___ Thin Dark Surface (S9) **(MLRA 147, 148)**
- ___ Loamy Gleyed Matrix (F2)
- ✓ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)
- ___ Iron-Manganese Masses (F12) **(LRR N, MLRA 136)**
- ___ Umbric Surface (F13) **(MLRA 136, 122)**
- ___ Piedmont Floodplain Soils (F19) **(MLRA 148)**
- ___ Red Parent Material (F21) **(MLRA 127, 147)**

Indicators for Problematic Hydric Soils[3]:

- ___ 2 cm Muck (A10) **(MLRA 147)**
- ___ Coast Prairie Redox (A16) **(MLRA 147, 148)**
- ___ Piedmont Floodplain Soils (F19) **(MLRA 136, 147)**
- ___ Very Shallow Dark Surface (TF12)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: ____________

Depth (inches): ____________

Hydric Soil Present? **Yes** ✓ **No** ___

Remarks:

Wetland Function-Value Evaluation Form

Total area of wetland 0.05 ac Human made? No Is wetland part of a wildlife corridor? Yes or a "habitat island"? No

Adjacent land use Forest, residential Distance to nearest roadway or other development ~70'

Dominant wetland systems present PFO Contiguous undeveloped buffer zone present ~70'

Is the wetland a separate hydraulic system? No If not, where does the wetland lie in the drainage basin? High

How many tributaries contribute to the wetland? None Wildlife & vegetation diversity/abundance (see attached list)

Wetland I.D. WL1
Latitude 38.13059 / Longitude -77.249874
Prepared by: EB, HT Date 3/25/2020
Wetland Impact:
Type — Area —

Evaluation based on:
Office ✓ Field ✓
Corps manual wetland delineation completed? Y ✓ N ___

Function/Value	Suitability Y	Suitability N	Rationale (Reference #)*	Principal Function(s)/Value(s)	Comments
Groundwater Recharge/Discharge	✓				Hillside seep wetland w/ concave pockets retaining surface water runoff from residences upslope
Floodflow Alteration	✓				Retains runoff from upslope
Fish and Shellfish Habitat		✓			
Sediment/Toxicant Retention	✓				Excess sediments/toxicants from residences upslope
Nutrient Removal	✓				Excess nutrients from residences upslope.
Production Export		✓			
Sediment/Shoreline Stabilization		✓			
Wildlife Habitat	✓				Observed hawk catch a frog in wetland. Wetland is within a county park.
Recreation	✓				Wetland is within a county park, adjacent to a walking path
Educational/Scientific Value	✓				See note above.
Uniqueness/Heritage	✓				Within county park surrounded by residential development.
Visual Quality/Aesthetics		✓			
ES Endangered Species Habitat		✓			
Other					

Notes:

*Refer to backup list of numbered considerations.

WETLAND DETERMINATION DATA FORM – Eastern Mountains and Piedmont Region

Project/Site: CA-5 City/County: Montgomery Sampling Date: 3/24/20

Applicant/Owner: MDOT SHA State: MD Sampling Point: WTP-2

Investigator(s): HT, EB Section, Township, Range: ____

Landform (hillslope, terrace, etc.): floodplain Local relief (concave, convex, none): concave Slope (%): 0-2

Subregion (LRR or MLRA): MLRA 148 Lat: 39.13074 Long: -77.250859 Datum: NAD 83 (2011)

Soil Map Unit Name: Brinklow-Blocktown channery silt loams, 15-25% slopes NWI classification: PFO1B

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ✓ No ____ (If no, explain in Remarks.)

Are Vegetation ____, Soil ____, or Hydrology ____ significantly disturbed? N Are "Normal Circumstances" present? Yes ✓ No ____

Are Vegetation ____, Soil ____, or Hydrology ____ naturally problematic? N (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ✓ No ____	Is the Sampled Area within a Wetland? Yes ✓ No ____
Hydric Soil Present?	Yes ✓ No ____	
Wetland Hydrology Present?	Yes ✓ No ____	

Remarks:
Photo 7 - west
Flags WL2-1 to 17

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

- ✓ Surface Water (A1)
- __ High Water Table (A2)
- __ Saturation (A3)
- __ Water Marks (B1)
- __ Sediment Deposits (B2)
- ✓ Drift Deposits (B3)
- __ Algal Mat or Crust (B4)
- __ Iron Deposits (B5)
- __ Inundation Visible on Aerial Imagery (B7)
- ✓ Water-Stained Leaves (B9)
- __ Aquatic Fauna (B13)
- __ True Aquatic Plants (B14)
- __ Hydrogen Sulfide Odor (C1)
- __ Oxidized Rhizospheres on Living Roots (C3)
- __ Presence of Reduced Iron (C4)
- __ Recent Iron Reduction in Tilled Soils (C6)
- __ Thin Muck Surface (C7)
- __ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- __ Surface Soil Cracks (B6)
- __ Sparsely Vegetated Concave Surface (B8)
- ✓ Drainage Patterns (B10)
- __ Moss Trim Lines (B16)
- __ Dry-Season Water Table (C2)
- __ Crayfish Burrows (C8)
- __ Saturation Visible on Aerial Imagery (C9)
- __ Stunted or Stressed Plants (D1)
- __ Geomorphic Position (D2)
- __ Shallow Aquitard (D3)
- __ Microtopographic Relief (D4)
- __ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present?	Yes ✓	No ____	Depth (inches): 0.5*
Water Table Present?	Yes ____	No ✓	Depth (inches): ____
Saturation Present? (includes capillary fringe)	Yes ✓	No ____	Depth (inches): 0

Wetland Hydrology Present? Yes ✓ No ____

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks: rain in previous 24 hrs
wetland originates along toe of slope and extends through floodplain, draining to the mainstem (WC_) and WC_

* surface water in 25% of plot

VEGETATION (Four Strata) – Use scientific names of plants. Sampling Point: WTP-2

Tree Stratum (Plot size: 30')	Absolute % Cover	Dominant Species?	Indicator Status
1. Acer negundo	50	✓	FAC
2. Acer rubrum	15	✓	FAC
3. Betula nigra	10		FACW
4.			
5.			
6.			
7.			
	75 = Total Cover		
50% of total cover: 37.5	20% of total cover: 15		

Sapling/Shrub Stratum (Plot size: 30')	Absolute % Cover	Dominant Species?	Indicator Status
1. Rubus phoenicolasius	5	✓	FACU
2. Rosa multiflora	3	✓	FACU
3.			
4.			
5.			
6.			
7.			
8.			
9.			
	8 = Total Cover		
50% of total cover: 4	20% of total cover: 1.6		

Herb Stratum (Plot size: 30')	Absolute % Cover	Dominant Species?	Indicator Status
1. Microstegium vimineum	75	✓	FAC
2. Boehmeria cylindrica	35	✓	FACW
3. Cinna arundinacea	20		FACW
4. Lonicera japonica	10		FACU
5. Viola sp.	3		N/A
6. Veronica hederacea	15		UPL
7.			
8.			
9.			
10.			
11.			
	158 = Total Cover		
50% of total cover: 79	20% of total cover: 31.6		

Woody Vine Stratum (Plot size: 30')	Absolute % Cover	Dominant Species?	Indicator Status
1. None			
2.			
3.			
4.			
5.			
	___ = Total Cover		
50% of total cover: ___	20% of total cover: ___		

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 4 (A)

Total Number of Dominant Species Across All Strata: 6 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 67% (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species	___	x 1 = ___
FACW species	___	x 2 = ___
FAC species	___	x 3 = ___
FACU species	___	x 4 = ___
UPL species	___	x 5 = ___
Column Totals:	___ (A)	___ (B)

Prevalence Index = B/A = ___

Hydrophytic Vegetation Indicators:

- ___ 1 - Rapid Test for Hydrophytic Vegetation
- ✓ 2 - Dominance Test is >50%
- ___ 3 - Prevalence Index is ≤3.0[1]
- ___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Definitions of Four Vegetation Strata:

Tree – Woody plants, excluding vines, 3 in. (7.6 cm) or more in diameter at breast height (DBH), regardless of height.

Sapling/Shrub – Woody plants, excluding vines, less than 3 in. DBH and greater than or equal to 3.28 ft (1 m) tall.

Herb – All herbaceous (non-woody) plants, regardless of size, and woody plants less than 3.28 ft tall.

Woody vine – All woody vines greater than 3.28 ft in height.

Hydrophytic Vegetation Present? Yes ✓ No ___

Remarks: (Include photo numbers here or on a separate sheet.)

SOIL

Sampling Point: WTP-2

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox %	Type[1]	Loc[2]	Texture	Remarks
0-6	10YR3/1	90	7.5YR4/4	10	C	M, PL	sicl	
6-10	2.5Y5/3	90	7.5YR4/4	10	C	M, PL	fscl	
10-12+	2.5Y5/4	60	7.5YR4/4	15	C	M	scl	w/ gravel
	2.5Y5/2	25						

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators:

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5)
- ___ 2 cm Muck (A10) **(LRR N)**
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1) **(LRR N, MLRA 147, 148)**
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Dark Surface (S7)
- ___ Polyvalue Below Surface (S8) **(MLRA 147, 148)**
- ___ Thin Dark Surface (S9) **(MLRA 147, 148)**
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ✓ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)
- ___ Iron-Manganese Masses (F12) **(LRR N, MLRA 136)**
- ___ Umbric Surface (F13) **(MLRA 136, 122)**
- ___ Piedmont Floodplain Soils (F19) **(MLRA 148)**
- ___ Red Parent Material (F21) **(MLRA 127, 147)**

Indicators for Problematic Hydric Soils[3]:

- ___ 2 cm Muck (A10) **(MLRA 147)**
- ___ Coast Prairie Redox (A16) **(MLRA 147, 148)**
- ___ Piedmont Floodplain Soils (F19) **(MLRA 136, 147)**
- ___ Very Shallow Dark Surface (TF12)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: ______

Depth (inches): ______

Hydric Soil Present? Yes ✓ No ___

Remarks:

Wetland Function-Value Evaluation Form

Total area of wetland 0.13 ac Human made? No Is wetland part of a wildlife corridor? Yes or a "habitat island"? No

Adjacent land use Forest Distance to nearest roadway or other development ~170'

Dominant wetland systems present PFO Contiguous undeveloped buffer zone present >150'

Is the wetland a separate hydraulic system? No If not, where does the wetland lie in the drainage basin? Mid

How many tributaries contribute to the wetland? None Wildlife & vegetation diversity/abundance (see attached list)

Wetland I.D. WL2
Latitude 39.13074 Longitude -77.250859
Prepared by: EB, HT Date 3/25/2020
Wetland Impact:
Type — Area —

Evaluation based on:
Office ✓ Field ✓
Corps manual wetland delineation completed? Y ✓ N

Function/Value	Suitability Y	Suitability N	Rationale (Reference #)*	Principal Function(s)/Value(s)	Comments
Groundwater Recharge/Discharge		✓			
Floodflow Alteration	✓				Within floodplain of mainstem, receives runoff from residences
Fish and Shellfish Habitat		✓			
Sediment/Toxicant Retention	✓				Excess sediment/toxicants from residences upslope.
Nutrient Removal	✓				Excess nutrients from residences upslope
Production Export		✓			
Sediment/Shoreline Stabilization		✓			
Wildlife Habitat	✓				Within a county park, evidence of deer in wetland, observed birds.
Recreation	✓				Within a county park, walking trails near wetland.
Educational/Scientific Value	✓				See note above.
Uniqueness/Heritage	✓				Within county park surrounded by residential development
Visual Quality/Aesthetics		✓			
ES Endangered Species Habitat					
Other					

Notes:

* Refer to backup list of numbered considerations.

WETLAND DETERMINATION DATA FORM – Eastern Mountains and Piedmont Region

Project/Site: CA-5 City/County: Montgumery Sampling Date: 3/24/20

Applicant/Owner: MDOT SHA State: MD Sampling Point: WP-3

Investigator(s): HT, EB Section, Township, Range: ____

Landform (hillslope, terrace, etc.): floodplain Local relief (concave, convex, none): concave Slope (%): 0-2

Subregion (LRR or MLRA): MLRA 148 Lat: 39.130201 Long: -77.257702 Datum: NAD83(2011)

Soil Map Unit Name: Codorus silt loam, 0-3% slopes, occasionally flooded NWI classification: PFO1A

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ✓ No ____ (If no, explain in Remarks.)

Are Vegetation ____, Soil ____, or Hydrology ____ significantly disturbed? N. Are "Normal Circumstances" present? Yes ✓ No ____

Are Vegetation ____, Soil ____, or Hydrology ____ naturally problematic? N (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present? Yes ✓ No ____	Is the Sampled Area within a Wetland?	Yes ✓ No ____
Hydric Soil Present? Yes ✓ No ____		
Wetland Hydrology Present? Yes ✓ No ____		

Remarks:
Photo 14- north *sewerline crossing through wetland

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

- ✓ Surface Water (A1)
- ✓ High Water Table (A2)
- ✓ Saturation (A3)
- ___ Water Marks (B1)
- ___ Sediment Deposits (B2)
- ___ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ___ Iron Deposits (B5)
- ___ Inundation Visible on Aerial Imagery (B7)
- ✓ Water-Stained Leaves (B9)
- ___ Aquatic Fauna (B13)
- ___ True Aquatic Plants (B14)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres on Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Thin Muck Surface (C7)
- ___ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ___ Surface Soil Cracks (B6)
- ___ Sparsely Vegetated Concave Surface (B8)
- ✓ Drainage Patterns (B10)
- ___ Moss Trim Lines (B16)
- ___ Dry-Season Water Table (C2)
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Stunted or Stressed Plants (D1)
- ___ Geomorphic Position (D2)
- ___ Shallow Aquitard (D3)
- ___ Microtopographic Relief (D4)
- ___ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present? Yes ✓ No ____ Depth (inches): * 1"

Water Table Present? Yes ✓ No ____ Depth (inches): 0"

Saturation Present? (includes capillary fringe) Yes ✓ No ____ Depth (inches): 0"

Wetland Hydrology Present? Yes ✓ No ____

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:
*surface water in 10% of plot

VEGETATION (Four Strata) – Use scientific names of plants.

Sampling Point: WTP-3

Tree Stratum (Plot size: 30')	Absolute % Cover	Dominant Species?	Indicator Status
1. Acer negundo	10		FAC
2. Betula nigra	30	✓	FACW
3. Populus deltoides	50	✓	FAC
4. Acer rubrum	15		FAC
5.			
6.			
7.			
	105 = Total Cover		
50% of total cover: 52.5	20% of total cover: 21		

Sapling/Shrub Stratum (Plot size: 30')	Absolute % Cover	Dominant Species?	Indicator Status
1. Rosa multiflora	10	✓	FACU
2. Berberis thunbergii	5	✓	FACU
3.			
4.			
5.			
6.			
7.			
8.			
9.			
	15 = Total Cover		
50% of total cover: 7.5	20% of total cover: 3		

Herb Stratum (Plot size: 30')	Absolute % Cover	Dominant Species?	Indicator Status
1. Cinna arundinacea	25		FACW
2. Microstegium vimineum	80	✓	FAC
3. Boehmeria cylindrica	40	✓	FACW
4. Veronica hederifolia	20		UPL
5. Allium vineale	5		FACU
6. Lonicera japonica	5		FACU
7. Rosa multiflora	5		FACU
8. Juncus effusus	3		FACW
9.			
10.			
11.			
	183 = Total Cover		
50% of total cover: 91.5	20% of total cover: 36.6		

Woody Vine Stratum (Plot size: 30')	Absolute % Cover	Dominant Species?	Indicator Status
1. None			
2.			
3.			
4.			
5.			
	= Total Cover		
50% of total cover:	20% of total cover:		

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 4 (A)

Total Number of Dominant Species Across All Strata: 6 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 67% (A/B)

Prevalence Index worksheet:

Total % Cover of:	Multiply by:
OBL species	x 1 =
FACW species	x 2 =
FAC species	x 3 =
FACU species	x 4 =
UPL species	x 5 =
Column Totals: (A)	(B)

Prevalence Index = B/A =

Hydrophytic Vegetation Indicators:

___ 1 - Rapid Test for Hydrophytic Vegetation
✓ 2 - Dominance Test is >50%
___ 3 - Prevalence Index is ≤3.0[1]
___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Definitions of Four Vegetation Strata:

Tree – Woody plants, excluding vines, 3 in. (7.6 cm) or more in diameter at breast height (DBH), regardless of height.

Sapling/Shrub – Woody plants, excluding vines, less than 3 in. DBH and greater than or equal to 3.28 ft (1 m) tall.

Herb – All herbaceous (non-woody) plants, regardless of size, and woody plants less than 3.28 ft tall.

Woody vine – All woody vines greater than 3.28 ft in height.

Hydrophytic Vegetation Present? Yes ✓ No ___

Remarks: (Include photo numbers here or on a separate sheet.)

*many dead ash

SOIL

Sampling Point: WTP-3

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox %	Type[1]	Loc[2]	Texture	Remarks
0-3	10YR4/2	95	7.5YR4/4	5	C	M	sil	
3-10	2.5Y5/3	80	7.5YR5/8	20	C	M	sicl	gravel
10+	restrictive layer							

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators:

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5)
- ___ 2 cm Muck (A10) **(LRR N)**
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1) **(LRR N, MLRA 147, 148)**
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Dark Surface (S7)
- ___ Polyvalue Below Surface (S8) **(MLRA 147, 148)**
- ___ Thin Dark Surface (S9) **(MLRA 147, 148)**
- ___ Loamy Gleyed Matrix (F2)
- ✓ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)
- ___ Iron-Manganese Masses (F12) **(LRR N, MLRA 136)**
- ___ Umbric Surface (F13) **(MLRA 136, 122)**
- ___ Piedmont Floodplain Soils (F19) **(MLRA 148)**
- ___ Red Parent Material (F21) **(MLRA 127, 147)**

Indicators for Problematic Hydric Soils[3]:

- ___ 2 cm Muck (A10) **(MLRA 147)**
- ___ Coast Prairie Redox (A16) **(MLRA 147, 148)**
- ___ Piedmont Floodplain Soils (F19) **(MLRA 136, 147)**
- ___ Very Shallow Dark Surface (TF12)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: clay

Depth (inches): 10"

Hydric Soil Present? Yes ✓ No ___

Remarks:

Wetland Function-Value Evaluation Form

Total area of wetland 0.11 ac Human made? No Is wetland part of a wildlife corridor? Yes or a "habitat island"? No

Adjacent land use Forest Distance to nearest roadway or other development ~500'

Dominant wetland systems present PFO Contiguous undeveloped buffer zone present 500'

Is the wetland a separate hydraulic system? No If not, where does the wetland lie in the drainage basin? Mid

How many tributaries contribute to the wetland? None Wildlife & vegetation diversity/abundance (see attached list)

Wetland I.D. WL3
Latitude 39.13020 Longitude -77.257702
Prepared by: EB, HT Date 3/25/2020
Wetland Impact:
Type — Area —

Evaluation based on:
Office ✓ Field ✓
Corps manual wetland delineation completed? Y ✓ N

Function/Value	Suitability Y	Suitability N	Rationale (Reference #)*	Principal Function(s)/Value(s)	Comments
Groundwater Recharge/Discharge		✓			
Floodflow Alteration	✓				Within floodplain of mainstem + tributary
Fish and Shellfish Habitat		✓			
Sediment/Toxicant Retention		✓			
Nutrient Removal		✓			
Production Export		✓			
Sediment/Shoreline Stabilization		✓			
Wildlife Habitat	✓				Within a park, evidence of deer in wetland. Observed birds.
Recreation	✓				Within a county park w/ walking trails adjacent.
Educational/Scientific Value	✓				See note above
Uniqueness/Heritage	✓				Within a county park surrounded by residential development.
Visual Quality/Aesthetics		✓			
ES Endangered Species Habitat		✓			
Other					

Notes:

* Refer to backup list of numbered considerations.

WETLAND DETERMINATION DATA FORM – Eastern Mountains and Piedmont Region

Project/Site: CA-5 Mitigation Site City/County: Montgomery Sampling Date: 3/27/2020

Applicant/Owner: MDOT SHA State: MD Sampling Point: WTP-4

Investigator(s): EB, MN Section, Township, Range: ____

Landform (hillslope, terrace, etc.): Oxbow Local relief (concave, convex, none): concave Slope (%): 2%

Subregion (LRR or MLRA): MLRA 148 Lat: 39.130034 Long: -77.257783 Datum: NAD83 (2011)

Soil Map Unit Name: Codorus silt loam, 0-3% slopes, occasionally flooded NWI classification: PFO1A

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ✓ No ____ (If no, explain in Remarks.)

Are Vegetation ____, Soil ____, or Hydrology ____ significantly disturbed? N Are "Normal Circumstances" present? Yes ✓ No ____

Are Vegetation ____, Soil ____, or Hydrology ____ naturally problematic? N (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ✓ No ____	Is the Sampled Area within a Wetland? Yes ✓ No ____
Hydric Soil Present?	Yes ✓ No ____	
Wetland Hydrology Present?	Yes ✓ No ____	

Remarks:

Flags WL4-1 to 7 Ph1-5

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

- ____ Surface Water (A1)
- ✓ High Water Table (A2)
- ✓ Saturation (A3)
- ____ Water Marks (B1)
- ____ Sediment Deposits (B2)
- ____ Drift Deposits (B3)
- ____ Algal Mat or Crust (B4)
- ____ Iron Deposits (B5)
- ____ Inundation Visible on Aerial Imagery (B7)
- ✓ Water-Stained Leaves (B9)
- ____ Aquatic Fauna (B13)
- ____ True Aquatic Plants (B14)
- ____ Hydrogen Sulfide Odor (C1)
- ____ Oxidized Rhizospheres on Living Roots (C3)
- ____ Presence of Reduced Iron (C4)
- ____ Recent Iron Reduction in Tilled Soils (C6)
- ____ Thin Muck Surface (C7)
- ____ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ____ Surface Soil Cracks (B6)
- ____ Sparsely Vegetated Concave Surface (B8)
- ____ Drainage Patterns (B10)
- ____ Moss Trim Lines (B16)
- ____ Dry-Season Water Table (C2)
- ____ Crayfish Burrows (C8)
- ____ Saturation Visible on Aerial Imagery (C9)
- ____ Stunted or Stressed Plants (D1)
- ✓ Geomorphic Position (D2)
- ____ Shallow Aquitard (D3)
- ____ Microtopographic Relief (D4)
- ✓ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present?	Yes ____	No ✓	Depth (inches): —	
Water Table Present?	Yes ✓	No ____	Depth (inches): 10"	
Saturation Present? (includes capillary fringe)	Yes ✓	No ____	Depth (inches): 0"	**Wetland Hydrology Present?** Yes ✓ No ____

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

VEGETATION (Four Strata) – Use scientific names of plants.

Sampling Point: WTP-4

Tree Stratum (Plot size: *)	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
5.			
6.			
7.			
	= Total Cover		
50% of total cover:	20% of total cover:		

Sapling/Shrub Stratum (Plot size: *)	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
	= Total Cover		
50% of total cover:	20% of total cover:		

Herb Stratum (Plot size: *)	Absolute % Cover	Dominant Species?	Indicator Status
1. Cinna arundinacea	50	✓	FACW
2. Impatiens capensis	5		FACW
3. Rosa multiflora	15		FACU
4. Microstegium vimineum	15		FAC
5. Carex sp.	5		N/A
6.			
7.			
8.			
9.			
10.			
11.			
	90 = Total Cover		
50% of total cover: 45	20% of total cover: 18		

Woody Vine Stratum (Plot size: *)	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
5.			
	= Total Cover		
50% of total cover:	20% of total cover:		

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 1 (A)

Total Number of Dominant Species Across All Strata: 1 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 100% (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species		x 1 =
FACW species		x 2 =
FAC species		x 3 =
FACU species		x 4 =
UPL species		x 5 =
Column Totals:	(A)	(B)

Prevalence Index = B/A =

Hydrophytic Vegetation Indicators:

- ___ 1 - Rapid Test for Hydrophytic Vegetation
- ✓ 2 - Dominance Test is >50%
- ___ 3 - Prevalence Index is ≤3.0[1]
- ___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Definitions of Four Vegetation Strata:

Tree – Woody plants, excluding vines, 3 in. (7.6 cm) or more in diameter at breast height (DBH), regardless of height.

Sapling/Shrub – Woody plants, excluding vines, less than 3 in. DBH and greater than or equal to 3.28 ft (1 m) tall.

Herb – All herbaceous (non-woody) plants, regardless of size, and woody plants less than 3.28 ft tall.

Woody vine – All woody vines greater than 3.28 ft in height.

Hydrophytic Vegetation Present? Yes ✓ No ___

Remarks: (Include photo numbers here or on a separate sheet.)

* Plot size is entire wetland, ~12'x10'

Only emergent veg within wetland, however wetland is in forested setting w/ approximately 60% canopy cover of LITU; ACRU + PLOC

Unable to identify Carex sp due to time of year.

SOIL

Sampling Point: USTP-4

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox %	Type[1]	Loc[2]	Texture	Remarks
0-3	2.5Y4/2	60	7.5YR4/6	5	C	M,PL	SiL	
	10YR4/1	35						
3-10	2.5Y4/1	90	7.5YR3/4	5	C	M	SiCL	
			7.5YR4/6	5	C	M		
10-12+	2.5Y4/1	75	7.5YR4/6	25	C	M	SaCL	Gravel

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators:

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5)
- ___ 2 cm Muck (A10) **(LRR N)**
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1) **(LRR N, MLRA 147, 148)**
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Dark Surface (S7)
- ___ Polyvalue Below Surface (S8) **(MLRA 147, 148)**
- ___ Thin Dark Surface (S9) **(MLRA 147, 148)**
- ___ Loamy Gleyed Matrix (F2)
- ✓ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)
- ___ Iron-Manganese Masses (F12) **(LRR N, MLRA 136)**
- ___ Umbric Surface (F13) **(MLRA 136, 122)**
- ___ Piedmont Floodplain Soils (F19) **(MLRA 148)**
- ___ Red Parent Material (F21) **(MLRA 127, 147)**

Indicators for Problematic Hydric Soils[3]:

- ___ 2 cm Muck (A10) **(MLRA 147)**
- ___ Coast Prairie Redox (A16) **(MLRA 147, 148)**
- ___ Piedmont Floodplain Soils (F19) **(MLRA 136, 147)**
- ___ Very Shallow Dark Surface (TF12)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: ____________

Depth (inches): ____________

Hydric Soil Present? Yes ✓ No ___

Remarks:

Wetland Function-Value Evaluation Form

Total area of wetland 0.004 ac Human made? No Is wetland part of a wildlife corridor? Yes or a "habitat island"? No

Adjacent land use Forest, Utility ROW Distance to nearest roadway or other development ~1000'

Dominant wetland systems present PFO Contiguous undeveloped buffer zone present ~50'

Is the wetland a separate hydraulic system? No If not, where does the wetland lie in the drainage basin? Mid

How many tributaries contribute to the wetland? None Wildlife & vegetation diversity/abundance (see attached list)

Wetland I.D. WL4

Latitude 39.130636 Longitude -77.257783

Prepared by: EB Date 4/9/2020

Wetland Impact:

Type — Area —

Evaluation based on:

Office ✓ Field ✓

Corps manual wetland delineation completed? Y ✓ N

Function/Value	Suitability Y	Suitability N	Rationale (Reference #)*	Principal Function(s)/Value(s)	Comments
Groundwater Recharge/Discharge		✓			
Floodflow Alteration	✓				Adjacent to stream, receives excess flood water as stream levels rise
Fish and Shellfish Habitat		✓			
Sediment/Toxicant Retention		✓			
Nutrient Removal		✓			
Production Export		✓			
Sediment/Shoreline Stabilization	✓				Adjacent to stream, bank is not eroded [illegible] wetland edge as it is on other parts of the stream [illegible]
Wildlife Habitat	✓				Within a county park surrounded by residential development, evidence of deer + birds observed
Recreation	✓				Within a county park, walking trail adjacent to wetland
Educational/Scientific Value	✓				See note above
Uniqueness/Heritage	✓				County park surrounded by residential + commercial development
Visual Quality/Aesthetics		✓			
ES Endangered Species Habitat		✓			
Other					

Notes:

* Refer to backup list of numbered considerations.

WETLAND DETERMINATION DATA FORM – Eastern Mountains and Piedmont Region

Project/Site: CA-5 Mitigation Site City/County: Montgomery Sampling Date: 3/27/2020

Applicant/Owner: MDOT SHA State: MD Sampling Point: WTD-5

Investigator(s): EB, MN Section, Township, Range: ______

Landform (hillslope, terrace, etc.): Floodplain depression Local relief (concave, convex, none): concave Slope (%): 2%

Subregion (LRR or MLRA): MLRA 148 Lat: 39.130038 Long: -77.257262 Datum: NAD83(2011)

Soil Map Unit Name: Codorus silt loam, 0-3% slopes, occassionally flooded NWI classification: PFO1A

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ✓ No ____ (If no, explain in Remarks.)

Are Vegetation ____, Soil ____, or Hydrology ____ significantly disturbed? N Are "Normal Circumstances" present? Yes ✓ No ____

Are Vegetation ____, Soil ____, or Hydrology ____ naturally problematic? N (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ✓ No ____	Is the Sampled Area within a Wetland? Yes ✓ No ____
Hydric Soil Present?	Yes ✓ No ____	
Wetland Hydrology Present?	Yes ✓ No ____	

Remarks:
Flags WL5-1 to 13
Ph 4-W

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- ✓ Saturation (A3)
- ___ Water Marks (B1)
- ___ Sediment Deposits (B2)
- ___ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ___ Iron Deposits (B5)
- ___ Inundation Visible on Aerial Imagery (B7)
- ✓ Water-Stained Leaves (B9)
- ___ Aquatic Fauna (B13)
- ___ True Aquatic Plants (B14)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres on Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Thin Muck Surface (C7)
- ___ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ___ Surface Soil Cracks (B6)
- ___ Sparsely Vegetated Concave Surface (B8)
- ✓ Drainage Patterns (B10)
- ___ Moss Trim Lines (B16)
- ___ Dry-Season Water Table (C2)
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Stunted or Stressed Plants (D1)
- ___ Geomorphic Position (D2)
- ___ Shallow Aquitard (D3)
- ___ Microtopographic Relief (D4)
- ___ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present?	Yes ____	No ✓	Depth (inches): ____
Water Table Present?	Yes ____	No ✓	Depth (inches): ____
Saturation Present? (includes capillary fringe)	Yes ✓	No ____	Depth (inches): 0-3"

Wetland Hydrology Present? Yes ✓ No ____

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:
Saturation perched over tight clay soils. Rain w/in past 12 hrs.

VEGETATION (Four Strata) – Use scientific names of plants.

Sampling Point: WTP 5

Tree Stratum (Plot size: *)	Absolute % Cover	Dominant Species?	Indicator Status
1. Acer rubrum	30	✓	FAC
2.			
3.			
4.			
5.			
6.			
7.			
	30 = Total Cover		
50% of total cover: 15	20% of total cover: 6		

Sapling/Shrub Stratum (Plot size: *)	Absolute % Cover	Dominant Species?	Indicator Status
1. Elaeagnus umbellata	3	✓	N/A
2. Rosa multiflora	3	✓	FAC
3.			
4.			
5.			
6.			
7.			
8.			
9.			
	6 = Total Cover		
50% of total cover: 3	20% of total cover: 1.2		

Herb Stratum (Plot size: *)	Absolute % Cover	Dominant Species?	Indicator Status
1. Microstegium vimineum	50	✓	FAC
2. Cinna arundinacea	25	✓	FACW
3. Boehmeria cylindrica	5		FACW
4. Allium vineale	2		FACU
5. Carex sp.	2		N/A
6. Dichanthelium clandestinum	2		FAC
7. Rosa multiflora	4		FACU
8.			
9.			
10.			
11.			
	90 = Total Cover		
50% of total cover: 45	20% of total cover: 18		

Woody Vine Stratum (Plot size: *)	Absolute % Cover	Dominant Species?	Indicator Status
1. None			
2.			
3.			
4.			
5.			
	= Total Cover		
50% of total cover:	20% of total cover:		

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 4 (A)

Total Number of Dominant Species Across All Strata: 5 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 80% (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species		x 1 =
FACW species		x 2 =
FAC species		x 3 =
FACU species		x 4 =
UPL species		x 5 =
Column Totals:	(A)	(B)

Prevalence Index = B/A =

Hydrophytic Vegetation Indicators:

- __ 1 - Rapid Test for Hydrophytic Vegetation
- ✓ 2 - Dominance Test is >50%
- __ 3 - Prevalence Index is ≤3.0[1]
- __ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- __ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Definitions of Four Vegetation Strata:

Tree – Woody plants, excluding vines, 3 in. (7.6 cm) or more in diameter at breast height (DBH), regardless of height.

Sapling/Shrub – Woody plants, excluding vines, less than 3 in. DBH and greater than or equal to 3.28 ft (1 m) tall.

Herb – All herbaceous (non-woody) plants, regardless of size, and woody plants less than 3.28 ft tall.

Woody vine – All woody vines greater than 3.28 ft in height.

Hydrophytic Vegetation Present? Yes ✓ No ____

Remarks: (Include photo numbers here or on a separate sheet.)

* Entire wetland = Plot size.
Unable to identify carex sp due to time of year.
Elaeagnus umbellata does not have an indicator status.

SOIL

Sampling Point: WTP-5

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox Features %	Type[1]	Loc[2]	Texture	Remarks
0-2	2.5Y4/2	95	7.5YR4/6	5	C	M,PL	SiCL	
2-10	10YR4/4	90	7.5YR5/6	10	C	M	SiC	
10-12+	2.5Y5/3	90	7.5YR4/6	10	C	M,PL	SiC	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators:

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5)
- ___ 2 cm Muck (A10) **(LRR N)**
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1) **(LRR N, MLRA 147, 148)**
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Dark Surface (S7)
- ___ Polyvalue Below Surface (S8) **(MLRA 147, 148)**
- ___ Thin Dark Surface (S9) **(MLRA 147, 148)**
- ___ Loamy Gleyed Matrix (F2)
- ✓ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)
- ___ Iron-Manganese Masses (F12) **(LRR N, MLRA 136)**
- ___ Umbric Surface (F13) **(MLRA 136, 122)**
- ___ Piedmont Floodplain Soils (F19) **(MLRA 148)**
- ___ Red Parent Material (F21) **(MLRA 127, 147)**

Indicators for Problematic Hydric Soils[3]:

- ___ 2 cm Muck (A10) **(MLRA 147)**
- ___ Coast Prairie Redox (A16) **(MLRA 147, 148)**
- ___ Piedmont Floodplain Soils (F19) **(MLRA 136, 147)**
- ___ Very Shallow Dark Surface (TF12)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: ____________

Depth (inches): ____________

Hydric Soil Present? Yes ✓ No ___

Remarks:

Wetland Function-Value Evaluation Form

Total area of wetland 0.01 ac Human made? No Is wetland part of a wildlife corridor? Yes or a "habitat island"? No

Adjacent land use Forest, Utility ROW Distance to nearest roadway or other development ~800'

Dominant wetland systems present PFO Contiguous undeveloped buffer zone present ~50'

Is the wetland a separate hydraulic system? Yes If not, where does the wetland lie in the drainage basin? —

How many tributaries contribute to the wetland? None Wildlife & vegetation diversity/abundance (see attached list)

Wetland I.D. WL5
Latitude 39.130638 Longitude -77.257262
Prepared by: EB Date 4/9/2020

Wetland Impact:
Type — Area —

Evaluation based on:
Office ✓ Field ✓

Corps manual wetland delineation completed? Y ✓ N ___

Function/Value	Suitability Y	Suitability N	Rationale (Reference #)*	Principal Function(s)/Value(s)	Comments
Groundwater Recharge/Discharge		✓			
Floodflow Alteration	✓				Located in flat floodplain, receives runoff from residences upslope + Utility ROW.
Fish and Shellfish Habitat		✓			
Sediment/Toxicant Retention		✓			
Nutrient Removal		✓			
Production Export		✓			
Sediment/Shoreline Stabilization		✓			
Wildlife Habitat	✓				Within a county park surrounded by residential development. Evidence of deer + observed birds.
Recreation	✓				Within a county park adjacent to a walking trail.
Educational/Scientific Value	✓				See note above.
Uniqueness/Heritage	✓				Within a county park surrounded by residential + commercial development
Visual Quality/Aesthetics		✓			
ES Endangered Species Habitat		✓			
Other					

Notes:

* Refer to backup list of numbered considerations.

WETLAND DETERMINATION DATA FORM – Eastern Mountains and Piedmont Region

Project/Site: CA-5 Mitigation Site City/County: Montgomery Sampling Date: 3/27/2020

Applicant/Owner: MDOT SHA State: MD Sampling Point: WTP-6

Investigator(s): EB, MN Section, Township, Range: ______

Landform (hillslope, terrace, etc.): Floodplain Local relief (concave, convex, none): Concave Slope (%): 2%

Subregion (LRR or MLRA): MLRA 148 Lat: 39.130527 Long: -77.2508524 Datum: NAD83 (2011)

Soil Map Unit Name: Baile silt loam, 0-3% slopes NWI classification: PFO1A

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ✓ No ____ (If no, explain in Remarks.)

Are Vegetation ____, Soil ____, or Hydrology ____ significantly disturbed? N Are "Normal Circumstances" present? Yes ✓ No ____

Are Vegetation ____, Soil ____, or Hydrology ____ naturally problematic? N (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present? Yes ✓ No ____	Is the Sampled Area within a Wetland?	Yes ✓ No ____
Hydric Soil Present? Yes ✓ No ____		
Wetland Hydrology Present? Yes ✓ No ____		

Remarks:
Flags WL61-22 + 1A-3A
Ph19-W

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- ✓ Saturation (A3)
- ___ Water Marks (B1)
- ___ Sediment Deposits (B2)
- ___ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ___ Iron Deposits (B5)
- ___ Inundation Visible on Aerial Imagery (B7)
- ✓ Water-Stained Leaves (B9)
- ___ Aquatic Fauna (B13)
- ___ True Aquatic Plants (B14)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres on Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Thin Muck Surface (C7)
- ___ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ___ Surface Soil Cracks (B6)
- ___ Sparsely Vegetated Concave Surface (B8)
- ✓ Drainage Patterns (B10)
- ___ Moss Trim Lines (B16)
- ___ Dry-Season Water Table (C2)
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Stunted or Stressed Plants (D1)
- ✓ Geomorphic Position (D2)
- ___ Shallow Aquitard (D3)
- ___ Microtopographic Relief (D4)
- ___ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present?	Yes ____	No ✓	Depth (inches): ____
Water Table Present?	Yes ____	No ✓	Depth (inches): ____
Saturation Present? (includes capillary fringe)	Yes ✓	No ____	Depth (inches): 0-5"

Wetland Hydrology Present? Yes ✓ No ____

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:
Rain w/in past 24 hrs

VEGETATION (Four Strata) – Use scientific names of plants.

Sampling Point: WTP-6

Tree Stratum (Plot size: 10×10')	Absolute % Cover	Dominant Species?	Indicator Status
1. Acer rubrum	30	✓	FAC
2. Acer negundo	10	✓	FAC
3.			
4.			
5.			
6.			
7.			
	40 = Total Cover		
50% of total cover: 20	20% of total cover: 8		

Sapling/Shrub Stratum (Plot size: 10×10')	Absolute % Cover	Dominant Species?	Indicator Status
1. None			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
	= Total Cover		
50% of total cover:	20% of total cover:		

Herb Stratum (Plot size: 10×10')	Absolute % Cover	Dominant Species?	Indicator Status
1. Cinna arundinacea	10		FACW
2. Microstegium vimineum	40	✓	FAC
3. Lonicera japonica	8		FACU
4. Allium vineale	3		FACU
5. Rosa multiflora	10		FACU
6. Smilax rotundifolia	2		FAC
7. Potentilla sp.	5		N/A
8.			
9.			
10.			
11.			
	78 = Total Cover		
50% of total cover: 39	20% of total cover: 15.6		

Woody Vine Stratum (Plot size: 10×10')	Absolute % Cover	Dominant Species?	Indicator Status
1. None			
2.			
3.			
4.			
5.			
	= Total Cover		
50% of total cover:	20% of total cover:		

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 3 (A)

Total Number of Dominant Species Across All Strata: 3 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 100% (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species		x 1 =
FACW species		x 2 =
FAC species		x 3 =
FACU species		x 4 =
UPL species		x 5 =
Column Totals:	(A)	(B)

Prevalence Index = B/A =

Hydrophytic Vegetation Indicators:

- ✓ 1 - Rapid Test for Hydrophytic Vegetation
- ✓ 2 - Dominance Test is >50%
- ___ 3 - Prevalence Index is ≤3.0[1]
- ___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Definitions of Four Vegetation Strata:

Tree – Woody plants, excluding vines, 3 in. (7.6 cm) or more in diameter at breast height (DBH), regardless of height.

Sapling/Shrub – Woody plants, excluding vines, less than 3 in. DBH and greater than or equal to 3.28 ft (1 m) tall.

Herb – All herbaceous (non-woody) plants, regardless of size, and woody plants less than 3.28 ft tall.

Woody vine – All woody vines greater than 3.28 ft in height.

Hydrophytic Vegetation Present? Yes ✓ No ____

Remarks: (Include photo numbers here or on a separate sheet.)

SOIL

Sampling Point: WIP-6

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox %	Type[1]	Loc[2]	Texture	Remarks
0-1	10YR 3/2	100					SiL	Rootlets
1-5	2.5Y 3/1	95	7.5YR 4/6	5	C	M, PL	SaCL	
5-7	2.5Y 4/1	98	7.5YR 4/6	2	C	M	SaCL	
7-12+	5Y 5/1	85	10YR 5/6	15	C	M	SaC	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators:

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5)
- ___ 2 cm Muck (A10) **(LRR N)**
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1) **(LRR N, MLRA 147, 148)**
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Dark Surface (S7)
- ___ Polyvalue Below Surface (S8) **(MLRA 147, 148)**
- ___ Thin Dark Surface (S9) **(MLRA 147, 148)**
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ✓ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)
- ___ Iron-Manganese Masses (F12) **(LRR N, MLRA 136)**
- ___ Umbric Surface (F13) **(MLRA 136, 122)**
- ___ Piedmont Floodplain Soils (F19) **(MLRA 148)**
- ___ Red Parent Material (F21) **(MLRA 127, 147)**

Indicators for Problematic Hydric Soils[3]:

- ___ 2 cm Muck (A10) **(MLRA 147)**
- ___ Coast Prairie Redox (A16) **(MLRA 147, 148)**
- ___ Piedmont Floodplain Soils (F19) **(MLRA 136, 147)**
- ___ Very Shallow Dark Surface (TF12)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: Clay

Depth (inches): 7"

Hydric Soil Present? Yes ✓ No ___

Remarks:

Wetland Function-Value Evaluation Form

Total area of wetland 0.05 ac Human made? No Is wetland part of a wildlife corridor? Yes or a "habitat island"? No

Adjacent land use Forest Distance to nearest roadway or other development ~250'

Dominant wetland systems present PFO Contiguous undeveloped buffer zone present ~250'

Is the wetland a separate hydraulic system? No If not, where does the wetland lie in the drainage basin? Mid

How many tributaries contribute to the wetland? None Wildlife & vegetation diversity/abundance (see attached list)

Wetland I.D. WL6
Latitude 39.130527 Longitude -77.250854
Prepared by: EB Date 4/16/2020
Wetland Impact:
Type — Area —

Evaluation based on:
Office ✓ Field ✓
Corps manual wetland delineation completed? Y ✓ N

Function/Value	Suitability Y	Suitability N	Rationale (Reference #)*	Principal Function(s)/Value(s)	Comments
Groundwater Recharge/Discharge		✔			
Floodflow Alteration	✓				Within the floodplain, receives runoff from uplands
Fish and Shellfish Habitat		✓			
Sediment/Toxicant Retention	✓				Residences upslope
Nutrient Removal	✓				
Production Export		✓			
Sediment/Shoreline Stabilization	✓				Abuts a stream, banks within wetland have minor erosion compared to other parts of the stream.
Wildlife Habitat	✓				Within a county park, observed birds + evidence of deer within wetland.
Recreation	✓				Wetland is w/in a county park, adjacent to a walking path
Educational/Scientific Value	✓				See note above.
Uniqueness/Heritage	✓				Within a county park surrounded by residential development
Visual Quality/Aesthetics		✓			
ES Endangered Species Habitat		✓			
Other					

Notes:

* Refer to backup list of numbered considerations.

WETLAND DETERMINATION DATA FORM – Eastern Mountains and Piedmont Region

Project/Site: CA-5 Mitigation City/County: Montgomery Sampling Date: 11/10/20

Applicant/Owner: MDOT SHA State: MD Sampling Point: WTP-7

Investigator(s): HT, SP Section, Township, Range: ______

Landform (hillslope, terrace, etc.): bench Local relief (concave, convex, none): Concave Slope (%): 0-2

Subregion (LRR or MLRA): MLRA 148 Lat: 39.129680 Long: -77.257387 Datum: NAD83(2011)

Soil Map Unit Name: Codorus Silt loam, 0-3 percent slopes occasionally flooded NWI classification: PFM1B

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ✓ No ___ (If no, explain in Remarks.)

Are Vegetation ___, Soil ___, or Hydrology ___ significantly disturbed? N Are "Normal Circumstances" present? Yes ✓ No ___

Are Vegetation ___, Soil ___, or Hydrology ___ naturally problematic? N (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ✓ No ___	Is the Sampled Area within a Wetland? Yes ✓ No ___
Hydric Soil Present?	Yes ✓ No ___	
Wetland Hydrology Present?	Yes ✓ No ___	

Remarks:

photo 11 - NW

Flags WL7-1-WL7-7

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

- ___ Surface Water (A1)
- ✓ High Water Table (A2)
- ✓ Saturation (A3)
- ___ Water Marks (B1)
- ___ Sediment Deposits (B2)
- ___ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ___ Iron Deposits (B5)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Water-Stained Leaves (B9)
- ___ Aquatic Fauna (B13)
- ___ True Aquatic Plants (B14)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres on Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Thin Muck Surface (C7)
- ___ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ___ Surface Soil Cracks (B6)
- ___ Sparsely Vegetated Concave Surface (B8)
- ___ Drainage Patterns (B10)
- ___ Moss Trim Lines (B16)
- ___ Dry-Season Water Table (C2)
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Stunted or Stressed Plants (D1)
- ✓ Geomorphic Position (D2)
- ___ Shallow Aquitard (D3)
- ___ Microtopographic Relief (D4)
- ✓ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present?	Yes ___	No ✓	Depth (inches): ___
Water Table Present?	Yes ✓	No ___	Depth (inches): 3"
Saturation Present? (includes capillary fringe)	Yes ✓	No ___	Depth (inches): 0"

Wetland Hydrology Present? Yes ✓ No ___

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

wetland bench abutting WC6

Sampling Point: WTP-7

VEGETATION (Four Strata) – Use scientific names of plants.

Tree Stratum (Plot size: *)

	Absolute % Cover	Dominant Species?	Indicator Status
1. none			
2.			
3.			
4.			
5.			
6.			
7.			
= Total Cover			
50% of total cover: ___ 20% of total cover: ___			

Sapling/Shrub Stratum (Plot size: *)

	Absolute % Cover	Dominant Species?	Indicator Status
1. none			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
= Total Cover			
50% of total cover: ___ 20% of total cover: ___			

Herb Stratum (Plot size: *)

	Absolute % Cover	Dominant Species?	Indicator Status
1. Scirpus polyphyllus	30	Y	OBL
2. Microstegium vimineum	50	Y	FAC
3. Juncus effusus	10		FACW
4. Leersia oryzoides	30	Y	OBL
5. Arthraxon hispidus	30	Y	FAC
6.			
7.			
8.			
9.			
10.			
11.			
= Total Cover	150		
50% of total cover: 75 20% of total cover: 30			

Woody Vine Stratum (Plot size: *)

	Absolute % Cover	Dominant Species?	Indicator Status
1. none			
2.			
3.			
4.			
5.			
= Total Cover			
50% of total cover: ___ 20% of total cover: ___			

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 4 (A)

Total Number of Dominant Species Across All Strata: 4 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 100% (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species		x 1 =
FACW species		x 2 =
FAC species		x 3 =
FACU species		x 4 =
UPL species		x 5 =
Column Totals:	(A)	(B)

Prevalence Index = B/A = ___

Hydrophytic Vegetation Indicators:

___ 1 - Rapid Test for Hydrophytic Vegetation
✓ 2 - Dominance Test is >50%
___ 3 - Prevalence Index is ≤3.0[1]
___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Definitions of Four Vegetation Strata:

Tree – Woody plants, excluding vines, 3 in. (7.6 cm) or more in diameter at breast height (DBH), regardless of height.

Sapling/Shrub – Woody plants, excluding vines, less than 3 in. DBH and greater than or equal to 3.28 ft (1 m) tall.

Herb – All herbaceous (non-woody) plants, regardless of size, and woody plants less than 3.28 ft tall.

Woody vine – All woody vines greater than 3.28 ft in height.

Hydrophytic Vegetation Present? Yes ✓ No ___

Remarks: (Include photo numbers here or on a separate sheet.)

*plot size is limited by wetland size.

SOIL

Sampling Point: WP-7

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox %	Type[1]	Loc[2]	Texture	Remarks
0-6	2.5Y 4/2	90	7.5YR 5/8	10	C	M	Fine SL	
6-12+	10YR 4/2	75	7.5YR 5/6	25	C	M	Fine SL	w/ gravel

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators:

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5)
- ___ 2 cm Muck (A10) **(LRR N)**
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1) **(LRR N, MLRA 147, 148)**
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Dark Surface (S7)
- ___ Polyvalue Below Surface (S8) **(MLRA 147, 148)**
- ___ Thin Dark Surface (S9) **(MLRA 147, 148)**
- ___ Loamy Gleyed Matrix (F2)
- ✓ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)
- ___ Iron-Manganese Masses (F12) **(LRR N, MLRA 136)**
- ___ Umbric Surface (F13) **(MLRA 136, 122)**
- ___ Piedmont Floodplain Soils (F19) **(MLRA 148)**
- ___ Red Parent Material (F21) **(MLRA 127, 147)**

Indicators for Problematic Hydric Soils[3]:

- ___ 2 cm Muck (A10) **(MLRA 147)**
- ___ Coast Prairie Redox (A16) **(MLRA 147, 148)**
- ___ Piedmont Floodplain Soils (F19) **(MLRA 136, 147)**
- ___ Very Shallow Dark Surface (TF12)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: ______

Depth (inches): ______

Hydric Soil Present? Yes ✓ No ___

Remarks:

Wetland Function-Value Evaluation Form

Total area of wetland 0.008ac Human made? N Is wetland part of a wildlife corridor? Yes or a "habitat island"? No

Adjacent land use Forest, residential Distance to nearest roadway or other development >100'

Dominant wetland systems present PEM Contiguous undeveloped buffer zone present Yes

Is the wetland a separate hydraulic system? No If not, where does the wetland lie in the drainage basin? high

How many tributaries contribute to the wetland? 1 Wildlife & vegetation diversity/abundance (see attached list)

Wetland I.D. WL7

Latitude 39.12968 Longitude 77.25738

Prepared by: LR, SP Date 11/10/2020

Wetland Impact:
Type – Area –

Evaluation based on:
Office ✓ Field ✓

Corps manual wetland delineation completed? Y ✓ N ___

Function/Value	Suitability Y	Suitability N	Rationale (Reference #)*	Principal Function(s)/Value(s)	Comments
Groundwater Recharge/Discharge	✓				Wetland begins [illegible] with high water table and [illegible]
Floodflow Alteration	✓				Abuts WL6 receiving and conveying variable flood water
Fish and Shellfish Habitat		✓			
Sediment/Toxicant Retention		✓			
Nutrient Removal		✓			
Production Export		✓			
Sediment/Shoreline Stabilization		✓			
Wildlife Habitat		✓			
Recreation		✓			
Educational/Scientific Value		✓			
Uniqueness/Heritage		✓			
Visual Quality/Aesthetics		✓			
ES Endangered Species Habitat		✓			
Other					

* Refer to backup list of numbered considerations.

Notes:

WETLAND DETERMINATION DATA FORM – Eastern Mountains and Piedmont Region

Project/Site: CA-5 Mitigation City/County: Montgomery Sampling Date: 11/10/2020

Applicant/Owner: MDOT SHA State: MD Sampling Point: WTP8

Investigator(s): HK, SD Section, Township, Range: ______

Landform (hillslope, terrace, etc.): bench, oxbow Local relief (concave, convex, none): concave Slope (%): 0-1

Subregion (LRR or MLRA): MLRA 148 Lat: 39.129323 Long: -77.257129 Datum: NAD83(2011)

Soil Map Unit Name: Codorus silt loam 0-3 percent slopes, occasionally flooded NWI classification: PEM1A

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ✓ No ______ (If no, explain in Remarks.)

Are Vegetation ______, Soil ______, or Hydrology ______ significantly disturbed? N Are "Normal Circumstances" present? Yes ✓ No ______

Are Vegetation ______, Soil ______, or Hydrology ______ naturally problematic? N (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ✓	No ______
Hydric Soil Present?	Yes ✓	No ______
Wetland Hydrology Present?	Yes ✓	No ______

Is the Sampled Area within a Wetland? Yes ✓ No ______

Remarks:

photo 15-S

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

- __ Surface Water (A1)
- __ High Water Table (A2)
- __ Saturation (A3)
- __ Water Marks (B1)
- __ Sediment Deposits (B2)
- __ Drift Deposits (B3)
- __ Algal Mat or Crust (B4)
- __ Iron Deposits (B5)
- __ Inundation Visible on Aerial Imagery (B7)
- __ Water-Stained Leaves (B9)
- __ Aquatic Fauna (B13)
- __ True Aquatic Plants (B14)
- __ Hydrogen Sulfide Odor (C1)
- __ Oxidized Rhizospheres on Living Roots (C3)
- __ Presence of Reduced Iron (C4)
- __ Recent Iron Reduction in Tilled Soils (C6)
- __ Thin Muck Surface (C7)
- __ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- __ Surface Soil Cracks (B6)
- __ Sparsely Vegetated Concave Surface (B8)
- ✓ Drainage Patterns (B10)
- __ Moss Trim Lines (B16)
- __ Dry-Season Water Table (C2)
- __ Crayfish Burrows (C8)
- __ Saturation Visible on Aerial Imagery (C9)
- __ Stunted or Stressed Plants (D1)
- ✓ Geomorphic Position (D2)
- __ Shallow Aquitard (D3)
- __ Microtopographic Relief (D4)
- __ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present?	Yes ______	No ✓	Depth (inches): ______
Water Table Present?	Yes ______	No ✓	Depth (inches): ______
Saturation Present? (includes capillary fringe)	Yes ______	No ✓	Depth (inches): *

Wetland Hydrology Present? Yes ✓ No ______

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

* Saturation present throughout soil profile however water table below 12 inches

wetland bench & oxbow abutting / draining to WC6

VEGETATION (Four Strata) – Use scientific names of plants. Sampling Point: WYP-8

Tree Stratum (Plot size: *)	Absolute % Cover	Dominant Species?	Indicator Status
1. None			
2.			
3.			
4.			
5.			
6.			
7.			
	= Total Cover		
50% of total cover:	20% of total cover:		

Sapling/Shrub Stratum (Plot size: *)	Absolute % Cover	Dominant Species?	Indicator Status
1. None			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
	= Total Cover		
50% of total cover:	20% of total cover:		

Herb Stratum (Plot size: *)	Absolute % Cover	Dominant Species?	Indicator Status
1. Microstegium vimineum	80	Y	FAC
2. Dichanthelium clandestinum	25		FAC
3. Alliaria petiolata	10		FACU
4. Perilla frutescens	10		FACU
5. Cinna arundinacea	3		FACW
6. Scirpus polyphyllus	10		OBL
7. Boehmeria cylindrica	5		FACW
8.			
9.			
10.			
11.			
	143 = Total Cover		
50% of total cover: 71.5	20% of total cover: 28.6		

Woody Vine Stratum (Plot size: *)	Absolute % Cover	Dominant Species?	Indicator Status
1. None			
2.			
3.			
4.			
5.			
	= Total Cover		
50% of total cover:	20% of total cover:		

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 1 (A)

Total Number of Dominant Species Across All Strata: 1 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 100% (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species		x 1 =
FACW species		x 2 =
FAC species		x 3 =
FACU species		x 4 =
UPL species		x 5 =
Column Totals:	(A)	(B)

Prevalence Index = B/A =

Hydrophytic Vegetation Indicators:

- ___ 1 - Rapid Test for Hydrophytic Vegetation
- ✓ 2 - Dominance Test is >50%
- ___ 3 - Prevalence Index is ≤3.0[1]
- ___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Definitions of Four Vegetation Strata:

Tree – Woody plants, excluding vines, 3 in. (7.6 cm) or more in diameter at breast height (DBH), regardless of height.

Sapling/Shrub – Woody plants, excluding vines, less than 3 in. DBH and greater than or equal to 3.28 ft (1 m) tall.

Herb – All herbaceous (non-woody) plants, regardless of size, and woody plants less than 3.28 ft tall.

Woody vine – All woody vines greater than 3.28 ft in height.

Hydrophytic Vegetation Present? Yes ✓ No ___

Remarks: (Include photo numbers here or on a separate sheet.)

*Plot Size is limited by Wetland Size

SOIL Sampling Point: WNP-8

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	%	Redox Features Color (moist)	%	Type[1]	Loc[2]	Texture	Remarks
0-2	5Y 5/2	70	7.5YR 5/6	30	C	M	SL	
2-8	10YR 4/1	80	7.5YR 4/6	20	C	M/PL	SL	
8-12+	10YR 4/1	40	7.5YR 4/6	30	C	M	SL	w/ gravel
			7.5YR 5/8	10				

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators:

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5)
- ___ 2 cm Muck (A10) **(LRR N)**
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1) **(LRR N, MLRA 147, 148)**
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Dark Surface (S7)
- ___ Polyvalue Below Surface (S8) **(MLRA 147, 148)**
- ___ Thin Dark Surface (S9) **(MLRA 147, 148)**
- ___ Loamy Gleyed Matrix (F2)
- ✓ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)
- ___ Iron-Manganese Masses (F12) **(LRR N, MLRA 136)**
- ___ Umbric Surface (F13) **(MLRA 136, 122)**
- ___ Piedmont Floodplain Soils (F19) **(MLRA 148)**
- ___ Red Parent Material (F21) **(MLRA 127, 147)**

Indicators for Problematic Hydric Soils[3]:

- ___ 2 cm Muck (A10) **(MLRA 147)**
- ___ Coast Prairie Redox (A16) **(MLRA 147, 148)**
- ___ Piedmont Floodplain Soils (F19) **(MLRA 136, 147)**
- ___ Very Shallow Dark Surface (TF12)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: ______________

Depth (inches): ______________

Hydric Soil Present? Yes ✓ No ___

Remarks:

Wetland Function-Value Evaluation Form

Total area of wetland 0.05 ac Human made? NO Is wetland part of a wildlife corridor? Yes or a "habitat island"? NO

Adjacent land use Forest, Residential Distance to nearest roadway or other development >~100'

Dominant wetland systems present PEM Contiguous undeveloped buffer zone present Yes

Is the wetland a separate hydraulic system? NO If not, where does the wetland lie in the drainage basin? high

How many tributaries contribute to the wetland? 1 Wildlife & vegetation diversity/abundance (see attached list)

Wetland I.D. WL8

Latitude 39.129325 Longitude -77.257129

Prepared by: HC, SD Date 11/10/2020

Wetland Impact:

Type – Area –

Evaluation based on:

Office ✓ Field ✓

Corps manual wetland delineation completed? Y ✓ N

Function/Value	Suitability Y	Suitability N	Rationale (Reference #)*	Principal Function(s)/Value(s)	Comments
Groundwater Recharge/Discharge	✓				Wetland bench/oxbow abutting WC6 with sandy soils
Floodflow Alteration	✓				Abuts WC6 receiving and combatting high flood waters
Fish and Shellfish Habitat		✓			
Sediment/Toxicant Retention		✓			
Nutrient Removal		✓			
Production Export		✓			
Sediment/Shoreline Stabilization		✓			
Wildlife Habitat	✓				Within county park, diverse wildlife observed including deer and birds
Recreation	✓				Within county park which includes walking trails adjacent to wetland
Educational/Scientific Value	✓				See note above
Uniqueness/Heritage	✓				Within county park surrounded by residential development
Visual Quality/Aesthetics		✓			
ES Endangered Species Habitat		✓			
Other					

Notes:

* Refer to backup list of numbered considerations.

COASTAL RESOURCES INC.

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410-956-9000
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MEMORANDUM

Date: November 13, 2020

Subject: I-495/I-270 Stream and Floodplain Wetland Mitigation Site No. CA-5 Forest Stand Characterization and Tree Survey

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Introduction

Coastal Resources, Inc. (CRI), under contract to the Maryland State Highway Administration (SHA), has completed a forest stand characterization and tree survey at the I-495/I-270 Stream and Floodplain Wetland Mitigation Site No. CA-5 project in Montgomery County, Maryland. Mitigation Site CA-5 is a stream and floodplain restoration project proposed by SHA in order to prepare Phase II Mitigation Documents with permit agency and landowner support, obtain PRD Concept Approval, and prepare the PRD Site Development Plan submittal. Field investigations were conducted on March 27th, April 9th, and November 10th, 2020.

Study Area Description

The study area consists of a buffer along the proposed restoration reach, which ranges in width from 50 to 200 feet along the stream channel and includes approximately 3,562 linear feet of an unnamed tributary to Great Seneca Creek and two tributaries. The study area is located in Gaithersburg, Maryland and is bound by Suffolk Terrace and Bradbury Lane to the north and a powerline ROW to the south (see **Appendix A** – Vicinity Map). Land use classifications within and adjacent to the study area include institutional, deciduous forest, and medium density residential. The proposed stream restoration occurs within the Seneca Creek watershed (MDE 8-digit 02140208), within the Piedmont Plateau physiographic province (MGS, 2008)**.**

Methods

A forest stand characterization and specimen tree survey were conducted in the study area, in accordance with the Maryland Department of Natural Resources (MDNR) *State Forest Conservation Technical Manual* (MDNR 1997). Trees were measured using a diameter at breast height (DBH) tape at 4.5 feet above the ground. Specimen trees (with a 30-inch DBH or greater or within 75% of the current state champion) were tagged and their species, size, and condition recorded. The locations of all identified trees were traditionally surveyed. Forest stand boundaries were delineated on project mapping and stand characteristics were recorded on datasheets (**Appendix C**). Information collected for each identified forest stand included, but was not limited to, successional stage, dominant and co-dominant species, common understory and herbaceous species, percent canopy closure, prevalence of downed woody debris, presence of invasive species, and basal area. Photographs of the forest stands were compiled in a photograph log (**Appendix D**).

Results

Forest Stands
A total of four forest stands were identified within the study area. The location of the forest stands is displayed on the Forest Stand Delineation and Specimen Tree Survey Map (**Appendix B**). The forest stands are described below.

Stand A
Stand A is a tuliptree – Eastern cottonwood forest occurring along the western floodplain of the CA-5 study area. The canopy of this early-mid successional forest is primarily in the 6-11.9" DBH size class and is dominated by tuliptree (*Liriodendron tulipifera*), ranging from 6-20" DBH and Eastern cottonwood (*Populus deltoides*), ranging from 10-18" DBH. Co-dominant species include red maple (*Acer rubrum*), American sycamore (*Platanus occidentalis*) , ash-leaf maple (*Acer negundo*), and black cherry (*Prunus serotina*). Sixteen (16) specimen trees occur within this stand and canopy closure is approximately 70 percent. The understory contains saplings of red maple and ash-leaf maple, in addition to Japanese barberry (*Berberis thunbergii*), Autumn-olive (*Elaeagnus umbellata*), Japanese honeysuckle (*Lonicera japonica*), wine raspberry (*Rubus phoenicolasius*), rambler rose (*Rosa multiflora*), and Northern spicebush (*Lindera benzoin*). Dominant herbaceous species include Japanese stilt grass (*Microstegium vimineum*), crow garlic (*Allium vineale*), an unknown violet species (*Viola* sp.), and sweet wood-reed (*Cinna arundinacea*). Invasive species cover was moderate, with 40 percent invasive cover in the understory and 35 percent invasive ground cover. Downed woody debris is a common feature throughout this stand. Overall, Stand A is in good condition, as the stand is diverse with multiple canopy layers, and the moderate invasive cover that has not yet impacted the canopy.

Stand B
Stand B is a tuliptree-American sycamore forest occurring along the hillslopes of the CA-5 study area. The canopy of this mid-successional forest is primarily in the 12-19.9" size class and is dominated by tuliptree in the 1-30+" DBH range and American sycamore in the 8-30+" DBH range. Co-dominant species include red maple, black cherry, and Virginia pine (*Pinus virginiana*). Twenty-four (24) specimen trees occur within this stand and canopy closure is approximately 75 percent. The understory contains saplings of tuliptree, red maple, and black cherry, in addition to Japanese barberry, Autumn-olive, and wine raspberry. Infill plantings, including Eastern redbud (*Cercis canadensis*) and various oak species (*Quercus* sp.), were observed but not included in the forest characterization. Dominant herbaceous species include an unknown violet species, crow garlic, garlic mustard (*Alliaria petiolata*), sweet wood-reed, Japanese stilt grass, and Christmas fern (*Polystichum acrostichoides*). Invasive species cover was moderate, with 15 percent invasive understory cover and 60 percent invasive ground cover present in the stand. Downed woody debris is a common feature throughout this stand. Overall, Stand B is in good condition, as the stand is diverse and well structured, and has moderate invasive cover that has not yet impacted the canopy.

Stand C
Stand C is a red maple-ash-leaf maple forest occurring in the eastern floodplain of the CA-5 study area. The canopy of this early-successional forest is primarily in the 6-11.9” DBH size class and is dominated by red maple in the 1-16” DBH range and ash-leaf maple ranging from 1-22” DBH. Co-dominant species include black cherry, Callery pear (*Pyrus calleryana*), and river birch (*Betula nigra*). Other common species include tuliptree and American sycamore. One specimen tree occurs within this stand and canopy closure is approximately 60 percent. The understory contains saplings of the canopy species, except river birch, in addition to horsebrier (*Smilax rotundifolia*), wine raspberry, Southern arrow-wood (*Viburnum dentatum*), and European privet (*Ligustrum vulgare*). Dominant herbaceous species include an unknown speedwell species (*Veronica* sp.), an unknown violet species, an unknown bittercress species (*Cardamine* sp.), Japanese stilt grass, sweet wood-reed, garlic mustard, and crow garlic. Invasive species cover was moderate for the stand, with 3 percent invasive canopy cover, 10 percent invasive understory cover, and 75 percent invasive ground cover. Downed woody debris is an abundant feature throughout this stand. Overall, Stand C is in fair condition, as the stand is diverse with multiple canopy layers, but there is trash and evidence of disturbance from the surrounding development, as well as a high percentage of invasive species.

Stand D
Stand D is a tuliptree forest occurring along the floodplain in the southwestern portion of the CA-5 study area. The canopy of this mid-successional forest is primarily in the 20-29.9” DBH size class and is dominated by tuliptree in the 8->30” DBH range. Co-dominant species include red maple. Other common species include to black walnut (*Juglans nigra*), American elm (*Ulmus americana*), and black cherry. Eight (8) specimen trees occur within this stand and canopy closure is approximately 80 percent. The understory contains autumn olive, Japanese barberry and wine raspberry. Dominant herbaceous species include Japanese stilt grass, crow garlic, garlic mustard, deer-tongue rosette grass (*Dichanthelium clandestinum*), and Christmas fern. Invasive species cover was moderate for this stand with 35 percent invasive understory cover and 90 percent invasive ground cover. Downed woody debris is a common feature throughout this stand. Overall, Stand D is in good condition as most trees are healthy with no invasive cover in the canopy; however invasive groundcover is high, and the stand lacks a liberal shrub layer and overall species diversity.

Specimen Tree Survey
Forty-nine (49) specimen trees were identified within or adjacent to the CA-5 study area. These trees are listed below (**Table 1**) and displayed on the Forest Stand Delineation and Specimen Tree Survey mapping **(Appendix B**).

Table 1 – Specimen Tree Summary Table

Tree No.	Common Name	Scientific Name	DBH	Comments
1	White Oak	*Quercus alba*	39	Fair, dead, broken limbs
2	White Oak	*Quercus alba*	31	Good
3	Tuliptree	*Liriodendron tulipifera*	32	Good
4	Tuliptree	*Liriodendron tulipifera*	41	Good

5	Tuliptree	*Liriodendron tulipifera*	30, 29	Good, double trunk, split below BH, vines
6	Tuliptree	*Liriodendron tulipifera*	32.5,29, 21.5	Good, slightly undercut by stream
7	Tuliptree	*Liriodendron tulipifera*	32, 9.5	Good, slightly undercut by stream
8	American sycamore	*Platanus occidentalis*	32.5	Good
9	American sycamore	*Platanus occidentalis*	31	Fair, broken limbs, bark damage/rot
10	American sycamore	*Platanus occidentalis*	31	Good, vines
11	American sycamore	*Platanus occidentalis*	30	Good
12	Tuliptree	*Liriodendron tulipifera*	32	Good, split above BH
13	American sycamore	*Platanus occidentalis*	65	Good, few dead limbs, triple trunk above BH
14	Tuliptree	*Liriodendron tulipifera*	32.5	Good
15	American sycamore	*Platanus occidentalis*	34	Fair, vines in canopy, trunk rot
16	Tuliptree	*Liriodendron tulipifera*	31	Good
17	Tuliptree	*Liriodendron tulipifera*	33	Good
18	Red maple	*Acre rubrum*	36	Fair, trunk rot
19	Tuliptree	*Liriodendron tulipifera*	37.5	Good
20	Tuliptree	*Liriodendron tulipifera*	33.5	Good
21	American sycamore	*Platanus occidentalis*	34	Good
22	Tuliptree	*Liriodendron tulipifera*	39	Good, slightly undercut, dead limbs
23	Tuliptree	*Liriodendron tulipifera*	36.5	Good
24	Tuliptree	*Liriodendron tulipifera*	48	Fair, trunk rot, vines
25	Tuliptree	*Liriodendron tulipifera*	37.5	Good
26	Tuliptree	*Liriodendron tulipifera*	32.5	Good
27	Tuliptree	*Liriodendron tulipifera*	45	Good, split above BH
28	Tuliptree	*Liriodendron tulipifera*	45	Good, vines
29	Tuliptree	*Liriodendron tulipifera*	43	Good

30	Tuliptree	*Liriodendron tulipifera*	30	Good
31	American sycamore	*Platanus occidentalis*	37	Good, vines
32	American sycamore	*Platanus occidentalis*	30	Poor, extensive trunk rot, missing leader
33	Tuliptree	*Liriodendron tulipifera*	35.5	Good, double trunk, split above BH
34	Tuliptree	*Liriodendron tulipifera*	31	Good
35	Tuliptree	*Liriodendron tulipifera*	30	Good
36	American sycamore	*Platanus occidentalis*	30	Fair, trunk damage
37	Tuliptree	*Liriodendron tulipifera*	32	Good, vines
38	Tuliptree	*Liriodendron tulipifera*	33.5	Good
39	Tuliptree	*Liriodendron tulipifera*	57	Fair, vines, hole in trunk
40	Tuliptree	*Liriodendron tulipifera*	34	Good
41	Tuliptree	*Liriodendron tulipifera*	32.5	Good
42	Tuliptree	*Liriodendron tulipifera*	30.5	Good
43	Tuliptree	*Liriodendron tulipifera*	44	Good
44	Tuliptree	*Liriodendron tulipifera*	39	Poor, trunk rot, dead limbs
45	Tuliptree	*Liriodendron tulipifera*	42.5	Good
46	Tuliptree	*Liriodendron tulipifera*	42	Good
47	Tuliptree	*Liriodendron tulipifera*	37	Good
48	Tuliptree	*Liriodendron tulipifera*	36.5, 28.5	Fair, dead limbs
49	Tuliptree	*Liriodendron tulipifera*	37	Good

Conclusions

Four forest stands and 49 specimen trees were identified within the CA-5 study area. Impacts to forest and/or specimen trees will require authorization from the MDNR.

References

Maryland Department of Natural Resources (MDNR). 1997. *State Forest Conservation Technical Manual*. Third Edition. Annapolis, MD.

Reger JP and ET Cleaves. 2008. *Physiographic Map of Maryland.* Maryland Geological Survey. http://www.mgs.md.gov/geology/physiographic_map.html [Accessed 30 March 2020].

Appendix A – Vicinity Map

Appendix A
I-495 & I-270 Managed Lanes Study
Phase II Mitigation Design Plan
Stream Site CA-5
Great Seneca Creek
Bradbury Dr. Tributary

Montgomery County, Maryland
November 2020

N
W E
S

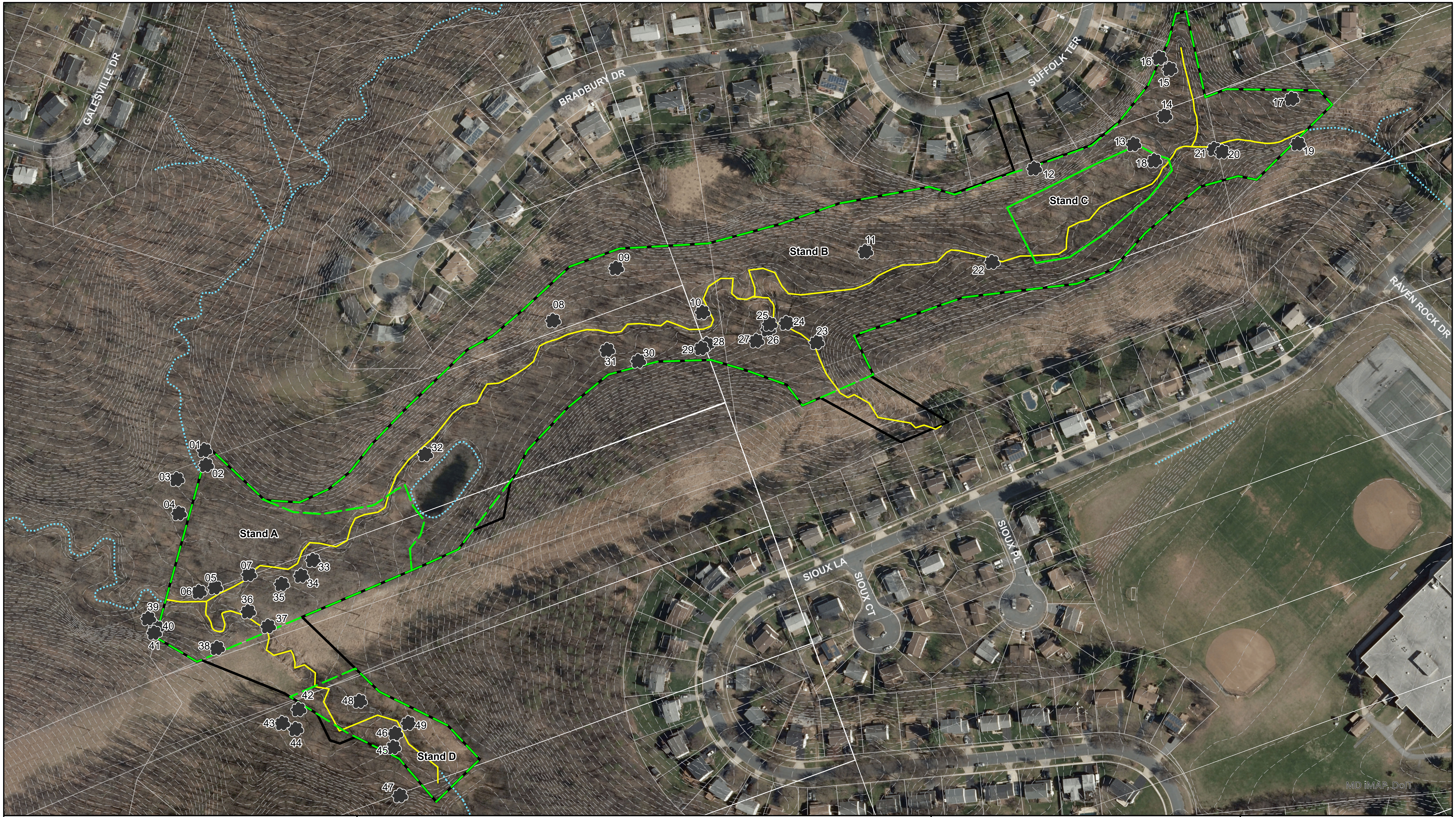
1 inch = 2,400 feet

0 2,400 4,800
feet

Study Area

270 495 MANAGED LANES STUDY

Appendix B – Forest Stand Delineation and Specimen Tree Map



Appendix B
I-495 & I-270 Managed Lanes Study
Phase II Mitigation Design Plan
Stream Site CA-5: Great Seneca Creek Bradbury Dr. Tributary

Forest Stand Delineation and Specimen Tree Survey

- Study Area
- Specimen Tree
- Delineated Forest Stand
- Potential Stream Restoration Reach
- Parcel Boundary
- County Mapped Stream or Pond
- 2' Contour

1 inch = 180 feet

0 180 360
feet

495 270 MANAGED LANES STUDY

Appendix C – Datasheets

Forest Characterization Field Datasheet

Project Area: CA-5 Mitigation
Date: 3/27/20, 4/9/20
Stand ID: A
Investigators: AM, EM
Location: Floodplain, western end of study area
Photos: 1,E; 2,W; 3,W; 4,E
Forest Association: Tuliptree - Eastern Cottonwood
Successional Stage: early-mid
Slope/Aspect: 2% / W

Average DBH Size Class (in): ☐ 2-5.9 ☒ 6-11.9 ☐ 12-19.9 ☐ 20-29.9 ☐ ≥30

Condition: ☒ good ☐ fair ☐ poor **Explain:** Diverse floodplain forest, moderate invasive cover on ground, not in canopy

Retention Potential: ☐ good ☐ fair ☐ poor **Explain:**

Transplant and Regenerative Potential: ☒ good ☐ fair ☐ poor **Explain:** Species likely to recover, invasives should be managed to prevent further invasive cover

Dominant and Co-dominant Tree Species	Most Common DBH (in)	DBH Range	Approximate % of Dominant Species: Canopy	Approximate % of Dominant Species: Understory
1. Liriodendron tulipifera	10	6 - 30	60	0
2. Prunus serotina	8	7 - 10	5	0
3. Acer rubrum	6	2 - 30+	10	15
4. Populus deltoides	14	10 - 18	30	0
5. Platanus occidentalis	12	7 - 30+	20	0
6. Acer negundo	2	1 - 6	0	10
7.				

Other Common Tree Species:

Common Regenerating Species: Acer negundo, Acer rubrum

Common Shrub and Vine Species	Average Height (ft)	Approx. % Cover
*1. Berberis thunbergii	3	20
*2. Lonicera japonica	2	3
*3. Elaeagnus umbellata	5	5
*4. Rubus phoenicolasius	3	5
*5. Rosa multiflora	1	8
6. Lindera benzoin	10	5
7.		
8.		

Common Herbaceous Species	Approx. % Cover
1. Microstegium vimineum	30 *
2. [illegible]	5 *
3. Viola sp.	3
4. Carex [illegible]	8
5.	
6.	
7.	
8.	

Estimate total % cover of exotic invasive plants (include "*" next to invasives listed above):

Canopy: 0 Understory: 40 Ground Cover: 35

Approximate % Cover:

Canopy: 70 Understory: 30 Herbaceous: 95

Basal Area (ft² – taken in two locations with 10x prism): 1. 110 2. 140

Downed Woody Debris (≥6" DBH): ☐ rare ☒ common ☐ abundant

Additional Notes:

Forest Characterization Field Datasheet

Project Area: CA-5 Mitigation
Date: 4/9/20
Stand ID: B
Investigators: AM, EM
Location: Upper slopes of study area
Photos: Ph 4, E, Ph 5, W
Forest Association: Tuliptree - Am. Sycamore
Successional Stage: mid
Slope/Aspect: 10 / W

Average DBH Size Class (in): ☐ 2-5.9 ☐ 6-11.9 ☒ 12-19.9 ☐ 20-29.9 ☐ ≥30

Condition: ☒ good ☐ fair ☐ poor Explain: Well structured forest, moderate diversity, invasive ground cover moderate

Retention Potential: ☐ good ☐ fair ☐ poor Explain:

Transplant and Regenerative Potential: ☒ good ☐ fair ☐ poor Explain: Species should be able to return quickly, invasives should be managed

Dominant and Co-dominant Tree Species	Most Common DBH (in)	DBH Range	Approximate % of Dominant Species: Canopy	Understory
1. Liriodendron tulipifera	18	1-30+	80	10
2. Platanus occidentalis	12	8-30+	20	0
3. Acer rubrum	8	1-20	5	20
4. Prunus serotina	7	4-10	5	3
5. Pinus virginiana	10	6-12	3	0
6.				
7.				

Other Common Tree Species:

Common Regenerating Species: Acer rubrum, Liriodendron tulipifera

Common Shrub and Vine Species	Average Height (ft)	Approx. % Cover	Common Herbaceous Species	Approx. % Cover
*1. Berberis thunbergii	3	8	1. Allium vineale	5 *
*2. Elaeagnus umbellata	10	5	2. Alliaria petiolata	5 *
*3. Rubus phoenicolasius	2	3	3. Viola sp.	3
4.			4. Cinna arundinacea	5
5.			5. Polystichum acrostichoides	3
6.			6. Microstegium vimineum	50 *
7.			7.	
8.			8.	

Estimate total % cover of exotic invasive plants (include "*" next to invasives listed above):

Canopy: 0 Understory: 15 Ground Cover: 60

Approximate % Cover:

Canopy: 75 Understory: 55 Herbaceous: 90

Basal Area (ft² – taken in two locations with 10x prism): 1. 150 2. 160

Downed Woody Debris (≥6" DBH): ☐ rare ☒ common ☐ abundant

Additional Notes: Plantings along pathways include redbuds & oaks, not included in FSD assessment.

Forest Characterization Field Datasheet

Project Area: CA-5 Mitigation **Date:** 4/9/20

Stand ID: C **Investigators:** AM, EM

Location: Eastern floodplain in study area **Photos:** Ph 6,E

Forest Association: Red Maple - Ash-leaf Maple

Successional Stage: early **Slope/Aspect:** 1%, W

Average DBH Size Class (in): ☐ 2-5.9 ☒ 6-11.9 ☐ 12-19.9 ☐ 20-29.9 ☐ ≥30

Condition: ☐ good ☒ fair ☐ poor **Explain:** Young forest with some impacts from surrounding development, moderate invasive cover

Retention Potential: ☐ good ☐ fair ☐ poor **Explain:**

Transplant and Regenerative Potential: ☐ good ☒ fair ☐ poor **Explain:** Canopy includes invasive species, invasive species cover is high and may impact growth.

Dominant and Co-dominant Tree Species	Most Common DBH (in)	DBH Range	Approximate % of Dominant Species: Canopy	Approximate % of Dominant Species: Understory
1. Acer rubrum	10	1-16	20	10
2. Acer negundo	12	1-22	35	8
3. Prunus serotina	8	5-12	10	3
4. Pyrus calleryana	4	1-7	3	8
5. Betula nigra	8	7-12	8	0
6.				
7.				

Other Common Tree Species: Liriodendron tulipifera, Platanus occidentalis

Common Regenerating Species: Acer rubrum, Acer negundo, Pyrus calleryana

Common Shrub and Vine Species	Average Height (ft)	Approx. % Cover
1. Smilax rotundifolia	2	5
*2. Rubus phoenicolasius	3	5
3. Viburnum dentatum	8	4
*4. Ligustrum vulgare	2	3
5.		
6.		
7.		
8.		

Common Herbaceous Species	Approx. % Cover
1. Viola sp.	5
2. Microstegium vimineum	20 *
3. Veronica sp.	70 *
4. Cinna arundinacea	5
5. Cardamine sp.	3
6. Alliaria petiolata	3 *
7. Allium vineale	3 *
8.	

Estimate total % cover of exotic invasive plants (include "*" next to invasives listed above):

Canopy: 3 Understory: 10 Ground Cover: 75

Approximate % Cover:

Canopy: 60 Understory: 15 Herbaceous: 95

Basal Area (ft² – taken in two locations with 10x prism): 1. 70 2. 80

Downed Woody Debris (≥6" DBH): ☐ rare ☐ common ☒ abundant

Additional Notes:

Forest Characterization Field Datasheet

Project Area: CA-5 Mitigation **Date:** 11/10/2020

Stand ID: D **Investigators:** HK, SP

Location: SW Portion of Study Area, S of Powerline Trail **Photos:** 14, E

Forest Association: Tuliptree

Successional Stage: Mid **Slope/Aspect:** 5% W

Average DBH Size Class (in): ☐ 2-5.9 ☐ 6-11.9 ☐ 12-19.9 ☑ 20-29.9 ☐ ≥30

Condition: ☑ good ☐ fair ☐ poor Explain: Overall healthy forest with an open understory and full canopy however diversity is lacking

Retention Potential: ☐ good ☑ fair ☐ poor Explain: Stand is within floodplain of proposed stream restoration

Transplant and Regenerative Potential: ☑ good ☐ fair ☐ poor Explain: Species likely to recover, germinate. Invasives should be managed.

Dominant and Co-dominant Tree Species	Most Common DBH (in)	DBH Range	Approximate % of Dominant Species: Canopy	Approximate % of Dominant Species: Understory
1. Liriodendron tulipifera	24	8-730	80	0
2. Acer rubrum	12	8-24	10	0
3.				
4.				
5.				
6.				
7.				

Other Common Tree Species: Juglans nigra, Ulmus americana, Prunus serotina

Common Regenerating Species: Regen lacking; heavy deer browsing is likely preventing.

Common Shrub and Vine Species	Average Height (ft)	Approx. % Cover	Common Herbaceous Species	Approx. % Cover
*1. Elaeagnus umbellata	8'	10	*1. Microstegium vimineum	80
*2. Berberis thunbergii	4'	20	*2. Allium vineale	15
*3. Rubus phoenicolasius	3'	5	*3. Alliaria petiolata	15
4.			4. Dichanthelium clandestinum	10
5.			5. Polystichum acrostichoides	5
6.			6.	
7.			7.	
8.			8.	

Estimate total % cover of exotic invasive plants (include "*" next to invasives listed above):

Canopy: 0 Understory: 35 Ground Cover: 90

Approximate % Cover:

Canopy: 80 Understory: 35 Herbaceous: 100

Basal Area (ft² – taken in two locations with 10x prism): 1. 80 2. 70

Downed Woody Debris (≥6" DBH): ☐ rare ☑ common ☐ abundant

Additional Notes:

CRI 2019

Appendix D – Photo Log

Appendix D: Forest Stand Characterization Photograph Log

Photo 1. Looking west at Forest Stand A, located at the western end of the study area.

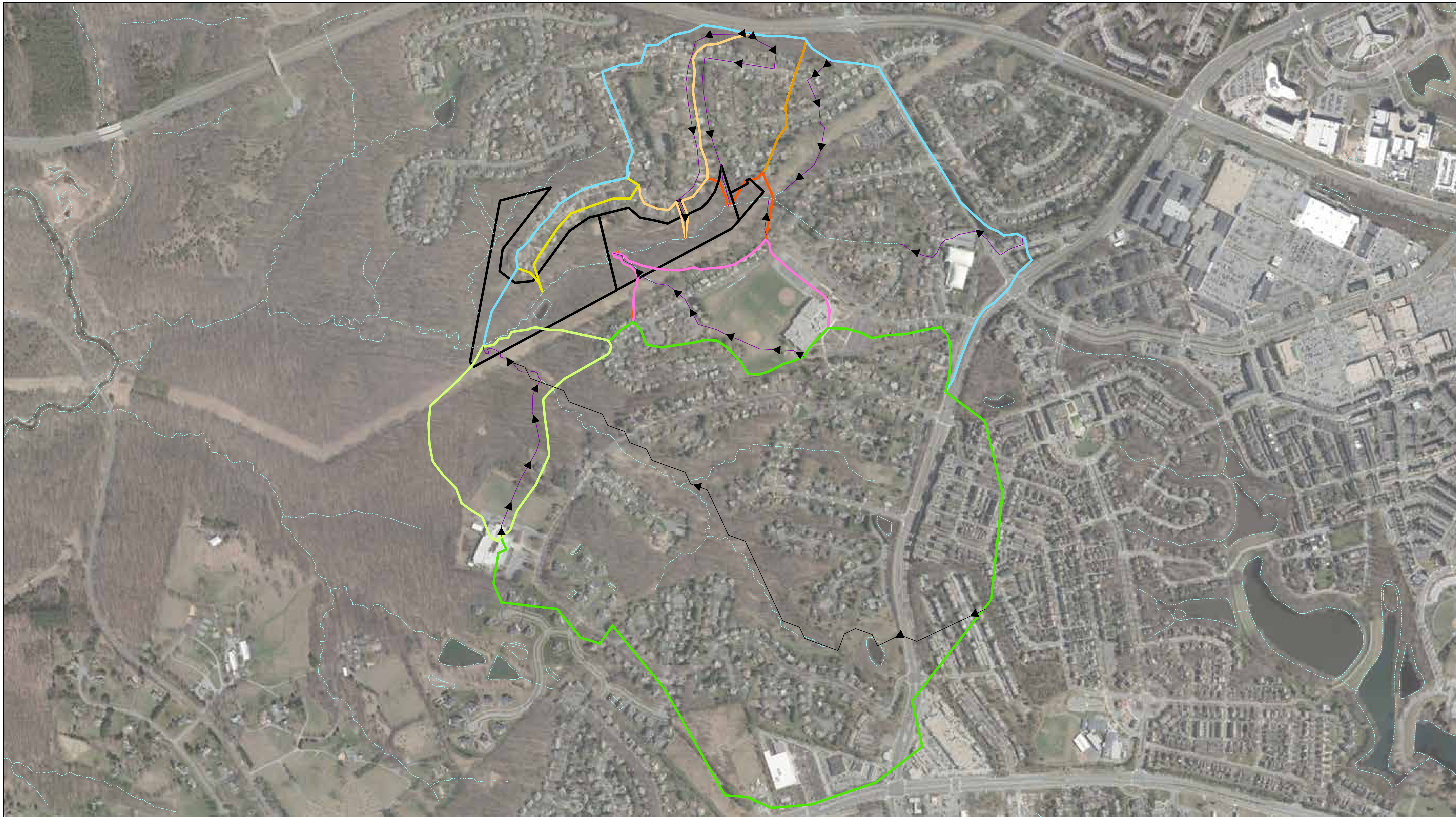
Photo 2. Looking east at Forest Stand B, located along the slopes of the study area.

Appendix D: Forest Stand Characterization Photograph Log

Photo 3. Looking east at Forest Stand C, located in the eastern floodplain of the study area.

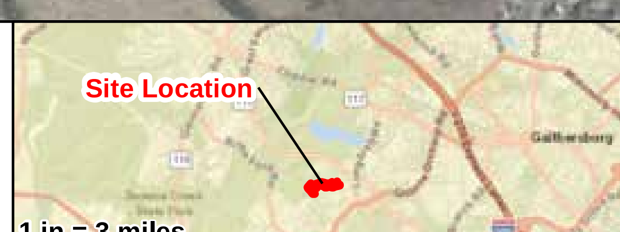
Photo 4. Looking east at Forest Stand D, located in the southwestern portion of the study area.

APPENDIX D.1 EXISTING HYDROLOGIC ANALYSIS



I-495 & I-270 Managed Lanes Study
Phase II Mitigation Design Plan
Stream Site CA-5: Great Seneca Creek
Bradbury Dr. Tributary

CA-5 Semi-Final Hydrology Map



Legend

- Time of Concentration
- Mainstem Drainage Area
- Mainstem Above Pond Drainage Area
- Mainstem Below Pond Drainage Area
- Upper Main Drainage Area
- Trib 1 Drainage Area
- Trib 2 Drainage Area
- SD2 Drainage Area
- SD1 Drainage Area
- Residual Drainage Area
- Streams
- MNCPPC Property Boundary

N E S W

1 inch = 700 feet

0 350 700 Feet

270 495 MANAGED LANES STUDY

Hydrologic Soil Group—Montgomery County, Maryland
(Quince Orchard)

Map Scale: 1:8,680 if printed on A landscape (11" x 8.5") sheet.

N

Meters: 0, 100, 200, 400, 600

Feet: 0, 400, 800, 1600, 2400

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 18N 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 1:15,800.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

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: Montgomery County, Maryland
Survey Area Data: Version 15, Sep 13, 2019

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

Date(s) aerial images were photographed: May 3, 2015—Feb 22, 2017

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.

Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
1C	Gaila silt loam, 8 to 15 percent slopes	B	23.3	14.4%
2B	Glenelg silt loam, 3 to 8 percent slopes	B	55.8	34.5%
2C	Glenelg silt loam, 8 to 15 percent slopes	B	1.5	0.9%
6A	Baile silt loam, 0 to 3 percent slopes	C/D	6.9	4.2%
16D	Brinklow-Blocktown channery silt loams, 15 to 25 percent slopes	C	30.5	18.9%
37B	Travilah silt loam, 3 to 8 percent slopes	C/D	33.0	20.4%
53A	Codorus silt loam, 0 to 3 percent slopes, occasionally flooded	C	0.9	0.5%
65B	Wheaton silt loam, 0 to 8 percent slopes	B	10.1	6.2%
Totals for Area of Interest			**161.8**	**100.0%**

NOAA Atlas 14, Volume 2, Version 3
Location name: Gaithersburg, Maryland, USA*
Latitude: 39.1179°, Longitude: -77.2525°
Elevation: 436.83 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

G.M. Bonnin, D. Martin, B. Lin, T. Parzybok, M.Yekta, and D. Riley

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.340 (0.308-0.376)	0.407 (0.368-0.450)	0.485 (0.438-0.536)	0.543 (0.489-0.599)	0.616 (0.551-0.680)	0.671 (0.597-0.740)	0.725 (0.641-0.801)	0.778 (0.683-0.862)	0.846 (0.736-0.942)	0.899 (0.776-1.00)
10-min	0.544 (0.491-0.601)	0.651 (0.588-0.720)	0.777 (0.701-0.859)	0.868 (0.781-0.958)	0.982 (0.878-1.08)	1.07 (0.950-1.18)	1.15 (1.02-1.27)	1.23 (1.08-1.37)	1.34 (1.16-1.49)	1.42 (1.22-1.58)
15-min	0.680 (0.614-0.751)	0.819 (0.740-0.905)	0.983 (0.887-1.09)	1.10 (0.988-1.21)	1.24 (1.11-1.37)	1.35 (1.20-1.49)	1.46 (1.29-1.61)	1.56 (1.37-1.72)	1.68 (1.47-1.88)	1.78 (1.53-1.99)
30-min	0.932 (0.842-1.03)	1.13 (1.02-1.25)	1.40 (1.26-1.54)	1.59 (1.43-1.76)	1.84 (1.65-2.03)	2.04 (1.81-2.25)	2.23 (1.97-2.47)	2.42 (2.13-2.68)	2.68 (2.33-2.98)	2.88 (2.48-3.22)
60-min	1.16 (1.05-1.28)	1.42 (1.28-1.57)	1.79 (1.62-1.98)	2.07 (1.87-2.29)	2.45 (2.19-2.71)	2.76 (2.46-3.05)	3.07 (2.72-3.40)	3.40 (2.98-3.76)	3.85 (3.34-4.28)	4.20 (3.63-4.69)
2-hr	1.36 (1.23-1.51)	1.66 (1.50-1.84)	2.11 (1.90-2.33)	2.46 (2.21-2.71)	2.96 (2.65-3.26)	3.37 (3.00-3.72)	3.81 (3.36-4.21)	4.27 (3.74-4.72)	4.94 (4.28-5.49)	5.49 (4.70-6.12)
3-hr	1.46 (1.32-1.63)	1.78 (1.61-1.98)	2.26 (2.03-2.50)	2.64 (2.37-2.92)	3.19 (2.85-3.53)	3.65 (3.23-4.04)	4.14 (3.64-4.58)	4.66 (4.06-5.17)	5.42 (4.66-6.04)	6.05 (5.14-6.76)
6-hr	1.81 (1.64-2.02)	2.19 (1.98-2.43)	2.77 (2.50-3.07)	3.24 (2.91-3.59)	3.94 (3.51-4.37)	4.54 (4.01-5.03)	5.20 (4.55-5.76)	5.91 (5.12-6.56)	6.96 (5.94-7.77)	7.85 (6.61-8.79)
12-hr	2.20 (1.98-2.47)	2.65 (2.39-2.98)	3.36 (3.02-3.77)	3.97 (3.55-4.45)	4.90 (4.33-5.47)	5.71 (5.00-6.38)	6.61 (5.72-7.40)	7.62 (6.51-8.54)	9.16 (7.67-10.3)	10.5 (8.64-11.9)
24-hr	2.54 (2.31-2.83)	3.07 (2.80-3.42)	3.94 (3.58-4.38)	4.71 (4.27-5.22)	5.89 (5.29-6.49)	6.94 (6.18-7.61)	8.13 (7.17-8.88)	9.47 (8.26-10.3)	11.5 (9.91-12.5)	13.4 (11.3-14.5)
2-day	2.95 (2.68-3.27)	3.57 (3.24-3.96)	4.56 (4.15-5.07)	5.42 (4.91-6.02)	6.72 (6.04-7.43)	7.85 (7.01-8.65)	9.10 (8.06-10.0)	10.5 (9.21-11.5)	12.6 (10.9-13.8)	14.4 (12.3-15.8)
3-day	3.12 (2.84-3.46)	3.77 (3.44-4.19)	4.82 (4.39-5.35)	5.73 (5.20-6.35)	7.09 (6.38-7.83)	8.27 (7.40-9.11)	9.59 (8.50-10.5)	11.1 (9.71-12.1)	13.3 (11.5-14.6)	15.1 (13.0-16.7)
4-day	3.29 (3.00-3.65)	3.98 (3.63-4.42)	5.08 (4.63-5.64)	6.03 (5.48-6.68)	7.46 (6.73-8.23)	8.70 (7.79-9.57)	10.1 (8.95-11.1)	11.6 (10.2-12.7)	13.9 (12.1-15.3)	15.9 (13.6-17.5)
7-day	3.81 (3.49-4.19)	4.59 (4.21-5.05)	5.80 (5.32-6.37)	6.83 (6.24-7.49)	8.38 (7.61-9.16)	9.72 (8.77-10.6)	11.2 (10.0-12.2)	12.8 (11.4-14.0)	15.2 (13.4-16.7)	17.3 (15.0-18.9)
10-day	4.36 (4.00-4.78)	5.23 (4.81-5.74)	6.53 (6.00-7.15)	7.62 (6.98-8.33)	9.20 (8.39-10.0)	10.5 (9.55-11.5)	12.0 (10.8-13.0)	13.5 (12.1-14.7)	15.8 (13.9-17.2)	17.7 (15.5-19.3)
20-day	5.89 (5.46-6.38)	7.01 (6.50-7.58)	8.47 (7.85-9.15)	9.66 (8.93-10.4)	11.3 (10.4-12.2)	12.6 (11.6-13.6)	14.0 (12.8-15.1)	15.5 (14.1-16.7)	17.5 (15.8-18.8)	19.0 (17.1-20.6)
30-day	7.25 (6.78-7.78)	8.58 (8.02-9.21)	10.2 (9.52-10.9)	11.5 (10.7-12.3)	13.3 (12.4-14.2)	14.7 (13.7-15.8)	16.2 (15.0-17.3)	17.7 (16.3-19.0)	19.7 (18.0-21.2)	21.3 (19.4-22.9)
45-day	9.10 (8.54-9.70)	10.7 (10.1-11.4)	12.5 (11.8-13.3)	13.9 (13.1-14.8)	15.8 (14.8-16.8)	17.2 (16.0-18.3)	18.5 (17.3-19.7)	19.9 (18.5-21.2)	21.6 (20.0-23.1)	22.9 (21.1-24.5)
60-day	10.8 (10.2-11.5)	12.8 (12.0-13.5)	14.7 (13.9-15.6)	16.2 (15.3-17.2)	18.2 (17.1-19.3)	19.6 (18.4-20.8)	21.0 (19.6-22.2)	22.3 (20.8-23.7)	24.0 (22.3-25.5)	25.2 (23.3-26.8)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

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PF graphical

GISHydro 2000 Watershed

```
Watershed Statistics for:
GISHydro Release Version Date: January 8, 2011
Hydro Extension Version Date:  January 8, 2011
Analysis Date:                 April 9, 2020

Data Selected:
     Quadrangles Used: germantown, gaithersburg, seneca
     DEM Coverage: NED DEMs
     Land Use Coverage: 2010 MOP Landuse
     Soil Coverage: SSURGO Soils
     Hydrologic Condition: (see Lookup Table)
     Impose NHD stream Locations: Yes
     Outlet Easting:        377753 m. (MD Stateplane, NAD 1983)
     Outlet Northing:       162453 m. (MD Stateplane, NAD 1983)

Findings:
     Outlet Location:       Piedmont
     Outlet State:          Maryland
     Drainage Area          0.3 square miles
       -Piedmont (100.0% of area)
     Channel Slope:         130.5 feet/mile
     Land Slope:            0.061 ft/ft
     Urban Area:            79.2%
     Impervious Area:       35.0%
 ******************************************************
     URBAN DEVELOPMENT IN WATERSHED EXCEEDS 15%.
     Calculated discharges from USGS Regression
     Equations may not be appropriate.
 ******************************************************
     Time of Concentration: 1.0 hours  [W.O. Thomas, Jr. Equation]
     Time of Concentration: 0.9 hours  [From SCS Lag Equation * 1.67]
     Longest Flow Path:     0.98 miles
     Basin Relief:          95.5 feet
     Average CN:            76
     % Forest Cover:        13.9
     % Storage:             0.0
     % Limestone:           0.0
     Selected Soils Data Statistics:
        % A Soils:          0.0
        % B Soils:          69.2
        % C Soils:          26.9
        % D Soils:          3.9
     SSURGO Soils Data Statistics (used in Regression Equations):
        % A Soils:          0.0
        % B Soils:          69.2
        % C Soils:          26.9
        % D Soils:          3.9
     2-Year,24-hour Prec.:  3.08 inches
```

Inputs:									
Drainage Area:		0.252	sqmi						
% Lime:		0.00							
% Impervious Area:		35.50		Estimated from GISHydro					
Maryland Hydrology Panel, 2016, Application of Hydrologic Methods in Maryland (4th Edition), July 2016									
Wilbert O. Thomas, Jr. and Glenn E. Moglen									
Interval	Discharge (cfs)	Range	Constants				Standard Error		
1.25	68.08	(31.93 - 104.22)	63	0.685	-0.09	0.284	53.1%		
1.5	88.73	(45.87 - 131.59)	89.8	0.669	-0.1	0.253	48.3%		
2	120.29	(67.84 - 172.73)	131.7	0.653	-0.112	0.225	43.6%		
5	232.38	(150.58 - 314.18)	283.7	0.625	-0.136	0.184	35.2%		
10	340.71	(233.05 - 448.37)	434.7	0.61	-0.148	0.166	31.6%		
25	518.90	(363.23 - 674.57)	683.3	0.599	-0.164	0.153	30.0%		
50	693.52	(479.91 - 907.12)	929.6	0.591	-0.174	0.145	30.8%		
100	914.18	(612.5 - 1215.86)	1240.1	0.584	-0.184	0.139	33.0%		
200	1180.36	(748.35 - 1612.37)	1616.8	0.578	-0.193	0.134	36.6%		
500	1630.58	(931.06 - 2330.1)	2252.2	0.571	-0.205	0.129	42.9%		

Inputs:								
Drainage Area:		0.41	sqmi					
% Lime:		0.00						
% Impervious Area:		33.80		Estimated from GISHydro				
Maryland Hydrology Panel, 2016, Application of Hydrologic Methods in Maryland (4th Edition), July 2016								
Wilbert O. Thomas, Jr. and Glenn E. Moglen								
Interval	Discharge (cfs)	Range	Constants				Standard Error	
1.25	93.74	(43.96 - 143.51)	63	0.685	-0.09	0.284	53.1%	
1.5	121.41	(62.77 - 180.05)	89.8	0.669	-0.1	0.253	48.3%	
2	163.53	(92.23 - 234.82)	131.7	0.653	-0.112	0.225	43.6%	
5	312.25	(202.34 - 422.16)	283.7	0.625	-0.136	0.184	35.2%	
10	454.87	(311.13 - 598.61)	434.7	0.61	-0.148	0.166	31.6%	
25	689.49	(482.65 - 896.34)	683.3	0.599	-0.164	0.153	30.0%	
50	918.29	(635.46 - 1201.12)	929.6	0.591	-0.174	0.145	30.8%	
100	1206.71	(808.49 - 1604.92)	1240.1	0.584	-0.184	0.139	33.0%	
200	1553.88	(985.16 - 2122.6)	1616.8	0.578	-0.193	0.134	36.6%	
500	2139.79	(1221.82 - 3057.75)	2252.2	0.571	-0.205	0.129	42.9%	

```
GISHydro Release Version Date:    October, 2020
Project Name:                     CA-5_Additional_Trib
Analysis Date:                    November 10, 2020
Data Selected:
     DEM Coverage:                NED DEM 201805
     Land Use Coverage:           2010 MOP
     Soil Coverage:               SSURGO 201805
     Hydrologic Condition:        Good
     Impose NHD stream Locations: Yes
     Outlet Easting:              377743 m (MD Stateplane, NAD 1983)
     Outlet Northing:             162438 m (MD Stateplane, NAD 1983)
Findings:
     Outlet Location:             Piedmont
     Outlet State:                Maryland
     Drainage Area                0.41 square miles
       -Piedmont 100.00 percent of area

     Channel Slope:               143.36616295 feet/mile (0.02715268 feet/feet)
     Land Slope:                  0.08255392 feet/feet
     Urban Area (percent):        69.9
     Impervious Area (percent):   33.8

     Time of Concentration:       1.07 hours [W.O. Thomas, Jr. Equation]
     Time of Concentration:       0.75 hours  [From SCS Lag Equation * 1.67]
     Longest Flow Path:           0.97 miles
     Basin Relief:                95.59 feet
     Average CN:                  76.9
     Forest Cover (percent):      21.7
     Storage (percent):           0.3
     Limestone (percent):         0.0
     Selected Soils Data Statistics Percent:
        A Soils:                  0.0
        B Soils:                  57.2
        C Soils:                  26.1
        D Soils:                  16.5
     SSURGO Soils Data Statistics Percent (used in Regression Equations):
        A Soils:                  0.0
        B Soils:                  57.2
        C Soils:                  26.1
        D Soils:                  16.5
     2-Year,24-hour Prec.:        3.07 inches
     Mean Annual Prec.:           42.14 inches
```

KAS

Quince Orchard
Upper Main plus channel to equal Mainstem 1
Montgomery NOAA_C County, Maryland

Sub-Area Summary Table

Sub-Area Identifier	Drainage Area (ac)	Time of Concentration (hr)	Curve Number	Receiving Reach	Sub-Area Description
Mainstem 1	161.50	0.298	79	Outlet	

Total Area: 161.50 (ac)

KAS

Quince Orchard
Upper Main plus channel to equal Mainstem 1
Montgomery NOAA_C County, Maryland

Sub-Area Time of Concentration Details

Sub-Area Identifier/	Flow Length (ft)	Slope (ft/ft)	Mannings's n	End Area (sq ft)	Wetted Perimeter (ft)	Velocity (ft/sec)	Travel Time (hr)
Mainstem 1							
SHEET	58	0.0200	0.011				0.013
SHALLOW	898	0.0368	0.050				0.081
SHALLOW	299	0.0502	0.025				0.018
CHANNEL	1411	0.0716	0.035	6.00	7.00	10.314	0.038
CHANNEL	3636	0.0305	0.035	14.00	16.00	6.824	0.148
					Time of Concentration		.298

WinTR-55 Current Data Description

--- Identification Data ---

User: KAS Date: 2/5/2021
Project: CA-5 Units: English
SubTitle: Mainstem 2 Areal Units: Acres
State: Maryland
County: Montgomery NOAA_C
Filename: G:\Active\2017-29 BCS 2015-05A Design-Construction, WRA\Task 25 CA-5 Phase II design\Hydrology\T

--- Sub-Area Data ---

Name	Description	Reach	Area(ac)	RCN	Tc
Total		Outlet	262.4	77	0.425

Total area: 262.40 (ac)

--- Storm Data --

Rainfall Depth by Rainfall Return Period

2-Yr (in)	5-Yr (in)	10-Yr (in)	25-Yr (in)	50-Yr (in)	100-Yr (in)	1-Yr (in)
3.07	3.99	4.71	5.97	7.03	8.88	2.54

Storm Data Source: User-provided custom storm data
Rainfall Distribution Type: NOAA_C
Dimensionless Unit Hydrograph: <standard>

==

KAS CA-5
Mainstem 2
Montgomery NOAA_C County, Maryland

Sub-Area Time of Concentration Details

Sub-Area Identifier/	Flow Length (ft)	Slope (ft/ft)	Mannings's n	End Area (sq ft)	Wetted Perimeter (ft)	Velocity (ft/sec)	Travel Time (hr)
Total							
SHEET	100	0.0355	0.011				0.016
SHALLOW	97	0.0355	0.025				0.007
CHANNEL	1205	0.0898	0.035	2.00	6.28	5.977	0.056
CHANNEL	3859	0.0196	0.035	6.00	16.00	3.098	0.346
						Time of Concentration	0.425

==

```
WinTR-20 Printed Page File      Beginning of Input Data List
G:\Active\1 ASSOCIATES TEMP FILES\Katie\TR-20\CA5Total.inp

WinTR-20: version 3.20                  0         0         1.0       0
CA-5 Mainstem 1 and Mainstem 2

SUB-AREA:
          1         Outlet    GAGE      0.252     79.       0.298
          2         weir      GAGE      0.41      77.       0.425


STREAM REACH:
          weir      Outlet              Weir


STORM ANALYSIS:
          p1-06     GAGE                1.81      rtp1-06   2
          p2-06     GAGE                2.19      rtp2-06   2
          p10-12    GAGE                3.97      rtp10-12  2
          100yrNOAACGAGE                8.88      TYPE NO_C 2



STRUCTURE RATING:
          Weir      318.3
                    318.3     0.        0.
                    320.      2.23      .464
                    322.      3.15      2.206
                    324.      3.86      5.324
                    325.12    4.35      7.605
                    325.5     91.52     8.466
                    326.      265.87    9.6643
                    328.      1455.620  15.0605




RAINFALL DISTRIBUTION:
          rtp1-06             0.1
                    0.0000    0.0065    0.0129    0.0194    0.0258
                    0.0323    0.0388    0.0452    0.0517    0.0581
                    0.0646    0.0710    0.0775    0.0840    0.0904
                    0.0969    0.1032    0.1095    0.1158    0.1222
                    0.1285    0.1402    0.1519    0.1636    0.1753
                    0.1871    0.2113    0.2355    0.2742    0.3359
                    0.5000    0.6641    0.7258    0.7645    0.7887
                    0.8129    0.8247    0.8364    0.8481    0.8598
                    0.8715    0.8778    0.8842    0.8905    0.8968
                    0.9031    0.9096    0.9160    0.9225    0.9290
                    0.9354    0.9419    0.9483    0.9548    0.9612
                    0.9677    0.9742    0.9806    0.9871    0.9935
                    1.0000
          rtp2-06             0.1
                    0.0000    0.0065    0.0130    0.0195    0.0260
                    0.0325    0.0390    0.0455    0.0520    0.0585
                    0.0650    0.0715    0.0780    0.0845    0.0910
                    0.0975    0.1037    0.1099    0.1160    0.1222
                    0.1284    0.1400    0.1515    0.1631    0.1747
                    0.1863    0.2111    0.2360    0.2756    0.3381
                    0.5000    0.6619    0.7244    0.7640    0.7889
```

	0.8137	0.8253	0.8369	0.8485	0.8600
	0.8716	0.8778	0.8840	0.8901	0.8963
	0.9025	0.9090	0.9155	0.9220	0.9285
	0.9350	0.9415	0.9480	0.9545	0.9610
	0.9675	0.9740	0.9805	0.9870	0.9935
	1.0000				
rtp10-12		0.1			
	0.0000	0.0031	0.0061	0.0092	0.0122
	0.0153	0.0184	0.0214	0.0245	0.0275
	0.0306	0.0337	0.0367	0.0398	0.0428
	0.0459	0.0489	0.0520	0.0551	0.0581
	0.0612	0.0642	0.0673	0.0704	0.0734
	0.0765	0.0795	0.0826	0.0857	0.0887
	0.0918	0.0970	0.1022	0.1074	0.1126
	0.1178	0.1230	0.1282	0.1334	0.1386
	0.1438	0.1490	0.1542	0.1594	0.1646
	0.1698	0.1748	0.1798	0.1848	0.1898
	0.1948	0.2050	0.2153	0.2256	0.2358
	0.2461	0.2692	0.2922	0.3274	0.3797
	0.5000	0.6203	0.6726	0.7078	0.7308
	0.7539	0.7642	0.7744	0.7847	0.7950
	0.8052	0.8102	0.8152	0.8202	0.8252
	0.8302	0.8354	0.8406	0.8458	0.8510
	0.8562	0.8614	0.8666	0.8718	0.8770
	0.8822	0.8874	0.8926	0.8978	0.9030
	0.9082	0.9113	0.9143	0.9174	0.9205
	0.9235	0.9266	0.9296	0.9327	0.9358
	0.9388	0.9419	0.9449	0.9480	0.9511
	0.9541	0.9572	0.9602	0.9633	0.9663
	0.9694	0.9725	0.9755	0.9786	0.9816
	0.9847	0.9878	0.9908	0.9939	0.9969
	1.0000				

GLOBAL OUTPUT:

	1.	0.1	YNNNN	YNNNNN

WinTR-20 Printed Page File   End of Input Data List

CA-5 Mainstem 1 and Mainstem 2

Name of printed page file:
G:\Active\1 ASSOCIATES TEMP FILES\Katie\TR-20\CA5Total.out

STORM p1-06

Area or Reach Identifier	Drainage Area (sq mi)	Rain Gage ID or Location	Runoff Amount (in)	Peak Flow Elevation (ft)	Peak Flow Time (hr)	Peak Flow Rate (cfs)	Peak Flow Rate (csm)
2	0.410	GAGE	0.350		3.37	97.1	236.84

weir	0.410	Upstream	0.350		3.37	97.1	236.84
weir	0.410	Downstream	0.340	324.63	6.41	4.1	10.08
1	0.252	GAGE	0.414		3.26	89.2	353.98
OUTLET	0.662		0.368		3.26	91.6	138.34

STORM p2-06

Area or Reach Identifier	Drainage Area (sq mi)	Rain Gage ID or Location	Runoff Amount (in)	Peak Flow Elevation (ft)	Peak Flow Time (hr)	Peak Flow Rate (cfs)	Peak Flow Rate (csm)
2	0.410	GAGE	0.553		3.36	163.8	399.60
weir	0.410	Upstream	0.553		3.36	163.8	399.60
weir	0.410	Downstream	0.544	325.23	4.30	28.5	69.55
1	0.252	GAGE	0.636		3.24	143.3	568.84
OUTLET	0.662		0.579		3.24	146.0	220.57

STORM p10-12

Area or Reach Identifier	Drainage Area (sq mi)	Rain Gage ID or Location	Runoff Amount (in)	Peak Flow Elevation (ft)	Peak Flow Time (hr)	Peak Flow Rate (cfs)	Peak Flow Rate (csm)
2	0.410	GAGE	1.788		6.30	450.9	1099.65
weir	0.410	Upstream	1.788		6.30	450.9	1099.65
weir	0.410	Downstream	1.776	326.21	6.44	389.3	949.52
1	0.252	GAGE	1.938		6.22	354.2	1405.46
OUTLET	0.662		1.838		6.39	615.5	929.78

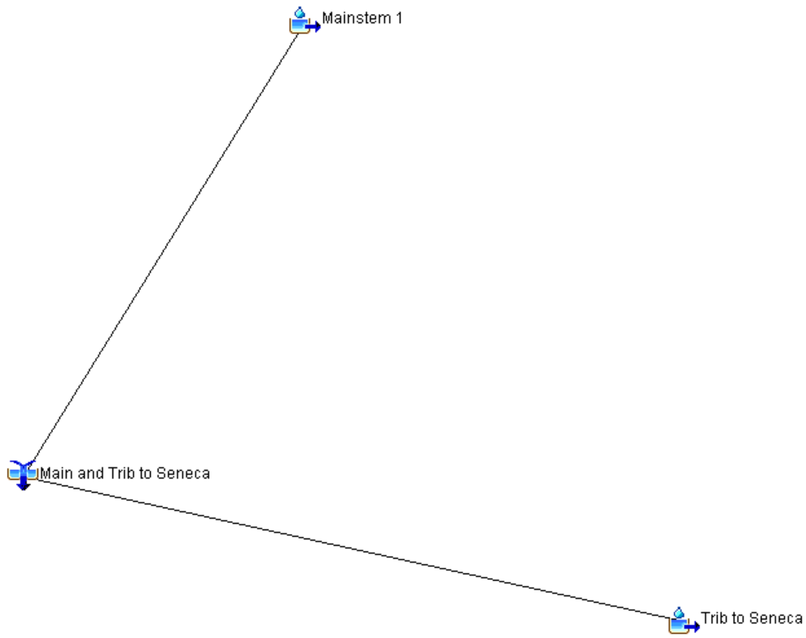
STORM 100yrNOAAC

Area or Reach Identifier	Drainage Area (sq mi)	Rain Gage ID or Location	Runoff Amount (in)	Peak Flow Elevation (ft)	Peak Flow Time (hr)	Peak Flow Rate (cfs)	Peak Flow Rate (csm)
2	0.410	GAGE	6.086		12.30	1225.8	2989.65
weir	0.410	Upstream	6.086		12.30	1225.8	2989.65
weir	0.410	Downstream	6.075	327.54	12.35	1181.6	2881.93
1	0.252	GAGE	6.330		12.22	916.4	3636.51
OUTLET	0.662		6.172		12.28	1956.1	2954.86

CA-5 Mainstem 1 and Mainstem 2

Area or Reach Identifier	Drainage Area (sq mi)	----------- Peak Flow by Storm ----------- p1-06 (cfs)	p2-06 (cfs)	p10-12 (cfs)	100yrNOAAC (cfs)	(cfs)
1	0.252	89.2	143.3	354.2	916.4	
2	0.410	97.1	163.8	450.9	1225.8	
weir	0.410	97.1	163.8	450.9	1225.8	
DOWNSTREAM		4.1	28.5	389.3	1181.6	
OUTLET	0.662	91.6	146.0	615.5	1956.1	

HEC-HMS Schematic Simple Model



Project: CA-5 Simple   Simulation Run: 1 YR

Start of Run: 26Oct2018, 00:00   Basin Model: CA-5
End of Run: 26Oct2018, 06:00   Meteorologic Model: 1 yr NOAA C
Compute Time: 15Feb2022, 11:15:46   Control Specifications: 6 hour

Show Elements: All Elements   Volume Units: (•) IN ( ) ACRE-FT   Sorting: Hydrologic

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Trib to Seneca	0.410	98.3	26Oct2018, 03:22	0.33
Mainstem 1	0.252	89.6	26Oct2018, 03:15	0.40
Main and Trib to Seneca	0.662	179.0	26Oct2018, 03:19	0.36

Project: CA-5 Simple   Simulation Run: 2 YR

Start of Run: 26Oct2018, 00:00   Basin Model: CA-5
End of Run: 26Oct2018, 06:00   Meteorologic Model: 2 yr NOAA C
Compute Time: 15Feb2022, 11:15:48   Control Specifications: 6 hour

Show Elements: All Elements   Volume Units: (•) IN ( ) ACRE-FT   Sorting: Hydrologic

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Trib to Seneca	0.410	165.9	26Oct2018, 03:21	0.53
Mainstem 1	0.252	143.8	26Oct2018, 03:15	0.62
Main and Trib to Seneca	0.662	296.7	26Oct2018, 03:18	0.56

Project: CA-5 Simple   Simulation Run: 10 YR

Start of Run: 26Oct2018, 00:00   Basin Model: CA-5
End of Run: 26Oct2018, 12:00   Meteorologic Model: 10 yr NOAA C
Compute Time: 15Feb2022, 11:15:47   Control Specifications: 12 hour

Show Elements: All Elements   Volume Units: (●) IN ( ) ACRE-FT   Sorting: Hydrologic

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Trib to Seneca	0.410	455.3	26Oct2018, 06:18	1.76
Mainstem 1	0.252	355.4	26Oct2018, 06:13	1.92
Main and Trib to Seneca	0.662	785.7	26Oct2018, 06:16	1.82

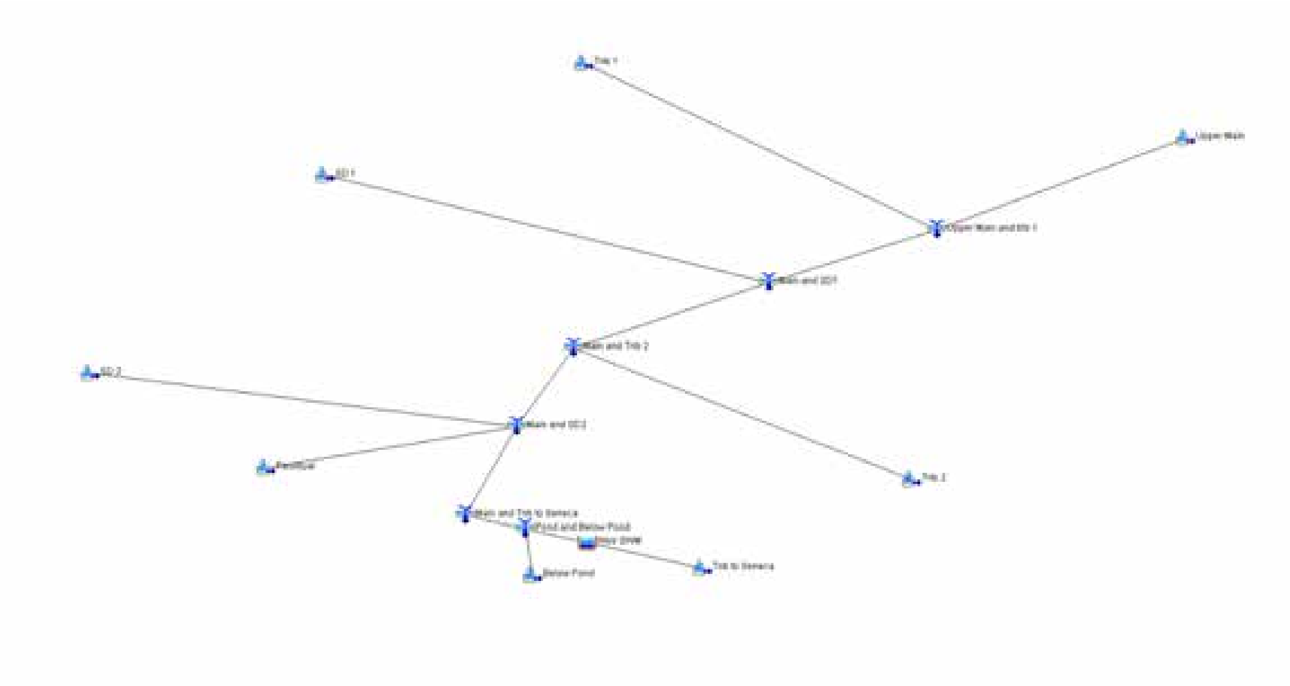
Project: CA-5 Simple   Simulation Run: 100 YR

Start of Run: 26Oct2018, 00:00   Basin Model: CA-5
End of Run: 27Oct2018, 00:00   Meteorologic Model: 100 yr NOAA C
Compute Time: 15Feb2022, 11:15:47   Control Specifications: 24 hour

Show Elements: All Elements   Volume Units: (●) IN ( ) ACRE-FT   Sorting: Hydrologic

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Trib to Seneca	0.410	1238.6	26Oct2018, 12:18	6.06
Mainstem 1	0.252	919.7	26Oct2018, 12:13	6.31
Main and Trib to Seneca	0.662	2100.4	26Oct2018, 12:16	6.15

HEC-HMS Schematic



Weir Stormwater Management Stage-Storage-Discharge

Paired data functions for the combined table data

Storage-Discharge Function: Weir SWM

Elevation-Storage Function: Weir SWM

Elevation (FT)	Storage (ACRE-FT)	Discharge (CFS)
318.30	0.0000	0.00
320.00	0.4640	2.23
322.00	2.2059	3.15
324.00	5.3240	3.86
325.12	7.6050	4.35
325.50	8.4660	91.52
326.00	9.6640	265.87
328.00	15.0605	1455.62

Project: CA5_SWMUpdate
Simulation Run: 1 YR
Simulation Start: 25 October 2018, 24:00
Simulation End: 26 October 2018, 06:00

HMS Version: 4.7.1
Executed: 15 February 2021, 16:32

Global Results Summary

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Upper Main	0.1	47.91	26Oct2018, 03:09	0.4
Trib 1	0.03	7.04	26Oct2018, 03:20	0.33
Upper Main and trib 1	0.13	51.14	26Oct2018, 03:09	0.39
Sd 1	0.03	6.34	26Oct2018, 03:16	0.28
Main and SD1	0.16	55.64	26Oct2018, 03:10	0.37
Trib 2	0.04	12.5	26Oct2018, 03:18	0.43
Main and Trib 2	0.2	63.62	26Oct2018, 03:11	0.38
Residual	0.05	11.48	26Oct2018, 03:16	0.28
Sd 2	0.01	1.68	26Oct2018, 03:10	0.28
Trib to Seneca	0.35	89.24	26Oct2018, 03:19	0.33
Weir SWM	0.35	3.86	26Oct2018, 06:00	0.04
Below Pond	0.06	6.69	26Oct2018, 03:16	0.16
Pond and Below Pond	0.41	9.14	26Oct2018, 03:17	0.06
Main and SD2	0.25	74.36	26Oct2018, 03:12	0.36
Main and Trib to Seneca	0.66	82.11	26Oct2018, 03:12	0.17

Project: CA5_SWMUpdate
Simulation Run: 2 YR
Simulation Start: 25 October 2018, 24:00
Simulation End: 26 October 2018, 06:00

HMS Version: 4.7.1
Executed: 15 February 2021, 20:03

Global Parameter Summary - Subbasin

Area (MI2)

Element Name	Area (MI2)
Upper Main	0.1
Trib 1	0.03
Sd 1	0.03
Trib 2	0.04
Residual	0.05
Sd 2	0.01
Trib to Seneca	0.35
Below Pond	0.06

Downstream

Element Name	Downstream
Upper Main	Upper Main and trib 1
Trib 1	Upper Main and trib 1
Sd 1	Main and SD1
Trib 2	Main and Trib 2
Residual	Main and SD2
Sd 2	Main and SD2
Trib to Seneca	Weir SWM
Below Pond	Pond and Below Pond

Loss Rate: Scs

Element Name	Percent Impervious Area	Curve Number
Upper Main	0	79
Trib 1	0	77
Sd 1	0	75
Trib 2	0	80
Residual	0	75
Sd 2	0	75

Trib to Seneca	0	77
Below Pond	0	70

Transform: Scs

Element Name	Lag	Unitgraph Type
Upper Main	5.4	Standard
Trib 1	13.5	Standard
Sd 1	10.15	Standard
Trib 2	13.46	Standard
Residual	10.26	Standard
Sd 2	5.4	Standard
Trib to Seneca	13.28	Standard
Below Pond	8.28	Standard

Global Results Summary

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Upper Main	0.1	115.13	26Oct2018, 03:09	0.93
Trib 1	0.03	19.06	26Oct2018, 03:18	0.8
Upper Main and trib 1	0.13	127.16	26Oct2018, 03:09	0.9
Sd 1	0.03	18.89	26Oct2018, 03:14	0.72
Main and SD1	0.16	142.23	26Oct2018, 03:09	0.87
Trib 2	0.04	29.98	26Oct2018, 03:17	0.96
Main and Trib 2	0.2	163.76	26Oct2018, 03:10	0.88
Residual	0.05	34.24	26Oct2018, 03:14	0.72
Sd 2	0.01	4.9	26Oct2018, 03:09	0.73
Trib to Seneca	0.35	241.39	26Oct2018, 03:17	0.8
Weir SWM	0.35	79.22	26Oct2018, 03:44	0.39
Below Pond	0.06	28.26	26Oct2018, 03:13	0.51
Pond and Below Pond	0.41	85.4	26Oct2018, 03:44	0.41
Main and SD2	0.25	198.11	26Oct2018, 03:10	0.85
Main and Trib to Seneca	0.66	227.94	26Oct2018, 03:11	0.57

Project: CA5_SWMUpdate
Simulation Run: 10 YR
Simulation Start: 25 October 2018, 24:00
Simulation End: 26 October 2018, 12:00

HMS Version: 4.7.1
Executed: 15 February 2021, 16:32

Global Parameter Summary - Subbasin

Area (MI2)

Element Name	Area (MI2)
Upper Main	0.1
Trib 1	0.03
Sd 1	0.03
Trib 2	0.04
Residual	0.05
Sd 2	0.01
Trib to Seneca	0.35
Below Pond	0.06

Downstream

Element Name	Downstream
Upper Main	Upper Main and trib 1
Trib 1	Upper Main and trib 1
Sd 1	Main and SD1
Trib 2	Main and Trib 2
Residual	Main and SD2
Sd 2	Main and SD2
Trib to Seneca	Weir SWM
Below Pond	Pond and Below Pond

Loss Rate: Scs

Element Name	Percent Impervious Area	Curve Number
Upper Main	0	79
Trib 1	0	77
Sd 1	0	75
Trib 2	0	80
Residual	0	75
Sd 2	0	75

Trib to Seneca	0	77
Below Pond	0	70

Transform: Scs

Element Name	Lag	Unitgraph Type
Upper Main	5.4	Standard
Trib 1	13.5	Standard
Sd 1	10.15	Standard
Trib 2	13.46	Standard
Residual	10.26	Standard
Sd 2	5.4	Standard
Trib to Seneca	13.28	Standard
Below Pond	8.28	Standard

Global Results Summary

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Upper Main	0.1	178.28	26Oct2018, 06:08	1.93
Trib 1	0.03	32.92	26Oct2018, 06:16	1.76
Upper Main and trib 1	0.13	201.57	26Oct2018, 06:09	1.89
Sd 1	0.03	33.76	26Oct2018, 06:13	1.62
Main and SD1	0.16	231.92	26Oct2018, 06:09	1.84
Trib 2	0.04	48.17	26Oct2018, 06:16	1.99
Main and Trib 2	0.2	269.58	26Oct2018, 06:09	1.87
Residual	0.05	61.26	26Oct2018, 06:13	1.62
Sd 2	0.01	8.32	26Oct2018, 06:08	1.63
Trib to Seneca	0.35	416.53	26Oct2018, 06:16	1.76
Weir SWM	0.35	328.13	26Oct2018, 06:25	1.35
Below Pond	0.06	58.48	26Oct2018, 06:11	1.3
Pond and Below Pond	0.41	358.68	26Oct2018, 06:25	1.34
Main and SD2	0.25	334.07	26Oct2018, 06:10	1.82
Main and Trib to Seneca	0.66	555	26Oct2018, 06:23	1.52

Project: CA5_SWMUpdate
Simulation Run: 100 YR
Simulation Start: 25 October 2018, 24:00
Simulation End: 26 October 2018, 24:00

HMS Version: 4.7.1
Executed: 15 February 2021, 16:32

Global Parameter Summary - Subbasin

Area (MI2)

Element Name	Area (MI2)
Upper Main	0.1
Trib 1	0.03
Sd 1	0.03
Trib 2	0.04
Residual	0.05
Sd 2	0.01
Trib to Seneca	0.35
Below Pond	0.06

Downstream

Element Name	Downstream
Upper Main	Upper Main and trib 1
Trib 1	Upper Main and trib 1
Sd 1	Main and SD1
Trib 2	Main and Trib 2
Residual	Main and SD2
Sd 2	Main and SD2
Trib to Seneca	Weir SWM
Below Pond	Pond and Below Pond

Loss Rate: Scs

Element Name	Percent Impervious Area	Curve Number
Upper Main	0	79
Trib 1	0	77
Sd 1	0	75
Trib 2	0	80
Residual	0	75
Sd 2	0	75

Trib to Seneca	0	77
Below Pond	0	70

Transform: Scs

Element Name	Lag	Unitgraph Type
Upper Main	5.4	Standard
Trib 1	13.5	Standard
Sd 1	10.15	Standard
Trib 2	13.46	Standard
Residual	10.26	Standard
Sd 2	5.4	Standard
Trib to Seneca	13.28	Standard
Below Pond	8.28	Standard

Global Results Summary

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Upper Main	0.1	479.36	26Oct2018, 12:09	6.32
Trib 1	0.03	89.56	26Oct2018, 12:16	6.06
Upper Main and trib 1	0.13	548	26Oct2018, 12:09	6.26
Sd 1	0.03	97.53	26Oct2018, 12:13	5.82
Main and SD1	0.16	634.18	26Oct2018, 12:09	6.19
Trib 2	0.04	121.17	26Oct2018, 12:16	6.43
Main and Trib 2	0.2	727.98	26Oct2018, 12:09	6.23
Residual	0.05	176.9	26Oct2018, 12:13	5.82
Sd 2	0.01	24.84	26Oct2018, 12:09	5.83
Trib to Seneca	0.35	1132.92	26Oct2018, 12:16	6.06
Weir SWM	0.35	1083.36	26Oct2018, 12:19	5.65
Below Pond	0.06	198.67	26Oct2018, 12:11	5.21
Pond and Below Pond	0.41	1220.2	26Oct2018, 12:18	5.59
Main and SD2	0.25	912.4	26Oct2018, 12:10	6.14
Main and Trib to Seneca	0.66	1959.18	26Oct2018, 12:14	5.8

WinTR-55 Current Data Description

--- Identification Data ---

User: KAS Date: 2/12/2021
Project: Quince Orchard Units: English
SubTitle: Upper Main Areal Units: Acres
State: Maryland
County: Montgomery NOAA_C
Filename: G:\Active\2017-29 BCS 2015-05A Design-Construction, WRA\Task 25 CA-5 Phase II design\Hydrology\T

--- Sub-Area Data ---

Name	Description	Reach	Area(ac)	RCN	Tc
Mainstem 1		Outlet	66.1	79	.15

Total area: 66.10 (ac)

--- Storm Data --

Rainfall Depth by Rainfall Return Period

2-Yr (in)	5-Yr (in)	10-Yr (in)	25-Yr (in)	50-Yr (in)	100-Yr (in)	1-Yr (in)
3.07	3.99	4.71	5.97	7.03	8.13	2.54

Storm Data Source: User-provided custom storm data
Rainfall Distribution Type: NOAA_C
Dimensionless Unit Hydrograph: <standard>

==

KAS

Quince Orchard
Upper Main
Montgomery NOAA_C County, Maryland

Sub-Area Time of Concentration Details

Sub-Area Identifier/	Flow Length (ft)	Slope (ft/ft)	Mannings's n	End Area (sq ft)	Wetted Perimeter (ft)	Velocity (ft/sec)	Travel Time (hr)
Mainstem 1							
SHEET	58	0.0200	0.011				0.013
SHALLOW	898	0.0368	0.050				0.081
SHALLOW	299	0.0502	0.025				0.018
CHANNEL	1411	0.0716	0.035	6.00	7.00	10.314	0.038
						Time of Concentration	.15

==

WinTR-55 Current Data Description

--- Identification Data ---

User: KAS
Project: Quince Orchard
SubTitle: Trib 1
State: Maryland
County: Montgomery NOAA_C
Filename: G:\Active\2017-29 BCS 2015-05A Design-Construction, WRA\Task 25 CA-5 Phase II design\Hydrology\Q

Date: 2/12/2021
Units: English
Areal Units: Acres

--- Sub-Area Data ---

Name	Description	Reach	Area(ac)	RCN	Tc
Total		Outlet	17.9	77	.375

Total area: 17.90 (ac)

--- Storm Data --

Rainfall Depth by Rainfall Return Period

2-Yr (in)	5-Yr (in)	10-Yr (in)	25-Yr (in)	50-Yr (in)	100-Yr (in)	1-Yr (in)
3.07	3.99	4.71	5.97	7.03	8.13	2.54

Storm Data Source: User-provided custom storm data
Rainfall Distribution Type: NOAA_C
Dimensionless Unit Hydrograph: <standard>

==

KAS

Quince Orchard
Trib 1
Montgomery NOAA_C County, Maryland

Watershed Peak Table

Sub-Area or Reach Identifier	Peak Flow by Rainfall Return Period 2-Yr (cfs)	10-Yr (cfs)	25-Yr (cfs)	100-Yr (cfs)	1-Yr (cfs)
SUBAREAS					
Total	15.98	35.05	50.83	78.92	10.55
REACHES					
OUTLET	15.98	35.05	50.83	78.92	10.55

==

Montgomery NOAA_C County, Maryland

Sub-Area Time of Concentration Details

Sub-Area Identifier/	Flow Length (ft)	Slope (ft/ft)	Mannings's n	End Area (sq ft)	Wetted Perimeter (ft)	Velocity (ft/sec)	Travel Time (hr)
Total							
SHEET	99	0.0200	0.240				0.241
SHALLOW	292	0.0274	0.050				0.030
CHANNEL	580	0.0276	0.011	3.14	6.28	14.646	0.011
CHANNEL	1167					3.500	0.093
						Time of Concentration	.375

===

KAS

Quince Orchard
Trib 1
Montgomery NOAA_C County, Maryland

Sub-Area Land Use and Curve Number Details

Sub-Area Identifier	Land Use	Hydrologic Soil Group	Sub-Area Area (ac)	Curve Number
Total	Residential districts (1/4 acre)	B	14.3	75
	Residential districts (1/4 acre)	C	3.6	83
	Total Area / Weighted Curve Number		17.9	77

===

WinTR-55 Current Data Description

--- Identification Data ---

User: KAS
Project:
SubTitle: CA-5 SD 1
State: Maryland
County: Montgomery NOAA_C
Filename: G:\Active\2017-29 BCS 2015-05A Design-Construction, WRA\Task 25 CA-5 Phase II design\Hydrology\T

Date: 9/23/2020
Units: English
Areal Units: Acres

--- Sub-Area Data ---

Name	Description	Reach	Area(ac)	RCN	Tc
SD 1		Outlet	18	75	.282

Total area: 18 (ac)

--- Storm Data --

Rainfall Depth by Rainfall Return Period

2-Yr (in)	5-Yr (in)	10-Yr (in)	25-Yr (in)	50-Yr (in)	100-Yr (in)	1-Yr (in)
3.07	3.99	4.71	5.97	7.03	8.13	2.54

Storm Data Source: User-provided custom storm data
Rainfall Distribution Type: NOAA_C
Dimensionless Unit Hydrograph: <standard>

==

KAS

CA-5 SD 1
Montgomery NOAA_C County, Maryland

Sub-Area Time of Concentration Details

Sub-Area Identifier/	Flow Length (ft)	Slope (ft/ft)	Mannings's n	End Area (sq ft)	Wetted Perimeter (ft)	Velocity (ft/sec)	Travel Time (hr)
SD 1							
SHEET	100	0.0250	0.240				0.222
SHALLOW	430	0.0600	0.050				0.030
CHANNEL	1218	0.0210	0.011	3.14	6.28	12.531	0.027
CHANNEL	312	0.1350	0.011	3.14	6.28	28.889	0.003
						Time of Concentration	.282

==

WinTR-55 Current Data Description

--- Identification Data ---

User: KAS
Project: Quince Orchard
SubTitle: Trib 2
State: Maryland
County: Montgomery NOAA_C
Filename: G:\Active\2017-29 BCS 2015-05A Design-Construction, WRA\Task 25 CA-5 Phase II design\Hydrology\T

Date: 2/12/2021
Units: English
Areal Units: Acres

--- Sub-Area Data ---

Name	Description	Reach	Area(ac)	RCN	Tc
Total		Outlet	22.97	80	.374

Total area: 22.97 (ac)

--- Storm Data --

Rainfall Depth by Rainfall Return Period

2-Yr (in)	5-Yr (in)	10-Yr (in)	25-Yr (in)	50-Yr (in)	100-Yr (in)	1-Yr (in)
3.07	3.99	4.71	5.97	7.03	8.13	2.54

Storm Data Source: User-provided custom storm data
Rainfall Distribution Type: NOAA_C
Dimensionless Unit Hydrograph: <standard>

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KAS

Quince Orchard
Trib 2
Montgomery NOAA_C County, Maryland

Watershed Peak Table

Sub-Area or Reach Identifier	2-Yr (cfs)	10-Yr (cfs)	100-Yr (cfs)	1-Yr (cfs)
SUBAREAS				
Total	24.35	50.05	106.97	16.76
REACHES				
OUTLET	24.35	50.05	106.97	16.76

(Peak Flow by Rainfall Return Period)

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KAS

Quince Orchard
Trib 2

Montgomery NOAA_C County, Maryland

Sub-Area Time of Concentration Details

Sub-Area Identifier/	Flow Length (ft)	Slope (ft/ft)	Mannings's n	End Area (sq ft)	Wetted Perimeter (ft)	Velocity (ft/sec)	Travel Time (hr)
Total							
SHEET	100	0.0200	0.240				0.243
SHALLOW	775	0.0320	0.050				0.075
CHANNEL	397					8.000	0.014
CHANNEL	534					3.500	0.042
					Time of Concentration		.374
							========

==

KAS

Quince Orchard
Trib 2
Montgomery NOAA_C County, Maryland

Sub-Area Land Use and Curve Number Details

Sub-Area Identifier	Land Use		Hydrologic Soil Group	Sub-Area Area (ac)	Curve Number
Total	Industrial		B	9.23	88
	Residential districts (1/4 acre)		B	11.27	75
	Woods	(good)	B	.15	55
	Woods	(good)	C	2.21	70
	Woods	(good)	D	.11	77
	Total Area / Weighted Curve Number			22.97	80
				=====	==

==

WinTR-55 Current Data Description

--- Identification Data ---

User: KAS Date: 2/12/2021
Project: Quince Orchard Units: English
SubTitle: Residual Watershed Areal Units: Acres
State: Maryland
County: Montgomery NOAA_C
Filename: G:\Active\2017-29 BCS 2015-05A Design-Construction, WRA\Task 25 CA-5 Phase II design\Hydrology\T

--- Sub-Area Data ---

Name	Description	Reach	Area(ac)	RCN	Tc
Residual		Outlet	66.1	79	.285

Total area: 66.10 (ac)

--- Storm Data --

Rainfall Depth by Rainfall Return Period

2-Yr (in)	5-Yr (in)	10-Yr (in)	25-Yr (in)	50-Yr (in)	100-Yr (in)	1-Yr (in)
3.07	3.99	4.71	5.97	7.03	8.13	2.54

Storm Data Source: User-provided custom storm data
Rainfall Distribution Type: NOAA_C
Dimensionless Unit Hydrograph: <standard>

==

KAS

Quince Orchard
Residual Watershed
Montgomery NOAA_C County, Maryland

Sub-Area Time of Concentration Details

Sub-Area Identifier/	Flow Length (ft)	Slope (ft/ft)	Mannings's n	End Area (sq ft)	Wetted Perimeter (ft)	Velocity (ft/sec)	Travel Time (hr)
Residual							
SHEET	40	0.0100	0.240				0.154
SHALLOW	255	0.1490	0.050				0.011
CHANNEL	2469	0.0217	0.035	14.00	16.00	5.715	0.120
					Time of Concentration		.285

==

WinTR-55 Current Data Description

--- Identification Data ---

User: KAS
Project:
SubTitle: CA-5 SD 2
State: Maryland
County: Montgomery NOAA_C
Filename: G:\Active\2017-29 BCS 2015-05A Design-Construction, WRA\Task 25 CA-5 Phase II design\Hydrology\T

Date: 9/23/2020
Units: English
Areal Units: Acres

--- Sub-Area Data ---

Name	Description	Reach	Area(ac)	RCN	Tc
SD 2		Outlet	3.65	75	.15

Total area: 3.65 (ac)

--- Storm Data --

Rainfall Depth by Rainfall Return Period

2-Yr (in)	5-Yr (in)	10-Yr (in)	25-Yr (in)	50-Yr (in)	100-Yr (in)	1-Yr (in)
3.07	3.99	4.71	5.97	7.03	8.13	2.54

Storm Data Source: User-provided custom storm data
Rainfall Distribution Type: NOAA_C
Dimensionless Unit Hydrograph: <standard>

==

KAS

CA-5 SD 2
Montgomery NOAA_C County, Maryland

Sub-Area Time of Concentration Details

Sub-Area Identifier/	Flow Length (ft)	Slope (ft/ft)	Mannings's n	End Area (sq ft)	Wetted Perimeter (ft)	Velocity (ft/sec)	Travel Time (hr)
SD 2							
SHEET	69	0.0250	0.150				0.113
SHALLOW	440	0.0600	0.025				0.025
CHANNEL	520	0.0210	0.011	3.14	6.28	12.037	0.012
						Time of Concentration	.15

==

WinTR-55 Current Data Description

--- Identification Data ---

User: KAS
Project: CA-5
SubTitle: Mainstem 2 Pond
State: Maryland
County: Montgomery NOAA_C
Filename: G:\Active\2017-29 BCS 2015-05A Design-Construction, WRA\Task 25 CA-5 Phase II design\Hydrology\T

Date: 2/15/2021
Units: English
Areal Units: Acres

--- Sub-Area Data ---

Name	Description	Reach	Area(ac)	RCN	Tc
Total		Outlet	225.1	77	.369

Total area: 225.10 (ac)

--- Storm Data --

Rainfall Depth by Rainfall Return Period

2-Yr (in)	5-Yr (in)	10-Yr (in)	25-Yr (in)	50-Yr (in)	100-Yr (in)	1-Yr (in)
3.07	3.99	4.71	5.97	7.03	8.88	2.54

Storm Data Source: User-provided custom storm data
Rainfall Distribution Type: NOAA_C
Dimensionless Unit Hydrograph: <standard>

==

KAS CA-5
Mainstem 2 Pond
Montgomery NOAA_C County, Maryland

Sub-Area Time of Concentration Details

Sub-Area Identifier/	Flow Length (ft)	Slope (ft/ft)	Mannings's n	End Area (sq ft)	Wetted Perimeter (ft)	Velocity (ft/sec)	Travel Time (hr)
Total							
SHEET	100	0.0355	0.011				0.016
SHALLOW	97	0.0355	0.025				0.007
CHANNEL	1205	0.0898	0.035	2.00	6.28	5.977	0.056
CHANNEL	3234	0.0196	0.035	6.00	16.00	3.098	0.290
					Time of Concentration		.369

==

WinTR-55 Current Data Description

--- Identification Data ---

User: KAS
Project: CA-5
SubTitle: Mainstem 2 Below Pond
State: Maryland
County: Montgomery NOAA_C
Filename: G:\Active\2017-29 BCS 2015-05A Design-Construction, WRA\Task 25 CA-5 Phase II design\Hydrology\T

Date: 2/15/2021
Units: English
Areal Units: Acres

--- Sub-Area Data ---

Name	Description	Reach	Area(ac)	RCN	Tc
Total		Outlet	37.3	70	.23

Total area: 37.30 (ac)

--- Storm Data --

Rainfall Depth by Rainfall Return Period

2-Yr (in)	5-Yr (in)	10-Yr (in)	25-Yr (in)	50-Yr (in)	100-Yr (in)	1-Yr (in)
3.07	3.99	4.71	5.97	7.03	8.88	2.54

Storm Data Source: User-provided custom storm data
Rainfall Distribution Type: NOAA_C
Dimensionless Unit Hydrograph: <standard>

==

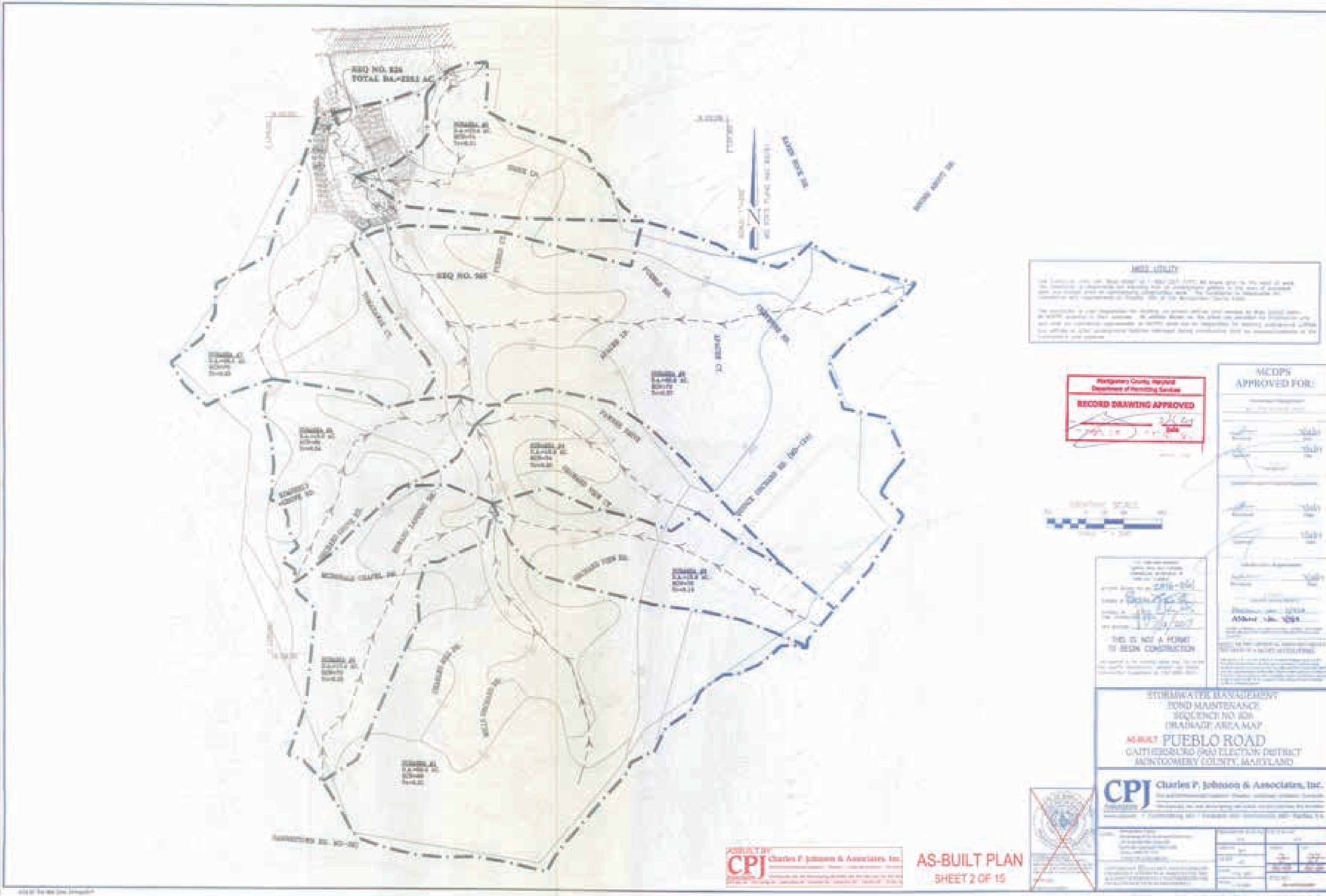
KAS

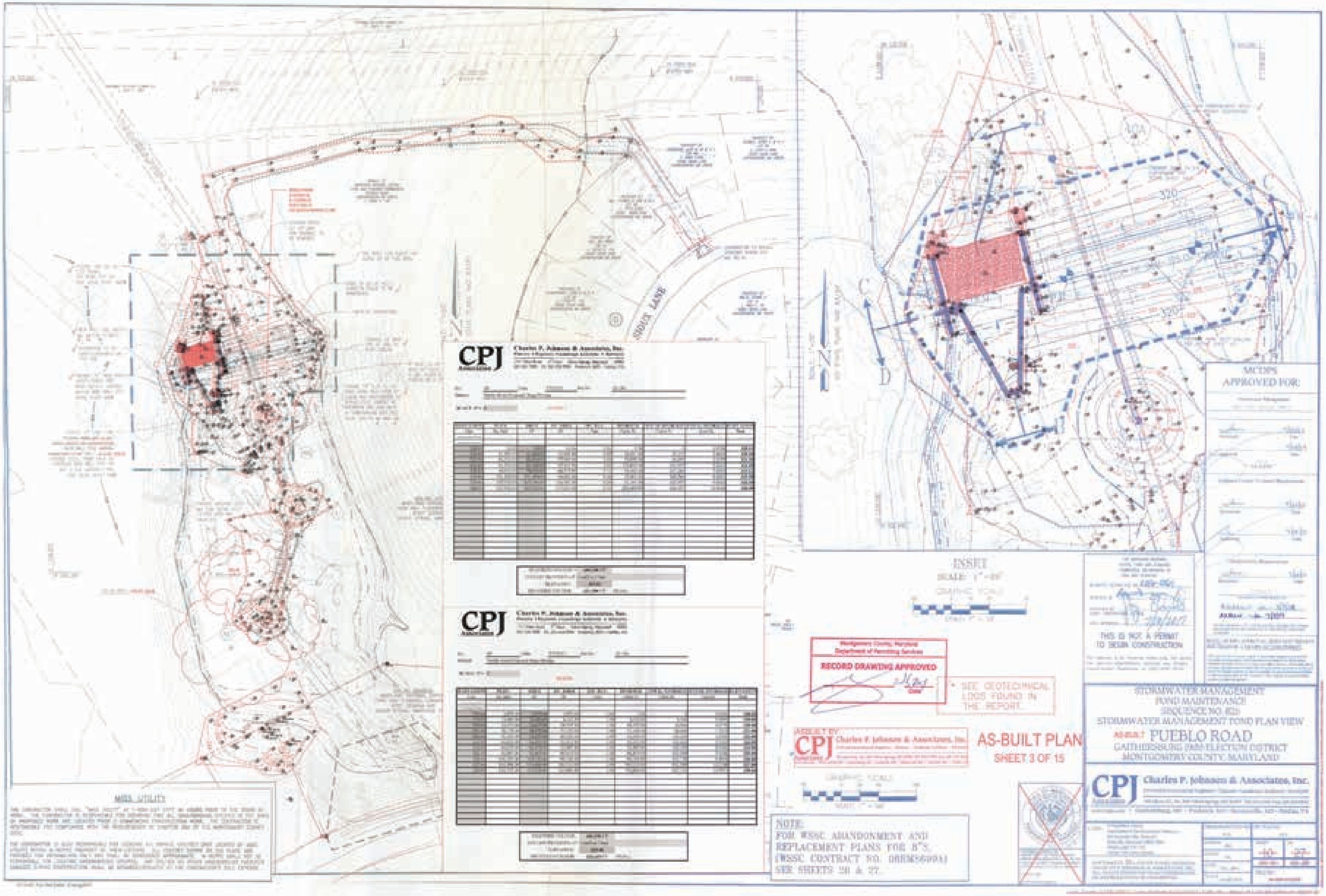
CA-5
Mainstem 2 Below Pond
Montgomery NOAA_C County, Maryland

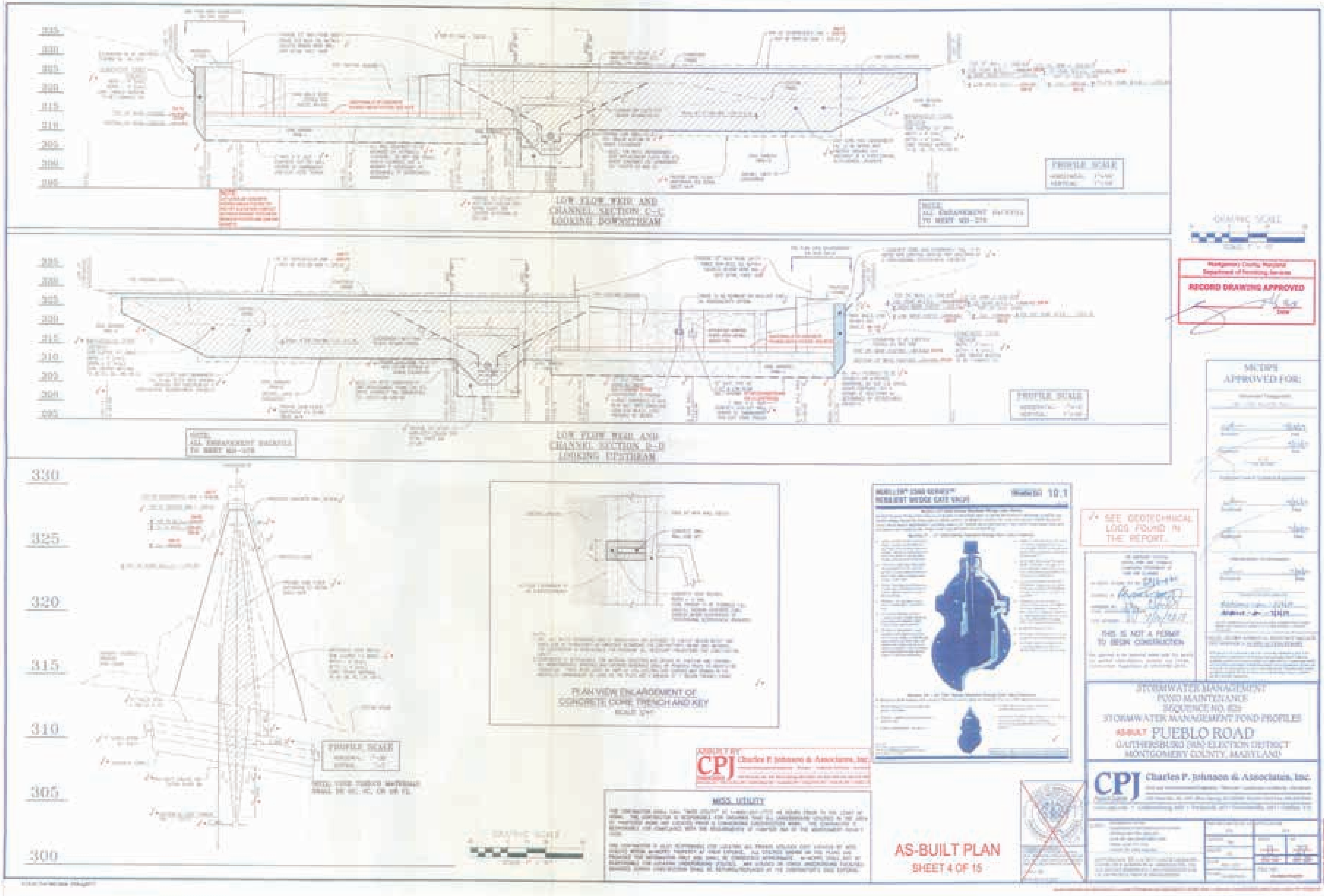
Sub-Area Time of Concentration Details

Sub-Area Identifier/	Flow Length (ft)	Slope (ft/ft)	Mannings's n	End Area (sq ft)	Wetted Perimeter (ft)	Velocity (ft/sec)	Travel Time (hr)
Total							
SHEET	90	0.0222	0.011				0.018
SHALLOW	339	0.0050	0.050				0.083
CHANNEL	759	0.0817	0.035	10.00	40.00	4.792	0.044
CHANNEL	796	0.0239	0.035	10.00	40.00	2.601	0.085
					Time of Concentration		.23

==


SEQ NO. 826
SEQ NO. 165
MISS UTILITY
Montgomery County, Maryland
Department of Permitting Services
RECORD DRAWING APPROVED
MCDPS
APPROVED FOR:
THIS IS NOT A PERMIT
TO BEGIN CONSTRUCTION
STORMWATER MANAGEMENT
POND MAINTENANCE
SEQUENCE NO. 826
DRAINAGE AREA MAP
AS-BUILT PUEBLO ROAD
GAITHERSBURG (9th) ELECTION DISTRICT
MONTGOMERY COUNTY, MARYLAND
CPJ
Charles P. Johnson & Associates, Inc.
AS-BUILT PLAN
SHEET 2 OF 15


MISS UTILITY
CPJ Charles P. Johnson & Associates, Inc.
MCDPS APPROVED FOR:
INSET
SCALE: 1"=20'
GRAPHIC SCALE
THIS IS NOT A PERMIT TO BEGIN CONSTRUCTION
Montgomery County, Maryland
Department of Permitting Services
RECORD DRAWING APPROVED
* SEE GEOTECHNICAL LOGS FOUND IN THE REPORT.
AS-BUILT BY
AS-BUILT PLAN
SHEET 3 OF 15
STORMWATER MANAGEMENT
POND MAINTENANCE
SEQUENCE NO. 8(2)
STORMWATER MANAGEMENT POND PLAN VIEW
AS-BUILT PUEBLO ROAD
GAITHERSBURG (9TH) ELECTION DISTRICT
MONTGOMERY COUNTY, MARYLAND
NOTE:
FOR WSSC ABANDONMENT AND REPLACEMENT PLANS FOR 8"S, (WSSC CONTRACT NO. 0REM5609A) SEE SHEETS 26 & 27.



LOW FLOW WEIR AND CHANNEL SECTION C-C LOOKING DOWNSTREAM
PROFILE SCALE
NOTE: ALL EMBANKMENT BACKFILL TO MEET MD-378
GRAPHIC SCALE
Montgomery County, Maryland Department of Permitting Services
RECORD DRAWING APPROVED
LOW FLOW WEIR AND CHANNEL SECTION D-D LOOKING UPSTREAM
PROFILE SCALE
NOTE: ALL EMBANKMENT BACKFILL TO MEET MD-378
MCDPS APPROVED FOR:
330
325
320
315
310
305
300
PLAN VIEW ENLARGEMENT OF CONCRETE CORE TRENCH AND KEY
PROFILE SCALE
GRAPHIC SCALE
MUELLER 2360 SERIES RESILIENT WEDGE GATE VALVE
10.1
SEE GEOTECHNICAL LOGS FOUND IN THE REPORT.
THIS IS NOT A PERMIT TO BEGIN CONSTRUCTION
CPJ Charles P. Johnson & Associates, Inc.
MISS UTILITY
AS-BUILT PLAN
SHEET 4 OF 15
STORMWATER MANAGEMENT
POND MAINTENANCE
SEQUENCE NO. 825
STORMWATER MANAGEMENT POND PROFILES
AS-BUILT PUEBLO ROAD
GAITHERSBURG (9th) ELECTION DISTRICT
MONTGOMERY COUNTY, MARYLAND
CPJ Charles P. Johnson & Associates, Inc.

USDA United States Department of Agriculture
Natural Resources Conservation Service

Report Generated 12/07/2020
EFT Version 4.0.2.6

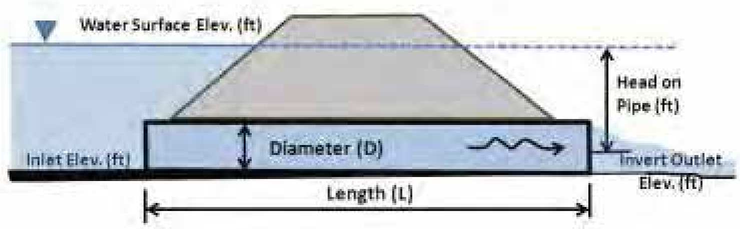
Pressure Flow

Project Name: CA-5 Low Flow Orifice 7.75
Project Description: _________________

Location: _________________
Practice: _________________

Designed by: _________________
Checked by: _________________
Approved by: _________________

Date:____________
Date:____________
Date: ____________



$$Q = A\sqrt{\frac{2\,g\,H}{1+Ke+Kb+KpL}}$$

$$Kp = \frac{5087\,n^2}{d^{4/3}}$$

Inputs

Water surface elevation : 328.00 ft
Invert outlet elevation : 317.99 ft
Diameter of pipe : 7.75 in
Length of pipe : 2.50 ft
Manning's Coefficient (n) : 0.011
Entrance Coefficient (Ke) : 0.20
Bend Coefficient (Kb) : 0.00

Outputs

Flow Q : 7.17 cfs
Velocity : 21.89 ft/sec
Friction Coefficient (Kp) : 0.040
Max allowable fall in pipe when outlet is not submerged : 0.75 ft

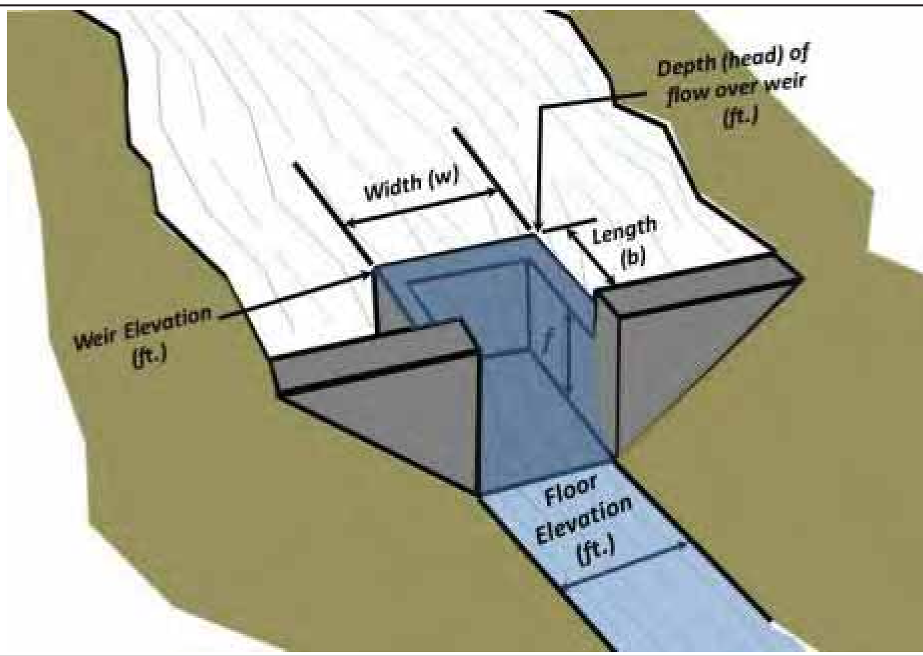
United States Department of Agriculture
Natural Resources Conservation Service

Report Generated 12/07/2020
EFT Version4.0.2.6

Box Drop Inlet

Project Name: CA5 SWM Weir
Project Description: _________________
Designed by: _________________
Date:____________

Location: _________________
Practice: _________________
Checked by: _________________
Date:____________



Inputs

Width of Weir : 5.00 ft
Length of Weir : 50.00 ft
Head on Weir : 10.00 ft
Weir Elevation : 325.12 ft
Floor Elevation : 318.00 ft

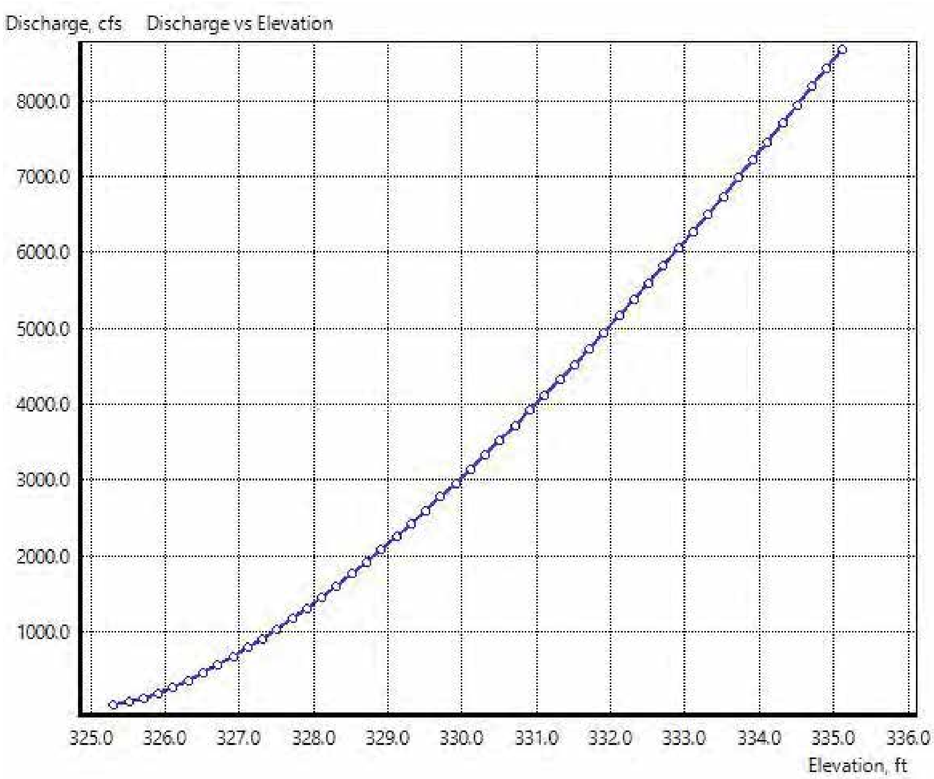
Outputs

Flow Q : 8681.13 cfs
Min Channel Width : 195.00 ft
Top Elevation : 335.12 ft

United States Department of Agriculture
Natural Resources Conservation Service

Report Generated 12/07/2020
EFT Version4.0.2.6

Box Drop Inlet



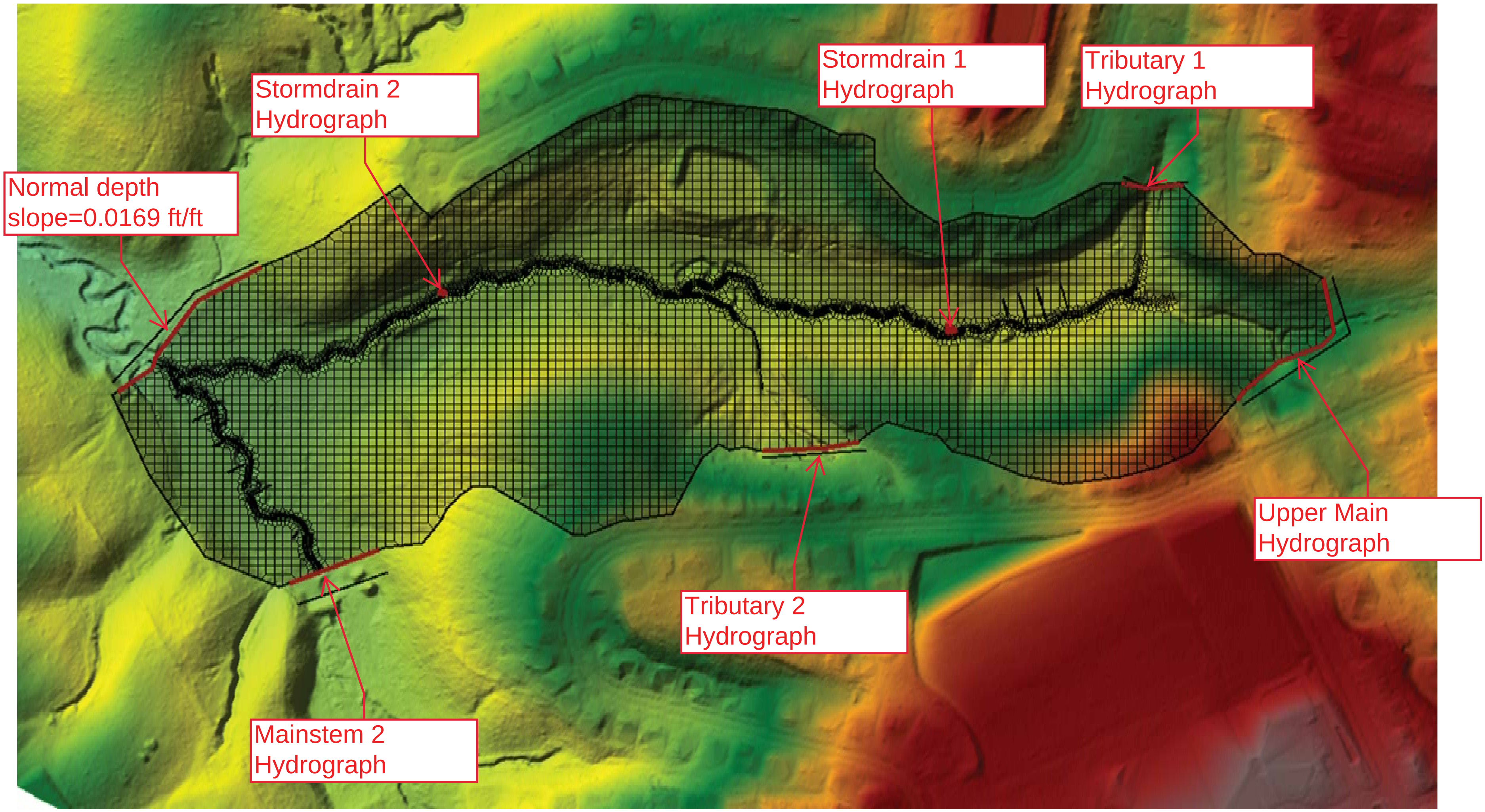
Stage, ft	Discharge, cfs
325.32	18.48
325.52	58.99
325.72	114.69
325.92	182.67
326.12	261.15
326.32	348.90
326.52	444.99
326.72	548.71
326.92	659.48
327.12	776.80
327.32	900.27
327.52	1029.53
327.72	1164.27
327.92	1304.23
328.12	1449.15
328.32	1598.82
328.52	1753.05
328.72	1911.65
328.92	2074.47
329.12	2241.35
329.32	2412.15
329.52	2586.75
329.72	2765.03
329.92	2946.88
330.12	3132.19
330.32	3320.87
330.52	3512.83
330.72	3707.98
330.92	3906.24
331.12	4107.54
331.32	4311.80
331.52	4518.96
331.72	4728.95
331.92	4941.70

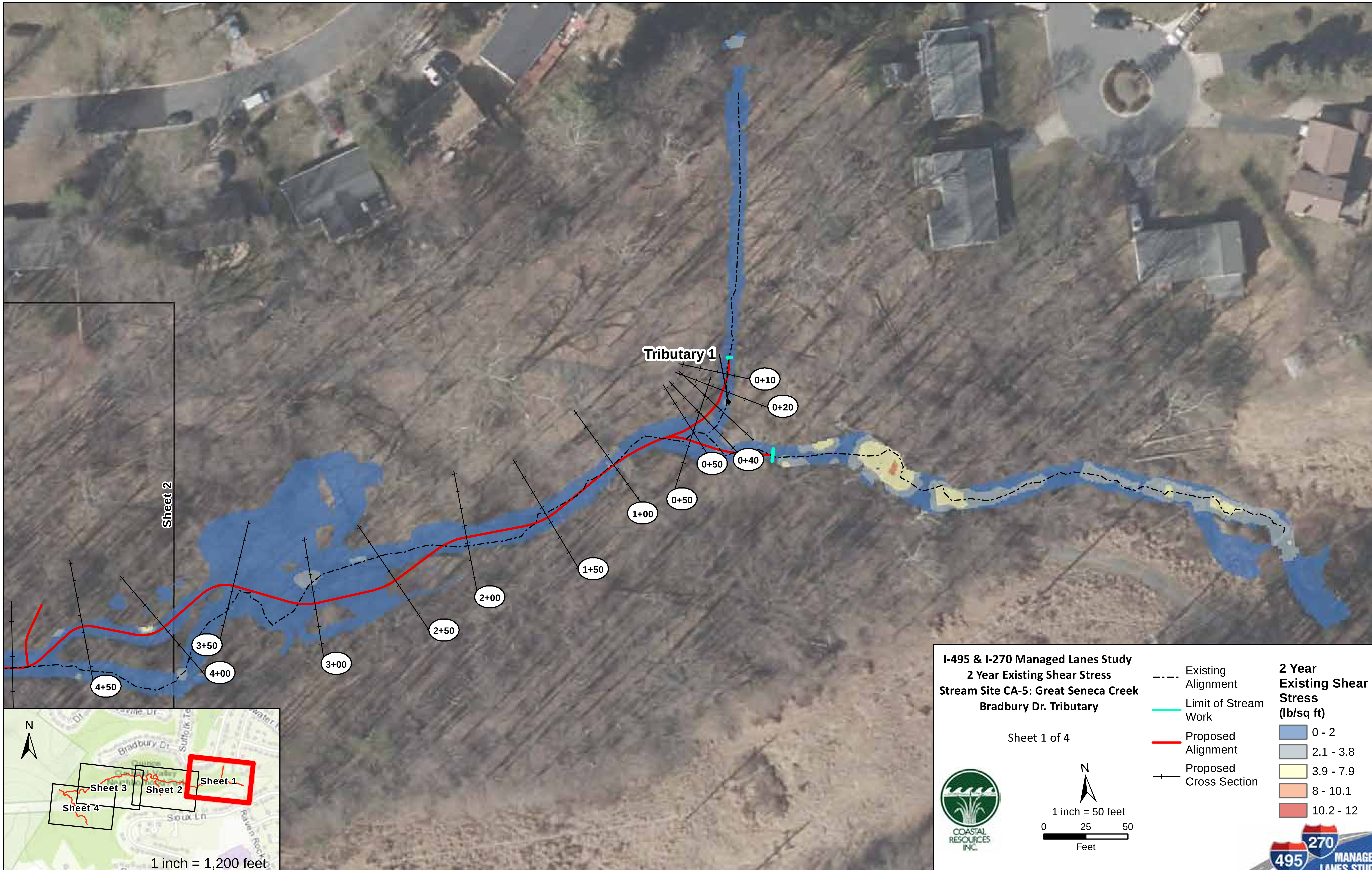
CA-5 Trib to Seneca Stormwater Management Pond Stage Storage Discharge

elev	vol ac-ft	Head, ft	7.75" orifice	weir	total				
318.3	0	0	0						
320	0.464	2.022917	2.23						
322	2.2059	4.022917	3.15						
324	5.3241	6.022917	3.86						
325.12	7.6052	7.142917	4.35	0	4.350		low weir crest		5-7 feet
325.5	8.4661	7.522917	4.59	86.93	91.520		high weir crest		angled up 50' on both sides and 5' perpendicular
									110' total approximately
326	9.6643	8.022917	4.47	261.4	265.870				
							100 yr WSE		326.95
328	15.0605	10.02292	4.99	1450.63	1455.620				

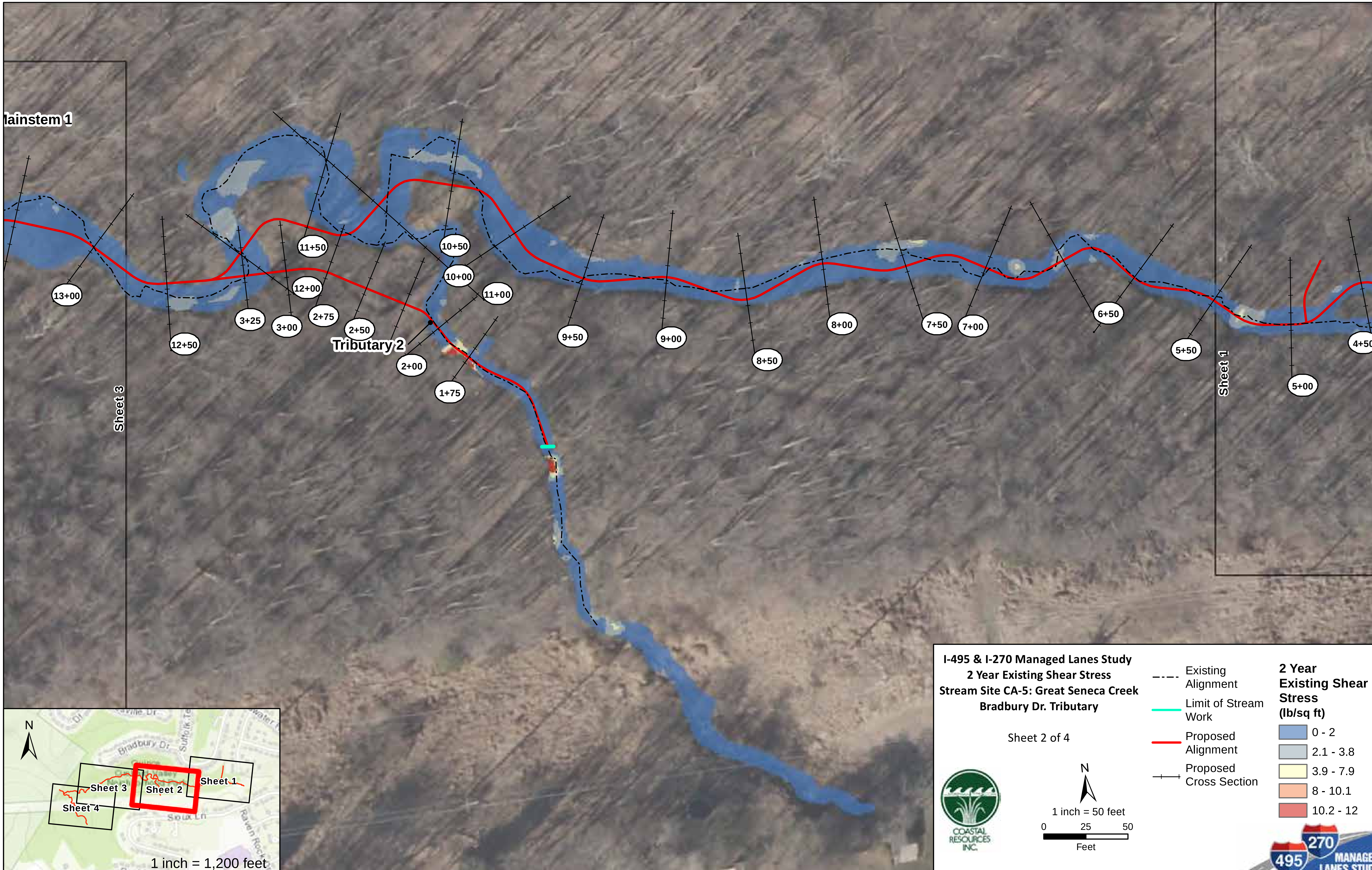
APPENDIX D.2 HECRAS ANALYSIS

HEC RAS Geometry Schematic

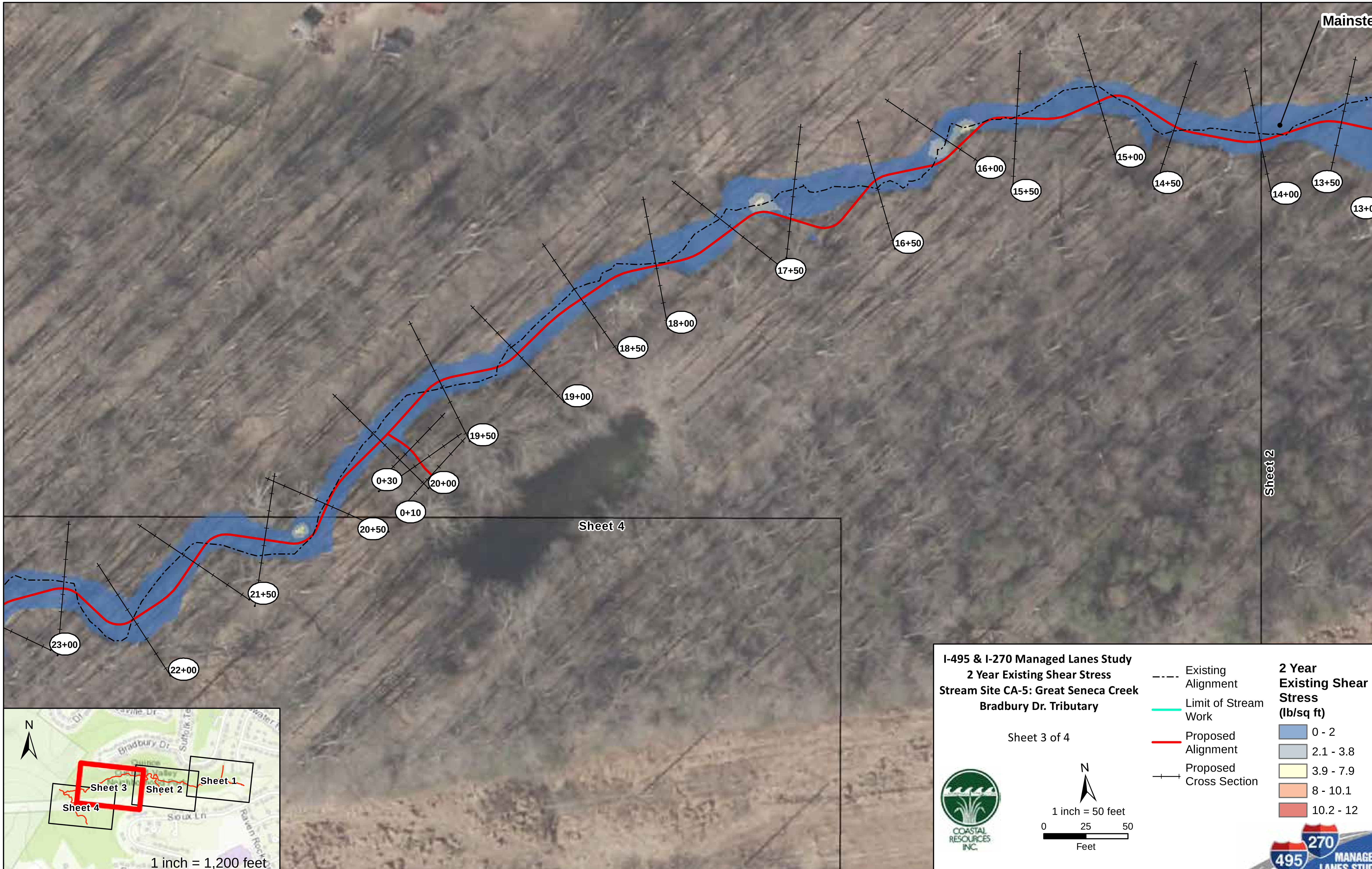




Tributary 1
0+10
0+20
0+40
0+50
0+50
1+00
1+50
2+00
2+50
3+00
3+50
4+00
4+50
Sheet 2
N
Bradbury Dr
Sheet 1
Sheet 2
Sheet 3
Sheet 4
Sioux Ln
1 inch = 1,200 feet
I-495 & I-270 Managed Lanes Study
2 Year Existing Shear Stress
Stream Site CA-5: Great Seneca Creek
Bradbury Dr. Tributary
Sheet 1 of 4
COASTAL RESOURCES INC.
N
1 inch = 50 feet
0 25 50
Feet
Existing Alignment
Limit of Stream Work
Proposed Alignment
Proposed Cross Section
2 Year Existing Shear Stress (lb/sq ft)
0 - 2
2.1 - 3.8
3.9 - 7.9
8 - 10.1
10.2 - 12
270
495
MANAGED LANES STUDY



I-495 & I-270 Managed Lanes Study
2 Year Existing Shear Stress
Stream Site CA-5: Great Seneca Creek
Bradbury Dr. Tributary
Sheet 2 of 4
Existing Alignment
Limit of Stream Work
Proposed Alignment
Proposed Cross Section
2 Year Existing Shear Stress (lb/sq ft)
0 - 2
2.1 - 3.8
3.9 - 7.9
8 - 10.1
10.2 - 12
1 inch = 50 feet
0 25 50
Feet
1 inch = 1,200 feet
Mainstem 1
Tributary 2
Sheet 1
Sheet 2
Sheet 3
Sheet 4
13+00
12+50
12+00
11+50
11+00
10+50
10+00
9+50
9+00
8+50
8+00
7+50
7+00
6+50
5+50
5+00
4+50
3+25
3+00
2+75
2+50
2+00
1+75
COASTAL RESOURCES INC.
495
270
MANAGED LANES STUDY



I-495 & I-270 Managed Lanes Study
2 Year Existing Shear Stress
Stream Site CA-5: Great Seneca Creek
Bradbury Dr. Tributary

Sheet 3 of 4

COASTAL RESOURCES INC.

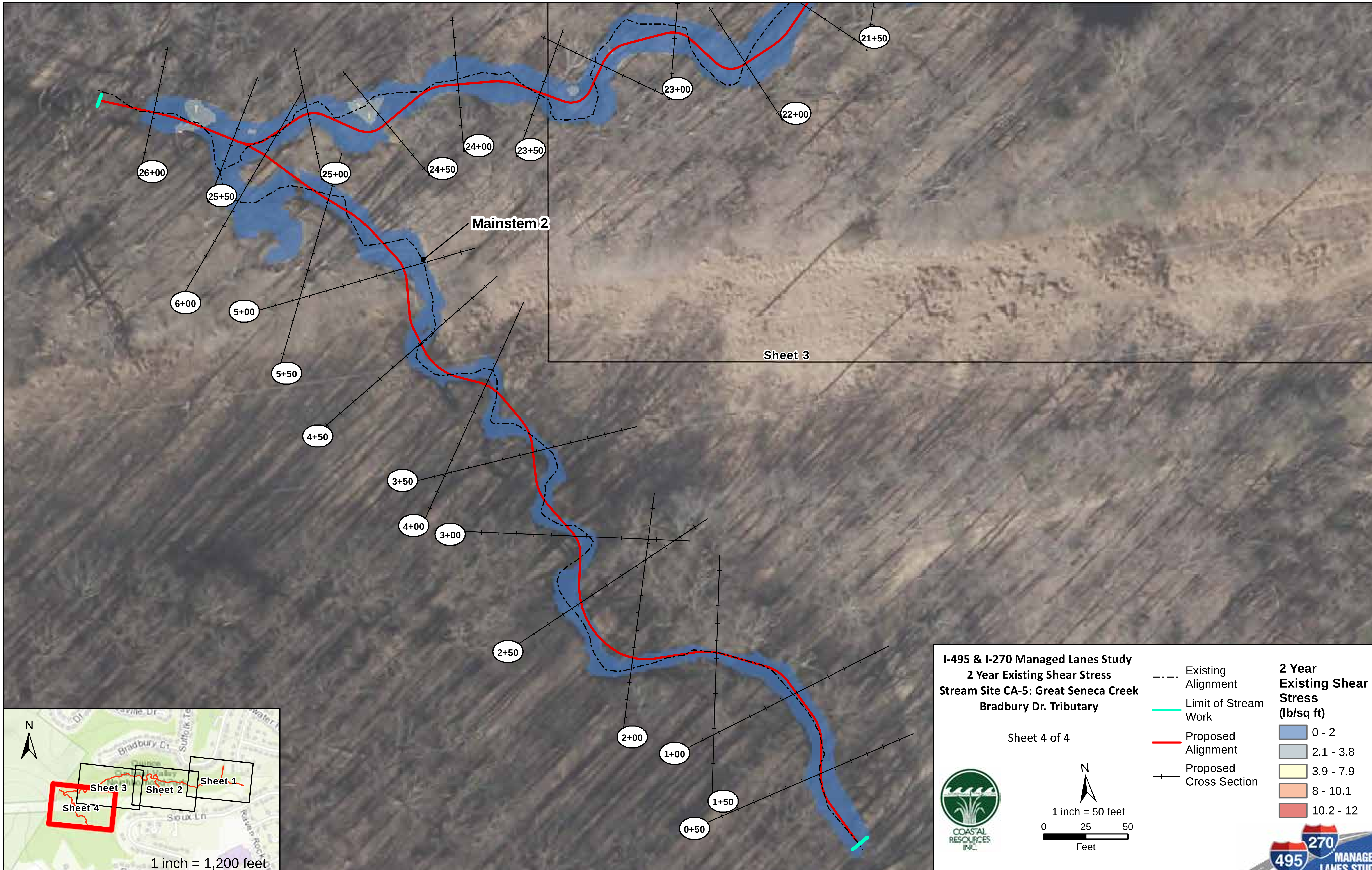
N
1 inch = 50 feet
0 25 50
Feet

Existing Alignment
Limit of Stream Work
Proposed Alignment
Proposed Cross Section

2 Year Existing Shear Stress (lb/sq ft)

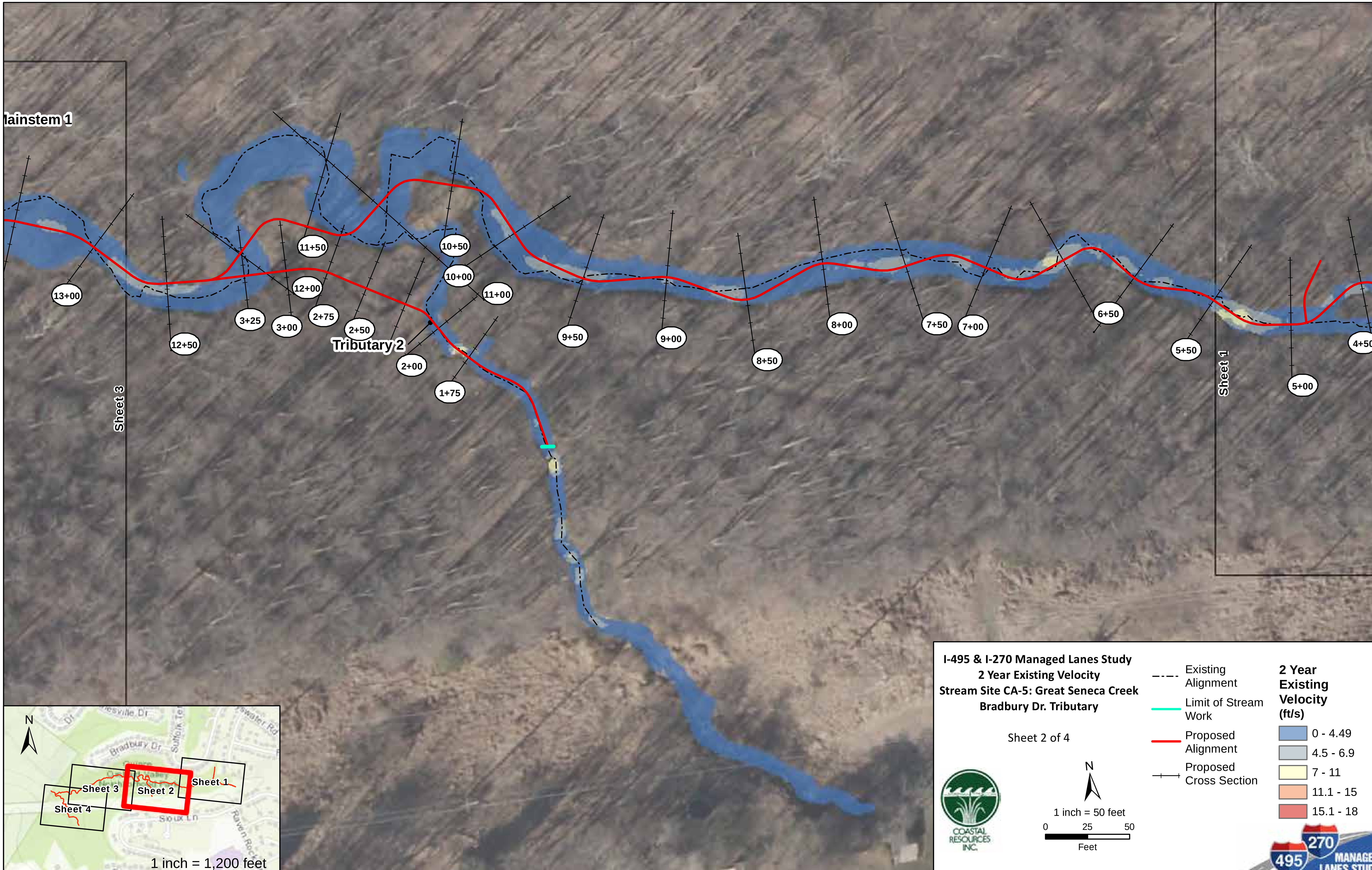
- 0 - 2
- 2.1 - 3.8
- 3.9 - 7.9
- 8 - 10.1
- 10.2 - 12

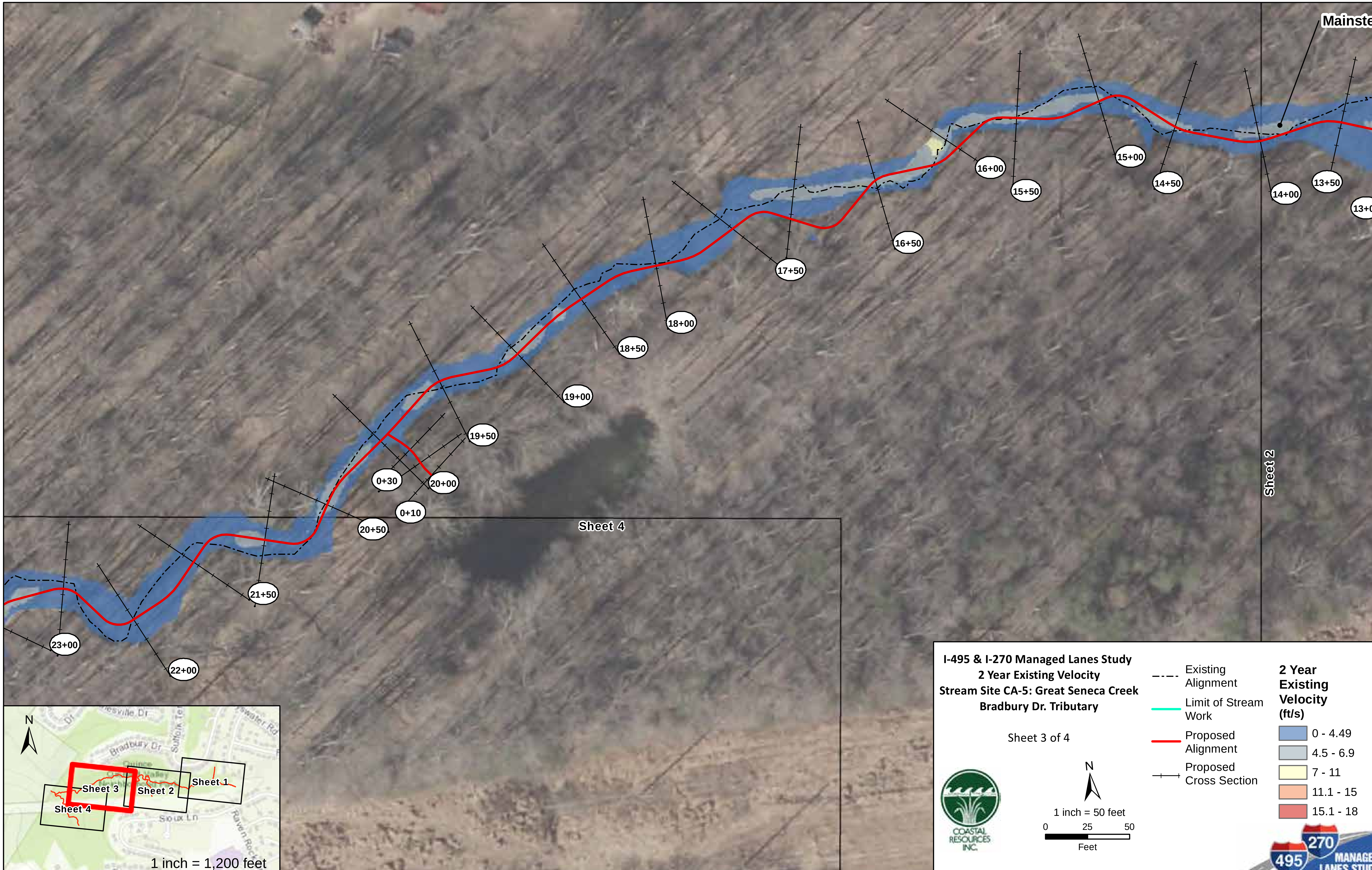
495 270 MANAGED LANES STUDY

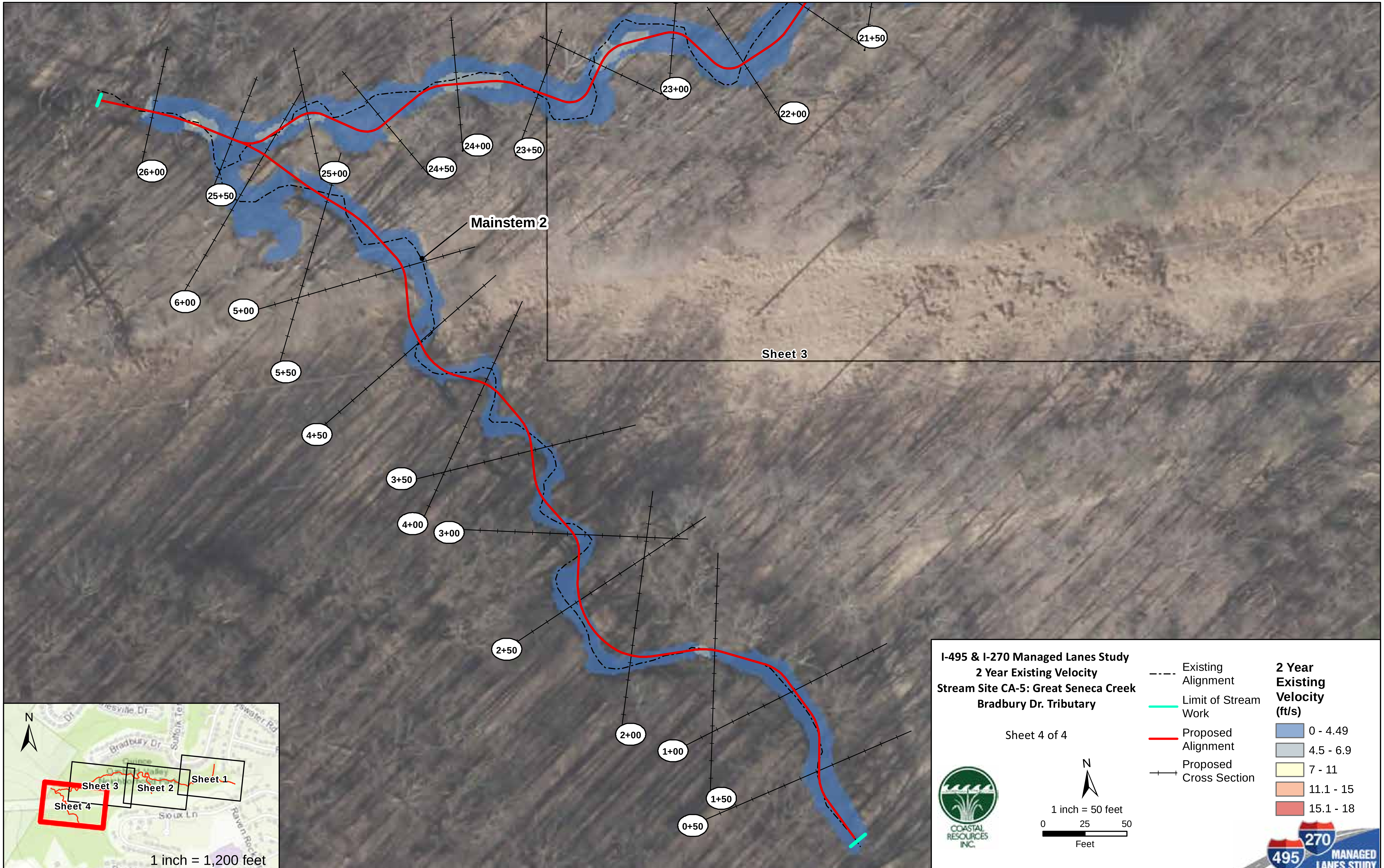


21+50
22+00
23+00
23+50
24+00
24+50
25+00
25+50
26+00
Mainstem 2
6+00
5+00
5+50
4+50
3+50
4+00
3+00
2+50
2+00
1+00
1+50
0+50
Sheet 3
Sheet 3
Sheet 2
Sheet 1
Sheet 4
Bradbury Dr
Sioux Ln
1 inch = 1,200 feet
I-495 & I-270 Managed Lanes Study
2 Year Existing Shear Stress
Stream Site CA-5: Great Seneca Creek
Bradbury Dr. Tributary
Sheet 4 of 4
1 inch = 50 feet
0 25 50
Feet
COASTAL RESOURCES INC.
Existing Alignment
Limit of Stream Work
Proposed Alignment
Proposed Cross Section
2 Year Existing Shear Stress (lb/sq ft)
0 - 2
2.1 - 3.8
3.9 - 7.9
8 - 10.1
10.2 - 12
495
270
MANAGED LANES STUDY


Tributary 1
0+10
0+20
0+40
0+50
0+50
1+00
1+50
2+00
2+50
3+00
3+50
4+00
4+50
Sheet 2
N
Bradbury Dr
Sheet 1
Sheet 2
Sheet 3
Sheet 4
Sioux Ln
1 inch = 1,200 feet
I-495 & I-270 Managed Lanes Study
2 Year Existing Velocity
Stream Site CA-5: Great Seneca Creek
Bradbury Dr. Tributary
Sheet 1 of 4
COASTAL RESOURCES INC.
N
1 inch = 50 feet
0 25 50
Feet
Existing Alignment
Limit of Stream Work
Proposed Alignment
Proposed Cross Section
2 Year Existing Velocity (ft/s)
0 - 4.49
4.5 - 6.9
7 - 11
11.1 - 15
15.1 - 18
270
495
MANAGED LANES STUDY


I-495 & I-270 Managed Lanes Study
2 Year Existing Velocity
Stream Site CA-5: Great Seneca Creek
Bradbury Dr. Tributary
Sheet 2 of 4
Existing Alignment
Limit of Stream Work
Proposed Alignment
Proposed Cross Section
2 Year Existing Velocity (ft/s)
0 - 4.49
4.5 - 6.9
7 - 11
11.1 - 15
15.1 - 18
N
1 inch = 50 feet
0
25
50
Feet
COASTAL RESOURCES INC.
270
495
MANAGED LANES STUDY
Mainstem 1
Tributary 2
Sheet 3
Sheet 1
13+00
12+50
12+00
11+50
11+00
10+50
10+00
9+50
9+00
8+50
8+00
7+50
7+00
6+50
5+50
5+00
4+50
3+25
3+00
2+75
2+50
2+00
1+75
Sheet 1
Sheet 2
Sheet 3
Sheet 4
Bradbury Dr
Suffolk Ter
Sioux Ln
Raven Rock
Pueblo Rd
1 inch = 1,200 feet


Mainstem
13+00
13+50
14+00
14+50
15+00
15+50
16+00
16+50
17+50
18+00
18+50
19+00
19+50
20+00
20+50
21+50
22+00
23+00
0+10
0+30
Sheet 2
Sheet 4
I-495 & I-270 Managed Lanes Study
2 Year Existing Velocity
Stream Site CA-5: Great Seneca Creek
Bradbury Dr. Tributary
Sheet 3 of 4
Existing Alignment
Limit of Stream Work
Proposed Alignment
Proposed Cross Section
2 Year Existing Velocity (ft/s)
0 - 4.49
4.5 - 6.9
7 - 11
11.1 - 15
15.1 - 18
N
1 inch = 50 feet
0
25
50
Feet
COASTAL RESOURCES INC.
495
270
MANAGED LANES STUDY
Bradbury Dr
Sheet 1
Sheet 2
Sheet 3
Sheet 4
Sioux Ln
1 inch = 1,200 feet



I-495 & I-270 Managed Lanes Study
2 Year Existing Velocity
Stream Site CA-5: Great Seneca Creek
Bradbury Dr. Tributary
Sheet 4 of 4
N
1 inch = 50 feet
0 25 50
Feet
Existing Alignment
Limit of Stream Work
Proposed Alignment
Proposed Cross Section
2 Year Existing Velocity (ft/s)
0 - 4.49
4.5 - 6.9
7 - 11
11.1 - 15
15.1 - 18
COASTAL RESOURCES INC.
495 270 MANAGED LANES STUDY
Mainstem 2
Sheet 3
26+00
25+50
25+00
24+50
24+00
23+50
23+00
22+00
21+50
6+00
5+00
5+50
4+50
3+50
4+00
3+00
2+50
2+00
1+00
1+50
0+50
N
Sheet 3
Sheet 2
Sheet 1
Sheet 4
Bradbury Dr
Sioux Ln
1 inch = 1,200 feet

Tributary 1
0+10
0+20
0+40
0+50
0+50
1+00
1+50
2+00
2+50
3+00
3+50
4+00
4+50
Sheet 2
Sheet 1
Sheet 2
Sheet 3
Sheet 4
N
1 inch = 1,200 feet
I-495 & I-270 Managed Lanes Study
2 Year Proposed Shear Stress
Stream Site CA-5: Great Seneca Creek
Bradbury Dr. Tributary
Sheet 1 of 4
Legend
Limit of Stream Work
Proposed Alignment
Proposed Cross Sections
Structures
Proposed Stream Structure
Proposed Toe Wood
Proposed Stone Toe
Proposed Rock Pack
Proposed Riffle Grade Control
2 Year Proposed Shear Stress (lb/sq ft)
0 - 2
2.1 - 3.8
3.9 - 7.9
8 - 10.1
10.2 - 12
N
1 inch = 50 feet
0
25
50
Feet
COASTAL RESOURCES INC.
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MANAGED LANES STUDY


I-495 & I-270 Managed Lanes Study
2 Year Proposed Shear Stress
Stream Site CA-5: Great Seneca Creek
Bradbury Dr. Tributary
Sheet 2 of 4
Legend
Limit of Stream Work
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Proposed Rock Pack
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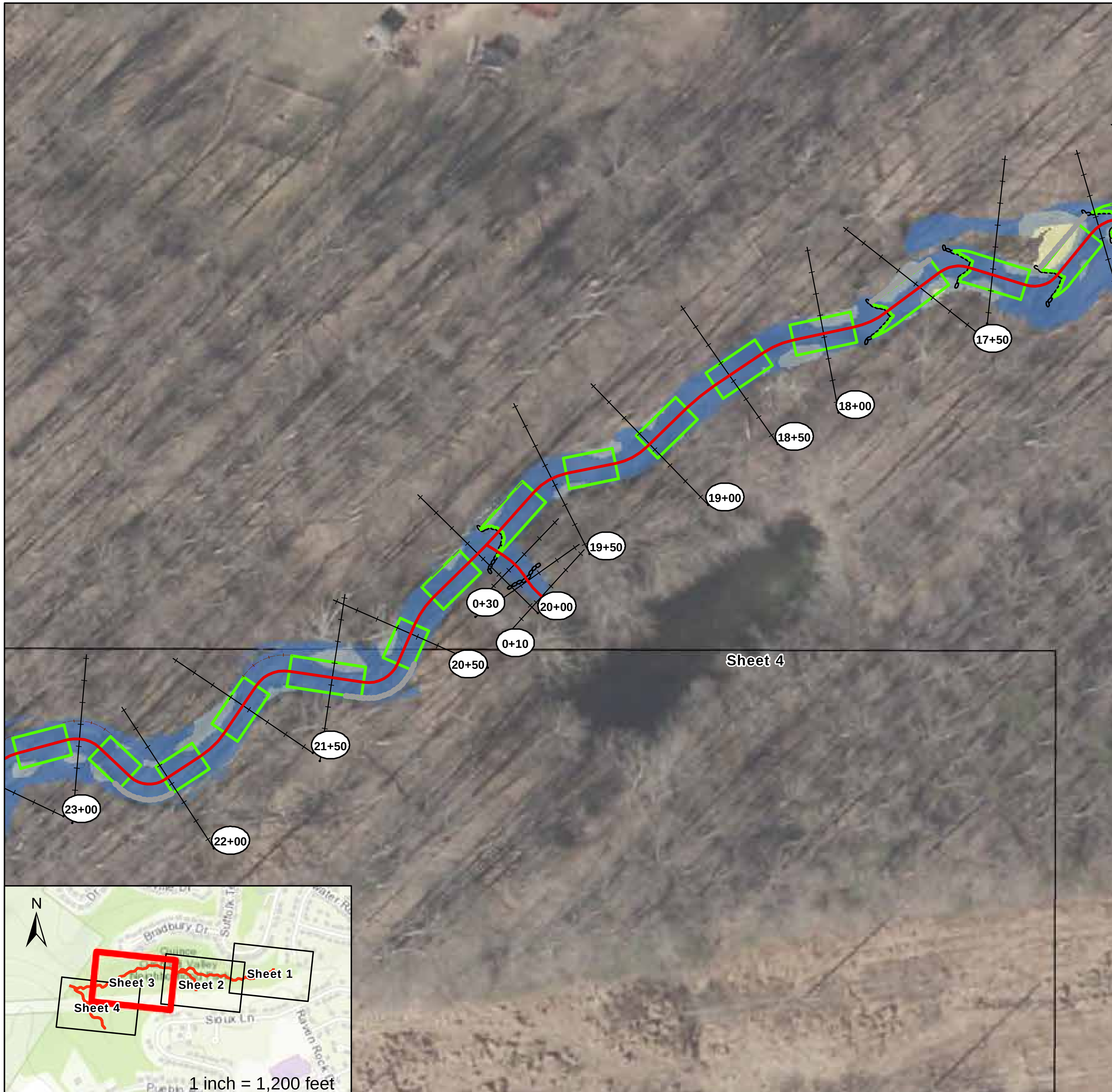
2 Year Proposed Shear Stress (lb/sq ft)
0 - 2
2.1 - 3.8
3.9 - 7.9
8 - 10.1
10.2 - 12
N
1 inch = 50 feet
0
25
50
Feet
COASTAL RESOURCES INC.
495
270
MANAGED LANES STUDY
stem 1
Tributary 2
Sheet 3
Sheet 1
13+00
12+50
12+00
11+50
11+00
10+50
10+00
9+50
9+00
8+50
8+00
7+50
7+00
6+50
5+50
5+00
4+50
3+25
3+00
2+75
2+50
2+25
1+75
N
Bradbury Dr
Sheet 1
Sheet 2
Sheet 3
Sheet 4
Sioux Ln
1 inch = 1,200 feet



I-495 & I-270 Managed Lanes Study
2 Year Proposed Shear Stress
Stream Site CA-5: Great Seneca Creek
Bradbury Dr. Tributary

Sheet 3 of 4

N
1 inch = 50 feet
0 25 50
Feet

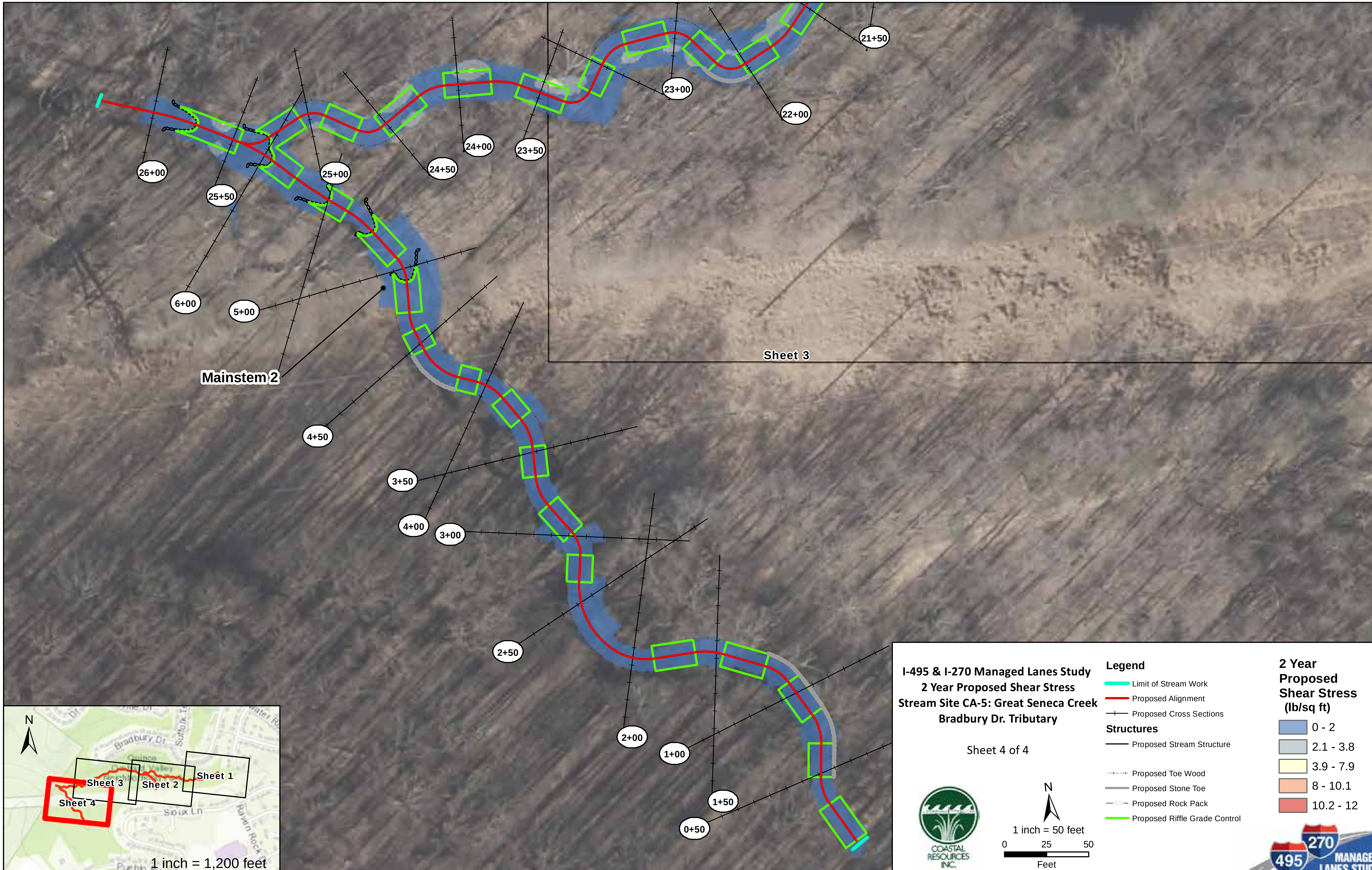
COASTAL RESOURCES INC.

Legend
- Limit of Stream Work
- Proposed Alignment
- Proposed Cross Sections

Structures
- Proposed Stream Structure
- Proposed Toe Wood
- Proposed Stone Toe
- Proposed Rock Pack
- Proposed Riffle Grade Control

2 Year Proposed Shear Stress (lb/sq ft)
- 0 - 2
- 2.1 - 3.8
- 3.9 - 7.9
- 8 - 10.1
- 10.2 - 12

495 270 MANAGED LANES STUDY



I-495 & I-270 Managed Lanes Study
2 Year Proposed Shear Stress
Stream Site CA-5: Great Seneca Creek
Bradbury Dr. Tributary
Sheet 4 of 4
Legend
Limit of Stream Work
Proposed Alignment
Proposed Cross Sections
Structures
Proposed Stream Structure
Proposed Toe Wood
Proposed Stone Toe
Proposed Rock Pack
Proposed Riffle Grade Control
2 Year Proposed Shear Stress (lb/sq ft)
0 - 2
2.1 - 3.8
3.9 - 7.9
8 - 10.1
10.2 - 12
N
1 inch = 50 feet
0
25
50
Feet
COASTAL RESOURCES INC.
495
270
MANAGED LANES STUDY
Sheet 3
Mainstem 2
0+50
1+00
1+50
2+00
2+50
3+00
3+50
4+00
4+50
5+00
6+00
21+50
22+00
23+00
23+50
24+00
24+50
25+00
25+50
26+00
N
Sheet 1
Sheet 2
Sheet 3
Sheet 4
Bradbury Dr
Sioux Ln
1 inch = 1,200 feet


Tributary 1
0+10
0+20
0+40
0+50
0+50
1+00
1+50
2+00
2+50
3+00
3+50
4+00
4+50
Sheet 2
N
Bradbury Dr
Sheet 1
Sheet 2
Sheet 3
Sheet 4
Sioux Ln
1 inch = 1,200 feet
I-495 & I-270 Managed Lanes Study
2 Year Proposed Velocity
Stream Site CA-5: Great Seneca Creek
Bradbury Dr. Tributary
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Proposed Rock Pack
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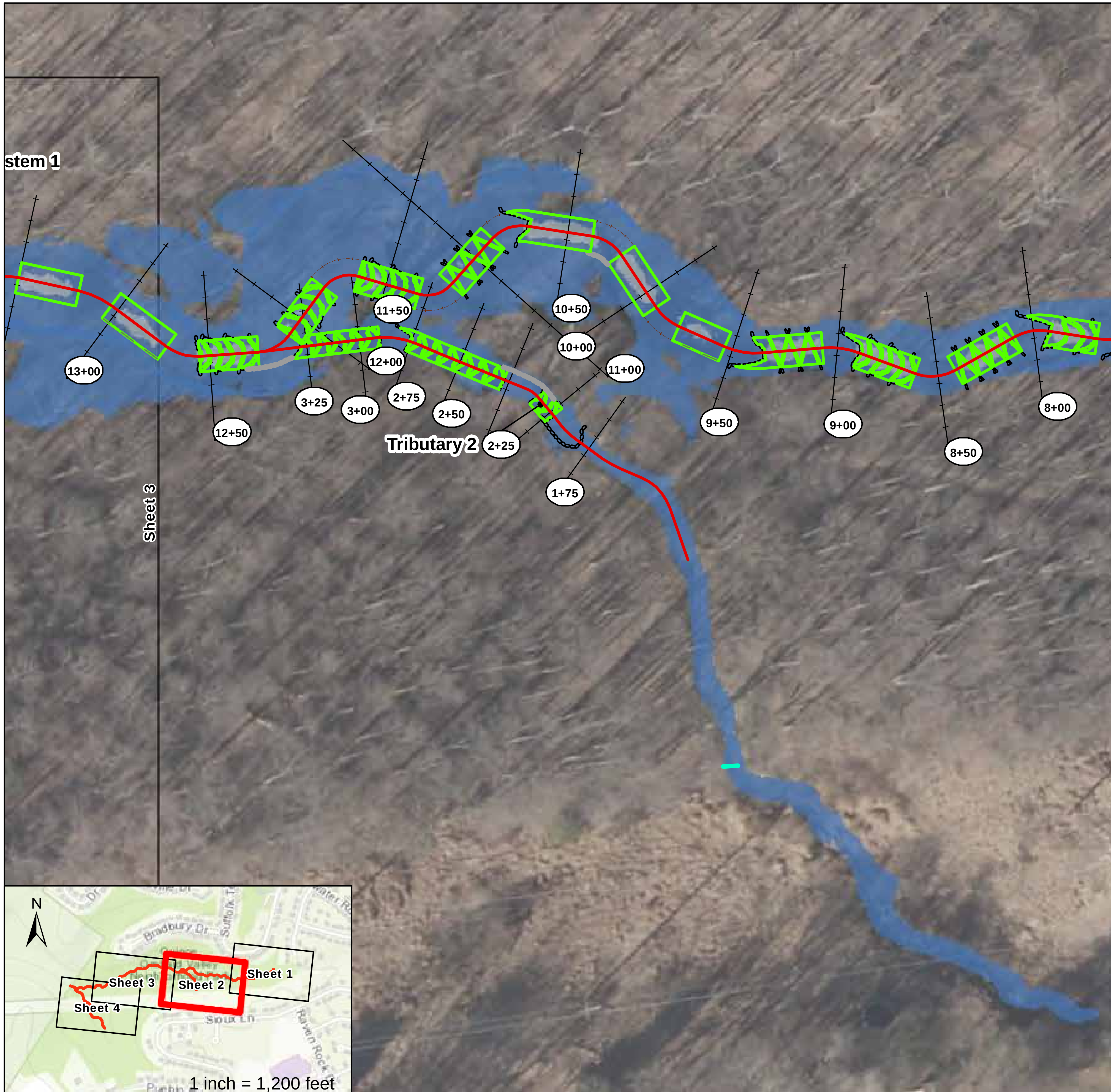
0 - 4.49
4.5 - 6.9
7 - 11
11.1 - 15
15.1 - 18
N
1 inch = 50 feet
0
25
50
Feet
COASTAL RESOURCES INC.
495
270
MANAGED LANES STUDY



I-495 & I-270 Managed Lanes Study
2 Year Proposed Velocity
Stream Site CA-5: Great Seneca Creek
Bradbury Dr. Tributary

Sheet 2 of 4

N

1 inch = 50 feet

0 25 50

Feet

Legend

- Limit of Stream Work
- Proposed Alignment
- Proposed Cross Section

Structures

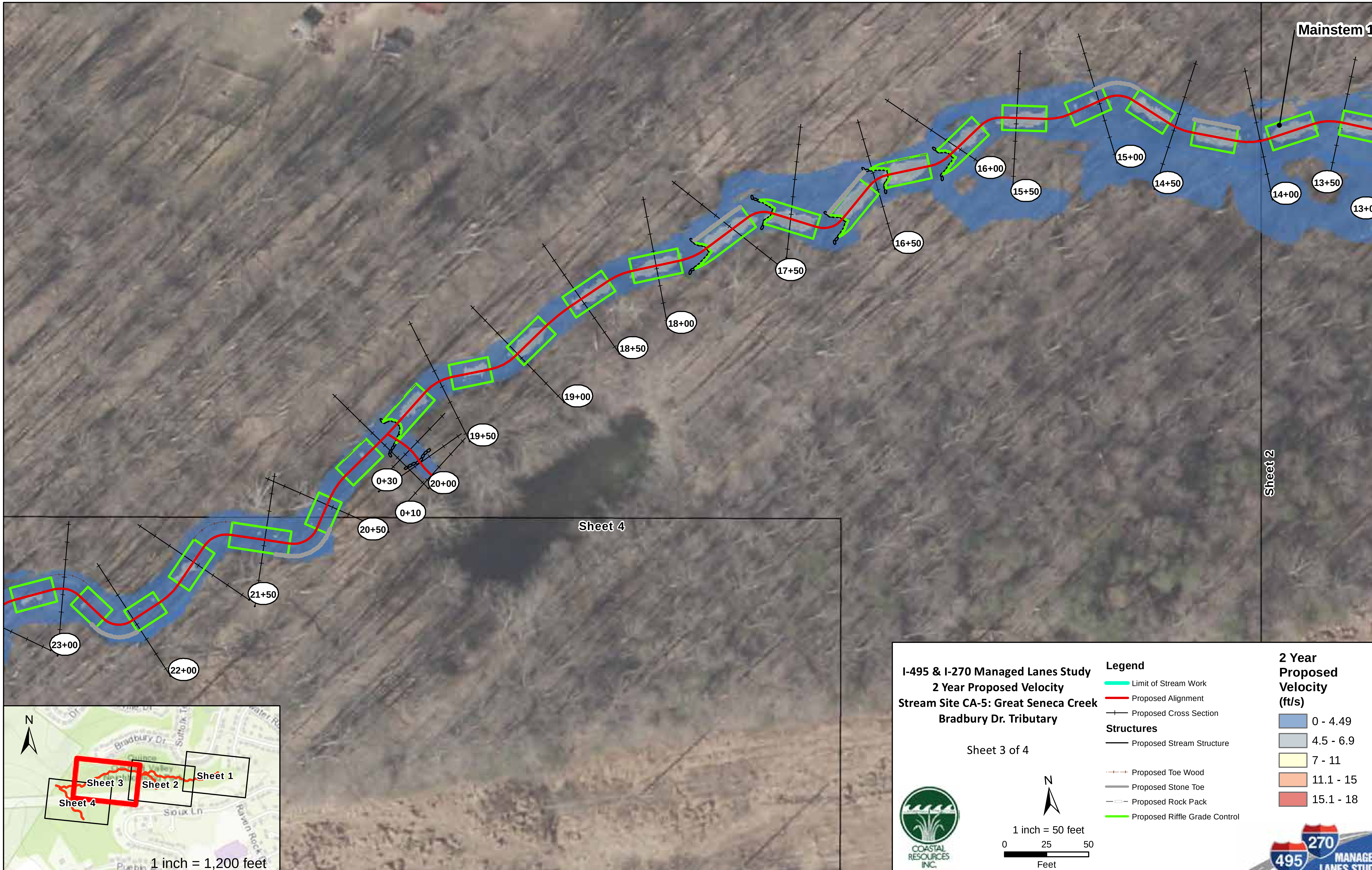
- Proposed Stream Structure
- Proposed Toe Wood
- Proposed Stone Toe
- Proposed Rock Pack
- Proposed Riffle Grade Control

2 Year Proposed Velocity (ft/s)

- 0 - 4.49
- 4.5 - 6.9
- 7 - 11
- 11.1 - 15
- 15.1 - 18

COASTAL RESOURCES INC.

495 270 MANAGED LANES STUDY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13+00
13+50
14+00
14+50
15+00
15+50
16+00
16+50
17+50
18+00
18+50
19+00
19+50
20+00
0+30
0+10
20+50
21+50
22+00
23+00
Sheet 4
Sheet 2
Sheet 3
Sheet 1
Bradbury Dr
Sioux Ln
1 inch = 1,200 feet
I-495 & I-270 Managed Lanes Study
2 Year Proposed Velocity
Stream Site CA-5: Great Seneca Creek
Bradbury Dr. Tributary
Sheet 3 of 4
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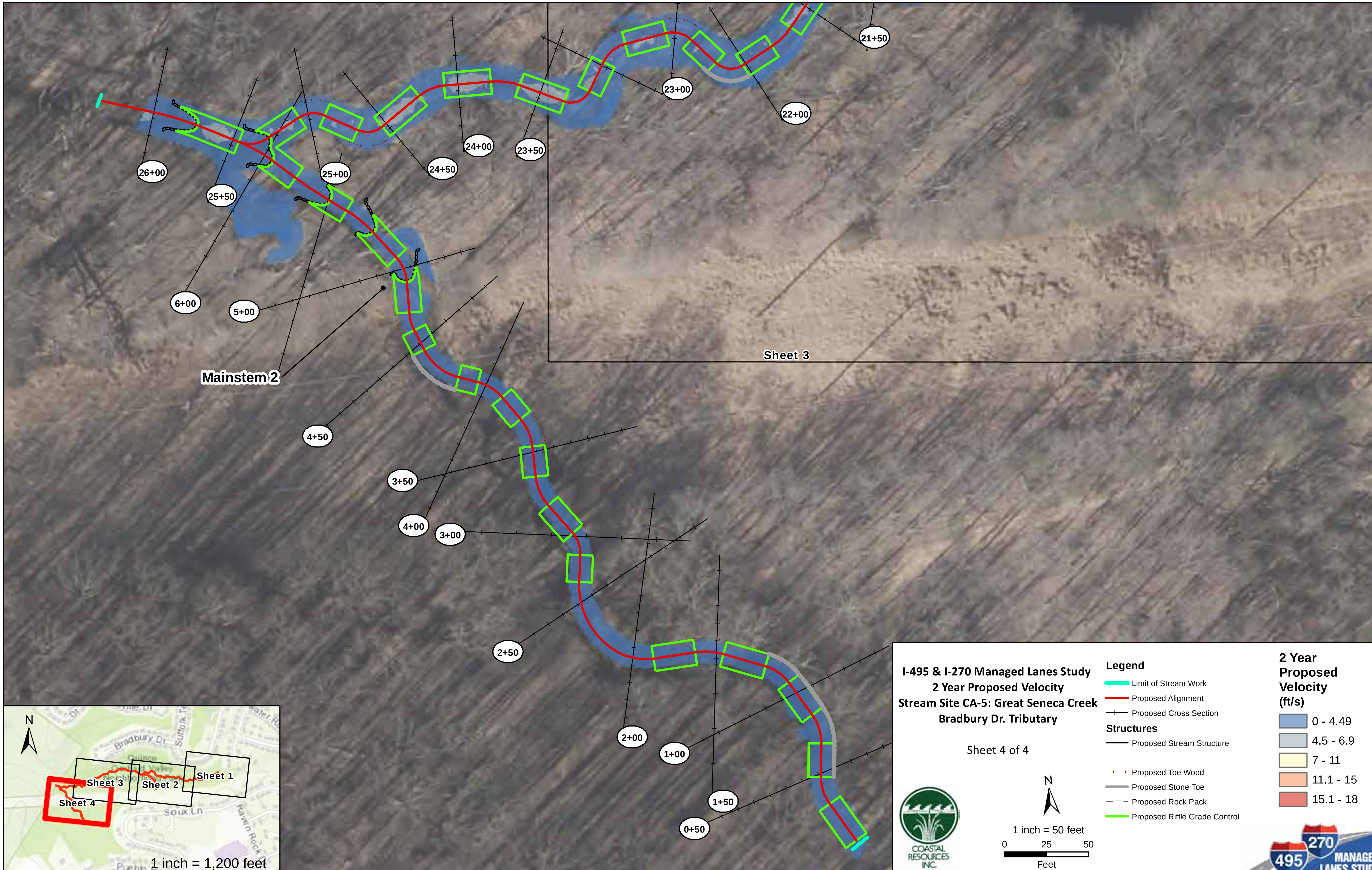
0 - 4.49
4.5 - 6.9
7 - 11
11.1 - 15
15.1 - 18
N
1 inch = 50 feet
0 25 50
Feet
COASTAL RESOURCES INC.
495 270 MANAGED LANES STUDY


I-495 & I-270 Managed Lanes Study
2 Year Proposed Velocity
Stream Site CA-5: Great Seneca Creek
Bradbury Dr. Tributary
Sheet 4 of 4
Legend
Limit of Stream Work
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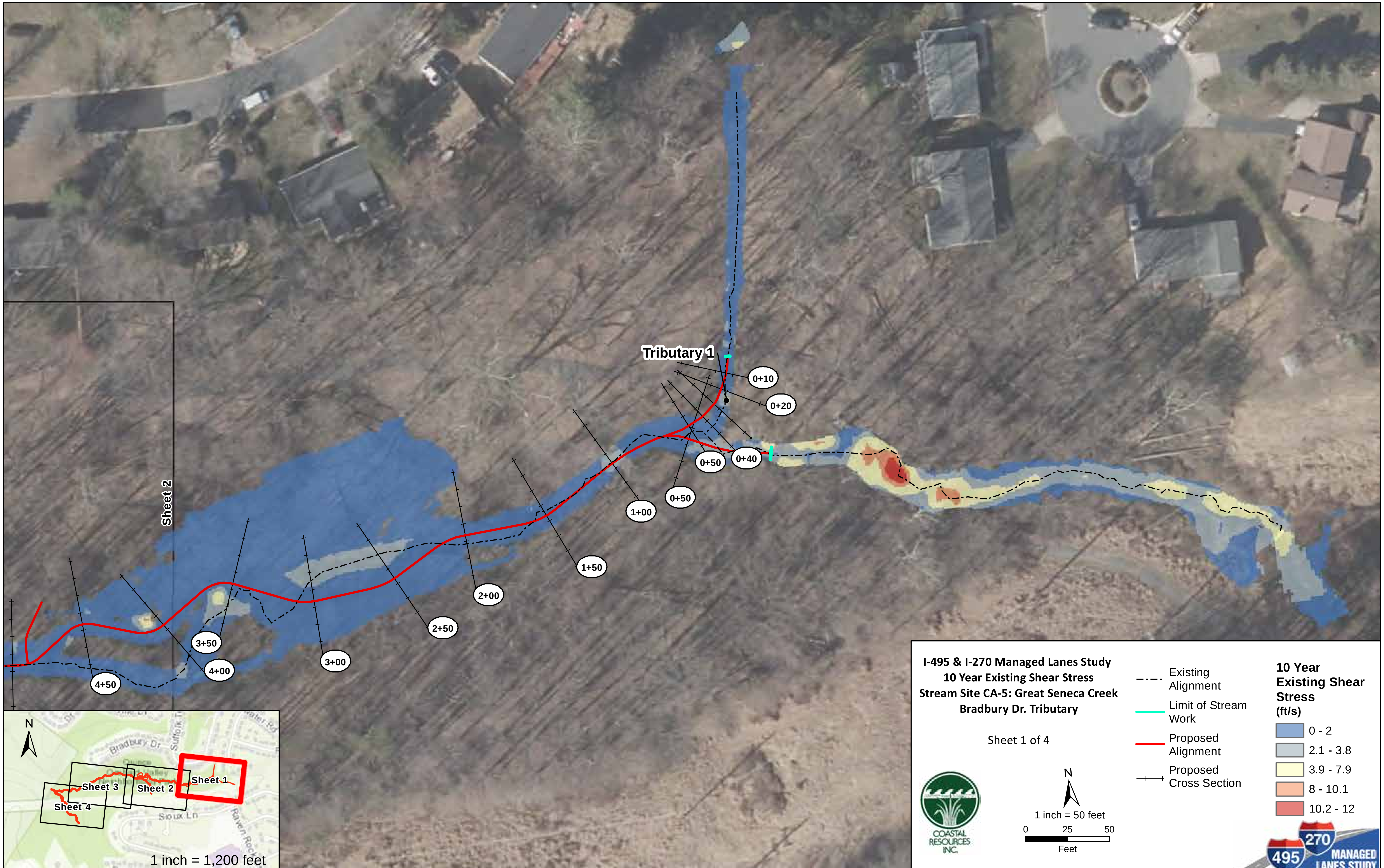
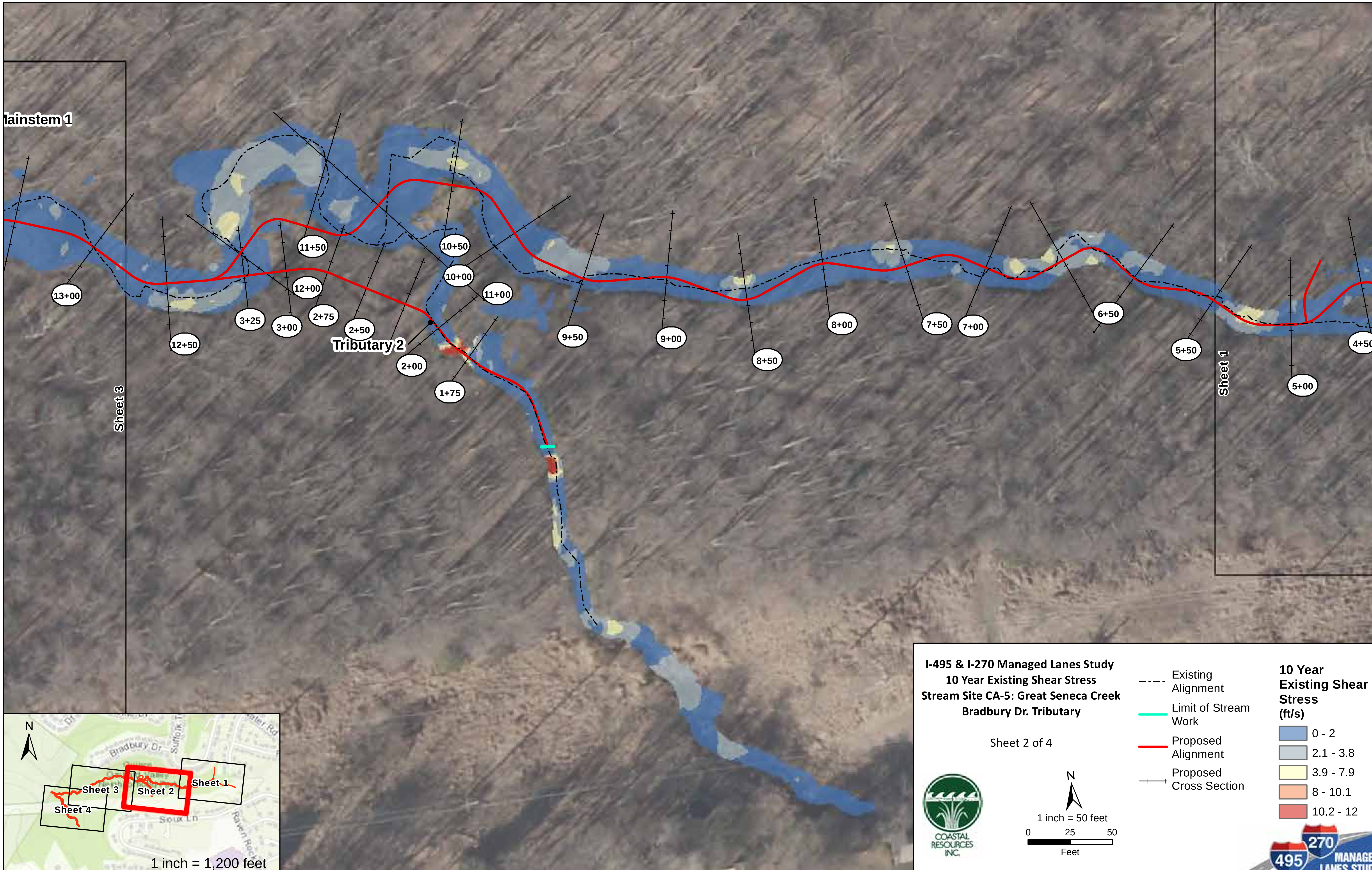
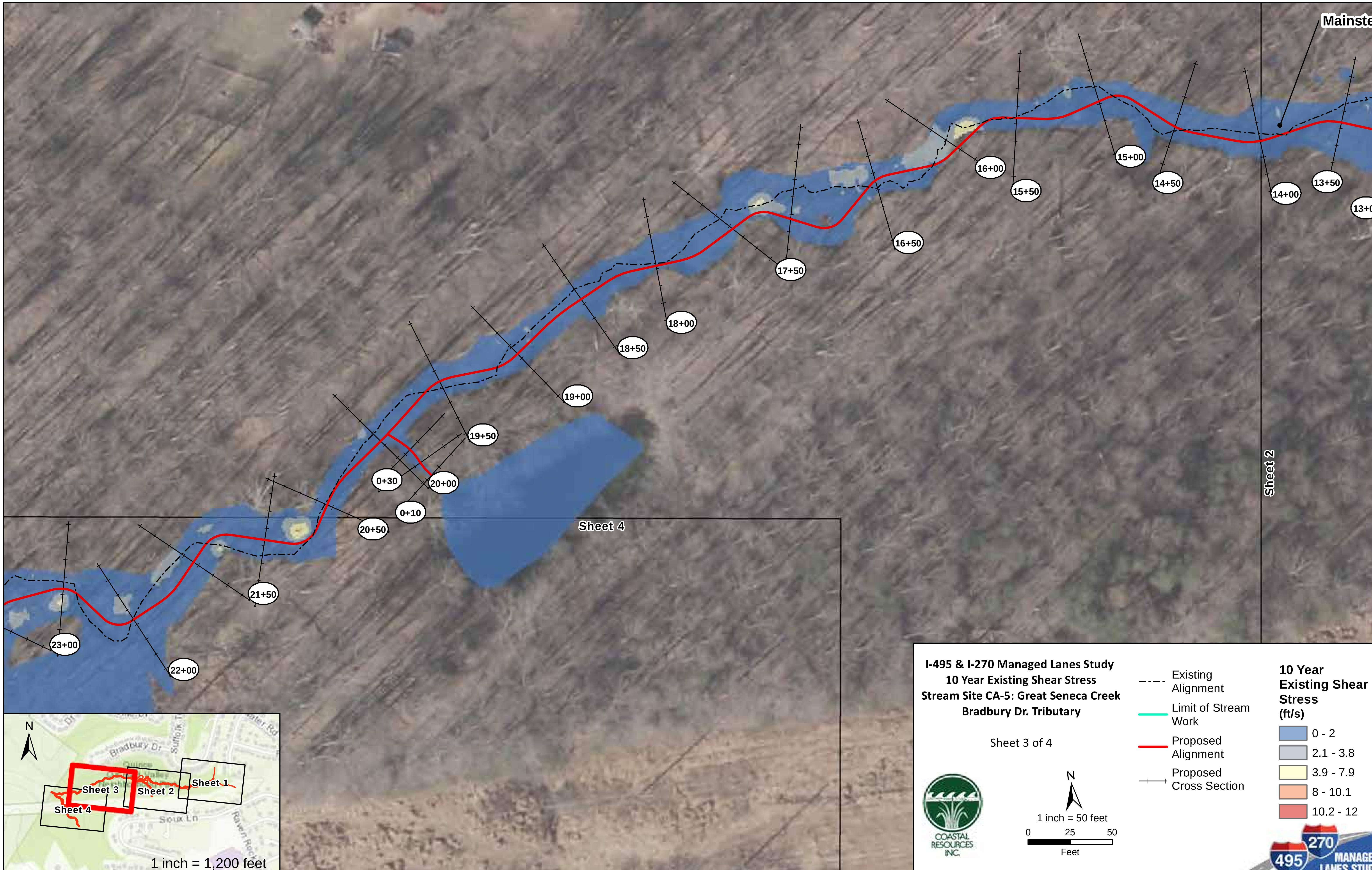
11.1 - 15
15.1 - 18
N
1 inch = 50 feet
0 25 50
Feet
COASTAL RESOURCES INC.
270
495
MANAGED LANES STUDY
Mainstem 2
Sheet 3
0+50
1+00
1+50
2+00
2+50
3+00
3+50
4+00
4+50
5+00
6+00
21+50
22+00
23+00
23+50
24+00
24+50
25+00
25+50
26+00
N
Sheet 1
Sheet 2
Sheet 3
Sheet 4
Bradbury Dr
Sioux Ln
1 inch = 1,200 feet



Tributary 1
0+10
0+20
0+40
0+50
0+50
1+00
1+50
2+00
2+50
3+00
3+50
4+00
4+50
Sheet 2
Sheet 1
Sheet 2
Sheet 3
Sheet 4
1 inch = 1,200 feet
I-495 & I-270 Managed Lanes Study
10 Year Existing Shear Stress
Stream Site CA-5: Great Seneca Creek
Bradbury Dr. Tributary
Sheet 1 of 4
Existing Alignment
Limit of Stream Work
Proposed Alignment
Proposed Cross Section
10 Year Existing Shear Stress (ft/s)
0 - 2
2.1 - 3.8
3.9 - 7.9
8 - 10.1
10.2 - 12
N
1 inch = 50 feet
0
25
50
Feet
COASTAL RESOURCES INC.
270
495
MANAGED LANES STUDY


I-495 & I-270 Managed Lanes Study
10 Year Existing Shear Stress
Stream Site CA-5: Great Seneca Creek
Bradbury Dr. Tributary
Sheet 2 of 4
Existing Alignment
Limit of Stream Work
Proposed Alignment
Proposed Cross Section
10 Year Existing Shear Stress (ft/s)
0 - 2
2.1 - 3.8
3.9 - 7.9
8 - 10.1
10.2 - 12
N
1 inch = 50 feet
0
25
50
Feet
COASTAL RESOURCES INC.
270
495
MANAGED LANES STUDY
lainstem 1
Tributary 2
Sheet 1
Sheet 3
13+00
12+50
12+00
11+50
11+00
10+50
10+00
9+50
9+00
8+50
8+00
7+50
7+00
6+50
5+50
5+00
4+50
3+25
3+00
2+75
2+50
2+00
1+75
Sheet 1
Sheet 2
Sheet 3
Sheet 4
Bradbury Dr
Sioux Ln
Raven Rock
1 inch = 1,200 feet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14+50
15+00
15+50
16+00
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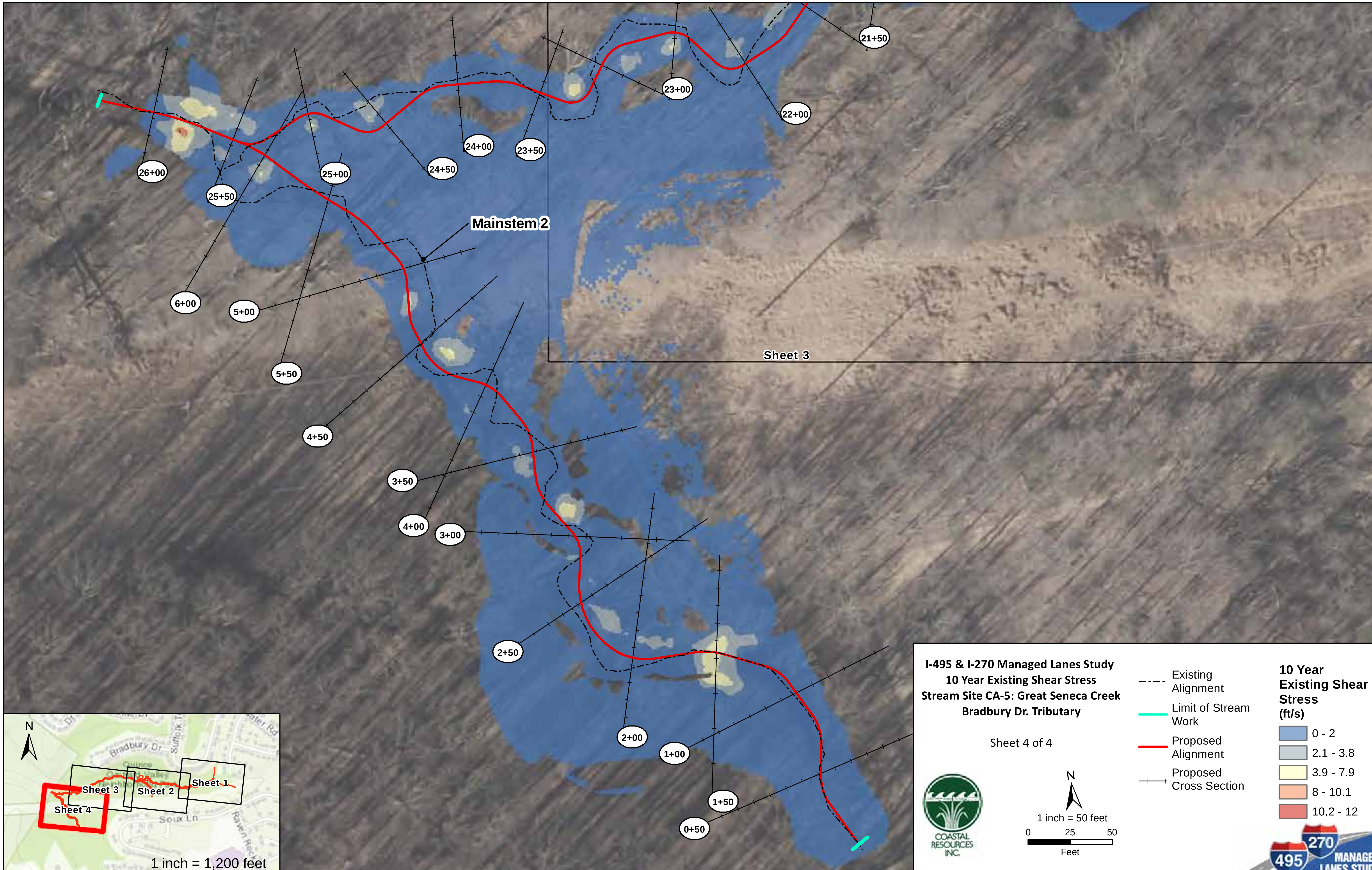
17+50
18+00
18+50
19+00
19+50
20+00
20+50
21+50
22+00
23+00
0+10
0+30
Sheet 4
Sheet 2
I-495 & I-270 Managed Lanes Study
10 Year Existing Shear Stress
Stream Site CA-5: Great Seneca Creek
Bradbury Dr. Tributary
Sheet 3 of 4
Existing Alignment
Limit of Stream Work
Proposed Alignment
Proposed Cross Section
10 Year Existing Shear Stress (ft/s)
0 - 2
2.1 - 3.8
3.9 - 7.9
8 - 10.1
10.2 - 12
N
1 inch = 50 feet
0
25
50
Feet
COASTAL RESOURCES INC.
495
270
MANAGED LANES STUDY
N
Bradbury Dr
Sheet 1
Sheet 2
Sheet 3
Sheet 4
Sioux Ln
1 inch = 1,200 feet



21+50
23+00
22+00
24+00
23+50
26+00
25+00
24+50
25+50
Mainstem 2
6+00
5+00
5+50
Sheet 3
4+50
3+50
4+00
3+00
2+50
2+00
1+00
1+50
0+50
N
Bradbury Dr
Sheet 3
Sheet 2
Sheet 1
Sheet 4
Sioux Ln
1 inch = 1,200 feet
I-495 & I-270 Managed Lanes Study
10 Year Existing Shear Stress
Stream Site CA-5: Great Seneca Creek
Bradbury Dr. Tributary
Sheet 4 of 4
COASTAL RESOURCES INC.
N
1 inch = 50 feet
0 25 50
Feet
Existing Alignment
Limit of Stream Work
Proposed Alignment
Proposed Cross Section
10 Year Existing Shear Stress (ft/s)
0 - 2
2.1 - 3.8
3.9 - 7.9
8 - 10.1
10.2 - 12
495
270
MANAGED LANES STUDY

I-495 & I-270 Managed Lanes Study
10 Year Exisiting Velocity
Stream Site CA-5: Great Seneca Creek
Bradbury Dr. Tributary

Sheet 1 of 4

Existing Alignment
Limit of Stream Work
Proposed Alignment
Proposed Cross Section

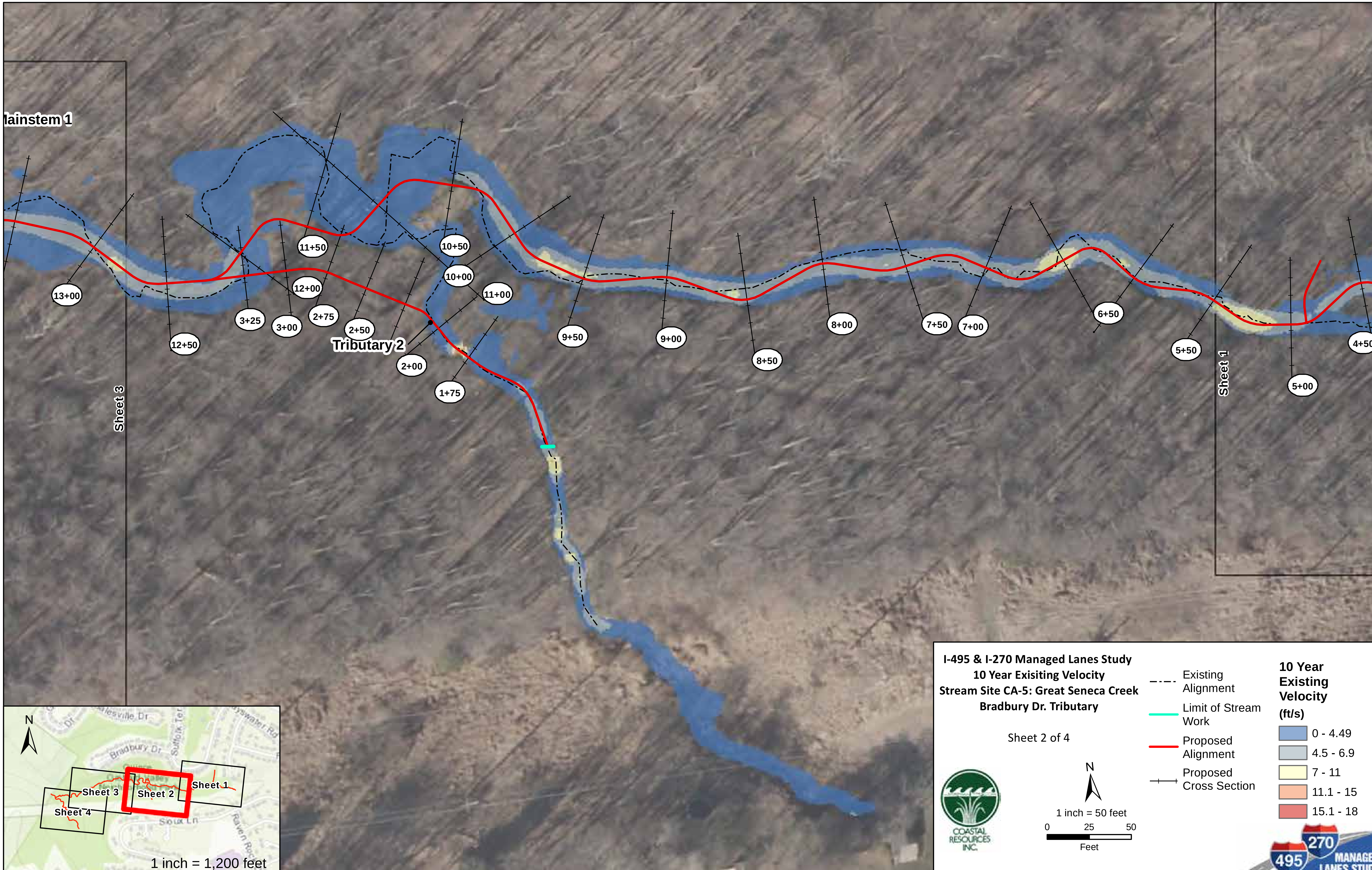
10 Year Existing Velocity (ft/s)

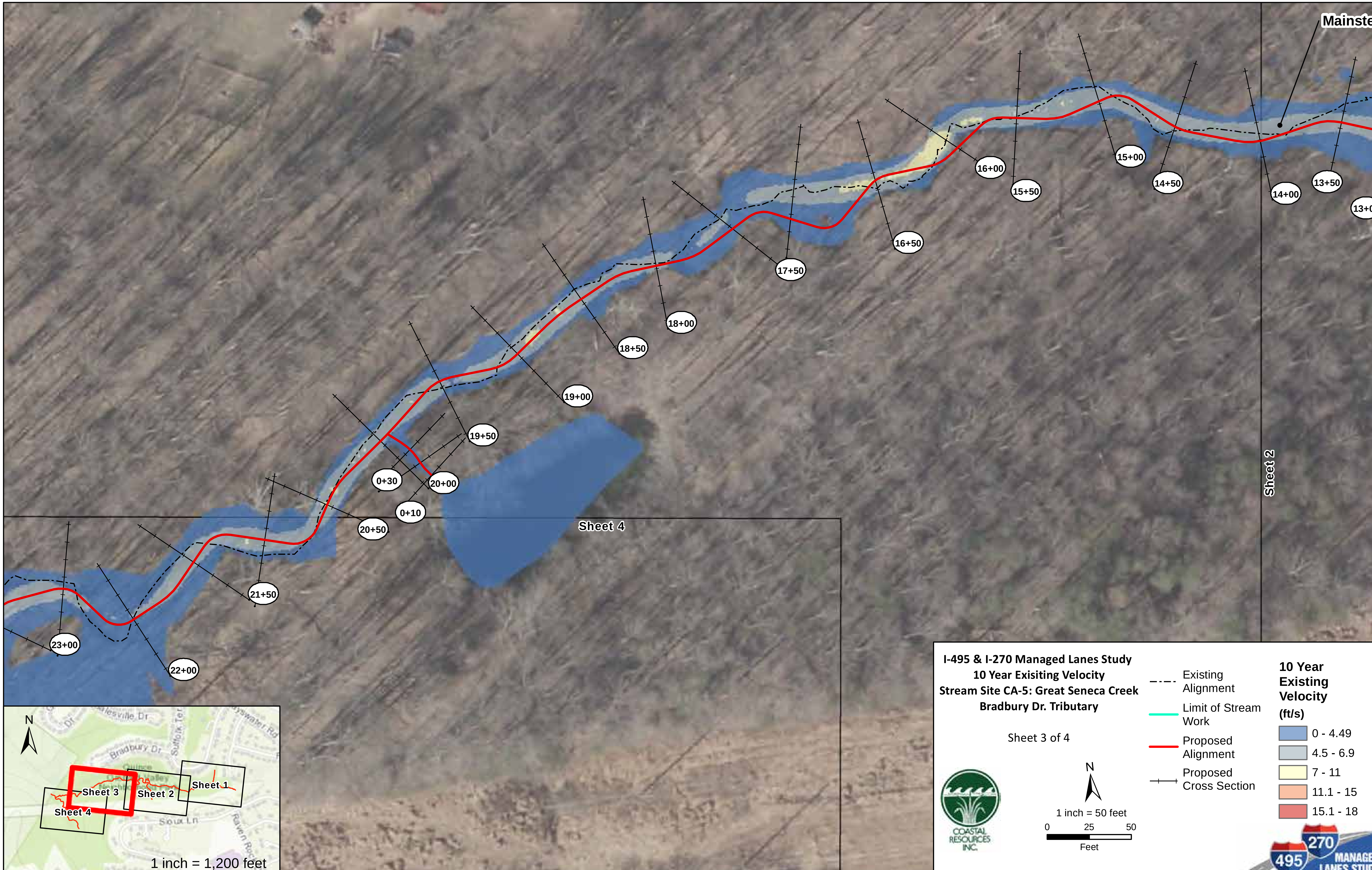
- 0 - 4.49
- 4.5 - 6.9
- 7 - 11
- 11.1 - 15
- 15.1 - 18

N
1 inch = 50 feet
0 25 50
Feet

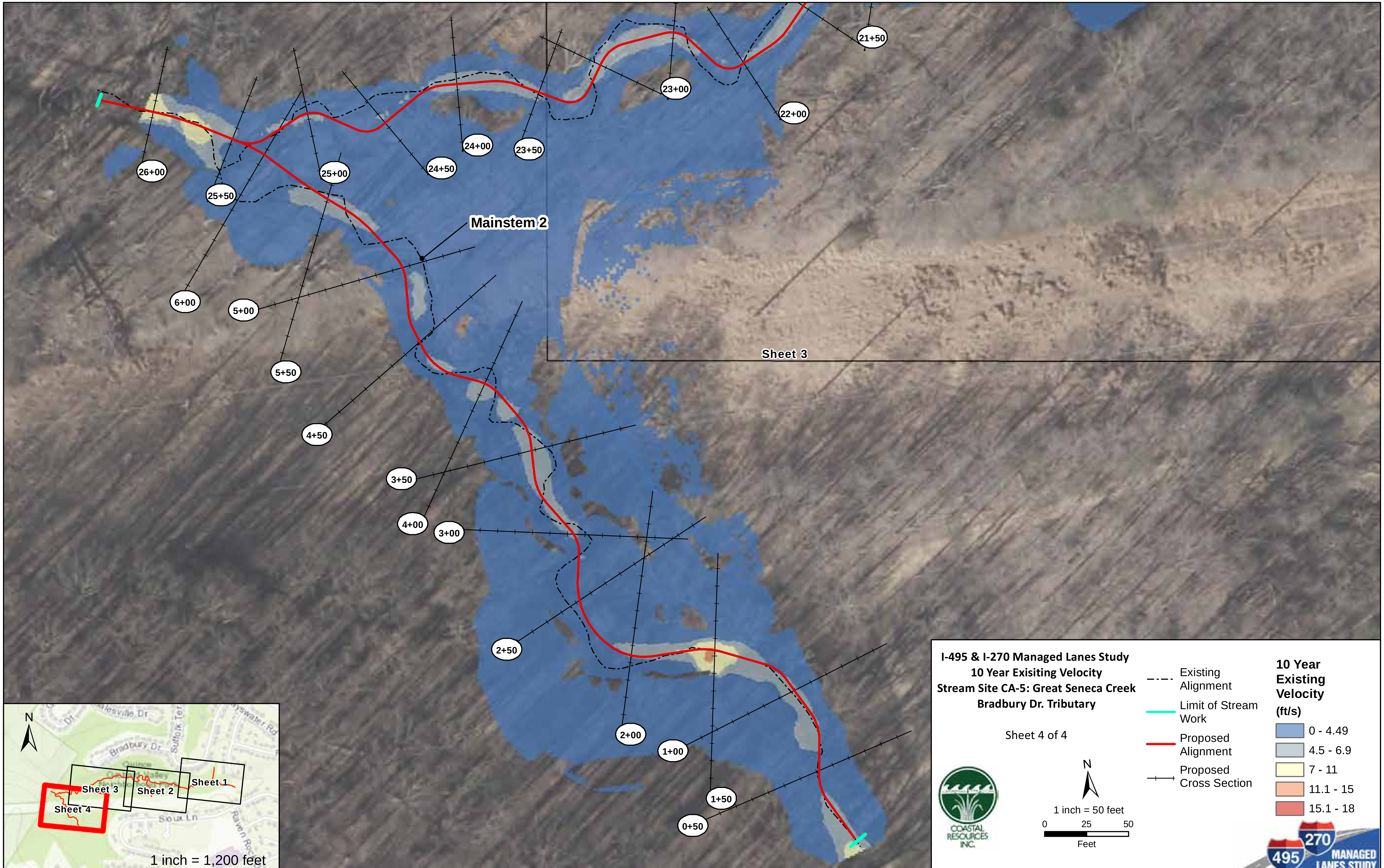
COASTAL RESOURCES INC.

495 270 MANAGED LANES STUDY


I-495 & I-270 Managed Lanes Study
10 Year Exisiting Velocity
Stream Site CA-5: Great Seneca Creek
Bradbury Dr. Tributary
Sheet 2 of 4
Existing Alignment
Limit of Stream Work
Proposed Alignment
Proposed Cross Section
10 Year Existing Velocity (ft/s)
0 - 4.49
4.5 - 6.9
7 - 11
11.1 - 15
15.1 - 18
1 inch = 50 feet
0 25 50
Feet
N
Mainstem 1
Tributary 2
Sheet 3
Sheet 1
13+00
12+50
12+00
11+50
11+00
10+50
10+00
9+50
9+00
8+50
8+00
7+50
7+00
6+50
5+50
5+00
4+50
3+25
3+00
2+75
2+50
2+00
1+75
Sheet 2
Sheet 4
Bradbury Dr
1 inch = 1,200 feet
COASTAL RESOURCES INC.
270
495
MANAGED LANES STUDY



Mainstem
16+00
15+50
15+00
14+50
14+00
13+50
13+00
16+50
17+50
18+00
18+50
19+00
19+50
20+00
0+30
0+10
20+50
21+50
22+00
23+00
Sheet 4
Sheet 2
Sheet 3
Sheet 1
1 inch = 1,200 feet
I-495 & I-270 Managed Lanes Study
10 Year Exisiting Velocity
Stream Site CA-5: Great Seneca Creek
Bradbury Dr. Tributary
Sheet 3 of 4
N
1 inch = 50 feet
0
25
50
Feet
Existing Alignment
Limit of Stream Work
Proposed Alignment
Proposed Cross Section
10 Year Existing Velocity (ft/s)
0 - 4.49
4.5 - 6.9
7 - 11
11.1 - 15
15.1 - 18
COASTAL RESOURCES INC.
495
270
MANAGED LANES STUDY



I-495 & I-270 Managed Lanes Study
10 Year Exisiting Velocity
Stream Site CA-5: Great Seneca Creek
Bradbury Dr. Tributary
Sheet 4 of 4
Existing Alignment
Limit of Stream Work
Proposed Alignment
Proposed Cross Section
10 Year Existing Velocity (ft/s)
0 - 4.49
4.5 - 6.9
7 - 11
11.1 - 15
15.1 - 18
N
1 inch = 50 feet
0
25
50
Feet
COASTAL RESOURCES INC.
270
495
MANAGED LANES STUDY
Mainstem 2
Sheet 3
0+50
1+00
1+50
2+00
2+50
3+00
3+50
4+00
4+50
5+00
5+50
6+00
21+50
22+00
23+00
23+50
24+00
24+50
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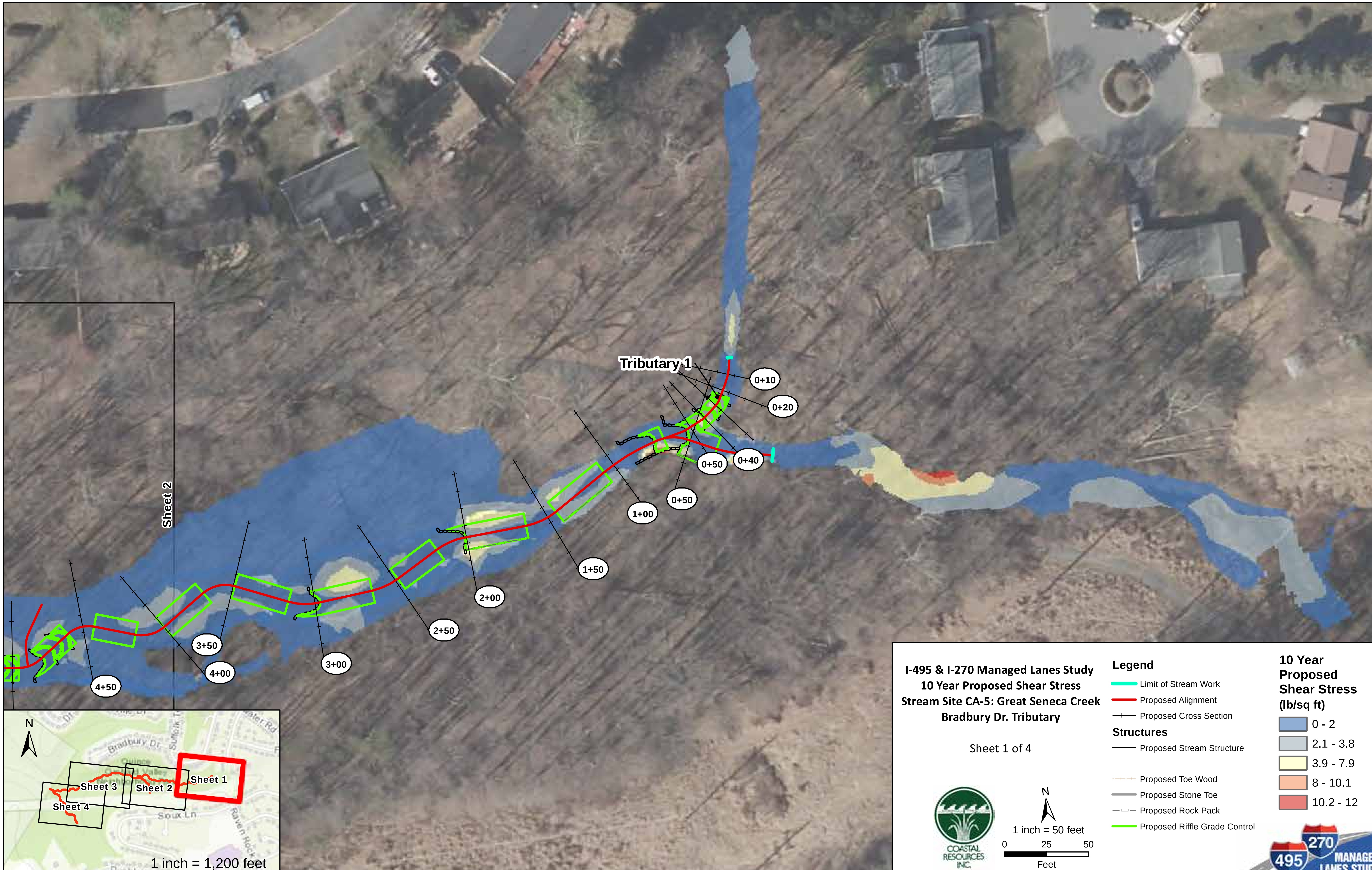
25+50
26+00
Sheet 1
Sheet 2
Sheet 3
Sheet 4
Bradbury Dr
Suffolk Ter
Sioux Ln
1 inch = 1,200 feet



I-495 & I-270 Managed Lanes Study
10 Year Proposed Shear Stress
Stream Site CA-5: Great Seneca Creek
Bradbury Dr. Tributary
Sheet 1 of 4
Legend
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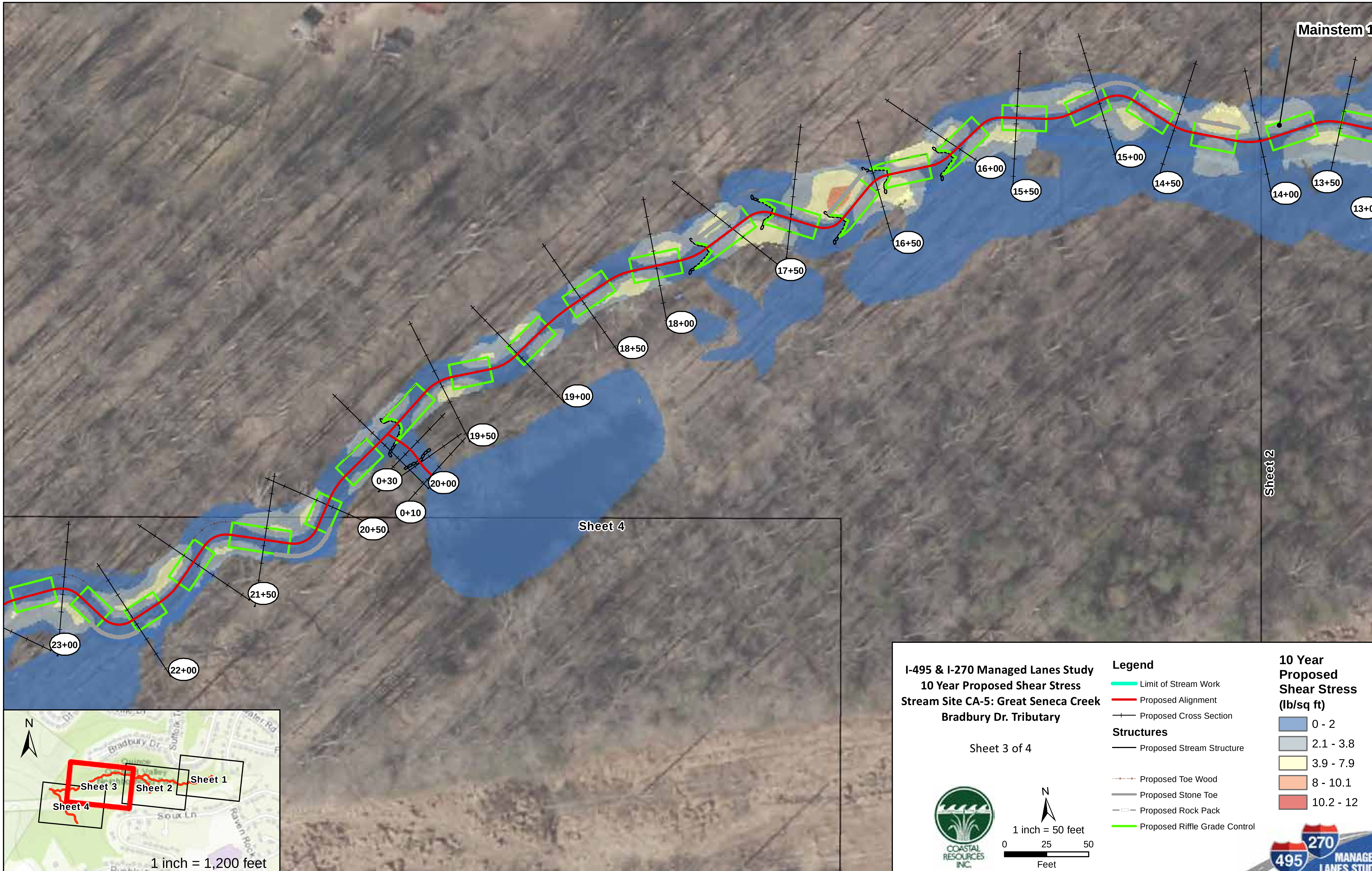
Proposed Stone Toe
Proposed Rock Pack
Proposed Riffle Grade Control
10 Year Proposed Shear Stress (lb/sq ft)
0 - 2
2.1 - 3.8
3.9 - 7.9
8 - 10.1
10.2 - 12
N
1 inch = 50 feet
0
25
50
Feet
COASTAL RESOURCES INC.
270
495
MANAGED LANES STUDY
Tributary 1
0+10
0+20
0+40
0+50
0+50
1+00
1+50
2+00
2+50
3+00
3+50
4+00
4+50
Sheet 2
Sheet 1
Sheet 2
Sheet 3
Sheet 4
Bradbury Dr
Soux Ln
Raven Rock
1 inch = 1,200 feet

I-495 & I-270 Managed Lanes Study
10 Year Proposed Shear Stress
Stream Site CA-5: Great Seneca Creek
Bradbury Dr. Tributary

Sheet 2 of 4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13+00
13+50
14+00
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15+00
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16+00
16+50
17+50
18+00
18+50
19+00
19+50
20+00
20+50
21+50
22+00
23+00
0+10
0+30
Sheet 2
Sheet 4
Sheet 1
Sheet 2
Sheet 3
Sheet 4
1 inch = 1,200 feet
I-495 & I-270 Managed Lanes Study
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N
1 inch = 50 feet
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25
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Feet
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495
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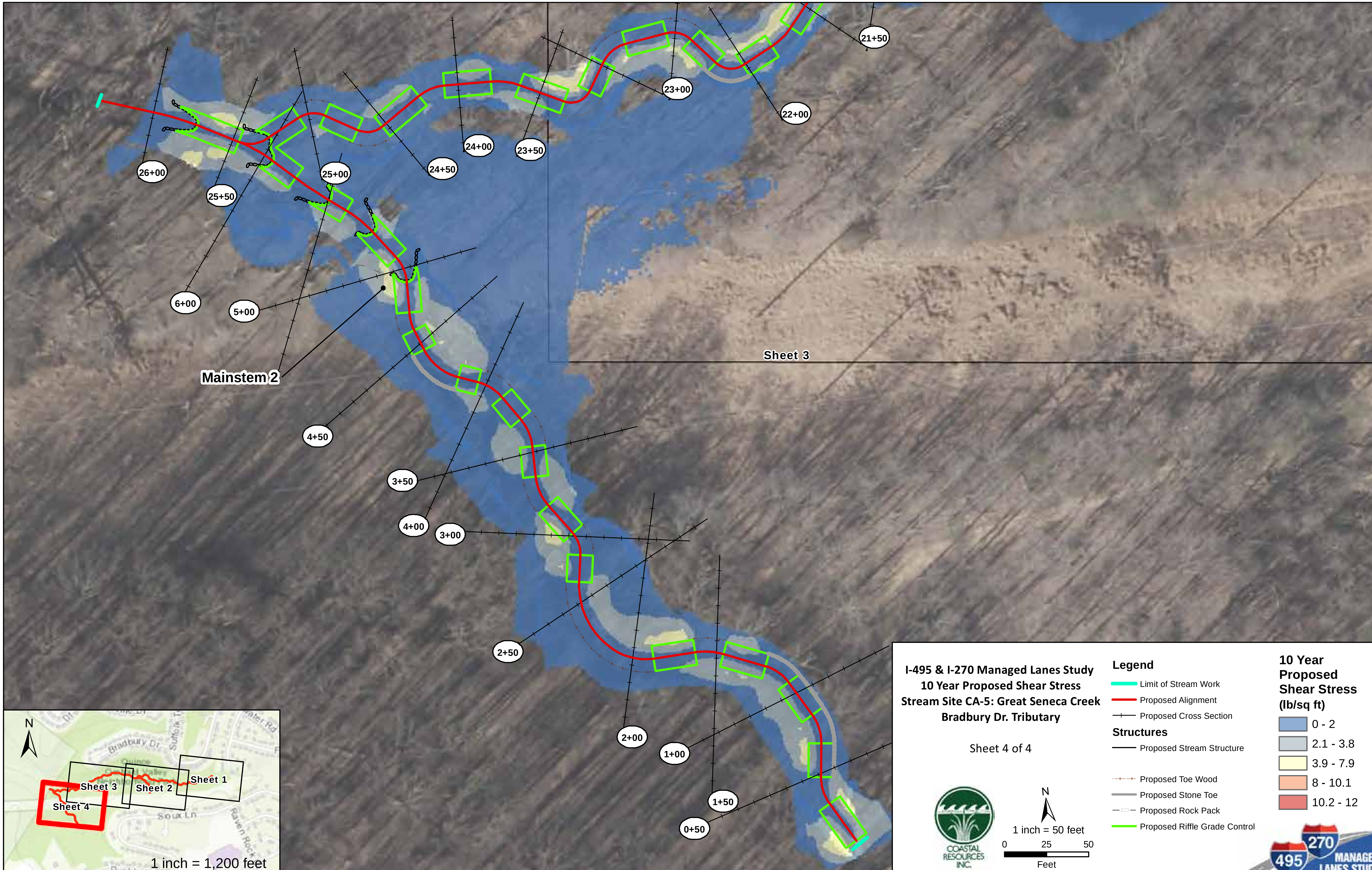
MANAGED LANES STUDY


I-495 & I-270 Managed Lanes Study
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1 inch = 50 feet
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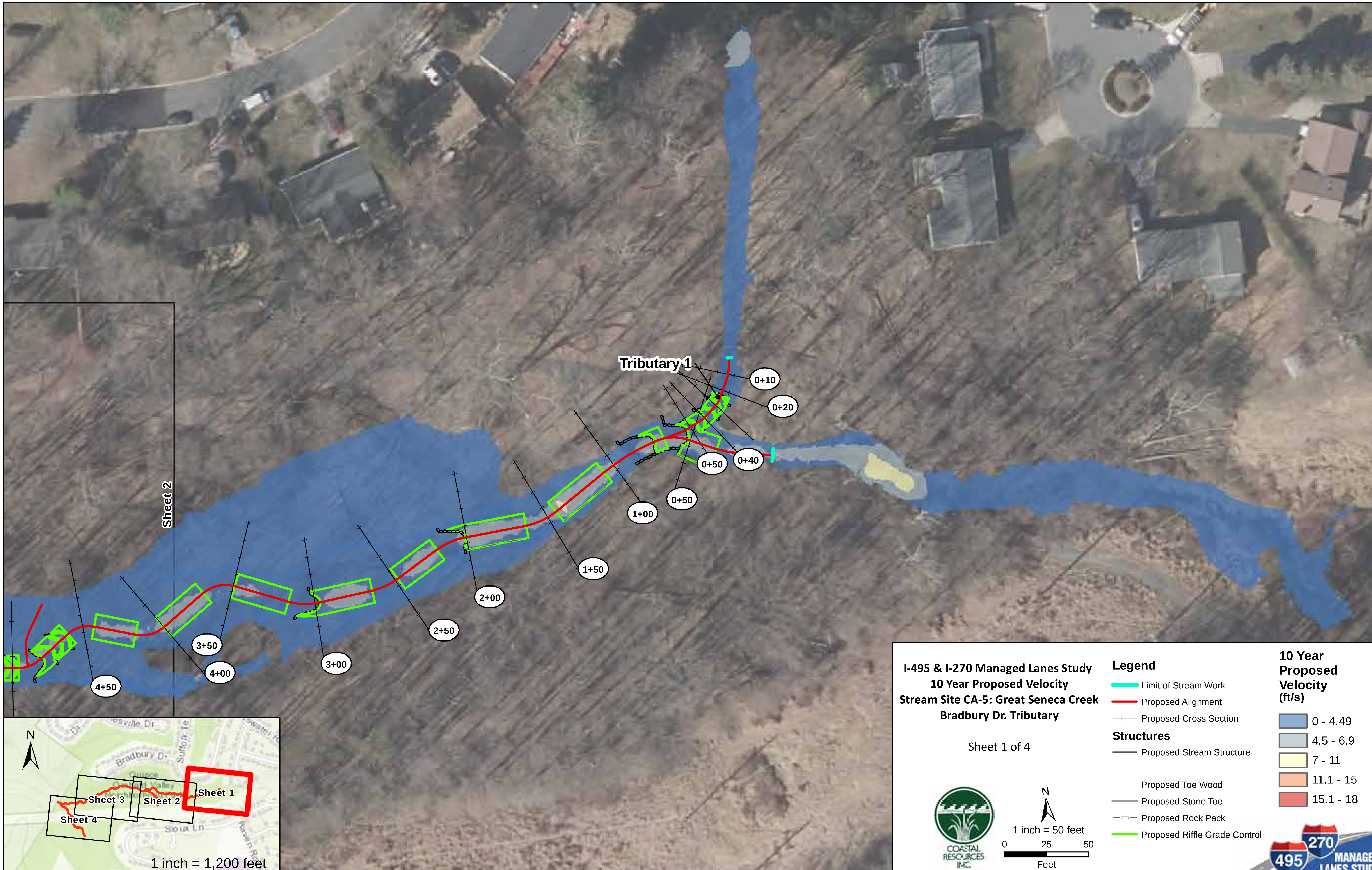
25
50
Feet
COASTAL RESOURCES INC.
495
270
MANAGED LANES STUDY
Mainstem 2
Sheet 3
0+50
1+00
1+50
2+00
2+50
3+00
3+50
4+00
4+50
5+00
6+00
21+50
22+00
23+00
23+50
24+00
24+50
25+00
25+50
26+00
N
Sheet 1
Sheet 2
Sheet 3
Sheet 4
Bradbury Dr
Sioux Ln
1 inch = 1,200 feet


Tributary 1
0+10
0+20
0+40
0+50
0+50
1+00
1+50
2+00
2+50
3+00
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4+00
4+50
Sheet 2
N
Bradbury Dr
Sheet 1
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Sheet 3
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I-495 & I-270 Managed Lanes Study
10 Year Proposed Velocity
Stream Site CA-5: Great Seneca Creek
Bradbury Dr. Tributary
Sheet 1 of 4
COASTAL RESOURCES INC.
N
1 inch = 50 feet
0 25 50
Feet
Legend
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Proposed Stone Toe
Proposed Rock Pack
Proposed Riffle Grade Control
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0 - 4.49
4.5 - 6.9
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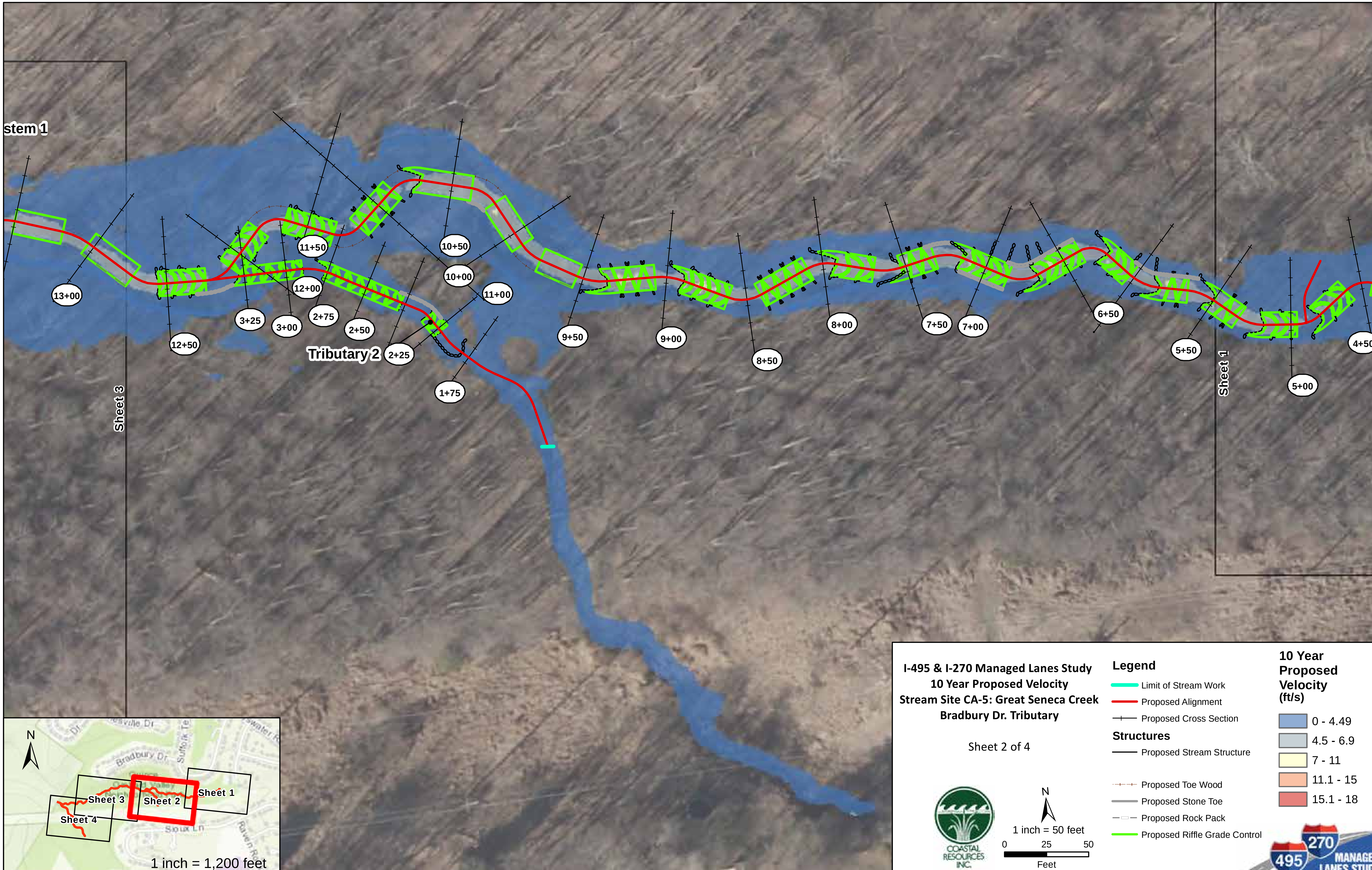
11.1 - 15
15.1 - 18
495
270
MANAGED LANES STUDY


I-495 & I-270 Managed Lanes Study
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Stream Site CA-5: Great Seneca Creek
Bradbury Dr. Tributary
Sheet 2 of 4
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15.1 - 18
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Feet
COASTAL RESOURCES INC.
270
495
MANAGED LANES STUDY
stem 1
Tributary 2
Sheet 3
Sheet 1
13+00
12+50
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4+50
3+25
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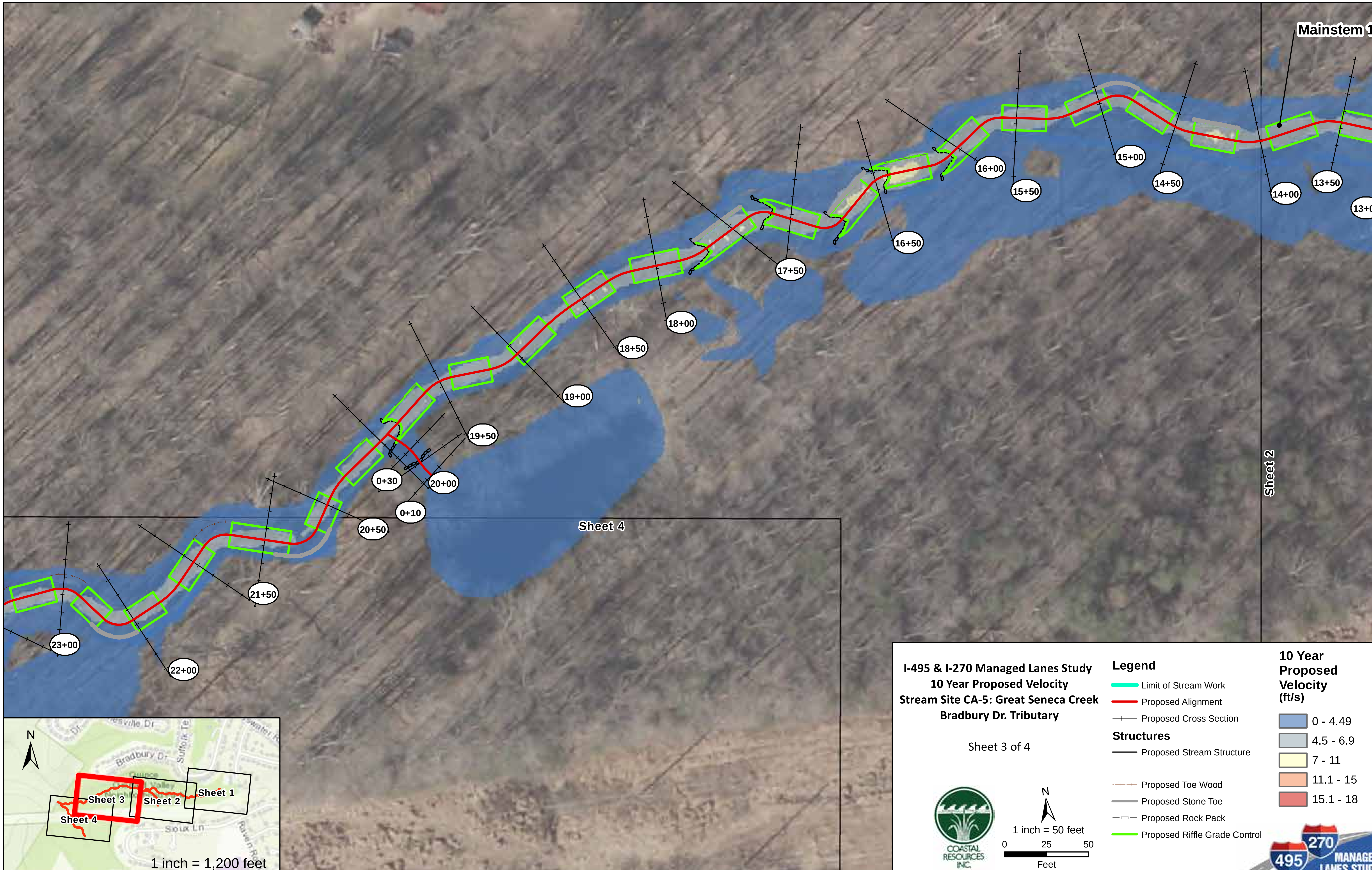
Sheet 3
Sheet 4
Bradbury Dr
Sioux Ln
1 inch = 1,200 feet



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Sheet 4
Bradbury Dr
Sioux Ln
1 inch = 1,200 feet
I-495 & I-270 Managed Lanes Study
10 Year Proposed Velocity
Stream Site CA-5: Great Seneca Creek
Bradbury Dr. Tributary
Sheet 3 of 4
Legend
Limit of Stream Work
Proposed Alignment
Proposed Cross Section
Structures
Proposed Stream Structure
Proposed Toe Wood
Proposed Stone Toe
Proposed Rock Pack
Proposed Riffle Grade Control
10 Year Proposed Velocity (ft/s)
0 - 4.49
4.5 - 6.9
7 - 11
11.1 - 15
15.1 - 18
COASTAL RESOURCES INC.
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1 inch = 50 feet
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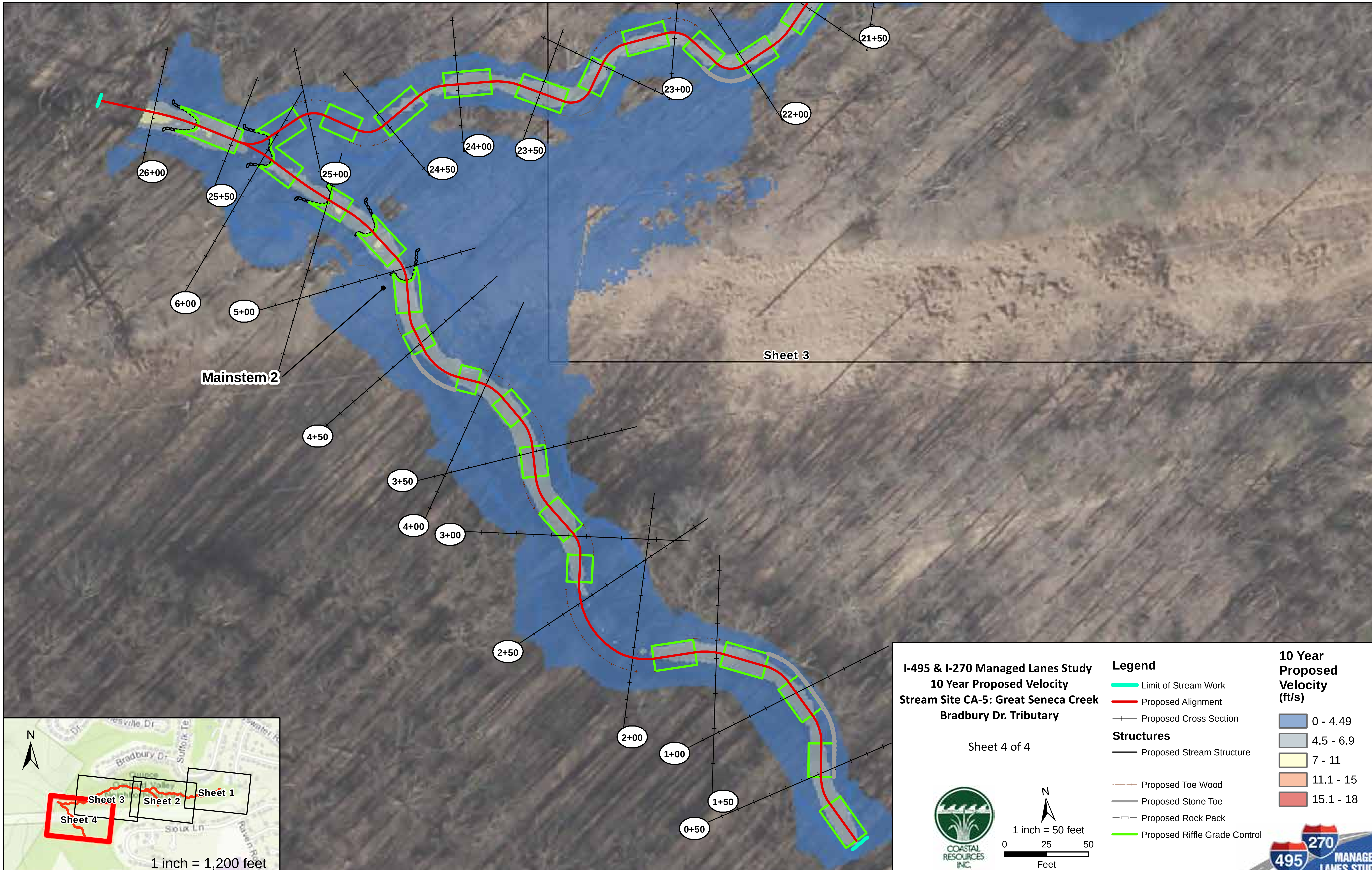
MANAGED LANES STUDY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1 inch = 50 feet
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Feet
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MANAGED LANES STUDY
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Mainstem 2
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Bradbury Dr
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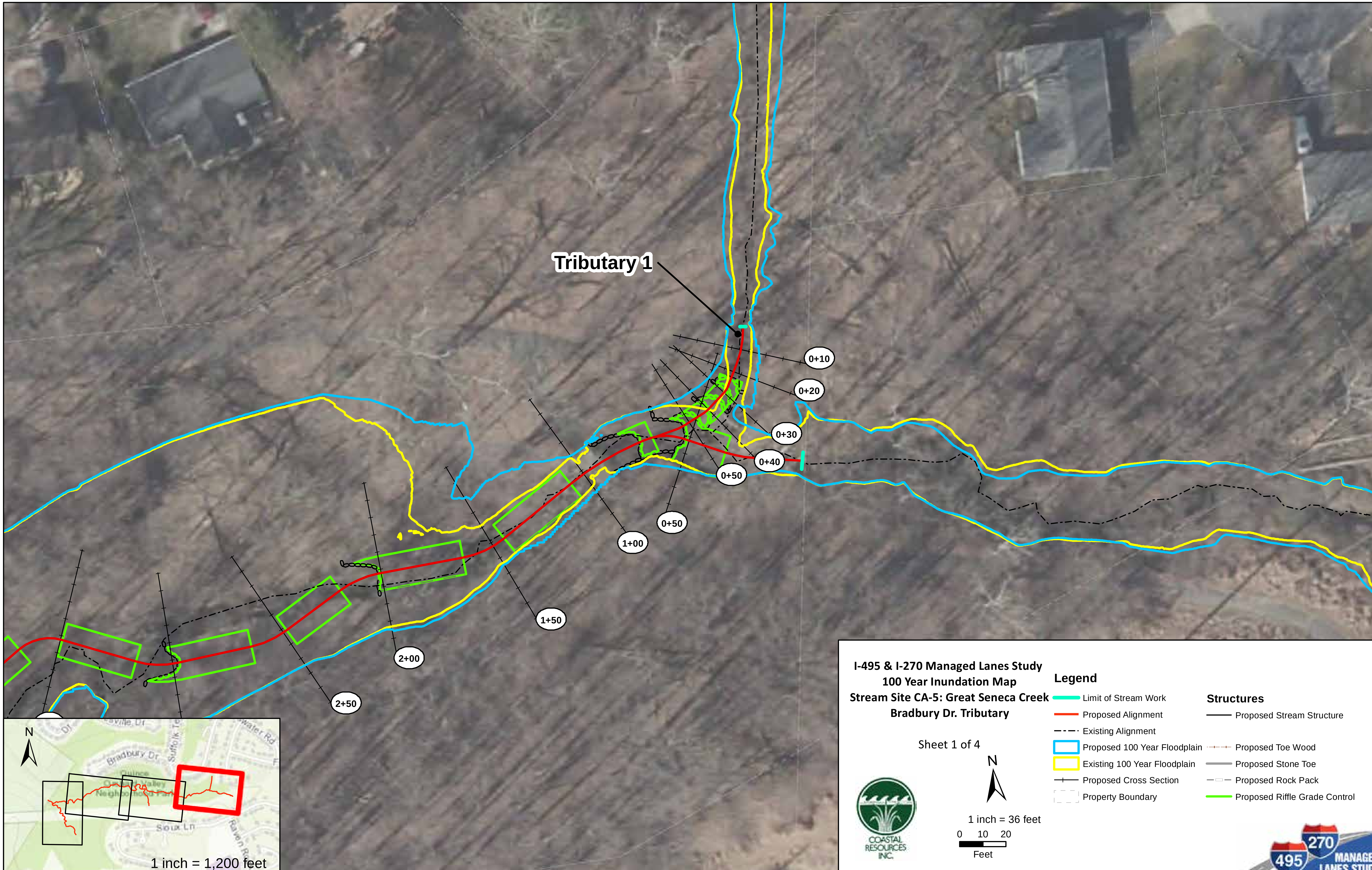
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I-495 & I-270 Managed Lanes Study
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Proposed Cross Section
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Proposed Rock Pack
Proposed Riffle Grade Control
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1 inch = 36 feet
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MANAGED LANES STUDY
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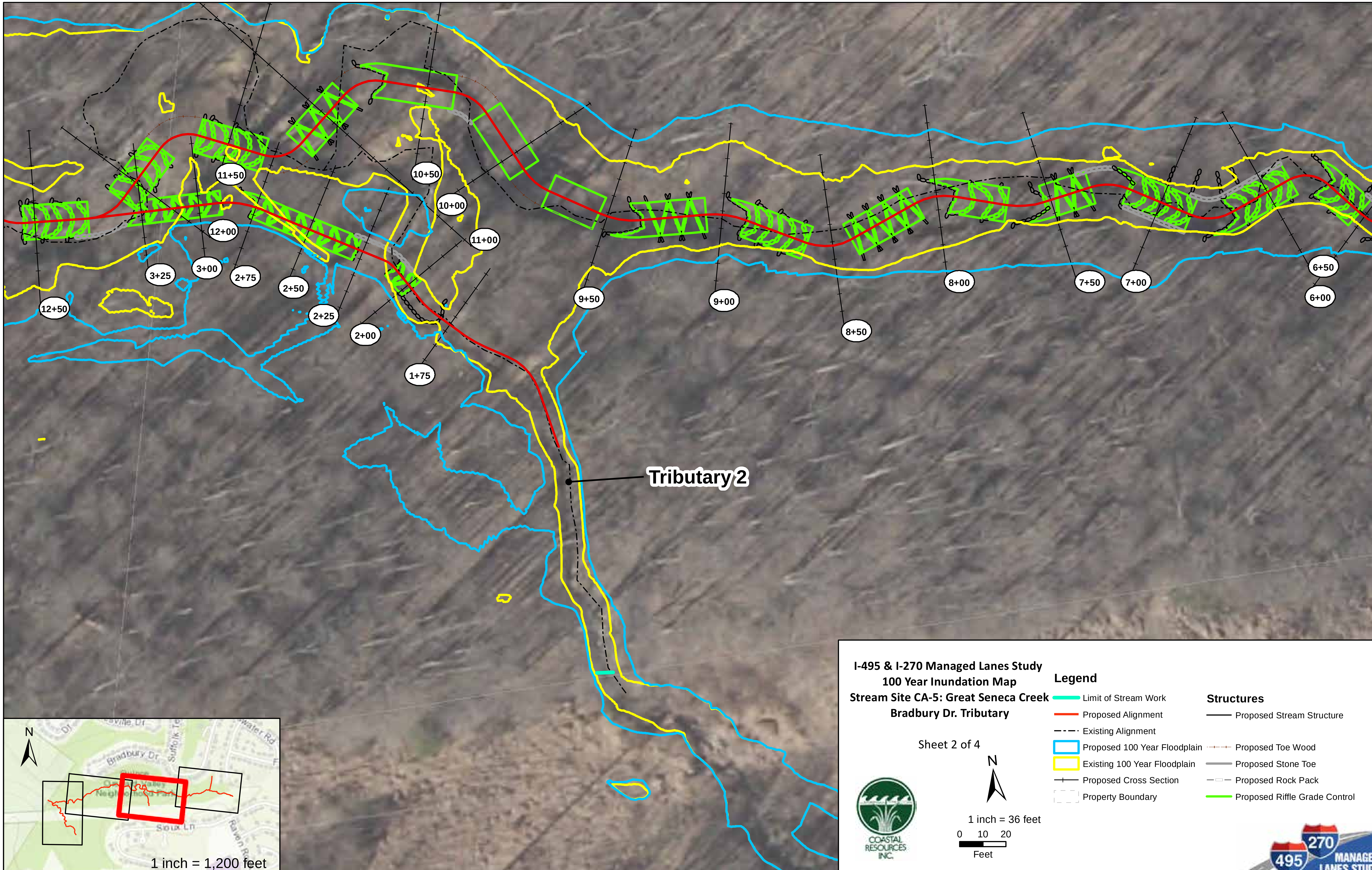
1 inch = 1,200 feet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1 inch = 1,200 feet
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1 inch = 36 feet
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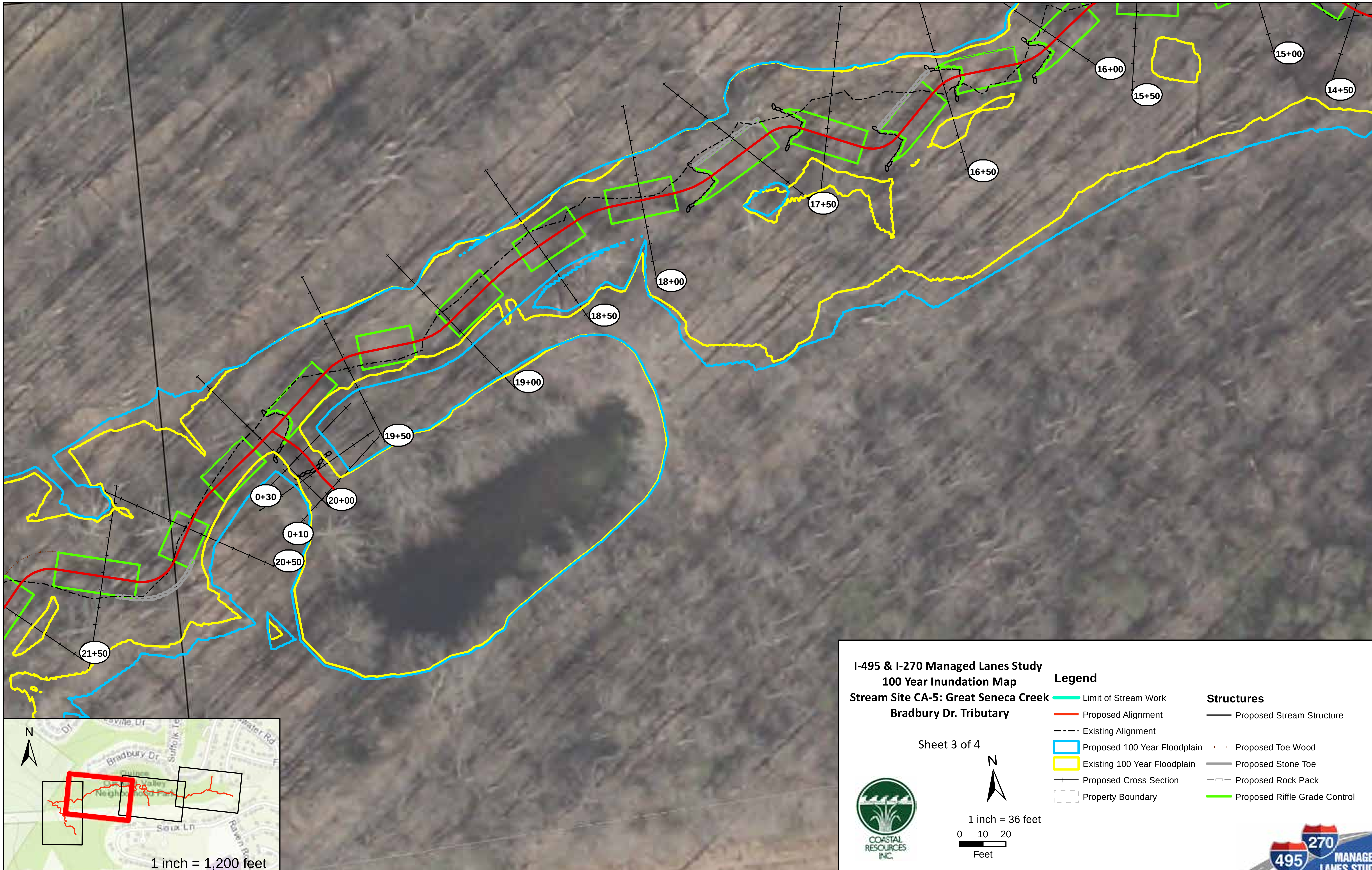
MANAGED LANES STUDY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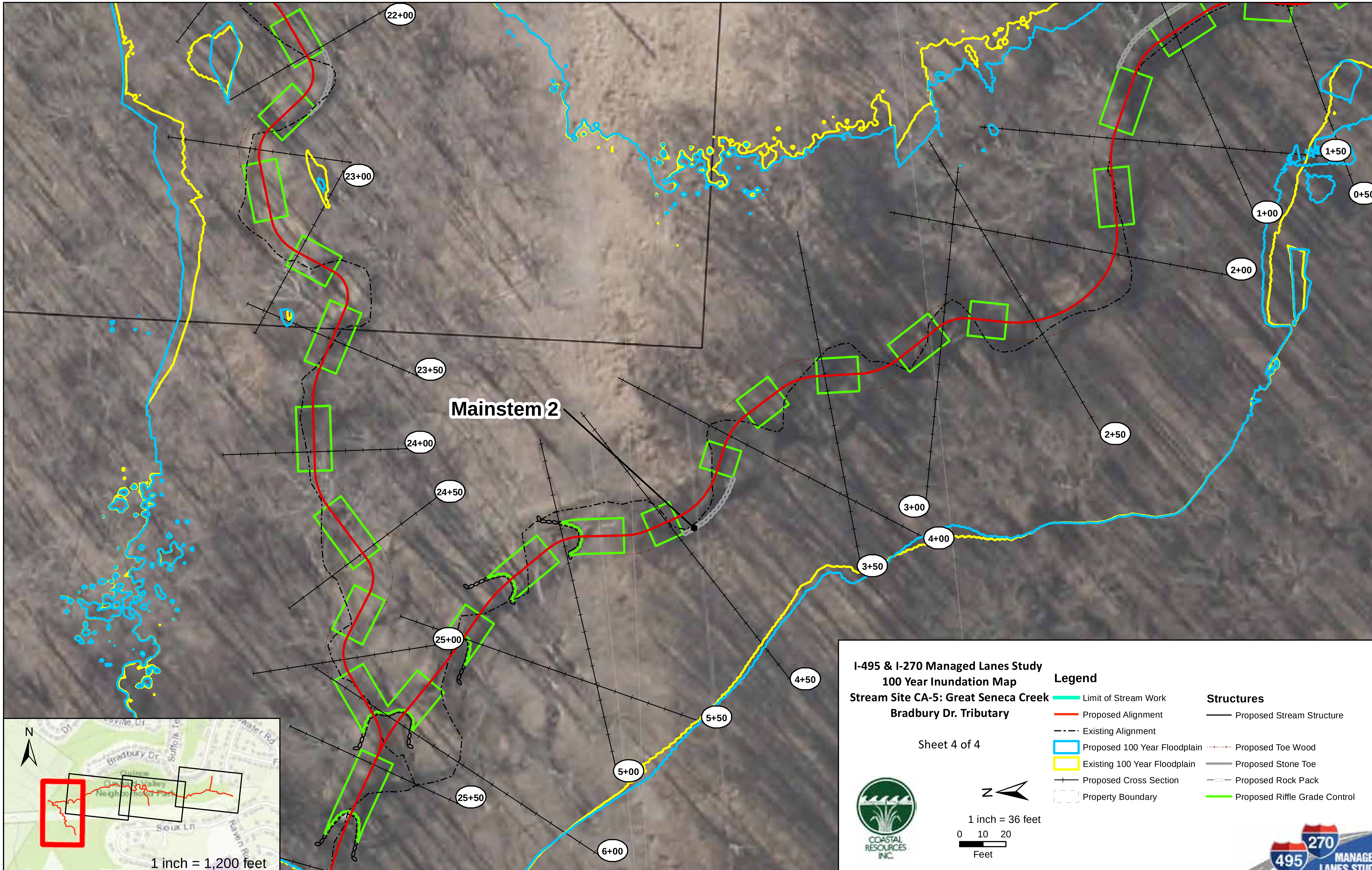
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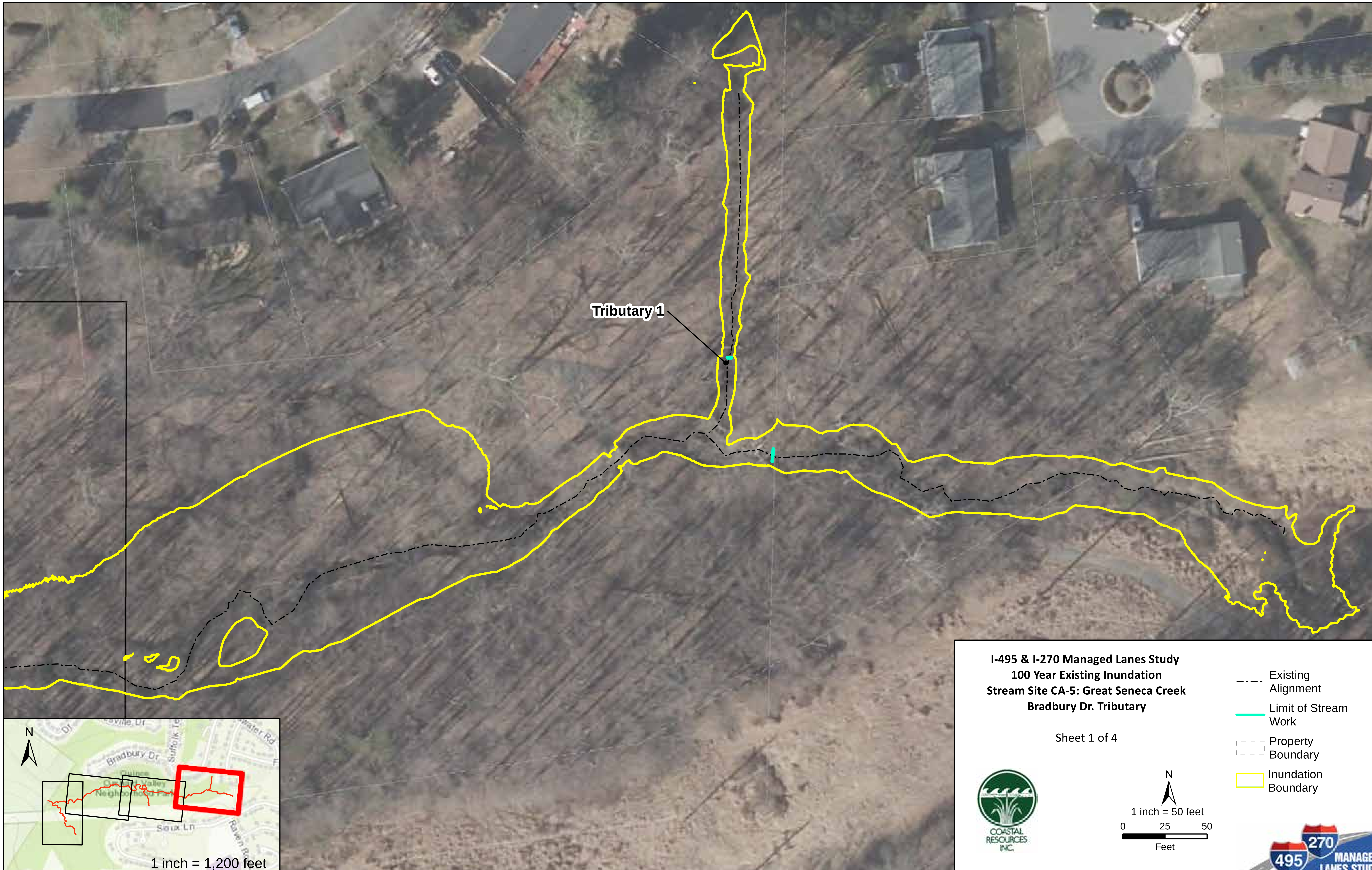

I-495 & I-270 Managed Lanes Study
100 Year Existing Inundation
Stream Site CA-5: Great Seneca Creek
Bradbury Dr. Tributary

Sheet 1 of 4

COASTAL RESOURCES INC.

N
1 inch = 50 feet
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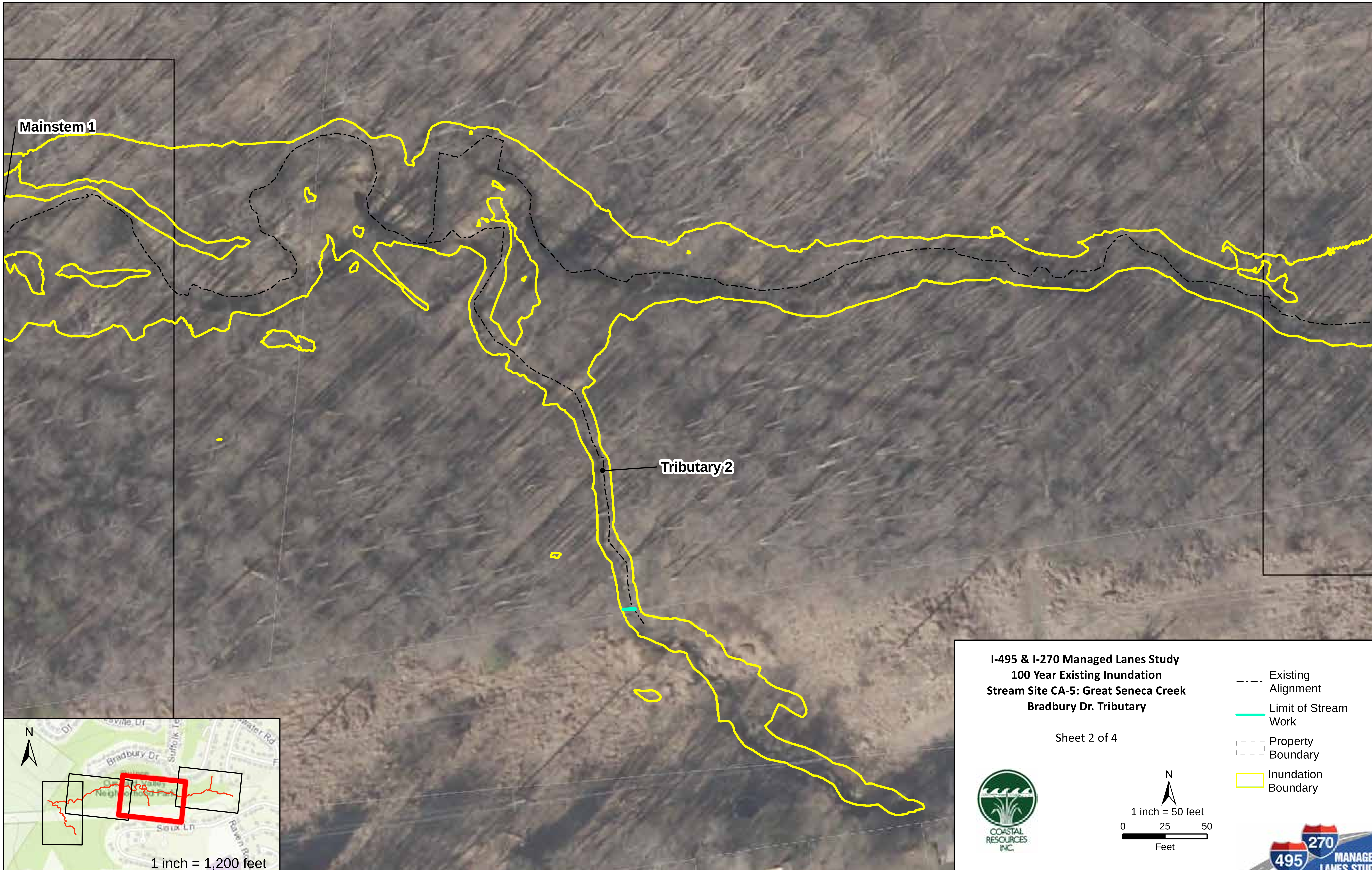
Existing Alignment
Limit of Stream Work
Property Boundary
Inundation Boundary

270 495 MANAGED LANES STUDY


Mainstem 1
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I-495 & I-270 Managed Lanes Study
100 Year Existing Inundation
Stream Site CA-5: Great Seneca Creek
Bradbury Dr. Tributary
Sheet 2 of 4
Existing Alignment
Limit of Stream Work
Property Boundary
Inundation Boundary
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1 inch = 50 feet
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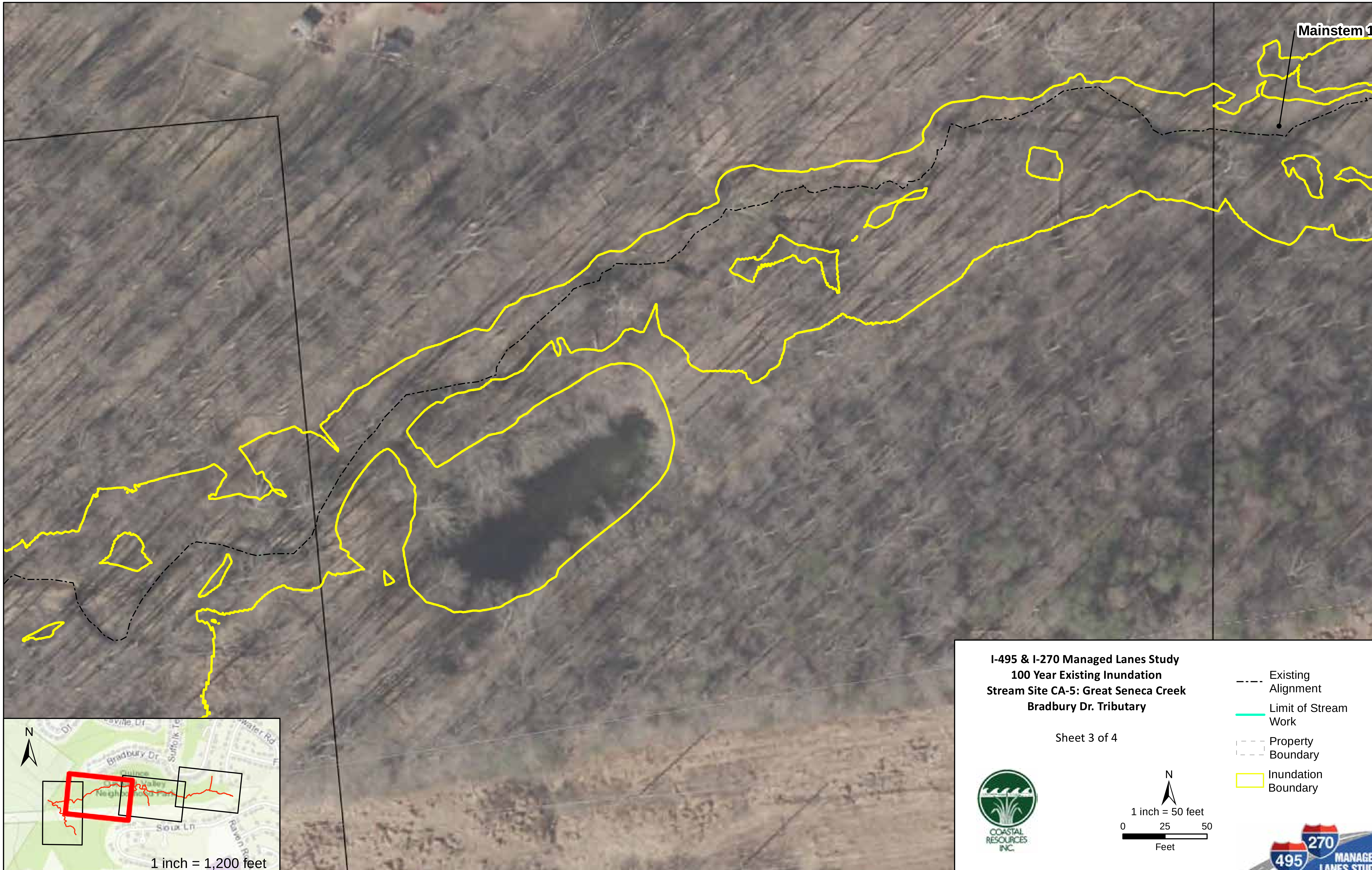
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I-495 & I-270 Managed Lanes Study
100 Year Existing Inundation
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Sheet 3 of 4
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Inundation Boundary
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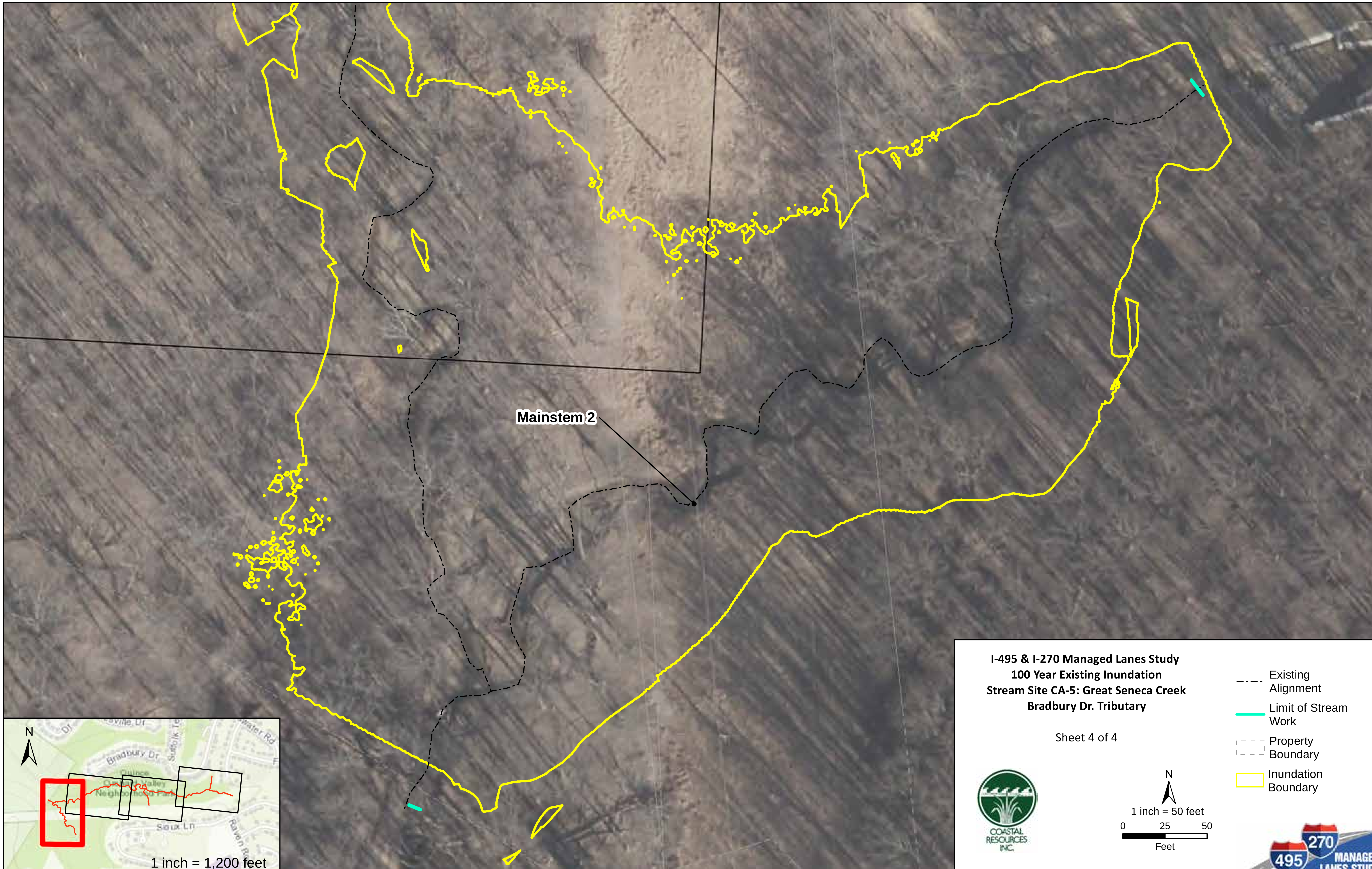
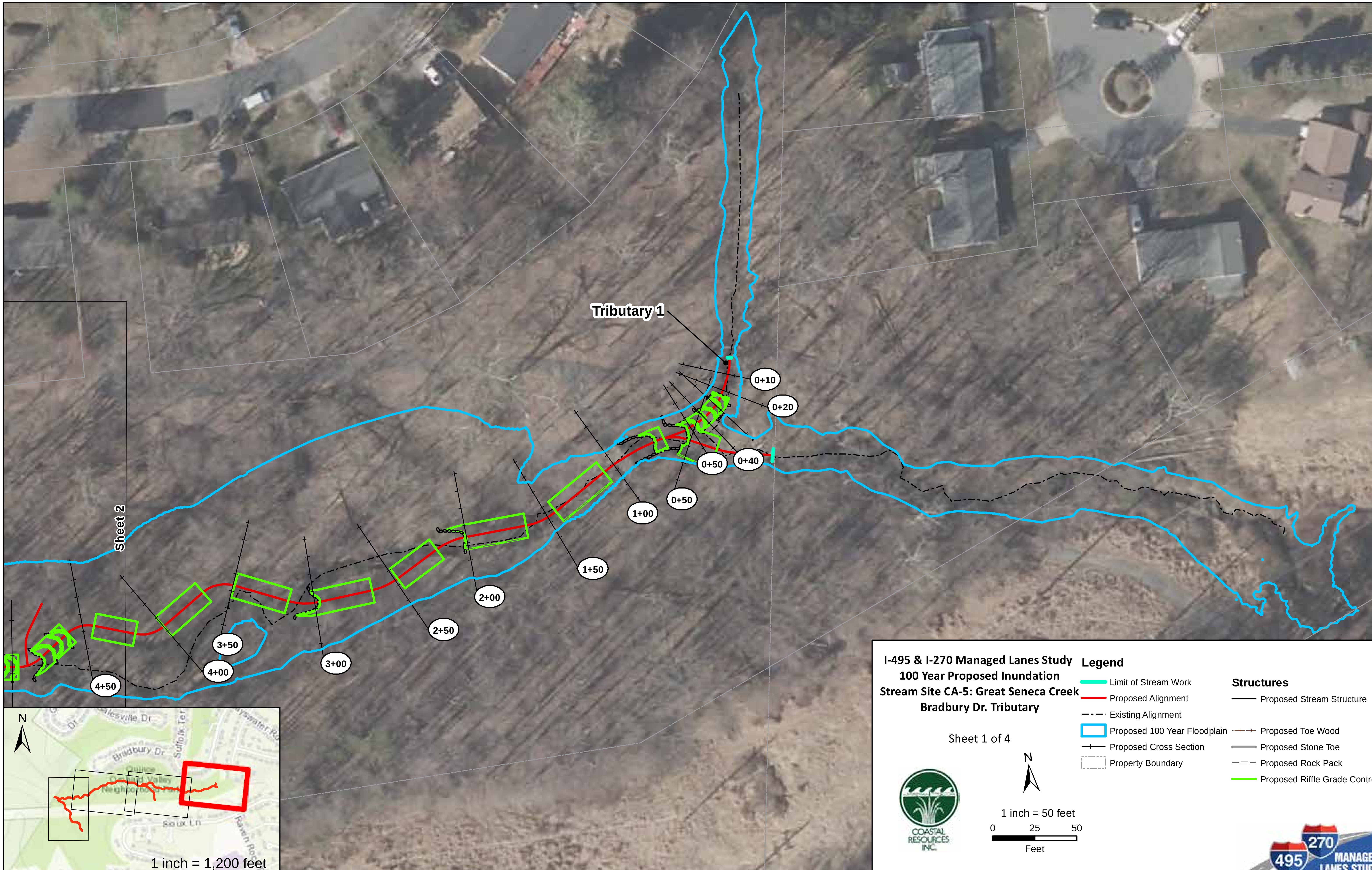


I-495 & I-270 Managed Lanes Study
100 Year Existing Inundation
Stream Site CA-5: Great Seneca Creek
Bradbury Dr. Tributary

Sheet 4 of 4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Feet
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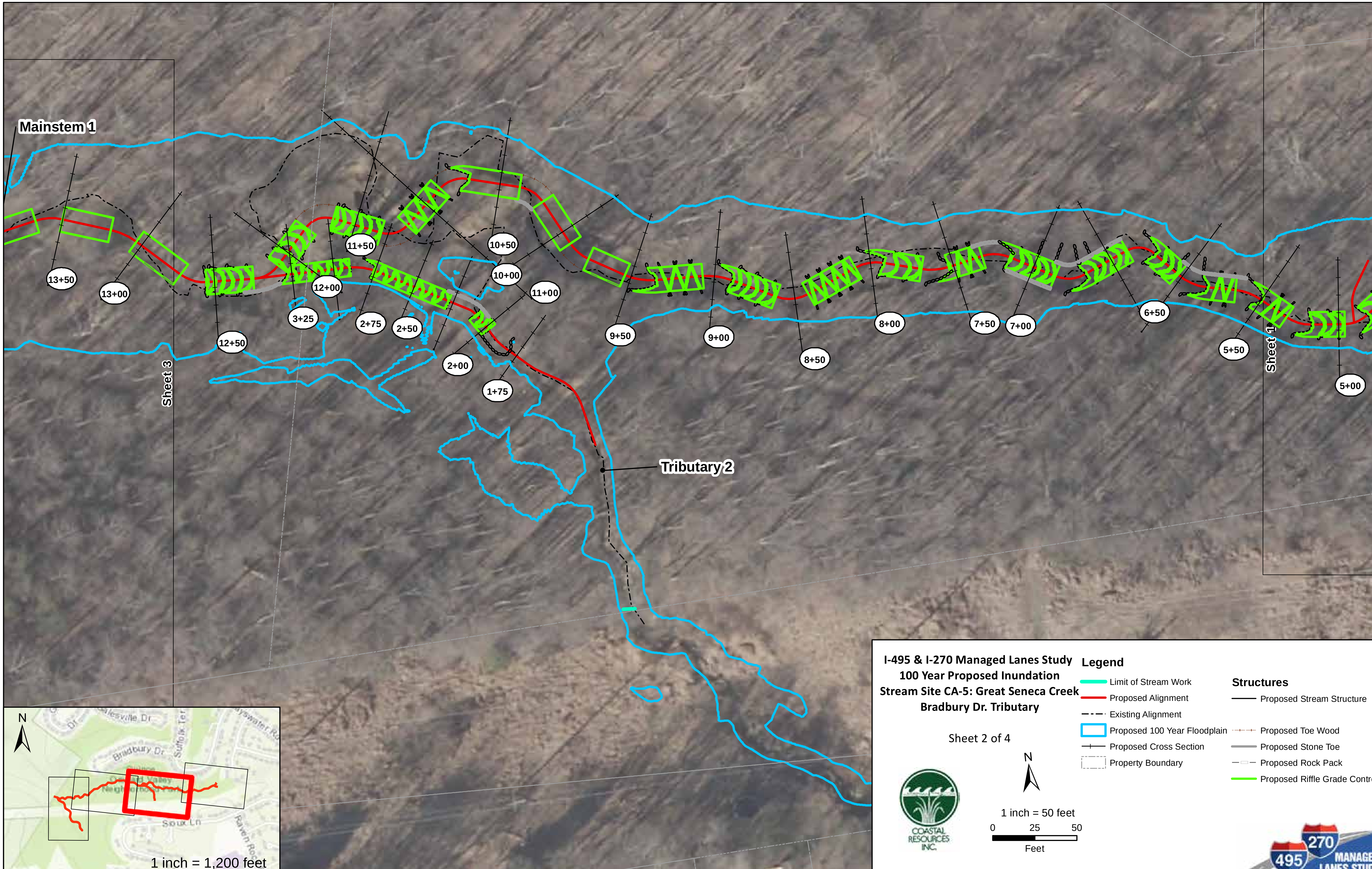

I-495 & I-270 Managed Lanes Study
100 Year Proposed Inundation
Stream Site CA-5: Great Seneca Creek
Bradbury Dr. Tributary

Sheet 2 of 4

Legend

- Limit of Stream Work
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- Existing Alignment
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- Proposed Riffle Grade Control

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1 inch = 50 feet

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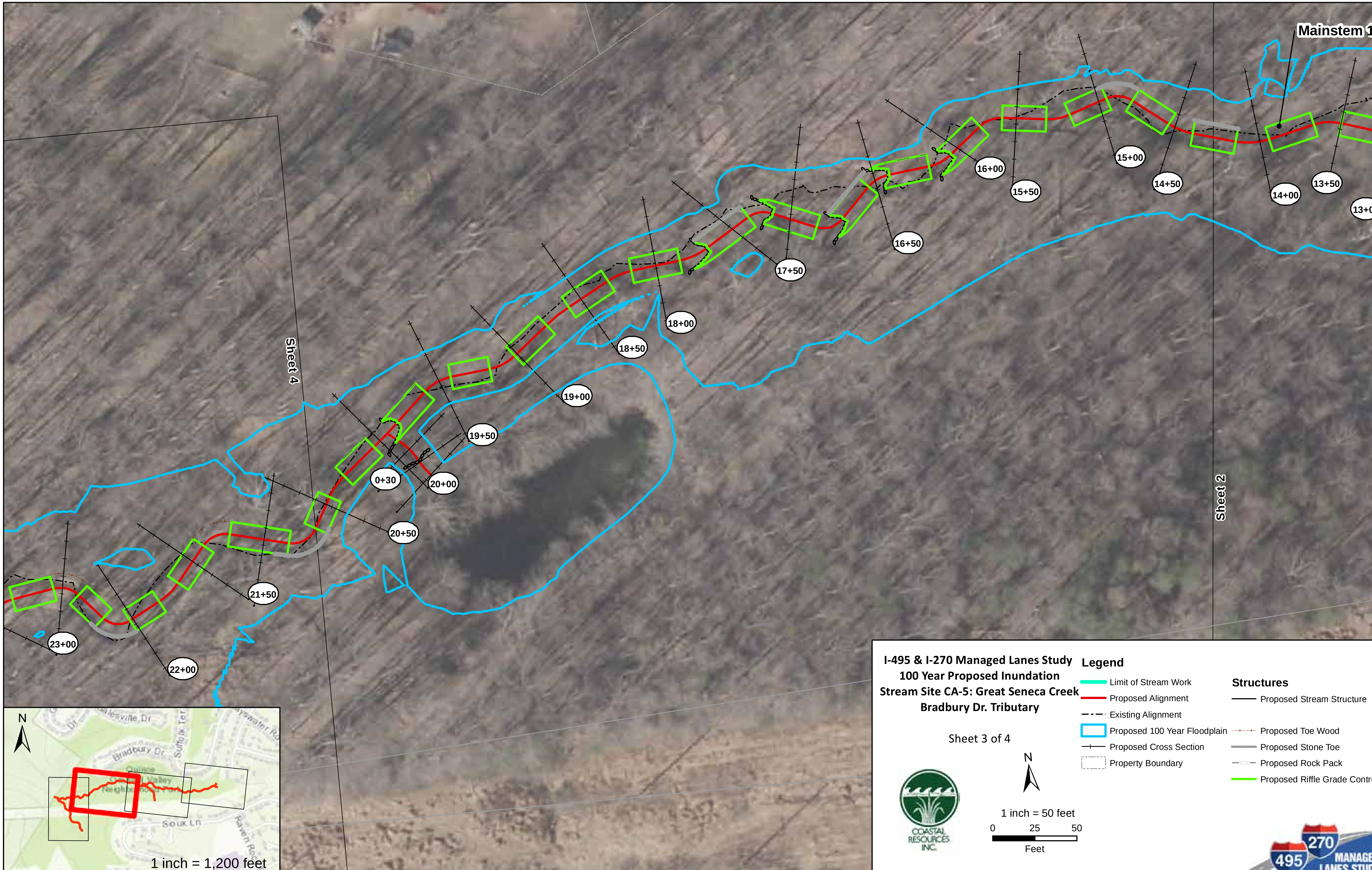
Feet

COASTAL RESOURCES INC.

495 270 MANAGED LANES STUDY



I-495 & I-270 Managed Lanes Study
100 Year Proposed Inundation
Stream Site CA-5: Great Seneca Creek
Bradbury Dr. Tributary

Sheet 3 of 4

Legend

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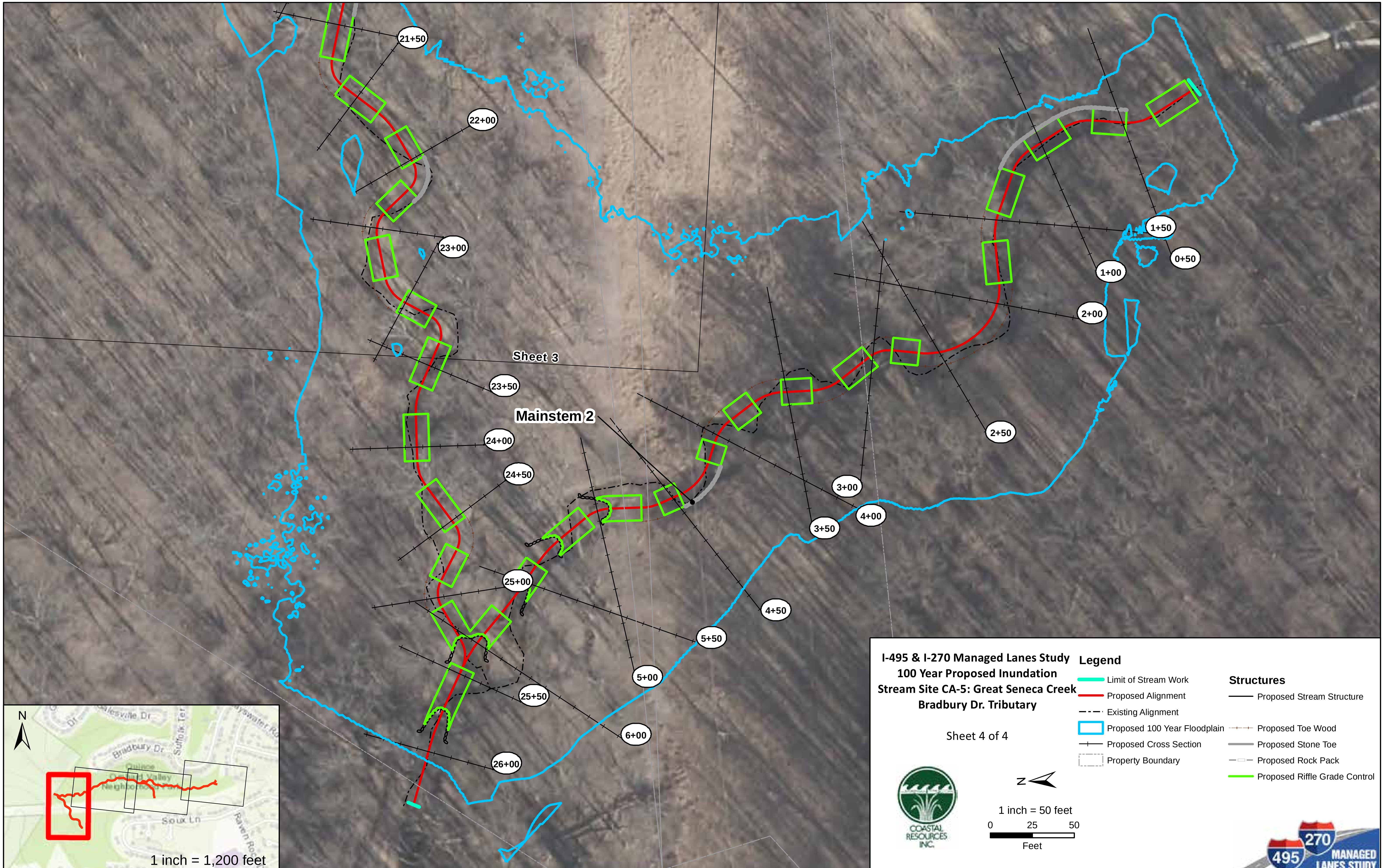
0 25 50

Feet

COASTAL RESOURCES INC.

495 270 MANAGED LANES STUDY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100 Year Proposed Inundation
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1 inch = 50 feet
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MANAGED LANES STUDY
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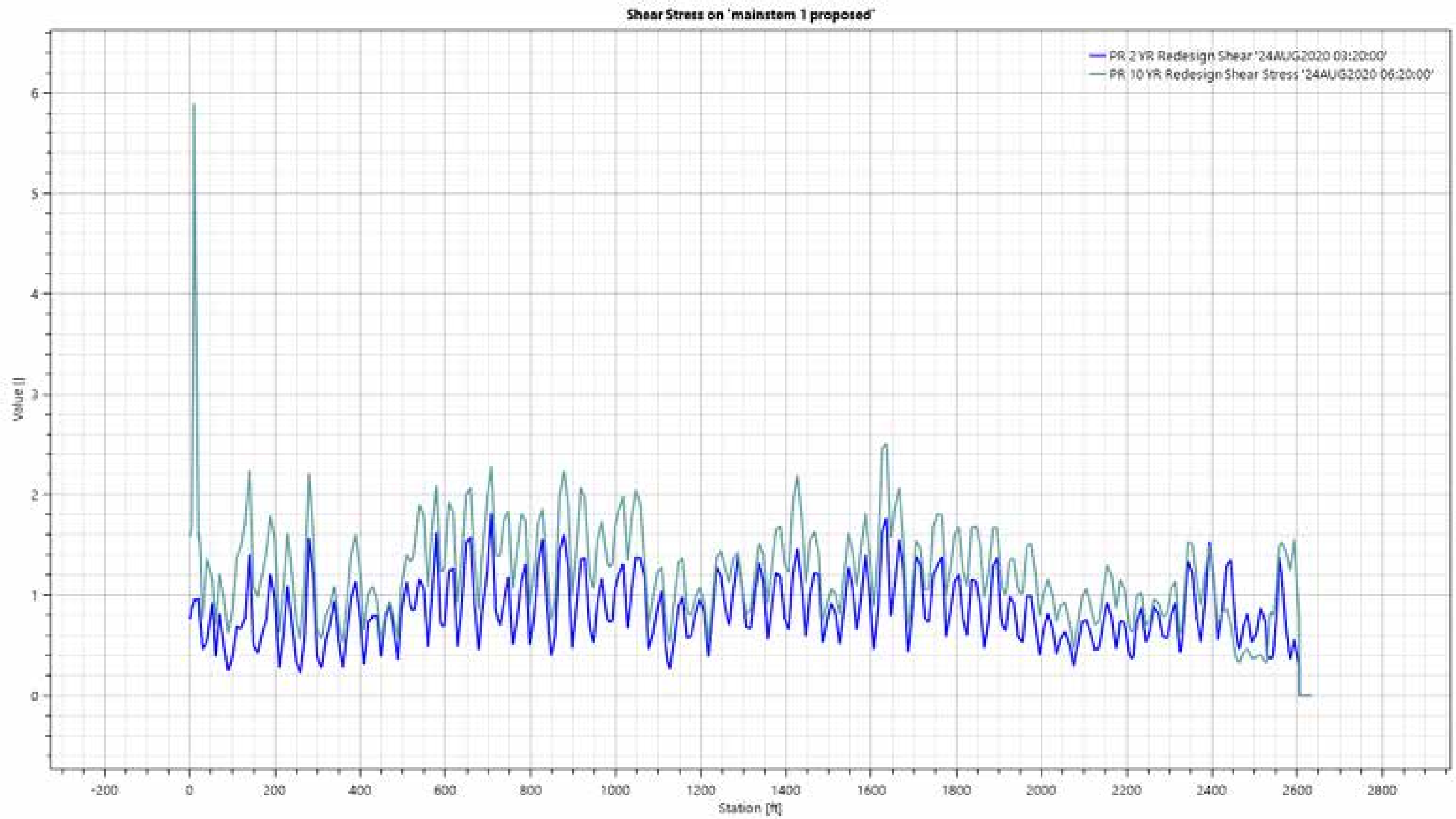
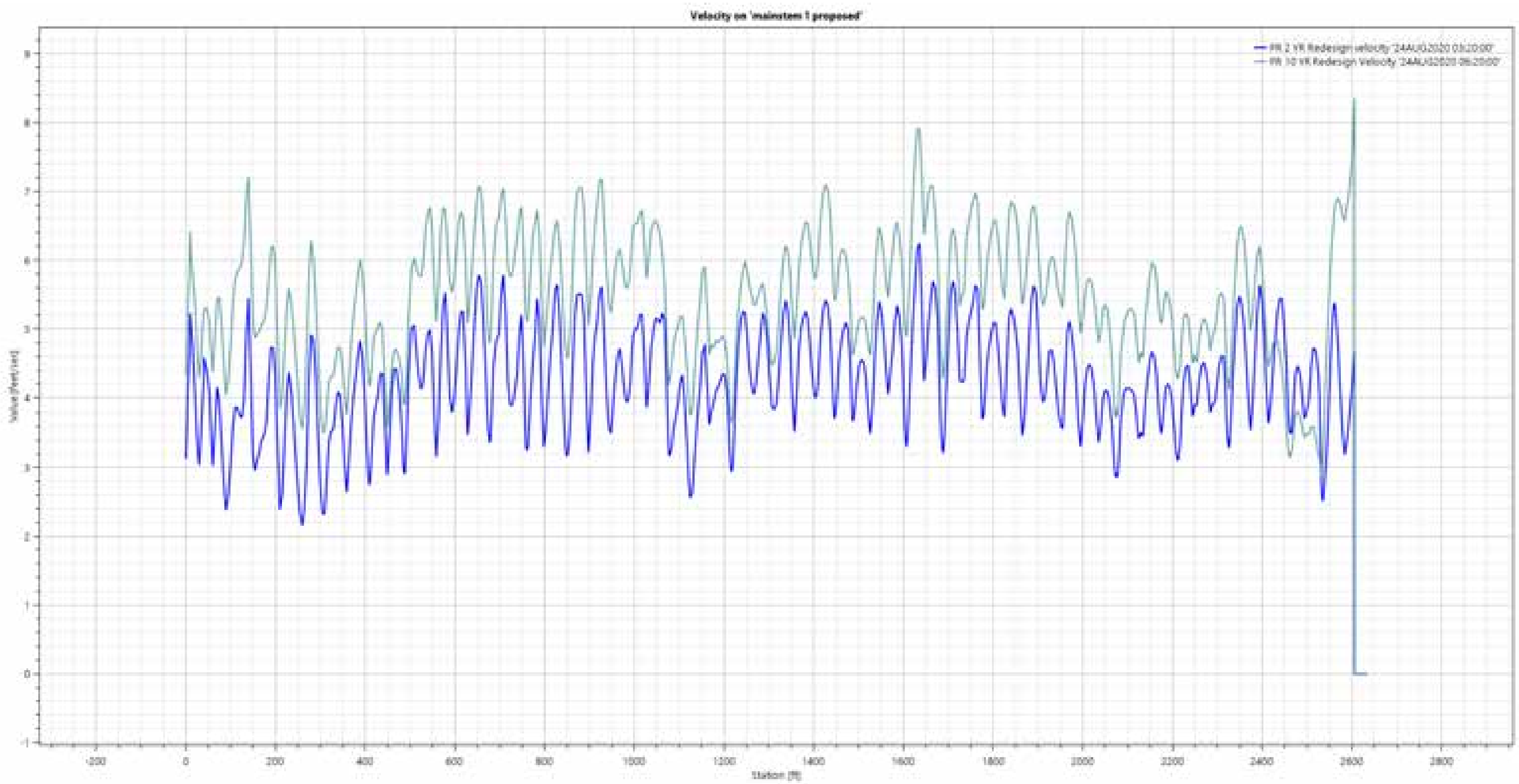
Bradbury Dr
Sioux Ln
1 inch = 1,200 feet

CA-5 HEC-RAS Graphs

CA-5 HEC-RAS Graphs



CA-5 HEC-RAS Graphs



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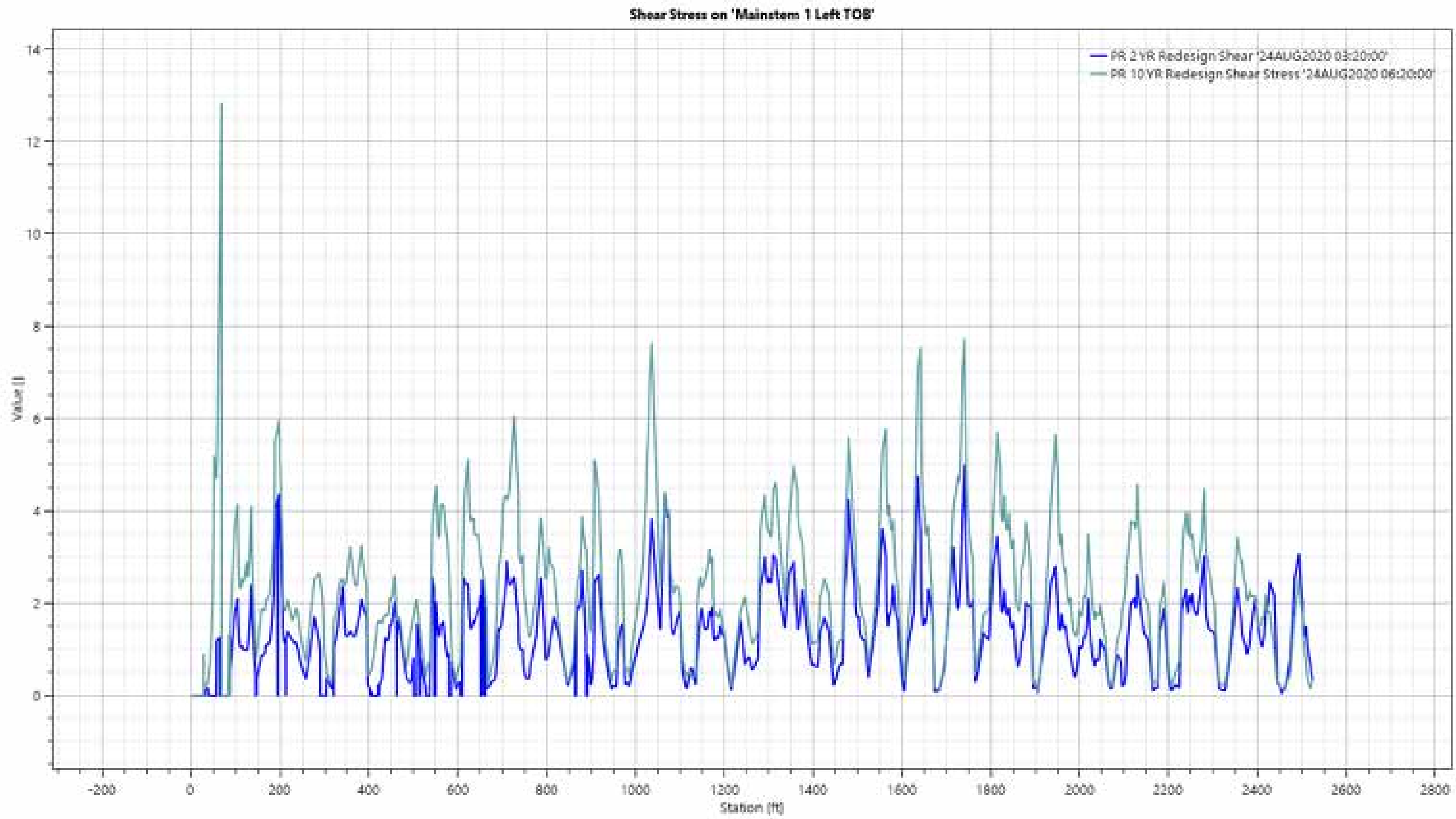

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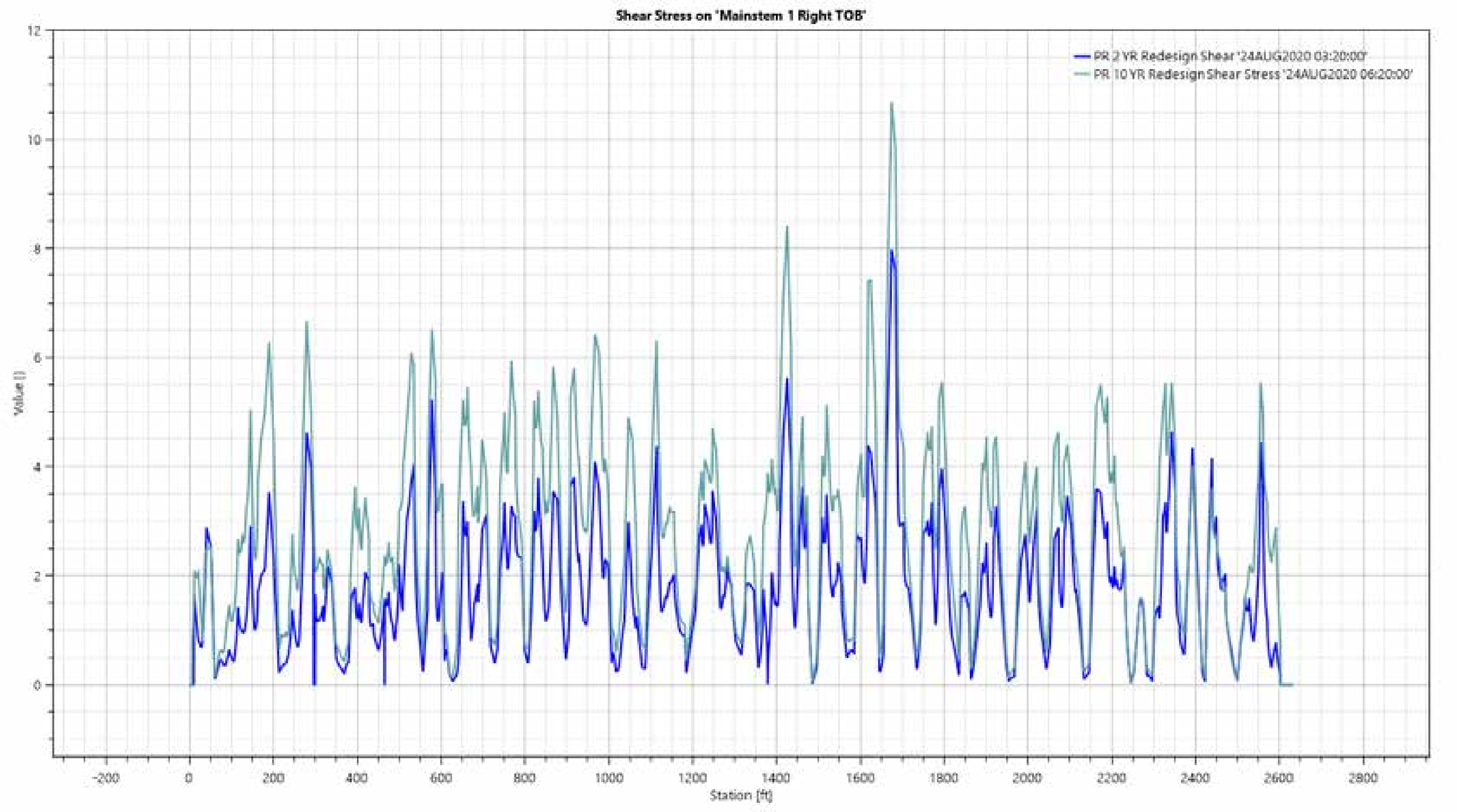

CA-5 HEC-RAS Graphs

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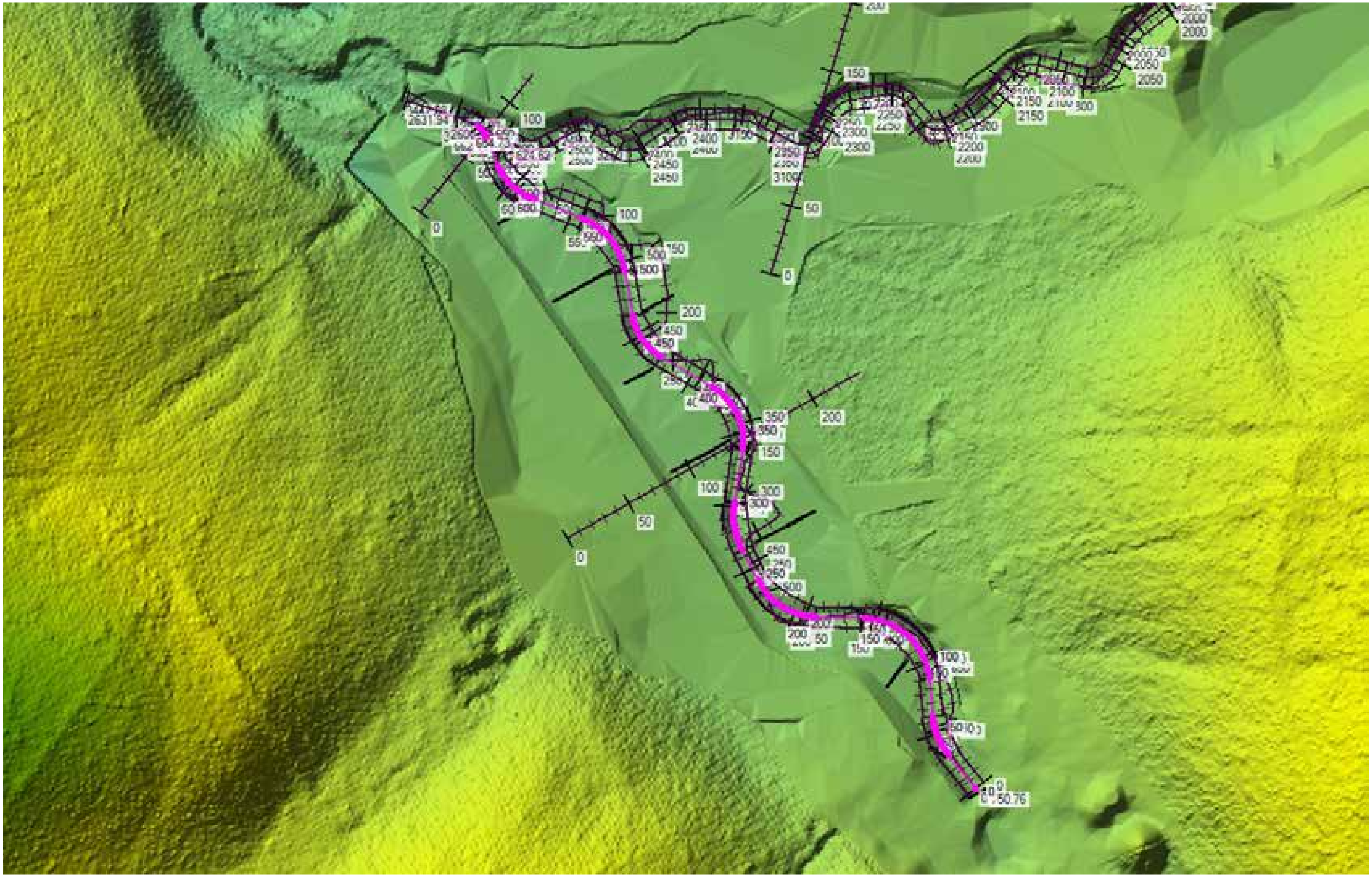

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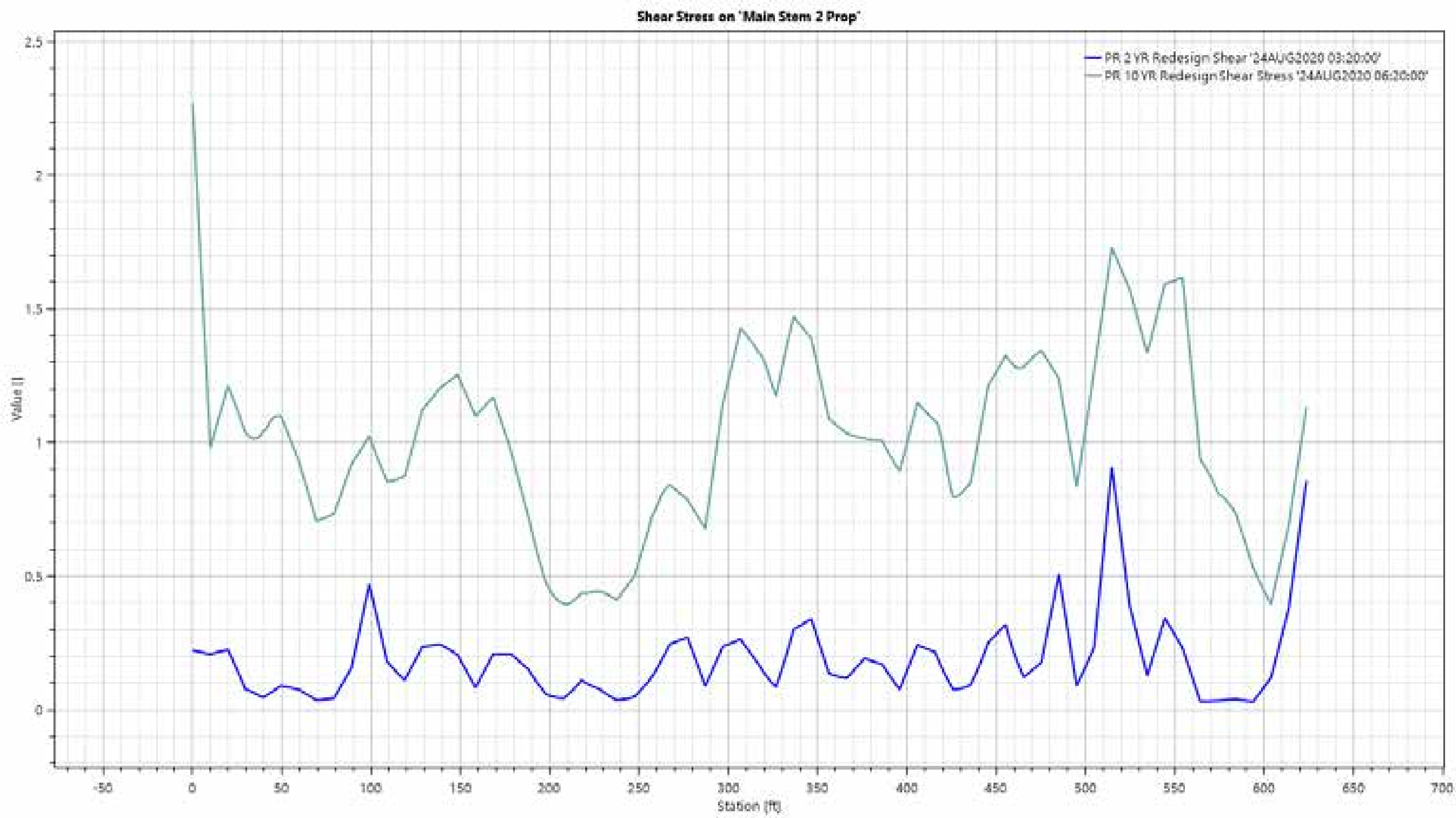
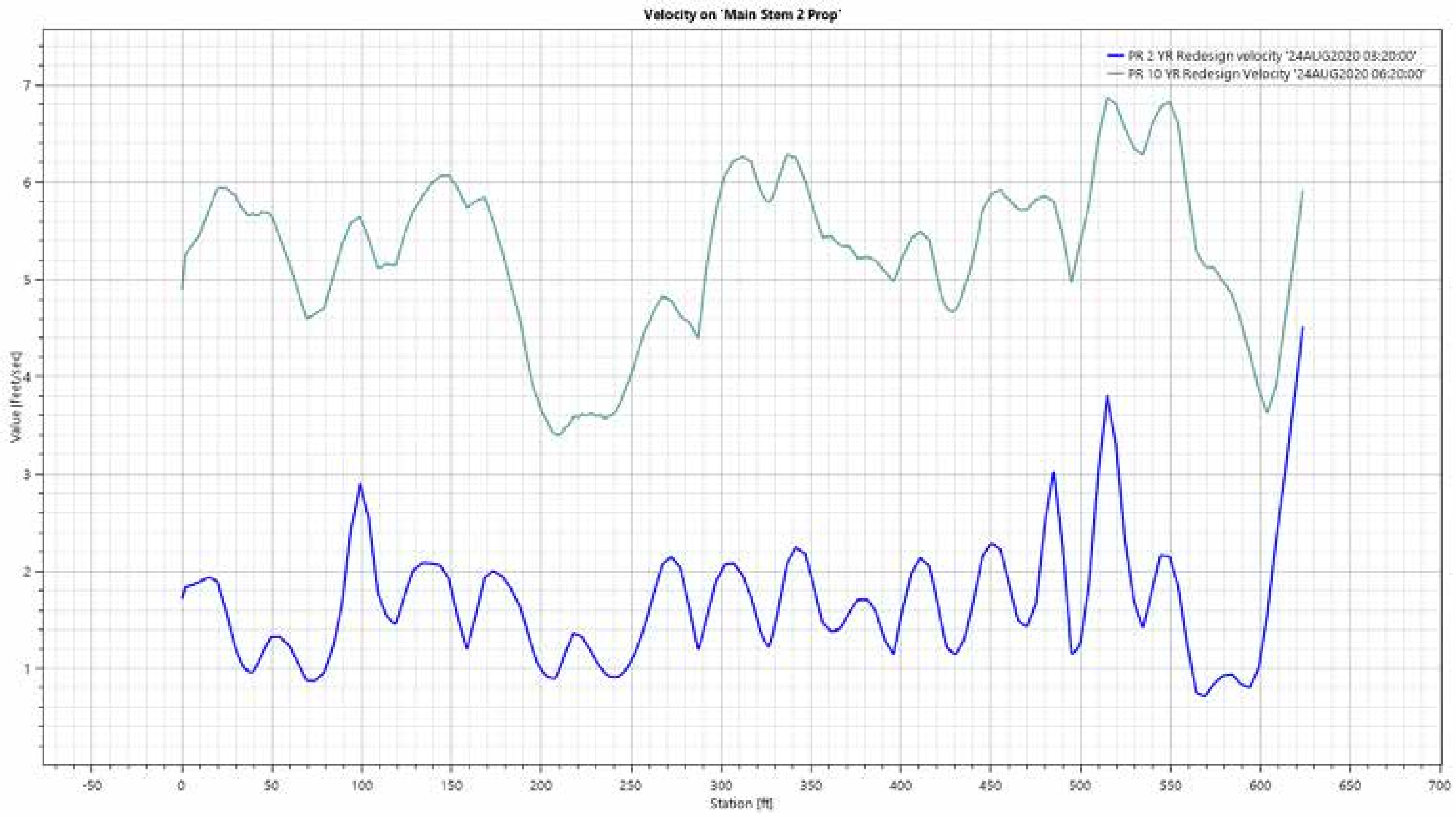


CA-5 HEC-RAS Graphs



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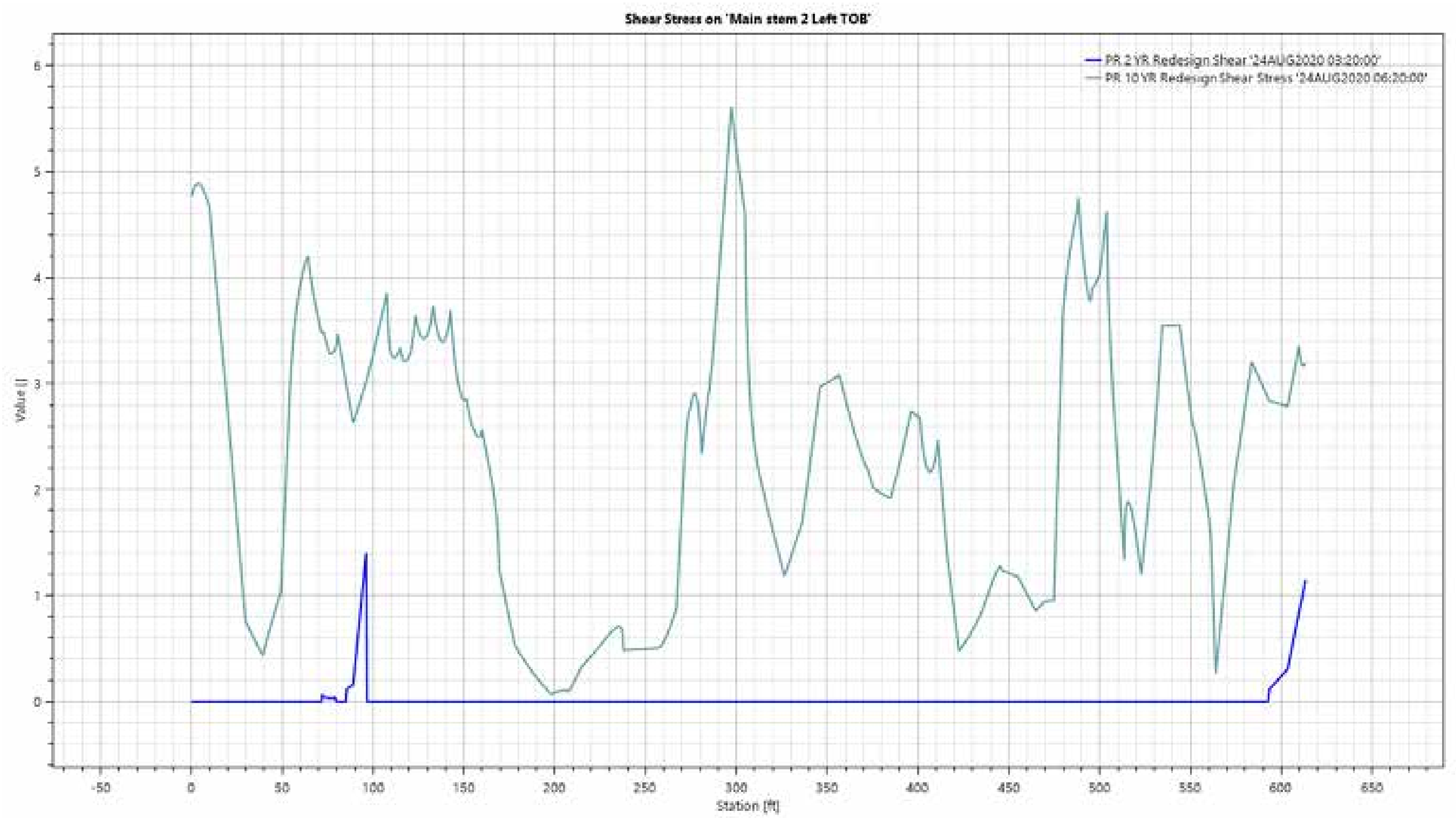

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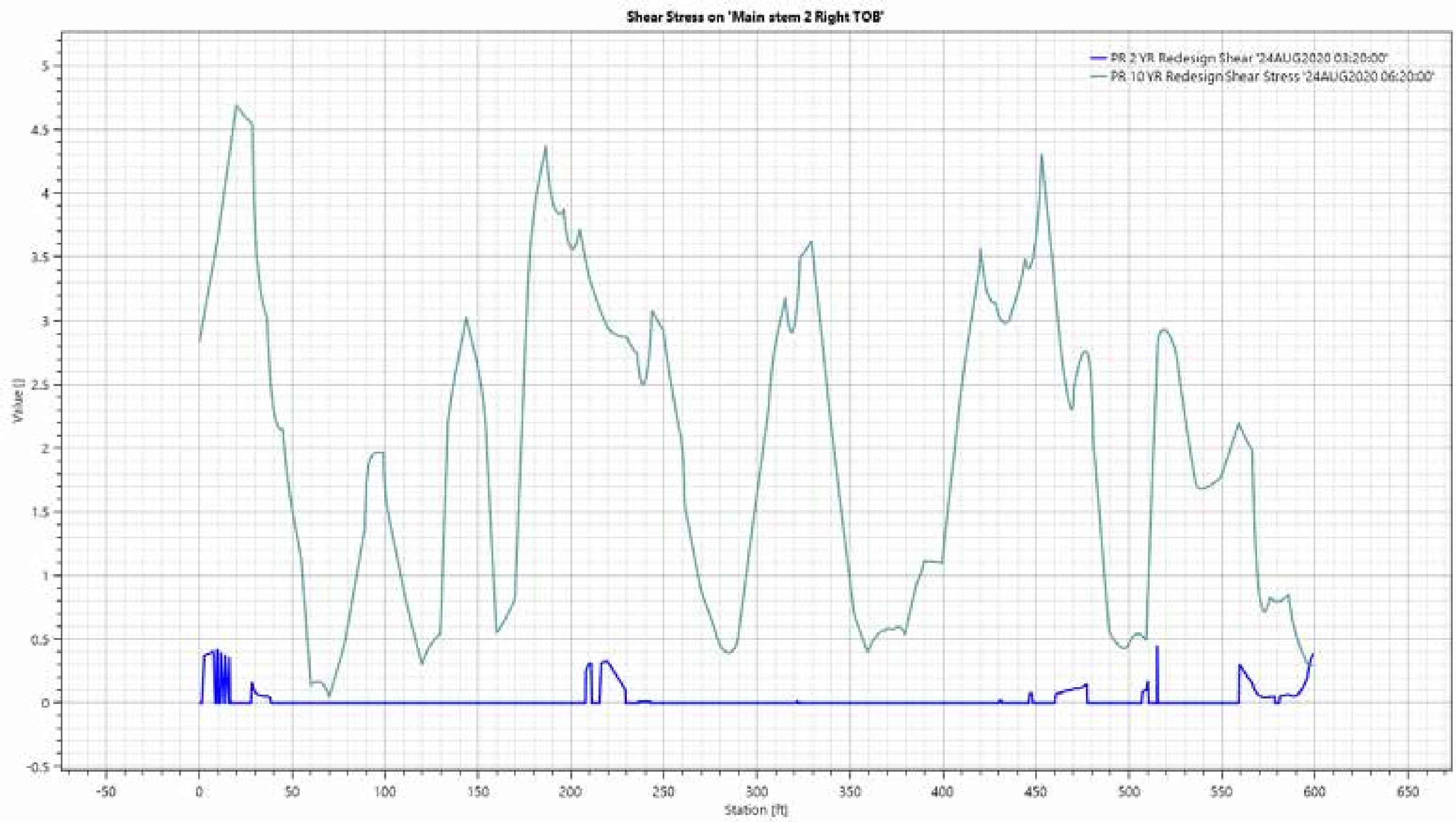

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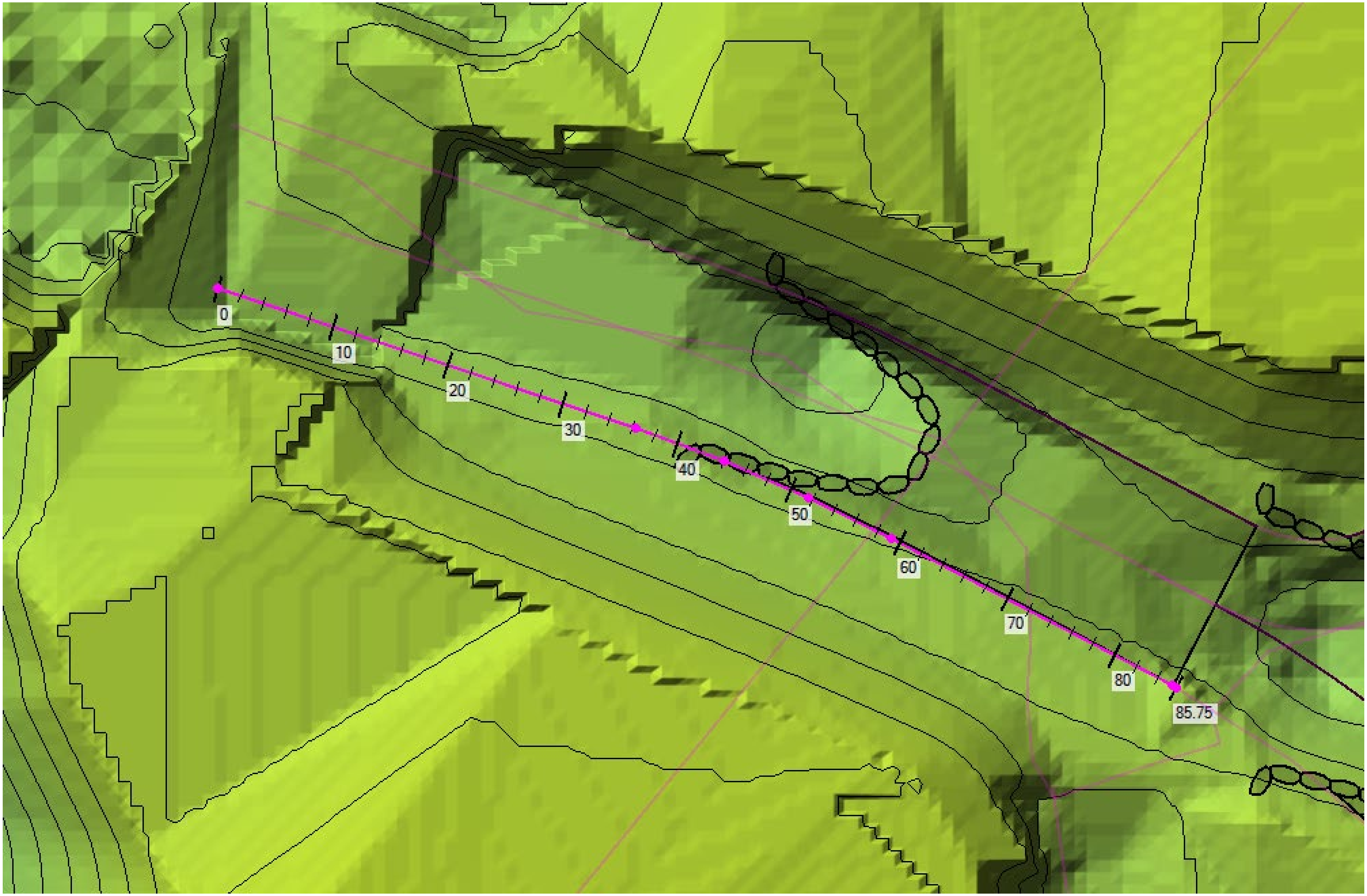

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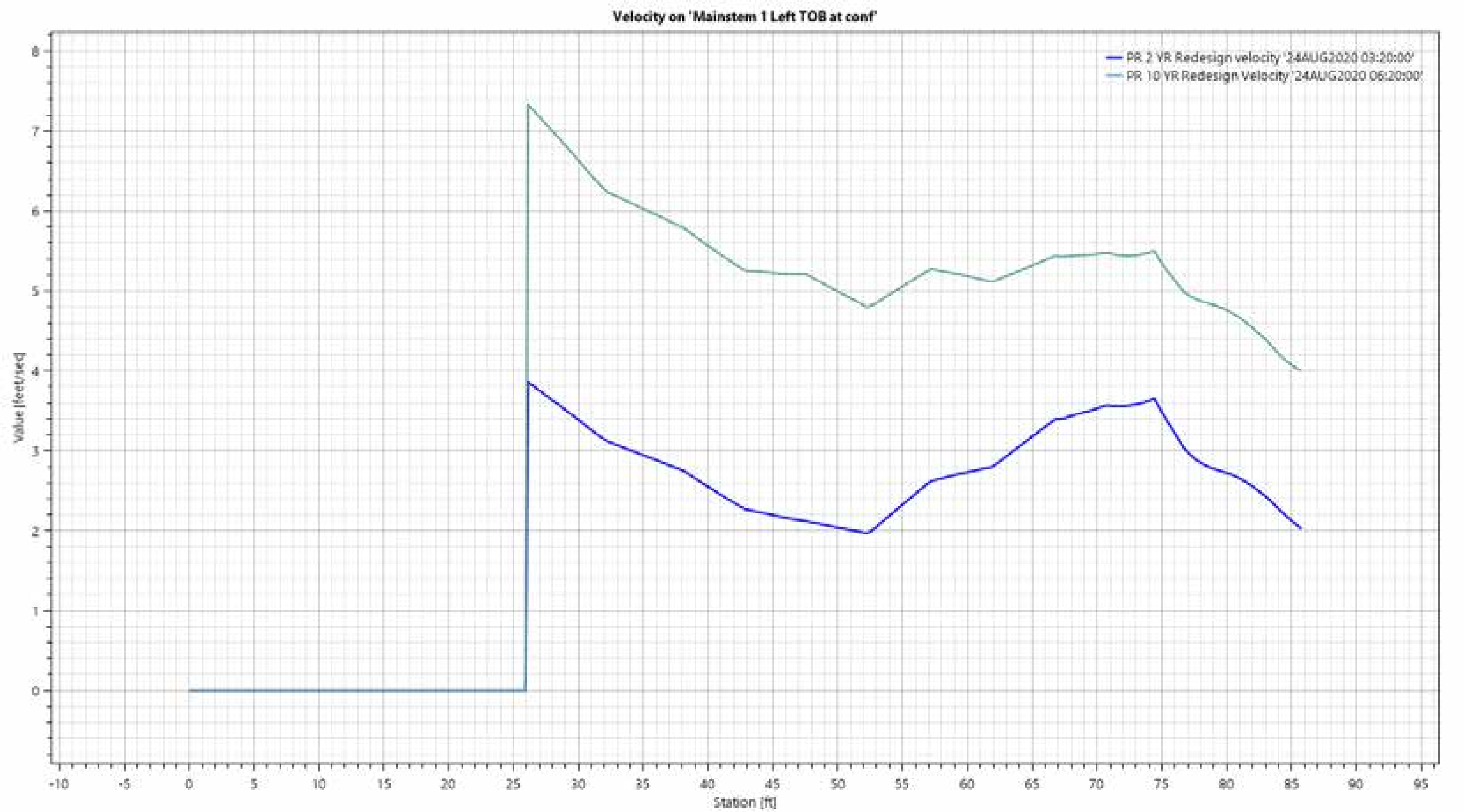


APPENDIX E. DESIGN DOCUMENTS

Summary	
Project Name:	495/270 MLS Mitigation
Prepared By:	Sarah Norton
Stream:	CA-5 Tributary to
Project No:	2017-29
Date:	3/5/2020
Reach:	Main Trib Reach 1
Drainage Area:	**0.24** sq.mi.
Valley Type:	U-AL-FD
Hydro. Region:	Piedmont

Physical Parameters	Existing Condition (EC)		***Proposed***		
W_{bkf}:	14.60	ft.	***W_{bkf}:***	***14.70***	ft.
d_{bkf}:	0.80	ft.	***d_{bkf}:***	***0.82***	ft.
$Area_{bkf}$:	11.68	sq.ft.	***$Area_{bkf}$:***	***12.00***	sq.ft.
d_{max}:	1.30	ft.	***d_{max}:***	***1.10***	ft.
slope	0.026	ft./ft.	***slope***	***0.0209***	ft./ft.
Wp	15.60	ft.	***Wp***	***15.02***	ft.
K	1.25		***K***	***1.06***	
Fpw	22	ft.	***Fpw***	***25***	ft.
Andrews d_{bkf} Stability	Degrading		Andrews d_{bkf} Stability	***Stable***	
Andrews S_{bkf} Stability	Degrading		Andrews S_{bkf} Stability	***Stable***	

Rosgen Classification			
W/D	18	***W/D***	***18***
E_R	2	***E_R***	***1.7***
Type	**B**	***Type***	***B***

Geometry

Williams Existing Condition Planform (ft.)	**min (ft.)**	**mean (ft.)**	**max (ft.)**
L_m	65	104	165
R_c	12	20	36
W_{blt}	40	62	97
Williams Proposed Planform (ft.)	***min***	***mean (ft.)***	***max (ft.)***
L_m	*80*	*132*	*218*
R_c	*17*	*26*	*41*
	44	*75*	*131*
Design Planform (measured from prop alignment)	***min***	***mean (ft.)***	***max (ft.)***
L_m	98.3	125.0	166.7
R_c	42.0	125.0	71.0
W_{blt}	36.0	49.7	68.4
Near-Bank Stress (Method 2)			
R_c/W_{BKF}	2.86	8.51	4.83
	Low	Very Low	Very Low

Hydrology

Regional Curve used for Design

Piedmont (Thomas)

		Existing Condition:		***Proposed:***		
Discharge:	56.3	**u/u***	**Mannings n**	***u/u****	***Mannings n***	
Velocity:	---	58.3	59.8	57.0	59.0	**cfs**
$Area_{bkf}$:	---	5.0	5.1	4.8	4.9	**fps**
Recurrence (yr):	**1.25**	**XS Area (sqft):** 11.7		**XS Area (sqft):**	12.0	**sq.ft.**

Existing Riffle	
$D_{50\ (mm)}$	16
$D_{84\ (mm)}$	55
$D_{max\ (mm)}$	256
Design Riffle	
$D_{50\ (mm)}$	**16**
$D_{84\ (mm)}$	**55**
$D_{max\ (mm)}$	**256**

Proposed Entrainment

Summary 495/270 MLS Mitigation | Reach: Main Trib Reach 1 | Date: 3/5/2020

Enter Field Data

16	D_{50} - Riffle bed material (mm)				
1	$D^{\wedge}_{50}$ - Bar Sample (mm)	Conversion to ft			
0.43	D_{max} - Largest particle from bar sample (ft)	130.00	mm	304.8	mm/ft
0.02089154	S - Proposed bankfull water surface slope				
0.82	d - Proposed bankfull mean depth (ft)				
1.65	γ_s - Submerged specific weight of sediment				
62.4	γ				

Select Appropriate Equation and Calculate Critical Dimensionless Shear Stress

---	$D_{50}/D^{\wedge}_{50}$ - Range 3 - 7 use Equation 1 (τ^*_{ci} = $0.0834(D_{50}/D^{\wedge}_{50})^{-0.872}$)				
---	τ^*_{ci} Not in range? Select equation 3				
If Equation 1 or 2, Use These τ^*_{ci}		**Equation**	**3, Dimensional t**	**Dimensional Shear**	1.04
---	D_{max}/D_{50} - Range 1.3 - 4.0 use Equation 2 (τ^*_{ci} = $0.0384(D_{max}/D_{50})^{-0.887}$)				
---	τ^*_{ci}				

Calculate Bankfull Mean Depth Required for Entrainment of Largest Particle in Bar Sample

0.80	d_r - Required bankfull mean depth (ft)
Stable	Proposed Condition

Calculate BKF Water Surface Slope Required for Entrainment of Largest Partical in Bar Sample

0.0204	S_r - Required bankfull water surface slope (ft)
Stable	Proposed Condition

Sediment Transport Validation

1.04	τ_c - Bankfull Shear Stress(lb/ft^2) ($\tau_c = \gamma RS$)	R* = 0.80 $S_{Proposed}$ = 0.0209
Shields	Colorado	
81	157	Movable particle size (mm) at bankfull shear stress (Figure 3-11, River Stability Field Guide p 3-102)
1.63	0.81	Predicted shear stress required to intiate movement of D_i (mm) (Figure 3-11, River Stability Field Guide p 3-102)
1.25	0.62	Predicted mean depth required to initiate movement of measured Dmax (mm)
0.0321	0.0159	Predicted mean slope required to initiate movement of measured Dmax (mm)

Required inputs are in yellow

Design Condition

A_{BKF} =	12.0	ft^2
W_{BKF} =	14.70	ft
D84 (riffle) =	55	mm
d_{mBKF}	0.82	ft
WP	15.0	ft
$D84_{ft}$	**0.18**	ft
R	**0.80**	
R/D84	**4.43**	

1, $D_{50}/D^{\wedge}_{50}$
2, D_{max}/D_{50}
3, Dimensional τ

d_r - Required bankfull mean depth (ft)

S_r - Required bankfull water surface slope (ft) ($S_r = (\tau^*_{ci}\gamma_s D_i)/d$)

Using Equation 1 ($D_{50}/D^{\wedge}_{50}$) or Equation 2 (D_{max}/D_{50}):

$$d = \frac{\tau^* \gamma_s D_{max}}{S}$$

$$S = \frac{\tau^* \gamma_s D_{max}}{d}$$

Using Equation 3 (Dimensional Shear Stress):

$$d = \frac{\tau}{\gamma S}$$

$$S = \frac{\tau}{\gamma d}$$

Summary	
Project Name:	495/270 MLS Mitigation
Prepared By:	Jon Stewart
Stream:	Mainstem 2
Project No:	2017-29
Date:	11/1/2021
Reach:	Mainstem 2
Drainage Area:	**0.43** sq.mi.
Valley Type:	U-AL-FD
Hydro. Region:	Piedmont

Physical Parameters	Existing Condition (EC)		*Proposed*	
W_{bkf}:	11.30	ft.	***14.97***	ft.
d_{bkf}:	1.10	ft.	***0.94***	ft.
$Area_{bkf}$:	12.43	sq.ft.	***14.01***	sq.ft.
d_{max}:	1.60	ft.	***1.00***	ft.
slope	0.097	ft./ft.	***0.0120***	ft./ft.
Wp	13.50	ft.	***15.43***	ft.
K	1.24		***1.02***	
Fpw	22.3	ft.	***80***	ft.
Andrews d_{bkf} Stability	Degrading		***Stable***	
Andrews S_{bkf} Stability	Degrading		***Stable***	

Rosgen Classification	Existing	*Proposed*
W/D	10	***16***
E_R	2	***5.3***
Type	FALSE	***C***

Geometry

Williams Existing Condition Planform (ft.)	min (ft.)	mean (ft.)	max (ft.)
L_m	68	108	172
R_c	12	21	37
W_{blt}	41	65	101

Williams Proposed Planform (ft.)	*min*	*mean (ft.)*	*max (ft.)*
L_m	*74*	*117*	*186*
R_c	*13*	*23*	*40*
	45	*70*	*109*

Design Planform (measured from prop alignment)	*min*	*mean (ft.)*	*max (ft.)*
L_m	98.3	125.0	166.7
R_c	42.0	125.0	71.0
W_{blt}	36.0	49.7	68.4

Near-Bank Stress (Method 2)			
R_c/W_{BKF}	2.81	8.35	4.74
	Low	Very Low	Very Low

Hydrology

Regional Curve used for Design
Piedmont (Thomas)

		Existing Condition:		*Proposed:*		
		u/u*	**Mannings n**	***u/u****	***Mannings n***	
Discharge:	85.8					
Velocity:	---	143.6	151.7	32.2	35.3	**cfs**
$Area_{bkf}$:	---	11.6	12.2	2.3	2.5	**fps**
Recurrence (yr):	**1.25**	**XS Area (sqft):**	12.4	**XS Area (sqft):**	14.0	**sq.ft.**

Existing Riffle	
D_{50} (mm)	16
D_{84} (mm)	55
D_{max} (mm)	256

Design Riffle	
D_{50} (mm)	**100**
D_{84} (mm)	**180**
D_{max} (mm)	**256**

Trib 1 RIFFLE X-Section

Width/Depth	28.0	
*Max Depth Ratio	1.1	
Width	10.2	
Depth	0.37	
Bankfull Area	3.731	
Riffle Side Slope	2.5	:1
% Low Flow Channel	0%	
Low Flow Side Slopes	3	:1
Max depth	0.40	
$D_{trymain}$	0.4	
Total Area	**3.7**	**sqft**

Trib 1 POOL X-Section

**Depth Ratio	3.3	
Pool Max Depth	1.2	
Point Bar Slopes	5.0	:1
***Width Ratio	1.1	
Width of Pool	11.2	
Point Bar Ratio	0.65	
OPTIONAL POOL ADJUSTMENT		
Area of Pool	8.4	
3rd Slope Pool	0	ft
4thSlope Pool	0	ft
5th Meander Bank pt	0	ft
	2.24	

Press to Calculate Area

Verify Calculations

OKAY - The calculation of flow channel depth is okay.

OKAY - The calculation involving Lower Bankful Area, Steepen Riffle..., and depth ration is verified.

*equals Dmax/Dbkf

**equals Dpool/Dbkf

*** equals Wpool/Wbkf

Floodplain Adjustment
8

Calc Q	22.0
Slope	0.111
Mannings' n	0.043
Des Q	22

Size Channel to Des Q

Trib 2 RIFFLE X-Section		
Width/Depth	22.0	
*Max Depth Ratio	1.1	
Width	10.3	
Depth	0.47	
Bankfull Area	4.8	
Riffle Side Slope	2.5	:1
% Low Flow Channel	0%	
Low Flow Side Slopes	3	:1
Max depth	0.51	
$D_{trymain}$	0.5	
Total Area	4.8	sqft

Trib 2 POOL X-Section		
**Depth Ratio	3.3	
Pool Max Depth	1.5	
Point Bar Slopes	4.0	:1
***Width Ratio	1.1	
Width of Pool	11.3	
Point Bar Ratio	1	
OPTIONAL POOL ADJUSTMENT		
Area of Pool	11.5	
3rd Slope Pool	0	ft
4thSlope Pool	0	ft
5th Meander Bank pt	0	ft
	2.40	

Press to Calculate Area

Verify Calculations

OKAY - The calculation of flow channel depth is okay.

OKAY - The calculation involving Lower Bankful Area, Steepen Riffle..., and depth ration is verified.

*equals Dmax/Dbkf

**equals Dpool/Dbkf

*** equals Wpool/Wbkf

Calc Q	32.0
Slope	0.05
Mannings' n	0.04
Des Q	32

Size Channel to Des Q

Floodplain Adjustment
8

RIFFLE X-Section

Width/Depth	**25.0**	
***Max Depth Ratio**	**1**	
Width	8.5	
Depth	0.34	
Bankfull Area	**2.8658**	
Riffle Side Slope	**3**	:1
% Low Flow Channel	**0%**	
Low Flow Side Slopes	**3**	:1
Max depth	0.34	
$D_{trymain}$	**0.4**	
Total Area	**3.0**	**sqft**

POOL X-Section

****Depth Ratio**	**2.44**	
Pool Max Depth	0.8	
Point Bar Slopes	**1.5**	:1
*****Width Ratio**	**1.0**	
Width of Pool	8.5	
Point Bar Ratio	**0**	
OPTIONAL POOL ADJUSTMENT		
Area of Pool	5.2	
3rd Slope Pool	**0**	ft
4thSlope Pool	**0**	ft
5th Meander Bank pt	**0**	ft
	1.82	

Press to Calculate Area

Verify Calculations

OKAY - The calculation of flow channel depth is okay.

OKAY - The calculation involving Lower Bankful Area, Steepen Riffle..., and depth ration is verified.

Floodplain Adjustment
8

*equals Dmax/Dbkf

**equals Dpool/Dbkf

*** equals Wpool/Wbkf

Calc Q	11.0
Slope	**0.045**
Mannings' n	**0.04**
Des Q	11

Size Channel to Des Q

Calculate stone sizing for a stream based on the Modified Andrews equation. This equation assumes the stream is a threshold design. If the stream is not of threshold design then use the original Andrews equation 1983.

Modified Andrews Equation (1)	
$\tau_{ci}^* = 0.0375(d_i/d_{s50})^{-0.872}$	(1)

Shear Stress Equation (2)	
$\tau_{ci} = \tau_{ci}^*(\rho_s - \rho_w)gd_i$	(2)

The following values are assumed or known:

Median Sediment Size	d50	m
Sediment Size Being Assesed(d_i)*	d30	m
Gravitational Acceleration(g)	9.81	m/s^2
Bulk Density of Water(ρ_s)	1000	kg/m^3
Bulk Density of Material(ρ_w)	2600	kg/m^3
* d30 = 0.3 x d50		

Substituting known values into equation(1) and (2) and solving for the dimensionless critical shear stress and critical shear stress, respectively:

$\zeta_{ci*} = 0.0375(0.3d_{50}/d_{s50})^{-0.872}$

$\zeta_{ci} = 15700\zeta_{ci*}\ d30$

Reduce and solve equation (1):

$\zeta ci* = 0.107$

Solve for d_{30} in equation (2):

$\zeta ci = 15{,}700*0.107*d_{30}$

$d_{30} = 0.000594\zeta ci$

Use ζci at

	Design Shear Stress		Max shear stres based on safety factor of 2	2
	1.82	lbs/sf	3.64	lb/sf

Increase the shear by 1.2 to account for variation in the channel and convert to Pa

ζci =	2.184	lbs/sf	ζci =	4.368
ζci =	104.461	Pa	ζci =	208.92

Therefore:

d30min =	0.0620 m =	2.38 in	d30max =	0.1241 m =	4.77 in
d50min =	0.2068 m =	7.94 in	d50max =	0.4137 m =	15.88 in

Create your stone distribution as you see fit.

min distribution based on 1.82 lb/sf

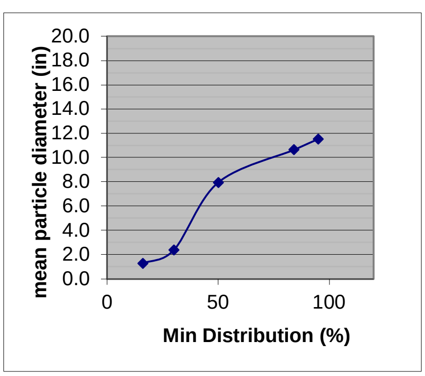
%	size (in)
16	1.2708
30	2.3827
50	7.9424
84	10.6428
95	11.5164

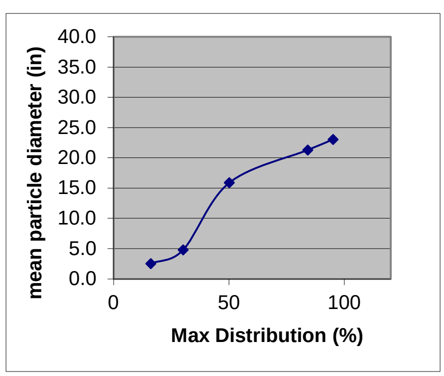
max distribution based on 3.64 lb/sf

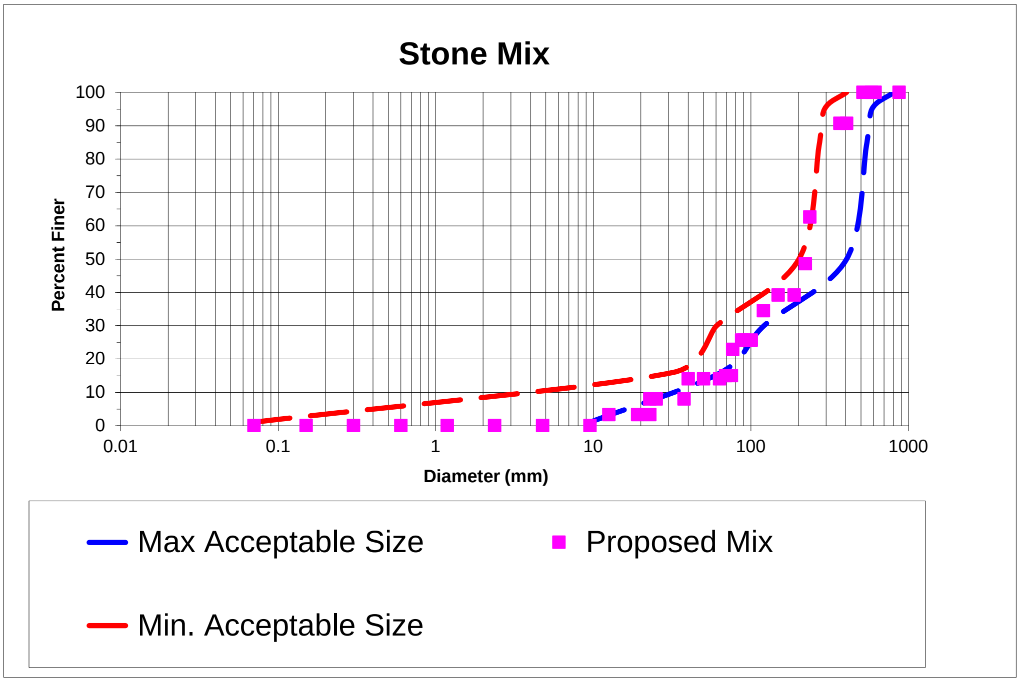
%	size (in)
16	2.5416
30	4.7654
50	15.8847
84	21.2855
95	23.0328

(yellow)	known value from above calcs
(white)	assumed value based on d50
23.82707	depth = 1.5x d50

If<D100, us







Proposed Mix

Amount of Stone(%)	Stone Type
20%	Natural Channel
20%	Class 0
60%	Class 1